



A Kid's Eye View

The Science Behind the Scenery of Acadia National Park

Study Guide for Teachers



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The National Park Foundation

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and

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Parks As Classrooms

I hear and I forget. I see and I remember. I do and I understand. Boiled down to its purest essence, that's what the National Park Service's *Parks As Classrooms* program is all about. It's a concerted nationwide initiative to utilize the wonderful resources of the parks for teaching and learning purposes - in the process, making education active, experiential and fun.

The parks, after all, are classrooms. They are battlefields and Presidents' houses, where history was made. They are canyons and deserts, where geological processes have been played out eon after eon. They are historic trails, over which pioneers migrated and intermingled and resettled. They are monuments to civil rights leaders, where the lessons of cultural history are real and vivid. They are seashores and preserves, where a million forms of life offer daily lessons in biology, botany, evolution, and survival amidst an endangered ecosystem. The national parks, in essence, help textbooks and lesson plans come to life. *Parks as Classrooms* is an idea whose time has come. Visit the National Park Service's homepage (<http://www.nps.gov/>) to explore these classrooms.

Acadia's Classroom

The foresight of stewardship-minded individuals at the turn of the century created this first national park east of the Mississippi in 1916. The majority of lands comprising the park are a gift to the American people given by generous donations of land from private citizens. Today Acadia National Park protects close to 40,000 acres of coastal Maine.

Close to three million people a year come to Acadia to enjoy the park's lakes and ponds, mountains and miles of ocean shorelines. *A Kid's Eye View, The Science Behind the Scenery of Acadia National Park*, swings open Acadia's classroom doors, exploring beyond Acadia's natural beauty to discover the important scientific work that will help protect the park for years to come.

A Kid's Eye View - The Science Behind the Scenery of Acadia National Park

Using the Video and Study Guide

The target audience for this video and guide is students in grades six through nine. Teachers working with younger and older students may also find applications for its use. The video consists of six segments plus the introduction and conclusion. It can be used in its entirety, or in separate segments. It is designed for you, the teacher, to pick and choose topics that you feel will be beneficial to your students and/or complement their studies. The introduction to the video should accompany at least one video segment to provide a complete picture.

The accompanying study guide offers activities chosen to enhance one or more of the subjects discussed in each segment. The study guide consists of the following:

- 1) An introduction to each video segment and review/discussion questions for use after watching.
- 2) Background information for teacher's use which includes more information regarding the studies and/or problems as well as natural history information.
- 3) Two or more activities to extend the lesson.
- 4) Glossary.
- 5) Resources for teachers.

We hope *A Kid's Eye View, The Science Behind the Scenery of Acadia National Park*, provides both you and your students with a new perspective on the important scientific work at Acadia National Park.



A Kid's Eye View - The Science Behind the Scenery of Acadia National Park

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The Science Behind the Scenery of Acadia National Park

Knowing The Park - Inventory

An inventory provides information on what exists in the park. When compared with inventories taken at other times it can help identify trends or potential threats. Inventorying gives a better understanding of the resources and strategies for their management.

Acadia's Little Creatures - Small Mammal Inventory

Part of Acadia National Park since 1929, Schoodic Peninsula had no in-depth resource information. The inventory gathered information on the plants, small mammals, amphibians, reptiles, and forest types on this mainland portion of Acadia National Park.

Knowing What's Happening - Monitoring

Monitoring provides an understanding of the park's normal and natural processes and helps managers detect early warnings if something is wrong.

Sweet Waters of Acadia

By keeping track of changes in both the chemical and biological aspects of many of the park's lakes and ponds, park managers have documented that Acadia has relatively clean, healthy water.

Understanding How it Works - Scientific Research

Scientific research is a tool for learning more about the natural world. Research results may answer critical questions or suggest how to repair any damage discovered through inventory and monitoring.

A National Treasure

Why are Acadia's bald eagles not doing as well as those in other states? Annual monitoring of bald eagle nests found that eagles living on the Maine coast were raising very few young. More detailed research found that many eagles and their eggs had extremely high levels of toxic chemicals, such as PCB's and dioxin.

Tracking Acadia's Deer

How healthy is Acadia National Park's deer population? By tracking both does and fawns, researchers learned about the role predators play in the park's white-tailed deer population. This enables park managers to better understand the deer population dynamics.

What draws people to Acadia National Park? One hundred and twenty miles of hiking trails, 45 miles of carriage roads, spectacular scenery, lakes for fishing, coastlines for pondering on ... the list is long. But Acadia is more than recreation. Some people compare Acadia, and other national parks, to a living laboratory. Within national parks are some of the world's greatest ecosystems. Preservation of these systems is a large responsibility carried by the parks.

National parks follow a stewardship path that comes from the 1916 organic act outlining the role of the National Park Service. It states "... to conserve scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same ... [so as to] leave them unimpaired for the enjoyment of future generations."

A pretty big job? Absolutely! Acadia National Park protects the plants, animals, geologic features, natural processes, archeology, historic features, and natural beauty - in a word - Acadia's resources. Much of this work happens behind the scenes, rarely seen by the public. Here's a snapshot of the various elements involved in the stewardship of Acadia National Park.



Deciding on Solutions - Management and Evaluation

Research results and information are compiled and examined. The implications of the data are considered. Finding solutions to maintain, restore, and/or protect park ecosystems are vital.

Plant Invasions

An inventory showed purple loosestrife, introduced from Europe, was present in some of Acadia's wetlands. Monitoring showed it was spreading while research elsewhere demonstrated the tendency of purple loosestrife to crowd out native plants. Careful study yielded a solution to manage loosestrife through a short-lived herbicide. Evaluation of the program's effectiveness and a search for other alternatives are important and necessary parts of the solution. This program is currently under review.

Native Plants

One of Acadia's effective solutions to combat eroded areas due to off-trail hikers was to use native plants to fill bare spots left behind by wandering feet. The native plants used for the project were taken from along the edges of the park's carriage roads undergoing rehabilitation.

Taking Action - Resource Protection

The park staff at Acadia is a team sharing a common goal: resource protection. Everyone puts management solutions into action.

Watching the Wanderer - Peregrine Falcons

Park staff closed a popular hiking trail to protect a nesting pair of peregrine falcons, an endangered species, on Acadia's Champlain Mountain. Staff educate park visitors and monitor the peregrine's activity. The young chicks are banded to gain more information about their migration, mortality, and life history.

Common to all of these studies is the need to know more about the resources of Acadia National Park. Fundamental to the protection of park resources is an understanding of the elements protected within the park, ecosystem functions, and human-caused changes over time.

National parks like Acadia are not isolated. What happens outside the park can have profound effects inside the park. The reverse is true as well. Partnerships enable Acadia National Park to accomplish much more than it could utilizing its own resources. The most important partners? Everyone. National parks need supporters who share in the role of park stewards. Armed with stewardship partners and reliable scientific data, Acadia National Park stands prepared for the future while holding true to the original directive of 1916.



A Kid's Eye View - About the Video

This video highlights just some of the research and scientific work in Acadia National Park. It also showcases for students different jobs in the science field. In some cases, you will see park biologists, other times biologists from cooperating agencies such as the U.S. Fish and Wildlife Service or institutions, such as the University of Maine. All are involved in the task of studying the environment. Students from Bar Harbor, Maine interviewing the biologists are asking questions that they were personally interested in.

Running time for the entire video is approximately 55 minutes. Segments vary in length from 5 to 10 minutes. Because all VCR's are different, the segment time codes listed here may vary and should only be used as a guide.

Introduction -	00:30
<u>Watching the Wanderer</u> - Acadia's Peregrine Falcons	02:28
<u>A National Treasure</u> - Bald Eagles at Acadia	12:09
<u>The Sweet Waters of Acadia</u> - Monitoring Water Quality	19:19
<u>Plant Invasions!</u> - Native Plants Versus Non-Native Plants	26:09
<u>Acadia's Little Creatures</u> - The Small Mammal Inventory	36:05
<u>Tracking Acadia's Deer</u> - The Deer Fawn Study	41:31
Conclusion	50:38



Watching The Wanderer - Acadia's Peregrine Falcons

Mike Amaral, a U.S. Fish and Wildlife Service biologist works with Acadia National Park staff to band the peregrine chicks. Troy Miller, a Bar Harbor student, talks to Mike about banding, and discovers why it is a valuable method for learning more about peregrine falcons.

- 1) What do banders need to think about before banding the birds to provide for both their safety?
- 2) Why are two different bands used?
- 3) Why is banding important to help monitor peregrines? What information might be gained?
- 4) Peregrine falcons are being considered for removal from the endangered species list. How will this work help in making a national decision about the status of these birds?

A National Treasure - Bald Eagles at Acadia

Angela Matz, a researcher from the University of Maine works with Acadia National Park to monitor the population of bald eagles nesting in the park. The information gained from her research helps in understanding how pollutants in the food chain may harm eagles. Troy Miller joins Angela as she bands and takes blood, tissue, and feather samples from an eaglet.

- 1) What are the measurements of the young eagle for?

- 2) Why are eagles at Acadia and in Maine not reproducing so well?
- 3) What type of disturbance do you think is created doing this type of research? Is it justified?
- 4) Do you think this type of work is easy? Rewarding?

The Sweet Waters Of Acadia - Monitoring Water Quality

Bill Gawley, a park biologist checks certain lakes and ponds to gather data on the pH, dissolved oxygen, transparency, and temperature. Jessica St. Germaine, a middle school student from Bar Harbor, assists Bill in monitoring Jordan Pond's water quality.

- 1) What are the water quality tests for?
- 2) Why are the lakes and ponds tested at the same time of day?
- 3) If the lakes and ponds of Acadia seem healthy, why do biologists continue to monitor them?
- 4) What does Bill do with the information once he has it? Why is this important?

Plant Invasions! Native Versus Non-Native Plants

Kate Tanski, a Bar Harbor middle school student, accompanies park botanist Linda Gregory and park biologist Judy Hazen-Connery to learn more about native and non-native plants. She assists Linda in a revegetation project using native plants and works with Judy to monitor the presence of non-native purple loosestrife in Acadia's wetlands.

- 1) Why are native plants important to use?

A Kid's Eye View

- 2) Why is the park concerned with controlling purple loosestrife?
- 3) How did purple loosestrife end up in the park?
- 4) Explain how study plots help biologists monitor purple loosestrife.

Acadia's Little Creatures - Small Mammal Inventory

Glen Mittlehauser, a park biologist, discovers what lives on Schoodic Peninsula, a mainland portion of Acadia National Park. Jessica St. Germaine, works alongside Glen as he checks small mammal traps as part of the project.

- 1) What has Glen discovered so far?
- 2) List some reasons why it would be important to do an inventory.
- 3) How do park managers know if the park ecosystem is healthy?
- 4) How will the information from this inventory help park managers?

Tracking Acadia's Deer - The Deer Fawn Study

Robert Long, a graduate research associate from the University of Maine, studies the deer fawn population's survival rate at Acadia. Jessica, Troy, and Kate learn more about the study and radio telemetry, one method Robert uses to track the fawns.

- 1) What are researchers hoping to learn from the deer fawn study?
- 2) How will this information be helpful?
- 3) How does Robert locate the fawn with the radio collar on?
- 4) Should anyone walk up to a fawn?



School Yard Investigations

Vocabulary

Inventory - Study of a specific area, site or habitat to determine the number of species present and population size.

Monitoring - Study of the individuals in one or more populations of a species over time.

Summary: Students turn their school yard into a year round ecological study site.

Objectives:

Students will:

- ☐ Develop mapping skills.
- ☐ Investigate a variety of ecological aspects of a school study site.
- ☐ Gain an understanding of habitat quality and potential impacts on that habitat.

Materials:

- ✎ Tape measure
- ✎ Stakes
- ✎ String
- ✎ Field guides
- ✎ Trowels
- ✎ Graph paper
- ✎ Rulers
- ✎ Journals
- ✎ Camera (optional)

Preparation:

You don't need a large area for this activity. A section around a parking lot with weeds or a border between woods and a field will work just as well as a large forested area or field. Check with school officials about setting up an official study area at your school.

If a school yard really is non-existent, perhaps a parcel of land in a local park can be adopted. Check with park personnel in advance about any restrictions such as collecting. In Acadia National Park, all leaves, trees, flowers, rocks, little creatures, big creatures, etc. must remain. There is a no collecting policy in national parks so they may be preserved for generations to come. State and local parks may have similar rules.

Background:

Areas that are large like national parks benefit greatly from scientific work designed to understand more about the systems park managers are responsible for protecting. But national parks aren't the only areas that can benefit from inventories, monitoring, and research. Small areas are just as important to understand too. The school yard is an ideal location to create a mini-inventory and monitoring site. The same procedures done in national parks can be accomplished in a school yard, year after year.

Procedure:

Before developing the site, determine what the class wishes to use a study site for. Is it for a general inventory? To monitor year after year and watch for changes? To use as a teaching tool for other classes? Once the purpose is outlined, begin creating the study site.

Mapping

A map is a tool used in all field research. Creating a base map of the potential site is the first step in understanding the ecology of an area.

1) Before beginning, review with students other types of maps (highway, park, topographic). What is indicated on them? How are the keys used? What symbols might be important to use?

2) Make a base map of the area chosen to be the study site. Later, the base map will be used for documenting abiotic (non-living) and biotic (living) components of the site.

3) Use a tape measure that is fairly long (at least 25 feet) to measure the perimeter of your study area. Students may want to do a rough sketch

of the area as they measure it. Ask students to keep careful notes of distances between obvious features and their distances from the perimeter measured. This will help in transferring the information into a map.

If you do not have a tape measure, students can pace the study area instead. This method also requires math skills. To pace: Students determine what their normal pace is (not an exaggerated walk) by measuring their stride. While walking the study area, students should count their paces. They can then estimate the distance simply by multiplying the number of steps taken by the length of their pace. Different terrain may affect the pacing - stride is longer downhill, shorter uphill.

4) With the initial information gathered, students can now draw the map to scale on graph paper.

5) Put in permanent features such as roads and buildings. Students may wish to use symbols such as those on topographic maps or create their own to illustrate the area.

6) This next step requires a more extensive investigation of the study site. Other dimensions should now be added to the base map (plants, rocks, soil type, evidence of animals, etc.)

Discussion:

Why is the information collected in a study site important? What changes might happen in the next 10 years if the area is left alone? If not?

Extensions:

For more detailed activities and ideas for your school study site, check under *Resources* for books that will help you in your project.

Activities for Your Study Site

Signs of animals

- * Look for droppings, pine cones eaten, holes in trees, holes in ground, chewed plants, bird songs, insects, and of course, actual observation of animals.
- * Do basic sketch drawings to record the multitude of little critters found.

Plants

- * Identify plants with the help of a field guide.
- * Estimate tree height and measure trunk circumference with tape measure.
- * Show changes through the year with photos.
- * Identify different habitats according to the type of plants present.
- * Draw plants. (When students are drawing plants, ask them to look closely at the shape of the leaves, how they are attached to the stem, the number of petals on a flower, etc.)
- * Create a field guide to the study site.
- * Collect a sample (if allowed) of leaves and flowers from the plants. (These can be dried by placing them between newspaper sheets and then placing heavy books on top).
- * Start a classroom herbarium with collected plants. (Mount dried plants on cardstock using contact paper to hold plants in place. Include the plant name and where and when it was collected.)

Soil

- * Describe soil based on texture, color, temperature, wet vs. dry areas.
- * Determine the percentage of sand, silt and clay in soil. (Fill a plastic jar with 1/3 soil and 1/3 water. Shake the mixture and let stand for up to 24 hours. Sand, being the heaviest and largest of the particles, will settle to the bottom first. Next, silt will fall and finally clay, consisting of the smallest and lightest particles of the three. Organic debris will settle on top.)

General Activities

- * Document changes over a year with a journal, drawings, and photographs.
- * Have students create a bulletin board display of the study site.
- * Develop a trail guide to use with younger students or to invite the community.
- * Compare areas in the study site. (For example, ask for an area of grass not to be mowed. How does it change over a year compared to mown areas?)

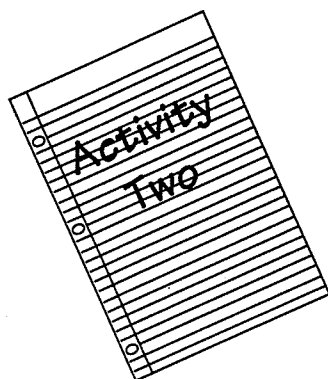
Resources

Ecology Discovery Activities Kit - Complete Teaching Unit for Grades Four - Eight
Janet R. Galle/Patricia A. Warren
The Center for Applied Research in Education, 1989
West Nyack, NY 10995

Education Goes Outdoors
Frank A. Jones, Kurt Allen Liske, Amy L. Evans
Addison Wesley Publishing Co.
Menlo Park, CA 1986

(All three can be ordered from Acorn Naturalists 714-838-4888)

Beyond the Classroom - Exploration of Schoolground and Backyard
Charles E. Roth, Cleti Cervoni, Thomas Wellnitz, Elizabeth Arms
Massachusetts Audubon Society,
South Great Road
Lincoln, MA 01773



Who Does What?

Summary: Students research potential careers in the field sciences.

Objectives:

Students will:

- ☐ Name at least three jobs related to field science.
- ☐ Learn interview and research skills.

Materials:

None

Procedure:

1) Ask students to brainstorm some jobs that might be related to field science. Ask them to think about aspects of nature - are there jobs tied to each aspect? Here are some areas for students to investigate:

Ornithology - study of birds

Botany - study of plants

Limnology - study of water bodies (streams, lakes, ponds)

Marine Biology - study of marine ecosystems

Entomology - study of insects

Wildlife Biology - study of wildlife

Geology - study of earth processes

Meteorology - study of climate and weather

Soil Sciences - study of soil

2) Each area can be broken down into more specific jobs. Once students have chosen a career, ask them to think of ten questions they would like answered about that job. Some questions may be answerable through library research, others may require contacting someone in the job. In addition to the listings provided here, students may also contact local chapters of the Audubon Society and Nature Conservancy, as well as local cooperative extensions and universities.

