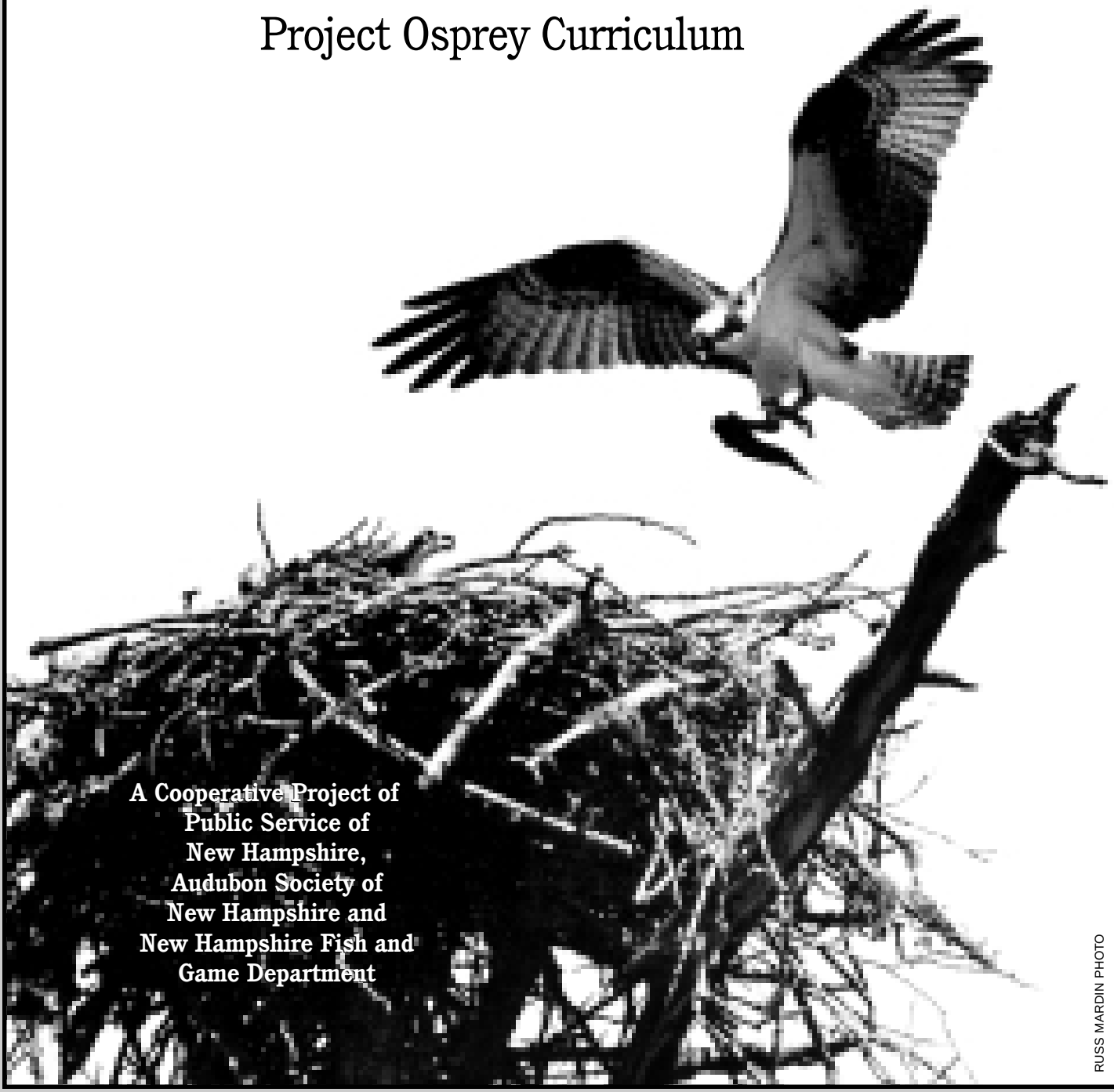
The Return of the Fish Hawk

Project Osprey Curriculum



A Cooperative Project of
Public Service of
New Hampshire,
Audubon Society of
New Hampshire and
New Hampshire Fish and
Game Department

RUSS MARDIN PHOTO

Project Osprey: A Partnership for Recovery

As a five-year project, the Public Service Company of New Hampshire (PSNH), Audubon Society of New Hampshire (ASNH) and the New Hampshire Fish and Game Department have joined forces to concentrate efforts on removing ospreys from the state's threatened species list. Project Osprey expands ongoing recovery efforts with the added benefit of a corporate partner, PSNH. It represents a major investment from a corporation and will result in the first recovery plan for a state-listed species.

Project Osprey has three goals: to foster a self-sustaining osprey population; develop a comprehensive educational program; and promote the partnership as a model for more collaboration among the business community, government agencies and environmental organizations.

The project began during the spring of 2000, with biologists developing a recovery plan and determining how strong the osprey population should be before it can be considered recovered. PSNH has long been a partner in osprey recovery by providing crews and equipment to erect artificial nesting platforms for ospreys. Project plans include the erection of fifteen more platforms. Nesting platforms are critical for attracting ospreys into new areas to spread out the distribution so they are not all concentrated in one part of the state. Once ospreys start using new breeding areas, others will follow.

The educational component of Project Osprey includes developing a teachers curriculum on ecological concepts, establishing a web site for students to keep tabs on the project, training volunteers to help monitor ospreys and even providing live video images of ospreys. Project coordinators are hoping to have cameras at a nest site that schools will be able to use to access real-time video of what's happening on the nest.

Public Service
of New Hampshire
The Northeast Utilities System

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A Teachers' Note

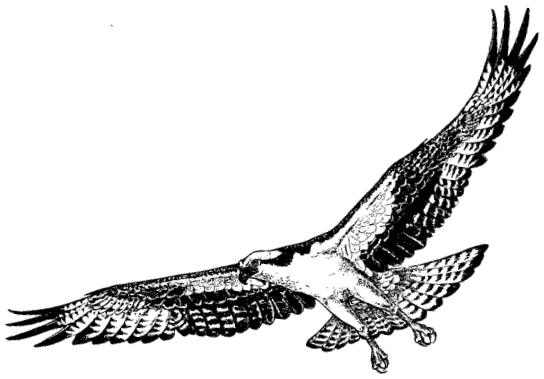
The Project Osprey teacher resource booklet contains a two-week, multi-disciplinary curriculum that focuses on ospreys. It can be used in its entirety or broken into parts that can be used individually as supplemental educational materials and activities. The informational materials and activities are designed for middle school students, but can be modified to reach both younger and older students.

The osprey resource booklet can be divided into four sections, each based on a specific theme. The first section "Osprey's the Name, Fishing's the Game," provides an introduction to ospreys and the physical and behavioral adaptations that make them unique among raptors; the second, "Poisoned!" focuses on food chain contamination; the third "How Many Ospreys Can Live Here?" provides an insight into habitat needs, limiting factors and carrying capacities; and the fourth, "Migration Gyrations," delves into migration issues. Each section contains background information and activities to provide interactive learning opportunities.

When preparing to introduce the activities to a class, teachers should read the four theme introductions and the background sections for each activity. They will help foster an adequate understanding of the four themes and the facts and concepts needed to lead the activities. You are encouraged to extend the activities with further discussions, additional research and by using some of the activities listed in the extension section at the end of most of the activities. You are welcome to copy any of the activity sections to use as handouts.

By far the most exciting and memorable activity for teachers and students would be a visit to one of the active nest sites located in different areas of New Hampshire. To arrange for a site visit with a trained docent in the Great Bay area contact staff at the Sandy Point Discovery Center in Stratham at (603) 778-0015. For information about other active and accessible nest sites in the state, contact staff at the Audubon Society of New Hampshire at (603) 224-9909 or check its website at: www.nhaudubon.org. Teachers in the north country may want to contact U.S. Fish and Wildlife Service staff in Errol at (603) 482-3415 for information about osprey viewing opportunities in the Lake Umbagog area.

Welcome Back!



How exciting it is to once again catch the sight of an osprey flying and hovering above, scanning a wetland or river for its next meal of fish. Once it spots its prey, it folds its wings close to its body, plummets down, then plunges in feet first with a great splash. It comes up moments later to fly off with a wriggling fish in its talons to take to its hungry young, waiting impatiently nearby in a huge nest of sticks.

Ospreys *(Pandion haliaetus)*, large, fish-eating raptors, sometimes referred to as fish hawks, are considered a threatened species in New Hampshire. Once relatively common breeders in the state, and all along the Atlantic seaboard, osprey populations plummeted to seriously low levels in the 1950s, 1960s and 1970s due to the widespread use of the chemical DDT as a pesticide on agricultural and forest crops. As with many North American raptors at the top of their food chains, high concentrations of DDT accumulated in the fatty tissues of ospreys causing them to lay eggs with shells so thin they broke during incubation. The New Hampshire population was decimated to a mere handful of pairs left in the remote, northern area of Lake Umbagog.

Ospreys are found throughout the world. The four subspecies are divided primarily by geographic location. One subspecies is found in Europe, and includes those ospreys inhabiting the northwest coast of Africa, and parts of Asia. A second subspecies is found in the Caribbean, a third in Australia and the fourth in North America. The North American subspecies can be divided, again geographically, into four populations, which are in the northwest, Mexico's Baja Peninsula, the northern Midwest (primarily Canada, but extending into Minnesota, Wisconsin and Michigan) and the Atlantic seaboard (extending around the coast of Florida to the Gulf coasts of Mississippi and Alabama). Fifty percent of the United States' ospreys are found on the Atlantic seaboard. It was that population, and to a lesser degree, the Midwest ospreys that were most seriously decimated by DDT use.

Now, more than thirty years since the 1972 ban of the use of DDT in the United States, ospreys are back and expanding their range in New Hampshire. It has only recently become an increasingly common sight to see ospreys hunting the shallows of Great Bay, an expansive coastal estuary in the southeast corner of the state, and along the Androscoggin River in more northern New Hampshire. In addition, breeding pairs can now be found at a number of sites in the Lakes Region and in the lower Merrimack River basin.

Human intervention in New England and some other areas is now helping, rather than hurting ospreys. It has been found that artificial structures, such as radio and light towers, power poles, buoys and special platforms are fast replacing trees as preferred nest sites in many areas. The artificial structures provide wide, sturdy bases on which to build nests and they are usually more difficult for predators to climb. Biologists feel that the osprey population in some portions of New Hampshire is limited by the lack of well-located, available nest sites. To address that need many folks in the state are working together to provide more artificial nest sites. In addition, they are working to educate the public about ospreys and ways they can help the state's small, but growing population.

