Acknowledgements

Project WILD's reach to millions of students in the program's 35-year history is a result of the dedicated efforts of a vast network of educators and environmental professionals.

The updated and revised edition of the *Project WILD K-12 Curriculum & Activity Guide*, released in 2018, is available to provide an even better teaching tool that incorporates field investigations, WILD Work career education, STEM connections, and updated and new activities, all building upon needs in education and conservation.

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To all educators who are committed to teaching young people about wildlife and the environment, we honor what you do each day, and it is because of you that we have such hope and promise that wildlife and natural systems will be there in the future for all to enjoy.

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GOOD BUDDIES: *Barnacles on Whale*, Aleria Jensen, NOAA; *Whale*, Christopher Michel (flickr.com, CC-BY-2.0); *Remora*, Lakshmi Sawitri (flickr.com, CC-BY-2.0); *Shark*, Pxhere.com; *Bee* (cropped photo used twice), Franco Folini; *Marabou Stork*, Pxhere.com; *Silverfish*, Jean-Raphaël Guillaumin; *Black Ant*, Chris Sorge; *Hermit Crab*, Pxhere.com; *Snail Shell*, Pxhere.com; *Cowbird*, Ken Gibson (flickr.com, CC-BY-2.0); *Bison*, "Tupulak" (flickr.com, CC-BY-2.0); *Yucca*, Don Graham (see www.flickr.com/photos/23155134@N06/); *Yucca Moth*, Rob Hannawacker (flickr.com, public domain); *Ostrich*, Stig Nygaard (flickr.com, CC-BY-2.0); *Gazelle*, Susan Adams (see www.susanEAdams.com); *Oxpecker*, Bernard DuPont; *Rhinocerous*, Pxhere.com; *Flower*, Susanne Nilsson; *Sea Anemone*, Pixabay; *Clownfish*, Pixabay.com; *Monarch*, Pixabay.com; *Milkweed*, Pixabay.com; *Mistletoe*, Rob Glover; *Blue Spruce*, FD Richards; *Cuckoo* (cropped) (flickr.com, CC-BY-2.0); *Reed Warbler*, Tony Court; *Flea*, Olha Schedrina Natural History Museum; *Mouse*, Pixabay.com; *Tick*, Pxhere.com; *Deer*, Pixabay.com.

GRAPHANANIMAL: *Field Study*, Michigan Department of Natural Resources; *Eastern Eyed Click Beetle*, Kerry Wixted.

HABICACHE: *Observing Nest*, Natalie Elkins; *Orienteering*, Steve Hillebrand, USFWS.

HABITAT CIRCLES: *Habitat Lap Sit Option*, Florida Fish & Wildlife Conservation Commission.

HERE TODAY, GONE TOMORROW: *Mountain Goat*, Oregon Department of Fish & Wildlife; *Grizzly Bear* (cropped), Christopher Michel (flickr.com CC-BY 2.0); Species Profile Cards--USFWS photos: *Western Yellow-billed Cuckoo*, *Loggerhead Sea Turtle*, *Red-cockaded Woodpecker*, *American Burying Beetle*, *Jaguar*, *Canada lynx*, *Karner blue butterfly*; Other Species Profile Cards--*Oregon Spotted Frog*, Gary Nafis; *Shortnose Sturgeon*, Noel Burkhead (USGS); *Kiwikiu* (Maui Parrotbill) Robby Kohley.

HABITAT HEROES: *Planting*, USFWS; *Installing Nesting Box*, USFWS.

INSECT INSPECTION: *Bee on Flower* (cropped), Nigel Winnu (flickr.com CC-BY-2.0); *Dragonfly* (cropped), Nigel Winnu (flickr.com CC-BY-2.0).

INTERVIEW A SPIDER: *Frog*, Gary Eslinger, USFWS; *Grasshopper*, Heather Hopkins; *Butterfly*, Laura Hubers, USFWS; *Spider*, Ryan Kaldari, (flickr.com, public domain); *Snake*, Brian Gratwiche (flickr.com, CC-BY-2.0).

KEEPING COOL: *Great Basin Collared Lizard*, NPS; *Lizard on Rock*, Ryan Hagerty, USFWS; *Copperhead*, TPWD; *Turtle*, Scott Campbell (Wikimedia Commons, CC-BY-2.0).

LEARNING TO LOOK, LOOKING TO SEE: *Ant*, Martin LaBar.

LET'S TALK TURKEY: *Tom Turkey* (cropped), Vicki DeLoach.

LIGHTS OUT! *Students Making Poster 1*, Kari Rea; *USA at Night*, NASA; *Baby Sea Turtle*, Becky Skiba, USFWS; *Students Making Poster 2*, Kari Rea; *Racoon*, William Gladish; *Types of Lighting Fixtures Illustration*, Bob Crelin; *Dark Sky Hero Susan Harder*, Kyle Bromley.

LIMITING FACTORS: HOW MANY BEARS? *Black Bear and Black Bear Cub in Tree* (cropped), Herbert Lang, Wisconsin Department of Natural Resources; *Urban Landscape with Building Cranes*, Pexles.com; *Black Bear Cub Behind Fallen Tree*, Jason Mrachina; *Black Bear Cub Standing on Tree Limb*, USFWS.

MAP THAT HABITAT: *Diagram of Compass* (with modified delta symbol), Thomas W. Kozlowski "Odder" (Wikimedia Commons, CC-BY-SA-3.0); *Compass in Hand*, Joe Baust; *Monarch*, USFWS.

MIGRATION BARRIERS: *Wildlife Land Bridge in Banff National Park*, Parks Canada; *Deer and Fence*, Don DeBold (flickr.com, CC-BY-2.0).

MONARCH MARATHON: *Kaleidoscope of Monarchs*, Gene Nieminen, USFWS; *Monarch*, Ryan Hagerty, USFWS.

MUSEUM SEARCH FOR WILDLIFE: *Bruno Liljefors' "Winter Hare"* (Wikimedia Commons, public domain); *Niko Pirosmani's "Bear"* (Wikimedia Commons, public domain).

MUSKOX MANEUVERS: *Two Muskoxen*, Alaska Department of Fish & Game; *Students Simulating Muskox Defensive Behavior*, TPWD; *Muskoxen in Circle Defense Formation*, Wayne Lunch.

MY KINGDOM FOR A SHELTER: *Students Identifying Leaves*, MDWFP-MNS.

NATURAL DILEMMAS: *Barn*, Frances Junn (Unsplash.com).

NATURE IN ART: *Girl Taking Photo*, Dmitry Sladkov. *Girl Playing Guitar*, Gianni Sarti (flickr.com, CC-BY-2.0).

NO WATER OFF A DUCK'S BACK: *Oil Platform*, Pixabay.com; *Oil Removal from Pelican*, USFWS.

OH DEER! *Two Does*, Tom Koerner, USFWS; *WILD Educator*, Wyoming Project WILD; *Three Deer*, Kenneth Cole Schneider; *Buck*, TPWD; *Deer at Dusk*, pxhere.com.

OWL PELLETS: *Barn Owl*, Dr. Thomas Barnes, University of Kentucky, courtesy of USFWS; *Least Shrew*, TPWD; *Mouse*, Steve Matarano, USFWS; *Grass*, Bob Nichols, USDA; *Owl Pellet Dissection*, Jerrie Miller; *Bone Illustrations on "Owl Pellet Data Sheet,"* Nebraska Game and Fish.

PAY TO PLAY: *Mother and Son Fishing*, Bill Butcher, USFWS; *Girl with Pine Cone*, USFWS; *Boy in Kayak*, USFWS.

PHENOLOGY AT PLAY: *Hammond's Flycatcher*, Alan Schmierer (flickr.com, public domain); *Vermillon Flycatchers*, Alan Schmierer (flickr.com, public domain); *Oak Leaves*, Franz Kohler (flickr.com, public domain); *Caterpillar*, "Jason" (flickr.com, CC-BY-2.0); *Flycatcher*, Alan Schierer, (flickr.com, public domain).

POWER OF A SONG: *Girl Playing Guitar*, Gianni Sarti (flickr.com CC-By-2.0).

QUICK-FROZEN CRITTERS: *Rabbit*, Houmann Khosrozadeh MD; *Opossum Playing Possum*, Tony Alter (flickr.com, CC-BY-2.0).

RAINDROPS AND RANGES: *New World Cactus*, "skeez," Pixabay.com; *Old World Euphorbia Species*, Hans Braxmeier, Pixabay.com; *Students Working at Computer*, Pexels.com.

SEED NEED: *Student with Seeds on Sock*, AFWA; *Bird and Berries*, Pxhere.com; *Acorn*, Pixabay.com; *Milkweed Pods*, Pxhere.com; *Cones on Fir Tree*, Pixabay.com; *Seed Investigation Sheet: Squirrel and Mangrove* images, Pixabay.com; *Dandelion* and *Greenjay* images, Pxhere.com; *Burr on Sleeve*, "Dano" (flickr.com, CC-BY-2.0); *Exploding Seed Pods*, Seymour Jacklin.

SMOKEY BEAR SAID WHAT? *Wild Fire 1* and *Wild Fire 2*, USFWS.

SURPRISE TERRARIUM: *Children Observing Nature*, MDWFP-MNS.

SUSTAINABILITY: THEN, NOW, LATER: *Schoolyard Garden Project*, USDA; *Students Exhibiting Desalination Project*, EPA.

THE POWER OF PLANNING: *Solar Panels*, Sarah Swenty, USFWS; Three Photo Collage--*Wind Turbine* (cropped), Lewis Castle UHI (flickr.com CC-BY-2.0); *Power Plant*, Pixabay.com; *Solar Panels* (cropped), Mountain/\Ash (flickr.com CC-BY-2.0).

THICKET GAME: (none).

TIME LAPSE: *Timber Harvest*, Unsplash.com; *Forest*, Pennsylvania Department of Conservation and Natural Resources; *Taking Core Sample from Pine*, USFWS; *Forest Succession Diagram A*, Doug Pifer, Virginia Cooperative Extension; *Forest Succession Diagram B*, Sheri Amsel; *Sample Animals Illustration*, Jim McVoy, New Hampshire Fish and Game.

TO ZONE OR NOT TO ZONE: *Land Use Map*, Wyman Laliberte (flickr.com, CC-BY-2.0); *Students and Teacher*, Norton Gusky (flickr.com, CC-BY-2.0).

TRACKS! *Tracks in the Snow*, Tom Koerner, USFWS; *Track Identification Illustrations* and *Leg Bone Structure Illustrations* by Elizabeth Biesiot from *A Field Guide to Mammal Tracking in North America* by James Halfpenny; *Animal Gaits Patterns Illustrations*, Rick Curtis, Princeton University.

TROPHIC TRANSFER: *Fox with Prey*, USFWS; *Red-tailed Hawk with Prey*, John Davis; *Great Blue Heron with Fish*, USFWS.

TURKEY TALLIES: *Two Turkeys*, AFWA.

URBAN NATURE SEARCH: *Bird on Fence*, Kenny Louie (Wikimedia Commons, CC-BY-2.0). *Squirrel on Brick Walkway*, Bob Travis.

WATER MILEAGE: *Student with Fish Identification Guide*, NPS; *Bighorn Sheep*, NPS; *Tortoise Eating Cactus*, Andrea Westmoreland.

WHAT BEAR GOES WHERE? *Polar Bear*, Christopher Michel. *Grizzly Bear*, Jim Peaco, NPS; *Black Bear*, Eileen Hornbaker, USFWS.

WHAT YOU WEAR IS WHAT THEY WERE: *Girl in Recycled Material Fashion Show*, Nic McPhee.

WHAT'S THAT, HABITAT? *Boy Drinking Water*, Pixabay.com; *Deer in River*, CPW; *Burrowing Owl Chick*, CPW.

WHAT'S WILD? *Feral Horses*, BLM; *Mexican Gray Wolf*, Arizona Zoological Society.

WHICH NICHE? *Girl with Net*, Joe Baust; *Red-winged Blackbird*, Kathy Munsel, Oregon Department of Fish and Wildlife; *Great Blue Heron with Fish*, Cameron Rognan, Cornell Lab of Ornithology; *Red Knots*, Pixnio.com; *Boy in Nature with Hand Lense*, Fotolia.com; *Girl with Worm*, Cara Schildtknecht, USFWS; *Students Posing Near Water*, Jane Wells; *Students in Forest*, PRDNER; *Student Squatting on Ground* (AFWA); *Students Observing Plant*, PRDNER

WILD BILL'S FATE: *Capitol Building*, Leonard Marchini, Pixabay.com.

WILD WORDS: *Woman with Field Journal*, Gary Peeples, USFWS.

WILDLIFE AND THE ENVIRONMENT: COMMUNITY SURVEY: *Two Women with Survey*, "Malouette" (flickr.com, used with permission); *Students in Seminar*, Chase Fountain, TPWD.

WILDLIFE SYMBOLS: *Tiger*, Mathius Appel (flickr.com, public domain); *USA Emblem*, Government of the United States; *Save Vanishing Species Stamp*, USFWS; *Objee the Bear*, US Coast Guard Academy.

WORLD TRAVELERS: *Zebra Mussels on Native Mussel*; USFWS; *Students Examining Raised Beds*; Kathleen Brulc; *Students Inventorying at Study Sight*, Kathleen Brulc; *Purple Loosestrife*, Kerry Wixted; *Student Data Sheet*, Kathleen Brulc.

APPENDIX (by page number): **513**, TPWD; **526**, TPWD; **527**, Lanyna Burke; **528**, Steve Hillebrand, USFWS; **535**, AFWA; **536**, Meghan Kearney, USFWS; **537**, Gary M. Stolz; **538**, (top right) Cyndi Souza; (middle left) Laurel Wilkerson, USFWS; (bottom right); Mary Hollinger, NOAA; **539**, Chelsi Hornbaker; **540**, TPWD; **541**, Sherry James, USFWS; **542**, USFWS; **343**, Chris Poulin; **345**, Lamar Gore, USFWS; **551**, USFWS; **552**, stockunlimited.

Early Childhood Classrooms

Special Note: *Growing Up WILD: Exploring Nature with Young Children* is an award-winning early childhood curriculum and training program for educators of children ages 3–7, available through your Project WILD state coordinator. Visit ***www.projectwild.org/growingupwild*** for more information.

Adaptation Artistry

1. Read a children's book with color photographs to help the students see and understand an animal's adaptations. Discuss adaptations that are easy to see, such as color or camouflage, beaks, feet, size, and animal locomotion. Discuss with the students what it would feel like to have the special animal features talked about in the story and activity.

2. Watch nature videos to show the students the differences in animal locomotion. Have students try to copy the animal's movements. Discuss why these special features may help the animals to survive.

3. Have students use clay to sculpt animals with adaptations. Have the students describe the special features their animal has and how those features help their animal to survive.

Animal Charades

Design *Animal Charade* cards using laminated drawings or photos that students can pull out of a hat. Ask students: If this animal walked across the room, how would this animal move? If this animal swam across a pond, how would it move in the water? Can you make your face look like the face of this animal? What does this animal look like when it is eating?

Ants on a Twig

1. Have students finger paint their ant observations.

2. Demonstrate ant behavior by playing Follow the Leader, using one single line, rather than two opposing lines.

Color Crazy

Begin this activity with an introduction to bright colors. Have students identify, compare, and sort the colors in their classroom and school yard.

Fabled Fauna

Have students create a classroom poster on chart paper. Using bears as an example, draw a line down the middle and label each side: Things Story Bears Do / Things Real Bears Do. Have students come up with characteristics for each. Have them decorate the poster border with bear drawings.

First Impressions

Create three large circles on the floor of the room with rope, masking tape, or hula-hoops. Within each circle draw a face: one with a smile, one with a frown, and one with a straight line.

Have the students stand around the outside of the three faces, and explain to them the names of each face: Smiley, Frowny, and Undecided. Hold up a photo of an animal, and ask students to walk into the face that best describes how they feel about the animal. Write the name of the animal on a chart, and make a tally list for each face. Ask the students what they already know about the animal. Read more about the animal, and then discuss whether anyone changed their mind about the animal and why they did.

Insect Inspection

Have students locate and draw pictures of insects and other small wildlife, such as pill bugs. How do the bodies of the various insects and other tiny animals compare?

Interview a Spider

1. Have an adult represent an animal. Let students ask questions about the animal. Draw the animal, and write the answers on chart paper.

2. The animal can be a "secret." Let students guess which animal is being represented.

Limiting Factors: How Many Bears?

For Optional Procedure II, "Comparing Black Bear and Human Growth Rate," teachers can make a life-sized wall mural of the life stages of both humans and bears. Have students compare their own sizes to the drawings on the wall mural.

My Kingdom for a Shelter

1. Display a variety of photos or drawings of humans, domesticated animals, and wild animals in their habitats. Show the first photo, for example, of a grassy field. Ask the students, if they were going to live in this field, what would they as humans need? Then ask the same for pets and wildlife. Compare.

2. Read stories about animal shelters and provide pictures. Create a matching game with pictures that match animals to their shelters.

Go outsitde and look for signs of animal shelters.

Oh, Deer!

Provide big name cards or pictures that the students can wear as necklaces to represent food, water, shelter, and space rather than having them hold their arms to represent what component of habitat they represent. The name cards can be laid out on the ground. When they turn around to face away, the students can choose one and put it on.

Seed Need

Students can make mini-collages or minipictures with what they find on their socks.

Surprise Terrarium

Distribute squares of wallpaper or some kind of patterned paper for a real or imaginary background scene. Tell the students that each square is habitat for a special animal. Distribute the paper, and let them draw and create collage animals that might live there. When they are finished, let students share what kind of animal it is and how it blends into its habitat.

Tracks!

Help students to make tracks of their own feet by using water-based paints. Let students compare their own tracks to an animal's tracks.

Urban Nature Search

1. Discuss with students how to become a wildlife explorer by observing nature or looking for animal tracks and signs. Students should find a partner. Give each pair of students a special place in the school yard where they can look for signs of wildlife. Have students spend up to 10 minutes observing their place. Afterwards, the pairs can draw a picture of what each saw to show to the rest of the class.

2. Have the students create a wildlife explorer journal. Students can color a new page for each new place and each new day they look for wildlife.

3. Conduct this activity in each season to see what changes take place from fall, winter, summer, and spring. Try this activity before and after a rain shower. What were the differences?

What Bear Goes Where?

Build a bear den in the classroom, specific to each species, using a large cardboard box. Paint, color, or collage the outside of the box to look like the bears' habitat. Create a bear habitat in the classroom, and eat things the bear might eat (e.g., fruit, gummy insects, and berries for the black bear).

What's Wild?

1. Read stories to students about both wild animals and domesticated (pets and farm) animals. Discuss similarities and differences.

2. Show the students photos of animals. Allow the students to classify the photos into two groups: Wild and Not Wild/Domesticated.

Discuss why each animal is classified into the group.

Adapted from Early Childhood Extensions contributed by Audrey Walker, Utah Division of Wildlife.