3) To contact someone to discuss their job, students should first call the

Resources

Bureau of Land Management
Interior Building
1849 C Street NW
Washington, DC 20240
202-208-5717

National Marine Fisheries Service
U.S. Department of Commerce
1335 East-West Highway
Silver Spring, MD 20910
301-713-2370

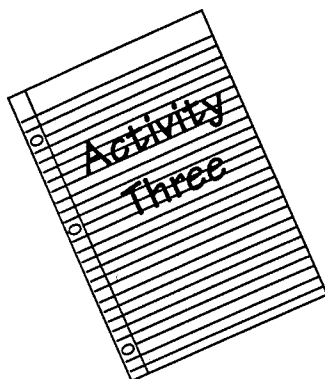
National Park Service
Interior Building, PO Box 37127
Washington, DC 20013-7127
202-208-4747

U.S. Fish and Wildlife Service
Interior Building
1849 C Street, NW, Room 3447
Washington, DC 20240
202-208-5634

In Maine: (207 area code)
Maine Department of Inland Fisheries and Wildlife: 287-2871
Maine Conservation Department
Forest Service: 287-2791
Entomology Lab: 287-2431
Geologic Survey: 287-2801
Maine Department of Environmental Protection: 287-7688
Marine Resources: 624-6550

agency to ask who would be a good person to talk to. They should then send a letter, either asking for more information to answer their questions, or to set up a phone interview time. If setting up a phone interview, be sure students will be able to stick to the time. A follow-up thank you letter is always a nice gesture.

4) Once information is gathered, students can report back to the class about the different types of jobs or set up a "job fair" for other students at the school to attend to learn more.



Your Own National Park

Summary: Students create a national park and design a park brochure to share with others.

Objectives:

Students will:

- ☐ Describe features in a national park.
- ☐ Explain why national parks are preserved.
- ☐ Create their own park brochure.

Materials:

- ✎ Art supplies
- ✎ Reference materials
- ✎ Acadia National Park brochure

Background:

There are over 350 parks in the national park system. When you visit a national park, what might you find? Glaciers, waterfalls, deserts, thick forests, oceans, rolling mountains, jagged peaks -- scenery that can cause one's heart to miss a beat. Under the protection of the national park system you'll also find historical buildings or sites where important events took place, battlefields, presidents' homes, American Indian dwellings and much more -- all filled with the stories of our country.

Procedure:

All parks provide visitors with a park brochure. The brochure includes information about the park's history and uniqueness, and a map of the park showing roads, hiking trails, scenic lookouts, historic sites, campgrounds, and picnic areas. In this activity, students create a natural area national park brochure.

1) Begin with a discussion about national parks. Why do students think we have national parks? How many students have visited a national park?

What was special about the park? What features did it have? List on the board student answers about what they would expect to find in a national park.

2) Show students Acadia's brochure. This serves as an example for students, not what they should copy. What information is found on it?

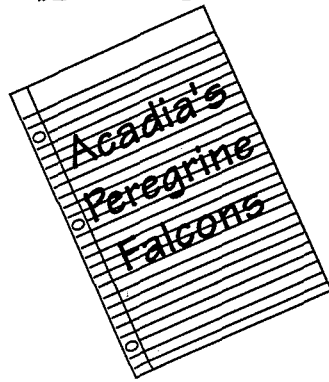
3) Divide students into pairs and explain that they are to design a national park and a brochure to help people learn more about it. To help students think about features they would like (an ocean setting or mountains? Desert or canyons?) bring in some books on national parks for students to look at. Brochures (similar to Acadia's) are also available from each park. Students don't need to create "real" land forms or animals and plants. They can create an entirely new ecosystem!

4) Provide students with research time to develop what will be in their park. They should also indicate places especially important to preserve in the park and any rare or endangered plants or animals that need special protection.

5) Give students art supplies for developing their own brochures. When completed, students should set up their own "entrance station" where other students can come to view their map and learn more about these new national parks!

For more information on other national parks, contact: *Education Coordinator, Acadia National Park, Box 177, Bar Harbor, ME 04609 207-288-3893 or visit the National Park Service's home page at (<http://www.nps.gov/>).*

Notes



Watching the Wanderer

For centuries, peregrine falcons hunted the skies of the world, displaying their impressive, in-flight hunting tactics. Peregrines were sighted on Mount Desert Island as early as 1936; the last known nesting pair prior to their reintroduction was 1956. By the mid-1960s, researchers determined peregrines were no longer a breeding species in the eastern United States. Today the eastern peregrine falcon is protected as an endangered species.

Endangered

Nest robbing, trapping, and shooting first contributed to their downfall, followed in the 1950s by ingestion of chemical pesticides and industrial pollutants. Occupying a position high on the food chain, peregrines are still exposed to high levels of chemical residues. This can happen if they migrate to other countries using pesticides now banned in the United States, or eat migrant songbirds contaminated in those countries. As in all birds of prey, ingested chemical toxins accumulate in their body fat and cause reproductive failure, leading to the decline and sometimes the eventual extinction of the species.

When Congress passed the Endangered Species Act in 1973, mandating all federal agencies to protect endangered species and their habitats, Acadia National Park responded enthusiastically by participating in a cooperative management plan to restore a self-sustaining population of peregrines to the eastern United

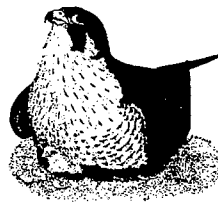
States. The Eastern Peregrine Falcon Reintroduction Program's goal is to remove the peregrine from the national endangered species list through recovery of the species. This goal is facilitated by carefully reintroducing hand-reared chicks into the wild through a process termed hacking. Acadia participated in the hacking program from 1984 - 1986.

Acadia's Peregrines Return

Selected adult birds were bred in captivity, their eggs incubated and hatched in a laboratory. At three to four weeks old the chicks were trans-

ferred to artificial rearing nests called hack sites. Here in Acadia, 22 peregrine chicks were successfully released off of Penobscot Mountain.

Hack sites are staffed around the clock by trained specialists who carefully monitor, tend, and feed the chicks for approximately three weeks. Attendants observe only from a distance. Food drops are made via a long, sloping tube, preventing the association of food with humans. When their wings are strong enough for flight, fledglings are released. The young falcons continue to eat at the



Peregrine Characteristics

Feeding: Hunts most vigorously at dawn and dusk in open areas; shores, marshes, and valleys. Plucks feathers from the prey as it feeds.

Strikes: Usually in mid-air, knocking the quarry to the ground. Less commonly, it will strike and grab prey and fly away.

Nesting: Mostly on precipitous cliffs, but will also nest under suspension bridges and atop tall city buildings. Eggs are laid on a sand or gravel covered ledge that has been scratched in preparation for the clutch. This area is called a *scrape*.

Wings: Long, pointed, sickle shaped. All falcons in a dive appear to have sickle shaped wings. Wing shapes depend on the degree to which the bird is soaring or diving. Be careful in making identifications.

Head: Small with dark "helmet and sideburns."

Size: Crow-sized, female larger than male.

Feet: Large (hence the nickname *big-footed falcon*).
Adult—yellow. *Immature*—light green.

Plumage: *Adult*—White breast, dark gray back.
Immature—Streaked breast, brown back.

Peregrine Watch

March to Mid-April (courtship)

Adult falcons fly close to each other near the nesting cliff, feeding each other, and perform in-flight acrobatics. The falcons are most vocal at this time. Typical breeding vocalizations are: "chup, chup, chip" or "Eeee, chup chup chup chup."

Mid-April through May (nesting)

One falcon incubates eggs while the other perches nearby. Adults may exchange food in mid-air.

June

In early June, young falcons may be seen at the edge of the nest cliff as "tiny white snowballs." Their markings will change as they mature. They may flap their wings to build strength for flight. They take their first flights in late June or early July.

July through August (fledging)

Young falcons practice flight, exploring farther afield. Watch for them flying above the cliff or other parts of Acadia National Park. They may perch anywhere on the cliff's ledges or on dead trees.

Fall and Winter (migration)

Peregrines from Greenland and Canada migrate through Acadia National Park from August through October. Some may spend the winter in the Acadia National Park area depending on the severity of the winter. Biologists are not sure where Acadia National Park's summer peregrines migrate.



Did You Know?

The peregrine's Latin name *Falco peregrinus* means "the wandering falcon".

hack site until they learn to hunt on their own.

Adult peregrine falcons often return to areas near their original hack sites. Acadia discontinued the hacking program in 1987 when adult peregrines returned to the area, for it was feared these adults would prey upon any released chicks.

From 1987 to 1990, adult peregrines returned to Acadia but did not produce young. 1991 marked the first successful nesting at Acadia in 35 years! Since that year, chicks have been successfully raised here. Each year, in early spring, park resource managers watch intently for signs of returning peregrines. If mating or nesting behavior is suspected, certain trails may be temporarily closed to avoid disturbance to the nesting area. It is hoped these measures will help this magnificent falcon in making a triumphant comeback in Acadia National Park.

Banding

Banding peregrine chicks in Acadia National Park is an important component of the recovery program's success. Banding aids in learning more about peregrine migration, habitat use, and longevity. Since the 1920s more than 40 million birds of all species have been banded. Despite that impressive number, only about 5% are recaptured or recovered. Why put so much effort into what appears to be

limited success? Because the information gained from the 5% recaptured population provides biologists with vital data on migration, age, mortality, wintering areas, and life histories.

The United States Fish and Wildlife Service is responsible for banding and working with licensed cooperators. Permits are required to become a licensed bander. Special permission is required for capturing waterfowl, eagles, and endangered species.

Anyone finding a banded bird or spotting one should send that information to the bird banding lab in Maryland. Information should include: recording the band serial number, age, and sex (if possible to determine), condition of bird, and the precise geographic location. That information can be sent to:

U.S. Fish and Wildlife Service
Bird Banding Laboratory
Laurel, MD 20708

A certificate will be returned to you with information about the banding origin of the bird you found.

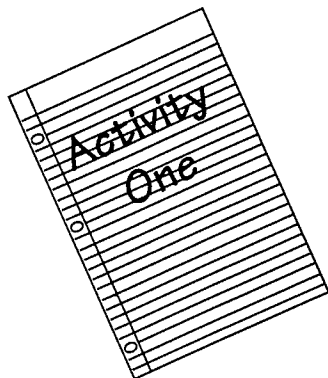


You can help protect and promote the conservation of peregrine falcons in Acadia National Park by:

Learning characteristic field marks and behavior to make a positive identification.

Reporting your sightings to any park information station.

Keeping away from areas where peregrines are nesting and reporting any person who fails to do the same. Avoid observing the birds from a location higher than nest site. Adult peregrines generally won't tolerate people above them and may dive at intruders, particularly if they are defending a nest or chicks.



Who Gets Saved?

Summary: Students research different endangered species and then create an opinion poll based on their knowledge of specific endangered species.

Vocabulary

Endangered Species - A plant or animal that is in immediate jeopardy of becoming extinct due to low or declining numbers.

Endangered Species Act (ESA) - A legislative act signed into law in 1972 designed to protect endangered and threatened plants and animals through recovery of the species. Recovery means that decline is halted or reversed. The goal of the ESA is to downlist these species by returning them as self-sustaining members of their ecosystems. Recovery programs work to: (1) identify ecosystems and species facing the greatest threat; (2) determine how to reduce or eliminate the threats; (3) work towards recovery by prioritizing species with the most immediate need; and (4) reclassify species as necessary.

Protection of individual species without concentrating on preservation of their habitat and other species they interact with is inadequate. The primary agency responsible for the protection of endangered and threatened species, the U.S. Fish and Wildlife Service, works with other agencies to protect the ecosystems these species depend on. Although there are still 728 U.S. listed species (as of 1992), there are many success stories due to the protection of the ESA. The bald eagle is just one example of this success.

Objectives:

Students will:

- ☐ Gain a better understanding of the diversity of plants and animals on the Endangered Species List.
- ☐ Use research and writing skills and learn interview techniques.

Materials:

- ✎ Listing of endangered species or biographies

Preparation:

If you do not have access to a listing of endangered species, you may want to acquire it by writing to the two agencies listed under resources on the following page.

Background:

The return of the peregrine falcon is an inspiring story. Due to the successful peregrine reintroduction program and the protection of the Endangered Species Act, they are making a comeback. Species with the amazing speed of the peregrine or the grandeur of the bald eagle are almost always guaranteed a supportive audience. But what if you are a snail? Or a grass? Is there as much of an outcry to protect you?

The value humans place on an individual species has a significant impact even though it may not translate into the importance a species plays in an ecosystem. People generally look at plants and animals in different ways. The emphasis on "who wins over whom" is very different with each perception. People may use the fol-

lowing four philosophies to rate the importance/significance of plants and animals.

1) Use to humans - Is the plant/animal directly used for medicine, shelter, food, clothing? Does the plant/animal play a critical role in an ecosystem? Is it an animal used for recreational hunting?

2) Aesthetic reasons - This can include religion and the artist's view. Wildlife and plants are seen in a different light that is not necessarily tangible. This category can include comments like "it makes me feel".

3) Potential Value - This is based on the possibilities of a species. For example, could certain plants or animals help in the fight against cancer? Those with this philosophy wish for all species to survive even if their use to humans is undiscovered. This belief leads to the idea that species in the greatest danger of extinction should be protected.

4) Diversity - The three views mentioned above use humans as the judge and jury. Despite decades of research, we do not know all the intricacies and interconnections of species. The fourth argument, one that is not voiced often enough, hinges on diversity. Diversity, both through species and genetics, is a key to stability in ecosystems.

Procedure:

1) Once materials are available, students can work in small groups researching plants and animals. Assigning four species per group is sufficient. If you are not using the resources listed, you may ask students to generate a list of endangered spe-

cies on their own. If using this option, request students to do a little research digging, otherwise the list may only consist of well-known species.

2) Information regarding their place of origin, preferred habitat or food (if animal), and why they are endangered should be included. Any information on the natural history of the plant or animal should also be included. With information gathered, students can create quick and easy reference sheets.

3) Once groups have researched their species, they should report back to the rest of the class on their findings. Another option is for students to complete displays or exhibits for the school.

4) Your class is now ready to develop an opinion poll designed to gather information about people's feelings regarding the value of certain species and the Endangered Species Act. With reporting concluded, the class should decide on 10 different species for the opinion poll. Very short two to three sentence descriptions of these 10 species should be written. Students determine what background questions should be asked in general about the Endangered Species Act in addition to asking people what species they feel should be protected. Students should also discuss who should be polled - other students? Their family? The community?

5) Be sure students understand what the Endangered Species Act is so they can let people know more about it. The opinion poll can take place in the school or at home or as a random community survey.

6) It's a good idea to have students practice questioning each other before interviewing other people. Remind students that this is a fact finding mission, not judgemental. People interviewed should feel comfortable in expressing their opinions. Students should realize there are many sides to controversial issues.

Discussion:

After conducting the research, discuss some of the reasons why plants and animals are endangered. Are some naturally rare? Are some "picky eaters?" Do some have very specialized habitat requirements? This may provide a good opportunity to discuss those issues - is it worthwhile to protect something that has such requirements? Why is it important to save these species? Some reasons that are often given include preserving the gene pool and maintaining species diversity. Discuss the results of the opinion poll. What different viewpoints did students find?

Resources

The Environmental Protection Agency publishes one page summaries of endangered plants and animals. To request a copy of these biologies, write to:

Director, Office of Endangered Species
U.S. Fish and Wildlife Service
Washington DC 20240
(or contact the Education Coordinator at Acadia National Park).

In addition to this listing, you may purchase from the Government Printing Office a copy of *Report to Congress, Endangered and Threatened Species Recovery Program*. Write to:

U.S. Government Printing Office
Superintendent of Documents
Mail Stop: SSOP,
Washington DC
20402-9378

Internet Sites

U.S. Fish and Wildlife - Lots of facts and some pictures.
<http://www.fws.gov/~r9endspp/endspp.html>

National Wildlife Federation - Lesson plans and fun facts.
<http://www.nwf.org/nwf/ed/wildlife/index2.html>



A Sample Opinion Poll

Here are some possible sample questions for an opinion poll.

1) Do you favor the continuation of the Endangered Species Act? (This is where students may need to give people some background information.)

2) If you had to choose, which would you give priority to - an endangered animal or plant?

3) List some reasons why you think it is or is not important to protect endangered species.

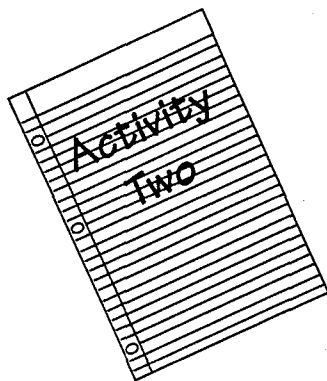
4) List in order of importance which of the following plants and animals you would try to save. Is this their real value? Are there other considerations that you would need to know before making a decision? (These are just sample plants and animals - students will use their own list and descriptions).

- * Missouri Bladderpod
- * Kentucky Cave Shrimp
- * Piping Plover
- * Florida Panther
- * Chisos Mountain Hedgehog Cacti
- * Hawaiian Dark Rumped Petrel
- * Devils Hole Pupfish
- * Mission Blue Butterfly
- * Grizzly Bear

5) If people want to know how to help, students can offer these suggestions:

- * Write to Congress in support of the Endangered Species Act.
- * Follow current legislation.
- * Watch their own actions at home. Recycling, energy conservation, and reduced use of toxic chemicals can all help.





Global Trekkers

Summary: Students trace the migration routes of 12 birds found at Acadia National Park in the spring and summer.

Vocabulary

Migration - To move from one region to another, either on an annual basis or seasonally. Migration can be as far as thousands of miles or shorter than 100 miles.

Objectives:

Students will:

- ☐ Use map skills to find the winter homes of 12 birds.
- ☐ Name some theories of why and how birds migrate.
- ☐ List two concerns people have regarding migrant bird species.

Materials:

- ✎ Bird list
- ✎ Map of North and South America

Background:

Acadia National Park's peregrine falcons only spend a few months here. Biologists are not sure where Acadia's peregrines spend the winter. Peregrine falcons have spent winters as far north as Manchester, New Hampshire and as far south as the Andes Mountains in Peru. Most of Acadia National Park's approximately 300 bird species are migrants on their way further north or south.

