Chapter 4. Life in Water

Key Concepts:

- Life in water has different opportunities and challenges than life on land
- Different bodies of water provide different settings for living things
- Characteristic communities exist for each water habitat type

From microscopic bacteria to fish that weigh as much as some fifth graders, Minnesota waters are home to a wide range of living things. As with things that live on land, the biodiversity—mix of plants, animals, and other living things found in aquatic habitats—varies dramatically from one place to another, depending on variables such as temperature, chemical characteristics of the water, depth, availability of sunlight, season, presence of other living things, and more.

A Different Life

Life in water differs from life on land in many ways. For example:

- Because water is denser than air, plants are able to stand upright with less cell-wall support than plants on land need. Animals, also, can get by with a less rigid infrastructure. Some, like the freshwater jellyfish, have a well-defined shape in water, but collapse into a formless heap when taken out of the water.
- Water is a wonderful transporter. It helps deliver nutrients to plants as well as deliver food to animals. A freshwater mussel, for instance, can stay in one place on the bottom of a river without running out of food. As water flows over its mouth, it filters tiny plankton from the current. Water also helps some animals reproduce. Fish and frogs release sperm and unfertilized eggs into the water. The water provides a medium for bringing the two together to start new life.
- Underwater habitats make it possible for living things to move vertically, as birds do when they fly through the air, rather than just along a surface, as mice and moose do as they walk on land.
- Because water has a high specific heat, plants and animals that live in water enjoy more moderate temperature swings than their terrestrial cousins.

Some Minnesota water plants, such as sago pondweed and coontail, have pockets of air in their tissues that allow them to float at the surface of a lake or pond.


Coontail

Aquatic Communities

Just as different groupings of plants and animals are found in different habitats on land, various aquatic habitats harbor distinct communities of living things. Which creatures inhabit a particular portion of a lake, stream, or wetland depends on the many physical, chemical, and biological traits of the water body, including its size and three-dimensional shape of the water body; the temperature, acidity, clarity, and other traits of the water; the type of rock or soil underlying it; whether the water is moving or still; and what other things are living there. When you think of the diversity of combinations of these and related characteristics that occur across Minnesota, it's not surprising that aquatic communities are many and varied as well.

Although aquatic communities vary widely, they share one important trait with each other and with land-based communities: Energy flows through them in an eat-and-be-eaten network known as the food web. Roughly speaking, all aquatic life forms can be divided into five groups, depending on how they obtain their energy.

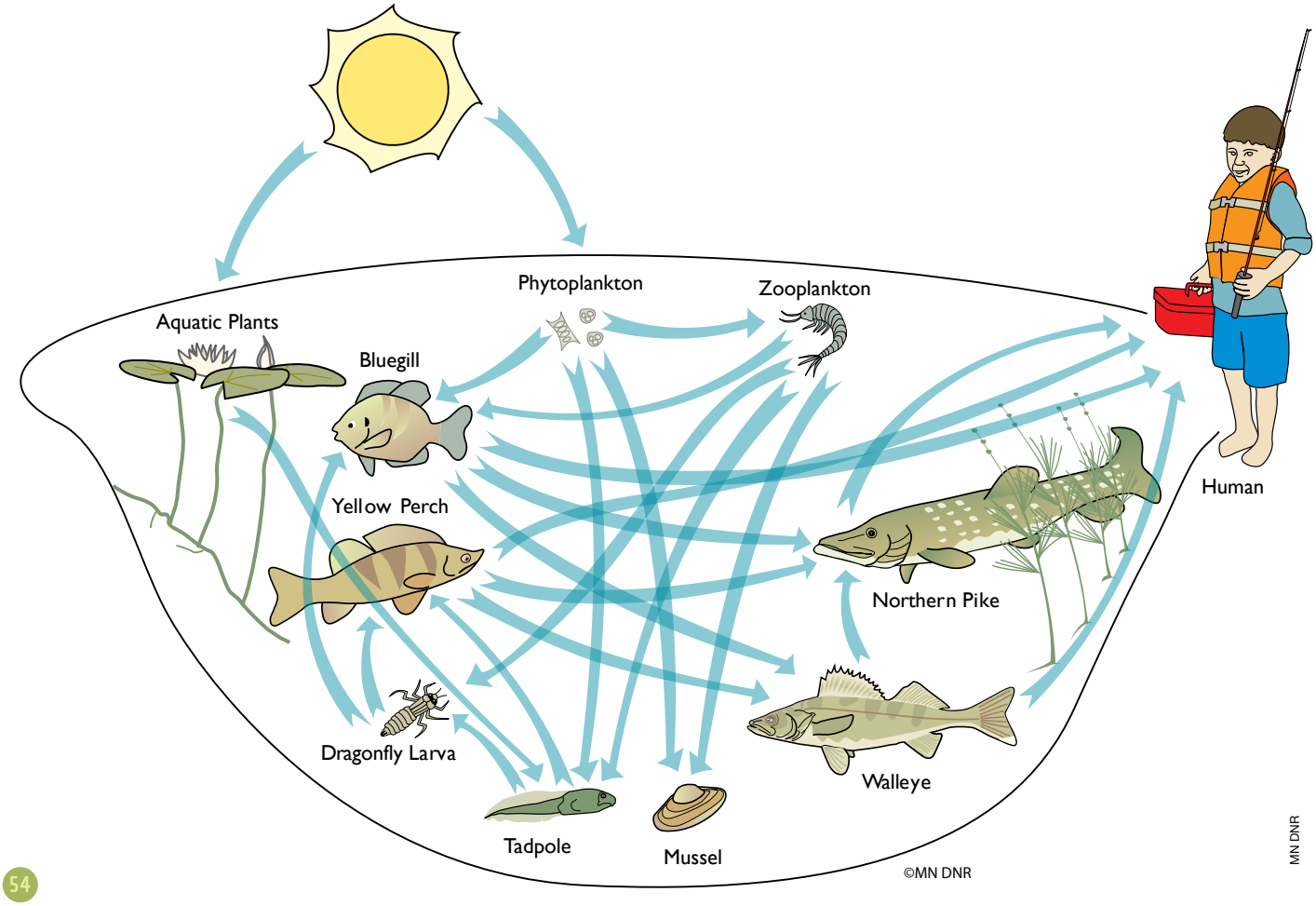
Primary producers are living things that capture energy from the nonliving environment—most often in the form of sunlight. Plants are the best-known primary producers. Other primary producers that provide energy to aquatic ecosystems include protists, such as chlamydomonas, and autotrophic bacteria such as cyanobacteria (blue-green algae).

