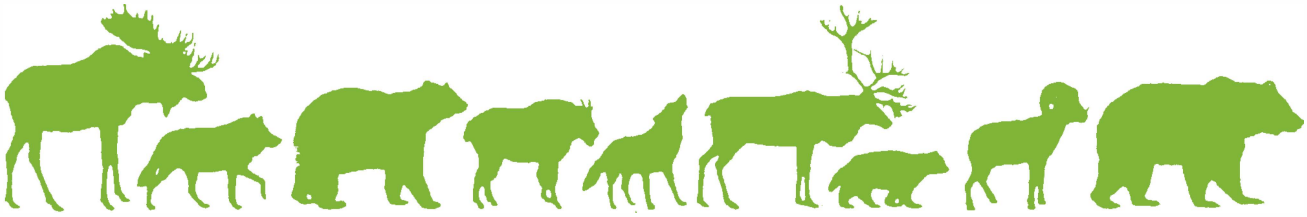
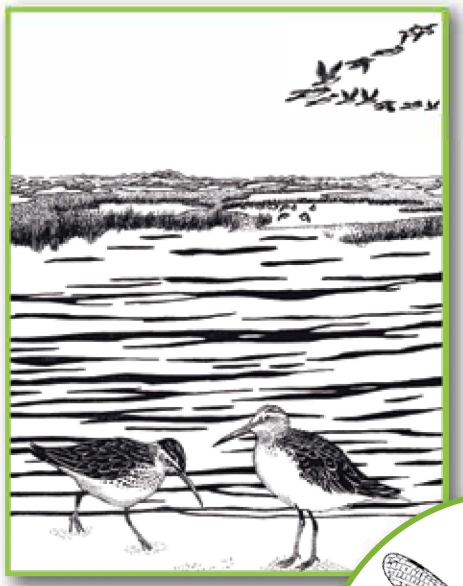


Alaska's Wetlands & Wildlife

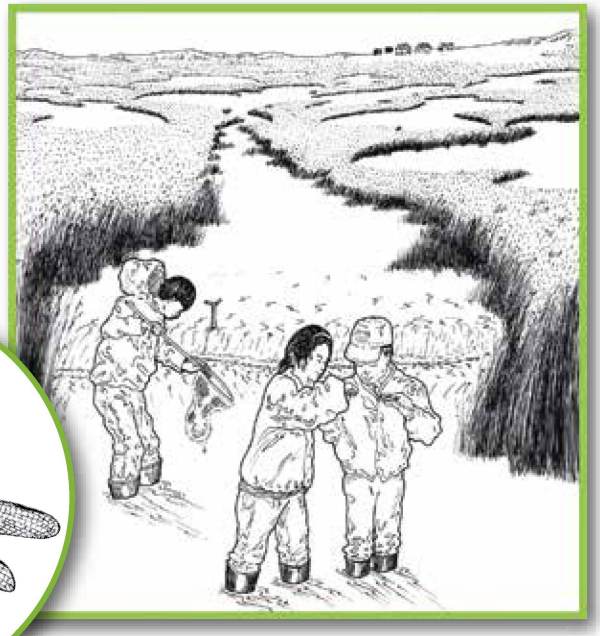
ALASKA WILDLIFE CURRICULUM TEACHER'S GUIDE



K-12

Teacher Background Information, Illustrations, and Resources, Student Activities and Investigation

CORRELATED TO THE STATE STANDARDS AND NGSS



Alaska Department of Fish and Game

Alaska's Wetlands and Wildlife

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The Alaska Wildlife Curriculum is a resource for educators teaching today's youth about Alaska's wildlife. This volume is dedicated to today's teachers and youth, building leaders for tomorrow.

Alaska's Wetlands and Wildlife was first created in 1992. The original materials involved the hard work of many individuals, including Marilyn Sigman, Susan Jordan, Susan Quinlan, Janet Ady, Beverly Farfan, Colleen Matt, Karen McKibbin, Cathy Rezabeck, Connie Allen, Rick Turner and Fineline Graphics.

Susan Quinlan wrote, illustrated, and produced the original Alaska Wildlife Week materials on this topic, while Janet Ady and Beverly Farfan coordinated inclusion of activities from the Teach About Geese curriculum. Other contributors to the original curriculum included Jay Bellinger, Norene Blair, Steve Breeser, Nancy Byers, Ellen Campbell, Mark Chase, Max Copenhagen, Tom Demeo, Sandy Frost, Dan Gibson, Amy Keston, Paul Marks, Norm Matson, Russ Meserole, Pam Nelson, Bety Olivalo, Janet Schempf, Reva Shircel, Candace Ward, Cathy Rezabeck and Steve Young.

This 2007 revision includes many of the activities, background information and artwork from the original curriculum.

Heartfelt gratitude goes to Robin Dublin, whose long-lasting dedication to wildlife education has been a critical component of this project.

Other Alaska Wildlife Curriculum materials include:

Alaska's Forests and Wildlife
Alaska's Ecology
Alaska's Tundra and Wildlife
Wildlife for the Future
Alaska's Ecology Cards

The Alaska Department of Fish and Game has additional information and materials on wildlife conservation education. The Alaska Wildlife Curriculum is revised periodically. For information, or to provide comments on this book, please contact the Alaska Department of Fish and Game:

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Alaska's Wetlands and Wildlife

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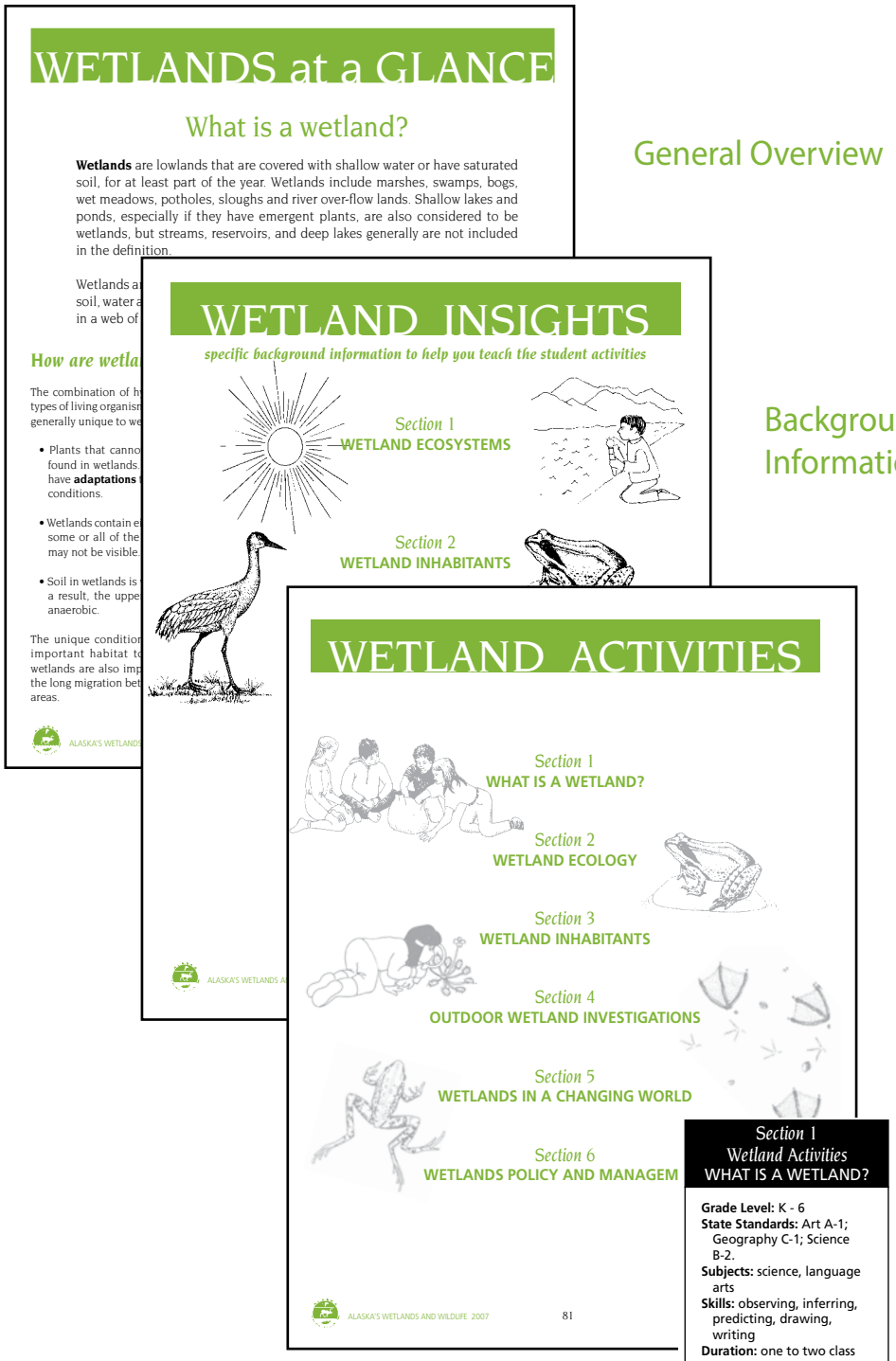


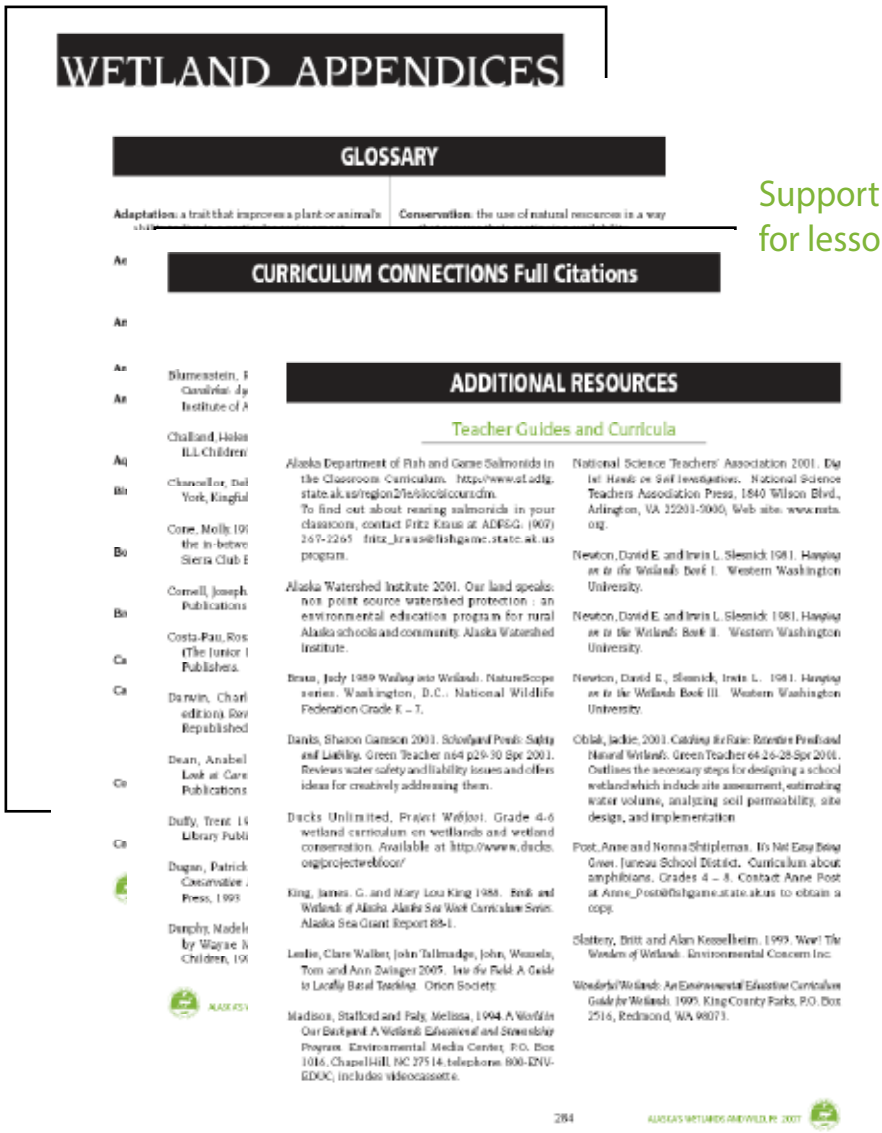
General Overview

Background Information

Activities

Student Activity boxes provide a quick planning reference

How to use this curriculum CONTINUED



WETLAND APPENDICES

GLOSSARY

Adaptation: a trait that improves a plant or animal's

Conservation: the use of natural resources in a way

CURRICULUM CONNECTIONS Full Citations

ADDITIONAL RESOURCES

Teacher Guides and Curricula

Alaska Department of Fish and Game Salmonids in the Classroom Curriculum. http://www.sf.adfg.state.ak.us/region2/fe/sloc/slcourse.cfm. To find out about rearing salmonids in your classroom, contact Fritz Kraus at ADF&G: (907) 267-2265 fritz_kraus@fishgame.state.ak.us program.

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Post, Anne and Nonna Shtipleman. It's Not Easy Being Green. Juneau School District. Curriculum about amphibians. Grades 4 – 8. Contact Anne Post at Anne_Post@fishgame.state.ak.us to obtain a copy.

Slattery, Britt and Alan Kesselheim. 1993. Wow! The Wonders of Wetlands. Environmental Concern Inc.

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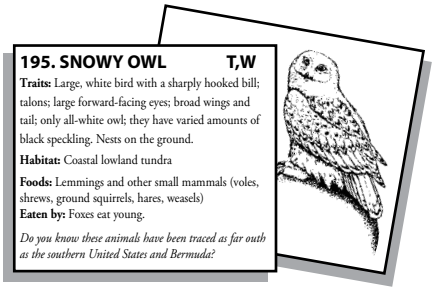
Support materials for lesson planning.

Alaska Ecology Cards – Student-directed learning resources in ready-to-copy sheets applicable to all books in the Alaska Wildlife Curriculum.