Birds migrate for numerous reasons, some of which are still unclear. For many birds, winter migration to tropical areas is a response to dwindling, northern seasonal food supplies (i.e. insects, freshwater, plants.) Their northward spring return may be to take advantage of breeding areas where they are less densely packed than in their tropical wintering grounds. Half of all migrant songbirds spend their winter crammed into six million square kilometers of land in Mexico and the Caribbean. Their summer range, however, is spread over 40 million square kilometers of land in the United States and Canada. Mi-

gration may also be an ancient response to the most recent glacial episode, when birds were likely pushed southward as the ice sheet descended from the north.

How are migrant birds, driven by centuries of evolution, able to make this amazing trek? There are many theories. Birds may have biological compasses allowing them to orient by celestial navigation (sun position and stars). For example, indigo buntings placed in a planetarium flew in the direction of their migratory route following the ceiling star patterns. Reversing the projected star map on the ceiling caused the birds to reverse their direction as well. Recognizing geographical features such as mountains, rivers and lakes and predominant wind currents and changing barometric pressure may direct migrants toward their winter and summer homes. Other theories include alignment with the earth's magnetic field or navigating by smell. Despite all these theories, migration and orientation remains an incredible mystery.

Although many migrants travel some amazing distances, there are some truly extraordinary migration stories. For example, the ruby-throated hummingbird, only about the weight of a penny, can fly 500 miles across the Gulf of Mexico in a 10 hour, nonstop night time voyage! Blackpoll warblers, which breed annually at Acadia National Park, fly over the Atlantic Ocean to South America in about 80 to 90 hours - NONSTOP! That is equal to a person running 1200 consecutive four minute miles. An amazing sight at Acadia National Park is the autumn hawk migration, best seen from Cadillac or Beech Mountain. On September 15, 1993, 671 hawks were counted in a six hour period!

Many birds not only migrate, but return to the same nesting area each year. Shearwaters, a seabird, taken from their nesting burrows in England and released in Boston, returned to their same burrows 12 days later! Acadia's peregrine falcons are another example of this homing instinct. The male peregrine on Champlain Mountain has been returning since 1988.

Banding is an important tool to help keep track of arriving and departing migrant birds. A purple finch banded in central Massachusetts turned up in Bar Harbor three days later. An Arctic tern banded as a chick in Greenland on July 8 was recaptured on October 30 in South Africa!

It is also helpful to have people watching for migrants. There is concern among ornithologists and avid bird watchers that migrant populations, especially songbirds, are declining. What these feathered global trekkers will find when they return to their summer and winter homes each year is hard to say. Deforestation of their wintering grounds, altered wetlands along their migration routes and/or fragmented breeding grounds due to development may greet them. There is also the added problem of chemicals banned in the United States being indiscriminately used in other countries. Political boundaries mean nothing to migrant species.

Procedure:

1) Ask students to define migration and name some birds that they know migrate. Ask students to think of some reasons why birds migrate. Tell students some amazing migration facts, such as those found in the background information.

2) Give students the list of birds and maps. Tell students that the wintering areas on the list show how far the predominate number of individuals within the species will migrate. Some may not go as far. Students should work in small groups and use the in-

How To Help

Here are some suggestions:

- 1) Discourage habitat fragmentation due to development of local woods and parks.
- 2) Plant and preserve native trees and bushes on your property.
- 3) Be cautious about the indiscriminate use of pesticides.
- 4) Join in bird counts in your local area.
- 5) Report sightings of banded birds.
- 6) Participate in your local chapter of the Audubon Society.
- 7) Support conservation organizations working in Central and South America.



formation for the 12 birds to place on their maps of North and South America. Or you may choose to display a large map on a bulletin board and have students place tags indicating where migrants head.

3) If desired, have students research each of the birds. A field guide would be helpful (see resources in appendix.)

Extensions:

Internet Connections

Try this site focusing on midwest peregrines. It features video of the nest, sound recordings of the chicks, and lesson plans about raptors.
<http://www.raptor.cvm.umn.edu/>

Journey North is an Internet-based learning adventure that engages students in a global study of wildlife migration and seasonal change. Up to the minute news about migration is exchanged between classrooms as students report observations from their own home towns.

Follow That Bird!



These birds are found at Acadia during the spring and summer. Where do they head for the winter? Sub-tropical and tropical climates far from the snows of Acadia National Park!

Peregrine falcon - Winters in Southern U.S., Mexico, Central America and West Indies. Has been found as far south as the Andes in Peru.

Ruby-throated hummingbird - Northeast Mexico and Costa Rica.

Robin - Southern U.S. to Northern Mexico.

Broad winged hawk - South from Guatemala to East Peru, Bolivia and southern Brazil.

Wood thrush - From eastern Mexico to Panama and Northwest Columbia.

White-throated sparrow - New York south to northeast Mexico.

Laughing gull - Southern coast of the United States to Peru, Columbia and the Amazon (coastal areas.)

Hermit thrush - Southern U.S. to Guatemala, El Salvador.

Blackpoll warbler - South America (some as far as Venezuela.)

Great blue heron - Southern areas of the United States and Mexico.

Yellow warbler - Northern Mexico

For more information contact:
Journey North
125 North First Street
Minneapolis, MN 55401
or call 612-339-6959.



A National Treasure

Persistent Pollutants

Chemicals manage to stay in the environment long after their obvious, deleterious effects result in prohibiting their use. For example, the banning of DDT did not get bald eagles out of the "chemical" woods. With a half-life of 35 years in Maine's cold, acidic soils, DDT still haunts Maine eagle populations. Maine coastal birds also have another claim to fame - the highest PCB levels found anywhere in the country.

PCB's are made of over two hundred different compounds and were once used in paints, adhesives, and fluids for lubricating machinery. Production halted in 1977 after studies indicated high levels accumulating in the environment. PCB's in humans may lead to birth defects, cancer, liver damage, and nerve disorders. In birds, PCB's cause reproductive failure through birth defects and eggs that aren't viable. High levels of PCB's can also kill eagles directly.

It is imperative to monitor these pollutants for their impacts on eagles and other wildlife in the Acadia watershed. Frenchman Bay, bordering Acadia National Park's eastern side, seems to be a hotspot for PCB's. Two possible sources for the contaminants are from the industrial midwest as airborne particles and from local paper mills and contaminant waste sites. The source of contaminants for Frenchman Bay is still undetermined.

Acadia's study area falls between Frenchman Bay and Blue Hill Bay to the west. Blood and feather samples from both the chicks and adults were tested for heavy metals and PCB content. From eagles tested in Maine so far, indications show coastal eagles with a higher level of PCB's present



Bald Eagles

Bald eagles, our national symbol, give each of us a sense of the wild. They are large birds with a wingspan of up to seven feet. Their characteristic white head and tail set them apart. "Bald" comes from an old English word meaning white. Their Latin name, *Haliaeetus leucocephalus*, means white-headed sea eagle. This characteristic trademark does not appear until they are between four and six years old.

Keen eyesight and huge talons assist in searching for their primary food - fish. Bald eagles also eat carrion and occasionally bully other birds to abandon food. On the coast of Maine, the majority of their diet is seabirds. Their preferred habitat is forested shoreline along open water. Eagles are found from British Columbia and Alaska, across Canada, and down towards Florida. In Maine, the highest concentration is along the rocky coastline.

in their system then eagles in other areas. Some levels are remarkably high. One mature eagle found dead in Frenchman Bay contained 430 ppm(parts per million) PCB's - a highly elevated level capable of killing an adult eagle.

In addition to the sampling work, chicks and adults were banded. Retrieved bands from the birds tell researchers more about the habits, daily activities, and longevity of the eagles. Two adult bald eagles equipped with

A milestone for bald eagles, as well as an outstanding achievement for the Endangered Species Act, was their removal from a federally endangered species to threatened on July 4, 1995. Populations are doing well in many parts of the country although habitat destruction and shooting continue to cause problems. Persistence of environmental contaminants like heavy metals (lead, mercury) and organochlorines (synthetic chemical compounds like DDT or PCB's) also continue to cause concern. In Maine, bald eagles are still endangered.

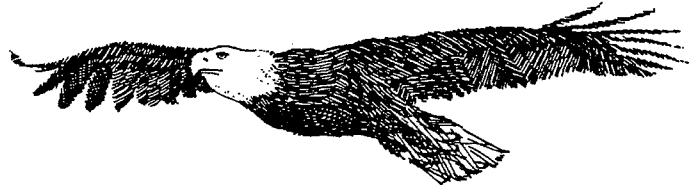
Acadia National Park's Concern

Bald eagles generally give birth to one or two chicks. Maine bald eagles are averaging less than one chick per pair. A statewide nesting survey flown in April 1992 indicated 140 nesting pairs with only 113 fledged nestlings, 30% below normal. The 12 to 15 pairs nesting annually in the Acadia area are nowhere near their potential productivity level. Reproductive failure estimates are at 40%. Unusually high levels of contaminants may be linked to this lower reproduction.

Bald eagles' top level in the food web make them an excellent barometer for an ecosystem. Their health reflects the condition of the system in general. Acadia National Park is an ideal location to answer the many questions regarding bald eagle reproductive failure because of its large bald eagle population and distance from major industrial areas.

Family Life

Eagles build large nests of sticks, known as aeries. Look for an eagle's aerie just below the crown of trees or on a ledge. Each year eagles return to the same nest site, adding more sticks. Some nests may eventually measure up to eight feet in diameter and 10 feet deep. Eagles raise one brood each year consisting on the average of one or two chicks. Both parents share in incubating the speckled white eggs for approximately 35 days. The white downy young rapidly grow to match their large "beak and feet" size.



It can take up to four months for flight feathers to develop on eaglets. Feeding occurs several times a day during this time. As the eaglets grow and strengthen, the parents provide whole prey for them to tear up. Wing flapping practice begins as they approach the date of their first flight. Imagine the eagle's amazement once they are airborne! Usually only one eaglet from the nest will make it to adulthood. Their life span may be as long as 30 years.

radio transmitters allowed researchers to track the traveling birds and may help in determining where they feed.

Other Factors

Maine is near the northern edge of bald eagle breeding range. Possibly, breeding rates are low because of weather. A recent harsh winter and cold, wet spring may be one factor in the premature death of some of Acadia National Park's adult bald eagles. A lower productivity rate (60% failure in 1996 in the Acadia National Park area) may be related to this as well.

Disturbance is another concern, creating stress both directly on the chicks and on the parents who must deliver food to the hungry chicks on a regular schedule. Five sites in the Acadia study are monitored for behavior related to disturbance. If you have caused an eagle to fly from its nest, then you have created a disturbance and are too close!

Bald Eagle Protection

The goal of the Endangered Species Act is to recover species to the point where they are again viable, self-sustaining members of their ecosys-

tems. The final goal is the removal of all species from the list. Animals listed as federally threatened, such as the bald eagle, still have the same amount of protection as those listed as endangered. Terms endangered and threatened represent the threat of extinction, not the level of protection.

Partnered with the University of Maine, Acadia National Park is working towards meeting this goal. The park's responsibility and commitment to protect bald eagles is clear. Monitoring their populations and the problems they face can only help in finding solutions to provide a healthier planet for all creatures.



The Road from Endangered to Threatened

In Maine, four criteria need to be met before the state will change the bird from endangered to threatened. They are:

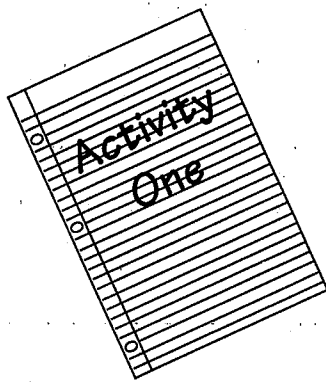
- 1) 120 nesting pairs for three years.
- 2) 120 young produced for three years in a row.
- 3) 50 nests in conservation ownership.
- 4) Change in the federal status.

At this stage, some of the criteria have been met. Reclassification will acknowledge the progress of Maine's bald eagles.

Acadia National Park staff specifically:

- 1) Continues to annually monitor traditional nesting sites, noting eagle residence, nesting activity, breeding success, and productivity of nesting territories on park property.
- 2) Monitors human disturbance to nesting pairs.
- 3) Attempts to find the cause of repeated nest failures.





Bald Eagles in Other Places

Summary: Students join in a letter writing investigation to determine the status of other states' bald eagle populations.

Objectives:

Students will:

- ☐ Gain skills in investigating agencies responsible for the protection of bald eagles.
- ☐ Gain skills in letter writing.
- ☐ Compile data and transform it into maps, graphs, and/or charts.

Materials:

- ✎ Writing materials (envelopes, stamps)
- ✎ Poster board
- ✎ Markers and/or paints for creating maps, graphs or tables

Preparation:

If you are interested in a guest speaker for your classroom, contact them early.

Background:

In Maine, the Department of Inland Fisheries and Wildlife is responsible for the management and protection of bald eagles in addition to other species. Other agencies, such as the National Park Service at Acadia National Park, and the U.S. Fish and Wildlife Service are also responsible for their protection. Private agencies, such as the Audubon Society, maintain a very strong interest in monitoring eagle populations. Every state has similar agencies overseeing eagle populations. State and federal agencies are required to protect endangered and threatened plants and animals and provide preservation of habitat.

Procedure:

1) Ask students to discuss in small groups questions they would like to pose regarding different states' bald eagles. To generate good questions, students need to know what type of data they are looking for. Questions might include: *What is the current population of bald eagles? Are there current research projects on-going with the eagles? What are the concerns? Are they reproducing well?*

2) Once a list of questions is complete, give student groups a region of the country to investigate where letters should be sent. Letters can be mailed to state, federal, and private agencies that might work with wildlife. Addresses can be found in a library (if they have phonebooks) or the Internet, if there is access. A list of state agencies is at the back of this section.

3) Letters should be written as a group and include a brief summary of Acadia National Park's bald eagles, a description of the project, followed by the questions. Be sure questions are clear. Fewer questions will have a much better chance of being answered than many. Expect one month to elapse before all information is in. Agencies not responding immediately are not ignoring student requests - it just may take them a while to answer.

4) Once responses are received, each group should review their information to use in an entire class discussion centered on sharing information and the best way to show the data. Would a written format or a visual approach work better? Is there a way to take the information and present it graphically? Some possible examples: (1) a color-coded map of the

country indicating states concerned with bald eagle populations versus those that feel they are doing well; (2) a graph showing reproduction rates in different states; (3) designing a table to be used to compile a variety of data. Let students determine the best method. The result can be displayed in school.

Resource List for State Agencies Responsible for Wildlife

These agencies may be contacted through state government offices.

Alabama Department of Conservation and Natural Resources

Alaska Department of Fish and Game

Arizona Game and Fish Department

Arkansas Game and Fish Commission

California Department of Fish and Game

Colorado Division of Wildlife

Connecticut Department of Environmental Protection

Delaware Department of Natural Resources, Game and Fish Division

Idaho Department of Fish and Game

Illinois Department of Conservation

Indiana Department of Natural Resources, Division of Fish and Wildlife

Iowa Department of Natural Resources

Kansas Parks and Wildlife Department

Kentucky Department of Fish and Wildlife Resources

Louisiana Department of Wildlife and Fisheries

Maine Department of Inland Fisheries and Wildlife

Maryland Forest, Park and Wildlife Service

Massachusetts Division of Fisheries and Wildlife

Minnesota Department of Natural Resources

Mississippi Department of Wildlife, Fisheries and Parks

Montana Department of Fish, Wildlife and Parks

Nebraska Game and Parks Commission

Nevada Department of Wildlife

New Hampshire Fish and Game Department

New Jersey Division of Fish, Game and Wildlife

New Mexico Department of Game and Fish

New York Department of Environmental Conservation

North Carolina Wildlife Resources Commission

North Dakota Game and Fish Department

Ohio Division of Wildlife

Oklahoma Department of Wildlife Conservation

Oregon Department of Fish and Wildlife

South Carolina Wildlife and Marine Resources Department

South Dakota Department of Game, Fish and Parks

Tennessee Wildlife Resources Agency

Texas Parks and Wildlife Department

Utah Division of Wildlife Resources

Vermont Fish and Wildlife Department

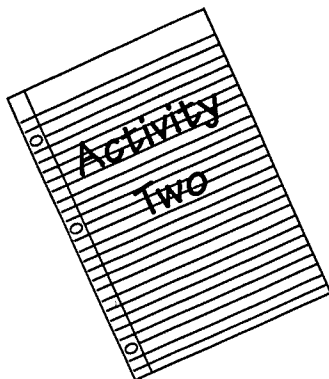
Virginia Department of Game and Inland Fisheries

Washington Department of Wildlife

West Virginia Department of Natural Resources

Wisconsin Department of Natural Resources





Where's The Point? Non-Point Source Pollution

Summary: Students look close to home for possible sources of environmental contaminants.

Objectives:

Students will:

- ☐ Name three potential environmental contaminants within the community, home, and/or school.
- ☐ Determine possible sources of environmental contaminants within the community.
- ☐ Discover three possible alternatives to some common household products.

Materials:

- ✎ Poster board for graphs

Background:

Environmental contaminants come from two sources point and non-point. Point sources are major and obvious - particulate matter from coal fired plants or discharge from sewage plants for example. Non-point sources are not as evident. They can include general run-off from agricultural practices or leaching of toxins in landfills to groundwater. The original source is not identifiable. For example, high levels of mercury, a neuro-toxin to animals, are found in areas of Maine where no identifiable point sources can be found. Mercury originates from coal-fired plants, smelters, factories, and solid waste incinerators found out of state. One of the highest levels of mercury in a Maine captured fish came from Hodgdon Pond on Mount Desert Island.

Industries release an estimated 22 billion pounds of toxic wastes into the air, water, and land each year. That

is an overwhelming amount. Pollutant culprits, however, do not come only from industry - each individual American plays a role too. Each person accumulates 160 pounds of household hazardous waste (anti-freeze, household cleansers, paint, lawn care products, etc.) on an annual basis.

Approximately 60% of environmental contaminants come from non-point pollution sources. These pollutants may eventually end up traveling through the food chain in water and terrestrial systems. Bald eagles, as well as humans, are far from exempt from that food chain. In different research studies done throughout the country and world, 45 different synthetic chemicals have been found in various animal species. Initial results show that large doses of these chemicals may upset hormonal systems, causing reproductive failure. Individually, these compounds may not leave any lasting effects; combined, they may represent time bombs.