Grade Level Index

KEY

LE = Lower Elementary (K–2) **MS = Middle School (6–8)**
UE = Upper Elementary (3–5) **HS = High School (9–12)**

Activity	LE	UE	MS	HS
A Dire Diet			●	
A Home Away from Home			●	
A Picture Is Worth a Thousand Words			●	●
Adaptation Artistry		●	●	
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Color Crazy	●	●		
Deer Dilemma				●
Does Wildlife Sell?		●	●	●
Dropping in on Deer				●
Eco-Enrichers			●	●
Ecosystem Architects			●	●
Environmental Barometer		●	●	●
Fabled Fauna	●	●		
Fire Ecologies				●
First Impressions	●	●		
Food Footprint			●	●
Forest in a Jar		●	●	
Good Buddies		●	●	
Graphananimal	●			
HabiCache		●	●	
Habitat Circles		●	●	
Habitat Heroes		●	●	●
Here Today, Gone Tomorrow			●	●
Insect Inspection	●			
Interview a Spider		●		
Keeping Cool		●		

Activity	LE	UE	MS	HS
Learning to Look, Looking to See		●	●	
Let's Talk Turkey	●	●		
Lights Out!		●	●	●
Limiting Factors: How Many Bears?		●	●	
Map that Habitat		●	●	
Migration Barriers			●	●
Monarch Marathon		●	●	
Museum Search for Wildlife		●	●	
Muskox Maneuvers		●	●	
My Kingdom for a Shelter	●	●	●	
Natural Dilemmas			●	●
Nature in Art		●	●	
No Water Off a Duck's Back		●	●	
Oh Deer!		●	●	●
Owl Pellets		●	●	
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Phenology at Play			●	●
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Seed Need	●	●		
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Surprise Terrarium	●			
Sustainability: Then, Now, Later			●	
The Power of Planning			●	●
Thicket Game	●	●		
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To Zone or Not to Zone			●	●
Tracks!		●	●	
Trophic Transfer		●	●	
Turkey Tallies				●
Urban Nature Search		●	●	
Water Mileage			●	●
What Bear Goes Where?	●	●		
What You Wear Is What They Were	●	●	●	
What's That, Habitat?	●	●		
What's Wild?	●	●		
Which Niche?		●	●	
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Wild Words		●	●	●
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Activity Name	Page Number	Grade Level/National Learning Standards Correlation	Indoors (I) or Outdoors (O)	Field Investigation	Cross-Discipline Skills: Analysis	Application	Classification	Comparison	Construction	Description	Evaluation	Generalization	Observation	Problem-solving	Research	Synthesis	Subject Area Skills: Science	Mathematics	Social Studies	Language Arts	Environmental Ed.	Expressive Arts
A Dire Diet	361	MS	I		●	●				●			●		●		▲				▲	
A Home Away from Home	222	MS	I			●		●	●	●					●	●	▲				▲	
A Picture Is Worth a Thousand Words	463	MS, HS	I		●	●				●	●		●				▲				▲	
Adaptation Artistry	206	UE, MS	I		●	●			●	●	●	●	●	●		●	▲			▲	▲	▲
Animal Charades	337	LE, UE	I,O		●	●	●						●				▲				▲	▲
Animal Poetry	339	UE, MS	I,O							●						●				▲	▲	▲
Ants on a Twig	105	LE	O	✔	●		●	●		●		●	●				▲				▲	▲
Back from the Brink	414	HS	I		●				●	●	●					●	▲		▲	▲	▲	
Bat Blitz	135	UE, MS	I,O		●	●				●	●	●					▲	▲			▲	
Bird Song Survey	459	MS, HS	O	✔	●	●	●	●	●	●			●				▲				▲	
Birds of Prey	184	HS	I		●			●		●	●	●	●	●			▲	▲			▲	
Bottleneck Genes	268	MS, HS	I		●	●				●	●	●				●	▲				▲	
Busy Bees, Busy Blooms	111	LE, UE	I,O		●			●		●			●				▲		▲		▲	
Career Critters	433	UE, MS	I		●	●		●		●	●			●		●	▲		▲	▲	▲	
Carrying Capacity	55	MS, HS	I		●			●		●	●	●	●				▲				▲	
Changing the Land	395	MS	I		●	●		●		●	●	●	●	●	●	●	▲		▲		▲	
Checks and Balances	448	MS	I		●						●						▲	▲			▲	
Color Crazy	8	LE, UE	I						●	●		●	●				▲			▲	▲	▲
Deer Dilemma	481	HS	I		●	●		●		●	●			●	●	●	▲		▲	▲	▲	
Does Wildlife Sell?	294	UE, MS, HS	I		●		●				●		●							▲	▲	
Dropping in on Deer	475	HS	O	✔	●	●	●				●		●	●		●	▲	▲			▲	
Eco-Enrichers	177	MS, HS	I,O	✔	●	●	●	●		●		●	●		●		▲				▲	
Ecosystem Architects	260	MS, HS	I		●	●	●		●		●			●	●	●	▲		▲	▲	▲	
Environmental Barometer	158	UE, MS, HS	O	✔	●		●	●			●		●				▲				▲	
Fabled Fauna	281	LE, UE	I		●		●	●			●		●			●			▲	▲	▲	▲
Fire Ecologies	233	HS	I,O	✔	●						●	●	●		●	●	▲				▲	
First Impressions	278	LE, UE	I		●			●		●		●			●					▲	▲	
Food Footprint	365	MS, HS	I		●	●	●	●	●		●			●		●	▲		▲	▲	▲	
Forest in a Jar	218	UE, MS	I		●	●		●	●	●		●			●		▲			▲	▲	
Good Buddies	128	UE, MS	I			●	●								●		▲				▲	
Graphananimal	61	LE	I,O	✔	●		●		●				●				▲	▲			▲	
HabiCache	123	UE, MS	O	✔	●	●		●	●	●		●	●		●	●	▲			▲	▲	▲
Habitat Circles	78	UE, MS	I,O									●					▲				▲	▲
Habitat Heroes	499	UE, MS, HS	I,O		●	●			●	●	●			●		●			▲		▲	
Here Today, Gone Tomorrow	251	MS, HS	I		●		●									●	▲				▲	
Insect Inspection	2	LE	O	✔	●		●	●		●		●	●				▲			▲	▲	
Interview a Spider	15	UE	I							●		●			●		▲			▲	▲	
Keeping Cool	200	UE	O	✔				●	●	●		●	●		●		▲				▲	

Activity Name	Page Number	Grade Level/National Learning Standards Correlation	Indoors (I) or Outdoors (O)	Field Investigation	Cross-Discipline Skills												Subject Area Skills					
					Analysis	Application	Classification	Comparison	Construction	Description	Evaluation	Generalization	Observation	Problem-solving	Research	Synthesis	Science	Mathematics	Social Studies	Language Arts	Environmental Ed.	Expressive Arts
Learning to Look, Looking to See	334	LE, UE	I,O							●	●		●							▲	▲	
Let's Talk Turkey	322	UE, MS	I		●			●	●	●		●			●	●	▲		▲		▲	
Lights Out!	366	UE, MS, HS	I,O	✔	●	●	●	●		●	●		●	●		●	▲		▲		▲	
Limiting Factors: How Many Bears	26	UE, MS	O		●			●	●			●					▲	▲			▲	
Map that Habitat	73	UE, MS	O		●		●	●					●			●	▲				▲	
Migration Barriers	455	MS, HS	I		●	●		●	●	●	●	●	●			●	▲		▲		▲	
Monarch Marathon	18	UE, MS	O		●				●	●			●				▲		▲		▲	
Museum Search for Wildlife	284	UE, MS	I		●	●						●	●						▲	▲	▲	▲
Muskox Maneuvers	209	UE, MS	O		●					●	●	●	●				▲				▲	▲
My Kingdom for a Shelter	70	LE, UE, MS	I,O			●			●	●			●				▲				▲	▲
Natural Dilemmas	297	MS, HS	I		●	●					●			●		●			▲		▲	
Nature in Art	343	UE, MS	O			●			●			●	●			●				▲	▲	▲
No Water Off a Duck's Back	353	UE, MS	I		●							●	●				▲	▲			▲	
Oh Deer!	42	UE, MS, HS	O			●		●		●		●	●				▲	▲			▲	▲
Owl Pellets	146	UE, MS	I		●		●	●				●					▲				▲	
Pay to Play	309	MS, HS	I		●	●	●				●	●				●	▲		▲		▲	
Phenology at Play	167	MS, HS	I		●			●		●	●	●		●			▲				▲	
Power of a Song	288	UE, MS	I								●										▲	▲
Quick-Frozen Critters	214	UE, MS	O		●					●	●	●	●				▲				▲	
Raindrops and Ranges	99	MS, HS	I		●			●				●				●	▲		▲		▲	
Seed Need	117	LE, UE	O	✔	●		●	●		●			●				▲	▲			▲	
Smokey Bear Said What?	357	UE, MS	I		●		●	●	●	●	●				●	●	▲		▲		▲	
Surprise Terrarium	189	LE	I,O			●						●	●				▲				▲	
Sustainability: Then, Now, Later	491	MS	I		●		●	●	●	●	●	●			●	●	▲		▲	▲	▲	▲
The Power of Planning	382	MS, HS	I		●	●		●		●	●	●	●	●	●	●	▲		▲		▲	
Thicket Game	193	LE, UE	O		●	●				●		●	●				▲				▲	▲
Time Lapse	239	UE, MS	I		●	●	●	●	●	●		●				●	▲				▲	▲
To Zone or Not to Zone	388	MS, HS	I		●	●		●		●	●	●		●	●	●			▲		▲	
Tracks!	36	UE, MS	O	✔	●	●	●	●					●			●	▲				▲	▲
Trophic Transfer	151	UE, MS	I		●		●	●				●				●	▲	▲			▲	
Turkey Tallies	426	HS	I		●									●			▲	▲			▲	
Urban Nature Search	94	UE, MS	O	✔	●	●	●	●		●		●	●				▲			▲	▲	
Water Mileage	226	MS, HS	I		●						●	●					▲	▲			▲	
What Bear Goes Where?	195	LE, UE	I		●	●	●	●	●	●		●	●			●	▲				▲	▲
What You Wear Is What They Were	304	LE, UE, MS	I		●		●	●	●	●	●		●			●	▲				▲	
What's That, Habitat?	65	LE, UE	I		●			●				●					▲			▲	▲	▲
What's Wild?	12	LE, UE	I				●		●				●				▲			▲	▲	▲
Which Niche?	82	UE, MS	O	✔	●	●	●	●		●		●			●	●	▲		▲	▲	▲	
Wild Bill's Fate	328	HS	I		●						●				●				▲	▲	▲	
Wild Words	51	UE, MS, HS	O			●			●	●			●				▲			▲	▲	▲
Wildlife and the Environment: Community Survey	346	MS, HS	I		●	●	●				●				●	●	▲			▲	▲	▲
Wildlife Symbols	291	UE, MS, HS	I		●			●	●		●				●	●			▲		▲	▲
World Travelers	404	MS, HS	I,O	✔	●	●	●	●			●	●	●		●	●	▲	▲			▲	

Topic Index

Duration refers to time needed to complete the activity. The codes represent the following times: A = up to 45 minutes, B = 45-60 minutes, C = 60-90 minutes, D = 90 minutes to 3 hours, E = over 3 hours, V = variable in length. Symbol Note: The dot and triangle symbols are of equal value. They are placed in alternating columns to make tracking easier.

Activity Name	Page Number	Grade Level/National Learning Standards Correlation	Duration (A,B,C,D,E,V)	Cross-Discipline Skills: Adaptations	Biodiversity	Change	Consumptive Use	Culture	Economics/Commerce	Environmental Quality	Food Chains/Food Webs	Habitats	Interdependence	Issues	Land Use	Ocean/Marine	Political Processes	Population Dynamics	Resource Management	Responsible Action	Sustainability	Urban	Values
A Dire Diet	361	MS	C			●		●		●		●	▲	●		●	▲			●	▲		▲
A Home Away from Home	222	MS	B	●				●				●	▲	●	▲				▲	●			
A Picture Is Worth a Thousand Words	463	MS, HS	B			●	▲	●	▲			●	▲			●	▲		▲	●			▲
Adaptation Artistry	206	UE, MS	C	●	▲																		
Animal Charades	337	LE, UE	A	●	▲																		▲
Animal Poetry	339	UE, MS	A																				▲
Ants on a Twig	105	LE	C	●										●	▲								
Back from the Brink	414	HS	D		▲	●													▲				
Bat Blitz	135	UE, MS	C	●		●						●		●				●					
Bird Song Survey	459	MS, HS	D		▲							●							▲			●	▲
Birds of Prey	184	HS	C	●		●					▲	●		●	▲	●		●					
Bottleneck Genes	268	MS, HS	B	●	▲	●								●							▲		
Busy Bees, Busy Blooms	111	LE, UE	A	●						●				●						●			
Career Critters	433	UE, MS	A							●									▲		▲		
Carrying Capacity	55	MS, HS	B			●						●			▲			●					
Changing the Land	395	MS	D			●			▲			●	▲					●	▲	●	▲		
Checks and Balances	448	MS	C			●	▲		▲	●		●		●	▲	●			●	▲	●	▲	
Color Crazy	8	LE, UE	C	●														●					
Deer Dilemma	481	HS	C	●			▲	●	▲	●		●				●	▲	●	▲	●	▲	●	▲
Does Wildlife Sell?	294	UE, MS, HS	D					●	▲											●	▲		▲
Dropping in on Deer	475	HS	V								●								▲				
Eco-Enrichers	177	MS, HS	C		▲	●								●								●	
Ecosystem Architects	260	MS, HS	D	●	▲	●			▲					●	▲	●			▲	●	▲	●	
Environmental Barometer	158	UE, MS, HS	D		▲	●						●		●							▲	●	
Fabled Fauna	281	LE, UE	B					●															
Fire Ecologies	233	HS	E		▲	●		●	▲			●		●					▲	●	▲		▲
First Impressions	278	LE, UE	A					●	▲				▲						▲	●			▲
Food Footprint	365	MS, HS	V					▲	●	▲	▲			●	▲						▲		▲
Forest in a Jar	218	UE, MS	D V			●								●									
Good Buddies	128	UE, MS	C											●									
Graphanamimal	61	LE	C	●	▲	●						●											
HabiCache	123	UE, MS	D	●								●			▲							●	
Habitat Circles	78	UE, MS	A			●						●			▲								
Habitat Heroes	499	UE, MS, HS	D			●		●	▲			●		●	▲	●	▲	●	▲	●	▲	●	▲
Here Today, Gone Tomorrow	251	MS, HS	C	●	▲	●						●	▲		▲			●	▲	●	▲		▲
Insect Inspection	2	LE	D	●								●											▲
Interview a Spider	15	MS	C	●								●			▲								
Keeping Cool	200	UE	D	●		●						●											

Activity Name	Page Number	Grade Level/National Learning Standards Correlation	Duration (A,B,C,D,E,V)	Cross-Discipline Skills																			
				Adaptations	Biodiversity	Change	Consumptive Use	Culture	Economics/Commerce	Environmental Quality	Food Chains/Food Webs	Habitats	Interdependence	Issues	Land Use	Ocean/Marine	Political Processes	Population Dynamics	Resource Management	Responsible Action	Sustainability	Urban	Values
Learning to Look, Looking to See	334	LE, UE	A																				▲
Let's Talk Turkey	322	UE, MS	B			●	▲		▲				▲										
Lights Out!	366	UE, MS, HS	D			●				●				●					▲	●		●	▲
Limiting Factors: How Many Bears?	26	UE, MS	A			●						●		●	▲			●					
Map that Habitat	73	UE, MS	D							●				●	▲							●	
Migration Barriers	455	MS, HS	C			●	▲	●		●		●	▲	●	▲	●	▲	●	▲		▲	●	▲
Monarch Marathon	18	UE, MS	C	●		●				●		●	▲	●					▲	●			
Museum Search for Wildlife	284	UE, MS	V				●					●											▲
Muskox Maneuvers	209	UE, MS	A	●		●												●					
My Kingdom for a Shelter	70	LE, UE, MS	D	●								●			▲							●	
Natural Dilemmas	297	MS, HS	A			●	▲	●															▲
Nature in Art	343	UE, MS	A																				▲
No Water Off a Duck's Back	353	UE, MS	C					●	▲	●		●		●						▲	●	▲	
Oh Deer!	42	UE, MS, HS	B			●						●		●	▲			●					
Owl Pellets	146	UE, MS	A	●							▲			●	▲			●					
Pay to Play	309	MS, HS	V				▲	●	▲				▲			●	▲		▲	●	▲		▲
Phenology at Play	167	MS, HS	C			●					▲	●	▲					●					
Power of a Song	288	UE, MS	B					●	▲				▲										▲
Quick-Frozen Critters	214	UE, MS	A	●										●	▲			●					
Raindrops and Ranges	99	MS, HS	V	●	▲	●						●		●	▲				▲				
Seed Need	117	LE, UE	C	●									▲										
Smokey Bear Said What?	357	UE, MS	B			●						●		●					▲	●	▲		
Surprise Terrarium	189	LE	C	●		●																	
Sustainability: Then, Now, Later	491	MS	D		▲	●	▲	●	▲	●			▲	●	▲	●			▲	●	▲		▲
The Power of Planning	382	MS, HS	D			●		●	▲			●		●	▲	●	▲	●	▲	●	▲	●	▲
Thicket Game	193	LE, UE	A	●										●				●					
Time Lapse	239	UE, MS	B		▲	●						●	▲	●									
To Zone or Not to Zone	388	MS, HS	D		▲	●		●	▲			●	▲	●		●	▲			●	▲	●	▲
Tracks!	36	UE, MS	D	●	▲									●	▲				▲				
Trophic Transfer	151	UE, MS	B		▲						▲			●									
Turkey Tallies	426	HS	C	●		●						●			▲			●		●			
Urban Nature Search	94	UE, MS	V											●					▲			●	
Water Mileage	226	MS, HS	B	●		●												●	▲		▲		
What Bear Goes Where?	195	LE, UE	A	●		●						●			▲								
What You Wear Is What They Were	304	LE, UE, MS	C	●				●	▲				▲		▲							▲	▲
What's That, Habitat?	65	LE, UE	A											●	▲								
What's Wild?	12	LE, UE	B		▲																		▲
Which Niche?	82	UE, MS	V	●								●		●								●	
Wild Bill's Fate	328	HS	E					●															▲
Wild Words	51	UE, MS, HS	B														▲						▲
Wildlife and the Environment: Community Survey	346	MS, HS	D					●		●			▲				▲		▲	●			▲
Wildlife Symbols	291	UE, MS, HS	C					●															▲
World Travelers	404	MS, HS	D	●	▲	●								●							▲	●	

Unit Planning Suggestions

	Activities that may be grouped by thematic units (listed by grade range)			
	LE (K–2)	UE (3–5)	MS (6–8)	HS (9–12)
Adaptations	Animal Charades; Ants on a Twig; Busy Bees, Busy Blooms; Color Crazy; Graphananimal; Insect Inspection; My Kingdom for a Shelter; Seed Need; Surprise Terrarium; Thicket Game; What Bear Goes Where?; What You Wear Is What They Were	Adaptation Artistry; Animal Charades; Bat Blitz; Busy Bees, Busy Blooms; Color Crazy; HabiCache; Keeping Cool; Monarch Marathon; Muskox Maneuvers; My Kingdom for a Shelter; Owl Pellets; Quick-Frozen Critters; Thicket Game; Seed Need; Tracks!; What Bear Goes Where?; What You Wear Is What They Were; Which Niche?	A Home Away from Home; Adaptation Artistry; Bat Blitz; Bottleneck Genes; Ecosystem Architects; HabiCache; Here Today, Gone Tomorrow; Interview a Spider; Monarch Marathon; Muskox Maneuvers; My Kingdom for a Shelter; Owl Pellets; Quick-Frozen Critters; Raindrops and Ranges; Tracks!; Water Mileage; What You Wear Is What They Were; Which Niche?; World Travelers	Birds of Prey; Bottleneck Genes; Deer Dilemma; Ecosystem Architects; Here Today, Gone Tomorrow; Raindrops and Ranges; Turkey Tallies; Water Mileage; World Travelers
Biodiversity	Animal Charades; Graphananimal; What's Wild?	Adaptation Artistry; Animal Charades; Environmental Barometer; Time Lapse; Tracks!; Trophic Transfer; What's Wild?	Adaptation Artistry; Bird Song Survey; Bottleneck Genes; Eco-Enrichers; Ecosystem Architects; Environmental Barometer; Here Today, Gone Tomorrow; Raindrops and Ranges; Sustainability: Then, Now, Later; Time Lapse; To Zone or Not to Zone; Trophic Transfer; Tracks!; World Travelers	Back from the Brink; Bird Song Survey; Bottleneck Genes; Eco-Enrichers; Ecosystem Architects; Environmental Barometer; Fire Ecologies; Here Today, Gone Tomorrow; Raindrops and Ranges; Sustainability: Then, Now, Later; To Zone or Not to Zone; World Travelers
Changing Land; Changing Climate	Graphananimal; Surprise Terrarium; What Bear Goes Where?	Bat Blitz; Environmental Barometer; Forest in a Jar; Habitat Circles; Habitat Heroes; Keeping Cool; Let's Talk Turkey; Lights Out!; Limiting Factors: How Many Bears?; Monarch Marathon; Muskox Maneuvers; Oh Deer!; Smokey Bear Said What?; Time Lapse	A Dire Diet; A Picture Is Worth a Thousand Words; Bat Blitz; Bottleneck Genes; Changing the Land; Checks and Balances; Eco-Enrichers; Ecosystem Architects; Environmental Barometer; Food Footprint; Forest in a Jar; Habitat Circles; Habitat Heroes; Migration Barriers; Here Today, Gone Tomorrow; Let's Talk Turkey; Lights Out!; Limiting Factors: How Many Bears?; Monarch Marathon; Muskox Maneuvers; Oh Deer!; Phenology at Play; The Power of Planning; Raindrops and Ranges; Smokey Bear Said What? Sustainability: Then, Now, Later; Time Lapse; To Zone or Not to Zone; Water Mileage; World Travelers	A Picture Is Worth a Thousand Words; Back from the Brink; Birds of Prey; Bottleneck Genes; Carrying Capacity; Eco- Enrichers; Ecosystem Architects; Environmental Barometer; Fire Ecologies; Food Footprint; Forest in a Jar; Habitat Heroes; Here Today, Gone Tomorrow; Lights Out!; Migration Barriers; Oh Deer!; Phenology at Play; The Power of Planning; Raindrops and Ranges; To Zone or Not to Zone; Turkey Tallies; Water Mileage; World Travelers

	Activities that may be grouped by thematic units (listed by grade range)			
	LE (K–2)	UE (3–5)	MS (6–8)	HS (9–12)
Ecosystems	Ants on a Twig; Busy Bees, Busy Blooms; Graphananimal; Insect Inspection; My Kingdom for a Shelter; Seed Need; Surprise Terrarium; What Bear Goes Where?; What's That, Habitat?	Busy Bees, Busy Blooms; Career Critters; Environmental Barometer; Forest in a Jar; Good Buddies; Graphananimal; HabiCache; Habitat Circles; Habitat Heroes; Interview a Spider; Limiting Factors: How Many Bears?; Map that Habitat; Muskox Maneuvers; My Kingdom for a Shelter; No Water Off a Duck's Back; Oh Deer!; Owl Pellets; Quick-Frozen Critters; Seed Need; Smokey Bear Said What?; Thicket Game; Time Lapse; Trophic Transfer; Urban Nature Search; Water Mileage; What Bear Goes Where?; What's That, Habitat?; Which Niche?	A Dire Diet; A Home Away from Home; Bottleneck Genes; Career Critters; Carrying Capacity; Changing the Land; Checks and Balances; Ecosystem Architects; Environmental Barometer; Food Footprint; Forest in a Jar; Good Buddies; HabiCache; Habitat Circles; Habitat Heroes; Here Today, Gone Tomorrow; Limiting Factors: How Many Bears?; Map that Habitat; Migration Barriers; Muskox Maneuvers; My Kingdom for a Shelter; No Water Off a Duck's Back; Oh Deer!; Owl Pellets; Phenology at Play; Quick-Frozen Critters; Raindrops and Ranges; Smokey Bear Said What?; Time Lapse; To Zone or Not to Zone; Trophic Transfer; Urban Nature Search; Water Mileage; Which Niche?; World Travelers	Back from the Brink; Bird Song Survey; Birds of Prey; Bottleneck Genes; Carrying Capacity; Deer Dilemma; Dropping in on Deer; Ecosystem Architects; Environmental Barometer; Fire Ecologies; Food Footprint; Habitat Heroes; Here Today, Gone Tomorrow; Migration Barriers; Oh Deer!; Phenology at Play; Raindrops and Ranges; To Zone or Not to Zone; Turkey Trouble; World Travelers
Investigations	Ants on a Twig; Environmental Barometer; Graphananimal; Insect Inspection; Keeping Cool; Learning to Look, Looking to See; Seed Need; Thicket Game	Animal Poetry; Environmental Barometer; HabiCache; Habitat Heroes; Keeping Cool; Learning to Look, Looking to See; Lights Out!; Map That Habitat; Nature in Art; Seed Need; Thicket Game; Tracks!; Urban Nature Search; Which Niche?; Wild Words	Animal Poetry; Bird Song Survey; Eco-Enrichers; Environmental Barometer; HabiCache; Habitat Heroes; Lights Out!; Map That Habitat; Nature in Art; Tracks!; Urban Nature Search; Which Niche?; Wild Words; World Travelers	Bird Song Survey; Dropping in on Deer; Eco-Enrichers; Environmental Barometer; Fire Ecologies; Habitat Heroes; Lights Out!; Wild Words; World Travelers

Expanded Topic Index

Using Simulations for Instructional Purposes

An educational simulation is an instructional activity that models aspects of the real world to teach one or more concepts. Simulations—especially those that involve students in kinesthetic learning experiences—are used frequently in Project WILD.

