Taking Action Opportunities

connecting kids to wildlife with trail cameras

Fisher, Martes pennanti, Fall

White-tailed deer, Odocoileus virginianus, Spring

Virginia opossum, Didelphis virginian

Coyote, Canis latrans, Fall

Jim Krueger, Cedar Creek Ecosystem Science Reserve

White-tailed deer, Odocoileus virginianus, Summer

Gray fox, Urocyon cinereoargenteus, Fall

Northern raccoon, Procyon lotor, Spring

Jim Krueger, Cedar Creek Ecosystem Science Reserve

Black bear, Ursus americanus, Fall

Striped skunk, Mephitis mephitis, S

Minnesota DEPARTMENT OF NATURAL RESOURCES

TAO

TAKING ACTION OPPORTUNITIES

Taking Action Opportunities (TAO)
addressing Habitat Loss and Landscape Fragmentation

TAO helps teachers use trail cameras in schoolyards and protected areas to connect students to habitat loss and landscape fragmentation issues and empower environmentally responsible behavior.

Partners: MN Project WILD, University of Minnesota, Cedar Creek Ecosystem Science Reserve, Afton State Park, Afton-Lakeland Elementary, and MN Department of Natural Resources

Funding and donated resources: Wilkie Research Grant, Conservation Biology Program at the University of Minnesota, Stillwater Area Schools, Gander Mountain, The Bell Museum of Natural History, and MN Trappers Association

Special thanks to the schools that opened their doors and classroom to allow baseline research on environmental attitudes and behaviors in the 5th grade including: Afton-Lakeland Elementary, Cedar Park STEM Elementary, Como Park Elementary, Isanti Intermediate, Lily Lake Elementary, Long Prairie Public, St. Anthony Park Elementary, St. Mary of Mount Carmel Elementary, and St. Paul Open schools.

Author and Photos: Dawn Tanner
Layout: Collin Grant

Dedication

This curriculum is dedicated to the teachers, students, and staff at Afton-Lakeland Elementary. Thank you to Sharon Lovell and Jan Erickson, 5th grade teachers at ALE. You are models and mentors for me. Thank you for modeling excellence in teaching, helping me to work with your students, providing limitless flexibility and support in creating and implementing new lessons like rearranging the classroom into an archeological site, Calvaria Cave, with a moment's notice for example! Without you this curriculum would truly not have been possible. Thank you also to Tom Hobert, principal at ALE. Your support and excitement about this project demonstrate to the students how important their research and their discoveries in the schoolyard are. Thank you to Derek Olson for helping me test lessons with his students in fall 2008. Thank you to the parents for supporting and participating with your children as they embarked on this project, working with remote cameras in the schoolyard, especially for volunteering funds to provide bussing to Afton State Park, where the students got to work on habitat improvement projects with outstanding wildlife professionals. Finally, the biggest possible thank you to the students who have put their energy, enthusiasm, curiosity, and scientific exploration into the remote cameras in their schoolyard. You are the best part of my week!

Sincerely, Dawn Tanner
TAO author

Background Information for Teachers:

Remote cameras are used globally as a tool for conservation and wildlife ecological research. Researchers, wildlife managers, and conservation organizations use cameras to document animal presence and absence, develop species inventories, explore questions about animal behavior, and estimate abundance and population density of target species. Information gathered by remote cameras informs conservation strategies for rare and secretive species such as snow leopards, tigers, bears, rhinos, and wolverines. Individual animals are tracked over time when identifying marks and characteristics are available, providing valuable life-history information. These studies have been especially successful informing management of critical wildlife areas so that action can be taken before species are lost from habitat patches, and connection among habitat patches can be improved for wildlife use. Discoveries of rare animals and their habitat requirements aid in protection of forests where rare and endangered species are found. Remote cameras are also used to monitor structures developed to improve wildlife access to habitat. Around the world, road-crossing structures such as culverts, overpasses, and underpasses are built for wildlife, and remote cameras are effective tools to monitor wildlife use of these structures. As the trail cameras have become increasingly accessible for hunters and trappers, the cost and ease of implementing cameras for research has improved dramatically. Continued development of this technology is resulting in lighter, cheaper cameras; infrared capture to remove flash disturbance for nighttime pictures; reduced shutter noise; higher image resolution; increased chip size for saving large numbers of images; and video capture to better monitor animal behavior. Advances in understanding effective trail-camera use and the cost-effective benefits make this technology especially attractive for elementary and middle-school students to monitor wildlife, conduct research, and better understand landscape-scale effects on biodiversity.

The TAO curriculum incorporates remote trail cameras into classroom lessons and schoolyard activities for 12 weeks. In parallel, protected areas in Minnesota have been monitored with these cameras. Data from these sites are available electronically and can be accessed through the MN Project WILD website at http://www.dnr.state.mn.us/projectwild/index.html. Students use the images they collect in the schoolyard to compare to a protected area site in Minnesota, which is selected by the teacher.

The TAO curriculum combines educational theories of teaching for conceptual change and experiential learning. Each lesson begins with a series of questions that allows students to express their thoughts and ideas so that new material can be presented to help students acknowledge, confront, replace, and build upon previous knowledge. Each lesson then features an experiential exercise where students use and explore new information. Lessons also include a taking action opportunity (TAO) that challenges the students to take action, providing a supportive environment to practice stewardship; each lesson concludes with an opportunity for reflection. Each lesson builds on previous lessons so that the entire curriculum functions in a progression, encouraging students to build upon previous knowledge and use this knowledge in innovative ways. In addition to establishing placement, baiting, and monitoring of remote trail cameras, this curriculum provides lessons that support education about biodiversity and landscape change. This curriculum requires one classroom hour per week, with additional time outside of class to download images, refresh bait at the camera stations, move cameras to new locations, and conduct data collection on schoolyard birds.

Students learn about landscape effects on wildlife composition by using trail cameras in their schoolyard and comparing their captures to images documented in a nearby protected area. Students compare species they expect to find in their cameras based on their geographic area with captures in the protected area. They use that comparison to investigate differences in capture versus differences in presence or absence of particular species. Students better understand the changes that have occurred to their own schoolyard landscape, and are empowered to take action toward improving habitat in ways that integrate human and wildlife needs.

Contact Information

If you are using or preparing to use the TAO curriculum with your students, please contact us with questions. We will do our best to ensure your success with this curriculum. We can also refer you to teachers and schools that have already implemented TAO in their classroom.

Dawn Tanner
University of Minnesota
TAO author
200 Hodson Hall
University of Minnesota, MN 55108
tann0042@umn.edu

Jan Welsh
Minnesota Project WILD
Program Coordinator
18310 Zodiac St. NE, Forest Lake, MN 55025
jan.welsh@dnr.state.mn.us

Mary Spivey
Cedar Creek Ecosystem Science Reserve
Community Education Coordinator
2660 Fawn Lake Drive
East Bethel, MN 55005
763-434-5131
spive007@umn.edu
www.cedarcreek.umn.edu

Calendar of Events

Lesson 1 ✦	**Setting the Trap: Introduction to Trail Cameras and Locating Animal Sign** **TAO:** Student representatives are elected to visit each classroom and inform other grades about the purpose of the trail cameras in the schoolyard.
Lesson 2	**Finding a Place in the World: Student Scientists Track Rare Cat Habitat with Google Earth** **TAO:** Before next week's lesson, spend one-half to one hour at home collecting animal sign. Bring specimens for the touch table.
Lesson 3	**Using Google Earth to Analyze the Schoolyard Landscape** **TAO:** Bring home field journals and discuss today's lesson with your family. Ask parents/guardians to write a short comment in the student's field journal about the discussion.
Lesson 4	**Checking the Score Part 1** **TAO:** Write an essay about schoolyard cameras for the school newsletter (if one is available). Students use secret ballots to vote on 1-2 stories to submit to the newsletter. If there is no school newsletter, use the sample brochure to gather student quotes about schoolyard biodiversity and send home with all students in the school.
Lesson 5	**Using Google Earth to Analyze and Compare Our Protected Area to Our Schoolyard** **TAO:** Bring home field journal and discuss how today's lesson compares with the habitat analysis of the schoolyard habitat. Ask parents/guardians to write a short comment in the student's field journal about the discussion.
Lesson 6 ✦	**Habitat Fragmentation Board Game** **TAO:** Each student is asked to bring a $1 voluntary donation for next week (see letter to parents sent home with students). Students may choose an organization from a list provided or nominate their own. The class votes to decide which organization they would like to receive the classroom donation.
Lesson 7	**Checking the Score Part 2** **TAO:** Tally total donation. Students discuss and vote to choose one organization to receive their money and elect a student to write a letter to accompany the donation.
Lesson 8	**From Fieldwork to the Classroom: Wildlife Biologist DVD with University of Minnesota Cat Researchers** **TAO:** Select pictures for classroom TAO poster. Print for classroom if possible. If printing is cost is prohibitive, consider sending a note home with the students and allow them to pay the cost to have a poster of their own.
Lesson 9 ✦	**What's in a Skull or a Tooth? Understanding how animals found in our cameras are adapted to their habitat** **TAO:** The local community paper interviews students for an article. The paper covers camera results and highlight the students' goals and progress in understanding biodiversity.
Lesson 10	**Checking the Score Part 3** **TAO:** Students elect classroom representatives who will present results to Park staff next week. Meet with the students to help them write in their field journal what they want to say with each slide. Practice before Lesson 11.
Lesson 11	**How do Protected Area Managers Keep Parks Healthy for Wildlife: Guest park staff discusses park conservation strategies** **TAO:** Elected students present results from Checking the Score to Park Staff.
Lesson 12	**Improving our Schoolyard for Wildlife Habitat Classroom Forum** **TAO:** Students elect representatives to have lunch with the principal to discuss the proposal the class has developed and schedule a time to present their proposal to the school's parent organization.

✦ Indicates a lesson that you may want to break into two lessons with your students. An optional division location is noted in the lesson.

Getting Started A:

Preparing for the TAO semester

Reserve with MN Project WILD

- Remote Camera Kit: A kit includes all of the supplies you will need to mount two cameras in your schoolyard:

  2 Moultrie™ remote cameras
  2 Moultrie™ lock boxes to prevent against theft or tampering of cameras
  4 cables
  4 cable clamps to secure cables in place
  2 ratchet wrenches
  2 SD memory cards
  8 batteries
  1 roll camouflaged duct tape
  2 padlocks with key
  2 license holders to hold ID card for camera
  1 MN Trapline Products catalog for ordering wildlife lures

- **Classroom Set-up/Touch Table Kit:** A kit includes supplies you will need to prepare your classroom. You will also need to secure salvage permits for your touch table. These need to be initiated at least a couple of months in advance. A kit includes:

12 clipboards
3 field guides (mammals, mammal tracks, and birds)
1 MN DNR posters of common feeder birds to mount in classroom
2 TAO posters to mount in the school
1 suction-cup bird feeder to mount on classroom windows (or choose wooden hanging feeder to mount in a location in the schoolyard)
2 laminated bird ID guides for common winter birds
2 stopwatches for bird data collection
1 specimen collection log book (Books are provided with specimen record description tags. Permits should be laminated and paper-clipped inside the back cover once they have been received.)
10 overhead grid sheets for use in Lessons 3 and 5
4 sets of Habitat Fragmentation Game for use in Lesson 6
1 DVD of "Lights, Camera, Capture" for use in Lesson 8
1 Woodworking for Wildlife for use in Lesson 12
1 Prairie Moon Nursery catalog for use in Lesson 12
1 Wild School Sites for use in Lesson 12

Contact for wildlife salvage permits:
Nongame State Salvage Permit
State of Minnesota Department of Natural Resources
Division of Fish and Wildlife
500 Lafayette Road, Box 20
St. Paul, MN 55155
651-259-5148

Federal Migratory Bird Salvage Permit
US Fish and Wildlife Service
Migratory Bird Regional Permit Office
One Federal Drive
Fort Snelling, MN 55111
612-713-5438

- **What's in a Skull or a Tooth Kit:** A kit provides a collection of skulls from common Minnesota mammals, parts of mammal skulls and jaws for the students to use in the identification challenge that concludes this lesson, and 20 hand lenses. There are a limited number of kits for this lesson. Please reserve yours early, and note that you may need to present this lesson during a different week than specified in the Calendar of Events.

Supplies provided by MN Project WILD and prepared for each schoolyard

- **Animal Sign Worksheet** for use in Lesson 1
- **1 Poster of schoolyard paired with protected area**

Supplies not included in kits needed for classroom

Wildlife Lures for camera traps as selected by students. Corn and ground acorn can be purchased through Gander Mountain or other local feed stores. Wildlife lures can be ordered through MN Trapline Products at 320-599-4176 or through their website at www.minntrapprod.com. Note: 1 catalog is included in the remote camera kit. Predator scent disks (ceramic disks with fatty acids soaked into them) are another option for attracting wildlife. These scent disks can be purchased from the Pocatello Supply Depot at: 208-236-6920 or e-mail: psd.usda@nuvek.com.

Classroom Computer Access where the adult volunteer can download images, view images, and enter data. Students can participate with these activities when time in the classroom permits.

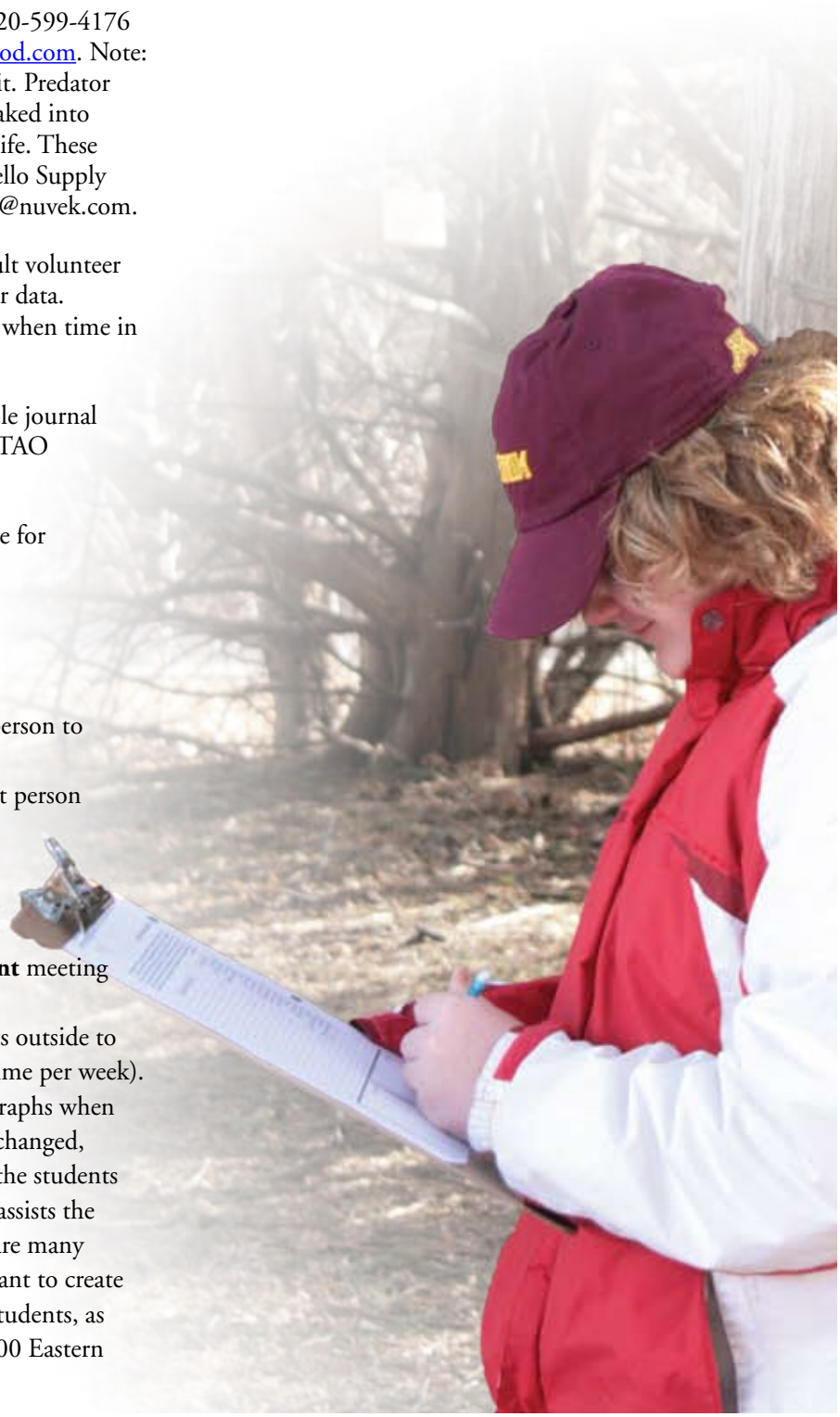
Field Journals one for each student. A sample journal from a previous student participating in the TAO curriculum is provided for reference.

One Box of Ziplock Baggies per touch table for containing touch table specimens

Bird Seed for bird feeders

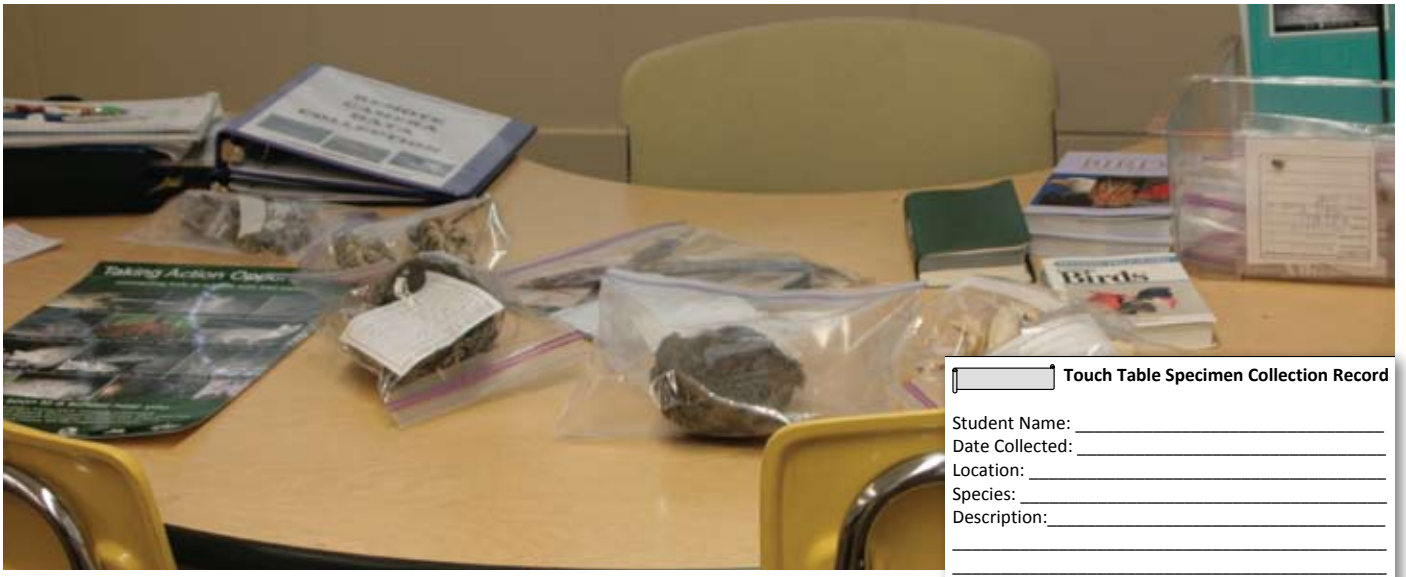
Contacts needed

- **Protected area** office and/or field staff person to participate in Lesson 11
- **School newsletter** deadlines and contact person
- **Local newspaper** contact to schedule interviews with reporter
- **Schoolboard or parent organization** meeting schedules and contact person
- **School principal and/or superintendent** meeting time for student representatives
- **Adult volunteer** to take pairs of students outside to check cameras and monitor birds (one time per week). The adult volunteer also reviews photographs when the chips in the schoolyard cameras are changed, deletes non-wildlife images after taking the students outside to check cameras, and enters or assists the students in entering their data. If there are many mammal captures in a week, you may want to create a folder of the best images to show the students, as their attention may wear thin viewing 600 Eastern cottontail pictures, for example!



Getting Started B:

Classroom set-up

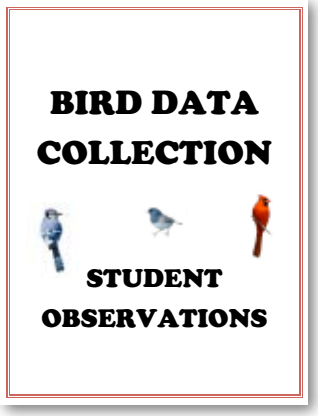


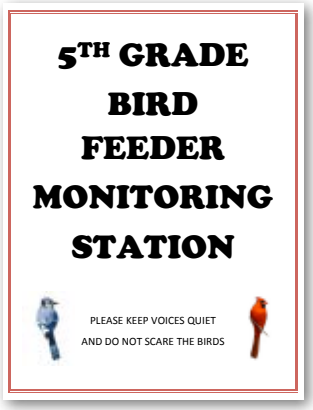
Touch Table Specimen Collection Record

Student Name: _____
Date Collected: _____
Location: _____
Species: _____
Description: _____
_____
_____
_____
_____

- **Touch table** A place in the classroom for students to collect animal sign during the semester that is transportable and acceptable for classroom use. The collection of animal sign will continue throughout the semester as students make outdoor discoveries. The table should contain:

  - a field guide for mammals, mammal tracks, and birds
  - laminated bird ID guides for common winter birds
  - MN DNR poster of common feeder birds should be near the touch table if possible
  - suction-cup bird feeder should be mounted near the touch table if possible
  - stopwatches for bird data collection
  - specimen collection log book
  - blank specimen collection description tags and ziplock baggies
  - clipboards may be stored underneath the touch table if desired
  - sign-up sheets for camera monitoring and bird observation





- **Data station** On a classroom computer. Excel datasheets and sample graphs are provided. When students or the adult volunteer finish downloading data from the cameras, they will check the images from their week and enter data onto a remote camera data sheet. The adult volunteer will enter the complete dataset into Excel.

- **Bird Identification** A place for students to identify and observe birds visiting the schoolyard. Ideally, a bird feeder will be mounted on the classroom window when possible. Suction-cup bird feeders have Plexiglas internal walls to optimize viewing. If the classroom is not on the ground floor or the location of the classroom is such that birds may not visit the window feeder with sufficient frequency for students to collect data, consider placing a feeder in the schoolyard and allowing students to conduct their bird observations outside. If students conduct their observations outside, each group will need to bring: a stopwatch, an observation data sheet secured to a clipboard, a pen, a laminated bird ID guide, and their field journal.

Bird Observation Directions

1. Bird observations are done in student pairs or groups of three.
2. Review Common MN Backyard Birds Poster.
3. Review observations from previous students.
4. Have your field journal, a pen or pencil, and a bird data sheet.
5. Start stopwatch timer at 10 minutes.
6. Tally each species of bird that you see or hear from the list of common species. If you see a species that does not appear on the list, do your best to describe it and write it at the bottom of the page.
7. When you have finished your observation and entered your data sheet into the data book, write a brief entry in your field journal answering at least two of these questions:

Questions for journal reflection

- How difficult was it for you to identify bird species?
- What most helped you identify the birds you saw?
- What is one thing that surprised you while watching the feeder?
- How would you learn more about the birds that you observed?
- Do you think the birds you would see in the protected area would be different than the ones you observed at the feeders?

