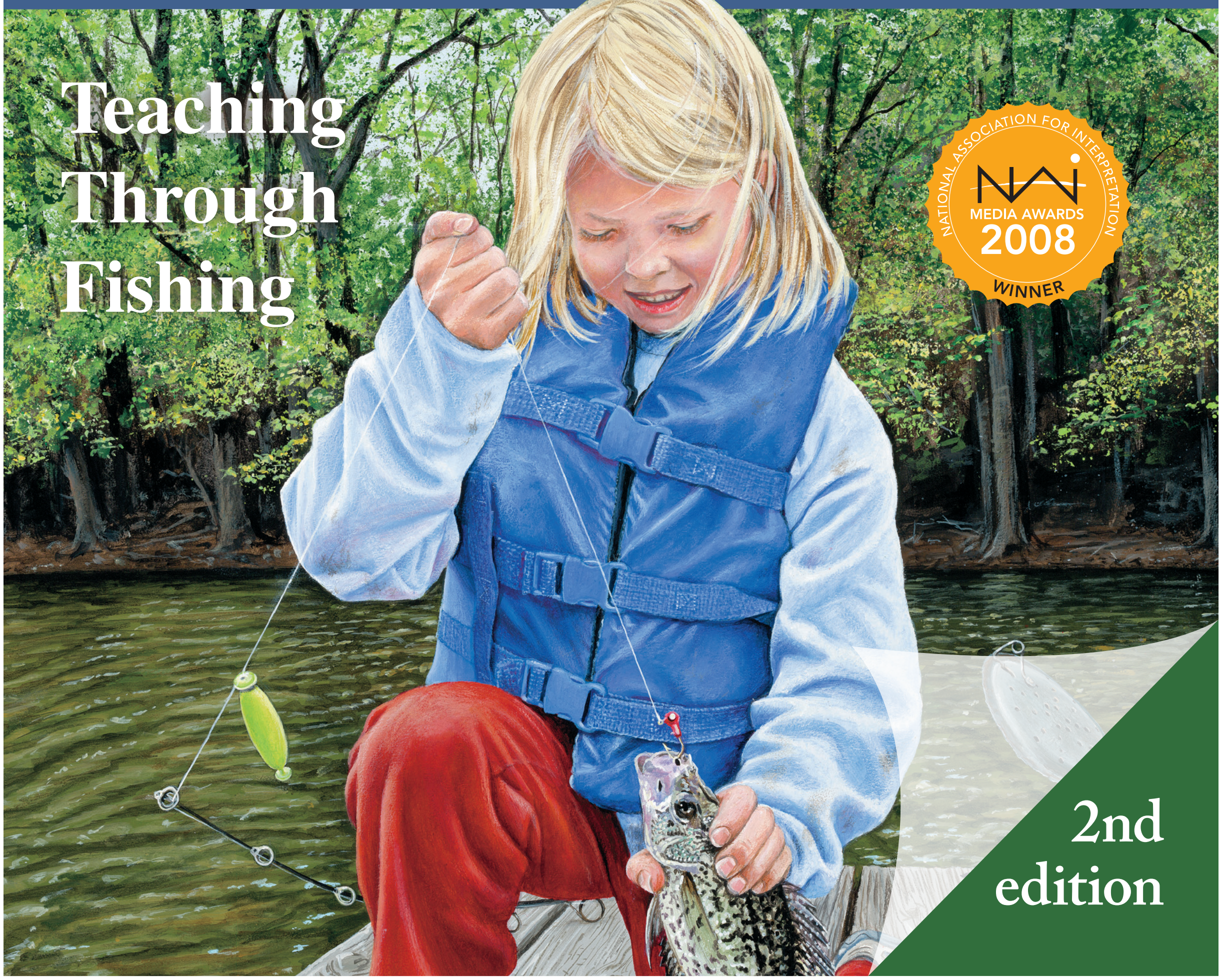
Minnesota
DEPARTMENT OF NATURAL RESOURCES

MinnAqua
Fishing: Get in the Habitat!

SPORT FISH RESTORATION

Fishing: Get in the Habitat!
Leader's Guide



Teaching Through Fishing

2nd edition

Fishing: Get in the Habitat!

Leader's Guide

©MN DNR, C. Iverson

The MinnAqua Program receives support from the Sport Fish Restoration Program of the U.S. Fish and Wildlife Service.

Preface

Welcome to MinnAqua, the angling and aquatic education program of the Minnesota Department of Natural Resources Division of Fish and Wildlife. We appreciate your investment of time, energy, and talent as you help others learn about Minnesota's natural resources.

Whether you're an avid angler or have never picked up a fishing rod, we've designed the *Fishing: Get in the Habitat! MinnAqua Leader's Guide* to make it easy for you to educate others about the value of our waters, habitat, and Minnesota's great fisheries. Our *MinnAqua Leader's Guide* will also help you plan fishing field trips that are safe and educational. It is our hope that, through the teaching of science and the activity of fishing, we can collectively plant the seed of conservation in our youth and ultimately benefit from their understanding of our natural world.

Our *MinnAqua Leader's Guide* gives you a framework for success, meaning each lesson contains biology background information, a lesson layout to aid planning and implementing, and supportive student and instructor pages. We've also linked the lessons to the Benchmarks of the Minnesota Academic Standards and the Environmental Literacy Scope and Sequence. Our goal is to help you, as an educator, meet your needs through these tools.

The *MinnAqua Leader's Guide* has passed through the hands of more than 100 reviewers. They represent technical, research and pedagogical experts, field and classroom instructors, editors, artists, and others who are passionate about educating the citizens of Minnesota about our natural resources and fishing-related activities. These reviewers have our most sincere and heartfelt thanks.

We hope you find the *MinnAqua Leader's Guide* useful and always within easy reach. And we look forward to hearing from you as you experience the rewards that come from teaching others the joy of fishing and learning more about the habitats around us.

Minnesota Department of Natural Resources
Division of Fish and Wildlife Management
and MinnAqua Program Staff

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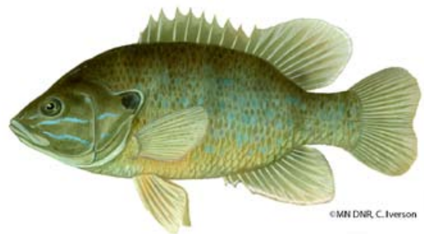


The redesign of the *Fishing: Get in the Habitat! MinnAqua Leader's Guide* has been a journey with an expanding partnership of devoted, talented, and passionate people, from the MinnAqua Education Specialists and graduate student staff who carried a vision and goal to a quality product, to Minnesota DNR management staff that supported us along the way. The Minnesota Department of Education proved to be an invaluable partner by providing the MinnAqua Program not only with tangibles, but also afforded us access to the expertise of Minnesota's state Academic Content Area Specialists and Science Assessment Team. And we thank the hundreds of partners who participated in planning, design, the extensive review process, and pilot testing.

We stand proud of this product. The following is a list of those who have devoted their time, talent, and energy to this resource. It includes DNR fisheries staff, editors, artists, graphics staff, layout designers, teachers, specialists, educators, school administrators, scientists, professors, and numerous other experts and reviewers. Again, thank you so very much. This *MinnAqua Leader's Guide* is what it is today because of all of you!

Lesson Writers
MinnAqua Education Specialists
Minnesota DNR
Kathy Beaulieu
Linda Bylander
Michelle Kelly
Nadine Meyer
Kay Razenka
Roland Sigurdson

MinnAqua Program Coordinators
Minnesota DNR
Kathleen Kipka
Jenifer Matthees

Evaluation
Amy Grack Nelson

Editors
Susan Maas
Mary Olson

Graphic Design
Tom McGregor
  McGregor Design
Minnesota DNR Creative Services

Interactive Design
Kenton Hanson

Contract Illustrators
Carlyn Iverson
Gina Mikel

Creators/Contributors
Minnesota DNR
Amy Beyer
Collin Grant
Deserae Hendrickson
Nadine Meyer
Deb Rose
Steve Seefeldt
Adele Smith

Reviewers and Lesson Contributors
Minnesota DNR Fisheries Section Staff and MinnAqua Liaisons
Kyle Anderson
Heather Baird
Randy Binder
Dave Coahran
Ryan Doorenbos
Jeff Eibler
Paul Eiler
Mandy Erickson
Steve Erickson
Edie Evarts
John Frank
Dave Gilbraith
Mark Gottwald
Scott Gustafson
Jody Henry
John Hiebert
John Huber
Gene Jeseritz
Roy Johannes
Dennis Johnson
Mike Knapp
Jim Levitt
Kelly McQuinston
Kevin Martini
Gary Mattson
Mark Nemeth
Joe Ostazeski
Al Stevens
Joe Stewig
Ed Stork
Doug Thompson
Jeff Tillma
Cindy Tomcko
Rick Walsh

Reviewers and Lesson Contributors
Minnesota DNR, Waters Division
April Rust
Minnesota Project WET Coordinator

Minnesota DNR Fish and Wildlife Division Management
C.B. Bylander
Linda Erickson-Eastwood
Ron Payer
Dave Shad

Review Teams
Lesson Pilot Testing
Diane Bartz
Teacher
Browns Valley School
Pamela Beecham
Teacher
Cedar Creek Community School
Stephan P. Carlson
Environmental Education and Evaluation
Graduate Student Advisor
University of Minnesota College of Natural Resources Science and Management
Darlene Cross
Teacher
Bel Air Elementary
Rick Erickson
Teacher
Roosevelt Elementary
Russ Dunn-Foster
Teacher
Washington Elementary
Shelly Gilson
Teacher
Rossman Elementary
Mary Hayes
Teacher
Bagley Elementary
Chris Holmes
Teacher
Roosevelt Elementary
Ruth Holmgren
Teacher
Viking Elementary
Angie Lawrence
Teacher
Bluff Creek Elementary
Jenny McComber
Educator
Home School Elk River
James Minerich
Teacher
Pequot Lakes Elementary
Bonnie Nelson
Administrator
Victory Christian Academy
Louis Parenteau
Teacher
Merritt Elementary

Cleo Simonett
Teacher
Ramsey International Fine Arts Center
Diane Sterna
Teacher
Browns Valley School
Steve Zamzo
Teacher
Rossman Elementary

Lesson Reviewers and Contributors Academic Standards, Assessments, and Appendices

Deb Boros
MnSTA Elementary Representative
Mississippi Elementary
Dawn Cameron
Science Assessment Specialist
Minnesota Department of Education
Karen Coblentz
Principal
Dassel Elementary
Marty Davis
Catalyst Science Coach
St. Paul School District
Jennifer Dugan
Math Assessment Specialist
Minnesota Department of Education
Randee Edmundson
K-12 Science Coach
St. Paul School District
Clark Erickson
Minnesota State Science Specialist
Minnesota Department of Education
Rebecca Garay-Heelan
Indian Education
Minnesota Department of Education
Rosemary Heinitz
Math Assessment Specialist
Minnesota Department of Education
Ed Hessler
President, MnSTA
Hamline University Center for Global Environmental Education
Bonnie Houck
Minnesota State Reading Specialist
Minnesota Department of Education
Michelle Kamenov
Minnesota State Service-learning Coordinator
Minnesota Department of Education
Melissa Manikkam
Middle School Lead
Bell Center
Tom Muchlinski
Minnesota State Math Specialist
Minnesota Department of Education
Karen Newell
Science Chair
Plymouth Intermediate School District
Polly Saatzer
Teacher
Garlough Elementary
Teresa Saum
President
Minnesota Council of Teachers of English
Carman Shepard
Teacher
Pike Lake Elementary
Matt Silberglitt
Science Assessment Specialist
Minnesota Department of Education
Charlie Skemp
Minnesota State Social Studies Specialist
West St. Paul, Mendota Heights, Eagan School District

Reviewers and Contributors Nonformal Education and Industry

Su Beran
Education Specialist
Minnesota Environmental Literacy Scope and Sequence
Minnesota Pollution Control Agency
Joseph Campbell
International Speaker
Mdewakanton Sioux Tribe
Stephan Carlson
4-H
University of Minnesota
Tannie Eschenaur
Health Educator
Minnesota Department of Health
Dawn Flinn
Minnesota DNR Education Specialist
Minnesota DNR
Deb Gallop
Interpretive Program Supervisor
Wargo Nature Center
Anne Kuitunen
Fisheries Biologist

Minnesota DNR
Mike Kurre
Retail Marketing Coordinator
Gander Mountain
Sheldon Langager
Aquarium Coordinator
Cabela's Retail, Inc.
Lisa Lee
Director
Girl Scouts Peacepipe Council
Mike Link
Executive Director
Audubon Center of the North Woods
Barb Liukkonen
University of Minnesota,
Water Resources Center
Minnesota Sea Grant
Kurt Marple
Coordinator
Camp Courage, Maple Lake
Rose Masanz
Troop Leader
Cub Scouts
Bruce Matthews
CEO
Recreational Boating and Fishing Foundation
Pat McCan
Research Scientist
Minnesota Department of Health
Brian McNeil
Regional Extension Educator
4-H Youth Development
Kate Mylan
4-H Program Coordinator
Lake County-Two Harbors
Sue Register
Leader
Boy Scouts
Nathan Reinbold
Environmental Education Outreach Coordinator
Fond du Lac Reservation
Dave Schaeffer
Director of Education
Great Lakes Aquarium
Konrad Schmidt
Ichthyologist
Minnesota DNR
Karen Terry
Extension Educator
Minnesota Extension Service

Image Reviews
Minnesota DNR
MinnAqua Staff
Kathy Beaulieu
Michelle Kelly
Nadine Meyer
Jenifer Matthees
Roland Sigurdson

Image Reviews
Minnesota DNR Staff
Darryl Bathel
Wendy Crowell
Carol Hall
John Hiebert
Jodie Hirsch
Steve Klotz
Dale Logsdon
Steve Marod
Huon Newberg
Joe Ostazeski
Don Pereira
Donna Perleberg
Rod Pierce
Bruce Pittman
Vaughn Snook
Konrad Schmidt
Luke Skinner
Al Stevens
Dan Swanson
Nicole Hanson-Welch
Chip Welling

Image Reviews
University of Minnesota
Jay T. Hatch
Associate Professor
University of Minnesota-Twin Cities
Dr. Andrew M. Simons
Associate Professor
University of Minnesota-Twin Cities

Introduction: How to Use the *MinnAqua Leader's Guide*

Goals and Intent

The *Fishing: Get in the Habitat! MinnAqua Leader's Guide* was created in an effort to meet the Minnesota Department of Natural Resources goal of providing environmental and natural resources stewardship education to Minnesota citizens. The *MinnAqua Leader's Guide* is for instructors who work with children in grades 3-5 in both formal and nonformal education settings as a source of lessons, activities, ideas, and information.

Although the lessons target grades 3-5, most lessons include a K-2 option as well as ideas for extensions that further develop the concepts introduced in the lessons. Instructors working with groups of older students will find many of the lessons in the *MinnAqua Leader's Guide* suitable or adaptable to their needs, too.

The *MinnAqua Leader's Guide* addresses three key education and outreach goals of the Minnesota DNR, including: building an effective, coordinated, Minnesota DNR natural resources stewardship education effort with consistent messages and measurable outcomes; expanding Minnesota DNR working relationships with preK-12 audiences and providers; and collaborating with other natural resource agencies and organizations to provide natural resources stewardship education. The MinnAqua Program addressed these goals by consulting national and state standards, highly qualified instructors, and organizations to guide the development of the *MinnAqua Leader's Guide,* as well as by including leading Minnesota education and natural resources experts, stakeholder groups, and intended users in a formative evaluation process.

The MinnAqua Program's mission is to **"provide lifelong educational programming that will increase people's knowledge and understanding about aquatic ecosystems, management, and resource issues; help acquire skills related to aquatic recreation, careers, and teaching; and foster a better stewardship of the state's natural resources."**

The MinnAqua Program's goals for the *MinnAqua Leader's Guide* are that instructors will use it to:

- teach about Minnesota fish, aquatic resources, and resource management
- lead students outdoors and initiate self-sustaining programs such as volunteer monitoring, shoreline restoration, and other service-learning projects
- connect students to their local aquatic resources through the recreational activity of angling
- and promote lasting stewardship of Minnesota's aquatic resources.

The *MinnAqua Leader's Guide* lessons and activities are Minnesota-focused, engaging, and provide an angling and aquatic education context for learning. By enlisting the Recreational Boating and Fishing

Foundation's Best Practices for Boating, Fishing, and Aquatic Resources Stewardship Education, the *MinnAqua Leader's Guide* is designed to be an effective teaching resource with learner-centered lessons and activities for a variety of educational settings, including:

- traditional grade 3-5 classrooms
- home-schools
- charter schools
- non-traditional schools
- retail outreach
- youth groups
- 4-H
- Cub Scouts
- Girl Scouts
- park and recreation centers
- environmental learning centers
- community centers
- museum programs
- sporting groups
- after-school programs
- day care centers
- state agencies
- watershed districts
- nature centers
- camps
- resorts
- fisheries resource management instructors
- environmental and outdoor recreation instructors
- all other groups that wish to teach youth in grades 3-5 about Minnesota fisheries and water resources, angling skills, and aquatic stewardship

By aligning the lessons with the Minnesota Academic Standards, the MinnAqua Program has ensured that teachers in the formal setting won't be adding something "extra" to their already-full curriculum plates by using the *MinnAqua Leader's Guide* lessons in their classrooms. Instead, they'll enhance and enrich their curricula by engaging their students in a relevant, real-world, place-based, hands-on, minds-on, interdisciplinary, systems-based environmental—and fun—context to effectively achieve their academic goals, while helping students become environmentally-literate citizens.

The *MinnAqua Leader's Guide* underwent an extensive formative evaluation process that included nonformal and formal instructors, who pilot-tested lessons with their students and youth groups. The review process included input from outreach partners and stakeholders, as well as experts in instructional design, Minnesota fisheries biology, academic standards and environmental education guidelines, and accessibility for people with physical disabilities.

The CD ROM and ring binder format of the *MinnAqua Leader's Guide* is intended to provide flexibility and ease of use of copy pages, images, and background materials to enhance utility and ease of implementation in a variety of settings. This publication has been designed for printing, allowing instructors to print the pages back-to-back—just choose the "print front to back" option in your print dialogue box. Pages can then be punched, placed in a three-ring binder, and removed and used as needed.

Components and Organization of the MinnAqua Leader's Guide

Chapters

The *MinnAqua Leader's Guide* contains 39 lessons in six chapters:

- **Chapter 1: Aquatic Habitats**
- **Chapter 2: Minnesota Fish**
- **Chapter 3: Water Stewardship**
- **Chapter 4: Fish Management**
- **Chapter 5: Fishing Equipment & Skills**
- **Chapter 6: Safety & the Fishing Trip**

Each chapter has a number of interdisciplinary lessons that contribute to a better understanding of Minnesota's aquatic systems and basic fishing skills.

Lessons

Each of the lessons can stand alone or be combined and constructed into a variety of thematic units—or you can choose specific lessons to incorporate into your current curriculum or activities and outreach efforts. Each lesson is a complete freestanding package. Each lesson contains extensive background information on biology, and the necessary copy pages to provide the instructor with the confidence and the resources to teach the lesson. Many of the lessons are quite comprehensive, and the instructor may choose to do one portion, several parts of a lesson, or adapt a lesson to meet specific academic or programming needs.

The *MinnAqua Leader's Guide* lessons were developed with these overarching guidelines:

- to ensure concepts, environmental issues, and problems are addressed with accuracy and fairness
- to feature content specific to Minnesota culture, natural resources, and fisheries management

Lesson features include:

- extensive background and biology information for each lesson
- well-defined steps and procedures for lesson implementation
- alignment with the Minnesota Academic Standards
- alignment with the Environmental Literacy Scope and Sequence
- clear and measurable student learning objectives met by doing the Activity section of the lesson and measured by the assessment options
- authentic assessment ideas, including a student checklist and a scoring rubric
- developmentally-appropriate activities and concepts that build on students' prior knowledge
- accommodation of multiple learning styles in lesson activities
- a K-2 option that provides ideas on how to adapt lessons to best support the emerging and developing abilities of these students
- extensions that enable students to delve deeper, further develop concepts, or exercise different learning style strengths
- making connections to students' everyday lives
- outdoor as well as indoor setting activities
- self-directed, student-centered learning opportunities
- incorporation of individual and group activities
- interdisciplinary, hands-on, and inquiry-based activities
- lessons that can stand alone or can be used as part of a unit
- a plan for incorporating service-learning opportunities and ideas

The Lesson Format

The lesson format provides instructors with easy access to the information needed to successfully carry out an activity.

(Some of the teaching tips appearing in this section have been adapted from *The ABCs of Environmental Education*, U. S. Environmental Protection Agency, June 2006.)

Minnesota Acedemic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.

The Benchmark is mentioned or touched on, but not addressed in depth.

Some—but not all—of the Benchmark is addressed. A portion of a Benchmark may be addressed in a rigorous way, but another part of the Benchmark may not be covered completely. (For example, the concept may be addressed in the activity but all of the vocabulary words stated in the Benchmark aren't used).

All parts of the Benchmark are addressed. The activity is taught in such a way that students will have a complete understanding of the concepts and terms stated in the Benchmark.

Each lesson lists the Minnesota Academic Standards to the Benchmark level for grades 3-5 for Science, Social Studies, Language Arts, and Mathematics that are addressed by the Activity section of the lesson. This is a timesaving resource for instructors and program planners for school groups, and it demonstrates and supports the value of the *MinnAqua Leader's Guide* lessons and activities in formal education settings. See the ***Appendix:***

Minnesota Academic Standards Correlations for a comprehensive matrix of all of the standards listed down to the benchmarks cross referenced with the lessons that introduce, partially address or fully address each benchmark.

Academic standards are *not* identified based on the assessment options in the lesson. They're addressed by the *content of the lesson.*

The listed Benchmarks will enable you to quickly determine if the lesson addresses required academic standards.

Programs that can demonstrate that their activities and lessons address required academic standards are appropriate for school groups and attractive to teachers and school administrators.

> "The *Environmental Literacy Scope and Sequence* is a tool for instructors that provides a systems approach to environmental education in Minnesota for preK through adult learners. It describes key concepts about the interaction of natural and social systems and a sequence in which they are to be taught."
>
> —Minnesota Office of Environmental Assistance, 2005

Environmental Literacy Scope and Sequence

These preK-2 and grades 3-5 Benchmarks define the broad systems-based environmental ideas students should understand by the end of each of these two grade level groupings.

It's important to note that each Benchmark progressively builds on the previous benchmark to bring the student knowledge to a higher level of understanding. Students construct knowledge based on their prior level of understanding, not necessarily according to standards set for their actual grade level.

Review the Benchmarks to determine if your students have the appropriate environmental systems background for the concepts expressed in the lesson. If your students lack the systems Benchmarks knowledge noted for grades 3-5, begin with an experience, lesson or activity to introduce or reinforce the Benchmarks from the preK-2 level. After mastering these Benchmarks, your students will be able to more effectively make connections to new knowledge, and understand and incorporate the grade 3-5 level Benchmarks into their knowledge base.

Grade Level: 3-5
Activity Duration: two 50-minute periods
Group Size: any
Subject Areas: Expressive Arts, Science, Language
Academic Skills: communication, construction, ma
researching, small group work
Setting: Part 1: computer lab
Part 2: indoor or outdoor gathering area with tables
Vocabulary: Lake Finder, lake survey, limit, open se
access, regulations
Internet Search Words: Explore Minnesota, Minne

Grade Level: 3-5

The lessons are designed for grades 3-5, but they can be adapted for use with younger or older students, too. It is most helpful to know your audience for the lesson. Where are the students academically? Developmentally?

Activity Duration: two 50-minute periods

Check the lesson's time requirement and read the lesson to develop a sense of how long it will take to complete the lesson. The lessons are generally planned for 45- to 55-minute sessions—not including time needed for the initial purchase, obtaining, or creation of activity materials. In ***Appendix: Planning Aids*** there is a document called *Activity Timeline Matrix*, which lists the time needed for each part of each lesson on one page.

Group Size: any

Some activities can be used with groups of any size. Others work best with a minimum or maximum number of participants. Check Group Size to determine whether an activity is appropriate for your group.

Subject Areas: Expressive Arts, Science, Language A

The academic subject areas addressed in the *MinnAqua Leader's Guide* lessons include Expressive Arts (art, theater, dance), Health and Safety, Language Arts, Math, Physical Education, Science, and Social Studies (including History, Geography, and Economics). Most lessons are interdisciplinary and can be used to meet learning objectives in a variety of academic subject areas. In ***Appendix: Planning Aids*** there is an *Academic Subjects Matrix* that lists all of the academic subjects suggested in each of the lessons and checks off which lessons introduce each subject. In ***Appendix: Planning Aids*** there is an *Academic Subjects Matrix* that lists all of the academic subjects suggested in each of the lessons and checks off which lessons introduce each subject.

Academic Skills: communication, construction, map

The *MinnAqua Leader's Guide* lists the academic skills introduced or practiced in the lesson to assist the instructor with lesson planning or the targeting of particular skills. Academic skills include: analysis, communication, observation, graphing, identification, inference, classification, mapping, measuring, modeling, construction, prediction, reading, and recording data.

For a complete grid correlating academic skills to each lesson in the *MinnAqua Leader's Guide* go to ***Appendix: Planning Aids*** and select the document called *Academic Skills Matrix.*

Setting: Part 1: computer lab

Lessons can be conducted in the various suggested settings, which include a gym or large, open area, gathering area with tables, gathering area, water's edge, or computer lab. Check Settings recommendations to determine if the lesson will work in your setting. The settings for each lesson are also documented in the *Location and Settings Matrix* found in the ***Appendix: Planning Aids.***

Vocabulary: Lake Finder, lake survey, limit, open sea

This section includes key words introduced and defined for the instructor's benefit in the Instructor's Background Information section. (They're also listed alphabetically in a ***Appendix: Additional Information & Resources***, *Glossary.)*

Internet Search Words: Explore Minnesota, Minne

These words and terms, typed into an Internet search engine, lead to additional information related to the lesson content.

Summary

This brief overview includes the lesson's main points and activities.

Student Objectives

Objectives are specific, measurable learning outcomes. The lessons contain multiple objectives. The stated objectives usually begin with a capability verb ranging from basic comprehension (such as "to understand") to higher-order thinking levels (such as "to synthesize" or "to evaluate").

The student learning objectives describe what students will do to acquire further knowledge and skills, as well as what students will be able to do as a result of participating in the lesson. The lesson objectives also describe the conditions under which students' performance will be accomplished. These objectives are measurable. From the objectives, the instructor can determine criterion for judging satisfactory attainment of the objectives.

The Assessment Options section at the end of each lesson helps the instructor measure whether students have met lesson objectives.

Materials

All materials needed for activities are listed in the margins of the first few pages of each lesson and are intended to be readily available or easily acquired.

You can devise substitutions for some materials. Remember that, if asked, local or statewide sports groups and retail discount stores may be willing to donate materials and supplies for educational efforts. Comprehensive lists of the materials needed for each lesson organized by chapter, material type, and lessons is available in Appendix: Materials, Materials Master Matrix, Craft Materials Matrix and Basic Fishing Equipment Matrix.

This icon accompanies notes that deal with safety precautions identified in this section.

Instructor's Background Information

Comprehensive background information and biology information is provided for each lesson. *Don't let the length of this section deter you.* This section equips any instructor or youth leader with all of the information, understanding, and confidence to present and competently teach the lesson regardless of previous knowledge of the topic. You're bound to learn something new about Minnesota fish, aquatic habitats, and fishing—even if you're an avid angler! This comprehensive background information can also be especially useful in training new education program staff.

This icon accompanies notes that deal with supporting information.

This icon accompanies notes containing fun fish facts. A complete list of fish fun facts and water fun facts can be found in ***Appendix: Additional Information & Resources,*** *Minnesota Water Facts* and *Minnesota Fun Fish Facts.*

Procedure

These are the items that the instructor must prepare ahead of time in order to present the activities in the lesson.

Activity

Activity sections in each lesson include Warm-up, Lesson, and Wrap-up sections containing all sequential steps and instructions necessary to carry out the lesson. The Activity addresses the learning objectives and lesson concepts. Questions that will prompt student learning are suggested throughout this section.

This icon accompanies notes that deal with safety precautions identified in this section.

Warm-up

The Warm-up provides an activity to set the stage and introduces the main lesson topics.

Lesson

The Lesson is the heart of what you'll be teaching. It includes an easy to follow step-by-step process for teaching the lesson.

You may choose to adapt the lesson to suit your curriculum and programming needs. The MinnAqua Program has strived to create comprehensive and rich learning experiences for your students with each lesson, but time limitations may impact your ability to run an activity in its entirety. Most lessons can be easily altered or condensed to suit your needs. Be sure to assess participants' learning after any adaptation to the lesson—this will provide feedback on whether your adapted lesson still enables students to achieve your learning objectives.

The lessons are designed to encourage instructors to be creative and flexible while teaching to maintain student interest and curiosity, and to address various learning style preferences of individual students (such as visual learners, auditory learners, and tactile learners).

Wrap-up

This section provides an opportunity to enable students to summarize, review, debrief, and reflect on the content covered in the lesson. This is an important step in the learning process, providing students with a chance to better absorb and make lasting connections to new concepts. The Wrap-up is an important component that enhances learning retention.

Assessment Options

Each lesson contains authentic assessment ideas, including a Checklist and a Scoring Rubric based on the lesson objectives. For each lesson, read the Assessment Options and use those that best suit your student evaluation needs. Assessment activities allow students to demonstrate that they've successfully achieved and understood the lesson objectives. The Assessment Options relate directly to the learning objectives for each lesson and provide multiple ways to measure objectives and accommodate various learning styles. They present students with real-world (authentic) challenges that require them to use higher-order thinking skills and apply a range of knowledge.

Planning a Fishing Trip Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Use the Internet to Finder feature on t

The Checklist provides criteria that address the learning objectives. The instructor can use the Checklist to assess student learning—or the student can use it as a self-assessment to measure the degree to which they've met the lesson objectives. The Checklist can also be given to students prior to the lesson as a guide to successful completion of the lesson (formative evaluation).

Planning a Fishing Trip Scoring Rubric

Fishing Trip, Poster, Brochure, or Skit Criteria	4 Excellent
Fishing trip components and lake map	Uses a lake map with location of where to fish for a particular species, species information, lake accesses, seasons/limits information, type of bait to use (what the fish species eats), weather information, safety considerations, lodging sites, guide services, bait shops, and other recreational activities for th area, to help plan a fishing trip, fishing trip planning skit, poster, brochure.
Research	Can use the Internet to locate th

This section corresponds to one of the lesson's Assessment Options and addresses the lesson objectives. It clearly states what students need to do to achieve a range of scores for various criteria. You may choose to give the Scoring Rubric to your students prior to the lesson to let them know what they're expected to do and learn as they participate in the activities. You may also choose to use it as a guide to create a rubric that addresses a different Assessment Option.

Diving Deeper

Extensions

This section contains suggested follow-ups that provide students with an advanced or enriched opportunity and further explore a topic or concept covered in the lesson. Extensions build on the lesson's original objectives. Extension activities also provide ideas for additional ways to address a variety of learning style preferences or student skills, or to adapt the lesson to an audience that may be more academically or culturally diverse.

For the Small Fry

K-2 Option

Included for most lessons, the K-2 Option provides ideas on how to adapt the lesson to best support the emerging and developing abilities of these students.

Appendices

The *MinnAqua Leaders Guide* contains detailed Appendices to assist you in planning your curriculum, unit, or programming needs.

Appendix: Additional Information & Resources

Glossary

The Glossary is an alphabetized list of specialized terms and their meanings as they're highlighted and used within the context of the *MinnAqua Leader's Guide* lessons.

Conceptual Framework

Service-learning

This section includes a brief description of service-learning, a list of service-learning resources, and service-learning project ideas related to the content of Chapters 3-6. These project ideas are meant to give students opportunities to take action, get involved, and apply the skills and knowledge acquired from *MinnAqua Leader's Guide* lessons to identify and address problems in their local environments and communities. A service-learning project can be done as a capstone to any unit or strand developed from the *MinnAqua Leader's Guide* to empower students and develop their stewardship and citizenship skills.

Student Reading List

Arranged and related to the *MinnAqua Leader's Guide* chapters, content, and concepts, this list contains books with age-appropriate reading levels.

Minnesota Water Facts

Minnesota, the "Land of 10,000 Lakes," also has many tens of thousands of miles of rivers and streams. Pique your students' curiosity and enjoy these interesting facts about Minnesota lakes, rivers, and streams.

Minnesota Fun Fish Facts

Minnesota is home to 160 interesting fish species. Impress your friends and relatives and enhance learning with these fun facts about fish and fishing!

Appendix: MN Academic Standards Correlations

MN Academic Standards Correlations

This matrix correlates the *MinnAqua Leader's Guide* lessons with Minnesota Academic Standards to the Benchmark level for Science, Social Studies, Language Arts, and Math for grades 3-5.

Appendix: Correlations

Correlations matrices cross-reference all lessons to provide quick curriculum and program planning information at a glance.

4-H Correlations Matrix

The 4-H Correlations matrix illustrates how lessons can help meet various 4-H sportsfishing project area requirements. It also illustrates how activities from the *MinnAqua Leader's Guide* and 4-H activities complement one other, and how lessons and service-learning ideas provide useful ideas for fair projects or supplements to other 4-H activities.

Cub Scout Correlations Matrix

This matrix illustrates how lessons and service-learning projects can help meet requirements for various Cub Scouting badges. In addition to meeting various badge requirements, incorporating the lessons into Cub Scout activities can provide opportunities for creating family scouting events related to angling.

Girl Scout Correlations Matrix

This matrix illustrates how lessons and service learning projects can help meet requirements for various Junior Girl Scouting badges. In addition to meeting various badge requirements, incorporating the lessons into Junior Girl Scout activities can provide opportunities for creating family scouting events related to angling.

Appendix: Planning Aids

Alphabetical List of Lessons

Academic Subjects Matrix

Academic Skills Matrix

Seasons Matrix

Topics Matrix

Unit Matrix

The *MinnAqua Leader's Guide* is a versatile and interdisciplinary instructor's resource. You may find the suggested units or strands in this matrix useful, or you may want to create a different themed unit or strand to suit your particular curriculum or programming needs. See the Topics Matrix Appendix—it will help you create a unit or lesson strand not listed above. Individual lessons can also stand on their own merit, or you can choose one or several to supplement or enhance your current lessons and programs.

Locations and Settings Matrix

Activity Timeline Matrix

Addressing Physical Disabilities

This section addresses accessibility and includes a set of planning documents to aid instructors in adapting teaching methods and the lessons for individuals with physical disabilities. The documents include:

- an overview
- a needs assessment for identifying an individual's physical abilities and limitations
- a lesson analysis record for analyzing a lesson based on its physical activity requirements
- an adaptation guide to help instructors consider accommodations that may be necessary to enable individuals to participate

Appendix: Materials

Materials Master Matrix

This matrix is a master list of the materials required for all lessons. It groups these items as craft materials, fishing materials, scientific materials, and miscellaneous materials.

Craft Materials Matrix

Basic Fishing Equipment Matrix

The Benefits of Using the MinnAqua Leader's Guide

The *MinnAqua Leader's Guide* incorporates a broad range of environmental education strategies, best practices, and guidelines to increase the outreach and effectiveness of the education efforts of the Minnesota DNR. It incorporates Environmental Education strategies that address social connections to Minnesota aquatic environmental issues and problems. Through innovative and research-based approaches to education in both formal and non-formal settings, educators can reach students in energizing and transforming ways. The *MinnAqua Leader's Guide* provides educators with an engaging and fun context for learning. Aquatic ecology and angling is a context for learning that can be used in a variety of educational settings. It presents an innovative strategy to actively involve students in their learning, enhance critical thinking and problem solving skills, and teach individuals to weigh various perspectives on environmental issues to make informed and responsible decisions.

The educators who pilot-tested these lessons found that the *MinnAqua Leader's Guide* connects participants to local aquatic environments and to learning and increases overall academic performance and achievement. Students enjoy the lessons—and instructors enjoy teaching and facilitating them. Students already familiar with fishing are able to share their skills and knowledge with classmates. Some students who might not otherwise actively participate in class have a chance to shine. You might just find that some parents and local experts will be more than happy to share their knowledge of fishing skills with your students.

Because the lessons make connections to Minnesota students' daily lives and are place-based, the lessons are easy to understand, build on prior knowledge, and can easily accommodate a variety of learning styles and abilities.

The lessons and activities in the *MinnAqua Leader's Guide* focus on local environment and community, which makes them very useful for building partnerships and mentoring opportunities related to angling.

The MinnAqua Program's Hope

Using the *MinnAqua Leader's Guide* will make the "what" and "how" of your teaching more deliberate, relevant, and empowering, enabling students to: acquire awareness and direct experience with aquatic and natural resources in their communities; gain knowledge and skills needed to enjoy the lifelong activity of fishing (Minnesota's pasttime); become empowered, engaged citizens capable of informed and responsible environmental choices and decisions; develop the ability to identify, address, solve, and prevent ever-growing environmental problems and challenges; and be inspired to live in their communities in a sustainable manner. Working together, we can ensure a lasting legacy of aquatic and fisheries resources for future generations of Minnesotans.

The MinnAqua Program intends that the *MinnAqua Leader's Guide* will enhance learning opportunities for students, provide them with authentic experiences in local surroundings, enable a deeper understanding of their role in the environment, and—ultimately—guide them toward a path of stewardship.

The History of Fishing in Minnesota

Fishing, a Minnesota Tradition

Would you like to go fishing? Would you like to teach others about Minnesota's fisheries resources? Minnesota, known as the Land of 10,000 Lakes, is the perfect place to start! Within the state boundaries, there are 11,842 lakes larger that ten acres and more than 15,000 miles of streams and rivers.

As you embark on a Minnesota fishing trip, you'll take part in a tradition that spans thousands of years!

Subsistence Fishing

Minnesota has a rich fishing history. As early as 11,500 years ago, people first arrived in present-day Minnesota. Not much is known about these ancient cultures, but evidence buried beneath earthen mounds reveals they fished here. Excavations of prehistoric sites in and around early settlements have unearthed thin, inch-long, J-shaped artifacts that appear to have been chipped stone fish hooks.

Approximately 3,000 years ago, Dakota tribes that lived in the Midwest migrated northward through what is now Minnesota to the southern and western areas of Lake Superior. The Dakota fished the area's many lakes, streams, and rivers. What they hunted or gathered depended on the season, but fish could be angled, netted, or speared year-round.

Sometime around the year 900, a group of Anishinaabeg, or Ojibwe, people began migrating from the east coast of Canada. They traveled along the St. Lawrence River, along the shores of what is now Lake Michigan and the Canadian border, to the waters of Lake Superior or *Gitchi Gummi*, as they called it, meaning big water.

The Ojibwe found an abundance of fish in the area's waters. Ojibwe fishermen used large birchbark canoes and nets made from twisted and knotted strands of willow bark to catch lake trout, whitefish, and sturgeon. In winter, they used hand-carved wooden decoys as bait and speared fish through holes chopped in the ice. By the mid-1700s, the Ojibwe people had settled in what is now central Minnesota. Like the Dakota, they subsisted on what the land and waters produced throughout the seasons.

The first Europeans known to travel into Minnesota were French fur traders from Quebec. They began exploring and trading with native peoples in 1655. When they returned to Montreal, they told of the riches of Minnesota country. They were amazed at the abundance of fish in Minnesota waters. Most of their early settlements were built on the shores of rivers or lakes, not just as a source of water, but also a readily available source of fish. Fish was a diet staple for many of the settlers who came to Minnesota from Scandinavia. Having brought a rich fishing tradition with them, they readily adapted to fishing in Minnesota waters.

The La Pointe Treaty of 1854 ceded from the Ojibwe to the United States the entire Minnesota shoreline of Lake Superior. When this treaty was adopted in September of 1854, dozens of men staked claims along the North Shore—primarily where copper deposits were thought to exist—and at the mouths of the larger streams. Some prospectors began commercial fishing at several sites on Lake Superior during this period. The 1857 U. S. census indicates ten commercial fishermen were operating in St. Louis County and 89 in Lake County.

Commercial Fishing

Commercial fishing on Lake Superior flourished during the early decades of the twentieth century. Norwegian immigrants dominated the industry, although a number of Swedish and Finnish immigrants also cast their nets into the icy waters. Annual catch rates varied over the years, but the all-time record occurred in1915, when almost 10,000 tons of fish were harvested out of Duluth alone. By the 1920s, catches began to decrease as a result of over-harvest and the accidental introduction of the sea lamprey from the Atlantic Ocean—the sea lamprey feeds parasitically on the blood of lake trout. Decreased catches caused many commercial harvesters to find alternate sources of income. Those that continued fishing caught herring, lake trout, chubs, and ciscoes. In ensuing years, populations of the lake's commercial species steadily declined due to pollution from lakeshore industry, over-harvesting, and the sea lamprey, all of which upset the ecosystem of the lake.

In 2006, 25 commercial fishermen were licensed for Lake Superior. They fish mostly herring, which they sell to North Shore restaurants and smokehouses during the summer.

In 1964, approximately 50 commercial harvesters operated on the Mississippi River and the state's inland lakes. In 2006, there were approximately 56 commercial licenses held in Minnesota. Commercial harvesters catch and sell about three million pounds of fish each year—a decrease from the approximately five million pounds taken in the mid-1960s. Commercial harvest on the Mississippi River suffered as consumer demand for carp, catfish, and other species began declining in the late 1970s when health researchers warned that some fish carried contaminants (mercury and PCBs) harmful to human health. Today, anglers are more confident in keeping their catch for a meal because point source pollution in our waters has been reduced, and the Minnesota Department of Health provides statewide and site-specific guidelines for the safe eating of fish.

Popular Pastime

Today, Minnesota is known nationally and internationally for its wonderful sport fishing opportunities. How popular is sport fishing in Minnesota? Consider the following: as many as two million anglers cast their lines into Minnesota waters each year. Approximately 29 percent of Minnesotans fish. The Minnesota DNR sells as many as 1,500,000 fishing licenses each year, with the remaining anglers being children under 16 years of age who, under current regulations, don't require fishing licenses. Additionally, the DNR manages 5,400 game fish lakes, 3,700 miles of trout streams, 192 lakes for trout, and 15,000 miles of streams and rivers.

Rod, reel, boat, and tackle manufacturers are found throughout Minnesota. Indeed, many of today's larger boat, motor, and tackle manufacturers started their operations in Minnesota.

Managing Our Fisheries Resources

In 1931, Governor Harold Stassen created the Department of Conservation to care for the state's rich resources. In 1971, the name was changed to the Department of Natural Resources. Its purpose has always been to care for the state's rich resources and to preserve them for present and future generations. Management, research, and education are important elements in preserving the state's natural heritage. The Minnesota DNR "extends" its work force through partnerships with private individuals and hundreds of citizen and stakeholder groups. Their efforts have been responsible for natural resource achievements that would have been impossible otherwise. As physical, social, economic, and political changes occur in the state, the Minnesota DNR faces constant and ever-changing challenges. In addition to challenges inherent in natural resource management, reaching a balance between sustainability of natural resources, and development that may affect those resources increases the management role of the Minnesota DNR and the stewardship role of the citizens of Minnesota. Although the Minnesota DNR exists to conserve and manage the state's resources, it also oversees outdoor recreation opportunities and commercial uses of natural resources in a way that creates a sustainable quality of life. The Minnesota DNR strives to conserve natural systems and maintain biodiversity to ensure the needs of current and future generations, and requires sharing the role of stewardship with citizens and partners working together to address interests that sometimes conflict.

To that end, it's important to remember that the fish in Minnesota's waters are a limited resource. As angler pressure increases, the number of fishing waters remains constant. Fluctuations in seasonal and annual cycles also affect the fish that inhabit the waters. An environmentally literate citizenry is needed to ensure the sustainability of the resource. We all must work together, pooling our awareness, knowledge, and skills to initiate and practice good stewardship.

A Changing Fishery

Minnesota is currently home to 160 different species of fish, 141 of which are native to our state. The Minnesota DNR has introduced some species of fish to Minnesota waters as a management decision over the years. In each case, this was done to increase or provide a recreational fishery where none had previously existed, but where the environment could sustain one. Of the 160 fish species, twelve are considered nuisance exotics. All nuisance exotics were introduced by people—whether they released a pet goldfish or dumped bilge water from trans-Atlantic shipping vessels. Additionally, as climate changes affect the temperatures of Minnesota waters, the number of species present in the state will continue to change. Although this represents a natural phenomenon, we must diligently protect our waters from future exotic nuisance species introductions and their rapid impact on native fish populations.

The MinnAqua Program Teaches Youth

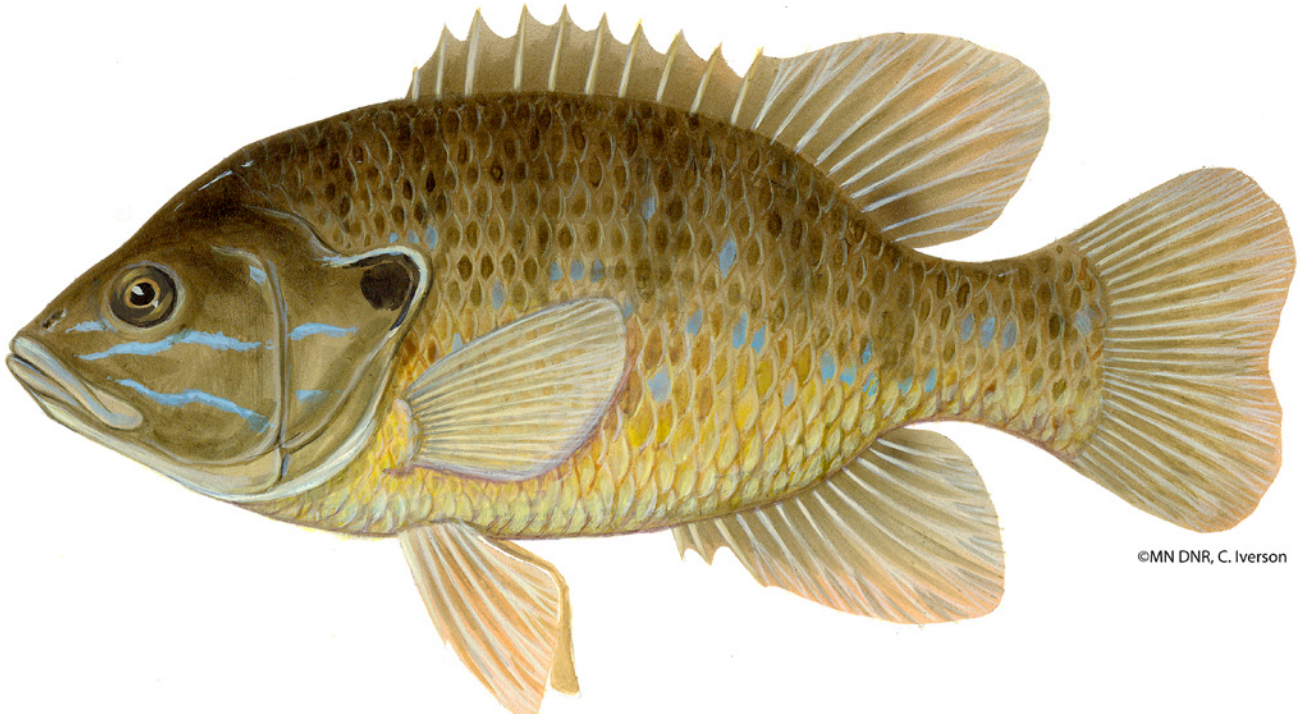
In 1989, a needs assessment was completed for the development and design of an angling education program that would educate and promote the importance of Minnesota's fisheries resource, management, regulations, and the stewardship roles of anglers and other users of the resource. With an ever-changing landscape and increasing population, recreational angling remains a pastime that brings friends and families together in Minnesota. The continuing education of users remains a priority for the Minnesota DNR.

The MinnAqua Program offers basic instruction in lake and stream ecology, fish population dynamics, water quality, and sport fishing skills, connecting participants to Minnesota's aquatic resources through the lifelong activity of fishing. Participants understand the vital roles that clean water, healthy watersheds, aquatic habitat, and quality fisheries play in their lives, and how their own decisions and activities impact water quality, local watersheds and fisheries. They learn to make informed decisions and develop skills for using resources in a sustainable way.

Would you like to teach others about fishing, but don't know how to begin? The *MinnAqua Leader's Guide* is one resource that will assist you in your efforts to teach Minnesota citizens about the natural resources of fisheries.

Minnesota's rich angling heritage also builds bridges to new and culturally diverse communities, which have their own strong fishing traditions and a similar appreciation and enthusiasm for the fisheries resource. Due to the historic and continuing importance of fishing to the culture, economy, and quality of life in Minnesota, education on fish and aquatic ecology is relevant and vital to ensure that we all know how to use and enjoy the resource in a sustainable way. With success in this endeavor, many future generations of Minnesotans will have the opportunity to value and enjoy our state's rich fishing heritage.

Become part of fishing history and tradition in Minnesota: take someone fishing!



Aquatic Habitats

Fish live in aquatic habitats, which meet their basic needs.

What Will the Students Learn?

Through immersion in their local aquatic habitat, students begin to gain a greater awareness of their environment, develop the ability to understand natural systems (or sets of interactions), and discover their place within those systems.

Chapter Concepts

Looking Closely at Habitat Elements and Structure

Lesson 1: 1—Design a Habitat
Lesson 1: 4—Water Habitat Site Study
Lesson 1: 5—Habitat Hideout

As students "get in the habitat" and investigate a pond, lake, stream, or river, they'll begin to view habitat as the home of many different types of organisms, including fish. A habitat provides the basic needs of food, water, cover or shelter, and space for organisms.

Numerous organisms can be observed in or on the water and near the shores of local lakes, ponds, rivers, or streams. You might see cattails, lily pads, algae, turtles, birds, fish, snails, dragonflies, water striders, frogs, crayfish, snakes, and other plants and animals. Some living things in the water, such as some plankton and bacteria, are too small to see with the unaided eye.

"The catalyst that converts any physical location—any environment, if you will—into a place is the process of experiencing it deeply. A place is a piece of the whole environment that has been claimed by feelings."

—Alan Gussow

Each species, including fish, requires a specific type of habitat to supply its basic needs for food, cover, space, and water quality. Learning about the habitat needs of different fish species yields clues about the types of fish that might be swimming in the vegetation under the fishing pier at your neighborhood lake.

Food Chains

Lesson 1: 2—Food Chain Tag

Organisms need food energy to carry out their daily activities. Food energy is transferred from one organism to another through a food chain. A food chain illustrates how producers, prey, predators, and decomposers are inextricably connected, relying upon each other and upon their habitat for survival. Food chains interconnect, creating a food web. By exploring the relationships between aquatic predators and prey, students learn how predation in a lake actually encourages the success of fish populations and contributes to ecosystem balance.

We enjoy an abundant fisheries resource in Minnesota, but is it possible to have too much of a good thing with a large number of fish in a lake, river, or stream? A water habitat provides a limited quantity of food, space, and cover. A habitat's carrying capacity for a fish species is determined by the maximum number of individuals that a given environment can support without detrimental effects on fish or other components of the ecosystem.

Bacteria, plankton, plants, and animals (including people) perform vital roles in food chains as producers, consumers, and decomposers. Balance within an ecosystem depends on the quality of all of its parts. Disrupting one part of a habitat or removing a single member of a food chain can impact an entire food web.

"For if one link in nature's chain might be lost, another might be lost, until the whole of things will vanish by piecemeal."

—Thomas Jefferson

"Wonder is the beginning of wisdom."

—Greek proverb

Migration

Lesson 1: 3—Run For Your Life Cycle

Many fish annually migrate from one aquatic habitat to another to feed, or to complete life cycles and breeding cycles. The northern pike is an example of a Minnesota freshwater fish that migrates during its life cycle. These fish deposit eggs that hatch in shallow water or wetlands. The young fish travel to the deeper water of lakes and rivers to mature, returning to the shallow water area to spawn. Many natural and human-induced factors along this migration route can challenge or threaten northern pike survival.

Life Cycles

Lesson 1: 3—Run For Your Life Cycle
Lesson 1: 6—From Frozen to Fascinating

An organism's life cycle is a progression through a series of developmental stages throughout its lifespan. Each developmental stage is typically timed to take advantage of seasonal conditions, or to address seasonal challenges in an attempt to ensure successful growth and reproduction.

Seasonal Cycles and Adaptations

Lesson 1: 6—From Frozen to Fascinating

Minnesota winters present special challenges for fish and other organisms. Many months of cold temperatures, snow, and ice cause shortages of food, sunlight, and dissolved oxygen. Even the most minute aquatic organisms have special adaptations for surviving Minnesota's dramatic seasonal climate changes. Springtime brings increased sunlight and higher temperatures triggering some tiny aquatic plants and animals to emerge from the state of dormancy that enables them to survive our cold, dark winters.

The Human Connection

All Lessons

People exist and function within natural environments that provide places to live and resources to meet our needs for food, clothing, water, building materials, and other necessities. For these reasons, it's important for students to gain an awareness of and begin to understand the relationships between the living and non-living parts of the natural environment—as well as the human-constructed parts of the environment—by spending time establishing connections, experiencing, and exploring the environment in which they live.

The concepts of food webs, seasonal cycles, life cycles, and migration illustrate a myriad of interdependencies. These concepts also show us that aquatic habitats are dynamic places of constant change. As human populations, resource demands, and human impact on the environment intensify, the process of change accelerates. Many of these changes occur faster than natural systems can adapt to or accommodate them, and environmental systems and cycles can be disrupted, impaired, or destroyed. Students who spend time exploring and observing natural environments learn that, over time, people's activities can have positive or negative consequences and that, indeed, everything is connected.

Exploring and learning about the habitats where fish live is an important step in increasing future angling success and helps students see how they, too, are connected to aquatic habitats.

"If there is magic on this planet, it is contained in water."

—Loren Eisley

Design a Habitat

Ponds are lively habitats! Can you imagine the birds, dragonflies, and fish? If you were a bluegill, what would you need to survive?


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Table of Contents

Chapter 1 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Design a Habitat

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Grade 3
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions.

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 1 • Lesson 1

Design a Habitat

Grade Level: 3–5
Activity Duration: Part 1: 30 minutes
Part 2: 60 minutes
Group Size: any
Subject Areas: Expressive Arts, Language Arts, Science
Academic Skills: description, identification, listening, modeling, visualization, writing
Setting: Part 1: indoor or outdoor gathering area
Part 2: water area and computer lab (optional)
Vocabulary: habitat, habitat needs, limiting resource, plankton
Internet Search Words: freshwater ecosystems, pond ecology, pond habitat, pond life

Instructor's Background Information

A habitat is where a plant or animal lives—a place that meets the organism's basic needs. The four basic **habitat needs** of all living things are food, water (in aquatic ecosystems, water also provides dissolved oxygen for respiration), cover (shelter), and space. All organisms—from cattails to sunfish to people—need food, water, cover, and space to survive. A bluegill spends its day attempting to meet its needs by feeding on small invertebrates, drawing oxygen from water, hiding from predators in plant cover, and finding enough space to move around with other bluegills in small groups called schools. If a place regularly meets all of these needs, the bluegill has found a satisfactory habitat.

Food

Fish get their food from the lake, pond, or stream where they live. Small fish eat plankton. **Plankton** is the name for tiny plants and animals that live in water, many of which are microscopic. Examples of plankton include algae and daphnia. A healthy diet for bluegills includes a variety of small invertebrates (animals without backbones), such as mosquito larvae or dragonfly nymphs. Small fish, frogs, and crayfish are food for bigger fish such as largemouth bass and walleye.

Water

Water is critical to fish survival. Water conditions often determine which species and the number of individuals that can live in a given lake, pond, or stream. Factors that affect water conditions include clarity, pH (acidity and alkalinity levels), nutrients (levels of phosphorous, nitrogen, and organic matter that fuel algae and plant growth), water temperature, dissolved oxygen, and contaminants or pollutants. Water temperature is important, too: cold water holds more dissolved oxygen than warm water. Each fish species requires specific

Summary

The instructor leads students on an actual or a virtual field trip to a pond. As they listen to a narrative or observe an actual pond, students discover that the pond shelters a variety of animals. They begin to see how the watery habitat meets the basic needs of a bluegill sunfish. Students then work creatively with craft materials to construct a diorama illustrating how a fish's habitat provides the food, water, cover, and space that help it survive.

Student Objectives

The students will:

1. Individually describe mental pictures of an aquatic habitat visualized by listening to the **Field Trip to a Pond Narrative** (or after observing an actual pond setting).
2. Define habitat as the place where a plant or animal lives, and where its basic needs are met.
3. Name the four basic habitat needs of fish.
4. Describe how food, water, cover, and space are limiting resources.
5. Construct a diorama that models a fish in a habitat that meets its needs.

Materials

Part 1: Virtual Field Trip to a Pond

- **Field Trip to a Pond Narrative**
- Bubbling water fountain (optional) or pond sound recording to play as you read narrative (optional), such as

"Lily Pond Lullaby" or "Lake at Sunset," available from NatureSong, P.O. Box 1921, Bonita Springs, FL 34133; 239-498-5300 (phone) or 305-433-7431(fax) or online at **www.naturesong.net/flash/retail.html**

Part 2: Field Trip to a Pond

- Journal, small notebook, or a sheet of paper on a flat writing surface such as a clipboard, one per student

Part 3: Making Habitat Dioramas

- Whiteboard
- Whiteboard markers
- Shoeboxes, one per student (or make boxes using the **Template for a Diorama Box**)
- Scissors
- Glue
- Clear tape
- Stapler
- Construction paper, all colors
- Markers, crayons, paint
- Paint trays
- Paintbrushes
- Wooden sticks and twigs
- Small rocks
- Dry sand
- Craft items, such as pipe cleaners, feathers, felt, glitter, construction paper, modeling clay, and other available art materials
- Blue plastic wrap
- Reference books on Minnesota fish, pond life, and aquatic habitats
- **Fish Illustrations for Dioramas** or other pictures of bluegill sunfish, aquatic invertebrates (such as water striders, dragonfly nymphs, and diving beetles) and aquatic plants (such as cattails, lily pads, and duckweed)
- Computer access or library access (optional)

water conditions and oxygen levels. Stream trout, for example, require cold, clear, fast-moving water with high levels of dissolved oxygen. Bluegills, on the other hand, can live in the warmer, quieter waters of many lakes and ponds. Bullheads can survive in water with relatively low dissolved oxygen levels.

Cover

Aquatic plants, rocks, fallen trees, underwater ledges, and other objects provide cover (or shelter) and hiding places for fish. Each species has a strategy for using cover. Small fish, such as bluegills, stay in cover to hide from the larger fish that would eat them. Larger fish, such as northern pike, might use cover as camouflage, lying in-wait behind a clump of aquatic plants, and darting out to ambush unsuspecting prey. Fish large and small utilize cover for shade—fish don't have eyelids, so shade protects their eyes on sunny days. Keen-sighted walleyes, for example, have large eyes that are sensitive to bright sunlight. On a sunny afternoon they seek shaded areas in cover or deeper water. Some fish require vegetation or other types of cover for spawning.

Space

All living things require space in which to live and carry out their daily activities. The amount of available space directly affects the number and kinds of fish that can live in a given area. Overcrowding stresses fish; too many of one type of fish in a lake leads to food shortage. Some fish, such as fathead minnows, need very little space. They swim in schools, feeding on plankton and staying close together in a small amount of space. But larger predatory fish, such as catfish or muskellunge, need more roaming space in which to find food. Different fish species require different types of sites for spawning, including sandy bottoms, rocky areas, or thick vegetation.

Limiting Resources

Occasionally, a habitat doesn't provide the resources to continuously meet all of a fish's needs. The amount and quality of food, water, cover, and space available are known as the habitat's **limiting resources**. Limiting resources determine how large individual fish can grow in a given habitat, which fish species can live in the habitat, and how many fish (population size) can live in the habitat. There might not be enough food if too many of one fish species are present in a pond. For example, if too many sunfish inhabit a pond relative to its available space, fish growth can be stunted. Water quality can also be degraded by runoff (nutrients from lawn fertilizer that enter lakes, ponds, and rivers) that causes algae to grow quickly and excessively. Dissolved oxygen levels drop as the algae die and decompose. (Bacterial decomposers deplete dissolved oxygen.) Excessive algae also block the sunlight that aquatic plants need for photosynthesis. As aquatic plants become less abundant, fish lose valuable food and cover. Also, as people create sandy beaches or boat launches, they often remove aquatic plants that provide food and cover for fish and other water dwellers.

As we investigate aquatic habitats and the habitat needs of fish, we begin to see how resources and numerous organisms are vitally interconnected in an ecosystem.

Procedure

Preparation

Part 1: Virtual Field Trip to a Pond
If you and your students are unable to walk or travel to a nearby pond or other body of water, use the **Field Trip to a Pond Narrative** guided imagery to take a virtual trip. If your group can actually travel to a nearby pond, skip Part 1 and proceed to Part 2.

Part 2: Field Trip to a Pond

1. For each student, gather a journal, small notebook, or a sheet of paper on a flat writing surface such as a clipboard.

Part 3: Making Habitat Dioramas

1. Ask students to bring in a shoebox (or something similar in size) from home. If students can't bring shoeboxes, they can make diorama boxes using tagboard and the **Template for a Diorama Box.**
2. Obtain a variety of books, field guides, pond life books, and other reference materials, or search the Internet for information about different species of Minnesota fish, pond life, and aquatic habitats.
3. Gather supplies.


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Activity

Part 1: Virtual Field Trip to a Pond
Warm-up

1. During this virtual field trip activity, you may wish to play a recording of pond sounds or plug in a bubbling fountain to help set the mood, provide background sound, and reinforce visualization. If your students haven't previously visited a pond, stream, or wetland, the group could look at books, field guides, posters, or magazines for relevant photos of pondscapes, fish, frogs, turtles, dragonfly nymphs, cattails, ducks, water striders, and other organisms mentioned in the **Field Trip to a Pond Narrative.**
2. Ask the students if they've been to a pond, stream, lake, or riverbank. What did they see? Did plants grow there? Was it a hot day or a cool one? What did they hear? Encourage students to share descriptions of the ponds, lakes, streams, or riverbanks they may have visited or seen in pictures.
3. Tell the students that the areas they've been describing are special habitats: aquatic habitats. Define **aquatic** as something associated with water. Define **habitat** as a home, or as the place where an animal lives. Aquatic habitats are important natural areas for people

and wildlife. To learn more about these habitats, students will close their eyes and picture the things you describe in a virtual field trip to a pond.

Lesson

1 Ask students to clear their workspaces.
2 Instruct them to sit in a comfortable and relaxed position with their eyes closed. If the group is outside, they may want to lie down.
3 Wait until students appear relaxed before you begin reading the **Field Trip to a Pond Narrative**. Encourage them to picture in their minds the things they'll hear in the story.
4 Speaking slowly and clearly, begin reading the narrative. Remember to speak slowly and steadily. In order to create rich mental pictures, students must have adequate time to process what they hear. It takes about as much time to create mental pictures of images as it does to carefully review physical settings.
5 When you've finished reading the narrative, and before they open their eyes, invite students to review all of the images they saw in their minds. Again, try to allow enough time for an adequate visual review—at least one or two minutes.

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6 Ask the students to open their eyes and remain quiet. Begin discussing the virtual field trip in terms of the lesson: students should be thinking of the pond as a habitat, and discovering how the pond meets the habitat needs of fish. Ask the students these questions.
   - Which plants were described in the story?
   - What type of food did the bluegill seek?
   - Why did the bluegill swim away so suddenly?
   - What types of animals were in the pond?
   - What are the bluegill's habitat needs?

Wrap-up

1 Ask the students to share some of their favorite images from the reading.

Part 2: Field Trip to a Pond
Warm-up

1 Review safety guidelines with your students before taking them to a nearby pond, wetland, or lake.
2 Have students make small writing journals, provide them with a small notebook or a sheet of paper, a clipboard or other flat writing surface, and a pen or pencil. Walk with your students to a nearby pond or other body of water. If there isn't one within walking distance or a reasonable drive, do Part 1, skip Part 2, and continue with Part 3.
3 At the site, have the students find a place to sit quietly. Ask them to observe their surroundings. What do they hear? What do they smell? What can they touch? What do they see? Ask them to look for the animals, birds, and insects that live in and around the water,

and to think about the places where these plants and animals live. What kinds of things do these animals need to survive in these surroundings? Have students record their observations in their journals, notebooks, or on the sheet of paper. (They can write descriptions, compose poetry, draw, or a combination.) Return to the classroom or meeting space.

4 Review the definition of habitat with the students.

Wrap-up

1 Ask students about sitting quietly at the pond, lake, or wetland site. Was it easy or difficult to sit still for ten to fifteen minutes? Were they surprised by anything they observed?

Part 3: Making Habitat Dioramas

Warm-up

1 Ask students to think about the kinds of animals living in the aquatic habitat they visited or envisioned during the virtual field trip. Discuss these questions: How do those animals survive there? Would *you* be able to live there? What do you need in order to survive? As students describe their habitat needs, list them on the whiteboard. Help students brainstorm a list of fish habitat needs, including food, water, cover, and space. Point out the similarities between people's habitat needs and those of fish. Food, water (including dissolved oxygen available for respiration for aquatic organisms), cover, and space are the basic habitat needs required for the survival of all organisms. If a place provides all of an organism's basic habitat needs, it's likely to be a suitable habitat. Discuss how habitat needs are the limiting resources that determine how big an individual fish can grow, which species survive, and the population size of each fish species in a habitat. What would happen to a fish population if there were a shortage of food? Water? Cover? Space?

2 As an extension, you might ask students to choose and research a Minnesota fish. Have them look up specific foods and other habitat requirements for their fish.

Lesson

This is an opportunity for students to make dioramas using a variety of craft materials creatively.

1 Remind students to think about the habitat needs for the fish that they've listed, including food, water, cover, and space. Their dioramas will show how an aquatic habitat provides for the basic needs of a bluegill, or for the fish species they chose to research.

2 Hand out shoeboxes, one per student.

3 Cut a peephole (approximately two and one-half inches in diameter) in the center of one of the short sides of the shoebox using a pair of scissors or a cardboard cutter. Students may need assistance. The peephole is for viewing the completed habitat. This creates a neat visual effect—everything in the habitat appears larger. See **Template for a Diorama Box**.

Except for some forms of bacteria, all organisms require a gas (such as oxygen) for respiration.

If students don't have shoeboxes, a box can be made using a template. One shoebox will be required for use as a template, or use the **Box Template for a Diorama.** Carefully take apart the shoebox and lay it flat, or enlarge and cut out the box template. Trace your template on sheets of tagboard and cut out one for each student. Demonstrate how to fold the tagboard cutouts into boxes, and have students secure three sides with tape, staples, or glue, leaving the side that will have the peephole. Cut the peephole, fold up the last side of the box, and secure the two remaining corners.

Use caution when cutting cardboard with scissors or the cutting tool. *Using scissors to cut peepholes can be tricky.* Cutting peepholes can be time-consuming and difficult for students—you may wish to cut the circular peepholes into the ends of the boxes in advance.

4 The box represents a pond, lake, stream, or river. Tell the students that they can use the materials provided to construct a model of a habitat for a Minnesota fish. Remind them that their diorama should show how the habitat meets the fish's habitat needs.
5 Students may want to first paint the inside of their box blue or green to represent water. They can then begin creating the background and habitat of their water body in the box using the materials provided. They may want to make sandy bottoms, rocks, sticks to represent fallen logs, submerged vegetation, foods (other fish, insects, frogs, crayfish, plankton), shorelines, and predators (larger fish, otters, herons, eagles, bears, anglers). Attach and mount the various habitat items to the box with glue or tape.
6 When the diorama is complete, cover the top of the box with a piece of blue plastic wrap to admit light and represent the water surface of the pond.
7 Crafted water lilies, cattails, duckweed, or other floating plant species and emergent plants can be added on top of the blue plastic wrap representing the water's surface.
8 When the dioramas are complete, ask students to create a label for their diorama listing the four habitat needs for their fish: food, water, cover, and space. Note how each is represented in the diorama. Have students glue, tape, or otherwise attach the labels to the outside of the diorama.

A completed habitat diorama.

Wrap-up

1 Display the dioramas and written paragraphs (see Assessment Options) in the classroom.

Assessment Options

1 Have each student write a paragraph about their fish, describing how its needs are met by its habitat, and how habitat needs can limit the number and sizes of fish that can live in an area. Review the students' paragraphs to ensure they understand the four essential habitat needs, and that food, water, cover, and space are limiting resources.

2 Assess the dioramas, making sure each one demonstrates how the habitat meets the four basic habitat needs of the fish.

3 Have students take turns presenting their dioramas to the class. They should be able to describe how each of the fish's four habitat needs are illustrated in their diorama. Have students explain why the food, water, cover, and space modeled in the diorama are limiting resources.

4 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

19–21 points = A
Excellent. Work is above expectations.

15–18 points = B
Good. Work meets expectations.

14–17 points = C
Work is generally good. Some areas are better developed than others.

10–13 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0–12 points = F
Work is unacceptable.

Design a Habitat Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Diorama shows three specific types of food eaten by fish.
2	______	______	Student uses materials to replicate water in diorama.
3	______	______	Student uses bottom, below surface, and surface of the water column area in diorama.
3	______	______	Diorama shows specific shelter types used by fish.
2	______	______	Diorama has adequate room for species present.
2	______	______	Nice layout and design. Organisms in the habitat are easily seen.
2	______	______	Paragraph clearly written and well-organized; presentation of diorama clearly delivered and well-organized.
4	______	______	All habitat needs (food, water, shelter, and space) that appear in the diorama are mentioned in the paragraph or presentation.
Total Points			
21	______	______	**Score** ______

Design a Habitat Scoring Rubric

Diorama Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Food and water	Shows three specific types of fish foods. Materials replicate water and utilize bottom, below surface, and the surface of the water column areas.	Shows two specific food types. Materials replicate water. Utilizes below surface and bottom water areas.	Shows one specific food type. Utilizes the bottom area only.	Shows no specific foods. Utilizes the bottom area only.	Diorama not completed. No fish foods represented in the habitat diorama.
Shelter and space	Diorama shows specific shelter types used by fish. Has adequate room for species shown.	Shows specific shelter types but not those used by the species in diorama. Has adequate room for species shown.	Shelter shown, but doesn't represent correct shelter types. Space is crowded.	No shelter shown. Too many organisms for the size of the water body.	Diorama not completed. No shelter represented in the diorama.
Design	Nice layout and design, completed with care. Easy to see organisms in their habitat. Entire water column utilized in diorama: bottom, below surface, and surface.	Nice layout. Some organisms hard to see. Only below surface and bottom utilized.	Layout is adequate, but difficult to see or discern all organisms. Organisms are on the bottom or below surface only.	Haphazard design. Doesn't represent a pond, lake, or stream system.	Diorama not completed.
Presentation	Paragraph clearly written and well-organized. All habitat needs (food, water, shelter, space) represented in the diorama are mentioned in the paragraph.	Paragraph written clearly. Only three habitat needs mentioned in the paragraph.	Paragraph written with some prompting and direction. Only two habitat needs mentioned in the paragraph.	Paragraph written, but is not clear. Understanding of habitat needs not demonstrated.	No paragraph written.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1. Do the Habitat Lap Sit activity from the Project Wild Curriculum Guide (see Resource List).
2. Have students write their own virtual field trip narrative for a pond, lake, river, or stream and read it to the class.
3. You may wish to do **Lesson 1:2—Food Chain Tag** to complement this lesson. It provides information on food chains that can help the students create their dioramas.
4. If you used the narrative prior to making the dioramas, arrange a visit to a nearby pond or wetland area. Ask students to look for signs of animal life, and to think about what those organisms need to survive in their habitat. Compare students' observations from the actual visit to a pond or water body with the mental pictures they observed during the narration.

For the Small Fry

K-2 Option

1. With younger students, visit a pond or shoreline habitat prior to this activity. Have the students look for animals, birds, and insects. Point out places where these plants and animals live, and talk about the things they need to survive in the habitat. Afterward, read a story to help students remember and visualize the things they saw. (Titles of suggested picture books appear in the Student Reading List Appendix). Spend some additional time talking about fish and their habitat needs. Compare the habitat needs of fish to the habitat needs of people. Show fish photographed in their habitats.
2. Younger students can make dioramas, but they may need some help with gluing and taping. Make sure the students include a fish, what that fish eats (food), where that fish lives and gets its oxygen (water), the things in or near the water that provide shade and help fish hide from other animals (cover), and some room for the fish to swim and find food (space).

To simplify diorama-making, use paper plates rather than shoeboxes to create fish habitats. Items can be drawn and painted and glued or taped to the paper plate. This eliminates the need to cut peepholes, requiring less dexterity.

INSTRUCTOR COPY

Field Trip to a Pond Narrative

It's a warm spring day. The sun is shining brightly. What a wonderful day to be sitting on a dock overlooking the pond! The light from the sun sparkles and dances on small waves over the pond's surface.

You close your eyes and feel the warm sunshine on your face. Your ears fill with the sounds of ducks skimming the water, their feet stretched forward as they land. You hear quacking as they settle on the surface. "Ker-plunk!" Startled by the quacking ducks, a frog jumps with a splash into the water from its sunny perch on a nearby lily pad. It's quiet again. Then you notice the soothing songs of the red-winged blackbirds. Slowly you open your eyes, squinting at the bright reflections of fluffy white clouds on sparkling blue water.

Take a deep, deep breath. Smell the scent of green plants growing in and near the water. As your eyes adjust to the light, the shapes of water lilies, cattails, and rushes become sharp and clear. Among the plants on top of the water, you see tiny beetles swimming in circles. A long-legged water strider perches on its tiptoes as if trying not to get wet. Your ears focus on a buzzing sound. It's coming from the beating wings of a dragonfly as it darts past and comes to rest on a cattail. Its brightly-colored body glitters green and purple in the sunshine.

You lie down on the warm, wooden surface of the dock, lean over the water, and gaze out onto the glittering surface. Then, through the tiny, floating green plants—they're called duckweed—and past the quivering lily pad stems, you spot a silver flash! What was *that*? A *bluegill* darting through a shimmering school of small minnows! This pond is busy with many living animals.

You search for where the bluegill might have gone. A small ripple spreads over the water, then another and another. You realize that several fish are rising from below, trying to catch the insects on the surface: There is more than one bluegill in this pond. You wonder why they are all swimming here, weaving in and out of the plants instead of cruising out in the open water. Are there more insects here? Yes, the bluegills are here amongst the plants, searching for their food.

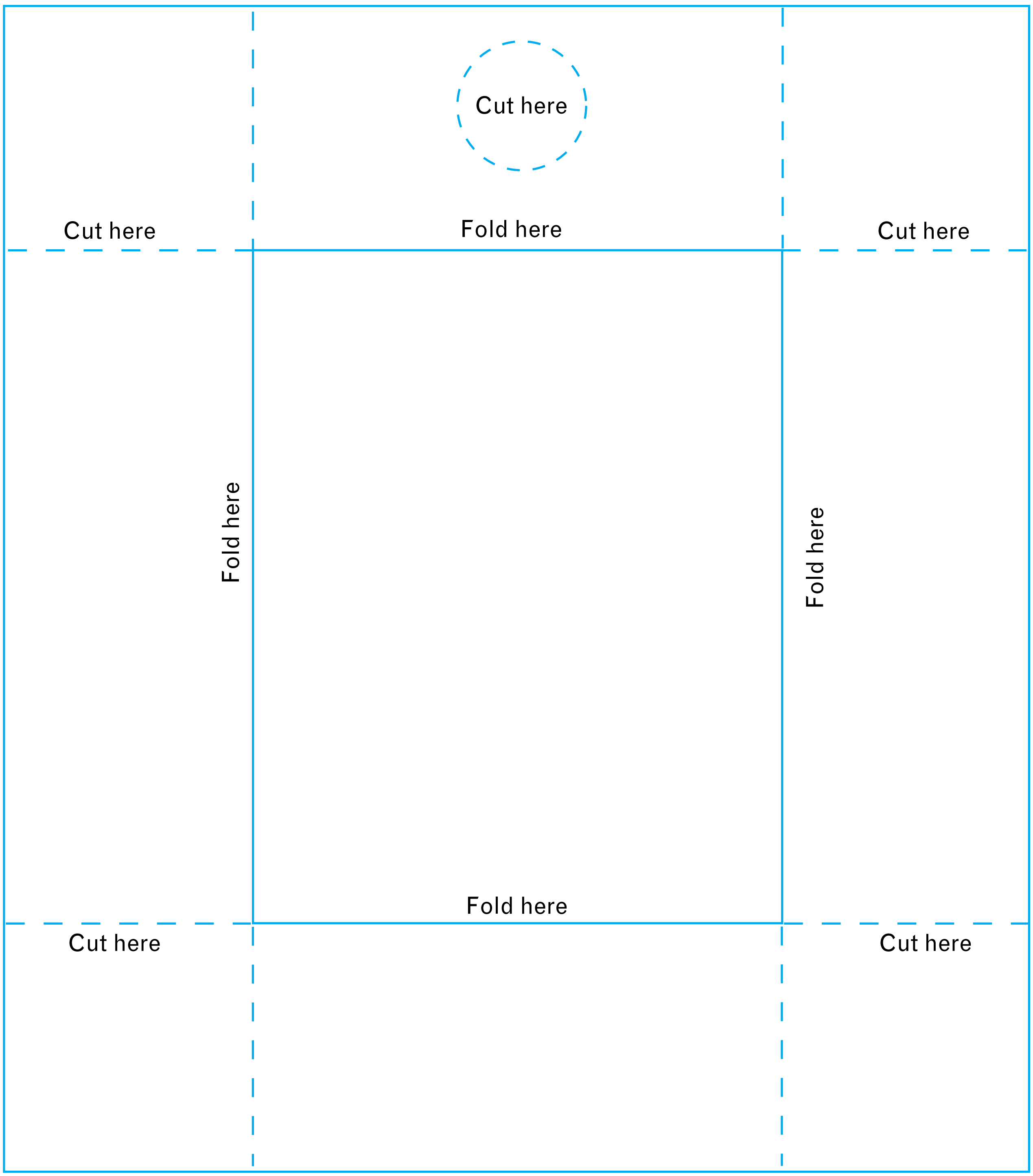
Your back begins to feel warm in the sun. You're thinking that maybe the water plants give the bluegills a shady, cool place to swim, and that that is where they find their food, too. There's a loud splash. You didn't see the fish that jumped, but it must have been a big one. Large waves spread over the water in expanding circles. Was that a big fish looking for a meal of bluegills? You say to yourself, "If I were a bluegill, I would use the plants as a place to hide from that big fish."

Your eyes drift down into the shadows under the dock. You see a fish, almost hidden among the underwater plants and rocks. It's waiting, unblinking and still; the only movement is the faint wave of a gill, and a fin. It's a sunfish—another bluegill. It must be resting. Then, suddenly, it turns. With a flip of its tail, it disappears into the shadows and waving plants. The bluegill is gone. A diving beetle darts through the plants where the sunfish was, using its back legs like oars. There is so much to see at the pond!

It's getting late. As you get up from your spot on the dock, birds fly in and out of the tangle of cattails and rushes. A frog begins to croak; another frog sends its reply. You take one last sweeping look across the glittering pond before heading home. You've made many discoveries today, and when you come back tomorrow there will be more. As you head up the winding path toward *your* home, you realize that this pond is the home of all these frogs, birds, insects, and fish.

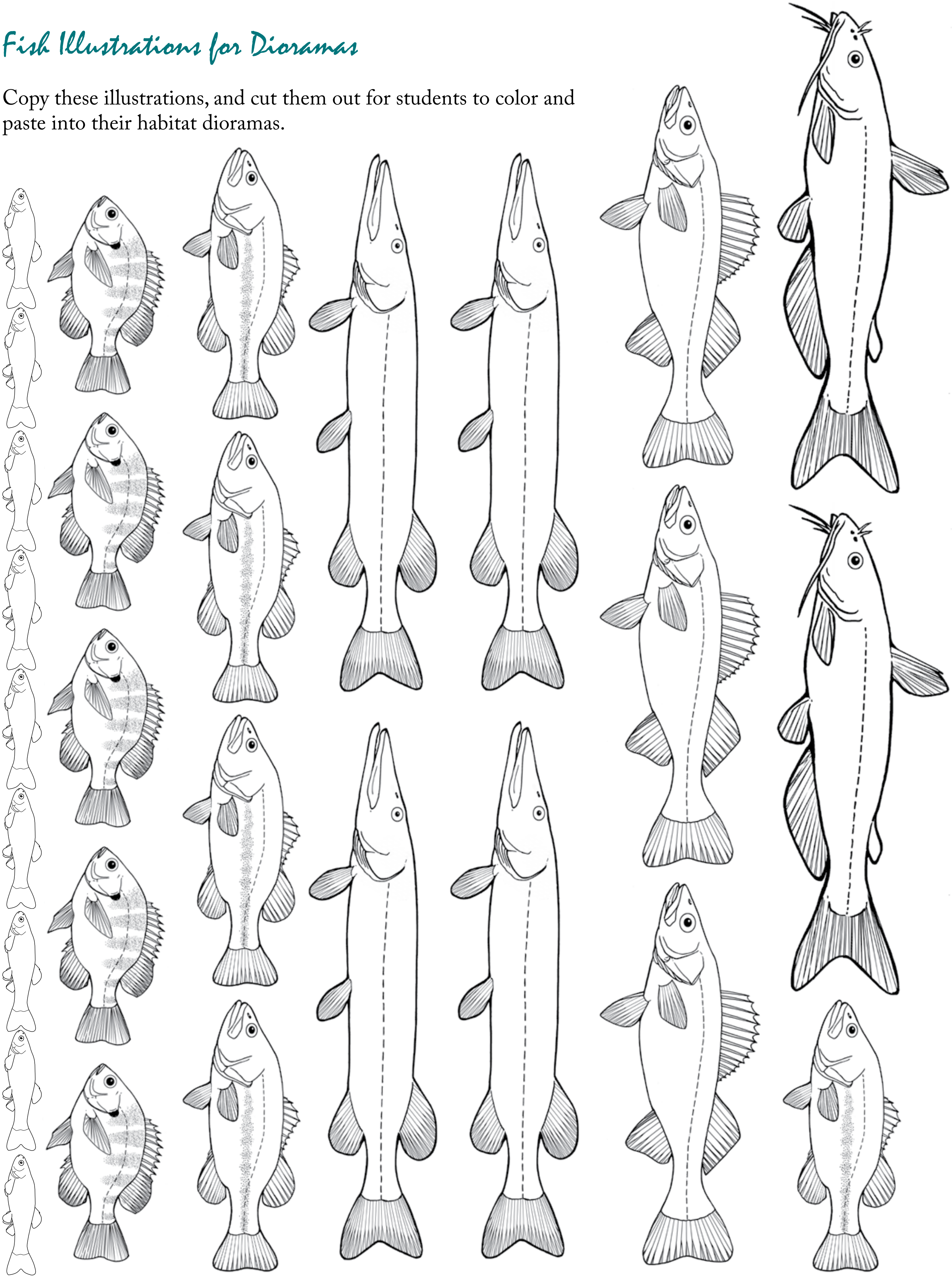
Template for a Diorama Box

- Enlarge the template to 17" x 22"
- Trace the template on a sheet of 17" x 22" tagboard or card stock
- Cut along the solid lines.
- Cut out the solid circle as a peephole for the diorama.
- Fold along the dotted lines to form a box.
- Bring the cut ends together at right angles to form a box.
  Fold the excess strips (about two inches) over the cut ends to hold the box together.
- Glue or staple the sections together.



Fish Illustrations for Dioramas

Copy these illustrations, and cut them out for students to color and paste into their habitat dioramas.



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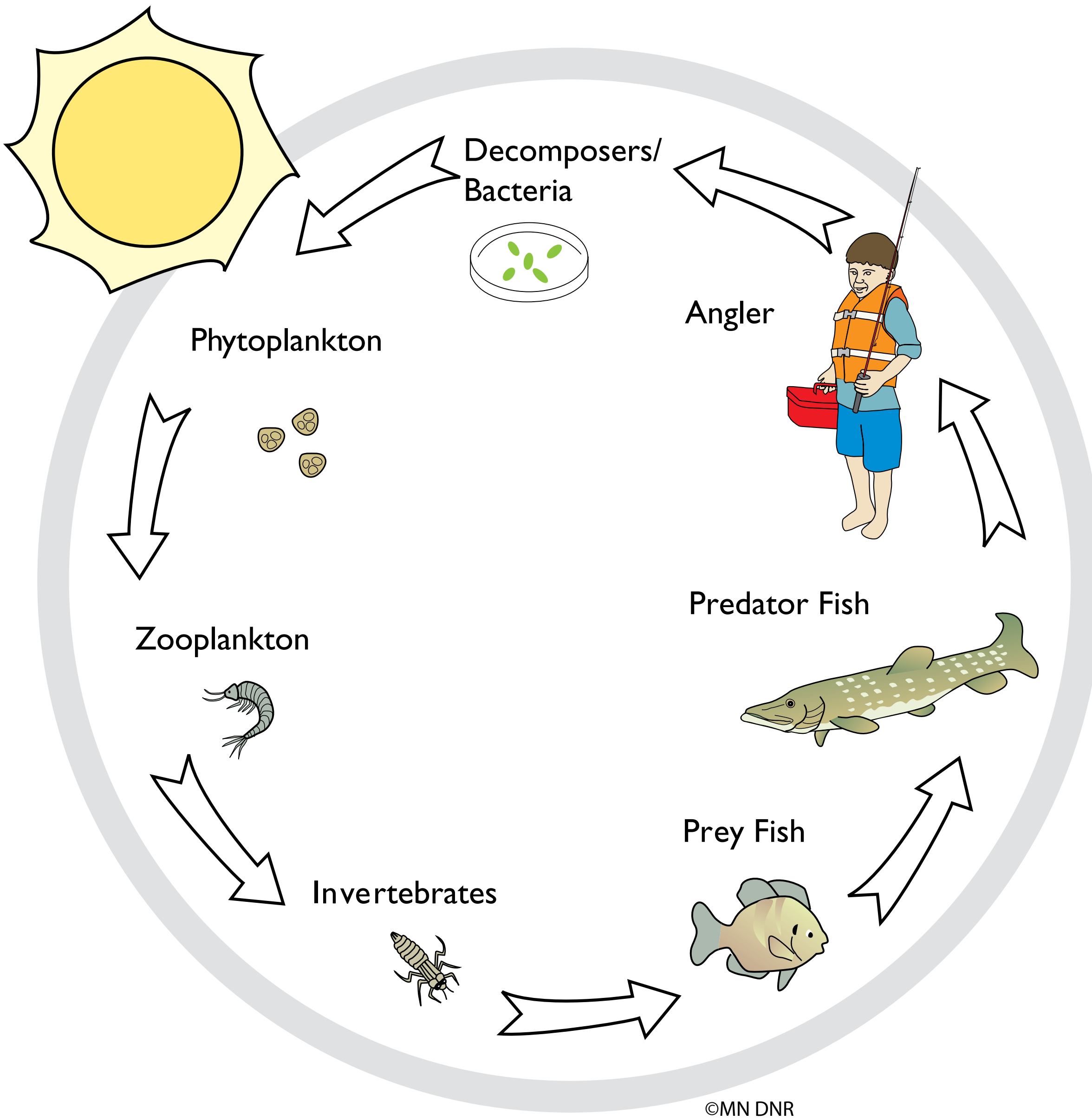
Food Chain Tag

Who's hungry? Let's become bacteria, minnows, perch, northern pike, and anglers and join a food chain in action!



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Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Food Chain Tag

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
Benchmark 3—The student will use context and word structure to determine the meaning of unfamiliar words.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.

Grades 4 and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate and follow agreed—upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Science

Grade 3
III. Earth and Space Science
C. The Universe:
Benchmark 3—The student will observe that the sun supplies heat and light to the Earth.
IV. Life Science
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 5
IV. Life Science
F. Flow of Matter and Energy
Benchmark 1—The student will recognize that organisms need energy to stay alive and grow, and that this energy originates from the sun.
Benchmark 2—The student will use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota.
Benchmark 3—The student will recognize that organisms are growing, dying and decaying, and that their matter is recycled.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 1 • Lesson 2

Food Chain Tag

Grade Level: 3-5
Activity Duration: 30 minutes
Group Size: 15-40
Subject Areas: Language Arts, Physical Education, Science
Academic Skills: analysis, application, gathering, interpretation, kinesthetic concept development, large group skills
Setting: large indoor or outdoor open area
Vocabulary: angler, balance, biomass, carrying capacity, consumer, decomposer, ecosystem, emigrate, food chain, food web, nutrient cycle, phytoplankton, plankton, predator, prey, primary consumer, producer, secondary consumer, zooplankton
Internet Search Words: decomposition, food chain, food web, plankton, predator-prey relationship

Summary

In this active role-playing lesson, students discover how energy flows and is transferred between the interdependent organisms of an ecosystem by assuming various roles (minnows, perch, northern pike, bacteria, and anglers) in an aquatic food chain. Each species feeds on plankton—or on one another—to obtain the food that provides the needed energy for survival in the lake. Decomposers break down dead plants and animals, recycling nutrients. In successive rounds of Food Chain Tag, new species are introduced and population ratios altered in an effort to balance the simulated ecosystem.

Student Objectives

The students will:
1. Illustrate that energy is transferred through an aquatic food chain by producers, consumers, and decomposers.
2. Illustrate how decomposers recycle nutrients from dead plants and animals.
3. Examine predator-prey relationships by assuming the roles of predators and prey in a lake ecosystem.
4. Define carrying capacity.
5. Determine the necessary number of predators and prey to achieve balance in a simulated lake ecosystem.
6. Explain how organisms in a food chain depend on one another for survival.

Instructor's Background Information

All things on the planet—both living and nonliving—interact. An **ecosystem** is defined as the set of elements, living and nonliving, that interact, over time, within a defined locale. A food chain demonstrates one way in which ecosystem elements interact in a systematic manner.

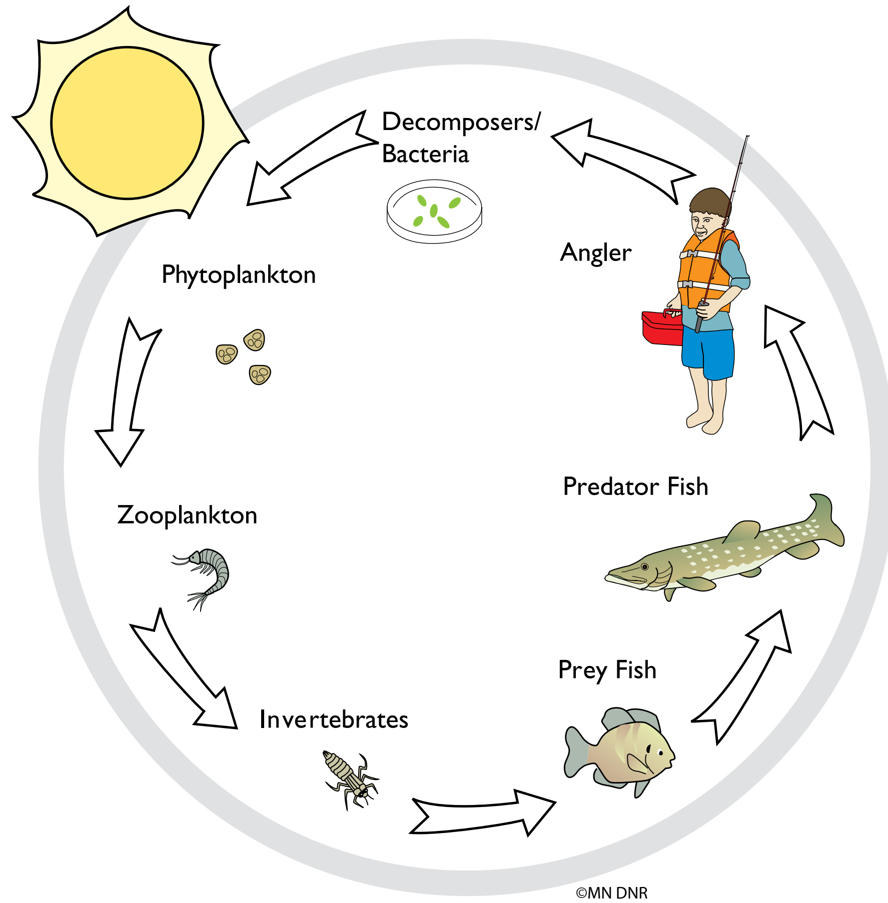
Food Chains

In an ecosystem, numerous interactions between organisms result in a flow of energy and cycling of matter. Food chains, the nitrogen cycle, and the carbon cycle are examples of these interactions. A **food chain** is the sequence of steps through which the process of energy transfer occurs in an ecosystem. All organisms need a continuous supply of energy. Energy flows through an ecosystem in one direction—through food chains.

Food chains illustrate how energy flows through a sequence of organisms, and how nutrients are transferred from one organism to another. Food chains usually consist of producers, consumers, and decomposers. If a food chain has more than one consumer level, its consumers are defined as primary, secondary, or tertiary consumers. Primary consumers eat plants, secondary consumers eat primary consumers, and tertiary consumers eat secondary and primary consumers.

Materials

- **Aquatic Food Chain Sheet**
- **Aquatic Food Chain Cards**
- Scissors
- Glue
- Construction paper or card stock
- Clear contact paper or laminating material
- **Food Chain Identification Tags**
- Clothespins or other clips, string, or yarn to thread through identification tags so they can be worn necklace-style
- Paper plates, one per student (optional)
- Markers (optional)
- 500 poker chips (or other tokens) to simulate plankton
- Plastic cups or plastic sandwich bags, one per student, to simulate stomachs
- Hula-hoops, two or more, to simulate cover
- Several laminated illustrations of lily pads
- Masking tape, for creating boundaries that simulate cover
- Rope, 50-100 feet long, or several field cones, to define lake boundary
- Whistle or other noisemaker

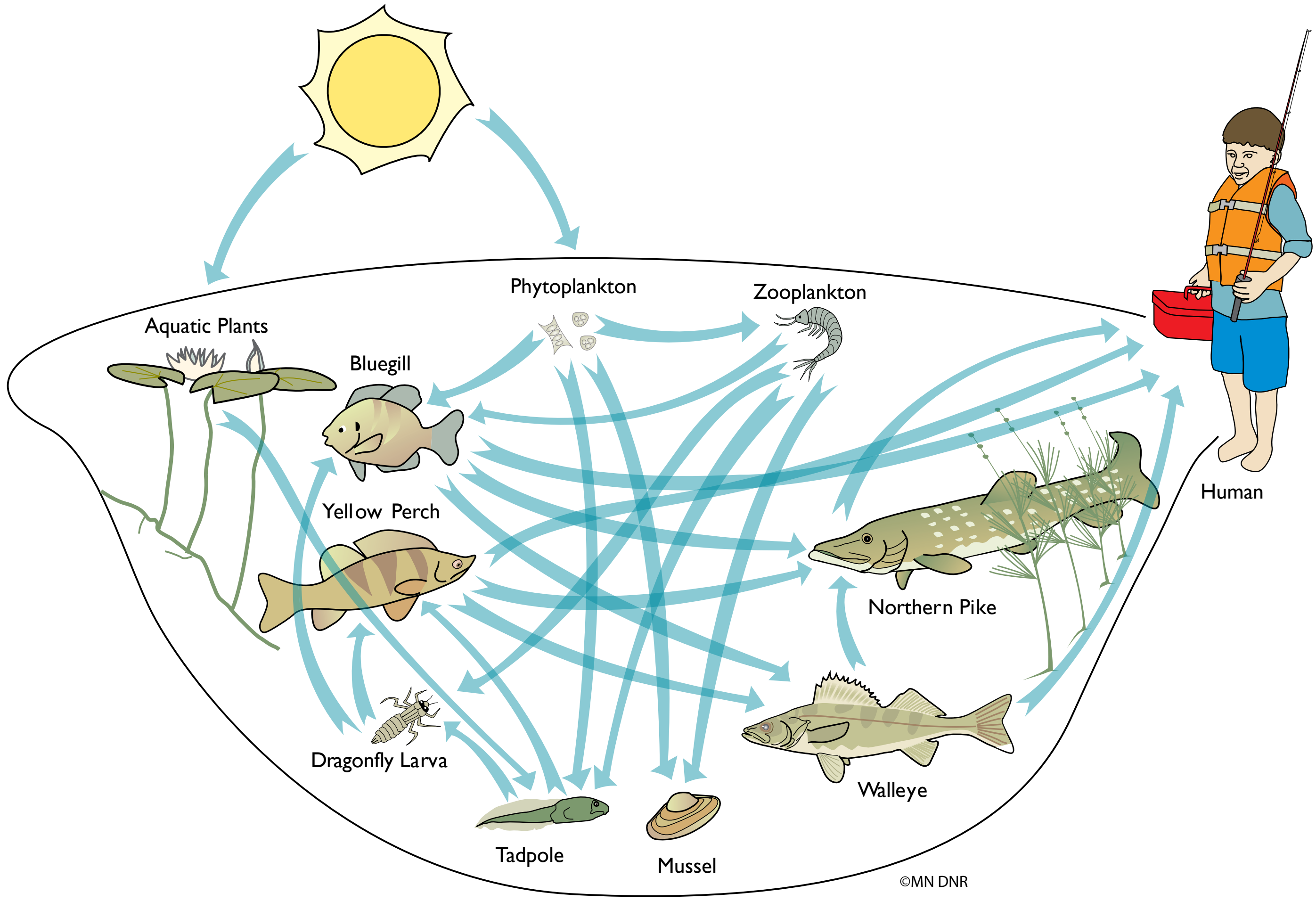


A food chain illustrates the movement of energy in an ecosystem.

The sun is the ultimate source of energy for all food chains. Through the process of photosynthesis, plants use light energy from the sun to make food energy. Energy flows, or is transferred through the system as one organism consumes another.

Food Webs

The concept of a food chain is an abstraction or generalization. Ecosystems are more complicated than a single food chain would indicate. Most aquatic ecosystems contain many more species than those in a single food chain, and all of these species interact and are interdependent. Like people, most aquatic organisms consume more than one type of food. A **food web** is a diagram of a complex, interacting set of food chains within an ecosystem.



Parts of a Food Chain
A food chain includes the sun, plants, primary consumers, secondary consumers, and decomposers.

The sun provides light energy (radiation), the ultimate energy source for all freshwater aquatic food chains.

Plants are the next link in a food chain. **Plankton** are among the smallest living organisms in ponds, lakes, rivers, and streams. This group includes tiny free-floating plants, animals, and some forms of bacteria. They range in size from microscopic bacteria and single-celled organisms to larvae and invertebrates large enough to be visible to the unaided eye. With little or no swimming ability, most plankton floats freely with the currents in open water.

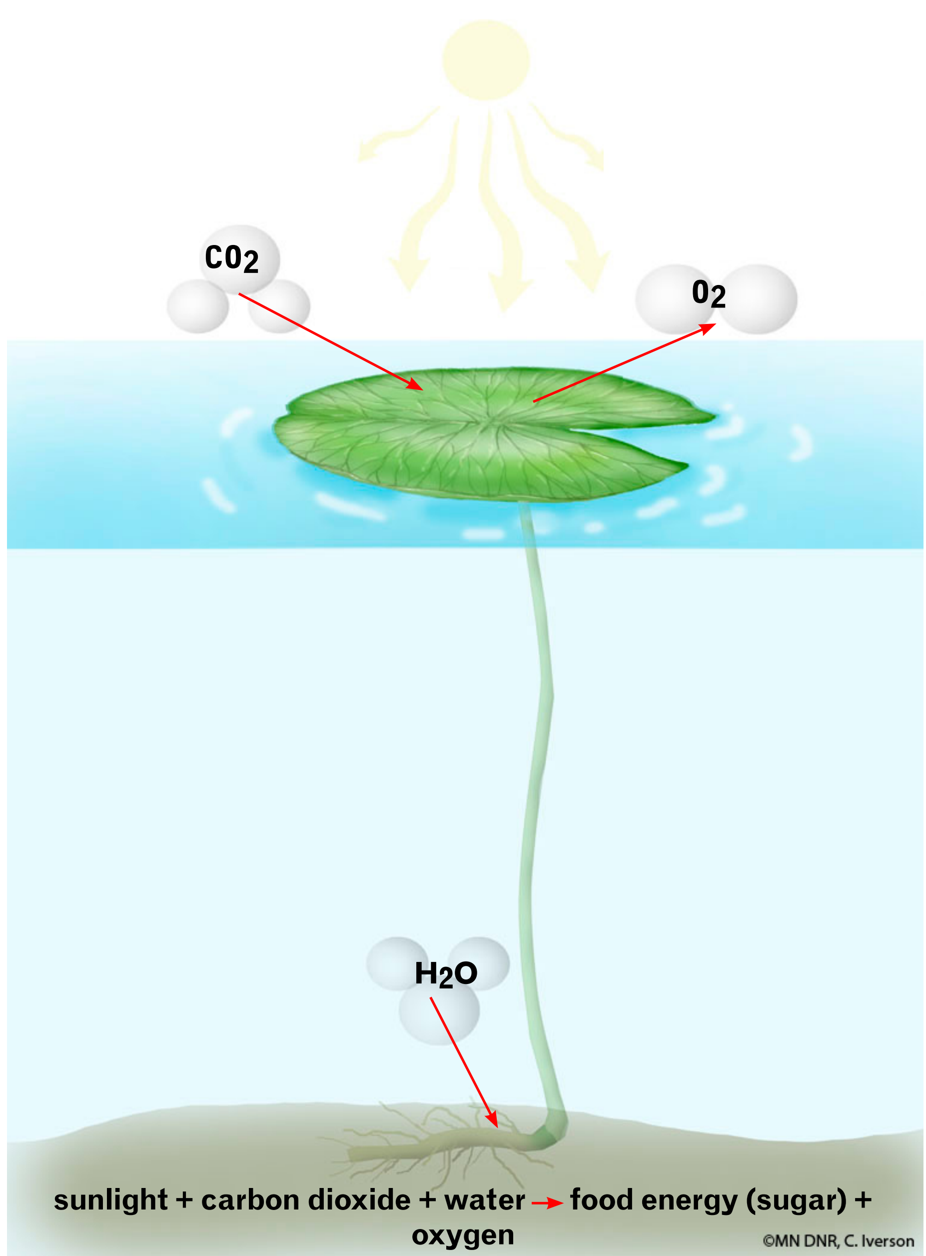
Phytoplankton are free-floating microscopic plants and bacteria suspended in the water that, like other plants, produce food energy directly from the sun's light energy. Plants (including phytoplankton) are called **producers** because they can produce simple nutrients and sugars (food energy) directly from the sun's light energy through the process of photosynthesis. As the base of food chains, phytoplankton populations are indicators of aquatic health. The food energy produced by phytoplankton supports much of the other life in the water.

A food web illustrates complex feeding relationships within an ecosystem. All organisms in a food web are interdependent. A food chain is just one strand of a food web.

By their shear numbers, phytoplankton are the main producers in the lake. If you could weigh all of these microscopic plants, they would weigh more than macroscopic plants.

Plants contain the green pigment chlorophyll and other pigments known as carotenoids. These pigments capture the sun's light energy, which plants convert to chemical energy (carbohydrates or sugar) through the process of photosynthesis. Other organisms consume plants to obtain the chemical energy that fuels life processes, including respiration, movement, growth, and reproduction. Plants obtain additional substances necessary for photosynthesis (carbon dioxide and hydrogen) from the air, water, and soil. Oxygen is a by-product of photosynthesis. Producers are the first link in every food chain, and they support all forms of animal life, including people.

Why do most plants look green to us? Plant pigments don't effectively absorb green and yellow light, so this light passes through the leaves, or is reflected from the surface of the leaves. This reflected light is the green color that we perceive.

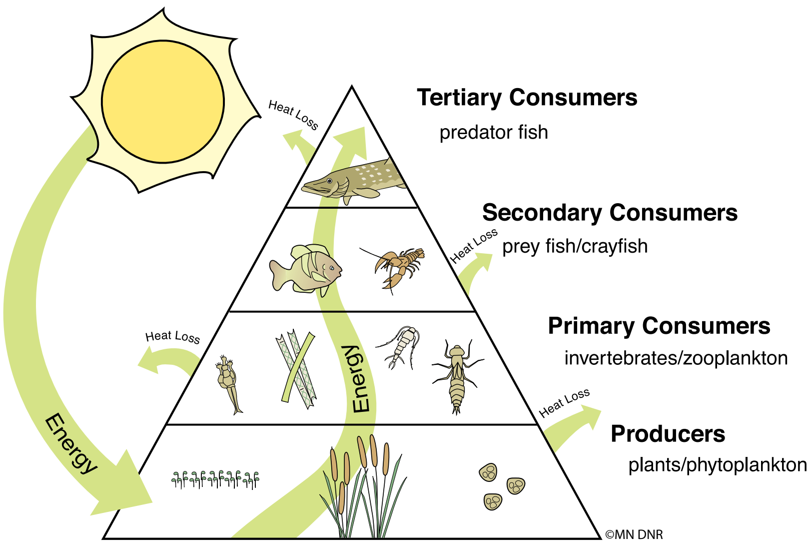


The chemical description of photosynthesis is:

LIGHT ENERGY	+	$6C0_2$	+	$6H_20$	=	$C_6H_{12}0_6$	+	60_2
		carbon dioxide		water		simple sugars or food energy		oxygen

Food energy transfers to microscopic aquatic animals, or **zooplankton**, as they consume phytoplankton. The zooplankton population in a lake or river can be a useful indicator of future fishery health because zooplankton are an important food for small fish (such as minnows) that are next in line in the food chain. Many larger fish, such as yellow perch, depend on a diet of smaller fish.

A **consumer** is an organism that obtains energy from eating other plants or animals. A relatively large quantity of plant material is required to support primary consumers. Animals that eat only plants (or phytoplankton) are primary consumers, or herbivores. Primary consumers, in turn, support a relatively smaller number of secondary consumers, or carnivores—animals that eat other animals. In food chains, most of the food energy consumed by organisms fuels growth and other functions. As an organism uses energy, food energy is converted to heat energy, which is lost from the system. Some food energy is stored in the tissues of organisms, and is, in turn, consumed and used by other organisms in the food chain.



This aquatic food pyramid illustrates energy transfer and relative biomass (defined below) in an aquatic ecosystem. Producers make up the greatest biomass in the system, and support all other life forms. Producers convert light energy from the sun into food energy. This food energy is transferred through the levels of the food pyramid, or trophic levels, as one organism consumes another. At each level in the food pyramid, energy is lost to the surrounding environment as heat as the organisms use food energy to feed, respire, grow, and reproduce. For this reason, each trophic level can only support or provide energy for a smaller biomass of organisms. Energy is also lost as heat on each level as organisms eat, move, grow, and reproduce. The sun continually replaces the energy in the system. Because energy is lost at each level, most food pyramids contain, at most, four trophic levels.

Biomass describes any organic plant or animal material available in an ecosystem on a renewable basis. A large biomass of producers at the bottom of the food pyramid supports a relatively smaller biomass of consumers, which support an even smaller biomass of secondary consumers. Energy flows from one level to the next as the organisms use it.

An animal that hunts, captures, and consumes other animals is a **predator**. Northern pike and eagles are predators, for example. An animal consumed by a predator is described as **prey**.

Some carnivores can also be called **piscivores**, which are animals that eat fish.

From bacteria to northern pike to people, all living things are composed of these elements:

- carbon
- hydrogen
- nitrogen
- oxygen
- phosphorus
- sulfur

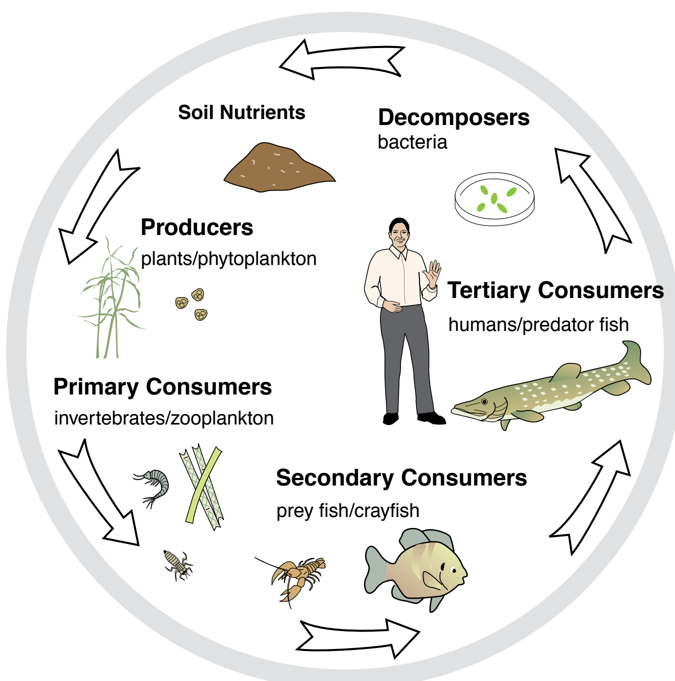
All plants require sixteen elements or basic nutrients. Most plants take in at least 23 different elements. Some nutrients aren't required by plants, but they're beneficial or needed by other organisms that consume plants.

Decomposers, such as bacteria and fungi, complete the food chain by consuming dead plants and animals and breaking them into nutrients. One nutrient by-product of decomposition is carbon dioxide, a simple substance that producers need to create food energy. Decomposers are the crucial last link in a food chain—they put nutrients back into the ecosystem. They also keep the landscape tidy—imagine what it would be like if decomposers didn't break down dead plants and animals!

Food Energy and the Nutrient Cycle

Nutrients are continually recycled in all ecosystems, but energy flows one way.

Nutrients are the materials required for life, and they build and renew organisms as they cycle through food chains. For example, carbon dioxide and water (which contains carbon, hydrogen, and oxygen), which plants use to convert the sun's energy into carbohydrates, also cycle through consumers as the consumers eat plants. (They also cycle through other consumers.) When consumers die, bacteria and fungi decompose them, releasing these and other nutrients (phosphorous, nitrogen, and sulfur) into the soil, water, and air. These nutrients are available to plants again, which use them to convert the sun's energy into carbohydrates. Decomposers are often referred to as **nutrient recyclers** because they break down dead material to provide the nutrients producers need to continue the cycle. Each plant, animal, and person is composed of nutrients that have been—and will be—used by other organisms in a continuous cycle. This sharing and recycling of nutrients is known as the **nutrient cycle.**



In an aquatic nutrient cycle, energy and vital elements (nutrients) transfer through trophic levels.

A Food Chain Is a System

Producers, primary consumers, secondary consumers, and decomposers are connected and interdependent by means of habitat needs and simple food chains. Loss or damage to just one link in a food chain eventually affects all organisms in the food chain system.

A food web is a larger, more complex system. But, as in food chains, loss or damage to a single strand in the food web impacts the entire system.

The food chain system is composed of parts, including the sun, plants, herbivores (plant-eaters or primary consumers), carnivores (animal-eaters or secondary consumers) and decomposers. A food chain illustrates how the various parts of a natural system have *functional* as well as *structural relationships*. Two main processes occur in this energy transfer system. One involves the movement of energy—in the form of light energy or radiation from the sun—to plants through photosynthesis. The second involves the movement of energy, in the form of organic molecules or food energy, from plants to herbivores to carnivores through consumption of biomass, as illustrated in the food pyramid model.

The parts of a food chain work together efficiently and demonstrate integration. Through the process of evolving together over time, present-day species of plants, herbivores, carnivores, and decomposers have developed ecological relationships. These relationships—of one species to another and between each species and its environment—maintain population levels and balance within ecosystems.

Carrying Capacity

The maximum number of individuals or inhabitants that an environment can support without detrimental effects on the habitat or to the organisms over time is referred to as **carrying capacity.** Aquatic habitats contain limited amounts of necessary food, water, cover, space, and other resources. The quantity and quality of these resources influence the carrying capacity of a habitat. Because resources are limited, the population growth of a given species slows as its population approaches the habitat's carrying capacity. At times, a population may exceed carrying capacity but it will decrease eventually. Population numbers tend to fluctuate over time, depending on seasons and changes in weather, climate, and other environmental shifts. Other influences include excessive predation, the introduction of exotic species, disease, pollution, over-harvesting, poaching, development, agriculture, and recreation.

If a fish population grows dramatically, becoming larger than the carrying capacity of the lake ecosystem, the fish consume resources much faster than they can be naturally replenished. Eventually, this can result in serious habitat degradation and a reduced carrying capacity.

Because all organisms are interconnected and depend on one other for survival, other populations of organisms are impacted, too. Excessive numbers of one type of fish competing for food and other resources will eventually lead to the death of many individuals if balance isn't restored. Fish sometimes **emigrate** (leave an area) and the size of the population in the habitat decreases. This, in turn, affects the predators that normally depend on that type of fish for food. This eventually impacts the entire food chain.

Balance

An ecosystem that can sustain itself over time through the interrelationships of its living and nonliving components is said to be in **balance.** Food chains are one type of interaction among organisms, and are part of a larger system of cycles, checks, and balances that maintain stable ecosystems—those that function continuously and remain viable over time. An ecosystem in balance is sustainable.

Procedure

Preparation

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1. To make the **Aquatic Food Chain Cards**, copy and cut them from the sheet.
2. Glue each picture to a sheet of construction paper or card stock. Laminate them or cover them with contact paper.
3. To make **Food Chain Identification Tags**, copy and cut them from the sheets. To make a set for each game, you'll need
   - 36 minnow cards
     twelve yellow perch cards
   - three northern pike cards
   - two angler cards
   - two bacteria cards
4. Attach each card to a sheet of construction paper or card stock—use a different color of construction paper or card stock for each species..
5. Laminate the cards, or cover them with contact paper.
6. Attach clothespins or other clips, string, or yarn so the tags can be worn necklace-style.

Activity

Warm-up

1. When the students settle down and you have their attention, ask them where they get all that energy! (We get our energy from the food we eat. All food energy can be traced back to the sun.) Ask the students what they ate for dinner last night. You may wish to have them draw pictures of the foods on a paper plate. Ask them to diagram the flow of food energy from their dinner back to the sun. Did anyone have fish for dinner?
2. Ask students to think about how fish get the energy they need to swim around, and to grow. What do fish eat?

3 Choose six volunteers to come to the front of the class.
4 Give each volunteer one **Aquatic Food Chain Card.**
5 Ask the volunteers to try to line up in the order of a food chain (without talking). How did they do? Explain food chains, food webs, and predator-prey relationships. Explain that light energy from the sun helps tiny green plants called phytoplankton (producers) grow and produce food energy in a lake. Zooplankton and aquatic invertebrates (water insects, bugs and crustaceans) and small fish, like minnows (primary consumers), eat the phytoplankton. Larger fish, like perch (secondary consumers), eat the smaller fish. Then, an even larger fish, such as a northern pike, eats the perch. Finally, an eagle or an angler might catch a perch or northern and eat if for dinner. The steps through which food energy flows and is transferred is called a food chain.
6 Ask the students the following questions. Which organisms in our food chain are predators? Which animals are prey species? Can an animal be both predator and prey? (The perch is one example of a species that is both predator and prey. Perch eat minnows, and are also eaten by larger fish such as northern pike.)

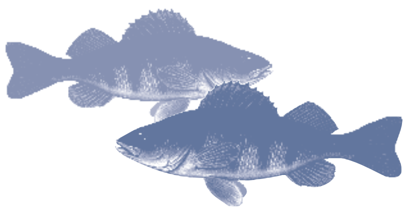
Lesson
1 To begin the game, identify the boundaries of your lake ecosystem (an area approximately half the size of a basketball court) and conduct the activity within this space. Use a rope or field cones to mark the boundary. Define ecosystem for the students.
2 Scatter plankton (poker chips) randomly around the lake, reserving approximately 100 poker chips for use in Round Three.

This activity is a simulation, so some of the species' roles are simplified. In actual aquatic habitats, many species eat more than one type of food. In this activity, one food chain is identified. It can be a strand in a more complex aquatic food web.

Round One: Primary consumers—15-36 minnows
1 Distribute a minnow identification tag to each student.
2 Hand students a "stomach" (plastic cup or sandwich bag) in which to put their "food" (poker chips). Put all the "minnows" (students) in the lake. When the activity starts, the minnows will try to fill their stomachs, one poker chip at a time, with as much "plankton" as they can.
3 Tell the students the rules of the lake:

- To avoid collisions, tell the students that they may not run! Repeat this, if necessary, throughout the activity. The instructor may wish to assume the role of an eagle—whose eagle eyes see every fish in the lake. The eagle is a predator and will make a quick lunch of any fish that runs!
- Everyone must stop "feeding" (putting poker chips in their plastic cup or bag) promptly at the sound of the signal. Demonstrate the signal on the whistle or other noisemaker.
- Everyone must remain within the lake boundary.

4 Let the feeding continue until the minnows have eaten all the plankton.
5 When the plankton are gone, give the signal to stop feeding. Ask the students how many minnows filled their stomachs with fifteen or more poker chips (plankton)? Those minnows survived! What happened to all the food in the lake?
6 Introduce the term carrying capacity. What will happen in our lake now that all the food is gone?
7 Thinking about the food chain, how could we balance the lake?
8 Have students return plankton to the lake.



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Round Two: Secondary consumers—four to twelve perch (depending on class size)

1 Put two hula-hoops into the lake. Tell the students the hula-hoops represent cover and are safe places for prey. Only one student at a time may hide in a hula-hoop, and only for five seconds at a time. Tell students that they can't stand next to the cover and go in and out. They must move to other areas of the lake before they can return to cover.
2 Add another layer of consumers to the lake. Exchange several students' minnow identification tags for perch identification tags. The number of perch will depend on the size of your class. If your group size is about fifteen, you may wish to start with four perch. If your group size is closer to 35, try starting with eight or nine perch.
3 Tell students the perch can eat plankton in the lake, just as the minnows do. But, perch are predators and can also eat minnows. Predators catch their prey by tagging them. When tagged, the minnow, or prey, must empty the contents of its stomach into the stomach of the predator, which is the perch. The tagged fish is now "dead" and must sit down at the edge of the lake.
4 Begin the feeding and continue until most of the plankton has been eaten before giving the signal to stop feeding.
5 How many minnows have plankton in their stomachs? Those minnows survived! How many minnows survived? How many perch survived? A perch has survived if it has food in its stomach.
6 What would happen to the food if we kept playing? Is anything missing from our lake?
7 Have students return plankton back to the lake.

Round Three: Decomposers—one to four bacteria

1 Select one or two of the minnows to portray bacteria.
2 Tell students the bacteria break down the dead plants and animals into nutrients and they're called decomposers. In this round, when the minnows are tagged, they must sit down and wait to be decomposed by the bacteria. The bacteria will take them to the edge of the lake. To prevent students from feeling frustrated at having been tagged and sitting out the rest of the round, demonstrate that it can be fun to "decompose" on the edge of the lake! (Be dramatic.) Give the 100 reserved poker chips to the bacteria. The bacteria

toss a few poker chips back into the lake when they take a tagged minnow to the edge of the lake. This represents the nutrients the bacteria release, which provide new phytoplankton growth in the lake. The phytoplankton, in turn, provides food for zooplankton and other consumers.

3 Start the game again. You may wish to periodically add a few minnows (the ones that get tagged) back into the game as this round progresses, to show reproduction of minnows.
4 Let the feeding occur until most of the plankton are consumed, or after several minutes of your aquatic ecosystem functioning in balance.
5 How many minnows survived? How did the bacteria affect the lake ecosystem? Is our ecosystem balanced? What does our ecosystem need? (You may need to adjust the ratio of minnows, perch, and bacteria to better balance the system).
6 Ask students if anything else could be missing from the lake. Can they think of another predator to add to the lake?
7 Have students return the plankton to the lake.

Round Four: Predators—one to four northern pike, depending on class size

1 Add northern pike to the lake. Exchange up to three minnow identification tags from the remaining minnows for northern pike identification tags, depending on the size of your class. You may also wish to have some minnows and perch trade roles, giving more students opportunities to be predators. The northern pike are predators that feed on the perch. When a perch gets tagged, the student must empty half the contents of its stomach into the stomach of the northern pike and sit down to wait for the bacteria to take them to the edge of the lake. Then they give their remaining poker chips (food energy) to the bacteria to scatter back into the lake as phytoplankton. (The northern pike can eat perch or minnows. But remind the students that northern pike usually go after the perch because they're larger and give them more food energy for less work. Perch still eat both minnows and plankton. Minnows eat only plankton.)
2 Both minnows and perch may hide in the cover (hula-hoops), but the same rules apply: only one fish in a hula-hoop at a time, and for only five seconds. They must then move around the lake.
3 Restart the game. When much of the plankton is gone, or when the system has been operating in balance for several minutes, stop the game. Determine how many survivors remain in the lake. Are there minnows left? How many perch are left? Did the northern pike survive? A northern pike has survived if it has food (poker chips) in its stomach. A healthy, balanced lake will have more prey individuals than predators. How could you adjust the numbers so this occurs? (An approximate ratio of 6 (minnows): 3 (perch): 1(northern pike) balances this simulated lake.
4 Students should begin to understand that energy flows through

ecosystems and is constantly being replenished by the sun as nutrients cycle or circulate through the ecosystem. Tell students that an ecosystem is defined as all living and nonliving things interacting within a defined place. One way that living and nonliving things interact is by means of a food chain.

5 Have students return the plankton to the lake.

Round Five: Top predators—one or two anglers

1 Discuss with students how people are part of the ecosystem, and how they might impact it.

2 Select one or two of the minnows to be anglers. Give each an angler identification tag to wear. Explain that anglers must first find bait—by tagging one minnow—before they can fish. While linking arms, the minnow and angler must then try to catch a perch or northern pike by having the minnow ("bait") tag that fish. (Only one fish can be caught at a time.) The angler will then take the fish's food energy and escort this "caught" fish to the edge of the lake. Ask students what happens to the food energy (poker chips) from the fish the angler catches. Remind students that the fish can still use the cover to hide from predators and anglers.

3 When most of the plankton is gone, stop the game. Determine which species survived. If the lake ecosystem is in balance, there should be more minnows than perch, and more perch than northern pike.

4 Have students discuss the results of this round. Is the lake balanced or is it headed for trouble? How did anglers affect the lake ecosystem? If the impact was dramatic, what could be done to limit the anglers' impact on the lake? (Examples include creating regulations such as designating fishing seasons for certain species or establishing catch limits.) What would happen if the number of northern pike exceeded the carrying capacity? (Eventually, they could be the sole remaining fish and have no more food to eat.) Could the northern pike survive this situation?

5 If time permits, try to balance the lake by varying the ratios of different fish species in the lake, then play more rounds and discuss what happens. Have the students determine what adjustments after each round to balance the ecosystem. Try adding more anglers and introduce fishing regulations to maintain a balanced ecosystem.

Wrap-up

1 Hand out copies of the **Aquatic Food Chain Sheet** and review definitions of food chain, ecosystem, and carrying capacity.

2 What was it like to be a prey species? A predator? Why?

3 What would happen if anglers caught too many predators? Would the ecosystem be balanced? (If the northern pike were overfished, there would be few predators left to eat the perch. The perch population would increase until they ate most of the minnows. If the perch were overfished, the northern pike would be affected because their food source would be diminished. The northern pike

population in this case might start to decline. They may have to find their way to another lake through an outlet or stream flowing into the lake—or succumb to starvation.)

4 What was the role of the bacteria? (They are decomposers and return nutrients to the food chain.) What is the role of the plankton? (Phytoplankton, a producer, makes food energy from the sun's energy through the process of photosynthesis. Zooplankton are primary consumers that eat phytoplankton, and provide food for larger organisms in the lake.)

5 Why can't all lakes be brimming with large or "trophy" fish? (Too many large predators deplete the numbers of available prey. Carrying capacity limits the population size of each species in the lake ecosystem.)

Assessment Options

1 Have students demonstrate their understanding of food chains by drawing a food chain poster. The poster should illustrate energy transfer starting with light energy from the sun through a producer, primary consumer, secondary consumer, and decomposer. Encourage students to do some research and include local aquatic organisms other than the ones used in Food Chain Tag.

2 Have students write a story or poem about what it was like to be a minnow, perch, northern pike, or angler in the game. They should include how their organism fits into the food chain in relation to the other organisms in the lake. They should also consider how they're affected by changes in the ecosystem, or if an ecosystem becomes unbalanced.

3 Divide the class into groups of five or six have the groups research an aquatic food chain containing organisms different from those in the game. They should determine what each organism eats, and which are producers and consumers. (These food chains could include muskrats, eagles, herons, other types of fish, and so forth.) Have the students play an additional round of Food Chain Tag as a narrated skit, acting the different predator-prey-producer roles to show different ways of balancing the system. (For example, if we have too many predators, we must increase the amount of prey or decrease the number of predators to balance the system.) Ask the students to include an explanation of what happens when the system becomes unbalanced with more members of a species than the system can support. Ask them to explain carrying capacity.

4 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

26-28 points = A
Excellent. Work is above expectations.

22-25 points = B
Good. Work meets expectations.

17-21 points = C
Work is generally good. Some areas are better developed than others.

13-16 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Food Chain Tag Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
6	______	______	Student understands roles of *producers*, *consumers* and *decomposers* in Food Chain Tag.
4	______	______	Student understands the importance of *predators* in balancing the lake ecosystem and limiting the size of prey populations.
3	______	______	Student understands that a larger number of *prey* are necessary to support a smaller number of predators.
2	______	______	Student defines *carrying capacity*.
2	______	______	Student defines *plankton*.
3	______	______	Student draws a link from the sun to a specific family or species of aquatic producers in the poster.
3	______	______	Student draws a specific primary and secondary consumer. The link is accurate for the food chain.
2	______	______	Student draws a decomposer and links it to the food chain.
3	______	______	Student's poster is attractive, legible, and easily seen from a distance.
Total Points			
28	______	______	**Score** ______

Food Chain Tag Scoring Rubric

Food Chain Poster Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Food chain tag role-playing	Understands the roles of producers, consumers, and decomposers. Suggests addition of predators to balance lake ecosystem and limit size of prey populations. Understands ratio of predators to prey (larger number of prey necessary to support a smaller number of larger predators). Defines carrying capacity and plankton.	Understands role of producers and consumers and decomposers. Understands that predators limit size of prey populations. Understands that plankton are tiny plants and animals that live in water, and that phytoplankton are producers.	Understands predator-prey relationships (predators hunt, capture, and eat prey species). Understands that bacteria consume and break down dead plants and animals, releasing nutrients back into the lake, where phytoplankton use them to produce food energy.	Remembers that minnows eat plankton, yellow perch eat minnows, northern pike eat yellow perch, anglers catch fish, and that bacteria put nutrients back into the lake.	Doesn't understand the food chain concept or predator-prey relationships.
Source of energy and producers	Poster links the sun to a specific family or species of aquatic producers.	Poster shows accurate producers that are examples of various aquatic plants.	Poster links the sun to a producer and shows examples of terrestrial and aquatic plants.	Poster shows no direct link between the sun and the producers. Only aquatic or only terrestrial plants shown in poster.	No producers indicated or identified on the poster.
Consumers and decomposers	A specific primary and secondary consumer are drawn. The link is accurate for food chain. A decomposer is drawn in the food chain.	A specific primary consumer is linked to the producer. A decomposer is drawn in the food chain.	A variety of consumers are drawn, but none consume the producers drawn in the food chain. Decomposer drawn in the food chain.	A secondary consumer is linked to a producer. No decomposers present in the food chain.	No producers indicated or identified on the poster.
Design and materials	Poster is attractive, legible, and easily viewed from a distance.	Poster is attractive and easily viewed.	Poster is not easily viewed from a distance.	Poster is messy, illegible, and not easily viewed from a distance.	No producers indicated or identified on the poster.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Select a poker chip color to represent pollution in the lake—but don't tell the students that this color has significance until later in the game. This color can signify a contaminant such as mercury or PCBs. Let the fish feed on all colors of chips. At some point during the game, stop the action and tell the students that one chip color represents contaminants, such as mercury or PCBs, in the lake. Assess the levels of contamination in each type of fish. Which type of fish has eaten the largest amount of the polluted poker chips, and why? (There should be larger concentrations of the pollution-colored poker chips in the stomachs of the secondary and tertiary consumers that are higher in the food chain.)

- Define and discuss the concepts of **bioaccumulation** and **biomagnification**. Demonstrate how levels of contaminants accumulate in higher concentrations in the upper portions of the food chain. How could this affect people?
- Tell students that the fish in the game whose stomachs contain a concentration of more than 75 percent of the pollution colored chips are unhealthy, and that they demonstrate unusual behaviors. Assign these students a movement other than walking (such skipping, crawling, or walking backward) and resume the game. What impact does this have on the balance of the lake?
- Define mercury and PCBs (polychlorinated biphenyls). Discuss what happens when mercury and PCBs enter the environment in terms of lakes and streams and people. Point out that some fish in lakes and streams may have unhealthy levels of mercury, PCBs, and other contaminants in their bodies. These fish can be harmful to people that eat them, particularly if they're eaten regularly. People can reduce their risk of consuming harmful contaminants by following guidelines found in the Minnesota Department of Health Fish Consumption Advisory that can be viewed online at **www.health.state.mn.us**. (For more information on mercury, PCBs, and other contaminants, see **Lesson 6:5—Eating Fish.**)

2 Form a food web with the students. Paste or draw pictures of the sun, plants, and animals on cards. Form a circle and give one card to each student sitting in the circle. Start with the student holding the sun card, and give them a ball of yarn. Have that student say, "I am the sun, and I give my energy to the phytoplankton." The sun should holds one end of the yarn and pass the ball to the student holding the phytoplankton card. The phytoplankton then holds part of the yarn and continues the process. At the end, each student will hold part of the yarn, making it evident that these items are

connected in the multiple food chains that form a food web. Make cards to illustrate and include multiple food chains, such as:

sun ➔ phytoplankton ➔ zooplankton ➔ sunfish ➔ decomposer ➔ cattail ➔ muskrat ➔ fox ➔ hawk ➔ decomposer ➔ algae ➔ water penny ➔ minnow ➔ largemouth bass ➔ human

Pull or tug at one of the strands of the web to indicate a disruption in the system. For example, silt from a development project covers all the sunfish eggs, decreasing the population of sunfish in the lake. As members of the food web feel a tug, have that student explain how they were impacted by the disruption in the food chain. That student must then tug on the yarn. How far through the web is the impact of the original disruption felt?

3 For the final round of the game, ask students what they think a Minnesota DNR Fisheries Manager might do to manage a lake to provide good fishing year after year. You may want to institute a fishing license when the anglers are added by writing the word "license" on the angler identification tags. Suggestions might include stricter regulations, habitat improvement projects, and stocking plans. Impose restrictions on anglers by having them hop on one foot or walk backwards. Play out the final round to demonstrate the students' various management suggestions. Discuss Minnesota fishing regulations, and special regulations on certain lakes. (See the current Minnesota fishing regulations booklet and **Lesson 4:1—Fishing Regulations and Sportsmanship** for more information.)

4 To further explore aquatic habitats and food webs with an investigative, hands-on "desktop ponds" activity, obtain the Great Explorations in Math and Science (GEMS) instructor's guide, *Aquatic Habitats: Exploring Desktop Ponds*, by Katherine Barrett and Carolyn Willard (This guide is available through the Lawrence Hall of Science, University of California at Berkeley, Berkeley, CA 94720-5200, 800-727-4368.)

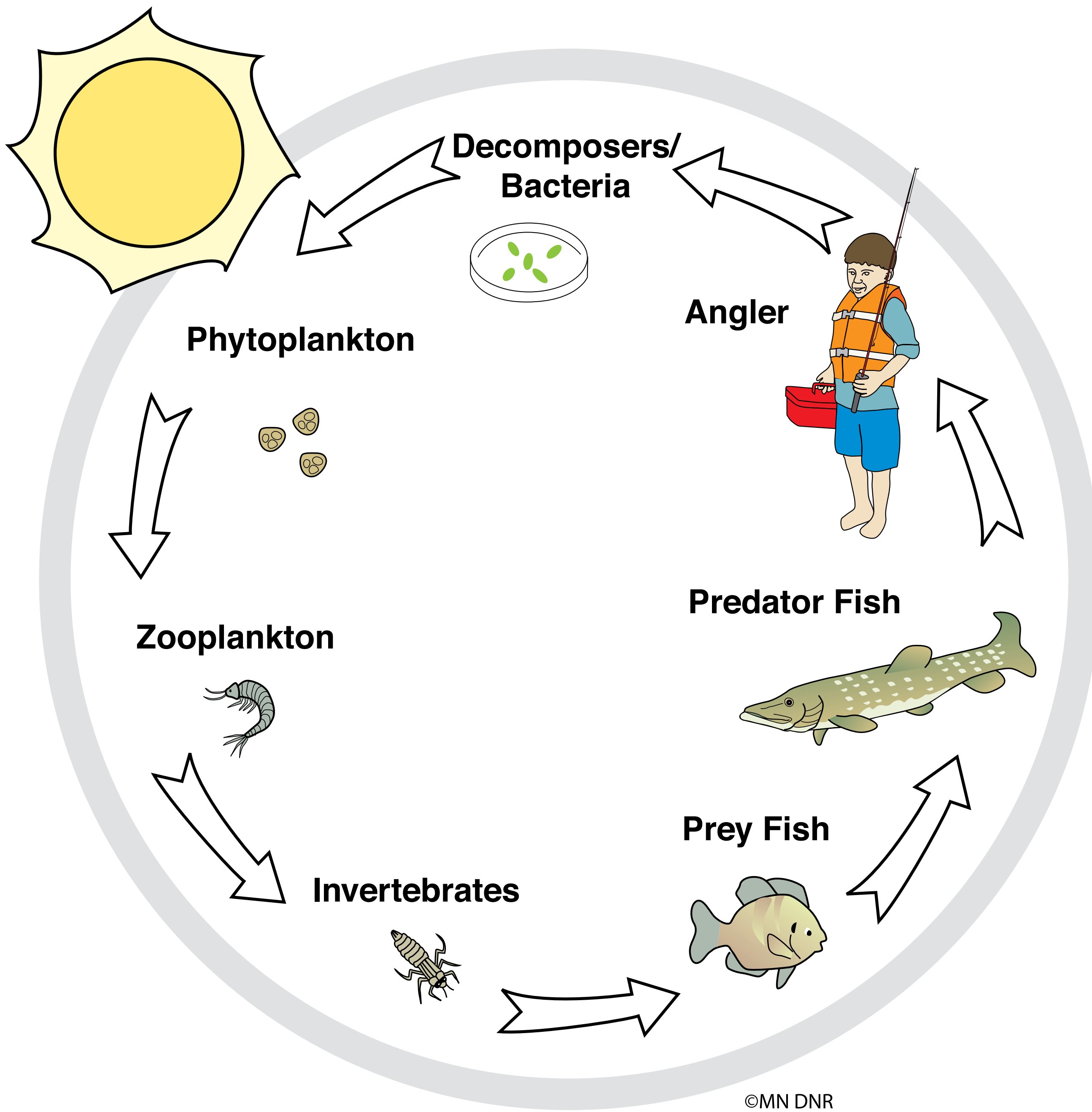
For the Small Fry

K-2 Option

1 Ask the fish to count the number of chips in their stomachs after each round. For example, minnows may need five chips to survive, perch may need ten chips, and northern pike may need 20 chips.
2 In Round Two, have the captured minnows empty their stomachs into the stomachs of the perch, but then allow them to continue feeding (collecting chips) instead of sitting out.
3 Do only Rounds One, Two, and Four, skipping Round Three.
4 Reinforce that light energy from the sun makes plants (including phytoplankton) grow. Describe a food chain for the students. (Small animals, insects, and small fish eat plants. Big fish eat the small fish. People can eat the big fish.) Introduce the terms food chain, predator, and prey. Disregard the terms producer, consumer, decomposer, and carrying capacity.

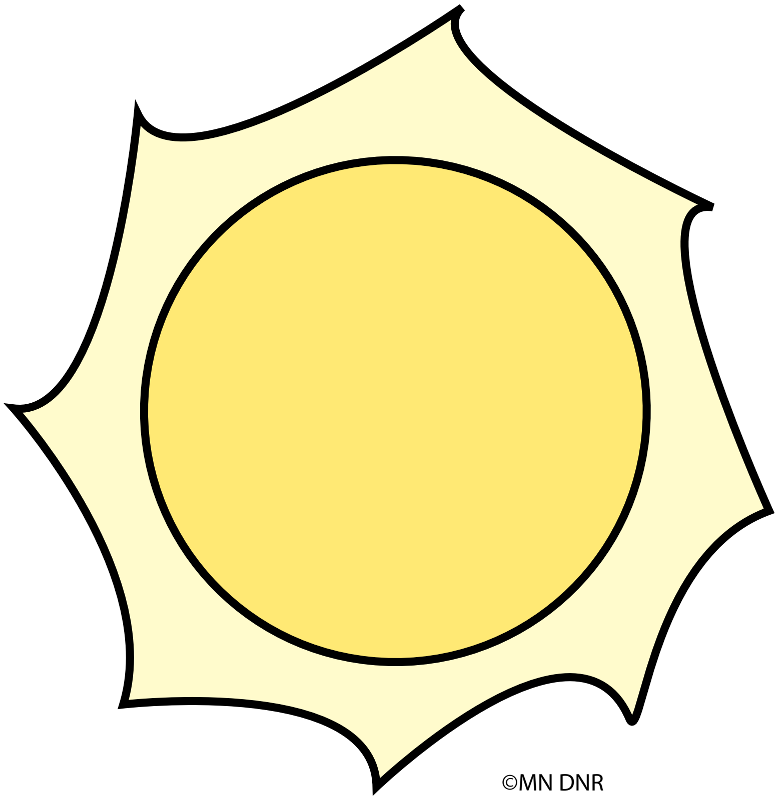
INSTRUCTOR COPY

Aquatic Food Chain Sheet

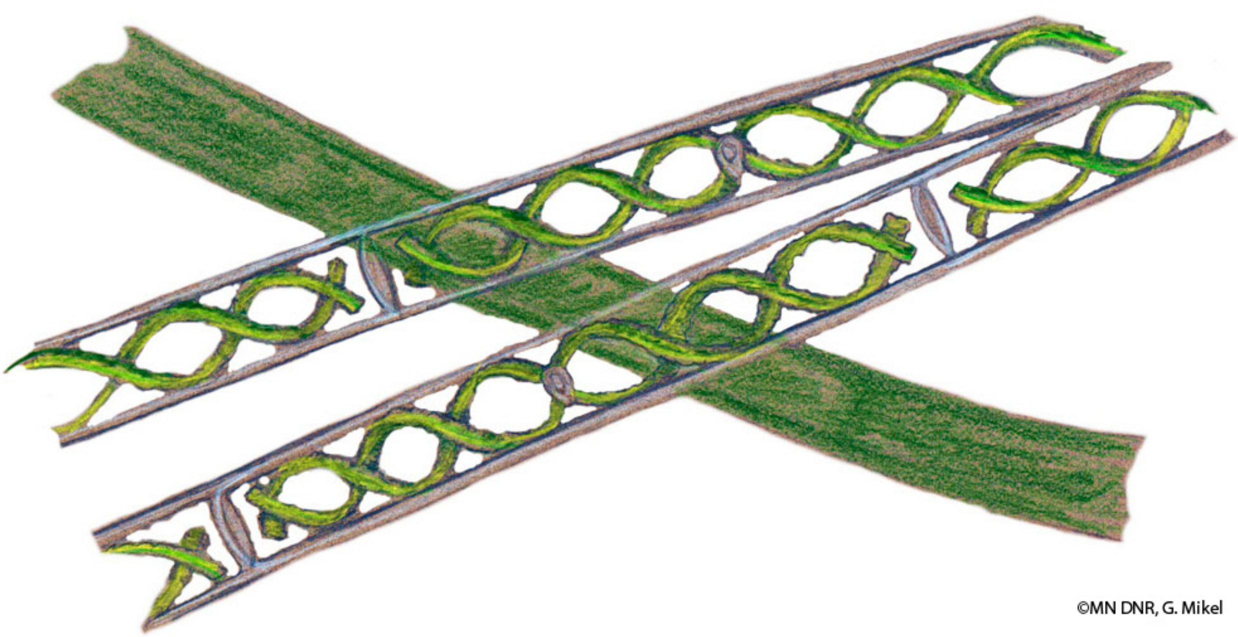


A food chain models the flow of energy through an ecosystem and the transfer of food energy from one organism to another. The sun is the source of energy in food chains. In a food chain all organisms are connected to one other and interdependent. If one link in a food chain is damaged or destroyed, all parts of the food chain are affected and the functioning of the system will be impaired.

Aquatic Food Chain Cards

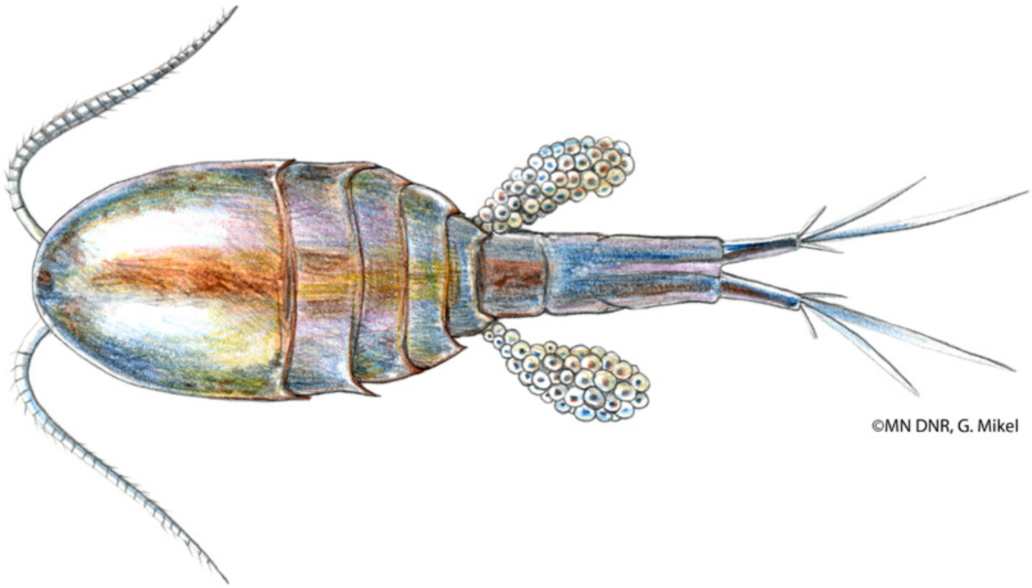


Sun



Phytoplankton: Spirogyra

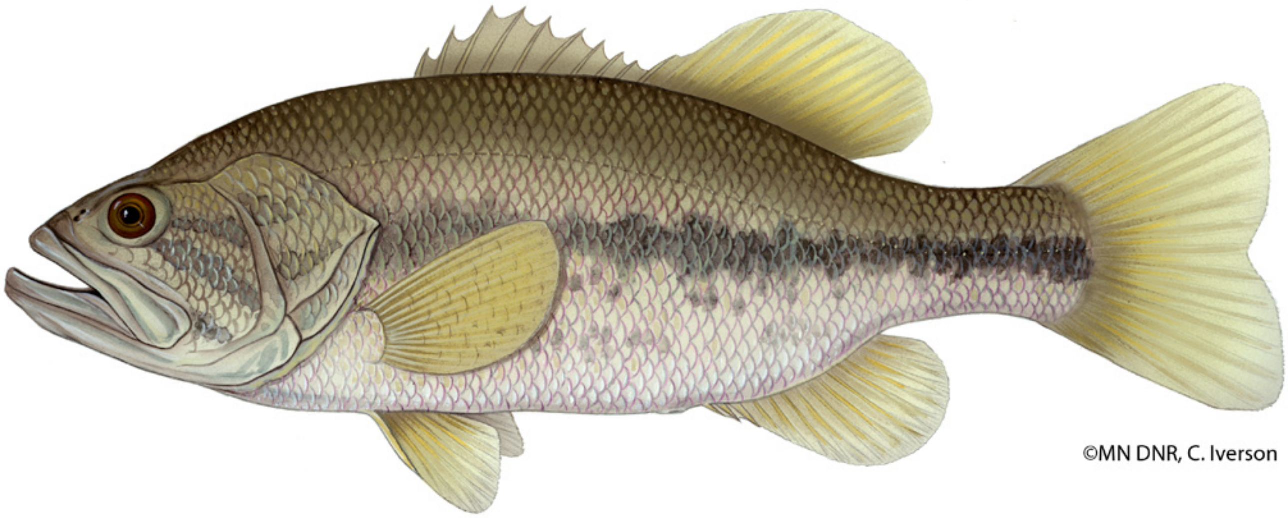
Aquatic Food Chain Cards



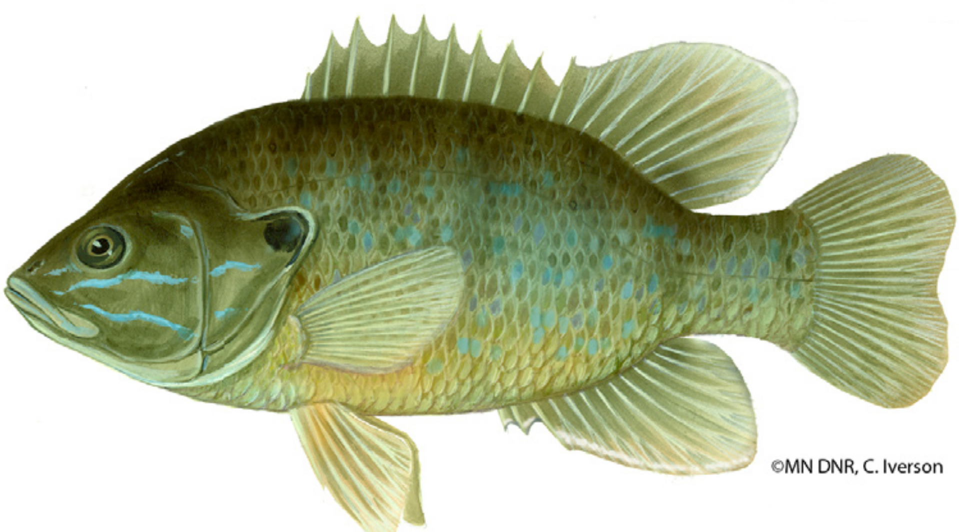
Zooplankton: Cyclops (Copepod)

Dragonfly Larva

Aquatic Food Chain Cards



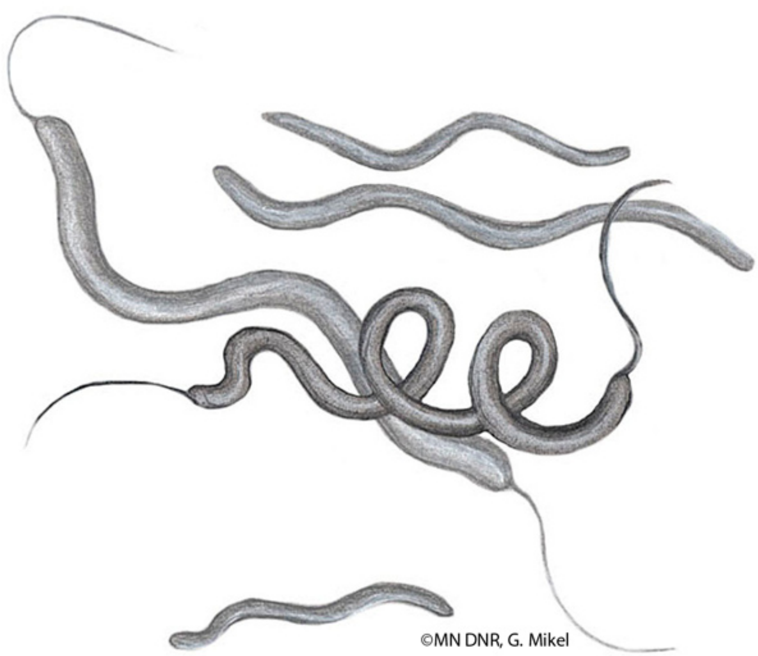
Largemouth Bass



Green Sunfish

Aquatic Food Chain Cards

Angler



Decomposer: Bacteria

Food Chain Identification Tags

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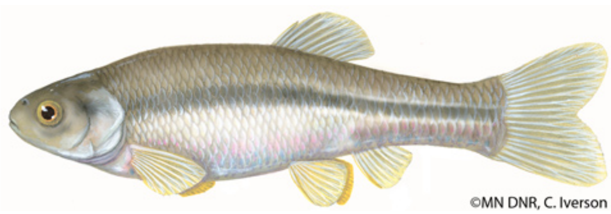
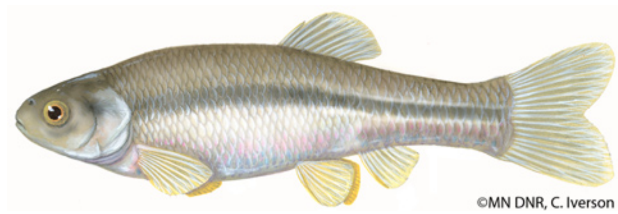
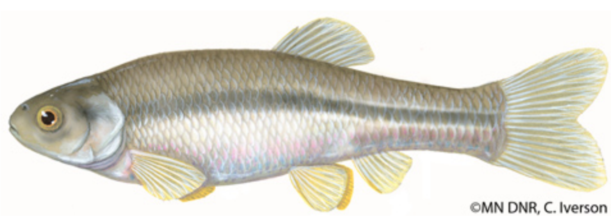


Fat Head Minnow



Fat Head Minnow



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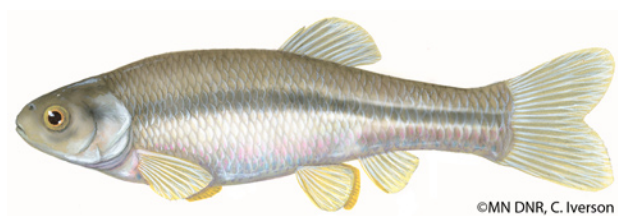

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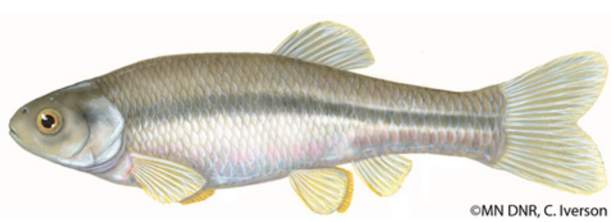

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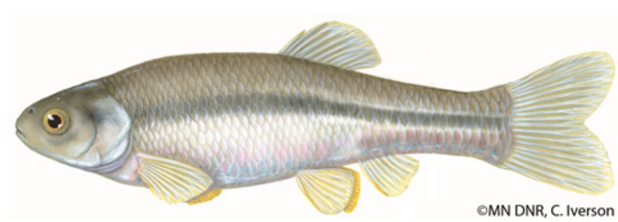


Fat Head Minnow

Food Chain Identification Tags

Make three copies of this page

Yellow Perch

Yellow Perch

Yellow Perch

Yellow Perch

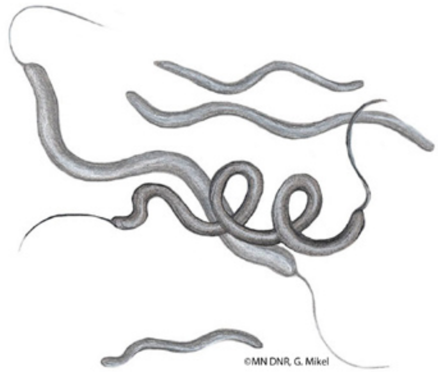
Yellow Perch

Northern Pike

Food Chain Identification Tags

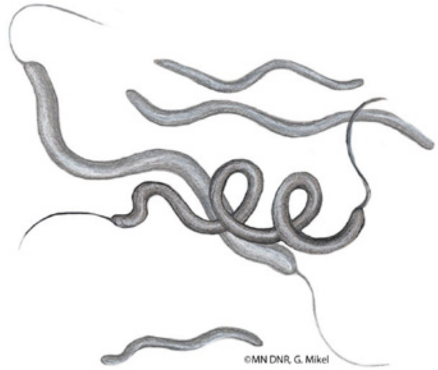
Make one copy of this page.

Angler



Bacterial Decomposer

Angler



Bacterial Decomposer

Run For Your Life Cycle

A fish migration route is full of obstacles! How does a northern pike negotiate three habitats to complete its life cycle?

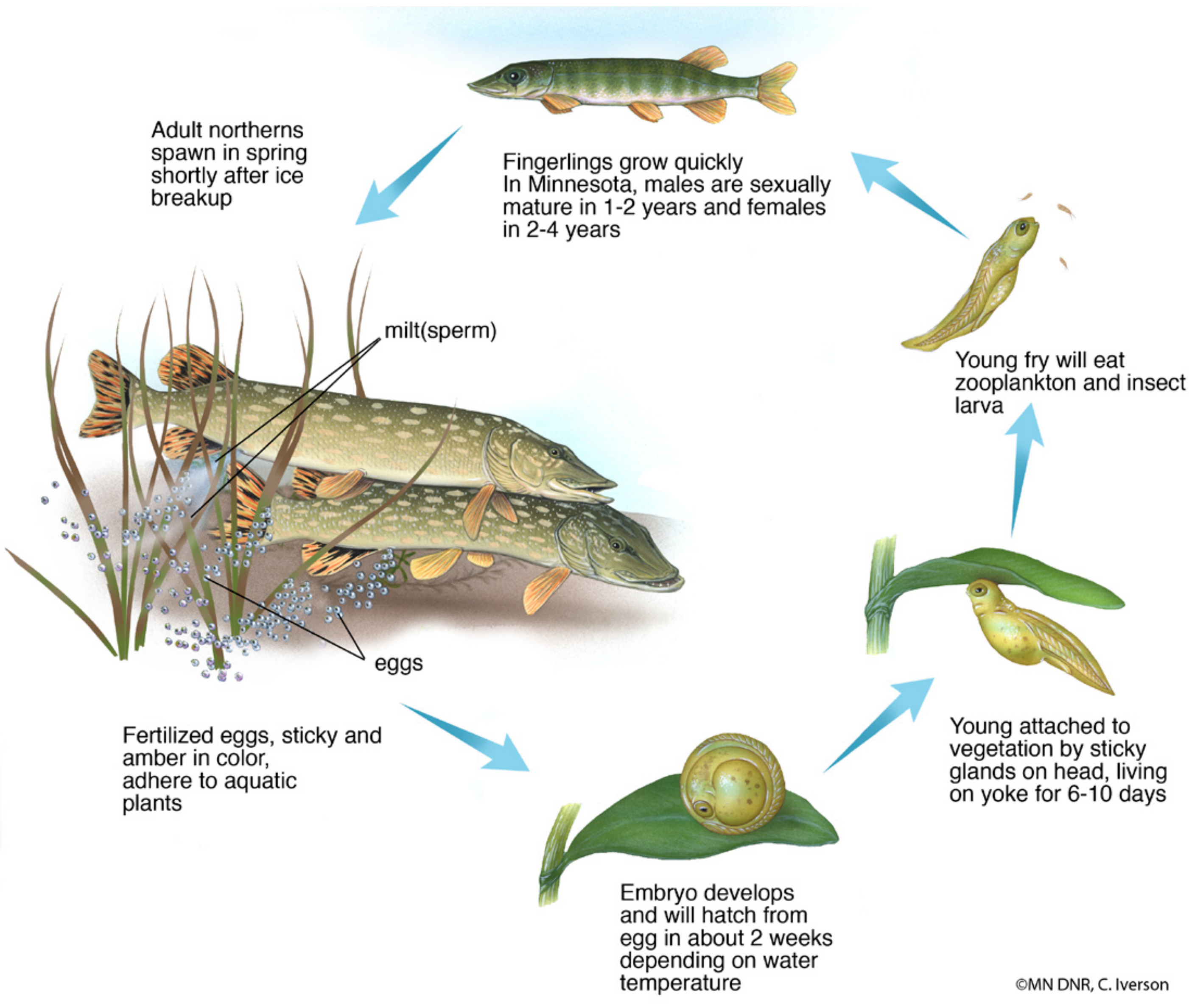


Table of Contents

Chapter 1 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Run For Your Life Cycle

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading. ●
Benchmark 3—The student will use context and word structure to determine the meaning of unfamiliar words. ◑
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups. ●
Benchmark 2—The student will demonstrate active listening and comprehension. ●
Benchmark 3—The student will follow multi-step oral directions. ●
Benchmark 5—The student will organize and express ideas sequentially or according to major points. ◑

Grades 4 and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading. ●
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups. ●
Benchmark 2—The student will demonstrate active listening and comprehension. ●

History and Social Studies

Grades K–3
IV. Historical Skills
A. Concepts of Time:
Benchmark 1—Students will define and use terms for concepts of historical time. ◒ (Life cycles and seasons)

Grades 4–8
II. Minnesota History
G. Post–World War II to the Present:
Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues. ◒ (low-head dams)

Geography

V. Geography
D. Interconnections:
Benchmark 1—Students will recognize changes over time in nearby landscapes, resulting from human occupation. ◑

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food. ●
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism. ●

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Grade 5
IV. Life Science
F. Flow of Matter and Energy:
Benchmark 1—The student will recognize that organisms need energy to stay alive and grow, and that this energy originates from the sun.
Benchmark 2—The student will use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 1 • Lesson 3

Run For Your Life Cycle

Grade Level: 3-5
Activity Duration: 50 minutes
Group Size: 20-60
Subject Areas: Language Arts, Social Studies, Physical Education, Science
Academic Skills: drawing conclusions, generalization, kinesthetic concept development, large group skills, listening, public speaking, reading, role-playing, simulation
Setting: large indoor or outdoor open area
Vocabulary: embryo, fingerling, fish passage, imprint, life cycle, limiting factor, low-head dam, migration, population, run, sac fry, swim-up fry, spawn
Internet Search Words: fish life cycle, fish limiting factors, fish migration, low-head dam, Minnesota DNR Fisheries, northern pike, northern pike life cycle

Instructor's Background Information

Cold winters, hot summers, dry seasons, lack of food, and the need for a safe spot to bear young are factors that induce animals to travel from one habitat to another. Many animals, including mallard ducks, caribou, and butterflies, travel from one location or habitat to another at some point in their lives. **Migration** is the annual or seasonal movement of an organism from one habitat to another, and typically involves a return trip to the original habitat. Many fish migrate at specific times in their **life cycle**. An organism's life cycle is its progression through a series of developmental stages from inception to its sexually mature state.

Summary

The northern pike is an example of a Minnesota fish species that migrates to complete its life cycle. In this role-playing activity, students become northern pike traveling a migration route through a course depicting a wetland, a stream, and a deep-water lake. Dangers accompany migration—the northern pike encounter both natural and human-induced obstacles as they grow to adulthood and return to the wetland to spawn.

Student Objectives

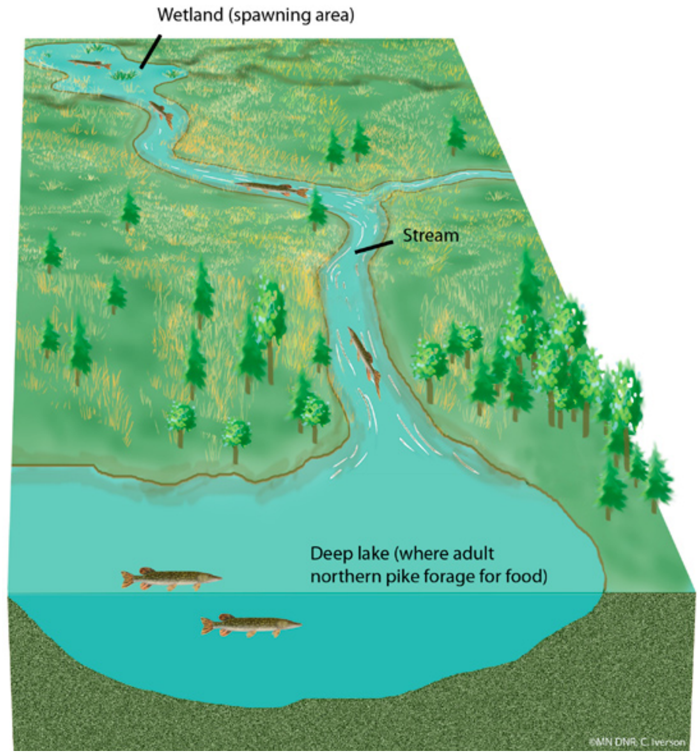
The students will:

1. Name three habitats through which northern pike migrate during their life cycle.
2. Identify the stages of the life cycle of northern pike (egg, sac fry, swim-up fry, fingerling, and adult), as well as the northern pike's place in the food web (as both predator and prey) at each stage.
3. List three natural and three human-induced limiting factors that can affect northern pike during their life cycle.

Materials

- **Northern Pike Life Cycle Sheets**
- **Northern Pike Migration Sheets**
- **Northern Pike Life Cycle Cards**
- **Playing Field Diagram**
- Laminating materials
- Large playing area (100 x 50 feet)
- 100-200 feet of rope, six traffic cones, or masking tape for marking boundaries
- Six to eight traffic cones or other objects to represent aquatic plants in the wetland
- Two jump ropes, each approximately sixteen feet long
- **Kingfisher Name Tag Sheet** (for making name tags or headbands)
- Card stock for kingfisher name tags
- Clothespins or yarn for kingfisher name tags
- Two cardboard boxes, small milk crates, or plastic tote boxes (approximately the size of a shoebox)
- 100 tokens, such as poker chips, crushed balls of newspaper, large washers, woodworking biscuits, or other similar objects
- Two containers for tokens, such as coffee cans or ice cream pails
- Marked area for broad jump, such as two jump ropes
- Whistle or other noisemaker
- Laminated signs for labeling obstacles and game areas (optional)

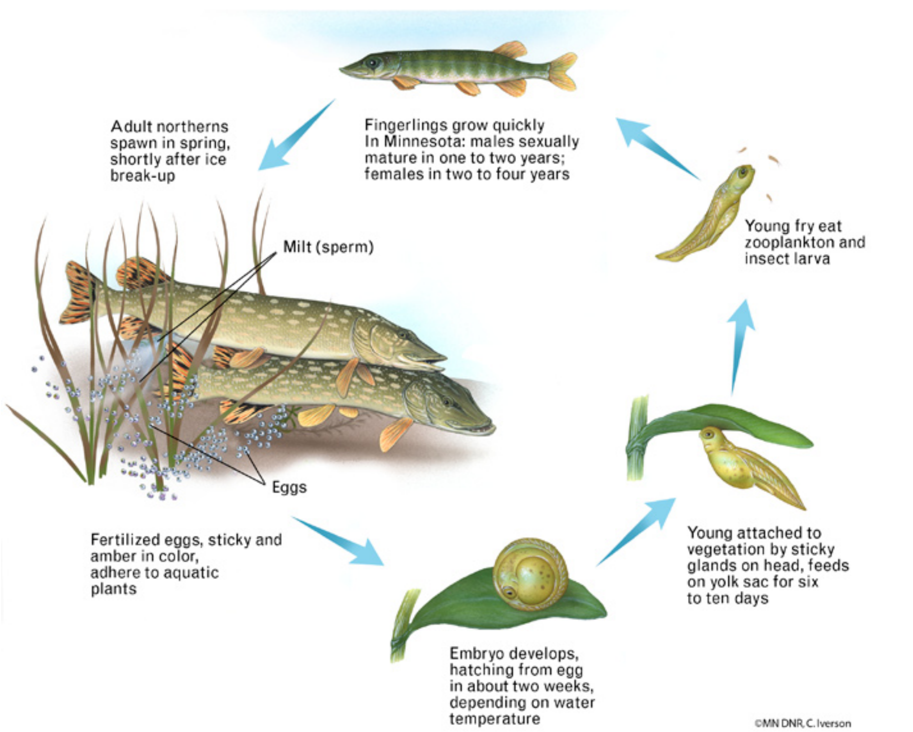
The northern pike is an example of a freshwater fish that migrates to complete its life cycle. Northern pike depend on varied habitats, such as the shallow areas of lakes, wetlands or flooded areas, in which they lay their eggs (their young also use these areas) and streams leading to the deep-water lakes where, as adults, they forage for food.



Fish migration or fish traveling to a spawning location is known as a run.

In Minnesota, northern pike spawning begins in late March to early May, when water temperatures reach 33˚ to 52˚ F and lake ice begins to melt. To spawn, male and female northern pike swim, or migrate, from deep water in lakes or large rivers to shallow, vegetated water in wetlands or flooded areas connected to lakes. **Spawning** (reproduction) occurs when the female fish releases and randomly scatters eggs, which are then fertilized by milt (fluid containing sperm) released by the males. Females scatter approximately 32,000-100,000 eggs over plants in water that is often no more than three feet deep. Northern pike eggs are immediately vulnerable to a variety of environmental factors, including predators (crayfish, aquatic invertebrates, and small fish) and suffocation due to oxygen deprivation. After spawning, the male and female northern pike swim back to deeper water, leaving the fertilized eggs, or **embryos,** on their own. The sticky fertilized eggs sink slowly in the water. As they fall through the water, the eggs cling to live or decaying plants, or to the roots of aquatic vegetation. The eggs stick to the plants for approximately two weeks. The embryos then hatch, and are referred to as **fry**.

The shallow water of a wetland warms faster than the deeper water in lakes. The warmer temperatures cue the eggs to develop and hatch, usually in twelve to fourteen days, when water temperatures reach approximately 49° F.



Northern pike life cycle

Newly hatched northern pike are called **sac fry**. Their sticky heads keep them attached to plants as they absorb proteins from yolk sacs located near their bellies. Sac fry are vulnerable to the same environmental factors as eggs. After a few weeks, the yolk sacs disappear, and the small, free-swimming fish are called **swim-up fry**. Swim-up fry are vulnerable to predation by small fish, dragonfly larvae, back swimmers, predacious diving beetles, and other aquatic insects. The ravenous swim-up fry consume plankton and aquatic invertebrates, but soon switch to a diet consisting mostly of small fish. Because northern pike are the first Minnesota fish species to spawn, and their eggs are the first to hatch each year, young northern pike have an advantage—they can eat the fry of other fish species emerging from their egg stages. After a few more weeks, the swim-up fry are four inches long—the length of a finger—and are called **fingerlings**. In late spring or early summer, the fingerlings move from shallow water to deeper, cooler water to find room to grow and more fish to eat. Juvenile northern pike are vulnerable to predation by larger fish and other aquatic organisms.

When the fingerlings are a year old, they're considered adults. Small adult northern pike remain in shallow, weedy water throughout much of the year, where they find food and hide from larger predators. At two years old, an adult reaches sexual maturity. Large adult northern pike move to deeper water, seeking well-oxygenated water of 65° F or cooler. Northern pike often live for ten to twelve years, but some have lived for more than 20 years.

Female sunfish lay eggs in nests hollowed from the lake bottom by the males. After fertilizing the eggs, male sunfish stay to guard the nests, fanning their tails over the eggs to keep them free of silt and sediment and to keep them oxygenated. The males also protect newly hatched fry from predators.

All organisms, including fish embryos, juveniles, and adults, need food energy to grow and to function. All food energy originates from the sun. The sun's energy enters the food chain when plants convert the sun's energy into food energy through the process of **photosynthesis.**

Large northern pike become lethargic in warm water—their metabolism slows and they eat very little, sometimes losing weight. During prolonged exposure to high temperatures and low oxygen levels, northern pike can actually starve to death.

Like salmon, northern pike return to their original spawning sites. Juvenile northern pike **imprint** or memorize, the unique odors of their home spawning sites. As adults, their sense of smell helps them detect these odors, guiding them on the return trip upstream to their original spawning area.

The state record for the largest northern pike caught in Minnesota is 45 pounds, 12 ounces. This fish was caught in Basswood Lake in Lake County on May 16, 1929.

A low-head dam and water current.

Adult northern pike eat a variety of fish species. With a torpedo-like body shape, they're built for quick acceleration in the water. Due to their large size, northern pike can't afford to expend a lot of energy pursuing small morsels. They concentrate their effort on larger forage, often swallowing prey one-third their own length. Common foods include yellow perch, tullibee, suckers, large minnows, and other northern pike. Although northern pike do eat sunfish and bass, they prefer cylindrical-shaped fish—they're a better fit for their mouths, and they usually swallow their prey head-first. Northern pike also eat leeches, frogs, and crayfish, and pretty much anything else that comes within reach of those large, sharp-toothed mouths!

Limiting Factors

Northern pike face a variety of **limiting factors** from egg stage through adulthood. A limiting factor is a condition influencing the survival of an organism or population. A **population** is the collection of organisms of a particular species living in a given geographic area. Limiting factors can be natural, or can result from human activity.

Natural limiting factors include drought, floods, and other weather conditions, as well as predators, food shortages, inadequate cover, lack of space, and disease. Human-induced limiting factors include pollution, overfishing, drainage of wetlands for development or agriculture, and accidental chemical or waste spills.

Low-head dams are small, relatively inexpensive concrete structures built to control water levels at the outlet of a lake or a stretch of river. During the 1930s, the Works Progress Administration built hundreds of low-head dams throughout Minnesota. Low-head dams can be limiting factors because they block or impede fish migration. They also create dangerous backflows on their downstream sides. The flow of water over the head (top) of the dam creates a waterfall, and below this waterfall, a turbulent **backflow** or circulating water current is produced. The backflow can capture and hold animals or objects that pass over the dam. When fish attempt to jump over the head of the dam during their spawning run, they often can't pass the backflow—or the dam. Low-head dams pose danger to people as well as to fish. Because the tops of the dams are low in the water on their upstream sides, boaters and swimmers sometimes don't notice the dams until it's too late, and they're suddenly swept over the top of the dam and into the backflow. Numerous drownings have occurred in this manner.

Low-head dams can be removed or modified to include fish passages that help restore natural spawning runs. **Fish passages** are water-filled canals, ladders, or staircases placed in front of the dam. All are designed to help fish bypass human-constructed obstacles. In Minnesota, fish passages over low-head dams are often created by adding boulders and backfill to raise the level of the stream to the height of the dam. This type of project is usually less expensive than removing the dam. Fish passages minimize the dangers of the head, the drop, and the backflow current, allowing fish to pass upstream or downstream. The risk of people drowning in the backflow currents of the dam is also greatly reduced.

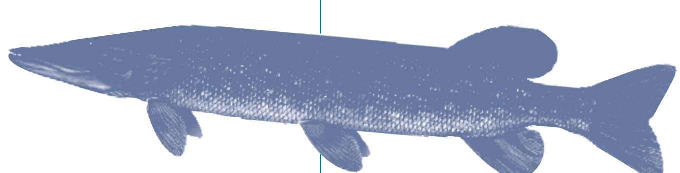
A style of fish passage commonly used in Minnesota.

Fishing pressure can also be a limiting factor for northern pike populations. State fishing regulations keep fishing pressure in check, preventing overharvest.

Biologists view habitat destruction as a primary concern for the health of northern pike populations. Causes of habitat destruction include wetland drainage, loss or removal of aquatic and shoreline plant life, and the construction of barriers (dams or roads) between wetland areas and lakes.

Predators are another limiting factor for northern pike, and include turtles, otters, mink, kingfishers, egrets, great blue herons, osprey, other northern pike, and people (anglers).

A female lays from 32,000 to 100,000 eggs during a spawning season. Due to natural and human-induced limiting factors, only a small percentage of these offspring survive to return to the wetlands where they hatched to spawn as mature adults.



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Procedure

Preparation

1 Copy one **Northern Pike Life Cycle Sheet** and one **Northern Pike Migration Sheet** for each student, or enlarge them and make posters to hang in the classroom.

2 Make one set of **Northern Pike Life Cycle Cards.**

3 Using the **Kingfisher Name tag Sheet**, make two kingfisher Name tags or headbands.

4 Refer to the **Playing Field Diagram** and set up the playing field as shown. Include the wetland spawning grounds, plants, low-head dam, downstream, lake with two token containers, upstream, low-head dam (with a waterfall), and broad jump.

5 You may want to make laminated signs for each area along the migration course to remind students what each obstacle course area represents: wetland, plants, downstream, lake, upstream, low-head dam, waterfall, and fish passage.

Activity

Warm-up

1 Choose five student volunteers to stand in front of the class. Distribute one **Northern Pike Life Cycle Card** to each. Have students hold their cards on their foreheads with the picture side facing out. Ask them to arrange themselves in order of youngest to oldest northern pike life stage. When they're in the correct order, have each student read their card aloud to the class. Discuss the definition of life cycle with the students.

2 Project or distribute copies of the **Northern Pike Life Cycle** and **Northern Pike Migration Sheets**. Tell students that northern pike migrate to complete their life cycle. Ask students what it means to migrate.

3 Ask students to think of the types of obstacles or challenges that a fish might encounter as it travels along its migration route to spawning habitat. Answers will be general and will vary because the students don't yet have a specific type of fish or habitat to consider.

4 Tell students that they're going to travel an obstacle course to learn more about the migration and life cycle of northern pike. As they play the game, ask them to think about the various food web roles that northern pike play during different stages of their life cycle.

Lesson

Round One: Playing the Game

1 Explain the general set-up of the playing field to the class. Tell the students they're all northern pike eggs—newly deposited in a wetland—and that they'll try to complete their life cycles. Their job will be to migrate from the wetland, down the stream, and into the big lake. When they reach the lake, they'll find lots of food and grow into adults. They'll then migrate upstream (the upstream

- The **Playing Field Diagram** illustrates the set-up for each round of the game.
- Each student participates in every round. You may wish to switch the students' roles (northern pike, kingfishers, anglers) in different rounds.
- You may wish to time each round and have students discuss the reasons why it takes differing amounts of time to complete each round.

area is separated from the downstream area to avoid collisions) and return to the wetland to spawn and have their own young.

2 Describe the course locations the students will visit during Round One.

Wetland spawning ground—This is where the game starts. Six to eight cones in the wetland represent aquatic plants. The northern pike begin their lives as eggs, which attach themselves to the plants. Students begin the game curled up next to the cones. **Downstream—**After hatching and growing into fingerlings, the northern pike travel downstream to the lake. **Lake—**In the lake, the northern pike must move back and forth across the lake area to gather four tokens: there is a container of tokens on each side of the lake. The tokens represent food, and players can pick up only one at a time—first from one container and then, after crossing the lake, from the other container. As it crosses the lake and returns to the first container, each northern pike picks up a third token, and travels back across the lake for a fourth token. When a fish has four tokens, it has had enough food to grow into a mature adult fish, which may then migrate upstream to the wetland to spawn. **Upstream—**The adult northern pike travel upstream to the wetland. **Wetland spawning ground—**This round ends when all northern pike return to the spawning ground.

3 Review the northern pike life cycle with the students. Explain that each northern pike should loudly declare the stage of their life cycle as they proceed from one stage to the next.

- As the game begins, students curl up next to plants (cones) in the wetland. They should all shout, "Egg!" and touch a cone. They should continue to touch the cone while slowly counting aloud to fourteen (it takes approximately fourteen days for an embryo to hatch from an egg).
- Then they must stand, with their hands still on the cone, and shout, "Sac fry!" and count aloud to ten.
- Shouting, "Swim-up fry!" the students may let go of their cones and swim (crawl) around the wetland, moving up and down, while slowly counting aloud to 21.
- After counting to 21, the northern pike shout, "Fingerling!" and begin their journey downstream to the lake.
- Upon reaching the lake, and after gathering the four tokens as instructed, the northern pike shout, "Adult!" They've spent one or two years growing and maturing in the lake. They're ready to head downstream toward the wetland to spawn.
- When the northern pike reach the wetland, they shout, "Spawn!" They've now completed their life cycle.

4 Using a whistle or other noisemaker, signal the students to begin Round One.

5 This round concludes when all northern pike have reached the wetland spawning ground. Signal the end of Round One. Discuss with students what happened in this round. How many northern pike completed their life cycle? (All of the northern pike should

During the round, stop students at different points along the migration route. Ask students to state their stage of the northern pike life cycle at that point. Ask them what a northern pike might eat, and what might eat them during this stage of their life cycle. What roles do they play in the food web—predator, prey, or both?

have completed the cycle because there were no obstacles, or limiting factors, on the migration route.)

Round Two: Natural Predators as Limiting Factors

1 Follow the same directions as for Round One, but this time, add a natural predator (kingfishers) as a limiting factor for the northern pike as they travel downstream.
2 Choose two students to be kingfishers and give them kingfisher Name tags (or headbands). Place them in the downstream area of the course. The predators must catch (tag) the northern pike with both hands after the fingerlings leave the wetland and arrive in the downstream area. Tagged fish are dead and must sit out. They may become eggs again after the first successful adult northern pike return to the wetland to spawn. The kingfishers must escort the tagged northern pike to a designated area outside of the stream. (This allows some northern pike to pass downstream to the lake without the kingfishers present.)
3 Can the students predict what will happen in this round?
4 Signal the students to begin the round. You may wish to continue the round, allowing the returning northern pike to spawn. The students on the sidelines can become eggs again, while the surviving adults continue back downstream after they've spawned. Signal the end of the round sometime after the last surviving adult northern has returned to the wetland to spawn.
5 At the end of this round, discuss with the students the number of northern pike that made it back to the wetland to spawn, comparing the results to Round One. Discuss why fewer adult northern pike made it back to the wetland in this round.

You can adjust the number of anglers and other predators according to class size.

Round Three: Anglers as Limiting Factors

1 Follow the same directions as Round Two, but this time, add an angler as a limiting factor for the northern pike in the lake. (Keep at least one kingfisher in this round if you have enough participants.)
2 Choose two students to be anglers and give each a cardboard box to represent a fishing boat. With one foot in the box, anglers should shuffle along in the lake to attempt to catch (tag) northern pike in the lake with both hands. Tagged fish must sit out. The anglers then escort the tagged northern pike to a designated area outside of the lake. Again, this allows some northern pike to pass freely while anglers lead their catches to the designated area.
3 At the end of this round, discuss with the students the number of northern pike that made it back to the wetland to spawn in Round Three, comparing the results to the previous rounds. Discuss why a different number of northern pike may have made it back to the wetland this time.

Round Four: Low-head Dam as a Limiting Factor

1 Follow the same directions as in Round Three, but add a low-head dam as a limiting factor as northern pike travel between the stream and the lake.

2 Choose two adults or tall students to be a team. Between the downstream section of the course and the lake, this team swings the jump rope, which represents a low-head dam located in the downstream area next to the lake. The students must jump rope before entering the lake, representing northern pike jumping over the head of the dam and trying to clear the turbulent water below. The northern pike must not go around the jump rope twirlers. They may slip under the twirlers' arms, but *must not get touched by the twirlers or the rope as they do so.* They may also run underneath the twirling rope or jump it several times, if they prefer. A northern pike "dies" if touched by the twirling jump rope at any time.

3 When all the northern pike moving downstream have passed the dam, the rope twirlers simulating the low-head dam should move to the upstream side of the course, between the upstream area and the lake, to represent the waterfall, or jumping the head of the dam. They should place two jump ropes on the ground (see **Playing Field Diagram**) to represent the distance that northern pike must jump to clear the waterfall and the dam. Be sure this jumping distance is challenging, but the students should be able to do it as a standing broad jump. The northern pike must jump the entire distance of the standing broad jump to continue. If a northern pike fails to make the jump, it doesn't survive the waterfall and backflow current and must sit out.

4 At the end of this round, discuss with the students the number of northern pike that made it back to the wetland to spawn, comparing results from the previous rounds. Discuss why there might have been a difference in the number of northern pike that made it back to the wetland this time.

Round Five: Fish Passage Reducing the Impact of a Limiting Factor

1 Follow the instructions for Round Four, but place a fish passage between the lake and the wetland on the upstream side of the stream—to take the place of the upstream waterfall over the lowhead dam. The lowhead dam on the downstream side of the course will still remain.

2 Any northern pike that "dies" during in this round will immediately become part of the fish passage. The kingfishers and anglers will escort the tagged northern pike to the fish passage. This removes the predators from the field regularly, providing a more realistic survival ratio.

3 The students depicting the fish passage should kneel on the ground in a line facing the wetland, an arm's-length apart, and in single file. The adult northern pike must weave through the line of students forming the fish passage in order to enter the wetland. This enforced trip through the fish passage demonstrates how restricted

If you wish, use cones rather than students to represent the fish passage. The expired northern pike can be escorted to the sideline area.

and tedious an upstream journey through a fish passage can be. Within the fish passage, the predators may not tag the northern pike.

4. At the end of this round, discuss with the students the number of northern pike that made it back to the wetland to spawn, comparing the number to previous rounds. Discuss why there might have been a difference in the number of northern pike that made it back to the wetland this time.

Round Six: A Drought Year as a Limiting Factor

1. Follow the instructions for Round Five, but this time, drought is the limiting factor for fish traveling downstream.
2. Narrow the size of the stream to simulate reduced water flow. This will crowd the students and make it harder for them to get past the kingfishers.
3. At the end of this round, discuss with the students the number of northern pike that made it back to the wetland to spawn, comparing the number to previous rounds. Discuss why there might have been a difference in the number of northern pike that made it back to the wetland this time.

Wrap-up

1. Engage the students in a discussion of the following questions:
   - Do all northern pike fingerlings become adults?
   - What were the limiting factors in the game? Can you think of other limiting factors?
   - What was the most challenging part of the migration course?
   - Where were the most northern pike caught? Which parts of the route were less difficult?
   - What would happen if all the fingerlings made the journey successfully?
   - What seemed realistic about this game? What didn't seem realistic?
   - Name the three habitats though which northern pike must migrate to complete its life cycle.
   - Do northern pike have more than one role in a food web? At what stages of its life cycle is it a predator? At what stages is it prey for other predators?
   - Why do adult female northern pike produce so many eggs?
2. Have students draw the limiting factors they encountered during the game on their copies of the **Northern Pike Migration Sheet**.
3. Encourage the students to form the generalization that all animals, not just northern pike, are affected by limiting factors in their environments.

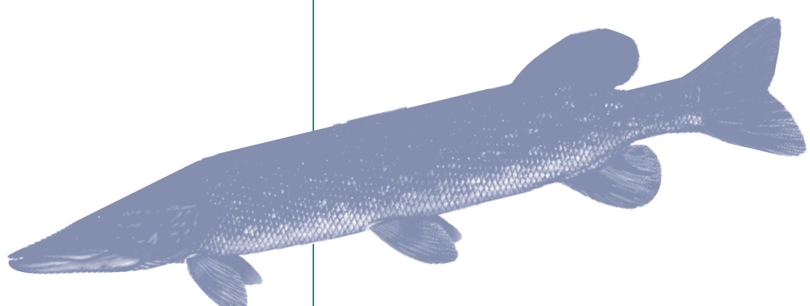
Assessment Options

1 Have students draw a picture of a northern pike's migratory route, including the following:
- major stages of the life cycle (egg, sac fry, swim-up fry, fingerling, adult)
- the locations to which northern pike travel (wetland, stream, lake)
- some natural limiting factors (such as drought, floods and other weather conditions, predators, food shortages, inadequate cover, crowding, and disease)
- at least three human-induced limiting factors (such as pollution, anglers, drainage of wetlands for development or agriculture, and accidental chemical or waste spills)

2 Have students draw or make a model of a food web that includes northern pike eggs, sac fry, swim-up fry, fingerlings, and adults. You could also have them use a computer graphics program to make their food web.

3 Have students compose a ballad (narrative song or poem, especially a traditional one telling a story in a number of short, regular stanzas, often with a refrain) that depicts the life cycle of northern pike and the challenges or limiting factors they face as they migrate to complete their life cycle.

4 Assessment options include the Checklist and Rubric on the following pages.



Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

20-22 points = A
Excellent. Work is above expectations.

17-19 points = B
Good. Work meets expectations.

13-16 points = C
Work is generally good. Some areas are better developed than others.

9-12 points = D
Work does not meet expectations; it isn't clear that student understands objectives.

0-8 points = F
Work is unacceptable.

Run For Your Life Cycle Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
5	______	______	Student draws all life stages (egg, sack fry, swim-up fry, fingerling, and adult).
3	______	______	Student draws all three habitats (lake, stream, wetland).
3	______	______	Student places the correct life stage in each of the three habitat areas.
6	______	______	Student draws or describes at least three natural and three human-caused limiting factors.
3	______	______	Poster is attractive, legible, and easily viewed from a distance.
2	______	______	Student defines *migration* and *life cycle*.
Total Points			
22	______	______	**Score** ______

Run For Your Life Cycle Scoring Rubric

Migratory Route Poster Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Life stages of northern pike	Drawing contains all life stages: egg, sack fry, swim-up fry, fingerling, and adult.	Drawing contains four life stages.	Drawing contains three life stages.	Drawing contains two life stages.	Didn't attempt to complete drawing.
Habitat	Drawing contains all three habitats (lake, stream, wetland) with the correct life stages.	Drawing contains all three habitats. One of the life stages appears in an incorrect habitat.	Drawing contains two habitats. Life stages appear in the correct habitat.	Drawing contains two or fewer habitats. Life stages appear in incorrect habitats.	Didn't attempt to complete drawing.
Natural and human-caused limiting factors	Drawing or description contains at least three natural and three human-caused limiting factors.	Drawing or description contains at least two natural and two human-caused limiting factors.	Drawing or description contains at least one natural and one human-caused limiting factor.	Drawing or description contains one natural or one human-caused limiting factor.	Didn't attempt to complete drawing.
Materials and design	Final product is attractive, legible, and easily viewed from a distance.	Final product is attractive, and easily viewed. A few marks on the poster.	Final product is hard to read from a distance and lacks visual appeal.	Final product is messy, illegible and not easily viewed from a distance.	Didn't attempt to complete drawing.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

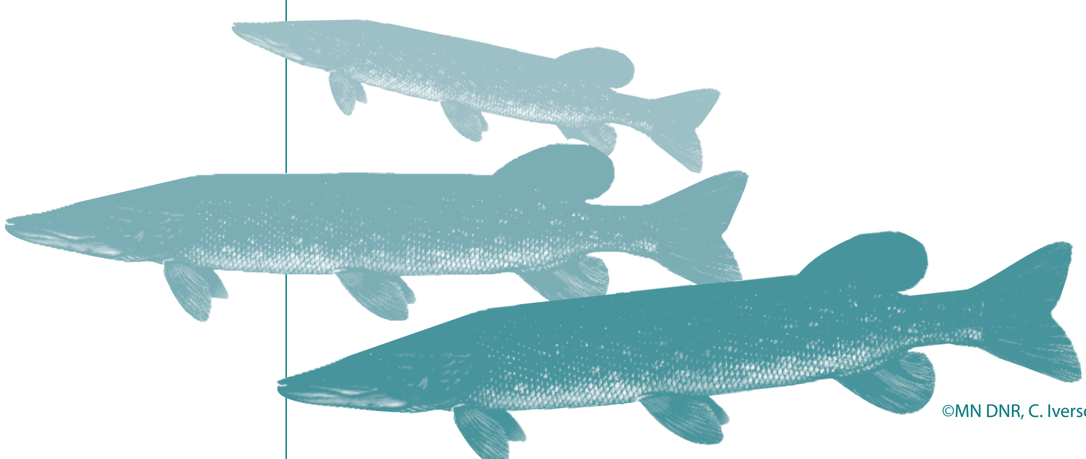
Extensions

1 Compare and contrast the life cycle of the northern pike with the life cycle of another fish such as pumpkinseed sunfish, rainbow trout, or fat head minnows.
2 Tour a fish hatchery that raises migratory species.
3 Look up Minnesota Fishing Regulations referring to northern pike.
4 Call your local Minnesota DNR Fisheries Office and find out if it's possible to view northern pike running (migrating) in your area in the early spring. If so, you could plan to complete this lesson during the spring migration, and then take your students to the stream to view the migrating northern pike. Have students look for rocks and ledges where the northern pike might stop to rest. Ask the students to remember what it was like for them in the Run For Your Life Cycle Game as they tried to pass the various obstacles as they migrated. Help them compare their experiences in the game with their observations of what the northern pike appear to be experiencing as they migrate.

For the Small Fry

K-2 Option

You can do this activity with K-2 students—just reduce the number of limiting factors in the game and play fewer rounds.



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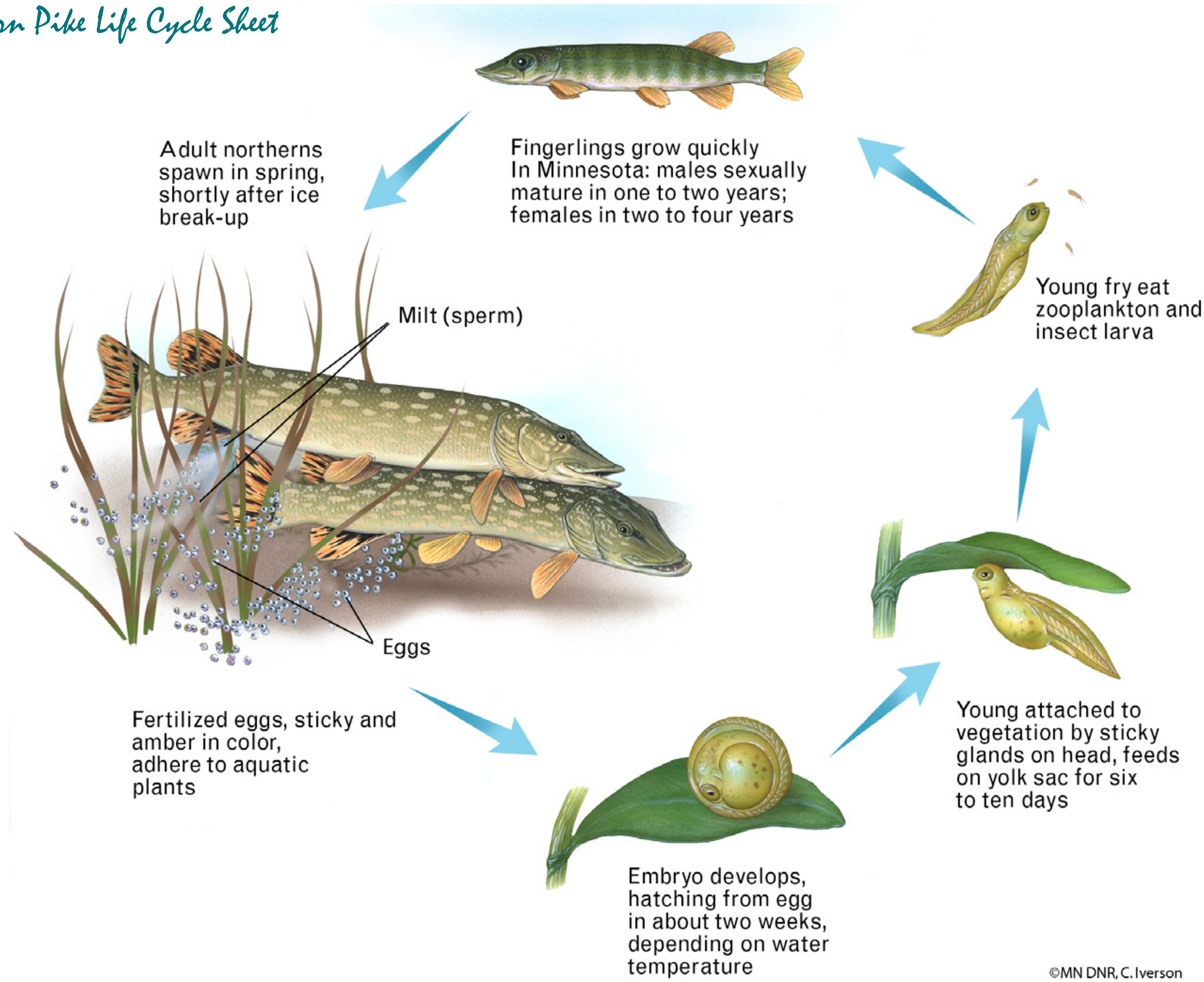
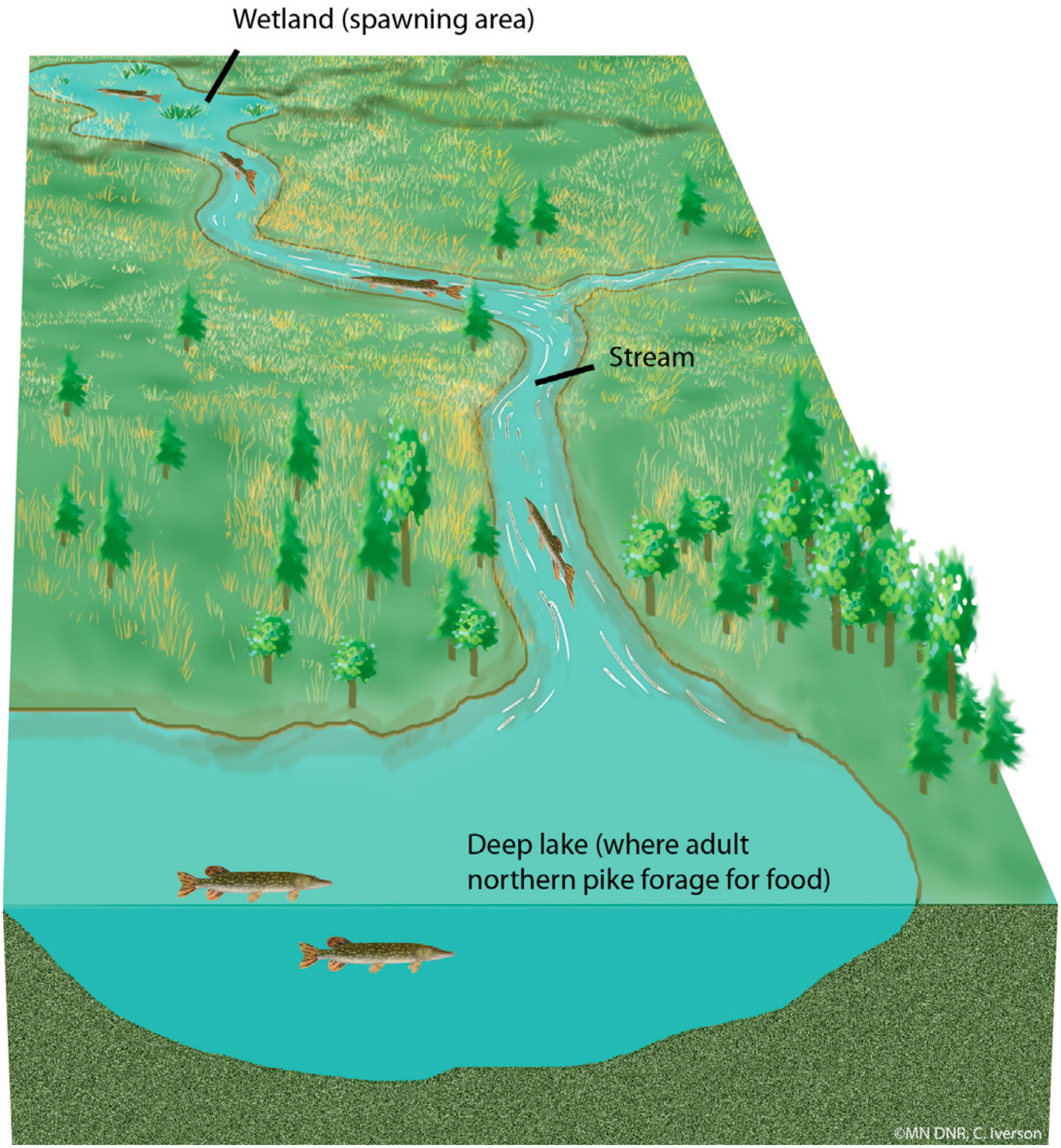
STUDENT COPY

Northern Pike Life Cycle Sheet



STUDENT COPY

Northern Pike Migration Sheet



Northern Pike Life Cycle Cards

Copy these cards, cut them out, and cut or fold them to make two-sided cards.
Glue them to card stock or laminate them.

Egg: 14 days

I'm an **egg**. I'm stuck to a plant in a shallow water area called a wetland.

Sac fry: 6-10 days

I'm a **sac fry.** I've just hatched out of my egg. I absorb food from a yolk sack near my belly. My head sticks to a plant in the wetland to keep me from falling into the muck.

Swim-up fry: 21 days

After my yolk sac is gone, I get very hungry! I eat plankton, little bugs, and small fish. I'm learning to swim, so when I try to swim up, I sink. That's why I'm called a **swim-up fry**.

Northern Pike Life Cycle Cards

Fingerling: 90 days

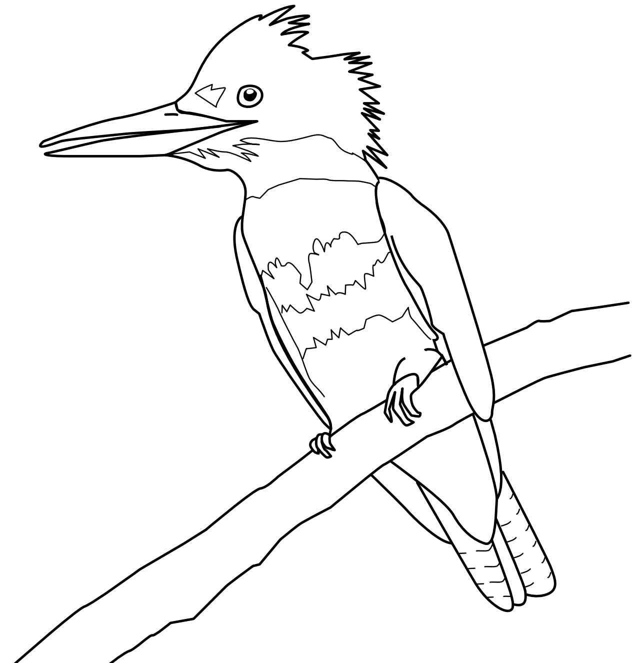
When I've grown as long as a person's finger, I'm called a **fingerling**. I move out into the bigger lake to eat bigger prey and to grow some more.

Adult: One year
Sexually mature adult: One to two years

After a year or two, I'm an **adult,** and I'm ready to reproduce. In spring, I *migrate* from the big lake or river back to a small stream or wetland to reproduce. After I *spawn* (lay eggs if I'm a female, or fertilize eggs if I'm a male), I return to the lake or river until next year.

Kingfisher Name Tag Sheet

To make identification name tags or headbands, copy and cut out the tags and glue (or laminate) them to card stock. Students may color the kingfishers.



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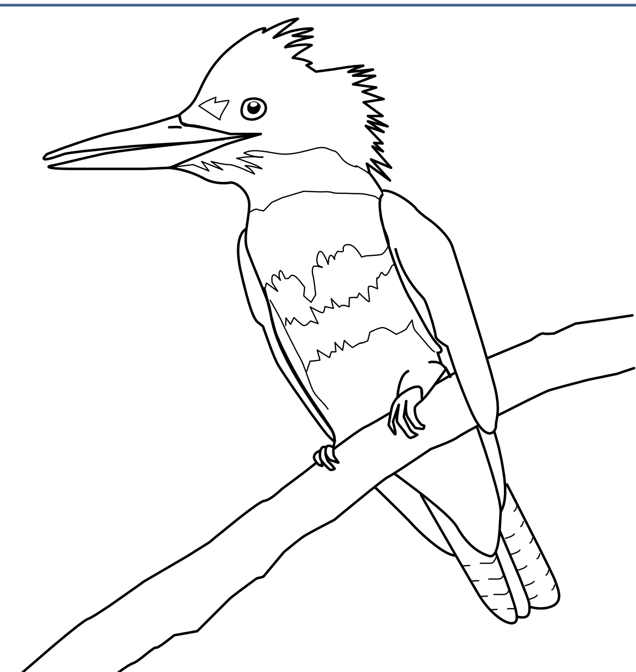
Kingfisher



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Kingfisher

INSTRUCTOR COPY

Playing the Game—Crib Sheet

- Do the Life Cycle activity explained in the Warm Up of this lesson.
- Explain the general set-up of the playing field to the class. Tell the students they're all northern pike eggs—newly deposited in a wetland—and that they'll try to complete their life cycles.
- Explain that students will migrate from the wetland, down the stream, and into the big lake.
- When they reach the lake, they'll retrieve 4 poker chips, one at a time from each side of the lake.
- They'll then migrate upstream (the upstream area is separated from the downstream area to avoid collisions) and return to the wetland to spawn and have their own young.

Round One:

- Curl up next to plants (cones) in the wetland and touch a cone. Shout EGG, counting aloud to 14.
- Shout SACK FRY, continue to touch the cone, and count aloud to 10.
- Shout SWIM UP FRY, let go of their cones, swim (crawl) around the wetland, moving up and down, count aloud to 21.
- Shout FINGERLING and begin their journey downstream to the lake.
- Gather four tokens, shout ADULT, head downstream toward the wetland to spawn.
- At the wetland shout SPAWN.
- Discuss with students what happened in the round.
- This cycle is repeated in the rest of the rounds.

Round Two: Natural Predators as Limiting Factors

- Add a natural predator (kingfishers) as a limiting factor for the northern pike as they travel downstream.

Round Three: Anglers as Limiting Factors

- Add an angler (or two) as a limiting factor for the northern pike in the lake. (Keep at least one kingfisher in this round if you have enough participants.)

Round Four: Low-head Dam as a Limiting Factor

- Add a low-head dam as a limiting factor as northern pike travel between the stream and the lake. (Keep kingfishers and anglers if you have enough participants.)

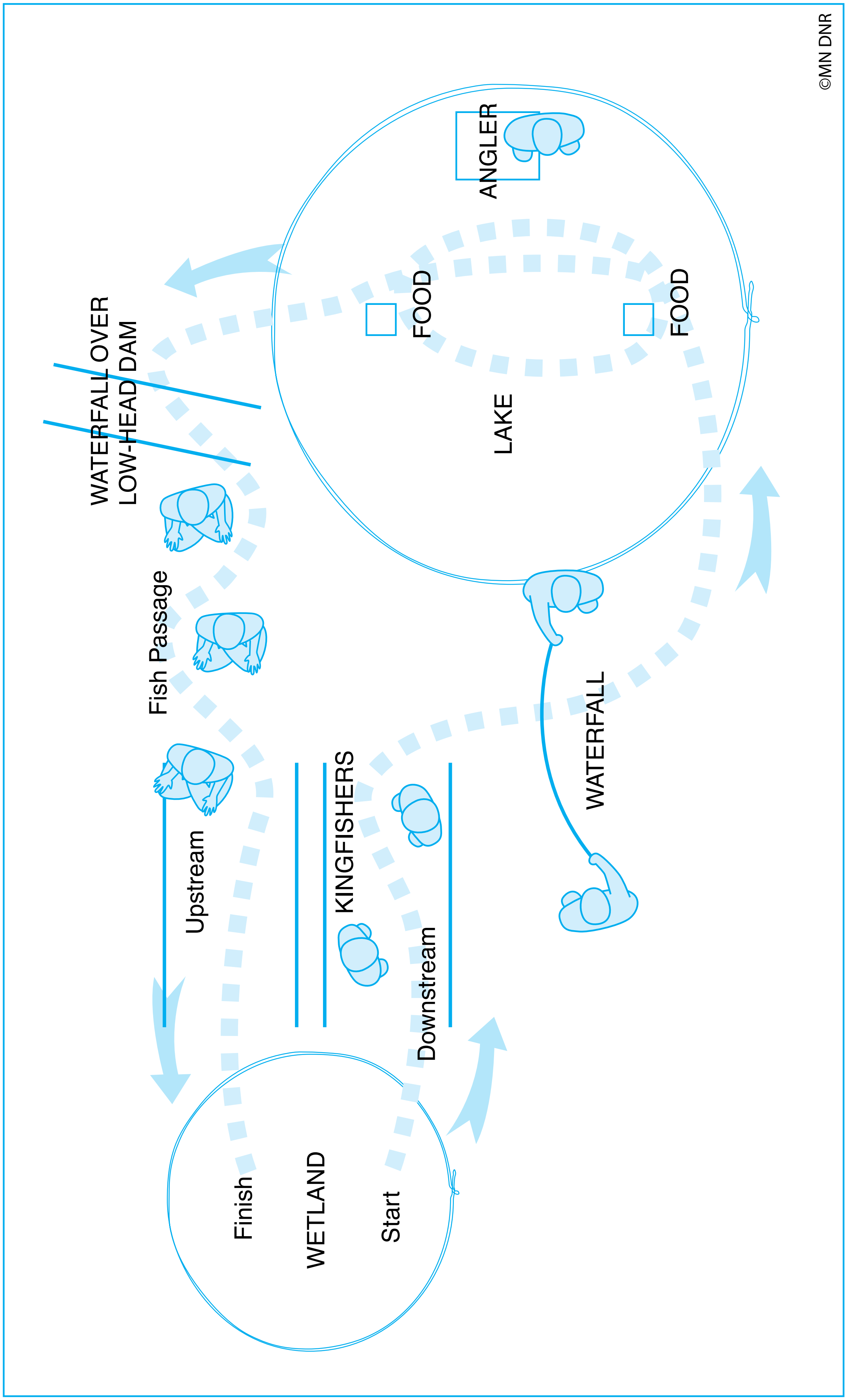
Round Five: Fish Passage Reducing the Impact of a Limiting Factor

- Place a fish passage between the lake and the wetland on the upstream side of the stream—to take the place of the upstream waterfall over the lowhead dam. The lowhead dam on the downstream side of the course will still remain. (Keep kingfishers and anglers if you have enough participants.)
- Any northern pike that "dies" during in this round will immediately become part of the fish passage. The kingfishers and anglers will escort the tagged northern pike to the fish passage. This removes the predators from the field regularly, providing a more realistic survival ratio.

Round Six: A Drought Year as a Limiting Factor

- Narrow the size of the stream to simulate reduced water flow. This will crowd the students and make it harder for them to get past the kingfishers. (Keep or remove lowhead dams and/or anglers.)

Playing Field Diagram



Water Habitat Site Study

Meet the water dwellers in your local pond, stream, or lake. What are the special features that help them survive in the water?

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Table of Contents

Chapter 1 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Water Habitat Site Study

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◒ Lesson *partially* addresses this Benchmark.
◒ Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 1—The student will read unfamiliar complex and multi-syllabic words using advanced phonetic and structural analysis.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 1—The student will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 2—The student will recall and use prior learning and preview text, using title, headings and illustrations to prepare for reading.
Benchmark 7—The student will follow three-step written directions.
II. Writing
D. Research:
Benchmark 1—The student will use grade-level appropriate reference materials to obtain information from dictionaries, glossaries, encyclopedias, and the Internet.
III. Speaking, Listening, and Viewing
B. Media Literacy:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Grade 4
I. Reading and Literature
A. Word Recognition, Analysis and Fluency:
Benchmark 1—The student will read unfamiliar complex and multi-syllabic words using advanced phonetic and structural analysis in grade-appropriate text.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 1—The student will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 2—The student will recall and use prior learning and preview text to prepare for reading.
Benchmark 9—The student will follow multiple-step written instructions.
II.Writing
B. Elements of Composition:
Benchmark 4—The student will create informative reports, including gathering material, formulating ideas based on gathered material, organizing information, and editing for logical progression.
D. Research:
Benchmark 1—The student will locate information in various reference materials including dictionaries, online dictionaries, glossaries, encyclopedias, and the Internet.
III. Speaking, Listening, and Viewing
B. Media Literacy:
Benchmark 1—The student will read print, view pictures and video images and listen to audio files and identify distinctions in how information is presented in print and non-print materials.
Benchmark 3—The student will use print, pictures, audio and video to express ideas and knowledge gleaned from these sources.

Grade 5
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 1—The student will read familiar, complex and multi—syllabic words using advanced phonetic and structural analysis.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction as well as independent reading.
Benchmark 4—The student will analyze word structure and use context clues in order to understand new words.
C. Comprehension:
Benchmark 1—The student will read aloud grade—appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 13—The student will follow multiple—step written directions.
D. Literature:
Benchmark 1—The student will read a variety of high quality, traditional, classical and contemporary literary works specific to America, as well as significant works from other countries.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry:
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.

Grade 4
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1— The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 1 • Lesson 4

Water Habitat Site Study

Grade Level: 3-5
Preparation Time: 15 minutes
Activity Duration: Part 1: 60 minutes for field trip
Part 2: 30 minutes for food web activity
Group Size: 1-30
Subject Areas: Expressive Arts, Language Arts, Science
Academic Skills: classification, comparison, drawing, observation
Setting: outdoors, at a body of water
(Lesson can be done indoors if specimens are collected within three hours prior to class starting time start of class. Fall and spring collections yield primarily macroinvertebrates. Summer and early fall collections yield primarily plants.)
Vocabulary: aquatic, aquatic ecosystem, benthic organisms, emergent plants, floating-leaf plants, free-floating plants, habitat, identification key, littoral zone, macroinvertebrate, metamorphosis, pollution, runoff, submerged plants, vertebrate
Internet Search Words: aquatic macroinvertebrates, aquatic plants, pond life

Summary

In this activity, students explore a local water ecosystem and discover organisms living in various habitats. Many of these organisms provide food and cover for fish. Each student collects aquatic invertebrates using a dip net and sorts through muck scooped from the lake bottom. Students also use a rake to collect aquatic plant specimens. They'll have the opportunity to sketch the specimens, and to use field guides and identification keys to study and identify the plants and animals. From these sketches, they'll make a pond, stream, or lake discovery book.

Student Objectives

The students will:

1. Collect specimens of aquatic plants, macroinvertebrates, and other animals from a variety of habitat types in a local water ecosystem using a dip net, rake, and bottom-sifting sampling methods.
2. Observe features or adaptations of aquatic organisms.
3. Draw and describe examples of organisms collected with each sampling method.
4. Use field guides or identification keys to identify aquatic plants and animals.
5. Group illustrations of organisms into types or categories and create and illustrate a pond, stream, or lake discovery book.

Instructor's Background Information

Aquatic refers to water. Scoop some water from a stream or pond, look closely, and you'll find some fascinating living organisms. These small aquatic plants and animals are crucial components of an aquatic ecosystem. They're extremely important for healthy aquatic food chains and food webs. (See **Lesson 1:2—Food Chain Tag** for more information on aquatic food chains.) An **aquatic ecosystem** is any body of water (such as a stream, river, or lake) and all of its organisms and nonliving components that, together, function as a natural system. A **habitat** is an area that provides food, water, cover, and space to adequately meet an organism's survival needs. The ability to identify each organism in an aquatic ecosystem is, for young children, less crucial than having the opportunity to discover the diversity of life in a pond or stream—and spending some time contemplating how fish rely on these many aquatic organisms for survival.

Aquatic Plants

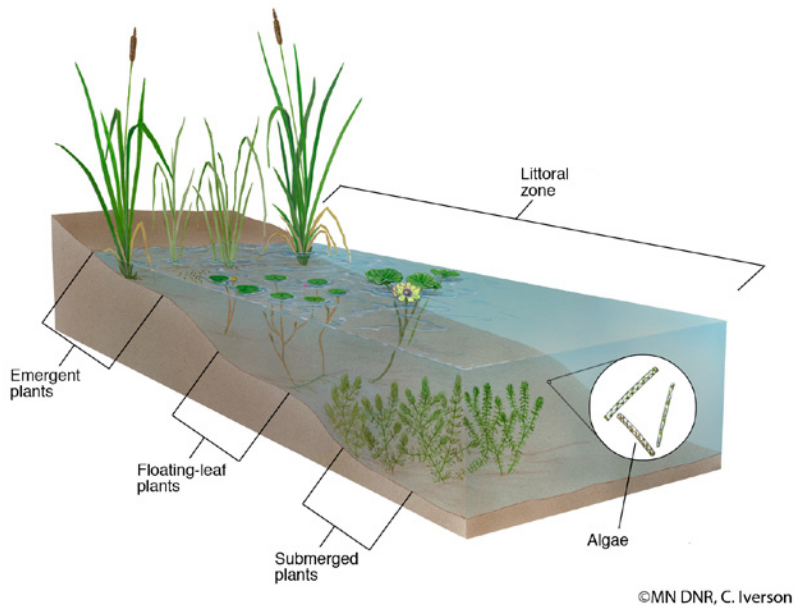
Minnesota streams, rivers, ponds, lakes, and wetlands are home to approximately 150 species of aquatic plants and macroscopic (visible to the unaided eye) algae categorized into four groups. Aquatic plants that are not attached to the bottom and float on the surface are **free-floating plants**. Examples include duckweed, planktonic algae, and watershield. Plants that are attached to the bottom, and have true

Materials

- **Aquatic Insect Life Cycle Sheet**, one per student (or as projection)
- **Water Habitat Site Study Identification Key** to plants and animals
- **Water Habitat Site Study Check-Off Sheet**, one per group or per student
- Various pond life field guides (See Part 1, Step 2 of lesson for recommendations.)
- Kitchen strainers, dip nets, or Hester-Dendy collectors
- Rake
- Shovel
- Buckets, two
- White trays with sides (such as plastic ice cube trays, which separate organisms for study), three or more
- Assorted containers or plastic cups
- Spoons
- Tweezers or forceps
- Magnifying lenses (worn on straps)
- Clipboards, preferably plastic covered, or five by seven-inch spiral-bound sketchbooks
- Pencils
- Paper, for drawing pictures of organisms
- Camera and film, to document field conditions
- Video program about pond life (optional)
- Drawing paper and materials for creating a class pond, stream, or lake discovery book

continued

stems, roots, and leaves with more than half of their vegetative parts projecting from the water are **emergent plants**. Examples include wild rice, cattails, and bulrush. Rooted plants with leaves that float on the surface are called **floating-leaf plants**. Examples include water lilies and lotus. Plants that grow completely underwater or with more than half of their parts growing beneath the surface are **submerged plants**. Submerged plants include wild celery, coontail, and water milfoil. Non rooted plants that float on the surface and can drift, such as duckweed, are called **free-floating plants.**



The zone in which emergent, floating-leaf, and submerged plants grow is known as the littoral zone. In many Minnesota lakes, the littoral zone extends to a depth of approximately fifteen feet.

Aquatic plants are important to fish and to other organisms in the ecosystem. Plants make their own food through photosynthesis, a process that uses the energy from the sun. Oxygen, a by-product of photosynthesis, is dissolved in water and respired by fish and other aquatic animals. Plants also provide food, cover, and spawning habitat for many types of fish and other animals. Many submerged plants provide food for waterfowl, as well as habitat for the insects they eat.

Aquatic plants further benefit water bodies and aquatic animals by absorbing excess nutrients, such as phosphorus and nitrogen, from runoff. **Runoff** is the water that "runs off" the land into lakes, streams, wetlands, and rivers.

Emergent plants also protect shorelines and bottoms by dampening wave action, stabilizing sediments, and preventing erosion.

Sheltering vegetation in or along the water provides food and cover for macroinvertebrates, fish, turtles, frogs, muskrats, snakes, birds, and many other types of wildlife. The loss of this vegetation can result in the loss of animals, too.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates are animals without backbones (invertebrates) that are large enough to be seen with the unaided eye (macro) and spend most or all of their life cycles in water (aquatic). Examples include mosquitoes, mayfly larvae, pouch snails, blackfly larvae, crayfish, whirlygig beetles, water striders, dragonfly larvae, and fingernail clams.

Aquatic macroinvertebrates are found swimming freely, or attached to things like rocks, docks, plants, or fallen logs, or buried in the bottom sediments of lakes or streams. A good way to find macroinvertebrates is to pick up a rock or log in a stream or along the lakeshore and watch the rock or log's surface for movement.

Macroinvertebrates can be herbivores, carnivores, or omnivores. Herbivorous invertebrates consume plants and algae. The macroinvertebrates that eat small fish, small amphibians, and other invertebrates are carnivores. Omnivores eat both plant and animal material. Aquatic macroinvertebrates are consumers, and they also provide food for other organisms such as fish, birds, frogs, and turtles. They're critical to a healthy aquatic ecosystem.

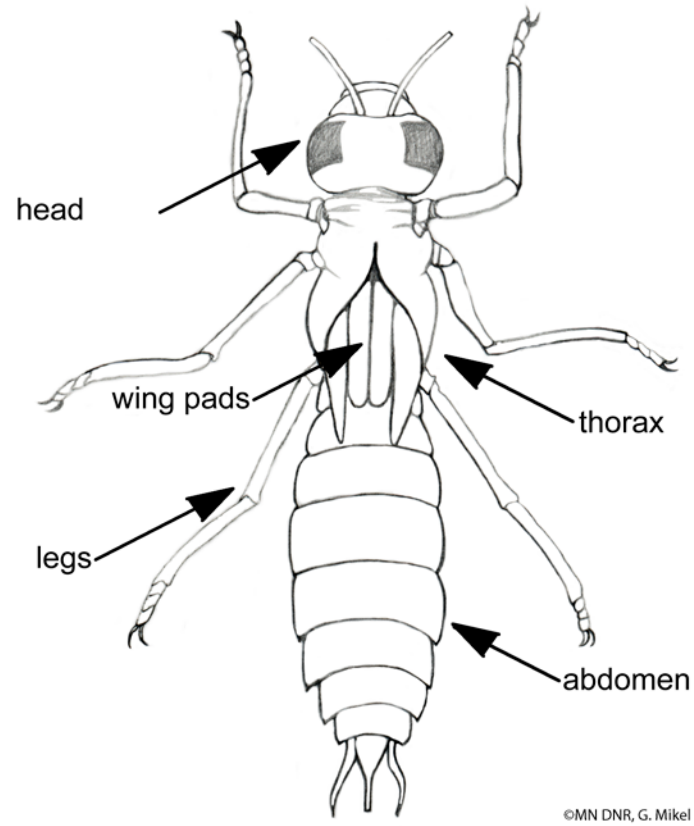
Organisms at various stages of their species' life cycle can be collected in a single water sample. At each life stage, members of the same species can look quite different from one another and display different characteristics. This is clearly illustrated by aquatic insects. You can collect dragonfly larvae from the water while the adults of the same species fly in the air around you.

Aquatic insects are a group of macroinvertebrates that have three-part bodies (with a head, thorax, and abdomen), and, in the adult stage, six legs. Aquatic insects live all or parts of their life cycles in the water.

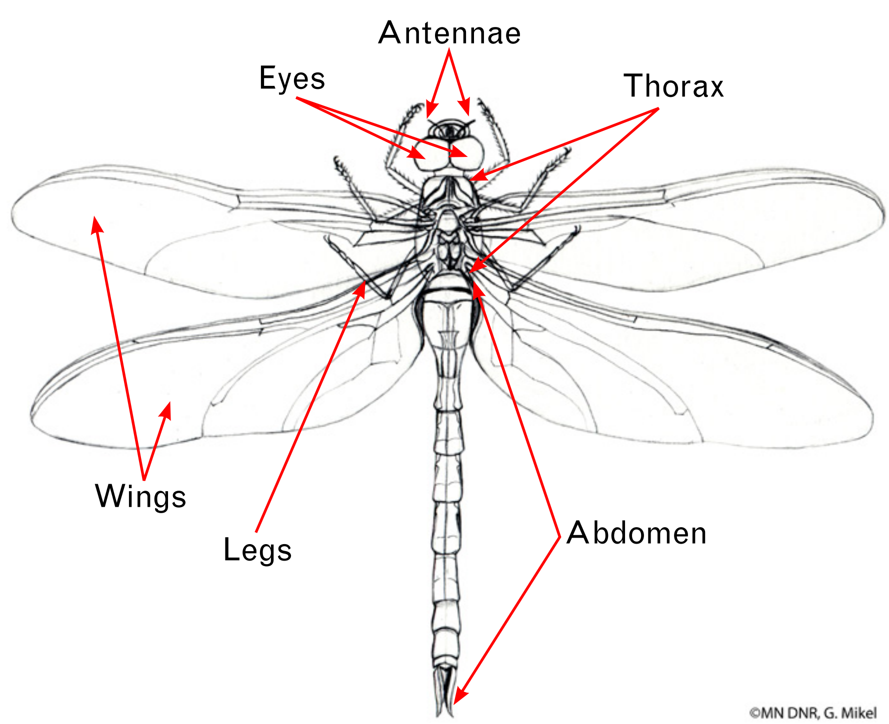
Materials (continued)

Basic Safety Equipment for Field Activities

- Waterproof shoes, rubber boots, or waders
- Walking stick (with measurements) for balance, probing, and measuring
- Insect repellent and sunscreen
- First aid kit
- Tarps, for gathering areas, sitting, and setting trays
- Towels, in case someone gets wet
- Whistle to summon help in emergencies, and to signal the beginning and end of activities
- Refreshments and drinking water



Dragonfly larva



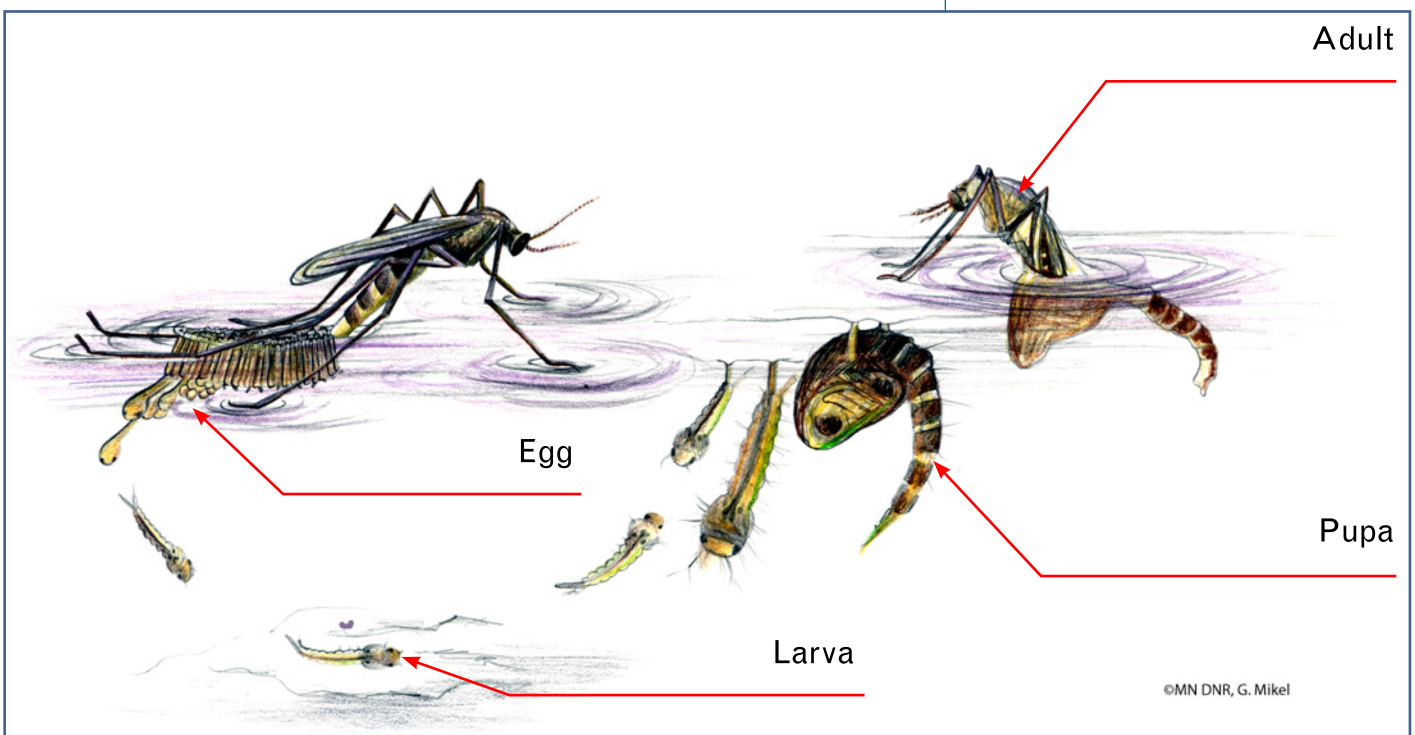
Adult dragonfly

A dragonfly larva spends most of its life cycle in the water before emerging to the air as an adult.

Macroinvertebrates, such as whirligig beetles, snails, aquatic sowbugs, and leeches, emerge from eggs, grow, and become adults without leaving the water. Most aquatic insects, however, spend at least a few days of their lives as winged adults in the air. Dragonflies, after as long as two years of development in the water, emerge to the air as adults to feed and to mate. Mayfly larvae and adults also have different features. The larvae have mouths, but the adults don't. Adults are too short-lived and occupied with mating to even need mouths—they die within seven days of emergence and mating. Although they're referred to as mayflies, various species from this group emerge all year long—some even in the dead of winter.

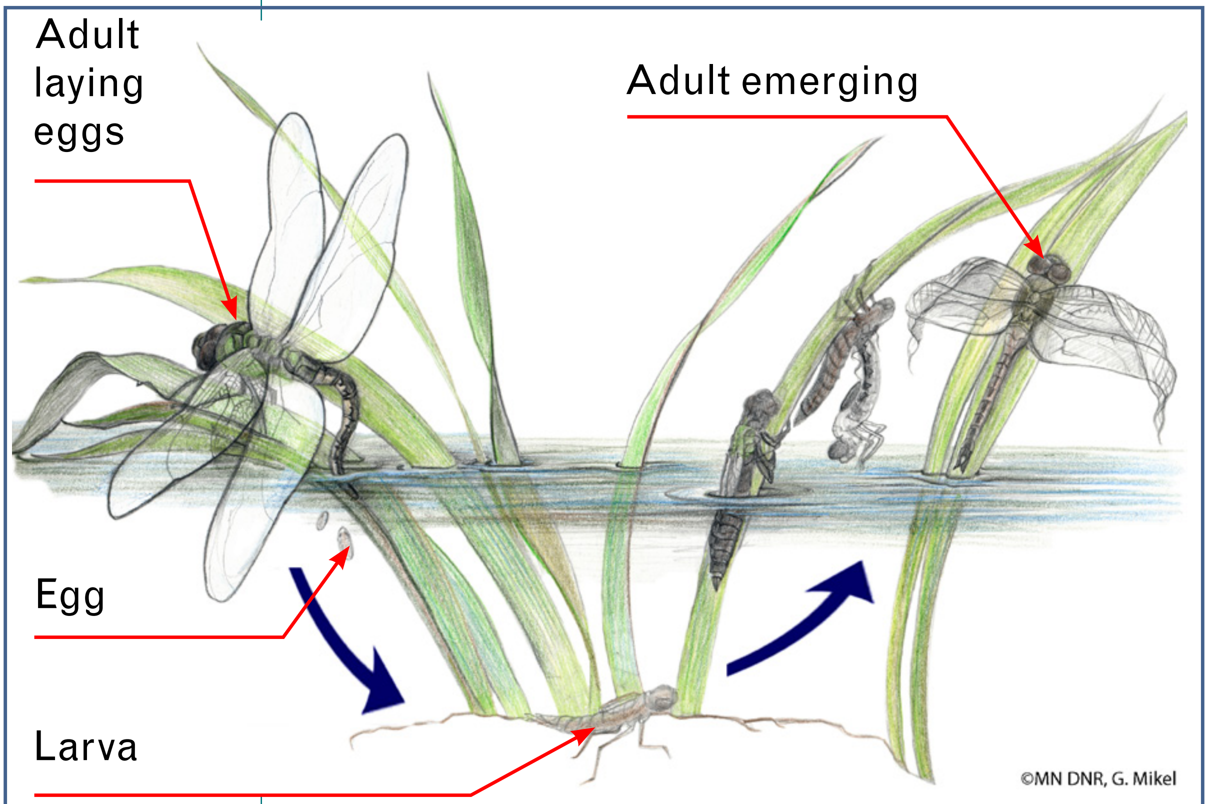
Many aquatic insects undergo numerous dramatic physical changes during their life cycles. The series of stages that the young undergo on the way to maturity is known as **metamorphosis**. There are two basic types of metamorphosis.

Complete metamorphosis involves a series of four stages. An egg matures, becoming a larva, a pupa, and finally, an adult. The pupa is non-feeding, typically in a cocoon or hardened case. The appearance of insects that undergo complete metamorphosis changes dramatically as they pass from one stage to the next. Examples of insects that undergo complete metamorphosis include mosquitoes, caddisflies, and blackflies.



During the process of complete metamorphosis, the mosquito matures from egg to larva to pupa to adult.

Incomplete metamorphosis, a more primitive type of development, doesn't include a pupa stage. After hatching from its egg, the young insect undergoes a series of instar stages (or molts), shedding its exoskeletons and growing ever larger until it emerges directly from its exoskeleton as a winged adult. Examples of insects that undergo incomplete metamorphosis include dragonflies, stoneflies, and damselflies.



During incomplete metamorphosis, the dragonfly matures from egg to larva to adult.

Aquatic Vertebrates

Vertebrates are animals with backbones or spines. Aquatic vertebrates include fish, turtles, salamanders and frogs. Vertebrate organisms (such as minnows or other small fish or tadpoles) might also be collected in your samples.

Aquatic Plants and Macroinvertebrates Are Indicators of Water Quality

Biologists often monitor aquatic plant and macroinvertebrate populations to determine habitat diversity and to measure water quality. The proportion of rooted aquatic plants versus algae is a good indicator of water quality. The absence of rooted aquatic plants and a high concentration of algae indicates excessive nutrient input from the surrounding watershed.

Macroinvertebrates are excellent indicators of water quality because they usually live most or all of their life cycles in the same area of a stream or lake, so changes in their populations can be directly related to changes in their water habitats.

Pollution is any substance or condition that makes water less useful or desirable. Pollution impairs water quality. Some species of macroinvertebrates are more tolerant of pollution and low water oxygen levels than others. For example, leeches, pouch snails, and aquatic sowbugs are relatively tolerant of pollutants. Stonefly larvae, alderfly larvae, and Dobsonfly larvae (sometimes referred to as hellgramites) are very sensitive to pollutants in the water. Crayfish, dragonfly larva, and clams are aquatic macroinvertebrates usually found in water of moderate (or better) quality. Identifying the macroinvertebrates that appear in a sample can give clues to the water quality of the lake or stream. For example, if most of the macroinvertebrates sampled are pollution-tolerant species, the lake or stream may be polluted. Or, if many of the macroinvertebrates sampled are pollution-sensitive species, the lake or stream may be healthy.

If aquatic macroinvertebrate monitoring indicates a possible water quality problem, definitive chemical analyses are needed to determine which pollutants or other water quality issues are impacting the health of the organisms. See **Lesson 3:6—Macroinvertebrate Mayhem** for more information on macroinvertebrates as water quality indicators.

Identification and Observation of Diversity Build Understanding

Identification keys, field guides, and careful observations can unlock the identity of the plants and animals that the students collect. The varied features of the specimens also highlight the diversity exhibited in aquatic habitats. The more students observe aquatic plants and animals and their interactions, the better they'll understand the importance of these organisms and their roles in aquatic ecosystems.

Sampling Techniques

Collecting plants and animals from a stream is a fun and exciting activity for students. They'll be surprised and amazed by the whole new water world they discover. Plants can be collected using common kitchen strainers and a rake.

Macroinvertebrates and other animals are collected in various ways. One common technique is to place a collection net in a stream and then use a stick, hands, or feet to stir the gravel *upstream* from the net. Dislodged animals will be then wash into the net. Empty the contents of the net into a specimen bucket for observation and identification.

Kick Nets

Kick nets are used in streambeds and are useful for rapid coverage of bottom dwelling organisms from large sections of water. One type of kick net has two rods or handles with a mesh net between them. The

Macroinvertebrates tolerant of polluted water or low oxygen will also thrive in clean, well-oxygenated water. Finding only pollution-tolerant species in a lake or stream indicates that the water is polluted or low in oxygen.

When collecting aquatic plants and animals, take care to minimize impact at the site. Collect small amounts of plant and animal material—it isn't necessary to take large samples.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.

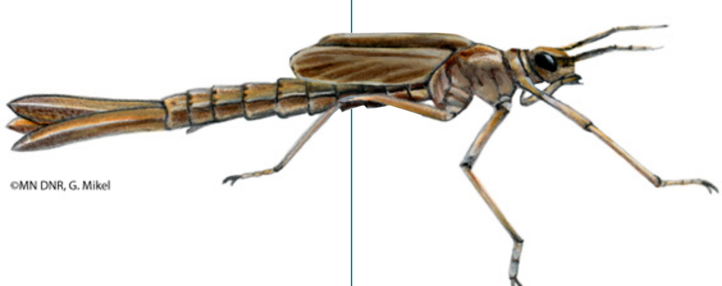
It is illegal to remove aquatic vegetation from areas posted by the Minnesota DNR as Infested Waters, Scientific and Natural Areas, or Fish Spawning Areas.

net is stretched across fast-moving water and placed on the bottom to trap organisms. One person holds the net and another kicks the rocks in front of the net, dislodging animals on the rocks. The animals flow downstream and the net captures them. The net can be folded for carrying. The bottom of the net is weighted to keep it from floating during sampling.

A mesh kick net with two handles.

Make your own kick net by stapling a section of screen to two four-foot long dowels.

Dip Nets
These nets are designed for sweeping over light vegetation or for use in shallow ponds and streams.

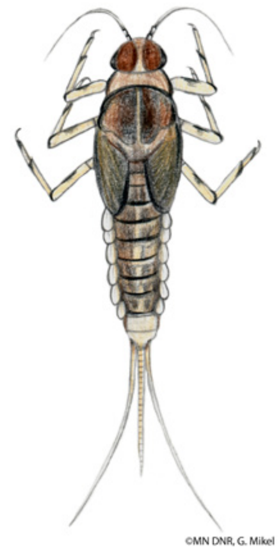


D-frame Dip Net
A D-frame dip net ring is made of steel and is D-shaped with a flat bottom. It's wrapped in heavy, durable muslin, with rope reinforcement at the net ring. The bottom of the net has mesh screening that allows water to flow through, catching organisms, plants, sediment, and other debris. The ring is attached to a long wooden handle that's usually about five feet long.

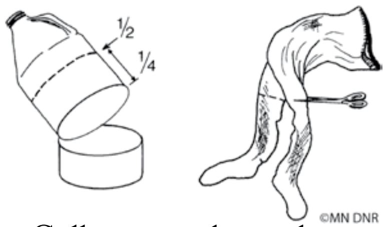
A D-frame dip net.

Triangle Dip Net
A triangle aquatic dip net is designed to take samples in heavy weeds. The steel ring is triangle-shaped, with heavy muslin and rope reinforcement at the net ring. Like the D-frame dip net, the bottom side is flat, but the top side comes to a narrow point with an attached handle.

A triangle dip net.



How to Make a Simple Dip Net



1. Collect enough coat hangers, pantyhose, and plastic bottles for each net that you plan to make. Prepare bottles and pantyhose as illustrated. The bottoms of the bottles can be saved and used as study trays for the collected specimens.

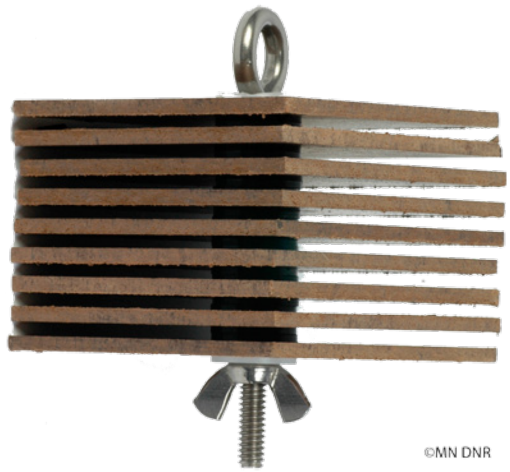
2. Insert the middle section of the plastic bottle into the top of the panty hose and attach it with waterproof glue.

3. Make a handle by bending the wire coat hanger to fit around the bottle. Secure the hanger to the bottle by with a few wraps of duct tape.

4. The top portion of the bottle can be used to scoop or dredge bottom sediments to look for benthic (bottom dwelling) invertebrates. Attach a piece of mesh screening to the screw-top opening of the bottle top by twisting a wire (or wrapping a rubber band) tightly around the screening and cap threads. Scoop a thin layer of bottom sediments, allow the water to filter through the screening, and look for invertebrates wiggling in the remaining sediments.

Hester-Dendy Sampler

A Hester-Dendy sampler is a commonly recommended device for aquatic macroinvertebrate sampling. It's compact, lightweight and inexpensive. It can be suspended, floated, or attached to underwater objects (such as large rocks, or a post) and left in the water for as long as two weeks. When it's retrieved from the water, the aquatic macroinvertebrates can be collected from the plates, put in trays, observed, and identified.



A Hester-Dendy sampler.

Benthic Dredges

Aquatic macroinvertebrates can also be found inhabiting the muck and sediment in the bottoms of lakes and streams. Organisms that inhabit the bottom substrates of water bodies are **benthic organisms.** Benthic bottom dredges, also known as "grabs," are devices usually used to sample macroinvertebrates from the top few centimeters of sediments on lake, reservoir, or pond bottoms. They're essentially metal scoops attached to a rope or cable. The scoops resemble miniature construction shovels. Four sizes of dredges—the Peterson dredge, the Ponar Dredge, the LaMotte Dredge, and the Eckman Dredge—are used to collect samples from different types of terrain. The small and lightweight Eckman Dredge is typically used to collect samples from finer silt and sand bottoms. A dredge is usually lowered to the bottom of a body of water from a boat with a winch or by hand. The end of the rope or cable is secured to reduce the risk of losing the dredge. The dredge is "tripped" to grab and hold a sample of sediment, and retrieved from the water. A bucket is placed under the dredge just before the dredge is lifted above the surface, so that none of the sample drips away.

An Eckman dredge.

Making Your Own Dredges
You can make a dredge or "muck scooper" for collecting benthic organisms. Use an empty soup can for the scoop, and attach it to a handle with three screws, nuts, and washers. For the handle, use a long, sturdy dowel (or a one-by-two board) at least three feet long.

A homemade dredge, also known as the muck scooper.

Macroinvertebrates can also be obtained by collecting a few submerged rocks from a lake, pond, or stream. Place them in a bucket, take them back to the classroom, then very gently scrub the bottoms of the rocks with a soft dishwashing brush to dislodge the macroinvertebrates into the water.

Procedure

Preparation

1 Before the class trip, visit the site. Survey the entire area you plan to study. Look for possible safety concerns such as steep banks, fast-moving water, loose footing, thick brush, and poison ivy. Become familiar with the plants and animals that live in and near the body of water.
2 Choose collection sites. Your areas for collecting specimens should be shallow, accessible, and safe. Beach areas provide little habitat for aquatic plants and animals. Docks, fishing piers, and areas with vegetation, rocks, and fallen logs will provide a wider diversity of species.
3 Obtain permission to use the site if it is located on private land.
4 Discuss with your students what they should wear for the field trip to the pond.

Protect Minnesota's Aquatic Resources and Native Species

For additional information, see *A Field Guide to Aquatic Exotic Plants and Animals*, a brochure available from the Minnesota DNR.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.

- The law prohibits removing aquatic vegetation within areas posted by the Minnesota DNR as Infested Waters, Scientific and Natural Areas, or Fish Spawning Areas. Obtain all required permits, refer to the current Minnesota fishing regulations booklet, or check with MinnAqua staff, your local conservation officer, or a DNR resource biologist for proper procedures concerning transportation, collection, and disposal of water and aquatic organisms. You can refer to *Minnesota Rules Chapter 6280 Item G, and the Minnesota Exotic Species statutes Chapter 84D*. These rules and guidelines will also help prevent the spread of invasive species and diseases to native aquatic organisms.
- Never put water, plants, animals, or sediment from one aquatic system into another.
- All sample-collecting equipment should be dried or frozen after use to prevent the spread of aquatic diseases and invasive species. Or, if it is to be used again in an infested area, mark that equipment and only use it in the same infested waters. Your Minnesota fishing regulations booklet may not include the most recently infested waters. For more information on aquatic invasive species and infested waters see:
www.mndnr.gov/eco/invasives.html

If you can't take the students to a body of water, you can go out beforehand and collect a sample large enough to evenly divide between groups in the classroom. Students can then pick through the water and debris to locate, observe, draw, and identify organisms.

- This activity will disrupt the pond bottom or streambed, which can stir up any contaminants that may have settled in the water body. Avoid areas of major contaminant spills, as well as areas near discharge sites.
- Do *not* repeatedly use a single area for habitat site study visits. Give each area time to recover by rotating to another spot—this way, you'll limit harm to a good study area.

Activity

Warm-up

1. Prior to going outdoors, ask the students which living things they expect to find in different places or different habitats of the pond or stream. After making a list, ask the students why it might be important to identify these organisms.
2. Explain how to use an identification key. Define ecosystem.
3. Explain that different organisms can be found in different types of aquatic habitats.
4. You may wish to show a video program on pond life to the class. There are many excellent video programs on freshwater life available (such as *Eyewitness Nature Pond and River* and *Animal Discovery Fun for Kids! Pond Life*, available through SVE & Churchill Video).
5. Discuss the life cycles of aquatic insects and explain that students may find macroinvertebrates in different life stages. Hand out copies of the **Aquatic Insect Life Cycle Sheet** or project it in the classroom.
6. Review the basic safety rules (or guide the class in creating their own list of safety rules).
   - Ask students to stay dry and remain within set boundaries.
   - Discuss the importance of minimizing impact on the sample area by treading lightly, taking only small amounts of samples, and placing rocks, water organisms, and other materials back in their original positions at the conclusion of the activity.
7. Tell the students how to use the equipment at each station. They'll use different kinds of equipment to collect organisms from different habitats in the lake or pond.
   - At Station 1, use strainers and dip nets for scooping into the water from shore or a dock. Place strained items into a bucket of water on shore. Students on shore can sift through the bucket and place organisms on shallow white trays (with water) for easy viewing.
   - At Station 2, from shore, use a shovel or homemade dredge to collect loose material and substrate from the bottom and put it in a bucket. The students can sift through the material with spoons, tweezers, or small cups. Use the shovel with care. Small scoops will yield many organisms that live in the bottom muck.

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STOP AQUATIC HITCHHIKERS!

Prevent the transport of nuisance species. Clean all recreational equipment.

Do not transport water, plants or animals from areas known to be infested with harmful invasive plants or animals. Look for signs or postings indicating the presence of invasive species. Be careful not to fragment plants or leave organisms along the shore. Check the Minnesota DNR website for a current list of infested waters.

To save time, you may have each group bring their sample trays, after one rotation, to a central location where all students can identify and draw the organisms. At the completion of the activity, carefully return all specimens to the water body.

You may wish to divide the students into six groups so the groups are smaller and more manageable. In that case, you'll need to set up two of each of the stations at the site.

- At Station 3, use the rake from shore to collect small amounts of submerged aquatic plants from the water into a bucket. Students can separate different types into shallow trays. Do not disturb or remove emergent plants that can be easily observed from shore (such as cattails, water lilies, and bulrushes). Instead, point them out to students to identify using identification keys or field guides.
- At each station, use half of the time for collecting specimens and placing them into white trays for observation. Use the second half of your time to examine the organisms closely. Use magnifying lenses. Notice the special features of the different plants and animals. Use identification keys to identify the organisms. Make a detailed drawing of each different type of specimen in your tray.
- At the instructor's signal, carefully empty trays and return specimens to the water. Leave sampling equipment at the station for the next group. Rotate to the next station.

8 Divide the students into three working groups. Assign one or two adult supervisors to each group. If you have two adult volunteers per group, one volunteer can help students with the collection equipment while the other helps students identify organisms.

9 Determine locations for the three stations and set the necessary equipment at each station.

Lesson

Part 1: Sampling and Identification

1 Begin with a site survey. Pause with your students—away from the water's edge—and take in the site. Be observant! Look, listen, and note the sights and sounds. Note the weather conditions, amount of vegetation, and the most prominent signs of living things in the area. What evidence of human activity do you observe?

2 Distribute sampling equipment to each student group: buckets, white trays, strainers, dip nets, and small rakes or shovels. Each student should have a clipboard or other firm writing surface, paper or a journal, a pencil, and a **Water Habitat Site Study Check-Off Sheet**. Each instructor and adult leader should have copies of the identification keys:

- **Water Habitat Site Study Identification Sheets** and **Keys** in this lesson
- *A Guide to Aquatic Plants*, Minnesota DNR
- *Through the Looking Glass: A Guide to Aquatic Plants*, University of Wisconsin-Extension

3 Signal the groups to rotate to each of the three stations. Each group should have time to collect, draw, and identify several plants or animals at each station. Students should also check off the organisms that they find on the **Water Habitat Site Study Check-Off Sheet.**

4 Carefully return the animals and plants to the exact locations from which they were collected.

Station 1
- Use the dip nets to collect organisms on or below the water's surface. This should be done from a gentle sloping bank or from a fishing pier. Set your net firmly against the bottom of the pond or stream, and sweep to dislodge animals that live on or under rocks, allowing them to float into the net.
- Students should place their specimens in the white trays. The white of the trays allows details to be seen in the organisms collected. Keep about an inch of water in the tray and place it in a cool, shady spot. Change the water as often as needed to keep the animals cool.
- Have each student study and draw one or two different animal or insect specimens. Use the key to help identify the animals and label the drawings.

Station 2
- Sift through the mud and muck from the bottom that an adult leader has collected using a small shovel or homemade dredge. A small scoop of substrate is adequate, just enough to place on a tray. (The students may use their bare hands, spoons, tweezers, and cups for sifting.) This group could also try stirring up the bottom muck and silt, then scooping up organisms with a net or strainer.
- Place about one inch of water in a tray and empty the contents of the shovel onto it. Sift through the debris to look for small animals that might be hiding. Consider why these tiny animals are more abundant than larger creatures like fish and crayfish in your sample.
- Have each student study and draw three different animals on separate sheets of paper. Use the key to help identify the animals and label the drawings.

Station 3
- Sort through the plant samples collected with the rake and a strainer. Remember to make the least possible impact and take only what is needed. Place small pieces of the collected plants in the white tray.
- Have each student study and draw three different plants on separate sheets of paper. Use the key to help identify the plants and label the drawings.

Part 2: Use the Drawings to Create a Pond, Stream, or Lake Discovery Book

1. Bring your budding biologists back together to share their discoveries.
2. Collect the students' drawings and view them with the class.
3. Ask the students to group the drawings according to types of organisms. Keep track of the groups on the whiteboard. Group names might include shore plants, submerged plants, emergent plants, floating plants, macroinvertebrates, and vertebrates. Or students may wish to group the organisms according to the various habitats in which they were collected. Plants and animals can also be grouped according to physical characteristics or behaviors. Characteristics used for grouping depend on the purpose of the

grouping.

4 Divide the class into as many groups as the groups of organisms. Give the corresponding set of drawings to each group of students.

5 Each group can then use their set of drawings to create and write a chapter about that type of organism. These chapters can then be incorporated into a class book on the aquatic life found at the lake, pond, or stream ecosystem that the class visited.

6 Have each student create a cover page and title for the book. Students can vote to determine which will be the cover for the class book.

7 Collect and compile the chapters into a book and attach the winning cover. The book can be kept in the classroom or school library and posted on the school website as a reference and guidebook to life in the local water body.

8 You may wish to make a copy of the book for each student, using each student's own cover design for their personal copy.

Wrap-up

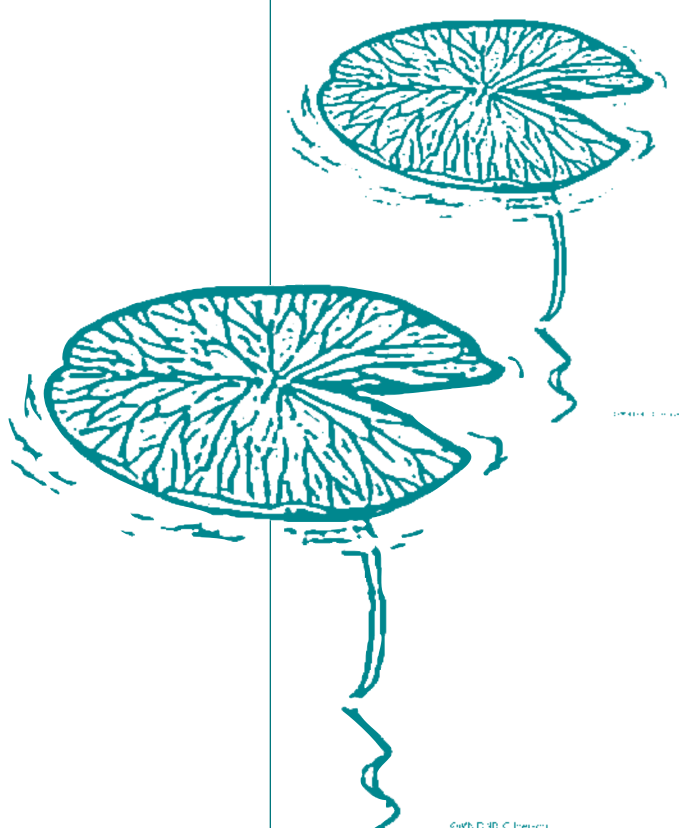
1 Review with your students the four basic habitat needs of aquatic animals: food, water, shelter, and space. Ask students to name some examples of food, water, shelter, and space that they might have observed during the water habitat site survey. What role do aquatic macroinvertebrates play in the aquatic ecosystem?

2 Discuss what might happen if one member of the aquatic community disappeared. How might people be affected? Remind students that all the organisms in an ecosystem are connected in a food web.

Assessment Options

1 Observe students working in groups at the site and as they create the book chapters. Assess each group's chapter, group participation, and contributions to class discussion.
2 Have students make a poster or graphic organizer that describes the various sampling methods they used to collect plants and animals at the site. They should also describe the types of organisms found using each method.
3 Have each student choose an organism from one of their drawings and describe the adaptations that help it survive in its watery habitat.
4 Write an article for the school newspaper or website about the field trip and the discovery book created by the class.
5 Assessment options include the Checklist and Rubric on the following pages.

Graphic organizers can take the form of a concept map, tree, star or web showing definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause and effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. Cut and folded paper can be fashioned into flaps that, when lifted, reveal details, definitions, descriptions, or explanations.



Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

29-32 points = A
Excellent. Work is above expectations.

26-28 points = B
Good. Work meets expectations.

21-25 points = C
Work is generally good. Some areas are better developed than others.

17-20 points = D
Work doesn't meet expectations; it's not clear that student understands objectives.

0-16 points = F
Work is unacceptable.

Water Habitat Site Study Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
6	`______`	`______`	Student describes three types of sampling equipment: dip nets, bottom sampler (spade, dredge, or shovel), and rake.
6	`______`	`______`	Student describes how to use the three types of sampling equipment.
3	`______`	`______`	Student describes types of organisms collected with all three types of sampling equipment.
3	`______`	`______`	Poster is attractive, legible, and easily seen from a distance.
2	`______`	`______`	Student can define *aquatic macroinvertebrate*.
2	`______`	`______`	Student collects aquatic plants, macroinvertebrates, and other animal specimens from a variety of habitat types in a local water ecosystem using a dip net, rake, and bottom-sifting sampling methods.
3	`______`	`______`	Student draws and describes examples of organisms collected using each sampling method.
3	`______`	`______`	Student identifies the plants and animals collected with each sampling method using field guides or identification keys.
4	`______`	`______`	Student groups organism illustrations into different types or categories of organisms and creates and illustrates materials for the discovery book.
Total Points			
32	`______`	`______`	**Score** `______`

Water Habitat Site Study Scoring Rubric

Sampling Methods Poster Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Sampling equipment and use	Illustrations show at least three types of equipment: dip nets, bottom sampler, and rake. Text states how equipment is used.	Illustrations show two types of sampling equipment. Text states how equipment is used.	Illustrations show two types of sampling equipment. Inaccurate description of equipment use.	Illustrations show one type of sampling equipment. Inaccurate description of equipment use.	Doesn't complete illustrations.
Types of organisms collected, by equipment type	Illustrations describe or visually show types of organisms collected with all three types of sampling equipment	Illustrations describe or visually show types of organisms collected with at least two types of sampling equipment.	Illustrations describe or visually show types of organisms collected with at least one type of sampling equipment.	Illustrations lack description of types of organisms collected with sampling equipment.	Doesn't complete illustrations.
Materials and design	Illustration attractive, legible, and easily seen from a distance.	Illustration attractive and easy to view.	Illustration hard to read and lacks visual appeal.	Illustration illegible.	Doesn't complete illustrations.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Create an aquatic food web using the plants and animals in the pond, stream, or lake discovery book the students created, as well as those organisms from the list of living things students expected to see at the site. Include producers, primary consumers, secondary consumers, herbivores, and carnivores. Refer to **Lesson 1:2—Food Chain Tag**. Remind the students that all living things are interconnected. Have all of the students create a food web by arranging the drawings in the center of the room—if an organism eats another organism, position the two drawings so that one corner of one drawing touches the corner of the other drawing. Connect as many of the organisms as possible! Could people be a part of this food web? What does a food web illustrate? Tape the food web together to display in the classroom, or on a wall in the school where everyone can see what lives in the local pond or stream, and how these organisms are connected.

2 Bring some of the pond water and macroinvertebrates that you collect into the classroom and look at the water and organisms with a microscope. Observe and draw the features of the macroinvertebrates in detail. See if students can find the extremely small and microscopic organisms listed on the **Water Habitat Site Study Check-off Sheet.** Determine which adaptations these organisms have that allow them to eat, and note how they move around in the water. Add a microscopic organisms chapter to the pond, stream, or lake discovery book.

3 Ask students to research and write a one-page paper on the adaptations to life in the water developed by pond or stream macroinvertebrates. (Examples include gills, breathing tubes, suction cups, streamlined or flat body shapes, and the ability to walk on the water.)

4 Investigate the camouflage capabilities and building skills of caddisflies, which use silk to glue small sticks and pieces of rock together to make "armored" case structures for themselves.

5 Have students investigate the differences between the complete metamorphosis that mosquitoes undergo and the incomplete metamorphosis of dragonflies and mayflies.

6 Have your students participate in a local volunteer stream monitoring effort. They'll learn more about how some types of aquatic macroinvertebrates are more sensitive to water pollution, and that others are more tolerant of pollution or degraded conditions (including turbidity and silt, low oxygen levels, and toxins).

For the Small Fry

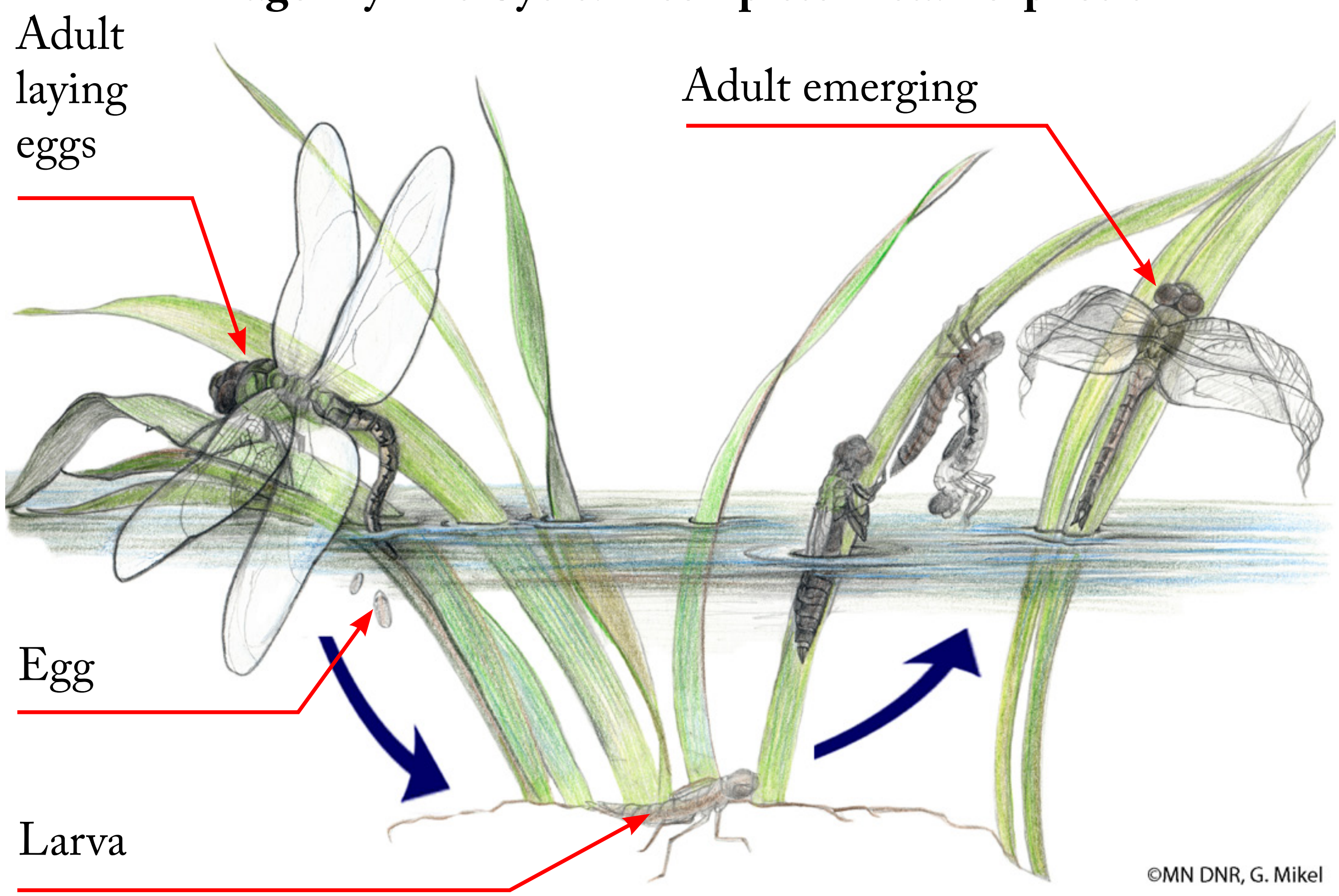
K-2 Option

Instead of making drawings and creating a pond, stream, or lake discovery book, have the student groups play Water Habitat Bingo as they rotate through each station at the site. To play Bingo, ask each group to mark a **Water Habitat Bingo Sheet**, placing an X in each box that names an organism that they find at a station. Four Xs in a row indicate a bingo! Allow students to rotate through the stations until one team gets a bingo and wins the game.

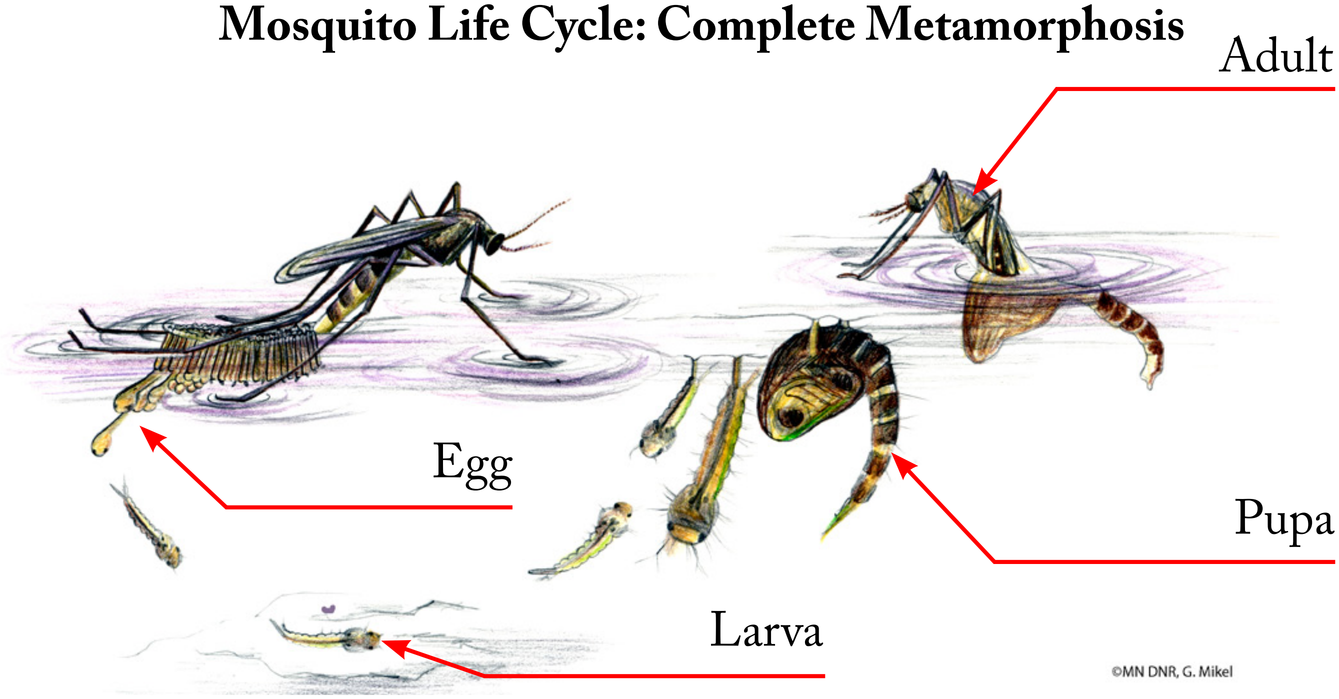
STUDENT COPY

Aquatic Insect Life Cycle Sheet

Dragonfly Life Cycle: Incomplete Metamorphosis



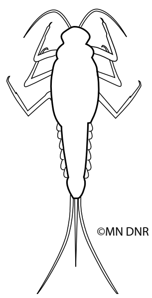
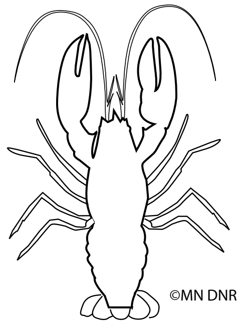
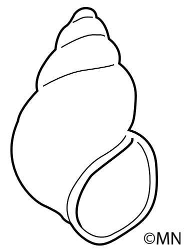
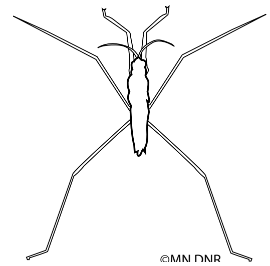
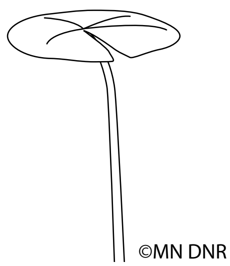
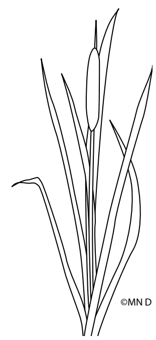
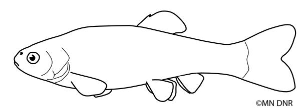
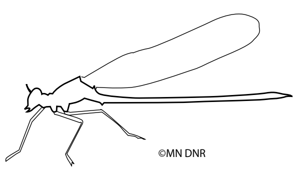
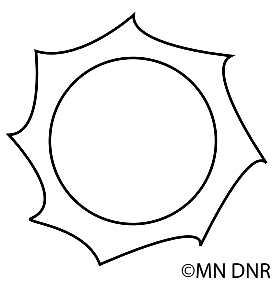
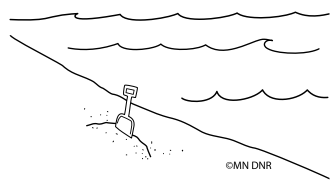
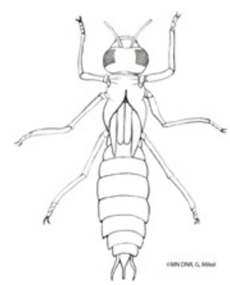
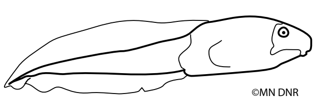
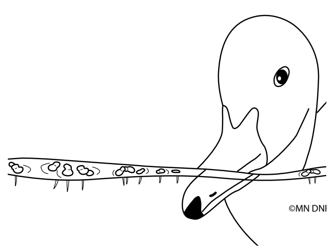
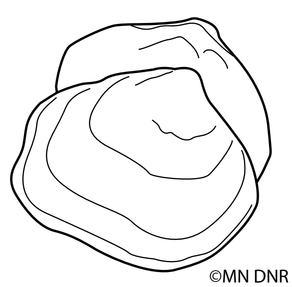
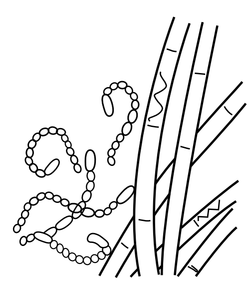
Mosquito Life Cycle: Complete Metamorphosis



STUDENT COPY

Name(s) ______________________________ Date ______________

Water Habitat Bingo Sheet (for K-2)

Mayfly larva 	**Crayfish** 	**Snail shell** 	**Water strider** 
Arrowhead 	**Lily pad** 	**Cattail** 	**Small fish** 
Adult damselfly 	**Sun** 	**Water** 	**Dragonfly larva** 
Tadpole 	**Duckweed** 	**Mussel** 	**Algae** 

STUDENT COPY

Name(s) ______________________________ Date ______________

Water Habitat Site Study Check-off Sheet

Macroinvertebrates

_____ Dragonfly
_____ Damselfly
_____ Caddisfly
_____ Mayfly
_____ Stonefly
_____ Scud
_____ Fairy Shrimp
_____ Water Boatman
_____ Backswimmer
_____ Predaceous Diving Beetle
_____ Whirligig Beetle
_____ Water Strider
_____ Mussel shell
_____ Snail shell
_____ Crayfish
_____ Water Scorpion
_____ Giant Water Bug
_____ Leech

Vertebrates: Reptiles and Amphibians

_____ American Toad
_____ Bullfrog
_____ Chorus Frog
_____ Green Frog
_____ Leopard Frog
_____ Newt
_____ Painted Turtle
_____ Tiger Salamander larva
_____ Spring Peeper
_____ Tadpole

Vertebrates: Fish

_____ Fathead Minnow
_____ Creek Chub
_____ Northern Redbelly Dace
_____ Bluntnose Minnow
_____ Darter
_____ Brook Stickleback
_____ Mudminnow
_____ Killifish
_____ Sunfish
_____ Black Bullhead
_____ Golden Shiner

STUDENT COPY

Name(s) ______________________________ Date ______________

Water Habitat Site Study Check-off Sheet

Aquatic Plants

_____ Wild Celery
_____ Common Waterweed
_____ Large-leaf Pondweed
_____ Northern Watermilfoil
_____ Eurasian Watermilfoil (invasive species)
_____ Coontail
_____ Curlyleaf Pondweed (invasive species)
_____ Small Duckweed
_____ Large Duckweed
_____ White Water Lily
_____ Yellow Water Lily
_____ Yellow Lotus
_____ Arrowhead
_____ Soft-stem or Hard-stem Bulrush
_____ Common Rush
_____ Cattail
_____ Northern Blue Flag Iris
_____ Wild Rice
_____ Purple Loosestrife (invasive species)

Other Aquatic Plants or Animals

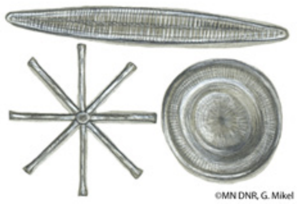
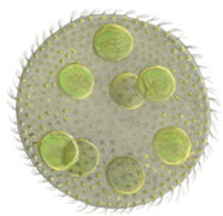
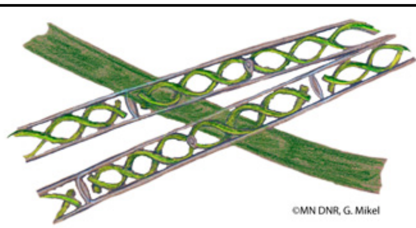
____
____
____
____
____
____
____
____
____
____
____

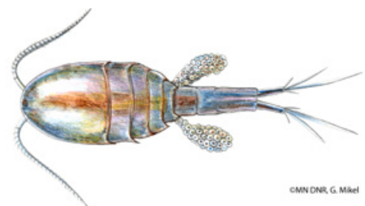
STOP AQUATIC HITCHHIKERS!™
Prevent the transport of nuisance species.
Clean all recreational equipment.