Osprey's the Name, Fishing's the Game

Imagine trying to live and feed your family only on the fish you could catch with your "bare" hands, without the benefit of a hook, line, spear or net. Well, ospreys do just that. Both their similarity to hawks and the fact that they feed almost exclusively on fish have resulted in their being dubbed "fish hawks."

Ospreys are generally found in shallow fresh and saltwater areas, where schools of fish swim near the surface of the water. Ospreys spot and dive for fish from sometimes more than a hundred feet above the surface of the water. Plunging in feet-first, they catch fish in their talons, and emerge to fly with the fish to a nearby tree or nest site.

What makes ospreys so adept at hunting and catching fish, when other hawks are not? They have several adaptations, or specific evolved physical characteristics, that enable them to fill a niche that excludes other hawks. Perhaps most distinctive, are an osprey's feet and legs, which can be considered its hunting weapons. The talons are very long and sharp and can snap shut in 2/100 of a second. The base of the footpad and toes are covered with short, sharp spines that enable ospreys to grip slippery fish. In addition, they have a flexible outer toe that can reverse position, so there are two toes forward and two back for better gripping. Long legs, with few feathers, enable an osprey to reach well down into the water to catch fish. Once caught, the fish are turned so they are facing forward and can be carried torpedo fashion to minimize wind resistance.

Osprey beaks are strong and hooked, with a cutting edge for pulling and tearing loose bites of fish, which are tough-skinned and often bony. Plumage is dense and oily, which helps keep the birds dry, even when submerged. As with most birds, ospreys have a preen gland that produces oil which they work into their feathers to waterproof them. As with humans in most "waterproof" rain gear, though, ospreys will eventually get soaked in a heavy rain, or when repeatedly plunging into the water, which is often what happens when their fishing attempts are unsuccessful. Ospreys may die from the cold and wet, especially young birds that are not as adept at fishing.

Like most hawks, but unlike many other birds, ospreys molt their feathers in such a way that efficient flight is maintained at all times. They do not lose their flight feathers at the same time, but rather molt their primaries gradually, and in successive waves, starting near the body on each wing and working out toward the tip. Adjacent flight feathers are never molted at the same time.

Ospreys are strong fliers due to powerful musculature, a nearly five-foot wing span and a slightly bent wing shape. Imagine the strength an osprey must have to take off wet from the water carrying a wriggling fish in its talons that weighs up to thirty percent of its body weight. In addition, unlike most other birds of prey, ospreys do not rely on wind currents and thermals to help them during migrations. In fact, they are able to minimize the distances they travel during migrations by flying directly over large bodies of water, rather than around them as most raptors do.

Raptors: Check Them Out!

(adapted from Adaptation Artistry: Project WILD ©Council for Environmental Education 2000 and Peregrine Falcons - the Flight to Recovery: Right on With Raptors; Colorado Division of Wildlife)

Duration: 2 - 45 minute classes

Materials: art supplies; field guides that include raptors

New Hampshire curriculum frameworks supported: science: 3b, 3c; language arts: 3, 6

Objectives

Students will be able to: 1) define the term adaptation as it applies to plants and animals; 2) identify and describe three raptor adaptations; and 3) describe five adaptations specific to ospreys and the advantages they provide.

Method

Through research and discussion, students identify raptor and osprey characteristics and create their own ospreys.

Background

Raptors, also called birds of prey, have several similar behavioral and physical characteristics. They are carnivorous; have strong, hooked bills for tearing flesh; have powerful feet with long talons (claws) for grasping prey; and forward-facing eyes for acute long-distance vision. There are many kinds of raptors, including ospreys, owls, hawks, eagles, falcons and vultures. Each has characteristics that distinguish it from other raptors.

Ospreys are large, fish-eating hawks that plunge into the water from high above to catch fish with their talons. Osprey feet have a pivoting outer toe and sharp scales, which enable them to catch and grasp slippery fish.

Owls are silent, mostly nocturnal (nighttime) hunters. They have large eyes that gather large amounts of light, enabling them to hunt in darkness. They also have cup-like facial disks around their eyes, which help focus sound and improve hearing.

Falcons have narrow, pointed wings that help them to fly fast and maneuver skillfully. They have black eyes, hooked talons and conspicuously notched bills (tomial teeth).

Vultures are scavengers (carrion eaters). They have unfeathered heads, which is an important adaptation for carrion-eating birds that poke their heads into carcasses to feed. Strong feet and sharp talons are not as important to carrion eaters because they don't catch and transport live prey.

Accipiters are woodland-dwelling hawks. They have long, squarish tails and short, rounded wings that enable them to maneuver through trees as they hunt for small birds.

These characteristics are adaptations that enable raptors to survive in their unique environments.

Procedure

1. Discuss the term adaptation as it applies to animals and plants.
2. Define "raptors," including mention of the species identified in the background information and general characteristics that separate them from other types of birds.
3. Provide the "Raptor Adaptations" list (included) on the board or provide the list as a handout. Working in small groups using the adaptations list and field guides have

students list two adaptations specific for each of the raptor species identified in the background section; and briefly describe advantages of those adaptations.

4. Create a chart on the board based on each groups' findings.
5. Discuss ospreys in further detail, including their habitat, fishing habits and techniques, and the fact that they migrate long distances each year. Have students work individually or in small groups to design and create an osprey based on what they know about its lifestyle, by drawing or sculpting it (or by another artistic technique), with at least five specific adaptations that would enable it to function well in the niche it occupies.
6. In addition to each artistic creation have each group write a list of the adaptations it has selected, the reasons for the adaptations and the advantages they provide.
7. Have groups share their creations with the class, describing the specific adaptations and their advantages.
8. Provide as a handout or on the board a list of osprey adaptations and share photographs or illustrations that show the adaptations that have evolved and how they make ospreys uniquely suited to their niche as "fish hawks." Students can compare their creations with what has evolved naturally.

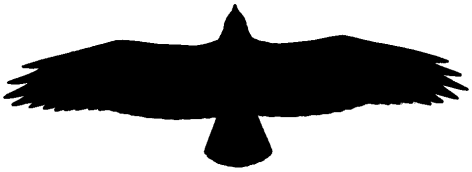
Extensions

1. Write a story from the perspective of an osprey. Students can describe what they see and feel as an osprey perched in a large tree or hovering above the water in search of fish.
2. Collect pictures of raptors, including ospreys, to develop a bulletin board showing some of the adaptations discussed.

Ospreys have long, slightly bent, pointed wings and medium-length, rounded tails.

Falcons have long, pointed wings and long tails.

Turkey vultures have long, narrow and slightly rounded wings and long tails.



Eagles are a kind of large buteo-like hawk with wingspans of 1.8 - 2.5 meters (6 to 8').

Accipiters have short, rounded wings and long tails.

Buteos are high-soaring hawks with long, broad wings that hunt during the daytime.

Raptor Adaptations

Raptor Characteristic	Survival Advantage
• strong, hooked bill	tearing flesh
• powerful talons	grasping prey
• small, unfeathered head	keeping clean while eating carrion
• broad, long wings	soaring, searching for food
• long, narrow, pointed wings	skillful maneuvering and speed
• short, rounded wings	maneuvering through trees
• short flight muscles	long distance flying
• notched bill (tomial tooth)	shearing neck of vertebrate prey
• soft fluffy feathers	muffling sound
• large eyes	good vision at night
• facial disks	keen hearing

Osprey Adaptations

Talons designed for catching and grasping slippery, wiggling fish

- very long and sharp
- can snap shut in 2/100 second
- base of footpads and toes covered with short, sharp spines
- flexible outer toe that can reverse position, so there are two toes forward and two back

Legs for reaching well-down into the water

- long
- few feathers

Beaks adapted for pulling and tearing loose bites of fish

- strong and hooked
- cutting edge

Plumage needs to be waterproof and arranged to enable flight at all times

- dense and oily
- preen gland
- molt flight feathers gradually and in successive waves

Wings for strong flight for carrying fish out of the water and long migrations

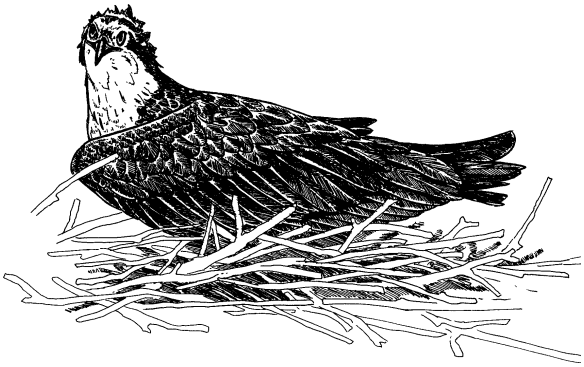
- powerful muscles
- slightly bent shape
- long

Poisoned!

Humans and wildlife are intricately connected to each other and to the earth, which we all share. Our ability to manipulate the environment to seemingly better suit our needs, and the close connection human actions have with wildlife populations, presents us with a great responsibility and unique challenge. The earth's ecosystems are so intricately woven and delicately balanced that even seemingly small changes or disruptions can have long-reaching, devastating effects.

The effect of human actions on wildlife became clearly evident in the 1950s and 1960s when populations of ospreys and other raptors, including eagles, brown pelicans and peregrine falcons, in the United States dramatically plummeted to nearly unrecoverable low levels. Scientists linked the population declines to the widespread use of DDT *(dichlorodiphenyltrichloroethane)* as a pesticide. To reduce insect damage and enhance productivity, agricultural crops across the country were sprayed with DDT. Water runoff from snowmelt, rain and irrigation carried the deadly chemical into water systems where fish and other aquatic organisms were poisoned. Also, contaminated insects and plants were eaten by fish and small birds, thus passing the poison directly to them. Those fish and birds were then eaten by raptors, which accumulated the chemical in their bodies.

The accumulation of chemicals in organisms in increasingly higher concentrations at successive trophic levels, or higher steps in a food chain, is called biomagnification. Scientists found that DDT accumulates in the fatty tissues of birds, mammals and fish and that it passes through food chains. In other words, in the case of ospreys, the birds fed on large quantities of fish, which had eaten insects



contaminated with DDT. Each fish had eaten many contaminated insects, thereby accumulating the DDT from each of those insects. Then, although each fish may not have had a high level of the chemical in its body, ospreys ate many of them. The amount of DDT each osprey accumulated was the result of it being magnified by the number of fish it ate.