TAOs Each week our lesson includes a taking action opportunity (TAO) to encourage the students to become active with the information they are learning with their bird observations, cameras, and classroom lessons. The TAOs begin with rather simple activities such as spending time outside searching for animal sign to advanced activities such as presenting their work to a park guest and meeting with the principal to propose habitat improvement projects for the schoolyard. You may find that a particular TAO is not well suited to your classroom if your school does not do a school newsletter or a reporter from your local newspaper is unable to interview students. If you have a week that you do not think the connected TAO will work for your classroom, consider implementing an alternate TAO such as:

- Build a hall bulletin board using pictures from the schoolyard cameras
- Conduct a schoolyard clean-up
- Write/contact a local political leader individually or as a class
- Film a segment for the school news show (if your school has one)
- Assist students in presenting their work to the school board or parent organization
- Visit the protected area and assisting with a habitat-improvement project for a day
- Invite parents to visit the classroom and ask student volunteers to prepare ("curate") their touch table for a museum-type display for parents

Classroom Bird Feeder Observation Sign-Up

(Sign up in pairs or groups of three for each station)

Lesson #	Name
3	1. 2. 3. 4.
4	1. 2. 3. 4.
5	1. 2. 3. 4.
6	1. 2. 3. 4.
7	1. 2. 3. 4.

Bird Data Collection Sheet

Student Names: _____

Tally each time you see or hear a bird during your 10-minute observation. Listed are common birds found year-around in central Minnesota. Tally next to the name provided. Use the blank lines to add additional bird species that you see. If you see a bird and are unsure about its identification, use the box at the bottom to sketch the bird or write notes. Look up the bird when you return to the classroom using the bird field guide on the touch table. Use the notes section to write about your experience.

Common Name	Number of times observed
American crow	
American goldfinch	
American robin	
Black-capped chickadee	
Blue jay	
Brown creeper	
Common redpoll	
Dark-eyed junco	
Downy woodpecker	
European starling	
Hairy woodpecker	
House finch	
House sparrow	
Northern cardinal	
Pine siskin	
Red-bellied woodpecker	
Rock pigeon	
White-breasted nuthatch	

Notes:

Draw here:

Lesson 1

Setting the Trap: Introduction to remote trail cameras and locating animal sign

Focus Question: How do we predict the species we will observe in our schoolyard will compare to the list of species found in our protected area?

Objectives

Students will:

- Be able to describe how remote cameras are used in conservation and wildlife research
- Document animal sign in the schoolyard
- Analyze the schoolyard for areas of animal use
- Begin selecting locations for camera placement

Method

Begin this lesson with the focus question and the mammal list from the protected area on the board. The focus question each week is the backdrop against which the lesson is framed and should be visible to students during the lesson. Read or present a brief introduction about remote cameras in research, introduce the poster featuring the schoolyard and protected area side-by-side, discuss with the students which mammals found in the protected area may also be found in the schoolyard, and present the PowerPoint on animal sign. Students will walk the schoolyard documenting animal sign, and begin selecting locations for remote camera sites. Site selection will be finalized during Lesson 2. Letter to parents should be sent home with students today.

Materials

Advance set-up in the classroom: Before beginning this lesson, set up the touch table and bird observation location, print worksheets for documenting animal sign, print sign-up sheets and data collection sheets, and mount poster of schoolyard and protected area in the classroom. You may want to explore the schoolyard in advance to find places where students will be able to find animal sign. Use the mammal track field guides to assist in your exploration. In the winter, look for tracks and scat in the snow and especially under trees and bushes. In the fall, look for places where the ground is muddy and water is available. These places are excellent locations to begin identifying animal sign. Students will need a field journal (notebook) dedicated to TAO.

Background Information for Teacher

Biodiversity is the variety of life, including humans and other mammals, birds, plants, insects, and more. A healthy ecosystem contains numerous organisms that are interconnected in a web of life. Ecosystems that can buffer environmental changes and minor events that cause temporary loss of some organisms have complex interconnections among their community members so that if one species is lost temporarily, others are available to prey and be preyed upon in the web of life. Humans often change the biodiversity of an area, simplifying the ecosystem. Species can be lost from an area through drivers including habitat modification, introduced species, and direct harvest. As species are lost in ecosystems, ecosystems become more simplified and lose resilience. In other words, the intricate fabric that makes up the ecosystem begins to unravel. The ecosystem becomes less able to buffer normal and human-caused variation.

Schoolyards provide habitat for some species, especially small animals, birds, insects, and plants. Often schools are built in the middle of a community and are characterized by buildings, parking lots, playgrounds with a surface of sand and gravel, mowed grass, and trees and shrubs that are cut and trimmed. Some schools are built in areas that are connected to wild/green spaces. There are many opportunities to provide additional habitat for animals in the schoolyard. We will explore some of these projects during the curriculum.

Prior knowledge questions (5 minutes)

Hand out field journals. Ask students to put their name on the first page and label that page with Lesson 1. Each lesson should be labeled so that students can refer back to their answers for specific lessons. Begin today by asking the students to use the poster-size image of the schoolyard and protected area to answer the three prior knowledge questions. This will serve as a prop to stimulate thoughts about land-use change and biodiversity throughout the curriculum. Ask students to begin using their field journals by writing answers to the questions below. Note that "I don't know" is an acceptable response to the questions if it is an accurate answer for the student. Students should write out the questions as well as their answers so they can refer back to previous entries with ease.

Prior Knowledge Questions

- What does biodiversity mean to you?
- How does human land-use change biodiversity?
- Which animals do you think use your schoolyard as habitat?

Exercises

1. Setting the Scene (10 minutes):

May be read or presented:

"Remote cameras are used in research around the world to study jaguars, rhinos, snow leopards, and tigers. Remote cameras are also used in our state and country to study endangered species and understand wildlife movements. Deer hunters use remote cameras to find good places for their deer stands. In Minnesota, scientists use remote cameras to monitor Canada lynx. In California, remote camera images have documented wolverines in new locations, and in this curriculum we are using remote cameras to monitor animals in (protected area name). Remote cameras use an infrared beam that is invisible to us. This beam is activated by motion and by the animals' body heat as they pass through it. When an animal (including you) passes through the beam, this triggers the camera to take a picture."

Sample Identification Camera Tag

"We have mammal and bird lists from the protected area, so we know which species use the park as habitat. Using this list, we will predict which mammals we think may also use the schoolyard as habitat. Among the mammals you think may be found in the schoolyard, predict which ones you think we will be able to capture with our cameras. Mark each mammal species on the board as:

+ mammals that we think use the schoolyard as
√ mammals we think will be captured by our cameras"

Note: Add these predictions to your hard copy of the mammal list. These predictions will be used during each "Checking the Score" lesson.

2. Classroom tour: Describe to students the bird observation stations, touch table, and sign-up sheets (students will sign up next week, but the sheets should be in place as part of the classroom tour).

3. Animal Sign PowerPoint

✦ ✦ (Optional place to split this lesson) ✦ ✦

Site Selection (30 minutes)

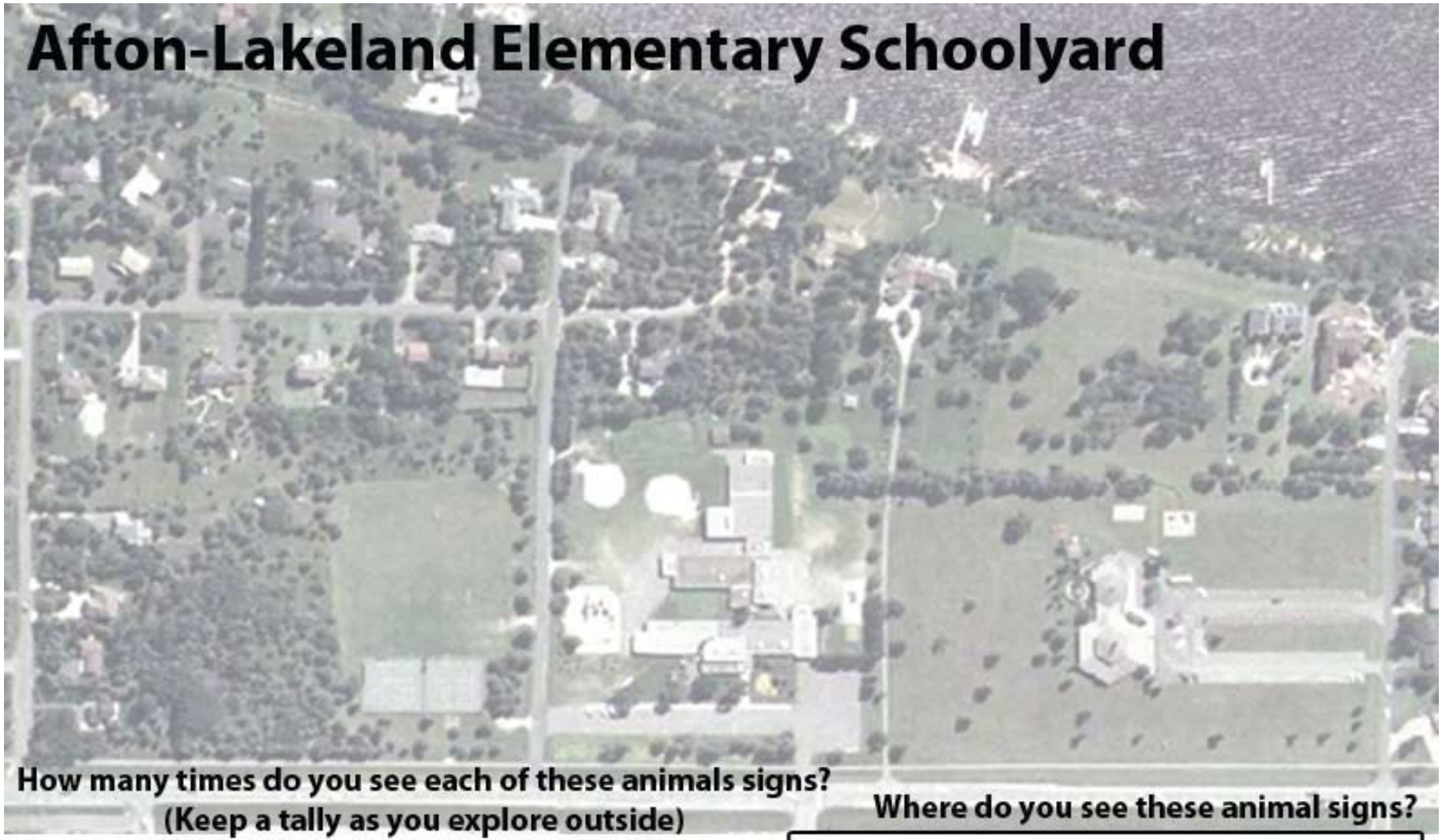
You may choose to break this lesson into two parts. During the first lesson, you would conduct all activities except the excursion outside to look for animal sign and the concluding Reflection questions. During the second session, you would dedicate more time to exploration outside searching for animal sign, ending with the Reflection questions.

4. In the schoolyard: Students work in pairs. They need a pen or pencil outside with them. Each pair of students should have a clipboard with a schoolyard animal sign worksheet. They will mark places they find animal sign in the schoolyard on the worksheets. Each pair will vote for one location in the schoolyard where they would like to have the camera placed. Save students' worksheets and their chosen sites for next week. Students will vote as a class next week to choose camera sites from those nominated by each pair of students.

TAO: After the animal sign in the schoolyard maps are turned in, students elect two student representatives to visit each classroom and inform other grades about the purpose of the trail cameras in the schoolyard. They should tell students about the project and ask everybody to avoid tampering with the cameras. A sample script is available at the end of this lesson if you would like to give this to students to help them as they visit the other classrooms.

Reflection (10 minutes): Once students have selected their school site(s) for camera trap placement, they record their predictions in their field journal: "Do you predict that the schoolyard or the protected area will have more kinds of animals captured? What evidence did you find investigating the schoolyard today to support your predictions about schoolyard animals?"

Sample Schoolyard Worksheet



How many times do you see each of these animals signs?
(Keep a tally as you explore outside)

Tracks? ☐

Scat? ☐

Homes (burrows, nests...) ☐

Signs of grazing or browsing? ☐

Animal Trails? ☐

Fur or feathers? ☐

Live or Dead animals? ☐

Where do you see these animal signs?

Schoolyard Remote Camera Sign-Up

Lesson #	Name
3	1. 2. 3.
4	1. 2. 3.
5	1. 2. 3.
6	1. 2. 3.
7	1. 2. 3.
8	1. 2. 3.
9	1. 2. 3.

Remote Camera Data Collection Sheet

Site name: _____ Week #: _____

Date installed : _____ Date checked: _____ # trap nights: _____

After you retrieve the SD card from your camera, use a computer to look at your images. Delete images that do not contain mammals or birds. Keep one image to record each bird species. Write down each mammal species that you see, and put a tally mark for the time of day the image was recorded. Use the notes section to list the bird species that you observed and describe other important details.

Common Name	Scientific Name	Number of times observed			
		Morning (daylight – 12:00 noon)	Afternoon (12:00 noon – 4:00 pm)	Evening (4:00 pm – sunset)	Night (sunset – sunrise)

Total for week = _____

Notes:

Completed Example

Mammals of Afton State Park (provided by ASP)

*Sample filled out for reference based on student predictions at Afton-Lakeland Elementary

	Classroom 1		Classroom 2	
Species Documented in Protected Area Mammal List	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras
Coyote (*Canis latrans*)	+	✓	+	✓
Gray fox (*Urocyon cinereoargenteus*)			+	✓
Red fox (*Vulpes vulpes*)	+	✓	+	✓
Black bear (*Ursus americanus*)				
Raccoon (*Procyon lotor*)	+	✓	+	✓
River otter (*Lontra canadensis*)				
Long-tailed weasel (*Mustela frenata*)			+	
Ermine (*Mustela erminea*)	+		+	✓
Mink (*Mustela vison*)			+	
Badger (*Taxidea taxus*)				
Striped skunk (*Mephitis mephitis*)	+	✓	+	
Eastern spotted skunk (*Spilogale putorius*)			+	
Virginia opossum (*Didelphis virginiana*)	+	✓	+	
Southern flying squirrel (*Glaucomys volans*)	+		+	✓
Woodchuck (*Marmota monax*)	+	✓		
Eastern gray squirrel (*Sciurus carolinensis*)	+	✓	+	✓
Eastern chipmunk (*Tamias striatus*)	+	✓	+	✓
Red squirrel (*Tamiasciurus hudsonicus*)	+	✓	+	✓
Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)	+		+	
Fox squirrel (*Sciurus niger*)				
Plains pocket gopher (*Geomys bursarius*)	+		+	
American beaver (*Castor canadensis*)				
House mouse (*Mus musculus*)	+	✓	+	
White-footed mouse (*Peromyscus leucopus*)	+	✓	+	
Meadow vole (*Microtus pennsylvanicus*)	+		+	
Muskrat (*Ondatra zibethicus*)	+		+	
Prairie deer mouse (*Peromyscus maniculatus*)	+	✓	+	
Norway rat (*Rattus rattus*)	+		+	
Meadow jumping mouse (*Zapus hudsonius*)	+	✓	+	
White-tailed deer (*Odocoileus virginianus*)	+	✓	+	✓
White-tailed jackrabbit (*Lepus townsendii*)	+	✓	+	✓
Eastern cottontail (*Sylvilagus floridanus*)	+	✓	+	✓
Northern short-tailed shrew (*Blarina brevicauda*)	+		+	
Cinereus shrew (*Sorex cinereus*)	+		+	
Star-nosed mole (*Condylura cristata*)	+		+	
Eastern mole (*Scalopus aquaticus*)	+			
Little brown myotis (*Myotis lucifugus*)	+	✓	+	✓
Big brown bat (*Eptesicus fuscus*)	+	✓	+	✓

Mammals of Afton State Park (provided by ASP)

	Classroom 1		Classroom 2	
Species Documented in Protected Area Mammal List	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras
Coyote (*Canis latrans*)				
Gray fox (*Urocyon cinereoargenteus*)				
Red fox (*Vulpes vulpes*)				
Black bear (*Ursus americanus*)				
Raccoon (*Procyon lotor*)				
River otter (*Lontra canadensis*)				
Long-tailed weasel (*Mustela frenata*)				
Ermine (*Mustela erminea*)				
Mink (*Mustela vison*)				
Badger (*Taxidea taxus*)				
Striped skunk (*Mephitis mephitis*)				
Eastern spotted skunk (*Spilogale putorius*)				
Virginia opossum (*Didelphis virginiana*)				
Southern flying squirrel (*Glaucomys volans*)				
Woodchuck (*Marmota monax*)				
Eastern gray squirrel (*Sciurus carolinensis*)				
Eastern chipmunk (*Tamias striatus*)				
Red squirrel (*Tamiasciurus hudsonicus*)				
Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)				
Fox squirrel (*Sciurus niger*)				
Plains pocket gopher (*Geomys bursarius*)				
American beaver (*Castor canadensis*)				
House mouse (*Mus musculus*)				
White-footed mouse (*Peromyscus leucopus*)				
Meadow vole (*Microtus pennsylvanicus*)				
Muskrat (*Ondatra zibethicus*)				
Prairie deer mouse (*Peromyscus maniculatus*)				
Norway rat (*Rattus rattus*)				
Meadow jumping mouse (*Zapus hudsonius*)				
White-tailed deer (*Odocoileus virginianus*)				
White-tailed jackrabbit (*Lepus townsendii*)				
Eastern cottontail (*Sylvilagus floridanus*)				
Northern short-tailed shrew (*Blarina brevicauda*)				
Cinereus shrew (*Sorex cinereus*)				
Star-nosed mole (*Condylura cristata*)				
Eastern mole (*Scalopus aquaticus*)				
Little brown myotis (*Myotis lucifugus*)				
Big brown bat (*Eptesicus fuscus*)				

Mammals of Bear Head Lake (developed using distribution maps for Minnesota mammals)

	Classroom 1		Classroom 2	
Species with Distribution that Includes Bear Head Lake	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras
Arctic shrew (*Sorex arcticus*)				
Masked shrew (*Sorex cinereus*)				
Water shrew (*Sorex palustris*)				
Pygmy shrew *(Sorex hoyi*)				
Short-tailed shrew (*Blarina brevicauda*)				
Star-nosed mole (*Condylura cristata*)				
Little brown bat (*Myotis lucifugus*)				
Northern long-eared myotis (*Myotis septentrionalis*)				
Big brown bat (*Eptesicus fuscus*)				
Red bat (*Lasiurus borealis*)				
Hoary bat (*Lasiurus cinereus*)				
Snowshoe hare (*Lepus americanus*)				
Eastern chipmunk (*Tamias striatus*)				
Least chipmunk (*Tamias minimus*)				
Woodchuck (*Marmota monax*)				
Gray squirrel (*Sciurus carolinensis*)				
Red squirrel (*Tamiasciurus hudsonicus*)				
Northern flying squirrel (*Glaucomys sabrinus*)				
Beaver (*Castor canadensis*)				
Deer mouse (*Peromyscus maniculatus*)				
Red-backed vole (*Myodes gapperi*)				
Meadow vole (*Microtus pennsylvanicus*)				
Muskrat (*Ondatra zibethicus*)				
Southern bog lemming (*Synaptomys cooperi)*				
Norway rat (*Rattus rattus*)				
Meadow jumping mouse (*Zapus hudsonius*)				
Woodland jumping mouse (*Napaeozapus insignis*)				
Porcupine (*Erithizon dorsatum*)				
Coyote (*Canis latrans*)				
Gray wolf (*Canis lupus*)				
Red fox (*Vulpes vulpes*)				
Black bear (*Ursus americanus*)				
Raccoon (*Procyon lotor*)				
Marten (*Martes americana*)				
Fisher (*Martes pennanti*)				
Short-tailed weasel (*Mustela erminea*)				
Mink (*Mustela vison*)				
Striped skunk (*Mephitis mephitis*)				
River otter (*Lontra canadensis*)				
Bobcat (*Lynx rufus*)				
Lynx (*Lynx lynx*)				
White-tailed deer (*Odocoileus virginianus*)				
Moose (*Alces alces*)				

Mammals of Cedar Creek Ecosystem Science Reserve (provided by CCESR)

	Classroom 1		Classroom 2	
Species Documented in Protected Area Mammal List	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras	+ = students think species uses schoolyard as habitat	☑ = species students predict we will capture with our cameras
Virginia opossum (*Didelphis virginiana*)				
Arctic shrew (*Sorex arcticus*)				
Masked shrew (*Sorex cinereus*)				
Water shrew (*Sorex palustris*)				
Pygmy shrew *(Sorex hoyi*)				
Short-tailed shrew (*Blarina brevicauda*)				
Common mole (*Scalopus aquaticus*)				
Star-nosed mole (*Condylura cristata*)				
Little brown bat (*Myotis lucifugus*)				
Northern long-eared myotis (*Myotis septentrionalis*)				
Silver-haired bat (*Lasionycteris noctivagans*)				
Eastern pipistrelle (*Pipistrellus subflavus*)				
Big brown bat (*Eptesicus fuscus*)				
Red bat (*Lasiurus borealis*)				
Hoary bat (*Lasiurus cinereus*)				
Eastern cottontail (*Sylvilagus floridanus*)				
Snowshoe hare (*Lepus americanus*)				
White-tailed jack rabbit (*Lepus townsendii*)				
Eastern chipmunk (*Tamias striatus*)				
Woodchuck (*Marmota monax*)				
Franklin's ground squirrel (*Spermophilus franklinii*)				
Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)				
Gray squirrel (*Sciurus carolinensis*)				
Fox squirrel (*Sciurus niger*)				
Red squirrel (*Tamiasciurus hudsonicus*)				
Northern flying squirrel (*Glaucomys sabrinus*)				
Southern flying squirrel (*Glaucomys volans*)				
Plains pocket gopher (*Geomys bursarius*)				
Plains pocket mouse (*Perognathus flavescens*)				
Beaver (*Castor Canadensis*)				
Western harvest mouse (*Reithrodontomys megalotis*)				
White-footed mouse (*Peromyscus leucopus*)				
Deer mouse (*Peromyscus maniculatus*)				
Red-backed vole (*Clethrionomys gapperii*)				
Prairie vole (*Microtus ochrogaster*)				
Meadow vole (*Microtus pennsylvanicus*)				
Muskrat (*Ondatra zibethicus*)				

continued on next page

Southern bog lemming (*Synaptomys cooperi)*				
Norway rat (*Rattus rattus*)				
House mouse (*Mus musculus*)				
Meadow jumping mouse (*Zapus hudsonius*)				
Porcupine (*Erithizon dorsatum*)				
Coyote (*Canis latrans*)				
Gray wolf (*Canis lupus*)				
Red fox (*Vulpes vulpes*)				
Gray fox (*Urocyon cinereoargenteus*)				
Black bear (*Ursus americanus*)				
Raccoon (*Procyon lotor*)				
Fisher (*Martes pennanti*)				
Short-tailed weasel (*Mustela erminea*)				
Long-tailed weasel (*Mustela frenata*)				
Least weasel (*Mustela nivalis*)				
Mink (*Mustela vison*)				
Badger (*Taxidea taxus*)				
Spotted skunk (*Spilogale putorius*)				
Striped skunk (*Mephitis mephitis*)				
River otter (*Lontra canadensis*)				
Bobcat (*Lynx rufus*)				
Lynx (*Lynx lynx*)				
Mule deer (*Odocoileus hemionus*)				
White-tailed deer (*Odocoileus virginianus*)				

✦ ✦ ✦ (Use species lists to read online 24-hour graphs) ✦ ✦ ✦

TAO: Optional script to use when visiting other classrooms

1) Introduce yourselves

2) Read: "We are doing a project outside to learn more about animals and birds that live in our schoolyard. We are monitoring animals and birds in our schoolyard with remote trail cameras. If you see our cameras, they will take your picture, and we will see you along with other animals like red squirrels, gray fox, and cottontail rabbits. Please do not touch a camera if you see it. If you touch or bump one of our cameras, you may change the position of the camera and make it so we don't get animal pictures. We are very excited about this project, and we hope you are too!"