STUDENT COPY

Name(s) ______________________________ Date ____________

Water Habitat Site Study Check-off Sheet

X	Microscopic Organisms
	 Clam or Seed Shrimp
	 Diatom
	 Volvox
	 Euglena
	 Spirogyra
	 Rotifer

X	Microscopic Organisms
	 Hydra
	 Cyclops/Copepod
	 Daphnia
	 Paramecium
	 Amoeba

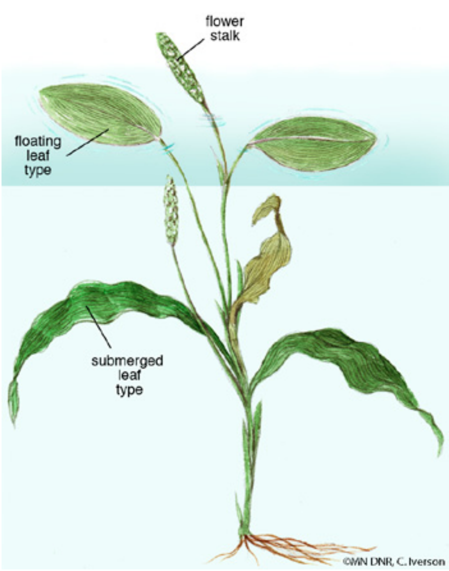
Water Habitat Site Study Identification Sheet: Plants

Submerged Plants

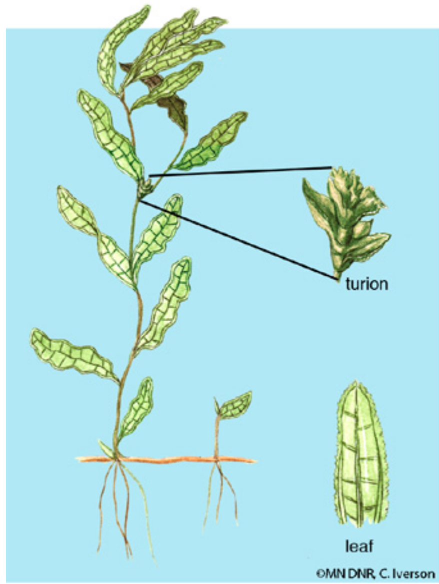
Entire leaves: opposite or whorled

Common Waterweed
Elodea Canadensis

Entire leaves: alternate or basal



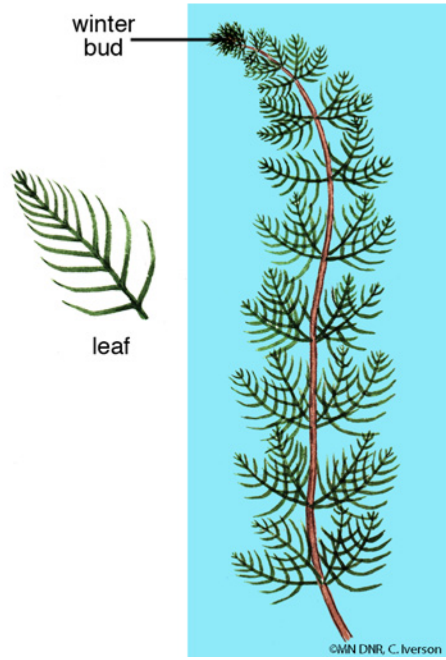
Large-leaf Pondweed
Potamogeton amplifolius



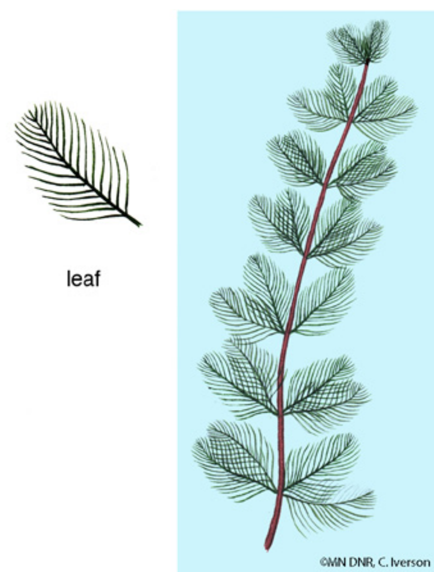
Curly-leaf Pondweed
Potamogeton crispus
(Invasive Species)

Wild Celery
Vallisneria Americana

Finely-divided leaves



Northern Water Milfoil
Myriophyllum sibiricum

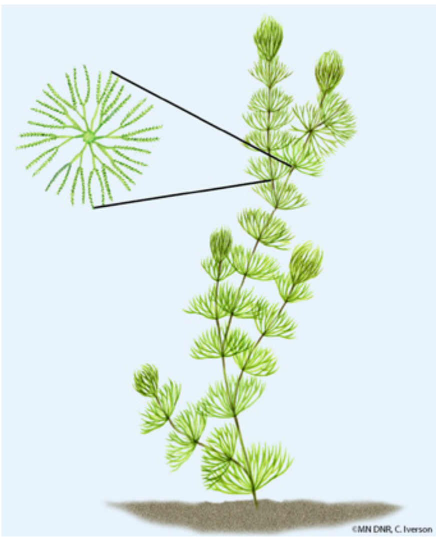


Eurasian Water Milfoil
Myriophyllum spicatum
(Invasive Species)

Water Habitat Site Study Identification Sheet: Plants

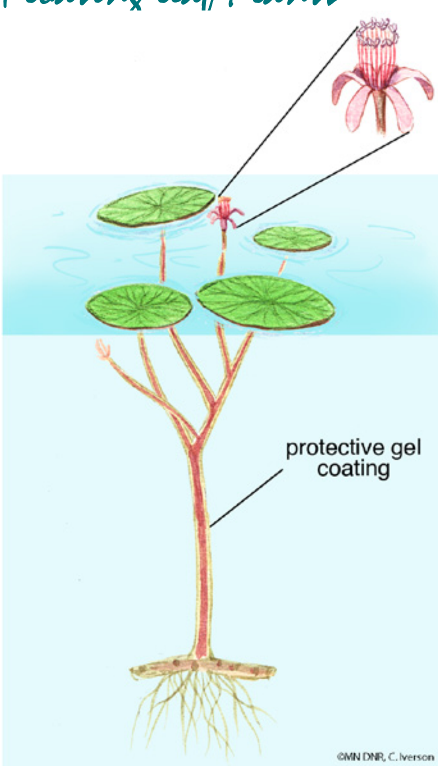
Submerged Plants

Finely-divided leaves



Coontail
Ceratophyllum demersum

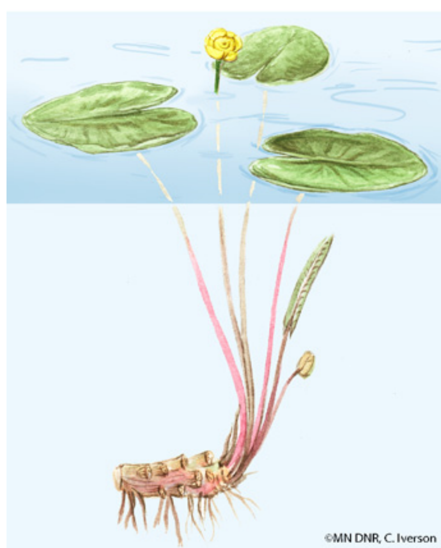
Floating-leaf Plants



Watershield
Brasenia schreberi

American Lotus
Nelumbo lutea

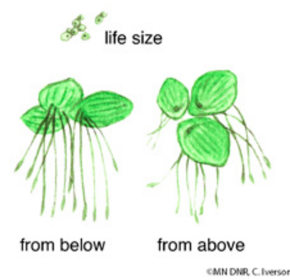
White Water Lily
Nymphaea odorata



Yellow Pond lily
Nuphar advena

Water Smartweed
Polygonum amphibium

Free-floating Plants



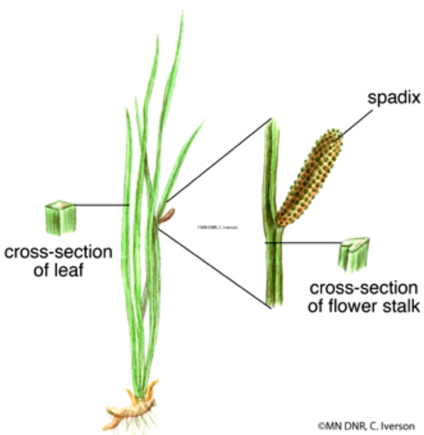
Large Duckweed
Spirodela polyrhiza

Small Duckweed
Lemma minor

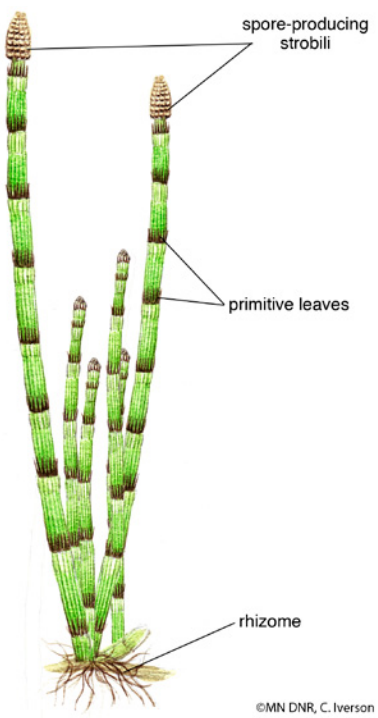
Water Habitat Site Study Identification Sheet: Plants

Emergent Plants

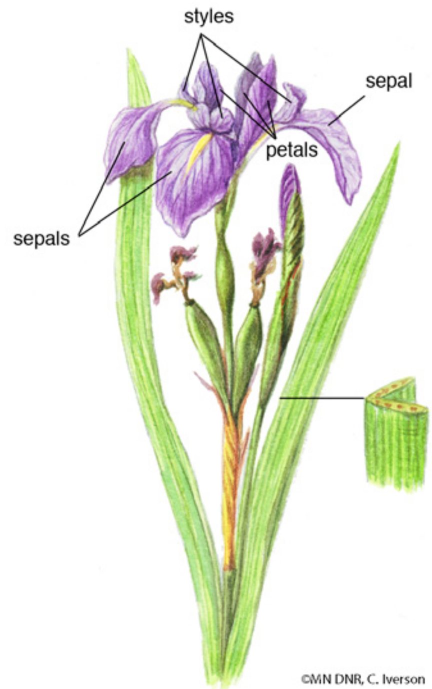
Narrow leaves



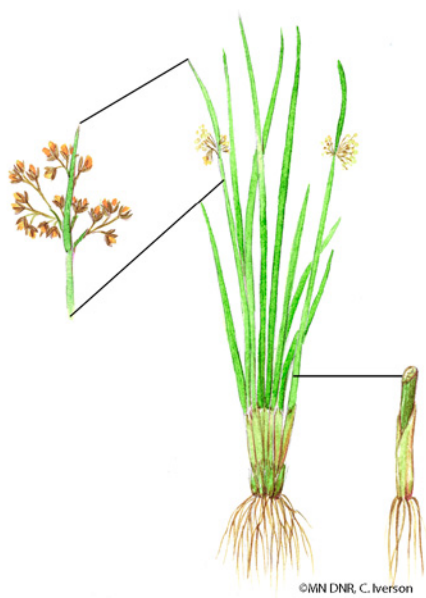
Sweetflag
Acorus calamus



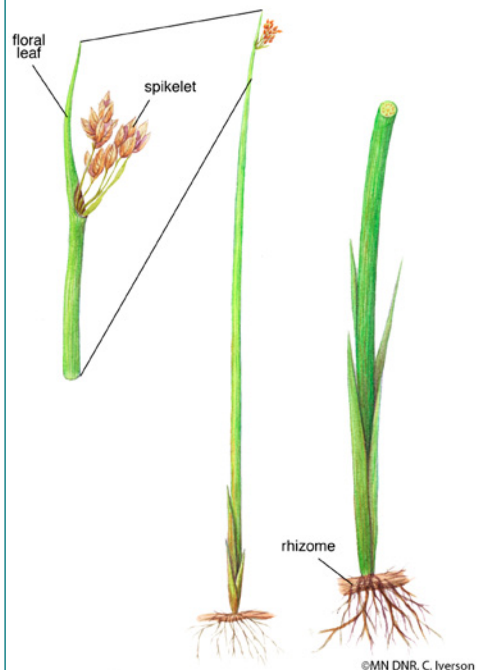
Water Horsetail
Equisetum fluviatile



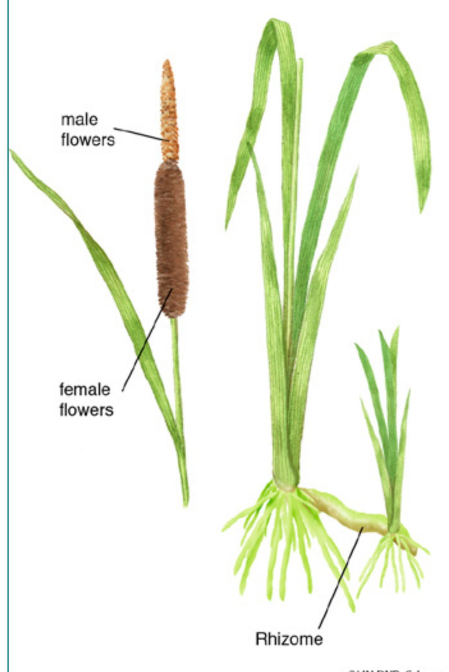
Northern Blue Flag Iris
Iris versicolor



Common Rush
Juncus effusus



Hardstem Bulrush
Scirpus acutus

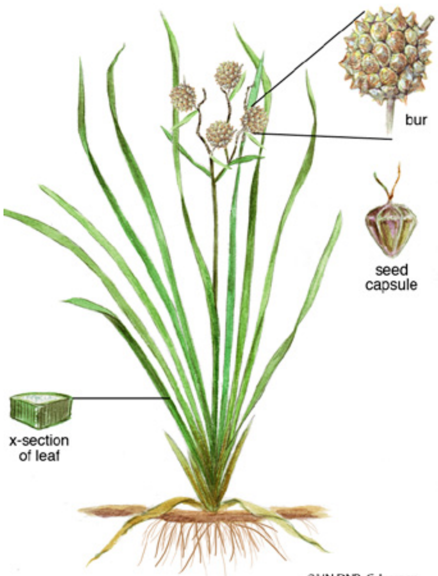


Broad-leafed Cattail
Typha latifolia

Water Habitat Site Study Identification Sheet: Plants

Emergent Plants

Narrow leaves



Common Bur-reed
Sparganium eurycarpum

Common Reed
Phragmites australis

Wild Rice
Zizania spp.

Softstem Bulrush
Scirpus validus

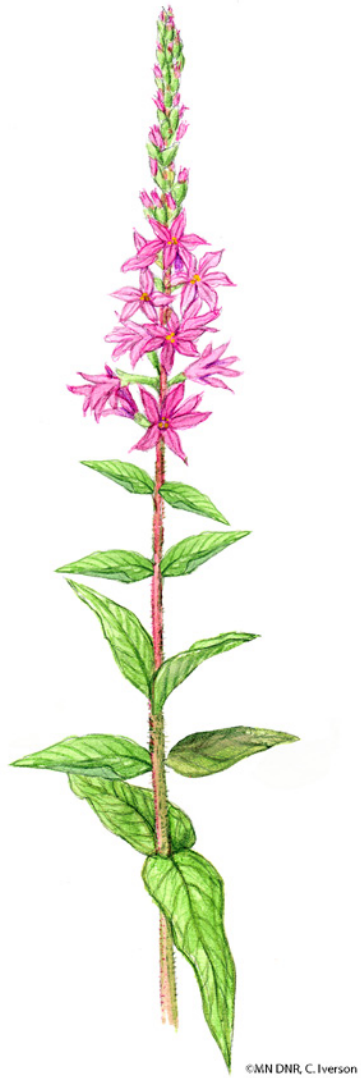
Water Habitat Site Study Identification Sheet: Plants

Emergent Plants

Broad leaves

Common Arrowhead
Sagittaria latifolia

Pickerelweed
Pontederia cordata



Purple Loosestrife
Lythrum salicaria
(Invasive Species)

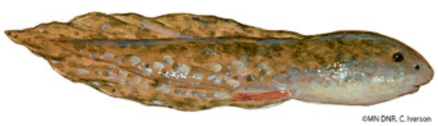
Water Hemlock
Cicuta maculata

Wild Calla
Calla palustris

Water Habitat Site Study Identification Sheet: Reptiles and Amphibians

Frogs

Bullfrog*
Rana catesbeiana



Bullfrog Tadpole
Rana catesbeiana

Chorus Frog
Pseudacris triseriata

Green Frog
Rana clamitans

Leopard Frog
Rana pipiens

Spring Peeper
Pseudacris crucifer

Toads

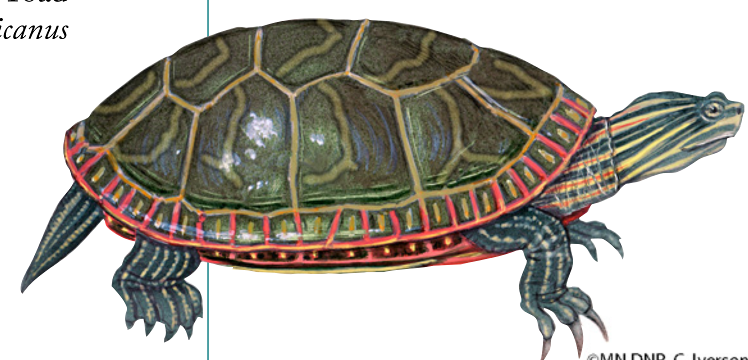
American Toad
Bufo americanus

Salamanders

Eastern Tiger Salamander
Ambystoma tigrinum

Eastern Tiger Salamander Larva
Ambystoma tigrinum tigrinum

Turtles



Painted Turtle
Chrysemys picta bellii

* Note: native only to southeast Minnesota.

Water Habitat Site Study Identification Sheet: Fish

Minnow Family

Fathead Minnow
Pimephales promelas

Creek Chub
Semotilus atromaculatus

Northern Redbelly Dace
Phoxinus eos

Bluntnose Minnow
Pimephales notatus

Golden Shiner
Notemigonus crysoleucas

Perch Family

Johnny Darter
Etheostoma nigrum

Stickleback Family

Brook Stickleback
Culaea inconstans

Mudminnow Family

Central Mudminnow
Umbra limi

Killifish Family

Banded Killifish
Fundulus diaphanus

Sunfish Family

Bluegill
Lepomis macrochirus

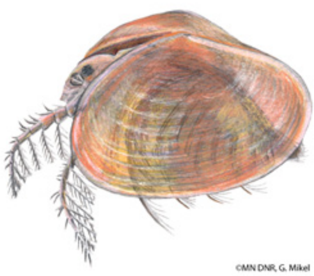
Catfish Family

Black Bullhead
Ameiurus melas

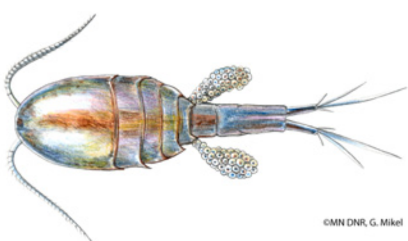
Water Habitat Site Study Identification Sheet: Microscopic Organisms

Zooplankton

Amoeba



Clam Shrimp
(Conchostraca)

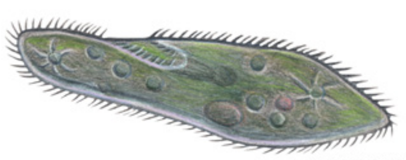


Cyclops / copepod

Daphnia / water flea
(Cladocerans)

Euglena
(Mastigophora; motile
unicellular algae)

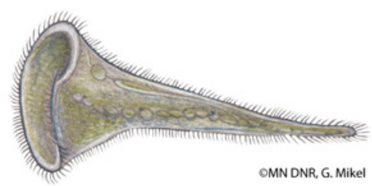
Hydra



Paramecium
(Ciliophora)

Rotifer

Seed Shrimp
(Ostracoda)



Stentor
(Ciliophora)

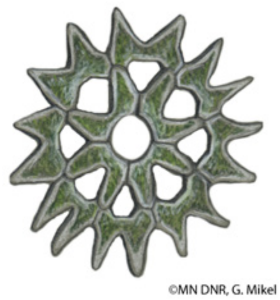
Water Habitat Site Study Identification Sheet: Microscopic Organisms

Phytoplankton

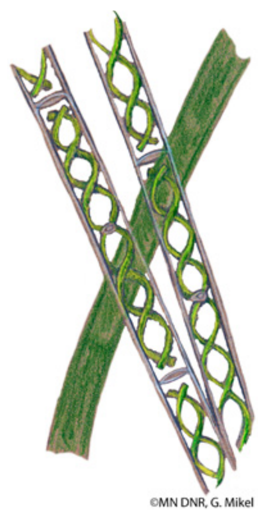
Anabaena
(planktonic blue-green algae)

Chara
(plant-like algae)

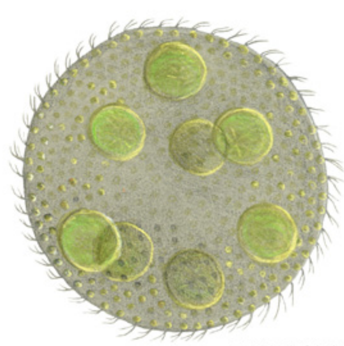
Diatom (hard-sided phytoplankton)



Pediastrum

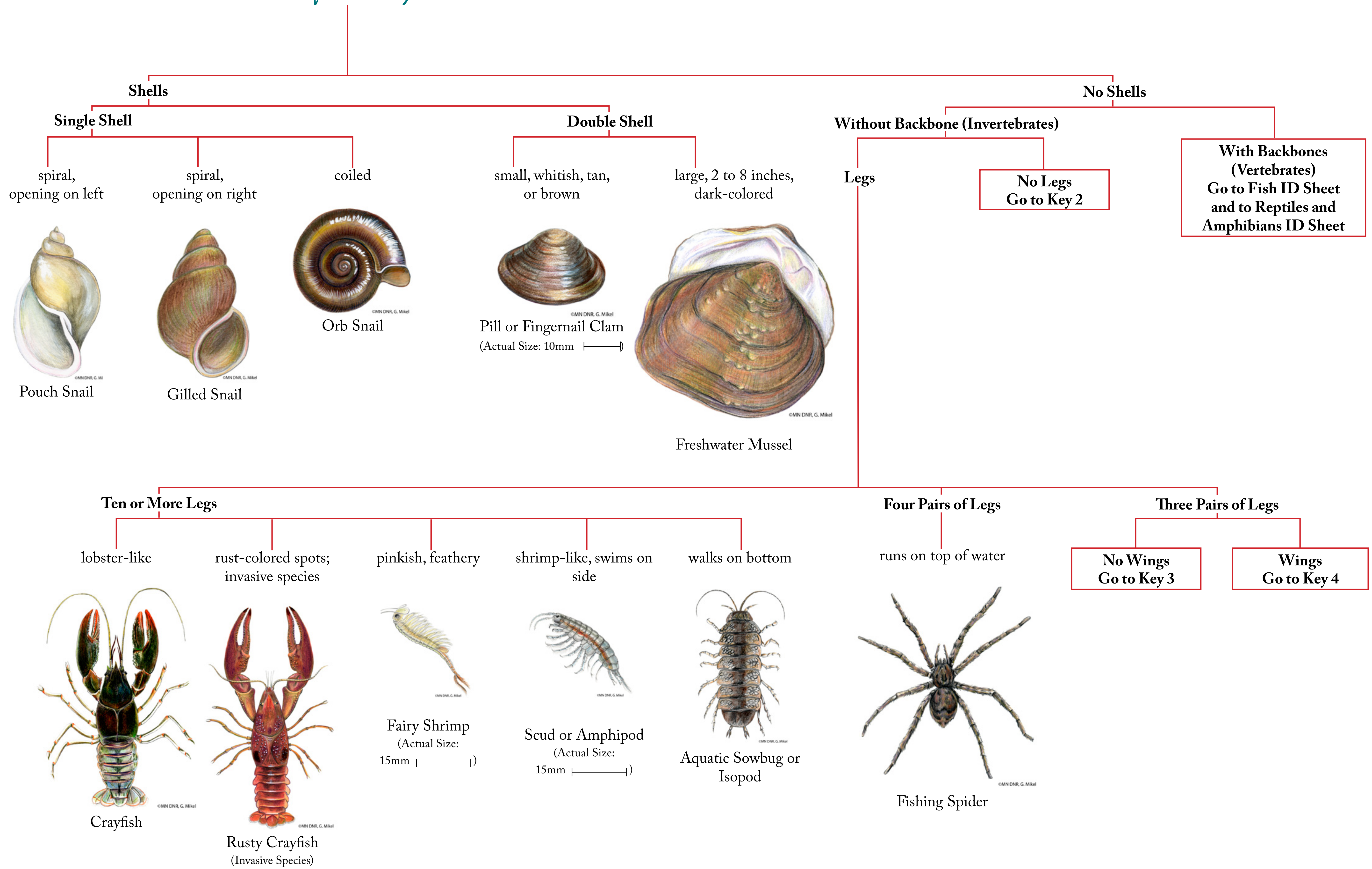


Spirogyra
(filamentous green algae)



Volvox
(Mastigophora; colonial algae)

Identification Key #1



Macroinvertebrate keys based on the work of University of Wisconsin-Extension,
the Wisconsin Department of Natural Resources, and the Riveredge Nature Center, Newburg Wisconsin

Identification Key #2

No Legs

- **Microscopic**
  Go to Microscopic ID Sheet
- **Wormlike**
  - suckers, expands and contracts

    ventral dorsal

    Leech
  - reddish brown

    Tubiflex Worm
  - glides along bottom

    Flatworm or Planaria
  - tan to brown, long

    Horsehair Worm
  - small, hairlike, swims in S shape

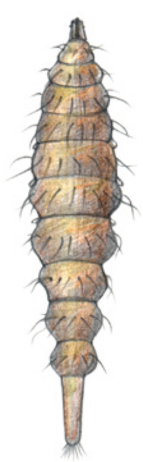
    Nematode or Threadworm
- **With Tentacles, Brushes, or Tails**
  - breathing tube at rear

    Mosquito Larva
  - large head, wriggles

    Mosquito Pupa
    (Actual Size: 18mm)
  - on surface, stiff, with tail disk

    Soldier Fly Larva
  - long breathing tube

    Rat-tailed Maggot Larva
    (Actual Size: 16mm)
  - smooth, stiff, small head

    Horsefly Larva
  - white or grey, with tentacles

    Cranefly Larva
  - red, green, or tan; twists

    Midge Larva
    (Actual Size: 20mm)
  - big "head," active

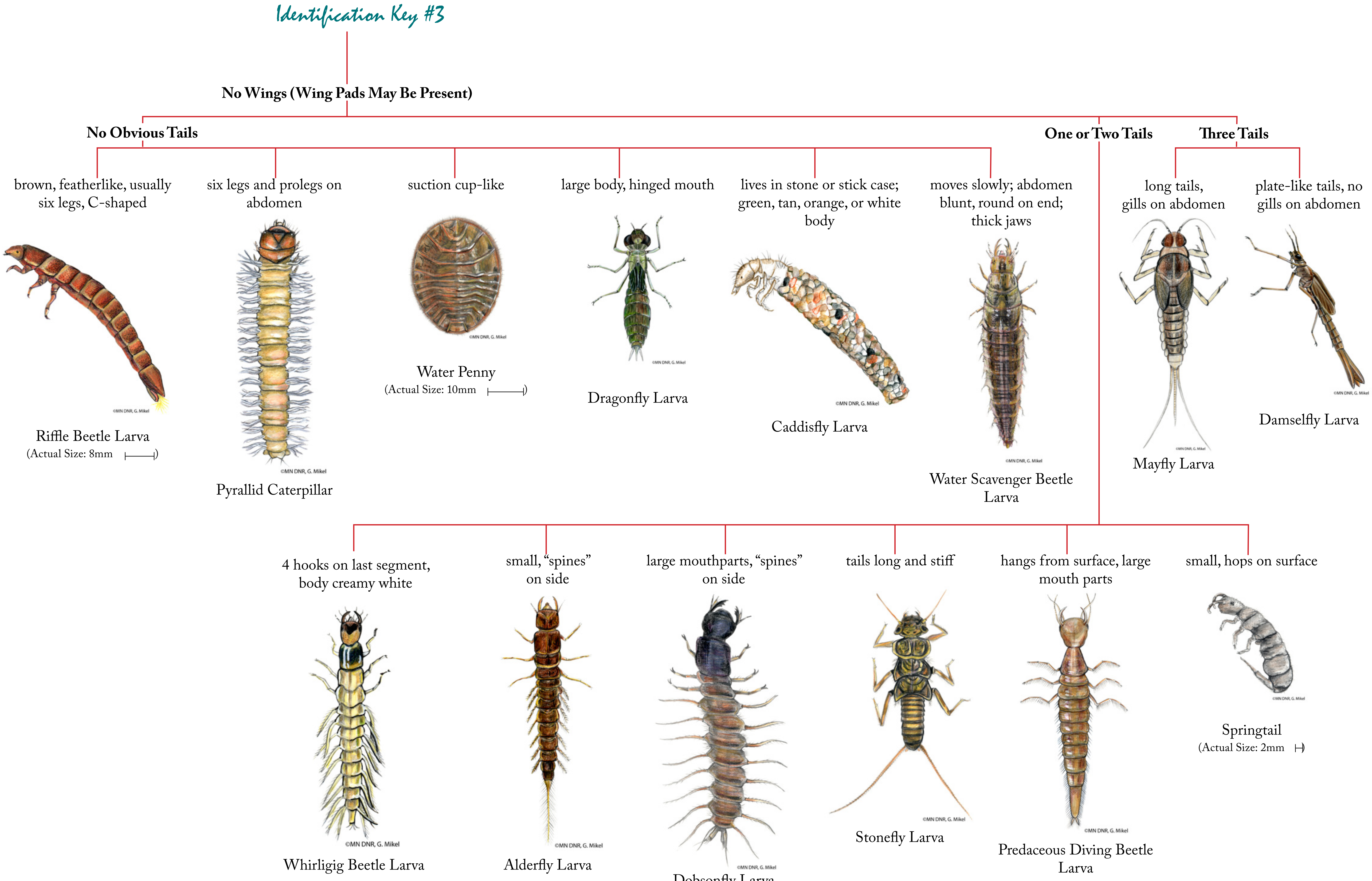
    

    Midge Pupa
    (Actual Size: 20mm)
  - small, black, attaches to rocks

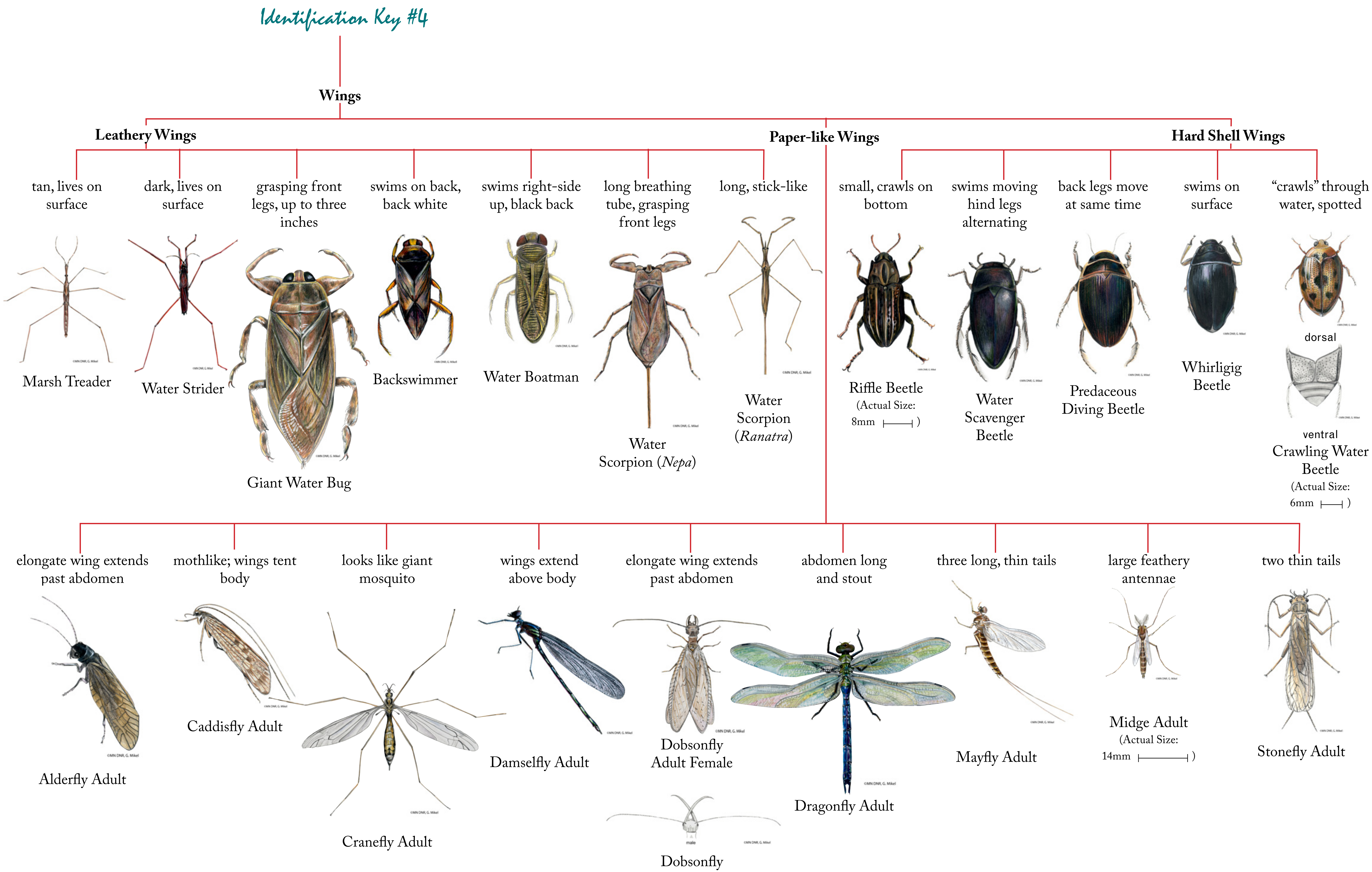
    

    Blackfly Larva
    (Actual Size: 8mm)

Macroinvertebrate keys based on the work of University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, and the Riveredge Nature Center, Newburg Wisconsin



Macroinvertebrate keys based on the work of University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, and the Riveredge Nature Center, Newburg Wisconsin



Macroinvertebrate keys based on the work of University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, and the Riveredge Nature Center, Newburg Wisconsin

Habitat Hideout

Living in the fast lane can be exciting, but it takes a lot of energy. Fish seek places where they can rest, find food, and evade predators.

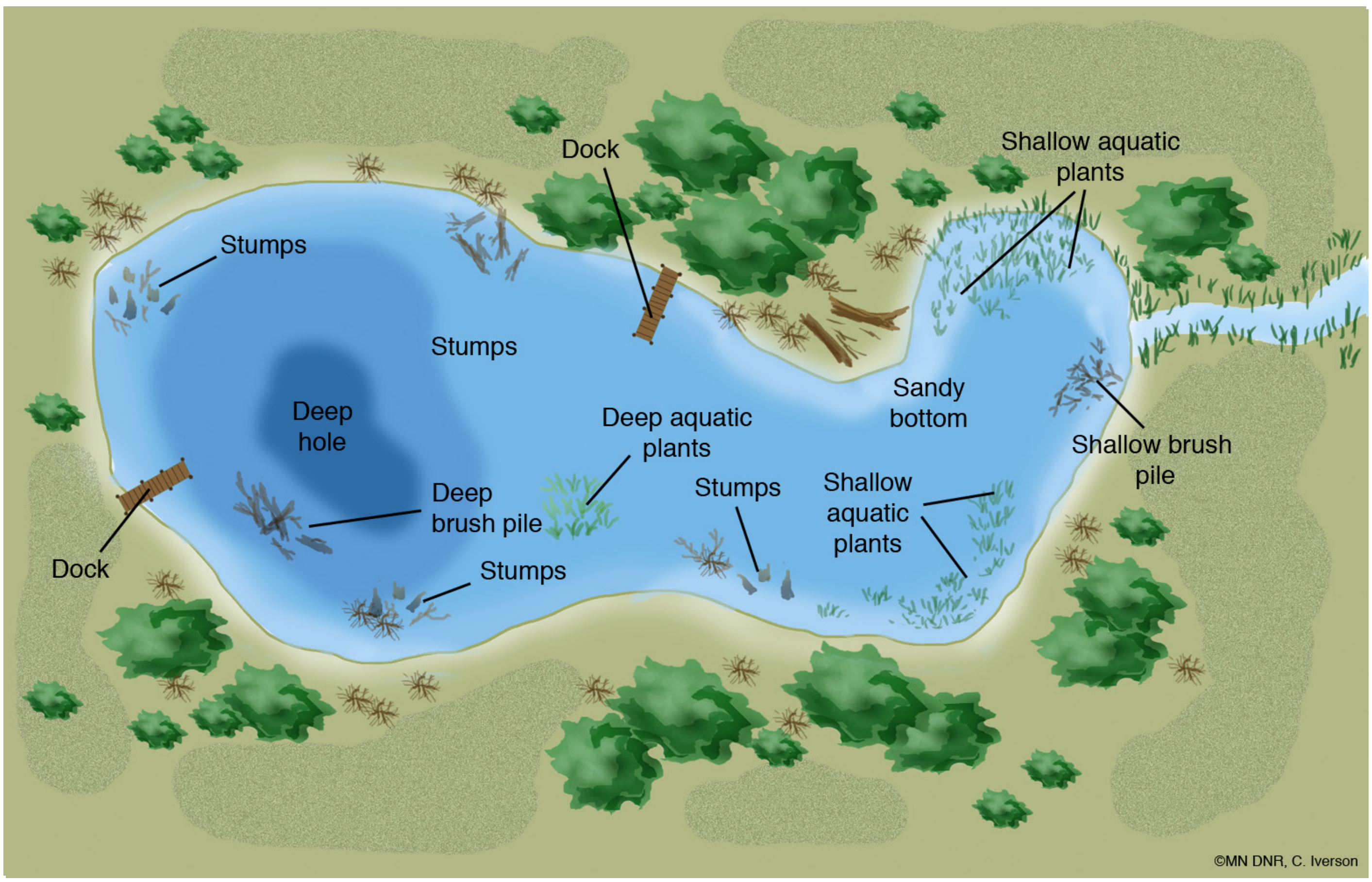


Table of Contents

Chapter 1 • Lesson 5

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Habitat Hideout

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—Students will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 1—Students will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 1—Students will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—Demonstrate active listening and comprehension.

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—Students will follow multi-step oral directions.

History and Social Studies

Grades K—3
V. Geography
A. Concepts of Locations:
Benchmark 2—Students will use maps and globes to locate places referenced in stories and real-life situations.
Benchmark 4—Students will name and use directional words to describe locations of places in the community. Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above.
V. Geography
B. Maps and Globes:
Benchmark 1—Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above.

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 1—Students will know that organisms interact with one another in various ways besides providing food.
Benchmark 2—Students will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—Students will identify and investigate environmental issues and potential solutions.

Grade 5
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 3—Students will describe how waves, wind, water and ice shape and reshape the earth's surface.
Benchmark 5—Students will explore the interaction of lithosphere, atmosphere, hydrosphere and space.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 1 • Lesson 5

Habitat Hideout

Grade Level: 3-5
Activity Duration: Part 1: 45 minutes
Part 2: two class periods
Part 3: 30 minutes
Group Size: any
Subject Areas: Language Arts, Physical Education, Science
Academic Skills: construction, recognition, writing
Setting: Part 1 and Part 2: indoor or outdoor gathering space with tables
Part 3: large indoor or outdoor open area
Vocabulary: current, cut-bank, eddy, limnetic zone, littoral zone, meander, pool, riffle, structure, undercut
Internet Search Words: fish habitat, fish structure, lake structure, stream structure

Instructor's Background Information

If you fish from shore, a pier, a boat, or a bridge, do you see the fish in the water? Probably not. It can be difficult to see underwater because the sunlight reflecting from the surface of the water produces glare. And the water might be deep, dark, or murky. But even if you can't actually *see* the fish, you can often find clues to where they might be hidden by noticing things protruding from the water, or the way that the water swirls and flows as it moves downstream. The features of the bottom of a lake or stream can also help an informed observer pinpoint the location of elusive fish.

When anglers know what to look for in and around the water, and know something about the types of habitat in a water body, they significantly increase their chances of finding the fish they're trying to catch. There's nothing like knowing just where to cast your line for the best chance of success!

Structure

Although fish may move to different locations at different times of the day, or during different seasons, most fish seek structure. **Structure** can be any lump, bump, hole, drop-off or other hideaway in a lake or streambed. Submerged stumps, rocks, trees, plants, brush piles, boat docks, and fishing piers are examples of structure, too. Learning about the behaviors of fish species reveals clues about the types of habitats or structures that they prefer.

Summary

Different kinds of fish prefer different types of habitat. In this lesson, students learn to identify preferred fish habitats to help them locate fish "hideouts" when they go fishing. In groups, students create lake and stream habitat murals showing areas of structure and, on habitat maps, show where various fish species might prefer to live. A relay game helps reinforce the concepts they've learned.

Student Objectives

The students will:

1. Identify three types of habitat structure in a lake or stream.
2. For each habitat structure identified in objective one, list three different fish species that would use each habitat.
3. Compare the littoral and limnetic zones in the habitat preferences of the fish listed in objective two.
4. Define meander, pool, riffle, and undercut in reference to a stream, and state what each means in terms of fish habitat.
5. Discuss how changes in a habitat can benefit or harm fish.

Materials

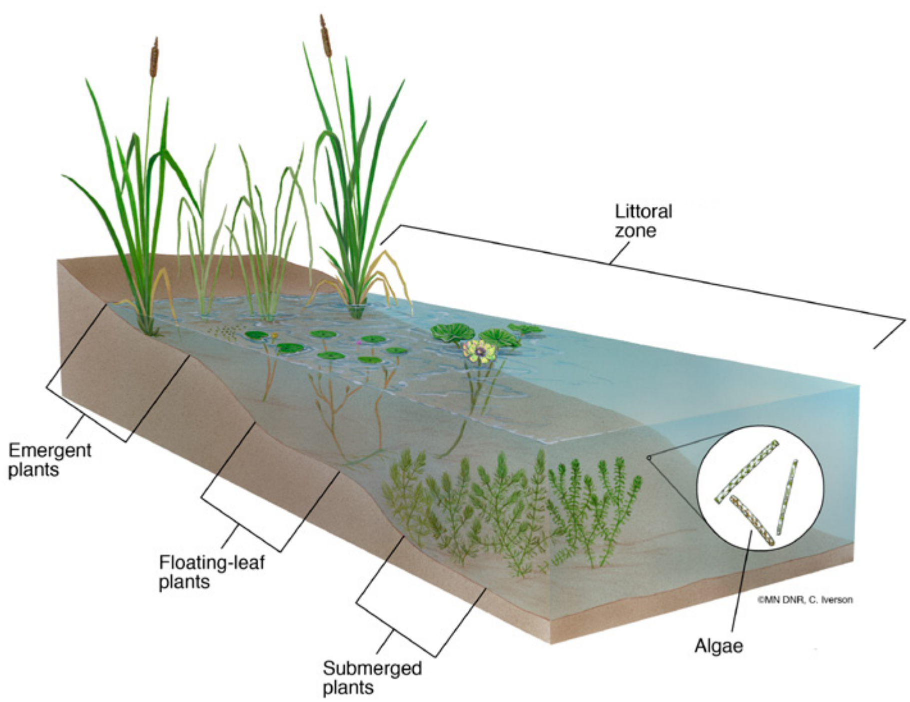
- **Lake Habitat Sheet**, one per student
- **River or Stream Habitat Sheet**, one per student
- **Fish Habitat Chart**, one per student
- Two sets of **Habitat Hideout Fish Identification Cards** for the relay game
- Paper clips
- Card stock and paper, 8.5" x 11"
- Laminating materials
- Markers, one orange and one blue
- Scissors
- Glue
- Hula-hoops, three
- Roll of butcher paper or newsprint
- Markers or crayons
- Clipboards
- Pencils
- Double-sided tape, self-stick Velcro, or self-stick magnets
- Wooden dowels, three feet long, or pop can casters rigged with lines and casting plugs (See **Lesson 5:3—Pop Can Casting** for instructions for making pop can casters)
- 8.5" x 11" print-outs of images of Minnesota fish

Fish are attracted to structure for many reasons. Structure provides a place for prey to hide from predators—it also gives predators a covert place from which to strike. On sunny days, structure provides shade for fish with light-sensitive eyes. River and stream fish find resting places where structure shelters them from strong currents. Structure sometimes serves as a landmark or place marker, just as a street sign tells us that we're home.

If there are no smallmouth bass in the spot where you're fishing, of course you won't catch any smallmouth bass. But if you know how to identify and locate the structure preferred by the species you seek, you'll be more likely to catch those fish consistently. Structure can be viewed as a target for your carefully aimed cast.

Lakes

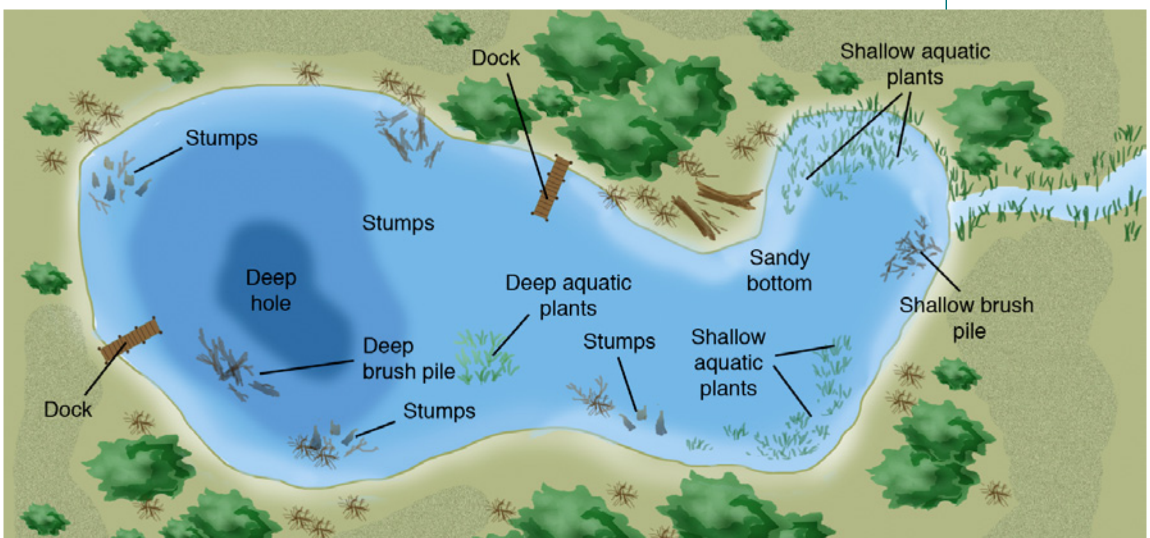
Lakes consist of two zones, shallow water and deep water. The shallower portion of the lake, where sunlight penetrates the surface and reaches the bottom with enough intensity to allow the growth of rooted aquatic plants, is called the **littoral zone**. Prey fish, such as sunfish (pumpkinseeds and bluegills) and minnows, may hide and feed in vegetation, such as lily pads and cattails, in the littoral zone. Many prey fish feed on the invertebrates that live among the plants. Predator fish, such as northern pike and largemouth bass, may also hide among plants in the littoral zone as they wait to ambush an unsuspecting sunfish.



The zone in which emergent, floating-leaf, and submerged plants grow is referred to as the littoral zone. In many Minnesota lakes, the littoral zone is approximately zero to fifteen feet deep. Free-floating plants grow anywhere on the surface of a water body.

Largemouth bass, crappies, and bullheads often hide in areas with submerged logs or brush piles. Fallen trees and brush attract minnows and insects. These areas may be in or just outside the littoral zone, where the water is slightly deeper.

The open, surface water above the deep area of a lake (surrounded by the littoral zone), where rooted plants can't grow is the limnetic zone. Walleyes are often found near rocky drop-offs in limnetic zones. Deeper water and drop-offs provide shade from bright sunlight. Walleye and northern pike can move through deep water on their way to other parts of the lake to search for prey.



Lake structure types preferred by fish.

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Streams and Rivers

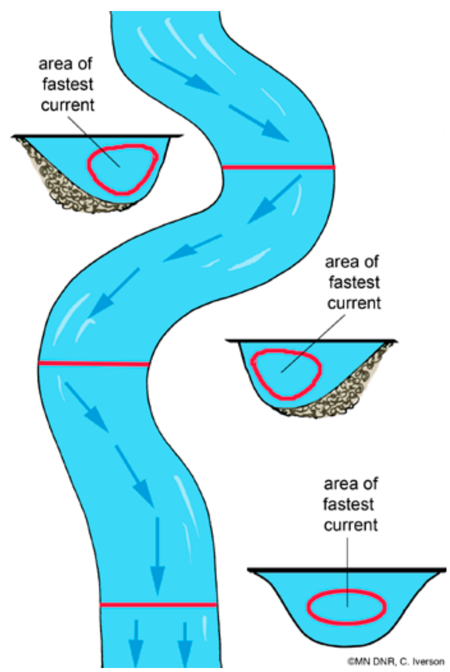
Streams and rivers have shallow and deep-water areas, too. Flowing water cuts into the banks on the outside bend of a **meander**, or curve in the course of a stream or river.

When the water hits the outside bend, the water causes some of the bank to erode as it changes direction. This outside bend where soil is hollowed away is called the **cut-bank**.

The water sometimes carves deeply enough into the outer bank to form small caves that protect fish (such as trout or smallmouth bass) from the sun and from predatory birds. These small caves are referred to as **undercuts**. The current carries eroded silt and sand downstream.

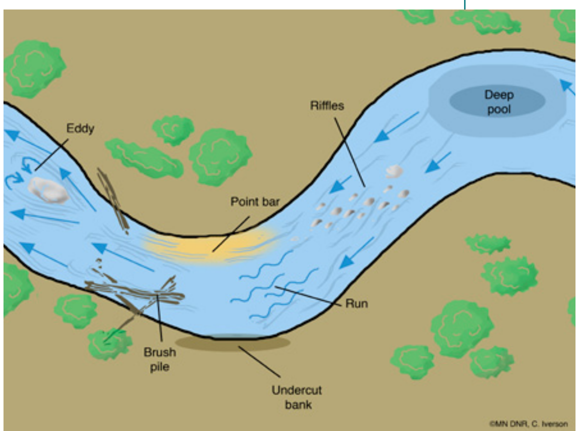
On the inside bend, the current velocity slows and sediment is deposited. This shallow inside bend is called a **point-bar**.

Rivers are dynamic—they're always changing. As time passes, the cut banks and point bars migrate downstream so, several years later, they may be in different locations. The proportions (number of meanders, pools, riffles, and so forth) will remain the same.



Areas of fastest current in a river or stream.

When flowing water hits an obstruction, such as a rock, brush pile, or log, it goes around it or over the top of the structure. The water curls and swirls around the structure, forming an **eddy** and often scouring a hole on the downstream side of the object. These spots make good places for fish to rest. Because it takes less energy to swim in these pocket areas, fish use less energy and need less food than they would if they spent all of their time swimming in the currents. From these resting spots, fish can dart out and capture passing prey from the currents. Carp, smallmouth bass, and trout can be found in eddies.



Structure types in a river or stream.

Shallow areas where the water moves quickly over rocks spread across the width of the stream are called **riffles**. (In larger rivers with greater water flow, these areas are called rapids.) The turbulence of the flowing water hitting the rocks mixes oxygen from the air into the water, and frothy air bubbles can make the water appear white. Insects that require high levels of oxygen live on the rocks in riffles. Fish, such as trout, swim just below the riffle areas to catch the insects, such as stonefly larvae and mayfly larvae, that get knocked off or let go of the rocks to be carried downstream by currents. The areas of quieter water downstream of the riffles are referred to as runs. Quiet deeper areas where fish rest are called pools.

Examples of fish that live in streams include brook trout and smallmouth bass. Streams provide conditions that suit the needs of these fish, including higher dissolved oxygen levels, cooler water, abundant invertebrates, and adequate cover. The types of fish species that live in a stream can vary, depending on stream temperature. Trout need cooler streams, and smallmouth bass can be found in warmer water. (Although brook trout are typically found in cold water streams, some other species of fish, such as smallmouth bass, can be found in streams, rivers, or lakes.) Stream fish can be found in or behind structure such as pools, below riffles, in undercut banks, and behind rocks and brush piles.

Rivers can support a great diversity of fish species. Larger fish species that aren't found in small streams (such as sturgeon, paddlefish, catfish, and gar) live in Minnesota rivers. Rivers also contain some fish species usually found in lakes, including walleye, northern pike, and bass.
As in streams, areas of slow-moving water or structure provide good habitat for fish in rivers. Gar find respite from stronger currents behind logs, in brush piles, or in aquatic plants growing in the slow-moving backwaters. Catfish particularly like to sit in deep pools where they can rest from river currents. When they're hungry, the fish move to the front of the pool and wait for food to flow downstream to them.

Altering Aquatic Habitat

Efforts to remove structure from lakes, rivers, and streams can damage or eliminate habitat, negatively impacting fish populations.
In lakes, a major concern is the removal of aquatic plants and shoreline

vegetation. This is often done when a new owner decides to put in a swimming area on their lake front property. The removal of plants eliminates hiding and resting places, protected spawning areas, and important food sources (invertebrates and small fish living in the plants) for fish. The removal of plants can also increase erosion and decrease water quality. Because aquatic plants provide habitat for a diversity of aquatic species, including fish, property owners may need approval from the Minnesota DNR to remove aquatic plants.

In rivers and streams, one major concern is channelization. When the meanders are removed from a river or stream, so is structure. Cut-banks, undercut banks, and point-bars are eliminated. With the new straightened channel, water speeds are uniform from bank to bank, so there is no slack water or and little or no vegetation. Without meanders to catch them, the current flushes logs and brush piles downstream.

For these reasons, people who plan to purchase land bordering lakes, rivers, and streams should look for shoreline and lake or stream bottoms that already match their intended activities such as fishing, boating, or swimming. If you would like to improve your site for fishing, contact the Shoreland Habitat Program at the Minnesota DNR.

For more information on laws governing the removal of aquatic vegetation and the benefits of various water plants, contact the Minnesota DNR for the free brochure, *Aquatic Plant Management.*

To learn more about how you can improve fish and wildlife habitat and keep water clean, look on the Minnesota DNR web site or on these CD-ROMs published by the Minnesota DNR: *Restore Your Shore: A Guide to Protecting and Restoring the Natural Beauty of Your Shoreland* and *Healthy Rivers, a Watercourse: An Interactive Tool to Understand the Management of River Systems.*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Procedure

Preparation

1. Draw an outline of a lake (an irregular circle) and a stream (two parallel lines meandering like a ribbon) on the whiteboard or prepare overhead transparencies. Do not add structures to these water bodies at this point.
2. Make two sets of **Habitat Hideout Fish Identification Cards** for the activities. Copy each page twice and cut out each set of three pieces. Group each set of three pieces and paper clip them with the fish picture and the text back to back with the structure picture (deep pool, brush pile, or aquatic plant) in the middle. Using markers, put an orange dot on one set of cards and a blue dot on the other to differentiate teams, or copy the cards on two different colors of paper. You may wish to laminate the cards for future use.

3 Cut six 8.5" x 11.5" sheets of paper into three 8.5" x 3.5" pieces. Label each piece with the name of one of these three habitat types: aquatic plants, brush pile, pool (for a river or stream) or drop-off (for a lake). Make several of these labels for each habitat type. Place double-sided tape, self-stick Velcro, or self-stick magnets on the back of each label—these labels identify the different types of habitat for the murals and the relay game.

4 Laminate the **Habitat Hideout Fish Identification Cards, Lake Habitat Sheet, River or Stream Habitat Sheet**, and the **Fish Habitat Chart**, if you wish to preserve them for future use.

5 Copy one **Lake Habitat Sheet**, one **River or Stream Habitat Sheet**, and one **Fish Habitat Chart** for each student.

Activity

Warm-up

1 Ask the students where they catch fish when they go fishing. Ask them what leads them to think that they might catch fish in those spots. Tell the students that different fish species prefer to live in different locations within a lake or stream. Make a list of locations where the students have found fish in the past. Ask the students why they think the fish like those particular "hideouts." What do they know about certain species of fish that might give them some clues as to where those fish can be found? You can ask these questions as an informal discussion, or have the kids brainstorm ideas and record them in a graphic organizer.

2 Ask students how changes in the habitat might benefit or harm fish.

3 Ask students to think about these questions throughout the rest of the lesson.

4 Define structure for the students. Write the definition on the whiteboard.

5 Direct the students' attention to the lake and stream outlines on the whiteboard. Add the various types of structure to these lake and stream drawings. Label and define each type of structure as you draw them:
- structure types for a lake: aquatic plants, fallen logs and brush piles, drop-offs, deep holes or pools, and docks
- structure types for the stream or river: aquatic plants, fallen logs and brush piles, riffles, runs, deep holes or pools, cut-banks, undercuts, point-bar, rocks, and eddies

6 Explain that the drawings of the lake and stream or river are habitat maps that illustrate a birds-eye view of structure and characteristics. These maps can help anglers locate likely fish habitat hideouts!

7 If you have photos from magazines or books that show stream, river, or lake habitat or photos of a local lake or stream, show them to the students and ask them to compare the drawings on the board with the photos. Can they identify stream or river and lake habitat structure in these photos?

Graphic organizers can take the form of a concept map, tree, star or web showing definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause and effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. Cut and folded paper can be fashioned into flaps that, when lifted, reveal details, definitions, descriptions, or explanations. (Research graphic organizers on the Internet for more ideas on how to make them.)

Lesson

Part 1: Identifying Habitat Hideouts

1. Pass out a **Lake Habitat Sheet**, a **River or Stream Habitat Sheet**, and a **Fish Habitat Chart** to each student. The drawings on the whiteboard should resemble those on the **Lake Habitat Sheet** and the **River or Stream Habitat Sheet.** Later in the lesson, the students will use these sheets as guides for creating their own large lake and river or stream habitat map murals.
2. Ask a volunteer to choose a **Habitat Hideout Fish Identification Card** from your stack. Ask the volunteer to read the name of the fish species to the class. Describe the fish and refer to the illustration on the **Fish Habitat Chart**. You may also wish to hold up, or point to, a large picture or replica of the fish if you have large pictures or mounts available. Print fish illustrations from the *MinnAqua Leader's Guide* image CD on 8.5" x 11" sheets, or find fish photos in magazines or on the Internet.
3. Have your volunteer read the back of the card to the class and decide where in the lake or river or stream this fish might live. Would you find that type of fish in a lake or stream? Is this fish most likely to be found in aquatic plants, in a brush pile, or in a pool?
4. Discuss why the fish might prefer that location and habitat. What kind of food does it eat? Where does it find its food? Are its eyes sensitive to light?
5. If the fish can be found in more than one place, have the student choose one likely location and, using the drawings on the whiteboard, point to this habitat or structure.
6. On their **Fish Habitat Charts** have students list the characteristics and preferred habitat for that fish.
7. Complete Steps 5-7 for all sixteen cards in the deck. Ask the students to complete the **Fish Habitat Charts**.

Part 2: Making Habitat Map Murals and Practice Casting

1. Divide the class into two groups. Using paper from the roll of butcher paper or newsprint (a canvas tarp or white sheet can be used to make the mural more durable for display), have one group of students work together to design a large river or stream habitat map mural. The other group should create a large lake system habitat map mural. You may wish to divide the students into smaller groups and have half of the groups make river or stream habitat maps, and the others make lake habitat maps. Be sure that the students show the various eddies, pools, and aquatic plants, but ask them not to label them at this point.
2. Have the students place the self-sticking labels noting the types of structure (eddy, pool, brush pile, aquatic plants, and so forth) in the appropriate areas on the river or stream and lake maps.
3. Flip the text part on each set of the **Habitat Hideout Fish Identification Cards** so the blank side faces out.
4. Separate the students into pairs. Hand out a **Habitat Hideout Fish**

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You may wish to have the students make their large habitat maps of a local lake and river or stream. Visit these locations and ask the students to make preliminary observations and drawings. Note the locations of various types of structure. When you return to the classroom, have the students refer to the field drawings as they draw their habitat map murals.

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Identification Card to each pair of students. Have students place their fish into the appropriate area on the lake and river banner without using their **Fish Habitat Charts**. When the students are finished, go through all of the fish and their characteristics and discuss why each might prefer to live in a specific location. Ask students where they would go to fish for each of the species. Where would they cast?

5 Gather the pop can casters with casting plugs tied to the lines. (See **Lesson 5:3—Pop Can Casting**.) The casting plugs and **Fish Identification Cards** can be fitted with self-stick Velcro so that the students can try to cast and catch fish. Place the hooked pieces on the casting plugs, and the looped pieces on the fish cards. Place each fish card in the appropriate structure area on the habitat map murals. Have students form lines to take turns casting for fish on the large lake and river or stream murals. Before casting, ask each student to identify the type of fish they'd like to catch and to name the habitat type that would be the best place to aim their cast.

6 Have students compare their ideas or concept maps from the Warm-up discussion with what they've learned about fish habitat, structure, and fish characteristics. Ask the students to explain how the things they've learned about fish habitat and structure could make them more successful anglers.

Part 3: Relay Game

1 To reinforce what the students have learned, play a relay game.

2 Divide the class into two teams.

3 Line up the teams single file on one end of the field.

4 Place three hula-hoops with their representative habitat labels (aquatic plants, brush pile, and pool) on the far end of the field, approximately 50-75 feet from where the teams are lined up. (See **Habitat Hideout Playing Field Diagram**.)

5 Flip the text part of each set of **Habitat Hideout Fish Identification Cards** so the blank side faces out and set one set of each picture side up in front of each team.

6 When signaled to begin the relay, the first person in line on each team picks up a fish card and races to put it in the appropriate hula-hoop (structure type). This student then returns to their team and goes to the end of the line. The student in the front of the line then repeats this process.

7 It might be difficult, sometimes, to decide where a fish belongs. Each student should choose a location—and be able to explain their choice.

8 At the end of the game, go through each card with the class and review where it belongs. Lift up the fish picture to see the structure symbol underneath to see if the card is placed in the correct habitat structure.

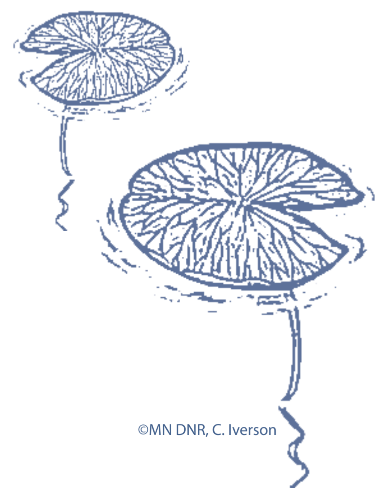
9 If cards have been placed in the wrong habitat locations, discuss why. The team placing the most cards in the correct habitats wins the game. In case of a tie, the team that finishes first wins.

Wrap-up

1 Ask students to describe actions that might result in habitat loss. (Removal of vegetation to create a beach or to build a dock, removal of brush piles or fallen logs to clear paths for boats.) Ask students to describe some ways aquatic habitat might be improved. (Adding structure such as brush piles, fallen logs and submerged rocks, planting native aquatic vegetation, restoring meanders in a stream.) For each type of habitat change resulting in habitat loss or in habitat improvement, have students decide if the action impacts fish positively or negatively.

Discuss how people who are purchasing shoreline property should consider an area that matches their desired activities (such as fishing, boating, or swimming). For more information, see the presentations *Restore Your Shore: A Guide to Protecting and Restoring the Natural Beauty of Your Shoreland* and *Save Our Shorelines: A Strategy for Helping Shoreline Owners Preserve Wildlife and Water Quality*. These programs are available in CD format from the Minnesota DNR Information Center at 651-296-5481 or 1-888-MINNDNR (646-6367).

2 Why do fish need habitat hideouts? Review where to fish for different species of fish.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Assessment Options

1 Have students complete the **Lake Habitat Sheet** and **River or Stream Habitat Sheet**, including:
- Labels for three different types of structure in the lake and three types of structure in the river or stream, or have students create a color-coded key to identify the types of structure shown in their habitat map murals.
- Draw and label the different fish species likely to use each of these structure types as a preferred habitat.
- Choose one of the fish from the river or stream and one from the lake and write a paragraph describing the reasons each species would prefer a particular structure type in the river or stream or lake.

2 Assess student participation in Wrap-up discussion for understanding how habitat changes can impact fish populations positively or negatively. Ask the students to identify how particular habitat alterations could impact a specific type of fish.

3 Have students write their own angling column on what to look for in a good fishing spot when angling for several different species of fish. The title of this article could be “Fishy Habitat Hideouts.”

4 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

26-28 points = A
Excellent. Work is above expectations.

23-25 points = B
Good. Work meets expectations.

19-22 points = C
Work is generally good. Some areas are better developed than others.

14-18 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-13 points = F
Work is unacceptable.

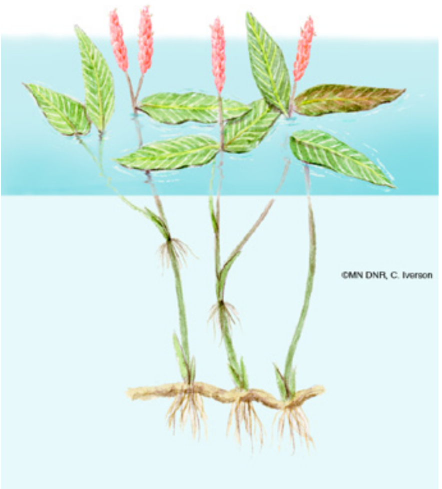
Habitat Hideout Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
6	______	______	Student identifies three different fish habitat structure types on a lake, river, or stream habitat map.
6	______	______	Student lists at least two types of fish that live in each of the three habitat types.
3	______	______	Student describes how three different types of structure provide beneficial habitat for fish.
3	______	______	Student describes appropriate adaptations or characteristics of fish species that are suited to each of the three habitat structures.
2	______	______	Student defines *structure*.
4	______	______	Student defines *meander, pool, riffle,* and *undercut.*
4	______	______	Student explains why learning about lake and river or stream structure—and the types of structure fish need—can help anglers catch fish.
Total Points			
28	______	______	**Score** ______

Habitat Hideout Scoring Rubric

Fish and Structure Criteria	4 Excellent	3 Good	2 Fair	1 Unacceptable	0 Unacceptable
Structure	Identifies three different types of fish habitat structure on a lake, river, or stream map..	Identifies two different types of fish habitat structure on a lake, river, or stream map.	Identifies one type of fish habitat structure on a lake, river, or stream map.	Can't identify a type of habitat structure on a lake, river, or stream map.	Makes no effort to identify structures.
Fish species	Lists at least two types of fish that live in each of the three habitat structures.	Lists at least one type of fish that live in each of the three habitat structures.	Lists at least one fish that lives in at least two different habitat structures.	Lists at least one fish that lives in one habitat structure.	Makes no effort to identify fish.
Habitat characteristics	Describes two types of structures in a lake and two types in a river or stream that are good habitat for fish. Describes appropriate characteristics of one fish species that prefers each of the four habitat structures. .	Describes two types of structures in a lake and in a river or stream that are good habitat for fish. Describes appropriate characteristics of one fish species that prefers each of the three habitat structures.	Describes one type of structure in a lake and one type in a river or stream that are good habitat for fish. Correctly identifies characteristics of a fish species that prefers each of the two habitat structures.	Describes one type of structure in a lake or in a river or stream that is good habitat for fish. Describes appropriate characteristics of a fish species that prefers that habitat structure.	Makes no effort to describe structures or fish characteristics.

Score ______ (Calculate score by dividing total points by number of criteria.)



Diving Deeper

Extensions

1 Have students draw a map of their local lake (or print maps available online on the DNR Lake Finder at **www.mndnr.gov**) and chart the fish hideouts. If the student has caught fish or observed fish at a certain spot, make sure that spot is indicated on the map.
2 Ask the students to write a hypothetical letter to a lakeshore owner who intends to remove all the aquatic vegetation from their lakeshore to create a sandy beach. What would they want to say to the person about vegetation and fish habitat? You could also ask them to write a letter to the editor of a lake association newsletter concerning the importance of aquatic vegetation in the lake.
3 Fill a large white pan or children's pool with water. If the water isn't dechlorinated, let it sit uncovered overnight. Add minnows to the water and observe where they rest. One at a time, add types of structure such as large rocks, weighted sticks, or plants and observe where the minnows rest. Be sure to return minnows only to the water body where you collected them, or use them for fishing.
4 Do **Lesson 2:6—Adapted for Habitat** with your class.

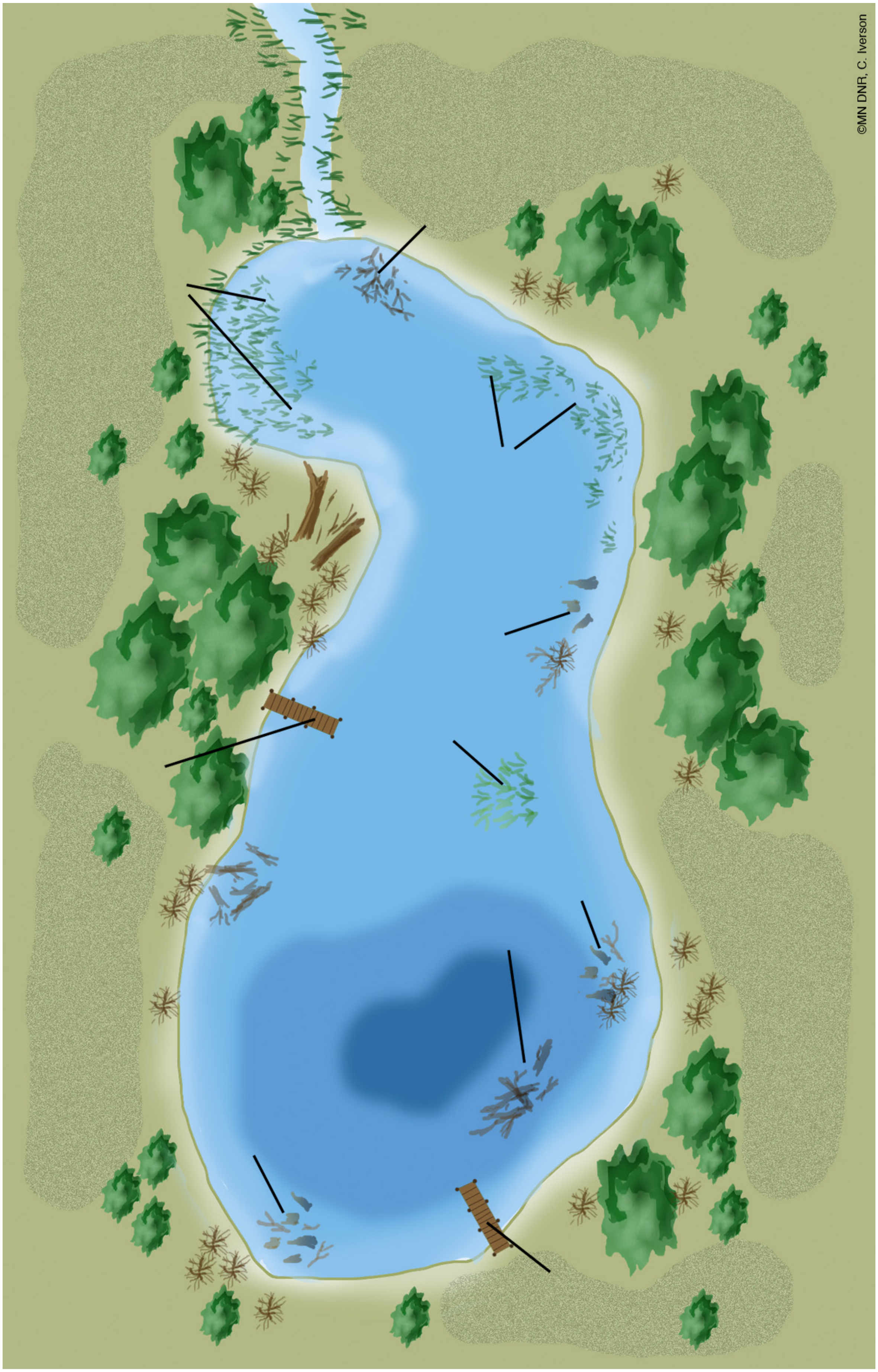
For the Small Fry

K-2 Option

1 Use the **Habitat Hideout Fish Identification Cards** with only the fish and structure pictures (aquatic plant, brush pile, and pool). Have students play the relay game using two sets of the two-sided cards. Players should try to match the habitat on the back of the card with the correct hula-hoop habitat. Matching helps students discover that fish live in varied habitats. (Use three hula-hoop habitats labeled aquatic plants, brush pile, or pool). After the game, ask the students if they can guess why each type of fish prefers its habitat. Discuss characteristics of the fish and how they're related to their preferred habitat. (The bluegill has a small mouth and eats insects—and insects live among the plants in the water.)
2 Flip the structure picture of the **Habitat Hideout Fish Identification Cards** so the blank side faces out. Place the cards with the fish illustration side down in the appropriate habitat and structure on a lake or river mural. Have the students "go fish" with dowel poles or pop can casters to discover the kinds of fish that can be found in different types of habitat in the lake or river or stream. Have the students place the fish cards face-up in the appropriate structure in the lake or river or stream. They can then take turns to decide what type of fish they want to catch and aim for the appropriate structure when they cast.

STUDENT COPY

Lake Habitat Sheet



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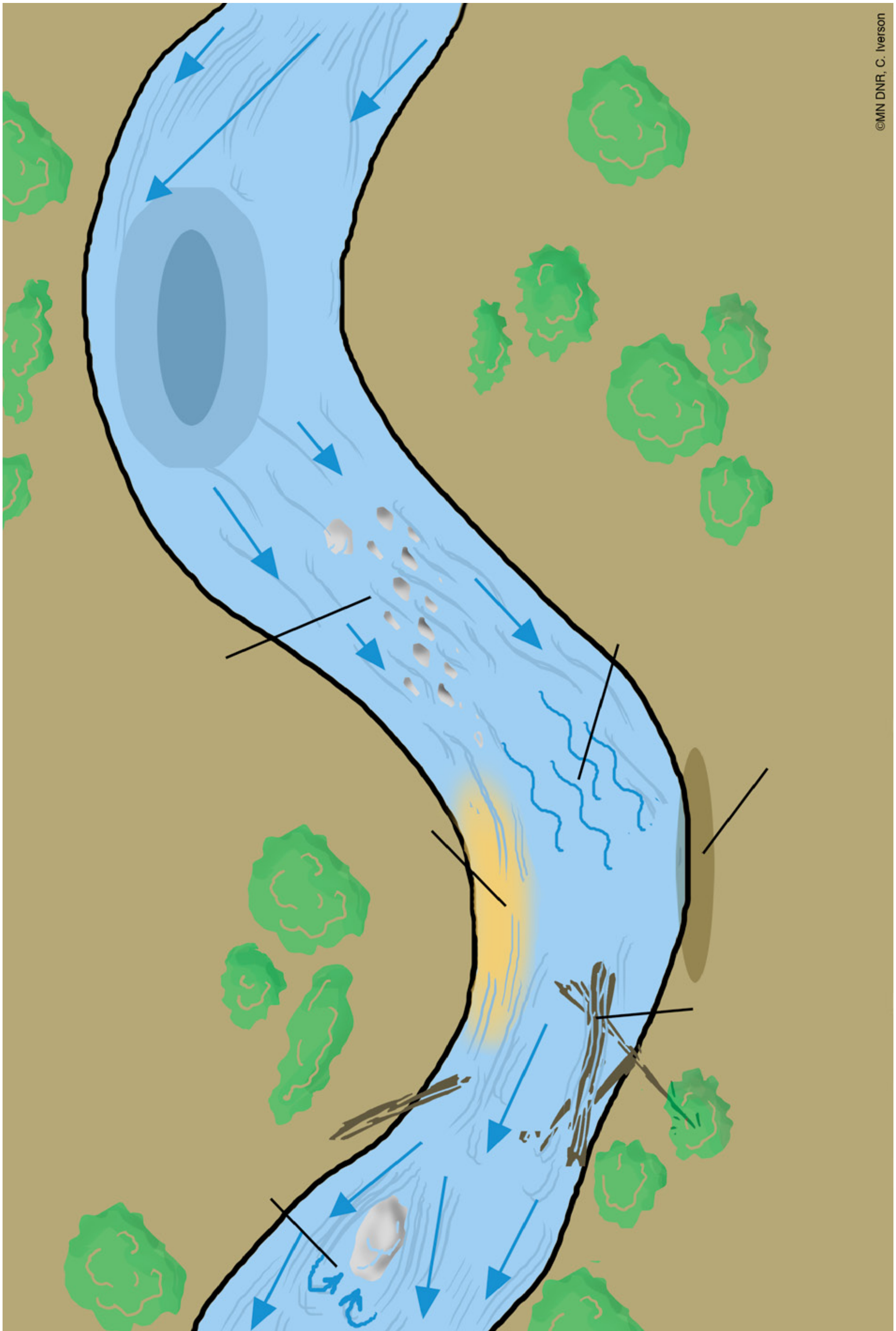
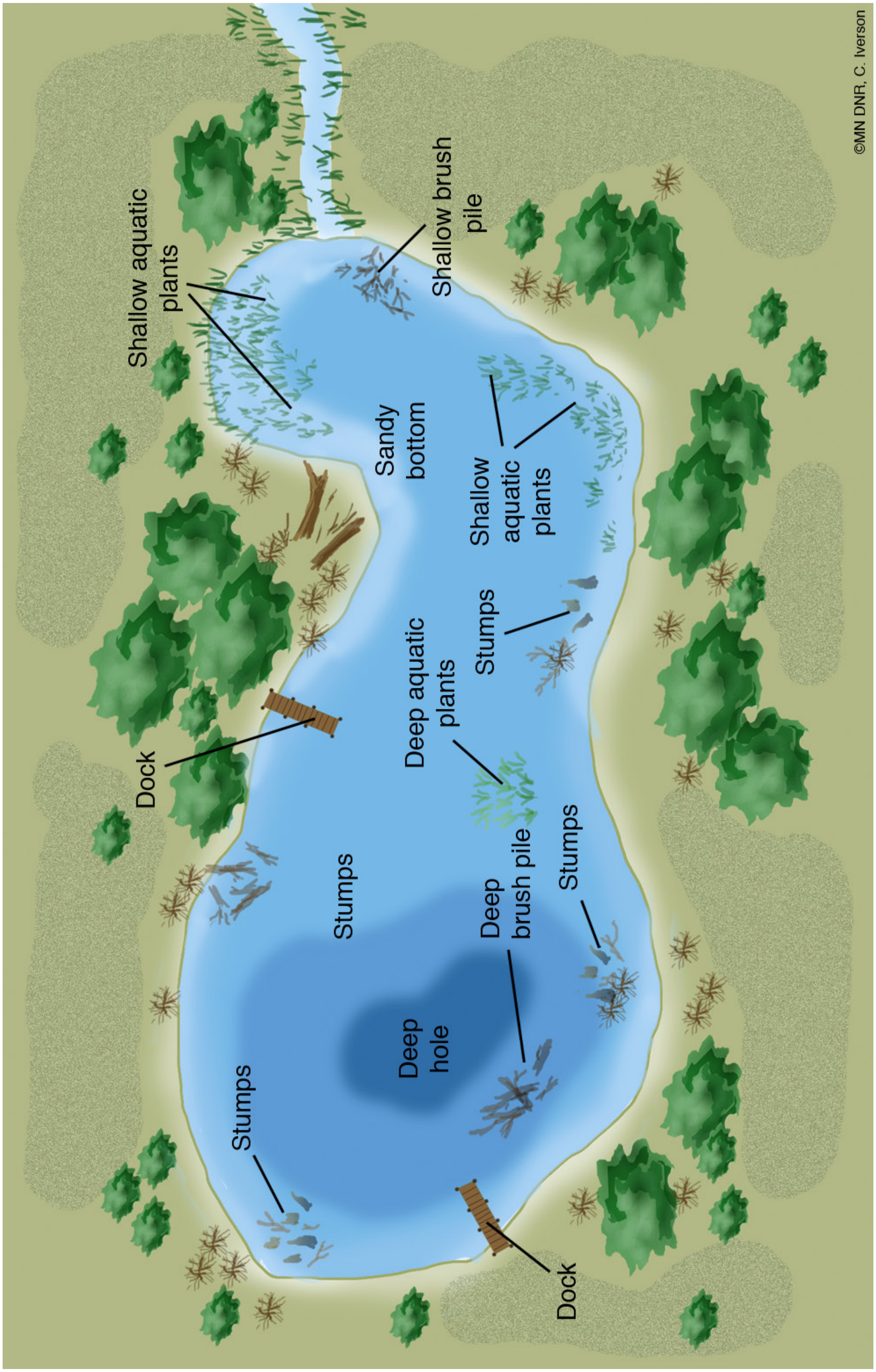
River or Stream Habitat Sheet



INSTRUCTOR COPY

Lake Habitat Answer Sheet



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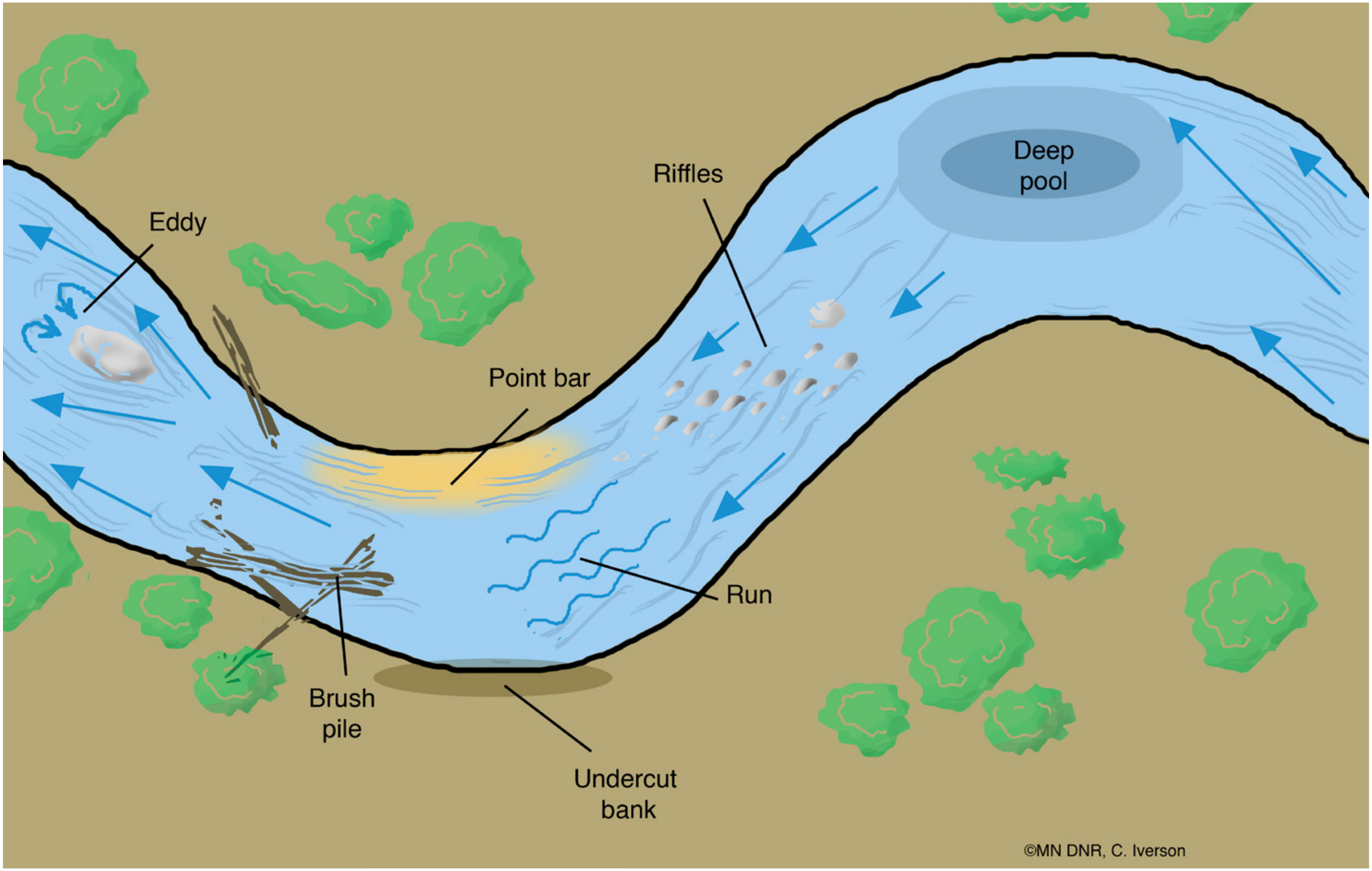
River or Stream Habitat Answer Sheet



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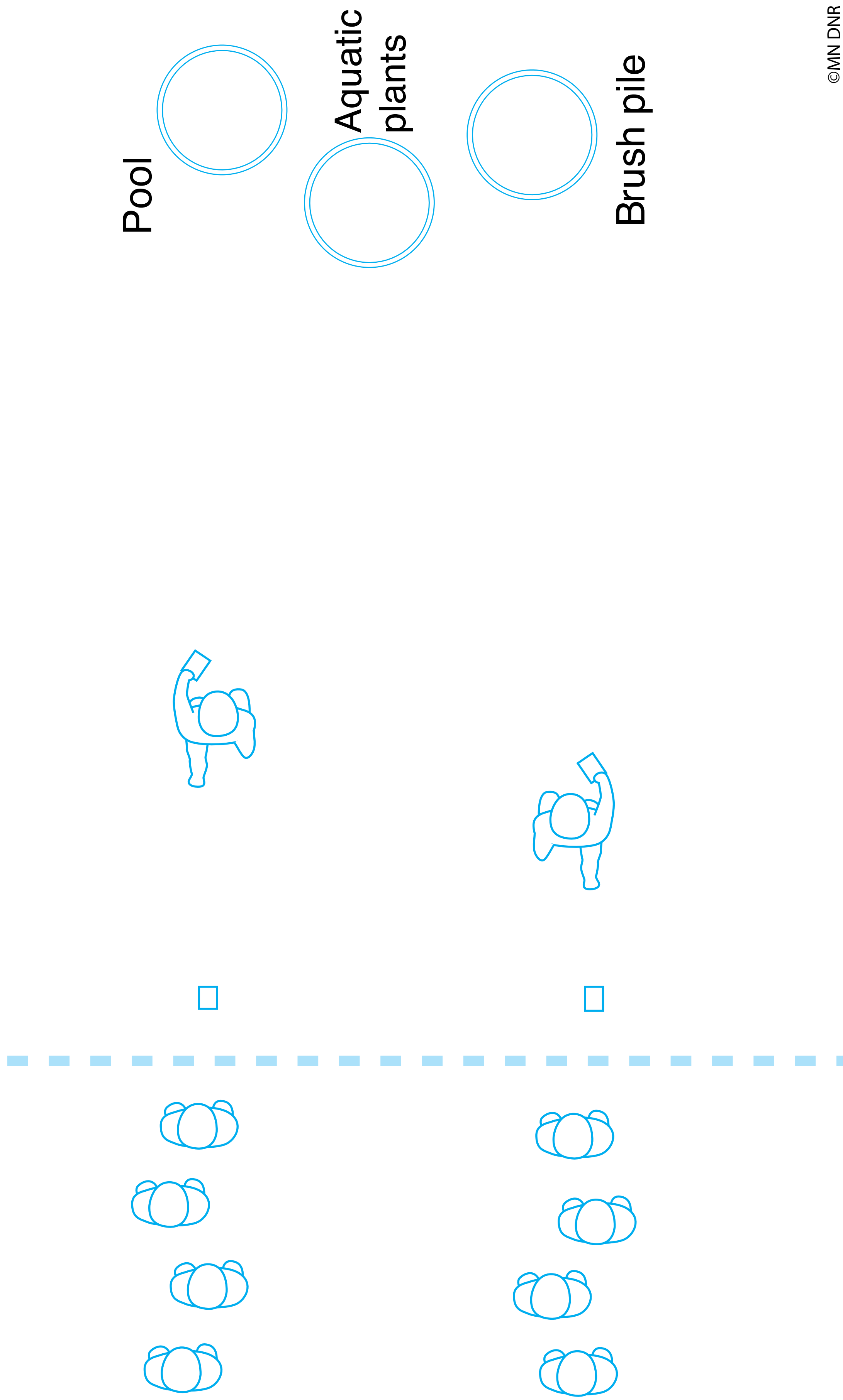
Habitat Hideout Playing Field Diagram



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Name ______________________________ Date ______________

Fish Habitat Chart

Fish Species	Characteristics	Preferred Habitat
 1. Largemouth Bass *Micropterus salmoides*		
 2. Black Bullhead *Ameiurus melas*		
 3. Freshwater Drum *Aplodinotus grunniens*		
 4. Burbot *Lota lota*		
 5. Lake Sturgeon *Acipenser fulvescens*		
 6. Brook Trout *Salvelinus fontinalis*		

STUDENT COPY

Name ______________________________ Date ______________

Fish Habitat Chart

Fish Species	Characteristics	Preferred Habitat
 7. Northern Pike *Esox lucius*		
 8. Black Crappie *Pomoxis nigromaculatus*		
 9. Rainbow Trout *Oncorhynchus mykiss*		
 10. Bluegill *Lepomis macrochirus*		
 11. Channel Catfish *Ictalurus punctatus*		

STUDENT COPY

Name ______________________________ Date ______________

Fish Habitat Chart

Fish Species	Characteristics	Preferred Habitat
 12. Walleye *Sander vitreum*		
 13. Longnose Gar *Lepisosteus osseus*		
 14. Yellow Perch *Perca flavescens*		
 15. Smallmouth Bass *Micropterus dolomieu*		
 16. Common Carp *Cyprinus carpio*		

Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Bluegill
Lepomis macrochirus

Walleye
Sander vitreum

Habitat: Lakes and rivers in shallow water among aquatic plants

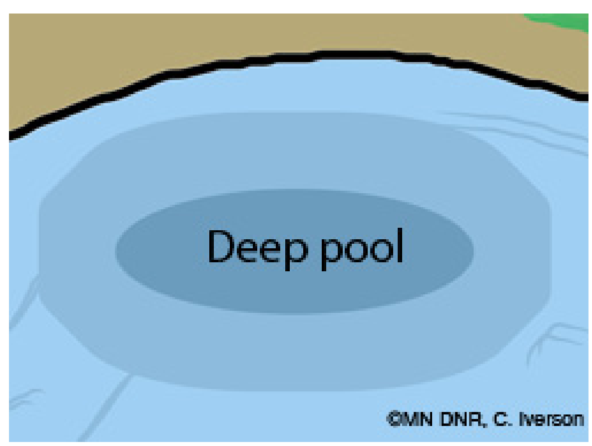
Behavior: Travels in schools; stays in shade during daytime

Food: Insects, snails, and zooplankton

Habitat: Lakes and rivers in deep water such as pools and near drop-offs

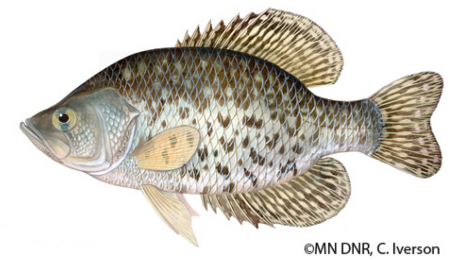
Behavior: Moves to shallower water on cloudy days or at night; travels in loose schools

Food: Small fish, insects, crayfish, and leeches



Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.



Black Crappie
Pomoxis nigromaculatus

Northern Pike
Esox lucius

Habitat: Lakes and rivers along aquatic plants and in the branches of fallen trees in weed lines and submerged woody debris

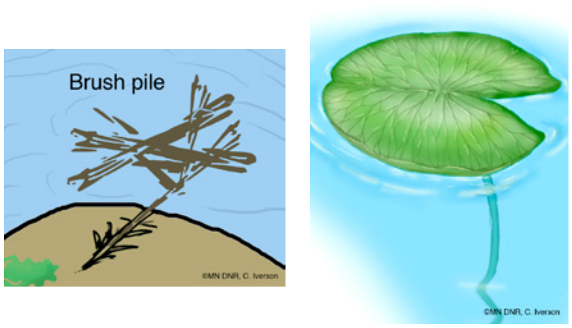
Behavior: Gathers in loose groups around cover

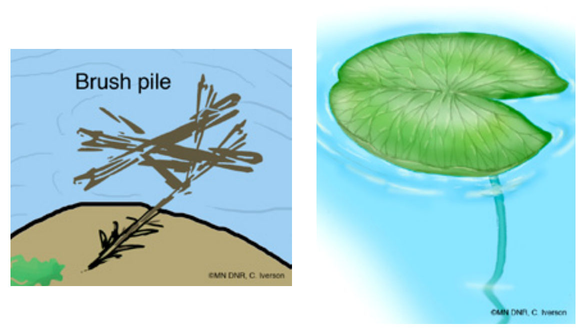
Food: Small fish, invertebrates, and zooplankton

Habitat: Lakes and rivers near aquatic plants

Behavior: Hides from prey in brush or aquatic plants; very fast and aggressive when chasing prey fish

Food: Small and medium fish





Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Common Carp
Cyprinus carpio

Black Bullhead
Ameiurus melas

Habitat: Lakes and rivers

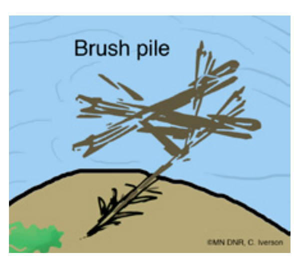
Behavior: Feeds on bottom among aquatic plants

Food: Insects, crayfish, plant roots, shoots, and seeds

Habitat: Lakes or rivers among aquatic plants or brush

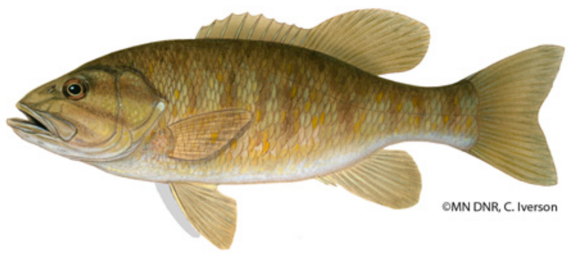
Behavior: Locates food using taste and smell; has taste buds on barbels (whiskers) and on entire body

Food: Aquatic plants, insects, crayfish, frogs, and small fish

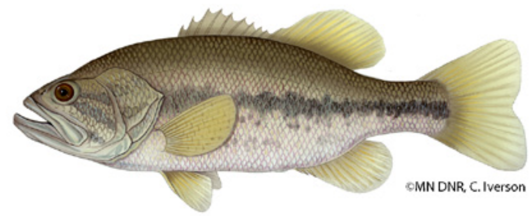


Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.



Smallmouth Bass
Micropterus dolomieu



Largemouth Bass
Micropterus salmoides

Habitat: Lakes and rivers near rocks, brush and drop-offs

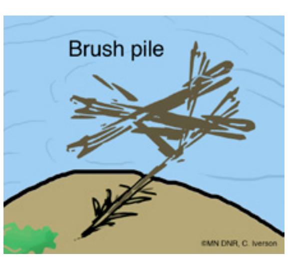
Behavior: Ambush feeder; most active in morning and evening; highly territorial

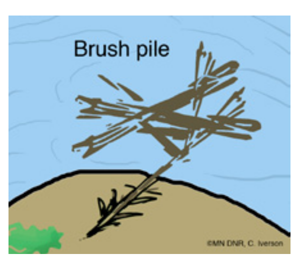
Food: Small fish, crayfish, and leeches

Habitat: Lakes and rivers in brush and aquatic plants

Behavior: Ambushes prey from hiding spot in brush or aquatic plants; highly territorial

Food: Small fish, crayfish, and frogs





Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Brook Trout
Salvelinus fontinalis

Yellow Perch
Perca flavescens

Habitat: Cold water streams with deep pools and undercut banks

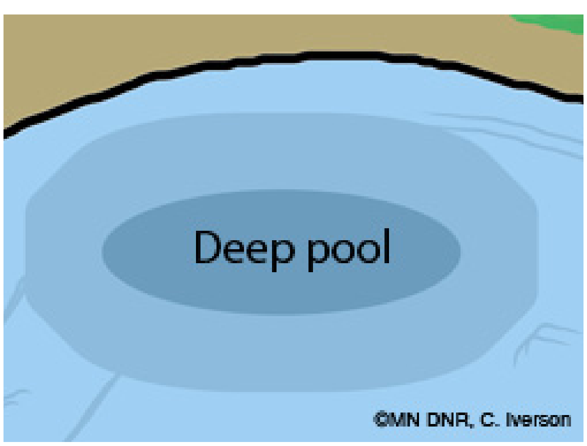
Behavior: Rests in pools and undercut banks; feeds on organisms swept downstream

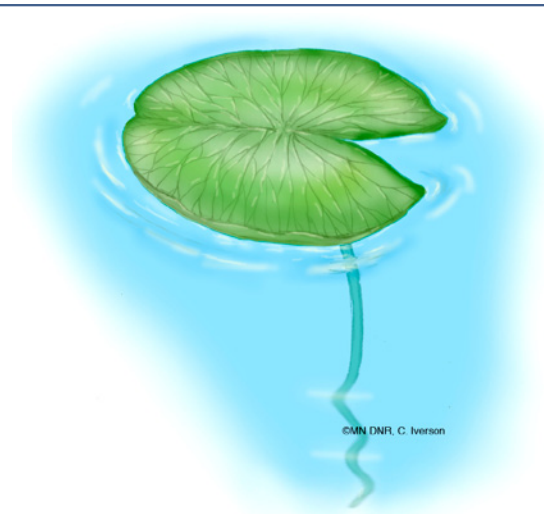
Food: Small fish, insects, and scuds

Habitat: Lakes and rivers near rocks and aquatic plants

Behavior: Swims in large schools

Food: Small fish, zooplankton, insects, snails, and crayfish





Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Rainbow Trout
Oncorhynchus mykiss

Burbot
Lota lota

Habitat: Cold water streams with deep pools and undercut banks

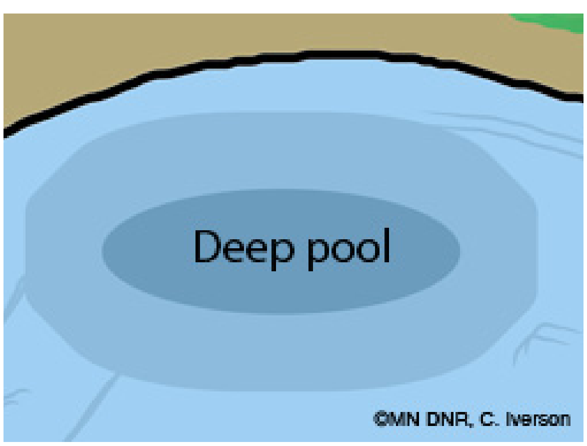
Behavior: Rests in pools and undercut banks; feeds on organisms swept downstream

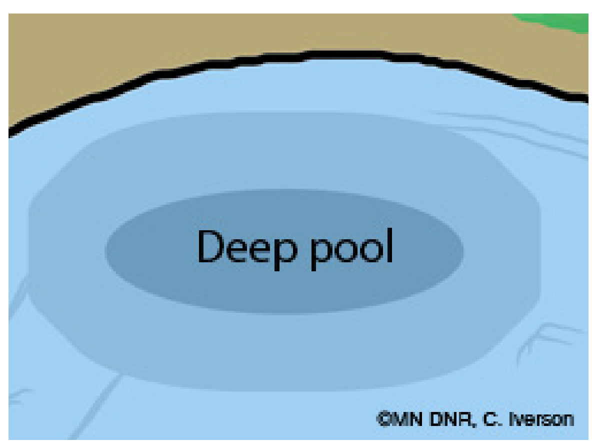
Food: Small fish, insects, and scuds

Habitat: Cool water lakes in deep water and in pools or holes

Behavior: Spawning takes place very early in the year, often before ice melt; known to gorge on food, which expands their stomachs

Food: Yellow perch, whitefish, and ciscoes





Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Channel Catfish
Ictalurus punctatus

Lake Sturgeon
Acipenser fulvescens

Habitat: Rivers in undercut banks and pools

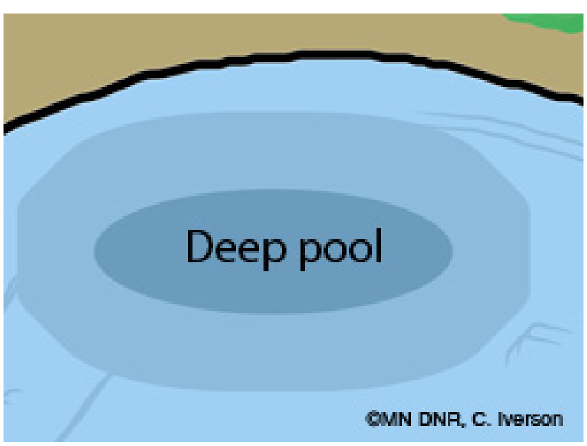
Behavior: Locates food using taste and smell; has taste buds on barbels (whiskers) and on entire body

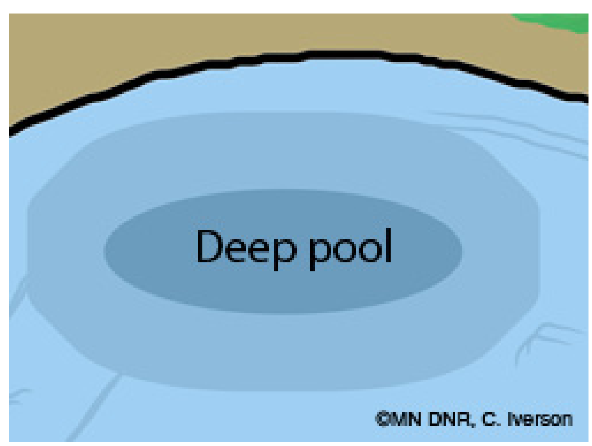
Food: Aquatic plants, insects, crayfish, frogs, small fish

Habitat: Large rivers and lakes in deep pools and near drop-offs

Behavior: Sucks food off bottom with tube-shaped mouth

Food: Snails, clams, crayfish, and insects





Habitat Hideout Fish Identification Cards

Prepare cards as indicated in Step 2 of the lesson Preparation.

Freshwater Drum
Aplodinotus grunniens

Longnose Gar
Lepisosteus osseus

Habitat: Lakes and rivers in central, western, and southern Minnesota

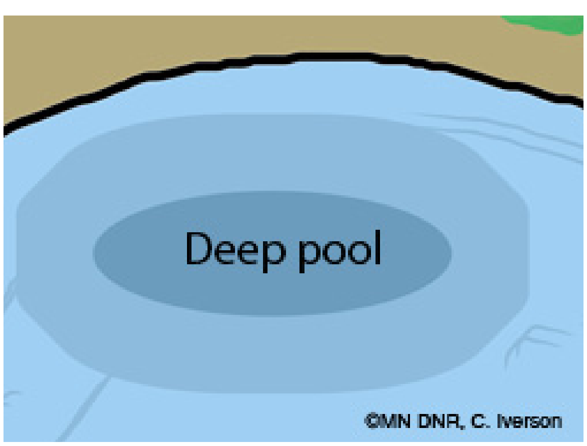
Behavior: Stays near bottom and in pools; makes croaking or booming sound using its swim bladder

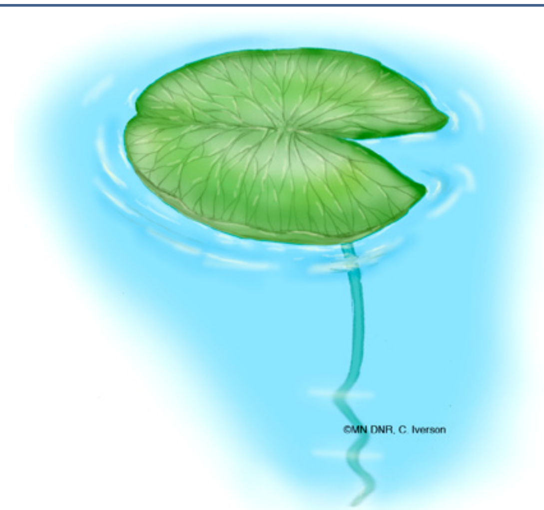
Food: Insects, crayfish, clams, snails, and, occasionally, zebra mussels

Habitat: Large river systems, in backwater bays and side channels, and in aquatic plants

Behavior: Hunts lie-in-wait-style by quietly floating like a log until a small fish comes within snapping distance

Food: Other fish such as minnows and gizzard shad





From Frozen to Fascinating

Can tiny aquatic organisms survive Minnesota's frosty winters? Watch them emerge from a scoop of frozen muck!

Table of Contents

Chapter 1 • Lesson 6

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

From Frozen to Fascinating

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
C. Comprehension:
Benchmark 4—The student will retell, restate or summarize information orally, in writing, and through graphic organizers.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will organize and express ideas sequentially or according to major points.

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 6—The student will distinguish fact from opinion, determine cause and effect, and draw conclusions.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.
Benchmark 4—The student will organize and summarize ideas, using evidence to support opinions or main ideas.

Grade 5
I. Reading and Literature
C. Comprehension:
Benchmark 9—The student will determine cause and effect and draw conclusions.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.
Benchmark 5—The student will restate or summarize and organize ideas sequentially using evidence to support opinions and main ideas.

History and Social Studies

Grades K—3
IV. History Skills
A. Concepts of Time:
Benchmark 1—Students will define and use terms for concepts of historic time. (Present, future, weeks, seasons)

Math

Grades 3, 4, 5
I. Mathematical Reasoning:
Benchmark 1—The student will communicate, reason and represent situations mathematically.

Grade 3
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 2—The student will collect data using observations or surveys and represent the data with pictographs and line plots with appropriate title and key.
V. Spatial Sense, Geometry, and Measurement
C. Measurement:
Benchmark 1—The student will select an appropriate tool and identify the appropriate unit to measure time, length, weight and temperature.

Grade 4
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 1—The student will collect data using observations or surveys and represent the data with tables and graphs with labeling.
Benchmark 2—Use mathematical language to describe a set of data.

Grade 5
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 3—The student will collect data using measurements, surveys or experiments and represent the data with tables and graphs with labeling.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
III. Earth and Space Science
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will measure, record, and describe weather conditions using common instruments.
III. Earth and Space Science
C. The Universe:
Benchmark 3—The student will observe that the sun supplies heat and light to the Earth.
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
Benchmark 2—The student will know that plants have different structures from animals that serve the same necessary functions in growth, survival and reproduction.
IV. Life Science
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will recognize when comparisons might not be fair because some conditions are not kept the same.
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.
II. Physical Science
A. Structure of Matter:
Benchmark 1—The student will observe that heating and cooling can cause changes in state.
IV. Life Science
A. Cells:
Benchmark 1—The student will recognize that cells are very small, and that all living things consist of one or more cells.
Benchmark 2—The student will recognize that cells need: food, water and air, a way to dispose of waste, and an environment in which they can live.

Grade 5
I. History and Nature of Science
A. Scientific World View:
Benchmark 2—The student will recognize that clear communication of methods, findings and critical review is an essential part of doing science.
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 1 • Lesson 6

From Frozen to Fascinating

Grade Level: 3-5
Activity Duration: 30 minutes once a week for at least four weeks
Group Size: any
Subject Areas: Science, Expressive Arts, Health and Safety, Language Arts, Math
Academic Skills: communication, comparison, description, drawing, drawing conclusions, estimation, experimentation, identification, inquiry, measuring, observation, organization, prediction, presentation skills, recording data, reporting, small group work
Setting: Preparation: pond or stream
Parts 1-4: indoor gathering area
Vocabulary: adaptation, algae, aquatic organism, dormant, emerge, over-winter, phytoplankton, plankton, sediment, zooplankton
Internet Search Words: algae photos, aquatic invertebrate photos, aquatic plant photos, bottom sediment, daphnia, daphnia photos, dormancy, freshwater zooplankton photos, seasons, submergent aquatic plant photos, winter adaptations, zooplankton

Summary

In this activity, students investigate how spring-like conditions trigger plankton and algae from bottom sediments to emerge and resume activity after winter dormancy. Students add scoops of bottom sediment (liquid or frozen, and collected in winter) from an icy-cold lake, pond, or wetland to large containers of water to make "mini-ponds."

Working in groups, students design their own experiments and place their mini-ponds in various environments within the classroom to encourage dormant organisms to emerge. Groups make predictions, decide where—and in which conditions—in the room to place their mini-ponds, record observations over a four-week period, and draw conclusions. They also use identification keys and pond field guides to identify and sketch organisms in the developing mini-pond. Each group prepares a final presentation that communicates their results to the class.

Instructor's Background Information

Seasons bring dramatic weather changes in Minnesota. How do people survive winter conditions here in the northern latitudes? We dress in layers of warm clothing, spend more time indoors, store food, and wear waterproof shoes and insulated boots. But what happens to plants and animals that live in the water during the cold, freezing months of winter? How do aquatic organisms survive dramatic seasonal changes?

An **aquatic organism** is a living thing that spends all or most of its life cycle in water. Some examples include water lilies, duckweed, Canada geese, fish, dragonflies, frogs, turtles, and beavers. Let's look at a few of the winter survival strategies of some of Minnesota's smallest aquatic organisms.

Small Aquatic Organisms
Many types of aquatic organisms are very small. But, despite their size, they impact aquatic ecosystems in big ways. **Plankton** are extremely small and microscopic organisms that live suspended in the water.

Extremely small and microscopic plants and bacteria are called **phytoplankton**. *Phyto* refers to plant, and like other plants, phytoplankton make their own food energy directly from sunlight through the process of photosynthesis. Animals eat plants or other animals to get their food energy. Because phytoplankton can produce food energy that supports other organisms, they're called producers.

Student Objectives

The students will:

1. Carry out an experiment studying the effects of varying amounts of natural or artificial light and various temperature conditions on over-wintering aquatic organisms.
2. Predict what will occur in the mini-pond over a four-week period and decide which indoor conditions to provide and where to place the mini-ponds to test their predictions.
3. Observe the mini-pond one to three times a week for four weeks and record observations.
4. Draw conclusions about varying amounts of sunlight and temperatures on over-wintering organisms within the mini-pond and communicate their results.
5. Discuss the relationship of sunlight, temperature, and seasonal cycles.
6. List some basic adaptations (including seeds, eggs, and dormancy) that enable aquatic organisms to survive cold winters in Minnesota.

Materials

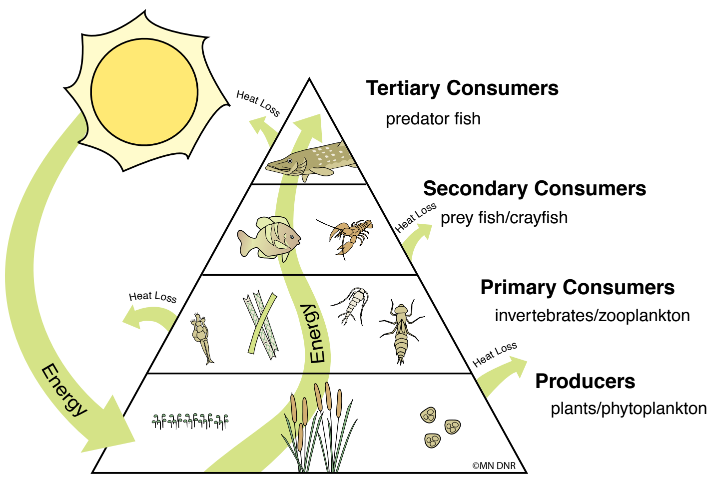
- Distilled water, well water, or melted ice and snow from the schoolyard (avoid ice and snow with heavy concentrations of road salt)
- *Or, if using tap water*, water dechlorinator drops, available at pet stores
- Ice auger or chisel (if necessary)
- Bottom sediment from a pond or wetland

continued

Some species of bacteria are capable of photosynthesis, so they're also classified as phytoplankton.

Organisms that can't photosynthesize depend on producers to make food energy. Some organisms consume plants to get food energy to carry out functions such as growth, reproduction, and finding food. Organisms that eat plants are called primary consumers. Organisms that eat primary consumers to get their food energy are called secondary consumers. These trophic levels (or levels of consumption) can also be considered in terms of a pyramid of life. Phytoplankton and larger aquatic plants compose the vast supporting food base of the aquatic pyramid of life.

An aquatic food pyramid



This fish food pyramid illustrates energy transfer and relative biomass in an aquatic ecosystem. Producers make up the greatest biomass in the system, and support all other life forms. All energy originates from the sun and is converted into food energy by producers. Food energy is transferred through the levels of the food pyramid as one organism consumes another. At each level in the food pyramid, energy is lost to the surrounding environment as heat as organisms use food energy to find food, respire, grow, and reproduce.

Food energy is not the only product of photosynthesis. Phytoplankton and larger aquatic plants release oxygen into the water as they photosynthesize, increasing the quantity of dissolved oxygen that aquatic animals (including fish) need for respiration.

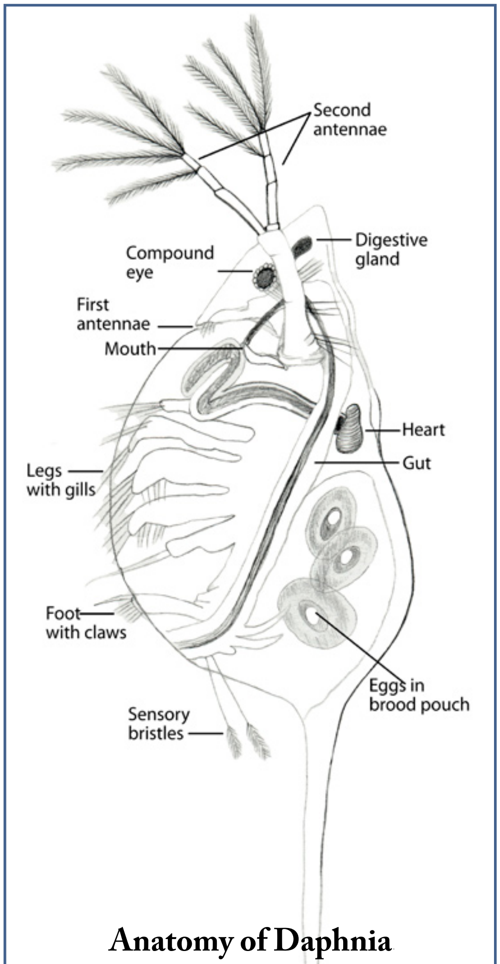
Like larger plants, phytoplankton recycle nutrients (basic materials such as carbon and sulfur). Producers take in these nutrients from their environments and combine them to make the materials needed to grow and function. Primary consumers eat producers to get the building block materials for their growth and structure, but they don't take up nutrients directly from the environment. Nutrients from the producers are passed through the food pyramid as one organism consumes another. When a plant or animal dies, bacteria decompose it, breaking its form or structure back into basic nutrients.

Zooplankton are extremely small or microscopic animals such as copepods, daphnia, and rotifers. Zooplankton and larger invertebrates, such as caddisfly and mayfly larvae, are primary consumers. They eat phytoplankton to get their food energy. They form the second tier or trophic level of the aquatic pyramid of life. Despite their abundance, zooplankton and invertebrates combined comprise a small fraction of a lake's total biomass.

The Natural History of Daphnia

Daphnia is a group of zooplankton commonly found in Minnesota waters. They're very small crustaceans, and are an important food source for many invertebrates and small fish. Although many types of zooplankton are microscopic, daphnia are large enough to see with the unaided eye. During most of the year, daphnia reproduce through parthenogenesis, producing only cloned females, which they incubate inside their bodies beneath their exoskeletons. The young daphnia are released when the female sheds her exoskeleton during molting cycles. Just prior to winter, however, daphnia produce freeze-resistant eggs. Environmental cues, such as limited food or shorter day length, stimulate production of the freeze resistant eggs that can survive the winter. Many of the eggs drop from the water into the top few inches of bottom sediment (muck) of a pond, lake, or wetland. In the spring, warmer temperatures and longer days trigger hatching of these eggs. The young daphnia then emerge from the sediment and begin to swim within the water column.

As filter feeders, daphnia eat minute organisms in the water. A single daphnia can filter almost a liter of water every day. Without healthy populations of daphnia and other filter-feeding crustaceans, our lakes would be green with excessive quantities of algae!



Anatomy of Daphnia

Materials (continued)

- Bucket and shovel for collecting sediment
- Fluorescent "grow light," to increase day length (optional)
- **Guide to What to Expect in the Mini-ponds**
- For each group of two to five students:
  - Paper cup
  - One clear gallon container
  - Nylon knee-high stocking, or mosquito netting to cover container tops
- **Predictions and Summary Sheet**
- **From Frozen to Fascinating Data Sheet**, *twelve copies per student* (This number depends on the number of observations students are to record each week—changes will be more dramatic with fewer observations.)
- Pencil
- Clipboards, if working without tables
- Thermometer
- Disposable pipettes
- Study plate (shallow white food storage containers or white plastic plates with rims work well)
- Magnifying glass, one per student
- Identification sheets and keys from **Lesson 1:4—Water Habitat Site Study**
- Pond field guides (such as *Pond Life Book: Golden Pocket Guide* and *Through the Looking Glass: A Field Guide to Aquatic Plants*, by Susan Borman, et al)
- Microscope, hand microscope, or projection microscope
- Internet access (optional)

Anabaena
planktonic

Spirogyra
filamentous

Chara
plant-like

Common types of Minnesota algae.

Algae

Algae encompass several types of organisms that aren't really plants, animals, or fungi. Many types of algae resemble simple plants, but algae don't have leaves, roots, or flowers. Examples of algae include red algae and green algae. (Blue-green algae are actually bacteria.) Some species of algae are terrestrial (they live on land) and some are aquatic (these live in water). Like plants, almost all algae use the process of photosynthesis to turn light energy into chemical energy or food energy. They also release oxygen into the water as a by-product of photosynthesis. Many algae are one-celled organisms, but some types are multi-cellular.

Some forms of free-floating aquatic algae photosynthesize, and are included in the phytoplankton group that forms the basis of aquatic food chains. Some green algae are multi-cellular. If you've seen "pond scum" or the green filamentous growths found on dock posts, rocks, and other underwater objects, you're familiar with green algae.

Large numbers of algae in great densities are called algal blooms. Algal blooms are a result of excessive nutrients (particularly phosphorus and nitrogen) entering the water as pollution from the land. Algal blooms can make the water green, produce noxious odors, and even produce toxins that harm or kill other organisms. In large densities, algae can outcompete other organisms, using much of the available light, food, and space.

Algal blooms have a major impact on water bodies in another way, too. When the algae die, they sink to the bottom of the water body and, like any other deceased organism, are decomposed by bacteria. The bacterial decomposers use oxygen during this process. When large densities of algae from an algal bloom die, bacteria reproduce quickly as they decompose such large quantities. The bacteria use dissolved oxygen during respiration. Greater numbers of bacteria consume greater amounts of oxygen, leaving less available oxygen for fish and other aquatic organisms. **Summerkill** refers to an event where fish die from oxygen shortages triggered by the decomposition of an algal bloom.

Winter Adaptations

Aquatic organisms have **adaptations** that help them survive extreme winter temperatures and conditions in the water. An adaptation is an evolved physical characteristic or behavior that equips an organism for life in its environment, enabling it to survive specific conditions and characteristics of that environment.

Like daphnia's freeze-resistant eggs, other Minnesota plants and animals have a variety of strategies or adaptations that help them survive winter conditions. Various species exhibit different types of winter adaptations. For example, flat-stemmed pondweed produces seeds resistant to the effects of freezing. The seeds of this aquatic plant have a tough protective coat with a waxy covering that prevents the living tissue inside the seed from freezing and drying. When the seeds sprout in the spring, the new plants grow during the milder weather conditions of spring, summer, and fall. The plant then produces another generation of seeds that can survive winter.

Similarly, a species of zooplankton known as fairy shrimp lay eggs that don't freeze in winter. During egg formation, some cell water is replaced with sugar, which has a lower freezing point than water. The sugar acts as antifreeze, preventing ice crystals from forming in the fluids of the cells. Fairy shrimp eggs also have a tough protective covering that prevents them from drying and freezing. In the spring, the eggs hatch—and the species has survived another winter.

Over-winter is a term referring to how an organism addresses the challenges of winter survival. While many species over-winter as seeds or eggs, other species become dormant. **Dormancy** is a survival strategy of inactivity or rest exhibited by various plants and animals in temperate climates. In a state of dormancy, an organism slows down or stops growing and reduces its metabolic rate so it needs less food. It can then conserve energy until more favorable environmental conditions allow it to resume activities such as eating more food, growing, and reproducing.

Daphnia

As winter approaches, many organisms, eggs, and seeds settle into bottom sediment. **Sediment** is the accumulation of erosion from the watershed (silt, sand, and organic and inorganic material) and organic material produced within the body of water that accumulates on lake, river, and stream bottoms. It is in the sediment that organisms slow down and become dormant for the winter as temperatures drop. The warmer temperatures and longer daylight hours of spring signal them to **emerge,** or break dormancy, and return to a fully active state. As ice and snow cover melt from the water's surface and days become longer, aquatic plants and phytoplankton resume photosynthesis, producing more food energy and oxygen for themselves and other aquatic organisms.

A large variety of small organisms, including zooplankton, aquatic macroinvertebrates, larval organisms, phytoplankton, algae, and other plants over-winter in the frozen sediments of ponds, lakes, and streams.

A scoop of frozen bottom muck collected from a lake, stream, river, pond, or wetland in winter—exposed to warmer temperatures and sunlight—allows you to discover the life that lies under the winter ice, and to watch it emerge from dormancy.

Algal blooms are a result of excessive nutrients (particularly phosphorus and nitrogen) entering the water as pollution from the land.

Sediments from wetlands and small ponds will have more organisms than lakes due to the absence of fish, which prey on invertebrates.

Procedure

Preparation

1 Collect the sediment. Sediment is best collected after there is safe ice on the lake, pond, or wetland. Drill or chisel a hole near the shoreline and vegetated areas, but away from beaches. This is the area in which invertebrate eggs have been concentrated by wind and wave action. The east side of the water body is often the best location due to prevailing westerly winds in the fall. Collect enough bottom sediment to fill one small paper cup for each group. You may wish to collect an additional sample for the instructor. Collect only the top inch of sediment: over-wintering seeds and eggs will be present on the surface of the sediment. You can collect the sediment the day before or even a week before class use. Store the filled paper cups in the refrigerator until you're ready to begin the activity. Thawed or frozen sediments yield similar results.

Precautions to Take While Collecting Sediment

Due to the increase in the number of harmful invasive species that have entered Minnesota waters, it's important to follow a few guidelines and the laws that protect aquatic resources. Refer to A Field Guide to Aquatic Exotic Plants and Animals, a brochure available from the Minnesota DNR, for additional information and assistance with invasive species identification.

- Avoid collecting sediment or organisms from a lake, pond, or wetland that has been posted "Infested Waters" by the Minnesota DNR. It's illegal to transport water from these sites. A list of infested waters is posted on the DNR website.
- Wetlands are not usually posted for invasive species. But if you know that an area contains purple loosestrife, don't collect sediment there—it's illegal to transport purple loosestrife seeds or parts.

Purple loosestrife.

- Properly dispose of materials at the end of the experiment by either returning the material to its original site or drying the material and placing it in a trash container.
- Never move or return water, plants, animals, or sediment from one aquatic system into another.
- Clean and dry sediment-collecting equipment before using it again.
- Refer to *MN Rules Chapter 6280 Item G,* and the *Minnesota Exotic Species Statutes Chapter 84D.* These guidelines also help prevent the spread of diseases to native aquatic organisms.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.

Minnesota law also prohibits the removal of aquatic vegetation from posted fish-spawning areas and Scientific and Natural Areas. Obtain all required permits. Refer to the current Minnesota fishing regulations booklet or check with MinnAqua staff, your local conservation officer, or a DNR resource biologist for proper procedures concerning the transportation, collection, and disposal of water and aquatic organisms.

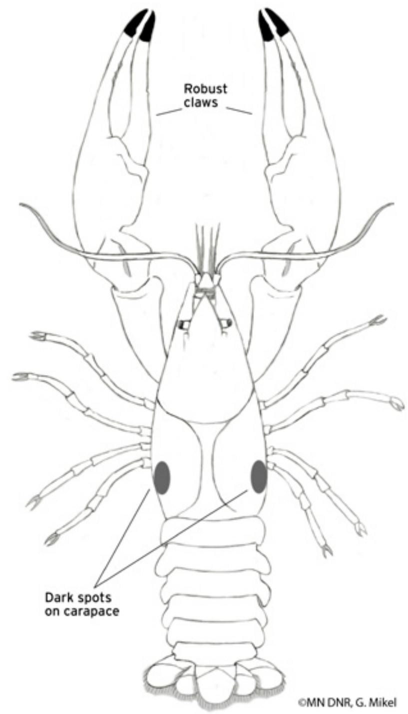
When choosing a site for collecting frozen muck it's important to remember that you will be disturbing bottom sediment, which can release any settled contaminants into the water. Avoid discharge areas and toxic spill locations.

- If this activity will be repeated throughout the season, or from year to year, don't repeatedly collect from the same area. Rotate sites to avoid disturbing a good study area.

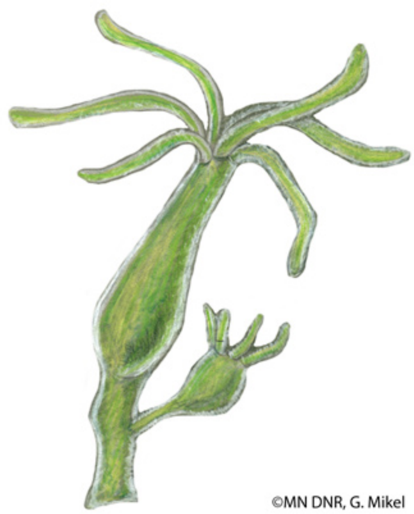
2 Clean the clear gallon containers thoroughly with a mild soap solution. Make sure to rinse all soap residues from the containers before use.

3 If you plan to use chlorinated tap water in the gallon containers, dechlorinate it with dechlorinator drops available at pet stores. You could also purchase distilled water, let the chlorinated tap water sit overnight in open containers, use well water, or use melted ice and snow. Avoid using snow from areas with heavy concentrations of road salt.

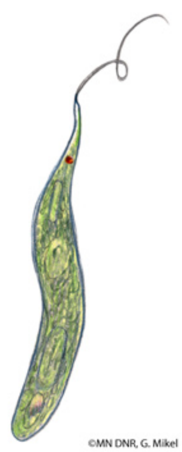
STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.



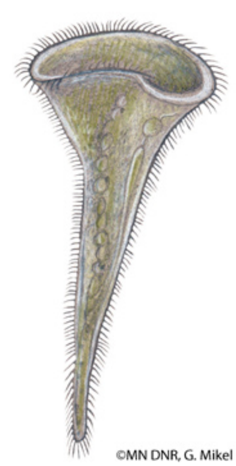
The rusty crayfish is an example of an invasive species that has spread through Minnesota waters, at least in part, by schools that have ordered them from biological supply businesses, studied them, and released them into ponds and lakes. Adult rusty crayfish have relatively large claws with black bands at their claw tips. They usually have dark, rusty colored spots on each side of their carapace at mid-body. For more information, request publication number X34 from Minnesota Sea Grant, University of Minnesota, Duluth at 218-726-8106.



Hydra



Euglena



Stentor

Activity

Warm-up

1 Conduct a questioning and brainstorming session. Discuss dramatic seasonal changes in Minnesota. Ask the students what makes life challenging in winter. List their responses on the whiteboard, interactive whiteboard, or overhead. The list should include:
- snow
- cold temperatures
- less light for photosynthesis
- and less available food.

Ask students what happens to these winter conditions in the spring. Answers should include:
- longer days
- warmer temperatures
- more sunlight
- plants turn green and can photosynthesize
- and there is more food available.

2 Introduce the definition of **adaptation**, a characteristic or feature that helps an organism survive in the environmental conditions where it lives. Write the definition above the list of winter conditions. Ask students how people adapt to winter conditions in Minnesota. For as long as people have lived in cold climates, they've needed strategies for surviving extreme weather conditions. Plants and animals have strategies or adaptations, developed over very long periods of time, for surviving extreme weather conditions where they live.

3 Ask students to list adaptations that plants and animals have that help them survive Minnesota winter conditions. List the responses on the whiteboard, interactive whiteboard, or overhead. The list should include:
(for plants)
- some trees slow their metabolic rates
- stop photosynthesizing
- and drop their leaves and seeds;

(for animals such as insects and frogs)
- by becoming dormant (the students may say hibernation). Ask students if they've ever wondered how plants and animals in the nearby lake or pond survive the winter under the ice and snow?

4 Discuss how Minnesota waters have tiny plants and animals called plankton that form the base of aquatic food chains. Tell students that plankton are very tiny, and that many types of plankton are too small to see without a microscope. Many are single-celled organisms. Plankton and larger plants make up most of the weight of living things in a water body. Like larger plants and animals, these tiny microscopic plants and animals have strategies or adaptations for surviving in winter.

5 Tell students they will be working in groups and that each group will have a mini-pond to observe. Each group will get a small cup of refrigerated or frozen sediment from a local water body to place

in a large jar of water. Explain that this jar of water with the very cold sediment on the bottom represents a pond in the winter.

6 Divide the students into groups of two to five students.

7 Tell students that, now that the mini-ponds are indoors, we are simulating the end of winter and the beginning of spring. What weather conditions change as winter gives way to spring? Tell students that each group will make their own predictions about what will happen in their mini-ponds as the spring conditions continue.

Lesson

Part 1: Making Mini-ponds

1 Have each student group gather materials and prepare their mini-ponds:
- Fill the gallon containers three-quarters full of distilled water, well water, melted ice or snow, or dechlorinated tap water. You may have to add additional water to the jars over the course of the experiment due to evaporation.
- Distribute one paper cup of sediment to each student work group. Holding the sides of the cup in the hands for two minutes will thaw and loosen the sediment from the sides of the cup if it's frozen solid.
- Add the muck from the paper cup to the gallon container.
- Stretch a nylon knee-high stocking or some mosquito netting over the opening of the container. (*This prevents winged insects from emerging from the mini-ponds later in the experiment.*)

2 Ask the students if they think any plant or animal life exists in their mini-ponds.

Part 2: Making Predictions

1 Pass out one **Predictions and Summary Sheet** to each group.

2 Prompt the students with these questions:
- What do you think might happen in the mini-pond in the future as conditions change from winter to spring (from cold sediment from the refrigerator to indoor conditions in the classroom)?
- Which springtime seasonal conditions do you think will have the greatest impact on the wintertime mini-pond?

3 Ask the groups to write down two predictions regarding what they think might happen to their mini-ponds as springtime conditions continue.

Part 3: Beginning the Experiment

1 Give each student a **From Frozen to Fascinating Data Sheet**. Tell students that the groups are now going to test their predictions with an experiment. To design their experiment, each group must decide on the springtime conditions to which they will expose their mini-ponds in the classroom. These conditions should be the ones that will best test their predictions. You may need to remind them that some corners of the room are darker, some spots in the room

Prior to beginning this activity, you may wish to set up a florescent grow light in one location. A student group may choose this spot to observe any differences that the grow light (sunlight) might make in the mini-ponds.

Before students begin making observations, you may want to review the proper way to use a thermometer and record temperatures, as well as instruct students on the use of magnifying lenses or microscopes.

are noisier, some places might be draftier, and so forth.

2 Have the student groups place the mini-ponds in the classroom locations they have chosen to test. Appropriate locations in the room may include spots that receive different amounts of sunlight. Some students may place their mini-ponds on the window ledge to get sunlight during the day.

3 When the groups have determined the spots in which to place their mini-ponds, have students fill out the top portion of their **From Frozen to Fascinating Data Sheets** and record initial observations.

Part 4: Recording Observations

1 Students should record their observations one to three times per week at a set time of day for at least four weeks. They will use thermometers to measure water temperatures in the mini-ponds during each observation. Provide students with a new **From Frozen to Fascinating Data Sheet** for each day they collect and record observations.

2 Refer to the **Guide to What to Expect in the Mini-ponds** for an explanation of the organisms that the students may find emerging in their mini-ponds. Because this experiment may produce mostly extremely small and microscopic organisms (such as plankton, daphnia, or algae), have students move some water from the mini-ponds into a small dish or onto a slide. They can then look at the water using a hand lens or microscope during observations. What do they see now that they weren't able to see without the hand lens or microscope?

3 Have groups use pond field guides, websites, or the identification keys and sheets in **Lesson 1:4—Water Habitat Site Study** to identify organisms. (See Internet Search Words on the first page of this lesson for keywords to use to search for images of aquatic organisms.) Have student groups draw any organisms observed and label the drawings.

4 At the end of the four weeks, each group should fill out the summary portion of their **Predictions and Summary Sheet**. In their summaries of observations, they should describe the actual changes they've observed in their mini-ponds.

5 Have students create line graphs illustrating the change in number of organisms observed over the course of the four weeks.

6 As students complete the conclusion section of the **From Frozen to Fascinating Data Sheet**, you may wish to prompt them to answer the following types of questions: Were your predictions supported by the results of your experiment? Why or why not? How did the location of your mini-pond within the room influence your results? Which environmental conditions did you test in your experiment? Was your location warmer or cooler than those of the other groups? Did your location have more or less light than other spots in the room? How do springtime light and temperature conditions differ from winter light and temperature conditions? How might these seasonal differences impact aquatic organisms?

Students will notice more dramatic changes in their mini-ponds if they make fewer observations each week.

Mini-ponds in dark, cool areas tend to show fewer changes than those in lighter or warmer spots. You may wish to make your own mini-pond, put it in a dark, cool spot, and record observations. Or, if a group has nothing happening in their mini-pond after a week, you may wish to allow them to move it to a different spot. Although this strays from the scientific method by changing variables mid-experiment, it may help hold the students' interest. Make sure they record any changes in their mini-pond location on their **From Frozen to Fascinating Data Sheet**. A group may wish to collaborate with other student groups to compare 24 hours of artificial light vs. the effects of natural daylight exposure vs. placing the container in a darkened corner of the room.

Wrap-up

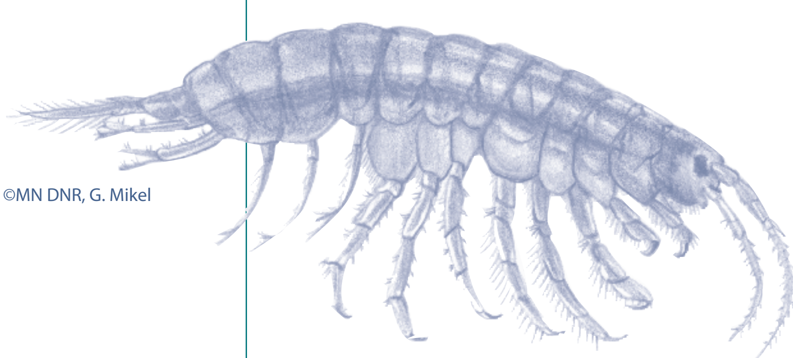
1 So students can communicate their results and compare their predictions and experimental results with those of the other groups, have each group prepare and present an oral report to the class. Ask groups to display data in graphs, tables, posters, drawings, or dramatic interpretation. Allow time for questions and answers after presentations.

Have each group address the following questions in their presentations:
- What did you observe over the four weeks?
- Were your predictions shown to be correct?
- What conclusions did you reach?
- What interesting thing did your group learn from this lesson?
- What would your group do differently next time?
- Did you have other questions after you completed this activity?
- Were you surprised as organisms began to emerge in the mini-ponds?
- Why are organisms more active in the spring than in winter?
- Why didn't you notice organisms in the wintertime mini-ponds? Where were the organisms?

2 After the presentations, conclude with a class discussion. Facilitate the discussion by asking the following questions. Guide the student discussion to include the following:
- How were the organisms able to survive winter conditions? Were they frozen solid? (No, the organisms were not frozen solid, even though the muck may have been frozen. Many of the organisms were in dormancy or in an egg stage. Dormancy protects organisms because, as they slow down and use less energy, they need less food. Eggs are fertilized, but no cell division takes place until light and temperature conditions are more favorable in the spring. Resting or over-wintering eggs have adaptations, such as thick outside coverings or antifreeze-like substances, that prevent them from freezing by keeping ice crystals from forming in the cells.)
- What triggered the organisms to hatch from over-wintering eggs, sprout from seeds, or emerge from dormancy? (Longer hours of sunlight and warmer temperatures.)
- Where would you place your mini-pond in the room the next time you wanted to simulate spring conditions? (In a warmer spot with more light.) Why? (These spring conditions trigger over-wintering organisms to emerge, hatch, and sprout.)
- How might the community in your mini-pond differ from a real pond? (Mini-ponds have less biodiversity because they lack larger plants and animals such as fish, birds, beavers, and other animals. There are no larger predators to eat the small organisms.)
- What effect did the amount of light or the temperature have on the speed at which your mini-pond developed? (More light

and warmer temperatures speed the emergence of organisms.) Why might this be important to the organisms that live in a real ecosystem? (When temperatures are warmer in the spring, the daylight hours are longer. This triggers the organisms to emerge at the right time of year—when they can be more active and survive without freezing, and find enough food to produce energy for activities such as growing, feeding, and reproducing.)

- Why do you think the types of organisms and number of organisms changed during the duration of the experiment? (Some were better able to find food and survive conditions in the jar. Maybe some types didn't find the food they needed after they emerged. With more light and warmer temperatures, the algae could photosynthesize and grow. Over time, the surviving organisms reproduced and their numbers increased—if they had enough food. Some types of organisms ate other types of organisms in the jar.)
- How might the organisms have emerged or developed differently in a real pond? (They would have needed the right outdoor environmental conditions to emerge in spring. Predators that weren't in the mini-ponds, but would have been present in the wild might have eaten some organisms.)
- Which pollutants might enter the pond in the spring through stormwater or snowmelt runoff? How could these impact organisms living in the pond? (Road salt can be toxic to aquatic organisms. Motor oil from automobiles on the roads can enter ponds via stormwater and snowmelt in the spring. In winter, sulfuric and nitric acids from auto exhaust and coal burning power plants mix with water in the atmosphere to become acid snow. When the snow melts in the spring, these acids enter water bodies with the runoff, producing an acid shock. These and other pollutants harm aquatic organisms and ecosystems.)
- What are some basic adaptations that help organisms survive Minnesota winters? (Special seeds and eggs, dormancy.)



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Assessment Options

1 Allow students to choose their own presentation method. They may create and present a poster, videotape a news report of their experimental results, prepare a written report of their results, or make a formal presentation. The groups may also choose to present their findings in a discussion, comparing similarities and differences and posing questions about their findings. They may think of other ways to present their results. Evaluate group presentations to ensure students address the questions from the Wrap-up. Presentations should also demonstrate the students' understanding of their experimental designs, including prediction, determining where to place the mini-pond to test the prediction, making observations, recording observations, drawing a conclusion from the class results, and reporting results.

2 Invite parents, caregivers, or other adults or another class to a winter scientific forum. Guests can view the organisms in the mini-ponds, listen to the group presentations, and learn what the students discovered about winter adaptations of aquatic organisms. Create forms so that the guests can evaluate each presentation.

3 Assessment Options include the Checklist and Rubric on the following pages.

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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

27-30 points = A
Excellent. Work is above expectations.

24-26 points = B
Good. Work meets expectations.

19-23 points = C
Work is generally good. Some areas are better developed than others.

14-18 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-13 points = F
Work is unacceptable.

From Frozen to Fascinating Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
10	______	______	Student presentation includes predictions, study design, observations, and conclusion. Questions generated by the study included.
2	______	______	Student presentation explains how experiment demonstrates the role of temperature in causing dormant organisms to emerge in spring.
2	______	______	Student presentation explains how experiment demonstrates the role of light in causing dormant organisms to emerge in spring.
2	______	______	Data presented in easily read format.
4	______	______	Uses at least two types of visual aids.
2	______	______	All members of the group participate in presenting information.
2	______	______	Voices were loud enough to hear.
2	______	______	Presentation length equal to the time limit given.
2	______	______	Group members define *dormant*.
2	______	______	Group members define *adaptation*.

Total Points

30 ______ ______ **Score** ______

From Frozen to Fascinating Scoring Rubric

Presentation Criteria	4 **Excellent**	3 **Good**	2 **Fair**	1 **Poor**	0 **Unacceptable**
Content	Presentation includes predictions, study design, observations, and conclusion. Questions generated by the study included.	Presentation includes predictions, observations, and conclusion Questions generated by the study included.	Presentation includes prediction, observations, and conclusion.	Presentation focused solely on the observations and conclusion.	Made no effort to complete presentation.
Experimental variables	Presentation explains how experiment demonstrates the role of temperature and light in causing dormant organisms to emerge in spring.	Presentation addresses the role of temperature and light in causing dormant organisms to emerge in spring.	Presentation addresses the role of temperature *or* light in causing dormant organisms to emerge in spring.	Presentation addresses environmental variables, but not temperature or light.	Presentation didn't address environmental conditions that could impact spring emergence of dormant organisms.
Visuals	Data presented in easily-read format. At least two types of visual aids used.	Data presented in easily read format. One type of visual aid used.	Data presented in visual format, but information was hard to understand and read.	Attempted to use a visual aid, but it didn't support presentation.	No visual aid used for data.
Presentation style	All members of the group presented information. Voices were loud enough to hear. The presentation was equal to the time limit given.	All members of the group presented information. Voices were loud enough to hear. The presentation was shorter or longer than the time limit given.	All members of the group presented information. Some voices were too soft. The presentation was shorter or longer than the time limit given.	Only a few group members presented information. Voices were too soft to hear. The presentation was shorter or longer than the time limit given.	Didn't complete presentation.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Explore how organisms that don't have over-wintering eggs or seeds (such as fish, birds, mammals, reptiles, amphibians, and terrestrial plants) survive during the winter months.

2 Begin this lesson with a discussion of cycles in nature and seasons. Seasonal changes are an example of one type of nature cycle. In Minnesota, we enjoy the variety brought by four very distinct seasons.

Why does it get so much colder in Minnesota in the winter than it does in Florida? This can be demonstrated very easily in a darkened classroom using a globe and a flashlight. Print the letter M on a piece of masking tape. Place the masking tape on the globe over the state of Minnesota. Ask for two student volunteers and have them stand in front of the class about three feet apart (you may adjust this distance depending on the strength of the flashlight beam you're using). One student should hold the globe, and one will hold the flashlight. The globe is the earth, and the flashlight represents the sun. The sun remains stationary, shining on the earth. Have the student holding the globe position it with the equator directly across from the straight-on or direct light of the flashlight.

With the class observing, tell the class it is winter and ask the student holding the globe to slowly begin to tilt Minnesota back and away from the direct sunlight. Ask the students in the class to observe the area covered by the sun's rays on the surface of the earth. What has changed? What happens to the sunlight over Minnesota? The sun's rays that reach Minnesota spread across the surface of the earth.

In the summer, the earth's equator tilts back towards the sun again. Ask the students to watch the area on the globe lit by the sun (flashlight). What happens to the area of sunlight on the earth's surface when the sun is directly over Minnesota? The sun's rays are more condensed, or direct.

Ask students, what season it is when the sun is directly overhead. (Summer.) Why? (The sun's rays are closer together and more concentrated, so it's warmer.)

Without changing the position of the globe, look at South America. What does the light look like there? The sun's rays are less direct (less concentrated and spread), so while Minnesota has warm summer temperatures, South America experiences its winter season.

In its elliptical orbit around the sun, the earth is actually closer to the sun during Minnesota's winter than it is in the summertime.

3 Students may wish to examine Minnesota's other temperature extreme—heat! Try the experiment a second time, placing the mini-ponds on a heating pad (set to a low setting) to simulate a really hot summer. Consider how evaporation and rainfall might affect the system.

4 Ask students to bring in sediment samples collected from different streams and ponds in winter. Put the samples in identical containers of dechlorinated water and place them in the same place in the room, where exposure to light and temperature will be identical for all of the mini-ponds. Have students record observations over four weeks, then compare and contrast the results in the various mini-ponds. Explore why different sediment collection sites might produce different results with different emerging organisms in the mini-ponds—even when all other variables are identical.

5 The class may wish to keep a phenology calendar to document the "firsts" of spring in a local aquatic habitat or in the schoolyard. They can also record the date that the ice goes out on a local pond or lake. If you have your students keep this phenology calendar from year to year, subsequent classes can compare the "firsts" of spring from year to year.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species.
Clean all recreational equipment.

Remember to dispose of these sediments in the trash. Do not transfer materials from one body of water to another.

For the Small Fry

K-2 Option

When working with younger children, you may find it easier to simplify the project by omitting the **From Frozen to Fascinating Data Sheets**. Observations can be made and recorded as a class. Do the whole project as a class, perhaps using an aquarium for class demonstration. Alter the concepts covered in the activity to include the following: Lakes have muck and sediment at the bottom. Small animals live in the sediment. Some of those animals sleep (become dormant) all winter and wake up (emerge) in the springtime when it gets warm and the days become longer. Do a roleplaying activity with students acting out what happens to the organisms as the conditions change and seasons progress and winter is followed by spring.

INSTRUCTOR COPY

Guide to What to Expect in the Mini-ponds

The organisms that will emerge from the frozen muck in the students' gallon jars will vary depending on the source of the sediment. You may want to collect sediment samples from different types of water bodies and compare the results.

Planktonic organisms occupy virtually every type of freshwater habitat, but sediments collected from wetland areas or ponds may produce a greater number and variety of organisms than those from large open lakes or the bottoms of fast-moving rivers. A wetland may have more vegetation, which provides cover and habitat for zooplankton and other tiny organisms. In a large lake, there may be more fish and other predators preying upon zooplankton and invertebrates. Water bodies with high nutrient levels resulting from agricultural and stormwater runoff containing nutrients (such as phosphates and nitrates) might produce more phytoplankton growth. Plants, algae, and phytoplankton are also abundant in areas receiving more sunlight for photosynthesis, which allows them to thrive as they convert the light energy to food energy.

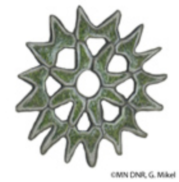
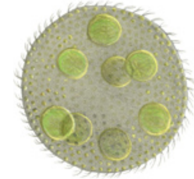
Mini-ponds placed in areas with more light, such as under a florescent grow light or windowsill, will demonstrate greater growth of plants and algae because light gives them an advantage in photosynthesis.

Mini-ponds placed in areas with warmer temperatures, such as under a grow light or next to a heating vent, will demonstrate increased growth and reproduction of both phytoplankton and zooplankton. Higher temperatures increase the metabolic rates of many of these organisms.

Microscopes allow students to observe tiny organisms that they couldn't otherwise detect. Prompt the students to look for the "very tiny life forms" that will emerge from the bottom sediment. Provide them with hand lenses or microscopes during the experiment. Have students use plankton field guides to identify the organisms they observe. Zooplankton are typically larger than phytoplankton.

INSTRUCTOR COPY

Guide to What to Expect in the Mini-ponds

Common Aquatic Organisms That Could Emerge in the Mini-ponds			
Green Algae Pediastrum Spirogyra	Plant (Phytoplankton)	Green algae are the most common algae in ponds and lakes. They're a major component of the base of the aquatic food pyramid. They can be single-celled (Pediastrum) or filamentous (Spirogyra).	 
Blue-Green Algae Anabaena	Bacteria	Blue-green algae are the "slimy stuff." Blue-green algal blooms often resemble pea soup or paint-like scum on beaches and shorelines. Blue-green algae aren't plants—they're actually bacteria that can photosynthesize their own food. They appear bluish-green under the microscope.	
Diatoms Cyclotella	Plant (Phytoplankton)	Diatoms are photosynthetic unicellular organisms. Found in almost all aquatic environments, they're an important part of the base of the aquatic food pyramid. Diatoms often have a crystalline structure and reflect light with a prism-like effect—their cell walls are made of silica, a material used to make glass.	
Mastigophora Euglena Volvox	Plant (Phytoplankton)	These protozoans (single-cell microscopic organisms) move with whip-like extensions (flagella) that beat or spin in the water. Some protozoans (Volvox) band together in colonies and beat their flagella in unison to move the colony through the water. Many have chloroplasts (green, disk-like structures), where photosynthesis takes place.	  *continued*

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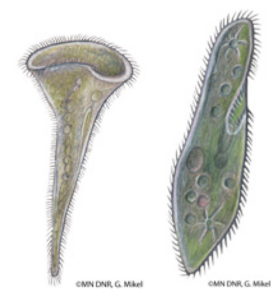
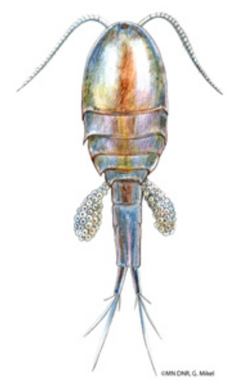
Guide to What to Expect in the Mini-ponds (continued)

Common Aquatic Organisms That Could Emerge in the Mini-ponds			
Ciliophora Stentor Paramecium	Single-celled animals (Zooplankton)	These protozoans (single-cell microscopic organisms) are called ciliates (si-le-its) and have hundreds of tiny cilia (hairs) that beat in unison to propel them through the water. In addition to locomotion, cilia sweep food into their gullets (throats).	
Sarcodina Amoeba	Single-celled animals (Zooplankton)	Sarcodina are a blob of protoplasm (a complex of proteins and water) formed into a single cell. They move by flowing their protoplasm forward into a "foot," and slithering the rest of their body into the foot space.	
Copepods Cyclops	Many-celled animals (Zooplankton)	Cyclops are very small crustaceans, approximately two to three millimeters long, with one black or red eye in the middle of the head. They're named after the one-eyed monster of Greek legend. They can be seen without a microscope, and appear as yellowish flecks jerking through the water. The females carry the eggs (see picture) in little side sacs.	
Rotifers Bdelloidea	Many-celled animals (Zooplankton)	Rotifera is derived from the Latin word for wheel-bearer. This name refers to the tufts of cilia around the mouth that, when in motion, resembles a wheel. The cilia are used for locomotion and to create a current that sweeps food into the mouth.	

continued

INSTRUCTOR COPY

Guide to What to Expect in the Mini-ponds (continued)

Common Aquatic Organisms That Could Emerge in the Mini-ponds			
Hydra Pelmatohydra	Many-celled animals (Zooplankton)	Freshwater Hydra are quite common in ponds, lakes, and streams throughout the world. Hydra capture food with stinging tentacles and swallow it whole through a mouth located in the center of the tentacles. Hydra appear as little whitish or yellowish hair-like structures attached to the bottom or sides of the mini-pond.	
Cladocerans Daphnia	Many-celled animals (Zooplankton)	Cladocerans, or "water fleas," are crustaceans related to copepods, crayfish, and shrimp. They have a single compound eye and move by beating their antennae. Cladocerans are slightly heavier than water so, without active movement, they settle to the bottom. They feed on algae, protozoa, bacteria, and decaying organic material. Most are filter-feeders that consume phytoplankton. They can be seen with the unaided eye, and look like small dots swimming smoothly through the water.	
Ostracoda Cypridopsis	Many-celled animals (Zooplankton)	Ostracods, also known as seed shrimp, move and feed by extending their legs from between the two halves of their shell and moving them very rapidly. Usually, the legs move too fast to see. Ostracods can be seen without out a microscope, and are typically found close to the bottom of the mini-pond.	

STUDENT COPY

Name(s) ______________________________ Date ______________

Predictions and Summary Sheet

Where was your sediment collected? ______________________________

____

Predictions
What you think (predict) will happen in your mini-pond over the next four weeks?

____

____

____

____

____

Testing Your Predictions
Where in the classroom did you place your mini-pond? ______________________________

____

Describe the environmental conditions at the location where you placed your mini-pond.

____

____

____

Recording Observations
Observe and record what you see in the mini-pond over the next four weeks—use the **From Frozen to Fascinating Data Sheets**. Then complete the Summary and Conclusion below.

Summary
Review the observations you recorded on the **From Frozen to Fascinating Data Sheets.** What happened in your mini-pond over the four weeks?

____

____

____

____

STUDENT COPY

Name(s) ______________________________ Date ______________

Predictions and Summary Sheet (continued)

Conclusions

Did your results support your predictions? ______________________________

Why or why not? ______________________________

____

____

____

Was your location warmer or cooler than other locations in the room? ______________

Did your location get more light or less light than other locations in the room? ______________

Do you think the conditions in the location that you chose for your mini-pond influenced your results? ______________________________

If you did the experiment again, which location in the classroom would you choose for your mini-pond? ______________________________

Why? ______________________________

____

____

Why didn't you see any organisms in your winter mini-pond at the beginning of the experiment? ______________________________

____

____

____

How do you think these organisms survive through the winter in the lake or pond where they live? ______________________________

____

Do you have any other questions about what you observed in your mini-pond?

____

____

____

STUDENT COPY

Name(s) ______________________________ Date ______________

From Frozen to Fascinating Data Sheet

Location of mini-pond in classroom ______________________________

____

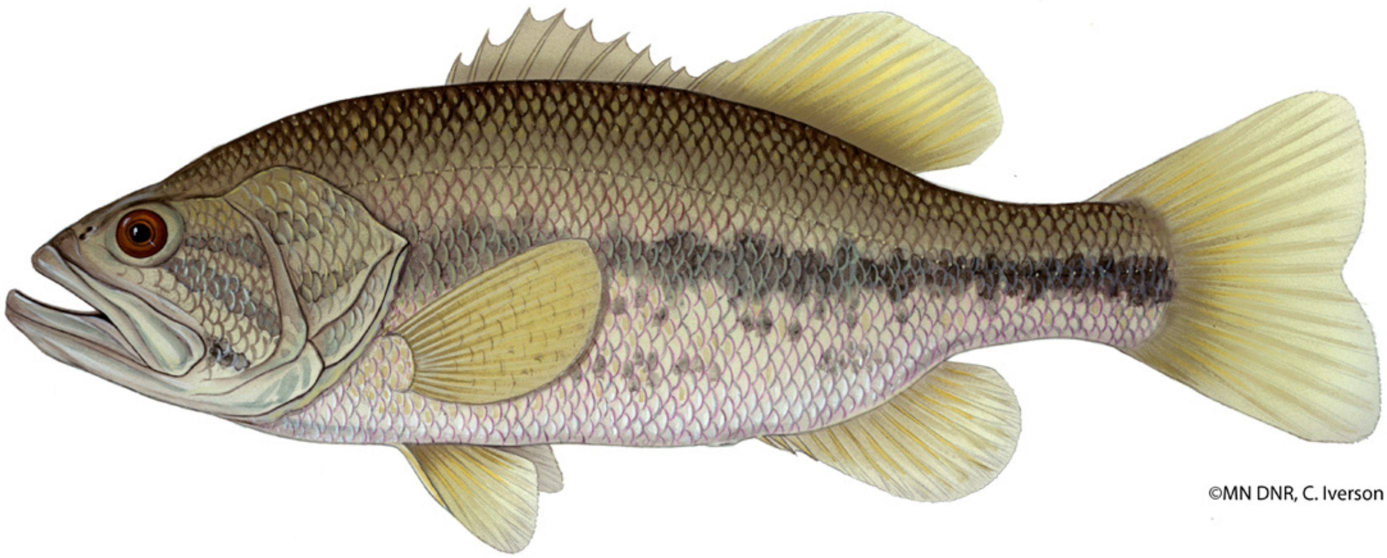
Week # __________ Date __________ Time __________ Do you see organisms? __________

Do you see more or fewer organisms than you saw during your last observation time? ________

Water Temperature __________ Light Source (Circle one.)

Sun Artificial Light Little Light No Light

Record Your Observations	Draw and Label Any Organisms You See in the Mini-pond
1.	
2.	
3.	
4.	



Minnesota Fish

Minnesota's great diversity of fish species corresponds to the diversity of its aquatic habitats.

What Will the Students Learn?

In 2006, Minnesota was home to 160 fish species. When a variety of living organisms exist in a given area, the area exhibits biodiversity. Students will learn to classify and identify common Minnesota fish species, study and make models of adaptations that enable fish to survive and flourish in Minnesota waters, compare similarities and differences between fish and people, and experience how cultural traditions reflect and influence people's attitudes and ideas about fish.

Chapter Concepts

Touching Fish!

Lesson 2:1—Fish Sense

Children have a natural curiosity about the world and its inhabitants. They're eager to dive in and discover the wonders connected with the many fish species inhabiting Minnesota's lakes and streams. Students learn gyotaku, the Japanese art of fish printing, to look at fish more closely, experience them through touch, and study numerous traits and features. They compare fish senses with their own five senses, and learn how fish use their senses to survive in a watery environment. Knowledge of fish characteristics and behavior also provides for richer angling experiences.

Minnesota Fish

Lesson 2:3—Fish Families
Lesson 2:4—Using a Key for Fish ID
Lesson 2:5—Diving Into Diversity
Lesson 2:6—Adapted for Habitat

Minnesota is home to a diversity of fish species. Why should we learn to identify them? What makes a rainbow trout different from a flathead catfish? Why is a bluegill shaped like a frying pan? How do vertical stripes help a yellow perch survive? The answers to these questions are tied to the relationship between these fishes' key traits and their habitats. Each species has adaptations (body features as well as habits or behavior) suited to its habitat.

Knowledge of fish characteristics helps anglers and observers know where, how, and when to fish for a given species. Correct fish identification also helps anglers follow fishing regulations.

> "Without habitat, there is no wildlife. It's that simple."
> –Wildlife Habitat Canada

Parts, Form, and Function

Lesson 2:1—Fish Sense
Lesson 2:2—Fins: Form and Function
Lesson 2:6—Adapted for Habitat

Form follows function. The shape and position of a body part relates to the function it performs to help the fish survive in its aquatic environment. Students make observations, study parts of fish, make and test predictions, make models, analyze similarities and differences, and learn about some survival strategies that enable various species to survive. With opportunities to become creative and apply what they've learned, students design fish suited to lives as a predator or prey species, or fish suited for lives in a hypothetical aquatic habitat of the future.

Diversity, Classification, and Identification of Minnesota Fish

Lesson 2:3—Fish Families
Lesson 2:4—Using a Key for Fish ID
Lesson 2:5—Diving Into Diversity

Fish identification becomes much easier when you're familiar with physical characteristics, which are the "keys" that unlock fish identities. In most cases, fish can be identified and organized into groups by comparing and contrasting external features. Scientists classify fish into groups to more efficiently study them and to share data. Identification keys, illustrations, descriptions, and classification systems based on physical characteristics are often used to identify plants and animals. When students accomplish the skill of classifying species, they'll probably be able to identify any fish they encounter.

"The value of biodiversity is more than the sum of its parts."
–Bryan Norton

Fish and Language

Lesson 2:7—Fish Tales

Language is one element that illustrates interconnections in natural and social systems. Stories, both spoken and written, have been used in every culture throughout history to communicate and transmit ideas, emotions, traditions, and information. Minnesota communities have rich histories and cultural diversity. Minnesota native cultures, such as Dakota and Ojibwe, illustrate that storytelling is a vital part of a culture—oral traditions convey knowledge, emotion, and attitudes concerning the natural world. Early European immigrants told tall tales to find relief from the difficulties of their daily lives. Stories are entertaining, too. By comparing and analyzing several fish tales, students will identify perceptions, and philosophies regarding fish. Using what they've learned about tall tales, they'll reveal their own feelings and ideas by writing a fish tale.

Winter Adaptations of Fish

Lesson 2:8—Fish in Winter

Minnesota's extreme climate produces natural limiting factors that challenge fish survival. How do fish survive Minnesota winters? Cold temperatures, short days, deep snow, and food shortages don't pose the greatest challenge—the possibility of low levels of oxygen in the water does. In this role-playing activity, students become fish in winter. They discover how ice and snow cover affect oxygen levels in the water, and what this means for Minnesota fish as winter progresses. They also explore some adaptations that help fish survive in winter.

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Test Your Knowledge!

Lesson 2:9—Fish Bowl

Students review fish facts, write questions, and work in teams to play a knowledge bowl game that demonstrates their understanding of Minnesota fish. Fish Bowl questions can also be modified to assess student knowledge of material from other chapters.

The Human Connection

All Lessons

Minnesota's more than 10,000 lakes and many thousands of miles of streams and rivers provide diverse aquatic habitats for equally diverse fish species. Minnesota's rich human history has also resulted in a colorful tapestry of diverse human cultures.

Both people and fish depend on biodiversity for survival. Biodiversity enables people and all other species to continually adapt to and survive changing environmental conditions, but everyday human activities cause degradation and loss of productive habitat at ever-increasing rates. Loss of habitat is the single largest threat to biodiversity, both on land and in the water.

With increased awareness, understanding, and appreciation for the diversity of species in our environment, and an understanding of how attitudes and ideas about the natural world are created and reinforced, students begin to develop skills enabling them to consider differing points of view and perspectives, make informed choices and decisions, and analyze environmental issues. To become our future's active citizens, they'll need these skills to solve problems, strengthen neighborhoods and communities, ensure that healthy habitats are available to protect biodiversity, and enjoy Minnesota's natural resources in a sustainable way.

Fish Sense

Fish depend on their senses for survival. Whether they eat a meal or become a meal depends on their ability to see, hear, smell, taste, and detect vibrations.

Table of Contents

Chapter 2 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish Sense

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Social Studies

Grades K—3
III. World History
A. Family Life Today and In the Past:
Benchmark 3—Students will compare technologies from earlier times and today, and identify the impact of invention on historical change. (Lesson provides a specific example of technological change concerning recording fish catches.)

Science

Grade 3
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food.
Grade 4
G. Human Organism:
Benchmark 1—The student will understand that humans have structures that serve functions in growth, survival and reproduction.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 2 • Lesson 1

Fish Sense

Grade Level: 3-5
Activity Duration: 45 minutes
Group Size: any
Subject Areas: Expressive Arts, Language Arts, Social Studies, Science
Academic Skills: observing, comparison, painting
Setting: indoor or outdoor gathering area with tables
Vocabulary: barbel, gyotaku, lateral line, nostrils, senses, school
Internet Search Words: AmeriCorps Water Stewards Project, fish prints, fish senses, gyotaku; on the Minnesota DNR website: fish sense

Summary

Students touch and hold a fish (or a rubber replica of a fish) to explore the six senses of fish and gain a better understanding of fish behavior. They compare and contrast their own senses with those of fish. When students have become comfortable with handling fish, they apply paint to a fish and print its image on a sheet of paper using the ancient Japanese art form of gyotaku (gee-oh-tah-koo).

Student Objectives

The students will:
1. Locate sense organs on a fish specimen and name the six senses of fish.
2. Describe the functions of the six fish senses.
3. Compare and contrast human senses with fish senses.
4. Create a fish print.
5. Describe how anglers can reduce the chances that fish will detect their presence.

Materials

- Whole fish with scales (sunfish, perch, or other fish), one per student, if possible (Catch the fish or purchase fresh or frozen fish from a grocery store. Or use rubber fish replicas available from arts and crafts and nature supply catalogs.)
- **Fish Senses Sheets** (you may post or project these if you wish)
- Paper plates, one per fish
- Paintbrushes, one per student (or a few paintbrushes for each paint color)

continued

Instructor's Background Information

Six Senses Versus Five

Senses are mechanisms that help organisms perceive their surroundings and survive in their environments. People experience the world around them using five senses. Fish have six senses. Human senses share some similarities with fish senses, but because people and fish live in different environments—land versus water—there are differences, too. In addition to taste, smell, sight, hearing, and touch, fish have a unique sensory structure, known as a lateral line, which enables them to sense vibrations in the water. The lateral line is referred to as the sixth sense of fish, and is an extension of their sense of hearing.

Good Taste

Fish have a sense of taste and use it, in conjunction with their other senses, to find food. Some fish, such as catfish and sturgeon, rely primarily on their sense of taste to find food.

Like people, fish have tongues containing thousands of taste buds. Some fish, such as walleye, also have taste buds on their lips and faces. A walleye can taste a fishing lure without ever opening its mouth. Sometimes walleye anglers say they feel a "bump," without getting a bite. That bump may have been a finicky fish tasting the lure with its face rather than its tongue.

Imagine tasting a chocolate sundae with your whole body! If you were a catfish, you could do just that—catfish and bullheads have taste buds on their bodies from head to tail. They also have whiskers, called **barbels**. These barbels look like stingers, but they're not. They're actually soft, whiskerlike structures above and below the mouth. Barbels are sensory structures containing many nerve endings, some of which are similar to the taste buds of humans. Catfish, carp, and other "whiskered" fish drag their barbels along the lake or river bottom to find food. When the barbels touch a tasty object—perhaps a dough ball, chicken liver, or stinkbait on the end of your line—the fish stops and takes a bite.

Materials (continued)

- Washable tempera paint or any opaque washable paint, several colors
- Containers for paint and water
- Large bucket of water for washing paint from fish, or a supply of wet wipes if water isn't available (but the water bucket is better)
- Paper or newsprint for fish prints
- Newspapers, to protect tables
- Paper towels and rags
- **Fish Anatomy Sheet**
- Small aquarium or fishbowl with live goldfish, one for each group of four or five students (optional)
- Fish food (optional)

T-shirt printing materials (optional)

- T-shirts
- Fabric paint
- Paper to place inside shirts during printing
- Clothesline for hanging and drying printed t-shirts
- Clothespins

If you plan to catch or collect your own fish for this project, you'll need a fishing license or a Minnesota DNR collector's permit to possess fish. Check the Minnesota fishing regulations booklet for current limits. Contact the Minnesota DNR for more information.

Nosy Fish

Fish use their noses for smelling rather than breathing. With its **nostrils**, usually two openings on either side of the snout, a fish can smell food from great distances. The fish swims to the source of the smell and uses its taste buds to find out if it's edible.

Fish also use taste and smell for navigation. After swimming hundreds of miles to and from the sea, salmon use their senses of taste and smell to find the stream where they were born. They then swim up this stream to their spawning area to lay and fertilize eggs.

Fish use their noses to sense danger, too. In fact, many fish can smell people. They will swim away from any bait that smells like hand lotion, perfume, deodorant, tobacco, gasoline, or insect repellent.

Fish Eyes

Fish don't see as clearly as people do. Even in clear water, most freshwater fish usually can see no further than fifteen feet. Like people, fish can see brightness and color. Some fish, such as shallow-water fish, can detect most colors seen by humans, although many fish can't see a full range of colors. For example, walleyes see primarily orange and green.

Unlike humans, fish lack eyelids. Their pupils are fixed—they remain the same size regardless of the amount of light. To protect their eyes from bright sunlight, fish usually spend sunny days in deep water or in the shade of lily pads, stumps, or trees. To find and catch fish during the middle of the day, anglers must "cast for cover," where fish will be spending time in the shade.

A fish can see in every direction except directly behind and below it. This is because its eyes are on the sides of its head, and each eye moves independently. This makes it hard to sneak up on a fish.

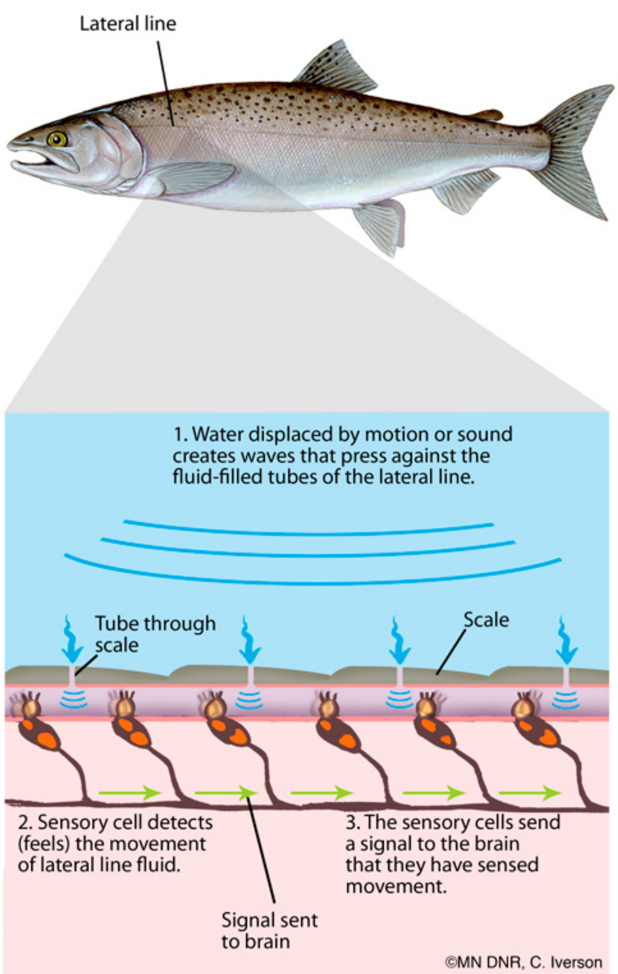
Hidden Ears

Have you ever *felt* the rumble of thunder? You were sensing sound vibrations. Fish hear sound vibrations moving through the water. Although fish have ears, they don't need ear openings on the outside of their bodies because sound travels so well through water. Fish ears are located under the skin, in the skull near the eyes. The structure of the inner ear is the same as a human's, and contains receptors for balance and hearing.

Fish hearing is so sensitive that they can hear a worm wiggling at the bottom of a lake. Even the faintest sound can spook fish and discourage the biting of bait. That's why it helps to remain quiet while fishing. Talking is fine, but sounds transmitted directly to water, such as the banging of feet on the bottom of a boat or on the dock, can scare fish away.

Vibration Detectors

Fish have an additional sense related to hearing, called the **lateral line**. This structure is a network of ultra-sensitive nerve endings that run along its sides from the gills to the tail.

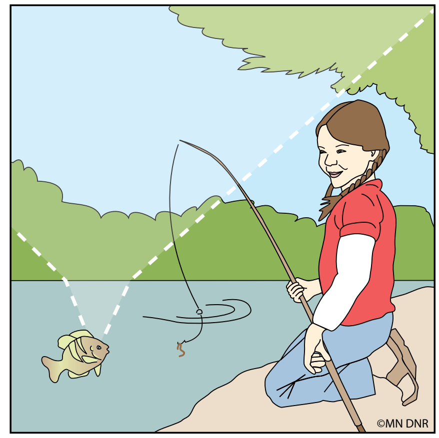


How a lateral line works.

A fish's lateral line consists of tiny pores containing hairs connected to many nerve endings beneath the skin. The sensitive hairs inside each pore detect the location and direction of vibrations in the water, allowing the fish sense the movement of other fish and aquatic organisms around them in dark or murky water, or at a distance before they might be able to see other organisms.

Fish detect bait by sound and through water movement or vibrations in the water. They hear and feel their way to fishing lures with their ears and lateral lines. When they see the lure, they can tell if it looks like something they usually eat. A fish might then smell or taste the lure before eating it.

A group of the same type of fish swimming together is called a **school**. Have you ever wondered how fish can swim so close together in a school without bumping into each other? Their lateral lines help them



Light and fish vision.

Light bends at an angle when it passes from air to water. The greater this angle, the more the light bends. A fish sees objects straight overhead in their true locations, but the images of objects near the horizon are shifted. Light from an object very low to the horizon doesn't penetrate the water at all. For this reason, it's possible to stay outside of a fish's field of vision—and avoid being seen—by crouching or sitting at the water's edge.

sense their proximity to one another by detecting vibrations in the water.

The lateral line helps a fish find a meal by sensing when smaller fish are swimming nearby. The lateral line also helps a fish avoid *becoming* a meal by sensing the presence of lurking predators.

Touchy, Touchy
Like people, fish have many sensory structures in the skin that detect touch. Their sense of touch relays information about pressure and temperature. Fish back up or swim away from the slightest contact. Because they can feel touch, it's important to practice correct methods of catch-and-release to minimize stress to fish.

Do Fish Feel Pain?
"Pain and fear in humans results from the stimulation of several regions of the cerebral cortex. The tiny cerebral cortex of fishes' brains lacks these regions. For this reason, fish do not have the same emotional response to pain. Fish may not experience pain the way humans do, but they do suffer from stress. When handling fishes, fish biologists follow stringent guidelines to reduce stress in fishes."

—Professor James D. Rose, Department of Zoology and Physiology, University of Wyoming

This is an example of gyotaku, a Japanese fish printing technique.

Japanese fisherman developed the art of **gyotaku** (gee-oh-tah-koo; *gyo*, meaning fish, and *taku*, meaning rubbing), or fish printing, in the mid-nineteenth century. Lacking the technology of cameras to help them record their catches, they painted them with a watery black ink and pressed rice paper or cloth onto the painted fish. When the paper was lifted, a detailed image of the fish was revealed. These prints were used for studying biology as well. Fisherman recorded information about the fish, such as the types and sizes of fish, and where and when they were caught. Fish prints also reveal the intricate detail and textures of features such as scales and fins.

Over time, gyotaku has become an art form that helps people understand and appreciate the beauty and variety of aquatic animals.

Procedure

Preparation

1 To prepare the fish, collect them prior to the lesson and keep them cold (or thaw frozen fish). The fish should be wiped clean of water and slime prior to use. Place the fish in bags of water before you freeze them to prevent freezer burn. Another option is to use a rubber fish replica for printing. Fish replicas molded from castings of fish are available at arts and crafts, science, and nature supply catalogs, and can be used instead of real fish in the fish printing activity. Students will have more difficulty locating the sense organs on replicas, so if you plan to use replicas, try to have at least one real fish available for showing the sense organs.

2 Prepare the paints—pre-mixed tempera paints in four to six colors work well.

3 To keep work surfaces clean, cover them with old newspapers or butcher paper. Place paper towels or rags at each work area for wiping excess water from the fish.

4 Place paper for the prints on the worktables.

5 Provide water (or wet wipes) for students to wash the paint from their fish after printing. Place the fish in a large bucket, tub, or a sink filled with water after they've been used for printing. If you plan to reuse the fish, place it in a cooler of ice to keep it fresh during the lesson. Wash and refreeze the fish as soon as possible after the activity.

Frozen fish can be reused approximately five times if immediately refrozen after each use.

Do not eat fish that have been used for fish printing.

Activity

Warm-up

1 If you have several small fish aquariums or bowls with small fish such as goldfish or minnows (one aquarium for each group of four or five students), start the lesson by dividing the students into groups. If small aquariums and fish aren't available, proceed to Step 2. Have the student groups observe the fish in their aquariums or fish bowls. Have the groups feed their fish by dropping in a small amount of fish food. Ask students to observe the fish. Ask students how the fish knew that food was available. How did the fish find the food? List responses on the whiteboard, interactive whiteboard, or overhead. The students will suggest that the fish *saw* the food, *smelled* the food, *heard* the food drop in the water, and so forth. On the whiteboard or overhead, ask students to list the parts of a fish that enable it to perform the functions they noted. (Eyes, nose or nostrils, ears, mouth with tongue or taste buds.) Have students look closely at the fish in the aquariums or fish bowls. Can they find eyes, ears, noses, taste buds, and other features? Some are more easily seen than others—some features are inside the fish and some are extremely small.

Some people are allergic to the slime on fish. Ask your students if anyone has this allergy prior to distributing and working with fish.

2 Read this paragraph to the class:

> There it is. A big sunfish. Right at the end of the dock. An easy catch! You run and get your rod. You cast a big, juicy worm right in front of its nose. The sunny swims closer. It stares at the wiggling worm. It appears ready to bite. But it doesn't—instead, it slowly swims away. What happened? Why didn't the fish bite?

- Ask the students if they've ever gone fishing without catching any fish. Discuss what may be happening when fish don't bite. Did it see you? Maybe. It might even have felt, heard, and smelled you. Fish can smell, taste, feel, hear, and see—just as people do.
- Review with the students our five senses of sight, touch, smell, taste, and hearing. Have them identify where their major sense organs are located. Ask the students how many senses they think fish have.

Lesson

1 Place each fish on a paper plate and distribute one to each student. Initially, some students may be reluctant to handle the fish. Encourage them to touch the fish, and work slowly with them until they begin to feel comfortable. Remind students that the fish are real and that they should be handled gently. Explain that you will reuse the fish with others later.

2 Discuss fish senses. Compare and contrast fish senses with human senses. Start with the sense the students notice first. Using a prepared fish specimen or the **Fish Senses Sheets**, point out the major organs associated with the sense, and have students follow along by finding the structures on their fish.

Taste

- Locate the tongue in the fish's mouth.
- Point out the similarities and differences between fish and human senses of taste. (Similar: fish have tongues with taste buds. Different: fish have taste buds on other parts of their bodies, too.)
- Ask the students, how taste buds help a fish survive in its environment.

Smell

- Locate the nostrils: two tiny openings on either side of the snout.
- Point out the similarities and differences between fish and human senses of smell. (Similar: fish have openings used for smelling on each side of their snouts. Different: fish use their noses only for smelling, not for breathing.
- Ask students how they think nostrils help a fish survive in its environment. (Examples include: finding food, sensing contaminants, and locating spawning areas.)

Sight

- Locate the fish's eyes.
- Point out the similarities and differences between fish and human senses of sight. (Similar: most fish have two eyes, which they use to see objects. Fish see colors and their eyes have pupils. Different: Fish eyes operate independently. Fish don't have eyelids, and their pupils are fixed. Most fish can see only short distances.)
- Ask students how they think a fish's eyes help it survive in its environment.

Hearing

- Fish ears aren't visible from the outside of its body—they're located underneath the skin near the eyes.
- Point out the similarities and differences between fish and human hearing. (Similar: fish have the same general inner ear structure as people, and they use their ears for balance and to hear vibrations. Different: fish ears have no external openings.)
- Ask the students how hearing helps fish survive in its environment.

Lateral Line

- Locate the lateral line along the sides of the body from the gill flaps to the tail. It resembles a line of sewing stitches.
- Point out that the lateral line is something that humans don't have, and that the nerve endings in the lateral line help fish feel vibrations.
- Ask students how the lateral line helps a fish survive in its environment.

Touch

- Point out the similarities between fish and human senses of touch. (Similar: both have a sense of touch. A sense of touch helps a fish avoid bumping into things, and to react quickly if they do.)
- Ask students how the sense of touch helps a fish survive in its environment.

3 Review the history of gyotaku and explain the process of fish printing.

4 Direct the students to take their fish to the tables covered with newspapers. Set out the containers of paint, clean water, paintbrushes, paper, and paper towels.

5 Have students gently pat their fish dry with a paper towel. The students might wish to spread out the tail fins and other fins of the fish. Then, using a paintbrush, they should apply a *thin layer* of paint over the fish. *Using less paint produces a better print that will reveal more detail.* Encourage the students to identify and explain the functions of the fish's parts as they paint their fish. You may suggest painting these parts (the eyes, fins, gills, tails, lateral line, and mouths) different colors.

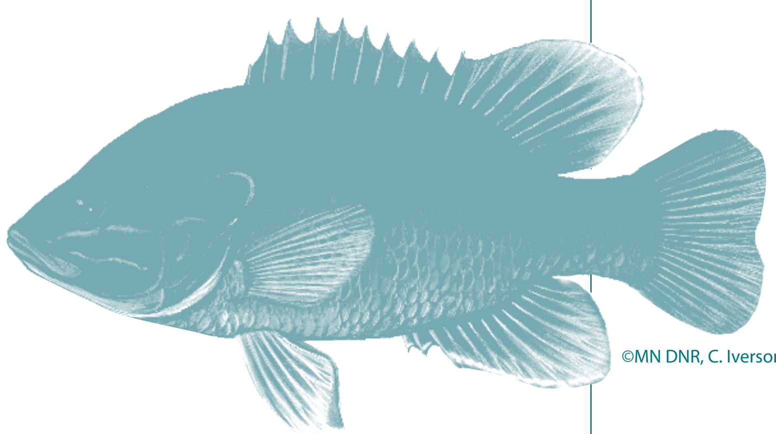
6 When students have finished painting their fish, they should gently place a sheet of paper on top of the fish. They should blot or gently pat the paper—do not smooth, push, or rub the paper, or the print will smear. Carefully pat all parts of the fish from the tip of the snout to the tips of each fin without moving the paper. Slowly lift the paper and view the work of art! A second print, done without applying more paint, sometimes shows more detail than the first. Again, less paint works better! Help students notice the details, like the scales and the rays of the fins. What other parts of the fish can they identify from their prints? To do additional prints, wash the fish in the bucket of water and repeat the above steps.
7 When the student is satisfied with a print, have them add the basic habitat needs of that fish to the background. (Food, shelter, space, and water containing dissolved oxygen.)
8 Ask the students to write their names on their prints. The prints should be moved to a safe place for drying. Using clothespins to clip the prints on a clothesline works well.

Wrap-up

1 Review the six fish senses.
2 Ask students to name some parts of the fish and describe the function of each part.
3 Ask students to think of other ways, besides senses, in which fish and people are similar or different. For example, both eat food, but different kinds of food; and both need shelter, but different kinds of shelter.
4. Discuss with students the ways to make sure that fish don't "sense" them when they go fishing. Examples include:
   - Stay low when fishing in shallow, clear water. If you stand tall in the boat or at the water's edge, the fish will probably see you and become wary and less likely to bite.
   - Try lures of various colors. Some colors work better than others, depending on water clarity, depth, time of day, and the kind of prey available to the fish in their particular lake or river. Most expert anglers prefer to use dark lures at night because, contrasting against the sky, they show up clearly. (The sky is usually lighter than the surrounding water.)
   - Keep hands clean while handling lures. Bass are especially repelled by DEET, a chemical found in many insect repellents.
   - Match your bobber size to the size of fish you want to catch. With smaller fish, like sunfish, use small, slender bobbers that better indicate slight bites. A sunfish can bite bait, taste it, and spit it out in an instant, and anglers can miss the signal to set the hook. You can miss many light bites if your bobber is too large.
   - Be fairly quiet while fishing to keep from scaring the fish away. Avoid running on the dock, making loud noises in the boat, or unnecessarily disturbing the water.

Assessment Options

1. Have students create two prints. One print can be designated their artistic version. The student should create the second print to demonstrate knowledge of fish senses by labeling the part of the body associated with each sense. Have students include a written description of each sense on the second print.
2. Have the students teach fish senses and fish printing to a younger class. They can decide how they might teach younger students about fish senses, but they should include comparing fish senses to human senses.
3. Students can write a play about how fish use their senses to help them survive in their aquatic environment. Plays should include all six fish senses.
4. Have students create a poster describing what anglers can do to avoid detection by fish and address all six fish senses.
5. Reread the paragraph in Step 2 of the Warm-up. Ask students why the fish didn't bite.
6. Assessment options include the Checklist and Scoring Rubric on the following pages.



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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

23-25 points = A
Excellent. Work is above expectations.

20-22 points = B
Good. Work meets expectations.

16-19 points = C
Work is generally good. Some areas are better developed than others.

12-15 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-11 points = F
Work is unacceptable.

Fish Sense Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
6	______	______	Student can locate all six senses on a fish.
6	______	______	Student can describe each of the fish's six senses.
3	______	______	Student can make a fish print using paints carefully and without assistance.
2	______	______	Student's fish print shows details of fins.
2	______	______	Student's fish print shows details of scales.
3	______	______	Student cleans up afterward.
3	______	______	Student explains how knowing about fish senses can be helpful when you go fishing.
Total Points			
25	______	______	**Score** ______

Fish Sense Scoring Rubric

Fish Sense Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Fish senses	Locates all six senses on a fish.	Locates five senses on a fish.	Locates four senses on a fish.	Locates fewer three or fewer senses on a fish.	Unable to locate senses on a fish.
Fish sense description	Describes each of the six fish senses.	Describes five fish senses.	Describes four fish senses.	Describes three or less of six fish senses.	Unable to describe fish senses.
Fish print	Makes a fish print, carefully using paints without assistance. Print represents a real fish and shows details of fins and scales. Cleans up afterward.	Makes a fish print, using paints with minimal assistance. Print represents a real fish and shows detail of fins and scales. Cleans up afterward.	Makes a fish print using paints, but print doesn't show details such as fins and scales. Must be prompted more than twice to clean up afterward.	Makes a fish print using paints, but needs much assistance. Print doesn't show details of the fish. Cleans up reluctantly.	Doesn't complete fish print or clean up afterward.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Make fish prints on T-shirts with fabric paints. To prevent paint from soaking through to the other side of the shirt, place a layer of paper inside the shirt before printing.
2 Invite an artist to your class to demonstrate how other media can be used to produce fish art.
3 Help your students find elementary student pen pals or chat pals from Japan. Have them ask their pals about fishing in Japan. They can also share information about Minnesota fish and fishing. Ask students to write a report on what they learn about the history of fishing in Japan, the importance of fishing in Japan, or their pen pals' experiences with fish and fishing.
4 Visit a museum to look for other examples of fish in art.
5 Discuss the structure, function, and names of the various fish fins. For additional information on fish fins, see **Lesson 2:2—Fins: Form and Function**, or conduct an Internet search using the keywords "identifying fish fins."
6 Visit the Minnesota DNR website and read the article "Fish Senses," from the *Minnesota Conservation Volunteer* magazine, May-June 1996.
7 Administer a short quiz, or play a game of Fish Jeopardy, including these questions:
   - A fish can't see in this direction.
     (What is directly behind it.)
   - Fish do this with bones (ears) beneath the skin.
     (What is hear.)
   - Catfish barbels (whiskers) have this sense.
     (What is taste.)
   - Salmon find their way back to spawning streams with this sense.
     (What is smell.)
   - This row of tiny holes runs along each side of a fish to sense vibrations.
     (What is the lateral line.)
   - These abilities can help a fish to better survive in its environment.
     (What are senses.)
   - This is a way to record your catch if you don't have a camera!
     (What is gyotaku, or fish printing.)

For the Small Fry

K-2 Option

1 This lesson works very well with K-2 students as long as you keep the activities simple. You may also want to check out a Fishing Trunk from the Minnesota DNR. The trunk contains the book *Fish Faces,* as well as other materials useful for teaching younger students about fish senses.

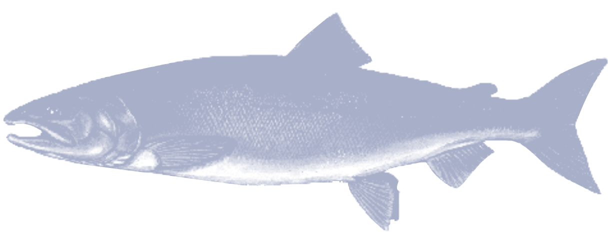
2 Ask students if they they've ever gone fishing. Be sure to allow enough time for students to share their stories. You may wish to read a storybook about fishing or fish in their habitats aloud.

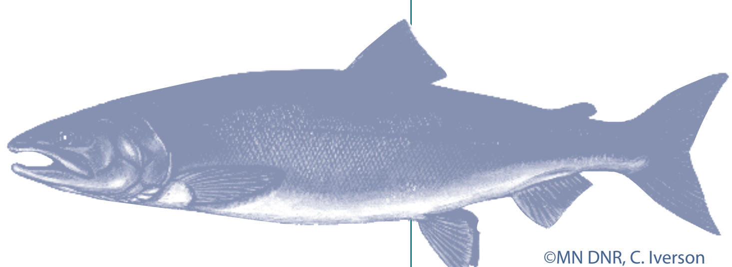
3 Review people's five senses with the students. The book, *My Five Senses,* by Aliki is an excellent introduction. Allow time for the students to experience their senses if this is a first time exposure to the topic.

4 Work in small groups, having students handle and look at real fish to discover their sensory organs. Have students find the sensory organs that are similar to ours. How are the features similar or different from their own eyes, ears, nose, and mouth?

5 To help students understand how a lateral line works, take a vibrating tuning fork and place it on the surface of water in a clear glass or bowl. Observe how the tuning fork vibrates with its sound, and how the vibrating fork makes waves that radiate through the water.

6 Do the gyotaku (fish printing) activity. This affords students the opportunity to touch and closely observe actual fish. Rubber fish replicas molded from castings of fish are available at arts and crafts, science, and nature supply catalogs, and can be substituted for real fish in the fish printing activity.





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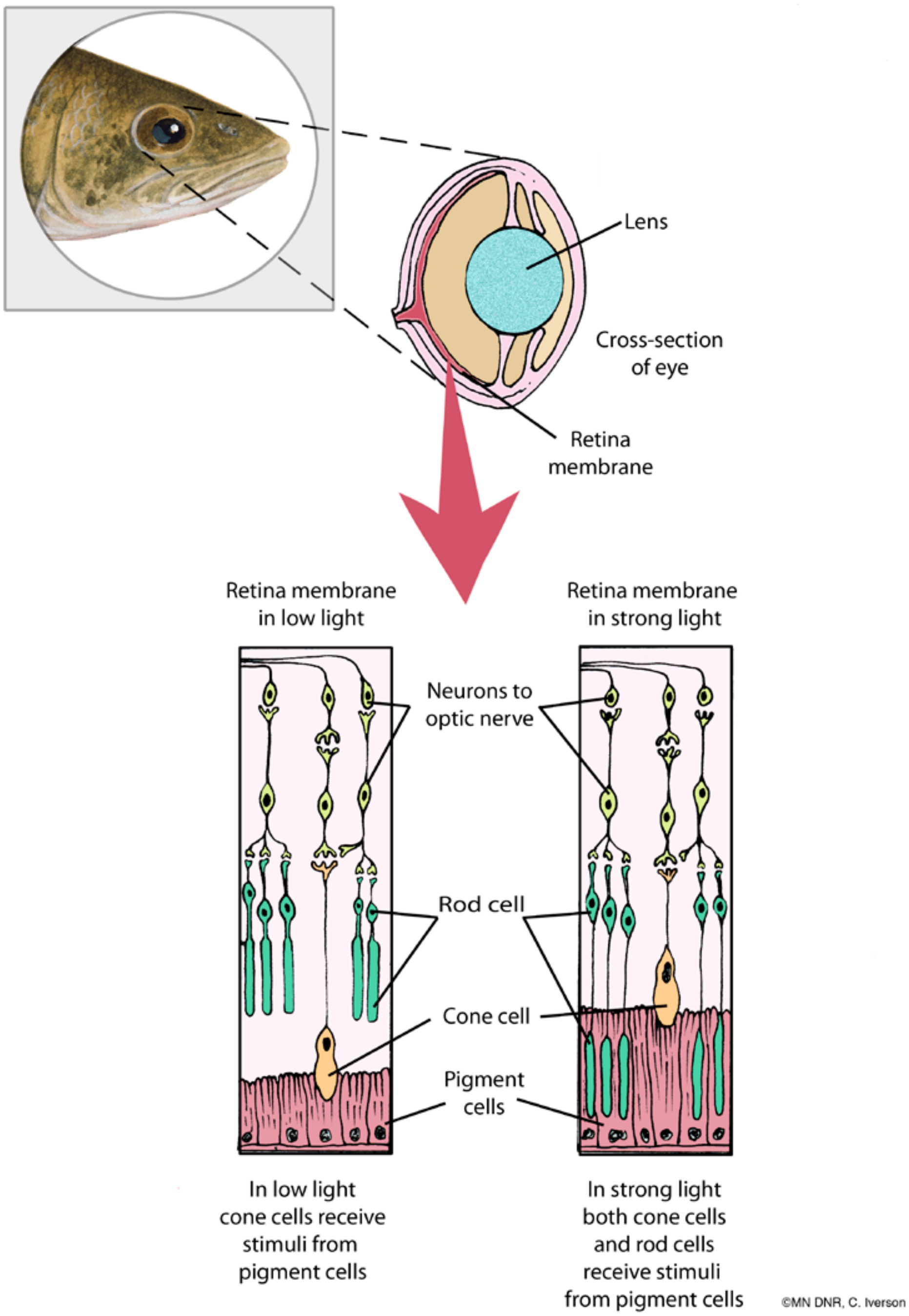
Fish Senses Sheets

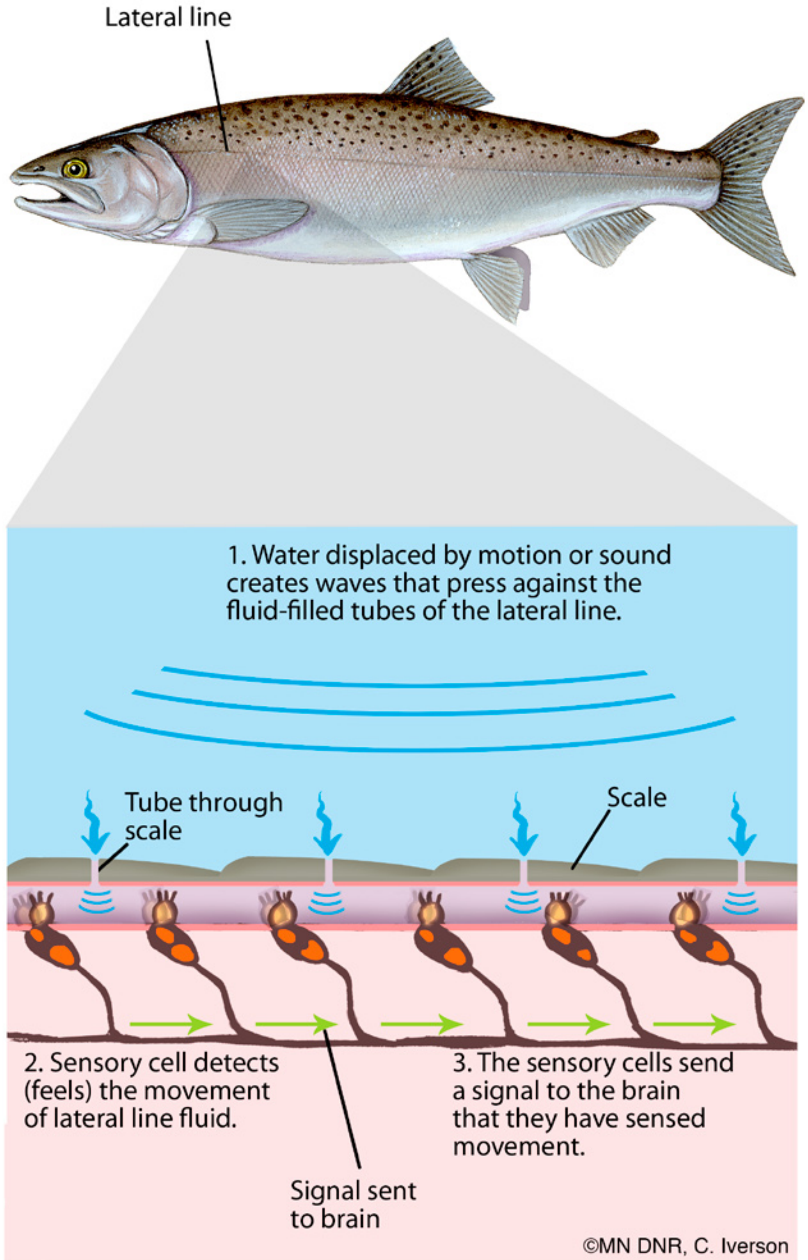
Sight



Fish have fixed pupils and no eyelids. They have excellent close-up vision and poor long-distance vision. Most fish species' eyes are located on the side of the head, allowing them to see in every direction except directly behind their tail fins. Scientists believe that fish can see at least 24 shades of color.

Fish Senses Sheets

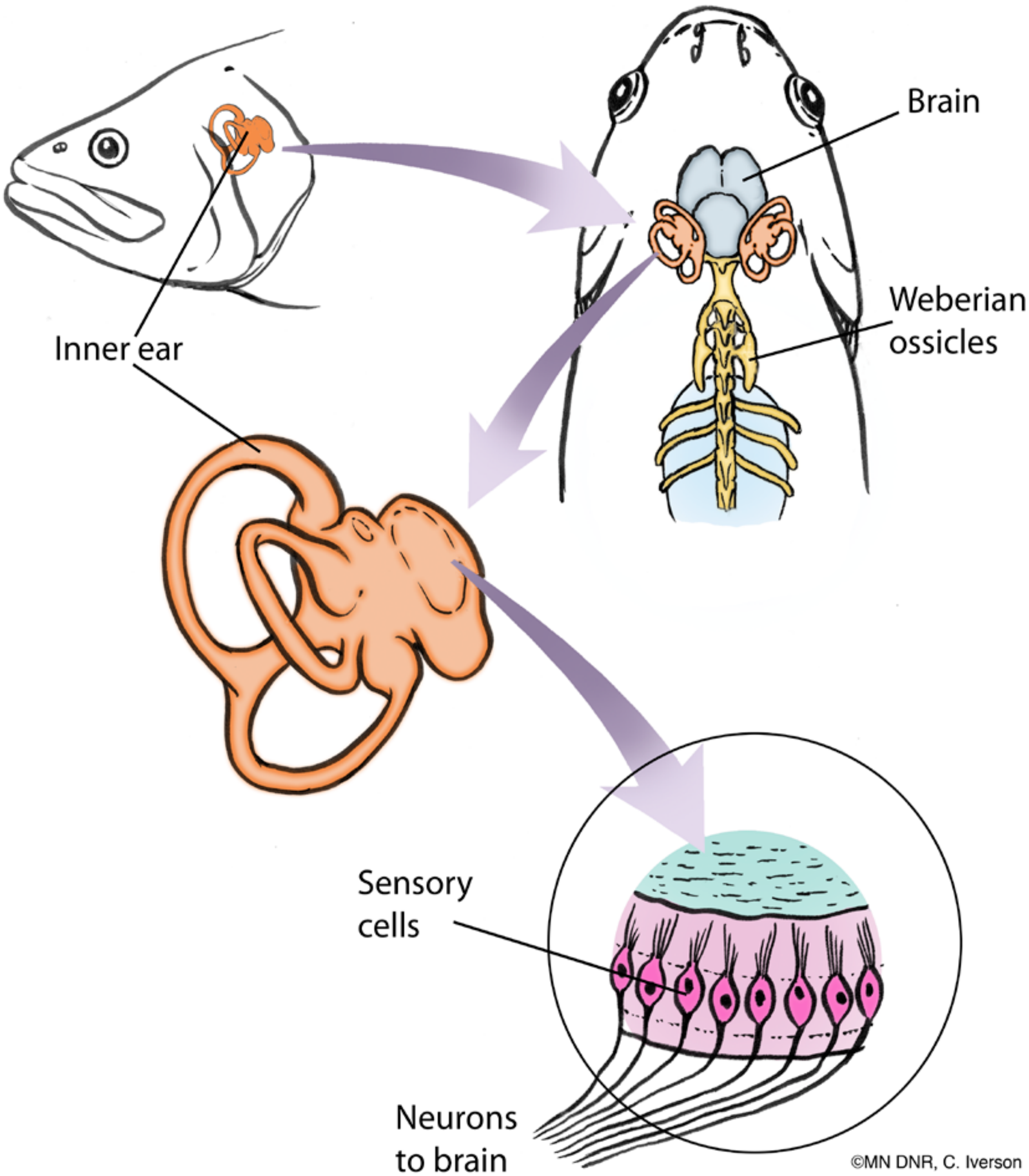
Lateral Line



Fish "feel" vibrations in the water with their lateral lines, a network of ultra-sensitive nerve endings that run along either side of a fish's body from the gills to the tail. No other vertebrate (animal with a backbone) has this sensory organ. The lateral line helps fish swim with precision in tight schools, navigate narrow streams, detect approaching predators, and find food.

Fish Senses Sheets

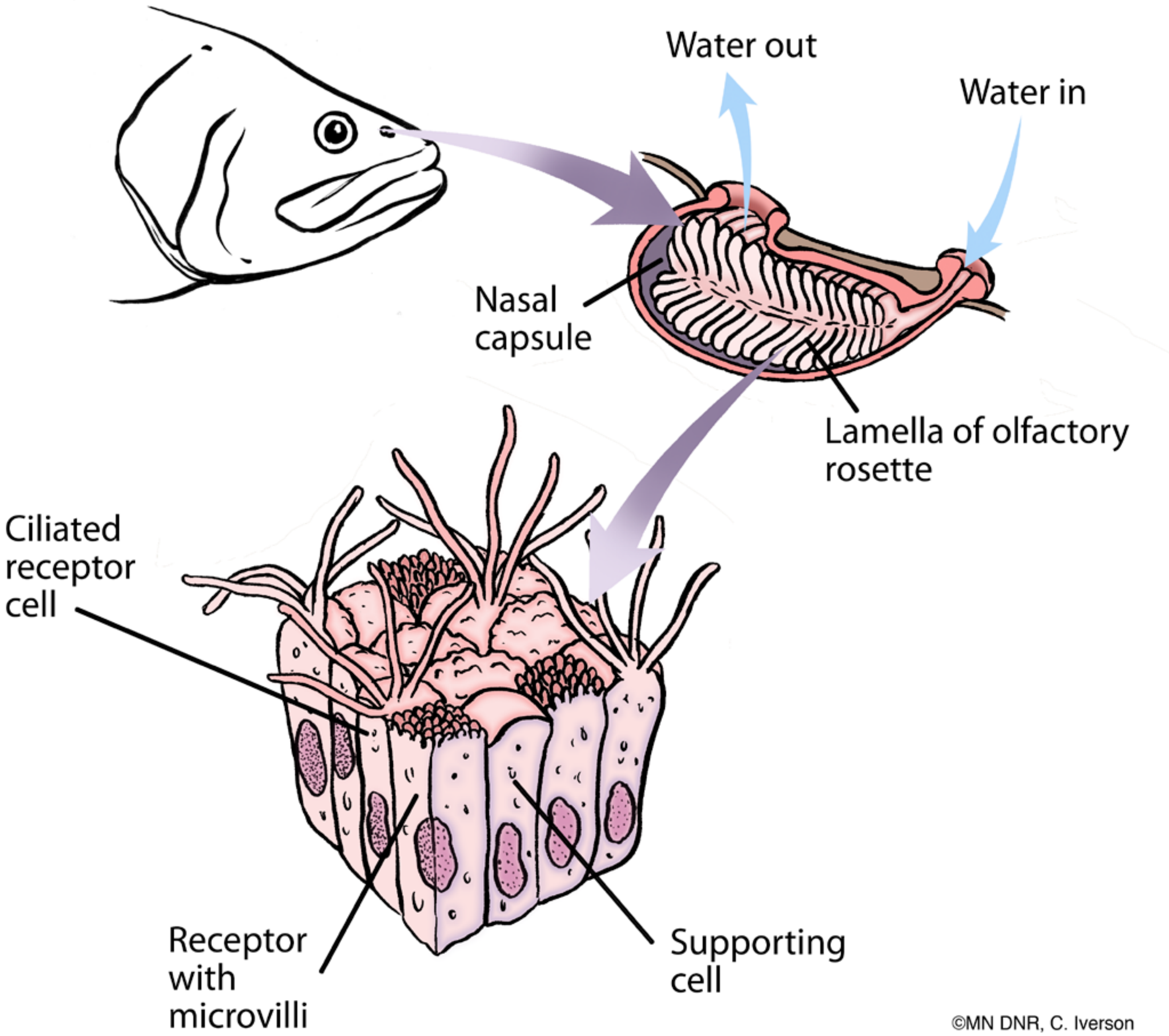
Hearing



Fish ears don't have external openings. The inner ear provides both hearing and balance. Scientists believe that the lateral line is an extension of the hearing mechanism. Sound travels very well through water, and fish are quite good at detecting and reacting to sound waves that signal food or danger. For instance, they can easily detect a school of bait fish moving in the water, or the noise of a tackle box scraped along the deck of a boat.

Fish Senses Sheets

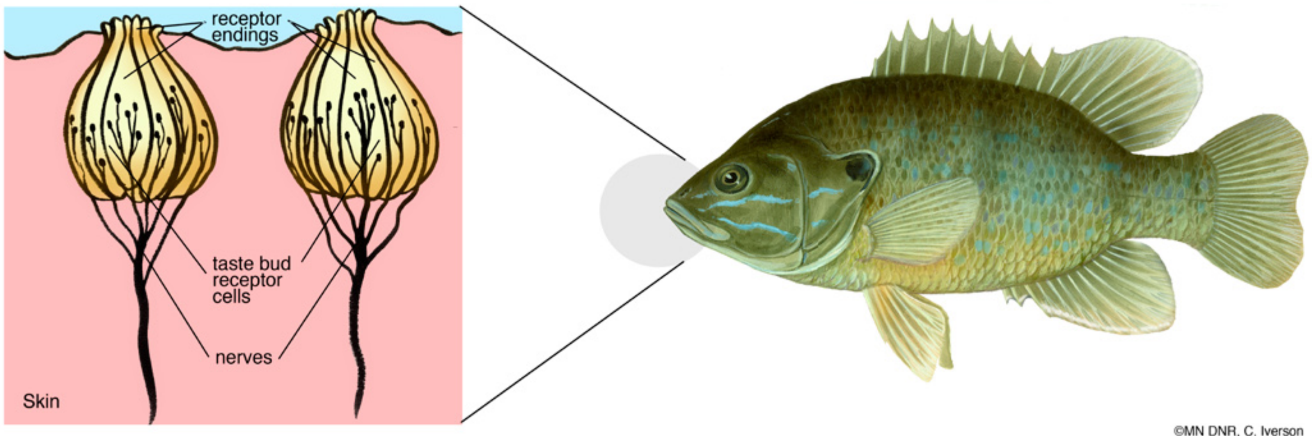
Smell



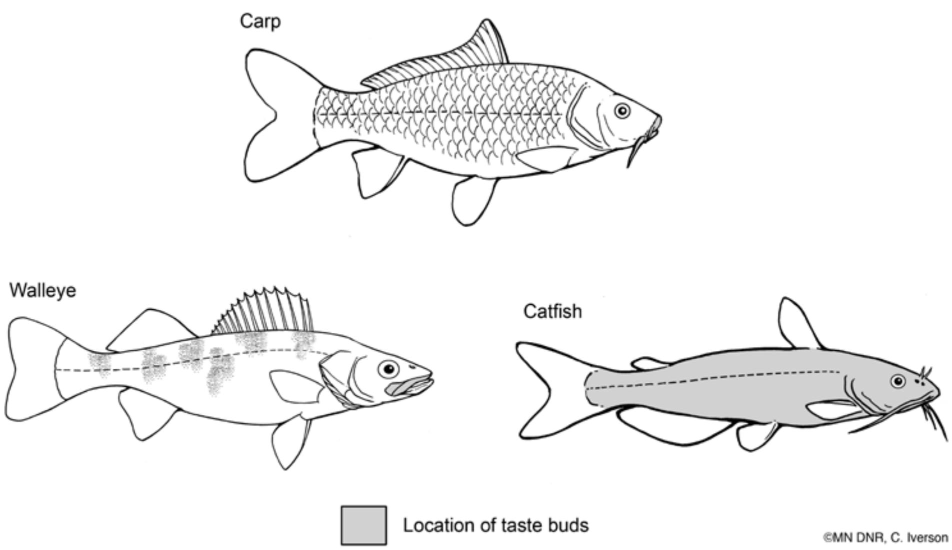
Fish have four nostrils, or nares—two on either side of their snouts. Each nostril is a simple pouch with a flap. Water enters through the opening of one nostril on each side, passes over the sensory lining of the pouch, and exits through the second nares, which are behind the first nares. The nostrils in Minnesota fish serve only as organs of smell (not for breathing), and have the same olfactory connections to the brain as those of higher animals. Fish use this sense to find food, detect danger, and find their way back to their original spawning areas.

Fish Senses Sheets

Taste



Fish have taste buds on the lips, tongue, and other parts of the mouth. Some fish species have taste buds on body surfaces, fins, and even the eyes!

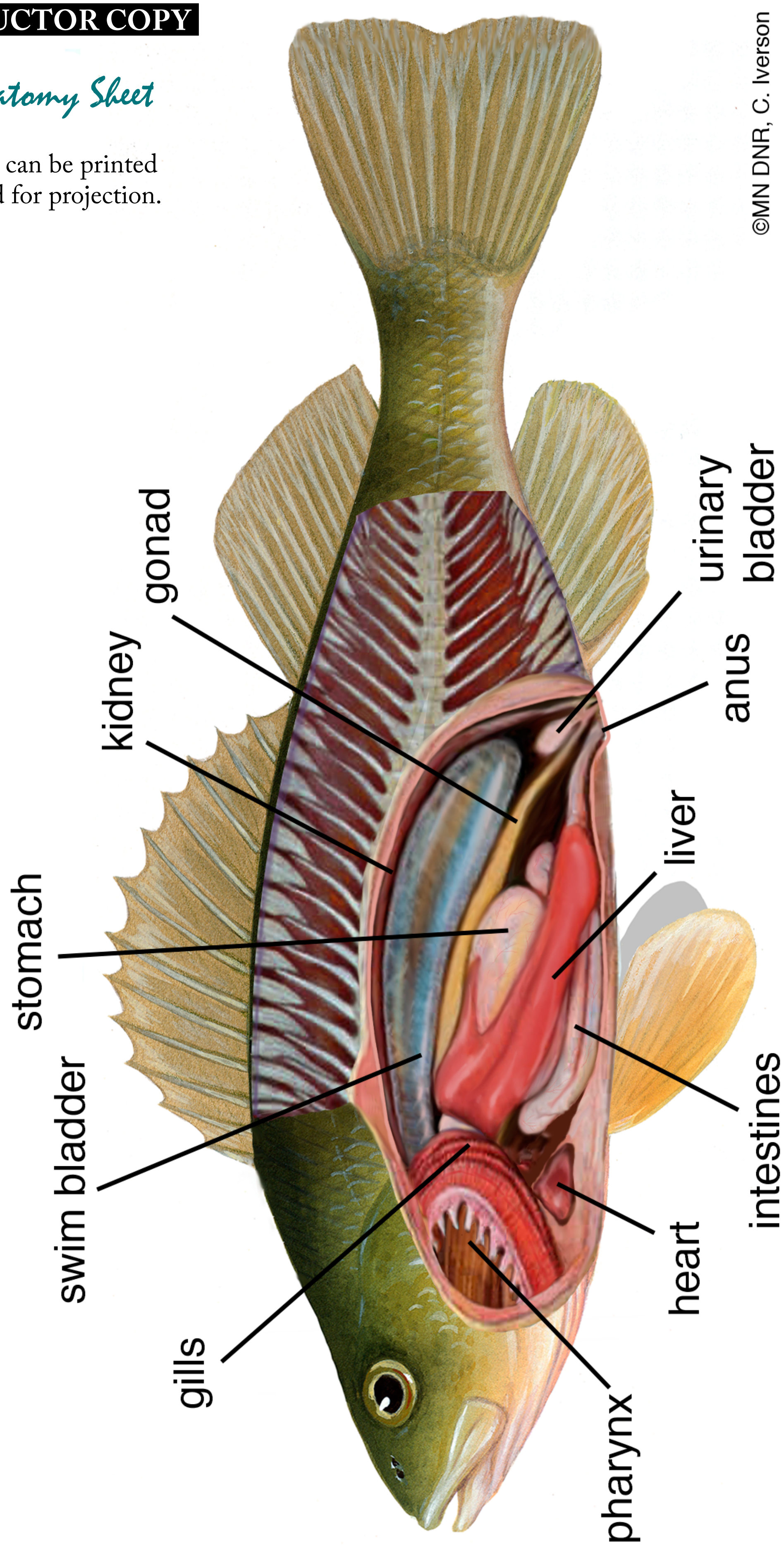


Fish taste by means of structures similar to human taste buds. Fish can distinguish between sweet, sour, salty, and bitter tastes. Some fish have taste buds over their entire bodies as well as on their tongues. Some fish have special features known as barbels, or "whiskers," that are covered with taste buds. One scientific study measured a 22-centimeter bullhead and found 20,000 buds in the mouth and throat and 175,000 buds over the rest of its body. Fish in the catfish family have more taste buds than other fish species.

INSTRUCTOR COPY

Fish Anatomy Sheet

This image can be printed or prepared for projection.



Fins: Form and Function

Fish fins function true to form!

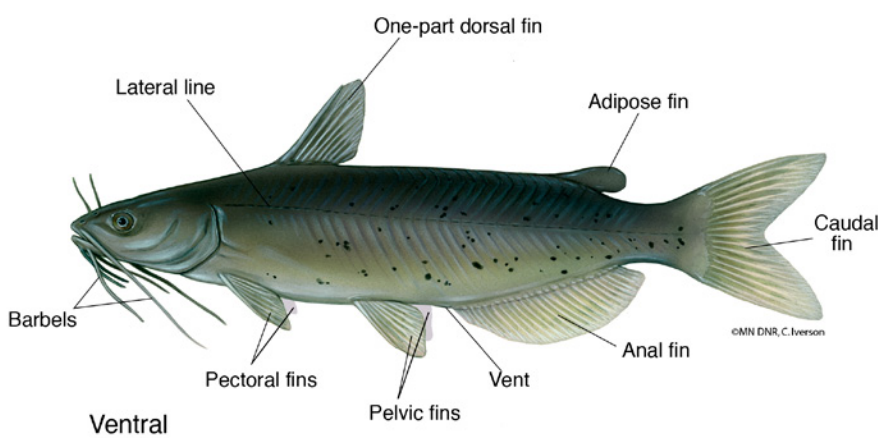


Table of Contents

Chapter 2 • Lesson 2

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fins: Form and Function

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II.Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning, including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.

Grade 4
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

Grade 5
I. History and Nature of Science
A. scientific World View:
Benchmark 2—The student will recognize that clear communication of methods, findings and critical review is an essential part of doing science.
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.
IV. Life Science
E. Biological Populations Change Over Time:
Benchmark 1—The student will recognize that individuals of the same species differ in their characteristics and that sometimes the differences give individuals an advantage in surviving and reproducing.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 2 • Lesson 2

Fins: Form and Function

 "What a Way to Travel" is adapted from Fish Ways: A Manual of Curriculum-based Lessons for Intermediate and Senior Level Teachers and Group Leaders on Fishes and Fisheries Management with the permission of the Ontario Ministry of Natural Resources and the Canadian Wildlife Federation. ISBN 0-7720-8576-6.

Grade Level: 3-5
Activity Duration: Part 1: 45 minutes
Part 2: two class periods
Group Size: any
Subject Areas: Language Arts, Expressive Arts, Science
Academic Skills: comparison, experimenting, identification, listening, modeling, observation, public speaking, small group skills, writing
Setting: Part 1: indoor or outdoor gathering area with tables
Part 2: area with wading pool, water tub, or water's edge
Vocabulary: adaptations, adipose fin, anal fin, caudal fin, dorsal fin, form, function, lie-in-wait predators, pectoral fins, pelvic fins, rays, rover-predators, spines
Internet Search Words: bullhead, carp, fish anatomy, fish fins, fish form and function, how fish swim, northern pike fins, perch, freshwater drum, sunfish, walleye

Summary

How do fish move forward, up, down, slow down, turn, and stop? To find out, students observe the functions of different fin types in a classroom aquarium and record their observations. These observations guide students in designing models to investigate how some fins help to stabilize fish. Students learn the names of different fin types, and that fins are an adaptation that helps fish survive in their habitats.

Student Objectives

The students will:

1 Observe fish in a classroom aquarium.
2 Describe how fish use their different fins to move forward, up, down, slow down, turn, and stop.
3 Design models to investigate how some fin types function to stabilize fish.
4 Identify the following parts of a fish: dorsal fin, spines, rays, adipose fin, caudal fin, anal fin, pelvic fins, and pectoral fins.
5 Describe at least one function for each of these parts: dorsal fin, spines, rays, caudal fin, anal fin, pelvic fins, and pectoral fins.

Instructor's Background Information

An amazing variety of fish species live in a tremendously wide range of environmental conditions throughout the world—in near-freezing Arctic waters, hot desert springs, high mountain lakes, cold water streams, muddy dried-up ponds, thermal vents on the ocean floor, and, of course, in Minnesota waters. Despite the great diversity exhibited by the 24,000 living species of fish, some general characterizations can be assigned to fish as a group.

> Fish are one of the oldest and most varied groups of animals on earth. Only insects have greater diversity—or more species. Biodiversity refers to the variety (or diversity) of all life forms in a given area. A lake habitat exhibits rich biodiversity if it contains numerous species of plants and animals, including fish.

Fish have **adaptations**, or specific features and behaviors enabling them to survive in their aquatic habitats. With some exceptions, most fish have fins and a long, streamlined body—or a thin, narrow body—enabling them to swim easily through water. The **form**, or shape, of a fish's body and body parts is often related to their **function**, or how those parts work. Function also depends on form. This relationship

Materials

Part 1: Watching Fish

- Several common objects of different shapes, such as a ball, wheel, bowl, shovel, umbrella (see Warm-up)
- Several illustrations or specimens of different plant and animal parts, such as a beaver's tail, giraffe's neck, cactus spines (see Warm-up)
- Class aquarium and fish; minnows require cold, well-oxygenated water; beta fish or goldfish work well (If live animals aren't allowed in your classroom, you could plan a trip to a pet store or aquarium so that students can observe fish movements.)
- Six- or eight-ounce capacity wide-mouth glass jars, one for each group of four or five students (wide-mouth jars provide more surface area, which keeps water oxygenated longer)
- Small fish net
- 8.5" x 11" images of fish from the *MinnAqua Leader's Guide* CD, or a variety of fish illustrations cut from sports and fishing magazines, or the video programs *Bigmouth* or *Bigmouth Forever*, available through the Minnesota DNR MinnAqua Program
- Notebook, one for each student
- Pencil or pen

continued

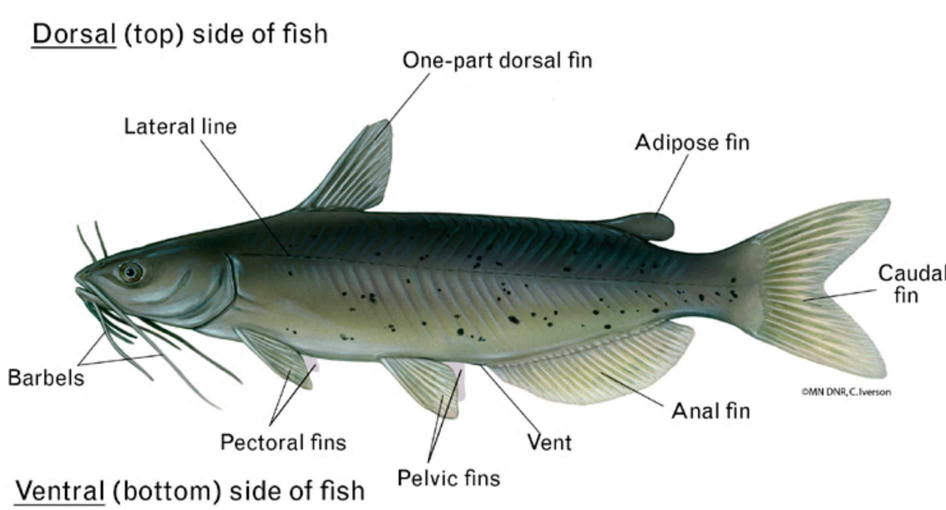
between form and function exists in the natural world, but it also pertains to things people invent and construct. A beaver's flat tail helps it steer as it swims, a duck's webbed feet helps it swim, the streamlined shape of a submarine moves easily through water, and an umbrella opens to form a wide, rounded surface that sheds water and protects its user from rain.

By observing and studying the different body parts of a fish you'll learn how the fish's body functions, why it is able to live where it does, and how it is able to capture food. One means of studying structures is to make models that, when tested under a variety of conditions, offer explanations for how the parts function and why they behave as they do. Models can be used to investigate how different types of fish fins enable various fish species to survive in their environments.

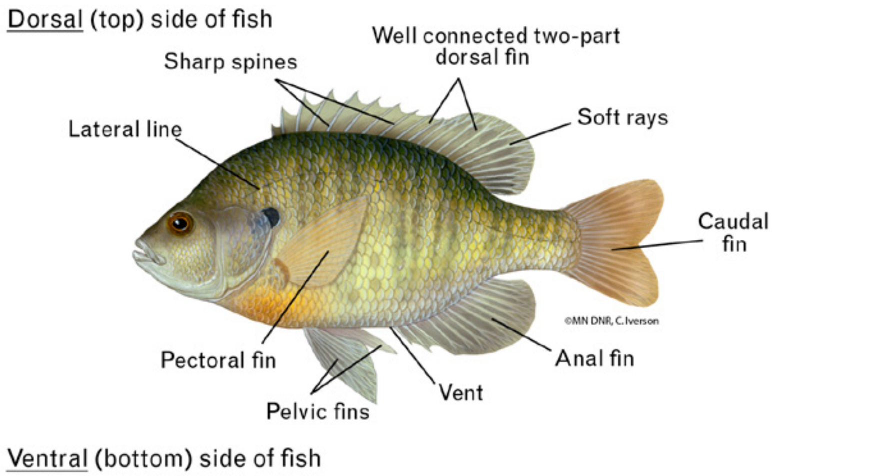
> Making observations using models is one way to look at the world as scientists do. Scientists study the world by making observations, posing questions, making predictions, designing experiments, gathering data, interpreting data, and sharing their results with others. This is how scientific knowledge about the world is continuously supported, refined, or challenged.

Fin Function Follows Form

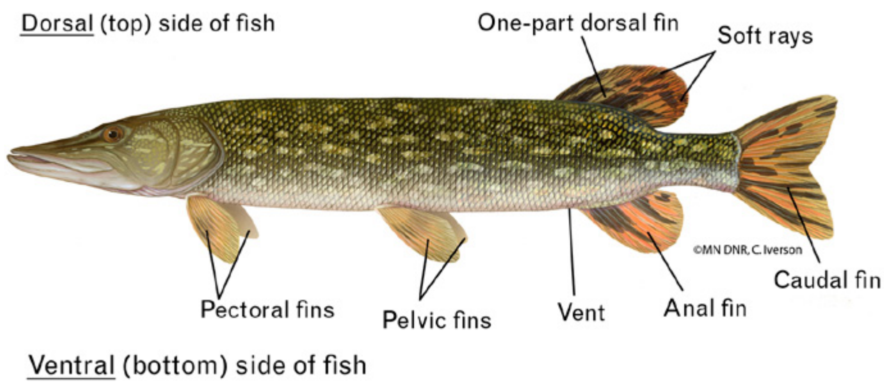
Taking a closer look at fins provides the opportunity to see that different body parts are **adapted,** or have special features that specifically function to help a fish survive in aquatic environments. Almost all fish have fins that they use for swimming (locomotion), balance, stability, and steering.



A catfish has dorsal, adipose, caudal, anal, paired pelvic, and paired pectoral fins.



Unlike a catfish, a bluegill lacks an adipose fin. A bluegill does have a large, two-part dorsal fin.



A northern pike lacks an adipose fin. Its one-part dorsal fin is located near its caudal fin.

Fin Structure

Fins consist of a membrane supported by rod-shaped structures called **rays** and **spines**. Rays are soft, flexible fin supports; spines are rays that are stiff and sharp. Spines in the dorsal fin can be used to raise the dorsal fin high enough to make the fish appear larger and less appetizing to a predator. Sharp spines can stick in the mouths and throats of predators. Small and medium-sized fish, such as those in the sunfish and catfish families, have well-developed spines that protect them from larger predators. However, some very small fish, such as gobies and sculpins, have spines that are as soft and pliable as rays, and minnows have no spines at all. These small fish spend much of their time camouflaged and hiding in tight spaces under logs and rocks.

Types of Fins

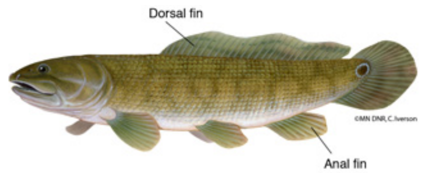
Dorsal and Anal Fins

A fish's dorsal and anal fins aid in turning, and serve to keep the fish upright (or prevent it from rolling over) in the water during sudden direction changes. The **dorsal fin** is located on the top of a fish, along

Materials (continued)

Part 2: Models

- Round plastic bottles, such as gallon juice bottles or one-or two-liter pop bottles, with caps, one per student (students can bring these from home; different sizes and shapes represent different types of fish bodies: long, round bottles represent northern pike or stream trout; shorter bottles represent perch or sunfish)
- One plastic bottle with flat sides, such as a half-gallon or gallon milk bottle, or flat plastic lids for cutting out fin shapes, two or three per student
- Sturdy scissors, two pairs for each group of four or five students
- Hot glue gun or roll of duct tape, one for each group of four or five students
- String, one six-foot length for each group of four or five students
- Gravel, sand, or water for filling fish models, as needed
- One large tub of water or a children's wading pool filled with water (or take class to a nearby swimming pool or lake pier to test models)
- Whiteboard
- Whiteboard markers
- **Fish Fins Sheet**, one per student
- **Fins: Form and Function Sheet**, one per student
- Pencil or pen



The bowfin (*Amia calva*) is also known as dogfish.

its back and between its head and tail. It may be a single fin, with or without spines, or consist of two connected or unconnected parts—a sharp-spined part and a soft-rayed part. The **anal fin** is located on the underside (or ventral portion) of a fish between the tail and pelvic fins, near the anus or vent. The anal fin provides stability, functioning like a keel on the bottom of a boat. Deep-bodied or laterally compressed fishes like the sunfish require greater stability to help keep them upright in the water, and generally have longer dorsal and anal fins. Dorsal and anal fins also tend to be long on eel-like fishes (such as the bowfin, burbot, and American eel), where they work in a sinuous fashion to assist the fish in swimming.

Caudal Fin

The **caudal fin**, or tail fin, is located at the end of the fish and provides the power that propels the fish forward, like a motor. It also acts as a rudder to assist in steering. Caudal fins come in varying shapes and can be forked, rounded, heart-shaped, or square.

Forked  **Coho Salmon**	**Rounded**  **Burbot**
Heart-shaped  **Black Crappie**	**Square**  **Flathead catfish**

Caudal fin shapes.

The shapes of caudal fins tend to correspond to the cruising speed of fishes. Fish that require speed or continuous movement, such as r**over-predators** (fish that spend much of their time cruising and searching for prey, including lake trout and channel catfish), typically have forked caudal fins. A forked caudal fin has less drag than a rounded or squared caudal fin. When the fish locates a potential meal, quick flicks of the forked caudal fin provide a sudden burst of speed, enabling the predator to overtake and capture its prey. **Lie-in-wait predators** also capture their prey with a sudden burst of speed, but instead of cruising to seek prey, they remain still, mimicking a stick or log (like the longnosed gar), or lying hidden in cover (like the muskellunge and northern pike). These fish lie still, wait for unsuspecting prey to swim nearby, and dart out to ambush it. Lie-in-wait predators have torpedo-shaped bodies with large caudal fins. Their dorsal and anal fins are typically located toward the backs of their long bodies, close to a large caudal fin. All of these fins work together to propel the fish forward with a burst of power.

Within a family of fish, the species with deeply-forked caudal fins move the fastest. Within the catfish family, for example, the channel catfish has a deeply-forked caudal fin and swims faster than the flathead catfish, which has a square caudal fin. Slower yet is the yellow bullhead, which has a rounded caudal fin. Deeply forked caudal fins enable speed in water because they generate less drag, or resistance, than other types of caudal fins. Similarly, square caudal fins with pointed tips are more efficient than rounded caudal fins..

A forked caudal fin allows a channel catfish to swim quickly.

A flathead catfish moves less quickly with its square caudal fin.

A rounded caudal fin makes the yellow bullhead the least speedy of these fish.

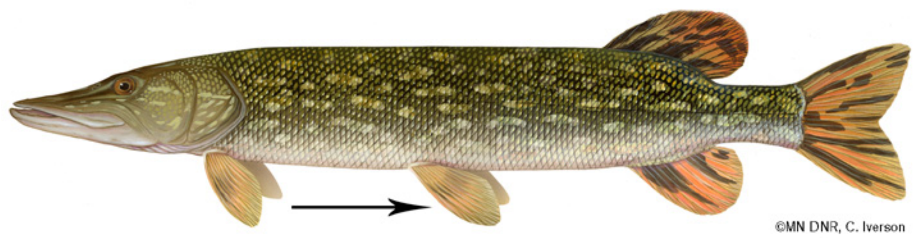
Most Minnesota fish are bony fish with homocercal tails, meaning that the upper and lower tail lobes are the same size. The sturgeon has a heterocercal caudal fin—the upper lobe is larger and longer than the lower lobe, resembling a shark's tailfin.

The lake sturgeon has a heterocercal caudal fin.

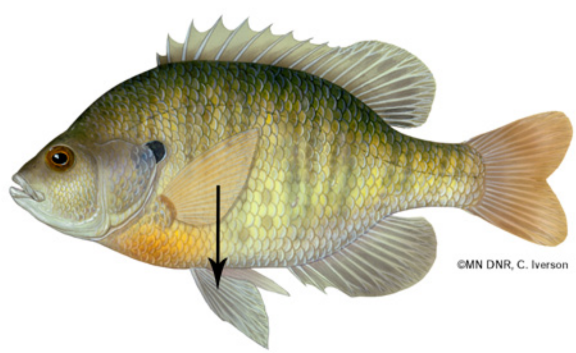
Pelvic and Pectoral Fins

Pelvic and pectoral fins are usually paired, allowing a fish to fine-tune its movements. **Pelvic fins,** located on the bottom of the fish in front of the anal fin, help balance the fish, keep it level, and prevent it from rolling from side to side. Fish sometimes rest by sitting on their pelvic fins. The **pectoral fins**, located on either side of the fish near the gills, do everything that pelvic fins do, and also help steer and control depth. Soft-rayed fish (pike, trout, and minnows) have pelvic and pectoral fins separated widely on their bodies. Both sets of fins are attached more-or-less horizontally, like wings on an aircraft.

Other fish, like most deep-bodied or laterally compressed panfish (sunfish, bass, and crappie), have pelvic and pectoral fins located closer together vertical to one another, with the pectoral fins higher on their sides close to the gill covers, and the pelvic fins below the pectoral fins on the bottom of the fish. Both fin pairs are closer to the fish's center of gravity, and provide maneuverability. The pectoral fins of these fish are attached to their bodies vertically rather than horizontally compared to the pelvic fins and often have a "wrist-like" function. This adaptation allows greater maneuverability through a variety of habitats. For a bluegill, which often lives in dense vegetation, the paired fins aid in moving between stalks, and in remaining stationary to pick insects off of plants.



Pectoral and pelvic fins of a northern pike, a lie-in-wait predator, are oriented horizontally.



The pectoral and pelvic fins of a bluegill sunfish, a panfish, are oriented vertically.

Adipose Fins

Fish in the salmon and catfish families have an **adipose fin** between their dorsal and tail fins. Adipose (or fat) fins have no spines or rays, and they're soft and fleshy, like an ear lobe. The function of the adipose fin is being studied by biologists. Experiments suggest that the adipose fin helps reduce drag and controls vortices, that is, improves swimming efficiency.

The adipose fin of a lake trout.

Procedure

Preparation
Part 1: Fish Watching

1 Collect a set of everyday objects and photos or specimens of plant and animal parts with varied shapes and functions. Some suggestions include: a ball (rolls and bounces), wheel (rolls), bowl (holds objects), shovel (scoops and digs), and umbrella (sheds rain). You also could also find specimens or photos of: cactus spines (which discourages animals from eating it), the flat tail of a beaver (helps the beaver steer as it swims and is used to create loud slapping sounds on the water if frightened by a predator), the long neck of a giraffe (helps it reach food in high places), a lion's teeth (holding, tearing, and eating prey), a Venus fly trap plant (catches insects), a duck's webbed feet (swimming), a bird's wings (flying).

2 Set up a classroom aquarium with fish or display fish identification posters, 8.5" x 11" fish illustrations, or photos of Minnesota fish cut from sports magazines. (Or show the video programs *Bigmouth or Bigmouth Forever*.) It's permissible for instructors to set up aquariums containing native Minnesota fish if a permit for education tanks is obtained. Contact the Minnesota DNR Central Office, 651-296-3327, for details and requirements for education permits for school aquariums.

3 Fill the wide-mouth glass jars with water from the aquarium. Using a small net, to transfer one fish from the aquarium to each jar.)

4 For each student, copy one **Fins: Form and Function Sheet** and one **Fish Fins Sheet.**

5 Each student should have a notebook and a pen or pencil.

It's illegal to release aquarium fish into any water body in Minnesota. Fish released from aquariums can carry fish diseases or spread through lakes, streams, or rivers.

It may be difficult for students to make the initial cuts into the plastic bottles and to cut through the rims of the plastic lids they're using to make fish fins. Keep an eye on the cutting, and be ready to assist if necessary.

Part 2: Models

1 Each student needs two plastic bottles (one round bottle with a cap, and another bottle with flat sides) or one round bottle and two or three flat plastic lids, a sturdy pair of scissors, and duct tape or a hot glue gun. (Assist the students as they use hot glue guns.)

2 Before the lesson, you may wish to cut and remove the necks of the flat-sided bottles so that the students won't stab their scissors into the bottles as they try to cut out fins.

3 You'll need a large tub, wading pool, or a children's water table filled with water or access to a nearby swimming pool, pond, or lake so that the class can test the models. The tub or pool can be placed outdoors or, if feasible, in the classroom.

Activity

The activity in Part 1, observing and recording observations of how a fish swims and uses its fins, can work well as part of a classroom learning center. A fish parts-themed learning center, for example, can be set up as a series of large or small stations with hands-on, open-ended, or interactive learning materials containing a variety of resources and activities relating to fish and external features of fish. Some stations could support different learning styles; others could enhance different teaching methods. Still others could provide opportunities to practice skills learned in the unit or address current issues related to the topic. Students can work in cooperative learning groups and rotate through the stations, or visit them throughout the unit as assignments are completed. The learning center creates a backdrop for the topic that the class is working on, and stimulates interest and questions throughout the duration of the unit.

Warm-up

1 Explain to students that the shape or structure of an object can tell us something about what it does. Hold up the various everyday objects or tools (or pictures of tools) and ask students what each is used for, or how to figure out how the object functions by considering its shape.

2 The shape of objects in nature can tell us something about how a plant or animal functions, too. Show pictures or specimens such as the objects from nature mentioned in the Materials List. Ask students if they can figure out how the organism or the part of the organism functions. Explain that, generally, the form or shape of an object is related to how the object functions.

Lesson

Part 1: Watching Fish

1 Tell students fish have unique parts that help them survive in their habitats. Observing the parts of a fish will help us figure out some interesting things about it. We can learn how a fish moves, how it might behave, why it lives where it does, or what it might eat. This information can be quite helpful if you plan to go fishing!

2 Divide the students into teams of four or five. Give each group one jar with a fish from the aquarium. If you have no classroom aquarium, visit a local pet store. Or students can record observations from fish illustrations (fish images from the *MinnAqua Leader's Guide* CD printed on 8.5" x 11" sheets, fish identification posters, or fish photos cut from magazines), or from the video programs *Bigmouth* or *Bigmouth Forever*, which are available for checkout from the Minnesota DNR MinnAqua Program.

3 Tell students they will be working in groups and observing how a fish moves in water. They will record their observations in their notebooks so they can use their notes to help them design fish models later. Ask students to think about the shapes and positions of the different fins as they watch how the fins work. They should record their observations in their notebooks and include:

- written observations about how the fish moves up, down, forward, or backward, and how it turns, stops, and remains still
- drawings and descriptions of the different fins
- explanations of what the different fins seem to do

4 What other animals move in water? Do they have features that work like fins? How do these features move? In this discussion, you can introduce the concept of human movement (such as people swimming) and any personal experiences can be discussed. Can students remember what kind of hand, foot, and body motions they made to start, stop, change direction, or move up and down in the water?

5 Ask students about the way fins look—why do fins have flat, thin webbing, firm rays, and stiff spines? Ask students to discuss how some fish parts are quite different from human body parts. Which parts help a fish move in its watery environment? Why is movement important? (Fish move to get their food, to get away from other fish that might eat them, to seek shelter, and so forth.) Summarize the discussion by talking about how fins help fish survive in their watery environments. Tell students that the features and characteristics they've listed, including fins, are called adaptations. Define adaptation (a characteristic that helps an organism to survive in its environment); have students write the definition in their notebooks.

- Ask students to write a description in their notebooks of how the various fins of the fish they observed would be considered adaptations (how they function to help the fish survive where it lives). Have them sketch their fish, paying close attention to the shape and location of each fin.

Part 2: Models

1 In the classroom, draw the outline of a generic fish (football shape) on the whiteboard.

2 Give each student a **Fins: Form and Function Sheet**.

3 Remind students that each part of the fish has a specific function. Now they will learn more about the fins of a fish. They will have noticed from observing fish that fins consist of membranes supported by rod-shaped structures called rays and spines. Rays are soft and flexible and spines are rigid and sharp. Fish have different kinds of fins.

4 One feature at a time, draw a fin (dorsal fin, spines and rays, tail fin, adipose fin, anal fin, pectoral fins, pelvic fins) on the fish body outline on the whiteboard and label each fin.

5 Have students label the parts on their own fish diagrams as they follow along.

6 Expand the discussion—distribute a **Fish Fins Sheet** to each student, and draw examples of different species of fish on the board (or use illustrations of fish) so the students can see how fin characteristics and arrangements vary among different species. Discuss and compare the functions and how they may benefit the

The students may not be familiar with the names of the different types of fins yet. Observing the fish lets them discover the function of the different fins on their own, before learning the names of the fins.

You can obtain a few fish from the grocery store or fish market and have the students look at the fins and other features.

different types of fish. For example, draw a two-part connected dorsal fin (bluegill). Next, draw a longer, narrower fish shape with a smaller one-part, soft-rayed dorsal fin located back near the tail (as in the pike family). Discuss how this location of the dorsal fin gives a muskellunge or northern pike the ability to quickly propel itself forward through the water to catch its prey. All the power is in the back, like a motor on a boat. On soft-rayed fishes, like the pike and trout/salmon families, pelvic fins are located far back on the body. On spiny-rayed fishes, like the bluegill and perch families, pelvic fins are moved forward underneath vertically oriented pecotral fins. This arrangement may increase manueverability in short-bodied species such as bluegill.

7. Remind students that members of the catfish and salmon family (including trout) have an adipose fin. Other Minnesota fish don't have adipose fins.
8. Students should label the following parts on the fish diagram on the **Fins: Form and Function Sheet**: dorsal fin, spines, rays, adipose fin, caudal (tail) fin, anal fin, pelvic fins, pectoral fins. The functions of the fin types should also be noted on the sheet. The diagrams can be kept in students' notebooks.
9. Option: Find illustrations of the types of fish that live in your local water body. Have students identify the fins and discuss their shapes and forms with a partner.

Using What You Know to Make Models

1. Students will make a static model to test how static fins may contribute to the movement of a fish. Tell students that making models is one method that scientists use to study different structures. Tell students that they'll make models to test how different fins work in water. Models simulate real objects or events and, when tested and used in experiments, they can provide data resulting in scientific explanations for how objects function and behave.
2. The fin shapes can be cut either from the bottle with flat sides (the neck should be removed in advance) or from the flat plastic lids. The round bottle will serve as the model fish's body, to which the fins will be attached. In groups, have students use a permanent marker to draw four to six fins of different shapes and sizes on the plastic bottle or on the flat plastic lids. Cut out the fins. Remind students to think about how the fin's design will fit its function. What "jobs" do these fins have to perform? (Propelling the fish forward, stabilizing the fish in the water, helping it move up, down, backwards, and helping it turn or stop). The different fin shapes and sizes should reflect the form of an actual fish to simulate how it would function in the real world.
3. Tell students to keep the following in mind when making and testing their models:
   - In order to provide accurate information about how the fins of real fish work, the models should resemble real fish and fins as

Students may have trouble cutting out fin shapes without first drawing fin designs on a sheet of paper to get a size and shape that is proportional to the body size of their model. When they have drawn fin shapes that please them, they can cut them out and use them as templates for making the four to six plastic fins for their models.

much as possible.

- It will be helpful for students to refer to their notes from observing fish parts, from studying illustrations, or from watching the video program in Part 1 while making their models. Do they remember how the fins on the real fish looked?
- Their teamwork skills will be evaluated as they work within their groups to design, create, and test their fish models.
- It's important to record their observations of how the different fish models work in the water so they can use their team's best fin designs to make their final model.
- As they design their final model, they should think about what their fish needs. Does it need to be more stable in the water? Does it need to turn quickly and make sharp turns in vegetation? Does it need to speed to propel it through the water? How do the shape and placement of fins on the body affect these abilities?
- The students will design two or three different models as a group to compare various shapes and designs of fins, saving two bottles to use for a final model that incorporates all of their best designs. This final model can be tested in a local stream or lake to gauge its stability and how it moves in the water.

4 As they finish cutting out their fins, have each group (one at a time) bring one of their capped, intact plastic bottles with no fins attached to the pool or tub of water and place it in the water. Have students blow on the bottle to see how it moves and spins. Remind students to record their observations in their notebooks.

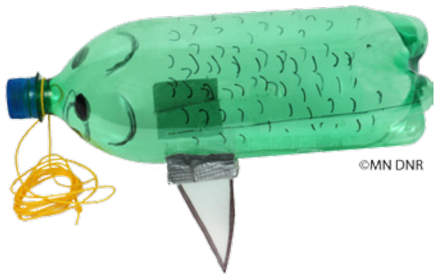
5 Each team can work together to design two or three different models to compare. In these groups, students should choose a different size and shape of fin to attach to their intact bottles to form an anal fin, which acts like a keel on the underside of a boat. The groups should mark where they want to attach their fins on the bottles. Help students attach the fins with duct tape, a glue gun, or by cutting a slit in the bottle and plugging any leaks in the bottle. If they cut a slit in the bottle, they should secure the fin to the bottle with a water-resistant glue or duct tape that also seals the slit around the fin.

A plastic bottle fish with an anal fin.

6 As the anal fins are secured, one group at a time should go to the tub or pool, place its model in the water, and blow on the it to see how the model with the anal fin moves. Students should record their observations, comparing how the different models move and speculating why the different models look or behave the way they do in the water. The bottles may tip to one side or the other in the water—ask students what would give tip-prone models more stability in the water. They may say they need two more fins, one on each side of the model, or one more fin facing another direction.

7 Have the groups modify their models with another fin attached to the end or bottom of the bottle like a tail fin (or caudal fin) to act as a rudder. They can choose to attach it straight or at an angle facing to the left or right. Which fin shape and orientation—vertical or

A plastic bottle fish with a caudal (tail) fin.



A plastic bottle fish with two pectoral fins--one is not visible.


Always use caution near water. Set boundaries for students. Test models in shallow water.

horizontal—would make a good rudder? (Vertical, as illustrated.) Help students use the glue gun or duct tape or help them cut slits. As each group secures the tail fins to their bottles, have them test their models in the tub or pool of water. Partially fill the bottles with gravel or water to evenly submerge the bottle so that its tail is underwater. Blow on the models and record observations on their movement. The group members should observe and compare the function of the various tail fins on the models. Students should draw the models with the anal and tail fins they designed, recording in their notebooks the observations and explanations for what they observe.

8 Empty the bottles and have students attach two more plastic fins to opposite sides of the bottles like pectoral fins. Ask students to consider the fin size they might require, and how these fins should be oriented on the fish's body—vertically, horizontally, or angled. Partially fill the bottles with enough gravel or water to partially submerge them so the fins are underwater. Blow on the models and record observations about their movements. Have students test, observe, and compare how their fish models function in the water. What function do the pectoral fins seem to serve? Did it make a difference if the pectoral fins were placed vertically or horizontally on the body? Up near the gill cover or lower on the body?

9 In their groups, have students review the observations they recorded in their notebooks and decide which fin designs were the most stable and helped their fish models move most efficiently. They can then incorporate the best fin designs to make a final fish model for their group to test in a nearby stream or lake. (If this isn't possible, the student teams can test their final models in the tub or pool.) This time, the student groups may include dorsal fins and pelvic fins if they choose. They should identify the functions their fins must perform to allow their fish to swim effectively in water, and they should create the designs on paper first—specifying, for example, the size of the fins, the number of fins, and where and how the fins should be placed on the fish. A group recorder can list the various functions of the different fins and draw the corresponding design features. Have the groups make their final fish model from their completed design.

10 Have each group attach a six-foot length of string to the bottle cover after partially filling the bottle with water or gravel to submerge—but not sink—the model and all of its fins during the test. Test each model in a nearby water body by holding the model by its string and placing it in the current of a stream or pulling it through the shallow water of a lake.

11 Back in the classroom, ask students to record in their notebooks their observations on how their models functioned. You may also ask them to identify the types of fish with a forms similar to the their designs. Have students draw their group's final design in their notebooks. Label the drawing to reflect the functions the fins performed.

Wrap-up

1 In their notebooks, have students write a concluding paragraph for this lesson, explaining which aspects of the fins they designed for their models were effective, and how fins help a fish survive in its environment. Did their models imitate the functions of real fish fins? (A real fish can move its fins.) What didn't work? What could have worked better? Students should consider fin size, shape, placement on the model body, and the concept that different fins work together to stabilize the model. They should use the names of the fin types in their descriptions.

2 Ask students to remember the function of each type of fin they described in their notebooks while observing the fish, and to describe the functions for each type of fin listed on the diagram on their **Fins: Form and Function Sheet**. As students complete the descriptions of how each fin type functions, guide the discussion to ensure that they list the correct functions of the fins.

3 Have student groups present their findings and results on how their models performed in the water. Have them explain why their fins functioned effectively, or how they would change the shape or location of the fins to improve how the model moves in the water.

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Assessment Options

1 Assess each group's models using the following parameters:
- The models should resemble real fish and fins as closely as possible.
- Did students refer to their notebooks and to earlier notes from observing fish parts, studying illustrations, or viewing the video program (during Part 1) while making the models?
- Did they work cooperatively in teams to design, create, and test their fish models?
- Did they carefully and thoroughly record in their notebooks their observations of how the different fish models worked in the water? Did they use the best fin designs from their team for their final model?
- As they designed their final model, did they consider the needs of their fish? (Does it need great stability in the water? Does it need to make fast, sharp turns? Does it need to swim through the water quickly?) Do the models reflect deliberate thought on how the shape and placement of fins affect these abilities? Did students consider how different fins could work together to perform a particular function such as providing stability or maneuverability?

2 Review student notebooks. Do the fish illustrations have fins drawn and labeled accurately? Are the functions of each fin type described?

3 Have students verbally explain fin functions and how their models function. Ask them to state two reasons why scientists use models in experiments. Ask them to describe how replacing the fins on their models with different-shaped fins would affect their model's performance in the water.

4 Assessment options include the Checklist and Rubric on the following pages.

Fins: Form and Function Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Student observes fish and watched fin movement for clues as to how fins help fish move in water.
3	______	______	Student neatly and accurately records observations of aquarium fish.
5	______	______	Student identifies all five fish fin types, including tail fin, dorsal fin, pectoral fins, pelvic fin, and anal fin.
5	______	______	Student describes shape and location of fins on fish.
5	______	______	Student describes how each type of fin helps a fish move through water.
4	______	______	Students contributed to design and creation of fish model.
3	______	______	Student worked cooperatively in the group.
4	______	______	Student neatly and accurately records observations of how models worked during testing.
4	______	______	Student records model-testing results for both fin location and fin shape were recorded.
2	______	______	Student explains two reasons why scientists use models in experiments about organisms.

Total Points

38 ______ ______ **Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

35-38 points = A
Excellent. Work is above expectations.

31-34 points = B
Good. Work meets expectations.

24-30 points = C
Work is generally good. Some areas are better developed than others.

18-23 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-17 points = F
Work is unacceptable.

Fins: Form and Function Scoring Rubric

Models Criteria	3 Excellent	2 Good	1 Fair	0 Unacceptable
Observation of fish in aquarium	Observes fish and watched fin movement for clues as to how fins help fish move in water. Observations neatly and accurately recorded.	Observes fish and watched fin movement for clues as to how fins help fish move in water. Observations weren't clearly recorded.	Observes fish, but didn't watch fin movement for clues as to how fins help fish move in water. Observations inaccurately recorded.	Observes fish. Didn't record observations.
Fin identification	Identifies all fish fin types, including tail fin, dorsal fin, pectoral fins, pelvic fin, and anal fin.	Identifies four fish fin types.	Identifies three fish fin types.	Can't identify fish fin types.
Fin form and function	Describes shape and location of fish fins and how each fin type helps a fish move through water, for example, a tail fin acts as rudder and propeller.	Describes shape and location of at least three types of fish fins and how each fin type helps a fish move through water, for example, a tail fin acts as rudder and propeller.	Describes shape and location of fish fins, but not how each fin type helps a fish move through water, for example, a tail fin acts as rudder and propeller.	Can't describe shape or location of fish fins or how each fin type helps a fish move through water.
Design contributions	Contributes to design and creation of fish model. Works cooperatively in the group.	Contributes to design and creation of fish model. Works cooperatively in the group with occasional correction from instructor.	Doesn't contribute as much as others to design and creation of fish model. Doesn't work cooperatively in the group.	Doesn't contribute to design and creation of fish model.
Experiment observations	Records observations on how models worked during testing. Records results for both fin location and shape.	Records observations on how models worked during testing. Records results for either fin shape or fin location	Records observations on how models worked during testing. Results not specific for either fin location or shape.	Didn't record observations on how models worked during testing.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Dissect a fish. Use a large fish specimen—obtained from the fresh fish counter at a grocery store, a fish used in **Lesson 2:1—Fish Sense**, or a fish that you have caught—for this demonstration. Go over the external parts and their functions. Dissect the fish to show the internal anatomy and discuss functions of internal parts, including physiology of the circulatory, nervous, digestive, and reproductive systems. (See the **Fish Anatomy Sheet** in **Lesson 2:1—Fish Sense**. Fish anatomy models are also available from science supply catalogs.)

2 Students can research the behaviors—including reproduction, spawning, schooling, and migration—that help fish species survive in particular environmental conditions. Have students list or discuss the features (or physical adaptations) that help the fish perform each behavior.

3 Have students research the functions of other parts of a fish, including gills, scales, vent, nostrils, barbels, operculum, slime, and lateral line.

4 Instead of making models with plastic bottles and testing them in water, you can adapt this lesson by having students create model fish from cardboard paper towel and toilet paper tubes. The longer tubes can be bodies of longer fish like northern pike and gar. The shorter tubes can represent the bodies of fish like sunfish and bass. Have the students design and cut fin shapes from tagboard or cardboard from things like cereal boxes. Remind students to add a tab on the end of each fin to use to attach the fin to the body. Squeeze the back end of the tubes vertically around the tail fin and staple or tape them shut. Trim edges of tube around tail. On the front end of the tube, cut a one and one-half-inch slit towards the middle of the tube on the top (dorsal) side and on the bottom (ventral) side. Squeeze the front ends of the tubes together, overlapping the cut sides of the slits to form an oval shape at the front. Use masking tape or staple these overlapped slits to make the mouth of the fish. Attach the rest of the fins using glue or tape. Have the students paint their fish, using tempera paint mixed on plastic ice-cream bucket covers, adding details such as eyes, gills, and scales. Stand the fish on their nose ends to dry. After drying, attach wiggly eyes. Have students explain the function of the fins on their fish models. Display the fish by hanging them from the ceiling, or by creating an "underwater" display in a glass display case in the school hallway. Hang the fish using clear monofilament line; add vegetation, driftwood, rocks, and other details. Lily pads "floating on the surface" on a glass shelf in the case are a nice touch!

5 Have students make a fish model out of a smashed pop can. You'll need one empty aluminum soda can for each student, silk flower petals or leaves, scissors, wiggly eyes, glue (527 Bond or other craft

glue), small paintbrushes for detail work, acrylic spray-paint in colors that match the body colors of the fish you're making (dark green, gray, white, bluish-gray, brown), bottled acrylic paint in a spectrum of colors for stripes, spots, and gills. (Metallic acrylic paint gives the fish a slight shimmer.) Rinse the cans and let them dry. Flatten each can at an angle, so that the top and bottom of the can aren't directly on top of each other. Squeeze the can by hand to start the flattening process. The entire bottom of the can should be facing up when finished (it becomes the mouth), and the top of the can should crunch to the side, completely behind the body. Finish the flattening process by stepping on the can. (Wear shoes!) Paint the can. Spray a base coat of body color on the front of the fish (the "mouth" end, or bottom of the can facing up). If making a largemouth bass you could use green, for example. Allow the can to dry, then flip it over and spray-paint the back. Allow the can to dry. Spray additional colors (such as a lighter belly underneath) on the front side, if needed for the type of fish you're making. Allow the can to dry. Add finer details with the paintbrush. Paint the crunched round bottom of the can black. (This represents the open mouth of the fish.) Add a pink tongue. Paint fish scales, spots, gills, and any other details. Allow the can to dry. Make fins using silk flower petals or leaves. Some will already be an appropriate shape; others can be cut into the correct shapes. Fins may also be painted or drawn with acrylic paint or magic markers. Glue the fins to the can in the correct positions and let them dry. Glue on the wiggly eyes. Finish the back of the can. Attach a loop of string or wire for hanging, or glue a bamboo skewer on the bottom to display in a garden. You can also mount the smashed can fish on cardboard covered with black felt, and label the fins for a very finished look!

A smashed can fish.

For the Small Fry

K-2 Option

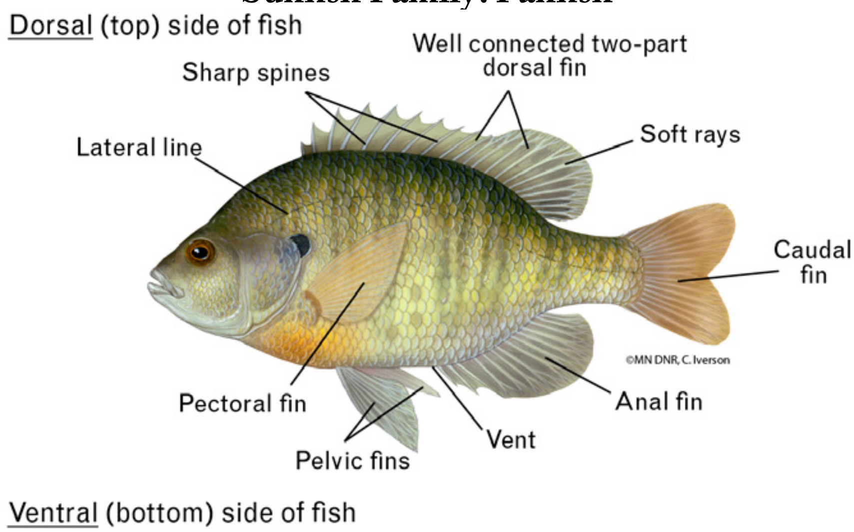
1 Have the students observe fish in a classroom aquarium to look at the different parts of a fish. Then play a game of Pin the Part on the Fish. Draw and cut out pictures of the various external parts of a fish, laminate them, and attach a piece of tape or Velcro to the back of each piece. Have students "pin" the fish part on a large poster showing a generic (football-shaped) fish body. Compare the fish parts to the body parts of children. Ask the students to figure out how each part helps a fish survive in its water habitat. Students can then draw a fish, showing the parts that help it survive in water.

2 Construct a variety of fish models as described in the lesson. Allow the students to test the models in a classroom water table. Have the students talk about their observations and tape record or dictate them to an adult. Discuss why each model worked differently in the water. Follow up by having students construct their own fish with distinctive fins and describe how their fish's fins help it swim in the water.

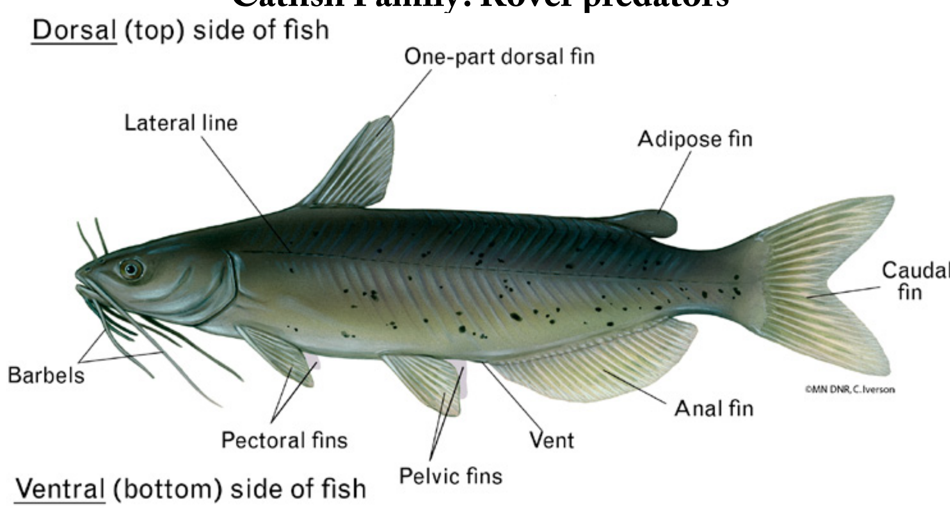
STUDENT COPY

Fish Fins Sheet

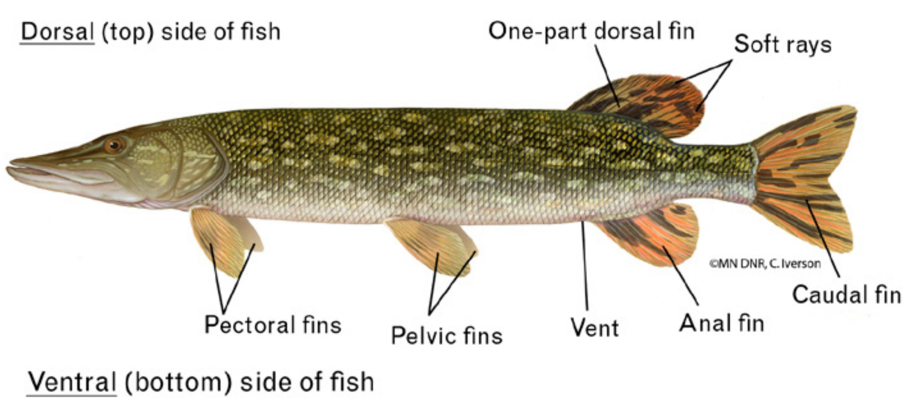
Sunfish Family: Panfish



Catfish Family: Rover predators



Pike Family: Lie-in-wait predators

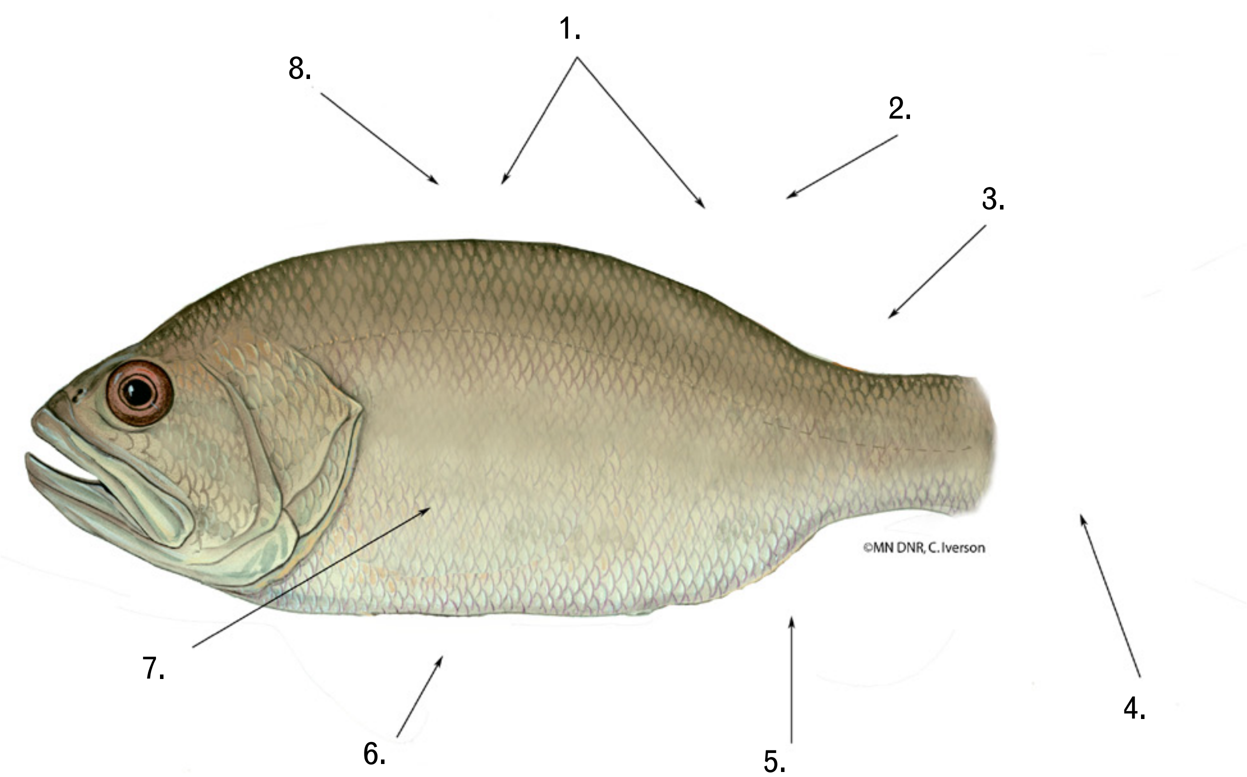


STUDENT COPY

Name ______________________________ Date ______________

Fins: Form and Function Sheet

Draw and label the fins, spines, and rays on this fish shape.
Then complete the table to describe the function of the fins, spines, and rays.

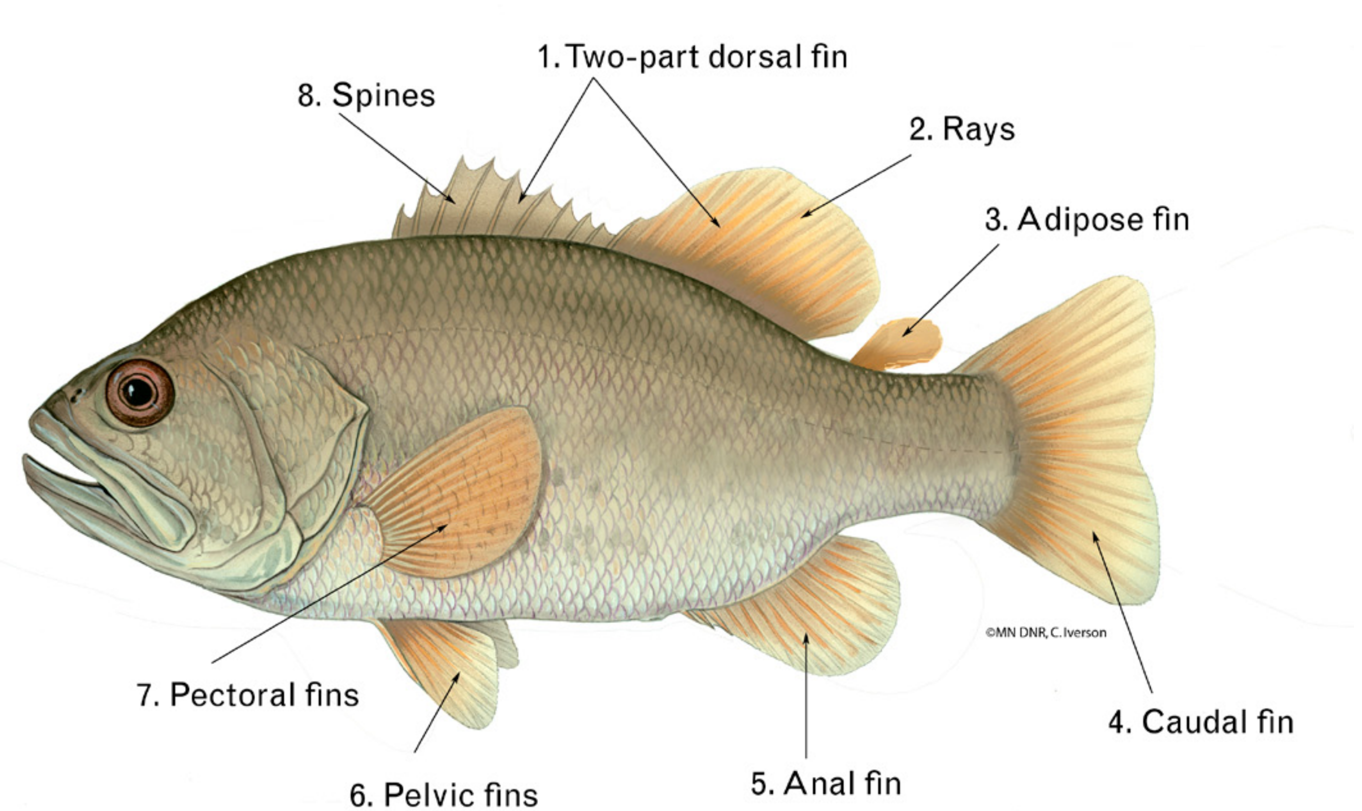


Fish Fins	Function
Caudal (tail) fin	
Dorsal fin	
Spines	
Pectoral fins	
Adipose fin (Salmon and catfish families)	
Anal fins	
Rays	
Pelvic fins	

INSTRUCTOR COPY

Fins: Form and Function Sheet Answer Key

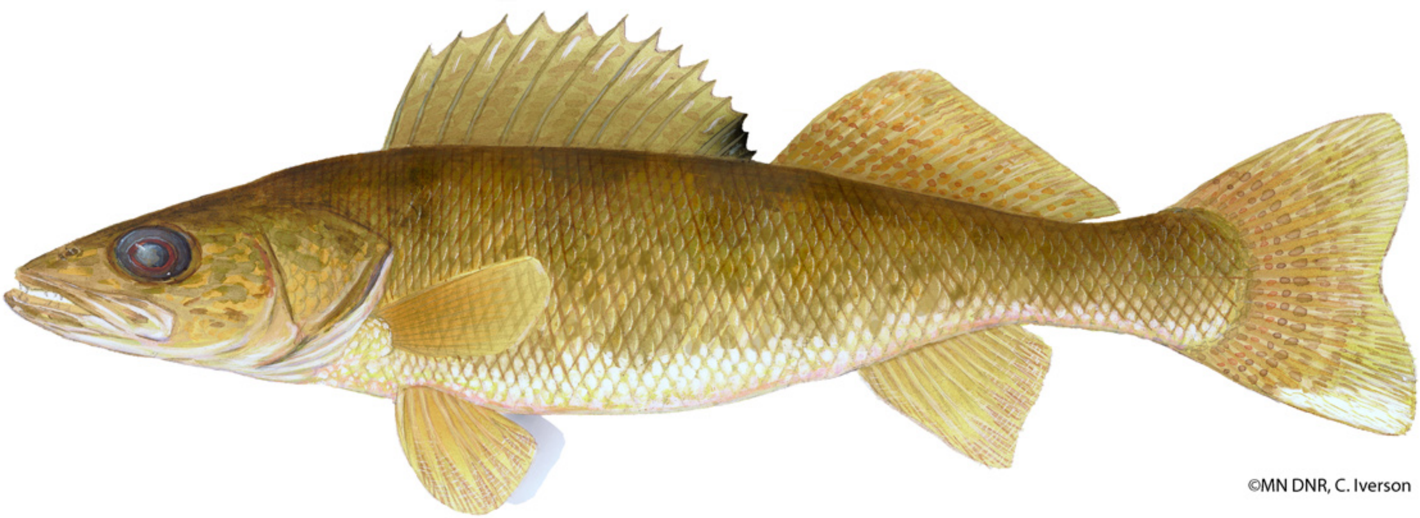
Draw and label the fins, spines, and rays on this fish shape. Then complete the table to describe the function of the fins, spines, and rays.



Fish Fins	Function
1. Dorsal fin	Stability, defense that helps fish look bigger, help in steering
2. Rays	To support fins
3. Adipose fin (Salmon family and catfish families)	Reduces drag and improves swimming efficiency
4. Caudal (tail) fin	Steering like a rudder and propelling forward like a motor
5. Anal fins	Stability, help steer, and prevent rolling over in sharp turns
6. Pelvic fins	Balance, resting, and maneuverability.
7. Pectoral fins	Maneuverability, going up, down, backward, forward steering, and remaining still
8. Spines	Sharp protection and defense, to hold up dorsal fin to look bigger and more difficult to swallow, to support fins

Fish Families

When it comes to classifying Minnesota fish, it's all in the families.



Minnesota's state fish commonly known as the walleye—and scientifically named *Sander vitreum*.

Table of Contents

Chapter 2 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish Families

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading.

History and Social Studies

Grades K–3
VII. Government and Citizenship
B. Beliefs and Principles of United States Democracy:
Benchmark 2—Students will recognize symbols that are significant for the state of Minnesota. (*The walleye is Minnesota's state fish.*)

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.

IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
A. Scientific World View:
Benchmark 2—The student will recognize that clear communication of methods, findings and critical review is an essential part of doing science.
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 2 • Lesson 3

Fish Families

Grade Level: 3-5
Activity Duration: 30 minutes
Group Size: any
Subject Areas: Language Arts, Science
Academic Skills: classification, listing, reading, small group skills
Setting: indoor or outdoor gathering area
Vocabulary: Agnatha, classification, Chondrichthyes, Osteichthyes
Internet Search Words: fishes of Minnesota

Instructor's Background Information

Classifying Organisms by Groups
Classification is a method of identifying, naming, and grouping related organisms. In order to communicate with one another, scientists use a worldwide, standardized method of classification called taxonomy. By classifying organisms into groups related to shared physical traits, physiology, genetics, and evolutionary history, scientists hope to discover other similarities among the groups.

Taxonomy uses a hierarchy of groups that starts with kingdoms. Kingdoms are divided into groups called phyla (phylum, in singular form), which are further divided into classes. Fish belong to the Kingdom Animalia and the Phylum Chordata, which includes all vertebrates.

Classifying Fish
Fish are often grouped into three main classes:

Class Agnatha: jawless fishes (Greek, *a* = without, *gnathos* = jaws)

Class Chondrichthyes: jawed fishes with cartilage skeletons (Greek, *chondros* = cartilage, *ichthyes* = fish)

Class Osteichthyes: jawed fishes with bony skeletons, also known as bony fish (Greek, *osteon* = bone, *ichthyes* = fish)

Fish from two of these classes inhabit Minnesota: the jawless (Agnatha) and bony fishes (Osteichthyes). Class Chondrichthyes contains mostly marine (saltwater) fish, none of which inhabit the fresh water of North America.

Most Minnesota fish belong to the Osteichthyes class; only the lampreys belong to the Agnatha class. And although sturgeon, paddlefish, and bowfin skeletons are composed partially or entirely of cartilage, they're classified as primitive members of the class Osteichthyes.

Summary

Minnesota boasts 160 fish species (141 of which are native) grouped into 27 fish families (25 native). Scientists classify fish into families depending on physical characteristics, physiology, genetics, and evolutionary history. In this activity, students learn how fish are classified and about the number of fish families in Minnesota. In a group exercise, students learn the key physical characteristics of five important Minnesota game fish families.

Student Objectives

The students will:
1. Recognize external characteristics used to identify fish.
2. Classify pictures of fish according to five family groups.

Materials

- Various pictures of fish, from magazines or other sources
- **Fish Families Cards,** one set per small group of four or five students (laminate the cards if you wish)
- **Fish Characteristics Sheet,** one per small group of four or five students
- **Fish Families Sheet,** one per small group of four or five students
- Glue
- Scissors
- Pencils, one per student
- Clipboards

The Three-Class System

Class Agnatha (Jawless Fishes)
Jaws absent
No paired fins
Variable gills, slits, or holes
Primitive cartilage skeleton
No scales

Minnesota Example
Minnesota is home to six species of jawless fishes.

American Brook Lamprey
Lampetra appendix

Class Osteichthyes (Bony Fishes)
Jaws
Some paired fins
One covered gill opening on each side of the body
Bony skeleton
Some have scales

Minnesota Example
Minnesota is home to 154 species of bony fishes.