Researchers discovered that high concentrations of DDT caused liver changes in the birds, which led to a decline in certain hormonal levels in females. Although the birds did not usually appear affected, the amount of calcium the females could use to produce eggs was reduced, resulting in thin eggshells. When the adults tried to incubate the eggs, they broke. It was also found in some cases, that DDT seemed to change the behavior of the parents, causing them to abandon their young.

Considering the role DDT played on the demise of raptor populations and the potential threat it posed to the health of humans, its use was banned in the United States in 1972. It does, however, continue to be manufactured in this country to be sold and used in other countries, such as those in Central and South America, where many ospreys and other raptors migrate and spend the first two or three years of their lives. In addition, even after the application of DDT is stopped, it can continue to be present in the environment for decades. Just because DDT is no longer used here, does not mean ospreys and other raptors are free of its effects.

Ospreys and the Deadly Link

(adapted from Hazardous Links, Possible Solutions: Project WILD: © Council for Environmental Education 2000)

Duration: 2 - 30-45 minute classes, with research time between

Materials: White and colored drinking straws; pipe cleaners; poker chips; approximately one-inch squares of construction paper; or multi-colored, dry dog food - about thirty pieces per student, two-thirds white or plain and one-third colored; one bag per mayfly (approximately 18 - 20)

New Hampshire curriculum frameworks supported: science: 2a, 2b, 3a, 3b; social studies: 2, 4, 14; language arts: 5, 6

Objectives

Students will be able to: 1) give examples of ways in which pesticides enter food chains; 2) describe possible consequences of pesticides entering food chains; and 3) explain the process of biomagnification in a food chain

Method

Students become ospreys, trout and mayflies in a physical activity.

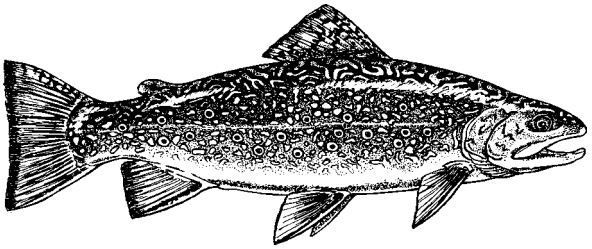
Background

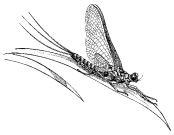
Pesticides are chemicals, often synthetic, inorganic compounds, developed to control organisms that have been identified as pests under some conditions. Herbicides are pesticides that control unwanted plants; and insecticides are pesticides that control unwanted insects. Pesticides frequently have unintended affects that extend well-beyond the target area. Not only can they poison non-target organisms, they can persist in the environment long after their application has ended, continuing to affect the food and water supplies of humans and wildlife for many years. In addition, biomagnification, which is the accumulation of chemicals in organisms in increasingly higher concentrations at successively higher trophic levels, can play a serious, unanticipated role. It results in the storage of the chemicals in the fatty tissue of organisms high in the food chain at much higher concentrations than would normally be found.

Public pressure is forcing changes in the application and availability of pesticides. For example, there is growing interest in integrated pest management. This agricultural approach considers the entire farm and garden ecosystem. Integrated pest management can include using a pest's predator as well as other biological controls to reduce crop damage. Integrated pest management also can include the selective use of naturally occurring and synthetic pesticides, as well as habitat manipulation. One concern with this approach is the possible introduction of non-native species.

Procedure

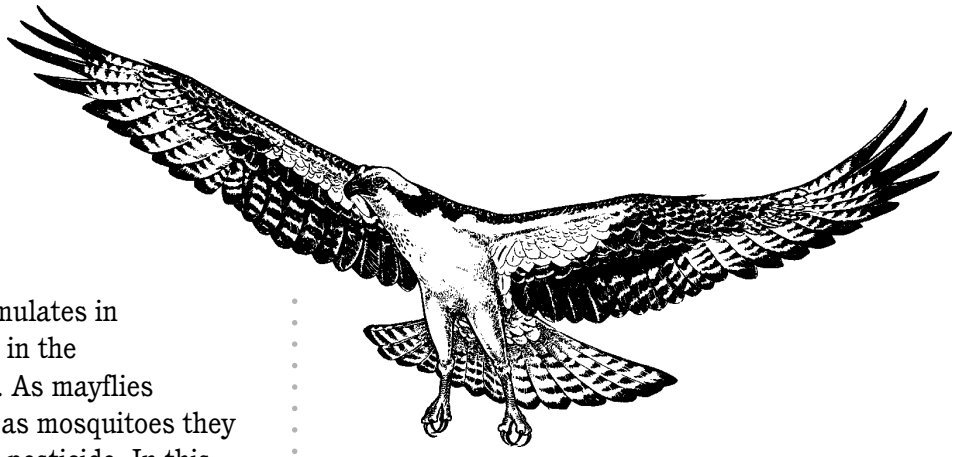
1. Discuss the term "food chain" with students. (Food chain is a sequence or "chain" of living things in a community, based on one member of the community eating another and so forth. An example is mayflies eat microscopic plants and animals that live in the water, trout eat mayflies, and ospreys eat trout.)
2. Divide the group into three teams. In a class of 26 students, there would be two "ospreys," six "trout" and 18 "mayflies." The activity works best with approximately three times as many trout as ospreys and three times as many mayflies as trout.



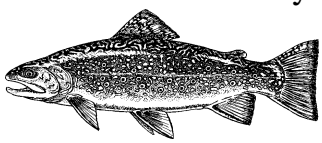


Optional: Have mayflies, trout and ospreys labeled so they can be identified easily. For example, a green cloth flag tied around an arm for mayflies, red bandanas for trout and brown cloth flags for ospreys.

3. Distribute a small paper bag or other small container to each "mayfly." The container is to represent the "stomach" of the animal.
4. With the students' eyes closed, or otherwise not watching where the food is placed, distribute the white and colored straws, or whatever material is used, around in a large open space. Outside on a playing field if it is not windy or on a gymnasium floor will work; a classroom also will work if chairs and tables or desks can be moved.
5. Give students the following instructions: the mayflies are the first to go looking for food. The trout and ospreys are to sit quietly on the sidelines watching the mayflies; after all, the trout and ospreys are predators and are watching their prey. At a given signal, the mayflies are allowed to enter the area to collect as many food tokens as they can, placing the food tokens in their stomachs (the bags or other containers). The mayflies have to move quickly to gather food. At the end of 30 seconds, the mayflies are to stop collecting food tokens.
6. Next, allow the trout to hunt the mayflies. The ospreys are still on the sidelines quietly watching the activity. The amount of time available to the trout to hunt mayflies should take into account the size area in which you are working. In a classroom, 15 seconds may be enough time; on a large playing field, 60 seconds may be better. Each trout should have time to catch one or more mayflies. Any mayfly tagged or caught by the trout must give its bag or container of food to the trout and then sit on the sidelines.
7. Next, allow from 15 to 60 seconds or whatever set time, for the ospreys to hunt the trout. The same rules follow. Any trout still alive may hunt for mayflies. If an osprey catches a trout, the osprey gets the food bag and the trout goes to the sidelines. At the end of the designated time period, ask all the students to come together in a circle, bringing whatever food bags they have with them.
8. Ask students who have been consumed to identify what animal they are and what animal ate them. If they are wearing labels this will be obvious. Next, ask any animals still alive to empty their food bags out onto the floor or on a piece of paper where they can count the number of food pieces they have. They would count the total number of white food pieces and total number of multi-colored food pieces they have in their food sacks. List any mayflies and the total number of white and multi-colored food pieces each has; list the number of trout left and the number of white and multi-colored pieces each has; and finally list the ospreys and the number of white and multi-colored food pieces each has.
9. Inform students that there is something called a "pesticide" in the environment. This pesticide was sprayed onto sluggish water areas to reduce the population of mosquitoes that annually plagued visitors in a nearby vacation resort. If the mosquitoes are really abundant then visitors can't enjoy the beach and would cut their vacations short, thereby reducing the income made by the resort owners and others whose work is associated with the local tourist industry.

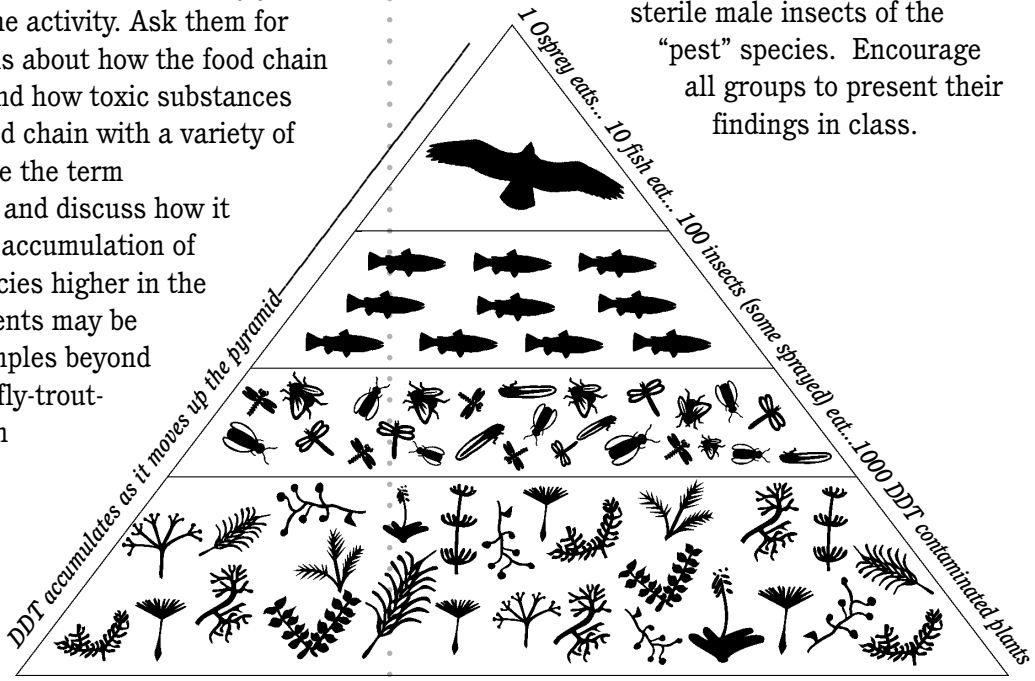


The pesticide used accumulates in food chains and can stay in the environment a long time. As mayflies frequent the same areas as mosquitoes they come in contact with the pesticide. In this activity, all of the multi-colored food pieces represent the pesticide. All of the mayflies that were not eaten by trout may now be considered dead, if they have any multi-colored pieces in their food supply. Any trout for which half or more of their food supply was multi-colored pieces also would be considered dead from chemical side effects. The one osprey with the highest number of multi-colored food pieces will not die; however, it has accumulated so much of the pesticide in its body that the egg shells produced by it and its mate during the next nesting season will be so thin that the eggs will not hatch successfully. The other ospreys are not visibly affected at this time.