3) Read: "Do you have any questions about this project that we are doing in the ____ grade?"

4) Thank you!

Dear Parents:

We are excited to be able to tell you about a wonderful opportunity that we are starting with our students this week. In partnership with our school, MN Project WILD, Afton State Park, Cedar Creek Ecosystem Science Reserve, the MN Department of Natural Resources, and the University of Minnesota, we are teaching Taking Action Opportunities, TAO. We will be doing science in our schoolyard with remote wildlife cameras and pairing the science we do outside with lessons inside the school.

The remote cameras we are using take pictures day and night, using an infrared beam in low-light conditions. You may have already used remote cameras for taking pictures of wildlife near your home, especially if you are or know someone who is a deer hunter. When the cameras are on, the beam from the camera senses both movement and heat from an animal's body when it crosses the beam, triggering the camera to take a picture. Each picture records the animal's image with the date and time that the picture was taken. We will have two cameras monitoring wildlife in our schoolyard. The students will be choosing the locations for their cameras and monitoring them over the next approximately 12 weeks and comparing their images with images previously collected in a Minnesota protected area.

As part of our lessons in the classroom, we will periodically ask the students to bring home ideas we are discussing in the classroom to share with you. We will send home their field journals for this discussion, and we encourage you to share in your child's excitement and discoveries during this time.

We will be conducting our TAO lessons on [days and time]. We would be delighted to have you join us at any point during the semester if you would like to learn more about TAOs and what we are doing.

Lesson 2

Finding a Place in the World: Student Scientists Track Rare Cat Habitat with Google Earth

Focus Question: What can we learn about wildlife habitat from satellite pictures?

Logistical Note: After the lesson this week, a teacher or adult volunteer installs schoolyard cameras. Cameras should be checked by students for the first time next week. Refer to Appendix 1 on installing your remote camera for tips to help you best capture wildlife images in the schoolyard.

Logistical Note: Google Earth should be installed on classroom computers before students begin today's lesson. Many school computers include Google Earth in basic software, so you may find that Google Earth is already installed. To install Google Earth: Go to http://earth.google.com/, Select Download Google Earth, and follow the onscreen instructions. Most school computers will not allow you to download unless you have administrator permission. If you do not already have administrator permission for your computer, you may need to ask for assistance from your computer support person.

Objectives

Students will:

- Select their first site for their classroom remote camera using worksheets from last week
- Describe animal sign
- Review images of animals previously captured in schoolyards
- Compare early schoolyard observations with research from a wildlife biologist working in Borneo (Siew Te Wong)
- Begin to navigate in Google Earth, zoom to different scales, and start thinking about what characteristics make good habitat for wildlife

Method

Expand upon concluding activities from the previous week and conduct Google Earth exploration in small groups or pairs. Depending on how familiar students already are with Google Earth, you may want to do this with the students using a projector so students can follow your lead on the screen and then repeat the same commands at their own computers.

Materials

PowerPoint slide show on wildlife schoolyard images captured and an international story about Siew Te Wong, wildlife researcher in Borneo (PowerPoint provided), signup sheets from last week remain posted in the classroom (students sign up today), sample data collection page for field journals, a slide with the schoolyard and points that each student group nominated last week (so students can vote to select their first camera site), and Student Scientists Track Rare Cats around the World directions with enough copies for each small group.

Background Information

Google Earth is a simple tool to use and offers exciting techniques to study land-use change and measure habitat characteristics. The exploration today provides a chance for the students to become comfortable using Google Earth, zooming to different scales, and thinking about questions related to wild places and habitat. As students explore wildlife habitat in this lesson, highlight examples of biodiversity and differences in habitat to support the prior knowledge questions that the students completed last week. The Google Earth lessons that follow take this exploration to the next level and give students the ability to measure land cover in the schoolyard and protected area.

Definitions for the Teacher

Habitat: "An animal's habitat includes food, water, shelter or cover, and space. Because animals need the food, water, shelter, and space to be available in a way that meets the animals' needs, we say that these things must be available in a suitable arrangement." -Project WILD K-12 Curriculum & Activity Guide

Biodiversity: The variability among living organisms. Biodiversity is the wonderful and rich variety of life in the world. Diversity of organisms, ecological complexity, and evolution are necessary to provide resilience in a rapidly changing world. We think about biodiversity at three levels: ecosystem diversity, species diversity, and genetic diversity. Each of these areas offers an opportunity for study and conservation. The variety of species living in ecosystems allows healthy ecosystems to function.

Prior Knowledge Questions (5 minutes)

Using field journals, students take 5 minutes to answer the following questions about animal sign, using the information they learned last week and referring back to animal sign discovered in the schoolyard last week.

1) What things can you find outside that shows presence of animals?
2) What signs of animals do you think we may have missed during our exploration last week?

Exercise (50 minutes)

1. Sign up: Each student signs up for a date to check the cameras and a date to conduct bird observations. Note: Adult volunteer will start taking small groups out of class next week to monitor cameras and conduct bird observations.

2. PowerPoint on Images and Site Selection: During this presentation, students' sites are included on a PowerPoint slide created from the worksheet that they used last week (sample slide is part of PowerPoint file and may be substituted with the image from your schoolyard). As a class, students vote for the site where they would like their camera placed initially. Then we visit Borneo with Siew Te Wong, a wildlife researcher studying sun bears and clouded leopards.

Read or present to the students along with the PowerPoint.

"Siew Te Wong is a scientist. He likes to be called by his last name, Wong. Wong uses remote cameras just like you will be doing for the next few weeks. Wong is studying sun bears and clouded leopards in Borneo. Wong spends hours trekking through the forest, searching for tracks, claw marks, and scat (animal poop). The clouded leopards in Borneo have recently been identified as a separate species from clouded leopards that live in other parts of SE Asia. Wong works to understand the habitat needs for clouded leopards because their forests are rapidly disappearing. When Wong finds sign that the clouded leopards are in an area, he baits the area with chicken and sets up remote cameras. Wong is looking for clouded leopards and sun bears, but he also finds monitor lizards, bearded pigs, and civets in his remote camera photographs. Clouded leopard sightings are rare and exciting. On very lucky days, Wong will find images of clouded leopards and sun bears. Then he's ready to set up large metal box traps that he will use to capture animals. Once he has captured a clouded leopard or a sun bear, Wong puts a radio tracking collar on the animal to understand its movements and habitat requirements. Many forests have already been cleared for lumber and for agriculture. Those changes threaten Borneo's wildlife. Wong's pictures are helping scientists learn about the habitat these animals need. Wong's research helps scientists protect the fragile forest habitat for many species including the clouded leopard and sun bear."

3. Student Scientists Track Rare Cats around the World:

In small groups, students use Google Earth to explore wildlife habitats, starting in their schoolyard, and exploring three global sites for rare cat species. Each site features clues to guide explorations on the worksheet and a question to guide student interpretation of each site. Students record answers on the field journal worksheet. To start this activity, create the setting for the students by explaining that scientists need to prepare for field work before they travel to a remote place in the world. One way scientists do that is by using images collected by satellites to analyze habitat. Today the students are wildlife scientists. They are preparing to conduct their own research using Google Earth to answer questions about wildlife habitat. As students arrive at a site, encourage them to click on the photo links to see even more specific images about that place in the world.

Note to teacher: Set the students up working in pairs or groups of three at a computer. You or your technology specialist may want to do the Google Earth exploration with the students using a projector so that they can watch the steps before they embark on their own. Go to a site so the students can watch you first, give the students 5-10 minutes to arrive and explore the site on their own, and then take them to the next site. Keeping the class working together will improve the success of this lesson and reduce student frustration if they have difficulty locating a site.

Reflection **(5 minutes)**

Write a field entry about habitat for cats around the world. Write one surprising discovery you made about another country as you explored. Can you list three things that you found in Google Earth that seemed to indicate good places for wildlife?

TAO: Before next week's lesson, spend 30 minutes at home exploring outside and collecting animal sign. Bring examples for the touch table. If you find animal sign that cannot or should not be collected, take a photograph, draw a picture, or make a rubbing instead. Each student will bring home the half-page letter to parents and a ziplock baggie with a Touch Table Specimen Collection Record inside. Students fill out their collection record and seal it inside the bag along with their animal sign.

Student Scientists Track Rare Cats around the World

Directions: Your team of scientists is preparing for fieldwork. You must be familiar with your animals' habitat. Use Google Earth to explore habitat in these wild places.

- Start Google Earth
- Click *View*, and select *Scale Legend* to add scale to your map
- Under *Search*, on the left side of the screen, find a box called *Fly To*
- Enter your school address in the box, hit *Enter* on your keyboard
    - The earth will spin, and zoom in on your school
    - Click *View*. At the bottom of the list is *Make this my start location*
    - Select *Make this my start location* and a marker is added on the screen
- Begin preparing for your fieldwork!

Find: the habitat of the South American Jaguar

- Clue-it is in Brazil, South America
- Clue-it is near Iguazu Falls, Argentina
- Clue-Jaguars come to the river to drink, hunt caiman, and swim in pools
- Use the Zoom tool on the screen to explore the Jaguar habitat
- Click Tools, then Ruler to measure the river

1. **Seek:** How wide is the river at its widest point?
2. **Seek:** Can you describe three things you can see in the habitat that would make this a good place for Jaguars?

Find: the habitat of the Lions of the Serengeti

- Clue-it is in Tanzania, Africa
- Clue-it is in the Serengeti National Park
- Use the Zoom tool on the screen to explore lion habitat
- When you see a blue-gray square on the screen, there are pictures available

3. **Seek**: Can you describe three things that are different between the Lion habitat and what you saw for the Jaguar?
4. **Seek**: When you Zoom to the view that you cannot make out images clearly anymore, what does the scale bar say?

Find: the habitat of the Bengal Tiger

- Clue-it is in Nepal, Asia
- Clue-it is in the Royal Chitwan National Park
- Use the Zoom tool on the screen to explore tiger habitat

5. **Seek**: How far is it from the Chitwan marker to the main river channel?

Student Scientists Track Rare Cats around the World: Field Journal

1.

2.

3.

4.

5.

Notes on your observations about rare cat habitat:

Dear Parents/Guardians:

Last week we found animal sign in the schoolyard and documented our discoveries on worksheets with a picture of the schoolyard. We used this exploration this week as the students voted for their first remote camera site. Animal sign is an important indication of animal activity. This week each student is requested to spend one half to one hour outside sometime before next Friday looking for animal sign in your yard and/or neighborhood. Please help your child select animal sign that will not be smelly in the classroom. Bones, very dry scat, fur, and photographs of sign that can't come to school are good examples of animal sign that we would like to see on the Touch Table. Bird sign (nests, feathers, etc.) can only be collected by teachers. If your child wants to share bird sign, help him/her take photographs or make rubbings to share with the class. When students find something for the touch table, they should fill out the Touch Table Specimen Collection Record and package their animal sign in the ziplock baggie. Specimens will become part of our classroom Touch Table. We have permits from the MN Department of Natural Resources and U.S. Fish and Wildlife Service to collect these specimens to use as learning tools.

Thank you for joining your child in this journey of discovery by spending a few minutes exploring outside and bringing something to share on our Touch Table!

Lesson 3

Using Google Earth to Analyze the Schoolyard

Focus Question: What can we learn about wildlife habitat in our schoolyard from satellites pictures?

Logistical Note: Review sample schoolyard print-out from Google Earth. You will want to select a view that encompasses the schoolyard. Make sure the scale-bar is visible in the image. From Google Earth, save the on-screen image as a jpg image file and print outside of Google Earth. Do this step in advance. For best results, print the schoolyard image on photo paper. Details in the landscape will be more vivid.

Helpful hints with Google Earth: To reorient the image, click on the compass in the upper right-hand corner. You can move North toward West, for example, and change the orientation of the image. Also, if students have changed the view when looking at an image and changed the perspective view of the image, click "Shift" + left-click on the mouse and move the mouse up or down. This will bring you back to a top-down view and remove the image perspective angle.

Logistical Note: Adult volunteer will take out the students who have signed up to check cameras and conduct bird observations this week.

Objectives

Students will:

- Collect data from schoolyard cameras
- Define land cover types for the schoolyard
- Measure land uses on print-outs of the schoolyard
- Measure linear distance of roads on print-outs of the schoolyard (if time permits)
- Build a bar graph of the schoolyard land cover

Method

Introduce protected area to students using images in PowerPoint. Collect data from the first week of mammal captures on the schoolyard cameras. Categorize and quantify land cover. Build bar graph and/or pie graph to illustrate land cover results (sample Excel graphs provided).

Materials

Print-outs of the schoolyard from Google Earth, 3 dry-erase grid sheets (1 per group), and 3 packets of dry-erase markers.

Background Information

Last week, we took a tour of the world and wild habitats using Google Earth. Today we will explore the schoolyard habitat, measure types of land cover, and calculate percentage of land cover in each class.

Exercise (50 minutes)

(10 minutes)

Expand introduction of PA/Begin Data Collection from Schoolyard: Introduce the partner protected area in more detail than you did when you used the Mammal List in Lesson 1. Show selected images that highlight photographs of wildlife captured in 14 trap nights in the protected area (folder of images provided in lesson folders). Introduce the name of the staff member from the protected area who will visit the class later in the semester. The first data collection in the schoolyard also occurred this morning (with the first 14 trap nights). A trap night equals one camera per night. With two cameras taking pictures in the schoolyard, you have a total of 14 trap nights so far. After showing highlights from the protected area, project the images captured in the schoolyard from the previous week. The adult volunteer should remove all non-mammal wildlife captures so students do not have to spend time reviewing no-data images. One image of each bird species captured should be included so students can list bird species captured at the bottom of their data collection worksheet. Either the adult volunteer or students who checked the cameras should fill out the datasheet. Viewing photographs happens each week at the beginning of the lesson until the cameras are removed. Depending on how prepared the students are for data collection, consider presenting data collection as an example and allow students to focus on a discussion of animals, frequency, and time of day images are collected.

(40 minutes)

1. Break the class into small groups at the computers.
2. Students begin in the schoolyard with Google Earth like they did last week.
3. Students choose a view onscreen where they can see detail in the schoolyard. They can zoom in and out to explore and identify land-cover classes.
4. Students examine the schoolyard and decide on classes they define to categorize the schoolyard (give a couple of examples, such as trees, water, buildings…).

Recommended classes: trees and shrubs, pavement and buildings, mowed grass, natural grassland, bare soil, water, wetland, agricultural fields, pasture

Specify colors if possible so students can compare grids

See sample image: trees and shrubs = green (21%), pavement and buildings = blue (36%), mowed grass = yellow (38%), and bare soil = red (3%)

5. List the classes that students identify and compare them to the list generated in advance. Are there classes that you would like to add to the existing list? Have students use the same final classes for their worksheet (so that results can be discussed across groups).
6. Hand out the printout of the schoolyard. Be sure that the scale-bar is visible on the printed version. Students need to know the scale of the image when they do Lesson 5.
7. Students overlay the dry-erase grid sheet and tape it into place.
8. Use the markers to draw around and color in each land use. Students decide how to classify each square. A square can only have one class designated. Students decide which land-cover class represents the majority of the square for those on an edge or with mixed types of land cover in a square.
9. Count the squares in each land-use. The number of squares is equal to the percentage of land cover because the grid is 10x10 = 100 squares.
10. Students record the total number of squares per land cover in their field journal.
11. Collect student data and compile in Excel datasheet.
12. As a class, create a bar graph and/or pie graph of land-use using one the average group data (see sample and Excel graphs provided).
13. Discuss: What percentage of the schoolyard would you classify as excellent wildlife habitat using your land-cover classes?
14. Save graphs for use in Lesson 5.

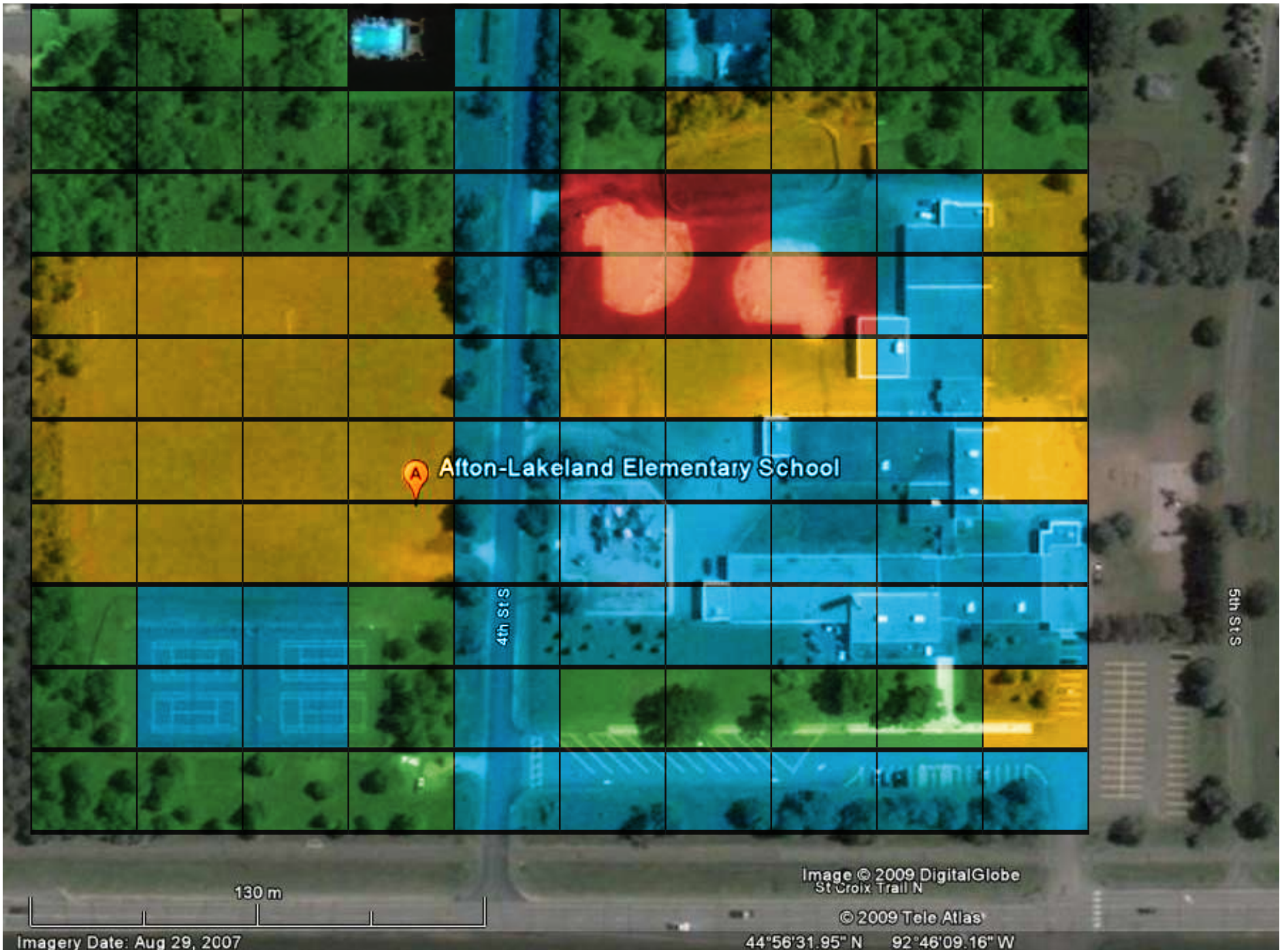
Reflection **(10 minutes)**

Using the graphs about land-use that you created at the end of today's lesson, write a paragraph in your field journal describing how you think these graphs would be different if you created them for your protected area.

TAO: Bring home today's lesson about schoolyard land-use and discuss with family over dinner. Ask parents to write a short comment in the student's field journal about the dinner discussion.

Suggestion for Implementation: Optional ways to expand upon today's lesson: Click on View > Historical Imagery (in Google Earth 5.0/Jan. 2009 or later). You will be able to go back to previous images for the schoolyard and could expand on today's lesson to add land-cover change over time. Choose an earlier date (10 years prior to the current date for example) and repeat today's exercise. You could add even more historical perspective by using MN DNR Landview aerial photographs available at http://www.dnr.state.mn.us/maps/landview.html. These photographs go back many decades depending on location. Conduct the exercise the same way that you did the schoolyard in Google Earth. Discuss ways the land cover has changed since the aerial photograph was taken using your data from this lesson.

Sample Schoolyard Image



Lesson 4

Checking the Score Part 1

Focus Question: What differences do we see in our camera captures from our schoolyard versus our protected area?

Logistical Note: Adult volunteer takes students outside to check cameras and conduct bird observations.

Objectives

Students will:

- Evaluate species captured among sites
- Compare and contrast results of remote cameras so far
- Describe habitat differences that may contribute to site differences
- Calculate percentages of species present versus species captured
- Decide if and where to move schoolyard cameras

Method

Students begin analyzing camera data

Materials

Thumbnail printouts of all of the images from the schoolyard (students work in groups of 3-4)
One set of images is needed for each group of students
*Consider printing costs and class time. If you have more than 150 pictures and 3 species captured in the schoolyard, you may want to print one set of the total photo captures for the class. Have groups of students create an index card for a single species. Compile each group's data onto the Species Score Card.
A score card to tally species that are possible and species that are documented in each location
A packet of 4x6 index cards (enough to have one card for each species captured per group)
A calculator to determine percentage of total species documented in each area
A pair of scissors to cut out voucher images from thumbnail photographs

Background information

Humans use and modify the landscape for development and agricultural practices, changing the suite of species present in an area and the abundance of those species (increasing abundance of some species and decreasing others). The protected area serves as a reference of the species present in the geographic location and local area. The protected area contains a suite of animals that may be close to the species that were present in the area historically. The protected area size and degree of isolation from other natural areas will affect the suite of species present.

Using the protected area's checklist for vertebrates and the predictions made during Lesson 1, we compile our photographic records and determine how our captures compare to the protected area.

Consider during analysis:

- Depending on camera angle and placement, smaller species may go undetected unless we specifically target them.
- Species that can adapt to habitat changes, especially those that can shift their diet (habitat generalists) may be found more often in highly modified habitat.
- Species with large home ranges may be difficult to detect even when present.
- Species that have large spatial requirements for survival will often be lost in areas with reduced habitat quantity.
- The protected area is a place that supports wild populations that could use and/or recolonize our schoolyard. However, some species will remain unable to use our schoolyard, which is why large, connected protected areas are important for species diversity.
- Our schoolyard is a human-modified landscape that we can change to better support species diversity.

Prior Knowledge Questions (5 minutes)

1) Which species have we found so far that surprised you?
2) Will we keep our cameras in their current location or move them?
3) If we choose to move the cameras, where should we move our classroom camera(s)?

Exercise (55 minutes)

Review photographs (10 minutes)

Show selected images that highlight photographs of wildlife captured from the 14 trap nights completed since we saw the images last week in the protected area (folder of images provided in lesson folders). The second data collection in the schoolyard also occurred today (with 14 trap nights). After showing highlights from the protected area, project the mammal images captured in the schoolyard during the previous week. The viewing of images is the same as last week (and done at the beginning of the lesson each week until cameras are finished). Graphs of number of times each species has been captured and captures by time of day may be shown and discussed. These graphs may be shown during each Checking the Score to allow students to see the graphs change over time, or these graphs may be shown as a summary during the final Checking the Score, depending on your preference and time availability.