Largemouth Bass
Micropterus salmoides

Class Chondrichthyes (Cartilaginous Fishes)
Jaws
Some paired fins
Five to seven gill slits on each side of the body
Advanced cartilage skeleton
Small, sandpaper-like scales

Minnesota Example
None—most of this class are marine (saltwater) species, such as sharks, skates, and rays.

The Five-Class System

Some scientists use a five-class system, in which jawless fish are further classified as hagfishes and lampreys and bony fishes are further classified as lobe-finned and ray-finned fishes.

Class Myxini (Hagfishes)
No vertebrae
Cartilaginous skeletons
No paired fins
No jaws

These fish are ocean dwellers.

Class Cephalospidomorphi
(Lampreys)
Vertebrae
Cartilaginous skeletons
No paired fins
No jaws

Many are parasites on other fish. Non-parasitic lampreys feed only during their larval stage; adults die soon after reproduction. Minnesota is home to six species of lamprey.

Class Chondrichthyes (Cartilaginous Fishes)
Vertebrae
Cartilaginous skeletons
Paired fins
Jaws (teeth not fused to jaws)
No swim bladder

Most are marine species, such as sharks, rays, and chimaeras.

Class Sarcopterygii (Lobe-finned Fishes)
Vertebrae
Most have bony skeletons
Paired fins
Jaws
Most have lungs

Lungfish and coelacanths belong to this class.

Class Actinopterygii (Ray-finned Fishes)
Vertebrae
Most have bony skeletons
Paired fins with sturdy rays
Jaws

More than 96 percent of all living fishes belong to this class. 154 of Minnesota's 160 fish species are in this class.

Classes are further divided into groups called orders. Orders are subdivided into families, which are subdivided into genera (or genus, in singular form), which are further subdivided into species. As the classification system subdivides, individuals within groups become increasingly similar. The members of each progressive subdivision share more and more physical, physiological, behavioral, and genetic traits.

Scientists identify unique fish types by their genus and species names. This scientific name is recognized worldwide, and remains constant, even though locally used common names may vary from place to place. The yellow perch, for example, is called lake perch or ringed perch in different parts of the country. These multiple common names would cause confusion if not for the scientific name for this species, *Perca flavescens*—genus name perca (Greek for perch) and species name *flavescens* (Latin for yellow).

Yellow Perch
Perca flavescens
Kingdom—Animalia Animal
Phylum—Chordata With backbone
Class—Osteichthyes With bony skeleton
Order—Perciformes With numerous short, fine-pointed teeth; prefer quiet waters
Family—Percidae Perches (walleye, yellow perch, and darters)
Genus—*Perca* Perch
Species—*flavescens* Yellow

Standardized Taxonomy Hierarchy
Kingdom
Phylum
Class
Order
Family
Genus
Species

Carolus Linnaeus (1707-1778), a Swedish scientist who studied and classified plants, developed the standardized classification system used today. He is best remembered for developing binomial nomenclature, which names organisms with two Latin words identifying the genus and species, such as:

Brook Trout =
Salvelinus = a little salmon
fontinalis = living in springs

Fish or Fishes?

The term **fishes** refers to more than one species of fish:

Two fishes found in the lake are bluegills and largemouth bass.

Fish refers to one or more than one individual of the same species. One bluegill is one fish. Ten bluegills are ten fish.

The number of Minnesota fish species could change as additional species are collected in Minnesota and recorded by the scientific community. Such changes can be due to whether a species is collected in Minnesota waters or contiguous waters, or to whether or not a species is actually established in Minnesota waters.

The walleye (*Sander vitreum*) is Minnesota's state fish. It's a member of the Percidae (perch) family.

With 46 species, the Cyprinidae—or minnow family—is Minnesota's largest fish family.

Minnesota Fish Families

Minnesota has a diversity of water types, from cold, shallow streams to large, cool, or warm rivers, and from large, deep, cold lakes to small, warm-water ponds. This diversity, combined with the sheer quantity of lakes and fishable streams, accounts for the 160 fish species found in Minnesota.

Five of Minnesota's fish families are considered game fish species—these are the fish most often sought by anglers:

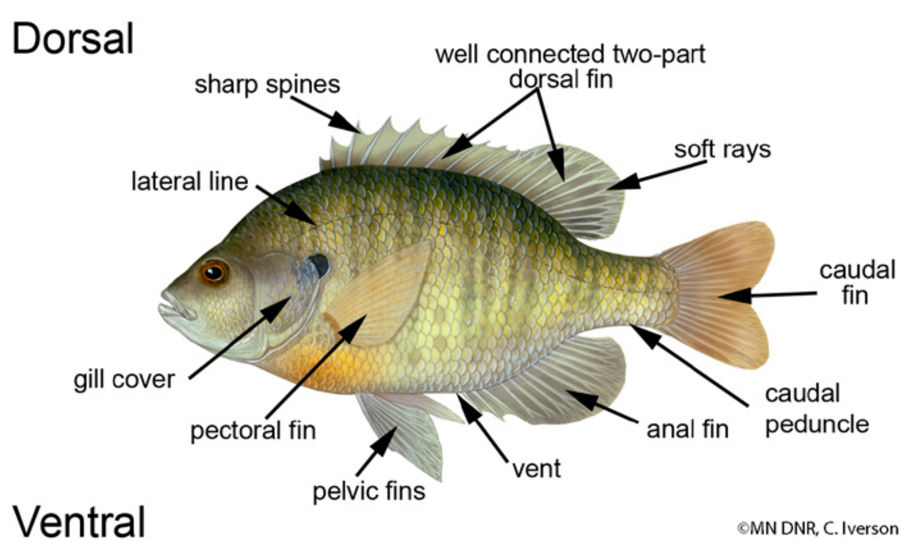
- Salmonidae: trout and salmon family
- Centrarchidae: sunfish family
- Esocidae: pike family
- Ictaluridae: catfish family
- Percidae: perch family

Physical Characteristics Classify Freshwater Fish

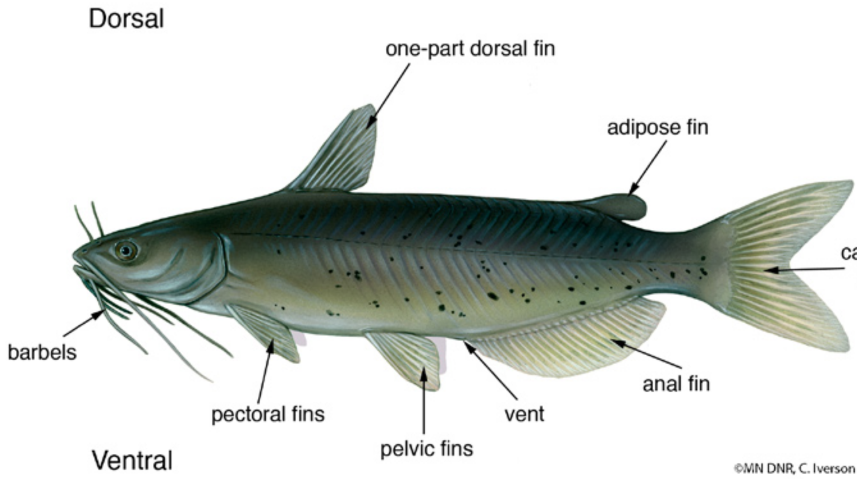
The appearance of external physical characteristics is one factor scientists consider in classifying fish. Scientists examine fins, rays and spines, scales, mouths, body shape, relative size and shape of body parts, and the presence or absence of structures such as barbels.

Internal features and characteristic behaviors, physiology, genetics, and evolutionary history are also used to compare species and taxonomically classify fish.

It's important to remember that size and color aren't always reliable features to use when classifying or identifying fish. These features can vary among individuals of the same species depending on age, sex, maturity, season, available food, and the water quality (minerals and nutrients) where they live.



The parts of a fish.



The parts of a fish.

Procedure

Preparation

1. Copy one **Fish Characteristics Sheet** and one **Fish Families Sheet** for each group of four to five students.
2. Copy and cut out one set of **Fish Families Cards** for each small group. You may wish to laminate the cards to preserve them for future use.
3. Collect fish posters for this activity. Fish identification posters are available from the Minnesota DNR Information Office at 651-296-5481 or 1-888-MINNDNR (646-6367)

Activity

Warm-up

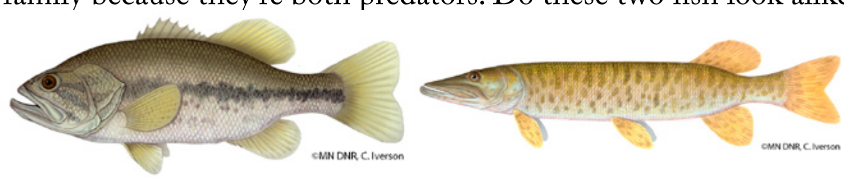
1. Ask students if they have ever been fishing. Many students will raise their hands. Ask them what kinds of fish they caught. Keep track of how many kinds of fish the students name. Tell them there are 160 species of fish in Minnesota. Can they name Minnesota's state fish? (It's the walleye.)
2. Tell students that, because there are so many different types of fish, scientists organize them into groups to make it easier to talk about and study them.
3. Divide the class into groups of four or five. Give each group a variety of fish pictures cut from fishing magazines. Have the student groups work together to sort the fish pictures any way they choose. Ask each group to explain how they sorted their fish, and to explain their reasons for doing so. After discussion, ask the students to list some other ways that the fish could be sorted (such as color, body shape, location of fins, or size of mouth). Then discuss how scientists sort organisms—including fish—into groups according to physical features and behavioral characteristics.

Some fish become more colorful or grow tubercles on their heads during mating season.

4 Using the fish pictures, ask the students to brainstorm different ways to distinguish one fish from another.
- body shape
- color and pattern
- size
- size, structure, shape, and location of fins
- presence or absence of barbels ("whiskers")
- presence or absence of adipose fins
- number of spines in dorsal or anal fins
- presence or absence of scales

5 Distribute the **Fish Characteristics Sheet** to each group. Point out the differences between the fish in the pictures, comparing them to illustrations on the **Fish Characteristics Sheet** so that each student can see the characteristics. Explain that scientists use physical characteristics to sort fish into family groups, but that not all characteristics are reliable traits for classifying fish. For example, many fish are olive-green, but a fish's color can change with the seasons, or due to minerals in the water. So in classifying fish, color should only be considered along with several other characteristics. Size is another example of a trait that may be unreliable—even within in the same species, a fish's size can vary with age, nutrition, and the length of the growing season. (All Minnesota fish hatch from eggs and begin their lives as "small fish.")

6 Discuss with students how the world's scientists use a universal classification system to communicate more precisely about organisms. Ask students to think about how difficult it would be to discuss fish characteristics if everyone didn't use the same classification system. For example, if one person's system classified fish according only to behaviors, instead of physical characteristics, muskellunge and largemouth bass could be grouped in the same family because they're both predators. Do these two fish look alike?



A largemouth bass, compared to a muskellunge.

No, they don't share similar physical characteristics, such as body shape, fin shape, or mouth type. In a classification system based on physical characteristics, muskellunge could be grouped with northern pike and largemouth bass could be grouped with sunfish.

Lesson

1 Divide the class into groups of four or five. Give each group a **Fish Families Sheet** and a set of **Fish Families Cards**.

2 Discuss the **Fish Families Sheet**. The five important game fish families in Minnesota are listed along with identifying characteristics. Minnesota has 27 fish families with 160 species, but this classification lesson is limited to the five families of game fish

found in Minnesota. These game fish families are well-known to anglers.

3 Have each group sort the pictures into the five family groups based on the characteristics listed. Ask students to write the names of each fish under the appropriate heading on the worksheet.

4 After each group is finished, ask the groups to explain why they sorted the fish as they did. Compare and discuss the different grouping systems. In which group did students place Minnesota's state fish?

5 Ask students to choose a fish from the **Fish Families Sheet**, and, as a class, identify the family into which most scientists have classified that fish.

6 Continue working through the **Fish Families Sheet** as a class by identifying the family group of each fish on the sheet.

Wrap-up

1 Some students may know of fish not mentioned in this activity. Ask the students to name other fish commonly found in Minnesota. Do they belong to the families listed on the worksheet? Why or why not? Minnesota is currently home to 160 fish species grouped into 27 different families. For a complete list, and for additional information on classification, conduct an Internet search using the keywords "fishes of Minnesota" to direct you to the University of Minnesota's Bell Museum of Natural History Fishes of Minnesota website.

2 Review with the students that a standardized classification system provides scientists with a precise method for talking about, classifying, and studying organisms.

Assessment Options

1 Evaluate student discussion conducted in Steps 3-5 of the Lesson. Collect and evaluate the worksheets.

2 For an authentic measure of the objectives, provide students with a blank sheet of paper. Pass out a set of fish cards to each student. Ask the students to sort the fish cards into family groups. Ask them to write a rationale for their grouping system, and to include illustrations of key characteristics for each of their family groups. Evaluate the rationale for the grouping system they develop.

3 Assessment options include Checklist and Rubric on following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

19-21 points = A
Excellent. Work is above expectations.

15-18 points = B
Good. Work meets expectations.

14-17 points = C
Work is generally good. Some areas are better developed than others.

10-13 points = D
Work doesn't meet expectations; it's not clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Fish Families Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student can state the number of fish families in Minnesota.
3	______	______	Student can explain that fish from the same family group share similar characteristics.
4	______	______	Student identifies five key traits used to classify Minnesota game fish into family groups.
2	______	______	Student can explain two reasons for using their grouping system to classify fish into family groups.
2	______	______	Student can discuss two problems they had sorting fish into their groups.
2	______	______	Student can identify two reasons why scientists classify organisms into family groups.
4	______	______	Worksheet is completed correctly and is legible.
2	______	______	Student can define *Osteichthyes*.
Total Points			
21	______	______	**Score** ______

Fish Families Scoring Rubric

Fish Families Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Recognize features used to classify fish into family groups	Can state number of fish families in Minnesota, and that family group members share similar characteristics. Can identify five key traits used to classify Minnesota game fish into family groups.	Can state that Minnesota fish are classified into groups called families, and that family group members share similar characteristics. Can identify four key traits used to classify Minnesota game fish into family groups.	Can state that Minnesota fish are classified into families. Can identify three key traits used to classify Minnesota game fish into family groups.	Can state that Minnesota fish are classified into families. Can identify two key traits used to classify Minnesota game fish into family groups.	Can't state that Minnesota fish are classified into families. Can't identify key traits used to classify Minnesota game fish into family groups.
Grouping fish	Can sort a set of fish cards into family groups according to shared characteristics that they've identified.	Can sort a set of fish cards into family groups according to shared characteristics that they've identified with some assistance.	Can sort a set of fish cards into family groups, not necessarily following a rationale based on shared characteristics or features of the fish.	Can sort a set of fish cards into family groups, but uses no criteria for grouping method.	Can't sort a set of fish cards into family groups.
Rationale for family grouping systems	Can explain two reasons for using their sorting system to classify fish into family groups. Can discuss two problems that arose as they sorted fish into groups.	Can explain two reasons for using their sorting system to classify fish into family groups. Can discuss one problem that arose as they sorted fish.	Can explain one reason for using their sorting system to classify fish into family groups.	Can't identify a reason for using their sorting system to classify fish into family groups.	Didn't classify fish into family groups.
Reasons for classifying organisms into family groups	Can identify two reasons why scientists classify organisms into family groups.	Can identify one reason why scientists classify organisms into family groups.	Can explain one reason why organisms would be grouped.	Can't correctly identify a reason why organisms would be grouped.	Didn't try to identify a reason why organisms would be organized into groups.
Worksheet and legibility	Worksheet is completed correctly and is legible.	Worksheet is 80% correct and is legible.	Worksheet shows half of the correct answers, but is barely legible.	Worksheet shows less than half of the correct answers, and isn't legible.	Worksheet not completed.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Instead of using worksheets, make a set of heading cards with the family names on them for each small group. Then ask the students to sort the **Fish Family Cards** by placing them under the correct heading on their tables.

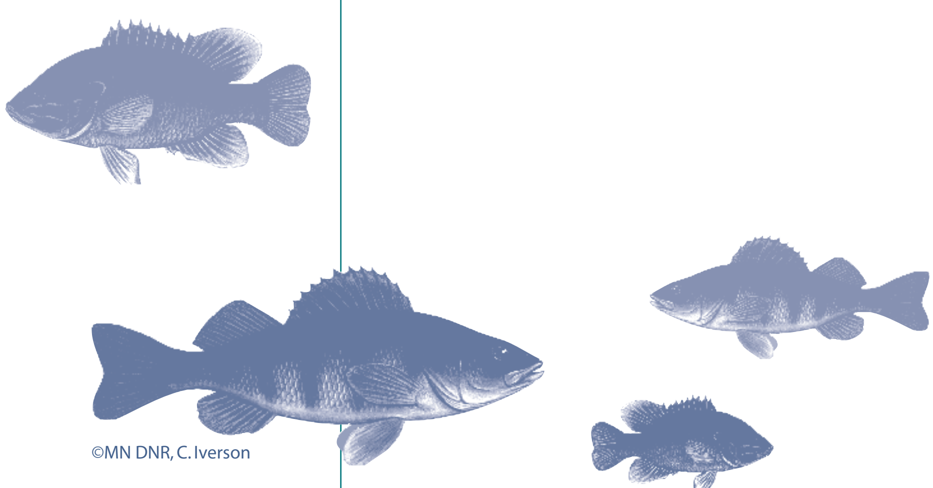
2 Explore Minnesota fish families. You can use information from the University of Minnesota's Bell Museum of Natural History Fishes of Minnesota website. Assign each student a different family. Have the students report on the identifying characteristics of the assigned family, and give examples of Minnesota fish that belong to this family.

3 Create fish family posters to display on the classroom walls.

For the Small Fry

K-2 Option

Have students use the **Fish Families Cards** to classify fish into five different family groups by sorting the fish according to the illustrations of physical characteristics.



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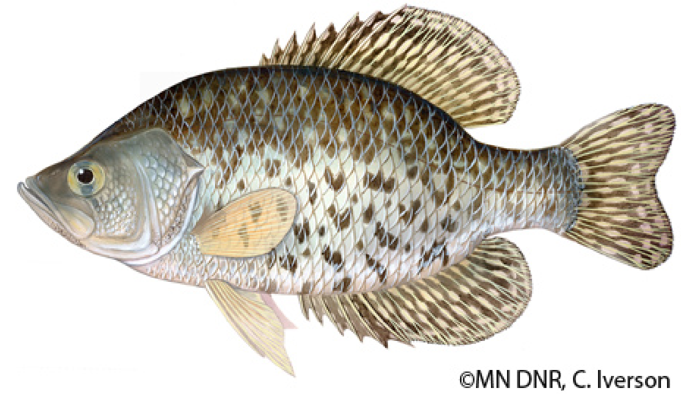
Fish Families Cards

Black Bullhead
Ameriurus melas

Body Shape: Flat-bottomed
Fins: Small dorsal fin center of back; (one spine and soft rays) adipose fin near tail
Unique Traits: Barbels (“whiskers”) near mouth
Scales: Absent



Black Crappie
Pomoxis nigromaculatus

Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present

Bluegill
Lepomis macrochirus

Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present

Brook Trout
Salvelinus fontinalis

Body Shape: Torpedo-shaped
Fins: Small dorsal fin center of back; (soft rays) adipose fin near tail
Scales: Present; very small

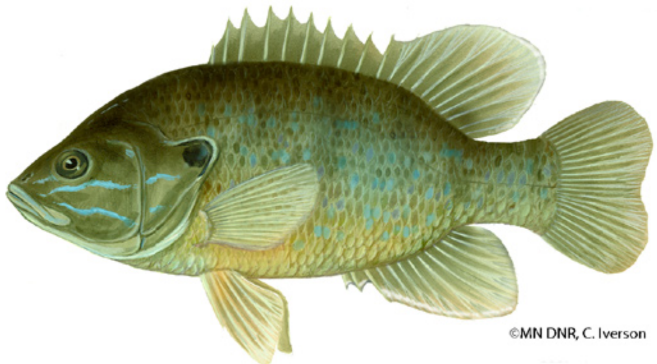
Brown Bullhead
Ameriurus nebulosus
Body Shape: Flat-bottomed
Fins: Small dorsal fin center of back; (one spine and soft rays) adipose fin near tail
Unique Traits: Barbels ("whiskers") near mouth
Scales: Absent

Channel Catfish
Ictalurus punctatus
Body Shape: Flat-bottomed
Fins: Small dorsal fin center of back; (one spine and soft rays) adipose fin near tail
Unique Traits: Barbels ("whiskers") near mouth
Scales: Absent

Coho Salmon
Oncorhynchus kisutch
Body Shape: Torpedo-shaped
Fins: Small dorsal fin center of back; (soft rays) adipose fin near tail
Scales: Present; very small

Flathead Catfish
Pylodictis olivaris
Body Shape: Flat-bottomed
Fins: Small dorsal fin center of back; (one spine and soft rays) adipose fin near tail
Unique Traits: Barbels ("whiskers") near mouth
Scales: Absent

Fish Families Cards



Green Sunfish

Lepomis cyanellus

Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present

Lake Trout

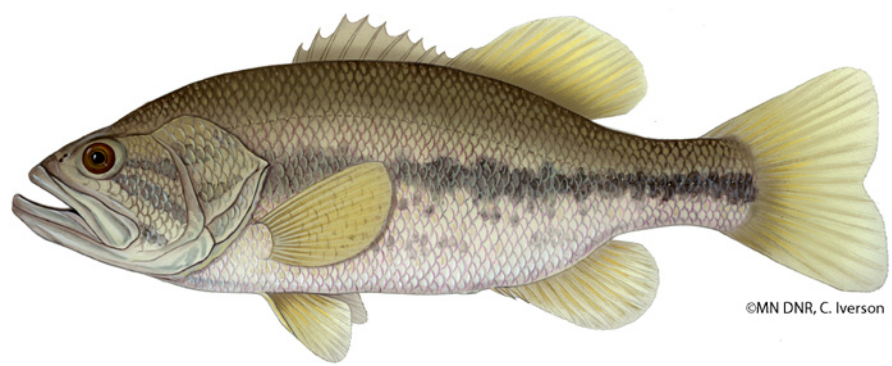
Salvelinus namaycush

Body Shape: Torpedo-shaped
Fins: Small dorsal fin center of back; (soft rays) adipose fin near tail
Scales: Present; very small

Lake Whitefish

Coregonus clupeaformis

Body Shape: Torpedo-shaped
Fins: Small dorsal fin center of back; (soft rays) adipose fin near tail
Scales: Present; very small



Largemouth Bass

Micropterus salmoides

Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present

Muskellunge

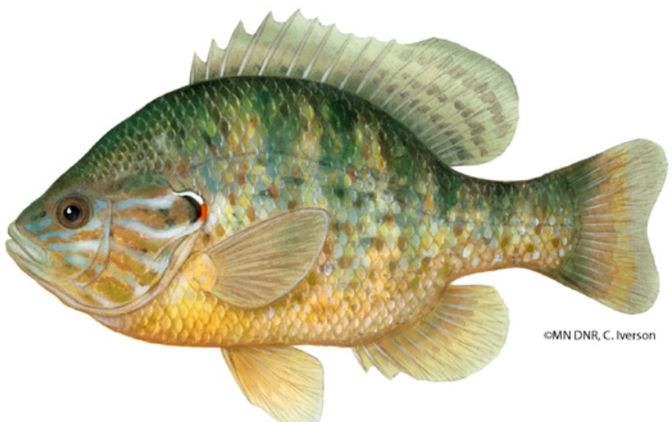
Esox masquinongy

Body Shape: Torpedo-shaped
Fins: Small dorsal fin near tail (soft rays)
Unique Traits: Duckbilled mouth, sharp teeth
Scales: Present

Northern Pike

Esox lucius

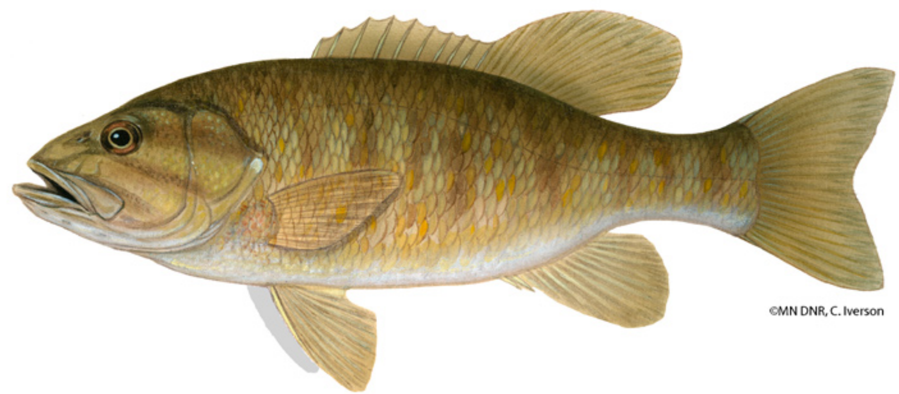
Body Shape: Torpedo-shaped
Fins: Small dorsal fin near tail (soft rays)
Unique Traits: Duckbilled mouth, sharp teeth
Scales: Present



Pumpkinseed

Lepomis gibbosus

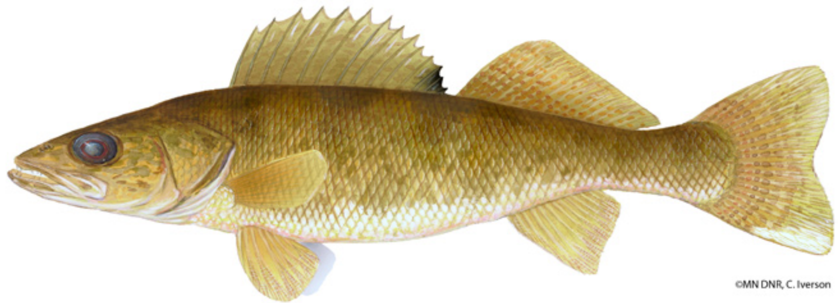
Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present



Smallmouth Bass

Micropterus dolomieu

Body Shape: Pan-Shaped
Fins: Connected two-part dorsal fin (sharp spines and soft rays
Scales: Present



Walleye
Sander vitreum
Body Shape: Torpedo-shaped
Fins: Separated two-part dorsal fin (sharp spines and soft rays)
Unique Traits: Sharp teeth
Scales: Present

Yellow Bullhead
Ameriurus natalis
Body Shape: Flat-bottomed
Fins: Small dorsal fin center of back; (one spine and soft rays) adipose fin near tail
Unique Traits: Barbels (“whiskers”) near mouth
Scales: Absent

Yellow Perch
Perca flavescens
Body Shape: Torpedo-shaped
Fins: Separated two-part dorsal fin (sharp spines and soft rays)
Unique Traits: Sharp teeth
Scales: Present

Pike Family: *Esocidae*

Members of this family have torpedo-shaped bodies, a small one-part dorsal fin near the tail, and duck-billed snout.

Catfish Family: *Ictaluridae*

Members of this family have flat undersides, an adipose fin near the tail, no scales and barbels (“whiskers”) on their faces.

Sunfish Family: *Centrarchidae*

Members of this family have pan-shaped bodies and a connected two-part dorsal fin (sharp spines and soft rays).

Trout and Salmon Family: *Salmonidae*

Members of this family have torpedo-shaped bodies and an adipose fin near the tail.

Perch Family: *Percidae*

Members of this family have torpedo-shaped bodies and a separated two-part dorsal fin (sharp spines and soft rays).

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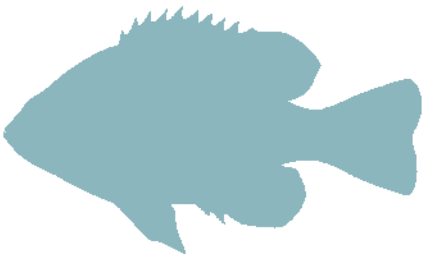
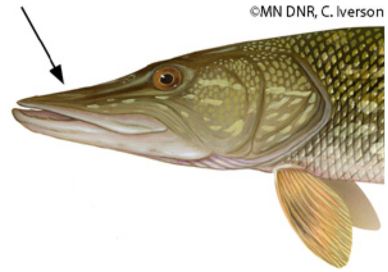
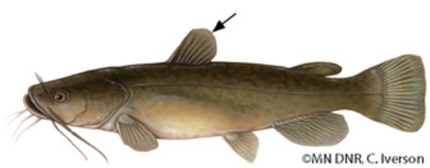
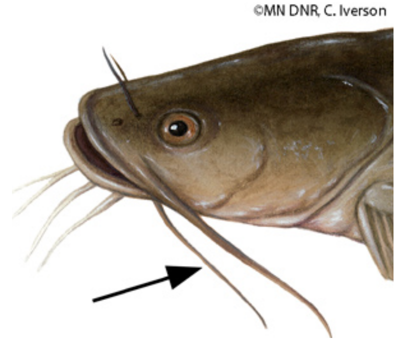
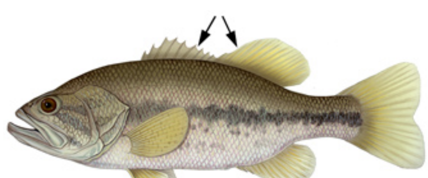
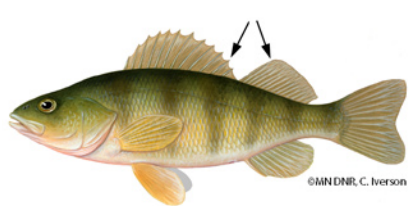
Fish Characteristics Sheet

Body Shape	Fins	Unique Traits
 Pan-shaped	 Adipose fin	 Duck-billed snout
 Flat underside	 One-part dorsal fin	 Barbels (“whiskers”)
 Torpedo-shaped ©MN DNR, C. Iverson	 Connected two-part dorsal fin	
	 Separated two-part dorsal fin	

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Name(s) ______________________________ Date ______________

Fish Families Sheet

First, use what you know about classification to sort your fish into these family groups. Then list the members of each family under the correct heading.

Catfish Family: Ictaluridae
Members of the catfish family have flat undersides, an adipose fin near the tail, no scales, and barbels ("whiskers") on their faces.

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

Sunfish Family: Centrarchidae
Members of the sunfish family have pan-shaped bodies and a connected two-part dorsal fin (sharp spines and soft rays).

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________

Trout and Salmon Family: Salmonidae
Members of the trout and salmon family have torpedo-shaped bodies and an adipose fin near the tail.

1. ____________
2. ____________
3. ____________
4. ____________

Perch Family: Percidae
Members of the perch family have torpedo-shaped bodies and a separated two-part dorsal fin (sharp spines and soft rays).

1. ____________
2. ____________

Pike Family: Esocidae
Members of the pike family have torpedo-shaped bodies, a small one-part dorsal fin near the tail, and a duck-billed snout.

1. ____________
2. ____________

INSTRUCTOR COPY

Fish Families Answer Sheet

First, use what you know about classification to sort your fish into these family groups. Then list the members of each family under the correct heading.

Catfish Family: Ictaluridae
Members of this family have flat undersides, an adipose fin near the tail, no scales and barbels ("whiskers") on their faces.

1. Black Bullhead
   Ameiurus melas
2. Brown Bullhead
   Ameriurus nebulosus
3. Channel Catfish
   Ictalurus punctatus
4. Flathead Catfish
   Pylodictis olivaris
5. Yellow Bullhead
   Ameiurus natalis

Sunfish Family: Centrarchidae
Members of this family have pan-shaped bodies and a connected two-part dorsal fin (sharp spines and soft rays).

1. Black Crappie
   Pomoxis nigromaculatus
2. Bluegill
   Lepomis macrochirus
3. Green Sunfish
   Lepomis cyanellus
4. Largemouth Bass
   Micropterus salmoides
5. Pumpkinseed
   Lepomis gibbosus
6. Smallmouth Bass
   Micropterus dolomieu

Trout and Salmon Family: Salmonidae
Members of this family have torpedo-shaped bodies and an adipose fin near the tail.

1. Brook Trout
   Salvelinus fontinalis
2. Coho Salmon
   Oncorhynchus kisutch
3. Lake Trout
   Salvelinus namaycush
4. Lake Whitefish
   Coregonus clupeaformis

Perch Family: Percidae
Members of this family have torpedo-shaped bodies and a separated two-part dorsal fin (sharp spines and soft rays).

1. Walleye
   Sander vitreum
2. Yellow Perch
   Perca flavescens

Pike Family: Esocidae
Members of this family have torpedo-shaped bodies, a small one-part dorsal fin near the tail, and a duck-billed snout.

1. Muskellunge
   Esox masquinongy
2. Northern Pike
   Esox lucius

Using a Key for Fish ID

With the right key, you can unlock the identity of a fish.

Table of Contents

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Chapter 2 • Lesson 4

Using a Key for Fish ID

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed—upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe the different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 2 • Lesson 4

Using a Key for Fish ID

Grade Level: 3-5
Preparation Time: 25 minutes
Activity Duration: 40 minutes
Group Size: any
Subject Areas: Language Arts, Science
Academic Skills: communication, comparison, description, drawing conclusions, identification, inquiry, matching, observation, ordering, problem solving, recognition, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: adipose fin, anal fin, barbel, caudal fin, dichotomous key, dorsal, dorsal fin, forked tail, gill chamber, gill opening, lateral line, lengthwise stripe, pectoral fin, pelvic fin, ray, rounded tail, spine, vent, ventral, vertical stripe
Internet Key Words: dichotomous key, Minnesota fish identification

Instructor's Background Information

Fish that are related or share similar characteristics are grouped into families. Minnesota currently has 160 fish species grouped into 27 families. Scientists use physical characteristics to identify and classify fish into family groups. Identifying and naming fish species provides a reference point for study and discussion. Fish identification is important to anglers, too. It helps them determine if their catch has broken a state record. It also helps them follow fishing regulations, tell good fish stories after fishing trips, and find the appropriate recipe for cooking their catch.

It's important to understand the difference between classification and identification. To **classify** (biologically or otherwise) is to place items in groups according to some articulated system of characteristics. To **identify** is to discover the group to which an individual has previously been assigned.

Identification Keys

Identification keys, illustrations, and descriptions based on external and internal characteristics are useful tools for identifying plants, animals, and other objects. Dichotomous keys can unlock an object's identity by presenting choices based on characteristics. Dichotomous keys are often included in field guides or reference books. They help users identify, to the species level, a specific object or organism.

Summary

Identification keys are useful tools. They identify an organism according to its physical characteristics. Using an identification key requires detailed observations of features and characteristics as well as comparing and contrasting these characteristics with those of similar organisms. Students will learn how to identify Minnesota fish species using a dichotomous key.

Although dichotomous keys are usually taught to students in grade 7, the purpose of this lesson is to develop observation skills and introduce students to a scientific tool that will help them identify organisms according to physical characteristics.

Student Objectives

The students will:

1. Identify five basic characteristics used to identify fish.
2. Use a dichotomous key to identify fish, and understand that an identification key is a tool for identifying organisms according to physical characteristics.
3. Identify similarities and differences between the physical characteristics of different species of fish using descriptions of characteristics as noted in a dichotomous key.

Materials

- **Dichotomous Key Warm-up Sheet**, one per student
- Book (any book will do)
- Pencil
- Sheet of paper
- Roll of masking tape
- Marker (with removable cap)
- **Definitions of the Parts of a Fish Sheet**, one per student (can be copied on back of **The Parts of a Fish Sheet**)
- **Caudal Fin Shapes Sheet** (or projection overhead)
- **Mouth Positions Sheet** (or projection overhead)
- **Minnesota Fishes Dichotomous Key**, one set per pair of students
- **The Parts of a Fish Sheet** (optional)
- **Fish Identification Cards**, one card for each pair of students
- **Fish Identification Cards Answer Sheet**
- Various dichotomous keys and identification guides (optional)

See **The Parts of a Fish Sheet** and the **Definitions for the Parts of a Fish Sheet** in this lesson.

The dichotomous key in this lesson is intended to familiarize students with a key using selected Minnesota fish. It's not a comprehensive key for identifying all Minnesota fish.

A **dichotomous key** is one type of identification tool used to identify something (such as a particular butterfly, plant, fish, lichen, or rock) by leading the user through a series of questions about physical characteristics. The key provides two possible answers to each question. The question series eventually leads to the correct name or classification group for the object. The key continuously divides a larger group of organisms into two smaller groups until only one choice remains. A dichotomous key used to identify fish families first lists the specific observable traits or characteristics of many fish species. For each trait, the key poses a question with two possible answers. Both responses lead to another question. By matching the option or answer to each question to the fish's features, the user can eventually identify the family to which the fish belongs. (This is similar to a game of Twenty Questions.)

> Dichotomous means separation of different or contradictory things: a separation into two divisions that widely differ or contradict one another. The term comes from the Greek words *dikho* (meaning apart, in two) and *temnein* (to cut). A dichotomous key provides two possible answers to a question.

Physical Characteristics Used to Identify and Group Fish

A dichotomous key for fish identification lists numerous observable traits of many fish species. Fish identification becomes much easier when you're familiar with the physical characteristics—the "keys" that unlock fish identities. These are the key characteristics to look for when identifying fish:

- body shape
- position of body parts, such as the mouth
- relative size and shape of body parts, such as dorsal and tail fins
- presence or absence of certain structures, such as barbels or an adipose fin
- number of scales, fin rays, or spines

In most cases, you can identify fish using only external features. Sometimes two fish species so closely resemble one another that internal structures must be examined as well.

Color and size aren't often used to identify fish. One reason for this is that color and size can vary among individuals of the same fish species, depending on age, sex, and season. Color can also vary, depending on the mineral content and water quality of a lake, river, or stream.

When students learn to use a key, they'll be able to identify many of the fish they encounter—as long as the fish species is included in the key, and the fish exhibits the characteristics listed in the key. (Some fish may not meet these criteria.)

Procedure

Preparation
1. Copy one **Dichotomous Key Warm-up Sheet** for each student.
2. Collect a book, pencil, sheet of paper, roll of masking tape, and marker.
3. Copy one **The Parts of a Fish Sheet** and one **Definitions of the Parts of a Fish Sheet** for each student.
4. Copy and cut out one or two **Fish Identification Cards**. (Make one card for each pair of students.) You may wish to have students help with the cutting. You can laminate the cards to preserve them for future use.
5. Copy one **Minnesota Fishes Dichotomous Key** for each pair of students.

Activity

Warm-up
1. Before using a key to identify fish, have the students distinguish several common classroom objects by using a simple dichotomous key. Distribute the **Dichotomous Key Warm-up Sheets** to the students. As a class, use the key to identify the book, pencil, sheet of paper, roll of masking tape, and marker. Guide them through the steps of using a dichotomous key. For each step, have them decide which of the two characteristic descriptions best fits the actual object, then move on to another pair of choices. Eventually they'll reach a point where the description fits the object and there are no more choices. Work step-by-step to reach the correct identification.
2. What if you wanted to identify objects that share many features, but are not as easily identified? An identification key is a tool that can direct its users, step by step, to observe characteristics, make comparisons, and eventually identify the object in a systematic way.
3. There are 160 fish species in Minnesota. Fishes share many physical features. How can you tell them apart and identify a particular species of fish? With the class, review ways of distinguishing one fish from another. Distribute **The Parts of a Fish Sheet** and the **Definitions of the Parts of a Fish Sheet** to each student. Go over the parts (characteristics) and their definitions. You can also use pictures of fish to point out differences so the class can better visualize these characteristics. It's especially important to cover these characteristics:
   - names and locations of fins
   - definition of barbels ("whiskers")
   - the difference between sharp spines and soft rays
   - location of lateral line
   - definition of vent
   - differences between forked, square, and rounded caudal (tail) fins
   - mouth position

You may want to do Lesson **2:2—Fins: Form and Function.**

Lesson

1 Divide class into pairs of students. Give each pair of students a **Minnesota Fishes Dichotomous Key** and a **Fish Identification Card.** Using the dichotomous key, have the students work on identifying the fish on the cards. If answers are incorrect, have them try again.
2 If time and interest allow, rotate the fish cards so that each group can identify each fish.
3 Give students a group of fish cards and have them create their own dichotomous key for identifying the fish. Have them write or explain to the class how their dichotomous key works, and how dichotomous keys are tools that help identify objects—including fish—according to physical characteristics.

Wrap-up

1 Ask the students about their experiences with the key. Was it easy to follow? Did they ever get lost and have to return to the beginning of the process?
2 After using a key to identify several fish, students will begin to remember the distinguishing characteristics of various fishes, such as body shape, mouth position, dorsal fin, tail fin, and special features. Ask each pair of students to summarize some of the most useful distinguishing features of the fish they identified, and to present those features to the class. (Include examples of kinds of fishes that share and don't share that characteristic.)
3 Ask the students to name other types of animals, plants, or other things that a dichotomous key could be used to identify, such as insects, birds, trees, flowers, or almost anything!

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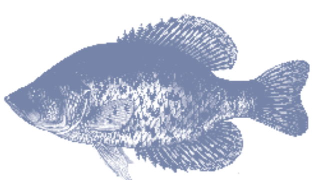


Assessment Options

1 Ask students to describe five physical characteristics they used to identify fishes. Observe all students as they use the dichotomous key and note their ability to realize and correct mistakes as they follow the steps in the key.
2 Have students create their own dichotomous key to identify the fish, or a group of organisms of their own choosing. Ask students to write or to explain to the class how their dichotomous key works, and how dichotomous keys are tools that help users identify things, including fish.
3 Give students a dichotomous key created by another student group. Ask students to use the key to identify the fish, and then evaluate how well that key worked. Ask them to write their evaluation, including any suggestions that would improve the key.
4 Assessment options include the Checklist and Rubric on the following pages.

Using a Key for Fish ID Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student identifies differences among fish species using at least five key characteristics of fish that are used for identification.
4	______	______	Student lists five key traits used to identify fish, such as body shape, mouth position, location of fins, and shape of tail.
4	______	______	Student creates an identification key and includes at least five key traits used to identify fish.
3	______	______	Student creates an identification key and designs a step-by-step method for determining differences in the key traits used to identify fish.
2	______	______	Student understands two reasons why scientists would use an identification key to identify an organism.
Total Points			
17	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

16-17 points = A
Excellent. Work is above expectations.

14-15 points = B
Good. Work meets expectations.

11-13 points = C
Work is generally good. Some areas are better developed than others.

8-10 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-7 points = F
Work is unacceptable.

Using a Key for Fish ID Scoring Rubric

Key Use Criteria	3 Excellent	2 Good	1 Fair	0 Unacceptable
Differences in fish characteristics	Can identify differences among fish species in at least five key characteristics used to identify fish.	Can identify differences in three different key characteristics used to identify fish.	Can identify differences in two different key characteristics used to identify fish.	Can identify differences in one or fewer key characteristics used to identify fish.
Fish traits	Can list five key traits used to identify fish, such as body shape, mouth position, location of fins, and shape of tail.	Can list three key traits used to identify fish.	Can list two key traits used to identify fish.	Can list one key trait used to identity fish.
Creating an identification key	Includes at least five key traits used to identify fish. Designs a method for determining differences in key traits for identifying fish.	Includes at least three key traits used to identify fish. Designs a method for determining differences in key traits for identifying fish.	Includes at least two key traits used to identify fish.	Doesn't include key traits as a means of identifying fish.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

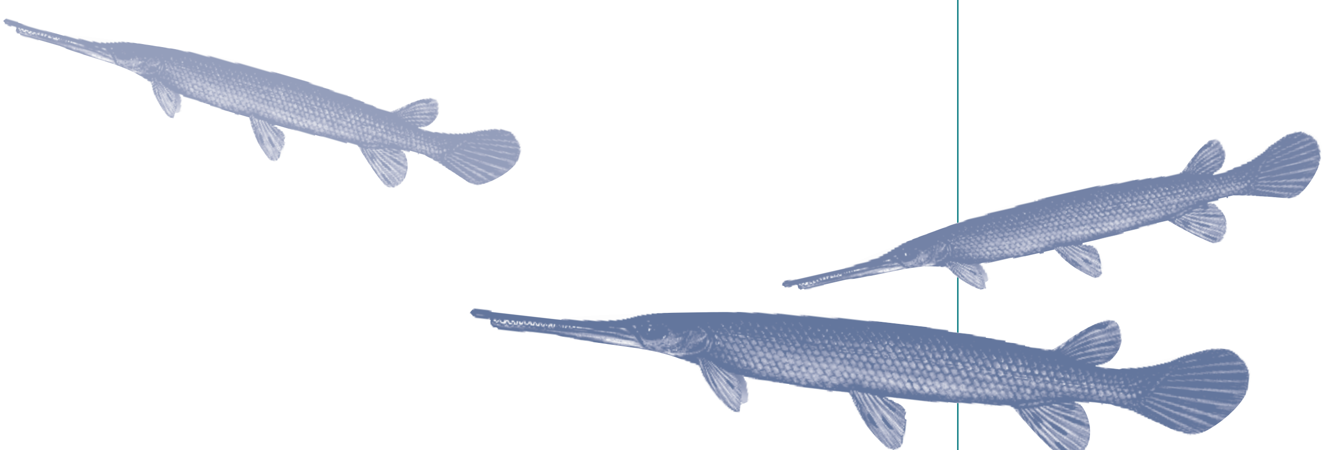
Extensions

1 Some identification keys are detailed and complex. Use a more complex key to identify some uncommon fish species. Try the key in *Fishes of the Minnesota Region,* by Gary L. Phillips, James C. Underhill, and William D. Schmid, published by the University of Minnesota Press.
2 Use dichotomous keys to identify other organisms such as insects, birds, trees, or flowers.
3 Have students create an identification key for plant species growing in the schoolyard, or for aquatic macroinvertebrates collected from a local stream.

For the Small Fry

K-2 Option

This lesson may not be appropriate for these younger students. Instead, you may wish to play a matching game (such as Concentration) with two sets of the **Fish Identification Cards.** Ask students to look closely at the fish characteristics as they make their matches. You might want to have them draw a fish before playing the game, and to draw another fish after playing the matching game with the fish cards. Ask students to compare their two drawings. Are they different? How? What could explain differences in the drawings?



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Dichotomous Key Warm-up Sheet

1a

Object has a square or rectangular shape with corners.
Go to 2

1b

Object does not have a square or rectangular shape with corners—it's cylindrical or round.
Go to 3

2a

Object can be opened and has several paper sheets between thicker covers.
Book

2b

Object cannot be opened.
Sheet of paper

3a

Object has a removable cover.
Marker

3b

Object does not have a removable cover.
Go to 4

4a

Object comes to a point on one end; has a central core of dark material.
Pencil

4b

Object has a hole in the middle.
Roll of masking tape

STUDENT COPY

Definitions of the Parts of a Fish Sheet

These words describe the parts, or characteristics, of a fish.

Dorsal: near the fish's back (top half)

Ventral: near the fish's belly (bottom half)

Dorsal fin: on dorsal side of fish; may be a single fin (one part dorsal fin) or two connected or unconnected parts (two-part dorsal fin) (Note: Some fish species that aren't native to Minnesota may have three-part dorsal fins.)

Spines: hard and often sharp; made of bone (otolithic); give structure and help support the fins

Rays: soft and usually flexible; made of a connective tissue core surrounded by scale-like bony plates (called lipidotrichia); give structure to fins

One-part dorsal fin: *single fin structure* located on the fish's back (top) side and supported by spines or rays

Two-part dorsal fin: *two-part fin structure* located on the fish's back (top) side, with one part supported by spines and a second part supported by rays; the two parts of the fin may be connected or unconnected, appearing as two separate fin structures along the back of the fish

Anal fin: fin on ventral side of fish in front of the caudal peduncle just behind the anal vent

Caudal fin: tail fin

Pelvic fins: usually paired, on the fish's ventral side, between the anal and pectoral fins

Pectoral fins: usually paired, located on the fish's ventral side, between the pelvic fin and the gill area

Adipose fin: a fleshy fin behind the fish's dorsal fin and near the tail; no supporting rays or spines

Rounded tail: no notch or fork in the caudal fin

Forked tail: notch in caudal fin

Barbels: sensory organs located on or near the mouth; sometimes called whiskers

Lateral line: a series of pores that contain nerves and run along each side of a fish; they sense movement or vibrations in the water

Vent: an opening to eliminate waste; sometimes referred to as anus

Vertical stripes: stripes that run up and down—from the dorsal to the ventral side of a fish

Lengthwise stripes: stripes that run from nose to tail

Gill chamber: where the gills are located inside the fish underneath the gill cover

Gill opening: an opening at the rear of head leading from the gill chamber to the outside; fish usually have one on each side

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Caudal Fin Shapes Sheet

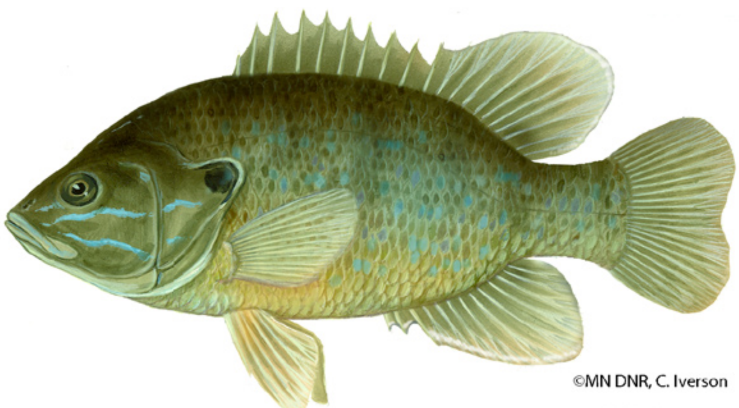
Forked Caudal Fin Shape

Channel Catfish
Ictalurus punctatus

Rounded Caudal Fin Shape

Mottled Sculpin
Cottus bairdi

Heart-shaped Caudal Fin Shape



Green Sunfish
Lepomis cyanellus

Square Caudal Fin Shape

Brown Trout
Salmo trutta

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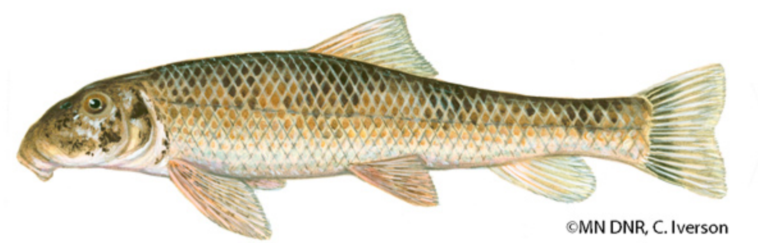
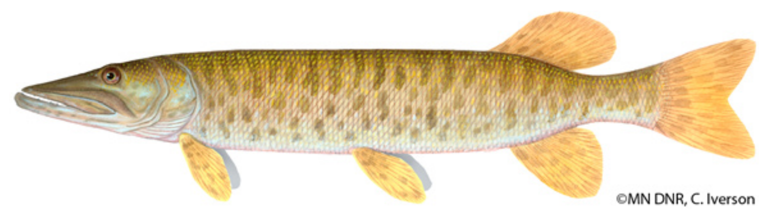
Mouth Positions Sheet

Bottom-facing Mouth Position



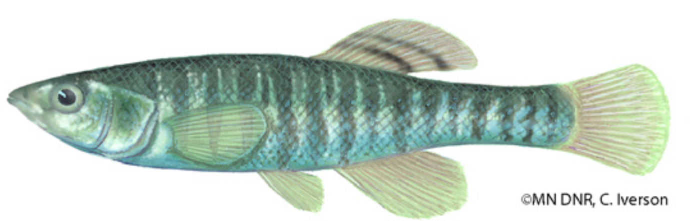
Northern Hogsucker
Hypentelium nigricans

Forward-facing Mouth Position



Muskellunge
Esox masquinongy

Upward-facing Mouth Position



Banded Killifish
Fundulus diaphanus

STUDENT COPY

Minnesota Fishes Dichotomous Key

Starting with the first pair of terms, choose the statement that best describes the characteristics of the fish you're trying to identify. If the statement you choose ends with a number, go to that number, read the pair of statements, and continue until you reach a statement that refers you to a fish name. Does the fish listed in the key have the same characteristics as this fish on your fish card? If so, you've identified your specimen properly. If not, you've made a wrong choice at some point, and you must start over.

1a Dorsal fin has one part .... Go to 2
1b Dorsal fin has two parts .... Go to 5

2a Mouth pointed down or on underside .... Go to 3
2b Mouth pointing forward .... Go to 10

3a Tail fin longer at the top portion than bottom part .... Go to 4
3b Tail fin not longer at the top portion than bottom part .... **White Sucker**

4a Body with bony plates .... **Lake Sturgeon**
4b Body without bony plates .... **Paddlefish**

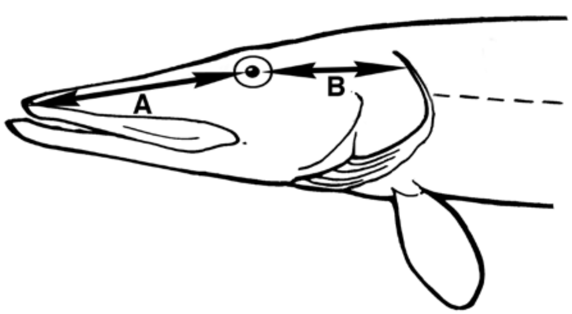
5a Two-part dorsal fin is well-connected (no space between the two parts) .... Go to 6
5b Two-part dorsal fin is not well-connected (space between the two parts) .... Go to 9

6a Lateral line goes through tail .... **Freshwater Drum**
6b Lateral line stops at tail .... Go to 7

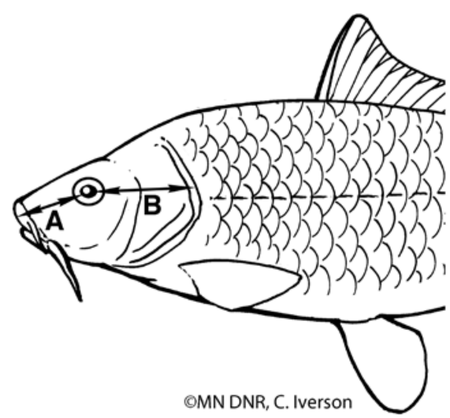
7a At least one horizontal (lengthwise) stripe .... **Largemouth Bass**
7b No horizontal (lengthwise) stripes .... Go to 8

8a Sides with black specks .... **Black Crappie**
8b Sides without black specks .... **Bluegill**

9a	Three or more anal spines	**White Bass**
9b	Two or fewer anal spines	Go to 14
10a	Snout measured from tip to center of eye **longer** than length measured from center of eye to gill opening (see illustration)	Go to 11
10b	Snout measured from tip to center of eye **shorter** than length measured from center of eye to gill opening (see illustration)	Go to 12
11a	Tail forked	**Northern Pike**
11b	Tail rounded	**Longnose Gar**
12a	Scales large and easily seen	**Common Carp**
12b	Scales not large and not easily seen	Go to 13
13a	Barbels present	**Channel Catfish**
13b	Barbels absent	**Brook Trout**
14a	Six or seven vertical stripes	**Yellow Perch**
14b	No vertical stripes	**Walleye**



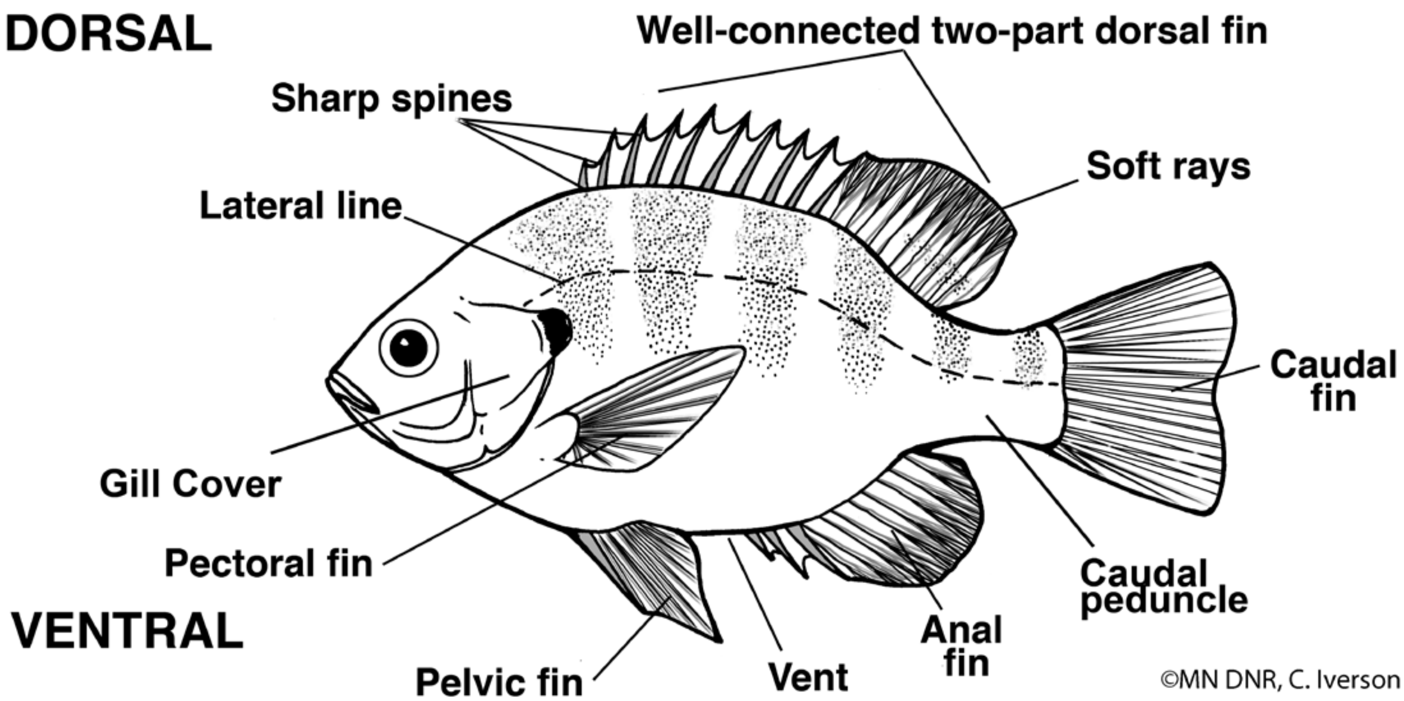
A is longer than B

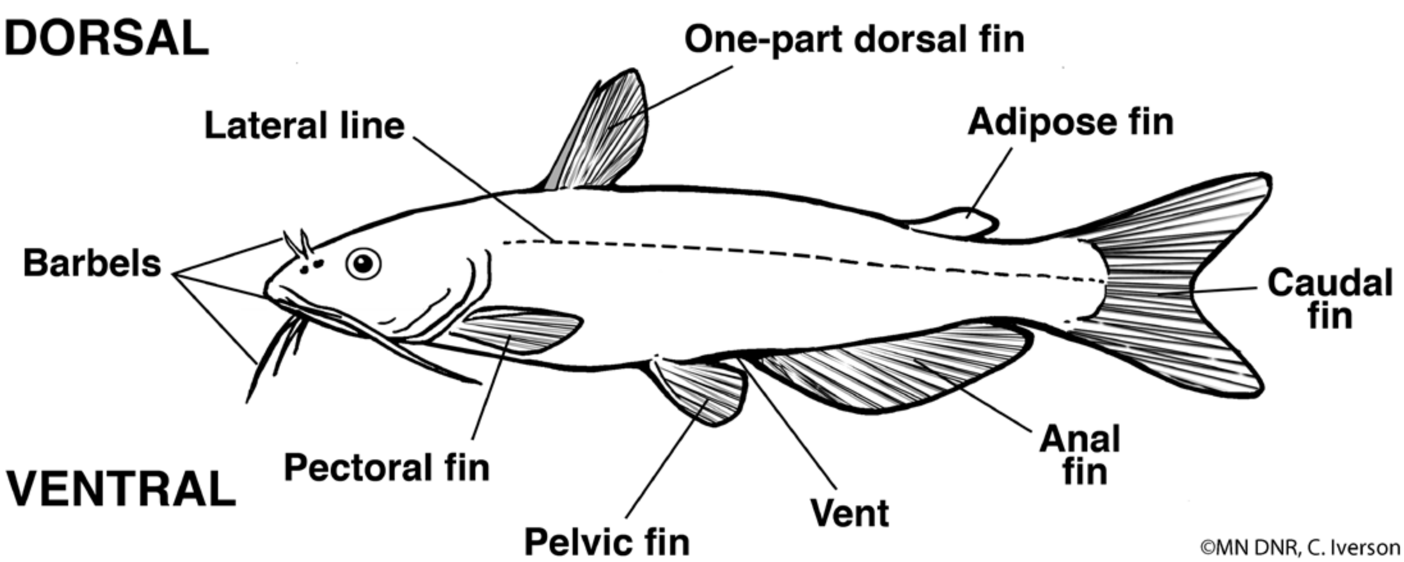


A is shorter than B

STUDENT COPY

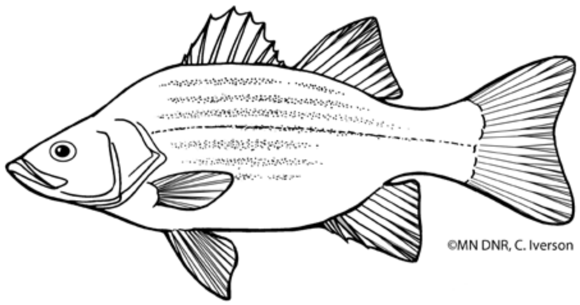
The Parts of a Fish Sheet



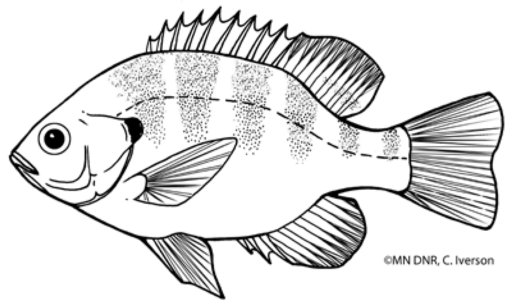


Fish Identification Cards

Copy these cards and cut them out.



A



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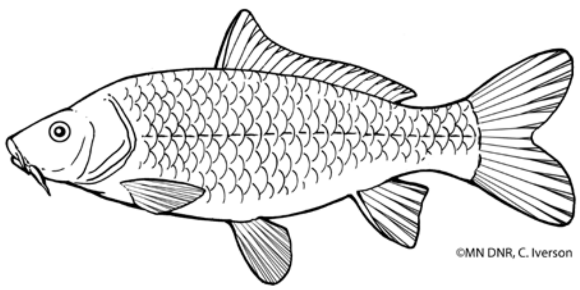

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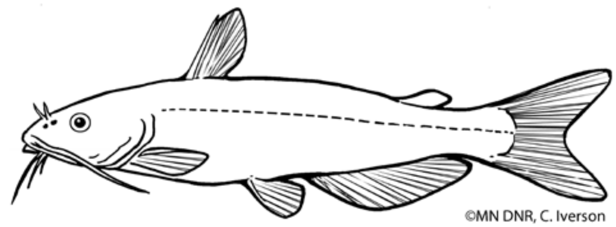

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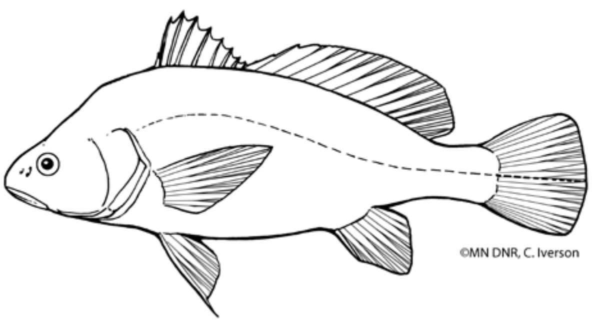

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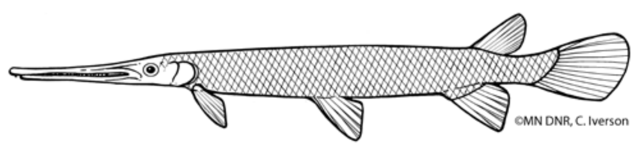

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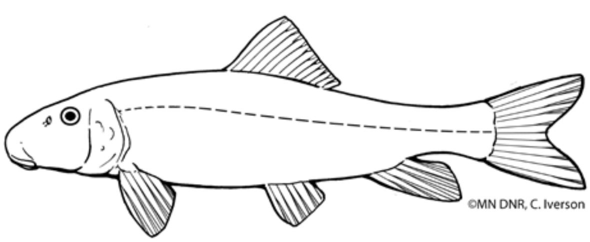

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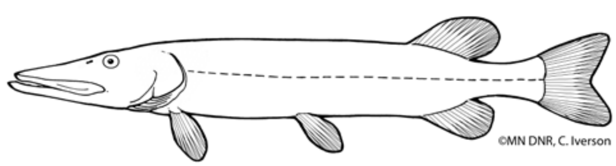
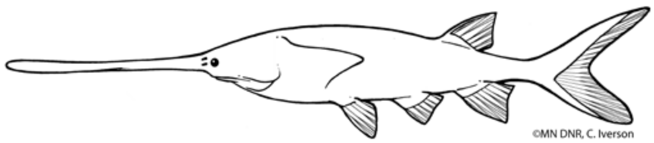


H

Fish Identification Cards

Copy these cards and cut them out.



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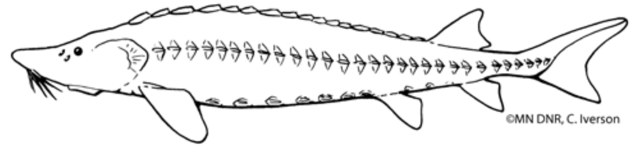

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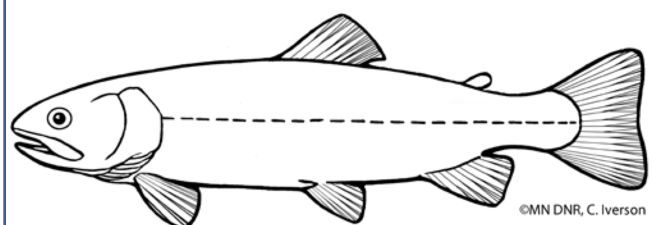

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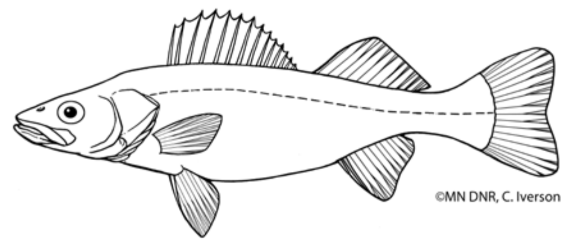

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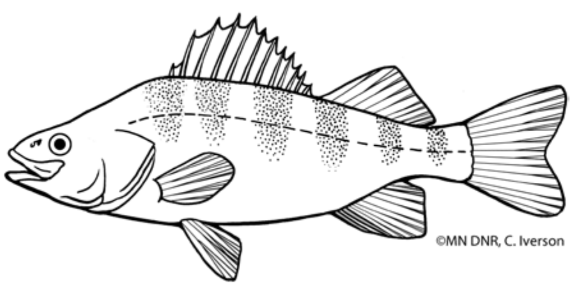

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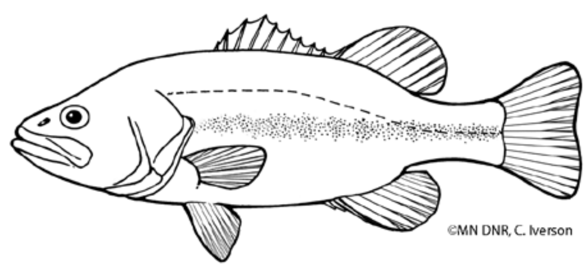

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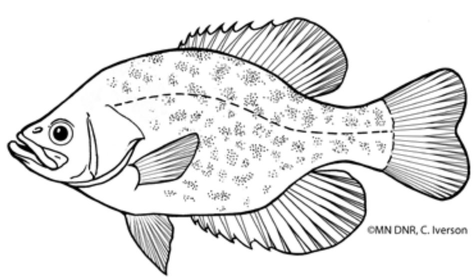

O

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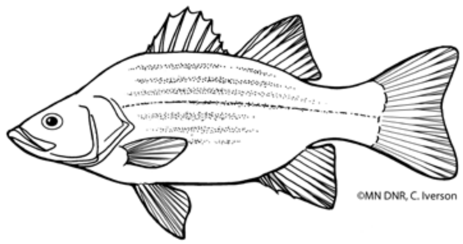
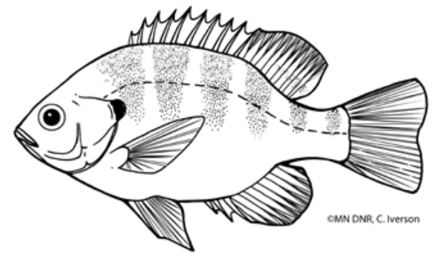
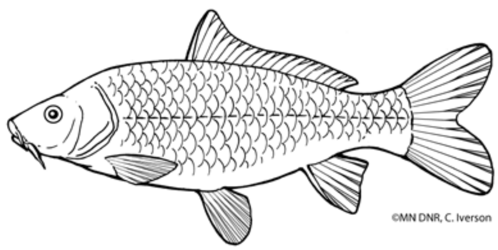
Fish Identification Cards Answer Sheet



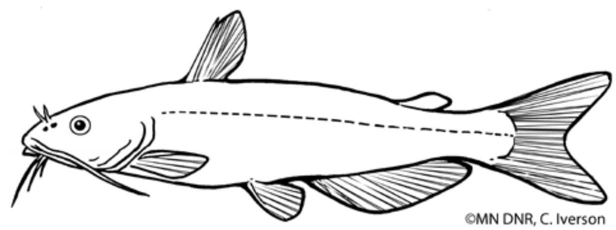
A
White Bass *Morone chrysops*
Temperate Bass Family Moronidae



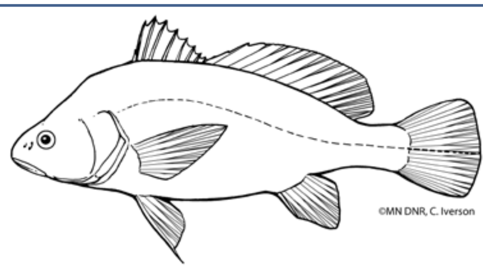
B
Bluegill *Lepomis macrochirus*
Sunfish Family Centrarchidae



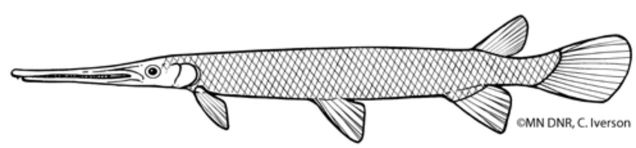
C
Common Carp *Cyprinus carpio*
Minnow Family Cyprinidae



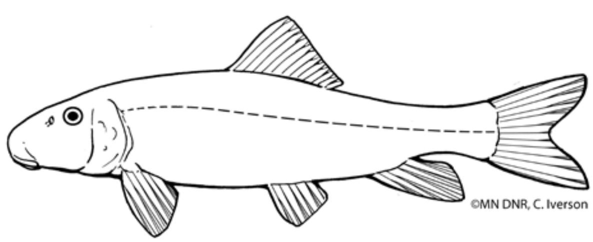
D
Channel Catfish *Ictalurus punctatus*
Catfish Family Ictaluridae



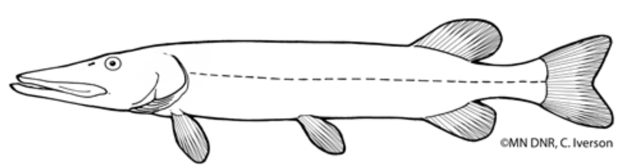
E
Freshwater Drum *Aplodinotus grunniens*
Drum Family Sciaenidae



F
Longnosed Gar *Lepisosteus osseus*
Gar Family Lepisosteidae



G
White Sucker *Catostomus commersoni*
Sucker Family Catostomidae



H
Northern Pike *Esox lucius*
Pike Family Esocidae

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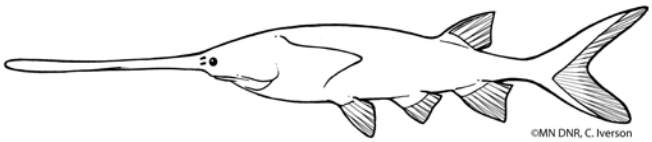
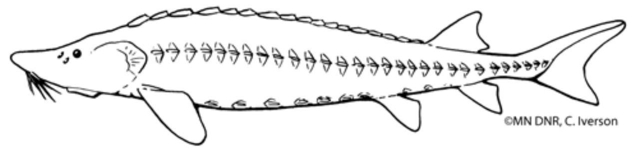
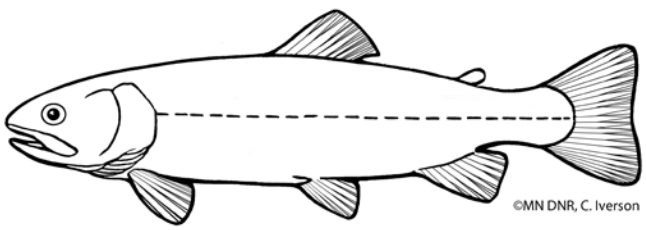
Fish Identification Cards Answer Sheet



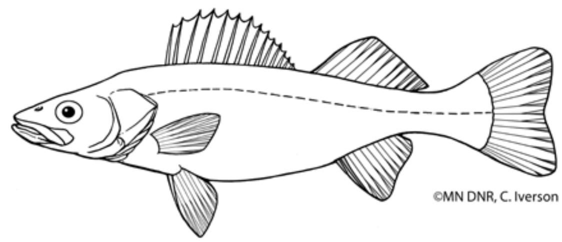
I
Paddlefish *Polyodon spathula*
Paddlefish Family Polyodontidae



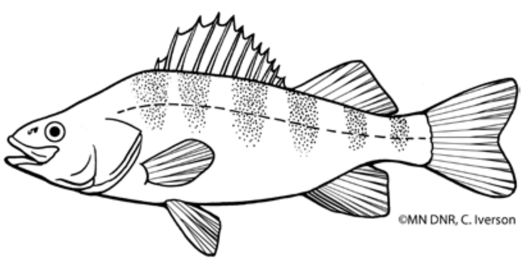
J
Lake Sturgeon *Acipenser fulvescens*
Sturgeon Family Acipenseridae



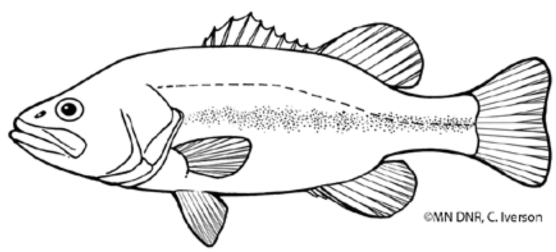
K
Brook Trout *Salvelinus fontinalis*
Salmon Family Salmonidae



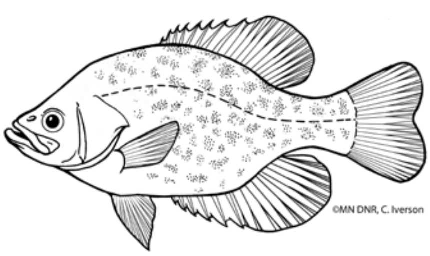
L
Walleye *Sander vitreum*
Perch Family Percidae



M
Yellow Perch *Perca flavescens*
Perch Family Percidae



N
Largemouth Bass *Micropterus salmoides*
Sunfish Family Centrarchidae



O
Black Crappie *Pomoxis nigromaculatus*
Sunfish Family Centrarchidae

Diving Into Diversity

How many ways can you classify Minnesota's diverse fish species?

Table of Contents

Chapter 2 • Lesson 5

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Diving Into Diversity

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will organize and express ideas sequentially or according to major points.

Grade 4
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.
Benchmark 4—Organize and summarize ideas, using evidence to support opinions or main ideas.

Grade 5
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will restate or summarize and organize ideas sequentially using evidence to support opinions and main ideas.

History and Social Studies

Grade K—3
VII. Government and Citizenship
B. Beliefs and Principles of United States Democracy:
Standard: The student will know key symbols, songs and locations that represent our nation and state.
Benchmark 2—Students will recognize symbols that are significant for the state of Minnesota. (The walleye is Minnesota's state fish.)

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
B. Scientific Inquiry:
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understanding.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
A. Scientific World View:
Benchmark 2—The student will recognize that clear communication of methods, findings and critical review is an essential part of doing science.
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 2 • Lesson 5

Diving Into Diversity

Grade Level: 3-5
Duration: Part 1: 20 minutes
Part 2: 70 minutes
Group Size: any
Subject Areas: Language Arts, Science
Academic Skills: analysis, classification, comparison, inquiry, observation, presentation skills, public speaking, small group skills
Setting: indoor or outdoor gathering area
Vocabulary: biodiversity, classification, species, taxonomy
Internet Search Words: fish diversity, biodiversity, classification

Summary

Students explore the diversity of Minnesota's fish species. Working in small groups, they examine similarities and differences between common fish species and design a classification system that helps them answer a question of their own devising, that they have about the fish. Each group articulates a question about Minnesota fish, shares the question in a class presentation, explains how they classified their fish species, and relates what group members learned from this activity.

Student Objectives

The students will:

1. Describe the benefits of the diversity of Minnesota's fish species.
2. Describe two different methods that can be used to classify or group fish. Students then use their classification methods to classify or group a set of fish that is new to them.
3. Conclude that fish can be sorted into groups in many different ways.
4. List two reasons why scientists classify organisms into groups.

Instructor's Background Information

Biodiversity
Our planet needs and supports a vast array of organisms or **species**. A species is a group of like individuals that are able to breed and produce fertile offspring. Species is also the classification category that follows the genus or subgenus grouping in the biological **classification** system. Classification is a systematic method of identifying, naming, and grouping like organisms according to shared features or characteristics.

A diversity of living organisms allows each individual organism to take advantage of the resources provided by the other organisms in the environment. For example, trees provide habitat and nutrients for birds, insects, other plants and animals, fungi, and microbes. The collection of all species in a particular area is referred to as the biodiversity of the region. **Biodiversity** on a global level is defined as the diversity of life on the planet, which includes genetic diversity, species diversity, and habitat diversity. More specifically, biodiversity is described by the Rutgers University Biodiversity Initiative as " . . . the sum total of all the plants, animals (including humans), fungi and microorganisms, along with their individual variations and the interactions between them. It is the set of living organisms and their genetic basis that make up the fabric of the planet Earth and allow it to function as it does, by capturing energy from the sun and using it to drive all of life's processes."

Materials

- 8.5" x 11" illustrations or photos of fish or fish images on the *MinnAqua Leader's Guide* CD
- **Fish Identification Cards**, one set per group
- **Fish Classification Part 1 Sheet**, one per group
- **Fish Classification Part 2 Sheet**, one per group
- Assortments of old house keys, luggage keys, and other types of keys (ask students to bring these from home)
- Assorted leaves

Humans have always depended on the earth's biodiversity for food, shelter, and health. Biological resources provide goods for human use, including:

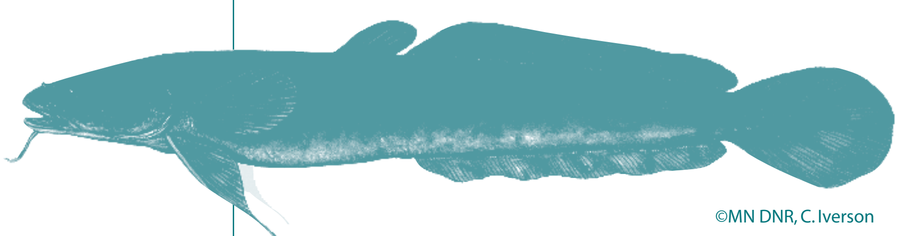
- food—numerous species that are hunted, fished, and gathered, as well as cultivated through agriculture, forestry, and aquaculture
- shelter and warmth—timber and other forest products, fibers from plants such as cotton, goose feathers for down, sheep fleece for wool, animal hides for leather
- medicines—traditional medicines as well as drugs synthesized from biological resources and processes

Biodiversity also supplies indirect services—often taken for granted—to people and other species. These include the various plants and organisms that filter and clean water, add oxygen to the atmosphere, and fertilize soils. The loss of populations, species, or groups of species can upset the normal function of an ecosystem and disrupt these ecological services.

Biodiversity provides medical models for research aimed at solving human health problems. For example, researchers study how seals, whales, and penguins use oxygen during their deep-water dives, hoping to find clues that will yield treatments for people who suffer strokes, shock, and lung disease.

Fish Diversity

In the context of the many groups of plants and animals that inhabit the earth, fish have amazing diversity. Among the vertebrates of the planet, fish actually have the *greatest* diversity. There are almost as many species of fish as amphibian, reptile, bird, and mammal species combined!



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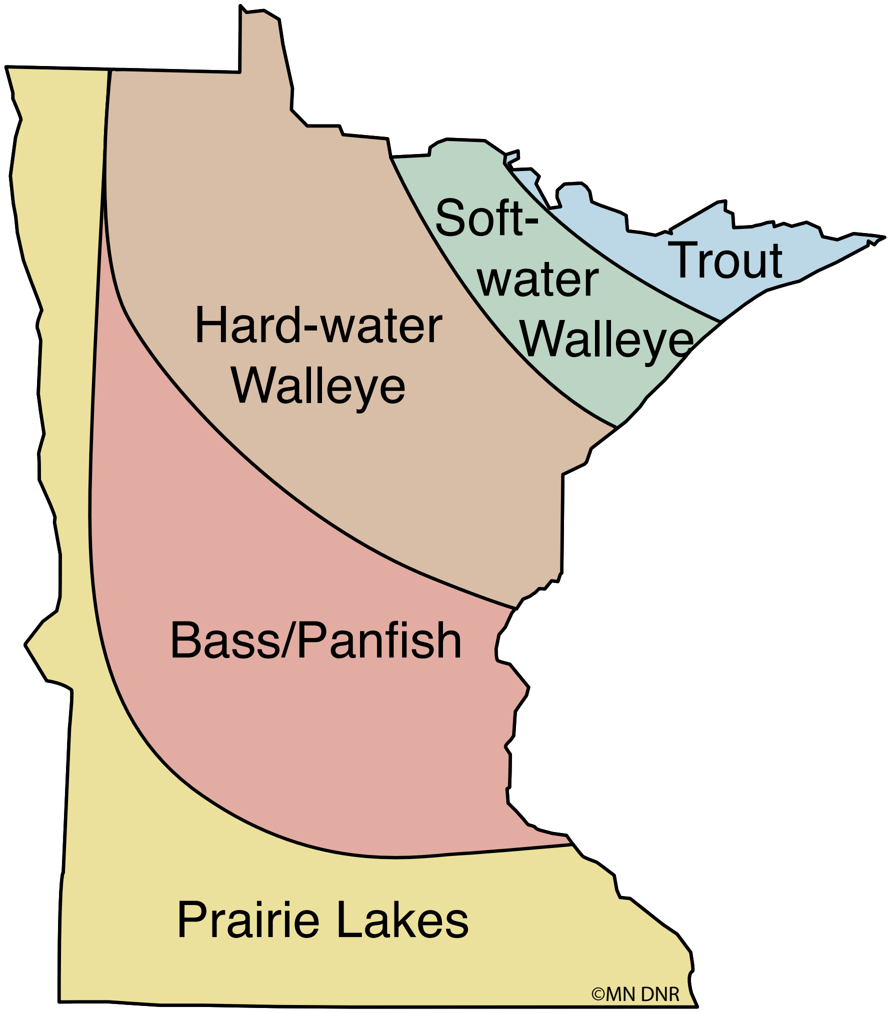


This map shows the ecological types of Minnesota waters. The state's many natural habitats shelter a rich diversity of fish. (See the Minnesota DNR publication *Managing Minnesota's Fish* for further information on habitat types.)

Minnesota Fish Diversity
With more than 12,000 lakes and 15,000 miles of fishable streams and rivers, Minnesota is currently home to 160 different species of fish. Minnesota's great diversity of fish is related to its aquatic habitats, which range from the walleye lakes of the north to the trout streams of the southeast and the prairie ponds of the southwest. This diversity allows Minnesotans to enjoy many kinds of fishing opportunities throughout the state. Fish vary in behavior traits as well as in physical characteristics. Specific behaviors and unique physical features are adaptations that help species survive the conditions existing in their environments.

There are 19,056 fish species scientifically described in the world.

Classification

Classification is the systematic grouping or arranging of objects or organisms into categories according to specific criteria. **Taxonomy** is a branch of biology concerned with classifying and naming the diverse forms of life. Carolus Linnaeus, often called the father of taxonomy, was a Swedish botanist and naturalist. In the 1700s, Linnaeus founded a classification system by assigning organisms into large groups and dividing these groups into increasingly smaller groups based on shared characteristics. Linnaeus is also credited with devising the two-part naming system for all living organisms. In the Linnaean system, also known as binomial nomenclature, an organism's name consists of its genus and species names.

Scientists use classification as a tool when researching organisms. Classification is used to show how organisms are related, and to describe changes to organisms over time. If, for example, a newly discovered organism can be placed in a classification group with organisms that share some of its characteristics, scientists may be able to learn more about it based on what they know about other organisms in that group.

As the groups in a classification system are divided and subdivided, the members of those successive groups are more and more related, sharing increasing numbers of common characteristics. The members of each successive group exhibit more shared physical features, behaviors, physiological characteristics, and genetic similarities, until the final species grouping contains one specific type of organism. This unique organism is universally distinguished from the vast diversity of all other organisms by its scientific name.

Scientific Names

Binomial nomenclature is especially important because it describes an organism using a scientific name that is recognized worldwide. When scientists refer to an organism, they use its scientific name to alleviate confusion and establish consistency. Most organisms also have common names, which can vary from place to place. For example, the scientific name of a certain well-known Minnesota fish is *Sander vitreum*. In many parts of North America, people refer to this fish as a walleye. But other languages may have different common names for this fish. The use of scientific names prevents this type of confusion because the walleye's scientific name is the same in every country.

The walleye is Minnesota's state fish and the game fish most often sought by the state's anglers. Yet panfish, including sunfish, are the fish that Minnesota anglers catch most often!

The classification system is comprised of seven taxonomic groups.

Kingdom	Phylum	Class	Order	Family	Genus	Species
Common Name: Walleye						
Animalia	Chordata	Osteichthyes	Perciformes	Percidae	*Sander*	*vitreum*
Common Name: Blue whale						
Animalia	Chordata	Mammalia	Cetacea	Balaenidae	*Balaenoptera*	*musculus*
Common Name: Red maple						
Plantae	Tracheophyta	Angiospermae	Sapindales	Aceraceae	*Acer*	*rubrum*
Common Name: Common loon						
Animalia	Chordata	Avies	Gaviiformes	Gaviidae	*Gavia*	*immer*

Procedure

Preparation

1 Post 8.5" x 11" fish illustrations or photos around the classroom.
2 Copy and cut out one set of **Fish Identification Cards** for each group of four or five students.
3 Copy one **Fish Classification Part 1 Sheet** and one **Fish Classification Part 2 Sheet** for each group of four or five students.

You may wish to laminate the **Fish Identification Cards** to preserve them for future use.

Activity

Warm-up

1 Introduce classification by telling the students that, every day, they classify things, or put objects into groups. Sorting objects, organizing them, and putting them in a specific group within a system is classification. Do you have a sock drawer in your dresser? How about a cabinet in your kitchen for storing your cups and plates? Do you collect baseball cards or stamps? How do you organize these things? Tell students that the class will practice classifying objects according to their physical structure and characteristics.
2 Begin with the assorted buttons. Have students group the buttons according to any characteristics they choose. Group or classify the buttons according to things like size, color, number of holes, and texture. Tell students to look for similarities and differences as they form the groups. Put buttons with similar characteristics into the

same groups. Next, group the keys according to characteristics and features including size, color, and shape.

3 Ask the students to sort the plant leaves according to external structures and characteristics. Then have students try regrouping them according to a different set of characteristics.

4 Ask students to consider how much easier it was to sort the inanimate buttons than the natural leaves and keys.

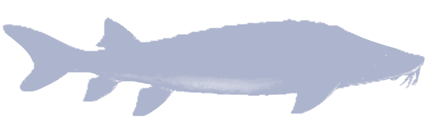
5 Emphasize that although the keys may have varied in structure, they're all still members of the same family or group of related objects.

Grouping Fish

1 Minnesota has 160 species of fish. Ask students what types of fish they have caught when they've gone fishing. How many different types can they name? Can they name the Minnesota state fish? The scientific name for walleye is *Sander vitreum.* The walleye is actually a member of the perch family because it shares characteristics with other members of that group, such as the yellow perch (or sauger), and many types of darters. When we look at fish closely, we start to notice similarities and differences. Have photos of various fish available for students to view. Ask the students to point out how two of the fish are similar and how two fish differ.

2 Tell students that sorting large numbers of fish into groups by finding similar characteristics makes it easier to learn about them. For instance, we can know that all members of the catfish family have barbels (whiskers) that help them find food and survive in a turbid environment. If we know that a yellow bullhead is a member of the catfish family, then we know it has barbels like other catfish family members, and that it probably uses its barbels to help it find food in murky water, too.

3 Ask the students if they can tell you the number of different fish species that live in Minnesota. (There are currently 160 species!) When there are many different species of fish in an area, the fish community is referred to as diverse. What are some benefits of having many species of fish in Minnesota? (There are more kinds of fish to catch, anglers can find fish in many different places such as shallow water and deep pools, and biodiversity is important and interesting.)



Lesson

Part 1: Classification

1 Divide the class into groups of four or five students. Distribute a set of **Fish Identification Cards** and **Fish Classification Sheets** to each group. Point out that, on one side of each **Fish Identification Card,** there are illustrations of physical features; the other side contains information about the fish.

2 Tell the students that they'll be designing their own classification system. Fish can be grouped in many ways, depending on what you want to know about them. For example, we can classify fish according to how they look (physical characteristics), or we can put them into groups according to where they live (habitat).

3 Have students look at all of their **Fish Identification Cards** and come up with a question about Minnesota fish. Have them record this question on the **Fish Classification Part 1 Sheet.** (Sample questions: What kind of mouths do these fish have? Where do they live? What color are they? Are their scales large or small? What is their body shape? Are they predators or prey?) The students should be able to answer the question by looking at the picture or reading the back of the card.

4 Have the students begin sorting the fish cards into groups that answer the question. The students will need to come up with descriptive headings that answer the question. For example, a group has received **Fish Identification Cards** for bluegill, rainbow trout, northern pike, yellow perch, and largemouth bass. If the group's question is "Where do they live?" the group could sort their fish cards under the headings of weeds, rocks, open water, and rivers

5 Ask students to list at least two reasons why organisms are classified into groups. As students discuss these reasons, write them on the whiteboard or projection device.

During this activity, observe the students in their groups and look for discussion and understanding that there are many ways to sort fish into groups.

The students may have some trouble when it's not clear to which group a fish belongs. A fish might share characteristics with fish in more than one group. Tell students that scientists have this problem, too, and that they must look for a way to make a decision based on the greatest number of similar characteristics or other criteria that they establish. Or perhaps one characteristic is more important than another characteristic for grouping purposes.

Part 2: Group Presentations

Have the student groups prepare presentations for the class. They may choose to perform a skit, write a poem, give a report, or create a graphic organizer to illustrate their grouping system.

The presentation should include the group's question, group headings and classification system, any problems they encountered as they grouped the fish, and whether or not they think their system would be a good way to classify all fish. Why or why not? Each group member should have a role in preparing and/or making the presentation. When all presentations are complete, have the students fill out the **Fish Classification Part 2 Sheet.**

Wrap-up

Summarize the different ways that students classified the fish. Ask the students why we choose certain classification systems. (There are several possible answers. It depends upon what we want to know about fish. And one classification system might be easier to use than another.)

A graphic organizer is a visual instructional tool that demonstrates how well a student understands a concept. Graphic organizers illustrate various aspects of concepts, issues, or problems, showing detail as well as the big picture or overall scheme, and they efficiently show relationships between concepts or ideas. Graphic organizers can take the form of a concept map, tree, star or web showing definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause and effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. Cut and folded paper can be fashioned into flaps that, when lifted, reveal details, definitions, descriptions, or explanations. Graphic organizers take on a variety of forms, but all forms enable students to use illustrations, short words, or phrases to demonstrate their understanding of complex ideas and concepts.

How does classification help you learn about fish? (One possible answer is that classification allows us to predict specific habitat needs for certain groups of fish and protect those sites. Or if a new species is discovered, and it can be placed in a group in the classification system, we might be able to learn more about it based on what we know about related organisms in that group that share many of its characteristics.) Scientists use physical characteristics and behaviors to organize fish into groups for many of these reasons. Scientists have classified the 160 species of Minnesota fish into 27 family groups.

Assessment Options

1 Assess student presentations for the following: the group question, group headings, any problems students had as they grouped the fish using the headings, and the reasons why (or why not) they think their system would be a good way to classify all fish. Students demonstrate an ability to classify fish into groups based on fish characteristics—and understand that there are multiple solutions to the problem of grouping organisms—by suggesting two or more ways to group the fish. Demonstrate how the classification methods that the groups chose helped them answer their questions about the fish. After the student presentations, ask the class to discuss the types of additional information that could be collected to help solve some of the grouping problems, or to answer questions about fish. Make sure that each student has a role in preparing and/or making the presentation, and that they participate in class discussion.

2 Have students prepare a written description of their reflections on their group's classification system and points noted in Assessment 1.

3 Have students act out different fish characteristics and determine a classification system for grouping the fish. Have students write a description of the classification system, including drawings of the fish characteristics that they portrayed. Give copies of three different grouping systems to each student and have them compare the different classification systems, describing one benefit and one problem for each grouping method.

4 Find pictures of fish that aren't in the **Fish Identification Card Set**. Have students figure out where the fish fit in the classification scheme they developed. They should describe why the fish fits, and the type of information about the fish that would help them better classify it.

5 Assessment options include the Checklist and Rubric on the following pages.

Diving Into Diversity Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student presentation includes the question the group posed for deciding how to group fish.
2	______	______	Student presentation includes mention of group headings.
2	______	______	Student presentation includes mention of the problems the student team faced as they grouped their fish.
2	______	______	Student presentation includes an explanation of whether or not their grouping system would be a good way to classify all fish.
2	______	______	Student identifies two reasons why scientists would classify fish into groups.
3	______	______	Student classifies the fish into groups based on reasonable criteria (such as features or food preferences).
2	______	______	Student appreciates that there are multiple ways to classify organisms.
2	______	______	Student understands that the details addressed in a classification system can influence the perception of organisms.
2	______	______	Student explains that there are many different fish species in Minnesota.
4	______	______	Student gives examples of three different fish groups whose members share some similar characteristics.
Total Points			
23	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

20-23 points = A
Excellent. Work is above expectations.

18-19 points = B
Good. Work meets expectations.

15-17 points = C
Work is generally good. Some areas are better developed than others.

11-14 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-10 points = F
Work is unacceptable.

Diving Into Diversity Scoring Rubric

Presentation Criteria	3 Excellent	2 Good	1 Fair	0 Unacceptable
Content	Presentation includes the question, group headings, problems encountered in grouping fish, and explanation of whether or not the group thinks their method would be a good way to classify all fish.	Presentation includes three-quarters of the required information.	Presentation includes half of the required information.	Presentation includes less than half of the required information.
Reasons for classification systems	Identifies two reasons why scientists would classify fish into groups.	Identifies two reasons why scientists would classify fish into groups with prompting.	Identifies one reason why scientists would classify fish into groups.	Can't identify why scientists would classify fish into groups.
Classification system details	Classifies the fish into groups based on reasonable criteria (such as features or food preferences). Appreciates that there are multiple ways to classify organisms. Understands that details addressed in a classification system can influence perceptions of organisms.	Classifies the fish into groups based on reasonable criteria (such as features or food preferences.). Appreciates that there are multiple ways to classify organisms.	Classifies the fish into groups. Appreciates that there are multiple ways to classify organisms.	Classifies the fish into groups, but the groups aren't based on reasonable criteria and are random.
Minnesota fish diversity	Explains that there are many fish species in Minnesota and that some species share some similar characteristics. Gives examples of three groups of fish that share some similar characteristics.	Explains that there are many fish species in Minnesota and that some species share some similar characteristics. Gives and example of one group of fish that shares some similar characteristics.	Explains that there are many fish species in Minnesota and that some species share some similar characteristics.	Can't explain that there are many fish species in Minnesota.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Do **Lesson 2:6—Adapted For Habitat** to illustrate that different species of fish have adaptations that that help fish survive in the conditions of their environments.
2 Do **Lesson 2:4—Using a Key for Fish ID** to illustrate how scientists identify fish.
3 Relate species diversity to habitat diversity by playing a relay game. Divide the class into two teams. Set up three hula-hoops representing habitat types (such as a shallow area of lake, a deep area of lake, and a stream) across the far end of the field. Line up the teams on the other end of the field. When signaled to start, the first person in line from each team picks up a **Fish Identification Card**, races across the field, and places it in the appropriate hula-hoop habitat. Upon returning to their team, the next student in line takes a card and runs across the field to the hula-hoops to place their card in the appropriate habitat. (Rather than grouping fish by physical characteristics, the students group the fish according to behavior. Where does each fish live?) It can be difficult, sometimes, to decide which habitat is appropriate for the fish. The student should make a choice, however, and be able to explain why they chose a particular habitat for their fish.
4 Obtain and review the *Fisheries Tour Packet* from the Minnesota DNR MinnAqua Program to prepare for a visit to an aquarium or fish hatchery.
5 Visit an aquarium or fish hatchery to see different species of Minnesota fish, examine their characteristics, observe their adaptations, and learn about their preferred habitats.
6 Research and report on endangered Minnesota fish species. What causes fish to become endangered?

For the Small Fry


©MN DNR, C. Iverson

K-2 Option

Group fish pictures by body shape, color, or other similar appearances. Name these fish groups. Have students create a new fish by drawing, painting, or modeling it with available craft materials. Determine to which group the new fish belongs, and give it a name.

STUDENT COPY

Name(s) ______________________ Date ____________

Fish Classification Part 1 Sheet

After looking at the Fish Identification Cards, your group should come up with a question about Minnesota fish. Write your group question here.

____

____

____

How did you group your fish? ______________________________

____

How many groups did you make? ______________________________

What did you name these groups? ______________________________

____

____

____

Group Heading 1 ______________________________

List the fish species in this group. ______________________________

____

____

____

Which characteristic do the members of this group share? ______________________________

____

____

____

____

continued

STUDENT COPY

Name(s) ______________________ Date ____________

Fish Classification Part 1 Sheet (continued)

Group Heading 2 ______________________

List the fish species in this group. ______________________

____

____

Which characteristic do the members of this group share? ______________________

____

____

____

Group Heading 3 ______________________

List the fish species in this group. ______________________

____

____

Which characteristic do the members of this group share? ______________________

____

____

____

Group Heading 4 ______________________

List fish species in this group. ______________________

____

____

Which characteristic do the members of this group share? ______________________

____

____

(If you have more than four groups, list them on the back of this sheet.)

STUDENT COPY

Name(s) ______________________________ Date ______________

Fish Classification Part 2 Sheet

Answer the following questions.

1. Did you have any problems putting fish into groups? If so, list these problems.

2. Would this be a good way to classify all fish? Why or why not?

3. List two reasons why scientists would classify fish into groups.

4. What did you learn about fish?

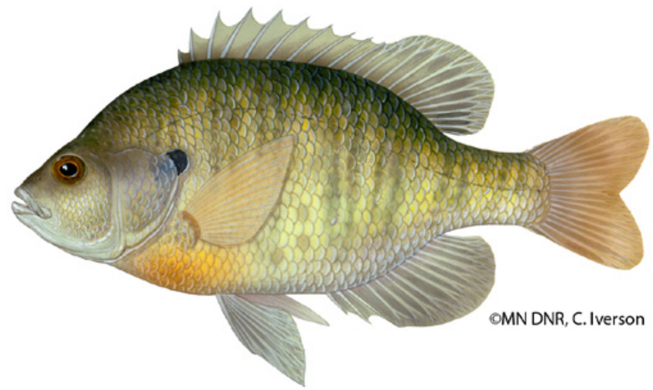
Fish Identification Cards

Copy the cards, cut them out, fold or cut them along the center lines, and laminate or mount them on card stock.

Brook Trout *Salvelinus fontinalis*

Shape: Torpedo-shaped
Mouth: Medium-sized and forward on the head
Fins: Adipose fin between the dorsal and tail fin; square caudal fin
Scales: Very small
Color: Dark green to silver with red spots; squiggly lines on back; white margins on anal and pelvic fins
Habitat: Cold, clear streams
Behavior: Unaggressive—often wait below aquatic vegetation such as watercress, feeding on organisms swept in front of them from upstream
Food: Small fish and insects
Fun fact: Minnesota's only native stream trout

Fish Identification Cards



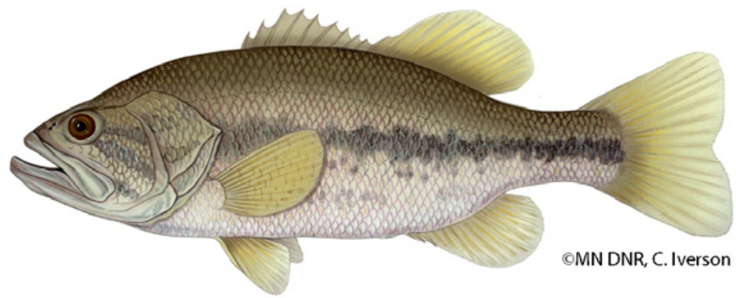
Bluegill *Lepomis macrochirus*

Shape: Pan-shaped
Mouth: Small and forward on the head
Fins: Dorsal or top fin along the back is well-connected between the spines and soft rays
Scales: Medium-sized; round
Color: Olive green and purplish tinge with orange to blue belly; solid black opercular lobe
Habitat: Heavily vegetated clear warm lakes
Behavior: Travels in schools; takes insects from surface
Food: Small fish, insects, snails, and zooplankton
Fun fact: The most commonly caught game fish in Minnesota

Northern Pike *Esox lucius*

Shape: Torpedo-shaped
Mouth: Duckbilled with many teeth and forward on the head
Fins: One-part dorsal; forked tail fin
Scales: Small and round
Color: Greenish back and white belly; light spots on a dark background
Habitat: Vegetated lakes, rivers, and streams
Behavior: Very aggressive while chasing prey fish
Food: Small and medium fish
Fun fact: Northern pike grow faster than muskellunge, but they don't become as large

Fish Identification Cards



Largemouth Bass ***Micropterus salmoides***

Shape: Pan- or football-shaped
Mouth: Large; jaw extends beyond eye
Fins: Dorsal fin well-connected between spines and soft rays
Scales: Medium and round
Color: Dark green with white belly and black lateral stripe
Habitat: Weedy, quiet, sand- and mud-bottomed lakes and streams
Habits: Ambushes prey from hiding spot; highly territorial
Food: Small fish, crayfish, and frogs
Fun fact: Anglers prized them for their fight and willingness to hit artificial lures

Yellow Perch ***Perca flavescens***

Shape: Short torpedo
Mouth: Small and forward on the head
Fins Two-part dorsal fin with a space between the spines and soft rays
Scales: Small and round
Color: Pale yellow to bright orange with dark, vertical stripes on side
Habitat: Rocky, vegetated, fairly deep lakes and rivers
Habits: Swim in large schools
Food: Small fish, zooplankton, insects, snails, and crayfish
Fun fact: Many anglers prefer the flavor of yellow perch to their more famous cousin, the walleye

Fish Identification Cards

Brown Bullhead ***Ameiurus nebulosus***

Shape: Flat-bottomed
Mouth: Forward and wide, with barbels
Fins: Adipose fin and one-part dorsal fin
Scales: None
Color: Body yellowish to black with a white belly
Habitat: Lakes and quiet steams and rivers
Habits: Parents guard young by patrolling edges of schools
Food: Feeds on almost anything such as minnows, crayfish, snails, and insects
Fun fact: Whiskerlike barbels are sense organs covered with taste buds, not stingers

Lake Sturgeon ***Acipenser fulvescens***

Shape: Torpedo-shaped
Mouth: Points downward with barbels
Fins: Tail fin longer on the top than the bottom.
Scales: Armored plates
Color: Blackish to greenish yellow on the back and sides with white belly
Habitat: Found in large rivers and lakes
Habits: Plucks insects from the bottom with vacuum-like mouth.
Food: Snails, clams, crayfish, and insects
Fun fact: The largest fish in Minnesota, they can live to be 150 years old

Fish Identification Cards

Paddlefish *Polydon spathula*

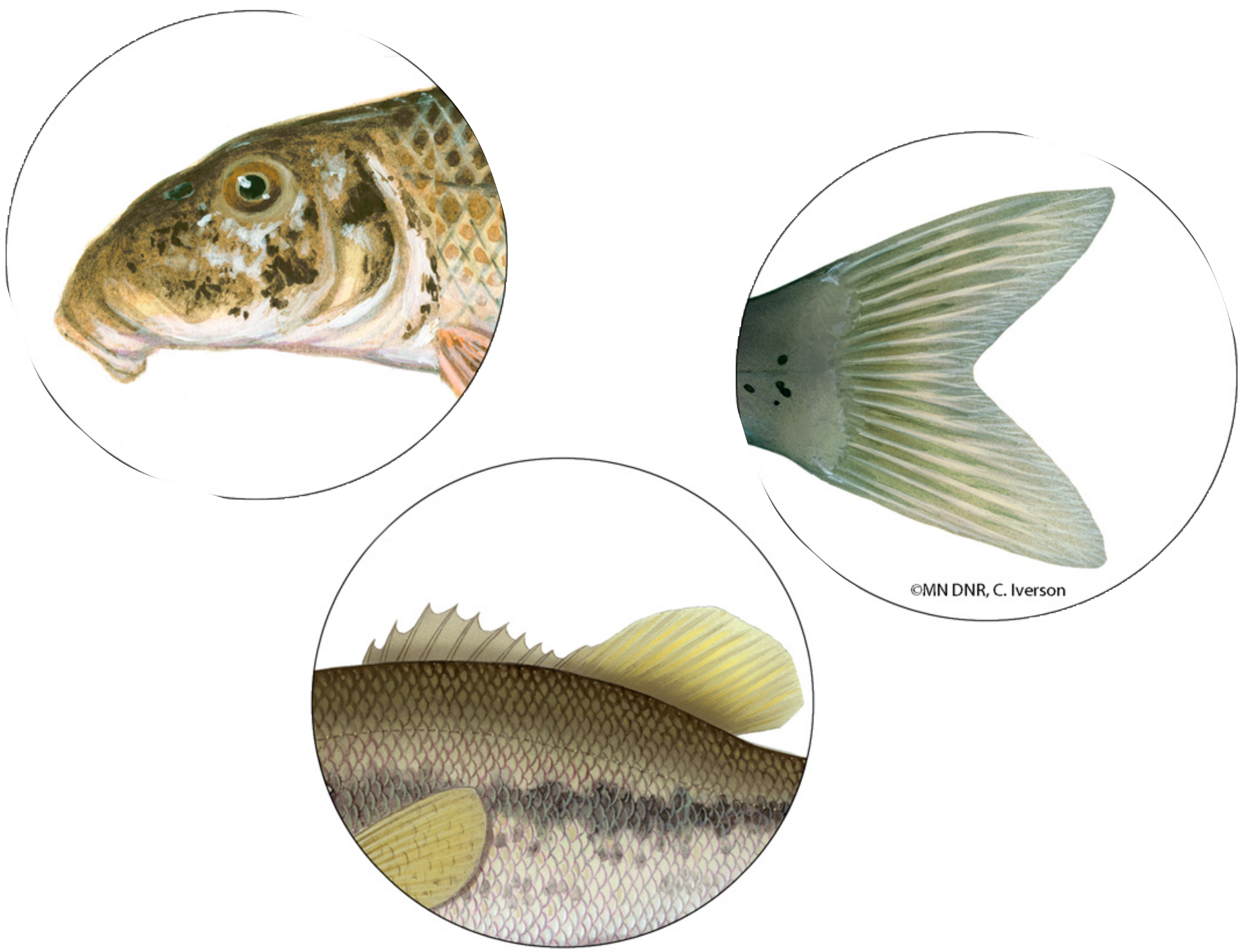
Shape: Torpedo-shaped
Mouth: Forward with upper jaw formed into a long, paddle-like snout
Fins: Tail fin longer on the top than the bottom
Scales: Few and rhomboid-shaped
Color: Dull gray, sometimes bluish on top and white below
Habitat: Open water areas of large rivers
Habits: Collects food by straining tiny organisms from the water as baleen whales do
Food: Plankton
Fun fact: Catches food by swimming with its mouth wide-open to gather plankton.

Burbot (Eelpout) *Lota lota*

Shape: Flat-bottomed
Mouth: Forward and wide
Fins: Two-part dorsal fin with space between the spines and soft rays
Scales: Small and round
Color: Dark olive with darker markings on the back and sides
Habitat: Deep water during the summer months; moves to shallower water during the winter
Habits: Known to gorge on food to the point that the stomach balloons
Food: Voracious eaters; feed on a numerous species of fish including perch, whitefish, ciscoes, and suckers
Fun fact: Members of the cod family, this tasty fish is known as "poor man's lobster."

Adapted for Habitat

The physical features and behaviors of fish enable their survival.



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Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Chapter 2 • Lesson 6

Adapted for Habitat

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning, including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversations and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

Grade 4
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of styles to express meaning, including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
f. persuasive
g. thank you note
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.

Grade 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II.Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning,
including:
a. descriptive
b. narrative
c. informative
d. formal letter
e. poetry
f. persuasive
g. thank you notes
h. reports

III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.

Science

Grade 3
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
IV. Life Science
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food.

Grade 4
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.
IV. Life Science
E. Biological Populations Change Over Time:
Benchmark 2—The student will recognize that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 2 • Lesson 6

Adapted for Habitat

Grade Level: 3-5
Duration: Part 1: 30 minutes
Part 2: 50 minutes
Group Size: any
Subject Areas: Expressive Arts, Science
Academic Skills: construction, drawing, generalizing, invention, modeling, presentation skills, public speaking, recognition, simulation, visualization, writing
Setting: indoor or outdoor gathering space with tables
Vocabulary: adaptation, biodiversity, camouflage, depth perception, disruptive coloration, dorsal fin, extinction, habitat, ichthyologist, predator, prey, redd, spawn
Internet Search Words: fish adaptations, fish features

Summary

Fish exist in a variety of sizes, shapes and colors. Unique characteristics called adaptations help them survive in their watery environments. In Part 1, two student volunteers “dress” in the adaptations of predator and prey fish. In Part 2, the class decides what a local lake or river environment might be like in the year 4000. Each student then designs a fish with adaptations suited to this habitat of the future.

Student Objectives

The students will:
1. Identify fish adaptations in each of the following categories: mouth, body shape, coloration, reproduction, and fins, for at least three different species of fish.
2. Describe how each adaptation might help the fish survive in its habitat.
3. Design a hypothetical fish species with adaptations suited for a set of futuristic environmental conditions.
4. Explain that adaptations are features, characteristics, and behaviors that help organisms survive conditions in the habitats where they live.

Instructor’s Background Information

Fish exist in all shapes, sizes, and colors, but they do have some traits in common. All fishes are cold-blooded vertebrates, for example. And all fishes have gills for absorbing oxygen from water and fins to help them maneuver underwater. Most fish species have scales that protect their bodies.

Although most fish share some characteristics, there are thousands of different species of fish in the world, and each has unique features that have developed over time, becoming progressively refined in response to changes in environmental conditions. As the biological adaptation of a species evolves over many hundreds or thousands of years, that species becomes better and better suited to its habitat. An **adaptation** is a physical characteristic or behavior of a plant or animal that suits it to its environment and enables it to better survive particular conditions. Adapted features are inherited, or passed genetically from generation to generation. Adaptations happen slowly over time. Adaptations also include behaviors that help an organism to be more successful in its environment.

Materials

Warm-up

- **Fish Identification Cards from Lesson 2:5—Diving Into Diversity**, four sets
- Large hat
- Sheet of drawing paper, one per student
- Drawing materials for each student, such as colored pencils, markers, or crayons

Part 1: Adapted for Habitat

- Two name tags marked “predator” and “prey”
- Shirt with camouflage pattern or stripes
- Drab-colored shirt
- Sturdy crate or box, eight to 20 inches tall and strong enough to hold the weight of a student standing on top of it (optional)
- One pair of earmuffs or a headband with large paper eyes taped or otherwise attached to either side
- Large eyeglass frames (such as plastic sunglasses with the lenses popped out)
- Three beanbags or foam balls
- Backpack, with a large spiky dorsal fin attached (fin can be cardboard)
- Backpack, with a small flimsy dorsal fin attached (can be paper or fabric)
- Two paper funnels (one should be large, with forward-protruding paper teeth taped to the inside of its wide end; the other should be smaller, without teeth)
- Two twelve-inch lengths of quarter-inch elastic, for attaching to funnels so students can wear them

continued

Because fish are one of the oldest groups of animals, they’ve had time to become one of the most diverse animal groups. Only insects exhibit a greater diversity of species. About half of the earth’s known species are insects (200,000 species). There are approximately 18,000 fish species, most of which are saltwater, or ocean-dwelling.

Fish Adaptations

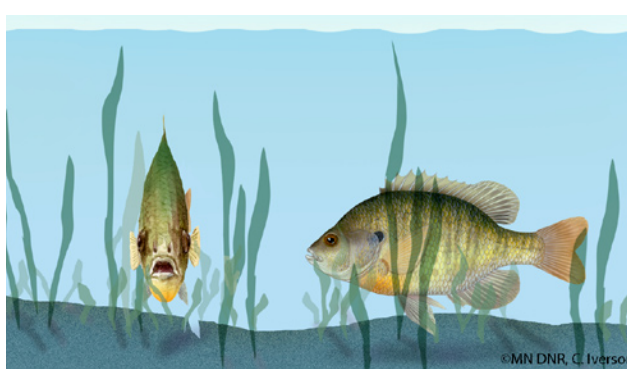
A wide variety of lakes, rivers, and streams provide a diversity of habitats for Minnesota’s many fish species. There are currently 160 fish species in Minnesota, each possessing special adaptations enabling it to survive in the conditions where it lives. For example, some fish live in deep, open water. Others prefer shallow areas near plants. Some fish are adapted to the fast-moving currents of streams or rivers. Others are suited to still waters.

Prominent adaptations include coloration patterns, body shapes, tail fin shapes and dorsal fin types, mouth features, eye (large or small, and where thay are placed on the head), and reproductive habits. If conditions change dramatically, for example, if an algae bloom results in a decrease in dissolved oxygen levels in a lake, a fish species suited to waters with high oxygen levels may no longer be suited for survival in the altered environment. **Ichthyologists** (scientists who study fish) continue to learn more about the adaptations of fish and how human activities impact aquatic environments and fish populations.

Body Shape

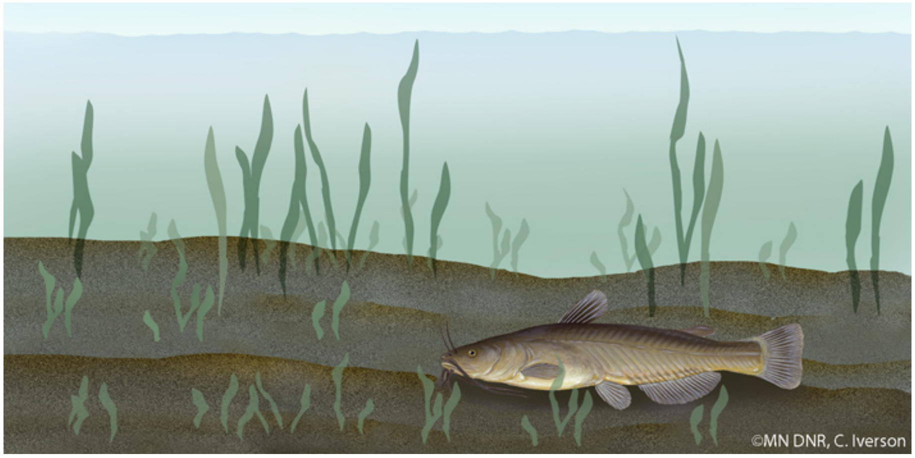
Fish have various body shapes, including flat or laterally compressed bodies, flat-bottomed bodies, and long, torpedo-shaped bodies.

Prey fish (fish eaten by other fish) often have bodies that are laterally compressed, or flat from side to side. This shape allows them to easily fit and maneuver in areas with many aquatic plants. In vegetation, these fish can find cover and hide from **predators** (fish that eat other fish). A sunfish is an example of a prey fish. These fish are also known as panfish because their shape fits a frying pan. Sunfish are small fish with small mouths suited for eating tiny things (like insects) that they find as they swim in areas of aquatic vegetation.



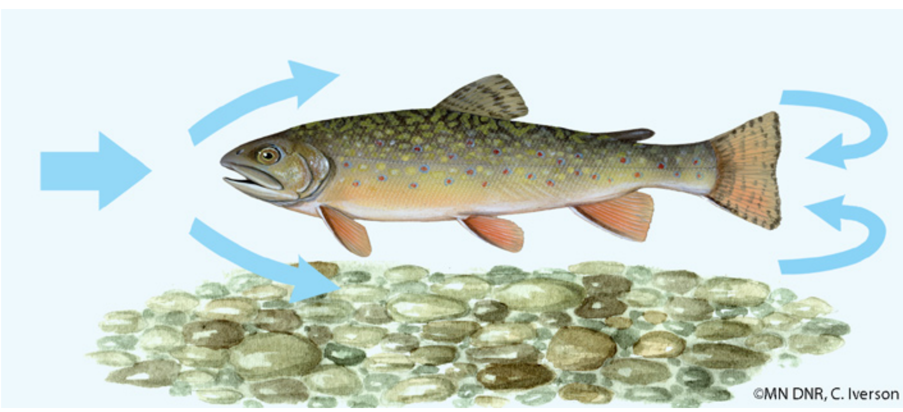
Because its shape is laterally compressed, a bluegill maneuvers easily in a cover of vegetation.

Flat-bottomed fish "hug" or travel along the bottom of a lake, river, or stream as they search for food.



Bullheads are bottom-feeders with flat undersides.

Some prey fish and many predator fish are torpedo-shaped. This streamlined shape enables the fish to swim quickly, with less drag in the water. Examples of torpedo-shaped fish include trout, salmon, northern pike, gar, and muskellunge.



A torpedo-shaped trout swims against the current. (Arrows show direction of current.)

Some fish are long and narrow, or ribbon-shaped, like snakes. Burbot, lamprey, and the American eel are ribbon-shaped fish. This shape enables them to swim very fast, maneuver currents, and fit into crevasses and holes in the rocks or sunken logs that afford cover and protection from other predators.

A ribbon-shaped burbot.

Materials (continued)

- Two handfuls of paper confetti, or the small paper circles from a hole punch
- Broom and dustpan for sweeping up the confetti scattered during the activity
- Small bowl
- **Fish Adaptations and Advantages Sheet**, one per student

Part 2: Future Fish of the Year 4000

- **Future Fish of the Year 4000 Sheet**, one per student
- **Fish Adaptations Sheet**, one per group
- Crayons, colored pencils, or markers
- Construction paper
- Selection of art and craft materials such as scissors, glue, construction paper, modeling clay, and paint
- Pencils and pens

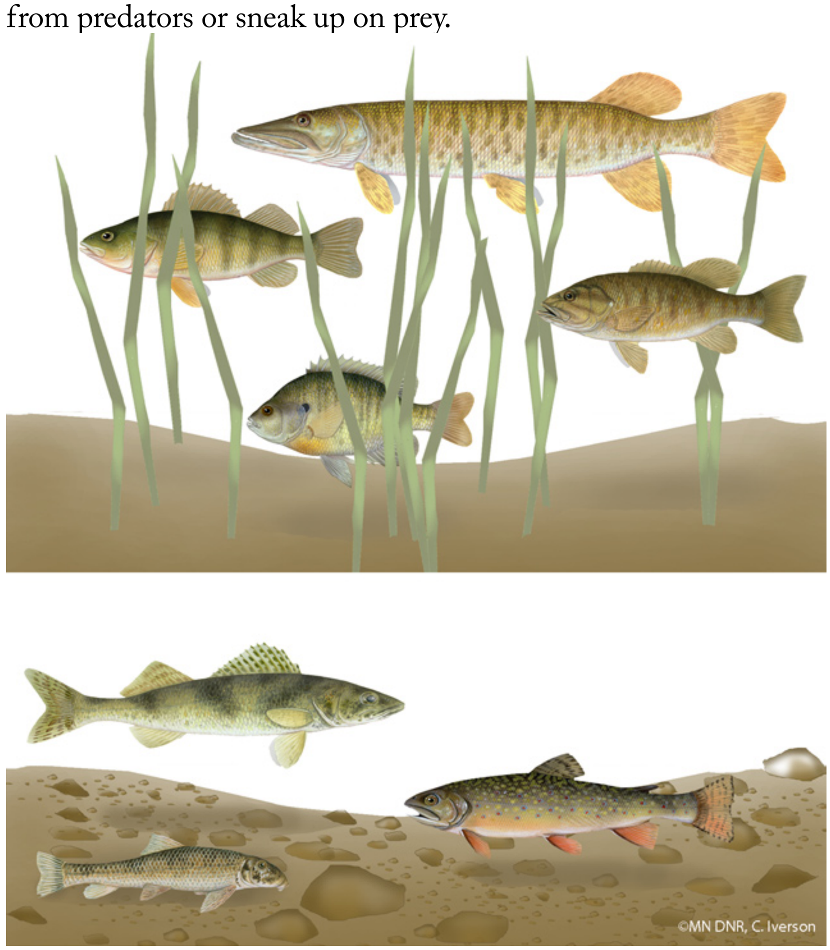
K-2 Option

- Sheets of white butcher paper (approximately three feet square), two per student or pair of students
- Crayons or markers
- Scissors
- Stapler or tape
- Crumpled newspaper, for stuffing fish
- Monofilament line, for hanging fish

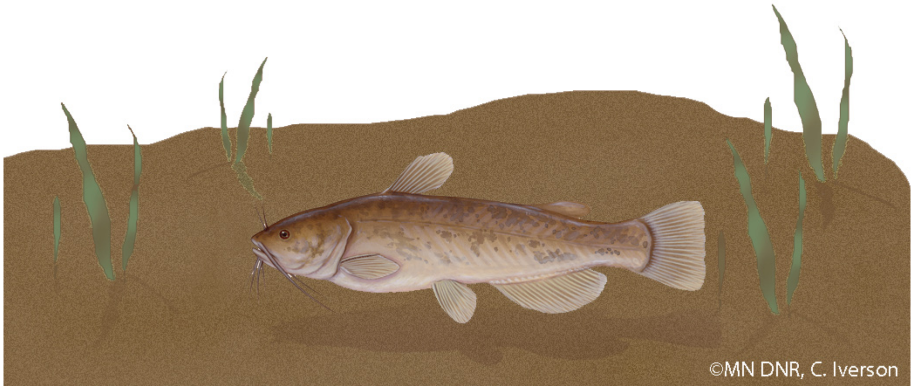
Coloration

Fish have many different colors and patterns. Each species is unique, and patterns and colors help a fish identify potential mates and others of its own species. Color and pattern are also survival tools, enabling fish to fool other fish by masquerading as something best avoided. A fish can distinguish predators from prey, and it recognizes the fish with which it can safely travel in schools. Colors and patterns are significant adaptations that help fish survive in other ways, too.

Coloration that helps fish blend into environments and prevent detection is called **camouflage**. An animal with **disruptive coloration** is marked with spots, stripes, mottling, or other patterns that break up its outline and help it blend into its background. Vertical stripes camouflage fish in backgrounds containing plants. Fish with vertical stripes include yellow perch, bluegills, smallmouth bass, and muskellunge. Fish marked with specks or dots merge with backgrounds containing air bubbles as would occur in riffles and rapids in a river. Specks or dots also camouflage fish in areas where small rocks or pebbles are the background. Brook trout have spotted patterns; sauger and northern hogsucker are examples of fish with mottled patterns. The drab coloration of some species, such as brown bullheads, helps them blend into murky, muddy, or dark backgrounds on pond bottoms. Camouflaged fish can more easily hide from predators or sneak up on prey.



Disruptive coloration like stripes, spots, and specks helps fish blend into their surroundings.

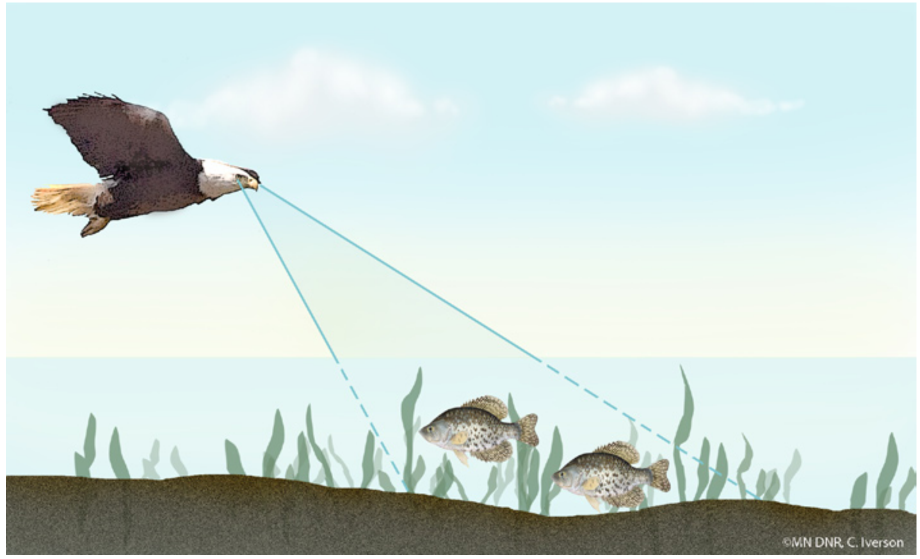


Drab coloration also blends fish into their surroundings.

There are occasions when a fish can benefit from drawing attention to itself. Some fish have bold, dramatic patterns that distract predators from recognizing them as lunch. For example, a bowfin (dogfish) has a large dark spot, a false eyespot, on its tail. The eyespot really looks like an eye, which confuses predators, causing them to target the prey's tail instead of its head. Some fish, such as rainbow darters, display bright colors only during the **spawning** (egg laying) season, to attract mates.

Notice the eyespot on the bowfin's tail.

Sunlight falls on a fish's environment from above. In these conditions, a light-colored bottom and a dark top (**countershading**) hides a fish from predators. Most minnows, perch, and walleye have light-colored undersides or bellies that make it hard for predators to see them from below because they blend in with the lighter sky. Fish with dark-colored upper sides include bluegills and crappies. Predators, such as eagles and osprey, have a difficult time seeing fish with dark upper-sides from their vantage above the water, because the fish blend in with the darker colors of lake or river bottoms.



A black crappie displays countershading—the eagle has a difficult time seeing it from overhead.

When threatened, sunfish display their large dorsal fin to look larger.

Dorsal and Caudal (Tail) Fins

Prey fish often have large fins—particularly dorsal fins. The **dorsal fin** is located along the back (topside) of a fish between its head and tail. A large dorsal fin helps stabilize a short, laterally compressed body, as the fish swims through the water. A large, flared dorsal fin also helps a small fish look bigger and more threatening, as illustrated by the sunfish. The dorsal fin of a sunfish also has sharp spines that can stick in a predator's throat, making the sunfish more difficult to swallow. Spines function as a defense against predators as well as a structural component of the fin.

The **caudal fin**, or tail fin, is located at the end of the fish and provides power that propels the fish forward, like a motor. It also acts like a rudder to assist in steering. Caudal fins have varied shapes, such as forked, rounded, heart-shaped, and square.

The shapes of caudal fins tend to correspond to the cruising speed of fishes. **Roving predators** (fish that spend much of their time cruising and searching for prey) require speed or continuous movement, and they typically have forked tails. A forked tail produces less drag in the water than a rounded or squared tail, enhancing speed. When a roving predator, such as a channel catfish, locates a potential meal, quick flicks of its forked tail provide a sudden burst of speed, enabling it to overtake and capture its prey. **Lie-in-wait predators** also capture their prey with a sudden burst of speed, but instead of cruising around looking for prey, they remain still, mimicking a stick or log. The longnose gar is an example of a lie-in-wait predator. They lie still, under cover, and wait for unsuspecting prey to swim by. They then dart out to ambush it. Some lie-in-wait predators have torpedo-shaped bodies with rounded caudal (tail) fins. Others have forked tails like roving predators. The dorsal and anal fins are usually located toward the back of the long body, close to the large caudal fin. Just as a motor provides power in the back of a boat, dorsal and anal fins lying close to the tail concentrate power at the back of a fish. These fins all work together to propel the fish forward with a burst of power as unsuspecting prey ventures near the camouflaged predator that has patiently awaited its approach.

The northern pike is a predator whose dorsal fin is located near its tail.

Sometimes smaller fins are beneficial. Prey species, such as minnows, and many stream or predator fish, such as brook trout, have small fins. These allow fish to swim in swift river currents without much resistance, hide from large predators in small crevices and holes, and swim quickly in currents as they chase prey. (See **Lesson 2:2—Fins: Form and Function** for more information on fin adaptations.)

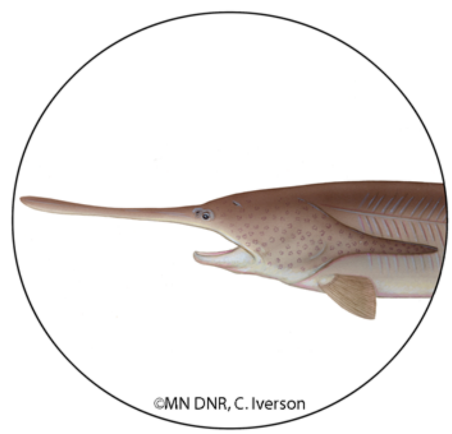
Mouths

The feeding behavior of fish can be discerned by the shape, size, and location of their mouths. Prey fish have small mouths suited to eating plankton, small plants, and insects. Predator fish have large mouths that enable them to eat other fish. Predators often have a mouthful of sharp teeth to help them catch and hold their prey. Fish mouths might point up for snatching insects from the surface of the water, straight ahead to reach food in front of the fish, or point down to find food on the bottom. (See the **Fish Adaptations Sheet** in this lesson for illustrations.)

Examples of Fish Mouths

Suckers and carp have soft-lipped, sucker-shaped mouths that point downward for sucking small plants and animals from the bottom. Sturgeon also have mouths—as well as sensory barbels, or whiskers—positioned underneath their snouts. They eat snails, clams, crayfish, and immature insects from the bottom.

Paddlefish have an elongated upper jaw that resembles a canoe paddle. The upper jaw protrudes beyond the lower jaw. Paddlefish swim with their mouths wide open, eating mostly plankton filtered from the water with screen-like structures (gill rakers) located at the backs of their throats. Their paddles, covered with sensory receptors, locate and guide the food (clouds of plankton) into their mouths.



The mouths of banded killifish point upward. With their elongated lower jaws, they feed on prey (floating insects) that they see above them on or near the water's surface.

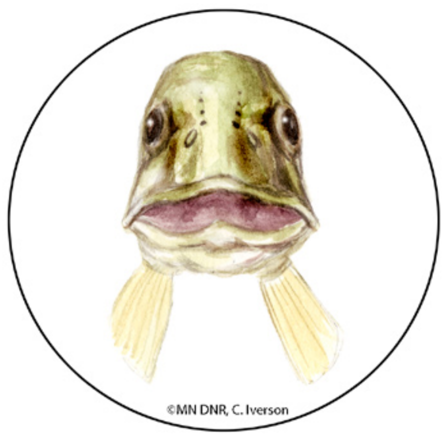
The large, duckbill-shaped mouths of northern pike and muskellunge allow these large predator fish to easily grasp sizeable prey. Numerous—and extremely sharp—teeth allow them to catch and securely hold their prey. The diet of the adults consists mostly of fish, but they eat just about anything they can catch, including frogs, mice, crayfish, muskrats, and ducklings. Northern pike and muskellunge can eat fish as long as one-third to half their own length!

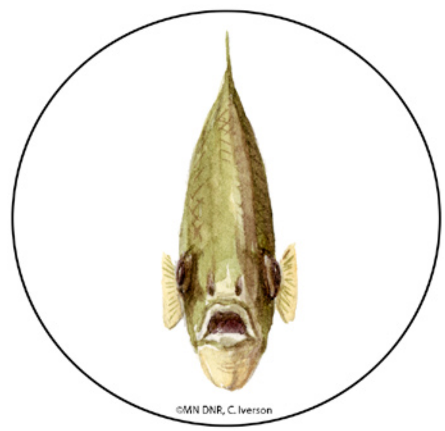
The relatively large jaws of the largemouth bass allow it to "inhale" smaller prey, sucking it in with water. Largemouth bass, as well as the garfish, grab large prey. They can turn it around in their mouths to swallow it head-first, so that the spiny dorsal fins of some prey species don't catch in their mouths. Like northern pike, a largemouth bass can consume prey nearly half its own length and it, too, eats almost anything it can catch, including other fish, frogs, crayfish, and insects.

Eyes

The eyes of a prey fish are located on either side of its head. The fish can see all around, but not directly above or directly behind itself. Fish with eyes on the opposite sides of their heads don't have very good **depth perception**—they can't easily determine distances between themselves and other objects.

Many predator fish have eyes located further forward on their heads. Having both eyes focused in the same direction provides better depth perception, enabling them to catch prey.





The eyes of a northern pike face forward; a bluegill's eyes are on the sides of its head.

Reproductive Behaviors

Most fish lay eggs instead of giving birth to live young. Different species of fish demonstrate a variety of **spawning** or breeding behaviors.

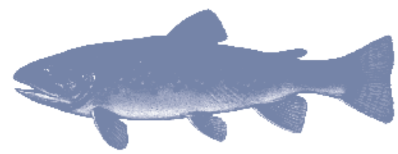
Nesting—Males in the sunfish family use their tails to sweep sediment and create bowl-shaped nests on lake or stream bottoms. The females supervise the nest building and choose and mate with the males who build the best nests and have the brightest coloration and patterns. After fertilizing the eggs, the males guard the nests and protect the eggs from predators. They also keep the nest free of debris and oxygenate the eggs by fanning their tail over them.

Fish in the salmon family dig depressions for their nests, which are known as **redds**. While the male wards off other males, the female does most of the digging by using her tail to fan away finer sediments. She then lays eggs in the redd. The male fertilizes the eggs by releasing milt over them, and buries them to hide them from predators.

Catfish find protected areas, such as hollow logs or holes in banks, in which they deposit eggs and guard them and the newly-hatched young.

Broadcast Spawning—Some fish, such as yellow perch or some minnow species, lay their eggs in a mass or string of jelly to be left alone hanging on a plant or an old log. Some fish even "glue" their eggs—one at a time—to aquatic plants. Other fish, such as freshwater drum, release their eggs into the open water, where they must fend for themselves. Yellow perch, northern pike, and carp randomly disperse their eggs near vegetation. The eggs have a sticky coat or covering. As they fall through the water, the eggs stick to vegetation, where they remain secure until they hatch.

Naming Fish
To distinguish one organism from another, scientists give each species a unique scientific name consisting of two words. The first word is the name of the genus. The second word is the species name for the organism. Scientific names are usually Latin or Greek. Scientific names often describe adaptations, such as physical features, physiological functions, behaviors, genetic makeup, or evolutionary history. Sometimes the name of the person who discovered the organism becomes a part of its scientific name.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Common Name	Scientific Name
Brook trout	*Salvelinus fontinalis* (Latin, meaning a little salmon living in springs)
Lake chub	*Couesius plumbens* (Named for the ornithologist Elliott Coues and Latin, meaning lead-colored)
Golden redhorse	*Moxostoma erythurum* (Greek, meaning mouth to suck and red-tailed)
Rock bass	*Ambloplites rupestris* (Greek, meaning blunt armature and Latin, meaning living among rocks)

What Causes Conditions to Change in Aquatic Environments?
Changes in an environment can occur naturally. Some environmental changes are seasonal or cyclical; some changes can be permanent. Natural events cause drought, temperature changes, disease, and flooding. Environmental changes are also caused by people's activities.

If conditions in an aquatic habitat change quickly, fish might do one of several things. They might migrate to an alternate habitat until conditions return to a tolerable state. Or they may be able to tolerate

Extinction occurs when a species as a whole can't adapt to changes in the environment and every member of that species dies. Extinction can occur gradually over generations as one species evolves into something else, or a species can become extinct when all organisms of that type die suddenly or relatively quickly. The term **mass extinction** describes an event where a large number of the earth's species cease to exist over an unusually short time frame.

the change and continue unhindered in their typical habitats. They might also change their activity levels, adjust in other ways, or die. If conditions are severe enough, or last long enough, the species may become **extinct**.

If environmental conditions change suddenly in a lake or river, the fish species with the most specialized adaptations may have the greatest difficulty tolerating change. They may not be able to survive. The fish with the most generalized adaptations—those that provide options to enable them to survive in the new conditions—are the most likely to survive.

Maintaining Aquatic Biodiversity

Biodiversity, or variety of life, usually refers to the total number of species inhabiting a given environment. Types of biological diversity include:

- community or ecological biodiversity: the variety of ecological communities or ecosystems that exist
- genetic biodiversity: the range of individual variation within a single species
- species biodiversity: this most common usage of the word includes different types of species—from bacteria to sturgeon and phytoplankton to Norway pines—that exist in a certain location

Biodiversity is important to people, too. We depend upon it for our very existence. Every ecosystem and every species of plant and animal has a unique place in the functioning of the earth's web of life or life support system. Interacting in the delicately balanced systems of the natural environment, the different species function to cycle oxygen, water, and nutrients and provide food for all life on the planet, including human life. The biggest threat to biodiversity today is loss of habitat. The rate at which we consume natural resources is increasing, which also poses a serious threat to biodiversity.

In most cases, a species needs many generations to adapt to changes in the environment, but people are changing the landscape faster, more dramatically, and in more ways than ever. Sustainable management of all Minnesota's land and water habitats is essential for the conservation of our aquatic biological diversity. Understanding the effects of land-use practices on aquatic habitats is increasingly important in guiding resource management, conservation, and restoration strategies. The individual daily decisions that people make about their consumption and use of resources are important decisions and do make a difference, either negative or positive, on our resources. For more information on how individuals can conserve Minnesota's aquatic habitats and biodiversity, see **Lesson 4:5—Fisheries Management and You.**

Procedure

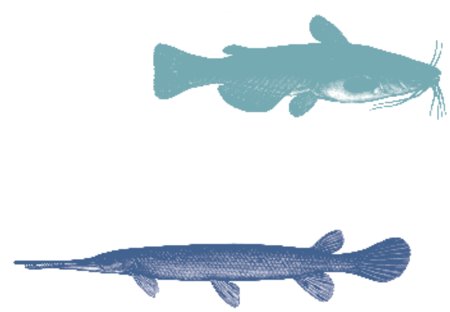
Preparation

1. Copy and make four sets of **Fish Identification Cards** from **Lesson 2:5—Diving Into Diversity**
2. Collect and assemble the props for the dress-up activity.
3. Copy the **Fish Adaptations Sheet**, one per student.
4. Copy the **Adaptations and Advantages Sheet**, one per student.
5. Copy the **Future Fish in the Year 4000 Sheet**, one per student.
6. Gather materials and supplies for creating the year 4000 fish in Part 2.

Activity

Warm-up

1. Ask the students to define adaptation. Tell students that they will revisit this definition, so it will be helpful to write down any ideas they may have about what the word means.
2. Conduct a class discussion on features and behaviors that people have to help them survive in our habitat. As a part of the discussion, ask the students to identify different kinds of features or behaviors another animal might have to help it survive similar conditions. Examples: Which features help humans eat their food? (Hands with fingers and thumbs to hold food and utensils; teeth for chewing and biting.) Which features help certain animals eat their food? (Some, like cougars, have sharp teeth; frogs have long sticky tongues; hummingbirds have long beaks to reach nectar; bears have strong claws to lift and turn rocks over to find grubs.)
3. Tell students that all of the things they've listed are called adaptations. Write this definition for adaptation on the whiteboard or projection device: adaptation—a feature or behavior that helps an organism survive in its environment (a characteristic that helps a plant or animal survive the conditions where it lives).
4. Write the categories of types of adaptation on the whiteboard or projection device, including the following: body shape, color, body parts (such as fins and scales), mouth, eyes, and behaviors.
5. Put one set of **Fish Identification Cards** from **Lesson 2:5—Diving Into Diversity** into a large hat. Pass the hat around to students. One at a time, have each student draw a fish identification picture from the hat. As each student draws a picture from the hat, ask the student to figure out an adaptation that the fish has, and to decide which category to put it in. Have the student tape the card on the whiteboard under one of the category headings. (Note that a card may fit under more than one heading.) Ask the student to choose a prominent adaptation type illustrated in the drawing and place it under the corresponding heading. If the student thinks the card could go under more than one heading, use additional cards of that fish from the other sets of **Fish Identification Cards** and place one under each adaptation heading the student identifies for that fish.



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6 Wrap up with a discussion describing how fish (like all organisms, including people) have different characteristics called adaptations, and discuss why having various adaptations is helpful. Ask students to compare their original definition of adaptation with the new definition on the whiteboard or overhead.

Lesson

Part 1: Adapted for Habitat

1 Ask two student volunteers to come to the front of the class. Wonder aloud with them: What type of adaptations do different types of fish have? (Explain that the answer depends on where the fish live, and what they do to survive the conditions there.)

2 Tell the class you will be “dressing” the students with fish adaptations. These fish live in a local lake, so consider habitat conditions in your local lake. One student will dress in predator adaptations. The other student will dress in adaptations suited to a prey fish.

Give each volunteer a nametag labeled “prey” or “predator”

3 For each body part or characteristic presented, ask the students in the class to decide which type of adaptation might be suitable for a predator fish, and then, what type of characteristic would be suitable for a prey species. Help the students through the process of deciding on an appropriate adaptation. As each body part is added, discuss its benefits, and how it helps the predator or prey fish survive.

In the following steps, as you hold up each prop you may wish to ask the class if they can guess which fish characteristic or adaptation it represents. Or you may wish to explain an adaptation and ask students to decide what type of prop could represent that feature—then present the prop you’ve provided.

You may refer to the **Fish Adaptations Sheet** for this part of the lesson, but don’t give copies of this to the class until after the dress-up is completed and the class has decided where (or in what type of habitat) each of the two dress-up species lives.

Fish Characteristics

Body Shape

- Have the prey fish stand sideways (with one side facing the class) to represent a fish that is laterally compressed.
- Have the predator fish stand tall on a box to become longer (torpedo-shaped).

Coloration

- Give the prey fish a camouflaged hunting shirt or a striped shirt to wear. Ask students what type of coloration the shirt mimics. (Camouflage for blending in and being more difficult to detect in vegetation.)
- Give the predator fish a drab-colored shirt to wear. This inconspicuous coloration helps a predator lie in wait for its prey, or approach prey without being noticed.

Fins

- Give the prey fish the backpack with the large, spiky dorsal fin attached to it. The spikes or points represent sharp spines.
- Give the predator fish a backpack with the smaller, flimsier dorsal fin attached to it.

Eyes

- Give the predator fish a pair of glasses to wear to emphasize the eyes located more towards the front of the face. Toss some beanbags to the student to try to catch, to illustrate a predator fish's depth perception (having both eyes focused on the beanbag).
- Give the prey fish volunteer a pair of earmuffs with eyes on them. The student should be standing sideways so one earmuff eye faces the class. Now ask the volunteer to cover or close one eye, to simulate the depth perception of a prey fish (being able to focus one eye in a particular direction). Toss the beanbags again. It should be more difficult for this student to catch the beanbag with one eye closed than it was for the other student (the predator fish), who had both eyes open. The prey fish will have trouble judging the location and distance of the beanbag.

Mouth

- Use a length of elastic to place a small funnel over the prey fish student's face (and under the nose) with the small end pointed outward.
- Place the large funnel (with the paper teeth) protruding outward over the predator fish student's face. The wide, open end should face outward from over the student's face—the student can hold the narrow end of the funnel up to their mouth.

Reproduction (Behavior)

- Hand the prey fish a handful of paper confetti (fish eggs) to carefully put into the small bowl placed on the floor behind them. The bowl represents the nest or redd that the male sweeps out on the lake or stream bottom. Tell the class that the female carefully lays the eggs in the nest. Afterward, the male guards the nest to keep predators away until the eggs hatch.
- Hand the predator fish a handful of paper confetti to scatter around the immediate area. These scattered eggs have a sticky coating that helps them stick to plants in the water. Fish that scatter their eggs and leave them wherever they fall are free to pursue prey.

4 Briefly review with the class the adaptations you have given each fish. Give each student a **Fish Adaptations Sheet**. With the two volunteers still in front of the class, ask the students if they can figure out where, or in what type of habitat of the local water body, each fish lives. (In the vegetated areas of the lake or stream, in fast-moving water, in the deeper open water, or in areas with sandy bottoms.)

5 Have the students compare and contrast the adaptations of the two dressed-up fish and describe how each characteristic helps the fish survive as a predator or prey fish in a watery environment.

Vision: One eye or two? Try this demonstration with the class. If you look at an object with just one eye instead of both eyes, depth perception is affected. This can be demonstrated by holding a finger up in front of your right eye. Hold that finger about six inches away from your right eye and keep it there. Close your left eye only. Look at the finger with your right eye and then, keeping your finger where it is, close your right eye and look at the finger with only your left eye. When you look at the finger with only your right eye, it will appear closer than when you look at it with only your left eye open, or even when looking at it with both eyes open.

6 Ask the class to name the two fish they have created. They can use names of real fish or they can make up species names that reflect the adaptations that the fish have, such as spiky-finned pancake fish, fast-water fly eater, or big-mouth prey chaser.
7 Ask students to complete the **Adaptations and Advantages Sheet.**

Part 2: Future Fish of the Year 4000

1 Tell the students that it's the year 4000. Ask them what changes could possibly occur in the environment over the next 2,000 years. What might lakes and rivers be like in Minnesota in the year 4000? What might the fish habitat and conditions be like in lakes and rivers? Encourage creativity, and suggest naming both positive and negative environmental changes. Consider food sources, weather, water quality, and other factors. What challenges will the fish face in the changed environment?
2 Tell students that they are ichthyologists (scientists who study fish) in the year 4000. A new fish is discovered in the local lake and the resident ichthyologist is notified. It's your job to study the fish, discover and describe its habitat, adaptations or features, behaviors, diet, defense mechanisms, and lifestyle. You must also give it a name. (Scientific names typically use words that describe features or behaviors of the organisms; sometimes an organism is named for the person who first discovered it.)
3 Hand out the **Future Fish in the Year 4000 Sheet** to students. Have students complete Question 1 by writing a paragraph describing the local lake, river, or stream in the year 4000. Or, you might ask them to illustrate the local water body by drawing or using a computer graphics program. What environmental changes do they envision? What could cause these environmental changes? What is the fish habitat like? Will current species of fish adapt to these future environmental changes or become extinct? Define and discuss extinction. Students may use their imaginations to create fantastical, positive, or negative environmental changes.
4 Complete Question 2 on the **Future Fish in the Year 4000 Sheet**. Students will design a new fish species that inhabits this lake, river, or stream in the year 4000. First, have students draw a small sketch of their fish to work out the details of their design before creating their fish. Ask students to keep the following questions in mind as they design their fish:
   - Where does your fish live? What is the fish habitat in the lake like? What adaptations help the fish survive the environmental conditions there?
   - What does your fish eat? What adaptations help it obtain its food? Does anything else eat your fish?
   - Is your fish a fast or a slow swimmer? How do you know?
   - Is your fish a predator? How do you know?
   - How does your fish protect itself?
   - What other special adaptations does your fish have? Why does it need them?

5 When they're satisfied with their designs, make materials available so that the students can construct models of their fish. Students can use various media and art forms to create their fish, depending on what you have available, such as various markers, crayons, colored pencils, construction paper, tag board, modeling clay, cardboard paper towel rolls, and paint. Or, ask the students to use computer graphics to design their fish. Remind them to include adaptations that help the fish to survive in its habitat.

6 After they've finished constructing their fish, have students complete Question 3 on the **Future Fish of the Year 4000 Sheet**. Students will list the adaptations exhibited by the fish that they've created, and describe the survival advantages of each.

7 Remind students how scientists name a newly-discovered species. Have the students name their fish and write the name in Question 4 on the **Future Fish of the Year 4000 Sheet**. Remind them to create a name that refers to the adaptations, behaviors, or features of the fish (and possibly the name of its discoverer).

Wrap-up

1 Ask each student to use his or her **Future Fish of the Year 4000 Sheet** to share with the class the habitat conditions they decided upon for the lake or river in the year 4000. Show the model of the new fish species that was found in the lake, describe its adaptations, and explain how the adaptations help the fish to survive in its habitat.

2 Ask the class to discuss why adaptations are useful for fish. Discuss how the various fish the students created fit into different **niches**, or fill different roles, in an ecosystem. Can students determine why biodiversity, or a variety of species, is important in an ecosystem? Have students research the word biodiversity, and locate and list three benefits of biodiversity. Compare the lists and count the number of benefits the class identified.

3 Have students design an aquatic ecosystem that includes micro-habitats suitable conditions for all of the fish they created. The ecosystem could be constructed on a classroom or hallway bulletin board. Have students each place their fish on the bulletin board in the appropriate habitat in the aquatic ecosystem.

Assessment Options

1 Evaluate the **Fish Adaptations and Advantages Sheet**. Students should have named three fish adaptations in each of the following categories: mouth, shape, coloration, reproduction, and fins, and described an advantage for each adaptation.

2 Evaluate student reports about the habitat conditions they decided upon for the lake or river in the year 4000 based upon descriptions of the habitat, the adaptations of the future fish, and the explanations for how those adaptations help the fish survive in its habitat.

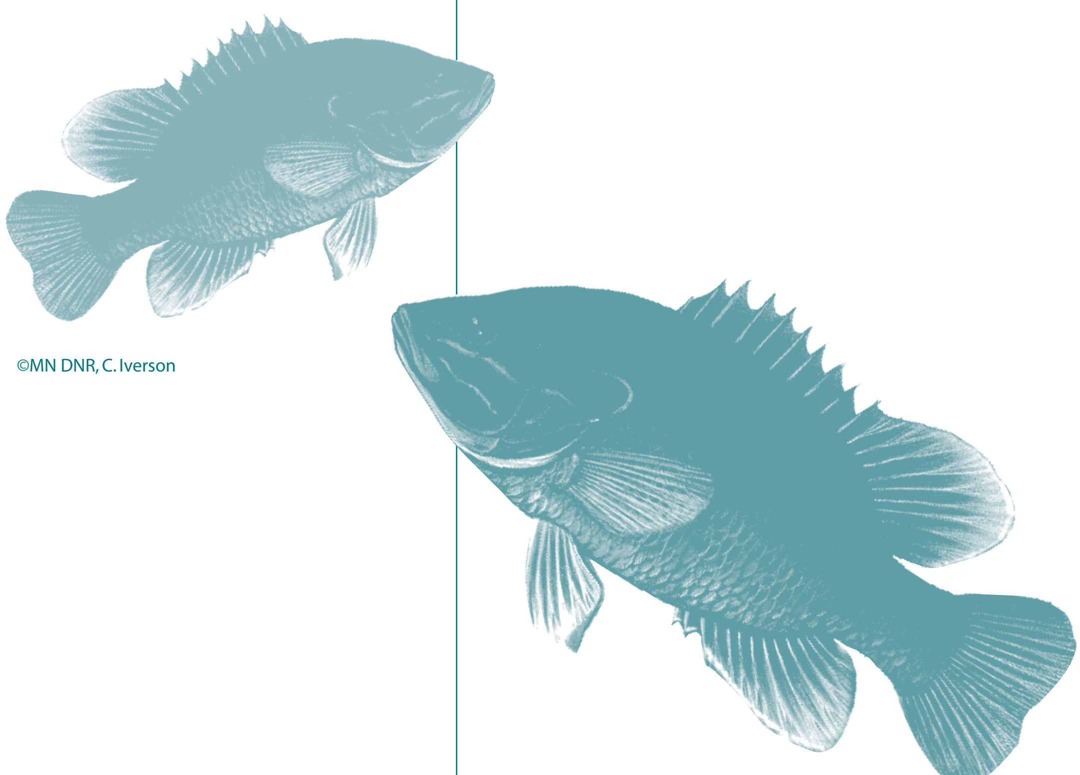
Review the Adapted for Habitat activity from Part 1 and the adaptations of the predator and prey fish. Students may use the **Fish Adaptations Sheet** as a guide. They should include adaptations from the following categories in their designs: coloration, body shape, eyes, fins, mouth, and reproductive behavior.

3 Have students exchange their habitat descriptions for the water body in the year 4000 with one another. Ask them to decide if the fish they created would be able to survive in this new habitat and explain why or why not. Create a new fish adapted to the conditions described for this habitat.

4 Have students create other aquatic organisms that live in the same lake with their year 4000 fish. If these other organisms prey on the fish they created, what adaptations would they need to obtain their food? If they're prey species, which adaptations would protect them from being eaten by the fish they created?

5 Have students build a model of a fish habitat for a fish species of their choosing. Ask students to write a description of the habitat and include how that habitat suits the characteristics of the fish they chose. Assign each student a partner and have the partners explain their habitat models to each other and describe how their habitat suits the characteristics of the fish for which they created the habitat.

6 Assessment options include the Checklist and Rubric on the following pages.



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Adapted for Habitat Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
5	______	______	Student identifies at least five features of fish that are adaptations.
2	______	______	Student defines *adaptation*.
4	______	______	Student names three adaptations and describes the advantage of each adaptation in helping the fish survive in the habitat where it lives.
4	______	______	Student designs a predator fish with four adaptations that help it to survive in the habitat where it lives.
4	______	______	Student designs a prey fish with four adaptations that help it to survive in the habitat where it lives.
2	______	______	Student determines possible habitat conditions of a local lake in the year 4000; can explain why habitat conditions might be as described in the year 4000.
4	______	______	Student creates a fish with four adaptations suited to help the fish survive in the local habitat as described for the year 4000.
2	______	______	Student names a fish in a way that reflects its adaptations or the name of the scientist who discovers it.
Total Points			
27	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

25-27 points = A
Excellent. Work is above expectations.

21-24 points = B
Good. Work meets expectations.

16-20 points = C
Work is generally good. Some areas are better developed than others.

12-15 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-11 points = F
Work is unacceptable.

Adapted for Habitat Scoring Rubric

Adaptation Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Recognizing adaptations	Identifies at least five features, such as type of mouth, fins, coloration, reproduction style, as adaptations and explains that adaptations are physical features or behaviors that help an organism survive in its habitat.	Identifies four features, such as type of mouth, fins, coloration, reproduction style, as adaptations and explains that adaptations are physical features or behaviors that help an organism survive in its habitat.	Identifies three features, such as type of mouth, fins, coloration, reproduction style, as adaptations and explains that adaptations are physical features or behaviors that help an organism survive in its habitat.	Recognizes that fish features are called adaptations, but can't correctly explain that adaptations are physical features or behaviors that help an organism survive in its habitat.	Doesn't recognize that the word adaptations refers to body parts, features, characteristics, or behaviors.
Functions of adaptations	Names three adaptations and describes the advantage of each in helping the fish survive in its habitat.	Names two adaptations and describes the advantage of both.	Names one adaptation and describes the advantage of one adaptation.	Names one adaptation, but not the advantage of that adaptation.	Can't describe how adaptations help an organism survive in its habitat.
Predator vs. prey	Designs two fish (a predator and a prey species) with four adaptations that help each fish survive in its habitat.	Designs two fish (a predator and a prey species) with three adaptations that help each fish survive in its habitat.	Designs either a predator or a prey fish species with two adaptations that help it survive in its habitat.	Designs a fish (neither a predator or a prey species) with two adaptations that help it survive in its habitat.	Can't identify adaptations of predator or prey species; can't describe how how the adaptations exhibited in their design help the fish survive conditions in its habitat.
Meeting future habitat challenges	Determines possible habitat conditions of a local lake in the year 4000; explains why habitat conditions might be as described in the year 4000. Creates a fish with four adaptations that help the fish survive in that habitat. Names fish in a way that reflects its adaptations or the name of the scientist who discovers it.	Determines possible habitat conditions of a local lake in the year 4000; creates a fish with three adaptations that help the fish survive in that habitat. Names fish, but in a way that doesn't reflect its adaptations or the name of the scientist who discovers it.	Determines possible habitat conditions of a local lake in the year 4000; creates a fish with two adaptations that help the fish survive in that habitat. Names fish, but in a way that doesn't reflect its adaptations or the name of the scientist who discovers it.	Determines possible habitat conditions of a local lake in the year 4000; creates a fish with one adaptation that helps the fish survive in that habitat. Doesn't name fish.	Creates fish, but doesn't connect fish features to habitat conditions. Can't provide reasons that explain the aquatic habitat conditions they envisioned for the year 4000.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 After doing the dress-up activity in Part 1, demonstrate the same concepts for the class comparing the adaptations of two real fish: a predator, such as northern pike, walleye, or muskellunge, contrasted with a prey fish such as a sunfish or perch.
2 Create a hallway or classroom exhibit of the fish the students created in Part 2. Students can create a lake or stream scene on the wall and tape their fish into it, like a mural. The completed **Future Fish of the Year 4000 Sheets**, with habitat and adaptation descriptions can be displayed next to the fish.
3 Look at photos of fish. (Fish photos can be obtained on the Internet, from angling magazines, or printed on 8.5" x 11" paper from the *MinnAqua Leader's Guide* CD.) Have students speculate on the habits and habitat of each fish by examining its coloration, fins, body shape, and mouth.
4 Investigate various Minnesota lake and river habitats and identify the types of fish that live in those habitats. Ask students to discuss and explain how those fish are suited or adapted for conditions in the habitat. Have students write a "Guide to Fishing in Minnesota: Where to Find Different Types of Fish" based on their discussion.

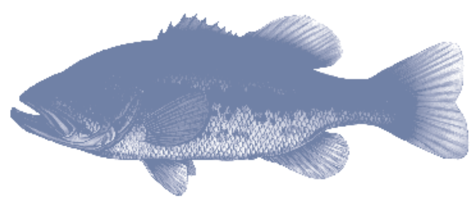
For the Small Fry

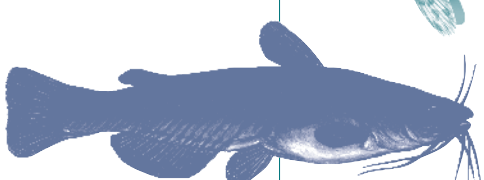
K-2 Option

1 If you do the Adapted for Habitat dress-up activity, make sure you have enough time for every student to dress up as a predator or prey fish—every student will want to be involved! Discuss the features of the fish and how the features help the fish survive where they live. Omit use of the term adaptation. Omit the Future Fish in the Year 4000 activity and instead do the following: Make 20 copies of illustrations of six different types of fish. Cut each fish into four parts: head, upper body and dorsal fin, lower body with pelvic and anal fins, and tail parts. Have each student or pair of students select one of each these fish part types. Ask the students to create a fish from these parts by gluing them together to form a new fish on a blank sheet of paper. They should be thinking about what kind of traits their fish may need to survive in its habitat, for example, a big mouth and a long body. Provide crayons or markers for coloring the fish. The students can draw in habitat. Explain that the name of a plant or animal often describes something about that organism. For example, a violet is a purple flower, or a catfish has whiskers. Have students write down (or dictate for an adult to write) a name for their new fish species. Then ask them to describe the type of habitat in which it lives and what it eats, based on the features of their fish.

2 Read the book *Fish Faces,* by Linda Bylander. The book can be obtained from the Minnesota DNR MinnAqua Program.

3 After the dress-up activity, ask students: If you could be a fish, what kind of fish would you be? Have students, either individually or in pairs, design a fish on large sheets of white butcher paper (approximately three feet square). Pass out two sets of large paper to each student or group. Draw both sides of the fish, one side on one sheet of paper, and the other side on the second piece of paper. Color the fish. Cut out these two sides of the fish. Staple or tape the two sides together and stuff the fish with crumpled pieces of newspaper. Have students name the fish they created. Ask each student to tell the class about the features they provided for their fish and explain how the features help the fish to survive in its habitat. Attach clear monofilament line to the fish and hang them from the ceiling in the classroom.





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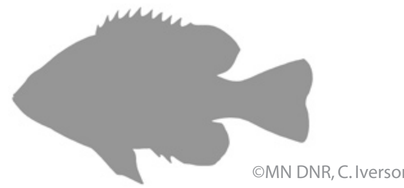
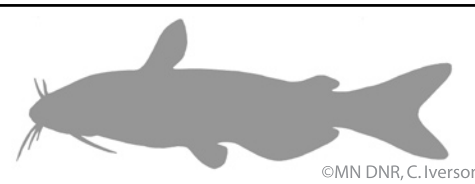
Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Body shape		
Laterally compressed	Swims through plants easily	 Bluegill, other sunfish
Torpedo-shaped	Swims fast to chase prey, or swims easily in fast-moving water	 Trout, Coho salmon, northern pike, muskellunge
Flat-bottom	Hugs the bottom, finds food on bottom	 Catfish, bullhead, sucker
Coloration		
Horizontal stripes	Camouflage breaks up outline of body against horizontal parts of underwater plants, brush piles, and fallen trees	 White or striped bass, largemouth bass
Vertical stripes	Camouflaged; can hide in vegetation, blending in with vertical plants	 Muskellunge, perch, smallmouth bass, sunfish

continued

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Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Coloration (continued)		
Mottled coloration	Blends in with rocks and gravel (camouflage)	 Brook trout, northern pike, young sturgeon, northern hog sucker
Dark topside	Camouflaged; difficult to see from above; blends in with dark lake or river bottom of lake or river underneath	 Bluegill, black crappie, catfish, sturgeon, carp
Light-colored underside	Camouflaged; difficult to see from below; blends in with light sky overhead	 Many minnows, yellow perch, walleye, catfish
Fairly uniform, no bold markings	Swims in open water	 Gizzard shad, lake whitefish
Fins		
Large dorsal fin with sharp spines	Fish appears larger; more stability for a short, wide body shape; sharp spines make the fish more difficult to swallow	 Bass, bluegill, yellow perch

continued

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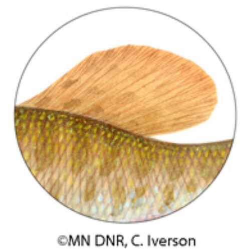
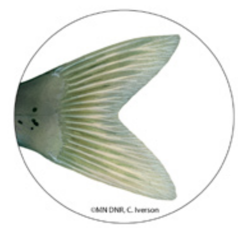
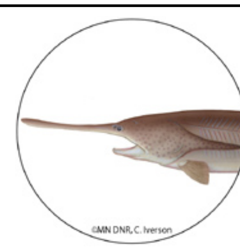
Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Fins (continued)		
Small dorsal fin	Swims faster; greater ease of movement in fast currents	 Trout, northern pike, muskellunge
Deeply-forked tail fin	Produces less drag; fast swimmer	 Channel catfish
Rounded tail fin	Effective acceleration and maneuvering ability; inefficient for prolonged continuous swimming	 Yellow bullhead
Mouth		
Ventral (located under the head)	Feeds at the bottom; "vacuums" or roots around for food from the bottom	 Sturgeon, sucker, carp
Extended upper jaw	Funnels clouds of plankton toward mouth	 Paddlefish

continued

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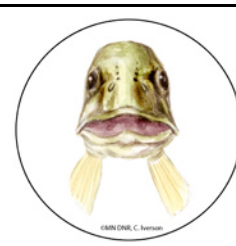
Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Mouth (continued)		
Protruding lower jaw/ mouth points upwards	Feeds on prey it sees above on surface	 Banded killifish
Duckbill-shaped mouth	Grasps prey	 Northern pike, muskellunge
Barbels (whiskers)	Locates food on bottom; senses or tastes food in murky water	 Catfish, bullheads, sturgeon, carp
Extremely large mouth	Surrounds prey	Largemouth bass
Strong jaws and teeth	Help it catch, hold, and eat prey	Walleye, northern pike, muskellunge, gar
No teeth	Eats plankton (tiny organisms floating in water)	Paddlefish
Eyes		
Eyes forward on front of head	Good depth perception helps determine distance to prey	 Northern pike, muskellunge

continued

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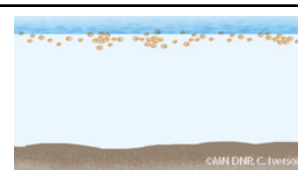
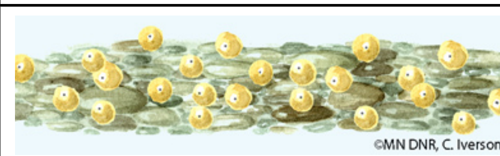
Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Eyes (continued)		
Eyes on sides of head	Can see predators coming from many directions; can see all the way around (except directly behind itself)	 Bluegill, other sunfish
Small eyes	Murky, dark, deep-water fish or bottom feeder. (Doesn't depend on sight to find food.)	 Catfish, bullhead, sturgeon
Large eyes	Depends on sight to locate food. Large eyes take in more light.	 Walleye, sauger, yellow perch, bass
Reproductive Behavior		
Broadcast spawning and eggs float	Some eggs will survive because large numbers are produced and released	 White bass, freshwater drum
Eggs released in rocks or gravel on bottom	Cover and protection from waves, currents and predators	 Walleye

continued

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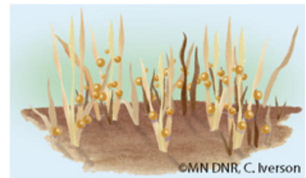
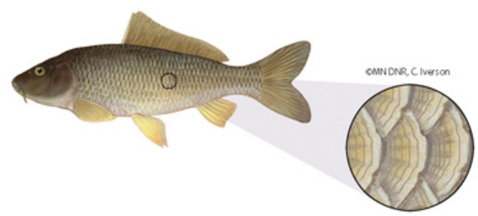
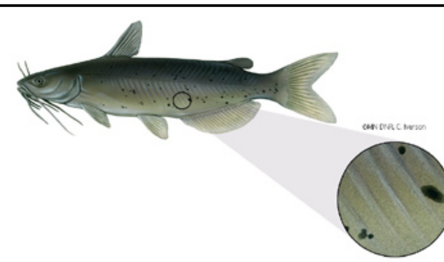
Fish Adaptations Sheet

Adaptation	Survival Benefit	Minnesota Fish
Reproductive Behavior (continued)		
Attaching eggs to vegetation	Eggs don't float away or get carried away in currents, cover and protection, suspended above muddy bottom	 Yellow perch, northern pike, carp
Fish sweep out depression on bottom (nest or redd) with tails	Nests protected by adults Redds protect eggs from currents in gravel depressions	 Nests: green sunfish, smallmouth bass, creek chub Redds: brook trout, salmon
Scales		
Large scales	Provide protection or a defense strategy	 Carp, sunfish, sucker
Small scales	More streamlined; allows for less drag, greater maneuverability, and speed	 Trout, northern pike, burbot
No scales	Allows for greater maneuverability in fast-moving water; allows catfish skin to have taste buds to sense or taste food in murky water	 Catfish, bullheads, sculpin

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Name ________________________________ Date ________________

Fish Adaptations and Advantages Sheet

	Adaptation Name three fish adaptations (features or traits).	**Survival Benefit** Describe the advantage of each adaptation—how does it help the fish survive in the conditions where it lives?
Mouth	*Example: strong jaws and teeth to catch, hold, and eat prey*	*Example: to catch, hold, and eat prey*
	1.	
	2.	
	3.	
Body shape	Adaptation	Advantage
	1.	
	2.	
	3.	

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Name ______________________________ Date ______________

Fish Adaptations and Advantages Sheet (continued)

	Adaptation Name three fish adaptations (features or traits).	**Survival Benefit** Describe the advantage of each adaptation—how does it help the fish survive in the conditions where it lives?
Coloration	Adaptation	Advantage
	1.	
	2.	
	3.	
Reproduction	Adaptation	Advantage
	1.	
	2.	
	3.	

	Adaptation Name three fish adaptations (features or traits).	**Survival Benefit** Describe the advantage of each adaptation—how does it help the fish survive in the conditions where it lives?
Fins	Adaptation	Advantage
	1.	
	2.	
	3.	

continued

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Name ________________________________ Date ________________

Future Fish of the Year 4000 Sheet (continued)

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Name ________________________________ Date ________________

Future Fish of the Year 4000 Sheet

1. Describe what you think the habitat of a nearby lake or river might be like in the year 4000.

____

____

____

____

____

____

____

2. Make a simple sketch of your new fish.

continued

What food does your new fish eat? Which adaptations help it find and eat its food?

Is your fish a predator or a prey species? How can you tell?

Is your fish a fast swimmer or a slow swimmer? How do you know?

Fish Tales

There's something fishy about that tale!

Table of Contents

Chapter 2 • Lesson 7

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish Tales

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 1—The student will read unfamiliar complex and multi-syllabic words using advanced phonetic and structural analysis.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 2—The student will recall and use prior learning and preview text, using title, headings, and illustrations to prepare for reading.
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate knowledge about what is read.
Benchmark 4—The student will retell, restate or summarize information orally, in writing, and through graphic organizers.
D. Literature:
Benchmark 1—The student will read from and listen to American Literature, as well as literature from other countries.
Benchmark 2—The student will identify, describe and respond to literary elements of characterization, plot, setting and theme.
Benchmark 4—The student will compare and contrast similar works by different authors in the same genre or same theme.
Benchmark 6—The student will identify and determine the meanings of similes and metaphors.
Benchmark 7—The student will critically read, and examine text to determine author's purpose.
Benchmark 8—The student will respond to literature using ideas and details from the text to support reactions and make literary connections.
Benchmark 9—The student will read from and respond to a variety of fiction, poetic and nonfiction texts of increasing complexity for personal enjoyment.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning, including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
B. Elements of Composition:
Benchmark 2—The student will use composing processes, including:
a. prewriting—planning strategies such as brainstorming, journaling, sketching, listing, outlining and determining audience, purpose and focus.
b. drafting—organizing, supporting and putting ideas into sentences and paragraphs.
c. revising—improving the quality of content, organization, sentence structure and word choice.
d. editing—correcting errors in spelling and grammar.
e. publishing—producing a document and sharing the writing with the audience.
Benchmark 3—The student will use verbalization (discussions, interviews, brainstorming) to prepare for writing.
C. Spelling, Grammar, and Usage
Benchmark 1—The student will compose complete sentences when writing.
Benchmark 2—The student will recognize and correct spelling errors when writing.

Benchmark 5—The student will apply grammar conventions correctly in writing ; including:
a. nouns
b. verbs
c. adjectives
d. pronouns.
Benchmark 6—The student will apply punctuation conventions correctly in writing, including:
a. periods, question marks, exclamation points
b. capitalization of proper nouns
c. abbreviations
d. sentence beginnings
e. commas in a series.
D. Research:
Benchmark 1—The student will use grade-level appropriate reference materials to obtain information from dictionaries, glossaries, encyclopedias, and the Internet.
E. Handwriting and Word Processing:
Benchmark 1—The student will write legibly, allowing margins and correct spacing between letters in a word and words in a sentence.
Benchmark 3—The student will begin acquiring keyboarding skills.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will organize and express ideas sequentially or according to major points.
Benchmark 6—The student will perform expressive oral readings of prose, poetry or drama.

Grade 4
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 2—The student will read aloud narrative and expository text with fluency, accuracy, and appropriate pacing, intonation and expression.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 2—The student will recall and use prior learning and preview text to prepare for reading.
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions about what is read to demonstrate understanding.
Benchmark 6—The student will distinguish fact from opinion, determine cause and effect, and draw conclusions.
Benchmark10—The student will compare and contrast information on the same topic from two sources.
D. Literature:
Benchmark 1—The student will read and respond to a variety of high quality, traditional, classical and contemporary literary works specific to America, as well as significant works from other countries.
Benchmark 2—The student will identify, respond to, and compare and contrast the literary elements of characterization, plot, setting, and theme.
Benchmark 4—The student will compare and evaluate similar works by different authors in the same genre or theme.
Benchmark 7—The student will identify and determine the meanings of similes and metaphors.
Benchmark 8—The student will critically read and evaluate text to determine author's purpose and point of view.
Benchmark 9—The student will respond to literature using ideas and details from the text to support reactions and make literary connections.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of styles to express meaning , including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
f. persuasive
g. thank you note.

B. Elements of Composition:
Benchmark 3—The student will use composing processes including:
a. prewriting—planning strategies such as brainstorming, journaling, sketching, listing, outlining and determining audience, purpose and focus
b. drafting—organizing, supporting and putting ideas into sentences and paragraphs
c. revising—improving the quality of content, organization, sentence structure and word choice
d. editing—correcting errors in spelling and grammar
e. publishing—producing a document and sharing the writing with the audience.
Benchmark 5—The student will use verbalization (discussion, interviews, brainstorming) to prepare for writing.
Benchmark 6—The student will consider audience in composing texts.
B. Spelling, Grammar, and Usage:
Benchmark 1—The student will compose complete sentences when writing.
Benchmark 4—The student will apply grammar conventions correctly in writing, including:
a. verb tense
b. adverbs
c. prepositions
d. subject and verb agreement
e. possessive pronouns.
Benchmark 5—The student will apply punctuation conventions correctly in writing, including:
a. apostrophes
b. capitalization of proper nouns
c. abbreviations
d. sentence beginnings
e. commas in a series
f. quotation marks
D. Research:
Benchmark 1—The student will locate information in various reference materials including dictionaries, online dictionaries, glossaries, encyclopedias, and the Internet.
E. Handwriting and Word Processing:
Benchmark 2—The student will apply basic keyboarding skills.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will perform expressive oral readings of prose, poetry or drama.

Grade 5
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 2—The student will read aloud narrative and expository text with fluency, accuracy and appropriate pacing, intonation and expression.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 2—The student will recall and use prior learning and preview text to prepare for reading.
Benchmark 4—The student will identify main idea and supporting details in fiction text.
Benchmark 7—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.
Benchmark 8—The student will distinguish fact from opinion and provide evidence to support conclusions.
Benchmark 11—The student will critically read and evaluate text to identify author's point of view and purpose.
D. Literature:
Benchmark 1—The student will read a variety of high quality, traditional, classical and contemporary literary works specific to America, as well as significant works from other countries.
Benchmark 2—The student will identify and analyze literary elements and devices in works of fiction including characterization, plot, tone and theme and the ways they convey meaning.
Benchmark 4—The student will interpret literature by answering questions that ask for analysis and evaluation.

Benchmark 5—The student will distinguish among various literary genres and subgenres.
Benchmark 7—The student will identify and determine the meanings of similes and metaphors.
Benchmark 8—The student will respond to literature using ideas and details from the text to support reactions and make literary connections.

II. Writing

A. Types of Writing:

Benchmark 1—The student will write in a variety of modes to express meaning , including:
a. descriptive
b. narrative
c. informative
d. formal letter
e. poetry
f. persuasive
g. thank you notes
h. reports.

B. Elements of Composition:

Benchmark 3—The student will use composing processes, including:
a. prewriting—planning strategies such as brainstorming, journaling, sketching, listing, outlining and determining audience, purpose and focus
b. drafting—organizing, supporting and putting ideas into sentences and paragraphs
c. revising—improving the quality of content, organization, sentence structure and word choice.
d. editing—correcting errors in spelling and grammar
e. publishing—producing a document and sharing the writing with the audience.

C. Spelling, Grammar, and Usage:

Benchmark 1—The student will compose complete sentences when writing.
Benchmark 2—The student will edit written documents for correct spelling.
Benchmark 4—The student will apply grammar conventions correctly in writing, including:
a. verb tense
b. prepositional phrases
c. adverbs
d. subject and verb agreement with simple subjects
e. possessive pronouns and plural possessives

Benchmark 5—The student will apply punctuation conventions correctly in writing , including:
a. apostrophes
b. capitalization of proper nouns
c. abbreviations
d. sentence beginnings
e. commas
f. quotation marks.

D. Research:

Benchmark 1—The student will locate and keep notes on the information in various reference materials including print and online dictionaries, glossaries, encyclopedias, CD reference materials and the Internet.

E. Handwriting and Word Processing:

Benchmark 2—The student will apply keyboarding skills.

III. Speaking, Listening, and Viewing

A. Speaking and Listening:

Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 6—The student will perform expressive oral readings of prose, poetry or drama.

Social Studies

Grades K-3

I. U.S. History

A. Family Life Today and In the Past:

Benchmark 1—Students will compare family life in his or her community from earlier times and today.

C. Many People and Cultures Meet in the Making of North America:

Benchmark 1—Students will understand that large and diverse American Indian nations were the original inhabitants of North America.

III. World History

A. Family Life Today and In the Past:

Benchmark 1—Students will compare family life in their own communities from earlier times and today.

IV. Historical Skills

B. Historical Resources:

Benchmark 1—Students will compare different kinds of historical sources and describe sorts of information the sources provide.

Grades 4-8
I. U.S. History
A. Pre—history through 1607:
Benchmark 1—Students will compare ways of life of Indian Nations from different regions of North America.
II. Minnesota History
A. Pre-contact to 1650:
Benchmark 2—Students will explain the major historical aspects of Dakota and Ojibwe culture, social organization and history, and compare and contrast them.
IV. Historical Skills
B. Historical Resources:
Benchmark 1—Students will identify, describe, and extract information from various types of historical sources, both primary and secondary.
Benchmark 3—Students will investigate the ways historians learn about the past if there are no written records.
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 4
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 2 • Lesson 7

Fish Tales

Grade Level: 3-5
Activity Duration: five 60-minute sessions
Group Size: any
Subject Areas: Language Arts, Expressive Arts, Social Studies, Science
Academic Skills: communication, description, evaluation, listening, listing, organization, peer review, presentation skills, problem solving, reading, research, small group work, writing
Setting: indoor or outdoor gathering area, computer lab (optional)
Vocabulary: exaggeration, folklore, hyperbole, main character, metaphor, setting, simile, tall tale, theme
Internet Search Words: Annie Oakley, Dakota Indian storytelling, exaggeration, fish stories, folklore, Ojibwe Indian storytelling, Paul Bunyan, storytelling, tall tales

Instructor's Background Information

Fishing has always played an integral role in the history, stories, traditions, and cultures of the people of Minnesota. Fish continue to be an important source of food for people and for other animals, including eagles, loons, bears, and other fish. And fishing is also a popular recreational activity enjoyed by many Minnesotans.

Native Minnesotans and Minnesota's Long Fishing History
Long ago, before political boundaries defined the state of Minnesota, and long before Europeans arrived and settled in this region, the land was inhabited by native cultures described by scientists as:

- Big Game or Paleo-Indians: approximately 7,000 years ago
- Eastern Archaic people: approximately 7,000-3,000 years ago
- Woodland peoples (northern part of the region): approximately 3,000-300 years ago
- Mississippian peoples, who migrated to the north from the southern areas of what is now the United States: 1,000-300 years ago. (Present-day Dakota, Choctaw, and Cherokee peoples are descended from this group, as are other present-day Indian tribes.)

Dakota tribes that lived in the Midwest migrated northward through what is now Minnesota to the southern and western areas of Lake Superior. The Dakota fished the area's many lakes, streams, and rivers. They also hunted other animals, including bison, deer, and elk, and they gathered what they could from the wild. They harvested wild rice in the fall. What they hunted or gathered depended on the season, but fish could be speared and caught year-round. The Dakota people had lived in the lower half of what is now Minnesota for several hundred years before French traders and fur trappers first ventured to the area in

Summary

The fish stories that many anglers tell today are part of a long tradition of storytelling in Minnesota. In the tradition of Dakota and Ojibwe Indians, and like the early frontier settlers and pioneers, students share fish stories around a simulated campfire. Students do research to learn more about the history and basic elements of tall tales, then write a tall fish tale about a heroic character who uses larger-than-life abilities to solve a problem about Minnesota fish, fishing, or aquatic habitats in an amazing way. Classmates review and edit one another's drafts of these tall tales.

Student Objectives

The students will:

1. Discuss the history of fishing and of storytelling in Minnesota.
2. Read, write, and share fish stories and tall tales.
3. Research the history and story elements of tall tales on the Internet, in the school library, or using resource books available in the classroom.
4. Write a tall tale that includes exaggeration, metaphors, similes, and a heroic main character that solves a present-day problem about Minnesota fish, fishing, or aquatic habitats in an amazing way.
5. Review two rough drafts of tall tales written by classmates, analyzing main character, setting, and theme.

continued

Student Objectives (continued)

6 Investigate how stories have been told for different reasons throughout history, and how stories sometimes reveal what the storyteller knows and believes about things in nature, such as fish.

Materials

- Small lamp or flashlight
- Sheets of notebook paper, several per student
- Sheet of unlined art paper, one per student
- Pens or pencils
- Stick or other object to serve as a "talking stick" (optional)
- Access to Internet for Web-based research on tall tales
- Large hat or container to collect paper
- Audio recorder (optional)
- **Tall Tales Research Sheet**, three for each student group of three or four students
- **Reviewing a Tall Tale Sheet**, two per student

Suggested Tall Tale Resources for Classroom Reference

Blair, Walter. *Tall Tale America: A Legendary History of Our Humorous Heroes*. Chicago: University of Chicago Press, 1987.

Blassingame, Wyatt. *John Henry and Paul Bunyan Play Baseball*. Champaign, IL, Garrard Publishing Co., 1971.

DeLeeuw, Adele. *Paul Bunyan and His Blue Ox*. Champaign, IL, Garrard Publishing Co., 1968.

Erdrich, Louise. *The Birchbark House*. New York: Hyperion Books for Children, 1999.

Martin-Pugliano, Carol. *Read-Aloud Plays: Tall Tales* (grades 3-5). New York: Scholastic, 2000.

Malcolmson, Anne. *Yankee Doodle's Cousins*. Boston: Houghton Mifflin, 1941. Pp. 229-260.

Mason, Jane. *Paul Bunyan and Other Tall Tales*. New York: Scholastic, 2002.

McLellan, Joe. *Nanabosho, Soaring Eagle and the Great Sturgeon*. Winnipeg: Pemmican Publications Inc., 1997.

Nolen, Jerdine. *Thunder Rose*. San Diego: Harcourt, 2003.

Pope Osborne, Mary. *American Tall Tales*. New York: Knopf, 1991.

Pope Osborne, Mary. *American Tall Tales* [unabridged] Audio CD. Scott Snively (Narrator). Audio Bookshelf, 2002.

Sabin, Louis. *Paul Bunyan*. Mahwah, NJ: Troll Associates, 1985.

Sanderson, Jeannette. *12 Tall Tale Mini-Books*. New York: Scholastic, 2002. Shapiro, Irwin. *Paul Bunyan Tricks a Dragon*. Champaign, IL: Garrard Publishing Co., 1975.

West, Tracey. Teaching *Tall Tales* (*Grades 3-5*). Scholastic, 1999.

approximately 1650. By the seventeenth century, many Dakota people had settled in and around Mille Lacs Lake.

Sometime around the year 900, a group of Anishinaabeg, or Ojibwe, people began migrating from the east coast of Canada. They traveled along the St. Lawrence River, along the shores of what is now Lake Michigan and the Canadian border, to the waters of Lake Superior or *Gitchi Gummi*, as they called it, meaning big water.

The Ojibwe found an abundance of fish in the area's waters. Ojibwe fishermen used large birchbark canoes and nets made from twisted and knotted strands of willow bark to catch lake trout, whitefish, and sturgeon. In winter, they used hand-carved wooden decoys as bait and speared fish through holes chopped in the ice. By the mid-1700s, the Ojibwe people had settled in what is now central Minnesota. Like the Dakota, they subsisted on what the land and waters produced throughout the seasons.

Because fish played an important role in people's daily lives, they became the subject of many stories, traditions, and myths passed from generation to generation in both the Dakota and Ojibwe cultures. Oral histories and stories play a very important role in Dakota and Ojibwe traditions and cultures. Today, the two main Native American tribes in Minnesota are still the Dakota and the Ojibwe. Each tribe is subdivided into various tribes, bands, clans, and villages. Some clans bear the names of various fish species.

Settlers and Pioneers

Just as the excellent fishing in Minnesota's lakes, rivers, and streams attracts many out-of-state vacationers and tourists to Minnesota today, fish were an important resource that helped attract the first European settlers to the region. Fish provided food as well as a source of income for the area's first commercial fishermen, as illustrated in this text from the North Shore Commercial Fishing Museum (located in Tofte, Minnesota) describing the beginnings of commercial fishing in Lake Superior:

"Commercial fishing began on Lake Erie and Ontario in the 1820s and spread westward in the late 1880s to Lake Superior, when, Scandinavian immigrants settled the rocky North Shore of Lake Superior. Lured by tales of abundance and opportunity, the first settlers traded the harsh coasts of their homeland for the equally harsh climate of the North Shore. Although the early settlers pursued both farming and logging, fishing was the primary occupation. Fish buyers in Duluth eagerly promoted the fledgling fishing industry by providing both fishing equipment on credit and a ready market for the catch. Glowing reports of success soon attracted more families from the homeland and commercial fishing became an established way of life in the new land. Many of these immigrants came directly from the coastal fishing

Spirit Lake was the Dakota name for the large central Minnesota lake that French explorers later named Mille Lacs.

Minnesota is derived from the Dakota word *Minisota,* which means sky-tinted waters.

Lake sturgeon from the St. Louis River provided a dietary staple for some of the northernmost bands of Ojibwe.

In Ojibwe tradition, the sturgeon is considered the king of fish and the Chief of the Fish Clan. Its Ojibwe name is namé (nah-may).

Dakota and Ojibwe peoples engaged in winter fishing long before European settlement. Ice fishing has long been practiced in Scandinavian countries, too. Finnish, Norwegian, and Swedish settlers brought their ice fishing traditions to Minnesota.

villages of Norway, bringing with them knowledge of appropriate fishing techniques, a formidable work ethic and a native hardiness. The North Shore offered many new challenges, but the familiarity of fishing from a cold, rugged shore provided them with a sense of place."

Minnesota Residents Today

Fishing is still a way of life—or at least an important recreational activity—for a significant percentage of Minnesotans, and for each new group of people that immigrates to the state. In addition to food, fish provide products such as fish oil and fertilizer, income for commercial fishermen, and tourism that benefits resorts, bait shops, fishing guides, and other local businesses. Fishing also provides recreational opportunities for the state's many anglers.

Fish Storytelling in Minnesota

Fishing seems to go hand-in-hand with storytelling. When avid anglers aren't fishing, they're probably telling fish stories, from reeling in a "big one" to almost catching "the one that got away." This was true for Minnesota's earliest anglers, too. Since human history began, people have passed on knowledge and culture through the oral tradition of storytelling.

Minnesota winters are long and hard, and long ago, native peoples spent much of the season confined inside their tipis (eastern Dakota) and wigwams (Ojibwe). They often passed the winter evenings sitting around the fire, recounting their history, teaching the young, and entertaining one another with stories. Many stories are oral histories or stories with a spiritual or ceremonial purpose, which are highly valued and important in the traditions and cultures of native peoples. Stories serve different purposes, depending on the intent of the storyteller. Elders from native cultures are well-versed in tribal history, traditions, customs, and ceremonies. They pass on this information by skillfully telling and retelling stories.

Some stories have been told to entertain children. Through long winters, elders have often elaborately embellished these stories to delight and hold the attention of the young ones. Reflecting the importance of fishing to their survival, many of these stories exist as colorful tales about fish and fishing. These are some of the earliest exaggerated Minnesota fish stories!

Ojibwe Stories

According to Ojibwe legend, the first snowfall brings the storytelling season, which lasts until the first boom of thunder in the spring. There are two types of Ojibwe stories. The first type is *Aadizookaan,* the Ojibwe word meaning traditional story. These stories relate far-reaching themes of human spirituality: where the people came from, how the people should live, how to cope with daily trials and hardships, and gratitude for the blessings and teachings of life. They were—and are—considered sacred. The second type consists of tales that teach, offer humor, provide entertainment, and answer the "why" questions about natural phenomena and behaviors. Storytellers sometimes own their stories; only they can tell them. In order for another person to tell a particular story, they would have to get permission from the story's owner, and offer the owner a gift of tobacco or possibly a blanket, clothing, food, or something else. Today, offering an elder tobacco or another gift for the privilege of telling a story is still a common practice.

Dakota Stories

The close connection between Dakota people and the natural world has always manifested itself in traditional spirituality, and this is expressed in their stories. In Dakota cultural practices, everything in nature has a spirit. All things are kindred, or related to each other, and to Wakan Tanka, the Great Mystery. The stories reflect the beliefs of the people. Often an animal would be the **main character** or central figure of a story, teaching people lessons or revealing which plants to use for food, medicines, or ceremonies or the plants to use for making canoes, tipis, wigwams, bowls, fishing nets, and other tools. Animal characters also teach people how to hunt and fish. Stories teach Dakota children about the world around them and about many principles and values, including the consequences of being greedy, boastful, or teasing others. Stories encourage children to listen, have patience, and to be observant and creative. Through storytelling, the peoples' knowledge, culture, values, traditions, and history pass from generation to generation.

> "The oral traditions of Native people are thousands of years old, and alive and flourishing today. Stories that are told . . . are integral elements of Native cultures, having meaning within the context of those cultures, and perhaps meant for only certain people within the culture . . . a work that is to be sung only by a certain person or persons, and at a certain time for a certain purpose. . . . Almost everyone likes a story and can learn from it, but there are incorrect versions of tribal stories circulating on the Web and in print; also, errors in details give inaccurate information about Indian people. A story is an effective teaching tool only if the teacher and the learner both understand how the story applies to the lesson. Often Native stories refer to certain people or a geographical region where something happened so that the meaning is tied with a personal acquaintance of people and place. Some stories should be told only at specific times of the year, or by certain people to a particular audience, or in a particular language. . . Knowing a story's tribal affiliation is essential to verify authenticity and to determine whether the story is one that should be available for public [listening] . . ."
>
> —Techniques for Evaluating American Indian Web Sites,
> Elaine Cubbins, MA-IRLS,
> **www.u.arizona.edu/~ecubbins/webcrit.htm**l
> and **ecubbins@u.arizona.edu**

The Walleye
A Traditional Dakota Indian Story

Long ago, before the land was formed, water covered all the earth. In the water lived many fish. Then, one day, the Great Mystery, Waken Tanka, said, "I will make land to walk upon for the Two-Leggeds who are to come. The land will separate the waters into oceans, rivers and lakes, and there will still be plenty of waters for my many Water Dwellers. Together, the Two Leggeds and Water

Dwellers will live in harmony and make use of all the earth."

Waken Tanka called to the Walleye who was a leader among the Water Dwellers. The Walleye knew how to follow currents to find cool, deep water. His large eyes allowed him to see clearly in the deep and dark waters.

Waken Tanka said to the Walleye, "I am going to send the Sun to warm the water and make land to walk upon for the Two-Leggeds who are to come, but do not fear. There will still be plenty of water for the Water Dwellers on the earth. During the time the land is appearing, the surface and shallows will not be safe for you. You must lead the water dwellers to cooler, deep water. The cooler waters will take you to your new homes where you will be fine. Remain there until I call you again, then you can return. Do not look back, and do not look at the Sun. Do as I ask and remember this warning."

The Walleye returned to the Water Dwellers and began to lead them to deeper, cooler waters. They traveled far and to the North, swimming deeper and deeper. The water did become cooler. And they swam farther and deeper. Some of the Water Dwellers were curious and said to the Walleye, "We have been swimming deeper and deeper and have traveled far. We haven't seen the Sun for a long time. What could be happening on the surface? Won't you go back while we wait here and check what is happening for us?" The Walleye responded, "Remember the warning that Waken Tanka gave to me: Do not look back, and remain in the deeper water until I call you again. He has not called me, I can't go back, yet." But they were very curious and persisted, "Just take a quick look and let us know what is happening, then we will wait to be called back." Finally the Walleye relented and swam back towards the surface to find out what was happening.


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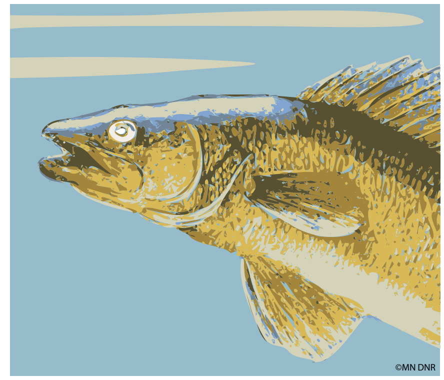
Waken Tanka sent the Sun to burn brighter in the sky and warm the waters. The waters of the earth began to give way to the forming of the land. Only the Walleye who was leader of the Water Dwellers ventured back to the surface during this time because of those who were curious.

At the surface the sun glowed bright and hot in the sky. Never had the Walleye known the sun to be so close to the earth or so hot. As the waters receded, the Walleye looked directly at the Sun. For an instant he saw the great yellow blinding glow, then the sky grew white and colorless. The Walleye hastily plunged back beneath the surface and began swimming towards cooler water. His eyes felt much pain, and he could not see where he was. Frightened, he called to the Water Dwellers, but they were far away and could not hear him.

He called to Waken Tanka, and Waken Tanka answered, "You are blind, Walleye. Because you have disobeyed my word and forsaken my warning, your eyes have become clouded and burned by the Sun. But, your people need you, as you are their leader, and so I will restore your sight. Still, you will not go unpunished. I decree that you and all your children, and all your people's children, shall wear the same blank, cloudy stare as your sightless eyes for all time to come. Let it remind them and all my children that my word is not to be disobeyed, nor my warnings forsaken."

And it was as The Great Mystery said. With his sight restored, Walleye was able to find his way back to where the Water Dwellers were waiting, but they were all surprised to see his large, cloudy, blank and blind-looking eyes upon his return. And so it is to this day, when the Two Leggeds walk on the land, that one fish species among all, the walleye, sees clearly through large, clouded "eyes-that-do-not-see," for it is the decree of Waken Tanka.



Walleye, with his sight restored by Waken Tanka.

This walleye story was most graciously shared for use in the *MinnAqua Leader's Guide* by Joseph Campbell, a highly respected and acclaimed international speaker, entrepreneur, storyteller, and member of the Prairie Island Mdewakanton Sioux Community.

Dakota and Ojibwe stories have been passed from generation to generation, maintaining a vast history through oral tradition for thousands of years. These stories keep the rich histories and traditions alive for each new generation. Native storytelling traditions should always be respected.

Folklore and Values

We can see that different types of stories serve different purposes. Besides telling stories to entertain or to relate details of an event, people often create and share stories to convey the history, understandings, and traditions of their culture. **Folklore** is the creative expression of a particular group of people whose traditions and beliefs are incorporated into stories in innovative ways. Folklore draws on the collective wisdom and experience of a group of people, and is expressed in a creative, engaging way. As stories are repeated and passed from generation to generation, they help shape the attitudes, values, knowledge, beliefs, and behavior of people over time. For this reason, stories are often used to teach lessons about proper cultural values, attitudes, and behaviors. Different types of folklore, such as myths, legends, tall tales, and fables, fall into this category of stories.

Tall Tales

Tall tales are entertaining stories that are outrageously exaggerated or bigger than life, even though they're told in a straightforward, believable style.

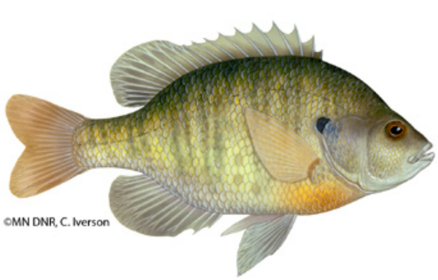
The origin of tall tale folklore is attributed to the early pioneers who recounted frontier trials and adventures during the settlement of the western United States.

Tall tales are stories about people who were supposed to have actually lived and had adventures in real places. As these stories were told and retold over the years, the true details of the lives of the main characters were exaggerated and revised. For example, real people, like Davy Crockett, Annie Oakley, and Johnny Appleseed, eventually became folk heroes. Some tall tale characters, like Paul Bunyan, never existed, but it may seem as though they had due to the number of times the stories have been repeated. These stories transform the main characters into heroic figures that perform superhuman deeds, such as roping a tornado (Pecos Bill), creating Minnesota's 10,000 lakes by romping with an ox (Paul Bunyan and Babe the Blue Ox), and melting drinking water from snow with the soles of his feet (Johnny Appleseed). Tall tales sometimes combine some factual information with wild fantasy.

Tall tales often include similes and metaphors, which describe the astounding abilities, traits, and feats of the heroic main character. Typically, the main character uses special abilities and skills to solve a difficult problem that arises in the story.

A **simile** is a figure of speech where two unlike things are compared, usually using the words *like* or *as:* Mary swims *like* a fish, or I'm busy *as* a bee.

A **metaphor** is a figure of speech in which a word or phrase that ordinarily refers to one thing is used to describe another object or idea. In a metaphor, something is something else: He's drowning in money, or Her eyes are deep, blue pools.



The Legend of Paul Bunyan's Bobber in Pequot Lakes, Minnesota!
As told by the historians of the Pequot Lakes Office of the Brainerd Lakes Area Chambers of Commerce, **www.pequotlakes.com.**

A long, long time ago, Paul and Babe were vacationing near Pequot Lakes after sending their last load of logs down the Mississippi. Paul thought he'd try his luck at catching Notorious Nate: Ol' One-Eyed Jakes' cousin, a 40-foot northern so mean that he was expelled from every school of fish in the five-state area. Nate had only one weakness: his love for Sunfish Sally, the sassiest, sexiest, fantail sunfish you ever did see!

Paul's plan was simple: Ole the Big Swede, Paul's blacksmith, forged a huge, deadly iron hook with barbs as sharp as Paul's axe. He attached it to a 90-foot pole and baited it with a juicy 6-foot worm. To complete this fantastic rig, Ole made the largest bobber ever known, 60 feet in circumference.

Armed with this pole, Paul and Babe headed for Whitefish Lake and cast it in off Pickerel Point, just where Sunfish Sally was sunning herself. Nate was nearby as usual, admiring Sally's spectacular silhouette. Sally took one look at that bait and darted after Paul's murderous hook. Nate, sensing the danger, headed Sally off. But, alas, the zinging hook caught Nate instead! Paul gave one mighty tug and with a last desperate flip, Nate flew so high in the air that he landed seven miles away in downtown Pequot Lakes.

The bobber caught in the tower scaffolding under construction for the new water tower and there it sits today, a mere souvenir of Paul's battle with the ill-fated Nate.

All the townspeople filled two freezers full of fish that spring. But the hole left by Nate puzzled them. The Pequotians decided to bake beans in it every July and that's how Bean Hole Days started.

Oh, yes, and when Paul and Babe were battling Ol' Nate, they left a few footprints, thus creating the Whitefish Chain. Paul named one Lake Bertha, after his aunt. And Babe named one Lake Hay, after his favorite fodder!

People have speculated on the fate of the beautiful Sunfish Sally. It has been said that poor Sally was so blue and brokenhearted over her beau's demise that ever after, each of her descendents carried the mark of her lover's remembrance and hence was born a new species: the bluegill!

So goes the Tale of Paul Bunyan's Bobber.

The water tower in Pequot Lakes, Minnesota.

Tall tales are thought to have originated in the United States in the nineteenth century, as early settlers and pioneers grappled with the daunting vastness of the western frontier. The many challenges of daily life required great fortitude and a good sense of humor. Heroic abilities attributed to main characters of tall tales helped pioneers believe that they could actually settle the expansive land. Each part of the country produced region-specific tall tale heroes and stories. For entertainment on the early frontier, people gathered around a campfire after a hard day's work and shared humorous tales. There were no televisions or movies, and books were extremely expensive and in short supply.

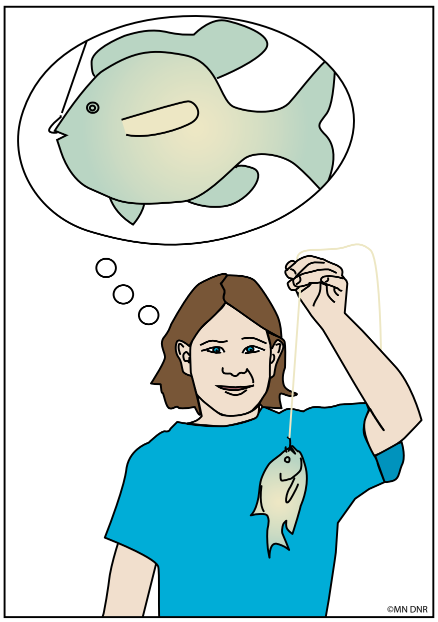
Parents retold the tall tales to their children at bedtime. When the children went to sleep, the tales fueled their dreams with images of amazing heroes with superhuman abilities in grand adventures that involved solving difficult problems.

Exaggeration and Fish Stories

Fish stories share many characteristics with tall tales. There's something about fishing that leads people who fish to tell exaggerated fish stories. The ability seems to come as naturally to first-time anglers as it does to those who are more experienced. Remarkably, each time a fish story

A storyteller uses **exaggeration** by enlarging, overstating, or representing an object, event, or characteristic as larger than normal.

Hyperbole is a figure of speech that employs exaggeration for emphasis or effect: I've been waiting for an eternity!



A Fish Tale
An angler described a bass that he caught on a recent fishing trip. "It weighed 30 pounds! I fought that monster for three hours," he told his friend.

The friend interrupted. "I saw the picture you took of that fish," he said. "You're lucky if it even weighed ten pounds."

"Well," said the angler, without losing a beat, "a fish can lose an awful lot of weight after three hours of fighting!"

is retold, it usually becomes more exaggerated. The fish may get a bit bigger and the fight a little tougher. You've probably heard a fish story from a neighbor or a family member, or you may have told a fish story of your own. Every angler seems to have at least one! Some fish stories sound more like fiction than truth, and fish storytellers have gotten a reputation for **exaggerating,** or embellishing the truth, no matter how earnestly the angler tells their story. You've probably heard stories about how someone caught a fish as big as a moose, or perhaps one about an elusive, mythical fish that no one has been able to catch. For a good fish story, entertainment is key—believability is optional. But an effective storyteller will make you feel that you "should have been there!"

The following is an oft-told example of a fish story that is less about catching fish than entertaining the listener. Notice how the story is told in a way that makes it believable. This keeps the listener involved until the very end.

The Fisherman's Sons
A Traditional Tall Fish Tale

A fisherman and his wife were blessed with twin sons. They loved the boys very much but fretted over what to name them. Finally the fisherman said, "Let's not worry about this. If we wait awhile, the names will come to us."

After several weeks had passed, the fisherman and his wife noticed a peculiar fact. When left alone, one of the boys would always turn towards the water's shore, while the other boy would face inland. It didn't matter which way the parents positioned the children; the same child always faced the same direction. "Let's call the boys Towards and Away," suggested the fisherman. His wife agreed, and from that point on, the boys were simply known as Towards and Away.

The years passed and the lads grew tall and strong. The day came when the aging fisherman said to his sons, "Boys, it is time that you learned how to fish." They provisioned their boat, said their good-byes, and set off for a fishing trip.

A terrible catastrophe happened while the father and twins were out in the boat. The father returned home to tell his wife what happened. He said to his wife, "We had just barely gotten out on the lake when Towards hooked into a great fish. Towards fought long and hard, but the fish was more than his equal. They wrestled upon the waves without either of them letting up. Yet eventually the great fish started to win the battle, and before I could reach him to help, Towards was pulled over the side of the boat. He was swallowed whole, and we never saw either of them again."

"Oh my, that must have been terrible!" said the wife. "What a huge fish that must have been! What a horrible fish."

"Yes, it was," said the fisherman, "but you should have seen the one that got Away!"

Fish Tales
By turning fish stories into tall tales, students can discover how heroic characters, creative metaphors and similes, ample exaggeration, and a sprinkling of humor combine to create fun, entertaining stories. Telling a good story is a skill that develops with practice and attention to detail. A storyteller should give some thought to describing the **main character**, creating the **setting**, and developing the **theme** of their story.

From the traditions and tales of others, students learn that stories reveal information about a people's history, transmit knowledge and culture, entertain, teach moral lessons, and convey attitudes, values, and beliefs. Stories can offer valuable perspectives on relationships between people as well as their interactions with the natural world.

The **main character** of a tall tale is a heroic figure that solves a problem in an amazing way.

A story's **setting** includes the time, place, and circumstances in which it takes place.

A **theme** is the plan, scheme, or main point of a story.

Procedure

Preparation
1 Set up a reading display using as many tall tale books as you can find, as well as books about early settlers in the Minnesota region.
2 Make copies of the **Tall Tales Research Sheet**—three for each group of three or four students.
3 Make copies of the **Reviewing a Tall Tale Sheet**—two per student.

Activity

Warm-up
1 Tell students that people have always told stories, even before they could preserve them in writing. Since prehistoric times, people all over the world have been passing on knowledge and culture through the oral tradition of storytelling. Passing stories from generation to generation has been important in many early cultures, and remains important today. Stories help families and communities share lessons, knowledge, and history. Have the students think about a time before video games, TV, books, and newspapers. How would the children of these times learn about history, their culture, or how to catch or grow food? Why would stories be an effective way to pass lessons, knowledge, and traditions to children? Compare the storytelling traditions of Dakota and Ojibwe peoples in Minnesota with stories of early settlers and present day anglers. Discuss why Dakota and Ojibwe traditions and stories should be respected. Do we tell stories in our families today?

In the interest of time, instead of doing the entire lesson, you may choose to do the portions of this lesson that best meet your class objectives and fit your available time frame. For example, you might just do the Warm-up, or choose to omit the writing portion of the activity and emphasize oral storytelling.

Why do you tell stories? What do these present-day stories teach you?

2 Discuss why fish and fishing have always been important to people who have lived in the land now called Minnesota. Is fishing still important in Minnesota?

3 Ask students if they have ever heard someone tell a fish story or if they have ever told a fish story. Was the story fact or fiction? Why do people tell fish stories? Who told the first fish stories in Minnesota?

If some students can't recall a fish story, you may wish to have several short fish story examples printed and ready to give to those students.

4 On a sheet of paper or in a journal, have students write a short (two or three paragraphs) fish story that they've heard or told. Tell the students that—like the early Ojibwe and Dakota peoples, the European settlers who settled in Minnesota, and present day campers—they'll tell their stories around a "campfire."

5 Have the class sit in a circle. You may wish to take the class outside to make the circle. If you stay inside, turn down the lights and position a small lamp or flashlight in the center of the circle to simulate a fire.

Some of the students' stories may contain more exaggeration than others at this point.

6 Have students take turns telling their fish stories as they sit in the circle. You may wish to introduce the "talking stick" concept, which comes from Native American tradition. It's a respectful way for a group of people to talk about things. The student holding the stick (or other item such as a stuffed fish toy, or bobber) is the circle's designated "talker" or storyteller, and everyone else is a respectful listener. The talking stick is then passed to the next person, who then becomes the storyteller.

7 After the fish stories are shared, define exaggeration.

8 Help students understand the definitions of similes and metaphors.

9 Have students practice writing similes and metaphors:

Ask students to take another sheet of paper and write a sentence about themselves describing single characteristics that make them unique, such as "My hair is red." Then have them add the word *as* or the word *like* to their sentences. Have the students finish their sentences by adding a noun or an object to which to compare the trait, such as "My hair is red like a fire engine." or "I can run as fast as a train." Have the students read their sentences aloud. They've written similes!

To practice writing metaphors, begin by showing several everyday items to the students. Some examples include a photo of a bear, a piece of bark, a fish mount, a locket, or a football helmet. Ask the students to compare the items to a different object or idea, using the words *is, are, was,* or *were*. For instance, a student might say, "a bear is strength," or "the tree's bark is a roadmap through valleys and cliffs," or "the fish were rainbow sparkles in the shadows beneath the dock."

10 Have students practice exaggeration using metaphors and similes. Not all stories are told for the same purpose. Some are told to

relate facts, others teach traditions, and some are told purely for entertainment. Tell the students that exaggeration is often used to make a fish story more interesting or entertaining. Similes and metaphors are literary tools that also make a story more colorful and descriptive. Tell the students they are anglers in a bragging contest that will entertain an audience. Contestants must use similes or metaphors when exaggerating or bragging about their fish and fishing adventures. It's important to use exaggeration in a way that's straightforward, and even believable. If the story is told in a believable style, it will surprise the listener and have more impact. Pass the talking stick around the circle to those students who wish to enter the bragging contest.

11 Now have each student choose one of the fish stories that were originally told around the campfire. Have them select someone else's story—not their own. Have them rewrite this story using similes, metaphors, and exaggeration—changing facts and details in whatever way they think will make the story colorful, humorous, interesting, and entertaining.

12 Using the talking stick, have students read their rewritten fish tales, introducing each story by saying, "According to the way I heard the story . . ."

13 Were the original stories fact or fiction? What happened to the original details in the retold stories? Did the stories become colorful and entertaining after they added exaggeration, similes, and metaphors? Were they told in a straightforward, believable style? Did the believable style provide surprise and humor? Have the students heard other fish stories that were a bit exaggerated and hard to believe, yet humorous, interesting, or entertaining?

To shorten this warm-up activity, you may wish to ask only a limited number of volunteers to share fish stories verbally.

Lesson

Part 1: Exploring Tall Tales

1 Ask your students: What tall tales do you know? What makes a story a tall tale?
- Tell students that early settlers told tall tales about superhuman characters doing amazing and grand deeds because, to these people, their new surroundings often seemed vast and their lives were very difficult.
- Tall tales were often passed orally from generation to generation until they were eventually preserved in writing.
- A story may be old, and possibly quite true at one time, but its details are likely to change as it's told over and over. We saw how that can happen with fish stories!

2 Start a story with an exaggerated sentence: "Long ago, there was a girl named Maggie who could see across Lake Superior."
- Ask a student to volunteer the next line.
- Have each student add another line to the story using a vocal tone to indicate the sentence is factual.
- Choose one student volunteer to create the last sentence, or ending, for the story.

- By the time the story ends it should be one whopper of a tall tale! You may want to make an audio recording or write down the story as the students tell it.
- At the conclusion of the story, have students discuss how a story that is passed down orally might change over time. Ask one or two students to retell the story. Does the story stay the same as the original version?

3 Help students set goals for the lesson.
- What do the students want to learn about tall tales?
- Goals might include writing and performing their own tall tales, or learning what makes a story a tall tale.

4 Have students work in groups of three and ask them to conduct Internet research, and/or use books in the classroom or school library to determine the characteristics of a tall tale and investigate and discover some famous examples. Give three **Tall Tales Research Sheets** to each group. Allow the groups approximately 45 minutes to find three tall tales, read them, and complete the sheet.

You may find it helpful to bookmark tall tale websites in advance so the students can use them for their research.

5 Define story setting and story theme. (A story's setting includes the time, place, and circumstances in which it takes place. A story's theme is its plan, scheme, or main point.)

Discuss with the class what the groups learned about tall tales. Were they able to find information on the history of tall tales in the United States? With the class, brainstorm (using information that the students collected) a list of features or characteristics of tall tales. Guide the students to create a list that contains these components of a tall tale:
- a larger-than-life heroic or superhuman main character with a specific job
- a problem that's solved in a funny and outlandish way
- exaggerated details that describe things as greater, larger, or smaller than they really are
- events that may be extraordinary, but described in a way that makes them seem believable to the audience
- similes and metaphors describing people, objects, events, virtues, and abilities

To shorten this exercise, you can provide some sample tall tales that can be read and discussed in class more quickly. Students can explore the characteristics of a tall tale as a class discussion, using the **Tall Tale Research Sheet** as a guide. As another alternative, ask each student group to look up one tall tale using the Internet, school library, or other available resource books to help them complete the **Tall Tale Research Sheet**. This takes less time and allows each student to really explore a tall tale.

6 Ask the students if exaggeration makes tall tales entertaining. Would they be as entertaining if they contained information that was completely factual or lacked embellishments?

Part 2: Writing a Tall Fish Tale

1 Each student will use their group's tall tale information and research to create their own original tall tale about fish or fishing. But first, they will need to select a problem to address in their tales.

2 Have students brainstorm a list of current issues related to fish, fishing, and aquatic resources in Minnesota. Write the problems and issues on the whiteboard or projection device.. Discuss each item as you list it.

The list could include:

- pollution in lakes and rivers
- erosion and sedimentation
- the causes of aquatic habitat loss and how this loss impacts fish and other aquatic species populations
- aquatic invasive species
- reasons for fishing regulations
- public awareness and knowledge of fish and fish ecology
- increasing development of lakeshore property
- impact of various land use practices on watersheds
- impact of increased use of sophisticated fishing equipment such as depth finders, fish locaters, and underwater cameras
- illegal overharvest of fish (poaching)
- how low head dams hamper fish migration

3 After the students have produced a sizable list, have each student write a different problem on a small sheet of paper.
- Collect the papers and put them into a hat.
- Pass the hat and have each student draw a problem from the hat.
- The problem drawn provides the plot for that student's tall tale.
- Remind students that, in their stories, the problems must be solved in an amazing way.

The students' solutions will probably not be realistic, but they'll probably start to appreciate that there are no simple solutions for some environmental problems.

4 To help the students practice developing exaggerated, creative solutions to fisheries problems, divide the class into groups of three or four students (or use the tall tale research groups) and have the students work in groups to come up with several exaggerated, outrageous, or unusual ways to solve the problems they've chosen.

5 Have the student groups share their most creative solutions with the class.

6 Finally, ask each student to create a main character and write a draft of a tall tale. Remind students that their main character should attempt to solve the problem they pulled from the hat.

7 Students should use the five components of a tall tale in their stories. To help with this process, ask students to make a simple graphic organizer from a folded sheet of paper. Give a sheet of plain (art) paper to each student. Have them fold the paper in half lengthwise.
- On the left side of the paper, students can draw a picture of their hero. Give the main character at least three heroic characteristics that will help them solve the problem—make the main character bigger, stronger, faster, or smarter than anyone else. Give the hero a name. Decide on the main character's job.
- On the right side of the paper, have students make three boxes. In the first box, have them write down their problem about fish. Have them write the solution in the second box. In the third box, have them decide on a setting for the story, other characters, and a plot.

Instead of having the students brainstorm a list, the instructor may wish to create a list of fisheries-related problems for the class, depending on relevant local issues and the amount of relevant material the students have covered prior to this lesson.

You may wish to review with students that Minnesota is home to people of many cultures and backgrounds. Traditional stories and folklore can reveal attitudes and values regarding the natural world that are held by those cultures or groups of people. Explain to students that it's important for resource managers know and understand the values and attitudes of diverse citizens throughout the state. When managing Minnesota fish, it's necessary to try to balance the needs and desires of all Minnesota citizens to preserve the biological integrity of fish populations, and to do so in a sustainable way. How could learning about the traditional stories of the diverse people who live in Minnesota help fisheries managers do their jobs?

- On the left side of the back side of the sheet of paper, have students list examples of things they can exaggerate in their story. On the right side, they should list ideas for similes and metaphors that they could use to make their story entertaining and fun. Remind them to use their imagination and sense of humor!

8 It's time to write the tall fish tale! Tell students to describe the main character in detail so that readers can recognize at least three characteristics of their hero. Remind students to describe the hero, events, and the solution—however extraordinary—in a believable style. Remind students that a good story has a strong ending. When typing their story drafts, students should double-space them for easier review. (If students aren't able to type their stories, have them print the stories neatly.)

Part 3: Reviewing and Revising Tall Tales

1 Make three copies of the typed or printed drafts of the students' stories for peer review.

2 Pass out two **Reviewing a Tall Tale Sheets** to each student. Divide the class into their previous groups of three or four students. Each student should receive one copy of each fellow group member's stories.

3 In the small groups, have each student read their own tall tale aloud as others in the group read along.

4 Each student may then complete a **Reviewing a Tall Tale Sheet** for two of the other group members' stories. Each group member should then receive two different peer reviews of their own tall tale.

5 Students should read the reviews of their tall tale, make any necessary additions or changes to their story, and write a final version of their story.

6 Have the students hand in their drafts, the peer reviews of their stories, and their final tall fish tales.

Wrap-up

1 Have students share their final fish tales in a storytelling circle.

2 Review the fact that a tall tale is a story that is exaggerated, yet told in a believable way. Ask the class why people have told tall tales. Discuss the hardships early settlers encountered and the origins of tall tales. Why do you think tall tales have endured for so long?

3 For further discussion, ask students: Did you learn more about fish from the different fish tall tales? Did you learn something about how the different writers thought about or regarded fish? After hearing these stories, do you think differently about fish? How? What might an American Indian fish story tell you about how the people think about fish? What might an early European settler's story tell you about how they thought about fish? What might a cultural story about fish told by an immigrant to Minnesota from a country in Africa, Southeast Asia, Eastern Europe, or elsewhere tell you about how that culture thinks about fish? What are some resources other than stories that tell us information about the past?

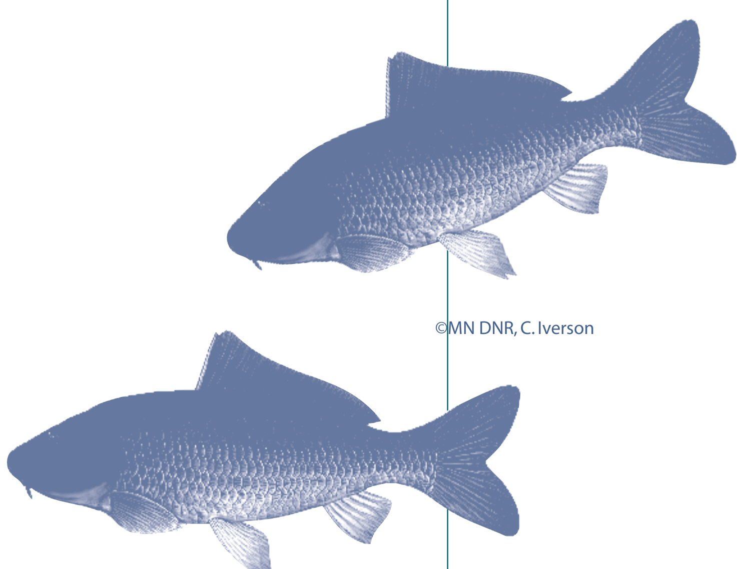
Instead of reading the final fish tales aloud, you might wish to have students illustrate their stories and create a book cover. Then, display the tall tale books in the classroom where students can read them at their leisure.

4 Remind students that different types of stories have different purposes. Can they give some examples of different types of stories and their purposes? Can they describe how today's storytelling might be different than the storytelling of many years ago? What are some similarities between the stories the students might tell or read today and the stories of Dakota or Ojibwe people? Between the stories told by early Minnesota settlers?

As students read their final fish tales aloud, record them with a digital audio recorder or a digital video recorder. The performances can then be posted on the school website.

Assessment Options

1 Evaluate the participation and research results from the student group work.
2 Assess the written tall tale for creativity, correct grammar and spelling, and incorporation of the five characteristics of a tall tale. Make sure that students included a larger-than-life heroic main character with a specific job; a problem that is solved in a funny and outlandish way; at least three extraordinary, superhuman traits for the main character; exaggerated details that describe things as greater, larger, or smaller than normal; similes and metaphors that describe people, objects, events, virtues, and abilities; and a believable style.
3 Assess participation in discussion and student's understanding that different kinds of stories are told for different purposes, and that stories can reveal what people might know and think about things in nature, like fish.
4 Assessment options include the Checklist and Rubric on the following pages.



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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

32-34 points = A
Excellent. Work is above expectations.

28-31 points = B
Good. Work meets expectations.

22-27 points = C
Work is generally good. Some areas are better developed than others.

16-21 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-15 points = F
Work is unacceptable.

Fish Tales Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student describes four examples of traditional purposes of storytelling, including oral histories, entertainment, teaching lessons, and passing on traditions.
2	______	______	Student defines *tall tale*.
2	______	______	Student defines *simile* and *metaphor*.
5	______	______	Student lists five elements of a tall tale without using notes.
3	______	______	Student provides the names of three tall tale characters identified during the research conducted on tall tales.
8	______	______	Student includes eight tall tale story elements in their tall fish tale, including a larger than life main character, a problem solved in an amazing way, humor, similes and metaphors, exaggeration, setting, title of story, and author's name.
2	______	______	Story is written in a style indicating that the story is to be considered reasonable and believable.
2	______	______	Story identifies a fisheries-related problem.
2	______	______	Main character solves problem in an amazing and creative way.
4	______	______	Final story incorporates the suggestions and ideas from peer review and original rough draft is improved in the final draft.

Total Points

34	______	______	**Score** ______

Fish Tales Scoring Rubric

Tall Tales Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
History of storytelling	Describes four examples of traditional purposes of story telling including oral histories, entertainment, teaching lessons, passing on traditions.	Describes three examples of traditional purposes of storytelling.	Describes two examples of traditional purposes of storytelling.	Provides one example of traditional purposes of storytelling.	Can't provide an example of traditional purpose of storytelling.
Characteristics of a tall tale	Defines tall tale, simile, and metaphor. Lists five elements of a tall tale, including larger than life main character, a problem that is solved in an amazing way, humor, similes and metaphors, exaggeration, setting, title, author. Provides the names of three tall tale characters, such as Paul Bunyan, Johnny Appleseed, and Annie Oakley, as identified in their research on tall tales.	Defines tall tale, simile, and metaphor. Lists four elements of a tall tale. Provides the names of two tall tale characters, such as Paul Bunyan, Johnny Appleseed, and Annie Oakley, as identified in their research on tall tales.	Defines tall tale. Lists three elements of a tall tale. Provides the names of two tall tale characters, such as Paul Bunyan, Johnny Appleseed, and Annie Oakley, as identified in their research on tall tales.	Defines tall tale. Lists two elements of a tall tale. Provides the name of one tall tale character, such as Paul Bunyan, Johnny Appleseed, and Annie Oakley, as identified in their research on tall tales.	Can't define tall tale. Can't list elements of a tall tale. Can't provide the name of a tall tale character, such as Paul Bunyan, Johnny Appleseed, and Annie Oakley, as identified in their research on tall tales.
Writing a tall fish tale	Story includes the eight tall tale story elements listed above. Story is written in a style indicating that it is to be considered reasonable and believable. Story identifies a fisheries-related problem. Main character solves problem in an amazing and creative way. Final story incorporates suggestions and ideas from peer review.	Story includes six tall tale story elements. Story is written in a style indicating that it is to be considered reasonable and believable. Story identifies a fisheries-related problem. Main character solves problem. Final story incorporates suggestions and ideas from peer review.	Story includes four tall tale story elements. Story identifies a fisheries-related problem. Final story incorporates suggestions and ideas from peer review.	Story includes three tall tale story elements. Story identifies a fisheries-related problem. Final story incorporates suggestions and ideas from peer review.	Story includes less than three tall tale story elements. Story doesn't identify a fisheries-related problem. Final story doesn't incorporate suggestions and ideas from peer review, and it not improved from rough draft.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 To diagram or map plotlines, document the sequence of events as a map. To determine congruence, identify similarities and differences between several versions of plots. Create a diagram that explains these discoveries using the two-circle Venn diagram method. Ask students to compare similarities and differences between fish tales written by two different students. Students should record at least five facts that are different in each story, as well as any facts, characteristics, or details that are the same in both stories.

Story #1	Both Stories	Story #2
Main character is a teacher Setting is in a city Kids help solve problem	Uses similes Exaggerated details Uses metaphors Humor Fish in both	Main character is a logger Setting is in a forest

2 Tall tales and fish biology ("Scales and Fish Tales")—Telling fish stories can offer an opportunity to study how fisheries managers determine the age of fish. Begin by telling fish stories. Then tell students that the scales of a fish can "tell tales." Biologists learn the age of fish by counting the rings on fish scales just as the age of a tree is determined by counting the rings in a cross-section of its trunk. Have each student draw a large fish scale on a paper plate with a number of rings that matches their own age. Brainstorm with the class all the ways fish are important to us (such as healthful source of food, recreational enjoyment, attract tourists to the state, provide jobs for fishing guides, those who fish commercially, and bait store owners). Ask the students to record these ways inside the rings drawn on their paper plate scales.

3 Tall tales and expressive arts—Have students illustrate their tall tales. Compile the tales into a class *Tall Fish Tales* book, or post the illustrated stories on a class website. Have students share and read their stories, or act out the stories for younger students.

4 Tall tales and communication—Discuss with the class the types of "stories" that appear in newscasts. Ask the students to think about the main characters in their tall fish tales. What things about this main character would you put into a news story, weather report, or sports report? Have the class create a news feature story about the main characters in their fish tales.

5 Tall tales and history—Have students draw a picture of a frontier or early settlement campsite with people sitting around the fire telling stories. Have them write a paragraph about what they think it would have been like to live on the Minnesota frontier. Ask students: Would it have been exciting or might it have been scary? How do you think you would have gone fishing? What kind of equipment would you have used to fish? Do you think you would have liked being a kid on the frontier? Why or why not? Would you be able to survive without TV, movies, computers, and video games?

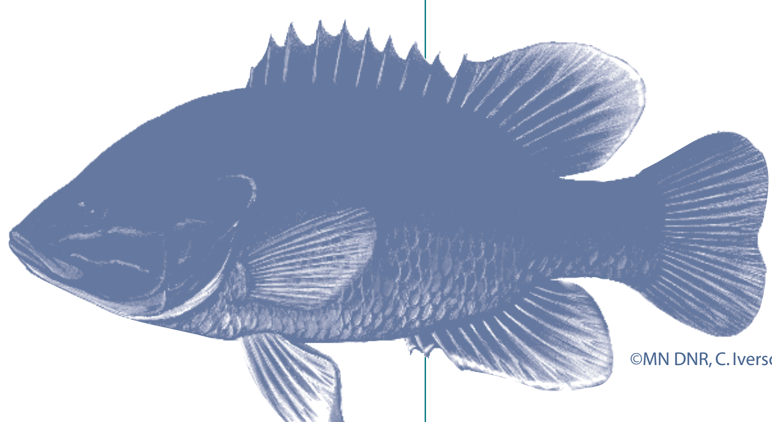
For the Small Fry

K-2 Option

1 Read several tall tales aloud to the students and talk about the characteristics of a tall tale. Ask students to share a fish story they have heard or told before. Divide the class into small groups. Each group can choose a story and create a play or puppet show, a mobile illustrating the scenes in the story, or a storyboard illustrating the chosen story.

2 Read several stories about fish to students to expose them to fish stories from different places and cultures. Have students draw the things they imagined while listening to the fish stories. Students can tell their own fish stories and illustrate them.

3 Have the entire class work together to create a classroom tall tale. Work together to pick a theme and then have each student add a part to the story. The story could relate to something that really happened in the classroom or it could be totally fictional.



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STUDENT COPY

Name(s) ______________________________ Date ______________

Tall Tales Research Sheet

Use one of these sets of sheets to answer these questions about *each* of the three tall tales your group finds.

1. What is the **title** of the tall tale? ______________________________

2. Who is the **main character**? ______________________________

3. List at least three **heroic** or larger-than-life traits of the main character. ______________

____

____

____

4. List examples of **exaggeration** in the story. ______________________________

____

____

____

5. Were **similes** and **metaphors** used in the story? If so, list them below.

Similes	Metaphors

continued

STUDENT COPY

Name(s) ______________________________ Date ______________

Tall Tales Research Sheet (continued)

6. What is the **problem** in the story? ______________________________

7. How is the problem **solved**? ______________________________

8. What is story's **setting?** (The time, place, and circumstances in which it takes place.)

9. What is the **theme** of the story? (The plan, scheme, or main points.) ______________

STUDENT COPY

Name(s) ________________________ Date ____________

Reviewing a Tall Tale Sheet

1. What is the **title** of the tall tale you are reviewing? ____________________

____

2. Who is the **author**? ____________________

3. Who is the **main character**? ____________________

Did the writer include at least three **heroic** or larger-than-life traits for the main character?

____

What are the **traits** of the main character?

- ____________________
- ____________________
- ____________________

4. What is the story's **setting**? (When and where does it take place?)

Time ____________________

Place ____________________

5. What was the story's **problem** about fish, fishing, or aquatic resources?

____

____

____

____

____

(continued)

STUDENT COPY

Name(s) ______________________________ Date ______________

Reviewing a Tall Tale Sheet (continued)

6. How did the main character **solve** the problem in the story? ______________

7. Does the tall tale use **exaggeration**? ______________ What was exaggerated in the story?

8. Is the story written in a way that sounds like the events could actually happen? Is it told in a believable way? Why or why not?

9. What is the **purpose** of the story? (For example, did it teach a lesson, entertain, record an event, or explain science?)

(continued)

STUDENT COPY

Name(s) ______________________ Date ____________

Reviewing a Tall Tale Sheet (continued)

10. Is the story **entertaining**? ____________ Did the writer use humor? ____________

11. What was your favorite part of the fish tale? ____________________________

12. What did you learn about fish from the story? ____________________________

13. Name one way in which the writer might improve the story. ____________________

Remember that a review helps the writer by offering suggestions and giving encouragement. Constructive feedback will help the writer create a better tall fish tale!

Fish in Winter

In the short, cold days of winter, lakes and rivers freeze. What happens to the fish?

Courtesy of Bill Linder

Table of Contents

Chapter 2 • Lesson 8

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish in Winter

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading. (no reading)
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Math

Grade 3
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason, and represent situations mathematically.
II. Number Sense, Computation, and Operations
A. Number Sense:
Benchmark 1—The student will read, write with numerals, compare, and order whole numbers to 9,999.
IV. Data Analysis, Statistics and Probability
A. Data and Statistics:
Benchmark 2–The student will collect data using observations or surveys and represent the data with pictographs and line plots with appropriate title and key.

Grade 4
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason, and represent situations mathematically.
Benchmark 3—The student will evaluate the reasonableness of the solution by considering appropriate estimates and the context of the original problem.
III. Patterns, Functions, and Algebra
A. Patterns and Functions:
Benchmark 1—The student will examine and describe patterns in tables and graphs.
IV. Data Analysis, Statistics and Probability
A. Data and Statistics:
Benchmark 1—The student will collect data using observations or surveys and represent the data using tables and graphs with labeling.
Benchmark 2—-The student will use mathematical language to describe a set of data.

Grade 5
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason and represent situations mathematically.
Benchmark 3—The student will evaluate the reasonableness of the solution by considering appropriate estimates and the context of the original problem.
Benchmark 7—The student will organize, record and communicate math ideas coherently and clearly.
III. Patterns, Functions, and Algebra
A. Patterns and Functions:
Benchmark 1—The student will examine and describe patterns in tables and graphs and explain how to extend those patterns.
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 1—The student will determine whether or not a given graph matches a given data set.
Benchmark 3—The student will collect data using measurements, surveys, or experiments and represent the data with tables and graphs with labeling.

History and Social Studies

Grades K-3
IV. Historical Skills
B. Historical Resources:
Benchmark 1—Students will define and use terms for concepts of historical time. (Seasons)

Science

Grade 3
II. Earth and Space Science
C. The Universe:
Benchmark 3—The student will observe that the sun supplies heat and light to the Earth.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival, and reproduction for plants and animals.
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
II. Physical Science
A. Structure of Matter:
Benchmark 1—The student will observe that heating and cooling can cause changes in state.
Benchmark 2—The student will describe the changes in the properties of a substance when it is heated or cooled.

Grade 5
IV. Life Science
E. Biological Populations Change Over Time:
Benchmark 1—The student will recognize that individuals of the same species differ in their characteristics and that sometimes the differences give individuals an advantage in surviving and reproducing.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 2 • Lesson 8

Fish in Winter

ISBN 0-7778-4035-9.

Grade Level: 3–5
Activity Duration: 45 minutes
Group Size: up to 30
Subject Areas: Language Arts, Math, Science
Academic Skills: drawing conclusions, graphing, kinesthetic concept development, large group skills, role-playing
Setting: large indoor or outdoor open area
Vocabulary: aeration system, anaerobic, cold-blooded, diapause, dissolved oxygen, hibernation, limiting factor, microclimates, migrate, respiration, warm-blooded, winterkill
Internet Search Words: fish in winter, winter adaptations

Instructor's Background Information

In winter, Minnesota's snow-covered landscape can often look lifeless and empty. But if you go outside for a closer look, you'll see plants and animals alive and thriving under the ice and snow. But unlike summertime when, as the song says, "the livin' is easy," winter does pose some survival challenges.

Winter can be the most stressful season for living things in the north, posing hardships, or limiting factors, that impact chances of survival for plants and animals. A **limiting factor** is anything that restricts the living conditions for an organism, species, or population. Some limiting factors caused by Minnesota winters include decreased food supplies, heavy snow, and cold temperatures.

Fish must cope with water temperatures that rarely rise above 35° F under the ice. But one of the primary limiting factors for fish in lakes under ice and snow is not the cold or even shortage of food, but lack of oxygen.

Summary

In a simulation game, students play the roles of fish attempting to survive a Minnesota winter. They discover how ice and snow cover can affect dissolved oxygen levels in the water, and why oxygen is the most important limiting factor for fish in climates with cold winters.

Student Objectives

The students will:
1 Become fish in a role-playing activity, and discover how oxygen is a limiting factor for fish during the winter.
2 Define dissolved oxygen and describe how oxygen dissolves in a lake or river.
3 Identify at least two natural factors that can cause a water body's dissolved oxygen levels to decrease during Minnesota winters.
4 Write a story to describe how fish survive in winter.

Materials

- 200 six-inch-diameter paper circles or 50 sheets of 8.5" x 11" paper cut in quarters or 200 poker chips or 200 small paper plates, to use as oxygen "markers"
- 8.5" x 11" (or larger) sheets of paper, six
- Whiteboard or graph paper
- Pen or pencil
- Marker
- Whistle or other noisemaker (to signal the beginning and ends game rounds)
- **Playing Area Diagram**

In winter, less food is available in lakes and streams. The winter season brings a reduction in aquatic plant activity and availability. Fewer daylight hours and the increased angle of the sun's rays reduce the photosynthetic performance of aquatic plants. Many aquatic animal species are also less active—some even hibernate during the winter.

The air has approximately 26 times more oxygen than the amount dissolved in an average, well-oxygenated body of water.

Dissolved Oxygen

Oxygen is a gas that we usually think of as the air that we breathe. Oxygen gas also exists in water, much like the carbonation bubbles in soda pop, although the "bubbles" are much smaller. Most living things require oxygen for survival whether they live on land or in the water. Fish use gills to obtain oxygen from the water. They take in water through their mouths. The water flows over their gill tissues, which draw oxygen from the water into the fish's bloodstream. Carbon dioxide waste (a by-product of cell respiration) is released from the bloodstream, through the gills, and into the water as it flows outward over the gill tissues.

Dissolved oxygen is oxygen gas dissolved in water. Gases, such as oxygen, nitrogen, and carbon dioxide, can dissolve in water, just as salt does. The oxygen available to fish is dissolved or mixed into the water by turbulence (wave action, currents, waterfalls, riffles, and rapids). Oxygen is also released into the water during photosynthesis—aquatic plants use the sun's energy and carbon dioxide to make food energy, releasing oxygen. Although oxygen occurs in much lower concentrations in water than it does in air, most water bodies have enough dissolved oxygen to support aquatic life.

The amount of oxygen that can dissolve in water depends on the temperature of the water. Cold water holds more dissolved oxygen than warm water.

But, if cold water holds more oxygen than warm water, why is oxygen availability a limiting factor for fish in winter? The amount of dissolved oxygen in lakes can vary greatly for a number of reasons. In warmer seasons, when the water isn't frozen, the wind, waves, and current constantly mix air into the water, dissolving oxygen into it. Underwater plants also produce oxygen through photosynthesis. But in winter, lakes blanketed by ice and snow can have lower oxygen levels because the ice seals off the surface air as a source of oxygen, and because the snow blocks sunlight, making it hard for underwater plants to photosynthesize. No new oxygen is being added into the water as fish and other aquatic organisms continue to breathe beneath snow-covered ice. They gradually use more and more of the available oxygen in the water as winter progresses. Oxygen levels in the water can potentially decline to dangerously low levels, depending on the depth of the water body and the duration of ice and snow cover.

Water Temperature

Water temperature also has an effect on fish **respiration** (breathing, or the physical and chemical process of supplying the fish's cells and tissues with oxygen for the processes of metabolism and release of carbon dioxide). Fish are cold-blooded animals, and their rates of metabolism increase in warmer water temperatures. As their respiration rates increase in warmer temperatures fish use more oxygen. Conversely, the rate of respiration decreases in cold water—even though the water may contain higher concentrations of dissolved oxygen. This is because fish require less oxygen as their metabolism slows in cold water and as a result, they don't need to work as hard to pass water over their gills to get the oxygen they need.

Winter Survival: A Balancing Act
If fish are to survive a Minnesota winter, a balance of factors determining the availability of oxygen are key. These include water temperature, ice and snow cover, the number of daylight hours, plant activity, and respiration rates.

Fish Winter Survival Strategies
Beneath the ice, in semi-darkness, fish and other aquatic animals must use the dwindling oxygen and food supply for as long as six months. It's a challenge to adjust to difficult winter conditions, and fish rely on a number of strategies to help them adapt. Conserving energy is the key to survival. Fish conserve energy in various ways, primarily through a combination of physical attributes (morphology or body parts), habitat, behavior or habits, and physiological capabilities (body chemistry and metabolic factors).

One behavior strategy fish employ to survive winter conditions involves changing their normal living habits. Cold weather triggers a physiological change. Metabolic rates slow and fish decrease their activity level, appearing to become more lethargic or sluggish. Because they become less active, fish can survive longer with the reduced amounts of food and oxygen in the water under ice and snow. Some fish spend winters in a state of dormancy. Fish can do this because they are **cold-blooded** like reptiles and amphibians. The body temperatures of cold-blooded animals are about the same as those of their surrounding environment because they absorb heat from the surrounding air, ground, or water. Cold-blooded animals reduce activity levels in winter conditions because the chemical activity that controls muscular activity occurs more slowly when their body temperatures are lowered.

Factors Affecting Oxygen Content of Aquatic Systems

Temperature—Cold water holds more oxygen than warm water. Shaded streams tend to be cooler than similar streams that aren't shaded. The cooler streams have relatively higher dissolved oxygen levels.

Depth—Shallow lakes don't hold as much water as deeper lakes of the same size, decreasing the overall oxygen content. Shallow lake systems also tend to have warmer water temperatures than deep lakes. Warm water doesn't hold as much dissolved oxygen as cold water, decreasing the amount of oxygen available to fish.

Competition—Fish aren't the only aquatic organisms that require oxygen. Aquatic vegetation is a crucial component of any aquatic system. It provides essential cover for fish and invertebrates. Plants also are a vital link in the food chain, producing food energy directly from the sun's light energy. Plants produce oxygen during photosynthesis, but also they *use* oxygen during respiration. If excessive amounts of vegetation grow in very small, shallow bodies of water, plants can eventually compete with fish for available oxygen. When many plants die suddenly, the bacteria that break down the plants also use oxygen.

Wind—Wind blowing across the surface of a lake or pond increases the amount of dissolved oxygen. If a body of water is covered with ice in winter, or if there are several calm days in summer, the amount of dissolved oxygen decreases.

—Michigan DNR information

Mammals (including people) and birds are **warm-blooded**. Their body heat comes from inside of their bodies from energy provided by the food they eat. Warm-blooded animals maintain a relatively constant body temperature independent of surrounding temperatures.

During hibernation, an animal's body temperature drops—its heartbeat, breathing, and other body activities are slowed and it uses very little energy. Hibernating animals prepare for their winter sleep by eating extra food and storing it as body fat. This body fat is the energy that will carry them through the winter. During hibernation, animals don't grow.

Some species of fish require more oxygen than others, depending upon their activity levels. Small, active fish, such as the brook trout, prefer fast-running cold streams with high oxygen levels. Other fish, such as carp, sticklebacks, and bullheads, can survive in warm, still waters with very little oxygen.

The body temperatures of cold-blooded animals are high when outside temperatures are hot and lower when their environments are cold. The body temperatures of fish can vary with the temperature of the water in which they swim. Because their body heat doesn't come primarily from the food they eat, fish require less food than mammals; they also convert a larger percentage of their food into body mass. Even though food is scarce in winter, fish are moving more slowly and expending less energy to obtain food, so they require less food during the winter. This is why decreased food supply is a much less serious wintertime limiting factor than oxygen shortage.

When temperatures start to get too cold, many animals **migrate,** or move to places with warmer temperatures for the winter season. Some fish, like many birds, migrate down rivers to warmer climates or, if that isn't possible, move to deeper water. Stress caused by predators, reduced oxygen levels, and extreme cold can increase fish activity levels and respiration rates, threatening their chances of surviving the winter.

For some aquatic animals, such as painted turtles and frogs, **hibernation** is the strategy of spending part or all of the cold season in a basically dormant state. In Minnesota winters, fish slow their metabolism, but they're not true hibernators. When temperatures drop, many fish move to the bottom of lakes and seek shelter under logs, rocks, and fallen leaves in the water. Some even burrow into the mud. They are quiet but awake. Some go into diapause, a suspended state with an extremely slow heart rate. These fish don't eat or release bodily wastes, but unlike true hibernators, they can be roused. One type of fish that enters diapause is the carp, which uses its tail to cover itself with mud from the bottom of the lake, river, or pond. Carp spend the winter partly buried in the mud on the bottom while northern pike and other fish move to deep water. The smallmouth bass dramatically slows its metabolism and rarely feeds when water temperatures drop below 40° F. In winter, fish metabolism slows as temperatures drop, and some fish even stop growing. But no matter how much fish slow down or stop growing, they still need some oxygen to survive.

Microclimates

Microclimates are climates within a small, defined area, possibly different than those of the immediate surrounding area. For example, places in a lake or stream with plants, logs, dead trees, snags, crevices, holes, and caves provide cover from predators, help reduce stress, and offer resting places and shelter. These places are critical for winter survival of fish.

The amount of dissolved oxygen varies, too, in the different microclimates within a lake or stream. Areas with turbulent water contain higher oxygen levels than less turbulent areas. Oxygen-rich locations include waterfalls, rapids, incoming streams, and springs.

In winter, when ice covers a lake, shallow areas contain less oxygen than deeper areas simply because they hold a smaller volume of water.

When deep snow cover doesn't keep sunlight from reaching aquatic plants through the ice in shallow areas, the plants can photosynthesize and produce oxygen. (Aquatic plants typically grow in the shallow areas of a lake, from shore to a depth of approximately fifteen feet.) In this case, shallow areas can contain much more oxygen than deep areas.

The areas of a lake deeper than fifteen feet are darker, without plants to produce oxygen. These areas can become **anaerobic** (meaning the state of being, living, or occurring without oxygen) as fish and other organisms deplete the available oxygen.

Frequent, heavy snows blanketing ice-covered lakes prevent sunlight from reaching the aquatic plants. Not only do the plants fail to photosynthesize, but they may begin to die and decay. Bacterial decomposers then go to work on the plants, multiplying and consuming more oxygen from the water in these areas of a lake.

Oxygen-rich Areas	Oxygen-poor Areas
Waterfall	Area of decaying plants
Incoming stream	Shallow area
Spring	Areas with pollution

Winterkill

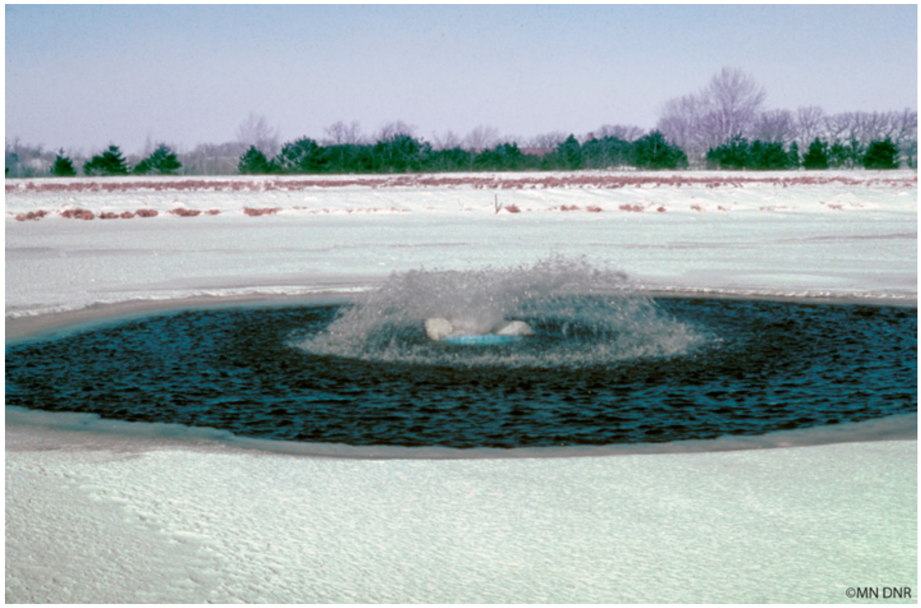
As winter progresses in some water bodies, dissolved oxygen levels can drop too low for fish to survive. Fish dying due to lack of oxygen is called **winterkill**. In many shallow lakes, most or all fish die every few winters due to winterkill, depending on the severity of the winter and the amount of snow cover on the ice. Usually it takes three or four years for a lake's fish population to recover after a winterkill.

In some lakes, dissolved oxygen levels can become dangerously low due to certain summer conditions, too. Fish dying from lack of oxygen in the summer is called a **summerkill.**

Aeration Systems

To prevent winterkill, an **aeration system** can be used to keep an area free from ice, and allow oxygen from the air to mix with the open water. One type of aeration system is a subsurface unit known as a "bubbler." Bubblers force air through a hose located at the bottom of a lake, creating air bubbles. The air bubbles cause upward currents that bring the warmer water up from the bottom of the lake and melt the ice. Another popular system is called a surface agitator. Surface agitators float on the water and contain a propeller or a sprayer that sprays water onto the ice. The propeller or sprayer creates a current that circulates the water to keep the ice open.

It's important to know and remember that winter ice can be thin and weak for many yards surrounding areas of open water. If you venture onto the ice for any reason, always stay well outside fenced areas indicated by thin ice signs.



An aeration system keeps water open on a frozen lake within a posted thin-ice area.

An aeration system is expensive to operate and is recommended primarily for waters used extensively by anglers. To ensure safe and appropriate use, permits are required for aeration systems. The Aeration Program of the Minnesota DNR has existed since 1974. The program has grown from issuing a handful of aeration permits annually to approximately 250 aeration permits statewide per year. Aeration is primarily used to prevent the winterkill of fish, but in recent years, its use has expanded to include shoreline protection, providing open water areas for captive waterfowl, and to some extent, water quality improvement.

A sign must be posted at the public access to indicate that an aeration system is operating on a lake.

Watch for these diamond-shaped signs out on the ice. They signify thin ice caused by many factors, including aeration systems.

Winter Suspense

Winter in Minnesota is a challenging time for fish. To survive, fish slow down, migrate, or make other changes in their lifestyle. Lakes under ice and snow have a decreasing supply of dissolved oxygen to offer as the long winter months progress. The story of fish in winter is a cliffhanger—will the snow and ice melt in time for wave action to renew the oxygen before the winter supply is completely expended?

Procedure

Preparation

1 In large letters, write each of the following words on sheets of paper: waterfall, incoming stream, spring, decaying plants, shallow area, and pollution. Place these labels around the classroom or playing area to indicate oxygen-rich and oxygen-poor areas in the lake. (See **Playing Area Diagram**.)

2 Cut out 200 six-inch-diameter paper circles or the one-quarter sheets of 8.5" x 11" paper or collect 200 poker chips or 200 small paper plates to use as oxygen "markers." Scatter these oxygen markers around the room, clustering more of them in oxygen-rich locations and fewer in oxygen-poor areas. Hang onto at least 30 oxygen markers for the warm-up part of the lesson. These markers will be placed in the lake after the warm-up

Activity

Warm-up

1 Like people, fish breathe oxygen, but it is mixed, or dissolved, into the water. Fish use their gills to get oxygen from the water. Ask the students how oxygen gets mixed into a lake or stream. (Aquatic plants produce oxygen through photosynthesis; waves, wind, and currents also mix oxygen into the water.)
2 Compare the respiration of fish with that of the students. Have students hold their breath. As they do this, ask them to think about whether they've ever been in a situation where oxygen was difficult to come by. Have them imagine what it would be like if they had to run to the other side of the school before being able to take another breath. Now let the students breathe. Invite them to tell about a situation in which they lacked oxygen.
3 Explore with students what might create more oxygen in one place and less in another. List their ideas. Guide students to include waterfalls, incoming streams, and springs. Have students write these items on the oxygen markers that will be used in the lesson. Make sure there are at least ten oxygen markers labeled waterfall, at least ten markers labeled incoming stream, and at least ten markers labeled spring. Scatter the remaining 30 oxygen markers in the appropriate places on the lake that you have set up as the playing area.

Students with breathing problems, such as asthma, may have difficulty with this lesson, which requires students to hold their breath for periods of time. Check with parents or the school nurse to make sure any students with asthma or other respiratory considerations will be able to participate in this lesson.

Lesson

Explain that fish don't always have plenty of oxygen available, and that lack of oxygen may affect them far more often than it affects us.

Round One: Spring, Summer, and Fall

1 Students will play the roles of fish. The oxygen markers (paper circles, quartered sheets, small paper plates, or poker chips) scattered around the room represent dissolved oxygen in a lake. Each fish must touch a marker in order to take a breath—they don't have to remain touching the oxygen as they inhale. But they can only take one breath per oxygen marker, and must take *five or more* steps before they stand on a new marker to take another breath. During this game, students must walk, not run. For this first round, announce that it is spring, summertime, and fall, and wave action and photosynthesis are mixing more oxygen into the water as the fish are breathing. The oxygen markers can be used, or touched by the students to breathe over and over. The students must keep moving around the lake and breathing until you signal them to stop in place.
2 Start the round. You may notice the "fish" clustering around the oxygen-rich areas in the lake.
3 Stop the game, and have students note the distribution of fish. Are there more fish in some areas of the lake than in others? Is there more oxygen in these same areas than in other areas of the lake? Have students count the number of fish in each location of the lake.

Record these numbers on a whiteboard or on graph paper. Students will make a graph to represent this data after the game.

4 Review that fish don't always have plenty of oxygen available, and that lack of oxygen may affect them far more often than it affects us.

Round Two: Early Winter

1 Ask the students to think about what usually happens to Minnesota lakes in December. (Lakes freeze over and snow accumulates on top of the ice.) How will oxygen be mixed into the water? Explain that oxygen isn't replenished in a lake that's under ice and snow.

2 Explain that, this time, the students will pick up and collect each oxygen marker, "using it up" as they take a breath. Again, they must take at least five steps before they stand on a new oxygen marker. When they can't reach another marker before they need to take another breath, they must sit down, having "suffocated" from lack of oxygen.

3 Start the round. Have students be fish in the ice-covered lake again, moving from marker to marker, breathing once at each oxygen marker, and picking it up before they move on to the next marker.

4 Stop the game before any fish sit down. Ask the students to explain what's happening to the oxygen in the lake. (It's getting used up.) Have students count the number of fish in each location of the lake. Record numbers for Round Two on the whiteboard or on graph paper. Students will make a graph to represent this data after the game.

5 Introduce the term limiting factor by asking students to describe how the fish are affected as oxygen is used up in the lake. If oxygen is impacting fish survival, it's a limiting factor in the lake. Define limiting factor. (A limiting factor is anything that restricts the living conditions for an organism, species, or population.) Discuss other limiting factors caused by Minnesota winters, including decreased food supplies, heavy snow, and cold temperatures.

6 Restart the game and play until students start sitting down due to lack of oxygen. What happens when a fish can't get the oxygen it needs?

Round 3: Midwinter

1 Collect the oxygen markers from the students and put them back in the lake, again concentrating more of them in the oxygen-rich areas. This time, hold back 50 oxygen markers from the oxygen-poor areas to represent the oxygen that was used up in December.

2 Tell the students that, during the winter, fish move more slowly to conserve energy and decrease their rate of oxygen use. During this round, students may take two breaths per oxygen marker, allowing them to spend more time at each marker. This will represent the fish slowing down and using the oxygen at a slower rate. Remind the students that they will collect each oxygen marker as they take their breaths, need to take at least five steps between markers, and that they must sit down if they can't get to another marker before

they need to take another breath.

3 Start the game. Monitor activity in the lake, and before any fish sit down, stop the game again. Have students stop where they are, and ask them what's happening to the oxygen in the lake. Even though there's less oxygen in the lake, the fish are surviving because they've slowed down and aren't using the oxygen as quickly. In which areas of the lake are most of the fish concentrated? Why? When oxygen levels are low in winter, fish move to oxygen-rich areas. Have students count the number of fish in each location of the lake for Round Three. Record these numbers on a whiteboard or graph paper for Round Three. Students will make a graph to represent this data after the game.

4 Restart the game and play until about half of the fish are sitting down. What is happening to the fish in the lake? Describe how oxygen can be a limiting factor.

Round 4: Late Winter

1 Collect the oxygen markers from the students and put them back in the lake, again concentrating more of them in the oxygen-rich areas. This time, remove 50 more oxygen markers from the lake to represent the oxygen that was used in midwinter. As you begin this round, there should be little or no oxygen in the oxygen-poor areas.

2 Start the game as in the last round. As the students start to sit down, stop the game and ask them to explain what is happening to the fish. Why are fish concentrating in certain areas in the lake? Have students count the number of fish in each location of the lake for Round Four. Record these numbers on a data sheet for this round. Students will make a graph to represent this data after the game.

3 Tell students that fish don't usually use up all of the oxygen in Minnesota lakes every winter. This does happen in some lakes during some winters, however. In what situations might the fish use all of the oxygen in a lake? Brainstorm a list, which may include:
- winter lasts too long, with continuous ice and snow cover
- there are no waterfalls, springs, or incoming streams (oxygen-rich areas)
- the lake is very shallow
- there are a lot of decaying plants, pollution, or both (oxygen-poor areas)
- a drought year has made the lake shallower, so it holds less oxygen
- snow cover blocks sunlight that would otherwise penetrate uncovered ice to reach aquatic plants; this prevents photosynthesis
- there are too many fish breathing the limited available oxygen

If fish don't use up all of the oxygen in a lake, is oxygen still a limiting factor?

4 Discuss the fact that when fish die in a lake during winter, it is not because the lake has frozen solid all the way to the bottom. Instead,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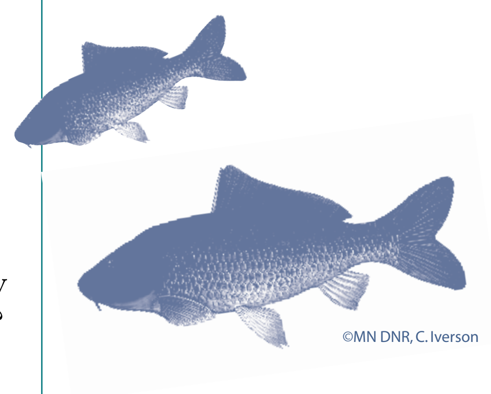
winterkill usually occurs because all of the oxygen in the water has been used. Fish species that require more oxygen than others will die off first. Lack of oxygen is a key limiting factor for fish survival in winter. The oxygen level in a lake in winter is one of the most important factors determining whether the fish in a lake will survive the season. Fish that can survive in water with lower oxygen levels, such as bullheads, may be able to survive until spring. Fish that require more oxygen probably won't. When ice and snow melt in the spring, wave action and increased photosynthesis replace dissolved oxygen lost during the winter.

Wrap-up

1 Have students make bar graphs for each of the four rounds. On the x-axis, have students note the different locations in the lake. On the y-axis, note numbers of fish. Have students write an appropriate title on the graph and include a key to explain symbols and data in the graph. Ask students to determine which areas of the lake had the highest oxygen levels in each round and note that below each graph. (Areas with the most fish as noted on the graphs should correlate to areas of the lake with highest oxygen levels.)



2 Review the term limiting factor. Have students identify at least three natural factors that result in lower dissolved oxygen levels in aquatic environments in winter. Discuss what it means to be cold-blooded. What happens to a lake in the winter? What does a heavy snow cover mean for aquatic plants? What does this mean for fish? Discuss the adaptations (physical, behavioral, physiological) that fish possess that help them survive a Minnesota winter.

3 Have students do research on the Internet to find the oxygen requirements for several Minnesota fish species, including black bullheads, carp, brook trout, walleye, smallmouth bass, and bluegill sunfish. Play the game with a different species of fish each time. Depending on the oxygen required by each species, have students determine how each fish species will move between oxygen markers. Discuss how the adaptations of different species can cause each species to require more or less oxygen to survive. Make a graph comparing the oxygen requirements of different types of fish. List oxygen requirement levels in ascending order on the y-axis, and species of fish along the x-axis of the graph. Have students write an appropriate title on the graph and include a key to explain symbols and data in the graph. Note overlaps and discuss factors that make setting minimum oxygen requirements for fish difficult and variable. (These include water temperature, plant activity, winter conditions, metabolic rates, and respiration rates.)

4 Suppose that some of the fish in a lake are stressed or sick. Discuss what might happen to those fish over the winter.

Graphic organizers can take the form of a concept map, tree, star, or web showing definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause and effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. Cut and folded paper can be fashioned into flaps that, when lifted, reveal details, definitions, descriptions, or explanations.

Assessment Options

1 After the simulation activity, have students construct a graphic organizer to include the following information:
   - Fish are cold-blooded. How do they maintain their body temperature?
   - What is usually the most important limiting factor for fish in winter?
   - Define dissolved oxygen and describe how oxygen enters and mixes into a lake or river.
   - Identify at least two natural factors that cause a decreased dissolved oxygen levels in a water body during Minnesota winters. (Answers include ice cover, snow cover on ice that blocks sunlight, shorter days, less photosynthesis performed by plants, lack of wave action to mix more oxygen into the water.)

2 Have students use the information in their graphic organizers to write a story from the perspective of a fish, explaining how they survive the winter in Minnesota. They can consider:
   - What are the limiting factors that concern them during the winter? (The limitations should include low oxygen levels and less available food.)
   - What strategies—behaviors or body functions—help them survive low oxygen levels in winter?
   - Explain how they prepare for winter. (Answers could include slowing metabolism, stopping growth, finding deeper water, finding an area with higher oxygen levels, and finding a sheltered location.)

3 As an alternative to having students create graphic organizers for Assessments 1 and 2, you may wish to have students write and illustrate a story about fish in winter that includes this information. Then have them present the story to a class of younger students. Or have students perform scenes from their story to answer the questions in Assessments 1 and 2. Or have the students simply prepare a list that includes the requested information.

4 Have students do research comparing the oxygen requirements of different fish species such as such as walleye, sunfish, bass, and northern pike. Play the game again, but in addition to the fish in the lake, add some other species (about one-quarter of the students). These could be carp or bullheads, fish that require less oxygen than the other types of fish. The carp or bullheads can take two breaths each time they step on an oxygen marker, and can take two breaths as they walk from one oxygen marker to another. Discuss what happens to the different species as the fish move around the lake throughout the winter during the various rounds. Graph population densities of the different types of fish as winter progresses during the four rounds of the game.

5 Assessment options include the Checklist and Rubric on the following pages.

Fish in Winter Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student's story explains that oxygen is important to fish.
4	______	______	Student's story clearly explains two ways that oxygen is depleted from water in a lake in winter.
3	______	______	Student's story shows an understanding of the definition of *limiting factor*.
2	______	______	Student's story notes that oxygen is the most important limiting factor for fish in winter.
2	______	______	Student describes two additional limiting factors for fish in winter.
3	______	______	Student's story describes how wind, waves, and plants oxygenate the water.
2	______	______	Student explains that when ice and snow block sunlight, plants don't make oxygen that fish need.
4	______	______	Student identifies four locations or features of a lake that result in higher oxygen levels in winter.

Total Points

22	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

20–22 points = A
Excellent. Work is above expectations.

17–19 points = B
Good. Work meets expectations.

14–16 points = C
Work is generally good. Some areas are better developed than others.

10–13 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0–9 points = F
Work is unacceptable.

Fish in Winter Scoring Rubric

Story Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Oxygen	Story clearly mentions oxygen mixed into water and why oxygen is important to fish.	Story mentions oxygen mixed into water and why oxygen is important to fish, but concepts aren't clearly stated.	Story mentions oxygen mixed into water, but not the importance of oxygen to fish.		Story doesn't mention oxygen in water or the importance of oxygen to fish.
How oxygen is depleted from water in winter	Story clearly explains two ways oxygen is depleted from the water of a lake in winter.	Story explains two ways oxygen is depleted from the water of a lake in winter, but lacks clarity.	Story clearly explains one way that oxygen is depleted from the water of a lake in winter.	Story incorrectly explains how oxygen is depleted from the water of a lake in winter.	Story doesn't mention how oxygen is depleted from the water of a lake in winter.
Limiting factor	Understands definition of limiting factor and that oxygen is the most important limiting factor for fish in winter. Describes two additional limiting factors other than oxygen for fish in winter.	Understands definition of limiting factor and that oxygen is the most important limiting factor for fish in winter.	Understands definition of limiting factor and that oxygen is a limiting factor for fish in winter.	Understands that oxygen is a concern for fish in winter.	Doesn't mention oxygen as a concern for fish in winter.
How oxygen mixes into the water	Story describes how wind, waves, and plants mix oxygen into the water. Explains that when ice and snow cover block sunlight, plants don't make oxygen. Identifies four locations or features of a lake that result in higher oxygen levels in winter.	Story describes how wind, waves, and plants mix oxygen into the water. Explains that plants don't receive sunlight under ice and snow cover. Identifies three locations or features of a lake that result in higher oxygen levels in winter.	Story identifies that wind, waves, and plants mix oxygen into the water. Identifies three locations or features of a lake that have higher oxygen levels.	Story identifies that wind, waves, or plants mix oxygen into the water. Identifies two locations or features of a lake that have higher oxygen levels.	Story doesn't identify wind, waves, or plants mixing oxygen into the water. Identifies fewer than two locations and features of a lake that have higher oxygen levels.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Add additional rounds to the game to illustrate how people's activities contribute to reduced oxygen levels in the lake or how installed aeration systems increase oxygen levels of lakes.

2 In early fall, have students predict when "ice-on" will occur at a local lake or pond. In late winter, they can try to predict when "ice-off" will occur. (Ice-on is when the lake or pond freezes over for the winter; ice-off is the day that a lake or pond loses its winter ice cover in the spring.) To make these predictions, students can work individually or in groups to make observations, gather information, and record data about the seasonal changes and conditions they observe at the lake or pond. Have them continue to record their observations until the actual ice-off date. This information can be included in a class record or calendar of natural occurrences at the lake or pond, along with their observations at the site. Students can also record conditions such as daily temperatures, winter snowfall, cloud conditions, and whether the ice gradually disappears from the lake or melts all at once. They might also observe and record the activities of animals and plants. This type of record or calendar is called a phenology chart. The students can make their phenology chart available to next year's class so those students can continue the school's recording of ice-on, ice-off, weather conditions, plant and animal sightings, and the like. Students can compare the actual ice-on or ice-off dates with their prediction dates and discuss any differences.

3 Visit a site with an aeration system. Ask a community resource person to explain how and why the system is used.

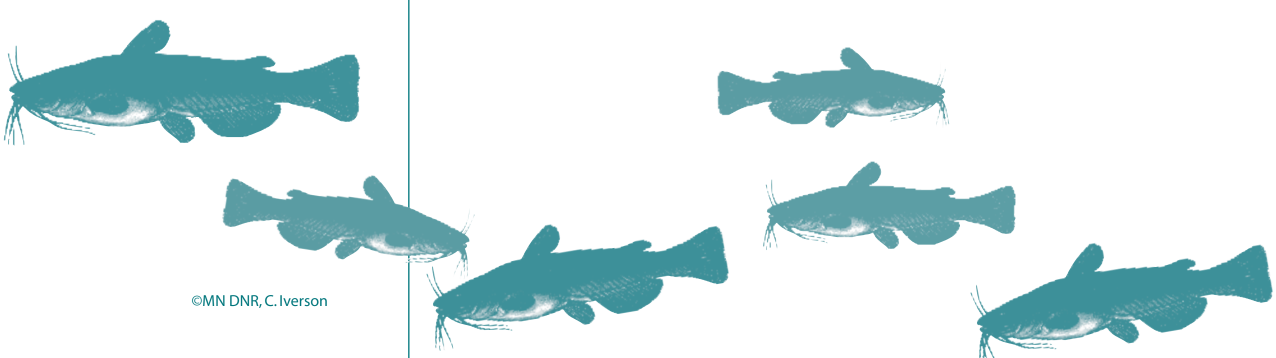
4 Has there been a winter fish kill in your area? Save newspaper articles about local fish kills to share and discuss with your students. Get additional information about a local fish kill from your area DNR office.

5 Visit the DNR website and search for the *Minnesota Conservation Volunteer* article "Life Under Ice and Snow," by Larry Weber to find out how other animals adapt to Minnesota winter conditions.

For the Small Fry

K-2 Option

1. Have students observe a fish breathing in the water. Watch the mouth and gill covers open and close. Discuss how fish use their gills to obtain oxygen from the water.
2. Visit a body of water near your school. Look for aquatic plants, inlets, and waves. As you discover these items, discuss how they put oxygen in the water for fish to breathe. If you're visiting the water body in the winter, note how the ice covers the water and prevents waves. Look for plants under the ice. Can you see them? Are they still green? Discuss how these things prevent oxygen from getting into the water. If a lake visit isn't feasible, use seasonal photos of lakes to show the vegetation and wave differences at different times of the year.
3. Have students create (by drawing or building a model) a summer lake habitat showing the areas where oxygen enters and mixes into the water. Create a second winter lake habitat, demonstrating the changes that allow less oxygen to enter and mix into the water.



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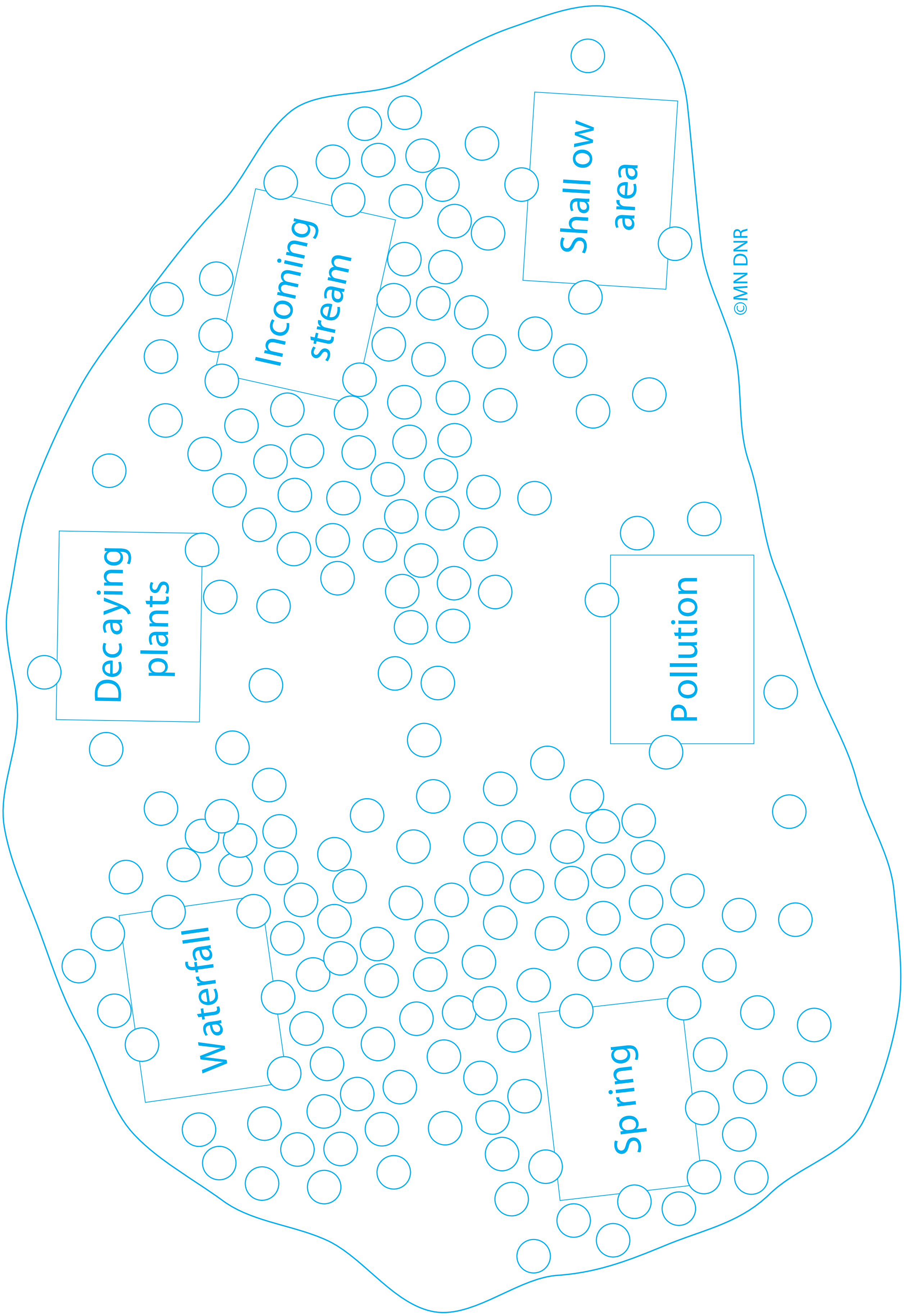

Playing Area Diagram

Fish Bowl

For answers that are perfectly clear, play a game of Fish Bowl!

Table of Contents

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Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish Bowl

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
II. Writing
C. Spelling, Grammar, and Usage:
Benchmark 1—The student will compose sentences when writing. (If students generate the questions for the game.)
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Math
(Students participate in scorekeeping.)

Grade 3
II. Number Sense, Computation, and Operations
B. Computation and Operation:
Benchmark 1— The student will use addition of up to three whole number addends, containing up to four digits each in real-world and mathematical problems.
Benchmark 2—The student will use subtraction with up to three digit whole numbers in real-world and mathematical problems.