10. Talk with students about what they just experienced in the activity. Ask them for their observations about how the food chain seems to work and how toxic substances can enter the food chain with a variety of results. Introduce the term biomagnification and discuss how it can result in the accumulation of chemicals in species higher in the food chain. Students may be able to give examples beyond those of the mayfly-trout-osprey food chain affected by the pesticide in this activity.

11. Divide the class into two, four or more groups. Ask one or two groups of students to research other chemicals, such as tributyltin (TBT), polychlorinated biphenyls (PCBs), or dieldrin, that have demonstrated the ability to persist and accumulate through food chains. What are the effects of these chemicals on organisms? Have other groups research ospreys and other raptors, such as peregrine falcons, brown pelicans and bald eagles, that experienced dramatic population declines due to the widespread use of DDT as a pesticide in the United States. Have other groups research alternative forms of pest control, such as integrated pest management, habitat manipulation, sprays of non-toxic substances, and the release of sterile male insects of the "pest" species. Encourage all groups to present their findings in class.



Is There Something in the Water?

(adapted from: What's is the Water?: Project WILD Aquatic ©Council for Environmental Education 2000)

Duration: 30 - 45 minutes

Materials: Nine different colors of construction paper (two sheets each); writing or graph paper; scotch tape or glue; paper punch; Pollutant Information Sheets (one for each student); ¼ teaspoon measure

New Hampshire curriculum frameworks supported: science: 2a, 3b, 4c; math: 5a; social studies: 12, 14

Objectives

Students will be able to: 1) identify major sources of aquatic pollution; 2) make inferences about the potential effects of a variety of aquatic pollutants on wildlife and wildlife habitats and 3) describe how contamination enters an aquatic food chain

Methods

Students analyze the pollution found in a hypothetical river; then graph the quantities of pollutants and make recommendations about actions that could be taken to improve the habitat.

Background

Waterways such as rivers, lakes and estuaries are important to humans and wildlife alike. Waterways are used for drinking water, transportation, recreation and as habitat for many wildlife species. Approximately 40 percent of our nation's rivers, lakes and estuaries are not fishable, swimmable or potable because of pollution *(Source: American Rivers).* Pollutants enter waterways from either point or non-point sources. Point sources are clearly defined, localized inputs such as industrial pipes and plants, sewer systems and oil spills. Federal and state governments monitor and regulate pollution from point sources. Unfortunately, non-point sources are harder to detect and control, so they are therefore the major source of water quality problems. Non-point sources are indistinct inputs that do not have a clearly defined source, such as runoff of petroleum products from roadways or pesticides from farmlands.

Non-point source pollution occurs when rainfall, snowmelt or irrigation runs over land or through the ground, picks up pollutants and deposits them into surface water or introduces them into ground water. Agriculture, forestry, grazing, septic systems, recreational boating, urban runoff, construction, physical change to stream channels and habitat degradation are all potential sources of non-point source pollution. Agriculture is the leading contributor to water quality impairments, degrading 60 percent of the nation's rivers and lakes. Runoff from urban areas is the largest source of water quality impairments to the nation's estuaries *(source: U.S. Environmental Protection Agency (EPA)).*

The most common non-point source pollutants are sediments and nutrients. These pollutants enter waterways from agricultural land, animal-feeding operations, construction sites and other areas of disturbance. Other common pollutants are pesticides, herbicides, pathogens, oil, toxic chemicals and heavy metals. Unsafe drinking water, fish kills, destroyed habitat, beach closures and many other severe environmental and human health problems result from these water pollutants. *(source: EPA: Office of Water).*

Pollution can be categorized into the following types.

- **Chemical Pollution:** The introduction of toxic substances into an ecosystem (e.g., acidic precipitation, contamination of water supplies by pesticides).
- **Thermal Pollution:** Varying temperatures above or below the normal condition (e.g., power plant turbine heated water).
- **Organic Pollution:** Oversupplying an ecosystem with nutrients (i.e., fertilizer inflow).
- **Ecological Pollution:** Stresses ordinarily created by natural processes, such as:
  1. Adding a substance that is not a naturally occurring substance in the ecosystem (e.g., extreme tides pour saltwater into habitats ordinarily protected from salt water);
  2. Increasing the amount or intensity of a naturally occurring substance (e.g., abnormal increase in sediments in runoff water to produce silt);
  3. Altering the level or concentration of biological or physical components of an ecosystem (changing the amount of something that is already there) (e.g., introduction of aquatic plants via bird droppings, etc.).

In the definition above, chemical pollution, through the introduction of toxic substances, is clearly caused by humans. Organic pollution in lakes and rivers typically results when chemical fertilizers used in agriculture enhance living organisms. Thermal pollution is predominately human caused through nuclear power plants, fuel-based electrical power production and many industries. Some hydroelectric dams also produce unnaturally cooled water with bottom discharge of water.

Surprisingly, these three forms of pollution – chemical, thermal and organic - can take place without human intervention. Pollution, which is not a result of human activity is most often ecological pollution. Natural ecological pollution may be beneficial, harmful or have no effect on wildlife and wildlife habitat. Examples include acidic precipitation resulting from volcanic eruptions, runoff from landslides and avalanches, hot springs and geysers causing heated water to flow into lakes and streams, and shifts in oceanic currents affecting water temperature and weather patterns.

Procedure

Before the Activity

Make 100 tokens of each of the nine colors of construction paper. The construction paper may be folded in quarters to speed up the process of cutting or punching. Punch out construction paper tokens with a paper punch. Put all the tokens together in a container and stir them so the colors are thoroughly mixed. Make one copy of the included Pollutant Information Sheet for each student.

1. List the four major categories of pollution (chemical, thermal, organic and ecological) on the board and discuss each.

   Note: Humans primarily cause the first three types of pollution, although there are cases in which natural processes can cause them. Ecological pollution is typically natural, although there are cases in which humans cause it.

2. Pass out the Pollutant Information Sheets. Review each kind of pollution with the students. Discuss how some of the pollutants can fit into more than one pollution

type. Color-code each with a different color of construction paper. Write a short description of the pollution on a piece of paper of the color to which it is coded. You may cut the descriptions on the Pollutant Information Sheets apart and paste the appropriate paragraphs on each of the colored sheets of paper. Post each sheet of colored paper with its corresponding description of the kind of pollution it represents in a row in a convenient place.

3. Once all the kinds of pollution have been discussed and students understand that each kind of pollution will be represented in this activity by one color of paper, tell students that they are to divide into teams of three. These will be research teams; each team will analyze the pollution content of a hypothetical river. Distribute the colored paper tokens. Pass the container with the colored paper tokens for each research team to measure out for themselves a heaping ¼ teaspoon of the tokens. Provide each team with a piece of graph paper.
4. The teams must separate the colored tokens into piles; using the color key, they should identify each type of pollutant. Next, have them count the number of each kind of pollutant they have identified and then use graph paper to construct a simple bar graph showing the whole array of pollutants. Arrange the pollutants in the same order as they are displayed in the color key that is posted in the classroom. This makes it easy to compare each team's findings. Remind them that each has a different river, so their results are not likely to be the same.
5. When the bar graphs are completed have them compare the teams' results. Tell them that any quantity above two units of each kind of pollutant is considered damaging to wildlife habitat. In their hypothetical rivers, what pollutants would be likely to cause the most damage to wildlife and wildlife habitat? Give examples and discuss the kinds of damage that could be caused; include the example of how osprey populations were affected by DDT contamination.

   Optional: Invite students to match the pollutants with the four categories of pollution listed at the beginning of the activity. Some seem to fit rather easily; others fit in more than one category, depending on the source of the pollution. For example, is the thermal pollution human or naturally caused (power plant water effluent or thermal hot springs)?
6. What could be potential affects of the pollution found in each of the hypothetical rivers to ospreys that might frequent those areas?

Extensions

1. Is DDT still being used, and where? Find out the current status of its use in the United States and other parts of the world. If used in other parts of the world, are U.S. populations of wildlife safe from its effects? Why? (migration)
2. List five things you can do to reduce the number of pollutants you add to the environment.
3. Conduct a field trip to a local waterway and attempt to identify what, if any, kinds of pollution are affecting it.
4. Get information about current national and state laws protecting water quality in the United States. Write a short history of the U.S. Clean Water Act.

Pollutant Information Sheet

Sediments

Particles of soils, sand, silt, clay and minerals wash from land and paved areas into creeks and tributaries. In large, unnatural quantities, these natural materials can be considered pollutants. Construction projects often contribute large amounts of sediment. Certain logging practices affect sediments in runoff. Sediments may fill stream channels and harbors that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the gills of bottom fish and shellfish.

Petroleum Products

Oil and other petroleum products such as gasoline and kerosene can find their way into water from ships, oil-drilling rigs, oil refineries, automobile service stations and streets. Oil spills kill aquatic life, including fish, birds, shellfish and vegetation. Birds are unable to fly when oil loads their feathers; and shellfish and small fish are poisoned. If oil washed on the beach, it requires much labor to clean up. Fuel oil, gasoline and kerosene may leak into ground water through damaged underground storage tanks.

Human and Animal Waste

Human wastes that are released to natural water bodies without being treated at a waste treatment plant may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery, hepatitis, flu and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. The main source of this problem is sewage getting into the water. People can come into contact with these microorganisms by drinking the polluted water or through swimming, fishing or eating shellfish living in polluted waters. Often unexpected flooding of barnyards or stock pens can suddenly increase the toxic effects of a fertilizer and create damage by increasing nutrients.

Organic Waste

Domestic sewage treatment plants, food-processing plants, paper mills and leather tanneries release organic wastes that bacteria consume. If too much waste is released, bacterial populations increase and use up oxygen in the water. Fish die if too much oxygen is consumed by decomposing organic matter.