Primary consumers are organisms that eat primary producers. Primary consumers common to Minnesota waterways include daphnia, fairy shrimp, tadpoles, and mosquito larvae.

Secondary consumers eat primary consumers. Minnesota examples include painted turtles, perch, and crayfish.

Tertiary consumers eat secondary consumers. Northern pike, loons, and otters are among water creatures that are tertiary consumers.

Decomposers are organisms that break down nonliving organic material (e.g., dead plants or feces) back into its constituent molecules. Aquatic fungi and some bacteria belong to this category.



Life in Running Water

Imagine spending your days in front of a very large fan that is continually blowing you in one direction. That's a bit like what life is like for plants and animals that live in running water. As water rushes downstream, they either have to literally "go with the flow," or find a way to hold themselves in place.

Rich Range

Running water is home to a rich range of living things. Some are tiny: Bacteria, phytoplankton, and zooplankton can be too small to see, or look like specks in a handful of stream water. Larger plants, macroinvertebrates, frogs, turtles, and fish are also part of the picture. All these life forms together can broadly be divided into four groups: floaters, drifters, swimmers, and sedentary life forms. Floaters and swimmers may travel with the water or propel themselves against it. Some, such as fish and tadpoles, have special shapes that make it easier for them to defy the current. Drifters, such as phytoplankton and zooplankton, more or less always go with the flow. Sedentary forms of life use gravity, hooks, and other structural or behavioral adaptations to anchor themselves in place. Some, such as black fly larvae, hold their own against the current by anchoring themselves to rocks. Others, such as crayfish, hide behind obstacles that deflect the flow. Mussels' streamlined shape helps them avoid tumbling downstream. Even suction comes in handy in the case of snails and leeches.

The quantity and specific types of living things in each stream varies with the physical and chemical characteristics of the stream. Particularly important are physical traits such as water speed and temperature, stream shape, water **turbidity,** and nature of the material on the bottom of the streambed. The fast-flowing brooks that arise in the Sawtooth Range along the North Shore of Lake Superior are home to a different mix of species than the sluggish streams flowing through farmland in the south, rich with sediment and nutrients. Large rivers are deep and wide, with plenty of habitat and productivity to support fish as big as the 70-pound flathead catfish that was caught in the St. Croix River in 1970.

Minnesota streams tend to show a gradient of increasing amounts of organic material and increasing biological productivity from the northeastern part of the state to the southwest. Thus, a southwestern waterway is likely to have a denser fish population than a northeastern waterway does.