Many of these chemicals are a threat because they do not break down quickly and are readily absorbed by the body. Individuals accumulate more and more contaminants. Biomagnification occurs when these high concentrations of toxins work through each level of the food chain, their effect magnifying as they approach the top.

Procedure:

In this activity, students investigate three areas where possible contaminants might be found and then chart and/or graph their findings.

Vocabulary

Biomagnification - Increase in concentration of a toxic element through food chains and food webs.

Contaminant - Any substance in the environment that causes an adverse effect to the environment and its inhabitants.

Non-point Source Pollution - Large or small unidentifiable places (crops, fields, streets, lawns) that discharge pollutants (fertilizer, oil from cars, pesticides, etc.) into the environment. The specific location of these pollutants cannot be obviously pinpointed.

Point Source Pollution - A single identifiable source that discharges pollutants into the environment (i.e. smokestacks, chimneys.) Point source pollution comes from an obvious location that can be directly found.

1) Ask students to inventory items found in the home (in the garage, under the sink, in the basement.) Items can include cleansers, beauty products (hair dyes, etc.), paints, and yard and garden products. Students may want to discuss with parents where the products came from and why they are used. Are some products more harmful than others?

2) Students should bring in their results and discuss them as a class. Any surprises? Any concerns? Let students decide how to categorize the types of products found and how they would display these on a graph. Are there alternatives to all these products? There may not be reasonable options to all of them. When, however, there is an alternative we should consider making it our choice.

Extensions:

1) Investigate where toxics (paints, batteries, etc.) should be dumped by visiting or calling the town office. Are there laws prohibiting the dumping of certain toxic substances in your community? Design an informational

pamphlet to distribute to the community to help them learn more about how to dispose of toxic materials and alternatives to their use.

2) Ask the school custodian about the products used at the school. Are there any alternatives?

3) Visit a local industrial plant (if any) to learn what measures they take to control pollution. A field trip of this nature should be considered informational, not confrontational. A visit to industry may offer students a clearer (or muddier) picture of the dilemma faced by American society.

4) Create a map of potential non-point pollutant sources in the community. Places to look at are: construction sites, residential areas, farmland, storm drains, sewage treatment plants, gas stations, parking lots, and underground gas and oil tanks. Where do students think these pollutants are headed? Are there surface water sources in your community? Include those water sources in your map.

Some Ideas for Product Alternatives

Floor Cleaner - One half cup white vinegar with one half gallon warm water.

Drain Cleaner - 1/4 cup baking soda, then 1/2 cup vinegar poured down the drain. When fizzing stops, flush with boiling water.

Toilet Cleaner - Baking soda and mild detergent.

Window Spray - Equal parts white vinegar and water.

Oven Cleaner - Baking soda, salt, and hot water mixed into a paste. Scrub with damp cloth after five minutes.





The Sweet Waters of Acadia

A canoe paddle ripples through the water while a loon's call is heard in the distance; screams of summer excitement at Echo Lake; an early morning sunrise along Ocean Drive. All these scenes possess a similar theme - water. Whether along the rocky coastline or an inland lake or pond, water is a central feature to an Acadia National Park experience.

Water Resources of Acadia National Park

Twenty-six lakes and ponds dot the Acadia landscape ranging in size from a few acres to almost 900 acres. Some are located entirely within Acadia National Park's boundaries while others are shared with private landowners and local communities. It may appear that these pristine lakes and ponds are untouched by human influences, but they are impacted by development within and adjacent to park lands. Increased water withdrawals, sewage disposal, and non-point source pollution are very real concerns.

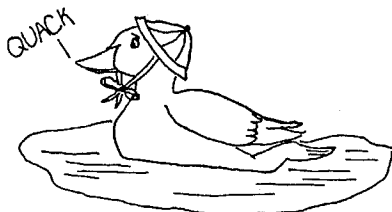
Other impacts to Acadia's water resources may come from oil or hazardous waste spills, landfills, and atmospheric deposition. In addition, Acadia National Park has limited jurisdiction over many of these water resources within the park boundaries. Seven towns, two counties, four municipal water districts and numerous state and federal agencies all hold interests in their management.

Considering these complications along with the heavy visitation to Acadia National Park, it is imperative that water resources be monitored closely. Acadia National Park's lake monitoring program provides baseline information characterizing physical and biological conditions. Information collected today supplements a data history extending back to 1942, providing a base to help identify future impacts and threats, and to document changes to these water resources.

Acadia's Monitoring Program

The program consists of sampling 15 lakes once in the spring and again in the fall. Surface temperature, pH, color, alkalinity and other measurements are taken. A subset of lakes within this larger group, selected for their fishery type, area, depth, productivity, human impact, and amount of existing data, are sampled monthly (warm weather months.)

Currently included in the monthly monitoring program are deep water lakes Eagle Lake, Jordan Pond and Echo Lake; shallower lakes include the Hadlock Ponds, Lake Wood, and Witch Hole Pond. Each of these are tested on a rotating basis. Monitoring includes pH, transparency, temperature, dissolved oxygen, and other tests.



For collected data to be consistent, each lake is monitored at the same spot each month and all sampling takes place between 9 a.m. and 3 p.m. Why are these tests important? What do they reveal about Acadia's water resources?

Temperature

Temperature influences numerous biological activities in water systems. The solubility of compounds, the density of water, the levels of dissolved oxygen, the distribution and abundance of organisms, and their metabolic rates (not to mention the comfort of swimmers at Sand Beach!) are all affected in one way or another by temperature.

Warm water is less dense than cold. This difference in density can create stratified water layers in the summer where less dense warm water sits on top of denser, colder water. This is thermal stratification. Oxygen levels also respond to this temperature gradient, with cold water holding more oxygen than warm. Organisms can be found at different levels according to their temperature preference as well as light and oxygen needs. The top warm layer (epilimnion), the bottom cold waters (hypolimnion), and the transition zone in between (metalimnion) are fairly distinctive during warm weather months in larger, deeper water systems.

Temperature can be measured with a thermometer or an electronic meter. Most of the lakes and ponds monitored thermally stratify. A few ponds, such as Lake Wood are shallow enough that the water warms to the pond bottom and stratification usually does not take place.

Dissolved Oxygen

Oxygen is as necessary for aquatic organisms as it is for terrestrial. Free oxygen in water, known as dissolved oxygen, comes from two primary sources - the atmosphere and photosynthesizing aquatic plants. Dissolved oxygen levels, recorded with an electronic meter or chemical tests, are measured in parts per million (ppm). These levels are an indicator of the life support system of a water body. Measurements of 5 ppm or less are not conducive to healthy water systems supporting a diversity of animal life.

The level of dissolved oxygen is influenced by many factors. A drop in dissolved oxygen occurs when oxygen is used by aquatic species and when algae, bacteria, and dead organisms decay. Very productive lakes produce more algae which in turn produce more oxygen. Mass die-offs of algae, however, deplete oxygen supplies due to decomposing bacteria's oxygen use.

During seasonal changes, oxygen levels at various depths change in part because of temperature stratification. For example, in the summer, oxygen from the atmosphere enters the warmer top layer. Although the colder water found below the warm water layer holds more oxygen, warm water's less dense nature causes it to "float" on top of the colder water, holding the incoming atmospheric oxygen. Because there is minimal mixing between the cold and warm water, little new oxygen enters into the lake system below a certain depth. In a sense, there is an invisible barrier. Whatever oxygen was in the lower depths before stratification is depleted through animal respiration and decomposition, and is not replenished until seasonal temperatures fluctuate again and mixing can occur, creating a more homogenous water column. When stratification occurs in a large lake, which would naturally hold more oxygen, this

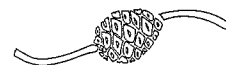
depletion may not have a large effect. Smaller lakes could seriously be affected however.

Consider fish that need colder temperatures. They need to stay below the epilimnion due to their temperature preference. Although there is enough oxygen already present at this level for their survival, very little new oxygen is being introduced into the system below this point. It is mainly being depleted. Many lake and pond ecosystems are generally capable of supporting aquatic populations during stratification. Concern arises when systems change due to outside influences which could affect the natural levels of dissolved oxygen.

Due to the fairly uniform water column temperature in Acadia's shallower lakes and ponds, dissolved oxygen levels remained moderate to high throughout the season. Eagle Lake and Upper Hadlock Pond, both of which thermally stratify, illustrate the change in oxygen levels clearly (see Activity Two). In 1994, Eagle Lake's oxygen levels dropped at about 12 meters but remained well above 5 ppm. Upper Hadlock Pond's oxygen levels dropped between 7 meters to 11 meters with oxygen levels below 7 meters at 4 ppm during August. Upper Hadlock Pond is significantly smaller than Eagle Lake. Its historically low oxygen levels in the summer suggest a need for continued monitoring to assure that outside influences do not cause more problems.

Transparency

Transparency, an important measure of water quality, indicates how far light can penetrate into the water column. It will change throughout the year due to spring and fall changes in algae and other dissolved, suspended material. Some reduction in visibility is normal; too much reduction may serve as a warning flag. For example, algae and zooplankton pro-



Eutrophication

A rapid change in the abundance of algae in lakes and ponds can result from additions of phosphorous and nitrogen. Eutrophication is a term used to describe this process. Some of the sources causing eutrophication may be natural while others may be related to human activities.

For example, algae can bloom profusely with the addition of nutrients from sources such as road/trail erosion, faulty septic systems or fertilizer runoff from lawns and crops. This "over-fertilization" may dramatically alter the water system. The rapid population growth of algae (algal bloom) may end in a rapid die-off. As dying algae sink to the lake bottom and decompose they use large amounts of available oxygen. If oxygen levels drop below 5ppm, it could result in a fish kill.



vide the base for the aquatic food chain. Too much algae, however, can reduce oxygen levels when they decompose. Too much silt could indicate local erosion and present a problem for gill breathing organisms, and limit photosynthesis. Yet a clear lake does not always indicate a productive or healthy one. Some lakes in the Adirondack Mountains of New York are crystal clear but unable to support fish due to high levels of acidity. Over a number of years, clarity monitoring can record changes which indicate decline or improvement in water quality. Ten to 15 years of bi-weekly monitoring in warmer weather months are necessary to begin to identify trends!

A simple tool for measuring clarity is the secchi disk. A secchi disk can easily be made by cutting an 8" diameter plywood circle and painting alternate quarters black and white. Adding a weight to the secchi disk and a tape measure attached to the center allows the user to determine at what depth the disk disappears.

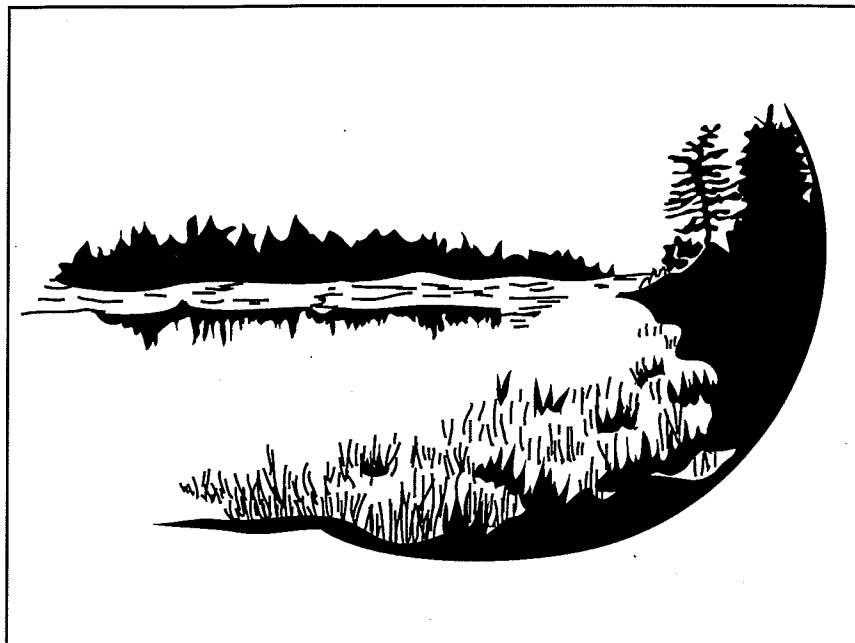
Generally a lake can be considered healthily productive if the disk disappears between 2m to 4m; moderately productive at 4m to 7m; and unproductive at 7m or more. Less than 2m can indicate water quality problems in the form of an algal bloom or heavy silt. Of course, there are exceptions to these rules. A disappearing secchi disk at 3 meters may indicate heavy siltation just as a visible secchi disk at 7m does not necessarily indicate an unhealthy water system.

At Acadia, some lakes are too shallow for accurate secchi disk readings. Eagle Lake's average secchi disk depth was 9.34 meters (unproductive) and Upper Hadlock Pond was 5.75 meters (moderately productive).

pH

Determining how acidic or basic(alkaline) a body of water is helps in determining the overall quality of the water and habitat suitability for organisms. The pH scale measures acidity/alkalinity on a scale of 0-14. Levels below 7 are on the acidic side; above 7, alkaline. The logarithmic measure of the pH scale shows for each increase/decrease in one pH unit, a tenfold increase/decrease in acidity or alkalinity. pH 3 is 10 times more acidic than pH 4 and 100 times more acidic than pH 5.

Although the pH scale ranges from 0 to 14, most organisms can only withstand pH levels between 5 and 9. The optimum pH range for most organisms is between 6.5 and 8.2. The pH levels of Acadia's lakes and ponds average around 6.0 to 7.0 despite lower pH level rainfalls. There is some con-



cern however, given the acidic precipitation of the area (average less than 4.6), that at some point a saturation level may be reached and the lake's buffering capability will not be able to compensate for continued acidic precipitation. Current studies indicate the buffering capacity of Acadia's lakes and ponds is remaining constant.

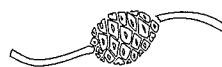
These four tests, give a snapshot of the shape Acadia's resources are in. They are not the only tests that can be conducted. Other tests that can be done to determine water quality include collecting E. coli bacteria (done on selected lakes at Acadia) and conducting various nutrient tests (for example, nitrogen and phosphorus.)

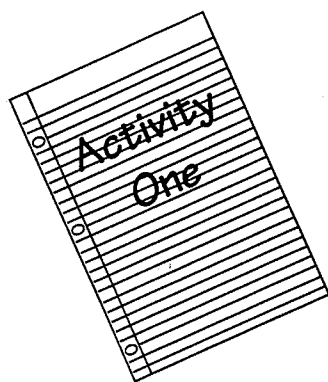
Acadia National Park's water resources are generally considered healthy and well suited to their uses despite current impacts. The continued monitoring of selected lakes allows managers to remain aware of significant changes which may indicate the need for better understanding or intervention. Monitoring also contributes information for the planning of future biological surveys and management plans. Acadia's monitoring programs aid in the protection of these precious lakes and ponds for the animals and plants that call them home as well as visitors who canoe and relax along their shores.



What is pH Anyway?

The pH number is a representation of the ratio of hydrogen ions (H-) to hydroxyl ions (OH+). Neutral (7.0) water has an equal amount of hydrogen ions to hydroxyl ions. Values below 7.0 pH indicate a greater number of hydrogen ions; values above 7.0 indicate a larger percentage of hydroxyl ions.





Dissolved Oxygen and Water Density

Vocabulary

Density - Ratio of mass of an object to its volume. When talking about water, cold water is denser than warm water, salt water is denser than fresh. This means warm water can float on cold water as can fresh water on salt.

Dissolved Oxygen - Oxygen dissolved in water. Measured as a given volume of water at a particular temperature and pressure, expressed in parts per million. To support life, aquatic systems need to hold dissolved oxygen at a level of at least 5 ppm.

Parts per Million (PPM) - Number of parts of an element, compound, or chemical found in one million parts of a particular gas, liquid, or solid.

Soluble - Ability of a substance to dissolve in a liquid.

Summary: Students conduct dissolved oxygen tests on different temperature water samples and create "density" rainbows illustrating the difference in density between colder and warmer waters.

Objectives :

Students will:

- ☐ Explain that dissolved oxygen levels decrease as water temperature increases.
- ☐ Use dissolved oxygen test kit.
- ☐ Demonstrate that warm water is less dense than cold.
- ☐ Experience "trial and error" in conducting an experiment.

Materials:

For Dissolved Oxygen

Four water samples made in advance:

Sample 1 - Water open to air with ice in it or put in the refrigerator

Sample 2 - Water at room temperature (leave sitting open)

Sample 3 - Water heated to about 100 degrees F

Sample 4 - Water heated to boiling

Thermometer

Dissolved oxygen test kit (available from LaMotte supplies - see resources in appendix.)

For Water Density

Test tubes

Water samples

Refrigerated water

Room temperature water

Water at 150 degrees

Food coloring

Eye droppers

Plastic clear cups

Index card

Paper towels!

Background:

See background information in previous section.

Dissolved Oxygen

Preparation:

Each water sample should be prepared in advance for testing. Water samples need to have the oxygen "fixed" (stabilized) so no new oxygen enters the sample. Prepare the above samples in wide-mouth and deep containers (buckets work well). Once the samples are prepared, take the collecting water bottle (usually included in a dissolved oxygen test kit) and put it under the water. You must be sure that there are no oxygen bubbles in the sample. To get rid of any, tip the top of the collecting bottle up before removing it from under the water. This should release any air bubbles. Cap the sample jar while it is still under water to prevent any atmospheric oxygen from entering. Use the appropriate chemicals provided with the dissolved oxygen kit to "fix" the samples in the collecting bottles. Once prepared, these bottles can wait indefinitely for the next step - determining the oxygen content. Code each bottle so you know the original temperature of each sample.

Procedure:

Levels of dissolved oxygen relate to water temperature - warmer waters hold less oxygen, cold waters hold more. This is due to oxygen's solubility in water. Oxygen is much more soluble in cold water than in warm. This activity clearly shows students this relationship.