Inorganic Chemicals

Inorganic chemicals and mineral substances, solid matter and metal salts commonly dissolve in water. They often come from mining and manufacturing industries, oil field operations, agriculture and natural sources. These chemicals interfere with natural stream purification and destroy fish and other aquatic life. They also corrode expensive water treatment equipment and increase the cost of boat maintenance.

Detergents and Fertilizers

Many of these substances are toxic to fish and harmful to humans. They cause taste and odor problems and often cannot be treated effectively. Some are very poisonous in low concentrations. The major source of pollution from agriculture comes from surplus fertilizers in the runoff. Fertilizers contain nitrogen and phosphorous that can cause large amounts of algae to grow and cover the water's surface. The algae die after they have used all the nutrients and sink to the bottom where bacteria feed on them. Bacterial populations increase and use up most of the oxygen in the water. Many aquatic animals die due to the loss of free oxygen. This process is called eutrophication.

Heated or Cooled Water

Heat reduces the ability of water to dissolve oxygen. Electric power plants use large quantities of water in their steam turbines. The heated water is often returned to streams, lagoons or reservoirs. With less oxygen in the water, fish and other aquatic life can be harmed. Water temperatures that are much lower than normal can also cause habitat damage. Dams built across rivers and streams are often opened to release water downstream. When water is released from the bottom of a deep dam, it is much colder than the water it flows into.

Acidic Precipitation

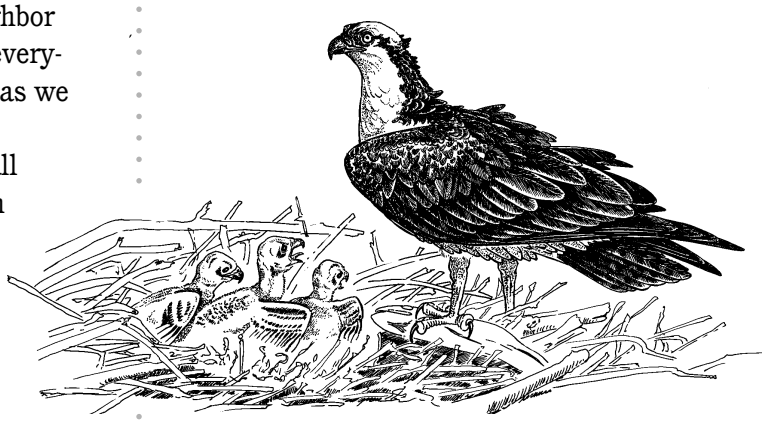
Aquatic animals and plants are adjusted to survive in a narrow range of pH levels. When water becomes too acidic, due to inorganic chemical pollution or from acidic rain, fish and other organisms die.

PInsecticides, Herbicides and Fungicides

Chemicals that are designed to kill or limit the growth of life forms are a common form of pollution. This pollution results from the attempts to limit negative effects of undesirable species on agricultural crop production. Irrigation, groundwater flow and natural runoff bring these toxic substances to rivers, streams, lakes and oceans.

How Many Ospreys Can Live Here?

An animal's habitat is the area or neighborhood in which it lives that provides everything that animal needs to survive. Just as we need food, water, shelter and space in a suitable arrangement to survive, so do all animals. Habitat includes all the land an animal needs to gather food, hunt, rest, find a mate and raise a family. Habitat needs may vary seasonally as survival requirements for many species change. For example, white-tailed deer in the northeast require hardwood forests, with mast (nut) producing trees to meet their nutritional needs; yet in winter, when food is limited or unavailable, they require dense stands of softwoods that protect them from severe cold, wind and deep snow, enabling the conservation of stored energy.



Each habitat can support or meet the needs of only a specific number of individuals of each species that lives within it. There may be only so much of a necessary food, a limited number of appropriate nest or den sites, or a limited amount of clean water that meets the needs of a certain number of individuals. When that number is reached the habitat is considered to be at its carrying capacity for that species. If the population continues to grow some members of the species will die or be forced to leave the area to meet all their survival needs.

There are a variety of factors that impact the carrying capacity for different species in each habitat. They include disease, predator/prey relationships, flooding, heavy snows, early freezes and environmental pollution. Wildlife populations normally rise and fall, often in relatively predictable cycles based on the variety of factors at play. The factors that limit the growth of a population over time are called limiting factors. It is the limiting factors that limit the growth of a population and keep it from extending beyond a certain level. Limiting factors are related to the availability of the critical habitat components of food, water, shelter and space.

What type of habitat is good for ospreys?

As fish comprise virtually all an osprey's diet, an area near clean, slow-moving water with a healthy population of shallow-water fish is essential. Ospreys also need large-crowned trees on which to build their nests that may be as wide as two meters. Dead trees in the water or on small islands are especially desirable for nests as predator access to eggs and young is limited. With steadily increasing development in New Hampshire and the desirability of homes near lakes and rivers, many of the large trees and those standing dead trees on river and lake shores have been cut to make way for new homes and other development.

Wanted: Prime Habitat

(adapted from Oh Deer!; Project WILD © Council for Environmental Education 2000)

Duration: 30 - 45 minutes

Materials: An area either indoors or outdoors that is large enough for students to run, such as a playing field or gym; chalkboard or flip chart; writing materials

New Hampshire curriculum frameworks supported: science: 3a, 3b; math: 7a; social studies: 14

Objectives

Students will be able to: 1) identify and describe food, water and shelter as three essential components of habitat; 2) define limiting factors and give an example; 3) define carrying capacity in terms of wildlife populations; and 4) recognize that some fluctuations in wildlife populations are natural as ecological systems undergo constant change.

Method

Students become "ospreys" and components of habitat in a highly involving physical activity.

Background

A variety of factors affect the ability of wildlife to successfully reproduce and to maintain their populations over time. Disease, predator/prey relationships, varying impacts of weather conditions from season to season (e.g., early freezing, high winds, flooding, drought), accidents, environmental pollution and habitat destruction and degradation are among these factors.

Some naturally-caused as well as culturally-induced limiting factors serve to protect wildlife populations from reproducing in numbers greater than their habitat can support. An excess of such limiting factors, however, leads to threatening, endangering and eliminating whole species of animals. When an equilibrium is reached by the availability of habitat components and the number of animals in a given area, the habitat is said to be at its carrying capacity. It can be expressed as a number indicating the population of any given animal a given area can support. Carrying capacity varies throughout the year. The population number varies from year to year, depending on the limiting factors.

The most fundamental of life's necessities for any animal are food, water, shelter and space in a suitable arrangement. Without these essential components, animals cannot survive.

This activity is designed for students to learn that:

- Good habitat is the key to wildlife survival;
- A population will continue to increase in size until some limiting factors are imposed;
- Limiting factors contribute to fluctuations in wildlife populations; and
- Nature is never in "balance," but is constantly changing.

Wildlife populations are not static. They continuously fluctuate in response to a variety of stimulating and limiting factors. We tend to speak of limiting factors as applying to a single species, although one factor may affect many species. Natural limiting factors, or those modeled after factors in natural systems, tend to maintain populations of species at levels within predictable ranges. This kind of "balance in nature" is not static, but is more like a teeter-totter than a balance. Some

species fluctuate or cycle annually. Quail, for example, may start with a population of 100 pairs in early spring; grow to a population of 1200 birds by late spring; and decline slowly to a winter population of 100 pairs again. This cycle appears to be almost totally controlled by the habitat components of food, water, shelter and space, which are also limiting factors. Habitat components are the most fundamental and thereby the most critical factors in most natural settings.

The major purpose of this activity is for students to understand the importance of suitable habitat as well as factors that may affect wildlife populations in constantly changing ecosystems. In addition, it will serve to introduce ospreys as a population that has the same fundamental needs as all wildlife, and that their populations, like those of other wildlife, are in a constant state of flux.

Procedure

1. Begin by telling students that they are about to participate in an activity that emphasizes the most essential things that animals need in order to survive. Review the essential components of habitat with students: food, water, shelter and space in a suitable arrangement. This activity emphasizes three of those habitat components – food, water and shelter – but students should not forget the importance of the animals having sufficient space in which to live, and that all the components have to be in a suitable arrangement or the animals will die.
2. Ask students to count off by fours. Have all the ones go to one area; all twos, threes and fours go together to another area. Mark two parallel lines on the ground or floor ten to twenty yards apart. Have the ones line up behind one line; the rest of the students line up behind the other line.
3. The ones become "ospreys." All ospreys need good habitat in order to survive. Ask students what the essential components of habitat are again: food, water, shelter and space in a suitable arrangement. For the purposes of this activity, we will assume that the ospreys have enough space in which to live. We are emphasizing food, water and shelter (specifically appropriate nest sites). *(Note: We will also assume that the habitat component of water must be free of DDT, so it will not pass through the food chain and collect in the ospreys causing reproductive failure.)* The ospreys (the ones) need to find food, water and shelter in order to survive. When an osprey is looking for food, it should clamp its hands over its stomach. When it is looking for water, it puts its hands over its mouth. When it is looking for shelter, it holds its hands together over its head. An osprey can choose to look for any one of its needs during each round or segment of the activity; an osprey cannot, however, change what it is looking for; e.g., when it sees what is available, during that round. It can change what it is looking for in the next round, if it survives.
4. The twos, threes and fours are food, water and shelter components of habitat. Each student gets to choose at the beginning of each round which component he/she will be during that round. Students depict which component they are in the same way the ospreys show what they are looking for; that is, hands on stomach for food, etc.
5. The activity starts with all players lined up along their respective lines (ospreys on one side; habitat components on the other side)

– and with their backs to the students at the other line.

6. The teacher begins the first round by asking students to make their signs. Each osprey decides what it is looking for, while each habitat component decides what it is. Give students a few moments to get their hands in place – over stomachs, mouths or over their heads. (As you look at the two lines of students, you will normally see a lot of variety – with some students as water, some food, some shelter. As the activity proceeds, students of the habitat may confer with each other and all make the same sign. That's okay, although don't encourage it. For example, all the habitat students might decide to be shelter during a round. That could represent a drought year with no available food or water.)

   Note: If students switching symbols in the middle of a round is a problem, you can avoid that by having stacks of three different tokens, or pieces of colored paper, to represent food, water and shelter at both the habitat and osprey ends of the field. At the start of each round, players choose one of the symbols before turning around to face the other group.