In conducting simulations for instructional purposes, you must remember that the activity can take on a life of its own. Students can become so involved in the role they are playing that they forget to relate the objects, events, and processes to what they represent in nature.

Students of all ages may tend to become competitive when they are responsible for capturing or escaping the animals depicted in an activity. Antic and energetic physical behavior often results. During such activity, students identify subjectively with the role they are playing. This identification is important and should be encouraged as part of the powerful learning that is possible through simulations. Yet it also is important to link the subjective experience with the objective concepts that are central to each activity.

Distinguish between what is realistic and what is not realistic about the simulation. Simulations, by definition, are simple representations of more complex natural interactions. Through discussion following simulation activities, teachers should help students understand how the simulation is like and unlike the real situation.

Simulations always leave out some elements that exist in nature. They simplify to make a point. Make sure students are clear about the point and the limitations of the activity in demonstrating the complexities of real-world situations.

Simulations in *Project WILD K-12 Curriculum and Activity Guide* include the following activities:

Animal Charades
Ants on a Twig
Busy Bees, Busy Blooms
Carrying Capacity
Habitat Circles
Limiting Factors: How Many Bears?
Muskox Maneuvers
Oh Deer!
Quick-Frozen Critters
Thicket Game
To Zone or Not to Zone
Trophic Transfer

Evaluating and Assessing Student Learning

Learning and assessment go hand-in-hand as part of effective educational practices. The National Research Council suggests that the following assessment standards be used with students:

- Assessment Standard A: Assessments must be consistent with the decisions they are designed to inform.
- Assessment Standard B: Achievement and opportunity to learn science (or other subject areas) must be assessed.
- Assessment Standard C: The technical quality of the data (or other information) collected is well matched to the decisions and actions taken on the basis of their interpretation.
- Assessment Standard D: Assessment practices must be fair.
- Assessment Standard E: The inferences made from assessments about student achievement and opportunity to learn must be sound.

Source: National Science Education Standards (Washington, DC: National Research Council, National Academy Press, 1996).

The Assessment section in each Project WILD activity includes guidelines for assessing student learning that correlate directly to the activity's stated objectives. Some of these guidelines help assess student understanding of factual information. Many of them ask students to demonstrate a theoretical or applied conceptual understanding.

Exemplary practice outlines the following strategies when assessing students' learning. Project WILD encourages educators to incorporate some of these methods when using this guide.

Educator-generated Tests

Unlike commercially produced tests, educatorgenerated tests are created by the instructor. They can be multiple choice, fill-in-the-blank, true/false, or essay type tests. Project WILD recommends that this type of evaluation be used on a regular basis for ongoing evaluation rather than as a cumulative tool.

Portfolios

A portfolio is a collection of class or project work chosen to specifically address a student's progress. Portfolios usually include examples of student work, reflections, self-evaluations, and goal-setting items. The purpose of a portfolio is to document what has been taught and the national standards that have been met. It also allows subject area assessments to be integrated and student growth to be charted.

Performance Tasks

A performance task is an assessment tool (generally chosen by the student) that demonstrates an understanding of concepts and processes as they apply to everyday life. The task is usually meant for a larger audience rather than for the educator alone. It is carefully planned and evaluated with detailed scoring. Teachers can present students with a new scenario, for which they will need to apply recently acquired ideas and information. For example, students may be asked to recommend a solution to a problem (such as food shortages) faced by animals when they experience a loss of habitat. Performance tasks can range from solving a real-life problem to preparing a speech or project, demonstrating a specific skill, or writing a paper or report.

Student-Initiated Assessment

Ask students, either as individuals or in groups, to create a list of preconceptions before beginning a new topic or activity. This may be a straightforward list, a web or concept map, or a journal entry. After completing the activity, ask students to revisit what they recorded and consider how their thoughts may have changed and how their knowledge and skills may have increased. Journals and logs are tools for students to use to record their own learning in a less formal manner. Journals are usually a subjective account of a student's perspective on what has been learned. Logs are more detailed and give a direct account that follows a given format. To assess overall classroom interest and information retention, ask students to submit written questions derived from newly learned information that will be discussed in an open-class forum. To read more on science notebooks and field journals, see page xxvii in "Project WILD Field Investigations."

Visual Vocabulary

An alternative method of assessment for the expression of learned concepts is through pantomime and creative movement. Students review vocabulary they have researched and then select specific terms that demonstrate their understanding of the activity's concepts.

Observation Checklists

Educators may use observation checklists to monitor whether a student has mastered a specific skill. This type of checklist is a useful tool to address specific skills.

Graphic Organizers

Web diagrams, charts, and other forms of graphics can be generated by students to demonstrate what they have learned and how it has been organized into their thought process.

Interviews and Conferences

Educators can assess learning by interviewing and conferencing with students using a systematic approach. When discussing a topic, students can clarify their thinking and educators can gather information on how students are processing what they have learned.

Rubrics

Rubrics are used for any of the assessment strategies outlined above. A rubric is a set of scoring criteria against which a product/activity is evaluated. Generally rubrics identify levels of quality (such as "Excellent, Good, Needs Improvement" or numeric scores "4, 3, 2, 1," which can be added for a total score). A rubric allows students and educators to know specifically what is expected and how each student has measured up to those expectations; they can also be used in self-evaluation or evaluation by peers or educators.

Journals and Learning Logs

Journals and logs are tools for students to use to record their own learning in a less-formal manner. Journals are usually a subjective account of a student's perspective on what has been learned. Logs are more detailed and give a direct account that follows a given format.

Inventory Methods

For Plants and Wildlife on School or Community Grounds

Part 1: Background

What Is an Inventory?

While there are many ways to study species that inhabit a school yard or community, a great way to start is by conducting an inventory. When exploring local ecosystems, consider the diversity of plants and animals within the area, the habitats in which they live, and the current and past land use.

An inventory is a list of the plants, animals, soil types, etc., in a given area. It may list the species of birds in a school yard or the different types of trees within a watershed. Such lists provide good information but may not necessarily include the actual number or census of specific plants or animals. The type of information found depends on how the inventory is conducted and the environmental factor (plant or animal) being inventoried. It may be a fairly simple task to count and identify all the trees in a small school yard. In this case, a simple inventory based on observation, identification, and actual count results in an inventory that includes the census or number of trees.

However, it is more difficult to get the exact number of a particular species of bird or butterfly in a school yard. Typically, a bird and butterfly inventory will provide a list of the species found in a certain area. The numbers of each species observed during the inventory may also be recorded. These numbers can then be used as an index to provide an idea of which species may be more common in that area or during a certain time of year.

Inventories can be based on a standardized method and timing, or they may be based on informal sightings. Many parks keep a running inventory of their plants and animals. Visitors jot down their sightings that, if confirmed, are then added to the park's inventory list. Other methods may be more formal, with volunteers doing an inventory in a given area at a given time. Before starting an inventory, educators and students should determine what it is they want to know. A variety of inventory methods exist to create lists of species, habitats, and land uses that exist in the area. To get an idea of numbers of each species, population density, or habitat use, consider using a more standardized method. (For many species, particular statistical methods and research techniques may need to be used to obtain accurate population estimates and population densities.)

Inventory data typically includes:

- Date
- Name of the observer
- Habitat
- Location
- Species identification
- Number of plants, animals, or signs of animals found

Examples of statewide or nationwide inventory projects are the Audubon Christmas Bird Counts, National Park Service Inventory and Monitoring Program, and Project Budburst, a citizen science program.

Designing a Monitoring Project

Monitoring takes it one step further by studying a population or habitat over a long period of time with multiple inventories. While conducting a one-time inventory of a habitat can be both educational and informative, students may be interested in comparing data from year to year. Studying a site over a long period of time can reveal changes in population, new species introduced to the habitat, or other trends that cannot be studied from a one-time visit. When developing an inventory method set to be used multiple times, it is important to establish a standard, repeatable procedure called a monitoring project.

Monitoring projects have very specific procedures that are repeated. Two examples of inventory methods used in monitoring projects are:

- *Point Count Method.* Often used for birds but also can be used for butterflies and amphibians. In this method, participants are assigned a route. At established points along the route, all birds are identified and counted, both seen and heard, within a given radius. An example of a project using the point count method is the Breeding Bird Census, which used this method to determine the population density of breeding birds over time. It is performed each year along the same routes or in the same study areas.
- *Spot Mapping Method.* Used to determine estimates of population density over a period of time. The spot mapping method involves establishing a study area, visiting the area several times during the breeding season, identifying birds within the area, and plotting their locations on a grid map.

Whether students conduct a one-time inventory or complete a yearlong monitoring project, it is important to respect all wildlife and natural areas. Refer to "Field Ethics" (page 548) for best practices on navigating instruction in outdoor settings.

Species Identification

Before conducting the inventory, it is helpful for older students to be familiar with at least some common species they may encounter. Depending on the specific inventory planned, give students time to research typical birds, mammals, fish, and other species in habitats similar to the study site. Photos or illustrations, as well as information about possible signs (tracks, eggs, lodges, or nests), will help students determine whether a particular species is present at the site.

Have students make and laminate identification cards to take on the inventory. Plan to have appropriate field guides on hand. A great way to record details of an organism while building critical observational skills is to bring a drawing pad and create a sketch. Place this in science notebooks to identify and label back in the classroom.

Younger students need not be too concerned about identifying exact species. General terms like "tadpole," "frog," "fish," or "duck" are developmentally appropriate descriptions of the different types of wildlife found at a particular site. If students show an interest in learning more, use child-friendly field guides to teach them common local species for the next inventory.

Part 2: Preparation

Introducing the Inventory

An inventory study of an organism, population, or habitat can be conducted with many of the same procedures used during a field investigation. An initial inventory of a study site will help students develop greater knowledge of their local environment and is thus a technique fit for conducting descriptive field investigations. That is, data collected in an inventory will help students answer many questions that describe a study site. With this knowledge, students can then go on to develop more involved questions that compare or correlate attributes or phenomena on a site (comparative and correlative investigations).

For more information on field investigations, including a list of field investigation activities in this guide, see "Project WILD Field Investigations" in the introductory pages. Refer to activities such as "Insect Inspection" (on page 2) and "Environmental Barometer" (on page 158) for guidance on helping students develop researchable investigative questions.

When initiating an inventory, explain to students that they will be conducting an inventory to learn about what organisms live in or near a habitat. Point out that scientists conduct field investigations to learn about plants, animals, and other living and nonliving elements of a habitat. Like other scientific investigations, inventories usually start with a question. The question guides the investigation and helps them determine the what, where, when, and how of their study.

Write the following question on the board: What plants and animals use resources or live in the study site? Ask students how this question might guide their inventory of the study site. Does it give information about what we would be looking for and where?

If a more specific investigation question is needed to guide the inventory, have students propose possible questions to consider. What precisely do they want to find out about the site, or about the wildlife that lives there? Is there anything they are particularly curious about? Do they want to know if a particular animal lives there? Or do they want to get a basic idea of all the plants and wildlife that inhabit the site? Do they want a detailed inventory of a particular group like birds or amphibians to study the population over time?

Taking time to formulate good questions before planning the inventory will encourage student-driven research and provide a solid foundation from which to design the study.

> **An inventory is a data collection technique students can use when conducting descriptive field investigations. That is, data collected in an inventory will help students answer many questions that describe a study site.**

Planning the Inventory

When conducting a survey of plants and wildlife, students should consider several factors:

Size. First, students must decide where to survey. Is the study area large or small? Then decide what to survey. Do they want to get a basic idea of all the plants and wildlife that inhabit the site? Do they want to make a list of all the plants that are in an area? Or, do they want to acquire general knowledge of common plants and wildlife with a more detailed inventory of a particular group like birds, trees, or amphibians?

Time. When should the survey occur? Approximately how long will it take? Will it occur once, or as an ongoing monitoring project? How much preparatory time is needed before students conduct the survey?

Level of Experience. How much survey experience do the students have? Which techniques might be easier and safer for them to use? Select an inventory method appropriate for the grade level.

Sampling Design. A sampling design is a step-by-step method of counting a species. Because an inventory is just a list, the design can be as formal or informal as desired. However, for accuracy and consistency, especially when conducting a long-term monitoring project, students must use a standardized method each time the inventory occurs. Standard methods or techniques exist for discovering various plants and wildlife that inhabit the site. Specific techniques tend to lend themselves more for inventorying the different groups of plants and animals (insects, mammals, birds, amphibians, or plants). **Plot studies** and **transect lines** are typical survey designs used in conducting inventorying and monitoring projects for a wide variety of plants and wildlife. The actual sampling design can be the same, but the techniques and timing to discover the organism differ.

For example, students may set up a transect line or simply walk a particular trail on site. At set distances, such as every 5 meters (or yards), check for mammals or signs of mammals in a 2-meter diameter from the observation point. Using the same design, they can also check for amphibians or birds. However, students will have to use different techniques to actually find the animal and may need to inventory at different times of the day. To find mammals, look on the ground, in trees and shrubs, etc. Students could also look for tracks, scat, eaten corn, etc. Amphibians can be found under logs or stones; to find birds look for nests and listen for songs or calls. Refer to "Part 3: Inventory Methods" on the following page to learn more on inventorying different species.

Analysis and Reporting. Analyzing and sharing the information gathered through inventorying, monitoring, or research projects is very important.

Some students may benefit from a reporting form, or format that will help them organize different types of data into meaningful analysis and recommendations. Before sharing, prompt students to reflect thoroughly on the inventory and what was learned. Begin with questions such as:

- What did you learn from the inventory or monitoring project?
- What surprised you?
- What questions did the study raise?
- Who else might be interested in what we learned?
- How could we share this information?
- What else could we study next?

All information contributes to the general knowledge base and may contribute to management and conservation programs. Contact your state wildlife and resources department (many have local offices) or a conservation organization to see if the inventory results could be valuable as a citizen science contribution. Adapt the results to a catchy report or "news" update on the school social media page or website. Students could also video the inventory and develop a short PSA for the morning announcements. Publishing in a pamphlet, newspaper, journal, or on a website is a great way to practice scientific writing skills.

Part 3: Inventory Methods

Inventorying and Monitoring: Wildlife Populations

A population is the number of a particular species of organisms that occupy a certain area at a certain time as defined by the people interested in the group. A population can be deer in Montgomery County in 1999 or the White Pines in the county park in 1884.

Conducting a census for wildlife has been done for centuries. There are many reasons to determine the population size of a given animal. However, the value of a one-time population estimate is limited. Noting trends in population size is much more valuable. This task is accomplished through repetitive estimates over time. For example, a one-time count gives the number at that time; it does not help assess the overall health or status of a population. However, population estimates over a period of years can indicate a decline or area of concern. Reasons for determining population size include the following:

- A species is endangered or threatened.
- The status of a species needs to be determined.
- A "nuisance" species needs to be monitored.
- Harvest size of a species needs to be determined or monitored.
- Habitat management practices require population information.
- Population information is needed to determine the environmental quality index.

Naturally, it would be ideal if all wildlife populations could be counted individual by individual. However, even if it appeared that all were counted, how would biologists be certain? The reality is that most counts are based on some type of sampling methods. Sampling methods inherently have problems; however, over the years, many methods have been shown to give fairly accurate population estimates. The following methods are examples of wildlife population assessment techniques:

Territorial Mapping Method of Bird Populations. This procedure involves participants observing individual birds during repeated visits and recording the location of the bird at each visit. These locations are mapped on a grid. Clusters on the grids are counted and used for determining breeding population densities in a given area.

Marked Sub-Sample Method. In this approach, a known number of animals are marked individually. A survey is conducted, often aerial, and the marked and unmarked animals are counted. Then, a ratio is used to determine the total population:

$$\text{Total Population Estimate} = \frac{(\text{Number of marked animals}) \times (\text{Total animals observed})}{(\text{Number of marked animals seen in survey})}$$

Change-in-Ratio Methods. These methods remove the animal from the population by means of trapping or hunting. Change-in-ratio methods involve two types of animals (e.g., male and female, with antlers and without antlers, adults and juveniles). For instance, a pre-hunt road count is made of deer with and without antlers. A hunt takes place, and the road count is conducted again. Then, changes in proportions are determined, resulting in a total population estimate.

Capture-Recapture Methods. These methods entail capturing and marking a known number of animals and then recapturing or observing animals at a subsequent time. Capture-recapture can provide two types of information:

- Data from the recapture of marked animals can be used to help determine survival rates.
- Proportions of the marked and unmarked animals captured at each sampling can be used to estimate population abundance.

An example of this method is the **Lincoln Index**. To use the Lincoln Index, biologists capture a group of animals and mark them. The number of marked animals becomes the sample size. If the biologists captured and marked 100 bears, 100 would be the sample size. At a later date, perhaps a year later, the biologists then recapture 100 bears in the same area and determine how many bears were marked. Then they use the following equation.

$$\text{Total Population Estimate} = \frac{\text{(Sample size)}}{\text{(Percentage of the sample that is marked)}}$$

There are many other techniques to measure populations. For more information, contact a local university or the state wildlife agency.

TRY IT OUT!

For experimenting with the capture-recapture method, have students use sunflower seeds, beans, or marbles as "organisms," or assign several students to be biologists and the other students to represent the organisms. Place the objects in a container or, if using student "organisms," have students spread out in a gym or outside. Collect a certain number of organisms for a sample and mark them. (Student biologists can use an armband to mark student organisms.) Then,"release" the organisms. Recapture the same number of organisms using the same method. Count the numbers that were marked within the recaptured group and use the equation to calculate the total population. (The calculation given in this text is the basic calculation with no corrections added for bias. To get an accurate count, the larger the sample size and the higher the percentage of marked organisms, the better the estimate will be.)

Developed by T. Alberici, PA Game Commission. Reference: *Research and Management Techniques for Wildlife and Habitat*, edited by Theodore A. Bookhout, The Wildlife Society, Bethesda, Maryland, 1994.

Inventorying and Monitoring: Plants

The composition of the plant communities in a particular site can be quantified in many different ways. The sampling method used depends on several factors, such as the sort of data the class is interested in obtaining, the type of vegetation, and the amount of time available. The methods described below consist of observing plants along one or more lines, which may be laid out systematically or randomly within a study area.

Point-Transect Line Method

This type of inventory is typically done in a field situation but could be used as part of a plot study in a forest or other location.