Testing For Dissolved Oxygen

- 1) Students can work in groups or this can be used as a demonstration. If you would like students working in groups at the same time, you may need to purchase extra titrators. There should be enough chemicals with the kit for a class. Another option, if equipment is limited, is to conduct other experiments, such as the one on density included in this guide. Students can go through different stations in a round-robin fashion.
- 2) Set up the four jars (see preparation). Don't let students know the temperature of each one. Write the four temperatures of the samples on the board and explain to students that they will have to deduce which sample is at what temperature. Remember, since samples were fixed, it does not matter if all the jars are now the same temperature.
- 3) Using the Winkler method (instructions included in test kits), students can determine the dissolved oxygen content of each sample and then deduce the temperature.
- 4) Once students have completed the testing, have students graph their results, showing the correlation of dissolved oxygen levels with temperature.

Discussion:

What consequences does this have for animals that are in warmer waters? What problems could be caused by human activities that increase water temperatures? For example, power plants that use water from natural bodies of water for cooling dump the water back in at a higher temperature. What problems can this cause? What solutions are there? (Cooling towers so water is returned at the same temperature).

Extension:

If you have a classroom aquarium you may wish to test it for oxygen levels.

Water Density

Preparation:

Prepare water samples listed under materials for water density.

Procedure:

Density plays an important role in both the physical and chemical dynamics of lakes and ponds. Colder water is denser than warm water. Salt water is denser than fresh water. Having students experiment with different temperature water samples will allow them to observe the differences in density and guess the temperatures.



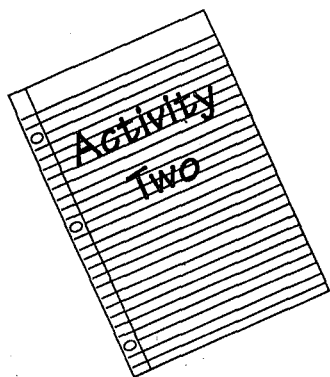
Density Rainbows

- 1) Prepare three water samples. One should be kept in the refrigerator, one at room temperature, and one that's been warmed. Use food coloring to add different colors to each one. Don't let students know what temperature each container is.
- 2) Using an eyedropper, students should take some water out of one container and transfer it to their test tube. It does not matter which sample they use.
- 3) The second sample should be placed on top of the first (it is best to have the water drip down the sides of the tube slowly instead of just dropping it in). The goal is for students to make a rainbow in their test tube according to water densities. There is bound to be some dumping of liquids until students figure out densities.
- 4) When they are done experimenting, ask students to identify the warmest and coldest water. How did they know?



Amaze Your Students!

As a demonstration to show density differences prior to the density rainbow activity and to amaze your students, try this. Using two plastic see-through cups, fill one with cold water (colored) and one with warm water (colored). Place an index card on top of the warm water cup. Place your hand over the card and flip the cup upside down (really- the card will hold the water in!) and place the cup over the colder water cup. Make sure the cup rims match and pull the index card out. The warmer water will float on top of the colder water - the color differences will make it obvious.



Acadia's Lakes and Ponds

Vocabulary

Dissolved Oxygen - Oxygen dissolved in water. Measured as a given volume of water at a particular temperature and pressure, expressed in parts per million. To support life, aquatic systems need to hold dissolved oxygen at a level of at least 5 ppm.

Epilimnion - The upper thermal layer that forms in lakes during the summer when warmer, less dense water is buoyed up by colder waters below.

Hypolimnion - The lower, colder thermal layer that forms in lakes during the summer when warmer, less dense water rises toward the surface, leaving the colder, denser water below.

Metalimnion - A thermal layer that forms in lakes during the warm season, in between the upper warm layer and colder layer beneath.

Parts per Million (PPM) - Number of parts of an element, compound, or chemical found in one million parts of a particular gas, liquid, or solid.

Thermal Stratification - Formation of vertical temperature zones in a lake or pond.

Summary: Using data and graphs from Acadia's lake monitoring program, students summarize dissolved oxygen, temperature, and depth correlation, as well as visualize summer stratification. **NOTE:** This activity may be more suitable for older grades which have had experience in graphing.

Objectives:

Students will:

- ☐ Use data in a graph form.
- ☐ Interpret graphs demonstrating dissolved oxygen, temperature.
- ☐ Explain why some lakes stratify and the implications for aquatic species.

Materials:

- Data tables and graphs
- Graph paper

Preparation:

Photocopy data tables and graphs.

Background:

Read background information in previous section.

Procedure:

This activity uses the actual data from the 1994 lake monitoring program. It shows the correlation between dissolved oxygen and lake stratification in the summer. Be sure students do not become confused by the level of dissolved oxygen expressed in the warmer waters versus the colder waters as being indicative of warmer water holding more oxygen. More oxygen is contained in the upper layers after stratification only because there is no mixing with the colder waters, hence no new oxygen is introduced into the system from the highly oxygenated surface waters. In

addition, both animals living below the metalimnion and the process of decomposition are constantly using oxygen. Before doing the graphing exercise, the other activities on density and dissolved oxygen levels in different water temperatures may be helpful for students to understand the data better.

1) Ask students to take the data for Eagle Lake temperature profile (table one) and graph the temperature and depth on graph paper. Temperature should run along the x axis, depth along the y axis. Let students decide what symbols or colors to use to distinguish each month.

2) After completing the depth temperature profile, students should make a second graph using the data for the depth/dissolved oxygen profile (table two). Place dissolved oxygen along the x axis and depth along the y axis. Again students need to decide what symbols or colors to use to distinguish each month.

3) After the graphs are completed, students should interpret the data. Some questions to assist them with this are on the following page. Once students have completed their own Eagle Lake graphs and understand the answers to the questions, ask students to look at the graphs for Upper Hadlock Pond. Ask them the questions found on the following page.

Extensions:

Water quality monitoring projects offer students an opportunity to be involved in a relevant project and offers teachers a chance to tie many disciplines together - social studies, history, math, science.

Eagle Lake Questions

- a) What reason can you give for the similar temperature at various depths in early June versus late June? What was happening in late June? *(Surface waters were beginning to warm.)*
- b) Early August shows some dramatic differences from June in temperature. Can you explain what the change represents? *(Lake has thermally stratified in August showing warm water on top of cold water.)*
- c) Where would you find the epilimnion (warm waters), metalimnion (transition area), and the hypolimnion (cold waters) for August? *(Above 10 m, between 10m and 15m, below 15 m respectively.)* Label these on your graph.
- d) How would you explain the drop in dissolved oxygen at different depths in the August sample? How does this correlate to the August temperature/depth profile? *(Because of stratification, little oxygen can enter below the metalimnion.)*
- e) If you were a cold water fish (liked temperatures below 16° C), at what depth might you be found in late August? *(Between 15 - 20m)* Remember, dissolved oxygen levels below 5.0 ppm are not healthy for fish. Where might you be found in late June? *(Around 7m)*
- f) Think! How can you explain the sudden dropoff of dissolved oxygen levels at the bottom of Eagle Lake? *(Think about all the dead stuff that falls to the bottom - all that decomposition uses up a lot of oxygen!)*

Upper Hadlock Pond Questions

- a) In what month did the pond begin to thermally stratify (show obvious differences in temperature?) *(June)*
- b) Where is the epilimnion in June? *(Above 2 m)* The metalimnion? *(Between 2m and 8m)* The hypolimnion? *(Below 8m)* . At what depth does the oxygen level change in June? *(11m)* How does the dissolved oxygen profile relate to the temperature change in June? *(Oxygen levels drop just below the metalimnion.)*
- c) If you were a cold water fish (prefer temperatures below 16° C) at what depth would you be found in early August? Remember, dissolved oxygen levels below 5 ppm will not support fish. *(Around 8 m where dissolved oxygen levels are between 5ppm and 6ppm.)*
- d) How would you explain the change in temperature profiles from August to September and October? What's changed? *(Fall turnover occurs and there is greater mixing in the water column; cooler temperatures in the fall drop surface water temperature.)*
- e) Explain why the graphs of Upper Hadlock and Eagle Lake show higher dissolved oxygen levels in the warmer temperatures and lower dissolved oxygen levels in colder. *(No new oxygen can enter deeper waters.)*

If your school is located near a pond, lake, river, or stream, you may want to take advantage of its proximity by setting up your own monitoring site. You can choose many things to monitor including dissolved oxygen and pH. You may also want to do a survey of the organisms living in the water bodies. The invertebrates found in a water system can offer clues to the health of the system. Following are some resources to help you get started.

Resources

The Volunteer Monitor (free newsletter)
Eleanor Ely
1318 Masonic Avenue
San Francisco, CA 94117
415-255-8049

The Lake Book
Libby Moore
Congress of Lake Associations (COLA)
RR 2, Box 391
Bayview Street
Yarmouth, ME 04096
207-846-4271

Izaak Walton League of America
(provides information and activities on monitoring streams)
1800 North Kent St.
Suite 806
Arlington, VA 22209

Clean Water - A Guide to Water Quality Monitoring for Volunteers
Monitoring Coastal Waters
Esperanza Stancioff
University of Maine Cooperative Extension
Sea Grant Communications
University of Maine/30 Coburn Hall
Orono, ME 04469
207-581-1440

Acadia's Lakes and Ponds - Data Tables and Graphs

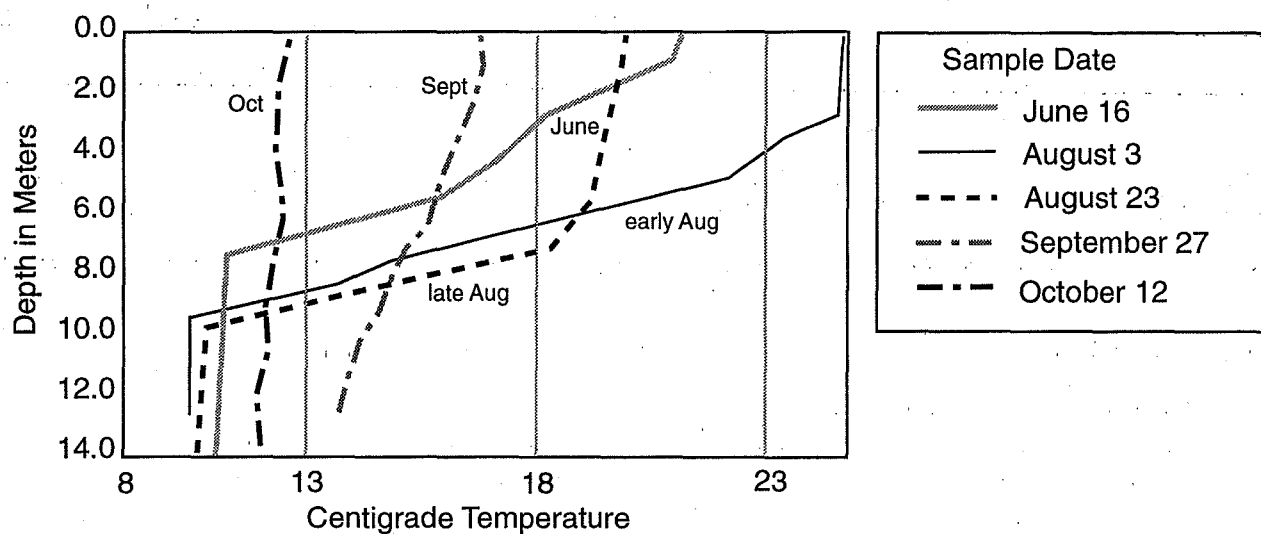
Table One - Eagle Lake Depth/Temperature Data - 1994

Temperature (Degrees Centigrade)				
Depth	Early June	Late June	Early Aug.	Late Aug.
0m	12.5	21	23.8	21
5m	12.3	18	23.5	21
10m	12	15	23.5	21
15m	12	14	15.5	15.5
20m	12	No data	15	15
25m	12	No data	15	15

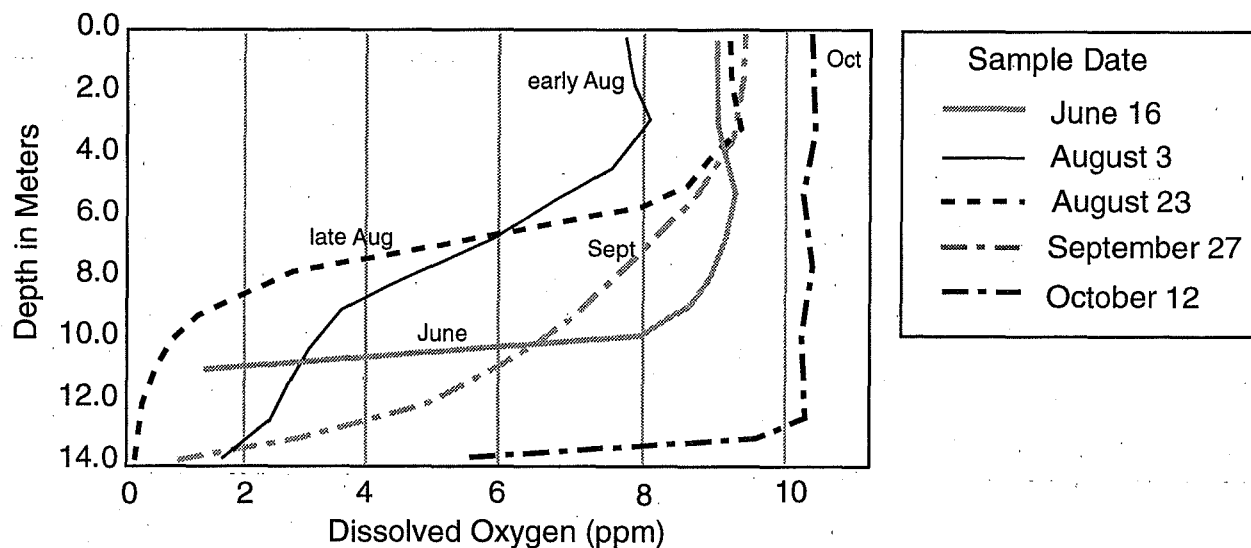
Table Two - Eagle Lake Depth/Dissolved Oxygen Data - 1994

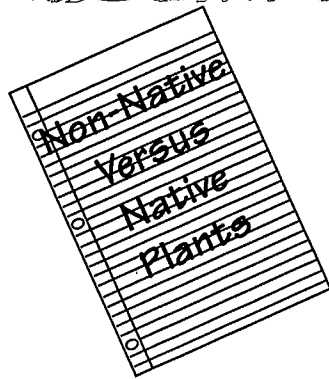
Dissolved Oxygen				
Depth	Early June	Late June	Early Aug.	Late Aug.
0m	9ppm	9ppm	8ppm	8.3ppm
5m	9ppm	10.1ppm	8ppm	8.3ppm
10m	9.2ppm	10.4ppm	8ppm	8.3ppm
15m	9.2ppm	10.1ppm	7ppm	6ppm
20m	10.1ppm	No data	6.1ppm	5ppm
25m	10ppm	No data	6.1ppm	4.3ppm
30m	No data	No data	0ppm	0ppm

Graph One - Upper Hadlock Pond/1994 Depth/Temperature Profiles



Graph Two - Upper Hadlock Pond/1994 Depth/Dissolved Oxygen Profile





Plant Invasions!

An exotic plant may bring the image of a brightly colored tropical flower to mind, but when a botanist hears the term exotic, they know it refers to a plant that is not native to an area. An exotic plant is one that has been brought, intentionally or unintentionally, into a region where the plant is not normally found. People may have deliberately brought a plant because it was a showy ornamental, or perhaps the plant arrived through seed in packing material or on people's shoes. Once established, a non-native plant can spread via carriers such as wildlife.

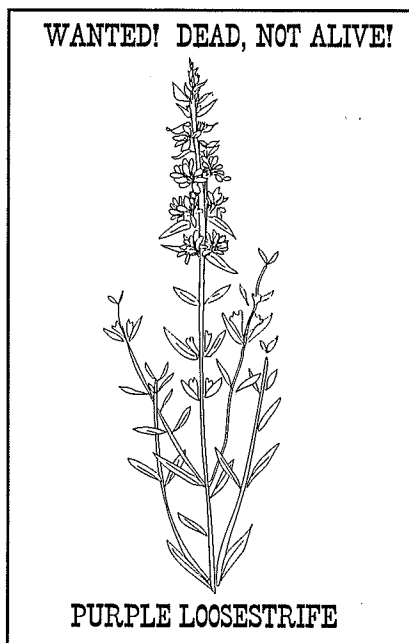
Exotic Examples

Sprinkled among the 1200 species of plants in Acadia National Park are almost 300 species of non-native plants. These plants journeyed to the Acadia landscape by escaping from gardens, through direct plantings, from seed carried by migrating wildlife, or from soil used as ballasts in ships travelling from Europe. For example, the familiar rugosa rose along the coastline is a relative newcomer. A native plant of Japan brought to the east coast of the United States in the 1600s, it has spread well along the northeast coast. It is now a common site along Acadia's rocky shore, mingling with the native red and white spruce, sheep laurel, and crowberry. Other examples of exotics scattered throughout the park are non-native lilacs and apple trees, remnants of old

homesites from the 1800s and the early part of the 20th century. The purple, blue, and pink fields of lupines are also non-native.

These particular examples of exotics do not directly threaten other plants or wildlife. Non-native species become a problem when they displace native plants that provide valuable habitat for native species. Peaceful coexistence becomes impossible.

Management of exotic species that threaten park resources or public health is attempted when it is prudent and feasible. Management includes determining whether a particular exotic will pose a serious threat to native resources, identifying and monitoring areas where non-native plants grow, and deciding what treatments will be effective. A prime example of this management scheme has been applied to purple loosestrife, an attractive yet serious threat to Acadia National Park's wetlands.



Purple Loosestrife

A showy, non-native perennial introduced from Europe, purple loosestrife has striking pink/purple or magenta colored flower spikes which bloom from mid-July through the end of August. Without its native European biological controls of insects and diseases, purple loosestrife threatens native plants and wildlife in wetlands by choking out native vegetation such as cattails. Mammals, fish, and waterfowl depend on the variety of aquatic plants replaced by a purple loosestrife monoculture.

Purple loosestrife thrives in wetlands, especially where soils are disturbed since it requires disturbed soil for germination. In some parts of the northeast, purple loosestrife has completely taken over wetlands, creating a monoculture by choking out native plants. In the summer, Maine Interstate 95 displays spikes of purple in drainage areas - evidence of purple loosestrife on the move.