Several lessons require or may be improved by use of the Alaska Ecology Cards. Download from ADF&G website at: http://www.adfg.alaska.gov/index.cfm?adfg=curricula.main

For more animal facts, refer to the Alaska Wildlife Notebook Series available at www.wildlife.alaska.gov/



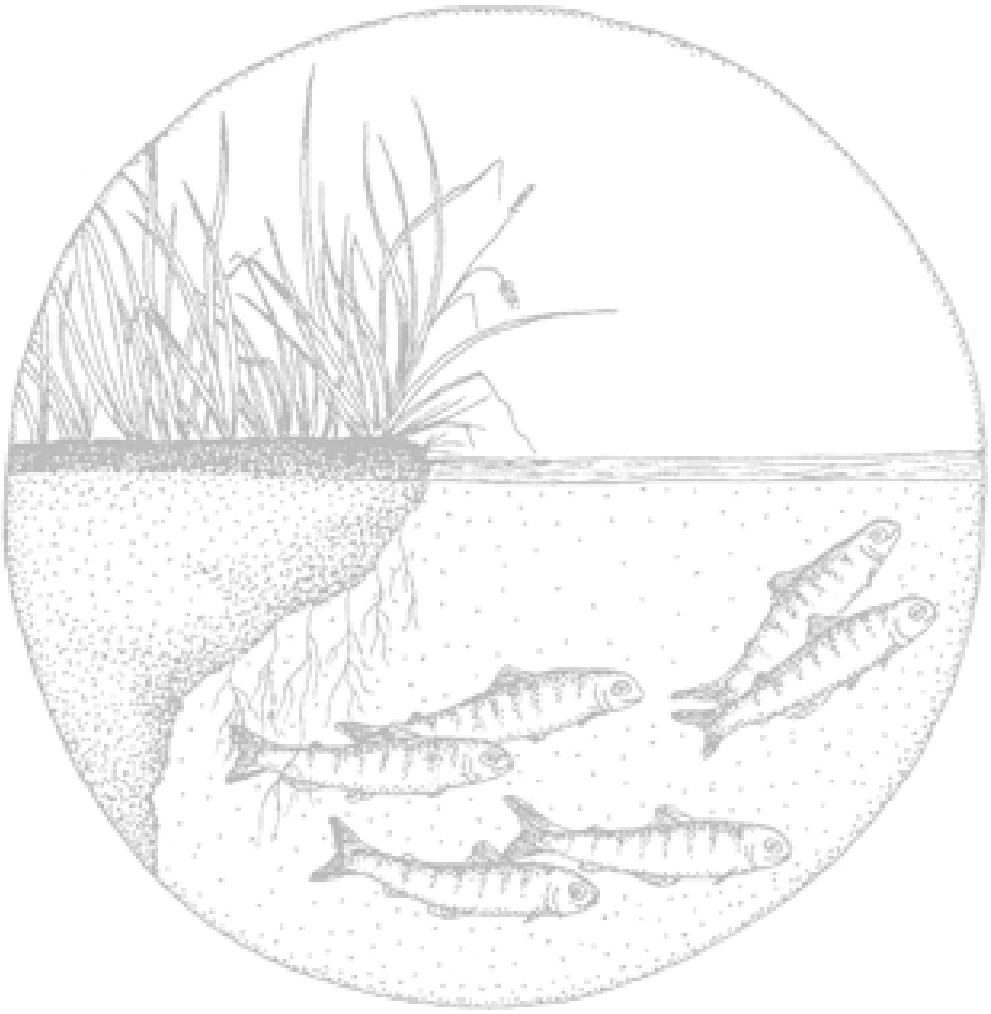
195. SNOWY OWL **T,W**

Traits: Large, white bird with a sharply hooked bill; talons; large forward-facing eyes; broad wings and tail; only all-white owl; they have varied amounts of black speckling. Nests on the ground.

Habitat: Coastal lowland tundra

Foods: Lemmings and other small mammals (voles, shrews, ground squirrels, hares, weasels)
Eaten by: Foxes eat young.

Do you know these animals have been traced as far outh as the southern United States and Bermuda?



WETLANDS at a GLANCE

What is a wetland?

Wetlands are lowlands that are covered with shallow water or have saturated soil, for at least part of the year. Wetlands include marshes, swamps, bogs, wet meadows, sloughs and river floodplains. Shallow lakes and ponds, especially if they have **emergent plants** (plants that stick out of the water), are also considered to be wetlands, but streams, reservoirs, and deep lakes generally are not included in the definition.

Wetlands are complex **ecosystems**, comprising both **non-living things** such as soil, water and air, and **living things** such as bacteria, fungi, plants and animals in a web of energy flow and material exchange.

How are wetlands unique?

The combination of hydrology, soil properties and types of living organisms in a wetland ecosystem are generally unique to wetlands:

- Plants that cannot survive flooding are rarely found in wetlands. Wetland plants and animals have **adaptations** that allow them to live in wet conditions.
- Wetlands contain either fresh or salt water during some or all of the growing season, although it may not be visible.
- Soil in wetlands is waterlogged or saturated. As a result, the upper part of the soils is usually **anaerobic**.

The unique conditions in wetlands also provide important habitat to waterbirds. Many Alaska wetlands are also important **stop over sites** amid the long migration between breeding and wintering areas.

Wetlands have other important functions, providing valuable **ecosystem services** such as flood control and groundwater recharge.

What types of wetlands are in Alaska?

Wetlands come in a range of sizes and types and have been classified many different ways. In this curriculum, we refer to five broad classifications: coastal wetlands, freshwater marshes, riparian (streamside) wetlands, peatlands, and tundra wetlands. Within each of these broad classifications, there are different habitat types.

Who uses Alaska's wetlands?

Alaska's wetlands are important habitat to a diverse array of wildlife from frogs, to shrews, bears and loons. Alaska's wetlands are critical to migrating birds, which rely on wetlands for habitat. These birds include 37 species of waterfowl, including 30 different duck populations. Alaska wetlands are the primary breeding grounds for 80 percent of the world's trumpeter swans, 50 percent of tundra swans, and six of the 11 sub-species of Canada geese. About 17 percent of all geese and 11 percent of all ducks harvested in North America breed in Alaska's wetlands.

Wetlands also provide important resources to humans who subsistence hunt, fish and collect plants, as well as urban dwellers who rely on ecosystem services of wetlands such as water purification. Wetlands also provide valued recreation opportunities .

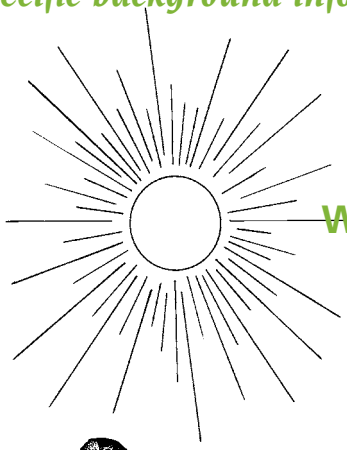
Wetland Loss

Overall wetland loss has been minimal in Alaska, (about 0.1%). However in parts of Alaska, such as the Anchorage bowl it has been greater than 50%. Wetland loss has been close to 50% in the lower 48 and over 90% in Europe.

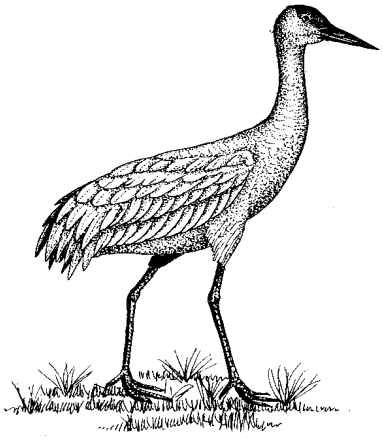
Reasons for wetlands loss include many human activities, such as agriculture, mosquito control; stream channellization and dredging; filling due to development, roads and solid waste disposal; construction of dikes, dams and levees; water pollution; mining of peat; and groundwater withdrawal. Storms, erosion and drought also contribute to wetland loss. More recently, climate change is an important driver of wetland loss in parts of Alaska. In some areas, warming may also cause more wetlands to be created that have not been there before.

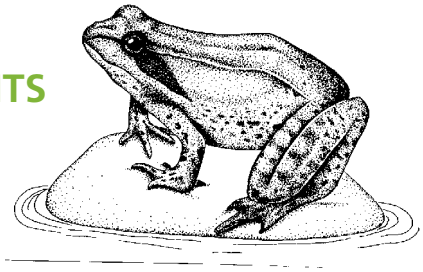
WETLAND INSIGHTS

specific background information to help you teach the student activities



Section 1
WETLAND ECOSYSTEMS

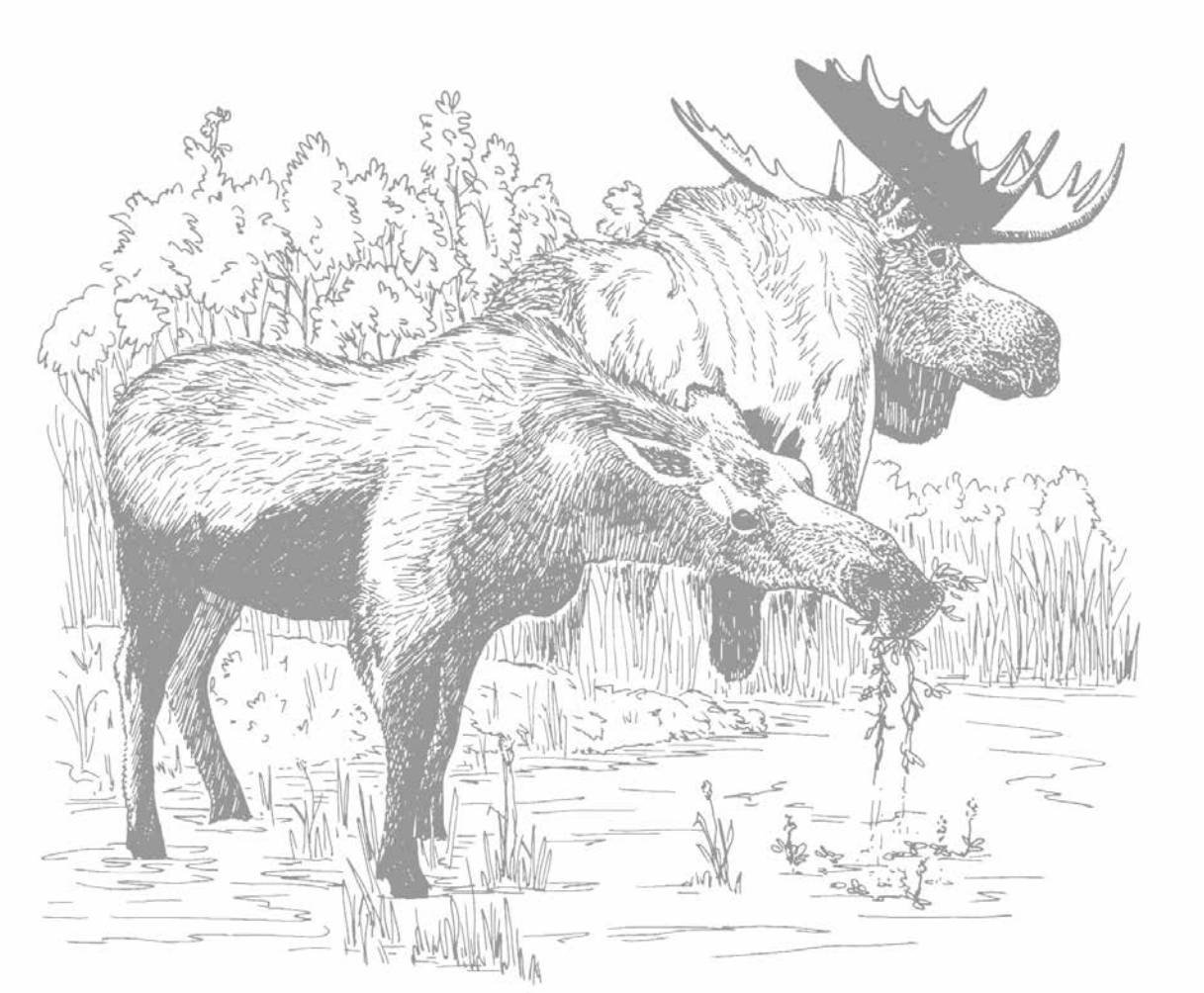




Section 2
WETLAND INHABITANTS

Section 3
WETLANDS IN A CHANGING WORLD

Section 4
WETLAND POLICY AND MANAGEMENT



What is a Wetland?

So what exactly is a wetland? Everybody seems to agree that wetlands are wet, at least for some of the time, but that's probably where the agreement stops. Many different wetland definitions exist, depending on perspective.

Travelers may consider wetlands to be soggy, inconvenient places where one gets bogged down, or becomes mired or swamped. Historically, humans have not had good things to say about these obstacles to travel. For example, Colonel William Byrd summed up the contemporary opinion of wetlands well when he wrote:

"...the foul damps ascend without ceasing, corrupt the air and render it unfit for respiration..... Never was Rum, that cordial of Life, found more necessary than in this Dirty Place"

Colonel William Byrd III, "Historie of the Dividing Line Betwixt Virginial and North Carolina" in *The Westover Manuscripts* written 1728-1736, Petersubrg, VA: E. and J.C. Ruffin, printers 1841

Hydrology affects the ecosystem. Unlike Colonel Byrd, hydrologists (people who study the water cycle) get pretty excited about wetlands. They will tell you that wetland **hydrology** is probably the most determinant factor in wetland processes. Wetland hydrology refers to the flow of water through the wetland.

Many important ecosystem factors are affected by whether the source of water in the wetland is surface water (streams), groundwater, precipitation, or flooding rivers. These ecosystem factors include nutrient availability, decomposition, species composition, and primary productivity (the amount of photosynthesis that occurs).

Soils determine wetness! Pushing hydrologists aside, **soil scientists** will tell you that, how long an area stays wet and how wet it becomes depends on the type of soil, the terrain and the existing plants. Water may disappear down into cracks and crevices between rocks or soil particles, become taken up by thirsty plants, or quickly stream off steep cliff faces. Where a subsurface layer of rock or permafrost, or water-retaining soil won't let it escape, water remains on the surface. Wetlands are these areas where water remains ponded or near the surface, and saturates the soils, leaving no room for oxygen.

Flora and fauna are adapted. Biologists know that wetlands are places where plants and soil-dwelling animals that live there have **adaptations to anaerobic conditions**. Wetland soils have limited or no oxygen. Therefore, wetland plants and soil-dwelling organisms have developed unique adaptations that allow them to survive in these anaerobic conditions. Some of these specialized plants can in fact serve as **indicators** of areas that are typically wet

Legal speak. If you're a **regulator**, charged with protecting the important functions of wetlands recognized by the Clean Water Act, wetlands have a specific legal definition that currently recognizes all three conditions described above.