1. Decide on the area to be inventoried.
2. Set up transect lines through the area. Students can use posts and string to make the lines.
3. Have students walk the transect lines. At set intervals along the line, record the plant closest to that point. The interval depends on how long the transect line is. For example, if the transect line is 25 meters, students may want to record data every 5 meters. Students could be asked to record the height of the plant and whether it produces berries, seeds, or flowers that might be useful to wildlife.
4. Summarize the data. Students will be able to figure out the most common species by looking at the percentage of occurrence (i.e., at how many points did this plant occur).

Variation on the Point-Transect Line Method

This procedure can be used in large field areas or to gain a basic idea of the most common plants in the area.

1. Divide the area into grids by establishing and numbering points along the length and width of the area.

2. Students randomly choose points to start the study by writing the numbers assigned to the points along the length of the site on slips of paper and putting those numbers into a container. Do the same for the numbers assigned to the width, putting those slips into another container. Next, have someone select a number from the width container and a number from the length container. Choose several of these sets of numbers (depending on how many starting points the class would like). Locate where the points intercept on the site. Then, using a meter (or yard) stick, place the beginning of the stick directly where the numbers intercept. Make sure the meter (or yard) stick always goes the same direction from the starting point. Ask students to record and identify each plant found at a determined point along the stick (e.g., every 10 centimeters).

3. Summarize the data. Have students determine the most common plant on site by looking at the percentage of occurrence at each point. Report all results after the plant inventory is complete.

Sampling with a Daubenmire Frame

A quadrat or Daubenmire frame is one type of frame that may be used to isolate a small area for study, often to determine the type and density of vegetation in a large area by sampling smaller areas (a hula hoop may also be used). When using frames for sampling, make sure all frames are the same size if using more than one in a study. Although biologists may count each stem within a frame, students may find this difficult.

Percentage estimates will work fine.

A grid on or in the frame can make estimating easier. Paint or mark alternating colors on the frame as visual cues to sections within the frame. Or, use string or wire attached at regular intervals to divide the interior of the frame. With a string grid, students can identify species at the intersection of grid lines similar to a point count. If sampling in a shrubby area, open one end of the frame so the frame can be placed around the base of a shrub.

Making a Daubenmire Frame

Supplies

- At least 1.5 meters (5 foot) length of 1/2 inch PVC pipe
- 4 one-half inch PVC right angle elbow connectors
- One Roll Electrical Tape
- Ruler
- Permanent Marker

Assembly:

- Cut two 25 cm (10 in) and two 50 cm (20 in) lengths of PVC.
- On the 50 cm (20 in) lengths of PVC mark 12.5 cm (5 in), 25 cm (10 in), and 37.5 cm (15 in) on the PVC pipe with a marker.
- Connect the PVC lengths together using the right angle elbow connectors to form a rectangle.
- Using the electrical tape, wrap the first and third 12.5 cm (5 in) segment of the 50 cm length of PVC.

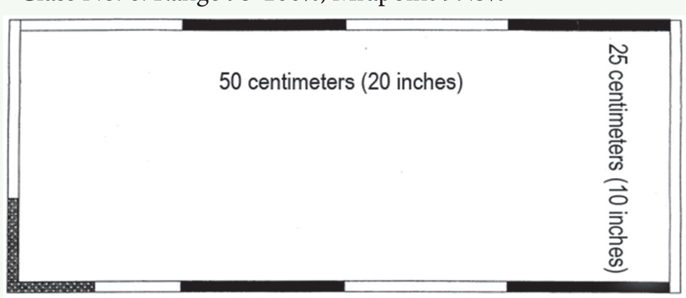
This frame, also known as a "six cover class frame" is divided into fourths by painting or taping alternate sections of the frame different colors as illustrated. In one corner of the frame, Delineate two ~8 cm (~3 in) sides of an area as illustrated. This represents ~5% of the frame area. The painted/taped design provides visual reference areas equal to 5, 25, 50, 75, 95, and 100% of frame area.

Using a Daubenmire Frame

- Observe the frame from directly above and estimate the cover class for all attributes you want to characterize.
- When estimating cover, imagine a line drawn around the leaf tips of the plants and projected onto the ground, then use the marks on the 50 cm (20 in) side of the frame to estimate percent cover.
- Estimate the percent cover of the target species, bare ground, litter, or other occurrence to the nearest 5%.
- An estimate of the numbers of individual occurrences of a plant (or other type of unit of study) in each frame
- will then provide an estimate as to whether the aggregate coverage falls in Class 1 or 2, etc.
- The total percent cover in a frame should be 100%.

Daubenmire's 6 Cover Classes

Class No. 1: Range 0-5%, Midpoint 2.5%
Class No. 2: Range 5-25%, Midpoint 15.0%
Class No. 3: Range 25-50%, Midpoint 37.5%
Class No. 4: Range 50-75%, Midpoint 62.5%
Class No. 5: Range 75-95%, Midpoint 85.0%
Class No. 6: Range 95-100%, Midpoint 97.5%



The inside dimensions of the frame are 25 x 50 centimeters (10 x 20 inches).

Source: Based on "How to Make a Daubenmire Frame", as found on the BugwoodWiki, published online by the Center for Invasive Species and Ecosystem Health at the University of Georgia.

Inventorying and Monitoring: Birds

Many different methods can be used to inventory and monitor bird species within an area. Two methods based on the **point count method** are suggested in this activity. One method is for smaller areas, similar to a small backyard. The other is for larger areas or areas with several types of habitats. Birds are resident and migratory; therefore, the inventorying and monitoring observation days should occur at different times of the year. Most birds are active in the morning and evening, so these times are better to conduct observations. However any time during the school day will also do.

Point Count Method

1. Select the area to be monitored.

2. Establish observation points.

- Option 1. If the area is small and this is a monitoring project, then establish one or two observation points, observation times, and procedures. For example, observe for 10 minutes between 8 a.m. and 10 a.m. Keep the length of each observation time consistent.
- Option 2. If the area is large or contains many different habitat types, conduct the more typical point count method. Establish routes through the area. At established points along the route, stop, identify, and count all birds seen or heard within a predetermined radius for a specified amount of time (generally between 5 and 15 minutes).

3. Ask students to count and identify each species observed. At a minimum, data collection should include date, time, weather, observer, species, and number. If students decide to conduct the inventory several times a day (for example, one class does the observations in the morning and another in the afternoon), be careful how they report the numbers of birds in the area. To determine the number for the day, use the largest number of the one species of bird observed at one time. For example, the morning group observed five robins; later that afternoon, the tally for robins was three. The total number reported for the day would be five. (In addition, it might be interesting to compare morning to afternoon numbers over a period of time.)

4. Conduct the inventory at least several times during the year to get an overall picture of what birds inhabit the area. While selecting the observation dates, consider when each bird species migrates.

5. At the end of the each season, have students summarize the data.

6. Using data summaries, students can draw conclusions and report to their class or school.

Winter Feed Count Method

One way to inventory winter birds that come to a feeder is to do feeder counts. Keep in mind that not all birds come to feeders and even birds that will use feeders also use different habitats. A feeder count will not reveal all the birds on the site, but it is a good start. Before a bird feeder program is started, research the types of food preferred by different species. Have students clean the feeders and area under the feeder (remove old seeds and hulled seeds) to prevent the spread of disease. Some people feed birds throughout the year, but keep in mind that other animals, such as squirrels, raccoons, and even bears will use the feeders, which can cause problems. People in areas with bears should not feed birds all year.

1. Research local birds that come to feeders.

2. Learn about the do's and don'ts of bird feeding by bringing in a guest speaker or conducting online research.

3. Select the area for a bird feeder or feeders. Feeders should be easy to refill and be within easy view of a window.

4. Establish observation times and points. Observations can be done once or multiple times a day. In this case (for example, one class does the observations in the morning and another in the afternoon), be careful how the numbers of birds are reported in the area. To determine the number for the day, use the largest number of the one species of bird observed at one time. For example, the morning group observed five chickadees; that afternoon the tally for chickadees was three. The total number reported for the day would be five. In addition, it might be interesting to compare morning to afternoon numbers over a period of time.

5. Count and identify each species observed. At a minimum, data collection should include date, time, weather, observer, species, and number.

6. Conduct the inventory at least once a week through the winter months.

7. At the end of the winter, have students summarize their data.

8. Using the data summary, have students draw conclusions and report them to their class or school.

If students would like to get involved with a national bird feeder inventory and monitoring project, contact Cornell University's Project FeederWatch program:

Project FeederWatch
Cornell Laboratory of Ornithology
159 Sapsucker Woods Road
Ithaca, NY 14850
Phone: (800) 843-BIRD (2473)
birds.cornell.edu/PFW

Inventorying and Monitoring: Mammals

Students often enjoy seeing mammals such as squirrels or deer near their school. Direct observation is the most obvious method to observe mammals, but unfortunately mammals are not always cooperative. Before beginning any type of inventory, have students research the habitat at the study site and make a list of mammals that might be found. Next, consider the type of signs those mammals may leave behind. Most often, mammal inventories are based on signs, rather than sightings of the actual animal. Below are two methods for inventorying mammals, but if students are conducting a monitoring project, the **line transect method** (see next page) is more appropriate.

Please do not allow students to touch, capture, corner, or chase any wild animal.

General Observation Method

1. Ask students to describe the habitats located at the study site. Examples are grassy, open areas, woods, creeks, gardens, or a deep pond.

2. Create a list of the mammals that may be found on site. Indicate those that definitely inhabit the study site. The latter can be done by confirmed sightings by students or nearby residents.

3. Have students research in teams the type of sign that the mammal or mammals they are counting may leave behind.

4. Divide area into sections. Make sure all habitat types are included.

5. In teams, have students walk the sections and search for signs of mammals and record information on a data sheet based on the sampling design. If possible, bring cameras or science notebooks to sketch the findings.

Mammal signs to search for include the following:

- Direct observation of the mammal
- Sounds and vocalization
- Scat (animal droppings)
- Tracks and trails
- Nests (for example, squirrels' nests among tree branches)
- Scratchings and rubbings (claw marks on trees from bears; rubbing marks from deer or elk)

- Gnawings
- Lodges and homes

6. Summarize the data collected.

7. Repeat this inventory several times during the year to include different seasons.

8. Publish an inventory of mammals on the site.

Developed by T. Alberici, Pennsylvania Game Commission. Based on the Project WILD activities "Wildlife is Everywhere!" and "Environmental Barometer."

Line Transect Method

1. With students, select an area to inventory and monitor.

2. Set up transect lines to cross the area using posts and string. Make sure the lines are far enough apart that observers are not counting the same animal. If the site contains different habitats, have students place transect lines in the different habitats. If this is a monitoring project, then they must develop a standard procedure. Brightly colored yarn, string, rope, or flags can be used to mark the line (e.g., one at every meter) so students can mark where along the transect line a mammal was observed.

3. Walk the transect lines and record the number and identification of all mammals observed. It is recommended to establish a maximum observation distance (e.g., 30 meters or 100 feet from the transect line). Suggested information to record includes observer, weather, length of transect line, habitat, animal, number, behavior of animal at time of observation, and date and time observed. Different animals are active at different times of day and at different times of the year. Prior research and careful planning will increase the chances of observing an animal.

NOTE: To estimate deer populations in an area, see the activity "Dropping in on Deer" on page 475.

4. Summarize the data collected. Keep in mind that if this is a monitoring project, the counts recorded are incomplete. Although they can be used as an "index" to the population, these counts do not provide a real census of the population.

5. Present the conclusions to schools, to the community, or to even broader audiences.

Adapted by T. Alberici from "Line Transects," *Research and Management Techniques for Wildlife and Habitats*, edited by Theodore A. Bookhout, published by The Wildlife Society, Bethesda, Maryland ©1994, 230–31.

Inventorying and Monitoring: Amphibians and Reptiles

Once a general inventory of the habitats and land use in the study site has been conducted and mapped, consider including reptiles and amphibians. Reptiles and amphibians are useful indicators when studying potential pollution, effects of drought, and insect populations. First, divide the site into quadrants. The boundaries of the blocks should be easily identifiable (street, streams, etc.) or based on a topographical map.

Before going out into the field to search for amphibians and reptiles, it is important to research which ones could be found in the area and which are venomous. Learn how to identify them. A resource person from a local university or state agency could be helpful during this process. Bring large color pictures of these species or a field guide to reference during the inventory.

Never allow students to approach or handle venomous animals.

The classes Amphibia and Reptilia possess groups with extreme variability, and no single technique will work to locate them. In general, amphibians and reptiles tend to be secretive in nature except during specific times of the year (e.g., mating season) and under specific environmental conditions such as high humidity or rainfall. Techniques for observing and collecting each group of amphibians and reptiles will be discussed separately.

Salamanders

Salamanders, especially terrestrial (land-based) and semiterrestrial species, can usually be found by looking under cover objects, such as rocks, logs, bark, and vegetation. Aquatic forms, such as newts,


TIGER SALAMANDER

can be observed swimming or floating in ponds or along the weedy, shallow margins of lakes. This is also true of spotted salamanders during the breeding season; however, they are seldom found except in fishless ponds in and near woods. Other aquatic salamanders, such as hellbenders and mud puppies, occasionally can be located by lifting submerged objects in streams and other appropriate bodies of water. Remember to replace the cover items where they were found to minimize habitat disturbance.

Generally, salamanders are active on the surface and are nocturnal, so slowly walking about at night in the appropriate habitat with a flashlight or lantern may prove successful. Any area that is likely to yield salamanders during daytime collecting (e.g., spring seeps, stream margins, wooded ravines, etc.) will also be a good area to locate salamanders at night. Rainfall and high humidity tend to stimulate salamander activity, so nighttime collecting for terrestrial and semiaquatic species is most productive under these environmental conditions.


EASTERN SPADEFOOT TOAD

Frogs and Toads
The fact that frogs and toads are highly vocal during the spring and summer breeding seasons makes them most likely to be located at this time. Listening for choruses at night is the most effective method of locating frogs and toads. When they are not calling, frogs can most frequently be encountered by searching the margins of streams, rivers, lakes, and ponds at night with a lantern or flashlight. Browse the Internet to learn frog calls of local species. The cricket frog, for example, can be called by rubbing two stones together in a pattern of increasing frequency. Using tricks to call frogs may help locate them around a body of water.


CHUCKWALLA LIZARD

Lizards
Lizards are often found on exposed rocky areas in forested regions when it is sunny and the air is calm. Search tree trunks, fence posts, and areas with nooks that lizards might use for quick hiding. Most skinks are also located in open rocky spots in forested areas, usually in the vicinity of streams.

Snakes
Small to medium-sized species of terrestrial snakes most likely will be found by looking under objects. Water snakes and queen snakes are best found by walking in and along streams and other bodies of water as well as by overturning objects, such as rocks and logs, along the margins of streams and ponds. Large species, such as black rat snakes and black racers, are usually found actively moving about in the open. In general, the best places to look for snakes are along the margins of streams and lakes, around human habitation, in open rocky areas and rocky slopes, and in areas where debris, such as boards and other building material, has been left outdoors. In early spring, open rocky areas with southern exposures may be especially likely to host snakes.


NORTHERN WATER SNAKE

Turtles
Many species of turtles bask either at the surface of the water (e.g., a variety of snapping turtles) or on emergent objects such as rocks, logs, and sandbars (e.g., painted turtles, map turtles, red-bellied turtles, soft-shelled turtles, etc.). Careful and quiet observation of suitable bodies of water through binoculars or spotting scopes will often reveal the presence of turtles. Late spring and early summer is egg-laying season, when individual turtles can occasionally be found moving about on land in search of nesting sites. Sightings are particularly common along the edges of roads in the vicinity of streams and bridges. In addition, heavy summer rains will often initiate terrestrial activity in otherwise aquatic species.


SNAPPING TURTLE

Inventorying and Monitoring: Invertebrates

Conducting an inventory of invertebrates can often yield large and consistent data sets for a monitoring project. Insects respond quickly to environmental and human influences since they often reproduce in high numbers and live less than one year, which increases the ability to observe population fluctuations during a school year. Invertebrates are found in every habitat, and can be a good option if the class is unable to conduct an inventory offsite. A common way to inventory these organisms is the **capture-recapture method** (see "Inventorying and Monitoring: Wildlife Populations" on page 532 for procedure).

Sweep Net Method (Terrestrial Invertebrates)
1. Similar to reptiles and amphibians, many invertebrates can be discovered by overturning leaves, rocks, logs, and disturbing leaf litter. If the study site possesses a grassy area, a sweep net is a easy and fast way to sample hidden invertebrates.

2. Place students in teams and create transect lines for each team to walk. Another option is to divide the area into sections or quadrants that each team inventories.

3. Have students use the sweep net to gently but swiftly swipe the grasses back and forth as they walk the line or quadrant. Once they have completed the sweep, quickly flip the net over on itself to prevent invertebrates from escaping. Use jars to remove and observe any caught specimens.

Kick Seine and Dip Net Method (Aquatic Invertebrates)
Aquatic macroinverterbates are excellent bio-indicators of freshwater health. Many terrestrial insects such as dragonflies, mayflies, deerflies, and mosquitoes begin and spend most of their lives under the water. Have students survey all bodies of water at the study site for signs of macroinvertebrates by observing mosquitoes, dragonflies, or other insects hovering above or around the water. There are many web resources that provide detailed lists of macroinvertebrates to use for their inventory sheet. To familiarize students with identifying aquatic insects, practice using an ID book or drawing sample insects in class to count appendages, study body shapes, and learn the sizes of common species. See the Aquatic WILD activity "Water Canaries" to provide a good foundation for the inventory as well. During the aquatic collection it may help to laminate the inventory sheets before arriving on site.

1. Select a collection site. Students could collect from a creek, pond, stream, or a river.

2. Gather the proper equipment. Any sturdy net will suffice, but a dip net provides a long handle to reach out into the water from the bank. Waders are knee or waist high boots that students can place over their clothes to carefully stand in the water and collect. Kick seines are made from two handles and a screen in the middle. Place one group member further up from the kick seine and have them churn up the water with their feet or a log. As the muddy water flows downstream, any invertebrates living in the bottom will be caught in the net.

3. Separate the class into teams and spread them evenly along the waterbody. Make sure to record locations on the inventory sheet. Macroinvertebrates can live in many different areas of a waterbody.

Some move freely through the water such as caddisflies or mosquitoes. Many live along the bank to hide from predators. Have students assess the area to collect from all parts of the aquatic habitat.

4. Begin collection. Bring all nets and kick seines to the bank and place the macroinvetebrates in a shallow pan. White pans work best to help the organisms stand out against the sediment and debris.

5. Determine as a class if the invertebrates will be released back into the water or if several specimens will be taken back to the classroom for further observation or sketches. Refer to "Field Ethics" (page 548) to make an informed decision about removing organisms from their habitat.

6. Summarize the data and report results. Make inferences about the health of the waterbody based on the species collected.

Inventorying and Monitoring: For Younger Students

Do not be concerned about identifying exact species. For this age group, general terms like "tadpole," "frog," "fish," or "duck" are adequate. Encourage students to create their own names for organisms they observe and discuss how scientists might select common names based on color, habitat, or mannerisms.

Look On, Look Under, and Look Above

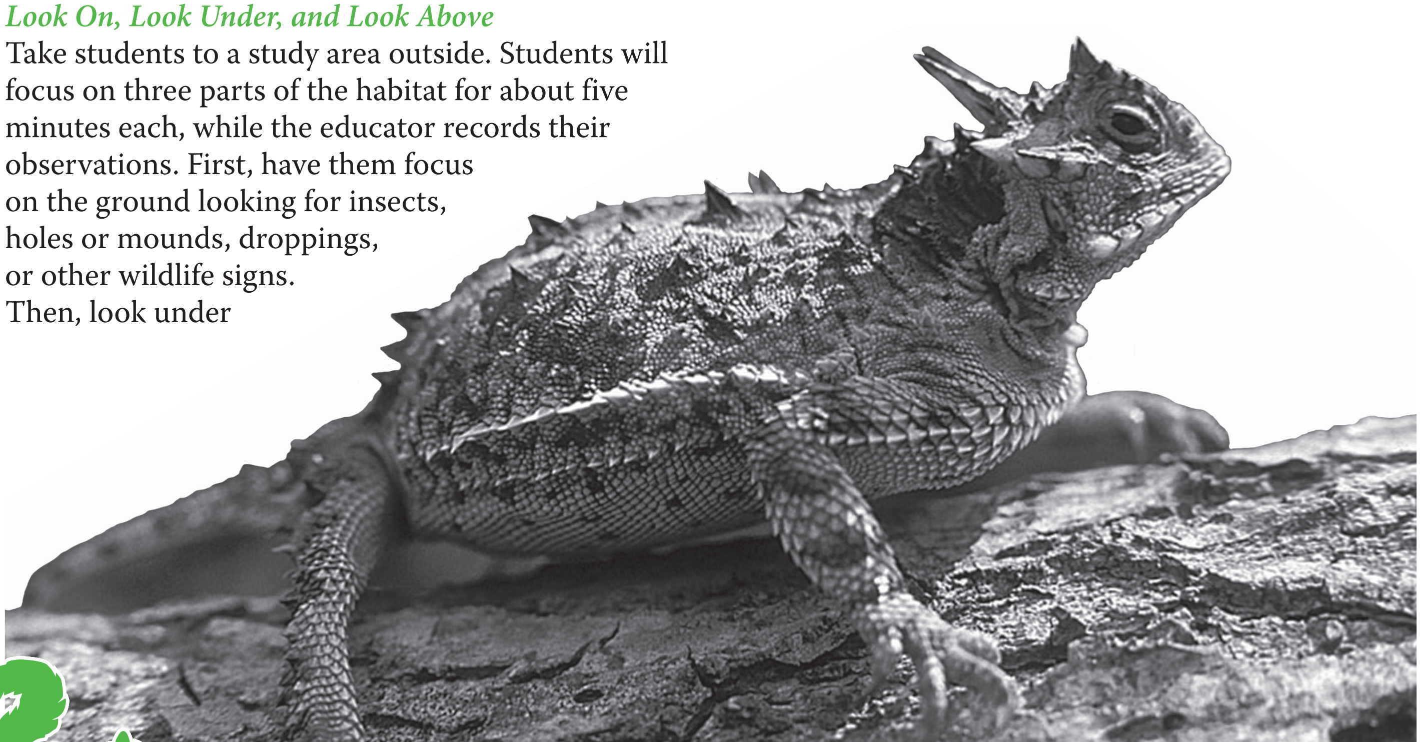
Take students to a study area outside. Students will focus on three parts of the habitat for about five minutes each, while the educator records their observations. First, have them focus on the ground looking for insects, holes or mounds, droppings, or other wildlife signs. Then, look under cover objects such as rocks, logs, leaves, and vegetation searching for any snakes, salamanders, or invertebrates. Finally, have them focus above the ground, looking for birds, insects, or other wildlife on buildings, up in overhanging branches, or well into the sky. Back in the classroom, make a list of the types of wildlife that use this habitat.