Grade 4
II. Number Sense, Computation, and Operations
B. Computation and Operation:
Benchmark 1—The student will use addition and subtraction of multi-digit whole numbers to solve multi-step real world and mathematical problems.
Benchmark 2—The student will add up to three whole numbers containing up to three digits each, without a calculator.
Note: Whether other benchmarks are addressed will depend on the questions you use for the game.

Science
Note: The standards and benchmarks addressed will depend on the questions you use for the game.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 2 • Lesson 9

Fish Bowl

Grade Level: 3-5
Activity Duration: 45-60 minutes for game set-up
45-60 minutes of game play
Group Size: minimum of 8
Subject Areas: Varies depending on questions asked; possibly Health & Safety, Language Arts, Physical Education, Science, Social Studies
Academic Skills: communication, large group skills, listening, listing, organization, small group skills, reading, writing
Setting: indoor or outdoor gathering area
Vocabulary: Knowledge Bowl
Internet Search Words: fish, fishing, Knowledge Bowl, Quiz Bowl

Instructor's Background Information

A **Knowledge Bowl** is sometimes referred to as an Academic Bowl or Quiz Bowl. **Fish Bowl** is a fun and fast-paced game in which students compete in teams to answer questions on topics they've studied in class. Team members need to be quick as well as knowledgeable to respond with the right answer. Points are awarded for correct answers, and the team with the most points wins the game.

Procedure

Preparation

1. Collect the materials.
2. If using the sample questions provided at the end of this lesson rather than having the students write their own questions, copy the **Sample Question Cards**, cut them apart, and attach them to note cards.
3. You may wish to prepare a bonus question for the end—in case there's a tie, or just for fun.

Activity

Warm-up

1. Tell the students they'll be playing a game referred to as a Knowledge Bowl, or in this case, a Fish Bowl.
2. Ask them to help you come up with five or six categories for your game, such as fish parts and adaptations, fish families, fishing equipment and bait, fish habitat, fish identification, or fishing regulations. The categories will vary, depending on what your students have studied.
3. Across the top of the classroom whiteboard, write the question categories as headings for columns.

Summary

This activity uses the format of a popular game show to reinforce concepts about fish identification, habitat, fish management, and other topics covered in the unit. Students review the material to write quiz questions and participate in a fish quiz bowl.

Student Objectives

The students will:

1. Write comprehensive quiz questions covering what they have learned about fish and fishing.
2. Answer Fish Bowl questions.

Materials

- Note cards, ten for each group of four to six students
- Pencils, one for each group of four to six students
- Tape
- Whiteboard
- Whiteboard markers
- Coin
- **Sample Question Cards**
- Noisemakers (such as party horns or buzzers), one type for each group of four to six students (optional)

Rather than having students write their own questions, you may use the **Sample Question Cards.**

Lesson

Game Set-up

1 Divide the class into groups of four to six students. Hand out the note cards and pencils. Ask each group to come up with a group name. Have each group write one or more questions with answers for each of the categories, drawing from material they've learned in class. Then ask them to assign each question a point value of 10, 20, 30, or 40 points, depending on its difficulty level.

2 Encourage the students to think through the questions they write so they're clear and understandable. Show them a good example and a poor example of a question. Suppose that the category heading is Fish Parts. An example of a good question: Which body part do fish use to collect oxygen from the water? (Answer: Gills) This is a good question because the answer is clear and simple. An example of a poor question: How does a fish breathe? (Answer: Gills) This question doesn't clearly ask the student to name the body part. The actual answer to this question is open-ended and the different answers could vary significantly. Correct answers to this question include getting oxygen from the water, taking in water through the mouth, or getting oxygen with gills. This open-ended question is too ambiguous and doesn't fit the category heading of Fish Parts.

3 Ask students to format their note cards like this:

Fish Parts 30 points	Q: What body part do fish use to draw oxygen from the water? A: Gills
Front of card: Category and point value	**Back of card: Question and answer**

4 Collect each group's note cards containing the questions and discard any duplicates. You may have to adjust point values so that each point value is used just once in each category. Alternately, you may have each group write questions for certain point values.

5 On the whiteboard, tape each question—with its point value facing the class—in ascending order under its appropriate category heading:

Heading	Heading	Heading	Heading	Heading
10 pts	10	10	10	10
20	20	20	20	20
30	30	30	30	30
40	40	40	40	40

6 Draw a scorecard on the whiteboard. Each team's name should head each score column. As questions are answered, a running point tally can be kept under the corresponding team heading. Assign a student to be scorekeeper, or assign a scorekeeper from each team to post their own team's points on the scoreboard.

Fish Bowl Scoreboard

Mighty Muskies	**Wonderful Walleyes**

Playing the Game

1 Explain the rules of the game. Remind students that the Fish Bowl is about reviewing knowledge, teamwork, and having fun! Fish Bowl is an exciting way to tie together, reinforce, and review what students have learned. Everyone contributes to the success of the game, and everyone is a winner.

2 You (the instructor) will be moderator, timekeeper, and scorekeeper.

3 Flip a coin to determine which team chooses the first question. That team chooses a category and point value (for example, Fish Foods for 10.)

4 Remove that question from the board and read it to the class.

5 Teams have ten seconds to confer and come up with an answer. As soon as a group agrees on an answer, team members should raise their hands or use their noisemaker. Call on the first person to raise a hand. (Each team can choose one member to be the spokesperson and give all the answers, or set up a predetermined order of students to be spokesperson, so everyone gets a chance to speak. Anyone may raise their hand, however.)

6 If the question is answered incorrectly or if time runs out, the next group that had raised their hands or used their noisemaker now has the opportunity to answer. Reread the question and give the group fifteen seconds to confer before offering an answer to the question.
7 Award the points to the team with the correct answer by taping the card under their team name. (Option: Give three chances at answers with reduced points after each failed attempt.)
8 Give each team a chance to choose the question.
9 When all the questions have been answered, have students total the scores for each team. If there's a tie, ask a "tie breaker" question. (You may wish to prepare a few tie breaker questions in advance.)
10 To add excitement at the end of the game, consider a bonus round. Create a final bonus question. Let teams wager some or all of the points they have earned so far. The team that answers the bonus question correctly earns their wagered points. If a team answers the question incorrectly, they lose all of their wagered points.

Wrap-up

1 Ask students how they liked the game. What could have made it better? Discuss the importance of writing clear, specific questions.
2 Ask students to think about other situations in which they may need to consult others and work in a team to solve a problem.

Assessment Options

1 Observe individual participation, teamwork, knowledge applied in writing and answering questions, and problem-solving. Evaluate whether students adequately reviewed material that was to be covered in this activity.
2 Another assessment option includes the Rubric on the next page.

Fish Bowl Scoring Rubric

Questions Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Written questions	Questions were thoughtful, well written, and contained the correct answer. Questions were legible.	Questions were thoughtful, well written, and contained the correct answer. Questions were legible, but contained a few grammatical errors.	Questions were thoughtful, and contained the correct answer. Questions were barely legible.	Questions weren't thoughtful or well written. Questions were illegible.	Student didn't write questions for the Fish Bowl.
Teamwork	Group worked together to write questions.	Group worked together to write questions. A few people occasionally dominated the writing.	One or two individuals dominated the group but the whole team did participate in the process.	Only a few people from the group participated in writing questions.	One person wrote questions for the rest of the group members.
Individual participation in Fish Bowl	Attentive and involved in the Fish Bowl game. Answered several questions. Participated in group discussions when appropriate.	Attentive and involved in the Fish Bowl game. Answered a few questions. Participated in group discussions when appropriate.	Attentive and involved in the Fish Bowl game. Answered one or two questions. Seldom participated in group discussions when appropriate.	Wasn't attentive or involved in the Fish Bowl game. Listened during group discussions.	Disrupted the Fish Bowl game. Didn't listen or participate in group discussions.

Score ______ Diving Deeper

Extensions

1 Provide teams with answers, and have them respond with a correct question. For example: Question in the form of an answer: Food, water, shelter, and space. Response in the form of a question: What are the four basic habitat needs of all living things?
2 Write the questions one day and play the game the next. Have students create banners for their teams and dress in a team color or wear a team emblem.
3 Invite parents and family members to be an audience for a "Fish Bowl Game Show." Choose students to play game show host, panel of judges, stage assistant (brings selected question to the host to read and tapes score cards under appropriate team to award points.) Have students create commercials for station breaks throughout the game show. They should base the commercials on lessons they've covered on fish, aquatic habitats, water stewardship, fish management, and fishing.

For the Small Fry

K-2 Option

1 Play the Fish Bowl using instructor-prepared questions. Allow two clues to help students respond with the correct answer.
2 Ask students to tell you about the things they've learned about fish and fishing. Make a chart or web that includes all the topics they list. Have each student pick one of the items and illustrate the main idea, have the students dictate information about their drawing to an adult, or write their own story on the drawing. Laminate the pictures and bind them together to make a class book about their learning experience.

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Food Chain Tag **10 points**	Q: Name one fish predator. A: Perch, northern pike (or other fish predators)
Food Chain Tag **20 points**	Q: Where do plants and and some plankton (phytoplankton) get energy to grow? A: From the sun

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Food Chain Tag **30 points**	Q: What do small fish (like minnows) eat? A: Plankton
Food Chain Tag **40 points**	Q: What decomposes dead plants and fish? A: Bacteria

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Run For Your Life Cycle **10 points**	Q: What is a newly hatched fish called? A: Fry, sack fry, or larva
Run For Your Life Cycle **20 points**	Q: Something that impacts fish and might lessen the chance for survival is called ____. A: A limiting factor

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Run For Your Life Cycle

30 points

Q: Name three habitats that a northern pike needs during its life cycle

A: Wetland, stream, and lake (or big river)

Run For Your Life Cycle

40 points

Q: Name two limiting factors that a northern pike might face in its lifetime.

A: Predators like kingfishers and anglers, dams, limited food, drought, loss of habitat

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Water Habitat Site Study **10 points**	Q: Aquatic plants grow in this area of a lake. A: Near shore, in shallow water called the littoral zone
Water Habitat Site Study **20 points**	Q: Name one piece of equipment you can use when collecting aquatic invertebrates and plants. A: Shovel, rake, strainer, dip net, or bare hands

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Water Habitat Site Study

30 points

Q: Name three places where you can find aquatic invertebrates.

A: Swimming on the surface; stuck to rocks, plants, or logs; under a dock; or in muck

Water Habitat Site Study

40 points

Q: What should you do with invertebrates when you're done studying them?

A: Return them to the water where you found them

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Habitat Hideout **10 points**	Q: Name two types of structure in a lake. A: Plants, rocks, brush pile, drop-off
Habitat Hideout **20 points**	Q: Slow water behind a rock where a fish can rest in a stream is called ____. A: An eddy

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

Habitat Hideout **30 points**	Q: The deeper part of a lake where plants don't grow is called ____. A: The limnetic zone
Habitat Hideout **40 points**	Q: Name two types of structure or habitat in a stream. A: Vegetation, boulder, log, under-cut bank, eddy, riffle, pool

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

From Frozen to Fascinating **10 points**	Q: Name two things that live in the sediment at the bottom of the lake in winter? A: Aquatic invertebrates and plant seeds (could list species names.)
From Frozen to Fascinating **20 points**	Q: What happens to aquatic invertebrates in the winter? A: They hibernate

Sample Question Cards

These questions use lessons from Chapter 1 as question categories.

From Frozen to Fascinating **30 points**	Q: What happens to aquatic plant seeds in the winter? A: They become dormant
From Frozen to Fascinating **40 points**	Q: Which two factors affect how quickly aquatic invertebrates come out of hibernation? A: Amount of light and temperature

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Sense **10 points**	Q: A fish can't see in this direction. A: Directly behind itself
Fish Sense **20 points**	Q: What does the lateral line sense? A: Vibrations in the water

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Sense **30 points**	Q: Name three places where a bullhead has taste buds. A: Tongue, lips, skin, barbels, tail
Fish Sense **40 points**	Q: Name at least three senses that fish have. A: Sight, touch, smell, taste, hearing, lateral line (the lateral line is an extension of hearing and is sometimes called a sixth sense)

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fins: Form and Function **10 points**	Q: Name the fin found on the back (top) of a fish. A: The dorsal fin
Fins: Form and Function **20 points**	Q: Name two functions of fish fins. A: To help fish balance, swim, and steer

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fins: Form and Function **30 points**	Q: Fins can be supported by these two structures. A: Soft rays and sharp spines
Fins: Form and Function **40 points**	Q: Name the fleshy fin on trout and catfish that has no known purpose. A: Adipose fin

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Families

10 points

Q: Which fish family has flat undersides, an adipose fin near the tail, and barbels?

A: Catfish family

Fish Families

20 points

Q: Which fish family has torpedo-shaped bodies, a small one-part dorsal fin near the tail, and a duckbilled snout?

A: Pike family

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Families **30 points**	Q: To which family does the largemouth bass belong? A: Sunfish family
Fish Families **40 points**	Q: The Minnesota state fish (walleye) belongs to which family? A: Perch family

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Using a Key for Fish ID **10 points**	Q: Name the ancient fish that has a skeleton composed entirely of cartilage and has a snout (nose) shaped like a paddle. A: Paddlefish
Using a Key for Fish ID **20 points**	Q: What's the easiest way to tell a yellow perch from a walleye? A: A perch has stripes; a walleye doesn't.

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Using a Key for Fish ID

30 points

Q: Name a primitive fish that has bony plates instead of scales.

A: Sturgeon

Using a Key for Fish ID

40 points

Q: Name the Minnesota fish with a lateral line that runs through its tail.

A: Freshwater drum (sheepshead)

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Diving Into Diversity

10 points

Q: What do we call the process of putting objects into groups according to their features or characteristics?

A: Classification

Diving Into Diversity

20 points

Q: Name two features that can be used to classify fish into family groups.

A: Fin shape, mouth location, mouth type, body shape, presence or absence of barbels or adipose fin, size of scales, or number of scales

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Diving Into Diversity

30 points

Q: How many species of fish live in Minnesota?

A: 160

Diving Into Diversity

40 points

Q: If an area has many different types of plants and animals, it is said to have this.

A: Biodiversity

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Adapted for Habitat

10 points

Q: When a fish blends in with its surroundings, it is said to be this.

A: Camouflaged

Adapted for Habitat

20 points

Q: What do we call a fish that eats other animals?

A: A predator, carnivore, or piscivore

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Adapted for Habitat **30 points**	Q: Describe the body shape of a bluegill. A: Round with flat sides (laterally compressed) or pan-shaped
Adapted for Habitat **40 points**	Q: Does the male or female bass guard the nest when the eggs are laid? A: Male

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Tales **10 points**	Q: What do we call the character that saves the day in an amazing way? A: A hero
Fish Tales **20 points**	Q: A story that is entertaining and that exaggerates the truth is called this. A: A tall tale (or fish tale)

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish Tales

30 points

Q: What do we call a figure of speech in which two unlike things are compared using the words like or as? For example, "Joy swims like a fish."

A: A simile

Fish Tales

40 points

Q: What do we call a figure of speech in which a word or phrase is given a new meaning? For example, "The northern pike was a torpedo chasing the bait."

A: A metaphor

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish in Winter **10 points**	Q: Name the body part that fish use to collect oxygen from the water. A: Gills
Fish in Winter **20 points**	Q: What is it called when fish die from lack of oxygen in an ice-covered lake or pond? A: Winterkill

Sample Question Cards

These questions use lessons from Chapter 2 as question categories.

Fish in Winter

30 points

Q: What is the most important limiting factor for fish in winter?

A: Oxygen

Fish in Winter

40 points

Q: Name one way oxygen is mixed into the water in a lake or stream.

A: Wind, waves, bubbling water from a waterfall, riffles (rapids), the arrival of spring and/or green plants, photosynthesis

Sample Question Cards

These questions use chapter headings as question categories.

Aquatic Habitats **10 points**	Q: What are the four basic habitat needs of fish? A: Food, water, shelter, and space
Aquatic Habitats **20 points**	Q: What do small fish (like minnows) eat? A: Plankton

Sample Question Cards

These questions use chapter headings as question categories.

Aquatic Habitats

30 points

Q: Name two types of structure or habitat in a stream.

A: Vegetation, boulder, log, under-cut bank, eddy, riffle, pool

Aquatic Habitats

40 points

Q: Name three places you can find aquatic invertebrates.

A: Swimming on the surface; stuck to rocks, plants, or logs; under the dock; or in the muck

Sample Question Cards

These questions use chapter headings as question categories.

Aquatic Habitats

50 points

Q: Something that impacts fish and might lessen the chance for survival is called _____.

A: A limiting factor

Aquatic Habitats

60 points

Q: What two factors affect how quickly aquatic invertebrates come out of hibernation?

A: Light and temperature

Sample Question Cards

These questions use chapter headings as question categories.

Minnesota Fish **10 points**	Q: What does the lateral line sense? A: Vibrations in the water
Minnesota Fish **20 points**	Q: Name two functions of fish fins. A: To help the fish balance, swim, steer

Sample Question Cards

These questions use chapter headings as question categories.

Minnesota Fish **30 points**	Q: To which family do largemouth bass belong? A: Sunfish family
Minnesota Fish **40 points**	Q: Name the fish that has a lateral line running through its tail. A: Freshwater drum

Sample Question Cards

These questions use chapter headings as question categories.

Minnesota Fish **50 points**	Q: How many species of fish live in Minnesota? A: 160
Minnesota Fish **60 points**	Q: Does the male or female bass guard the nest when the eggs are laid? A: Male

Sample Question Cards

These questions use chapter headings as question categories.

Minnesota Fish

70 points

Q: What is the limiting factor for fish in winter?

A: Oxygen

Water Stewardship

10 points

Q: Name three natural places where water can be found.

A: Soil, plant, river, cloud, ocean, lake, animal, groundwater, and glacier

Sample Question Cards

These questions use chapter headings as question categories.

Water Stewardship

20 points

Q: Name three ways that aquatic plants benefit fish.

A: Produce oxygen, provide cover, provide shade, provide invertebrate resting spots (fish food)

Water Stewardship

30 points

Q: What do we call an area of land where all water drains to one point such as to a particular stream, lake, or pond?

A: A watershed

Sample Question Cards

These questions use chapter headings as question categories.

Water Stewardship

40 points

Q: Name three types of pollution that can contaminate the water.

A: Litter, fertilizer/pesticides, oil from cars, animal waste, soil from erosion

Water Stewardship

50 points

Q: Name three specific ways in which people can keep water clean.

A: Don't litter, reduce fertilizer/pesticide use, recycle oil, keep buffer zones along lakes and streams

Sample Question Cards

These questions use chapter headings as question categories.

Water Stewardship

60 points

Q: Name two macroinvertebrates that are intolerant to water pollution.

A: Alderfly, dobsonfly, caddisfly, damselfly, mayfly and stonefly larvae

Water Stewardship

70 points

Q: Eurasian water milfoil, zebra mussels, and purple loosestrife are all examples of what?

A: Harmful exotic species

Sample Question Cards

These questions use chapter headings as question categories.

Fish Management **10 points**	Q: Name one reason the DNR sets fishing limits. A: To give more people a chance to catch fish; to give more fish a chance to grow and reproduce and to maintain a sustainable population
Fish Management **20 points**	Q: Anyone this age and older must have a fishing license to go fishing. A: 16 years old

Sample Question Cards

These questions use chapter headings as question categories.

Fish Management **30 points**	Q: The time period when you're allowed to fish for a certain species of fish is called ______. A: A fishing season
Fish Management **40 points**	Q: Why do fish biologists take scale samples from fish? A: To learn the age of the fish

Sample Question Cards

These questions use chapter headings as question categories.

Fish Management

50 points

Q: What type of area does a walleye prefer for spawning?

A: A shallow place with a gravel bottom

Fish Management

60 points

Q: What is one type of area that the DNR uses to maintain the natural environment of a lake or stream and protect the area from development?

A: Aquatic Management Area

Sample Question Cards

These questions use chapter headings as question categories.

Fishing Equipment and Skills **10 points**	Q: Name three types of rods and reels used in Minnesota. A: Spin-cast (closed-face reel), spinning (open-face reel), baitcasting, fly rod and reel, jiggle stick, cane pole
Fishing Equipment and Skills **20 points**	Q: What could you keep in your tackle box that would help you take a hook out of a fish's mouth? A: Needlenosed pliers or forcep

Sample Question Cards

These questions use chapter headings as question categories.

Fishing Equipment and Skills

30 points

Q: What kind of reel does a pop-can caster resemble?

A: Spin-cast or spinning

Fishing Equipment and Skills

40 points

Q: What is the most important step when casting?

A: Looking around and behind you *before* you cast

Sample Question Cards

These questions use chapter headings as question categories.

Fishing Equipment and Skills **50 points**	Q: Name three things that attract fish to a lure. A: Color, flash, scent, noise, movement
Fishing Equipment and Skills **60 points**	Q: Dry flies imitate which life stage of an aquatic insect? A: Adult. Dry flies are adult insect imitations that float on top of the water

Sample Question Cards

These questions use chapter headings as question categories.

Fishing Equipment and Skills **70 points**	Q: Why are ice fishing rods so short? A: Because there is no need to cast—you just drop your line through the hole in the ice
Safety and the Fishing Trip **10 points**	Q: What is one thing you can do to make your fishing trip safer? A: Be careful casting, bring personal flotation devices, tell someone where you're going, dress for the weather

Sample Question Cards

These questions use chapter headings as question categories.

Safety and the Fishing Trip

20 points

Q: What is the best way to dress when fishing outdoors in winter?

A: In layers

Safety and the Fishing Trip

30 points

Q: Where can you get information about what fish are in a lake?

A: Internet, DNR website, Lake Finder, a bait shop

Sample Question Cards

These questions use chapter headings as question categories.

Safety and the Fishing Trip **40 points**	Q: Name three live baits used in fishing A: Minnows, night crawlers, angleworms, wax worms, grasshoppers, crayfish, frogs, leeches
Safety and the Fishing Trip **50 points**	Q: Which size of fish are less likely to contain contaminants? A: Smaller fish

Sample Question Cards

These questions use chapter headings as question categories.

Safety and the Fishing Trip **60 points**	Q: Filleting and cooking fish should always be done with what? A: Adult supervision

Water Stewardship

Water quality not only determines where fish live, how they behave, and whether they survive—it is also important for human health and quality of life.

What Will the Students Learn?

Minnesota has an abundant resource of fresh water in its 11,842 lakes (of ten acres or larger) and 6,564 natural rivers and streams totaling 69,200 linear miles. In constant motion, water travels and changes states in the water cycle. Students will learn that the water cycle is a fundamental system that connects all living things. They begin to see the relevance of a variety of water issues as they analyze how we all need and use water and by discovering how a watershed works.

Fresh, clean water contributes to the quality of life for all living things. The things that happen on the land in a watershed are eventually reflected in the water quality of lakes and rivers. People's choices and actions within their watersheds impact water quality and can benefit or harm plants, people, fish, and other animals.

Chapter Concepts

Water: A Valuable and Vulnerable Resource

Lesson 3:1—The Incredible Journey
Lesson 3:2—The Function of Aquatic Plants
Lesson 3:3—Wonderful Watersheds
Lesson 3:4—Would You Drink This Water?
Lesson 3:5—The Lake Game
Lesson 3:6—Macroinvertebrate Mayhem
Lesson 3:7—Mussel Mania

Only three percent of the world's water is fresh. More than 75 percent of that amount is frozen in polar icecaps. Another 20 percent is trapped as ground water, much of which is inaccessible. Only a small portion of the world's total water supply is available for human use. Water is a limited resource. The water cycle enables the earth's living things to use the same water again and again.

Students participate in roleplaying activities, make models, and conduct experiments that demonstrate how people make choices about water use. They learn that land use Best Management Practices can help reduce or prevent negative impacts to water quality and help ensure that available fresh water supplies can continue to sustain life on earth.

Around in Cycles

Lesson 3:1—The Incredible Journey
Lesson 3:3— Wonderful Watersheds

Water is always moving. Students discover where—and how—water molecules travel. The water cycle is powered by the sun's energy and by gravity. Water travels downhill (thanks to gravity) and as it travels, it changes from a solid, to a liquid to a gas, depending on temperature (the amount of energy from the sun).

People can pollute water by adding things to it that negatively impact its quality. Point-source pollution enters water from a single source, such as an outflow pipe or an oil spill. Nonpoint source pollution can't be traced to a single source. Pollution—which can travel with water in the water cycle—often creates impacts far from where it entered the environment.

Water Dwellers

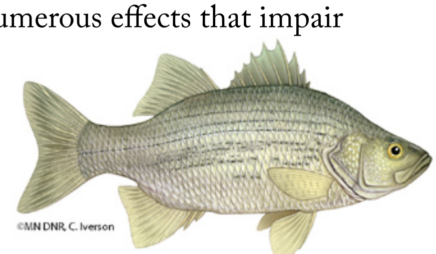
Lesson 3:2—The Function of Aquatic Plants
Lesson 3:6—Macroinvertebrate Mayhem
Lesson 3:7—Mussel Mania

A diversity of plants and animals live in and near Minnesota's waters. Each species has unique adaptations that help it survive in its environment. Each organism also plays a particular role in maintaining ecosystem balance, which ensures a healthy aquatic habitat for fish populations.

Personal Choices That Protect or Degrade Water Quality

Lesson 3:2—The Function of Aquatic Plants
Lesson 3:3—Wonderful Watersheds
Lesson 3:5—The Lake Game
Lesson 3:7—Mussel Mania

Pollution includes physical or biological agents that degrade water quality and affect the organisms that depend on it. Non-point source pollution results from numerous sources and can't be traced to a single source or point of origin. Because non-point source pollution is more difficult to address, it poses a greater threat to water quality than point source pollution. Erosion can be an example of non-point source pollution. Too much soil in the water can produce numerous effects that impair aquatic ecosystems. Human activities on land, including development, energy production, industry, livestock, farming,



"Never doubt that a small group of committed citizens can change the world; indeed, it's the only thing that ever has."
—Margaret Mead

and recreation can accelerate erosion and cause other types of water pollution, too. Buffers of plants on land and riparian areas help protect water by taking up nutrients, filtering sediments, slowing runoff, and stabilizing soil and shorelines. Transporting water or organisms from one location to another can introduce invasive species, which often compete with native species or otherwise harm habitat. Simulations and models can demonstrate how land use Best Management Practices and informed choices can help prevent or reduce the impact that human activities often have on water quality.

We All Live in a Watershed

Lesson 3:3—Wonderful Watersheds
Lesson 3:4—Would You Drink This Water?
Lesson 3:5—The Lake Game

What is a watershed? Where does the water go? How does water travel throughout the watershed? You live in a watershed. Natural and human made systems are interconnected by the water cycle and throughout a watershed. Students make models, experiment and make choices to discover how human activities on the land in the watershed impact water quality where we live. We each make decisions and choices every day that can impact water quality in a positive or negative way. Students continue to acquire the awareness, information and analytical skills to be able to make informed decisions and address environmental problems. If we are well informed and can critically analyze problems, we can choose to take action and be good stewards of our water resources.

Water continually changes from solid to liquid to gaseous states. Water can be recycled, or re-used, but ultimately, it's a limited resource—water can't be created.

Indicators of Water Quality

Lesson 3:4—Would You Drink This Water?
Lesson 3:6—Macroinvertebrate Mayhem

What *is* clean water? Students use their senses to discover that polluted water comes in many forms, *some* of which we can detect with our senses. Pollutants can be physical, chemical, or biological.

By inspecting and studying aquatic macroinvertebrates, students discover that these small organisms are indicators of water quality. The types and diversity of species existing in lakes, rivers, or streams provides clues for monitoring water quality.

Harmful Invaders

Lesson 3:7—Mussel Mania

Many non-native plant and animal species have been accidentally or intentionally introduced to Minnesota waters. Students discover how an invasive species can harm aquatic ecosystems. Students assume the roles of native mussels to find out what happens when zebra mussels are introduced into a Minnesota ecosystem. Everyone who engages in water activities must learn to prevent the spread of zebra mussels and other invasive species from infested to uninfested bodies of water.

Stewardship: A Call to Action

Service-learning Appendix

What can you do to conserve and use water in a sustainable way? Can one person make a difference? The lessons in Chapter 3 inform students they can choose to take action and practice good stewardship regarding water—which is everyone's responsibility. Service-learning offers students opportunities to become engaged in their communities and empowered to exercise the skills they've learned

"The frog does not drink up the pond in which he lives."
—Native American proverb

about water and watersheds by identifying a local water issue or problem, and designing a project to address it. This provides an early path to lifelong and active citizenship and stewardship.

Human activities, decisions, and choices can positively or negatively affect water resources. Cleaning degraded or polluted water isn't always possible—it can be prohibitively difficult and expensive. Land use Best Management Practices and sustainable use of water resources is more prudent, efficient, and cost-effective. As demands on water resources grow with a growing world population, the personal decision-making and creative problem solving skills of an informed citizenry are more necessary than ever. Sustainable use of water means taking care of water and fisheries resources—and our future.

Congress passed the Clean Water Act in 1972 to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." Its goal is to make all surface waters clean enough for fishing and swimming. Since the Act's enactment in 1972, progress toward this goal has been made, but much remains to be done.

The Incredible Journey

Become a water molecule and take a journey through the water cycle.

Table of Contents

Chapter 3 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

The Incredible Journey

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will read unfamiliar complex and multi-syllabic words using advanced phonetic and structural analysis.
II.Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning , including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
III. Speaking, Listening, and Writing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.

History and Social Studies

Grades K-3
IV. Historical Skills
A. Concepts of Time:
Benchmark 1—Students will define and use terms for concepts of historical time. Time in terms of processes of the water cycle.)

Science

Grade 3
III. Earth and Space Science
C. The Universe:
Benchmark 3— The student will observe that the sun supplies heat and light to the Earth.

Grade 4
II. Physical Science
A. Structure of Matter:
Benchmark 1—The student will observe that heating and cooling can cause changes in state.
Benchmark 2—The student will describe the changes in the properties of a substance when it is cooled or heated.
III. Earth and Space Science
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will describe the water cycle involving the processes of evaporation, condensation, precipitation and collection.
Benchmark 2—The student will identify where water exists on earth.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 3 • Lesson 1

The Incredible Journey

Adapted from Project WET Incredible Journey Activity Copyright International Project WET, © International Project WET

Grade Level: 3-5
Activity Duration: two 50-minute periods
Group Size: 9 to 30 students
Subject Areas: Language Arts, Expressive Arts, Science
Academic Skills: analysis, description, interpretation, organization
Setting: large indoor or outdoor open area
Vocabulary: condensation, evaporation, precipitation, respiration, transpiration, water cycle
Internet Search Words: evaporation, precipitation, water cycle

Instructor's Background Information

Water is always in motion. It travels through things like lakes, rivers, oceans, atmosphere, groundwater, icebergs, plants, and animals, and its path is known as the **water cycle**. Water changes form, or state, as it moves through the water cycle. These states are solid (ice), liquid, and gas (water vapor). As water circulates or passes from one form or state to another, its paths vary.

Heat energy directly influences the rate of water's motion. As the motion of water molecules increases with the amount of heat energy, water changes state from solid to liquid to gas. The sun is the energy source that evaporates water from the earth's surface and causes it to rise as water vapor. With each change in state, physical movement usually follows. For example, glacial melt runs to pools, which overflow into streams, where the water **evaporates,** or changes its form from liquid to a gas, and moves into the atmosphere.

Gravity further influences the water's travels under and above the earth's surface. As a solid, liquid, or gas, water has mass, and is subject to gravitational force—snow on mountaintops melts and descends through watersheds to the oceans of the world.

Liquid is the most visible state in which water moves. It is visible flowing in streams and rivers, or tumbling in ocean waves. Liquid water is found underground as well as on the earth's surface. Water travels slowly underground, seeping and filtering through particles of soil and pores within rocks.

Summary

By rolling some special dice, students are directed to travel from place to place as they simulate the movement of water within the water cycle.

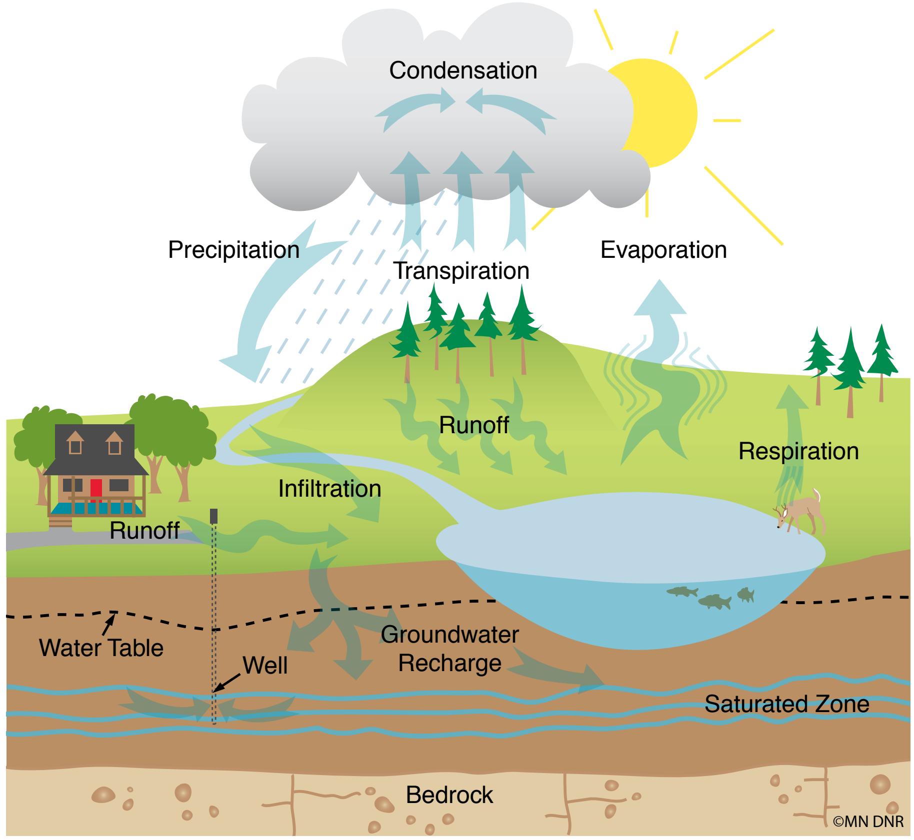
Student Objectives

The student will:

1. Identify the sun as the source of energy that evaporates water from the earth's surface.
2. Identify gravity as another force that moves water through the water cycle.
3. Describe the process of evaporation, condensation, and precipitation of water as it moves through the water cycle.
4. Identify the states of water (solid, liquid, and gas) as it moves through the water cycle.
5. Identify places that hold water as it moves through the water cycle, such as soil, plants, animals, lakes, rivers, clouds, glaciers, and oceans.

Materials

- **Water Cycle Table**
- One copy of each **Incredible Journey Station Sign**
- 8.5" x 11" illustration (or projection) of the water cycle
- Markers or pens, one per student (optional)
- Nine boxes, about three and one half inches square, for making dice (The type of gift boxes used for coffee mugs work well. Local mailing shops often carry cube-style boxes. To make boxes, use heavy tag board and the **Pattern for a Cube**.)
- **Incredible Journey Labels for Dice**
- Notebook or sheet of paper, one per student
- Clipboards
- Glue or tape
- Bell, buzzer, whistle, or other noisemaker
- Blocks of wood (two inches square), art foam, non-toxic ink pads, hot glue (K-2 Option)



The water cycle connects clouds, lakes, rivers, soil, plants, groundwater, and animals—including fish and people.

Water's most dramatic movements occur during its gaseous phase. Water constantly evaporates as a heat source, such as the sun, warms its molecules. As a vapor, water can travel over the earth's surface through the atmosphere—water vapor surrounds us at all times. Eventually, water condenses, or passes from gas to liquid, and returns to the earth. Where such condensation falls depends upon loss of heat energy, gravity, and the structure of the earth's surface.

Water condensation appears as dew on plants, or as water droplets on the outside of a glass of cold water. In clouds, water molecules collect on tiny dust particles. Eventually, these water droplets become so heavy that gravity pulls the water toward the earth as some form of **precipitation**, such as rain, sleet, or snow. Thanks to gravity, water flows downhill, drawing it from the earth's surface into the ground, or over the ground and into rivers, lakes, and oceans.

Snow and ice are water in solid form. Much of the fresh water on earth is frozen in icebergs and glaciers, where water molecules can remain for a long time. But glaciers and icebergs do melt eventually, releasing water into streams, rivers, and oceans. Evaporation also occurs on the surface of glaciers, where water rises from the ice in the form of water vapor.

Living organisms also move water. All animals, including people, carry water within their bodies. Water is either directly consumed by animals or is removed from foods during digestion. Water is excreted as a liquid, or leaves as a gas—usually through **respiration**, or breathing. Water is also dispersed through the skins of animals (perspiration), and evaporation follows.

Plants move large amounts of water. The roots of plants absorb water. Some of this water is used within the body of the plant, but most of it travels upward through the plant to the leaf surface. When water reaches the leaves, it is exposed to the air—and the sun's energy—and is easily evaporated. This process is called **transpiration**.

All these processes work together to move water around, through, and over the earth in a perpetual cycle.

Procedure

Preparation
Make the nine dice (or spinners) using the boxes and the information from the **Water Cycle Table**. For each station, make one or two dice. The **Water Cycle Table** provides directions on how to place the labels on each side of the die for each station. You can make labels using only the words (plant, animal, cloud, river, ocean, and so forth) or put illustrations on the labels, too. Mark each die to indicate its correct station placement for the game. Copy the **Incredible Journey Labels for Dice** and **Incredible Journey Station Signs**. You may wish to have students color the pictures. Review the **Water Cycle Table** for the explanations of water movement.

Warm-up

1. Ask students to identify the places water goes as it moves over, through, and around the earth. Write responses on the classroom whiteboard.
2. From the students' list, categorize the places into nine stations: clouds, plants, animals, rivers, oceans, lakes, groundwater, soil, and glaciers. Write the names of the stations on large sheets of paper and post them in locations around the room or schoolyard. (Students may illustrate these station labels. You may wish to laminate these for future use.)
3. Or, ask for nine student volunteers. Ask them to come to the front of the class, and have each hold an **Incredible Journey Station Sign** representing a different station. Ask the students if they can arrange themselves, facing their classmates, in the order that water moves through the water cycle. (Pathways can vary, so they might arrange themselves in a variety of ways.) Talk about how the sun and gravity provide the energy that moves water. Discuss how water changes form on its travels (solid, liquid, gas). Water's path, as it travels and changes form, is called the water cycle. Show the

The Incredible Journey dice illustrations match those in the Water Cycle Table. To quicken the pace of the game, you can use more than one die at each station, particularly the clouds and ocean stations.

For younger students, use pictures and words on the dice to show the destinations of water molecules leaving each station.

If you plan to use spinners rather than dice, each spinner needs six pie-shaped wedges, as well as an arrow that stops on a wedge at the end of its spin.

students a poster illustrating water cycle. Discuss the water cycle as illustrated.

Lesson

1 Tell students that they're going to be water molecules on a journey through the water cycle.

2 Assign an even number of students to each station (clouds, plants, animals, rivers, oceans, lakes, groundwater, soil, and glaciers). (The Cloud Station can have an uneven number of students.) Ask students to identify the various places that water can move to from their station of the water cycle. Discuss conditions that move the water; explain that water movement depends on energy from the sun (electromagnetic energy) and gravity. Explain that, sometimes water doesn't move anywhere for a very long time. After students have made lists, have each group share their work. Hand the appropriate die to each group and have students check the illustrations on the die to see if they've identified all the places that water can go. The **Water Cycle Table** at the end of the lesson **(www.montana.edu/wwwwet/watercycl.html)** provides an explanation of water movements from each station.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3 Tell students they will be acting out water's movement from one place to another. When they move as liquid water, they'll move in pairs, representing the many water molecules in a drop of water. When they move (evaporate) to the Clouds Station, they should separate from their partners and continuing moving alone, as individual water molecules. When water comes from the clouds (condenses) as rain or snow, the students should find a partner and move to the next location as a collection of water molecules in precipitation—rain, sleet, or snow.

4 In this game, a roll of the die, (or a spin of the spinner) determines where the water will move. Have students line up behind the die at their station. (At the Clouds Station they should line up single file. At the other stations, they should line up in pairs.) Students roll the die, and then proceed to the location indicated by the word on the upward-facing side of the die. If they roll the word *stay*, they must move to the back of the line.

5 When students arrive at the next station, they go to the back of the line. Upon reaching the front of the line, they roll the die and move to the next station (or go to the back of the line if they roll *stay*).

6 At the Clouds Station, students roll the die individually—but if they leave the clouds, they must take a partner (the student behind them) and move to the next station—the partner doesn't roll the die.

7 Students should keep track of their movements.
   - Have them keep a journal or notebook to record each move they make, including each time they rolled *Stay*.
   - Using another approach, half of the class plays the game while the other half watches. Assign each onlooker a student to watch during the game. Have them track this player, recording

each station to which the player travels. In the next round, the onlookers play the game while the other half of the class watches and does the tracking.

- Create a one-page sheet for recording the students' journeys, numbering their movements as they roll each die, and listing that number under an illustration of the station to which they've traveled.

8 Signal the beginning of the game with a bell, buzzer, or whistle.

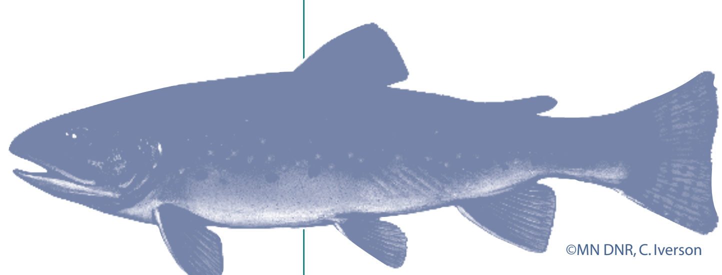
9 Stop the game periodically to discuss the forms of water as it moves from one location to another. Much of the movement from station to station occurs when water is in its liquid form. Gravity draws water downhill, but water moves to the clouds in the form of water vapor, with molecules moving rapidly and apart from each other. The sun provides the energy that evaporates water from the earth's surface. When water moves from clouds to the glacier, it condenses and can fall as snow, a solid. Again, gravity draws the snowfall to the earth's surface.

10 If you notice a large congregation of students at one or two stations (glacier, clouds, or ocean), stop the game to discuss possible reasons. Ask students if this happens during the journey of a real water molecule. (For example, a water molecule can remain in liquid form in Lake Superior for more than a century before it evaporates. Or, on land, a plant's roots might quickly absorb a water molecule just after it falls as rain.)

11 After approximately ten to twelve minutes, signal the end of the game.

Wrap-up

Have students use their travel records to write or verbally share stories about their journeys as water molecules. Have them describe the conditions that allowed them to move to each location, and their state or form as they moved. Discuss any *cycling* that may have occurred—did any students return to their original station? How do their experiences as water molecules in the game compare to the illustration on the water cycle poster?



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Assessment Options

1 Observe the students as they portray water molecules. Look for evidence that they understand the following:
- the path of water molecules moving through the water cycle;
- changes in state from solid to liquid to gas to liquid, and so forth along the path through the water cycle;
- that water *evaporates* into the air;
- that water molecules *condense* to form droplets in clouds;
- that the sun provides the energy for evaporation;
- and that gravity is another force that moves water through the water cycle.

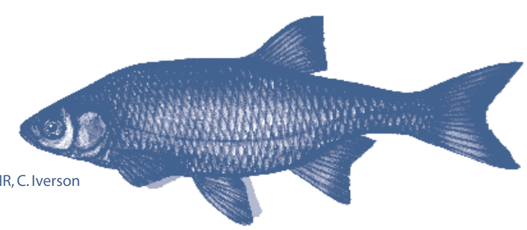
Evaluate how well the students identify water's state or form as it moves through the water cycle.

2 Using their written or oral stories describing water movement, evaluate if the students have identified the sun as the provider of energy for evaporation, that gravity is an additional force that moves water through the water cycle, and an understanding that water changes form as it moves through the water cycle.

3 Have older students teach The Incredible Journey to younger students. Evaluate accuracy in describing the path of water molecules through the water cycle, and the states or forms that water takes as it moves through the water cycle.

4 Provide students with a location that is different from the stations in the game, such as a parking lot, their back yard, the school rooftop, a nearby forest, a local hilltop, or an organ of the body such as the bladder, and have them apply what they learned in the water cycle activity. They should be able to identify the ways in which water moves to and from those sites. How would water travel to and from the site in winter? Have them identify the states of the water as it moves to each new site.

5 Assessment options include the Checklist and Rubric on the following pages.



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The Incredible Journey Checklist

Possible Points	**Points Earned** **Student**	**Points Earned** **Instructor**	
4	______	______	Student accurately shows all movement of water in the water cycle.
4	______	______	Student names evaporation, condensation, precipitation, and transpiration accurately.
3	______	______	Student can name and define the three states of water.
3	______	______	Student gives an example of each of the three states of water.
4	______	______	Student can identify and explain the two forces that provide the energy that drives the water cycle.
4	______	______	Student can define *precipitation, evaporation, condensation, and transpiration.*
2	______	______	Student can explain how all living things are connected by the water cycle.
Total Points 24	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

21-24 points = A
Excellent. Work is above expectations.

18-20 points = B
Good. Work meets expectations.

15-17 points = C
Work is generally good. Some areas are better developed than others.

11-14 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-10 points = F
Work is unacceptable.

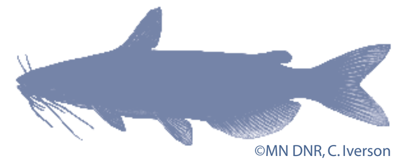
The Incredible Journey Scoring Rubric

Water Cycle Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Water cycle	Can name and describe all parts of the water cycle. Accurately illustrates all movement of water in the water cycle. Appropriately names evaporation, condensation, precipitation, and transpiration.	Can name all parts of the water cycle. Definition lacks clarity. Accurately demonstrates movement of water in the water cycle.	Can name most parts of the water cycle. Description of each part is unclear. Misses one or two connections in movement of water in the cycle.	Can't name all parts of the water cycle. Description of each part is inaccurate or unclear. Can't demonstrate correct water cycle movement.	Doesn't attempt to learn terms and process of the water cycle.
States of water	Can name and define the three states of water and gives an example of each within the water cycle.	Can name and define the three states of water. Definition lacks clarity. Can give an example of each.	Can name the three states of water but clearly defines only two states.	Can't name or correctly define the states of water correctly.	Doesn't try to name or identify the states of water.
What drives the water cycle?	Can identify and explain how the sun and gravity are the forces that power the water cycle.	Can identify the sun and gravity as the forces that power the water cycle.	Can identify the sun or gravity as a force that powers the water cycle.	Can't identify sun or gravity as forces that power the water cycle.	Doesn't attempt to identify a force that powers the water cycle.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions



1 Instead of recording their journeys in a notebook, have the students create a water cycle bracelet during the water cycle journey. Give each student a length of elastic cord with a knot tied in one end. At each of the nine stations, provide a container of colored beads—use a different color for each station. When each water molecule (student) arrives at a station, have the student take a bead to add to the bracelet. (If the roll of the die says *Stay*, add another bead.) At the conclusion of the game, have students wear their bracelets, and pointing to each bead, relate the water molecules' journeys through the water cycle.

2 Have students compare the movement of water during different seasons and locations on the globe. They can adapt the game by changing the faces of the dice or adding alternative stations to represent these different seasons or locations.

3 Have students investigate how water becomes polluted and is cleaned as it moves through the water cycle. For example, water picks up contaminants as it travels through the soil, leaving them behind as it evaporates at the surface. Challenge students to adapt The Incredible Journey to include these processes. For example, balls of rolled-up masking tape can be used to represent pollutants and stuck onto the students as they travel to the Soil Station. Some pollution can be filtered (left behind) as the water moves to the lake—and demonstrated by the students rubbing their arms to slough some tape. If they roll *clouds*, they remove all of the tape, indicating that pollutants are left behind when water evaporates.

4 Demonstrate water's changes of state. Heat water until it evaporates, and carefully use a potholder or insulated glove to hold a dinner plate or glass bowl above the heated water to demonstrate condensation. Go outside and look for morning dew, fog, ice, or snow. Have students hold snow in their hands and watch it melt—can they describe what happens to the water? Ask students if they've noticed that ice cubes shrink when left in the freezer for a long time—why does this happen? Explain **sublimation**, the process by which water changes from a solid to a gas without becoming liquid.

For the Small Fry

K-2 Option

1 Introduce the water cycle and trace it as a group. Follow Step 2 of the Warm-up.
2 Use art foam to create individual rubber stamps for each station. Hot-glue these art foam shapes to two-inch-square blocks. As students travel to each station, they rubber-stamp a sheet of paper marking their progress through the cycle. (Students like to use the stamps, so allow some time for them to do some extra stamping beforehand.)
3 Follow the steps in the lesson, eliminating Step 6 and using the rubber stamps to record the journey, as described in Step 7.
4 Have the students tell the stories of their journeys, following the order of the stamps on their sheets.
5 The bead activity described in Step 1 of the Extensions can work, but because it's somewhat abstract, it may be slightly more difficult for younger students to relate the beads to steps on their journeys.

Water Cycle Table

Station	Die Face Labels	Explanation
Soil	one side *plant*	Water is absorbed by plant roots.
	one side *river*	The soil is saturated, so water runs off into a river.
	one side *groundwater*	Water is pulled by gravity; it filters into the soil.
	two sides *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	one side *stay*	Water remains on the surface (in a puddle, perhaps, or stuck to a soil particle).
Plant	four sides *clouds*	Water leaves the plant through the process of transpiration.
	two sides *stay*	Water is used by the plant and stays in the cells.
River	one side *lake*	Water flows into a lake.
	one side *groundwater*	Water is pulled by gravity; it filters into the soil.
	one side *ocean*	Water flows into the ocean.
	one side *animal*	An animal drinks water.
	one side *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	one side *stay*	Water remains in the current of the river.
Clouds	one side *soil*	Water condenses and falls on soil.
	one side *glacier*	Water condenses and falls as snow onto a glacier.
	one side *lake*	Water condenses and falls into a lake.
	two sides *ocean*	Water condenses and falls into the ocean.
	one side *stay*	Water remains as a water droplet clinging to a dust particle.
Ocean	two sides *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	four sides *stay*	Water remains in the ocean.
Lake	one side *groundwater*	Water is pulled by gravity; it filters into the soil.
	one side *animal*	An animal drinks water.
	one side *river*	Water flows into a river.
	one side *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	two sides *stay*	Water remains within the lake or estuary.
Animal	two sides *soil*	Water is excreted through feces and urine.
	three sides *clouds*	Water is respired or evaporated from the body.
	one side *stay*	Water is incorporated into the body.
Groundwater	one side *river*	Water filters into a river.
	two sides *lake*	Water filters into a lake.
	three sides *stay*	Water stays underground.
Glacier	one side *groundwater*	Ice melts and water filters into the ground.
	one side *clouds*	Ice evaporates and water goes to the clouds (sublimation).
	one side *river*	Ice melts and water flows into a river.
	three sides *stay*	Ice stays frozen in the glacier.

Incredible Journey Labels for Dice

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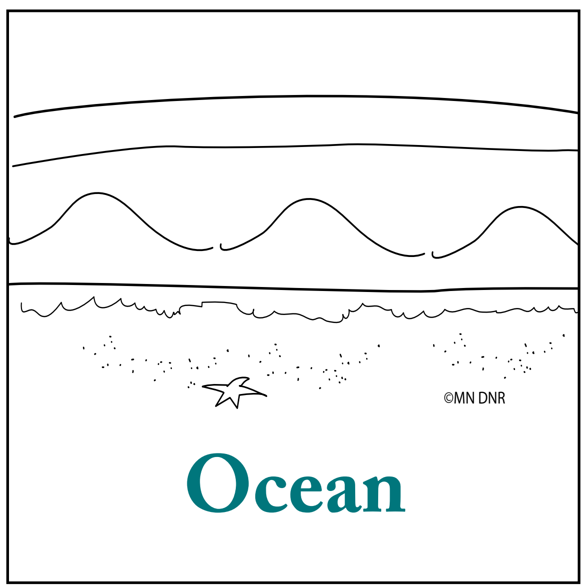

Incredible Journey Labels for Dice

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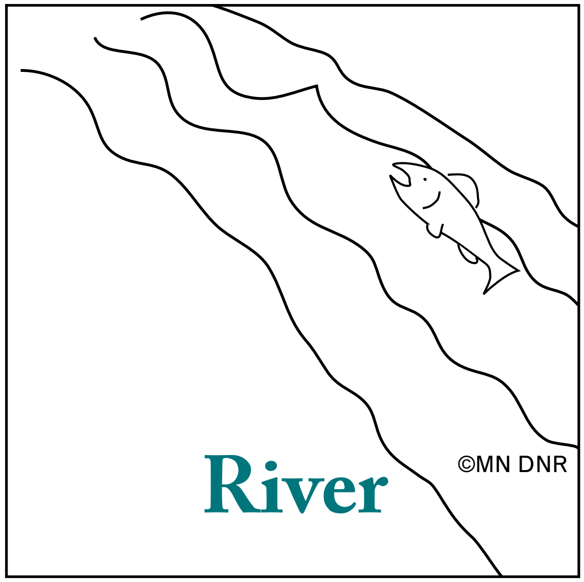

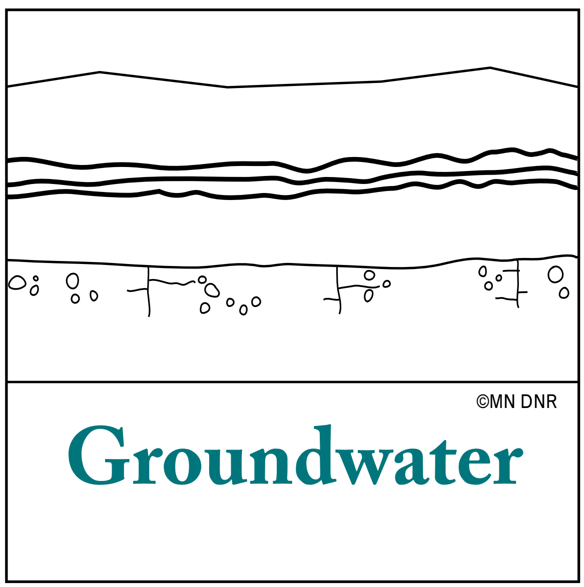

Incredible Journey Labels for Dice

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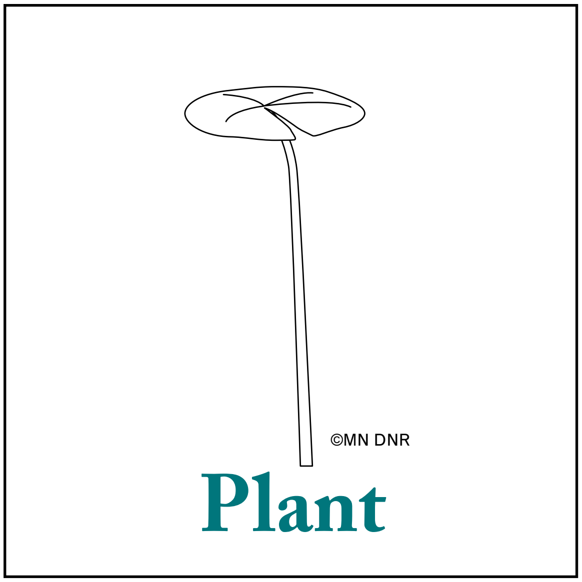

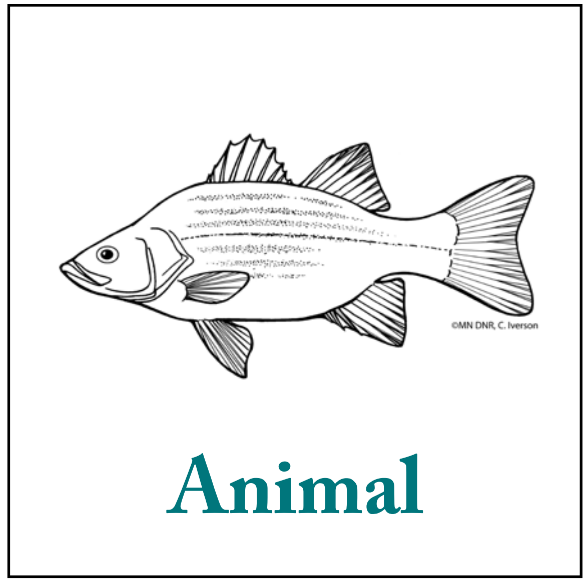

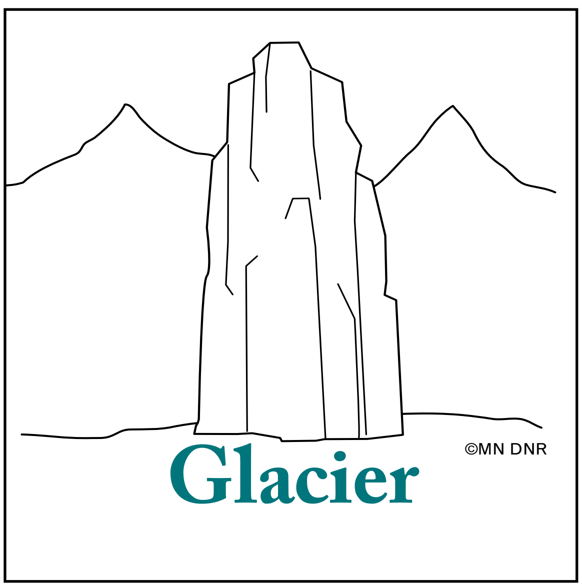

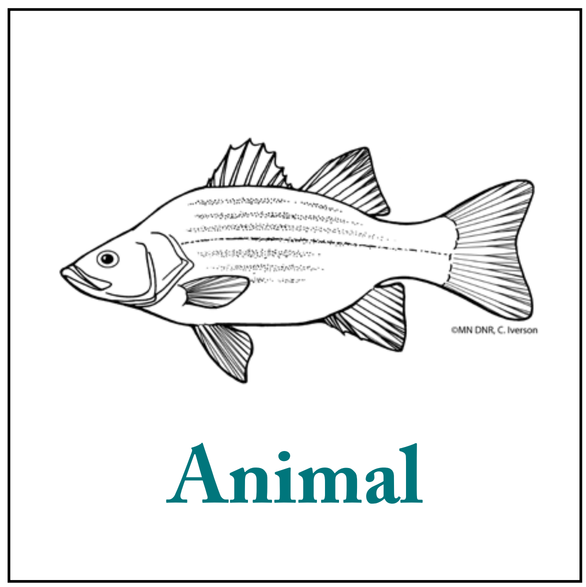

Incredible Journey Labels for Dice

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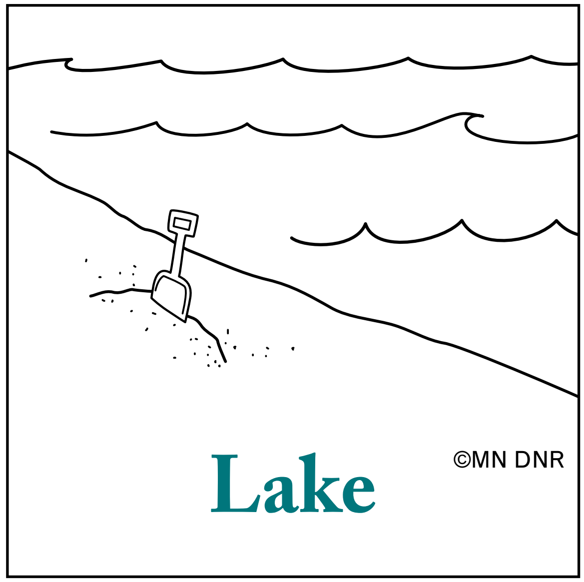

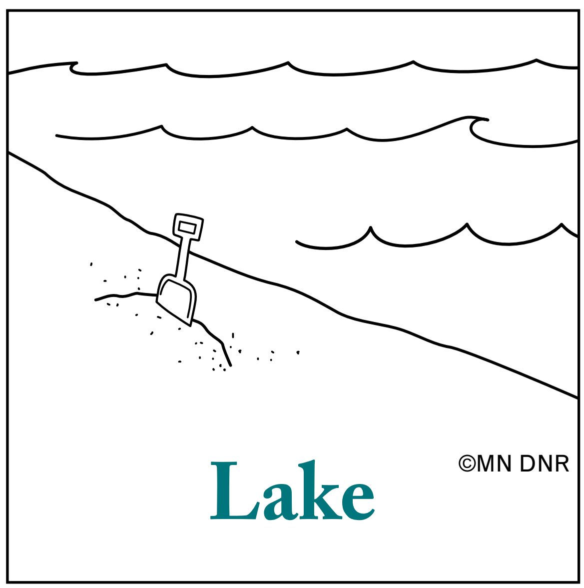

Incredible Journey Labels for Dice

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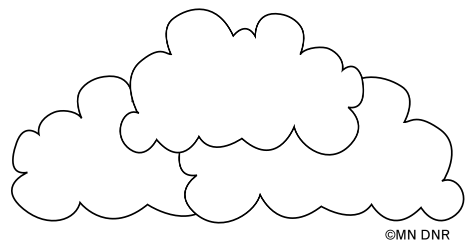
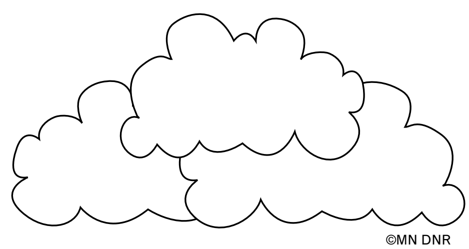


Clouds



Clouds

Incredible Journey Labels for Dice

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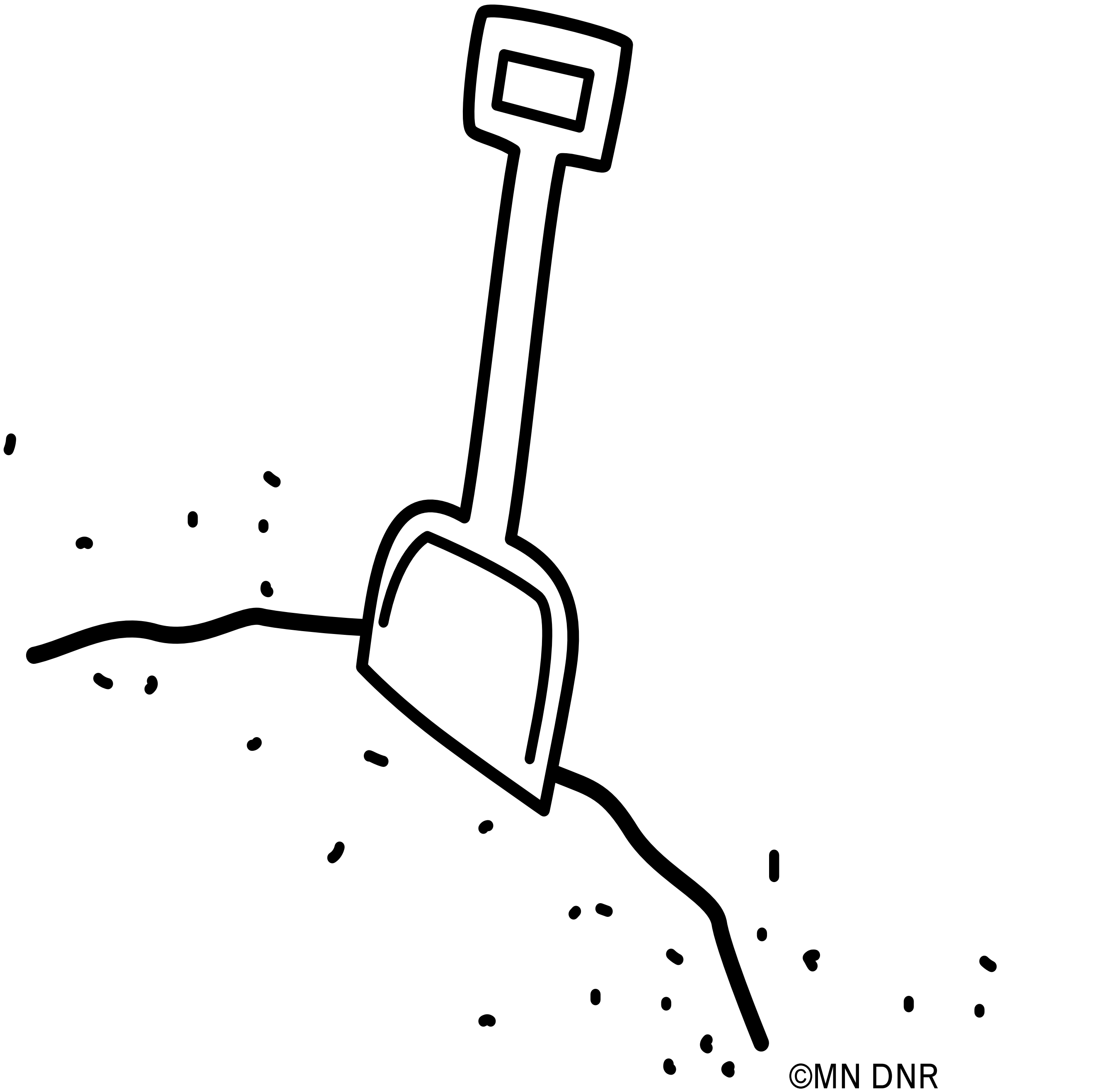
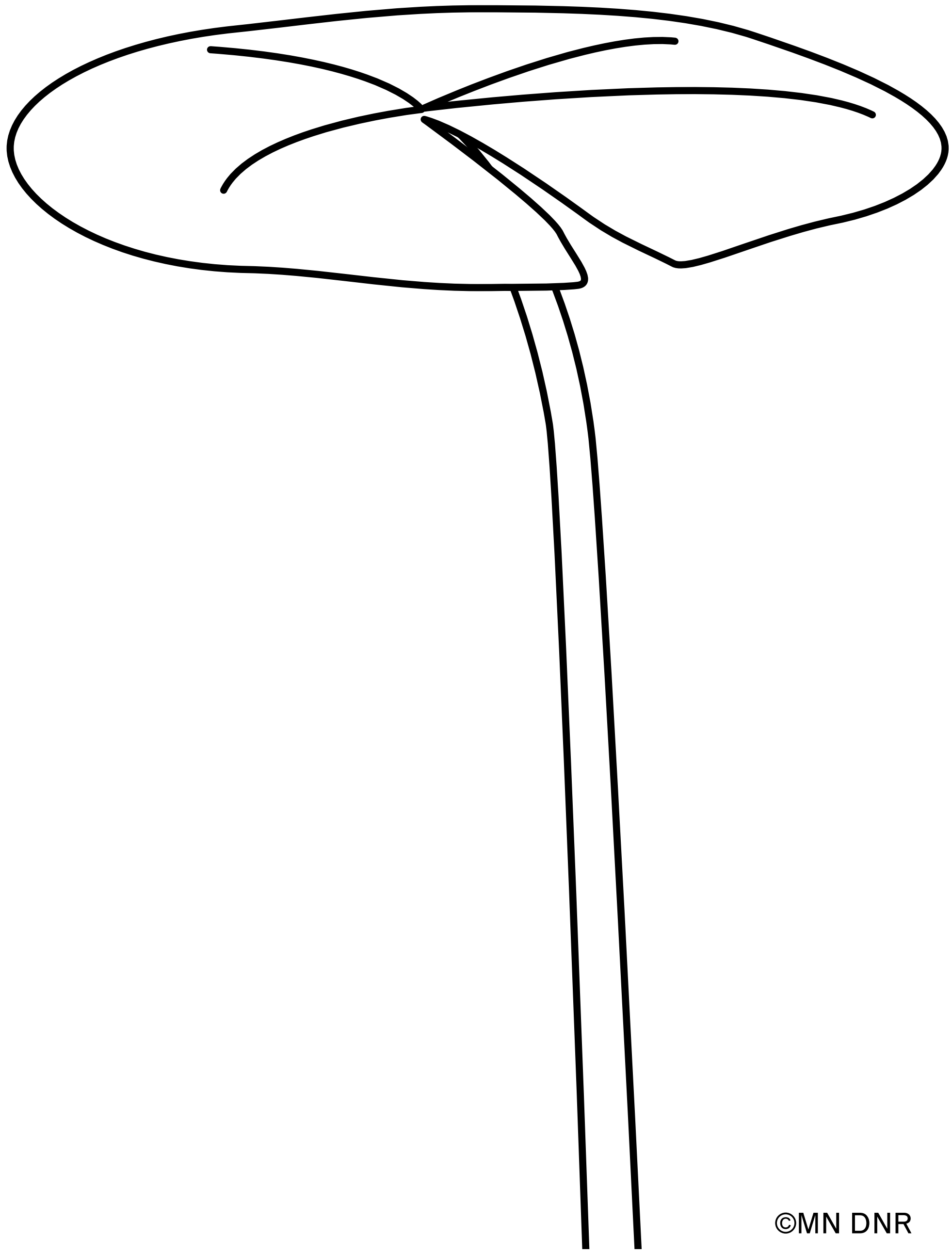
Incredible Journey Station Sign



Soil

Incredible Journey Station Sign



Plant

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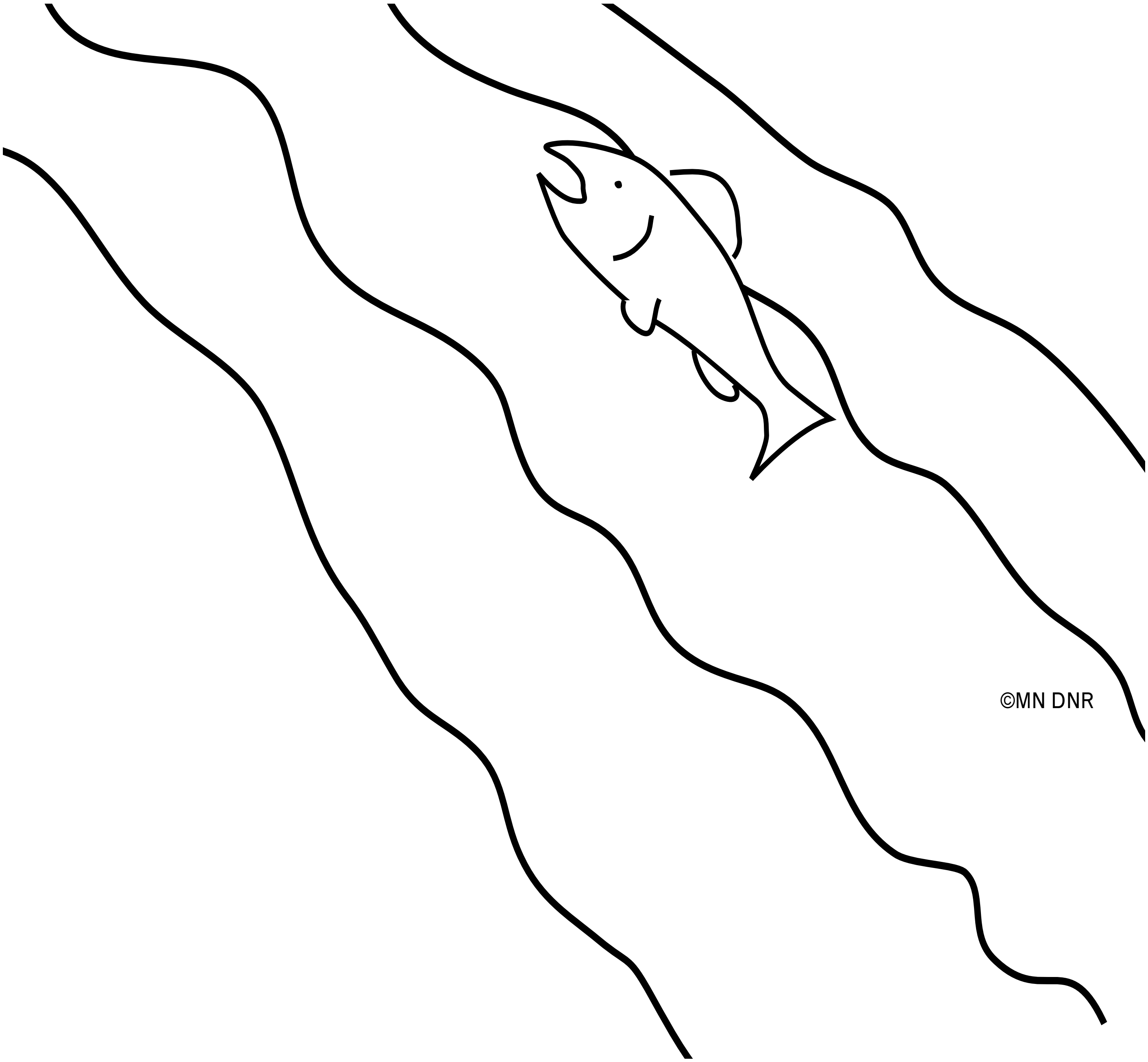

River

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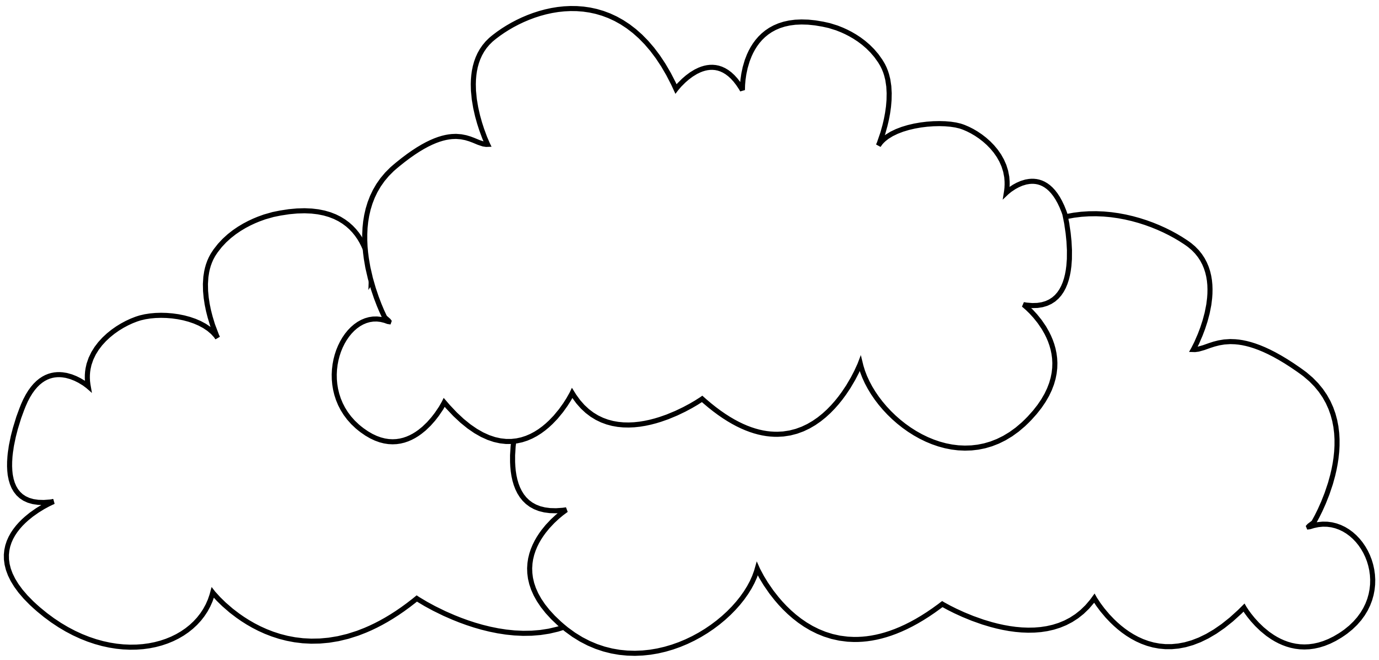

Clouds

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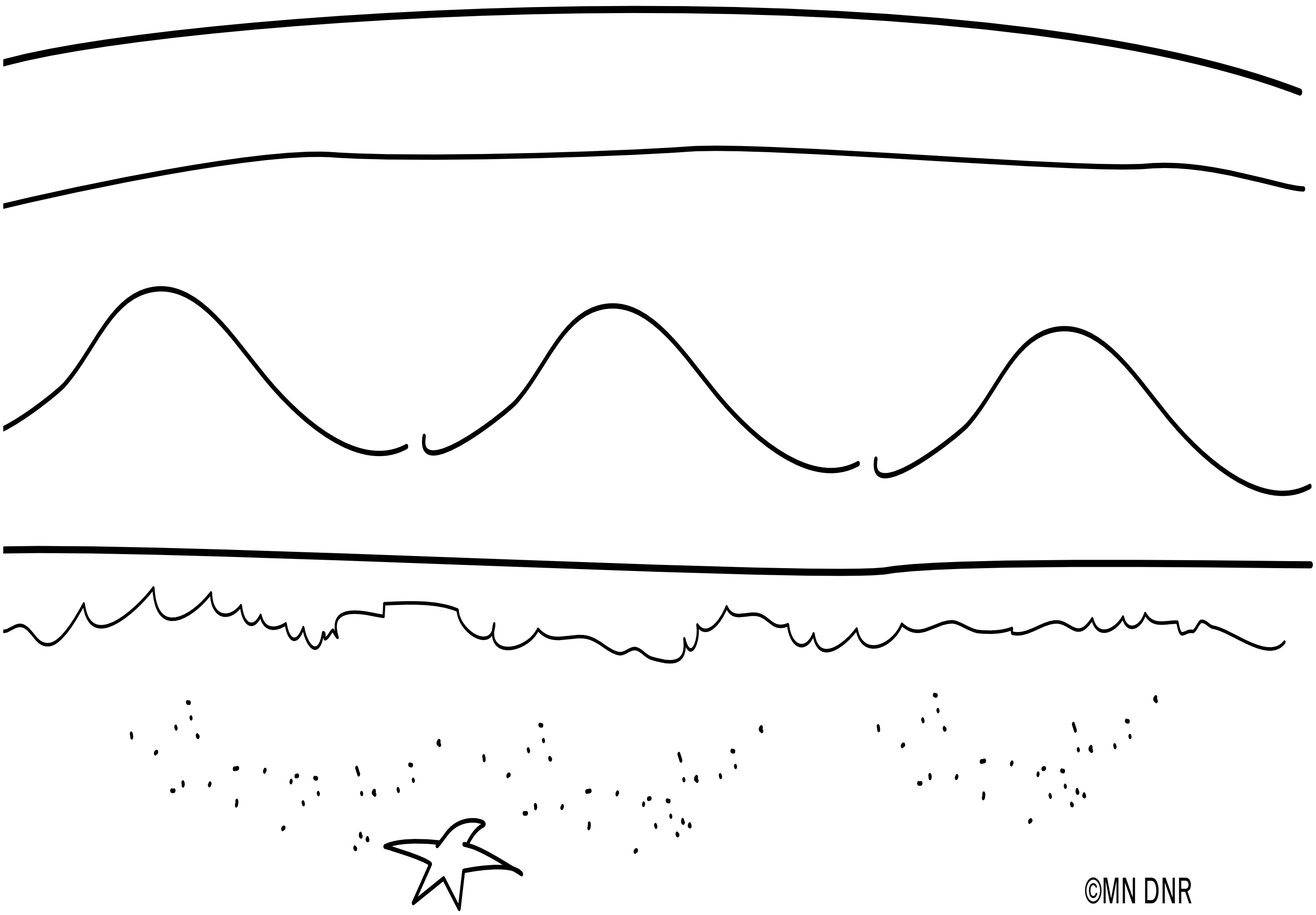

Ocean

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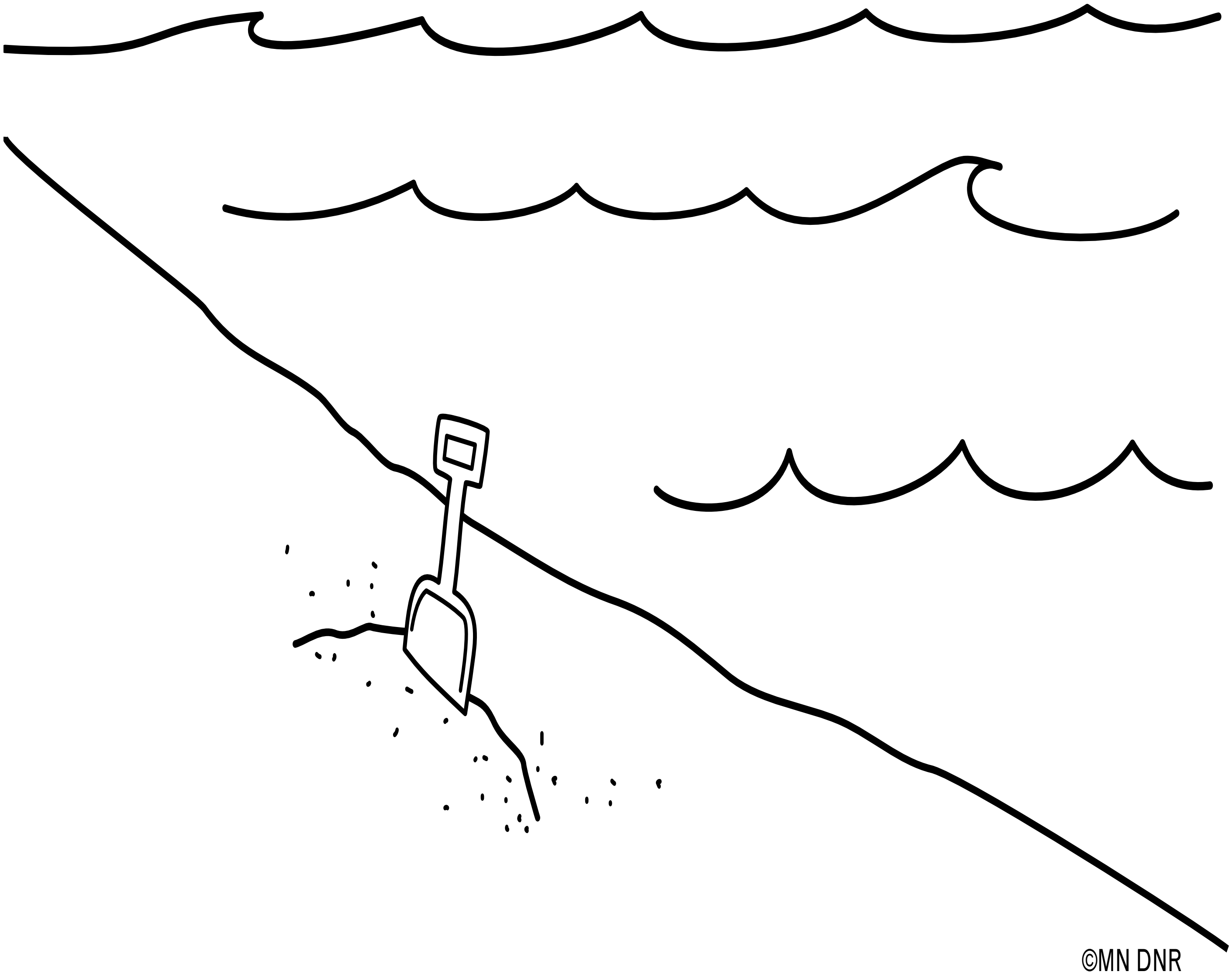

Lake

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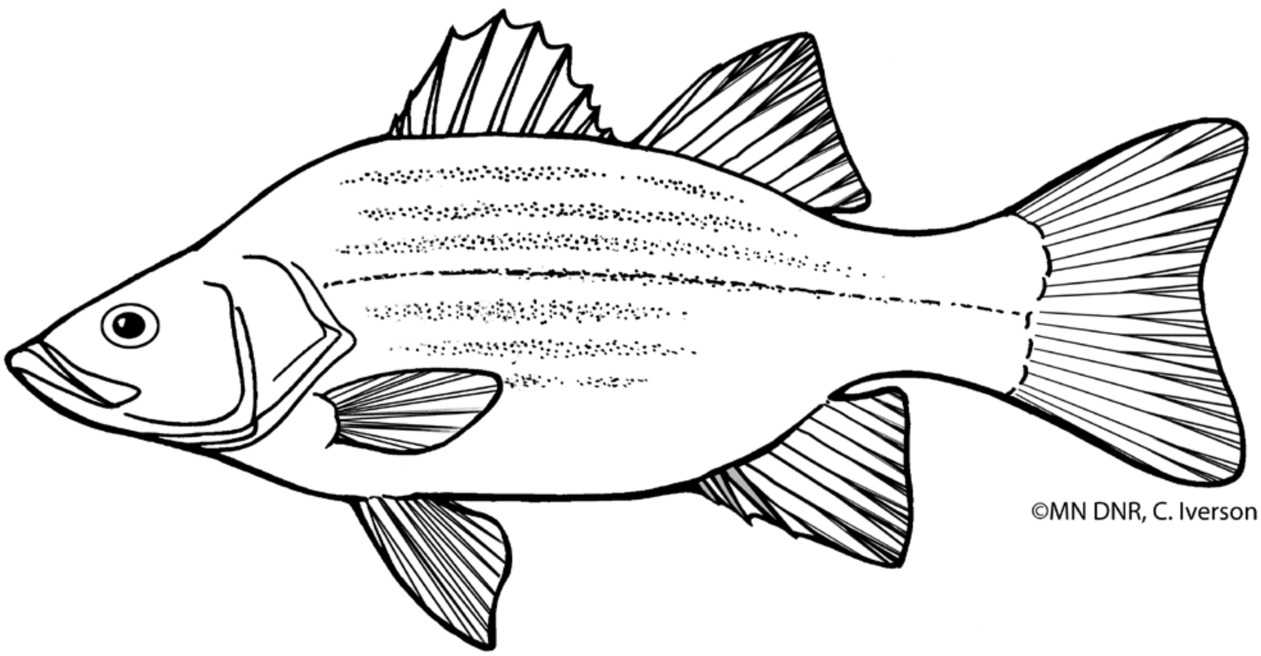

Animal

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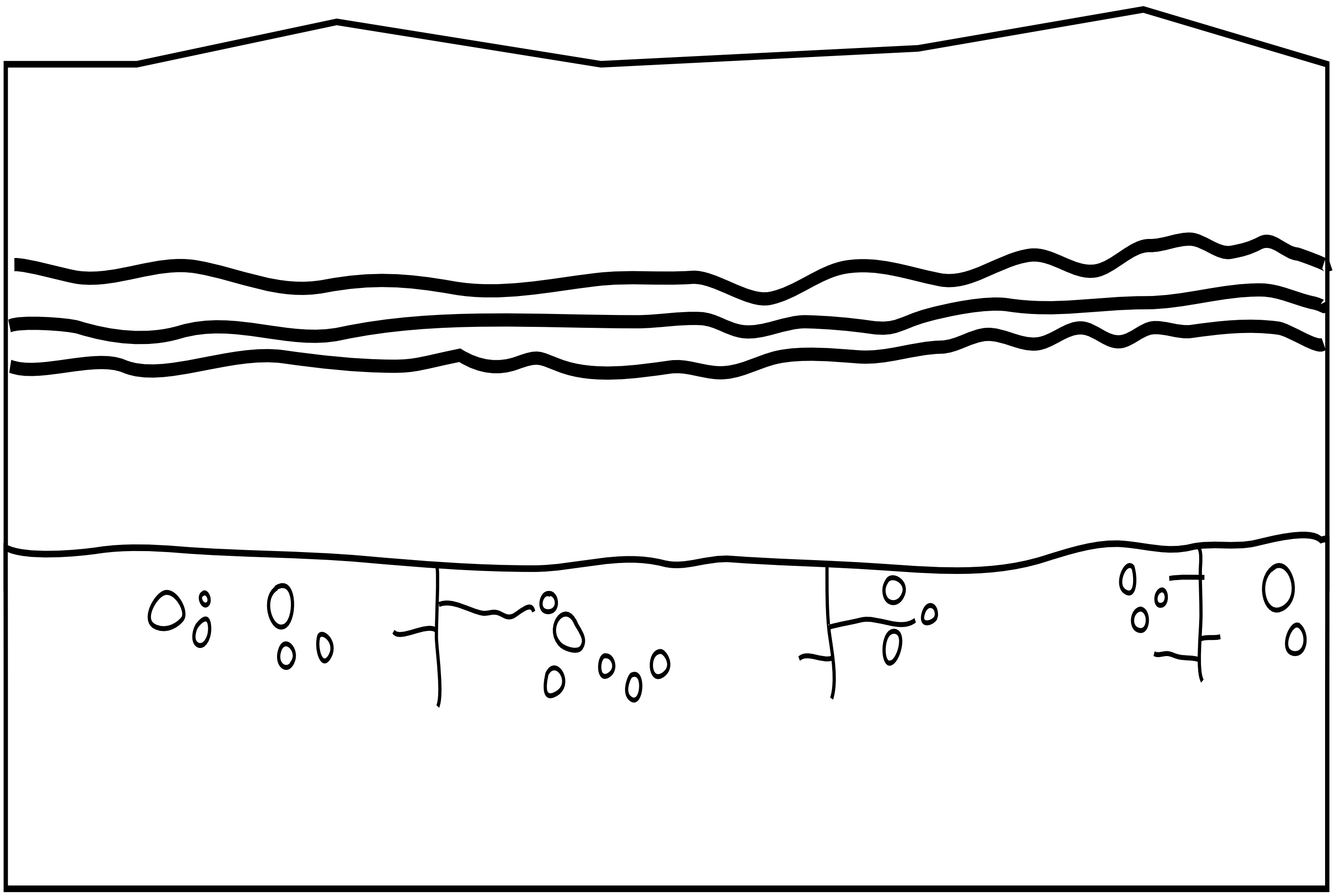

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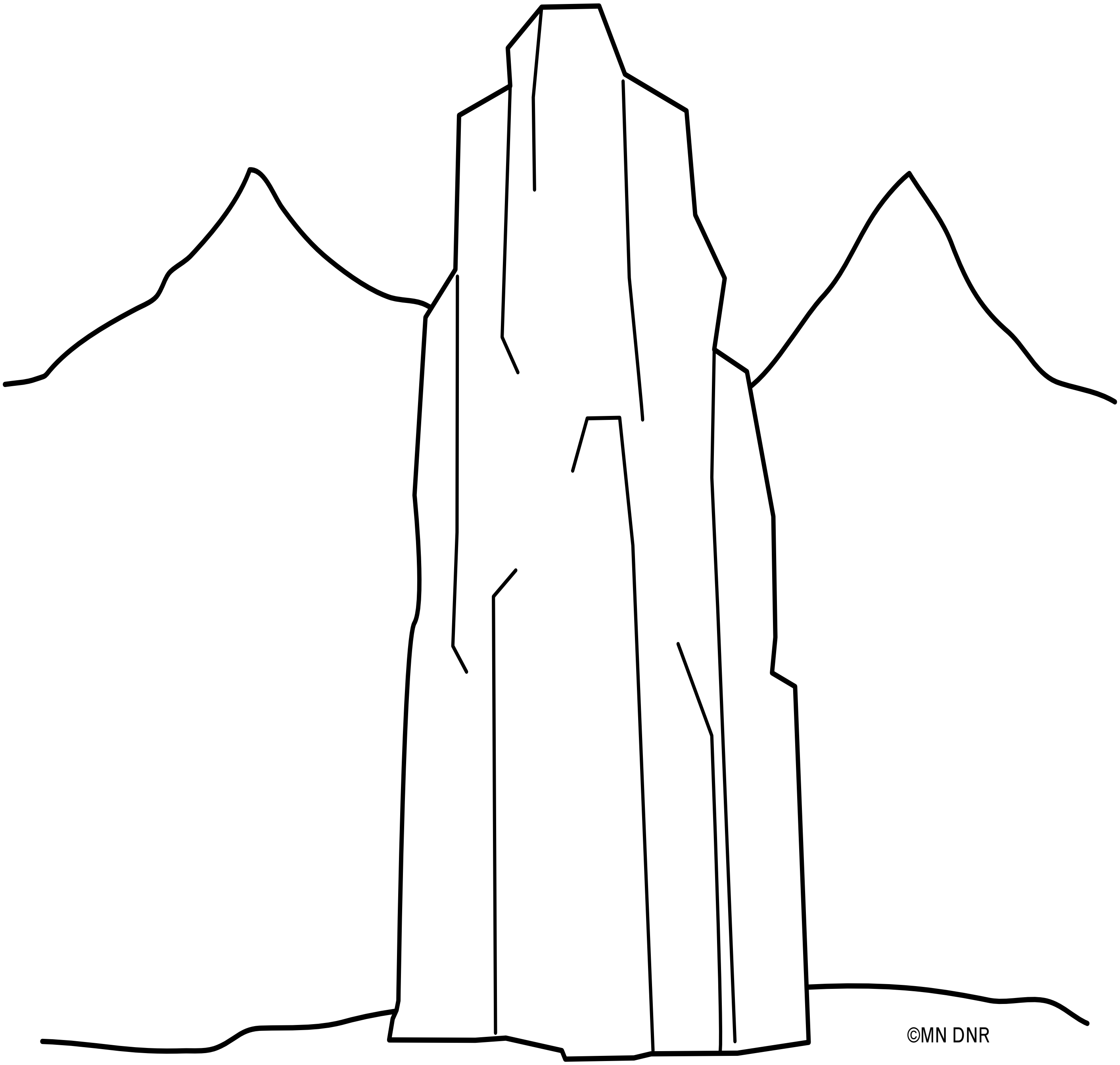
Groundwater

Incredible Journey Station Sign



Glacier

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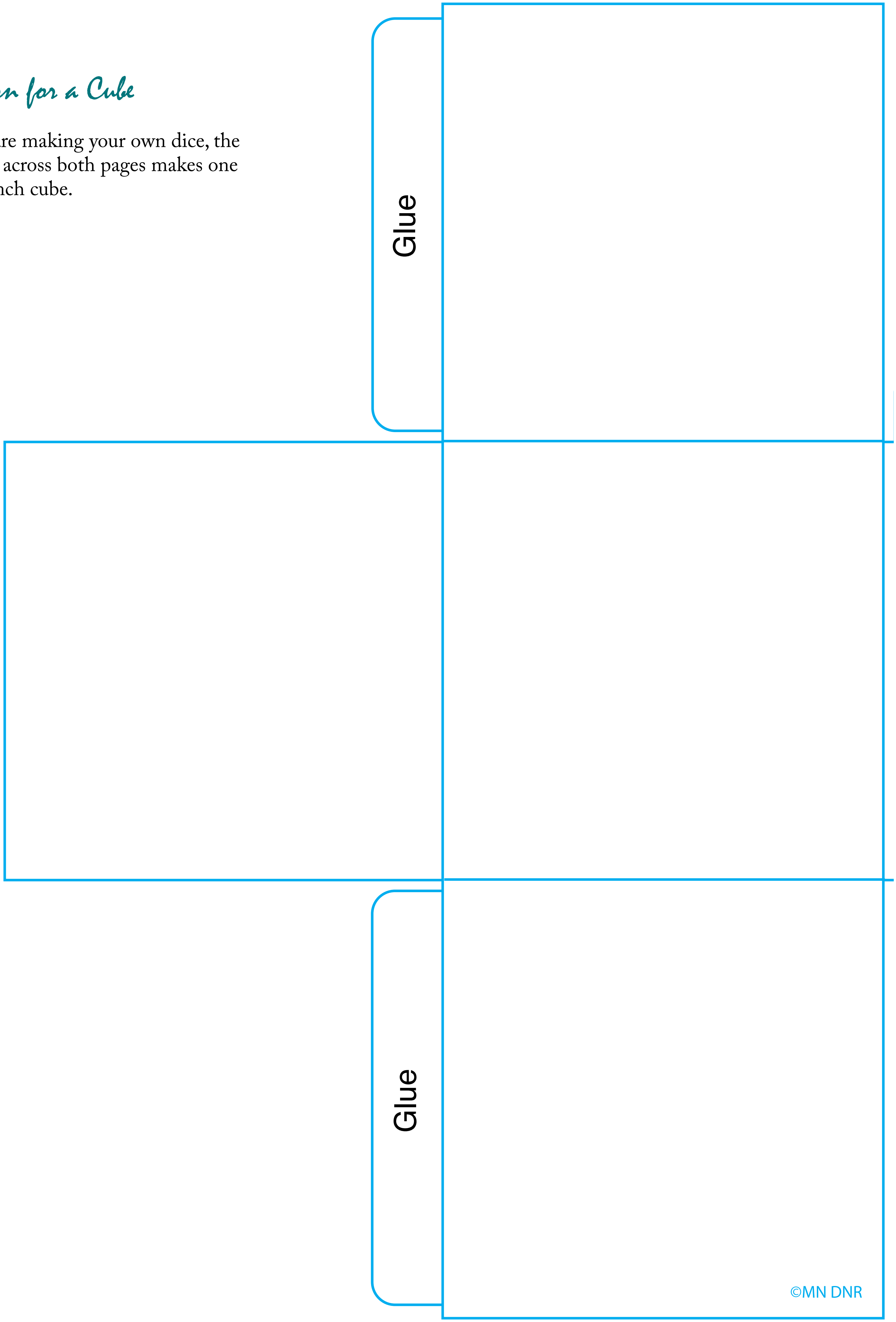
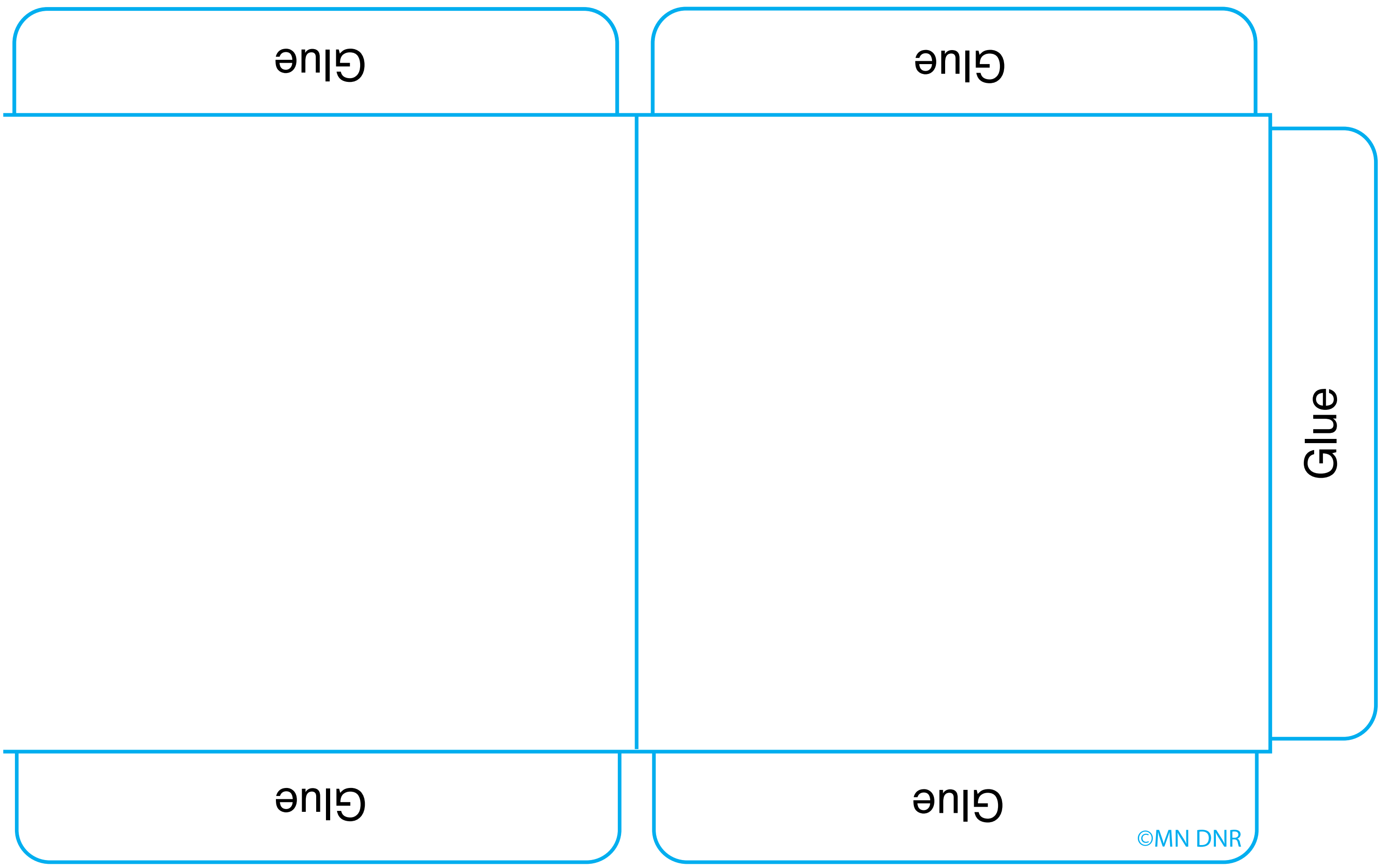
Pattern for a Cube

If you are making your own dice, the pattern across both pages makes one three-inch cube.




Glue
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The Function of Aquatic Plants

Imagine an underwater forest teeming with life!

Explore the world of aquatic plants and find out how they create healthy lake and stream habitats for fish and other aquatic animals.

Table of Contents

Chapter 3 • Lesson 2

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

The Function of Aquatic Plants

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

Grade 4
I. Reading and Literature B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.

Grade 5
I. Reading and Literature B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction as well as independent reading.
II. Writing D. Research:
Benchmark 2—The student will formulate research questions and collect relevant information or perform observations that address such questions.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The students will give oral presentations to various audiences for different purposes.

History and Social Studies

Grades 4-8
II. Minnesota History
G. Post-World War II to the Present:
Benchmark 4 - Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impacts of those changes and issues.
V. Geography D. Interconnections:
Benchmark 1—Students will recognize changes over time in nearby landscapes, resulting from human occupation.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.

IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
Benchmark 2—The student will know that plants have different structures from animals that serve the same necessary functions in growth, survival and reproduction.
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food.
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from controlled experiments.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.
III. Earth and Space Science
A. Earth Structures and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose of the grouping.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.

IV. Life Science
F. Flow of Matter and Energy:
Benchmark 1—The student will recognize that organisms need energy to stay alive and grow, and that this energy originates from the sun.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 2

The Function of Aquatic Plants

Grade Level: 3-5
Activity Duration: Part 1: 60 minutes
Part 2: 30 minutes to set up, plus daily observations for seven to fourteen days
Part 3: 30 minutes to set up, plus fifteen minutes to record results (48 hours later)
Group Size: 30 (maximum)
Subject Areas: Language Arts, Science, Social Studies, Expressive Arts
Academic Skills: communication, comparison, drawing, drawing conclusions, identification, inquiry, observation, public speaking, prediction, recording data, reporting, small group work
Setting: indoor or outdoor gathering area with tables
Vocabulary: algae, crucial habitat, emergent plants, erosion, floating-leaf plants, limnetic zone, littoral zone, nitrogen, phosphorus, submerged plants, surface runoff, xylem
Internet Search Words: bonfires, phosphorus, phosphorus-free dishwasher detergent, phosphorus-free fertilizer, bonfires, road salt, streams; on the Minnesota DNR website: lakescaping for wildlife, Restore Your Shore, water quality

Instructor's Background Information

Like terrestrial plants, aquatic plants need sunlight, water, carbon dioxide, and nutrients to grow. A houseplant will die if submerged in water for long, but aquatic plants thrive in wet conditions.

Aquatic plants and algae are usually green because of the chlorophyll pigment within their cells. Chlorophyll allows algae and aquatic plants to make their own food. This food-making process, photosynthesis, occurs when sunlight energizes reactions in chlorophyll that eventually produce sugars such as glucose. These sugars give energy to the plant and to any organism that eats the plant. Plants need carbon dioxide, water, light, and chlorophyll for photosynthesis. Plants can absorb nutrients and water from the soil, which travel to the leaves through the plant's xylem. Xylem consists of vessels, or tubes, that conduct water and dissolved minerals. Xylem also stores food and supports the plant.

Summary

Students conduct experiments to explore the value of aquatic vegetation to lakes and streams. In Part 1, students learn that aquatic vegetation provides food and shelter for fish and other wildlife. They will also learn about the types of aquatic vegetation living in the littoral zone. In Part 2 students learn how algae blooms can occur in nutrient-rich conditions. In Part 3, students learn that aquatic plants absorb nutrients and some polluting chemicals.

Student Objectives

The students will:

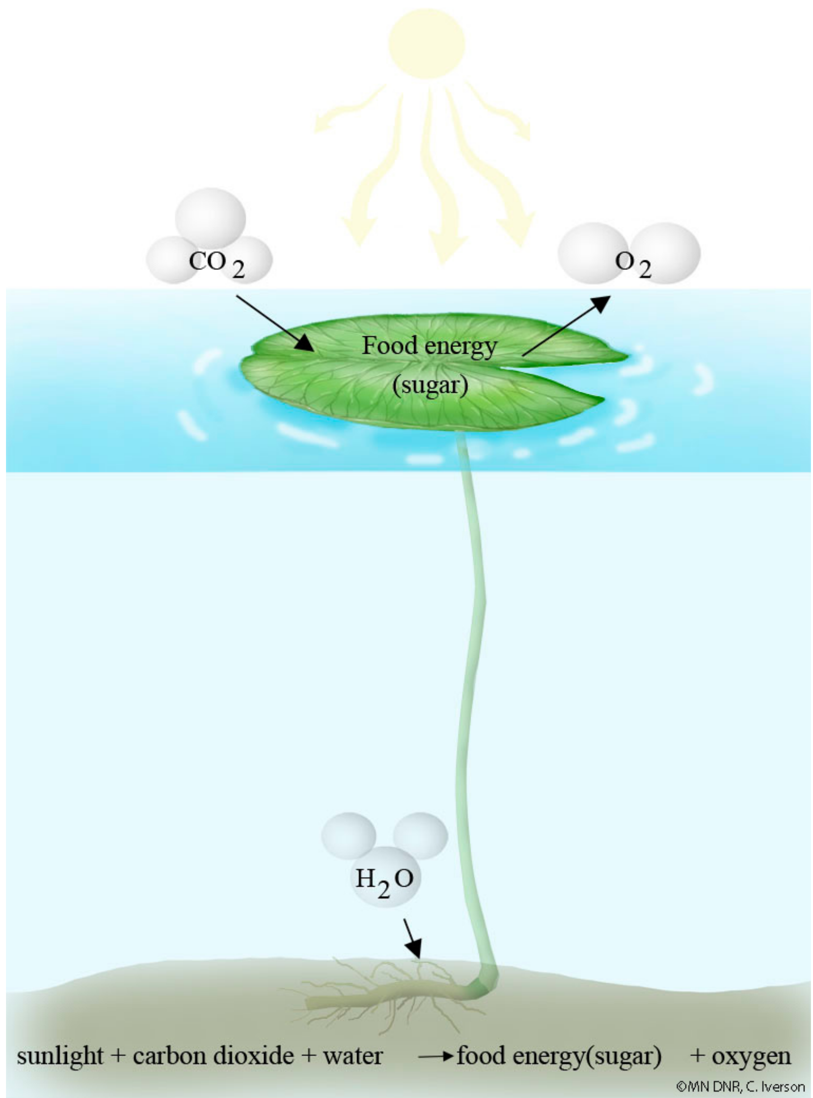
1. Illustrate different types of aquatic plants growing along the lakeshore.
2. List the value of aquatic plants to fish and wildlife.
3. Demonstrate that aquatic plants absorb nutrients and other chemicals.
4. Propose ideas for ways to use plants to help keep water resources healthy.
5. Understand that excessive nutrients in the water will cause algae growth (or an *algal bloom*), and propose ways to prevent excessive algae growth.

Materials

Part 1: Littoral Zone
In sufficient quantities for students to create a bulletin board display:

- Large sheets of poster board or paper
- Colored paper
- Colored pencils or markers
- Scissors
- Glue
- Magazine photos of wildlife
- Pictures or specimens of algae and emergent, submerged, and floating-leaf plants
- *Restore Your Shore or Save Our Shorelines* PowerPoint presentations on CD (optional); available from DNR Area Fisheries offices, or contact the Minnesota DNR Information Center at 651-296-6157, or toll free at 1-888-646-6367.

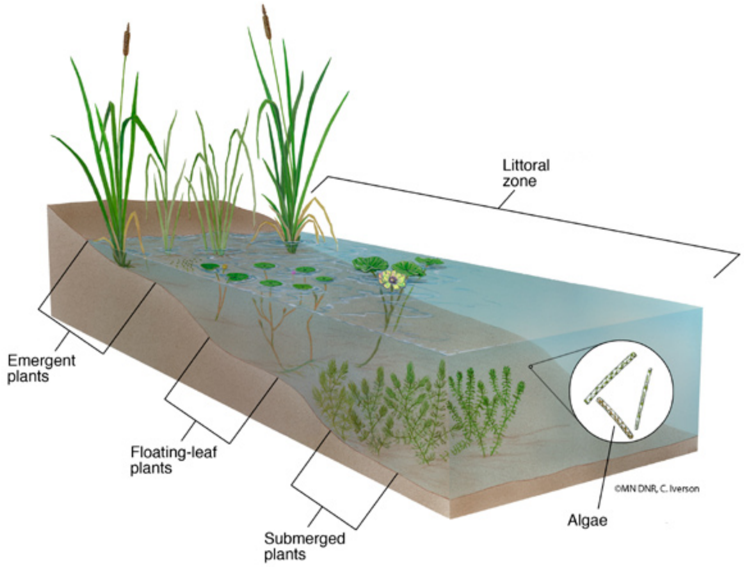
continued



Photosynthesis

Littoral Zone
The area where aquatic vegetation grows in a lake is its **littoral zone**—the shallower portion of the lake, where sunlight can penetrate to reach the bottom with enough intensity to allow the growth of rooted aquatic plants. In Minnesota, the littoral zone extends from the shore to a depth of fifteen feet, depending on water clarity. Shallow water, abundant light, and nutrient-rich sediment provide ideal conditions for plant growth in the littoral zone. Aquatic plants, in turn, provide food and shelter for many animals such as fish, frogs, birds, moose, muskrats, turtles, insects, and snails. Aquatic plants also produce the oxygen that aquatic life needs for survival.

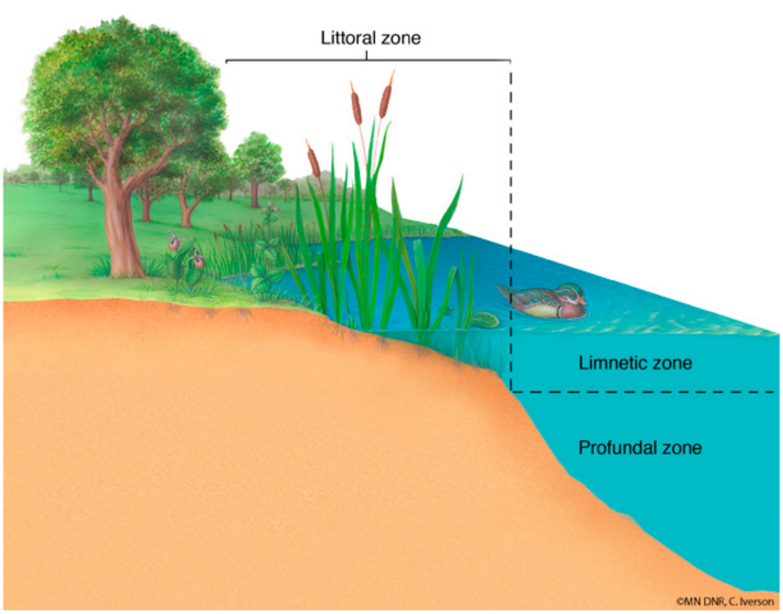
Some lakes are loaded with aquatic plants. Others have relatively few plants. Major factors influencing the amounts and types of aquatic plants include water depth, bottom type, water clarity, and nutrient availability. Shallow lakes have extensive littoral zones, but lakes with steep drop-offs have narrow littoral areas.



Free-floating plants can grow anywhere on the surface of a water body. The zone in which emergent, floating-leaf, and submerged plants grow is called the littoral zone. In many Minnesota lakes, this zone extends to a depth of approximately fifteen feet.

The **limnetic zone** is the open surface water above a lake's deep water (surrounded by the littoral zone), where rooted plants cannot grow. Plankton, phytoplankton and zooplankton inhabit this zone. A variety of freshwater fish also occupy this zone.

The **profundal zone** lies beneath the limnetic zone and extends to the bottom of the lake. Because sunlight doesn't penetrate these greater depths, this zone contains no green plants. Large numbers of bacteria and fungi live in the bottom (benthic) muck. The benthic community in the profundal zone may also include macroinvertebrates.



Limnetic and profundal zones

Materials (continued)

Part 2: Nutrient Soup

- Glass containers (such as baby food jars) or plastic cups
- Bucket of water from a pond, lake, or stream
- Pond plant, whole or parts (use a submerged plant that isn't an invasive species)
- Liquid fertilizer, such as Miracle Gro (or dry plant fertilizer)
- **Nutrient Soup Report Sheets**, one copy per student
- Pencils
- Clipboards

Part 3: Nature's Strainers

- Paper cups (large enough to support a celery stalk)
- Tape
- Fresh stalks of celery with leaves, two stalks per group
- One to two cups of salt

Permits are required for aquatic plant removal, but small amounts may be collected for educational use without a permit. You may legally collect small amounts of emergent and floating-leaf plants for educational purposes. But usually, due to their ecological value, these plants may not be removed without a permit from the Minnesota DNR.

Types of Aquatic Vegetation

Within the littoral zone, there are four categories of aquatic vegetation: submerged plants, floating-leaf plants, emergent plants, and algae. Each type of aquatic vegetation favors a certain water depth and bottom type. However, the growth areas are not sharply divided.

Algae have no true roots, stems, or leaves. They range in size from tiny, one-celled organisms to large, multicelled, plantlike organisms. Algae can be planktonic (single-celled, float in the water column), filamentous (forming chains, filaments, or colonies), or plantlike (such as chara). Although some algae aren't classified as plants (such as blue-green algae, which is considered to be related to bacteria), they're functionally similar to plants because most types are photosynthetic. They're primary producers—they can directly convert the sun's energy to make food energy. Planktonic algae grow throughout the littoral zone as well as the well-lit surface waters of an entire lake. Other forms of algae are common only in the littoral area.

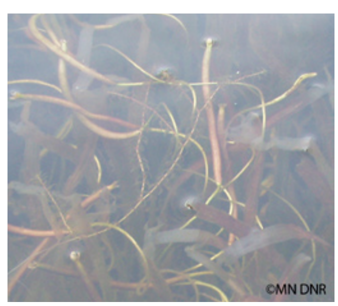
Anabaena planktonic | **Spirogyra** filamentous | **Chara** plant-like

Common types of Minnesota algae.

The roots, stems, and leaves of **submerged plants** grow entirely underwater, although some may also have floating leaves. Submergents grow from near shore to the deepest part of the littoral zone, and display a wide range of shapes. Common Minnesota submerged plants include coontail, bladderwort, water marigold, and wild celery.

Northern Water Milfoil
Myriophyllum sibiricum

Coontail
Ceratophyllum demersum



Wild Celery
Vallisneria americana

Large-leaf Pondweed
Potamogeton amplifoliu

Floating-leaf plants are rooted in the lake bottom with leaves and flowers that float on the water's surface. They usually grow in protected areas with little wave action. Common Minnesota floating-leaf plants include water lilies, American lotus, and floating-leaf pondweed. Free-floating plants also grow in the water. Duckweed and watermeal drift, freely and unattached, with wind and currents. Some are rootless. Others have roots consisting of simple hair-like projections that dangle from the underside of their leaves.

White Water Lily
Nymphaea odorata

American Lotus
Nelumbo lutea

Water Smartweed
Polygonum amphibium

Emergent plants are rooted in the lake bottom, but their leaves and stems extend beyond the surface. Emergent plants tolerate fluctuating water levels, and their dense stands dampen shoreline waves and **erosion**, the gradual wearing away of soil and rock surfaces by natural forces such as flowing water, wind, and ice. Erosion also occurs when human and animal activities disturb the soil and the vegetation that holds soil in place. The leaves of emergent plants have extensive spongy tissue and air spaces. Examples of emergent plants include cattails, bulrushes, and wild rice. Emergent plants typically grow in wetlands and along the shore, where the water is less than four feet deep.

Northern Blue Flag
Iris versicolor

Broad-leafed Cattail
Typha latifolia

Wild Rice
Zizania spp.

Pickerelweed
Pontederia cordata

Aquatic vegetation isn't just another term for "weeds." A lake's aquatic vegetation is essential to healthy populations of fish and other animals. Weeds are defined as undesirable or useless plants. But "weed" is a subjective term because one person's weed is often another person's treasure. Encourage students to use the term aquatic vegetation when discussing plants that live in the water.

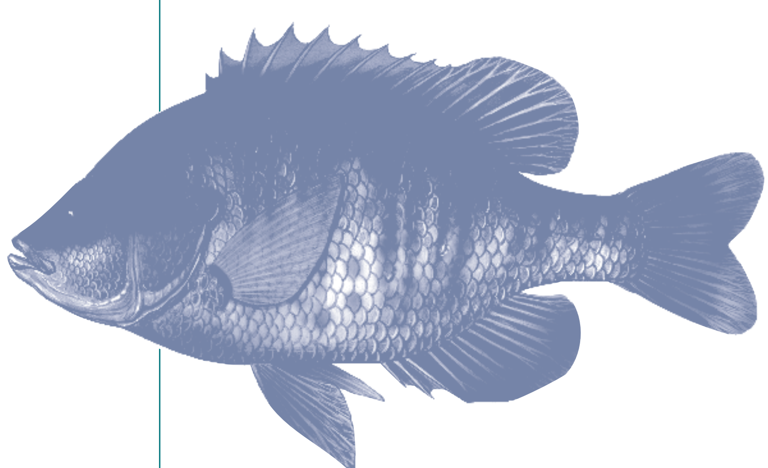
The Value of Aquatic Vegetation

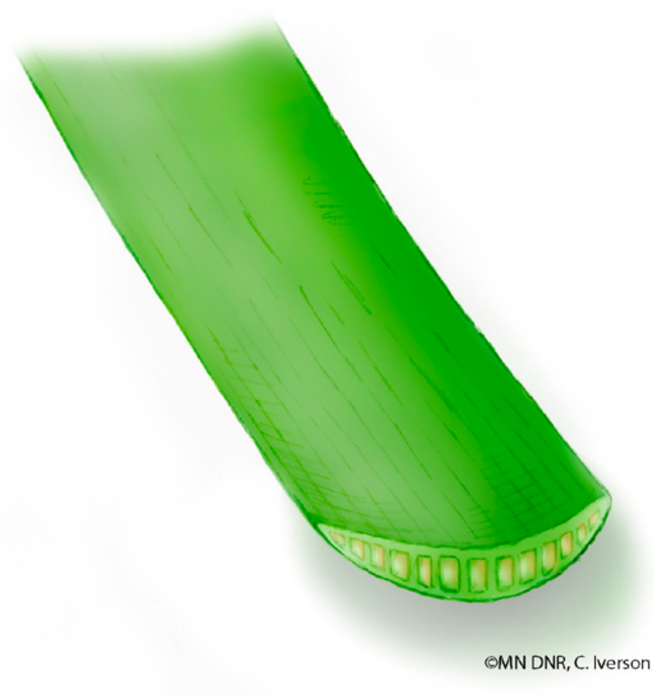
Aquatic vegetation is a vital part of a lake. Plants provide food and shelter for wildlife, improve water quality, protect shorelines, and provide economic value to lakeshore property. They're also aesthetically pleasing.

Food and Shelter for Fish and Waterfowl—Plants are the primary producers of food in aquatic ecosystems. In addition to providing a food source, they support the growth of other members of the food web. Areas of aquatic vegetation produce more food for fish than areas without plants. Insect larvae, snails and other macroinvertebrates, and zooplankton thrive among plants. These organisms provide an essential food source for the juveniles of game fish species such as walleye, northern pike, bass, crappies, sunfish, and catfish. Minnows, shiners, and darters (which aren't game fish, but essential to the effective functioning of ecosystems) feed on aquatic plants, too. The many organisms that thrive in vegetated areas are an important food for many kinds of adult fish and waterfowl.

Plants provide shelter, too. Juvenile fish, many types of adult fish, and wildlife seek safety from predators by hiding in vegetation. Aquatic plants provide **crucial habitat** for juvenile fish. **Crucial habitat** includes areas vital to viable populations of fish and wildlife during certain times of the year, reproduction periods, or other phases of life cycles. Bass and sunfish, for example, usually nest in areas with vegetation.

Many emergent plants, such as cattails, have leaves containing spongy tissue and air spaces. Made from these buoyant leaves, the nests of ducks and other birds float up and down with changing water levels. Nests constructed on the water's surface keep eggs and young birds out of the reach of many land-dwelling predators.





Cross-section of a cattail leaf.

Oxygen Production—Fish and other aquatic organisms depend on the water's dissolved oxygen for their survival. Plants use the sun's energy to produce food through the process of photosynthesis, and oxygen is a by-product of photosynthesis. The oxygen that aquatic plants produce is released directly into the water.

Water Clarity and Quality—Aquatic plants can improve water quality. Certain plants, such as bulrushes, can absorb and break down polluting chemicals. Water plants also absorb nutrients that, left unchecked, would cause nuisance algae blooms. The finely-divided leaves of aquatic plants function as a filtering system, trapping and settling particles from **surface runoff,** the precipitation and water that flow over the surface of the land directly into streams, lakes, and rivers. Shoreline plants act as a filter strip, holding soil in place and preventing erosion. Aquatic plants also provide oxygen, which fish and other animals need to survive. Aquatic plants also provide shade, which keeps water temperatures cool—a critical factor in the survival of fish species such as trout.

Shorelines and Lake Bottom Protection—Aquatic plants, particularly emergent plants like rushes and cattails, reduce the force of waves and prevent shoreline erosion. Their spreading horizontal roots create an interlocking network that helps these plants withstand wave action and stabilizes sediment, reducing erosion. Submerged and floating-leaf aquatic plants also cushion wave action and stabilize bottom sediment.

Fish don't have eyelids to protect their eyes from bright sunlight. Plants provide shady retreats for fish on sunny days.

Did you know that ashes from bonfires contain phosphorus? After your shoreline bonfire has died and cooled, grab a shovel, scoop the ashes, and dump them inland to prevent the phosphorus from leaching into the water.

One pound of phosphorus can fuel the growth of 300 to 700 pounds of algae.

Aesthetics—The visual appeal of a lake's shoreline often includes aquatic plants, a natural and critical part of any lake community. Water lilies, arrowhead, and pickerelweed have flowers that many people enjoy. The ecological diversity provided by native aquatic plants also contributes to keeping aggressive and harmful exotic plant species in check.

Economic Value—As a natural component of water bodies, aquatic plants support the economic value of all lake and river activities. Minnesota's extensive tourism industry depends on water bodies and the recreation they support. Tourists spend billions of dollars yearly to hunt, fish, camp, and watch wildlife around the state's waterways. Aquatic plants are a critical component of that enjoyment. The best thing that we can do for our lakes and streams at the water's edge is to avoid altering the natural shoreline—and to restore altered shorelines. A natural shoreline includes upland plants (those on land near shore), as well as emergent, submergent, and floating-leaf plants to provide a buffer zone between land and deep water. Human and non-human residents benefit from the maintenance of buffer zones between the land and water. In addition to protecting water quality and preventing erosion, a buffer zone adds beauty, increases privacy, and creates habitat for many wildlife species.

Too Much of a Good Thing

Although aquatic plants and algae are natural and healthy components of lakes and streams, they're "too much of a good thing" when they grow rapidly. The naturally-occurring elements **nitrogen** and **phosphorus** are nutrients essential to plant and algae growth. But too much nitrogen or phosphorus in a water body can stimulate an overgrowth of algae and aquatic plants.

Excessive algae and plant growth prevents light from reaching deeper waters, harms aquatic life, and poses an unpleasant nuisance to people. In most cases, dense plant growth helps rather than harms fish. Plants add oxygen to the water and promote the growth of organisms that fish eat. Too many plants, however, reduce predators' effectiveness, causing prey fish populations to increase beyond the limits of the food supply. Underfed fish can't grow properly, resulting in a stunted fish population. Dense aquatic vegetation is usually more of a nuisance to anglers than to fish, but it does make fishing more difficult and impacts fish population size structure.

When plants and algae die, bacterial decomposers begin to break them down, using oxygen in the process. Because most aquatic plants are confined to the littoral zone—in shallower water—they usually don't have much of an impact on the total dissolved oxygen levels in deeper water when they die and decay. But, floating mats of algae do grow over deeper water. When excessively large algae mats die and decompose, dissolved oxygen levels in deeper water can drop significantly. Without sufficient oxygen, fish and other aquatic organisms can't survive.

Excess amounts of nitrogen and phosphorus often enter water when fertilizers, grass clippings, and leaves enter waterways by way of storm drains. Many Minnesota communities have enacted ordinances limiting or banning the use of phosphorus fertilizer in an effort to protect water quality. Some dishwasher detergents also contain phosphorus that isn't removed by treatments in sewage facilities or septic systems. Phosphorus-free dishwasher detergents are available, providing an alternative to this form of pollution.

Procedure

Preparation

1 Prepare a bulletin board or wall to showcase the littoral zone plant drawings. Collect examples of algae, emergent, submergent, and floating-leaf plants to show to the class. Use pictures if live specimens aren't available. These plants can be collected from a local pond or lake, but when collecting plants from the wild, be sure to follow local laws, ordinances, and posted signs.

> Be careful not to collect, transport, or spread invasive species. Don't transfer plants from one water body to another. If you buy plants, discard them in the trash—not in a lake or stream. Consult the Minnesota DNR website for a list of waters infested with invasive plants: **www.mndnr.gov/eco/invasives/index.html**

2 Collect drawing supplies and colored paper for the students' plant drawings.
3 Collect magazines so students can cut out pictures of fish and other aquatic wildlife of the littoral zone.
4 Copy the **Nutrient Soup Report Sheets**, one per student.
5 Collect pond water for the algae growth experiment. *Do not dump water from one pond into another pond, lake, river, or stream.* If you can't return the water to its original pond, dispose of it on dry land well away from any body of water or storm drain.
6 Purchase household plant fertilizer. Liquid fertilizer is easy for students to use.
7 Purchase celery stalks with leaves (two stalks per group).
8 Bring in approximately one to two cups of salt.
9 Obtain plastic cups or glass containers (four per group).

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.

If aquatic plants won't be available when you teach this lesson, collect the plant samples at the end of summer and make direct color photocopies of the entire plant. Color photocopies provide plant images with a lot of detail. You may wish to laminate the photocopies to preserve them for future use.

Activity

Part 1: The Littoral Zone

Warm-up

1 Begin the lesson on aquatic plants by discussing the various plants that grow in lakes or streams. Ask students to brainstorm examples of aquatic plants familiar to them, and where they grow. Use pictures of aquatic plants, or show the Minnesota DNR *Save Our Shorelines*, a 20-minute narrated PowerPoint presentation available on CD from your Area Fisheries office.

2 Compare how plants in a lake or stream are similar to the plants in a forest. Discuss the ways in which fish and other animals benefit from aquatic vegetation.

3 Explain the littoral zone and why plants grow in this zone.

Lesson

1 Share pictures or plant specimens representing the four aquatic plant communities of the littoral zone. Explain the four communities of plants (submerged, emergent, floating leaf, and algae) and where they're found in the littoral zone. Place the pictures or specimens at stations and allow the students to explore the four categories of plants.

2 Divide the class into four groups. Assign a plant community to each group.

3 Distribute the colored paper and drawing materials. Working in small groups, students should make large drawings of the samples of plants found in their plant community. For instance, the group assigned to emergent plants will draw cattails, bulrushes, and blue flag iris. A field guide to aquatic plants and the Minnesota DNR CD programs are useful sources of additional examples, if available. The group working on algae will need a microscope to view live specimens, except for chara. Photos may work better than algae specimens for detailed observations. But actual specimens will show the small relative sizes of this plant group.

4 Each group should also draw pictures of types of wildlife or fish that live among their plant community.

5 When the students have completed their drawings, have them place their artwork on the bulletin board within the appropriate area of the littoral zone. Both plants and animals should be placed on the bulletin board.

6 As an alternative to posting the artwork on a bulletin board, the length of the classroom can be transformed into a three-dimensional littoral zone. By displaying the artwork at various heights throughout the room (to represent various water depths), students could "swim" through the different zones to visit the inhabitants. In addition to drawings, the students could also create three-dimensional models of plants and animals.

Wrap-up

Have each group deliver a class presentation about their plant community. They should share the plants' names, where the plants live within the littoral zone, which animals and fish use the plants, and how the plants benefit these animals.

Part 2: Nutrient Soup

It takes approximately seven to fourteen days for this algae growth experiment to develop observable results.

Warm-up

1. Explain that phosphorus and nitrogen are essential nutrients for plants, but that excessive amounts of these nutrients cause algae blooms. Explain that shoreline plants can absorb some excess phosphorus, nitrogen, and other nutrients that fuel nuisance algae blooms.
2. Explain why excessive algae growth harms aquatic organisms.
3. Display pictures or items of common household and yard products containing nitrogen and phosphorus. Discuss the ways in which these products are used, and how they enter waterways.

Lesson

1. Divide students into small groups.
2. Give each group two clear plastic cups or glass containers such as baby food jars.
3. Label one cup "Fertilizer" and the other "No Fertilizer."
4. Have the students fill both cups with pond water.
5. Add ten drops of liquid fertilizer (or about one-quarter teaspoon dry fertilizer) to the cup labeled "Fertilizer."
6. Place both cups in a sunny window. Keep light and temperature conditions identical for both cups. Plants need light energy from the sun to grow. Cover the containers with a lid or aluminum foil.
7. Give each student a copy of the **Nutrient Soup Report Sheets**. Each group should make a prediction about what they think will happen to the "Fertilizer" and "No Fertilizer" cups during the experiment and write their predictions on the sheet.
8. Over the course of seven to fourteen days, students should make daily observations of the plant and algae cultures in each of the containers, and record those observations on the **Nutrient Soup Report Sheets.** Observations may include water color, water clarity, and smell (relative to the other container and to the previous day.)
9. If desired, the containers may be kept for a few extra weeks so students can observe additional changes over time (for example, a change in the dominance of particular forms of algae). When the experiment is complete, dispose of the samples on the ground outdoors, well away from water. Don't pour them down any drain.

Avoid getting fertilizer on hands. In high concentrations, it can irritate skin.

Students should observe that both cups become greener over time, but the "Fertilizer" cup should contain a higher concentration of algae and appear greener.

Depending on the size of your containers, the type of fertilizer used, and temperature and light conditions in your room, results may vary, and you may want to decrease the amount of fertilizer that is suggested.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species. Clean all recreational equipment.

Wrap-up
Within their groups, have students complete the Conclusions section of their **Nutrient Soup Report Sheets.** On the back of the sheet, have students summarize their observations and some possible reasons for the phenomena they observed. Have groups prepare a report on their observations, conclusions, and summary. Students should be able to describe the effects of excessive algae growth on fish and other aquatic organisms. Students should conclude their reports with proposed ideas for things that can be done to keep lakes and streams clean by preventing nuisance algae growth. Groups can present their reports as an oral presentation for the rest of the class, or turn it in as a written report.

For additional study, discuss residential and agricultural fertilizer use with the students. Then have them perform research to investigate how statewide fertilizer use has changed over time As a class, create a chart that illustrates how statewide use of lawn care and agricultural fertilizers has increased during the past century. Note the positive and negative effects over time.

Part 3: Nature's Strainers
This experiment requires a 48-hour waiting period before results become observable.

Warm-up
1. Discuss how some aquatic plants, such as bulrush, can filter and break down pollutants. Also discuss how plants can absorb excess nutrients.
2. Discuss with students some of the ways chemicals enter lakes or streams. Some examples include an oil or gasoline spill on the ground that washes into the water through a city storm drain, or winter road salt washing from roads into lakes and streams.

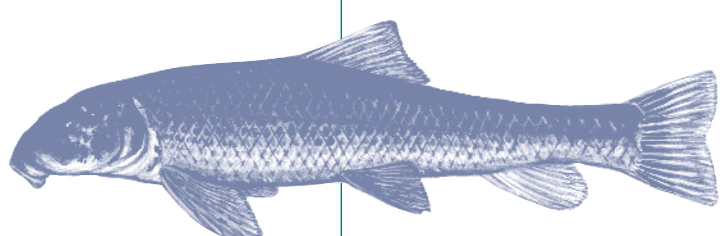
Lesson
1. Divide students into small groups of three to five students.
2. Give each group two cups, two stalks of celery (with the leaves attached), and two tablespoons of salt.
3. Have the students label the cups "Water" and "Salt Water."
4. Fill the cups half full with drinking water.
5. Add the salt to the "Salt Water" cup. Carefully stir the water with a straw or spoon to dissolve the salt.
6. Place a stalk of celery in each cup.
7. Place both cups in a window. Keep light and temperature conditions identical for both cups.
8. Each group should make a prediction about what they think will happen during the experiment. This prediction should be recorded on paper.
9. After 48 hours, taste the leaves from each celery stalk.
10. Record the results.

Wrap-up

1 The leaf in the "Salt Water" cup should taste salty. Ask the students to explain why the leaves taste like salt even though the leaves weren't touching the water. Plants absorb the salt and the water, which move to the leaves through the xylem. Ask students to think about how this experiment relates to aquatic plants. How does salt get into lakes and streams, and how might high concentrations of salt affect aquatic life?
2 Tell the students that outdoor plants can remove excess nutrients and some pollutants from runoff before they flow into lakes and streams—just as they witnessed in their experiment. Wetlands are particularly valuable environmental filtration areas. Plants in wetlands and in zones surrounding lakes and streams absorb and filter excess nutrients and chemicals that run off the land. For example, high concentrations of road salt that entering water body with snowmelt can make the water toxic to fish and other aquatic animals over time. But if plants surround the lake or stream, they can absorb the salt—or filter it from the runoff water, preventing a large influx of salt (and other harmful compounds) into the lake or stream.
3 Ask students to think of other chemicals that can get into the water (a very long list, containing, oil, detergent, fertilizers), and discuss the ways which plants could be used to prevent these chemicals from reaching the water.

Assessment Options

1 Evaluate students' presentations about the plant communities they drew for Part 1. Presentations should include where their plant type grows, and how organisms benefit from the plants.
2 Evaluate the students' predictions, observations, and conclusions on the **Nutrient Soup Report Sheets** for Part 2.
3 Evaluate students' explanations of why the celery leaf tastes salty and what this means for aquatic plants exposed to chemicals in aquatic environments for Part 3.
4 Assessment options include the Checklist and Rubric on the following pages.



Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

28-31 points = A
Excellent. Work is above expectations.

24-27 points = B
Good. Work meets expectations.

19-23 points = C
Work is generally good. Some areas are better developed than others.

15-18 points = D
Work does not meet expectations; it isn't clear that student understands objectives.

0-14 points = F
Work is unacceptable.

The Function of Aquatic Plants Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Group includes at least four examples of their plant type in the poster.
4	______	______	Plants are drawn with lifelike shapes and dimensions.
5	______	______	Poster shows combination of at least five types of native wildlife and fish species that utilize each plant type.
3	______	______	Design well-organized. Organisms easily seen and placed in habitats.
4	______	______	Plants and animals appear under the water's surface, on the bottom, on the surface, and in habitat above the water.
4	______	______	Design utilizes at least four types of materials.
2	______	______	Student can define *littoral zone*.
2	______	______	Student can define *surface runoff* and *erosion*.
3	______	______	Student can describe three benefits to wildlife and habitats provided by aquatic plants.

Total Points

31	______	______	**Score** ______

The Function of Aquatic Plants Scoring Rubric

Group Project Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Aquatic plant type	Group includes at least four examples of their plant type in the poster. Plants drawn with lifelike shapes and dimensions.	Group includes three examples of their plant type in the poster. Plants drawn with lifelike shapes and dimensions.	Group includes two examples of their plant type in the poster. Plants drawn with lifelike shapes, but dimensions aren't quite right.	Group includes one plant type in the poster. Plants aren't drawn with lifelike shapes or dimensions.	Group doesn't complete the poster.
Wildlife and fish species	Poster shows at least five types of native wildlife and fish species that utilize each plant type.	Poster shows at least four types of native wildlife and fish species that utilize each plant type.	Poster shows at least two to three types of native wildlife and fish species that utilize each plant type.	Poster shows only one native wildlife and fish species that utilize each plant type.	Wildlife species shown don't utilize plant species shown.
Design	Design nicely organized. Organisms easily seen and appear in entire water column, bottom, and area above water.	Design well-organized. Some organisms hard to see, and appear only in below- surface water column.	Design is okay, but it's hard to see all organisms. Organisms appear only on lake bottom.	Haphazard design. Doesn't represent a real lake or stream system.	Poster not completed.
Materials	Design utilizes at least four types of materials.	Design utilizes at least three types of materials.	Design utilizes at least two types of materials.	Design utilizes just one material.	Poster not completed.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

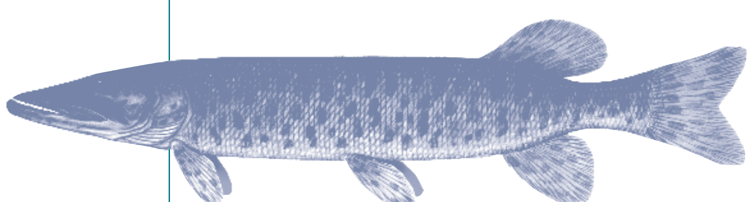
Extensions

1 Take a field trip to a local pond. Ask students to bring wading shoes or boots. Have them examine the littoral zone and locate the four communities of plants that they see. As they explore the littoral zone, students should look for animals hiding within vegetation. They may use a journal to record the numbers and types of animals they observe in a vegetated area compared to a non-vegetated area.

2 An extension of the algae growth experiment in Part 2 could include examining samples of pond water under a microscope at various times throughout the observation period. Over time, different algae may become dominant—and students can record these observations in addition to their macroscopic observations.

3 Have students design posters advertising phosphorus-free fertilizer and dishwashing detergents. These can then be given to the stores that carry them.

4 Have students become involved in a local shoreland restoration project.



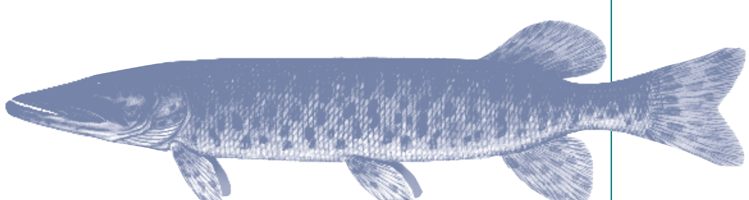
For the Small Fry

K-2 Option

1 Ask students if they've ever seen a lake or pond in the summer that has "turned green." Explain that tiny organisms called algae turn the water green. Excessive algae blooms affect fish and other animals that live in and on the water, too. Do the algae growth experiment, using a simpler data sheet on which students can record observations.

2 Ask students about plants they may have seen in and around lakes, streams, or ponds. Ask them what they think plants do to keep the environment healthy.

- Demonstrate how plants absorb nutrients by placing one white carnation in two glasses of colored water. To do this cut the stem of the carnation in half lengthwise from the end to approximately halfway to the flower. Fill each of the two glasses three-quarters full of water. Add three to five drops of red food coloring to one glass, and the same amount of blue food coloring to the other glass. Gently stir to mix in the food coloring. Place one end of the flower stem in the glass with the red water and the other end of the flower stem in the glass with the blue water.
- Let the flowers stand in the water for 48 hours. The white flower will then turn half red and half blue. The colored water was absorbed through the tiny tubes, called xylem, in the plant's stem. When the colored water reached the petals, the color was distributed to all the cells in those areas of the plant. This is how nutrients in the water move to a plant's cells: the nutrients dissolve in water and move to the roots, leaves, and flowers. Aquatic vegetation along shorelines absorbs excess nutrients in the water that can cause algae growth to run amok.



STUDENT COPY

Name(s) ______________________________ Date ______________

Nutrient Soup Report Sheet

Prediction

What do you expect to happen in the cup labeled **Fertilizer?**

What do you expect to happen in the cup labeled **No Fertilizer?**

Observations

STUDENT COPY

Name(s) ______________________ Date ______________

Nutrient Soup Report Sheet

Record your observations of the two containers. Notice things like the color of the water, whether or not it's clear, and how it smells when compared to the other container and to the previous day.

Day #	No Fertilizer (control)	Fertilizer (experimental)
1		
2		
3		
4		
5		
6		
7		

STUDENT COPY

Name(s) ______________________________ Date ______________

Nutrient Soup Report Sheet

Conclusions

Did you observe what you expected to observe in your prediction? Explain why or why not.

What would you do to improve the experiment for next time?

How could an algae bloom like the one you may have observed in this experiment occur in a lake instead of a cup?

What are some consequences of an algae bloom in a lake or pond? How do algae blooms affect fish in a lake?

What can you do to prevent an algae bloom from happening in your favorite lake?

Wonderful Watersheds

A river or lake is not isolated. The entire valley is reflected in its waters. It's part of a system: the watershed.

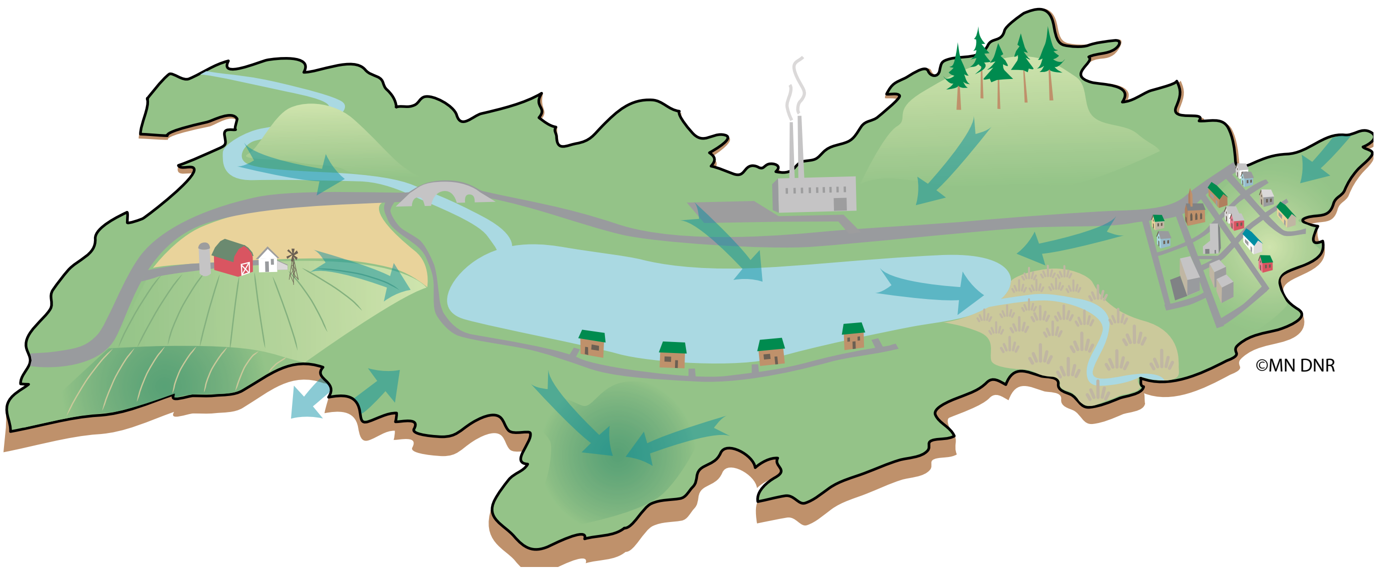


Table of Contents

Chapter 3 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Wonderful Watersheds

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening, and Viewing
A. Speaking and Listening
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussion in large and small groups.

Math
Alignment to the 2007 Minnesota Academic Math Standards coming soon.

Grade 3
V. Spatial Sense, Geometry, and Measurement
C. Measurement:
Benchmark 1—The student will identify lines of symmetry in geometric shapes. (Identify direction water will flow in a watershed).

History and Social Studies

Grades K – 3
V. Geography
A. Concept of Location:
Benchmark 2—Students will use maps and globes to locate places referenced in stories and real life situations.
Benchmark 4—Students will name and use directional words to describe locations of places in the school and community. Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above.
B. Maps and Globes:
Benchmark 1—Students will locate places by using simple maps and understand that maps are drawings of places as viewed from above.
C. Physical Features and Processes:
Benchmark 2—Students will explain and use introductory geographical terms.

Grades 4 – 8
II. Minnesota History
G. Post-World War II to the Present:
Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues.
V. Geography
C. Physical Features and Processes:
Benchmark 2—Students will describe and locate major physical features in their local community and analyze their impact on the community.
D. Interconnections:
Benchmark 2— Students will analyze how the physical environment influences human activities.
D. Interconnections:
Benchmark 1— Students will recognize changes over time in nearby landscapes, resulting from human occupation.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
IV. Life Science
C. Interdependence of Life
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss the responsible use of science.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will describe the water cycle involving the processes of evaporation, condensation, precipitation and collection.
Benchmark 2—The student will identify where water exists on earth.

Grade 5
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 3—The student will describe how waves, wind, water and ice shape and reshape the Earth's surface.
Benchmark 5—The student will explore the interaction of the lithosphere, atmosphere, biosphere, hydrosphere and space.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

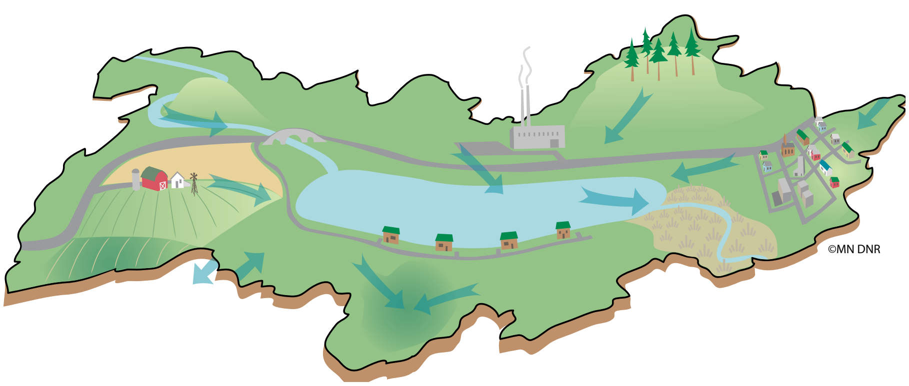
Chapter 3 • Lesson 3

Wonderful Watersheds

Grade Level: 3-5
Activity Duration: one or two class periods
Group Size: any
Subject Areas: Language Arts, Science, Social Studies, Expressive Arts
Academic Skills: comparison, experimentation, modeling, observation, recording data
Setting: indoor or outdoor gathering area with tables
Vocabulary: best management practices, erosion, groundwater, nonpoint source pollution, percolation, point source pollution, ridgelines, riparian habitat, surface runoff, water pollution, watershed
Internet Search Words: land use practices, nonpoint source pollution, point source pollution, riparian zone, watershed, watershed education, watershed outreach

Instructor's Background Information

What is a watershed? When you think of something that sheds water, you usually think of a raincoat or an umbrella. But a watershed also catches water. Turn an opened umbrella upside-down and you'll form a clearer picture of how a watershed works. A **watershed** is an area of land that catches precipitation (rain, sleet, and snow) that flows and drains into a body of water such as a wetland, stream, river, lake, or groundwater. A watershed can also be compared to a bowl, a dishpan, or a tub. A watershed is a well-defined area that drains into a water body—and the water can collect below the ground or on the surface.



A watershed is an area of land that drains into a body of water. Every place on earth has its watershed, and we all live within a watershed.

Summary

Students investigate watersheds in three dimensions. They'll make a watershed model, "rain" on their models using a spray bottle, observe where the surface water travels, and determine how the water cycle is related to a watershed. Simulating various land use practices and adding "pollutants" to the models will demonstrate how activities on land can impact water quality in lakes and rivers. Students will then test the effectiveness of various strategies for Best Management Practices (BMPs) to prevent or reduce the effects of nonpoint source pollution on water quality in their watershed models. Learning how a watershed works helps students see how their actions can impact water quality in local lakes and streams as well as in waters many miles away, and can help them identify how human activity on land can impact water quality over time.

Student Objectives

The students will:

1. Describe how water moves through a watershed by referring to the water cycle.
2. Describe how pollution moves through a watershed.
3. Demonstrate how water pollution is related to land use practices.
4. List at least four Best Management Practices for land use that can improve water quality.
5. List at least two ways their own daily actions impact fish habitat.

There are a variety of effective substitutes for these items. Ask parents or volunteers to provide some of the everyday items. Take students outside to collect leaves, small rocks, grass clippings, litter, soil, small twigs, and other materials for their watershed models.

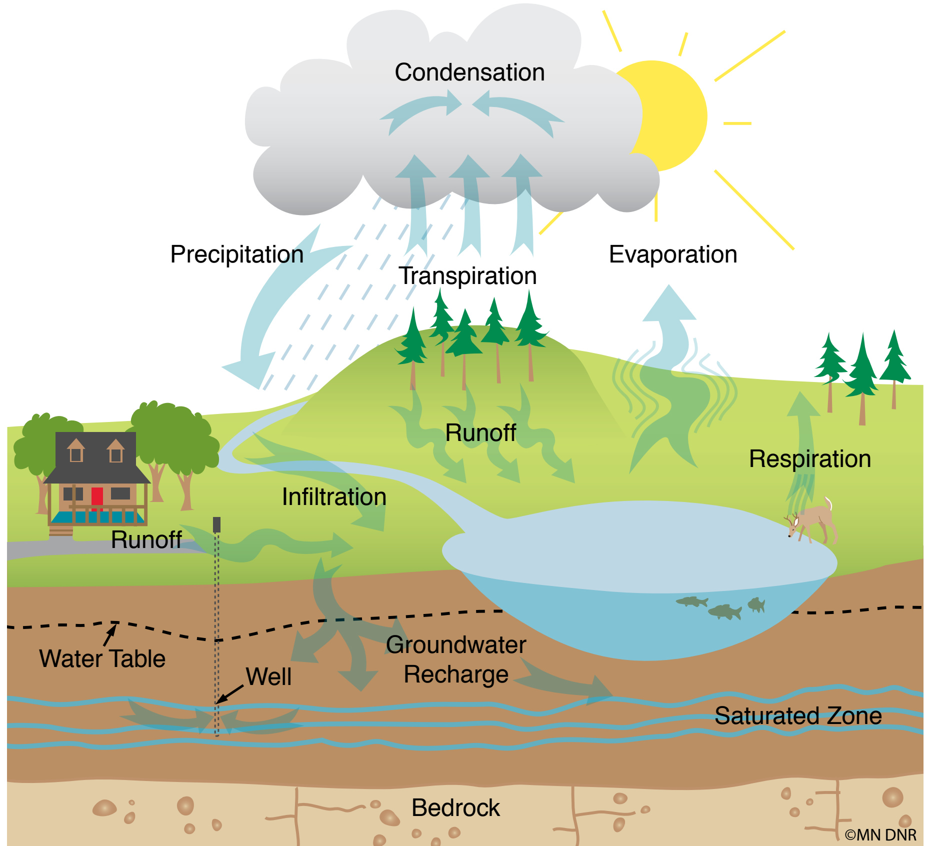
If each student will be making their own model, provide materials for each student. As an alternative, you can have three or four students work as a group—they can then share the materials. Ask the students to measure and use the necessary materials.

As an alternative to using aluminum foil and the underlying materials, you can use a mixture of plaster, sand, and rocks to mould the watershed topography in the bottoms of the boxes or roasting pans.

Materials

- **Watershed Model Sheet** to project on a screen or interactive whiteboard or distribute
- Scissors
- Plastic storage boxes, foil roasting pans, or cardboard boxes (lined with plastic); students may bring these from home
- *Heavy* aluminum foil, three-foot-long sheets
- Rocks (various sizes), crumpled paper balls, small boxes or containers, or dense clay soil—place in bottom of the boxes or pans (under the foil) to form hills and valleys (watershed topography)
- Small toy buildings, vehicles, building blocks, farm animals, model trees, or other items—use these to build model communities
- Light-colored cellulose sponges cut into half-inch-thick strips, enough for several strips for each student or group
- Light-colored felt approximately six inches square, one per student or group
- Scissors, one per student or group
- Brightly-colored unsweetened powdered drink mix, three different colors, one teaspoon per color
- Watercolor paint set and brush
- Food coloring, several drops
- Sand or sediment, dirt, or dried coffee grounds, one tablespoon
- Cocoa powder or powdered ice tea, one tablespoon
- Colored sugar, one tablespoon
- Vegetable oil, one teaspoon
- Leaves, grass clippings (short lengths), chocolate sprinkles, parsley flakes, dried basil flakes, or small paper scraps, two tablespoons of each
- Small plastic bags to hold each dry "pollutant"
- Spray bottle filled with water
- Newspapers for covering work areas
- Paper towels
- Bucket of water or access to sink
- Science notebook
- Pencils or pens

Everyone lives within a watershed. Schoolyards, backyards, farmyards, parking lots, homes, neighborhoods, towns, and cities are part of a watershed. If you travel anywhere, you're in a watershed. Most of us drink water that comes from somewhere within a local watershed, and we all depend on the quality of our local water. Although people in rural areas often draw their water supply from local wells (groundwater), public water supply systems (drawn from surface water or groundwater) are more prevalent in urban towns and cities. In the United States, most people receive drinking water from groundwater sources. And wildlife, especially fish, depends on the quality of our lakes, rivers, and streams, too!



The water cycle connects clouds, lakes, rivers, groundwater, soil, plants, and animals—including fish and people.

Water Cycle and the Watershed

Water is continuously in motion in every watershed. The sun warms water on the earth in oceans, lakes, streams, and rivers. The warming causes water to evaporate and rise into the air, where it condenses to form clouds. Precipitation falls back to earth from clouds in the form of rain, sleet, or snow. Gravity causes water to run downhill from high ground to low ground, into hills and valleys, or to seep into the ground. This water cycle repeats continuously.

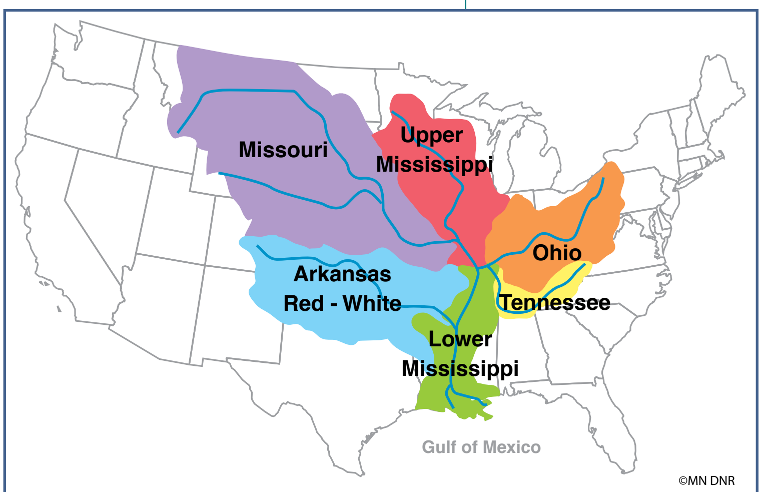
The water that flows directly over the surface of the land into a lake, stream, or river is called surface runoff, and it carries sand and sediment as it flows. Runoff can cause erosion, the gradual wearing away of soil and rock surfaces by natural forces such as flowing water, wind, and ice. Erosion also occurs when human and animal activities disturb the soil and the vegetation that holds soil in place. Impermeable surfaces, such as pavement, roofs, and patios deepen the effects of erosion because they prevent water from soaking into the ground—normally, soil and vegetation slow the rate of flow and allow filtration of sediments. When runoff flows rapidly over the hard surfaces, sediment runs quickly into wetlands, ponds, streams, lakes, and rivers. Eventually the water flows into oceans, seeps into the ground, or evaporates.

The removal of vegetation exposes underlying soil and rock to the elements. This accelerates erosion. Pavement and other non-porous materials also hasten erosion.

Some of the precipitation that falls to earth seeps directly into the soil. This process is known as **percolation** or **infiltration.** Water seeps down through the soil and into groundwater aquifers. Aquifers are sand, gravel, or rock formations below the earth's surface—they're porous and saturated with water. The water within an aquifer's cracks and porous materials is known as **groundwater**. The water obtained from many wells is groundwater from an aquifer. Groundwater may eventually resurface in a spring, and flow into a nearby water body. Water is always moving—this means that water bodies aren't isolated. They're part of a larger system: a watershed. The water cycle, in turn, connects all the elements and water bodies of a watershed, including groundwater, tiny streams, and large rivers.

How Large Is a Watershed?

Scope and size are integral to the understanding of how watersheds work. Watersheds exist in all shapes and sizes. Some are very large, such as the Mississippi River Basin, the largest watershed in the United States. Others are as small as a single acre draining into a schoolyard pond.



The Mississippi River watershed basin.
Where does the Mississippi River begin? The commonly accepted source of the Mississippi River is northern Minnesota's Lake Itasca. The length of the Mississippi River has been disputed, but it flows (according to staff at Lake Itasca State Park) approximately 2,552 miles from Lake Itasca to the Gulf of Mexico. It's the fourth longest river in the world. The Ojibwe called it *Messipi* or "Big River." It was also known as the *Mee-zee-see-bee* or the "Father of Waters."

Where Does Minnesota's Water Flow?

Apart from the Red River (which flows into western Minnesota from North Dakota and proceeds northward into Manitoba, Canada), no major water bodies flow into Minnesota. Minnesota is situated upstream from almost everywhere else. All of Minnesota's waters flow out of the state, too. Minnesota watersheds drain water into rivers and streams that flow northward to Hudson Bay, eastward to the Atlantic Ocean, or southward to the Gulf of Mexico. Approximately 34 percent of Minnesota's area drains to Hudson Bay. Nine percent flows through the Laurentian watershed basin and into Lake Superior. Approximately 57 percent of the land drains to the Mississippi River. The people of Minnesota have a responsibility to use water resources wisely and protect water quality for everyone who lives downstream.

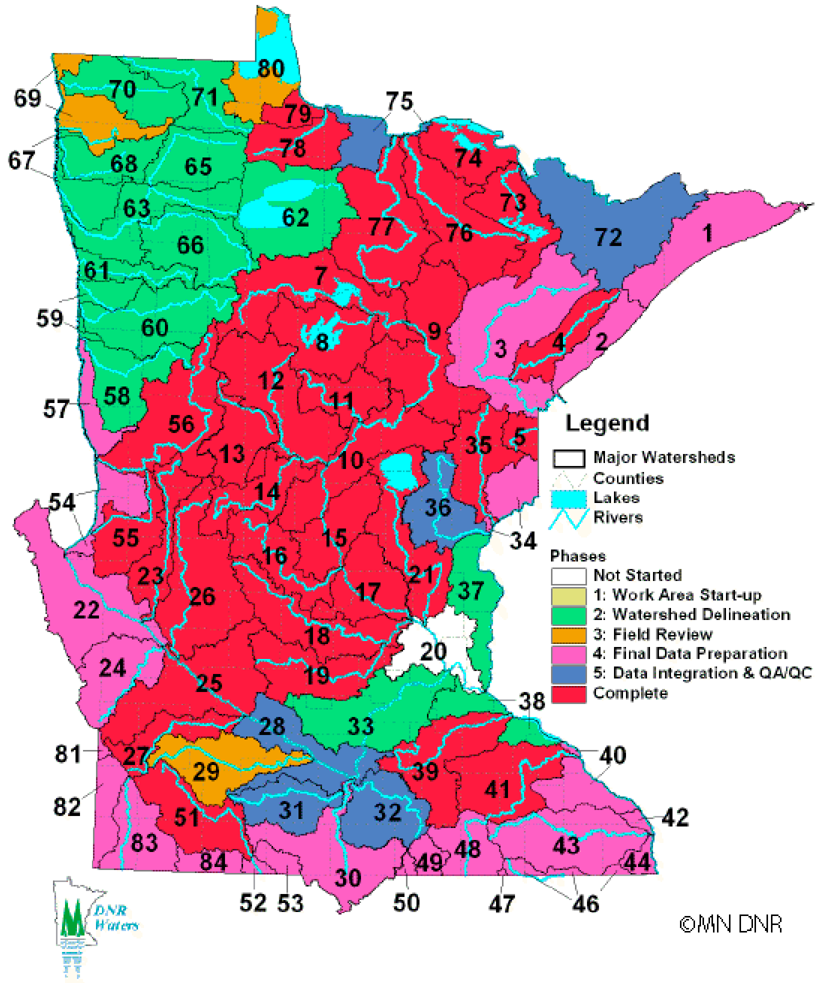
It's said that a raindrop that falls into Lake Itasca will arrive at the Gulf of Mexico in approximately 90 days. But the Mississippi is more than a river flowing between banks. All of the land draining into the river is part of the Mississippi River watershed basin. This watershed drains 41 percent of the continental United States. The watershed includes 31 states and two Canadian provinces, draining a total area of between 1,200,000 and 1,800,000 square miles. Early Europeans who mapped the backwaters and tributaries of the main river referred to the Mississippi as "a gathering of waters," and in reality, any raindrop that falls within this watershed is a source of the Mississippi River.

Watershed Boundaries

Political boundaries don't define watersheds. Watershed boundaries transcend city, county, state, and international borders. **Ridgelines**, an area's highest elevations, separate one watershed from another.

Many small watersheds can be part of a larger watershed. For example, a small watershed may include a tiny stream that flows into a larger river such as the Mississippi River. All of the land around the tributaries that drain into the Mississippi make up the Mississippi River watershed, but each of those smaller tributaries drain a smaller watershed area within the larger watershed.

Have you ever watched rain falling on the schoolyard and wondered where it goes? A watershed can be as small as the area that drains into a puddle in a parking lot, or as large as the Mississippi River watershed that drains 41 percent of the continental United States.

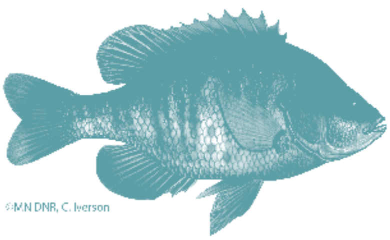


Map of major basins and watersheds of Minnesota. Small watershed areas are part of a larger watershed. Topographic ridgelines are the boundaries that separate watersheds.

Pollution

Water quality is a major concern in any watershed. **Water pollution** is contamination that makes water aesthetically unpleasant, less useful, or harmful to plants, people, fish, and other animals. Water pollution is classified into two categories: **point source pollution** and **nonpoint source pollution**. Both types can travel many miles before turning up in a stream, pond, or lake far from their original sources. Pollution that enters the waterway directly from a specifically identifiable location, such as a drainpipe from a factory or a wastewater treatment plant, is called point source pollution. Pathways that carry contaminants throughout a watershed aren't always obvious. Drain tiles, ditches, storm sewers, paved roads, and shallow groundwater can carry pollutants from residential, industrial, and agricultural areas into lakes, rivers, or wetlands. When we consider pollution, many types of point source pollution usually come to mind. But point source pollution is much less of a problem today, due to regulation, identification, reduction, and clean-up efforts.

Have students locate their local watershed and its boundaries using the Map of Major Basins and Watersheds of Minnesota on the MN DNR website at: **www.mndnr.gov/watersheds/map.html** You may wish to have your students use the **Major/Minor Watershed Search area** of the United States Geological Survey (USGS) website, too.



Nonpoint source pollution comes from sources whose locations aren't easily pinpointed. Nonpoint source pollution occurs due to water's continuous motion. As rainfall and snowmelt move over and through the ground, the runoff picks up and carries natural and human-made pollutants. Nonpoint source pollution can also travel long distances in the air and fall to earth in precipitation, such as in the case of acid rain. Nonpoint source pollution is difficult to measure and challenging to regulate and control. This form of pollution is widespread. It results from a variety of human activities on land.

Sources of nonpoint source pollution include the following:
- pesticides, herbicides, and nutrients, such as phosphorous and nitrogen, from fertilizers applied to agricultural lands and commercial and residential areas
- detergents (many dishwashing detergents contain phosphorous)
- grass clippings and leaves
- chemicals resulting from energy production
- engine drippings, such as oil, gas, grease; heavy metals from vehicle tire and brake pad wear
- salt, from irrigation practices and winter road salt
- silt and sediment from disturbed ground at construction sites, agricultural fields, forested lands, culverts, and eroding stream banks
- nutrients and bacteria, such as fecal coliform, from pet and livestock wastes and faulty septic systems
- airborne pollution, including acid rain and dust particles

People's activities definitely have repercussions that affect water, plants, people, fish, and other animals. The effects often occur far beyond the locales where these activities take place.

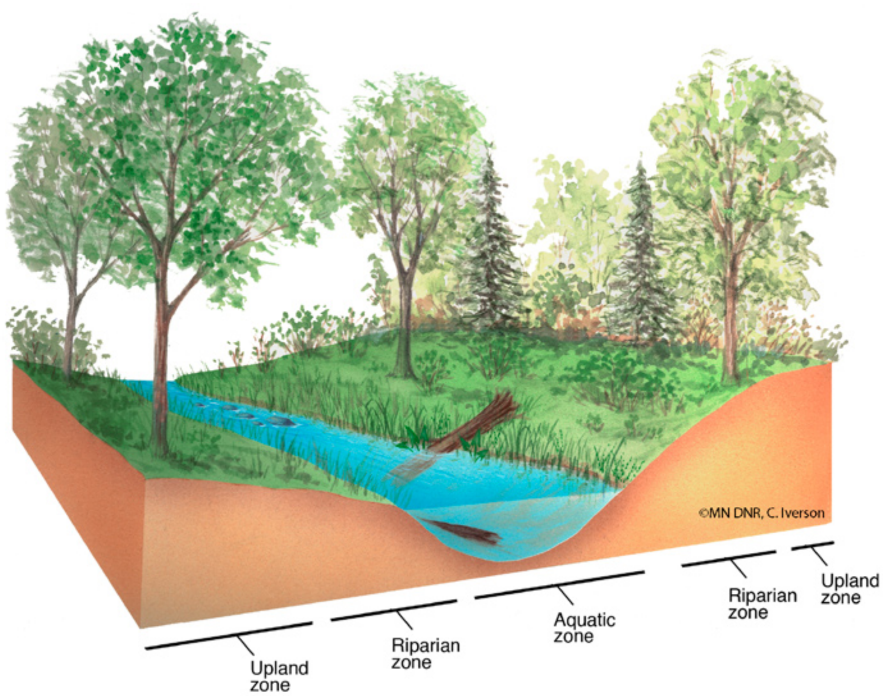
Land Use Practices
Every activity in the watershed affects water quality. As the population in a watershed increases, human impact increases. Over time, this can affect water quality, in both negative and positive ways.

People often harm water quality by applying excessive amounts of fertilizers to lawns (or apply them just before it rains) or apply fertilizers near wetlands and storm sewers. Fertilizers travel in surface runoff, flowing through storm sewers and into nearby wetlands, lakes, or rivers. The nutrients in the fertilizer (such as phosphorus) spark the growth of algae. These large amounts of algae eventually die and, as bacterial decomposers go to work, they consume the dissolved oxygen that fish and other aquatic organisms need to survive.

Other examples of harmful land use practices include:
- incorrectly installed or maintained silt fences at construction sites result in excessive erosion or runoff
- altering a watershed's natural water flow
- improper disposal of toxic materials such as paint, batteries, and

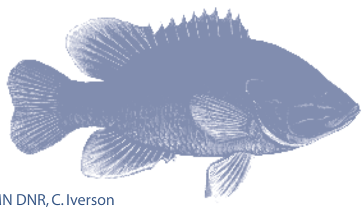
household chemicals
- dumping used oil, leaves and grass clippings, and car washing detergents into storm sewers
- failing to pick up and properly discard pet wastes
- improper use and excessive application of fertilizers, herbicides, and pesticides
- inadequate detention or containment of runoff from impervious surfaces, such as pavement and rooftops

Water quality also suffers with the removal of **riparian habitat**, the green corridor of native trees, shrubs, and grasses growing along lakes, rivers, ponds, or streams. Riparian areas are important in controlling nonpoint source pollution. Plants in a riparian zone work like a filter strip to prevent contaminants from reaching the water. The vegetation aids in removing excess nutrients and sediment from surface runoff and shallow groundwater before the sediment reaches the water body. The roots of shoreline plants, especially trees, also work to hold soil in place, reducing erosion and stabilizing stream banks. Riparian vegetation also slows the flow of floodwaters, reducing downstream flood peaks or high water levels that floods might otherwise reach. Shoreline vegetation also provides shade for water bodies, optimizing light and temperature conditions for aquatic plants and animals.



The riparian zones of lakes and riverfronts include plants on the land along the shore as well as in the water along the shore.

Some land use practices that cause riparian habitat loss include poor forestry practices, construction and development, and overgrazing. When riparian plants are removed, water moving through the disturbed habitat erodes away shoreline sediments. The effects of this erosion include: siltation and sedimentation of the lake or river bottom (which changes the substrate or bottom of the water body and covers plants), increased turbidity (decreased clarity of the water), fluctuating water levels, water temperature changes, and the loss of invertebrates and insect, frog, and fish eggs.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Shoreland Habitat Restoration

Positive actions on land, such as preservation or restoration of native vegetation on shorelines and throughout the watershed, ensure a diverse plant community with healthy aquatic and upland habitats. Shoreline degradation, erosion, and increasing development pressures have prompted Minnesotans to take action. We now recognize how our activities can affect the health of the shoreland:

- replacing native vegetation with lawns that extend to the water's edge destroys habitat for native animals
- removing native vegetation—from upland trees to underwater plants—destroys natural cover and water quality protection
- chronic overuse of fertilizers, herbicides, and pesticides contaminates water and disrupts natural processes

Shorelines that lack native vegetation—like this one—are susceptible to erosion and other types of pollution. Riparian plants' root systems stabilize the soil and filter nutrients and some pollutants from the water. Plants also prevent the erosion of sediments that reduce water clarity and degrade the quality of the lakeshore habitat.

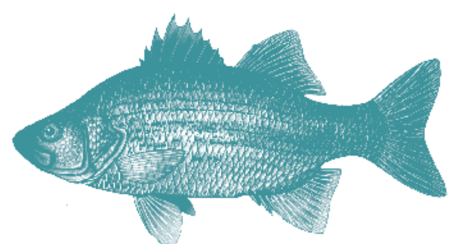
Fortunately, people have an opportunity to affect positive change. The *Restore Your Shore* PowerPoint presentation on CD, available through the Minnesota DNR Resources, guides property owners through the process of protecting a natural shoreline or restoring a degraded one with a natural buffer zone. The popular book, *Lakescaping for Wildlife and Water Quality,* by Carrol Henderson (Minnesota DNR nongame wildlife specialist), Carolyn Dindorf (award-winning soil and water conservationist), and Fred Rozumalski (highly acclaimed landscape ecologist), provided a catalyst to the Minnesota DNR's lakescaping initiatives.

Replanting native plants along disturbed shorelines and in the water reduces erosion and improves water clarity and quality. Riparian plants also restore the quality of lakeshore habitat for aquatic organisms, including fish.

Best Management Practices (BMPs)

Some land use practices improve the health of our aquatic resources. Best management practices are those conservation practices that prevent or reduce nonpoint source pollution and protect water quality. To make good decisions about land use, people must understand how watersheds work, as well as understand natural resources. Some examples of BMPs that protect or restore water quality include:

- restoring shoreline vegetation buffers
- placing farm areas vulnerable to erosion in conservation reserve programs (CRPs) rather than continuing to farm them
- replanting cleared forests
- halting erosion processes with soil conservation practices
- pursuing construction and development projects that preserve shoreline
- constructing settling ponds in areas vulnerable to erosion



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- fencing livestock to prevent access to streams and lakes, where they trample riparian vegetation and increase erosion
- implementing regular septic tank maintenance
- keeping waste, such as used automotive oil, out of storm sewers
- bagging or composting leaves and grass clippings rather than raking them into storm sewers
- recycling used motor oil
- using phosphate-free fertilizers
- reducing the use of toxic household chemicals
- reducing the use of dishwasher detergents containing phosphorous
- reducing the amount of impervious surfaces on private and public property
- erecting silt fencing at disturbed areas
- replanting areas of exposed soil with native vegetation as quickly as possible after disturbance
- placing land in conservation easements or trusts and restricting deeds so that, when a property is sold, only environmentally-friendly land use activities are allowed on that land
- and, of course, water conservation—using less water in our everyday lives

The list of best management practices continues to grow and improve. In the 2002 session of the Minnesota Legislature, state law was amended to include the regulation of phosphorous content in lawn fertilizers applied within the state. The current law prohibits the application of fertilizers containing phosphorus within the metropolitan counties, and limits to three percent by weight (for solids) or 0.3 pound per 1,000 square foot (for liquids) the amount of phosphate in fertilizers applied in the rest of the state (*Minn. Stat. Chapter 18C*).

A rain garden catches and holds runoff. This reduces the rate of runoff, slows erosion and keeps pollution and excess nutrients out of wetlands, lakes, streams, and rivers.

City planners and developers should consider including areas of pervious, or permeable, surface instead of concrete or asphalt pavement whenever possible. A permeable surface lets rainwater soak through to the ground, reducing the amount of water that enters storm sewers by way of nonporous surfaces such as roads, parking lots, and roofs. Some examples of pervious surfaces include: rain gardens, forests, lawns, green space, green roofs, and parkland. A rain garden is a landscape depression with loose soil, planted densely with flowers, grasses, or shrubs. Storm water runoff from driveways, roofs, and sidewalks is directed into the rain garden, where it's used by plants or seeps into the soil.

A green roof (or garden roof) is an engineered roof system that uses a lightweight soil mixture and plants as final cover rather than shingles or asphalt. Rainwater falling on a green roof is held in the soil or taken up by plants, reducing the volume of storm water entering lakes and rivers. Road builders deflect water from impervious surfaces by installing water bars—small, raised ridges on the road surface that deflect water flow into ditches.

Tradeoffs must often be considered in decisions to implement BMPs. Short-term monetary costs must be balanced against the potential long-term costs of degraded water quality in the watershed.

BMPs also include old-fashioned water conservation methods. Rain barrels collect roof runoff from gutters before it can carry sediment and contaminants into lakes and streams, and the rainwater can be used to water flowers and vegetable gardens. Barrels are available commercially or can be made from food grade scrap or wooden barrels. Using less water in everyday activities is important, too. Freshwater is a limited resource that plays a large role in the health of a watershed. (See **Lesson 3:4—Would You Drink This Water?**) Runoff that flows into storm sewers doesn't go to water treatment facilities. It flows directly into lakes and rivers. It's important to remember that it's expensive—and not always possible—to clean the polluted water that flows to water treatment plants. Keeping water clean by not polluting it in the first place is a much more cost-effective way to protect water quality.

Managing Water Resources

Communities across Minnesota have recognized that they must work at the watershed level to solve their diverse water resource issues. Boards of Soil and Water Conservation Districts, Watershed Districts, and the Minnesota DNR work with communities throughout Minnesota using similar basic management tools to mitigate the impacts of development and various other land use practices on water quality: watershed planning, land conservation, aquatic buffers, improved site design, erosion control, wastewater treatment, control of non-stormwater discharge, and watershed stewardship. Depending on an area's land use practices and watershed characteristics, these basic water resource management tools may be applied in different ways or in different combinations. Together they form the foundation for all water quality projects.

Who Protects the Watershed?

As our population continues to grow, and the human footprint on the land becomes larger, it's even more important to understand that everyone must play a role in protecting water quality in their own watershed, and in neighboring watersheds. Our watershed communities are interconnected, and we all live either upstream or downstream from someone else. We can work with federal, state, and local agencies to reduce and prevent pollution that arises from people's activities on land. The Minnesota DNR regulates the type and extent of development permitted near shorelines. Counties or municipalities may adopt and enforce restrictive ordinances regarding zoning or erosion control. County governments have responsibilities—ranging from road construction to hazardous waste management—that impact the local watershed. Every citizen can contribute to these efforts by practicing conservation and BMPs at home, and by making informed choices to change everyday habits and activities that impact the watershed.

When a landowner considers putting a piece of property up for sale, alternatives might include placing the land in conservation easements and trusts, or applying restrictions allowing only environmentally-friendly land uses.

We all share the responsibility for caring for our watersheds and water resources. People can work together to ensure a healthy ecosystem while meeting a community's needs that includes informed means of development using Best Management Practices, areas of native vegetation, natural shorelines, and clean lakes, rivers, and streams to ensure a healthful quality of life. History has shown that people's activities on land have indeed impacted our water quality, and we should heed this lesson.

Procedure

Preparation

1 Obtain materials needed to create watershed models.

Activity

Warm-up

1 Ask students where rain goes after a storm. (Answers should include: into the ground, storm sewers, lakes, rivers, and evaporation into clouds). Then ask students where the water in a nearby lake, river, or stream (name the water body) came from. Guide students to list rain, snow, storm sewers, water that runs downhill on the land, from springs (groundwater), and rain and snowmelt running down streets and sidewalks. Hold up an umbrella or foil roasting pan to demonstrate and define watershed for the students. You may also use the **Watershed Model Sheet** to help describe a watershed. Compare the land draining into the local lake, pond, stream or river to an upside-down umbrella, foil roasting pan, tub, or a dishpan. Explain that a watershed is a well-defined area around the water body.

2 Review the water cycle and ask why water is important. Tell students that we all live in a watershed. Where do we get the water that we drink? The water we use every day comes from the watershed where we live. Tell them they will explore how the activities that occur in their watershed affect the quality of the water in the watershed.

3 Have students close their eyes. Ask them to imagine what their neighborhood might have looked like 200 years ago, before there were houses, farms, and cars. Who lived on the land? What kinds of things were people doing on the land in the watershed? What do they think the water in the local lakes and streams was like? Why?

4 With their eyes still closed, ask students to think about their neighborhood today. What does it look like? Who lives on the land? Which human activities occur in the watershed? What do they suppose the water in the local lakes and streams is like today? Why?

5 Have students open their eyes. Have your students brainstorm a list of land use practices that occur in the local watershed. List their ideas on the classroom whiteboard or projection device.

Lesson

1 Pass out materials. If you don't have enough space or materials for students to work individually, place students in groups of three or four. If students are working in groups, one group member can gather materials while another fills the water spray bottle or sprinkling can and another covers the work area with newspaper. One student can be designated as the group's recorder and write down observations.

2 Have each student or group make a three-dimensional (relief) model of a watershed area surrounding a pond, lake, or stream inside of a plastic-lined box or foil roasting pan. Explain that these watershed models are three-dimensional maps of a watershed. When looking down on the model from above, the viewer can locate various places, land forms, water bodies, and the different ways in which people use land in the watershed.

3 Ask students to think about a watershed from 200 years ago, before modern development. First add the rocks and clay to the container. Place the slightly crumpled foil sheet on top, moulding it over rocks or clay soil mounds, creating relief topography and securing it to the edges of the pan. Be careful not to tear or poke holes into the foil. Tell students the watershed models should include some relief (hills, valleys, plains, fields, lakes, and rivers). Students can use permanent markers, felt, small toys, sand, and other materials to represent vegetated areas, wooded areas, open fields, and other features. Strips of dampened sponges and felt can represent vegetation alongside water bodies and wetlands. Ask students to include at least one lake or river in their watershed models. The instructor can crumple and shape a sheet of foil to demonstrate the procedure, or show a pre-prepared model as an example. Remind the students that watersheds come in many shapes.

4 Now ask students to look at their watersheds and think about their neighborhoods and communities of today. Have them use permanent markers and small toys, and other materials to map out or draw yards, paved areas, roads, parking lots, and any developed areas with buildings, factories, houses, farms, parks, or other places. Have them lightly sprinkle a bit of sand, dirt, or cocoa powder on any open fields, disturbed ground, or paved areas.

An example of a completed watershed model.

5 While the students are creating their watershed models, the instructor should circulate around the classroom to make sure models are being constructed according to directions, and to answer any questions students may have.

6 When models are complete and the instructor has approved the design, students may play the role of clouds and "rain" on their watersheds, using a spray bottle to produce the showers. Before raining on the models, the students should be sure that any wetlands or vegetated areas (sponges or felt) are still damp. Have students pay attention to what happens to their model as they rain on the watershed. They should record in their notebooks where the rain falls, how it moves through the watershed, where it collects, and how the rain affects different areas in the watershed. Discuss the students' observations with them. Are there differences between what happened in the models? For example, did some models show more erosion (movement of sand or soil) than others? Ask students why this might have happened. (Answers include: some models have more exposed or disturbed land, steep hills, pavement, or sparse vegetation). Did the water collect in certain areas? Where? Why?

7 Define surface runoff. (Surface runoff is water that runs off the land into a water body.) Remind students that water runs downhill. Discuss why surface runoff carries sediments and other pollutants from the land to lakes, rivers, streams, ponds, and wetlands.

8 Define pollution. (Pollution is contamination caused by natural or human-made substances that reduce the useful qualities of any part of the environment's soil, water, or air.) Is erosion pollution? Define the two categories of pollution: point source and nonpoint source pollution.

9 When students understand how water moves through a watershed, tell students the sun is out, and water is evaporating up into the clouds. Use paper towels to dry the watershed models.

10 Have students introduce some hypothetical human activities on the land (land use practices) to their watershed and describe them in their notebooks (examples might include: a new housing development under construction in the valley, leaky septic systems detected in one part of town, logging in the forest, grass clippings raked into streets after mowing, a neighbor doesn't pick up and properly dispose of pet waste.)

11 Now students can add "pollutants," the products of their land use activities, to the appropriate sites on their models. They can use food coloring, watercolor paint, and vegetable oil to represent chemical spills, lawn fertilizer, or oil. They can use colored sugar or packaged drink powder to represent granular fertilizers on farm fields and lawns. They can sprinkle cocoa powder, coffee grounds, or powdered iced tea mix to represent erosion in areas of development or other sites where the ground has been disturbed. They can remove vegetated areas to represent development projects and logging. Chocolate sprinkles can represent waste from pets or livestock. Small leaf pieces, short lengths of grass clippings, dried

herbs, or paper scraps can represent yard waste from mowing or raking lawns, and so forth.

12 Have students use their spray bottles or watering cans to rain on their watershed. They should record in their notebooks how the pollutants travel and where they end up. Have students lift the strips of sponge and felt representing vegetation and observe their colors and trapped sediments. What color is the accumulated water in the lakes and rivers in their models? Students will observe that surface runoff carries the pollutant into bodies of water in the watershed. Vegetated areas absorb some of the pollutants. Lakes and rivers will accumulate a variety of pollutants from different areas in the watershed. What effect will these pollutants have on the fish, insects, and other organisms in the water? Students should specify in their notebooks whether the pollutants that end up in the water bodies are nonpoint source pollutants or point source pollutants.

13 The sun comes out after the rain, and students may again dry their watershed models. Define and discuss best management practices and have the students devise ways to incorporate some BMPs in their watershed model. They can use various materials, such as pieces of sponge or felt, to represent vegetation buffers and plant restoration projects and reforestation. They can propose better ways to dispose of oil and chemicals, use plain sugar to represent phosphate-free fertilizers instead of the colored drink mix powder, place silt fence barriers around construction sites, conduct septic tank maintenance, and other practices.

14 Have students rain on their watersheds with the BMPs in place and record their observations.

15 Ask students to write one paragraph that compares what happened in their watersheds before and after human activities on the land, and a second paragraph comparing what happened with human activities in the watershed before and after they added Best Management Practices.

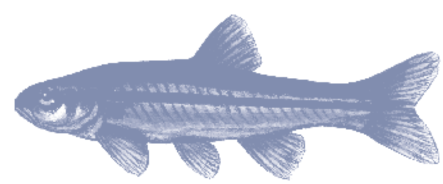
Wrap-up

1 Discuss the students' observations with them. Discuss that models and maps are tools that can help us understand what happens in a watershed on a larger scale. Students will have observed that water travels downhill in the watershed and collects in water bodies.

2 How is the water cycle related to the watershed? Water is always moving, evaporating into the atmosphere and then condensing into clouds and raining or snowing back down on the watershed. Water flows downhill to lakes, streams and rivers; it can cause erosion and carry pollution. Pollutants can travel to lakes, rivers, and streams from faraway sources. This is called nonpoint source pollution.

3 Many of the land use practices they first demonstrated in their models aren't illegal, but all land use activities can impact the cleanliness and quality of the water.

4 List activities on land that can be sources of non-point source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pollution. Digging one foundation for a house, or paving one street may not greatly impact a stream or river, but all activities in the watershed can accumulate to impact local water quality. Ask students why we should we worry about pollution that occurs five miles away. Is your neighborhood highly developed or more rural? Where does the rainwater from your schoolyard, local streets, local ponds and rivers, and driveways go? Where does the rainwater from local farms, fields, or forests go? Where does your drinking water come from?

5 What can students do to have a positive impact on water quality in their watershed? (Examples include picking up pet waste, properly disposing of litter, raking leaves from sidewalks and streets, turning off running faucets and hoses, washing bikes or cars on the lawn or another permeable surface rather than in the driveway.) What are Best Management Practices? Which BMPs did they use in their watershed models? Were they effective? In real life, who decides if BMPs will be used? (We all do!)

Assessment Options

1 Ask students to write two short paragraphs or to draw two illustrations. For Paragraph 1 or Drawing 1: define or make a map illustrating a watershed. Describe or show four activities and land use practices occurring in your watershed that can positively or negatively impact water quality in your local pond, lake, or stream. Who depends on good water quality in that water body? Describe how human land use practices have changed in your watershed over time. For Paragraph 2 or Drawing 2: describe or make a map that illustrates two everyday actions (personal BMPs) that you can take to improve water quality in your watershed. Why is it everyone's responsibility to protect water quality in the watershed?

2 Have students make a poster or map illustrating a healthy watershed where people reside. This can be a watershed they create, or a map of the local watershed. The poster or map should promote good land use practices (BMPs). Tell students their poster or local watershed map will be assessed on the following:
- presence of water bodies
- arrows showing the flow of water in the watershed, specifically how this movement relates to the water cycle
- inclusion of Best Management Practices for land use activities

3 Assessment options include the Checklist and Rubric on the following pages.

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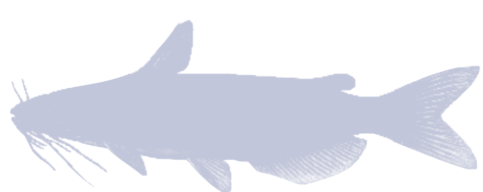


Wonderful Watersheds Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Watershed model includes a wetland buffer around the entire perimeter of open water.
3	______	______	Student can clearly describe the importance of a wetland buffer.
3	______	______	Student can clearly describe how people's activities on land impact water quality.
2	______	______	Model includes one or two structures at least six inches from the water's edge.
3	______	______	Student can clearly describe how farm animals and pet waste impact water quality.
2	______	______	Model includes no access to open water for farm animals.
2	______	______	Student can define non-point pollution and point source pollution.
2	______	______	Student can define surface runoff and erosion.
3	______	______	Can describe three Best Management Practices (BMPs) for land use.
3	______	______	Model with BMPs included prevents pollution from entering water bodies, and allows little or no erosion.
2	______	______	Can state two reasons why it's everyone's responsibility to protect water quality in their home watershed.
Total Points			
29	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

27-29 points = A
Excellent. Work is above expectations.

24-26 points = B
Good. Work meets expectations.

20-23 points = C
Work is generally good.
Some areas are better developed than others.

16-19 points = D
Work doesn't meet expectations; it's not clear that student understands objectives.

0-15 points = F
Work is unacceptable.

Wonderful Watersheds Scoring Rubric

Watershed Model Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Wetland buffer area	Model includes wetland buffer around entire perimeter of open water. Can clearly describe the importance of a wetland buffer.	Model includes wetland buffer around 75% of the open water area. Can describe the importance of a wetland buffer.	Model includes wetland buffer around 50 % of the open water area. Description of the buffer's importance lacks clarity.	Model includes wetland buffer around less than 50 % of the open water area. Can't describe the importance of the buffer.	Model includes no buffer zones or wetlands around water.
Land use practices and structures	Can clearly describe how people's activities on land impact water quality (positive and negative). Model includes one or two structures placed at least six inches from the water's edge.	Can describe some ways that people's activities on land impact water quality. Model includes three to five structures placed at least four inches from the water's edge.	Description of the impact of people's activities on land is unclear. Model includes five or more structures placed one inch from open water.	Can't accurately describe how people's activities on land impact water quality. Model includes one or more structures placed on the edge of open water.	Doesn't attempt to describe the impact of people's activities on water quality.
Farm animals	Can clearly describe the impact of farm animals and pet waste. On model, animals have no access to open water.	Can describe the impact of farm animals. On model, animals have a one-inch access to open water.	Description of animals' impact is unclear. On model, animals have access to 50 % of open water.	Can't accurately describe the impact of animals. Animals have free access to all open water.	No description attempted.
Pollution	Can define non-point and point source pollution. On model, no pollution enters the water.	Can define non-point and point source pollution. A few sources of pollution enter the water.	Can define only one source of pollution. Pollution is trapped in 50% of area; the rest flows to open water.	Can't define non-point or point source pollution. Pollution flows freely through the watershed.	No description attempted.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Have students use a topographical map of the local watershed as a guide for making local watershed models. Use the models to demonstrate how water flows in the local watershed. Identify some land use practices that may negatively or positively impact water quality in the watershed.

2 Students can take a walking tour of the local watershed and create a map of the area to use to make a model of their local watershed. Show the location of the school on the model. Describe major natural and human-made features in the community. Determine a route from the school to a local water body. Discuss how different types of maps provide different information. Have local land use issues appeared in the news recently? Include all of this information in the watershed models.

3 Have students try to find historical photos or stories about land use practices, development, or water quality in their community. Compare the photos and stories to the watershed's current condition. Identify the land-based factors and activities that have changed over time. Infer what this means for water quality in local lakes and streams. Your local watershed district office might have this information.

4 Have students look for and bring in newspaper articles about the local watershed area to share with the class.

5 Read "Metro Home Owners Harm Waters," an article published in Minnesota DNR *Fish and Wildlife Today,* Spring 1997.

6 Interview an organic farmer from your area. Have students explore the definition of an organic farm, how it differs from other farms, and the types of crops grown. Ask about the challenges and the benefits of organic farming.

7 Contact the Minnesota Pollution Control Agency (MPCA) about their stream monitoring program, which allows citizens to observe the cleanliness and clarity of streams during various rainfall conditions over an entire open water season (from snow melt to hard freeze).

8 Have students research the source of their drinking water. Use local topographical maps to identify the watershed surrounding the source of drinking water. Take a walking tour of the watershed and identify land uses that could impact water quality. Invite someone from the water facility to the class to talk about how their efforts to ensure healthy drinking water. Investigate how treatment plants clean water. Is it more expensive to treat polluted water or cleaner water?

9 Find ways to educate the local community about the everyday activities that affect water quality in their watershed. Some possibilities include presenting a watershed play at a local community event, creating and distributing brochures or designing

posters to display at a public location. Students could choose a specific local water quality issue for further research, and determine how the issue relates to activities in the watershed—they could then conduct a public information campaign on that issue.

10 Tour the school to investigate how school activities impact water quality. Determine any BMPs that the students and staff can practice at school to reduce impacts on water quality in the watershed.

11 Research the many organizations within the Mississippi River watershed—such as the Minnesota DNR Adopt-A-River Program, your local Board of Soil and Water or Watershed District Office, and other organizations working together to improve the quality resources related to your area and the greater Mississippi River Watershed and its major tributaries.

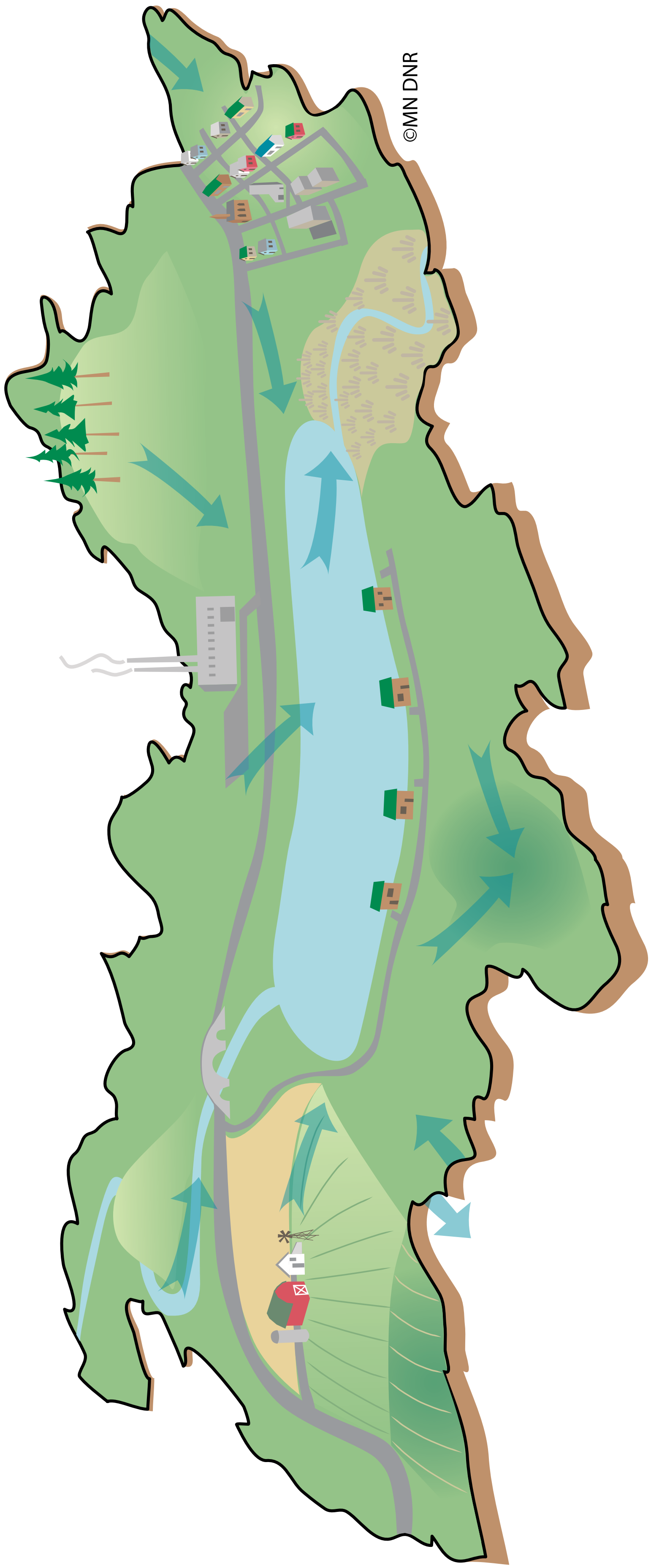
12 Almost no water flows into Minnesota from another state or Canada. All Minnesota waters flow out of the state. Have students look at topographical maps to trace the flow of water in their watershed. Does it flow to Lake Superior and through the Great Lakes? To the Mississippi River and on to the Gulf of Mexico? To the Red River and into the southern portion of Lake Winnipeg?

For the Small Fry

K-2 Option

1 Where does the water go? Visit the school grounds after a rain and ask students where the water went. They can bring spray bottles along outside to spray "rain" on various surfaces (parking lot, grass, rocks, slopes, and hills) and observe where the water goes. Make the connection that water runs downhill and eventually goes over and through the ground, parking lots, roads, and lawns into your nearby lake, river, or stream.

2 Have students create and perform a watershed play. In small groups, students can perform the various roles of the watershed, illustrating how all of the parts of a watershed are connected. Some components to choose from include: rain, groundwater, stream, lake, river, plants, plankton, frogs, fish, birds, farm, cows, golf course, parking lot, lawn, forest, soil, buildings, people, pets, and so forth. Focus on two or three components for the play. As students become more familiar with the concept, you may add components.



Watershed Model Sheet

Would You Drink This Water?

Can you safely rely on your eyes, nose, and taste buds to detect polluted water?

Table of Contents

Chapter 3 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Would You Drink This Water?

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.

Math
Alignment to the 2007 Minnesota Academic Math Standards coming soon.
Grade 3
II.Number Sense, Computation, and Operations
A. Number Sense:
Benchmark 3—The student will know how fractions are related to the whole, such as four-fourths equals a whole or three fourths equals three of four equal parts of a whole.
Benchmark 4—The student will represent and write fractions with pictures, models and numbers.
V. Spatial Sense, Geometry and Measurement
C. Measurement:
Benchmark 1—The student will select an appropriate tool and identify the appropriate unit to measure time, length, weight and temperature.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1-The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will describe the water cycle involving the processes of evaporation, condensation, precipitation and collection.
Benchmark 2—The student will identify where water exists on Earth.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 4

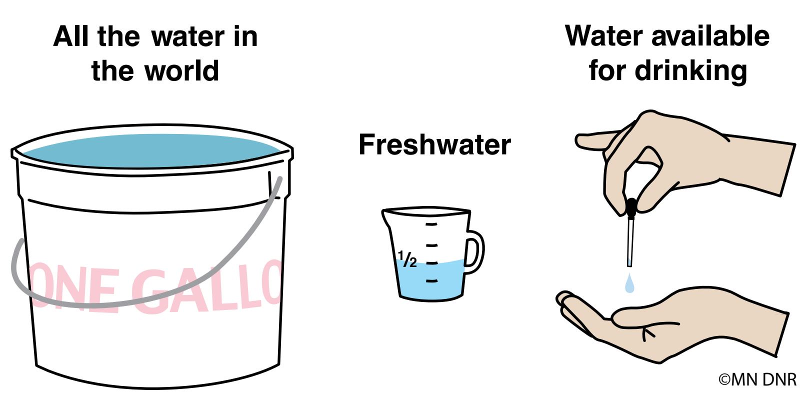
Would You Drink This Water?

Adapted with permission of the author. /What Water Would You Drink?/ 1993. On the Rocks: Earth Science Activities for Grades 1-8. SEPM (Society for Sedimentary Geology), Tulsa, OK. ISBN 1-56576-005-0.

Grade Level: 3-5
Activity Duration: 25 minutes
Group Size: any
Subject Areas: Language Arts, Math, Health & Safety, Science
Academic Skills: comparison, description, drawing conclusions, observation, recording data, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: erosion, evaporation, limited resource, precipitation, suspended sediment, transpiration, water cycle, water pollution
Internet Search Words: drinking water, mercury, water pollution, water quality, water treatment

Instructor's Background Information

Water is an essential resource for life on earth. Water covers approximately 75 percent of the planet's surface—but most of this water is salt water. For every 100 drops of water on earth, less than three drops are fresh, or less than three percent. Fresh water resides in lakes, rivers, underground aquifers, and frozen in ice, but all of this water isn't available for use. Some is trapped in ice, or too deep within the ground to retrieve. Less than one percent of all fresh water can be accessed for consumption. Fresh water is essential to our survival, so how we use and protect water is an important issue.



Water covers 75 percent of the earth. Less than three percent of the water is fresh water, and just one percent of this fresh water is available for use.

Water is considered a **limited resource** because we can't make new water. Just imagine this—the water we drink today is the same water

Summary

A demonstration illustrates the amount of the earth's fresh water available for use. Using their senses of sight, smell, and taste, small groups of students will examine six water samples (five of them "polluted") and decide which samples they would drink based on their observations. Students will discuss the ways in which water can be polluted and how to reduce water pollution.

Student Objectives

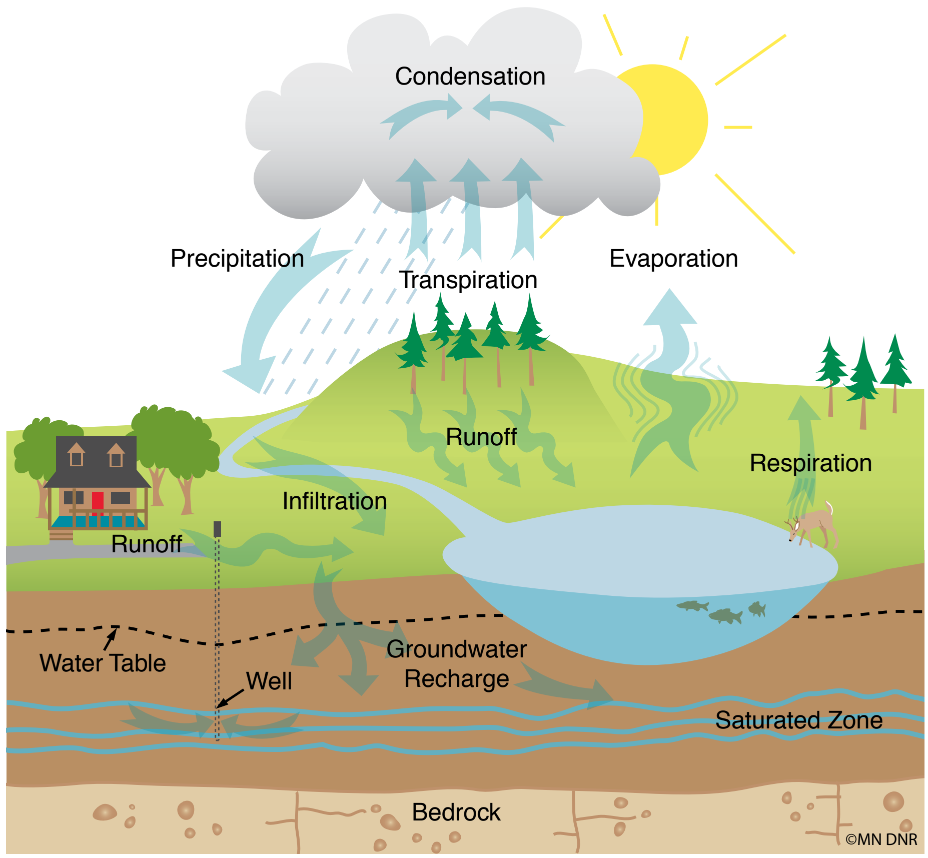
The students will:

1. Know how much of the earth's fresh water is available for use.
2. Evaluate whether or not water is safe to drink by using their senses of sight, smell, and taste.
3. Understand that some pollutants are difficult to detect using their senses alone.
4. Understand that some water that may seem unsafe to drink isn't necessarily polluted.
5. Propose three ways to reduce water pollution.

Materials

- One-gallon ice cream pail
- Paper cups, six for each group of four students
- Clear one-cup measuring cup
- Eyedropper
- Globe
- One 6-pack of bottled drinking water
- Five plastic spoons, for mixing materials into water samples
- Green food coloring
- Instant iced tea mix
- Powdered coffee creamer
- Onion, anise, or peppermint extract
- Salt
- Blindfolds (clean or unused), two for each group of four students
- Permanent marker
- **Would You Drink This Water? Data Sheet**, one per group of four students
- Pens or pencils for each student group

that the dinosaurs slurped! Water is made available for reuse through the water cycle, a process by which water changes states (solid, liquid, gas) and moves throughout the planet. Water falls to the earth in the form of precipitation (rain or snow). It moves to places where it's stored or used by organisms. Ultimately, it returns to the atmosphere through evaporation (the conversion of water into water vapor) or transpiration (evaporation that takes place through plants).



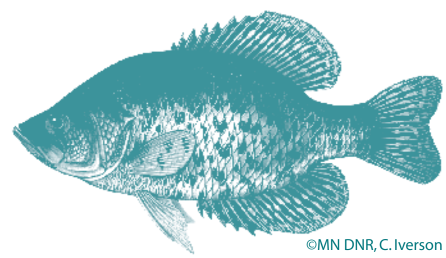
Water is always in motion in the water cycle, which connects clouds, lakes, rivers, groundwater, soil, plants, and animals, including people and fish.

Water Pollution

Protecting our water supply from pollution is essential because water is a limited resource. **Water pollution** is a form of contamination caused by natural or human-made substances that reduce the water's useful qualities, or make it unhealthful for humans or other organisms. Water pollution occurs naturally, such as in the case of a volcanic eruption or an animal carcass decaying in a stream. It also occurs as a result of human activities such as air emissions from vehicles, power plants, failing septic systems, improper disposal of household chemicals, or **erosion**. Erosion is the gradual wearing away of soil and rock surfaces by natural forces such as flowing water, wind, and ice or by human and animal activities that disturb the soil and vegetation that holds the soil in place and can be accelerated by human activities.

Natural processes purify some polluted water as water flows through the water cycle. Some pollutants are filtered from the water as it trickles through the ground. Wetlands and shoreline vegetation buffers trap wastes and decompose some toxic substances, too. Water treatment facilities and water filtration plants clean water, but, unfortunately, not all pollution can be removed by natural or human-designed systems.

People's activities have contributed to water pollution in numerous ways. When vegetation is cleared from the land, for example, a natural water filter is removed from the water cycle. Plants hold soil in place with their roots and prevent sediments from running into water. Without plants, the land becomes more susceptible to erosion, and sediment flows from the land into lakes and streams. Erosion also increases the amount of **suspended sediment** in lakes. (Suspended sediment is present in the water column; it's what makes water appear cloudy.) As suspended sediment settles on the river or lake bottom, it covers fish eggs, depriving them of needed oxygen. Suspended sediment also increases water temperature (sunlight is absorbed rather than reflected from the water), which reduces dissolved oxygen that fish need. Erosion also allows pollutants to flow into lakes and streams. Common pollutants, such as animal waste, pesticides, oil, and household chemicals can be washed into waterways, increasing the water's levels of bacteria and toxic substances. These pollutants may also harm people that drink the water or eat fish from the water.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Pollutants released into the air can also make their way into water systems. For example, although mercury occurs naturally, most of the mercury entering the waters comes from coal-burning power plants or from household and industrial wastes that contain mercury. Mercury from the air enters the water cycle when it rains or snows—often hundreds of miles from the emission source. Mercury is converted to methylmercury by bacteria in the water. Fish absorb methylmercury from their food. When ingested, mercury binds to the proteins of all fish tissue, including muscle. You can't see, smell, or taste mercury in the water or in a fish, and no methods of filleting or cooking will remove it.

Mercury in large quantities is a neurotoxin that can be harmful to humans. Small amounts have been found in fish tested from all Minnesota waters. Although mercury levels are usually low in individual fish, consuming large quantities can be harmful. Please refer to the Minnesota Health Department website for fish consumption guidelines specifics. Expectant mothers and youth should stick to recommendations from the Minnesota Health Department. (The amount allowed varies by fish species). For more information on mercury, see **Lesson 6:5—Eating Fish**.


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You can obtain updated fish consumption advisories on the Minnesota Department of Health website: www.health.state.mn.us/divs/eh/fish/index.html

The list of potential water pollutants is long. In general, any form of pollution that affects the land or air can also affect water. Pollutants in water can be visible, such as oil spills, excessive algae growth, and litter. Other pollutants may be invisible, yet detectable by smell. For example, waters polluted with animal waste have a distinct odor. Other chemical pollutants, such as pesticides and mercury, aren't easily detectable, and must be identified through water testing. On the other hand, some waters that look or smell polluted or have a "different" taste may actually be harmless. For example, water may be stained brown with iron from the ground or with tannins from the local vegetation. Both are natural conditions, and neither is harmful to humans or aquatic life. Drinking water from a well can taste different than bottled water because it contains naturally-occurring minerals—but these are harmless to consume. Well water can also taste different than "city" water because water from treatment facilities is often treated with chlorine, which you can taste in the water.

Preventing Water Pollution

The cleaning of polluted water can be difficult and expensive. Sometimes, it's not even possible. Although it may be impossible to eliminate all water pollution, we can take action to reduce the amount of pollution entering our waterways. One way to reduce erosion and pollutants in runoff is by preserving native habitat and wetlands, especially around waterways. Wetlands and vegetation around shorelines act as buffers by naturally trapping and filtering sediments. This is why measures should be taken to retain native vegetation and minimize soil disturbance, particularly in sensitive areas such as shorelines and wetlands.

A buffer zone of vegetation along a shoreline reduces erosion and maintains high quality fish habitat.

Another way to reduce water pollution is to conserve water. When people waste water, they expose it to pollutants unnecessarily. Overuse of water also stresses limited water supplies from streams, lakes, and underground. Conserving energy is also extremely critical—even switching off lights when leaving rooms reduces the amount of pollutants emitted from power plants.

Whenever possible, make an effort to use environmentally-friendly products, such as phosphorus-free fertilizers and detergents, organically-grown foods, and nontoxic household cleaners. Properly dispose of unwanted household products such as oil, paints, and pesticides rather than dumping them down the drain. Remember to "Reduce, reuse, recycle."

In the United States, each person uses an average of 80 gallons of water each day!

Procedure

Preparation

1. Fill the ice cream bucket (or another type of one-gallon bucket) with a gallon of water and mark a clear drinking cup with a half-cup line (or use a measuring cup).
2. Prepare "polluted" water samples.
   - Label the six water bottles from 1 to 6
   - "Pollute" the first five of them with a different substance:
     - green food coloring
     - onion extract
     - powdered coffee creamer
     - salt
     - powdered ice tea mix
   - The amount to use will depend on the substance and the size of the water bottle. Pollute lightly at first; you can always add more if the taste or odor is not observable.
   - *One bottle should be left as plain water, and not polluted.*
   - The plain water, onion, and salt should appear clear—shake them if necessary.
   - The food coloring and iced tea will color the water; the coffee creamer will make the water cloudy.
3. For each group of students, use small writing to discreetly label six clean cups from 1 to 6. Fill them three-quarters full of water from the same numbered bottles.
4. Place these cups out of sight for use later in the activity.

Activity

Warm-up

1. Ask the students about the various ways they use water each day. Supplement their responses with some less obvious uses such as growing food, making paper, generating electricity, transportation, and so forth. Then ask them if they have ever put litter into the water or seen someone else littering. How do they suppose the litter affected aquatic animals? Tell the students that water pollution exists in many forms and affects all living things; we all need water to survive.
2. Hold up and spin a globe and ask the students if they know how much of the planet's surface is covered with water. Explain that 75 percent of the earth is covered with water and the remaining 25 percent is land. Represent this amount with the bucket full of water. Tell students that we know the oceans are filled with salt water. Then ask them how much of the water in the one-gallon ice cream bucket represents the world's supply of fresh water. Have a student come to the front of the class and measure one-half cup of water from the bucket to represent all the fresh water in the world (less than three percent). Tell them that the rest of the world's water is salt water, and that we can't drink it.

The instructor could further develop Step 2 to include math skills. Students could determine percentages and fractions as they identify quantities such as the amount of the earth's surface covered by water, the amount of fresh water on earth, and the amount available for human use.

3 Ask students to think about how much of the world's supply of fresh water, represented by the half-cup, is actually available for plants and animals (including people's use). Have a student come to the front of the class and remove one drop of water from the half-cup. This amount represents all of the fresh water available for use! The rest is frozen in icebergs, glaciers, and polar ice caps. Explain that water continuously cycles throughout the world, and that no new supply of water is ever made. It's a limited resource.

Survey the class for any food allergies before this activity.

Lesson

1 Divide students into groups of four. Tell them that they're a team of scientists who have been asked to evaluate the quality of drinking water taken from several locations in their town. Instead of using their scientific equipment to test the samples, they will be using their senses. Their job is to find the clean drinking water. Reassure the students that all the samples are safe to drink, but that some might look, smell, or taste funny.

2 One student in each group should be designated "recorder" to record responses. Give each recorder a **Would You Drink This Water? Data Sheet**. The other students in each group will be "samplers." One should be the designated "looker," another the "smeller," and one as the "taster." Blindfold the smeller and taster and ask them to remain seated until they are called. Each group should be given a set of six cups to evaluate.

3 From a distance, let the looker examine the cups visually. No one but the recorder should be able to see the numbers on the cups. For each cup, lookers should decide whether they would drink the water based on its appearance. *To avoid influencing blindfolded evaluators, lookers should respond nonverbally by nodding "yes" or shaking their heads for "no."* The recorder should note responses on the data sheet.

4 Retrieve the smeller and taster. Remind them that the water is safe to drink and will not hurt them. Tell the tasters to take small sips.

5 In each group, with the recorder's assistance, the smeller and taster should evaluate each of the six samples after being asked, "Would you drink this water?" For each cup, they should nonverbally indicate "yes" or "no" by nodding or shaking their heads. The recorder then records the responses on the data sheet.

6 After all samples have been evaluated, the students may remove their blindfolds. If students detected an odor, taste, or unusual appearance, they may try to guess what it might be. The recorder can note these guesses on the data sheet.

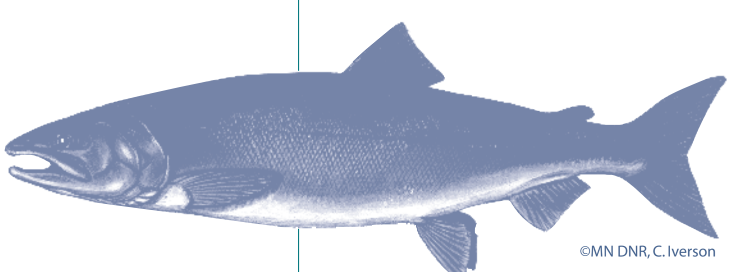
7 When all teams have finished, bring all the students back together as a class. Review each group's results. Ask students to compare the responses. Which samples did the tasters consider fit to drink? The smellers? The lookers? Which was the clean water? Reveal the contents in each of the samples and share with the students that these simulate a variety of water samples, some polluted and some not. For example, green food coloring could represent algae in the water, the odor of the onion might represent a chemical spill, the

iced tea may represent safe water stained with iron or tannins, and coffee creamer could signify cloudy water containing sediment. The sediment could be due to natural or human causes, and may or may not be safe to drink. Tell students that some pollutants can't be seen, smelled, or tasted. Examples include mercury, high temperature, acidic pH, and low oxygen levels. Scientific tests must be done to see if the water holds pollutants like these.

Wrap-up
Each team should answer the questions on the **Would You Drink This Water? Data Sheet.** Responses can be discussed as a class. Discuss with students that water with some odors, tastes, or appearances may not be harmful to people. For example, an iron flavor or rotten egg odor aren't necessarily harmful, just unpleasant. Other pollutants, such as mercury or toxic chemicals, may not be visible in our water supply but they're harmful. In order to keep drinking water safe and fresh water safe for lake and stream animals, we must perform many chemical tests to evaluate water quality. Students should share their ideas about what they can do to help prevent water pollution.

Assessment Options

1. Collect the **Would You Drink This Water? Data Sheet** from groups and evaluate the worksheets and group participation during the activity to ensure that students are able to define water pollution and that students know:
   - that there are various types of water pollution
   - how the different types of pollution affect fish and aquatic habitats
   - that some pollutants are difficult to detect using our senses alone
   - that not all water that may seem unsafe (by taste, smell or sight) is actually polluted
   - three things individuals can do to keep the water clean
2. Assessment options include the Checklist and Rubric on the following pages.



Would You Drink This Water? Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
7	_______	_______	Student completes all seven questions correctly.
5	_______	_______	Student demonstrates excellent understanding of contaminants and their effects on fish.
4	_______	_______	Completed worksheet is easy to read and contains no errors.
4	_______	_______	Student follows directions for group work.
4	_______	_______	Student works cooperatively to complete all role duties within the group.
3	_______	_______	Student can explain and give examples of why water that may appear clean isn't necessarily healthful to drink.
3	_______	_______	Student can explain and give examples of why water that looks, smells, or tastes contaminated may be clean and healthful to drink.
2	_______	_______	Student can define *water pollution.*
Total Points			
32	_______	_______	**Score** _______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

30-32points = A
Excellent. Work is above expectations.

27-29 points = B
Good. Work meets expectations.

20-26 points = C
Work is generally good. Some areas are better developed than others.

16-19 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-15 points = F
Work is unacceptable.

Would You Drink This Water? Scoring Rubric

Sensing Water Quality	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Would You Drink This Water? Data Sheet	Completed all eight questions correctly and demonstrated excellent understanding of contaminants and their effect on fish.	Completed six or seven questions correctly and demonstrated an understanding of contaminants and their effect on fish.	Completed five or four questions correctly and described the effects of one contaminant on fish.	Completed three or fewer questions correctly. Didn't demonstrate an understanding of water contaminants and their effects on fish.	Didn't complete questions.
Legibility	Worksheet legible and contained no errors.	Worksheet legible, but contained two or three grammatical errors.	Worksheet was hard to read, with numerous grammatical errors.	Worksheet illegible.	Didn't complete worksheet.
Small group skills	Followed directions for group work. Worked cooperatively and completed all role duties within the group.	Displayed some initial difficulty with following directions. Worked cooperatively but didn't complete all duties effectively.	Didn't follow directions. Displayed initial difficulties with working cooperatively within the group. Didn't complete duties in the group.	Didn't follow directions or work cooperatively.	Didn't participate in group activity.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Take a field trip to a local water treatment plant to see how cities clean their water and to talk with experts about local water issues.
2 Have students research the source of their town's water supply—is it a lake, a stream, or the ground? Have them propose some potential sources of pollution that could affect the water at that location.
3 Have students research a recent water pollution incident that happened close to home or elsewhere in the state (such as a chemical spill, feedlot discharge, a beach closing due to bacteria). Have them propose ways to reduce the chances of future incidents.
4 Ask students where they suspect pollution problems exist in their town. Discuss the possible source of these pollutants, the effects they have on the habitat, and how they affect fish that people catch and eat. Make a list of these sites or facilities and select a few to visit. Contact the owner or public relations department to set up a tour of the facility or get permission to visit the site. Have the tour guide explain where they collect the water, how they use it, if they clean it, how they dispose of it, as well as any other things they do to help protect our resources. After the tour, ask students what they themselves, the owner, or the company could do to help make the process less polluting, or to expand their positive efforts to other areas.
5 Have students act the roles of scientists who must invent ways to help people conserve water in their homes. They can describe, in writing or with an illustration, how their inventions help people conserve water.

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For the Small Fry

K-2 Option

1 Do the water testing with senses as an entire class while making an effort to actively engage each student. All students get a chance to participate by indicating (silently with raised hands) whether they would drink the water based on its appearance. For each of the six samples, the instructor can ask a different smeller and taster to be blindfolded and evaluate each water sample. Another student or two can record the data (yes or no) on the whiteboard. At the end of the activity, lead a group discussion.
2 Have some samples of actual pollutants in other bottles or buckets. For example, pour soil into some water and discuss how the polluted water could harm fish.

STUDENT COPY

Name(s) ______________________________ Date ______________

Would You Drink This Water? Data Sheet

For the looker, smeller, and taster, record YES or NO in the correct box after they indicate whether they would drink the water. After everyone is done and blindfolds are removed, team members may guess what substance, if any, is in each water sample.

	Looker	Smeller	Taster	What's in it?
Cup 1				
Cup 2				
Cup 3				
Cup 4				
Cup 5				
Cup 6				

STUDENT COPY

Name(s) ______________________________ Date ______________

Would You Drink This Water? Data Sheet

Part 1: Read the following statements carefully. Circle **True** if the statement is true. Circle **False** if the statement is not true. Explain why the statement is true or false.

1. **True or False** If water has a bad taste, it's always unsafe to drink.

Explain your answer. ______________________________

2. **True or False** Water that smells bad must be harmful to humans.

Explain your answer. ______________________________

3. **True or False** Water that looks clean isn't always safe to drink.

Explain your answer. ______________________________

Part 2: Answer these questions.

1. Define water pollution.

____

2. List two kinds of pollution we *can* see in a body of water such as a lake or stream.

____

3. List two kinds of pollution we *can't* see in a body of water such as a lake or stream.

____

4. How might water pollution affect fish and fish habitat?

____

____

____

____

5. List three things you can do to reduce water pollution.

____

____

INSTRUCTOR COPY

Would You Drink This Water? Data Sheet

Part 1:
1. **False** Water may taste bad to someone, but it could still be safe to drink.

Water with some odors, tastes, or appearances may not be harmful to us. For example, an iron flavor or rotten egg odor are not necessarily harmful, just unpleasant.

2. **False** Water that smells bad is not necessarily harmful to humans.

Water with some odors, tastes, or appearances may not be harmful to us. For example, an iron flavor or rotten eggs odor are not necessarily harmful, just unpleasant.

3. **True** Water that looks clean isn't always safe to drink.

Other pollutants, such as mercury or toxic chemicals, may not be visible in our water supply, but they're harmful.

Part 2:

1. Define water pollution.

Polluted water contains substances or has qualities that make the water unpleasant or unhealthful for humans and other organisms.

2. List two pollutants that we can see in a body of water such as a lake or stream.

Sediment, excessive algae growth, trash, or petroleum film on water

3. List two pollutants that we can't see in a body of water such as a lake or stream.

Mercury, pesticides, bacteria, or nutrients such as phosphorus

4. How might water pollution affect fish and their habitat?

Pollution can make the water cloudy, affecting a fish's ability to breathe and find food; it can make them sick if it accumulates in their bodies; it can kill plants or other animals that the fish depend on for food; it can change the nature of the water (temperature, oxygen content, or acidity) making it uninhabitable; it can change the nature of hiding, feeding, and nesting places.

5. List three things you can do to reduce water pollution.

Conserve water, dispose of waste properly, don't litter, use environmentally-friendly products, reduce-reuse-recycle-renew!

The Lake Game

People must work together to prevent pollution—
an ounce of prevention is worth a pound of cure.

Table of Contents

Chapter 3 • Lesson 5

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

The Lake Game

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3 and 4
I. Reading and Literature
C. Comprehension:
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.

Grade 5
I. Reading and Literature
C. Comprehension:
Benchmark 7—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.

History and Social Studies

Grades K – 3
VI. Economic Choices
A. Economic Choices:
Benchmark 4—Students will give examples of tradeoffs (opportunity costs).
B. Producers and Consumers:
Benchmark 2—Students will recognize and explain that natural resources, human resources, and human-made resources are used in the production of goods and services. (Good on addressing resources, weak on distinguishing producers and consumers).
VII. Government and Citizenship
B. Beliefs and Principles of United States Democracy:
Benchmark 1—Students will give examples of rules in the classroom/school and community, provide reasons for the specific rules, and know the characteristics of good rules.
Benchmark 2—Students will explain that rules and laws apply to everyone and describe consequences for breaking the rules or laws.

Grades 4 – 8
II. Minnesota History
G. Post—World War II to the Present:
Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues.
V. Geography
C. Physical Features and Processes:
Benchmark 2—Students will describe and locate major physical features in their local community and analyze their impact on the community. (Not everyone will have a lake nearby, if so, then lesson addresses Benchmark fully).
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.
D. Interconnections:
Standard: The student will describe how humans influence the environment and in turn are influenced by it.
Benchmark 1—Students will recognize changes over time in nearby landscapes, resulting from human occupation. (Not everyone will have a lake nearby, if so, then lesson addresses Benchmark fully)
VI. Economics
A. Producers and Consumers:
Benchmark 2—Students will explain that in market economics, individuals earn income by working for firms to produce goods and services, and firms incur costs by hiring individuals and earn revenue by selling goods and services.

B. Economic Choices:
Benchmark 2—Students will apply a decision-making process to make informed choices.
C. The Market Economy (Micro Economics):
Benchmark 1—Students will identify and compare and contrast various industries and the occupations related to them.

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 2—The student will discuss the responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.
III. Earth and Space Science:
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Grade 5
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 3—The student will describe how waves, wind, and water shape and reshape the earth's surface.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 5

The Lake Game

Adapted from: Liukkonen, B. (1998). The Lake Game, For People Who Care About Lakes. University of Minnesota Sea Grant Program. The Lake Game is reprinted with permission from the University of Minnesota Sea Grant Program.

Grade Level: 3-5
Activity Duration: 55 minutes
Group Size: any
Subject Areas: Science, Language Arts, Social Studies
Academic Skills: application, drawing conclusions, listening, observation, problem solving, reading, roleplaying
Setting: gathering area
Vocabulary: algae growth, designated use, economics, ecosystem-based management, erosion, land use, pollution, Secchi disc, sediment, sustainable, turbidity, user groups, values
Internet Search Words: water pollution, watersheds

Instructor's Background Information

Minnesota is known as the Land of 10,000 Lakes. Our lakes exist in environments ranging from developed urban settings to remote wilderness areas. Lakes face a variety of threats, including overuse, pollution, and the introduction of exotic species. Because Minnesota's lakes serve many people and purposes, there are probably as many viewpoints on their use and management as there are people in the state!

Throughout Minnesota, counties develop water management plans and citizens form lake associations. Individuals and groups involved in these processes may have very specific ideas about how water resources should be used or managed. One group may be concerned about **economics**, or the businesses and jobs in a community, while another group may be concerned about recreational opportunities like fishing and boating. Another group might be concerned about protecting a threatened species or the aesthetics of a particular area. The Lake Game introduces students to numerous environmental perspectives and the necessity of considering the **values**—those things considered important, beneficial, or useful—held by various community interest groups. In Minnesota, and elsewhere, people must work with those whose values differ from their own in order to protect and improve community water resources and use them in a sustainable way. **Sustainable** resource use means using natural resources in ways that meet present needs and aspirations without compromising the environment's ability to meet the needs and aspirations of future generations. Sustainability calls for conserving and restoring the natural environment while enhancing economic opportunity and community well-being.

Summary

The Lake Game challenges students to make decisions in a variety of situations related to water use, pollution, recreational and industrial values, economics, and exotic species. Using roleplaying cards, students assume the roles of various people and consider situations affecting a local lake. As the game progresses, the lake's water becomes polluted and depleted as a result of the players' decisions. After the game, the decisions are discussed and alternatives explored.

Student Objectives

The students will:

1. Participate in a game in which they make decisions that impact the quality of a local lake.
2. Discuss actions that make them better stewards of water resources.

Materials

Some of these materials are optional. You may find it helpful to read the lesson procedure before collecting materials.

- **Roleplaying Cards**, one set for students and **Discussion Cards**, one set for instructor
- Map of a local lake and the surrounding area
- Clear container to represent the lake, such as an aquarium, large bucket, wading pool, or a clear plastic garbage bag suspended from a frame

continued

Materials (continued)

- Clear plastic cup for withdrawing water from the "lake"
- Two buckets (one for dirty water, the other for clean water)
- Red and green food coloring, with droppers (one drop of red represents one unit of pollution; one drop of green represents one unit of fertilizer)
- Small shaker filled with soil (players add "shakes" of turbidity to the lake)
- One cup of molasses (to represent oil leaks and pet waste)
- Toilet paper, candy wrappers, crumpled paper, or napkins (to represent trash)
- Rubber worms (available from most sporting goods stores)
- At least three sponge silhouettes of fish, weighted to stand on the bottom of the lake
- At least ten small, colored fish (different than the sponge fish; these represent invasive fish species)
- Fishing rod made from a wooden dowel and string, with a magnet or paper clip hook (or an ice-fishing jiggle stick)
- One picture of a loon or other animal
- One pair of scissors
- Note cards, for mounting **Roleplaying Cards** and **Discussion Cards**
- Clear contact paper (optional)
- Rags
- A representation of a Secchi disc for use in the "lake" (optional; make your own)

This activity focuses on natural science within a social context, addresses the issue of environmental valuing, and identifies the actions that students and others can take to protect and enjoy the environment.

Minnesota Waters
Most of Minnesota's state boundaries are actually water—the Pigeon River and Lake Superior in the northeast, the St. Croix and Mississippi Rivers in the east and southeast, the Red River along the western boundary, and, to the north, the Rainy River and border lakes within the Boundary Waters Canoe Area wilderness. Three of the major continental drainage basins have headwaters in Minnesota. Surface water leaving Minnesota flows eastward through the Lake Superior basin and the Great Lakes to the Atlantic Ocean, southward through the Mississippi and Missouri Rivers to the Gulf of Mexico, or northward through the Red and Rainy Rivers to Hudson Bay.

Very little surface water enters Minnesota from a neighboring state or country. Minnesota exports surface water—and **pollution**—downstream to the water users in other states and Canada. Pollution is defined as anything that alters the water, or makes it harmful, less desirable, or less useful.

Water pollution comes from a variety of sources including: the atmosphere, municipal and industrial discharges, agricultural and urban runoff, contaminated groundwater, and contaminated **sediment**. Sediment is the accumulation of a watershed's erosion (silt, sand, and organic and inorganic material), which accumulates on lake, river, and stream bottoms. Types of water pollution include toxic substances (such as mercury and PCBs), debris (litter and garbage), and sediments (soil, sand, silt, particles). **Land use** practices, or people's activities on land, can cause **erosion,** defined as the gradual wearing away of soil and rock surfaces by natural forces, such as flowing water, wind, and ice. Animal activities can also disturb the soil and vegetation that holds the soil in place. When surface runoff carries silt and sediments from disturbed ground to rivers and lakes, water clarity declines, with increased **turbidity**. Turbidity refers to the quantity of solid suspended particles that scatter light rays through the water. Turbidity makes water cloudy or, in extreme cases, opaque. Silt and sediments negatively affect lakes and rivers. They can cover and suffocate the eggs of fish and other aquatic animals. Sedimentation also prevents sunlight from reaching aquatic plants, inhibiting photosynthesis and oxygen production.

The excessive growth of algae or **algae blooms**, can be triggered as additional nutrients enter water bodies in runoff, including: pet and farm animal wastes improperly collected, contained, or managed; grass clippings and leaves swept into storm sewers; and excessive amounts of fertilizers. Algae blooms also prevent sunlight from reaching aquatic plants. As algae mats die, bacteria decompose the dead plant matter. In the process of decomposition, bacteria use oxygen, reducing the water's oxygen levels. Algae blooms also diminish the water's beauty and cause unpleasant odors.

In Minnesota, all lakes and streams have a **designated use**. There are seven classes of water for the state, and each has a specific set of water quality standards. These designated use classifications are:

- Aquatic, Fish, and Wildlife
- Recreation
- Industrial
- Limited Resource Value
- Domestic Water Supply
- Agricultural
- Navigational

All Minnesota lakes and 99 percent of its river miles are designated for fishable and swimmable uses. All rivers are classified for agricultural, navigational, and industrial use. Water quality is most often considered in terms of fitness for human consumption, but many other uses also require protecting and preserving adequate supplies of high-quality water.

What is the source or your drinking water? Water contamination can pose the risk of health problems, as well as damaging fishing industries and associated businesses by making fish less desirable to eat. For more information on fish consumption advisories, see **Lesson 6:5—Eating Fish.**

Minnesota has many lakes and rivers, so it may appear that the state has plenty of water to meet its needs. But water consumption is becoming a concern worldwide. The waters of Minnesota are "public waters," meaning they belong to all of us. If property adjacent to lakes or streams is privately-owned, the owner may deny access to the water, but the water itself is in the public domain. This means that all of us are responsible for Minnesota's precious water resources, and numerous values must be considered when making decisions that impact water quality.

Management of Watershed Areas

Increasingly, Minnesota citizens and natural resource professionals are working together to provide sustainable management of the state's invaluable natural resources through management that considers all elements of an ecosystem.

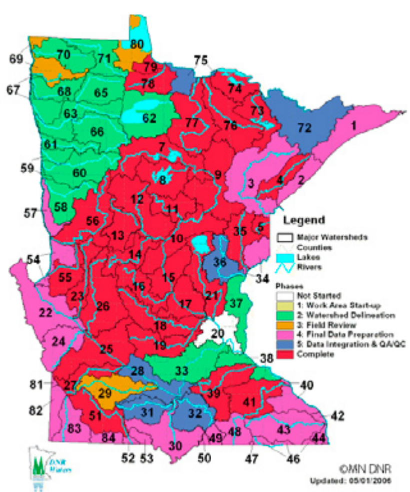
What is an ecosystem? It's a geographic area that includes all the living organisms (plants, animals, microorganisms), their physical surroundings (as soil, water, and air), and the natural cycles that sustain them. All of these elements are interconnected—managing

A **Secchi disk** is a simple, eight-inch diameter tool that measures water clarity (transparency). The depth at which a Secchi disk is visible is directly related to the transparency of the water in a lake.

As an optional addition to this game, you can make a Secchi disk from a white plastic coffee can lid. Cut a two-inch diameter circle from the lid and punch a hole in the center. Use an indelible black marker to color the disk as shown in the photo. Then thread a 16-24-inch length of string or cord through the hole. Use the indelible black marker to mark off every half-inch of the string or cord, beginning at the level of the disk. The disk must be weighted so that it sinks as it's lowered into the "lake" bucket or container. During the game, perform Secchi disk readings to measure the water clarity of the lake at regular intervals during the game. Record the depths at which you no longer see the disk's wedge-shaped markings.

To value something means to judge, rate, or scale its relative worth, cost, importance, or usefulness. For many community environmental issues, value considerations include aesthetics, convenience and efficiency, economics, ecosystem health, education, human health, jobs, recreation, religion, social factors, sustainability, water quality, and wildlife.

The term watershed, or catchment basin, refers to the entire physical area drained by a distinct stream or riverine system, physically separated from other watersheds by ridgetop boundaries. (This definition appears in *Entering the Watershed: A New Approach to Save America's River Ecosystems*, by The Pacific Rivers Council.) For more information on watersheds, see **Lesson 3:3—Wonderful Watersheds**.



This map of Minnesota watershed boundaries shows Minnesota's eight major basins and 82 major surface water watersheds.

one resource affects the ecosystem's other resources. Ecosystems can be small (a single pond) or large (an entire watershed including hundreds of forest stands owned by many different people).

An ecosystem-based management approach explicitly recognizes not only the environment, but also the critical importance of community and economic concerns.

Many stories framed by watersheds and landscapes illustrate the creative work of Minnesota's land managers—and numerous **user groups** (people that use resources in varied ways) including farmers and other landowners, hunters and anglers, DNR professional and technical staff, government and civic leaders, environmentalists, and business owners—as they consider how to best use and protect Minnesota's natural heritage. Individual watershed districts and landscape areas are geographic units that provide effective meeting places for citizens and natural resource professionals addressing environmental issues using the ecosystem-based approach. Many everyday decisions impact the condition of our natural resources, and ultimately, the lives of many people.

Considering that people interact with one another to obtain life's necessities from the environment, it's apparent that people are a component of an ecosystem, too. We must learn how to work together to use resources in a sustainable way.

Procedure

Preparation

1 Before playing the Lake Game, gather maps and factual information about your lake. Obtain a topographic map of the area. USGS maps for most of the state, at a scale of 1:24,000, are available from bookstores, outdoor outfitters, libraries, surveying companies, or the U.S. Government. It's also helpful for players to see the drainage area or watershed of the lake because it shows how land use affects the lake. Obtain copies of maps to pass out, or make a large version to display. Geographic Information Systems (GIS) maps for your area may be available from the Minnesota DNR. (See the Free Maps area on the Minnesota DNR website.) GIS are computer-generated layers of graphic information combined in one map to create a comprehensive view of a place. These layers can be used for different purposes, such as analyzing environmental damage or viewing public parks and waterways in a city. A bathymetric (bottom contour) map of the lake is helpful, too. Lake contour maps can be obtained for many Minnesota lakes from the lake survey information in the Lake Finder area of the Minnesota DNR website: **www.mndnr.gov.** Statewide land use and vegetation cover maps are also available from the Minnesota DNR.

2 Research your lake and its surrounding land uses. Possible questions include:
- What are the watershed's agricultural, residential, industrial, and forestry uses?
- How many streams flow into the lake?
- Does the lake have an outlet?
- How much of the lakefront is developed?
- Are lake levels or fishery resources managed? By whom? For what purposes?
- Do individuals or communities use the water for drinking?
- Are roadways near the lake salted during the winter?

3 Identify key issues relating to your area lake and land use. Which factors are of concern regarding your lake and surrounding area? Are people concerned about individual point source polluters, or nonpoint sources in general? Are they worried about using the lake for specific purposes such as swimming, fishing, or boating? Does the lake have problems related to invasive plants or animals? What are the primary issues to address during the roleplaying game? You may wish to create some additional role cards to fit the issues relevant to your situation.

4 Cut several fish silhouettes from sponges and weight their bases so they can stand on the bottom of the "lake." Each fish should have a paper clip at its mouth so it can be easily hooked with the fishing pole. You can either place a paperclip loop at the mouth, or, for magnet hooks, attach a paperclip to the mouth so the magnet will stick to it.

The fish silhouettes for the game are cut from sponges and weighted with paper clips, coins, or other items. Each fish should measure approximately four and one-half inches long, and have a paperclip "lip" that can be hooked or attracted to a magnet when players fish in the lake during the game. Examples of these fish silhouette species include bluegill, smallmouth bass, walleye, northern pike, and catfish.

Minnesota Lakes
- Minnesota's rich surface water resources include almost 92,000 miles of streams and more than 11,000 lakes larger than ten acres. (An acre is about the size of a football field.) That's more than 3,400,000 acres of water—not to mention approximately 5,000,000 acres of wetlands!
- Minnesota lake sizes range from less than ten acres to the 3,000,000-acre Lake of the Woods; half are smaller than 50 acres.
- More than 98 percent of Minnesota's lakes are found in the northern and central part of the state.
- Minnesota has 261 Mud Lakes. The other most common names are Long (256), Rice (122), Bass (83), and Twin (72).

The DNR has used GIS since the early 1970s. Minnesota DNR GIS Services staff works with DNR hydrologists and other staff, state and federal agencies, local units of government, and legislators. The staff develops new geographic data sets and provides or coordinates service delivery of GIS maps, data, and interpretive services for the state's wetlands, public waters inventory basins, river resources, watersheds, and calcareous fens. You can download much of this GIS data free of charge from the website: **www.mndnr.gov**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5 Copy and attach the **Roleplaying Cards** to note cards. Make one set—these are for the students. To make the instructor's **Discussion Cards**, place the situation from each of the student **Roleplaying Cards** on one side of a blank note card. Place the **Discussion Card** text on the other side of the card. Cards may be laminated or covered with clear contact paper to waterproof them.

6 Select the situation cards that are appropriate for your class, considering your students' ages and experience, your geographic region, and the economic issues affecting your part of the state. (You may wish to create some different cards than those included here. Take into account issues that may be affecting local water bodies.)

7 Number the cards in the order in which they should be played to allow some pollution of the lake to occur before students remove drinking water and go fishing.

8 Prepare materials. The fishing pole can be constructed from a length of string tied to a dowel, using a bent paper clip or magnet as a hook. Or you can use an ice fishing jiggle stick. If possible, trace a large-scale map of your lake on plastic or a large tarp. Or sketch the map on the ground with chalk. Indicate cities with dots and township or county borders with lines, but do not necessarily identify them by name. If roles have been assigned to specific locations, finding their "home" can be part of the experience for participants unfamiliar with the entire lake. The map should be large enough so that participants can sit around it as they play the game. Fill the container nearly full of clean water to represent your lake. Have access to an extra bucket or sink in which to dump water removed from the lake during the game. Fill an extra bucket with clean water to represent rain.

Option: You may also wish to set up a second lake to use as a control. In the concluding discussion, students can compare the clean water from the control lake with the polluted water of the lake used in the activity.

Activity

Warm-up

1 Ask a guest speaker from the Minnesota DNR or other state agency, a local watershed district representative, resort owner, angler, lake association representative, resource management specialist, city tourism official, bait shop owner, or member of another user group to give a short presentation about what they do and how they're involved with the local lake.

2 Or, ask students to name the nearest lake. Pass out copies of the map of a local lake and discuss the businesses, parks, homes, agriculture, tourism, recreational, and other activities taking place on and around the lake. Ask the students: Who uses the lake? What activities occur there? To whom is the lake important? Which animals and plants live in and around the lake? You may consider creating a PowerPoint presentation about the different user groups to introduce your students to issues surrounding your lake. Ask your local lake association or DNR office for information for this presentation.

Lesson

1 Place the container representing the lake in the center of the large lake map. Stand the fish silhouettes on the bottom of the container.

2 Place the pollution solutions, eyedropper, turbidity shaker, and the container for withdrawing water near the lake. Place the picture of wildlife near the lake. Keep the fishing pole and other game props until their particular roles are read during the game.

3 Distribute the **Roleplaying Cards** and explain the playing order. You may wish to give one card to each student, or have students draw a card before their turn. To reduce playing time and explore fewer situations, place students in groups of two or three per **Roleplaying Card.** Encourage the players to make decisions as they think the person described on their card would. Have participants sit around the map of the lake, read their cards, and consider their decisions.

4 As the participants' turns come, have them read their roles aloud and state the choices they've made if a choice is indicated. Each role should involve an action of some sort. You may or may not want to allow participants to influence one anothers' decisions. (You may read the cards to younger student groups.)

5 Have participants perform the actions indicated on the **Roleplaying Cards**. After the participant has made their decision, the instructor should read the text on the back of the card. This provides some background information and stimulates discussion.

6 Take Secchi disk readings to measure the water clarity of your lake at regular intervals during the game. Record the measurements at which the Secchi disk markings become indiscernible.

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Some students may get carried away with putting pollutants in the water just to see what the materials will do to the water in the container, or because it's more fun to add something to the container than not. To address this directly with the students, wait until the discussion at the end of the game, and then inform the students that the lake provides the community with its drinking water. Take a clear glass, dip it into the lake, lift it up for the students to see and ask, "Now, who would like to drink this water?" Discuss the actions that could have been taken to keep the community's drinking water supply clean. Remind students that it's more expensive to clean contaminants from the water at a treatment plant—if it is, indeed, possible—than it is to use water from a clean drinking water supply.

7 Discuss the decisions as you play. Balance economic considerations against idealism. If no one opts to pollute, question the realistic nature of the situation. Compare the multimillion-dollar decisions—which students may feel they can't influence—with personal decisions about actions that reduce or prevent pollution. Discuss how they can influence corporate decisions through letter-writing campaigns, boycotts, and other forms of consumer activism.

Wrap-up

1 Remind students that the container is a simplified model of your lake. In an actual lake, water is constantly added through precipitation (rain) and runoff. Pollution is diluted or flushed out at the outflow. Emphasize that the water in your lake is a limited resource: there isn't an infinite supply of water, and the effects of pollution can linger for many years.

2 Conclude with a review of the choices that polluted or depleted the lake water. Discuss values and economics. Have participants discuss which choices were acceptable and which choices were difficult to make. How could they alter their own or others' behavior patterns and values to better protect their lake? Although they may not be able to alter corporate decisions, they can choose to recycle, avoid littering, and support family actions that reduce pollution.

Option: If you set up a second lake as a control, compare the lake that the students polluted with the water in the control lake. Take a sponge fish from the polluted lake and squeeze out the water. Then squeeze out a sponge fish from the clean lake. Ask the students which fish they would rather eat! Discuss how the pollutants can contaminate fish. (See **Lesson 6:5—Eating Fish**.) Tell students that consumption advisories help people (particularly children and pregnant women) know how much fish they can safely eat if it came from lakes and rivers where these pollutants have been found.

Assessment Options

1 Have students identify a potential or existing local situation concerning conflicting water use interests. By writing a short story, students should identify the various interest groups, the conflicts, and a compromise reflecting the best interests of the community and the lake or stream.

2 Have students create situation and discussion cards based on lake or river protection actions that can be taken by children their age. Create a match game where students match the situation cards to the correct discussion cards. Ask students to write about how their decisions on each situation impact other community members and lake users. Have them include alternate choices or compromises that consider the values and needs of others in the community.

3 Assessment options include the Checklist and Rubric on the following pages.

The Lake Game Checklist

(This Checklist is for Assessment Option 1.)

Possible Points	**Points Earned**	**Points Earned**	
	Student	**Instructor**	
4	______	______	Story identifies a real or potential conflict in an issue related to a nearby lake or stream.
3	______	______	Interest groups are identified.
3	______	______	Issue is defined clearly and objectively.
4	______	______	Story clearly defines the water use conflict from the viewpoint of each interest group.
4	______	______	Story provides at least two solutions to the water use conflict that represent compromises for each interest group's position.
3	______	______	Story evaluates how the solution benefits each interest group.
3	______	______	Story is well-written with correct paragraph structure and without grammatical errors.
2	______	______	Student can define *compromise*.
2	______	______	Student can define *water stewardship*.

Total Points

28	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade
26-28 points = A
Excellent. Work is above expectations.

23-25 points = B
Good. Work meets expectations.

18-22 points = C
Work is generally good. Some areas are better developed than others.

14-18 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-13 points = F
Work is unacceptable.

The Lake Game Scoring Rubric

(This Rubric is for Assessment Option 1.)

Story Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Water issue	Story identifies a real or potential conflict in an issue related to a nearby lake or stream. Issue is clearly and objectively defined, with interest groups identified.	Story identifies a real or potential conflict in an issue related to a nearby lake or stream. Issue is clearly and objectively defined. Interest groups are unclear.	Story identifies a real or potential conflict in an issue related to a water body in general. Issue is defined but interest groups aren't clearly identified.	Story identifies an unrealistic conflict in an issue related to a made-up lake. Issue is unclear. Interest groups aren't clearly identified.	Doesn't complete story.
Conflicts	Story clearly defines the water use conflict from the viewpoint of each interest group.	Story defines the conflict from the viewpoint of each interest group, but definitions aren't clear.	Story defines the conflict from the viewpoints of a few major interest groups.	Story defines the conflict from the viewpoint of one interest group.	Story includes no water use conflict.
Solution	Story provides at least two solutions to the water use conflict that represent compromises for each interest group's position. Story evaluates how the solution benefits each interest group.	Story provides at least one solution to the water use conflict that represents a compromise for each party's interests. Story evaluates how the solution benefits each interest group.	Story provides at least one solution to the water use conflict that represents a compromise for each party's interests. Story evaluates how the solution benefits most of the interest groups.	Story provides an unsatisfactory solution to the water use conflict that doesn't demonstrate compromise. The story doesn't evaluate how the solution benefits each interest group.	Story provides no solution for the water use conflict.
Grammar and structure	Story is well-written, with correct paragraph structure and without grammatical errors.	Story is well-written, with correct structure and one or two grammatical errors.	Story is written with correct structure, but contains numerous grammatical errors.	Story is poorly-written with numerous errors.	Story isn't completed.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Contact resource people and leaders in your community before playing the game and invite them to your classroom to provide information and participate in the game. Key resource people may be representatives of state agencies such as the Minnesota DNR, the Board of Water and Soil Resources, the Minnesota Pollution Control Agency, and the Department of Health. Other contacts include representatives of local government (city, county, or township board members) and officials from local departments of zoning and planning, solid waste, highways and bridges, and public health. Other local resources include the University of Minnesota Extension Service, state Soil and Water Conservation districts, and colleges and universities.

2 You can also identify and contact key people involved in managing and protecting the lake. Does a lake association exist? Is there a core group interested in forming one? Have conflicts developed between user groups such as swimmers and boaters, urban and rural users, or new and long-time residents? If so, be sure to make advance arrangements to involve members from both sides of the dispute.

3 Ask students to research and report on the ecology of a local lake, including major causes and areas of pollution, surrounding population demographics, or the cultural history of the region.

4 Fish often accumulate toxins from polluted water in their bodies. Pollutants, such as PCBs and mercury, build up in the fatty tissues of fish. Have students show the class how to remove these contaminated parts when preparing fish for eating. (See fish consumption advisory information in **Lesson 6:5—Eating Fish.)**

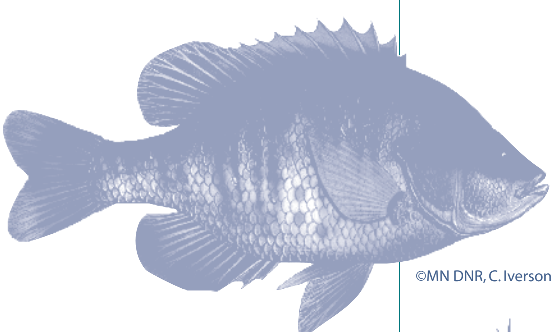
5 Encourage students to identify practices at home that positively and negatively impact the local aquatic environment. Have them list suggestions on how negative practices can be changed to protect the environment. Have them share these with their friends and families.

6 Have students make roleplaying cards for a lake association member, DNR conservation officer, city landowner, member of an angler's club, lake resident, farmer, highway department worker, and other members of groups that have various interests in a local lake or river. Have the students discuss the perspective, values, and point of view of each person depicted on a roleplaying card.

For the Small Fry

K-2 Option

The activity and concepts explored in this lesson may not be suitable for younger students. Instead, have students identify and draw some local community members that depend on the local lake or river for a job, drinking water, business, or recreation. (Possibilities include an angler, instructor, bait seller, tackle industry owner, water treatment plant worker, lakeside restaurant owner, resort owner, tourist, child who likes to swim, conservation officer, or lifeguard). Cut out each drawing. Then have students draw the local lake or river on a piece of poster board. Draw fish in the lake or river. Arrange and glue the community member cutouts around the lake or river. Underneath each cutout, write each person's name or position. Using string or yarn or drawn lines, have students connect the community members to the water and fish. Write the reasons why each person needs clean water or healthy fish (or both) on the line. Then have students make connections between the various people, indicating who is likely to need whom in the community. Discuss how people are part of the natural community and part of the human community. Ask students to place themselves in the picture. What, if anything, connects them to the lake? Are they connected to other members of the community? How? Within a habitat, people interact with one another to obtain life's necessities, or habitat needs. Ask the students to summarize how the lake or river is part of a natural community and how it is important to the human community. Have students create a title for their poster.



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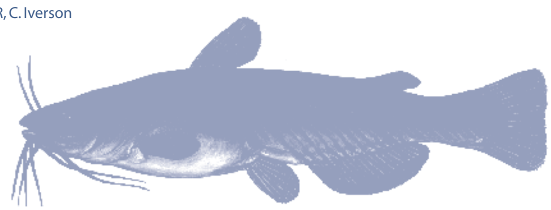

Roleplaying Cards

SITUATION 1: Swimming Beach
Your family moves into a new home on a lake. You can't wait to go swimming, but you see a lot of aquatic plants down in the water. What would you do?

1. Ask your parents to get a machine that removes all aquatic plants.
2. Explain that aquatic plants are important to lake health and to fish, and ask your parents to remove no more plants than the DNR allows.
3. Ask your parents to drive you to the public beach and leave the aquatic plants alone.

SITUATION 2: Jet Ski
You're at a friend's lake cabin. Your friend asks if you'd like to ride on a jet ski. You know that your friend rides very fast near shore. What would you say?

1. "Sure, I like going fast, and you don't get to ride a jet ski every day!"
2. "Yes, if we go slowly and don't ride fast near shore because that erodes the shore."
3. "No, thanks."

SITUATION 3: Fertilizer
You're volunteering with your scout group at a local park. There's a lake nearby. You help by picking up sticks so workers can mow the lawn. A worker notices the lawn is not very green or lush and decides to spread extra fertilizer on it. What would you say?

1. Nothing. You're just a kid and he's an adult.
2. "That seems like a lot of fertilizer. How much do you need to make the grass greener?"
3. "Does the fertilizer have phosphorus in it? I've heard that phosphorus can cause algae blooms that harm fish."

SITUATION 4: Leftover Earthworms
You dig or buy some earthworms to use as bait. When you're done fishing, you have extra worms. What would you do?

1. Put the earthworms in the refrigerator at home and use them the next day.
2. Leave the container of earthworms on the fishing pier for the next person to use as bait.
3. Pour the earthworms into the lake to feed the fish.
4. Dump the earthworms onto the shore to set them free.
5. Throw the whole container of earthworms into the trash.

Roleplaying Cards

SITUATION 5: Leftover Live Bait
After buying minnows and leeches from a local bait store, you go fishing at a fishing pier. When you're done, you have leftover minnows and leeches. What would you do?

1. Take the minnows and leeches home and use them the next day.
2. Give the minnows and leeches to a friend or to some other angler.
3. Pour the minnows and leeches into the lake.
4. Dump the water and minnows and leeches onto the shore.
5. Bury the minnows and leeches in your garden at home.

SITUATION 6: Aquarium Fish
You have an aquarium at home and you don't want the fish anymore. (Before answering this, decide how many you have—between one and ten fish—and how many you no longer want. Tell the instructor.) What would you do?

1. Ask friends or neighbors if they would like your fish for their aquariums, or give them your aquarium.
2. Release the fish into a lake.
3. Freeze the fish for fish printing.
4. Throw them away.

SITUATION 7: Oil Change
Your seventeen-year-old brother is changing the oil in his car. He asks you to get rid of the dirty oil by pouring it down the storm sewer in the street. What would you do?

1. Do as he says so he'll give you a ride in his car.
2. Dump the oil on the gravel driveway—the sewer is too far away and you've heard that oil keeps down the dust from the gravel.
3. Tell him that it's against the law to dump oil and that he should return it to the place he bought it so that it can be recycled.

SITUATION 8: Littering
You're fishing with a friend, and you notice that he's kind of messy. He opens a new fishing lure and throws the package on the ground. Then he gets a big tangle and has to cut the line. He rolls up the tangled line and leaves it on the ground. After a while he catches a carp and says it's a garbage fish and throws it up on the bank to die. The two of you are getting ready to go home for the day. What would you do?

1. Don't say anything because you think it will hurt his feelings.
2. Tell your friend to pick up his garbage and put the carp safely back in the water.
3. Open the garbage sack you keep in your tackle box and offer to help him clean up his mess.
4. Come back later and clean up his mess.

Roleplaying Cards

SITUATION 9: Pet Waste
You're taking your dog for a walk along your neighborhood lake. Your dog poops on shore. What would you do?

1. Just keep walking.
2. Look around to see if anyone saw what happened. If not, you keep walking.
3. Pull some grass from along the shore and cover it up so that no one sees it.
4. Use the plastic bag you brought along to pick it up and put it a trash can.

SITUATION 11: Electricity
Whenever you leave a room, your mother says, "Don't forget to turn off the light!" What would you do?

1. Turn off the lights because you know it's the right thing to do.
2. Ignore her—you're tired of hearing this and you don't really think there's a shortage of electricity.
3. Turn the lights off sometimes, but not always.

SITUATION 10: Flooding
It's been very rainy this season. It seems like it's rained every day. The streams are running very fast and soil from farm fields, construction sites, and riverbanks is washing into the stream. The stream looks brown in the place where it enters the lake. You wonder how this will affect the fish.

SITUATION 12: Fishing
You want to catch some fish for supper tonight. Have our decisions created a good fishing lake?

Discussion Cards

DISCUSSION 1: Swimming Beach
If you chose:
1. Put six shakes of soil into the water
2. Put three shakes of soil into the water
3. Don't do anything to the lake

Aquatic plants are important to fish because they:
- reduce erosion from waves
- clean the water
- provide food and shelter, and places to hide from predators
- shade the water from the sun, keeping it cool
- make oxygen
- provide places for fish to lay eggs

DISCUSSION 2: Jet Ski
If you chose:
1. Put six shakes of soil into the water
2. Put one shake of soil into the water
3. Don't do anything to the lake

Waves from jet skis and boats stirs sediment from the bottom of the lake and washes soil away from the shoreline. This is called erosion. Disturbed sediment can settle on fish eggs, which kills them.

Discussion Cards

DISCUSSION 3: Fertilizer
If you chose:
1. Put 3 drops of green food color into the water
2. Put 1 drop of green food color into the water
3. Don't do anything to the lake

Unneeded or excess fertilizer on grass can wash into lakes or down storm drains and flow into lakes and streams when it rains. Fertilizer may contain phosphorus, a nutrient that plants need, but when too much phosphorus gets into lakes, it can cause algae blooms that can harm for plants and animals, including people. Most fertilizers sold in stores (in small amounts) no longer contain phosphorus. But the large quantities of fertilizers sold to parks, industries, and farms may still contain phosphorus.

DISCUSSION 4: Leftover Earthworms
If you chose:
1. Don't do anything to the lake
2. Put 3 pieces of string into the water
3. Put 3 pieces of string into the water
4. Put 3 pieces of string into the water
5. Don't do anything to the lake

Never dump earthworms into a lake. This is littering. It's also illegal! Although it may seem like a good idea to leave the container of earthworms for the next angler, this is littering, too. All earthworms in Minnesota are non-native, invasive species from Europe and Asia. At least fifteen non-native worm species have been introduced so far, and research by University of Minnesota and forest managers has shown that at least seven species are invading Minnesota's hardwood forests, causing the loss of tree seedlings, wildflowers, and ferns.

Discussion Cards

DISCUSSION 5: Leftover Minnows and Leeches (Live Bait)
If you chose:
1. Don't do anything to the lake
2. Don't do anything to the lake
3. Add three plastic fish to the lake
4. Put 1 drop of red food color into the lake
5. Don't do anything to the lake

Never put any bait, including minnows and leeches, into a lake they didn't come from. This is illegal! They can spread diseases, or they might not be native to the lake. Dumping minnows and leeches on shore is littering. If possible, bury dead minnows or leeches away from the fishing site.

Minnesota Statute 609.68 Unlawful deposit of garbage, litter, or like.
Whoever unlawfully deposits garbage, rubbish, cigarette filters, debris from fireworks, offal, or the body of a dead animal, or other litter in or upon any public highway, public waters or the ice thereon, shoreland areas adjacent to rivers or streams as defined by section 103F.205, public lands, or, without the consent of the owner, private lands or water or ice thereon, is guilty of a petty misdemeanor.

DISCUSSION 6: Aquarium Fish
If you chose:
1. Don't do anything to the lake
2. Add colored fish sponges to the lake (the same number you said you wanted to get rid of)
3. Don't do anything to the lake
4. Don't do anything to the lake

It's illegal to release aquarium fish into the wild. They can carry diseases—or other invasive species from the aquarium water—including plants or other small animals.

It's illegal to transport live fish, including any in livewells, except for display in a home aquarium. These fish must be purchased from an authorized pet shop (you must have the sales receipt), or anyone over 16 can transport legally-caught largemouth bass, smallmouth bass, yellow perch, rock bass, black crappie, white crappie, bluegill, pumpkinseed, green sunfish, orange spotted sunfish, and black, yellow, and brown bullheads. No more than four of each species may be transported at one time, and individual fish can be no longer than ten inches. At no time may water from infested water bodies be transported.

Schools wishing to keep sportfish in an aquarium should contact the DNR for permit requirements.

Discussion Cards

DISCUSSION 7: Oil Change
If you chose:
1. Put 3 drops of molasses into the water
2. Put 1 drop of molasses into the water
3. Don't do anything to the lake

Anything placed in a storm sewer will end up in a lake or river. Oil dumped on land can also be washed into the water when it rains. Once in the water, oil can kill fish and other animals. It's illegal to dump used motor oil into lakes, sewers, wetlands, or on the ground. All used motor oil should be taken to a gas station or other place-of-purchase for recycling.

DISCUSSION 8: Littering
If you chose:
1. Add three squares of toilet paper to the water
2. Add two squares of toilet paper to the water
3. Don't do anything to the lake
4. Don't do anything to the lake

Littering is illegal. Besides, it's nicer to fish at an unlittered site. Litter (fishing line, food wrappers, and bait containers) can blow into the lake and harm fish and other animals. If people think all anglers litter all the time, they might want to close down your fishing area—so please don't litter.

The DNR Fishing Regulations say that anglers must return any fish back to the water if it "will not be utilized." Does this refer to carp and other rough fish? I thought we weren't supposed to put those fish back in the water.

This is commonly misunderstood because, at one time, it *was* illegal to release rough fish. This law was removed from the books in 1981 because it was ineffective. Only a few of the 35 rough fish species, including carp and bullheads, cause problems in lakes, and even those harm only some shallow lakes—not all lakes. (Rivers are almost never affected.) The small number of carp and bullheads caught by anglers has no effect on a lake's carp and bullhead populations. Due to the old law, anglers were tossing carp and a wide range of ecologically valuable rough fish (redhorse, mooneye, gar, suckers, and buffalo) onshore to rot. The old law seemed to encourage wanton waste, which is illegal. The current situation is that, if you catch a fish—whether it's walleye, carp, or mooneye—and you don't plan to keep it, return it to the water alive so that another angler may catch it someday.

—Q & A, *Conservation* Magazine

Discussion Cards

DISCUSSION 9: Pet Waste
If you chose:
1. Put 3 drops of molasses into the water
2. Put 3 drops of molasses into the water
3. Put 3 drops of molasses into the water
4. Don't do anything to the lake

When pet waste washes into lakes or streams, it decays. This uses up oxygen. Sometimes ammonia is released. Low oxygen levels and ammonia, combined with warm temperatures, can kill fish. Pet waste also contains nutrients that stimulate weed and algae growth. Overly fertile water becomes cloudy, green, and unattractive for swimming, boating, and fishing. Most importantly, pet waste can transmit diseases making water unsafe for swimming or drinking. When pet waste isn't properly disposed of, human health is at risk, too. Pets, children who play outside, and adults who do gardening are most at risk for infection caused by some of the bacteria and parasites found in pet waste. Flies can also spread diseases from animal waste. Pet waste may not be the largest or most toxic pollutant in urban waterways, but it's one of the many smaller sources of pollution that add up to a big problem. Fortunately, there are some simple things we can do to help keep our water clean.

DISCUSION 10: Flooding
Put 6 shakes of soil into the lake.
No option

You can't control nature. Big rains often cause soil erosion that can harm fish and other aquatic life. It's important to retain or restore buffers of trees, shrubs, and native grasses near waterways—they prevent erosion and runoff from entering lakes, rivers, and streams.

Turf grasses used for lawns have extremely shallow root systems, so they don't effectively prevent erosion. The deep roots of native trees, shrubs, and grasses resist erosion, soak up a lot of water, and hold the soil in place.

When you go fishing on a lake or stream, consider using fishing piers and other shore fishing structures rather than walking down a shore bank. This can prevent vegetation from being trampled and destroyed.

Discussion Cards

DISCUSION 11: Electricity
If you chose:
1. Don't do anything to the lake
2. Put 3 drops of red food color into the water
3. Put 1 drop of red food color into the lake

"Coal production has been increasing since the 1950s, and today the United States extracts huge quantities of coal (over 1 billion short tons in 1998) . . . over 90 percent of the coal produced is used for electricity generation. Besides being cheap and abundant, the only thing that coal has to recommend it is that is can provide power on-demand. Coal mining has major impacts on terrestrial and aquatic ecosystems. In many cases, whole mountaintops are removed for coal extraction, and valleys are filled in with the waste rock (tailings). Whether it is mountain-top removal, open-pit, or underground mining, however, a major problems stems from rain filtering through the coal mine and tailings. Some of the sulfur in the coal dissolves into the water, turning it acidic; this "acid mine drainage" has impacted thousands of stream miles across the country. The combustion of coal also produces many gaseous wastes, some of which are "scrubbed" out of the emission stream in smokestacks, but many are not, including carbon dioxide. A single household being supplied solely from coal-produced electricity would generate over 61 pounds of sulfur dioxide, 60 pounds of nitrogen oxide, 30 pounds of particulates, 6 pounds of carbon monoxide, 2 pounds of volatile organics, and 17,000 pounds of carbon dioxide, and require over 7,000 gallons of water."

–Environmental Working Environmental Working Group Report, *The Power of Information*, **www.ewg.org/reports/choosinggreenenergy/sources.html**

DISCUSSION 12: Fishing

Try to catch fish. Fifteen seconds will be allowed for fishing.

Squeeze the water from the fish to see how much contamination they've accumulated in their bodies.

Pollution in our environment can enter lakes. We can make choices that will result in less pollution and a better environment.

If you eat fish, you should consult the Lake Finder area of the Minnesota DNR website **www.mndnr.gov/lakefind/index.html** or the Minnesota Department of Health for fish-eating guidelines **www.health.state.mn.us/divs/eh/fish/index.html**. It's best to eat smaller fish because they have less body fat, and fatty tissue contains pollutants. Smaller fish are also less likely to be affected by biomagnification, the accumulation of pollutants in a food chain.

Macroinvertebrate Mayhem

How does the saying "appearances can be deceiving" apply to the water quality of a sparkling, crystal-blue stream?

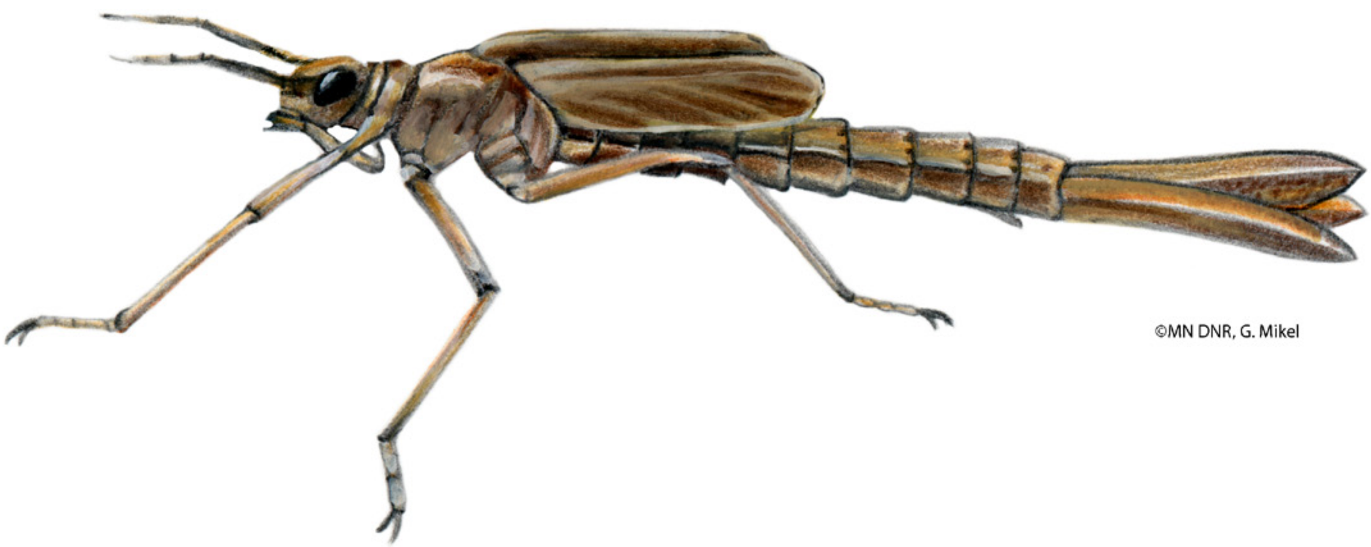

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Table of Contents

Chapter 3 • Lesson 6

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Macroinvertebrate Mayhem

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
C. Comprehension:
Benchmark 7—The student will follow three-step written directions.
II. Writing
A. Types of Writing
Benchmark 1—The student will write in a variety of modes to express meaning, including:
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
D. Research:
Benchmark 1—The student will use grade-level appropriate reference materials to obtain information from dictionaries, glossaries, encyclopedias, and the Internet.
III. Speaking, Listening, and Viewing
A. Speaking and Listening;
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

Grade 4
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading.
II. Writing
A. Types of Writing
Benchmark 1—The student will write in a variety of styles to express meaning, including
a. descriptive
b. narrative
c. informative
d. friendly letter
e. poetic
f. persuasive
g. thank you note
D. Research:
Benchmark 1—The student will locate information in various reference materials including dictionaries, online dictionaries, glossaries, encyclopedias, and the Internet.
III. Speaking, Listening, and Viewing
A. Speaking and Listening
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.

Grade 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction as well as independent reading.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning, including:
a. descriptive
b. narrative
c. informative
d. formal letter

e. poetry
f. persuasive
g. thank you notes
h. reports

III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use and effects of science in our interaction with the natural world.
IV. Life Science
B. Diversity of Organisms
Benchmark 1—The student will classify plants and animals according to their physical characteristics.
Benchmark 2—The student will learn that the characteristics used for grouping depend on the purpose for the grouping.

Grade 5
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will know that current scientific knowledge and understanding guide scientific investigation.
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 6

Macroinvertebrate Mayhem

Grade Level: 3-5
Activity Duration: Part 1: 50 minutes
Part 2: 50 minutes
Group Size: 20 or more
Subject Areas: Language Arts, Math, Physical Education, Science
Academic Skills: drawing conclusions, interpretation, kinesthetic concept development, large group skills, organization, simulation
Setting: large indoor or outdoor open space
Vocabulary: benthic, biodiversity, facultative, indicator species, intolerant, larva, larvae, macroinvertebrate, monitor, nymph, sensitive, tolerant
Internet Search Words: benthic macroinvertebrate, indicators of biological integrity, stream monitoring

Instructor's Background Information

Macroinvertebrates, those organisms that lack an internal skeleton and are large enough to be seen with the unaided eye, are an integral part of wetland and stream ecosystems. Examples of macroinvertebrates include aquatic insects (such as mayflies, stoneflies, dragonflies, and rat-tailed maggots), mollusks (such as snails); freshwater crustaceans (crayfish and scuds), annelids (worms and leeches), and microscopic water-dwelling animals, or zooplankton. These organisms spend all or part of their lives in water.

A variety of environmental stressors affect macroinvertebrate populations. Urban and agricultural runoff can produce intolerable conditions for some macroinvertebrates. Sewage and fertilizers present in streams promote the growth of algae and, eventually, bacteria that consume oxygen needed by macroinvertebrates. Land uses, such as poorly-protected construction sites or croplands, disturb or destroy natural vegetation and allow sediment to flow into the water. Sedimentation destroys stream habitats by smothering the rocky areas of macroinvertebrate habitat. The removal of trees along the banks, as well as changes in stream velocity or speed can alter normal water temperature patterns in the stream. Some organisms depend on temperature patterns to regulate changes in their life cycles. Other stressors include stream channelization and the introduction of non-native (invasive) species.

Summary

Students play a game of tag in a roleplaying activity that simulates the effects of environmental stressors on macroinvertebrate populations. Like the canaries once used in coal mines, macroinvertebrates can indicate water quality in their habitats.

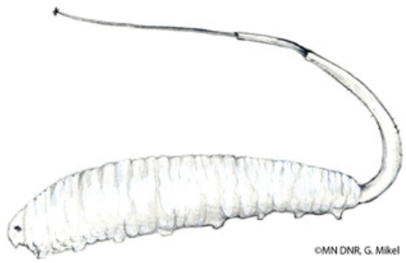
Student Objectives

The students will:

1. Illustrate how tolerance to water quality conditions varies among macroinvertebrate organisms.
2. Explain how macroinvertebrate population diversity provides insight into an aquatic ecosystem's health and water quality.