Three factors are used to define an area as a wetland:

- The **hydrology** (or water regime) indicates that the area is periodically flooded or saturated.

- The soil is **hydric** (it retains water), and it is generally anaerobic.

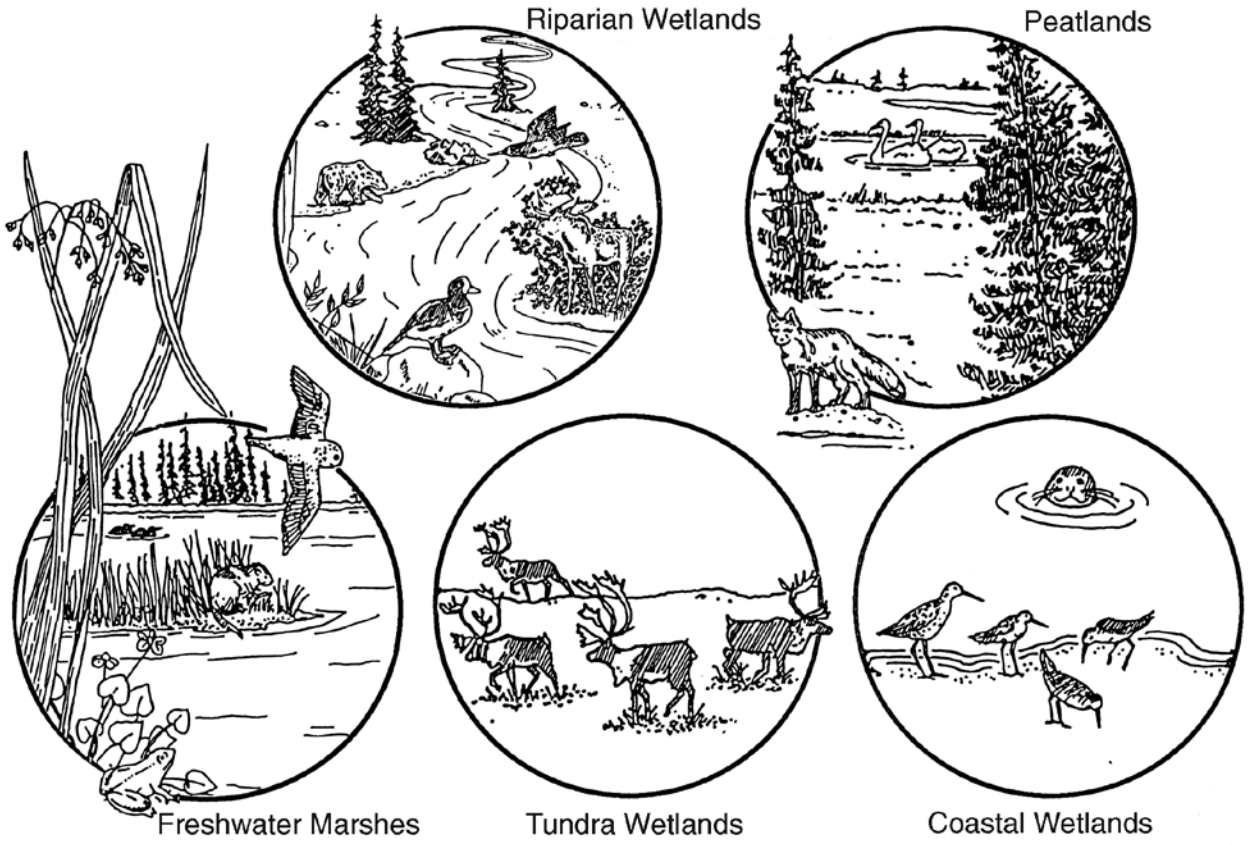
- The type of plants that grow there are dependent on wetland conditions and/or specifically adapted to growth in soils with low oxygen or no oxygen at all.

Regulation. With some specific exceptions, wetland permits are required for human activities that would clear, dredge or fill areas that meet the three criteria listed above. However, because the water cycle is dynamic and the wetness of an area varies accordingly, it is often difficult to determine in the field whether an area should be classified by federal and state agencies to be a wetland, especially if the area is temporarily or marginally wet (like tundra or seasonal ponds).

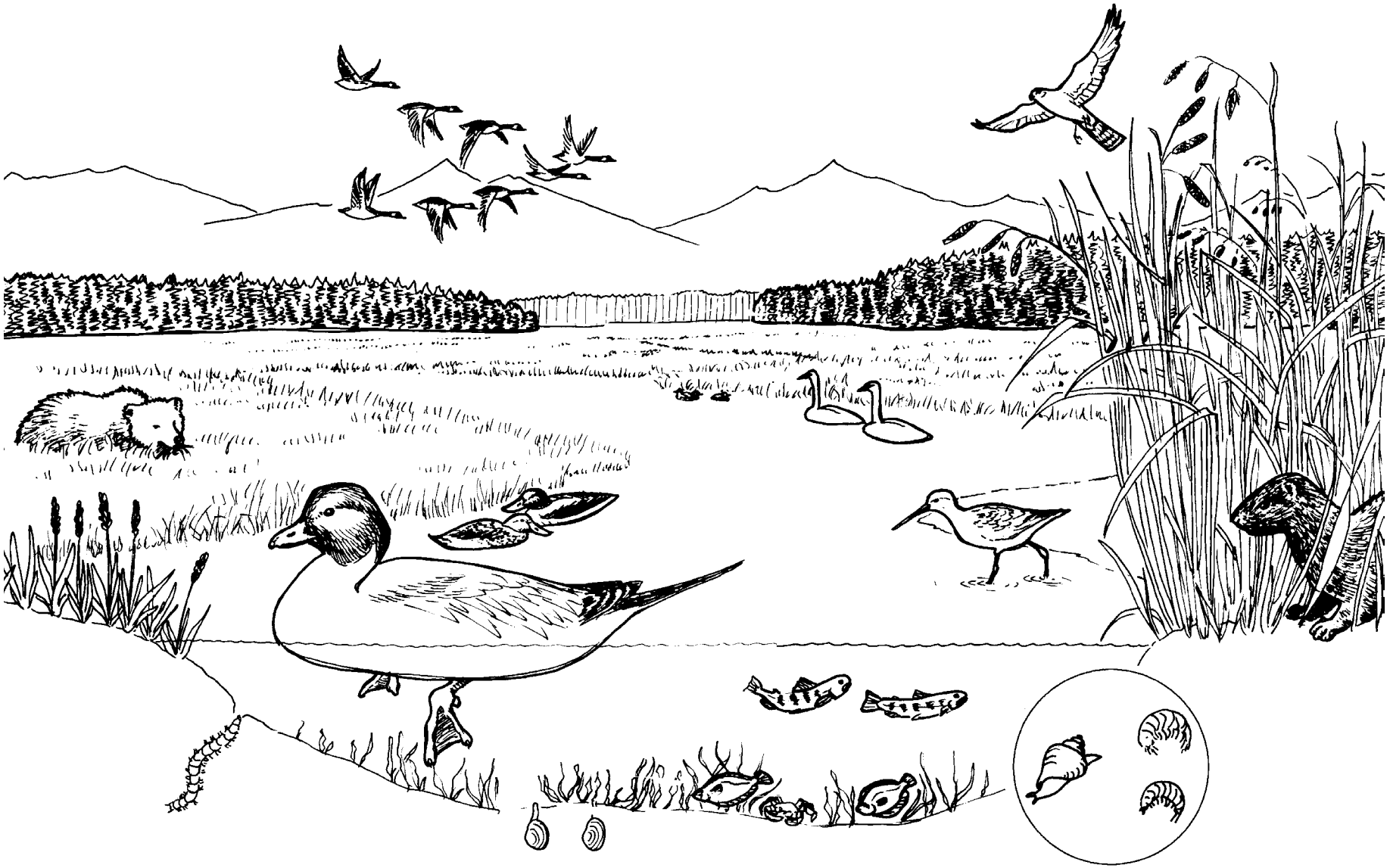
For the purpose of making consistent regulatory decisions concerning wetland protection, a set of federal guidelines (from the Clean Water Act Section 404 (b) (1)) is used by managers to identify wetlands in the field. Managers refer to these guidelines to evaluate proposed development in wetlands, such as urban expansion. The guidelines are periodically revised, field tested, and available for public comment.

Profiles of Alaska's Wetlands

Wetlands have been classified in many different ways, as there is such a broad range of sizes and habitat types. This curriculum emphasizes five distinct types of wetlands: coastal wetlands, freshwater marshes, riparian wetlands, peatlands, and tundra. Within each of these broad classifications, there are often several different habitat types.



COASTAL WETLANDS



Coastal Wetlands

KEY CHARACTERISTICS

- Water is saline or brackish (a mix of both salt water and fresh water).
- Nutrients are abundant due to tidal mixing.
- The habitat is often very important or crucial for migratory birds and juvenile fish.
- Vegetation is salt tolerant.
- Habitat types include salt marshes, mudflats, and eelgrass beds; land formations include estuaries, lagoon/barrier island and lagoon/spit systems.

Extremely productive. Vegetated saltwater wetlands along Alaska's coast are extremely productive "edge" areas where nutrients from the land flow down to the sea and nutrients from the sea are brought inland by the tides. Many are important feeding, resting, and nesting habitats for astonishing numbers of migratory birds. These wetlands are also the nursery for many juvenile fish and invertebrates such as salmon fry, bottomfish, crabs, and shrimp.

A small portion is vegetated. Although Alaska has approximately 2.1 million acres of coastal wetlands, only about 17% of those are vegetated. Much of Alaska's share of vegetated coastal wetlands is mud flats; a small percentage are salt marshes. Salt marshes are the only type of coastal wetland to be considered a true wetland according to the Clean Water Act Guidelines.

Coastal wetland habitat types

Salt marshes are in areas where protection from harsh wave action allows **halophytic** (prefers or tolerant of salt water) vegetation to grow. The soil is typically fine clay mixed with **humus** (decayed organic matter). Extensive stands of sea grasses and salt-tolerant sedges provide staging areas for migrating swans, geese, and other waterbirds. Salt marshes also help to protect ocean shores from erosion. Nearly half of Alaska's salt marsh habitat is along the coastline of western Alaska.

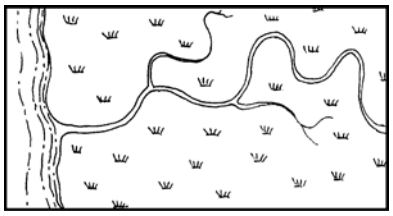
Mud flats are not as well known as important habitat, as most of the fauna that live there, are not visible, but reside below the surface of the flats. However, a rich diversity of invertebrates including many types of clams and worms provides critical food for shorebirds, diving and dabbling ducks, flatfish, juvenile salmon, and marine invertebrate predators. Vegetation is limited in mudflat wetlands, however microscopic phytoplankton live on and between the grains of sand and mud, and larger algae like sea lettuce grow on the surface.

Eelgrass beds grow completely submerged in shallow protected coastal areas. Alaska's Izembek Lagoon shelters one of the largest eelgrass beds in the world. Eelgrass is a flowering plant that provides essential food and shelter for a vast array of invertebrates, fish and other wildlife. Eelgrass survival is dependent upon adequate light availability, therefore it is easily impacted by human activities that stir up the water and increase water **turbidity** (cloudiness).

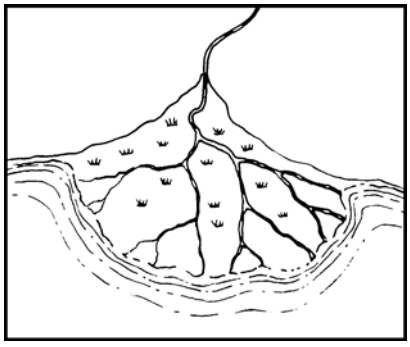
Coastal wetland land formations

Estuaries are areas where streams and rivers meet the sea, fresh and salt water mingle, and nutrients dissolved in the shallow water column are shunted back and forth by tidal action. The constant flows of fresh and seawater circulate nutrients several times daily, making estuaries some of the most biologically rich areas in the state.

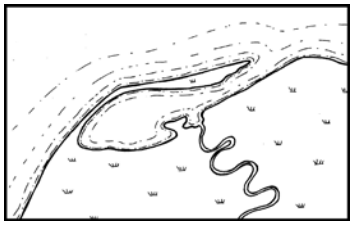
Deltas are a type of estuary where flat coastal topography allows the river to slow down so much that sediment drops out into a characteristic deposit, often dividing the river channel into a maze of multiple channels. More than 20 million shorebirds, including the entire world population of western sandpipers and most of the red knots and dunlin in North America, stop to rest and feed in the Copper River Delta. The Yukon-Kuskokwim Delta is the nesting grounds for nearly 2 million waterfowl and an estimated 100 million shorebirds.



Shallow lagoons are wetland areas hidden behind spits or barrier islands that blunt the force of icy winds, rough seas, or in the north – harsh scouring action of pack ice. Because they are protected, lagoons often permit the development of salt marshes. In summer, lagoons are relatively warm and brackish and support dense concentrations of fish close to the shore.



Nearly all of the Pacific Coast population of black brant stop to rest and feed at Izembek Lagoon before making a nonstop flight across the Gulf of Alaska and Pacific Ocean to the West Coast and Mexico. Nearly the entire world population of Steller's eiders and emperor geese gather in Alaska Peninsula lagoons during fall; many of these birds remain in Alaska throughout the winter.



Peatlands

KEY CHARACTERISTICS

- Two major types are bogs and fens.
- Decomposition is slow and incomplete, resulting in a buildup of dead and partially decayed plants called peat.
- Drainage is slow or lacking.
- Waters and soils are usually cold; in bogs they are acidic, and nutrient deficient.
- In bogs, sphagnum moss is a dominant plant, often growing very thick. Other plants are adapted to growth in acidic, nutrient deficient and waterlogged conditions.

Mucky wetlands. If you've spent time in the boreal forest, you've probably visited a peatland before, but perhaps did not realize you were in wetland, at least not in time to prevent your boots and socks from becoming soaked in black muck. Those mucky open spaces, surrounded by thick brown moss, a few shrubs and perhaps a "drunken" tree or two, are peatlands.