Not Fish. When you think of river life, what comes to mind? Many people think of fish as the primary inhabitant of running water. In reality, however, insects are generally more abundant in Minnesota's running waters.

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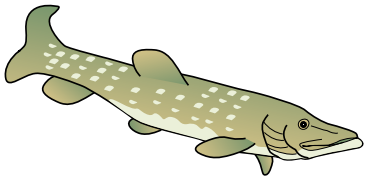
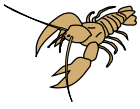
Floaters

Drifters

Swimmers



Sedentary life forms



Macro-what? Benthic macroinvertebrates are animals without backbones that are large enough to be seen by the unaided eye and live in or on the sediment at the bottom of lakes, rivers, and wetlands. Many of them live in the bottom of waterways for just a portion of their life cycle.

Researchers pay attention to macroinvertebrates because they are excellent indicators of water quality. Some macroinvertebrates (caddis fly larvae, mayfly larvae, stonefly larvae) are intolerant of poor water quality and either move away or die off when the water isn't clean enough or cool enough. Other macroinvertebrates (midge larvae, giant water bugs, mosquito larvae) are tolerant of poor water quality and can survive well where others cannot. Monitoring how many of which types of macroinvertebrates live in a stream is a relatively simple way to track the stream's health. Researchers and volunteers worldwide collect, categorize and compare which macroinvertebrates they find in their local streams to track the water's health.

Macroinvertebrates are not only excellent indicators of water quality, but their alien features make them a tremendous hit in the classroom. Whether students are fascinated or squeamish, macroinvertebrates draw them in. A stream or pond study near your school or even just observing macroinvertebrates in the classroom is an excellent way to engage your students.

Caddis Fly Larvae

Stonefly Larvae

Mayfly Larvae

Dragonfly Larvae

Bryozoan Balls. If you're big on "ick," you'll be hard pressed to come up with a better creature to get to know than bryozoans. Found attached to rocks or docks in streams around Minnesota, these invertebrates form colonies that resemble lumpy balls of slime-beige jello. Among the oldest forms of life on Earth, bryozoans help clean the water around them by filtering out detritus and algae for food. Check it out on the Internet—or better yet, in a slow-moving stream or pond near you!

Along the Way

Just as physical and chemical characteristics vary from stream to stream, habitat varies along a stream's course, creating different mixes of creatures in different parts of the same stream. This idea of the existence of a gradation in habitat and biotic communities is known as the river continuum concept.

At the headwaters, water tends to move quickly and sediment loads are low. Because the stream is narrow, much of it may be shaded. These conditions make these waters great habitat for fish like trout that like cool water and need a relatively silt-free bottom surface for successful spawning. Nutrients flow in from the surrounding land.

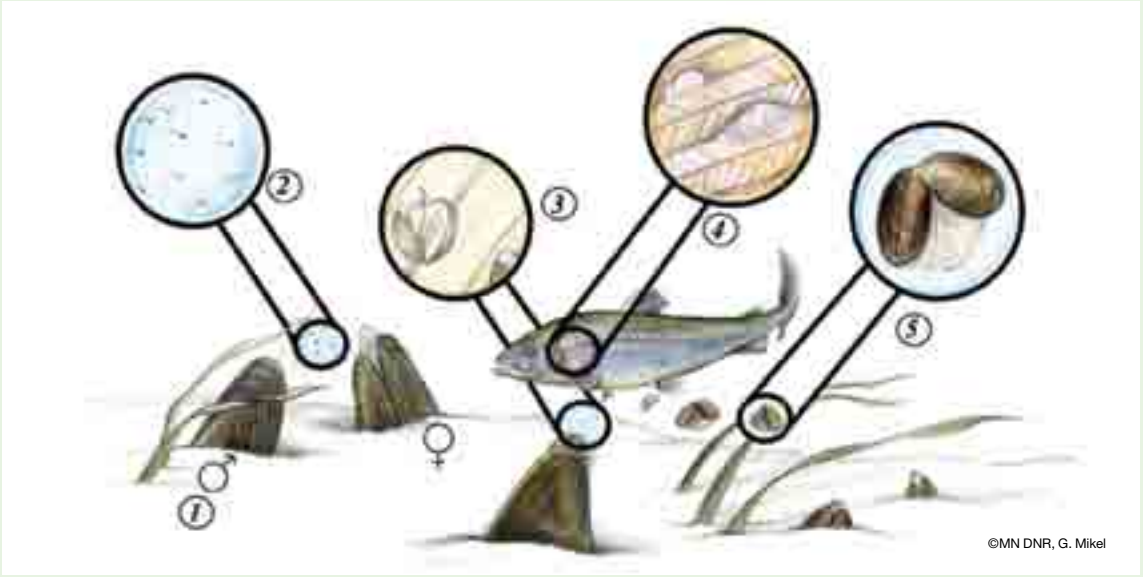
Midcourse, in what's known as the transfer zone, water carries sediment stirred up from upstream. By this point the water has collected a lot of organic material for filter feeders such as mussels to eat. Plant life tends to be rich in this part of a streambed.