Analyze captures (45 minutes)

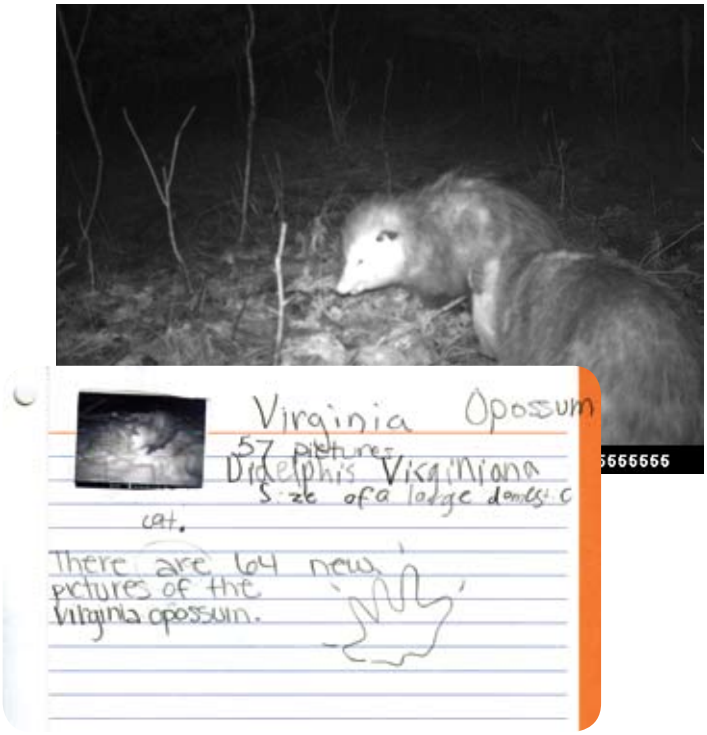
Students work in groups of 3-4, using a 4x6 index card to tally the number of times a species was found in the schoolyard. Students should compile data on their 4x6 card. Each card should contain:

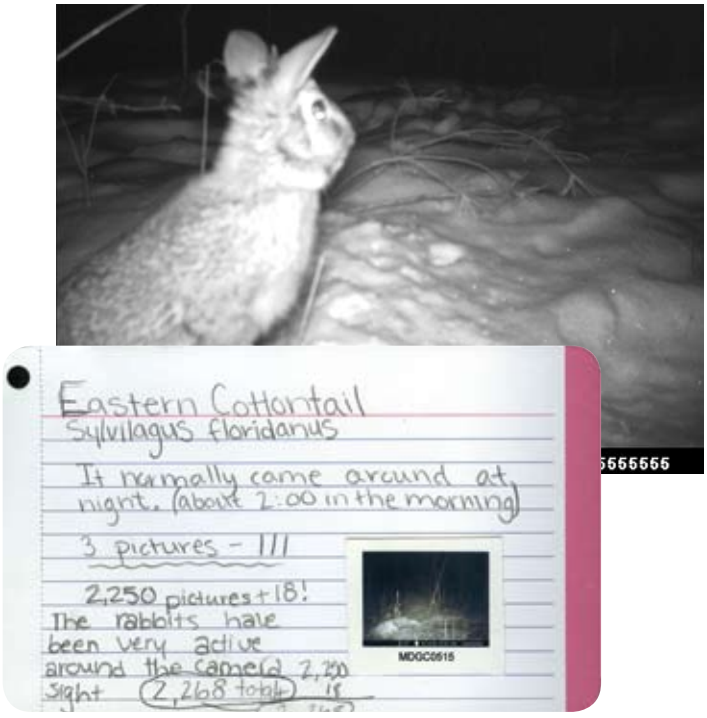
- The best image captured for the species so far. Glue the thumbnail to the 4x6 index card as a voucher for each species
- Label the card with the common name and the scientific name for the species, using mammal field guides on the touch table
- List one interesting fact about the species, using the mammal guides on the touch table
- Tally the number of captures
- Keep completed index cards and Score Card for use in Checking the Score Parts 2 and 3.

When students have finished filling out their index cards, transfer the species identified to the classroom Species Score Card. Calculate 1) the percentage of total mammal species found in the protected area so far, 2) the percentage of species found in the protected area and predicted to be found in the schoolyard, and 3) the percentage of species predicted to be found in the schoolyard that were captured so far? Students use the species scorecard and record final percentages in field journals.

Vote as a class to keep the cameras in the same location or move to a new site. If students vote to move cameras, the adult volunteer relocates the cameras today.

TAO: Write a short essay about schoolyard cameras for the school newsletter. Students vote on the story and choose (up to two) stories to submit by secret ballot. If the school does not have a school newsletter, consider building a brochure using student responses to the question "What does habitat mean for biodiversity in our schoolyard?" A sample brochure from Afton-Lakeland Elementary is provided. This brochure should be sent home with each student in the school.





Completed Example

Species Score Card: Afton State Park			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Coyote (*Canis latrans*)		✓	
Gray fox (*Urocyon cinereoargenteus*)		✓	✓
Red fox (*Vulpes vulpes*)	✓	✓	
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)	✓	✓	
River otter (*Lutra canadensis*)			
Long-tailed weasel (*Mustela frenata*)		✓	
Ermine (*Mustela erminea*)		✓	
Mink (*Mustela vison*)		✓	
Badger (*Taxidae taxus*)			
Striped skunk (*Mephitis mephitis*)		✓	
Spotted skunk (*Spilogale putorius*)		✓	
Virginia opossum (*Didelphis virginiana*)		✓	
S. flying squirrel (*Glaucomys volans*)		✓	
Woodchuck (*Marmota monax*)			
E. gray squirrel (*Sciurus carolinensis*)	✓	✓	
E. chipmunk (*Tamias striatus*)		✓	
Red squirrel (*Tamiasciurus hudsonicus*)	✓	✓	✓
13-lined ground squirrel (*Spermophilus tridecemlineatus*)		✓	
Fox squirrel (*Sciurus niger*)			
Plains pocket gopher (*Geomys bursarius*)		✓	
American beaver (*Castor canadensis*)			
House mouse (*Mus musculus*)		✓	
White-footed mouse (*Peromyscus leucopus*)		✓	✓
Meadow vole (*Microtus pennsylvanicus*)		✓	
Muskrat (*Ondatra zibethicus*)		✓	
Prairie deer mouse (*Peromyscus maniculatus*)		✓	
Norway rat (*Rattus rattus*)		✓	
Meadow jumping mouse (*Zapus hudsonius*)		✓	
White-tailed deer (*Odocoileus virginianus*)		✓	
White-tailed jackrabbit (*Lepus townsendi*)		✓	
Eastern cottontail (*Sylvilagus floridanus*)	✓	✓	✓
Northern short-tailed shrew (*Blarina brevicauda*)		✓	
Cinereus shrew (*Sorex cinereus*)		✓	
Star-nosed mole (*Condylura cristata*)		✓	
Eastern mole (*Scalopus aquaticus*)			
Little brown myotis (*Myotis lucifugus*)		✓	
Big brown bat (*Eptesicus fuscus*)		✓	
T = total number of species possible = **38**	PA = species found in protected area= **5**	P = predicted species found in schoolyard = **31**	SY = total species found in schoolyard= **5**

+ domestic dog in schoolyard ✓

Questions:

1. PA/T X 100 = 13%

(percentage of species found in the protected area captured in images so far)

2. P/T X 100 = 82%

(percentage of species found in the protected area predicted in the schoolyard)

3. SY/P X 100 = 16%

(percentage of species predicted in the schoolyard captured in images so far)

Species Score Card: Afton State Park			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Coyote (*Canis latrans*)			
Gray fox (*Urocyon cinereoargenteus*)			
Red fox (*Vulpes vulpes*)			
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)			
River otter (*Lutra canadensis*)			
Long-tailed weasel (*Mustela frenata*)			
Ermine (*Mustela erminea*)			
Mink (*Mustela vison*)			
Badger (*Taxidae taxus*)			
Striped skunk (*Mephitis mephitis*)			
Spotted skunk (*Spilogale putorius*)			
Virginia opossum (*Didelphis virginiana*)			
S. flying squirrel (*Glaucomys volans*)			
Woodchuck (*Marmota monax*)			
E. gray squirrel (*Sciurus carolinensis*)			
E. chipmunk (*Tamias striatus*)			
Red squirrel (*Tamiasciurus hudsonicus*)			
13-lined ground squirrel (*Spermophilus tridecemlineatus*)			
Fox squirrel (*Sciurus niger*)			
Plains pocket gopher (*Geomys bursarius*)			
American beaver (*Castor canadensis*)			
House mouse (*Mus musculus*)			
White-footed mouse (*Peromyscus leucopus*)			
Meadow vole (*Microtus pennsylvanicus*)			
Muskrat (*Ondatra zibethicus*)			
Prairie deer mouse (*Peromyscus maniculatus*)			
Norway rat (*Rattus rattus*)			
Meadow jumping mouse (*Zapus hudsonius*)			
White-tailed deer (*Odocoileus virginianus*)			
White-tailed jackrabbit (*Lepus townsendi*)			
Eastern cottontail (*Sylvilagus floridanus*)			
Northern short-tailed shrew (*Blarina brevicauda*)			
Cinereus shrew (*Sorex cinereus*)			
Star-nosed mole (*Condylura cristata*)			
Eastern mole (*Scalopus aquaticus*)			
Little brown myotis (*Myotis lucifugus*)			
Big brown bat (*Eptesicus fuscus*)			
T = total number of species possible = **38**	PA = species found in protected area=	P = predicted species found in schoolyard =	SY = total species found in schoolyard=

Questions:

1. PA/T X 100 = _____

(percentage of species found in the protected area captured in images so far)

2. P/T X 100 = _____

(percentage of species found in the protected area predicted in the schoolyard)

3. SY/P X 100 = _____

(percentage of species predicted in the schoolyard captured in images so far)

Species Score Card: Bear Head Lake State Park			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Arctic shrew (*Sorex arcticus*)			
Masked shrew (*Sorex cinereus*)			
Water shrew (*Sorex palustris*)			
Pygmy shrew *(Sorex hoyi*)			
Short-tailed shrew (*Blarina brevicauda*)			
Star-nosed mole (*Condylura cristata*)			
Little brown bat (*Myotis lucifugus*)			
Northern long-eared myotis (*Myotis septentrionalis*)			
Big brown bat (*Eptesicus fuscus*)			
Red bat (*Lasiurus borealis*)			
Hoary bat (*Lasiurus cinereus*)			
Snowshoe hare (*Lepus americanus*)			
Eastern chipmunk (*Tamias striatus*)			
Least chipmunk (*Tamias minimus*)			
Woodchuck (*Marmota monax*)			
Gray squirrel (*Sciurus carolinensis*)			
Red squirrel (*Tamiasciurus hudsonicus*)			
Northern flying squirrel (*Glaucomys sabrinus*)			
Beaver (*Castor canadensis*)			
Deer mouse (*Peromyscus maniculatus*)			
Red-backed vole (*Myodes gapperi*)			
Meadow vole (*Microtus pennsylvanicus*)			
Muskrat (*Ondatra zibethicus*)			
Southern bog lemming (*Synaptomys cooperi)*			
Norway rat (*Rattus rattus*)			
Meadow jumping mouse (*Zapus hudsonius*)			
Woodland jumping mouse (*Napaeozapus insignis*)			
Porcupine (*Erithizon dorsatum*)			
Coyote (*Canis latrans*)			
Gray wolf (*Canis lupus*)			
Red fox (*Vulpes vulpes*)			
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)			
Marten (*Martes americana*)			
Fisher (*Martes pennanti*)			
Short-tailed weasel (*Mustela erminea*)			
Mink (*Mustela vison*)			
Striped skunk (*Mephitis mephitis*)			
River otter (*Lontra canadensis*)			
Bobcat (*Lynx rufus*)			
Lynx (*Lynx lynx*)			
White-tailed deer (*Odocoileus virginianus*)			
Moose (*Alces alces*)			
T = total number of species possible = **43**	PA = species found in protected area=	P = predicted species found in schoolyard =	SY = total species found in schoolyard=

Questions:

1. PA/T X 100 = _____

(percentage of species found in the protected area captured in images so far)

2. P/T X 100 = _____

(percentage of species found in the protected area predicted in the schoolyard)

3. SY/P X 100 = _____

(percentage of species predicted in the schoolyard captured in images so far)

Species Score Card: Cedar Creek Ecosystem Science Reserve			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Virginia opossum (*Didelphis virginiana*)			
Arctic shrew (*Sorex arcticus*)			
Masked shrew (*Sorex cinereus*)			
Water shrew (*Sorex palustris*)			
Pygmy shrew *(Sorex hoyi*)			
Short-tailed shrew (*Blarina brevicauda*)			
Common mole (*Scalopus aquaticus*)			
Star-nosed mole (*Condylura cristata*)			
Little brown bat (*Myotis lucifugus*)			
Northern long-eared myotis (*Myotis septentrionalis*)			
Silver-haired bat (*Lasionycteris noctivagans*)			
Eastern pipistrelle (*Pipistrellus subflavus*)			
Big brown bat (*Eptesicus fuscus*)			
Red bat (*Lasiurus borealis*)			
Hoary bat (*Lasiurus cinereus*)			
Eastern cottontail (*Sylvilagus floridanus*)			
Snowshoe hare (*Lepus americanus*)			
White-tailed jack rabbit (*Lepus townsendii*)			
Eastern chipmunk (*Tamias striatus*)			
Woodchuck (*Marmota monax*)			
Franklin's ground squirrel (*Spermophilus franklinii*)			
Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)			
Gray squirrel (*Sciurus carolinensis*)			
Fox squirrel (*Sciurus niger*)			
Red squirrel (*Tamiasciurus hudsonicus*)			
Northern flying squirrel (*Glaucomys sabrinus*)			
Southern flying squirrel (*Glaucomys volans*)			
Plains pocket gopher (*Geomys bursarius*)			
Plains pocket mouse (*Perognathus flavescens*)			
Beaver (*Castor Canadensis*)			
Western harvest mouse (*Reithrodontomys megalotis*)			
White-footed mouse (*Peromyscus leucopus*)			
Deer mouse (*Peromyscus maniculatus*)			
Red-backed vole (*Clethrionomys gapperii*)			
Prairie vole (*Microtus ochrogaster*)			
Meadow vole (*Microtus pennsylvanicus*)			
Muskrat (*Ondatra zibethicus*)			
Southern bog lemming (*Synaptomys cooperi)*			
Norway rat (*Rattus rattus*)			
House mouse (*Mus musculus*)			
Meadow jumping mouse (*Zapus hudsonius*)			

Porcupine (*Erithizon dorsatum*)			
Coyote (*Canis latrans*)			
Gray wolf (*Canis lupus*)			
Red fox (*Vulpes vulpes*)			
Gray fox (*Urocyon cinereoargenteus*)			
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)			
Fisher (*Martes pennanti*)			
Short-tailed weasel (*Mustela erminea*)			
Long-tailed weasel (*Mustela frenata*)			
Least weasel (*Mustela nivalis*)			
Mink (*Mustela vison*)			
Badger (*Taxidea taxus*)			
Spotted skunk (*Spilogale putorius*)			
Striped skunk (*Mephitis mephitis*)			
River otter (*Lontra canadensis*)			
Bobcat (*Lynx rufus*)			
Lynx (*Lynx lynx*)			
Mule deer (*Odocoileus hemionus*)			
White-tailed deer (*Odocoileus virginianus*)			
T = total number of species possible = **61**	PA = species found in protected area=	P = predicted species found in schoolyard =	SY = total species found in schoolyard=

Questions:

1. PA/T X 100 = _____

(percentage of species found in the protected area captured in images so far)

2. P/T X 100 = _____

(percentage of species found in the protected area predicted in the schoolyard)

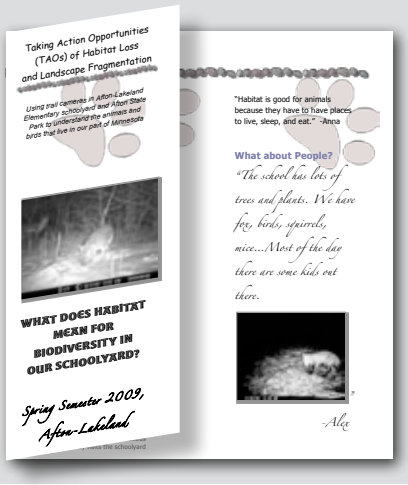
3. SY/P X 100 = _____

(percentage of species predicted in the schoolyard captured in images so far)

Sample TAO Worksheet

How do our schoolyard habitats support wildlife? What can we do to make our schoolyard habitats better for mammals and birds?

Sample TAO Brochure



Lesson 5

Using Google Earth to Compare our Protected Area and Schoolyard

Focus Question: What can we learn about wildlife habitat in our protected area from satellite pictures?

Logistical Note: Review the sample protected-area print-out from Google Earth. Select a view that matches the scale (as closely as possible) that you used when you did Lesson 3. Make sure the scale-bar is visible in the image. From Google Earth, save the on-screen image as a jpg image file and print outside of Google Earth. Do this step in advance. For best printing results, print on photo paper. Details in the landscape will be more vivid. Copy or project the categories of land uses and the bar and pie graphs from Lesson 3 before the lesson begins.

Helpful hints with Google Earth: To reorient the image, click on the compass in the upper right-hand corner. You can move North toward West, for example, and change the orientation of the image. Also, if students have changed the view when looking at an image and changed the perspective view of the image, click "Shift" + left-click on the mouse and move the mouse up or down. This will bring you back to a top-down view and remove the image perspective angle.

Logistical Note: Adult volunteer takes the students outside to check cameras and conduct bird observations.

Objectives

Students will:

- Continue collecting data from the schoolyard cameras
- Define land cover types for the protected area using lessons learned in the schoolyard exercise
- Measure land uses on print-outs of the protected area
- Measure linear distance of roads on print-outs of the schoolyard (if time permits)
- Build a bar and pie graph of the protected-area land cover and compare to the pie graph of the schoolyard

Method

Categorize and quantify land cover in the protected area. Compare to schoolyard analysis.

Materials

Print-outs of the protected area from Google Earth, 3 dry-erase grid sheets (1 per group), and 3 packets of dry-erase markers.

Background Information

Two weeks ago, we explored our schoolyard habitat, measured types of land uses, and calculated percentage of our land cover in each class. We reflected on how the land uses we found might be different in the protected area. Today we conduct the same exercises on our protected area and reexamine our predictions.

Prior Knowledge Questions (5 minutes)

1) How do you think our protected area habitat is different for wildlife from our schoolyard?
2) What do you think we could do to make habitat better for wildlife in our schoolyard?

Exercise (50 minutes)

(10 minutes)
Expand introduction of PA/Begin Data Collection from Schoolyard: Show selected images that highlight photographs of wildlife captured in 14 trap nights in the protected area (folder of images provided in lesson folders). Data collection continues in the schoolyard. Show the previous week's captures and compare to protected area highlights.

(40 minutes)

1. Break the class into small groups at the computers.
2. Students begin in the protected area with Google Earth. You may want to have the address on the board where students can view and type it in the "Fly To" box.
3. Students choose a view onscreen where they can see detail in the protected area. They can zoom in and out to explore and identify land-cover classes.
4. Students examine the schoolyard and decide on classes they would define to categorize the protected-area landscape (give a couple of examples, such as trees, water, buildings…).

Recommended classes: trees and shrubs, pavement and buildings, mowed grass, natural grassland, bare soil, water, wetland, agricultural fields, pasture

Specify colors if possible so students can compare grids

See sample image: trees and shrubs = green (90%), water = (5%), pavement and buildings = blue (4%), and bare soil = red (1%)

5. List classes that students identify and compare them to the list generated in advance. Are there classes that you would like to add to the existing list? Have students use the same final classes for their worksheet (so that results can be discussed across groups).
6. Hand out the print-out of the protected area. Be sure that the scale-bar is visible on the printed version and that it matches the scale that you used for the schoolyard as closely as possible.
7. Students overlay the dry-erase grid sheet and tape it into place.
8. Students use the markers to draw around and color in each land use. Students decide how to classify each square. A square can only have one class designated. Students should decide which land-cover class represents the majority of the square for those on an edge or with mixed types of land cover in a square.
9. Count the squares in each land-use. The number of squares is equal to the percentage of land cover because the grid is 10x10 = 100 squares.
10. Students record the total number of squares per land cover in their field journal. Compare to Lesson 3.
11. Collect student data and compile in Excel datasheet.
12. As a class, create a bar graph and/or pie graph of land cover using the average group data (see sample and Excel graphs provided).
13. Discuss: What percentage of the protected area would you classify as excellent wildlife habitat using your land-cover classes?
14. Compare today's graphs with those created for the schoolyard.
15. Discuss the differences that you see when you compare what we found in our schoolyard versus what we have calculated today about our protected area

Reflection (10 minutes)

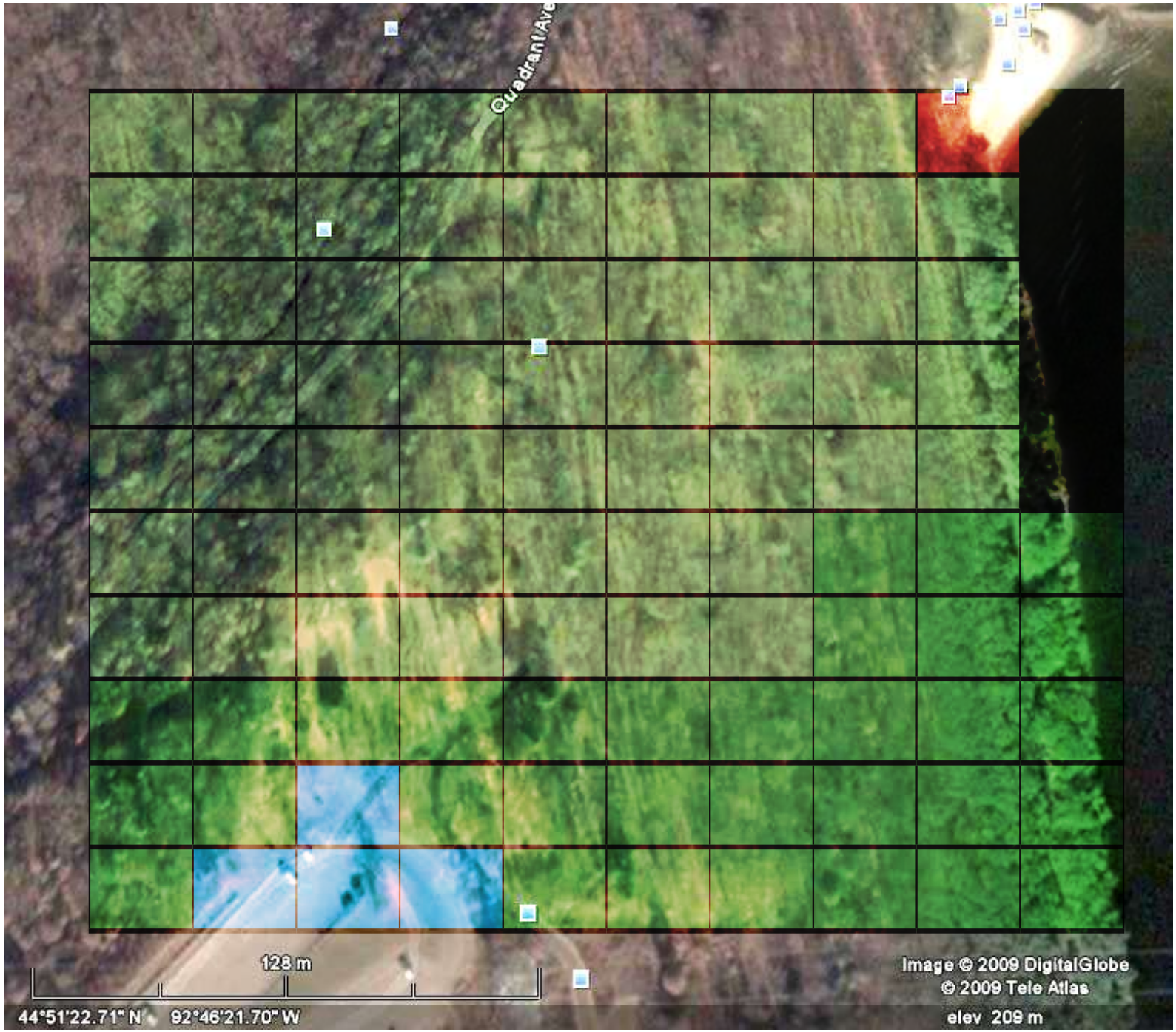
Using the differences that you found today in land cover from your schoolyard and protected area,

Which location do you think would be more similar to your home?