Materials

- Macroinvertebrate samples (optional)
- Field guides and other information resources
- **Macroinvertebrate Identification Tags**, one per student
- **Macroinvertebrate Mayhem Data Table**, one copy per game
- Pillowcases or burlap bags, one for each student in the caddisfly group
- Chart paper or whiteboard
- Pencil or board marker for instructor's use in keeping records on a chart



Some fly larvae are referred to as maggots. This rat-tailed maggot is the larva of a drone fly. The long, tail-like rear end protrudes from the water like a snorkel, enabling the maggot to breathe air from the surface as it feeds beneath the surface.

Some macroinvertebrates, such as the mayfly, stonefly, and caddisfly larvae, are **sensitive** or **intolerant**, to toxins and to changes in stream conditions that make survival difficult or impossible. These changes, caused by pollution, include water temperature and decreased concentrations of dissolved oxygen. Some organisms can move to more favorable habitats. Others die, or become unable to reproduce.

Macroinvertebrates that can survive in polluted conditions, such as rat-tailed maggots and midge larvae, are known as **tolerant** organisms. An organism is considered tolerant if it can survive in polluted conditions. Other **facultative**, or **semi-tolerant**, organisms (such as dragonfly and damselfly larvae), prefer good stream quality but can survive semi-polluted conditions.

Water quality researchers often sample macroinvertebrate populations to **monitor** (observe, check, and test) changes in stream conditions over time, and to assess the cumulative effects of environmental stressors such as increased sedimentation and changes in water temperature, dissolved oxygen levels, and pollutants. Environmental degradation can decrease the **biodiversity**, the variety of species in a community of macroinvertebrates, by eliminating intolerant organisms. Biodiversity is the total number of species of organisms living in a given area. The number of tolerant organisms may increase, but the diversity of species in the community may decrease. If the environmental stress is severe enough, species of intolerant macroinvertebrates may completely disappear. For example, if a sample of macroinvertebrates in a stream consists mainly of rat-tailed maggots, snails, and dragonfly larvae, the water quality of that stream is probably poor: it probably has low oxygen levels, increased sediment, contaminants, or all three. On the other hand, if the sample contains a diversity of organisms (including some intolerant species), the stream conditions are likely to be good. Acquiring baseline data for comparison is essential, however, because some healthy streams may, as a matter of course, contain very few macroinvertebrate species. A variety of food sources, adequate oxygen levels, and temperatures conducive to growth are all conditions that characterize a healthy stream.

Indicators of Biological Integrity

Water quality is monitored by collecting organisms from aquatic ecosystems and analyzing the number of types of organisms. Information on habitat quality, water level, and chemistry are also collected to support biological information. Biological information can be presented numerically as a value (or index) understandable and meaningful to scientists, civic leaders, and administrators. It can also be compared to reference conditions to determine the health of the water body. This process is called bioassessment.

An organism that can provide information about the quality of its living environment is known as an **indicator species** or bioindicator.

Bioassessments are based on the premise that a water body's community of plants and animals will reflect the health of that water body. When a water body is damaged, the diversity of its animals and plants often decreases and the composition of its species changes.

Like the canaries that coal miners once used to monitor air quality in mines, the monitoring and assessing of macroinvertebrate populations—or other populations of organisms—can signal possible changes in water quality. Using bioindicators as an early warning of degradation in an aquatic ecosystem can alert scientists and resource managers to problems that must be addressed to sustain the water resources in a watershed. Typically, organisms that are intolerant to human disturbances, such as chemicals, sedimentation, changes in water temperature, removal of vegetation and habitat, will die or leave disturbed environments. The organisms that are more tolerant of disturbance will remain, comprising a larger proportion of the individuals. For example, a disturbed stream where erosion from a construction project has increased sedimentation will probably exhibit fewer kinds of plants and animals than a healthier, undisturbed stream. Numerical bioassessment results can reveal that a water body has been damaged, changed, or stressed in any way. These results are also used to assess current water quality and to track and predict future changes.

Aquatic macroinvertebrates, as well as other groups of aquatic organisms, are biological indicators for water quality. Examples include:

Fish

For many years, fish populations have been used to indicate whether or not waters are clean, polluted, improving, or declining. Merely knowing that fish live in the waters isn't revealing. Information on species, numbers, and the state of their health is important, too. Fish are excellent indicators of watershed health because they:

- live in the water all of their life
- differ in their tolerances of types and amounts of pollution
- are easily collected, with the right equipment
- live for several years
- are easily identified in the field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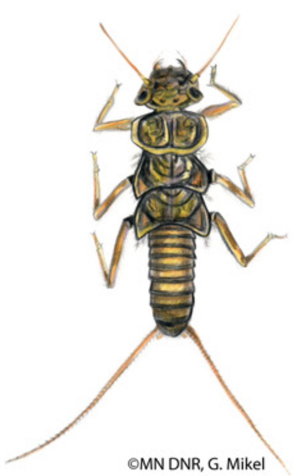
Fish are desirable components of biological assessment and monitoring programs and accurate indicators of environmental health because:

- Fish populations and individuals usually remain in the same area during summer seasons.
- Communities are persistent and recover rapidly from natural disturbances.
- Comparable results can be expected from an undisturbed site at various times.
- Fish have large ranges and are less affected by natural microhabitat differences than smaller organisms, making fish extremely useful for assessing regional and macrohabitat differences.

- Most fish species have long life spans (from two to more than ten years) and can reflect both current and long-term water resource quality.
- Fish continually inhabit the water, integrating the chemical, physical, and biological histories of the waters.
- Fish represent a broad spectrum of community tolerances, from very sensitive to highly tolerant, and respond to chemical, physical, and biological degradation in characteristic ways.
- From the human standpoint, fish are highly visible and valuable components of the aquatic community.
- Aquatic life uses and regulatory terms are usually characterized in terms of fish (such as the "fishable and swimmable" goal of the Clean Water Act).
- The sampling frequency for trend assessment is less than for short-lived organisms.
- The taxonomy of fishes is well established, enabling professional biologists to reduce laboratory time by identifying many specimens in the field.
- Many North American fish species' distributions, life histories, and tolerances to environmental stresses are documented in scientific literature.



Macroinvertebrates

Aquatic macroinvertebrates are referred to as **benthic** macroinvertebrates (derived from the Greek word *benthos*, meaning bottom). They live on the bottom—in sediments or attached to bottom rocks and plants. They're good indicators of watershed health and water quality because they:

- live in the water for most or all of their lives
- stay in areas suitable for their survival
- are easily collected
- differ in their tolerance to amount and types of pollution
- are easily identified in a laboratory
- often live for more than one year
- have limited mobility
- are integrators of environmental condition (meaning that, because they're always in the water, they take in the materials of their environments over time, and that these materials are eventually reflected in their tissues or in their overall health)

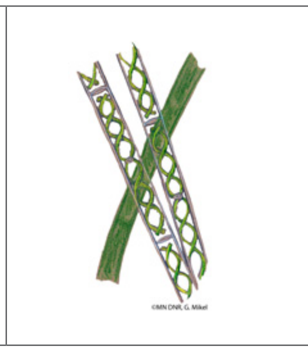
Periphyton

Periphyton are benthic algae that attach themselves to surfaces such as rocks or larger plants as they grow. Algae are primary producers—they can convert the sun's energy into food energy through photosynthesis. Algae are sensitive indicators of environmental change in waters because:

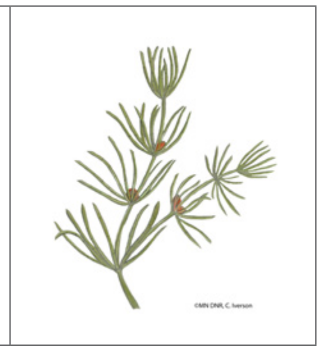
- they're found in all waters
- their number of species is naturally high
- they respond rapidly to both exposure and recovery
- experienced biologists can identify them to the species level
- sampling is easily performed, requiring few people
- for many species, the degree of tolerance or sensitivity to specific changes in environmental conditions is known

Common types of Minnesota algae.

Anabaena
(planktonic)



Spirogyra
(filamentous)

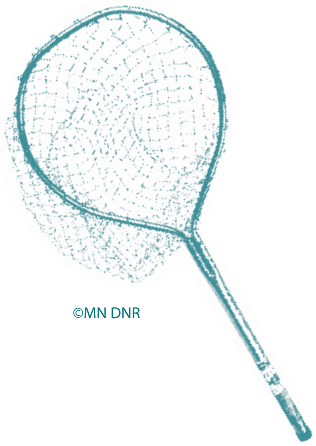


Chara
(plant-like)

Scientists combine information about changes in algae populations with data on macroinvertebrates and fish to form an even clearer picture of water quality. In assessing the health of periphyton populations, scientists typically measure biomass, species composition or diversity, and the organisms' biological condition.

Macrophytes

Macrophytes are aquatic plants large enough to be seen by the unaided eye (without a magnifying lens or microscope). These plants are emergent, submergent, or floating types. (**See Lesson 3:2—The Function of Aquatic Plants.**) Aquatic plants benefit lakes because they provide cover for fish and substrate habitat for aquatic invertebrates. They produce oxygen that aquatic organisms breathe and provide food for some fish and other wildlife. Some studies indicate that reduced populations of sport and forage fish and waterfowl are linked to the lack of macrophytes in local systems. An absence of macrophytes may also indicate water quality problems arising from excessive turbidity and herbicides and salt carried in runoff. Conversely, an overabundance of macrophytes can result from high nutrient levels, diminishing the water's aesthetic appeal and interfering with lake function and recreational activities (such as swimming, fishing, and boating).



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Aquatic plants are excellent indicators of the health of an aquatic ecosystem because they:

- respond to nutrients, light, toxic contaminants, metals, herbicides, turbidity, water level change, and salt
- are easily sampled using transects or aerial photography
- don't require laboratory analysis
- are easily used in calculating simple abundance metrics or indices
- are integrators of environmental condition

Volunteer Stream Monitoring

Across the nation, volunteer stream monitoring has proved an engaging and effective way to evaluate the health of water resources. Monitoring involves repeated visits to sites, where measurements are taken for comparison over time. Monitoring activities vary widely, depending on volunteers' interests and skill levels. A monitoring program may include the following:

- physical habitat monitoring, such as stream width or stream flow
- biological monitoring, such as collecting and identifying bottom-dwelling water insects and other benthic macroinvertebrates
- chemical monitoring, for such measures as pH, dissolved oxygen, or nutrients

Procedure

Preparation

1. Use the **Macroinvertebrate Identification Tags** to make game identification tags for the students. Divide the number of students by seven. Make that number of copies of each of the macroinvertebrate tags and environmental stressor tags, and cut them apart.
2. Copy enough "additional" copies of the rat-tailed maggot cards and midge larva cards to equal the number of students in your class (make half of these rat-tailed maggots and the other half midge larva.)
3. To assemble the identification tags:
   One side of each macroinvertebrate tag should have a picture of one of the seven macroinvertebrates. Using glue or clear contact paper, attach one of the "additional" rat-tailed maggot or midge larva pictures to the back side of each macroinvertebrate tag (but not to the original midge larva, rat-tailed maggot and environmental stressor tags—the back sides of these tags should be blank).
4. For durability, the tags may be laminated.
5. Use clothespins, tape or paper clips to attach the tags to students' clothing during the activity.
6. Copy the **Macroinvertebrate Mayhem Data Table.**

Activity

Warm-up

1 Review the conditions of a healthy ecosystem. (Enough of the right kinds of food, shelter, cover, and space.) Ask students to describe what could happen to an ecosystem if these conditions were altered, damaged, or eliminated. What clues would investigate to determine whether an ecosystem is healthy or unhealthy?

2 Remind students that a stream is a type of ecosystem. Organisms need healthy ecosystems to survive. Ask them how they would assess the health of a stream. Students may suggest conducting a visual survey of the surrounding area, considering the following questions: What are the area's land use practices and activities? How might these affect the stream? Does plant cover grow on the banks of the stream? Are the banks eroded? What color is the water? Is pollution entering the water? What kinds of organisms live in the stream?

3 Identify several environmental stressors (such as urban and agricultural runoff, erosion/sedimentation, or the introduction of exotic species). Discuss how environmental stressors impact a stream's health. Review the many types of plants and animals, including macroinvertebrates that live in streams. How might environmental stressors affect these organisms? Would all types of organisms be impacted in the same way? Why or why not?

4 Students should be familiar with the words *macroinvertebrate* and *biodiversity*. They should understand that, sometimes, it is possible to accurately assess the water quality of a stream by its appearance and odor. But polluted streams can also look and smell clean. Students should understand that there are different ways to test water quality, including water chemistry testing and macroinvertebrate sampling.

Lesson

Part 1

1 Introduce the practice of sampling macroinvertebrate populations to monitor stream quality. Show students pictures or specimens of macroinvertebrates used to monitor stream quality.

2 Divide the class into seven groups and assign a macroinvertebarte to each group:

Macroinvertebrate Groups

Caddisfly Larva
Mayfly Larva
Stonefly Larva
Dragonfly Larva
Damselfly Larva
Midge Larva
Rat-tailed Maggot


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Try to have at least four students in each group. For smaller classes, reduce the number of macroinvertebrate groups.

3 Have group members conduct library or internet research on their organism and prepare a report for the class. The group's report should include conditions (such as clean water, cool water, abundant oxygen, rocky bottoms, and vegetation) required for the survival of their assigned macroinvertebrate.

4 Have students present their reports to the class. Compare the types of conditions that each macroinvertebrate species requires. What would happen if one of these conditions were damaged or polluted by an environmental stressor? Did they find information that could tell them if their macroinvertebrate would be tolerant or sensitive to degraded or polluted stream conditions?

Part 2

1 Tell students that they're going to play a game that simulates the changes that happen in a stream when an environmental stressor, such as a pollutant, is introduced. Show students the playing field and indicate the boundaries.

2 Have one student volunteer to be an environmental stressor (such as sedimentation, sewage, or a toxic substance like mercury). Discuss the ways in which a stream becomes become polluted, and how pollution alters stream conditions. For a large class or a large playing field, you'll need more stressors.

3 To play the game, divide the rest of the class into seven groups. Each group represents a macroinvertebrate listed in the Macroinvertebrate Group list in Step 2.

4 On the **Macroinvertebrate Mayhem Data Table**, record the number of students in each macroinvertebrate group in the Start column.

5 Distribute the appropriate **Macroinvertebrate Identification Tags** to all group members. The tags have images on both sides, but the picture of each group's macroinvertebrate should face outward when students begin to play the game.

6 Inform students that they'll encounter hindrances as they try to cross the field. These obstacles in the following chart represent the sensitive organisms' tolerances to pollutants. Have the students practice these motions.

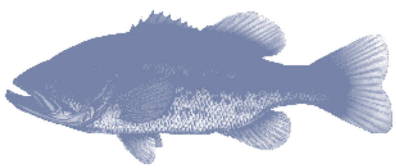
Intolerant Macroinvertebrates and Hindrances		
Organism	**Hindrance**	**Reason for Hindrance**
Caddisfly	Must place both feet in a bag and hop across field, stopping to gasp for breath every five hops.	Many types of caddisflies build cases of tiny sticks or stones and attach themselves to rocks for protection and stability. But they're intolerant of low oxygen levels in the water.
Stonefly	Must do a push-up every ten steps.	Stoneflies require high oxygen levels. When oxygen levels drop, stoneflies actually do push-ups to increase the flow of water over their gills. (Their gills lie underneath the thorax, where their legs attach to their bodies!)
Mayfly	Must flap arms and spin in circles when crossing field.	Mayflies often increase oxygen absorption by undulating their abdomens to increase the flow of water over their gills (Their gills are on their abdomens).

7 Assemble the macroinvertebrate groups at one end of the playing field and place the environmental stressor(s) midfield. When a round starts, the macroinvertebrates move toward the opposite end of the field and the stressor will try to tag them. To "survive," the macroinvertebrates must reach the opposite end of the field without being tagged by the environmental stressor. The environmental stressor can try to tag any of the macroinvertebrates, but will find it much easier to catch those with hindered movements. This mirrors life in a real stream—if the environment changes drastically enough—and a species lacks the adaptive characteristics necessary to survive changed conditions—that species will die and disappear from that environment.

8 Begin the first round of the game. Tagged macroinvertebrates must go to the sideline and flip their identification tags to display the more tolerant species (such as the rat-tailed maggot or midge larva). Tagged players who are already in a tolerant species group do not flip their labels.

9 The round ends when all the macroinvertebrates have been tagged or have reached the opposite end of the playing field. Record the new number of members of each species on the **Macroinvertebrate Mayhem Data Table**.

10 In the next rounds, the "new" rat-tailed maggots and midge larvae no longer have hindrances. Complete two more rounds, with all tagged players rejoining the macroinvertebrates who successfully survived the previous round. Record the number of members of each species on the data table at the end of each round. Because some players will have flipped their identification tags, there will be a larger number of tolerant species in each successive round.



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Wrap-up

1 The game is completed after three rounds. Discuss the outcome with the students.
2 Emphasize the changes in the distribution of organisms among groups. Have students compare the population sizes of groups at the beginning and at the end of the game, providing reasons for the changes.
3 Review why some organisms are more tolerant of poor environmental conditions than others.
4 Have students compare the stream environment at the beginning of the game to the environment at the end of the game.
5 What would happen if we added more environmental stressors to the stream? (Fewer sensitive macroinvertebrates would survive each round until there were only tolerant species left in the stream, or until there were no macroinvertebrates left in the stream.) What would happen if there were fewer environmental stressors? (More tolerant species would survive.)
6 Ask students how monitoring a stream to track macroinvertebrate diversity would provide information about water quality.

Assessment Options

1 Assess student participation in the game, and discussion in the Wrap-up. Can students articulate that tolerance to water quality conditions varies among different types of macroinvertebrate organisms? Can they explain how macroinvertebrate population diversity provides information about the health of an aquatic ecosystem and its water quality?
2 Have students research different aquatic macroinvertebrate organisms and identify the stream conditions they need for survival. Students can work in groups or individually. They can present their findings in a chart, poster, or written report. Offer students the option of presenting their findings in an exhibit or model form. Evaluate students' research, looking for detail in their descriptions of macroinvertebrate organisms and their ability to identify the stream conditions they need for survival.
3 Have each student make a model of a different type of macroinvertebrate and study its body parts. Ask them to investigate the physical adaptations that make the macroinvertebrate more sensitive or more tolerant to environmental stressors.
4 Have students explain why organisms like fish, algae, macroinvertebrates, and macrophytes could be good indicators of water quality. They can present their findings to a group of younger students as a written report, skit, mural, story, song, or demonstration.
5 Have students develop a match game in which pictures of streams of varying conditions or states of health are matched with organisms that might live there.
6 Assessment options include the Checklist and Rubric on the following pages.

Macroinvertebrate Mayhem Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
6	______	______	Student can explain how aquatic macroinvertebrates (including tolerant and intolerant species) reflect the health of a stream.
6	______	______	Student accurately describes the key physical and behavioral features of macroinvertebrates in the game.
2	______	______	Student accurately defines environmental stressor.
3	______	______	Student can give three examples of stressors to water environments.
3	______	______	Student defines tolerant, semi-tolerant and sensitive.
4	______	______	Student follows step-by-step verbal instructions throughout the game.
Total Points			
24	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

22-24 points = A
Excellent. Work is above expectations.

20-21 points = B
Good. Work meets expectations.

17-19 points = C
Work is generally good. Some areas are better developed than others.

13-16 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Macroinvertebrate Mayhem Scoring Rubric

Aquatic Macroinvertebrates as Indicators of Water Quality Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Stream analysis	Makes the connection that aquatic macroinvertebrates can be tolerant or sensitive to stressors, and that this is why a stream's macroinvertebrate populations reflect the health of a stream.	Describes how macroinvertebrate species have different tolerances to stressors in the game.	Knows that different types of macroinvertebrate species live in various stream environments, but can't explain the reason.	Doesn't understand that different types of macroinvertebrate species exist in different numbers in streams with varied environmental conditions.	Doesn't understand that aquatic macroinvertebrates are animals without backbones that spend all or most of their life cycle in water, and that they're visible to the unaided eye.
Diversity	Accurately describes key physical and behavioral features of macroinvertebrates in the game.	Can describe key features of 75% of the macroinvertebrates in the game.	Can describe features of 50% of the macroinvertebrates in the game.	Can describe features of fewer than 50% of the macroinvertebrates in the game.	Can't describe features of macroinvertebrates in the game.
Stressors	Accurately defines environmental stressor; can give three examples of stressors to water environments.	Can define environmental stressor; can give two examples of stressors to water environments.	Can define environmental stressor and provide one example.	Can't accurately define environmental stressor.	Doesn't try to define environmental stressor.
Following verbal instructions	Follows step-by-step verbal instructions throughout the game.	Follows verbal instructions during 90% of the game.	Needs occasional reminders to follow instructions.	Needs repeated reminders to follow instructions.	Doesn't follow verbal instructions.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Have students investigate a nearby stream. Take students to a nearby stream to sample and collect aquatic macroinvertebrates with dip nets. Place the organisms into shallow white trays. What types of macroinvertebrates live there? Use an identification key to identify the organisms. How would students describe the diversity of organisms? Do students' findings provide insight into the quality of the stream? What other observations can students make to determine stream quality? They may want to report their findings to local watershed managers or water quality inspectors.

2 Supplement the students' macroinvertebrate survey of the stream with chemical tests and water analyses. These can be purchased in kits to measure pH, temperature, oxygen, phosphates, sulfides, sulfates, nitrates, and nitrates.

3 You can repeat your stream surveys periodically during the school year, or from year to year with subsequent classes, and compare the results. Do you detect any changes from survey to survey? What could explain any changing results? If students discover water quality problems, they can develop an action plan or a service-learning project to address the issues they identified.

4 Have students design their own caddisfly case. They can use a computer graphics program, draw a design, or make a model using natural materials like sticks and stones, or craft items like tooth picks, popsicle sticks, pipe cleaners, pony beads, or modeling clay. Have students write a paragraph explaining how their case helps their caddisfly larva survive in its habitat.

5 Orient students to stream ecology prior to this lesson. Refer to the "Stream Sense" lesson in the **Project WET Activity Guide**, which activity provides a variety of streamside investigations. Students can learn how nonpoint source pollutants accumulate in a stream in the Project WET activity "Sum of the Parts." Treatment of polluted water is addressed in the Project WET activities "Sparkling Water" and "Reaching Your Limit." For information about Project WET, contact the Minnesota Project WET Coordinator, Minnesota DNR, at 651-296-6157, or toll free at 1-888-646-6367.

6 Have students study aspects of biodiversity by adding another round to the game. For example, add a fourth round in which all organisms are caddisflies. This added round demonstrates that, in an aquatic ecosystem with little biodiversity, a few intolerant species or a single species can quickly be eliminated.

Before conducting a macroinvertebrate survey or the chemical tests and water analyses, take students to the stream and ask them to do a visual assessment. Ask students to record their observations at the site. Does the water look clean? Is it cloudy, clear, milky, foamy, brown, oily, or green? What kind of human activities take place on the land near the stream? What types of plants and animals live nearby? Is the shoreline stable or does it show visible evidence of erosion? Does the water have an odor? If so, what does it smell like? Does the water feel cool or warm? How much shoreline vegetation exists? Are there emergent plants in the water such as cattails, reeds, and lily pads? Is the stream shaded, or does it receive direct sunlight? Do they see evidence of insects or animals in and around the stream? Are there other observations? After conducting either the macroinvertebrate survey from Extension 1 or the chemical testing and water analysis survey, compare your results with the visual survey of the stream. What can students conclude about the stream's water quality? What can you learn from a visual survey? What information does an aquatic macroinvertebrate survey supply? What can you learn from a chemical and water analysis survey?

For the Small Fry

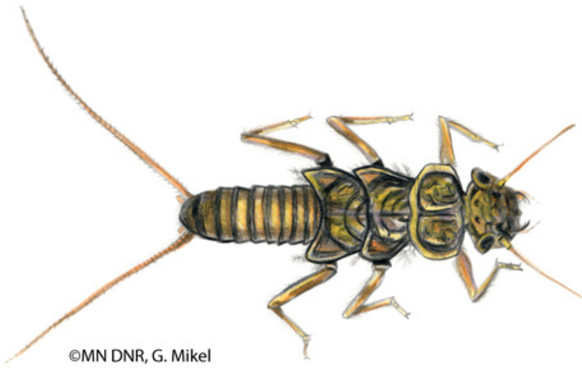
K-2 Option

Play the game using simplified vocabulary to help students understand that aquatic macroinvertebrates live in lakes and streams, that some are sensitive to pollution, and that others are more tolerant of contaminants in the water.

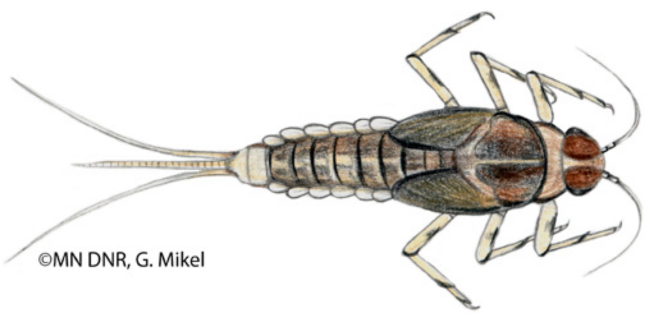
Macroinvertebrate Pollution Tolerance Level Chart

These macroinvertebrates are grouped according to their ability to tolerate pollution in their aquatic habitats. Some types of macroinvertebrates are very sensitive to water quality. Others are semi-tolerant of pollution. Some have adaptations that help them tolerate certain levels of pollution in the water.

Sensitive



Stonefly Larva
Stonefly larvae have two long tails, tubes of thread-like gills on their undersides in their “armpits,” wing pads on their backs, antennae, and two claws on each foot. They live among stones or plants in clear, cool, well-oxygenated streams.

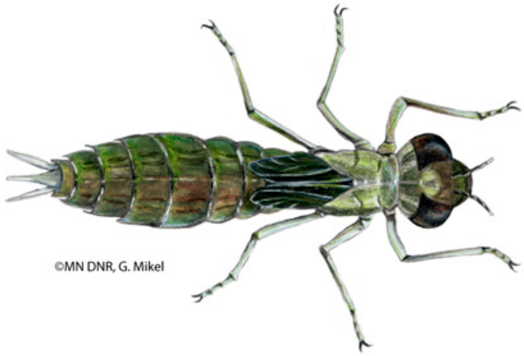


Mayfly Larva
Mayfly larvae have lateral gills along the abdomen, wing pads, and two or three long tail filaments. They have short antennae, and a single claw on each foot. They live under stones in fast-flowing water or among plants in slow-flowing water.

Caddisfly Larva
Caddisfly larvae are caterpillar-like insect larva with three pairs of legs on their first three body segments, and they breathe through the surface covering of their bodies. They usually live in protective cases that they make from rolled leaves, hollow twigs, or small stones. (*Caddis* means house or home.) Their head and legs protrude from these cases as they move.

continued

Semi-tolerant/Facultative

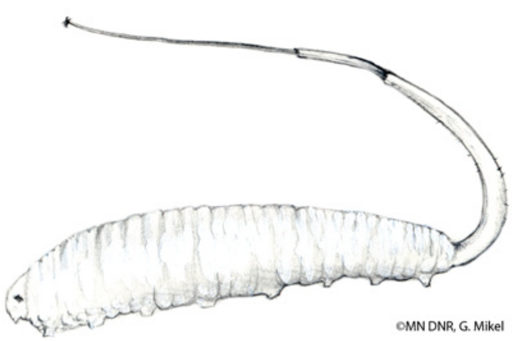


Dragonfly Larva
Dragonfly larvae are short, chunky predators with wing pads and internal gills. To breathe, they pump water in and out of the tip of their abdomen. They live on plants, among stones or leaf litter, and on the bottom.

Damselfly Larva
Damselfly larvae are more slender than dragonflies and have a distinct head section. They have three feather-like gills on the end of their abdomens. They live on plants, among stones and leaf litter, or on the bottom.

Tolerant

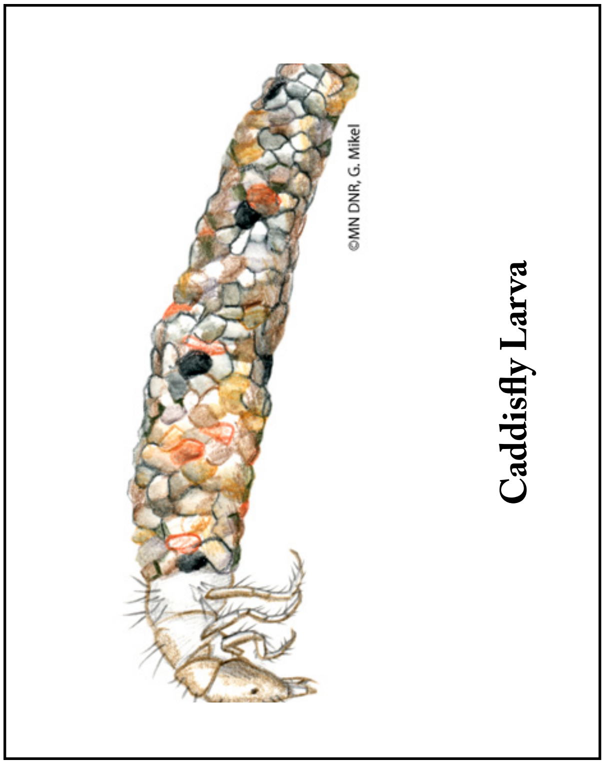
Midge Larva
Midge larvae are slender and wormlike. Some of them are red. They have no legs (or stumpy unjointed ones) and bristles. They live in all sorts of aquatic habitats: swimming along, on rocks, or on the bottom.

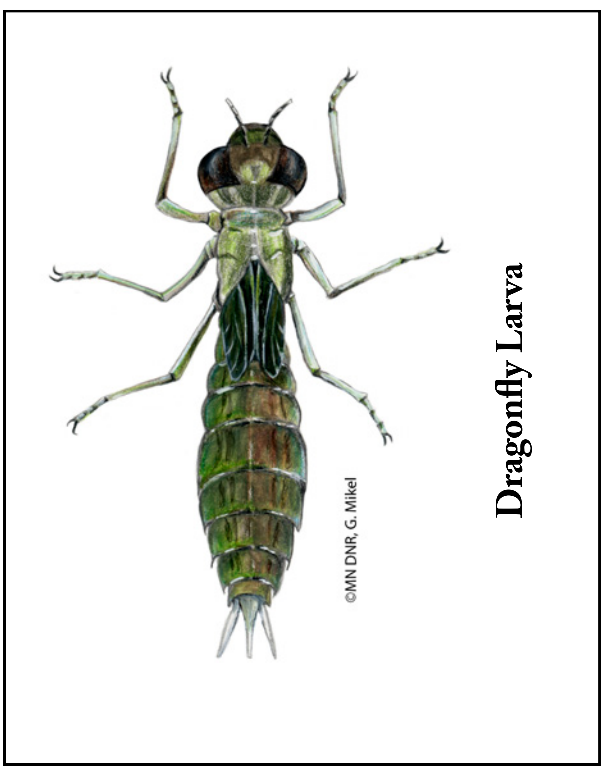


Rat-tailed Maggot
Rat-tailed maggots are semitransparent, soft-bodied fly larvae. Their ventral side ends in a single breathing tube that looks like a tail. These tail-like structures maintain contact with the air above the surface of the water. With this tail, the maggot breathes air from the surface, as it feeds and rests below the surface. Some species inhabit the water in tree holes. Some live in the shallow waters near the shores of pools, marshes, and ponds. They often live in organically rich (eutrophic) waters. Adults resemble honeybees.

Macroinvertebrate Identification Tags

See the Preparation section of this lesson for instructions on making identification tags and how to determine how many of each type of macroinvertebrate tag to make for your group.





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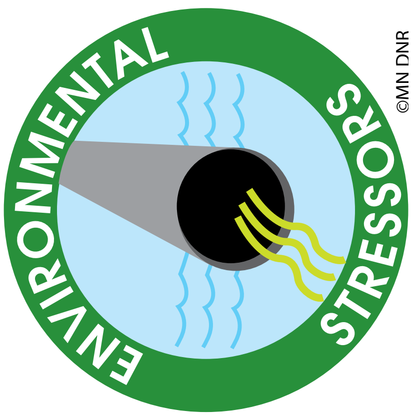
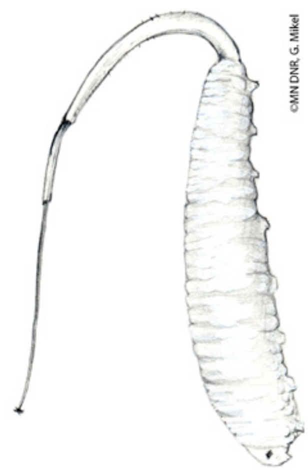
Macroinvertebrate Identification Tags

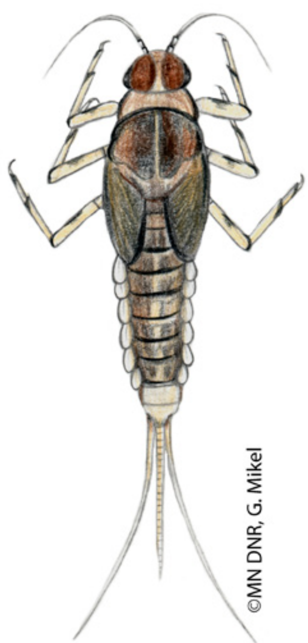


©MN DNR

Environmental Stressor


©MN DNR, G. Mikel

Rat-tailed Maggot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Mayfly Larva


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Midge Larva

Macroinvertebrate Mayhem Data Table

Macroinvertebrate	**Tolerance Level**	**Numbers (at the start and end of each round)**			
		Start	Round 1	Round 2	Round 3
Caddisfly Larva	Intolerant				
Mayfly Larva	Intolerant				
Stonefly Larva	Intolerant				
Dragonfly Larva	Semi-tolerant (facultative)				
Damselfly Larva	Semi-tolerant (facultative)				
Midge Larva	Tolerant				
Rat-tailed Maggot	Tolerant				
TOTAL					

Mussel Mania

The pearls of Minnesota are freshwater mussels.

Table of Contents

Chapter 3 • Lesson 7

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Mussel Mania

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark..

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading. ◑
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension. ●

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions. ●

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 4—The student will summarize and paraphrase what is read. ●

History and Social Studies

Grades 4-8
II. Minnesota History
G. Post-World War II to the Present:
Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues. ◒
IV. Historical Skills
A. Concepts of Time:
Benchmark 1—Students will define and use terms for concepts of historical time. ◒ (Before zebra mussels, after zebra mussels are introduced, and long term impacts of zebra mussels.)
V. Geography
D. Interconnections:
Benchmark 1—Students will recognize changes over time in nearby landscapes, resulting from human occupation. ◒

Science

Grade 3
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals. ●
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food. ●
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism. ●

Grade 4
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions. ●

Grade 5

IV. Life Science

E. Biological Populations Change Over Time:

Benchmark 2—The student will recognize that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.

F. Flow of Matter and Energy:

Benchmark 1—The student will recognize that organisms need energy to stay alive and grow, and that this energy originates from the sun.

Benchmark 2—The student will use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota.

Benchmark 3—The student will recognize that organisms are growing, dying and decaying, and that their matter is recycled.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 7

Mussel Mania

Grade Level: 3-5
Activity Duration: 20 to 30 minutes
Group Size: 15 to 35 participants
Subject Areas: Language Arts, Social Studies, Physical Education, Science
Academic Skills: kinesthetic concept development, large group skills, role-playing, simulation
Setting: large indoor or outdoor gathering area
Vocabulary: amphipods, carrying capacity, conglutinates, glochidia, invasive species, mollusk, native, substrate, veliger, zebra mussel
Internet Search Words: aquatic invasive species, zebra mussels

Summary

Students become native mussels, invasive zebra mussels, perch, walleye, or "plankton movers" in a game designed to help them understand how harmful invasive species can affect the balance within aquatic ecosystems.

Student Objectives

The students will:

1. Explain why native freshwater mussels are important to ecosystems.
2. Identify the effects of zebra mussels on other aquatic organisms.
3. Describe three ways that zebra mussels can take over habitat in Minnesota waters.
4. List two ways in which human activity has introduced zebra mussels and two ways that people spread zebra mussels in Minnesota waters.
5. Describe the life cycle of a freshwater mussel, including how the larval forms of many mussel species require fish hosts during a stage of their development.

Instructor's Background Information

Many people are unaware of the vast variety of animals that live under the surfaces of Minnesota waters. Mussels are one of these overlooked animals. Freshwater mussels inhabit the lakes and rivers in Minnesota, but they are found throughout the world, too, with North America supporting more species than any other continent.

Mussels are members of the second largest group of animals in the world, the **mollusks**. Mollusks are invertebrates whose soft, unsegmented bodies are usually enclosed by a shell. Mussels belong to the phylum Mollusca, and are closely related to other bivalves, such as marine mussels and clams, as well as to snails and octopuses.

Freshwater mussels have two shell halves, or valves. Inside the shell, a thin tissue—the mantle—surrounds the mussel's soft body. The mantle secretes the material that creates the shell. The valves, held together by an elastic-like hinge, close with the help of two strong muscles whenever the mussel senses a threat.

Why Are Mussels Important?
Mussels are an important food source for several different kinds of animals, including river otters and raccoons, as well as several fish species. Mussel shells form an important **substrate** to which algae and insect larvae attach themselves. (A substrate is an underlying surface on which other organisms can grow—rocks, gravel, plants, woody debris, and mussel shells are all substrates). When present in large numbers, mussels can become a sort of underwater garden that attracts feeding fish, including their host fish. Mussels are filter feeders, and they eat

Materials

- **Zebra Mussels Crash on Mississippi River Sheet**, one per student
- **Plankton Sheet**, one per student, or one transparency to project
- Tape, chalk, string, or rope for defining the lake boundary
- Two hula-hoops
- Newspaper or scrap paper crumpled into 100 or more tight balls, or 100 plastic golf balls, wiffle balls, or other substitute
- *Mussels of Minnesota* poster, available from the Minnesota DNR
- One legally collected native mussel shell (or other mollusk shell)
- *Field Guide to the Freshwater Mussels of Minnesota*, by Bernard E. Sietman (optional), available through the Minnesota DNR
- *Zebra Mussel Identification* cards, one per student (optional), available from the Minnesota DNR Information Center at 1-888-MINNDNR (646-6367)

small plants and animals known as plankton. Mussels also filter and clean the water by removing undesirable particles and chemicals as they feed.

Archeological digs in eastern North America have yielded shell materials used by native cultures as long ago as 8000 B.C. These cultures used mussels for food. They also used mussel shells to temper pottery and to make tools, utensils, and jewelry.

By the mid-1800s, European-Americans in the eastern United States were searching for natural pearls formed within mussel shells. Pearl hunting spread throughout the United States, and by the end of the century, "pearlers" were collecting mussels from as far west as the Mississippi River.

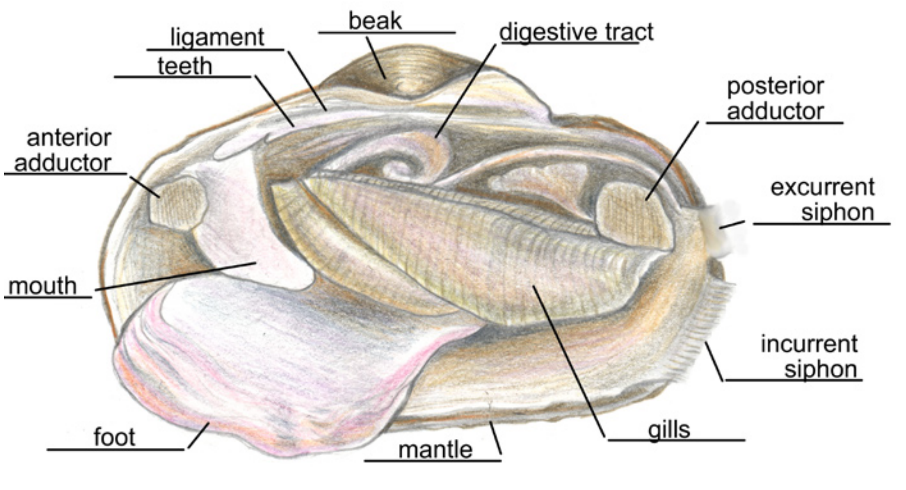
In the 1890s, mussel shells were first harvested and manufactured into pearl buttons. These early harvesters collected mussels by the ton from the Mississippi River and its major tributaries. Mussels were harvested for this multimillion-dollar industry until the 1940s, when plastic replaced pearl as a button material.

Freshwater mussels are presently harvested throughout much of their range for use in the cultured pearl industry. The shells are collected, ground into beads, and placed in live oysters, whose mantles then secrete a thin layer of mother of pearl upon the beads, forming a cultured pearl. These pearls are left inside the oyster for one to three years before they're removed, sorted, and sold. Most pearl industry practices now use synthetic materials instead of ground freshwater mussel shells to induce oysters to make pearls. Most states now have regulations prohibiting mussel harvest from their waters. In Minnesota, people who wish to harvest mussels from inland waters must have permits. But some freshwater mussel species are endangered, so permits haven't been issued for quite some time.

How Do Mussels Live?

Mussels spend most of their lives in a small area of a lake or streambed. They move using a muscular "foot," which they push into the sand or gravel to inch themselves along the bottom. This movement allows them to avoid fluctuating water levels and search for favorable habitats.

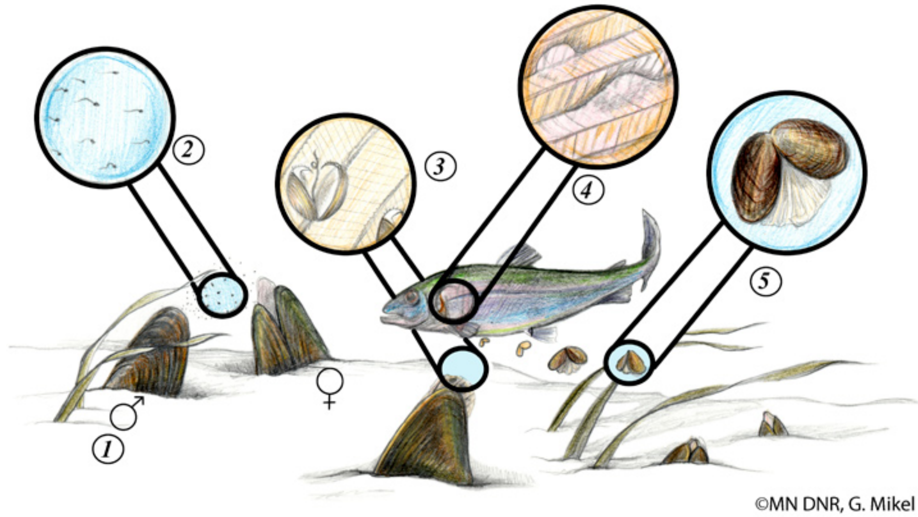
A mussel gathers food and oxygen by drawing water through an incurrent siphon. It removes the food and oxygen with its gills, and expels the water through an excurrent siphon. Tiny, hair-like cilia located on the gills sweep the food in the water—mostly plankton and organic matter—to the mussel's mouth.



Anatomy of a freshwater mussel.

Freshwater mussels have a complex life history that links them closely to fish. During their larval, or **glochidial** stage, mussels must attach themselves to fish tissue as parasites. Zebra mussel larvae are called **veligers**. Veligers are free-swimming larvae. They don't require a fish host during any portion of their life cycle. Some freshwater mussels require one particular fish species as a host, but others use many species. One mussel species, the salamander mussel, is so specialized that it exclusively uses the gills of an amphibian, the mudpuppy, as its host. After being released by the female, the glochidia attach themselves to the host's skin or gills, where they grow for a month or more.

To improve the larvae's chances for survival, many mussel species have evolved elaborate means of luring fish to gravid (pregnant) females. For example, the pocketbook mussel has a modified mantle flap that resembles a minnow. Other mussel species package their developing glochidia into cases called **conglutinates**. These sometimes resemble the insects on which fish normally feed. When a fish attempts to eat this imposter insect, it becomes infected with the mussel's glochidia, which develop into juvenile mussels while attached to the host fish. They then detach from their host, fall to the lakebed or streambed, and begin their lives as free-living mussels. This method of reproduction is also the primary way that mussels are distributed throughout a water body, so mussel species distributions are directly related to the host fish's distribution.



The life cycle of a freshwater mussel.

1. The male flushes sperm into the water, where currents can carry them downstream toward a female. The female draws in sperm to fertilize her eggs. Unless males and females are near one another, odds for fertilization are slim.
2. The female broods the fertilized eggs inside of her, and then releases thousands of tiny larvae called glochidia. She must sense the presence of a fish, timing her release so the glochidia can "hitch a ride" on the fish. Many species release their glochidia in clumps shaped like small worms or other fish food. Fish feed on them and then expel them through their gills, where the glochidia of many species settle. When a nest-building fish stirs up the river bottom, glochidia from the bottom may also attach and hitch a ride.
3. When microscopic glochidia touch the tissue of a fish, they clamp or hook themselves onto the fish's scales, fins, or gills. Some glochidia need a certain species of host fish on which to grow.
4. The fish grows a layer of skin over the hitchhiker, forming a cyst. Depending on the species, young mussels stay on the fish for several days to a few months while they grow into juveniles. This doesn't harm or stress the fish.
5. The cyst breaks open, and the juvenile mussel drops off to start its adult life. With luck, it will land in good habitat and join other mussels in making a bed in the river bottom.

Why Are Mussels in Trouble?
Freshwater mussels filter oxygen and particles from the water, cleansing the water in the process and absorbing what they consume into their bodies and shells. For this reason, mussels are sensitive to changes in their environment, and serve as indicators of the health of lakes and rivers. Degradation of lakes and rivers from runoff of silt and chemicals—together with physical changes from damming, channelization, and dredging—has taken a toll on **native mussels** in North America. (A native organism is a species that naturally occurs in a particular environment.) As a result, conservation groups, such as the

American Fisheries Society and The Nature Conservancy, list mussels as one of North America's most endangered animal groups. Of the 297 known species and subspecies of freshwater mussels in North America, 213 are listed as either endangered, threatened, or of special concern. In Minnesota, 25 of our 48 native mussel species are listed as endangered, threatened, or of special concern. Two Minnesota species are believed to be extinct from the state.

Unregulated commercial harvest of mussels in the early part of the last century has also affected mussel communities. Experts believe that populations of mussels no longer legally collected may still be experiencing the impact of having been harvested during the early 1900s. The State of Minnesota does not allow the harvesting of mussels from inland waters, and allows only limited commercial harvest of a single species from the Mississippi River along the border with Wisconsin. A special permit is required to legally harvest mussels from this portion of the Mississippi River.

Note the shape of the zebra mussel.

Zebra mussels *(Dreissena polymorpha)* are small, with sharp edges and "zebra" stripes.

More recently, mussels are especially threatened by the introduction of an **invasive** mussel species. **Zebra mussels** *(Dreissena polymorpha)*, are small clams, less than two inches in length, that attach to any solid object using tufts of fiber called byssal threads. Not native to North America, they were introduced from another part of the world. Zebra mussels are native to the Caspian Sea region of Asia and were brought from Europe into the Great Lakes in the late 1980s in the ballast water of transoceanic ships that discharged ballast water into Lake St. Clair, near Detroit. Tolerant of a wide range of environmental conditions, and having few natural predators in the U.S. to control their population, zebra mussels have extended their range to parts of all the Great Lakes and much of the Mississippi River. Zebra mussels were discovered in Minnesota in the Duluth Superior Harbor in 1989 and have since become established in the Mississippi River, the St. Croix River, Lake Zumbro (an inland lake north of Rochester), Lake Minnetonka (near the Twin Cities), and Lake Ossawinnamakee near Brainerd. Two zebra mussels were found in separate locations in Lake Mille Lacs on the northwest side of the lake in August 2005, during a routine dive survey for net locations by fisheries biologists from the Minnesota DNR. These were the first zebra mussels found in Mille Lacs. In 2005, an young angler found a zebra mussel in a minnow bucket attached to a dock on Rice Lake, near Brainerd. Subsequent investigation disclosed that the zebra mussel is established in Rice Lake.

Game fish have not yet shown impacts from zebra mussels in the Mississippi River, Lake Superior, or other Minnesota lakes where they've been discovered. The effects of zebra mussels, however, are difficult to predict. They're known to foul beaches, clog water intakes, harm native mussels, and possibly interfere in lake food chains.

A single zebra mussel female can produce more than 30,000 eggs, and the generations mature rapidly, making them difficult to control. A body of water with no detectable zebra mussels one year may have its bottom covered with them the next. Colonies can have from 70,000 zebra mussels per square yard—as in portions of Lake Erie—to the incredible 700,000 mussels per square yard that have been found in some utility water intake pipes. Zebra mussels feed by extracting microscopic plant life (phytoplankton) from the water, robbing native organisms of much-needed food sources. A single adult zebra mussel can filter a full liter of water daily for every day of its life. Zebra mussels live an average of about five years, so the mussel can filter 482 gallons (1825 liters) over its lifetime.

Large numbers of zebra mussels can filter *all* of the water in a lake or stream, removing plankton (tiny plants and animals) that serves as food for juvenile fish—and for native mussels. When zebra mussel populations peaked in Lake Erie, it was estimated that the entire volume of the Erie basin was filtered through zebra mussels every single day. When zebra mussels filter so much plankton, a link in the food chain is broken, causing severe damage to native species. Zebra mussels also affect native mussels by attaching in large numbers to any exposed areas of the native mussel's shell. This leads to increased vulnerability to parasitism, interference with movement, suffocation, starvation, and death.

Zebra mussels can form colonies so dense that they carpet the lake or river bottom in a layer several inches thick, eliminating the habitat required by native mussels and other bottom-dwelling animals and reducing the **carrying capacity** of the habitat for native mussel species. Carrying capacity is the maximum number of individuals or inhabitants that a given environment can support without detrimental effects to the habitat or to the organisms. Any firm surface that is not toxic can be colonized by zebra mussels, including boat hulls and motors, trailers, docks, anchors, and rocky beaches. In times of low water, a band of zebra mussels a few inches thick can be seen along the shores in areas of the Mississippi River.

Recent studies have shown that zebra mussels may move toxic materials from the sediments into the food chain in two ways. When they filter algae that have absorbed toxic materials, they ingest those toxins. The toxins can accumulate in the mussel's fatty tissue and be passed on to fish, ducks, or other predators. Or the mussels can release the toxins back into the food chain as waste, which is grazed upon by **amphipods** (small crustaceans, similar to tiny shrimp), which are then eaten by fish.

Commercial Effects

Power plants and water treatment plants located on Lake Erie have experienced 20 to 30 percent reductions in their pumping ability due to zebra mussels clogging the intake pipes. The utilities have spent up to one million dollars annually on controlling and researching the zebra mussel.


©MN DNR, C. Iverson

Commercial fishermen and clammers are beginning to feel the effects of dense infestations of zebra mussels on native clam beds and fish spawning areas. Several formerly productive beds have already been severely damaged by zebra mussel growth.

Recreational Effects

Zebra mussels attach to boat docks and boat hulls. They plug water intake ports, causing outboard motors to overheat. Huge deposits of dead zebra mussels can wash up on beaches, causing foul odors and cutting swimmers' feet with their sharp shells. In Lake St. Clair (located between Lake Huron and Lake Erie), the filtering action of zebra mussels has caused clearer water, allowing more sunlight to reach the bottom, which causes more vegetation to grow. Walleye are being replaced by other fish and are having difficulty reproducing successfully. Other formerly productive Great Lakes area fisheries are also in decline due to loss of food sources and spawning grounds caused by zebra mussel infestation.

Lake- or river-wide control of zebra mussels isn't feasible at this time. Europeans have been unable to find a control after two centuries of infestation. In the Great Lakes, no chemical toxicant has been developed that is both feasible for widespread use and nontoxic to other aquatic species. In North America, the species that are most likely to prey on relatively deep beds of zebra mussels are duck species like scaup, canvasback, and oldsquaw. Freshwater drum (also known as sheepshead) have also been observed feeding on the mussels, and yellow perch have been seen feeding on juveniles, mainly when the young mussels are detached and drifting.

STOP AQUATIC HITCHHIKERS!™

Prevent the transport of nuisance species.
Clean all recreational equipment.

Prevent the Spread of Invasive Zebra Mussels

If you are a water recreationist—a boater, angler, water-skier, sailor, or canoeist—there are some important things you can do to help prevent the spread of zebra mussels to non-infested waters. It is illegal in many states and provinces to transport **invasive species—**those species or types of organisms that are not native and that have been introduced through intentional or accidental means to a place where they weren't originally living.

- Carefully remove all aquatic plants from watercraft, trailers, and equipment.
- Completely drain all water from your boat, motor, and trailer, including live wells, bilges, and bait buckets before leaving an access site. Empty your bait bucket on land—never into the water. Microscopic zebra mussel larvae (veligers) can live in the water for many days.
- Wash everything using water heated to at least 140°F; pressure washers with hot water are most effective.
- Dry boats and trailers thoroughly in the sun for at least five days before using them in other waters.
- Never dip your bait or minnow bucket into one lake if it contains water from another lake.

What Does the Future Hold for Minnesota's Native Mussels?

The Minnesota DNR has initiated a statewide mussel survey project. Information gained about the distribution and abundance of mussels will be used to protect remaining areas where mussels and the water resources that sustain them are healthy, and to target areas where conditions indicate that improvements are needed. Because zebra mussels can rapidly colonize new habitats, it's important for people to recognize this invader so they don't inadvertently spread it throughout the state. To prevent the spread of zebra mussels and other invasive species, the DNR will continue its sustained public awareness campaign, urging boaters and others to carefully remove all aquatic plants from their watercraft, trailers, and equipment. By conserving native mussel habitats, we can maintain the health of the lakes and rivers that are an integral part of Minnesota's quality of life.

Harvest Regulations

No live mussels may be collected in Minnesota without a special permit. No live or dead mussels may be collected in National Park Services units, including the St. Croix River. If you pick up a live mussel, return it to the water immediately: carefully place its foot end in the lake or stream bottom so that about two-thirds of the shell is buried. Currently, a person with a fishing license may possess up to 24 whole or 48 half shells of dead mussels, collected from waters in the open season where fishing is allowed. It's illegal, however, to collect state-listed threatened species.

Procedure

Preparation

1. Collect the materials.
2. Crumple sheets of newspaper or scrap paper to make at least 100 balls (or use 100 plastic golf balls, wiffle balls, or other lightweight substitute).
3. Mark a circle, 20 feet in diameter, with tape, chalk, string, or rope. This area represents a portion of a lake or stream system.
4. In this circle, randomly place two hula-hoops to represent the native mussels' habitat, a soft lake bottom. The rest of the area in the lake is a hard bottom.
5. Within each of the two hula-hoops, stick a small piece of masking tape.

Activity

Warm-up

1. Ask students to list the organisms that live underneath the surface of lakes and rivers in Minnesota. Keep adding to the list until freshwater mussels (or clams) are noted. Discuss with students that Minnesota does have many different kinds of native mussel species. Bring out a copy of the *Mussels of Minnesota* poster, the *Field Guide to the Freshwater Mussels of Minnesota,* by Bernard E. Sietman (available through the Minnesota DNR), and a legally collected native mussel shell (or some other mollusk shell). Have fun noting the colorful, descriptive names of many native mussel species, such as the monkeyface, washboard, winged mapleleaf, ebonyshell, purple wartyback, fawnsfoot, flat floater, threeridge, fatmucket, elktoe and hickorynut. Ask students to discuss why they think each type of mussel was given its name.
2. Discuss the life cycle of the freshwater mussel with students. Make sure to talk about the veliger, which is the free-swimming larval form of the immature zebra mussels. Discuss how mussel glochidia use fish as hosts during a stage of their development. Just as the host of a party provides for the well-being of guests, the fish provides the glochidia (which attach themselves to the fish's gills or other tissues) an opportunity to travel, obtain food, and grow enough to eventually drop off of the fish and fend for themselves in the place where they land.
3. Explain to students the ways in which native mussels benefit Minnesota aquatic ecosystems, including filtering water as they feed, and providing food for other animals, including many types of fish.
4. Have students read, and summarize the newspaper article in the **"Zebra Mussels Crash on Mississippi River" Sheet**. Have students choose four main ideas from the article about the impacts of zebra mussels in Minnesota, and paraphrase those main concepts in a way that their best friend would understand. (To paraphrase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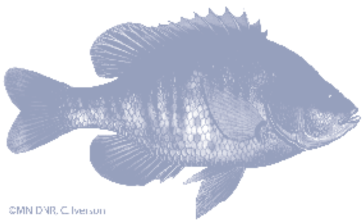


means to generate a new way to explain the main ideas.)

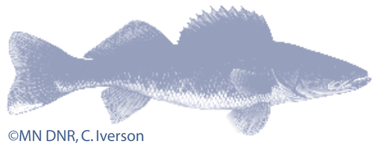
5. Ask students how a mussel called "zebra mussel" might have gotten its name. Show students an illustration of a zebra mussel. Discuss how aquatic species like the zebra mussel aren't native to Minnesota, and how the zebra mussel was transported to Minnesota.
6 Review the four components of habitat with the group: food, water, cover, and space. A body of water has limits on how much of each of these it can provide. The number of animals and plants that can be supported by a habitat without being detrimental is called the carrying capacity. If an invasive species like the zebra mussel in introduced to a Minnesota lake or river and has few, if any, predators, they can thrive and reproduce, creating a large population of the invader in the ecosystem. How might this impact native species in the lake or river?
7 Ask students if they can describe some ways that zebra mussels harm the Minnesota aquatic ecosystems and businesses noted in the newspaper article. Further discuss how invasive or non-native species have been harmful to Minnesota native species and ecosystems.
8 Describe the role of plankton as producers. Hand a copy of the **Plankton Sheet** to each student, or show a projection made from the **Plankton Sheet** to show students illustrations of some different types of freshwater plankton.
9 Tell the students that they will play a game. Each student will be a native mussel, yellow perch, walleye, or zebra mussel trying to meet its habitat needs.

Lesson

1 Have the students gather inside the circle and mill around. Tell them that they are baby native mussels, called glochidia, trying to find a great place to live. They have been traveling around the water body attached to the gills of a host fish and have grown enough to strike out on their own so they're ready to drop off the fish's gills. They'll be asked to mill around to represent drifting in the current after leaving the host fish. Tell students that the circle marks the boundary of an area of a stream, lake, or river.
2 Have the students begin wandering around the circle, drifting in the currents after dropping off the gills of a host fish. Call out "Stop!" Some students will be inside or touching the hula-hoops. Inform students that anyone not standing in a hula-hoop must leave the circle. Explain that native mussels live in muddy or sandy bottoms, which are only represented by the hula-hoops. Still, some remaining immature mussels will not survive to reach maturity.
3 The person nearest the small piece of tape inside the hula-hoop has found the very best spot for good mussel survival and can sit down. Others do not survive (they can't attach well where they landed, they get eaten by a fish or other animal, they don't get enough food, and so forth) and must leave the lake.

4. Over the course of many years, the two surviving young native mussels have grown into adult mussels. Emphasize that finding the right kind of lake or river bottom (space) is very important for the native mussels, and this habitat need limits their numbers.
5. Identify two students as plankton movers. They are the currents moving the plankton (food) into the area. They should sit outside the circle, facing away from the "lake." They will toss plankton (paper balls) at random over their shoulders into the circle. Explain to students that plankton are very small plants and animals that float or swim in the water. Hold up the **Plankton Sheet** to give students a visual image of plankton.
6. The native mussels must catch the plankton in the air to simulate feeding, remaining seated within the hula-hoops as they play. Anything missed stays on the ground until the end of the round.
7. Assign two scavengers to pick up the plankton and return it to the movers. (Later in the game, they'll also return plankton to the movers after retrieving it from the tagged perch.)
8. Tell students that other animals live in balance in the ecosystem with mussels and plankton. Select three students to be yellow perch and add them to the lake. Perch feed on plankton. They move around inside the circle and try to catch plankton in the air. They must catch the plankton without overtly interfering with or blocking the native mussels' feeding. Perch can also feed from the bottom (by picking up stray paper plankton balls).
9. After a few minutes, select two students to be walleye and add them to the lake. The walleye eat the perch. They can move around the outside of the circle, reaching in to eat the perch. Tagged perch must leave the circle and give their plankton to scavengers to return to the movers. As perch are eaten, add more, trying to maintain at least one perch in the circle at all times.
10. The rest of the students are zebra mussels. Begin to add zebra mussels to the lake three at a time. Explain that zebra mussels compete with native mussels for *food* and *space*. Zebra mussels can't live in the soft bottom like the native mussels, but must live on hard surfaces, like rocks, represented by the area outside the hula-hoops. The zebra mussels filter-feed and eat plankton from the water, just as native mussels do.
11. Gradually add more zebra mussels. Explain that, unlike the perch, zebra mussels have very few predators that will feed on them. This allows the zebra mussel population to expand to the limits of their food supply. As it gets crowded, tell the group that, because zebra mussels can stick to hard surfaces, they can sit or stand in the hoops as long as they're either touching each other or a native mussel. Continue until all the native mussels are smothered with zebra mussels or until everyone has had a chance to get back into the game.
12. End the game.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species.
Clean all recreational equipment.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Wrap-up

After the game, discuss the following questions:

1 What happened to the fish and native mussels as more zebra mussels were added to the lake? (Space became increasingly scarce while food became harder to find. Some of the fish and native mussels may have even starved because they couldn't get any food. The carrying capacity of the lake for fish and native mussels decreased as more and more zebra mussels were introduced.)

2 Why are native mussels important? What is their role in the ecosystem? (They're an important food source for many animals, including river otters, raccoons, and several species of fish. Mussels filter or clean the water during their feeding process. They also provide a surface to which bacteria and algae can attach, providing food for even more species that eat these organisms.)

3 How could zebra mussels impact facilities such as water treatment plants (water intake pipes), boat docks, motors, and boat hulls? (Because zebra mussels adhere to hard surfaces, they often clog intake pipes, build up on boat docks, motors, and boat hulls. It costs thousands of dollars remove them, and they just build up again over time.)

4 Why should anglers and recreational boaters always drain the water from their boats, minnow pails, and live wells? (To prevent the spread of harmful invasive aquatic species.)

5 Remind students that zebra mussels start out as free-swimming veligers, unlike native freshwater mussels, and they'll swim off into the next lake if they're allowed to survive the trip in standing water.

6 Discuss how nonnative species are intentionally introduced into an ecosystem. For example, brown trout and rainbow trout have been intentionally introduced as a management tool in some Minnesota cold water streams to provide trout fishing opportunities for anglers. Minnesota's only native stream trout species is the brook trout. As many cold water streams were degraded by human activities ranging from agriculture to logging to land development, many streams no longer supported populations of brook trout. Rainbow trout and brown trout are less sensitive than brook trout. They can survive conditions in some streams that no longer support brook trout.

Assessment Options

1 Have students complete a written summary of the newspaper article about zebra mussels. Evaluate each summary for inclusion of the definition of invasive species, how zebra mussels were introduced to Minnesota waters, and three harmful effects of zebra mussels, including how they impact native species.

2 Have students paraphrase the main concepts in the news paper article in a way that younger students (first graders, for example) might understand, by creating a different way to express the same concepts about impacts of zebra mussels in Minnesota waters. They could express the concepts by creating a play, a picture book, a zebra mussel game, and so forth.

3 Create and perform a skit on how zebra mussels affect other aquatic organisms. Include the characteristics and behaviors that allow zebra mussels to take over Minnesota water habitats and overtake or out-compete native aquatic organisms.

4 Draw or describe the life cycle of a freshwater mussel. Include three reasons why native freshwater mussels are important parts of the aquatic ecosystem.

5 Assessment options include the Checklist and Rubric on the following pages.

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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

30-33 points = A
Excellent. Work is above expectations.

26-29 points = B
Good. Work meets expectations.

21-25 points = C
Work is generally good. Some areas are better developed than others.

17-20 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-16 points = F
Work is unacceptable.

Mussel Mania Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Student faces the audience and speaks clearly and loudly enough for audience to understand presentation.
2	______	______	Student can explain that zebra mussels are not native to Minnesota waters.
3	______	______	Student can define *native species*, *invasive species*, and *harmful invasive species.*
3	______	______	Student can describe how zebra mussels are harmful to native species and to people.
3	______	______	Student can describe how zebra mussels came to Minnesota waters.
3	______	______	Student understands how zebra mussels spread as veligers.
3	______	______	Student can describe three other ways that zebra mussels spread to uninfected waters.
6	______	______	Student can describe multiple effects of zebra mussels on other aquatic organisms and the characteristics that enable that effect.
4	______	______	Student can describe the life cycle of mussels and explain how the life cycle is connected to fish.
3	______	______	Student can describe three ways in which native mussels are important to an ecosystem.
Total Points 33	______	______	**Score** ______

Mussel Mania Scoring Rubric

Performance Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Presentation	Faces the audience and speaks clearly and loudly enough for audience to understand presentation.	Speaks clearly and loudly enough for audience to understand, but didn't face audience.	Hard to understand due to lack of volume, body position, and speech clarity.	Not at all understandable.	Didn't present to audience.
Invasive zebra mussels	Can explain that zebra mussels are not native to Minnesota waters; can describe how they're harmful to native species and to people; can describe how they came to Minnesota waters.	Can explain why zebra mussels are considered an invasive species in Minnesota, and that they're harmful to native species.	Can identify that zebra mussels are considered an invasive species in Minnesota waters.	Can't identify zebra mussels as an invasive species in Minnesota waters.	Doesn't understand invasive species concept.
Spread of zebra mussels	Understands how zebra mussels spread as veligers; can describe three other ways that zebra mussels spread to uninfected waters.	Understands that zebra mussels spread widely; can describe two ways that zebra mussels spread.	Understands that zebra mussels spread widely and can give one reason why.	Has little understanding of how zebra mussels spread.	Has no understanding of how zebra mussels spread.
Impacts of zebra mussels on other aquatic organisms	Describes multiple effects on other aquatic organisms and the characteristics of zebra mussels that enable those effects.	Describes one effect on other aquatic organisms and the characteristics of zebra mussels that enable that effect.	Describes one effect on other aquatic organisms but doesn't understand that characteristics of zebra mussels can enable this effect (or vice versa).	Can't accurately describe any effects on other aquatic organisms or characteristics of zebra mussels.	Doesn't describe any effects on other aquatic organisms or characteristics of zebra mussels.
Life cycle and importance of native mussels	Accurately draws or describes the life cycle of a freshwater mussel, including how its life cycle is connected to fish; explains three reasons why native freshwater mussels are an important part of the aquatic ecosystem.	Accurately draws or describes the life cycle of a freshwater mussel and explains two reasons why native freshwater mussels are an important part of the aquatic ecosystem.	Can define life cycle; knows that freshwater mussels progress through life stages in their life cycle as they mature; can explain one reason that native freshwater mussels are and important parts of the aquatic ecosystem.	Can define life cycle; can explain one reason why native freshwater mussels are an important part of the aquatic ecosystem.	Can't define life cycle and doesn't know why fresh water mussels are important.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Make an informational poster about a harmful invasive aquatic species (plant or animal) in Minnesota. Examples include purple loosestrife, Eurasian water milfoil, curly leaf pondweed, yellow iris, flowering rush, Eurasian ruffe, round goby, spiny water flea, sea lamprey, rusty crayfish, white perch, and Asian carp. Display the posters throughout the community (at places such as bait shops, boat sales shops, and gas stations) or otherwise share them with people outside of class. See the Minnesota DNR website for information on aquatic invasive species.

2 Invite a local resource person to talk with your class about managing a lake or stream that is infested with a harmful invasive species. An *Aquatic Invasives* learning trunk is available through the Minnesota DNR MinnAqua Program.

3 Check the Minnesota DNR website and the Minnesota Sea Grant website for suggestions on how to help stop the spread of other harmful invasive species such as Eurasian water milfoil and purple loosestrife (plants), and Eurasian ruffe, Asian carp, and round goby (fish).

4 Have students identify other harmful invasive species and discuss how they may have moved from their native areas of the world to North America. Trace their paths to North America on a map. Was the introduction of this species a result of human activity? How did it happen? Was the introduction accidental or intentional? Discuss preventative measures that people should take to slow the spread of these invasive species. Have students design a method to stop the future unintentional introduction of invasive species to Minnesota waters.

5 Have your class write and perform an informational skit about a harmful invasive species and how it impacts native species. Include the preventive measures people should take to stop the spread of these invaders to uninfested Minnesota waters. Title possibilities include *Zeroing in on the Zebra Mussel, Losing Loosestrife, Sending the Sea Lamprey Packing, Flex Your Muscle Against Zebra Mussels, Foiling Eurasian Milfoil,* or *See Ya, Sea Lampreys*. Videotape the skit. Perform the skit, or show the video program of the skit to your local city council.

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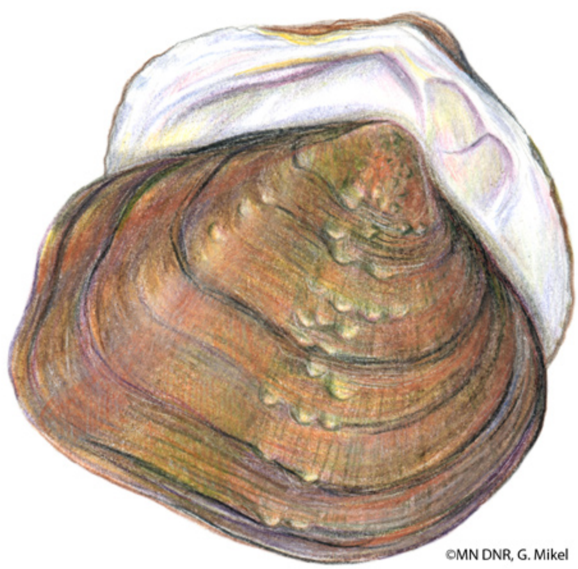
For the Small Fry

K-2 Option

1. Play the Mussel Mania game. Emphasize how the amount of available food can affect the number of organisms that live in a lake or river, and discuss the impact of a harmful invasive species on an ecosystem.
2. Instead of the Mussel Mania game, have students play the tag game in **Lesson 1:2—Food Chain Tag** to learn the concept that food is a limiting resource for aquatic organisms such as fish.



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"Zebra Mussels Crash on Mississippi River" Sheet

August 7, 2003

By **John Weiss**; Reprinted with permission from *The Post-Bulletin*, Rochester, Minnesota

The feared zebra mussel, an invasive species that invaded the Mississippi River and Lake Pepin in this region about a decade ago, crashed nearly two years ago and shows no sign of returning.

The only remaining evidence of the tiny striped mussels on the lake, a large natural reservoir of the river, are piles of fading shells littering the shore.

They are not showing up on boat hulls, on metal debris in the lake, nowhere on the lake or in the river, said John Hoxmeier, Department of Natural Resources large-lake specialist.

In the late 1990s, the DNR would find the mussels attached to any metal object, such as old bait buckets, it pulled up when trawling as part of studies. But this year, none were found, he said. "It took us completely by surprise," he said.

One theory is that the hot weather warmed the water in late 2001 and they were killed off, he said. Another thought is that, like other invading species, their numbers exploded when they entered a new ecosystem. That overtaxed the new environment and the population was killed off. Invasive species often come back, but not in such large numbers as they began with, he said.

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Zebra mussels exploded in such huge numbers that they would stack up inches thick on native mussels and kill them. Mike Davis, who monitors native mussels for the DNR, said he has noticed a significant reduction in zebra mussels on native mussels.

At the Lake City Marina, boats that were in the harbor but not used for a few months, would often develop engine problems because the zebra mussels would get into water intakes and clog them, said harbormaster Mark Lutjen. They were more of a nuisance than a serious headache, he said.

Helen Coffman, owner of Wabasha Marina in Wabasha, has seen the same thing. They would attach to docks and other hard surfaces. Like Hoxmeier, she has noticed a huge dropoff in their numbers beginning last fall when they took boats out of the water and didn't see the small mussels.

While the death of the zebras has been welcome, Davis said he's not celebrating. "We're not out of the woods yet," he said. If hot weather did kill them, some could have survived and they could recolonize the lake and river, he said.

While the zebra mussels died back in the Mississippi system, they have shown no sign of disappearing from Lake Zumbro, north of Rochester, said Joe Hensel, environmental specialist with Rochester Public Utilities. RPU owns the dam that created the lake on the Zumbro River.

"Lake Zumbro is still loaded," he said.

If the same thing happens on Lake Zumbro as is happening on the Mississippi, "that would be a great turn of events," he said.

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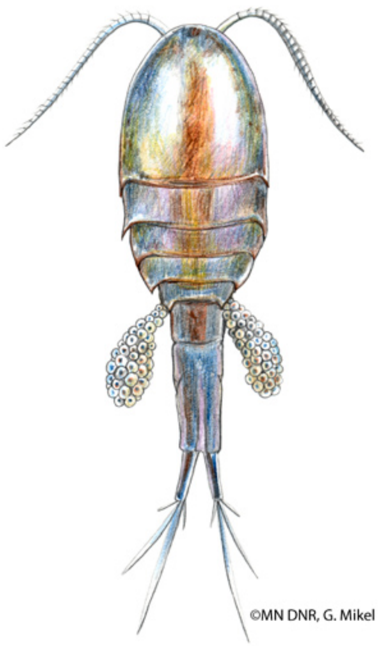
Plankton Sheet

Plankton are tiny organisms. Many float freely (or drift) in the water, and are eaten by mussels and fish.



Cyclops
(Copepod)

Rotifer

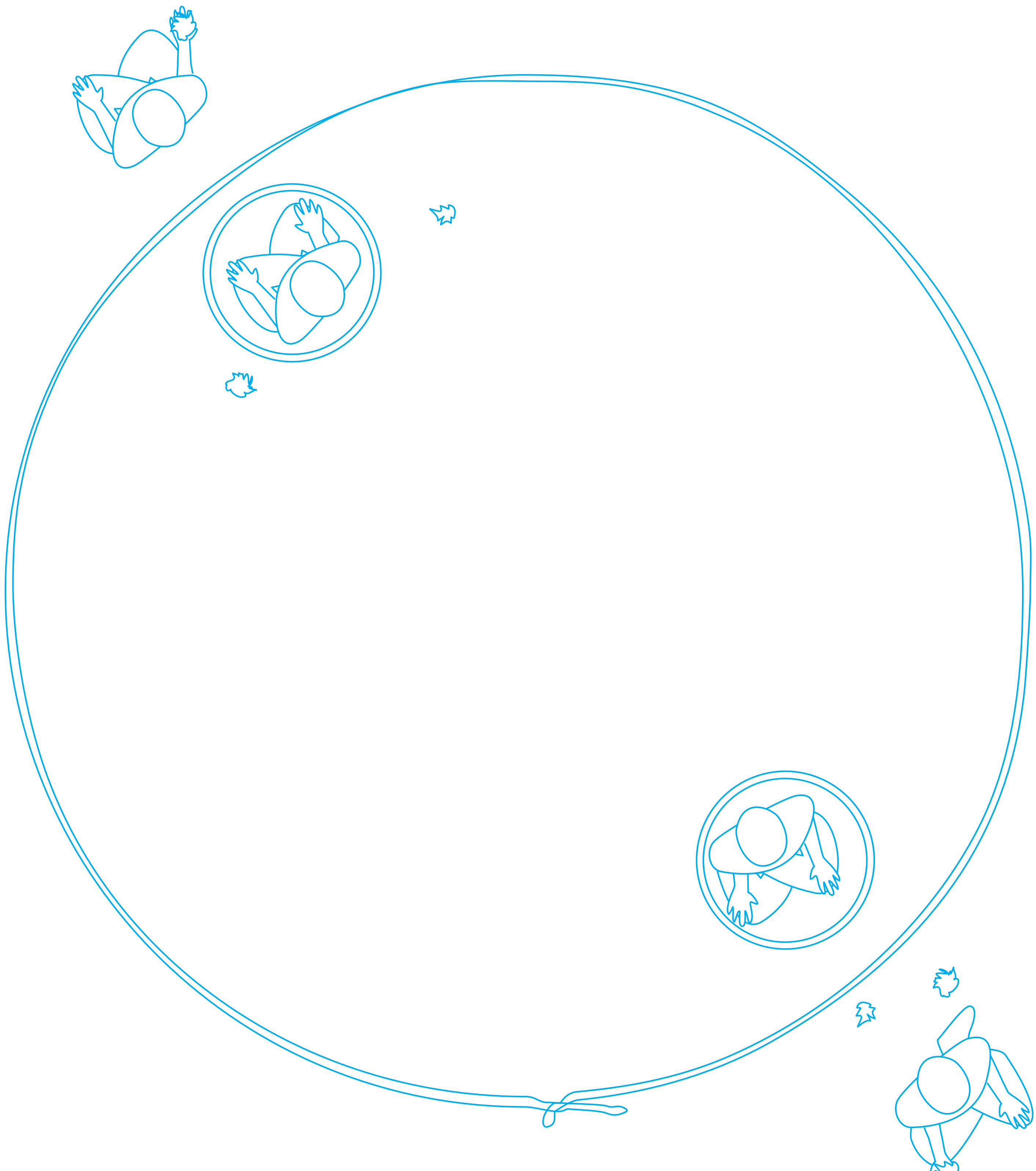
Water Flea or Daphnia

Spirogyra and Pediastrum
(Green Algae)

Anabaena
(Blue-Green Algae)

Diatoms

Mussel Mania Playing Field Set-up



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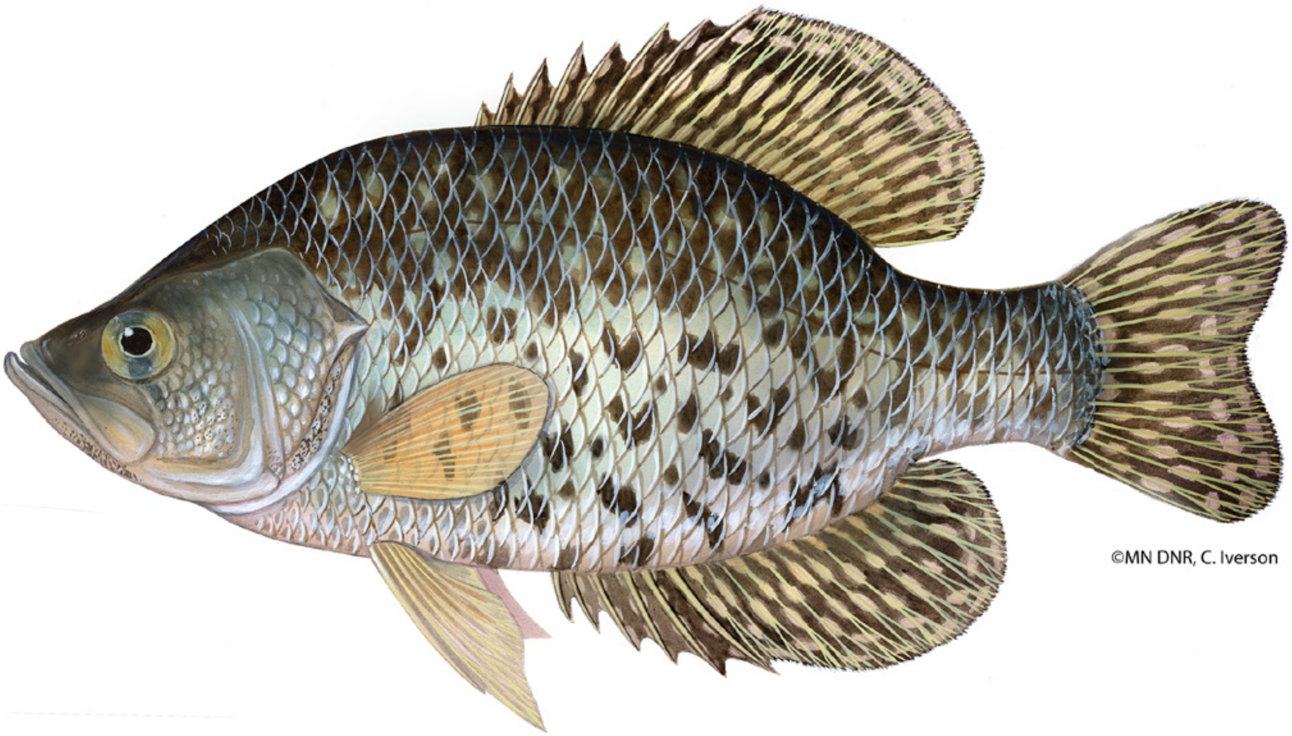


Fish Management

The Minnesota Department of Natural Resources works with people to conserve natural systems and maintain biodiversity while providing for the sustainable use of resources for social and economic purposes.

What Will the Students Learn?

All of us use natural resources and share the responsibility for ensuring a sustainable quality of life in our state. Through roleplaying and problem solving, students learn that the Minnesota DNR works with citizens to manage the state's natural resources. This is a big job, and all of us must play a part in this effort.

Chapter Concepts

The Minnesota DNR mission statement focuses the agency's efforts to manage the state's resources:

"Our mission is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life."

Minnesota citizens must possess the awareness, knowledge, and skills to work with the Minnesota DNR to address and solve resource management issues. Students learn how and by whom Minnesota's fisheries resources are managed, and, by practicing various citizenship skills, they'll learn how they can participate in an informed manner. Students discover the varied perspectives and values of diverse user groups, reflect on their personal values, consider requirements for healthy ecosystems, wrestle with compromise and consensus, and investigate and address some fisheries management issues.

Working Together to Manage Natural Resources

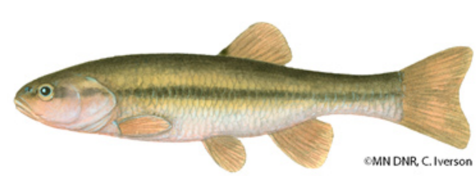
Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

Why are rules and regulations necessary? Why do we manage our natural resources? Population growth and development place increased demands on the environment, encroach upon habitat, and threaten the viability of ecosystems and plant and animal diversity. Many people work together to manage our aquatic and fisheries resources, including citizens, natural resource agencies, businesses, conservation groups, the tourism industry, sportsman's and recreation groups, recreational anglers, commercial fishers, community representatives, legislators, and many others. Sometimes users' needs conflict. There are a variety of tools or methods that fisheries managers employ to help resolve natural resource issues, including rules and regulations. In determining and applying regulations and other management tools, effective resource management considers the diverse needs of user groups as well as the needs of healthy ecosystems. The goal is to ensure quality of life for Minnesota citizens and to strive for conservation, and sustainable use of the state's natural resources.

Conservation Versus Preservation

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

It's important to understand that preservation and conservation play different roles in resource management plans. Preservation efforts ensure that resources remain intact, and often allows only minimal human disturbance. Conservation involves the responsible use of renewable resources. Sound science and research based management practices help us safely use natural resources without jeopardizing the continued supply of the resource or the viability of ecosystems.



"Individually, each of us can do only a little. Together, we can save the world."

—Denis Hayes, Coordinator of the first Earth Day

Fisheries Management Issues

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

As Minnesotans, we enjoy our state's abundant natural resources—and hold varying views about their use. Students learn how the Minnesota DNR utilizes a combination of public input and scientific management tools to meet the most needs and ensure sustainable use of resources. These are some major issues addressed by Minnesota DNR fisheries managers, Minnesota anglers, and citizens:

Experimental regulations—Biologists maintain that limiting the harvest of some sizes of fish is the most effective way to improve the average size of fish that anglers catch. With sound research, the Minnesota DNR continues to learn which regulations work best for various waters and species.

Bag limits—As they gather research data and input from anglers and others, fisheries managers and researchers examine the biological and social impacts of existing and proposed bag limits. (A bag limit is the number of fish of a particular species an angler may legally possess.)

More pressure, better gear—Fishing pressure has continued to increase since the 1950s, and continual improvements in technology and fishing gear have made anglers more effective at finding and catching fish—yet the number of fishing waters remains constant. Fisheries managers seek ways to address the issue of providing quality fishing opportunities despite increased fishing pressure.

Invasive species—Harmful aquatic plant and animal species, such as the zebra mussel, round goby, spiny water flea, ruffe, and Asian carp, increasingly threaten permanent harm to Minnesota's fish populations and fishing. These invasive species and others can displace native fish species and alter the food chain that supports game fish. Everyone shares responsibility for reducing these risks by limiting the spread of invasive species.

Stocking Up

In 2003, the Minnesota DNR stocked 165,000 pounds of walleye fingerlings and yearlings, surpassing that year's goal of 130,000 pounds. Those fish began to reach keeper size (about fourteen inches long) in 2006. Approximately 900 Minnesota lakes are stocked with walleye, but 86 percent of the state's annual walleye harvest comes from naturally-reproduced fish.

Fisheries Management: Tools of the Trade

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

Students play roles, discover the environmental consequences of some everyday choices and decisions, simulate public meetings and fisheries management techniques, and conduct experiments. They learn that—through public input, surveys, and data collection—fisheries biologists and managers determine the best management tools for meeting demands placed on aquatic resources by land use practices, development, wide-ranging public interests, and diverse user groups. Prevalent fisheries resource management tools include:

Gathering information—This is accomplished through direct observation and comprehensive

lake and stream surveys of fish populations, fish habitat, and fishing activities. Information from lake and stream surveys forms the foundation of every Minnesota DNR fisheries management activity.

Restoring and conserving habitat—Lakes and streams with the best fishing usually have the healthiest fish habitat. Each year, the Minnesota DNR teams up with a growing number of fishing clubs and lake associations to improve and conserve fish habitat on dozens of lakes and streams statewide. Restoring natural vegetation can cut maintenance costs, deter unwanted pests (such as Canada geese), attract butterflies and songbirds, and improve fish habitat in shallow water. Plants help prevent eroding shorelines from sending sediment into the water, where it smothers fish eggs and the underwater insects that fish eat. Plants also filter runoff, stabilize banks, and impact water temperature.

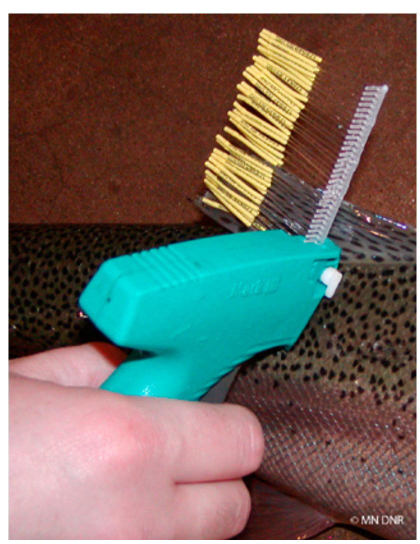
Stocking fish—On each lake, fisheries managers must balance the cost and the benefits of stocking, calculate the likely effects on other fish populations, and evaluate the results of previous stockings. Only then can they recommend the stocking of a lake.

Adjusting regulations—On 90 lakes and 25 streams and rivers, the Minnesota DNR has established experimental fishing regulations to protect certain sizes of various fish species. These regulations are called experimental because researchers are studying their effects on fish populations and angler harvest. In time, the researchers will determine which regulations work best for improving fishing for certain species on certain lakes. The goal is to eventually establish a range of regulations that local fisheries managers can offer to anglers seeking to improve fishing on local lakes and streams.

Informing and educating—Providing information and educating Minnesotans, including anglers, lakeshore owners, and children, is among the most important work that the Minnesota DNR does. Anglers are particularly interested in Minnesota DNR fisheries information. The Minnesota DNR website gets more than 60,000 daily "page hits," mostly from people checking lake survey reports. In spring, the Minnesota DNR Information Center gets hundreds of phone calls and email requests daily—mostly from anglers. Local fisheries managers meet regularly with many of the more than 300 fishing groups and 600 lake associations throughout the state. They listen to concerns, present lake survey information, propose experimental regulations, and discuss the state of local lakes and streams. Fisheries managers also give presentations to school and civic groups, speak regularly on radio programs, provide information to reporters, and field questions from visiting anglers and real estate agents. Fisheries managers also appear at fairs and other large events.

"In every deliberation, we must consider the impact of our decisions on the next seven generations."

–Great Law of the Iroquois Confederacy, eighteenth century



"If we can't work together, we can't make it work."
–Source unknown

MinnAqua Program—To increase public-knowledge of lakes, streams, and fisheries, the Minnesota DNR developed the MinnAqua aquatic education program. Its primary goal is to teach fishing skills and provide basic instruction on lake and stream ecology, fisheries management, stewardship, and angling sportsmanship. MinnAqua is a statewide program. The education staff develops many partnerships and works with schools, scout groups, 4-H groups, parks and recreation departments, community education programs, camps, state parks, nature centers, immigrant groups, parent and child groups, senior citizen groups, special needs groups, festivals, fairs, Environmental Education field days, sport shows, and other concerns to promote angling and aquatic education.

Providing increased access—If anglers can't get to the water, it doesn't matter how good the fishing may be. To provide anglers with access to Minnesota public lakes and rivers, the Minnesota DNR works with communities throughout the state on projects that include installing and maintaining fishing piers and constructing fishing platforms and boat ramps on public lakes and rivers. To provide access to trout streams, which are also public waters, fisheries managers buy easements from willing sellers.

Fishing in the Neighborhood Program (FiN)— FiN provides great fishing opportunities for residents and visitors in the Minneapolis-St. Paul metropolitan area. Since 2001, this urban fishing program has been working to expand Twin Cities fishing opportunities. With local partners, FiN stocks fish, installs fishing piers and platforms, restores shoreline habitat, and sponsors MinnAqua education programs.

Conducting research—Researchers assist fisheries managers in understanding and determining scientific solutions for improving fishing and effectively managing aquatic resources.

Multiple Use, Consensus, and Compromise

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

Integrated Resource Management means that the Minnesota DNR works to achieve mission results through partnerships and communication with other agencies, organizations, and community members. A critical balance must be achieved in considering multiple values and needs for resource use. This requires interdisciplinary coordination, ecosystem-based approaches, and sustainability considerations. Students practice the skills of identifying multiple users of an aquatic or fisheries resource, working out compromises, and reaching consensus in addressing environmental issues at the local level.

Citizenship and Personal Responsibility

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:3—Aquatic Plant Power
Lesson 4:4—Town Meeting
Lesson 4:5—Fisheries Management and You

All of us use natural resources and share responsibility for using them in a sustainable manner. Minnesota needs environmentally literate and engaged stewards who will work to ensure that present and future generations will enjoy a rich natural heritage and a healthy environment. As human populations grow, demands on our natural resources increase. This makes it even more important for everyone to make informed, sustainable stewardship choices and decisions.

Fisheries Careers

Lesson 4:1—Fishing Regulations and Sportsmanship
Lesson 4:2—Fish Surveys
Lesson 4:3—Aquatic Plant Power
Lesson 4:5—Fish Management and You

Students that enjoy fish and wildlife, the outdoors, learning about nature and ecosystems, and are passionate about working to ensure a healthy environment may be suited to a career in fisheries management. There are many fisheries professions to explore. A strong background in science and social studies is recommended for those who aspire to fisheries positions, but experience in aquatic environments (wetlands, lakes, rivers, and streams) through fishing, observing plants and wildlife, and comparing different habitats, can give students an impression of what it's like to work in a fisheries-related field.

The lessons and activities in this chapter give students some primary insight into many different types of fisheries management professions, including: fisheries biologists, research scientists, fisheries managers and program coordinators, engineers, botanists and aquatic plant specialists, habitat environmental planners, entomologists, educators, and conservation officers.

Stewardship: A Call to Action

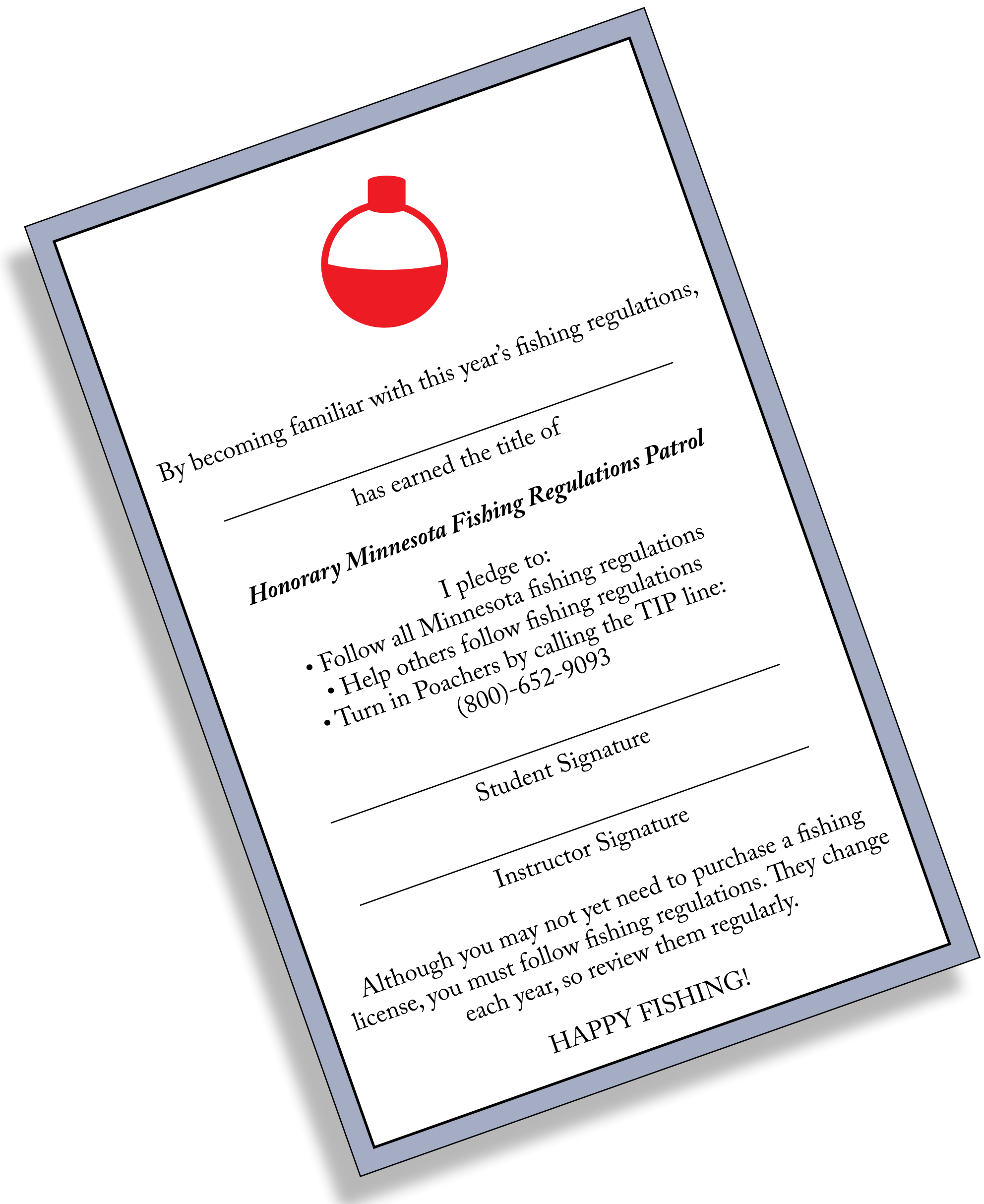
Service-learning Appendix

All of us use natural resources. And we're all fisheries resource managers, too, in a way. Fish are a significant natural resource in Minnesota in terms of food, economics, and recreation. Fish are also critical components of healthy aquatic ecosystems.

What can students do to help conserve and manage Minnesota's water and fisheries resources? Can one person make a difference? Using their knowledge and skills related to water, aquatic habitat, and fisheries management, students can become involved in their communities, actively addressing and solving environmental issues and participating in service activities. Service-learning provides students with a framework for this involvement. They identify a local water habitat or fisheries issue, seek community partners, and design a project that addresses an issue. The completion of a service-learning project empowers students and helps them become active citizens and stewards of fisheries resources.

Fishing Regulations and Sportsmanship

Following regulations and practicing good sportsmanship makes fishing fun for everyone!



By becoming familiar with this year's fishing regulations,

has earned the title of

Honorary Minnesota Fishing Regulations Patrol

I pledge to:

- Follow all Minnesota fishing regulations
- Help others follow fishing regulations
- Turn in Poachers by calling the TIP line: (800)-652-9093

Student Signature

Instructor Signature

Although you may not yet need to purchase a fishing license, you must follow fishing regulations. They change each year, so review them regularly.

HAPPY FISHING!

Table of Contents

Chapter 4 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fishing Regulations and Sportsmanship

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark. in

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading.
II. Writing
D. Research:
Benchmark 1—The student will use grade-level-appropriate reference materials to obtain information from dictionaries, glossaries, encyclopedias, and the Internet.

Grade 3
I. Reading and Literature
C. Comprehension:
Benchmark 1—The student will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.
II. Writing
C. Spelling, Grammar, and Usage:
Benchmark 1—The student will compose complete sentences when writing. (Assumed)
Benchmark 5—The student will apply grammar conventions correctly in writing, including:
a. nouns
b. verbs
c. adjectives
d. pronouns

Benchmark 6—The student will apply punctuation conventions correctly in writing, including:
a. periods, question marks, exclamation points
b. capitalization of proper nouns
c. abbreviations
d. sentence beginnings
e. commas in a series
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different purposes. (one audience)
Benchmark 6—The student will perform expressive oral readings of prose, poetry, or drama.

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 1—The student will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions about what is read to demonstrate understanding.
II. Writing
B. Elements of Composition:
Benchmark 1—The student will write topic sentences.
Benchmark 4—The student will create informative reports, including gathering material, formulating ideas based on gathered material, organizing information, and editing for logical progression.
Benchmark 5—The student will use verbalization (discussions, interviews, brainstorming) to prepare for writing.

III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes. (one audience)
Benchmark 5—The student will perform expressive oral readings of prose, poetry, or drama.

Grade 5
I. Reading and Literature
C. Comprehension
Benchmark 1—The student will read aloud grade-appropriate text (that has not been previewed) with accuracy and comprehension.
Benchmark 7—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.
II. Writing
C. Spelling, Grammar and Usage
Benchmark 1—The student will compose complete sentences when writing. (Assumed)
Benchmark 4—The student will apply grammar conventions correctly in writing, including:
a. verb tense
b. prepositional phrases
c. adverbs
d. subject and verb agreement with simple subjects
e. possessive pronouns and plural possessives.
Benchmark 5—The student will apply punctuation conventions correctly in writing, including:
a. apostrophes
b. capitalization of proper nouns
c. abbreviations
d. sentence beginnings
e. commas
f. quotation marks
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes. (one audience)
Benchmark 6—The student will perform expressive oral readings of prose, poetry or drama.

History and Social Studies

Grade K–3
VI. Economics
B. Producers and Consumers:
Benchmark 1—Students will distinguish between producers and consumers and between goods and services.
VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Standard: The student will describe civic values, rights, and responsibilities in a republic.
Benchmark 1—Students will demonstrate knowledge of civic values that facilitate thoughtful and effective participation in civic life.
B. Beliefs and Principles of United States Democracy:
Standard: The student will understand the role of government, rules, and law and why we have them.
Benchmark 1—Students will give examples of rules in the classroom/school and community, provide reasons for the specific rules, and know the characteristics of good rules.
Benchmark 2—Students will explain that rules and laws apply to everyone and describe consequences for breaking the rules or laws.
D. Governmental Institutions and Processes of the United States:
Benchmark 1—Students will describe examples of specific services provided by government. (Public forums for local decision-making, Department of Natural Resources to manage and protect natural resources.)

Grade 4–8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.
VI. Economics
B. Economic Choices:
Benchmark 2—Students will apply a decision-making process to make informed choices.

VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 2—Students will explain some of the responsibilities citizens have in a democracy.
Benchmark 3—Students will identify and research community problems and recommend solutions.
B. Beliefs and Principles of United States Democracy:
Benchmark 1—Students will explain how law limits both the government and the governed, protects individual rights, and promotes the general welfare.

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and possible solutions.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK–2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK–2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK–2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3–5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched, or misconnected. (3–5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 4 • Lesson 1

Fishing Regulations and Sportsmanship

Grade Level: 3–5
Activity Duration: 50 minutes
Group Size: any
Subject Areas: Language Arts, Social Studies, Science
Academic Skills: communication, gathering, listening, presentation skills, reading, researching, role-playing
Setting: indoor or outdoor gathering area
Vocabulary: culling, conservation officer, daily limit, invasive species, one-over limit, open season, poaching, possession limits, regulations, sportsmanship
Internet Search Words: catch-and-release fishing, turn in poachers; on Minnesota DNR website: conservation officer, fishing regulations, natural resources careers, turn in poachers

Summary

Students participate in a scavenger hunt for answers to questions derived from the Minnesota fishing regulations booklet. They explore how fishing regulations are laws that help maintain healthy fish populations and aquatic natural resources. Personal responsibility and choices made by citizens involving unwritten rules of sportsmanship also play a role in managing our state's resources. Students act out a short skit in response to a situation card that poses a fishing dilemma. They use the regulations booklet to defend or explain their choices and actions, then decide whether their decision was based on regulations or good sportsmanship.

Student Objectives

The students will:

1. Discover answers to questions about the current year's fishing regulations and discuss these issues as a group.
2. Write or ask questions about fishing regulations and offer answers.
3. Choose from a list of possible responses to fishing-related dilemmas and participate in a skit or discussion that explains or defends the chosen action.
4. Understand the difference between regulations and sportsmanship and describe why both help conserve resources, protect fish populations, promote healthy ecosystems, and ensure people's enjoyment of fishing.

Instructor's Background Information

Regulations

Fishing is one way that people enjoy Minnesota's many beautiful lakes and streams and the plants and animals that inhabit them. From boat fishing, to shore fishing, to ice fishing, we're fortunate to enjoy this sport in many waters throughout the year. To ensure that anglers will enjoy our lakes and streams for years to come, anglers must fish responsibly and respectfully. One of the simplest ways for anglers to show respect for our lakes, streams, and fish is to follow the "rules of the river" or the "laws of the lake," the Minnesota Fishing Regulations.

State fishing **regulations** are fishing laws designed to maintain healthy fish populations. They're also used in response to varying economic, social, and cultural demands on the state's fisheries. The Minnesota Department of Natural Resources is responsible for managing, conserving, and regulating state resources, including fish and aquatic resources. Every year, the DNR publishes *Minnesota Fishing Regulations*, a booklet summarizing state fishing regulations. Because it's just a summary, the regulations booklet contains only a portion of the statutes and rules regulating fishing. It's the angler's responsibility to know—and to follow—all regulations applying to fishing and aquatic natural resources. These can be found by searching "fishing regulations" in Statutes and Rules under the Minnesota State Legislature website. **www.leg.state.mn.us**

Anglers aged 16 and over are required to carry a fishing license, but all anglers—including children—must follow the regulations. Fishing

Materials

- Current Minnesota fishing regulations booklets, one per student (available at any DNR office, from the DNR website at **www.mndnr.gov**, or wherever fishing licenses are sold; new regulations booklets are printed annually)
- **Sample Scavenger Hunt Questions and Answers**
- **Angler Situation Cards**, one set for students and one set (containing answers) for instructor
- **Fishing Regulations Patrol Cards**, one per student

licenses (and trout stamps, for those who fish for trout) are required to fish legally. The income generated by license sales helps fund DNR efforts to manage and conserve the resources anglers enjoy. By fishing, anglers support the conservation of our state's fisheries and aquatic habitats.

Seasons and Limits
The regulation booklet contains important information on seasons and limits. **Open season** is the time of the year during which anglers may fish for a certain species (or type) of fish. It is legal to fish for that particular species only during its open season. Catch-and-release fishing for any species is not allowed when its designated season is closed. If a fish is accidentally caught out of season, it must be returned to the water immediately. Open seasons generally help to protect fish while they're reproducing (spawning). However, not all species of fish have a designated fishing season—some, such as crappies, bluegills, and perch, may be caught and kept all year long.

The booklet also provides information on **daily** and **possession limits**. A **daily limit** is the number of a particular species that you may take from any water in one day. A **possession limit** is the total number of a certain species, or combination of species, that an angler may possess at any given time, both on or off the water. Fish are in possession if they're on hand, in cold storage, in transport, or elsewhere the angler has placed them. For example, if an angler is fishing on a lake for which the northern pike limit is three, and that angler already has one northern pike in the freezer, that angler cannot keep more than two northern pike caught on that fishing trip. Otherwise, the angler will have more than three fish in possession. Minnesota's daily limits are primarily the same as possession limits. An exception is yellow perch, for which the limits are 20 daily and 40 in possession. In this case, if an angler catches 20 yellow perch one day and puts them in his freezer, that angler may catch and keep 20 additional the next day.

A limit prevents the commercialization of sport fishing and distributes the catch among anglers. In addition to possession limits, **one-over limits** are posted for some fish under possession. For example, an angler may keep three northern pike in one day, but no more than one northern pike more than 30 inches long may be taken each day. The one-over limit allows for the harvest of a trophy fish that an angler might catch once in a lifetime.

Once an angler has reached their possession limit, no **culling** (sorting and removing) of that species is allowed. For instance, if an angler already has six walleye in a live well (the water-filled fish storage area of a boat), and then catches a walleye bigger than one in the live well, it's illegal to replace the smaller fish in the live well with the larger fish. This is because the sooner a fish is released back into the water after it's caught, the better chance its chances for survival. A fish that has been on a stringer, or in a live well, is more stressed and less likely to survive if released.

Another section of the regulations booklet covers treaty, experimental, and special regulations. Some water bodies are closely studied and managed by the DNR on an individual basis, or are located within ceded territory (lands obtained by the U.S. from Indian bands). Treaty, special, and experimental regulations override the general regulations that apply to other lakes and streams throughout the state. Special regulations may apply to possession limits, size limits, and transport of fish. It's important for anglers to find out if any special regulations apply to the lake they're planning to fish.

Commercial harvest and tournament fishing are also regulated by the Minnesota DNR.

Invasive Species
Preventing the spread of nonnative or **invasive species** is discussed in the regulations booklet. It's illegal to transport certain invasive species, or to transport water from invasive species-infested lakes, because invasive species can be inadvertently transported in that water. Native species are organisms that normally live and thrive in a particular environment, such as Minnesota waters. An invasive species is one that migrated to the area, or was deliberately or accidentally introduced to the area from a distant location. Invasive species can pose a threat to Minnesota waters, native plants and animals, and ultimately, to fishing. To prevent the spread of invasive aquatic species, all anglers and other users of the water should be sure to remove plants and animals from boats, trailers, and equipment before leaving the water body. All water from the boat, motor, and live well must be drained before leaving the water body. Boats, fishing gear, and other wet equipment should be rinsed with hot (at least 140°F) tap water, or dried for at least five days before re-use in a different water body. If anglers plan to fish a number of lakes in one day, they must make sure that any equipment that has been used in waters containing invasive species—including boats, bait buckets, and even fishing poles—is not subsequently used in non-infested waters. A list of infested waters is posted on the Minnesota DNR website. Anglers should also discard unwanted bait in the trash—never on land or in water.

STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species.
Clean all recreational equipment.

Other Information in the Minnesota Fishing Regulations Booklet
The fishing regulations booklet also provides helpful information on fish identification, state record fish, and boating safety. All the booklet topics help anglers learn more about Minnesota's fisheries resources. Following regulations helps secure the future of fishing.

Consequences of Disregarding Regulations
Although most anglers use our natural resources responsibly, some do break the law, either deliberately or through ignorance. A person caught breaking a fishing law may be required to surrender their fish and fishing equipment (including their boat if the violation involved the use of the boat), their fishing license for a period of time, pay a fine based

To reach the Minnesota DNR Turn in Poachers (TIP) Hotline, dial 1-800-652-9093.

on the severity of the crime, or a combination of all these consequences. Even if a person isn't caught, they're cheating themselves as well as the other people who use the resource. The lawbreaking angler endangers the sustainability of the very natural resources enjoyed while fishing.

The Enforcement Division of the Minnesota Department of Natural Resources is responsible for enforcing natural resource regulations. DNR **conservation officers** (licensed peace officers trained in conservation regulations) enforce all regulations, including fishing regulations. Conservation officers also respond to tips from citizens who witness natural resource violations. By reporting witnessed incidences of **poaching**—the harvest of more fish or game than the law allows—citizens can help conservation officers protect and conserve aquatic natural resources. Citizens can report suspected poachers through a Minnesota-based program called **TIP (Turn In Poachers)**, a private, nonprofit organization of conservationists concerned about poaching problems. TIP provides all reward monies for this program. The DNR cooperates with the TIP program, whose purpose is to encourage the public to report natural resource violations. The information and the identity of the person reporting is kept confidential. The TIP phone number is (800) 652-9093.

Angling Sportsmanship

Although fishing regulations are written rules that apply to sport fishing activities, good sportsmanship can be described as the unwritten code of conduct that governs fishing behaviors. Good **sportsmanship** is based on common courtesy and a sense of stewardship of natural resources. It derives from, and results in, respect for oneself, for others, and for the environment.

Good sportsmanship *excludes* behavior that interferes with the fishing enjoyment of others, such as throwing rocks near where someone is fishing, fishing too close to another angler, playing loud music, or driving a boat or jet ski near another angler's fishing location. Good sportsmanship *includes* harvesting only enough fish for your immediate needs, practicing proper catch-and-release methods, leaving your fishing site cleaner than you found it, and treating the environment and living organisms with respect. An angler practicing good sportsmanship respects others and practices good stewardship of the fish and water resources.

Even though there are no written codes of personal conduct to follow when fishing, it's essential that all of us take responsibility for teaching and following the written regulations as well as the unwritten code of sportsmanship as we fish. Modeling good sportsmanship while fishing with others is essential—it ensures that these unwritten rules of conduct are passed along to future generations. Even though there are many *anglers* in Minnesota, the choices of the *individual* angler impact everyone's future fishing activities.

Procedure

Preparation

1 Prepare scavenger hunt questions. Examples are given on the **Sample Scavenger Hunt Questions and Answers Sheet**. You may wish to prepare some of your questions using some local fisheries or water issues.
2 See **Angler Situation Cards**. Make two sets of these cards: one for students, and one for the instructor. Put only the situation on the set of student cards. Put both the situation and the answer on the instructor's cards. You may also prepare some situation cards of your own that include local fisheries or water issues. Cards can be laminated or covered with clear contact paper.
3 Prepare **Fishing Regulations Patrol Cards** for students.
4 Familiarize yourself with the Minnesota fishing regulations booklet.

Activity

Warm-up

1 This activity will help students learn how to become more responsible citizens. Ask students if they know why we have fishing regulations. Laws and regulations don't regulate all fishing conduct. Some conduct just makes good sense, such as not crowding another party already in a fishing spot, or picking up others' discarded fishing line and bait containers. Everyone has the right to enjoy an outdoor experience like fishing. If someone takes more fish than allowed, poses threats to fish by deliberately polluting the water, or keeps fish caught out of season, that person is violating fishing regulations. These violations affect us all, because Minnesota's waters and fish are natural resources belonging to the public. Unsportsmanlike behaviors also interfere with others' rights to enjoy fish and water resources. With the privilege of enjoying these resources comes the responsibility of respecting them, and showing consideration for others.
2 Tell students that each person is responsible for knowing and understanding fishing regulations and fishing sportsmanship.

Lesson
Part 1: Fishing Regulations

1 Give each student or pair of students a current Minnesota fishing regulations booklet. Tell them that we're fortunate to live in Minnesota, with its many lakes and rivers. Minnesota has more than 5,400 fishable lakes and 15,000 miles of fishable streams and rivers. Ask students if they have ever been fishing. What kinds of fish did they catch?
2 Ask students if they know what the word *regulation* means. Explain that fishing regulations are the laws of fishing. Although they won't need a fishing license until they're 16, they must still know and follow the regulations when they go fishing. Emphasize that good

anglers follow the rules because they feel a sense of responsibility for taking care of our aquatic resources, not just because it's the law. Are there times when it might be difficult to follow fishing regulations? What are some benefits of following fishing regulations?

3. Ask students to open their Minnesota fishing regulations booklets to the Table of Contents and review the layout of the regulations booklet. Allow students to leaf through the booklet to become familiar with the location of various topics. Practice finding information in the booklet together. For example, find the page that discusses fishing seasons. Ask students to identify the dates of the walleye open season. Then discuss the purpose of fishing seasons.
4. Tell students that they'll be doing a scavenger hunt through the regulations booklet. You will ask them a number of questions, and then each student or group will have the opportunity to—as quickly as possible—look up the answers in the booklet. When an answer is found, the student should quickly raise their hand. The page number and the answer should then be read aloud to the class. Use these questions to discuss the answers with the group:
   - What is the purpose of that regulation?
   - Are there times when it might be difficult to follow that regulation?
   - What are the consequences of not following that regulation? (For the environment? For the lawbreaker? For fish? For other anglers?)
   - In what situation would it be important to know this regulation?
5. Explain to students that regulations do not cover every situation where you might have to make a decision about your behavior while fishing. Ask your students to define sportsmanship. Can they think of a fishing situation that might be related to sportsmanship instead of regulations?
6. Ask students to find a partner and create three to five of their own scavenger hunt questions. The answer and corresponding page number should accompany each question. These may be turned in as an assignment, or can be used to do another scavenger hunt. Follow agreed-upon grammar, punctuation standards, and expectations for writing.

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Part 2: Angling Regulations or Sportsmanship

1. Divide students into groups of three or four. Give each group an **Angler Situation Card**.
2. One student should read the situation and the potential best responses aloud. The group should discuss each option and decide how to best respond to the situation. They should also decide whether the situation involves a regulation, an example of fishing sportsmanship, or both. If it's a regulation, students should use their Minnesota fishing regulations booklets to support their decision. Emphasize that students should communicate their opinions and

listen carefully to others' opinions. Encourage students to offer alternative responses to the situations, too. They should also discuss the consequences of each possible response.

3 Once an answer is agreed upon, give the groups ten minutes to prepare a skit based on their situation. The skit should incorporate their response to the given situation.

4 When the groups have prepared their skits, bring the class together and have each group present their skit to the rest of the class. Ask the class to decide if the situation involves consideration of regulations, sportsmanship, or both. Do any existing fishing regulations support this decision? Discuss the responses and situations as a class.

Wrap-up

1 Ask students to share their thoughts on the importance of fishing regulations. What consequences could result from allowing everyone to catch and keep as many fish as they could? As a class, discuss whether students feel most people are sportsmanlike and law-abiding when they use the environment. Why might some people not follow fishing regulations or make unsportsmanlike judgments? Ask them what they can do to encourage others to follow the fishing regulations and to make good judgments as they enjoy our natural resources.

2 Ask students why we describe fishing as a privilege that all Minnesotans enjoy. What does this mean for everyone that goes fishing? (All of us must take care of fish and water resources so everyone else has a chance to enjoy them.) Name other sporting activities where rules or regulations and sportsmanship are important.

3 Distribute **Fishing Regulations Patrol Cards** to students at the end of the exercise. Remind them that, although they aren't required to purchase a fishing license until they're 16, they are responsible for knowing the annual fishing regulations if they go fishing. Congratulate your class on becoming more familiar with fishing regulations and sportsmanship!

Assessment Options

1 Assess the questions students create for the scavenger hunt.

2 For each group's skit, assess whether the group defended its response to the dilemma presented in the situation card and whether they correctly judged the situation as involving regulations, sportsmanship, or both.

3 Assessment options include the Checklist and Rubric on the following pages.

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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

17–19 points = A
Excellent. Work is above expectations.

14–16 points = B
Good. Work meets expectations.

12–14 points = C
Work is generally good. Some areas are better developed than others.

8–11 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0–7 points = F
Work is unacceptable.

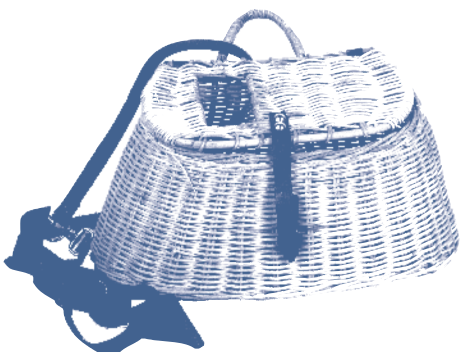
Fishing Regulations and Sportsmanship Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Student will become familiar with *Minnesota Fishing Regulations* and its Table of Contents.
3	______	______	Student will create five scavenger hunt questions about Minnesota fishing regulations problems with a partner.
3	______	______	Student will be able to say where answers to the fishing regulations questions are found in the Minnesota fishing regulations booklet.
2	______	______	Student will work with group members to read regulations or sportsmanship situation cards and decide on which action to take.
2	______	______	Student will cooperatively work with group members to plan and present a skit describing how the group decides to respond to the situation.
2	______	______	Student can define *regulation*.
2	______	______	Student can define *sportsmanship*.
2	______	______	Student will know how to look up answers to questions about fishing regulations in *Minnesota Fishing Regulations.*
Total Points			
19	______	______	**Score** ______

Fishing Regulations and Sportsmanship Scoring Rubric

Skit Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Fishing regulations scavenger hunt questions	Created four or five scavenger hunt questions with a partner and provided accurate answers as to where answers appear in *Minnesota Fishing Regulations.*	Created three scavenger hunt questions with a partner and provided accurate answers as to where answers appear in *Minnesota Fishing Regulations.*	Created two scavenger hunt questions with a partner and provided answers as to where answers appear in *Minnesota Fishing Regulations.*	Created one scavenger hunt question with a partner and provided inaccurate answer as to where answers appeared in *Minnesota Fishing Regulations.*	Didn't create scavenger hunt questions with a partner and provided no answers as to where answers appear in *Minnesota Fishing Regulations.*
Situation cards	Defended choice of action by using examples from the regulation booklet. Student noted legal/ethical violations as well as positive behavior they observed. Response to situation card well-defended and logically-reasoned.	Defended their action. Used regulation booklet at least once. Noted either positive or negative behavior they observed.	Defended action, but failed to use the regulation booklet.	Didn't defend action. Didn't observe behavior.	Didn't participate in skit preparation or presentation.
Skit presentation	Participated in developing well-prepared skit with roles dispersed evenly among group members. Students used loud, clear voices during role-playing. Easily understood.	Skit was prepared. Every group member had a role; some students had larger roles than others. Skit easily understood.	Skit was prepared and presented, but was disorganized, and dominated by a few group members.	Skit was extremely short and/or disorganized, and difficult to understand. Cooperation among group members wasn't exhibited.	Didn't cooperate or participate in skit preparation or presentation.

Score ______ (Calculate score by dividing total points by number of criteria.)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Diving Deeper

Extensions

1 Play Two Truths and A Lie. Using the regulations booklet, make cards with two true statements and one false statement. Have a student choose a card and read the three statements aloud. Ask the group to use the regulations booklet to find out which statement is false.
2 Invite a conservation officer to class to discuss fishing regulations and how they're enforced.

For the Small Fry

K-2 Option

1 Discuss and demonstrate catch-and-release fishing. Using paper pictures of a fish, felt squares, and scissors, have students make a felt fish. Show students how to correctly hold their felt fish and how to release it unharmed. You can also demonstrate how to treat and release a fish that has swallowed a hook—by cutting the line and releasing the fish rather than trying to remove the hook, which will dissolve inside the fish. (For more information, order the *Catch and Release* brochure from the Minnesota DNR Information Center by calling: 1-888-646-6367.)
2 Invite a conservation officer to class to discuss the purpose of fishing regulations and how they're enforced.

Sample Scavenger Hunt Question and Answer Sheet

(Some answers may vary each year as regulations change and some answers may be eliminated as standard information in the regulations synopsis. Please review answer sheet before assigning to participants.)

1. Licenses Found on page ___
At what age do you need a fishing license to fish in Minnesota? How much does it cost?
16 years old; $17 (*This price, from the 2010 regulations, may change. DNR collects $17, license sales operators may charge up to $1 extra to cover their expenses for selling the license.*)

Discussion Questions If you're under 16 and not required to have a fishing license, do you still need to follow the regulations? What happens to the money we pay for our fishing licenses?
Yes. Any angler, regardless of age, must follow fishing regulations. Income generated by fishing licenses funds DNR projects that help manage and preserve the very resources anglers enjoy. By fishing, anglers are supporting the conservation of Minnesota's fisheries. Strong support of the fishing regulations and income from licenses allow the DNR to continue research and other work ensuring healthy habitat and fish populations today and in the future.

2. Seasons Found on page ___
When is the season for walleye? May ___ to February ___ (*Example answer from 2010 Fishing regulations: May 9-February 28*)
When is the season for paddlefish? There is no paddlefish season in Minnesota.

Discussion Question Why do we have seasons?
Fishing seasons limit the times of year that people can legally catch fish. Seasons are usually set to protect fish species while they're reproducing (spawning). Seasons help ensure that fish have the opportunity to lay eggs and replenish the population.

3. Limits Found on page___
What is the limit for sunfish and bluegill? 20 fish.

Discussion Question Why do we have limits?
Possession limits protect fish populations from being over-harvested. Limiting the number of fish that anglers can harvest helps ensure that enough fish remain to reproduce, and that other anglers have a chance to catch fish.

4. Daily vs. Possession Limit Found on page___
For which fish species in Minnesota is the daily limit different than the possession limit? Yellow perch.

Discussion Question What is the difference between a daily limit and a possession limit?
For most fish species, daily limits and possession limits are identical. A daily limit is the number of fish you can harvest per day. A possession limit is the number of fish you can have in your possession at any given time—on a stringer, in the freezer, or both. For example, consider a lake in which the northern pike daily possession limit is three fish. If an angler already has one northern pike in the freezer, they cannot keep more than two northern pike caught on that lake that day; otherwise, the angler will have a total of more than three fish in possession.

5. Experimental and Special Regulations Found on page___
I am fishing at Melissa Lake in Becker County and I catch a 30-inch northern pike. Can I take it home? No.

Discussion Questions Why are some waters under special regulations? Why are there sometimes size or slot limits?
Some water bodies are closely managed by the DNR on an individual basis, or located within ceded territory (lands within an Indian reservation that have been sold by a tribe or obtained by the U.S.). Perhaps these lakes experience heavy fishing pressure or a decline in a fish species that the DNR is trying to recover. These special regulations override the general regulations that apply to other lakes and streams throughout the state. Special limits, such as size or possession, are intended, in some cases, to restrict the harvest of fish that are the most productive spawners. A special limit may also be set to encourage the growth of fish of certain sizes or ages. Maintaining a productive and healthy future fish population is central to such limits.

6. Border Waters Found on page___
I'm fishing in Big Stone Lake in Big Stone County. My friend says I can use two lines. Is that true? Yes.

Discussion Question Why are there special regulations for border waters?
Border waters are defined as those along the Minnesota border. Minnesota waters border Wisconsin, Iowa, North Dakota, South Dakota, and Canada, each of which has different fishing regulations. To avoid conflicting regulations on these bodies of water, special regulations are in place, and all states and countries must follow them. This helps conservation officers enforce regulations and helps prevent over-harvesting of fish by anglers on either side of the border.

7. Fish Identification Found on page___
How do you tell the difference between a northern pike and a muskellunge? Muskellunge have six or more pores on the underside of their jaw, northern pike have five or fewer. *(This information is no longer printed in the Fishing Regulations, but it is the surest way to tell the difference.)* The body markings of northern pike are light spots on a dark background. Muskies have dark markings on a light background.

Discussion Question Why do we need to be able to identify the fish that we catch?
Identifying the species of fish that you catch is not only fun (and an important part of the fish stories told to friends and family!), but also necessary to ensure that you're following the law. You need to know what kind of fish you've caught to comply with possession and daily limits, or to comply with special regulations such as size limits.

8. Harmful Invasive Species Found on page___
Can I dump the leftover minnows I bought and used as bait into the lake when I am done fishing? No.
What about leftover earthworms? Can they go in the lake or on the shore? No. Worms are to be treated as all other bait and are an invasive species.

Discussion Questions Why do we need to be careful with our bait? What are invasive species? Why are they a problem?
Native species are organisms that normally live and thrive in a particular environment such as Minnesota waters. An invasive species is defined as one that has migrated to an area, or was deliberately or accidentally introduced from a distant location. One example is Eurasian water milfoil, an aquatic plant native to Eurasia rather than the United States. Invasive species pose a threat to Minnesota waters, native plants and animals, and ultimately, to fishing. Because invasive species usually have no natural predators in their new environments, they can grow and reproduce rapidly. They crowd out native species, use up food supplies, or cause physical harm. Some types of fishing bait are not native to Minnesota, including earthworms. These

and other live bait should never be released alive into a lake or shore. Instead, they should be placed in trash receptacles. To prevent the spread of aquatic invasive species, be sure to remove plants and animals from your boat, trailer, or equipment before leaving the water body. All water from the boat, motor, and live well needs to be drained before you leave the water body. Boats, fishing gear, and other equipment that gets wet should be rinsed with hot tap water (at least 140˚F), or dried for at least five days before returning to the water.

9. Fish Management in Minnesota Found on page___
How many fishable lakes are there in Minnesota? How many miles of fishable streams are there?
5,400 fishable lakes and 15,000 fishable streams. (*This information is not always printed in the Fishing Regulations book.)*

Discussion Question Why are some Minnesota waters not good for fishing?
Some lakes and streams in Minnesota aren't productive fishing areas. For example, some lakes are very shallow and unable to support many fish, if any. Fish in such lakes may die over the winter due to lack of oxygen. These lakes may not be able to support fish, but they're still important waters to protect. Other creatures, such as ducks, frogs, and insects, call these waters home.

10. State Fish Records Found on page___
What is the largest Minnesota state record fish?
As of January 2007, the record was a 94-pound, 4-ounce lake sturgeon was caught on September 5, 1994 in the Kettle River.

Discussion Question: Is it important to catch the biggest fish?
No. The biggest fish are not necessarily the best fish, especially for eating. Older fish have had more time to accumulate certain toxins in their bodies, such as mercury or PCBs, than younger, smaller fish. As a result the Department of Health typically advises that people eat fewer meals of larger-sized fish. Also, larger fish are productive spawners who play an important role in maintaining a healthy fish population. When we harvest these large fish, we remove a great source of future fish. Catching small fish is just as fun as catching large fish! Small fish are often more feisty and more active when caught.

Angler Situation Cards

SITUATION 1
You're fishing on the shore. Another group of anglers is getting ready to move on, leaving behind pop cans, fishing line, bait packages, and other trash. What would you do?

1. Politely ask them to pick up their litter and offer to help.
2. Wait for them to leave. Then pick up the litter for them.
3. Remember what they look like and report them to a police officer.
4. Let them see you picking up their trash while they're still there.
5. Do nothing.

SITUATION 2
You're fishing at an isolated lake and you've caught and kept four walleyes during your first day at the lake. On the second day, the fishing is so great that you catch two walleye in the first hour. Both of these fish are bigger than the previous day's fish. Minnesota fishing regulations allow you to possess six walleye. What would you do?

1. Keep fishing, but look around frequently for conservation officers.
2. Throw away the small fish from yesterday, and keep fishing.
3. Eat the fish you caught today for lunch.
4. Try to catch species other than walleye.
5. Quit fishing and go rock climbing.

SITUATION 3
You and your friends are riding personal watercrafts. You see another friend fishing on a pier, near other anglers whom you do not know. Your friends want to speed by the anglers to rock the dock with waves. What would you do?

1. Do what your friends want, to go along with the crowd.
2. Tell your friends that riding too close to anglers will scare the fish away and that that wouldn't be a nice thing to do.
3. Encourage your friends to ride in another part of the lake.

Angler Situation Cards

SITUATION 4
You and a friend are steelhead fishing along Lake Superior's North Shore. The fishing has been quiet, and neither one of you has caught a fish all morning. Just before lunch, your friend lands a six-pound steelhead that she accidentally hooked by the belly. What would you do?

1. Tell your friend to release the fish.
2. Look around to see if anyone else has seen you—then put the fish in your ice chest.
3. Eat the fish for lunch.

SITUATION 5
It is June and you're fishing with your uncle and your friend at Lake Nokomis. Your uncle puts two lines in the water, saying, "You'll catch more fish more quickly this way." You and your friend each have just one line in the water. What would you do?

1. Add another line of your own to the water.
2. Tell your uncle it's against the law to have more than one line in the water.
3. Take your line out of the water and announce that you're leaving.
4. Look around for other people, put another line in the water, and move several feet away, pretending it's not your line.

SITUATION 6
You're fishing for largemouth bass. Your luck is tremendous, and the first fish you land is a three-pound largemouth bass. You decide to keep this fish. Within ten minutes, you catch another three-pound largemouth bass. What would you do?

1. Keep the fish and mount it—after all, how many good days do you get?
2. Keep it and keep angling, but if you catch a bigger fish, release it.
3. Take a photo and then release this and other "trophy" fish of the day so that you don't over-harvest the lake.

Angler Situation Cards

SITUATION 7
You're fishing and catch a carp (an underutilized, or "rough fish" species). This isn't one of the fish that you were fishing for that day. What would you do?

1. Throw it up on the shore.
2. Release it into the lake.
3. Decide to take it home.
4. Throw it in the garbage

SITUATION 8
You and your friend are fishing from a boat. Your friend catches a small sunfish. He tells you he wants to see how far he can throw this sunfish when he releases it into the water. What would you do?

1. Watch to see how far the fish can be thrown, encouraging your friend to throw hard.
2. Inform him that throwing can hurt the fish, and that the proper way to release the fish is to gently put it back into the water.
3. Say nothing and keep fishing.

SITUATION 9
Your mom told you to take your dog down to the lake to swim off the dock. When you get to the lake, you notice several people are fishing near the dock. What would you do?

1. Throw sticks for your dog from the dock as your mother asked you to do. Who cares about the anglers?
2. Move a short distance down shore from the anglers and throw the sticks.
3. Decide to take the dog swimming later, after the anglers have left.

INSTRUCTOR COPY

Situation Card Answer Sheet

Situation 1
Answers will vary. Littering is against Minnesota law. It's also considered poor sportsmanship.

Situation 2
According to Minnesota fishing regulations, anglers can no longer keep more than your possession limit or daily limit of fish. It's also illegal to "stringer sort," meaning the release of fish already on a stringer or in a live well and replacement with another fish.

Situation 3
It wouldn't be good sportsmanship behavior to drive a personal watercraft or boat too close to anglers—this would disturb their fishing.

Situation 4
This fish was "foul-hooked" (hooked or snagged in any place other than the mouth). Minnesota fishing regulations prohibit keeping fish caught in this manner. The regulations protect fish from intentional snagging.

Situation 5
Minnesota regulations dictate that, during the summer on inland lakes, anglers are only allowed to fish with one line. While ice fishing, an angler may use two lines—unless fishing at a designated trout lake.

Situation 6
Minnesota regulations permit you to keep this fish, unless the lake you're fishing has special regulations prohibiting it. But it would show good sportsmanship to release it, so you don't contribute to the over-harvest of trophy-sized fish.

Situation 7
As long as it's a legal fish species to harvest, you may take it home. Minnesota regulations say that any fish that will not be utilized must be returned to the water alive. A person cannot wantonly waste a fish by leaving it (or any usable portion of it) on the ice in winter, leave it on the bank, or intentionally kill it and put it back into the water—unless authorized to do so.

Situation 8
Practicing proper catch-and-release methods to help the fish survive would show good sportsmanship. Throwing the fish from the boat would most likely cause internal injuries that will eventually kill the fish.

Situation 9
Good sportsmanship calls for not disturbing the anglers. In this case, it would be best to take the dog swimming after the anglers leave.

Fishing Regulations Patrol Cards

By becoming familiar with this year's fishing regulations,

____

has earned the title of

Honorary Minnesota Fishing Regulations Patrol

I pledge to:

- Follow all Minnesota fishing regulations
- Help others follow fishing regulations
- Turn in Poachers by calling the TIP line: (800)-652-9093

____

Student Signature

____

Instructor Signature

Although you may not yet need to purchase a fishing license, you must follow fishing regulations. They change each year, so review them regularly.

HAPPY FISHING!

By becoming familiar with this year's fishing regulations,

____

has earned the title of

Honorary Minnesota Fishing Regulations Patrol

I pledge to:

- Follow all Minnesota fishing regulations
- Help others follow fishing regulations
- Turn in Poachers by calling the TIP line: (800)-652-9093

____

Student Signature

____

Instructor Signature

Although you may not yet need to purchase a fishing license, you must follow fishing regulations. They change each year, so review them regularly.

HAPPY FISHING!

Fish Surveys

How long would it take to count all the fish in the lake?

One fish, two fish, three fish . . .
Say! Let's not count them all, just yet—
Why not sample them with a net?

Table of Contents

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Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fish Surveys

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand, and use new vocabulary through explicit instruction and independent reading. (no independent reading)

Grade 3
I. Reading and Literature
C. Comprehension:
Benchmark 7—The student will follow three-step written directions.

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 9—The student will follow multi-step written directions.

Grade 5
I. Reading and Literature
C. Comprehension:
Benchmark 13—The student will follow multi-step written directions.

Math

Alignment to the 2007 Minnesota Academic Math Standards coming soon.
Grades 3, 4, and 5
I. Mathematical Reasoning:
Benchmark 1—The student will communicate, reason, and represent situations mathematically.
Benchmark 2—The student will solve problems by distinguishing relevant from irrelevant information, sequencing and prioritizing information and breaking multi-step problems into simpler parts.
Benchmark 3—The student will evaluate the reasonableness of the solution by considering appropriate estimates and the context of the original problem.
Benchmark 4—The student will know when it is appropriate to estimate and when an exact answer with whole numbers, fractions, or decimals is needed.
Benchmark 5—The student will express a written problem in suitable mathematical language, solve the problem and interpret the result in the original context.
Benchmark 6—The student will support mathematical results using pictures, numbers, and words to explain why the steps in a solution are valid and why a particular solution method is appropriate.

Grade 3
II. Number Sense, Computation, and Operations
B. Computation and Operation:
Benchmark 6—The student will demonstrate an understanding of the multiplication facts through 10 using concrete models.
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 2—The student will collect data using observations or surveys and represent the data with pictographs and line plots with appropriate title and key.

Grade 4
I. Mathematical Reasoning:
Benchmarks 1, 2, 3, 4, 5, 6 (see above)
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 1—The student will collect data using observations or surveys and represent the data with tables and graphs with labeling.
Benchmark 2—The student will use mathematical language to describe a set of data.

Grade 5

I. Mathematical Reasoning:

Benchmarks 1, 2, 3, 4, 5, 6 (see above)

Benchmark 7—The student will organize, record, and communicate math ideas coherently and clearly. ***A. Number Sense***

Benchmark 4—The student will use a variety of estimation strategies such as rounding, truncation, over- and underestimation and decide when an estimated solution is appropriate.

II. Number Sense, Computation, and Operations

B. Computation and Operation:

Benchmark 1—The student will use addition, subtraction, multiplication and division of multi-digit whole numbers to solve multi-step, real-world, and mathematical problems.

Benchmark 4—The student will multiply, without a calculator, a two-digit whole number or decimal by a two-digit whole number or decimal, such as 3.2 x 3.4.

Benchmark 5—The student will multiply, without a calculator, a three-digit whole number or decimal by a one-digit whole number or decimal, such as 3.51 divided by 3.

Patterns, Functions, and Algebra B. Algebra:

Benchmark 1—The student will evaluate numeric expressions in real-world and mathematical problems.

IV. Data Analysis, Statistics, and Probability

A. Data and Statistics:

Benchmark 2—The student will use fractions and percentages to compare data sets.

Benchmark 3—The student will collect data using measurements, surveys, or experiments and represent the data with tables and graphs with labeling.

Benchmark 4—The student will find mean, mode, median, and range of a data set.

History and Social Studies

Grade K–3

IV. Historical Skills

A. Concepts of Time:

Benchmark 1—Students will define and use terms for concepts of historical time. (recent past, present, future)

VII. Government and Citizenship

D. Governmental Institutions and Processes of the United States:

Benchmark 1—Students will describe examples of specific services provided by government.

Grade 4–8

V. Geography

D. Interconnections:

Benchmark 2—Students will analyze how the physical environment influences human development.

VI. Economics

C. The Market Economy (Micro Economics):

Standard: The student will understand business organizations, market structures, and financial institutions that operate within our economy.

Benchmark 1—Students will identify and compare and contrast various industries and the occupations related to them.

Science

Grade 3

I. History and Nature of Science

A. Scientific World View:

Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.

B. Scientific Inquiry:

Benchmark 2—The student will participate in a scientific investigation using appropriate tools.

Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.

IV. Life Science

C. Interdependence of Life:

Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful.

Grade 4

I. History and Nature of Science

A. Scientific World View:

Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.

B. Scientific Inquiry:

Benchmark 1—The student will recognize when comparisons might not be fair because some conditions are not kept the same.

Benchmark 2—The student will discuss the responsible use of science.

Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.

III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 4 • Lesson 2

Fish Surveys

Grade Level: 3-5
Activity Duration: 60-90 minutes
Group Size: any
Subject Areas: Mathematics, Language Arts, Science, Social Studies
Academic Skills: calculation, comparison, computation, estimation, graphing, inference, listening, modeling, recording data, role-playing, simulation, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: creel survey, electrofishing, estimate, mark-recapture, migration, population, proportion, ratio, recapture, researcher bias, sample, survey, tag
Internet Search Words: electrofishing, fish sampling, fish surveys, lake surveys, mark-recapture, population surveys, surveys

Instructor's Background Information

What is Fisheries Resource Management?

The Department of Natural Resources (DNR) is the lead agency responsible for fisheries management in Minnesota. Fisheries resource management covers a range of activities that include—in addition to providing angling opportunities—study, maintenance, enhancement, protection, and fish and water resource education. A crucial part of fisheries management involves knowing which fish inhabit the lakes, understanding changes and trends in fish populations over time, and assessing the health of fish populations. **Populations** are defined as the collection of organisms of the species inhabiting a given geographic area. This information helps fisheries managers address the needs of fish, aquatic ecosystems, anglers, commercial fishers, bait dealers, and everyone who enjoys the opportunities and resources that our waters provide.

Information from lake and creel surveys forms the foundation of every Minnesota DNR fisheries management activity undertaken to improve fishing—stocking fish, determining the effectiveness of fishing regulations, and restoring habitat. **Surveys** provide long-term information on trends in fish population size and structure (such as the proportion of fish in age or length groups), fish growth, reproductive success, species abundance, fishing pressure and harvest rates, seasonal fish movement or **migration** (the annual or seasonal movement of an organism from one habitat to another, which typically involves a return trip to original habitat), and habitat conditions in lakes. The Minnesota DNR also employs other angler survey techniques to gather economic and socio-demographic data that helps ensure effective management of the state's fisheries resources for all Minnesota citizens.

Summary

This lesson will help students learn why and how fisheries managers conduct fish surveys. Students will become familiar with some of the equipment and survey methods that Minnesota DNR fisheries biologists use. Special authorization, equipment, and expertise are needed to conduct a fish population survey in an actual lake, but you can conduct a survey *simulation* with student participation. Using tagging survey techniques and a formula involving multiplication and division, students estimate the number of walleye in an aquarium representing a lake. They conduct a problem solving investigation that helps them determine why local anglers are catching fewer fish in Lake MinnAqua.

Student Objectives

The students will:

1. Estimate the population of walleye in a lake using a formula involving multiplication and division.
2. Conduct a fish survey simulation to estimate the population size in the lake.
3. Recognize three types of fish sampling equipment used by fisheries biologists.
4. Give two examples of how fish surveys and research are used in fisheries management. (Scientific data is used to create and measure the success of fishing regulations, to help answer questions about fish populations, and to estimate the size of fish populations in lakes.)

Materials

- Baseball cap or work shirt labeled Fish Biologist (make your own label)
- **Fish Survey Gear Cards** or examples of fish sampling gear (you could enlarge these cards to post around the room, or make them into overhead transparencies)
- Minnesota fishing regulations booklet (contact the Minnesota DNR Information Center at 651-296-6157 or 888-646-6367 to obtain a copy)
- Clear fishbowl or large glass bowl
- Large box of fish-shaped crackers
- Fish mount or color picture of a walleye
- An empty one- to five-gallon fish aquarium with its sides covered with blue paper, or painted blue (with tempera paint, which washes off later) or a plastic storage container
- **Lake MinnAqua Scenario and Tagging Survey Scenario**, to read to class
- **Fisheries Biologist Survey Training Sheet**, one per student
- **Lake Survey Data Sheet**, one per student
- Small aquarium net
- Several small, short, wide plastic containers (holding at least 16 oz.), one for each team of two students
- One or two bags of dried white beans (about 300 beans for each team of two students)

continued

Lake surveys and creel surveys provide fisheries managers with tools for monitoring trends in population abundance: whether populations are steady, increasing, or decreasing. This form of trend analysis has been conducted in Minnesota for more than 50 years, and is the backbone of fish population monitoring. It also helps fisheries managers form conclusions and predictions about fish populations.

Minnesota's Lake Survey Program

The primary tool guiding fish management is the lake survey. Lake surveys consist of periodic monitoring of fish populations, angler creel surveys (see definition under creel survey heading), water chemistry, and fish habitat. Lake survey data is used to track fish population trends, assess harvest rates, evaluate the effectiveness of management actions (such as stocking), set realistic management goals for a given lake, and address issues concerning fish populations. Fisheries staff conduct an average of 600 lake surveys each year. Lakes with high angling pressure are surveyed once every three to nine years. Smaller, more remote, or lightly-used lakes may be surveyed just once every ten to twenty years. Most lake survey fieldwork takes place between early June and late August, but specialized sampling sometimes begins in early spring—just after ice-out—and continues until lakes freeze in late fall.

Lake Survey Database

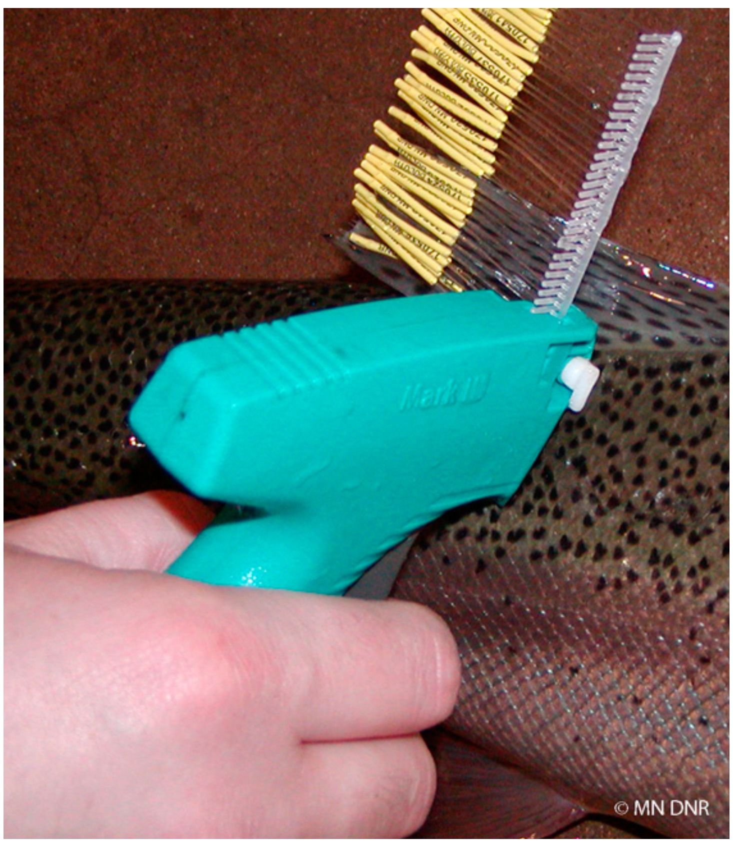
When the spring, summer, and fall fieldwork has been completed, there is much to do with the collected data. Information is entered into the lake survey database, checked for errors, analyzed, and reported. It usually takes approximately one year from the time the nets are lifted during a lake survey until the results of that survey are published on the Minnesota DNR website or are available as printed DNR reports. If you can't find a record for a lake that interests you, it's possible that the lake hasn't yet been surveyed or doesn't have public access. Or, the most recent data may have been collected prior to the development of the database and not yet entered. The lake survey database contains information on 4,500 Minnesota lakes and streams—more than any other state—and fisheries biologists add new information each year. Information from lake surveys is available to the public in the Lake Finder area on the Minnesota DNR website.

Fish Surveys

How do you determine the number of fish in a lake? Imagine trying to count each fish in Lake Winnebigoshish, Lake Mille Lacs, or Lake Superior! It wouldn't be feasible or practical to count and measure every fish in a lake. Instead, fisheries biologists collect a **sample**—a representative smaller number of fish—from lakes in order to make inferences about the entire population. This sample and data must be collected using methodical, consistent surveys of fish populations, fish habitat, and fishing activity. Fish surveys involve **estimating**, a determination of the approximate number of fish in the water, using special equipment, procedures, and training. Fisheries biologists use mathematical methods to accurately estimate fish populations.

Survey Techniques
Fisheries managers and their crews use various survey techniques for each fish species, depending on the species' behaviors or sizes. These techniques include tagging surveys, netting surveys, electrofishing, creel or angler surveys, and biological surveys.

Tagging Surveys
In tagging surveys, fisheries biologists place marks, or **tags** on fish. They begin by catching a sample of fish and tagging them. The tags identify each fish with a unique number or code, so that the fish can be tracked over time. If the tagged fish is caught again, or **recaptured**, by an angler, commercial fisherman, or biologist, its tag shouldn't be removed. The number on the tag should be reported to the DNR, with the time and location of the catch, the fish's length and weight, and the name of the person who caught the fish. The new information is then compared with the earlier information: when and where the fish was tagged and released and its size. By comparing this data, biologists gain information that can help them determine mortality rates, growth rates, travel distances, age, and preferred habitat. Tagging surveys also can be used to devise a population estimate.



If you catch a fish with a tag, call the DNR to make a report.

Materials (continued)

- One or two bags of dried brown beans (about 300 beans for each team of two students)
- Plastic sandwich bags, one for each team of two students
- One calculator for each team of two students
- Post-it notes (at least four inches wide) or small pieces of paper with tape, one for every pair of students
- Optional storybook, *One Fish, Two Fish, Red Fish, Blue Fish*, by Dr. Seuss

Some Species Codes Used in Survey Reports

WAE	walleye
NOP	northern pike
YEP	yellow perch
LMB	largemouth bass
MUE	muskellunge
TLC	tullibee
BLG	bluegill
PMK	pumpkinseed sunfish
BRB	brown bullhead
WTS	white sucker

Biologists have other methods of marking fish. These methods don't identify individual fish, but they do provide general population information. One such method involves the clipping of a portion of a fin. This doesn't harm the fish. To ensure survey accuracy, a fish tagging method shouldn't affect the survival or movement of the fish. Fin clipping and tagging are performed on fish that are to be stocked in lakes—this distinguishes them from naturally-reproduced fish. (This marking method is used in Lake Superior.)

One method that biologists use to mark fish involves clipping a fin.

When released into the stream or lake, tagged or clipped fish can be recaptured with nets, by **electrofishing** (see definition of electrofishing under the Fish Sampling Techniques heading) or by angling. Recaptured fish are counted and measured. This provides fisheries biologists with information on migrations and population changes. This method is known as a **mark-recapture** population survey.

Population Estimation Methods

To estimate the size of fish populations, biologists sometimes use mark-recapture sampling methods. For example, a biologist might set live traps for a certain kind of fish. Once collected, each is marked, tagged, or clipped and released After a time, perhaps a week, the traps are reset to catch another sample of fish. Some of the fish in the second group will be newly-caught, but others will be recaptured marked fish. The mathematical concepts of ratio and proportion are then used to estimate the total number of that fish type in the lake. **Ratio** is a comparison expressed as a fraction. For example, there is a ratio of three walleyes to two sunfish in a population (3/2, 3:2). A proportion is an equation that states equality between two ratios.

Survey Assumptions

Mark-recapture methods are based on a number of assumptions. Making assumptions is an important part of scientific research. The most basic assumptions made by scientists are that observations of individual organisms (or groups of organisms) will apply to the rest of the population that is not captured or seen, and that every individual in a population can always be identified as a member of the same species and counted accurately. The assumptions are carefully determined to ensure the methods will reflect reality. Here are some other assumptions related to mark-recapture sampling.

1. During the survey period, there are no fish leaving or entering the survey area (no immigration or emigration). The survey methods also assume that significant death or mortality, and significant recruitment or birth, aren't occurring.
2. The tags or marks placed on the fish aren't lost and are clearly recognizable.
3. Differential mortality doesn't occur during the time of the survey. In other words, it's assumed that there's no change in ratio between marked and unmarked fish during the interval between samplings. This means, for example, that the marking technique doesn't make a fish more susceptible to predators.
4. Marked and unmarked fish are equally vulnerable to sampling gear. Every individual in the population has an equal chance of being captured, ensuring that all samples are random samples.
5. There is random mixing—the marked group is always proportionally represented in relation to the total population in the collected samples. The time between samplings must be long enough to allow for thorough mixing of marked animals, but not so long to allow significant increase by immigration or reproduction.

Researcher Bias

To eliminate **researcher bias**, biologists use a specific, consistent technique to conduct a population survey. Researcher bias occurs when a researcher, knowingly or unknowingly, influences the results of an experiment due to personal viewpoint or an individual variation in technique. Each survey sample must use exactly the same technique and equipment; samples must be repeated at approximately the same time of year to ensure similar environmental conditions for all surveys. Specific results are comparable from survey to survey. To obtain a broad overview of the entire fish population in a lake, multiple survey samples may be taken from different locations of the lake.

Mark-recapture population estimate methods include the Peterson method and the Schnabel population estimate method. Both involve mathematical formulas using sample numbers from surveys to estimate the size of a total species' population. The Petersen method can be used for a single marking and recapture sample. The Schnabel method uses results from several samples. Each method results in an estimate, or approximate value for the total number of fish in a lake's population.

In this lesson's activity, students will use the Petersen method and average their results. But the two methods are similar.

Biologists and researchers use mark-recapture methods to estimate the size of wildlife populations other than fish.

Petersen method:
N = MC/R

Schnabel population estimate method:
N = (MC Sample A + **MC** Sample B + **MC** Sample C)/(**R** Sample A + **R** Sample B + **R** Sample C)

Or

$$\frac{\text{the sum of } \mathbf{MC} \text{ values for each sample}}{\text{the sum of } \mathbf{R} \text{ values for each sample taken}}$$

M = the number of fish originally **M**arked or tagged
C = the number of fish **C**aught at the time of recapture
R = the number of marked or tagged fish in the sample catch **R**ecaptured in the trap net
N = the estimate of population size or the estimate of the **N**umber of fish present at the time of the release of the originally marked individuals

These population estimate formulas are based on the concept of ratios: N/C = M/R or, N is to C what M is to R

Fish Sampling

Fisheries biologists use various techniques and equipment to trap fish for tagging and collecting data. Examples of data collected from fish-in-hand include length and weight and scale samples, which are later analyzed to determine age. After data is collected, most fish are returned to the water unharmed. (Some mortality does occur in surveys using gill nets.) In all survey techniques, a few fish are sacrificed for laboratory analysis, which determines sex, stomach contents, disease, and internal parasites.

Catches are reported separately, by gear type. In some more "active" fish sampling techniques, the capture gear is moved through the water by machinery or human power, such as electrofishing, pole seines, or angling. "Passive" capture gear is usually set and remains stationary. Passive capture gear includes entanglement devices (gill nets and trawls) and entrapment devices (trap nets, minnow traps, and weirs).

Behavior patterns determine whether a fish species will be collected with passive or active sampling technique.

The primary technique for fish population monitoring in Minnesota involves standard net surveys. Catches from surveys are standardized by calculating the number of fish of one species caught per unit of sampling effort. For example: if 10 nets were set during a survey and 40 walleye were caught, the net catch would be reported as 4.0 walleye per gill net set.

Minnesota's surveyed lakes have been categorized into 43 classes, or groups, based on similarities in their chemical and physical characteristics and fish communities. The term **normal range** describes the range of values for net catches, or average fish size, for each lake class. From many years of research and data collection, the DNR fisheries staff has determined normal range values for the fish species in each lake class—if the walleye gill net catch for a 1996 survey on Lake MinnAqua was 6.0 walleye per net, and the normal range for other lakes in the same lake class was reported as 2.0 to 4.5 walleye per net, the current population of walleye in Lake MinnAqua could be interpreted as higher than expected for that type of water body.

An electrofishing boat.

Using a backpack electrofishing unit.

Fish Sampling Techniques

- **Electrofishing** is an active fish sampling technique that uses equipment that produces an electrical charge that temporarily stuns fish and causes them to float to the surface. The voltage used varies by species and by the conductivity of the water at the survey site. The stunned fish are easily retrieved, measured, and weighed. Fish caught in this manner recover rapidly, and swim away when researchers put them back into the water. To estimate fish abundance with this technique, the number of fish surveyed per hour is compared to the normal ranges in the lake class.

Electrofishing is most often used for sampling largemouth bass, smallmouth bass, trout, and walleye. These fish tend to avoid nets or live in small streams where netting would be difficult.

- **Gill nets** are a passive type of fish sampling gear. Gill nets used in Minnesota waters are usually six feet tall and 250 feet long, with five 50-foot sections of mesh openings ranging from two inches to four inches wide. Varying mesh openings allow sampling of a broad range of fish sizes. The tops of gill nets have floats that are weighted along the bottom. Nets are suspended or positioned along the bottom like a fence. The gills catch fish small enough to put their heads through the mesh as they swim into the net. When they try to back out, they become wedged or entangled in the net. Gill nets are usually set in water more than nine feet deep, and left for 24 hours. Most fish taken in gill nets don't survive—those that do are released. Only a small portion of the lake's fish population is sampled during an individual survey. These nets are very effective for sampling northern pike, walleye, cisco, trout, salmon, whitefish, and yellow perch—all of these fish swim in water deeper than nine feet.
- **Trap nets** are another type of passive sampling gear and are commonly used to capture bluegills, crappies, bullheads, and other species near shore. The standard trap net is three feet tall by six feet wide with a 40-foot "lead" or "leader." The long lead net diverts fish into an enclosure and through a tunnel into a "pot," or trap. These trap nets are usually set perpendicular to shore in water less than four feet deep, and left in place for 24 hours. Most of the fish collected in trap nets are returned to the water unharmed as soon as biological data is recorded. The number of trap nets set during a survey depends on the lake's acreage.
- A **trawl** is a net attached to a boat with ropes. It's dragged along the bottom. Fish are funneled to a part of the net, and stay there until the net is pulled to the surface and into the boat. After fisheries personnel record the biological data, the fish are released into the lake unharmed. A trawl is active sampling gear, and captures small and young fish.
- A **seine** is a long, rectangular, small-meshed net whose ends are tied to two large poles called brails. If the seine is large, the bottom of the net is weighted to hold it close to the bottom. Seines come in many sizes. Two people must work together to corral the fish into an area where they can be trapped in the net and pulled from the water for the various survey measurements. Afterward, the fish are returned to the water unharmed. Like a trawl, a seine is active sampling gear used to capture small and young fish.

Vegetation Surveys

Analyses of aquatic vegetation are part of many lake surveys. Fisheries biologists' observations help them devise a general, lake-wide description of the abundance of shoreline and aquatic plants.

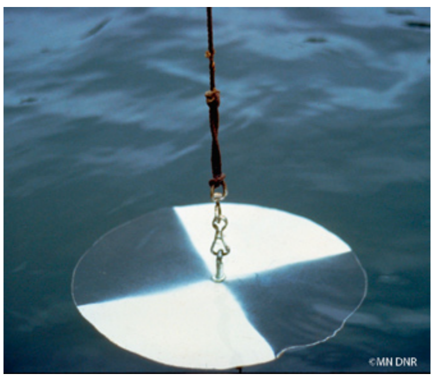
A gill net.

A trap net.

A trawl.

A seine net.

The standard **Secchi disk** is an eight-inch circular metal plate painted with a white and black pattern. To measure water clarity, the disk is lowered into the water until it disappears from view. The depth at which the disk can no longer be seen (the Secchi depth) is recorded. Secchi disk readings vary by season. The water is usually clearest in the spring, shortly after ice-out. Measurements are usually taken when fish samples are taken during summer lake surveys.



A creel. Creel is an old term describing a basket, usually wicker, that anglers used to hold their catches.

Water Analysis

Water analysis encompasses a variety of testing methods, including chemical tests to determine water temperature, dissolved oxygen levels, water pH, water fertility (a measure of nutrients present), phosphorous, nitrogen levels, and Secchi disc readings to measure water clarity. Besides measuring lake productivity, water analysis provides information on fish distribution in lakes.

Creel Surveys

Although a lake survey collects data on fish, vegetation, and water quality, a **creel survey** collects data on what anglers are catching by means of an on-the-spot interview. A creel survey might occur at a lake access point or as a roving survey out on the lake. Creel surveys help fisheries resource managers estimate fishing pressure, discern whether anglers are successfully catching fish, and assess a lake's fish harvest. Throughout the summer, on lakes across the state, DNR creel clerks ask anglers for the times they began and ended their fishing, the number of people in their parties; their home zip codes, the fish species they sought; the fishing equipment used; the weight, length, and number of fish they either kept or released; and where they fished in the lake. Creel survey data helps fisheries managers evaluate fishing regulations and angler satisfaction.

Lake and Stream Plans for Managing Fish Populations

Fisheries managers consider many factors to determine the information to collect from a lake or stream, and which sampling methods to use. Survey data is used to create the Lake and Stream Plans that guide fisheries work.

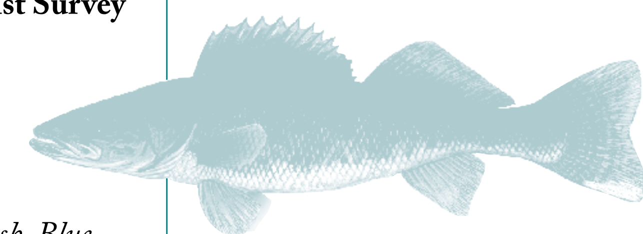
Sampling methods that yield a large number of samples may produce a more accurate population estimate, but taking more samples can cost more money. As managers make decisions regarding Lake and Stream Plans, budget concerns play a role, as well as considerations involving past and present lake conditions, species, management goals, and the needs of anglers and other users.

Lake surveys help fisheries managers determine how to best refine their Lake and Stream Plans and manage fish populations. Problems or questions about lake ecosystem and their fish populations are addressed. If anglers' catches are decreasing, a lake survey may reveal that the lake's fish population is declining. Or perhaps the anglers are using the wrong kind of bait. If a lake survey shows a declining fish population, the manager could decide that special regulations for harvest or size limits are necessary, that the fish population could benefit from stocking programs, or that habitat protection or restoration is necessary to ensure a healthy fish population for the future.

Procedure

Preparation
1 Gather materials.
2 Copy and cut out **Fish Survey Gear Cards**. Use one set for a demo. If desired, enlarge these images and post them in the room, or make overhead transparencies to show the class. Examples of real fish survey gear can also be used.
3 Fill the clear fishbowl with small fish crackers.
4 Put 300 white beans into the "lake" (empty aquarium or container). Set 300 brown beans aside in a plastic sandwich bag.
5 Put 250 white beans into each smaller plastic container (one for each team of two students). Place 250 brown beans in each plastic sandwich bag (one for each team of two students).
6 Create a Fisheries Biologist label and attach it to the front of a baseball cap or large work shirt.
7 Copy one **Lake MinnAqua Scenario** with the **Tagging Survey Scenario** on the bottom to read to the class.
8 Copy one **Fisheries Biologist Survey Training Sheet** and one **Lake Survey Data Sheet** for each student.
9 Make an overhead transparency of the **Fisheries Biologist Survey Training Sheet** and the **Lake Survey Data Sheet**.

Activity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Warm-up
Option: Read the Dr. Seuss book *One Fish, Two Fish, Red Fish, Blue Fish* to your class. This children's story is known to most students, and they'll be able to identify with it. It provides common ground—a base on which to construct knowledge. The book is about fish, counting, colors, and more. It can prompt your students to start thinking about fish, counting fish, and diversity. The lesson builds on the story by addressing real-world fish counting using an estimation method for determining the size of fish populations and various fisheries management tools.

Counting and Estimating
1 Ask students how they might determine the number of students in the class. They will probably say you can count them. Ask someone to count the students in the class.
2 Ask the students if they have heard of a population census. A census is a government count of the number of people in a community, state, or nation. A census can provide certain information such as population growth over time or the proportion of children to adults in a population. This information can be used to determine a need for new schools, or the number of new teachers needed. What if we want to find out how many fish are in a lake? How do fisheries biologists conduct a fish census?

3. Hold up a fishbowl full of fish crackers. Ask someone to count the number of fish in the fishbowl. You can decide that counting might take too long—but how can we more quickly figure out how many fish are in the bowl? Ask the students to try to guess, as accurately as possible, the number of fish crackers are in the fishbowl, and to write their guess (and their name) on a small piece of paper. Collect the students' guesses. Now have a student count the fish crackers in the bowl (they can count by tens, or count with partners and add up the totals.) Determine whose guess was most accurate. Ask students what methods they used to make their guesses.
4. On the whiteboard or overhead projection device, define **estimate** for the class: to determine the approximate value or number of something. There are ways scientists can estimate the size of a population when counting every individual isn't practical, and the methods for making scientific estimates are more accurate than guessing. We estimate numbers of fish in a lake not because there are too many to count, but mostly because it would be too difficult or too costly to count each individual fish.
5. Why count fish? Hold up a Minnesota fishing regulations booklet. Ask the students if they've ever been fishing, and ask them why we have fishing rules. Briefly explain that fisheries biologists collect biological information from lakes to design regulations. This biological information helps fisheries managers solve a variety of problems that fish may have in lakes, rivers, streams, wetlands, and watersheds. One thing a fisheries biologist might want to know is how many fish of a given species live in a particular lake, so fisheries managers can figure out if current regulations successfully protect that fish population. (Although knowing how many are *in* the lake is important, we must also know how many fish are *leaving* the lake, or being harvested, to make final population size determinations.)

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A walleye.

Lesson

Part 1: A Problem in Lake MinnAqua

1. Read the **Lake MinnAqua Scenario** to the class.
2. Display the covered aquarium with the pre-counted white beans in it. Tell the class: "This is Lake MinnAqua." Ask your students how many walleye are in Lake MinnAqua. After a few guesses, explain to the students that just like in a real lake, counting fish in a covered aquarium is more difficult than counting fish crackers in a clear fishbowl. You cannot see the whole fish population in the covered aquarium, just as you would not be able to count every walleye in Lake MinnAqua.
3. Tell students that they might be able to estimate the fish population in the lake using samples. But to solve the walleye problem of Lake MinnAqua, they will have to find a way to make an accurate estimate. Define "sample" on the whiteboard: a representative number of organisms collected to infer information about the entire population.

Part 2: Sampling Gear and Tagging Surveys

1 Display photos or examples of fish sampling equipment. Ask for five volunteer groups of three or four students and hand each group a **Fish Survey Gear Card**. Ask each group to read their card and demonstrate how each sampling method is set up and used to collect or sample fish.

2 Announce that the students are fisheries biologists who will conduct a tagging survey to estimate the size of the walleye population Lake MinnAqua. Hold up the mount or photo of a walleye and show the students how a fish can be tagged or marked. Show examples of various types of tags used to mark fish. On the whiteboard, define tag (to identify or mark). Define survey (a method used to determine the numbers of a population, the extent or condition of a situation, or the value of something).

3 Hand a **Fisheries Biologist Survey Training Sheet** to each student. Tell the students that, as fisheries biologists, they're required to document their tagging survey procedure and results. The data they gather can be used to identify fisheries issues and to solve the problem of estimating how many walleye are in the lake. The data and conclusions can be shared with the public.

4 Read and explain the **Tagging Survey Scenario** (at the bottom of the **Lake MinnAqua Scenario Sheet**) to the class. After you are finished discussing the **Tagging Survey Scenario,** tell the students, "Now, it's time for your fish survey training!"

Part 3: Fish Survey Training—The Mark Run

1 Ask a student volunteer to come to the front of the class to begin training for the Lake MinnAqua Walleye Survey. Put the baseball cap or work shirt with the Fisheries Biologist label on the student volunteer. All DNR Fisheries personnel must be in uniform when they are doing fieldwork!

2 Explain the proper sampling techniques: don't look into the "lake" while taking the sample, and take one quick scoop in the lake with the net. The student will tag or mark the fish that are captured. Give the small aquarium net to the volunteer and ask the student to use the net to take one scoop of walleye from the lake. Count the number of fish captured. (There should be approximately 80-100 white beans.)

3 Mark the captured walleye by exchanging them with an equal number of brown beans. Have the class record the number of marked walleye for the "M" value on the **Fisheries Biologist Survey Training Sheet** under Mark Run Data. Have the volunteer put the brown beans, or "marked walleye," into the aquarium with the white beans (the rest of the walleye population) that are still in the lake.

Do not place the replaced white beans back into the "lake."

This first capture of fish is the "mark run." Tell the class the fisheries biologist has marked or tagged a sample of walleye from Lake MinnAqua and is now returning them to the lake. Stir the beans for fifteen seconds to simulate the fish swimming around in the lake.

Part 4: Fish Survey Training—The Recapture Run

1 The next step in our Fish Survey Training is to take a "recapture run" sample.

2 Choose another volunteer to come to the front of the class and use the net to pull the next sample of "walleye" from Lake MinnAqua for the recapture run. Put the baseball cap or work shirt on the new volunteer fisheries biologist trainee before they take their sample.

If students look into the lake while taking a scoop, they will invariably "aim" for the marked brown beans, skewing their data!)

3 Again, explain the proper sampling techniques to use: don't look into the lake while taking a sample, and take one quick scoop in the lake with the net. It is important to use a consistent sampling technique. We use a consistent technique to eliminate researcher bias in our survey. Define researcher bias and write the definition on the whiteboard: researcher bias occurs when a researcher, knowingly or unknowingly, influences the results of an experiment due to personal viewpoint or technique.

4 Count the total number of beans in the net, both brown and white, and write the number on the **Fisheries Biologist Survey Training Sheet** for C. This is the total number of fish caught. Now count only the brown beans and write that number down for R. The brown beans in the student's net sample are the recaptured marked fish. Return the fish (the entire recapture run) to the lake and stir for fifteen seconds to simulate fish swimming and moving in the lake. We are sampling with replacement, or putting each sample back into the general population in the lake.

Part 5: Fish Survey Training—Do the Math!

1 Review with students:

M = the number of walleye originally **M**arked or tagged (the number of brown beans from the mark run)

C = the **C**atch sample size taken at the time of recapture (the total number of brown and white beans in the student volunteer's sample net in the recapture run)

R = the number of marked walleye in the sample that are **R**ecaptured (the number of brown beans that are recaptured in the sample net in the recapture run)

N = the total **N**umber of walleye estimated to be in Lake MinnAqua at the time of the release of the originally marked fish (the estimate of the total Number of all beans in the lake)

2 Students will now learn how to complete the calculations needed to estimate the total walleye population in Lake MinnAqua (**N**) using the Petersen method. Complete the calculation on the Training Survey section on the Lake Survey Data Sheet as a class. What is the value for "**N**"? How many walleye are estimated to be in lake MinnAqua?

3 Now have students compare their estimates to the real population of walleye in Lake MinnAqua. Explain that, in reality, you wouldn't know how many walleye are in the lake because it would be very difficult, if not impossible, to catch each walleye. In this case, we know the total number of beans so we can see the accuracy of our estimates. Tell the students that there were actually 300 walleye (beans) in Lake MinnAqua. Discuss with the class how close the estimate (**N**) was to the total number. At this point, you may wish to have students do Step 1 of the Extension.

4 Ask students if they think that the mark-recapture method is a good way to estimate the walleye population in the lake. Why or why not? Can students think of other situations where the mark-recapture method could be used to estimate the population of a different animal species?

Graduating Fisheries Biologists

Hum "Pomp and Circumstance" and tell the class they have all graduated and are now Fisheries Biologists. They are ready to conduct their own fish surveys in Lake MinnAqua!

To shorten the length of this lesson, or for third-grade students, stop here.

Part 6: Try It On Your Own—Fisheries Biologist Surveys of Lake MinnAqua

1 Put students into groups of two and explain that, for safety reasons, fisheries biologists work in teams when they go travel on the lake by boat.

2 Each student group will conduct mark-recapture lake surveys in their own Lake MinnAqua (smaller plastic cups) and use their hands as nets. It's important that their lake surveys are accurate, so they will be doing three recapture samples and taking the average.

3 Distribute the smaller plastic cups, each containing 250 white beans, to each team. Distribute plastic sandwich bags with 250 brown beans to each team.

4 Tell the class that each team, using the Peterson method, will work together to complete a lake survey to estimate the size of the walleye population. Follow the directions for completing the **Lake Survey Data Sheet** and for doing the calculations. If students need help with their calculations, have them ask the fisheries supervisor (instructor) for assistance. If necessary, the instructor can put a transparency of the data sheet on the overhead projector, or put the data up on an interactive whiteboard and guide the teams through the calculations. Each team will come up with an estimate for the number of walleye in the lake.

5 After they complete the survey and calculations on the **Lake Survey Data Sheet**, ask the teams to compare each value with the actual number of fish in the lake. Were some group estimates more accurate than others? How much did the various group estimates vary? Why might one group's estimate be more accurate than another's? Ask teams if they carefully avoided researcher bias during their surveys.

What Did We Learn About the Problem in Lake MinnAqua?

1 Ask students what has happened to the walleye population in Lake MinnAqua. Remind students of the lake survey that was done in the past (three years ago), compare their data from their present surveys, and discuss what can be determined regarding the lake's walleye population since the last survey. (The walleye population has declined in the three years since the previous lake survey was performed.)

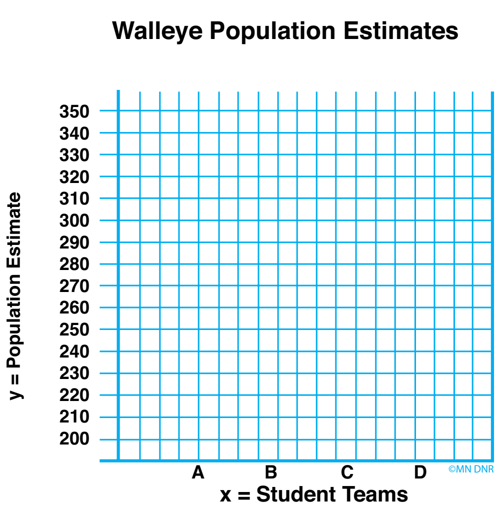
2 What's next? The fisheries supervisor will want to do more research to find out what has caused the population decline, and to determine how to restore the walleye population in the future. It might be determined that:

- Special fishing regulations need to be applied to Lake MinnAqua.
- Shoreline habitat may have to be restored so that walleye can spawn and find food.
- A stocking program may be needed to restore the population.
- To help improve water quality, lakeshore residents may have to reduce the phosphorous content of their lawn fertilizers.
- An exotic species may have entered the lake, negatively affecting the walleye population, and it will need to be controlled.

Part 7: Averaging Class Survey Results

1 Ask each team to write their walleye population estimate on a Post-it note.

2 Draw a graph on the whiteboard. Label the x-axis N=Population Estimate (use 200 to 350) and the y-axis Student Teams. (Have teams make up names or name them A, B, C, etc.) Title the graph Walleye Population Estimates. Have each team write their estimate as a number and as a point on the graph. Have students copy the graph of the class results on their **Lake Survey Data Sheets.** What is the range of values on the graph for our class survey data? Add the numbers on the graph together. (The instructor may decide to permit the use of a calculator.) Have students record this number on their Lake Survey Data Sheets.



3 Calculate the average population estimate by dividing the total by the number of estimates (teams) on the graph. For example, if there are fifteen team estimates on the graph, add the fifteen estimates together, and then divide the sum of the estimates by the number fifteen. This is the class average estimate for the number of fish in Lake MinnAqua. Discuss with students whether this value is

the mean, mode, or median for our class survey data set. (It's the mean). Have students record this value on the **Lake Survey Data Sheet.** What is the actual number of walleye that were in Lake MinnAqua? (250) How does the mean, or average, compare to the actual number?

4 Determine the median, mean, and mode values. How does each compare to the actual number of walleye in the lake? When does a fisheries biologist use mean? Mode? Median? It's up to the researcher to decide, depending on the goals of the study. The important thing is to know which type of data is being used. Median, mean, and mode are all "types" of averages. These types of averages are referred to as "measures of central tendency" in statistics. The mean is the arithmetic average, median is the middle value in a set of data, and mode is the most frequently occurring value in a set of data. When reporting research information, it's important to be specific about the type of average to use.

5 Determine the range of values on the graph. Ask the students to explain why the class obtained a range of values in their lake survey data.

Wrap-up

1 Discuss the importance of using consistent sampling techniques (such as scooping or netting in the same location, and in the same way, for each sample).

2 Compare the data of the various teams. Why do the numbers vary? (One reason might be that variations will occur if the fish sample sizes are different. Or, each team may have used a different technique for scooping fish.)

3 The Petersen method uses one sample to estimate population size. How can this be a problem? (The single sample may not have been representative of the entire fish population. Other sampling methods called the Schnabel and Schumacher methods use multiple samples.) How can this be helpful? (Using multiple samples increases the accuracy of the estimate because the chances of obtaining representative samples are increased.)

4 Discuss how the number of recaptured fish in the sample determines the estimated size of the total population.

5 What are some of the difficulties that fisheries biologists might encounter when doing lake surveys? (Bad weather conditions, poor sampling technique, researcher bias, lifting heavy nets filled with fish, all the tagged fish clustering in one part of the lake, not catching any fish in the sampling nets, many different fish species in a lake.)

6 What are the benefits of fish tagging? (Tags can identify individual fish by giving each fish its own number or code, allowing that fish to be tracked over time.) How might fisheries biologists increase the accuracy of tagging surveys? (They might take multiple samples.)

Mode The most frequently occurring value, or the value that repeats most often, in a group of data. It will be the number with the most points around it on the graph of the class data. A group of observations can have more than one modal value. Modes are often used for qualitative data, or data that describe qualities rather than quantities.

Median The middle value—half of the values are above and half the values are below the median value. Median is also defined as the middle piece of data, after data have been sorted from the smallest to the largest.

Mean The balance point, or average, of the values. The arithmetic mean of a set of values is a sum of all values, divided by their number.

Range The difference between the highest and lowest values on the graph.

7 How do lake surveys help fisheries managers? (Lake survey data is used to estimate fish population sizes and track population trends, evaluate the effectiveness of management actions such as stocking, and establish realistic management goals for a given lake.)

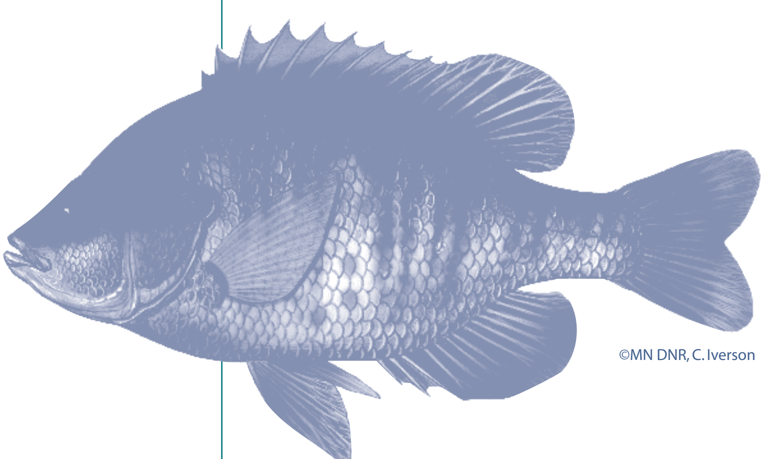
Assessment Options

1 Have students create a brochure to explain the benefits of lake surveys to another class.
2 Ask students to write a simple outline of a mark-recapture survey and explain why fish surveys are used to estimate the size of a fish population.
3 Have students explore the mark-recapture method further by completing the following exercises:

A. You have been asked to determine the walleye population in two lakes in your area. One lake is quite small; the other is a large lake. In your mark run you catch, tag, and release 50 walleye from each lake. The next day, you return to complete your recapture run. You use the same technique and catch 50 walleye from each lake. In the net, you have recaptured two tagged fish from the large lake, and twelve tagged walleye from the small lake.

The Petersen Index: **N = MC/R**

1. Use the Petersen method to estimate the size of the walleye population in the large lake.
2. Use the Petersen method to estimate the size of the walleye population in the small lake.
3. Explain why the large lake would have fewer recaptured walleye than the small lake.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B. Which of the following lake survey results are from the lake with the largest walleye population?
   a. small mark run sample (**M**), small recapture run sample (**C**), large number of recaptured tagged walleye (**R**)
   b. small mark run sample (**M**), large recapture run sample (**C**), large number of recaptured tagged walleye (**R**)
   c. large mark run sample (**M**), large recapture run sample (**C**), large number of recaptured tagged walleye (**R**)
   d. large mark run sample (**M**), large recapture run sample(**C**), small number of recaptured tagged walleye (**R**)

Survey d. was done in the lake with the largest walleye population. We know this because the mark run and the recapture run were both large samples, and only a small number of tagged walleye were recaptured in the recapture run. A low proportion of tagged fish in the recapture run indicates a larger population. Survey a. was done in the lake with the smallest walleye population because a small number of walleye were captured in the recapture run, and a large proportion of those were recaptured tagged walleye. A small recapture run with a high proportion of recaptured fish indicates a small population.

4 Assessment options include the Checklist and Rubric on the following pages.

In Exercise B, students can use example numbers to help them deduce the answer.
a. 40, 40, 30
b. 40, 75, 30
c. 100, 100, 35
d. 100, 100, 10

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

22-25 points = A
Excellent. Work is above expectations.

19-22 points = B
Good. Work meets expectations.

15-18 points = C
Work is generally good. Some areas are better developed than others.

11-14 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-10 points = F
Work is unacceptable.

Fish Surveys Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Student can identify three types of fish sampling equipment and describe how each is used.
4	______	______	Student can describe two examples of how fish surveys are used in fisheries management.
3	______	______	Student can explain why scientific research is used in fisheries management.
3	______	______	Student can explain why a formula is used to estimate a lake's fish population.
2	______	______	Student can define and give an example of researcher bias.
4	______	______	Student accurately uses the Peterson Mark/Recapture Method to estimate the size of a walleye population in a simulated lake.
2	______	______	Student can graph class results and determine the class average estimate.
4	______	______	Student can identify the significance of the letters N, M, C and R in the Peterson Mark/Recapture Method.
Total Points			
25	______	______	**Score** ______

Fish Surveys Scoring Rubric

The Peterson Method Criteria	4 Excellent	3 Good	1 Poor	0 Unacceptable
Peterson Mark-recapture method equation	Can use the Peterson Method equation, and identify what the letters N, M, C and R stand for. Can describe the mark-recapture method.	Can use the equation, and identify what the letters stand for. Can describe the mark-recapture method with assistance.	Needs help using the equation. Doesn't know what the letters stand for, or can't describe the mark-recapture method without assistance and prompting.	Can't use the formula or understand what the letters stand for. Can't describe the mark-recapture method.
Mark /recapture lake survey exercise	Can explain why a formula is used to estimate a lake's fish population.	Understands why a formula is used to estimate a lake's fish population when explained.	Has difficulty clearly understanding why a formula is used to estimate a lake's fish population when explained.	Doesn't understand why a formula is used to estimate a lake's fish populations when it is explained.
Calculating population estimates	Accurately uses the Peterson method to estimate the size of a walleye population in a simulated lake and determine the class average estimate.	Accurately uses the Peterson Method to estimate the size of a walleye population in a simulated lake.	Uses the Peterson Method to estimate the size of a walleye population in a simulated lake with moderate assistance.	With step-by-step guidance, uses the Peterson Method to estimate population size.
Fish sampling equipment	Can recognize three types of fish sampling equipment and describe how each is used.	Can recognize two types of fish sampling equipment and describe how each is used.	Can recognize one type of fish sampling equipment and describe how each is used.	Can't recognize fish sampling equipment.
Use of fish survey data	Can describe two examples of how fish surveys and research are used in fisheries management.	Can describe two examples of how fish surveys and research are used in fisheries management.	Can be prompted to describe one example of how fish surveys and research are used in fisheries management.	Can't describe how fish surveys are used in fisheries management.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Have student groups determine the percent error, the closeness of their population estimate from the survey results to the actual population size. It's helpful to know how accurately we expect an estimate to fall relative to the actual number of fish in the lake. Students can do this by determining the percent error. The percent error the proximity of an estimate to the actual population size. This formula is used to estimate percent error for your survey method.

Percent error is easily calculated if you know the total number of fish in a lake. But in a real lake, this isn't possible. Instead, fisheries biologists perform a more complex calculation to determine the confidence intervals for their lake surveys. Remember that *N = the estimate of population size or the estimate of the Number of fish present at the time of the release of the originally marked individuals*

$$\%\text{ error} = \frac{\mathbf{N}}{\text{The actual number of fish in the lake}} \times 100$$

2 Have each student use the Internet to go to the DNR website to look up Lake Survey information for a local lake. (See **Lesson 6:3—Planning a Fishing Trip**.) Students can use this Lake Data Report to answer the following questions about the lake:
- What kinds of fish are in this lake?
- When was the last lake survey done?
- What species of fish is the most numerous in this lake?

3 Write an outline for a lake survey simulation to determine the relative sizes of two different fish populations in a lake. The total number of fish in each of the two species can be determined by using proportions.

4 Invite a fisheries biologist to your classroom to demonstrate and discuss fish survey equipment.

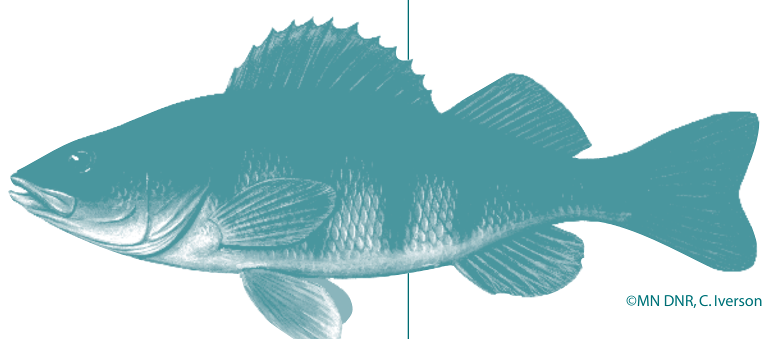
5 In the Warm-up, instead of counting the students in the class, ask students to count the number of boys in the class and the number of girls in the class. Is there an equal number? If there are approximately the same number of boys and girls, there's a similar proportion of boys to girls. Now use the following Lake MinnAqua problem scenario: Walleye eat bluegill. For the walleye to have enough to eat, there must be more bluegill in Lake MinnAqua than walleye. What is the proportion of bluegill to walleye in Lake MinnAqua? Put an unequal number of the two fish species in the "lake/aquarium" (two different colors of fish crackers, or two different colors of beans). For example, use a proportion of 3 to 1, or 4 to 1. Tell students the fisheries biologists must determine the best estimate for the proportion of the two species (walleye and bluegill) in the lake--the number of bluegills for every walleye in the lake.

Choose at least three student volunteers and have them come up to Lake MinnAqua one at a time. Have each take a sample (define sample) using the net. Remind each to not look in the lake and to take one sweep with the net. Return the fish to the lake after each sample and stir the fish to simulate them swimming in the lake. For each sample, write down the number of beans of each color. What is the proportion of bluegill to walleye in each sample? Conclude by discussing the results and determining the estimate of the proportion of walleyes to bluegills in Lake MinnAqua. Discuss why counting every fish in a lake to get an exact number isn't possible, and why collecting samples to gain information is useful. If you have time, take more samples, allowing each student a turn.

For the Small Fry

K-2 Option

Do the Warm-up. Invite a fisheries biologist to bring nets and fish survey equipment to class, and explain how they're used to capture fish. Use the aquarium with beans or fish crackers to show students that it isn't easy to estimate the number of fish in a lake when you can't see all of them.



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Lake MinnAqua Scenario

You're a fisheries biologist working for the state. Area residents have been calling your office to report that they're not catching as many walleye in Lake MinnAqua as they have in past years. The resort owners on the lake are concerned that people will stop coming to Lake MinnAqua to fish.

The fisheries supervisor knows that the walleye fishing on Lake MinnAqua has been very good for as long as she can remember. She also knows that fishing on the lake is very important for the local economy, and that people travel here from long distances for the fishing.

Any negative change in the quality of fishing on the lake can have a serious impact on local residents who depend on tourism for their livelihoods. The herons, loons, and eagles around the lake also depend on the fish in Lake MinnAqua for food. If there *are* fewer fish in the lake, it can be a sign that something unknown—loss of fish-spawning habitat, too much fishing pressure, or poor water quality—is causing the walleye to migrate or die. Any problems should be identified so the fisheries manager can decide which management tools to use to address the population decline.

But it's difficult to know from a few fishing trips how many fish are in the lake. Maybe the fish just aren't interested in the bait that the anglers are using this year. The fisheries manager needs to find out how many walleye are really in Lake MinnAqua.

A lake survey was done three years ago on Lake MinnAqua. The estimated walleye population at that time was 1,000 fish. The fisheries supervisor sends the fisheries biologists to Lake MinnAqua to do research, and to conduct a new lake survey to find out how many walleye are in the lake this year.

Tagging Survey Scenario

A tagging survey is a scientific method that can be used to estimate the number of fish of a given species in a lake. You'll use a net to take a sample of walleye (beans) from Lake MinnAqua, count them, mark them with tags, and release them back into the lake. Because fish move around, or migrate, in the lake, and Lake MinnAqua is fairly large, the fisheries biologists must take several samples at various locations throughout the lake while conducting population surveys. For each sample, the fisheries biologists will record the total number of walleye captured as well as the number of tagged walleye that are recaptured.

Fisheries biologists know that the total number of walleye in the lake can be estimated by determining the ratio of the number of tagged walleye recaptured in the nets to the number of known marked or tagged walleye that were first released in the lake. (Define *ratio* on the whiteboard board or overhead projection device. Ratio is the relationship or proportion between two or more values.)

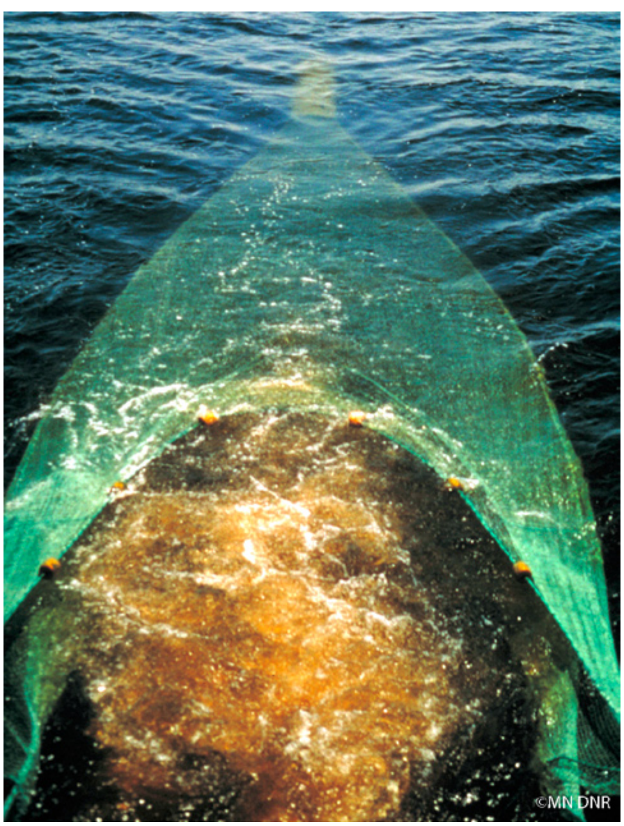
Electrofishing
Electrofishing is done on small streams with a backpack unit. On lakes or large rivers a unit is mounted on a specially-designed boat.

Electrofishing sends an electrical charge through the water to temporarily stun fish and make them to float to the surface. The stunned fish can be retrieved, measured, and weighed. Fish caught by electrofishing recover rapidly and swim away when returned to the water. Electrofishing is most often used for sampling largemouth bass, smallmouth bass, trout, and walleye, which tend to avoid nets or live in small streams.

Gill Netting
A gill net in Minnesota is usually six feet tall and 250 feet long. There are five sections. Each section has a different size opening in the mesh. With mesh openings ranging from two inches wide on the same net, a broad range of fish sizes is sampled. The tops of gill nets have floats that are weighted along the bottom. Nets are suspended or positioned along the bottom like a fence. Fish small enough to put their heads through the mesh as they swim into the net are caught by the gills when they try to back out. Gill nets are nets are very effective for sampling northern pike, walleye, cisco, trout, salmon, whitefish, and yellow perch—all of these fish swim in water more than nine feet deep.

Trap Netting

The standard trap net is three feet tall by six feet wide with a 40-foot "lead" or "leader." Fish swim up to the long lead net and follow it through a tunnel into a "pot," or trap they can't escape. Trap nets are commonly used to capture bluegills, crappies, bullheads, and other species near shore.



Using a Trawl

A trawl is a net attached to a boat with ropes. It's dragged along the lake bottom. Fish are funneled to a part of the net, and stay there until the net is pulled to the surface and into the boat. Trawls are used to capture small and young fish in large lakes.

Seining

A seine is a long, rectangular, small-meshed net whose ends are tied to two large poles, one on each end. The bottom of the net is weighted to hold it close to the bottom. Seines come in many sizes. Two people must work together to corral the fish into an area where they can be trapped in the net and pulled from the water. Shoreline seines are used to capture small and young fish near shore.

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Name ______________________________ Date ______________

Fisheries Biologist Survey Training

Peterson Method Mark-Recapture Population Survey

Mark Run Data

M (or the number of marked walleye) = ________

Recapture Run Data

C = ________

R = ________

Calculating N

$$N = \frac{M \times C}{R} = \frac{\_\_\_\_ \times \_\_\_\_}{\_\_\_\_} = \_\_\_\_\_\_\_\_$$

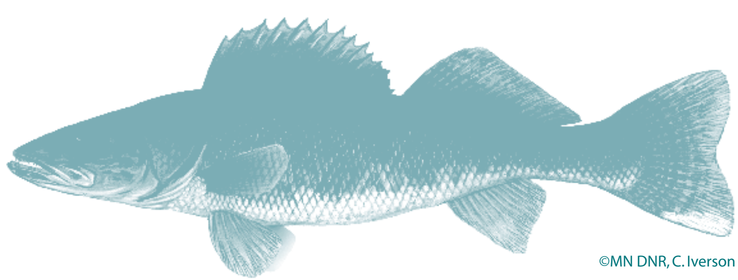
What Do These Letters Mean?

M = the number of walleye originally Marked or tagged and released into the lake (the number of brown beans from the mark run)

C = the Catch sample size taken in the recapture run (the total number of beans in the student volunteer's sample net in the recapture run)

R = the number of marked walleye in the sample that are Recaptured (the number of brown beans that are recaptured in the sample net)

N = the estimate of the total Number of walleye in the lake (the estimate of the total number of all beans in the lake)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Name ____ Date ____________________

Lake Survey Data Sheet

You and your team have been assigned to conduct a Lake Survey. Use the Peterson mark-recapture method to estimate the size of the walleye population in Lake MinnAqua.

Mark Run Data
Directions: Use your hand as a net to capture walleye (white beans) from the lake (container). Count this number of beans and set them aside. Count the same number of brown beans and put them back into the lake. Write this number in the blank below. The brown beans represent the marked walleye.

M (or the number of marked walleye) = _______

Recapture Run Data
Directions: Stir the beans for fifteen seconds. Without looking into the lake, use your hand to capture another sample of walleye. Count the total number of walleye you caught. Write this number by C. Now separate and count the number of brown beans, or marked fish. Write this number by R.

C = _______

R = _______

Calculating N
Directions: Write the values for M, C, and R in the blanks below. Now do the Math! What did you get for N, the walleye population estimate for Lake MinnAqua?

$$N = \frac{M \times C}{R} = \frac{\_\_\_\_\_ \times \_\_\_\_\_}{\_\_\_\_\_} = \_\_\_\_\_\_\_\_\_\_$$

What Do These Letters Mean?

M = the number of walleye originally **M**arked or tagged and released into the lake (the number of brown beans from the mark run)

C = the **C**atch sample size taken in the recapture run (the total number of beans in the student volunteer's sample net in the recapture run)

R = the number of marked walleye in the sample that are **R**ecaptured (the number of brown beans that are recaptured in the sample net)

N = the estimate of the total **N**umber of walleye in the lake (the estimate of the total number of all beans in the lake)

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STUDENT COPY

Name ______________________________ Date ______________

Lake Survey Data Sheet Questions

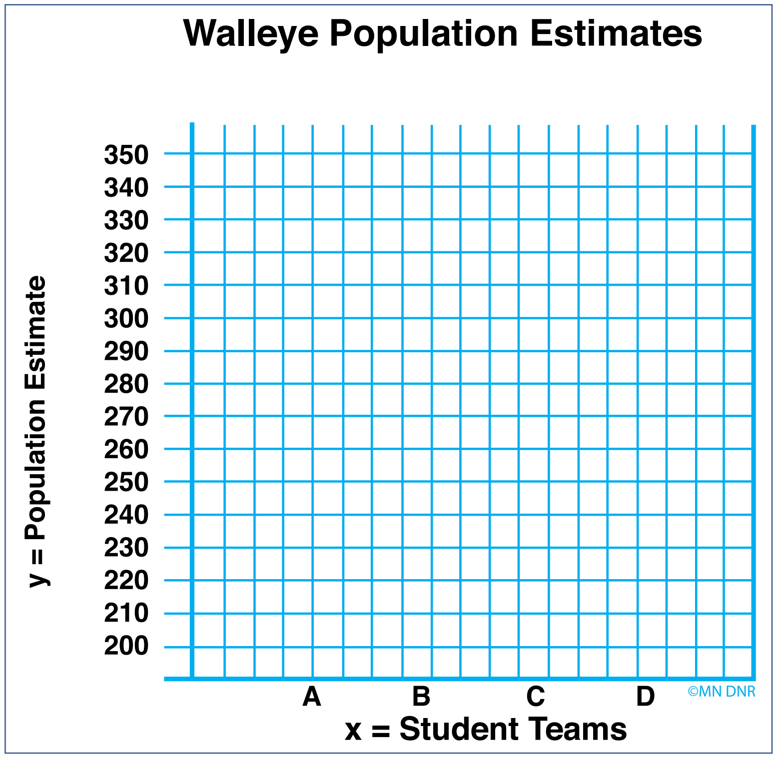
1. What is your survey team's estimate for the walleye population in Lake MinnAqua?

2. Place the values for each survey team's walleye population estimate in the proper place on the graph.

3. What is the **range** of values on the graph for our class survey data?

4. Using the graph, add the populations estimate numbers of all the survey teams. What is the **sum** of these numbers?

5. Divide this number by the number of estimates on the graph to find the **class average estimate** for the number of fish in Lake MinnAqua. For example, if there were fifteen team estimates on the graph, divide the sum you found in Question 3 by 15. This is the class average estimate. What is your class average estimate?



6. Is the class average estimate the median, mean, or mode for the class survey data?

7. What was the actual number of walleye (total number of beans) found in Lake MinnAqua?

8. Is the class average estimate value greater than, less than, or equal to the actual number of walleye in Lake MinnAqua?
   How close is the class average estimate value to the actual number of walleye in Lake MinnAqua?
   How close was your survey team's population estimate to the actual number of walleye in the lake?

9. The class average estimate value probably is not the same number as the actual number of walleye in the Lake. Why?

10. Compare your team's estimate to the class average estimate. Which estimate is closer to the actual number of walleye in the lake?

11. Why might a fisheries biologist take more than one sample for a lake survey?

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Lake Survey Data Sheet Questions Answer Sheet

The answers for Questions 1-5 and 8 will vary.

6. **Is the class average estimate the median, mean, or mode for the class survey data?**
   Mean

7. **What was the actual number of walleye (total number of beans) in Lake MinnAqua?**
   250

9. **The class average estimate value probably is not the same number as the actual number of walleye in the Lake. Why?**
   It's an estimate. The Petersen method and the Schnabel formula allow fisheries biologists to estimate population sizes. It isn't feasible to count every fish in a lake to get an exact number.

10. **Compare your team's estimate to the class average estimate. Which estimate is closer to the actual number of walleye in the lake?**
    Most likely, students will say the class mean is closer. Why? Using more than one sample and averaging all the survey teams' results provides a more accurate number than an individual team estimate that used many fewer samples.

11. **Why would a fisheries biologist collect more than one sample for a lake survey?**
    Using more than one sample in a survey can show a more accurate population estimate.

    When conducting lake population surveys, fisheries managers consider many factors to determine sampling methods. Sampling methods that yield a large number of samples may produce a more accurate population estimate, but taking more samples can cost more money. As managers make decisions regarding Lake and Stream Plans, budget concerns play a role, as well as considerations involving past and present lake conditions, species, management goals, and the needs of anglers and other users.

Aquatic Plant Power

Quality fish habitats are being lost throughout Minnesota. But there are many ways we can protect them!

Table of Contents

Chapter 4 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Aquatic Plant Power

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.

Math

Alignment to the 2007 Minnesota Academic Math Standards coming soon.
Grades 3
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason and represent situations mathematically.
Benchmark 2—The student will solve problems by distinguishing relevant from irrelevant information, sequencing and prioritizing information and breaking multi-step problems into simpler parts.
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 1—The student will read and interpret data from circle graphs using halves, thirds and quarters.
V. Spatial Sense, Geometry, and Measurement
C. Measurement:
Benchmark 4—The student will tell time to the minute using digital and analog time.
Benchmark 5—The student will determine time elapsed to the minute.

Grade 4
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason and represent situations mathematically.
Benchmark 2—The student will solve problems by distinguishing relevant from irrelevant information, sequencing and prioritizing information and breaking multi-step problems into simpler parts.
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 1—The student will collect data using observations or surveys and represent the data with tables and graphs with labeling.
Benchmark 2—The student will use mathematical language to describe a set of data.

Grade 5
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason and represent situations mathematically.
Benchmark 2—The student will solve problems by distinguishing relevant from irrelevant information, sequencing and prioritizing information and breaking multi-step problems into simpler parts.
IV. Data Analysis, Statistics, and Probability
A. Data and Statistics:
Benchmark 3—The student will collect data using measurements, surveys or experiments, and represent the data with tables and graphs with labeling.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.

Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.
III. Earth and Space Science
B. The Water cycle, Weather and Climate:
Benchmark 1—The student will measure, record, and describe weather conditions using common instruments.
C. The Universe:
Benchmark 3—The student will observe that the sun supplies heat and light to the earth.
IV. Life Science
C. Interdependence of Life:
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.
II. Physical Science
A. Structure of Matter:
Benchmark 2—The student will describe the changes in the properties of a substance when it is heated or cooled.
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 4 • Lesson 3

Aquatic Plant Power

Grade Level: 3-5
Activity Duration: Part 1: 45 minutes Part 2: 60 minutes
Group Size: any
Subject Areas: Science, Math, Language Arts, Environmental Education
Academic Skills: analysis, comparison, drawing conclusions, experimentation, graphing, measuring, observation, prediction, recording data, simulation, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: aquatic ecosystem, Aquatic Management Areas (AMAs), Aquatic Plant Management Program (APM), best management practices, buffer zone, crucial habitat, erosion, habitat, lunker structure, random spawners, sedimentation, spawning, Stream Habitat Program, substrate, sustainable use of resources
Internet Search Words: Minnesota DNR website: Aquatic Management Area, best management practices, shoreland habitat restoration

Summary

Students will conduct experiments to explore two significant ways that aquatic habitats support fish reproduction and growth. In Part 1, students will create a fish-spawning habitat in a container and compare good and poor spawning conditions. In Part 2, students will compare water temperatures in shaded and non-shaded stream environments, investigating how shoreline vegetation creates suitable water temperatures for certain types of fish.

Student Objectives

The students will:

1. Create a fish-spawning mini-habitat to explore suitable spawning conditions for some common Minnesota fish.
2. Predict and determine the effects of shade on water temperature by conducting an experiment.
3. Record observations on a data sheet.
4. Communicate results by answering questions and constructing a graph.
5. Propose ideas for conserving and improving habitats crucial to fish survival and reproduction.

Instructor's Background Information

The Value of Aquatic Habitats

Strong economies and vibrant human communities depend on healthy, resilient ecosystems. Citizens, business leaders, and public officials need to understand how ecosystems function, how they support human uses, how human uses impact them, and how resource management practices and land use patterns affect long-term ecosystem health.

Walleyes, ducks, lily pads, dragonflies, bass—Minnesotans love their lakes, rivers, and streams, and the diversity of the resident life forms. Lakes, rivers, and streams shelter many species that, in turn, interact with one another and with the nonliving components of the environment such as water, rocks, and air. An **aquatic ecosystem** is composed of any body of water (stream, river, pond, wetland, or lake) and all organisms and nonliving components within it that function as a natural system. Aquatic **habitats** meet the survival needs of many organisms by providing food, water, shelter, nesting areas, and protection from predators. Various types of aquatic habitats located underwater and along the shoreline support a wide array of aquatic plants and animals.

Aquatic habitat diversity helps to fulfill the needs of different species of fish. Rocky or gravel bottoms of lakes and streams can be critical spawning (fish reproduction) habitats for many fish such as walleye, trout, and suckers. Fallen trees, aquatic plants, and large rocks provide places for fish to feed and to hide from predators. Aquatic plants,

Materials

Part 1: The Next Generation
For each group of four or five students:

- One gallon of tap water
- One clear plastic container (mini-aquarium or shoebox size)
- Large gravel, enough to cover the bottom of the container (available at landscaping stores or gravel pits; clean the gravel well before use)
- One cup of very fine sand (art sand works well and is available at gravel pits or arts and crafts stores)
- One-half cup of pea-size glass beads or small aquarium rocks (available from arts and crafts stores, catalogs, and pet stores)
- Two cups or small containers for beads and sand
- Large spoon (optional)
- Paper towels
- **The Next Generation Sheet,** one per student
- Pencils or pens

Part 2: Be Cool
One set needed for classroom demonstration:

- One gallon cool tap water
- Two eight-inch-square pans, small bread pans, or something similar (water will heat more quickly in dark or metal pans)
- Four to six leafy houseplants large enough to shade one pan (size and number will vary with pan size)
- Two lamps with bulbs of the same wattage (the higher the wattage, the faster the results)

continued

along with living and dead trees, provide shade that helps keep water temperatures cool. What's important to remember is that when habitat diversity is degraded or destroyed, fish populations can be negatively impacted over time.

Management of Aquatic Habitats
If you've visited lakes across Minnesota, you've probably noticed that some have many plants and others have very little vegetation. Aquatic vegetation helps to maintain clear water by absorbing excess nutrients that cause algae blooms, slowing runoff rates, and stabilizing bottom sediments and shorelines. Aquatic plants also provide cover, shelter, and food for fish, waterfowl, furbearers, insects, and amphibians. Sometimes landowners wish to remove aquatic plants near the shoreline because they interfere with their access to the water—but *aquatic plants growing in public waters are owned by the state*. The Minnesota DNR Aquatic Plant Management Program protects native vegetation and the aquatic environment from unnecessary harm while still permitting lakeshore homeowners limited control of some aquatic vegetation for water access. DNR permits are required for any application of herbicides to control submerged vegetation in lakes, as well as for the removal of emergent vegetation by mechanical means. DNR Aquatic Plant Management Specialists are responsible for site inspections and for general educational activities related to aquatic plants in their respective regions. These staff members are responsible for developing and providing educational materials and information for permit applicants, technical advice for the general public, coordinating herbicide regulations with the Department of Agriculture, updating and revising aquatic plant management rules, working with commercial aquatic plant harvesters, and for coordinating statewide efforts with regional fisheries aquatic plant management specialists.

The Aquatic Management Program also includes efforts to enforce laws related to pesticide use. Aquatic pesticide enforcement specialists also supervise herbicide treatments. They investigate reports of pesticide misuse in lakes and the unlawful destruction of aquatic vegetation. Pre- and post-herbicide application inspections are conducted to determine appropriate solutions to problems and evaluate results.

The Minnesota DNR Stream Habitat Program gathers and provides information on Minnesota's 90,000 miles of rivers and streams, helping to conserve and restore them. These waterways provide enormous benefits, including recreation, fish and wildlife habitat, and economic and ecological benefits for the state's citizens. Over the past century, though, urbanization and changes in land use have degraded many Minnesota rivers. Ditching, damming, straightening, polluting, dredging, and the removal of vegetation from riverbanks are just a few examples of activities that have harmed Minnesota rivers.

One of the primary objectives of the Stream Habitat Program is to protect fish and river ecosystems by making sure that adequate amounts of water flow through rivers and streams throughout the year. By studying rivers in each of the state's 39 major watersheds, biologists determine the amounts of water that constitute healthy ecosystems. This information is given to municipalities, public and private planners, state and federal natural resource agencies, and citizens, so they can make informed decisions that will protect river ecosystems. In conjunction with natural flow regimes, healthy rivers have stable banks, high water quality, natural shapes, variation in depths and water velocities, streambed **substrates** (bottom material such as rocks, gravel, or muck), varied vegetation cover, connectivity to other water bodies, and healthy floodplains. Together, these factors create diverse habitats, which, in turn, promote diverse, thriving communities of fish, amphibians, mussels, invertebrates, and plants. The Stream Habitat Program also collects and evaluates fish and other animals to determine types of habitat preferred and required by various species.

The Stream Habitat Program is actively involved in restoring degraded stream channels. Its restoration projects include the removal or modification of dams on the Pomme de Terre River in Appleton and on the Red River of the North in Fargo/Moorhead. These projects restored the connectivity of the streams, allowing fish to migrate upstream and people in canoes to move downstream. Another project involved a four-mile stretch of the Whitewater River in southeastern Minnesota. Many years ago, this segment of the river was converted to a straight ditch. The Program recently participated in restoring it to a meandering stream rich in diverse habitats that shelter thriving fish and other aquatic organisms

Spawning Habitat

The spawning (reproduction) of freshwater fish occurs when females lay a large number of eggs. During their breeding season, the adult fish typically move to shallow areas to lay and fertilize eggs around rocks, gravel, or vegetation. Males swim over the eggs, releasing milt (fish sperm) that fertilizes the eggs. Fertilized eggs develop into embryos, which hatch into small fish called **fry**.

Fish such as bluegills, salmon, trout, and largemouth bass make depression nests. To make nests, fish use their tails to sweep sediment and debris from the lake or stream bottom. Nests can be one to two feet wide and several inches deep. In the sunfish family, the males guard the nest to protect eggs and fry from predators.

Other fish, such as northern pike and walleye, don't construct nests. These fish, known as **random** or **broadcast spawners**, scatter their eggs randomly over their preferred spawning habitat. These fish don't tend their eggs. The preferred spawning habitat for northern pike is vegetation in shallow areas, or in wetlands connected to a lake. Walleyes spawn over shallow areas containing cobble and gravel in lakes or

Materials (continued)

- Two thermometers (room temperature ranges), preferably with one-half- or one-degree markings
- One gallon ice cream bucket
- One cup or other container to transfer water from bucket to pans
- Paper towels
- Graph paper
- **Be Cool Sheet,** one per student
- Pencils or pens

A typical female walleye lays more than 100,000 eggs each spawning season.

Although most Minnesota fish spawn in the spring, a few species, such as brook trout, brown trout, and lake trout, spawn in the fall.

streams. The walleye eggs fall into the crevices between rocks, which protect them from predators. Regardless of egg-laying style, fish eggs require a fresh supply of dissolved oxygen (oxygen molecules present and mixed with water) for proper development and growth. If heavy deposits of fine sediment cover the eggs, or if pollution has created low oxygen levels in the surrounding water, the probability of successful hatching is reduced.

Fish Habitat

Aquatic plants provide habitat for fish. Fish need aquatic plants, particularly for food and cover. Small fish take cover from predators in vegetation. Aquatic plants also shelter small organisms, such as zooplankton and macroinvertebrates, that are eaten by juvenile fish. These organisms are also an important food source for adult fish and waterfowl. Aquatic plants provide **crucial habitat** for juvenile fish (fish 20-100 millimeters long) of every species of interest to anglers—walleye, northern pike, bass, crappies, sunfish, and catfish–as well as for species of less interest to anglers, but essential to the effective functioning of aquatic ecosystems—minnows, shiners, and darters. The crucial habitat for juvenile fish is aquatic vegetation. No other habitat type, such as bare sediments, rocky shoreline, or deep-water, will ensure the survival of juvenile fish.

Soil erosion and sedimentation is, by volume, the largest pollutant in Minnesota lakes and streams.

Shoreline Vegetation

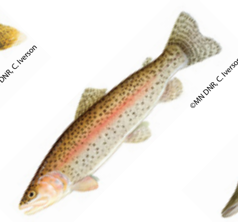
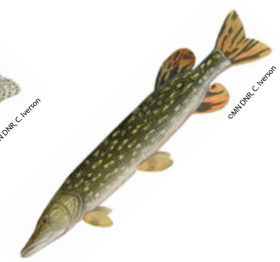
Shoreline vegetation includes plants growing on the land close to shore (upland plants) as well as the plants that grow in the water. Plants produce oxygen during photosynthesis, and plants growing in water add oxygen to the water. Fish use gills to "breathe" this oxygen from the water. Shoreline vegetation, both in and out of the water—such as trees, grasses, reeds, and lily pads—prevents **erosion**. Erosion is the gradual wearing away of land by natural forces such as flowing water or wind, or from human or other animal disturbance to the soil. Vegetation anchors soil, naturally filters surface runoff water, and can actually break down some chemicals and toxins, making them less harmful.

Shoreline vegetation also shades streams and lakes, giving fish valuable hiding and resting areas away from bright sunlight. (Fish have no eyelids to protect their eyes from the sun.) Fish also benefit from water temperature regulation afforded by the shade of plants. (Springs also keep some stream waters cold. If people draw too much water from a stream for irrigation, industry, or other uses, or there isn't sufficient recharge of underground springs, streams can become warmer, or even dry up.)

Although Minnesota fish have a range of temperature preferences, they usually become stressed in very warm water. Warmer water doesn't hold as much oxygen as colder water, so fish may have difficulty breathing in water that is too warm. Some fish, such as brook trout, require high concentrations of dissolved oxygen for survival and reproduction.

Cold water (50˚ to 60˚ F) can support these high dissolved oxygen levels. Many trout streams must have shade provided by trees or other overhanging vegetation in order for cool water temperatures to be maintained throughout the warm summer months. If shade sources are removed from shorelines, water temperatures can increase dramatically. Over time, these changes affect the types and numbers of fish that can survive in streams.

Water quality requirements for freshwater fish.

	 Channel Catfish	 Bluegill	 Walleye	 Rainbow Trout	 Northern Pike
Water Temperatures	75-85 F	65-80 F	35-80 F	40-60 F	45-75 F
Water Type	Eutrophic; warmwater streams, rivers, and ponds	Eutrophic to mesotrophic; warmwater streams, rivers, and ponds	Mesotrophic; coolwater large lakes and streams	Mesotrophic to oligotrophic; coldwater streams, rivers, and deep lakes	Mesotrophic to oligotrophic; coolwater lakes, large rivers, and reservoirs
Clarity	Clear to turbid; can adapt to waters most fish canít tolerate	Less turbid waters than tolerated by channel catfish	Clear, sometimes turbid waters with good fertility	Clear, with some to very little fertility and moderate vegetation	Clear, with moderate amounts of aquatic vegetation
Oxygen (Minimum)	3 ppm	3-5 ppm	5 ppm	6 ppm	4 ppm
pH	4.5-9	5.5-9	6-9	6.5-8.5	6-9

Human Impact and Fish Habitat

Human activity has tremendously impacted aquatic habitats in Minnesota. Historically, farming, industrial waste, and untreated municipal sewage have been the worst polluters in our aquatic environments. More recently, the furious pace of lake home construction, the straightening of streams for irrigation, and poorly-planned development within the watershed have led to numerous problems in lakes and streams throughout the state. A negative impact on just one component of a complex aquatic community can directly or indirectly affect many other components of the system. For instance,

Lawns that run to the edge of a lake increase runoff and erosion.

Buffer zones reduce runoff and erosion.

the removal of native vegetation from land or water increases erosion and eliminates important habitats for fish. The resulting increase in fine soil particles (sediment) in the water, **sedimentation**, damages spawning habitat by covering rock and gravel patches that many fish need for successful reproduction. Sediment that settles after eggs have been laid prevents them from obtaining sufficient oxygen. The vegetation itself may have been spawning habitat for other species of fish such as northern pike. The removal of shoreline plants also eliminates the shade that helps regulate water temperatures. Many human activities—on the land and in the water—contribute to decreased water quality and loss of productive fish habitat.

In some cases, activity on land *increases* plant growth in aquatic ecosystems. Intense cultivation or land development near a lake often causes nutrients to run off from the watershed into the water, stimulating the growth of aquatic plants. Nutrient-laden discharges from sewage treatment plants, livestock feedlots, and leaky septic systems promote heavy growth of algae and aquatic plants. Development within a watershed also speeds up a lake's aging process, or eutrophication. The addition of houses, paved driveways, and other hard surfaces also promote a more rapid flow of nutrient-rich runoff into lakes and streams. For these reasons, lakes and ponds that didn't naturally support a dense growth of aquatic plants may show increased plant growth due to human activities.

Because plants add oxygen to the water and provide habitat for aquatic macroinvertebrates, it's often assumed that dense vegetation helps rather than harms fish, invertebrates and other microorganisms. It's important to remember that healthy plant growth must be distinguished from excessive plant growth. Excessive plant growth can negatively impact fish populations by reducing the effectiveness of predators on prey fish (dense vegetation hides smaller prey fish more effectively.)

When algae and plants die, bacterial decomposers go to work, consuming dissolved oxygen in the process. Because aquatic plants are often confined to a narrow littoral zone, their decay doesn't greatly affect overall dissolved oxygen levels in deeper waters (hypolimnion). But floating mats of dense algae produced by nutrient-rich or fertile water can drift over the deeper areas of a lake. When these algae mats die and decompose, dissolved oxygen levels in the lake can be significantly reduced. The balance of a water body's aquatic life can be upset when oxygen levels fall too low to support fish populations and other aquatic organisms.

Resource Managers Work With Citizens and Communities

To be most effective, the Minnesota DNR must work with all Minnesota citizens to solve the problem of fish habitat loss. It's a big job. Aquatic vegetation is so important to fish. Education is one of the most important management tools of Minnesota DNR Fisheries. When people understand the value of lake and river vegetation to aquatic ecosystems, they have reason to maintain their shoreline vegetation. Fortunately, there are many things that we can all do to reduce or reverse fish habitat loss if we work together now! Best Management Practices (BMPs) outline what shoreline property owners can do to reduce damage to aquatic environments. BMPs for shorelines most often involve retaining the natural characteristics of shoreline. If a shoreline has already been altered, BMPs call for restoring it with filter strips or buffer zones of natural vegetation. Buffer zones help restore degraded aquatic habitat to productive habitat that include places for fish to feed, hide, and spawn. Planning and participating in a shoreline-planting event is one way that people can work together to efficiently replant buffer zones with native shoreland vegetation.

To improve fish habitat, the DNR implements a variety of cooperative projects to restore disturbed areas to more natural conditions. The Shoreland Habitat Restoration Program works with shoreland property owners and citizen groups to replant native aquatic and shoreland plants and protect existing shoreline from erosion to improve the quality of shoreline habitat. Other restoration efforts include adding dead trees, or **snags** to provide habitat, constructing underwater habitats known as **lunker structures** (box frames placed in the water along the edges of streams where fish can safely hide from predators and grow larger), and improving the substrate for spawning. These efforts improve feeding, hiding, and spawning habitats for fish. Restoration projects raise awareness of the value of native shoreline and aquatic vegetation by enlisting volunteers from local schools and community organizations. Signs posted in restored areas inform visitors of the goals and benefits of shoreland habitat restoration projects.

Look for this sign at shoreline habitat restoration sites.

It's more cost effective to maintain existing vegetation and aquatic habitat than to restore them after damage or disturbance. To this end, the DNR works with citizens through the **Aquatic Management Areas (AMA) Program.** AMAs are purchased from landowners willing to preserve shoreline and littoral (shallow water) edges of lakes and streams. The AMA Program targets critical shoreline habitats for its acquisitions—these often include fish spawning and nursery areas. Once purchased, these public areas are protected from development. In 2006, there were more than 100 AMAs throughout Minnesota.

Government and Habitat Protection

The Minnesota Legislature has long recognized the enormous value of the state's water resources and understands that sustainable shoreland ecosystems promote healthy communities, environment, and economy. **Sustainable** use of natural resources (**sustainability**), means using natural resources in ways that meet the needs and aspirations of the present generation without compromising the ability of the environment to meet the needs and aspirations of future generations.

The Legislature acted to preserve and protect our waters and adjacent lands. In 1969, it enacted the Shoreland and Flood Plain Management Acts, and in 1973, the Minnesota Wild and Scenic Rivers Act. These statutes enabled the Minnesota DNR to establish standards and criteria that are periodically reviewed and amended. On July 3, 1989, the revised statewide standards for shoreland management were adopted. Other programs, such as Local Water Planning and the Pollution Control Agency's Clean Water Partnership, also address the challenge of watershed management at the local government level.

Maintaining a High Quality of Life *and* Sustaining High-quality Natural Resources

A high quality of life can be achieved through low impact development that meets communities' social and economic needs as it sustains high-quality natural resources. Recommendations for **water quality and watershed protection and management** include:

- Watershed-wide impacts and benefits must be considered in all land use decisions.
- All surface water must have healthy buffer or filter strips along the shoreline to reduce and slow runoff, filter remaining runoff, and increase infiltration.
- Land use beyond the filter strip must also be carefully managed.
- Healthy wetland systems are critical to good water quality.
- Preservation and restoration of native vegetation on shorelines and throughout the watershed provide a diverse plant community and healthy aquatic and upland habitats.

Recommendations for **natural resource conservation and balanced land use** include:

- Residential communities that preserve natural vegetation and habitats that improve the environment.
- Development in the entire watershed must follow established Best Management Practices.
- Sustainable farming practices are critical for a balanced and healthy natural environment.
- Commercial development must be integrated into the environment in ways that minimize negative effects on the natural environment.
- An understanding of how plants keep fish habitat and aquatic ecosystems healthy is vital to sustainable use of natural resources.

Procedure

Preparation

Part 1: The Next Generation

1. Collect the materials needed. Wash the gravel prior to use.
2. Set up a demonstration container with an appropriate amount of gravel for comparison. The amount of gravel will vary with the size of the container. Add at least enough to completely cover the bottom of the container and create small crevices.

3. Make copies of **The Next Generation Sheet** on which students can record their observations.

Part 2: Be Cool

1. Set up a class experiment as a demonstration in an area where all students will be able to see from their seats.
   - Fill an ice cream bucket with cool tap water.
   - Use a smaller container or measuring cup to transfer water into one pan until the water is about one-half-inch deep. Add the same volume of water to the second pan.
   - Around one of the pans, place several plants that are large enough to shade the entire container. The other pan should not be shaded.
   - Set up a lamp next to each pan. Adjust the lamps so they're exactly the same distances from the pan, and directing light towards the water. The bulbs should be as close to the water as possible without touching any plant parts. The lamplight simulates solar energy hitting the water in one pan and the plants in the other pan. Both lamps should be turned off.
   - Set a thermometer in each pan, making sure that the tips are submerged.
2. Photocopy the **Be Cool Sheets** for students to use to record data. Write any additional desired questions on the whiteboard.

Part 2 of this activity requires one class period dedicated to observing temperature changes in the water. Students may become restless during the intervals between temperature readings. To prevent this, you may wish to begin the lesson starting with the Part 2 demonstration and take the first water temperature reading. Then proceed to the Part 1 activity. Have students continue taking the temperature readings of the two water samples when the timekeeper calls out the time during the Part 1 activity.

When you set up this experiment, be sure that the plants cover and shade the entire container—no light energy should reach the water.

Activity

Part 1: The Next Generation
Warm-up

1 As a group, ask students to create a list of animals that lay eggs. If fish are not mentioned, tell them that most fish also lay eggs that develop into small fish called fry. What unique survival challenges might fish eggs face that eggs laid on land do not? Explain some of the conditions necessary for successful hatching of fish eggs: protection from predators and the circulation of clean water, which provides oxygen and keeps the eggs free of dirt and silt.

2 Ask students to imagine a mud puddle. Ask them to describe the appearance of the water in a mud puddle. Is it clear? Is it murky? What happens to the water if you stir up the bottom? Explain that, if large amounts of sediment from land continue to wash into the water over time, lakes and streams can begin to resemble a large-scale mud puddle. Explain that some sediment washes into lakes and streams naturally, but if a lot of sediment washes in over a long period of time, this causes problems for fish. Ask them to think of some reasons why the land may erode near water bodies. Remind students that most fish need clean water to successfully reproduce. Then inform them that they will be exploring these themes by constructing a spawning habitat with features similar to those used by some common Minnesota fish.

Lesson

1 Separate students into groups of four or five. Give each team a clear plastic container, gravel, sand, glass beads, and paper towels. Distribute **The Next Generation Sheet** to each student.

2 Each team should add enough gravel to the container to cover the bottom completely, and to create spaces into which glass beads can fall. This container represents a rocky substrate used by random spawners, such as walleye, to lay their eggs. After students have created the spawning habitat, they should carefully add enough water to the container to fill it halfway. Have students record what type of fish would use this habitat for spawning.

3 Explain to students that their glass beads represent fish eggs. To simulate fish spawning, one student should slowly "sprinkle" the glass beads over the water so all areas of the container have been exposed to the beads. The glass beads will sink to the bottom. Another student should gently stir the water by hand or with a spoon (without disturbing the rocks on the bottom) for five to ten seconds—this simulates water currents. Tell students that the beads represent fish eggs that will develop into fry if conditions are right.

4 Students should observe the location of glass beads among the gravel. Encourage them to view the spawning habitat from the top and all four sides to help them make complete observations. Where did most of the beads settle? Did some beads settle in crevices? Does it appear that the beads in the gravel are exposed to clean,

fresh water and oxygen? Each group should record their observations.

5. Tell students that they will now simulate erosion-causing sediment entering the lake from an area recently cleared of its shoreline vegetation. Water running off the cleared land will wash soil into the lake and over the spawning bed. Have one student carefully sprinkle one-half to one cup of sand (depending on the size of the container) over the entire surface of the water. Again, one student should gently stir the water by hand or with a spoon for five to ten seconds to simulate water currents. Allow the sand to settle.
6. Have students record observations about where the sand settled in the habitat. Are the eggs covered with sand? Does it appear that the beads in the gravel are still exposed to clean, fresh water and oxygen?

Wrap-up

Ask students to imagine that their model is a real fish spawning area in a lake or stream, and that they are DNR Fisheries staff working to protect spawning areas. Will the eggs covered with sediment survive? Why or why not? Ask them to review some possible causes of erosion and sedimentation in natural lakes or streams. What might they be able to do, as DNR Fisheries staff, to protect spawning habitats from erosion and sedimentation?

Part 2: Be Cool

Warm-up

1. Ask students to imagine being outside in a park on a clear and sunny summer day. Where is the air temperature cooler—in the shade of a tree or out in the open? Then ask them to imagine being near a stream. On a data sheet, students should predict whether there would be water temperature differences between a stream shaded by trees and another with little vegetation along its banks.
2. Remind students that both humans and fish breathe oxygen, but that fish get their oxygen from the water. Explain that cool water can hold more oxygen than warm water. Because fish breathe the dissolved oxygen as water passes over their gills, oxygen levels in the water impact the types and numbers of fish that the water can support. Tell them that some fish, such as brook trout, are very sensitive to changes in water temperature and oxygen concentration. If a stream is too warm, these sensitive fish will be unable to survive the low-oxygen conditions.

In this activity, you'll detect only a slight difference (one to four degrees) in water temperature between the two pans. Explain that the sun is hotter than a light bulb, and that lack of shade will increase the water temperature enough to eventually affect the type of fish that can live in the stream.

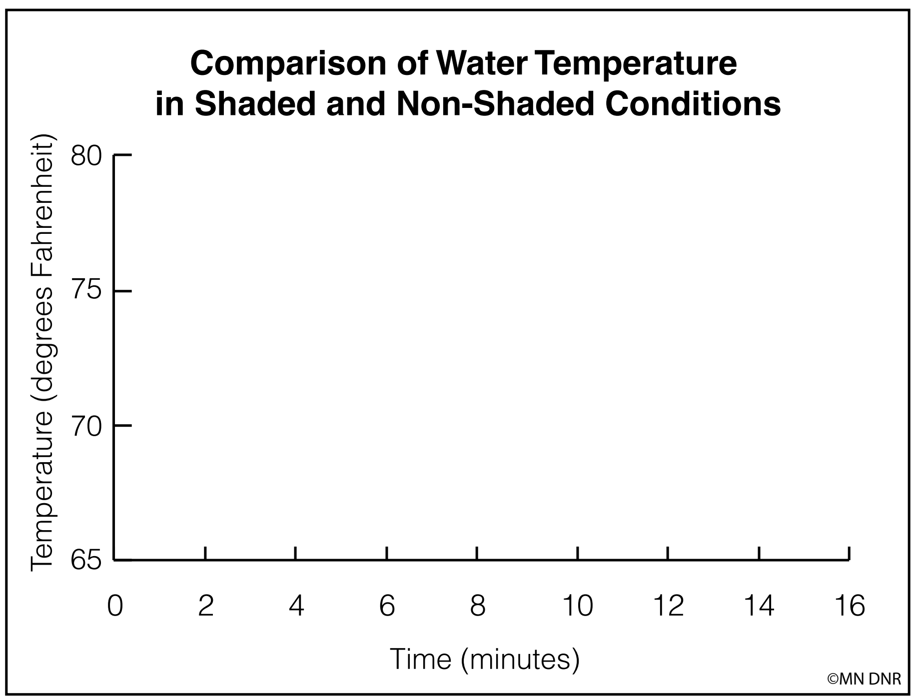
Caution! Lamp bulbs and frames will get very hot.

Caution! Be careful using electricity near water.

Data for each pan can be plotted on the same graph (as long as the two lines are distinguishable.)

Lesson

1. Ask students to imagine that they are DNR Fisheries staff members trying to find ways to improve the trout fishing in an impaired local stream.
2. Distribute the **Be Cool Sheets** and graph paper. Make sure all students know how to read a thermometer.
3. Have them direct their attention to the experiment setup and prepare to take notes. Ask for a volunteer to read the temperature of the water in each pan without removing the thermometers from the water. Students should record these pre-experiment temperatures.
4. Ask for another volunteer to be the class timekeeper. The timekeeper should note the time, and both lamps should be turned on. Every five minutes, the timekeeper announces that it's time to take a reading. Each time, have a different student volunteer read and announce the water temperature in each pan. Students should record the temperatures on their data sheets.
5. After 60 minutes (or one class period), stop the experiment. Each student should construct a two-line graph of temperature vs. time for both pans: one line for shaded pan temperatures, the other line for unshaded pan temperatures. To get them started, draw a sample graph on the whiteboard or projection device.



Wrap-up

1. Did students observe a temperature difference between the two pans? If so, what could explain the difference? Have students review their predictions. Were their predictions accurate?

2 Extend these results to the natural world and to the hypothetical fish management situation. What consequences do warm streams pose to fish species? What are some natural sources of shade along stream banks? How might a fisheries manager cool a warm stream so that trout can survive there again? Have students record their answers and ideas on their data sheets.

Assessment Options

1 Assess student participation in each activity and in the Warm-up and Wrap-up discussions. Collect and evaluate all data sheets, observations, and graphs.
2 Evaluate students' proposals and ideas for ways to protect and improve aquatic plant habitat.
3 Have students write an acrostic poem that summarizes what they learned in both activities. To write an acrostic poem:
- choose a word or concept related to activities in the lesson
- write the word vertically as shown to the right. (bold type)
- for each letter of the word, insert horizontally a phrase or word that contains that letter—the words should string together to make a sentence or phrase that demonstrates understanding of the vertical word in relation to the activities in the lesson

4 Have students work together in small groups to create a graphic organizer of a fictional lake that connects concepts used in the lessons, including: the impact of runoff and erosion on fish spawning areas, how plants influence water temperature and what this means for fish, the impact of habitat loss and habitat restoration on fish, and the role of plants in maintaining water quality. Graphic organizers are visual tools that can take the form of a concept map, tree, star, or web to show definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables are graphic organizers that show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause-and-effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. A piece of paper can be cut and folded to create flaps, windows or dials that reveal details, a definition, a description, or explanation when lifted, folded back, or otherwise manipulated.
5 Have students draw a map of a lake illustrating concepts from the lesson and including a key identifying: the impact of runoff and erosion on fish spawning areas, how plants influence water temperature and what this means for fish, the impact of habitat loss and habitat restoration on fish, and the role of plants in preventing erosion and maintaining water quality for fish.
6 Assessment options include the Checklist and Rubric on the following pages.

An acrostic poem.

Plan**T**s
shad**E**
strea**M**s and
kee**P** the
wat**E**r
coole**R**
And help
Trout to
s**U**rvive
with mo**R**e
oxyg**E**n.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

23-25 points = A
Excellent. Work is above expectations.

20-22 points = B
Good. Work meets expectations.

16-19 points = C
Work is generally good. Some areas are better developed than others.

12-15 points = D
Work does not meet expectations, it isn't clear that student understands objectives.

0-11 points = F
Work is unacceptable.

Aquatic Plant Power Checklist

Possible Points	**Points Earned** Student	**Points Earned** Instructor	
3	______	______	Student can explain how sediment from erosion prevents fish eggs from surviving and hatching.
2	______	______	Student can give an example of a species of fish that deposits eggs in gravel stream bottoms.
2	______	______	Student can define *spawn* and *fry*.
3	______	______	Student can record observations and data from an experiment.
4	______	______	Student can describe two causes of erosion and sediment in a water body.
2	______	______	Student can graph data from a water temperature experiment and present data to class.
2	______	______	Student can reasonably predict how shade affects water temperature in a stream.
3	______	______	Student can describe one way that the water temperature of a stream impacts trout.
4	______	______	Student can propose two ideas on improving or conserving fish habitat

Total Points

25	______	______	**Score** ______

Aquatic Plant Power Scoring Rubric

Fish Habitat Experiments	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Habitat requirements for successful spawning	Can describe three ways erosion and sediment impact fish egg survival.	Can describe two ways erosion and sediment impact fish egg survival.	Can describe one way erosion and sediment impact fish egg survival.	Description of how erosion and sediment impact fish egg survival isn't reasonable.	Can't describe how erosion and sediment impact fish egg survival.
Shade and water temperature	Can make a reasonable and measurable prediction as to how shade impacts a stream's water temperature; can describe how water temperature impacts a stream's oxygen levels and how this affects fish.	Can make a prediction as to how shade impacts water temperature; can describe one way this impacts fish.	Can make a prediction as to how shade impacts water temperature.	Doesn't understand how to make a reasonable or measurable prediction, but can make a guess as to how shade impacts water temperature.	Can't guess how shade impacts water temperature in a stream.
Communicating results	Can record observations and data accurately and clearly, construct a neat graph illustrating experimental data; can clearly communicate experimental results.	Can record observations and data and construct a graph illustrating experimental data; can communicate experimental results.	Can record observations and data and construct a graph illustrating experimental data; needs assistance to communicate experimental results in an organized and understandable way.	Inaccurately records observations and data. Graph doesn't accurately reflect data.	Doesn't record observations and data; can't construct a graph to illustrate data.
Ideas for improving and conserving habitat	Can develop four reasonable ideas for improving and conserving fish habitat soundly based on experimental results.	Can develop three reasonable ideas for improving and conserving fish habitat based on experimental results.	Can develop two reasonable ideas for improving and conserving fish habitat based at least in part on experimental results.	Can develop one idea for improving and conserving fish habitat, but idea isn't based on experimental results.	Can't develop an idea improving and conserving fish habitat after completing Part 1 and Part 2 of the lesson.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Take a field trip to a local stream and measure water temperatures in a shady part of the stream and a sunny part of the stream. Compare results.
2 Watch the 20-minute *Save Our Shorelines* CD as a class. Created by the Minnesota DNR, this presentation outlines strategies that shoreline property owners can use to protect aquatic wildlife and water quality. Contact your local DNR office to obtain a copy.
3 Explore an Aquatic Management Area. If there is an AMA near your town, research it in class. If possible, take a field trip to the AMA.
4 Volunteer in a shoreland restoration project. Help plant native shore plants, help to inform and educate the community or school about the project, or help maintain a shoreland restoration site. Contact your local DNR Fisheries office for notices of projects in your area.
5 Have students visit the DNR website to find examples of ways in which the DNR is protecting fish habitat. Students can read a success story, find the lake or stream on a map, and summarize work that has been done to protect critical aquatic habitats.

For the Small Fry

K-2 Option

1 The spawning habitat activity can be done as a demonstration, excluding steps 5 and 6, and the class could make collective observations. Be sure to limit the demonstration to one variable.
2 The temperature experiment could also be done as a demonstration (without data collection). Be sure to model the scientific method and use real scientific tools. Temperatures can be read as numbers and the students determine if one temperature is greater or less than the other.

STUDENT COPY

Names ______________________________ Date ______________

The Next Generation

1. Name a type of fish that lays its eggs in a gravel bed. ______________________________

2. Where did the fish eggs (glass beads) settle in the gravel bed? ______________________________

   Are the eggs exposed to clean water and oxygen? ______________________________

3. When sand was poured into the gravel bed, where did the sand settle? ______________________________

4. What happened to the "fish eggs"? ______________________________

____

____

5. What happens to real fish eggs when they're covered with sand? ______________________________

____

____

6. How could soil get into the water of a stream or lake? ______________________________

____

____

7. What are two things people can do to help prevent soil from entering our lakes and streams? ______________

____

____

STUDENT COPY

Names ______________________________ Date ______________

Be Cool

1. Prediction: Which stream will get warmer in this experiment? The one with plants or the one without plants? Why do you predict this?

____

____

____

2. Record the water temperature in each of the pans every five minutes.

Time (Minutes)	TEMPERATURE	
	No Plants	Plants

continued

STUDENT COPY

Names ______________________________ Date ______________

Be Cool

3. Did you observe a temperature difference between the two pans of water? __________

4. If so, what could explain the temperature difference? ______________________

5. What effects could warmer water temperatures have on cold-water fish such as trout? ______________________

6. What are some ways we could manage streams to help keep them cool during the summer? ______________________

INSTRUCTOR COPY

The Next Generation Answer Sheet

1. **Name a type of fish that lays its eggs in a gravel bed.**
   Walleye, trout

2. **Where did the fish eggs (glass beads) settle in the gravel bed?**
   Most of the eggs should settle in the gravel crevices.

   Are the eggs exposed to clean water and oxygen?
   Yes

3. **When sand was poured into the gravel bed, where did the sand settle?**
   Most of the sand settles in the crevices and on top of the fish eggs.

4. **What happened to the "fish eggs"?**
   They were covered by sand, either partially or totally.

5. **What happens to real fish eggs when they're covered with sand?**
   The eggs will no longer be exposed to clean water. Without the oxygen they need to stay alive, they'll die.

6. **How could soil get into the water of a stream or lake?**
   It washes into lakes from the land when it rains.

7. **What are two things people can do to help prevent soil from entering our lakes and streams?**
   Don't remove plants near the shore or in the water; help with shoreline restoration projects, and so forth.

Be Cool Answer Sheet

1. **Prediction: Which stream will get warmer in this experiment? The one with plants or the one without plants? Why?**
   The stream without plants over it will get warmer because there's no shade.
2. **Record the water temperature in each of the pans every five minutes.**
   Answers will vary.
3. **Did you observe a temperature difference between the two pans of water?**
   Hopefully.
4. **What could explain the temperature difference?**
   The amount of shade, the distance of the lamps from the water, the wattage of the bulbs might explain the temperature difference.
5. **What effects could warmer water temperatures have on cold-water fish such as trout?**
   It would reduce the amount of oxygen dissolved in the water and make it hard for them to breathe.
6. **What are some ways we could manage streams to keep them cool during the summer?**
   Add shoreline plants to provide shade and keep the water cool.

Town Meeting

Involved citizens can make decisions about lakeshore land use that benefit the community, the economy, and the environment.

Table of Contents

Chapter 4 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Town Meeting

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark

Language Arts

Grades 3, 4, 5
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups. ●
Benchmark 2—The student will demonstrate active listening and comprehension. ●

Grade 3
I. Reading and Literature
C. Comprehension:
Benchmark 7—The student will follow three-step written directions. ●

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 9—The student will follow multiple-step written instructions. ●

Grade 5
I. Reading and Literature
C. Comprehension:
Benchmark 13—The student will follow multiple-step written directions. ●

History and Social Studies

Grade K—3
VI. Economics
A. Economic Choices:
Benchmark 1—Students will identify the difference between basic needs (food, clothing, and shelter) and wants (things people would like to have). ●
Benchmark 3—Students will understand and explain that the concept of scarcity means that one cannot have all the goods and services that one wants. ◑
VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 1—Students will demonstrate knowledge of civic values that facilitate thoughtful and effective participation in civic life. ◒
Benchmark 2—Students will explain the rights and responsibilities of people living in a democracy, including the principle of majority rule and minority rights. ◑
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 4—Students will explain that people have diverse viewpoints and that speaking and listening to others is important. ●
D. Governmental Institutions and Processes of the United States.
Benchmark 1—Students will describe examples of specific services provided by government. ◒
(Town meeting forums, state agencies to manage natural resources…)

Grade 4—5
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities. ◒
VI. Economics
A. Producers and Consumers:
Benchmark 2—Students will explain that in market economies, individuals earn income by working for firms to produce goods and services, and firms incur costs by hiring individuals and earn revenue by selling goods and services. ◒
VI. Economics
B. Economic Choices:
Benchmark 2—Students will apply a decision-making process to make informed choices. ◑
C. The Market Economy (Micro Economics):
Benchmark 1—Students will identify and compare and contrast various industries and the occupations related to them. ◒

VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 2—Students will explain some of the responsibilities of people living in a democracy.
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 1—Students will explain the steps necessary to become an informed voter and an engaged citizen.
Benchmark 2—Students will explain the meaning of civic life and how all members of a community can be engaged.
Benchmark 3—Students will identify and research community problems and recommend solutions.

Science

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss the responsible use of science.
Benchmark 3— The student will recognize the impact of scientific and technological activities on the natural world.
III. Earth and Space Science
A. Earth Structures and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Grade 5
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 4 • Lesson 4

Town Meeting

Adapted from "Land Use Hearing" from YMCA Camp St. Croix Environmental Center, Nature's Classroom, Inc. by Chris Olson, Spring 1986.

Grade Level: 3-5
Activity Duration: three 45-minute periods
Group Size: minimum of 10
Subject Areas: Expressive Arts, Language Arts, Social Studies, Science
Academic Skills: communication, debate, presentation skills, public speaking, reading, role-playing, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: compromise, concerned citizen group, consensus, public land use hearing
Internet Search Words: public hearing

Instructor's Background Information

Local governments in communities have formal procedures for addressing environmental and land use issues. Many people are unaware of the important role they can play in community decision-making. Citizenship and full participation in a democracy requires more than voting at the polls on Election Day. Simulating a public land use hearing introduces elementary school students to citizenship, illustrating how individuals can become informed and engaged as they participate in the democratic process.

Town residents with similar perspectives and values often form a **concerned citizen group**. These groups may have conflicting perspectives and values on certain issues, such as how to develop a piece of shoreline property in the community. At a **public hearing**, these groups can have their positions heard and considered. Citizen group members can also hear the opinions and concerns of others. Minority groups and interests can be represented in a town meeting format. Final decisions are be made based on the most compelling group presentation, the most accurate information and facts, or in an attempt to meet the needs of the greatest number of people and interest groups in the community.

With many sides of an issue presented and addressed in a town meeting setting, policymakers can make informed decisions. After considering the concerns and suggestions of all interested citizen groups, and when officials generally agree on how to proceed with a decision, they have reached a **consensus**. Without consensus, each party may need to sacrifice some wants or needs to reach a **compromise**. Public hearings offer a means of addressing

Summary

Students play various roles in a simulation of a land-use public hearing. They will demonstrate how citizens can participate in local decision-making in their communities. Working in small groups, they design and defend proposals for the development of a piece of lakeshore property. Each group takes on the role of a different concerned citizen group with predetermined interests.

Student Objectives

The students will:

1. Play various roles, portraying the concerns of an interest group in a public hearing simulation.
2. Write a group proposal for a use plan for a piece of lakeshore property.
3. Create a poster to illustrate the proposal.
4. Listen and respond to questions and concerns and different opinions about their proposal from other interest groups.
5. Investigate multiple perspectives regarding lakeshore development.
6. Understand how different user groups can discuss their viewpoints to reach decisions by consensus or by compromise.

Materials

- Whiteboard and markers
- Butcher paper, one sheet for each group of four or five students
- Crayons, one box per group
- Blank paper, three sheets per group
- Pencils, one per group
- **Concerned Citizen Group Roles Sheet**, one per group
- **Concerned Citizen Group Duties Sheet**, one per group
- Overhead or projected copy of **Lakeshore Property Sale Map**

environmental issues and reaching solutions that serve the greatest good and balance human, economic, and environmental concerns.

This simulated **public land use hearing** is an opportunity for students to explore the public hearing process and to actively consider the human, economic and environmental concerns surrounding the issue of lakeshore property development. This activity juxtaposes what students have learned about fish, fish habitat, and environmental stewardship with the people's needs and the interests of various community groups. It offers an important connection to the "real world" by showing students how local governments often reach decisions affecting the community, and how each citizen can play a role in those decisions.

Students will also have an opportunity to consider how basic needs (food, clothing, and shelter), wants (desires beyond basic needs), and wide-ranging values can play a part in public meetings where groups attempt to reach consensus. Resources are limited, and it's critical that society makes good decisions about how to best use resources to meet the needs, wants, and values of the most people—in the most viable and sustainable ways—while also considering the welfare of ecosystems in the natural environment.

The town meeting allows students to temporarily adopt a perspective and a specified set of values that may be different from their own. In this way, the students can learn about the process of decision-making in a non-threatening manner. Students will be able to transfer what they learn to other environmental issues in their communities that may require decision-making, consensus or compromise, and possibly a public hearing. Well-informed, skilled citizens are needed if we are to solve our increasingly complex environmental issues, including how to best use and manage our natural resources.

Procedure

Preparation

1. Make an overhead of the **Lakeshore Property Sale Map**.
2. Copy and cut out the various roles on the **Concerned Citizen Group Roles Sheet**.
3. Copy the **Concerned Citizen Group Duties Sheet**, one for each group of four or five students.
4. Gather the other materials.
5. You may choose to tailor the situation and concerned citizen group roles to address a current local issue about lakeshore use in your community.

Activity

Warm-up

1 Tell the class that you will be holding a mock public land use hearing. Define a public land use hearing with your students and emphasize that no one is on trial at a public hearing. Remind students that there are no winners or losers in this lesson, and that they'll be learning how a public hearing helps communities reach important decisions. Remind them that playing their roles will require them to represent and defend some ideas and positions that may not necessarily reflect their own feelings and positions.

2 The students will pretend that there is a 30-acre piece of property for sale on a lakeshore at the edge of town. Project a copy of the **Lakeshore Property Sale Map** so students can see the area whose use they'll debate. To help them visualize the size of 30 acres, explain that the area of a football field is approximately 1.3 acres. Thirty acres of land, then, is equivalent to 23 football fields. Another comparison—the Mall of America in Bloomington, Minnesota covered 94.6 acres in 2004.

Some facts about the property, lake and town include:

- The property is undeveloped, with trees and plants growing along the very the edge of the water. Bulrushes and other native aquatic plants grow in the water. The water in front of the property has been known as a good place to go fishing.
- All around the lake are small to mid-size homes on five- to ten-acre plots. There is also one large farm with livestock (cows and pigs). The people live in homes year-round. Most of them have docks and cleanly cut lawns that extend to the very edge of the lake, although there are some spots between the houses with trees and aquatic plants.
- The town itself is growing. The lake used to be a few miles from town, but there are now houses and businesses from the lake to the downtown area. Many new people are moving to the area, and they need jobs, homes, schools, goods and services, and recreational opportunities.
- Some residents are worried that the fishing in the lake hasn't been especially good for the past few years. They think this may be due to all the development around the lake.

Discuss these facts about the property, lake, and town with the students so they understand them well.

3 The class will be broken into small groups. Each small group will represent a different concerned citizen group. Each group will be assigned a different role.

This activity provides an opportunity for you to introduce your students to Parliamentary Procedure. They'll be able to practice Parliamentary Procedure skills in the Town Meeting role-playing activity.

4 Write the following outline on the whiteboard:
Public Hearing
1. Preparation
2. Opening statements and proposals
3. Question-and-answer period
4. Final questions
5. Closing statements
6. Decision

Lesson

1 Divide the class into small groups of four or five students.

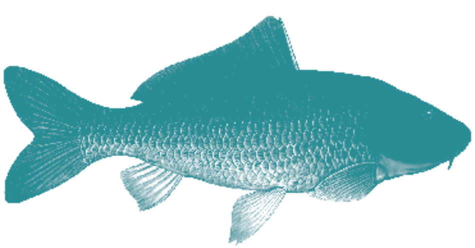
2 Explain how the hearing will proceed. Refer to the outline written on the board.

3 Give each group one role card from the **Concerned Citizen Group Roles Sheet** and other listed materials. Tell students that they will assume the roles listed on their role card. Their job is to decide, as a group, what they would like to do with the land if they could buy it. Read through the **Concerned Citizen Group Duties Sheet** with them.

4 Give each group a **Concerned Citizen Group Duties Sheet** that contains instructions for them to follow.

5 Send each group to a corner of the classroom. Give the groups 30 minutes to prepare the position statements, posters, and presentations described below.

6 Remind groups to clarify their specific "needs" (things necessary to survival or efficient operation) and "wants" (things the group would like to have happen on the piece of land) as a group. Lakeshore resources in the community are limited. Ask each group to develop a position statement on how they believe the lakeshore property should be developed.


©MN DNR, C. Iverson

7 Have each student groups make a poster that helps explain their position.

8 Before starting the public meeting proceedings, describe the meeting guidelines:
- Each group has a designated spokesperson.
- Only the student addressed by you (portraying the City Council) may speak.
- A different spokesperson can be chosen for each new round of questions.
- If citizens have a question during the public hearing, they're to raise their hands to be recognized by the City Council (the instructor or group leader).

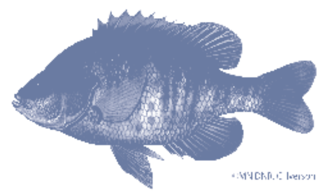
9 Presentation period: After all groups have had time to prepare a position statement and poster, each group will stand and present their poster to the class, making sure to state their group name, describe their group's role, and explain what they've decided would be best for the land. They will then answer the two questions on the **Concerned Citizen Group Duties Sheet.**
- When each group has had a chance to present, the instructor

will assign each group to pose a question to another group. (For example, you have the Youth group ask the DNR group a question.)

- After two minutes, the instructor will call on a group, which will then ask their question. The responding group will have one minute to prepare before answering the question. Each group will have one turn to ask a question and one turn to answer a question.
- Next, the instructor may choose to ask each group a question. The responding group has one minute to prepare before answering the question.
- Each group will then restate their plan to the class.
- The City Council (instructor) will then take five minutes to deliberate the hearing, review notes, and prepare feedback. The City Council will share one positive impression about each group, each presentation/plan, and one suggestion for improvement.

10 The decision:

- Option 1: At this point the instructor can act as the City Council members and approve a plan awarding the land to one group based on the most comprehensive presentation that considered the needs and aspirations of the majority, or best met the needs of the community (a consensus).
- Option 2: You may wish to have the students vote as a group to choose the most comprehensive and viable plan.
- Option 3: Students may choose to award the land to a group with certain stipulations based on concerns and ideas presented by other groups (a compromise).
- Option 4: Alternately, the City Council (instructor) could state that more information is needed and that an additional hearing must be scheduled. If this route is chosen, there is no expectation of an additional hearing in class. Explain that subsequent public meetings may be required to present additional information, or make adjustments to the plans. Tell students that this happens in real life. Provide students with specific reasons for postponing a decision.



Wrap-up

1 To end the hearing, thank the special interest groups and council members for their involvement and attention.

2 Remind the students that local governments hold town meetings in the "real world" to collect public input on decisions impacting the community. Politicians, interest groups, and citizens can voice their opinions and concerns at public meetings. It's important to be prepared and well-informed about an issue before presenting your concerns and ideas at a public meeting. Challenge students to become informed and to voice their opinions when they feel committed to an issue.

3 Why are public hearings important? Who is a citizen? What are a citizen's responsibilities? How can one person make a difference in environmental issues? How can citizens learn more about local issues that may concern them? Did the groups clearly present the differences between needs and wants during the town meeting? What are some of the responsibilities of people living in a democracy?

4. Discuss the many ways in which citizens in a democracy can get involved and influence decision-making in their communities.
5. Comment on issues where children have made a difference in public policy and encourage students to learn more about getting involved in their community.
6. Debrief the students. You may want to ask:
   - Which course would others have chosen if they had been the decision-makers?
   - How did the students feel about the hearing? During the process, they may have experienced some frustrations and limitations that they want to express. Why do people get frustrated? How are people limited in public decision-making processes?

Assessment Options

1. Observe student involvement in small groups and during the hearing.
2. Evaluate the posters made for the hearing. Have student group members perform different roles in writing a proposal, organizing the poster, and presenting their posters.
3. Have student group members devise a fictional land use issue and create a short story based on this issue and how a community might resolve it. They may also illustrate the story and organize it into a storybook format.
4. Have students write a letter to a legislator or a letter to the editor discussing the impacts of all sides of a current land use issue related to shore line development in your community, or with regard to public waters used by boaters, water craft operators, swimmers, tourists, resort owners, conservation groups, campers, anglers, etc. As an alternative, have students choose a local environmental issue concerning lakes or rivers, and have them write a courtroom drama-style play about a public hearing for the issue. Present the play to another class.
5. Assessment options include the Checklist and Rubric on the following pages.

Town Meeting Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student can follow directions and agreed-upon rules for working in a group, sharing ideas, and reaching group decisions.
2	______	______	Student can explain user group.
3	______	______	Student gives two reasons why different user groups can have different ideas regarding the best use of lakeshore property.
2	______	______	Student can define *consensus*.
2	______	______	Student can define *compromise*.
3	______	______	Student can defend a viewpoint that may be different than their own in a role-play situation.
2	______	______	Student can describe four different ways that community groups might want to develop a piece of lakeshore property.
4	______	______	Student can work with group members in a town meeting simulation to prepare and present a proposal developing a piece of lakeshore property.
Total Points			
22	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles

Grade
19-22 points = A
Excellent. Work is above expectations.

15-18 points = B
Good. Work meets expectations.

14-17 points = C
Work is generally good. Some areas are better developed than others.

10-13 points = D
Work does not meet expectations; it isn't clear that student understands objectives.

0-9 points = F
Work is unacceptable.

Town Meeting Scoring Rubric

Poster Presentation Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Group participation	All members participated and discussed topic. Group agreed on what to do with the land; all contributed to the poster.	Group discussed what to do with the land, but the workload was put on a few students.	One or two students dominated the group discussion and planned the poster.	Group didn't cooperate well; group discussion on how to create the poster or on what to do with the land wasn't seen.	Group didn't produce a poster. Student disrupted group setting.
Lakeshore development perspectives and values	Student demonstrates clear understanding that different user groups have different perspectives and values on the best use of lakeshore property. Demonstrates understanding of consensus and compromise in community decision-making.	Student demonstrates understanding that different user groups have different perspectives on the best use of lakeshore property. Demonstrates understanding of consensus in community decision-making.	Student demonstrates understanding that different user groups have different perspectives on the best use of lakeshore property.	Student has difficulty understanding that different user groups have different perspectives.	Student doesn't understand that different user groups have different perspectives. Doesn't work to reach consensus or find ways to compromise to reach a decision in the town meeting exercise.
Poster content and design	Group poster shows how the land is developed. Map with key included. Explains how land development will positively and negatively impact people and the environment. Poster is well-organized and laid out, easy to view from a distance, and easy to read and understand.	Poster shows how the land is developed. Map with key included. States how it positively or negatively benefits and impacts people or the environment. Poster is laid out well, easy to view from a distance, and easy to understand.	Group created poster with a map and key, but failed to clearly explain what they did to the land and how it will impact people and the environment. Poster isn't well organized, but it's understandable.	Poster didn't include a map, key, or information on human and environmental impacts. Poster is disorganized and difficult to understand.	Poster not understandable or not completed.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Have students bring in public hearing announcements from local newspapers. Choose one and prepare a class statement on the issue to present at the hearing. (This statement will become part of the public record on the issue.) Have students present their comments, or take their comments to the hearing and let them know how people responded to their ideas.

2 Have students attend an actual public hearing on an environmental issue. Compare it to your classroom public hearing.

3 Write to local officials about an environmental issue of particular concern.

4 See **Lesson 4:5—Fisheries Management and You**, for background information on fisheries management, regulations, special regulations, experimental regulations, and the fisheries regulations toolbox. Contact your local fisheries office for information about rule making and experimental fishing regulations. The Minnesota DNR works cooperatively with other agencies and with the community before enacting special fishing regulations. No toolbox regulation is implemented without public input and support.

5 Have students find information on the fish populations, habitat, and water quality of a local lake on Lake Finder by going to the Minnesota DNR website at **mndnr.gov** and clicking on “Lake Finder.”

6 Look at the current Minnesota fishing regulations booklet to determine if there are special fishing regulations already implemented for the lake. Have students research who the various participants of a special, experimental regulations, or regulations toolbox public meeting might be. Use all the information the students collect to create and conduct a town meeting to discuss and decide whether to implement special or experimental fishing regulations on the local lake.

7 Ask a fisheries manager or field staff person to participate in the town meeting.

There is no K-2 Option for this lesson.

Concerned Citizen Group Roles

- Copy this page and cut the roles apart. Give one role to each small group.
- Create additional or different concerned citizen groups (farmers, foresters, fishing club) if desired. You may wish to include groups similar to those in your community.
- Encourage each concerned citizen group to develop their own ideas for their proposal. Remind them that they must stay within their basic role. Groups must outline their proposals as clearly as possible during the first class period. The instructor's role is one of a facilitator: asking probing questions, clarifying issues, keeping track of time, and answering factual questions, but not offering too many ideas. Let the students take charge.

Business (service)
This group of people wants to build on the property. They would build a business that would be a sports arena, amusement park, hotel, apartment complex, restaurant, resort, golf course, or marina. What type of business would provide the most jobs for the local community? What type of business would attract tourists? Is the lakeshore the best place to build the business?

Industry (product)
This group wants to make a product they can sell, and run a profitable business. An industry might make something that the people in town would use, such as food, clothing, furniture, boats, or fishing rods. A factory would provide jobs for people in the town, too. A parking lot would have to be built for the employees' cars. What would be the best kind of industry to put on this property? This might be a good place to build a factory because it is close to town, and employees wouldn't have far to drive to get to work. Is this the best place to build a factory?

Department of Natural Resources
The DNR is concerned with protecting and conserving natural resources and ensuring that they're used in a sustainable way. Sustainable means that resources can be maintained for use by future generations—in other words, not all used up. What is an appropriate use of the land that will ensure that future generations can also enjoy good fishing, clean water, and a healthy environment? The DNR is also interested in teaching people how to conserve and wisely use natural resources. How could the shoreline property be used to provide a demonstration site to help others learn about the importance of shoreline vegetation? How does shoreline vegetation improve fishing? Would this demonstration site need a parking lot for those who came to enjoy it? Is there another way that people might want to use this property?

Lake Association
This group of people own property on the lake, and they're concerned about keeping the water clean for themselves and others for drinking, swimming, fishing, and other uses. They might want to teach people how to keep the water clean for both people and animals. They may be concerned that new invasive species, pollution, overfishing, or too many rules and regulations might interfere with people's enjoyment of the lake. What are some important concerns of those who own lakeshore property? How would they like to see the property used?

Concerned Citizen Group Roles

Town Government
Elected officials are responsible for making good decisions for people who live in the town. The town government would like to provide more jobs for its townspeople and attract newcomers to expand its tax base. The town government is also concerned about keeping the town a healthy place to live. With more tax money, the town could improve its schools, streets, and water treatment plant. What would be the best way to use the property for the good of the people in the town?

Youth Group
This group of kids wants the land to be a place where they can go to hang out. There isn't a recreation center in the town, and the baseball fields at the playground are always busy. Some kids in the group like hiking, hunting, birdwatching, and fishing. The lake doesn't have a public fishing pier. Some kids would like their older brothers and sisters to be able to find a job close to town. Many older kids have to move to another town to find jobs when they graduate from high school and college. The youth group had many discussions to reach their own agreement on the best use of the lakeshore property. Now they want to present their idea to be considered by the adults at the town meeting.

University
The University has scientists who want to study the area. It may want to develop a research facility or study station to learn about a specific subject, such as lake's animals or a rare plant. Students could come to the study station to see plants and animals that they only read about in textbooks back at the University. University biologists know that an undeveloped piece of lakeshore property with a lot of plants provides good habitat for many kinds of birds, insects, and animals. Aquatic plants provide good habitat for fish, too. The university has other scientists—economists—who study how businesses create products, make money, and provide jobs. What other kinds of scientists might the university have?

STUDENT COPY

Concerned Citizen Group Duties

1. Choose one person to read the description of your concerned citizen group aloud.
2. Within your group, discuss the facts about the property, the lake, and the town.
3. Do some research in the library or on the Internet to find more information about the issues that your citizen group might consider for the property, the lake, and the town.
4. Decide how your group would like to use or develop the land.
5. Make a poster showing how your group would use the land. Include a map of the area.
6. Make up a name for your group and put it on the poster.
7. Make a table tent with your group's name on it.
8. Answer the question: How will your project benefit people in the town? How will your project benefit the lake? How will your project be a good use of the lakeshore property?
9. Answer the question: How will your project be good for the environment? Is your project a sustainable use of the property—will the resources of the property remain available for future generations? Will your project benefit the plants or animals?
10. Will your project have any negative effects on the property, people, plants or animals, town, or lake?
11. Which of the benefits are the most important for your citizen group and for the community? Why?
12. Be sure all members of your group participate. Make sure you consider the opinions of everyone in the group and arrive at a decision together.
13. Choose one person from your group to be spokesperson and explain your poster to your instructor.

STUDENT COPY

Lakeshore Property Sale Map

Fisheries Management and You

When it comes to fisheries management, we're all part of the solution.

Table of Contents

Chapter 4 • Lesson 5

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Fisheries Management and You

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grade 3, 4, and 5
I. Reading and Literature
A. Word Recognition, Analysis, and Fluency:
Benchmark 2—The student will read aloud narrative and expository text with fluency, accuracy, and appropriate pacing, intonation, and expression.
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.

Math
Alignment to the 2007 Minnesota Academic Math Standards coming soon.

Grade 3
V. Spatial Sense, Geometry, and Measurement
C. Measurement:
Benchmark 1—The student will select an appropriate tool and identify the appropriate unit to measure time, length, weight and temperature.

History and Social Studies

Grade K—3
VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 1— Students will demonstrate knowledge of civic values that facilitate thoughtful and effective participation in civic life.
B. Belief and Principles of United States Democracy:
Benchmark 1—Students will give examples of rules in the classroom/school and community, provide reasons for the specific rules, and know the characteristics of good rules.
Benchmark 2—Students will explain that rules and laws apply to everyone and describe consequences for breaking the rules or laws.
D. Government Institutions and Processes of the United States:
Benchmark 1—Students will describe examples of specific services provided by government.

Grade 4—8
II. Minnesota History
G. Post-World War II to the Present:
Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues.
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.
VI. Economics
B. Economic Choices:
Benchmark 2—Students will apply a decision-making process to make informed choices.

Science

Grade 3
IV. Life Science
C. Interdependence of Life:
Benchmark 1—The student will know that organisms interact with one another in various ways besides providing food.
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interactions with the natural world.
Benchmark 2—The student will discuss responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and possible solutions. (Depends on which cards are drawn during the game).

Grade 5
I. History and Nature of Science
C. Scientific Enterprise:
Benchmark 1—The student will describe different kinds of work done in science and technology.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 4 • Lesson 5

Fisheries Management and You

Grade Level: 3-5
Activity Duration: 40 minutes
Group Size: classroom (each gameboard accomodates two to six students)
Subject Areas: Science, Language Arts, Math, Social Studies, Environmental Education
Academic Skills: communication, listening, measuring, reading, roleplaying, small group skills
Setting: indoor or outdoor gathering area
Vocabulary: bag limit, carrying capacity, conservation, electrofishing equipment, fingerling stocking, fishing regulations, fry stocking, gill nets, harvest slot limit, lunker structure, maximum size limit, minimum size limit, one-over limit, possession limit, preservation, protected slot limit, seines, stewardship, trap nets, trawls, trotlines, water analysis, winterkill, year class
Internet Search Words: Minnesota Department of Natural Resources, fisheries management, fish surveys

Instructor's Background Information

Each state has agencies responsible for managing and protecting natural resources. In Minnesota, one of the key agencies is the Department of Natural Resources. But did you know that you're a steward of natural resources, too? Well, you are! **Stewardship** is defined as the careful and responsible management of anything entrusted to one's care.

Fish are one of Minnesota's many valuable natural resources. Fisheries resources include fish populations, water bodies, shoreline habitat, stream habitat, watersheds, and aquatic plants and other organisms.

In Minnesota, lakes, wetlands, and watercourses that meet criteria stated in Minnesota Statutes, Section 103G.005, subd. 15, and 17b are public waters. The Minnesota Department of Natural Resources Division of Waters has regulatory jurisdiction over public waters. Public waters include waters with public access, navigable waters, designated basins, including scientific and natural areas, trout streams or trout lakes, water basins designated as wetlands of ten acres or larger outside incorporated areas (city boundaries) or larger than two and one-half acres within incorporated areas, and water basins totally surrounded by public lands. Public waters belong to all state citizens.

Summary

Play a game of Fisheries Management and You to become familiar with fisheries management tools and techniques. Find out that aquatic resource management is an ongoing partnership between government agencies charged to protect these resources and the citizens that use and enjoy them.

Student Objectives

The students will:

1. Define preservation, conservation, stewardship, and sustainable use of natural resources.
2. Discuss a variety of the management tools that fisheries managers use in their work.
3. Write a Natural Resources Department mission statement that includes the following points:
   - working with the citizens of Minnesota
   - conserving natural resources
   - using natural resources in a sustainable way
   - one original goal for natural resources management.
4. Conclude that, as citizens, we're all responsible for managing our natural resources.

This lesson is best utilized as a review for students after they've completed at least one lesson from Chapter 1, Chapter 3, and Chapter 4 (Fish Management). Lessons from these chapters expose students to topics and vocabulary that appear in this lesson.

Materials

- **Fisheries Management and You Gameboard,** one for every two to six students
- **Fisheries Management and You Roleplaying Cards,** one set per gameboard
- Six place-holders (buttons, beans, or beads) per gameboard
- One six-sided die per gameboard
- **Size Limit Fish Cutouts**, one set for every four or five students (Each set should contain three cutouts less than four inches long, four cutouts six to eight inches long, and two cutouts longer than twelve inches.)
- Twelve-inch ruler, one per group
- **Weigh Your Fish With a Ruler Chart**, one per group

> Fisheries management focuses on managing or controlling aquatic habitats—and people's use of them—so that fish will always be available for angling and enjoyment. Based upon scientific and conservation principles, good fisheries management considers every component of a watershed or ecosystem.

Whether a person works for the Minnesota DNR, goes fishing, uses water, enjoys recreation in or near the water, or participates in land-based activities affecting watersheds, that person shares ownership—and management responsibility—for Minnesota's fisheries resources.

Continued use and enjoyment of our natural resources depends on all of us. Sometimes this means something as simple as doing everyday things responsibly, such as taking household chemicals to a toxic disposal facility instead of pouring them down the drain. Other times, complex issues arise, demanding difficult decisions ranging from preservation of fragile habitats to allowing unrestricted access for development or recreational uses. To practice personal and civic responsibility for environmental decisions, all Minnesotans must develop critical-thinking and problem solving skills, and become informed, active citizens.

The terms preservation and conservation are often confused. It is important to know the difference when making natural resource management decisions. **Preservation** refers to complete protection with little human disturbance. In some cases, preservation is a necessary management tool, to ensure, for example, that wilderness areas remain wild, and that certain unique habitats remain intact for wildlife. Animals threatened with extinction are totally protected to ensure the survival and recovery of those species. **Conservation** refers to responsible and sustainable uses of resources. For example, fish are a renewable resource that can be used, managed and replenished. As with most living things, the reproductive potential of fish exceeds the carrying capacity of the ecosystem. **Carrying capacity** is the maximum number of individuals or inhabitants that a given environment can support without detrimental effects to the habitat or to the organisms. Predation, disease, competition or other natural causes hold populations in check. In most cases, anglers and commercial fishing enterprises can safely harvest a certain amount of surplus fish while still leaving a viable population and a healthy aquatic ecosystem. The fisheries resource is used in a sustainable way and conserved for the benefit and enjoyment of future generations. Sustainable use of resources means using natural resources in a way that meets the needs and aspirations of the present without compromising the ability of our environment to meet future needs and aspirations. Sustainability means conserving and restoring the natural environment, while enhancing economic opportunity and community well-being.

The Minnesota DNR endorses natural resource management that sustains ecosystem integrity through partnerships and interdisciplinary teamwork. This approach seeks to sustain ecological health as well as to satisfy socioeconomic needs. This means that the DNR operates as both a science- and a community-based organization. We all have a stake in natural resource management—and we share responsibility for environmental stewardship.

This lesson describes what the Minnesota DNR does to manage the state's aquatic resources and the individual citizen's role in aquatic stewardship. The mission statement of the Minnesota DNR is:

"The mission of the Minnesota Department of Natural Resources is ***to work with citizens*** *to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life."*

In the long run, government alone cannot protect and conserve Minnesota's resources. Every Minnesota citizen is responsible for being an informed, active environmental steward.

Minnesota Aquatic Resources Statistics (2004)

Resident and nonresident anglers	1.5 million
Number of anglers including children	2.3 million
Game fish lakes	5,400
Miles of streams and rivers	90,223
Miles of managed trout streams	3,600
Public water access sites	3,000
Fishing piers and shore fishing sites	288
DNR fisheries staff	320
Area fisheries offices	28
State fish hatcheries	18

How the Minnesota DNR Manages Minnesota's Fisheries and Aquatic Resources

Information Gathering

If two anglers catch their limit, does this mean that the lake is packed with fish and has no need for limit reduction? Of course not—no more so than the instance of an angler not catching anything on a fishing trip would mean the lake contained few or no fish.

The observations of a few anglers' catches aren't an accurate indication of fish population status. Successful fishing may be due to a hungry fish, extraordinary skill, or simple good luck rather than an abundance of fish.

The unreliability of casual observation is the main reason the DNR invests so much time and money in gathering information by means of comprehensive, scientific lake and stream surveys. Observations by anglers can be valuable, but such information must be balanced, and supported with methodical, consistent surveys of fish populations, fish habitat, and fishing activity.

Natural resources are the elements of the environment (such as plants, animals, land, water, and air) that people value because they:

- sustain life
- provide food, clothing, building materials, energy, trade, and recreation
- have aesthetic or economic worth
- add quality to our lives

Public Waters

The waters within the Ordinary High Water Level (OHWL) boundary "belong" to all Minnesota citizens. The OHWL is the highest water level maintained for a period of time sufficient to leave evidence on the landscape. Public Waters Inventory (PWI) maps show the general location and area of public waters and wetlands on a county-by-county basis. PWI maps are available for viewing at all County Auditors' offices, the Minnesota DNR Division of Waters regional, area, and central offices, Soil and Water Conservation District offices, and Watershed District offices. These maps can also be purchased from Minnesota's Bookstore, 660 Olive Street, St. Paul, MN 55155, 1-651-297-3000 (metro area) or 1-800-657-3757 (statewide)

A gill net.

A trap net.

A trawl.

An electrofishing boat.

Surveys gather information from lakes and streams. They're the foundation of every DNR fisheries management effort to improve fishing—from stocking fish to restoring aquatic habitat. The surveys provide long-term information on fish population size, structure, reproductive success, species abundance, growth and movement, and habitat conditions. Fisheries field staff conduct surveys by netting, seining, trawling, electrofishing, interviewing anglers (creel surveys), and analyzing water. (These survey methods are described below.) Fisheries managers use survey information to develop resource management plans. These plans provide the foundation and guidance for the work of the fisheries staff. As one fisheries manager observed, "Without the lake and stream surveys, everything we do would be guesswork."

Lake and Stream Surveys

Each year, field crews of biologists throughout the state survey several hundred lakes and several dozen streams or rivers. Most lakes are surveyed every three to nine years, although large lakes with heavy fishing pressure are monitored yearly. There is now a database of survey information for 4,500 lakes and streams—more than any other state—and biologists add new information every year.

In the short term, surveys show the relative proportion of large and small fish, and whether each year's new generation of fish (a **year class**) is relatively weak (a small population) or strong (showing a high survival rate). By compiling many years' information, long-term trends and patterns appear, such as how quickly fish grow in various lakes, or gradual losses sustained to important spawning habitat.

Survey Techniques

Fisheries managers and their crews use different survey techniques for various fish species or sizes.

Gill nets, usually 250 feet long, are used to capture walleyes, northern pike, whitefish, and yellow perch. Biologists release live fish after measuring them and taking fish scales, that will be viewed in a lab, to determine age. Some fish die in gill nets—these are further analyzed to determine sex, stomach contents, parasites, and diseases.

Trap nets are smaller than gill nets. They capture bluegills, bullheads, and other near-shore species, allowing fish to be released unharmed.

Trawls and shoreline seines are small-meshed nets used to capture young fish.

Electrofishing equipment generates an electrical charge that temporarily stuns fish so they can be measured and weighed. Often used in streams and rivers, the equipment is also used in lake surveys of bass, crappies, and young walleyes. Fish recover quickly and are released unharmed.