In the lower part of a stream, called the depositional zone, water moves more slowly across a broader area. Sediments picked up by the river float along in the water, decreasing the availability of light to rooted plants. Fish in these stretches tend to be plankton eaters, such as carp and catfish.

Even within one part of stream living conditions vary. Fast-flowing waters are interspersed with pools and backwaters of relatively quiet water, each with its own unique habitat characteristics. The variety is valuable to living things; stretches of a river with diversity in structure and materials provide richer habitat than more homogeneous stretches. Riffles (stretches of more turbulent water) provide important habitat for young fish, mussels, insects, and other invertebrates that prefer them over more placid places. Trees along the edges of rivers provide welcoming shade to fish and invertebrates and help keep the water cool.

Mussels are easily harmed by habitat disruption, sediment, and chemical pollutants. Because of human activity, more than half of Minnesota's 48 native species of mussel have been extirpated or are listed as endangered, threatened, or of special concern.

Where Baby Mussels Go to Grow. Bottom-dwelling mussels lack the ability to move very far on their own. So how do they disperse? When it comes time to send their young out into the world, they enlist the aid of organisms with more mobility. A female mussel releases her young, called glochidia, into the water when a fish swims by. Some glochidia attach themselves to the fish's gills. When they metamorphose into juveniles, they fall off—potentially some distance from where their odyssey began.



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Life in Lakes

As is the case with rivers, biotic communities vary both from lake to lake and within a lake. The actual species that make up any one habitat depends on a variety of factors, including climate, **geomorphology,** land use, water depth, hydrologic history, and water chemistry characteristics such as pH and nutrient content.

Minnesota is home to 14 species of frogs and toads.

Lake to Lake

We saw in Chapter 2 that each lake has unique physical characteristics. In the same way, each lake has its own biological fingerprint as well.

The clear, cool, deep lakes of northern Minnesota with their rocky shores have relatively few nutrients to support plant life and an extensive "dark zone" below which plants can't grow. Because of the coolness (cool water holds more oxygen than warm water) and the lack of demand for oxygen by plants, these lakes can support life forms such as trout that have high oxygen needs.

Because of geomorphology and land use, lakes in southern Minnesota tend to be shallower and more nutrient rich than those in the north. Vegetation is abundant, and fish and other animals are limited to those species that can survive in relatively warm, low-oxygen conditions. Clear Lake in Jackson County, for example, has a maximum depth of 9 feet and is rich with algae. Common fish in this lake include yellow perch, black bullheads, channel catfish, and freshwater drum.

Example Cool Water Fish Species

Brown Trout

Rainbow Trout

Brook Trout

Lake Trout

Example Warm Water Fish Species

Channel Catfish

Yellow Perch

Black Bullhead

Freshwater Drum

Littoral Zone

The littoral zone is the part of a lake where light reaches to the bottom. With abundant sunlight, nutrient input from land, and organic debris frequently stirred up by waves, the littoral zone is a riot of biological richness. Near shore, rooted emergent plants such as wild rice and bulrushes stand tall above the water's surface, providing shelter for ducklings, young fish, tadpoles, snails, and other invertebrates. Insects and insect larvae swim at or below the surface or cling to plants, providing abundant food for the larger animals. In some lakes, snapping turtles lurk near submerged objects, waiting for pretty much anything that looks like a meal to float or swim by.

One of Minnesota's more famous lake occupants is the common loon, *Gavia immer.* Some 12,000 loons spend the summer on our lakes, torpedoing beneath the surface in pursuit of perch or bluegills or perched high on a bundle of dried grasses waiting for eggs to hatch. Their solid bones help them dive, and their red eyes help them see underwater. Loons are well known for the haunting sounds they make as they call to one another or announce their territory. They are unusual among birds in that they are better adapted to aquatic life than they are to terrestrial life, with legs so far back on their bodies that the best they can muster on land is an ungainly waddle. The loon was named the state bird of Minnesota in 1961.

Slippery Stuff. If you've ever had to pull a littoral-zone plant off your fishhook, you may have noticed that parts of it seem particularly slimy. The slime is not part of the plant, but a whole world of other plant and even animal species living on it. If you had a microscope, you could find a variety of one-celled and multiple-celled creatures comprising the slime.