Write about similarities and differences that you would expect to see if you did this Google Earth exercise for your home.

TAO: Students bring home field journal. Discuss at home. Ask parents to write a short comment in student's field journal about the discussion.

Sample Protected Area Image



Lesson 6

Habitat Fragmentation Board Game

Focus Question: How do the species that live in a habitat change when we change the landscape?

Logistical Note: Adult volunteer takes students outside to check cameras and conduct bird observations.

Objectives

Students will:

- Continue collecting data from the schoolyard cameras
- Simulate animal population fluctuation in high-quality habitat
- Simulate animal population changes as habitat is modified (cities and roads are added, wetlands are drained, fields are added, and natural habitat patches become more isolated)
- Discuss differences observed in both simulations

Method

Play two rounds of the habitat fragmentation board game with the class. Discuss changes that occur from Round 1 to Round 2.

Materials

4 copies of the Habitat Fragmentation Board Game, and letter to parents/guardians for today's TAO.

Game Instructions

1) Set up game board on a table with chairs for 4-5 students. If you have 4 students, each chooses a playing piece. If you have 5 students, one will be the score keeper for the first round. This person will play the second round, and another student will take the job of the scorekeeper.

Playing pieces represent four of the possible decision makers in society. Each student chooses a role when they select their playing piece. Playing pieces are: Wildlife Researcher, Mayor, Park Manager, or Environmental Group Leader. Each piece is labeled and represented by a unique symbol.

2) Use tape (if necessary) to keep the playing board in place. Set up the species cups (minus the cottontail, red fox, and bobcat) next to the playing board. The playing cards go in the boxes indicated in the center of the board. In Round 1, use the Population, Decision, and Random Events cards that are beige. Keep the blue Population cards separate.

3) Students begin Round 1 by populating the habitat in the center of the board. Each animal piece is labeled to indicate how many animals this piece represents in our habitat. Note: nothing goes in the grayed-out boxes on the scoresheet. The grayed-out boxes mean that species is not present in the round.

Populate the Board for Round 1 with: 5 wolves (5 pieces), 25 lynx (5 pieces), 10 bears (2 pieces), 80 coyotes (8 pieces), 24 gray fox (12 pieces), 500 deer (10 pieces), 700 raccoon (14 pieces), 20,000 snowshoe hares (20 pieces)

Read to the Students:

"Keep your animal pieces clustered with like individuals for ease of counting. Imagine your animals moving about, using habitat in ways that fit their needs for food, water, and cover/shelter. In the center of our game board is 200 km^2 of Minnesota wildlife habitat. Even this remote habitat is not removed from our impacts. The decisions we make affect the kinds and numbers of animals that survive. Keep your role (playing piece) in mind as you play Round 1 and 2 of the Habitat Fragmentation Game. If you run out of a species as you play, do not substitute another—just ignore the instruction. Because our habitat is not totally separated from other natural habitats, the species may enter our habitat again through Reproduction cards. When this happens, a young animal from a nearby place wandered into our habitat and established territory where the earlier ones were removed."

TAO FRAGMENTATION GAME SCORECARD

SPECIES	ROUND 1			ROUND 2		
	# PIECES	X NO./ PIECE	= NO. ANIMALS	# PIECES	X NO./ PIECE	= NO. ANIMALS
BEAR		X 5			X 5	
WOLF		X 1			X 1	
LYNX		X 5			X 5	
BOBCAT		X 1			X 1	
COYOTE		X 10			X 10	
GRAY FOX		X 2			X 2	
RED FOX		X 5			X 5	
DEER		X 50			X 50	
RACCOON		X 50			X 50	
SNOWSHOE HARE		X 1000			X 1000	
EASTERN COTTONTAIL		X 1000			X 1000	

Begin the game by rolling a die and moving the number rolled. When students land on a picture, they draw a Population card and add or remove species animal pieces as indicated. When they land on a Decision square, they should read the card to their group, then take the action specified for their playing piece only. When they land on a Random Event square, they should read the card to their group, then add or remove pieces as indicated.
Round 1 ends when the first person reaches the Finish square. At the end of the round, students use the scorecard to add the number of each animal species in their habitat at the end of the round. The scorecard helps the students convert the number of animal pieces to the number of animals. A calculator may be helpful.

✦ ✦ ✦ (Optional place to split this lesson) ✦ ✦ ✦

Students begin Round 2 removing everything from the center of their board. Tape the new layer to the habitat that includes cities and fields that have been added to the habitat. Swap the beige Population cards with the blue Population cards. Remove the lynx, snowshoe hares and gray fox pieces. Replace these with bobcat, Eastern cottontail, and red fox. Begin by repopulating the habitat.

Populate the Board for Round 2 with: Start with: 3 wolves (3 pieces), 8 bobcats (8 pieces), 5 bears (1 piece), 100 coyotes (10 pieces), 60 red fox (12 pieces), 600 deer (12 pieces), 900 raccoon (18 pieces), 25,000 cottontail rabbits (25 pieces)

Read to the Students:
"Changes have occurred to our habitat since Round 1. Cities expanded, fields were added to grow crops, and a major road now connects the cities. These changes took place over years and are changing the species that survive in our habitat. Natural areas are more separated, so species have more trouble moving from one natural area to another. Species that survive well as people open up habitat moved in and replaced species found here in Round 1—species that need large tracts of forest and large patches of habitat to survive. Differences from Round 1 include: wolves and bears declining. As wolves decline, coyotes survive better. Coyotes prey on gray fox, and red fox replace gray fox in open areas. Gray fox do not live in our habitat anymore. Snowshoe hares were replaced by cottontail rabbits. As the forest was cleared, the cottontail rabbits were better able to survive and reproduce than the hares. With the loss of snowshoe hares and young conifer forest patches, lynx were replaced by bobcats. Bobcats feed on a variety of small animals and are not as dependent as lynx on snowshoe hares. Deer and raccoons are on the rise. Both of these species are good at living alongside people."

Students play Round 2 in the same manner as Round 1.
Round 2 ends when the first person reaches the Finish square. At the end of the round, students use the scorecard to add the number of each animal species that populated their habitat.
Note: If students take longer than your allotted time to finish Round 1 or Round 2, you can give them a second die and have them play with two dice to speed up the game.
Discuss how the animals that survived in our habitat changed from Round 1 and Round 2. How do you see these changes reflected in our communities? Did you have species that you wanted to survive or not during each round? How do you think this kind of selection happens in our communities as we make decisions that affect wildlife habitat?

TAO: Each student is asked to bring a $1 voluntary donation for next week (see letter to parents sent home with students) and discuss with their family and/or do internet research at home to find a conservation organization that they would like to support. Provide a short list of local environmental organizations to give students ideas that get them started.

*Note: Contact information is not provided. Students will likely use these organizations as suggestions and nominate their own organizations. You will only need to locate the address/contact person for the organization selected by the students.

Just A Few of the Many Excellent Possibilities for our Class Donation (Sample List)

Afton State Park
Mission: Oak savannah and tallgrass prairie restoration, improving habitat for wildlife and recreation for people to hike, ski, and view wildlife in our park

Audubon Society
Mission: Conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity

Ducks Unlimited Minnesota
Mission: Conservation Today; Wetlands Tomorrow

Friends of the Mississippi River
Mission: Working to protect the Mississippi River and its watershed in the Twin Cities area

Izaak Walton League
Mission: A common-sense approach toward protecting our country's natural heritage and improving outdoor recreation opportunities for all Americans

Minnesota Deer Hunters Association
Mission: Betterment of deer and deer hunting by educating youth and adult hunters, acquiring and improving deer habitat, and many community projects

Pheasants Forever
Mission: Conservation of pheasants, quail and other wildlife through habitat improvements, public awareness, education and land restoration

The Nature Conservancy in Minnesota
Mission: The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive

Trout Unlimited
Mission: To conserve, protect and restore North America's trout and salmon fisheries and their watersheds

Dear Parents/Guardians:

We are having a fun and educational time monitoring our remote trail cameras in the schoolyard. I hope that your child has been excited and sharing the discoveries that we make each week. Some of our favorites have been watching the pair of gray fox that use our schoolyard extensively, rare and inquisitive glimpses of opossums passing through our schoolyard, and red squirrels scampering around our schoolyard habitat. We've been thinking about and studying habitat in many ways. This week our class is gathering a voluntary donation of $1 per person if you and your child agree that you want to participate. I have provided a list of just a few of the wonderful organizations working to improve habitat for wildlife in our area and state (see back of this page). The students may nominate their own organization or select an organization from this list. If your child would like to participate in this effort, please send $1 before [date] when we check our cameras next. As a class, we will vote and send a letter with our donation to the conservation organization that gets the most votes to help this organization with the projects they do for the environment.

Thank you for joining your child in this journey of discovery, and I hope that you will want to participate in this activity. At home, please feel welcome to discuss an additional organization that your child might like to nominate when we do our voting next week!

Afton State Park
Mission: Oak savannah and tallgrass prairie restoration, improving habitat for wildlife and recreation for people to hike, ski, and view wildlife in our park

Audubon Society
Mission: Conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity

Ducks Unlimited Minnesota
Mission: Conservation Today; Wetlands Tomorrow

Friends of the Mississippi River
Mission: Working to protect the Mississippi River and its watershed in the Twin Cities area

Izaak Walton League
Mission: A common-sense approach toward protecting our country's natural heritage and improving outdoor recreation opportunities for all Americans

Minnesota Deer Hunters Association
Mission: Betterment of deer and deer hunting by educating youth and adult hunters, acquiring and improving deer habitat, and many community projects

Pheasants Forever
Mission: Conservation of pheasants, quail and other wildlife through habitat improvements, public awareness, education and land restoration

The Nature Conservancy in Minnesota
Mission: The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive

Trout Unlimited
Mission: To conserve, protect and restore North America's trout and salmon fisheries and their watersheds

Lesson 7

Checking the Score Part 2

Focus Question: What discoveries have we made since we last Checked the Score?

Logistical Note: Adult volunteer takes students outside to check cameras and conduct bird observations. This is the final week of bird observations.

Objectives
Students will:

- Evaluate species captures among sites
- Compare and contrast results of remote cameras so far
- Describe habitat differences that may contribute to site differences
- Calculate percentages of species present versus species captured
- Decide if and where to move cameras at each site
- Evaluate bird observations compared to protected area list

Method

Students continue analyzing camera data

Materials

- Thumbnail printouts of all of the images from the schoolyard (students will work in groups)
  One set of images will be required for each group of students
  *As in the last Checking the Score, if you have more than 150 pictures and 3 species captured in the schoolyard, you may want to print one set of the total photo captures so far for the entire class. Some student groups will make new cards for species captured since the last Checking the Score, while others update cards already started. If students are updating species cards, they will add the number of captures since last time and add an interesting fact about behavior of the species either from a field guide or from the photographs. You may choose to give the students a page of selections of new species so that they can choose a voucher image and provide the total number of photographs if you have more than 30 pictures for a species.
- A score card for each group to assess predictions
- A packet of 4x6 index cards (enough to have one card for each species captured per group of as above)
- A calculator to determine percentages
- A pair of scissors to cut out voucher images from thumbnails

Prior Knowledge Questions (5 minutes)

1) Are there species that you have found that surprised you?
2) Will we keep our cameras in their current location or move them?
3) If we choose to move the cameras, where should we move our classroom camera(s)?

Exercise (55 minutes)

Review photographs (10 minutes)
Show selected images that highlight photographs of wildlife captured from the protected area and classroom sites. Graphs of number of times each species has been captured and species captures by time of day can be shown and discussed. These graphs may be shown during each Checking the Score to allow students to see the graphs change over time, or these graphs may be shown as a summary during the final Checking the Score, depending on your preferences and time availability.

Analyze captures (45 minutes)
Students work in groups of 3-4, using a 4x6 index card to tally the number of times each new species was found in the schoolyard and update the index cards previously started. Students should compile data on their 4x6 card. Each card should contain:

6) The best image captured for the species so far for new species. Glue the thumbnail to the 4x6 index card as a voucher for each species
7) Label the card with the common name and the scientific name for the species, using mammal field guides on the touch table
8) List one interesting fact about the species, using the mammal guides on the touch table
9) Tally the number of captures
10) Update the cards started during Checking the Score Part 1
11) Keep completed index cards and score cards for use in Checking the Score Part 3

When students finish filling out their index cards, transfer the species identified to the classroom Species Score Card. Students should calculate 1) the percentage of total mammal species found in the protected area so far, 2) the percentage of species found in the protected area predicted to be found in the schoolyard, and 3) the percentage of species predicted to be in the schoolyard that have been captured so far? Students should document their species percentages in their field journal.

Vote as a class to keep the cameras in the same location or to move them to a new site. If students vote to move cameras, the adult volunteer relocates the cameras today.

TAO: Tally donation total. Students discuss and vote on which organization will receive their money and elect a student or pair of students to write a letter to accompany the donation.

Species Score Card: Afton State Park (Sample)			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Coyote (*Canis latrans*)		✓	
Gray fox (*Urocyon cinereoargenteus*)		✓	✓
Red fox (*Vulpes vulpes*)	✓	✓	✓
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)	✓	✓	
River otter (*Lutra canadensis*)			
Long-tailed weasel (*Mustela frenata*)		✓	
Ermine (*Mustela erminea*)		✓	
Mink (*Mustela vison*)		✓	
Badger (*Taxidae taxus*)			
Striped skunk (*Mephitis mephitis*)		✓	
Spotted skunk (*Spilogale putorius*)		✓	
Virginia opossum (*Didelphis virginiana*)		✓	✓
S. flying squirrel (*Glaucomys volans*)		✓	
Woodchuck (*Marmota monax*)		✓	
E. gray squirrel (*Sciurus carolinensis*)	✓	✓	✓
E. chipmunk (*Tamias striatus*)		✓	
Red squirrel (*Tamiasciurus hudsonicus*)	✓	✓	✓
13-lined ground squirrel (*Spermophilus tridecemlineatus*)		✓	
Fox squirrel (*Sciurus niger*)			
Plains pocket gopher (*Geomys bursarius*)		✓	
American beaver (*Castor canadensis*)			
House mouse (*Mus musculus*)		✓	
White-footed mouse (*Peromyscus leucopus*)		✓	✓
Meadow vole (*Microtus pennsylvanicus*)		✓	
Muskrat (*Ondatra zibethicus*)		✓	
Prairie deer mouse (*Peromyscus maniculatus*)		✓	
Norway rat (*Rattus rattus*)		✓	
Meadow jumping mouse (*Zapus hudsonius*)		✓	
White-tailed deer (*Odocoileus virginianus*)	✓	✓	
White-tailed jackrabbit (*Lepus townsendi*)		✓	
Eastern cottontail (*Sylvilagus floridanus*)	✓	✓	✓
Northern short-tailed shrew (*Blarina brevicauda*)		✓	
Cinereus shrew (*Sorex cinereus*)		✓	
Star-nosed mole (*Condylura cristata*)		✓	
Eastern mole (*Scalopus aquaticus*)		✓	
Little brown myotis (*Myotis lucifugus*)		✓	
Big brown bat (*Eptesicus fuscus*)		✓	
T = total number of species possible = **38**	PA = species found in protected area= **6**	P = predicted species found in schoolyard = **33**	SY = total species found in schoolyard= **7**

+ domestic dog in schoolyard ✓

+domestic dog and domestic cat in ASP ✓

Questions:

1. PA/T X 100 = 16%

(percentage of species in the protected area captured in images)

2. P/T X 100 = 87%

(percentage of species in the protected area predicted in the schoolyard)

3. SY/P X 100 = 21%

(percentage of species predicted in the schoolyard captured in images)

Our School
Street Address
City, State, Zip

Date

Organization
Street Address
City, State, Zip

Dear :

At [our school] this year, we are learning about the wildlife in our schoolyard. We are doing this by using remote trail cameras through MN Project WILD. Each week, we monitor our cameras in our schoolyard, and we compare the animals we capture in our schoolyard with the animals captured in [protected area]. We do lessons to support the work we are doing with our cameras, and we think about how the changes people make to our landscape change the animals that can live in a place.

We have seen many exciting species and interactions in our schoolyard. My favorite sighting from our schoolyard is 1._____. This was exciting to me because 2._____. My favorite sighting in [protected area] is 3._____. This was exciting to me because 4._____.

We discuss the importance of habitat for wildlife in many ways. We also learn about organizations that work to improve habitat for wildlife. This is important because 5._____. As part of our lessons, we asked everybody in our class to bring a $1.00 voluntary donation. We collected a total of 6. $____. We, as a class, decided which organization that works on wildlife habitat would receive our donation. Our class voted to support [organization] because 7._____.

We think it is important for everybody to do their part to improve habitat for wildlife. One way I plan to do this with my family is 8._____. I am happy to be writing this letter on behalf of my class. I hope that our donation helps with your projects that you do to improve wildlife habitat.

Sincerely,

Lesson 8

From Fieldwork to the Classroom: DVD biologists discuss camera traps in conservation research

Focus Question: How are researchers using cameras to help with conservation of tigers in SE Asia, lions in Tanzania, and lynx in Minnesota?

Logistical Note: Adult volunteer takes students outside to check cameras.

Review photographs (10 minutes)

Show selected images that highlight photographs of wildlife captured from the protected area and classroom sites. Graphs of number of times each species has been captured and species captures by time of day can be shown to the students as done each week.

"Stories from the Field"
(25-minute video)

Here are just a few stories of innovative people using remote cameras to conduct conservation research and better understand wild species and their habitat needs.

Dr. J.L. David Smith: For more than 25 years, Dave Smith has studied the behavior, ecology and conservation of tigers in South and Southeast Asia. He specializes in tiger social organization and dispersal patterns. This work has led to long-term monitoring of individual tigers and an interest in the exchange of individuals among populations. Remote cameras are a critical element of the toolbox whenever Dave heads to Asia to conduct fieldwork. His leadership and skill in the field have led Dave to foster many young conservation scientists in their work to conduct their graduate studies and become conservation leaders in park management, government and non-government agencies. Because of the success of Dave's work, he has expanded his research on Asian mammals to include projects on small carnivore communities, tropical bear ecology, and the banteng, a species of wild cow. He uses remote cameras along with other conservation technologies to explore approaches to conservation that are based on influencing human land-use patterns outside traditional park and reserve systems in Asia.

PhD Candidate Hadas Kushnir: Hadas works to mediate problems with lions that attack humans in Tanzania. She has used remote cameras in pilot testing work with another colleague where they sought to find if cameras could be used effectively to monitor lion movements. In their work, one camera got caught in a grassland fire, bush pigs visited the cameras, and baboons were especially curious about the foreign-looking objects. In this work, they did not find lions in their cameras, but they did learn about how to use cameras in the field and experienced rugged field conditions. In the research that Hadas does, she works to characterize and compare how people undertake activities that put them at high risk for lion attack, identify the ecological and human factors influencing the locations of lion attacks, and discover environmental conditions that may be leading to the recent increase in numbers of attacks. Human-carnivore conflict has intensified throughout the world due to human population growth and ecological impacts. In Tanzania, lion attacks on humans have increased fivefold since 1990, with close to 600 people killed and at least another 300 injured. These attacks are cases of lions entering human settlements and agricultural areas in search of human prey. Hadas's work is important to help both the lions living in the grasslands and the humans that live in nearby communities.

Dr. Ron Moen: Since 2003, Ron has been working to photograph and put radio collars on Canada lynx in northeastern Minnesota. He has successfully placed radio collars on 33 lynx as of spring 2009. Once a radio collar is on a lynx, the collar records locations where the lynx spends its time. Combined with maps, these locations can be used to better understand how lynx use a variety of habitat types. Ron has been able to learn many things about the way the lynx use habitat, including habitat most needed for lynx to find their primary prey, snowshoe hares, and to build their dens in the springtime. Ron also uses remote cameras to locate and monitor lynx. He started out using film cameras, which were cost effective but needed to be checked often. In recent years, Ron and his team have switched to digital trail cameras, that operate day and night, with a red light source for night-time IR pictures and have the option to take videos as well. Among the advantages of using digital cameras are increased sensitivity, faster reaction time, and more images. In addition to digital pictures and video of lynx, Ron also regularly finds pine marten, black bears, and fishers in his photographs.

The DVD features "Lights, Camera, Capture" as the main video. "More stories" are a few longer stories from Dave Smith. These stories may be useful for more advanced students in small group discussions.

Reflection (5 minutes): Following the video, students write a journal entry in their field journal addressing the question: "If I were going to do research like the people in the video, what species and where in the world would I choose to conduct research? Why?"

TAO (5 minutes): Select pictures for classroom TAO poster. Print for classroom if possible. If printing is cost prohibitive, consider sending a note home with the students and allow them to pay the cost to have a poster of their own. Cost is usually about $2.50-$3.50 depending on printing company and volume. Kinko's can easily do the printing, and DigiGraphics is a Minneapolis-based company that has done printing for the TAO curriculum in the past. If you would like to contact DigiGraphics, mention the TAO curriculum and let them know that you would like to print TAO posters for your class. They will be able to do the printing and can let you know what a current price is per poster. Ask for Shannon Kelly (612)721-2434.

Lesson 9

What's in a Skull or a Tooth? Understanding how animals found in our cameras are adapted to their habitat

Focus Question: How do animal skulls help us understand how animals use their habitat?

Logistical Note: Adult volunteer takes students outside to check cameras. This is the final week of camera monitoring.

Logistical Note: Reserve a place in your school where you can set up the cave exploration grid. See diagram and photographs for samples.

Objectives

Students will:

- Identify structures on mammal skulls
- Sketch skulls looking for notable characteristics
- Compare and contrast skull structures among mammal species
- Develop confidence in making an educated guess about species identification
- Connect skull structures to ways animals use their habitat

Method

Students learn skull structures, and then implement their knowledge on an archeological cave exploration scenario

Materials

- Skull box with specimens to use for example and labeled for location in cave grid exercise. Using the protected-area mammal lists and common species found in Minnesota, an assortment of animal skulls is provided in the skull box.
- Masking tape to build grid on floor (use gym or media center as space is available in your school)
- Print outs of tooth count table worksheets (1 per student for field journal)
- Rulers
- Hand lenses
- Grid assignment numbers
- Species cards with important information on mystery skulls (1 set per kit)

Review photographs (10 minutes)

Show selected images that highlight photographs of wildlife captured from the protected area and classroom sites. Graphs of number of times each species has been captured and species captures by time of day can be shown to the students.