Peatlands are commonly called muskeg, an old Algonquian term referring to a soggy bog. However, the term can be confusing, as it has been used for many different types of habitats. Alaska has about 127 million acres of peatlands, roughly 75% of all Alaska's inland wetlands.

Two types. Two major types of peatlands are **bogs** and **fens**. Bogs are distinguished by a lush growth of moss (usually sphagnum) and thick, organic, acidic soils. The water source in bogs is mainly precipitation. **Fens** are complexes of groundwater-influenced linked channels that usually receive some drainage.

Not much drainage. Peatlands form in places where drainage is slow or scarcely existent and soil and water temperatures are low. They often form when ponds and lakes are covered by floating plants and eventually become filled in by accumulating dead plant materials.

Peat buildup. Unlike other wetlands, where decomposition and export of dead plants is rapid, cold, acidic and nutrient poor conditions in bogs and fens result in the slow build-up of **peat**. In Interior and northern Alaska, cool temperatures are the main factor that slows decomposition and results in peat buildup, whereas in southeastern Alaska, a wet climate that waterlogs soils and restricts oxygen is the primary factor for peatland formation. Thick layers of peat and surface mosses insulate the soil, causing further cooling, and preventing thawing of permafrost.

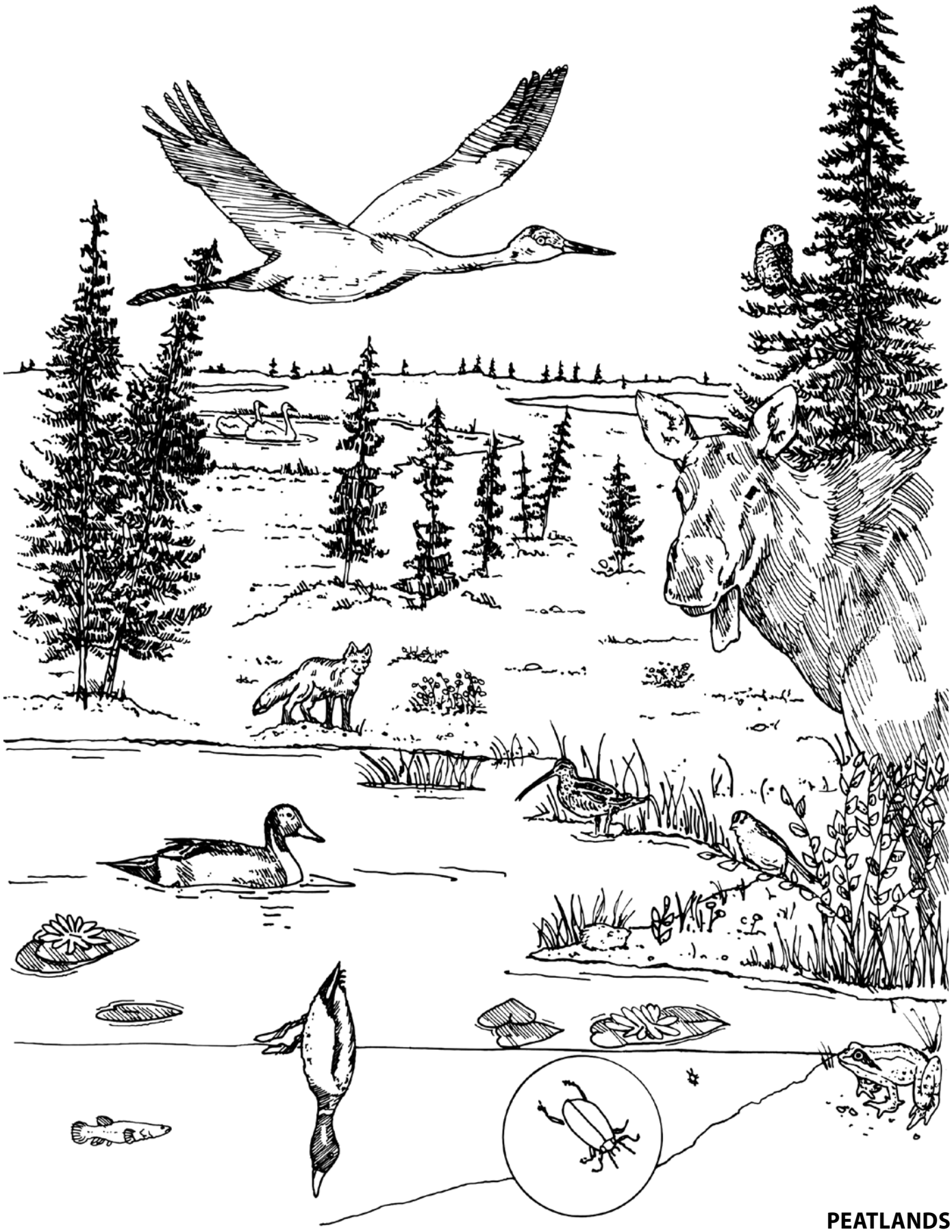
Mosses rule. Mosses found in bogs influence what else can or cannot grow there. Certain peat mosses facilitate waterlogged conditions due to their ability to hold 200 times their weight in water – similar to a sponge. Leaf-like projections on the small moss stems contain gas-filled cells that fill with water. If they are not already saturated, mosses can also wick up groundwater. Peat mosses also release acids, creating conditions intolerable to decomposing bacteria and many plants.

Tough plants. Plants that can tolerate these difficult conditions include heath plants like the pungent Labrador tea (*Ledum palustre*), bog blueberry (*Vaccinium uliginosum*), bog rosemary (*Andromeda polifolia*), and Tamarack (*Larix laricina*) (also called Larch). Insectivorous plants, such as the Sundew (*Drosera rotundifolia*) thrive in the low-

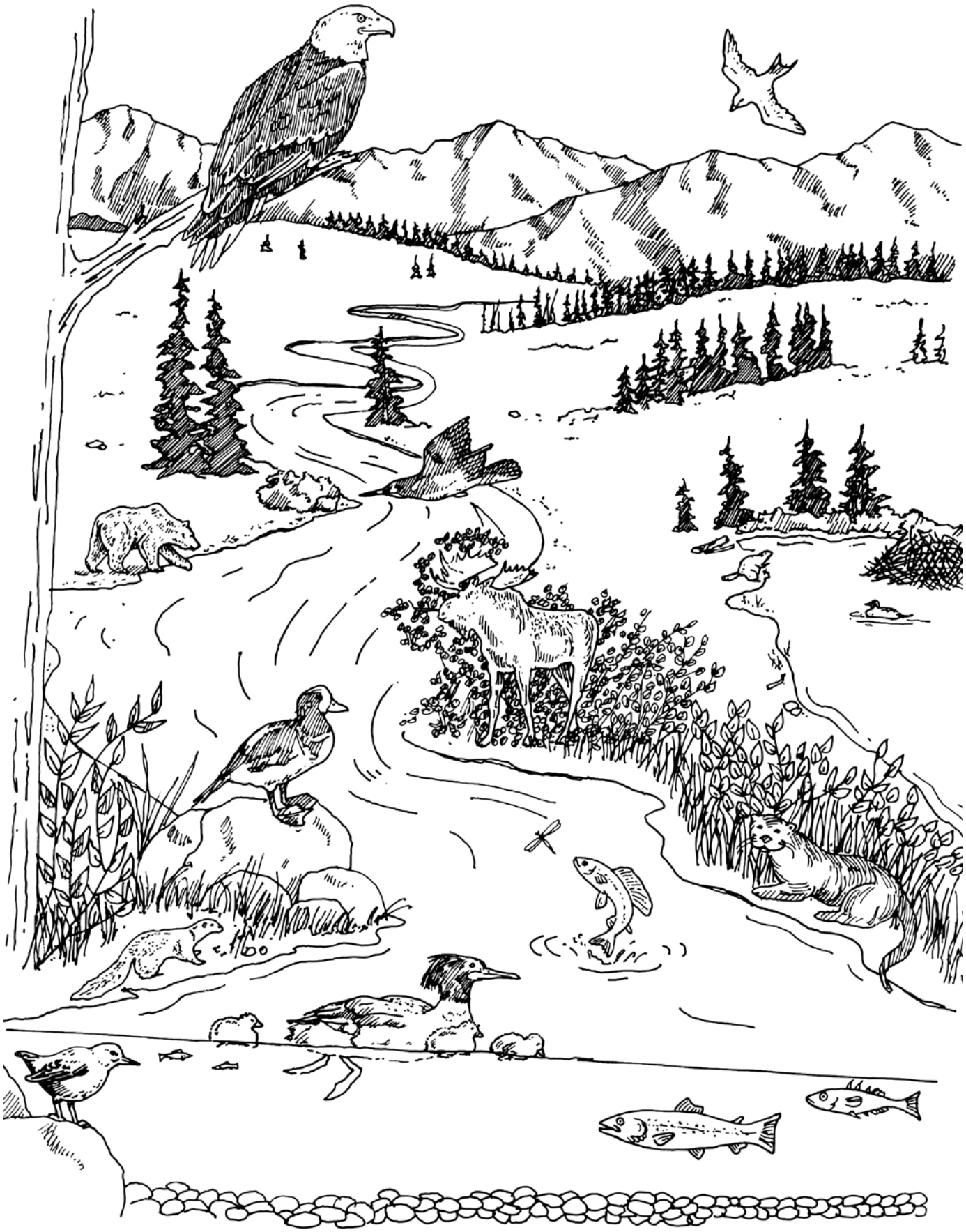
nutrient soils because they are able to gain nutrients from insects. Black spruce trees (*Picea mariana*) are the dominant tree, but lodgepole pines sometimes inhabit peatlands in southeastern Alaska.

Wildlife vary. Bogs are generally areas of low productivity; meaning food for wildlife is not as abundant as in other wetland areas. The acidic water that slows decomposition and cycling of nutrients also inhibits growth of algae and bacteria, which are essentially the bottom of the food chain. However peatlands are important for different wildlife species during all seasons. Insectivorous birds like songbirds, raptors like the harrier, and grazing birds like swans all use peatlands as feeding areas. Wood frogs use bogs and fens for breeding and depositing their eggs. Aquatic or semi-aquatic mammals such as beavers, mink, and otter often find their preferred foods in these wetlands. Moose browse on willows, as well as on the mineral-rich submerged vegetation.

Important open areas. Fens serve as important open areas in forests because they are either treeless or support only scattered, stunted trees. Open areas are valuable for different wildlife species during different seasons. In fall, deer and moose use these wetlands for courting. During spring and summer, the open areas provide room for birds to engage in aerial displays. Hawks and owls find good vantage points along the edges of such areas, where they can be ready to dive toward lemmings and voles that may venture out of mossy nests.



PEATLANDS



RIPARIAN WETLANDS

Riparian Wetlands

River connection. The **riparian zone** refers to the ecosystem bordering streams and rivers. Riparian wetlands include ponds, abandoned stream channels called oxbow lakes, and gravel bars with tall willow stands. Riparian wetlands are created by seasonal flooding of the adjacent river, or a shallow groundwater or other hydrological connection to the main channel.

Nutritious floods. Ice formation, ice cover, break-up, and alternating storms and dry periods bring periods of flooding to the riparian zone. Such flooding nourishes riparian wetlands when the rich load of organic debris and nutrients overflows stream banks. In fact, the frequency with which riparian wetlands are connected to stream or river systems is one of the key factors determining the amount of food available for fish and birds. When the river is not flooding, riparian wetlands may drain back into streams, returning nutrients that are eventually carried into estuaries.

A good home. Shrubby riparian wetlands with stands of willows, birches, and alders are important to Alaska's wildlife. Many types of songbirds nest or feed in floodplain willow stands during the summer. Willows are also a primary food for moose during both summer and winter. Silt deposited during flooding is a rich substrate for showy flowering plants such as River Beauty (*Chamerion latifolium*), and favorite bear foods like Eskimo Potato (*Hedysarum alpinum*) and Soapberry (*Shepherdia canadensis*).

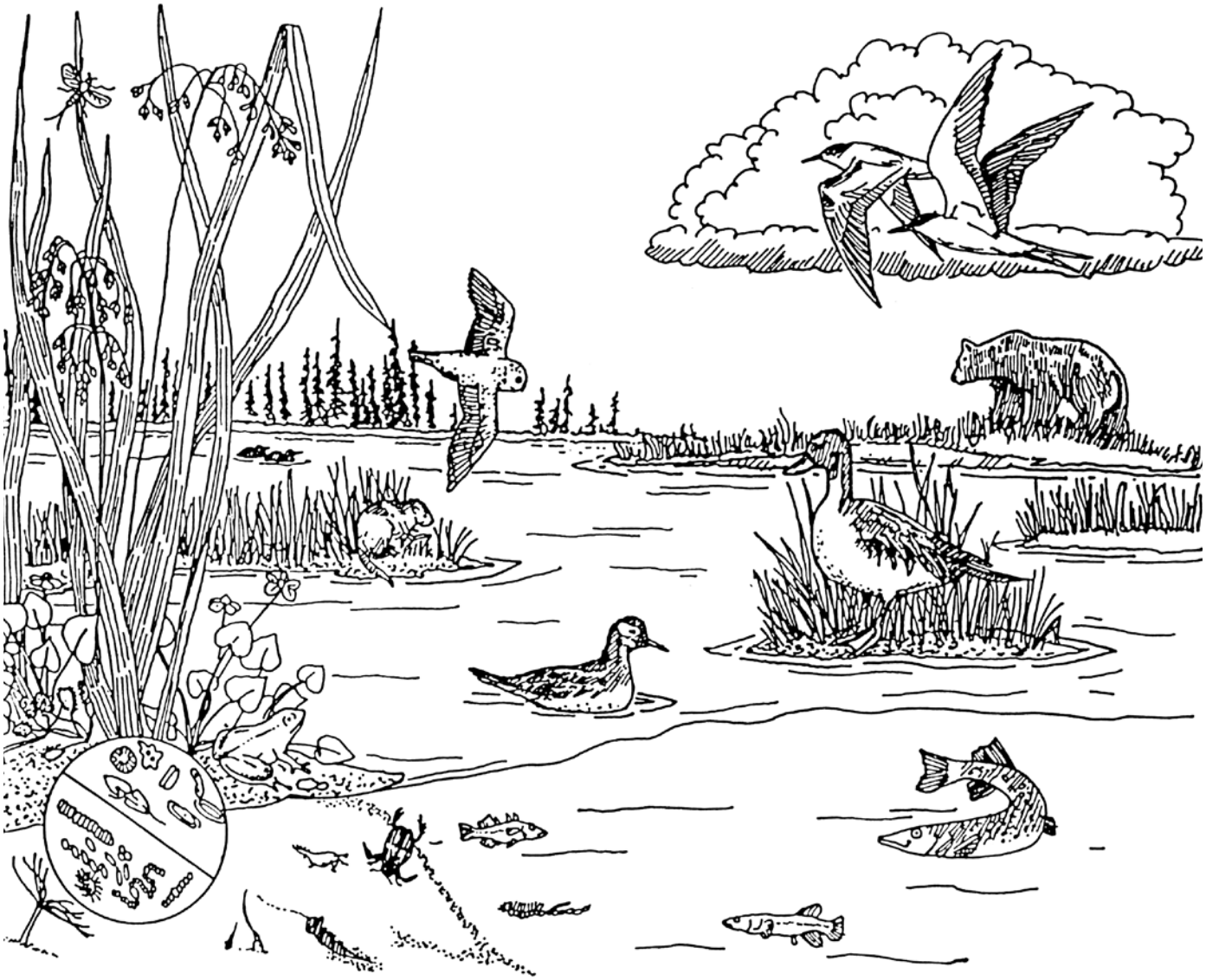
Food for fish. Many types of fish rely indirectly on riparian areas for food because decomposing leaves from shrubs and plants is an important energy source for the aquatic invertebrates that fish eat. Decaying salmon carcasses in turn provide valuable marine-derived nutrients to the riparian area.