7. When students are ready, count: "One . . . two . . . three." At the count of three, each osprey and each habitat component turn to face the opposite group, continuing to hold their signs clearly.

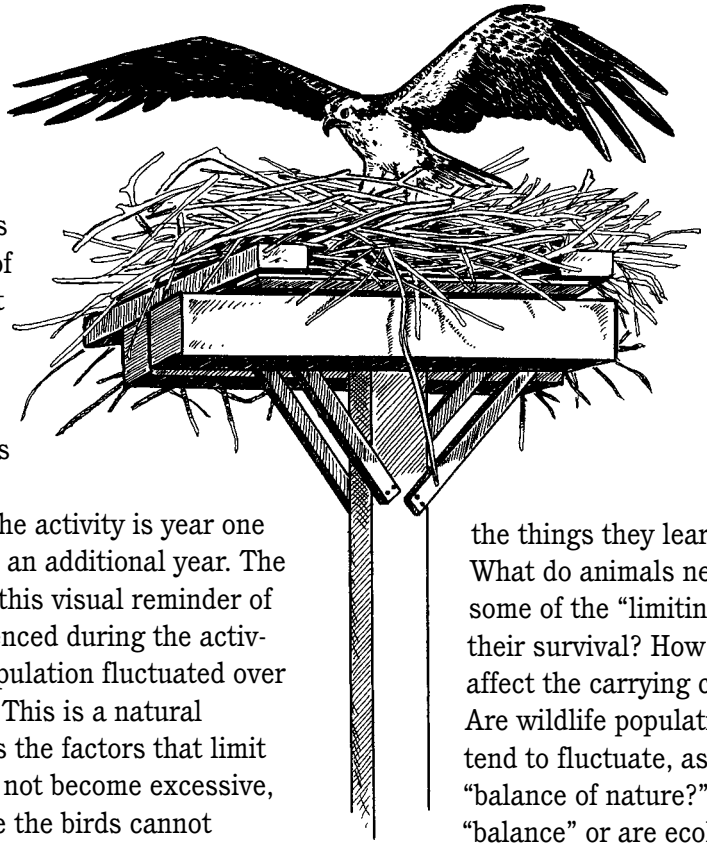
8. When ospreys see the habitat component they need, they are to run or "fly" to it. Each osprey must hold the sign of what it is looking for until getting to the habitat component person with the same sign. Each osprey that reaches its necessary habitat component takes the "food," "water" or "shelter" back to the osprey side of the field. This is to represent the osprey's meeting its needs and successfully reproducing as a result. Any osprey that fails to find its food, water or shelter dies and becomes part of the habitat. That is, in the next round, the ospreys that died become habitat components.

   Note: When more than one osprey reaches a habitat component, the student that gets there first survives. Habitat components stay in place on their line until an osprey needs them. If no osprey needs a particular habitat component during a round, the habitat component just stays where it is in the habitat. The habitat person can, however, change which component it is from round to round.

9. The teacher keeps track of how many ospreys there are at the beginning of the activity; and at the end of each round records the number of osprey. Continue the activity for approximately fifteen rounds. Keep the pace brisk.

10. At the end of fifteen rounds, gather the students together to discuss the activity. Encourage them to talk about what they experienced and saw. For example, they saw a small population of ospreys (seven students in a class size of 28) begin by finding more than enough of its habitat needs. The population expanded over two or three rounds of the activity until the habitat was depleted and there was not enough food, clean water or nest sites/shelter for all the members of the population. At that point, ospreys starved, became contaminated with pesticides in the food chain due to water pollution, or they couldn't find nest sites they needed to reproduce.

11. Using a flip chart pad or available chalkboard, post the data recorded during the



activity. The number of ospreys at the beginning of the activity and at the end of each round represents the number of ospreys in a series of years. That is, the beginning of the activity is year one and each round is an additional year. The students will see this visual reminder of what they experienced during the activity: the osprey population fluctuated over a period of years. This is a natural process as long as the factors that limit the population do not become excessive, to the point where the birds cannot successfully reproduce. Wildlife populations will tend to peak, decline and rebuild, peak, decline and rebuild – as long as there is good habitat and sufficient numbers of animals to successfully reproduce.

12. In discussion, ask students to summarize some of the things they learned from the activity. What do animals need to survive? What are some of the "limiting factors" that affect their survival? How do the limiting factors affect the carrying capacity of the habitat? Are wildlife populations static, or do they tend to fluctuate, as part of an overall "balance of nature?" Is nature ever really in "balance" or are ecological systems involved in a process of constant change?

Fast Frozen Flounders

(adapted from Quick Frozen Critters, Project WILD © Council for Environmental Education 2000)

Duration: 20 - 40 minutes

Materials: Food tokens (pieces of cardboard), enough for three per student; gym vests or other labeling devices to mark predators; four or five hula hoops to serve as "cover," markers; pencil and paper to record number of captures, if desired

New Hampshire curriculum frameworks supported: science: 3a, 3b

Objectives

Students will be able to: 1) discuss predator/prey relationships, including adaptations; 2) describe the importance of adaptations in predator/prey relationships; and 3) recognize that limiting factors – including predator/prey relationships – affect wildlife populations.

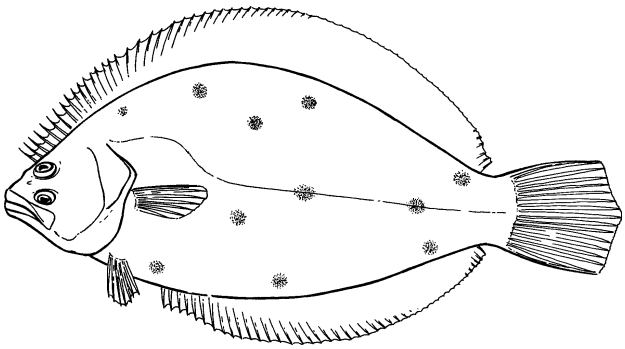
Method

Students play an active version of "freeze tag."

Background

Note: this activity is best done after one or more that introduces the concepts of adaptations and limiting factors.

There are many influences in the life history of any animal. When disease, climate, pollution, accidents or shortages of food, for example, exceeds the limits of tolerance of that animal, it becomes a limiting factor. It then drastically affects the well-being of that animal. Predators, animals that kill and eat other animals for food, are limiting factors for



prey. Prey, those animals that are killed for food by other animals, are limiting factors for predators. Animals display a variety of behaviors in predator/prey relationships that are referred to as survival adaptations.

Some prey behaviors are signaling to others, flight, posturing a fighting position, scrambling for cover and even "freezing" on the spot to escape detection or capture by predators. The kind of behavior exhibited partly depends on how close the predator is when detected by the prey. Each animal has a threshold for threat levels. If a predator is far enough away for the prey to feel some safety, the prey may signal to others that a predator is near. If the predator comes closer the prey may try to swim or run away. If the predator is too close to make fleeing feasible, the prey may attempt to scurry or swim to a hiding place. If the predator is so close that none of these alternatives is available, the prey may freeze in place. The closer the predator comes to the prey animal, the more likely it is that the prey will "freeze" in place. This "freezing" occurs as a kind of psychological shock. Shelter or camouflage may also make them invisible to the predator when they freeze. Flounder, for example, are flat fish that dwell on the bottom substrate. Their coloration, which is very similar to that of the substrate, enables them to be virtually invisible when staying motionless on the bottom. Too often people that come

upon animals quickly and see them immobile infer that the animals are unafraid when, in reality, the animals are "frozen", or, as the adage goes, "frozen stiff."

The major purpose of this activity is for students to recognize the importance of adaptations to both predators and prey and to gain insight into limiting factors affecting wildlife populations.

Procedure

1. Identify students as being either ospreys as predators, or flounder as prey, for a version of "freeze tag" – with approximately one predator per every four to six prey.
2. Using a gymnasium or playing field, identify one end of the field as the "food source" and the other end as the "shelter."
3. Four to five hula hoops are placed on the open area between the "shelter" and the "food." These represent additional shelter or "cover" for the prey and can be randomly distributed on the field. If hula hoops are not available, string might be used, or chalk on asphalt.
4. Food tokens are placed in the "food source" zone on the ground. Allow three food tokens for each prey animal.
5. Predators (ospreys) should be clearly identified. Gym vests or safety patrol vests may be available.
6. Use a whistle or some other prearranged signal to start each round. When a round begins, flounders start from their "shelter." The task of the flounders is to move from the primary shelter to the food source, collecting one food token each trip and returning to the primary shelter. To survive, flounders have to obtain three food tokens. Their travel is hazardous, however. They need to be alert to possible predators. If they spot an osprey, they can use various appropriate prey behaviors, including warning other prey that a predator is near. Flounders have two ways to prevent themselves from being caught by ospreys: they may "freeze" anytime an osprey is within five feet of them; or they may "swim" to cover, with at least one foot within one of the hula hoops. Frozen flounders may blink, but otherwise should be basically still without talking.
7. Predators (ospreys) start the activity anywhere in the open area between ends of the field and thus, are randomly distributed between the prey's food and primary shelter. Predators attempt to capture prey (flounder) to survive, tagging only moving, not frozen, prey.

   Optional: Flounders can have bandanas in their pockets that ospreys have to capture to represent the successful predation. Ospreys must capture two flounders each in order to survive. Captured flounders are taken to the sidelines by the ospreys who captured them.

   Note: Establish a ground rule for student behavior: Behave in ways that are not harmful to other students, even when simulating predator behavior; e.g., no full tackles.
8. A time limit of five to seven minutes is suggested for each round of the game. Captured flounders on the sidelines will get restless if rounds are much longer. Remind flounders they can remain frozen for as long as they like, but if they do not have enough food at the end of the activity they will starve to death. In nature an animal must balance the need to find food with the

sometimes, conflicting need for safety.

9. Play four rounds, allowing each student to be both prey (flounder) and predator (osprey).
10. Discuss with students the ways they escaped capture when they were flounders. Which ways were easiest? Which were most effective? What means did they use as ospreys to capture prey? Which ways were best? What did the predators do in response to a flounder that "froze?" In what ways are adaptations important to both predator and prey? Ask students to summarize what they learned about predator/prey relationships. How do predator/prey relationships serve as natural limiting factors affecting wildlife?