Trotlines and angling are used to survey catfish and other species that aren't often effectively captured by other means.

Water analysis consists of chemical and physical tests, including percentage of dissolved oxygen, amounts of nitrates and phosphorus, and water clarity.

Creel Surveys

Throughout the summer, on selected lakes across the state, DNR creel clerks ask anglers for the times they began and ended their fishing, the number of people in their parties; their home zip codes, the fish species they sought; the fishing equipment used; the weight, length, and number of fish they either kept or released, and where they fished in the lake. Creel survey data helps fisheries managers determine fishing pressure, the size and number of fish harvested on a particular lake, and angler catch rates. This information aids in determining how to best manage the harvest of fish populations.

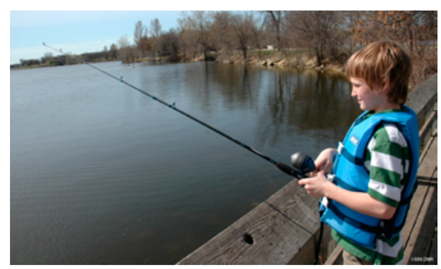
A creel. *Creel* is an old term describing a basket, usually wicker, that anglers used to hold their catches.

Habitat Improvement

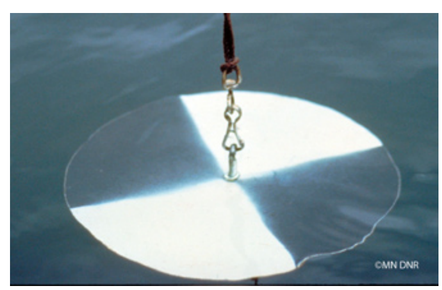
Years ago, hunters recognized the link between healthy habitat and abundant wildlife. Today, anglers are making the same connection, noticing that the best fishing lakes and streams have the healthiest fish habitats. Unfortunately, this realization has come too late in many areas where habitat degradation has harmed fish populations.

Using a backpack electrofishing unit.

A trotline.



An angler.



A Secchi disc measures the clarity of the water.

Pesticides, fertilizers, and soil from agricultural fields drain into lakes and rivers, killing aquatic insects, depleting dissolved oxygen, and smothering fish eggs. Dams that have outlived their usefulness may needlessly restrict fish migration. Leaves, grass, and fertilizer wash off urban and suburban lawns through storm drains into lakes, where these excessive nutrients fuel massive algae growth, or "algae blooms." Rapid housing development on fishing lakes is converting native lakeshore and shallow-water vegetation to lawns, rocky riprap, and sand beaches. Many lakeshore owners remove native plants, which they consider "weeds." But these native plants are actually vital in sustaining healthy fish populations.

©MN DNR, C. Iverson

There is some good news to report, however. Each year, fisheries managers collaborate with growing numbers of homeowners, fishing clubs, lake associations, local units of government (LUGs), and a variety of state and federal agencies to conserve and restore fish habitat on dozens of lakes and streams statewide.

Aquatic Plant Restoration

To restore the natural features of lakeshores, which provide habitat and protect shorelines from erosion, fisheries managers work with local lakeshore owners on lake-friendly landscaping. This new approach replaces either portions or entire lakeside lawns and beaches with native wildflowers, shrubs, grasses, and aquatic plants. More and more lakeshore owners are finding that the restored natural vegetation cuts maintenance costs, discourages pests such as Canada geese, attracts butterflies and songbirds, prevents erosion and loss of shore land, and improves shallow water fish habitat.

Spawning-area Improvement

Fisheries managers work to prevent eroding shorelines from shedding sediment into the water, where it smothers the fishes' eggs and underwater insect prey. Cooperating landowners learn how state or federal conservation programs make it cost effective to convert cleared or mowed lake edges to native grasses and trees that anchor the soil and prevent erosion.

River and Stream Habitat Improvement

On large rivers, fisheries managers work with ecological services staff, local units of government, state and federal agencies, and other organizations to improve fish access to spawning habitat. On the Red River in northern Minnesota, for example, several lowhead dams have been replaced with a series of rapids that allow fish to successfully migrate to upstream spawning tributaries.

In other cases, natural curves, or meanders, have been restored in stretches of rivers and streams formerly straightened and distorted by artificial channels. The DNR also works with anglers to improve streams for trout by installing box frames, or **lunker structures**, where fish can hide from predators as they grow. Other forms of stream improvement involve placing boulders along eroding stream banks, or installing underwater rocks to force currents to deepen and scour streambeds, which creates pools for trout.

Lake Aeration

Thick ice and snow can prevent sunlight from reaching underwater plants. As bacterial decomposers break down these dead plants, they consume oxygen that fish need. As a result, many shallow lakes lack sufficient oxygen to support fish. This is known as **winterkill**, and it usually takes three or four years for the lake's fish population to recover. One solution involves adding oxygen with an aeration system. There are sub-surface units (bubblers) and surface agitators that use propellers. The dissolved oxygen of a water basin can be depleted in summer, too, when overabundant algae dies and decays. (Elevated levels of nutrients enter the water in runoff containing phosphates, nitrates, and other materials, causing this excessive growth, or algae bloom.) Again, bacterial decomposers break down dead algae and consume oxygen. **Summerkill** occurs when dissolved oxygen levels drop too low to support fish populations.

Lake Rehabilitation

Some of Minnesota's shallow lakes are being destroyed by a combination of human behavior and fish behavior. Many activities on land cause erosion and release excess nutrients into lakes. Carp and black bullheads then burrow in silty lake bottoms, stirring up this nutrient-laden sediment. Murky water prevents sunlight from reaching the aquatic plants, which would normally stabilize the lake bottom and provide oxygen and habitat for other species of fish and water insects. Bluegills and bass population numbers then decrease as bullheads and carp thrive in the turbid water. Although carp are well-established in many Minnesota waters, this species isn't native to North America. Bullheads are a native fish species that, at normal population levels, don't harm the environment and are integrated into the ecosystems they inhabit. Problems arise when the population of any fish species increases dramatically enough to create an ecosystem imbalance.

©MN DNR, C. Iverson

The only proven method of restoring ecological balance to these unbalanced lakes is to kill the entire fish population and restock the lake with more desirable fish. This process, known as lake rehabilitation requires appropriate permits. Rotenone, a natural chemical derived from a South American tree species, kills gilled animals by blocking their ability to utilize dissolved oxygen. In the concentrations used by the DNR, the chemical is harmless to humans—or to any wildlife that happen to eat dead fish that have consumed it. Rotenone breaks down to carbon dioxide and water within a few weeks, and is then completely harmless. Barriers are often placed at inlets and outlets to prevent the re-entry of unwanted species after rehabilitation. Barriers are also installed to prevent new connections to other water bodies that result from road building, agricultural drainage, or construction.

Lake rehabilitations aren't long-term solutions because the carp and bullheads eventually return to lakes through connected waters, or during large flooding episodes. Also, Rotenone treatment is very costly. Fisheries managers increasingly focus on reducing nonpoint source pollution and sediments and habitat restoration as part of a long-term solution to improving fishing in these problem lakes.

Habitat Conservation

Land Acquisition
In 1992, the Minnesota Legislature created a new public land classification called aquatic management areas (AMAs). Modeled after wildlife management areas, AMAs are purchased from willing sellers to protect environmentally vital shorelines and littoral (shallow water) edges of lakes, streams, and rivers. The focus of AMA acquisitions is critical shoreline habitat, muskellunge spawning areas, and walleye fingerling production. When purchased, AMAs are owned by the state and are protected from development and other human degradation.

Another purpose of land acquisition is to provide public access areas to water bodies. The Minnesota DNR has also been working with private landowners since the early 1900s to purchase easements providing public access to streams, lakes and rivers.

Fish Stocking

Fisheries managers also use stocking to manage Minnesota's lakes and rivers. Stocking is the practice of adding a particular species of fish to lakes or rivers capable of producing fish in addition to the native fish originally present.

The goal is usually to increase numbers of a particular species, or to introduce a new species. Most lakes have established fish populations that use all of the lake's available food resources. In these situations, stocked fish will either displace native fish, or the stocked fish won't survive. Lakes lacking food, spawning habitat, or good water quality may not respond to stocking. Stocking isn't effective in lakes containing natural populations of fish and adequate habitat. (When stocked fish are added to populations already in the lake, the stocked fish can replace the existing fish populations, wasting existing natural reproduction. This can be a costly mistake.) But occasionally, stocking can be an effective management tool. Some Minnesota lakes now contain populations of game fish that wouldn't have naturally occurred without stocking. For example, several lakes in southern Minnesota now have excellent walleye fisheries. And there are trophy tiger muskies in many Twin Cities metro area lakes. Stocking can restore extirpated populations such as Lake Superior's native lake trout. Fisheries managers stock our state fish, the walleye, in roughly 900 lakes throughout the state, adjusting stocking levels as necessary. The goal is to find stocking levels that increase or maintain marginal walleye populations while not being detrimental to the rest of the fish in the community. Walleye stocking shouldn't be done in lakes with well-established, healthy walleye populations. Many large, windswept northern lakes already have good natural reproduction, making stocking unnecessary. Any lake, regardless of size, can sustain only a certain number of fish and other organisms. This is known as **carrying capacity.** If managers were to add fish to a lake already at carrying capacity, most of the new fish would die from starvation, lack of habitat, or overcrowding—this would be a waste of time and money. There is also the possibility that genetically inferior stocked fish could displace natural fish, resulting in reduced natural reproduction.

On each lake, fisheries managers weigh the costs against the benefits of walleye stocking, the likely effects on other fish populations, and the effectiveness of previous stockings. Only then do they decide whether or not to stock the lake. Some lakes aren't stocked with walleyes because they don't have good walleye habitat and may be better suited to other species such as black crappie, largemouth bass, catfish, muskellunge, smallmouth bass, stream trout, lake trout, or salmon.

Red Lake's Remarkable Comeback

"In the early 1990s, Red Lake in northern Minnesota in Beltrami County suffered a dramatic drop in the walleye population due to overharvest. State, federal, and tribal resource managers joined together in 1999 to develop the Red Lake Recovery Plan. They prescribed a total walleye harvest moratorium, stepped-up enforcement, and science-based fry stocking (newly hatched fish, less than ¼ inches in length). And they let nature take its course. Recent DNR test netting indicates the stocking of 41 million walleye fry in 1999, the stocking of 32 million fry in 2001, and stocking again in 2003 was a huge success. 'In only five years Upper and Lower Red Lakes held the largest year class of mature walleye in well over a decade, and two strong year classes are right behind,' noted Henry Drewes, DNR regional fisheries manager at Bemidji. "We gave the lake the rest and the shot of fish it needed," said Drewes. 'That was the cure. Now we need to work on stable, sustainable, and collaborative forms of fish management. We want anglers to enjoy this fishery as soon as possible but not at the expense of a population setback. Inherently, this means conservative fishing regulations at first, followed by monitoring and data evaluation.' The big question is: Can anything be done to prevent the walleye population from collapsing again? Yes. The DNR, Red Lake Band of Chippewa, and the Bureau of Indian Affairs are committed to complete recovery and sustainability. They have also enlisted the expertise of the University of Minnesota, U.S. Fish and Wildlife Service, and Red Lake Fisheries Association to achieve that goal.

'There are more players and cooperation than ever before,' said Drewes. 'Together, we want to put the collapse behind us and a lot of good fishing ahead of us.'"

—C.B. Bylander, "Field Notes: Red Lake Update," *Minnesota Conservation Volunteer,* January-February 2004

Lake Region	Time to Reach One Pound
South	2-4 years
North	4-5 years
Northern border	5-6 years

Common Walleye Stocking Questions

What's the difference between stocking walleye fry and stocking walleye fingerlings?
It's more cost effective to stock fry (newly hatched fish less than one-quarter-inch long) than fingerlings (four- to six-inch fish). Stocking walleye fry costs approximately one tenth as much as stocking fingerlings, and fry are more likely to establish large year classes. So fry are stocked most often.

How long does it take a stocked fish to reach catchable size?
It takes several years for walleyes stocked each spring or fall to reach one pound, or about fourteen inches. Southern lakes are more productive and have longer growing seasons, so walleyes reach a catchable size sooner in those waters.

How many fish are stocked in a lake?
Most lakes receive an average of 1,000 fry, or one pound of fingerlings per littoral acre (a surface area less than fifteen feet deep).

Why are some lakes stocked with more walleyes than others?
Larger lakes usually receive more stocked fish than smaller lakes. Stocking levels vary, though, depending on available prey and lake productivity.

Why doesn't the DNR stock lakes every year?
A generation of walleyes stocked or hatched one year (a year class) can eat much of the food needed by the next year class. This phenomenon, known as year class suppression, is prevented with a one- or two-year elapse between stockings. This also allows fisheries managers to check the lake's natural reproduction. Walleye in a year class from a non-stocked year are naturally reproduced. If natural reproduction adequately maintains the walleye population, it's less expensive and more efficient to let nature do the stocking.

Enacting and Enforcing Regulations

Fishing regulations
Laws that place limits and seasons on angling activity—exist primarily to protect fish populations from overharvest. Regulations also reduce the harvest per angler, creating an opportunity for sharing the harvest among the growing number of Minnesota anglers.

More Pressure, Better Gear
Fishing pressure has been experiencing an upward trend. Although the number of anglers has risen moderately over the years, there has been an apparent and dramatic increase in the average number of days each angler is on the water. Meanwhile, continual improvements in fishing gear have made anglers more effective at finding and catching fish. Anglers have graduated from rowboats to comfortable fishing rigs, from steel poles to graphite rods, from braided Dacron to monofilament, and from using a rock on a string to gauge lake depth to sophisticated depth finders and fish locators. As fishing pressure and technological advances increase, the number of fishing waters remains constant. One result is that, on many lakes, the average size of the fish caught has become smaller.

Bag Limits
Why are Minnesota's bag limits set at their current levels? Many bag limits were set more than 50 years ago, so the rationale for them isn't exactly clear. It's likely that past managers set limits based on the best scientific research and biological data available at the time, and in addition to their own knowledge and experience.

DNR Fisheries continues to examine the biological and social ramifications of existing and proposed bag limits. Because most anglers rarely catch their limit on a given day, and many catch no fish, or only a few per day, lowering limits (such as the fifteen-fish bag limit for crappies), by just one or two fish usually does little to reduce harvest. Most anglers support reducing bag limits by a few fish, but they don't tend to support major reductions that would significantly reduce harvest and promote conservation. As anglers learn how restricted bag limits could spread the harvest among more anglers, they might be more likely to accept significant bag limit reductions.

Experimental Regulations
Special harvest regulations are tailored to individual lakes and streams and to different fish species. On Lake Winnibigoshish, for instance, all walleyes between 17 and 26 inches must be released immediately. Biological research shows that limiting the harvest of some sizes of fish is the most effective way to improve the average size of fish that anglers catch. Managers then set the sizes of harvest regulations based on considerable public input from anglers, ranging from those who don't want to release "keeper" sized fish, to those who say it's worth releasing those fish in order to be able to catch larger ones from that lake in the future, to resort owners who believe the regulations drive away customers who will just go fish on another lake, and still others who see the regulations as the best way to increase fish size and attract future customers. A delicate balance is needed between regulations—simplifying them to make them more universal to ensure better compliance—and meeting the management needs of specific lakes. Meanwhile, managers continue to study how regulations can best serve various waters and species.

Species-Specific Regulations
The Minnesota DNR is committed to providing the quality fishing demanded by our fishing public. To that end, a new effort was developed to improve Minnesota's walleye, bass, crappie, and sunfish populations through a simplified set of special possession limits and length-based regulations. These regulations aim for fewer variations of special regulations (which are easier for the public to remember), as well as a broader sweep of lakes and rivers with common population goals. These science-based regulations are implemented with public input and support, and are used to enhance or improve local fish populations.

Terminology of Limits

- **Bag, or possession limit**, is the total number of a species that an angler may possess. Possession may be regulated over one day or over several days, and usually includes all fish in possession, on the water and off. For example, an angler may not possess more than six walleyes, including the fish in a live well (a boat's water-filled fish storage compartment), and at home in the freezer.
- **Protected slot limit** indicates the size range, or slot, of fish that must be released. A twelve- to sixteen-inch slot limit for bass calls for the release of all bass from twelve to sixteen inches long.
- **Harvest slot limit** is the size range of fish may be kept. For example, a fourteen- to eighteen-inch harvest slot indicates that fish between fourteen and eighteen inches may be kept and all others released.
- **Minimum size limit** requires that all fish below a set length must be released. For example, the statewide minimum size limit for muskellunge is 40 inches, meaning that you must release muskies shorter than 40 inches.
- **Maximum size limit** requites that all fish above a set length must be released. A 24-inch maximum size limit for northern pike means that you must release any northern longer than 24 inches.
- **One-over limit** indicates that you may keep just one fish over a specified length.

Controlling Invasive Species

Invasive species are those species, or types of organisms, that are not native and that have been intentionally or accidentally introduced into a place they did not originally inhabit. Invasive species, such as the zebra mussel, Eurasian milfoil, round goby, spiny water flea, bighead carp, and ruffe can permanently damage Minnesota's fish populations and fishing as they overtake or substantially alter fish habitats. Anglers and boaters must help prevent the spread of invasive species by removing plants and draining the live wells of their boats prior to leaving the water.

Informing and Educating

Why is it not in the public interest to stock walleye in every Minnesota lake? Why are aquatic shoreland plants so important to small walleye, bass, northern pike, perch and sunfish? How can a private landowner protect shoreland vegetation and fish populations? Will a slot limit increase fish size in my lake? Which farming practices ease erosion and benefit fish populations? DNR fisheries managers throughout the state answer questions like these continually. Providing information to anglers, lakeshore owners, other citizens, and kids is one of the most important functions of DNR Fisheries.

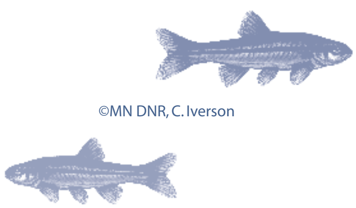
Anglers are always searching for information. They appreciate having access to DNR Fisheries lake survey information. Each day, the DNR website receives more than 60,000 page hits, primarily from people checking lake survey reports. In the spring, the DNR Information Center receives hundreds of phone calls and e-mail requests daily. Local fisheries managers meet regularly with more than 300 fishing groups and 600 lake associations throughout the state. The managers listen to the concerns of anglers and lakeshore owners, present lake survey information, propose experimental regulations, and discuss the state of local lakes and streams. Fisheries managers also educate school and civic groups, speak on radio shows, provide information to reporters, and field questions from visiting anglers and real estate agents.

MinnAqua

According to the 2000 U.S. Census, most rural counties in Minnesota showed population decreases as urban counties gained residents. One result of Minnesota's growing urbanization is that fewer children spend time outdoors. The MinnAqua aquatic education and angling program was developed to increase public knowledge of lakes, streams, and fisheries, particularly for the urban public. MinnAqua's main goal is to provide basic instruction on lake and stream ecology, fisheries conservation, and angling stewardship as it teaches people to fish. Fishing is a recreational sport that can become a lifelong activity connecting participants with their local aquatic environment. Fishing also encourages stewardship and appreciation of natural resources. Anglers learn what kind of habitat and foods enable fish survival. MinnAqua has grown since its inception in 1990, and is now a statewide program whose education efforts have reached more than 450,000 people. Its educational approaches emphasize developmentally appropriate hands-on learning, the development of critical thinking and problem-solving skills, and the grasp of concepts spanning academic disciplines.

"By helping more people understand how our natural world works, we will encourage environmental stewardship, assuring healthier habitats for fish and wildlife—as well as humans—for generations to come."

—Ron Payer,
Minnesota DNR
Fish and Wildlife Division



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8. Increasing Access

It doesn't matter how good the fishing may be if anglers can't get to the water. To provide angler access to Minnesota's lakes, rivers and trout streams, and other public waters—the DNR buys lakeshore and stream easements from willing sellers, then installs and maintains fishing piers and boat ramps.

Boat Ramps

Half of the 3,000 public boat ramps on Minnesota lakes and streams were built by and are maintained by the DNR—counties or local units of government administer the rest.

Fishing Piers and Shore-fishing Sites

Anglers can fish from hundreds of fishing piers and shore-fishing sites throughout Minnesota. New piers and shore-fishing sites are designed to meet the needs of anglers with disabilities. They are generally within 300 feet of a paved parking area, and can be reached via a solid, wheelchair-accessible surface.

FiN

The Minnesota DNR's FiN (Fishing in the Neighborhood) Program was initiated in 2001 in the Twin Cities Metro Area to improve public access and fishing opportunities in area neighborhoods. FiN works with local partners to develop safe, family-friendly ponds situated in residential areas where people can enjoy a day in the park and some good fishing. With its partners, FiN stocks fish, installs fishing piers and platforms, restores shoreline habitat, and sponsors MinnAqua aquatic education programs to create high-quality fishing opportunities.

Conducting and Utilizing Scientific Research

The DNR's fisheries research scientists study how to make fisheries management more successful and efficient. Fisheries managers tell research scientists which management tools they need—special regulations, hatchery applications, best stocking practices, fish population dynamics, new technology, or statistical modeling—and the research scientists evaluate which tools will be most effective. Minnesota's fisheries research scientists tackle the most significant management problems facing fisheries managers and anglers today.

Researchers conduct studies under major fisheries resource issue headings, including status of fish populations, fish stocking, new technologies, regulations, habitat issues and watersheds, genetics, and human dimensions.

Researchers conduct experiments that answer specific questions posed by managers, anglers, and academics, such as:

- What is the current status of fish populations in Minnesota?
- How are improved fishing technologies affecting the fish population?
- How can regulations, habitat and watershed work, and genetic research improve fish populations?
- How can we measure the cumulative effect of habitat loss on fisheries?

Some Significant Minnesota DNR Fisheries Research Findings

- Habitat improvement techniques: Research showed that trout numbers rise dramatically (per mile of stream) if channels are narrowed, banks stabilized, riffles kept free of silt, and brush allowed to grow along stream banks.
- Stocking: Researchers studied conditions in walleye-rearing ponds used for walleye stocking and refined hatchery techniques to increase egg fertilization rates, enabling more walleyes to be produced at a lower cost.
- Fish genetics: Fish (such as muskie) have numerous genetic strains, or variations within the species. Some strains do better than others in Minnesota waters. Researchers have determined which strains are the best to stock.

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- Human Dimension: A joint study by the University of Minnesota and the Minnesota DNR recently enabled research personnel to work with angling constituents in southeast Minnesota. This cooperative effort resolved some of the angling groups' long-standing concerns about balancing quality trout fishing opportunities and sustainability of trout resources.

Research findings are disseminated by presentations at area and regional managers' meetings, at professional meetings, through publication of Investigational Reports, and publications in peer-reviewed journals. The Fisheries Research Unit has published more than 500 Investigational Reports, and in the past twenty years, more than 85 papers in scientific journals. These are widely cited by other researchers and scientists.

Through research and careful monitoring of the fishery, the DNR can conduct a fish management program that relies on science and clearly expressed goals. Working with an informed citizenry to manage fisheries resources eventually produces positive results. Fishing will be better, and future generations of Minnesotans will enjoy a healthier environment.

Procedure

Preparation

1 Copy the **Fisheries Management and You Gameboard** and glue it to tag board or cardboard backing. You may want to provide printed game instructions on the back of each gameboard, or as a separate sheet. Make one board for each group of two to six students. For reuse, laminate all materials.

2 Copy the **Fisheries Management and You Roleplaying Cards**, one set per gameboard.

3 Make, find, or purchase suitable place markers for each player, one set per gameboard. Differently colored buttons, dried beans, or glass beads make good place markers.

4 Copy the **Size Limit Fish Cutout** and make one set per group that contains:
- three cutouts less than four inches long
- four cutouts six to eight inches long
- two cutouts longer than twelve inches

5 Collect one twelve-inch ruler per group.

6 Copy one **Weigh Your Fish With a Ruler Chart** per group.

7 Collect one die per gameboard.

Activity

Warm-up

1 Talk to students about what they think a fisheries manager does during a typical day. Use information provided in the background to suggest various management activities that the students may not be familiar with. Review terminology found in the **Fisheries Manager and Citizen Roleplaying Cards** before students play the game. Define and discuss ecosystem-based management, sustainability, preservation, and conservation.

2 Review the information presented in the Terminology of Limits section of the Instructor's Background Information with students so that they understand the meaning of each scenario: bag or possession limit, protected slot limit, harvest slot limit, minimum size limit, maximum size limit, and one-over limit.

3 Supply photocopies of various-sized fish and have students use a ruler to measure the fish to determine if they are within the limit specifications. For the purposes of the game, use a protected slot limit in which all sunfish from six to eight inches long must be released. Ask students why it might be important to have these regulations like this for one lake. Why wouldn't we have them on all lakes?

4 Anglers often want to know the weight of a fish they catch. But, if the fish will be released, it is important to remember that weighing can hurt fish. Ask students what tools are used to weigh things. Answers might include different types of scales and balances. They may be surprised to learn that anglers can estimate a fish's

weight by measuring it with a ruler! Have students use the **Weigh Your Fish With a Ruler Chart** to determine the approximate weight of the fish based on its length. Ask students why an angler would want to know how much a fish weighs. Answers could include: to be able to tell others about the fish they caught, or to help determine if they've caught a record fish. Students may wish to search the Minnesota DNR website or Minnesota Fishing Regulations Booklet for Minnesota record fish sizes and weights. Ask students if they can determine how a chart that helps you weigh fish with a ruler might have been created. Weights on the chart are approximate for corresponding sizes of fish. Many fish were measured and weighed to determine average weight per length for each fish species on the chart.

5 Discuss the DNR mission statement: *The mission of the Minnesota Department of Natural Resources is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.* What does "*work with citizens*" mean? Ask students why the DNR should work with citizens to manage the state's natural resources.

6 Have students rewrite the Minnesota DNR mission statement in their own words.

7 Discuss the definition of stewardship. Ask students how each of them could "work with the DNR to protect and manage the state's natural resources" as a citizen of Minnesota.


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Lesson

Divide students into groups and allow them to play several rounds of Fisheries Management and You. Students will take turns rolling a die to determine how many spaces they will move. If they land on a space indicating a Fisheries Manager or Citizen, they will draw a roleplaying card from the corresponding deck, read the card out loud to the group, and follow the directions. The first student to reach Lake Sustainability wins. Before play begins, make a point of telling the students that the game includes situation cards that direct the player to move back spaces when they land on the game spaces that reflect poor decision making by a citizen or fisheries manager, or a setback or barrier to completing a task.

Wrap-up

Upon completion of the games, bring student groups back together to discuss how a fisheries manager's job complements what we do as individual stewards of our aquatic resources. Ask them if they think an individual citizen can make a difference in conserving natural resources in a sustainable way. Should citizens be involved in managing natural resources? Why or why not? Ask students to list ways they can participate in managing our state's fisheries and water resources. Review the definitions of preservation, conservation, stewardship, sustainable use of resources, and ecosystem-based management.

Assessment Options

1. Assess student participation and discussion during the Warm-up and Wrap-up portions of the lesson. Evaluate whether the students' discussion demonstrated understanding of stewardship, sustainability, ecosystem-based management, preservation, and conservation, and their roles as citizens in helping to manage our natural resources.
2. Observe and assess student participation in group discussions, as well as understanding of terms during the game time.
3. Evaluate the students' mission statements to include the following points: a mission statement that includes working with the citizens of Minnesota, conserving natural resources and using them in a sustainable way, and at least one additional original goal for natural resources management.
4. Ask students to create their own board game about environmental stewardship and the decisions they make in their own homes, schools, and neighborhoods that impact natural resources in Minnesota.
5. Assessment options include the Checklist and Rubric on the following pages.

Fish Management and You Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student reviews terms and vocabulary words from previous MinnAqua Lessons completed with class.
4	______	______	Student plays board game with understanding of vocabulary words and terms used on playing cards.
4	______	______	Student plays board game respectfully with other students and helps others understand vocabulary words and terms during the game.
4	______	______	Student can define preservation, conservation, stewardship, and sustainable use of natural resources.
4	______	______	Student creates a mission statement that includes working with the citizens of Minnesota, conserving natural resources and using them in a sustainable way.
2	______	______	Mission statement is original, stating at least one additional goal for natural resources management.
Total Points			
22	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

19-22 points = A
Excellent. Work is above expectations.

15-18 points = B
Good. Work meets expectations.

14-17 points = C
Work is generally good. Some areas are better developed than others.

10-13 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-9 points = F
Work is unacceptable.

Fish Management and You Scoring Rubric

Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Knowledge	Understands at least 75% of the game terms, including *preservation*, *conservation*, *stewardship* and *sustainable use of natural resources*, and especially *limits* as referring to fishing regulations. Can explain why limits are important and why some lakes have different limits than others.	Understands at least 75% of the game terms. Knows what *limits* are, and can give one reason why they're important.	Understands less than 50% of the situation card terms during the game. Has some understanding of the term *limits*, but can't give reasons why they're important.	Understands less than 30% of the terms. Can't define *limits*. Needs frequent help to participate in the game with understanding.	Understands no new terms. Can't define *limits*.
Group participation	Respectful of others; asks questions. Helps others with questions.	Respectful of others; asks one question or shows interest in lesson.	Has a hard time respecting others; doesn't show much interest in the board game.	Shows no participation in board game.	Disrupts others in the group during the game.
Mission statement	Creative in writing the statement. Had the same goals as current DNR statement and added at least one more goal.	Created original statement promotion and protection of natural resources.	Created a statement, but used little creative thought. Statement addressed stewardship of natural resources in a limited way.	Created a statement, but short and incomplete; didn't address stewardship, conservation or sustainable use of natural resources.	Didn't create a mission statement.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Invite a local fisheries manager to come and speak to the class about the job.

2 Visit a DNR Hatchery or Aquatic Management Area to observe some of the tools that fisheries managers use to protect our aquatic resources. You can find your area Fisheries office by visiting the Minnesota DNR website (mndnr.gov) or by calling 1-888-MINN-DNR. Obtain a Fisheries Tour Packet curriculum guide available for loan from the Minnesota DNR MinnAqua Program prior to a hatchery tour to prepare your students for the experience.

For the Small Fry

K-2 Option

Laminate the bag limit fish and put paper clips on the mouth of each fish. Make a set of fishing poles out of dowels, string, and magnets. Make a large fish ruler to measure the laminated fish when the students catch them. Have the students catch fish and work together to determine if it's okay to keep the fish. Each round can have different bag limits and size limits.

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Fisheries Management and You

Roleplaying Cards

Copy these Fisheries Manager Cards and the Citizen Cards on two different colors of paper.

Fisheries Manager
A lake in your area has more people fishing on it now than it did five years ago. You decide to do more creel surveys to ask anglers how many fish they're catching—and to make sure they're not harvesting too many. ***Move ahead 3 spaces.***

Fisheries Manager
A small lake in your area has been a good kids' fishing spot for many years. In recent years, the fish population is mostly bullheads and carp. You use lake rehabilitation to create balanced sunfish and bass populations. ***Move ahead 2 spaces.***

Fisheries Manager
There's a pond in your neighborhood where kids could walk to go fishing. You work with the Parks Department to build a fishing pier and a walking path. You stock the pond with bluegill and black crappies. ***Move ahead 3 spaces.***

Fisheries Manager
A Conservation Officer tells you that they've been working on a lake with a new regulation, and that most anglers are obeying the new 10-inch minimum regulation. Draw a fish from the pile. Decide if you're going to keep it. Now measure it. ***If it's less than 10 inches long, move back 1 space. If it's more than 10 inches, move forward 1 space.***

Fisheries Manager
You think a lake in your area has a good largemouth bass population, so you decide to do an electrofishing survey. This gives you better information to make lake management decisions. ***Move ahead 2 spaces.***

Fisheries Manager
You see an area of aquatic plants that makes good largemouth bass spawning habitat. You talk to the landowner and the two of you decide to create an Aquatic Management Area (AMA) to protect this habitat. ***Move ahead 3 spaces.***

Fisheries Manager
You find a great spot for a fishing pier on a kids' fishing pond, but due to other management priorities, it will have to wait until next year. ***Move back 1 space.***

Fisheries Manager
Management priorities require that you must survey a popular fishing lake and skip a smaller lake this year. ***Move back 2 spaces.***

Fisheries Manager
A creel survey shows that kids fish a pond frequently. You decide to stock some extra fish into the pond to make fishing better.
Move ahead 2 spaces.

Fisheries Manager
You are a summer intern for the MinnAqua program and you teach hundreds of kids how to fish safely. ***Move ahead 3 spaces.***

Fisheries Manager
You have so many meetings this week that you're unable to attend a citizen lake association meeting to which you were invited. ***Move back 1 space.***

Fisheries Manager
You organize a public meeting to see how citizens feel about your plans to stock muskies in their lake.
Move ahead 2 spaces.

Fisheries Manager
A fish survey and a creel survey show that the sunfish are getting smaller due to overharvesting by anglers. You ask for a special regulation to change the possession limit to five fish.
Move ahead 2 spaces.

Fisheries Manager
You get several phone calls from citizens wanting a boat ramp on a nearby lake. You meet with other members of the community, look at your lake survey, and work with the county planners. You decide to ask for money to put in the new boat ramp. ***Move ahead 2 spaces.***

Fisheries Manager
Anglers discover an invasive fish from another part of the world in the rivers of your state. You work with neighboring states to try to keep them from spreading. ***Move ahead 2 spaces.***

Fisheries Manager
You hire a summer intern to help with lake surveys. This gives her experience working for the Department of Natural Resources.
Move ahead 3 spaces.

Fisheries Manager
You work with a citizen lake association to monitor the water quality of a lake.
Move ahead 3 spaces.

Fisheries Manager
You discover that stocked lake trout fingerlings don't survive well in some parts of the state. You make suggestions about where it's best to stock them. ***Move ahead 3 spaces.***

Fisheries Manager
You go to an elementary school and talk to students about your job as a fisheries manager.
Move ahead 2 spaces.

Fisheries Manager
Your research scientists did a study on black crappie spawning and have been invited to show their results at a National Fisheries Society meeting.
Move ahead 2 spaces.

Fisheries Manager
You notice that the only way to get to one of the fishing piers you've installed is a bumpy gravel path. You work with the county to get a paved trail so wheelchairs can travel it, too.
Move ahead 3 spaces.

Fisheries Manager
It was a very long, cold winter. Several shallow lakes in your area had winterkills for the first time in many years. It will take a number of years for fish populations in these lakes to recover.
Move back 2 spaces.

Citizen
The lake that you're fishing has a six-inch to eight-inch protected slot limit for sunfish.
Draw a fish from the pile. Decide if you're going to keep it. Now measure it. If it's in the slot,
Move back 2 spaces.

Citizen
Your family has a dairy farm. Drought has reduced the amount of pasture grass for your cows. You decide that you need to let them eat the grass closer to the stream. The cows' feet stir up sediment in the water as they graze, making it hard for fish to spawn. ***Move back 2 spaces.***

Citizen
You live on a lake and don't like to swim around aquatic plants. You ask your parents to remove all the plants from the water. ***Move back 2 spaces.***

Citizen
You don't know very much about fishing. You go to a Take A Kid Fishing Clinic with your mom. You learn a lot and have a fun time too.
Move ahead 2 spaces.

Citizen
While fishing on Lake Mille Lacs, you have the best luck ever and catch a 30-inch fish and a 31-inch fish. The regulations say you can only have one fish over 28 inches, so you release the second fish immediately so it will survive. ***Move ahead 3 spaces.***

Citizen
You went fishing with friends and left your empty lunch bag and candy wrappers on the pier instead of putting them in the trash container.
Move back 3 spaces.

Citizen
You see some tangled fishing line laying near the place you fish, but you choose not to pick it up and throw it away or take it with you to recycle at a bait shop. ***Move back 2 spaces.***

Citizen
You're fishing on the river with some friends and notice that other anglers are throwing fish on the bank and letting them die. You tell them it is illegal to do that, and that it will make the fishing spot stinky. ***Move ahead 3 spaces.***

Citizen
Your little brother got a goldfish for his birthday, but doesn't take care of it anymore. He wants to put it in the lake. You tell him that that would hurt the other fish populations and it would be illegal. He decides to give it to a friend. ***Move ahead 3 spaces.***

Citizen
The DNR is considering special fishing regulations for a lake near your house. You attend a public meeting with your parents to share your opinion.
Move ahead 2 spaces.

Citizen
Mercury pollution in water comes from power plants that burn coal to make electricity. You often forget to turn off the lights when you leave a room. ***Move back 1 space.***

Citizen
You live on a lake and don't like to swim around aquatic plants. You ask your parents to remove all the plants from the water. ***Move back 2 spaces.***

Citizen
You help your dad wash the car. You remind him that it's better to wash the car on the lawn instead of on the driveway so the soap and dirt don't run directly into the storm sewer that drains to the river. ***Move ahead 2 spaces.***

Citizen
You're a lakeshore owner and you decide to put the area in front of your property into an Aquatic Management Area (AMA) to save fish habitat instead of making a sandy beach. ***Move ahead 4 spaces.***

Citizen
Your mom asks you to rake leaves. If you choose to collect the leaves into bags for composting, ***Move ahead 1 space*** If you rake the leaves into the street for the street sweeper, many of the leaves will enter the storm sewer, so ***Move back 1 space.***

Citizen
A large number of yellow perch eggs hatch in the lake, which means more food for the walleye. Walleye like to eat perch. The walleye are very full and they're not biting on lures. Anglers aren't happy. ***Move back 1 space.***

Citizen
Your teacher assigns a project for Science. You choose to research water quality and share how our decisions affect the water quality in the watershed where we live. ***Move ahead 3 spaces.***

Citizen
When you return home from your fishing trip, you put your leftover worms in the trash because they could damage the forests near your home if you release them on the ground. Worms are invasive species in Minnesota. ***Move ahead 3 spaces.***

Citizen
The lake that you are fishing has a six-inch to eight-inch protected slot limit for sunfish. Draw a fish from the pile. Decide if you're going to keep it. Now measure it. If it's in the slot, ***Move back 2 spaces.***

Citizen
You're fishing on a small pond, and you only catch small fish that keep swallowing the hook. With the next fish, instead of cutting the line and handling the fish gently, you get frustrated, rip out the hook, and throw the fish on shore. ***Move back 3 spaces.***

Citizen
You live on a beautiful trout stream, but do not fish much yourself. You decide to let trout fisherman cross your property so they can enjoy fishing on the stream, too. ***Move ahead 3 spaces.***

Citizen
You're a Boy Scout or Girl Scout who organizes a group of people to plant aquatic plants in a storm water pond. This helps the pond to remove extra pollution. ***Move ahead 3 spaces.***

Citizen
While you're out fishing, you take the time to answer a creel survey so there's more information about the fish in the lake that you love to fish. ***Move ahead 3 spaces.***

Citizen
You're a member of a 4-H club that organizes a group to clean up trash along the river near your home. ***Move ahead 3 spaces.***

Citizen
You're a member of a fishing club. You suggest that your club raise money to put a new fishing pier on a local lake for everyone to enjoy. ***Move ahead 2 spaces.***

Citizen
You know your shoreline is eroding (washing away) more and more each year. You contact a fisheries manager and work with them to plant native plants along your shoreline to stop the erosion. ***Move ahead 3 spaces.***

Citizen
You're a city planner and you work with a fisheries manager and a local fishing club to get an aeration system (bubbler) installed on a popular kids' fishing pond in your town. This aeration system will prevent fish kills in the winter. ***Move ahead 3 spaces.***

Citizen
You go out fishing for walleye and they're biting like crazy! You could take home six fish, but you remember that you have two in the freezer at home. You only take four fish so that you don't go over your total possession limit of six walleye. ***Move ahead 3 spaces.***

STUDENT COPY

Weigh Your Fish With a Ruler Chart

This chart can be found in the Minnesota fishing regulations booklet available from the Minnesota DNR.

Why weigh fish with a ruler rather than a scale?
Fish can get hurt when weighed with scales. By using this chart, you can quickly find approximate weight of your fish by measuring it with a ruler or a tape measure.

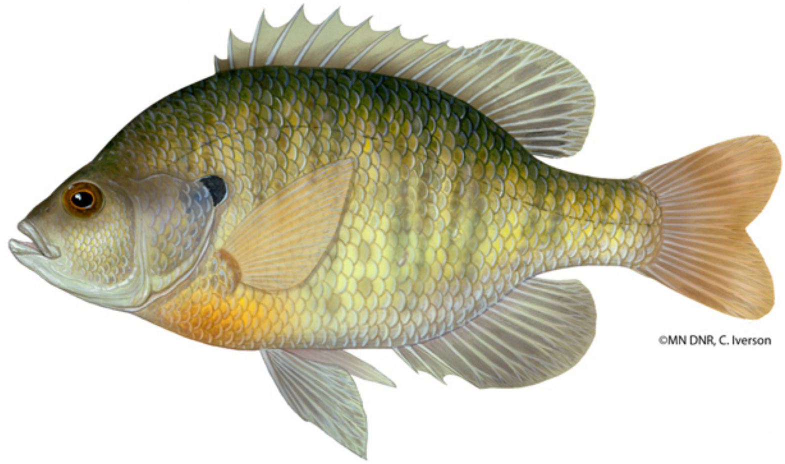
These figures are rough estimates only. Actual weights vary slightly by lake and stream.

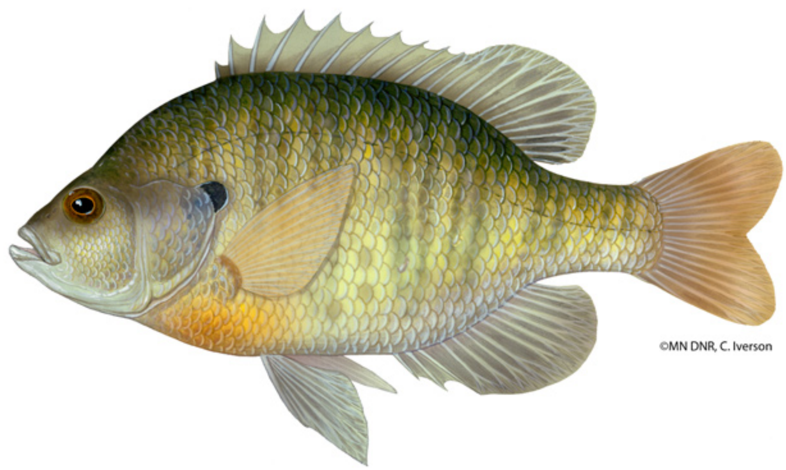
Crappie		Trout		Bass		Walleye		Northern Pike		Sunfish	
length (inches)	weight (lbs.)	length (inches)	weight (lbs.)	length (inches)	weight (lbs.)	length (inches)	weight (lbs.)	length (inches)	weight (lbs.)	length (inches)	weight (lbs.)
8	0.3	8	0.2	12	1.0	14	1.0	24	3.2	8	0.4
9	0.4	9	0.3	13	1.3	15	1.2	25	3.6	9	0.6
10	0.6	10	0.4	14	1.7	16	1.5	26	4.0	10	0.8
11	0.8	11	0.6	15	2.1	17	1.8	27	4.6	11	1.1
12	1.1	12	0.8	16	2.5	18	2.2	28	5.2	12	1.5
13	1.4	13	0.9	17	3.0	19	2.5	29	5.8	13	1.9
14	1.8	14	1.1	18	3.6	20	3.0	30	6.4	14	2.4
15	2.2	15	1.4	19	4.2	21	3.5	31	7.1	15	3.0
16	2.7	16	1.6	20	5.0	22	4.1	32	7.8	16	3.7
17	3.3	17	1.8	21	5.7	23	4.7	33	8.6		
		18	2.3	22	6.6	24	5.4	34	9.4		
				23	7.6	25	6.1	35	10.3		
						26	6.9	36	11.2		
						27	7.8	37	12.2		
						28	8.8	38	13.3		
						29	9.8	39	14.4		
								40	15.6		
								41	16.8		
								42	18.1		

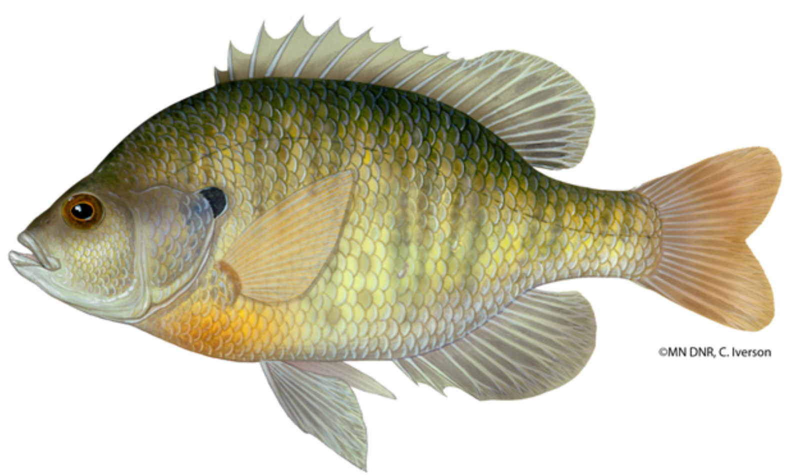
Size Limit Fish Cutouts

Copy these Size Limit Fish Cutouts, and make one set per group containing:

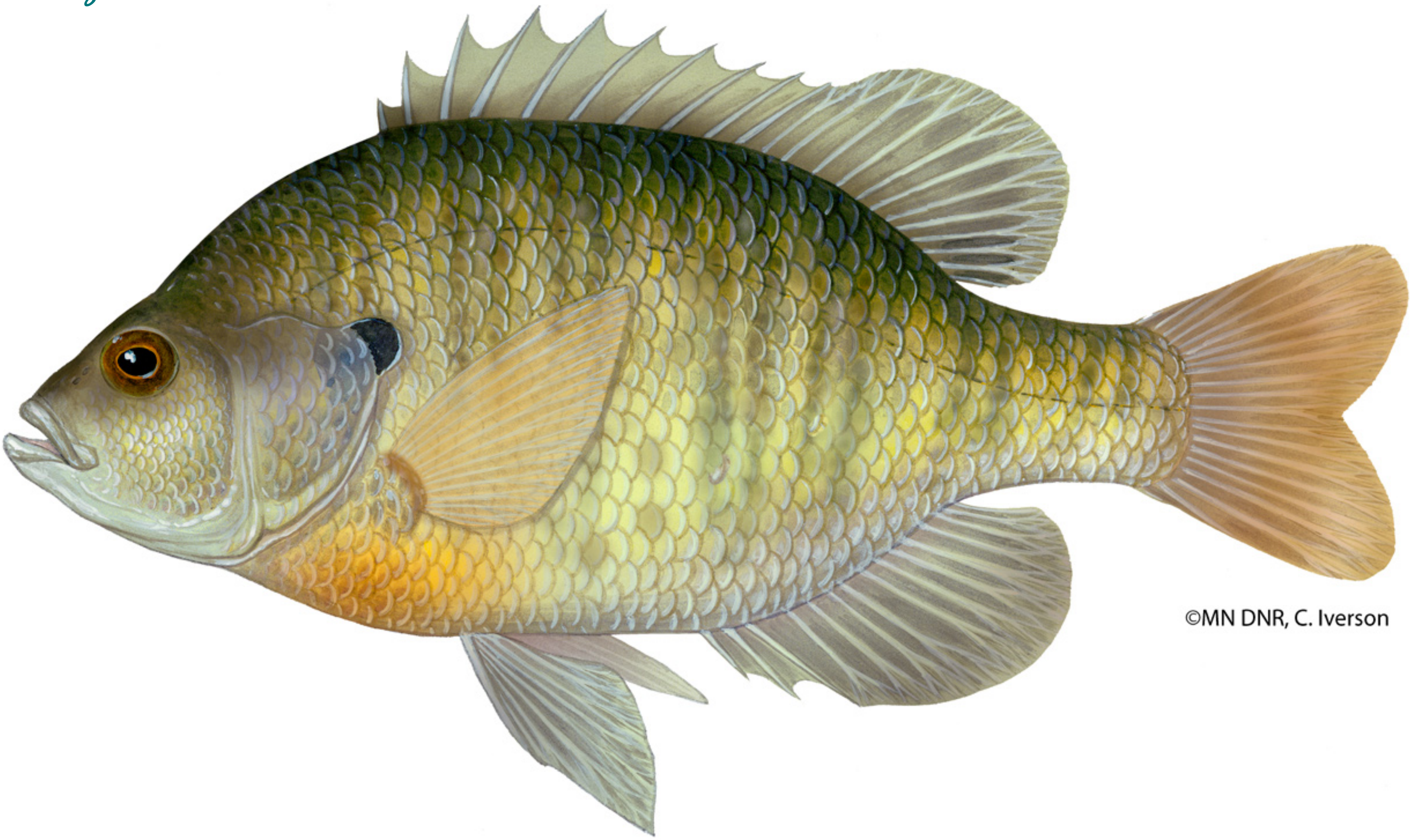
- three fish less than four inches long
- four fish six to eight inches long
- two fish longer than twelve inches



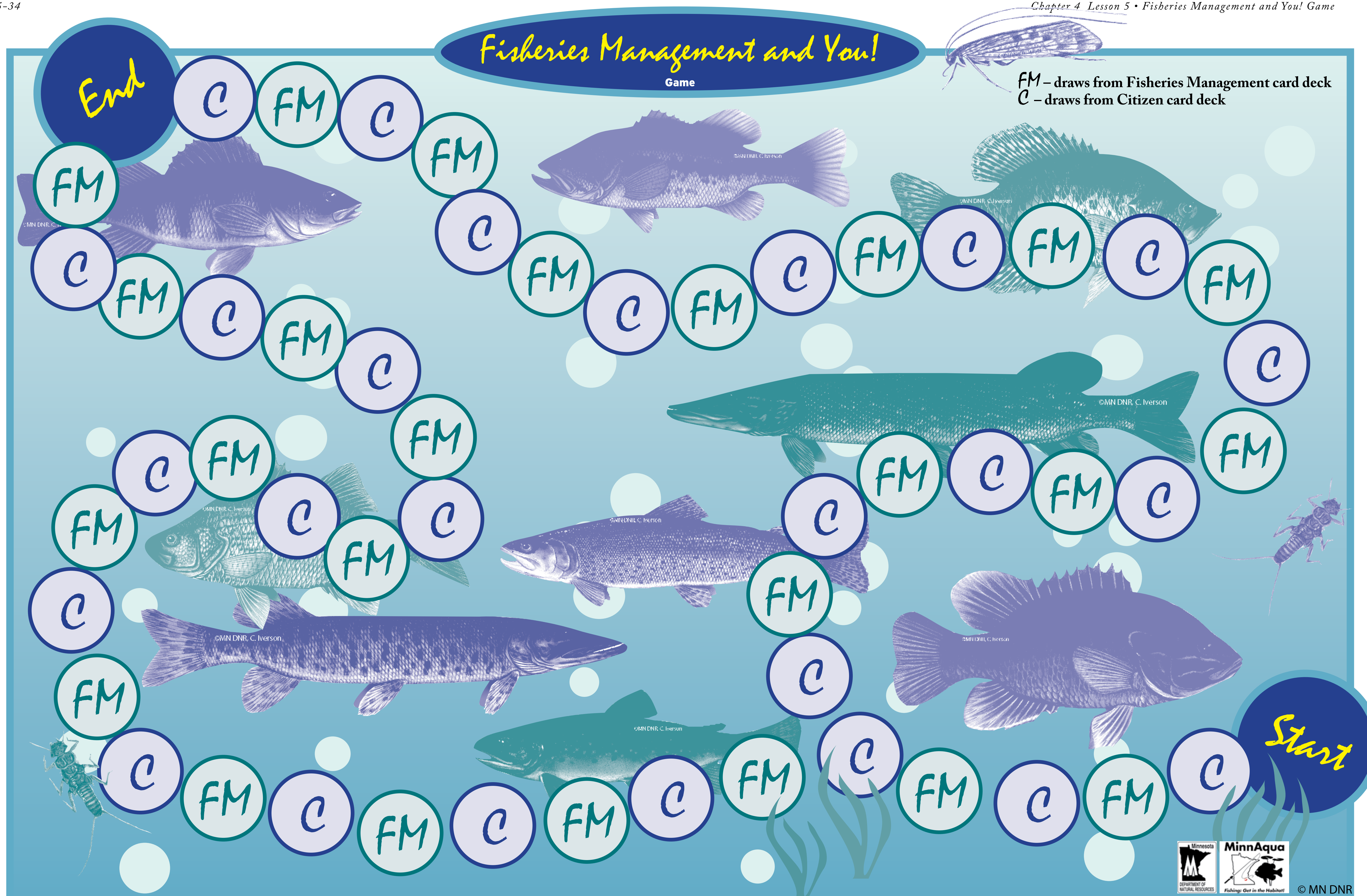




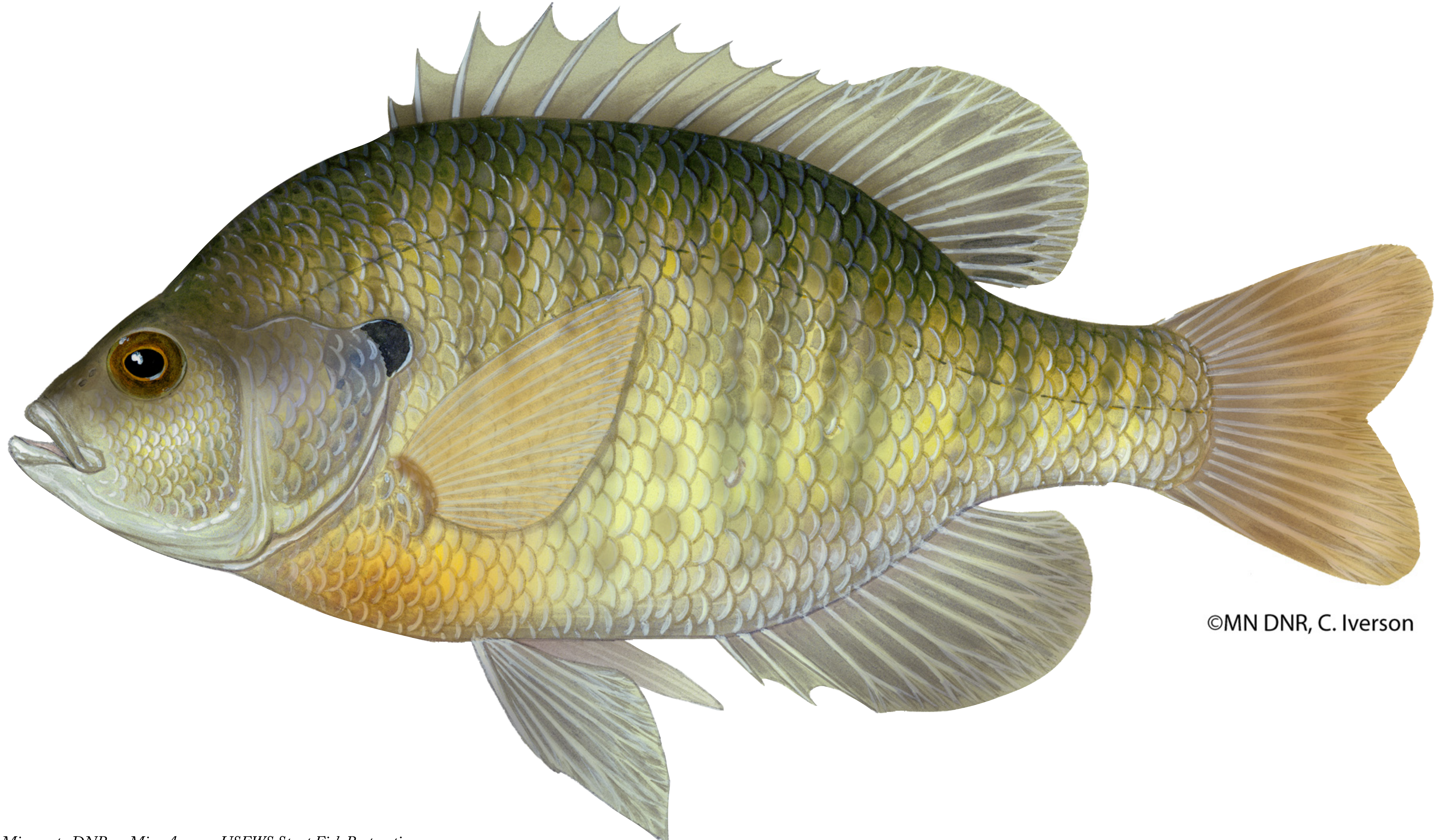
Size Limit Fish Cutouts



See Size Limit Fish Cutout


Fisheries Management and You!
Game
FM – draws from Fisheries Management card deck
C – draws from Citizen card deck
End
Start
MinnAqua
© MN DNR

Size Limit Fish Cutout



Fishing Equipment & Skills

Youth who are exposed to fishing can learn patience, gain self-esteem, find time for reflection, learn problem-solving skills, and develop an appreciation for the outdoors and for our natural resources.

What Will the Students Learn?

Students will learn how to tie knots, make their own fishing rigs, cast a closed-faced (spin-casting) rod and reel, and select correct baits, lures, and fishing locations based on fish habitats and food preferences.

Fishing is a lifelong activity that takes people outdoors and provides opportunities that develop awareness, knowledge, and enjoyment of ponds, lakes, rivers, and streams. Fishing brings families together and builds friendships by strengthening bonds between those who share experiences and special memories.

Chapter Concepts

Fishing is a strong tradition in Minnesota. Approximately 36 percent of Minnesotans fish, and people from many other places come to fish in Minnesota waters as well. More than two million anglers fish in the state each year.

Anyone can fish. Knowledge of skills and equipment presented in this chapter, combined with concepts learned in each of the previous chapters, make anglers of every experience level more successful. Above all, instructors can ignite students' enthusiasm for the sport of fishing and aquatic stewardship by empowering them with angling skills. Fishing will leave a lasting impression!

Rigs, Rods, and Reels: You Can Keep It Simple!

Lesson 5:1—Freshwater Rods and Reels
Lesson 5:2—Casting a Closed-face Rod and Reel Combo
Lesson 5:3—Pop Can Casting
Lesson 5:7—Making Ice Fishing Jiggle Sticks

Minnesota's more than 5,400 fishing lakes, 15,000 miles of fishing streams and rivers, and 160 fish species offer unparalleled opportunity to explore the benefits of fishing—yet many people never learn to fish. Angling doesn't have to be expensive to be enjoyable. Fishing rigs can be made from pop cans, and bait can be found in your own backyard. One basic fishing knot keeps a hook or lure securely attached to a line, and placing a hook, bobber, and sinker on your line is as easy as can be! Part of the adventure of fishing is discovering how truly simple and accessible it can be.

Light and Sight

Lesson 5:5—Flashy Fish Catchers

What color lure should you choose? Students learn that water quality affects how light travels through water and that the colors that fish can see are affected by water depth. A demonstration shows that turbidity affects the way in which light travels through water. Students use what they've learned to make a lure designed to attract a certain type of fish in specific water conditions.

Baits and Lures

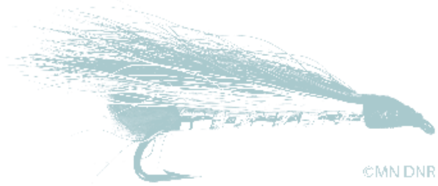
Lesson 5:4—Tackling Your Tackle Box
Lesson 5:5—Flashy Fish Catchers

Students will learn how lures mimic the foods that fish eat. Why would a largemouth bass chase a fluorescent, dancing spider jig? A jumble of items overflowing from tackle boxes can be daunting, confusing, and overwhelming. Deciding which equipment and lures you need in your tackle box is really quite simple—if you select them based on the fish you want to catch and the conditions at your fishing location.

Casting

Lesson 5:1—Freshwater Rods and Reels
Lesson 5:2—Casting a Closed-face Rod and Reel Combo
Lesson 5:3—Pop Can Casting

Safety always comes first when fishing. Students learn to carry a rod and reel and cast safely. They'll learn to cast for cover—to where fish are hiding. With a little practice, students will be able to aim their casts with consistency and accuracy. Pop can casters are a *can*-do activity, and casting a closed-face reel rig is as simple as a jig!



"If people concentrated on the really important things in life, there'd be a shortage of fishing poles."

—Doug Larson

Fly Fishing

Lesson 5:6—Fool Fish With Flies

Students play a card game to learn how flies mimic the various types of food that fish eat. Aquatic macroinvertebrates are an important part of the food chain for fish in streams, rivers, ponds, and lakes. Understanding their life cycles and developmental stages increases anglers' success in catching some types of invertebrate-eating fish in given habitats at certain times of the year. Flies have to be convincing for fish to bite them. Match the hatch and you'll get the catch! Learning what fish eat is an important step in understanding the art of fly angling.

Ice Fishing

Lesson 5:7—Making Ice Fishing Jiggle Sticks

Minnesota winters provide an entirely different setting in which to enjoy the fun and excitement of fishing. Students learn about the special tackle and equipment needed, as well as safety considerations for ice fishing. They make their own jiggle sticks and learn how to rig their lines!

Stewardship: Spreading the Word

Service-learning Appendix

Experiencing the wonders of nature first-hand will endow students with a greater enthusiasm for participating in outdoor activities and a deeper interest in the stewardship of our environment. Capping your fishing unit or program with a service-learning project enables students to share their knowledge of Minnesota fisheries resources, Minnesota fish and fishing skills, and the importance of sustainable use of aquatic and fisheries resources with schoolmates and members of their communities. Your students could choose to teach fishing skills to a group of younger students or hold a fishing clinic for families at a neighborhood lake. They could adopt a "grandparent" from a local senior facility, take them fishing, and find out what kind of equipment and lures the grandparent may have used earlier in life and hear Minnesota fishing stories from long ago. They could choose to interview anglers, conduct research, assemble a display illustrating the history of fishing equipment in Minnesota, and present it at a local museum or history center.

It's exciting to see students sharing their enthusiasm for fishing and knowledge of aquatic resources. They can engage others in learning the fishing skills that will "get them in the habitat" and establish deeper connections to the natural world. Those who fish—and wish to continue to do so—learn the importance of resource stewardship. The people that your students encourage during a service-learning project could possibly be inspired to participate in environmental and community action as well, ensuring that future generations of Minnesotans will enjoy the state's rich legacy of fishing.

"Give a person a fish, and you feed them for a day. Teach a person to fish and you feed them for a lifetime."

–Chinese proverb

Freshwater Rods and Reels

With the right rig, fishing is reel fun!

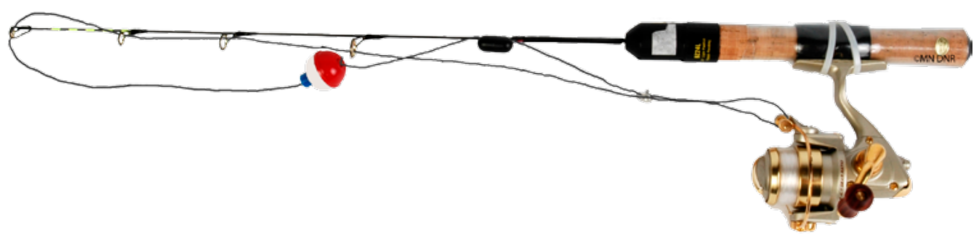


Table of Contents

Chapter 5 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Freshwater Rods and Reels

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent thinking. ◒
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension. ●

Grades 3, 4
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions. ●

History and Social Studies

Grade 4-8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities. ◑

Science

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world. ◒
Benchmark 2—The student will discuss responsible use of science. ◒
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world. ◒

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 5 • Lesson 1

Freshwater Rods and Reels

Grade Level: 3-5
Activity Duration: Part 1: 45 minutes
Part 2: 45 minutes
Group Size: any
Subject Areas: Language Arts, Social Studies, Science, Physical Education
Academic Skills: application, comparison, kinesthetic concept development, listening, observation
Setting: large indoor or outdoor open area
Vocabulary: bail, bait, baitcasting reel, cane pole, casting plug, closed-face reel, fly fishing reel, grip, jiggle stick, line guides, open-face reel, rod tip
Internet Search Words: fishing equipment, freshwater rods

Summary

Fishing is a popular sport enjoyed by many Minnesotans. To join in a long tradition of fishing in Minnesota, you must become familiar with basic equipment and skills. In this lesson, students examine different types of freshwater rods and reels, learn the fishing conditions to which each is suited, and practice casting two types of fishing rigs.

Student Objectives

The students will:

1. Match the fishing rig with the species and habitat to which it is best suited.
2. Demonstrate the ability to cast using two different fishing rigs.
3. Review rod and reel terms by drawing and labeling them and completing a crossword puzzle.

Instructor's Background Information

Approximately one-third of Minnesota's residents fish! ! One reason that angling is such a popular pastime is attributable to the state's diverse aquatic habitats, which provide many different kinds of fishing opportunities. You can fish for lake trout in the deep-water lakes of the northeast on one day, and go further inland to habitat more suited to fish like walleye the next. You can take your family fishing for bass and panfish, or head out to catch a few stream trout in the streams in the southeast or near the North Shore (Lake Superior region). If you don't mind staying up late, you might just catch a trophy catfish in the Minnesota River. And if you don't get enough of fishing in the spring, summer, and fall, you can head for a frozen lake, drill a hole in the ice, and drop a line.

It takes more than luck to catch fish. Taking time to learn how to match the correct equipment to fishing conditions ensures a more successful fishing trip. You also need some skill in using the equipment. It takes practice to accurately cast the lure or bait to the places where the fish are likely to be.

Rods and Reels

With such diverse fishing opportunities, it isn't surprising that many Minnesotans have more than one type of fishing rig in their garage or basement. A rod and reel combination is referred to as a **combo, rig,** or **outfit.** Choosing a rod and reel depends on the size of fish you're angling for, where you're going fishing, and the size of the lure or bait you plan to use. Learning about some of the rigs and their basic uses will help you choose a rod and reel combo that best suits your needs.

Materials

Part 1: Equipment Types
- **Freshwater Rods and Reels Sheet**, one per student
- **Freshwater Rods and Reels Crossword Sheet**, one per student
- **Fishing Rig Fill-in-the-blank Sheet**, one per student
- Pole and line
- Closed-face rod and reel combo
- Open-face rod and reel combo
- Baitcasting rod and reel combo
- Fly fishing rod and reel combo
- Ice fishing jiggle stick
- Pop can caster (See **Lesson 5:3—Pop Can Casting**)
- At least one adult presenter or helper with fishing experience (it's best if they bring their own equipment)
- Nature journal or science notebook for drawing different types of rods and reels
- Pencil or pen

Part 2: Parts of a Rod and Reel and Casting
- Three closed-face rod and reel combos
- Three open-face rod and reel combos
- Six casting plugs (or a few more, in case some get stuck in trees)
- Six hula-hoops
- Six casting targets (buckets, additional hula-hoops, or other bright objects)
- Two or more adult helpers with casting experience

Pole and Line
Who hasn't seen an old photograph of a youngster sitting on the end of a dock holding a cane pole? It's hard to find a **cane pole** in a store today, but they're easy to make. There's no reel—just a simple setup of a bamboo pole or wooden stick with line tied to the end. The pole is approximately eight feet long. These old-fashioned rigs work well for fishing near shore for panfish, and are a great way to introduce a child to fishing. You don't have to worry about casting and, without a reel mechanism holding lots of line, there will be fewer tangles.

See the Freshwater Rods and Reels Sheet for photos of each equipment type.

Closed-face Rod and Reel Combos
The rods used with closed-face reels are about five feet long and have small line guides. The line is threaded through the **line guides**, small circles of steel with a ceramic coating, along the length of the rod. Line guides keep the line in place so it's less likely to tangle during a cast. The **closed-face reel** sits on top of the rod and has a push-button for releasing the line. Closed-face reels have a cover and are sometimes called push-button or spin-cast reels. This type of reel is simplest to learn to use—the line is less likely to tangle than with an open-face reel.

Closed-face rod and reel combos are very affordable. Ideal for beginners, they're often used to catch panfish, but they can also be used to fish for a variety of species in numerous fishing situations.

Open-face Rod and Reel Combos
Rods with open-face reels are available in various lengths. They have a longer, straighter **grip** (the handle used to hold the rod) and larger-diameter line guides than rods with closed-face reels. The guides hang below the rod rather than on top of it because the open-face reel is situated underneath. The **open-face reel** has no cover, and is sometimes referred to as a spinning reel. The open reel and larger line guides release line more quickly, enabling the angler to cast further. This rig works well with lightweight lures.

The open-face reel has a wire **bail** that must be opened to release the line, and for casting. When closed, the bail holds the line inside the reel. The spool doesn't turn. Instead, the bail spins as it returns the line to the reel as the angler reels it in.

This type of reel is somewhat more complicated to learn to cast and more prone to tangling than a closed-face reel. Because heavy monofilament line springs off the open spool and tangles easily, this type of reel is better when using light line - about 4-10 pound test.

Open-face rod and reel combos work well for a wide variety of fish species and in a variety of fishing situations.

Baitcasting Rod and Reel Combos

Like open-face rods, baitcasting rods have long grips, with smaller guides. The guides and reel sit on top, as on a closed-face rig. Baitcasting rods are usually stiffer than open-face rods. **Baitcasting reels** are open and often have a push-button that releases the line. The line comes off a spool that is horizontally oriented to the pole. These rods offer accurate casting because the angler can "thumb" the spool to stop the line and drop the lure on target. It's important to test the lure drop to ensure that drag is set correctly for this type of reel. In both closed-face and open-face reels, the spool is fixed and parallel to the rod. The spool on the baitcasting reel is perpendicular to the rod and turns when the button is pushed. Baitcasting reels aren't recommended for novice anglers who are learning to fish. The line can be easily tangled on these reels if the angler isn't familiar with their proper use.

Baitcasting rigs are generally used for large fish or for fishing in deep water. They're typically used with heavier line than open-face rods and reels. On this type of reel, the line is more likely to stay on the reel under stress.

Fly fishing Rod and Reel Combos

Fly fishing rods are longer (usually seven and one-half to nine feet) and more flexible than other rods. The line guides and reel hang below the rod, but the **fly fishing reel** isn't used in casting—it only stores the line. Instead, the rod, fly line, and a special casting technique take the light fly out onto the water. The special fly line, rather than a heavy lure, provides the casting weight to propel the tiny fly to its target.

Fly fishing differs from other types of fishing, requiring a little more time and practice to master. You can fly fish for almost any species, including panfish, bass, and trout.

Ice Fishing Rods and Reels

Ice fishing rods are very short, because they don't need to be cast to take the line a horizontal distance from the angler. The line is dropped straight down through a hole in the ice. Some ice fishing combos have reels, but these usually just store line. The line guides and reel typically hang below the rod. A **jiggle stick** is an ice fishing stick or pole without a reel. The line is wrapped around two pegs on the pole. Moving the stick up and down is called jigging, which entices fish to the bait.

For more information and pictures of ice fishing rods and reels, see **Lesson 5:7—Making Ice Fishing Jiggle Sticks.**

Ice fishing is inexpensive and good for beginners, but extra winter safety measures are critical such as dressing in layers and choosing a spot with the safest ice. (See **Lesson 6:2—Ice Fishing and Winter Safety**.)

Hold the rod out in front, aiming for your target. Push and hold down the button, then look for obstacles above and behind you.

Bring the rod tip straight over your shoulder.

Bring the rod tip forward, aiming for your target. Release the button.

Some students may want to do a side-arm cast. Although this is a valid technique, in a group situation, it isn't as safe as the recommended over-the-shoulder method described here.

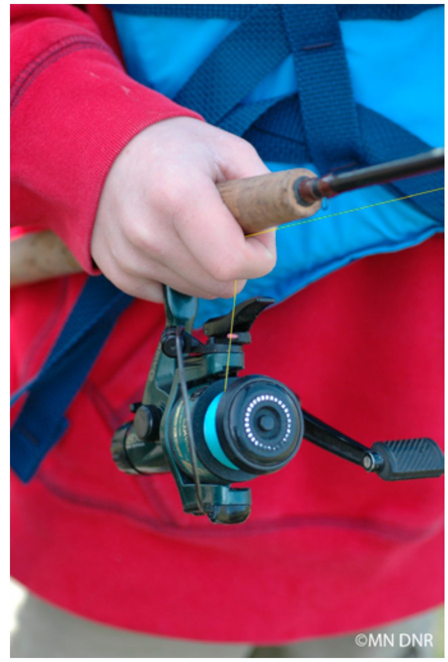
How to Cast a Closed-face Rod and Reel Combo

1. Demonstrate how the reel works. The **casting plug**, a weighted lure with no hook, should be attached to the line and hang about six inches from the end of the rod, or rod tip. Hold the grip with the reel on top. Using the same hand that holds the rod, push the button with your thumb and hold it in. Notice that nothing happens. Now release your thumb and watch how the line comes out and the casting plug drops. Pull some line out of the reel and notice how it keeps coming. Turn the reel handle forward and listen for a click. Now try to pull more line out. It shouldn't come out. Reel in the line.
2. Demonstrate an overhead cast. Hold the button in with your thumb. The rod should be straight in front of you. Make sure the line isn't wrapped around the top of the rod! *Remember to look over your shoulder to make sure no one is standing behind you when you cast; look overhead and behind you for any obstructions (such as power lines, tree branches, bushes, pets) before you cast.* Lift and bend your elbow to bring the rod tip back over your shoulder as you watch it. Then bring the rod tip forward over your shoulder again, watching it until you're pointing the rod to a point just above the horizon. Release your thumb as you bring the rod forward, and point the rod tip in the direction you want the casting plug to go. Watch as the casting plug takes the line straight out in front of you.
3. How far did the line go? If the line hits the ground right in front of you, you didn't release the button soon enough. If the casting plug took the line high in the air above you, you released the button too soon.
4. Try to get the casting plug to land right where you want it to go.

How to Cast an Open-face Rod and Reel Combo

1. Demonstrate how the reel works. Hold the grip in your hand with the reel hanging below the rod. Place two fingers behind the reel seat, where the reel mounts to the rod, and two in front of the reel seat. Your thumb goes on top of the grip. Hold the line against the reel with the index finger of the same hand that holds the rod. The casting plug should hang about six inches from the rod tip.
2. With your other hand, flip open the bail from one side of the spool to the other. Let go of the line with your index finger and watch how the casting plug drops and how line falls easily off the spool. Turn the reel handle forward and watch the bail close or flip back in place to its original side. You can also close the bail by flipping it back with your hand. Now try to pull line out. It shouldn't come out easily. But if the line doesn't move with forced pulling, the drag is too tight.
3. Demonstrate an overhead cast. Flip open the bail. Use your finger to hold the line. After the forward motion, let go of the line with your finger. The rest of the procedure is the same as the closed-face rod and reel combo cast.

Remember to look over your shoulder to make sure no one is standing behind you when you cast; look overhead and behind you for any obstructions (such as power lines, tree branches, bushes, pets) before you cast.



To cast with an open-face reel, open the bail and hold the line with your index finger.

Comparing Freshwater Rods and Reels

Combo	Grip	Rod Length	Line Guides	Reel	Habitat	Fish
Pole and Line	None	8 feet (wooden pole)	None	None	Near shore Shallow	Panfish
Closed-face (or spin-cast)	Short	5 feet	Small On top	Closed Push-button Has drag Sits on top of rod	Near shore Shallow (option: any)	Usually panfish (option: any)
Open-face (or spinning)	Long Straight	6 feet	Large On bottom	Open Has drag Hangs below rod	Any	Panfish Stream trout Larger game fish such as bass, walleye, northern pike
Baitcasting	Long	6 feet	Small On top	Open Push-button Has drag Sits on top of rod	Deep water	Larger game fish such as bass, walleye, northern pike, catfish
Fly	Long Straight	7½-9 feet	Large On bottom	Open Has no drag Doesn't assist cast Hangs below rod	Any	Panfish Stream trout Larger game fish such as bass, walleye, northern pike
Jiggle stick	None	1½ feet (wooden stick)	Small On bottom	None	Any, in winter	Panfish Larger game fish such as walleye and northern pike

Procedure

Preparation

1 Gather the listed materials or ask a fishing enthusiast to bring equipment to class and help demonstrate.
2 Make copies of the **Freshwater Rods and Reels Sheet**, the **Freshwater Rods and Reels Crossword Sheet**, and the **Fishing Rig Fill-in-the-blank Sheet.**
3 Set up the gymnasium or large open area for casting practice. Place six hula-hoops on one end of the field and the six casting targets at the other end, about twenty feet away. (If it's windy outdoors, it will be easier to cast with the wind.)
4 Tie casting plugs on the rod and reel combos to be used for casting practice.
5 Place a rig near each hula-hoop. Alternate closed-face rod and reel combos with open-face combos.

Activity

Warm-up

1 Ask the students to raise their hands if they've ever been fishing. Where in Minnesota did they go fishing? What did they fish for? Were they on a small lake, large lake, stream, or river? What type of rod and reel did they use?
2 Tell the students that there are many different types of fishing and special equipment is used for each type of aquatic habitat they might fish in, and for the different types of fish they want to catch.

Lesson

Part 1: Equipment Types

1 Distribute a **Freshwater Rods and Reels Sheet** to each student. Go through the sheet and show examples of each type of rod and reel you've collected. Describe the situation in which each is used. (Use the **Comparing Freshwater Rods and Reels** chart for easy reference. Don't worry if you can't find every type of rod—just collect a few to compare. If possible, ask a fishing enthusiast to bring their gear to class and explain how they use it.)
2 Demonstrate or ask students to help you point out similarities and differences between the various rigs.
3 Have students draw and label the various types of rods and reels in a nature journal or science notebook.

Part 2: Parts of a Rod and Reel and Casting

1 Review the basic parts of a rod and reel combo with your students. Cover grip, rod tip, reel, and line guides. (For an example, see the **Parts of a Closed-face Rod and Reel Combo Answer Sheet** in **Lesson 5:2—Casting a Closed-faced Rod & Reel Combo**.)
2 Demonstrate how to cast both the closed- and open-face rod and reel combos.

3 Separate the students into six groups. Have the first person in each group stand in the hula-hoop. Explain that the casting targets represent areas of cover where fish might be: near lily pads, under a dock, in a brush pile, in a drop-off or hole, for example. Emphasize that casting is not about who can cast the furthest, but casting *accurately* to the spot where the fish are, whether fishing from a boat, from shore, or from a pier or dock.

4 Have each student practice casting each type of rig three times by rotating through two of the lines. Post an adult between casting stations to help with technique and to loosen any tangles.

5 Option: After all students try casting each type of rig, set up a casting contest. Form three teams. Have each team choose different people to cast each type of rig. Tell the students that they will be evaluated on team spirit, good sportsmanship, and casting accuracy.

Wrap-up

1 Hand out the **Fishing Rig Fill-in-the-blank Sheets.** Have students match the fishing rig to the type of fish it's designed to catch and to the habitat to which the rig is suited.

2 Ask the students the following questions. Which combo was easiest to use? Which was most difficult? Which allowed more accuracy? Which allowed the furthest casts? Was anyone surprised at how easy or difficult it was to cast? What could you do to improve your casting skills? (Practice!)

3 Pass out the **Freshwater Rods and Reels Crossword Sheet** and have the students fill in the missing words.

Assessment Options

1 Observe participation in the discussion and casting practice. Collect the **Freshwater Rods and Reels Crossword Sheet** and the **Fishing Rig Fill-in-the-blank Sheets**.

2 Evaluate the students' drawings of the equipment. Note that drawings are accurate and correctly labeled.

3 If you asked a fishing enthusiast to demonstrate equipment in class, have students write thank-you letters to the volunteer, referring to what they learned about the different types of equipment. Collect and assess the letters before sending them to the volunteer.

4 Assessment options include the Checklist and Rubric on the following pages.

Freshwater Rods and Reels Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	_______	_______	Student completely and correctly fills out the **Freshwater Rods and Reels Crossword Sheet**
4	_______	_______	Student completely and correctly fills out the **Fishing Rig Fill-in-the-blank Sheet.**
3	_______	_______	Student can identify three types of fishing rigs.
3	_______	_______	Student can identify two types of fish typically caught on each of the three rigs.
3	_______	_______	Student can identify the type of water habitat where each of the three rigs is most commonly used.
4	_______	_______	Student understands how to operate two kinds of rod and reel fishing rigs.
4	_______	_______	Student follows safety procedures for handling rod and for casting with two types of rigs.
4	_______	_______	Student casts accurately with two types of rigs.
Total Points			
29	_______	_______	**Score** _______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

27-29 points = A
Excellent. Work is above expectations.

23-26 points = B
Good. Work meets expectations.

18-22 points = C
Work is generally good. Some areas are better developed than others.

13-17 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Freshwater Rods and Reels Scoring Rubric

Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Freshwater rods and reels crossword	All of the crossword puzzle is filled in correctly.	80 % of the crossword puzzle is filled in correctly.	Half of the crossword puzzle is filled in correctly.	Less than half of the crossword puzzle is correct.	Doesn't complete the crossword puzzle.
Fishing rig Fill-in-the-blank	The sheet is complete and correct.	80% of the sheet is completed correctly.	Half of the sheet is completed correctly.	Less than half of sheet is correct.	Doesn't complete the sheet.
Matching rod and reel type to type of fishing	Can identify three types of fishing rigs and the types of fish typically caught on each of the rigs.	Can identify two types of fishing rigs and the types of fish typically caught on each of the rigs.	Can identify two types of fishing rigs and one type of fish typically caught on the rigs.	Can identify one type of fishing rig and one type of fish typically caught on the rig.	Can't correctly identify any type of fishing rig.
Practice casting	Understands how to operate two kinds of rod and reel combos. Follows safety procedures, for handling rod and for casting. Casts accurately.	Understands how to operate two kinds of rod and reel combos. Follows safety procedures, for handling rod and for casting. Casts accurately some of the time.	Understands how to operate one kind of rod and reel combo. Remembers to follow safety procedures most of the time.	Understands how to operate one type of rod and reel combo, but can't cast safely or with accuracy.	Doesn't understand how to operate rod and reel combo for casting.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Ask guest speakers to bring their fishing equipment to class and explain how they use it. (Guest speaker possibilities include parents, grandparents, seniors, local fishing professionals, tackle store employees, or other fishing enthusiasts.)
2 Ask guest speakers to demonstrate how they fish for their favorite species.
3 Ask a guest speaker to demonstrate casting a baitcasting rig or a fly rod.
4 Ask students to bring in their own fishing rig and explain how they've used it.
5 Take your class on a fishing trip. See **Lesson 6:3—Planning a Fishing Trip.**

For the Small Fry

K-2 Option

1 Discuss the differences between summer and winter fishing. Show a closed-face rod and reel combo and a jiggle stick.

2 Teach the students to cast the closed-face rig. Use casting plugs instead of hooks. Arrange an adult/student ratio of one to one, or allow one student to cast at a time. Make sure that adults remain with the student casters at all times. Cast in an open area such as a gym or playing field. You can mark standing spaces for the students using hula-hoops or rope. Casting stations should be two pole lengths apart.

STUDENT COPY

Freshwater Rods and Reels Sheet

Pole and Line
Grip: None
Rod Length: 8 feet (wooden pole)
Line Guides: None
Reel: None
Habitat: Near shore, shallow
Fish: Panfish

Closed-face Reel (or Spin-cast Reel)
Grip: Short
Rod Length: 5 feet
Line Guides: Small, on top
Reel: Closed, push-button, has drag, sits on top of rod
Habitat: Near shore, shallow (could be any)
Fish: Usually panfish (but any)

Open-face Reel (or Spinning Reel)
Grip: Long, straight
Rod Length: 6 feet
Line Guides: Large, on bottom
Bail: Metal wire-like device to control release of line
Reel: Open, has drag, hangs below rod
Habitat: Any
Fish: Panfish, stream trout, larger game fish such as bass, walleye, and northern pike

STUDENT COPY

Freshwater Rods and Reels Sheet

Baitcasting Reel
Grip: Long
Rod Length: 6 feet
Line Guides: Small, on top
Reel: Open, push-button, has drag, sits on top of rod
Habitat: Deep water
Fish: Larger game fish such as bass, walleye, northern pike, and catfish

Fly Reel
Grip: Long, straight
Rod Length: 7½-9 feet
Line Guides: Large, on bottom
Reel: Open, has no drag, doesn't assist cast, hangs below rod
Habitat: Any
Fish: Panfish, stream trout, larger game fish such as bass, walleye, and northern pike

Jiggle Stick
Grip: None
Rod Length: 1½ feet (wooden stick)
Line Guides: Small, on bottom
Reel: None
Habitat: Any, in winter
Fish: Panfish and larger game fish such as walleye and northern pike

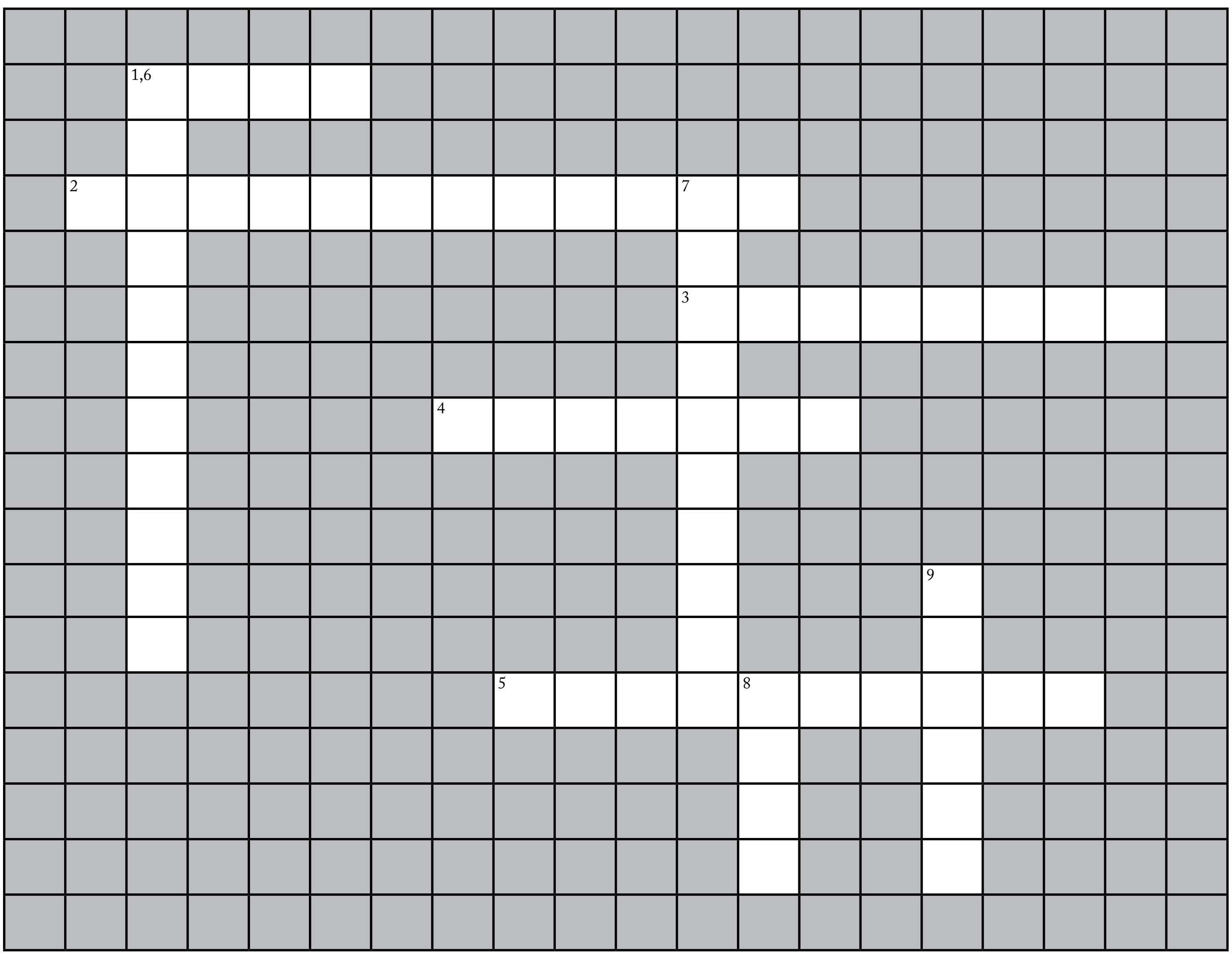
STUDENT COPY

Name ____ Date ____________________

Freshwater Rods and Reels Crossword Sheet

ACROSS
1. Metal wire-like device that controls release of line from the reel
2. Used in ice fishing
3. There is no cover on this type of reel
4. Holds the line on a very long flexible rod
5. Holes through which the line feeds

DOWN
6. Used to catch big fish or fish in deep water
7. This reel has a button to push
8. The place you hold the rod
9. A casting plug or lure should hang about six inches from this before you try to cast



INSTRUCTOR COPY

Freshwater Rods and Reels Crossword Answer Sheet

ACROSS
1. Metal wire-like device that controls release of line from the reel **(bail)**
2. Used in ice fishing **(jiggle stick)**
3. There is no cover on this type of reel **(open face)**
4. Holds the line on a very long flexible rod **(fly reel)**
5. Holes through which the line feeds **(line guides)**

DOWN
6. Used to catch big fish or fish in deep water **(baitcasting)**
7. This reel has a button to push **(closed face)**
8. The place you hold the rod **(grip)**
9. A casting plug or lure should hang about six inches from this before you try to cast **(rod tip)**

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STUDENT COPY

Name ______________________________ Date ______________

Fishing Rig Fill-in-the-blank Sheet

Fill in the chart by matching each fishing rig to the type of fish it's designed to catch *and* to the type of habitat where you would use the fishing rig. There can be more than one answer for the types of fish. See the **Freshwater Rods and Reels Sheet** for pictures of the fishing rigs.

Fish		
 **Panfish** (bluegills, perch, and crappies)	 **Deep-water fish** (lake trout and salmon)	 **Larger game fish** (walleye and northern pike)

Habitats				
Lakes and streams	**Deep-water (like Lake Superior)**	**Through the ice**	**Shallow water near shore**	**Any**

Fishing Rig	**Fish**	**Habitat**
Pole and line (cane pole)		
Baitcasting rod and reel combo		
Jiggle stick		
Open-face rod and reel combo		
Fly rod and reel combo		
Closed-face rod and reel combo		

INSTRUCTOR COPY

Fishing Rig Fill-in-the-blank Answer Sheet

Fill in the chart by matching each fishing rig to the type of fish it's designed to catch *and* to the type of habitat where you would use the fishing rig. There can be more than one answer for the types of fish. See the **Freshwater Rods and Reels Sheet** for pictures of the fishing rigs.

Fish		
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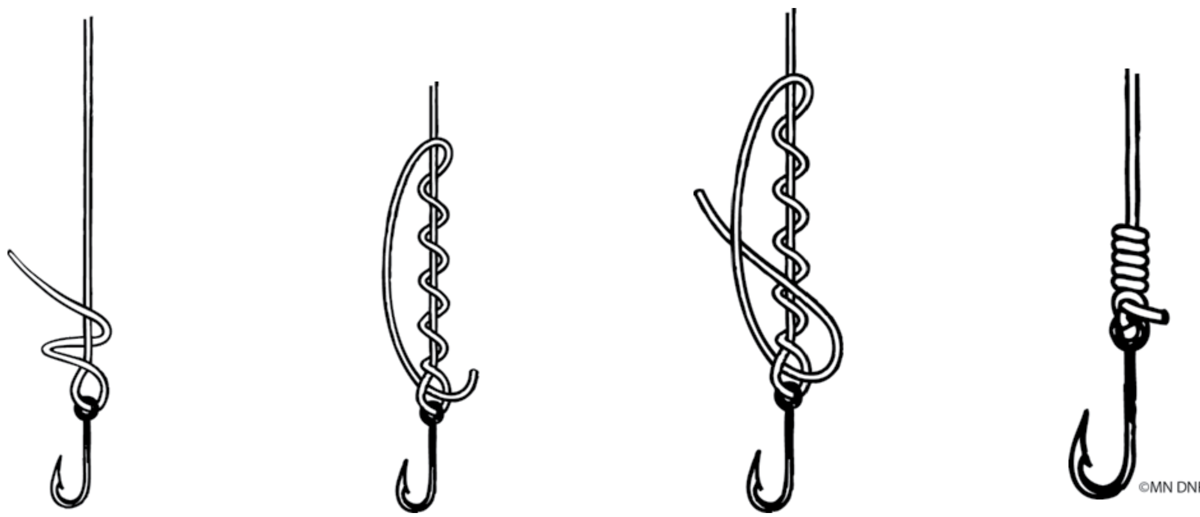
Habitats				
Lakes and streams	**Deep-water (like Lake Superior)**	**Through the ice**	**Shallow water near shore**	**Any**

Fishing Rig	**Fish**	**Habitat**
Pole and line (cane pole)	Panfish	Shallow water near shore
Baitcasting rod and reel combo	Larger game fish Deep-water fish	Deep water
Jiggle stick	Panfish Larger game fish	Through the ice
Open-face rod and reel combo	Panfish Larger game fish	Shallow water near shore/any
Fly rod and reel combo	Panfish Larger game fish	Any
Closed-face rod and reel combo	Panfish Larger game fish	Any

STUDENT COPY

Tying an Improved Clinch Knot Sheet

The clinch knot is probably the most popular fishing knot used today. When properly tied, the clinch knot is very strong and it won't slip. This is a versatile fishing knot, and it can also be used to attach lures to your fishing line.



1. Thread one end of the line through the eye of the hook.
2. Wrap the line around itself five times to make five twists. Fishing tackle manufacturers have found that five wraps of the line work best. With fewer than five wraps, fish might pull out the knot. With more than five wraps, the line may break.
3. Take the tag (loose) end of the line and put it through the first twist, near the hook.
4. Notice the new loop you have made. Take the same tag end and pass it through the new loop. (This is the "improved" part of the knot that prevents it from slipping.)
5. Drop this end.
6. Slide the whole knot down to the hook.
7. Gently tug on the end you previously dropped.
8. Neaten the knot. It's important to make sure the knot is "neat," or that the coils are tightly lined up. If there are loose wraps, or wraps on both sides of the eye, the knot may snag and break.
9. Voila! There should be neatly stacked coils lined up next to the eye.

Casting a Closed-face Rod and Reel Combo

Fishing is the great Minnesota pastime!

Table of Contents

Chapter 5 • Lesson 2

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Casting a Closed-face Rod and Reel Combo

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions.

History and Social Studies

Grades 4-8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss the responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 5 • Lesson 2

Casting a Closed-face Rod and Reel Combo

Grade Level: 3-5
Activity Duration: 60 minutes
Group Size: any
Subject Areas: Language Arts, Social Studies, Science, Physical Education
Academic Skills: application, communication, kinesthetic concept development, observation
Setting: Part 1 and Part 3: indoor or outdoor gathering space
Part 2: large indoor or outdoor open area
Vocabulary: anti-reverse, bobber, butt end, casting plug, circle hooks, closed-face reel, cover, drag, grip, hook, improved clinch knot, line guides, line opening, reel handle, reel seat, rod tip, sinker, tag end, thumb button
Internet Search Words: children and fishing, non-lead sinkers, spin-cast rig

Instructor's Background Information

Taking a group of students fishing can be very rewarding. Many students have never been fishing—or they've relied on their parents to do the knot-tying, rigging, baiting, casting, and reeling for them. This lesson allows students to practice these skills on their own. It also allows students who have experience with fishing to help their classmates and share their enthusiasm. This lesson familiarizes you with the equipment and skills needed for your first outing. After this lesson, you and your class will be ready to plan for a safe trip and go fishing. See **Lesson 6:1—Safety at the Water's Edge** to plan for and embark upon your fishing trip.

Closed-face Rod and Reel Combo
The rods used with closed-face reels are about five feet long and have small line guides. The line is threaded through the **line guides**, small circles of steel with a ceramic coating, along the length of the rod that keeps the line in place so it's less likely to tangle during a cast. The **closed-face reel** sits on top of the rod and has a push-button for releasing the line. Closed-face reels have a cover and are sometimes called push-button or spin-cast reels. This type of reel is simplest to learn to use—the line is less likely to tangle than with an open-face reel.

Closed-face rod and reel combos are very affordable. Ideal for beginners, they're often used to catch panfish, but they can also be used to fish for a variety of species in numerous fishing situations. For more information on rods and reels used in Minnesota, see **Lesson 5:1—Freshwater Rods and Reels.**

Summary

Students practice basic rod and reel rigging and fishing skills.

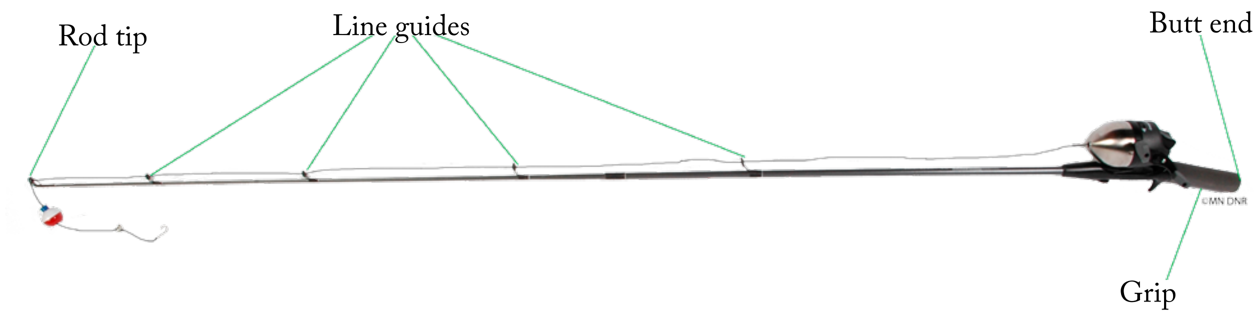
Student Objectives

The students will:
1. Tie an improved clinch knot.
2. Handle a rod and reel safely.
3. Demonstrate how to cast a rod and reel.
4. Show how to rig and bait a rod and reel for panfish.

Materials

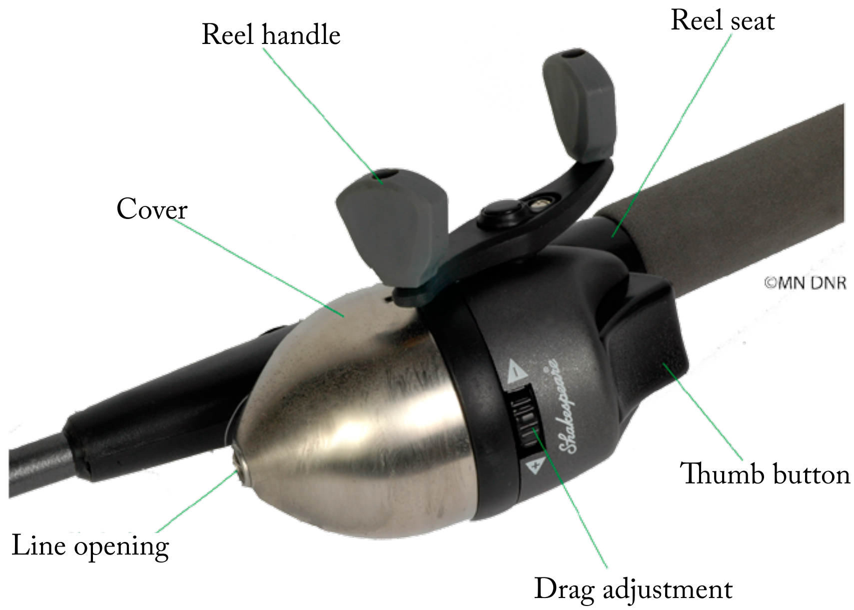
- Nylon cord or rope (one-quarter-inch thick, cut in two-foot lengths), one per student
- Hula-hoops, one for each group of four or five students
- **Tying an Improved Clinch Knot Sheet**, one for each group of four or five students
- **Parts of a Closed-face Rod and Reel Combo Sheet**, one per student
- Fishing rods with closed-face reels and 6- or 8-pound test mono-filament line, one per student
- Casting targets or hula-hoops, one per group
- Casting plugs, one per group
- Bobbers (one-inch round clip-on type), at least one per student
- Split shot sinkers (quarter-ounce, preferably non-lead), at least one per student
- Hooks (size 6-10), at least one per student (try circle hooks with a long shank)
- **The Perfect Rigging Sheet**, one per group
- **Fishing Rod and Reel Maintenance** sheet
- Adult helpers, one for every five to ten students
- Pencils or pens

Parts of a Rod



Name	Description
Butt end	Base of the rod handle
Grip	Handle
Line guides	Guides line to the rod tip
Rod tip	End of the rod

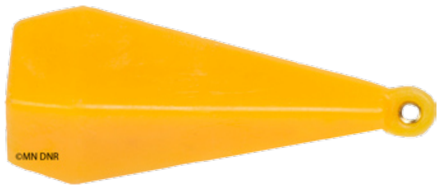
Parts of a Closed-face Reel



Name	Description
Cover	Covers the interior gears and spool of line
Drag adjustment	Adjusts the tension on the line when a fish is pulling on it
Line opening	Where the line comes out of the cover
Reel handle	Crank to reel in the line
Reel seat	Connects the reel with the rod
Thumb button	Releases the line when depressed and released

Casting a Closed-face Rod and Reel Combo

It's a good idea to practice casting before going to the water with a group of students. Some students actually prefer casting practice to fishing.



Casting plugs are sold at stores, but they're easy to make. Cut one-inch diameter dowels into one and one-half-inch lengths and insert a small eye screw into one end of each length.

The following steps will help you demonstrate how a closed-face reel works. Tie a **casting plug**, a weighted dummy lure without a hook, to the end of the line. Hold the grip of the rod with the reel on top. The casting plug attached to the line, should hang about six inches from the end of the rod, or **rod tip**. Using the same hand that holds the rod, push the button with your thumb and hold it in. Notice that nothing happens. Now release your thumb and watch how the line comes out and the casting plug drops. Pull some line out of the reel and notice how it keeps coming. Turn the reel handle forward and listen for a click. This will secure the line by engaging the drag feature. Now try to pull more line out. It shouldn't come out without resistance.

Adjusting the **drag** changes the amount of resistance in the line. Drag refers to the tension on the line as it comes out of the reel. If the drag is set so tightly that no line is released, a large fish pulling on it could break the line. If it's too loose, it will be impossible to reel in even the smallest fish. To check the reel's drag adjustment, tie the line to something sturdy. Move the drag adjustment lever so the line comes out easily. Gradually lift the rod until it bends, tightening the drag adjustment as you increase the tension on the line. Now jerk the rod, as if setting the hook. The drag should slip slightly. If it doesn't, loosen the drag until it does. Now reel in the line.

Some reels have an anti-reverse lever to prevent reeling the line in backward onto the spool. Be sure the lever is in the on position before practicing casting.

Before you cast, choose a spot at which to aim. On the lawn, you may aim for a hula-hoop or other target. On water, you should aim to cast for cover. Cast toward where the fish are—and cast for accuracy, not distance. Many fish spend time near places with cover and food, such as vegetation, drop offs, docks, fallen logs, or brush piles.

Casting a Closed-face Rod and Reel Combo

Hold the rod out in front, aiming for your target. Push and hold down the button, then look for obstacles above and behind you.

Bring the rod tip straight over your shoulder.

Bring the rod tip forward, aiming for your target. Release the button.

To demonstrate an overhead cast, hold the button in with your thumb. The rod should be straight in front of you. Make sure the line isn't wrapped around the top of the rod. *Remember to look over your shoulder to make sure no one is standing behind you when you cast; look overhead and behind you for any obstructions (such as power lines, tree branches, bushes, pets) before you cast.* Lift and bend your elbow to bring the rod tip back over your shoulder as you watch it. Then bring the rod tip forward over your shoulder again, watching it until you're pointing the rod to a point just above the horizon. Release your thumb as you bring the rod forward, and point the rod tip in the direction you want the casting plug to go. Watch as the casting plug takes the line straight out in the targeted direction.

Common Casting Problems

The weight of the lure and drag on the line determine the distance of the cast, not how much power you use. Remember that, in casting, accuracy is more important than distance.

How far did the line go? If the line hit the ground directly in front of you, you didn't release the button soon enough. If the casting plug took the line high in the air, you released the button too soon. Try to get the casting plug to land directly on its target.

When practice casting with a group of young anglers, some common themes will be evident. Gentle coaching will correct the following.

The Lob

If the casting plug goes further vertically than horizontally, you released the button too soon. (Try releasing the button a bit later.)

The Grounder
If the casting plug hits the ground before gaining much horizontal distance, you released the button too late. (Try releasing the button a bit sooner.)

The Winder
If the casting plug wraps around the tip of the rod, you released the button too late or not at all—or the line was wrapped around the tip before you started your cast.

Distance Record
If the casting plug went twice as far as necessary to reach its intended target, use less power. Emphasize accuracy over distance.

Some students may want to do a side-arm cast. Although this is a valid technique, in a group situation, it isn't as safe as the recommended over-the-shoulder method described here.

What if a line gets stuck in a tree? Make sure others are out of the way, and give the line a good yank—pull away from your body and look away before yanking so the hook doesn't fly into you if it comes loose. The line could come free or it could break. If it does neither, cut the line and tie on a new casting plug. If you cut the line, the plug or tackle might just slide out of the tree. This process also works for lines snagged on rocks, logs, or water plants while fishing.

Many students have seen people cut fishing line by biting on it with their teeth. This is a safety concern because people can chip teeth or swallow a loose piece of line. Use nippers or nail clippers to cut fishing line. Many students have seen someone secure a sinker by biting on it. Sinkers are easily swallowed and they're made of hard metal that can chip teeth. Use needlenosed pliers to open and secure sinkers. Most sinkers are still made of lead, which can be toxic if ingested. Always keep sinkers away from the mouth.

Get the Lead Out

Consider using fishing tackle that doesn't contain lead. Lead is a toxic metal and, in sufficient quantities, it adversely affects the nervous and reproductive systems of mammals and birds. Ask for non-lead tackle at your bait shops.

Rigging and Knot Tying

There are many types of fishing tackle. The basics are hooks, sinkers, and bobbers. Hooks catch the fish by holding bait and piercing the lip of the fish, sinkers weight the line so it sinks into the water, and bobbers float on the surface, keeping the hook at a fixed depth and signaling, by its movements (bobber submerging below the surface or being pulled across the water's surface), when a fish is biting on the hook.

Hooks—When taking students fishing for the first time, it helps to use **circle hooks**. The point faces the shank and is designed to hook the fish in the mouth as it turns to swim away rather than having to set the hook and rely on a quick response. Fish are less likely to be throat-hooked with circle hooks. This can reduce hooking mortality for catch-and-release. If circle hooks are available in your area, buy ones with long shanks that make them easier to handle.

Circle hooks decrease catch-and-release fish mortality. If circle hooks aren't available, you can use regular hooks. It helps to flatten the barb, the small point opposite the tip, with needlenosed pliers.

Knots—Students take great pride in learning to tie on their own hooks. It's an important skill—improperly tied knots can break or slip, allowing fish to get away! There are many different knots, but you only need to learn a few for most fishing styles. One of the most versatile is the **improved clinch knot**. See the **Tying an Improved Clinch Knot Sheet** for instructions on how to tie this knot.

Sinkers—Split shot sinkers are small weights with "wings" on one end and a deep slit or "mouth" on the other. If you squeeze the wings together, the mouth opens. Split shot sinkers are made of ceramic materials, lead, tin, or other non-lead metals. Sinkers allow the bait to be cast, and they help it sink. They also keep the line tight so the angler can sense that a fish is biting. Using needlenosed pliers, open the mouth slightly and slide in the line—about nine inches from the **tag end** of the line. The tag end is the loose end with nothing attached. With needlenosed pliers, pinch the mouth together tightly on the line to hold the sinker to the line securely.

Bobber—To attach a clip-on bobber, put your thumb over the button and press down. Watch how a small "hook" comes out of the bobber at the bottom end. Attach the line onto this small hook, about eighteen inches from the end of the line.

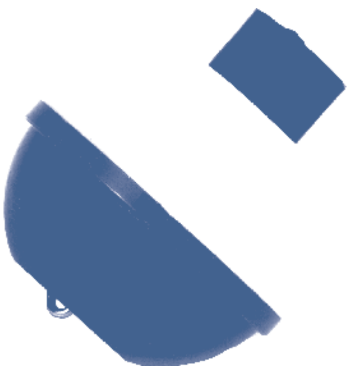
Release the button and put your thumb over the spot on the bottom of the bobber where the tiny hook receded into the bobber. Pull the edges of the button down. Another small hook should come out of the top of the button. Clip that top hook onto the line so the button end of the bobber points towards the rod tip.

Although slip bobbers are easier to cast, the "tiny hooks" clip-on bobbers are quicker and easier for children to put on by themselves. Some anglers tie the line around the "tiny hooks" on clip-on bobbers to prevent them from slipping. Hooking or wrapping works just as well, and it's easier to change the depth of the line when fishing—this is especially important when going fishing with a large group.

Hook the line above and below to keep the bobber from slipping.

Carrying a Closed-face Rod and Reel Combo Safely
Walking to the shore with a group of students carrying fishing rods with swinging hooks would be dangerous. The best way to carry a rod is by putting the hook into the lowest line guide toward the grip, holding the rod just above the hook to prevent the hook from slipping out, and keeping the rod tip pointed upward and out of the way. Remind students to always pay close attention to where their hooks are while carrying rods.

To walk safely with a rod, grip the rod just above where the hook is secured to prevent it from getting loose. Hold the rod vertically to keep the rod tip from hitting someone.



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Procedure

Preparation

1. Gather adult safety helpers, knot tying, and casting equipment.
2. Cut the nylon cord or rope for knot-tying into two-foot lengths for your class. Consider melting or knotting the ends so they don't come unraveled.
3. Set up a practice casting area. Put the hula-hoops on one end of the field and the casting targets at the other end, about twenty feet away. (If you're casting outside, it will be easier to cast with the wind.)
4. Use an improved clinch knot to tie the casting plugs onto the rod and reel combos to be used for casting practice.

Activity

Warm-up

1. Ask the students if they've ever gone fishing. There are usually a few students who have, and they'll be eager to share their stories. Did they fish from shore, dock, or a boat? Who went with them? What (if anything) did they catch? What was their favorite part of the day?
2. Tell the students that, whether or not they have fishing experience, they can learn how to fish and practice their fishing skills.

Lesson

Part 1: Knot-tying

1. Pass out the **Tying an Improved Clinch Knot Sheet**—one per student—so the students can refer to it as you demonstrate tying the knot. Using a hula-hoop and nylon cord, demonstrate how to tie an improved clinch knot as shown on the sheet. The hula-hoop represents the eye of a fish hook. The nylon cord represents the fishing line with one end of the line attached to a rod and reel. The other end of the line (the tag end) is free.
2. Have a student hold the hula-hoop while you talk through the steps and tie the knot.
3. Untie the knot and have the class talk you through the steps as you tie the knot again.
4. Divide the class into groups of four or five. Give each group a hula-hoop. Give the students their length of cord, and ask them to practice tying the knot onto the hula-hoop. Assist those who need additional help, and encourage those who tie the knot successfully to help others.
5. Make sure everyone has mastered this knot before going on to rigging.

Part 2: Parts of a Rod and Reel and Casting

1 Pass out the **Parts of a Closed-face Rod and Reel Combo Sheet.** Have students fill out the sheet as you go over the parts and functions of a closed-face rod and reel combo.
2 Demonstrate how the reel works.
3 Demonstrate a cast. Remind students to always check above and behind them for obstacles before casting.
4 Demonstrate how to safely carry a fishing rod.
5 Line the students up in three rows. Each row should have a rod and reel with a casting plug on the end. Tell the students that accuracy is more important than distance in casting. Sunfish live close to shore under docks and near plants and fallen logs. Ask the students to think of the casting targets or hula-hoops as sunfish habitat for which they should aim. After a student practices three casts, they should move to the end of their row.
6 Instruct students to get help from an adult if a line gets tangled or stuck in a tree.

Part 3: Rigging

1 Give everyone a rod and reel with no rigging (no casting plug, hook, sinker or bobber attached to the line).
2 Hand out **The Perfect Rigging Sheets.**
3 Have the students pull out line so a two-foot length hangs from the end of the rod tip.
4 Demonstrate how to put on each piece of tackle.
5 Hand out the tackle one piece at a time so students don't lose the small pieces. Have students rig their rods.
6 It often helps to tape the hook to the top of a desk or table using a piece of masking tape, with the hook's eye exposed over the edge. The students then have both hands free for for tying the improved clinch knot, and the sharp hook is safely secured.
7 Check to make sure that everyone has a properly rigged rod.
8 Secure the hooks safely to the rods by hooking them to the loop on the rod (near the grip) or to the bottom line guide eyelet, and tightening the line.
9 Review how to safely carry a fishing rod.

Wrap-up

1 Review why accurate casting is important.
2 Review the parts of the rod and reel combo.
3 Review how to safely handle hooks and carry a rod.
4 You're ready to go fishing! See **Lesson 6:1—Safety and Fishing at the Water's Edge** to prepare for your fishing trip.

Assessment Options

1 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

17-18 points = A
Excellent. Work is above expectations.

15-16 points = B
Good. Work meets expectations.

12-14 points = C
Work is generally good. Some areas are better developed than others.

9-11 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-8 points = F
Work is unacceptable.

Casting a Closed-face Rod and Reel Combo Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student releases the button when the rod tip points upward and forward.
2	______	______	During casting, student brings rod tip back to ten o'clock position and forward to two o'clock position.
2	______	______	Student correctly places the hook, bobber and sinker on the line unassisted.
2	______	______	Student can tie a clinch knot.
4	______	______	Student always looks to the side, front, and back before casting.
3	______	______	Student carries rod and reel in a vertical position.
2	______	______	Student accurately casts the plug at a target.
3	______	______	Student understands the reason for casting for cover.
Total Points			
18	______	______	**Score** ______

Casting a Closed-face Rod and Reel Scoring Rubric

Skill Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Handling rod and reel and casting safely	Releases the button when the rod tip points upward and forward. During casting, rod tip is at ten- and two o'clock positions.	Releases the button a little too early or too late. During casting, rod tip varies slightly from the ten- and two o'clock positions, but is close.	Releases the button much too early or too late. During casting, rod tips of not at the ten- and two o'clock positions, but rod movement is controlled.	Releases the button at wrong time. Rod movement uncontrolled and dangerous.	Doesn't understand how to operate reel for casting.
Rigging fundamentals	Can correctly place the hook, bobber, and sinker on the line unassisted. Can tie a clinch knot.	Can correctly place the hook, bobber, and sinker on the line unassisted. Can tie a clinch knot but doesn't bait the hook.	Can attach a hook, bobber, and sinker but places two of the items on the wrong spot on the line. Needs help tying the clinch knot and baiting the hook.	Needs assistance in placing the hook, bobber, and sinker on their line. Doesn't know how to tie a clinch knot or bait the hook.	Doesn't understand how to rig line.
Safety	Always looks to the side, front and back before casting. Carries rod and reel in vertical position.	Looks to the side, front and back before casting 75% of the time. Carries rod and reel in vertical position.	Looks to the side, front and back before casting half of the time. Usually remembers to carry rod and reel in vertical position.	Looks to the side, front and back before casting less than half of the time. Must be reminded to carry rod and reel in vertical position.	Disregards instructions for safe handling of equipment.
Accuracy and casting for cover	Can accurately cast the plug at a target all of the time. Understands the reason for casting for cover.	Can accurately cast the plug at a target 75% of the time. Understands the reason for casting for cover.	Can accurately cast the plug at a target half of the time. Understands the reason for casting for cover.	Can accurately cast the plug at a target less than half of the time. Doesn't understand the reason for casting for cover.	Doesn't aim for target when casting.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

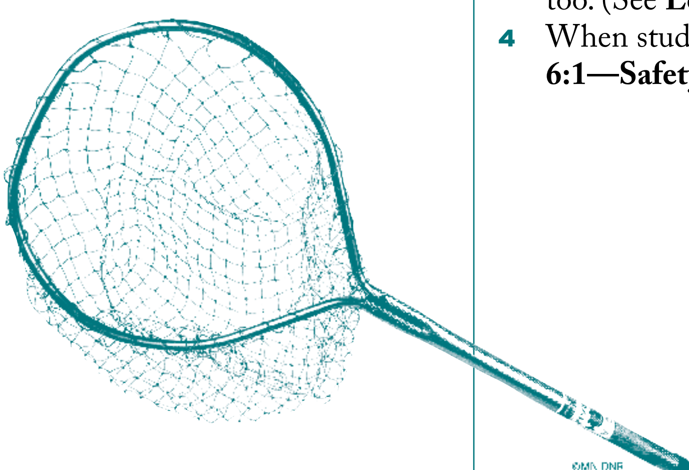
Extensions

1. Have students research tackle and fishing techniques for species other than sunfish.
2. Have the students interview an angler, asking why the person likes fishing, or what they've learned from fishing.
3. Have students teach another class the fishing skills they've learned.

For the Small Fry

K-2 Option

1. For younger students, arrange for at least one adult volunteer to help each group of five with knot-tying, rigging, baiting hooks, and removing fish. Encourage students to practice, and to try these activities on their own. Be sure to review hook safety. (Always carry your hook and pay attention to where it is—never let it swing.) Barbless hooks are recommended for this age group.
2. Using short "kid-sized" rods, teach the students to cast the closed-face rig. Use casting plugs instead of hooks. Arrange an adult/student ratio of one to one, or allow one student to cast at a time. Make sure that adults remain with the student casters at all times. Cast in an open area such as a gym or playing field. You can mark standing spaces for the students using hula-hoops or rope. Casting stations should be two pole lengths apart. See **Lesson 5:3—Pop Can Casting**.
3. Instead of rods, use cane poles or pop can casters—these work well, too. (See **Lesson 5:3—Pop Can Casting**.)
4. When students are confident with their fishing skills see **Lesson 6:1—Safety at the Water's Edge** to prepare for the fishing trip.



STUDENT COPY

Name ______________________________ Date ______________

Parts of a Closed-face Rod and Reel Combo Sheet

Draw a line from each word to its place on the picture.

Butt end

Clip-on bobber

Closed-face reel

Drag adjustment

Grip

Line guides

Line opening

Reel handle

Reel seat

Rod tip

Split shot sinker

Thumb button

Hook

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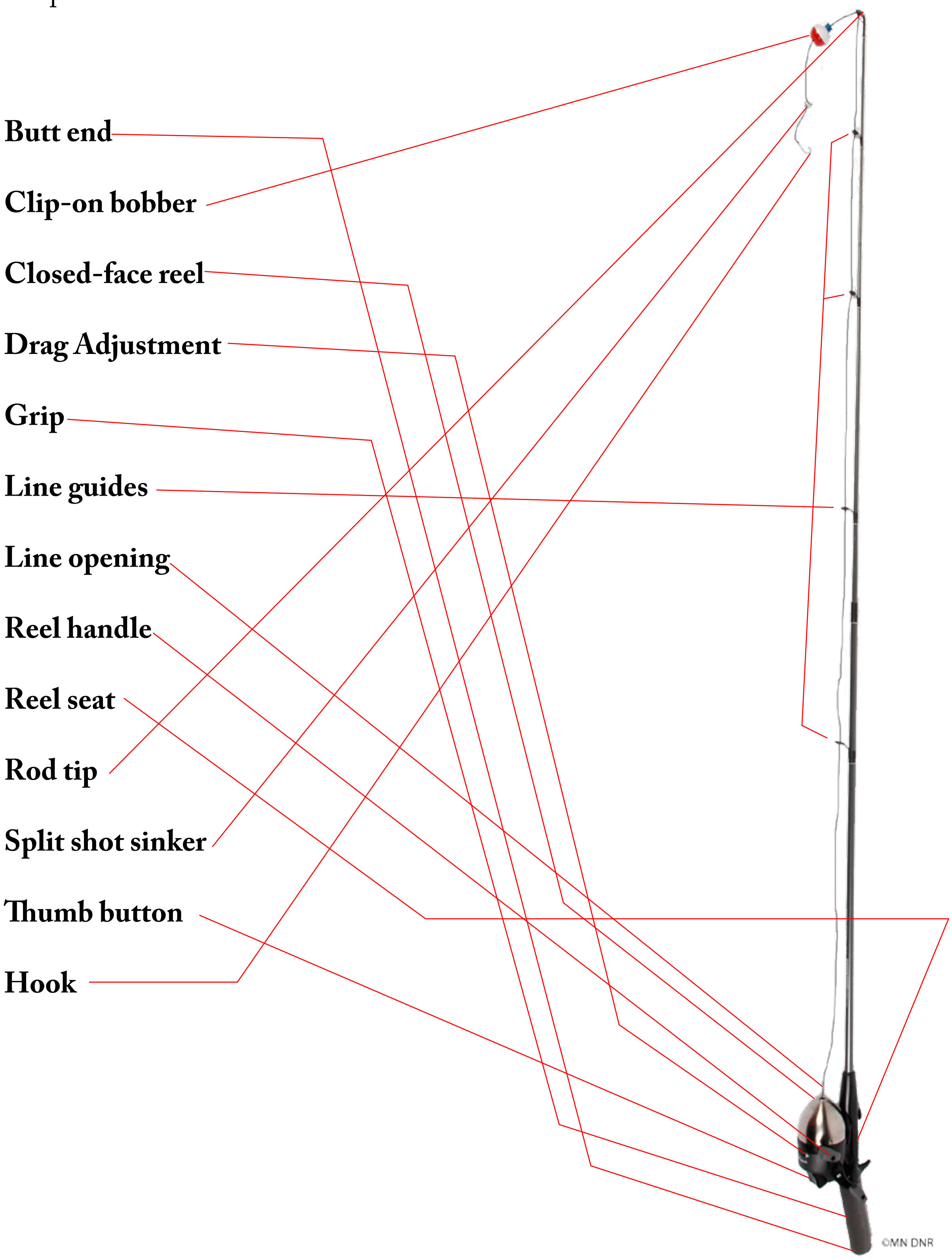
Parts of a Closed-face Rod and Reel Combo Answer Sheet

Draw a line from each word to its place on the picture.



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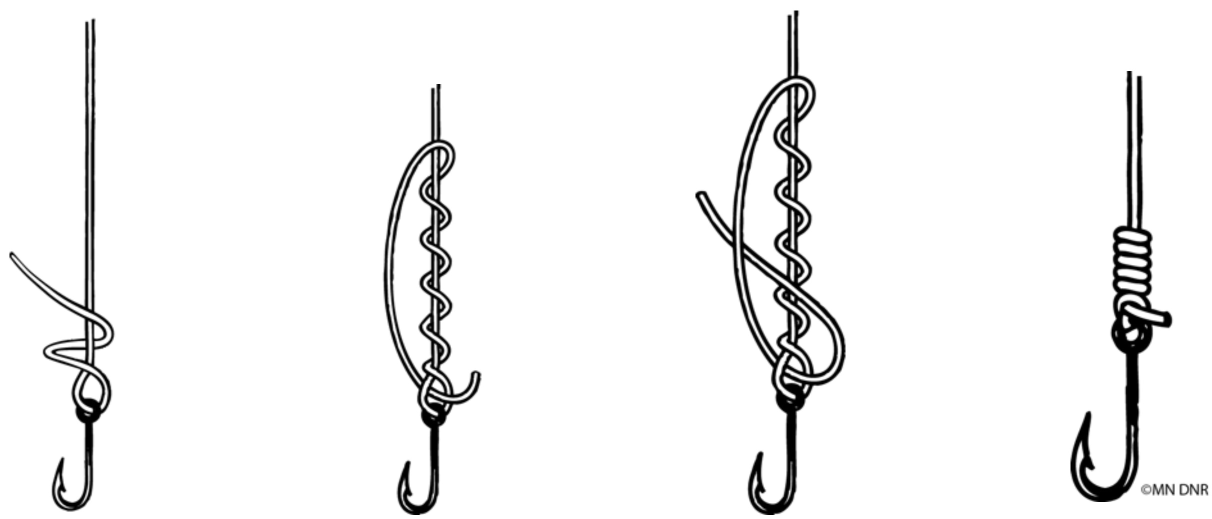
Tying an Improved Clinch Knot Sheet

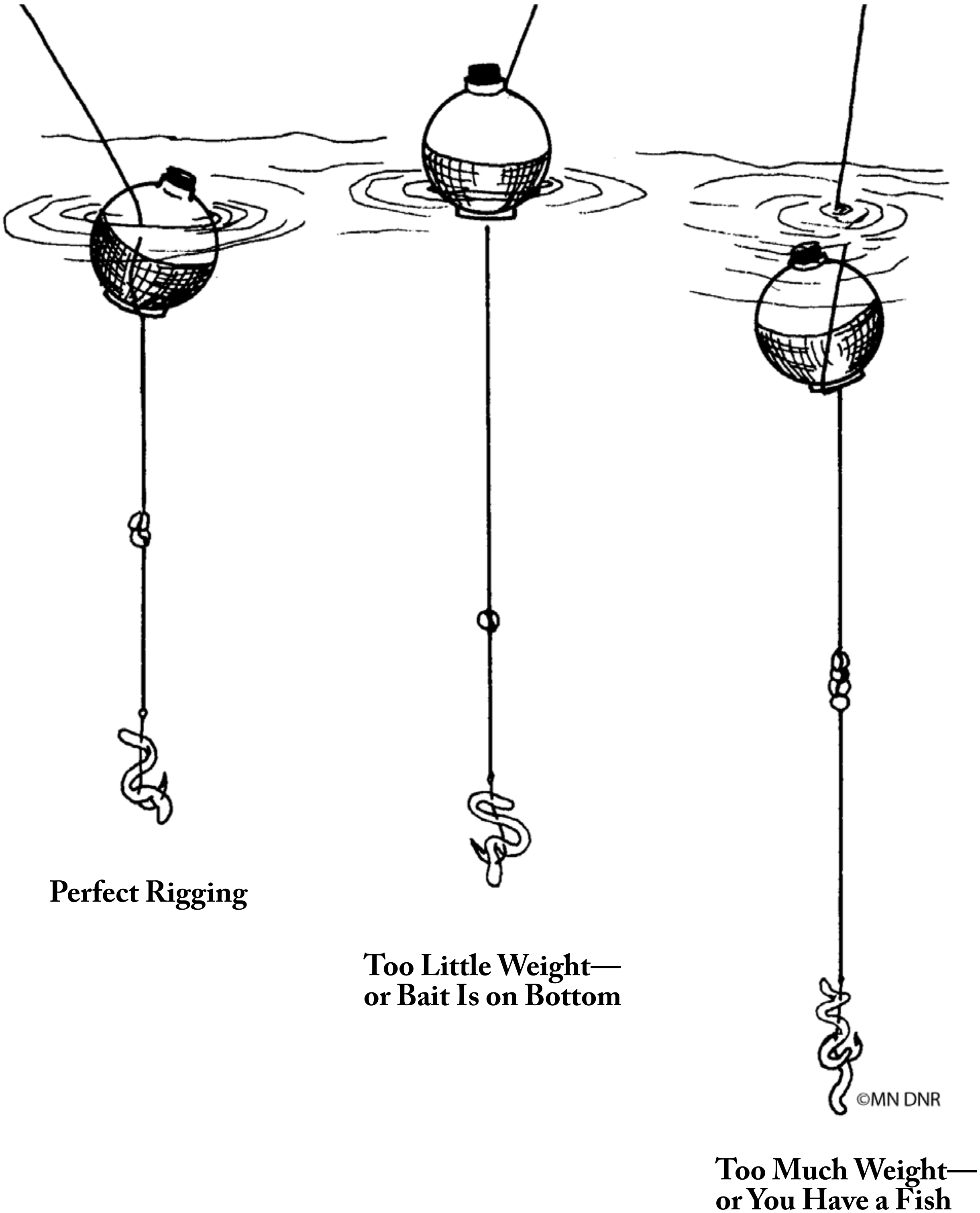
The clinch knot is probably the most popular fishing knot used today. When properly tied, the clinch knot is very strong and it won't slip. This is a versatile fishing knot, and it can also be used to attach lures to your fishing line.



1. Thread one end of the line through the eye of the hook.
2. Wrap the line around itself five times to make five twists. Fishing tackle manufacturers have found that five wraps of the line work best. With fewer than five wraps, fish might pull out the knot. With more than five wraps, the line may break.
3. Take the tag (loose) end of the line and put it through the first twist, near the hook.
4. Notice the new loop you have made. Take the same tag end and pass it through the new loop. (This is the "improved" part of the knot that prevents it from slipping.)
5. Drop this end.
6. Slide the whole knot down to the hook.
7. Gently tug on the end you previously dropped.
8. Neaten the knot. It's important to make sure the knot is "neat," or that the coils are tightly lined up. If there are loose wraps, or wraps on both sides of the eye, the knot may snag and break.
9. Voila! There should be neatly stacked coils lined up next to the eye.

STUDENT COPY

The Perfect Rigging Sheet



INSTRUCTOR COPY

Fishing Rod and Reel Maintenance

Questions and Answers

What if the line doesn't come out of the reel?
You may have a tangle under the reel cover. Unscrew the reel cover to check. Otherwise, check the button to see if it's catching properly.

What if there's a tangle?
Loosen the tangle and scoot it off the end of the rod. This makes it easier to untangle. You can always cut the line and and re-rig if necessary.

What if it seems like there is sand in the reel or it's gummed up with something?
Take the reel cover off and clean the reel with a wet paper towel. You may want to put a little oil on the gears.

How often should I change the line?
Once a year. Old line becomes brittle and may break easily. Old line may look curly as it comes off the reel. Return old line to a sporting goods store for recycling.

What if the rod tip breaks off or the line guides come off?
You can cut the tip down to the next line guide. Displaced line guides can be glued back into place.

Pop Can Casting

Pop can casting is a can-do activity!

Table of Contents

Chapter 5 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Pop Can Casting

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions.

History and Social Studies

Grade 4-8
V. Geography
D. Interconnections:

Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss the responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 5 • Lesson 3

Pop Can Casting

Grade Level: 3-5
Activity Duration: 60 minutes
Group Size: any
Subject Areas: Language Arts, Social Studies, Science, Environmental Education, Physical Education
Academic Skills: application, communication, kinesthetic concept development, observation
Setting: Warm-up, Part 1, and Part 3: indoor or outdoor gathering area with tables
Part 2: large indoor or outdoor gathering area
Vocabulary: improved clinch knot
Internet Search Words: casting, knot tying

Summary

In this activity, students will learn that, like early native peoples and Minnesota settlers, they can use everyday materials to make fishing gear. They'll learn how to tie a clinch knot and make a pop can rig. They'll practice casting, using hula-hoops to simulate fish cover. Once they've mastered casting, they'll learn basic fish handling and release techniques. The final step is rigging the pop can with hooks, bobbers, and sinkers in preparation for the fishing trip—and learning the signs that tell you that you've got a bite!

Student Objectives

The students will:

1. Tie an improved clinch knot.
2. Make a fishing rig from a pop can.
3. Demonstrate how to accurately cast a line.
4. Relate fishing techniques to fish habits and habitats.

Instructor's Background Information

Traditionally, people have fished to feed themselves, their families, and their communities. Archeological research and ancient literature reveal that fishing has been as important as hunting to many aboriginal people worldwide. The survival of numerous ancient tribes and civilizations depended on fishing skills. Knowledge of fish behavior, migration patterns, and habitats were essential for people who relied on fishing. Having a bad fishing day just wasn't an option when lives depended on an adequate supply of fish. Many people in the world still rely on fish as a primary food source. People who depend on the fish they catch as a primary food source are involved in the activity referred to as subsistence fishing.

Sport fishing, or angling for enjoyment, began in medieval times. Sport anglers may fish for food, too, but fish isn't these anglers' primary food. The sport angler has fun fishing and enjoys the challenges of learning about fish behavior and developing fishing skills. These anglers also enjoy spending time outdoors, appreciating nature, and spending time with friends and family. Fly-tying, boating, making fishing equipment, and taxidermy are fulfilling, lifelong hobbies for many sport anglers. In Minnesota, more people fish per capita than in any other state. The majority of these anglers fish for recreation or sport rather than subsistence.

Many techniques for harvesting fish have been developed over the centuries. People have long used everyday materials to make fishing gear. Techniques include: catching fish with bare hands, hooks and lines, spears, nets, night fishing with lights, weirs (traps), and dip nets. The rod and reel assembly used by most modern sport anglers is a relatively recent invention, first documented in fifteenth century

Materials

- **Pop Can Rigging Sheet**, one per student
- **To Cast Your Line**
- **Tying an Improved Clinch Knot Sheet**, one per student
- Four to six hula-hoops
- Nylon cord or rope (five pieces per hula-hoop—quarter-inch thick, cut in two-foot lengths
- One or two needlenosed pliers
- One or two fingernail clippers
- Three or four rolls of masking tape
- Construction paper (for making cover props such as lily pads, stumps, docks, rocks)
- Scissors
- Eye screws, paper clips, or magnets (for K-2 Option)
- Adult helpers, one for every five to ten students

Enough for each student:

- sinkers
- bobbers
- #6 or #8 hooks
- clean pop cans (residual sugar attracts bees, leading to painful stings)
- monofilament line pony spools (6-pound test)
- casting plugs

literature. In many parts of the world, angling is still done by hand with a hook and line rather than with a rod. The hook, bait, and weight are simply cradled in the angler's throwing hand while holding the end of the line with the other. The whole assembly is then tossed into the water toward good fish habitat.

Although many people who fish today take advantage of widely available technological advances in fishing gear and equipment, such as graphite rods, depth finders, and underwater cameras, expensive high-tech equipment isn't necessary for catching fish and enjoying angling. Everyday materials can still be used to make a fishing rig. In this lesson, basic hook and line fishing techniques will be used to construct pop can fishing rigs.

Pop can fishing rigs are simple to make with a few basic supplies. With an ordinary pop can, a length of monofilament fishing line, a bobber, sinker, hook, and the improved clinch knot (a versatile fishing knot), students will make their own fishing rig. Catching fish on rigs they've made themselves is exciting and satisfying for students.

The pop can rig is made from everyday materials—and it works!

Pop can casting was developed to allow participants to learn basic fishing skills using limited resources. Everyone can learn to enjoy the thrill of sport angling. Many instructors find that this simple fishing gear allows students to learn about and experience ancient fishing techniques.

Today, we may not often think about the source of our food. Our modern lives can seem quite disconnected from the skill and work that brings our food to the supermarket. Today, we simply buy fish provided by commercial fishers. Fishing with pop can casters can help students learn some basic skills needed to acquire food for themselves. They will also begin to understand and appreciate how environmental resources provide for our daily needs.

Procedure

Preparation

1 Gather supplies from the Materials List.
2 Make a sample pop can caster to show to students before beginning the lesson.

Activity

Warm-up

1 Minnesota has many lakes and rivers with fish. Ask students to discuss foods eaten by early native peoples and Minnesota settlers. Did they have grocery stores back then? Did their diet include fish? Discuss the different fishing methods that these people may have used. Where did they get materials to make their fishing gear?
2 Where do we get the materials for fishing gear today? Do we *need* expensive equipment to catch fish? Tell students that, if they know how to rig a line, they can use everyday materials to make a fishing rig that will catch fish!
3 Begin by teaching the group how to tie a clinch knot. This knot is important because it links your hook to the line. Without a sturdy setup, you're likely to lose your fish!
4 Pass out the **Tying an Improved Clinch Knot Sheets.** Using a hula-hoop and nylon cord, demonstrate how to tie an improved clinch knot as shown on the handout. The hula-hoop represents the eye of the hook. The nylon cord represents the fishing line. One end of the fishing line is the end of the line that would be attached to the pop can; the other end of the cord is the free end (or tag end) of the line.
5 Have a student hold the hula-hoop while you talk through the steps and tie the knot.
6 Untie the knot and have the class talk you through the steps as you tie the knot again.
7 Divide the class into groups of four or five, and give each group a hula-hoop. Give each person a length of cord and ask the student to practice tying the knot onto the hoop. Assist those who need additional help, and encourage those who tie the knot successfully to help others.
8 Make sure everyone has mastered this knot before going on to rigging.

Make sure that the pop cans are clean. Residual sugar attracts bees, leading to painful stings.

With any group, it's important to emphasize safety when casting. Make sure students stand several feet apart. Remind everyone to look around for other people, overhead wires, branches, and other obstacles before casting.

Many students have seen people cut fishing line by biting the line with their teeth. This is a safety concern because people can chip teeth or swallow a loose piece of line. Use nippers or nail clippers to cut fishing line. Many students have seen someone secure a sinker by biting on it. Sinkers are easily swallowed and they're made of hard metal that can chip teeth. Use needlenosed pliers to open and secure sinkers. Most sinkers are still made of lead, which can be toxic if ingested. Always keep sinkers away from the mouth.

Lesson

Part 1: Make the Pop Can Casters

Your group is now ready to construct the pop can rig shown on the **Pop Can Casting Sheet.** These rigs take the place of a rod and reel—and yes, you can catch fish with these rigs!

1. Hand out the **Pop Can Casting Sheet.**
2. Set up the empty pop cans, masking tape, fishing line, clippers, and casting plugs at tables, allowing enough work space for everyone.
3. Have students follow the steps on the sheet.
4. At this time, change Step 4 on the handout to attaching only a casting plug with an improved clinch knot so students can use the pop can rigs for casting practice.

Part 2: Casting for Cover

1. Discuss the importance of casting close to cover. For instance, largemouth bass wait for prey in the shade of a lily pad. Our fishing lure imitates prey. If we can fool the bass, we'll get a bite!
2. Demonstrate the proper technique for casting a pop can rig. Make sure your hand or thumb isn't over the line wrapped around the can.
3. To practice casting, and to reinforce the importance of habitat in picking a fishing spot, set up a pop can casting course. Place hula-hoops on the ground for targets. Set up a series of stations golf course-style, with each station representing a different fish habitat. For example, put construction paper lily pads around one hula-hoop to represent good largemouth bass habitat. Then let the group "cast for cover" from fifteen to twenty feet away. Allow everyone at least three tries at each station before moving to the next station. Once a person casts inside the hula-hoop, they should be asked to identify the type of fish they would have caught and move on to the station of their choice. Watch the group and help as needed.

Part 3: Rigging for Fishing

1. Remove the casting plugs.
2. Refer to the **Pop Can Rigging Sheet** distributed earlier.
3. Have the students pull a two-foot length of line from the pop can.
4. Demonstrate how to attach each piece of tackle (bobber, sinker, and hook). (See **Lesson 5:2—Casting a Closed-face Rod and Reel Combo** for detailed instructions on how to rig a line.)
5. Hand out the tackle one piece at a time so students don't lose the small pieces. Have students rig their pop can casters.
6. It might help to tape the hook to the top of a desk or table using a piece of masking tape, with the eye exposed over the edge. The sharp hook is safely secured, and the students then have both hands free for tying the knot.
7. Check to make sure that everyone has properly rigged their pop can caster.
8. Review how to safely carry the pop can casters.

Wrap-up

Remind students that they don't need a lot of expensive equipment to go fishing. Once they know how to tie a clinch knot and attach a split shot sinker and bobber, they can make their own pole and reel with an empty, clean soda pop can! The pop can rig will work best when fishing for crappies, sunfish, and perch. Now you are ready to go fishing. See **Lesson 6:1—Water's Edge Safety and Fishing** to plan your fishing trip.

Assessment Options

1. Assess accurate construction of the pop can rig. Ask students to describe the importance of tying good fishing knots, and how they will handle the fish they catch. Ask students to think of everyday materials other than pop cans that could be used to make fishing rigs. How would they make rigs from these items?
2. Have students draw or describe the different habitats in a lake, indicating the best places to cast for specific types of fish (such as bluegills or crappies).
3. Assessment options include the Checklist and Rubric on the following pages.

Get the Lead Out

Consider using fishing tackle that doesn't contain lead. Lead is a toxic metal and, in sufficient quantities, it adversely affects the nervous and reproductive systems of mammals and birds. Ask for non-lead tackle at your bait shops.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

20-22 points = A
Excellent. Work is above expectations.

18-20 points = B
Good. Work meets expectations.

14-18 points = C
Work is generally good. Some areas are better developed than others.

11-14 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-10 points = F
Work is unacceptable.

Pop Can Casting Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Tie a clinch knot with both rope and monofilament line.
2	______	______	Explain the importance of a clinch knot.
3	______	______	Correctly place the hook, bobber, and sinker on the line.
3	______	______	Describe the reason for using a hook, bobber and sinker.
4	______	______	Make a pop can caster without extra assistance.
3	______	______	Aim for cover and accuracy rather than distance in casting.
3	______	______	Identify three types of fishing equipment or methods used in Minnesota before European settlement.
2	______	______	Understand that, historically, people have used available materials to make fishing rigs.

Total Points

22	______	______	**Score** ______

Pop Can Casting Scoring Rubric

Skill Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Clinch knot	Can tie a clinch knot with both rope and monofilament line. Can explain the importance of using a clinch knot.	Can tie a clinch knot with both rope and monofilament line. Has an idea why fishing knots are important.	Can tie a clinch knot with a rope but needs help tying the knot using monofilament line. Can't explain the importance of the knot.	Can't tie a clinch knot unassisted.	Didn't try to tie a clinch knot.
Hook, bobber, and sinker	Can correctly place the hook, bobber, and sinker on the line unassisted. Can describe the reason for each item.	Can correctly place the hook, bobber, and sinker on the line unassisted. Can describe the reason for two of the items.	Can attach a hook, bobber, and sinker, but places two of the items in the incorrect spot on the line. Can describe the reason for two of the items.	Needs assistance in placing the hook, bobber, and sinker on the line; doesn't know the reason for each of the items.	Didn't try to rig the line.
Pop can caster making and casting for cover	Can make a pop can caster without assistance and aims for cover and accuracy rather than distance in casting.	Can make a pop can caster without assistance and aims for cover for 75% of their casts with the pop can rig.	Can make a pop can caster with slight help from instructor. Aims for cover and accuracy in 50% of their casts with the pop can rig.	Can make a pop can caster with significant help. Aims for cover and accuracy in less than 50% of their casts with the pop can rig.	Didn't follow directions and didn't complete the pop can caster.
History of fishing	Can identify three types of fishing equipment or methods used in Minnesota before European settlement. Understands that people used everyday materials to make fishing rigs.	Can identify two types of fishing equipment or methods used in Minnesota before European settlement. Understands that people used everyday materials to make fishing rigs.	Can identify one type of equipment or method used in Minnesota before European settlement. Understands that people used everyday materials to make fishing rigs.	Can't correctly identify a type of equipment or method used in Minnesota before European settlement.	Can't identify a type of equipment or method used in Minnesota before European settlement.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Introduce live bait hunting. Have students search the school area for insects, worms, and other invertebrates that would make good fishing bait to use with their pop can casters.

For the Small Fry

K-2 Option

1 Prepare the pop can casters ahead of time. Tape the hook to the can for safety.
2 Teach students how to tie the improved clinch knot with ropes and hula-hoops. Young students may not always be able to tie the knot with the fishing line, but they can tie the knot with rope and some assistance.
3 Attach fishing line to dowels or hula-hoops. Have students handle the bobbers and practice opening the hooks on each side. Then have students put bobbers on fishing line. (**See Lesson 5:2—Casting a Closed-face Rod and Reel Combo** for detailed instructions on how to rig a line and attach a bobber.) Students can also practice closing sinkers on fishing line. Use eye screws to practice attaching the line to a hook. Students can try to tie the knot with the fishing line, and a paper clip or magnet can be attached to the end of the line instead of an eye screw so the students can place the "hook" in the correct place on the line. Review the order that the tackle needs to be placed on the fishing line.
4 Review how to safely carry hooks. Have them practice carrying the fully-rigged pop cans. (Hooks can still be covered.)
5 Practice fishing with the pop cans using casting plugs, or with the hooks covered with paper and tape. (The paper helps with tape removal later—hooks covered in tape alone are very hard to get out of the tape!) Students can drop the plug to the floor and practice wrapping the line around the can to reel in the fish. Casting is not necessary, especially if fishing on a dock or pier. See **Lesson 6:1—Water's Edge Safety and Fishing** to plan your fishing trip.

STUDENT COPY

Pop Can Rigging Sheet

You don't need a lot of expensive equipment to fish. Once you know how to tie a clinch knot and attach a split shot sinker and bobber, you can make your own pole and reel from an empty, clean soda pop can! Your soda pop can rig will work best when fishing for crappies, sunfish, and perch.

Materials for a Pop Can Rig

- One clean, empty pop can (must be clean: sugary pop attracts bees!)
- Masking tape
- 6- to 8-pound test fishing line (about 50 wraps)
- Fingernail clipper to cut the line
- Hook
- Split shot sinker (or sinkers)
- Bobber

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Build Your Pop Can Rig

1. Tie one end of the line to the tab on the soda pop can, or around the top of the can with a knot.
2. Securely tape the knot and fishing line near the top of the soda pop can.
3. Wrap the line around the pop can 50 times. Tape the line down and leave approximately 2 feet of line loose from the can.
4. Attach the bobber, split shot sinker, and hook.

STUDENT COPY

To Cast Your Line

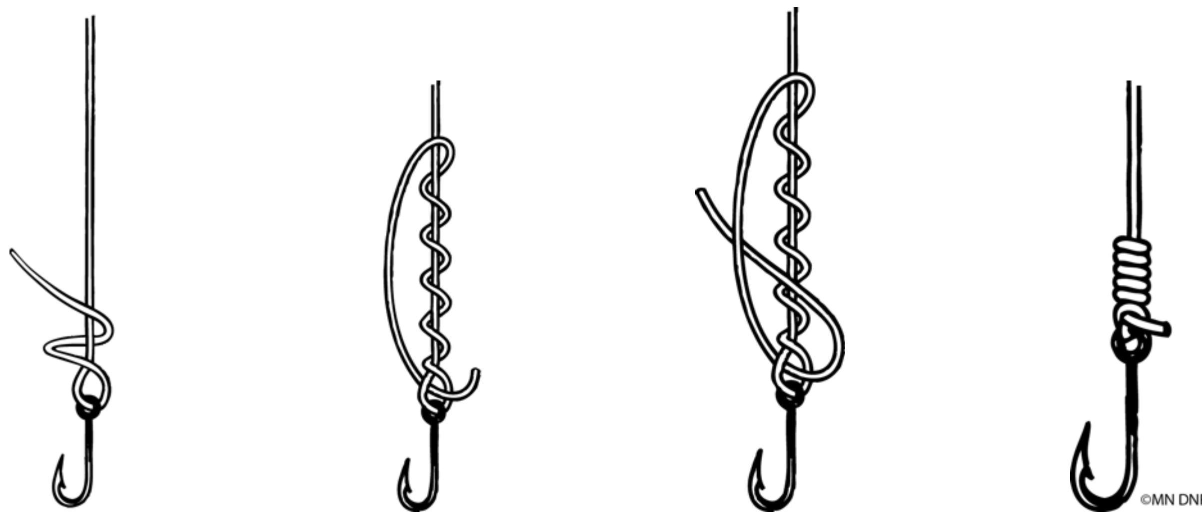
1. Unwind your line about two feet past the bobber.
2. Hold the top end of the pop can in one hand and the bobber in your other hand. Remember not to cover the line wrapped on the pop can with your hand or fingers as you cast.
3. Point the bottom end of the pop can at the place in the water where you want the bobber to fall.
4. Toss the bobber underhanded toward the water.
5. The rest of the line should unwind and follow.

To Reel in Your Fish
If your bobber tells you that you've got a bite, give the line a quick jerk to set the hook. If using circle hooks, just begin to wind the line without setting the hook. Then wind the line around the can, keeping it tight until you can grab the fish.

STUDENT COPY

Tying an Improved Clinch Knot Sheet

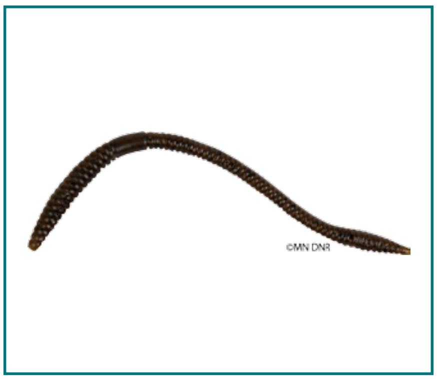
The clinch knot is probably the most popular fishing knot used today. When properly tied, the clinch knot is very strong and it won't slip. This is a versatile fishing knot, and it can also be used to attach lures to your fishing line.



1. Thread one end of the line through the eye of the hook.
2. Wrap the line around itself five times to make five twists. Fishing tackle manufacturers have found that five wraps of the line work best. With fewer than five wraps, fish might pull out the knot. With more than five wraps, the line may break.
3. Take the tag (loose) end of the line and put it through the first twist, near the hook.
4. Notice the new loop you have made. Take the same tag end and pass it through the new loop. (This is the "improved" part of the knot that prevents it from slipping.)
5. Drop this end.
6. Slide the whole knot down to the hook.
7. Gently tug on the end you previously dropped.
8. Neaten the knot. It's important to make sure the knot is "neat," or that the coils are tightly lined up. If there are loose wraps, or wraps on both sides of the eye, the knot may snag and break.
9. Voila! There should be neatly stacked coils lined up next to the eye.

Tackling Your Tackle Box

A tackle box is an angler's toolbox.



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Chapter 5 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Tackling Your Tackle Box

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I.Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent thinking.

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different reasons.
Benchmark 5—The student will organize and express ideas sequentially or according to major points.

Grade 4
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3-The student will give oral presentations to different audiences for different reasons.

Grade 5
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.

Math
Alignment to the 2007 Minnesota Academic Math Standards coming soon.
Grade 3
II. Number Sense, Computation and Operation
A. Number Sense:
Benchmark 1—The student will read, write with numerals, compare and order whole numbers 1 to 9,999.
B. Computation and Operation:
Benchmark 1—The student will use addition of up to three whole number addends, containing up to four digits each in real world and mathematical problems.
C. Measurement:
Benchmark 6—The student will make change using as few coins as possible up to a dollar.

Grade 4
II. Number Sense, Computation and Operation
B. Computation and Operation:
Benchmark 1—The student will use addition and subtraction of multi-digit whole numbers to solve multi-step real-world and mathematical problems.
C. Measurement:
Benchmark 3—The student will make change using as few coins and bills as possible up to $20.00.

Grade 5

B. Computation and Operation:

Benchmark 2—Add and subtract numbers with up to two decimal places in real-world or mathematical problems.

History and Social Studies

Grades K-3

VI. Economics

A. Economic Choices:

Benchmark 3—Students will understand and explain that the concept of scarcity means that one can not have all the goods and services that one wants.

Grades 4-8

V. Geography

D. Interconnections:

Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 4

I. History and Nature of Science

A. Scientific World View:

Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.

Benchmark 2—The student will discuss the responsible use of science.

Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

III. Earth and Space Science

A. Earth Structure and Processes:

Benchmark 1—The student will identify and investigate environmental issues and potential solutions.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 5 • Lesson 4

Tackling Your Tackle Box

Grade Level: 3-5
Activity Duration: 50 minutes
Group Size: up to 30
Subject Areas: Physical Education, Language Arts, Social Studies, Science
Academic Skills: identification, listening, matching, observation, presentation skills, recognition, small group work
Setting: indoor or outdoor gathering area with tables
Vocabulary: bobber, crankbait, hook size, jig, spinner, split shot sinker, spoon, stringer
Internet Search Words: fishing lure, fishing tackle, improved clinch knot; on the Minnesota DNR website: Lake Finder

Instructor's Background Information

Would you play a game of soccer without a soccer ball? Go canoeing without a paddle? Go biking without a bike? Like any other sport, fishing requires special gear.

But what do you buy? Sporting goods stores carry seemingly endless arrays of tackle and fishing gear, including specialized equipment for every situation.

To purchase wisely, consider your target species. What type of fish do you hope to catch? After you choose a fish, you must learn a few things about it, such as its mouth size, food preferences, where it spends most of its time, and its typical size.

Spend some time learning about fish, their habits, preferred baits and lures, and fishing techniques. Information is available in books, magazines, and online. Even a small amount of information can help you get started, and familiarity with basic tackle will help you effectively match tackle to a target fish species. (**Lesson 5:6—Fool Fish With Flies, Lesson 6:4—Piscatorial Palate,** and **Lesson 2:1—Fish Senses** contain additional information about artificial lures, baits, and how they attract fish.)

A sunfish, for example, has a small mouth, so it's best to use a small bobber, sinker, and hook with small bait such as wax worms. Sunfish aren't large or heavy, so a basic rod and reel with a light line of 4-pound test suffices. (You may choose a slightly heavier line, such as 6-pound test, when fishing with young children because they're more likely to snag their lines.) Knowing that sunfish live in shallow water, you'll know where to fish for them—from shore, or from a dock or fishing pier.

Summary

When anglers have the information that helps them select the correct equipment, chances for fishing success are greatly improved. A show-and-tell activity and a matching activity familiarize students with common lures and tackle. Using a limited amount of money, students shop in a virtual tackle store to stock a tackle box with basic lures and baits appropriate for catching their targeted fish species. On a second virtual shopping trip, students return prepared with information on the characteristics of their targeted fish species. In a presentation to the group, they compare items purchased on the two shopping trips and share their reasons for choosing them.

Student Objectives

The students will:

1. Identify various pieces of fishing equipment and describe the function of each.
2. Select tackle appropriate for catching a particular type of fish.
3. Work cooperatively in small groups to present an explanation of their groups' choices of fishing tackle for targeted fish species.
4. Describe how knowledge of fish characteristics leads to economical and effective choices of tackle box items.

Materials

These items can be purchased at a sporting goods store or borrowed from an avid angler such as a parent, instructor, or fishing club member.

- Tackle box
- Bobbers, one-inch red and white (plus one spring and one slip, if desired)
- Split shot sinkers, a few in different sizes—non-lead, if available
- Hooks mentioned in the lesson, sizes 10, 8, 6, 2, 1, 1/0
- Containers for hooks, one for each hook size (clear 35mm film canisters work well)
- Fingernail clipper
- Needlenosed pliers
- Common artificial lures mentioned in the lesson—jig, plastic worm, straight-line spinner, spinnerbait, crankbait, surface lure, spoon—one of each type, in various sizes
- Snap swivel
- Leader
- Spools of fishing line mentioned in the lesson, 4-, 6-, 10-, 12-, and 20-pound test
- Knot-tying card
- Practice casting plug
- Measuring tape or ruler
- Fish stringer
- Whistle
- First aid kit (or a few band-aids to represent a first aid kit)
- Personal safety gear (sunscreen, hat, sunglasses, insect repellant)
- Small plastic trash bag
- Sample fishing license
- Minnesota fishing regulations booklet

continued

Northern pike, on the other hand, are typically larger and heavier than sunfish, so a sturdier rod and reel with a heavier line is a better choice. (Try a line of 12-pound test or heavier.) These fish have bigger mouths than sunfish, calling for larger hooks and bait. Northern pike typically eat other fish (rather than invertebrates), so a minnow is a better choice than a wax worm. (Northern pike actually have many teeth that can cut line, so anglers often attach a metal leader to the end of their line next to the lure or bait.) Northern pike come close to shore to feed on the smaller fish that live there, so it's possible to catch them by casting from shore.

Some anglers prefer artificial lures to live bait. Artificial lures are easier to keep in a tackle box. They're more expensive than live bait intially, but they can be reused if you don't lose them.

To keep things simple and limit fishing expenses, anglers should collect only the gear that they really need for their typical style of fishing. It's best for beginners to start with simple tackle and to outfit their tackle boxes with some essentials. A few extra hooks, sinkers, bobbers, a fingernail clipper, needlenosed pliers, and a few band-aids in a small tackle box come in handy if there's a snag, or if someone loses something or gets cut by a hook. The tackle box shouldn't be so overstocked with unused equipment that it becomes heavy, cumbersome, or difficult to use.

No one item can guarantee that you'll catch a fish, but a few simple tools can make a fishing trip more pleasant and successful. These are suggested items for a tackle box. Most can be found at sporting goods stores or bait shops.

- **Tackle box**—These containers store gear and keep it organized and easily accessible. A small, top-opening tackle box with one tray is a good first box. Plastic tackle boxes are rugged and will keep your tackle dry. Select one that's easy to carry.
- **Bobbers**—Usually made of plastic or foam, bobbers are floats for the fishing line and keep bait at a specific depth. They also signal when a fish nibbles at the bait by bobbing up and down—when a fish takes the bait, they submerge, or are pulled along the surface of the water. Bobbers come in several styles. There are bobbers that remain fixed on the line (like the round red and white type or thin spring lock type). A slip bobber slips or slides along the line until it hits a knot placed on the line to a set depth.

  Fixed bobbers are easier for young people to put on and take off by themselves, but slip bobbers are easier to cast, especially in deeper water. Round bobbers work well with heavier baits, lures, and rigs. Thin bobbers are more sensitive to the movements of nibbling fish. The size of any bobber should match the weight of the bait and other tackle on the line.
- **Split shot sinkers**—These are small weights with a split down the center and they attach to a line. Split shot can be made of ceramic

materials, lead, tin, or other non-lead metals. Sinkers weight the fishing line, allowing the bait to be cast and to sink. Sinkers also keep the line tight so the angler can tell when a fish bites. Split shot sinkers are easy for young anglers to attach and remove by themselves. They come in a range of sizes, and assortment packs are available. Use just enough split shot on your line so the bobber rests upright and half of it sticks out of the water. Other types of sinkers are used for special fishing situations, but split shot are a good starter sinker.

Many students have seen people cut fishing line by biting it with their teeth. This is a safety concern because people can chip teeth or swallow a loose piece of line. Use nippers or nail clippers to cut fishing line. Many students have seen someone secure a sinker by biting on it. Sinkers are easily swallowed and they're made of hard metal that can chip teeth. Use needlenosed pliers to open and secure sinkers. Most sinkers are still made of lead, which can be toxic if ingested. Always keep sinkers away from the mouth.

- **Hooks**—Hooks come in a variety of sizes and styles. Carrying assorted hooks helps anglers catch different types of fish and use various types of natural bait.

  Hook Size—Hooks need to be large enough to hold the bait, but small enough to fit in the fish's mouth. Hook sizes 10, 8, and 6 work well for smaller-mouthed fish such as panfish and stream trout. Larger hooks, such as 2, 1, and 1/0, are required for larger fish such as walleye, northern pike, muskellunge, and largemouth bass.

  Shank Length—The shank is the part of the hook between the bend and the eye. Hooks have a short shank or long shank. Choose a long shank hook for chunky baits such as night crawlers.

  Styles—Circle hooks are designed to hook fish in the mouth as soon as the fish bites down and turns to swim away. The point of the hook faces the shank, and may or may not be slightly offset. Circle hooks are particularly good for beginners because you don't have to set the hook by jerking the line—they're self-setting. Fish hooked in the mouth (rather than in the throat or stomach) have a better chance of surviving catch-and-release.
- **Hook containers**—Tackle boxes stay neat and safe with hooks organized into small containers like clear 35mm film canisters. Use a different canister for each hook size. Hooks can also be stored hooked into a piece of foam or a cork.
- **Fingernail clipper**—The tackle box fingernail clipper isn't for manicures, but for cutting fishing line! A fingernail clipper is handy if a hook swallowed by a fish needs to be cut free, a knot needs

Materials (continued)

- Lake, stream, or fishing pier map
- Hook sharpener
- Play money (optional)
- **Tackling Tackle Cards**, one set for each group of three students
- **Tackling Tackle Checklist,** one for each group of three (and enough extra copies for any student who wants to take one home)
- **Tackling Your Tackle Box Price List**, two for each group of three students
- **Fish Information Cards**, one for each group of three students
- **Fish Tackle Cards**, one for each group of three students
- Mail order catalog of fishing equipment and supplies from a sporting goods store (optional)

Get the Lead Out

Consider using fishing tackle that doesn't contain lead. Lead is a toxic metal and, in sufficient quantities, it adversely affects the nervous and reproductive systems of mammals and birds. Ask for non-lead tackle at your bait shops.

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Many catch-and-release anglers flatten the barb of the hook by pinching it down with needlenosed pliers. This reduces the chance of a hook getting caught deep in a fish. It's also easier to remove.

Alluring Names

Manufacturers name lures, so names can be very similar or identical to names of other well-known and popular lures. Anglers loyal to one company may know only the trade name for their favorite lure. Names used here are as general as possible, but students may know these lures by other names.

Traditionally, jig heads have been made with lead, but jigs made of non-lead materials are becoming more common. Ask your local fishing supply store for non-lead jigs. You can also order these directly from some manufacturers—look for them online.

trimming, or for adding a new line to a reel. Biting monofilament line can damage teeth. Fishing stores carry "nippers," a similar device.

- **Needlenosed pliers**—Needlenosed pliers or long-handled forceps allow anglers to gently and safely remove a hook from a fish's mouth. They also allow you to reach further into the mouth while keeping fingers away from sharp teeth. Pliers are especially important for catch-and-release fishing.
- **Artificial lures**—Selecting fishing lures can be an overwhelming task with the many types of lures available on the market today. Each lure style comes in a dazzling variety of shapes, sizes, and colors. (It's been said that fishing lures are designed to catch anglers as well as fish!) To start, select a few types of lures in sizes that can be used for the fish you most often seek. As you gain fishing experience, increase your skills, or expand your fishing to a wider variety of species, add the appropriate lures to your collection.

For more information about the color of fishing lures, and how lures attract fish, see **Lesson 5:5—Flashy Fish Catchers**. To learn about a special type of artificial lure often used in flyfishing, refer to **Lesson 5:6—Fool Fish with Flies.**

Types of Lures

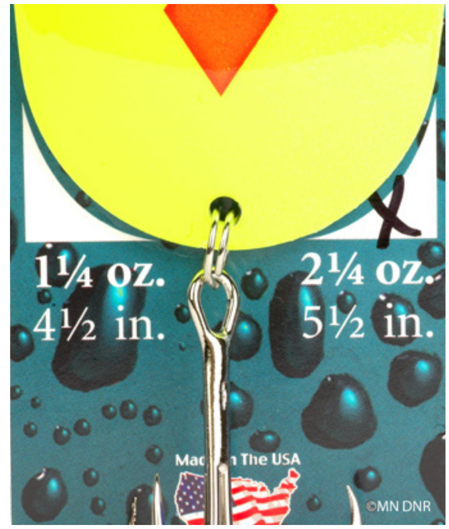
The following isn't a complete list of all types of lures, but introduces some of the most popular ones.

- **Jigs or jig heads** have weighted heads and a hook. A jigtail made of feathers, hair, or soft plastic can be purchased separately and slid over the hook to make a tail. Jigs resemble natural fish food such as insects and small fish. They're lifted and lowered near the bottom (as in dancing a jig.) The most common types are feather jigs and twistertail jigs. Feather jigs are used to catch smaller fish like panfish. Twistertail jigs are used to catch all species. A small piece of natural bait, such as a minnow or worm, can be added to jig hooks to further entice fish to bite.
- **Plastic worms** are commonly used to catch bass, but sunfish and walleye will also bite them. They're made of soft plastic and come in many shapes and sizes. Some contain scents attractive to fish. They don't have hooks, so they're threaded onto a basic hook or another lure attached to the line. An easy way to use a plastic worm is to hook it to a plain jig head.
- **Spinners** have one or more blades that spin around a metal shaft. Fish see the flash of the revolving blade from a distance and feel its vibrations. Most have tails made of soft plastic or animal hair that resemble natural fish food such as insects. Common types are straight-line spinners and spinnerbaits. Spinnerbaits look like an open safety pin, with a spinning blade on one end, and a jig on the other. Spinners can be used to catch all species.
- **Diving lures or crankbaits** imitate baitfish, with "lips" that cause them to dive and wiggle. The size and angle of the lip and the weight

of the lure determine how deep the lure will travel. Crankbaits are great for attracting larger predator fish that swim in deeper areas such as northern pike, muskellunge, walleye, bass, and salmon.

- **Surface lures** float on the surface of the water. They resemble insects or frogs and can be used for all species, especially sunfish, bass, northern pike, and muskellunge. Some, called poppers, have flat or scooped-out fronts that splash as they're jerked across the water.
- **Spoons** have one large heavy blade that wobbles through the water like a baitfish. Spoons typically have one shiny silver or gold side, with the other side painted in bright colors. Fish see the flash, the color, and the movement, and may sense some vibrations. Spoons are used to attract trout and larger predator fish such as northern pike, muskellunge, walleye, bass, and salmon.
- **Snap swivels**—A swivel keeps the line from being twisted as certain types of lures wiggle and twist through the water. One looped end of the swivel is tied to the end of the fishing line—the lure is then clipped or snapped to the other end loop while the center of the swivel twists. Snap swivels make frequent changes of lures easier. Swivel sizes should be matched to lure sizes.
- **Leaders**—Leaders are six- to twelve-inch lengths of line that often contain metal cores. They're tied to the end of the line when fishing for large fish with big, sharp teeth such as walleye, northern pike, and muskellunge—these fish might cut the line when they bite.
- **Extra fishing line**—It's not uncommon for an angler to have to cut a fishing line to free a snag or to repair a bad backlash (line tangled on the spool of the reel). To replace the line on a reel, it's wise to keep spare fishing line in the tackle box. Fishing line comes in different sizes, or "tests," measured in pounds. The higher the pound test, the heavier or stronger the line. For example, 4-pound test line is appropriate for catching sunfish, trout, and perch. The 4-pound test line won't break unless there's four pounds or more of pull on the line. Fishing for northern pike or muskellunge calls for 12-pound test or higher. This line is stronger and more durable than lower test line that could break if tugged by large fish.

  Don't litter when replacing or cutting fishing line! Discarded line left in the water or on the ground can entangle and endanger animals such as birds. Many bait shops accept used monofilament line for recycling.
- **Knot-tying card**—A well-tied knot will prevent you from losing the big fish you worked so hard to lure and hook. A fishing line is only as strong as the knot! There are many different knots, but the improved clinch knot is one of the most versatile, and it suits most fishing styles. A knot-tying card reminds anglers how to tie various knots. You can make your own, or find them in sporting goods stores or bait shops.
- **Practice casting plug**—A casting plug is made of rubber, plastic, or wood with a heavy center, and is the approximately weight of a typical lure. It doesn't have a hook or other parts that could catch



A lure package.

Lure sizes are listed on their packages. Jig heads, spinnerbaits, diving lures, surface lures, and spoons are sold by weight, usually in fractions of an ounce. Heavier lures are larger and sink deeper—they typically attract larger fish. Diving lures, surface lures, and spoons may also state the lure length. Longer lures attract fish with larger mouths. Diving lure packages give a range for how deep the lures will dive or "run," as determined by the weight and the size and angle of the lip. The backsides of lure packages also often suggest a number of fish species attracted to the particular lure.

Recommendations for lure types, sizes, and colors depend on individual fish sizes, fishing locations, and water and weather conditions.

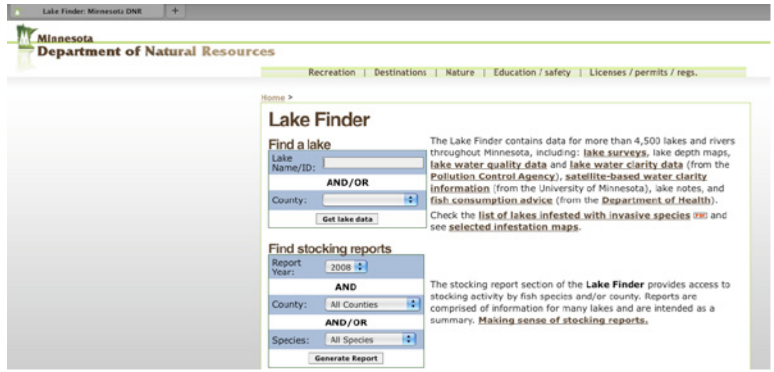
When a fish swallows a hook, the best practice is to cut the line. If the hook is forcibly removed it can tear tissues and injure the fish. The fish may swim away, but such injuries can be fatal.

on plants, objects, or people during casting practice. Although the plug isn't used for fishing, it's good to keep one in the tackle box for sharpening casting skills. Casting skills can be practiced on land, but having the plug handy at the water offers the opportunity to practice casting lures to the right spots in actual fishing conditions, as well.

- **Measuring tape or ruler**—Measure your catch from nose to the tip of the tail. In some lakes and streams, special regulations apply to the size of fish anglers can keep. When ice fishing, anglers can measure the thickness—and safety—of the ice.
- **Fish stringer**—If you catch a fish and plan to keep it, a fish stringer keeps fish fresh in the water. A cooler of ice may also be used to keep fish fresh, especially on hot summer days.
- **Whistle**—A whistle can be used to call for help in an emergency such as someone falling in the water. Blow three long blasts.
- **First aid kit**—Clean wipes and band-aids treat punctures from hooks, scratches, or bug bites. Rubber gloves and additional wraps and bandages are useful for more serious medical emergencies. Consider an emergency kit with matches, rain poncho, water and snacks, and a throwable personal flotation device on a rope.
- **Personal safety gear**—For protection from the sun, keep a bottle of sunscreen, a pair of sunglasses, and a hat with a brim in the tackle box. Before you leave for fishing, check the weather. Long sleeves protect skin from sun, biting insects, or walking through brush. Bring a jacket if it will be cold, or rain poncho if it looks like rain. Always bring a bottle of drinking water to stay hydrated. Wear a personal flotation device if wading or on a boat.
- **Small plastic trash bag**—Bring a bag to pack out trash or pick up any litter found on the fishing trip. Always leave the fishing spot cleaner than you found it.
- **Fishing license**—Any angler 16 years of age or older is required to have a fishing license. Younger anglers aren't required to have fishing licenses, but they must follow all rules in the Minnesota fishing regulations booklet. Revenue from the sale of fishing licenses and trout stamps supports the work of the Minnesota DNR in protecting and improving fisheries resources throughout the state. A trout stamp is usually required for anglers 16 to 64 years of age who intend to fish for trout or salmon. Check the Minnesota fishing regulations booklet for specifics.
- **Minnesota fishing regulations booklet**—*Minnesota Fishing Regulations* is published annually by the Minnesota DNR, and contains information essential to responsible and law-abiding anglers. It summarizes all of the state's fishing rules and regulations. Fishing regulations are the laws that govern sport fishing and are designed to maintain healthy fish populations throughout the state. All anglers are responsible for following and supporting these rules today to ensure that they can continue to enjoy good fishing tomorrow. The Minnesota fishing regulations booklet contains information on seasons and limits, as well as a fish identification

section so anglers can confirm the types of fish they catch.

- **Lake or stream map**—Maps of many Minnesota lakes and streams are accessible on the Internet. For example, lake maps appear on the Minnesota DNR website under Lake Finder. These maps show anglers lake sizes and depths, fishing spots to try, and how to get to the lakes. They provide insight into safety measures to consider before going to the lake. Lake maps are contour maps displaying water depth and topographical information, which helps anglers find underwater features like drop-offs, ridges, or shallow areas that certain species of fish may inhabit. Having a lake map of the best fishing sites handy on a fishing trip saves time—time that can be spent fishing!
- **Camera**—Consider keeping a camera in the tackle box to photograph that first fish, unusual fish, or large fish.
- **Hook sharpener**—A hook sharpener keeps hooks sharp, making them easier to bait and more effective for hooking fish.
- **Fillet knife**—Keep a sharp fillet knife for cleaning the catch for a shore lunch or for preparing it for transport. Sharper knives slide through the fish more easily than dull ones, reducing the risk of slipping. (Children shouldn't carry knives in their tackle boxes.)



The Lake Finder area of the Minnesota DNR website.

Tackle Maintenance

Remember that your fishing tackle requires periodic maintenance and attention. It's a good idea to get in the habit of drying tackle after a fishing trip so lures and hooks don't rust. Wipe off wet lures and leave the tackle box lid open for a few days to promote drying. Cleaning and drying gear also helps prevent the spread of any aquatic invasive species that may have hitched a ride on tackle or fishing line.

Choosing Tackle

The hooks, line sizes, lure types and sizes, and bait to choose depend on the target fish species. Sporting goods and bait shop personnel, fishing clubs and organizations, fishing shows, the Internet, and fishing books and magazines provide good information on the appropriate equipment for different types of fishing. See **Lesson 6:3—Planning a Fishing Trip** for an exercise on employing the Internet and other sources to research information for planning a fishing trip.

To choose the right tackle for a tackle box and spend fishing dollars wisely, invest time in learning about the fishing site and the fish you want to catch. See **Lesson 1:5—Habitat Hideout** and **Lesson 5:5—Flashy Fish Catchers.**

It takes some time to assemble all of these items for a tackle box, but the experience of a great fishing day will make this worthwhile! Although these items give beginners a good collection of gear for several different fishing styles, keep in mind that more advanced anglers may have several tackle boxes that they use for different conditions. Ice fishing supplies may be in one tackle box, stream fishing tackle in another, and summer lake fishing in yet another. But every tackle box should be neat, organized, and well stocked to help ensure successful fishing adventures!

Procedure

Preparation

1. Collect all materials.
2. Fill the sample tackle box with the materials on the **Tackling Tackle Checklist.** Covering the hook tips with masking tape or hot glue makes the hooks safer to handle.
3. Make a set of **Tackling Tackle Cards** (one card per student).
4. Copy the **Tackling Your Tackle Box Price List** (one for each group). You may wish to have a variety of lures, lines, and other equipment available for demonstration.
5. Copy the **Tackling Tackle Checklist** (one for each group).
6. Copy and cut the **Fish Information Cards** and **Fish Tackle Cards.**

If you've previously completed one or more lessons on lures, bait, or flies, this activity can be used as a review of those lessons.

Activity

Warm-up

1. Start the lesson by asking students to think about what they would need if they wanted to go fishing. Then ask them to brainstorm a list of some types of natural bait that fish like to eat. Write the list on the whiteboard or use a projection device so that the class can see it. The list will probably include worms, minnows, wax worms, frogs, grasshoppers, and so forth.
2. Tell students that many of these items are indeed used for fishing, but that live bait can be difficult to store and carry. There are other types of tackle and fishing gear that are easily stored and carried in a tackle box. Show students a closed tackle box. Tell them that they'll be deciding which items to put into a tackle box.
3. Ask the students to brainstorm another list of terminal tackle (which goes at the end of a fishing line). Record this list of items next to the list of bait types. Finally, brainstorm a third list of additional fishing equipment needed for fishing. Record this in a third list or column. This list might include a stringer, pliers, ruler, clippers to cut line, and so forth. Some items on the terminal tackle list could include hook, bobber, sinker, artificial, lures, and bait.
4. Ask students if they've ever been to the tackle section of a store where fishing gear is sold. Comment on the many types and varieties of fishing tackle and gear available for purchase. You might show students a mail order catalog from a sporting goods store to demonstrate the variety of tackle and equipment available.

Lesson

Part 1: Basic Tackle Box

1. Open the tackle box in front of the class. Display and describe some or all of the items, their uses, and how to handle them safely. You can pass the items to students so they can look at more closely. Emphasize that hooks are sharp and can be dangerous if not handled with care.
2. To actively engage students, you may wish to have volunteers come forward to hold an item and display it to the group as they explain how they think it might be used. Remember to emphasize safety in handling the equipment.

Part 2: Lures and Terminal Tackle

1. When students have reviewed the basic items in the tackle box, tell them that they will now do a matching activity to become more familiar with some of the common types of lures and terminal tackle they listed in the Warm-up, as well as some items they may not have listed.
2. Give each student a **Tackling Tackle Card**. Some students will get a card with a picture, others a card with a name, and still others, a card with a description. Have students circulate around the room and form groups of three by matching the picture, name, and description of a piece of tackle. For example, the student with the card showing a picture of a hook will search for the student who has the "hook" name card and the student who has the card containing the description of a hook ("Holds the fish to the line. For best results, must be sharp.") After students locate their teammates, they should gather into these groups of three and continue to hold onto their cards until all students have found their matches and formed groups.
3. Ask one person from each group to represent the group and to present to the class the type of lure or terminal tackle card they received, and describe the item's use. (If you've collected actual lures to use during this lesson, you could show them during these presentations.)
4. When the groups have completed their presentations, ask group members to return their cards to the instructor.

Students might use brand names or several different common names for similar types of lures.

Hooks are sharp! You can cover hook tips with masking tape or glue (with a hot glue gun) for safe handling during the lesson.

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Part 3: Shopping Trip, Round One

1. Tell the students that now that they've learned about some types of tackle, they'll go "shopping" to purchase items to stock a tackle box for a fishing trip. Each group of students will plan to go fishing for a different species of fish and each group will have twenty dollars to spend on tackle. Tell students to think about the amount of money they have to spend as being a limited resource. Discuss the meaning of **limited resource.** Because the amount of money is limited, they'll probably want to make good decisions about how to spend that money. Briefly review that, in real life, we all make decisions about our purchases based on needs, wants, values, and how much money we have to spend.
2. Have one volunteer from each group formed in Part 2 present an idea to the rest of the class about making good decisions about spending or saving money. The volunteers might recount a personal experience about making a good decision about spending money received as a birthday present or allowance.
3. Assign a fish (sunfish, yellow perch, crappie, trout, bullhead, walleye, smallmouth bass, largemouth bass, catfish, northern pike, or muskellunge) to each group of three students.
4. Give each group a **Tackling Tackle Checklist**. Tell the students that each group already has all of the checked items on this list in their tackle box. These are basic tackle box items for many types of fishing.
5. Each group has been given a budget of twenty dollars. With this money, they can buy a few more items for their tackle box that will help them catch their target fish. How will they choose to spend this money?
6. Give a **Tackling Your Tackle Box Price List** to each group. Explain that this list is based on prices from a fishing catalog. The students will shop by catalog. Ask each group to decide which items to check off the list to purchase (or order) for their tackle boxes that will help them catch their target fish.
7. Have them multiply the number of individual items selected by the price of each item, and write the total in the cost line across from the item. In the space provided, have them write their reason for purchasing the item. Remind the student groups to add up the prices of the items as they "shop." They have a twenty-dollar spending limit. If available, give each group twenty dollars in play money in assorted bills and change to count out as they decide on purchases.
8. After each group has completed their purchases, remind them to write down the total cost of their purchases, and how much change they have left from their twenty dollars.
9. Ask a spokesperson from each group to present how much money the group spent, how much money they have left over, and what they bought. Ask each group to explain how they decided which items to buy. How are they sure that their items are the best choices to help them catch their desired fish? Did they have enough money to buy

everything they needed? Did they spend all of their money? If they didn't spend all of the money, what could they do with the rest?

10 When all the groups have finished presenting, ask the students if there is any type of additional information that might make it easier to choose the items for their tackle box.

11 Ask students to set the **Tackling Your Tackle Box Price Lists** aside.

Part 4: Shopping Trip, Round Two

1 If you don't know what to look for, shopping for bait and tackle can be overwhelming. Stores are filled with many different types of tackle, in all shapes, sizes, and colors. Tell students that knowing a little bit about their target fish species can help their groups decide which items to purchase for their tackle box. Ask the students if they know why this is the case. How might they find out which equipment is appropriate to buy and to use to angle for their fish species? Some answers include asking someone who catches that type of fish, asking storeowners, looking on the Internet, looking in a book or fishing magazine, or watching a television fishing program.

2 Tell the students that you've collected some information on each fish species from a Minnesota DNR fish biologist. Give each group the appropriate **Fish Information Card**. Ask the groups to silently read their card and plan which items they might purchase using this new information.

3 Hand a second **Tackling Your Tackle Box Price List** to each group. Ask each group to repeat the shopping exercise with their new information in mind. (Reminder: They don't need to spend all of their money.)

4 After groups have decided on their purchases, again ask them to carry over the price for each item they bought, write down why they decided to purchase it, and total the amount spent on all of the tackle.

5 Ask the students how they knew what to buy during Round Two. Was it easier to decide this time? Why? Are they more confident that the items they chose will help them catch their target fish? Did they have enough money to purchase what they thought they needed? Did they spend all of their money? Why or why not? Compared to the first order from Round One, how much money did they have left?

6 Tell the students that you have information on the tackle recommended for catching each species. Hand the appropriate **Fish Tackle Card** to each group. Ask the students to compare what they bought in each of the two rounds with the items on their **Fish Tackle Card.**

7 Ask each group to present to the class what they bought and why they decided to buy the items they chose during the second shopping trip. Have students use visual aids in their presentations, such as drawings, PowerPoint presentations, pictures of tackle and their targeted fish. Was each item they purchased recommended on the **Fish Tackle Card?** Did they purchase more of the

recommended items on the **Fish Tackle Card** during their first or second shopping trip? Why? Did they spend more money on their first or second shopping trip? Why or why not? On which of the two shopping trips did they think they spent their money more wisely? Why?

8 Collect cards from the students.

9 Variation: If the students have already studied fish or completed lessons in **Chapter 2—Minnesota Fish,** and have previously studied the characteristics of different types of fish, they may not need to do the Round Two shopping trip. At the end of Round One, give them the **Fish Tackle Cards** to check their work. In this case, the lesson could assess students' ability to apply knowledge of fish characteristics to the selection of tackle for a particular fish species.

Wrap-up

1 Ask the students what was important to learn about the fish in order to make good decisions about choosing tackle. The size of the fish determines the line size. Habitat and food preferences help determine which type of lure or bait to use. Mouth size helps determine the size of the lure or bait. A bluegill has a small mouth that measures less than one inch wide. Would it be able to swallow a large sucker minnow or be expected to bite on a seven-inch crankbait? (Often, beginning anglers try to catch small fish with oversized tackle.)

2 Did the students make different choices in how to spend their money in Round Two than in Round One? Why? Did they want to spend all of their money, or did they save some? How can knowing more about your target fish help you save money when you shop for tackle?

3 Ask the students if they were able to purchase everything on their list. Bait and tackle stores can contain an overwhelming amount of merchandise. It may be appealing to buy numerous items. Encourage new anglers to do research ahead of time so they don't buy things they don't need, and to try only a few new items at a time. Review that we may have many *wants*, but that it's important to know that what we want may differ from the items that are truly most useful. Ask students to think of another situation where it would be helpful to research a product before making a purchase.

As anglers become more familiar with using the tackle that they have, they gain more experience. They may have the opportunity to fish with others who are more experienced, or to read books and articles about fishing that will help them learn more about the different types of fish and fishing techniques. Then, they may just want to branch out and stock their tackle boxes with equipment and lures for those new kinds of fishing adventures!

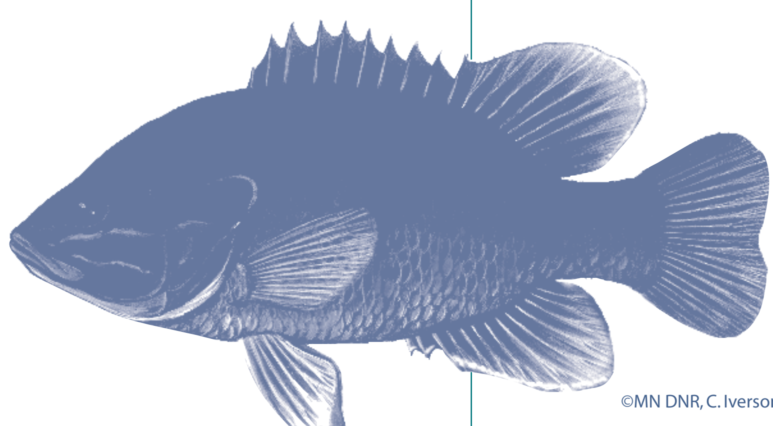
Assessment Options

1 Use an observation checklist to assess whether students could identify various pieces of fishing equipment and their functions throughout the activities in the lesson. Design a Bingo game with pieces of equipment found in a tackle box. Create clues for the uses for each item, and read them in random order. Students place an X on the tackle box item on their Bingo card if it matches the use. Students with "bingos" win. Check the winners' cards to have students determine if the correct tackle box items were chosen to match the uses read.

2 Place all of the completed **Tackling Your Tackle Box Price Lists** from Shopping Round Two at stations around the room. Provide each student group with **Tackling Tackle Checklists** for each of the other groups. Have students rotate from station to station to review whether or not the tackle box items chosen were appropriate for the type of fish the group was assigned. Evaluate the reviews and give verbal feedback to the class regarding the item choices.

3 Evaluate each group's presentation after the second shopping trip. Presentations should include:
- the name and function of the gear on the team card
- the fish they plan to catch
- the hook type to use for live bait and why it was chosen
- the lure type for their fish and what the lure mimics
- the fishing line best for this fish and why it was chosen
- a statement to the effect that knowing the characteristics of their target fish helps them make better choices when buying tackle for a tackle box
- two criteria for making good decisions about how to spend (or save) money

4 Assessment options include the Checklist and Rubric on the following pages.



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Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

24-25 points = A
Excellent. Work is above expectations.

21-23 points = B
Good. Work meets expectations.

17-20 points = C
Work is generally good. Some areas are better developed than others.

13-16 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Tackling Your Tackle Box Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Presentation includes name and function of the gear on the team's cards.
2	______	______	Presentation includes the type of fish they plan to catch.
2	______	______	Presentation includes the hook type to use for this fish.
2	______	______	Presentation includes a lure type and what the lure mimics.
2	______	______	Presentation includes proper fishing line for this fish and why it was chosen.
3	______	______	Student can explain three reasons why it's important to know characteristics of target fish when purchasing tackle.
2	______	______	Presentation utilized two types of supporting visual aids.
4	______	______	Student participates in the group presentation.
2	______	______	Voice is loud enough to hear. The length of presentation is equal to the time limit given.
4	______	______	Student identifies and understands the different types of tackle and gear found in a tackle box throughout the lesson and can identify how each is used on a fishing trip.
Total Points **25**	______	______	**Score** ______

Tackling Your Tackle Box Scoring Rubric

Second Shopping Trip Presentation Criteria	3 **Excellent**	2 **Good**	1 **Fair**	0 **Unacceptable**
Content	Presentation includes name and function of the items purchased on their team's shopping list, the type of fish they plan to catch, the hook type to use for this fish, a lure type and what the lure mimics, proper fishing line for this fish and why they chose it. Purchased items were compared to items on the recommended tackle cards. Understands importance of knowing characteristics of targeted fish when buying tackle. Two criteria for making decisions on how to spend money (a limited resource).	Presentation includes name and function of the items purchased on their team's shopping list, the type of fish they plan to catch. Purchased items were compared to items on the recommended tackle cards. Understands importance of knowing characteristics of targeted fish. Two criteria for making decisions on how to spend money (a limited resource).	Presentation includes name and function of at least half of the items purchased on their team's shopping list, the type of fish they plan to catch. Understands importance of knowing characteristics of targeted fish. One criterion for making decisions on how to spend money (a limited resource).	Presentation contains less than half of the required information.
Visuals	Information presented utilized visuals. At least two types of visual aids used. Visuals were easily read or seen from a distance.	Information presented utilized visuals. At least two types of visual aids used. Visuals weren't easily seen from a distance.	Information presented utilized visuals. One type of visual aid used. Visuals weren't easily seen from a distance.	No visuals used in presentation.
Participation and presentation style	All members of the group presented information. Voices were loud enough to hear. The talk was equal to the time limit given.	All members of the group presented information. Voices were loud enough to hear. The talk was shorter or longer than the time limit given.	All members of the group presented information. Some voices were too soft. The talk was shorter than the required time limit.	Only a few group members presented information. Voices were too soft to hear. The talk was shorter than the required time limit.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

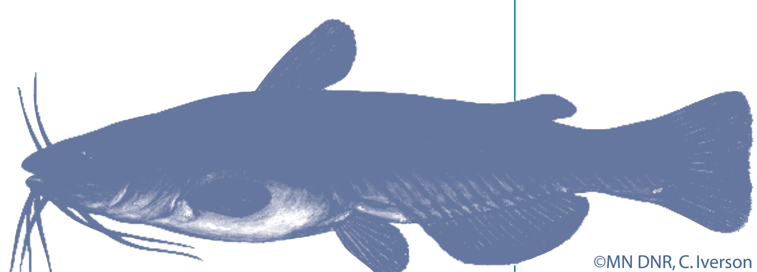
1 Do **Lesson 5:5—Flashy Fish Catchers.**
2 Do **Lesson 6:3—Planning a Fishing Trip.**
3 Take the **Tackling Tackle Checklist** to a fishing tackle store and write down the prices for each item. Compare prices from more than one store.
4 Using resources in the library or the Internet, research the history of fishing tackle. Find pictures of unique fishing tackle. Discover how much or how little a certain type of tackle has changed over time. Bring fishing lure books from the library to class and show students the wide variety of lure types and antique lures. Point out the tiniest of trout flies to the biggest muskie lures. Investigate the history of lure making and the history of fishing gear.
5 Have students practice knot tying and rigging a line with hooks and lures.
6 Have students be fishing sportswriters who have just received an assignment from their editor to write an article entitled "Tackling Your Tackle Box" for their fishing magazine. Their assignment is to write an article telling anglers which items to include in their basic tackle box and why these items are important. Students could also write and illustrate magazine advertisements for the items to be included in a tackle box. Then have students read the article "Let's Outfit a Tackle Box," from the July-August 2006 *Minnesota Conservation Volunteer* magazine, which is available online at mndnr.gov.
7 Have students bring in a bobber, favorite lure, or interesting piece of tackle. Have each student tell a story about the item. Where did they get it? What kind of fish did they catch with it? Was it handed down from a grandparent? Have students classify the items. They might classify them according to the type of fish they could catch, materials, colors, sizes, or types of gear. Decorate a tree (or bare branches) with the items and display it in the classroom—or string the bobbers or tackle on a monofilament line to hang along a wall.
8 Your students may want to bring their own tackle boxes from home to show and discuss in class.
9 Sorting and categorizing lures and gear can be related to periodic table activities. Elements are arranged in a certain type of order in the periodic table, just as lures and fishing tackle are grouped and organized according to the target fish species and fishing conditions.

For the Small Fry

K-2 Option

1 Place several tackle boxes around the classroom, each filled with safe and sturdy fishing equipment including bobbers, lures without hooks (or cover the hook points with masking tape), fishing line, plastic worms, needlenosed pliers, fish ruler, sunscreen, band-aids, fishing license, fishing regulations book. Next to the tackle boxes, place simple fishing rods (or jiggle sticks) and stuffed fish or fish models. Divide students into groups of four or five and have the groups investigate the contents of the tackle boxes. Ask students to discuss the contents, and how each item might be used. Have students act out the steps of fishing—applying sunscreen, checking fishing regulations, choosing a lure for a target fish or to match fishing conditions, tying on a lure, putting on a bobber and sinker, deciding where to cast, and so forth.

2 Give each student (or pair of students) an abbreviated or illustrated checklist, a fishing equipment mail order catalog, scissors, and glue. Have them cut out pictures of equipment and paste them to a sheet of paper to make a poster showing the contents of their tackle box.



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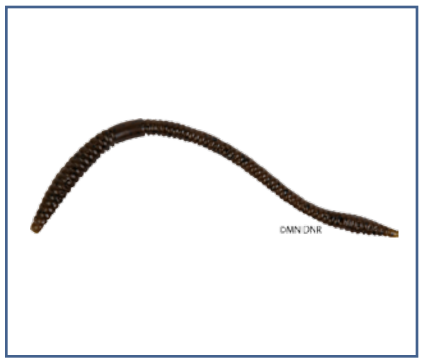
Tackling Tackle Checklist

Packed	Item
X	Tackle box
X	Bobbers
X	Split shot sinkers
	Hooks in container (appropriate sizes for target fish)
X	Fingernail clipper
X	Needlenosed pliers
	Live bait (appropriate types for target fish, may carry separately)
	Fishing lures (appropriate types and sizes for target fish)
X	Swivels and leaders
	Extra fishing line (appropriate sizes for target fish)
X	Knot-tying card
X	Practice casting plug
X	Measuring tape or ruler
X	Fish stringer
X	Whistle
X	First aid kit
X	Personal gear (sunscreen, hat, sunglasses, rain gear)
X	Small plastic bag for trash
X	Fishing license—applies to anglers age 16 and older (also trout stamp if fishing for trout or salmon)
X	Fishing regulations booklet
X	Lake or stream map, or fishing pier map
X	Camera (optional)
X	Hook sharpener

Tackling Tackle Cards



Tackling Tackle Cards

Line	**Jig**	**Crankbait**
Hook	**Plastic Worm**	**Surface Lure**
Split Shot Sinker	**Spinners Straight-line Spinner and Spinnerbait**	**Spoon**
Bobber	**Stringer**	

Tackling Tackle Cards

Comes in a variety of sizes or strengths. Use a lighter pound-test for smaller fish and a heavier pound-test for larger fish.	This heavy head on a hook may have a tail made of hair or soft plastic.	Has a lip that helps them dive. They imitate fish foods like minnows or crayfish.
Holds the fish to the line. Comes in different sizes. For best results, it should be sharp.	Pierce a plain hook into this soft plastic to catch a sunfish, walleye or—especially—a bass.	It floats on the surface of the water and imitates fish foods like frogs or insects.
Heavier than water, it helps the lure or bait drop underwater.	Named for the revolving blade attached to the lure.	One large metal blade wobbles through the water. One side is shiny and the other side is painted.
Suspends the bait or lure at a specific depth in the water.	Contains a fish while keeping it fresh.	

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Names ____

Fish Species ____

Tackling Your Tackle Box Price List

Item	Price	Cost	Why did you choose this item?
Hooks 			
10 Hooks, Size 10	$1.50		
10 Hooks, Size 8	$1.50		
10 Hooks, Size 6	$1.50		
10 Hooks, Size 2	$1.50		
10 Hooks, Size 2	$1.50		
10 Hooks, Size 1	$1.50		
10 Hooks, Size 1/0	$1.50		
Line 			
4-pound test line	$5.00		
6-pound test line	$5.00		
10-pound test line	$6.00		
12-pound test line	$6.00		
20-pound test line	$7.00		
Jigs and Plastic Baits 			
Jighead, 1/16 oz	$0.25		
Jighead, 3/8 oz	$0.25		
Jighead, 1 oz	$0.25		
			
Jigtail, 2 inches	$0.20		
Jigtail, 3 inches	$0.20		
Jigtail, 4 inches	$0.20		
Total Cost, Page 1			

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Names ____

Fish Species ____

Tackling Your Tackle Box Price List

Page 2

Item	Price	Cost	Why did you choose this item?
Plastic Worm, 5 inches 	$0.35		
Spinners 			
Straight-line Spinner, size 0	$2.60		
Spinnerbait 			
Spinnerbait, 1/16 oz	$2.00		
Spinnerbait, 3/8 oz	$3.50		
Spinnerbait, 1 oz	$5.50		
Diving Lures 			
Crankbait, 2 inches, shallow runner	$2.50		
Crankbait, 3 inches, shallow runner	$3.80		
Crankbait, 4 inches, shallow runner	$4.80		
Crankbait, 3 inches, deep runner	$3.80		
Crankbait, 4 inches, deep runner	$4.80		
Crankbait, 5 inches, deep runner	$6.00		
Crankbait, 7 inches, deep runner	$7.00		
Surface Lures 			
Surface Lure, 2 ½ inches, 3/8 oz	$3.50		
Surface Lure, 7 ½ inches, 2 ½ oz	$5.50		
Total Cost, Page 2			

STUDENT COPY

Names ____

Fish Species ______________________________________

Tackling Your Tackle Box Price List

Page 3

Item	Price	Cost	Why did you choose this item?
Spoons 			
Spoon, 1 3/8 inches, 3/16 oz	$2.30		
Spoon, 2 7/8 inches, ¾ oz	$4.80		
Spoon, 5 3/8 inches, 3 ¼ oz	$5.80		
Live Bait 			
Wax worms or grubs (1 dozen)	$1.50		
Worms (1 dozen)	$2.50		
Nightcrawlers (1 dozen)	$2.50		
Leeches (1 dozen)	$2.80		
Crickets (1 dozen)	$2.00		
Crayfish (5)	$2.75		
Crappie minnows - small (1 scoop)	$2.50		
Fathead minnows - medium (1 scoop)	$2.50		
Sucker or shiner minnows - large	$6.80		
Total Cost, Page 3			
Total Cost, Page 2			
Total Cost, Page 1			
Total Cost, All Pages			
Amount of change left over			

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Names ______________________________

Fish Species ______________________________

Tackling Your Tackle Box Price List

Page 4: Miscellaneous Tackle and Equipment

Item	Price	Cost	Why did you choose this item?
Tackle box (1 fold-out drawer)	$5.99		
Bobbers (3-pack)	$1.00		
Split shot sinkers (12 pack)	$1.00		
Fingernail clipper	$1.00		
Needlenosed pliers	$5.00		
Swivels (4-pack)	$1.25		
Leaders (3-pack)	$1.45		
Knot-tying card	$0.35		
Practice casting plug (2-pack)	$1.25		
Measuring tape or ruler	$12.00		
Fish stringer	$1.50		
Whistle on lanyard	$2.50		
First aid kit	$5.00		
Sunglasses	$15.00		
Hat	$5.00		
Sunscreen	$5.50		
Emergency rain poncho	$1.50		
Fishing license	$17.00		
Trout stamp	$10.00		
Single-use camera, optional	$5.00		
Minnow bucket and scoop	$6.00		
Fillet knife	$15.00		
Knife sharpener	$2.00		
Hook sharpener	$2.50		
PFD, vest type	$25.00		
Hook covers (25-pack)	$2.00		

Fish Information Cards

Sunfish
Mouth size: Small
Fish weight: Light
Fish length: Short
Primary habitat: Shallow water
Food preferences: Insects, worms, leeches, crickets, grasshoppers

Yellow Perch
Mouth size: Small
Fish weight: Light
Fish length: Short
Primary habitat: Shallow to mid-deep water
Food preferences: Small fish, worms, leeches, crickets

Crappies
Mouth size: Small to medium
Fish weight: Light
Fish length: Short
Primary habitat: Shallow to mid-deep water
Food preferences: Small fish, worms

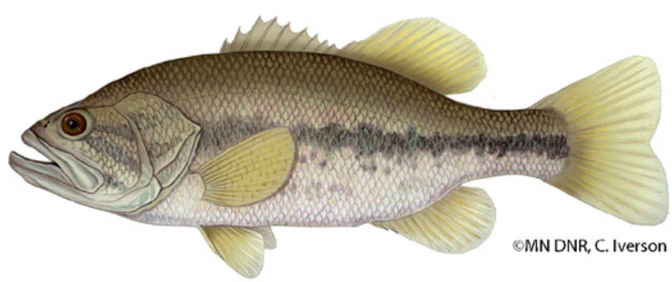
Stream Trout
Mouth size: Small to medium
Fish weight: Light
Fish length: Short to medium
Primary habitat: Shallow to mid-deep streams
Food preferences: Insects, small fish

Fish Information Cards

Bullheads
Mouth size: Small to medium
Fish weight: Light
Fish length: Short to medium
Primary habitat: Shallow to mid-deep water, likes bottom
Food preferences: Aquatic insects, worms, leeches, crayfish, snails, crickets

Walleye
Mouth size: Medium to large, with teeth
Fish weight: Medium to heavy
Fish length: Medium to long
Primary habitat: Deep water
Food preferences: Medium to large fish

Smallmouth Bass
Mouth size: Medium
Fish weight: Medium
Fish length: Medium
Primary habitat: Medium to deep water
Food preferences: Medium fish, insects, crayfish



Largemouth Bass
Mouth size: Large
Fish weight: Medium to heavy
Fish length: Medium to long
Primary habitat: Shallow to medium water
Food preferences: Frogs, medium fish, crayfish

Fish Information Cards

Catfish
Mouth size: Large
Fish weight: Heavy to very heavy
Fish length: Long
Primary habitat: Shallow to deep water, likes big rivers
Food preferences: Frogs, crayfish, large fish, decaying matter

Northern Pike
Mouth size: Large, with teeth
Fish weight: Heavy to very heavy
Fish length: Long
Primary habitat: Shallow to deep water
Food preferences: Large fish

Muskellunge
Mouth size: Large, with teeth
Fish weight: Heavy to very heavy
Fish length: Long
Primary habitat: Deep water
Food preferences: Large fish

Fish Tackle Cards

Sunfish
Hook size: 10
Line size: 4-pound test
Lures: Jig, spinnerbait
Lure sizes: 1/16 oz. jig with 2-inch tail, 1/16 oz. spinner bait
Live bait: Worms, wax worms, leeches, crickets, grasshoppers

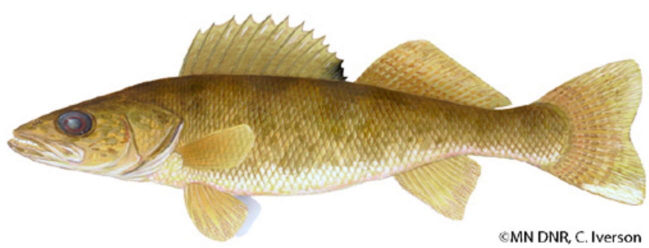
Yellow Perch
Hook size: 8
Line size: 4-pound test
Lures: Jig, spinnerbait
Lure sizes: 1/16 oz. jig with 2-inch tail, 1/16 oz. spinner bait
Live bait: Small minnows, worms, wax worms, leeches, crickets

Crappies
Hook size: 6
Line size: 4-pound test
Lures: Jig, spinnerbait
Lure sizes: 1/16 oz. jig with 2-inch tail, 1/16 oz. spinner bait
Live bait: Small minnows, wax worms

Stream Trout
Hook size: 6
Line size: 4-pound test
Lures: Jig, straight-line spinner, crankbait, spoon
Lure sizes: 1/16 oz. jig with 2-inch tail, size 0 spinner, 2-inch shallow runner crankbait, 3/16 oz. spoon
Live bait: Worms, hellgrammites

Fish Tackle Cards

Bullheads
Hook size: 2
Line size: 4-pound test
Lures: Lures not usually used
Live bait: Worms, leeches, crayfish, snails, crickets



Walleye
Hook size: 2
Line size: 6-pound test
Lures: Jig, Crankbait, spoon
Lure sizes: 3/8 oz. jig with 3-inch tail, 4-inch deep diver crankbait, ¾ oz. spoon
Live bait: Nightcrawlers, leeches, 2- to 4-inch minnows

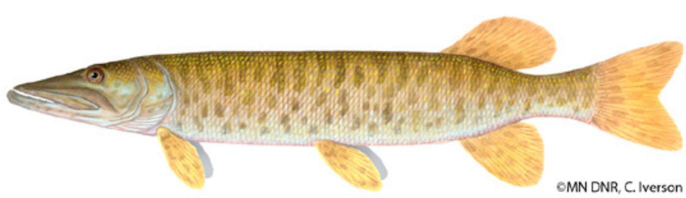
Smallmouth Bass
Hook size: 1
Line size: 6-pound test
Lures: Jig, plastic worm, spinnerbait, crankbait, surface lure
Lure sizes: 3/8 oz. jig with 3-inch tail, hook with 4-inch plastic tail, 3/8 oz. spinnerbait, 3-inch shallow or deep runner crankbait, 3/8 oz. surface lure
Live bait: Crayfish, 2- to 4-inch minnows, nightcrawlers, hellgrammites

Largemouth Bass
Hook size: 1/0
Line size: 10-pound test or higher
Lure sizes: 3/8 oz. jig with 3-inch tail, hook with 4-inch plastic tail, 3/8 oz. spinnerbait, 3-inch shallow or deep runner crankbait, 3/8 oz. surface lure
Live bait: Frogs, 3- to 6-inch minnows, crayfish, nightcrawlers

Fish Tackle Cards

Catfish
Hook size: 1/0
Line size: 10-pound test or higher
Lures: Lures not usually used
Live bait: Frogs, nightcrawlers, crayfish, live or dead minnows (small minnows for small catfish or 6 to 12-inch minnows for big catfish)

Northern Pike
Hook size: 1/0 or larger
Line size: 12-pound test or higher
Lures: Jig, spinnerbait, crankbait, surface lure, spoon
Lure sizes: 1 oz. jig with 4-inch tail, 1 oz. spinnerbait, 4- to 5-inch shallow or deep runner crankbait, 2 ½ oz. surface lure, ¾ oz. spoon
Live bait: 4- to 8-inch minnows



Muskellunge
Hook size: 1/0 or larger
Line size: 20-pound test or higher
Lures: Jig, spinnerbait, crankbait, surface lure, spoon
Lure sizes: 1 oz. jig with 4-inch tail, 1 oz. spinnerbait, 7-inch deep runner crankbait, 2 ½ oz. surface lure, 3 ¼ oz. spoon
Live bait: 6- to 12-inch minnows

Flashy Fish Catchers

It's been said that fishing lures are designed to catch anglers as well as fish!

Table of Contents

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Chapter 5 • Lesson 5

Flashy Fish Catchers

Minnesota Academic Standards

- Lesson *introduces* this Benchmark.
- Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.

Grade 3
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

Grade 4
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.

Grade 5
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

History and Social Studies

Grade 4—8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
II. Physical Science
C. Energy Transformation:
Benchmark 2—The student will know that light tends to maintain its direction of motion until it is absorbed, refracted or reflected by an object.
III. Earth and Space Science
C. The Universe:
Benchmark 3—The student will observe that the sun supplies heat and light to the Earth.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.

Grade 4
IV. Life Science
G. Human Organism:
Benchmark 1—The student will understand that humans have structures that serve functions in growth, survival and reproduction.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 5 • Lesson 5

Flashy Fish Catchers

Grade Level: 3-5
Activity Duration: two 55-minute class periods
Group Size: any
Subject Areas: Expressive Arts, Science, Language Arts, Social Studies, Environmental Education
Academic Skills: application, construction, experimentation, invention, listening, observation, small group work, synthesis
Setting: indoor or outdoor gathering area with tables
Vocabulary: adaptation, gorge, light quality, light quantity, light spectrum, lure, turbidity, wavelength
Internet Search Words: antique lure, fishing lure

Instructor's Background Information

Since the dawn of fishing, anglers have pondered which types of lures or artificial baits to use to attract fish. People have long practiced fishing as a means of subsistence. References to fishing and fishing implements occur throughout recorded history. One of the earliest depictions of fishing illustrates Egyptians fishing with rods, lines, and nets approximately 4,000 years ago. Another written account approximately 2,400 years old refers to silk line, a hook made from a needle, and a bamboo rod—with cooked rice as bait!

Selecting tackle to attract and catch fish has always been a primary concern for anglers. Some of the earliest fishing tools were pieces of bone or stone sharpened and used as a **gorge**. These were covered with numerous types of bait and tied to lines fashioned from a variety of readily available materials. A pull on the line wedged the gorge in a fish's throat—the fish was then pulled in with the line. Although North American native cultures had many available food resources, fish was extremely important. The techniques and tools used to catch fish varied widely and included gaffs, hooks, lines, sinkers, lures, floats, clubs, spears, harpoons, nets, and traps. *The Treatise of Fishing*, written in 1496 and attributed to Dame Julianna Berners, an Englishwoman, described fishing equipment and tackle and included instructions for making artificial lures and flies suited to the feeding behaviors of different types of fish. In 1653, Izaak Walton, another Englishman, wrote *The Compleat Angler*. This classic text—still in print—discusses the art of constructing tackle, the basic science of aquatic biology, and the philosophy of recreational angling. Walton spent many years observing fish in their natural habitats, using his observations to create detailed accounts of the feeding habits and life cycles of various species of fish. This knowledge also informed his ideas on tackle-making and fishing techniques.

Summary

Using their knowledge of fish senses, students design their own fishing lures for a selected target fish species and the water conditions that allow lures to work most effectively.

Student Objectives

The students will:

1. Name the senses fish use to locate prey (food).
2. Describe how the colors, sounds, and flashes of lures stimulate fish senses.
3. Describe how light is absorbed in water in terms of light quantity (brightness) and light quality (color).
4. Describe how water depth influences color perception.
5. Design and create a lure to attract a particular type of fish in specific habitat and water conditions.

Materials

Warm-up

- A variety of lures in different shapes, styles, and colors (or use the **Lure Types Reference Sheet**, if necessary)

Part 1: Investigating the Physics of Light and Color in Water

- One large, transparent jar of turbid (dirty) water
- One large, transparent jar of clear water
- Darkened classroom
- Light source (flashlight or projector lens)
- Prism
- A variety of underwater photos (from fishing or

continued

Materials (contined)

nature magazines) taken with natural light, including both close-ups and distance shots, to pass around and to display.

- **Underwater Light Quality Sheet**, one per student (or set up for projection)

Many of the materials used in this lesson can also be used in **Lesson 2:1—Design a Habitat.**

Part 2: Making Flashy Fish Catchers

- Lure blanks, one per student

Lure blanks are ¾-inch-diameter wooden dowels cut into three-inch lengths with eye screws placed in one end. Dowels are sold in three-foot lengths at hardware stores or lumberyards—you'll need to cut them into three-inch lengths.

- Fast-drying craft glue
- Pipe cleaners, various colors
- "Googly" eyes (plastic eyes used for crafts), two per student
- Sequins, various colors and sizes
- Sheets of self-adhesive Mylar in various colors; gold, copper, silver, and neon colors are suggested (Mylar is available in most art supply stores, or substitute foil-type wrapping paper)
- Colored feathers
- Assorted art scraps (cloth, tinsel, leather, plastic, ribbon, yarn)
- Scissors
- Books about fish and fishing (optional)

Fishing technology has evolved, but anglers still wonder which lures will attract the fish they want to catch. The more anglers and lure designers know about fish and fish behavior, the more effective the lures become.

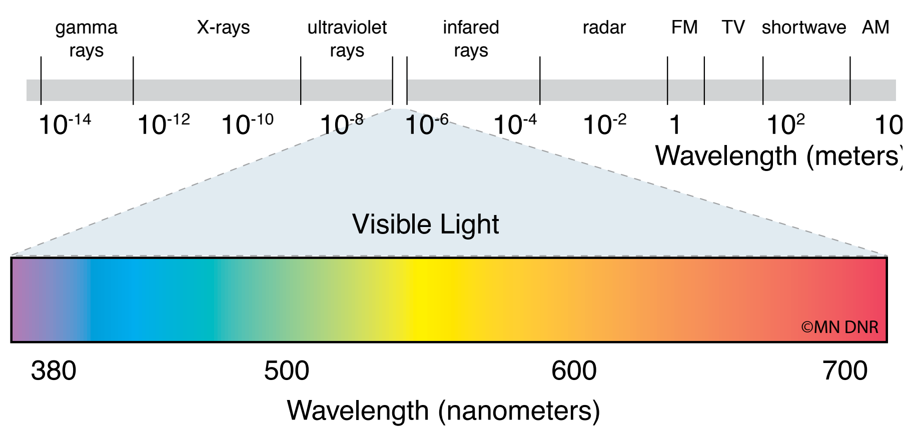
In lure design, some features to consider are color, flash, and sound. How do these features attract fish?

Fish use all of their sensory adaptations to find food. Signals sent by prey—or by lures—create stimuli in their eyes, ears, nose, taste buds, skin, or lateral lines. Hunger determines how fish react to the prey or stimuli-producing lures. Some fish species use some senses more effectively than others. This is connected to habitat conditions. A catfish, for example, will rely more on its keen sense of smell and taste than on sight due to the turbidity (solid particles suspended in water that scatter light rays) of its habitat.

Color

Anglers frequently wonder which lure colors best attract fish. Most fish have excellent vision and can perceive color, although fish don't have predisposed attractions to particular colors. Contrast is critical—contrast between the background and the color of the prey, food, or lure, under various water and light conditions.

To help students understand this concept, the following provides a brief introduction to the interaction of the physical properties of water and light, and the role they play in attracting fish.



The primary source of all energy on the earth is the sun. Sunlight consists of the entire electromagnetic spectrum. Visible light makes up just a small portion of the light spectrum. The **light spectrum** is made up of electromagnetic radiation from approximately 380nm (violet) to approximately 700nm (red). This is the visible range. Natural, or ambient, light is referred to as white light, but is actually a combination of all the colors of the rainbow, or spectrum of visible light. Blackness is an absence of light or complete absorption of light. Each color of light (red, orange yellow, green, blue, indigo and violet—abbreviated as

ROY-G-BIV) is composed of light waves (also described as packets or particles) of different wavelengths. **Wavelength** refer to the distance between two successive points of an electromagnetic waveform, usually measured in nanometers (nm). Red colors have the longest wavelengths and violets have the shortest wavelengths. Short wavelengths (violets and blues) have high energy; long wavelengths (reds and oranges) have lower energy.

When sunlight strikes an object, some of that light is reflected and some of it is absorbed by the object. The eyes of humans and fish detect reflected light—the colors that an object reflects are the colors seen. But light behaves differently in water than it does in air because water is approximately 800 times denser than air.

Water can be transparent, allowing light to pass though it, but even clear water absorbs some light. Two important factors affect color visibility in water. First, general water clarity impacts visibility and light penetration in water and is a consideration when selecting a lure color. The amount of light that penetrates water depends on its **turbidity**, or the amount of silt, sediment, dissolved minerals, and debris suspended in the water. **Light quantity** refers to brightness or intensity of light transmitted or absorbed through water. Materials in the water scatter and absorb light rather than reflecting or transmitting it. Colors that are very visible in clear water include chrome, white, and pearl, plus shades of gray, brown, green, blue, and purple. In water stained with tannic acid from decomposing plant material (or clouded with algae or sediments), chartreuse, orange, red, lime green, and pink provide more contrast. In very turbid or murky water, the brightest and most visible colors, such as fluorescent orange, red, and pink, are often required to consistently attract fish.

The second factor affecting color visibility in water concerns color wavelength and water depth. Light color refers to **light quality**. The different colors or wavelengths of light within the light spectrum are absorbed at different depths by water and sediment particles as the light travels through water. The longest wavelengths contain less energy and are absorbed by water and sediment particles first. That explains why colors, such as reds and then oranges, are the first to "disappear" or become less visible, as light penetrates to greater depths. Loss of the color red is already noticeable at twenty inches, and red starts to significantly fade at a depth of about eight feet. Red is completely absorbed or filtered from the visible light spectrum at approximately fifteen to twenty feet. Orange light begins to disappear at 30 to 40 feet. As fish swim progressively deeper, yellows are the next to become invisible to them; yellow colors disappear at 60 to 70 feet. Finally, only green and blue colors (the wavelengths with the highest energy) are left—they remain visible to the depth that light penetrates the water.

As different colors are absorbed at increasing depths, the overall light

Why do the air and sky appear blue?

Because blue light tends to bounce or scatter through air and water molecules.

See the **Underwater Light Quality Sheet** at the end of the lesson.

intensity also decreases. This means that the deeper a red lure is placed, the less bright its color appears. Red disappears at a depth of from fifteen to twenty feet. At depths greater than twenty feet, there's no advantage in using a red lure because it would appear to be blue and blend into the background, no matter how bright the light.

Time of day also determines how much light penetrates the water. When choosing a lure color, consider whether you'll be fishing at dawn, midday, or at night. A fish that is nocturnal and feeds at night will strike a different colored lure than a fish feeding during the day. Light-colored lures provide more contrast in dark water at night. Darker lures provide more contrast in clear water in daylight.

Flash

A quality closely related to color is flash. Many lures, such as spinners, crankbaits, and spoons, create considerable flash as the lure rotates or wiggles through the water. Silver, gold, brass, copper, and chrome spinners produce a flash that often attracts fish. The flash of a lure mimics the flash that might come from the silvery scales on the sides of a prey species such as a golden shiner or fathead minnow.

Vibrations or Sound

Fish also use their sense of hearing to help them find food. In addition to color and flash, it's important to determine if the prospective lure makes a sound that fish will associate with food. Fish have a bundle of sensory and supporting cells with projecting hairs encased in a gelatinous cap, called the **lateral line**, that run the length of their bodies. This sensory organ is an adaptation that allows them to detect very slight vibrations in the water. Predator fish can sense vibrations produced some distance away by potential prey such as smaller fish, crayfish, or other invertebrates moving in the water.

Lures such as spinners or poppers allow the angler to choose not only color and flash, but also lures that produce sounds that mimic wounded minnows or frogs. Spinner baits are used to attract fish in shallow or medium-depth water. They usually have one or two blades that spin and wiggle on swivels attached to the lure, sending vibrations through the water. Poppers are surface lures that are pulled along the surface of the water. They resemble insects or frogs and can be used for all species, particularly sunfish, bass, northern pike, and muskellunge. Their flat or scooped-out fronts splash as they're jerked across the water. Fish hear these lures, or sense the vibrations—even when they can't see them.

Movement

The purpose of using lures is to mimic the appearance and behavior of prey, enticing fish to strike and take the lure. Various dressings are added to lures to control sink rates, action, and movement. Hair, feathers, fur, soft plastic tails, rubber legs, and metallic tinsel are used to imitate wiggling worms, minnows, insects, leeches, frogs, or other kinds

Fly fishing anglers often tie intricate lures with feathers, fur, tinsel, and yarn to make lures that imitate insect prey.

of potential fish food. Some lures are designed to dive, wiggle, sink, or float, depending on the fish food they're supposed to resemble.

Odor and Flavor

Several kinds of fish rely heavily on their senses of smell and taste to find food. There are many soft plastic lures on the market today that are impregnated with scents, so they taste or smell good to a fish, too. A variety of scents can also be sprayed on any lure to add extra allure for stimulating fish senses.

By appealing to a variety of fish senses, an angler increases the chance that fish will not only notice lures, but bite them. Tackle companies have designed a staggering array of lures of many sizes, shapes, and colors made from many kinds of materials. With a well-chosen assortment of artificial lures in the tackle box, anglers are free to head to the lake or river without stopping for live bait. When they're done fishing, they don't have to deal with leftover bait. In some areas, such as select trout streams, using live bait is illegal, and lures are the only choice. As effective and appealing as lures can be, though, depending on conditions, there are many times when live bait will produce the best results. To be successful, anglers must get to know their target fish by learning its adaptations, habits, and behaviors, and by considering water conditions and temperature along with the amount of vegetation and woody debris in lakes, ponds, streams, and rivers.

Procedure

Preparation

1 Gather materials.
2 Gather in a room with tables and chairs. An art classroom works well.

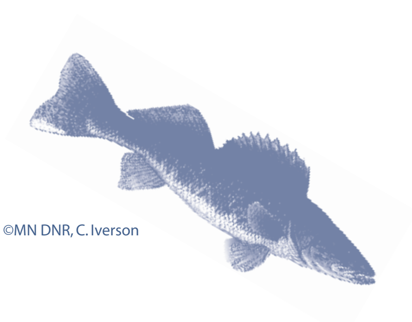
Activity

Warm-up

1 Ask students to review their five senses and compare them to those of a fish. Cover sight, smell, taste, touch, hearing, and the lateral line. Discuss how the lateral line contributes to a fish's ability to detect vibrations and what this means in terms of locating food. Drawing a fish on the whiteboard and labeling these parts as students discuss them can reinforce this information. Refer to **Lesson 2:1—Fish Sense** for additional information about fish senses and the lateral line.
2 Display a variety of fishing lures that you've borrowed or purchased. Include lures of different sizes, shapes, styles, and colors. Have students describe how these lures might stimulate a fish's appetite, or ask why a particular lure might be appealing to a particular fish. Use the **Lure Types Reference Sheet** to guide the conversation. Ask the students what could be significant about a lure's color.

You may prefer to do Step 2 of the Warm-up as a Wrap-up instead. This could leave the creative process more open when the students design their own lures. Students will have an opportunity to devise their own strategies for attracting fish that can then be discussed as a backdrop or set the stage for a Wrap-up discussion on fish adaptations, including senses and food preferences.

Students will learn more about the physics of light and color to help them learn how to correctly select lure colors when they go fishing. You can tailor the introduction to the lesson based on the background knowledge of your students.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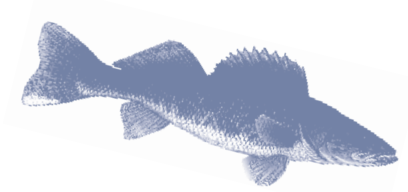
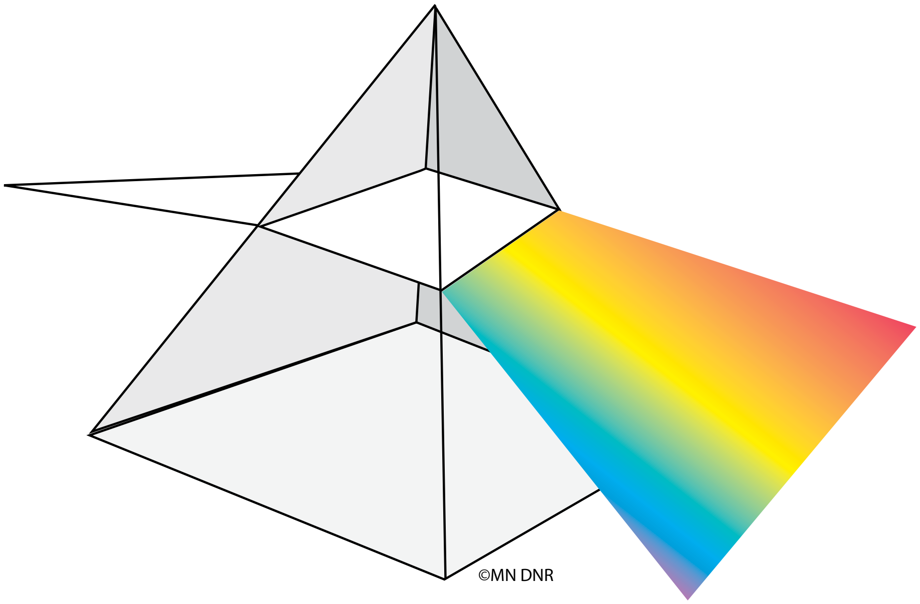
Remind students that, like people, fish can perceive color. Encourage them to start thinking about how they might design more effective lures than the ones displayed.

Lesson

Part 1: Investigating the Physics of Light and Color in Water

1. Divide the class into groups of no more than four students. Tell them that they'll be investigating one aspect of designing lures in more detail before they design their own. The color of lure to use is a common decision that anglers must make.
2. Have the students ever looked at a rainbow and wondered about the colors? A prism, a transparent object with two non-parallel flat sides, separates the various colors that make up natural (or white) light. A prism will create your own rainbow in the classroom. Ask students: What is the main source of light on earth? Discuss with the students how they see an object: the light bounces off the object and is reflected or transmitted to their eyes. Do they know that the color of an object is determined by which colors, or wavelengths, of light the object reflects? Review the difference between quantity of light (brightness or intensity) and quality of light (colors). Natural (white) light is made up of all the colors of the visible light spectrum.
3. To demonstrate light quality: prepare the students before you darken the room.
   - Tell them that you'll be making the room dark for the next demonstration.
   - Make sure the classroom is as dark as possible for the clearest results.
   - Shine a light (flashlight or projector light) through a prism.
   - Then turn off all of the other lights in the room.
   - Ask the students what colors they see. What is the order of the colors in the spectrum?
   - Have the students write the names of the colors in the order that they observe them.
   - Teach students the acronym ROY-G-BIV (Red, Orange, Yellow, Green, Blue, Indigo, Violet) to help them remember the colors of the light spectrum.
   - Explain that these colors are referred to as a light spectrum. When white light passes through a prism, it separates or refracts the white light into its component colors and arranges the different colors in order by wavelength and energy. A prism helps demonstrate that all the colors of the light spectrum combine to form white light. (Be aware of any participants that may have color blindness—they may not see red and/or green or yellow and/or blue.)



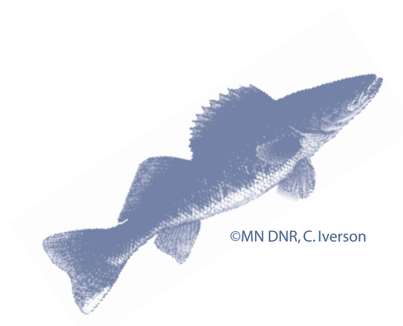


Light refracted through a prism results in a light spectrum.

4 Ask students if it would be a good idea to use a gray or blue lure in a lake or river with turbid water. (No. These colors are more visible in clear water because they contrast more sharply with the background and bottom of the water body). In water stained with tannic acid from decomposing plant material or clouded with algae or sediments, a lure of a brighter color is even more effective in attracting fish. Chartreuse, orange, red, green, and pink stand out in darker water. In very turbid or murky water, the brightest colors, such as fluorescent orange, red, and pink, are often required to consistently attract fish.

5 Pass around several underwater photos taken under natural light. Some photos can include objects in closer view that may show brighter colors in the objects in the foreground, but the objects in the background will show in hues of blue: the photographer may have used a flash to enhance the colors. Some photos can be underwater distance shots where everything looks blue. Ask students to consider what they know about light and colors that might explain the differences in the photos. (Colorful close-ups, blue backgrounds). (The water is absorbing more colors and reflecting or transmitting only blue from a distance, and light quality (or color) is changed as it is reflected or transmitted through the water.) Ask students if they can recall where blue light appeared on the light spectrum. Explain that light with short wavelengths (blues and violets) has the most energy and travels furthest through the water. What color might travel the shortest distance through the water, and be absorbed by (or disappear from) the water first? Why? (Red, because it's on the long wavelength side of the light spectrum, is absorbed by sediments and water first, and has less energy.)

6 How do fish see colors in water? They perceive colors in much the same way we do. But, light behaves differently in water than it does in air.



- To demonstrate light quantity: show students the jar of clear water and the jar of turbid water. (The turbid water could be tap water with enough tea added to cloud it.)
- Put a sheet of white paper behind each jar. Tell the students that you're going to shine a light through each jar.
- Ask the students to predict which reflected light will be brighter (more intense). Refer to quantity of light that will pass through the jars of water.
- Can the students identify what might cause water to be turbid in a lake, river, or stream? They may discuss this in their groups.
- Lead the students in a class discussion to help them understand that the particles suspended in the water absorb some of the particles of light, reducing the amount of light that is reflected or transmitted through the jar.

7 Explain how the different colors of the light spectrum are absorbed at different depths in water.

8 Pass out the **Underwater Light Quality Sheet** to each student, or project the image for students to see. Red is absorbed first, at the shallower depths, because it has a long wavelength—and less energy—than the other colors in the spectrum. Red is completely absorbed at a depth of about fifteen to twenty feet. Would it make sense to use a red lure if you were fishing for walleyes in 25 feet of water? Why or why not? What would be a good lure color to use in 25 feet of water? Why? (Yellow, green, or orange. Those colors are still visible at a depth of 25 feet.)

9 On a fishing trip, it's important to know about the quality of the water (clear, murky, or turbid) where you will fish, how light behaves in water of different depths, the behavior of your target fish (including what they eat and their preferred depths), weather conditions, and the time of day and year of the trip. By keeping track of fishing conditions, anglers can choose the most effective types, colors, and sizes of lures.

10 It's important to remember that, no matter how scientifically the lures have been selected, fish sometimes have their own ideas about what they're interested in chasing and biting. You might have to try a few different colors or types of lures to see what works best. Experienced anglers know that, on any given day, one lure works better than another—for reasons we can't always discern.

Part 2: Making Flashy Fish Catchers

1 Ask students to choose the species of fish they'd like to attract with their lure. They should know something about what that fish eats and what kind of habitat it prefers.

2 You may place several books about fish and fishing on a table in the room. Students can refer to these for information about the type of fish that they're designing their lure to catch. If students have already made fish habitat dioramas in **Lesson 1:1—Design a Habitat**, they can design a lure to catch the type of fish for which they designed their habitat diorama.


©MN DNR

A flashy fish catcher.

3 Many anglers have thought they could design a "better lure." Tell students that they've taken jobs with a tackle manufacturer. They get to research fishing in rivers and lakes to learn about fish and fish habitat. (Their resource materials are available on the table). They can use the information they find about the behaviors and habits of their fish, what they know about fish senses, and what they've learned about light and color in water to design a new lure for the their chosen fish.
4 Give one wooden dowel and one set of "googly eyes" to each student for their lures.
5 Give students time to go to the materials table to collect things to use for their lures. Encourage them to be creative and to make their lure unique, thinking of the senses of the fish and how their lure might attract their fish by appealing to one or more senses. Students can also use paint in the design of the lures if other materials are not available to glue or attach to the wooden plug.
6 Optional: have students give their new lures catchy names to attract anglers in the sporting goods store!

Wrap-up
1 Have the students present their lures to the rest of the class. They should discuss the characteristics of their lure that will stimulate a fish to eat it. How do different parts of the lure attract the fish? Why did they use these materials on their lures?
2 Ask the students the following questions as part of the wrap-up.
Fish use the following senses to find food:
a) internal map and compass
b) sight, smell, hearing, lateral line
d) a stomach rumble
(Answer: b)
Which color is easiest to see in deep water?
a) yellow
b) blue
c) red
d) green
(Answer: b. The other colors will "disappear" first in shallower water depths.)
Why do lure manufacturers use flashy silver and gold in their lure designs?
a) silver and gold are cool colors
b) fish think that the flash comes from a minnow
c) these colors work better than copper
d) fish can't smell silver or gold metal
(Answer: b)

Assessment Options

1 Evaluate the characteristics of the students' lures and presentations.
2 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

17-19 points = A
Excellent. Work is above expectations.

14-16 points = B
Good. Work meets expectations.

10-13 points = C
Work is generally good. Some areas are better developed than others.

8-9 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-7 points = F
Work is unacceptable.

Flashy Fish Catchers Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Presentation names those characteristics of created lures that stimulate a fish to want to eat it.
4	______	______	Presentation includes how various parts of the lure attract the fish.
3	______	______	Presentation includes an explanation of why student used various materials to make the lure (to mimic scent, color, sound, flash, or taste) and how the lure relates to fish senses.
2	______	______	Materials used to create the lure actually mimic the student's desired outcome.
2	______	______	Voice strength was good; presentation was easy to hear.
2	______	______	Visuals were easy to see and supported presentation.
2	______	______	The presentation length was equal to the time limit given.
Total Points			
19	______	______	**Score** ______

Flashy Fish Catchers Scoring Rubric

Lure Presentation Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Content	Presentation includes the characteristics of the lure that stimulate a fish to want to eat it and how the different parts of the lure attract the fish.	Presentation includes 75% of required information.	Presentation includes half of required information.	Presentation contains less than half of required information.	Presentation doesn't demonstrate understanding of concepts.
Materials	Presentation includes why student used various materials on the lure (to mimic scent, color, sound, flash, or taste) and how the lure relates to fish senses. Lure actually mimics the student's desired outcome.	Presentation includes why student used various materials on their lure (to mimic scent, color, sound, flash, or taste) and how the lure relates fish senses. Lure slightly mimics the student's desired outcome.	Presentation includes why student used various materials on their lure (to mimic scent, color, sound, flash, or taste) and how the lure relates fish senses. Material doesn't mimic the student's desired outcome.	Presentation doesn't address why materials were used on the lure.	Materials not discussed in the presentation.
Presentation style	Voice strength good. Visuals easily seen. Presentation length equal to the time limit given.	Voice strength good. Visuals okay. Presentation length slightly under or over the time limit given.	Voice too soft or too loud. Visuals hard to see. Presentation shorter than the time limit given.	Voice too soft to hear. Visuals difficult to see. Presentation shorter than the time limit given.	Presentation not understandable or not completed.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Fill a small child's swimming pool outside or walk to a local pond, lake, or swimming pool. Attach a fishing line to the eye screw and try each student's lure, pulling it through the water to see how it moves. Notice that the lure looks different now that it's wet. How did the lure move through the water? If you try this, it is a good idea to make sure the students construct waterproof lures. You may need to use water-resistant glue. (You can also do this with commercial fishing lures, even with the hooks removed.)

2 Design an experiment to test the students' lures in certain fishing conditions. The experiment should include a hypothesis, a question, a procedure to test the hypothesis, an explanation of what the experimental variable is, and a description of the controls.

3 Have students design an ad campaign to market their lures to anglers. They can design a poster to display in a sporting goods store, a radio or television commercial, a magazine ad, or packaging for their lures.

4 Invite a local fish decoy carver or someone who makes lures, jigs, or flies to do a demonstration for your class. Ask them to discuss their trade or hobby, and why they use certain colors and markings.

5 There are numerous tackle manufactures based in Minnesota. Ask students to research a local tackle manufacturer to find out how many people the company employs, what kind of tackle they make, and how they make tackle. Ask a company representative to come to your class and talk about the considerations that go into the making of their fishing lures.

For the Small Fry

K-2 Option

Before passing lures around, be sure to remove or cover any hooks with tape.

Keep the lure-building activity simple. Omit Part 1: Investigating the Physics of Light and Color in Water. Remind younger students that fish use their senses to find food. What senses do fish have? Emphasize that lures attract fish by resembling foods that fish like to eat. Show students a variety of different lures and discuss how these might attract fish and which senses the fish would use to detect the lures. Be sure to remove or cover any hooks with tape before passing them around. Younger children may have a difficult time working on the scale of the one- by three-inch wooden dowel to design their lures. You might substitute an empty toilet paper roll or other cylindrical item for the children to paint and attach materials to design their lures. Students can share how their lure would attract fish, what type of fish food it mimics, and how it would work to catch fish.

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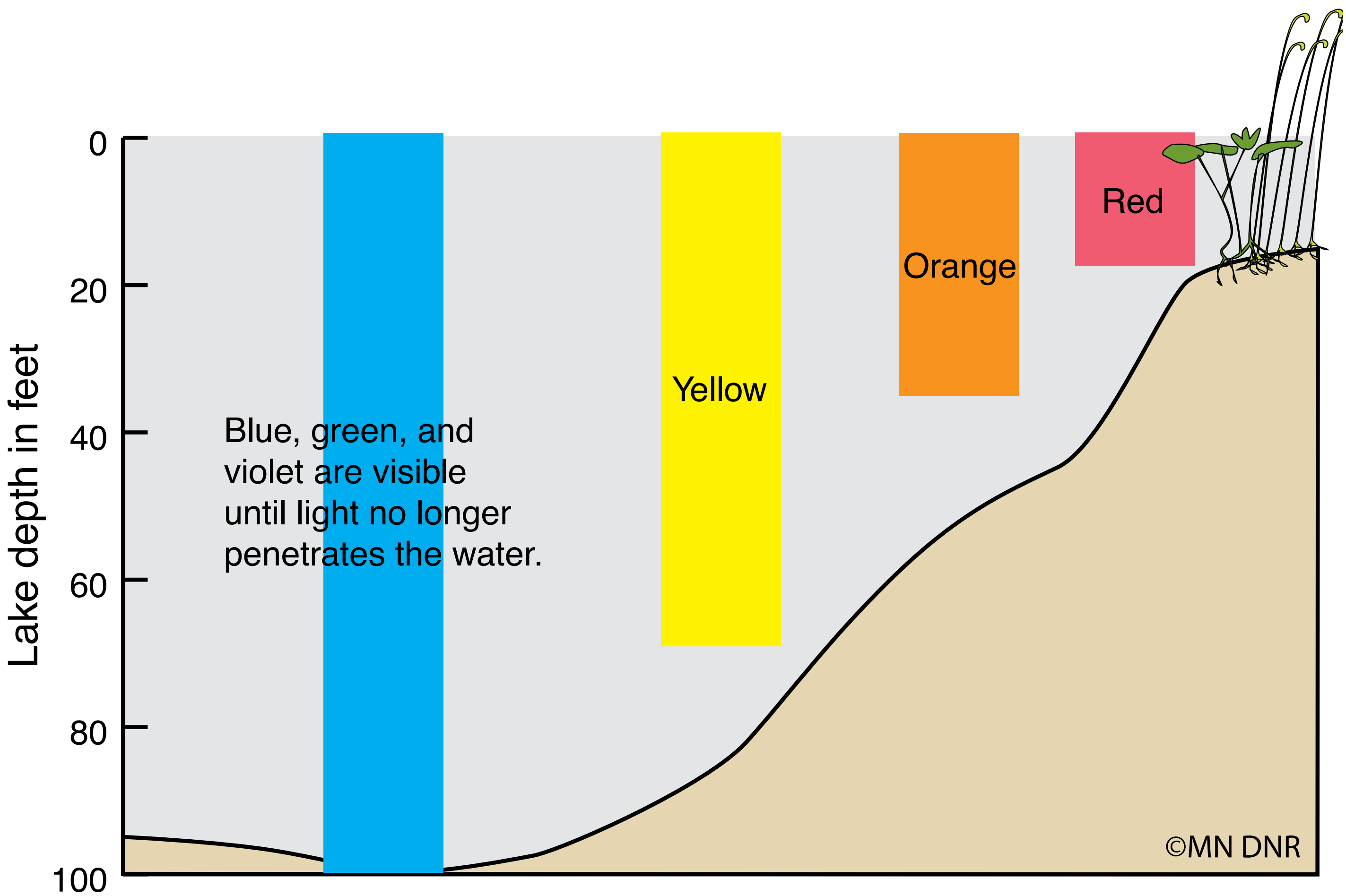
Underwater Light Quality Sheet

What Color Lure Should I Use?



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Lure Types Reference Sheet

Color, flash, vibration/sound, and movement can attract fish to lures.
Lures shaped like natural foods also attract fish.

Spinner
Color: May have colorful fur, feathers, or paint
Flash: Flash on blade
Vibration/sound: Blade makes a soft sound in the water as it spins
Movement: Blade moves, fur or feathers add movement as it's jerked through water

Spoon
Color: Bright colored paint catches the fish's eye
Flash: Shiny surface reflects sunlight and makes a "flash"
Vibration/sound: Wobbling creates soft sound
Movement: Spoon shape wobbles through water

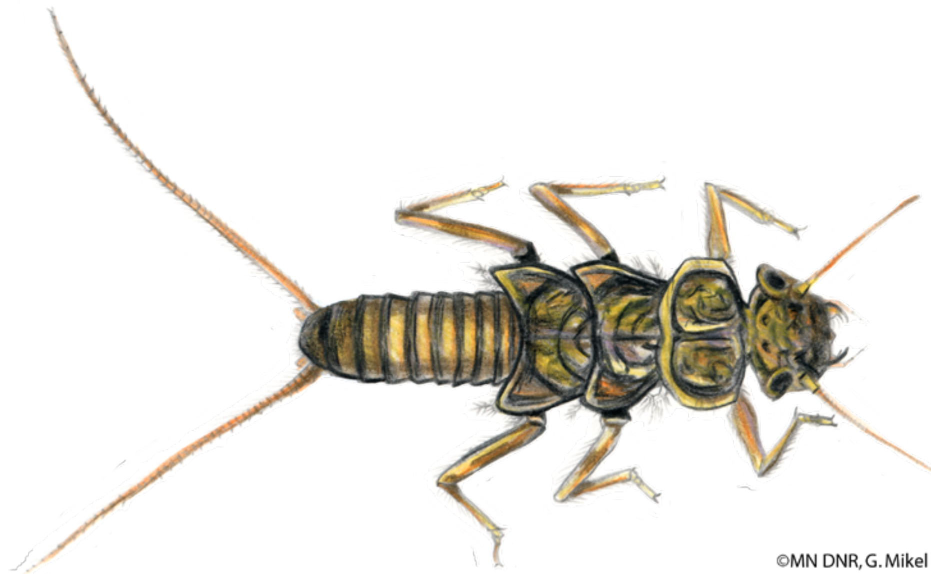
Popper
Shape: Shape has head separate from body
Color: Paint looks like frog; has eyes; skirt is bright
Vibration/sound: Scooped-out front makes splashes and noise as it's jerked along the surface
Movement: Body floats on the surface like a frog's; skirt moves like legs

Crankbait
Shape: Shaped like a fish
Color: Often painted to imitate the patterns and colors of baitfish
Flash: Some sides silver, gold, or iridescent to reflect light and resemble scales
Vibration/sound: Some types rattle
Movement: "Nose" or bib angle determines how deep the lure will travel

Mayfly Nymph (A type of fly pattern)
Shape: Distinct head, thorax, abdomen, legs, and gills resemble a mayfly nymph
Color: Closely imitates the color of a mayfly larva
Flash: Some have a shiny bead head
Movement: Resembles the insect as it's jerked through the water

Fool Fish With Flies

A dinner bell for fish, the pitter-patter of teensy flapping insect wings signals a heavy hatch.



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Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Chapter 5 • Lesson 6

Fool Fish With Flies

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent thinking.

History and Social Studies

Grade 4-8
V. Geography
D. Interconnections: Standard:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 3
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
D. Heredity:
Benchmark 2—The student will identify similarities and differences between parent and offspring.

Grade 5
IV. Life Science
F. Flow of Matter and Energy:
Benchmark 2—The student will use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 5 • Lesson 6

Fool Fish With Flies

Grade Level: 3-5
Activity Duration: 30 minutes
Group Size: at least 4
Subject Areas: Science, Language Arts, Social Studies
Academic Skills: listening, matching, recognition, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: abdomen, antennae, complete metamorphosis, dry fly, exoskeleton, flies, incomplete metamorphosis, larva, life cycle, molting, nymph, nymph pattern, pupa, spiracles, thorax, wet fly
Internet Search Words: metamorphosis, fly fishing, fly tying

Instructor's Background Information

Flies are small, lightweight, artificial lures that often resemble the insects or small fish that other fish eat. Early flies were made from natural materials, including fur, feathers, and wool yarn tied to the shank of a hook with silk thread. As anglers learned more about the habitats and food preferences of the fish they sought, they used the information to their advantage, making flies that more effectively enticed fish to bite. As technology and new materials have resulted in lighter rods, reels, and line, there have also been advances in artificial fly tying materials, with the introduction of products such as tinsel, synthetic yarn, foam, thin pieces of rubber, and glue. Even though materials have changed, the basic intent remains the same: to create a lure that mimics a fish's natural food, and to present it in a natural way. The more anglers learn about what fish eat, the greater their success in fooling a fish into biting.

Parts of an Insect
Some fish are extremely particular about what they will bite, so flies must closely resemble the foods fish prefer. Many fish eat a variety of insects. Fish often react first to the general body shape, or silhouette, of an insect, which includes its body parts. An insect's body has a hard **exoskeleton**, a shell-like structure on the outside of the body. The body is comprised of three parts: the head, thorax, and abdomen.

Summary

When fly anglers research the conditions of their fishing lakes and streams, they also study the life cycles of the aquatic insects living in those waters. This helps them determine which flies to use as lures, based on which species are hatching ("match the hatch") and the life cycle stages of the insects that the fish are likely to bite. In this lesson, students learn about the life stages and body parts of various aquatic insects, and play a game of Go Fly Fish to become familiar with some dry flies and nymphs and the aquatic insects they imitate.

Student Objectives

The students will:
1. Restate the life cycle of an insect.
2. Differentiate between complete and incomplete metamorphosis.
3. Diagram the external anatomy of an insect.
4. Identify the three basic fish flies and describe the purpose of each.

Materials

- **Parts of an Insect Sheet**
- **Aquatic Insect Life Cycles Sheet**
- **Fly Types Sheet**
- Examples of flies, especially dry flies and nymphs (optional)
- **Go Fly Fish Cards**

See the **Parts of an Insect Answer Sheet** for an illustration.

Head

Many insects' heads are dominated by two compound eyes oriented upward and to the sides. Each compound eye is composed of thousands of individual lenses, or facets. The front of the head has mouthparts that help the insect either chew or suck, depending on its diet. The **antennae** extend from the upper portion of the head, usually pointing forward. Insect antennae don't detect sound—they're sensory appendages used for touching, tasting, and smelling. From species to species, antennae vary widely in shape, length, and thickness.

Thorax

The **thorax** is usually the widest portion of an insect's body. It's located directly behind the head. The legs and wings are attached directly to the thorax. Insects have six legs, each consisting of jointed sections. Insect species have many kinds of specially adapted legs, which allow them to walk, perch, swim, scoop and otherwise handle prey, and even groom their eyes and faces.

Insect wings have many shapes and sizes as well. Some adult insects have two wings. Others have four, which are paired. Some wings are clear and others are colored. Some are as fragile as dried leaves and some are as hard as wood. Insects use their wings for flying, and as a visual display or a signal to other insects.

Abdomen

The **abdomen** contains the digestive tract. In most orders of insects, the abdomen contains eleven segments. Unlike other arthropods (including insects, crustaceans, spiders, scorpions, and centipedes), adult insects have no legs on the abdomen. Some larval, or immature, insects have appendages, referred to as pseudo-legs, or prolegs, on their final abdominal segment. These allow them to grip plants and sticks as they move.

Insects have no lungs. Adult insects breathe through spiracles, which are special openings in the side of the abdomen. Air enters the spiracles into the body through a series of smaller, branching pipes called tracheae. Many aquatic insect larvae have gills that work much like the gills of a fish to collect oxygen from the water. The adult forms of aquatic insects that spend their lives underwater, such as water beetles, don't have gills, and must go to the surface to capture an air bubble before diving underwater to search for food.

Life Cycles

Insects develop from egg to adult during the various stages of their life cycle. A fish may be attracted to a particular species of insect at a certain stage of its life cycle, or at a particular time of year. One of the challenges of fly fishing is to select the right fly (resembling the correct life stage) and knowing what interests the fish. This is why it's important to know about the developmental stages of insects when you're fly fishing.

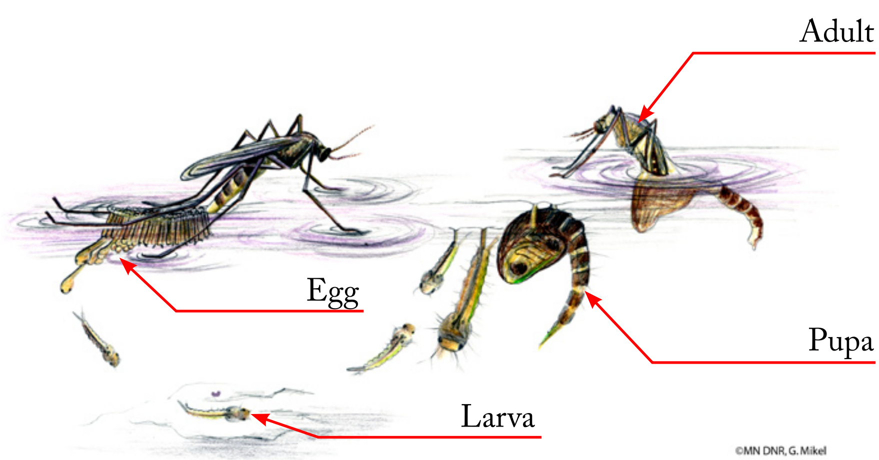
Molting

When an insect hatches from the egg it can usually survive on its own, but it is small, wingless, and sexually immature. Its primary purpose is to eat and grow. If it survives, it will periodically outgrow, shed, and replace its exoskeleton during a process called **molting**. As the insect grows larger, other physical changes occur inside the exoskeleton—wings grow, for example. When the exoskeleton becomes too tight, a release of hormones triggers molting. In some insect species, the number of molts is constant, but in other species the number of molts varies in response to temperature, food availability, or other environmental factors. When an insect reaches the adult stage, growing stops and it no longer molts.

Metamorphosis

Insects go through dramatic changes in the shape and function of their body parts as they mature. When an insect hatches from its egg, it follows one of two pathways of development. Each pathway is referred to as a metamorphosis. **Metamorphosis** in insects can be defined as the changes in form and lifestyle occurring during stages of development that lead to maturity.

Insects develop through either complete or incomplete metamorphosis. **Complete metamorphosis** has four stages: egg, larva, pupa, and adult. Complete metamorphosis is most commonly illustrated by the familiar changes that occur during the life cycle of a butterfly, which develops from egg to larva (caterpillar) to pupa (cocoon) to adult. The larval and pupal stages are quite different in form from the adult stage. Some aquatic insects, such as caddisflies and mosquitoes, undergo complete metamorphosis.



During the process of complete metamorphosis, the mosquito matures from egg to larva to pupa to adult.

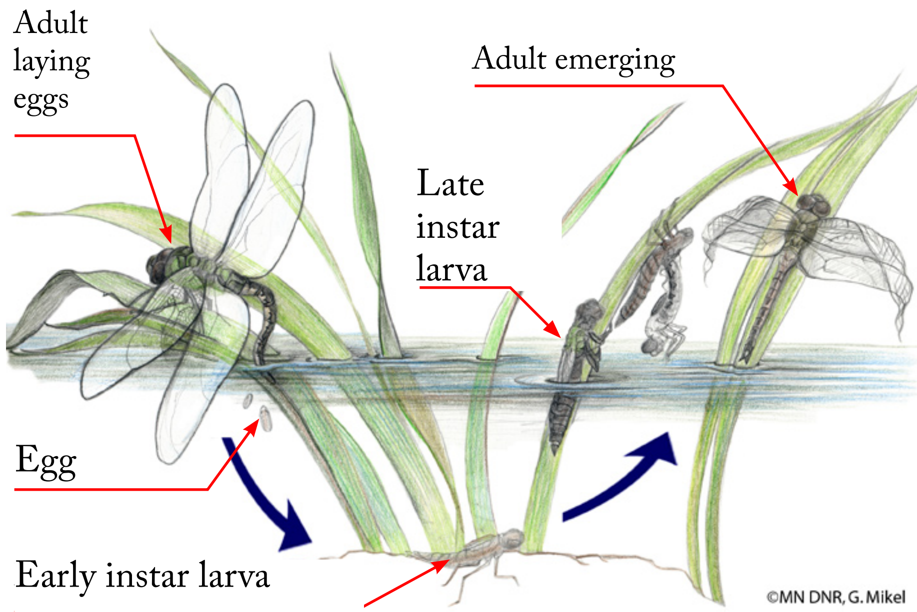
Larva or Nymph?

Technically, **larva** is the term that describes the juvenile stage of insects that develop through complete metamorphosis. **Nymph** is a term often used (rather than larva) when the juvenile insect more closely resembles the adult stage of insects that develop through incomplete metamorphosis. In fly fishing literature, however, you may see the terms larva and nymph used interchangeably.

Duns and Spinners

The metamorphosis of mayflies includes two adult stages. A dun is a sub-adult newly emerged from its juvenile stage. Because their wings lack blood, duns are often pale-colored. The dun molts into a spinner, or adult. Adults mate, return to the water to lay eggs, and die.

Incomplete metamorphosis is simpler and has three stages: egg, larva, and adult. With incomplete metamorphosis, the organism looks like a mini-adult when it hatches from its egg, and is called an **early instar larva**. As the larva grows larger, it more closely resembles the adult form of the insect, and is referred to as a **late instar larva**. Dragonflies are aquatic insects that develop by incomplete metamorphosis. They spend most of their lives as aquatic early and late instar larvae. When a dragonfly larva reaches maturity, it leaves the water, crawls out on a plant or tree trunk, and molts its exoskeleton for the last time. Its wings, which have grown slowly, unfurl and fill with blood. When the wings harden, the dragonfly flies away for the remainder of its relatively short adulthood.



During the process of incomplete metamorphosis, the dragonfly matures from egg to larva to adult.

Complete Metamorphosis	Incomplete Metamorphosis
Mosquito	Stonefly
Caddisfly	Mayfly
Black fly	Damselfly
Cranefly	Water boatman
Midge	Backswimmer

Fish Eat Aquatic Insects

All fish eat invertebrates, particularly aquatic insects, during some part of their lives. This stands to reason because the young fish have small mouths and can't eat larger prey. An early diet of crustaceans and insects helps small fish gain valuable nutrients that allow them to grow quickly. Rapid growth is an important survival mechanism because larger fish are less likely to be eaten by other fish. Some fish, such as trout, sunfish, and minnows, will feed on invertebrates their entire lives. Others, such as northern pike, walleye, and bass, switch to a diet consisting primarily of smaller fish.

Fishing Flies Resemble and Mimic the Motions of Aquatic Insects
Flies are categorized according to the types of fish foods they're intended to imitate: aquatic insects, terrestrial insects, crustaceans, frogs, eggs, and baitfish. The following flies resemble aquatic insects.

Dry Flies
A **dry fly** imitates an insect that has just emerged from the water in its transformation to an adult. It may also be an adult that has landed on the water to lay its eggs. These flies are made of lightweight, buoyant materials that don't readily absorb water, which is why they're described as "dry."

Wet Flies
Injured, struggling, or swimming insects attract fish because of their movement in the water. A **wet fly** is made from materials that absorb water. This allows them to to sink below the water's surface. Examples of wet flies are an emerging larva, a diving adult, or a drowning adult that has finished laying its eggs. Often, wet flies don't resemble a particular insect species.

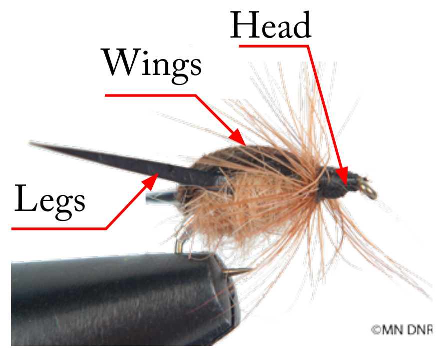
Nymph Patterns
Aquatic insects spend all or most of their life in the water. Typically, their entire immature life is spent underwater. Nymph patterns are created to resemble the larval forms of aquatic insects, particularly mayflies, stoneflies, and caddisflies. They're made of materials that absorb water, so they sink.

Tying Flies
Tying flies is a hobby for those who fly fish. Fly anglers like to have the flexibility to match their flies to the insects abundant in a stream at any given time. Based on stream experiences, anglers create flies that mimic insects and other invertebrates.

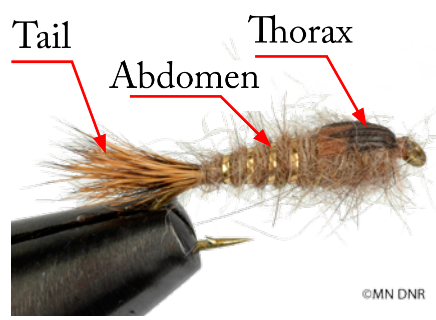
Fly tyers use special tools on their workbench. Basic tools include a vise to hold the hook, bobbins to hold the thread, and small scissors. Fly tyers use natural and synthetic materials for tying flies. Some materials include feathers, fur, wire, thread, tinsel, foam, and glue.

There are many good books and manuals with instructions and step-by-step pattern details for tying flies. Local sport fish groups or bait shops also offer fly tying courses.

Dry flies float, mimicking sub-adult and adult aquatic insects.



Wet flies sink. They don't necessarily imitate an organism.



Nymphs sink. They imitate immature forms of underwater aquatic insects.

A hatch occurs when a large number of insects of an aquatic species emerge from juvenile to adult stage. Fly anglers choose flies resembling the species that is hatching. Hence the expression "Match the hatch."

Procedure

Preparation

1 Copy one **Aquatic Insect Life Cycles Sheet** for each student.
2 Copy one **Parts of an Insect Sheet** for each student.
3 Copy one **Fly Types Sheet** for each student.
4 Copy and cut two sets of **Go Fly Fish Cards** for each group of four or five students. You may wish to copy these on cardstock and laminate them for durability.

Activity

Warm-up

1 Ask your students if they've ever heard of a type of artificial fishing lure that's very small, lightweight, and resembles an insect. This type of lure is used to catch fish with a fly rod. (The special lures are called **flies**.)
2 Although there are many types of flies, tell students that they're going to look at some flies that resemble aquatic insects.

If you're concerned about students sticking themselves with the sharp hooks, cover them with masking tape.

Lesson

1 To fool a fish, the fly must look like—and imitate the motion of—an aquatic insect. It must have the same parts as the insect. Pass out the **Parts of an Insect Sheet** and, as a class, label the parts.
2 Every adult aquatic insect has a head, thorax, abdomen, antennae, compound eyes, wings, and six legs. Some also have tails. Juvenile insects may have all of these parts, except wings, or they may look quite different from the adults. A fly can imitate an adult aquatic insect or a juvenile form. The juvenile form spends its time in the water and is called a larva or nymph. It doesn't have wings. The adult form has wings and it sits on the water's surface, or flies above it.
3 Ask your students if they know the word for what happens when an insect's body changes from its juvenile stage to its adult stage. Explaining that caterpillars go through this same sort of change when they turn into butterflies may prompt them to come up with the word. (This process of extreme change is called metamorphosis.)
4 Pass out the **Aquatic Insect Life Cycles Sheet**. Review the definition of life cycle. Discuss the two basic types of metamorphosis and label the sheets as you go.
5 Pass out the **Fly Types Sheet** so students can see the examples. Flies have their own special names. Flies that imitate a juvenile or larval form of an aquatic insect are called nymphs. Flies that resemble adult aquatic insects are usually called dry flies. There are also flies that imitate drowned adults and struggling immature insects—these are called wet flies. If you have some examples of flies to show the class, pass them around the class.

6 Tell the students that they're going to play a game of **Go Fly Fish** with a set of aquatic insect and fly cards. Form groups of four or five students and give each group two sets of cards (there should be a total of 28 pairs, or 54 cards, in each deck.) Have each group appoint a dealer. Have the dealer shuffle the deck and pass out five cards to each student, placing the rest of the cards face down in the center of the student group.

7 To begin, each student places any two matching cards from their hand face up on the table in front of them. (Match the artificial fly to the corresponding insect that it mimics.) The student to the left of the dealer then asks another student if she has any of one type of card. If that student does have that type, they must give it up. The first player puts down their new match and takes another turn. If the other student does not have the card, they can say, "Go fly fish!" The first player then draws a card from the deck. Then the player to the left of the first player takes a turn. The game continues until one student has no cards left in their hand. The player with the most pairs at that time wins.

Wrap-up

Ask the students what they looked at on the cards to make a match. Was it the name written on the cards? Was it the body parts on the pictures? Let the students know that some fish are very picky about what they eat and will only bite on a fly that looks like the aquatic insects that are in and around the water at that time. The fish looks at color, size, body parts (shape and silhouette), and movement through the water to determine if the insect or fly resembles a natural food that it wants to eat.

Assessment Options

1 Collect the student worksheets and observe participation in the game.

2 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

23-24 points = A
Excellent. Work is above expectations.

20-22 points = B
Good. Work meets expectations.

16-19 points = C
Work is generally good. Some areas are better developed than others.

12-15 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-11 points = F
Work is unacceptable.

Fool Fish With Flies Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student identifies and correctly labels all six insect parts on the **Parts of an Insect Sheet**.
4	______	______	Student correctly labels all stages of metamorphosis on the **Parts of an Insect Sheet**.
3	______	______	Student accurately labels three flies on the **Aquatic Insect Life Cycles Sheet**.
3	______	______	Student identifies each of the three flies on the **Aquatic Insect Life Cycles Sheet**, and describes why they attract fish.
3	______	______	Student accurately labels three flies on the **Fly Types Sheet**.
3	______	______	Student describes why the three types of flies on the **Fly Types Sheet** attract fish.
4	______	______	Worksheets are neat and easy to read.
Total Points			
24	______	______	**Score** ______

Fool Fish With Flies Scoring Rubric

Worksheet Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Parts of an Insect Sheet	Can identify and correctly label all six insect parts.	Can identify and correctly label five of the insect parts.	Can identify and label four of the insect parts.	Can identify and label less than four of the insect parts.	Can't identify insect parts.
Life Cycle Sheet	All stages of metamorphosis correctly labeled.	Six stages of metamorphosis correctly labeled.	Four or five stages of metamorphosis correctly labeled.	Less than three stages of metamorphosis correctly labeled.	No stages of metamorphosis correctly labeled.
Fly Types Sheet	Three flies accurately labeled. Describes one specific reason why each of them attracts fish.	Two flies accurately labeled. Describes why fish are attracted to artificial flies in general.	One fly accurately labeled, but can't describe why it would attract a fish.	Labels no flies accurately.	Doesn't label flies.
Legibility	Worksheets are legible.	Worksheets show two or three marks or stains but are legible.	Worksheets barely legible, with numerous marks or stains.	Worksheets messy and illegible.	Doesn't complete worksheet.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1. Ask a fly tyer (such as a parent who fly fishes, a member of a local fly fishing group, or someone from a local fly shop) to visit your class to demonstrate fly tying. Ask them to discuss the materials they use, the kinds of insect their flies imitate, and the types of fish they attract.
2. Bring some aquatic invertebrates to the classroom for observation and identification. Watch for signs of molting and metamorphosis.
3. Do Lesson **1:4—Water Habitat Site Study**. Have the students identify the aquatic invertebrates they collect.
4. Modify **Lesson 5:5—Flashy Fish Catchers** by having students use the **Go Fly Fish Cards** to create a series of flies resembling aquatic insects at various life stages.

For the Small Fry

K-2 Option

1. Create a puppet show to demonstrate metamorphosis.
2. Place felt cut-outs illustrating the stages of an insect's life cycle on a felt board as you discuss metamorphosis with the students.
3. Have students collect caterpillars and keep them in jars to watch them as they make cocoons.
4. Collect dragonfly larvae from a nearby pond and bring them to class for students to observe. Compare the dragonfly larvae to illustrations of adult dragonflies. Note similarities and differences.
5. Create the **Go Fly Fish Cards** and use them for a matching game and a game of Go Fish.

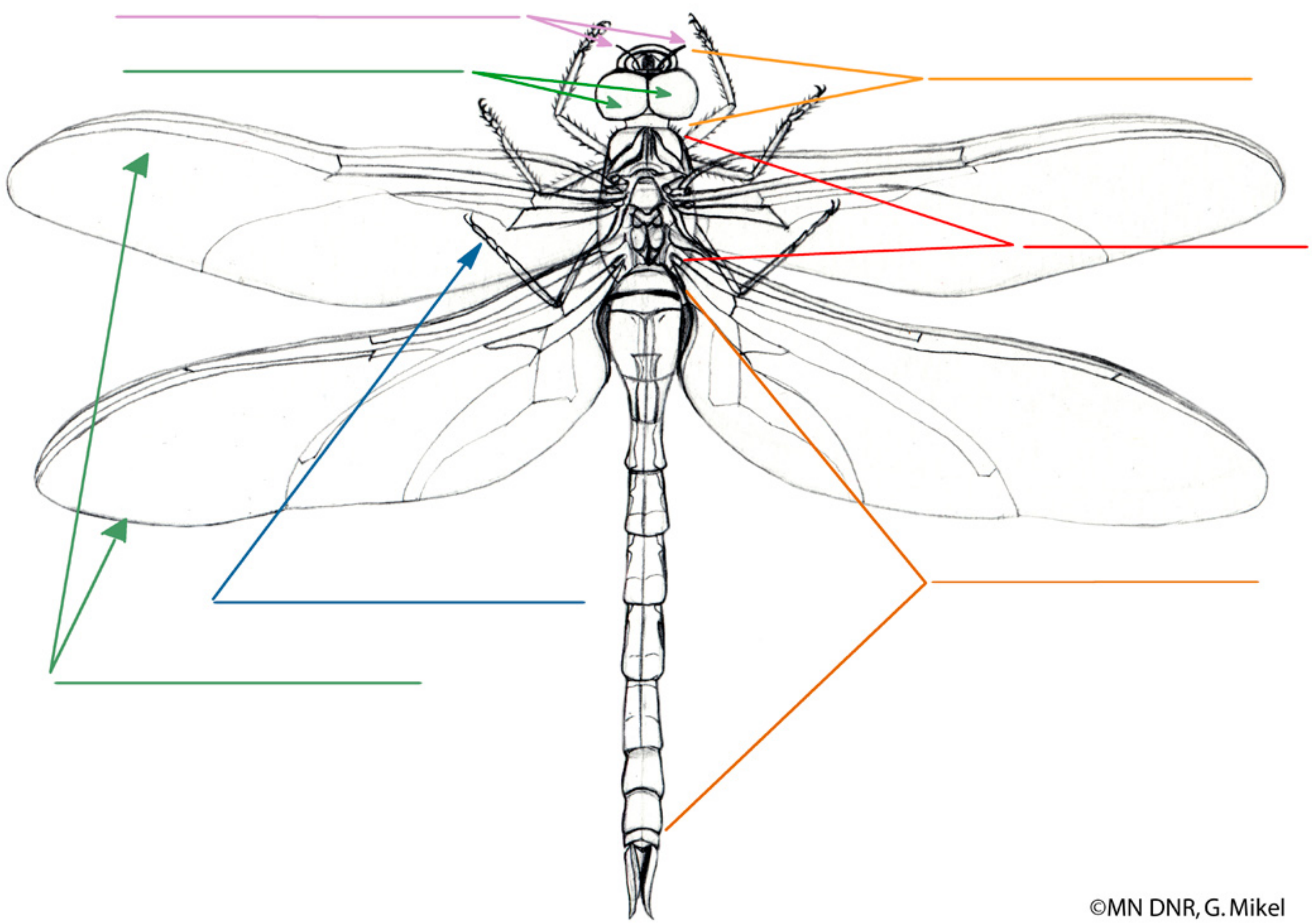
STUDENT COPY

Name ______________________________ Date ______________

Parts of an Insect Sheet

Use these words to label the parts of this adult insect. Then color the dragonfly.

Head
Eyes
Abdomen
Antennae
Thorax
Wings
Legs



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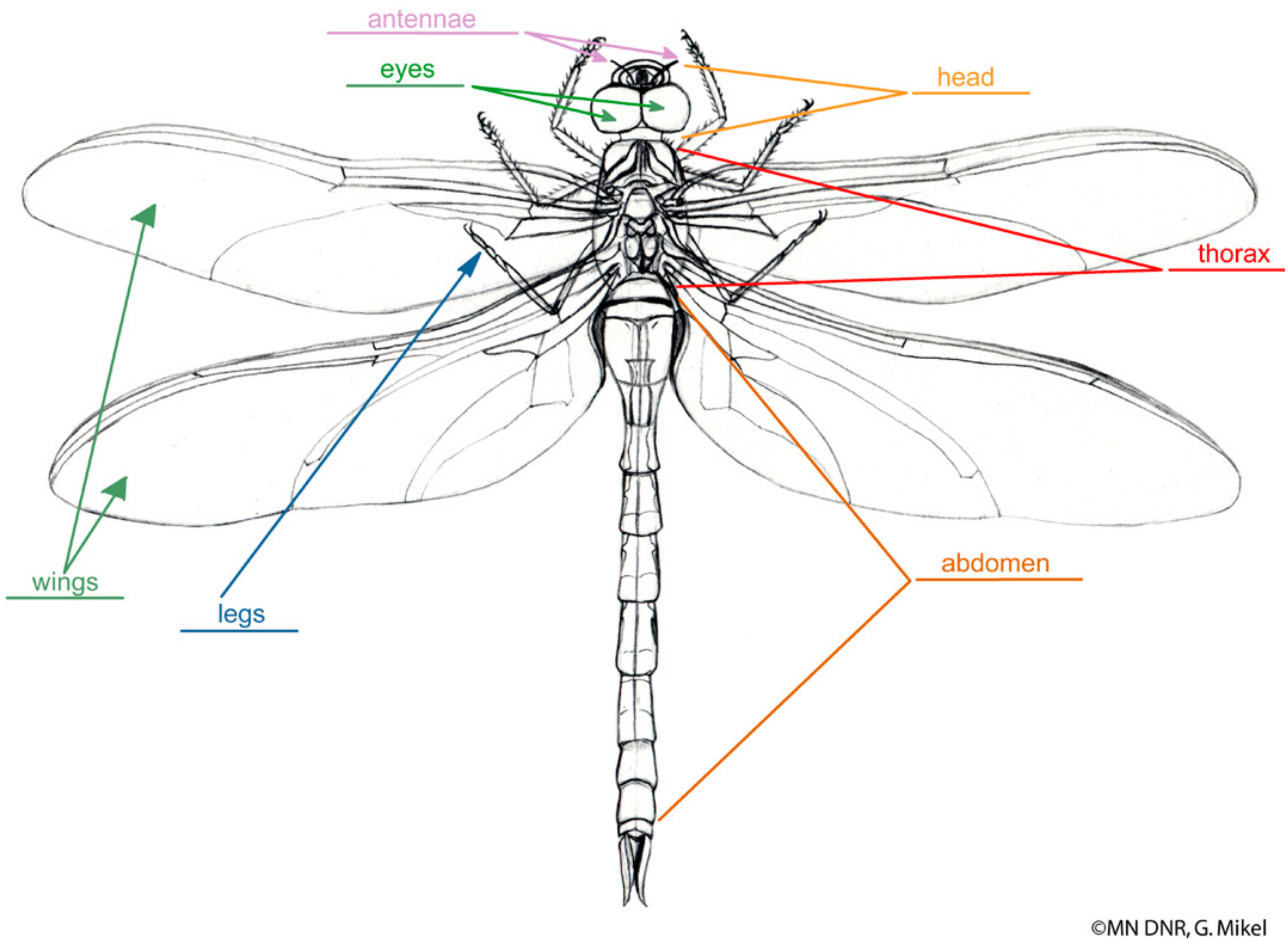
INSTRUCTOR COPY

Parts of an Insect Answer Sheet

Use these words to label the parts of this adult insect. Then color the dragonfly.