KEY CHARACTERISTICS

- Rivers or streams are the major influence.
- Nutrients are moved downstream by way of channeled flows.
- Water levels change in response to precipitation, freeze-up, and break-up.
- Plant and animals are distributed in zones relative to the distance from main channels
- Fish and wildlife use them as important movement corridors.

In a green place lanced through
With amber and gold and blue –
A place of water and weeds,
and roses pinker than dawn
And ranks of lush young reeds
And grasses straightly withdrawn
From graven ripples of sands.
The still blue heron stands.

– Theodore Goodridge Roberts
"The Blue Heron"



FRESHWATER MARSHES

Freshwater Marshes

Shallow basins. Freshwater marshes exist where water collects in shallow depressions, created as a result of a variety of geological processes. For example, glaciers gouge holes as they flow over bedrock, and when glaciers recede, these holes are exposed. Freezing and thawing in permafrost soils creates basins when ice-formed polygons thaw and subside. Where soil conditions allow, these holes and basins collect and hold water either from precipitation, groundwater, or nearby lakes and streams. The movement of rivers over time also leaves behind abandoned channels called oxbow lakes, which develop into marshes as they fill in.

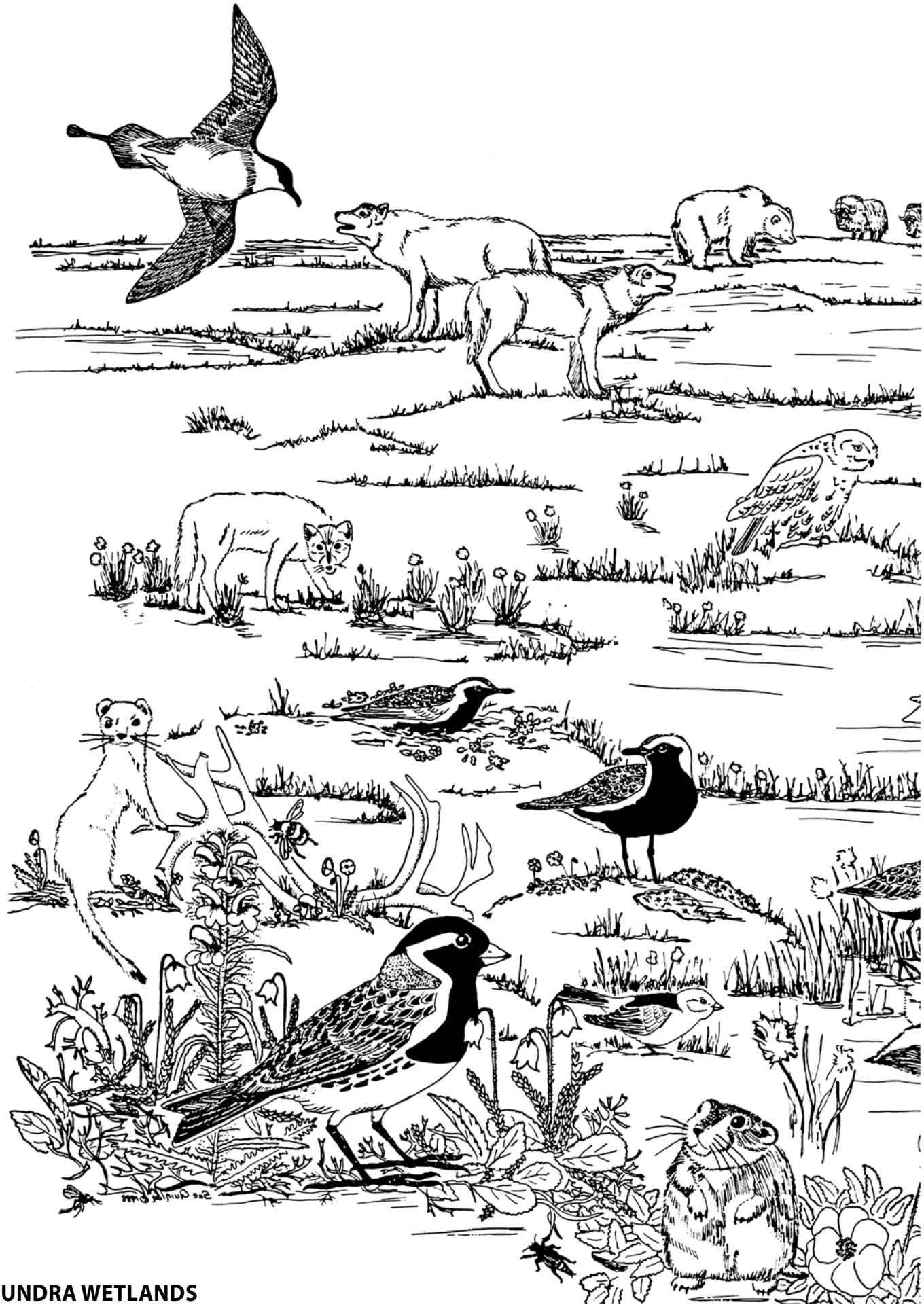
Freshwater marshes may be as shallow as a few inches, but usually not deeper than a few feet. Some marshes may dry out completely during parts of the year. Water depth determines what types of plants and animals exist, as sunlight penetration and oxygen availability decrease with water depth. The bottom of the wetland is exposed to oxygen when water levels decline during dry spells, facilitating decomposition and an ensuing release of important nutrients.

Vegetation emerges! A major characteristic of freshwater marshes is emergent vegetation such as cattails (*Typha* spp), Yellow pond lily (*Nuphar polysepalum*)), Five-fingered cinquefoil (*Potentilla palustris*), horsetails (*Equisetum* sp) and sedges. Many of the plants have adaptations to life in shallow water including floating leaves and flowers; entire plants that float; "emergent" growth forms that allow the plant to live with roots submerged and stems partially covered by water; and abilities to carry on photosynthesis while being totally submerged.

KEY CHARACTERISTICS

- Waters are shallow.
- Soft-stemmed vegetation emerges (stems, leaves and/or flowers stick out) from the water (emergent vegetation).
- The soil bottom is made up of a high concentration of organic materials and is rich in minerals.

Wildlife uses. Freshwater marshes support a wide array of plants, invertebrates and wildlife. Emergent vegetation provides food and cover for invertebrates and fish such as grayling and sticklebacks. Larger fish forage on aquatic invertebrates and terrestrial insects that drop from plants into the water. Many species of loons, diving ducks, and other waterbirds nest in or near lakes, ponds, and marshes, using the plants for nesting materials and for cover at the first hint of trouble.



TUNDRA WETLANDS

Tundra Wetlands

Cold and flat. Tundra dominates in western and northern portions of Alaska where flat or gently sloping areas have poor drainage and are often underlain by permafrost. Large portions of these tundra areas are wetlands. Tundra is also found in alpine areas statewide, but only a small portion of alpine tundra is wet enough to be considered a wetland. Most of lowland tundra remains wet or moist throughout the short season of thaw because water cannot seep through the permafrost and instead flows slowly over flat ground. Slow decomposition also results in peat deposits in some lowland tundra.

Landform medley. Tundra is a mosaic of many different landforms and plant communities. On a micro level, elevation is an important factor determining where different plants can grow because it affects the degree of wetness of an area. Often completely different plant communities are separated by only a few inches in height. The wettest tundra areas typically have shallow standing water throughout the summer. Sedges and related plants such as cottongrass (*Eriophorum* spp.) thrive in this type of environment.

In somewhat drier patches, such as gravel bars, river banks, hummocks, and tops of ice-wedge polygons, surface waters drain by late summer. The drier conditions allow grasses and dwarf willows to become established, as well as tiny saxifrages and other flowers like mountain avens (*Dryas* spp.) and poppies. If conditions are dry enough, tussock-forming cottongrasses (e.g. *Eriophorum vaginatum*) may create their own mini-uplands. The tussocks may be only several inches higher than the surrounding tundra, but the height is enough to provide a dry roothold for dwarf and shrub birches (*Betula glandulosa/nana*), Labrador tea (*Ledum palustre*), lichens, and many berry-producing plants such as lingonberry (*Vaccinium vitis-idaea*) and cloudberry (*Rubus chamaemorus*).

Abundant food. Some tundra wetland areas are very productive during the brief arctic summer. Migrations of millions of shorebirds, waterfowl, and other water birds return to the tundra to nest from wintering grounds as far south as Antarctica and South America. In general, densities of nesting water birds are higher closer to the coast. Other wildlife like caribou also find abundant food near tundra wetlands. Lemmings graze green growth and stockpile "haystacks" for the coming winter. Grizzly bears, arctic foxes, jaegers, and snowy owls roam the tundra searching for small mammals, or bird eggs and nestlings to eat.

KEY CHARACTERISTICS

- The growing season is short, and challenging due to severe cold and persistent wind.
- Trees are absent.
- Elevation is the most important factor determining where plants grow.
- Some are extremely productive during the thaw period, providing good habitat for migratory water birds and some mammals (for example, lemmings).

In winter some move on. After the brief summer ends, many fish and birds migrate to more southern areas, while polar bears and arctic foxes head north with the ice pack. Brown bears dig dens, and arctic ground squirrels dig burrows and then sleep away the long winter. Insect larvae go dormant and fish find deep, spring-fed holes in rivers. Still, some wildlife are adapted to the harsh winter conditions. Lemmings and voles, muskoxen, ptarmigan, ravens, and caribou remain active year-round.

Wetland Ecosystem Functions

Wetland ecosystems provide many essential functions – so essential that some are characterized as **"ecosystem services"**. When wetlands are filled, the loss of such services can cost governments millions of dollars. Within a landscape, wetlands are linked to both upstream and downstream ecosystems, and their functional values may extend well beyond their own boundaries. In the case of some migratory birds, habitat functions can extend even to other continents. Ecosystem functions of wetlands are summarized below.

- **Water storage and flood control:** Wetlands control flooding by catching and absorbing surface water and preventing it from running off before it reaches rivers and lakes. Wetlands store this surface water and spread it out over a large area. Mosses associated with some wetlands retain huge amounts of water, as well as the hydric (waterlogged) soils. When wetlands are lost, governments often have to enact very costly flood control measures to replace the valuable ecosystem service.

- **Groundwater recharge and discharge:** Some wetlands replenish drinking water aquifers; some maintain stream flow by slowly releasing water during dry spells.

- **Water quality maintenance:** Wetlands filter both natural and human-made contaminants such as heavy metals. Suspended solids are also retained by wetlands, decreasing the turbidity of streams draining from the wetland. Wetlands also retain excess nutrients, preventing drainage waters from becoming sites of algal blooms with low oxygen availability. This nutrient retention aspect is especially important downstream from agricultural activities where fertilizers are used.

- **Erosion control:** Wetlands control erosion by dissipating the energy of flowing water. In some wetlands, mats of vegetation and layers of organic soil also effectively protect mineral soil from being lost. Some peatlands facilitate the formation of permafrost, which further stabilizes the soil.

- **Carbon storage:** The slow decomposition process in peatlands and some tundra wetlands results in storage of large amounts of carbon. Some wetlands also take up and store atmospheric carbon dioxide (CO_2) (act as CO_2 **sinks**), which has important implications in the face of climate change.

- **Aquatic habitat:** As mentioned in earlier fact sheets, many species of birds, fish, invertebrates and wildlife rely on wetlands for critical habitat. Wetland loss has severe consequences on the populations of these species.

- **Recreation and aesthetics:** Swimming, boating, wildlife photography and viewing, and relaxing by gently gurgling waters – these are all activities we sometimes take for granted in Alaska where wetlands are abundant.

- **Hunting and subsistence:** Hunting and subsistence use of wetlands in Alaska is extensive, ranging from waterfowl or moose hunting, to gathering berries. Many of Alaska's valuable berry crops grow only in and around wetlands.

Wetland Soils

Too wet for air. The technical definition of a wetland includes having **hydric** soil; that is, soil that has been saturated so long that anaerobic conditions exist, and only certain types of vegetation can grow. The size of soil particles determines how much water drains away. For example, water can seep quickly through rocks and sand, but not very easily through fine silt and clay.

Regardless of soil type, most soils can become hydric if something deeper down prevents water from draining. Permafrost is a prime example; the perennially frozen soil prevents water from draining regardless of what may lie above it. As a result, Alaska has no shortage of wetlands. Compacted glacial silt in many parts of Alaska can also impede water drainage.

Soils are classified in four ways. Soils are classified on the basis of four major components: mineral content, organic content, water, and oxygen. Mineral content is responsible for the texture of the soil, which has an important influence on soil properties such the ability to hold water and permit growth of plants.

Slippery, gritty or smooth? Soil texture is defined according to the amount of sand, silt, and clay in the soil.

- Excluding cobbles and gravel, **sand** is the largest particle size, ranging from .05 mm to 2.0 mm. As we've all experienced, individual grains are easily seen. The texture of sand should be familiar too, as we've all probably enjoyed gritty sand in our beach sandwiches.