Hula Hoop Transect

Lay out hula hoops (or sections of rope—all of the same length—formed into circles) in an outdoor study area. Have pairs or small groups of students work together to investigate each circle transect. They can use their science notebooks to draw pictures of each different plant, insect, caterpillar, or other wildlife—or sign of wildlife—within the circle. Have them count (or estimate) the numbers of each and write the totals next to their drawings.

Promoting Stewardship through Inventorying and Monitoring

Using inventory and monitoring methods provides a framework for constructive observation and exploration of the natural environment. Conducting multiple inventories of a site close to the school connects students to wildlife that may not otherwise be noticed and can build a stewardship ethic among students. After teaching the ethics and procedures of an inventory with the class, encourage students to conduct an inventory in their backyards or at a nearby park with their family.



Service Learning

Engaging Students In Environmental Action Projects

What is an Action Project?

Project WILD has defined environmental action projects as any activities that get students involved in tackling an environmental issue or problem or that aim at improving an environmental setting. Activities are often most successful when they are focused on the local community, such as the enhancement of outdoor habitats or the development of natural sites within a neighborhood or on the school grounds. Projects can also work on a much broader scope—raising money to adopt sea turtles, for example.

An action project can be simple or complex—as straightforward as putting up a community bulletin board of current environmental events, or as involved as developing and implementing a community plan for oil collection and recycling. However complex, most action projects will fit into a variety of educational settings. Many educators find that action education blends well with their regular teaching duties, while others choose to make it the basis for afterschool sessions. Action learning is effective in informal settings, too, involving young people through nature centers, zoos, aquaria, and scouting programs.

Who Can Do Action Projects?

Students of all ages can take part in service learning projects, matching the complexity of the tasks to the abilities of students. Older students can get involved in issues that require research, issue analysis, in-depth discussion, careful planning, and follow-up. Students might establish river monitoring activities or conduct community education initiatives. Younger students can begin with projects that don't involve heated controversy, long-term commitments, or complex solutions. Picking up litter, writing a letter about an environmental concern, or planting a butterfly garden are excellent starting points for younger students.

Some Tips to Keep in Mind

Encourage student ownership and initiative.

The more students are involved in the project, the more they will get out of it. To the extent possible, allow students to make their own decisions on which problem to focus, how to conduct the project, and how to share results. Help students chart their own course, evaluate the pros and cons of each choice, and then gauge how much direction is needed.

Encourage parents and other community members to support the project.

Conflict sometimes can surface when students interact with community members who don't agree with a specific activity or don't feel that action projects are an appropriate educational approach. In many cases, you can diffuse this response by discussing projects with parents and community members beforehand and by explaining how environmental action projects enhance educational goals.

Keep your opinions in perspective.

Allow students to research material, discuss the issues, and form their own perspectives on the issues. Allow everyone the chance to openly express his or her opinions, no matter how different they may be. It is also critical to keep students on track

and focused on the facts. Emotionally charged debate and hotly contested points of view can obscure the real facts and divert students' attention from the issue under scrutiny.

Encourage student cooperation, compromise, and understanding.

Have students work in small groups as much as possible. Besides the well-documented educational benefits of cooperative learning, group work offers a taste of real-life problem solving. Teams of scientists, politicians, business people, and concerned citizens often arrive at a plan of action together. Ideally, each person brings his or her own perspectives and talents to the process, and the results reflect the strengths of those human resources. Multiple perspectives encourage thoughtful debate, boost critical thinking skills, and allow students to make informed choices—especially if opinions are accompanied by reliable information.

Help students evaluate their methods and change their plans if necessary.

From time to time over the course of a project, have students assess the overall scheme and evaluate their methods. Ask if they think things are running as smoothly as expected. If they think there's room for improvement, ask what might be done to adjust the situation. In some cases, problem-solving teams can brainstorm ways to deal with the snags and setbacks encountered along the way.

Help students appreciate the value of their work.

It's important for students to know that their project, no matter how small, is significant. Assure students that every action counts. Even if students' actions do not seem to have much effect right away, the long-term results can be very important.

Approaches to Environmental Action

Teach It!—The Educate-and-Inform Approach

Projects that focus on teaching others about environmental issues (These might include older students mentoring younger students, conducting community education programs, writing and performing songs and poems, or conducting workshops with school or community groups.)

Make the Case—The Persuasive Approach

Projects designed to convince people to support a certain course of action or point of view (Activities include creating posters or brochures, creating virtual discussion forums through social media, conducting debates, writing letters to the editor, giving speeches, and distributing public service announcements.)

Be on the Money—The Economic Approach

Strategies that encourage consumers to shop with the environment in mind, as well as projects that raise money to support specific organizations, programs, or individuals working on environmental issues (Activities might include promoting environmentally friendly products, asking for cash or in-kind donations of time and materials from businesses and community groups, or applying for grants.)

Get Physical—The "Ecomanagement" Approach

Projects that physically improve the environment, such as planting trees, landscaping school grounds, cleaning up neighborhood parks or streams, or building bird and bat houses

Make Decisions—The Political Action Approach

Projects focusing on political action that could include speaking at a public hearing, meeting with an elected representative to discuss specific legislation, testifying before lawmakers, circulating petitions and fliers, writing letters to the editor, or campaigning for candidates

Become Legal Eagles—The Courtroom Approach

Projects that attempt to create change through legislation, or that take legal action against an individual, corporation, community, or government agency (Although most projects that involve primary and secondary students will not involve actual legal action, many projects can educate youngsters about existing laws and the workings of the legal system.)

Source: "Approaches" adapted with permission from *Investigating and Evaluating Environmental Issues and Actions* by Harold R. Hungerford et al. (Champaign, IL: Stipes Publishing Co., 10–12 Chester St., 1992)

Seven Steps to Action

Here are some basic steps that will help students get action projects off the ground. While the steps are listed in order, it's important to note that planning and implementing a project is not always a clear-cut, linear process. In some cases, students will investigate an issue, discuss it, begin to work on it, and then change their strategy as they use new information. They might decide to narrow their focus or switch projects after realizing that the potential solutions are beyond their capabilities. Such adjustments are a normal part of the learning process.

1. Get Informed

Before students decide which environmental projects to pursue, they need to become informed about the possibilities. Students may collect a pool of information from web resources, newspapers, and magazines; interview community members and parents; or contact organizations and government agencies that focus on environmental issues.

Another important step in this initial process, if it can be arranged, is for students to get out and see local environmental problems firsthand. A field trip to a stream in need of cleanup is much more powerful than reading about water pollution. Even if students eventually select a problem that's occurring thousands of miles from their community, the exposure to concerns in their own backyard will be an important learning experience.

2. Create a List of Possibilities

Once the students' search has highlighted a number of potential topics, have them work in groups to develop a list of the most interesting or worthwhile ones. Then have students draft a list of projects to address all or part of each topic.

Environmental topics can be very broad and there are almost always several project possibilities for each topic. For example, water quality in the community might encompass pollution in a local river, lead in the city water system, or leaks in a landfill. Projects might include monitoring the pollution levels in the river over time and presenting data to the city council, conducting an education campaign about lead in the city's drinking supply, or developing a recycling plan to reduce the pressure on a landfill. Have students list the topic they most want to tackle, then they can brainstorm specific projects that might help the situation, listing any additional information they'll need to evaluate each project.

3. Narrow the Choices

Once the groups have selected the issues and projects they are most interested in, they need to evaluate and narrow their choices. For each project listed, the groups need to realistically address what they might accomplish and what problems the project might solve.

Encourage students to discuss the feasibility of each possibility by asking specific questions that help them think about the details of accomplishing certain tasks. Students may want to develop criteria to help them first select a project and then decide how they will determine the most appropriate solution. How much time will the project take? How complex is it? What resources are needed? Whom will they need to talk to?

Sometimes it's difficult for students to decide among local, national, and global projects. Although each will provide learning opportunities, an advantage of a local project is that students will learn more about how their own community works. They'll also be more likely to see real results.

4. Select a Project

By this point, students should have narrowed the list to the top three to five projects. Give them adequate time to research. Then encourage online research, the use of libraries, interviews with experts, surveys, newspaper articles, local news, and so on. Invite experts or resource people in to discuss problems, find potential solutions, and help evaluate students' ideas. The more your students know about specific possibilities, the better equipped they'll be to develop a realistic action plan.

As students approach their final decision, have each group present a case for one or more of the projects the group feels strongly about. Then hold a group vote or have a large group discussion to reach consensus. The important thing is to let students have as much say in the decision-making process as possible, choosing a project that they think is both interesting and achievable.

5. Create an Action Plan

Once students have done their research and selected a project, help them get started on their action plan by asking, "What do you hope you'll be able to accomplish by doing this project?" After students share their answers, guide them in developing a goal for the project and specific, concrete objectives that need to be accomplished along the way.

Remind students to keep the goal and objectives in mind as they work to complete a planning sheet that includes the following:

1. What environmental problem or issue will the project address?

2. How would you briefly describe the goal of the project and the strategy to accomplish this goal?

3. What are the specific objectives that will help the group reach its overall goal?

4. What are the approximate starting and ending dates of the project?

5. Did you list the tasks to accomplish to meet each objective? Include a tentative completion date for each task, the names of people responsible, the supplies and equipment needed, any funding needed, and ideas of where to get materials and funding.

6. Did you write down the names of people and organizations that may be able to provide useful information, specific skills, expertise, or other help?

7. Did you list ideas on how to publicize and generate support for the project?

8. Did you describe how your success will be measured?

A large-format task and timeline chart may help the groups keep track of responsibilities and deadlines. As students work on their action plan, guide them toward realistic objectives. One of the most common problems for students is thinking too big. Help them focus and simplify the project by discussing the responses to the questions on their planning sheet and by asking them to really consider hard questions. How will the funds be raised? Can the problem be tackled on a smaller scale?

6. Put the Plan into Action

Students' projects will work best if they keep careful records of what they've done, when they did it, whom they've contacted, etc. They will also need to keep track of who is doing what to make sure crucial tasks are being completed and to avoid duplicating efforts. It's important that students take stock of the project periodically to see if they are on target and to make modifications, if necessary. Remind them that it's acceptable to rethink their goals and objectives and to revise their plan of action in light of new information or unexpected obstacles.

To build support for action projects, publicize any successes and showcase the ways that action learning promotes educational goals and addresses community priorities. There are many ways to let others know what students have done—holding a community awards event, posting successes through social media, getting a reporter from the local newspaper or television station to cover a project, or sending out public service announcements (PSAs). Have students brainstorm ways to publicize their work.

7. Assess, Generalize, Apply, and Celebrate!

Taking time to reflect upon and evaluate an action project helps students understand what they've accomplished and allows them to recognize how their project has facilitated their personal growth. As a project nears completion, guide students in assessing the project itself, as well as their feelings about the experience. Remember to incorporate a celebration of the project's success! It's important for students to evaluate the success of each project and to think about improvements for the next time. It's also important that they look beyond the immediate impact to more long-term, broad-scale gains—skills, knowledge, and attitudes that they can apply to other aspects of their lives.

Ideas for Measuring Success

Assessing Student Knowledge

- Keep a video or photo log of project highlights. After the project is completed, use the video or photo scrapbook as a springboard for discussions in which students share what they learned and their feelings about the experience.
- Collect memorabilia (articles about the project, newspaper photos, students' own photos, planning schedules, and so on) to create an action project scrapbook that students can sign and write comments in.
- Ask students whether they've changed their thinking or behaviors as a result of the project. Have students write essays describing what those changes are and what students think prompted them.
- Have students keep a journal or blog to record feelings about the project, its progress, and its setbacks and to keep notes about working with others. After the project, students share parts of their journals with the group and discuss their perceptions.
- Have students evaluate other members of their group, as well as themselves. Before they do, give students pointers on positive, constructive feedback. Focus the session on specific points, such as contribution to the project, effort, conflict resolution approach, etc.
- Have community members who were involved in the project assess student performances. Educators can develop an assessment form or have students conduct short interviews.

Assessing Project Success

- Have students describe how well they think their project accomplished the objectives they outlined at the start.
- Have students conduct surveys, field studies, or interviews to assess the success of their completed project. What worked? What didn't? Why?
- Evaluate how students planned for ongoing maintenance and sustainability of the project.
- Have community members and others who were involved in the project assess project outcomes.

Using Local Resources

In the course of conducting activities in Project WILD, educators may find that local resource professionals would be of great assistance. Some topics covered in Project WILD activities address areas in which many educators may not have extensive background experience. Experts from the community can be invited to share with students their special knowledge of wildlife, environmental, or natural resource topics. However, involving such resource people should be done in a manner that uses each expert's time effectively. Preparing in advance is important before inviting experts to speak to classes, sending students to interview them, or taking field trips to special facilities. Here are a few basic suggestions that may help you with this process.

Have students explore the question of who might have special knowledge to contribute to a particular activity or topic.

One of the important skills that students can learn is "How can we find out?" Part of this process may involve asking someone who knows more than we do. Students can conduct web searches for potential experts. Where could they find someone who knows about local water quality? At the local city health department? In the state water commission? In the In the Office of the Environment? At a local college or university? Are any citizen groups interested in the topic? Do they publish any resource materials? Develop a list of possible avenues to explore in order to identify the experts on a topic in your area.

To some extent, everyone in a community is an expert on something. Perhaps students will want to know what something in the community looked like 20 or 40 years ago. If any public opinion surveys or interviews in public places are planned, students should be supervised by adults. People who might be concerned (businessowners, mall managers, etc.) need to be asked in advance and informed about the project and its purposes. If people do not want to be interviewed, thank them politely for their time. An in-class practice session using role-playing techniques can be an effective preparation for actually conducting interviews.

Develop a plan for approaching the agencies or organizations where "experts" may be found.

Once students have decided where experts might be found, they will need to decide how to approach those institutions in order to actually acquire the names of people who might be speakers, lead field trips, or be interviewed. Some governmental agencies, for example, have public affairs departments, and those departments might be the best place to start. Some public libraries have information librarians who specialize in this sort of task and know whom to approach. Some universities and colleges publish speaker lists that include topics faculty members are willing to speak about. Local businesses may also have people who are experts. Web searches of organizations and governmental agencies may result in staff biographies with e-mail addresses

Using Real Data Sets

Collecting, analyzing, and interpreting real-world data is an important part of all scientific investigations. Many activities in this guide, namely field investigations, involve these processes as students collect, record, organize, and analyze data to answer a question about their surroundings. In order to make inferences and draw conclusions, scientists must have sufficient data to ensure that unusual circumstances or outliers do not lead to false assumptions. Having multiple groups of students collect data in the same way over time will help generate a robust body of data that can be analyzed and interpreted to answer questions about local wildlife and habitats.

Aside from data produced by students themselves, a broad range of real-world datasets can be accessed from government agencies, such as wildlife agencies, agricultural extension offices, and national scientific administrations and services; universities; and citizen scientist projects. Many databases are available online, while certain specific datasets may be obtained only by special request. When students are researching questions that involve species or circumstances beyond their schoolyard or backyard, these institutions may be able to provide data as well as guidance for interpreting data sets.

For more resources relating to real data sets, visit *www.projectwild.org*.

included. Sometimes you may be referred directly to the resource person. In this case, consider the next suggestion before proceeding with your project.

Once you have identified potential resource people, develop a strategy for determining whether they would be willing to act as experts for your class and, if so, how they would like to work.

As a teacher, it is recommended that you speak with resource people before inviting them to your class. Sometimes, an expert might recommend a colleague who would be better suited to speak on the topic of the project. Some experts are not comfortable speaking to large groups of people, especially young students. They may want to talk to a small group, or even one student, who can take the information back to the rest of the class. Some might not be able to get away from their work to visit your school during the day. In that case, consider whether a field visit would be possible for the class.

If the resource person is willing to work directly with students, find out what advance preparation is needed and in what type of setting the expert would like to work. Would he or she like written questions from the class beforehand? Would he or she be willing to be recorded or videotaped or written up in the school or local newspaper? If the expert is coming to your school, what sort of special equipment will be needed? If the class will take a field trip to visit the resource person at his or her work place, what should the class know in advance? Are any special clothes required? How long will the visit be? Attention to this kind of detail can make the trip more productive, effective, and appropriate.

Decide who will act as interviewers, recorders, moderators, and hosts. Brief the class about the roles each of these students will serve, and the responsibilities and expectations for behavior of all students.

A letter or e-mail to the resource person in advance will help to verify the details of their visit. When a guest arrives at the school, a student can meet and escort the visitor to the classroom. If student interviewers visit the resource person, they should be encouraged to send a letter of introduction prior to their visit, they should be briefed about how to interview the person, and they should operate in pairs or with adult supervision. Students who leave the school grounds to interview people should see themselves as representing the school and your class in particular. Whether guests come to school or students visit resource people in the community, the importance of courteous, considerate, and responsible behavior should be stressed.

Do advance work on the topic.

Resource people usually do not mind sharing their time with people they think can use it well. If you and the class have done some homework on the subject, you are more likely to ask intelligent questions and be able to understand what the expert has to offer. This advanced preparation is strongly recommended in any circumstance.

Maintain respect and professionalism during an interview.

Students should be reminded to conduct themselves in a professional manner and to keep an interview focused on the purposes of the research. Rather than the students using the interview to expound their own views on the topic, their task is to learn the subject's views and respect those views even if they differ from their own. If any form of recording is desired, ask for permission in advance, and advise them how the information will be used. Before using a quote with the interviewee's name cited, give them the opportunity to see the written proceedings of the interview, review any excerpts to be used, or review the recording before any class or public use of the information takes place.

Remember that a little consideration and hospitality go a long way.

Resource professionals can become lifelong supporters of your school and its programs or lifelong critics. Which will happen depends not only on suggestions offered here, but also on courtesies such as thanking them at the time of their visit (or your visit) and following up with a letter. If the class uses the information from the resource person in some special way, send a picture or samples of the work to the resource person to show what was accomplished. If the local media produce an article, send along a copy to your expert. Do not expect or demand large amounts of additional time from the experts, but do let them know that their expertise was appreciated as well as how it was used.

Field Ethics

Exploring in nature exposes students to a variety of natural objects. Often students desire to take an object with them if it strikes them as beautiful, interesting, or unique. Yet removing objects from natural settings—either temporarily or permanently—may cause an unnatural impact on the environment, especially when multiplied by many others who wish to collect similar objects. Individual educators and their students must decide on the appropriateness of collecting objects from natural settings, based on thoughtful decision making, caution, and respect for the living environment. In most cases, Project WILD and Aquatic WILD urge no collecting at all and recommend instead simply leaving the natural environment as it is found, with as little impact as possible from students in the process of learning.

There are times, however, when it may seem appropriate and so instructionally powerful that some limited forms of collecting are desired. Collecting for instructional purposes can take a variety of forms. Sometimes it involves going outside and picking up fallen leaves on an autumn day or picking up shells at the seashore. Collection can also involve using a net and examining organisms found in pond water, perhaps keeping the organisms temporarily in a classroom.

If any collecting is to be done, it should begin with a respect for the environment and the organisms you are collecting. Educators should determine in advance what laws or restrictions may apply and closely adhere to these. Then, if collecting is permitted, involve students in deciding what, if anything, to collect and how much collecting is appropriate. By involving students in the process of deciding whether and what to collect, they are more likely to develop an ethic that considers the impact on ecosystems and individual species. This kind of thoughtful decision making about the consequences of our individual and collective actions is an important, lifelong skill.