Prior Knowledge Questions (2 minutes)

Write in your field journal three things that you think you can learn by looking at the skull of an animal.

Background Information

Animals are uniquely adapted to utilize habitat and occupy a niche in the ecosystem. For the past ten weeks, we have been observing primarily mammals in our camera trap sites in the schoolyard and our protected area. These animals have structures that help them to find and process food, and escape from predators and other dangers. These characteristics translate to recognizable components in skulls and teeth that teach us about animals and their adaptations to their environment. The skull and teeth are especially useful in identifying muscle attachment locations and muscle mass and food resources. Once we have learned how to look at skulls and teeth, we can learn a lot about how that animal uses its environment.

Exercise

Introduction to skull structures (15 minutes)

Write these terms on the white or chalkboard:
Sagittal crest, Foramen magnum, Incisors, Canines, Premolars and Molars

Use labeled sample skulls for demonstration during this part of the exercise.

Read or present to the students:

"Animal skulls have evolved for millions of years to protect the brain and sensory organs in mammals. Skulls feature mechanisms that support specific functions, including getting and processing food, gathering sensory information, and protecting the brain from trauma. Based on the design of an animal's skull, many of its dietary and social patterns can be identified. Mammals have four main kinds of teeth: incisors, canines, premolars and molars.

"Carnivores have long canines to rip and tear meat; sharp molars toward the back of the mouth to further rip and shred meat; and binocular vision, with eyes at the front of the head to enable depth perception, needed to catch prey. Predators that tackle large prey often have a sagittal crest, which provides attachment for the temporalis muscle, giving the animal bite force to quickly shut its jaws. Sagittal crests are often larger in males than in females.

"Herbivores have well-developed flat premolars and molars, with sharp ridges on the tops; incisors are large and used to snip off foliage from branches; usually there are no canines; and eyes are located on the side of the head to allow wider field of view to help them detect approaching predators.

"Omnivores have a variety of kinds and shapes of teeth. We are omnivores, and so are bears and raccoons. Omnivore teeth are usually not as well defined as carnivores or herbivores. Omnivores have eyes on the front of their heads like carnivores, to best catch prey.

At the base of the skull is a large hole, the foramen magnum. The foramen magnum allows the spinal cord and nerves to pass from the base of the brain to the rest of the body. Because it connects the skull to the spine, the placement of the foramen magnum can be used to determine an animal's posture."

-adapted from University of California San Francisco's Science & Health Education Partnership at http://seplessons.ucsf.edu/print/366

✦ ✦ ✦ (Optional place to split this lesson) ✦ ✦ ✦

Schematic for Cave Floor Layout

	Path for Bs			Path for Cs	
A1		B1	C1		D1
A2		B2	C2		D2
A3		B3	C3		D3
A4		B4	C4		D4
A5		B5	C5		D5

Cave exploration field trip (30 minutes)

Read or present to the students:

"Today we're taking a field trip to a new archeological site.

"Caves are often a source of exciting discoveries about present and past wildlife that inhabit an area. The remains of animals that make their way into caves are protected from the forces that weather and decompose remains. Rare fossil finds can teach us a lot about the animals that used to live in and around the places we now call home. The Minnesota Conservation Volunteer (March-April 2009) recently featured new fossil discoveries in Minnesota from Tyson Spring Cave. From this cave, scientists have learned that the now-extinct stag-moose and Smilodon, a saber-tooth cat, used to live in Minnesota, as did other large ice-age animals such as mammoths and giant beavers.

"We have discovered a new cave, *Calvaria Cave.* Calvaria is Latin for "skull." Calvaria Cave does not hold fossil specimens. Instead it contains an entire floor covered with bones and skulls of animals that are alive today. This cave flooded periodically over the past couple hundred years. Each time floods come through Calvaria Cave, new bones and debris are deposited on the cave floor. Because of the periodic floods, there are some bones from species that do not live in our part of the state anymore, animals like bison and wolves that have been displaced by our activities.

"Scientists are cataloguing the exciting specimens from Calvaria Cave. Keeping accurate records is important to future study. To do this, we marked a grid on the cave floor surrounding the specimens. Today, your assignment is to help the scientists by working to identify the specimens in the grid that you are assigned so that the bones can be accurately recorded and later moved to a museum for further study. You will need your field journal. I will assign you a grid number. When you get to the cave floor, walk carefully to avoid damaging these rare finds, find your grid square, and use your hand lens to carefully examine the specimen(s) in your grid square. In your field journal, answer the questions that are displayed on the screen (*use a project or write in a place where students can see while working on this part of the exercise*).

When you have an idea about the identity of your specimen(s), bring your specimen, along with your field journal notes to the site director (your teacher). The site director will confirm the identification of your specimen and give you a voucher card for your specimen."

Questions: Skull Observations for Field Journal

1) Measure your skull (length and width in cm). How big is it?
2) Sketch your skull.
3) Do you think this animal is predator or prey? Why?
4) Which types of teeth do you observe? (use table to mark/paste in field journal)
5) Are the eyes in front or on the side of your skull?
6) Based on the information you have observed, do you think your animal is an herbivore, omnivore, or carnivore?
7) What do you think this animal eats? What evidence do you yhave for this?
8) What do you think might eat this animal (if anything)?
9) What is your guess of which animal this might be?

Tooth Count Table for Identification

Which type of teeth do you observe?

Tooth Type	Yes/ No	How many?	What do these teeth do?
Incisor			
Canine			
Molar & Pre-molar			

TAO: The local community paper interviews students for an article. The paper will cover the camera results and highlight the students' goals and progress in understanding biodiversity.

Dear Parents/Guadrians:

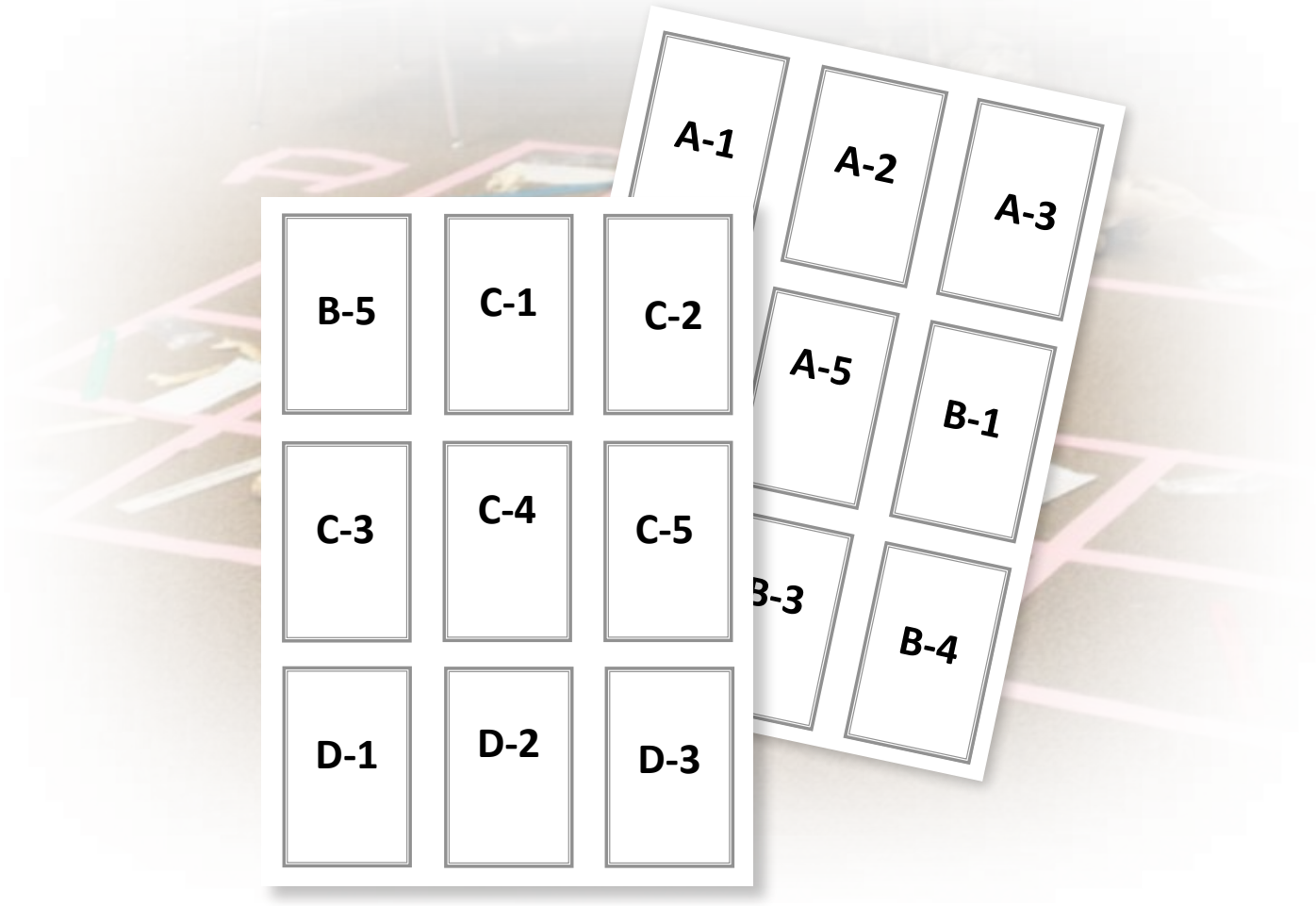
We have been learning a lot about the mammals and birds that live in our schoolyard. We have posters up in our school highlighting mammals found at a range of sites. For our TAO this week, we voted on which pictures we would like to feature on a poster for our school. We have a proof available if you would like to see our poster. If your child would like to have a copy of the poster to bring home (and display on the fridge or in his/her room ☺), we will make copies for each student that orders one. The cost to print the posters will be $2.50-$3.50, depending on the quantity we order.

Please check one box and send this note back to school.

☐ Yes, my student would like one copy of the poster at $2.50-$3.50.

☐ No, my student is not interested in having a copy of our poster.

Student's Name_____



Lesson 10

Checking the Score Part 3
Final results of camera captures in the schoolyard and protected area

Focus Question: How can we improve habitat for wildlife in our schoolyard?

Logistical Note: Prepare a short slideshow as a culmination of the camera captures. See example for formatting and ideas for how you can set this up.

Objectives
Students will:
- Evaluate species captures among sites
- Compare and contrast results of remote cameras
- Describe habitat differences that may contribute to site differences
- Calculate percentages of species present versus species captured
- Nominate peers to present to park guest next week

Method
Students conclude analyzing camera data

Materials
- Thumbnail printouts of all of the images from the schoolyard (students will work in groups)
  One set of images will be required for each group of students
  *Same considerations for cost and number of images to print as the previous Checking the Score
- A score card to tally species that are possible and species that are documented in each location
- A packet of 4x6 index cards (enough to have one card for each species captured per group of as above)
- A calculator to determine percentage of total species documented in each area
- A pair of scissors to cut out voucher images from thumbnails

Exercise (60 minutes)

Review photographs (5 minutes)
Show selected images that highlight photographs of wildlife captured from the protected area and classroom sites. Graphs of number of times each species has been captured and species captures by time of day should be shown and discussed with students.

Prior Knowledge Questions (5 minutes)
Revisit the reflection from Week 1 in students' field journals. What have students learned about their prediction? Students should read what they wrote during the first week of the curriculum and write one paragraph describing the species they have discovered that surprised them and one project that they think the class might be able to do in the schoolyard to improve habitat for the species they are describing.

Wrap up bird observations (15 minutes)

Use sample worksheet (Excel—provided) to label bird species observed during the past six weeks. Students use this worksheet to plot a bar graph of bird observations. Look at the graph created and ask students to answer 1-3 questions in their field journal. Sample questions: Which bird species did we observe the most times? Which species might we expect to observe more if we continued our observations for a full year? How do the numbers of species we have observed compare to the number found in the park? How do we think this might change if we were able to monitor our bird diversity as extensively as the park does? A sample PowerPoint is provided showing how a previous semester of bird observations were concluded.

Bird Observation Graph

Name: _____

Black-capped chickadee																																						
Northern cardinal																																					
American crow																																					
Dark-eyed junco																																					
Chipping sparrow																																					
American robin																																					
Downy woodpecker																																					
Blue jay																																					
European starling																																					
House finch																																					
White-breasted nuthatch																																					
American goldfinch																																					
Brown creeper																																					
House sparrow																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		50		75		100		125		150		

Updating Classroom Index Cards

(10 minutes)
Students work in groups of 3-4, using a 4x6 index card to tally the number of times a new species was found in the schoolyard and update previous cards. Students should compile data on their 4x6 card. Each card should contain:

1) The best image captured for the species so far for new species. Glue the thumbnail to the 4x6 index card as a voucher for each new species
2) Label the card with the common name and the scientific name for the species, using mammal field guides on the touch table
3) List one interesting fact about the species, using the mammal guides on the touch table
4) Tally the number of captures
5) Update the cards from Checking the Score Part 2. Note: You will probably have few new species by this point, so the focus will be on updating and concluding the index cards for all species

When students have finished filling out their index cards, transfer the species identified to the classroom Species Score Card. Students calculate 1) the percentage of total mammal species found in the protected area, 2) the percentage of species from the protected area predicted to be found in the schoolyard, and 3) the percentage of species found in the schoolyard from those predicted. Students document final species percentages in their field journal. Lead a discussion that highlights the fact that cameras are one tool of many used by wildlife biologists to document and monitor mammal species. Which species do we now think would be most difficult to capture using cameras (burrowing, flying, and rare species for example). How might we document their presence or absence if we wanted to focus on particular species for further schoolyard investigation?

PowerPoint to Summarize Results (15 min.)
See sample provided for ideas on content and formatting.

TAO (10 min.): Students elect classroom representatives to present results next week to the park staff. Ask students to nominate classroom representatives for this important project. When a student nominates a peer, they should give 1-2 sentences about why they think this student would be a good choice. The student nominated has the opportunity to accept or decline the nomination. If they accept, they will present, in a small group representing the class, to the park staff member. Students may use the PowerPoint that is part of today's lesson. If they would like to add/change, they can be invited to do so. Note: Scripting and practicing the presentation will take additional time not included in today's lesson.

Completed Example

Species Score Card: Afton State Park (Sample)			
Species Documented in Protected Area Mammal List	☑ species found in protected area	☑ species predicted in schoolyard	☑ species found in schoolyard
Coyote (*Canis latrans*)		✓	
Gray fox (*Urocyon cinereoargenteus*)	✓	✓	✓
Red fox (*Vulpes vulpes*)	✓	✓	✓
Black bear (*Ursus americanus*)			
Raccoon (*Procyon lotor*)	✓	✓	
River otter (*Lutra canadensis*)			
Long-tailed weasel (*Mustela frenata*)		✓	
Ermine (*Mustela erminea*)		✓	
Mink (*Mustela vison*)		✓	
Badger (*Taxidae taxus*)			
Striped skunk (*Mephitis mephitis*)		✓	
Spotted skunk (*Spilogale putorius*)		✓	
Virginia opossum (*Didelphis virginiana*)		✓	✓
S. flying squirrel (*Glaucomys volans*)		✓	
Woodchuck (*Marmota monax*)	✓	✓	
E. gray squirrel (*Sciurus carolinensis*)	✓	✓	✓
E. chipmunk (*Tamias striatus*)	✓	✓	
Red squirrel (*Tamiasciurus hudsonicus*)	✓	✓	✓
13-lined ground squirrel (*Spermophilus tridecemlineatus*)		✓	
Fox squirrel (*Sciurus niger*)			
Plains pocket gopher (*Geomys bursarius*)		✓	
American beaver (*Castor canadensis*)			
House mouse (*Mus musculus*)		✓	
White-footed mouse (*Peromyscus leucopus*)	✓	✓	✓
Meadow vole (*Microtus pennsylvanicus*)		✓	
Muskrat (*Ondatra zibethicus*)		✓	
Prairie deer mouse (*Peromyscus maniculatus*)		✓	
Norway rat (*Rattus rattus*)		✓	
Meadow jumping mouse (*Zapus hudsonius*)		✓	
White-tailed deer (*Odocoileus virginianus*)	✓	✓	
White-tailed jackrabbit (*Lepus townsendi*)		✓	
Eastern cottontail (*Sylvilagus floridanus*)	✓	✓	✓
Northern short-tailed shrew (*Blarina brevicauda*)		✓	
Cinereus shrew (*Sorex cinereus*)		✓	
Star-nosed mole (*Condylura cristata*)		✓	
Eastern mole (*Scalopus aquaticus*)		✓	
Little brown myotis (*Myotis lucifugus*)		✓	
Big brown bat (*Eptesicus fuscus*)		✓	
T = total number of species possible = **38**	PA = species found in protected area= **10**	P = predicted species found in schoolyard = **33**	SY = total species found in schoolyard= **7**

+ humans, domestic dog, and domestic cat in schoolyard and ASP✓

Questions:

1. PA/T X 100 = 26%

(percentage of species in the protected area captured in images)

2. P/T X 100 = 87%

(percentage of species in the protected area predicted in the schoolyard)

3. SY/P X 100 = 21%

(percentage of species predicted in the schoolyard captured in images)

Lesson 11

How do Protected Area Managers Keep Parks Healthy for Wildlife: Guest park staff discusses park-conservation/habitat-improvement strategies

Park staff is invited to come and speak with the class. The instructor should request that the park staff focus on answering the question "How do you keep the park healthy for wildlife?"

Begin with a 15-minute presentation by the students elected last week about what the class found comparing biodiversity in the schoolyard and the protected area. Following the student presentation, the park staff person will present to the class.

TAO: Students present results from Checking the Score to park staff.

Lesson 12

Improving our Schoolyard for Wildlife Habitat Classroom Forum

Focus Question: What can we do to improve habitat in the schoolyard for species we observe with our trail cameras?

Background Information

Using what we've learned from the animals found in remote cameras, students propose a project to improve schoolyard habitat. During the past 12 weeks, the students have become experts on biodiversity in their schoolyard and the protected area. They have been building upon their questions since the first week of the curriculum and using inquiry to answer their questions and explore issues of biodiversity. For today's forum, the students work in small groups to develop proposals to improve habitat in the schoolyard. At the end of the first session, students select a spokesperson from the group to present their proposal to the class. The class votes to select the group proposal they like best. Students who want to work on their project have the option to sign the Commitment to Action that specifies that they are dedicated to making this project happen if the principal and/or school board or parent group organization support their proposal. If students decide not to sign the Commitment to Action, they may choose to write a one-page essay in their field journal about why they chose not to participate in the class proposal and describe a project that they may do instead with their family.

Students should be encouraged to think big, but still keep their ideas within a realistic timeframe (e.g., a weekend to a couple of weeks or a growing season). Research shows that people learn how to take action and build life-long patterns of action with respect to the environment by having a supportive environment in which they can practice new behaviors. This workshop is an opportunity for students to formulate ideas for problem solving and practice decision-making skills. Providing a list of possible projects on the board will give students a place to start by selecting one of the provided options or using these options to generate their own ideas.

Examples of projects and sources of ideas that students might consider include:

- Creating a native-plant garden in the schoolyard (See: http://www.fws.gov/chesapeakebay/schoolyd.htm and the Prairie Moon Nursery catalog included)
- Building an interpreted trail in or near the schoolyard
- Building and mounting bird or bat houses (*Woodworking for Wildlife* by Carrol Henderson is an excellent resource for plans, patterns, and directions included)
- Conducting a schoolyard clean-up
- Obtaining schoolyard certification for wildlife habitat through National Wildlife Federation (See: http://www.nwf.org/schoolyard/#)
- *Wild School Sites,* a Project WILD publication, provides planning for implementation of schoolyard habitat improvement projects

Materials

Copies of any of the resources previously listed above and (if desired) 1 computer per student group for internet-based project research

Forum (50 minutes):

Students will work in groups of 3-4 to build a proposal for the schoolyard. A timeline of the forum should be written on the board to help students stay on task as they develop their project proposals. Keep close track of time and ring a bell at the end of each time unit so students are aware that they should move on to the next part of the proposal.

- Discuss possible ideas (**10 minutes**): One group member should keep track of the group's ideas so they can choose from their list at the end of the 10 minutes. If the group has problems deciding, they should vote. The teacher may provide a tie-breaker if needed.
- Write an outline of the project (**15 minutes**): The outline should include the possible dates and the expected length of the project, a schedule of how the project will be conducted, number of volunteers needed for each date (if multiple days are required for the project), number of adults they will need to help, the amount of money required, and how the money will be raised.
- Each group briefly describes their idea to the class (**15 minutes**)
- Class votes both on which project to present to the principal, school board, and/or parent organization and students sign the Commitment to Action.

TAO (10 minutes): Students elect representatives to have lunch with the principal to discuss their proposal and/or schedule a time to present their proposal to the school's parent group organization.

Commitment to Action

I am committed to working with my class to conduct our schoolyard habitat improvement project. I will listen to instructions and help in every way that I can while we work on our project. I understand that I do not have to work on this project and that I am choosing to work on this project to do my best to help improve our schoolyard habitat for the species we see in our remote trail cameras.

Students sign a class commitment page to post in the classroom.

Appendix 1:
Installing Remote Cameras in the Schoolyard

Setting the Camera and the Site

As you prepare to set up your cameras, consider if you want to attract animals to your site or rely on finding active animal trails. You will have the most success by doing both. Issues with baits and lures are changing and a part of active discussion in Minnesota. If chronic wasting disease is found in Minnesota in deer populations, bird seed and grain even in bird feeders may not be allowed to prevent the nose-to-nose spread of the disease in deer. Places where deer gather in large numbers and feed together can become a problem, and we may see this if CWD is found. Currently, baits and lures are allowed, especially in small amounts. We recommend when setting up your camera site using a combination of small predator attractants (Hiawatha and Violator 7) applied to a small piece of lambs' wool. You can obtain lures from Minnesota Trapline Products. Tim and Nancy Caven have been providing expert advice to TAO teachers since TAO's inception. You can contact them by calling (320)599-4176 or visit their website at www.minntrapprod.com. If you think you have specific species present (such as muskrat or beaver, especially if your school is close to a wetland), ask Tim and Nancy for their recommendations for lures. They are experts and will be able to guide you in setting up your cameras in the schoolyard. In a generic set-up, place about 1 coffee-can-sized container of corn, powdered acorn, or other grain at the site with a combination of predator lure applied to lambs' wool. This will give you an opportunity to attract a range of species without allowing wildlife to become acclimated to the food resource, because this small amount will be depleted in 3-4 days.