- **Silt** is smaller in size, ranging from .002 mm to .05 mm, too small to see with a naked eye. Silt often feels smooth slippery between the fingers, but it is not sticky, even when wet.

- **Clay** is the smallest size, less than .001 mm. Particles are so small, that they have a huge amount of surface area in relation to their mass. They stick to each other easily, as well as to water. You know when you've walked through soils containing lots of wet clay – you have a sticky mass of soil stuck to your shoe, and when it dries, it's a solid clod. In general, the amount of clay in a soil has a strong influence on how well it retains water.

Terminology. Soil texture is described using terms like sandy clay loam, silty loam etc. The activity "Investigating Wetland Soils" in Section 4 of the Student Wetland Activities explains how to use a Soil Texture triangle to determine the type of soil.

Organic matter. Living and decaying organisms in the soil (e.g. nematodes, microbes, plant roots, etc.) also affect how well soils bind together, and how well they hold water. Nutrients are released during the process of decomposition of organic material, so the ability of microbes to decompose organic material determines the quantity and quality of nutrients available to plants. Like clay, some organic matter sticks to water and nutrients, and can vastly increase the amount of water a soil can hold.

In-stream Flow

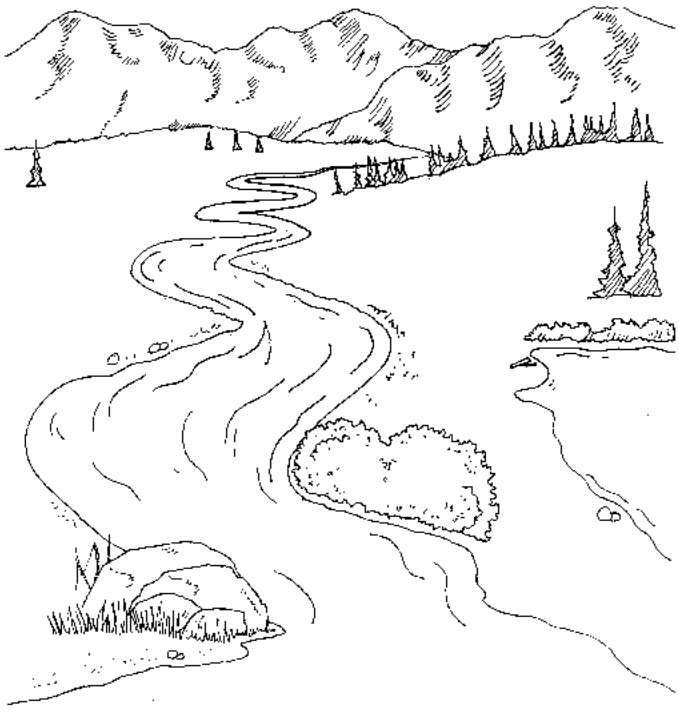
Useful information. Aquatic scientists and managers measure stream flow to help learn important information about a stream, and how it may be affecting associated wetlands. Stream flow can affect whether or not pollutants and other substances can be washed out by the stream; the amount of oxygen and the temperature of the water; and the amount of sediments that can be carried by the stream. Stream flow will also affect the physical features of the stream and associated wetlands, and in this manner determines the type of habitat available to fish, plants, and other animals.

How is it measured? Stream flow is measured as the volume of water moving past a given point per unit time. Flow is a combination of velocity – or speed of the stream, and volume – the amount of water in the stream.

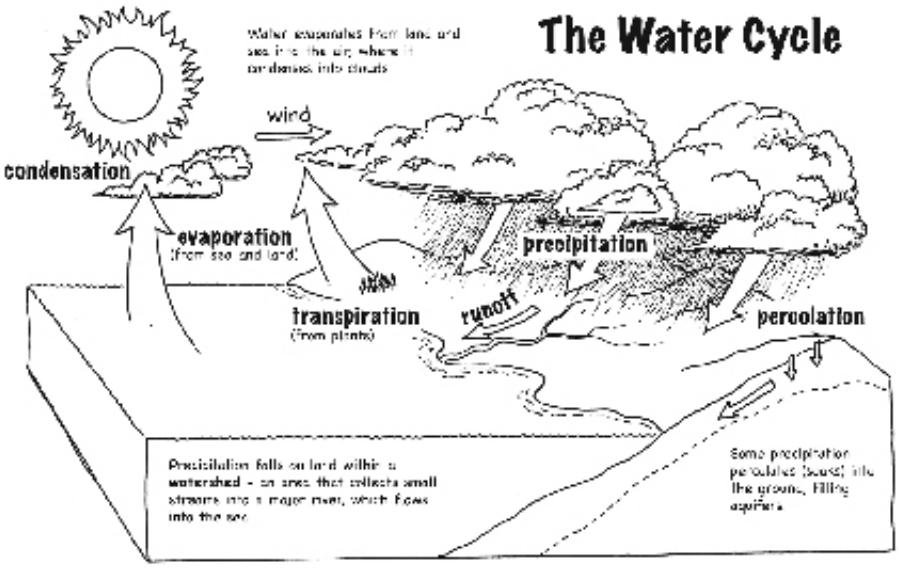
Stream flow affects everything. Many of the organisms that reside in a stream are adapted to a certain flow. Radical changes in flow can thus have negative consequences for the stream's residents. In Alaska, government regulations exist to ensure that water consumption; either by individuals, agriculture or industry does not reduce the flow beyond a minimum level. Anyone is able to reserve water rights for the purpose of protecting fish and wildlife habitat; recreation and parks; navigation and transportation; and water quality.

Everything affects stream flow. Stream flows are affected by many factors. Precipitation, seasonal climate variations, vegetation, and adjacent springs and wetlands all influence the volume of flow. Gradient and resistance, which is determined by what is on the bottom of the stream, channel shape and what is in the middle of the stream, all affect the velocity of the stream.

Human activities can also increase or decrease stream flow. Wetland loss (through filling and paving etc.) and the removal of vegetation can increase stream flow. However, in dry years, the loss of such water storage mechanisms has the result of decreased stream flow. While historic practices called for straightening and "cleaning out" streams, we now know that such channeling activities increase the velocity of a stream, causing erosion down stream. Dams of course are the most radical way in which humans alter flow.



The Water Cycle



Not much for drinking! Water covers 71% of the earth's surface; however, 97% of that water is salt water in the oceans and another 2% is locked up in glaciers and ice caps. Only 1% of the water on earth is fresh water, found in rivers, lakes and groundwater. As most life on land depends on fresh water, that's not much!

Continually recycled. Fortunately, in the **hydrologic** or **water cycle**, water is constantly renewed, cycling from one form to another, and from non-living things to living things. The water that you used to brush your teeth today could in fact, be water that was once used to irrigate crops in ancient Egypt!

- Through **evaporation**, water from earth's surface is changed into water vapor and flows to the atmosphere.

- Water is also **transpired** to the atmosphere by plants. Plants essentially suck up water from the soil as the roots take in nutrients and the leaves conduct photosynthesis. Most of this soil water is then transferred to the atmosphere. In this process of transpiration, one tree may pump up to 350 gallons of water every day! Vegetation thus has an important effect on how much water is available in the soil, and how much is transferred to the atmosphere. Clearcutting and forest fires often result in an increase in soil moisture.

- Water in the atmosphere **condenses** into clouds and is moved over land by air currents.

- Through **precipitation**, water returns to earth's surface in the form of rain or snow.

- Once on the ground, water **runs off** back into lakes, ponds and oceans via streams and rivers etc.

- Or, the surface water **percolates** into the soil and recharges the groundwater table.

The main source of energy for all these exchanges is of course, the sun.

The amount of time that water stays in each of its many forms varies tremendously according to the location. However on average, water remains in the atmosphere for 9 days, in rivers for 12 to 20 days, in lakes from days to centuries, and in the ocean, an average of 3,100 years.

Marine-derived Nutrients

Fertilizing the water. Salmon play an extremely important role as ecosystem "fertilizers" because they bring important nutrients from the ocean to wetlands and other fresh water ecosystems. During their adult life in the ocean, salmon feed on a variety of foods, such as plankton, crab larvae, shrimp, squid and small fish, and build up stores of nutrients in their bodies. When the salmon then return to fresh waters to spawn, they bring these **marine-derived nutrients** with them. Salmon eggs, salmon carcasses, and even salmon sperm, thus contain high amounts of these nutrients!

Most ecosystems in Alaska, both in water and on land, have a limiting supply of nutrients (especially nitrogen). That is, plant growth is usually limited by the lack of available nutrients, more than any other factor. Decaying salmon carcasses and eggs can thus have a very important impact! Nutrients released from salmon carcasses cause increased plant growth. Such riparian vegetation stabilizes stream banks and filters sediment and pollution, while overhanging roots provide shade and shelter for young fish. Leaves that fall into the water also provide food for insects, which in turn feed other fish in the wetland or stream.

Fertilizing the land. Marine-derived nutrients even make their way on to land by way of the animals that eat salmon. Bears, eagles, gulls, and foxes all deposit marine-derived nutrients on land near riparian areas and other wetlands via their feces, or just by physically carrying them out of the water.

The opposite situation – salmon declines. Marine-derived nutrients can be so important to ecosystems, that drops in salmon populations can have negative consequences as well. The productivity and nutrient availability of streams and associated wetlands often decrease when salmon runs decline.

The science behind the facts. Scientists have measured the inputs of marine-derived nutrients using a fascinating technique of closely examining the nitrogen in soil and plants in riparian ecosystems. Remember chemistry? Nitrogen appears naturally on the earth in two isotopic forms – the most abundant kind is ^{14}N (14 is the atomic weight, N is the atomic symbol for nitrogen). However, a less abundant type, ^{15}N tends to accumulate high up on the food chain. In this manner, the nitrogen in salmon carcasses "looks different" – it tends to be high in ^{15}N. When scientists tested the nitrogen in soil and plants in riparian ecosystems, they indeed discovered that the ^{15}N content was higher than in other soil and plants. The nitrogen from the salmon was showing up in the trees!

Alaska's Waterbirds and Wetlands

Waterbirds are those species found around fresh water or salt water. These birds get their food from the water and can be found in Alaska wetlands. Examples of waterbirds include waterfowl, shorebirds, loons, grebes, gulls, terns, cranes, and herons.

Waterfowl. Ducks, geese, and swans together are called waterfowl. The world's 145 waterfowl species are all web-footed swimming birds, and along the edges of their broad bills, they all have a row of tooth-like serrations that they use to tear vegetation, grasp small fishes, or strain edible plants from pond water. All have downy young that unlike the naked, helpless young of most other birds, are able to see, walk, eat, and run within hours of hatching.

Divisions. Waterfowl can be divided into two groups: ducks, and geese and swans. The duck group can be further sub-divided into diving ducks or "divers" and puddle ducks or "dabblers".

Some differences. **Geese and swans** mate for life; they molt (replace their feathers) only once a year; and the male guards the nest and helps the female care for the young. They are adapted for walking on land and for grazing on vegetation. Ducks on the other hand mate only for a single season, each year going through elaborate courtship rituals. The male leaves the female once she begins to sit on the eggs and thereafter has nothing to do with her or her young.

Diving ducks dive for clams, insects, crustaceans, fish, and deep plants. Most nest at or over water, preferring large marshes and lakes. Some divers can go down to 150 feet. When they take off from the water, their short pointed wings require that they build up speed in a long pattering run along the water surface (loons and grebes also take off this way). Diving ducks that nest in Alaska include the bay ducks, also known as inland divers (canvasback, redhead, ring-necked duck, and scaup), and sea ducks (eiders, scoters, long-tailed ducks, harlequin ducks, goldeneyes, bufflehead, and mergansers).

Dabbling ducks feed on insects and crustaceans on the surface of the water by walking through the water. They also feed on bottom-dwelling animals and plants by "tipping up" so that only their bottom and wagging tail can be seen in areas of shallow water. Because their broad wings allow them to fly quickly off the water when taking off, they can nest and feed on small ponds (hence the nickname "puddle ducks"). Mallards, pintails, green-winged teal, American wigeon, gadwalls, and northern shovelers are dabbling ducks that migrate through and breed in Alaska (the mallard is the most common duck in North America).

Loons are striking birds with black and white spots and stripes. They sit low in the water and often sink straight down like a submarine. Young loons are carried right on their mothers' backs. In flight, loons hold their heads lower than their body. Webbed feet and sharply pointed bills are other characteristics of this excellent diver that feeds on fish or aquatic invertebrates. All five species of loons found in North America use Alaska's wetlands and coastal waters for nesting, brood-rearing and wintering. Breeding is most likely to occur on waters that are relatively free of human disturbance.

Grebes have long, skinny necks and are smaller than loons. Instead of having webbed toes, grebes' toes are lobed. Like loons, grebes carry their young on their backs. Unlike loons, grebes dive forward, rather than sinking. Both red-necked grebes and horned grebes can be seen swimming and diving in Alaska's freshwater lakes, ponds, and slow-moving rivers. Western and pied-billed grebes can be found in southeast Alaska during autumn and winter.

Shorebirds and waders. Shorebirds, in general, have long legs for wading, short tails, and sharp, pointed wings such as falcons and other fast flyers. Dowitchers, godwits, plovers, turnstones, sandpipers, curlews, snipe, phalaropes, and yellowlegs are among the many whirling flocks that migrate through Alaska. They stage in areas like the Copper River Delta by the millions.

Some shorebirds are upland birds in the sense that they feed and nest in drier areas away from wetlands; but as a group, these birds are among the most abundant users of Alaska wetlands, where they find food, stage along their migration route, or nest. Some shorebird species, such as the bristle-thighed curlew, the black turnstone, and the western sandpiper, nest only in Alaska wetlands.

Seabirds. A wide variety of birds fit into the category of "seabird", which include gulls, terns, and cormorants. In general seabirds have webbed feet, and their bills are sharp for snatching up fish and invertebrates. Several seabirds spend the summer in inland wetlands, although a larger variety of seabirds nest on the coast or on islands. Many seabirds spend most of the year (September through April) along the coast or at sea.

POPULATION TRENDS OF WATERBIRDS

Natural fluctuations. Populations of waterbirds naturally fluctuate in response to climatic conditions, ecological factors (habitat conditions and predators), and the effects of human actions. Many waterbird species that occur in Alaska are still abundant, but some populations have shown downward trends recently and others over the long term.