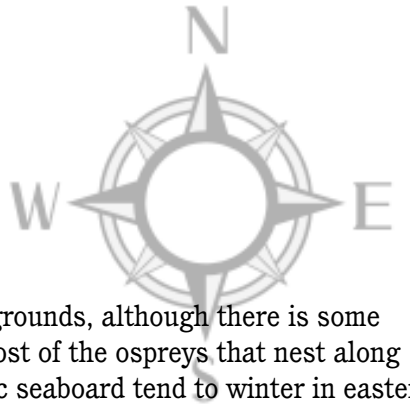
Variation

Conduct the activity for three or four rounds, recording the number of captures each playing period. Have students who are captured become ospreys, and each osprey not getting enough food become a flounder in the succeeding round. This quickly leads to the concept of dynamic balance as prey and predator populations fluctuate in response to each other.

Extension

Divide students into small groups and have each group select either ospreys, or one of five common prey species of ospreys, including flounder, yellow perch, herring, sunfish and menhaden. Have each group research their selected species and prepare a written report, poster, skit, or puppet show to share their findings with the rest of the class. Information about habitat needs, physical and behavioral adaptations that enhance survival as prey or predator, and identification of at least three limiting factors that could affect that species population.

All Aboard for Points South



Ospreys, like most other hawks and falcons of the north temperate latitudes, migrate south for the winter. Although there are many unanswered questions about osprey migration, the reason they head south is not one of them. One need only to think about what they eat and what happens to most water bodies in the winter to figure it out. Not all water bodies freeze, though. Many rivers and coastal waters stay relatively free of ice. Why, instead of migrating thousands of miles each year don't ospreys congregate in those open water areas? As fall temperatures drop, cold-blooded fish move from the surface waters and shallows to greater depths where the temperatures remain above freezing and are more constant. The move makes them inaccessible to ospreys. Even if fish were accessible, frequent fall and winter storms and fewer hours of light each day would seriously limit the amount of time ospreys could fish at a time of year when more food is required, just to maintain their body temperature.

For ospreys in north temperate regions, which include most of the ospreys breeding in Canada and the northern United States, migration begins in late summer. Adults generally leave first, while the newly fledged young may linger a few weeks longer on the breeding grounds, a strategy which buys them additional time in which to strengthen and improve flying and foraging techniques. As fish are still abundant when ospreys start to head south, it is believed that the decreasing length of day stimulates hormonal changes that trigger migration.

Most of the information about where ospreys winter and the routes they take to get there comes from recovered banded ospreys. North American ospreys generally winter in the tropics of southern Central America and northern South America. The breeding populations of ospreys found at different latitudes in North America tend to stay separated on the wintering grounds, although there is some overlap. Most of the ospreys that nest along the Atlantic seaboard tend to winter in eastern Brazil, while those from the west coast tend to winter on the west coast of Central America. Ospreys tend to follow mountain ranges or the Atlantic seaboard south, but then fly directly across large bodies of water, without flying around them or sticking to island chains as most other diurnal bird of prey do. Most ospreys arrive at their wintering grounds by late November. Winter habitat includes lush rainforest ecosystems, coastal mangrove forests, estuaries and shallow river mouths. The spring migration usually begins in late February, follows the same route north that was followed south, and is much speedier than the fall migration. There is an urgency to arrive early, as early nesters have greater success. Migrants return to the same nesting territories and nest sites they occupied the year before.

Migration is not the quick and easy alternative to wintering in the north as it might seem. There are many hazards associated with flying thousands of miles, over unfamiliar territory, through many different countries, and finally arriving in a new territory as the new guy on the block. Migrants face the perils of flying in bad weather, into power lines, and near busy metropolitan airports. They must fish in unfamiliar waters during their journeys and may encounter a variety of pollutants along the way. Although DDT has not been used as a pesticide in this country since 1972, it is still used in Central and South America. In many of the countries ospreys migrate through and where they winter, hunting birds of prey is legal. Habitat destruction is occurring rapidly in the rainforests of Central and South America where ospreys winter, and in the United States and other countries in areas used for resting and feeding during migration.

Migration Headache

(adapted from: Project WILD Aquatic © Council for Environmental Education 2000)

Duration: 1 - 45 minute class

Materials: Large playing field or gymnasium; two bases (paper plates or carpet squares, for example) for every two or three students

New Hampshire Curriculum Frameworks supported: science: 3a, 3b; social studies: 4, 14

Objectives

Students will be able to: 1) list limiting factors affecting habitats and populations of migrating ospreys; 2) predict the effects of such limiting factors; 3) describe the effects of habitat loss and degradation on populations of migrating ospreys; and 4) make inferences about the importance of suitable habitat for migrating ospreys.

Method

Students portray migrating ospreys traveling between nesting habitats and wintering grounds.

Background

Birds that migrate depend not just on having one suitable habitat, but two and often three habitats. For example, some birds nest and raise their young in the northern limits of their ranges. The same birds may also require suitable habitats in the southern limits of their range to live during winter. Because migrating birds, including ospreys, travel hundreds or thousands of miles between nesting and wintering grounds, resting and feeding sites (known as stopovers) are crucial.

A variety of remarkable migrating shorebirds, waterfowl and ospreys inhabit the skies and waters of the United States. Many migrating birds - ducks, cranes, herons, rails, terns, plovers and ospreys, for example – require wetlands in their breeding, stopover and wintering grounds. Without wetlands, dozens of species of water birds face loss of necessary habitat.

During the last 150 years water bird populations have been threatened by the alteration of habitats and direct mortality of birds. Numerous populations of water birds have declined, some significantly. The disappearance and degradation of wetlands are major threats to the survival of migratory water birds. Destruction of wetland habitats reduces the quantity of suitable nesting, feeding and resting areas. Alteration of habitats often reduces the quality of habitats, making them unsuitable for water birds. Wetland habitats, usually found in low, fertile plains along watercourses, were historically prized for conversion to farmland and settlements. Agriculture and development, both residential and industrial, have reduced the number and quality of natural wetlands.

Direct mortality of water birds occurs in various ways. The migration routes of North American water birds are well known. Before the passage of regulations regarding the hunting of water birds, market hunters of the nineteenth and very early twentieth centuries decimated the flocks by taking advantage of the vast numbers of water birds that concentrated at strategic points along these routes. Pollution, through pesticide use for example, has also taken a toll. The birds ingest the poisons through the food chain, sometimes with lethal effects. In some cases, pesticides also kill the birds' food, reducing their food supply.

Most international, federal, state and private groups recognize the importance of wetland habitats to wildlife preservation. In the early 1900s several laws and treaties were enacted and signed that regulated the hunting of water birds, as well as protecting the habitat on which they depended. Laws that conserve and enhance wetland habitats have slowed the alteration of these habitats. The Clean Water Act of 1977 and the Farm Bill of 1985 are two major pieces of such legislation. In addition, techniques have been developed to build new wetlands as well as enhance the quality of existing wetlands. The U.S. Fish and Wildlife Service (USFWS) has principal legal responsibility in the United States for managing migratory wildlife at the federal level. State wildlife agencies share some responsibilities with the USFWS in conserving migratory water birds.

Natural occurrences and human management efforts during the 1990s have produced mixed results. The North American Waterfowl Management Plan, coordinated by the USFWS, has worked through private/public partnerships to conserve and enhance waterfowl habitat in Canada and the United States. This effort, aided by several years of plentiful rain and snow, has enabled populations of many species of waterfowl (ducks, geese and swans) to rebound from near record lows in the 1980s and early 1990s to near historic high numbers. On the other hand, shore birds like plovers, terns and the red knot continue to suffer losses because of habitat loss and alteration along coastal regions.

In this activity each student (assuming a class of 30) represents hundreds of ospreys. Thus, occasional losses to predation and other events of relatively minor magnitude during the course of migration are not emphasized in the simulation. The major purpose of this activity is for students to dynamically experience some of the important factors that affect habitat quality and the associated survival of migratory osprey populations.

Procedure

1. Select a large playing area about 70 feet in length. Place an equal number of bases in three areas on the playing field as shown below:

   Choose the number of bases so there is one base for each two or three students at each of the three areas of the field. Designate one of the end areas the “wintering habitat,” the other end, the “nesting habitat” and the area in the middle as “stopover habitat.”

2. Explain to students that they are ospreys and will migrate between these three areas at your signal. Tell students the bases represent wetlands. These wetlands provide suitable habitat for ospreys. At the end of each migration, the students will have to have one foot on a base in order to be allowed to continue (survive). Tell students that only two (or three as decided in Step 1) ospreys can occupy a habitat (base) at one time. If they can’t find a habitat that isn’t “filled,” then they have not found any suitable habitat. They “pass away,” and have to move, at least temporarily, to the sidelines. During the migration, the students may want to flap their “wings,” moving like birds in flight.

3. Explain that many factors will limit the survival of populations of ospreys. Some involve change in the wintering, stopover and nesting habitats. There will be periods of time when food, water, shelter and space are suitably arranged to meet the habitat

requirements of the birds. There will be other times when the habitat is stressed, with many factors limiting the potential for the birds' survival

4. Begin the activity with all ospreys at the wintering habitat. Announce the start of the first migration. Have students migrate slowly until they become familiar with the process. Then they can speed up. On the first try, all the ospreys will successfully migrate to the stopover habitat.
5. Explain that ospreys need these areas to rest and eat before continuing the migratory journey. Then have them migrate from the stopover habitat to the nesting habitat. Explain that there has been no loss in the area of available high-quality habitat. Thus, a successful nesting season is at hand.
6. Before students migrate back "south," remove one base from the stopover habitat. Explain that a developer has received a permit to drain a wetland to build a mall. Repeat the instruction to migrate and send the birds to the stopover habitat. Have students who could not find available habitat stand on the sidelines. Tell students these birds died as a result of habitat loss. Remind any "deceased" ospreys that they will have a chance to get back into the activity. They can come back as surviving hatchlings when favorable conditions prevail and habitat is available on the nesting ground.
7. Continue the migrations by reading the habitat scenarios included. Teachers may want to appoint two students as monitors to remove and add bases (habitats) as required on the cards.
8. After the activity, ask students to identify factors that caused osprey populations to decline or increase. What are the short- and long-term effects of the decline or increase? Which factors are human-caused? Which are natural? Which factors reduced or enhanced the quality of the habitat? What are the benefits and liabilities related to these factors for the community?