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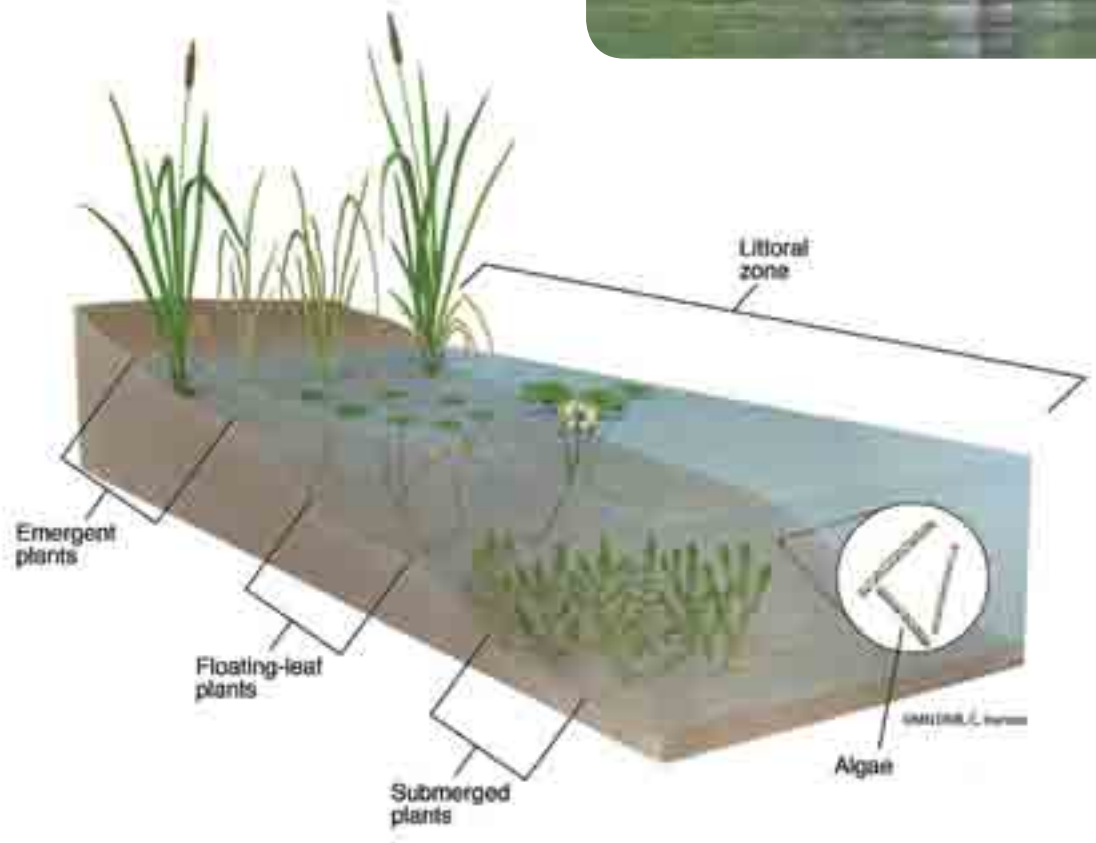

Limnetic Zone

The limnetic, or open-water zone, begins where the water becomes deep enough that light does not reach the bottom. Vegetation found in this zone is floating rather than attached to the bottom of the lake.

Fish are well-known occupants of the limnetic zone. Which fish live in which lakes, and in which parts of lakes, varies dramatically with traits of the fish and traits of the lake. *Oligotrophic* lakes—lakes with clear, cool water—for example, can support trout. Lakes with more nutrients, known as *mesotrophic* lakes, are better suited for walleye, perch, northern pike, and their kin. *Eutrophic* lakes, rich with nutrients, support crappies, largemouth bass, sunfish, suckers, and carp.

The limnetic zone is also home to plankton, microscopic plants and animals that thrive in a myriad of forms and under a myriad of conditions. Plankton show interesting variations in abundance and location over time. On a daily basis, some undergo a vertical migration, rising upward in the water column during the day and dropping down toward the bottom at night. Over the course of a summer, the types of plankton ebb and flow as well, with diatoms dominant in spring, green algae prevailing in June and July, blue-green algae peaking at the end of the growing season, and diatoms once again emerging in late fall.

Diatoms

Profundal Zone

The profundal zone is the area of open water below which not enough light penetrates to support photosynthesis. Even though it is by definition a dark place, the profundal zone is not lifeless. Fish and zooplankton thrive here, nourished by nutrients washed into the lake or captured by the algae above.