Who's stable? Examples of populations of species that appear to be healthy in most areas are gulls, swans, snow geese, dabbling ducks, and sandhill cranes. Examples of species that have experienced some decline in the past but have since increased include cackling and white-fronted geese in western Alaska, and the Aleutian goose. (The Aleutian Canada goose population was as low as 800 birds in 1967 but now is over 80,000 birds and has been removed from the endangered species list). Examples of species that appear to be diminished or declining are the emperor goose, the dusky Canada goose, most sea duck species (eiders, scoters, long-tailed ducks), and most shorebirds. Among the species that are officially listed as **threatened or endangered** are the Eskimo curlew, spectacled eider, and Steller's eiders that breed in Alaska.

WATERBIRD MIGRATION

Migration is a mysterious topic. How do birds, fish, mammals, and insects travel such immense distances with such exactness?

Some migratory animals travel at night, some during the day, some in the skies, some on land, and others deep within the sea. Unerringly, migrating animals locate their necessary habitats. Scientists have proposed that migrating animals use the stars, the sun, and even the Earth's magnetic field for guidance. Some animals such as salmon, use their sense of smell to guide them. Most migrating species probably use a combination of means to guide their journeys.

Geese migrate along flyways. Geese migrate in a V-shape or cluster formation at about 50 mph. Their movement is steady and unhurried and closely follows the movements of the seasons. Geese migrate along four different flyways (Pacific, Central, Mississippi, and Atlantic), which are generalized migration pathways. Geese make their spring migration (south to north) from February to April. Fall migrations (north to south) occur from September to December. Some birds use only the Pacific Flyway while others cross or use all four North American Flyways. Although species' actual migrations do not strictly conform to these flyways, they are a useful way of generalizing migration routes.

Many migrate. There are a variety of remarkable migrating waterbirds in Alaska, including ducks, geese, swans, cranes, herons, gulls, terns, and shorebirds. Arctic terns make the longest journey, traveling all the way from Antarctica to Alaska to breed. Wetlands are important to all for both breeding and wintering. Additionally, wetlands are important stopover sites for food and rest during the long migrations.

MIGRATORY BIRD BANDING

Route study. Bird banding allows researchers to study migratory birds routes. Through recovery and sightings of bird bands, researchers can determine which flyways are being used, as well as how long migration takes. From bird band returns biologists have discovered that during spring migration birds make more stopovers as they follow improving weather northward. In fall, the birds wait and move south all at once to good weather.

Banding Lab. The U.S. Fish and Wildlife Service Bird Banding Laboratory in Laurel, Maryland maintains a record of all bird bands in the United States. All researchers must obtain permits from the Bird Banding Laboratory in order to embark on a bird-marking project. Marked birds must have a silver colored U.S. Fish and Wildlife band with an 8 or 9 digit number. This number and all information about the bird–such as sex, age, weight, condition, date, and place of banding–are on file at the Bird Banding Laboratory.

Finding banded birds. If you find a banded bird and can read any or all of the numbers on the bands or the neck collar, you should contact the U.S. Fish and Wildlife Service and they will forward the information to the Bird Banding Laboratory. The laboratory staff will look up the numbers and contact the biologists who initiated the study. The biologists will then use the information that you gave them about the circumstances in which you saw the bird in their studies. The laboratory will also let you know when and where the bird was banded.

Other Birds and Wetlands

Birds of Prey. These birds, called "raptors," include those species of birds that have powerful curved bills and sharp talons for capturing and eating birds, fish, mammals, amphibians, and crustaceans. Raptors include eagles, hawks, falcons, and owls. Some perch near freshwater wetlands, while others either soar high or fly low over them. Once they see or hear prey, raptors either dive down to grab it in their talons, or fly fast and capture in mid air. All birds of prey have acute vision for spotting prey over long distances. Many owls can also hear prey, even when it is beneath deep snow.

Bald eagles are common along the coast of Alaska where they feed on fish. Ospreys are also specialized to prey upon fish and nest regularly in Alaska along lakes, rivers, and coastlines south of the Brooks Range. The northern harrier is a medium-sized hawk formerly known as the marsh hawk because of its characteristic low-flying, gliding hunt over marshy areas in quest of small mammals. Buteos (soaring hawks) and many owls often perch on dead trees to spot prey. Rough-legged hawks, kestrels, snowy owls, short-eared owls, peregrine falcons, and golden eagles are raptor species commonly spotted over open marshes or tundra wetlands. Hawks hunt during the day while most owls are nocturnal hunters.

Songbirds and others. Songbirds (also called passerines) are usually perching birds, with feet designed for grasping a perch. This group includes flycatchers, swallows, jays, chickadees, thrushes, warblers, finches, sparrows, and many other birds. Many species are true forest birds; others are most common in forest openings or at the edges of forest stands where they can perch, find cover and nesting places, and keep a sharp eye out for insects over ponds, marshes, or muskegs.

Flycatchers, swallows, warblers, and sparrows are common throughout Alaska in wetlands or along wetland edges, and the dipper is a specialized year-round inhabitant of streams that stay open during winter. Shrub thickets in riparian wetlands are excellent nesting habitat for a variety of songbirds. Other birds that may be found in or near Alaska wetlands include woodpeckers, swifts, belted kingfishers, hummingbirds, ptarmigan, and red-winged blackbirds.

Mammals and Wetlands

Many different mammal species use Alaska wetlands during part or all of the year. During spring, deer, moose, and bears are attracted to lush plant growth in tidal salt marshes; interior brown bears graze the green growth on broad river floodplains; and caribou roam tundra wetlands, seeking out tender sedge roots. Bats hunt insects above ponds and bogs at dusk in mid summer and beaver, muskrat, snowshoe hares, martens, and lemmings live in Alaska's wetlands year round.

Wetland architects. Beavers create deep-water habitats by their damming activities and opening clear areas by cutting down trees. Beaver dams slow river current, decreasing the erosive power of the stream, and allowing organic materials and nutrients to settle to the bottom of the pond instead of being carried away. Beavers also enhance the growing conditions for willow, and remove the competition of larger, older trees, creating good moose habitat. Beaver activity can block the movement of fish trying to swim upstream, but new ponds also provide good spawning and rearing habitat, if the fish can get there.

Moose like riparian areas, ponds, and marshes. In summer, river floodplains provide an abundance of tender willow leaves – a favorite food of moose. In winter, the same areas provide shelter from winds and deep snows. Moose feed in ponds and marshes throughout the summer. They submerge their heads to obtain mineral-rich aquatic plants that help replace calcium lost through nursing or antler development.

Muskrats, the pond dwellers. Muskrats feed on aquatic plants such as the roots and stems of cattails, lilies, sedges, and grass and occasionally feed on mussels, shrimp, and small fish. Living below the ice in ponds during winter, they create "push-up" holes where they push up piles of the grasses collected during summer and keep an air hole open to access their cache. As shallow ponds freeze, the muskrats move to deeper ponds. Small amounts of available food and long, cold winters result in high mortality among these rodents.

Aquatic hunters – otters and mink. Land otters (also known as river otters) and mink forage on both land and in fresh or salt water. Mink prefer streams, ponds, beaches, and marshes, but will move inland to take advantage of an abundance of mice or hares. Ponds and marshes provide these animals with a variety of animal foods and plants, including small fish, crustaceans, and mollusks.

Other year-round residents. Many wetland dwellers stay year-round rather than migrating to warmer or drier regions during winter. One of the most characteristic of the year-round dwellers is the lemming, the primary food source for snowy owls. Brown, Siberian, black-footed, and northern bog lemmings are year-round tundra inhabitants in arctic Alaska. Lemmings are herbivores, storing cut plants in "hay piles" that they feed upon throughout the winter. When lemmings are particularly abundant, weasels may move to lowland tundra areas to hunt them. Other predators such as wolves, coyotes, lynx, foxes, and wolverines also include wetlands in their hunting ranges. River corridors especially, are important for travel during both summer and winter.

Don't forget the polar bear! Polar bears are officially classified as marine mammals, but wetlands and shores are important foraging grounds for polar bears in summer when seals are out of reach. The bears find bird eggs, rodents, and berries in these wetland areas.

Fishes Use of Wetlands

Alaska's wetlands are nursery areas for many fish species. Streams, rivers, and riparian wetlands produce the millions of salmon upon which Alaska's commercial, sport, and subsistence fisheries depend. Saltwater estuaries are critical to the successful transition of juvenile salmon from their freshwater birthplace to their adult life in the ocean. Estuaries are nurseries for other important commercial fish species such as halibut, sole, crab, and shrimp.

The emergent plant communities at the shallow edges of streams and rivers, in areas of slow-moving water, and in riparian wetland areas are especially important to small fish such as sculpins, young freshwater fish, and juvenile salmon. Such areas provide an abundance of invertebrate food, and protection from strong currents.

Amphibians in Alaska

All kinds of wetlands are ideal habitat for amphibians, as most require a life both in water and on land. Many people are surprised to discover that there are six species of amphibians native to Alaska. Most are only found in wetlands in the southeast part of the state, but one – the Wood Frog (*Rana sylvatica*), is found throughout Alaska, and has been documented as far north as on the north slope! All six species and where they are found are listed below.

- **Northwestern salamander** *(Ambystoma gracile)* – coastal forest wetlands in Southeast Alaska
- **Rough skin newt** *(Taricha granulosa)* – in spruce and hemlock forest wetlands in Southeast Alaska
- **Long-toed salamander** *(Ambystoma macrodactylum)*– Southeast Alaska wetlands
- **Spotted frog** *(Rana pretosia)* – wetlands and surrounding forests and grasslands from southern Yukon (Bennett Lake) all the way down to Nevada.
- **Western toad** *(Bufo boreas boreas)* – Southeast Alaska wetlands, but as far north as Montague island in Prince William Sound
- **Wood frog** *(Rana sylvatica)* – throughout Alaska in all kinds of habitats.

A FEW AMPHIBIAN FACTS

Amphibians breathe and absorb water through their skin. Their permeable skin is a very helpful feature when it comes to being efficient both in water and on land. However it also means that amphibians easily absorb pollutants and other toxins that might be in the water or in the air. This vulnerability is one of the reasons amphibians are known as "indicators" of environmental health.

All amphibians produce poisonous skin secretions to protect them from predators, keep the skin moist and prevent bacteria, molds, and diseases from entering the body. The rough-skin newt, which resides in southeast Alaska, is one of the most poisonous animals known. Ingestion is lethal to humans, and even handling the animal can be dangerous if the toxin enters the blood stream via a cut on the hand.

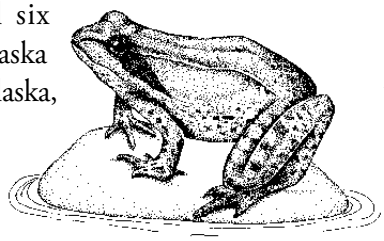
Frogs have amazing eyes – they can see in almost all directions at once, having the most extensive visual field among vertebrates, with exception of a few fishes. Frogs can also see colors.

Amphibians are ectotherms ("cold blooded") meaning they cannot generate their own body heat, but instead must absorb it from the environment.

Amphibians have a very unique life cycle. The word amphibian comes from the Greek word 'amphibios' which means two lives. Amphibians all start out their lives in water, breathing through gills, and eventually develop lungs, which enable them to exist on land. As with insects, the process of changing from one life form into another is called **metamorphosis**. Wood frogs develop from tadpoles to adults faster than any other frog in North America. The life cycle of the wood frog is detailed on the following pages.

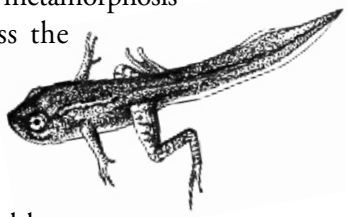
WOOD FROG LIFE CYCLE AND HABITS

Because wood frogs are distributed throughout Alaska, and have such interesting survival strategies, we've focused on this species in this curriculum. However, wetlands are critical habitat for all six species of amphibians in Alaska and if you live in Southeast Alaska, your students may enjoy learning about all six.



Wood frogs begin their lives as tadpoles hatching from eggs in spring, usually residing in the warmest and most shallow part of the wetlands. Tadpoles breathe through both gills as well as their skin and have sieve-like filter organs in their pharynx for feeding. Between their mouth and gills, they trap bacteria, protozoa, floating algae, pollen grains and other small particles suspended in water. Tadpoles usually school up with other siblings to stir up food, increase temperature via body mass, and alert each other when predators are coming.

Mature tadpoles have legs!
After a few weeks as tadpoles, metamorphosis begins. During the process the tail is absorbed back into the body, limbs grow, larval mouth parts are replaced by true jaws, teeth, and tongue; moveable eyelids form; lungs and skin glands develop; the gut assumes an adult form – including a stomach; bones harden and the intestine changes. Additionally, because the animal is most vulnerable to predators at this stage, it becomes more poisonous (less edible to predators).



Filamentous green algae are an important part of the tadpole's diet at this stage. In this manner, frogs play an important ecosystem role, helping to clean out ponds so that fish can live in them. Algae can otherwise use up all the oxygen in a wetland. Tadpoles are an important food for a variety of animals, including beetle and dragon fly larvae.

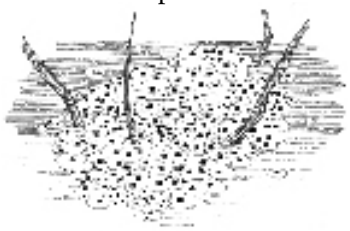
By mid summer the tadpole has developed into a young froglet. Male frogs reach maturity by the end of one year, whereas females do not become **mature frogs** until 2 years following metamorphosis. Frogs may live for 5 – 10 years, but most Wood Frogs do not live longer than 4 years. They may travel away from the wetland, consuming a diet of mostly insects (like mosquitoes!) but also worms, snails, millipedes, molluscs, and other small invertebrates. They are an important food source for fresh water fish and birds.

Wood frogs freeze solid during winter!
Wood frogs have an amazing strategy to survive the cold temperatures of winter. In fall when temperatures start to drop, they make a nest in last year's vegetation duff. Falling leaves and snow provide additional insulation. The frog's liver is then stimulated to manufacture huge amounts of glucose (sugar), which goes into the blood. (If a human had as much sugar in her blood, she would go into a diabetic coma!).