The following list of field ethics was developed by a class of sixth graders in Illinois:

1. We should obey all laws protecting plants and animals.
2. We should ask the owner before we take anything.
3. We should collect an animal only if we know we can keep it alive long enough to learn from it.
4. We should not collect things that will hurt us.
5. We should collect something only if there are a lot of them in that place.
6. We should collect something only if we can learn something very important about it.

Obviously, any collecting for instructional purposes should alter the environment as little as possible and should not significantly damage wildlife or their habitat. Where possible, anything collected from the environment for instructional purposes should be returned to its original location at the conclusion of the activity.

Beyond the collecting issue, students must understand that humans can affect living things in other ways. For example, just by walking over fragile areas outdoors or observing animals under certain conditions, we can destroy or disturb organisms. Walking on rocks can remove new soil and crush mosses and lichens if they are present. Thoughtful decision-making and responsible behavior are not just an outcome or goal of Project WILD and Aquatic WILD, but a path to developing a lifelong conservation ethic.

Animals in the Classroom

The following is a portion of the NSTA Position Statement on "Responsible Use of Live Animals and Dissection in the Science Classroom." Please see the NSTA website www.nsta.org/about/positions.aspx *to view the entire statement, which includes a section on dissection that is not represented below. Note that digital, interactive dissection software is now commercially available online.*

NSTA supports the decision of science teachers and their school or school district to integrate live animals and dissection in the K–12 classroom. Student interaction with organisms is one of the most effective methods of achieving many of the goals outlined in the National Science Education Standards (NSES). To this end, NSTA encourages educators and school officials to make informed decisions about the integration of animals in the science curriculum. NSTA opposes regulations or legislation that would eliminate an educator's decision-making role regarding dissection or would deny students the opportunity to learn through actual animal dissection.

NSTA encourages districts to ensure that animals are properly cared for and treated humanely, responsibly, and ethically. Ultimately, decisions to incorporate organisms in the classroom should balance the ethical and responsible care of animals with their educational value.

While this position statement is primarily focused on vertebrate animals, NSTA recognizes the importance of following similar ethical practices for all living organisms.

Including Live Animals in the Classroom

NSTA supports including live animals as part of instruction in the K–12 science classroom because observing and working with animals firsthand can spark students' interest in science as well as a general respect for life while reinforcing key concepts as outlined in the NSES.

NSTA recommends that teachers

- Educate themselves about the safe and responsible use of animals in the classroom. Teachers should seek information from reputable sources and familiarize themselves with laws and regulations in their state.
- Become knowledgeable about the acquisition and care of animals appropriate to the species under study so that both students and the animals stay safe and healthy during all activities.
- Follow local, state, and national laws, policies, and regulations when live organisms, particularly native species, are included in the classroom.
- Integrate live animals into the science program based on sound curriculum and pedagogical decisions.
- Develop activities that promote observation and comparison skills that instill in students an appreciation for the value of life and the importance of caring for animals responsibly.
- Instruct students on safety precautions for handling live organisms and establish a plan for addressing such issues as allergies and fear of animals.
- Develop and implement a plan for future care or disposition of animals at the conclusion of the study as well as during school breaks and summer vacations.
- Espouse the importance of not conducting experimental procedures on animals if such procedures are likely to cause pain, induce nutritional deficiencies, or expose animals to parasites, hazardous/toxic chemicals, or radiation.
- Shelter animals when the classroom is being cleaned with chemical cleaners, sprayed with pesticides, and during other times when potentially harmful chemicals are being used.*
- Refrain from releasing animals into a nonindigenous environment.

Adopted by the NSTA Board of Directors June 2005

*Project WILD encourages the use of non-toxic, "green" cleansers.

Reference: National Research Council. (1996). National Science Education Standards. Washington, DC: National Academy Press.

Effective Climate Change Education

Climate change education offers students an opportunity to use systems thinking to build ecological knowledge, explore values, respect other cultures, and develop skills to engage in personal actions toward a sustainable future. Discussions of the causes of recent climatic changes, however, have generated emotional and political debates, to the point where some educators may avoid the topic for fear of bringing advocacy or politics into the classroom.

Discussion of the effects of a changing climate on populations of fish, wildlife, and marine species and their habitats can potentially avoid the politically fraught discussion of cause and instead shift the focus of the conversation to concrete conservation and adaptation actions that can be taken by all responsible stewards of our natural resources.

Earth's climate has changed considerably throughout the planet's history, from steamy coal forests to frigid ice ages. However, scientific evidence indicates that the planet's climate is now changing at a faster rate than at any point in last 10,000 years (National Oceanic and Atmospheric Administration). Global average temperature is rising, snow and rainfall patterns are shifting, ice sheets and glaciers are shrinking, wildfires and droughts are more intense, and extreme weather events are occurring more frequently. Scientists are also observing changes in the oceans, including rising sea levels and increased ocean acidity. (National Aeronautics and Space Administration, National Climate Assessment, and United States Environmental Protection Agency).

Warming global temperatures are resulting in changes to the geographic ranges for many species, as the lower temperature ranges to which many organisms are adapted shift toward the Earth's poles and to higher elevations. Temperature changes are also altering the timing of life cycle events in nature. This accelerated increase allows little time for plants and animals to adapt to the new conditions, especially for already threatened or endangered species.

There are many opportunities to connect natural resource conservation to human well-being through a better understanding of climate science and climate adaptation. For example, scientists are now studying the capacity of healthy ecosystems to buffer the impacts of extreme events such as fires, floods, and severe storms. And climate-driven movements of species populations, such as lobsters in the Atlantic Ocean, can have cascading effects on local economies.

How can an educator most effectively teach about the effects of climate change? And how can Project WILD help?

Separate action from advocacy. The Association of Fish and Wildlife Agencies defines natural resource stewardship as informed, responsible action/behavior on behalf of the environment and future generations. Climate adaptation actions are an important component of natural resource stewardship, increasing the efficiency and effectiveness of conservation activities by reducing the negative impacts and taking advantage of the potential benefits of a changing climate.

Sound environmental education takes into account knowledge and awareness, personal values, community norms, emotions and a perception of control—believing you can make a difference. Social studies education emphasizes preparedness for college, careers and civic life (the C3 Framework) through skills of critical thinking, problem solving and participatory skills to become engaged citizens. These approaches do not prescribe action, but encourage the knowledge and skills to deal with information and make informed choices.

Make education relevant and engaging. Experts such as Monroe *et al* in the *Journal of Environmental Education Research* (2017), the North American Association for Environmental Education, and others, agree that effective education should focus on personally relevant and meaningful information. Local examples, such as exploring the impacts of climate change on local species and their habitats, are an excellent way to bring relevancy and meaning to a concept. Experts also emphasize using active and engaging teaching methods, which Project WILD provides through hands-on activities.

Explore the natural world. Offer students opportunities for local, observable experiences. Since changing ecosystems is one of the key indicators of climate change, it is ideal for climate change education.

Reinforce the difference between weather and climate. Weather is the state of the atmosphere at any given time and place, such as temperature, precipitation, clouds, and wind that people experience throughout the course of a day. Climate describes the long-term averages and variations in weather measured over a period of several decades. Recent weather experiences often confuse the public about the facts of climate trends.

Effective climate change education should:

- Incorporate nature-based, systems thinking
- Research and explore local ecosystems and issues to make relevant and personal connections
- Focus on opportunities for students to take action to safeguard fish, wildlife, and habitats over the long-term, taking into account possible future climatic shifts
- Address misconceptions; use validated sources of information
- Engage in deliberative discussions; consider possible actions and their effects
- Interact with scientists when possible
- Implement school or community projects
- Explore values and beliefs
- Be age appropriate and hopeful. Climate change topics can be complex and overwhelming. Children develop at their own pace; however, in general:
  - Ages 5-9 years old think concretely rather than abstractly and learn by experience. Provide small group activities and lots of opportunity for them to be active and take age-appropriate steps to help.
  - Ages 10-12 years old love to learn facts, especially unique ones, and they want to know how things work and what sources of information are available to them. They still think in terms of concrete objects and handle ideas better if they are related to something they can do or experience with their senses. They are beginning to move toward understanding abstract ideas. This age loves to help.
  - Ages 13-15 years old are moving from concrete to more abstract thinking. Use small groups for in-depth, longer learning experiences. They can begin to deal with abstractions and the future. They are ready to test making a difference.

- High school students are future-oriented and can engage in abstract thinking. Teenagers continue to be group-oriented, and belonging to the group motivates much of their behavior and actions. Let them plan their own projects, providing suggestions and guidance only as needed.

Project WILD provides a variety of experiences that lend themselves to discussions regarding critical trends and current topics in the environment. Natural resource agencies worldwide are currently investigating adaptive management and conservation efforts in response to our changing climate. Project WILD encourages students to become part of this discussion through classroom activities, projects, and field experiences.

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The Ecosystem Concept and Project WILD

The Project WILD K–12 Curriculum and Activity Guide and *Aquatic WILD K–12 Curriculum and Activity Guide* are designed to invite students of all ages to ask questions about how ecosystems work. To address these questions, educators need not be professional ecologists nor have extensive backgrounds in biology or wildlife management. This appendix serves as a reference to help educators develop a few simple and powerful ecological concepts with students.

The Ecosystem

Ecosystem combines two words: ecology and system. "Eco" comes from the Greek word "household" and can be thought of as the household of nature. A system is any group of parts that work together as a unit. Ecology regards a system as a set of living and nonliving parts that interact over time. Ecologists have offered a number of definitions of this concept. A question that often arises is the size and scope of an ecosystem. Some have seen pictures of Earth from space and heard the entire planet referred to as an ecosystem. This ecosystem is called the "global ecosystem" or "biosphere." Essentially, there is no closed natural ecosystem, even the biosphere, but scientists often create boundaries to study relationships between a set number of living and nonliving things.

The term ecosystem helps to categorize different sections of the natural world and identify differences in how each system operates. The redwood forests in California and the bottom of the Atlantic Ocean both have an energy source, but one uses the sun while the other uses hydrogen sulfide from thermal vents. We can draw an imaginary line around a section of the larger world, decide to treat its elements separately from the rest, and call it an ecosystem. When describing how organisms in the system behave, interact, grow, adapt; what they eat; how long they live; what happens to them when they die; and what they require to stay healthy or to reproduce, we are studying how the household system operates—and thinking SYSTEM-atically.

Connections between elements of a system are often subtle and hard to see or understand. Quite frequently, this is because they take a long time to happen. The life cycle of certain tree species in North American west coast forest ecosystems is 300 to 500 years. In an average human life span, we might see little change in those forests. But the life cycle of an ecosystem in a pond that dries up during the summer and is frozen in the winter might be 12 months. Life cycles in a jar of microbes might be measured in hours.

An ecosystem represents a concept rather than a place or set of things. When students set up a wide-mouth jar in the classroom with pond water, a few small animals, and some plants, then cap the bottle tightly, they have established an ecosystem. The jar contains biotic and abiotic elements. The biotic elements are all the living things in the jar: plants, snails, microbes, and so forth. The abiotic elements are the nonliving elements: air, water, rocks, and bottom debris. Both the biotic and abiotic elements will interact with each other in the ecosystem. The animals might use plants for food or shelter, while the plants recycle nutrients from their waste to grow.

This little ecosystem in a jar will quickly turn into a gooey mess unless placed under indirect sunlight. The system in the bottle is not going to operate without a source of energy, namely light energy. If there are not too many animals, or consumers, in the jar, the bottle can be sealed, even "air tight", and may operate as a self-contained environment for many years. It will slowly change over time as some organisms will die and decompose. Slow hatching eggs or spores may develop and germinate. The acidity of the water may change. The color of the water may change and absorb more heat and light. The system will undergo a life cycle of its own, slowly aging and changing. Throughout all these fluctuations the key to any self-sustaining, successful ecosystem is a balance of inputs and outputs. When the term ecosystem is used in Project WILD and Aquatic WILD, it describes a system in which there are living and nonliving components, and a primary source of energy interacting over time within a defined area. In most systems, the primary source of energy is the sun. We could establish organisms in various environments, but unless there was an appropriate balance or set of relations among them, the system would quickly or slowly go into crisis and die. Many people have seen examples of changed systems when they have cleaned out refrigerators or discovered last month's uneaten lunch in the bottom of their lockers.

One ecosystem often studied in school is a pond. "Pond" is not a word typically used with a precise definition and is similar to the word ecosystem in many ways. In some parts of the world, a pond is a small body of freshwater. In other places, a pond can be a lake quite reasonable in size and depth or a small bay with narrow entrances to the ocean. Here we use the term to refer to small, shallow, freshwater waterbody.

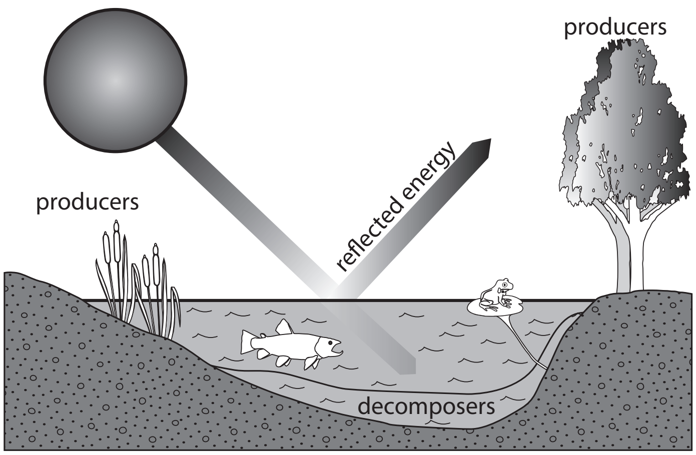


Diagram A

Diagram A shows a simple illustration of a pond and includes the basic elements of most ecosystems. The sun is the energy source and acts as the "engine" which drives the rest of the system. The biotic components are the green plants and animals. The green plants are direct "sun catchers." The wonderful process of capturing the sun's energy is known as photosynthesis—photo (light) and synthesis (assembly, connection, manufacture). The energy of the sun is stored in the form of chemical bonds in molecules. During photosynthesis, plant cells store solar energy by assembling complex molecules with six carbon atoms from building blocks of CO_2 and water. Animals are not capable of photosynthesis but rely on green plants to catch solar energy and to use it to assemble food materials. Known as producers, green plants are the food factories in natural systems. Equally important, plants also provide oxygen as a byproduct of this process.

Not all animals eat plants directly. Those that eat plants and only plants are known as primary consumers, or herbivores. They are one step away from producers. Animals that eat other animals are two steps away from the sun, so they are often called secondary consumers, or carnivores (meat eaters). The sequence becomes more complex if we add animals that prey on other meat eaters: tertiary consumers (three steps away from the sun). **Diagram B** illustrates some of those relationships.

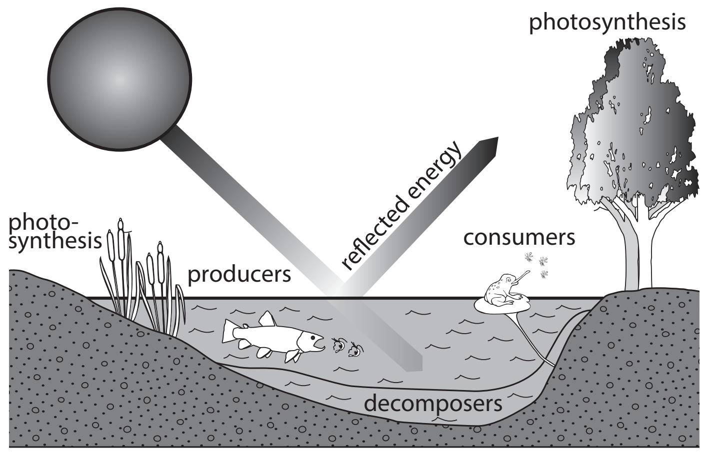


Diagram B

A diagram linking some of these organisms as producers and consumers is illustrated as a food chain. **Diagram C** shows a simple food chain that might be associated with a pond. In this diagram, the eagle eats the fish that eats the frog. In turn, the frog eats spiders and the spiders eat insects.

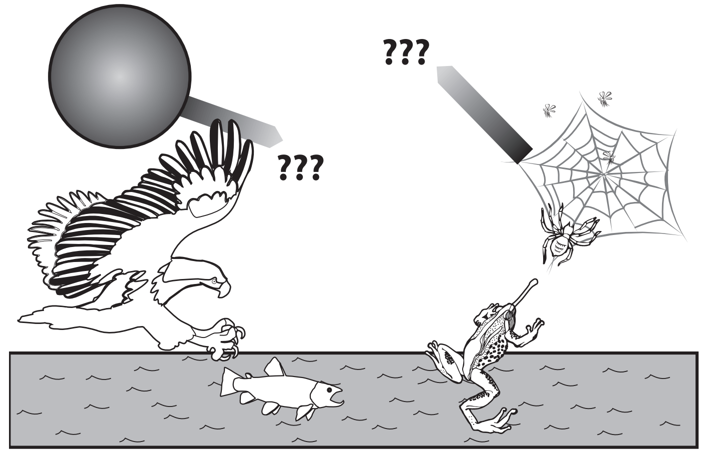


Diagram C

This food chain is not an ecosystem as important elements are missing. There are no direct producers capable of photosynthesis. The eagle cannot capture energy from the sun directly. It is at least three steps away from the sun's input of energy. In its tadpole stage, the frog eats plant material. The insect might feed on plant nectar, or its larval stage might eat leaves. The food chain describes only a portion of the connections in a pond ecosystem. If the diagram were more complex, then a food web would be produced. Food webs balance inputs and outputs in the ecosystem, allowing it to exist for long periods of time. It would include all the producers and consumers in the pond and introduce a new set of special consumers, called decomposers.

Decomposers are the garbage collectors of nature, breaking down a variety of materials into simpler compounds. Similar to consumers, decomposers receive their energy from other organisms and cannot perform photosynthesis. Decomposers produce CO_2 and release needed elements into the system. Without these recyclers, the entire ecosystem would gradually run down. Imagine a forest in which none of the fallen trees, branches, dead animals, and leaves ever rotted. Soon it would be impossible to move through the debris and nothing new could grow. Without decomposition in ponds, the accumulation of materials falling to the bottom would result in the pond's rapidly becoming so shallow that it would no longer hold water.

As a general principle, students should understand that both energy and materials constantly circulate in all ecosystems. Plants, through the process of photosynthesis, are the major point of entry of the sun's energy into the natural system. However, that energy works in other ways throughout the ecosystem. Solar heating of the atmosphere and oceans produces winds and great patterns of air circulation in the atmosphere. The absorption of solar energy in the oceans is expressed in the flow of ocean currents. In a way, the entire planet is a great solar-powered engine. All materials cycle—some slowly, some quickly.

Carbon dioxide, for example, is a byproduct of respiration in plant and animal cells. The carbon of CO_2 is used by green plants in photosynthesis and becomes the building block of many biological molecules, including sugars, proteins, and fats. Once assembled into these materials, the carbon can be taken in by animals when they eat food materials—whether from plant or animal sources. Food is both a source of energy and a source of raw materials for biological construction.

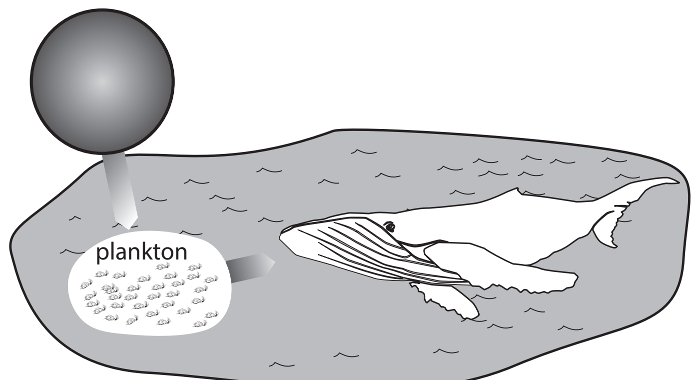


Diagram D

The carbon cycle is one of the great cycles in natural systems. Nitrogen, water, and elements such as phosphorus are also involved in cycles. The passage of materials along food chains and through cycles is responsible for the concentration of chemicals such as pesticides. Small amounts of pesticide molecules passed along a food chain may accumulate when they reach the top consumer, whether that be an eagle or a human. Sometimes animals like the Humpback Whale "shorten" the steps between the input of solar energy and themselves by feeding directly on millions of small animals and plants that are closer to the source of solar energy. (See **Diagram D**.)

An ecosystem, therefore, may be viewed as a set of living and nonliving elements interacting over time within a defined locale. Ecologists attempt to define ecosystems in terms of sets of elements that directly or indirectly interact with each other. At a global level, all elements on the planet interact. The rain that falls today on the plains may have evaporated yesterday from the leaf of a tree in a coastal forest. But in practical terms, for studying and understanding the interactions among organisms in the environment it is useful to draw boundaries around certain groups of organisms that are normally interacting in a relatively direct way, as a community or neighborhood grouping. This grouping may be considered an ecosystem.

Within these biological neighborhoods, it is possible to assign organisms both an "address," describing their typical location in space, and an "occupation," or role that they play in the system. An organism's address is its habitat. The occupation of an organism in an ecosystem is called its niche. For many people, the term niche describes a location or group. Ecologists use the term to describebean organism's role or activities in the system. This definition can often be a source of confusion.