Once loosestrife is established, it is hard to remove. Through management, however, Acadia National Park staff are able to contain loosestrife at low levels and work toward decreasing its population. Management of purple loosestrife includes preventing soil disturbance that would promote invasions in wetlands and the careful use of a herbicide on individual plants.

Acadia's Attack!

At Acadia, part of the original plan for loosestrife control was pulling loosestrife by hand (would you like that job?!). Loosestrife's extensive root system is difficult to yank completely, often leaving pieces of roots to resprout. Hand-pulling can also dis-

turb the soil creating a suitable habitat for germination. After a frustrating and failed attempt at handpulling, park biologists tried cutting and burning the flower heads to destroy the source of seeds, a procedure that may slow, but does not eliminate, loosestrife spread. Eventually this method gave way to the careful use of an herbicide on individual loosestrife plants. Any use of an herbicide in a national park requires adherence to strict guidelines. First, it must be determined that the use of the herbicide is the only reasonable option and that the problem, ignored, could worsen. Second, the chosen herbicide must have undergone rigorous testing and be considered safe for use by the Environmental Protection Agency. Approval for use must be obtained from the Department of Agriculture, National Park Service, and the Maine Board of Pesticide Control. The least toxic herbicide that remains in the environment for a very short time before biodegrading was selected.

Purple loosestrife is sprayed cautiously by Acadia National Park biologists. Instead of broadcast spraying an entire area, each plant is individually treated. Cutting the flower heads prior to seeding is an extra measure of insurance. To keep track of the control program's effectiveness, permanent grids of one square meter quadrats were established in wetlands where purple loosestrife was present. Each year, loosestrife stems over three inches tall are counted and population estimates are made based on numbers within the quadrats. Comparing data from previous years, park managers can determine if loosestrife is declining. The management program is currently being reviewed by a group of experts to assure that the park is using the best methods available.

Native Plants

Problems created by plants like purple loosestrife provide a clear example of the implications of non-na-



HOW YOU CAN HELP



Acadia National Park is working to protect native plants. You can actively help the survival of native plants in the park and at home by following these tips:

- Watch your step! While exploring natural areas, stay on designated trails to avoid crushing tiny plants underfoot and disturbing habitats.
- Check your own home or garden. Are the plants native to your area? Do their seeds spread to other areas?
- Contact local nurseries which sell native plants. Your local extension service, nature centers and garden clubs can also assist you with your gardening needs.
- Use plants native to your area and appropriate for your garden's conditions. Remember, plants that flourish in Acadia will not be successful in other regions.

Wilderness areas cannot be used
as a source for collecting plants.

tive plants in national parks. Charged with preserving natural ecosystems, National Park Service policies direct parks to use native rather than non-native plants for landscaping and revegetation within their boundaries.

Using native plants preserves the genetic integrity of native plant communities and assures compatibility with plants already growing there, increasing the chances for plant survival. Native plants have adapted over centuries to the area's climate and soils and need virtually little care. The base of the food chain for the area is formed by native plants that provide food wildlife depends upon.

Salvaging plants that would otherwise have been destroyed during the carriage road rehabilitation project is one example of how Acadia uses native vegetation. These plants are used to restore sites damaged from trampling and erosion, reduce or prevent visitor impacts, screen development from view, or stabilize soil during and after construction. Relocating these plants within the park guarantees that

genetically native materials are planted, versus those purchased at a nursery. Although nurseries may carry native species, the plants they sell are probably not the same genetic stock growing naturally in Acadia National Park. Another part of the project includes the collection of the seeds of 27 species native to Acadia. These seeds will provide native stock for future revegetation projects.

Acadia National Park's vigilant monitoring and control of purple loosestrife protects wetlands for native plant species and wildlife while the establishment of a native revegetation program is a vital part of the protection of all park habitats. Both of these projects are an important component in maintaining the park ecosystem intact well into the future.





Plant Patrols - Monitoring A Study Site

Vocabulary

Dominance - A measure of the most common distribution of a species within a community.

Quadrat - A square sample unit or plot that may vary in size, shape, number and arrangement depending on the objectives of the study.

Transect - Method of study using an imaginary line to help focus a count of species within a certain size area.

Summary: Students study plant communities using field methods such as quadrat plots and transects. As an extension, students can design their own field guides to the area studied and share the information with the rest of the school.

Objectives:

Students will:

- ☐ Use scientific based research methods, data recording skills, and graphing skills.
- ☐ Use math skills to determine plant dominance.
- ☐ Describe an area by types of plants found with the help of field guides.
- ☐ Recognize some common plant species.

Materials:

- ✎ Tall and short stakes
- ✎ 1 meter squares (can be made out of pieces of wood nailed together - perhaps assistance can be found in your school's industrial arts program!)
- ✎ Tape measure and string
- ✎ Sketch book for drawing or pressing plants (if you choose to collect)/ paper for field notes
- ✎ Field guides
- ✎ Graph paper

Preparation:

Check your proposed study site in advance for any safety hazards to students - bee nests, poisonous plants, etc.

Background:

Acadia National Park's management of purple loosestrife includes monitoring areas that were treated the year before with an herbicide. This yearly monitoring helps park biologists determine the success of the program and discover new growth of purple loosestrife in areas being controlled for purple loosestrife spread. Transects are set using a compass. Bearings are taken from a permanent point (often marked in the ground with a piece of steel bar) to a second point marked with a stake ending approximately 100 feet away. These bearings are duplicated each year. When the exact bearing is found again, a tape measure is attached from the starting point to the stake. The transect line is now ready to be used as a base line. Using a square meter lined up against the tape measure and moved down the transect line, biologists count purple loosestrife plants.

Procedure:

This method of study can be used when describing the plants of an area as well. In this activity, students follow a similar method as in the purple loosestrife study. By setting up permanent plots with a compass, the plots can be used year after year by subsequent classes.

This activity can take more than one class period unless you have double periods.

Follow the steps outlined in "Developing a School Yard Plant Monitoring Site" on the next page.

Developing a School Yard Plant Monitoring Site

1) Student groups will be responsible for setting up their own transect. A good group size is four students. Classes of twenty would then have five transect lines spaced evenly apart. A field is ideal for this activity.

2) Each group of students should first mark and stake the starting point for their transect line and plant study. (It is a good idea for you to survey the area ahead of time and decide on a random starting point before students begin the activity.) One student from each group should then walk from their group's starting point for a predetermined distance (could be 100 feet or shorter) with a tall stake and tape measure. Using a permanent stake for the starting point (such as a steel bar) will allow classes in the future to return to the same site and recreate the study.

3) Student should place the tall stake in the ground at the end of the transect line. Have another student site the stake using a compass

to establish a bearing. This bearing should be recorded. This will be important for re-establishing the plots in the future. For students just learning the compass, it may be easier to give them a cardinal direction (N, S, E, or W) prior to walking the transect and setting up the tall stake from the starting point.

4) Once the second stake is set, run a string between the two stakes marking the transect line (or if you have enough tape measures for each group, just leave them in place.) Students are ready to use their one meter square. The square should lay alongside the right side of the transect line at the starting point.

5) Ask students to look at the plants in the meter square and try to identify them with field guides, or just describe in detail what they find. Depending on the season, some plants will be easier to identify because they will be in flower or have obvious identifying character-

istics. Identification of all plants is probably not possible.

6) A journal will be very helpful for recording results. Unknown plants may be sketched or collected (if allowed) and pressed to be identified later. Students may also count the number of plants of each species. Another option is only to identify those plants that are dominant (greater number of them than other species.) Grasses, sedges and rushes are difficult to identify; your best bet is just to describe different grass types. For younger students, just noting the differences in plants will work fine.

7) Students should complete five samples using the meter square along their transect line. Determining where to put the square meter should be a random selection. This can be accomplished by throwing a stick along the transect line. Wherever it lands becomes the next sample area. This method avoids personal preferences in choosing a sampling location.



Discussion:

After each group has completed their transect, and all data is recorded, students can compile all data in the classroom. Ask students about their findings. How does this information help a biologist determine a plant community? Some possible activities to do with their data include:

* Estimate percent cover of the square according to each species found.

* Plot on a map the plants and their general location. A key should be included.

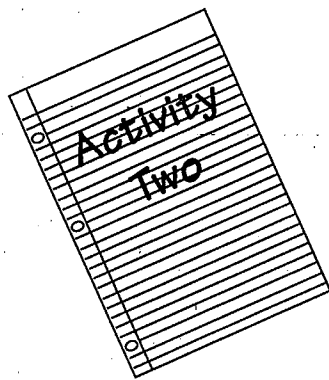
* Students can record their data at each square meter location and choose one of their meter squares to graph according to dominant plants. What plants were found? How many of each? Which ones seem to be dominant? To figure out species dominance, give students this formula.

$$\frac{\text{Total \# of one species}}{\text{Total \# of all species}} = \% \text{ Dominance}$$

The plant with the highest percentage is the most dominant.

Extensions:

How might students find out the percentage of non-native species? Botany field guides may be helpful. Look in the appendix for possible resources. You may want students to develop their own field guides to the study area. These can be shared with other classes.



Getting Along - How Seeds Move

Summary: Students collect seeds to examine the various methods of travel from a variety of plants.

Objectives:

Students will:

- ☐ Explain the different mechanisms of seed travel.
- ☐ Describe how certain seeds can travel long distances and enable plants to invade an area.

Materials:

- ☒ Small containers for collecting
- ☒ Seeds
- ☒ Masking tape
- ☒ Cardstock
- ☒ Colored pens and/or pencils

Background:

The spread of non-native plants is often facilitated by the plant's ability to move via seed dispersal. Seeds can be carried by wind, ingested by animals to be dropped elsewhere, or hitchhike, attaching themselves to anything that moves along. The wide variety of seed dispersal mechanisms are adaptations allowing the plant greater survivability as a species. The ability to take advantage of favorable areas for growth is an advantage. Once established, plants may have other adaptations that also help, such as spreading via roots. Purple loosestrife spreads primarily by seed (up to 2.7 million seeds per plant per year!) but once established, it can propagate from broken roots.

Procedure:

1) Let students visit different sites in the school yard to collect seeds (best time of year for this is in the late summer or fall.) Equipped with a small container and masking tape wrapped around one hand, (sticky side out - this is to help collect small seeds), students should try to find a wide variety of seeds by waving their hand through the plants. Tape can be wrapped on shoes as well. Another option for seed collecting is to wear socks over shoes or knit gloves on hands. A field is an excellent area for collection. In addition, have students collect berries and windblown seeds that they find during their walk.

2) If possible, students should try to identify the plant the seed comes from. Have students research how seeds travel. Some resources are included in the appendix of this guide.

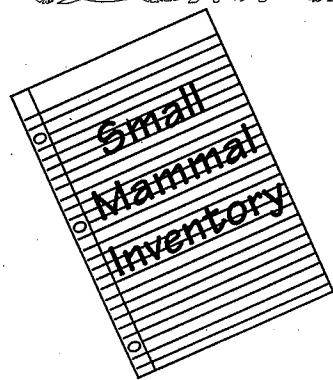
3) After researching the seeds' adaptations, students can make a seed card of their finds according to method of travel.

4) Hand out pieces of cardstock or cardboard. Fold the card in half. On the inside, glue or tape the seed (contact paper works well). On the outside cover, students should write how the seed travels and, if known, what plant it is from.

Extension:

Have students create their own moving seeds. What adaptations will they give them? Supplying students with materials like paper clips, pipe cleaners, Styrofoam packing materials, beans, toothpicks, cotton, etc. will elicit some creative adaptations!

Notes



Acadia's Little Creatures

National parks are valued for their preservation of outstanding scenic beauty, impressive geologic features, and multitude of natural resources. They serve as inspiration for people, and protect ecosystems for the park inhabitants - the plants and animals. Protection of these attributes for future generations is the responsibility of all of us - but for park managers, it is of the utmost priority. To meet the challenge of the preservation of these important areas, park managers need to know the park resources. This is not an easy task because the lands that became national parks didn't come with a list of everything found within the park boundaries.

Park Inventories

A careful list of resources is an inventory. The inventory adds to the general knowledge of park resources and assists park managers in addressing current and future questions. Although inventories serve an important role in providing basic data, an inventory is not an end in itself. Often it points the way toward further investigation. Fortunately for Acadia National Park, Mt. Desert Island had extensive scientific inventories conducted in the late 1800s and early 1900s resulting in numerous flora and fauna species lists. This work assists in guiding park management and research studies in the park today.

Not all of Acadia benefited from early scientific work, however. The 2000-acre mainland section of Acadia National Park on Schoodic Peninsula remained uninventoried until recently.

The Schoodic Inventory

Schoodic Peninsula is a one hour drive north from the main portion of Acadia National Park on Mt. Desert Island. Sharing the peninsula with the park is a United States Navy base, the staff of which are also concerned with the peninsula's protection. Because it is a protected area, Schoodic is a refuge from hunting and trapping for many animals. Coastal in nature, it may also serve as an important area during seasonal bird migration. This section of Acadia lacked basic biological information for both park and Navy managers to plan a management program. Conducting an inventory would provide the needed information.

Three study areas, two within the park and one on Navy lands, were established. The objectives for the entire Schoodic inventory were designed to:

- 1) Develop mammal, amphibian reptile, and plant species lists.
- 2) Identify federal or state listed endangered or threatened species and Maine species of management concern.
- 3) Identify non-native species and evaluate the extent of intrusion for the most invasive species.
- 4) Characterize forest communities.

The Small Mammal Inventory

With little historical documentation of the mammals of Schoodic Peninsula, each discovery was technically a new one. Besides generating a species list for the Peninsula, there was also interest in determining small mammal population density. Biologists chose the type and level of data required and the best research methods to meet the objectives. Inventory efforts such as the small mam-



The Proctor Study

William Proctor, of Proctor and Gamble fame, conducted a survey of the insects and spiders of Mount Desert Island between 1927 and 1945 "to add to the general knowledge on the insect fauna of a part of the Northeast section of this country." The thoroughness of his effort is best illustrated by some of his descriptions of collection sites and conditions:

Oct. 6, 1927 Stanley's Lobster Pound, Sea Wall. Old Lobster, clam shells, and fish refuse.

June 25, 1928 Salsbury Cove. Hatched from fungus found under birch log.

June 26, 1929 Long Porcupine Island, breaking up rotten logs, mostly birch.

June 6, 1938 Bald Mountain, West side of Island, sweeping blueberry flowers and wild cherry blossoms, PM.

Aug. 29, 1944 Town Hill cow dung, for beetles.

A survey this extensive which is over 50 years old is very rare. There is a proposal to repeat this survey to find out how the insect diversity on Mount Desert Island has changed over the past half century. Such a study would tell us a lot about the biological diversity of the coast of Maine, including whether that diversity is increasing or decreasing as pollution and summer populations rise.

What Good is An Inventory?

* Document Changes - To document changes, baseline data is critical for monitoring purposes. Identification of potential threats can only be supported by good historical documentation.

* Understand Ecosystems - This requires extensive data collected over a long period. For example, information gathered can provide insight into predator-prey dynamics or limiting factors of both plant and animal populations.

* Identify Sensitivity - Inventories can help to identify species that may be sensitive to disturbance or change. These species may serve as important environmental indicators and be similar to the role a canary in a coal mine once played.

* Further Monitoring - During an inventory, data collected may indicate a need for continued monitoring of an animal, plant or natural feature (such as a lake.)

* Make Decisions - Knowledge of the park resources and understanding their relationships can only enable park managers to make better informed decisions.

* Influence Others - Inventory information can be used to influence or convince others outside park boundaries who make decisions that could affect the park.

* Compliance with Legal Mandates - Protection of endangered and threatened species within national parks are in part the result of federal mandates. Inventories can help locate these special concern species.

mal survey are no small investment of time. Three hundred and seven hours were spent verifying the presence of 31 mammal species. Using the correct field methods saves time and money.

Obviously, determining population density cannot rely on counting every individual mouse living in 2,000 acres! Sampling a part of this population is one way to reach an estimate. Researchers with the small mammal inventory chose a sampling technique that uses transect lines. These straight lines, set with a compass, focus a population count within a specific plant community. Placement and length of the transect lines are randomly chosen according to the needs of the study. Recording the compass bearings and starting point for each transect line enables biologists to return to the same site in future years and recreate the same study. Information from subsequent year studies will help them learn more about the population dynamics of the species and area studied.

Finding the Little Creatures

Twenty 100 meter line transects with 11 trapping stations each were estab-

lished within the major identified habitat types. Two different sizes of live traps were placed at 10 meter intervals. Paying careful attention to assure limited mortality, researchers added dry polyfiber for bedding and moist cotton for water in each trap. Grasses and woody debris shaded those placed in open areas. Traps were set each evening and baited with a mixture of peanut butter, rolled oats, suet, raisins, and paraffin. Small mammals, such as the red-backed vole, attracted to this culinary delight, entered the trap and tripped the trap door closed.

After checking each trap in the morning, captured mammals were identified. Identification of a species was not as easy as opening up a field guide and matching a picture. For example, to identify shrews, dental patterns had to be used. For mice, saliva was collected and sent to outside labs to distinguish between two individual species. Tail, body length, and weight were recorded. To prevent recounting captured mammals, a small patch of fur was clipped from the back of each trapped animal before it was released.

The First Steps

Research is a way of asking questions. Much information, from identifying habitat type to observing species competition, can be collected through research, but to focus a study, specific methods need to be selected. With the objectives established, the remaining job is to fit the methods to the specific conditions of the study. Do you want to understand more about a mammal's daily activities or just need to know what mammals are present? Methods for this data collection may be as complex as radio telemetry or as simple as looking for indirect evidence of mammals. Do you want to know one species' population size or learn more about their relative abundance compared to other populations? Should the study use quadrats (study plots) or set up line transects? Again, the questions asked by the study will drive the methods. This is the art of science.