Benthic Zone

The benthic zone is the bottom of the lake. Invertebrates thrive here, nourished by the rich rain of energy-bearing dead creatures, waste products, vegetation, and other materials carried down through the water column. Examples of animals living at the bottom of Minnesota lakes include mussels, dragonfly nymphs, worms, and bottom-feeding fish.

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Buried Alive. In the fall, painted turtles dig their way into the muck at the bottom of a pond or lake. They remain there, buried alive, until changes in the water above them signal that spring has arrived.

Ducks, Snails, and Itchy Swimmers. Many a Minnesotan who has enjoyed a swim on a warm summer's day has ended up with a close encounter with Schistosome cercariae, one of our less welcome water inhabitants. *S. cercariae* is a tiny flatworm that lives in the digestive tract of waterfowl and other animals that inhabit lakes. The flatworm's eggs are shed in the host animal's feces and hatch in the water into young called miracidia. The miracidia are picked up by snails that inhabit shallow water. Inside the snails, the miracidia morph into another form called cercariae. After several weeks, the cercariae leave the snail in search of a host for their adult phase. If a cercaria happens to be in a water droplet attached to you as you leave the lake, it will try to burrow into your skin to survive as the droplet dries. Your body's immune system will quickly kill it, leaving you with an itchy red spot at the scene.

Swimmer's itch is most common in late June and early July. You can minimize your chances of a close encounter by not attracting waterfowl to your swimming area, not swimming in shallow water when the wind is blowing toward shore, keeping beaches clear of debris that harbors snails, and toweling off briskly when you leave the lake.

Life in Wetlands

Just as there are many kinds of wetlands, there are many kinds of plant and animal communities that inhabit them. In wetlands where there is standing water, the species might be similar to those found in the littoral zone of a lake—small fish, cattails, water lilies, snails, and a variety of plankton. Cold, acidic bogs harbor a unique mix of plant species adapted to thrive under the unique conditions they present, such as sphagnum moss and pitcher plants.

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Pitcher plant.

Wetland Plants

Wetland plants have it made when it comes to water and nutrients. Both are found in abundant amounts in these soggy habitats. But wetland plants also face special challenges. The waterlogged soil in which they are rooted has little oxygen, so survival demands adaptations that reduce the oxygen needs of roots or help them obtain it from somewhere other than the pores in the soil. Many wetland plants have special airspaces in their tissue that allow oxygen absorbed above water to travel to submerged tissues, including roots.

Sphagnum moss, of course, is the iconic species in peat bogs. It may be accompanied by tussock cottongrass (a sedge) or by a variety of broad-leaved plants. An interesting type of adaptation that has evolved in several bog plants is the ability to trap and dissolve insects and other tiny animals. Bladderwort, sundew, and pitcher plant all have special structures that allow them to attract and capture prey, then dissolve it and extract needed substances from the remains. This trait is commonly found in habitats low in nitrates and ammonia, nutrients plants need to grow.

A number of Minnesota shrub and tree species have adaptations that allow them to thrive in wet habitats. Willows, with their flexible branches, can stay standing in the face of the ebb and flow of changing water levels. Black ash, black spruce, and tamarack have adaptations that allow them to tolerate substantial moisture in the soil. As in other habitats, what grows where is linked to physical, chemical, and biological traits of the setting. Northern white cedar will grow in a wetland with rich, high-pH (basic) soil for instance, while tamarack is more likely to be found on acidic soils that have a low-pH and lack abundant nutrients.

Black Spruce

MN DNR

Wetland Animals

The abundant vegetation of wetlands is attractive to animals that eat plants—and as a result, to the animals that eat plant-eaters as well.

Many kinds of birds spend time in wetlands. Ducks, geese and swans use them for nesting during the summer and for resting on their spring and fall migrations. Grebes, herons, and other long-legged birds spend their days fishing among the vegetation with their long spearlike bills.

Perhaps the most common wetland bird species is the red-winged blackbird. Found in abundance throughout the United States, this bird nests among emergent vegetation. Its distinctive "conk-a-reeee" song is often one of the first signs of spring in Minnesota.

When it comes to mammals, muskrats are probably among the most abundant in Minnesota wetlands. These water lovers not only eat cattails and other wetland plants, they also build their homes out of them. Muskrat lodges have been found up to 9 feet in diameter.

Smaller animals commonly found in Minnesota wetlands include tadpoles, dragonfly larvae, fairy shrimp, snails, clams, salamanders, and snakes.