Extensions

1. Research a species of water bird. Conduct this activity again with each student representing a specific kind of water bird.
2. Explore the major factors affecting habitat loss and alteration, or gain and restoration, in your area. Research the causes for long-term habitat loss, as well as any major efforts underway to prevent these increasing losses. How would these habitat losses and restoration efforts affect ospreys in your area?
3. Using a map, plot the major migratory routes of North American birds.
4. Visit a national wildlife refuge, state wildlife area, bird observatory, private sanctuary, seashore or other habitat for migratory water birds.
5. What other animals migrate? Are the problems they face similar to those of migratory birds?
6. There are national laws and international treaties protecting migratory species. Find out about some of these. What is their history? Are they effective? Are there problems enforcing them? What migrating species, if any, are unprotected by such laws?
7. Find out how wetlands have changed or remained the same in your community throughout the last 100 years. Are there wetland regulations or zoning laws in your community?

Habitat Scenarios

These scenarios can be used during the activity to assist teachers with the factors that may reduce or enhance a wetland habitat. *(Teachers may want to photocopy this page prior to beginning the activity.)*

- **A marsh has been dredged to allow a marina to be built.** Remove one habitat from the stopover habitat.
- **A landowner has agreed to re-flood fields after harvesting, increasing acreage for wintering birds.** Add one habitat to the wintering habitat.
- **A joint federal/state wetland restoration project involved removing drain tiles allowing a former wetland to flood and return to its natural state.** Add one habitat to the stopover habitat.
- **A large increase in the number of mink and raccoons has reduced the value of a marsh nesting area.** Remove one habitat from the nesting habitat.
- **Wintering habitat is reduced by the conversion of bottomland hardwood forests to cropland.** Remove one habitat from the wintering habitat.
- **New legislation restricts motorboat traffic on a number of lakes and large marshes, reducing the human disturbance to wildlife.** Add one habitat to stopover habitat.
- **Several years of sufficient rain and snow have replenished the water supply, thus increasing the food supply.** Add one habitat to the nesting habitat.
- **A timber company has agreed to preserve a forested wetland in exchange for tax credits.** Add one habitat to the stopover habitat.
- **Filling and diking reduces the amount of tidal wetlands available to waterfowl.** Remove one habitat from the wintering habitat.

Which Way is Home?

(Adapted from: Peregrine Falcons - The Flight to Recovery: Following Peregrine Migrations; Colorado Division of Wildlife)

Duration: 2 - 45 minute classes

Materials: copies of North American osprey migration routes handout (included), research materials, handout of activity questions, ruler, paper, pencil, detailed map of the Western Hemisphere

New Hampshire curriculum frameworks supported: science: 3a, 3b; math: 4c, 7a; social studies: 4, 10, 14, 15

Objectives

Students will be able to: 1) describe the general migration pattern of two North American osprey populations, including the Atlantic seaboard population; 2) explain why ospreys migrate; and 3) describe three hazards ospreys might encounter during migration.

Methods

Students become familiar with various aspects of osprey migration through research and mathematical manipulation of hypothetical data.

Background

Bird migration, the seasonal movement of birds from one place to another, has always fascinated humans. Scientists are just beginning to understand how birds navigate during migration and suggest that birds use the stars, sun, moon, wind currents, landmarks and even the earth's magnetic field to find their way.

Procedure

1. Have students work individually or in small groups to research the following topics: a.) why do birds migrate? b.) why some ospreys migrate and some don't; c.) home ranges of the four osprey populations of the world; d.) home ranges of the four osprey populations in North America. Discuss the hazards that migrating ospreys might face and ask students to suggest steps that could be taken to minimize these dangers.
2. When students have completed their research, either lead a class discussion about the topics or have students report on their topics in writing or orally, summarizing their research for the rest of the class.
3. Create a handout for each student or group of students and distribute it with a copy of the included map. *(Note: The map depicts hypothetical migration paths of different North American populations of ospreys.)* The handout might include the following questions:
   A. Calculate the distances traveled by ospreys 1, 2, 3 and 4. Give answers in both miles and kilometers.
   B. From and to which countries did ospreys 1 and 2 migrate (include state and provinces of the U.S. and Canada)?
   C. Name the large bodies of water osprey 4 flies over during its migration.
   D. Over which states did ospreys 2 and 3 fly?
   E. Assuming that ospreys 2, 3 and 4 all took three weeks to migrate north, what was the average number of kilometers or miles traveled per day by each osprey?
   F. Osprey 1 flew what percentage of the total kilometers or miles that osprey 2 flew?

G. What hazards might ospreys 2 and 4 encounter while migrating that osprey 1 would not encounter?

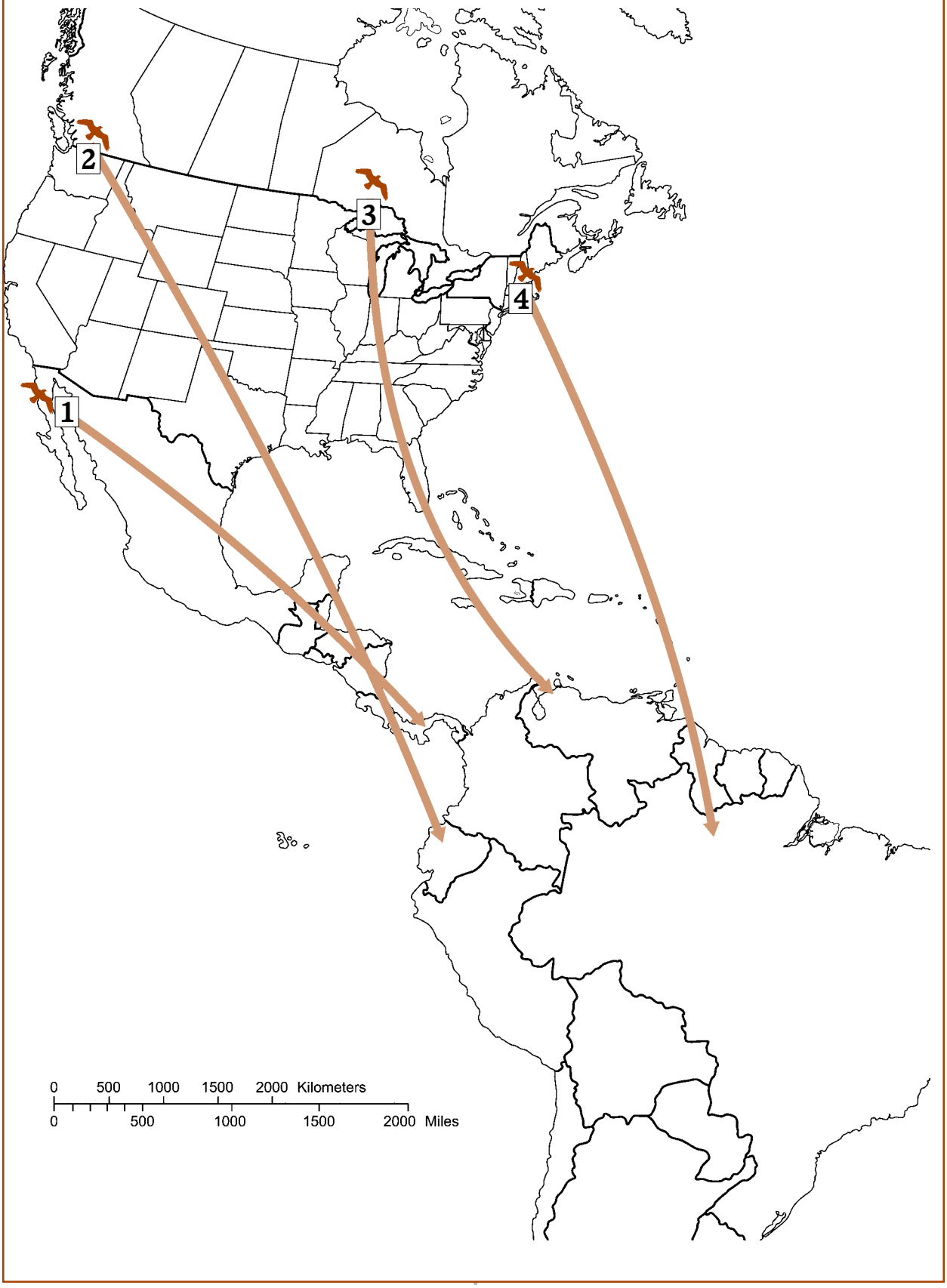
H. Name the countries that ospreys 1 and 4 would cross over during migration.

I. If osprey 3 flew at an average speed of 35 kilometers per hour without stopping, how long did it take to complete its migration?

4. Have students answer the questions individually or in small groups. Compare and discuss the answers with the rest of the class, including a discussion of the methods used to arrive at the answers.

Extension

1. What is the approximate longitude and latitude where the flyways of ospreys 1 and 2 intersect? In which country is the intersection located?
2. Have students write a story from the perspective of an osprey about their migration from New Hampshire to Brazil. They could highlight the major events of their journey, including landscapes crossed and hazards encountered flying over the Caribbean. Have students detail their experiences while flying over the Virgin Islands, Trinidad and Venezuela.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References

Brown, Phillip and Waterson, George. *Return of the Osprey.* London: Collins, 1962 (out of print).

Carpenteri, Stephen D. *Osprey: The Fish Hawk.* Minnetonka: NorthWord Press, 1997.

Dennis, Roy H. *Ospreys.* Colin Baxter Photography, 1991.

Gessner, David. *Return of the Osprey, A Season of Flight and Wonder.* Chapel Hill: Algonquin Books, 2001.

Henningsen, Nancy. *Return of the Ospreys.* New York: Peregrine Press, 1991.

Poole, Alan F. *Ospreys: A Natural and Unnatural History.* New York: Cambridge University Press, 1989.

Audubon Society of New Hampshire, includes webcam at Lake Massabesic
www.nhaudubon.org/research/nhosprey.htm

Journey North, track the journeys of several migratory species
www.learner.org/jnorth

The Raptor Center at the University of Minnesota
www.raptor.cvm.umn.edu

Osprey Project at Rutland Water, United Kingdom
www.ospreys.org.uk

Osprey camera at Blackwater Reservoir, Maryland
www.friendsofblackwater.org/osprey.html

Highland Foundation for Wildlife, osprey management in Scotland
www.roydennis.org

Osprey nest camera at Loch Garten, Scotland
www.rspb.org.uk/webcams/

Osprey nest monitoring, northern England
www.lakesfd.co.uk/osprey.htm

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