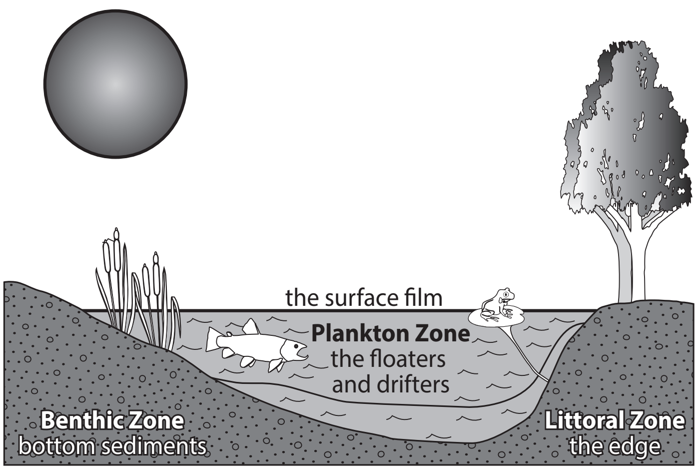


Diagram E

Although there are many different aquatic ecosystems, all can be divided into a set of zones which are usually categorized by depth. **Diagram E** illustrates some of the zones that can be found in a typical pond ecosystem. Organisms occupying the edge or margins of the pond live in the littoral zone. The planktonic zone is named for microscopic organisms, plants or animals, that float and drift through the water without means of locomotion. Other organisms like catfish or aquatic insects live around or in the bottom sediments of the pond. Though few, organisms like water-striders use surface tension to inhabit the narrow surface film zone at the top of the waterbody. Sometimes organisms inhabit different zones during different stages in their lives.

It is important to explore a variety of zones in multiple habitats because students might encounter quite different sets of organisms. Often, people tend to overlook certain zones—possibly because at first glance they seem devoid of life. It may seem tedious to sift through the muck on a pond bottom when dip nets are filled with interesting things found in the water or on rushes at the shore line. However, to develop an understanding of the diversity of life forms that inhabit an ecosystem we need to explore the whole range of addresses where they might be found.

Tips for Studying Ecosystems

A major purpose in having students study ecology is to develop an awareness and understanding of relationships. This process entails developing the ability to see systems, or sets of interactions, and think about how they have changed and will change with time. With enough exposure, students will begin to understand living systems as complex mosaics in which all the parts fit together to make a whole. The removal of one seemingly unimportant component can often have major consequences on the health and function of the ecosystem.

Building miniature ecosystems in jars or small glass aquariums can help students to begin thinking about what elements are needed to keep an ecosystem healthy. Foster an understanding of interactions by asking students to sketch a web connecting a natural object to as many other things, including themselves, they can think of. A dead leaf floating on the surface of a pond might be seen as unimportant to the ecosystems until—by drawing connections in as many directions and dimensions as possible—the student starts to see it as food, habitat, and former harvester of the sun's energy. These exercises help students appreciate all abiotic and biotic components in a habitat, even a dead leaf.

Individual organisms can be strange, beautiful, or even humorous. The next step in developing an ecosystem mindset is to try to appreciate the role played by an organism in the community of which it is a part. Is this a predator, or prey? Ultimately all organisms are "food" even if for microbes. Does one organism provide a home for other organisms? Do two different species work together to obtain resources they need but the other provides? Is it a producer that captures and stores solar energy? An important part of the activities in Project WILD and Aquatic WILD is asking students to think about these connections, and ultimately to connect themselves to the system as well.

Naming is often both an asset and an obstacle to the study of natural systems. When students visit a community, they want to know the names of the organisms they encounter. This is a good time to learn and recognize some plants and animals. But often it is enough to appreciate differences and similarities, and encourage students to assign names of their own making to the things they see. Do not let a lack of detailed knowledge of names discourage study. Instead, use this opportunity to pose the "How can we find out?" questions. Emphasize characteristics of plants and animals and their interactions, rather than losing sight of those attributes in a quest to label the parts.

Finally, it can be a powerful experience for students to visit and revisit a natural setting at various seasons of the year. Spring is an ideal season to study ponds and streams. But it is a mistake for students to think of nature as dead, or even as largely dormant, in the winter. Seasonal changes are important to the economy of nature. Ecosystems change over time. The changes of the seasons are an important expression of continuing natural change in natural systems.

Have students follow an ecosystem—perhaps a pond, stream, lake, or river—through the seasons from late summer to fall, through winter and into spring and summer. School grounds can also provide useful opportunities of this kind. Some schools have adopted a local pond or stream and use it as the focus of studies by classes over many years. If the past data is saved, students can appreciate what is happening to their local ecosystems.

Glossary

abdomen: the posterior part of the body of an arthropod

abiotic: a nonliving factor in an environment (e.g., light, water, temperature)

accumulate: the buildup of a material overtime

acidity: the state of having a pH lower than 7; if acidic levels are too high organisms have difficulty surviving

adapt: to adjust or modify to make suitable for present conditions; typically refers to a species adapting in behavior, physiology, or anatomy permanently over many generations through natural selection, although an individual may also adapt its behavior temporarily in its lifetime

adaptation (biological): an alteration or adjustment in structure or habits by which a species or individual improves its condition in relationship to its environment; a physical, behavioral, or physiological trait that helps a population or species to thrive; the process or the product of natural selection over many generations that changes an organism's behavior, physiological function, or anatomical structure, so that it is better suited to its environment

adaptation (climate change): adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities

advertising: the act of offering goods and services to the general public through media

aestivation: dormancy, similar to hibernation, and typically during hot and dry periods (also spelled estivation)

alike: describes things that are similar

alkalinity: the state of having a pH higher than 7; organisms have difficulty surviving in highly alkaline environments

amphibian: an animal that typically lives in an aquatic habitat breathing by gills as young, and primarily in a terrestrial habitat breathing by lungs and through moist glandular skin as adult (e.g., frog)

anadromous: species of fish that live their lives in the ocean and migrate to fresh water to spawn

animal: a living organism other than a plant (or protist, fungi, algae, etc., as classified by some scientists).

animal community: animals of various species living within a certain habitat, each occupying a specific position in this particular environment; directly parallel and related to plant communities

annual: a plant that completes its life cycle from seedling to mature seed-bearing plant during a single growing season

antennae: the long pair of sensory appendages on the heads of some arthropods

anthropocentric: valuing the environment and its resources for human needs and interests

anthropogenic: a phenomena event caused by humans

anthropomorphism: the attribution of human characteristics to nonhumans, especially animals

aquatic: growing, living in, or frequenting water

arboreal: inhabiting trees

appreciate: recognize the full worth of something; understand (a situation) fully; recognize the full implications

arrangement: the location, in relation to one another, of sources of food, water, and shelter in an animal's habitat

art: something created to express an image, idea, or feeling; can take multiple forms such as drawing, singing, dancing, painting, and many more

arthropod: organisms with a hard, jointed exoskeleton and paired, jointed legs

artist: a person who creates art

attitude: one's opinion or state of mind

autotroph: an organism that can produce its own food

bag limit: the maximum number of animals allowed to be taken by an individual in regulated fishing or hunting

barometer: an instrument for measuring atmospheric pressure and change in pressure. Something used to predict or indicate change

basic needs: fundamental requirements that serve as the foundation for survival (i.e. food, water, shelter, space)

basking: to lie in the sun or light; ectotherms bask in order to raise their body temperatures

behavior: the actions and reactions of humans or animals in response to stimuli

belief: an information-based assumption; it may be correct or incorrect

biennial: a plant that lives for two growing seasons, producing leaves during the first season, flowers and seeds during the second

big game: a term for large species of wild animals, birds, or fish hunted for food or sport (e.g. deer, elk, moose, bear)

bill: a draft of a proposed legislation

bioaccumulation: the storage of chemicals in an organism in higher concentrations than are normally found in the environment

biocentric: a person whose attitude toward the environment considers all of the plants and animals

biodegradable: capable of being decomposed by biological agents, especially bacteria

biodiversity: a term used to represent the variety of life forms in a given area

biogeochemistry: the scientific discipline that involves the study of all the processes and reactions (chemical, physical, geological, and biological) that govern the composition of the natural environment

biological control: the control of a pest by the introduction of a natural enemy or predator

biologist: a person who studies living organisms and their relationship to one another

biomagnification: the accumulation of chemicals in organisms in increasingly higher concentration at successive trophic levels

biome: a large geographic area with somewhat uniform climatic conditions; a complex of communities characterized by a distinctive type of vegetation and maintained under the climatic conditions of the region

biosphere: the layer of planet Earth where living organisms exist

biota: the animal and plant life of a region

biotic: the living organisms in a given community, including all plant and animal life within the community

blind: a hiding place for observing wildlife

breeding: a series of complex behavioral interactive patterns from courtship to rearing of young that are necessary for the continuation of a species

broadleaf: the term describing a plant with wide, broad leaves rather than needlelike leaves

brood: the offspring of a bird or mammal

browse: to feed on the twigs, leaves, and shoots of woody plants and other vegetation

burrowing: to dig a hole or tunnel for habitation or refuge

camouflage: the ability to blend in with surroundings

canopy: layer formed by the leaves and branches of the forest's tallest trees

carbon dioxide: a gas that is essential to life on Earth, but that can have negative impacts when released into the atmosphere in excess quantities; plants, trees, and some bacteria convert carbon dioxide (CO_2) into oxygen through photosynthesis

carnivore: a meat eater

carrion: the bodies of dead animals, usually found in nature in the process of decay

carrying capacity: the maximum number of individuals or inhabitants that a given environment can support without detrimental effects

cast: to regurgitate indigestible prey remains

chemicals: naturally occurring or synthetic material used to compose other things

chrysalis: the pupa stage of a butterfly; the hard skin around the body of a butterfly when it is in the pupa state of development

circadian rhythm: the natural 24-hour physiological cycles of plants and animals that are affected by periods of light and dark

citizen science: the involvement of the general public in scientific research

classification: the assignment of organisms to groups within a system of categories

clay: a soil type with the smallest particles; clay is very compact, can be hard to dig, allows for limited water and nutrients to reach plants for absorption, can also trap water which damages roots

climate: weather conditions in a particular area over an extended period of time; the average condition of the weather

climate change: a long-term change in Earth's climate; current climatic warming is occurring much more rapidly than past warming events

climax: the final stage of plant or animal succession; when environmental conditions have been stable long enough for an area to develop a semi-permanent biome

climax community: a stage in ecological development in which a community of organisms, especially plants, is stable and capable of perpetuating itself

clutter: excessive grouping of artificial lights, frequently occurring in urban areas

coal: fossilized carbon that is used for energy

cocoon: a silk web that encloses the pupae of many moths and other insects, but not butterflies

color, coloration: a genetically controlled pattern or marking that protects an individual organism

commensalism: a relationship between two living organisms where one benefits and the other is neither harmed nor helped

community: a group of plants and animals living and interacting with one another in a specific region under relatively similar environmental conditions.

compass: a navigational tool used for determining direction

compass rose: a circle with degrees or cardinal directions printed on a map for orientation

competition: the simultaneous demand by two or more organisms for limited environmental resources, such as nutrients, living space, or light

composting: collecting discarded organic matter to create a richer soil as it decomposes

conifer: a plant that bears its seeds in cones; mostly needle-leafed or scale-leafed; mainly evergreen

coniferous: refers to cone-bearing (A coniferous forest is one composed of pines, firs, spruces, or a combination of these.)

consensus: when a group of people reach a general agreement

consequences: a result or effect of an action or condition

conservation: the use of natural resources in a way that ensures their continuing availability to future generations; the wise and intelligent use or protection of natural resources

conservation easement: a voluntary legal agreement that limits uses of land to protect its conservation values. For example, a conservation easement may stipulate that the land owner continues to own the property and may still use it for agriculture, but that the land may not be developed (built upon) or changed to a higher density zoning

consumer: an organism in an ecosystem that feeds on plants or other animals

consumptive use: in general terms related to wildlife, any activity resulting in the harvesting of wildlife

cooperation: the process of working together to accomplish something, usually that is mutually beneficial

courtship: a behavior pattern that ensures mating with a suitable partner of the correct species at the correct time

cover: the vegetation, debris, and irregularities of the land that provide concealment, sleeping, feeding, and breeding areas for wildlife

covey: a small flock or group, often a family group, of birds such as quail

crepuscular: active at dawn and dusk

critically endangered: a species that will not survive without direct human intervention

culling: the targeted removal of animals from a particular population, typically by professionals with advanced wildlife identification and shooting skills; often utilized in areas where hunting is not feasible or permitted

cultural carrying capacity: the largest number of a wildlife species that humans will tolerate in their community

dabbling ducks: ducks that frequent shallow marshes, ponds, and rivers and "tip up" to feed; dabbling ducks feed with body above water and take off vertically when startled; also called "puddle ducks" (see "diving ducks")

deciduous: trees that shed or lose foliage at the end of the growing season

decomposer: those organisms (e.g. bacteria, fungi) that convert dead organic materials into inorganic materials

deed: a legal document often used for property rights

defense: a means of protecting something from attack

dependent variable: variable that experience a change during an experiment

development: the purpose of converting land to a new purpose by constructing buildings or making use of its resources

different: describes things that are not the same as each other in some way

digitigrade: term used to describe animals that walk or run on their toes; examples are cats and coyotes

dilemma: a difficult situation or problem

disease: an ailment or sickness that causes the body to not function properly

dispersal: the scattering of an object or objects

display: an observable behavioral pattern that is used to communicate visually, such as the presentation of colors or plumage by male birds as part of courtship or intimidation

distribution: the way that something is divided or shared out; the natural geographic range or place where any category of items occurs

diurnal: active by daylight; the opposite of nocturnal

diversity: variety

diving ducks: ducks that prefer deep water as in lakes and bays; ducks that feed primarily by diving below the surface

domesticated: term used to describe an animal or plant that has been trained or adapted to live in a human environment and to be of use to human beings

dominant species: plant or animal species that exert a major controlling influence on the community

echolocate: to locate objects using sound waves; animals that echolocate typically emit high-frequency sounds and interpret the echoes to determine the location and orientation of objects

ecological niche: a specific role played by an organism in a biological community; can be defined by food preferences, requirements for shelter, special behaviors, or the timing of its activities (e.g., nocturnal or diurnal)

ecologist: a scientist who studies the interrelations of living things to one another and to their environment

ecology: the study of the relation of organisms or groups of organisms to their environment; the science of the interrelations between living organisms and their environment

ecosystem: a natural unit that includes living and nonliving parts interacting to produce a stable system in which the exchange of materials between the living and nonliving parts follows closed paths; a set of elements, living and nonliving, interacting over time to produce a stable system within a defined locale

ecosystem service: any benefit provided to humans by ecosystems

ectotherm: term used to describe an animal that cannot maintain a stable body temperature and therefore depends on environmental factors to keep its body temperature within an acceptable range; commonly referred to as "cold-blooded"

edge community: the area that borders two habitats; a transition zone

edge effect: the tendency of wildlife to use the areas where two vegetative types come together forming an edge

elevation: height above sea level

eminent domain: the power of government agencies to acquire property for public use so long as the government pays the property owner just compensation

endangered: a species that is in danger of extinction throughout all or a significant portion of its range

endotherm: an animal that is able to maintain a stable body temperature due to metabolic processes despite environmental temperatures

energy: the capacity to do work; source of usable power

environment: the circumstances and conditions surrounding an organism that influences its existence, including physical, biological, and all other factors

environmental issue: a situation in which there is disagreement about solutions to an environmental problem, often because of differing values and beliefs

environmental problem: a difficult situation involving the interaction between people and the environment

environmental quality: the state of the environment and its wellbeing; can be impacted by pollution, population, and development

erosion: to wear away or corrode

estivation: (see aestivation)

ethics: a personal or social moral code

eutrophication: enrichment of soils and water resulting from fertilization, sewage, effluent, or other waters that carry a high plant-nutrient component

evaporation: the process of a substance changing from a liquid to a gas by exposure to air, heat, or both

evergreen: a plant having foliage that remains green throughout the year

evidence: information or observations that help determine what is true

exoskeleton: a hard skeleton located on the outside of an invertebrate's body

exotic: a plant or animal that is not native to a region or habitat (e.g., the ring-necked pheasant, native to Asia, is considered an exotic species in North America)

exponential growth: growth that becomes increasingly more rapid

extinct: a term used to describe the condition when all members of a species have been removed from existence

extirpated: missing from native range but not extinct

fear: an unpleasant emotion caused by the belief that something is dangerous, able to cause pain, or threatening

fecal pellets: animal droppings that can be used in tracking

feelings: an emotional state or reaction; a belief

feral: referring to domesticated animals that are now wild

finite: having bounds or limits; capable of being counted or measured

flower: the reproductive part of a plant that produces the seed

flyway: fly routes established by migratory birds

food: material, usually of plant or animal matter, that living organisms use to obtain nutrients

food chain: the transfer of food energy from one organism to another as each consumes a lower member and in turn is preyed upon by a higher member

food web: an interlocking pattern of food chains

forage: refers to vegetation taken naturally by herbivorous animals

forb: a broad-leaved flowering plant such as sunflower and prairie clover; does not include grasses, sedges, trees, shrubs

forest floor: the layer of decomposing material that covers the soil in a forest

forest management: the practical application of scientific, economic, and social principles to the administration of a forest for specified objectives

fragmentation (habitat fragmentation): the creation of isolated habitats by partially destroying a larger and more continuous habitat

fragrance: the scent of a flower that helps determine which pollinators it attracts

fruit: part of the flowering plant that is produced by the ovary and surrounds the seed

fry: small, young fish that have recently hatched

funding: a source for money; to furnish a fund for

game animal: legal designation for animals that may be managed and hunted only under regulation

fuel load: the total amount of combustible material in a defined space that is quantified in heat units or in its equivalent weight in wood

fungi: organisms that reproduce through spores and gain nutrients through decomposition and moisture absorption

gait: an animals characteristic walking pattern, determined by the animal's shape

game animal: legal designation for animals that may be managed and hunted under regulation

gene pool: the availability of genes within a species or population

generator: a machine for converting mechanical energy into electricity

genetic diversity: the chromosomal diversity available within a species or population

genotype: the entire set of genes an organism has

geocaching: a popular form of recreation where people or organizations hide items and list the coordinates of the hidden cache as a challenge for others to find

glare: the presence of excessive bright light that causes discomfort, ranging from mild to disabling

Global Positioning System (GPS): capabilities that provide longitude and latitude coordinates

global warming: a rise in annual average temperature of the Earth's climate

greenhouse effect: a natural occurrence in which heat from the sun is trapped in the atmosphere by clouds and certain gases such as carbon dioxide

greenhouse gases: a gas that contributes to the greenhouse effect such as carbon dioxide and methane; an increase in greenhouse gases results in more heat being trapped in the atmosphere

habitat: the arrangement of food, water, shelter or cover, and space suitable to animals' needs

harvest: the intentional gathering of plants, animals, and other natural resources for use

hatchery: a place where fish eggs are hatched and raised

herb: any flowering plant or fern that has a soft, rather than woody, stem

herb layer: the layer of soft-stemmed plants growing close to the forest floor

herbicide: pesticides that control unwanted plants

herbivore: a plant eater

herd: a group of animals

heritable: describes a trait that is inherited genetically

heterotroph: an organism that cannot use its own system to produce food; in order to survive the organism must consume other living things

hibernacula: places where an animal hibernates or overwinters (hibernaculum, singular)

hibernation: the act of passing the winter, or a portion of it, in a state of sleep; a torpid or resting state

host: an organism that houses another organism through a symbiotic relationship

host plant: a specific plant upon which an animal relies for egg-laying, nesting, feeding, or raising its young

humus: organic material resulting from decaying plant and animal matter

hunter: a person or animal who is in search of wildlife for harvest or consumption

hunting: searching for and stalking an animal with the goal of harvesting it for consumption

hydropower: energy that is harvested from the movement of water

hypothesis: an educated prediction; part of a scientific experiment

imaginary: existing only in the mind or imagination; unreal

imagine: to form a mental image or concept

impact: an effect or influence

independent variable: variable that is manipulated in an experiment

indicator species: an organism whose presence, absence, or abundance reflects a specific environmental condition

indigenous: a naturally occurring species

inflow: how much water is entering a source of water

information: facts provided or learned about someone or something

inorganic: term used to describe substances not derived from living things

insect: an arthropod with a head, thorax, abdomen, three pairs of jointed legs, a pair of antennae, and compound eyes

insecticide: a chemical used to kill insects

insectivore: an organism that eats primarily or exclusively insects

insectivorous: refers to insect eaters

inspiration: motivation behind an action

interaction: the relationship of one organism to another; the action of one population affecting the growth or death rate of another population

interdependence: when different species within an ecosystem rely upon one another for survival

interview: to question someone to discover their opinions or experiences

introduced species: a non-native species that is intentionally or accidentally brought into an ecosystem

invade: to enter or permeate an area; to overrun

invasive species: a species that has that has become a pest to the environment

inventory: a detailed, itemized list used in the process of identifying and counting animals

invertebrate: animal that does not have a backbone

investigation: an examination or search in order to discover facts or gain information

journal: records that reflect a person's observations or thoughts

keystone species: a species that plays a crucial role in an ecosystem, where many organisms are impacted by its presence

land use: the purpose for which land is used by people

land-use planning: planning for land development

larva: an immature form of the adult animal that is active; a stage of metamorphosis

latitude: geographic measurement that describes the distance north or south of the equator

law: a written rule or collection of rules prescribed under the authority of a state or nation

legend: a table or list on a map that explains the symbols used

legislation: a law, or set of laws, made by a government

legislator: a person who makes laws; a member of the legislative body

license: in wildlife terms, a legal permit for hunting, fishing, trapping, and so forth

lichen: algae and fungus growing together in a symbiotic relationship

life cycle: the continuous sequence of changes undergone by an organism including birth, growth, reproduction, and death

light pollution: excessive, misdirected, or obtrusive artificial light

light trespass: occurs when light spills into areas where it is not needed, wanted, or intended such as into a neighbor's windows

limiting factors: influences in the life history of any animal, population of animals, or species that affect the number or range of the animal(s) (e.g., disease, predation, food, water, shelter, space, climatic conditions, pollution, hunting, poaching)

linear: term used to describe change at a constant rate

litter: carelessly discarded garbage; the number of young born per birthing to a mammal

loam: a soil mixture of clay and sand that allows for nutrients and water to reach plants while still maintaining structural security

locomotion: the act or power of moving from place to place

longitude: geographic measurement that describes the distance east or west of the prime meridian

macroinvertebrate: invertebrate animals (animals without a backbone) large enough to be observed without the aid of a microscope or other magnification

management: in general terms related to wildlife, the intentional manipulation or nonmanipulation of habitat or the organisms within the habitat

market hunting: hunting on a commercial level for the sale of hides, pelts, or meat

media: the means of communication through which information is spread to a large number of people

metamorphosis: a fundamental developmental change in the form or structure of an animal (as in a butterfly or a frog) occurring after birth or hatching

microhabitat: a small habitat within a larger one in which environmental conditions differ from those in the surrounding area

microorganism: an organism microscopic in size, observable only through a microscope

migration: seasonal movement from one region or country to another

migratory: birds or other animals that make annual moves from one region or country to another to settle

mimic: sharing common colors with another species to increase chances of survival

mitigate: to make up for; to substitute some benefit for losses incurred

mixed forest: a forest that includes both coniferous and deciduous trees

monoculture: the raising of a crop of a single species, generally even-aged (Parts of the Midwest are a monoculture of corn or soybeans.)