Tiger Salamander

Red-winged Blackbird

Sandhill crane colt.

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Land Life Meets Water

Plants and animals that spend all their time in the water are most intimately associated with lakes, rivers, streams, and wetlands. But creatures that spend time on land use bodies of water in many ways, too. In fact, riparian areas (the land along rivers and lakes) are among the richest of all habitats. Moose, ducks, osprey, raccoons, otters, loons, herons, and many other birds and mammals forage for food in lakes and rivers. Salamanders, frogs, dragonflies, and other insects use them as breeding grounds. Some turtles and amphibians winter in the mud at the bottom.

Birds use lakes and rivers as navigational aids when migrating. Hawk Ridge in Duluth sees a remarkable concentration of raptors each fall as south-migrating birds encounter Lake Superior and funnel down its shore to the southwestern corner. More than 300 species birds use the Mississippi River as a navigational highway. Four out of every 10 waterfowl in North America migrate south along this river.

Beavers have a particularly interesting relationship with waterways: They not only benefit from them, but dramatically alter them, too. Beavers cut down trees with their teeth and use the logs and branches to build dams across flowing waters, creating ponds on which they build their lodges, also made of cut-down trees. A beaver dam can be 100 feet long. Some dams are taller than a person!

Bullfrog

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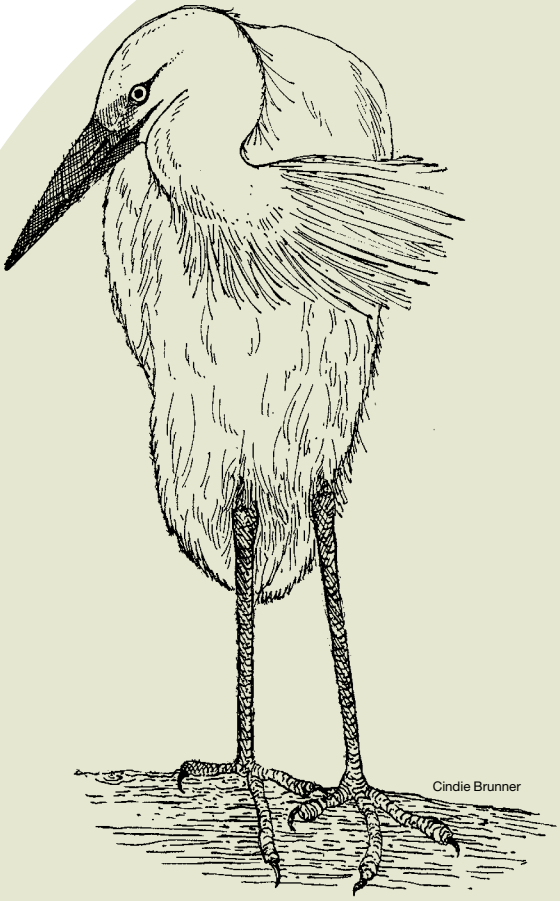
River otter.

Snowy Egret



Cindie Brunner

CAREER PROFILE

Bernard Sietman
Malacologist,
Minnesota DNR
St. Paul

If you think you're immersed in your work, you should see Bernard Sietman. He's often in it over his head—literally. A malacologist (mussel scientist) with the DNR, Sietman spends some of his workdays in scuba gear sampling mussels at the bottom of the Mississippi or St. Croix rivers.

Mussels are among the world's most imperiled animals. Past problems with water quality in the Minnesota eliminated these aquatic invertebrates from many of the state's waters. Sietman studies mussels and habitat to understand where various species of threatened, endangered, and rare mussels live or historically lived, and what they need to survive. He then reintroduces mussels to areas from which they have been eliminated. To do that, he and colleagues survey rivers and lakes. They learn about when female mussels reproduce, and determine suitable host species for larval mussels, which must attach themselves to fish to survive. They then use information from their research and that of other scientists to grow juvenile mussels and reintroduce them to suitable areas within their historic range.

When he's not in scuba gear, Sietman conducts laboratory experiments to learn more about how various fish serve as hosts for microscopic mussel larvae. He also shares the results of his studies with others so they can help save mussels, too.

Sietman became fascinated with the diversity found among mussel species when he was taking an aquatic invertebrates class in college and has been working with mussels ever since. He says a sense of curiosity and experience in the outdoors are valuable attributes for success in his field. "Go fishing, camping, and hiking," Sietman recommends. "Wade around in a stream and get wet and dirty. Observe and appreciate nature." A college degree in biology or environmental science—preferably a graduate degree—is important preparation as well.