Head
Eyes
Abdomen
Antennae
Thorax
Wings
Legs



STUDENT COPY

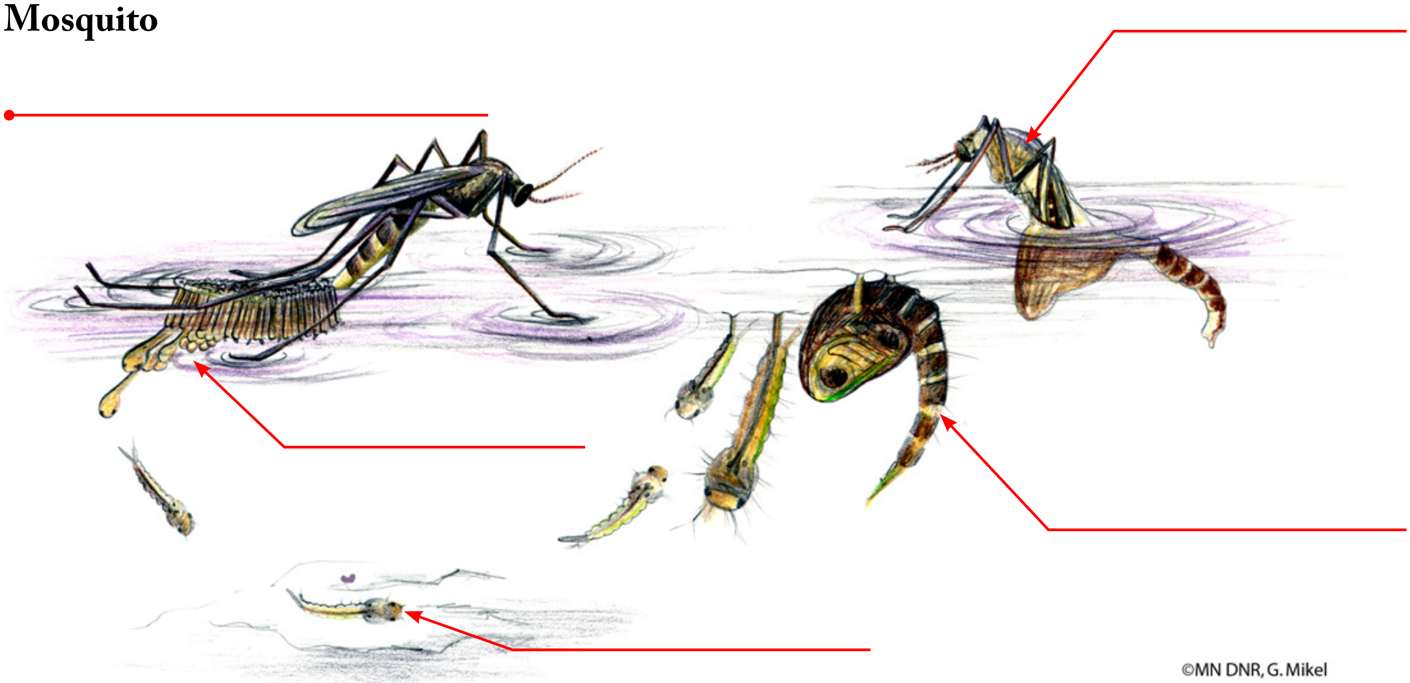
Name ______________________________ Date ______________

Aquatic Insect Life Cycles Sheet

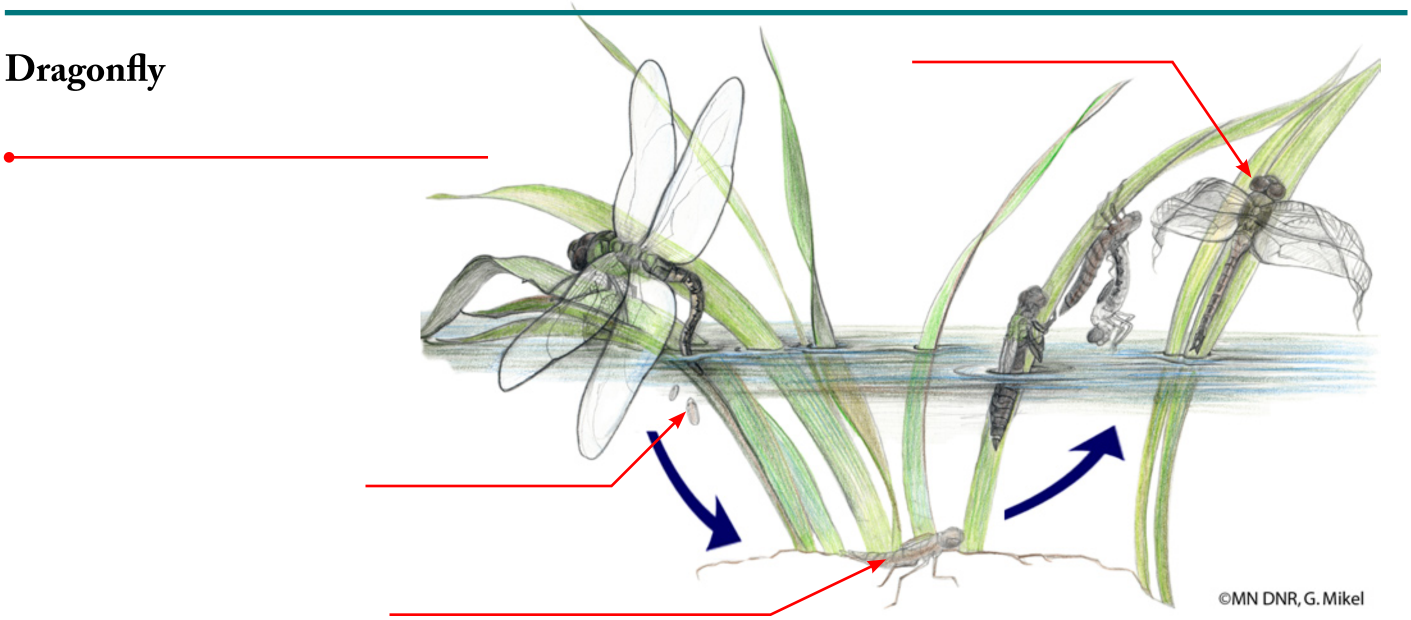
Use these words to label the stages of metamorphosis.
Some of the words may be used more than once.

Larva	Pupa	Incomplete metamorphosis
Adult	Egg	Complete metamorphosis

Mosquito



Dragonfly



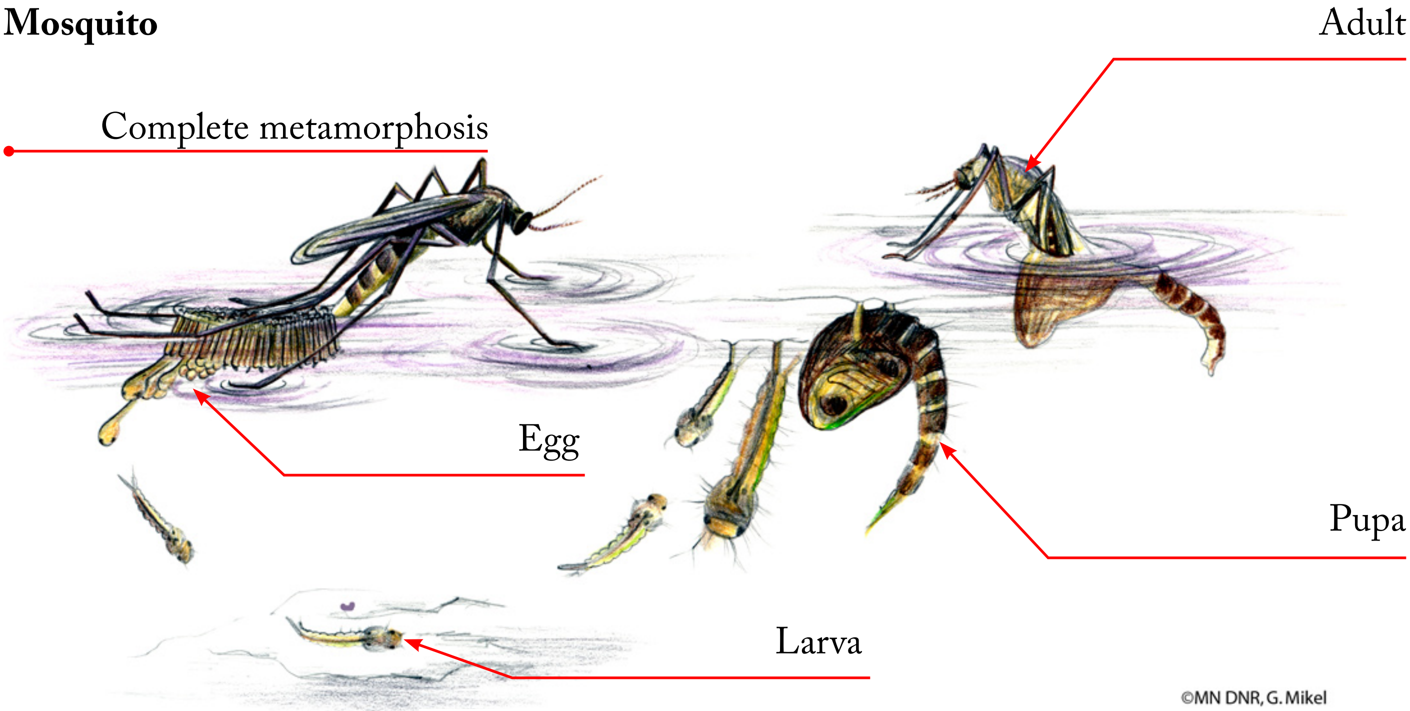
INSTRUCTOR COPY

Aquatic Insect Life Cycles Answers Sheet

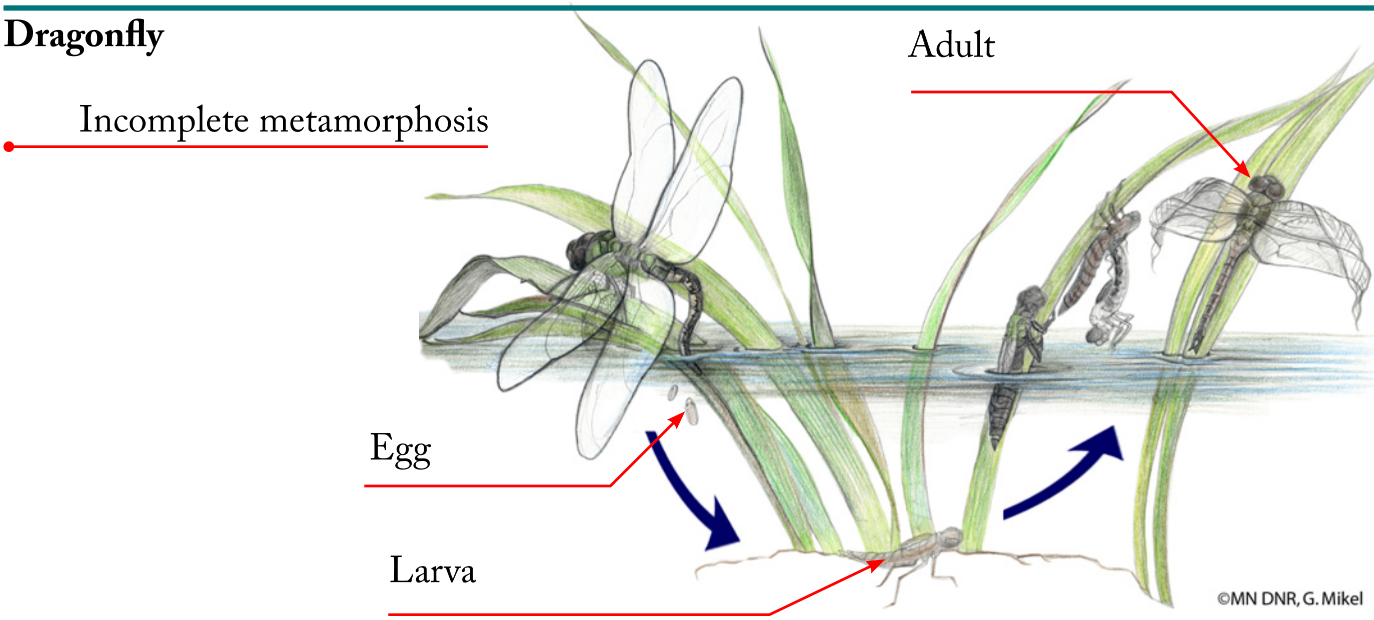
Use these words to label the stages of metamorphosis.
Some of the words may be used more than once.

Larva	Pupa	Incomplete metamorphosis
Adult	Egg	Complete metamorphosis

Mosquito



Dragonfly



STUDENT COPY

Name ______________________________ Date ______________

Fly Types Sheet

1. Use these names to label the flies. Each fly name may be used just once.

Dry fly
Wet fly
Nymph pattern

Fly A

____
Name of Fly A

Fly B

____
Name of Fly B

Fly C

____
Name of Fly C

2. Give one reason that a fish would be attracted to each fly.

Fly A ______________________________

Fly B ______________________________

Fly C ______________________________

INSTRUCTOR COPY

Fly Types Answer Sheet

1. Use these names to label the flies. Each fly name may be used just once.

Dry fly
Wet fly
Nymph pattern

Fly A	Fly B	Fly C
		
Dry fly	Nymph pattern	Wet fly
Name of Fly A	Name of Fly B	Name of Fly C

2. Give one reason that a fish would be attracted to each fly.

Fly A Dry flies float and mimic adult and sub-adult aquatic insects.
Fly B Nymph patterns sink and represent forms of underwater aquatic insects.
Fly C Wet flies sink and resemble swimming or drowning adult insects or larvae struggling to reach the surface.

Go Fly Fish Cards

Copy these and cut them out.

Adult Alderfly
Dry Fly

Adult Caddisfly
Dry Fly

Adult Cranefly
Dry Fly

Adult Dragonfly
Dry Fly

Mayfly Larva
Nymph Pattern

Damselfly Larva
Nymph Pattern

Go Fly Fish Cards

Copy these and cut them out.

Caddisfly Larva
Nymph Pattern

Stonefly Adult
Dry Fly

Water Boatman (adult and larva look alike)
Wet Fly

Stonefly Larva
Nymph Pattern

Midge Larva
Nymph Pattern

Hellgrammite (Dobsonfly) Larva
Nymph Pattern

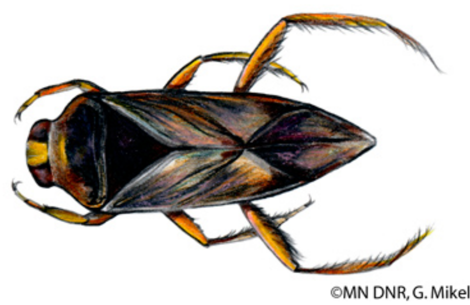
Go Fly Fish Cards

Copy these and cut them out.

Backswimmer Adult
Wet Fly

Mayfly Adult
Dry Fly

Alderfly
Adult



Backswimmer
Adult

Caddisfly
Adult

Caddisfly
Larva

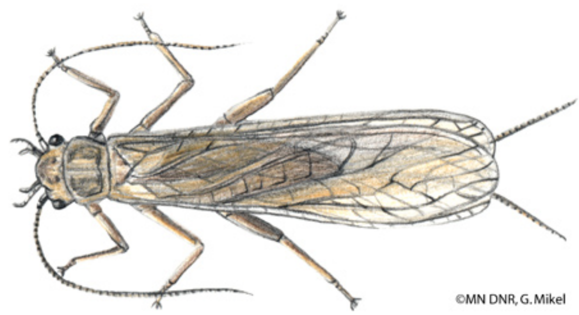
Go Fly Fish Cards

Copy these and cut them out.

Cranefly
Adult

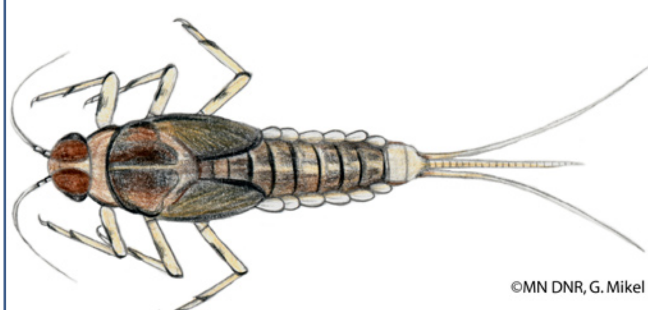
Damselfly
Larva

Dragonfly
Adult



Stonefly
Adult

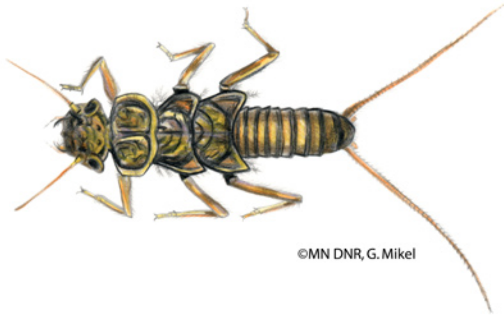
Mayfly
Adult



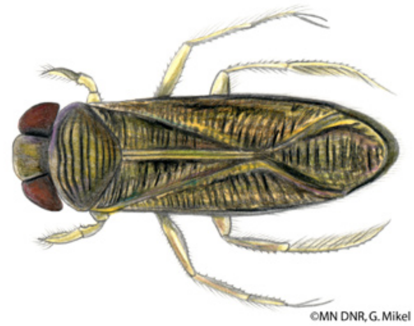
Mayfly
Larva

Go Fly Fish Cards

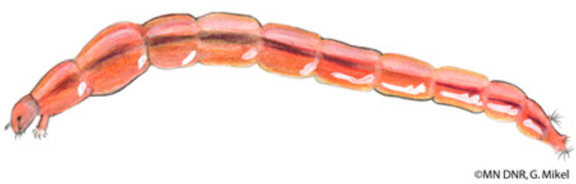
Copy these and cut them out.



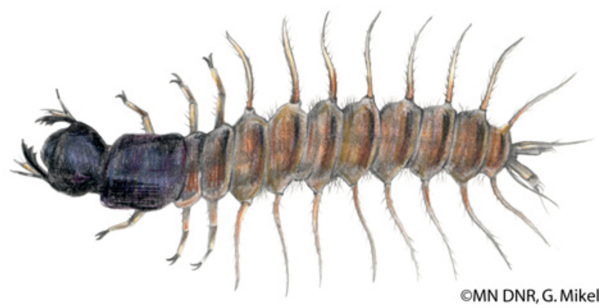
Stonefly
Larva



Water Boatman
Adult



Midge
Larva



Hellgrammite (Dobsonfly)
Larva

Making Ice Fishing Jiggle Sticks

"Cold, alone, and waiting—ah, the good life."

—The title of an article on Lake Mille Lacs ice fishing
by Abraham McLaughlin, *The Christian Science Monitor*, February 18, 1999

Table of Contents

Chapter 5 • Lesson 7

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Making Ice Fishing Jiggle Sticks

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instructions and independent reading. ●
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension. ●

Grade 3
III. Speaking, Listening and Viewing
A. Speaking and Listening:
Benchmark 3—The student will follow multi-step oral directions. ●

History and Social Studies

V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities. ◒

Science

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world. ◒
Benchmark 2—The student will discuss responsible use of science. ◒
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world. ◒

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 5 • Lesson 7

Making Ice Fishing Jiggle Sticks

Grade Level: 3-5
Activity Duration: 90 minutes
Group Size: any
Subject Areas: Language Arts, Social Studies, Science, Environmental Education
Academic Skills: application, communication, construction, demonstration, observation, problem solving, small group skills
Setting: indoor gathering area with tables and chairs
Vocabulary: clip-on depth finder, hand auger, ice scoop, jiggle stick, jigging rod and reel, rattle reel, spinning combo, throwable personal flotation device, tip-up
Internet Search Words: children and ice fishing, ice fishing equipment

Instructor's Background Information

Minnesotans have traditionally and enthusiastically participated in winter sports and activities. Finnish, Norwegian, and Swedish settlers brought ice fishing to Minnesota. Ice fishing is a great way to take advantage of cold, snowy weather. With basic equipment, a few skills, and good planning, ice fishing can be easy, enjoyable, and exciting.

In this lesson, students will learn about ice fishing equipment and skills. They will also learn that ice fishing outings will be even more fun when they use ice fishing rods that they've made themselves.

Before taking students on an ice fishing trip, complete **Lesson 6:2—Ice Fishing and Winter Safety** to prepare students for winter weather, ice conditions, ice fishing safety—and fun.

Equipment
Ice fishing gear is different than fishing gear used during other parts of the year. Ice fishing rods are short because ice fishing doesn't require casting. The line guides are wide to accommodate ice filling some of the space. Reels are simple—or absent—because, with no casting involved, they merely hold line.

A lightweight monofilament fishing line (4- to 8- pound test) is sufficient for most types of ice fishing trips. If you're fishing for northern pike or walleye, use the heavier line.

Summary

Students make and rig their own ice fishing jiggle sticks.

Student Objectives

The students will:
1. Identify the equipment used in ice fishing.
2. Tie an improved clinch knot.
3. Assemble and rig a jiggle stick.

Materials

Part 1: Equipment and Techniques
- Hand auger or ice chisel (optional)
- Ice scoop (also known as a skimmer), to remove ice chips from fishing hole
- Ruler
- Rod and reel types, including a jiggle stick, jigging rod, spinning combo, tip-up, rattle reel (collect as many of these as possible, or use pictures)
- Clip-on depth finder
- Needlenosed pliers
- Fingernail clipper
- Ice rescue claws (optional)
- Small tackle box with tackle such as ice flies (optional)
- First aid kit
- Throwable personal flotation device
- Bucket, for carrying things and, later, to sit on
- Wool blanket
- Sled
- **Basic Ice Fishing Equipment Cards** (or projection overhead)

Part 2: Knot Tying
- Nylon cord or rope (one-quarter-inch thick, cut in two-

contined

Materials (continued)

foot lengths), one per student
- Hula-hoops, one for each group of four or five students
- **Tying an Improved Clinch Knot Sheet**, one per group
- Adult helpers, one per group

Part 3: Making and Rigging a Jiggle Stick
- Wood dowels (one-half to three-quarter-inch diameter, cut in eighteen-inch lengths), one per student
- Eye screws, at least one per student
- Square bend screws, at least two per student
- Pony (small) spools of 4- to 8-pound test monofilament line, one per student
- Bobbers, one -inch round clip-on type, at least one per student
- Split shot sinkers, four-ounce (preferably non-lead), at least one per student
- Hooks, sizes 6, 8, or 10, at least one per student (if available, try circle hooks with a long shank; see photo in **Lesson 5:2—Casting a Closed-face Rod and Reel,** or use ice flies, which are small hooks with colored "heads")
- Rubber bands, at least one per student
- Scissors or fingernail clipper, one per adult helper
- Needlenosed pliers, one per adult helper
- **Making and Rigging a Jiggle Stick Sheet**
- **Setting Bobber Depth Sheet**
- Adult helpers, one for each group of four or five students

Basic Equipment for Ice Fishing

To prepare for an ice fishing trip, you'll need to collect some basic equipment in addition to jiggle sticks. These are some other items that will make your fishing trip successful and lots of fun.

Hand auger—To catch fish through the ice, you must first drill a hole. Traditionally, people used long chisels to chip holes in the ice. The invention of the hand ice auger in the 1940s made this chore much easier. An auger looks like a giant screw with a sharp blade on one end. To use an auger, push down on the top of it as you wind the handle—two people can do this together. Power augers make hole-drilling fast and easy, but they're too heavy for children. Another handy tool is a **spud**, a long-handled chisel with a sharp blade, which is used to check ice thickness and chip extra ice from holes.

Ice scoop—A ladle-type tool with small holes is used to scoop ice chips from the hole so they don't freeze to the line and keep the angler from noticing a bite.

Ruler—Use this to measure ice thickness and the length of the fish you catch. Some scoops have rulers etched into their handles, or you could tape a rule to the handle.

Jiggle stick—This is a fishing pole without a reel. The line wraps around two pegs. A long pole and reel aren't necessary for ice fishing because there is no casting. A reel isn't necessary: when a fish is on the line, the angler drops the rod and pulls the line by hand. Moving the stick up and down is referred to as jigging and entices fish to the bait. Students will learn to make their own jiggle sticks in this lesson.

Jigging rod and reel—This type of ice fishing rod has a reel that holds the line. The reel has no drag feature, so the line comes out freely.

Spinning combo—This rod looks more like those used in summer, only shorter, and with larger line guides. It has a spinning reel (or open-face reel) that holds the line and has drag, that can be set so line doesn't come out freely.

Tip-up—Some anglers use a tip-up for larger fish such as northern pike and walleye. A tip-up allows hands-free fishing. A tip-up rests over the hole. A short rod swings down into the water—it's attached to a spool with line.Tip-ups are used with larger bait such as a big sucker minnow. When a fish takes the bait, a flag springs up from the stick and across the hole to alert the angler, who can then pull the fish up with the line. (Minnesota fishing regulations allow anglers to use as many as two fishing rigs at a time while ice fishing.)

Rattle reel—Who says you even need a rod? Sometimes anglers attach a free-spinning reel with no drag to the wall of their fish house. These reels have a mechanism that clicks as the line comes off the reel, alerting the angler. As the fish makes off with the bait, the wooden spool spins, causing the beads or bells inside to click or rattle, hence the name.

Clip-on depth finder—A weight on a spring-clip that helps locate the desired position to set the bobber on the line so the bait or lure will be at a specific depth in the water while fishing.

Bait—For ice fishing, use worms in a Styrofoam container or minnows in Styrofoam bait bucket with a minnow scoop. The Styrofoam will keep bait from freezing.
Small tackle box—Inside the tackle box should be a clip-on depth finder for setting the location of the bobber, needlenosed pliers for removing hooks, a fingernail clipper to cut line, hooks, bobbers, and sinkers.
Ice rescue claws—If anglers fall through the ice, they can use these as handholds to pull themselves out of the water.
First aid kit—This should include bandages and hand warmers, for emergencies.
Throwable personal flotation device—The PFD should be on a rope so it can be thrown just past an angler who has fallen through the ice.
Wool blanket—Someone might get cold or wet.
Buckets—An overturned bucket makes a great chair—and a good container for transporting fish.
Sled—To carry gear or pull someone to shore in an emergency.

If this seems like a lot of gear, it is! Ask an ice fishing enthusiast to bring their equipment to show to your class. You may wish to find out if a local sportsman's club or sporting goods store will donate fishing gear and tackle to your group.

Fish Houses and Shelters

Some ice anglers use fish houses or shelters, which block the wind and offer relief from the weather. Portable propane heaters provide quick warmth.

Fish houses can make an ice fishing experience much more enjoyable with children. With a group of children, it may be good to have at least one fish house on the ice to serve as a windbreak or warming house. You may wish to ask a local ice angling enthusiast to set up a fish house for your group.

Procedure

Preparation

1. Find adult volunteer helpers.
2. Collect equipment and materials.
3. Cut the nylon cord or rope into two-foot lengths for your class. Consider melting or knotting the ends so they don't come unraveled.
4. Cut dowels into eighteen-inch lengths and pre-drill three holes in each, as shown on the **Making and Rigging a Jiggle Stick Sheet**. Drill the holes in line with one another. Drill one hole one and one-half inches from the tip, one hole nine inches from the tip, and the last hole twelve inches from the tip, for a total of three holes, all in line with one other.
5. Make copies of the **Tying an Improved Clinch Knot Sheet**, one per group of four or five students. (Copy one per student if you think they'd like to take one home.)

The heaters in fish houses can be safety hazards, so take precautions if you use them. Anglers are tempted to get too close to them when cold and wet, resulting in burnt skin, singed clothes, or fires. Define a boundary between students and heaters, and don't allow students to hang mittens and socks on them. Heaters also produce carbon monoxide, a deadly gas. Follow these tips to prevent carbon monoxide build-up inside the fish house:

- Use only those heaters listed and approved for indoor use.
- Follow the manufacturer's installation recommendations.
- Check all gas connections for leaks.
- Place propane cylinders outside the fish house.

Tip-ups that automatically set the hook are illegal in Minnesota.

6 Make copies of the **Making and Rigging a Jiggle Stick Sheet**, one per group of four or five students.

Activity

Warm-up

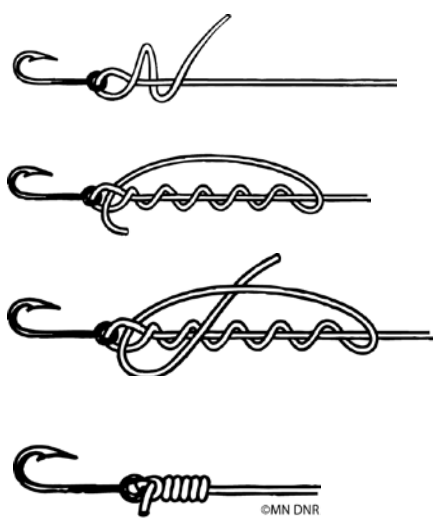
1 Ask the students what type of winter outdoor activities they enjoy. Have any students ever been ice fishing? What was it like—or what do they think it would be like? Discuss how winter fishing is different than fishing in the summer.

2 Tell the students that they will make their own jiggle sticks to use for ice fishing.

Lesson

Part 1: Ice Fishing Equipment and Techniques

Show the students the ice fishing equipment. Have them help you deduce how each piece is used. You can use the cards, or project the images on the **Basic Ice Fishing Equipment Cards.**



Part 2: Knot Tying

1 The knot that attaches your hook to your line is important. If it's not tied properly, you could lose your fish! Using a hula-hoop and nylon cord, demonstrate how to tie an improved clinch knot as shown on the **Tying an Improved Clinch Knot Sheet.**

2 Have a student hold the hula-hoop while you talk through the steps on the sheet and tie the knot. The hula-hoop represents the eye of the fish hook. The length of cord represents fishing line.

3 Untie the knot and have the class talk you through the steps as you tie the knot again.

4 Divide the class into groups of four or five and give each group a hula-hoop. Give each student a length of cord and ask them to practice tying the knot onto the hula-hoop. Assist those who may need additional help, and encourage those who can tie the knot to help others.

5 Make sure everyone has mastered this knot before making jiggle sticks.

Part 3: Making and Rigging Jiggle Sticks

1 Divide the students into small groups, with one adult helper for each group. Give each adult a pair of needlenosed pliers, scissors or fingernail clipper, and the **Making and Rigging a Jiggle Stick Sheet.**

2 Hand out the dowels, square bend screws, and eye screws. Have the students twist the screws into the predrilled holes in the dowels as shown on the sheet. An adult may need to help with the last few twists by using needlenosed pliers.

3 Hand out the spools of line. Have students tie an improved clinch knot on one of the square bend screws.

4 Make about 80 wraps around the square bend screws. Cut the line with scissors or a fingernail clipper. Thread the tag end (or free end)

of the line through the eye on the tip of the stick.

5 Have the students pull out line so that about two feet of line hangs from the tip of the rod. Hand out the tackle one piece at a time so students don't lose the small pieces.

6 Hand a split shot sinker to each student. Split shot sinkers are the easiest for students to put on and remove by themselves. Notice that one end has "wings" and the other has a deep slit, or "mouth." If you squeeze the wings together, the mouth opens. Open the mouth slightly, using needlenosed pliers or your fingers, and slide in the line—about nine inches from the end of the line. Now squeeze the mouth of the sinker tight onto the line with your fingers. Occasionally, you'll need pliers to help squeeze the sinker. If you use ice flies or teardrops, they're already weighted, but you may still need to place a split shot sinker above the teardrop to balance the weight. The holes in teardrops may be painted closed—to open them, take another hook and poke it through the eye.

7 Before handing out hooks, remind the students that the hooks are sharp. (You may wish to cover the sharp ends with masking tape.) Have the students tie their hook onto the end of the line using the improved clinch knot they practiced earlier. Snip off the tag end of the line close to the hook.

8 Wait until the group is outside to attach bobbers. See the **Setting Bobber Depth Sheet.** For setting bobber depth with the class, also see **Lesson 6:2—Ice Fishing and Winter Safety.**

9 Hand out a rubber band to each student. Have students wrap the rubber band over the line to secure the line to the jiggle stick while they wait to go outside.

10 Check to make sure everyone has a properly rigged jiggle stick.

Wrap-up

1 Ask the following knowledge questions. Name three pieces of equipment you might need for ice fishing. (See the equipment list. in this lesson.) How is a jiggle stick different from a rod you would use in the summer? Why is it different? (It 's shorter; it doesn't need a reel; it's made of wood.)

2 Go on to **Lesson 6:2—Ice Fishing and Winter Safety** to conduct a safe fishing trip.

Assessment Options

1 Assessment options include the Checklist and Rubric on the following pages.

Many students have seen someone secure a sinker by biting on it. Sinkers are easily swallowed and they're made of hard metal that can chip teeth. Use needlenosed pliers to open and secure sinkers. Most sinkers are still made of lead, which can be toxic if ingested. Always keep sinkers away from the mouth.

Get the Lead Out

Consider using fishing tackle that doesn't contain lead. Lead is a toxic metal and, in sufficient quantities, it adversely affects the nervous and reproductive systems of mammals and birds. Ask for non-lead tackle at your bait shops.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

18-19 points = A
Excellent. Work is above expectations.

16-17 points = B
Good. Work meets expectations.

13-15 points = C
Work is generally good. Some areas are better developed than others.

10-12 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-9 points = F
Work is unacceptable.

Making Ice Fishing Jiggle Sticks Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student ties a clinch knot with a rope.
2	______	______	Student ties a clinch knot with monofilament line.
2	______	______	Student explains the importance of using a clinch knot.
3	______	______	Student correctly places the hook, bobber and sinker on the line without assistance.
3	______	______	Student describes reasons for using hook, bobber, and sinker.
3	______	______	Student follows instructions.
4	______	______	Student makes the jiggle stick without assistance.
Total Points			
19	______	______	**Score** ______

Making Ice Fishing Jiggle Sticks Scoring Rubric

Skill Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Clinch knot	Ties a clinch knot with both rope and monofilament line. Can explain the importance of using a clinch knot.	Ties a clinch knot with both rope and monofilament line. Knows why fishing knots are important but can't explain why.	Ties a clinch knot with a rope, but needs help tying the knot using monofilament line. Can't explain the importance of the knot.	Can't tie a clinch knot unassisted.	
Hook, bobber, and sinker	Correctly places hook, bobber, and sinker on the line without help. Can describe the reason for each item.	Correctly places the hook, bobber and sinker on the line without help. Can describe reasons for two of the items.	Can attach a hook, bobber, and sinker, but places two of the items on incorrect spots on the line. Can describe the reason for two of the items.	Needs help placing the hook, bobber, and sinker on the line. Doesn't know the reason for each of the items.	
Jiggle stick construction	Follows instructions and completes the jiggle stick without assistance.	Follows instructions and completes the jiggle stick with minimal assistance.	Follows instructions and completes the jiggle stick with moderate assistance.	Unable to build a jiggle stick without assistance.	

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Try **Lesson 6:2—Ice Fishing and Winter Safety** and **Lesson 2:8—Fish in Winter.**
2 Make rod holders out of wire coat hangers.
3 Set up a portable fish house in your classroom the week before your trip and add equipment.
4 Design your ideal ice fishing house.
5 Ask a volunteer to set up a dark house with a spearing decoy out on the ice for the students to examine, or have a volunteer demonstrate decoy carving and talk about fish spearing.
6 Use the Internet to research Minnesota ice fishing events and contests or the history of ice fishing.
7 What types of materials and tools might early Minnesota Indian cultures have used for winter fishing? You could ask your students to brainstorm ideas and then have them do research on the Internet or in the library. Compare these materials with the ones they used to make their own jiggle sticks.

For the Small Fry

K-2 Option

1 Younger students will have a hard time making jiggle sticks, but they could still go fishing. Increase the adult-child ratio to 1:2, and plan to be outside for no longer than 45 minutes. See **Lesson 6:2—Ice Fishing and Winter Safety**.
2 Talk about fun things to do outside in the winter. Read a story about an ice-fishing trip. Try *Fishing for Methuselah,* by Roger Roth or *Kitaq Goes Ice Fishing*, by Margaret Nicolai.

INSTRUCTOR COPY

Basic Ice Fishing Equipment Cards

This sheet can be cut into cards or projected.

Hand augers drill holes in the ice.

Jiggle sticks are ice fishing rods without reels. Try jigging by moving them up and down.

Ice scoops or skimmers scoop ice chips from the hole in the ice to prevent it from re-freezing.

Jigging rods and reels have reels that hold the line but have no drag, so the line comes out freely. Try jigging by moving them up and down.

Rulers measure ice thickness and the length of fish.

Spinning combos sized for winter have reels to hold the line and provide drag.

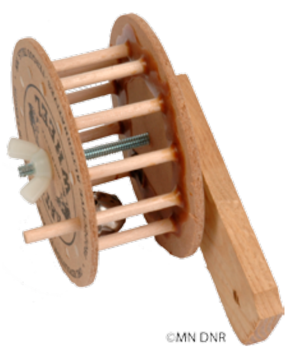
INSTRUCTOR COPY

Basic Ice Fishing Equipment Cards

This sheet can be cut into cards or projected.

Tip-ups sit over a hole in the ice. When a fish takes the bait, a lever releases a flag to alert the angler.

Bait kept in a Styrofoam container won't freeze as quickly. If using minnows instead of worms, don't forget the minnow scoop!



Rattle reels are free-spinning, clicking reels with no drag. Find them attached to the wall of an icehouse.

Small tackle box holds a clip-on depth finder, needlenosed pliers, a fingernail clipper, hooks, bobbers, sinkers, and ice fishing lures.

Clip-on depth finders set the depth of the bobber.

Ice rescue claws allow people who have fallen through the ice to pull themselves out of the water.

INSTRUCTOR COPY

Basic Ice Fishing Equipment Cards

This sheet can be cut into cards or projected.

First aid kit holds bandages and hand warmers for emergencies.

Buckets carry gear and fish. You can also sit on an overturned bucket.

Throwable personal flotation device on a rope can be tossed to someone who has fallen through the ice to pull them to safety.

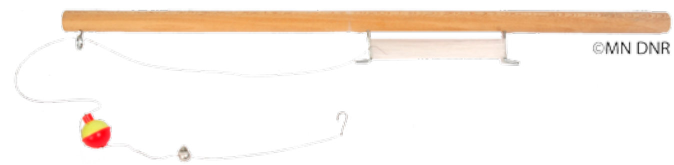
Sled carries gear, or can be used to pull someone to shore in an emergency.

Wool blankets warm people who get cold or wet.

Making and Rigging a Jiggle Stick Sheet

The instructor does Steps 1 and 2. Students begin at Step 3.

Use these materials to make a jiggle stick.



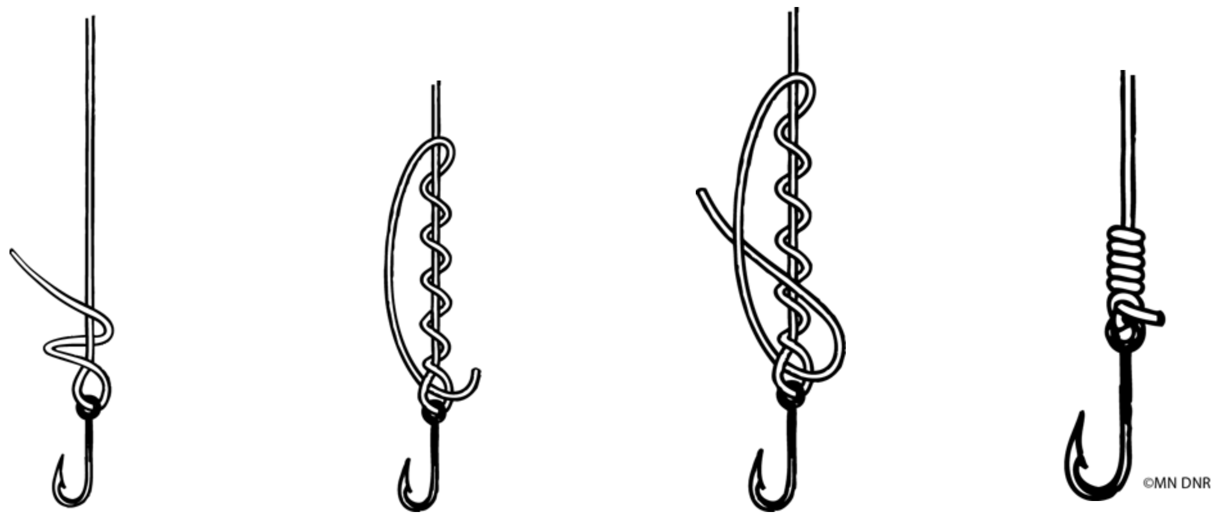
A completed (rigged) jiggle stick.

1. Cut a ½- or ¾-inch diameter dowel into an 18-inch length.
2. Drill three holes in line with one another as shown: 1½ inches from the tip, 9 inches from the tip, and 12 inches from the tip. Use the drill bit size recommended on the boxes of the eye screws and square bend screws.
3. Twist an eye screw into the hole 1½ inches from the tip as shown. (Squeeze the eye screw to close it if there's a gap that lets the line slip through it.)
4. Twist the square bend screws into the other holes. When you're finished, the ends should be pointing away from each other as shown.
5. Using an improved clinch knot, tie the line to one square bend screw.
6. Wrap the line around the square bend screws approximately 80 times.
7. Cut the line and thread the end through the eye screw, so that about two feet of line hangs from the tip of the rod.
8. Attach the sinker about 9 inches from the end of the line.
9. Tie on the hook with an improved clinch knot. And remember—hooks are sharp.
10. Secure the line to the jiggle stick with a rubber band to keep the hook from swinging when you're not fishing.
11. At the fishing spot, set the bobber depth with a depth finder and bait the hook. Now you're ready to go ice fishing!

STUDENT COPY

Tying an Improved Clinch Knot Sheet

The clinch knot is probably the most popular fishing knot used today. When properly tied, the clinch knot is very strong and it won't slip. This is a versatile fishing knot, and it can also be used to attach lures to your fishing line.



1. Thread one end of the line through the eye of the hook.
2. Wrap the line around itself five times to make five twists. Fishing tackle manufacturers have found that five wraps of the line work best. With fewer than five wraps, fish might pull out the knot. With more than five wraps, the line may break.
3. Take the tag (loose) end of the line and put it through the first twist, near the hook.
4. Notice the new loop you have made. Take the same tag end and pass it through the new loop. (This is the "improved" part of the knot that prevents it from slipping.)
5. Drop this end.
6. Slide the whole knot down to the hook.
7. Gently tug on the end you previously dropped.
8. Neaten the knot. It's important to make sure the knot is "neat," or that the coils are tightly lined up. If there are loose wraps, or wraps on both sides of the eye, the knot may snag and break.
9. Voila! There should be neatly stacked coils lined up next to the eye.

STUDENT COPY

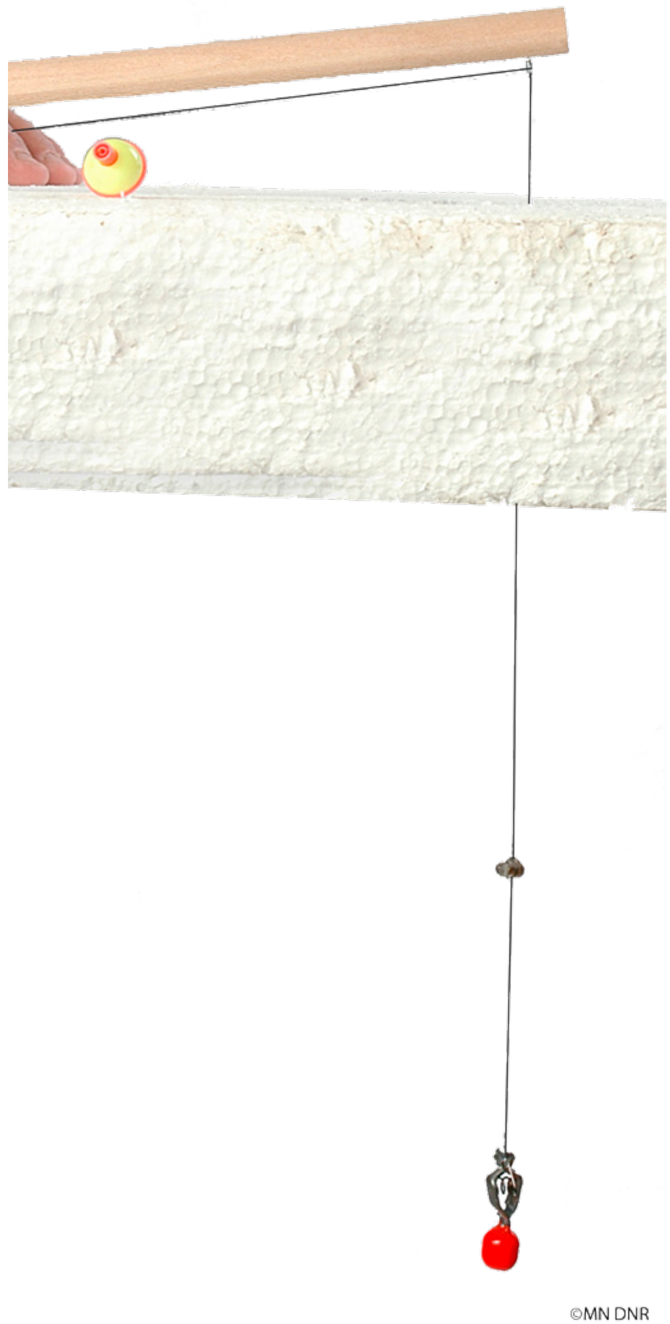
Setting Bobber Depth Sheet

Demonstrate how to use a depth finder using a jiggle stick.

1. Set up a simulated ice hole on two chairs.

2. Attach the clip-on depth finder to the hook on the end of the line.

3. Drop the weighted depth finder until it hits the bottom. You'll see some slack in the tension when it hits the bottom.



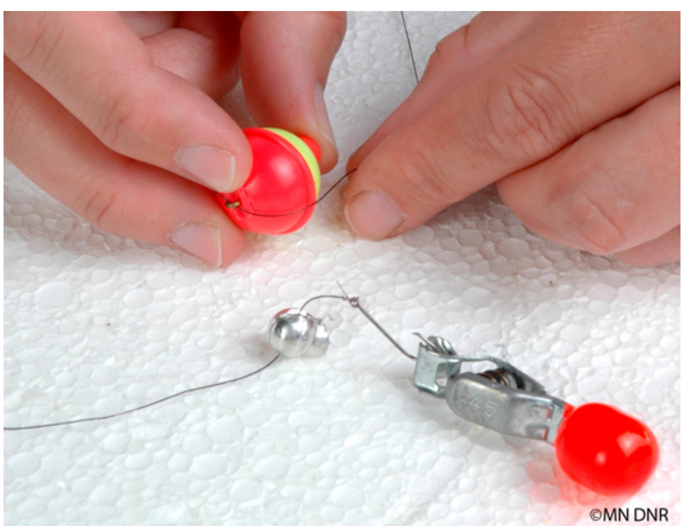
continued

STUDENT COPY

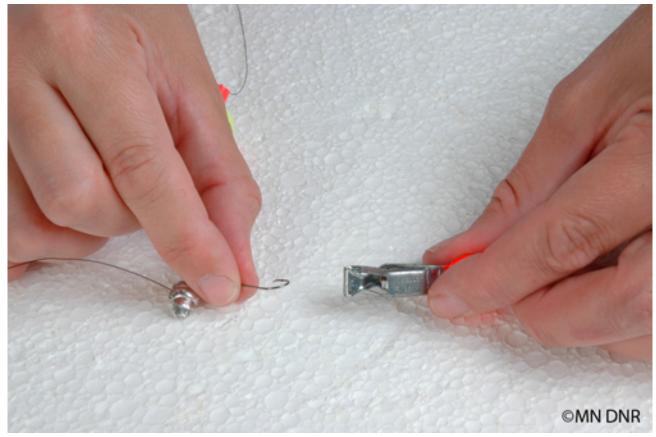
Setting Bobber Depth Sheet (continued)

4. Pinch the line at the water level and lift it up about one foot.

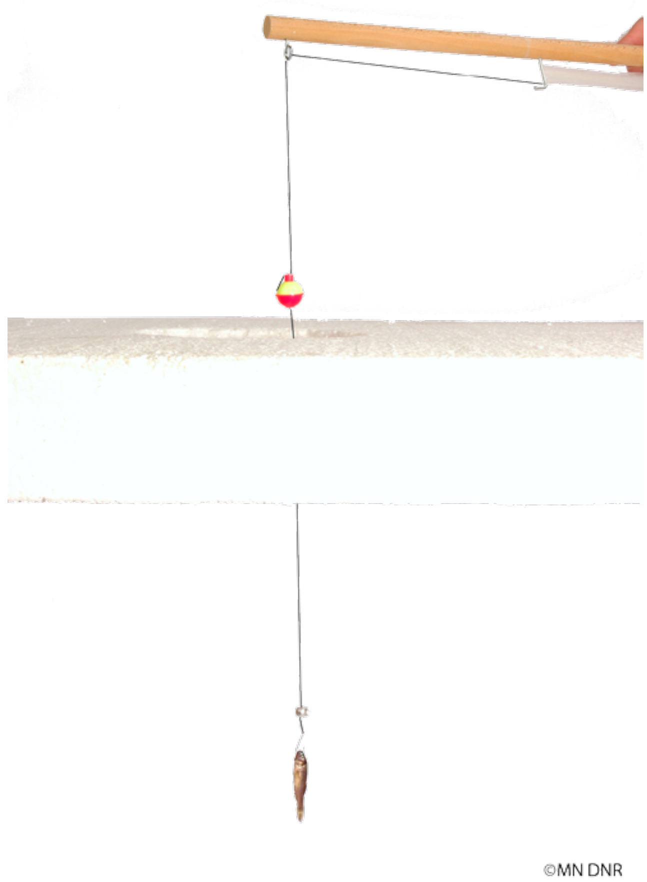
5. Attach your bobber at the water's surface.

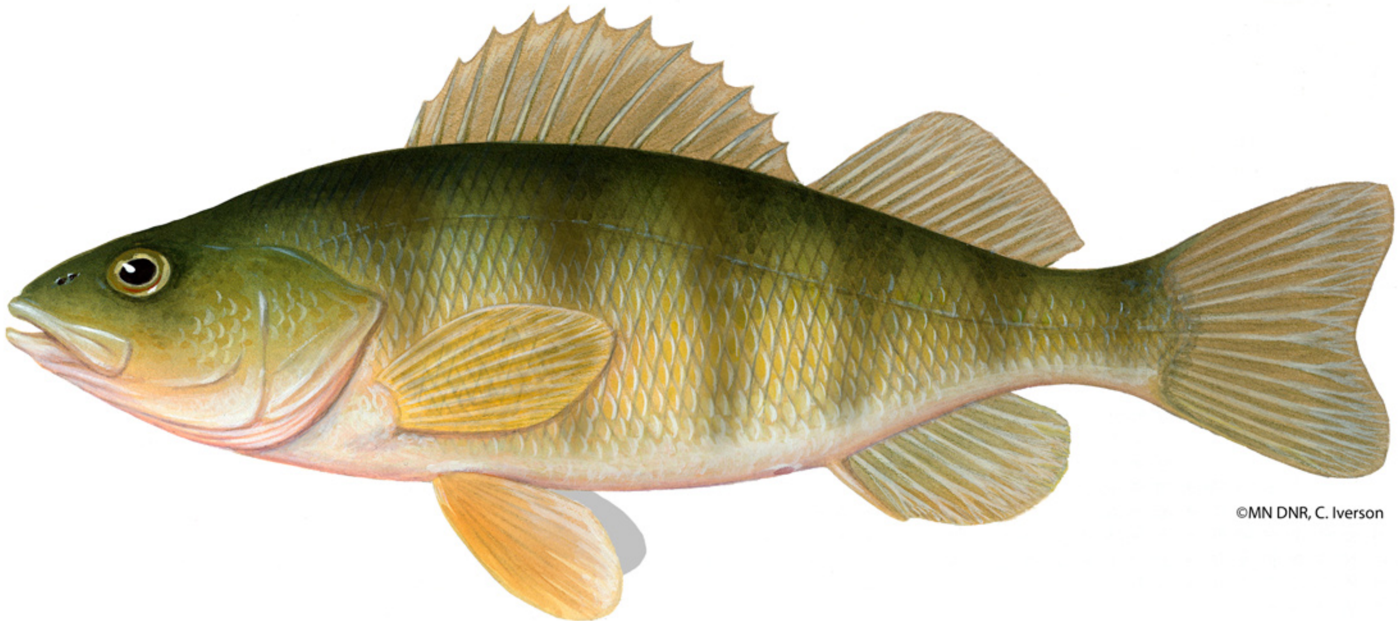


6. Pull up your line and remove the depth finder.



7. Now you are ready to bait the hook!





Safety & the Fishing Trip

Even with the best planning, there is no guarantee that you'll catch a fish every time you go fishing—which is why this pastime is called fishing rather than catching! Yet good planning can go a long way in ensuring a safe, successful fishing trip.

What Will the Students Learn?

Students will learn how to plan a safe fishing trip, develop competency in fishing techniques and skills, and demonstrate responsible fishing practices and sportsmanship. They can experiment with various baits to discover which ones best attract fish. They'll know what to do when a fish takes the bait. They'll learn to practice safe, responsible handling of fish to promote catch-and-release survival. They'll learn how to store, fillet, cook, and safely enjoy the nutritional benefits of the fish they choose to keep.

Chapter Concepts

When people have a fun and safe fishing experience, they might cultivate a fishing habit that gets them outdoors and "in the habitat" more often. With knowledge of the resource and how it is managed, an understanding of responsible stewardship practices, and practical fishing and safety skills, students will be ready to pursue fishing as a lifelong recreational, educational, reflective, and inspirational outdoor activity—and share their newfound knowledge and skills with friends and family!

Be Safe, Be Prepared

Lesson 6:1—Safety and Fishing at the Water's Edge
Lesson 6:2—Ice Fishing and Winter Safety
Lesson 6:3—Planning a Fishing Trip
Lesson 6:5—Eating Fish

Lessons from previous chapters provide background information on habitats, food webs, fish identification, water quality, watersheds, stewardship, regulations, and resource management. But there are just a few more important things to learn before diving into fishing, and the first is safety at the water's edge. Students learn to assess their site for safety, bring a buddy, form a safety plan, be prepared and protect themselves from sun, weather, insects, and poisonous plants in the summer, and from cold temperatures and thin ice in winter. They'll learn how to safely handle equipment (including sharp hooks) and fish, and to prepare and consume fish safely.

Planning the Fishing Trip

Lesson 6:1—Safety and Fishing at the Water's Edge
Lesson 6:2—Ice Fishing and Winter Safety
Lesson 6:3—Planning a Fishing Trip

Where is the best place to go fishing? How do you get there? What kind of fish are anglers likely to catch there? What are the fishing conditions? These are a few of the questions that you must explore before setting out on a fishing trip. Students will use a variety of resources to plan a fishing trip, including guidebooks, Minnesota DNR Lake Survey information, maps, the local Chamber of Commerce, and the Internet. The best fishing trips start with sound research and well-made plans!

Go Fish!

Lesson 6:1—Safety and Fishing at the Water's Edge
Lesson 6:2—Ice Fishing and Winter Safety
Lesson 6:4—Piscatorial Palate

Students are now prepared to "get in the habitat" and apply their knowledge and skills. During the fishing time, learning continues with an experience that includes safe, respectful fishing practices, sportsmanship, careful handling of fish, leaving no trace, and a great deal of fun! Students will bait hooks, cast and retrieve their lines, land fish, remove fish from hooks and gently release—or safely keep—their fish.

A fishing trip can encompass much more than catching fish. Investigate the fishing site with your students. The fishing trip is an opportunity to explore, observe, and identify plants and animals. While the lines are in the water, take some time to reflect on the day or just enjoy being outdoors. This is also a good time to observe people and how they interact with their environment.

Enjoy your fishing experience! You and your students can use what you learn on this trip to help you be even more successful on the next fishing trip.

Luring Fish to Bite

Lesson 6:4—Piscatorial Palate

What *do* fish like to eat? They can be picky eaters! On the fishing trip, students experiment with various bait materials. Their discoveries can provide insight into fish food preferences—and this is useful information for the next fishing trip.

Safe, Nutritious Eating

Lesson 6:5—Eating Fish

As part of a balanced and healthful diet, fish provide important nutrients, such as Omega-3s and protein, that prevent disease, promote healthy nervous systems, and keep people strong. It's important to understand the benefits of eating fish, and to know where to find—and how to critically assess—information on risks that might be associated with consuming your catch. Pollutants in the water, such as mercury and PCBs, can accumulate in fish. Students learn to use the Minnesota DNR Lake Finder and fish consumption information from the Minnesota Department of Health to evaluate and reduce risks associated with cooking and eating fish. With this information at their disposal, the students will try some fish recipes and enjoy a taste of their catch. By cooking and tasting fish they've caught themselves, students become more aware that all of our food is derived from the living things from the land and water—and that people, too, are part of the food chain.

Stewardship: Future Fishing

Service-learning Appendix

You've prepared your students to develop the skills needed to "get in the habitat," care for aquatic resources, enjoy fishing as a lifelong activity, and share their fishing skills with others, including their family and friends.

Depending on the students' interests and concerns, they could choose a service-learning project that informs neighbors of fishing opportunities in the community; monitor or clean up a local fishing stream, river, lake, or pond; work toward increasing fishing opportunities in the community by initiating a habitat restoration project; raise funds for fishing pier construction; conduct a neighborhood fishing clinic for younger, disabled, or less fortunate children; plan a fishing event for senior citizens; write a public service announcement that encourages responsible and respectful fishing for broadcast on a local radio station; or establish a community fishing sports column in the school newspaper.

Awareness, information, skills, and imagination are the only limiting factors when it comes to engaging in stewardship. Your students have experienced immersion in their local aquatic environment by learning to fish. They've been exposed to environmental concepts, issues, and problems. They've had a chance to practice investigative, analytical, and problem solving skills by completing a variety of lessons in the *MinnAqua Leader's Guide.* You've fueled their imaginations—exciting possibilities for service-learning and stewardship await!

"Many men go fishing all of their lives without knowing that it is not fish they are after."

–Henry David Thoreau

Safety and Fishing at the Water's Edge

To be safe, be prepared!

Table of Contents

Chapter 6 • Lesson 1

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Safety and Fishing at the Water's Edge

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, and 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II. Writing
A. Types of Writing:
Benchmark 1—The student will write in a variety of modes to express meaning, including: a. descriptive, b. narrative, c. informative, d. friendly letter, e. poetic.

Grade 3
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will follow multi-step oral directions.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.
Benchmark 6—The student will perform expressive oral readings of prose, poetry or drama.

Grade 4
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.
Benchmark 5—The student will perform expressive oral readings of prose, poetry or drama.

Grade 5
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.
Benchmark 6—The student will perform expressive oral readings of prose, poetry or drama.

Math
Allignment to the 2007 Minnesota Academic Math Standards coming soon. (If students complete the SPF Assessment Option #5)

Grades 3, 4, and 5
I. Mathematical Reasoning
Benchmark 1—The student will communicate, reason and represent situations mathematically.
Benchmark 5—The student will express a written problem in suitable mathematical language, solve the problem and interpret the result in the original context.

Grade 3
II. Number Sense, Computation, and Operations
A. Number Sense:
Benchmark 1—The student will read, write with numerals, compare and order whole numbers to 9,999.

B. Computation and Operation:
Benchmark 6—The student will demonstrate an understanding of the multiplication facts through 10 using concrete models.

Grade 4
II. Number Sense, Computation, and Operations
A. Number Sense:
Benchmark 3—The student will use fractions and decimals to solve problems representing parts of a whole, parts of a set and division of whole numbers in real-world and mathematical problems.
II. Number Sense, Computation, and Operations
B. Computation and Operation:
Benchmark 4—The student will demonstrate mastery of multiplication facts for the numbers 0-10, without a calculator.
Benchmark 5—The student will use multiplication and division of whole numbers to solve simple real-world and mathematical problems.

Grade 5
II. Number Sense, Computation, and Operations
B. Computation and Operation:
Benchmark 1—The student will use addition, subtraction, multiplication and division of multi-digit whole numbers to solve multi-step, real-world and mathematical problems.
Benchmark 4—The student will multiple, without a calculator, a two-digit whole number or decimal by a two-digit whole number or decimal, such as 3.2 x 3.4.

History and Social Studies

Grades K-3
VII. Government and Citizenship
B. Beliefs and Principles of United States Democracy:
Benchmark 1—Students will give examples of rules in the classroom/school and community, provide reasons for the specific rules, and know the characteristics of good rules.
Benchmark 2—Students will explain that rules and laws apply to everyone and describe consequences for breaking the rules or laws.

Grades 4-8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 3
III. Earth and Space Science
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will measure, record, and describe weather conditions using common instruments.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 6 • Lesson 1

Safety and Fishing at the Water's Edge

Grade Level: 3-5
Preparation Time: 30 minutes
Activity Duration: Part 1: 60 minutes
Part 2: 90 minutes, plus travel time
Group Size: any
Subject Areas: Health & Safety, Physical Education, Science, Social Studies, Language Arts
Academic Skills: application, calculation, demonstration, identification, kinesthetic concept development, listening, recognition, writing
Setting: Part 1: indoor or outdoor gathering area
Part 2: water body
Vocabulary: dehydration, hypothermia, PFD, respect, responsibility, severe thunderstorm warning, severe thunderstorm watch, snagged, SPF
Internet Search Words: biting insects, exposure, first aid, fishing ethics, fishing safety, handling fish, invasive species, Minnesota fishing regulations, poisonous plants, SPF, UV radiation, water safety, weather safety

Instructor's Background Information

Fishing is fun! In order to create an enjoyable experience for your students, be sure to plan for safety. *Safety is always the first consideration for any fishing trip.* Even for the most experienced anglers, outdoor safety precautions are a priority. This lesson includes safety precautions to consider as the class *prepares* for its fishing trip as well as safety precautions to take *while* fishing at the water's edge.

Part 1: Safety and Preparing for the Fishing Trip
Outdoor skills and fishing skills vary from person to person. It's important to take the time to develop your safety plan so that your fishing experience is safe and enjoyable for everyone. If you haven't fished yourself, and the prospect of taking your students fishing seems daunting, enlist help from people who do fish, or from some people who can help supervise. Most people who fish will be eager to help, and to share their expertise and enthusiasm with a group of young future anglers!

When taking groups of students on a fishing trip, safety is a priority for everyone, but the program leader or lead instructor should be sure that safety is taught, and that safety procedures are followed before and during the trip. Involve the students in choosing a safe site and

Summary

A safe fishing trip begins long before you head to your site. For safety, survey the site prior to your class fishing trip. Create a safety plan. Discuss safety procedures and explain safety equipment. Be sure students know how to cast, handle fishing equipment, and fish safely. Be aware of and respect the space of others using the water resources.

Students will help choose a safe fishing site and write a safety rap, song, or poem with safety rules and tips for the trip. Then, they'll put their skills and planning into action and have fun fishing!

Student Objectives

The students will:

1. Participate in a discussion on how to pick a safe fishing location and create a fishing site safety checklist to use in identifying a safe shore-fishing location.
2. Demonstrate respectful and responsible behavior during pre-trip planning and during the fishing trip.
3. Select appropriate safety rules to follow for a fishing trip, incorporating the rules into a safety, rap, song, or poem.
4. Identify and properly use safety items brought to the fishing site.
5. Evaluate whether the class fishing trip included adequate planning and safety considerations, making any necessary adjustments for future fishing trips.
6. Have a safe and successful fishing trip!

Materials

Part 1: Safety and Preparing for the Fishing Trip

- Cell phone
- First aid kit
- Drinking water
- Cups
- Throwable personal flotation device (PFD) attached to a rope at least 50 feet long
- Additional personal flotation devices (PFDs), as needed
- Map of local fishing site
- **Don't Get Hooked Sheet**
- **Safety and Site Evaluation Form**
- **MinnAqua Program Water's Edge Safety Overview**
- Sunscreen, 15 SPF or higher
- Hats, with brims
- Insect repellant
- Comfortable clothing (that can get dirty): long sleeved shirt, jacket, long pants
- Sturdy shoes, such as hiking shoes or tennis shoes (no sandals or flip-flops)
- Polarized sunglasses with UV protection
- Whistle, attached to a lanyard

Part 2: Fishing Safely at the Water's Edge

- Fishing rods and reels, rigged and ready to go, one per student
- Adult chaperones, one for each group of five to ten students
- Needlenosed pliers or forceps for removing hooks from fish, one per adult
- Fingernail clippers for cutting line, one per adult (may be attached to lanyards)

continued

Words to Remember While Making a Safety Plan

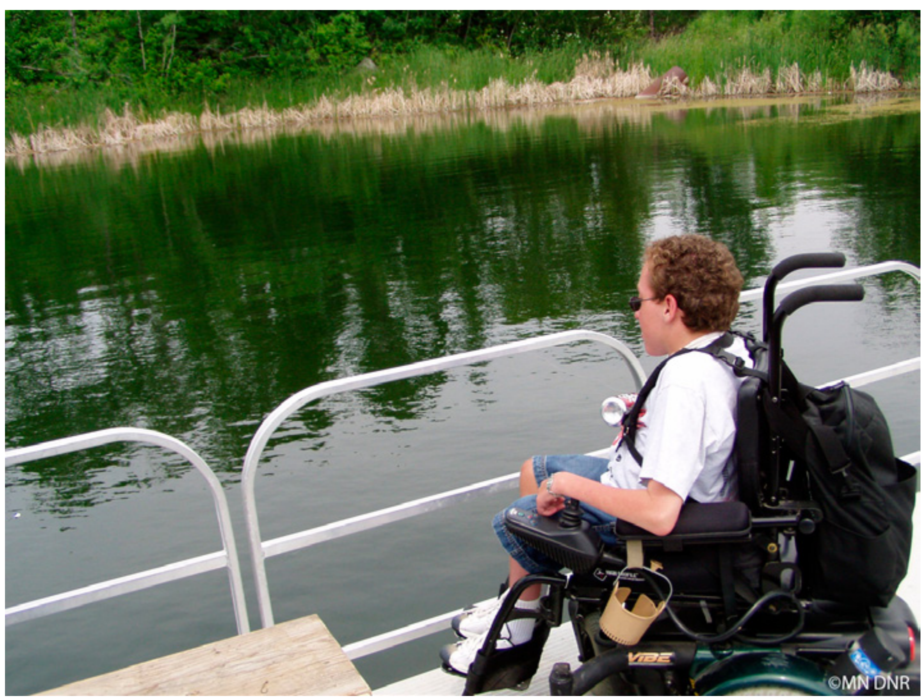
Respect: showing special attention, concern, or consideration for something, or having a high regard or esteem for something. Respect is central to all safety considerations. Safety involves respecting self, others, other living things, the environment, and equipment.

Responsibility: accountability, reliability, and trustworthiness. Practicing safety is a display of responsibility

determining safety rules and angling etiquette to follow during the trip. Be certain that students understand why rules are necessary, and have them suggest and agree to the rules as a group. By involving students in the creation of your safety plan, you're not only securing their help in ensuring a safe trip, you're also helping them develop lifelong safety habits.

Enlist the help of other instructors, parents, or adult volunteers to adequately supervise the group. Never take a group of students to a body of water by yourself. Safety precautions must be taken every time you're near the water. Water doesn't have to be deep to be dangerous. Be aware of allergies or other special needs your students may have.

Complete any permission slips that your organization, school or district requires, and bring along emergency contact information for every participating student.



If your trip includes people who use wheelchairs, look for piers with low or interrupted railings. Along streams, look for sites with bumper rocks.

Selecting the Site
Be sure to choose a safe and productive fishing area along the shoreline of a pond, lake, or stream. If possible, visit the site prior to your scheduled fishing trip to survey the area. If you can't do this in advance, contact your local park district or city offices for information on the site.

Things to Check and Plan When Choosing a Fishing Spot

Check on	Plan for
Water near dams and reservoir releases can be deep, with strong and unpredictable currents. Avoid choosing these areas as fishing spots.	A safe, productive area along the shoreline of a pond, lake, or stream.
Accessibility to water. Are trails, fishing platforms, or piers available?	Students' special needs for access to the site
Fast-moving water—it can be dangerous.	Moving water. If fishing on a river or fast stream, position an adult downstream from the group to mark a boundary and aid in rescue if someone should fall in upstream.
Overhead branches or other obstacles that could catch hooks as anglers cast.	Open area for safe casting.
High, steep banks.	Fish only on low banks that gently slope to the water access/fishing site.
Adequate shade.	Shelter in case of inclement weather (sun, cold, heat, wind, rain, hail, lightning, tornadoes). Or, keep buses onsite during trip. If weather becomes threatening, you can come back to fish on another day.
Mud, or wet or slippery footing.	Dry, secure footing.
Beach or swimming areas—these aren't good spots for fishing.	Fishing, not swimming. Fish at a distance from beaches for public safety and to keep lost hooks out of swimming areas. Good fish habitat includes aquatic plants, submerged logs, rocks, brush piles, stumps, docks, or piers. Many of these things are usually removed to create swimming areas.

continued

Materials (continued)

- Bait—choose one, or a combination of the following:
  - angleworms or nightcrawlers, two per student
  - wax worms, three per student
  - minnows, three per student
  - extra bobbers, sinkers, and hooks
- **The Perfect Rigging Sheet**
- **Safe Angler Certificate Sheet**, one per student
- Pens or pencils
- Clipboards
- Stringer and ice cooler (if you plan to keep fish)
- Minnesota fishing regulations booklets
- Fishing licenses for anyone 16 and older, including adult helpers
- First aid kit and safety items discussed in Activity 1

Optional assessment materials
- **Factoring in SPF Sheet**, one per student
- Pencils or pens

If your site is on private property, always secure permission from the landowner prior to your trip. Write down and save the owner's name and address so your class can send a thank-you card after the trip.

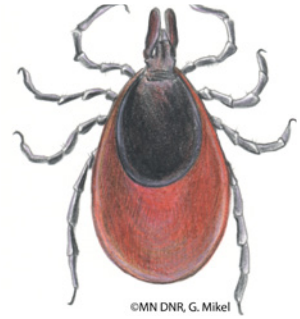
Check on	Plan for
Check weather conditions and forecasts.	Remain informed of weather conditions. Be aware of approaching storms. A **severe thunderstorm watch** is issued when severe thunderstorms are possible in an area. A **severe thunderstorm warning** is issued when a severe thunderstorm occurs in an area.
Rain	Schedule an alternate date for your fishing trip in case of rain.
Lightning	Don't fish in lightning. Carbon fiber rods, lead-cored lines, and all wet tackle conduct electricity. Seek shelter.
Sun—the sun's ultraviolet (UV) rays can cause burns on both sunny and overcast days. The sun's reflection on water can also make it difficult to watch a bobber or to look under the surface of the water.	Shaded areas. Provide frequent shade breaks to let students cool off and get out of the sun to avoid sunburn and **dehydration** (losing too much water). Bring along and use waterproof sunscreen with an **SPF** (sun protection factor) of at least 15. Students should wear sunglasses, polarized if possible, and a hat with a brim to shield eyes from the sun. Sunglasses and hats will also help protect eyes and ears from any misguided hook scratches or punctures, especially when fishing on windy days.
Cold	Refer to **Lesson 6:2—Ice Fishing Safety** to prepare for cold weather conditions.
Hypothermia	**Hypothermia** occurs when the body loses heat faster than it can produce it. Hypothermia can occur in any weather, and at any temperature lower than 98.6° F. When a person gets wet, the water conducts heat away from the body 25 times faster than air. Staying dry is as important as staying warm.
Restrooms—available, open, and stocked.	Bring extra toilet paper.
Running water available for washing hands.	Bring soap or antiseptic wipes.

continued

Check on	Plan for
Running water available for drinking (or bring drinking water).	Have water available to students and provide frequent water breaks to prevent dehydration. Avoid beverages with high sugar content or caffeine, which increase the risk of hypothermia.
Biting insects, including black flies, deerflies, horseflies, stable flies, and tiny biting midges (no-see-ums), and, lest we forget, mosquitoes! Chigger and deer tick bites should be avoided, too.	Use repellant and wear long sleeves and long pants to cover skin, and provide some protection from insect bites. Avoid brushy, wooded places from mid-May through mid-July when the risk of Lyme's disease-causing deer tick bites is high. Use a tick repellant containing permethrin or DEET on clothing.
Poisonous plants.	Survey the site for plants such as poison ivy, poison oak, poison sumac, stinging nettles, and wild parsnip. Be certain that students could avoid these plants if present in the fishing area. The poisonous oil (urushiol) covers the entire plant including leaves, berries, and stems. Active year-round, this oil causes an allergic rash in 85% of us.
Be familiar with any student allergies.	Bring along emergency contact information and a plan to follow if a student suffers a reaction.
Know the location and phone number of the nearest hospital or emergency treatment facility.	Bring along emergency contact information for your students.
Is cell phone coverage available at the site?	If your cell phone won't work at the site, make an alternate plan for calling 911 or emergency contacts for students should the need arise.
Ratio of adults to students on the trip	We recommend a ratio of one adult for every five to ten students.

Pack These Items in Your First Aid and Emergency Kit

- local map
- extra sunscreen and insect repellant
- extra drinking cups for water
- throwable PFD (personal flotation device) with 50 feet of rope securely attached
- life jackets or PFDs, as needed
- emergency whistle attached to a lanyard



Female Deer Tick

Male Deer Tick

Chigger

To help you identify poison ivy, remember this saying: "Leaves of three, let it be!"

Choose a place where there will be fish to catch! Look for good fish habitat. Areas providing cover and shade for fish include aquatic plants, submerged logs, rocks, brush piles, stumps, docks, or piers. Find out which species of fish may be caught at the site by checking the Lake Finder area of the DNR website, or by checking with your local DNR Fisheries office.

Adults can take youth under the age of 16 fishing without a license twice a year during Take a Kid Fishing weekend and Take a Mom Fishing weekend. Check the fishing regulations booklet or DNR website for dates.

- band-aids, bandaging tape, antiseptic ointment, scissors, gauze, rubber gloves, plastic bags, twist ties
- paper cup to cover and protect embedded hook injuries
- cell phone, if coverage will be available at site
- other items, as needed

Clothing

Proper clothing can make the trip safer and more comfortable for your students. Tell them to dress for the weather in comfortable clothes that can get dirty. Light-colored clothing, long-sleeved shirts, and long pants provide protection from sun and insects. Lightweight clothes prevent overheating on hot days. Layered clothing provides insulation in colder weather. A windproof outer shell provides better protection and heat retention than an outer shirt or sweatshirt. Students can always remove a layer or two if they get too warm, or if the temperature rises.

Sturdy shoes, like tennis shoes, reduce the chance of turning an ankle on uneven terrain, and protect sensitive feet from rogue hooks. Students should wear sunglasses, polarized if possible, and a hat with a brim to shield their eyes from the sun. Sunglasses and hats can also protect eyes and ears from any misguided hook scratches or punctures, especially when fishing on windy days. Hats and other head coverings prevent heat loss and keep students warm on cold days.

Sunscreen

Wear sunscreen. Ask each student to bring waterproof sunscreen with an SPF of at least 15. Be especially certain that students apply sunscreen generously to their noses, ears, and necks. A lip balm containing sunscreen is advisable, too. After applying sunscreen or insect repellant, students should thoroughly clean the palms of their hands to avoid getting sunscreen or insect repellant on bait or tackle. Unusual tastes and smells can turn very appealing bait or lures into something a fish would prefer to avoid.

Part 2: The Fishing Trip and Safety at the Water's Edge

It's a good idea to enlist, in advance, the help of experienced anglers. All adult helpers must have a fishing license. When taking a group of students fishing, you should bring along an adult certified in first aid and CPR. Some school districts require that a water safety instructor or lifeguard accompany groups of students planning to be near water.

Take time to think—in advance—about the various elements of a safety plan: the things you'll do to keep everyone safe. Don't take any unnecessary risks.

Implement Your Emergency Plan

- Post one adult near the safety equipment (first aid kit, throwable personal flotation device (PFD), water station, sunscreen, insect repellant).
- Decide which adults should cover these distinct responsibilities in the event of an injury, illness, or other emergency.
    - At least one adult should remain with the class or group, caring for the rest of the students and maintaining order
    - One adult should be assigned to get help, if needed.
    - One adult should stay with any ill or injured student.
- Be prepared to offer any emergency help needed—without putting yourself in an unsafe situation. Stay near an emergency scene only if it's safe to do so.

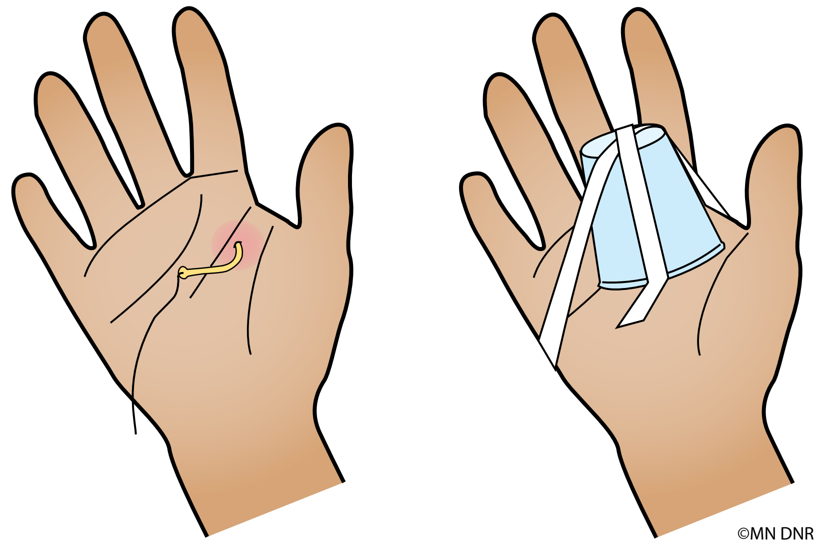
Hook Safety

Hooks are sharp! Make sure everyone is well-aware of potential injury from fishing hooks. A few common-sense practices will ensure that no one accidentally gets hooked.

- Consider using barbless hooks or use pliers to flatten barbs.
- Tell students that they will be responsible for knowing where their hooks are at all times.
- Never run when holding a fishing rod.
- Always keep the hook secured to the rod. Don't walk with a fishing rod pointed in front of you—carry it in a vertical position.
- Practice how to cast safely.
- *Always* look behind you before casting!
- While fishing, keep hooks and lures out over the water, and don't crowd others. Ask for help with freeing snagged lines.
- Wear a hat and sunglasses to protect your eyes, ears, and head from wayward hooks.

Puncture wounds hurt, and they can cause infections or tetanus. Hooks aren't always clean, and they can be rusty. Antibiotics and a tetanus shot are recommended for hook puncture injuries. Always thoroughly clean and disinfect any wound, cut, or scrape caused by a hook. If a hook sticks someone, but doesn't penetrate the tissue deeply enough to go past the barb, the hook can be removed by gently backing it out in the direction that it entered the skin. Treat minor cuts and scrapes from hooks by cleaning the wound and applying antiseptic ointment and a band-aid. A doctor should treat deep puncture wounds.

If a hook punctures the skin and the barb becomes embedded, or punctures tissue in the face, a medical professional should remove it. Attempting to remove an embedded hook yourself can cause further damage to the injured tissue. Cover the embedded hook or lure with a paper cup or tape to protect the area, and get the victim to a hospital or emergency clinic as soon as possible.



Immobilize an embedded hook by covering the area with an overturned paper cup, tape, or both.

Baiting the Hook

Students will achieve a sense of independence by baiting their own hooks. This will also save you a great deal of time—time better spent watching the group, sharing the students' excitement as they reel in fish, or taking memorable photos. Some students may be apprehensive about handling live bait at first, so your positive attitude will be important in encouraging them to bait their own hooks.

Wax worms, angleworms, and nightcrawlers are excellent bait choices for most types of shore-fishing, and they're easy to obtain from bait shops. Minnows can be used, too, but they're harder to keep alive. If you're using angleworms or nightcrawlers, pinch, tear, or cut them into two or three smaller pieces when fishing for sunfish. Sunfish have small mouths!

Bait your hook with a nightcrawler, angleworm, mealworm, or minnow.

Place bait securely on the hook. Thread worms or a worm piece by hooking through it two or three times. Teach students to lay their rod down while baiting the hook. It's much easier to maneuver the slippery or wiggly bait onto a sharp hook with both hands when not holding on to the rod, too. Remind students to pick up any dropped fishing hooks to prevent others from stepping on sharp hooks. Also remind them to pick up all unused or cut pieces of fishing line so animals don't get tangled up in it. Many bait and tackle shops recycle monofilament line.

Discarding Unused Bait

It's illegal to discard unused bait into the lake or onto the ground. Leftover bait should be saved for another day of fishing. Or you may dispose of any unused bait (nightcrawlers, minnows, etc.) in a container in the trash. Don't discard it into the water, near shore, or on land. Worms aren't native to Minnesota, and worms and other bait can be harmful to native plant and animal communities. Throw unused worms in the trash or save them in your refrigerator for another day. Unused minnows may be buried in your garden. Bait species may harbor diseases that can be transferred to other organisms in the water.

It's also illegal to transport any live fish that you catch unless you have a permit obtained from the DNR, or you are under 16 and using them in a home aquarium—and they are the species listed in the DNR's Minnesota fishing regulations booklet under "Possessing and Transporting Fish." Read the regulations booklet to become familiar with regulations designed to prevent the spread of aquatic invasive species.

Invasive Species

Invasive species are plants and animals that aren't native to a particular area. They can be harmful to native species. To protect and ensure the safety of native species, check to see if the fishing site is posted for the presence of exotic species. You'll need to take extra care in cleaning all fishing lines and equipment before leaving the fishing site to remove any plant material, eggs, larvae, or tiny organisms. This prevents invasive species from spreading from one place to another.

Equipment and Casting Safety
Make sure all fishing equipment is in good working order before the fishing trip. Let students know that it's important to respect equipment and to handle it with care if they want it to help them catch fish!

Students may own their own rods and reels. If they plan to use their own equipment, consider collecting it a few days prior to your event to make sure it's in good working order. If necessary, refer to the Fishing Rod and Reel Maintenance Q&A at the end of **Lesson 5:2—Casting a Closed-face Rod & Reel Combo**.

When carrying a rod, hold it vertically.

At the site, set up a fishing equipment and bait station, so rods and bait can be distributed and collected in an orderly fashion. The station should also be stocked with hooks, weights, and bobbers.

Before handing out fishing equipment, remind students how to hold a rod. First, secure the hook by hooking it into the hook keeper or a low line guide. Grip the rod just above where the hook is secured to prevent it from loosening. Hold the rod vertically to keep the rod tip from hitting another person. Remind students never to run with fishing rod in hand.

Bring along a couple of spare rods in case someone's rod jams or breaks during the fishing trip. Swapping a malfunctioning rod for one in good working order simply prevents unnecessary frustration and lost fishing time!

When students return equipment to the station, they should do so in an orderly fashion, without running, and carrying rods vertically with hooks secured.

Casting
Before your fishing trip, have students practice casting with a casting plug tied to a fishing line instead of a hook. Set up some scenarios to demonstrate how accidents can happen while casting. Have students practice safe casting skills. For specifics, see **Lesson 5:1—Freshwater Rods and Reels** or **Lesson 5:2—Casting a Closed-face Rod and Reel Combo.** When every student consistently demonstrates safe casting, you're ready for the fishing trip!

On the trip, each student should carefully choose a casting spot on the shore or on a pier. Before you cast, always:
- look behind you for people, pets, bushes, tree branches, power lines, or other obstacles that could get hooked
- if necessary, move a safe distance away from any potential obstacle
- look in every direction

- check behind yourself again, before you cast
- look in the direction of, and beyond your cast, too
- watch for swimmers, waterfowl, water plants, and submerged branches in the water—never cast directly toward another person

Snags

It is always possible for a cast to veer off-target and become **snagged** on a branch or elsewhere above or below the water's surface. Tell students to ask an adult to help them with a snagged line.

Move close to a snagged hook that is within your reach to try to free it by hand first. If the hook isn't within reach, don't pull on the line with your hand. Monofilament line can very easily cut fingers and hands. Lock your line by reeling forward, tighten the drag, point the rod tip toward the stuck hook or lure, and slowly and steadily reel in the line tightly—but not too tightly! Pull the rod straight back, but hold the rod handle out at an angle away from yourself. Don't pull the line toward you. Turn your head and look away before you pull back: you'll be able to feel the hook come free, or the line break. Don't jerk the rod—this can cause the hook to fly through the air. Keep everyone out of the way, just in case the hook does fly.

If the hook won't come loose after a few tries, you may need to cut the line. If this happens, just re-rig the line and start fishing again.

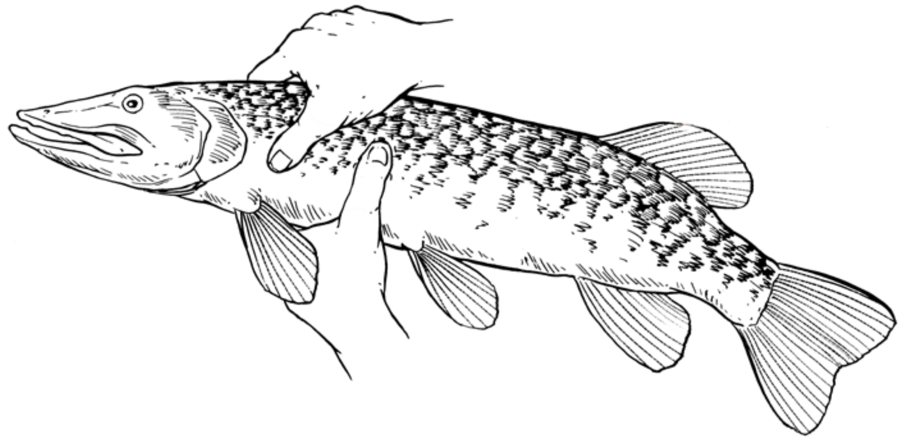
Handling Fish Safely

Teach students how to identify fish. Which ones have sharp teeth, gill covers, or spines that they must avoid? Teach students how to handle these fish carefully to avoid punctures, cuts, and bites from sharp teeth! Proper handling also helps minimize injuries to fish. Anglers have a responsibility to respect and protect aquatic resources, including fish.

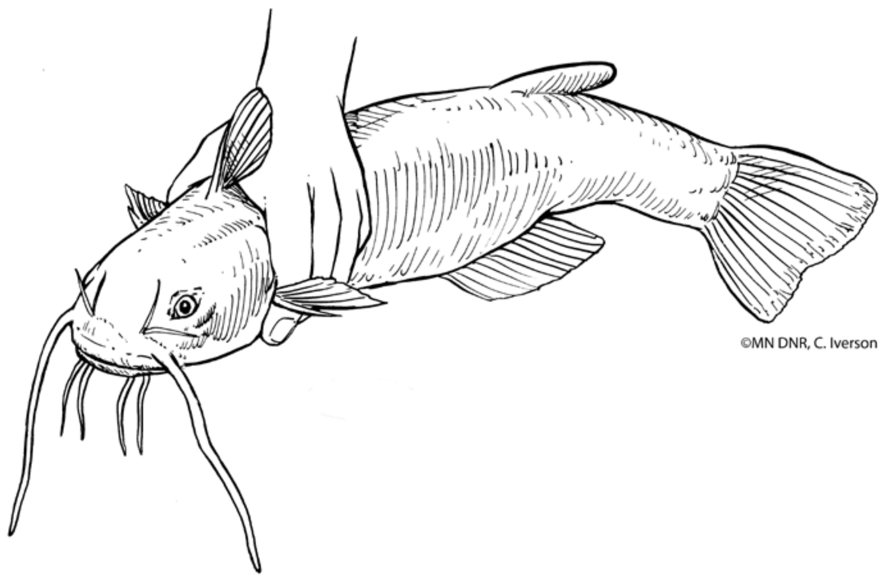
Tips for handling fish responsibly:

- Use non-lead sinkers and tackle. Lead is toxic. When waterfowl or other birds and small animals ingest lost tackle, they can be poisoned by the lead and die.
- To reduce the probability of having a fish swallow the hook, teach students how to set a hook when they get a bite, or use circle hooks.
- Reel in the fish quickly to avoid excessive tiring, especially when you plan to release it.
- Always wet your hands before handling a fish to minimize disturbance to the protective slime that covers its scales. The slime protects the fish from diseases and parasites. The slime doesn't stick to wet hands.
- Keep the fish in the water as long as possible. Quickly return the fish to the water after handling.
- Wait until the fish is calm before lifting it from the water and removing the hook.

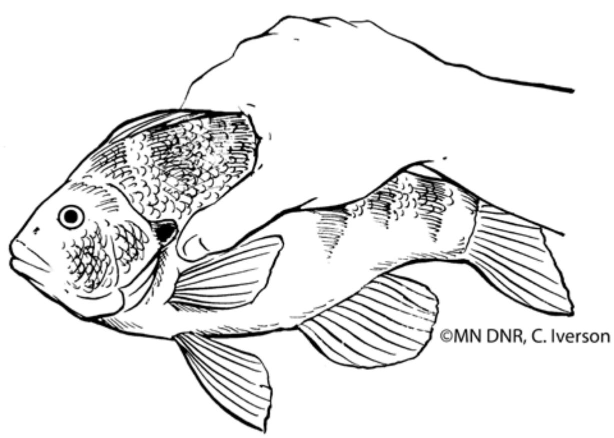
If taking students fishing for the first time, it helps to use circle hooks. The point faces the shank and is designed to hook the fish in the mouth as it turns to swim away rather than having to set the hook and rely on a quick response. Fish are less likely to be throat-hooked with circle hooks. This can reduce hooking mortality for catch-and-release. If circle hooks are available in your area, buy ones with long shanks that make them easier to handle.



Muskellunge, northern pike, and walleye have big teeth! Avoid holding them near their mouths.



Catfish and bullheads have thick, sharp spines in their dorsal (top) and pectoral (side) fins. Be careful not to let them pierce your skin.



Smooth the spines in the dorsal fin of a sunfish from nose to tail.

Removing the Hook
Use needlenosed pliers, forceps, or a hook remover to remove hooks quickly and with care.

If the fish swallows the hook, cut the line, and leave the hook in the fish. Attempts to remove a deeply-embedded hook will extensively injure the fish. The fish's stomach acids will dissolve a hook.

Release Fish Gently
If you aren't keeping the fish, quickly and gently ease it back into the water. Let the fish swim away after water flows over its gills and it recovers. Handling the fish quickly, safely, and gently will give it a chance to grow bigger so it can be caught again on another day!

You can obtain the Minnesota DNR's detailed catch-and-release brochure from the DNR Information Office by calling 1-651-296-5481 or 1-888-646-6367.

Keeping Fish Fresh
Remember that fish decay quickly after they die, especially in the heat. Bring a chest filled with ice to keep the fish cold until you're able to clean them. Fish should be cleaned as soon as possible after they're caught, and kept cold until they're cooked. Fish should be frozen if you don't plan to cook and eat them immediately. Wrap and label packages for freezing, noting contents, quantity, and date. Frozen fish can be kept for as long as three months, and should be thawed in the refrigerator—never at room temperature.

Consider Other Anglers and Recreationists
Other anglers may also be fishing at your chosen lake, river, or stream. Always give them plenty of room, and respect their space. Students should be friendly, courteous, and quiet so they don't disturb the anglers—or the fish they're trying to catch.

Anglers aren't the only users of lakes, streams, and rivers. When fishing, students should be respectful, polite, and patient with swimmers, canoeists, bird watchers, walkers, and others enjoying the resource. Avoid casting near private docks with sunbathers, or near others enjoying the lake or stream.

Protect and Respect the Environment
Remember to be a steward of the environment you visit. Follow rules and regulations, stay on trails, pack out trash and any cut or broken monofilament line. Heed the saying "Leave no trace!" by leaving your site as clean—or cleaner—than you found it.

Harvesting Fish
Before the fishing trip, decide whether to keep or release the fish that the students catch. MinnAqua encourages catch-and-release fishing. But instructors can choose to keep fish if they practice proper use of the resource, including handling, transportation, preparation, and good use (harvesting the amount actually needed for a meal rather than taking extra fish that will go to waste).

Is My Fish Safe to Eat?
Check the Minnesota Department of Health website for information on toxins and Minnesota fish consumption advisories. Following the recommended guidelines for fish consumption will reduce the known health risks posed by consuming fish from polluted waters.

Have Fun

Most students are satisfied with catching a greater number of smaller fish, such as bluegills, rather than catching a few big fish. Catching a few fish on the first outing will pique students' interest and make them look forward to the next trip. Fishing piers and shoreline areas with nearby aquatic plants are good places to catch small sunfish like bluegills.

Some students may want to fish all day. For others, 30 minutes is long enough. Plan for about 90 minutes—this is long enough to get organized and fish for about an hour and should satisfy everyone.

Emphasize that fishing is fun and catching a fish is an added bonus. You can always go fishing again! Instill good conservation habits by picking up litter, following regulations, and carefully returning fish to the water if you don't plan to eat them.

With good planning, everyone can have a safe, fun, and successful fishing trip!

Procedure

Preparation

1. Know and follow the safety policies of your school or program. Some school districts may require that you have a certified water safety instructor (WSI), lifeguard, or certified medical professional present if students are to attend activities at a water body.
2. Pack a backpack with a jacket or raincoat, hat, sunglasses, sunscreen, bug spray, and water bottle.
3. Obtain items on materials list, and check and restock your first aid kit.
4. Obtain required parent/guardian permission slips.
5. Schedule adult volunteers to assist with the fishing trip (one adult for every five to ten students). You may want to secure backup volunteers in case anyone must cancel at the last minute.
6. Learn about and prepare for any allergies or special needs of students and participants.
7. Choose a fishing site. Visit the fishing site and complete the **Safety and Site Evaluation Form.**
8. Post the **Don't Get Hooked Sheet** in the classroom.
9. Make copies of the **The Perfect Rigging Sheet.** You may want to laminate these for future use.
10. Make copies of the **Safe Angler Certificates**, one per student, and the **Factor in SPF Sheets** if your students will be completing Assessment 5, one per student

Activity

Part 1: Safety Before the Fishing Trip
Warm-up

1 Have students create a checklist for determining the safety of a fishing site. Prompt them to include safe access and footing, water conditions, poisonous plants, availability of shade, water and restrooms, overhanging branches or other obstacles that could impair casting. How would they plan for weather considerations?

2 Emphasize that fishing is a safe activity, but that accidents can happen during any activity. Explain that you will need their help in planning the trip, and that safety precautions must be taken ahead of time. Ask students to brainstorm a list of other safety factors to consider before a fishing trip. List their suggestions on the whiteboard or overhead projection device. The list could include rain, lightning, clothing, sun, overheating, hypothermia, hydration, staying dry, staying in boundaries, water safety, sharp hooks, safe fish handling, poisonous plants, insects, allergies, casting, animals, avoiding fast water, and others.

3 Discuss the importance of preparing for and preventing possible accidents involving the factors on both lists. Ask students for ideas on how to plan for each consideration on the list before the trip. On the whiteboard, write appropriate suggestions next to each item on the list. For example, next to "sun," write "wear sunscreen and sunglasses;" next to "water safety," write suggestions like "be careful near the water, use fishing piers and platforms for shore fishing, take a break in the shade if you get hot, bring along a throwable PFD, wear a life jacket if you can't swim," and so forth. Ask students why safety rules are necessary. Remind them that you want them to have fun rather than injuries or accidents during the fishing trip. Be prepared to help others without risking your own safety.

4 No one should ever go fishing alone, and you should always tell someone where you plan to fish. Stress the importance of the buddy system for anglers. Ask students to name one or two people that could accompany them on a future fishing trip—a parent, friend, grandparent, sibling, neighbor, aunt, or uncle. For the group fishing trip, pair each student with a classmate, or have students choose fishing buddies.

Lesson

1 Discuss what to wear and personal items to bring on the fishing trip. To demonstrate the items students should bring, use a backpack packed with a jacket or raincoat, a hat, sunglasses, sunscreen, bug spray, and water bottle. Pull items one at a time out of the backpack and discuss the safety importance of each one. Talk about dressing for the weather and wearing proper footwear.

You may wish to make up cards on hypothermia, clothing, sun, heat emergencies, and other safety situations, and give them to groups of three students. Have the groups review the information on the cards and share or act out the information for the rest of the class.

Everyone in the group should plan to shout the word "Danger!" in case of emergency. Shouting "Help!" is less clear because, often, students will be asking adults for "help" when they have lost bait, have a fish on a line, or a snagged line. Tell students that, when anyone hears "Danger!" adults and students understand that there is an emergency, and will immediately launch the emergency plan.

2. Discuss safety precautions to follow near water. Teach the students what to do if someone falls in the water—to shout "Danger!" Tell an adult. Don't go into the water after the victim—an adult will grab the throw-able PFD from the safety station to toss to the person in the water. Make sure the rope is securely attached. Hold on to the end of the rope with one hand and toss the flotation device past the victim, and carefully pull PFD to victim. The victim should grab the rope or flotation device, and hang on until they're safe.
3. Tell students they will help develop a safety plan for their fishing trip. They will incorporate their safety rules into a rhyming poem, rap, or safety song. In pairs (with their fishing buddy) have students write the poem, rap, or safety song. Students may refer to the safety list on the whiteboard. Ask each pair to perform their piece for the class. You may have the class vote to judge the best piece (the one with the most complete safety information) or combine all of the poems, raps, and songs into one that includes all the safety items you want the students to remember.
   Some rules to include:
   - Never run with fishing rod in hand.
   - Look behind you before you cast, and then look forward in the direction of your cast.
   - Always know where your hook is.
   - Stay with your buddy, and within designated boundaries.
   - Don't wade or swim.
   - Wear a PFD (if this is your school policy).
4. Help the class learn the final safety rap, poem, or song. Distribute **Safe Angler Certificates** to students upon demonstrating they have learned the class fishing safety poem, rap, or song.
5. Practice casting. For instructions, see **Lesson 5:2—Casting a Closed-face Rod and Reel Combo**.
6. Discuss how to identify and properly handle fish.

Wrap-up
Practice the poem, rap, or safety song. Have students perform their pieces for another group, class, or for parents to reinforce, teach, and demonstrate rules ensuring safety at the water's edge while fishing.

If possible, have students accompany you on visits to two or more nearby water bodies or several locations on a particular lake or river. At each location, they should consult their checklist to determine the safest site for shore-fishing. Use the safest site for your class fishing trip. Point out that the students now know how to look for good shore-fishing sites for future fishing trips.

Part 2: Fishing Safely at the Water's Edge

Warm up

1. Do a buddy check, and set boundaries. Tell students they're not to go outside the boundaries, and that they should remain with their buddies at all times.
2. Discuss the use and location of safety equipment, including the water station, first aid kit, shade, shelter, bathroom, and throwable PFD.
3. Blow your whistle and let students know that the whistle blast means that you need everyone's attention. For example, you might blow the whistle if inclement weather approaches, another safety concern has arisen, or it's time to pack things and return to school. When students hear the whistle, they should locate their buddies, stop all noise and activity, and wait for directions from the instructor or leader.
4. Discuss techniques for helping a person in danger, and what the students should do to make the rescue go smoothly. Students should be reminded to shout "Danger!" to attract the attention of an adult during an emergency. Tell students that, when anyone hears "Danger!" adults and students understand that there is an emergency, and will immediately launch the emergency plan.
5. Practice shouting "Danger!" loudly as a group. Stress the importance of stopping all unrelated activity and talking whenever someone shouts "Danger!" or blows the whistle. The nature of the emergency must be identified immediately, and addressed by adults. Everyone else's safety must be considered, too, and the cooperation of everyone in an emergency or dangerous situation is essential.
6. Review the safety rules (have students recite the safety poem or rap, or sing the safety song).
7. Know the specified emergency roles for each adult. Be aware of who will carry a cell phone.
8. Non-swimmers and those students whose parents have requested life jackets or personal flotation devices (PFDs) must wear them. Near deep, fast-moving, or very cold water, everyone should wear a PFD. Demonstrate the proper use of life jackets: choose one that fits, show students how to put it on, secure a snug fit, and how to remove it. If someone is required to wear a PFD, demonstrate proper fit to the entire class. Have two PFDs available, a very large one and another that's the correct size. Put the large one on a student volunteer, buckle it, and pull it off over their head to demonstrate its ineffectiveness. Then demonstrate how to wear the proper-sized PFD: securely and snugly, with all buckles and belts fastened.

Only adults should use the throwable PFD and rope. Keep the attached rope coiled, so it can be easily thrown. Introduce the adult in charge of each group. (You may want to assign one adult to each group of five students.)

Lesson

1 Review the proper handling and carrying of rods. Review casting safety.

2 Review hook-handling safety. Demonstrate baiting the hooks. Ask students who have fished to demonstrate baiting a hook. Encourage students to bait their own hooks as they become comfortable.

3 Demonstrate how to land a fish. Have one volunteer be a bass, one a bluegill, and another an angler. Let the fish "swim" near "cover," such as hula-hoops or another target easy to cast toward. Using a casting plug, the angler gently casts the plug near the "cover." The appropriate fish takes the bait (by holding it in their hands). Talk the angler through the landing of this fish. For example, is the fish diving for the bottom? Keep tension on the line, and slowly feed some line to the fish to avoid breaking the line. Is the fish swimming toward you? Reel your line in quickly to keep the line taught! Demonstrate this a few times. Remind the group not to drag the fish across the ground or pier when it's landed.

4 Using a replica (felt cutout, pillow, or mount) or a real fish, demonstrate the proper way to hold the fish while removing a hook. When handled gently, quickly, and with a few precautions to have the fish out of the water for the shortest possible time, released fish have excellent chances of surviving. Handling tips are detailed in the Minnesota DNR brochure, *Catch and Release*, which is available from your area fisheries office or the DNR Information Center (1-888-MINN-DNR). Always wet hands to help keep the slime covering intact. Emphasize that, unless fish are to be eaten—or, occasionally, prepared as trophy mounts—they should be immediately released unharmed into the lake. The fish will then grow bigger to be caught on another day. This voluntary recycling of fish helps maintain Minnesota's quality fishing.

5 Show students **The Perfect Rigging Sheet**.

6 Show or review what the bobber does to tell anglers that they're about to catch a fish.

7 Discuss with the students what can be done to prevent injury if the fish is hooked so deeply that removing the hook would hurt the fish.

8 Ask the students, "What if your hook gets stuck on a branch, log, or rock in the water?" (Students should ask an adult to free the line. Don't jerk the line; warn others nearby that you're trying to free a snag; look away, and slowly and steadily pull your pole straight back at an angle away from yourself. Sometimes hooks can fly through the air when freed. Cut the line and re-rig if you can't get the hook free.)

9 Assign a small group of students to each adult helper and indicate fishing boundaries. Give each adult helper a fingernail clipper for cutting line and a needlenosed pliers or forceps for unhooking fish.

10 Pass out poles and bait. Have fun fishing! Return fishing equipment to the station.

Remember to reinforce concepts of habitat, ecosystems, fish identification, and stewardship—including picking up litter and leaving only footprints.

Wrap-up

1 After your fishing trip, ask the students questions. Which rules worked? Were you prepared? Was the trip safe? What would you plan for the next time you go fishing?

2 Ask each student to write down all the safety measures they must consider while fishing. They should include: tell someone where I am going; find a buddy (preferably an adult or older person) to go with me; find an area where there are other people during the day; gather all equipment; check the weather forecast and dress accordingly; put on sunscreen and bug repellant; decide whether to keep or release the fish I catch; know the fishing regulations; respect others, respect the fish, and be a good environmental steward.

3 You could also ask the following knowledge questions.

- What is the most important step in rigging a fishing rod? (The knot.)
- Where would you cast a line to catch sunfish? (Near cover, such as docks, plants, or fallen logs.)
- What does it mean when a bobber goes under the water? (That you either have a fish, or that your split shot sinkers are too heavy for the bobber you've chosen.)
- How should one handle a fish? (Quickly and gently. If the fish has swallowed the hook, don't try to remove it—just cut the line.)
- What is catch-and-release fishing? (Releasing fish that you don't plan to eat back into the water unharmed. This gives them a chance to grow larger, and to reproduce.)

5 If your event took place on private property, have students write a thank-you letter to the property owner. You may wish to send along copies of photos taken on your trip.

6 Have students make and send thank-you notes to the volunteers who helped on the fishing trip.

7 Provide students with **Safe Angler Certificate** and have them complete them as directed.

Assessment Options

1 Evaluate the fishing trip safety, site safety checklist, safety rules poems, raps, or songs for the following criteria: safe access and footing, water conditions, poisonous plants, overhanging branches or other obstacles to casting, weather conditions and availability of shade, water, and restrooms,

2 Have students write a fishing trip safety evaluation after the fishing trip to determine whether the class had a safe fishing trip, if the safety plans resulted in a safe trip with students demonstrating safe and respectful behavior. Identify and describe the use of safety equipment brought on the trip, including changes or additions to the site safety checklist and safety poems, raps, or songs that suggest possible improvements for future fishing trips.

3 Complete the **Safe Anglers Certificate**. Check students' answers to the questions on the certificate.

4 Have students teach another class or group how to plan a safe fishing trip.

5 Have students learn about sun protection factor ratings for sunscreen and determine the minimum SPF required for protection during various sun exposure periods. Hold up a bottle of sunscreen and tell the class that sunscreens provide important protection from harmful UV rays. Depending on one's skin type, it usually takes from fifteen minutes to a couple of hours for UV rays to cause sunburn. It doesn't have to be sunny for UV rays to cause sunburn—they can pass through clouds. "Sun sensible" people wear sunscreen on overcast days, too. Give the SPF rating on the bottle, and ask if anyone knows what the number means. For the group fishing trip, ask everyone to bring sunscreen with an SPF of 15 or greater because water reflects UV rays, increasing the risk of sunburn. Review the following with students: SPF ratings and sunscreen. SPF is an abbreviation for Sun Protection Factor. SPF numbers for sunscreen range from 2 to 50, telling users how much longer they could stay in the sun without getting burned than they could if wearing no sunscreen. For example, if one normally starts to burn after spending 20 minutes in the sun, a sunscreen with an SPF of 8 will protect that person from sunburn for eight times longer than that (160 minutes, or two hours and 40 minutes).

   20 minutes x SPF 8 = 160 minutes

   If a person normally starts to burn after 30 minutes in the sun, a sunscreen with an SPF of 8 will protect that person from sunburn for 240 minutes (three hours).

   30 minutes x SPF 8 = 240 minutes

6 Do the **Factoring in SPF Sheet**.

7 Assessment options include the Checklist and Rubric on the following pages.

Safety and Fishing at the Waters Edge Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Student can identify criteria for a safe fishing site, including footing, access to water, absence of poisonous plants, available shade, shelter, and drinking water.
3	______	______	Student can use that criteria to judge whether or not a fishing site is safe.
4	______	______	Student can define: • *hypothermia* • *dehydration* • *respect* • *responsibility*
2	______	______	Student understands the relationship between respectful and responsible behavior during trip preparation, the fishing trip, and safety evaluation.
4	______	______	Student can give an example of fishing trip-related behaviors showing respect and responsibility toward: • self • fellow students • group leaders • rules and regulations • land owners • other anglers • others using the water resource • the fish resource • the natural environment

continued

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

34-38 points = A
Excellent. Work is above expectations.

30-33 points = B
Good. Work meets expectations.

25-29 points = C
Work is generally good. Some areas are better developed than others.

19-24 points = D
Work does not meet expectations, it isn't clear that student understands objectives.

0-18 points = F
Work is unacceptable.

4	______	______	Student cooperates within group to develop a set of safety rules that help ensure a safe fishing trip, including: • consideration of weather conditions • sun exposure • insects • hydration • safety near the water • fishing with a buddy • informing an adult of fishing plans • handling equipment and fish safely
3	______	______	Student uses safety rules to create and present a safety rap.
4	______	______	Student can identify fishing safety items and give an example of how to use each on a fishing trip, including: • throwable PFD • personal PFD • first aid kit • sunscreen • insect repellant • local map • safety whistle
4	______	______	Student can state two reasons for the importance of evaluating plans and safety measures post-trip, including: • ensuring that future fishing trips will be successful and safe • determining whether safety rules should be changed to make future fishing trips more safe
2	______	______	Student can bait a hook.
4	______	______	Student describes fast release and gentle handling techniques that maximize survival odds for released fish.

Total Points

38	______	______	**Score** ______

Safety and Fishing at the Water's Edge Scoring Rubric

Shore Fishing Safety	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Safe site selection	Can identify criteria for a safe fishing site, including footing, access to water, absence of poisonous plants, available shade, shelter, and drinking water. Can use criteria to judge whether or not a fishing site is safe.	Can identify at least three of the following criteria for a safe fishing site: footing, access to water, absence of poisonous plants, available shade, shelter, and drinking water. Can use criteria to judge whether or not a fishing site is safe.	Can identify criteria for a safe fishing site, including at least two of the following: footing, access to water, absence of poisonous plants, available shade, shelter, and drinking water.	Can identify one criterion for a safe fishing site, including: footing, access to water, absence of poisonous plants, available shade, shelter, and drinking water.	Can only identify one criterion for a safe fishing site.
Respectful and responsible behavior is safe behavior	Understands relationship between respectful and responsible behavior during trip preparation, the fishing trip, and safety evaluation. Demonstrates respectful and responsible behavior toward self, fellow students, group leaders, rules and regulations, land owners, other anglers, others using the water resource, the fish resource, and the natural environment.	Understands relationship between respectful and responsible behavior during trip preparation, the fishing trip, and safety evaluation. With one reminder, demonstrates respectful and responsible behavior toward self, fellow students, group leaders, rules and regulations, land owners, other anglers, others using the water resource, the fish resource, and the natural environment.	Understands that respectful and responsible behavior is required during trip preparation and the fishing trip. With no more than three reminders, demonstrates respectful and responsible behavior toward self, fellow students, group leaders, rules and regulations, land owners, other anglers, others using the water resource, the fish resource, and the natural environment.	Ignores the requirement for respectful and responsible behavior during trip preparation. With more than three reminders, demonstrates general respectful and responsible behavior.	Doesn't demonstrate general respectful and responsible behavior during trip preparation or the fishing trip.
Trip preparation	Cooperates within group to develop an exceptional set of safety rules that help ensure a safe fishing trip, including consideration of weather conditions, sun, insects, hydration, safety near the water, fishing with a buddy, informing an adult of fishing plans, and handling equipment and fish safely. Participates in creating and presenting an entertaining and inspiring safety rap.	Cooperates within group to develop a set of safety rules that help ensure a safe fishing trip, including consideration of weather conditions, sun, insects, hydration, safety near the water, fishing with a buddy, informing an adult of fishing plans, and handling equipment and fish safely. Participates in creating and presenting a safety rap.	Participates to a lesser degree than other group members to develop a set of safety rules that help ensure a safe fishing trip, including consideration of weather conditions, sun, insects, hydration, safety near the water, fishing with a buddy, informing an adult of fishing plans, and handling equipment and fish safely. Participates minimally in creating and presenting a safety rap.	Doesn't cooperate with other group members. Suggests a set of safety rules that won't help ensure a safe fishing trip.	Doesn't participate in developing a set of safety rules. Doesn't participate or cooperate with group to develop and present safety rap. Doesn't demonstrate regard for safety during fishing trip.

Shore Fishing Safety	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Equipment for a safe fishing trip	Can accurately identify and appropriately use fishing safety items, including a throwable PFD, personal PFD, first aid kit, sunscreen, insect repellant, local map, and whistle.	Can identify and appropriately use most of the following fishing safety items, including a throwable PFD, personal PFD, first aid kit, sunscreen, insect repellant, local map, and whistle.	With assistance, can identify and appropriately use most of the following fishing safety items, including a throwable PFD, personal PFD, first aid kit, sunscreen, insect repellant, local map, and whistle.	Can't identify and appropriately use most of the following fishing safety items, including a throwable PFD, personal PFD, first aid kit, sunscreen, insect repellant, local map, and whistle	Uses safety equipment inappropriately, and without regard to safety.
Evaluate trip safety	Can state at least two reasons for the importance of evaluating plans and safety measures, including: ensuring that future fishing trips will be successful and safe; determining whether safety rules should be changed to make future fishing trips more safe.	Can state at least one reason for the importance of evaluating plans and safety measures, including: ensuring that future fishing trips will be successful and safe; determining whether safety rules should be changed to make future fishing trips more safe.	With assistance, can state at least one reason for the importance of evaluating plans and safety measures, including: ensuring that future fishing trips will be successful and safe; determining whether safety rules should be changed to make future fishing trips more safe.	Can't understand that evaluation of fishing trip safety is connected to ensuring that future fishing trips will be successful and safe; determining whether safety rules should be changed to make future fishing trips more safe.	Doesn't demonstrate cooperation and participation in planning and carrying out a safe fishing trip.
Handling fish and hook baiting	Describes fast release and gentle handling techniques that maximize survival odds for released fish. Can bait hook safely.	Discusses either fast release or gentle handling techniques that maximize survival odds for released fish. Can describe how to safely bait a hook.	Knows what to do, but not how it helps fish. Can identify bait but can't describe how to bait a hook.	Can't accurately describe proper handling and releasing of fish or bait a hook.	Doesn't try to describe proper handling and releasing of fish or how to bait a hook.

Score______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Water safety classes, first aid classes, and boating safety classes are offered for young people and adults through a variety of agencies (the Minnesota DNR, American Red Cross, local community centers, and others). Encourage your students to sign up for these classes, and to bring along a family member. You might also want to take a course as a class.

2 Invite a conservation officer or emergency medical technician to talk to your class about safety on fishing trips and to demonstrate various personal flotation devices and their proper use. Invite the school nurse, a doctor, or a representative from the Red Cross to talk to your class about first aid, outdoor safety, sunburn, heat emergencies, hydration, hypothermia, and treatment for insect bites and poisonous plants.

3 Prior to your fishing trip, have students create graphic organizers that illustrate safety concerns and precautions for anglers. Let students exercise creativity with different sizes and colors of paper. Have them cut and fold the paper to make moveable flaps, fold-outs, windows, and pockets as they design a large brochure or a poster.

4 At the site, conduct a life jacket relay race. (Strongly consider this activity if your school requires that all students wear PFDs near water.) Students will need to know how to wear them correctly before the race. Demonstrate the proper fit of a life jacket. Divide the class into teams of six to ten students each. Have each team form a line. Place a line of playing field cones about ten yards in front of the team lines, one cone in front of each team. Hand the first member of each team a life jacket. Each student will put on and fasten the life jacket properly, signal a thumbs-up, and run the ten yards to out around the cone and back. When they get back, they remove the life jacket and hand it to the person behind them in line. Each member of the team repeats the fitting and running, until one team finishes the relay and wins the race.

5 Conduct a "Leave No Trace" scavenger hunt. Have an adult volunteer visit the fishing site just before the fishing trip to set up a scavenger hunt course along a trail through a grove of bushes or trees. Plant objects of litter (candy wrappers, pop cans, plastic bags, tangled monofilament line, old fishing lures, an old shoe, a broken fishing pole, a bucket, and so forth) along the trail and in the trees and bushes. You could also stage people along the trail: "fishing" too close together, wearing a PFD that is not fastened, pretending to discard extra bait on shore, being loud and noisy, holding a fishing rod improperly—plus a few who are fishing properly and safely. Keep track of the number unsafe, undesirable, or out-of-place items planted along the trail. Upon students' arrival, give each pair of buddies a pencil and a sheet of paper. Send pairs through the

Graphic organizers can take the form of a concept map, tree, star, or web showing definitions, attributes, examples, classifications, structures, examples, relationships, and brainstorming. Charts and tables show attributes, characteristics, comparison, and organization. A chain or timeline illustrates processes, sequences, cause-and-effect, and chronology. Diagrams, charts, and drawings show physical structures, spatial relationships, and concrete objects. Cut and folded paper can be fashioned into flaps that, when lifted or otherwise manipulated, reveal details, definitions, descriptions, or explanations.

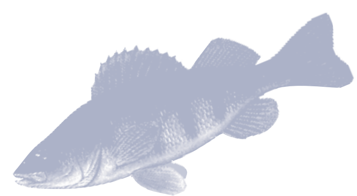
Leave No Trace Trail in two- to three-minute intervals. Each team should try to detect and record unsafe or undesirable items, and as many correct items, as they walk through the trail. When all teams have finished, note which teams detected all of the items. Be sure to leave no trace yourselves—collect all scavenger hunt items after the game! This scavenger hunt can also be staged on school grounds.

For the Small Fry

K-2 Option

1 Omit the Factor in SPF activity and worksheet. Safety issues are important with this group, but introduce safety ideas more slowly over time—not all at once—to prevent overwhelming the children.

2 Use barbless hooks while fishing. Be sure to have at least one adult for every three children. Use cane poles or pop can casters for fishing and fish from a pier or dock to eliminate the need for casting. All students should wear a life jacket for safety's sake.



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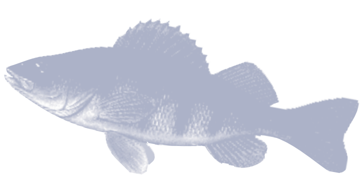


INSTRUCTOR COPY

MinnAqua Water's Edge Safety Overview

When planning an outdoor angling activity, consider:
- participants with varied skills and levels of experience
- many people fishing in one area
- maintenance of orderly behavior and control in the event of an emergency
- a safety plan
- respect for self, others, equipment, the activity, property, rules and regulations, water, fish, the environment, and the future

Safety actions include:
- A **Site and Safety Evaluation Form** (see end of lesson) should be completed prior to conducting a fishing program. This form will help identify any possible hazards at the fishing site and provide a plan of action in case of emergency.
- Have all permission slips and permits completed and collected. Obtain emergency contact information for each participant.
- Prior to the program, find out if any of the participants have special medical needs (allergies to bee stings, asthma, other allergies).
- Review this form with the volunteers who will assist with your program.
- Have a cell phone with you at all times.
- Pre-assign adult responsibilities to follow in case of emergency: calling 911 or going for help, caring for and maintaining order among group participants, staying with the injured party
- Every MinnAqua program will have at least two adults familiar with the emergency action plan present at all times.
- Recommended adult-to-child ratios should be kept during all programs for maximum participant safety: dry site 1 adult:15 children; shoreline/pier 1:5; with additional assistance for special needs participants.
- Water's edge safety guidelines (as presented in this lesson) must be taught to all participants prior to shoreline fishing.
- A first aid kit must be available and displayed in an obvious location during any program. A first aid booklet and an emergency contact information folder should be included in each kit.
- A throwable personal flotation device with an attached rope should be in plain sight during any program held near the water. The rope shouldn't be wrapped around the cushion—it should be coiled for ease of deployment.
- Life vests may be required for non-swimmers. Life vests must be worn by any participant whose parent or guardian has requested that they do so.
- Never attempt to remove a hook embedded below the barb. Send the injured person to the nearest medical facility.

Don't Get Hooked Sheet

Fish safely, have fun, and DON'T GET HOOKED!

Fishhooks are sharp!

Puncture wounds hurt—and they can cause infections or tetanus.

Protect yourself and those around you! Know where your hook is at all times.

Pinch barbs on hooks or consider using barbless hooks.

Hooks and lures that are in use should be held out over the water.

Keep hooks and lures in a latched tackle box when you're not using them.

Always look behind you before you cast—and look forward as you cast!

Keep rod tip pointed away from other people.

Land your fish carefully.

When removing fish from hooks, use needlenosed pliers to get a good grip on the hook.

Pinch the barb of the hook down.

IF YOU GET HOOKED

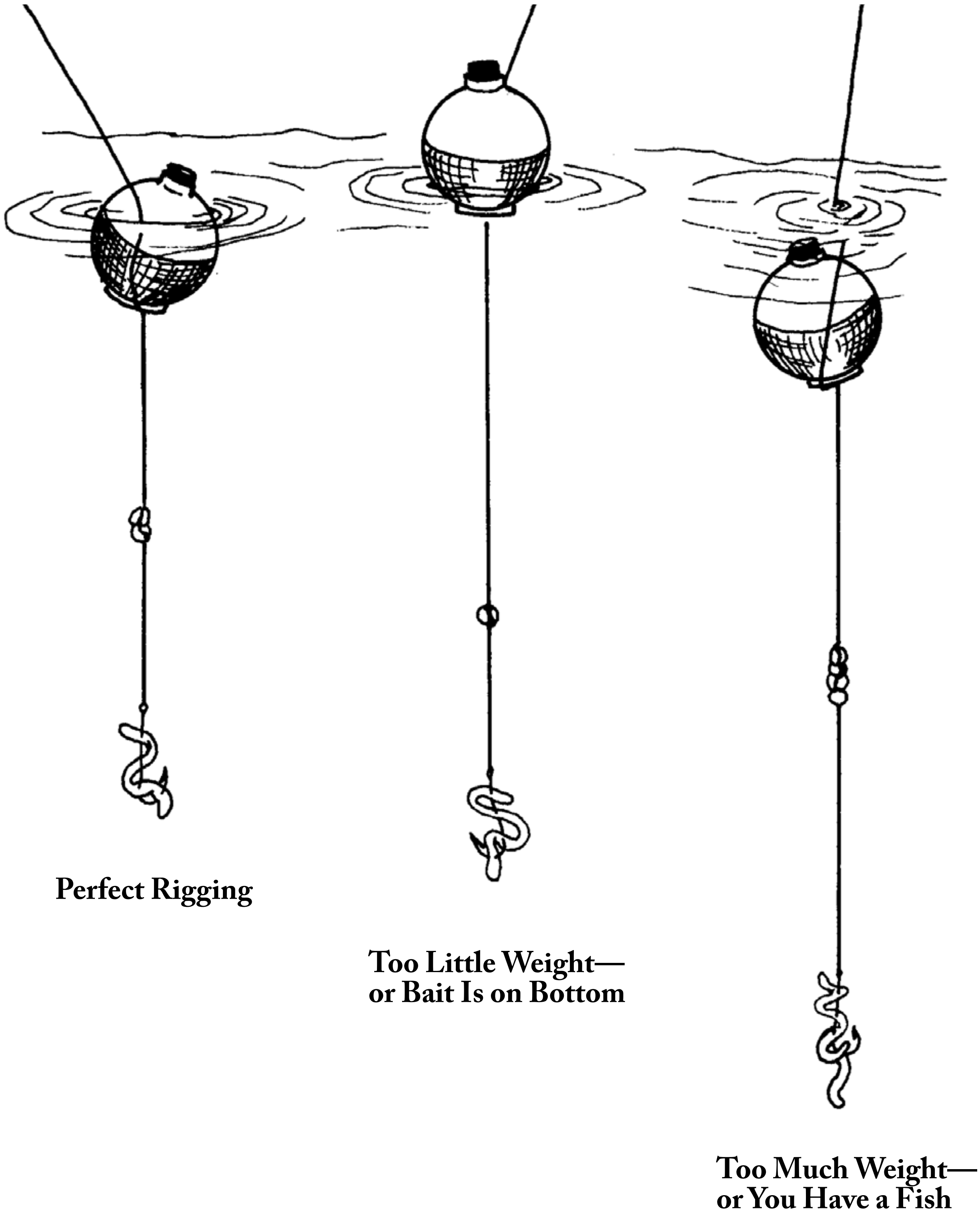
Is the hook embedded? Ouch!

- immobilize the hook with tape or cover it with a paper cup
- have a doctor remove the hook
- antibiotics and a tetanus shot are recommended

PLAY IT SAFE: pinch your barbs, fish with a buddy, and wear your life jacket!

STUDENT COPY

The Perfect Rigging Sheet



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INSTRUCTOR COPY

Safety and Site Evaluation Form

Site information may already be available from your MinnAqua contact. Otherwise, make sure you evaluate your site prior to your program. Instructors and youth leaders should keep this form on file. MinnAqua leaders and volunteers should return this form to their education specialist immediately after your program.

Date ____________________ Site ____

County __________________ Time __________ Nearest Town ___________________________

Instructor ____

Safety Plan

Cell Phone Number ________________________ Directions to Site ________________________

Emergency Phone Number ___________________ Hospital Phone Number ____________________

Safety Equipment Checklist

______ First Aid Kit ______ Fire Extinguisher (if cooking)

______ Throwable Personal Flotation Device with Rope ______ Drinking Water

Volunteer Roles During Emergency

Stays with Hurt Student _____________________ Calls for Help __________________________

Stays with Group ___________________________ Other Duties ___________________________

If anyone is hurt during an authorized MinnAqua program, the instructor must call their MinnAqua contact within 24 hours to fill out appropriate forms. Certified volunteers are covered under Worker's Compensation. All others' coverage depends on who covers the program liability.

Site Information (check all that apply)

Access Type ______ Shoreline ______ Pier ______ Public ______

Private (if private property, is permission from owner obtained? Yes ______ No ______)

______ Electricity ______ Indoor Facilities ______ Drinking Water Available

______ Shelters ______ Trash Receptacles ______ Bathrooms

______ Parking ______ Tables

______ **Handicapped Accessible** (identify) ____

______ On Bus Route (identify) ____

______ Safety Hazards to Avoid ____

______ Fees (identify) ____

Best fishing for ____

Seasonal Changes (plant growth, special regulations) _________________________________

Is site posted for presence of exotic species? ______________________________________

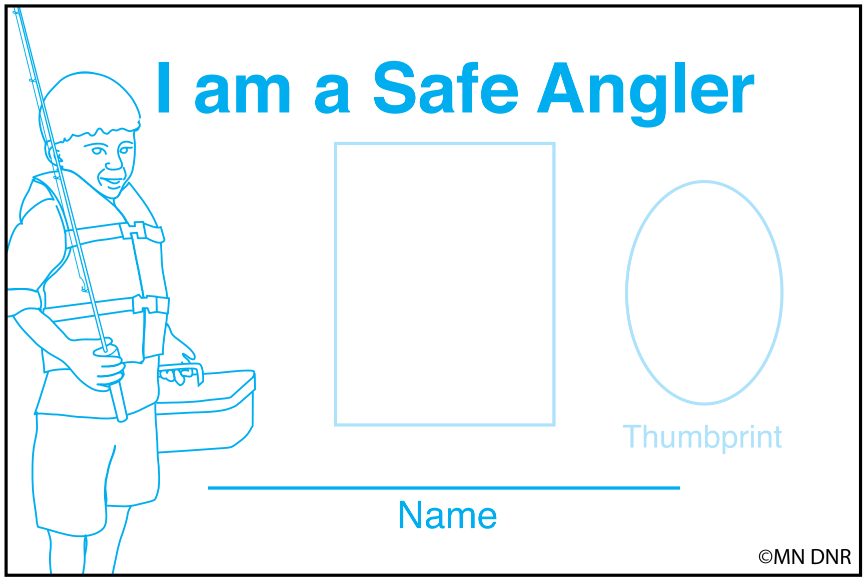
Comments ____

STUDENT COPY

Name ______________________________ Date ______________

Safe Angler Certificate

Draw yourself in the box in the Safe Angler Certificate.
Using an inkpad, place your thumbprint in the circle provided.
Read the following rules aloud. Then add your own fishing rules to the list.
Be sure you show caring, sharing, and respect when fishing.
Then you have earned your Safe Angler Certificate!



1. Safe anglers respect others' space, privacy, and territory. They fish quietly so they don't frighten fish or bother people. They don't crowd other people out of a fishing spot.
2. Safe anglers always practice safe fishing. They're careful when casting. They pick up all fishhooks so people don't step on them, and all fishing lines so animals don't get tangled in them.
3. Safe anglers know the size and number of fish that they may legally keep (or limit). Limits provide more chances for more people to catch fish.
4. Safe anglers land fish carefully, and release fish back into the water right away if they don't plan to eat them.
5. Safe anglers clean their lines and equipment before they leave a fishing spot. They don't move exotic species from place to place.
6. Safe anglers fish with a buddy and always tell a grownup where they're going, when they're leaving, and how long they expect to be gone.

7. ______________________________

8. ______________________________

9. ______________________________

10. ______________________________

Responsibility means accountability, reliability, and trustworthiness!

STUDENT COPY

Name ______________________________ Date ______________

Factoring in SPF Sheet

The SPF rating printed on a container of sunscreen says how much longer a person wearing that sunscreen can stay in the sun without getting sunburned than they could if they weren't wearing sunscreen. People with darker skin tend to burn less quickly than people with lighter skin. Doctors recommend a sunscreen with an SPF rating of at least 15 to protect most people from sunburn.

1. Some things reduce a sunscreen's effectiveness. These are listed below. Can you think of two more?
- Some medicines cause skin to be more sensitive to UV rays.
- Sunscreen washes off when people swim.
- Sunscreen can take as long as an hour before it starts to protect the skin—it should be applied well in advance.
- A thin coat of sunscreen doesn't protect the skin as well as a thicker layer.

- ______________________________
- ______________________________

2. You can usually stay in the sun for 20 minutes before your skin starts to burn. Your sunscreen is SPF 15. How long will it protect you from sunburn while you're fishing?

____

3. Your fishing buddy uses a sunscreen with SPF 8, and usually begins to burn after spending fifteen minutes in the sun. You've been fishing for four hours. Is the sunscreen still protecting your buddy? If not, which SPF is best for your buddy?

____

4. You have sensitive skin, and it only takes ten minutes before you start to get sunburned. Your brother and sister are taking you fishing and you plan to stay at the lake for three hours. Which SPF is best for you?

____

5. You're going fishing today! You woke up to cloudy skies. Should you wear sunscreen? Why or why not?

____

INSTRUCTOR COPY

Factoring in SPF Answer Sheet

1. **Some things reduce a sunscreen's effectiveness. These are listed below. Can you think of two more?**
   - Some medicines cause skin to be more sensitive to UV rays.
   - Sunscreen washes off when people swim.
   - Sunscreen can take as long as an hour before it starts to protect the skin—it should be applied well in advance.
   - A thin coat of sunscreen doesn't protect the skin as well as a thicker layer.

   Additional answers:
   - Sweating is another thing that makes sunscreen less effective.
   - Hats shield the head from burning rays—you can't put sunscreen on your hair.
   - UV rays reflected from the water burn more easily, especially the face under the brim of a hat!
2. **You can usually stay in the sun for 20 minutes before your skin starts to burn. The sunscreen you've brought along is SPF 15. How long will it protect you from sunburn while you're fishing?**
   20 minutes x SPF 15 = 300 minutes = 5 hours
3. **Your fishing buddy uses a sunscreen with SPF 8, and usually begins to burn after spending fifteen minutes in the sun. You've been fishing for four hours. Is the sunscreen still protecting your buddy? If not, which SPF is best for your buddy?**
   At least SPF 16.
   SPF 16 = 240 minutes
   15 minutes
4. **You have sensitive skin, and in ten minutes, you start to get sunburned. Your brother and sister are taking you fishing and**
   you plan to stay at the lake for three hours. Which SPF is best
   for you?
   At least SPF 18
   SPF 18 = 180 minutes
   10 minutes
5. **You're going fishing today! You woke up to cloudy skies. Should you wear sunscreen? Why or why not?**
   Yes. UV rays pass through clouds. They can cause sunburn, premature aging, skin cancer, and cataracts.

Ice Fishing and Winter Safety

Words of winter wisdom:
Be wary of weather and wind chill, watchful on the ice, and stay warm and dry.

Table of Contents

Chapter 6 • Lesson 2

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Ice Fishing and Winter Safety

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 2—The student will demonstrate active listening and comprehension.

History and Social Studies

Grades K—3
VII. Government and Citizenship
B. Beliefs and Principles of United States Democracy:
Benchmark 1—Students will give examples of rules in the classroom/school and community, provide reasons for the specific rules, and know the characteristics of good rules.
Benchmark 2—Students will explain that rules and laws apply to everyone and describe consequences for breaking the rules or laws.

Grade 4—8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.

Science

Grade 3
III. Earth and Space Science
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will measure, record, and describe weather conditions using common instruments.

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world.
Benchmark 2—The student will discuss responsible use of science.
Benchmark 3—The student will recognize the impact of scientific and technological activities on the natural world.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 6 • Lesson 2

Ice Fishing and Winter Safety

Grade Level: 3-5
Activity Duration: Part 1: 15 minutes
Part 2: 30 minutes
Part 3: 90 minutes, plus driving time
Group Size: any
Subject Areas: Health and Safety, Physical Education, Language Arts, Social Studies, Science
Academic Skills: application, identification, kinesthetic concept development, listening, role-playing, simulation
Setting: Part1 and Part 2: gathering area
Part 3: ice-covered lake
Vocabulary: hypothermia
Internet Search Words: ice fishing, ice rescue claws, ice safety

Instructor's Background Information

Ice fishing provides fun winter adventure in Minnesota, but heading onto the ice can be risky business. Cold weather, short winter days, and unsafe ice conditions can, singly or jointly, make ice fishing dangerous. With a little preparation, though, you can minimize danger and stay safe. This lesson discusses ice safety, ice rescue, and how to dress for an ice fishing trip. Students learn how to rig a line, fish through the ice, and what to do with their catch!

Cold Weather and Wind Chill
Minnesotans are used to extreme weather, but how cold is too cold? It's likely that your school has established guidelines for taking children outside in cold weather. If the temperature or wind chill factor is below 0˚ F, consider rescheduling the trip. If the temperature or wind chill is colder than minus 10˚ F, you should definitely reschedule.

Plan a trip in early or later winter to take advantage of warmer temperatures, but not too early or too late in the season—ice conditions must be kept in mind. In early and late winter, panfish frequent shallower areas, which are closer to shore and an easier walk for the class.

continued on page: 6:2-3

Summary

Minnesota's winter conditions demand extra safety preparations for outdoor activities. Before going on an ice fishing trip, it's imperative to cover basic ice fishing safety. Students learn about dressing in layers, ice self-rescue, ice fishing techniques, and enjoying an ice fishing trip.

Student Objectives

The students will:

1. Identify the importance of dressing in layers and staying dry during an ice fishing trip.
2. Identify the minimum suggested ice thicknesses that safely support walking on ice, ATVs, small pickups, and groups of people—and know that ice can never be considered 100 percent safe.
3. Demonstrate how to rescue a person who has fallen through the ice and describe what is appropriate for children to do in an ice emergency.
4. Demonstrate self-rescue technique.
5. Use a depth finder to set bobber location on a line and rig and bait a jiggle stick or ice fishing rod for panfish.
6. Demonstrate ice fishing techniques and what to do with the catch.

Materials

Part 1: Dressing for Ice Fishing

- **Dressing for Ice Fishing Word Finder Sheet**, one per student
- Stocking cap
- Scarf or neck gaiter
- Mittens and thin gloves
- Warm layers of clothing, such as long underwear, long pants, turtleneck, wool sweater
- Winter coat
- Snow pants
- Wool socks
- Insulated rubber-soled boots

Part 2: Ice Safety

- **Ice Safety Sheet**, one per student
- Seat cushion-type personal flotation device with attached rope
- Ice rescue claws—purchased or homemade with floating handles.
- *Danger, Thin Ice, Hypothermia the Cold Facts* brochures, and *Recommended Minimum Ice Thickness* cards available from the DNR info center 1-888-MINNDNR.
- *Danger, Thin Ice*, a video program available from the DNR information center or on-line at the DNR ice safety web page www.mndnr.gov/safety/ice (optional)

Part 3: Ice Fishing Trip

- Adult chaperones, one for each five to ten students, depending on students' ages and abilities
- **Setting Bobber Depth Sheet**, one per student
- Power auger (If you're taking the whole class fishing, each student will need a hole, so a power auger is recommended—ask an experienced ice angler to help. You may want to bring a hand auger as a demo, or to keep kids busy.)
- Fishing licenses for anyone 16 and older, including adult helpers*
- Ice scoops, one per adult*
- Clip-on depth finder, one per adult*
- Scrap of plywood (2' x 2'), cardboard, or Styrofoam, for simulated ice hole
- Needlenosed pliers, one per adult*
- Fingernail clippers for cutting line, one per adult*
- Ruler (for measuring ice depth and fish length; some scoops have rulers inscribed on their handles)
- Jiggle sticks, rigged and ready to go, one per student
- Bait, choose one or a combination of the following:
  - wax worms, five per student
  - minnows, three per student in Styrofoam bait bucket with minnow scoop
  - Eurolarva, ten per student
- Extra bobbers, sinkers, and hooks
- First aid kit
- Throwable personal flotation device (seat cushion-type) on a long rope
- Wool blanket (in case someone gets cold and wet)
- Sled with attached rope
- Cell phone
- Participants should dress in layers for the weather—emphasize insulated rubber-soled boots, stocking caps, scarves, and mittens
- Buckets or lawn chairs, one per person, (optional)
- Hot chocolate with cups and a trash bag, (optional)
- Camera, for taking photos of the class (optional)
- Underwater camera for viewing fish and plants (optional, but if you can borrow one from a parent or elsewhere, students will love the view)

* You may consider asking adult helpers to bring their own items for the trip. Otherwise, you can purchase ice fishing gear at any sporting goods store.

The Right Clothing Keeps Anglers Warm and Dry

Stocking Cap—Wear a knitted hat or cap that covers ears. A baseball cap just doesn't provide warmth. Worn alone, earmuffs or headbands don't cover the top of the head. Because 80 percent of the body's heat escapes through the head, a stocking cap may be the most important piece of winter clothing. In addition, a hood helps block the wind.

Scarf or Neck Gaiter—Out on the ice, there's little protection from wind. A scarf, or neck gaiter can be pulled over the face if it gets windy.

Mittens—Mittens trap more heat than gloves. Mittened fingers share heat with one another. Mittens should be thick and warm. While ice fishing, people often remove mittens while baiting hooks or taking fish off lines. This way, mittens don't get wet. Thin gloves worn under mittens are good in this situation. Connecting mittens to jacket cuffs may be a good idea for some.

Warming Layers—Layers of clothing trap body heat between them. They can be removed or added, depending on the weather and level of activity. The first layer (nearest the skin), wicks moisture away from the skin. Most long underwear made of polypropylene (or silk) does this. The second layer provides warming insulation. Ideal materials retain some insulating qualities, even when wet (such as a wool sweater or fleece jacket). If it's really cold, wear more than one insulating layer. The top layer blocks the wind. Most winter coats and snow pants have an insulating layer *and* an outer shell that blocks wind.

Socks—Encourage students to wear thick wool socks. Some people like to wear two pairs of socks.

Boots—Boots should be insulated and rubber-soled. Rubber soles keep feet dry by repelling water and provide some traction on ice. Make sure boots aren't too tight—toes should have room to wiggle.

Staying Dry

It's important to pay attention to body temperature. When you're out in the cold, you want to be warm and dry, not hot and sweaty. Your body cools you by sweating, but sweat can be deadly in the cold because body heat is lost 60 percent faster when you're wet.

Try not to get too sweaty. If you start to feel too hot while pulling your gear sled to your fishing site, unzip your jacket. If you feel cold at the fishing site, zip up your jacket.

If someone should get completely wet, the best thing would be to wrap them in a blanket and find a warm building or vehicle. Some materials, like polypropylene, wool, and fleece, will retain some insulating value when wet, so it's not always best to remove wet clothing. If there is extra clothing available, replace wet clothes with dry ones.

Dressing for Winter

Ice fishing is much more enjoyable when you're properly dressed for the weather.

Many students won't have clothes made from the most current materials, so stress the importance of trapping heat between layers and blocking the wind.

In addition to following your school's policies for off-site trips, you may want to ask an emergency medical technician or nurse to come along as a guest. It's also a good idea to notify your county sheriff's water patrol that you will be conducting an ice-fishing event.

Hypothermia

When the body is slightly chilled, it shivers to stay warm. If you lose too much body heat, the shivering will stop and you may be subject to the onset of **hypothermia**, a potentially fatal condition in which core body temperature drops. Warning signs of hypothermia include a dazed expression, stumbling, and difficulty speaking. Victims of hypothermia need medical attention.

If someone shows signs of hypothermia, call for medical help. Begin immediately to work on conserving body heat and rewarming the victim: get them out of wet, cold, or windy conditions, remove wet clothing, and add additional layers of dry clothing. Increase physical activity to generate heat. Provide food to replace the victim's body fuel—theirs has rapidly burned in an attempt to generate heat. A shivering person can rewarm at a rate of 3.6° F per hour. Provide hot liquids, if available, but avoid alcohol and caffeine.

Frostbite and Frostnip

Frostbite occurs when skin tissue freezes. It usually happens on areas of exposed skin, such as cheeks, nose, ears, and fingers. Watch for signs of the skin turning white and feeling numb and hard. Frostbite is a serious condition—to treat it, take the victim indoors and warm affected areas slowly, without rubbing, which can cause further tissue damage.

Frostnip is a precursor to frostbite. Exposed skin may turn blue before turning white, and feel cold to the touch. Warm affected area before frostbite occurs.

Proper clothing prevents frostbite and frostnip. You can also play active games on the ice, or show the students some motions to practice, such as stomping feet, clapping hands, and wiggling toes and fingers.

Games

Another way to keep warm is to plan some games for the day. Organize activities like Quick Frozen Critters (like frozen tag), making snow sculptures, a game of Follow the Leader involving the tracing of large patterns and designs in the snow, or Boot Hockey (soccer played on the lake.)

Basic Safety Gear for Your Ice Fishing Trip	
Personal flotation device on rope	to rescue someone if they fall in the water (seat cushion-type)
Cell phone (fully charged)	to call for help
Ice rescue claws (several sets with adults in group)	for self-rescue in case of falling through ice
Hand warmers	to warm hands and feet
Sled with attached rope	to carry gear—or a person, if necessary
Wool blanket or sleeping bag	for warming anyone who gets wet or cold
Band-aids	to patch hook pricks or minor cuts
Hot chocolate	to keep anglers happy

Ice Thickness
Your first concern should be the ice. Ice isn't the same thickness all the way across a lake, nor does its thickness remain constant throughout the winter. Inquire about known thin-ice areas at a local resort or bait shop.

Before going out on the ice, always test it using an auger or a chisel and a ruler. Although no ice is considered safe, make sure the ice is *at least* twelve inches thick along the entire distance from the shore to your fishing spot. This is the thickness recommended to safely support a truck, and assumes the total weight of your class is about the same as a truck. It's preferable to walk students onto the ice rather than driving.

Watch the weather and be wary of above-freezing temperatures during the days before your trip. If the temperature has been above 32 degrees for 24 hours, don't go on the ice until it returns below 32 for several days. Look for places where the ice may have melted and refrozen. This forms layers of ice with water between them, and if you break through the top layer of ice, you'll soak your feet. Also look for iced-over holes and springs. Early and late ice fishing seasons are the most dangerous, especially near the shore. Contact people who live on the lake and fish often, local resorts and bait shops, or the county sheriff's water patrol for assistance in gauging ice safety conditions.

See the **Ice Safety Sheet** at the end of this lesson—it provides ice rescue information and instructions on what to do if anyone (including yourself) falls through the ice. A life jacket and ice picks—or a pair of screwdrivers—are critical safety items out on the ice. If someone falls through, they can punch ice claws or screw drivers into the ice and use them as handholds to haul themselves out of the water and onto more stable ice. Review the **Ice Safety Sheet** and practice ice rescue with your students before your ice fishing trip.

Beware of Accidents Other Than Falling Though the Ice

Accident	Preventive Measures
Slipping on the ice	Wear boots with rubber soles. Don't run on the ice.
Stepping in a hole	Set boundaries. Watch where you step. Look for holes in the ice.
Sunburn	Wear sunscreen.
Windburn	Cover your face. Wear layers to block wind.
Frostbite	Remain alert. Are you getting too cold? Wiggle fingers and toes. Tell an adult that you're feeling cold.
Getting lost	Know your area. Carry a phone, compass, map or a GPS unit.

For more ice safety information, check the DNR website **www.mndnr.gov/safety/ice** or obtain the *Danger, Thin Ice* and *Hypothermia, the Cold Facts* brochures by calling 651-296-6157 or 1-888-646-6367.

The Ice Fishing Trip
You've gathered safety equipment, scheduled adult volunteers, and prepared your students to dress properly and stay warm. You've practiced ice rescue. You have ice fishing poles for each student or the students have made their own jiggle sticks as described in **Lesson 5:7—Making Ice Fishing Jiggle Sticks**.

The Perfect Spot for Ice Fishing
If you need help finding a good spot to take your class for ice fishing, ask experts. Salespeople at sporting goods stores and bait shops, sportsmen's club members, and the DNR can help. Visit the lake and note the locations of icehouses. You can also check the DNR website's Lake Finder area for information about fish species and lake topography for the larger local lakes. Panfish frequent water that is fifteen to twenty feet deep near drop-offs and the edges of plants. In winter, panfish are more likely to cluster in schools. So, if one of your students catches a fish, there's a good chance that several others will, too. Dusk may be the best time to catch perch or crappies.

Setting the Depth
Panfish swim near the bottom of the lake in winter (it's warmer), but crappies may be closer to the surface. Use a **clip-on depth finder** to find out where to attach your bobber on the line in order to hold the bait or lure six to twelve inches from the bottom. Clip the weighted depth finder on your line and lower it through the hole you've drilled

Is there a specific date by which Minnesota lakes are typically frozen over to allow for safe recreation?

It is not a good idea for anglers or anyone to rely on the calendar to determine whether or not a frozen lake is safe. In years past, ice may have been passable by December 1, but a warm start to another Minnesota winter makes it difficult to determine just when a lake or pond will freeze thick enough to allow recreation. Even once this finally happens, it is important realize that ice is never 100 percent safe. The DNR recommends the following ice thickness for these intended uses: a minimum of 4 inches of new, clear ice for foot traffic; 5 inches for ATVs and snowmobiles; and a minimum of 8 to 12 inches for cars or small trucks. Once the ice has started to soften in warm temperatures, these thicknesses no longer apply. Local resorts and bait shops can often provide information about ice thickness and point out dangerous areas. Also, anglers and others who venture out on the ice should take ice picks with them and wear a life jacket as a precaution.

—Tim Smalley,
DNR Boat & Water
Safety Specialist,

through the ice. When the depth finder touches the bottom, lift the line six to twelve inches, and attach your bobber at the water's surface level. Bring in the line, remove the depth finder and finish rigging the line with your sinker, hook and bait or lure. If you don't catch anything at that depth, re-rig the line and try fishing a little closer to the surface.

Ice Fishing Rigging, Bait and Lures

After attaching your bobber for the proper depth, fish for panfish (such as yellow perch, crappies, and sunfish) with a sinker and a small, plain hook with a wax worm or small minnow. Minnows weighted with small sinkers will actively swim for quite a long time in the cold water and cover a larger area to attract more fish than heavily weighted bait. Also try an ice fly or teardrop jig (a very small, weighted head with a hook), and put a wax worm or small minnow on the hook. Live bait also attracts walleye and northern pike. Large bait will attract the larger fish.

Lower the rigged line into the fishing hole. Jiggle the bait periodically. When a fish bites, and the bobber is pulled below the surface, set the hook and bring in the line, keeping it taught. Let a larger fish run with the line to tire the fish, keeping the line taught to prevent it from throwing the hook, and, as the fish tires, bring in the line and raise your rod to gently lift the fish through the hole in the ice.

Conservation

Emphasize that fishing is fun and that catching a fish is an added bonus. Instill good stewardship habits by picking up litter, following regulations, and carefully returning fish to the water if you don't plan to eat them.

What should you do with your catch? You could save the fish for dinner, clean and cook a few for the class, or practice catch-and-release. If you're going to keep some fish to eat, they'll stay fresh on the ice until you collect them and place them in a cooler for the ride home. Keep them cold and clean them as soon as possible. Cook them immediately, or freeze them. Check the fishing regulations for current limits, as well as information on filleting, and transporting fish.

To practice catch-and-release, land (reel in) the fish quickly. Carefully remove the hook from the mouth, and gently lower the fish into the water. Try not to handle the fish too much or you'll disturb its protective slime coating, which protects the fish from parasites, bacteria, and fungus, and reduces friction as it swims. The sooner the fish returns to the water, the better its chances for survival. Released fish may grow larger and reproduce—or be caught by another angler, conserving resources. Catch-and-release sustains healthy ecosystems and fishing opportunities for Minnesota anglers.

Clip-on depth finder.

If taking students fishing for the first time, it helps to use circle hooks. The point faces the shank and is designed to hook the fish in the mouth as it turns to swim away rather than having to set the hook and rely on a quick response. Fish are less likely to be throat-hooked with circle hooks. This can reduce hooking mortality for catch-and-release. If circle hooks are available in your area, buy ones with long shanks that make them easier to handle.

Before having students use an ice auger, demonstrate safe operation. Ice auger blades are sharp! Using the ice auger to practice drilling holes is a good activity to help students keep warm. It will also hold their interest while they're out on the ice.

Procedure

Preparation

1 Obtain one ice fishing rigs for each student, or have students make their own jiggle sticks as illustrated in **Lesson 5:7—Making Ice Fishing Jiggle Sticks**. Students feel especially excited and empowered when they catch fish on rigs of their own making.
2 Make a copy of **Dressing for Ice Fishing Word Finder Sheet** and **Ice Fishing Safety Sheet** for each student.
3 Collect the materials.
4 Find a scrap of plywood, cardboard, or Styrofoam, and cut an eight-inch hole in the center. This is your simulated ice hole.
5 Choose a good fishing spot with accessible bathrooms. Watch the weather and ice thickness.
6 Confirm the fishing dates with students, obtain all necessary permissions from parents and the school administration, and organize and confirm ice fishing trip dates with your adult volunteers. (Use one adult chaperone for each five to ten students, depending on students' ages and abilities.)
7 Find volunteers to drill several holes with the ice augers scattered at your fishing site on the morning of the event. Place the holes at least 25 feet apart. The number of holes to drill depends the size of your group. Bring the hand auger along to have students practice using it to drill some holes.
8 Ask a volunteer to bring hot chocolate or cider, and to set up an area for serving the hot drinks. You may ask an emergency medical technician or nurse to come along. This person could stay with the hot drinks, safety gear, blanket, extra wool socks, mittens, scarves, hats, etc.
9 Notify the county sheriff's water patrol of your ice fishing event.
10 Buy bait.
11 Collect all equipment and ask the students to bring their jiggle sticks to the event.
12 Remind the students to dress appropriately.

Activity

Warm-up
It's always important to prepare for weather conditions to ensure safety during outdoor activities. Winter weather in Minnesota poses special safety considerations. With the students, brainstorm a list of dangers pertinent to winter weather and going out on the ice. Tell the students you'll be discussing these dangers throughout the lesson as the class talks about ice fishing safety. Have students suggest additional things they can do to have a safe ice fishing trip.

Lesson
Part 1: Dressing for Ice Fishing

1. Discuss the importance of dressing in layers. Explain types of layers: wicking, insulating, and wind-proofing. Choose one student in the group to stand at the front of the class and model winter gear. (This will be more humorous to students if you use adult clothing on the student. It might also be fun for the students to see their instructor or other adult chaperones dressed up.) Set the pile of clothes to the side.
2. Call on a student to pick one article of clothing from the pile and give it to the volunteer to put on. Ask the student to tell the class why they think this item is necessary for ice fishing. Expand on their answer if necessary. Ask the students to think of things that might be good substitutes.
3. Continue until all the clothes in the pile are used.
4. It's all right if items aren't chosen in a logical order. Just ask the volunteer to take off the boots to put on the socks.
5. Ask the volunteer if they're getting warm. If so, have the volunteer unzip the jacket and take off the hat. Discuss the danger of sweating in the cold. Tell the students that they lose body heat faster when they're wet than when they're dry.
6. To demonstrate this, ask the students to blow on their bare wrists. Then have them wet their wrists and blow on them again. Which feels colder?
7. Tell students that, when they dress in layers, they can remove or add layers to stay warm and dry. For example, they might get warm while walking to the fishing site and cold while sitting still and waiting for a fish to bite. Also, the weather might be warm when the sun is out, but it will get colder when the sun begins to set.
8. Hand out the **Dressing for Ice Fishing Word Finder Sheet**. When students have completed this, go over the answers as a class.

Part 2: Ice Safety

1 Hand out the **Ice Safety Sheets.**

2 Ask students how they know whether the ice is safe for ice fishing. Discuss how ice thickness varies on different parts of the lake, or from day to day. Remind them that they should always take a responsible adult with them when traveling on the ice. What equipment could you bring that would help you get out of the water and back to safe ice if you fell through? (Ice rescue claws or screwdrivers.)

3 Show the optional *Danger: Thin Ice* video program listed in Materials.

4 Discuss what to do if someone falls through the ice. Emphasize that children should never attempt to rescue someone who has fallen through the ice. They need to find an adult and/or call 911 immediately.

5 Discuss the steps you would take if *you* fell through the ice. As you read the steps a second time, have the students act out what they would do if they were the victims.

Part 3: Preparing for Fishing

1 Review the method of tying an improved clinch knot. This is the knot used to tie a depth finder and a hook or lure to a line. Instructions for tying an improved clinch knot can be found in **Lesson 5:7—Making Ice Fishing Jiggle Sticks**.

2 Demonstrate how to use a depth finder using the simulated "ice hole" and a jiggle stick. Attach the clip-on depth finder to the end of the line, and drop it until it hits the bottom. Then lift it up about a foot. Put your bobber at the water's surface. (You can adjust your fishing depth later if you don't catch any fish.) Then pull up your line, take off the depth finder, and bait the hook. Use the **Setting Bobber Depth Sheet** for easy reference. For more information on how to rig a jiggle stick or other ice fishing equipment see **Lesson 5:7—Making Ice Fishing Jiggle Sticks**. Students can set their own depths and attach their bobbers when they get to their fishing hole.

Part 4: Fishing

1 When you bring students to the fishing site and the holes that have been drilled, ask one volunteer to use a ruler or tape measure to measure ice thickness with group. It should be at least twelve inches thick at every site. Review ice thickness safety with the students. Ice should be at least four inches thick to safely support a person. To safely support a *group* of students (which weighs approximately as much as a pickup truck), the ice should be twelve inches thick. Review with students some conditions that could affect ice thickness in any given area such as springs, recent warm days, etc.

2 Baiting the hook—give the adults enough bait for their small groups of students. Have them show the students what type of bait you will use and how to put it on the hook. Refer to the illustrations. Keep the bait in an insulated container so that it doesn't freeze. When using minnows, emphasize keeping mittens dry. Encourage students to bait their own hooks.

Bait your hook with a wax worm or minnow.

3 Split into small groups—assign a small group of students to each adult volunteer and give them a cluster of holes to fish. Give each adult one bobber per student, a depth finder for students to use to set the depth of their bobbers, fingernail clippers for cutting line, and needlenosed pliers for unhooking fish.

4 Discarding bait—it's illegal to discard unused minnows and worms on the ice or in the lake. Leftover bait should be saved for another day of fishing or put into the trash.

5 Landing and releasing fish—explain that when the bobber goes down under the water's surface you've got a fish! (Winter bites may be light, so watch the bobber closely!) Set the hook by pulling up on the jiggle stick. Then, set down the jiggle stick and pull in the line, keeping it taught. Gently grasp the fish by the sides and quickly take out the hook. Handle the fish carefully and briefly, disturbing the fish's slime covering as little as possible. If the fish has swallowed the hook, don't tug on it as this may tear the stomach. Instead, cut the line. If you haven't made arrangements to take fish home, release the fish immediately—and gently—back into the water. When handled gently, quickly, and with a few precautions, fish have an excellent chance of surviving when released. There are more catch-and-release tips in the *Catch-and-Release* brochure available through the Minnesota DNR, and in the Minnesota fishing regulations booklet.

6 Send students to their fishing spots and have fun!

7 Observe students as they are fishing. Rotate the groups to the warming station for hot chocolate or hot cider breaks. If students are getting cold, have them warm up with an activity, by stomping their feet, or playing a game. Demonstrate use of the ice auger to each group. Ask students why they may or may not be getting bites. Take photos of your trip!

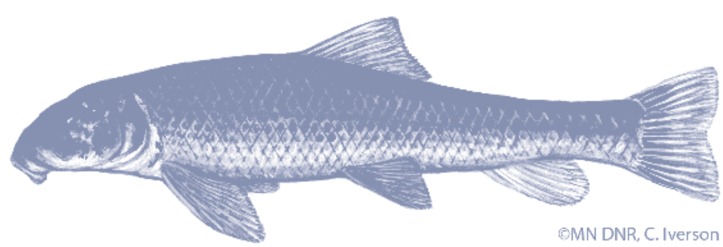
STOP AQUATIC HITCHHIKERS!
Prevent the transport of nuisance species.
Clean all recreational equipment.

Wrap-up

1 Review the list that the students made at the beginning of the class regarding the dangers of going on the ice. If there was a danger that wasn't covered, or a fear not alleviated, discuss those situations now. Review the ice thickness recommendations for various types of winter recreational activities on frozen lakes. Discuss the reasons why ice is never considered 100 percent safe.

2 Be sure you know that, although ice is never considered 100 percent safe, understanding ice, being prepared for your trip, keeping warm, and staying alert will help make ice fishing trips fun and safe.

3 Take some time to reflect on your fishing trip. Have students write down or share their answers to the following questions:
- What was your favorite part of the day?
- What did you notice about lakes in winter that you haven't noticed before?
- What was one new thing you learned or a skill you improved?
- How far off the bottom did you start to fish? At what depth did you catch fish? (From approximately six inches to one foot. The depth at which students caught fish will vary.)
- How should you handle the fish that you catch? Why should fish be released gently? (Quickly and gently. If the fish swallows the hook, don't try to remove it—just cut the line. This gives the fish a better chance of surviving. This conserves the fish resource and keeps the ecosystem healthy. The fish can then grow and reproduce and people will have fish to catch in the future.)
- Could you show someone else how to go ice fishing?
- Would you like to go ice fishing again?



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Assessment Options

1 Have students make ice safety posters to display throughout their school. The posters should address one of the topics touched upon in this lesson—dressing warmly, supplies to bring on the trip, ice thickness, rescuing another person, and self-rescue.

2 Have students record information from four fellow classmates' posters. Include looking for the points covered in the student learning objectives:
   - Identify the importance of dressing in layers and staying dry during an ice fishing trip.
   - Identify the minimum suggested ice thicknesses for new clear ice that safely support walking on ice, ATVs, small pickups, and groups of people—and to know that ice can never be considered 100 percent safe.
   - Demonstrate how to rescue a person who has fallen through the ice. Practice throwing a flotation device into a circle the size of a hula hoop.
   - Demonstrate self-rescue after falling through the ice.
   - Demonstrate ice fishing techniques and what to do with the catch.

   Then have students evaluate whether the information is complete.

3 Observe students while ice fishing to see if they can demonstrate how to use a depth finder, attach a bobber correctly, rig and bait the line, ice fish, handle and release fish gently and quickly.

4 Have students create an ice fishing catch-and-release brochure to distribute to local bait shops and fishing equipment retailers. Include tips for handling and releasing fish, and reasons why anglers practice catch-and-release fishing.

5 Using photos from their ice fishing trip, have students write a news story for their local paper about ice fishing safety, ice rescue, how to ice fish, and their ice fishing experience. If you used a digital camera during the trip, students can use the computer to choose and arrange photos and write their article. Then have students review one anothers' stories and combine elements from all of the stories to create a final draft to submit to the local paper.

6 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Ice Fishing and Winter Safety Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Student can define *hypothermia*.
3	______	______	Student can explain how *dressing in layers* keeps you warm.
2	______	______	Student can state two reasons why it's important to dress for the weather.
4	______	______	Student can list winter clothing important to wear for most ice fishing trips, including: • hat • scarf • mittens • neck gaiter • mittens and gloves • long underwear • wool sweater • wool or polypropylene clothing (versus cotton) • winter jacket • snow pants • wool socks • insulated rubber soled boots
4	______	______	Student can identify suggested minimum ice thickness that safely supports • ice fishing • ATVs • snowmobiles • cars • small pickup trucks • medium-sized pickup trucks
2	______	______	Student understands why ice that looks safe may not be safe, and states that thickness should be tested prior to going out on the ice.

3	______	______	Student can identify three factors that can cause thin ice (springs, aerators, moving water, etc.)
6	______	______	Student can identify six items of ice fishing safety equipment and reasons for using them on ice fishing trips, including: • ice rescue claws • warm beverages • hand warmers • blanket • throwable PFD • sled with attached rope
4	______	______	Student can demonstrate self-rescue and get out of the water if they should fall through the ice, including reducing or treating the subsequent threat of hypothermia using ice fishing safety equipment.
4	______	______	Student can demonstrate how to throw a PFD towards a designated target, recall that they should never attempt an ice rescue and they should find an adult and call 911, and demonstrate or describe how to treat hypothermia using ice fishing safety equipment.
2	______	______	Student can properly use a depth finder to set fishing depth and place bobber on line.
2	______	______	Student can tie an improved clinch knot and rig a line for ice fishing.
2	______	______	Student can bait the hook.
5	______	______	Describe fast release and gentle handling of fish, which maximizes survival odds for released fish.

Total Points

45 ______ ______ **Score** ______

Grade

41-45 points = A
Excellent. Work is above expectations.

36-40 points = B
Good. Work meets expectations.

31-35 points = C
Work is generally good. Some areas are better developed than others.

24-30 points = D
Work doesn't meet expectations, it isn't clear that student understands objectives.

0-23 points = F
Work is unacceptable.

Ice Fishing and Winter Safety Scoring Rubric

Ice Fishing and Winter Safety Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Dressing for the weather	Can state two reasons why it's important to dress for the weather. Can state why dressing in layers is important in winter. Can list winter clothing important to wear for most ice fishing trips, including: hat, scarf, mittens, neck gaiter, mittens and gloves, long underwear, sweaters, wool or polypropylene clothing (versus cotton), winter jacket, snow pants, wool socks, insulated rubber-soled boots.	Can state one reason why it's important to dress for the weather. Can state why dressing in layers is important in winter. Student can list at least eight winter clothing items important to wear for most ice fishing trips, including: hat, scarf, mittens, neck gaiter, mittens and gloves, long underwear, sweaters, wool or polypropylene clothing (versus cotton), winter jacket, snow pants, wool socks, insulated rubber-soled boots.	Can state one reason why it's important to dress for the weather. Can state why dressing in layers is important in winter. Can list at least five winter clothing items important to wear for most ice fishing trips, including: hat, scarf, mittens, neck gaiter, mittens and gloves, long underwear, sweaters, wool or polypropylene clothing (versus cotton), winter jacket, snow pants, wool socks, insulated rubber-soled boots.	Can state one reason why it's important to dress for the weather. Student can't state why dressing in layers is important in winter. Can list at least five winter clothing items important to wear for most ice fishing trips.	Can't state a reason why it's important to dress for the weather. Can't state why dressing in layers is important in winter. Can't list at least five winter clothing items important to wear for most ice fishing trips.
Ice thickness	Can identify suggested minimum ice thickness that safely supports ice fishing or walking on ice (four inches), ATVs (five inches), snowmobiles (5 inches), cars and small pickups (eight to twelve inches), and medium-sized pickups (twelve to fifteen inches).	Can identify suggested minimum ice thickness that safely supports ice fishing and three of the following: ATVs, snowmobiles, cars and small pickups, and medium-sized pickups.	Can identify suggested minimum ice thickness that safely supports ice fishing and two of the following: ATVs, snowmobiles, cars and small pickups, and medium-sized pickups.	Can identify the suggested minimum ice thickness that safely supports ice fishing.	Can't identify the suggested minimum ice thickness that safely supports ice fishing.

Ice Fishing and Winter Safety Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Thin ice dangers	Understands that ice is never considered 100% safe, why ice that looks safe may not be safe, and that ice thickness should be tested. Can identify three factors that can cause thin ice (springs, aerators, moving water, etc.)	Understands why ice that looks safe may not be safe, and that ice thickness should be tested. Can identify two factors that can cause thin ice (springs, aerators, moving water, etc.)	Understands that ice that looks safe may not be safe. Can identify one factor that can cause thin ice (springs, aerators, moving water, etc.)	Understands that ice that looks safe may not be safe. Can't identify one factor that can cause thin ice.	Doesn't understand that ice that looks safe may not be safe. Can't identify one factor that can cause thin ice.
Ice rescue, self	Can identify six items of ice fishing safety equipment and reasons for using them on ice fishing trips, including ice rescue claws, warm beverages, hand warmers, blanket, throwable PFD, and a sled with attached rope. Can demonstrate self-rescue and get out of the water if they should fall through the ice, including reducing or treating the subsequent threat of hypothermia.	Can identify four items of ice fishing safety equipment and reasons for using them on ice fishing trips, including ice rescue claws, warm beverages, hand warmers, throwable PFD, and a sled with attached rope. Can demonstrate self-rescue and get out of the water if they should fall through the ice.	Can identify two safety items including ice rescue claws. Can demonstrate self-rescue should they fall through the ice.	Can demonstrate self-rescue should they fall through the ice.	Can't demonstrate an effective response for self-rescue should they fall through the ice.
Ice rescue, another person	Recalls that children should never attempt to rescue a person who has fallen through the ice, states that children should find an adult and/or call 911. Can demonstrate how to throw a personal floatation device, and how to treat hyperthermia.	Recalls that children should never attempt to rescue a person who has fallen through the ice, states one of the following: that children should find an adult and/or call 911. Can demonstrate how to throw a personal floatation device or how to treat hyperthermia.	Recalls that children should never attempt to rescue a person who has fallen through the ice, states one of the following: that children should find an adult and/or call 911.	Can demonstrate how to throw a personal floatation device or how to treat hyperthermia.	Doesn't recall that children should never attempt an ice rescue and cannot demonstrate how to throw a PFD or how to help someone with hypothermia.

Ice Fishing and Winter Safety Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Handling fish and depth finder; rigging and hook-baiting	Describes fast release and gentle handling of fish, which maximizes survival odds for released fish. Can tie an improved clinch knot, set depth for bobber placement, and bait hook safely.	Discusses either fast release or gentle handling, which maximizes survival odds for released fish. Can describe how to use a depth finder and bait a hook safely. Can tie an improved clinch knot.	Knows what to do, but not how it helps fish. Can identify a depth finder, and bait and describe how to rig a line.	Can't accurately describe how to handle and release fish, or how to bait a hook.	Doesn't try to describe how to handle and release fish or how to bait a hook.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1. Have students perform ice safety skits for their classmates.
2. Ask a conservation officer, water patrol, or other ice safety specialist to visit your class and discuss ice safety.
3. Make ice rescue claws with your class. Find instructions from the DNR website by entering "ice rescue claws."
4. Have students plan an ice fishing event and invite their parents, caregivers, grandparents, or other adults.
5. Have students plan an ice fishing event for a group of younger students.

For the Small Fry

K-2 Option

Do the Dressing for Winter demonstration. Have students act out the self-rescue. Follow the instructions for Part 3: Ice Fishing.

STUDENT COPY

Name ______________________________ Date ______________

Dressing for Ice Fishing Word Finder Sheet

Unscramble the words and circle them in the word find.

cgikostn acp ______________ ______________ (two words)

rascf ______________ (one word)

stnmeti ______________

ertwni aotc ______________ ______________

sonw stanp ______________ ______________

sscko oowl ______________ ______________

rtinwe tosob ______________ ______________

gonl raewrednu ______________ ______________

Bonus: yweeaarslr ______________ ______________

P	L	M	O	K	N	I	J	B	U	H	V	Y	G
S	C	T	F	W	X	R	D	Z	E	S	W	W	A
S	T	A	K	O	N	E	R	R	D	U	M	L	F
Q	P	S	T	O	O	B	R	E	T	N	I	W	M
W	A	O	L	L	M	S	F	T	T	A	T	E	A
E	C	S	C	S	M	A	G	E	W	E	T	A	A
R	G	S	N	O	W	P	A	N	T	S	E	R	R
T	N	D	Z	C	I	Z	H	U	C	B	N	L	R
Y	I	F	X	K	N	N	J	A	E	Y	S	A	M
U	K	G	C	S	B	X	R	O	K	H	I	Y	Y
I	C	H	V	C	V	F	K	L	A	T	E	E	T
L	O	N	G	U	N	D	E	R	W	E	A	R	O
O	T	A	O	C	R	E	T	N	I	W	U	S	L
P	S	J	B	T	A	O	O	R	E	T	N	I	W

INSTRUCTOR COPY

Dressing for Ice Fishing Word Finder Answer Sheet

cgikostn acp	**stocking cap**
rascf	**scarf**
stnmeti	**mittens**
ertwni aotc	**winter coat**
sonw stanp	**snow pants**
sscko oowl	**wool socks**
rtinwe tosob	**winter boots**
gonl raewrednu	**long underwear**
Bonus: yweeaarslr	**wear layers**

P	L	M	O	K	N	I	J	B	U	H	V	Y	G
S	C	T	F	W	X	R	D	Z	E	S	W	W	A
S	T	A	K	O	N	E	R	R	D	U	M	L	F
Q	P	S	T	O	O	B	R	E	T	N	I	W	M
W	A	O	L	L	M	S	F	T	T	A	T	E	A
E	C	S	C	S	M	A	G	E	W	E	T	A	A
R	G	S	N	O	W	P	A	N	T	S	E	R	R
T	N	D	Z	C	I	Z	H	U	C	B	N	L	R
Y	I	F	X	K	N	N	J	A	E	Y	S	A	M
U	K	G	C	S	B	X	R	O	K	H	I	Y	Y
I	C	H	V	C	V	F	K	L	A	T	E	E	T
L	O	N	G	U	N	D	E	R	W	E	A	R	O
O	T	A	O	C	R	E	T	N	I	W	U	S	L
P	S	J	B	T	A	O	O	R	E	T	N	I	W

STUDENT COPY

Ice Safety Sheet

Ice Thickness Guidelines

These **ice thickness guidelines** are okay for new, clear, solid ice. But bear in mind that many things other than thickness can make the ice unsafe. **No ice is 100 percent safe!**

- four inches of new clear ice is the minimum thickness for travel on foot
- five inches is the minimum thickness for snowmobiles and ATVs
- eight to twelve inches is the minimum thickness to safely support cars or small trucks

STUDENT COPY

Ice Safety Sheet

What should you do if someone falls through the ice?

1. Stay calm. Think of a solution.
2. Do *not* run up to the hole. It's more than likely that you could fall in, too.
3. Throw or extend an item to the victim to pull them out of the water. Use a throwable personal flotation device attached to a rope, jumper cables, ski, sled, boat, or any object available.
4. If you can't rescue the victim immediately, call 911.
5. Get medical assistance for the victim. People coming out of very cold water can suffer a potentially fatal condition called **afterdrop**. Afterdrop occurs as the cold blood that had pooled in the body's extremities begins to circulate as the victim starts to rewarm.

What if you fall in?

1. Stay calm.
2. Turn toward the direction from which you came.
3. Place your hands and arms on the unbroken surface of the ice. Work forward onto the ice by kicking your feet. If you are carrying ice picks, dig the pointed ends into the ice to give you a handhold to grip.
4. If the ice breaks, maintain your position and slide forward again.
5. When you get out of the water and are lying on the ice, don't stand up. Instead, roll away from the hole. This spreads your weight over a greater area until you reach solid ice.
6. Get to a warm, dry place as soon as possible. Take off wet clothes and seek medical assistance.

STUDENT COPY

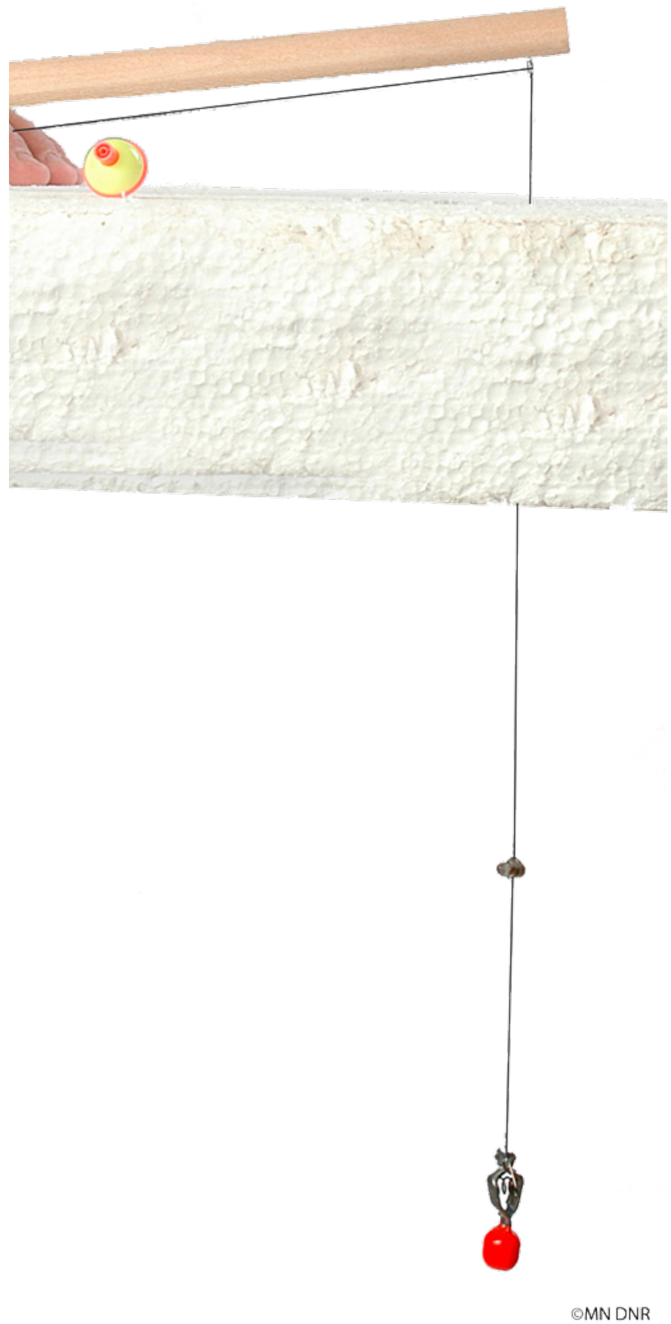
Setting Bobber Depth Sheet

Demonstrate how to use a depth finder using a jiggle stick.

1. Set up a simulated ice hole on two chairs.

2. Attach the clip-on depth finder to the hook on the end of the line.

3. Drop the weighted depth finder until it hits the bottom. You'll see some slack in the tension when it hits the bottom.



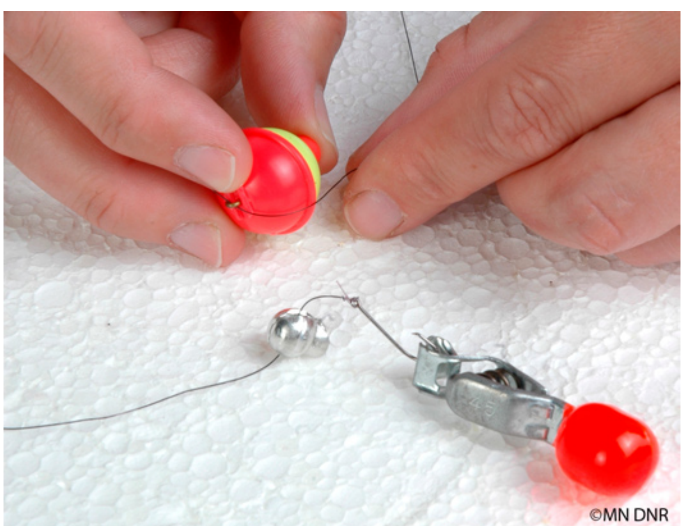
continued

STUDENT COPY

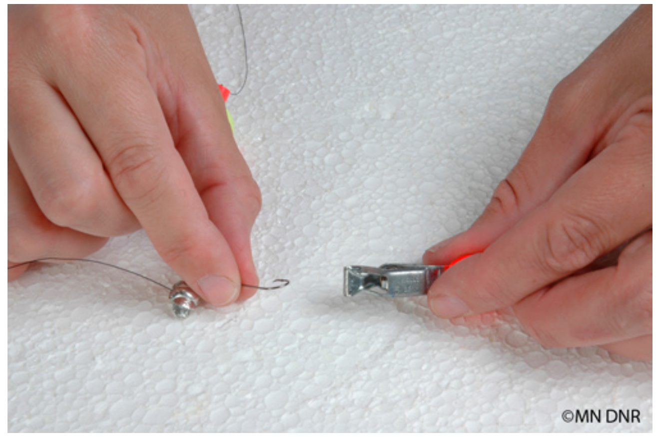
Setting Bobber Depth Sheet (continued)

4. Pinch the line at the water level and lift it up about one foot.

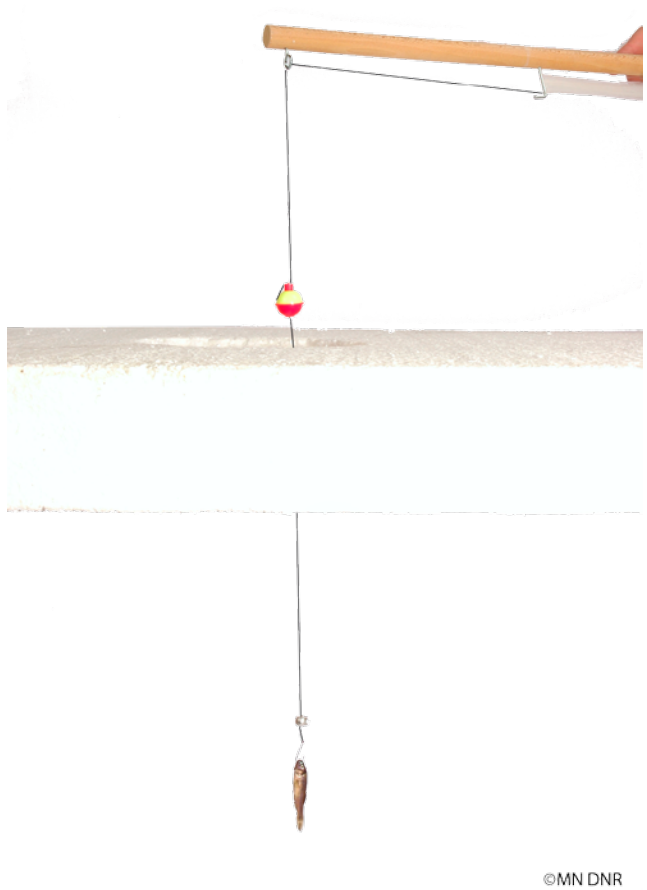
5. Attach your bobber at the water's surface.



6. Pull up your line and remove the depth finder.



7. Now you are ready to bait the hook!



Planning a Fishing Trip

Are you fully prepared for your next fishin' mission?

Table of Contents

Chapter 6 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Planning a Fishing Trip

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading.
II. Writing
D. Research:
Benchmark 1—The student will use grade-level appropriate reference materials to obtain information from dictionaries, glossaries, encyclopedias, and the Internet.

Grade 3
I. Reading and Literature
C. Comprehension:
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.
Benchmark 4—The student will retell, restate or summarize information orally, in writing, and through graphic organizers.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to different audiences for different purposes.

Grade 4
I. Reading and Literature
C. Comprehension:
Benchmark 3—The student will generate and answer literal, inferential, interpretive and evaluative questions about what is read to demonstrate understanding.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 3—The student will give oral presentations to different audiences for different purposes.

Grade 5
I. Reading and Literature
C. Comprehension:
Benchmark 6—The student will generate graphic organizers to enhance comprehension of texts and to describe text structure and organization.
Benchmark 7—The student will generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read.
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.
Benchmark 2—The student will demonstrate active listening and comprehension.
Benchmark 4—The student will give oral presentations to various audiences for different purposes.

History and Social Studies

Grade K-3
V. Geography
A. Concepts of Location:
Benchmark 2—Students will use maps and globes to locate places referenced in stories and real life situations.
Benchmark 4—Students will name and use directional words to describe locations of places in the school and community. Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above.
V. Geography
B. Maps and Globes:
Benchmark 1—Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above.
VII. Government and Citizenship
A. Civic Values, Skills, Rights and Responsibilities:
Benchmark 1—Students will demonstrate knowledge of civic values that facilitate thoughtful and effective participation in civic life.

Grade 4-8
V. Geography
D. Interconnections:
Benchmark 2—Students will analyze how the physical environment influences human activities.
V. Geography
E. Essential Skills:
Benchmark 1—Students will demonstrate the ability to obtain geographic information from a variety of print and electronic sources.
Benchmark 2—Students will make inferences and draw conclusions about the character of places based on analyses and comparison of maps, aerial photos and other images.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
III. Earth and Space Science
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will measure, record, and describe weather conditions using common instruments.

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 6 • Lesson 3

Planning a Fishing Trip

Grade Level: 3-5
Activity Duration: two 50-minute periods
Group Size: any
Subject Areas: Expressive Arts, Science, Language Arts, Social Studies
Academic Skills: communication, construction, mapping, reading, researching, small group work
Setting: Part 1: computer lab
Part 2: indoor or outdoor gathering area with tables
Vocabulary: Lake Finder, lake survey, limit, open season, pier, public access, regulations
Internet Search Words: Explore Minnesota, Minnesota DNR, National Weather Service; on the Minnesota DNR website: boat safety, compass, fish watch, fishing regulations, fishing reports, lake finder, maps, public water access, nature snapshots, recreation;
on the Explore Minnesota website: bait, fishing guide, guide service, lodging, tackle

Summary

There are many things to consider in planning a safe, successful fishing trip. Students will gather information from a variety of sources, including the Minnesota DNR website, plan a fishing trip and make a poster illustrating how they planned for a safe, successful trip.

Student Objectives

The students will:

1. Find fishing and lake information on the Minnesota DNR website.
2. Utilize the Minnesota DNR website and other sources to gather information on a specific lake and the types of fish they want to catch on a trip to that lake, including:
    - a map of the lake
    - a fish species inhabiting the lake
    - that fish species' diet
    - relevant fishing regulations (such as open fishing season and catch limits) for that fish
    - the location of a fishing pier or public access
    - weather and other safety considerations
    - local lodging, guide services, and bait shops
3. Create a poster showing the steps of planning a fishing trip and other information needed to ensure a safe, successful fishing trip.

Instructor's Background Information

If you want to go fishing, the first things to decide are where you want to go and what kind of fish you want to catch. Knowing which fish live in your chosen lake, what they eat (so you can choose appropriate bait and lures), and familiarity with fishing **regulations**, laws that govern fishing in the state, will help you plan your fishing trip. The Internet is a great tool for finding information about Minnesota lakes and fish. An important resource for anglers planning a fishing adventure is the Minnesota DNR website at **mndnr.gov**. On this site, anglers can quickly and easily locate detailed information on Minnesota lakes, the fish in those lakes, and rules to follow while fishing. By browsing through the main categories on the Minnesota DNR home page, or by searching with keywords, anglers can gather a variety of critical information that will help them enjoy a safe and successful fishing trip.

The Minnesota DNR website contains a **Lake Finder** feature. Lake Finder contains research data for more than 4,500 lakes throughout Minnesota. The data provides information from lake surveys, lake depth maps, water quality, fish consumption advisories, and other information. In addition to Lake Finder, the Minnesota DNR website contains information on fishing licenses, fishing regulations, public access points, fishing piers, and fish identification.

Lake Surveys

The Minnesota DNR is the lead agency responsible for fisheries management in Minnesota. Lake management plans are developed from **lake surveys** conducted during the summer by fisheries staff.

Materials

- Computers with Internet access
- *Minnesota Fishing Regulations* (booklet available from Minnesota DNR and local vendors that sell Minnesota fishing licenses)
- Printer
- Poster boards
- Construction paper
- Glue
- Scissors
- Markers, crayons, or paints
- County public water access maps, one for each group of three or four students (may be ordered from the DNR Information Center at 888-646-6367)
- **Poster Guidelines for Planning a Fishing Trip Sheet**, one for each group of three or four students

Creel surveys are another type of lake survey. DNR creel clerks interview anglers at water access sites, asking them about the quantities, types, and sizes of fish caught, and how long they fished. Creel surveys also play an important role in evaluating management plans and helping fisheries managers set objectives.

Lake surveys involve sampling fish populations using trap nets, gill nets and seines, aquatic plant surveys, and tests of water clarity and chemistry, as well as the monitoring of wildlife habitat. Lakes are surveyed on a rotating schedule determined by a lake's management plan objectives, available fishery resources, size, and accessibility. Some lakes are surveyed each year, while others may only be surveyed once every ten years. Lake survey data results are used to produce lake management plans that help the DNR track fish population trends, evaluate the effectiveness of management actions (such as stocking and aquatic plant restoration), and establish management goals for the lake.

Lake Maps

Aerial views of lakes are fascinating—and they simplify the planning of a safe, successful fishing trip. Lake maps provide instructions on how to get to the lake, as well as information on size, depth, and the location of good fishing spots. Maps also provide insight into safety considerations particular to each lake. They also show how to reach other nearby lakes that may be accessible through channels or streams.

Public Accesses and Fishing Piers

Before venturing onto a lake, anglers must know where they may launch boats or fish from shore. **Public access** refers to those lake areas where people may legally carry in or launch boats by trailer. Use of Minnesota DNR public access areas is free, and most access areas are open 24 hours. **Fishing piers** (floating, wooden structures) and shore fishing sites are designated public fishing sites. There is no cost to use a Minnesota DNR public pier or shore fishing site, but private owners, local units of government, and parks may charge for the use of their facilities. Public access or fishing piers aren't available on every lake in Minnesota—anglers must know where it's legal to launch a boat or fish from shore so they can avoid trespassing on private property. Always respect private property while fishing on the water or shore.

Fishing piers offer enhanced fishing opportunities across the state.

Minnesota Fish

When planning a fishing trip, anglers naturally think about the fish they're hoping to catch. To increase their chances of catching their favorite type of fish, anglers should take time to learn its feeding preferences so they can select the correct baits and lures. The DNR website provides illustrations and general information on the habits of common Minnesota fish.

A public access site.

Regulations

Fishing regulations are laws planned and enacted to maintain healthy fish populations throughout the state. If all anglers follow and support these rules today, they'll continue to enjoy good fishing tomorrow. The Minnesota fishing regulations booklet summarizes Minnesota fishing laws and regulations in effect for the current year. It's an excellent resource for checking a fish species' **open season** (the time of the year anglers may fish for a certain species of fish) and **limit** (how many of these fish anglers may legally possess). Additional fish identification tips are also included. The booklet includes information and special or experimental regulations designed for particular lakes or streams. These regulations override the general regulations for those waters. The Minnesota fishing regulations booklet is available through the Minnesota DNR and from other vendors, including many bait shops, fishing sports equipment stores, and gas stations that sell Minnesota fishing licenses. Fishing regulations are also posted on the Minnesota DNR website.

Minnesota State Parks

Many State Parks in Minnesota provide excellent fishing opportunities. The Minnesota DNR website contains links to Minnesota State Parks, including their locations, park maps, programs and activities, and information on reserving camping and lodging facilities. Rangers in the parks can also provide good fishing tips.

Lodging, Guide Services, and Bait Shops

Other details useful in planning a fishing trip include information on lodging, guide services, and bait shops. The websites and offices of Minnesota tourism or Chambers of Commerce provide excellent information, such as details on local resorts and motels, guide services, and bait shops. They can also suggest activities other than fishing—when you're taking a break, or for fellow travelers who don't fish. Local bait shop owners and guides know their area's "hot" fishing spots, and may even suggest the best tackle or baits.

Weather Updates and Boating Safety

Safety is a priority when planning a fishing trip. Before setting out, anglers should check the local weather predicted to confirm safe conditions. If storms are forecast, anglers should postpone a boat trip to a lake, especially to large lakes where waves can become dangerous. Weather forecasts also dictate what anglers need to wear. Hot summer days require sunscreen, hats, and lots of water; cold days call for warm, layered clothing.

Weather can also affect fish movement and feeding activity. As the saying goes, "Wind from the east, fish bite least; wind from the west, fish bite best." The movement of cold fronts may account for this phenomenon.

When planning to fish by boat, you must follow safe boat operating procedures and pack the proper emergency safety equipment. Wearing a lifejacket on a boat should be as automatic as wearing a seat belt in a car. You must also follow boating safety rules. Safety courses are offered through the Minnesota DNR, whose Boat & Water Safety program provides safety information and public education, including a free—and mandatory—boating and safety education program for people between the ages of 12 and 17. The Minnesota Boating Guide summarizes Minnesota boating laws and regulations in an easy-to-read format. It supplies the information that boaters need if they're to operate watercraft on the state's lakes and rivers. The guidebook includes boating and water regulations and other laws.

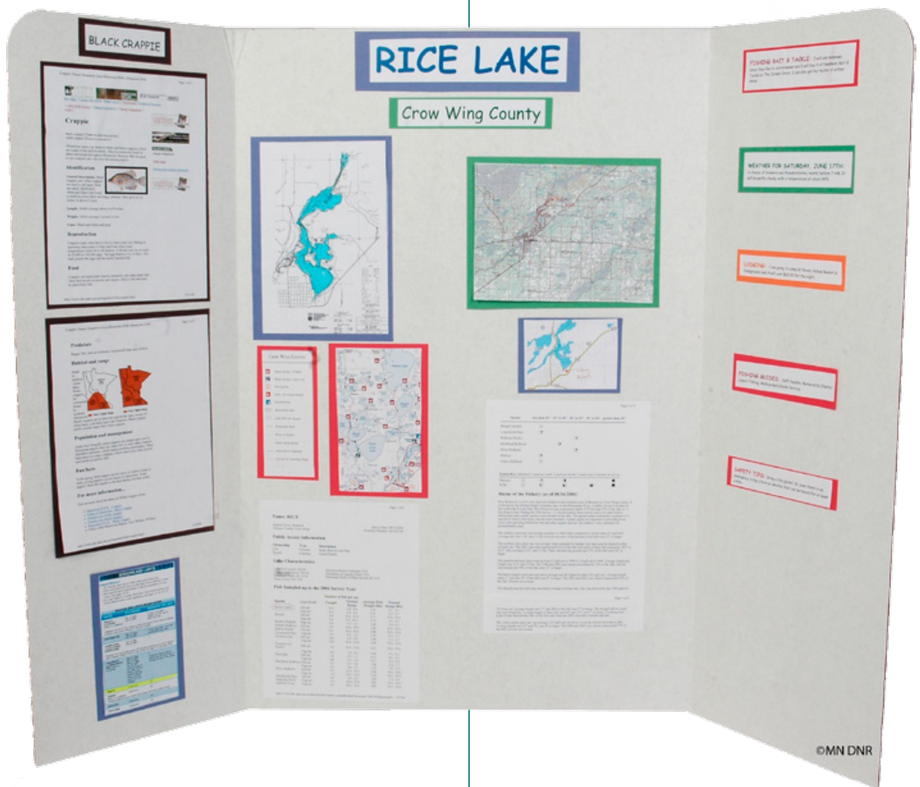
The Boat Operator's Course and Test Packet can be ordered online, or the Boat Minnesota course can be taken online at **mndnr.gov**

Nothing guarantees that you'll catch a fish, but planning and preparation will certainly improve your chances, and your fishing trip will be safe and lots of fun. And *that's* a successful fishing trip!

Procedure

Preparation

1 Become familiar with the Minnesota DNR website. Click on Lake Finder and explore the Lake Survey and Lake Map features. Back on the Minnesota DNR home page, click on Maps, and then, under Online Maps and Recreation, click on Water Access for public access and fishing pier maps. From the Minnesota DNR home page, again click on Regulations, Licenses & Permits to find the fishing regulations booklet. Search the DNR website for the Nature Snapshots and Fish Watch areas for information about fish. See the Safe Boating area for safety tips.



2 Order a set of county public water access maps for your area. You'll need one for each group of students. To order, contact the DNR Information Center at 1-888-646-6367.

3 For student reference, create a poster highlighting information on planning a fishing trip to a lake. Include all necessary information listed under the Objectives section, or use the **Poster Guidelines for Planning a Fishing Trip Sheet** as a guide.

4 Copy the **Poster Guidelines for Planning a Fishing Trip Sheet**, one per group of three or four students.

5 Collect poster board, construction paper, and art supplies for the students to use in creating their posters.

6 Arrange for computer lab time to complete this assignment.

7 You may want to pre-select the lakes that the students look up and explore.

The DNR website's Lake Finder contains information on 4,500 lakes with public access and have been surveyed by the Minnesota DNR Fisheries Section—all Minnesota lakes aren't listed.

Activity

Warm-up

1 Ask the students what kind of information they would need to plan a successful fishing trip to a lake they haven't previously fished.

2 Discuss why we have fishing laws and regulations, and why fishing regulations vary for different types of fish and water bodies. "If you fish, you share the responsibility to practice good stewardship of the fisheries resource." What does this statement mean? If you're not old enough to need a fishing license, do you have to follow fishing regulations? (In Minnesota, you aren't required to carry a fishing license until you're sixteen, but anglers of all ages must follow the fishing regulations.)

3 Ask students where they could find the types of information they need for planning a safe and successful fishing trip. Inform them that the many types of information they need is available on the Minnesota DNR website. Demonstrate how to access and navigate the website.

4 Provide examples and suggestions for other sources of information as noted on the **Poster Guidelines for Planning a Fishing Trip Sheet.** Most Minnesota fishing regulations can be found in the Minnesota fishing regulations booklet.

5 Explain that, using the Internet, they will create a poster that illustrates the planning of a safe and successful fishing trip. The poster should include information needed to plan a trip to a lake of their choice. Show an example of a poster containing all information noted in the Objectives section. Emphasize that each group's poster should feature all of these considerations. Have the students use the Minnesota DNR website and other sources to gather information on a specific lake and the types of fish they'd like to catch on a trip to that lake, including:

- a map of the lake
- fish species inhabiting the lake
- that fish species' diet
- relevant fishing regulations (such as open fishing season and catch limits) for that fish
- the location of a fishing pier or public access
- weather and other safety considerations
- local lodging, guide services, and bait shops

Show the steps for planning a fishing trip and other information needed to ensure a safe, successful fishing trip.

Lesson

1 Divide students into groups of three or four.

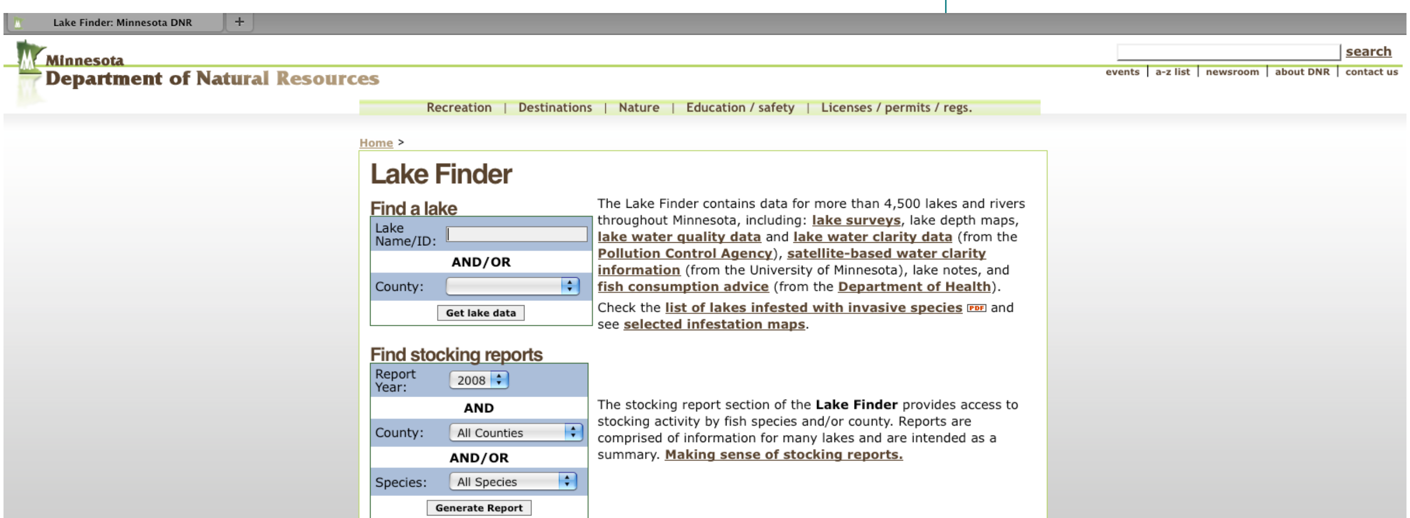
2 Have each group choose a Minnesota lake and plan a fishing trip to that lake. Or, allow students to choose from several lakes that you've selected in advance.

3 Have students collect the information listed below from the Minnesota DNR website and other recommended sites. The Search

DNR feature should be used to search for keywords within the DNR website. Direct links may exist from the home page to some of these sites at the time students do this lesson, so those shortcuts may be used as well.

- **Demonstrate how to use the Lake Finder.**
  Go to **mndnr.gov** to access the home page of the Minnesota DNR website. Click on "Lake Finder." From the Lake Finder page, you can access lake survey data by entering the name of the lake or the county in which the lake is located. The lake name and county will appear with a table of information. Show students that selecting items in the table provides additional information about those items. Examination of a Lake Survey will provide a list of fish species found in the lake and their relative abundance. Have students select one of these fish species (one that they'd like to fish for) to further investigate.
- **Have students go the to Minnesota DNR website, locate the Lake Finder feature and print a Lake Survey report of their lake.**

Can't find your lake in the Lake Finder? The DNR has surveyed most Minnesota lakes, but not all of them. Large lakes that experience heavy fishing pressure may be surveyed every year or two; others may not have been surveyed for ten or fifteen years. Lakes that have never been surveyed don't appear in Lake Finder.



- **Have students print a lake map of their lake—retrieve one by selecting "lake map" or "topographic maps."** Within Lake Finder, there are two methods for students to obtain a bird's-eye view of their lake. The report headings "lake map" and "topographic map" direct students to maps that provide an aerial view of the lake. Topographic maps also display information about surrounding lands. Both lake map styles feature zoom in tools that reveal more detailed information. Find another useful feature by doing a keyword search for "Recreation Compass," or simply click that heading on the homepage of the Minnesota DNR website. Some of the maps and aerial photographs can be found at this site. From one of these locations, students should print a map of their lake to use on their poster.
- **Have students find public accesses and fishing piers on their lake. Demonstrate how to find pier maps on the DNR website—**under Search DNR, type in "public water access."

The online county public water access maps can be difficult to navigate due to the small size on the computer screen. Using hard copies of the county public water access maps makes it easier for students to find piers and other public water accesses on their lakes.

To find maps of fishing piers and public shore fishing sites in Minnesota, students can conduct a search using keywords "maps," "public water access," or water access." The Statewide Fishing Pier map and county Public Water Access maps provide information about public fishing and boat launching sites.

- **Have student groups use the county public water access maps to find the fishing accesses and piers on the lake each group has chosen.**
- **Have students find food preferences for their fish species—under Search DNR, type "nature snapshots," then click on Fish.** In the Fish section, students can select their fish species to find out what it likes to eat. This site also describes the distribution of the fish throughout the state and other interesting facts about its characteristics and behaviors. Students may wish to print an illustration of their fish from this site, or search other websites for additional images to use on their poster.
- **Have students find the fishing seasons and limits for their chosen fish species—under Search DNR, type "fishing regulations."** The complete DNR fishing regulations booklet can be viewed at this site. To find information on the fishing season and limits for various fish in effect for the current year, students should open this site's regulations book and go to the "Seasons and Limits" bookmark, which will direct them to that chapter. Students should also check the section marked "Treaty, Experimental, and Special Regulations" to determine if any special regulations are in effect for their lake, such as size or number limits. Special regulations can override other season and limit regulations for their chosen fish species.
- **Have students find safety information—under Search DNR, type in "boat safety."** If students are planning on fishing by boat, they can find boat safety tips on the DNR website by performing a search with keywords "boat safety." Required boat safety equipment is provided on this site in the *Safe Boating Guide*. The complete guide booklet can be viewed here. Students should examine the sections on required equipment and boating safety tips for information to display on their poster. Boat and water safety tips can also be found in the DNR fishing regulations booklet. Students should visit a weather website to obtain the current weather forecast. This will help them decide the best days and times to take their trip. They can go to the National Weather Service website at **www.nws.noaa.gov**, or they can visit a local radio or television station website for weather links. On their posters, they should display the weather forecast for upcoming days.

- **Look for lodging, guide services, and bait shops.** Minnesota's state tourism website, **www.exploreminnesota.com**, offers information on lodging, guide service, and bait and tackle shops near lakes. On this site, students can search for keywords such as "lodging," "guide service," "fishing guide," "bait," and "tackle" to find local listings. If students can't find all of the information on this site, they could also search a local city's Chamber of Commerce website.

4 After they've located and printed or recorded all information needed to plan their fishing trip, students should create a display on poster board. Encourage imaginative and artistic displays providing various fishing trip information in both printed and hand-designed forms. Students may want to consider providing their viewers with interactive opportunities like three-dimensional elements, or features with moveable pieces.

Wrap-up
In a presentation to the class, team members can share information on their fishing site, how they planned their trip, and things they considered during their planning process. Allow time for the students to view other groups' posters after the presentations.

Assessment Options

1 Evaluate the posters. Make sure they include the following information:
- a map of the lake
- a fish species inhabiting the lake
- that fish species' diet
- relevant fishing regulations (such as open fishing season and catch limits) for that fish
- the location of a fishing pier or public access
- weather and other safety considerations
- local lodging, guide services, and bait shops

2 Have students design an informational brochure entitled *Planning Your Fishing Trip* that includes the same elements.

3 Another assessment option entails having the students choose their own assessment method. They could choose to do Assessment 1, Assessment 2, write a story or skit to address the elements in the assessments, or design their own assessment project or method that demonstrates that they've met the lesson's objectives.

4 Assessment options include the Checklist and Rubric on the following pages.

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Planning a Fishing Trip Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
4	______	______	Use the Internet to locate the Lake Finder feature on the Minnesota DNR website; find a map of the Minnesota lake that is the destination for your planned fishing trip
2	______	______	Locate information about a fish species on the Minnesota DNR website, including: the diet of one fish species, limits/seasons/other regulations for that fish, recommended bait and tackle, how to fish for that species, etc.
2	______	______	Locate hotel and lodging information for a Minnesota Lake using the Explore Minnesota website or a local city Chamber of Commerce website.
3	______	______	Locate weather information on the Internet, from a newspaper, or other weather report for an area near a particular Minnesota lake.
4	______	______	Locate resources and information for a Minnesota lake, including the following: • a lake map • where to fish for a particular species (habitat preferred by chosen species) • lake accesses • weather information • considerations regarding boating safety, water safety, handling fish safely, etc. • local guide services, bait shops, restaurants, and other recreational activities

4	______	______	Use all information to plan a fishing trip by making a fishing trip plan poster, brochure, or writing a skit about how to plan a fishing trip.
2	______	______	Include plans that address rainy weather and storms, what to do if the fish aren't biting, or other unexpected things that might happen on the trip.
2	______	______	State two reasons why it's important to collect information and make good plans, including safety considerations.

Total Points

23	______	______	**Score** ______

Grade

20-23 points = A
Excellent. Work is above expectations.

17-19 points = B
Good. Work meets expectations.

14-16 points = C
Work is generally good. Some areas are better developed than others.

11-13 points = D
Work does not meet expectations, it's not clear that student understands objectives.

0-10 points = F
Work is unacceptable.

Planning a Fishing Trip Scoring Rubric

Fishing Trip, Poster, Brochure or Skit Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Fishing trip components and lake map	Uses a lake map with location of where to fish for a particular species, species information, lake accesses, seasons/limits information, type of bait to use (what the fish species eats), weather information, safety considerations, lodging sites, guide services, bait shops, and other recreational activities for the area, to help plan a fishing trip, fishing trip planning skit, poster, or brochure.	Uses a lake map with location of where to fish for a specific species, and at least four additional pieces of information to help plan a fishing trip, fishing trip planning skit, trip planning poster, or brochure.	Uses a lake map with location of where to fish for a specific species, and at least three additional pieces of information to plan a fishing trip.	Uses at least two pieces of information to plan a fishing trip.	Doesn't use at least three pieces of information to plan a fishing trip.
Research	Can use the Internet to locate the Minnesota DNR website. Can find fishing and lake information on the site that will help to plan a fishing trip. Can collect and identify at least four other sources of information helpful in planning a fishing trip.	Can use the Internet to locate the Minnesota DNR website. Can find fishing and lake information on the site that will help to plan a fishing trip. Can collect and identify three other sources of information helpful in planning a fishing trip.	Can use the Internet to locate the Minnesota DNR website. With assistance, can find fishing and lake information on the site that will help to plan a fishing trip. Can collect and identify two other sources of information helpful in planning a fishing trip.	Can use the Internet to locate two types of information on fishing and/or lakes in Minnesota.	Finds no resources or information that will help to plan a fishing trip.
Fishing trip plan	Can produce a fishing trip plan that is thorough, and makes the connection that planning and gathering information and resources will help ensure a safe and more successful fishing trip. The plan considers multiple aspects of a fishing trip, considers safety precautions, and contains contingency or plans, (i.e. what to do in poor weather.)	Can produce a plan that makes the connection that planning and gathering information and resources will help ensure a safe and more successful fishing trip. The plan considers multiple aspects of a fishing trip and considers safety precautions.	Can produce a plan that makes the connection that planning will help ensure a safe and more successful fishing trip. The plan considers multiple aspects of a fishing trip, including at least one safety precaution.	Can produce a minimal plan for a fishing trip. The plan considers at least two aspects of a fishing trip.	Doesn't produce a plan for a fishing trip.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 In addition to the poster, ask students to map a driving route from their school to the lake. They could print a map and highlight the road(s) that lead from school to the nearest public access or pier.
2 Organize an actual fishing trip to a local lake. Prior to this fishing trip, have students research the lake. Have students invite parents or caregivers, grandparents, or a group of younger students to the fishing trip they've planned.
3 Ask students to examine some local newspapers, sports publications, and websites to view current fishing reports. The DNR website provides several links to fishing publications. Students can search for the keywords "fishing reports" for information from publications such as *Outdoor News, Explore Minnesota, Outdoors Weekly*, and the *Star Tribune* fishing page.

For the Small Fry

K-2 Option

1 Have students plan a fishing trip—without using Internet resources—but focusing on safety and preparation. As a class, compile a list of basic fishing equipment, clothing, and safety gear, as well as things to do before leaving, like teaming up with a responsible adult fishing buddy. Display a collection of the equipment, or symbols of these themes, in a box in the front of the class. Each time the class comes up with an item on the list, a different student can come to the front of the class, collect that item, and move it to another location to signify that it's been "packed" for the trip.
2 Watch the *Grandpa, Can We Go Fishing?* video program available through the MinnAqua Program.

STUDENT COPY

Names ____ Date ____________________

Poster Guidelines for Planning a Fishing Trip Sheet

You will create a poster about planning a safe and successful fishing trip to a lake. Follow the guidelines below to help you find information to include in your poster. Check off each item after you collect that information. You can also look for other information that will help you plan your fishing trip. Record all the information you collect. You will include this information in your Planning a Fishing Trip poster.

Checklist

1. Search for fish information and lake data on the **Minnesota DNR Website**. Go to **mndnr.gov** and go to **Lake Finder**.

❑ Choose a lake. **What is your lake name? Which county is it in?** Does your lake have a Lake Survey? If not, choose another lake. Lake name:

____

____

❑ Find and print the **Lake Survey** for your lake. What is at least one fish species you would like to catch in this lake? Fish species:

____

____

❑ Find and print the **lake map** for your lake.

❑ Find **public accesses and fishing piers** for your lake. This may be called water access. Add these to your map.

❑ Find the fishing regulations. What is the **fishing season, size limit** and **possession limit** for the fish you chose?

____

____

____

STUDENT COPY

Names ____ Date ________________

Poster Guidelines for Planning a Fishing Trip Sheet

❑ Search for **"Nature Snapshots"** and **"Fish Watch"** for information about fish. **What does your chosen fish like to eat? Which baits and tackle will catch them?**

____

❑ Search for "Safe Boating." **What are some safety tips people should consider when fishing from a boat?** ____

____

2. Now explore the Internet outside of the DNR website.

❑ Choose a weekend to go fishing. Try the National Weather Service website at **www.nws.noaa.gov** or visit a local radio or television station's website for weather links. **What is the weather forecast or typical weather during the time of your fishing trip?** ____

____

❑ For local lodging, guide services, and bait shops, try the state tourism website, **www.exploreminnesota.com**, or search a local Chamber of Commerce website. Will you camp or stay in a hotel? **Where will you stay overnight? How much will it cost?**____

____

❑ When people are new to an area, they sometimes use a fishing guide. List some fishing guides available near your lake.

____

____

❑ What is the name of a store where you will **buy your bait**? ____________________ Can you **collect your own bait**? __________ What is the name of a store where you **will buy fishing tackle?** ____

Piscatorial Palate

On any given day, a fish might eat just about anything!

Table of Contents

Chapter 6 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Piscatorial Palate

Minnesota Academic Standards

Lesson *introduces* this Benchmark.
Lesson *partially* addresses this Benchmark.
Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
III. Speaking Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups.

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment.
I. History of Nature and Science
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically.
Benchmark 2—The student will participate in a scientific investigation using appropriate tools.
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer.
IV. Life Science
B. Diversity of Organisms:
Benchmark 1—The student will describe the structures that serve different functions in growth, survival and reproduction for plants and animals.

Grade 4
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment.
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings.

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

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Chapter 6 • Lesson 4

Piscatorial Palate

Grade Level: 3-5
Activity Time: 3 hours, including fishing trip
Group Size: any
Subject Areas: Science, Language Arts
Academic Skills: application, comparison, evaluation, experimenting, gathering, graphing, hypothesizing, observation, prediction, reporting, research
Setting: indoor or outdoor gathering area and water's edge
Vocabulary: barbels, control group, doughball, palate, piscatorial, stinkbait
Internet Search Words: carp bait recipes, doughball recipes, stinkbait recipes

Instructor's Background Information

In the world of fishing products, none have enjoyed greater success than the profusion of scented baits. Today's tackle industry has created a wide array of scents for dipping or spraying lures, as well as scents embedded in plastic baits to make them attractive to piscatorial palates. (**Piscatorial** comes from pisces, the Latin word for fish; **palate** refers to the sense of taste.)

Anglers have long realized that fish use their senses of smell and taste to search for food. This is even more pronounced in fish, such as catfish and carp, which have taste buds on their **barbels** (whiskers), as well as on their tongues and lips. Catfish rely on their many taste buds to locate food. Baits prepared by catfish anglers are often referred to as **stinkbaits**. The ingredients in some of these concoctions include a variety of smelly items (fish heads, for instance). All possible ingredients may not be appropriate for classroom use, but it can be fun for students to discuss why they might appeal to fish.

In this lesson, students will brainstorm a list of some common foods that they think might attract fish. Suggestions will vary. Encourage students to be creative and to open-mindedly consider some obscure answers. The only criterion for this experiment is that the suggested bait must stay on a hook for a minimum of five minutes. Suggested food items might be used alone if they can be cut to go on a hook. Otherwise, they can be puréed and mixed with flour (as a flavor carrier) to produce a **doughball**.

Summary

Many anglers have preconceived notions about which baits will attract a particular species of fish. Tackle industry researchers must often find and produce new and unique fishing baits that will be as productive—or more productive—than natural baits. In this lesson, students will have an opportunity to let their creativity run wild by suggesting common foods to try as alternatives to traditional baits. Some of these alternative baits just may help students catch the "big one!"

Student Objectives

The students will:

1. Design an experiment.
2. Make predictions about foods that will attract fish.
3. Record observations and draw conclusions.

Materials

- Box of zip-locking sandwich bags
- Knife for preparing bait
- Scented fishing bait (optional)
- **Piscatorial Palate Question Sheets,** one per student
- **Piscatorial Palate Data Sheets**, one per group
- Pencils or pens
- Clipboards

These are some foods you can use as baits if the students' lists are incomplete. (You can search for ideas on the Internet, too.)

- whole kernel corn
- strawberries, or other fruits
- cheese or cheese spread
- "gummy" candy products
- hot dogs
- bacon
- marshmallows
- potatoes
- angleworms or nightcrawlers (one group will use these as control bait)

Students will experiment to determine how well various baits perform on their fishing trip. Using the baits that they've suggested, student fishing teams will fish for one hour to determine if fish are attracted to the experimental baits. Meanwhile, one group, a **control group**, fishes with worms or nightcrawlers. A control group provides a standard against which other conditions can be compared in a scientific experiment. We know that fish will reliably eat worms or nightcrawlers, so they'll be useful to compare with other baits. Students will record the type of bait they used and the species of any fish that were enticed to bite. Data will be recorded on the **Piscatorial Palate Data Sheet**.

Procedure

Preparation

1. Purchase prospective bait supplies on the list created by the instructor and students.
2. Cut up new baits in sizes that will fit on a hook and in the mouth of a panfish.
3. Plan your fishing trip to test these new baits using the guidelines in **Lesson 6:3—Planning a Fishing Trip.**

Activity

Warm-up

1. Review the basics of fish senses as outlined in **Lesson 2:1—Fish Sense.**
2. Ask students why they think fish might go after a lure or bait. Answers will vary. Ask students what they think might taste good to a fish. Don't attempt to correct their ideas at this point—the students should begin thinking about the reasons that a fish might be attracted to a particular type of bait or lure. If you have the resources, purchase a sample of packaged, scented fishing bait and present it to the class. As you pass it around the classroom, encourage students to smell the contents and describe the scent. Why would a fish like to eat this? What else in the lake would smell like this?
3. Do all fish find food by smelling? Or do some concentrate on sight or vibration? Compare pictures of a visual predator, like a bass or northern pike (with large, well-developed eyes), to a smelling predator like catfish (which has smaller eyes). Ask students to describe the differences between these fish. Compare the habitats of these different types of fish, noting the water clarity they seem to prefer. Why do scent-oriented fish do better in turbid water than fish that depend on their eyesight to locate food?

Lesson

1. Work with the students to brainstorm a list of their favorite (or not so favorite) foods that might appeal to certain fish. Discuss the ways in which these food items could be attached to a hook and used as

bait. This should be done before you purchase the bait supplies.

2 Place students into fishing groups at this time. Limit group size to four or five students.

3 Limit the number of items on the list to the number of students in each group.

4 Pass out the **Piscatorial Palate Question Sheets** to each student. In their groups, have students answer Questions 1 and 2. These require students to make predictions about which baits they think will work best and why. Record these predictions and form them into a hypothesis: a statement that can be answered or can be proven or disproved in the experiment when the data have been collected and summarized.

5 In order to get enough data to be able to make a positive statement about the success of each new type of bait, every student group will fish with the same four or five types of baits. Each student in a group will use one of the baits for the entire length of the experiment.

6 Pass out **Piscatorial Palate Data Sheets**, one per group. During the fishing trip, have each group record on its data sheet the bait tried, number of nibbles felt, number of fish caught, species caught, and whether or not the bait stayed on the hook.

Wrap-up

1 In the classroom, have the original groups gather to complete the **Piscatorial Palate Question Sheet** and prepare to report their findings to the class.

2 As each student group reports on their findings, make a master sheet on the whiteboard or overhead projector that includes all data collected by the individual groups.

3 Make a bar chart for the students, based on the data on the master sheet, that depicts the number of fish caught on each type of bait and the bait that caught the most species of fish. Then have the individual student groups make a similar graph from their data and compare their results to the combined results of the class.

4 Discuss the positives and negatives for each type of bait. Why did some effectively catch fish while others didn't? What problems did students encounter with the various baits? What recommendations could they make for the next fishing trip? What criteria would they use for choosing baits in the future?

5 What are the natural foods of the fish they are trying to catch? And how—if at all—did the new bait mimic those tastes, smells, and appearances?

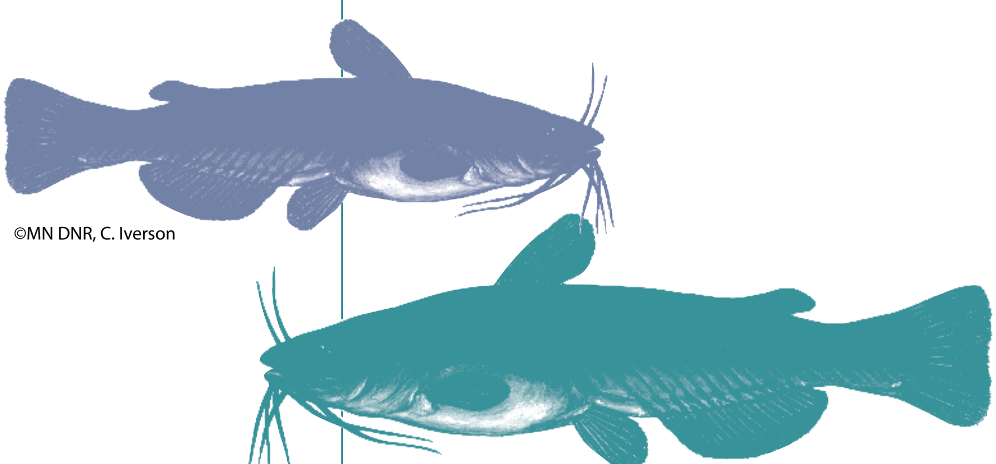
6 If no one catches anything on the day of the experiment, what does this suggest? Were there no fish in the lake? Were none of the baits appetizing to fish? What reasons could there be for fish not feeding on a particular day? (Incoming weather systems often seem to make fish sluggish eaters, although there is little scientific data to help us understand why.)

In Minnesota, it is illegal to use game fish, carp or gold fish, or their parts for bait. In some areas—designated trout streams, for example—live bait use isn't allowed. Also, depositing entrails or fish parts into public waters or leaving them on lake or stream shores is prohibited. Refer to the Minnesota fishing regulations booklet for regulations concerning the use of bait.

It is recommended that one adult accompany every five children while fishing. (See **Lesson 6:1—Safety and Fishing at the Water's Edge** for more information.)

Assessment Options

1. Have students design an experiment to determine what type of artificial lure would best attract sunfish when shore-fishing at a specific local lake during a particular time of year. Evaluate the experimental design for its inclusion of a hypothesis or prediction, a control, clear experimental procedures, consideration for at least two variables (such as weather conditions or time of day), and a chart or table for recording observations and final results. Ask students to include an explanation of why good experimental design provides a better conclusion or result than poor experimental design.
2. Have students interview a family member, neighbor, instructor, or other adult at the school or in the community who is an avid angler, asking how they determine which baits or lures to use. Afterward, have students evaluate the method the angler uses to determine if the method would be effective. Have students improve upon the angler's method by using scientific experimental design criteria. Students can then write a letter to the angler, sharing their experimental design.
3. Have students communicate the results of the bait experiment in this lesson to the outdoor editor of the local newspaper by producing a news release announcing the findings of their bait experiment. Alternately, they could write a news column about their experimental process and results for the school newspaper or website.
4. Assessment options include the Checklist and Rubric on the following pages.



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Piscatorial Palate Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
2	______	______	Discuss what fish might like to eat. Define bait.
4	______	______	Work cooperatively in small group to make a prediction about which foods or bait will attract fish.
5	______	______	Work within a group to design an experiment including the following: • a prediction about bait • steps to test your prediction • making observations • recording data • drawing a conclusion
3	______	______	Conduct bait experiment, collect data, and record observations on the data sheet.
4	______	______	Work within a group to present the results and data from your experiment. Your presentation should: • list all the parts of your scientific experimental design • explain what a *control group* is, and why this experiment had a control group • state whether or not your experiment proves your group prediction about bait; why did it prove, or not prove, your prediction? • state two reasons for including all the parts of an experiment.
4	______	______	Make graphs to compare data from all groups.
2	______	______	Draw a conclusion about which bait will attract more fish to bite from the experimental results and graphs.
3	______	______	State why different types of fish prefer different types of food.
2	______	______	Give an example of why one type of fish might prefer a certain type of bait.
Total Points 29	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

26-29 points = A
Excellent. Work is above expectations.

22-25 points = B
Good. Work meets expectations.

18-21 points = C
Work is generally good. Some areas are better developed than others.

14-17 points = D
Work does not meet expectations, it isn't clear that student understands objectives.

0-13 points = F
Work is unacceptable.

Piscatorial Palate Scoring Rubric

Fish Bait Preferences Experiment	3 Excellent	2 Good	1 Fair	0 Unacceptable
Predictions: what does a fish like to eat?	Participates in class discussions about what fish might like to eat; works cooperatively within small group to predict which bait (food) will attract fish to bite.	With some encouragement and prompting, participates in class discussions about what fish might like to eat; works cooperatively within small group to predict which bait will attract fish to bite.	Listens in class during discussions about what fish might like to eat; doesn't contribute to small group to help predict which bait will attract fish to bite.	Doesn't listen in class during discussions about what fish might like to eat; disrupts small group.
Design an experiment	Works with group to design an experiment including prediction, how to test prediction, observations, recording data, comparing data, and drawing a conclusion.	Works with group to design an experiment including at least four of the following experiment components: prediction, how to test prediction, observations, recording data, comparing data, and drawing a conclusion.	Works with group to design an experiment, but experiment design doesn't contain listed components.	Doesn't work with group to design an experiment, or experiment isn't completed.
Record observations/ data	Participates in collecting data and recording observations on the data sheet for the bait experiment accurately and in an organized way.	Participates in collecting data and recording observations on the data sheet.	Doesn't participate as fully as other group members in collecting data and recording observations on the data sheet.	Doesn't participate in collecting data and recording observations on the data sheet.
Compare data and draw conclusions	Follows instructions to make graphs comparing data from different groups' results. Can draw three or more conclusions from results and graphs.	Follows instructions to make graphs comparing data from different groups' results. Can draw one or two conclusions from results and graphs.	Has some difficulty in completely following directions to make graphs from different groups' results. Doesn't draw conclusions from the results and graphs.	Doesn't follow directions or complete graphs. Draws no conclusions.

Fish Bait Preferences Experiment	3 Excellent	2 Good	1 Fair	0 Unacceptable
Reporting results	Works with group to communicate experimental results and conclusion in a clear, organized way, including explaining components of scientific experimental design. Also includes reasons for including a control group in the experiment. States whether conclusions support the original prediction, and offers reasons based on data or further predictions. States two reasons for designing an experiment using the scientific method.	Works with group to communicate experimental results and conclusion in an organized way, including explaining most components of scientific experimental design. States whether conclusions support the original prediction. States one reason for designing an experiment using the scientific method.	Works with group to communicate experimental results and conclusion. States whether conclusions support the original prediction. States one reason for designing an experiment using the scientific method.	Doesn't participate or cooperate within group to communicate experimental results and conclusion. Can't state a reason for using scientific method to design an experiment.
Bait	Demonstrates understanding that different fish prefer different types of food, based on their physical features and habitat type. Can give an example of why one type of fish prefers a certain type of bait (visually stimulating, odor, taste, etc.)	Demonstrates understanding that different fish prefer different types of food, based on their physical features and habitat type.	Demonstrates understanding that different fish prefer different types of food.	Doesn't demonstrate understanding that different fish prefer different types of food.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 Use the Internet to find catfish "stinkbait" recipes, and have students create these baits as well. It can be fun to make a recipe that they find, or to create a new one of their own.
2 Have students market their most successful new bait. Include a name, a drawing of the bait and the kinds of fish it may catch, and the recipe.
3 Have students create a "menu" for fish, in which they attempt to market each tested bait to fish that come to a "restaurant" to eat them. Have them use creative, appealing language like that used in real restaurant menus. (For example, "Crisp texture, with a savory crayfish aftertaste.") Have the class vote on the best new product.
4 Live Bait Hunt—have students search the school grounds for organisms that might make good bait, including worms, caterpillars, slugs, and other invertebrates.

For the Small Fry

K-2 Option

With younger students, omit the use of the worksheets; let them make predictions about the different foods and what fish will eat. Choose and try different food items as bait while fishing. Afterward, talk about which baits worked, which didn't, and possible reasons.

STUDENT COPY

Names ________________________________ Date ______________

Piscatorial Palate Question Sheet

1. Which bait(s) do you think will catch the most fish? Why?

2. Create a hypothesis based on your predictions in Question 1.

3. Which bait worked best? Why?

4. What conclusions can you make about the types of bait you tested?

STUDENT COPY

Names ______________________________ Date ______________

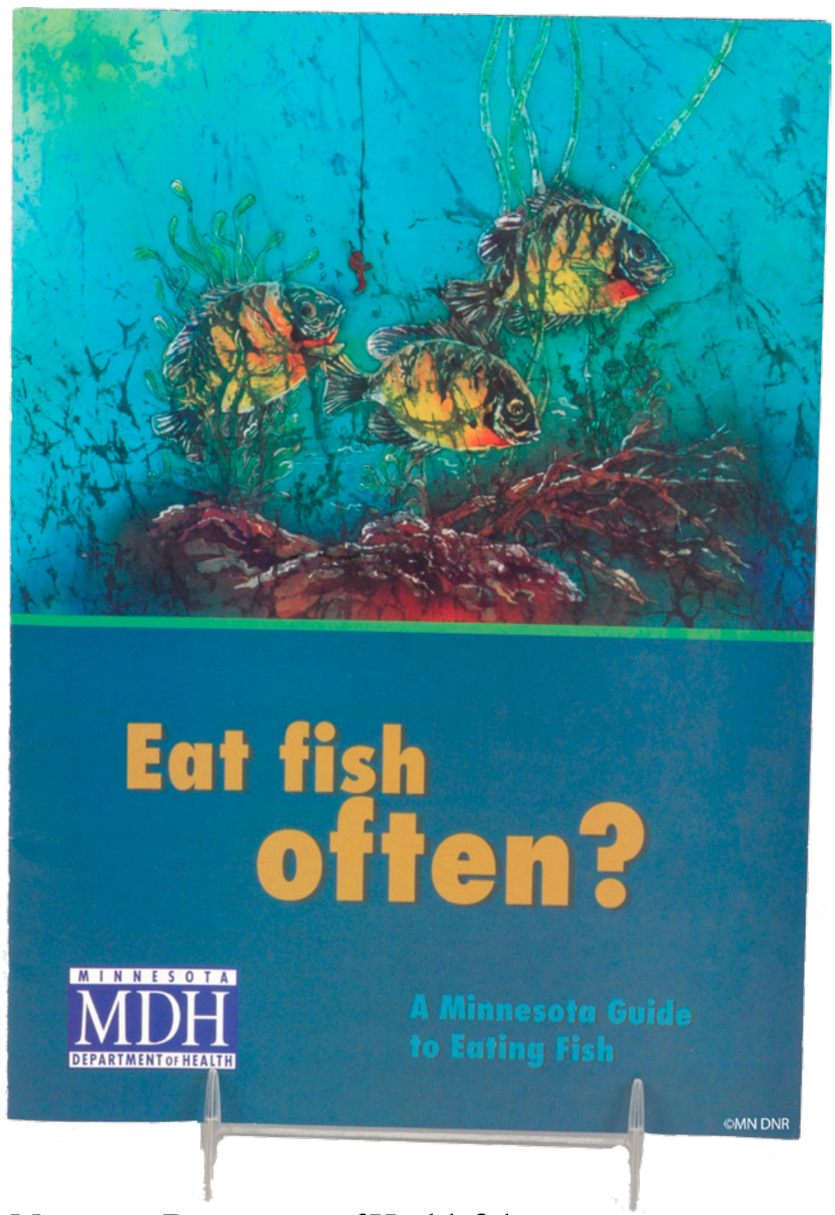
Piscatorial Palate Data Sheet

For each column, write the type of bait used. Then record the number and species of fish caught for each bait, along with whether the bait stayed on the hook or not.

	Bait #1 ________	Bait #2 ________	Bait #3 ________	Bait #4 ________	Bait #5 ________
Number and species of fish caught with each bait. **Example:** **bluegill** **///** **bullhead** **/** **trout** **//**					
How many nibbles did you get?					
Did the bait stay on the hook?					

Eating Fish

Fish: good food for your brain



Minnesota Department of Health fish consumption guidelines brochure.

Table of Contents

Chapter 6 • Lesson 5

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Eating Fish

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◑ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading. ● (Fully addresses Benchmark if computer research is completed, otherwise partially addresses Benchmark.)

History and Social Studies

Grade 4-8
V. Geography
D. Interconnections
Benchmark 2—Students will analyze how the physical environment influences human activities. ●

Science

Grade 3
IV. Life Science
C. Interdependence of Life
Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism. ●

Grade 4
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions. ●

Grade 5
IV. Life Science
F. Flow of Matter and Energy:
Benchmark 2—The student will use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota. ◒

Environmental Literacy Scope and Sequence

Benchmarks
- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)
- For the full Environmental Literacy Scope and Sequence, see: **www.seek.state.mn.us/eemn_c.cfm**

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Chapter 6 • Lesson 5

Eating Fish

Grade Level: 3-5
Activity Duration: Part 1: 15 minutes
Part 2: 15 minutes
Part 3: 60 minutes
Group Size: any
Subject Areas: Health and Safety, Language Arts, Social Studies, Science
Academic Skills: application, comparison, drawing conclusions, listening, measuring, observation, researching, simulation
Setting: Part 1: indoor or outdoor gathering area
Part 2: computer lab
Part 3: kitchen with stove
Vocabulary: bioaccumulation, biomagnification, fish advisory, mercury, omega-3s, parts per billion (ppb), PCBs, risk
Internet Search Words: eating fish, Minnesota Department of Health Fish Consumption Advice, nutrition and fish, omega-3s, protein; on the Minnesota DNR website: search on Lake Finder and then by individual lake

Summary

The American Heart Association recommends two servings of fish per week. Fish are a nutritious source of low-fat protein and omega-3s and provide many health benefits. Pollution in lakes, rivers, and streams can impact fish. Fish containing pollutants may pose some risk to people, but we make choices about balancing risks and benefits every day. What should you do? Gather information and assess it effectively. Studies show that the benefits of eating fish outweigh the risks as long as the fish are low in contaminants. In this lesson, the instructor demonstrates using a recipe and cooking fish. Students will taste the fish.

Student Objectives

The students will:

1. List three nutritional benefits of eating fish.
2. List two pollutants that can impact fish, explain how each gets into water and can impact fish, and state a reason for each to explain how this can pose a risk for people.
3. Define risk, understand that hazards and risks occur daily in our lives, and identify three ways to reduce some risks associated with eating contaminated fish, including gathering and assessing information.
4. State the American Heart Association's recommended amount of fish to include in a healthful diet for the general population.
5. Observe a filleting demonstration that also

Instructor's Background Information

In China, some people believe that eating fish makes wishes come true. In Celtic mythology, eating fish bestows infinite knowledge. What are the myths and facts about eating fish?

The foods we eat do influence our health. The October 18, 2006 issue of *Journal of the American Medical Association (JAMA)* includes an important article about the benefits of eating fish. It states that fish is an excellent source of protein that is low in saturated fats, and that fish is also rich in other nutrients such as minerals and vitamins. Fish is not only packed with protein, healthful vitamins such as Vitamin D, and minerals such as selenium, but it is a major source of omega-3 fatty acids.

The Power of Protein

Neil Osterweil, an award-winning medical writer and Senior Associate Editor of *MedPage Today* in his article, "The Benefits of Protein," (see **(www.webmd.com/content/article/85/98824.htm)** reports that: "protein is an important component of every cell in the body. Hair and nails are mostly made of protein. Your body uses protein to build and repair tissues. You also use protein to make enzymes, hormones, and other body chemicals. Protein is an important building block of bones, muscles, cartilage, skin, and blood. Along with fat and carbohydrates, protein is a 'macronutrient,' meaning that the body needs relatively highlights removal of fat, participate in a cooking demonstration, and taste fish!

Materials

Part 1: Bioaccumulation

- Six name tags
- Six one-gallon sized ziplocking bags
- One large bag of popcorn
- Permanent marker, for writing on name tags and plastic bags

Part 2: Fish Advisory

- **Fish Consumption Report for Sleepy Eye Lake**, one per student or group
- **Safe Eating Guidelines** Sheet or "Eat Fish Often?" brochures from the Minnesota Department of Health
- Computer with Internet access

Part 3: Filleting, Cooking, and Tasting

- Video, *Landing and Caring for the Catch* (15:22), optional (available through the MinnAqua Program)
- **Basic Filleting Sheet**, one per student
- Whole fish (fresh is best, thawed okay)
- Sharp fillet knife
- Cutting board
- Table covering
- Fabric butcher gloves—helps with gripping and holding fish while filleting (optional)
- Plastic bag for garbage
- Paper towels
- Cooking pans, waxed paper, aluminum foil
- Ingredients for fish strips (6 fish fillets, 2 eggs, 1 cup bread or cracker crumbs, ½ cup butter or margarine)
- **Fish Recipes Sheet,** one per group
- Crackers and napkins (for serving fish)

large amounts of it. (Vitamins and minerals, which are needed in only small quantities, are called 'micronutrients.') Unlike fat and carbohydrates, the body does not store protein, and therefore has no reservoir to draw on when it needs a new supply." (The body needs a continuous supply of protein.)

We should also be aware of some myths about protein. Osterweil continues, "We've all heard the myth that extra protein builds more muscle. In fact, the only way to build muscle is through exercise. Bodies need a modest amount of protein to function well. Extra protein doesn't give you extra strength."

And according to the U.S. Department of Health and Human Services:

- Teenage boys and active men can get all the protein they need from three daily servings for a total of seven ounces.
- For children age two to six, most women, and some older people, the government recommends two daily servings for a total of five ounces.
- For older children, teen girls, active women, and most men, the guidelines give the nod to two daily servings for a total of six ounces.

Osterweil also notes that, "Everyone who eats an eight-ounce steak typically served in restaurants is getting more protein than their bodies need."

Fish, on the other hand, provides a healthy low-fat source of protein:

"Fish are proven to offer multiple nutritional benefits—they are high in protein, low in saturated fat and they contain many other nutrients that are important for proper growth and development."

—Lester M. Crawford, DVM, PhD,
Acting Commissioner, U.S. Food and Drug Administration
www.fda.gov/oc/opacom/hottopics/mercury/mercuryop-ed.html

Omega-3s

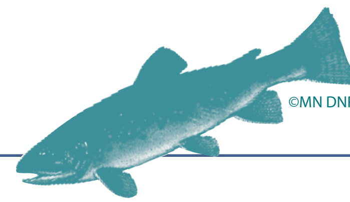
Omega-3s are a group of polyunsaturated (good) fats found in foods such as flaxseed, walnuts, canola oil, and fish native to cold waters, such as salmon and trout. Omega-3s are important components of cell membranes, particularly in the brain and eyes.

A flood of recent studies have shown that eating fish routinely (once a week) can reduce the chance of death from a heart attack, heart disease, diabetes, and other chronic illnesses. This is not a myth. Omega-3s are good for healthy brain development and they can reduce the chance of heart attack. Other benefits may include: reduction in blood pressure and heart rate, warding off dementia and stroke in the elderly, and possibly guarding against dry-eye syndrome. Researchers from the Harvard School of Public Health completed a comprehensive analysis of fish and health (which appears in the October 18, 2006, issue of

*The Journal of the American Medical Association***).** This was the first comprehensive summary of levels of omega-3 fatty acids, mercury, PCBs, and dioxins in various species of fish and other foods, including chicken, beef, pork, butter, and eggs. This research was supported by the National Institutes of Health.

The results show that the benefits of eating a modest amount of fish per week—about three ounces of farmed salmon or six ounces of mackerel—reduced the risk of death from coronary heart disease by 36 percent. Notably, by combining results of randomized clinical trials, the investigators also demonstrated that intake of fish or fish oil reduces total mortality—deaths from any causes—by seventeen percent.

Fish is one of a few foods that contains the omega-3 fatty acids needed for proper development of the brain and nervous system. For pregnant women, mothers who are breastfeeding, and women of childbearing age, fish intake is important because it supplies DHA, a specific omega-3 fatty acid product that is beneficial for the brain development of infants.


©MN DNR, C. Iverson

Fish—particularly oily fish, such as salmon, trout, catfish and herring—is rich in omega-3 polyunsaturated fatty acids. Some potential health benefits of consuming omega-3s include:

- preventing heart disease
- reducing the effects of depression
- supporting bone growth
- reducing the risk of cancers, including breast, prostate, and colon cancers
- reducing symptoms of inflammatory and autoimmune disorders such as asthma, rheumatoid arthritis, lupus, and inflammatory bowel disease
- decreasing insulin resistance in diabetics
- warding off dementia and stroke in the elderly
- guarding against dry-eye syndrome

In the latest studies of fish-related health benefits, published in the *Archives of Ophthalmology*, researchers found that eating fish rich in omega-3s also reduces the risk of macular degeneration, the leading cause of age-related blindness. This research supports earlier findings. The strongest evidence is for benefits related to neuodevelopment and heart disease. The other benefits listed above are less certain.

Eating fish can also boost intelligence. A Harvard University study appearing as a series of five articles in the November 2005 *American Journal of Preventive Medicine* (Joshua Cohen, lead author) showed that women who ate fish every week had children with higher intelligence scores than the children of women who did not do so. And eating fish regularly may reduce rates of Alzheimer's disease in the elderly. A 1995 study, "Fish Consumption and Cardiovascular Disease in the Physicians' Health Study: A Prospective Study," by Martha Clare Morris, JoAnn E. Manson, Bernard Rosner, Julie E. Buring, Walter C. Willett, and Charles H. Hennekens, which appeared in the *American Journal of Epidemiology* found that seniors who ate fish twice a week had a seventeen percent lower rate of mental decline than those who didn't eat fish.

So perhaps the Celtic myths about eating fish to increase knowledge aren't so very far off base! And, if you wish for good health and a longer life, Chinese tradition suggests that you eat fish to fulfill this wish.

Other food sources of omega-3s include flaxseed and flaxseed oil, canola oil, soybean oil, soybeans, walnuts, walnut oil, and purselane, a green leafy plant. Eggs high in omega-3s are also available in grocery stores—they come from flaxseed-fed hens. These are sources of ALA (alpha-linolenic acid). Fish contain DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid). ALA may be converted into DHA and EPA when ingested from food sources, but the process is inefficient.

Is There a Catch?

You may have seen news reports about fish containing high levels of contaminants such as mercury, PCBs, and other substances. In a world where we increasingly know more and more about what we eat, it can be hard to decipher what's good for you and what you should avoid—and many people want to know if eating fish poses health risks.

Most people understand that risk is a normal part of everyday life. For starters, driving, storms, swimming, bungee jumping, mowing the lawn, walking to school, stepping into the shower, skateboarding, snowboarding, and biking involve risk. Is anything 100 percent risk-free? It makes sense to develop assessment and decision-making skills to help determine whether the risks associated with an activity or event outweigh any benefits or pose a serious concern.

What is risk? **Risk** is the likelihood or probability that a harmful consequence will occur as a result of exposure to a health or safety hazard. We make decisions every day that weigh the possible negative or harmful consequences against positive consequences or benefits.

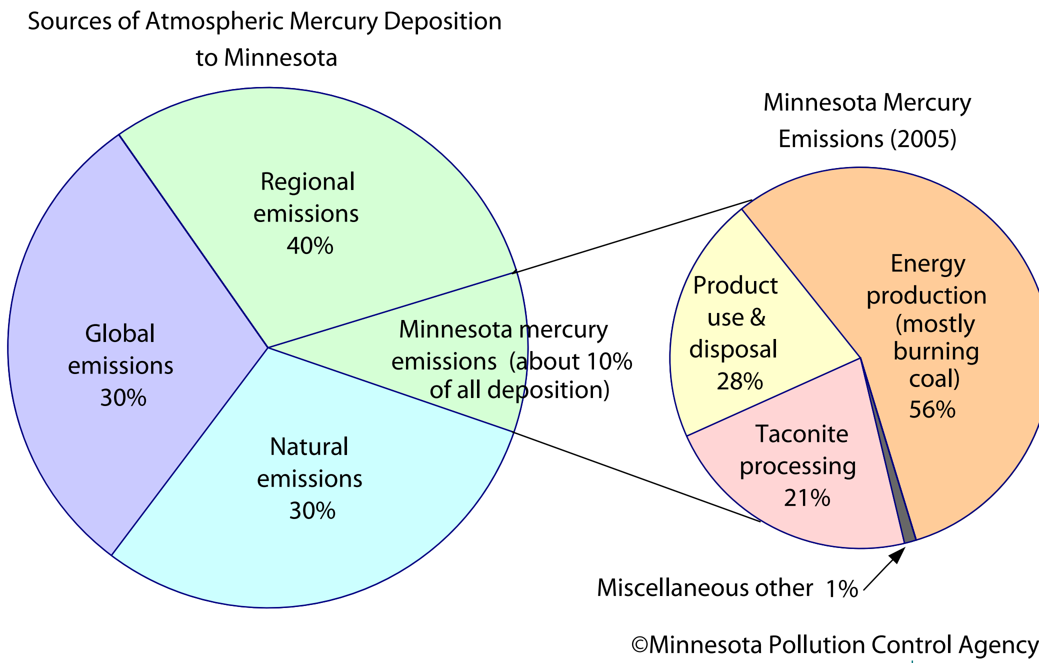
In order to evaluate risk in an effective way, it's necessary to be well informed, know how to find as many facts as possible, analyze information critically, and make choices.

Fish acquire contaminants from their surroundings. Contaminants or pollution can reach rivers and lakes from local sources such as improperly stored wastes and abandoned dumps. If a local source of pollution is identified, it may be possible to clean it up and decrease the contamination of the lake or river. Contaminants, however, reach remote and pristine lakes from the atmosphere. Fish bought from markets and grocery stores also contain contaminants from the waters where they were caught. So it's recommended that people follow Department of Health fish consumption advisories and guidelines to reduce risk, regardless of immediate, identifiable, or potential sources of pollutants.

Minnesota fish are low in most contaminants tested, but mercury warrants some closer attention. Generally, most people do not eat enough fish for mercury to be an issue. The risk is somewhat greater for pregnant women, nursing mothers, and young children but, although there is a greater risk in those demographics, the health benefits of eating fish are not to be neglected, either. To weigh the benefits and risks of eating fish, become informed by gathering facts—then manage the risk. Managing risk involves finding ways to prevent or reduce harmful consequences and deciding whether or not it is worthwhile to do so. By choosing to eat fish low in mercury you can get the benefits of eatinf fish and reduce the risks from exposure to mercury.

Mercury

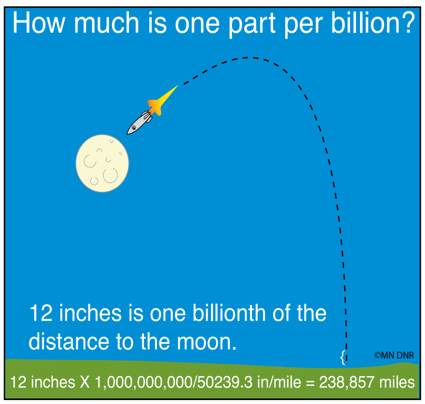
How does mercury get into fish? **Mercury** is a naturally occurring metal in the earth's crust and it's found in coal and many other rocks. Although some mercury occurs naturally in the environment, most of the mercury that enters Minnesota waters is first released into the air as a result of burning coal and other fossil fuels. Mercury is also released from wastes containing household and industrial mercury. Released mercury travels and cycles between soil, water, and air. When it rains, mercury enters water and soil, often far from its original source.



Once in the water, bacteria convert mercury to methylmercury. This is the form of mercury that that enters the tissue of fish and shellfish. Large amounts of mercury may harm the human nervous system. As people absorb or ingest toxic levels of mercury, and the levels of the contaminant increase, the ability to walk, speak, see, and hear can also be affected in subtle ways. Too much exposure to mercury may affect a child's ability to learn and process information. The fish consumption guidelines and advisories issued by the Minnesota Department of Health are intended to keep the quantity of mercury in the human body below levels that damage the nervous system.

Methylmercury gets into fish through the food they eat. The longer a fish lives and the larger it grows, the more contaminants it ingests. **Bioaccumulation** occurs when a chemical builds up in the body and the concentration is higher inside the body than in the environment outside of the body.

Another reason why larger fish accumulate more contaminants than smaller fish is due to **biomagnification**, when the chemical accumulates in animals higher up in the food chain that have eaten animals with high concentrations of the chemical in their bodies. Biomagnification can be illustrated by a food chain. Small organisms in the water filter plankton for food from the water, and through this process they also take in very low concentrations of methylmercury. Larger organisms in the aquatic food web eat these small organisms with their accumulated methylmercury. Small fish eat the small organisms, too, and larger fish eat smaller fish. Once ingested, methylmercury is tightly bound to proteins in the cells of all fish tissue, including muscle, where it continues to accumulate. This means that, with each step up the food chain, the amount of methylmercury increases. The tiny organisms are eaten by smaller fish, which are eaten by medium-sized fish, which are then eaten by larger fish, and the amount of mercury is biologically amplified in increasing concentrations higher up the food chain. This phenomenon is called biomagnification.



Mercury levels are measured in parts per billion (ppb).

In his book *How Much is a Million?* David M. Schwartz says: "How big is a billion? If a billion kids made a human tower, they would stand up past the moon. If you sat down to count from one to one billion, you would be counting for 95 years. If you found a goldfish bowl large enough to hold a billion goldfish, it would be as big as a stadium."

Managing Risk

Mercury is found in all fish tested from Minnesota lakes, most often at a level safe for human consumption. It may take months or years of frequent fish eating for people to accumulate levels that are a health concern. You can reduce your risk levels further by eating smaller fish. Larger, older, and predatory fish pose the highest risk levels. Smaller fish (and younger fish) and those species lower on the food chain don't have an opportunity to accumulate as much mercury in their bodies as larger predatory fish. Eating a variety of types of fish also further reduces risk.

Government guidelines advise eating a balanced diet that includes a variety of fish, and smaller fish, but there are no specific U. S. Food and Drug Administration (FDA) recommendations on limits for older children and other adults. Mercury levels in fish are typically measured in **parts per milliom** or **ppm**. Certain people, such as children (under age 15), and women who are or may become pregnant are more sensitive to mercury and should take some precautions and limit the quantity and types of fish that they eat.

The U. S. Environmental Protection Agency and the FDA have advised that it is, in fact, prudent for pregnant women, nursing mothers, women who may become pregnant, and young children to continue eating fish—but to simply to avoid those fish that contain higher levels of mercury.

There is good news concerning mercury emissions in Minnesota. Human-caused emissions of mercury have dropped more than 45 percent since 1990. Government regulations now limit the amount of mercury used in batteries and paint, and require increased pollution controls for municipal waste combustion and medical waste incineration. A further step, taken in March 2005, was to reduce emissions from coal-fired electric power plants. Under a compromise agreement, legislation passed into law in May 2006 requires Minnesota's largest coal-fired power plants to cut mercury emissions by 90 percent by 2015. This legislation exceeds the federal government requirement of a 70 percent reduction by 2018. Reducing mercury emissions that come from burning fossil fuels is a step in the right direction in decreasing levels of mercury contaminants in lakes and rivers—although 90 percent of the mercury that accumulates in Minnesota fish comes from sources outside the state.

Although the levels of mercury released into our atmosphere in the U.S. has been reduced, the levels of mercury found in fish has shows an increase in the past decade. A recent study published by the Minnesota Pollution Control Agency describes this trend: "Regression analysis of the 25-year record of mercury concentrations in standardized length predator fish has shown a trend reversal, from downward to upward, in the early to mid-1990s. Furthermore, a pairwise comparison of years within lakes indicates 60% of the lakes had decreasing SPFHg (mercury levels) before 1995 and 60% were increasing after 1995. Despite the plausible mechanisms for increased bioavailability caused by changing climate, there is no evidence of an explicit trend shift in the factors associated with changing climate that, by themselves, could explain the trend reversal of SPFHg. Causes of the trend reversal may include delayed responses and additive effects from multiple factors. Changes in mercury deposition and climate could combine to give the observed trend reversal of mercury concentrations in fish."

—Trend Reversal of Mercury Concentrations in Piscivorous Fish from Minnesota Lakes: 1982#2006
Bruce A. Monson
Environ. Sci. Technol., Article ASAP • DOI: 10.1021/es8027378 Publication Date (Web): 09 February 2010
Downloaded from http://pubs.acs.org on February 10, 2010

"It makes sense to be concerned about mercury in our environment and to reduce human-caused emissions. But it makes just as much sense to continue eating fish."

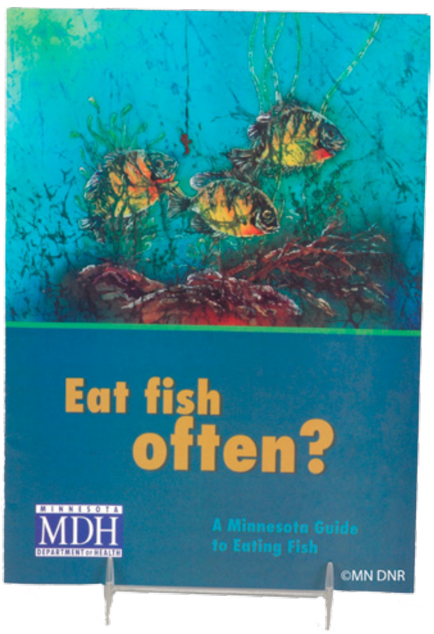
—Patrick Moore,
co-founder of Greenpeace and environmental movement leader,
PhD (Ecology);
B.S. (Forest Biology)

Even as we reduce our mercury emissions locally and eventually globally, mercury never goes away, the amount of mercury already on the planet will continue to cycle forever.

The ABCs of PCBs

Polychlorinated biphenyls, or **PCBs**, are found mainly in Lake Superior and major rivers such as the Mississippi River. These synthetic oils once had many industrial uses and are still found in electrical transformers, cutting oils, and carbonless paper. Although banned in 1976, they don't decompose easily and remain in the water and lake sediments for many years. PCB levels in Minnesota waters are slowly decreasing.

Why are PCBs a concern? PCBs bioaccumulate, just as methylmercury does, but rather than accumulating throughout all fish tissues, PCBs are soluble in fat, so they accumulate in the fatty tissues of fish. Consumption advice for PCBs is meant to protect children from developmental problems linked to high levels of PCB exposure. High exposure to PCBs also cause changes in the blood, liver, and immune functions of adults. They've been shown to cause cancer in laboratory animals and may cause cancer in humans.



Managing Risk
Fish absorb fat-soluble chemicals like PCBs from water, suspended sediments, and food. And again, because PCBs concentrate in the fat tissue of fish, they accumulate in greater amounts in fatty fish such as carp and catfish. To reduce risks posed by PCBs, it is recommended that you remove the fat when you clean or fillet your fish. Larger, older fish and fish that eat other fish accumulate more contaminants than smaller, younger fish that have eaten fewer contaminated prey. Eating smaller fish also reduces risks posed by PCBs and other types of contaminants. In Minnesota, the levels of these chemicals (including PCBs and dioxins) in fish, including farmed fish, are significantly lower than safety guidelines and similar to levels in meats and dairy products. When compared with the health benefits of eating fish, the health risks posed by these chemical levels are very low, and shouldn't deter people from eating a healthful diet that includes fish. Consult the Minnesota Department of Health fish consumption advice for eating guidelines for fish caught in the lakes where you fish.

Staying Informed
Overall, the health benefits of eating fish greatly outweigh the potential risks—especially when up-to-date research information and recommended consumption guidelines are used to further reduce the probability (likelihood of occurrence) of being affected by these risks.

The Minnesota Department of Health publishes a **fish consumption advice** report, which provides guidelines on choosing fish people can safely consume with minimal risks from contaminants. Fish consumption advice is available online at **www.health.state.mn.us** or in *Eat Fish Often?* a brochure issued by the Minnesota Department of Health at 651-201-4911 or 1-800-657-3908. The Minnesota Department of Health provides two types of advice on how often fish can safely be eaten:

- **Statewide Safe Eating Guidelines**—General guidelines for the entire state to help you decide if you and your family need to make changes in your fish-eating habits.
- **Site-Specific Advice**—Detailed consumption guidelines for lakes and rivers where fish have been tested for contaminants can be found by accessing the DNR Lake Finder at http://www.mdnr.gov/lakefind/fca/index.html The information found on Lake Finder provides site-specific advice and consumption guidelines for lakes and rivers where fish have been tested for contaminants, and is compiled directly from the Minnesota Department of Health Fish Consumption Advice.

These consumption guidelines are also searchable by lake on the Lake Finder feature of the Minnesota DNR website.

Fish consumption advise is published so people can reduce risks, make informed decisions about where they get their fish, find out which species, sizes, and quantities to eat, and find consumer advice on how to select fish to maximize its benefits. They explain how certain pollutants can affect animals and people, and underline the importance of preventing pollution. Informed citizens have access to facts that enable them to make better decisions for themselves and the environment.

For further information on good nutrition and the benefits of eating fish, see:

- Food and Drug Administration
  Food Safety Information Line
  888-SAFE-FOOD
  www.fda.gov
- American Heart Association
  www.americanheart.org
- American Dietetic Association
  www.eatright.org

Look for fish consumption information from the Minnesota Department of Health and the American Heart Association to best assess your risk. With good information, you can make good decisions. The consumption guidelines are based on the contaminant level measured in fillets of particular species of fish taken from particular lakes for your risk category.

Fish—particularly fatty or oily fish—is nutritious and healthful for the general population. As experts say, eating fish once or twice a week is good for our health as long as the fish are low in contaminants.

Do eat fish—but eat smaller fish and a variety of fish. Become aware of nutrition and fish consumption advice, and eat what's most healthful for you!

Although eating fish may not make all your wishes come true, as in Chinese tradition, or give you the infinite knowledge promised by the Celtic myth, there's no question that fish is good for you—and for your brain! Including fish as a recommended part of a nutritious diet will help you to live healthier and longer, too.

Filleting Tips

- Use a very sharp fillet knife. A dull knife will rip and tear the flesh. A dull knife is also a safety hazard because you will use more force and the potential for slipping is greater.
- Use a big fish at first. It's more difficult to fillet a small fish.
- Removing the fillet from the rib cage is the most difficult step. Be very careful and go slowly.
- The fillet may not look perfect the first time you try this. Like anything else, filleting improves with practice.
- Always cut in a motion that takes the knife away from your body—and your other hand—in case the knife slips.

Filleting Your Catch

Cleaning and filleting is a skill. Here are some instructions to help you practice filleting.

1. Raise the pectoral fin. Lay the knife just behind the head and cut through the body cavity to the backbone.
2. Hold the fish firmly. Turn the blade nearly parallel to the backbone, and with a sawing motion, cut through the rib section toward the tail.

3. Stop at the base of the tail. It isn't necessary to cut the fillet all the way off.
4. To skin the fillet, hold the tail firmly with your fingertips and work the flat of the blade forward between the flesh and skin using a sawing motion.
5. The fillet will now have only rib bones remaining.
6. Remove rib bones by sliding the knife along ribcage.
7. Turn the fish over and repeat this procedure on the other side of the fish.
8. Cut away the dark area running the length of the fillet. (This may not be very evident on some fish species.) This is where the vein that takes blood to the tail is located—it's an area of fatty tissue. Cut a V-shaped trough around the length of the dark line and remove it.
9. Cut off any fat along the fish's back or belly.
10. Rinse the fillets in cold water. Pat them dry.
11. Put the carcasses into a plastic garbage bag and seal. Discard in the trash or bury in your garden to fertilize your flowers or vegetable crops.

Cooking Fish the Healthful Way

Fish is a tasty food favored by people from almost every culture and background. There are about a half dozen basic ways to cook fish, and once you learn them, you can cook almost any type of fish dish. Sauté, grill, bake, braise, or poach fish. Try marinating fish or sprinkling it with your favorite herbs and spices to complement and enhance its flavor. There are many good recipes for simple, delicious fish dishes.

Unhealthful or improper preparation of fish can be a health risk, though. Avoid commercially fried fish and don't choose cream sauces to serve with fish. Deep frying or serving fish with heavy fat and calorie-laden sauces can make healthful food unhealthful. Prepare fish without added saturated and trans fats. Another potential problem is undercooked fish, which can lead to parasite infections. Unless you're skilled at making sushi, make sure you cook your fish until it's flaky and tender, with no sign of translucency to the meat. To test for doneness, poke the fish with a fork at its thickest point, and check all the way through the fish. (You can poke the piece of fish that you plan to serve to yourself—or garnish it well to hide the poking!)

When it's done, enjoy!

Procedure

Preparation
Part 1
Make six name tags (three bluegills, two bass, one eagle) and collect other materials.

Part 2
1. Reserve the computer lab.
2. List one nearby lake for each pair of students.
3. Make one copy per student of the **Fish Consumption Report for Sleepy Eye Lake** and the **Safe Eating Guidelines Sheets**.

Part 3
1. Reserve the kitchen or set up a grill outdoors and collect the cooking materials and ingredients.
2. Make one copy per student of the **Basic Filleting Sheet** and the **Fish Recipes Sheet.**

Activity

Warm-up
The Benefits of Eating Fish and Managing Risk
1. Ask students if they ever go fishing. Do you eat fish? Why do we eat fish? Does your family have any traditions about eating fish? (Such as cooking fish a special way or fish dishes or meals associated with holidays.) Fish has traditionally been an important part of a healthy diet for many people around the world.
2. Discuss with your students the health benefits of eating fish.
3. Define risk for your students. (The likelihood or probability that a harmful consequence will occur as a result of exposure to a health or safety hazard.)
4. We make decisions every day to balance negative or harmful consequences and positive consequences or benefits. Ask the students to list everyday activities or situations that could pose a risk. Discuss the probability or likelihood for harmful consequences for each. When might you decide to take a risk? When would you decide not to take a risk?
5. Discuss with students that, to balance the benefits and risks of eating fish, it's important to know how to gather facts, become informed, and then manage the risk. Managing risk involves finding ways to prevent or reduce harmful consequences, as well as deciding whether or not to do so.

Lesson
Part 1: Bioaccumulation and Biomagnification
1. Ask students if eating fish can ever be risky. How? Brainstorm a list of reasons. There are many health benefits of eating fish. Review the

American Medical Association's recommendation for eating fish. (Two meals per week, as part of a healthy diet.)

2 Tell your students that, as with just about everything we do each day, there are also potential risks for eating some fish. Discuss contaminants. You may wish to discuss it in this way:
- Sometimes, pollution in the water can get into fish. Usually, the pollution that could be in fish would not be enough to hurt us. But there is information available to help us to learn more about the risks and be aware of the pollutants that can get into fish.
- The pollutant most often present in Minnesota fish is called mercury. Mercury is released from burning fossil fuels, such as coal, to make electricity and heat our homes. The mercury rises into the atmosphere with the smoke and then falls back to the earth when it rains. These raindrops may fall far from where they first began to develop, so sometimes mercury in Minnesota arrives from a faraway state or country. If people ingest too much mercury, it can have some harmful effects on the way that the brain and the nervous system work. Rain containing mercury can fall into lakes and rivers. It gets into the flesh of fish from the food they eat.
- Other pollutants called PCBs are sometimes present in Minnesota fish, although they are less common than mercury. PCBs came from synthetic or manufactured oils once used as an insulator in electrical transformers. Sometimes, PCBs would end up in the environment because they leaked from old transformers or other electrical equipment and traveled with rain and snowmelt over the ground to lakes, rivers, and streams. PCBs have been banned and can no longer be used. But PCBs are still in the environment, and still end up in some fish through the food they eat. PCBs are known to hurt the development of babies and they may cause cancer in adults. PCBs collect in the fat of a fish so, unlike mercury, much of the PCB contamination can be cut away when the fish is cleaned and filleted prior to cooking and eating.

3 What kind of information can help reduce our risk of eating fish with contaminants? Larger fish may contain more toxins than smaller fish. Larger fish have eaten more contaminated fish than little fish have, so more contaminants may have accumulated in the bodies of larger fish. This is called biomagnification. How might this information help us reduce our risk of eating contaminated fish?

4 Try the following demonstration to illustrate the concept of biomagnification (you can do this outdoors or indoors):
- Choose six volunteers from the group. Give each a name tag and a clear plastic bag. (Name tags: three bluegills, two bass, one eagle)
- Arrange the students in the order of a food chain. (Or let the students do this themselves.)
- Spread the popcorn on the floor or on the ground.
- Tell the students that when you say, "Start feeding!" the

bluegills should begin picking up popcorn and putting it in their bags. When you say, "Stop," they have to stop.

- Say, "Start!" Let the bluegills feed for 20 seconds or so. Say, "Stop!"
- Draw a "fill line" on each bluegill's bag—this is where the popcorn ends.
- Now tell the bass that it's their turn to feed. Have one bluegill pour their popcorn into a bass's bag. Have the other two pour their popcorn into the other bass's bag. Draw lines on the bags of the two bass.
- Next, tell the eagle that it's its turn to feed. Have the bass pour their popcorn into the eagle's bag.
- Compare the bag levels. Notice that the eagle's bag has much more food in it than the bass' or bluegills' bags. If the food was contaminated with toxins like mercury, the eagle's body would contain more contamination than the bass' or bluegills.' This process is called biomagnification. (You can point out that the concentration of pollutants in the water is less than the concentrations in the bluegills and eagle.)
- Thank the volunteers and put away the props.

5 Managing risk (or reducing risk): Discuss with students that there are steps they can take to reduce their risk of eating fish that contain contaminants.
   - Eat smaller fish. A small walleye hasn't eaten as many fish as a bigger walleye, so it hasn't had the chance to collect as many contaminants in its body.
   - Eat fish lower on the food chain, such as like bluegills, crappies, and perch, instead of larger predators such as walleyes and northern pike, which can accumulate larger concentrations of contaminants.
   - Trim fat from fish before you cook and eat it. Some contaminants, like PCBs, are stored in the fat. The fat on a fish is located on the back and belly, and along the dark strip through the fillet where the vein that carries blood to the tail is located. The fat looks white, like the fat on a pork chop. (If you are doing a filleting demonstration, you can show the students what the fat looks like, and demonstrate how to remove it.)

6 Review the health benefits of eating fish. Ask students to list at least three benefits of eating fish.

If computers aren't available to your class, you can just do Steps 1 and 2.

Part 2: More Ways to Reduce Risk—Finding Fish Advisory Information

1 Ask your students how they could find more information about the fish that they might catch on a fishing trip. Tell students about fish advisory information on the Internet, the Minnesota Department of Health website, and the Minnesota DNR website.

2 Hand out the **Fish Consumption Report for Sleepy Eye Lake**. Go through the symbols in the key with your class.

3 Have the students find partners and sit at a computer. Go to the

Minnesota DNR website: **mndnr.gov**

4 Click on Lake Finder.
5 Under Find a Lake, type in a lake name and its county. You may wish to assign a lake to each group, or have them pick their own. Click on Get Lake Data.
6 Click on the checkmark under Fish Consumption Advisory [MDH]. The fish advisory for that lake should appear.
7 Note how the chart is broken into two sections: one for pregnant women and children and another for everyone else. Explain that fetuses and growing children are more susceptible to toxins than adults.
8 Then ask the students:
   - Are there any contaminants that they might want to be aware of in their lake?
   - What are these contaminants?
   - Which fish species contain these contaminants?
   - What sizes of fish have more contaminants?
   - What is the suggested consumption limit for each type of fish?

9 Ask students to discuss how this information can help them reduce risks associated with eating fish from lakes that contain contaminants. Can they list three ways to reduce risks?
10 Ask students to try to locate the Fish Consumption Advice on the Minnesota Department of Health website. Then, using the Internet, locate information about the health benefits of eating fish.

Part 3: Filleting, Cooking, and Tasting

1 Watch the (optional) video, *Landing and Caring for the Catch* (15:22).
2 Tell the students you will do a filleting and cooking demonstration for the class.
3 Hand out the **Basic Filleting Sheet** to the students so they can follow along if they wish.
4 Remember to point out the steps in which you are removing fat from the fish. (PCBs accumulate in the fat deposits of the fish.)
5 If you have a large class, consider using a camera (such as a Scopecam) that captures a small demonstration area and projects the image to a television or large screen so that the students can see a larger projected view of the filleting demonstration.

Cooking

(You may wish to ask students to bring favorite recipes from home to use for the cooking demonstration. You can also compile a class cookbook using recipes that the students bring from home. Highlight those prepared for cultural events, holidays, or other family traditions.)

1 Use the fish you filleted and two others that you've filleted ahead of time.
2 From the **Fish Recipes Sheet**, use the Fish Strips recipe or Captain Nelson's Charcoal Broiled Salmon or Lake Trout recipe to demonstrate how to follow directions to prepare the fish according to the recipe, or use the recipes that the students have brought from home.

Or divide the students into small groups of four or five; have each try a different recipe with one fillet. (One fillet is one side of a fish.)

3 In a school kitchen facility, on a portable cook stove set up in the classroom or outdoors, or on a charcoal grill outdoors, demonstrate cooking the prepared fish according to directions in the recipe(s).

4 Hand out the **Fish Recipe Sheet** for the students to take home.

Tasting

(Have napkins and crackers available for serving fish.)

1 Distribute cooked fish to the students so they can taste it.

2 Enjoy the health benefits of eating fish!

Wrap-up

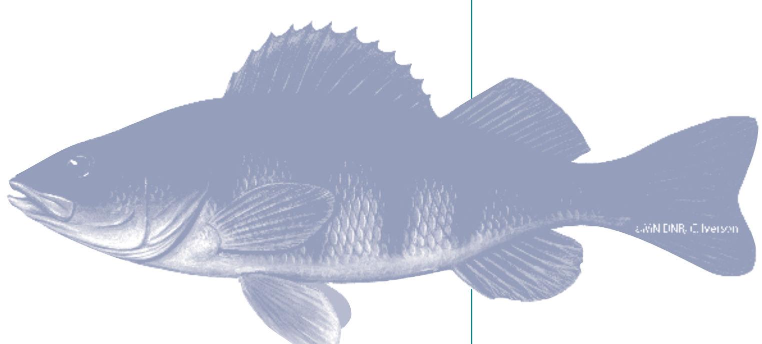
1 Remind students that fish is a healthful food. List the health benefits of eating fish. Everyday activities present risks. Review the definition of risk. We can follow the guidelines for safe eating, just in case the fish we eat contains contaminants. This reduces risks. Send the Safe Eating Guidelines Sheet home with the students to share with their families.

2 Discuss the importance of reducing pollution and keeping our waters clean. What is the meaning of the saying, "Everything is connected?" Remind the students that pollution enters the water from various locations, including the air. Reducing air pollution reduces water pollution and contamination levels in fish. What does this mean for people?

3 How can students reduce air pollution? Students can help by using less electricity at home, by switching off unneeded lights, for example. Using less energy at home helps reduce the amount of mercury produced by power plants.

4 What are some other ways to reduce the amount of energy that we use? What benefits does energy provide? What are the risks of using different types of energy sources (such as coal, natural gas, hydroelectric, nuclear, oil, biofuels, and wind energy)? Can the students think of additional ways that conserving energy reduces health risks for people? Have students pledge to try one of the ideas to reduce energy use for one week, and report back to the class on how they did, the changes they made, and the impacts of those changes.

5 Ask students how they liked the fish. Fish tastes good—and is good for you, too!



Assessment Options

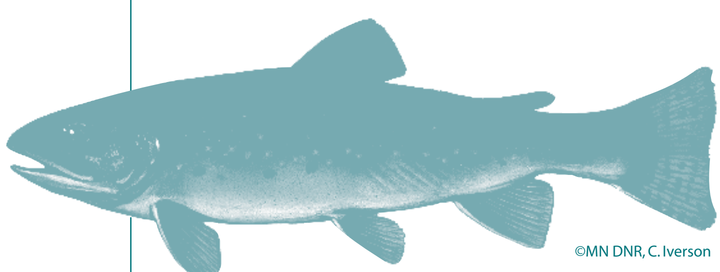
1 Have students name three nutritional benefits of eating fish, and identify a source of information on nutritional benefits of fish. Ask students to state the American Heart Association's recommendation for how much fish to eat as part of a healthy diet.

2 Locate a source for Minnesota fish consumption advisory information for a local lake (the Minnesota Department of Health website or the Lake Finder area of the Minnesota DNR website). Ask students to determine how often, in general, children under fifteen are advised to eat fish from that lake, and how often pregnant women are advised to eat fish from the lake.

3 Have each student write a report on mercury and PCB contaminants found in Minnesota lakes, including where contaminants come from, how they get into lakes and fish, how these contaminants pose risks to people, and three ways to reduce risks from eating fish that may be contaminated.

4 Have students create an informational brochure about fish consumption advisory information for three local lakes. Ask them to include nutritional benefits of eating fish, three suggestions for reducing risks of eating fish that may be contaminated, and list further sources of information. Make copies of the brochure to distribute and display (with permission) at a local bait shop, doctor's office, or lakeshore resort.

5 Assessment options include the Checklist and Rubric on the following pages.



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Eating Fish Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
3	______	______	Lists three healthful nutrients found in fish.
3	______	______	Lists three health benefits of eating fish.
1	______	______	Defines *risk*.
2	______	______	Explains how mercury and PCBs get into water.
2	______	______	Explains how fish get toxins such as mercury and PCBs from the food they eat, and that fish get more in of these things in their tissues as they eat more food and grow.
2	______	______	Explains why fish higher in a food chain can have higher levels of toxins in their tissues.
4	______	______	Lists two types of harmful toxins found in fish, and states one reason why each toxin is harmful to humans.
2	______	______	Knows that a fish consumption advisory chart tells how often it is safe to eat a meal of fish from a lake or river.
3	______	______	Lists three ways to further reduce health risks from eating fish contaminated with toxins (including gathering and assessing information to balance benefits and risks).
2	______	______	Explains that PCBs accumulate in the fatty tissues of fish, and that some fatty parts can be removed before you cook a fish.
2	______	______	Makes the connection that we're exposed to risks every day, and that we can evaluate risks and benefits to make decisions that are good for our health.

Total Points

26	______	______	**Score** ______

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

24-26 points = A
Excellent. Work is above expectations.

21-23 points = B
Good. Work meets expectations.

17-20 points = C
Work is generally good. Some areas are better developed than others.

13-16 points = D
Work does not meet expectations; it isn't clear that student understands objectives.

0-12 points = F
Work is unacceptable.

Eating Fish Scoring Rubric

Eating Fish Criteria	3 Excellent	2 Good	1 Fair	0 Unacceptable
Fish nutrition: benefits of eating fish	Lists three nutritional benefits of eating fish, including: source of protein, importance of omega-3s from some fish, fish are low in fat, and reduce risk of some diseases.	Lists two nutritional benefits of eating fish, including: source of protein, importance of omega-3s from some fish, fish are low in fat, and reduce risk of some diseases.	Lists one benefit of eating fish.	Can't list nutritional benefits of eating fish.
Accumulation of toxins in fish	Defines risk and explains how mercury and PCBs get into water, how fish accumulate toxins in their tissues from the food they eat over time, and that larger fish and fish higher in a food chain can have higher levels of toxins.	Defines risk and explain show mercury and PCBs get into water, that fish get toxins from the food they eat, and that larger fish can have higher levels of toxins that smaller fish.	Explains that fish get toxins from the food they eat, and that larger fish can have higher levels of toxins than smaller fish. Or can define risk.	Can't define risk or state that fish get toxins from the food they eat, or that larger fish can have higher levels of toxins.
Reducing risks of eating fish	Lists at least three ways to reduce risks associated with eating fish, including: gathering and assessing information from nutrition data and fish consumption advisories, eating smaller fish, eating fish lower on the food chain, trimming away fat when filleting fish, cooking fish thoroughly before eating, avoiding commercially fried fish, and not using trans fats when cooking fish.	Lists at least two ways to reduce risks associated with eating fish, including: gathering and assessing information from nutrition data and fish consumption advisories, eating smaller fish, eating fish lower on the food chain, trimming away fat when filleting fish, cooking fish thoroughly before eating, avoiding commercially fried fish, and not using trans fats when cooking fish.	Lists one way to reduce risks associated with eating fish.	Can't name a single way to reduce risks associated with eating fish.
Fish consumption advisory report—gathering information	Reads a fish consumption advisory chart and identifies fish species found in the lake, whether the lake has been tested for contaminants, and deciphers consumption guidelines.	Reads a fish consumption advisory chart and identifies fish species found in the lake and whether the lake has been tested for contaminants.	Can read a fish consumption advisory chart.	Can't read or understand a fish consumption advisory chart.
Fish filleting and cooking	Observes a filleting demonstration, or participates in filleting discussion and can explain why removing fat helps reduce levels of PCBs in the fillets. Makes the connection that very small amounts and limited amounts of toxins are not as big of a health risk as not eating nutritional food.	Observes a filleting demonstration, participates in discussion and understands that removing fat helps reduce levels of PCBs in the fillets. Understands two ways to prepare fish to reduce health risks.	Observes a filleting demonstration and participates in discussion, but can't state that PCBs are absorbed into the fatty tissue of the fish. Understands one way to prepare a fish fillet to reduce health risks.	Doesn't make a connection between preparing fish and reducing health risks for some toxins.