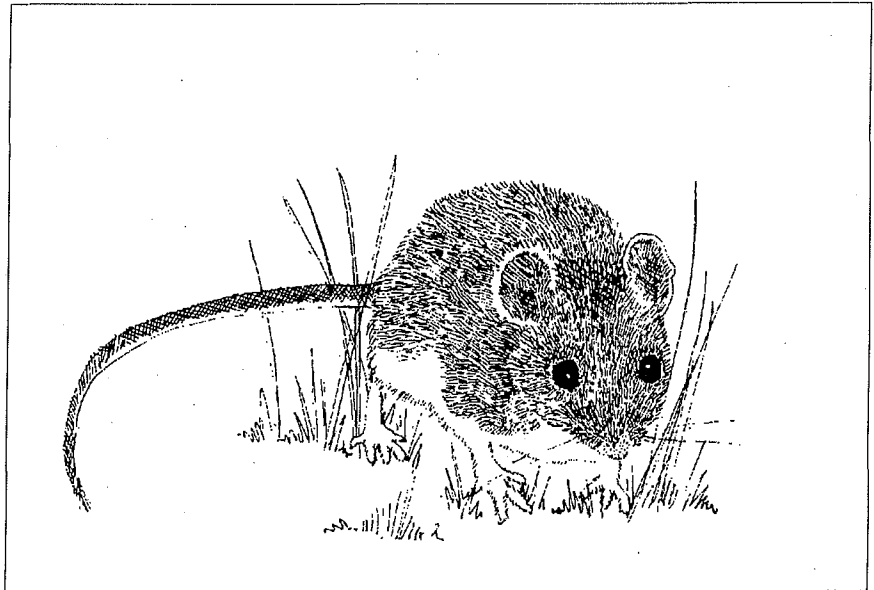
A straight line drift fence with pitfalls was another method used. Drift fences are short barriers placed in the ground with pitfall traps (often cans) placed at the end or somewhere along the length of the barrier. Pitfall traps are just what the name implies. As animals scurry across the forest floor they contact the barrier and try to run along the length of the drift fence only to drop into the pitfall trap. When the pitfall traps were not in use, weighted lids were placed on top.

Indirect methods of sampling yielded more information about medium to large mammals. This type of sampling is appropriate for generating a general species list but cannot reveal information about species density. Ground surveys were conducted to find feces, tracks, hair, lodges, and burrows. A .5m x .5m cleared area served as scent lure station. Animals attracted to the scent left tracks behind, evidence of their visit. Biologists checked the scent stations weekly and identified animal tracks of moose, coyote, porcupine, bobcat, feral housecat, snowshoe hare, river otter, striped skunk, mink, long-tailed weasel, white-tailed deer, muskrat, raccoon, gray squirrel, eastern chipmunk, red squirrel, black bear, and red fox.

In field work it is inevitable that there will be mortality. The goal of field researchers is to limit it as much as possible. Animals that do die are never discarded. Each death is preserved as a voucher specimen from the study site. Specimens are important to document species, allow for comparisons, and to assure the credibility effort of the study. The small mammal inventory did not collect specimens intentionally. Photos were the voucher information of choice, working just as well as preserved animals.

Biological Survey Discoveries

Simply generating a species list was an important component of the sur-



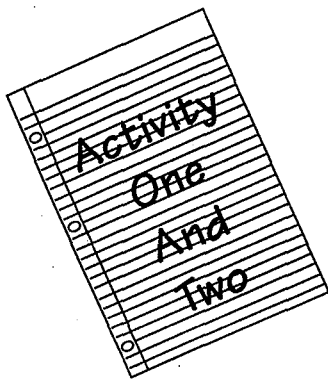
vey. Other important results were recommendations to continue another year of sampling and to carry on monitoring to track species diversity and mammal distribution. Long-term monitoring and management recommendations for the park and navy were also made.

The small mammal inventory, combined with the results from the four other surveys (plants, reptiles, amphibians, and forest type), was an important leap forward in understanding more about the Schoodic Peninsula ecosystem.

Of the nine amphibian and reptile species and 31 mammals identified, no federal listed species of concern were found; however one Maine listed mammal of concern, the northern long-eared bat, was identified. The presence of the white-footed mouse provided confirmation of the extension of its northeastern range limit. The forest community study yielded one stand of old growth forest. No federally listed endangered plant species were discovered, although 10 Maine listed threatened plants were found along with three state endangered species. Of the 335 vascular plants identified, 75 non-native species were documented with none being highly invasive.

This acquired knowledge of park resources is a first step in the continued protection of Acadia National Park. Equipped with information regarding Acadia's resources, park managers can make effective decisions. Park constituents can be sure these decisions affecting the park are informed actions based on a strong foundation of research.





Population Predictors

Vocabulary

Density - The number of individuals per area of habitable space.

Mark-Recapture - Method for determining population size involving capturing, marking and releasing animals and then recapturing or resighting them at a later time.

Summary: Students estimate a stationary population of beans based on wildlife census methods. After the initial estimate, their beans are on the move and populations need to be determined using capture-recapture techniques.

Objectives:

Students will:

- ☐ Estimate a population utilizing mathematical skills.
- ☐ Name two census methods used in field research.
- ☐ Explain how sampling a population can lead to an approximate number for that population.

Materials:

- ☞ Beans
- ☞ Paper bags
- ☞ Permanent marker
- ☞ Grid
- ☞ Masking tape

Preparation:

Count the number of beans before the activity. This will help to check the accuracy of student's calculations. (See following page for a quick way to count beans).

Background:

Wildlife census methods, an important tool in determining wildlife populations, can tell biologists the estimated population size, density, distribution and range of wildlife. Initial data compared with later data may lead to an understanding of the population's growth or decline, associated factors affecting that fluctuation, and potential relationships among different species' populations (for example: predator-prey.) The actual population number may not be critical. It is the monitoring of changes within that population that provides significant information.

There are numerous methods to census a population. Observation of animals will generate a species list and is one helpful method to give a sense of what lives in the area. A species number list is helpful to indicate the number of times a species was observed, but it cannot tell if you are counting the same animal more than once. Sampling is one way of selecting a portion representing the total population. Knowing the number of one species in a small area allows one to extrapolate the sample to a larger area. In any sampling method, it is imperative to maintain quality control and duplicate the same method when returning to conduct another sample. These next two activities demonstrate different sampling methods.

Procedure:

Quadrat Census Technique

Animals or plants that stay still (or don't move around much) can be sampled using a quadrat method. A quadrat is a small area marked off for use in sampling. Quadrat size (i.e. a meter or 10 square meters) depends on the size of the organism being sampled (trees vs. snails.)

1) This activity can be done indoors or outside. If your classroom floor is made up of square tiles you already have built in quadrats. If not, you can use butcher block paper and make a large grid. Determine the area you want to use (20 squares, 40 squares?) and tape off that section. The beans will be released in this area. You (the teacher) should know in advance the number of beans.

2) Randomly spread the beans in the quadrat area to be sampled. Students can work in pairs and pick one square to count the beans.

How to Count a Hill of Beans!

This can be done by estimating the weight. If you have a pound of beans, count the number in an ounce and then multiply by 16. This saves you from counting each individual bean!



3) After counting the first square, students should choose (randomly!) a few more squares to count and average the numbers. They now have an average per square.

4) Multiply that number times the number of squares and they have an estimate for the bean population in the entire grid. How does it compare with other groups? How does it compare with the estimate of the number of beans according to weight?

5) Ask students to collect the beans from the squares. Once the beans have been collected, hand out paper bags to each group of students. They should put their beans in the bag. Their population has changed now from one that remained still to one that moves around (in a confined area.) Using the quadrat method will not work. Why? (Animals could move in and out of the squares - one wouldn't know if a species had been counted twice.) A technique called capture/recapture can be used instead.

Capture-Recapture

1) Add more beans to each bag so students have at least over 100 (estimate.) Prior to the census method, let students guess how many beans they have.

2) Ask students to pull out 20 beans. Each one of these should be marked with a waterproof pen mark. Put beans back in bag and shake.

3) Remove another 20 beans. Count the number of beans recaptured. To calculate the population size using

the data collected, students can use the following formula (or challenge them to come up with it on their own.)

$$\frac{\# \text{ Beans pulled and marked}}{\# \text{ Marked beans recaptured in second sample}} = \frac{\text{Total population size}}{\text{Total marked beans}}$$

You marked 20 beans the first time. The second time you pulled out 20 beans and 4 of them were marked. Your estimate will be:
 $20/4 = N/20$ or $N = 5 \times 20 = 100$ beans in a bag.

4) Numbers will vary from group to group but should be in the ballpark of the total number of beans in the bag. If students want to check the accuracy, let them count the number of beans in the bag. How close were the estimates to the guesses? Just guessing is not an option in census - using estimates gives a much better idea.

Discussion:

What problems might occur? Do sampling methods ever cause the animals to die? How might this be reduced? How might animals be marked in the field? What cautions do biologists need to consider when marking animals?

Extensions:

Do the quadrat activity with plants outside. Use a one meter square or simply stretch a wire coat hanger into a square shape). Field guides can be used to identify plants (or just create descriptions of the various plants.) Have students count the number of plants for each species in their quadrat. How might they estimate the number in a larger area (a field for example?)

Capture-recapture can be done with grasshoppers or pillbugs and nailpolish. Place small dots of nailpolish applied with a toothpick on the back of the head (if working with grasshoppers it is best done in fall.) Try to mark at least 50-100 grasshoppers or pillbugs. Return the next day or week later to do a new count (grasshoppers/and or pillbugs do not need to be recaptured.)

Notes



Tracking Acadia's Deer

White-tailed deer populations at Acadia National Park have fluctuated in the past half century. Prior to the fire of 1947, which burned over 17,000 acres on Mt. Desert Island's east side, Acadia's deer herd was smaller than a few years after the fire. This increase resulted from the replacement of the predominant spruce forest with a forest abundant in the favorite food of deer - certain species of deciduous trees (such as birch) and shrubs. In time, these forests changed again due to the natural progression of succession. Finding browse for the larger deer herd became more difficult, resulting in overbrowsing and malnourishment. The population stabilized toward the end of the 1960s due in part to a selective hunting program in the park. The program ended once the deer herd was considered healthy.

Current Deer Populations

White-tailed deer, when provided with enough food and no outside control of their population (i.e., hunting or predators), have no self-regulating population controls of their own at first. Eventually, as the deer herd expands beyond their food supply, disease and/or malnutrition provide that control. Recent studies show that the quality and quantity of preferred food for white-tailed deer in Acadia National Park and the surrounding area is sufficient to support a larger population. Biologists compared Acadia's deer herd with stud-

ies of deer herds in other New England areas that have similar conditions of abundant food and no population controls. They discovered that Acadia's current deer population should be higher. Acadia National Park's estimated deer population is proportionally similar to deer herds in other parts of the state where hunting is allowed.

If Acadia National Park's deer population is low, what are the controlling factors? Is it caused by poor reproduction, predators, or another cause? Did the presence of coyotes in the Acadia area as of 1982 play a role? The deer fawn study complements previous studies on coyote/deer interaction and deer food availability to try to draw a conclusion to the question "What control mechanisms are affecting deer populations in Acadia National Park?" Researchers also had to decide what the most effective method of study would be to understand deer population levels.

Population surveys, which provided census numbers for deer before and after the fire of 1947, were not a viable option because of expense. Population surveys in forested areas often require many people doing visual counts of animals. Because of this limitation, a different approach was required to determine the soundness of the deer population by studying the number of fawns and their survival rate. How to assess the health of this population? By tracking fawns and does with radio telemetry.

Radio Telemetry

Radio telemetry aids researchers in learning more about the day to day movements of wildlife and their feeding habits, social interactions, and

White-Tailed Deer

White-tailed deer are extremely plentiful in the United States. Population estimates are at 12 million. The proximity of agriculture and forested areas provides abundant habitat for white-tailed deer and is one reason for their large populations. Deer, under good conditions, eat about 2.5 lbs. of food a day. The preferred browse in Acadia National Park is cedar and certain species of pine, maple, and birch. In addition, acorns, apples, alfalfa, and clover are favorites. During winter months, deer often congregate. Feeding is then at a minimum.

The results of the previous November's mating season are evident as does give birth, usually to twins, in May or June. To protect the young, the mother finds a safe and densely wooded area where the young's protective white spots mesh with dappled sunlight on the forest floor. Fawns barely move until 8 to 10 days old - their ability to remain still is their most important survival tool until they are able to run to escape danger. Does, attempting not to draw attention to the young, will leave for two to eight hours at a time to forage, and return only to nurse each fawn for a few minutes. People who stumble across fawns may mistakenly believe they have been abandoned and try to take them - usually to the detriment of the fawn. Deer are reproductively mature by one and a half years, and in their prime reproductive years until they are eight years old.



causes of death. Equipment consists of a directional antennae and receiver, in addition to the radio carried by the animal, whether as an ear tag, collar, or ingested. This equipment is supplemented by binoculars, tape recorder, notebook, maps, and compass.

The deer-fawn study used radio collars which constantly transmitted signals at different frequencies. These signals told the researcher whether the animal was moving or stationary. An animal's movement or lack of it and general location can be detected by determining the direction of several signal transmissions and using a compass and geometry skills.

Triangulation, the ability to geometrically determine an animal's position, is an important part of radio telemetry. A compass bearing is taken in the direction of the strongest signal. Bearings, preferably at 90° angles, need to be taken from different locations. Where these bearings intersect is the approximate location of the animal.

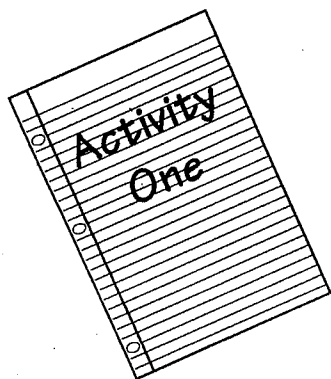
Radio telemetry was essential for finding and collaring the fawns for the study. Researchers first located pregnant collared does ready to give birth. Then, once the fawns were born, researchers searched for and collared them. Twenty-nine fawns were equipped with collars which expand and eventually fall off as the fawn grows.

Findings

What was learned from this study? First, most does were having twins, indicating that the does were in good health and that their food supply in the Acadia National Park area was adequate. If food availability was limited, does would respond by having one fawn or none. Although they may become pregnant with twins, their body absorbs one or both embryos in response to nutritional stress. Despite the health of the does and the area's potential carrying capacity, 17 of the 29 collared fawns died in their first year of life.

Predators accounted for 52% of fawn mortality, with almost half being killed by coyotes. Another source of mortality was domestic dogs. Deer chased to the brink of exhaustion by loose dogs are unable to fend off other possible attacks, including those by the dogs themselves. (One of the many reasons dogs are to be leashed at all times in the park.) Drowning and automobiles also contributed to their mortality. Results from the coyote/deer interaction study also showed that deer make up a large part of coyote's diet on Mount Desert Island. Their scat indicates that almost 40% of their diet at certain times of the year comes from deer (with raccoon being the next largest food choice.) The results of the deer fawn study coupled with previous studies seem to indicate that there is a natural control in place in the park - coyotes are keeping white-tailed deer populations below carrying capacity.





Track That Deer!

Summary: Using a topographic map, compass rose, and already established bearings, students determine five approximate locations of deer.

Objectives:

Students will:

- ☐ Apply geometry skills in locating five sets of bearings.
- ☐ Understand how triangulation aids researchers in determining wildlife locations.

Supplies:

- ▣ Compass rose (included)
- ▣ Topographic map (included)
- ▣ Rulers (transparent are best)

Preparation:

Photocopy topographic maps. Photocopy compass roses on transparency sheets. Compass roses should be cut out so each student has one.

Background:

At Acadia, researchers tracked deer by traveling and listening for the familiar beep of the radio collar. Once

the direction of a strong signal was detected, a compass was used to determine the exact bearing of the signal. At least one more bearing from another location was necessary to locate the deer. Where this line intersected the first bearing line was the probable location of the deer (with the consideration that the deer is moving and once a bearing is taken, it will change). Since the researcher must move to another area to get a second bearing, a certain amount of time will transpire which will translate into a potential change in the deer's position. Hence, it is an approximate location. It is more accurate for simultaneous bearings to be taken, but this requires more people.

Procedure:

1) Hand out page 44 and the compass roses. Review with students the cardinal directions on a compass and the degrees they are associated with. Review the orientation of the topographic map and the lines running N/S, E/W. This will help to align the compass rose to north.

2) Practice the first bearing with everyone. Students should place the center of the compass rose over the first location (1A) where the bearing was taken from, with 0 degrees lined up with the N-S lines on the map. Using a ruler to line up the exact bearing, mark the bearing on the map. Remove the compass rose and draw a line that intersects both the point of origin of the first bearing (1A) and the bearing just marked on the map. The deer is somewhere along this line. Repeat the exercise with the second bearing (1B.) Where the two bearing lines intersect, is the general location of the deer.

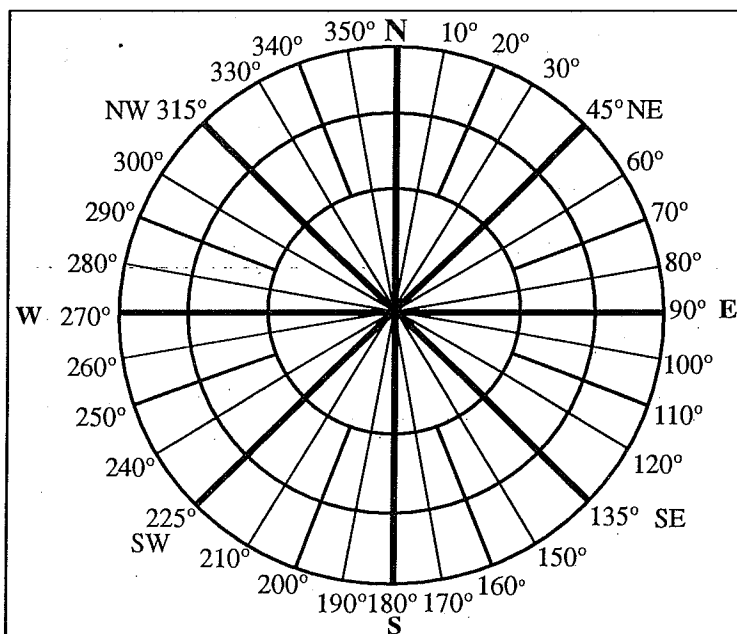
3) Have students complete the other bearings on their own.