Related careers:
fisheries biologist,
ecologist

Suggested Project WET Activities and Minnesota Connections

EL = elementary | MS= middle school | HS=high school

Water is essential for all life to exist

Aqua Bodies (water in living things) EL

The Life Box (basic needs) EL

Life in the Fast Lane (wetland species needs) EL, MS, HS

Water Address* (adaptations) EL, MS, HS - Activity cards and pictures of Minnesota species.

Water resources are managed

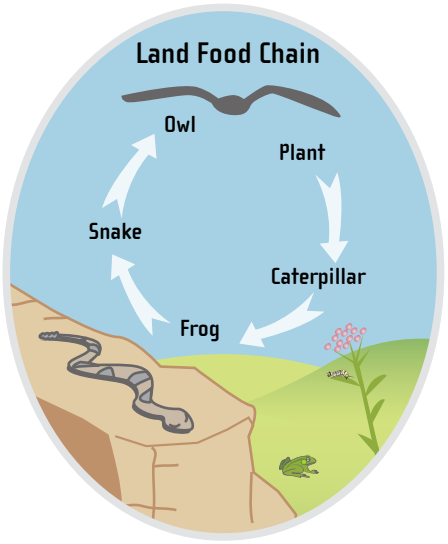
Macroinvertebrate Mayhem* (benthic macroinvertebrates & water quality) EL, MS - Example macroinvertebrate species data for Minnesota's three main watersheds.

* Some Project WET Activities have Minnesota adaptations posted online for Minnesota Project WET Educators in the trained teacher page at www.mndnr.gov/projectwet. Additional adaptations will be added when possible.

Classroom Connections

Comparing Aquatic Communities: Compare and contrast plant and animal communities in various bodies of water, including major types of creatures: producers, consumers, decomposers. What are the common ones in each?

Food Chains: Compare land and water food chains. Which are longer and more complex? Why?



Simple Aquatic Plant and Animal Identification: Show very young students large pictures of a variety of well-known Minnesota aquatic animals and plants and ask "Who am I?" types of questions for each. Follow this up by learning more about each animal or plant and its habitat. See "Nature Snapshots" on the DNR website for species background information.

Class Pet: Help very young students appreciate the importance of water to life by keeping a fish, toad, or other animal in your classroom. How does it use water?

Out and About

What's in the Water? Collect a jar full of water from a nearby pond or creek. Take it back to your classroom and pour it into white plastic bins or glass pie tins sitting on white sheets of paper. Have students use magnifying glasses to find and observe the activities of tiny living things in the water. How many different types of organisms do they see? How do the organisms move differently from one another? Where might they live in their natural habitat (on the bottom, floating in the water, under a rock, etc.)?

Windowsill Water Observation: If your circumstances allow, place a large bowlful of water outside your classroom window. Keep a clipboard, paper, and pencil near the window so students can record observations. What animals use the water, and how? Do plants start to grow in it?

Pond Study: Do a local pond study or macroinvertebrate monitoring of a local stream to learn about what lives in the water and help determine the water quality.

A few excellent resources:

1. Keys to life in the pond and stream, University of Wisconsin Extension Service. http://clean-water.uwex.edu/pubs/wav.htm Two 11x17-inch keys to help identify river and pond life for different grade levels.

2. *Wonderful Wacky Water Critters,* University of Wisconsin Extension Service. http://watermonitoring.uwex.edu/pdf/level1/WWWC.pdf A detailed, illustrated guide for young readers that was created in conjunction with the Keys to life in the pond and stream. Describes insects included in pond and river keys.

3. Macroinvertebrate key to life in the pond and stream in color, MN DNR. Available through DNR's MinnAqua Program—see www.mndnr.gov/minnaqua to contact the MinnAqua specialist near you.

4. *Field Guide to the Freshwater Mussels of Minnesota,* MN DNR. http://www.dnr.state.mn.us/eco/nhnrp/mussel_survey/fieldguide.html Contains photographs, shell descriptions, habitat associations, and distribution maps. Also contains general information about mussels, their importance in the ecosystem, threats to their survival, collection methods and collection regulations.

5. aniMap: An interactive mapping tool, MN DNR. http://www.dnr.state.mn.us/maps/animap/index.html Use this website to locate common animal species, view animal lists for your area of interest. Based on data collected by the Minnesota County Biological Survey.

Want More? See www.mndnr.gov/projectwet for resources and information:

Academic standards correlations to Project WET activities
Educational materials/classroom resources for Project WET teachers
Out and About—field trip ideas
Citizen science/service learning opportunities
Useful websites
Suggested books