Score ______ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1 After researching and reporting on contaminants found in fish, such as mercury and PCBs, have students compose a Jeopardy game to reinforce what they've learned.
2 Ask students to bring their favorite fish recipe from home. Compile a cookbook of these recipes. Highlight recipes used on special family occasions and traditional or cultural fare. Send a copy home with each member of the class.
3 Before your filleting demonstration, discuss the external parts of a fish (fins, eyes, mouth, scales, gill cover, and so forth) with your students. You may also wish to look up fish dissection on the Internet, and explore the internal parts of a fish, too. The **Anatomy of a Fish Sheet** at the end of this lesson will aid in identifying the internal parts of fish.
4 Have your students go fishing and cook their own catch. (See Chapter 5 for angling skills development as well as **Lesson 6:1—Safety & Fishing at the Water's Edge** or **Lesson 6:2—Ice Fishing & Winter Safety**.)

For the Small Fry

K-2 Option

Nutritional benefits of fish, cooking, and tasting can be completed with younger children. Do the Warm-up and Part 3 of the Activity.

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Fish Consumption Advisory Report for Sleepy Eye Lake

Fish consumption guidelines

These **fish consumption guidelines** help people make choices about which fish to eat and how often. Following the guidelines enables people to reduce their exposure to contaminants while still enjoying the many benefits from fish.

Pregnant Women, Women who may become pregnant and Children under age 15

LAKE NAME County, DOWID	Species	Meal Advice				Contaminants
		Unrestricted	1 meal/week	1 meal/month	Do not eat	
SLEEPY EYE Brown Co., 08004500	Northern Pike		All sizes			Mercury
	Yellow Perch		All sizes			Mercury

General Population

LAKE NAME County, DOWID	Species	Meal Advice				Contaminants
		Unrestricted	1 meal/week	1 meal/month	Do not eat	
SLEEPY EYE Brown Co., 08004500	Northern Pike	All sizes				
	Yellow Perch	All sizes				

DOWID - MN DNR, Divion of Waters' lake ID number.

Contaminants listed were measured at levels high enough to warrant a recommendation to limit consumption.

Listing of consumption guidelines do not imply the fish are legal to keep, MN DNR **fishing regulations** should be consulted.

Dioxin
Mercury
PCBS - Polychlorinated biphenyls
PFOS - Perfluorooctane sulfanate

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Safe Eating Guidelines Sheet

Safe Eating Guidelines* for Pregnant Women, Women who may become pregnant, and Children under age 15

Kind of fish		How often can you eat it?
EAT		
Catfish (farm-raised), cod, crab, flatfish, herring, oysters, pollock, salmon**, sardines, scallops, shrimp, tilapia, and other purchased fish low in mercury	→	2 meals per week
OR		
Canned "light" tuna **Minnesota caught:** Sunfish, crappie, yellow perch, bullheads	→	1 meal per week (see exceptions)*
**salmon-farm-raised or wild, Pacific and Atlantic - not Great Lakes		
AND		
Canned "white" tuna, chilean seabass, grouper, halibut, marlin, orange roughy, tuna steak **Minnesota caught:** bass, catfish, walleye shorter than 20 inches, northern pike shorter than 30 inches, and other MN gamefish	→	1 meal per month (see exceptions)*
DON'T EAT		
Shark, Swordfish, tile fish, king mackerel **Minnesota caught:** walleye larger than 20 inches, northern pike longer than 30 inches, muskellunge	→	**Do not eat**

*Fish from some Minnesota Lakes and rivers have been found to have higher levels of mercury or PCBs. If you eat certain fish from these waters, you should eat it less often than these guidelines. See exceptions tables (above) for further information on restrictions for eating fish from the specific Minnesota lakes and rivers.

There is no change in these guidelines for eating fish just during vacation or one season.

Safe Eating Guidelines for Men and Women not planning to be pregnant

Kind of fish		How often can you eat it?
EAT		
Minnesota caught: Sunfish, crappie, yellow perch, bullheads	→	unrestricted
Minnesota caught: Walleyes, northern pike, smallmouth bass, largemouth bass, channel catfish, flathead catfish, white sucker, drum, burbot, sauger, carp, lake trout, white bass, rock bass, white fish, other species	→	1 meal a week
AND		
Limit the following species: shark, swordfish, tile fish, king mackerel	→	1 meal a month

In general, adults who eat fish just during vacation or one season can eat fish twice as often as recommended in these guidelines.

MINNESOTA MDH DEPARTMENT OF HEALTH

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Basic Filleting Sheet

1.

2.

3.

4.

5.

6.

7.

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Fish Recipes Sheet

Fish Strips

6 fish fillets
2 eggs, cracked into a bowl and mixed with a fork
1 cup bread or cracker crumbs, spread on a plate or waxed paper
½ cup butter or margarine, melted in a microwave or on the stove

1. Cut the fillets into long strips, about one inch wide.
2. Dip the strips into the eggs, and then into the bread or cracker crumbs.
3. Place them on a pan lined with aluminum foil.
4. Pour the melted butter or margarine over the strips.
5. Bake at 400 degrees for 15 to 20 minutes.
6. Poke the fish to check for doneness. Enjoy!

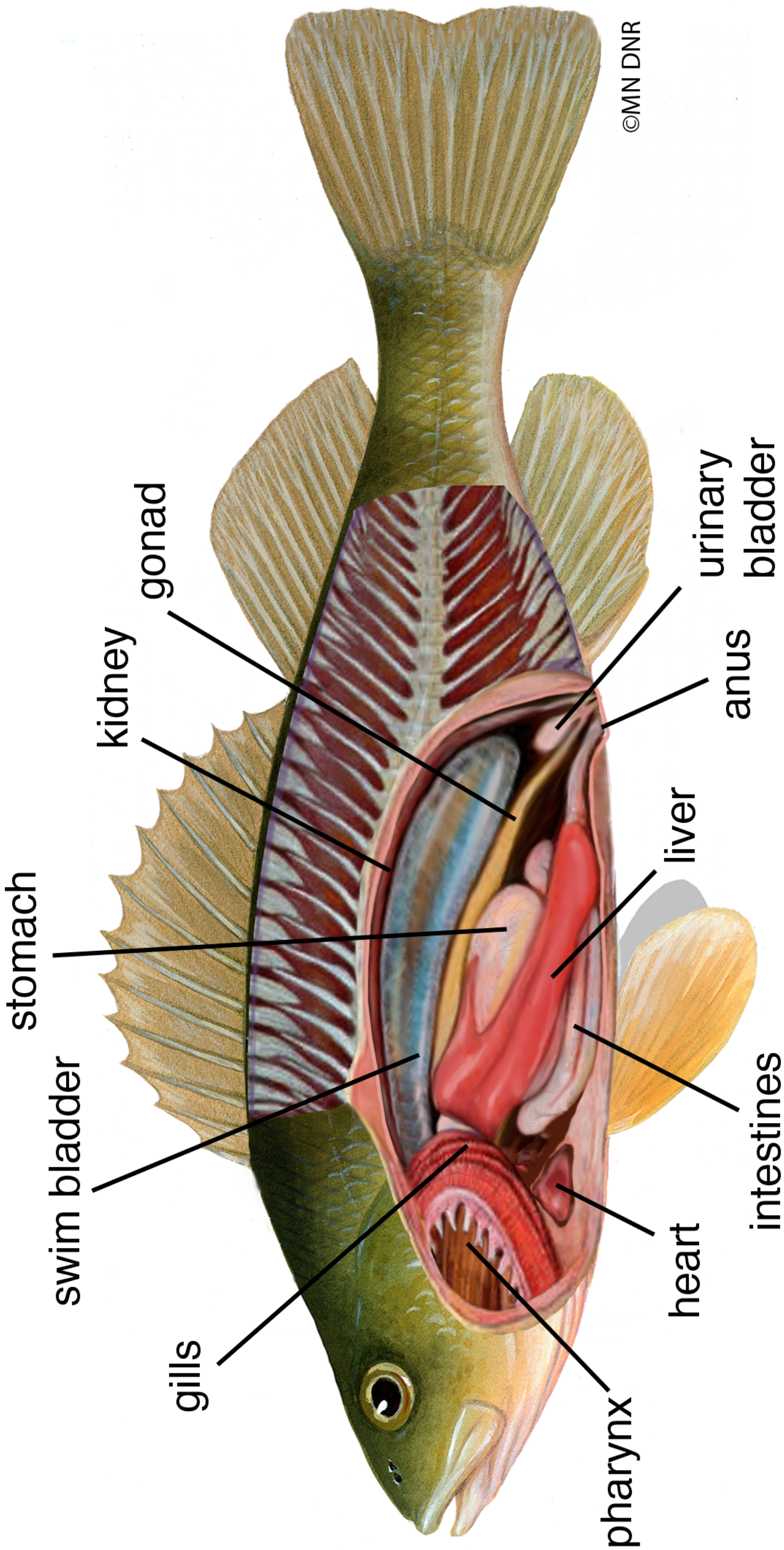
Captain Nelson's Charcoal Broiled Salmon or Lake Trout

2 pounds salmon or lake trout fillets
¼ cup butter, melted
¼ cup soy sauce
¼ cup brown sugar

1. Melt the butter. Add soy sauce and brown sugar and mix.
2. Place fillets, skin side down, on a grill over a moderate charcoal fire and cover them with foil.
3. Baste fillets with the mixture occasionally during cooking. Do not turn fish.
4. When the fish flesh flakes easily—in approximately twelve minutes, depending on grill temperature and fillet thickness—lift the fillets off skin with a spatula and serve. (Serves 4.)

(This recipe comes from Dexter Nelson, Lake Superior Charter Captain, First Mate Charters.)

Fish Anatomy Sheet



Appendices

Glossary

The Glossary is an alphabetized list of specialized terms and their meanings as they're highlighted and used within the context of the *MinnAqua Leader's Guide* lessons.

Abdomen On an insect, the third body part; contains the digestive tract.

Adaptation A physical characteristic or behavior developed by a plant or animal that makes it better suited to its environment and enables it to survive particular conditions.

Adipose fin A small fleshy structure with no rays or spines; located between the dorsal fin and tail fin.

Aeration system A mechanical device used to add or mix oxygen into the water of a lake or pond.

Agnatha The classification name for jawless fishes; from the Greek words *a* (meaning without) and *gnathos* (jaws).

Algae Any various primitive, chiefly aquatic, one-celled or multicellular plants that lack true stems, roots, and leaves, but usually contain chlorophyll and utilize the process of photosynthesis to turn light energy and nutrients into chemical energy or food energy and release oxygen into the water.

Algae (or algal) bloom A proliferation of algae in a body of water often associated with excess nutrients (particularly phosphorus and nitrogen) in the water column or sediments.

Amphipods A class of small crustaceans; also referred to as scuds or side-swimmers.

Anaerobic The state of being, living, or occurring without oxygen.

Anal fin The fin located on the underside of a fish between the tail and pelvic fins, near the anus or vent. The anal fin provides stability, functioning much the same way as a keel on the bottom of a boat.

Anglers People who fish for sustenance, recreation, or commercial purposes.

Antennae The long, thin, jointed projections from an insect's head that inform it about touch, sound, taste, and odor, as well as the temperature and humidity of the world outside its exoskeleton.

Anti-reverse A feature on a fishing reel that prevents the handle from turning in the reverse direction.

Aquatic Relating to, consisting of, or being in water, such as an aquatic environment.

Aquatic ecosystem Refers to a body of water, such as a stream, river, or lake, and all organisms and nonliving components within it that functions as a natural system.

Aquatic insect A group of macroinvertebrates that have three body parts and six legs and that spend all or most of their life cycles in the water.

Aquatic macroinvertebrate Animals without backbones (invertebrates) that are large enough to be seen with the unaided eye (macro) and spend most or all of their life cycles in water (aquatic).

Aquatic Management Area (AMA) Areas purchased by the DNR with the intent to preserve shoreline and littoral (shallow water) edges of lakes and streams.

Aquatic organism Refers to any living thing that lives in or frequents water.

Aquatic Plant Management (APM) The Minnesota DNR Aquatic Plant Management Program protects native vegetation and the aquatic environment from unnecessary harm while providing for lakeshore owners to control some aquatic vegetation for water access.

Bag limit The total number of a species that an angler may possess. For example, an angler may not possess more than six walleyes, which includes the fish in a live well (the water-filled fish storage compartment on a boat) and in a freezer.

Bail A metal, semicircular arm on an open-face spinning reel that guides the line back on the reel after a cast.

Baitcasting reel This style of fishing reel doesn't have a cover, yet has a push-button to release the line. The line comes off a spool oriented horizontally to the pole.

Balance The state in which an ecosystem is able to sustain itself over time through the interrelationships of its living and nonliving components.

Barbels Sensory structures resembling whiskers that contain many nerve endings, some of which are similar to human taste buds. Barbels help fish find food through the senses of taste and touch.

Behaviors The actions or reactions of an object or organism, usually in relation to the environment.

Benthic Pertaining to the bottom substrate of an aquatic environment.

Benthic organisms Animals and plants dwelling on the bottom of a water body. These organisms inhabit the sediments and other substrates on lake, river, or stream bottoms, as well as bottoms of marshes and other wetlands.

Best Management Practices Methods determined to be effective, practical means of preventing or reducing pollution from nonpoint sources. (See **nonpoint source pollution**.)

Bioaccumulation The gradual accumulation of a substance or chemical in the tissues of a living organism. Some toxic chemicals gradually increase in plants, fish, or people as they breathe contaminated air, drink contaminated water, or eat contaminated food.

Biodiversity The diversity of life on the planet, which includes genetic diversity, species diversity, and habitat diversity. More specifically, it can be described as the total of all the plants, animals (including humans), fungi, and microorganisms, along with their individual variations and interactions.

Biomagnification The process by which the concentration of toxic chemicals increases in each successive link in the food chain.

Bobber A float (made of plastic, wood, or foam) used to keep bait suspended at a specific depth. A bobber is attached to the fishing line and floats on the water's surface above the bait or lure and the sinker (weight). It indicates when a fish nibbles at or takes the bait as it bobs or submerges beneath the surface. (A bobber is also called a float or a cork.)

Buffer zone An area of natural vegetation, adjoining an up-gradient from water bodies, which intercepts and filters surface runoff and subsurface flow from upland sources, removing (or buffering) the effects of runoff and associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters and groundwater recharge areas.

Butt end On a fishing rod, the base of the rod handle.

Camouflage Coloration and patterns that enable fish and other organisms to blend into their environments, offering protection from predators.

Cane pole For fishing; a bamboo pole or long wooden stick with a length of line tied on the end. A cane pole has no reel.

Carrying capacity The maximum number of individuals or inhabitants that a given environment can support without detrimental effects on the habitat or the organisms.

Casting plug A weighted dummy lure with no hook used to practice casting.

Caudal fin Also called a tail fin, it is located at the back end of the fish and, like a motor, provides the power to propel the fish forward through the water. It also acts as a rudder to assist in steering.

Chondrichthyes The classification or group of jawed fishes with a skeleton made of cartilage From the Greek words *chondros* (meaning cartilage) and *ichthyes* (fish).

Circle hooks Designed to hook fish in the mouth as soon as the fish bites down and turns to swim away. The point of the hook is turned back towards the shank and may or may not be slightly offset. They're particularly good for beginners, who don't then have to "set the hook" by jerking the line. They're self-setting. Fish hooked in the mouth (not the throat or stomach) have a better chance of surviving during catch-and-release.

Classification Systematic methods of naming, and grouping like organisms according to shared features or characteristics.

Clip-on depth finder A lead weight on a spring-clip used to set the depth of the bobber. Typically used for ice fishing.

Closed-face reel A fishing reel that sits on top of the rod and has a push-button for releasing the line. Closed-face reels have a cover over the spool that holds the line and are sometimes called push-button or spin-cast reels.

Cold-blooded Animals, such as fish and amphibians, that require the sun's warmth for heat and have an internal body temperature that varies according to the temperature of their surroundings.

Complete metamorphosis The process of development in which the immature form of an organism looks and behaves differently from the adult; the stages of development are egg, larva, pupa, and adult.

Compromise A group decision in which one or all parties may need to sacrifice some wants or needs in order to reach group consensus or a decision.

Concerned citizen group An organized group of people with similar perspectives and values regarding an issue.

Condensation When cooling temperatures cause water vapor to change states from a gas to a liquid and form droplets, or from a gas to a solid (as in forming snow flakes).

Conglutinate A gelatinous case containing numerous developing mussel larvae or glochidia. (See **glochidia**).

Consensus When several groups or individuals with differing perspectives and ideas agree on how to proceed with a decision.

Conservation Management of the human use of the biosphere so that it can yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. It includes the preservation, maintenance, sustainable utilization, restoration, and enhancement of the environment.

Conservation officer Licensed peace officer trained in conservation regulations.

Consumer An organism that obtains its food energy for growth, metabolism, reproduction, and other functions by eating other plants and animals.

Control group A standard or untreated group against which other conditions or variables can be compared in order to validate the results of the study or scientific experiment.

Cover A shelter for resting and protection from environmental elements and predators: one of the four basic habitat needs of most living organisms (food, water/oxygen, cover, and space). Or a fixture over the interior gears and spool of line on a closed-faced fishing reel.

Crankbait Artificial bait or lure that imitates baitfish and has "lips" that cause it to dive and wiggle. Crankbait is useful for attracting larger predator fish that swim in deeper areas such as northern pike, muskellunge, walleye, bass, and salmon.

Creel survey Survey that collects data, through an interview process at lake access sites, regarding the fish that anglers catch. Creel surveys are also conducted on the lake or river, boat to boat.

Crucial habitat Habitat essential to maintaining viable populations of fish and wildlife during certain seasons of the year, specific reproduction periods, or periods of a life cycle.

Culling An illegal practice by which a smaller fish of a given species (in a live well or on a stringer) is replaced by a larger one caught later in the day.

Current The rate of fluid flow, especially water in a river or ocean. A current can be any continuous, directed movement of a fluid of various speeds.

Cut-bank The outside curve of a bend or meander in a stream that is scoured by the faster and more direct impact of the moving water removing sediment, sand, and other materials composing the bank. Hollows in the outer bank may result. Water not only flows faster along the outer bend, but also flows more directly and forcefully into the outer bend as it flows through a curve in a stream or river.

Cycle A series of natural events repeating continuously, or involving a complete process of growth or action.

Daily limit The total number of a certain species or combination of species that an angler may take in one day.

Decomposer Organisms that consume dead organisms breaking them down into simpler forms of matter.

Dehydration A dangerous condition caused by the loss of too much water from the body through sweating, vomiting, and so forth, or resulting from the inadequate intake of water.

Depth perception The ability to judge the relative distance of objects and the spatial relationship of objects at different distances.

Designated use All lakes and rivers in Minnesota have a recognized or assigned use, and each designation has a specific set of water quality standards. The seven classifications are: aquatic, fish, and wildlife; recreation; industrial; limited resource value; domestic water supply; agricultural; or navigational. A water body may have several designated uses.

Diapause A suspended state in which an organism exhibits an extremely slow heart rate; a behavioral adaptation that helps an organism survive a seasonal or limited period of extreme or harsh environmental conditions.

Dichotomous key An identification tool, used to determine the identity of an organism that involves answering a series of either/or questions or yes or no questions regarding physical characteristics.

Disruptive coloration Coloring, consisting of spots, stripes, or mottled patterns, that blur an animal's outline and allow it to blend into the background colors and textures of its surroundings.

Dissolved oxygen Oxygen gas dissolved in water.

Diversity The distribution and abundance of plant and animal species within a given area.

Dormant A state in which plants or animals slow growth, reduce metabolism, and reach a state of biological rest or inactivity in which they're able to wait until environmental conditions are more favorable to resume normal activity.

Dorsal A Latin word describing the back side or top side of an organism.

Dorsal fin The fin located along a fish's back between its head and tail. It may be a single fin, with or without spines, or consist of two connected or unconnected parts, a sharp-spined part and a soft-rayed part. It provides stability and allows the fish to remain upright in the water.

Dough ball Flavors puréed and mixed with flour (which acts as a flavor carrier) and formed into balls that can be placed on a hook.

Drag The amount of tension on the line as it comes out of the reel.

Dry fly An artificial lure that floats on the surface of the water and imitates an insect that has just emerged from the water in its transformation to an adult, or an adult that has just landed on the water to lay its eggs.

Economics The study of how to use limited resources and the production and distribution of goods and services to satisfy humankind's needs and wants as fully as possible; the study of supply and demand in the allocation of limited resources.

Ecosystem A complex and self-sustaining natural system involving the interactions between the living organisms and non-living world. Humans are part of the ecosystems where they live and are interconnected with the living and non-living parts of the system.

Ecosystem-based management A method of natural resources management that recognizes the environment and ecological systems as well as the importance of the human community and its economy.

Eddy Pocket of slower water behind structures such as rocks or debris in a stream or river. An eddy provides cover or a good resting spot and a good place for fish to hide prior to darting out and grabbing passing prey from the currents.

Electrofishing An active fish sampling technique that uses an electrical charge to temporarily stun fish and cause them to float to the surface, where they're captured with nets.

Electrofishing equipment Equipment used in the water that employs an electrical charge to temporarily stun fish so they can be collected, measured, and weighed. Fish quickly recover and are released unharmed.

Embryo Fertilized egg.

Emerge As applied to plants and animals, to come out of dormancy (stimulated by favorable environmental conditions) and return to a fully active state in the spring.

Emergent plants Plants attached to the lake, river, or stream bottom; they have true stems, roots, and leaves with more than half of their vegetative parts sticking out of the water.

Emigrate To leave an area; emigration decreases the size of the population in a given area.

Erosion The gradual wearing away of soil and rock surfaces by natural forces, such as flowing water, wind, and ice, or by human and animal activities that disturb the soil and vegetation holding the soil in place.

Estimate To use a statistical method to roughly calculate the approximate number of something such as fish in a body of water.

Eutrophic The condition of lakes or ponds whose waters are rich in mineral and organic nutrients. This promotes a proliferation of plant life, particularly algae, which can, in excessive quantities, lead to reduced levels of dissolved oxygen and kill other aquatic organisms, including fish. Derived from the Greek words *eutrophos* (meaning well-nourished), *eu*, and *trephei* (to nourish).

Evaporate When water changes states from a liquid to a gas and energized molecules disperse into the atmosphere at temperatures below the boiling point. Amount of surface area exposed, ambient humidity, and temperature influence the rate of evaporation.

Exaggeration When an object, event, or characteristic is overstated, enlarged, or represented as larger than life.

Exoskeleton A hard, shell-like structure on the outside of an organism (exterior skeleton), such as an insect or crustacean, that provides protection and support for its body.

Extinction Occurs when an entire species cannot adapt to changes in its environment and every member of that species dies.

Facultative Describes semi-tolerant organisms (such as dragonfly and damselfly nymphs) that prefer good stream quality, but can survive in semi-polluted conditions.

Fingerling A developmental stage in the life cycle of a young fish, before it matures into an adult; a fish approximately four inches long—approximately the length of an adult person's index finger.

Fingerling stocking A fisheries management practice involving the addition of four- to six-inch fish to manage or increase the population of a certain species of fish in a water body.

Fish advisory A report that provides guidelines on how much fish people can safely consume while minimizing their risks from contaminants.

Fish passage Water-filled canals, ladders, or staircases that enable fish to bypass or circumvent dams and other constructed obstacles.

Fishes/fish The term fishes is used when referring to more than one species of fish. Fish refers to one or more than one individual of the same species.

Fishing regulations The laws that govern fishing in the state and are designed to maintain healthy fish populations.

Flies Small, lightweight lures typically associated with fly fishing.

Floating-leaf plants Aquatic plants rooted to the bottom of a water body, with leaves that drift and float on the surface of the water.

Fly fishing reel The reel used on a fly fishing rod; not used in casting and used only to store the line.

Folklore The creative expression of a particular group of people in which their traditions and beliefs are incorporated into stories in innovative ways.

Food chain A sequence, of typically not more than four steps, through which the process of energy transfer occurs in an ecosystem beginning with photosynthesis in plants and continuing successively as one organism consumes another.

Food web A diagram of a complex, interacting set of food chains in an ecosystem.

Forked tail Term used to describe a caudal fin with a notable notch. (See **caudal fin**.)

Form As pertaining to fish, the shape of a fish's body and body parts in relation to their functions.

Free-floating plants Aquatic plants not attached to the bottom that float on the surface.

Fry Newly-hatched fish.

Fry stocking A fisheries management practice involving the addition of newly hatched fish (less than one-quarter inch long) to manage or increase the population of a certain species of fish in a water body.

Function How a part works.

Gill chamber In fish, cavities with external openings, protected by the gill cover, or operculum, located just behind the head on each side of the body where the gills are located.

Gill nets A loosely set and almost invisible wall of fine netting (mono- or multi-filament nylon), usually 250 feet long, that traps fish by their gill cover(s). These nets are used to capture walleyes, northern pike, whitefish, and yellow perch. Some fish may become entangled and die in gill nets. Gill nets are used in some types of fish surveys.

Gill opening The opening at the rear of a fish's head from the gill chamber to the exterior. Most fish have one on each side.

Glochidia A larval developmental stage of mussels. Glochidia mimic insects to entice fish to ingest them—the fish hosts them for a stage of their development. (See c**onglutinate, mussel, and veliger**.)

Gorge-hook A bone shaped to act like a toggle used to catch fish or waterfowl. When swallowed, it will catch in the stomach of the prey and can't be withdrawn.

Grip The portion of a fishing rod used to hold the rod (handle).

Groundwater The water existing within cracks and porous materials in the aquifer (underground).

Gyotaku The Japanese art form of fish printing, originally developed by fishermen in the mid-1800s to record details of their catches.

Habitat An area that meets the survival needs of many organisms by providing food, water, cover, and space.

Habitat needs The basic things an organism needs to survive where it lives: including food, water (in aquatic ecosystems, water also provides dissolved oxygen for respiration), cover (shelter), and space.

Hand auger A sharp, corkscrew-shaped tool used for drilling holes in ice by hand, usually for ice fishing.

Harvest slot limit A size range in which fish may be kept. For example, a fourteen- to eighteen-inch harvest slot means that only fish between fourteen and eighteen inches may be kept. All others must be released.

Hibernation A survival strategy for spending part or all of the cold season in a basically dormant state of inactivity brought about by short daylight hours, cold temperatures, and limited food.

Hook An implement that catches the fish by holding bait and piercing the lip of the fish.

Hook size The numbers that define hook sizes can be confusing, but the system is actually fairly simple. Hook sizes are based on an arbitrarily set standard hook size of zero. Hook sizes with a number followed by a zero increase in size as the number goes up. For instance, a 4/0 ("four aught") hook is one size up from a 3/0, which is one size up from a 2/0, etc. Hook sizes not followed by a zero decrease in size as the number increases. For example a size 6 hook is smaller than a size 2 hook, which is smaller than a size 1 hook. Although almost all hook manufacturers follow this basic numbering system to indicate the increase or decrease in size of each hook within an individual pattern, there is, unfortunately, little standardization in overall size.

Hyperbole A figure of speech in which the use of exaggeration is intended for emphasis or effect, as in "I've been waiting for all eternity!"

Hypothermia A potentially fatal condition that occurs when the body loses heat faster than it can produce it.

Ice scoop A ladle-type tool with small drain holes that is used for scooping ice chips from a hole in the ice.

Ichthyologist A scientist who studies fish.

Identification key A tool used to unlock the identity of plants and animals requiring careful observation of the specimens.

Imprint A fish's memorization of the unique odors of its home spawning site.

Improved clinch knot A knot that is used for securing fishing line to a fishing lure.

Incomplete metamorphosis A type of insect life cycle wherein an insect hatches from an egg and acquires adult features and behaviors gradually through a series of molts; typically, there is no inactive, non-feeding pupa stage. The stages of development are egg, larva/nymph, and adult.

Indicator species An organism that can provide information about the conditions and quality of the environment where it lives.

Intolerant An organism that is sensitive to pollutants and is incapable of developing and growing normally in degraded conditions.

Invasive species Species or types of organisms introduced—intentionally or accidentally—into places where they're not native and did not originally occur, and adversely affect the habitats they invade environmentally, ecologically, or ecomomically.

Jig Lure resembling natural fish food such as insects and small fish. A jig has a weighted "head" and a "tail" that can be purchased separately. These types of lures are called jigs because they are typically fished by bouncing, or jigging, them along the bottom of a water body to attract fish.

Jigging rod and reel A style of ice fishing pole with a reel that holds the line, but has no drag, so the line comes out freely.

Jiggle stick An ice fishing stick or pole with no reel; instead the line is wrapped around two pegs inserted into the pole near the grip. When ice fishing the short stick is jiggled intermittently to wiggle the lure or bait to attract fish. (See **grip**.)

Knowledge bowl Sometimes called an academic bowl or quiz bowl; a fun and fast-paced game in which students compete in teams to answer questions on topics they've studied in class.

Lake Finder Located on the Minnesota DNR website, the Lake Finder is an interactive website for the public that contains research data for more than 4,500 lakes throughout Minnesota.

Lake survey A resource management tool to sample plant and fish populations in a lake using trap nets, gill nets, seines, and aquatic plant surveys, as well as testing water clarity and chemistry and monitoring wildlife habitat to acquire sound information for a variety of aquatic and fisheries management purposes.

Land use The way land is developed and used in terms of the types of activities permitted (such as forestry, agriculture, urban, recreation, and industry).

Larva The immature stage of development of an organism before change of form or color (or metamorphosis) takes place and the organism becomes an adult.

Larvae The plural of larva.

Lateral line Unique sensory mechanism that enables fish to feel vibrations in the water. It's often called the sixth sense of a fish, but is actually an extension of the fish's hearing.

Lengthwise stripes Color patterns or stripes that run from the nose to the tail of a fish.

Lie-in-wait predators Northern pike, muskellunge, gar, and other fish exhibiting a particular type of predatory behavior. Instead of cruising around and looking for prey, they lie still on the bottom, mimicking a stick or log, or remain hidden in cover. They capture their unsuspecting prey by surprise, with a sudden burst of speed.

Life cycle The progression through different stages of development from egg to reproductive adult.

Light quality Different colors or wavelengths of light within the light spectrum.

Light quantity The brightness or intensity of light that is transmitted or absorbed through water.

Light spectrum The visible range of light that can be seen by the human eye. It's made up of electromagnetic radiation in wavelengths from approximately 380nm (violet) to approximately 700nm (red).

Limit See **daily limit** and **possession limit.**

Limited resource Something produced by or found in nature that is used by people. Only a finite amount is available and more cannot be made.

Limiting factor A condition that influences the survival of an organism, population, or species.

Limiting resource The amount and quality of food, water, cover, and space available that determines how big an individual organism can grow, which species can survive in a particular habitat, and how many organisms of a particular species can live in the habitat (population size).

Limnetic zone The open surface water above the deep area in a lake where rooted plants can't grow (typically deeper than fifteen feet), surrounded by the littoral zone.

Line guides Small circles of steel with a ceramic coating located along the length of a fishing rod; they keep the line in place so it is less likely to tangle during a cast.

Line opening Place where the line comes out of the cover of a closed-face reel.

Littoral zone The shallower portion of a lake, usually less than fifteen feet deep, where sunlight can penetrate to the bottom with enough intensity for rooted aquatic plants to grow.

Low-head dam A small, relatively inexpensive concrete structure used to control water levels at the outlet of a lake or a stretch of river.

Lunker structure Box frames placed in the water along the edges of streams that provide cover where fish can hide from predators and grow larger.

Lure Artificial bait used to attract fish.

Macroinvertebrate Organism lacking an internal skeleton and large enough to be seen with the unaided eye—an integral part of wetland and stream ecosystems.

Macrophytes Aquatic plants large enough to be seen by the unaided eye (without a magnifying lens or microscope).

Main character In a tall tale, the main character is a heroic figure that solves a problem in an amazing way.

Mark-recapture A fish survey method that involves tagging or otherwise marking an initial number of fish and releasing them back into the general population. A subsequent sampling is taken and numbers of marked fish are compared to numbers of unmarked fish in the sample to statistically estimate population size and population vital rates such as survival, movement, and growth.

Maximum size limit A limit requiring all fish larger than a set length to be released. A 24-inch maximum size limit for northern pike means an angler may not keep a northern longer than 24 inches.

Meander Term used to describe the curve of a stream or river.

Mercury A naturally-occurring metal that poses health risks to humans and other animals; most of the mercury that enters Minnesota waters comes from burning coal and other fossil fuels, but is also released from wastes containing household and industrial mercury.

Mesotrophic Lakes containing moderate quantities of nutrients, which are moderately productive in terms of aquatic animal and plant life.

Metamorphosis A striking or abrupt change (or series of changes) in the physical form of an animal, such as insect, that occurs during its life cycle after hatching (or birth), as it develops into an adult.

Metaphor A metaphor is a figure of speech in which a word or phrase that ordinarily refers to one thing is used to describe another object or idea, such as “He’s drowning in money,” or “Her eyes are deep, blue pools.”

Microclimates Term used to describe climates within a small, defined area, possibly different from the area directly surrounding it.

Migrate/migration The annual or seasonal movement of an organism from one habitat to another; typically involves a return trip to the original habitat.

Minimum size limit A limit requiring that all fish smaller than a set length be released. For example, the statewide minimum size limit for muskellunge is 40 inches, meaning that one must release muskies shorter than 40 inches.

Mollusk An invertebrate animal with a soft, unsegmented body, usually enclosed in a shell.

Molting The act of outgrowing, shedding, and replacing the exoskeleton of an invertebrate.

Monitor To observe, check, and test.

Native A species that has lived in a particular region for thousands of years, and, as such, has coevolved with its associates (other animals, plants, fungi, and bacteria). It’s not enough for the species to have reproduced in the area for a few generations unaided by humans—these species are described as naturalized, but not native.

Nitrogen A naturally-occurring element necessary for plant and algae growth.

Nonpoint source pollution Pollution emanating from sources not easily identified; occurs when runoff or wind picks up and disperses or carries natural or manmade pollutants.

Nostrils Fish usually have two openings on either side of their snouts that facilitate sense of smell. Also called nares.

Nutrient cycle A set of processes recycling nutrients from their simple mineral states in the atmosphere, soil, and water to plants and from one organism to another and back to the atmosphere, soil, and water in an ecosystem.

Nymph A larva of an insect that undergoes incomplete metamorphosis (such as a dragonfly or a mayfly).

Nymph pattern A type of design or pattern used when tying flies (small lightweight artificial lures) to result in a fly that mimics the larval forms of an aquatic insects, particularly mayflies, stoneflies, and caddisflies.

Oligotrophic Scantly nourished lakes that are very low in nutrients; minimal algae grow and the water is very clear. Lake Superior is Minnesota's best example.

Omega-3s A group of polyunsaturated (good) fats found in foods such as flaxseed, walnuts, canola oil, and fish native to cold waters, such as salmon and trout. They're important components of cell membranes, particularly in the brain and eyes.

One-over limit A limit allowing anglers to keep one fish over a set length.

Open season The time of the year anglers may fish for a certain species, or type, of fish.

Open-face reel A style of fishing reel that has no cover, also called a spinning reel. The spool of line is oriented perpendicular to the rod.

Osteichthyes The classification or group of jawed fishes with skeletons made of bone. Also referred to as bony fish, coming from the Greek words *osteon* (meaning bone) and *ichthyes* (fish).

Over-winter Technique in which an organism addresses the challenges of winter and survives throughout the winter months.

Palate The roof of the mouth in humans and other vertebrate animals. Often refers to the sense of taste.

PCBs Polychlorinated biphenyls. These toxic synthetic oils once had many industrial uses and are still found in electrical transformers, cutting oils, and carbonless paper.

Pectoral fins Fins located on either side of the fish near the gills that help the fish steer, stop, and stay near lake or river bottoms. Pectoral fins also help provide lift, like wings on an aircraft.

Pelvic fins Fins located on the bottom of fish, in front of the anal fin, that help balance the fish, keep it level, and prevent it from rolling to one side or the other.

Percolation The movement of precipitation that has fallen to earth as it seeps directly into the soil.

Periphyton Algae that grows attached to surfaces such as rocks or larger plants at the bottom of lakes and other bodies of water.

PFD Personal flotation device.

Phosphorus A naturally-occurring element necessary for plant and algae growth.

Photosynthesis A process by which green plants and algae use light energy captured from the sun by chlorophyll to turn carbon dioxide and water into simple carbohydrates (food energy) and oxygen.

Physical characteristics Observable features of an object or organism, such as shape, form, color, size, and texture, as opposed to behavioral characteristics.

Phytoplankton Microscopic plants and bacteria that produce food energy by capturing light energy directly from sun light with chlorophyll through the process of photosynthesis.

Pier Floating wooden structure used for fishing.

Piscatorial A derivative of a Latin word (*Pisces*) meaning fish.

Plankton Tiny microscopic organisms (plants and animals) that usually live suspended in the water and are eaten by fish and other aquatic life and form the base of aquatic food chains.

Poaching The harvest of more fish or game than the law allows, or the taking fish or game by illegal means.

Pollution Anything that alters or makes water, air, or soil harmful, less desirable, or less useful for plants and animals, including people.

Pool An area of slower, deeper water in a river or stream, typically downstream of riffles.

Population The collection of organisms of a particular species living in a given geographic area.

Possession limit The total number of a species that an angler may legally possess. For example, an angler may not possess more than six walleyes, including fish in both a live well (the water-filled fish storage compartment on a boat) and in a freezer.

Precipitation The phenomenon by which water droplets in the atmosphere become heavy enough to be pulled by gravity to the earth, in the form of rain, sleet, or snow.

Predator An animal that hunts and captures other animals for food.

Preservation Complete protection of a resource or ecosystem allowing for little human disturbance.

Prey An animal consumed by a predator.

Primary consumer An animal that eats only plants (or phytoplankton).

Producers Plants (including phytoplankton) that can produce sugars (food energy) directly from the sun's light energy and simple nutrients through the process of photosynthesis.

Profundal zone The zone that lies beneath the limnetic zone and extends to the bottom of the lake.

Proportion In mathematics, an equation that states equality between two ratios.

Protected slot limit A size range, or slot, in which fish must be released. For example, a twelve- to sixteen-inch slot limit for bass means that all bass between twelve and sixteen inches long must be released.

Public access Areas on lakes or other bodies of water where boats may be carried in or launched by trailer enabling public access to the water.

Public land use hearing An open forum or meeting in which different groups can have their opinions about development or use of land in the community heard and considered.

Pupa A developmental stage of many insects, intermediate between the larva and the adult; this stage is generally inactive and encased in a case or cocoon.

Random spawners Fish that scatter their eggs randomly over their preferred spawning habitat (such as on gravel or cobble).

Ratio In mathematics, a comparison expressed as a fraction.

Rattle reel A free-spinning ice fishing reel that makes noise when a fish pulls on the line attached to the reel, often attached to the wall of an ice fishing house.

Rays Fin supports; they're almost always soft and flexible, and often branched.

Recapture Previously tagged or marked fish that are caught again.

Redd A depression created by members of the salmon/trout family; these fish use their tails to fan away finer sediments to create a space in which females deposit and males fertilize their eggs (spawn).

Reel handle The crank on a fishing reel used to wind in the line.

Reel seat The part of the reel that is mounted onto the rod, also called a reel foot.

Regulations Legal restrictions formally made public by government authority. See fishing regulations.

Researcher bias A situation occurring when a researcher knowingly or unknowingly influences the results of an experiment due to personal viewpoint or individual technique.

Respect To show special attention, concern, consideration, or thoughtfulness for something; to hold in high regard or esteem

Respiration The physical and chemical process of supplying the cells and tissues of an organism with oxygen for the processes of metabolism and releasing carbon dioxide.

Responsibility Accountability, reliability, and trustworthiness.

Ridgelines The highest elevation levels in an area.

Riffle Shallow area in a stream where the water moves quickly over rocks and is distributed from one bank to another.

Riparian habitat The green corridor of native trees, shrubs, and grasses that grow along lakes, rivers, ponds, or streams.

Rod tip A term used to describe the end of a fishing rod held furthest from the angler during casting and fishing.

Rounded tail Describes a caudal fin without a notch. (See **caudal fin**.)

Rover-predators Fish that spend much of their time cruising and searching for prey. Rover-predators include bass, many minnows, and trout.

Run When fish migrate or travel to another location to spawn.

Sac fry A newly-hatched fish with a full yolk sac containing proteins attached to its belly.

Sample A representative number of fish taken from a lake; used to make inferences about the entire population.

School A group of the same type of fish swimming together.

Secchi disk A simple tool used to determine water clarity (transparency).

Secondary consumers Animals that eat other animals (carnivores or omnivores).

Sediment Erosion from the watershed (silt, sand, and organic and inorganic material) that accumulates on lake, river, and stream bottoms.

Sedimentation The deposition or settling of soil particles suspended in water.

Seines Small-meshed nets used to capture small and young fish. Seines are attached to a pole on each end and are typically used by wading in from shore.

Senses Biological processes that help organisms perceive their surroundings and survive in their environments.

Sensitive Describes species that are intolerant to pollutants that can survive only within a narrow range of environmental conditions; a sensitive species' disappearance from an area is an indication of pollution or other environmental change.

Setting The time, place, and circumstances in which a story takes place.

Severe thunderstorm warning Statement issued by the National Weather Service when a thunderstorm is occurring in an area.

Severe thunderstorm watch Statement issued by the National Weather Service when a thunderstorm is possible in an area.

Simile A figure of speech in which two dissimilar things are compared, usually using the words like or as: "Mary swims like a fish," or "I'm as busy as a bee."

Sinker A weight attached to a line so to make it sink into the water.

Snagged Term describing the state of a fishing line caught on a branch or elsewhere above or below the water's surface.

Snags Dead trees submerged in the water; snags provide cover and habitat for fish.

Spawn The process by which fish reproduce. Females release eggs, which are subsequently fertilized by milt (fluid containing sperm) from males.

Spawning Active process of laying and fertilizing eggs.

Species A group of like individuals able to breed and produce fertile offspring. Species is also the classification category that follows the genus or subgenus grouping in the biological classification system.

SPF Sun protection factor.

Spines True fin spines are derived from the soft rays; they're unjointed and of a single structure, can be sharp and bony.

Spinner A lure that has one or more blades that spin around a metal shaft.

Spinning combo A fishing rod with a spinning reel (or open-face reel) that holds the line and has drag, so it can be set to prevent the line from coming out freely.

Spiracles The openings in the sides of an insect's abdomen through which it breathes.

Split shot sinker Small weights with a split down the center to attach to a line.

Spoon One large heavy blade that wobbles through the water like a baitfish. Typically one side is shiny silver or gold, the other side painted bright colors.

Sportsmanship As exhibited by anglers, common courtesy for others, respect for the regulations, the fish, and water resources, as well as a sense of stewardship for natural resources.

Stewardship The careful and responsible management of something entrusted to one's care.

Stinkbait Highly aromatic baits prepared by anglers and usually used to catch catfish. (See **dough balls**.)

Stream Habitat Program Program that gathers and provides information on Minnesota's 90,000 miles of rivers and streams, helping to protect and restore them.

Stringer A device made of cotton, polyester, or wire that is put through a fish's lip or gills in order to prevent it from swimming away while being held in the water to keep it fresh.

Structure Any lump, bump, hole, or hideaway in a lake or streambed that can provide cover or shelter for a fish. Structure also includes rocks, plant beds, stumps, logs, piers, drop-offs, and "points" of shallow water extending into deeper water.

Submerged plants Aquatic plants with roots, stems, and leaves that grow entirely underwater, although some may also have floating leaves.

Substrate Bottom materials such as rocks, gravel, or muck.

Surface runoff Precipitation and melt water that flows over the surface of the land directly into streams, lakes, and rivers.

Survey To gather long-term information on population size and structure (such as the proportion of fish in age or length groups), fish growth, reproductive success, species abundance, fishing pressure and harvest rates, seasonal fish movement or migration, and habitat conditions (including plants, plankton, and invertebrates).

Suspended sediment Sediment floating in the water column; makes the water appear muddy or cloudy.

Sustainable use of natural resources Using natural resources in a way that meets the needs and aspirations of the present generation without compromising the ability of the environment to meet the needs and aspirations of future generations.

Swim-up fry A stage of development in the life cycle of a fish. After hatching, and after its yolk sac is absorbed (see **sac fry**), the fish is free to "swim up" to the surface to fill its air bladders and begin feeding.

Tag To mark or identify individual fish by giving each fish its own number or code so that it can be tracked over time.

Tag end The loose end of the fishing line or rope with nothing attached to it.

Tall tale Stories that are outrageously exaggerated or larger than life, usually told in a straightforward, believable style.

Taxonomy A branch of biology concerned with classifying and naming the diverse forms of life.

Theme The plan, scheme, or main point of a story.

Thorax The portion of an insect's body directly behind the head to which its wings and legs are attached.

Throwable PFD A personal flotation device attached to a rope; can be thrown to an angler who has fallen into water or through the ice.

Thumb button Mechanism on a closed-face fishing reel that releases the line when the button is depressed and then released.

Tip-up A disc- or cross-shaped ice fishing rig that sits over a hole in the ice. When a fish takes the bait, a lever releases a flag to alert the angler.

Tolerant Describes organisms with special features, behaviors, or adaptations that enable them to survive in polluted or degraded environmental conditions.

Transpiration In plants, the process whereby water reaches the leaves, is exposed to the air and the sun's energy, and is easily released into the atmosphere in a gaseous state.

Trap nets Small nets used to capture bluegills, bullheads, and other near-shore species for fish surveys. Live fish can be released from trap nets unharmed.

Trawls Small-meshed nets that are towed behind a boat and used to capture young fish.

Trotlines A series of baited hooks strung along a rope. This tool is used to survey catfish and other species that often can't be effectively captured by other means.

Turbidity The amount of solid particles suspended in water that cause light rays shining through the water to scatter. Turbidity makes the water cloudy, or even opaque, in extreme cases.

Undercut Small caves or hollowed out areas in the banks of streams and rivers.

User groups Groups of people that use resources in varying ways and could have divergent values and perspectives on land use.

Value To rate the relative importance or monetary worth of a thing; to rate or scale its usefulness. Things considered important, beneficial, or useful are said to have value.

Veliger Free-swimming larva produced by zebra mussels.

Vent Sometimes referred to as anus, the opening on the ventral (underbelly) side of a fish near its tail, through which waste is eliminated.

Ventral The underside or underbelly of an organism.

Vertebrate Anatomical term used to describe animals with backbones or spines.

Vertical stripes Stripes that run up and down from the dorsal side to the ventral side of a fish.

Warm-blooded Organisms that produce body heat and regulate body temperature from within their bodies using energy from the food they eat. Warm-blooded animals maintain a relatively constant body temperature independent of the outside temperature.

Water analysis Chemical and physical tests undertaken to determine quantities of materials such as dissolved oxygen, nitrates, and phosphorus, as well as water clarity.

Water cycle Describes the continuous movement of water on, above, and below the surface of the Earth.

Water pollution Contamination that makes water aesthetically unpleasant, less useful, or potentially toxic to plants and animals, including people and fish.

Watershed An area of land that catches precipitation (rain, sleet, and snow) and drains into a body of water such as a wetland, stream, river, lake, or groundwater.

Wavelength Refers to the distance between two successive points of an electromagnetic waveform, usually measured in nanometers (nm).

Wet fly Fishing lures typically used in fly fishing made from materials that absorb water and imitate drowning or struggling adult insects and insect larvae.

Winterkill When fish under ice cover die due to lack of oxygen during winter.

Xylem Anatomical term describing a plant's vessels or tubes that conduct water and dissolved minerals, store food, and provide support.

Year class A term describing each year's new generation of fish.

Zebra mussel Invasive (or non-native) clams, shorter than two inches across that, by means of tufts of fiber (abyssal threads) attach themselves to any solid object. Their shells have dark "zebra" stripes and very sharp edges.

Zooplankton Microscopic aquatic animals.

Conceptual Framework for

Fishing: Get in the Habitat! MinnAqua Leader's Guide

This section provides an overview of the structure and foundation of the core content for instructors and youth leaders who wish to implement the lessons and activities in the *MinnAqua Leader's Guide*. It's also a blueprint that will guide efforts to increase the effectiveness of the MinnAqua Program's education and outreach efforts.

The Educational Purpose of the MinnAqua Leader's Guide: To Get in the Habitat

The *MinnAqua Leader's Guide* helps build an environmentally literate citizenry by providing necessary awareness, knowledge, skills, and motivation to prevent and solve natural resource issues and to address other management goals of the Minnesota Department of Natural Resources. The skills taught in the *MinnAqua Leader's Guide* support the development of a lifelong stewardship ethic and better prepare the citizenry and local leaders for making informed natural resources decisions.

Minnesota educators will use the *MinnAqua Leader's Guide* for:

- teaching about Minnesota fish, aquatic resources, and resource management
- leading youth groups and students outdoors, providing the background and inspiration for initiating self-sustaining service-learning projects such as volunteer monitoring projects, shoreline restoration, and teaching others to fish
- connecting students to their local aquatic resources through the lifelong recreational activity of angling
- promoting lasting stewardship of Minnesota's aquatic resources

MinnAqua Program Goals for the MinnAqua Leader's Guide

Goal 1: To support the mission of the Minnesota Department of Natural Resources.

"The mission of the Minnesota Department of Natural Resources is to *work with citizens* to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources *in a way that creates a sustainable quality of life.*"

—*A Strategic Conservation Agenda 2003-2007: Measuring Progress Toward Mission,*
Minnesota Department of Natural Resources
mndnr.gov/conservationagenda/index.html

The *MinnAqua Leader's Guide* will increase the outreach potential of the Minnesota DNR and the MinnAqua Program by empowering others to effectively teach angling and aquatic education programs throughout Minnesota.

An environmentally literate citizenry will support the Minnesota DNR goal of working with the citizens of Minnesota to conserve, manage, and use our state's natural resources in a sustainable way.

Goal 1 Objectives

To develop an informed and engaged citizenry that:

- understands the value of fish and aquatic resources as a public trust
- appreciates that conservation and management of fisheries and water resources are essential to sustaining fish, water quality, the outdoor landscape, and the quality of our lives
- understands and actively participates in stewardship and support of natural resources
- understands, accepts, and lawfully participates in fishing and other types of resource-related outdoor recreation
- understands the need for and actively supports funding for fish and wildlife conservation

(These objectives are adapted from the *North American Conservation Education Strategy Vision Statement,* Association of Fish and Wildlife Agencies, March 2005.)

Goal 2: To support the mission of the MinnAqua Program.

"The mission of the MinnAqua Program is to provide lifelong educational programming that will increase people's knowledge and understanding about aquatic ecosystems, management, and resource issues; help acquire skills related to aquatic recreation, careers, and teaching; and foster a better stewardship of Minnesota's natural resources."

—*MinnAqua Program Mission Statement*,
mndnr.gov/minnaqua/index.html

Providing angling and aquatic resources education to the public is a core activity of the MinnAqua Program. The *MinnAqua Leader's Guide* outcomes include partnerships, expanded public participation in fish management activities, increased awareness of natural and altered systems and their management, increased compliance with fisheries regulations, increased access to natural resources information, increased stewardship and environmental literacy, and maintaining or expanding public participation in fishing.

Fishing is often referred to as Minnesota's pastime. Through angling, the *MinnAqua Leader's Guide* connects students to their local aquatic resources in a way that is relevant to the everyday life of Minnesota youth. It allows students to get outdoors and explore local aquatic habitats.

The *MinnAqua Leader's Guide* encourages expanded use of local aquatic places as the focus of learning *and* as a "connector" of science and environmental literacy for students.

By incorporating the Recreational Boating and Fishing Foundation (RBFF) Best Practice Recruitment-Training-Retention Intervention Model into the design of the *MinnAqua Leader's Guide*, the MinnAqua Program has worked to develop active stewards, and future voters and elected officials who are environmentally literate and prepared to respond to tomorrow's natural resources challenges.

Goal 2 Objectives

To develop an effective program that:

- is relevant to the mission of the agency or organization sponsoring the program
- is experiential
- is relevant to the everyday life of the learner
- uses an interdisciplinary approach to help learners develop skills, formulate concepts, and examine issues
- identifies and targets one or more outcomes or skills, beyond the subject matter, that are broadly useful to the learner
- contains organizational mission, education program goals, and instructional objectives aligned to reflect stewardship education
- considers how ethical principles and reasoning support stewardship
- provides opportunities for learners to have positive contact with the outdoors over an extended time period
- encourages long-term stewardship behavior

(The "Effective Program Objectives" are adapted from the 2003 *Best Practices Workbook for Fishing, Boating and Aquatic Resources Stewardship Education,* Recreational Boating and Fishing Foundation which served as an important supporting document for the design, development, and implementation of the *MinnAqua Leader's Guide.* For more information, see **www.RBFF.org/educational/bestpractices.cfm** or contact RBFF at 601 North Fairfax Street, Suite 140, Alexandria, VA 22314-2054, or by phone at 703-519-0013.

To develop a Minnesota citizenry that will:

- have an awareness of and connection to local aquatic habitats and local environmental issues
- have knowledge about Minnesota fish, Minnesota waters, aquatic habitats and ecosystems, and fisheries management; a systems based understanding of the interconnection of the natural, built and social components of the environment in which we live; and an understanding of the interdependence of all organisms and the need for conserving natural resources
- examine how personal, and cultural attitudes about fishing and aquatic resources impact the quality of life in Minnesota; understand the cause and effect relationship between human attitudes and behavior and the environment; and understand the issues surrounding multiple uses of the environment
- have observation skills, science and inquiry skills, personal decision-making skills, skills to identify and evaluate alternative responses to environmental issues and problems, fishing skills, stewardship and citizenship skills
- engage in the activity of fishing in a way that provides an awareness and appreciation of the need to conserve and sustain our natural resources and with an understanding of the value of our fisheries and aquatic resources as a public trust
- be motivated to participate in the lifelong activity of fishing and share that activity with others
- participate in local communities as informed decision-makers, active stewards of aquatic resources, and engaged citizens able to maintain a sustainable lifestyle

Goal 3: To be a tool that comprehensively illustrates angling and aquatic ecology concepts, guides effective instruction, and emphasizes safety and stewardship for use by educators in nonformal and formal education settings.

Increasing Outreach in Nonformal and Formal Educational Settings

"Angling and aquatic education programs are more effective when the programs reach their audiences from multiple settings, and when programs target audience needs and learning styles. Different audiences have different motivations and constraints regarding participation. When students are reached in both formal and non-formal settings, connections can be made between what students are learning in school, what they learn in outside activities and programs, and the activity of fishing and stewardship concepts become more relevant to students' daily experience.

'An effective angling and aquatic education program is built on science-based research, a solid plan, well-trained instructors, strong support, and continued program evaluation."

—*Best Practices Workbook for Boating, Fishing, and Aquatic Resources Stewardship Education,* Recreational Boating and Fishing Foundation, 2003

Goal 3 Objectives

These objectives of Goal 3 were used as guidelines for revising the original 1992 *MinnAqua Leader's Guide* to create this new edition. These guidelines ensure that this edition of the *MinnAqua Leader's Guide* can be used in indoor and outdoor settings and formal (school) or nonformal settings (such as scout groups, 4-H, community groups, retail outlets, and camps). By linking indoor activities to outdoor settings near or in the "backyards," of participants, it provides a "locus of control," or a setting that helps them feel connected to their environment and helps to empower participants with the feeling that they are indeed able to change or conserve that environment.

To be effective, the *MinnAqua Leader's Guide* will:

- be developmentally appropriate and build on students' prior knowledge
- utilize best practices and research in education practices, environmental education and recreational fishing and aquatic education
- contain extensive background biology and fisheries resources management information in each lesson
- include lessons with well-defined steps and procedures for carrying out the lessons and activities
- be aligned with the Academic Standards and Environmental Literacy Scope and Sequence
- have measurable student learning objectives
- have authentic assessment ideas, scoring rubrics, and student checklists to assess student learning
- accommodate multiple learning styles in lesson activities
- include ideas on how to adapt lessons for use with grades K-2
- address concepts and environmental issues and problems with accuracy and fairness
- feature content that is specifically relevant to Minnesota culture, natural resources, and fisheries management
- make connections to students' everyday lives
- include indoor classroom and outdoor activities
- include self-directed, student-centered learning opportunities
- incorporate individual and group activities
- include interdisciplinary, hands-on, minds-on, and inquiry-based lessons
- clearly address safety and regulations for the purpose of reducing risk and instilling comprehensive awareness of safety and regulations
- provide service-learning ideas and resources
- include lessons that can stand alone or be used as part of a unit
- include engaging and effective graphics and copy pages
- include helpful matrices, a glossary, and supporting resources that instructors can easily use
- include developmentally appropriate student reading lists that correspond to topics in the lessons

Goal 4: To develop participants' interest—and continued participation—in Minnesota angling.

Fishing is educational. It teaches participants about a world of fascinating underwater species. Fishing is a way to explore lakes and streams—and it's fun! It's a pastime that can be enjoyed alone or with friends and family.

In the Land of 10,000 Lakes, angling-based activities provide Minnesotans with millions of hours of outdoor recreation and generate billions of dollars for the state's economy. Minnesotans have abundant opportunities to get outdoors and enjoy the state's rich aquatic resources. Angling is a lifelong activity that is wholesome, healthy, connects participants to local aquatic environments, and contributes to the state's economy and quality of life.

Goal 4 Objectives

The students will:

- understand, accept and lawfully participate in fishing, wildlife watching, and other types of resource-related outdoor recreation
- understand the value of our fisheries resources as a public trust managed by government agencies
- understand that ownership of land does not convey ownership of wildlife (and fish)
- understand that sustainable use of natural resources depends on the support of an informed and responsible citizenry
- understand that regulations are necessary for natural resources conservation
- appreciate that conservation and management of water resources are essential to sustaining fish, the outdoor landscape, and the quality of our lives
- understand that the health and well-being of fish and humans depends on the quality of their environment
- understand that fish resources provide recreational benefits directly to participants and increase advocacy for conservation
- understand that responsible users of fish and aquatic resources and the outdoors respect the rights and property of others

(These objectives are adapted from *Conservation Education Strategy Core Concepts for Conservation Education,* Association of Fish and Wildlife Agencies, March 2005.)

Goal 5: To Provide teachers and students with the background and information they need to initiate self-sustaining stewardship projects and programs in their communities.

Environmental stewardship involves informed, responsible behaviors and actions undertaken by people on behalf of the environment and future generations.

The *MinnAqua Leader's Guide* includes a Service-learning Appendix to encourage instructors and students to apply content knowledge, critical thinking, and good judgment to address genuine community needs. Service-learning empowers students with experience and the opportunity to demonstrate goal-setting, commitment, and community engagement, which support the development of a long-term stewardship ethic.

Goal 5 Objectives

The *MinnAqua Leader's Guide* will:

- serve as an effective resource for teaching about Minnesota fish, aquatic resources, resource management, and aquatic stewardship
- lead students outdoors and initiate self-sustaining programs such as volunteer monitoring projects, shoreline restoration, and other service-learning projects
- connect students to their local aquatic resources and engage them in aquatic stewardship through the recreational activity of angling
- promote lasting stewardship of Minnesota's aquatic resources
- promote sustainable use of Minnesota's natural resources

Chapter Framework: Chapter Themes

The chapter themes, combined with the Service-learning Appendix, organize lessons and activities along a developmental continuum of learning from the awareness level to knowledge, attitudes, and skills development to the action level. Students have an opportunity to exercise higher learning skills and develop a sense of empowerment when they apply acquired knowledge and skills and engage in a relevant activity, "real world" problem solving, or address issues in their communities.

Chapter 1: Aquatic Habitats
The lessons in this chapter provide students with opportunities to begin to explore their local aquatic habitat, discover what lives in and near the water, compare their own habitat needs with the those of fish, and learn how fish survive in lake, river, or stream habitats. Students will be immersed in their

local aquatic habitat and begin to gain a greater awareness of their environment, develop the ability to understand natural systems (which are sets of interactions), and discover their place within those systems. In order for students to gain an awareness of their environment and begin to understand and appreciate relationships between themselves and the living and non-living parts of the natural environment and their communities, they must spend time becoming *connected*—experiencing and exploring their local environment.

Experience + Exploration of Local Environment = Engagement

Chapter 2: Minnesota Fish

Children have a natural curiosity about the world and its inhabitants. They're eager to dive in and discover the different types of fish—and other wonders—that inhabit Minnesota's lakes and streams. Chapter 2 builds increased awareness, knowledge, understanding, and appreciation for the diversity of fish species in Minnesota. These lessons explore the exterior parts of fish (structure and function), fish senses, adaptations, behaviors, habitat requirements, life cycles, interactions with other species, and environmental challenges and limitations, as well as fish identification and classification. Students compare different types of fish, and explore differences and similarities between fish and themselves. Fish tales help students gain an understanding of how attitudes and ideas about the natural world are created and reinforced. Increased knowledge of fish biology and behavior also increases angling success. For an angler or observer, knowing the characteristics of various fish species provides information that reveals where, how, and when to fish for particular species. Knowing how to identify fish helps anglers follow fishing regulations. There is a world of information to learn about fish!

Chapter 3: Water Stewardship

Minnesota has 11,842 lakes that are larger than ten acres and 6,564 natural rivers and streams containing 69,200 miles of moving water. All water is continually in motion, traveling and changing states in the water cycle, a fundamental system that connects all living things. Chapter 3 increases awareness and knowledge of the critical ideas that all plants and animals need water, we all use water, and that each of us lives in a watershed. These lessons also develop observation and critical thinking skills. Fresh, clean water contributes to a healthful quality of life for all living things. Things that happen on the land within a watershed eventually are reflected in the water quality of lakes and rivers. Students also investigate personal attitudes and values; and the viewpoints, attitudes and values of other. Our choices and actions in the watershed impact water quality—they can benefit or harm plants and animals, including fish and people. The lessons in this chapter help students identify and develop their own attitudes and values concerning water, and help them gain an appreciation for Minnesota's abundant water resources.

As students acquire increased awareness, comprehensive information, and improved analytical skills they gain abilities to make informed decisions and address environmental problems. If people feel connected to their local aquatic habitats, are well informed, consider their own attitudes and diverse sets of values of others, understand ecosystems and multiple uses of resources, and critically analyze problems, they will know how to use natural resources in a sustainable manner and become effective stewards.

Chapter 4: Fish Management

Chapter 4 lessons develop students' understanding of the roles of the Minnesota DNR and citizens in managing fisheries. The mission statement of the Minnesota DNR focuses its efforts on managing the state's resources. The DNR strives to work with the state's citizens to manages resources, conserve natural systems and maintain biodiversity while providing for sustainable use of the resources for social and economic purposes. We all use natural resources and share the responsibility of ensuring a sustainable quality of life in our state. Students learn that this is a big job, and that we all must do our part. They will begin to practice and develop skills enabling them to consider personal values, varied points of view and perspectives, rules, regulations, responsibility, the importance of informed choices and decisions. They will begin learning how to critically analyze environmental issues.

Minnesota's citizens must have the awareness, knowledge, and attitudes and skills to work together—and with the Minnesota DNR—to address and solve resource management problems and issues. Students will learn how Minnesota's fisheries resources are managed, and who performs this work. They'll practice a variety of citizenship skills to learn how they can participate as informed citizens within communities. Students will discover the diverse perspectives and values of varied user groups, reflect on their reflect on their personal values and attitudes, consider requirements for healthy ecosystems, wrestle with compromise and consensus, and investigate some fisheries management issues and techniques.

Chapter 5: Fishing Equipment & Skills

Fishing is a tradition deeply embedded in Minnesota's history and culture. Approximately one-third of Minnesota's more than five million residents engage in fishing, and anglers come to Minnesota from many other places, too. More than two million anglers fish in Minnesota waters each year.

Chapter 5 lessons help students learn skills that will help them become self-sufficient anglers, including: knot-tying, making their own fishing rigs, and casting a closed-faced (spin-casting) rod and reel. They'll be able to select the correct bait, lures, and fishing locations for target species' habitat and food preferences. Students exposed to fishing can learn patience, gain self-esteem, take time to reflect, learn problem-solving skills, and develop an appreciation for the outdoors and our natural resources.

Fishing is a lifelong activity that that gets people outdoors, connects them to their aquatic resources, and provides an opportunity to develop awareness, knowledge, and enjoyment of ponds, lakes, rivers, and streams. Fishing can bring family members together, build friendships, and strengthen bonds between people through shared experiences and special memories.

Anyone can fish. This chapter's information on skills and equipment, combined with the concepts learned in each of the previous chapters, helps bring added success to anglers of every experience level. Above all, you can ignite enthusiasm for the sport of fishing and aquatic stewardship, provide relevance to learning across disciplines, and engage students in their learning while empowering them with basic skills for successful angling. These lessons will leave a lasting impression.

Chapter 6: Safety & the Fishing Trip

Chapter 6 lessons help students learn how to fish and how to plan and participate in fishing trips. Students will learn that planning goes a long way to ensure a safe, successful fishing trip. And students will be "empowered by doing" with these active, hands-on lessons.

This chapter engages students in developing competency in fishing techniques and skills and demonstrating responsible and safe fishing practices. They'll experiment with various baits to discover how to best attract fish. They'll find out what to do when a fish takes their bait. Students learn to practice the safe, responsible handling that helps ensure the survival of fish that will be released. They'll learn how to safely store, fillet, cook, and enjoy the nutritional benefits of the fish they choose to keep. When students have a safe and fun fishing experience, they just might develop a fishing habit that gets them outdoors more often, connecting them to their habitat. With knowledge of the resource and how it is managed, an understanding of responsible stewardship practices, and practical fishing and safety skills, students will be empowered to pursue fishing as a lifelong recreational, educational, reflective, and inspiring outdoor activity. And they'll be able to share their new knowledge and skills with their family, friends, and community.

Engagement + Action = Empowerment

Service-learning Appendix

Service-learning focuses on citizenship. It shares a common commitment with natural resources and stewardship education to make education relevant to the students' lives beyond the classroom walls. Stewardship education and service-learning empower students with the knowledge, skills, and experience to take responsibility for the environment and quality of life in the communities around them.

Incorporating a service-learning experience as a central component of learning reinforces and brings to life the concepts and skills learned from the lessons and activities. The practical application of this learning provides students with the opportunity to further develop skills for identifying and analyzing a problem, learn how their actions can impact their communities, practice communicating with others, create partnerships with others, work as individuals and as members of teams, and develop citizenship skills. Students inevitably reach higher levels of learning, have a richer learning experience and, in school settings, exhibit greater engagement in their studies, which results in greater academic achievement.

The lessons and activities, especially from chapters 3, 4, 5, and 6, prepare students to engage in service-learning experiences. The action component of service-learning then transfers learning to real life, providing a relevant, authentic, and empowering experience. Reflection throughout the experience involves personal evaluation, and assessment of the experience helps students understand how their actions have impacted their communities and themselves. Finally, recognition reinforces the students' effort and achievement, encouraging lifelong learning and stewardship.

Service-learning

"It's nice to work on something when you don't know exactly what is going to happen next, there are lots of surprises as things unfold. This makes learning exciting."

—Student quoted in *Lessons Learned about Service-learning: Voices of Experience About Urban Service-learning in Saint Paul Public Schools*

Students have the opportunity to apply the concepts, knowledge and skills they learn from completing lessons in the *MinnAqua Leader's Guide* by planning and participating in a service-learning project. Fisheries and aquatic resources related service-learning projects engage students in their own learning, help empower students with civic skills to effect positive change in their communities through social and environmental action, and start them on a path to lifelong stewardship of Minnesota aquatic resources.

How Service-learning Differs from Community Service

"*Service-learning* is a form of experiential learning whereby students apply content knowledge, critical thinking and good judgment to address genuine community needs.

'. . . *Community service* is volunteerism that is done within a defined community, which could be a classroom, school, community, etc., and it has no intentional tie to learning; the emphasis is strictly on service."

—Minnesota Department of Education

"Example: *Service* is cleaning up a riverbank. *Learning* is sitting in a science classroom, looking at water samples under a microscope.

'Service-learning is science students meeting state standards by taking samples from local water sources, then analyzing the samples, documenting the results, presenting the scientific information to a pollution control agency and reflecting on the impact these results may have on future pollution control issues and our own behaviors and attitudes."

—Adapted from the Minnesota Department of Education and from *St. Paul Public Schools Plan for District-wide Service-learning*, National Youth Leadership Council, May 2000

Service-learning projects are not field trips, time away from class, extra projects, or add-ons. Rather, authentic, truly integrated service-learning enhances the academic studies or the education components of the programs in which students participate. The projects are aligned with required student outcomes and academic standards. Structured time for reflection activities that require higher-order thinking skills is used to enable students to measure their progress and adjust their plans and actions accordingly throughout the project. And service-learning incorporates accountability and student assessment.

Service-learning can occur within the school, community, or in the local natural environment. Preparation, planning, developing community partnerships, and commitment to follow through are all essential elements of a high-quality service-learning experience. Projects need to be designed to meet a genuine community need in a meaningful way. It's also important for all individuals and partners in a service-learning project to find benefit and value. This ultimately results in stronger connections that can build bridges and goodwill between schools, students, parents, and the local community and natural environment.

In high-quality service-learning, instructors are facilitators enabling students to plan, make decisions, direct, and carry out projects. This may be a new way of teaching for some instructors, and may require a little extra effort to learn how it works. It is surprising to learn young people's capabilities when supported with guidance and direction. Students have an energy, enthusiasm, creativity, and boldness just waiting to be channeled into positive action.

Service-learning benefits students as they practice self-direction. They learn how to ask questions, seek answers, and find solutions to real-world problems. Students have a personal stake in their learning when they make the decisions, and they become motivated and engaged learners. Instructors experience a classroom with fewer discipline problems. Practicing higher-order thinking skills gives academic performance a boost. Political, social, scientific, and environmental issues become accessible and tangible to young people, improving civic, science, and environmental education. Students gain exposure to future possible career choices and related practical experience. And service-learning makes teaching and learning relevant, interesting, and fun!

Students become empowered as they investigate and learn about problems or issues, identify and use talents and skills to develop a plan of action, form working partnerships with others in their community, and take steps to complete a project. They discover that good things can be accomplished by combining what they're learning in their studies with action, hard work, patience, and teamwork. The intended outcomes of service-learning are achieved as students discover how to be informed and active citizens who do more than merely provide service. They are also learning how to focus on the underlying principles, issues, actions, and consequences of their service. They might choose to participate in civic and environmental action and service throughout their lives.

Perhaps the greatest benefit resulting from service-learning happens when students reflect on their progress and celebrate a valiant effort or a job well done. They realize that they're not "just" kids, but responsible, informed participants in their schools, communities, and local environments.

"K-12 Service-learning Standards and Indicators"

"In 2008. the National Youth Leadership Council published new K-12 Service-learning standards and Indicators to help ensure "Quality Practice" in Service-learning efforts. The K-12 Service-learning Standards and Indicators can be located at the National Youth Leadership Council website at www.nylc.org/standards.

How to Get Started

Gather information and support for service-learning projects from school administrators, parents, organizations, agencies, and partners. There are a variety of available resources for funding and grants for service-learning projects, additional information and step-by-step guides, partnership opportunities, and connections to local, statewide, or national service-learning organizations, agencies, programs, and events.

Service-learning Project Ideas

What can third, fourth, and fifth grade students really do? They have numerous skills to tap. They can create and share songs, artwork, posters, fliers, and performances educate others, address a local environmental issue, raise money, or promote a cause. They can produce videos, articles, and public service announcements to educate others on local issues. They can write letters to newspaper editors, participate in city council meetings, and communicate with their Congressional leaders to enact social change. They can tailor-make books and brochures for non-English speaking members of the community. They can interview business owners and state agency professionals to gather information on topics. They can plant native plants to restore (and plan a program to maintain) a shoreline or monitor the water quality of a local stream they've studied and report the data to a volunteer monitoring program or agency. They can work with younger students, physically- or mentally-challenged youth, a new immigrant group in the community, or "adopt" a senior citizen and share their knowledge about fishing equipment and skills. They can acquire and pass on a lifelong interest in outdoor activity that connects people to water resources. Or, your students just might have some ideas of their own!

The following service-learning project ideas (grouped according to the *MinnAqua Leader's Guide* Chapters 3, 4, 5, and 6) incorporate learning and skills developed in lessons from those chapters. Your students may decide to use one of these project ideas, or you might encourage them to develop an idea of their own that addresses a real need or issue in their community that is meaningful to them. Not all service-learning projects are done the same way. Remember to support your students' creativity and facilitate the project so they can take charge and make the project their own.

Chapter 3: Water Stewardship

Service-learning projects that emphasize aquatic stewardship provide an active educational component in areas such as ecology, watershed land use, water quality, and risk and decision-making skills. An effective way to develop a stewardship project is to explore interconnections, or how one activity or problem affects or contributes to another issue. Projects may benefit the community ecologically, aesthetically, or economically and could include the following.

- The aquatic environment and Environmental Education—develop water related curricula for your school
- The aquatic environment and human health and safety—focus on local community issues, such as drinking water, flooding, and beach closings
- Citizenship and what your students are learning about water science, such as physical and chemical properties of water body—recommend changes in water use in the local community based on data they've gathered from media sources, state agencies, and other resources. Enhance understanding of water science by sharing data and information with other students in the school or creating a public service announcement.
- Water ecology and the plants and animals that inhabit a local water body—investigate and report on how local development is impacting the habitat needs of plants and animals (including fish).
- Water quality and government and citizenship—trace a water issue of local importance to identify which—and how—various units of government are involved. Present findings at a city council meeting and in letters to the editors of newspapers.

- Water stewardship and other academic subject areas—reading, literature, a second language, art, music, math, economics, social studies, geography, physical education, and so forth—what are the students learning in these subject areas that connects to water and stewardship? How can this knowledge be applied to addressing an issue or problem in the local watershed?
- Water quality and the landscape—native plants shoreline restoration (stream bank stabilization, seed collecting and planting, creating a plan to maintain a shoreline restoration project over time)
- Water quality and your school—research how the school uses water and how it can improve. Organize a school wide water conservation campaign to reduce the amount of water used in your school. Make posters, put them up in classrooms, lavatories, the cafeteria, and other rooms where water is used.

More Project Ideas

- Create a school nature area around a pond, stream, or wetland on the school grounds. Teach other teachers in the school how they can use the site for learning opportunities for their students. Contact the Minnesota DNR School Forest Program for guidance.
- Contact your local Minnesota DNR office to get involved in watercraft inspection programs that check boats and watercraft at public lake accesses and other locations.
- Organize a community shoreland restoration project. Contact your local Minnesota DNR office for guidance. Involve local residents in the project.
- Design and distribute fliers in your community about preventing yard waste, such as leaves, lawn clippings, and pet waste, from entering runoff and storm drains. Survey the neighborhood to determine the impact of the fliers on people's awareness and behavior. Help residents learn to properly dispose of yard wastes and to compost leaves and grass to reduce phosphorous pollution in lakes and rivers.
- Conduct an environmental audit of a government building or business in your community. Share results with building supervisors and provide suggestions for improvements to protect water quality in the watershed. Contact the University of Minnesota Extension Service or the Minnesota Pollution Control Agency for assistance.
- Pick up trash along waterways to protect wildlife and make it more pleasant for swimmers, boaters, and hikers. When other people care for places in this manner, the general public tends to care for them, too. Survey the area afterward to determine if the effort has made a difference.
- Stencil storm drains. Untreated street runoff flows directly into lakes, streams, and wetlands. Use stencils to paint "Do Not Dump! Drains to River" or "Drains to Lake, Stream, or Wetland" next to storm drains. Leaflet houses to communicate simple tips to prevent pollution. The Environmental Protection Agency recommends stenciling storm drains to raise public awareness and encourage public participation in preventing and detecting illegal discharge and elimination of contaminants into storm sewer systems. Get permission to stencil and obtain storm water maps from your local government public works or storm water office. The Minnesota Adopt-A-River Program of the Minnesota DNR Trails and Waterways Division can provide information, materials, and planning aids for storm drain stenciling projects.
- Test soil for nutrient contents such as phosphorous. Report results to homes and businesses. Promote preventing detergents, grass clippings, leaves, and pet waste from entering storm drains.
- Plant to prevent erosion. Eroded sediment and silt cloud water and fill in lakes and rivers. Eroded soils also carry pollutants. Plant native grasses, shrubs, and trees to stop erosion and provide habitat for wildlife.
- Conduct a public awareness campaign about impervious surfaces in the community, and how

these surfaces impact runoff and flooding in the area. Provide suggestions for alternatives.

- Monitor water quality. Volunteer stream monitors help public agencies watch water quality in Minnesota's many lakes and streams. Join monitoring networks for training, equipment, and materials. The Minnesota Pollution Control Agency has a stream monitoring program that enlists citizen participants in observing cleanliness or turbidity in streams under a variety of rainfall conditions over an entire open water season, from snow melt to freeze-up. Contact the Volunteer Stream Monitoring Partnership in the seven county metropolitan area for assistance and information.

- Contact the Minnesota Pollution Control Agency for information and programs on other water-related topics.

- Programs and information available through Minnesota DNR programs include Shoreline Restoration and Adopt-A-River (clean-ups). Contact the Minnesota DNR Information Center at 651-296-6157 or 888-646-6367 for more information.

- Compile and distribute information about preventing the spread of aquatic invasive species. Federal agencies and the pet industry have collaborated to help consumers prevent the release and escape of non-native aquatic plants and animals through *Habitattitude,* a new public education and outreach effort. Visit the website, **www.habitattitude.net** to learn more about responsible behaviors and how to prevent the spread of potential aquatic nuisance species. The site includes information on federal and state laws and statutes that regulate aquatic organisms, recommended alternatives to releasing plants and animals, instructions on how individuals and clubs can get involved and detailed information on some of the aquarium and water garden species that have created problems in native aquatic systems.

Chapter 4: Fish Management

Fisheries resource management-based service-learning projects emphasize learning by taking action in the community that is focused on natural resource management and fisheries activities. These types of Service-learning projects would ideally be based on concepts that students learn from an active educational component in areas such as managing fish populations, multiple use of natural resources, issues and decision making, regulations and enforcement, fisheries career exploration, habitat protection, conservation, restoration and improvement, risk and decision-making skills. Some examples of Fisheries Management Service-learning Projects might include:

- Conducting a stream walk and habitat assessment to look for potential problems with water quality and fish. Suggest improvements. Provide the information to the Minnesota Pollution Control Agency or Minnesota DNR. Compile your findings and publish them in local newspapers.

- Letting the local community know how they can enjoy Minnesota's fisheries resources as they work toward a sustainable future for all citizens. Issue an alert to overlooked problems, or praise recent accomplishments.

- In a locale with a Spanish, Hmong, Vietnamese, Somalian, Russian, or other foreign-language-speaking community, develop and translate brochures and fliers issued by the Minnesota DNR, Minnesota Pollution Control Agency, or other local agency. This type of project not only serves the particular foreign-language-speaking community, but it also develops or utilizes students' language skills and enables them to learn more about an immigrant culture and natural resource issues. Form a partnership with an immigrant organization in the community to distribute the brochures and fliers.

- Hold a family conference, debate, or town meeting on a local fisheries issue (such as stocking, treaty rights, invasive species, or shoreline development). Consult local experts about the issue and invite them to participate in your discussions. Reflect on the complex problems that result from efforts to consider the values, needs, wants, and concerns of many different stakeholders. Draft plans for compromises and possible solutions to share with those involved in the issue.

- Contact your local Trout Unlimited, Muskies, Inc. or other sportsman's club to learn about their involvement in conservation and restoration work. Discover other groups in your community that may be involved in similar projects. Create a directory of organizations for volunteer opportunities in resource conservation and restoration. Distribute and publish the directory.

- Obtain the Minnesota DNR Fisheries Tour Packet to prepare for a tour of a local DNR fish hatchery. Arrange to interview fish hatchery workers. Compile a fisheries career information booklet to present to your school library's career section.

- Research fisheries-related regulations and enforcement issues. Arrange to become acquainted with your local Minnesota DNR Conservation Officer and accompany them during a day on the job. Use this experience to teach another youth group about a Conservation Officer's duties, and how the citizens of Minnesota work with the Minnesota DNR for the protection and conservation of aquatic resources.

- Learn about fisheries management tools and lake surveys. Contact your local Minnesota DNR Fisheries Office about the possibility of boarding and observing on an electrofishing boat, or helping with a lake survey. Spend a day learning to make or fix nets, and interview the people who do this work for a career. Add this information to a fisheries career brochure for your school library.

- Work with the local DNR Creel Survey crews and help conduct creel surveys at lake access sites and collect data from local and state government agencies about fish populations in the local lakes, streams, or rivers. Analyze the information and design an informational brochure about local fish populations to share at community environmental events and water festivals, and in demonstration lessons to students in primary grades. Project partners could include state parks, and the local Minnesota DNR Fisheries Office.

Chapter 5: Fishing Equipment & Skills

Upon completion of a unit that contains a lesson or lessons from Chapter 5, your students can apply what they've learned about fishing to community action. There are various ways to help others learn about and participate in the lifelong activity of fishing—which connects people of all ages to the outdoors and to aquatic resources. Fishing equipment and skills service-learning projects can provide an active educational component in areas such as: pursuing lifelong recreational activities and sports; health; developing, producing and marketing fishing equipment; and learning, teaching, and practicing new skills, including decision-making skills. These activities provide social, recreational, educational, and economic benefits for communities, as well as improving people's overall health and level of physical activity and enriching their connections with the natural environment. Project ideas include:

- Organize a fishing festival for the entire school. Invite members of various cultural groups in the community to share their fishing techniques, equipment, stories, lore, and fishing history. Publicize the event.

- Hold a fishing skills workshop for families. Conduct seminars on regulations, skills, equipment, nearby fishing places, fishing ethics, and sportsmanship. Plan a family fishing event at a local lake and establish it as an annual event.

- Teach a class of younger students how to use fishing equipment. Write stories about fishing to read to the younger students and help them write their own stories to compile into a book. Then take them fishing and add their stories about the fishing trip to the book.

- Research and create a display about the fishing equipment and techniques used by cultures worldwide. Interview and enlist the help of various cultural groups in your community.

- Interview grandparents and senior citizens about fishing equipment and methods they used when they were young. Research the history of fishing equipment and techniques. Create a timeline that displays changes in fishing equipment and techniques from early human history to the present-day. Invent fishing equipment for the future. Create a mural to illustrate your timeline.

- Investigate the issue of lead versus non-lead tackle in Minnesota. Sponsor and conduct a lead tackle exchange event. For more information about lead tackle issues and lead tackle alternatives, exchanges, and programming contact the Minnesota Office of Environmental Assistance at 651-296-3417 or 800-657-3843 or www.moea.state.mn.us

- Host a collection site for rods and reels for donation to schools and youth organizations.

- Collect old monofilament line from lakeshores and streams to recycle. Local bait shops usually have recycling containers. Conduct a public awareness campaign about the harmful effects of discarded monofilament line, and where anglers can take old line for recycling.

- Help refurbish rods and reels, fill children's tackle boxes, make casting plugs and felt fish for casting practice for the MinnAqua Program. Contact the program at mndnr.gov/minnaqua.

Chapter 6: Safety & the Fishing Trip

Upon completion of a unit that includes a lesson or lessons from Chapter 6, your students can apply what they've learned about safety and fishing to community action. Safety and the fishing trip-themed service-learning projects provide an educational component in areas such as: safety; stewardship activities; fishing sportsmanship and ethics; health and nutrition; multiple uses of resources; actual fishing experiences; and risk assessment and decision-making skills. Project ideas include some of those listed above under Chapter 5 as well as the following:

- Make a connection between the aquatic environment and human health and safety and focus on local community fish consumption advisories, nutrition, and health. Inform senior citizens, parents, new immigrants, other students, or the general community of fish consumption advisories.

- Adopt a "grandparent" at a local senior retirement center and take them fishing.

- Take the kindergarten class on a fishing trip. Teach them how to plan and prepare for a safe trip. Make a scrapbook with photos and notes on the project.

- Conduct seminars to teach cooking and filleting skills to various community members and groups. Demonstrate how to remove the fatty portions (where PCBs and other toxins may accumulate) of various fish species. Tell seminar participants about the nutritional benefits of eating fish. (Fish is a good source of protein and omega-3 fatty acids.)

- At a fair or sports show, hold a seminar on selecting good fishing sites and planning safe and successful fishing trips. Produce a local guide or brochure on the topic and distribute it through your Chamber of Commerce or at local resorts and parks.

- Make fishing and water safety posters to display at a grocery store, outfitter, fishing equipment retailer, or health clinic. The Minnesota Department of Health and the American Red Cross can provide safety information and resources.

- Organize and charter an after-school fishing club. Recruit teachers, parents, and local experts to help organize and guide the fishing club. Plan a school club structure and activities that can be continued from year to year.

As you can see, there is no shortage of ideas for service-learning projects. To help students select one of these projects—or create one of their own—focus on their knowledge and skills, integrate academic studies, and discover their interests and concerns. Pinpoint a real need in your community, and analyze these issues' interconnections and complexities. Identify stakeholders and the "movers and shakers." After considering logistics and possible obstacles, make a plan. Set a goal and establish a timeline. Gather information, resources, and partners. Involve students in the project in a variety of ways and help them remain focused. As the students make their service-learning project their own and start working on it, the experience and benefits they'll gain will be well worth the effort! Upon completion of the project, enlist students in conducting an evaluation of the project's successes and things that could have been done differently. What did the students and or community learn. What would be the next steps? Plan how to continue and sustain the project, if applicable. And, always recognize and celebrate your students' achievements!

Service-learning Project Plans and Activity Mapping

An activity map is a tool that can provide a framework for incorporating the primary elements of what is taught (content), how instruction occurs, when it's delivered, skills, objectives, and academic benchmarks into a project plan. The following three examples show how to use activity mapping to incorporate interdisciplinary concepts into a service-learning project plan for sample project ideas from chapters 4, 5, and 6. A Curriculum Activity Map Template for creating an Interdisciplinary Service-learning Project Plan follows the three sample Project Plans. Use this Activity Mapping template and the three Project Plan examples to help you develop a project map to incorporate the concepts, skills, and learning objectives that your students have been acquiring by participating in lessons from the *MinnAqua Leader's Guide.*

A children's Literature list follows the Curriculum Activity Map Template. This list includes summaries of a number of story books that provide an engaging way to introduce the concept of Service-learning to your students.

Chapter 4: Fish Management Service-learning Project Plan Example

Project Title: Stream or River Habitat Assessment		
Project Description: Conduct a stream walk and habitat assessment in the community to look for potential problems that may be harmful to water quality and fish. Suggest improvements. Provide the information to the Minnesota Pollution Control Agency and/or Minnesota DNR. Write up findings and publish in local newspaper.		
English/Language Arts Read the story, *A River Ran Wild*, by Lynne Cherry. Write about how the local stream or river has been impacted by humans. Submit to local newspaper for publication.	**Social Studies/History** Collect oral histories from local senior citizens about the stream or river as it was in their youth. Contact county, local government, or watershed district for information on the stream or river.	**Physical Education** Before taking a walk along the stream or river, perform stretches to protect muscles and joints from injury. Discuss how walking is a great form of exercise for all ages.
Theater, Music, and Visual Arts Research the Japanese art of gyotaku (fish printing). Use a real fish (one that students caught or a store-bought fish) to create fish rubbings. See **Lesson 2:1-Fish Sense.** Display the art in the community with education information.	**Science** Prior to the walk along the stream or river, study what makes a healthy stream or river. Brainstorm the signs of potential problems. At the stream or river, conduct macroinvertebrate sampling or water quality tests using test kits. Record the findings.	**Computers** Create a chart to record findings at the stream or river. Use the chart at the site, and then enter data upon return to school.

Chapter 5: Fishing Equipment & Skills Service-learning Project Plan Example

Project Title: Teaching Younger Students to Fish		
Project Description: Teach a class of younger students how to use fishing equipment. Write stories about fishing to read to younger students, and help them write their own stories to compile a book. Them take them fishing, and add their stories about the fishing trip to the book.		
English/Language Arts Write stories about fishing to share with younger students. The stories could be based on personal experience, tall tales, or folklore. See **Lesson 2:7-Fish Tales.** Work with younger students to record and create their own book of stories.	**Social Studies/History** Research the history of fishing and equipment. Use the information to enhance presentations to younger students.	**Physical Education** Bring in an expert to teach the class how to cast off and reel in their fishing line. Practice casting with the younger students. Teach the younger students about safety at the water's edge, handling fishing poles and hooks safely, and handling fish safely. Go on fishing field trip.
Theater, Music, and Visual Arts Create puppet shows using stories about fishing as the storyline. Or put on a short skit about fishing regulations and safety for the younger students. Write a fishing safety rap and teach it to the younger students.	**Science** Learn how a rod and reel works. What are the specific principles that apply, such as simple machines or mechanisms? See **Lesson 5:1-Freshwater Rods and Reels.** For example, the rod acts as a shock absorber to keep the fish from jerking the angler off their feet and as a lever when reeling in the fish.	**Computers** Using the Internet and the Lake Finder feature of the Minnesota DNR website, research the types of fish in local lakes and streams. Create a presentation on these fish that includes habitat requirements and diet.

Chapter 6: Safety & the Fishing Trip Service-learning Project Plan Example

Project Title: The Aquatic Environment and Human Health and Safety		
Project Description: Make a connection between the aquatic environment and human health and safety. Focus on local community fish consumption advisories, nutrition and health. Inform senior citizens, parents, new immigrants, other students, or the community at large about fish consumption advisories.		
English/Language Arts Read articles about fish contamination in local streams and rivers. Good sources of information are the Minnesota Department of Health, and the Minnesota DNR. See **Lesson 6:5-Eating Fish.**	**Social Studies/History** What populations rely on fishing in your community? Research the local demographics and the role of fishing in the different cultures.	**Physical Education** Fish play an important role in a healthy diet. Learn the health benefits and risks of eating fish. See **Lesson 6:5-Eating Fish.**
Theater, Music, and Visual Arts Students share their knowledge of fish consumption advisories by creating a short public service announcement for the cable access channel	**Science** How does the health of a lake, stream, or river impact the fish for human consumption? Study the guidelines for consumption for children, pregnant women, adults, and senior citizens.	**Computers** Research fish consumption advisories for the local community using the Internet and create a brochure about the advisories, specifically focused on local streams, rivers, and lakes. Post the information on the class (or school) website.

Curriculum Activity Map Template for Creating an Interdisciplinary Service-learning Project Plan

This blank activity mapping template is included for your use.

Project Title:		
Project Description:		
English/Language Arts	**Social Studies/History**	**Physical Education**
Theater, Music, and Visual Arts	**Science**	**Computers**

Literature to Help You Introduce Service-learning to Students

One Less Fish
Kim Michelle Toft and Allan Sheather
(Charlesbridge, 1998)
Summary: Fish begin to disappear in Australia's Great Barrier Reef. This story tells of the hazards of offshore drilling, trash in the ocean, over fishing, and more.

The Shape of Betts Meadow: A Wetlands Story
Meghan Nuttall Sayres (Millbrook Press, 2002)
Summary: A medical doctor becomes a "wetland doctor" and helps restore Betts Meadow to its original state—a wetland with wildflowers, elk, and tree frogs. This book includes a glossary of wetland terms and resources.

Our Poisoned Waters
Edward Dolan (Cobblehill, 1997)
Summary: Information is presented on how industry, farm waste, sewage, and oil spills damage waters, and how a growing population is depleting fresh water supplies. Key questions are raised in this book and it presents opportunities for discussion on roles, origins of problems, and what people can do.

A River Ran Wild
by Lynne Cherry (Harcourt, 1991)
Summary: A river that once provided food to indigenous people is polluted by industry and cities. Can a determined local citizen restore the river?

A Cool Drink of Water
Barbara Kerley (National Geographic Society, 2002)
Summary: This book takes you on a journey from Thailand to Rome to Canada to see water stored in clay pots and a burlap bag. People drink from a river, a well, and a tin cup. Strategies for protecting water supplies are given.

The Wartville Wizard
Don Madden (Alladin, 1993)
Summary: To fight a town of litterbugs, a wizard makes litter stick to all who attempt to drop it! A memorable and colorful tale of how people learn the consequences of their actions. Easily adapted into an amusing play with an important message.

Washing the Willow Tree Loon
Jacqueline Briggs Martin (Simon & Schuster, 1995)
Summary: A barge hits a bridge and a thick rush of oil coats the birds of Turtle Bay. People from all walks of life (bakers, doctors, house painters, and artists) stop their work and help.

Ducks Disappearing
Phyllis Reynolds Naylor and Tony Maddox
(Antheneum, 1997)
Summary: Young Willie solves the mystery of disappearing ducks. Most importantly, he explains to the adults how ducks belong to everyone. A great story of a child who pays attention and cares to make a difference.

Backyard Rescue
Hope Ryden (Tambourine, 1994)
Summary: Two friends set up a backyard wildlife hospital for wounded animals. When faced with closure due to fish and game laws, they find local resources to protect the animals in their care.

Sources of Funding and Grants

For a single class service-learning project, you may want to look for local donations or fundraising activities. For sustainability, finding a stable funding source, such as a district line item or long term grant, is preferred. For community organizations and youth groups like scouting organizations, 4-H or any variety of non-formal education settings the organizations listed below are a source of grants or resources to help you with your Service-learning projects.

In the school setting Service- learning is a teaching strategy and therefore, as they allow, established classroom budgets should cover expenses related to ongoing projects. In Minnesota, through community education, school districts may access special revenue to support youth development and youth service programs. To supplement these existing funding sources, many service learning grants are available a sample is listed below.

National Funding and Support

The Grantmaker Forum on National and Community Service
www.gfcns.org
Provides resources for grant writers and links to publications of service-learning and civic engagement research.

Learn and Serve America
www.learnandserve.org
Contains applications for Learn and Serve and other grants. Also see: **www.nationalservice.org/egrants/index.htm**l, the Corporation for National and Community Service's online grant application and management system.

The Corporation for National and Community Service engages Americans of all ages and backgrounds in service to help strengthen communities through Learn and Serve America, AmeriCorps and Senior Corps. www.cns.gov

National Service Learning Clearinghouse
www.servicelearning.org
Contains a searchable database of awards, fellowships, scholarships, funding resources, grants, and funders called Funding Sources **www.servicelearning.org/article/archive/42/**

National Service Learning Partnership
www.service-learningpartnership.org/youth_innovation/resources.cfm
Contains sample funding applications and press releases and provides timelines for fundraising and grant writing.

Constitutional Rights Foundation Robinson Mini-Grants provide seed money for student-teacher teams and community organizations engaged in service learning projects that address serious community problems. www.crf-usa.org

Do Something is a non-profit that seeks to get more young people engaged in social action through grant giving and online networking. www.dosomething.org

The Starbucks Foundation funds programs for youth, ages 6-18, that integrate literacy with personal and civic action in the communities where they live. Grants range from $5,000-$20,000. www.starbucks.com/aboutus/grantinfo.asp

Youth Service America offers grants to help young people and organizations plan and implement service projects for Global Youth Service Day as well as ongoing service learning throughout the year. www.ysa.org/awards

The ING Unsung Heroes award program selects 100 winners to receive $2,000 to help fund their innovative class projects. Three of those are selected to win the top three awards of $25,000, $10,000 and $5,000. www.ing.com/us/unsungheroes

For a more complete list, visit: www.servicelearning.org/resources/funding_sources/index.php

Print Resources

Billig, Shelley H. "Funding Your Service-learning Program." In *Building Support for Service Learning*, edited by Shelley H. Billig, 105-124. Denver: RMC Research Corporation, 1998.

Corporation for National and Community Service
800-808-SERVE
www.cns.gov

Minnesota Funding and Support

ServeMinnesota! manages YouthWorks, Americorps, and Community-Based Learn and Serve federal grant programs. With the Minnesota Department of Education, ServeMinnesota! has published:

Partner Power: Minnesota Service-learning Manual for Community-Based Organizations. (2003) Rich Cairn of Cairn & Associates. (24 pages.)

Other resources are available, too.

ServeMinnesota!
431 South Seventh Street, Suite 2540
Minneapolis, MN 55415
612-333-7749 (phone); 612-333-7758 (fax)

Minnesota Department of Education (MDE)
Service-learning offers grants on a regular basis to fund the development of an infrastructure supportive of service learning. education.state.mn.us MDE also provides sub-grants and training to schools through the Federal Leaern and Serve Program in addition to resources including:

*Assessing Learning Through Service***,** a video and guide on service-learning and performance-based assessment. In 1996, the Minnesota Department of Children, Families & Learning (now, the Minnesota Department of Education) sought to help teachers with this important aspect of service-learning. The Department secured a three-year Corporation for National Service grant to find out who was best at assessing students' service-learning experiences, and share these best practices statewide through this publication.

Learn & Serve America, School-Based, The Corporation for National and Community Service provides funds to support service learning in K-12 schools. The Minnesota Department of Education receives those funds and in turn grants them to Minnesota school districts.

Community Education, Youth Development and Youth Service Programs, All school districts have the option to levy special funds to support youth development and youth service programs through Community Education. Through these funds, more than 200,000 youth participate in service every year.

Peer Consultants, Funded by the W.K. Kellogg Foundation and Learn and Serve America, peer consultants provide teacher development in the area of service learning. There are peer consultants located throughout Minnesota available at no cost to school districts.

Minnesota Department of Education
Michelle Kamenov, Service-learning
1500 Highway #36 West, Roseville, MN 55113
651-582-8434 or 888-234-1279 (phone)
651-582-8492 (fax)
Michelle.Kamenov@state.mn.us
education.state.mn.us/mdeprod/groups/CounselCharacService/documents/FAQ/032542.pdf

Minnesota Service-learning Organizations and Partners

Minnesota is home to many organizations that provide support for service-learning.

The National Youth Leadership Council (NYLC) serves as the nationwide training and technical assistance arm of the Corporation for National Service. This organization has developed the guide *Essential Elements of Service-learning* to promote high quality school-based service-learning. Resources include:

Route to Reform: Service-learning and School Improvement video program, 1994

Essential Elements of Service-learning for Effective Practice: Organizational Support, National Service-learning Cooperative, 1998 (34 pages)

National Youth Leadership Council
1667 Snelling Avenue North, Suite D300
St. Paul, MN 55108
651-631-3672 (phone); 651-631-2955 (fax)

The Minnesota Alliance With Youth, part of the national organization America's Promise-Alliance for Youth, encourages and supports youth programs, mentoring and community service, and features a commitment to offer young people community service opportunities as one of their five organizational promises or goals.

Minnesota Alliance With Youth
625 Northwest Third Avenue
Faribault, MN 55021
888-666-6427

Adopt-A-Watershed is a school-community learning experience that uses local watersheds as living laboratories to develop collaborative partnerships and reinforce learning through the community.
www. Adopt-A-Watershed.org

Americorps VISTA-Senior Corps supports service-learning efforts including America Reads.

VISTA-Senior Corps, Minnesota Office of the Corporation for National and Community Service
431 S. Seventh Street, Suite 2480
Minneapolis, MN 55415
612-334-4083

Pollution Prevention Project Guide
Since 1994, Cairn & Associates helped hundreds of Minnesota teachers and youth workers organize water quality protection projects involving thousands of students. Based on these experiences, this guide offers step-by-step instructions on how to organize some of the most popular projects. Access the entire Guide on-line, or download it free as PDF files:
cgee.hamline.edu/watershed/action/projects/ppp_guide.htm

Earth Force is a youth-driven organization, engaging young people in problem solving to discover and implement lasting solutions to environmental issues in their communities.
www.earthforce.org

Eco-Education is a non-profit environmental education organization based in St. Paul, Minnesota, that has served more than 130,000 students since 1991. This organization is committed to making environmental education relevant to urban learners and to helping them address their unique environmental concerns. **www.ecoeducation.org**
Great River Greening topics include: ecosystems, service-learning, exotic species, and rivers. Great River Greening is a nonprofit, community-based organization that helps communities restore, manage, and learn about their natural environments through volunteer involvement.

Great River Greening
35 W. Water Street, Suite 201
St. Paul, MN 55107
651-665-9500 (phone); 651-665-9409 (fax)
jstubblefield@greatrivergreening.org
www.greatrivergreening.org

Hamline University Center for Global Environmental Education has a Watershed Action site offering one-stop help in planning and organizing service-learning projects to prevent water pollution in your watershed. Within this site you can access everything from scientific background information and curricula, to local experts and stencils for painting storm drain signs. **cgee.hamline.edu/watershed/action/**

River Keepers is a private non-profit group that was formed to coordinate improvements of and along the Red River in the Fargo, North Dakota and Moorhead, Minnesota area. They offer several environmental service-learning opportunities including an Adopt-the-Red program (similar to Adopt-A-River), and a Paint the Drain program focused on getting local groups and students to stencil storm drains to prevent the public from dumping hazardous wastes in them. They provide equipment and the training for both programs.

Serving the Environment: A Guide to Best Practices for Environmental Service Learning,
Audrey Anderson, Stowe Elementary in Duluth, Minnesota. This is a guide and website written to combine "best practice" advice from the experts and practical wisdom from teachers and staff at Stowe Elementary School. What works at Stowe may not work at your site, but the wisdom and advice Stowe teachers have offered are helpful for any service-learning project.
www.duluth.k12.mn.us/stowe/service_learning/index.htm

The following organizations are involved with mobilizing students in communities. Many of them support networks of service-learning programs. Some publish curricula, guidebooks, and other materials. A few offer training and technical assistance to local programs.

Center for Service Learning & Social Change
City of Lakes Corps
Future Force
Minnesota Alliance with Youth
Minnesota Campus Compact
Minnesota Community Education Association
Minnesota Conservation Corps
Minnesota Educational Effectiveness Program
Minnesota 4-H Extension
Minnesota Mentor Network
Minnesota Office of Citizenship and Volunteer Services
Minnesota Service Association
Retired and Senior Volunteer Program
Search Institute
Serve Minnesota
Twin Cities One-to-One Mentor Network
Twin Cities Urban Corps

National Resources and Service-learning Organizations

America's Promise www.americaspromise.org

Americorps is a network of national service programs that engages more than 50,000 Americans each year in intensive service to meet critical needs in education, public safety, health, and the environment. Contact the Americorps program sponsors to see if members are available to help with your project. **www.americorps.org**

Close Up Foundation
www.closeup.org

Constitutional Rights Foundation
www.crf-usa.org

Corporation for National and Youth Community Service publishes Students in Service to America, a guidebook for engaging students in a lifelong habit of service. Corporation for National and Community Service, Students in Service to America, Washington, DC 20525

Earth Day Network works for a healthy environment and a peaceful, just, and sustainable world through environmental education, capacity-building, year-round programs, and support of worldwide Earth Day organizing.
www.earthday.net

Education Commission of the States, Compact for Learning and Citizenship,
700 Broadway #1200, Denver, CO 80203-3460
303-299-3600 (phone); 303-296-8332 (fax)
www.ecs.org

Give Water A Hand is a national watershed education program that involves young people in local environmental service projects. Following the steps in the Give Water A Hand Action Guide (which can be downloaded free of charge from

www.uwex.edu/erc/gwah), your youth group or class can plan and complete a community service project to protect and improve water resources. Two publications are available: Youth Action Guide and Leader Guidebook (for youth leaders and teachers). These easy-to-follow, illustrated guides show how to organize and carry out effective action-oriented projects.

Learn and Serve America is a program of the Corporation for National and Community Service, providing funding and training support for service-learning programs in schools, community-based organizations, and higher education institutions.
www.learnandserve.org

Learning In Deed
www.learningindeed.org

National Dropout Prevention Center
www.dropoutprevention.org

National Service-learning Clearinghouse, at **www.servicelearning.org** provides many resources, some of which are fully available online.

National Youth Development Information Center
www.nydic.org

Points of Light Foundation advocates community service through a partnership with the Volunteer Center National Network. Its guides and resources include:

- *Service Project Ideas for Youth.* The resources in this packet help the reader generate ideas for youth service projects, both episodic and ongoing, that meet community needs in a creative way.

- *Critical Elements of Service-learning.* This resource packet explains critical elements essential for effective service-learning: community need/voice, learning objectives, youth voice and planning, orientation and training, action, reflection, evaluation, and celebration/recognition

- *Reflection.* This resource packet presents a variety of sources and perspectives on the importance of reflection, with suggestions for creative reflection methods.

- *Agencies + Schools = Service-learning—A Training Toolbox*, Rich Cairn and Cynthia Scherer, 1996 (92 pages)

- *Practical Guide for Developing Agency/School Partnerships for Service-learning,* Eugene Roehlkepartain, 1995 (138 pages).

Points of Light Foundation
1400 I Street NW, Suite 800,
Washington, DC 20005
202-729-8000 or 800-272-8306

The **River Watch Program** helps people collect, understand, and use information about the health of their rivers and the people who depend on them. They support community-based watershed monitoring and assessment projects. They gather and interpret information on the health of watersheds and communities and promote public awareness of watershed values, issues, problems, and solutions. They create opportunities for students to learn science and other subjects through hands-on projects, and gather information that helps community leaders identify and solve problems. They track ecological and human health conditions and trends to assess whether protection and restoration efforts are working. River Watch also works closely with Native American tribes, who play a unique role in setting and monitoring clean water standards. River Watch is part of the River Network, a national non-profit organization that offers consulting, publications, training, and small grants to raise money, build organizations, and monitor and protect rivers and watersheds.

River Watch, River Network
520 SW Sixth Avenue, Portland, Oregon 97204
503-241-3506
www.rivernetwork.org

Youth Service America is a resource center and alliance of over 300 organizations committed to increasing the quantity and quality of opportunities for young Americans to serve locally, nationally, or globally. The site offers a listing of funding sources and access to the full text of the funding opportunities. And sponsors the National Youth Service Day with the National Youth Leadership Council. National Youth Service Day is also a service-learning curriculum, and guide for developing project management skills.

Youth Service America
1101 Fifteenth Street, Suite 200
Washington DC, 20005
202-296-2992 (phone); 202-296-4030 (fax)
www.ysa.org

Additional Resources

The Courage to Care. The Strength to Serve. Draft Instructional Framework in Service-learning for Elementary Schools. Maryland Student Service Alliance (1991). Baltimore, MD: Maryland Department of Education.

Joining Hands: Community-Service-learning Resource Kits: For Kindergarten Through Eighth Grade Service-learning Programs. Available from the University of Iowa, Service-learning Department, 215 Seashore Hall Center, Iowa City, IA 52242-1402
800-369-IOWA

The Kid's Guide to Service Projects, Barbara A. Lewis. (1995). Minneapolis, MN: Free Spirit Publishing. The Kid's Care Book: 50 Class Projects That Help Kids Help Others. Novelli, J. and Chayet, B. (1991). New York: Scholastic Professional Books.

Park Service-learning Model. Peace Corps, Paul D. Coverdell. World Wise Schools, **www.peacecorps.gov/wws/service/getstarted/slmodel.html**

Pocket Guide to Service-learning, (1995) Dickenfield, M. & Wright, J. (Eds.) National Dropout Prevention Center, Clemson University, College of Health, Education and Human Development,
205 Martin Street, Clemson, SC 29634-0726

Service-learning Toolbox: Work Pages and Checklists to Help You Get Started and Keep You Going.
Elke Geiger. Rural Education Program.
Northwest Regional Educational Laboratory
101 SW Main Street, Suite 500
Portland, Oregon 97204
www.nwrel.org/ruraled/learnserve/resources/SL_Toolbox.pdf

Standards of Quality for School-Based Service-learning. Alliance for Service-learning in Education Reform (1993). Chester, VT.

Community Partnerships

Community partners can provide technical expertise, support and materials—seek assistance from:

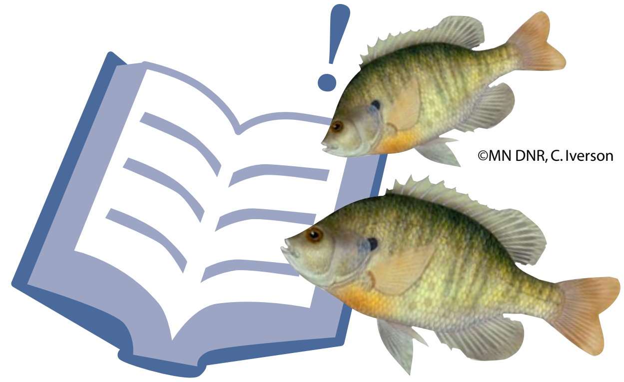
- local Boards of Soil and Water Conservation Districts
- local businesses
- churches
- civic organizations and clubs
- colleges and universities
- corporate volunteers
- county governments
- environmental organizations
- local media
- local officials
- parents
- senior citizens
- sportsman's organizations
- state agencies
- VFWs and American Legions
- volunteer organizations
- YMCA and YWCA
- youth organizations (Big Brothers Big Sisters, Camp Fire USA, 4-H, Girl Scouts, Boy Scouts)

Celebrate your good work! Information on Service-learning Recognition and Awards

Minnesota Student Service Awards: Founded in 1988, the Minnesota Student Service Awards seek to celebrate and recognize programs and organizations throughout Minnesota that involve students in community service and/or service learning.

Outstanding Contributions to Service Learning Awards: These awards recognize individual teachers, administrators, higher education faculty and staff, consultants, volunteers, students, legislators, community agency personnel, community leaders, coordinators, policy makers and advocates who serve to advance the field of service learning. Awards are given in the areas of policy, practice and passion.

Minnesota Service Learning Leader Schools: Selection as a Minnesota Service Learning Leader District or School is a great honor. It is recognition of excellence in service learning. Reviewers place recipients in one of two categories: emerging leaders or established leaders.



Student Reading List

This list includes titles that provide content-related, grade-appropriate reading opportunities for your students as they participate in the MinnAqua Leader's Guide lessons and activities. These recommended titles support the lesson concepts and learning objectives of each chapter.

Chapter 1: Aquatic Habitats

All Night Near the Water
Jim Arnosky, 1999
Grades: PreK-2
Summary: A charming story of a family of ducks surviving a night at a pond.

Around the Pond: Who's Been Here?
Lindsay Barrett George, 1996
Grades: PreK-5
Summary: Join two children on a discovery walk along a path to a pond. A page of text discusses clues left an unseen animal, and asks readers to figure out "Who's been here?" Opposing pages present this information in illustrations, with a follow-up double-page spread revealing the animal.

Exploring Freshwater Habitats
Diane Snowball; Cynthia A. Belcher, 1994
Grades: 2-5
Summary: Young readers can explore a variety of freshwater habitats worldwide, including Africa's Nile River, Russia's Lake Baikal, a Maryland cypress swamp, the Florida Everglades, and a Canadian stream.

In the Small, Small, Pond
Denise Fleming, 1993
Grades: PreK-2
Summary: Even the youngest child will enjoy this introduction to the seasons, presented through a frog's-eye view of a small pond.

Jump, Frog, Jump!
Robert Kalan; illustrated Byron Barton, 1981
Grades: PreK-3
Summary: "This is the turtle that slid into the pond and ate the snake that dropped from a branch and swallowed the fish that swam after the frog—Jump, Frog, Jump!" This catchy, cumulative tale introduces the concept of food chains and refers to people's place in them.

Life in the Pond
Eileen Curran; Elizabeth Ellis, 1985
Grades: PreK-2
Summary: Take a round-the-clock look at plants and animals in and around a pond. Excellent, accurate watercolor illustrations and simple text make this book a fine introduction to aquatic habitats.

Minn of the Mississippi
Holling C. Holling, 1978
Grades: 3-6
Summary: The history of the Mississippi River Valley is told in text and pictures featuring the adventures of Minn, a snapping turtle, as she travels downstream.

Nim's Island
Wendy Orr, 2002
Grades: 2-5
Summary: Nim lives on the most beautiful island in the world (its location is a closely guarded secret) with a marine iguana, a sea lion, and her scientist

dad, Jack. When he goes off to explore the world of plankton, the child occupies herself with typical Swiss Family Robinson-like chores and keeping her dad's batteries charged so she can check his e-mail on the laptop computer . . . Children will love this unshakable, strong female character and the zany things that happen to her. They'll also enjoy the way adults seem to bungle everything. There are plenty of sketches to add visuals to this wild tale, which never loses its momentum. Teachers can springboard many geographic or scientific studies off this novel as they read it aloud, but kids can just enjoy the fun." (Debbie Whitbeck, West Ottawa Public Schools, Holland, Michigan, © 2001 Reed Business Information, Inc.)

The Salamander Room
Anne Mazer; Steve Johnson, 1991
Grades: K-3
Summary: A little boy finds an orange salamander in the woods and thinks about the many things he can do to turn his bedroom into a perfect salamander home. In the process, the habitat requirements of a forest floor dweller are nicely described.

Song of the Water Boatman & Other Pond Poems
Joyce Sidman; Beckie Prange, 2005
Grades: PreK-5
Summary: A Minnesota author and illustrator have compiled an excellent pond book with accurate images and text, described on the book's jacket as, "From spring's first thaw to autumn's chill, the world of the pond is a dramatic place. Though seemingly quiet, ponds are teeming with life and full of surprises. Their denizens—from peepers to painted turtles, duckweed to diving beetles—lead secret and fascinating lives. A unique blend of whimsy, science, poetry, and hand-colored woodcuts, this collection invites us to take a closer look at our hidden ponds and wetlands . . . "

Squish! A Wetland Walk
Nancy Luenn, Ronald Himler, 1994
Grades: PreK-2
Summary: In simple, poetic language, this book defines a wetland, introduces the animals that call it home, explains the importance of wetlands, and entices readers with the promise of a marvelous, muddy adventure.

The Raft
Jim LaMarche, 2002
Grades: 1-5
Summary: Nicky isn't a bit happy about spending the summer with his grandmother in the Wisconsin woods. But when a raft appears, everything changes. As Nicky explores, the raft evokes its subtle magic and Nicky begins to see wonders everywhere—the animals of the river and woods, his grandmother's humor and wisdom, and his own special talent as an artist.

What's in the Pond?
Anne Hunter, 1999
Grades: PreK-2
Summary: What would you see if you sat at the edge of a pond and looked into the water? In this hand-sized book, Anne Hunter illustrates with loving detail the creatures of the pond, including a water spider, tadpole, red-winged blackbird, painted turtle, and others. Simple, yet detailed text describes each animal's habits and characteristics.

Where the River Begins
Thomas Locker, 1993
Grades: PreK-3
Summary: Two young boys and their grandfather embark on a camping trip to find the source of the river that flows past their home.

Willa in Wetlands (a play)
Peyton Lewis and Rory Chalcraft, 1991
Grades: PreK-2 (view performance of play); 3-5 (view performance and read)
Summary: This is a very creative, funny, and engaging play with catchy, upbeat songs. The cast includes Willa the student, Sherman and Shirley Shrimp, Johnny Rockfish, Wild Rice, Blue Heron, and many other wetland dwellers. The play begins with Willa setting off to find a "wetland treasure" mentioned by her teacher. She soon discovers that "looking for a treasure in a swamp or marsh is a hard job. I see nothing that looks the least bit priceless." The treasures she finds aren't what she expects, and her search leads her to a bald eagle, a muskrat lodge, some fiddling fiddler crabs, and much more. Willa concludes, "I came here looking for gold and silver but I think I've learned what the real treasure is. Everyone I met was a jewel." Scripts for *Willa in Wetlands* are available at no charge from

the Wetlands Information Hotline, which can be reached toll-free at **1-800-528-7828**. A teacher's guide is also available.

Chapter 2: Minnesota Fish

A Million Fish . . . More or Less
Patricia C. McKissack; Dena Schutzer, 1996
Grades: K-3
Summary: A boy learns that, on the Bayou Clapateaux, the truth is often stretched. But he gets a chance to tell his own version of a bayou tale when he goes fishing.

Big Al
Andrew Clements, 1988
Grades: PreK-2
Summary: A big, ugly fish has trouble making the friends he longs for because of his appearance—until the day his scary looks save them all from a fishing net.

The Biggest Fish in the Lake
Margaret Carney, 2001
Grades: 1-4
Summary: The author remembers how childhood fishing with her grandfather created a special bond between them.

Classifying Fish
Richard A. Spilsbury, 2003
Grades: 3-6
Summary: This book defines fish, explains how they differ from other animals, and discusses freshwater fish, sea fish, deep-sea fish, shallow-water fish, sharks, and others.

The Cod's Tale
Mark Kurlansky; S.D. Schindler, 2001
Grades: 3-6
Summary: The life story of the cod—to be driven by insatiable hunger—is interwoven with the insatiable hunger of people from the Viking Age to the present day. The illustrations are both informative (a cross-section of the Continental Shelf, a map of the Atlantic) and humorous (New Englanders comically dancing in joy at the invention of frozen fish fingers). Along the way, readers incidentally learn a great deal about Vikings, Basques, the American Revolution, and the slave trade, as well as the current prospect, formerly deemed impossible, of cod being fished to extinction.

Elephants Swim
Linda Capus Riley; Steve Jenkins, 1995
Grades: PreK-2
Summary: This book introduces a variety of animals from around the world that are adapted to live in large bodies of water.

Fish
Ann Heinrichs, 2003
Grades: 3-5
Summary: An introduction to physical characteristics, how fish move, habitats, feeding habits, life cycles, and different types of fish.

Fish
Rod Theodorou, 2001
Grades: 1-3
Summary: An introduction to young fish, including hatching, development, characteristics, care, and feeding habits.

Fish Eyes
Lois Ehlert, 1990
Grades: PreK - 1
Summary: Easy to understand, this book is written for the very young reader learning to count the brilliantly colored fish that swim through its pages. The story actively involves the reader in the lives of fishes, and teaches the child to count the fish as they begin their life cycles in wetlands. Readers are asked to imagine donning scales, fins, and tail for a downriver swim.

Fish is Fish
Leo Lionni, 1974
Grades: PreK-2
Summary: A minnow and a tadpole are inseparable until the tadpole turns into a frog. The minnow wants to see the world as the frog does, and jumps out of the water. But when the frog returns him to the water, the minnow learns that water is the most beautiful of all worlds.

The Fisherman and His Wife
Brothers Grimm; translated by Elizabeth Shub, 1978, 1992
Grades: 2-4
Summary: A classic tale of a fisherman's greedy wife who isn't satisfied with the wishes granted to her by an enchanted fish.

Fishing for Methuselah
Roger Roth, 1998
Grades: PreK-3
Summary: Ivan and Olaf are best friends and share an ambition to out-do one other while ice fishing. But the fish they want, Methuselah, is the smartest fish in the lake. Ivan and Olaf share many adventures.

Fishing in the Air
Sharon Creech, 2000
Grades: 2-4
Summary: A nicely-illustrated book about a young boy and his father discovering the power of imagination on a fishing trip.

Fishing With Dad: Lessons of Love and Lure from Father to Son
Michael Rosen, 1996
Grades: 2-5
Summary*:* In a lyrical story told in blank verse, the author shares a true account of Sundays spent with Dad at a favorite fishing hole.

Life Cycle of Fish
Louise A. Spilsbury and Richard Spilsbury, 2003
Grades: 3-5
Summary: A discussion of how fish differ from other animals, including topics such as habitat, development, feeding, reproduction, and life expectancy.

Minnesota Seasons—Classic Tales of Life Outdoors
Scott Bestul, editor, 1998
Grades: 3 and up
Summary: There is much good reading in this collection of stories that are short, but quite different from one another. Some highlights include: "Buster" (about a sunfish and a three-year-old, by Denis Anderson); "Seasons, Of Ice, Eelpout, and Men" (by Richard Behm); "Tin Fins and Lead Bellies" (a tale of spearfishing by Ted Nelson Lundrigan); and "Far Back" (a poem about trout in winter by Orval Lund).

My Five Senses
Aliki, 1962, 1989
Grades: PreK-2
Summary: This book helps readers explore the five human senses.

What is a Fish?
Bobbie Kalman and Allison Larin, *Science of Living Things* Series, 1998.
Grades: PreK-2
Summary: This book introduces various fishes, including freshwater and saltwater species. It discusses habitat, anatomy, reproduction, and feeding.

What is Fish?
Robert Snedden, 1997 (reprint)
Grades: 2-5
Summary: A description of types of fish, as well as respiration, movement, senses, feeding, defensive behavior, growth and development.

KidPub
www.kidpub.com
Summary: This site offers culturally diverse fishing stories written by girls and boys from various parts of the nation.

Chapter 3: Water Stewardship

A Cool Drink of Water
Barbara Kerley, 2002
Grades: PreK-2
Summary: Gorgeous full-page illustrations and minimal text provide a global perspective on water's critical role in human life. Photos depict people collecting, transporting, and drinking water, as poetic text reminds readers that "everyone everywhere" enjoys a "nice, cool drink of water." The book's type is visually interesting, and a picture index offers thumbnail versions of the illustrations, and captions, as well as a map.

A Drop Around the World
Barbara McKinney, Michael S. Maydak, 1998
Grades: PreK-2
Summary: Presents the water cycle through a raindrop's journey through the sky, on land, underground, and in the sea, in its liquid, solid, and vapor forms.

A River Ran Wild
Lynne Cherry, 2002 (reprint)
Grades: 1-4
Summary: Almost six centuries ago, on the banks of a clear, clean, sparkling river, a group of Indian people found an idyllic home. Soon English settlers joined them. Inspired by the vision of those who fought to restore the river to its original state, Lynne Cherry has created an engrossing, richly illustrated history that encourages us to reconsider the value of natural resources and what we can do to restore them.

The Case of the Missing Cutthroats
Jean Craighead George, Suzanne Duranceau, 1999 (reprint)
Grades: 3-6
Summary: After Spinner Shafter catches a cutthroat trout in the Snake River, she and her cousin Alligator search nearby mountains to determine where the endangered fish came from and how it survived.

Frog Girl
Paul Owen Lewis, 1999
Grades: 3-6
Summary: This is a tale from Pacific Northwest Native Americans. It is about a young girl who journeys to the world beneath her village's lake after all of the lake's frogs disappear. There she meets "Grandmother," who asks where all of her frog "children" have gone? The girl must return the frogs to save her village.

I Know an Old Lady Who Swallowed a Trout!
Teri Sloat, Reynold Ruffins, 1998
Grades: PreK-3
Summary: "There was an old lady who swallowed a trout that splished and splashed and thrashed about. It wanted out!" So begins this cumulative rhyme based upon the tried-and-true nonsense verse "I Know an Old Lady Who Swallowed a Fly." Sloat's version has a Pacific Northwest setting—salmon, otter, seal, porpoise, walrus, whale, and an ocean are consumed. The verse concludes with the Old Lady opening her mouth to free the ocean and everything else she has swallowed.

Life in a River
Valerie Rapp, 2003
Grades: 4-7
Summary: The complex ecosystems of rivers, tributaries, and the lands through which they flow provide excellent examples of biodiversity and interdependence. In one chapter, the author concentrates on a single species, the salmon, using it to illustrate the ease with which people interrupt the fish's life cycle and the entire ecosystem in a variety of unforeseen ways. Color photographs of creatures that live in and near the river predominate. Drawings illustrate the key scientific concepts of water cycle and watershed. A map of the Columbia River watershed as it evolved naturally is juxtaposed against a map of the river as it is today with its various dams and impoundments.

The Lorax
Dr. Seuss, 1971
Grades: PreK- 3
Summary: This Dr. Seuss book considers the impact of environmental pollution. In the days when the grass is green and the ponds still wet, Once-ler comes to the glorious places and sees the glorious Truffula Trees growing mile after mile with their bright-colored tufts. Dr. Seuss is perhaps the most popular and best-loved children's book author of all time. Most of us have grown up with his unique characters and stories indelibly imprinted on our minds. *The Lorax* is his stunning and deeply felt cautionary tale for youngsters that teaches the value and importance of doing our best to preserve and protect our environment.

The Magic School Bus at the Waterworks
Joanna Cole; Bruce Degan, 1986
Grades: K-6
Summary: When Ms. Frizzle, the strangest teacher in the school, takes her class on a field trip to the waterworks, everyone experiences the interior of a water purification system. Evaporation, the water cycle, and filtration are but a few of the concepts explored in this whimsical trip.

Marshes and Swamps
Gail Gibbons, 1999
Grades: PreK-3
Summary: Ms. Gibbons shows where both freshwater and saltwater wetlands are found, how they developed and are maintained, the plants, animals, invertebrates, plants and insects who live there, and why human activities threaten them. The book explains a bit about freshwater marshes, saltwater marshes, freshwater swamps, and mangrove swamps.

The Mississippi River
Maria Mudd-Ruth, 2000
Grades: 5-8
Summary: Flowing from Lake Itasca in northwestern Minnesota to the Gulf of Mexico, the Mississippi River traverses approximately 2,350 miles. This majestic river bisects the United States and serves as both an amazing source of resources and a diverse ecosystem. In this science text, the complex elements of the multiple ecosystems comprising the Mississippi River Way are presented in an understandable and comprehensive manner. The environmental effects of dams, dredging, flood control levees, and pollution are presented in a balanced fashion. Plants and wildlife that use the Mississippi as their homes are described in a way that affords an in-depth glimpse of this wonderfully complicated natural resource.

One Less Fish
Kim Michelle Toft, Allan Sheather, 1998
Grades: PreK-2
Summary: Tropical fish shimmer across the pages in this cautionary tale of a countdown that warns of threats to a fragile ecosystem. Fish disappear one by one—where have they gone? Will they come back? Set in Australia's Great Barrier Reef, *One Less Fish* offers straightforward suggestions for preserving underwater environments and shows how to prevent the countdown from becoming reality. Stunning silk paintings portray the beauty of an environmental treasure in this unique counting book. (Adapted from Minnesota State University, Mankato © 2001 Cahners Business Information.)

Our Wet World
Sneed B. Collard, James N. Needham, 1998
Grades: 4-7
Summary: Water is by far the most abundant and valuable liquid on earth. Not only do all plants and animals need water to live and grow, it's home to many living things. In this fact-filled book, Collard explores thirteen different aquatic eco-systems, from gentle streams and mighty rivers to the rich continental shelf. In an age where environmental issues are at the forefront of public debate, this book's lucid explanations about the value of the aquatic ecosystems is a worthy read. A glossary at the end of the book provides useful explanations of key terms. Realistic illustrations support the text nicely.

Paddle-to-the-Sea
Holling C. Holling, 1980
Grades: 3-5
Summary: A young Indian boy from Nipigon country in the Canadian wilderness carves an Indian figure in a twelve-inch canoe and names it Paddle-to-the-Sea. Wishing that he could undertake a journey to the Atlantic Ocean, the boy sends the toy carving instead. Paddle-to-the-Sea begins on a snow bank near a river that eventually leads to the Great Lakes, the St. Lawrence River, and the Atlantic Ocean. Along the way, Paddle-to-the-Sea's journey is fraught with dangers, including wild animals, saw mills, fishing nets, and a shipwreck. Paddle-to-the-Sea receives help staying on course from people who read the carved message, "Put me back in the water. I am Paddle-to-the-Sea." Four years later, Paddle-to-the-Sea reaches his destination, an incredible story complete with geography, nature, drama, and adventure.

Rain Drop Splash
Alvin Tresselt. Lothrop, 1965, 1990
Grades: K-2
Summary: This picture book tells a simple story: raindrops begin to fall, forming a puddle that eventually becomes a pond with water lilies and fish. Raindrops continue to fall as the pond spills over into a lake containing bigger fish, pickerelweed, and red-winged blackbirds. The raindrops flood farms, roads, and cities and impact many things, including the lives of people.

The Snowflake: A Water Cycle Story
Niel Waldman, 2003
Grades: K-3
Summary: This is a simple and elegantly presented picture book showing the cycle of water, from earth to cloud and back again, as well as how this process continues throughout the year. Waldman's beautiful pastel illustrations add a gentle touch to this enriching, informative, and entertaining work, which is especially recommended for young readers ages six through eight.

The Wartville Wizard
Don Madden, 1999
Grades: PreK-4
Summary: A tidy old man spent his time cleaning up the litter left behind by the thoughtless slobs of Wartville. One day, tired of his lot, he gives up, and Mother Nature gives him "power over trash." He then commands litter to "go back and stick to the person who threw you." The townspeople are dismayed, and a wizard agrees to release them from their trash if they promise not to litter again.

Washing the Willow Tree Loon
Nancy Carpenter, 1995
Grades: 2-4
Summary: This book stresses the importance of wildlife rescue by focusing on the fate of an oil-slicked loon. When a barge hits a bridge on Turtle Bay, many birds are caught in the resultant spill. People from all walks of life work together to save the birds. The loon is washed, rinsed, medicated, fed, and allowed to recover its natural waterproofing before it's released back into the wild. Each stage in the loon's recovery is illustrated with large, softly expressive oil paintings in glowing blues and yellows.

Water Insects
Sylvia A. Johnson, Photographer Modoki Masuda, 1990
Grades: 3-7
Summary: Well-designed and illustrated in a style that appeals to children without oversimplifying or sacrificing accuracy. *Water Insects* focuses predominantly on insects occurring in ponds and wetlands, with photographs highlighting every aspect of insect life.

Waterways
Gail Radley, Jean Sherlock,
Jean Matheny, 2001
Grades: 3-6
Summary: This book offers interesting juxtapositions of factual information about endangered species with short poems. Each book provides basic facts about ten animals from various parts of the world and outlines the threats to their survival. Conservation efforts and results are noted, but the impact of human destruction of habitat continues to compromise long-term survival prospects for most of the animals. The poems are well-positioned on full-page, full-color paintings of the animals. Together, they evoke an emotional response that facts alone often fail to provide. The same introduction in each volume presents an overview of the severity and complexity of the problem and encourages action. Suggestions at the end of each book offer concrete ideas. A map of animal ranges rounds out the volumes. (Kathy Piehl, School Library Journal, Minnesota State University, Mankato, Minnesota Copyright 2002 Reed Business Information, Inc.)

Chapter 4: Fish Management

A Fish Out of Water
Helen Palmer, 1961
Grades: PreK-2
Summary: "This little fish," I said to Mr. Carp, "I want him." This cautionary tale tells how a boy overfeeds his fish, which grows and grows. With help from a man at a pet store, the boy learns a lesson. Comical illustrations show how the fish rapidly outgrows its bowl, a vase, a cook pot, and a bathtub.

A River Dream
Allen Say, 1988
Grades: 1-3
Summary: Breathtaking color illustrations complement this fun tale of Mark, a boy whose dreams merge with reality as he lies in bed with a fever and opens a prize box from an uncle. Mayflies flutter out of the box and Mark follows them outdoors to find a river has replaced his street. He climbs into a boat. Rowing, he sees his uncle fishing, joins him, catches magnificent trout in the shallow waters, and faces a tough choice. Should he keep the trout or release it and leave the river as he found it?

Fish Watching with Eugenie Clark
Michael Elsohn Ross, Wendy Smith, 2000
Grades: 3-6
Summary: This book describes the life and career of ichthyologist Eugenie Clark, who began her research by observing freshwater aquarium fishes before undertaking an underwater study of sharks and other marine animals. The book includes observation tips and related activities.

Fishing
Ann Love, Jane Drake, Pat Cupples, 2002
Grades: 2-5
Summary: The America at Work series introduces young children to the people, equipment, and environmental concerns involved in two leading resource-based industries. Fishing explains how fish farmers in Maine raise salmon and halibut, and traces the fascinating life journey of a wild salmon in Alaska. In Mining, kids explore an underground mine, a surface coalmine, and an oil-drilling site. Combining fact and fiction with colorful illustrations, these stories deliver lessons about appreciating and protecting natural resources.

For a Living
George Travis, 1998
Grades: 3-5
Summary: This introduction to commercial fishing includes information on boats and equipment, the dangers of pollution and overfishing, selling the catch, the nutritional value of fish, and laws governing commercial fishing.

Loon Lake Fishing Derby
Kathleen Cook Walden, Dean Griffiths, 1999
Grades: K-3
Summary: Wally goes into business selling worms. When his friends also enter the bait business, problems arise as everyone digs up all the gardens for worms. Then the fish take the bait without being caught.

Lord of the Deep
Graham Salisbury, 2003
Grades: 3-6
Summary: Working for his stepfather on a charter fishing boat in Hawaii teaches thirteen-year-old Mikey about fishing, taking risks, making sacrifices, and facing some of life's difficult choices.

The Magic School Bus Goes Upstream
Joanna Cole
Grades: 2-5
Summary: "It says here that some animals that migrate travel thousands of miles!" said Dorothy Ann. Travel with Ms. Frizzle on the Magic School Bus to learn about salmon migration.

The Shape of Betts Meadow
Meghan Nuttall Sayres, Joanne Friar, 2002
Grades: PreK-3
Summary: This picture-book account of the renewal of a dry meadow in Washington State begins when a local doctor decides to purchase the land and restore it to its original wetland state. Watercolor illustrations show the doctor first mapping the area from the air to establish where streams once flowed, and working with heavy equipment to dig holes for ponds. Other illustrations show the gradual return of birds, fish, frogs, and large mammals.

Chapter 5: Fishing Equipment & Skills

Buck Wilder's Small Fry Fishing Guide
Tim Smith and Mark Herrick, 1995
Grades: PreK-4
Summary: A factual book with cartoon-like illustrations. The authors tell you everything you need to know about catching common game fish, including where to find them.

Fishing Day
Andrea Pinkney, Shane W. Evans, 2003
Grades: K-4
Summary: Reenie and her mom are having fun and great success fishing in Jim Crow River, while Peter and his father are fishing for food and have nothing to show for it. Distanced by race and fear of change, Reenie and Peter watch each other surreptitiously, but their parents firmly prevent their interaction. When Peter is left alone for a few moments, Reenie takes the opportunity to help him.

Freshwater Fish and Fishing
Jim Arnosky, 1982
Grades: 3-6
Summary: This accurately illustrated book about freshwater fish and fishing skills provides hands-on activities and excellent information on where to find fish.

Go Fish
Mary Stolz, Pat Cummings, 1991
Grades: 1-3
Summary: Eight-year-old Thomas and his grandfather go fishing in the Gulf of Mexico. Grandfather is a collector of shells, petrified wood, and even sandstone containing fossil fish. In Chapter 2, their fishing gear is listed, including a record book for noting large specimens caught. They observe herons, pelicans, minnows, and jellyfish, as well as the blowfish, flounder, and other fish they seek. Back at Grandfather's, they share a card game of Go Fish! and an African folk tale. The book provides a wonderful model of friendship between generations and affirms the value of observing and questioning the world around us. The regional focus is refreshing, offering African-American characters in a non-urban setting.

Gone Fishing
Earlene Long, Richard Eric Brown 1984.
Grades: PreK-2
Summary: In this 180-word book, a child leaves a note for Mom on the refrigerator and is thrilled about planning a fishing day with Dad.

Island of the Loons
Dayton O Hyde, 1984
Grades: 4-7
Summary: This book tells the captivating and exciting adventure of Jimmy, an orphan who is captured by a convict and taken to an uninhabited island in Lake Superior where they fend together during the winter. Jimmy senses the convict's unfamiliarity with wilderness and realizes that, the more useful he is, the greater his chances of survival. Wetland settings described include sphagnum mosses and leatherleaf bogs. Jimmy's resourcefulness extends to creating brews from wetland plants such as pitcher plants, cattails, and lady's slippers.

Lost Island: Isle Royale Fishing, Minnesota's Twentieth Century: Stories of Extraordinary Everyday People
D. J. Tice, 1999
Grades: 3-6
Summary: An interesting and true story on pages 103-111 describes the family of famed artist Howard Sivertson fishing on Isle Royale and discusses fishing as a business.

Today, I'm Going Fishing With My Dad
N. L. Sharp, 1993
Grades: K-2
Summary: In this humorous book for readers aged five through eight, a boy doesn't like to fish or camp due to buzzing insects, wiggly worms, and smelly fish. But he does enjoy being with his father, so he goes along.

Where the Big Fish Are
Jonathan London, Adam Gustavson, 2001
Grades: 1-4
Summary: Two young boys refuse to give up when a fierce storm almost destroys their attempt to build a raft to take them "where the big fish are."

Chapter 6: Safety & the Fishing Trip

The Broken Blade
William Durbin, 1998
Grades: 3-6
Summary: Thirteen-year-old Pierre is the son of a voyageur, one of the French-Canadian canoemen who plied the fur trade in Canada during the past two centuries. The bulk of the novel concerns the Pierre's first canoe trip to the wilderness outpost of Grand Portage. The work is grueling and the food monotonous, but the men enjoy a rough camaraderie and savor the natural beauty that surrounds them. Middle school students will be attracted to this enjoyable, fast-moving story.

Chasing Bears
Earl Fleck, 1999
Grades: 5-8
Summary: Twelve-year-old Danny Forester is apprehensive as he embarks on a week-long canoe trip with his father and college-aged brother near the Minnesota-Canada border. While the three of them share great experiences fishing, canoeing, and camping, they also face threatening weather, dangerous waterfalls, and aggressive bears.

Chasing Fire
Earl Fleck, 2002
Grades: 5-8
Summary: This book is an enthralling young adult novel about thirteen-year-old Danny Forester, who sets out with his family for a grand canoe adventure. But in the Boundary Waters Canoe Area Wilderness, a deadly forest fire places all lives in jeopardy and forces them to make harsh choices in this gripping, highly-recommended adventure.

Ely Echoes
Bob Cary, 2000
Grades: 3 and up
Summary: Chapters of interest include: "There's Nothing Wrong with a Fish Dinner" (a true canoeing story that observes autumn beauty and ends with a fish supper); "Speckled Trophies of Tiny Brooks" (trout-catching strategies revealed in a setting near Isabella, Minnesota); and "Some Thoughts on Fishing" (the author fishes with children aged five to fifteen).

Fish
Elizabeth A. Clark, John Yates, 1990
Grades: 1-4
Summary: This book discusses the role of fish in history and how they're caught, processed, and prepared for food.

Fish, Volume 3
Jillian Powell
Grades: 3-5
Summary: This book describes how people have used fish as food throughout history, the ways in which fish have been raised and prepared, and the nutritional value of fish. The book includes recipes for baked haddock and shrimp-filled baked potatoes.

Fishing
Lisa Klobuchar
Grades: 3-6
Summary: Part of the fun of fishing is the mystery. As your line disappears into the water, you try to imagine what's going on under the surface. Is your hook and bait just dangling unnoticed in deep water? Or is a hungry fish eyeing it and getting ready to snap it up?

Hatchet
Gary Paulsen, 1988
Grades: 6-12
Summary: After a plane crash, thirteen-year-old Brian must survive alone in the Canadian wilderness. He slowly learns how to provide shelter, fire, and food for himself. By following some birds to a bush full of berries, he learns how valuable it is to observe the animals around him and adapt to his new environment. In several parts of the story, Brian is plagued with clouds of mosquitoes, but devises ways to avoid them. He also learns about fish as he works on catching some for food.

Kid's Incredible Fishing Stories
Shaun Morey, editor; Elwood Smith, 1996
Grades: 3-6
Summary: The author of *Incredible Fish Stories* turns his attention to young anglers who have their own stories to tell. Each tale, verified by Morey, works both as exciting entertainment and as a you-can-do-it-too lesson for kids who are just starting to take their fishing—and reading about fishing—seriously.

My Side of the Mountain
Jean Craighead George, 2001
Grades: 2 and up
Summary: Sam Gribley is terribly unhappy living in New York City with his family, so he runs away to the Catskill Mountains to live in the woods—all by himself. With only a penknife, a ball of cord, forty dollars, and some flint and steel, he intends to survive on his own. Sam learns about courage, danger, and independence during his year in the wilderness, a year that changes his life forever.

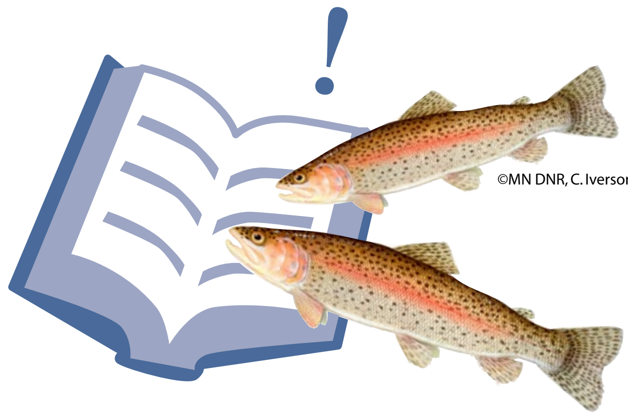
Once Upon an Isle: The Story of Fishing Families
Howard Sivertson, 1992
Grades: 3 and up
Summary: This nonfiction book contains beautiful paintings and stories, including: "Winter on the North Shore" (families wait for the ice-out on the lake); "Picking Baits" (a woman helps her husband prepare for a day of picking 500 herring from nets to use for bait); "The Fish House" (a flurry of activity as men and boys pack fish into boxes of ice and grandmother selects fish for supper); and "Emergency Repairs" (a fisherman fears the worst as winds pound his small boat).

Up North (Outdoor Essays and Observations)
Sam Cook, Bob Cary, 2003 (reprint)
Grades: 3 and up
Summary: Organized by time of year, *Up North* describes each season's pleasures—sled dog racing in winter, hooking a northern pike on the first spring fishing trip, building a summer campfire, watching the aurora borealis in fall. This book is an invitation to explore canoe country through Sam Cook's eyes and your own.

Up North at the Cabin
Marsha Wilson Chall, 1992
Grades: 1-5
Summary: This book of true recollections of childhood is a Minnesota-based story of a mother observing her children enjoying the birch trees, fishing, swimming, watching moose and other animals, as she did when she was young.

Winter Rescue
W. D. Valgarson, Ange Zhang, 1995
Grades: PreK-2
Summary: While helping his grandfather, an ice fisherman on Lake Winnipeg, Thor spots a man who drives a snowmobile through a weak patch of ice and makes a dramatic attempt to rescue the drowning man.

Wintering
William Durbin, 2000
Grades: 4-8
Summary: Fourteen-year-old Pierre La Page, originally introduced in *The Broken Blade,* works for the North West Company as a voyageur, a member of an expedition that transports goods and furs by canoe. Pierre is realistically depicted as a young man coming of age, who looks to the captain of the expedition as a father figure. Historical and cultural information is nicely woven into the plot, and the story never loses momentum. Scenes that include Pierre and the son of an Ojibwe chief tracking in the forest are nicely written, juxtaposing the beauty and quiet of the natural world with the life created by crew members during their winter stay.



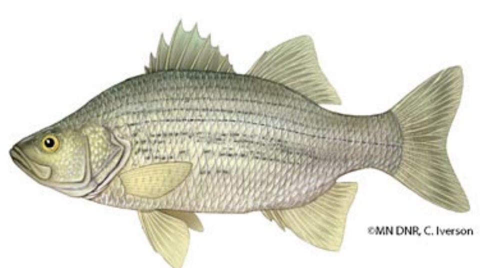
Minnesota Water Facts

- Earth is often called the Blue Planet because as much as 75 percent of its surface is covered by water.
- Although water may seem abundant in Minnesota, the Land of 10,000 Lakes (there are actually 11,842 lakes of ten acres or larger), water is a limited resource. Throughout the world, clean fresh water is increasingly scarce.
- The fresh water in Minnesota aquifers, lakes, and rivers is a legacy of retreating glaciers that shaped the landscape more than 10,000 years ago.
- Water has the strange property of first condensing as it cools to 4˚C and expanding when it further cools from 4˚C to 0˚C. The result of this is that ice is less dense than the water in which it floats. Fish are lucky in this respect—otherwise ice would sink and lakes would freeze from the bottom up during the winter. This is lucky for ice fishing anglers, too!
- The amount of water on earth today is exactly the same as it was when the earth was formed.
- Almost 98 percent of the world's water is salty or otherwise undrinkable. Almost two percent is locked in ice caps and glaciers. This leaves not quite one percent of all fresh water available for human needs, including agriculture, residences, industry, and communities.
- It takes 24 gallons of water to produce one pound of edible potatoes. It takes 182 gallons of water to produce one pound of corn.
- Number of pollutants the Environmental Protection Agency has found in U.S. drinking water: 700
- The average U.S. household uses more than 100 gallons of water a day. Landscape watering and toilets account for most of the water used in a typical home.
- U.S. households turn on water faucets an average of 70 times daily. Implementing simple conservation methods could save an estimated 50 percent of the water that families use.
- A dripping faucet can waste as much as 2700 gallons of water annually.
- A leaky toilet can waste as much as 200 gallons of water daily.
- The majority of surface water used in Minnesota is used for cooling in power generation, but this water is usually returned to the water body near the source from which it was removed—this isn't considered consumptive use.
- In Minnesota, 40 percent of total groundwater withdrawals are used for irrigation.
- Aquatic invaders (such as Eurasian water milfoil, zebra mussels, spiny water fleas, ruffe, and purple loosestrife.) cause habitat destruction, decrease biological diversity, and cause millions of dollars of damage in Minnesota. Many introductions are unintentional. Invasive species are carried on barges, boats and trailers, animals, vehicles, commercial goods, packing materials, produce, footwear and clothing, and in the ballast water of ships.

- Of the lakes and rivers tested in Minnesota, 40 percent are polluted with contaminants such as mercury, fertilizers, animal waste, human waste, and excessive phosphorus, which causes algal blooms.

Do you drink bottled water because you consider tap water unsafe? Many brands of bottled water are simply filtered and treated tap water. Public drinking water supplies are subject to more intense government regulation than bottled water.

- Minnesota's total surface water area (including wetlands): 13,136,357 acres
- Deep-water lakes and rivers: 2,560,299 acres
- Fishing waters: 3,800,000 acres
- Minnesota lies in a unique position on the North American continent. The state is at the head of four continental watersheds and contains the headwaters, or the origins, of three of these watersheds. Water flows north (Red River of the North Basin), south (Mississippi River Basin), east (Great Lakes Basin), and west (Missouri River Basin). From these four basins Minnesota's waters flow to three destinations: northward to Canada's Hudson Bay, eastward to the Atlantic Ocean, and southward to the Gulf of Mexico.
- Minnesota receives very little surface water from outside its boundaries.
- Minnesota boasts an acre of water for each 20 acres of land. Six percent of the state is covered with water—more than any other state.
- Minnesota has more miles of shoreline than Hawaii, California, and Florida combined.



Minnesota's Major Rivers

There are 6,564 (approximately 69,200 miles) natural rivers and streams in Minnesota.

In the heart of North America lies one of the world's greatest rivers, the mighty **Mississippi River**.

- The Ojibwa Indian word for the river is *Messipi*, meaning big river. It's also called the *Mee-zee-see-bee*, meaning the father of waters.
- Minnesota's Lake Itasca, located within Itasca State Park, is the source of the Mississippi River. It begins as a tiny brook and, more than 2,300 miles downstream, it empties into the Gulf of Mexico. The precise length of the river is difficult to measure because the river channel changes constantly. Staff members at Itasca State Park offer the distance of 2,552 miles. The U.S. Geological Survey has published a distance of 2,300 miles; the Environmental Protection Agency states that it's 2,320 miles long, and the Mississippi National River and Recreation Area states its length as 2,350 miles.
- The Mississippi River drains a watershed that covers 41 percent of the continental U.S., an area as large as 1.8 million square miles, which includes tributary rivers from 32 states and two Canadian provinces. The first 680 miles of the Mississippi River are within Minnesota state boundaries.
- The cities of Minneapolis, St. Paul, and St. Cloud rely primarily on the Mississippi River for public drinking water supplies.
- A raindrop falling in Lake Itasca arrives downstream at the Gulf of Mexico in approximately 90 days.
- There are 113 fish species recorded in the Minnesota-Wisconsin stretch of the Mississippi. Half of these species exist above St. Anthony Falls Lock and Dam in Minneapolis, which prevents the upstream migration of fish.
- The Mississippi River Valley is a major North American migration route for ducks, geese, swans, raptors (particularly bald eagles), and other birds. The Minnesota-Wisconsin stretch of the Mississippi harbors, over the course of a year, 285 bird species.

- There are more species of mussels in the Mississippi River watershed than anywhere else in the nation.

The **Red River** is a remnant of Glacial Lake Agassiz, a massive prehistoric lake.

- The Red River meanders northward 550 miles from its source in Breckenridge, Minnesota, and stretches through a prairie landscape from northeastern South Dakota and west-central Minnesota through eastern North Dakota and northwestern Minnesota and into southern Manitoba where it empties into the southern end of Lake Winnipeg.
- The Red River Valley is one of the world's flattest landscapes. The river's flow sometimes fluctuates widely, resulting in devastating floods associated with spring snowmelt and summer rain.
- The Red River watershed drains approximately 37,100 square miles of northwestern Minnesota. 17,842 miles of streams and 668,098 acres of lakes are in the Minnesota portion of the Red River Basin.

The watershed basin of the **Rainy River** lies along the Minnesota-Canada border.

- The Rainy River flows for 80-miles connecting Rainy Lake and Lake of the Woods.
- It is home to walleye, northern pike, smallmouth bass, sturgeon, and muskies. The forested basin also contains a number of fine trout streams.
- The waters from the Rainy River Basin eventually flow north to Hudson Bay.
- Voyageurs National Park and the Boundary Waters Canoe Area Wilderness are located within the Rainy River watershed basin.

The **Minnesota River** was named *Watapa Minisota*, meaning river of cloud-tinted water or water that reflects the sky, by local Dakota Indians.

- French fur traders christened the Minnesota River as *Riviere St. Pierre* in the late 1600s.
- It's approximately 340 miles long. It flows through a mostly agricultural landscape southeast from its source at Big Stone Lake (near the South Dakota border) into the Mississippi just north of Pike Island at Ft. Snelling State Park in St Paul.
- It drains an area of 16,770 square miles, or approximately ten million acres.

The **St. Croix River** begins in Wisconsin and flows west and south to join the Mississippi River at Prescott, Wisconsin.

- Approximately 80 percent (129 miles) of the St. Croix River forms part of the boundary between Wisconsin and Minnesota.
- The St. Croix watershed covers approximately 7,760 square miles and extends from near Mille Lacs Lake in Minnesota on the west to near Cable, Wisconsin, on the east. Approximately 46 percent of the river's watershed area is located within Minnesota boundaries.
- Its beauty has earned the St. Croix River's status as Minnesota's first stream in the national Wild and Scenic Rivers system. Administered by the National Park Service, the St. Croix National Scenic Riverway was designated in 1968 to preserve the scenic qualities of the river and provide adequate access for recreational users.

The **St. Louis River** is the largest U.S. tributary to Lake Superior.

- The St. Louis River watershed basin covers 3,650 square miles.
- Its headwaters are located near Hoyt Lakes, Minnesota.
- Its waters enter Lake Superior and flow eastward, joining the waters of the Great Lakes and eventually flowing into the Atlantic Ocean.

Minnesota Lakes

- Minnesota is often called the land of 10,000 lakes, but the actual number is closer to 15,000, depending on the source of the count. There are 11,842 lakes ten acres in area or larger.
- Counties without natural lakes: Mower, Olmsted, Pipestone, and Rock.
- Largest border lake: Lake Superior is 20,364,800 acres, 962,700 of which are located in Minnesota. Lake Superior is the world's largest freshwater lake.

- Largest inland lake (completely within Minnesota borders): Upper Red Lake and Lower Red Lake, with a combined total of 288,800 acres (451 square miles)
- Deepest inland lake: Portsmouth Mine Pit near Crosby (450 feet deep and rising).
- Deepest natural lake: Lake Saganaga, Cook County (240 feet deep).
- Longest shoreline: Lake Vermilion in St. Louis County (290 miles of shoreline).
- Major lakes include: Lake Superior, Upper Red Lake, Lower Red Lake, Mille Lacs Lake, Lake Vermillion, Rainy Lake, Lake of the Woods, Leech Lake, Lake Winnibigoshish, Lake Pepin, Lake Minnetonka.
- Most common lake names: Minnesota has 201 Mud Lakes, 154 Long Lakes, and 123 Rice Lakes.
- The majority of Minnesota lakes are in the northernmost half of the state, but many are scattered throughout rest of the state, too.
- There are more than 1,000 lakes in the Twin Cities metropolitan area alone.
- Seasonal changes in Minnesota transform the density of lake waters. This accounts for large-scale mixing of the water in many lakes. In autumn, as surface waters cool, they sink and change places with bottom waters. In the spring, as the ice melts, the melt water becomes denser and sinks to the bottom, again mixing the lake as it moves. This double annual mixing of water in lakes is known as turnover.

For more on frequently asked questions concerning Minnesota lakes, see:
mndnr.gov/lakes/faqs.html
www.pca.state.mn.us/water/lake-faq.html

Minnesota Wetlands

- What is a wetland? It can be a swampy, marshy place filled with ducks and cattails, or a place that appears dry for most of the year. It could even be covered with trees and shrubs. A wetland has mostly wet soil, is saturated with water either above or just below the surface, and it has plants adapted to wet conditions.
- Total wetland areas in 1850: 18.6 million acres.
- Total wetland areas in 2006: 9.2 million acres. (According to the Minnesota DNR, these acres cover approximately 24.4 percent of the state. As many as 90 percent of the state's original wetlands have been lost in some areas.)
- Wetlands bolster water quality by, among other things, filtering pollutants from surface water and groundwater, using nutrients that would otherwise pollute waters, trapping sediments, protecting shoreline, and recharging groundwater supplies.
- Wetlands help retain floodwater and stormwater and provide low-flow augmentation during times of drought.
- Wetlands provide public recreation and education in the form of hunting and fishing areas, places to view wildlife, and other natural areas.
- Wetlands provide commercial benefits, including growing areas for wild rice and cranberries and aquaculture areas.
- Wetlands benefit fish and wildlife in the form of habitats for many plant and animal species.
- In 1991, reacting to public concern about Minnesota's disappearing wetlands, the Minnesota Legislature approved and Governor Arne Carlson signed the Wetland Conservation Act, one of the most sweeping wetlands protection laws in the country.

Groundwater

- Groundwater lies beneath the land surface, filling the spaces between rocks and sediments. It exists everywhere beneath Minnesota's land surface, but it's *not necessarily available for use* everywhere.
- Groundwater discharge to surface waters allows streams to flow beyond rain and snowmelt periods and sustains lake levels during dry spells.
- Groundwater supplies approximately 75 percent of Minnesota's drinking water and nearly 90 percent of the water used for agricultural irrigation.
- There is one hundred times more groundwater than the quantity of surface water in all of the world's rivers and lakes.
- Of Minnesota's total water usage between 1985 and 1997, 18.6 percent came from groundwater.

- More than 70 percent of Minnesotans rely on groundwater for drinking water.
- Groundwater and surface water are connected as part of the hydrologic cycle. Withdrawing water from the ground can eventually impact springs; deplete wetlands, streams, lakes, and rivers; draw contaminants into the water system; and result in other ecological effects.

Climate Affects Waters

Minnesota's water resources are profoundly affected by the water cycle, which is, in turn, impacted by weather conditions. The very existence of many of Minnesota's aquatic resources has largely been determined by Minnesota's climate, the composite of day-to-day weather over a long period.

Water Conservation and Stewardship

> ". . . building a sustainable society does not mean reverting to a primitive existence. The challenge is to find a new synthesis that melds the wisdom of nature with human institutions and technologies and lifestyles. The benefit of such an approach can be told in one word: survival."
>
> —Daniel Chiras, *Lessons From Nature*, 1990

Increased water conservation will be important in the future. Minnesota's total water use increased 55 percent between 1985 and 2003, about twice the percentage increase in its population for the same period. Increased water use results in increased environmental effects, costs, and conflicts. All water users—large or small—including individuals, communities, businesses, and government, must play a role in conserving water. Voluntary action, conserving water, and adopting efficient water-use practices is critical, as are mandated actions for resource protection.

Households

Each person has many daily opportunities to save water in and around the home, including:

- Actions as simple as fixing leaky sinks and toilets. (One drop per second wastes as many as 2,700 gallons of water annually!)
- Install water-saving fixtures. If all plumbing fixtures in the country were replaced with water-conserving fixtures, we could save between 3.4 and 8.4 billion gallons of water a day.
- Use appliances efficiently or replace existing appliances with newer, more efficient ones. Installing a 1.6 gallon per flush toilet, for example, can save more than 15,000 gallons of water each year—and cost half as much to operate. Replacing showerheads with ultra-low-flow versions saves substantial amounts of water used for showering. Some of these fixtures use as little as 2.5 gallons of water per minute, as opposed to the five to seven gallons per minute used by many older showerheads.
- Outdoor landscape watering causes summer usage peaks. Limit quantities of water used on lawns and for showers, garbage disposals, and faucets. Reduced and efficient use of water indoors and outdoors is critical.
- Don't run the water while brushing your teeth, washing your face, or shaving.
- Use no-phosphate or low-phosphate cleaners and detergents.
- Consider taking your car to a commercial carwash that recycles water. If you wash your own car, park on the grass so that you can water the lawn at the same time. Water landing on impermeable surfaces, such as driveway pavement, flows through the watershed to the nearest body of water and deposits its contaminants. Your lawn, on the other hand, can trap and break down most foreign agents.
- Don't overwater your lawn. Lawns only need water every five to seven days in the summer—most of the year, lawns need just an inch of water per week. Position sprinklers so the water lands on the lawn and shrubs and not on paved areas.
- Limit the use of lawn fertilizers and be sure to use only those that are phosphorus-free. Most lawns already have sufficient phosphorus—when you add more, it flows through the watershed, fueling algae growth in surrounding lakes.
- Planting thickly and using mulches helps shade the soil and prevents precious available moisture from evaporating. Chipped bark, straw, grass

clippings, cocoa hulls, and compost are effective mulches.
- Use rain barrels for collecting rainwater for the garden.

Communities

Communities can implement practices to minimize summer peak water demand. In the Twin Cities metropolitan area, summer peak demand is an average of 2.6 times larger than winter demand, although in some communities, demand is as much as four times greater in summer. Most of the summer peak demand is for outdoor watering. Reducing summer peak demand includes several approaches, such as instituting effective watering habits, landscaping with plants that require less water, watering schedules that stabilize demand, watering restrictions, and the use of rain- or soil-moisture sensors for sprinkler systems.

Community water utilities can reduce waste from unaccounted water use, including those from system leaks. Water utilities can also consider water pricing that encourages conservation.

Business and Agriculture

Given the natural limitations of groundwater resources, Minnesota businesses can evaluate water supply needs much earlier in expansion or development planning than may have been practiced in the past. By becoming better water stewards and more knowledgeable about the sources of their water supply, businesses can reduce their risk and uncertainty as they save water, energy, and money.

The University of Minnesota offers MnTAP (Minnesota Technical Assistance Program), a free service, to Minnesota businesses and industries. A MnTAP team of specialists helps businesses by identifying ways to use water more efficiently. With assistance from MnTAP, one company saved $400,000 and thirteen million gallons of water per year. Another company saved more than $27,400 and 2.5 million gallons of water per year. This program is funded by a grant from the Minnesota Pollution Control Agency and is part of the University's School of Public Health.

The State of Minnesota

In the most recent update to Minnesota's water plan, *Watermarks: Gauging the Flow of Progress 2000-2010*, highlighted water conservation as important to future ecosystem and economic health. A key conservation objective recognized the need to maintain groundwater levels in relation to precipitation to sustain surface waters and provide for human needs. In support of that objective, the state collects and disseminates climatic and resource data, regulates water use and collects usage data, and requires appropriation permit holders to adopt and implement conservation plans. With public input, the state government and state agencies continue to review and improve regulatory and permitting methods and guidelines to improve water conservation and water-use efficiency.

On the National Level

Water is generally managed at the state level through state water laws. The federal government has instituted water efficiency standards for manufacturers of plumbing fixtures and appliances. Nationally, water conservation is implemented by several agencies (such as the Environmental Protection Agency, U.S. Department of Agriculture, and others) that set policy and require conservation measures as a condition of grants and loans to states and communities. Organizations, such as the American Water Works Association, National Ground Water Association, and others, work through their members and provide information to the public

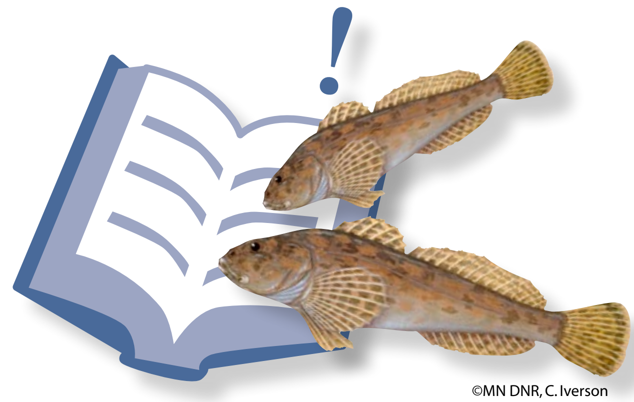
Take Action: Conserve, Protect, Learn, and Change

- Reconsider and change your daily habits to conserve water and reduce water pollution. Bike, walk, or travel by carpool to help reduce the production of toxic air pollutants that cause acid rain.
- Encourage local governments, employers, schools, and your own family to promote water conservation and to develop and promote a water conservation ethic.

- Support projects that lead to increased use of reclaimed wastewater for irrigation and other uses.
- Promote water conservation through community newsletters, bulletin boards, and by example. Encourage your friends, neighbors, and co-workers to be "water smart."
- Share your knowledge with others—people's actions, choices, and decisions have long-lasting and extensive impacts on the quality of freshwater resources—and each of us can make a difference.

Some sources for these facts include: The Environmental Protection Agency; *The Green Consumer,* by John Elkington, Julia Hailes, and Joel Makower, 1990; U.S. Geological Survey; National Drinking Water Alliance; and the Minnesota DNR.

Minnesota Fun Fish Facts


©MN DNR, C. Iverson

For more fun facts see the Nature Snapshots area of the Minnesota DNR website.

Fish Are Fascinating!

- All fish are craniates, with skulls of bone or cartilage.
- All fish are vertebrates (meaning that they have backbones) and breathe through gills.
- Most fish have fins and scales.
- Usually, fish are cold blooded, but several saltwater species, including some tuna and sharks, maintain elevated body temperatures that are substantially higher than surrounding waters.
- There are more than 27,000 living species of fish worldwide. Approximately 20,000 of these are bony fish.
- Fish are the largest population of vertebrates. There are more fish than all mammals, reptiles, amphibians, and birds combined. Although fish species are numerous, several groups of invertebrates far outnumber fishes. Nematodes, or roundworms, are the most abundant, with as many as one million estimated species. Approximately 20,000 species of nematodes have been described. One million insect species have been identified, so they, too, outnumber fishes. There are approximately 55,000 species of crustaceans, including lobsters, crabs, shrimps, and barnacles.
- A group of fish is called a school.
- Most fish lack eyelids—although some saltwater sharks have a nictitating membrane that acts as an eyelid.
- It's not always easy to tell the difference between a male fish and a female fish. In some species, males and females have different shapes or coloring; in other species there is no outwardly visible difference.
- Fish skin has glands that secrete mucous that gives fish their sliminess and odor. Mucous covers wounds to prevent infection, and protects fish from bacterial infections from fungus, mold, and other parasites. The slime covering also makes it easier for fish to slide through water and keeps scales lubricated.
- The muscle mass of most fish is segmented into zig-zaged shapes called myotomes. These muscle segments help fish move through the water. When you eat a fish, the meat is the muscle that folds or peels off in layers.
- The streamlined shape of a fish's body enables it to easily cut through water as it swims.
- An esophagus, the tube between the mouth and stomach, is flexible. A fish esophagus usually can handle anything that fits into the fish's mouth. It can even adjust mid-swallow—just in

case the fish eats something that happens to be considerably larger than itself.

- A fish's food slides through the esophagus into the stomach. From the stomach, food moves to the intestines where digestion continues. Fish intestines are lined with mucous that moves digesting food, and aids in the absorption of protein. The kidney, liver, and gall bladder contribute enzymes and acids that further process the food. After needed protein, fat, and carbohydrates have been extracted from the food and absorbed, the waste passes through the fish's vent, or anus.
- In order to be buoyant, and to expend as little energy as possible, most fish have an air (or gas) bladder to regulate buoyancy in the water. The air bladder inflates and deflates to keep the fish from sinking like a stone or bobbing to the surface. Adjusting the volume of gas in the air bladder brings the fish's overall density close to the density of the surrounding water. This gives the fish the ability to hover at a particular level in the water. Hagfish, lampreys, sharks, rays, and chimeras don't have gas bladders. There are also several species of ray-finned fishes that don't have gas bladders, including some Minnesota species.
- A fish's brain is located at the end of the vertebral column that runs through its body. The spinal cord inside the column transmits messages from various parts of the body to the brain and vice versa. The sections of the brain are the forebrain, 'tween brain, midbrain, and hindbrain, all of which are protected by a skull.
- Fish breathe by taking water in through their mouths and pushing it over the surface of their gills. The gills are protected by structures called gill rakers.
- The fish's inner ear includes an ear stone (otolith). Sound signals are transmitted to the brain after the sound registers in the ear stone. Otoliths grow each year, adding rings similar to the growth rings of a tree. Fish biologists examine the annual rings of the otolith to determine the ages of some types of fish. Ray-finned fishes have three otoliths and lobe-finned fishes have two. Paddlefish and sturgeon (like sharks, rays, and chimeras) don't have otoliths.
- Fish scales are laid down in rings each year (like tree rings) and can be used to age fish.

Minnesota Fish Family Trivia

In 2006, Minnesota was home to 160 species of fishes, 141 of them native. The number of species increases as new non-native species inextricably establish themselves in Minnesota waters. There are 26 families of Minnesota fishes. Here are some facts about some familiar fish families as well as some of the unusual fish families that live in Minnesota.

The Bowfin Family (Amiidae)

- Bowfin are the last surviving members of a formerly large family of fish—the rest exist only as fossilized remains.
- The name refers to the long, undulating dorsal fin along the back of these fish.
- Bowfin come to the surface every few minutes to breathe air, using their swim bladder like a lung. They also use gills to breathe in water. They can survive out of water for a considerable length of time. A farmer once found a live bowfin in moist soil while plowing a field that had been flooded a few weeks earlier.
- The male bowfin turns dark green while spawning and guarding its young.
- In recent years, aquaculturists have shown interest in harvesting bowfin eggs for caviar.
- Bowfin are also known as dogfish.

The Catfish Family (Ictaluridae)

Catfish exist throughout the world, but the Ictaluridae family lives only in North America. There are nine catfish species in Minnesota: three catfish species, three types of bullheads, and three smaller fish species. All members of this family have whisker-like barbels around their mouths and an adipose fin on their back between the dorsal and tail fins. Catfish bodies are covered with taste buds instead of scales. These many taste buds—and the barbels—help catfish locate food.

Catfish

- The two large species of catfish commonly found in Minnesota are channel catfish and flathead catfish.
- Catfish barbels aren't "stingers" and won't sting you. They're an organ that senses taste, touch, and smell. But these fish do have sharp spines with poison glands—one in the leading edge of their top (dorsal) and one in each of their side (pectoral) fins. If you're not careful when handling these fish, you can poke your hand on these spines.

Bullheads

- Minnesota has three species of bullheads: brown, black, and yellow.
- Bullheads have as many as 100,000 taste buds scattered over their bodies. Many taste buds are also found on their barbels. Scientists think that well-developed sensory abilities help bullheads find food in muddy, dark water.
- Black bullheads are extremely hardy and do well in aquaria, so they're often used in scientific studies.

The Codfish or Cuskfish Family (Lotidae)

Burbot

- Most codfishes live in oceans. The only freshwater species in this family is the burbot.
- In Minnesota, burbot are commonly known as eelpout. Eelpout is the name of a family of saltwater fishes (Zoarcidae), but burbot are called eelpout simply because they resemble these fishes. Their Latin name, *Lota lota,* comes from the French word for codfish. It's possible that the word burbot is derived from *bourbe*, a French word meaning mud from a pond or lake.
- Burbot have a single barbel located under the chin.
- Burbot are the first fish to spawn each year. They spawn in the middle of winter. They're the only fish in Minnesota to spawn under the ice.
- In early February, an annual International Eelpout Festival on Leech Lake includes a black-tie dinner on the lake, ice bowling, and a fishing tournament. The angler who catches the biggest burbot wins a seven-foot-tall trophy.

The Drum Family (Sciaenidae)

The freshwater drum is the only species of the large family of drum fishes that lives in Minnesota—and it's the only freshwater member of the drum family.

Freshwater Drum

- Freshwater drum are also known as sheepshead or croakers. It's the only freshwater fish with a lateral line that extends all the way to the end of its tail fin.
- Members of the freshwater drum family can produce audible sounds. Male drum make a deep, rumbling sound during spring breeding season by rubbing tendons against their swim bladders. They're the noisiest fish in Minnesota!
- Native Americans used the drum's otoliths, or ear bones, to make jewelry. These otoliths are notably larger than those of most other species.

The Gar Family (Lepisosteidae)

The long, narrow, bony snouts of members of this fish family are filled with many sharp teeth. Longnosed and shortnosed garfish exist in Minnesota; the entire family has seven species.

Longnose and Shortnose Garfish

- *Gar* is an old Anglo Saxon word meaning spear—in reference to the pointed snout of this fish.
- A gar has tough, armor-like scales that can flatten a bullet.
- In addition to breathing through gills, gar can take in oxygen by swimming to the surface and gulping air into their swim bladders. This ability to "breathe" surface air allows them to survive in water that has very little dissolved oxygen. They can even live out of water for many hours, as long as their bodies stay moist.
- Garfish eggs are poisonous to terrestrial wildlife.

The Minnow Family (Cyprinidae)

With 45 species—41 of them native—existing in the state, the minnow family is Minnesota's largest fish family. Minnows aren't necessarily small, and small fish aren't necessarily minnows.

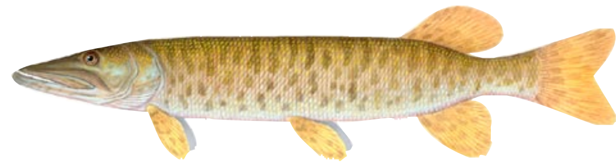
Minnows

- Minnows are a very important link in the aquatic food chain because they're a food source for many larger fish species.
- Many small minnow species are economically important to the state's bait industry.
- Some of the more common commercial minnow species include: fathead (crappie) minnows, finescale dace (rainbow chubs), hornyhead (red tail) chubs, northern redbelly dace (jumpers), and golden shiners.

Carp

- Carp are the largest members of the minnow family in Minnesota waters.
- Carp are the strongest swimmers of Minnesota's warm water species.
- Carp are invasive (non-native) species in Minnesota.

The Pike Family (Esocidae)



Pike are important top predators in aquatic ecosystems, and they help balance populations of smaller fish.

Muskellunge

- Muskellunge, also known as muskies, are the largest members of the Pike family.
- It takes five to seven pounds of live fish to produce one pound of muskie.
- Adult muskies can eat fish as large as one-third their own length. Younger muskies can eat fish almost as large as themselves.

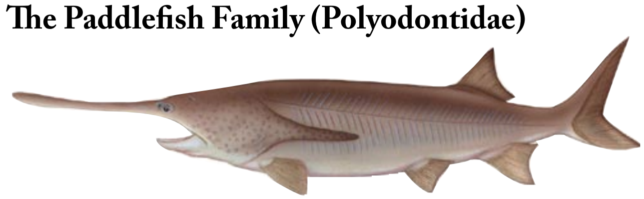
Northern Pike

- The northern pike is one of the world's most widely distributed species of freshwater fish.
- It's one of the fastest-growing freshwater fish.

Tiger Muskie

- This fish is a sterile hybrid cross of a muskellunge and a northern pike.

The Paddlefish Family (Polyodontidae)



- There are two species of paddlefish in the world, one in China and the other in North America. It's a fish of ancient origin, with a skeleton made of cartilage. Due to their long, canoe paddle-shaped snouts, they're sometimes called spoonbills.
- The snout of a paddlefish is covered in sensory organs that could be responsible for helping it find food.
- Although they're large fish, they grow slowly and eat tiny plants and animals called plankton.
- Paddlefish are quite sensitive to pollution and their numbers have greatly declined. They're a protected species in Minnesota.

The Perch Family (Percidae)

With eighteen species, the perch family is Minnesota's second largest fish family, which includes perch, walleye, sauger, and darters. Darters live only in North America—and fifteen species of these tiny fishes live in Minnesota.

Yellow Perch

- Like bluegills and other sunfish, yellow perch are considered panfish.
- They have several dark, vertical tiger stripes on their yellowish bodies.
- Yellow perch are a favored prey of walleye.

Walleye

- Although sometimes referred to as a walleye pike, it's not a member of the pike family.
- In 1965, the state legislature designated the walleye as Minnesota's state fish.
- Walleye refers to this fish's large, milky pupils. The inner part of the eye reflects light, allowing the fish to see in dark or murky water. This reflective membrane is called the tapetum lucidum, or bright carpet.
- Studies have shown that walleye live as long as 29 years in some waters.
- Minnesota's walleye stocking program is the largest in North America.
- A female walleye produces 40,000 to 250,000 eggs per season, depending on her size and condition.

Least Darter

- The least darter is the smallest fish in Minnesota. Actually, at one to one and one-half inches long, it's the smallest vertebrate animal in North America.

The Salmon Family (Salmonidae)

This family includes salmon, trout, whitefish, cisco, grayling, and char species. Like the catfish family, all fish in this family have an adipose fin on their backs between their dorsal and tail fins. Salmonids are cold-water fishes—they typically occupy waters colder than 72° F.

Trout

- Lake trout and brook trout are native to Minnesota.
- The Minnesota DNR stocks splake, a cross between male brook trout and female lake trout.
- Back in Minnesota's lumberjack days, logging outfits used to transport brook trout in milk cans and stock them in north woods streams. The fish then provided meals for loggers.
- Minnesota designates 3,700 miles of streams as trout habitat.
- Is the steelhead a salmon or a trout? This popular Lake Superior sport fish is actually a rainbow trout. The name refers to its steel-grey head. The steelhead migrates to sea as a juvenile and returns to fresh water to spawn as an adult.

Salmon

- Three species of Pacific salmon have been introduced to Lake Superior in the past few decades. All feed in the lake until they reach sexual maturity. In fall, they swim up rivers to spawn. They then die. The Chinook, or king salmon, is the largest and has best fared in its new environment.

The Sturgeon Family (Acipenserdiae)

Like the paddlefish, a sturgeon has a skeleton made largely of cartilage. There are two species of sturgeon in Minnesota: lake sturgeon and the smaller shovelnose sturgeon. A sturgeon's body is covered with large overlapping plates called skutes.

Lake Sturgeon

- Lake sturgeon are the largest fish in Minnesota.
- At the end of the 1800s, lake sturgeon eggs (caviar) were in high demand.
- Sturgeon grow slowly, but they live a long time, typically more than 100 years.
- Female lake sturgeon don't spawn until they're approximately 20 to 25 years old—and then just once every several years.
- Among Great Lakes Indians, the lake sturgeon was the most respected of all fish. The Ojibwe referred to it as Nahmay or Namé, meaning the king of fish.

Sucker Family (Catostomidae)

There are seventeen species of suckers in Minnesota.

Buffalo

- The bigmouth buffalo is Minnesota's largest member of the sucker family.
- Unlike other members of this family, the bigmouth buffalo has a mouth at the front of its face. It looks like a carp without barbels.
- One nickname for a bigmouth buffalo is baldpate—this fish has a large, bare head.

Blue Sucker

- The blue sucker is one of Minnesota's rarest fishes. A sensitive fish species that can be an indicator of water quality, it can't live in impaired waters.

Redhorse

- Minnesota has six of these species. Underneath their heads, they have mouths with thick soft lips. Even though each redhorse species has distinctively shaped lips that aid identification, they can be extremely difficult to tell apart.

White Sucker

- This is one of most common, numerous types of fish in Minnesota.
- White suckers are an important prey species for many other fish, including walleye and northern pike.
- White suckers are a popular commercial baitfish and are grown in ponds.

The Sunfish Family (Centrarchidae)

There are eleven species of sunfish in Minnesota, including the bluegill, pumpkinseed, crappies, largemouth bass, and smallmouth bass.

Bluegill

- Bluegill spawning beds, six to twelve inches in diameter, are found in shallow water. In some spots, as many as 50 beds may be clustered together. Spawning bluegills aggressively protect their spawning beds, attacking anything (even a hook) that comes near them. This makes them easy to catch during the spring.
- Members of this family are also referred to as panfish.
- Bluegill are the fish most often caught by Minnesota anglers. They're usually the first catch of beginning anglers.

Largemouth Bass

- This fish is a popular sport fish because it aggressively attacks lures and leaps out of the water when hooked.
- It takes about four pounds of food to produce every pound of largemouth bass.

Smallmouth Bass

- For its size, the smallmouth bass may be the hardest-fighting fish swimming in Minnesota's many waterways.
- Many of these fish have red eyes.

Crappie

- Minnesota is home to both white and black crappies—black crappies are more common.

Minnesota's Reputation for Good Fishing

As many as two million anglers wet their lines in Minnesota each year. Approximately 29 percent of Minnesota residents fish. As many as 1,500,000 fishing licenses are sold each year.

Approximately 49,700 Minnesota jobs are related to fishing, providing an economic benefit of 1.3 to 2.8 billion dollars annually.

In Minnesota, anglers spend 50 million dollars on bait annually.

More than 100 million pounds of fish are harvested from Minnesota waters each year—walleye: 35 million pounds, northern pike: 3.2 million pounds, and panfish: 64 million pounds.

Species most often caught, in order of prevalence, include: panfish (including bluegill, crappies, and yellow perch), walleye, and northern pike.

Of Minnesota's more than 10,000 lakes larger than ten acres, 5,493 are fishable.

There are 15,000 miles of fishable rivers and streams in Minnesota. Minnesota has 1,900 miles of trout streams.

The Minnesota DNR manages 3.8 million acres of fishing waters.

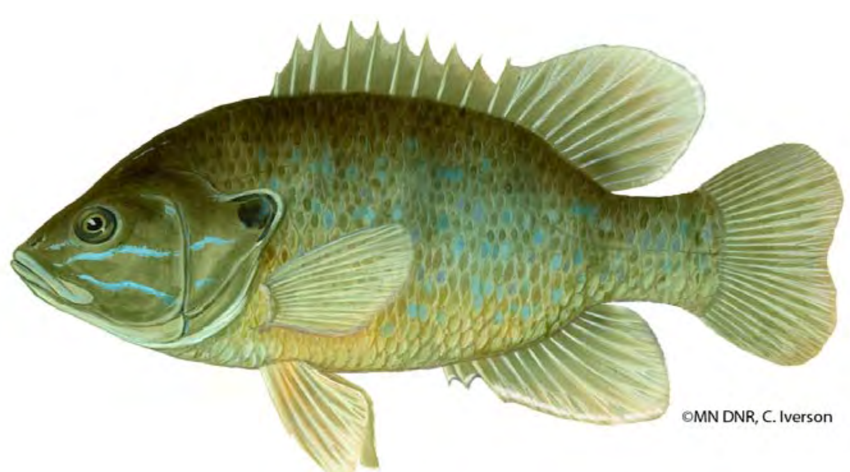
Minnesota fish hatcheries include five cold-water hatcheries (for trout and salmon), and twelve cool- and warm-water hatcheries (for walleye, muskie, catfish, and other fish).

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Minnesota Academic Standards Correlations

The lessons in the *Fishing: Get in the Habitat! MinnAqua Leader's Guide* have been developed from a comprehensive environmental systems perspective and are multidisciplinary and cross-curricular in nature. Many lessons cover a wide spectrum of topics.

All lessons are correlated to the Minnesota Academic Standards to illustrate the level to which each lesson addresses the learning Benchmarks within the Standards. Please note that the lessons in the *MinnAqua Leader's Guide* have not been developed to specifically meet the U.S. National Education Standards or the Minnesota Academic Standards. Specific requirements outlined within the Minnesota Academic Standards remain the responsibility of each instructor. We strongly encourage instructors to modify lessons from the *MinnAqua Leader's Guide* as they see fit. And although assessment suggestions and guidelines appear in each lesson, the instructor must still assess the students' work.



Addressing Benchmarks with Lessons in the *MinnAqua Leader's Guide*

Each lesson in the *MinnAqua Leader's Guide* lists Minnesota Academic Benchmarks addressed within that lesson.

This correlation represents the Minnesota DNR MinnAqua Program's interpretation of the Minnesota Academic Standards and their relation to the *MinnAqua Leader's Guide.*

Lesson *introduces* this Benchmark.
In the Minnesota Academic Standards Matrix, this symbol signifies that the lesson introduces some of the concepts and/or the language in the related Benchmark. By providing more specific emphasis and information, the instructor can expand on these concepts within the lesson, or in conjunction with another lesson, to address the Benchmark more fully.

Lesson *partially* addresses this Benchmark.
This symbol signifies that the lesson partially addresses the concepts, if not in the exact terms and/or language used in the Benchmark. By providing more specific emphasis and information, the instructor can expand on these concepts within the lesson or in conjunction with another lesson, to address the Benchmark more fully.

Lesson *fully* addresses this Benchmark.
This symbol signifies that the lesson fully addresses the concepts and language used in the Benchmark.

The MinnAqua Program sincerely hopes that you'll find these correlations useful as you incorporate the *Fishing: Get in the Habitat! MinnAqua Leader's Guide* into your curriculum.

4H Correlation Matrix

This matrix illustrates how 4-H participants can help meet various project area requirements by completing lessons and service-learning projects in *MinnAqua Leader's Guide* (for grades 3-5).

		Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish								
	Take the Bait	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Angling Skills	Let's Go Fishing!															
	It's a Clinch															
	Pop Can Casting															
	Casting Out															
Tackle Skills	Hook, Line, and Sinker															
	Tackling Tackle															
	Having the Right Stuff															
Aquatic Ecology	Clean Mean Fishing Machine															
	Home, Home on the Pond	X			X	X										
	Fishy Baits															
People And Fish	Kitchen Table Water Cycle															
	Which Fish Is It?								X	X	X	X				
	From Hook to Table															
	Sharp Teeth, Sharp Spine							X	X				X			

		Chapter 3: Water Stewardship							Chapter 4: Fish Management				
	Take the Bait	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Angling Skills	Let's Go Fishing!												
	It's a Clinch												
	Pop Can Casting												
	Casting Out												
Tackle Skills	Hook, Line, and Sinker												
	Tackling Tackle												
	Having the Right Stuff												
Aquatic Ecology	Clean Mean Fishing Machine												
	Home, Home on the Pond												
	Fishy Baits												
People And Fish	Kitchen Table Water Cycle	X		X	X	X							
	Which Fish Is It?												
	From Hook to Table												
	Sharp Teeth, Sharp Spine												

		Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
	Take the Bait	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Angling Skills	Let's Go Fishing!										X		
	It's a Clinch			X									
	Pop Can Casting			X									
	Casting Out		X										
Tackle Skills	Hook, Line, and Sinker		X										
	Tackling Tackle				X	X	X						
	Having the Right Stuff		X		X								
Aquatic Ecology	Clean Mean Fishing Machine				X								
	Home, Home on the Pond										X		
	Fishy Baits		X		X	X	X	X				X	
People And Fish	Kitchen Table Water Cycle												
	Which Fish Is It?												
	From Hook to Table												X
	Sharp Teeth, Sharp Spine												

continued

4-H Correlation Matrix (continued)

	Reel In the Fun	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
		1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tacklebox	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Angling Skills	Fishing on Line																		X											X										
Angling Skills	A Different Spin																												X											
Angling Skills	Turning the Crank																												X											
Angling Skills	Flying Far																												X					X						
Angling Skills	"Knot" Too Hard																														X									
People And Fish Tackle Craft	A Fine Kettle of Fish																																							X
People And Fish Tackle Craft	Clean Up the Litterbug																							X				X												
People And Fish Tackle Craft	Fishing by the Rules																							X																
Tackle Craft	Flashy and Fun																																X							
Tackle Craft	Making a Fly Wallet																																	X						
Tackle Craft	The Wooly Bugger																																	X						
Aquatic Ecology	Trapped in a Bottle				X		X																																	
Aquatic Ecology	What's in the Water?				X		X																																	
Aquatic Ecology	Fishy Smells Something							X	X				X																											
Aquatic Ecology	A Fish by Design							X	X	X	X	X	X	X																										

continued

4H Correlation Matrix (continued)

	Casting Into the Future	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish								
		1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Angling Skills	Sharing the Adventure													X		X
	A Reel Mess!															
	Designing a Skillathon Station															X
Tackle Skills	Beads, Dog Hair and Feathers															
	Making a Point															
	Customizing Plugs															
	Trash to Treasures															
Aquatic Ecology	Water, Water Everywhere															
	Collecting Aquatic Insects				X		X									
	What's Bugging You?															
People And Fish	Fishing Dilemmas															
	Cast into the Future															
	Keeping a Field Journal															
	Investigating Sportfishing Issues															
	Playing Know Your Fish									X	X	X				X

	Casting Into the Future	Chapter 3: Water Stewardship							Chapter 4: Fish Management				
		3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Angling Skills	Sharing the Adventure												
	A Reel Mess!												
	Designing a Skillathon Station												
Tackle Skills	Beads, Dog Hair and Feathers												
	Making a Point												
	Customizing Plugs												
	Trash to Treasures												
Aquatic Ecology	Water, Water Everywhere	X		X	X	X							
	Collecting Aquatic Insects												
	What's Bugging You?												
People And Fish	Fishing Dilemmas					X			X			X	X
	Cast into the Future												X
	Keeping a Field Journal												
	Investigating Sportfishing Issues								X	X		X	X
	Playing Know Your Fish								X				

	Casting Into the Future	Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
		5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tacklebox	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Angling Skills	Sharing the Adventure												
	A Reel Mess!		X										
	Designing a Skillathon Station												
Tackle Skills	Beads, Dog Hair and Feathers					X	X						
	Making a Point				X				X	X			
	Customizing Plugs					X							
	Trash to Treasures	X			X	X	X						
Aquatic Ecology	Water, Water Everywhere												
	Collecting Aquatic Insects												
	What's Bugging You?						X						
People And Fish	Fishing Dilemmas												
	Cast into the Future												
	Keeping a Field Journal												
	Investigating Sportfishing Issues												
	Playing Know Your Fish												

continued

4-H Correlation Matrix (continued)

		Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
	Sportfishing Helper's Guide	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tacklebox	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Planning For Success	Steps to a Successful 4-H Sportfishing Program																																							
	Evaluating Your 4-H Sportfishing Program																																							
	Ages And Stages of Youth Development																																							
	Teaching and Learning Experientially																																							
	Devleoping Skills For a Lifetime																																							
Developing Sportfishing Skills	Fish-Match Mixer																																							
	Let's Make Plans																																			X	X	X		
	Making Fish Prints							X																																
	Powder Painting Jigs																																X							
	Making Worms																																X							
	From Arbor to Albright Special																													X	X									
Fishing For Fun	Go Fish!																								X			X												
	Building a Watershed																X		X																					
	Planning a Fishing Trip																																					X		
	Boating Safety																																							
Playing Sportfishing Games	Fishing A to Z																												X	X	X	X	X	X	X					
	Playing PERCH Bingo															X																		X						
	Conducting a Sportfishing Quiz Bowl															X																								
	Sportfishing Skillathon Excitement																												X	X	X	X	X	X	X			X		
	Fun with Sportfishing Pyramid															X																								

Cub Scout Correlations Matrix

		Chapter 1: Aquatic Habitats					
		1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating
Scout Book	Scout Badge						
Cub Scout	Sharing Your World With Wildlife			5d			
Cub Scout	Family Outdoor Adventures						
Cub Scout	Water & Soil Conservation				E 15		
Webelos	Naturalist	11			2, 4	11	2, 3
Cub Scouts Academic & Sports Guide	Fishing						
Cub Scouts Academic & Sports Guide	Wildlife Conservation		×	×			

		Chapter 2: Minnesota Fish								
		2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Scout Book	Scout Badge									
Cub Scout	Sharing Your World With Wildlife					5a				
Cub Scout	Family Outdoor Adventures									
Cub Scout	Water & Soil Conservation									
Webelos	Naturalist					8				
Cub Scouts Academic & Sports Guide	Fishing									
Cub Scouts Academic & Sports Guide	Wildlife Conservation		×	×			×			

		Chapter 3: Water Stewardship						
		3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania
Scout Book	Scout Badge							
Cub Scout	Sharing Your World With Wildlife							5e
Cub Scout	Family Outdoor Adventures							
Cub Scout	Water & Soil Conservation			E15				
Webelos	Naturalist		11	8, 11	11	8, 11	8, 11	8, 11
Cub Scouts Academic & Sports Guide	Fishing							
Cub Scouts Academic & Sports Guide	Wildlife Conservation							

		Chapter 4: Fish Management				
		4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Scout Book	Scout Badge					
Cub Scout	Sharing Your World With Wildlife					5c
Cub Scout	Family Outdoor Adventures					
Cub Scout	Water & Soil Conservation					
Webelos	Naturalist					
Cub Scouts Academic & Sports Guide	Fishing	×				×
Cub Scouts Academic & Sports Guide	Wildlife Conservation		×			×

		Chapter 5: Fishing Equipment & Skills						
		5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks
Scout Book	Scout Badge							
Cub Scout	Sharing Your World With Wildlife							
Cub Scout	Family Outdoor Adventures							
Cub Scout	Water & Soil Conservation							
Webelos	Naturalist							
Cub Scouts Academic & Sports Guide	Fishing	×	×	×	×	×	×	×
Cub Scouts Academic & Sports Guide	Wildlife Conservation							

		Chapter 6: Safety & the Fishing Trip				
		6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Scout Book	Scout Badge					
Cub Scout	Sharing Your World With Wildlife					
Cub Scout	Family Outdoor Adventures			12d		
Cub Scout	Water & Soil Conservation					
Webelos	Naturalist					
Cub Scouts Academic & Sports Guide	Fishing	×	×	×	×	×
Cub Scouts Academic & Sports Guide	Wildlife Conservation					

This matrix illustrates how Cub Scouts (Bears and Webelos, aged eight to eleven) can meet requirements for Academic and Sports program belt loops and pins by completing lessons and service-learning projects from the *MinnAqua Leader's Guide*.

The numbers in the grid indicate the badge activity numbers related to lessons from the *MinnAqua Leader's Guide*. Each Cub Scout badge lists ten activities. Scouts must complete at least six of these activities to earn the corresponding badge. See *The Cub Scout Badge Book* (Bear or Webelos) for a description of the activities for each badge.

Girl Scout Correlations Matrix

Lessons and service-learning projects in the *MinnAqua Leader's Guide* (for grades 3-5) can help Junior Girl Scouts (between the ages of eight and eleven) meet numerous Activity requirements for earning badges.

Key: The numbers in this grid indicate the badge activity number related to the *MinnAqua Leader's Guide* lesson. Each Junior Girl Scout Badge has ten activities. Scouts must complete at least six of of those activities to earn the badge. See the *Junior Girl Scout Badge Book* ©2001 for descriptions of activities for each badge.

			Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
Badge Categories	Junior Girl Scout Badges	Service-learning Components for Chapters 3, 4, 5 & 6	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
1. Girl Scout Basics	Girl Scouting Around the World	8																																						
	Girl Scouting in My Future	1				1																									1	1				1	1		6(1)	1	
		8																																					10 (2)		
		10																																						
	Girl Scouting in the USA	10																																						
2. Adventures in Girl Scouting	Humans and Habitats																			9(3)																					
	Lead On	7																																						
		8																																						
	Model Citizen	9																																						
3. It's Great to be a Girl	Being My Best	1																																						
		9																																						
	It's Important to Me	10																																						
4. Family and Friends	Across	2																																						
	Generations	7																																						
	Local Lore	9											10																											
	My Community	7																																						
		9																																						
5. How to Stay Safe	The Choice Is Yours	4																																						
	First Aid																																			9				
6. Be Healthy, Be Fit	Environmental																			3	3	3												10				1				
	Health																																			4				
	Sports	9																												10	10	10	10	10	10	10	10	10	10		
	Sampler																																							
	Winter Sports																																7								

continued

Girl Scout Correlations Matrix (continued)

Badge Categories	Junior Girl Scout Badges	Service-learning Components for Chapters 3, 4, 5 & 6	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
			1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
7. Let's Get Outdoors	Camp Together					8																								2, 4			4								
	Earth Connections			5			5	9(4)	7	7				7		5, 7																									
	Eco-Action	3, 5, 8																																							
	Finding Your Way																			7																					
	Frosty Fun																																			7		1, 5, 8, 9			
	Outdoor Cook																																								2(5)
	Outdoor Creativity		1																																						
	Outdoor Fun																															8					1	1	1		
	Outdoors in the City	8				3																																			
	Plants and Animals										5		5											9																	
	Water Fun					8														7	7	7										6					1				
	Wildlife					2, 4, 7		7	4	4	4	4, 8	4	4	4		4						4	4											4						
	Your Outdoor Surroundings	4	9	10	10		10									10		10		4		4		10	4			4	4	5	5	5	5	5	5	5	1, 3	1	2		
8. Create and Invent	Art in 3-D													3 (6)						3																					
	Art to Wear								5																																
	Books														5																								7		
	Camera Shots																															3				3					
	Creative Solutions	7																																							
	Discovering Technology																																						4		
	"Doing" Hobbies	3, 8																												3, 6	3, 6	3, 4, 6	3, 6			7					
	Folk Arts														3																										
	"Making" Hobbies		6						6																																
	Math Whiz							7												9						5, 10															
	Prints and Graphics	8							3, 7			10			10																										
	Write All About It														5, 6																										

continued

Girl Scout Correlations Matrix (continued)

Badge Categories	Junior Girl Scout Badges	Service-learning Components for Chapters 3, 4, 5 & 6	Chapter 1: Aquatic Habitats — 1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	Chapter 2: Minnesota Fish — 2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	Chapter 3: Water Stewardship — 3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	Chapter 4: Fish Management — 4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	Chapter 5: Fishing Equipment & Skills — 5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	Chapter 6: Safety & the Fishing Trip — 6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
9. Explore and Discover	Rocks Rock	6																	10	10		10					10														
	Science Discovery	8				5, 8						5												7										9							
	Science in Every Day Life											10																													
	Water Wonders		8			5												1			2, 10																				
	Weather Watch																																					1 (7) 5	2 (8)		

(1) Planning a Fishing Trip—Girl Scouting in My Future Activity 6: This badge activity discusses Wider Ops and traveling. Activity 6 requires girls to look at the Wider Ops (now called Destinations) catalog and select a wider op and make tentative plans on how to travel there. A connection should be made between a wider ops destination and planning a fishing trip to fulfill this badge requirement.

(2) Planning a Fishing Trip—Girl Scouting in My Future Activity 10: This badge activity requires girls to plan a wider op for younger Girl Scouts. It's possible to fulfill the badge requirements if the students broaden the scope of the lesson to include planning and actually carrying out a wider op that includes a fishing trip.

(3) Wonderful Watersheds—Humans & Habitats Activity 9: Observe local geography from a watershed perspective. How do various land use practices impact water quality in the watershed?

(4) From Frozen to Fascinating—Earth Connections Activity 9: The lesson relates to fish, but not to birds or trees.

(5) Eating Fish—Outdoor Cook Activity 2: The requirements for this badge activity involve finding three recipes that use a common food, such as beans, rice, or potatoes, and preparing one of these recipes during a cookout. If cooking one of these food items is added to the lesson—along with cooking various fish recipes on a cookout—the lesson fulfills the badge requirement.

(6) Adapted for Habitat—Art in 3-D Activity 3: The 3-D medium is applicable, but the lesson doesn't incorporate Internet research.

(7) Safety & Fishing at the Water's Edge—Weather Watch Activity 1: This activity requires students to learn to read a weather map printed in a newspaper. Students must look for places where it's raining, hot, or cold, and form a weather prediction for their area using the given maps and information. This activity can be added into the weather safety portion of the lesson for planning a fishing trip.

(8) Ice Fishing & Winter Safety—Weather Watch Activity 2: This activity requires students to visit a weather station or interview a weather reporter or meteorologist about weather forecasting. Students must learn about various forms of equipment used to observe and predict weather. This activity can be added to the lesson for weather considerations for ice fishing safety.

Alphabetical List of Lessons

Academic Subjects Matrix

		Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
		1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
	Physical Education		×	×		×																×	×						×	×	×	×				×	×			
	Health & Safety						×									×				×																×	×			
	Expressive Arts	×			×		×	×	×				×	×			×	×	×													×	×					×		
	Math						×								×	×			×	×					×	×		×				×				×				
Language Arts	Speaking, Listening, Viewing	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×		×	×	×		×	×	×	×	×	×	×	×		×	×	×	×	×	
Language Arts	Writing				×				×				×	×		×	×	×				×		×												×				
Language Arts	Reading & Literature	×	×	×	×	×	×	×	×	×	×		×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		×		×
History & Social Studies	Government & Citizenship															×		×						×			×	×										×		
History & Social Studies	Economics															×					×			×			×	×												
History & Social Studies	Geography			×												×		×	×		×		×	×	×		×	×	×	×	×	×	×	×	×	×	×	×		×
History & Social Studies	Historical Skills													×		×																								
History & Social Studies	World History							×						×		×																								
History & Social Studies	Minnesota History			×										×		×		×	×																					
History & Social Studies	U.S. History													×		×																								
Science	Life Science	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×		×	×	×	×	×	×		×					×	×					×	×
Science	Earth & Space Science			×		×								×		×		×	×	×	×		×	×	×	×	×					×								×
Science	Physical Science														×	×	×									×							×							
Science	History & Nature of Science			×	×		×		×	×	×	×	×			×		×	×	×	×	×			×	×	×	×	×	×	×	×	×		×	×	×	×	×	
	Environmental Education	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

Academic Skills Matrix

Skills Matrix by Lesson

Chapter	Lesson	Analysis	Application	Calculation	Classification	Communication	Comparison	Computation	Construction	Debate	Description	Demonstration	Drawing	Drawing Conclusions	Estimation	Evaluation	Experimentation	Gathering	Generalizing	Graphing	Hypothesizing	Identification	Inference	Interpretation	Interviewing	Inquiry	Invention	Kinesthetic Concept Development	Large Group Skills
Chapter 1: Aquatic Habitats	1:1 Design a Habitat										X											X							
Chapter 1: Aquatic Habitats	1:2 Food Chain Tag	X	X															X						X				X	X
Chapter 1: Aquatic Habitats	1:3 Run For Your Life Cycle													X					X									X	X
Chapter 1: Aquatic Habitats	1:4 Water Habitat Site Study				X		X						X																
Chapter 1: Aquatic Habitats	1:5 Habitat Hideout								X																				
Chapter 1: Aquatic Habitats	1:6 From Frozen to Fascinating					X	X				X		X	X	X		X					X				X			
Chapter 2: Minnesota Fish	2:1 Fish Sense						X																						
Chapter 2: Minnesota Fish	2:2 Fins: Form & Function						X										X					X							
Chapter 2: Minnesota Fish	2:3 Fish Families				X																								
Chapter 2: Minnesota Fish	2:4 Using a Key for Fish ID					X	X															X				X			
Chapter 2: Minnesota Fish	2:5 Diving Into Diversity	X			X		X																			X			
Chapter 2: Minnesota Fish	2:6 Adapted for Habitat								X				X						X								X		
Chapter 2: Minnesota Fish	2:7 Fish Tales					X					X					X													
Chapter 2: Minnesota Fish	2:8 Fish in Winter													X						X								X	X
Chapter 2: Minnesota Fish	2:9 Fish Bowl					X																							X
Chapter 3: Water Stewardship	3:1 The Incredible Journey	X									X													X					
Chapter 3: Water Stewardship	3:2 Function of Aquatic Plants					X	X						X	X								X				X			
Chapter 3: Water Stewardship	3:3 Wonderful Watersheds						X										X												
Chapter 3: Water Stewardship	3:4 Would You Drink This Water?						X				X			X															
Chapter 3: Water Stewardship	3:5 The Lake Game		X											X															
Chapter 3: Water Stewardship	3:6 Macroinvertebrate Mayhem													X										X				X	X
Chapter 3: Water Stewardship	3:7 Mussel Mania																											X	X

Chapter	Lesson	Listening	Listing	Mapping	Matching	Measuring	Media Construction	Modeling	Observation	Ordering	Organization	Painting	Prediction	Presentation Skills	Problem Solving	Public Speaking	Reading	Recognition	Recording Data	Reporting	Researching	Roleplaying	Self/Peer Evaluation	Simulation	Small Group Work	Synthesis	Using Time & Space	Visualization	Writing
Chapter 1: Aquatic Habitats	1:1 Design a Habitat	X						X																				X	X
Chapter 1: Aquatic Habitats	1:2 Food Chain Tag																												
Chapter 1: Aquatic Habitats	1:3 Run For Your Life Cycle	X														X	X					X		X					
Chapter 1: Aquatic Habitats	1:4 Water Habitat Site Study								X																				
Chapter 1: Aquatic Habitats	1:5 Habitat Hideout																	X											X
Chapter 1: Aquatic Habitats	1:6 From Frozen to Fascinating					X			X		X		X	X					X	X					X				
Chapter 2: Minnesota Fish	2:1 Fish Sense								X			X																	
Chapter 2: Minnesota Fish	2:2 Fins: Form & Function	X						X	X							X									X				X
Chapter 2: Minnesota Fish	2:3 Fish Families		X														X								X				
Chapter 2: Minnesota Fish	2:4 Using a Key for Fish ID				X				X	X					X			X							X				
Chapter 2: Minnesota Fish	2:5 Diving Into Diversity								X					X		X									X				
Chapter 2: Minnesota Fish	2:6 Adapted for Habitat							X						X		X		X						X				X	X
Chapter 2: Minnesota Fish	2:7 Fish Tales	X	X								X				X		X				X		X		X				X
Chapter 2: Minnesota Fish	2:8 Fish in Winter																					X							
Chapter 2: Minnesota Fish	2:9 Fish Bowl	X	X								X						X								X				X
Chapter 3: Water Stewardship	3:1 The Incredible Journey										X																		
Chapter 3: Water Stewardship	3:2 Function of Aquatic Plants								X				X			X			X	X					X				
Chapter 3: Water Stewardship	3:3 Wonderful Watersheds							X	X										X										
Chapter 3: Water Stewardship	3:4 Would You Drink This Water?								X										X						X				
Chapter 3: Water Stewardship	3:5 The Lake Game	X							X						X		X					X							
Chapter 3: Water Stewardship	3:6 Macroinvertebrate Mayhem										X													X					
Chapter 3: Water Stewardship	3:7 Mussel Mania																					X		X					

continued

Academic Skills Matrix (continued)

Chapter	Lesson	Analysis	Application	Calculation	Classification	Communication	Comparison	Computation	Construction	Debate	Description	Demonstration	Drawing	Drawing Conclusions	Estimation	Evaluation	Experimentation	Gathering	Generalizing	Graphing	Hypothesizing	Identification	Inference	Interpretation	Interviewing	Inquiry	Invention	Kinesthetic Concept Development	Large Group Skills
Chapter 4: Fish Management	4:1 Fishing Regulations & Sportsmanship					X												X											
	4:2 Fish Surveys			X			X	X							X					X			X						
	4:3 Aquatic Plant Power	X					X							X			X			X									
	4:4 Town Meeting					X				X																			
	4:5 Fisheries Management & You					X																							
Chapter 5: Fishing Equipment & Skills	5:1 Freshwater Rods & Reels		X				X																					X	
	5:2 Casting a Closed-face Rod & Reel Combo		X			X																						X	
	5:3 Pop Can Casting		X			X																						X	
	5:4 Tackling Your Tackle Box																					X							
	5:5 Flashy Fish Catchers		X						X								X										X		
	5:6 Fool Fish With Flies																												
	5:7 Making Ice Fishing Jiggle Sticks		X			X			X			X																	
Chapter 6: Safety & the Fishing	6:1 Safety & Fishing at the Water's Edge		X	X								X										X						X	
	6:2 Ice Fishing & Winter Safety		X																			X						X	
	6:3 Planning a Fishing Trip					X			X																				
	6:4 Piscatorial Palate		X				X									X	X	X		X	X								
	6:5 Eating Fish		X				X							X															

Chapter	Lesson	Listening	Listing	Mapping	Matching	Measuring	Media Construction	Modeling	Observation	Ordering	Organization	Painting	Prediction	Presentation Skills	Problem Solving	Public Speaking	Reading	Recognition	Recording Data	Reporting	Researching	Roleplaying	Self/Peer Evaluation	Simulation	Small Group Work	Synthesis	Using Time & Space	Visualization	Writing
Chapter 4: Fish Management	4:1 Fishing Regulations & Sportsmanship	X												X			X				X	X							X
	4:2 Fish Surveys	X						X											X			X		X	X				
	4:3 Aquatic Plant Power					X			X				X						X					X	X				
	4:4 Town Meeting													X		X	X					X			X				
	4:5 Fisheries Management & You	X				X											X					X			X				
Chapter 5: Fishing Equipment & Skills	5:1 Freshwater Rods & Reels	X							X																				
	5:2 Casting a Closed-face Rod & Reel Combo								X																				
	5:3 Pop Can Casting								X																				
	5:4 Tackling Your Tackle Box	X			X				X					X				X							X				
	5:5 Flashy Fish Catchers	X							X																X	X			
	5:6 Fool Fish With Flies	X			X													X							X				
	5:7 Making Ice Fishing Jiggle Sticks								X						X										X				
Chapter 6: Safety & the Fishing	6:1 Safety & Fishing at the Water's Edge	X																X											X
	6:2 Ice Fishing & Winter Safety	X																				X		X					
	6:3 Planning a Fishing Trip			X													X				X				X				
	6:4 Piscatorial Palate								X				X							X	X								
	6:5 Eating Fish	X				X			X												X			X					

Seasons Matrix

Chapter 1: Aquatic Habitats	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run for Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating
Winter						X
Autumn				X		
Summer				X		
Spring				X		
All	X	X	X		X	

Chapter 2: Minnesota Fish	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Winter								X	
Autumn									
Summer									
Spring									
All	X	X	X	X	X	X	X	X	X

Chapter 3: Water Stewardship	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania
Winter							
Autumn							
Summer							
Spring							
All	X	X	X	X	X	X	X

Chapter 4: Fish Management	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Winter					
Autumn					
Summer					
Spring					
All	X	X	X	X	X

Chapter 5: Fishing Equipment & Skills	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks
Winter							X
Autumn							X
Summer							
Spring							
All	X	X	X	X	X	X	

Chapter 6: Safety & the Fishing Trip	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Winter		X			
Autumn	Activity 2				
Summer	Activity 2				
Spring	Activity 2				
All	Activity 1		X	X	X

Topics Matrix

The Environmental Literacy Scope and Sequence, ELSS, lists and defines numerous concepts that are important for building environmental literacy.

ELSS Concepts = *
Lesson defines topic = O
Lesson addresses topic = X
Varies depending on content = **

	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship						
	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania
Abiotic Factors *	X	X	X	X	X	X								X		X	X	X	X	X		X
Adaptations				X		X	X	O	X	X	X	O		X	**		X					
Angling		X	X										X	X						X		
Angling Equipment																						
Angling Skills					X						X											
Aquatic Ecosystem	O	O	O	O	X	O								X			O	O			O	O
Aquatic Macroinvertebrates	X	X		X																	O	
Aquatic/Fisheries Management		X	X	X										X			X	X	X	X		X
Aquatic Plants	O	X		O		O											O	X				
Bait																						
Biological Diversity	O	X	X	X		O					X	X		X			X	X		X	O	X
Biotic Factors *	O	O	O	O	O	O	X	X				X		X			X			X	X	X
Camouflage	X				O		X					O										
Careers													X	X						X		X
Carrying Capacity		O	O											O				X			X	X
Change & Constancy *		X				X						X		O		X	X	X		X	X	X
Community				X	X	X								X				X		X	X	X
Communication *	X						X						X			X			X	X		
Conservation		X	X	X										X		O		O	O	O		O
Cultural Perspectives		X	X				X						O	X								X
Cycles (Water, Life, Energy, Nutrient) *		O	O			X								X		O	O		X			O
Ecological Disturbance		X	X											X		X	X	X		X	X	X
Economics														O			X	X	X	X		X
Ecosystems	O	X	X	X	X	X						X		X		X		O		X	X	O
Endangered Species																						O
Energy		O		X										X		X						

	Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Abiotic Factors *					X	X	X	X		X	X	X	X	X	X	X	X
Adaptations										X	X						
Angling													O	O	O	X	X
Angling Equipment					X	O	O	O	O	O	O	O	X	X		X	
Angling Skills	X					O	O	O	O	O	O	O				X	
Aquatic Ecosystem	X	X	X										X	X	X	X	X
Aquatic Macroinvertebrates											O		X	X		X	
Aquatic/Fisheries Management	O	O	O	X	O								X	X	X		X
Aquatic Plants			O										X	X		X	
Bait									O	O	O		O	O		O	
Biological Diversity		X	X										X	X			X
Biotic Factors *		X	X	X	X					X	X		X	X		X	X
Camouflage																	
Careers	O	O	X	X	O	X	X	X	X			X	X	X	X		X
Carrying Capacity			X										X	X			
Change & Constancy *		X	X	X	X												X
Community	X	X	X	X	X								X	X	X		
Communication *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Conservation	X	X	X	X	O								X	X	X		X
Cultural Perspectives	X			X	X	X	X	X	X	X	X	X					X
Cycles (Water, Life, Energy, Nutrient) *		X	X										X	X			
Ecological Disturbance			X	X	X								X	X			X
Economics		X	X	O	O			X	O			X			X		X
Ecosystems			X	X	X										X		
Endangered Species	O																
Energy																	

continued

Topics Matrix (continued)

The Environmental Literacy Scope and Sequence, ELSS, lists and defines numerous concepts that are important for building environmental literacy.

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	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Environmental Impact	X	X	X	X									X	O		X	X	X	O	O	X	O	X		X	O	O	X							X	X	X		X
Erosion																	X	O		O					O	X													
Feedback *		X	X				X					X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Food	X	X	X		X									X														X	X	X	X	O	O	X	X	X		O	O
Food Chains/Webs	X	O																													X	X	X		X	X		X	
Function *	X						O	O	X	X	X	O	X	X		X	X	X	X			X	X		X	X	X	O	O	O	O	O	O	O	X	X			X
Habitat Restoration																	X	X		X		X			O	X	X												
Habitats*	O	X	X	O	O	X					X	X	X	X			X	X		X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X		
Health & Nutrition																			O		X						X												O
Identification/ Grouping*/ Classification				O	X	X	X	O	O	O	O	X					X				X	X	X	X	X			X	X	X	X	X	X	X			X	X	X
Individuals *	X	X	X	X	X	X	X	X											X	X			X	X		X	X	X	X	X				X	X	X	X		
Interdependence	X	O	X	X	O	X							X	X		X	X			X	O	O	X	X	X	X	X								X				X
Invasive Species				X		X														X		O	O												X	X			
Inventory				X		X															X		X	X	X	X	X	X	X	X	X			X	X	X	X		
Land Use				X									X	X		X	X	X	X	X			X		X	X	X								X	X	X		
Metamorphosis																					O												O						
Migration *			O																																				
Minnesota Fish							X	X	O	O	O	X		X									O	X			X				O	X	X		X	X		X	X
Monitoring/Surveys				X		X											X		X					O			X											X	X
Native Cultures													O																										
Natural Resources	X	X	X	X	X	X								X		X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X
Patterns *	X					X	X	X	X	X	X	X	X	X		X		X	X				X	X	X	X	X					X	X		X	X			
Photosynthesis		X		X		O								X			O																						
Pollution													X	X		X	X	X	O	O	O	X			X	X	X								X	X			X
Predator/Prey *	O	O	O					X	X			O		X								X									X	X	X		X	X		X	X
Properties *							O	O	O	O	O	O	X	X		X	X	X	X	X	X	X		X	X			O	O	O	O	O	O	O			X	X	X

continued

Topics Matrix (continued)

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	Chapter 1: Aquatic Habitats						Chapter 2: Minnesota Fish									Chapter 3: Water Stewardship							Chapter 4: Fish Management					Chapter 5: Fishing Equipment & Skills							Chapter 6: Safety & the Fishing Trip				
	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Recreation		X	X		X				X		X		X	X						O			O			O	O	O	O	O	O	O	O	O	O	O	O	X	X
Safety				X		X								X					X				X					O	O	O	O			O	O	O	O	X	O
Seasonal Change						O							X	O		X	X						X	X										X	X	X			
Senses							O		X				X																		X	X	X		X	X		X	
Shelters	X		O		O									X			X					X							X	X					X	X			
Similarities & Differences *		X	X	O	X	X	X	O	O	O	O	O	X	X			X	X	X		X	X	X	X	X	X	X	O	X	X	O	O	O	X	X	X	X	X	X
Stewardship			X										X	X		O	O	O	O	O	O	O	O		O	O	O								X	X	X		X
Stories (Myths, Fables, Legends, Folklore)													O			X																			X	X	X		
Structure *	O	X	X	X	X		O	O	X	X	X	O		X		X	X	X		X				X	X	X		O	O	O	O	O	O	O					X
Sunlight	X			X		O								O		X	O			X	X	X			O										X	X	X		
Sustainability	X	X											X	X			X	X	X	X	X	X	X		X	X	X								X	X	X		
Systems	O	O	O	X	X	X								X		X	X	O		X	X	X		X	X														X
Tackle																												O	O	O	O	O	O	O	X	X			
Tools				X	X	X							X	X										O	X		X	O	O	O	X	X	X	X	X	X	X		X
Trophic Levels		O	X	X							X																												
Water Quality	X			O		X								X		O	X	O	O	O	O	O		X	X	X	X					X			X	X	X		O
Watersheds																X	X	O	X	X	X					X	X								X	X	X		X

Unit Matrix

The *Fishing: Get in the Habitat! MinnAqua Leader's Guide* is versatile and interdisciplinary. The lessons can be used alone, integrated into an existing curriculum or program, or several lessons can be combined to form a thematic unit or strand. To create your own unit, see the Topics Appendix, or use one lesson from each chapter, or try all of the lessons in one chapter. A unit or strand that culminates in a fishing trip is infused with extra excitement and relevance as students complete the lessons that develop skills and lead up to the big day at the water's edge!

Strand/Unit	Chapter 1: Aquatic Habitats	Chapter 2: Minnesota Fish	Chapter 3: Water Stewardship	Chapter 4: Fish Management	Chapter 5: Fishing Equipment & Skills	Chapter 6: Safety & the Fishing Trip
Active (Indoor/Outdoor)	1:2—Food Chain Tag, 1:3—Run For Your Life Cycle, &/ or 1:5—Habitat Hideout	2:8—Fish in Winter	3:1—The Incredible Journey, 3:6—Macroinvertebrate Mayhem, &/or 3:7—Mussel Mania	4:1—Fishing Regulations & Sportsmanship (skits)	5:1—Freshwater Rods & Reels, 5:2—Casting a Closed—Face Rod & Reel Combo or 5:3—Pop Can Casting	6:1—Safety & Fishing at the Waters Edge &/or 6:2—Ice Fishing & Winter Safety
Expressive Arts (Indoor)	1:1—Design a Habitat	2:1—Fish Sense, 2:2—Fins: Form & Function, 2:6—Adapted for Habitat, &/ or 2:7—Fish Tales	3:1—The Incredible Journey (with story extension), 3:2—Function of Aquatic Plants &/or 3:3—Wonderful Water-sheds	4:1—Fishing Regulations & Sportsmanship	5:5—Flashy Fish Catchers	6:3—Planning a Fishing Trip
Communities (Indoor/ Outdoor)	1:4—Water Habitat Site Study, 1:2—Food Chain Tag, &/or 1:3—Run For Your Life Cycle	2:5—Diving Into Diversity & 2:3—Fish Families	3:6—Macroinvertebrate Mayhem	4:4—Town Meeting &/or 4:5—Fisheries Management & You	5:1—Freshwater Rods & Reels	6:3—Planning a Fishing Trip
Discovery or Inquiry & Investigation (Indoor/ Outdoor)	1:4—Water Habitat Site Study or 1:6—From Frozen to Fasci-nating	2:2—Fins: Form & Function &/or 2:9—Fish Bowl (as a unit wrap-up or assess-ment)	3:2—Function of Aquatic Plants	4:3—Aquatic Plant Power	5:5—Flashy Fish Catchers & either 5:2—Casting a Closed Face Rod & Reel Combo, 5:3—Pop Can Casting, or 5:7—Making Ice Fishing Jiggle Sticks	6:4—Piscatorial Palate & 6:1—Safety & Fishing at the Waters Edge
Fish Food (Indoor/Outdoor)	1:2—Food Chain Tag 1:4—Water Habitat Site Study	2:6—Adapted for Habitat	3:6—Macroinvertebrate Mayhem	4:1—Fishing Regulations & Sportsmanship	5:1—Freshwater Rods & Reels	6:1—Safety & Fishing at the Waters Edge & 6:4—Piscatorial Palate
Fishing & Environmental Issues (Indoor)	1:3—Run For Your Life Cycle	2:6—Adapted for Habitat	3:4—Would You Drink This Water?	4:3—Aquatic Plant Power or 4:4—Town Meeting	5:4—Tackling Your Tackle Box	6:5—Eating Fish
Heavy on Habitat (Indoor)	1:5—Habitat Hideout	2:6—Adapted for Habitat	3:7—Mussel Mania	4:2—Fish Surveys	5:6—Fool Fish With Flies	6:5—Eating Fish
Health & Safety	1:6—From Frozen to Fascinating	2:9—Fish Bowl	3:4—Would You Drink This Water?	4:3—Aquatic Plant Power (role of plants in healthy aquatic habitats)	5:2—Casting a Closed-face Rod & Reel Combo	6:1—Safety & Fishing at the Waters Edge, 6:2—Ice Fishing & Winter Safety &/or 6:5—Eating Fish
Interdisciplinary (Indoor)	1:3—Run For Your Life Cycle (phy ed)	2:7—Fish Tales (language arts)	3:2—Function of Aquatic Plants (biology)	4:2—Fish Surveys (math) & 4:4—Town Meeting (social studies)	5:5—Flashy Fish Catchers (creative arts)	6:5—Eating Fish (health)
Life Cycles, the Water Cycle, & Recycling (Indoor/ Outdoor)	1:3—Run For Your Life Cycle	2:1—Fish Sense	3:1—The Incredible Journey	4:1—Fishing Regulations & Sportsmanship	5:3—Pop Can Casting	6:1—Safety & Fishing at the Waters Edge
Loving Language (Indoor)	1:1—Design a Habitat	2:7—Fish Tales &/or 2:9—Fish Bowl	3:5—The Lake Game	4:1—Fishing Regulations & Sportsmanship &/or 4:4—Town Meeting		6:3—Planning a Fishing Trip

continued

Unit Matrix (continued)

Strand/Unit	Chapter 1: Aquatic Habitats	Chapter 2: Minnesota Fish	Chapter 3: Water Stewardship	Chapter 4: Fish Management	Chapter 5: Fishing Equipment & Skills	Chapter 6: Safety & the Fishing Trip
Math & Logic (Indoor)	1:5—Habitat Hideout &/or 1:6—From Frozen to Fascinating	2:4—Using a Key for Fish ID, 2:8—Fish in Winter &/or 2:9—Fish Bowl	3:2—Function of Aquatic Plants	4:2—Fish Surveys, 4:3—Aquatic Plant Power &/or 4:5—Fisheries Management & You	5:4—Tackling Your Tackle Box	6:1—Safety & Fishing at the Waters Edge, 6:4—Piscatorial Palate &/or 6:5—Eating Fish
Minnesota Winter (Indoor/ Outdoor)	1:6—From Frozen to Fascinating	2:8—Fish in Winter	3:1—The Incredible Journey	4:1—Fishing Regulations & Sportsmanship	5:7—Making Ice Fishing Jiggle Sticks	6:2—Ice Fishing & Winter Safety
Natural Resource Managers (Indoor)	1:3—Run For Your Life Cycle	2:4—Using a Key for Fish ID	3:3—Wonderful Watersheds &/ or 3:7—Mussel Mania	4:1—Fishing Regulations & Sportsmanship, 4:2—Fish Surveys &/or 4:5—Fisheries Management & You		6:5—Eating Fish
Similarities & Differences	1:4—Water Habitat Site Study &/or 1:5—Habitat Hideout	2:1—Fish Sense, 2:3—Fish Families &/or 2:5—Diving Into Diversity	3:4—Would You Drink This Water?, 3:6—Macroinvertebrate Mayhem &/or 3:7—Mussel Mania	4:3—Aquatic Plant Power	5:1—Freshwater Rods & Reels &/or 5:6—Fool Fish With Flies	6:4—Piscatorial Palate*
Stewardship (Indoor/ Outdoor)	1:1—Design a Habitat	2:6—Adapted for Habitat	3:5—The Lake Game	4:1—Fishing Regulations & Sportsmanship	5:3—Pop Can Casting	6:1—Safety & Fishing at the Waters Edge Consider capping this unit with a Service-learning project—see Service-learning Appendix
Strictly Fishing (Outdoor)	1:2—Food Chain Tag	2:5—Diving Into Diversity & 2:3—Fish Families	3:5—The Lake Game	4:1—Fishing Regulations & Sportsmanship	5:2—Casting a Closed Face Rod & Reel Combo or 5:3—Pop Can Casting	6:1—Safety & Fishing at the Waters Edge
Systems	1:2—Food Chain Tag, 1:3—Run For Your Life Cycle &/ or 1:6—From Frozen to Fascinating	2:4—Using a Key for Fish ID &/ or 2:8—Fish in Winter	3:1—The Incredible Journey & 3:2—Function of Aquatic Plants	4:3—Aquatic Plant Power, 4:4—Town Meeting &/or 4:5—Fisheries Management & You	5:5—Flashy Fish Catchers 5:6—Fool Fish With Flies	6:3—Planning a Fishing Trip
Watersheds (Indoor/ Outdoor)	1:4—Water Habitat Site Study	2:8—Fish in Winter	3:3—Wonderful Watersheds, 3:5—The Lake Game, &/or 3:6—Macroinvertebrate Mayhem	4:4—Town Meeting	5:6—Fool Fish With Flies	6:5—Eating Fish

* If you do this lesson, it is suggested that you culminate the unit with one of the fishing skills lessons 5:2, 5:3, or 5:7 and a fishing and safety lesson 6:1 or 6:2.

Locations and Settings Matrix

Chapter 1: Aquatic Habitats

Location	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating
Kitchen with Stove						
Computer Lab	Part 2 Optional					
Indoor/ Outdoor Gathering Area with Tables					X	
Lake/River				X		
Pond/ Stream	Part 2 Optional			X		Prep
Large Outdoor/ Indoor Open Area		X	X		X	
Indoor/ Outdoor Gathering Area	X					X

Chapter 2: Minnesota Fish

Location	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Kitchen with Stove									
Computer Lab							Optional		
Indoor/ Outdoor Gathering Area with Tables	X	X		X		X			
Lake/River									
Pond/ Stream		Part 2							
Large Outdoor/ Indoor Open Area								X	
Indoor/ Outdoor Gathering Area			X		X		X		X

Chapter 3: Water Stewardship

Location	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania
Kitchen with Stove							
Computer Lab							
Indoor/ Outdoor Gathering Area with Tables		X	X	X			
Lake/River							
Pond/ Stream							
Large Outdoor/ Indoor Open Area	X					X	X
Indoor/ Outdoor Gathering Area					X		

Chapter 4: Fish Management

Location	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Kitchen with Stove					
Computer Lab					
Indoor/ Outdoor Gathering Area with Tables		X	X	X	
Lake/River					
Pond/ Stream					
Large Outdoor/ Indoor Open Area					
Indoor/ Outdoor Gathering Area	X				X

Chapter 5: Fishing Equipment & Skills

Location	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks
Kitchen with Stove							
Computer Lab							
Indoor/ Outdoor Gathering Area with Tables			Warm-up & Parts 1 & 3	X	X	X	X
Lake/River							
Pond/ Stream					Extension		
Large Outdoor/ Indoor Open Area	X	Part 2	Part 2				
Indoor/ Outdoor Gathering Area		Parts 1 & 3					

Chapter 6: Safety & the Fishing Trip

Location	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Kitchen with Stove					Part 3
Computer Lab			Part 1		Part 2
Indoor/ Outdoor Gathering Area with Tables			Part 2		
Lake/River	Activity 2	Part 3		X	
Pond/ Stream				X	
Large Outdoor/ Indoor Open Area					
Indoor/ Outdoor Gathering Area	Activity 1	Parts 1 & 2		Warm-up	Part 1

Activity Timeline Matrix

Chapter 1: Aquatic Habitats

	1:1 Design a Habitat	1:2 Food Chain Tag	1:3 Run For Your Life Cycle	1:4 Water Habitat Site Study	1:5 Habitat Hideout	1:6 From Frozen to Fascinating
Extended time period						30 min/ week 4 weeks
Up to one week						
Several days						
Three hours or less						
120 minutes or less						
60 minutes or less	Part 2		X	Part 1	X	
30 minutes or less	Part 1	X		Prep Part 2		

Chapter 2: Minnesota Fish

	2:1 Fish Sense	2:2 Fins: Form & Function	2:3 Fish Families	2:4 Using a Key for Fish ID	2:5 Diving Into Diversity	2:6 Adapted for Habitat	2:7 Fish Tales	2:8 Fish in Winter	2:9 Fish Bowl
Extended time period									
Up to one week							X		
Several days									
Three hours or less									
120 minutes or less		Part 2			Part 2				X
60 minutes or less	X	Part 1		X		Part 2		X	
30 minutes or less			X	Prep	Part 1	Part 1		Prep	Prep

Chapter 3: Water Stewardship

	3:1 The Incredible Journey	3:2 Function of Aquatic Plants	3:3 Wonderful Watersheds	3:4 Would You Drink This Water?	3:5 The Lake Game	3:6 Macroinvertebrate Mayhem	3:7 Mussel Mania
Extended time period		Part 2					
Up to one week							
Several days		Part 3					
Three hours or less							
120 minutes or less	X		X				
60 minutes or less		Part 1			X	Part 1 Part 2	
30 minutes or less				X			X

Chapter 4: Fish Management

	4:1 Fishing Regulations & Sportsmanship	4:2 Fish Surveys	4:3 Aquatic Plant Power	4:4 Town Meeting	4:5 Fisheries Management & You
Extended time period					
Up to one week					
Several days					
Three hours or less				X	
120 minutes or less		X			
60 minutes or less	X		X		X
30 minutes or less					

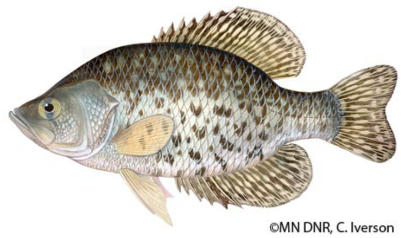
Chapter 5: Fishing Equipment & Skills

	5:1 Freshwater Rods & Reels	5:2 Casting a Closed-face Rod & Reel Combo	5:3 Pop Can Casting	5:4 Tackling Your Tackle Box	5:5 Flashy Fish Catchers	5:6 Fool Fish With Flies	5:7 Making Ice Fishing Jiggle Sticks
Extended time period							
Up to one week							
Several days							
Three hours or less		Part 2					
120 minutes or less					X		X
60 minutes or less	Part 1 Part 2	Part 1	X	X			
30 minutes or less						X	

Chapter 6: Safety & the Fishing Trip

	6:1 Safety & Fishing at the Water's Edge	6:2 Ice Fishing & Winter Safety	6:3 Planning a Fishing Trip	6:4 Piscatorial Palate	6:5 Eating Fish
Extended time period					
Up to one week					
Several days					
Three hours or less				X	
120 minutes or less	Activity 2	Part 3	X		
60 minutes or less	Activity 1				Part 3
30 minutes or less		Part 1 Part 2			Part 1 Part 2

Addressing Physical Disabilities



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The *MinnAqua Leader's Guide* was developed to provide equal opportunity for all participants to learn about Minnesota's fishing and aquatic resources and to develop angling and environmental stewardship skills. The Americans with Disabilities Act (ADA) intends to provide equal access to all aspects of work and life for people with disabilities. As a result, program and teaching professionals are obligated to provide equal access to programs unless undue hardship can be proven.

A little forethought and planning will help anyone feel more comfortable adapting lessons from the *MinnAqua Leader's Guide* to work for people with physical disabilities. This process includes the following steps.

Needs Assessment

The Needs Assessment helps gather information about an individual's abilities.

The best way to find information about an individual's abilities is to talk to the person or their parent or guardian. A personal care attendant or teacher may also be helpful, but privacy laws may limit information sharing. Fill out the Needs Assessment as completely as possible.

If someone with a physical disability comes to a program unannounced, as may be the case in nonformal programs or events, talk to the person about the abilities required for the activities planned. Establishing early rapport will make everyone more comfortable if the need arises to solve an issue about access or involvement. Requests for advance contact can also be made on public announcements and planning information. The MinnAqua Program requests this information on their participant release form.

Lesson Analysis

Use the Lesson Analysis as a guide. Read through the lesson and check off the physical tasks required in each step of the activity. Add tasks that may not be noted on the record.

Adaptation Guide

Use the Adaptation Guide to compare an individual's abilities with the tasks and abilities needed for the lesson. Changing the lesson is not always necessary. Sometimes just a clear understanding of how an individual might be involved is all that is needed.

Start by laying the completed Needs Assessment and Lesson Analysis record side by side. Look for the individual's abilities that match the activity's abilities and tasks. Record the matches on the Adaptation Guide.

Next, analyze procedures, location, or delivery style by filling out the Adaptation Guide. Review the completed Adaptation Guide before the activity and keep a copy with the lesson plan. Have fun and enjoy the program!

The ADA intends to protect people with a broad range of disabilities. Neither the author of this Appendix nor the Minnesota DNR make the claim that this process will meet the requirements of the ADA. This Appendix is merely meant as a guide, not legal process. The responsibility of meeting the ADA is the responsibility of the institution and professional offering the program. For more information on the ADA, search the Internet for the Americans with Disabilities Act, and refer to the home page.

Needs Assessment

Date of Program ________________ Group Name ____

Participant's Name ____ Total Number in Group __________

Description of Disabling Condition ____

Please describe the physical abilities and limitations.

Gross Motor (Ability to perform large muscle movements)
Does ________________ perform large muscle movements such as sit, walk, run, hop, jump, bend, throw, cast?

Pace and Endurance (Speed and distance limitations)
Does ________________ keep up with a group at a typical walking pace?
Can ________________ run short distances?
Can ________________ walk a half-mile?

Stability (Surface location and terrain limitations)
Do uneven or soft surfaces present a problem?

Fine Motor (Ability to manipulate objects)
Does ________________ perform fine motor skills such as grasp, cut, write, tie a shoelace?

Vision
Does ________________ have any vision impairment?
If yes, what does ________________ have the ability to see? Light? Shape? Color?

Hearing
Does ________________ have any hearing loss? If yes, what percent loss?

Sensory
Does ________________ have any other sensory impairments?

Personal Care Attendant
Will a Personal Care Attendant (PCA) or other assistant be accompanying? ________________

Equipment (Wheelchair, hearing devices, etc.)
Will ________________ bring any adaptive equipment? If yes, what types of equipment?

Final Suggestions
What suggestions do you have for us that will enable ________________ to be more effectively involved, engaged, or learn more easily?

Lesson Analysis

Date of Program ________ Lesson Title ________________________

Make a check mark next to the physical tasks used in the activity.

Gross Motor (What large muscle movements are required in this lesson?)

Sitting ______ Hopping ______ Throwing ______

Walking ______ Jumping ______ Casting ______

Running ______ Bending ______

Other, please list: ________________________

Pace and Endurance (How fast and how far are participants required to travel/move in this lesson?)
Pace:
Walking Slow ______ Walking Fast ______ Running ______

Distance:
25 yards or less ______ 50 yards ______ 100 yards ______

How far will the participants have to walk to the lesson or fishing site? ____________

Stability (Where will this lesson take place and on what type of terrain?)
Location:
Inside ______ Outside ______

Terrain:
Hard Surface (gymnasium, asphalt) ______ Lawn ______

Soft (sand, soft dirt) ______ Uneven Ground ______

Fine Motor (What fine motor movements are required in this lesson?)

Grasping ______ Cutting ______ Other (please list)

Writing ______ Knot-tying ______ ________________________

____

Sensory (What senses are used in this lesson?)

Sight ______ Taste ______ Touch ______

Hearing ______ Smell ______

Adaptation Guide

Date of Program ______________ Group Name ______________________________

Participant's Name ______________________________ Total Number in Group ________

Description of Disabling Condition ______________________________________

Task and Ability Matches
Compare the individual's abilities (Needs Assessment) to the tasks and abilities needed to do the lesson (Lesson Analysis). Note the matches in the space below.

Gross Motor
What procedures can be modified to minimize ability differences among participants? For example, change running to walking.

Pace, Endurance, and Stability
Can the activity location be moved to address concerns about pace, endurance, or terrain?

Fine Motor
What procedures can be changed or adapted to accommodate a particular ability or avoid a disability?

Sensory (Especially vision and hearing)
Where can tactile, auditory, or olfactory items be added to accommodate someone with a sight impairment?

Where can visual aids be added to accommodate someone with a hearing loss?

Personal Care Attendant
How or when might a helper assist the participant?

Comments/Additions

Chapter 1: Aquatic Habitats

See specific lessons for types and numbers of materials noted with an X.

	1:1—Design a Habitat	1:2—Food Chain Tag	1:3—Run For Your Life Cycle	1:4—Water Habitat Site Study	1:5—Habitat Hideout	1:6—From Frozen to Fascinating
Basic Fishing Equipment						
Bucket			2, ice cream-size	2		Clear gallon containers, 1 per group
First aid kit				X		
Insect repellent				X		
Pop can casters					X	
Sun protection				Sunscreen		
Ice Fishing Equipment						
Hand auger						X or chisel
Craft Supplies						
Construction paper	X	X or cardstock				
Craft items	Pipe cleaners, feathers, felt, glitter, construction paper, modeling clay, and any other art materials you have available				Self-stick velcro or magnets	
Glue	X	X			X	
Markers/crayons	X and whiteboard markers	Optional, permanent			X	
Newspapers/table covering				Tarps to sit on		
Paint	X (blue)					
Paintbrushes	X					
Paint trays	X					
Paper	Journal		Cardstock	X	Cardstock and regular paper, roll of butcher paper or newsprint	
String		Optional	Optional			
Hardware						
Dowels					3' dowels optional for fishing poles	
Nets				Dip nets		
Rake				X		
Rope		50-100'	500' and four 16' pieces			
Shovel				X		

Chapter 1: Aquatic Habitats

	1:1—Design a Habitat	1:2—Food Chain Tag	1:3—Run For Your Life Cycle	1:4—Water Habitat Site Study	1:5—Habitat Hideout	1:6—From Frozen to Fascinating
Office Supplies						
Box	1 shoebox per student, or use box template		2 shoeboxes			
Clipboards	X			X	X	X
Lamination		X	X		X or top-opening clip-on name badges	
Rubber bands						
Scissors	X	X			X	
Stapler	X					
Tape	Clear	Masking			Double sided	
Whiteboard	X					
Natural Materials						
Aquatic material						Bottom sediment
Plant material	Wooden sticks or twigs					
Rocks	Small					
Sand	Dry					
Water				Drinking water	Distilled, well, or tap water or melted snow	
Household Supplies						
Blue plastic wrap	X					
Clothes pins		X			X	
Clothing				Waterproof shoes, rubber boots, or waders		
Cups		1 per student plastic		Plastic		1 per group paper
Glass jars				Optional		
Hat						
Lamp						Fluorescent grow lights (optional)
Large eyeglass frames						
Nylon knee-high stockings						X or mosquito netting, 1 per group
Pans				3 or more white trays with sides		1 white tray with sides per group
Paper plates		Optional				
Paper towels/rags				X		

Chapter 1: Aquatic Habitats

	1:1—Design a Habitat	1:2—Food Chain Tag	1:3—Run For Your Life Cycle	1:4—Water Habitat Site Study	1:5—Habitat Hideout	1:6—From Frozen to Fascinating
Household Supplies (continued)						
Plastic bags		Optional				
Spoons				X		
Books, Multimedia, Copy Sheets, Photos, etc.						
8.5" x 11" images					Minnesota fish	
Copy sheets (provided in lesson)	Field Trip to a Pond Narrative, 1 copy; Fish Illustrations for Dioramas; Template for a Diorama Box, optional	Aquatic Food Chain Sheet; Aquatic Food Chain Cards; Food Chain Identification Tags	Northern Pike Life Cycle Sheet and Northern Pike Migration Sheet, for projection or to hand out; Northern Pike Life Cycle Cards; Kingfisher Name Tags; Playing Field Diagram, optional	Aquatic Insect Life Cycle Sheet and Water Habitat Site Study Check-off Sheet, 1 per student; Water Habitat Site Study Identification Sheets and Keys, 1 per group; Water Habitat Bingo Sheet (K-2 Option), 1 per student	Lake Habitat Sheet, River or Stream Habitat Sheet, and Fish Habitat Chart, 1 per student; Habitat Hideout Fish Identification Cards	Guide to What to Expect in the Mini-ponds, 1 per 2 students; Predictions and Summary Sheet, 1 per student; From Frozen to Fascinating Data Sheet, 12 per student
Internet access	X					X
Minnesota fish books	X			X, various pond life field guides		X pond books
Multimedia	Pond sounds recording			Camera and video on pond life, optional		
Water Habitat Site Study ID Sheets and Keys				X		
Miscellaneous Supplies						
Hula-hoops		2 or more			3	
Poker chips		500	100			
Noise maker		X	X	X		
Traffic cones		Several, optional	6			
Scientific Tools						
Dechlorinator						X
Disposable pipette						1 per group
Globe						X
Magnifying lenses				X		1 per group
Microscope						X
Thermometer						1 per group
Tweezers				X		

Chapter 2: Minnesota Fish

See specific lessons for types and numbers of materials noted with an X.

	2:1—Fish Sense	2:2—Fins: Form & Function	2:3—Fish Families	2:4—Using a Key for Fish ID	2:5—Diving Into Diversity	2:6—Adapted for Habitat	2:7—Fish Tales	2:8—Fish in Winter	2:9—Fish Bowl
Basic Fishing Equipment									
Bucket	One 5-gallon								
Pony spools						X			
Craft Supplies									
Confetti						X			
Construction paper						X			
Craft items					Assorted buttons and keys	X			
Fabric paint	X								
Glue			X			X			
Hot glue gun		1 per group							
Markers/crayons		White-board markers		X		X, and colored pencils		X	White-board markers
Newspapers/table covering	X					X			
Paint	X tempra					X			
Paintbrushes	X					X			
Paint trays	X					X			
Paper	X	Note-book		X		Drawing paper and butcher paper	Note-book and unlined art paper	8.5" x 11" paper and graph paper	
String		6', 1 per group				12" lengths of elastic string			
Hardware									
Milk crate or sturdy box						X			
Nets		Small fish net							
Office Supplies									
Clipboards			X						
Lamination			X						
Note cards									10 per group
Pencils		X	X	X		X	X		X
Rubber bands									
Scissors		X	X			X			
Office Supplies (continued)									

Chapter 2: Minnesota Fish

	2:1—Fish Sense	2:2—Fins: Form & Function	2:3—Fish Families	2:4—Using a Key for Fish ID	2:5—Diving Into Diversity	2:6—Adapted for Habitat	2:7—Fish Tales	2:8—Fish in Winter	2:9—Fish Bowl
Stapler						X			
Tape		Duct tape 1 per group		1 roll masking		X			X
Whiteboard		X						X	X
Natural Materials									
Plant material					Assortment of leaves		Talking stick		
Real fish	15-30 dead; live goldfish in bowl or aquarium, optional	Aquarium with fish							
Rocks		X							
Sand		X							
Water		Pool, tub, small pond, optional							
Household Supplies									
Backpack						2			
Bowl						Small			
Clothes line	X								
Clothes pins	X								
Clothing	T-shirts					Colorful, striped shirt & drab shirt			
Common objects of various shapes		X							
Earmuffs						Attach paper eyes			
Flashlight							X		
Food	Fish food, optional								
Glass jars		6-8 oz., 1 per group							
Hat						Large	Large		
Lamp							X		
Household Supplies (continued)									

Chapter 2: Minnesota Fish

	2:1—Fish Sense	2:2—Fins: Form & Function	2:3—Fish Families	2:4—Using a Key for Fish ID	2:5—Diving Into Diversity	2:6—Adapted for Habitat	2:7—Fish Tales	2:8—Fish in Winter	2:9—Fish Bowl
Large eyeglass frames						Lenses popped out			
Paper plates	1 per fish							200 6" Plates	
Paper towels/rags	X								
Plastic bags									
Plastic bottles with caps		1 round with cap per student; one flat-sided per student							
Vegetable scrubber	X								
Books, Multimedia, Copy Sheets, Photos, etc.									
8.5" x 11" images	Fish Anatomy illustration	Minnesota fish illustrations	Minnesota fish optional		Minnesota fish, optional				
Books, Multimedia, Copy Sheets, Photos, etc. (continued)									
Copy sheets (provided in lesson)	Fish Senses Sheets	Fish Fins Sheet; Fins: Form and Function sheet, 1 per student; Fins: Form and Function Answer Sheet	Fish Family Cards; Fish Characteristics Sheet, and Fish Families Sheet, 1 per group; Fish Families Answer Sheet	Dichotomous Key Warm-up Sheet; Definitions of the Parts of a Fish Sheet; Caudal Fin Shapes Sheet; Mouth Positions Sheet; Minnesota Fishes Dichotomous Key; Fish Identification Cards; Fish Identification Cards Answer Sheet	Fish Classification Part 1 Sheet; Fish Classification Part 2 Sheet; Fish Identification Cards, 1 per group	Fish ID Cards from Lesson 2:5-Diving into Diversity; Fish Adaptations and Advantages Sheet; Future Fish of the Year 4000 Sheet, 1 per student; Fish Adaptation Sheet, 1 per group	Tall Tales Research Sheet, 3 per group; Reviewing a Tall Tale Sheet 2 per student	Playing Area Diagram, optional	Sample Question Cards
Internet access							X		

Chapter 2: Minnesota Fish

	2:1—Fish Sense	2:2—Fins: Form & Function	2:3—Fish Families	2:4—Using a Key for Fish ID	2:5—Diving Into Diversity	2:6—Adapted for Habitat	2:7—Fish Tales	2:8—Fish in Winter	2:9—Fish Bowl
Books, Multimedia, Copy Sheets, Photos, etc. (continued)									
Minnesota fish books				Variety of fish ID books and keys, and one book of anything					
Multimedia		Video: *Bigmouth* or *Bigmouth Forever*							
Pictures		Illustrations of animal and plant parts	Various fish pictures from magazines						
Miscellaneous Supplies									
Bean bags						3			
Coin									X
Rubber fish	Optional								
Noise maker								X	X
Scientific Tools									
Funnels						Paper or plastic: 2			

Chapter 3: Stewardship

See specific lessons for types and numbers of materials noted with an X.

	3:1—The Incredible Journey	3:2—Function of Aquatic Plants	3:3—Wonderful Watersheds	3:4—Would You Drink This Water?	3:5—The Lake Game	3:6—Macroinvertebrate Mayhem	3:7—Mussel Mania
Basic Fishing Equipment							
Bait					Rubber worms		
Bucket		X	X or sink access	One-gallon	Two buckets		
Maps					Of local lake and surrounding area		
Craft Supplies							
Craft items	Art foam, non-toxic ink pads						
Felt			1 Light colored square per group				
Glue	X	X					
Hot glue gun	X						
Markers/crayons	X	X or colored pencils		Permanent		Whiteboard or regular markers	
Newspapers/ table covering			X				
Paint			X water color				
Paintbrushes			X				
Paper	Notebook or paper for each student	11" x 17" poster board or larger & colored paper	Notebook		Crumpled paper, candy wrappers, toilet paper, napkins	Chart paper per graph paper	100 + tightly crumpled paper balls
Hardware							
Dowels					One 3/4" diameter dowel with string attached and paper clip hook or magnet		
Liquid fertilizer		X					
Rope							50-100 ‘
Spray bottle			At least 6				
Wood blocks	2" square						

Chapter 3: Stewardship

	3:1—The Incredible Journey	3:2—Function of Aquatic Plants	3:3—Wonderful Watersheds	3:4—Would You Drink This Water?	3:5—The Lake Game	3:6—Macroinvertebrate Mayhem	3:7—Mussel Mania
Office Supplies							
Box	9 6" Cardboard cubes		Plastic, foil roasting pans, or cardboard with plastic lining 1 per student		Clear plastic box		
Clipboards	X	X					
Lamination					Contact paper		
Note cards					X		
Pencils	X	X	X	X		X	
Scissors		X	X		X		
Tape	X	X					X
Whiteboard						X	
Natural Materials							
Aquatic material		Aquatic plants, pond/lake/stream water, submerged pond plant, and algae				Aquatic insects	
Plant material			Leaves, grass clippings 1 tbs.				
Rocks			Various sizes, small enough to fit multiples in a shoe box				
Sand			1 tbs.		Or dirt		
Household Supplies							
Cups		Plastic & paper		Paper or plastic, dixie cup size & 1 clear 2-c measuring cup	One clear plastic cup		
Foil			Aluminum, 3' sheets, 1 per group				
Household Supplies (continued)							

Chapter 3: Stewardship

	3:1—The Incredible Journey	3:2—Function of Aquatic Plants	3:3—Wonderful Watersheds	3:4—Would You Drink This Water?	3:5—The Lake Game	3:6—Macroinvertebrate Mayhem	3:7—Mussel Mania
Food		Fresh celery with leaves, salt	1 Tbsp. vegetable oil; 1 Tbsp. sugar; 3 different brightly-colored powdered drink mixes and cocoa or iced tea powder, 1 Tbsp. each	Salt, ice tea & coffee creamer, onion extract	Molasses		
Food coloring			X	Green	Red and green		
Glass jars		X					
Paper towels/rags			X		Rags		
Pillow cases/burlap sacks						X	
Plastic bags			Small				
Plastic bottles with caps				6, small sized			
Small toys			X				
Sponge			Cellulose, light colored, cut into 1 per 2 inch thick strips				
Spoons				Plastic spoons for mixing			
Books, Multimedia, Copy Sheets, Photos, etc.							
8.5" x 11" images	Water Cycle	Emergent, submerged, and floating-leaf plants					
Copy sheets (provided in lesson)	Water Cycle Table; Incredible Journey Labels for Dice; Incredible Journey Station Sign; Pattern for a Cube	Nutrient Soup Report Sheet, 1 per student	Watershed Model Sheet	Would You Drink This Water? Data Sheet and Would You Drink This Water? Question Sheet, 1 per group	Roleplaying Cards; Discussion Cards	Macroinvertebrate Pollution Tolerance Level Chart; Macroinvertebrate Identification Tags; Macroinvertebrate Mayhem Data Table	"Zebra Mussels Crash on Mississippi River" Sheet; Plankton Sheet, 1 per student; Mussel Mania Playing Field Set-up (optional)

Chapter 3: Stewardship

	3:1—The Incredible Journey	3:2—Function of Aquatic Plants	3:3—Wonderful Watersheds	3:4—Would You Drink This Water?	3:5—The Lake Game	3:6—Macroinvertebrate Mayhem	3:7—Mussel Mania
Handouts							Zebra Mussel ID Cards
Minnesota fish books						Fish and aquatic insect field guides	Field guide to fresh water mussels
Books, Multimedia, Copy Sheets, Photos, etc. (continued)							
Multimedia		CD programs: *Restore your Shore* or *Save our Shorelines*					
Pictures		Wildlife & plant pictures			Loon and other wildlife		
Poster							Mussels of Minnesota
Miscellaneous Supplies							
Blindfolds				2 per group			
hula-hoops							2
Shaker					X		
Small fish					10 assorted small fish, as place holders		
Noise maker	X						
Sponge fish					At least 3 different colored fish silhouettes		
Scientific Tools							
Disposable pipette				X			
Globe				X			
Mounts/replicas							Legally collected mussel shell
Prism							
Secchi disk					X		

Chapter 4: Fish Management

See specific lessons for types and numbers of materials noted with an X.

	4:1—Fishing Regulations & Sportsmanship	4:2—Fish Surveys	4:3—Aquatic Plant Power	4:4—Town Meeting	4:5—Fisheries Management & You
Basic Fishing Equipment					
Bucket			One-gallon buckets, 1 per group, clear plastic container about shoebox size		
Current fish regs.	X	X			
Ruler					12-inch, 1 per group
Craft Supplies					
Craft items			1/2-cup glass beads or ball bearings per group		
Markers/crayons				Whiteboard markers; crayons, 1 box per group	
Paper		4" wide post-it notes, 1 package per 2 students	Graph paper	Butcher paper: 1 sheet per group & blank paper	
Hardware					
Nets		Small aquarium nets			
Office Supplies					
Box		Fish aquarium colored blue			
Pencils			X	X	
Whiteboard				X	
Natural Materials					
Plant material			4-6 leafy houseplants that cover the small pans		
Rocks			1/2-gallon large gravel mixture, 1 per group		
Sand			1 cup silt, mud, or very fine sand per group		
Water			2 gallons cool tap water		
Household Supplies					
Bowl		Fish bowl & plastic container 1 for every 2 students			
Calculator		1 per 2 students			
Cups			2 cups per group		
Food		300 beans per 2 students, white and brown; 1 large box of fish crackers			

Chapter 4: Fish Management

	4:1—Fishing Regulations & Sportsmanship	4:2—Fish Surveys	4:3—Aquatic Plant Power	4:4—Town Meeting	4:5—Fisheries Management & You
Household Supplies (continued)					
Hat		Baseball cap			
Lamp			2 with bulbs of same wattage		
Pans			2 8" x 8" dark pans		
Paper towels/rags			X		
Plastic bags		Sandwich size, 1 per 2 students			
Spoons			Large spoon		
Books, Multimedia, Copy Sheets, Photos, etc.					
8.5" x 11" images		Walleye			
Copy sheets (provided in lesson)	Sample Scavenger Hunt Questions; Angler Situation Cards 1 per group; Fishing Regulations Patrol Cards, 1 per student	Fish Survey Gear Cards; Lake MinnAqua Scenario and Tagging Survey Scenario; Fisheries Biologist Survey Training Sheet, and Lake Survey Data Sheet, 1 per student	The Next Generation Sheet; Be Cool Sheet, 1 per student	Concerned Citizen Group Roles Sheet; Concerned Citizen Group Duties Sheet, 1 per group; Lakeshore Property Sale Map	Fisheries Management & You Gameboard; Roleplaying Cards; Size Limit Fish Cutouts; Weigh Your Fish with a Ruler Chart, 1 per group
Minnesota fish books		*One Fish, Two Fish, Red Fish, Blue Fish* by Dr. Seuss			
Miscellaneous Supplies					
Die/dice					1 die per game
Place holders					6 per game
Scientific Tools					
Mounts/replicas		1 walleye mount			
Thermometer			2		

Chapter 5: Fishing Equipment & Skills

See specific lessons for types and numbers of materials noted with an X.

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:5—Flashy Fish Catchers	5:6—Fool Fish With Flies	5:7—Making Ice Fishing Jiggle Sticks
Basic Fishing Equipment							
35 mm film canister				X			
Adult helper	2 or more adult helpers or presenters with fishing and equipment experience	Ratio of 1:5	Ratio of 1:5				Ratio of 1:5
Bait casting rod and reel	X						
Bobbers		X	1 per student	1-inch round, one spring, one slip			X
Bucket							X
Casting plugs	6	1 per group	1 per student	X			
Casting targets	6	X					
Closed-face rod and reel	3	1 per student					X
Current fish regs.				X			
Fingernail clipper			5 or 6	X			X
First aid kit				X			X
Fish stringer				X			
Fishing license				Sample			
Fishing pole	X						
Fly rod and reel and reel	X						X
Hook sharpener				X			
Hooks		X	1 per student	Sizes 10, 8, 6, 2, and 1, 1 per student			X
Insect repellent				X			
Knot-tying rope		X	X				X
Maps				X			
Needlenosed pliers			5 or 6	X			X
Open-face rod and reel	3						
Personal flotation device							Throwable PFD
Pony spools			1 per student	X			X
Pop can casters	X						
Ruler				X			X
Split shot sinkers		X	1 per student	X			X

Chapter 5: Fishing Equipment & Skills

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:5—Flashy Fish Catchers	5:6—Fool Fish With Flies	5:7—Making Ice Fishing Jiggle Sticks
Basic Fishing Equipment (continued)							
Sun protection				Sunscreen, sunglasses, hat			
Tackle				Jig, plastic worm, straight-line spinner, spinnerbait, crankbait, surface lure, spoon: one of each type, collect various sizes; snap swivel, leader	variety of lures in different shapes, styles, and colors	Examples of flies especially dry flies and nymphs	Small tackle box with lures
Basic Ice Fishing Equipment							
Clip-on depth finder							X
Hand auger							X
Ice rescue claws							X
Ice scoop							X
Jiggle stick	X						Variety of types: jiggle stick, jigging rod, spinning combo, tip-up, rattle reel, etc.
Sled							X
Wool blanket							X
Craft Supplies							
Construction paper			X				
Craft items					Pipe cleaners, wiggly eyes, fabric scraps, sequins, self-adhesive mylar, feathers, fabric scraps		
Glue					Tacky glue, quick-drying		
Hot glue gun							
Newspapers/table covering							
Paint							

Chapter 5: Fishing Equipment & Skills

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:5—Flashy Fish Catchers	5:6—Fool Fish With Flies	5:7—Making Ice Fishing Jiggle Sticks
Craft Supplies (continued)							
Paper	Journal paper						
Hardware							
Dowels					1/2" diameter, cut into 3" lengths, 1 per student		3/4" diameter, 18" lengths
Square bend screws							X
Eye screws			K-2 option		1 per student		X
Office Supplies							
Box				Tackle box			
Pencils	X	X					
Rubber bands							X
Scissors			X		X		X
Tape			Masking, 3-4 rolls				
Household Supplies							
Empty pop cans			X				
Flashlight					X		
Glass jars					2, one with clear water, one with turbid water		
Lamp					X		
Plastic bags				Small plastic trash bag			
Books, Multimedia, Copy Sheets, Photos, etc.							
8.5" x 11" images							
Copy sheets (provided in lesson)	Freshwater Rods and Reels Sheet; Freshwater Rods and Reels Crossword Sheet; Fishing Rig Fill-in-the-Blank Sheet, 1 per student	Parts of a Closed-face Rod and Reel Combo Sheet; Tying an Improved Clinch Knot Sheet; The Perfect Rigging Sheet; Fishing Rod and Reel Maintenance, 1 per student	Pop Can Rigging Sheet; To Cast Your Line; Tying an Improved Clinch Knot Sheet, 1 per group	Tackling Tackle Cards and Tackling Tackle Checklist, 1 per 3 students; Tackling Your Tackle Box Price List, 2 per 3 students; Fish Information Cards and Fish Tackle Cards, 1 per group	Lure Types Reference Sheet; Underwater Light Quality Sheet, 1 per student or for projecting	Parts of an Insect Sheet, Aquatic Insect Life Cycles Sheet, and Fly Types Sheet, 1 per student; Go Fly Fish Cards	Making and Rigging a Jiggle Stick Sheet, Tying an Improved Clinch Knot Sheet, and Setting Bobber Depth Sheet, 1 per group; Basic Ice Fishing Equipment Cards
Handouts				Knot-tying cards			

Chapter 5: Fishing Equipment & Skills

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:5—Flashy Fish Catchers	5:6—Fool Fish With Flies	5:7—Making Ice Fishing Jiggle Sticks
Books, Multimedia, Copy Sheets, Photos, etc. (continued)							
Minnesota fish books					Books on fish and fishing		
Pictures				Mail-order catalog for fishing equipment	Underwater photos		
Miscellaneous Supplies							
Hula-hoops	6	1 per group	4 to 6				X
Noise maker				Whistle			
Play money				Optional			
Scientific Tools							
Prism					X		

Chapter 6: Safety & the Fishing Trip

See specific lessons for types and numbers of materials noted with an X.

	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety	6:3—Planning a Fishing Trip	6:4—Piscatorial Palate	6:5—Eating Fish
Basic Fishing Equipment					
Adult helper	Ratio of 1:5	Ratio of 1:5		Should have a ratio of 1:5 adults: children while fishing	
Bait	X	Wax worms, minnows, or eurolarva		Whole kernel corn, strawberries or other fruit, cheese or cheese spread, gummy candy products, hot dogs, bacon, marshmallows, potatoes, angleworms or night crawlers; scented bait—optional	
Bobbers	X				
Bucket		X			
Closed-face rod and reel	One per student				
Current fish regs.	X	X	X		
Fillet knife				X	X
Fingernail clipper	X	X			
First aid kit	X & cell phone	X & cell phone			
Fish stringer	X				
Fishing license	If over 16 years old	X			
Hooks	X	X			
Insect repellent	X				
Maps	X				
Needlenosed pliers	X	X			
Personal flotation device	Throwable and wearable	Throwable			
Ruler		X			
Split shot sinkers	X	X			
Sun protection	Sunscreen, sunglasses, hat				
Tackle		Basic ice fishing tackle			
Basic Ice Fishing Equipment					
Clip-on depth finder		X			
Ice hole mock-up		X			
Hand auger		X and power auger			

Chapter 6: Safety & the Fishing Trip

	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety	6:3—Planning a Fishing Trip	6:4—Piscatorial Palate	6:5—Eating Fish
Basic Ice Fishing Equipment (continued)					
Ice rescue claws		X			
Ice scoop		X			
Jiggle stick		X			
Sled		X			
Wool blanket		X			
Craft Supplies					
Construction paper			X		
Glue			X		
Markers/crayons			X		Permanent
Newspapers/table covering					X
Paint			X		
Paintbrushes			X		
Paint trays			X		
Paper			Poster board		
Office Supplies					
Clipboards	X	X		X	
Pencils	X	X		X	
Scissors			X		
Self-stick labels					Name tag
Natural Materials					
Real fish					For filleting & eating
Water	Drinking water				
Household Supplies					
Clothing	Long sleeves, long pants, jacket, sturdy shoes	Rubber-soled insulated boots, wool socks, snow pants, winter coat, long underwear, turtle neck, wool sweater, mittens, thin gloves, scarf muffler or neck gaiter, stocking cap			Fabric butcher gloves or filleting gloves
Cups	X	For hot chocolate			
Cutting board					X
Earmuffs		X			
Foil					X and waxed paper

Chapter 6: Safety & the Fishing Trip

	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety	6:3—Planning a Fishing Trip	6:4—Piscatorial Palate	6:5—Eating Fish
Household Supplies (continued)					
Food		Hot cocoa			Large bag of popcorn, 2 eggs, 1 c. bread or cracker crumbs, 1/2 c. butter or margarine, crackers
Pans					Cooking pans
Paper towels/rags					X
Plastic bags		Trash bags		Zip-locking style sandwich bags	6 1-gallon sized zip-locking & garbage bags
Books, Multimedia, Copy Sheets, Photos, etc.					
8.5" x 11" images					Fish anatomy
Copy sheets (provided in lesson)	Don't Get Hooked Sheet; MinnAqua Program Water's Edge Safety Overview; The Perfect Rigging Sheet, 1 per group; Safety and Site Evaluation Form; Safe Angler Certificate and Factoring in SPF Sheet, 1 per student; Factoring in SPF Answer Sheet	Dressing for Ice Fishing Word Finder Sheet, Ice Safety Sheet and Setting Bobber Depth Sheet, 1 per student	Planning a Fishing Trip Poster Guide, 1 for 3 students	Piscatorial Palate Question Sheet, 1 per student; Piscatorial Palate Data Sheet, 1 per group	Safe Eating Guide-lines Sheet and Basic Filleting Sheet, 1 per student; Fish Consumption Report for Sleepy Eye Lake and Fish Recipes Sheet, 1 per student or group
Internet access			X and a printer		X
Multimedia		*Danger, Thin Ice* Video, camera and underwater camera			
Miscellaneous Supplies					
Noise maker	Whistle	Whistle			

Craft Materials Matrix

See specific lessons for types and numbers of materials noted with an X.

	1:1—Design a Habitat	2:1—Fish Sense	2:2—Fins: Form & Function	2:6—Adapted for Habitat	5:5—Flashy Fish Catchers
Basic Fishing Equipment					
Bucket		One 5-gallon			
Tackle				Monofilament line—for K-2 option	Variety of lures in different shapes, styles, and colors
Craft Supplies					
Confetti				X	
Construction paper	X			X	
Craft items	Pipe cleaners, feathers, felt, glitter, construction paper, modeling clay, and any other art materials you have available			Modeling clay	Pipe cleaners, wiggly eyes, fabric scraps, sequins, self-adhesive mylar, feathers, fabric scraps etc.
Fabric paint		X			
Glue	X			X	Tacky glue, quick drying
Hot glue gun			1 per group		
Markers/crayons	X, and whiteboard markers		Whiteboard markers	X, and colored pencils	
Newspapers/ table covering		X		X	
Paint	X (blue)	X tempera		X	
Paint brushes	X	X		X	
Paint trays	X	X		X	
Paper	Journal	X	Notebook	Drawing paper and butcher paper	
String			6', 1 per group	12" lengths of elastic string	
Hardware					
Dowels					1/2" diameter, cut into 3" lengths, 1 per student
Milk crate or sturdy box				X	
Nets			Small fish net		
Eye screws					1 per student
Office Supplies					
Box	1 shoebox per student, or use box template				
Pencils			X	X	
Clipboards	X				
Scissors	X		X	X	X

Craft Materials Matrix

	1:1—Design a Habitat	2:1—Fish Sense	2:2—Fins: Form & Function	2:6—Adapted for Habitat	5:5—Flashy Fish Catchers
Office Supplies (continued)					
Stapler	X			X	
Tape	Clear		Duct tape, 1 per group	X	
Whiteboard	X		X		
Natural Materials					
Plant material	Wooden sticks or twigs				
Real fish		15-30 whole, thawed; live goldfish in bowl or aquarium, optional	Aquarium with fish		
Rocks	Small (1/4- to 1-inch)		X		
Sand	Dry		X		
Water			Pool, tub, small pond, optional		
Household Supplies					
Backpack				2	
Blue plastic wrap	X				
Bowl				Small, 2 quart	
Clothesline		X			
Clothespins		X			
Clothing		T-shirts		Colorful striped shirt, drab shirt	
Common objects of various shapes			X		
Earmuffs				Attach paper eyes	
Flashlight					X
Glass jars			6-8 oz. 1 per group		2, one with clear water and one with turbid water
Hat				Large	
Lamp					X
Large eyeglass frames				Lenses popped out	
Paper plates		1 per fish			
Paper towels/rags		X			
Plastic bottles with caps			1 round per student (with cap); 1 flat-sided per student		
Vegetable scrubber		X			

Craft Materials Matrix

	1:1—Design a Habitat	2:1—Fish Sense	2:2—Fins: Form & Function	2:6—Adapted for Habitat	5:5—Flashy Fish Catchers
Books, Multimedia, Copy Sheets, Posters, etc.					
Copy sheets (provided in lesson)	Field Trip to a Pond Narrative, 1 copy; Fish Illustrations for Dioramas; Template for a Diorama Box, optional	Fish Senses Sheets	Fish Fins Sheet; Fins: Form and Function sheet, 1 per student; Fins: Form and Function Answer Sheet	Fish ID Cards from Lesson 2:5--Diving Into Diversity; Fish Adaptations and Advantages Sheet; Future Fish of the Year 4000 Sheet, 1 per student; Fish Adaptation Sheet, 1 per group	Underwater Light Quality Sheet; Lure Types Reference Sheet, 1 per student or for projecting
8.5" X 11" images		Fish Anatomy illustration	Minnesota fish		
Internet access	X				
Minnesota fish books	X				Books on fish and fishing
Multimedia	Pond sounds CD or recording		Video: Bigmouth or Bigmouth Forever		
Pictures			Illustrations of animal and plant parts		Underwater photos
Miscellaneous Supplies					
Bean bags				3	
Rubber fish		Optional			
Scientific Tools					
Funnels				2, paper or plastic	
Prism					X

Basic Fishing Equipment Matrix

See specific lessons for types and numbers of materials noted with an X.

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:7—Making Ice Fishing Jiggle Sticks	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety
Basic Fishing Equipment							
Adult helpers	2 or more adult helpers or presenters with fishing and equipment experience	Ratio of 1 adult per 5 participants	Ratio of 1 adult per 5 participants		Ratio of 1 adult per 5 participants	Ratio of 1 adult per 5 participants	Ratio of 1 adult per 5 participants
Bait						X	Wax worms, minnows, or eurolarva
Bait casting rod and reel	X						
Bobbers		X	1 per student	One-inch round, one spring, one slip	X	X	
Bucket					X		X
Casting plugs	6	1 per group	1 per student	X			
Casting targets	6	X					
Closed-face rod and reel	3	1 per student			X	1 per student	
Current fishing regulations				X		X	X
Fillet knife				X			
Fingernail clipper			5 or 6	X	X	X	X
First aid kit				X	X	X & cell phone	X & cell phone
Fish stringer				X		X	
Fishing license				Sample		If over 16 years old	If over 16 years old
Fishing pole	X						
Fly rod and reel	X						
Hook sharpener				X			
Hooks		X	1 per student	Sizes 10, 8, 6, 2, 1, 1 per 0	X	X	X
Insect repellent				X		X	
Knot-tying rope		X	X		X		
Maps				X		X	
Needlenosed pliers			5 or 6	X	X	X	X

Basic Fishing Equipment Matrix

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:7—Making Ice Fishing Jiggle Sticks	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety
Open-face rod and reel	3						
Basic Fishing Equipment (continued)							
Personal flotation device					Throwable	Throwable and wearable	Throwable and wearable
Pony spools			1 per student	X	X		X
Pop can casters	X						
Ruler				X	X	X	X
Split shot sinkers		X	1 per student	X	X	X	X
Sun protection				Sunscreen, sunglasses, hat		Sunscreen, sunglasses, hat	
Tackle				Jig, plastic worm, straight-line spinner, spinnerbait, crankbait, surface lure, spoon: one of each type, collect various sizes: snap swivel, leader	Small tackle box with lures		Basic ice fishing tackle
Ice Fishing Equipment							
Clip-on depth finder					X		X
Hand auger					X		X and power auger
Ice scoop					X		X
Ice claws					X		X
Ice hole mock-up							X
Jiggle stick	X				Variety of types: jiggle stick, jigging rod, spinning combo, tip-up, rattle reel, etc.		X
Sled					X		X
Wool blanket					X		X

Basic Fishing Equipment Matrix

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:7—Making Ice Fishing Jiggle Sticks	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety
Craft Supplies							
Construction paper			X				
Paper	Journal paper						
Hardware							
Dowels					3/4" diameter, 18" lengths		
Eye screws			K-2 option		X		
Square bend screws					X		
Office Supplies							
Rubber bands					X		
Scissors			X		X		
Clipboards						X	X
Box				Tackle box			
Tape			Masking, 3-4 rolls				
Pencils	X	X				X	X
Natural Materials							
Water						Drinking water	
Household Supplies							
Clothing						Long sleeves, long pants, jacket, sturdy shoes	Rubber-soled insulated boots, wool socks, snow pants, winter coat, long underwear, turtle neck, wool sweater, mittens, thin gloves, scarf muffler or neck gaiter, stocking cap
Cups						X	For hot chocolate

Basic Fishing Equipment Matrix

	5:1—Freshwater Rods & Reels	5:2—Casting a Closed-face Rod & Reel Combo	5:3—Pop Can Casting	5:4—Tackling Your Tackle Box	5:7—Making Ice Fishing Jiggle Sticks	6:1—Safety & Fishing at the Water's Edge	6:2—Ice Fishing & Winter Safety
Empty, rinsed pop cans			X				
Hot beverages							X
Plastic bags				Small plastic trash bag			Trash bags
Books, Multimedia, Copy Sheets, Photos, etc.							
Copy sheets (provided in lesson)	Freshwater Rods and Reels Sheet; Freshwater Rods and Reels Crossword Sheet; Fishing Rig Fill-in-the-Blank Sheet, 1 per student	Parts of a Closed-face Rod and Reel Combo Sheet; Tying an Improved Clinch Knot Sheet; The Perfect Rigging Sheet; Fishing Rod and Reel Maintenance	Pop Can Rigging Sheet; To Cast Your Line; Tying an Improved Clinch Knot Sheet, 1 per group	Tackling Tackle Cards and Tackling Tackle Checklist, 1 per 3 students; Tackling Your Tackle Box Price List, 2 per 3 students; Fish Information Cards and Fish Tackle Cards, 1 per group	Making and Rigging a Jiggle Stick Sheet, Tying an Improved Clinch Knot Sheet & Setting Bobber Depth Sheet, 1 per group; Basic Ice Fishing Equipment Cards	Don't Get Hooked Sheet; MinnAqua Program Water's Edge Safety Overview; The Perfect Rigging Sheet, 1 per group; Safety and Site Evaluation Form; Safe Angler Certificate and Factoring in SPF Sheet, 1 per student; Factoring in SPF Answer Sheet	Dressing for Ice Fishing Word Finder Sheet; Ice Safety Sheet and Setting Bobber Depth Sheet, 1 per student
Handouts				Knot-tying cards			
Multimedia							Video: *Danger, Thin Ice*, camera and underwater camera
Pictures				Mail-order catalog for fishing equipment			
Miscellaneous Supplies							
Hula-hoops	6	1 per group	4 to 6		1 per 4 participants		
Noise maker				Whistle		Whistle	Whistle
Play money				Optional			