Vocabulary

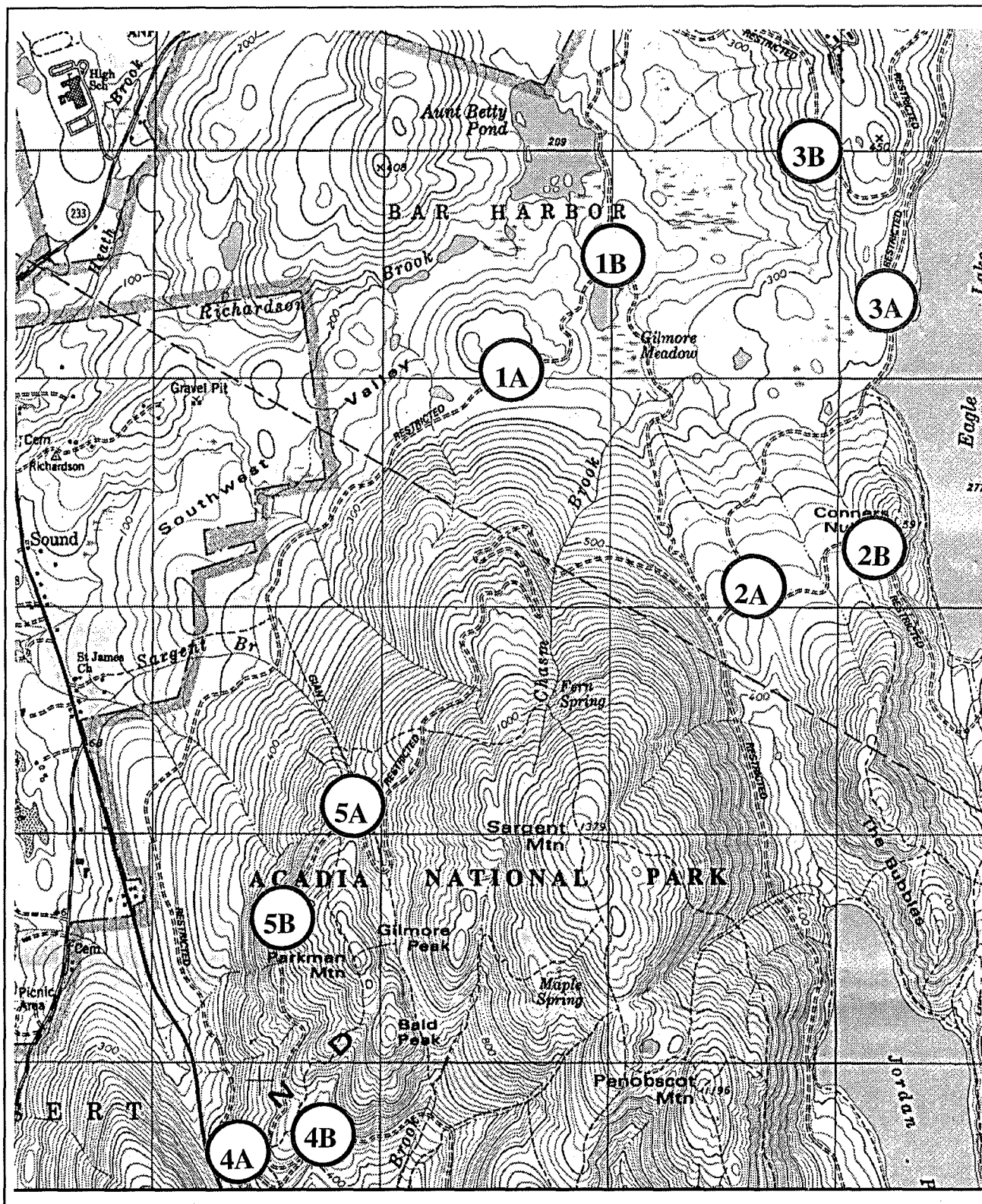
Bearing - Determination of a direction using a compass.

Radio Telemetry - A method of study in wildlife research that allows researchers to determine the location of an animal by placing radio transmitters on wildlife and then using the transmitted signal and geometry skills.

Triangulation - Application of geometry to find a position or location by means of taking a bearing from two fixed points a known distance apart.



Compass rose for placing on topographical map to determine bearings. Photocopy on transparency sheets for students to overlay on their maps.



Coordinates

1A - Due North

1B - Due West

2A - 45°

2B - 315°

3A - 290°

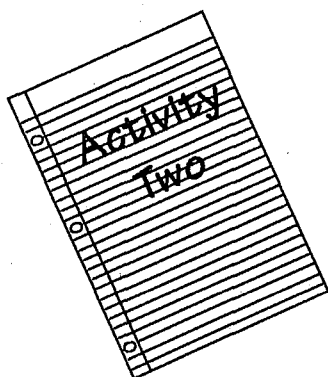
3B - 170°

4A - 30°

4B - 310°

5A - 250°

5B - 335°



The Ups and Downs of A Deer Herd

Summary: Students interpret a graph designed to simulate the fluctuations of a deer herd when carrying capacity is exceeded or when a predator is introduced.

Objectives:

Students will:

- ☐ Understand and describe carrying capacity and limiting factors.
- ☐ Interpret a graph showing events affecting a fluctuating deer population.

Materials:

- Graph worksheet

Preparation:

Photocopy worksheet. Read background information in previous section to share with students.

Background:

Wildlife populations are in a constant state of change. Fluctuations can occur on a seasonal or yearly basis or over a longer period of time. The size of a given population at any given time is dependent on carrying capacity and limiting factors.

Carrying capacity is the maximum number of individuals in a given population that can be supported in a certain habitat. Factors that play a role in determining carrying capacity are food, water, shelter and availability of space. When populations reach carrying capacity they will either fluctuate just a little above to a little below the carrying capacity of the area. If they greatly exceed carrying capacity of the habitat, the population will crash. A reflection of a habitat's carrying capacity is the number of births, deaths, and movement (both immigration and emigration) in a population.

While carrying capacity is dependent on habitat suitability, population in-

creases and declines are also dependent on other conditions. These limiting factors include predation, competition between species and individuals, migration, and climate. Human influences, such as pollution and habitat degradation are also limiting factors.

Procedure:

1) Review with students some of the changes that have occurred in Acadia's deer herd (from teacher background, pages 41-42.)

2) Hand out worksheets to students. Explain that the graph shows major changes in the white-tailed deer population over the past 50 years. The dotted line shows carrying capacity; the thick line shows the deer population. Below the graph are a number of events that have occurred influencing these fluctuations.

3) Students should first look at the graph, determine where large population increases and declines have taken place, and then read through the events. Students should try to place the event with the correlating letter on the graph. To help students get started, A is already identified.

4) The proper sequence of letters and related events is as follows: G, B, D, E, A, F, H, C.

Discussion:

What have some of the limiting factors been affecting the white-tailed deer population at Acadia? Where was carrying capacity exceeded? Why was it exceeded? How did the deer population respond? Why did the park begin a limited hunting program?

Extension:

Play *Project Wild's "Oh Deer!"*. Reference listed in appendix.

Vocabulary

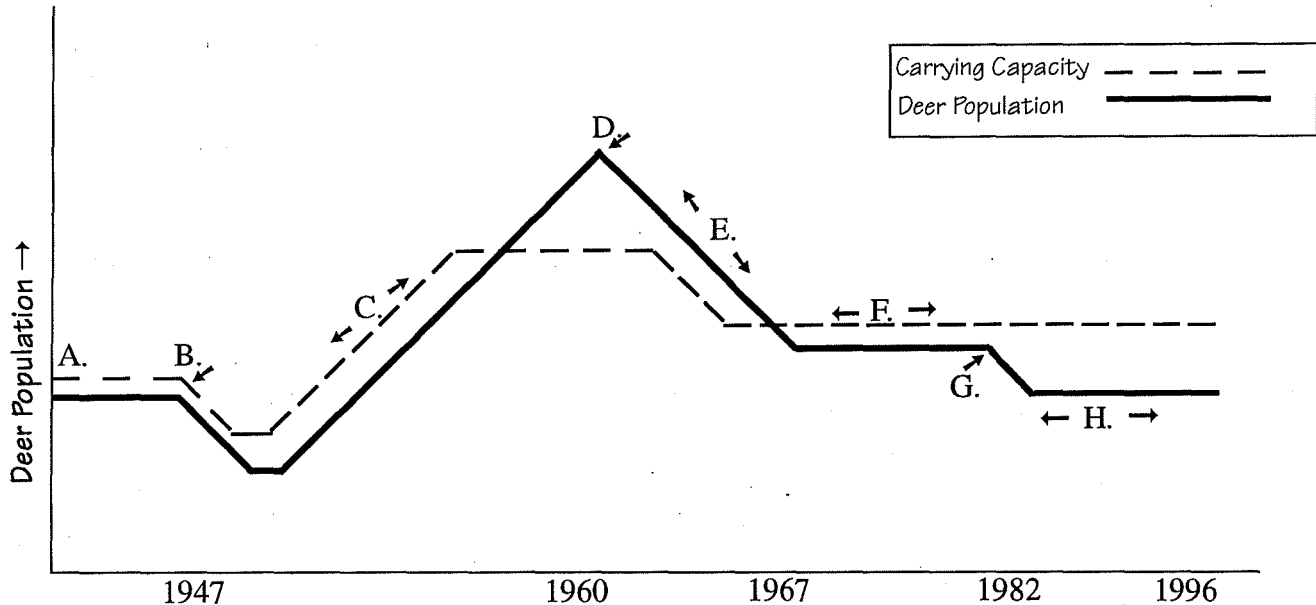
Carrying Capacity - Maximum population of a particular species that a given habitat can support over a period of time.

Limiting Factors - A habitat requirement such as food, water, shelter, etc. (usually in short supply) or specific conditions such as weather, predation, competition that will most likely affect individuals of a population so that the population does not exceed carrying capacity. If the habitat requirement becomes scarce, or the condition becomes more intense, the population may decline or become extinct. The response of wildlife populations to limiting factors varies among different species.

The Ups and Downs of A Deer Herd

This graph is a simulation of major events that have affected the white-tailed deer population in Acadia National Park. It represents the general trend of the white-tailed deer population over the past 50 years. It does not show the normal fluctuations of white-tailed deer population levels on a yearly basis.

Match the letter shown on the graph with the event you think it relates to.



- ☐ Coyotes appear for the first time in Acadia National Park and the surrounding area.
- ☐ There was a large fire which burned 17,000 acres of primarily coniferous forest on the eastern side of Mt. Desert Island and Acadia National Park.
- ☐ As the young saplings become taller trees, food became scarcer for the larger population of deer. Many deer are under nourished, becoming weak and sick. The deer population peaks and begins to crash.
- ☐ A limited hunting program takes place in the park to try to reduce the deer population to a more healthy level for the carrying capacity of the area.
- ☒ A At one time the eastern side of Acadia National Park was predominately coniferous with small areas of hardwoods.
- ☐ The white-tailed deer population are now at healthier levels. The park and surrounding area's habitat is able to support the population.
- ☐ Although many areas of Acadia National Park and the surrounding area can support a larger population of deer, the deer herd remains below carrying capacity.
- ☐ After the fire, the type of forest changed due to succession. Instead of a forest of red spruce and balsam fir, a young forest of birch, aspen and maple grew. These trees, in addition to other deciduous trees and cedar, are the preferred food of white-tailed deer. Young deciduous saplings are easily accessible. As the forest grew, so did the deer population.

Glossary

General Terms

Adaptation - A characteristic that improves the chances of a species' survival in a given habitat, allowing them to adjust to their environment.

Data - Factual information collected through measurement and observation to be used for analysis.

Ecosystem - All the living and non-living things found in a given area, such as plants, animals, sunlight, water and soil and their relationship to each other.

Erosion - Process by which earth materials (soil, rocks, etc.) are removed from one place and deposited in another.

Food Chain - Series of organisms, each eating or decomposing the preceding one.

Food Web - Complex network of many interconnected food chains and feeding relationships.

Habitat - Place or type of place where an organism or a population of organisms lives.

Monitoring - Watching one or more populations of a species or sites through time and recording observations.

Parts Per Million (PPM) - Number of parts of an element, compound or chemical found in one million parts of a particular gas, liquid, or solid.

Population - Group of individual organisms of the same species living in the particular area.

Productivity - A measure of the ability of an ecosystem to sustain life, including such factors as fertility, climatic conditions, and available sunlight and water.

Species - A population of organisms that is capable of reproducing among their own kind, but not with members of other, genetically different or geographically isolated groups. Offspring resemble one another in appearance, behavior, chemical makeup and processes, and genetic structure.

Vertebrates - Animals with a backbone.

Peregrine Falcons

Banding - A method to learn more about a wildlife species life history by placing numbered, colored bands on animals that can be identified at a later time if found.

Birds of Prey (Raptors) - Birds which are predatory, preying upon other animals. (Eagles, hawks, falcons, and owls.)

Endangered Species - A plant or animal that is in immediate jeopardy of becoming extinct due to low or declining numbers.

Extinct - When an entire species population no longer exists.

Bald Eagles

Biomagnification - The increased concentration of DDT, PCB's, and other fat-soluble chemicals that are slow to breakdown in organisms at successively higher levels in a food chain or web.

Contaminant - Any substance in the environment that causes an adverse effect to the environment and its inhabitants.

Mercury - A naturally occurring element that can be toxic to wildlife and people in certain forms. Methyl mercury (an organic compound having combined with carbon) is the most toxic. Inorganic mercury, often from industrial discharge, can turn into organic methyl mercury in nature.

Non-point source pollution - Large or small unidentifiable places (crops, fields, streets, lawns) that discharge pollutants into the environment.

Organochlorines - A man-made pollutant (dioxin, for example) created by combining carbon and hydrogen with other elements and chlorine. There are 75 different organochlorines.

PCB's - (Polychlorinated biphenyls) - A group of 209 different toxic, oily, synthetic compounds that can cause havoc in food chains and food webs as their effects are amplified traveling up through different levels.

Point Source Pollution - A single identifiable source that discharges pollutants into the environment. Examples include smokestack of a power or industrial plant, chimney of a house, or exhaust pipe of a car.

Threatened Species - A species that may become endangered if current population levels experience further declines.

Water Quality

Acid Precipitation - A form of air pollution formed from the combination of nitrogen and sulfur compounds with precipitation (rain, snow, fog) that has a pH lower than normal rainfall.

Alkalinity - Quality and quantity of compounds to bring a shift in the pH of a solution toward the alkaline side of the pH range.

Buffering Capacity - The ability of a solution to resist changes in pH.

Dissolved Oxygen - Oxygen dissolved in water. Measured as a given volume of water at a particular temperature and pressure, expressed in parts per million.

Epilimnion - The upper thermal layer that forms in lakes during the summer when warmer, less dense water is buoyed by colder waters below.

Eutrophication - The over nourishment of aquatic ecosystems with plant nutrients (mostly nitrates and phosphates) which can happen naturally or because of human activities. Human activities include: agriculture, urbanization, and discharges from industrial plants and sewage treatment plants.

Hypolimnion - The lower, colder thermal layer that forms in lakes during the summer when the warmer, less dense water rises toward the surface, leaving the colder, denser water below.

Metalimnion - A thermal layer that forms in lakes during the warm season, intermediate between the upper warm layer and colder layer beneath.

Mixing - A seasonal period when temperature currents and surface winds churn up nutrients from the bottom of the pond or lake and bring them to the surface. At the same time oxygen, from above is mixed into lower lake and pond layers. Mixing of waters will result in a more even water temperature throughout the pond or lake.

pH - A measure of acidity or alkalinity by measuring the percentage of hydroxyl ions to hydroxide ions. The pH scale ranges from 0 (most acid) to 14 (most basic) with a pH of 7 being neutral.

Productivity - (As related to water systems) The presence of important organic matter and nutrients at appropriate levels capable of sustaining a variety of life. These materials are constantly recycled in highly productive systems.

Soluble - Ability of a substance to dissolve in a liquid or semi-liquid (i.e., water or fat.)

Thermal Stratification - Formation of vertical temperature zones in a lake or pond.

Transparency - A measure of the ability of light to penetrate water, indicating the amount of living and non-living suspended solids and dissolved substances.

Native Versus Non-Native Plants

Dominance - A measure of the most common species within a community.

Exotic Species - Species that migrate into an ecosystem or are deliberately or accidentally introduced into an ecosystem by humans - some species may be beneficial while others are harmful.

Genetic Diversity - Variability in the genetic make-up among individuals within a single species.

Germination - Sprouting of plant seeds.

Herbicide - A chemical (man-made or naturally occurring) that is used to kill unwanted plants.

Native Plants - Species that normally live and thrive in a particular ecosystem.

Quadrat - A square sample unit or plot that may vary in size, shape, number and arrangement depending on the objectives of the study.

Systemic Toxin - A chemical that kills only the plant it is placed upon by working through its entire system, disrupting necessary biological functions.

Small Mammal Inventory

Density - The number of individuals per area of habitable space.

Drift Fence - An upright, fence-like structure usually made of metal or plastic, strategically placed, that intercepts a small mammal, reptile or amphibian as it moves along the ground.

Inventory - Study of a specific area to determine what species are present.

Mark - Recapture - Method for determining population size involving capturing, marking and releasing animals and then recapturing or resighting them at a later time.

Pitfall Trap - Can or bucket buried flush with the ground that traps small mammals, reptiles and amphibians when they fall into it.

Voucher Specimens - One or more collected representative individuals of a species serving to document the occurrence of that species at a site.

Deer Fawn Study

Browse - Refers to the twigs and leaves of woody plants eaten by deer (or elk and cattle) as food.

Bearing - Determination of a position using a compass.

Carrying Capacity - Maximum population that a habitat can support over a period of time.

Emigration - Migration out of individuals or populations of species from one area to take up permanent residence in another area. (Opposite of immigration.)

Over browsing - Overuse of browse by deer or other similar species that is in part the result of exceeding an area's carrying capacity.

Radio Telemetry - Using radio transmitters to track wildlife and then applying geometry skills to determine the location of the animal.

Triangulation - Geometry used for finding a position or location by means of bearings from two fixed points that are a known distance apart.

Appendix - Resources

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