mortality rate: the death rate; usually expressed in deaths per thousand

multiple use: a term referring to a system of management in which lands and waters are used for a variety of purposes

mutualism: a close association between two different species whereby each species derives some benefit

native species: a plant or animal species that was produced, grew, or originated in a certain region

natural gas: a naturally occurring underground gas, consisting mostly of methane, that can be harvested for fuel, electricity generation, and manufacturing

natural resources: anything that comes directly or indirectly from the earth

natural selection: a process in nature resulting in the survival and perpetuation of only those forms of plants and animals having certain favorable characteristics that enable them to adapt best to a specific environment

naturalist: a person who observes and studies plants and animals in nature

nectar: a surgary liquid produced by a plant to attract pollinators

niche: the function or position of an organism or a population within an ecological community

nitrogen fixation: the conversion of atmospheric nitrogen into organic compounds or to forms readily utilizable in biological processes

nocturnal: active by night; the opposite of diurnal

non-game animal: all wildlife species that are not commonly hunted, killed, or consumed by humans, such as songbirds and raptors

non-native species: in conservation terms, an organism that has been introduced into a new area

non-renewable resource: nonliving resources such as rocks and minerals that do not regenerate themselves and cannot be replaced in this geological age

nonconsumptive: using wildlife through watch, study, or record without the killing or extracting of an organism

nuclear power: power harvested from nuclear fission to create energy

nutrient: a substance that provides nutritional value

nutrient cycle: the breakdown and uptake of nutrients and their release back into the soil

observation: the act of viewing or noting a fact or occurrence for a scientific purpose

oil spill: a type of pollution in which oil is accidentally released into the environment, often marine areas

omnivore: an animal that eats both plant and animal materials

opinion: a view or judgment about something, not necessarily based on fact or knowledge

ordinance: a governing law, rule, or legislation

organic: term used to describe materials derived from living things

organism: a living thing; a form of life composed of parts that work together to carry on the various processes of life

owl pellets: the compacted bones and fur that cannot not be digested and are regurgitated by an owl

parasite: an organism that lives by deriving benefit from another organism, usually doing harm to the organism from which it derives benefit

parasitism: a relationship between two species in which one species (the parasite) nourishes itself to the detriment of the other species (the host)

pathway: the geographical path a species followed to a location

perennial: a plant that lives for several years and usually produces seeds each year

permafrost: a layer of soil that stays frozen throughout the year, found in the tundra biome

pesticide: a substand used to kill plants or animals considered to be pests

petroleum: liquid material that is extracted from rocks and refined to produce gasoline

phenology: the timing of nature's cycles, such as the blooming of a flower, the migration of a butterfly species or the changing color of leaves in the fall

phenotype: an organism's observable characteristics

phenophase: observable stages or phases in the annual life cycle of a plant or animal

pheromone: chemical scents shared by animals as a form of communication

photon: a discrete particle of energy

photosynthesis: the process of plants converting water and carbon dioxide in the presence of light energy from the sun into food for the plant

pioneer species: species that are the first to inhabit a destroyed site; often hardy due to the need to adapt; their presence causes changes to the site that in turn will make it habitable for other species

plankton: microscopic organisms that are suspended in an aquatic habitat and that serve as food for fish and other large organisms

plant communities: an association of plants, each occupying a certain position or ecological niche, inhabiting a common environment and interacting with each other

plantigrade: term used to describe animals that walk on the soles of the feet; examples are bears, raccoons

playa: shallow, circular depressions in the land that collect water to form wetlands, ranging in size from less than an acre to several hundred acres; commonly found on the high plains of the southwestern United States

plot: an area of land

poaching: hunting illegally, not complying with regulations regarding areas, sex, seasons, or limits

poetry: a form of literary expression that evokes impressions by the sound and imagery of its language

pollen: the small male reproductive grains found on the anther of a flower

pollination: transfer of pollen from the anther to the stigma of a flower

pollinator: living organisms that, in their search for food, transfer pollen from the anther to stigmas of flowers

pollution: contamination of soil, water, or atmosphere by the discharge of harmful substances

population: the number of a particular species in a defined area

population bottleneck: a decrease in the genetic diversity of a population that happens when the size of a population decreases due to a disturbance

porosity: the amount of space between soil particles; determines how much water and nutrients can seep through to plant roots along with the size of organisms that can inhabit the soil

pothole: depressions in the land—usually caused by glaciers—that fill in with water and form small lakes and ponds

prairie: a grassland habitat, characterized by precipitation from 12 to 40 inches, high evaporation rates and periodic fires

predaceous: living by seizing or taking prey

predation: the act of preying upon

predator: an animal that kills and eats other animals

prediction: a statement foretelling likely outcomes on the basis of observations and reasoning

prescribed burning: the planned application of fire to natural fuels with the intent to confine the burning to a predetermined area

preservation: protection that emphasizes nonconsumptive values and uses; to keep in a pristine or unaltered condition

prey: animals that are killed and eaten by other animals

primary consumer: a consumers that eats producers

primary producer: an organism that is able to manufacture food from simple organic substances

private lands: lands owned by particular people who can determine, within the law, how those lands will be used or managed

proboscis: a butterfly's tongue

producer: a green plant or bacterium that uses photosynthesis or chemosynthesis to make its own food and constitutes first trophic level in food chain; makers of a product

public lands: lands managed for and used by the public

pupa: the stage of complete metamorphoses the larval stage and adult (or imago) stage

rain shadow: an area on the leeward side of a mountain barrier that receives little rainfall

rainfall: the quantity of rain falling in a given area over a given time

range: the geographic region where a plant or animal normally lives and grows; an area grazed by livestock, wildlife, or both

rare: referring to wildlife species not presently in danger but of concern because of low numbers

real: actually present or occurring in the world; having verifiable existence

recovery: as related to conservation, when threats to an endangered or threatened species have been reduced to ensure the long-term survival of the species in the wild

recreation: entertainment that refreshes one's mind or body, frequently implying activity in the out-of-doors

regulation: control of an activity, process, law, or industry by official rules

reintroduction: as related to conservation, when a plant or animal species is introduced back into their natural habitat

renewable resource: a commodity or resource— such as plants and animals—that is replaceable by new growth and that has the capacity to renew itself when conditions for survival are favorable

reporting: giving a spoken or written account of something that one has observed, heard, done, or investigated

reptile: a class of vertebrate animals that have scales, typically lay amniotic eggs, and are ectothermic; includes crocodilians, turtles, lizards, snakes, and tuatara

resilience: the ability of an ecosystem to cope with and deal with outside stressors

resource: a portion of an environment that people have assigned value or that people see as being available for use

responsibility: an obligation to or accountability for something or someone

restoration: the act or process of bringing something back to a previous condition or position

revenue: money generated

riparian: located or relating to the banks of a stream, river, or other body of water

rodent: mammals with large incisors adapted for gnawing or nibbling (e.g., rabbits, rats, mice)

roost: a place where animals, particularly birds and bats, stay during their resting hours; also, the act of resting in such a place

sand: soil type with the largest particles and the highest porosity; it is easy for water to pass through, which can allow for plant roots to be unstable

savanna: a flat grassland with scattered trees or clumps of trees of tropical and subtropical regions

scale: a common feature of maps that indicates the proportional relationship between the distance or size of an object on a map and the actual distance or size in real life

scat: fecal material

scavenger: an organism that habitually feeds on refuse or carrion

science: the systematic study, through observation and experimentation of the natural world, the physical world, and the universe

season: parts of the year defined by differing weather patterns caused by the Earth's rotation around the sun; a time when hunting, fishing, or trapping is permitted for a particular species)

secondary consumer: consumers that eat either the primary consumers or the primary consumers and producers

seed: the part of a flowering plant that is able to develop into another plant of that species

segment: one of several parts of an organism

sense: perception through smell, sight, sound, taste, and/or touch; to be aware of

shelter: cover for natal activity or bedding and protection from weather

silt: particle size in between clay and sand; drains better than clay

skink: any of a family of smooth, shiny lizards having a cylindrical body and small or rudimentary legs and living chiefly in temperate and tropical regions

sky glow: illumination of the night sky often associated with artificial lights of cities and other urban areas

social media: online means of communications used by large groups of people to develop social and professional contacts

soil fertility: how nutrient-rich soil is

soil horizon: levels of soil in regards to depth in the ground; different horizons house different organisms, levels of decomposition, and fertility

soil profile: composition of the soil

solar energy: energy that is harvested from the sun's heat and light

source: the origins, or beginnings, of something; where something originally came from

space: the habitat area that an animal needs to survive, which varies in size

species: a group of organisms distinguised by their ability to breed and produce fertile offspring under natural conditions; a category of biological classification

species richness: how many different species there are in an area

succession: the orderly, gradual, and continuous replacement of one plant or animal community by another

survival: the state of continuing to live, typically in spite of challenging circumstances

survival needs: fundamental requirements for staying alive (i.e., food, water, shelter, space); also known as basic needs

sustainable: able to be maintained or kept going

sustainability: maintaining resources in such a way that they are able to renew themselves over time or to stay in existence without significantly reduced quality or quantity

sustainable communities: communities of people that are planned in a way to cause minimal environmental stress

sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs (*Brundtland Commission, 1987*).

symbiosis: a close living relationship between organisms

symbol: something that represents or stands for something else

synthetic: man-made

tame: no longer wild

technology: the application of scientific knowledge for practical purposes

terrestrial: living or growing on land

territory: dominance over a unit of habitat; an area defended by an animal against others of the same species

tertiary consumer: a consumer that is a top predator and eats primary and secondary consumers

thermoregulation: the manner in which an organism maintains its body temperature within a certain range; endothermy and ectothermy are two different types of thermoregulation

thicket: a dense group of bushes or trees

thorax: the middle section of the body between the head and abdomen

threatened: in wildlife terms, a species present in its range but in danger because of a decline in numbers

topography: the technique of representing surface areas of land on maps

toxic: poisonous

track: (noun) a single animal footprint; (verb) determine an animals movement and location by following its trail

trade-off: losing one quality or aspect of something in return for gaining another

trail: a set of tracks in succession

transect: a straight line or narrow section through an object or natural feature or across the earth's surface, along which observations are made or measurements taken.

transplant: to transfer from one area to another; also "translocate"

transportation systems: the infrastructure that allows people in a community to move from place to place

tree: a woody plant 12 or more feet (4 or more meters) tall with a single main stem (trunk) and a more or less distinct crown of leaves

trophic level: a group of living things that share the same level in the food chain

ungulate: a hoofed animal

unguligrade: term used to describe animals that walk on their toenails or hooves; examples are deer and elk

value: a worth attached to a place, idea, event, person, animal, etc; a guiding principle or standard of behavior used by groups of people

vector: the means, or transport mechanism, by which a species is moved from one location to another

vegetation: the mass of plants that covers a given area

vertebrate: an animal that has a backbone

vulnerable: species that are especially susceptible to becoming endangered

waterfowl: water birds, usually ducks or geese

water: the transparent fluid that forms the world's lakes, streams, oceans, and rain, and is the major constituent of all living things

weather: changes in the Earth's atmosphere (e.g., temperature, cloudiness, moisture) which occur by hour, day, or week

wild: not tamed or domesticated, living in a basically free condition; a wild animal provides for its own food, shelter, and other needs in an environment that serves as a suitable habitat

wildlife: animals that are not tamed or domesticated including, but is not limited to, insects, spiders, birds, reptiles, fish, amphibians, and mammals, if nondomesticated

wildlife management: the application of scientific knowledge and technical skills to protect, preserve, conserve, limit, enhance, or extend the value of wildlife and its habitat

wind energy: energy that is harvested from the movement air over turbines, causing them to rotate and generate power

zoning law: laws that divide land into areas according to what type of use or construction is allowed in that area

zoo: an establishment that maintains a collection of animals usually to exhibit to the public

What's My Question?

FOR STUDENTS

Preparing for a successful field investigation begins with developing a question that is researchable. While there are numerous important "big picture" questions about the environment and how people interact with the environment, many questions are too broad to be answered with a single investigation. Asking a question that can be tested or researched is a key part of scientific inquiry.

As you consider questions about your local environment to investigate, it is important to consider what observations you will be able to make, and whether those observations will help answer your investigative question. One way to help with this process is to categorize your investigative questions into one of three categories. Use the boxes below to record researchable questions you would like to investigate.

1. Questions about the big picture. List questions here that are too big to answer with a single field investigation:

2. Questions that help us describe. List questions here that focus on a single aspect of your local environment—questions that you can find answers to by measuring, observing, describing or mapping. These questions help us describe parts of a natural system such as how many, how frequently, how much, what happened, when, and where?

3. Questions that help us compare. List questions here that compare changes within a population or differences between groups. Observations may be made either on a single population under various conditions (time of year, location) or on different populations. Comparative questions ask, what will happen to the measured variable when one of the changes occurs?

4. Questions that help us correlate. List questions here that involve measuring or observing two variables and searching for a pattern. Correlative questions ask, what is the relationship between two variables?

Adapted from *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes*. 2007. Pacific Education Institute and Association of Fish & Wildlife Agencies.

FOR STUDENTS

Conclusions and Next Steps

1. Restate your investigative question:

2. Were you able to answer your research question with the data and observations you collected? If yes, go to Step 3. If no, explain why not. For example, were you able to make the kinds of observations you were planning to make?

How can you modify or rewrite your question so you are able to answer it using observations you can make at your study site?

3. Write a concise answer to your research question:

4. Now elaborate. What natural occurrences were happening at your study site that explain the data you collected? Be sure to include evidence or observations to support your answer.

5. How could knowing this answer help you or others take actions to benefit people and wildlife?

6. What other questions about your study site could you or others investigate?

7. Choose one question you listed in Step 6 above. Describe the kind of information you would need to collect in order to answer this question. How would you go about collecting that information?

Data Collection Form

FOR STUDENTS

Observer's Name: ____

City/County/State: ____

Describe your surroundings (forest, seashore, prairie, urban, suburb, rural, park, etc.):

____

____

____

Date	*Time*	*Weather*	*Species Name/ Description*	*How Observed? (Viewed, heard, tracks, etc.)*	*Latitude*	*Longitude*	*How many did you see?* #	*Is this an estimate?* ?

Metric Conversion Chart

Approximations

Symbol	When You Know	Multipy By	To FInd	Symbol
		Length		
in	inches	2.5	centimeters	cm
ft	feet	30.0	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.6	miles	mi
		Area		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.84	square meters	m^2
mi^2	square miles (640 acres)	2.6	square kilometers	km^2
acre	acre (43,560 ft^2)	0.4	hectares	ha
cm^2	square centimeter	0.16	square inches	in^2
m^2	square meter	10.8	square feet	ft^2
m^2	square meter	1.2	square yards	yd^2
km^2	square kilometer	0.4	square miles	mi^2
ha	hectare	2.5	acres	acre
		Mass		
oz	ounces (avoirdupois)	28.0	grams	g
lb	pound	0.45	kilograms	kg
t	short tons (2,000 lb)	0.9	tonnes (metric ton)	t
g	grams	0.035	ounces (avoirdupois)	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (metric tons)	1.1	short tons (2,000 lb)	t
		Volume		
tsp	teaspoons	5.0	grams	ml
Tbs	tablespoons	15.0	kilograms	ml
fl oz	fluid ounces	30.0	tonnes (metric ton)	ml
c	cups (liquid)	0.24	ounces (avoirdupois)	l
pt	pints (liquid)	0.47	pounds	l
qt	quarts (liquid)	0.95	short tons (2,000 lb)	l
gal	gallons	3.8	grams	l
ft^3	cubic feet	0.03	kilograms	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
ml	milliliters	0.2	teaspoons	tsp
ml	milliliters	0.07	tablespoons	Tbs
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	4.2	cups (liquid)	c
l	liters	2.1	pints (liquid)	pt
l	liters	1.06	quarts (liquid)	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35.0	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		Temperature		
˚C	degrees Celsius	(9/5 x ˚C) + 32	degrees Celsius	˚F
˚F	degrees Fahrenheit	5/9 x (˚F-32)	degrees Fahrenheit	˚C

Get More WILD!

Additional Project WILD Resources from AFWA

Aquatic WILD

This companion to Project WILD is an interdisciplinary conservation and environmental education program emphasizing aquatic wildlife and habitats. The goal of Project WILD and Aquatic WILD is to assist K–12 students in developing awareness, knowledge, skills, and commitment to result in informed decisions, responsible behavior, and constructive actions concerning wildlife and the environment.
Web: ***www.projectWILD.org***

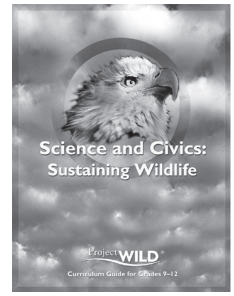
Growing Up WILD

This early childhood education program builds on children's sense of wonder about nature and invites them to explore wildlife and the world around them. Through a wide range of activities and experiences, Growing Up WILD provides an early foundation for developing positive impressions about the natural world and lifelong social and academic skills.
Web: ***www.pwGrowingUpWILD.org***

Flying WILD

Introducing students to bird conservation, Flying WILD uses standards-based classroom activities and environmental stewardship projects. Flying WILD encourages schools to work closely with conservation organizations, community groups, and businesses involved with birds to implement school bird festivals and bird conservation projects.
Web: ***www.flyingwild.org***

Science and Civics



Serving as a guide for involving high school students in conservation, Science and Civics is filled with environmental action projects aimed at benefitting local wildlife found in a community. It involves young people in decisions affecting people, wildlife, and their shared habitat in the community.
Web: ***www.projectwild.org/ScienceandCivics.htm***
Only publication available in electronic form.

Proyecto WILD

Proyecto WILD: Traducción en Español de Las Guías del Plan de Estudios y Actividades del Jardín de Niños Hasta La Preparatoria
This guide contains 34 translated activities taken from *Project WILD K–12 Curriculum and Activity Guide* and *Aquatic WILD K–12 Curriculum and Activity Guide*. The Spanish supplement introduces Project WILD to teachers; scout leaders; school volunteers; parks and recreation staff members; and nature center, zoo, and museum staff members who live and work in primarily Spanish-speaking communities.

WILD About Elk: An Educator's Guide

This 80-page guide is a product of the Rocky Mountain Elk Foundation and AFWA. WILD About Elk provides a summary of the biology and ecology of elk. Topics addressed include elk's physical characteristics and adaptations, habitat and historical range, behavior, life cycles, social structure, migratory patterns, and the present and historical relationships between elk and humans.

For more information

on Project WILD resources and professional development training, go to ***www.projectwild.org*** and ***www.fishwildlife.org***.

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Alphabetical Listing of Activities