1. Read through the manual for your camera. If you read through the manual each time you go out to work with your camera, you can save yourself time in the field getting the camera set. Make sure you know how to turn the camera on, use the laser test site, and change the SD card before you head outside.
2. Look for a place where animals are likely to travel (trails in long grass, areas close to water, deer trails are often highly visible and used by many species) and/or place bait or a lure to help attract wildlife. Baits and lures are allowed through MN DNR as long as no hunting is conducted at the site. To avoid habituating animals to a new resource, plan to have your camera in place for a short time and move your site often if you are planning longer-term monitoring. Call the area Wildlife Conservation Officer (Metro: Brad Johnson 651-646-8200) if you have any questions.
3. Bring at least essential supplies every time: Moultrie trail camera, camera identification tag, lock box, padlock, cable to secure the camera in place, cable clamp to lock the cable in place, a ratchet wrench to secure the cable clamp, camouflaged duct tape to better secure your camera and camouflage the lock box, and lures/bait to attract animals to your camera site.
4. Position your camera facing north. If at all possible, position your camera south of the intended photo area facing north. If you position your camera aiming east or west, you risk inadvertent triggers due to the rising or setting sun. This will cause false triggers as shadows move and the sun shines into the camera sensors. You may find a perfect site to set up the camera that does not have the optimal orientation. Try your site anyway understanding that you may have to delete pictures captured because of extreme shadows and light movement.
5. When placing your camera on an animal trail, position your camera at a 45-degree angle to the trail. Avoid positioning your camera perpendicular to the trail. Most cameras are not quick enough to capture a picture of animals moving perpendicularly.
6. Position your camera approximately 6-10 feet from the intended photo area. Most trail cameras can detect motion out to 30 feet, but many flashes don't reach past 20 feet. Night pictures taken under 4 feet or closer can white out the identifying features of your animal. Under most circumstances your best photo opportunities will be at 6-10 feet for capturing a range of sizes of mammals.
7. Cable the camera to a tree or post 12-24 inches off the ground. Make sure the tree is large enough not to blow in the wind, or false triggers will result. Aiming the camera parallel to the ground will produce the best pictures and will work best when the camera is set at a lower height. If you place the camera higher than recommended, aim your beam at your bait site on the ground. This will enable capture of small and large mammals alike.
8. Clear light vegetation from the sensing area of the camera. Avoid false triggers of branches and grass blowing in the wind. I usually minimize the amount of clearing that I do at a site, acknowledging that I may have many false triggers especially in long grass. In late fall, winter, and early spring, this is easier because leafy vegetation does not blow in the way. Watch especially

for any medium-sized branches likely to wave in front of your camera or saplings in the frame of your site in front of expected animals. The IR "flash" will white out branches directly in front of the camera and may block target animals.

9. Check battery level every time you monitor your camera. Make sure you don't lose valuable wildlife images by running out of battery power.
10. Turn camera on and confirm all settings, including date and time. Some cameras reset every time the batteries are removed and will need to be reset when batteries are changed.
11. Aim the camera at your target. Use the Moultrie laser to double-check your aim.
12. Use a small piece of duct tape inside the lock box to secure your camera in the center of the box and avoid wobbling inside the box.
13. Double-check attachment and secure all locking mechanisms. Secure the back of the lock box, using cable and cable clamps to secure the camera inside the box to the tree or other large support. Use camouflaged duct tape to further secure site. Try to do this without blocking your access to the camera as you check and download images.
14. Place camera in live mode, wait for time out period to expire and trigger camera. Note the time. Triggering your camera before you leave accomplishes two things. First, you are able to verify that it is working. Second, you now have a picture to reference if the date or time was not set correctly.
15. Close the front of the lock box over the camera, and lock the box closed with the padlock.

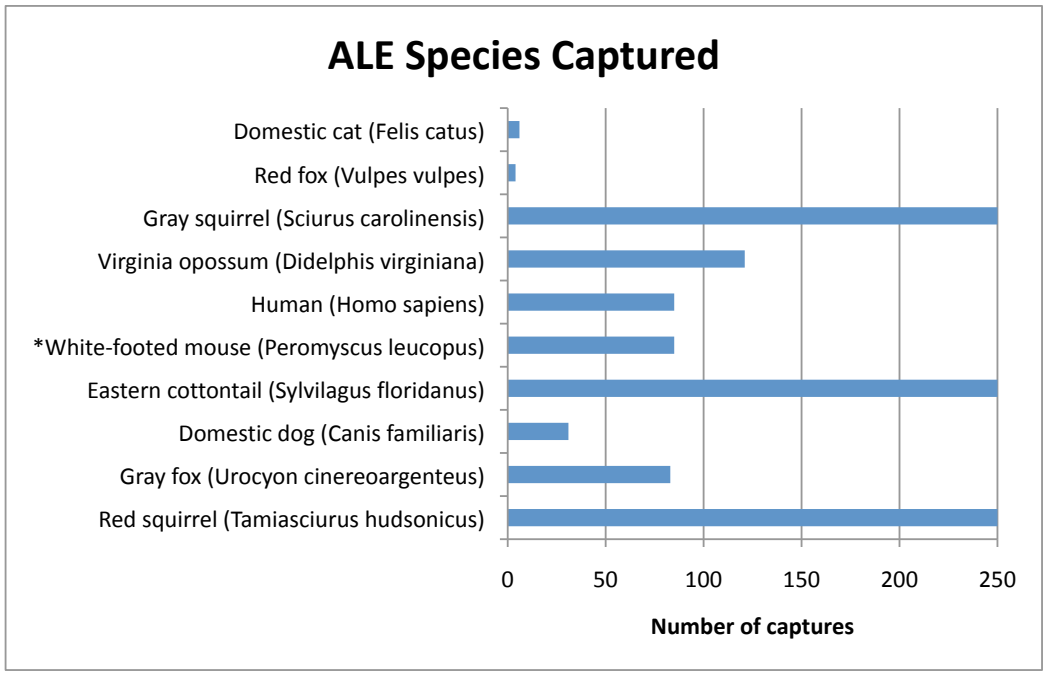
Retrieving pictures

1. Upon arriving, walk in front of the camera and trigger the motion sensor. This picture will verify that the camera is working and also serve as a reference if the date or time is incorrect.
2. Turn off the camera, pull media card, and review pictures. You can put a fresh card in the camera and view the pictures when you have returned from your site. If you are able to view the pictures first, you can find out if there are any changes you would like to make to your set before you re-trigger the camera.
3. Confirm settings.
4. Clean lens and motion sensor if needed.
5. Refresh your bait if you have decided to use it and it is depleted.
6. Place camera on live mode.
7. Secure and lock.

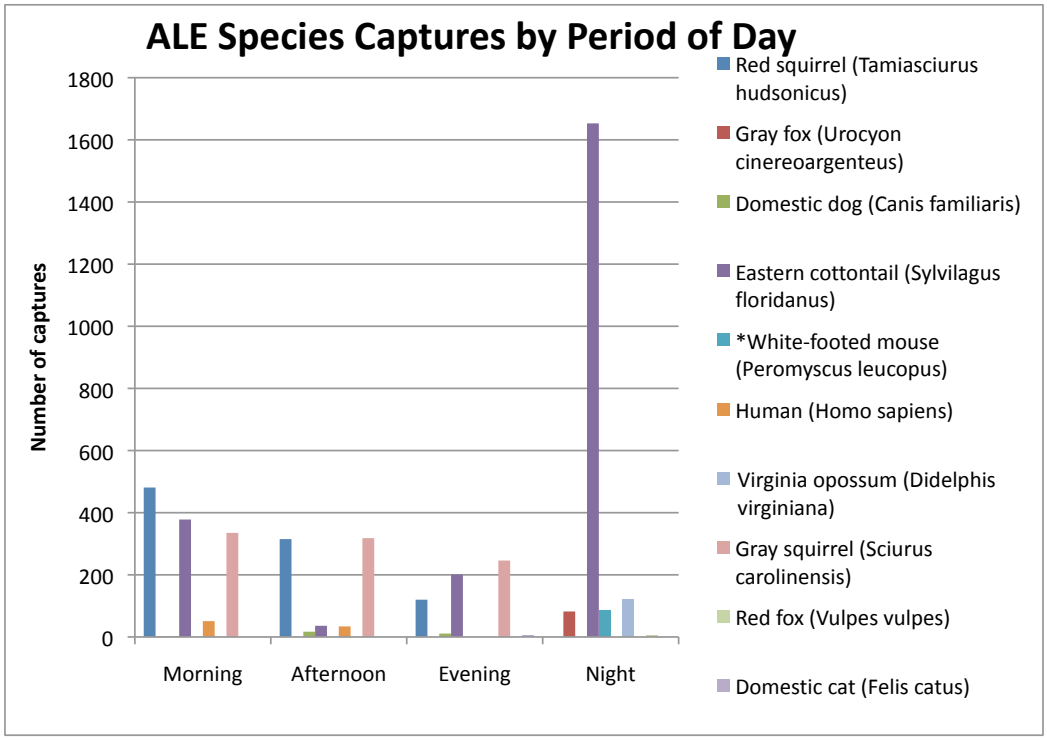
Appendix 2:

Example of Weekly-Compiled Graphs:

A) This graph shows number of captures by species. For this graph, the x-axis was set to a maximum of 250 captures so that the species captured less frequently were still visible on the graph. The Red squirrel, Eastern cottontail, and Gray squirrel were captured more than 250 times each.

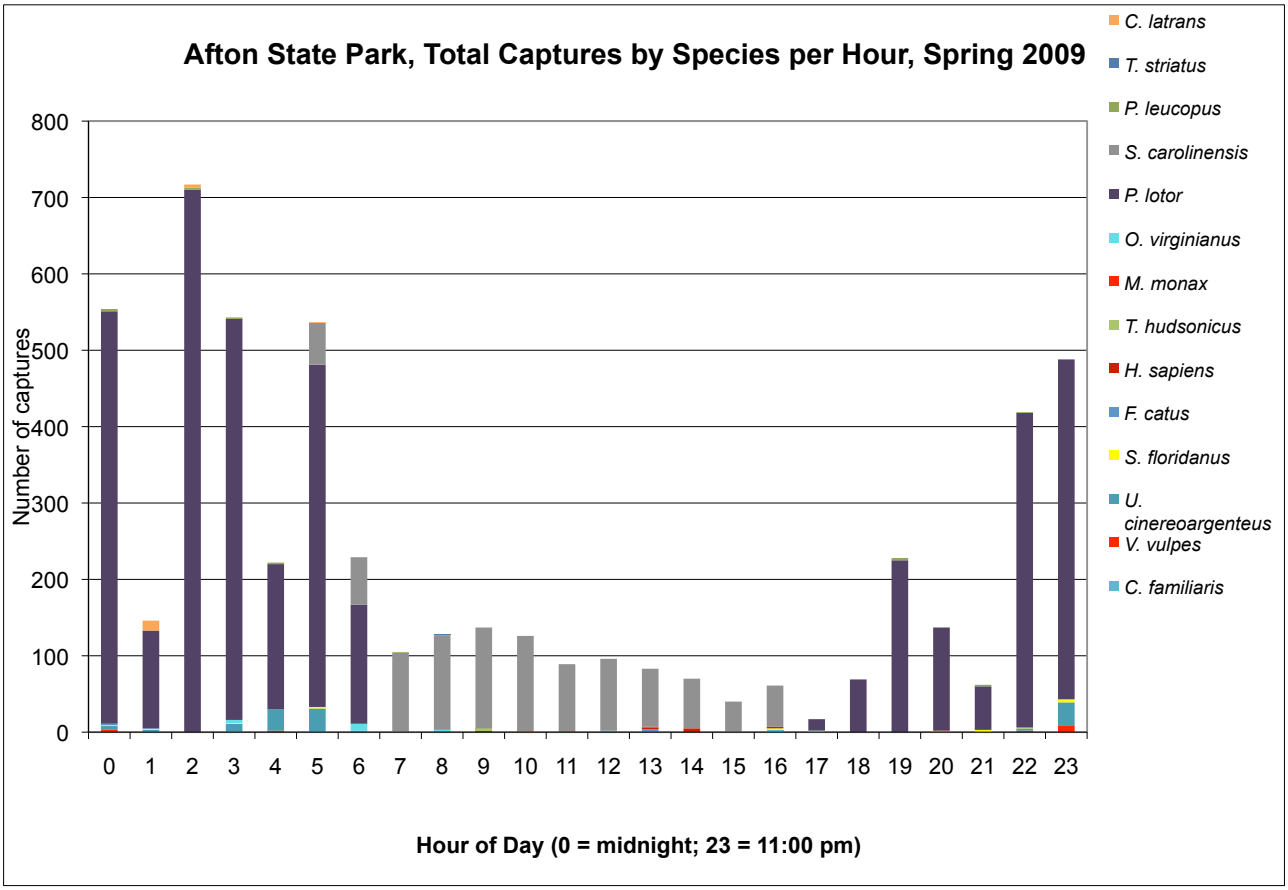


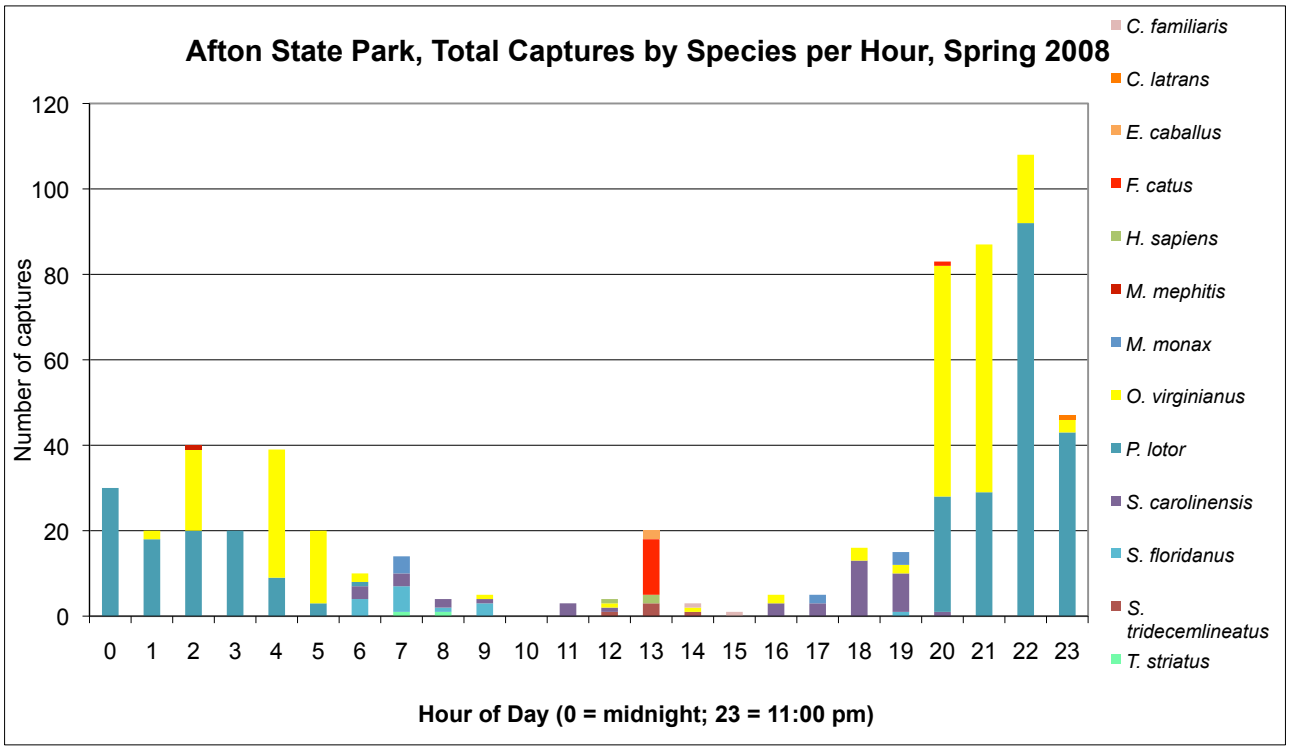
B) This graph shows the number of captures by time period. These give a more simplified output and help to identify diurnal and nocturnal mammals. This information can be better expressed in the 24-hour graphs.

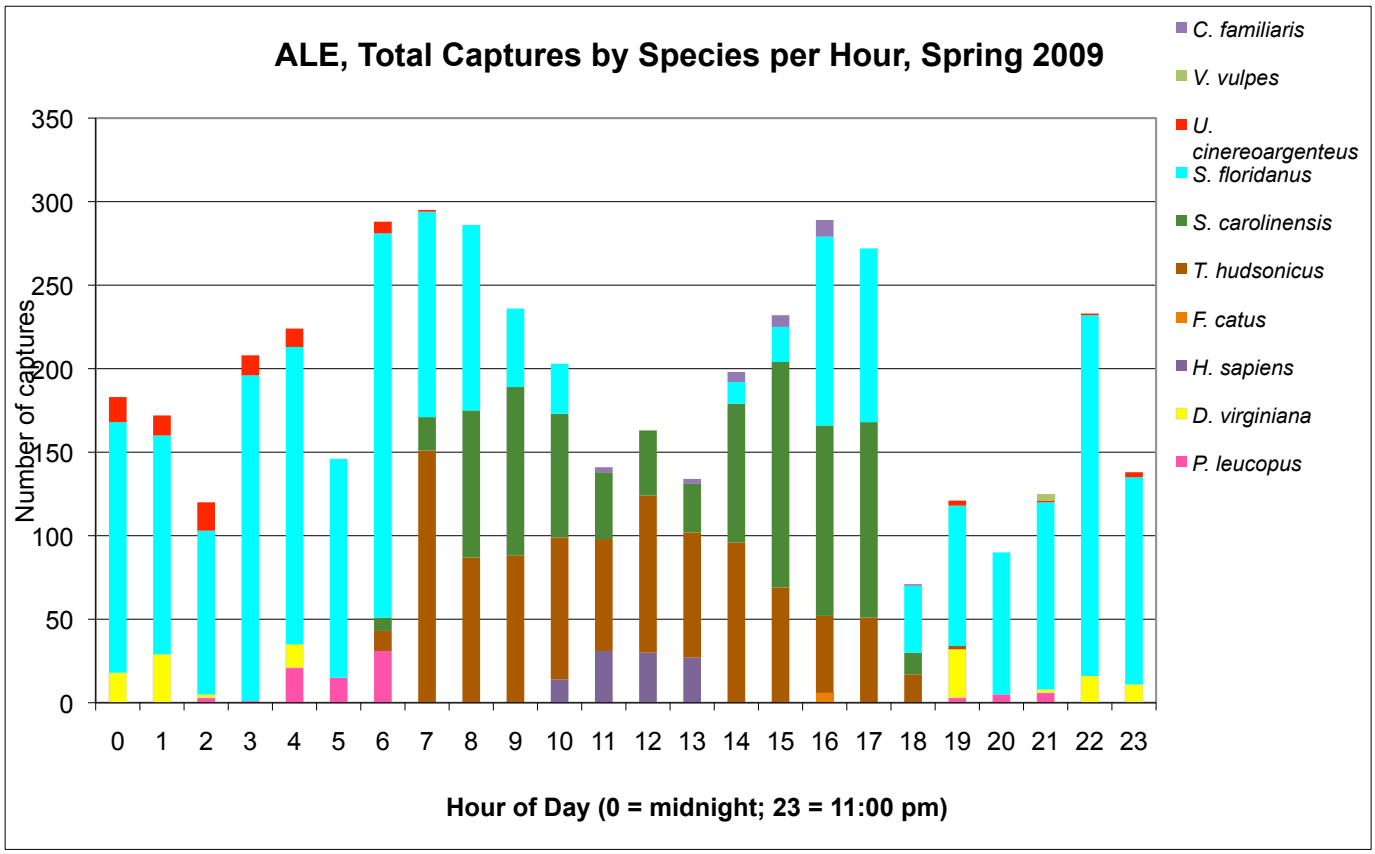


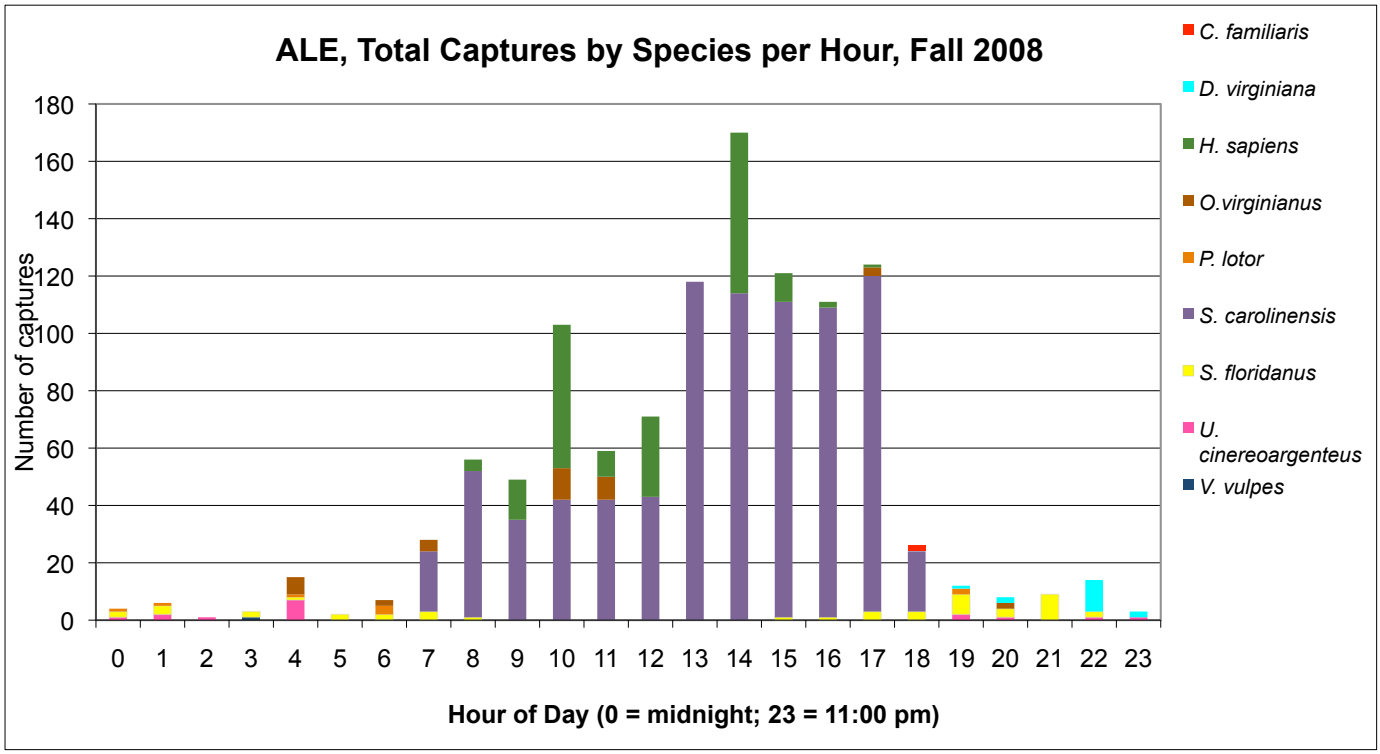
Example of 24-hour Activity Graphs:

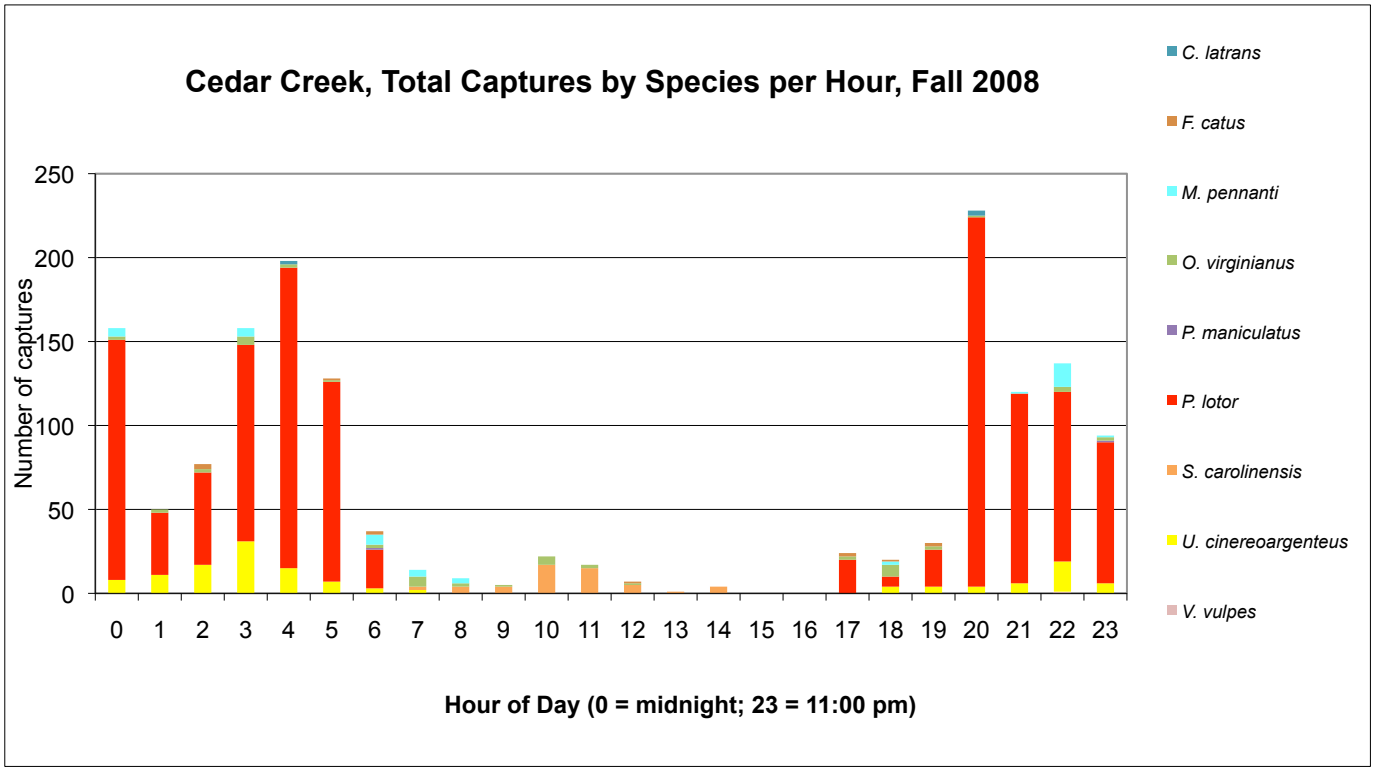
Take the weekly-compiled graphs by period of day and record the hour of capture to create graphs with more clear information about activity by species. This graph is the goal culmination graph for each site. Here you can see sample graphs for protected areas and schoolyards. You can see how activity of animals change in human-dominated sites vs. location with large tracts of wildlife habitat.






ALE, Total Captures by Species per Hour, Spring 2009
Number of captures
350
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of Day (0 = midnight; 23 = 11:00 pm)
C. familiaris
V. vulpes
U. cinereoargenteus
S. floridanus
S. carolinensis
T. hudsonicus
F. catus
H. sapiens
D. virginiana
P. leucopus


ALE, Total Captures by Species per Hour, Fall 2008
Number of captures
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of Day (0 = midnight; 23 = 11:00 pm)
C. familiaris
D. virginiana
H. sapiens
O.virginianus
P. lotor
S. carolinensis
S. floridanus
U. cinereoargenteus
V. vulpes

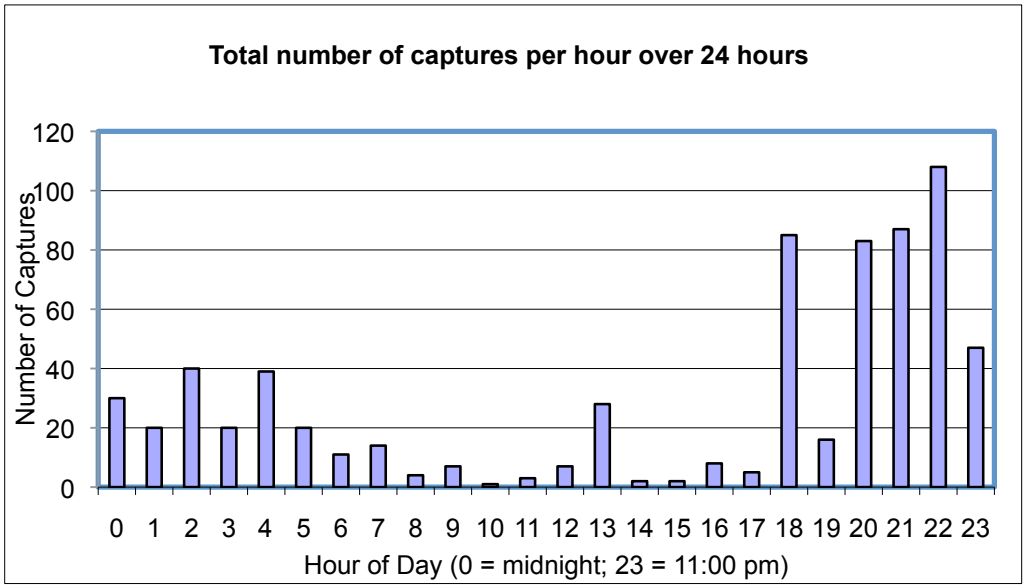


This table shows how to build the 24-hour graphs in Excel. Each species must be summed for total number of captures by each hour using a 24-hour, military clock.

	Hour																							
Species	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
P. leucopus	0	0	3	1	21	15	31	0	0	0	0	0	0	0	0	0	0	0	0	3	5	6	0	0
D. virginiana	18	29	2	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	2	16	11
H. sapiens	0	0	0	0	0	0	0	0	0	0	14	31	30	27	0	0	0	0	0	0	0	0	0	0
F. catus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
T. hudsonicus	0	0	0	0	0	0	12	151	87	88	85	67	94	75	96	69	46	51	17	2	0	0	0	0
S. carolinensis	0	0	0	0	0	0	8	20	88	101	74	40	39	29	83	135	114	117	13	0	0	0	0	0
S. floridanus	150	131	98	195	178	131	230	123	111	47	30	0	0	0	13	21	113	104	40	84	85	112	216	124
U. cinereoargenteus	15	12	17	12	11	0	7	1	0	0	0	0	0	0	0	0	0	0	0	3	0	1	1	3
V. vulpes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
C. familiaris	0	0	0	0	0	0	0	0	0	0	0	3	0	3	6	7	10	0	1	0	0	0	0	0

Additional graphs to consider as possibilities:

There are many ways yo analyze the information captured in these photographs. Use your imagination and encourage your students to do the same. this graph is a simplified version of the 24-hour graph. This graph collapses all species together and shows the number of captures by hour. The data table needed to create this graph is easier to develop than the 24-hour graphs by species.

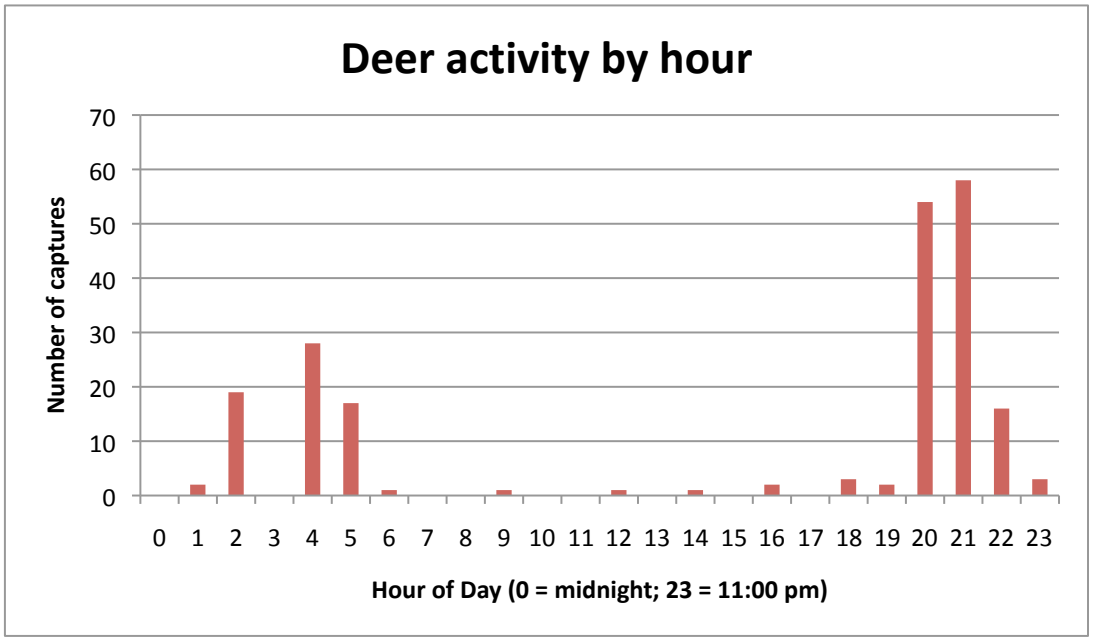


This table shows how to build a more simplified 24-hour graph in Excel.

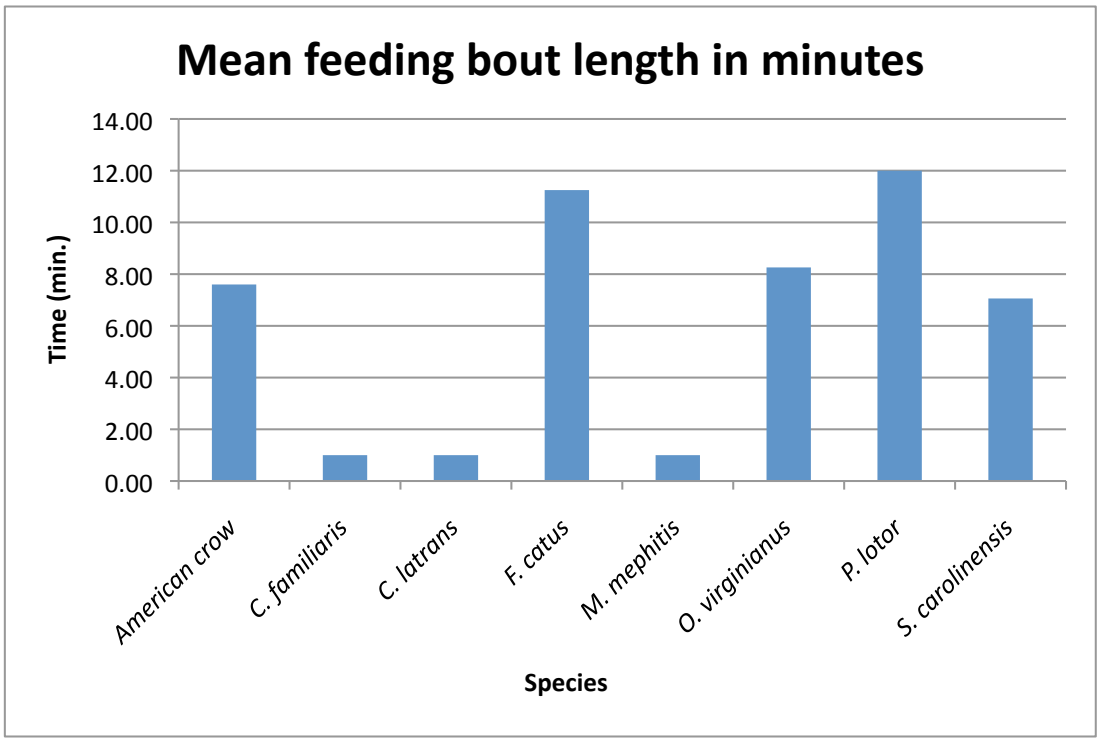
total number of captures (Count)
by the time that they were captured (Hour).

Count	Hour
30	0
20	1
40	2
20	3
39	4
20	5
11	6
14	7
4	8
7	9
1	10
3	11
7	12
28	13
2	14
2	15
8	16
5	17

Consider focusing on a particular species of interest and analyzing it compared to other species using a similar 24-hour graph but extracting only 1 species:



For species that are observed feeding (depending on attractant used at a site), consider developing a graph that shows how long animals feed at a site:



Sample for Set-Up of Excel Spreadsheet for Analyzing Additional Variables:

There are many variables you could choose to analyze as you implement TAO with your students. Consider the variables you are most interested in ahead of time. It will be easier to build these variables into a master Excel spreadsheet initially than it will to add information later. This table shows one way you may choose to set up your data that will allow more variables to be analyzed than the ones shown in this appendix.

Installation Code	*Species*	Count	Date	Time	Temp. (degrees F)	Moon	Hour
SITE1	*Procyon lotor*	1	10/30/2008	0:36	54	WxC	0
SITE2	*Procyon lotor*	1	10/15/2008	1:50	45	full	1
SITE2	*Sylvilagus floridanus*	2	9/23/2008	1:22	63	WnC	1
SITE3	*Sylvilagus floridanus*	1	10/5/2008	1:47	40	WxC	1
SITE1	*Urocyon cinereoargenteus*	1	11/3/2008	1:39	44	WxC	1
SITE1	*Urocyon cinereoargenteus*	1	11/3/2008	1:39	44	WxC	1
SITE1	*Urocyon cinereoargenteus*	1	11/4/2008	2:51	65	FQ	2
SITE3	*Sylvilagus floridanus*	2	10/29/2008	3:14	22	new	3
SITE2	*Vulpes vulpes*	1	10/13/2008	3:44	64	full	3
SITE1	*Odocoileus virginianus*	2	10/25/2008	4:08	44	WnC	4
SITE1	*Odocoileus virginianus*	1	10/25/2008	4:08	44	WnC	4
SITE1	*Odocoileus virginianus*	1	10/30/2008	4:22	41	WxC	4
SITE1	*Odocoileus virginianus*	1	10/30/2008	4:23	41	WxC	4
SITE1	*Odocoileus virginianus*	1	10/30/2008	4:24	41	WxC	4
SITE3	*Procyon lotor*	1	10/7/2008	4:15	59	FQ	4
SITE1	*Sylvilagus floridanus*	1	10/24/2008	4:22	47	WnC	4
SITE1	*Sylvilagus floridanus*	1	10/24/2008	4:22	47	WnC	4

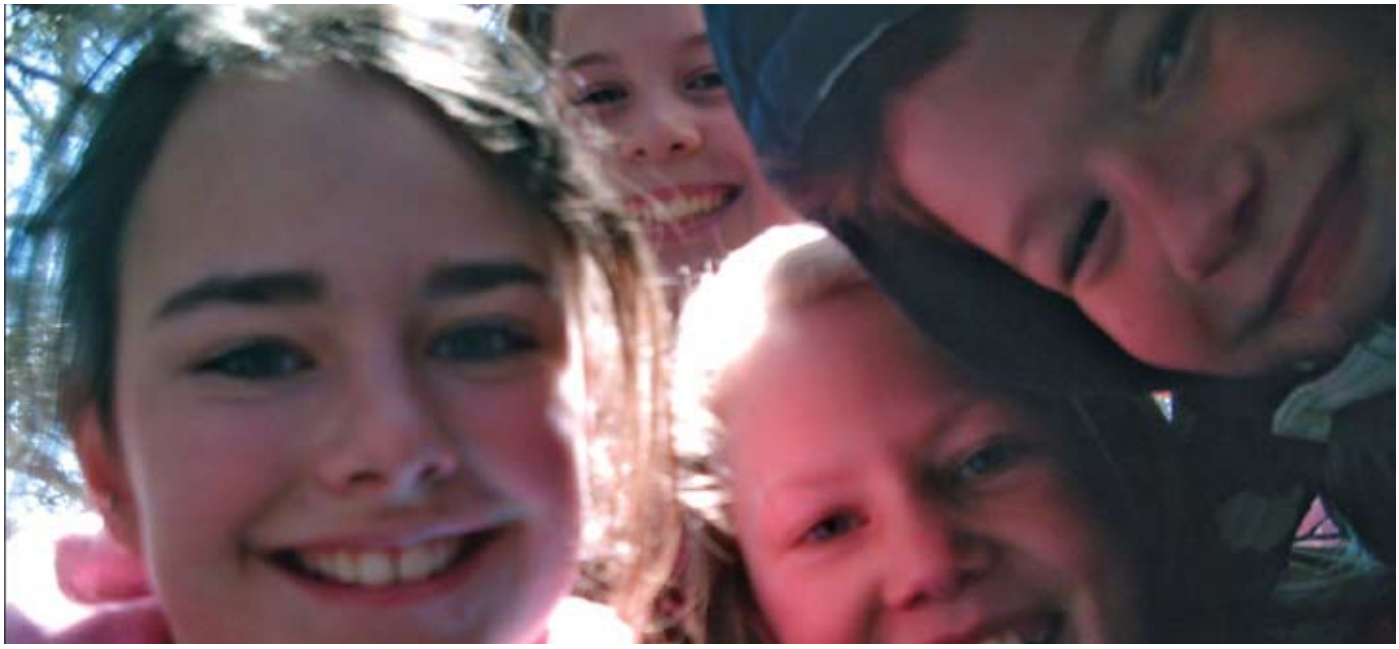
**** Use your imagination. You are only limited by what you can envision. These graphs are just a place to begin!***

Appendix 3:

This pre/post Student Opinion Survey was developed based on environmental education literature and assessments. This survey was developed to identify the results of TAO at achieving changes in student environmental knowledge, attitudes and behaviors with respect to issues of habitat loss and landscape fragmentation. By the age of 12, students have already become fairly set in their attitudes. Depending on the age of students you are teaching, you may not see much change in attitude results. However, this age is primed to acquiring and becoming confident in use of environmentally responsible behaviors.

If you would like to use this Student Opinion Survey, knowledge questions are numbers 34-37 in short-answer format. Question 34 assesses if students understand habitat. Question 35 asks how many mammals and birds students think could be found in the schoolyard. You can analyze this question by calculating mean and standard deviation for how many species students list before and after the curriculum. In early analysis, we find that students initially listed an average of 4 species for this question. After the curriculum, this increased to 12. For questions 35 and 36, you can consider possible categories and look at the percentage of responses in each category. Generally, the less complicated answers are seen prominently in early assessment. The complexity of answers and number of responses increases following the curriculum. Possible categories for question 35 are: Habitat destroyed, Animals killed/injured, Animals displaced, Causes some animals to adapt to human-dominated landscapes, Food-web interactions, Causes species extinction, Causes pollution, and Don't know. Possible categories for question 36 are: Build less (buildings and roads), Remove structures (buildings and roads), Use renewable building materials, Be eco-friendly, Talk to others about value of wildlife, Relocate wildlife, Restore habitats (plant trees, add parks), Reserve places for forests/wildlife, Make structures for wildlife (bird houses, enclosures, etc.), Conserve resources (energy, gas, recycle, etc.), Reduce pollution, Don't know, and Other. Attitude and Behavior questions are found between questions 1-33. All questions were randomized to determine their current order. Each question is scaled with a possible of 5 points. Some questions are reversed in expressing the desired response to prevent students from heading down a page and writing the same answer for each question. If a question is reversed, strongly disagree would = 5 points instead of the expected 5 points for strongly agree. Questions 9, 11, 13, 16, 18, 21, 24, and 26 are scored with strongly disagree = 5 points. Which questions to reverse in this way were randomly identified, and the number to reverse in this way were determined from previous EE assessments in the literature.

Attitude questions are scaled on a 5-point scale for a possible of 60 points. Questions 2, 3, 4, 5, 6, 8, 10, 12, 17, 18, 19, 21 ask questions to assess student attitudes. Environmentally responsible behavior (ERB) is the overarching goal of TAO. As such, there are three categories of behavior: confidence in an ability to do a behavior, intent to do a behavior, and practice of behaviors by frequency. Each category has a possible score of 35 points. ERB confidence questions are numbers: 1, 7, 11, 15, 22, 23, 24. ERB intent questions are numbers: 9, 13, 14, 16, 20, 25, 26. ERB practice questions are numbers 27-33. More detailed information will be published as part of this work as the testing of the curriculum is completed.



Student Opinion Survey

Please tell me a little bit about you.

Your gender: Male ☐ Female ☐ Your age: _____

How would you describe your neighborhood:

In a city ☐ In a suburb ☐ In a small town ☐ In the country (rural area) ☐

For each sentence below, choose the answer that best fits how you feel, not how you think you should feel or how someone else might feel about wildlife and the environment. There is no right or wrong answer.

		strongly disagree	disagree	neutral	agree	strongly agree
1.	I can find mail or e-mail addresses for people who make decisions about the environment.	○	○	○	○	○
2.	It makes me sad to see houses being built where animals used to live.	○	○	○	○	○
3.	Giving part of my allowance to a wildlife organization would be a good way to improve wildlife habitat.	○	○	○	○	○
4.	It makes me happy when people recycle used bottles, cans, and paper.	○	○	○	○	○
5.	It makes me happy to see animals living in natural habitats.	○	○	○	○	○
6.	It makes me happy to have more places around me where animals can live.	○	○	○	○	○
7.	I know how to identify projects where I can help improve wildlife habitat (like planting native seeds, building bird houses, removing non-native plants).	○	○	○	○	○
8.	I get angry about the damage pollution does to the environment.	○	○	○	○	○
9.	Wildlife habitat would not be an important part of my discussions if I was asked to meet with school leaders.	○	○	○	○	○
10.	It makes me happy to see people trying to save energy.	○	○	○	○	○
11.	If I were asked to help pick up litter, I would be confused about what to do to help.	○	○	○	○	○
12.	My actions will make the natural world different.	○	○	○	○	○
13.	I would not want to spend time on a weekend working on a project to improve wildlife habitat (like planting native seeds, building bird houses, removing non-native plants).	○	○	○	○	○
14.	I plan to find places around my home to watch birds and animals.	○	○	○	○	○
15.	I can correctly identify birds and animals in my neighborhood.	○	○	○	○	○
16.	I think it is a waste of my time to write to a group that works on environmental issues.	○	○	○	○	○

		strongly disagree	disagree	neutral	agree	strongly agree
17.	I am frightened to think that people don't care about the environment.	○	○	○	○	○
18.	I do not worry about environmental problems.	○	○	○	○	○
19.	I get upset when I think of the things people throw away that could be recycled.	○	○	○	○	○
20.	I would hand out information about a group that works on environmental issues.	○	○	○	○	○
21.	I do not worry about the ways habitat changes for birds and animals when new houses and roads are built in my town.	○	○	○	○	○
22.	I would feel confident selecting students from my class to present our ideas about wildlife habitat with leaders in our school.	○	○	○	○	○
23.	I know how to write a letter to my school newsletter or community paper about issues that are important to me.	○	○	○	○	○
24.	I would be worried about what my friends might think if I discuss my ideas about animal habitat.	○	○	○	○	○
25.	Discussing environmental issues with my friends is important.	○	○	○	○	○
26.	In my neighborhood or schoolyard, I do not plan to pick up litter I see on the ground.	○	○	○	○	○

Circle the number of times you have done each of the following actions in the last six months:

27.	Written letters or e-mailed politicians asking them to consider the environment.	0	1	2	3	4	5+
28.	Discussed the environment with my family.	0	1	2	3	4	5+
29.	Helped with projects to improve wildlife habitat (like planting native seeds, building bird houses, removing non-native plants).	0	1	2	3	4	5+
30.	Written letters or sent e-mail to people to improve wildlife habitat.	0	1	2	3	4	5+
31.	Spent time with my family watching birds or animals in our neighborhood.	0	1	2	3	4	5+
32.	Picked up candy wrappers or other litter I found on the ground.	0	1	2	3	4	5+
33.	Helped present ideas to my school (teacher, principal, or school board) to improve wildlife habitat in my schoolyard.	0	1	2	3	4	5+

For each question, answer as completely as you can. Use the back side if you need more room.

34. Think about one animal and its habitat. What is the animal, and how would you describe its habitat?

35. List as many mammals and birds as you can that might be seen (day or night) in your schoolyard.

36. People build houses, roads, and towns. How do you think this changes wildlife habitat?

37. Describe ways you think our houses, roads, and towns could be changed to improve wildlife habitat.


Minnesota
DEPARTMENT OF
NATURAL RESOURCES