The frog's heart rate doubles to pump all the vital organs with this new sugary blood. In the normal process of "freezing to death", water outside of an animal's cells freezes and through osmosis, all of the water is sucked out of cells and they collapse due to dehydration. Freezing to death is in fact dying of dehydration. But the concentrated glucose slush that remains in the cells of over-wintering wood frogs prevents the cells from collapsing or freezing solid, so the frog does not "freeze to death". Meanwhile, the frog's heart stops, and it doesn't even breathe! One could in fact, knock the frozen frog against something and it would feel like a rock.

Frogs breed as soon as they thaw out. As soon as temperatures warm in April, wood frogs thaw out quickly. Instead of eating, the first thing on their agendas is reproduction. They are explosive breeders, which means breeding occurs in just a few days. You can hear the mating call of male wood frogs at wetlands during spring. The staccato call sounds very similar to the quacking of ducks. Males engage in competition, and even fights for the females.

In **amplexus**, the male frog clasps the female and fertilizes eggs as she lays as many as 2000 to 3000 eggs in a jelly-like mass directly into the water. Eggs hatch within 4 to 8 days depending on the water temperature.



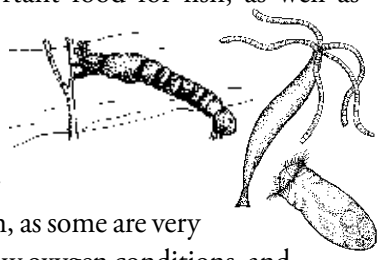
AMPHIBIANS IN DECLINE

Amphibians throughout the world, including Alaska, are disappearing fast. Thirty-two percent of amphibian species worldwide are threatened with extinction; 43% of species have declining populations and 122 species are believed to have become extinct since 1980. Additionally, deformities are widespread globally and reports of deformities in Alaska are on the rise. Throughout the state wood frogs have been found with partial, shrunken, deformed or missing legs, clubfeet, and missing eyes.

Several hypotheses exist for why amphibians are in such great trouble. Hypotheses include habitat loss; elevated UV radiation; pesticides and herbicides; warmer temperatures due to climate change; introduced species including diseases and fungi; acid precipitation; and heavy metals. No doubt all of these factors are working in concert to put pressure on amphibians. Research has shown many specific cases where declines in a species can be attributed to one of the above causes.

Aquatic Invertebrates

Who are they? Aquatic invertebrates in Alaska's wetlands include a wide array of macroscopic and microscopic animals, such as the larvae of flies, mosquitoes, and beetles; mollusks; different types of worms; hydra and rotifers. They are extremely important food for fish, as well as wetland birds.



Water quality indicators. Many aquatic invertebrates can be used as an indicator of stream or wetland health, as some are very tolerant of pollution and low oxygen conditions, and some can only inhabit clear, well oxygenated waters. For flowing waters,examples of low quality indicators include the tubifex worm and leeches. Mayflies, stoneflies and caddisflies are generally indicators of good water quality.

Functional groups. Aquatic invertebrates, like other animals, can be grouped according to their ecosystem and feeding functions. Many are important in different stages of decomposition.

- Some like the dragonfly larvae and the predacious diving beetle are **predators**, consuming other invertebrates, tiny fish and even tadpoles.
- **Shredders** like some stonefly larva, break leaves and other particulates greater than 1mm in size into smaller pieces. (Much of their nutrition is actually microbes living on these surfaces "the peanut butter on the cracker").
- **Collector filterers** like blackflies, and **collector gatherers** such as some caddisflies, process materials less than 1mm into even smaller pieces.
- **Grazers** and **scrapers** may graze on algae or on microbes decomposing organic material on submerged surfaces such as leaves and rocks.

- **Filter feeders** directly remove algae and other suspended particles from the water column.

Youngsters dominate. Many of the macroinvertebrates in the water are the larval form (called nymphs in some species) of terrestrial animals, and are very different looking from their adult counterparts. Some, like mayflies, are nymphs most of their lives (1-3 years), spending as little as 24 hours as mating and egg-laying adults.

Some adult forms of aquatic insects emerge during spring bird migration and nesting, and thus are a very important food source for migratory birds!

Summary of Animal Adaptations for Wetlands Living

Wetlands are partially defined by the presence of organisms with adaptations to wetland living. Challenges may include low oxygen availability, low nutrient availability, and of course all of the associated issues of living in the water, such as how to survive freezing! Most wetland organisms have some anatomical, physiological, or behavioral attribute that enhances their ability to live in a wetland environment. Adaptations in general may improve an animal's ability to live in one environment while reducing the ability to survive in another. A summary of animal adaptations for wetland life is listed on the next page.

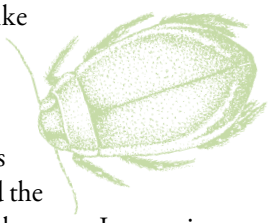
CHALLENGE #1

OXYGEN REQUIREMENTS

- All animals require oxygen to break down carbon chains and release the energy needed for their metabolism, growth, capture of food, reproduction, and escape from predators.
- Air-breathing animals must be able to temporarily survive underwater without air. Air-breathing animals must have a means of keeping water out of their respiratory system.
- Aquatic animals must obtain oxygen from water. Even water saturated with dissolved oxygen contains 30-40 times less oxygen than an equivalent volume of air.

STRATEGIES

INVERTEBRATES



Oxygen Storage. Some air-breathing invertebrates (like predaceous diving beetles) entrap a bubble of air and carry it with them as they swim underwater. The air bubble, in addition to being a store of oxygen, serves as a gill. When the oxygen in the bubble is depleted by the insect's respiration, oxygen diffuses from water into the bubble, and the insect is thus supplied with more oxygen than it carried underwater. In most insects, oxygen is carried to cells in gas form through open tracheae, rather than by blood. A few aquatic insects, however, have hemoglobin to store oxygen.

Get oxygen from water. Aquatic invertebrates, including fairy shrimp, water fleas, bivalve mollusks, flatworms, and others extract oxygen from water by diffusion. Some (like flatworms and some insects) have a body covering that is permeable to oxygen. Others have specialized membranes, called gills, which are permeable to oxygen and other gases. Gills are found on legs, the abdomen, thorax, or other parts of the body. Many invertebrates maintain a flow of water, and thus a renewed oxygen supply, by stirring the water with waving motions of their legs, antennae, or the gills themselves.

Breathing tubes. Some invertebrates are able to breath atmospheric oxygen through a tube to the water surface (for example, mosquito larvae). Some insects have special respiratory tubes, like siphons and snorkels to tap into air spaces of aquatic plants.

AMPHIBIANS

Get oxygen from water. Adult amphibians are able to extract oxygen from water by diffusion through their moist skin. They also have lungs to breathe the air.

Juvenile amphibians have gills.

STRATEGIES continued

FISH

Tolerance for CO_2. Some fishes are able to live in water with low oxygen levels because they can tolerate high levels of CO_2 in the blood.

Use a closed respiratory system. Fish absorb oxygen across gill membranes only. Alaska blackfish can also absorb atmospheric oxygen through a modified esophagus, allowing them to inhabit water low in oxygen.

Get oxygen from water. All fish have specialized membranes or gills for extracting oxygen from water through diffusion. Fish maintain an adequate flow of freshwater over their gills by continually pumping water with specialized muscles, and in some species by living in running water or water with high levels of dissolved oxygen. Fish gills are able to extract 4/5 of the oxygen dissolved in water.

BIRDS

Limit oxygen use. Birds that dive (loons, grebes, diving ducks) can reduce their heart rate by as much as 50% when underwater, thus greatly reducing their rate of oxygen use. Dippers, and perhaps other diving birds, can reduce the supply of blood to non-vital organs and tissues.

Tolerance for CO_2. Diving birds and dippers have the ability to tolerate high levels of CO2 in the blood and thus are able to stay underwater for longer periods than other birds that dive.

Oxygen storage. Diving birds have nearly two times as much blood and greater concentrations of hemoglobin (and thus a greater capacity for oxygen storage) than land birds of equivalent size.

Seal off openings. Dippers have special nasal flaps, which they close before going underwater.

MAMMALS

Reduce oxygen use. Some aquatic mammals (seals, beaver, whales, porpoises) can reduce their heart rate and the supply of blood to certain organs and tissues and thus reduce their rate of oxygen use.

Tolerance for CO_2. Diving mammals (whale, otter, beaver, muskrat, seal) can tolerate high levels of CO2 in their blood and are thus able to stay underwater without breathing for longer periods of time than other mammals.

Oxygen storage. River otters have relatively larger lungs than other mammals and can store more air for underwater use. Marine mammals have high hematocrit and hemoglobin levels and big blood volumes that increase their capacity for oxygen storage and transport.

Seal off openings. Most diving mammals have special flaps or specially shaped nostrils so they can close these openings when underwater. The beaver has a unique respiratory system that prevents it from breathing through the mouth. This adaptation allows beavers to open their mouths underwater to carry sticks.

Muskrats can close their lips behind their incisors, so they can gnaw while underwater.

CHALLENGE #2

MAINTAINING OR ATTAINING ADVANTAGEOUS POSITIONS IN THE WATER; MOVING IN WATER

- Water is denser than air and thus provides more resistance; animals need specialized appendages to propel themselves through water and a body shape that reduces the resistance of water (particularly important for animals in running water). A fusiform shape, that is, narrow about both ends and widest in the middle like a spindle, offers the least resistance.
- Air-breathing animals that float on the surface, but dive underwater need a means to overcome the buoyancy of water. Aquatic animals need a means of staying at the desired depth. Animals that live in running water need ways of staying in a desired spot.
- Animals that live on the water surface must have adaptations to stay afloat.

STRATEGIES

INVERTEBRATES

Varying methods of propulsion

- cilia (microscopic hairs) (e.g. paramecium).
- fringes of hairs to increase the surface area of appendages (e.g water mites).
- wide, flattened appendages (e.g.water boatmen).
- Internal gills used to suck in water and then expel rapidly to allow "jet propulsion" (e.g. dragonfly).

Air bladder. Some phantom midge larvae have a gas sac at each end of their body and can rise or sink in water by regulating the amount of air in these sacs.

Avoidance of current. Some invertebrates that live in running water avoid the water current by living in the boundary layer between the water and the bottom. Within a few millimeters of the bottom, friction reduces the water current to almost zero. Some mayflies have very flattened bodies and flattened appendages that stick out to the side rather than down, so the animals can keep out of the current.

Clasping appendages. Mayflies, caddisflies, and other aquatic insects have claws on their legs and/or anal hooks to hang onto the bottom. Some insect larvae do not have true legs, but have developed "prolegs" for hanging onto plants and stones.

Anchors. Aquatic caterpillars, leeches, and blackfly larvae have groups of tiny spines to attach themselves to the bottom. Bivalve mollusks, hydra, rotifers, aquatic caterpillars, midge larvae, and some other invertebrates anchor themselves to the bottom or to plants with sticky threads or glue-like secretions. Caddisfly larvae have hooks to hold onto their cases; the weight of their cases helps keep them on the bottom.

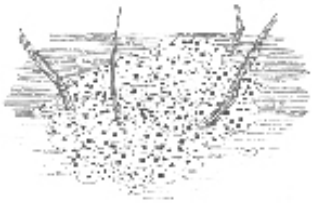
Use of surface tension. Tiny animals are able to stay afloat on the surface of the water by spreading their weight over a larger area, so that the surface tension of water remains unbroken. Water mites, water boatmen, and other invertebrates have long fringes of hairs; water striders have very long legs.

STRATEGIES continued

AMPHIBIANS

Strong swimming ability. Amphibians have webbed feet (frogs and salamanders), strong leg muscles, and their swimming legs are placed far back on the body to maximize their swimming ability.

Anchors. Frogs and salamander egg masses are anchored to underwater sticks or plants by sticky, mucous-like surfaces.



FISH

Strong swimming ability. All fish use fins (bony rays with skin stretched over them) to get through the water.

Stream-lined shape. Most fish have fusiform body shapes to minimize the resistance of moving in water or remaining stationary in running water. Lack of external appendages like eyelids and ears, overlapping scales, and slime also make fish hydrodynamic.

Air bladder. Some bony fish have a special air bladder located in the middle of their body. By regulating the amount of air and gases in this bladder they can control the depth at which they float.

Anchors. Lamprey have a powerful sucker, which they use to move against the current and hold themselves in place, in addition to holding on to animals they parasitize.

BIRDS

Strong swimming ability. Webbed feet (ducks, loons, gulls, terns, geese and swans) increase surface area and allow the bird to propel itself through the water. Swimming birds are also aided by large, strong leg muscles and legs placed far back on their body (grebes and phalaropes).

Stream-lined shape. Loons, grebes, and diving ducks have bodies that are flattened horizontally, have smaller wings, and short, vertically-flattened legs placed toward the rear of the body. All of these factors streamline the bird for underwater swimming.

Air bladder. Swimming birds can regulate the amount of air in the air sacs in their abdomen and the amount of air entrapped by their waterproof feathers; thus they make themselves buoyant for floating on the surface or less buoyant for diving underwater.

Clasping appendages. Dippers have long toes for clasping the bottom.

Ballast. Diving birds (loons, grebes, and diving ducks) have marrow-filled bones and few air sacs (while other birds have hollow bones and many air sacs as adaptations for flight). These birds are also able to tightly compress their feathers to expel the air trapped between them.

MAMMALS

Strong swimming ability. Some like the beaver, muskrat, and otter have webbed feet (beaver, muskrat and otter). Others propel themselves using fringes of hairs (water shrews and muskrats), while others use flippers and flukes (seals, sea lions, porpoises, and whales).

Stream-lined shape. Diving mammals in general have smaller appendages (ears, legs, tails) than similar sized land mammals. Also, swimming mammals have a fusiform shape.

Use of surface tension. Water shrews have long fringes of hair on their hind feet that allow them to capitalize on the water surface tension and run across the water surface without sinking.

CHALLENGE #3

FEEDING ON ANIMALS THAT LIVE IN WATER OR ALONG THE SHORE.

STRATEGIES

INVERTEBRATES

Filters. Invertebrates have the greatest variety of adaptations for filtering edible materials from water. Some, like hydra, move tentacles through the water. A wide variety (including bivalve mollusks, rotifers, water fleas, and others) have hair-like filters. Several insects (some mayflies and caddisflies) have fringes of hairs on their appendages which filter out food. Some caddisflies spin web-like nets, which they hold out in the water current to capture food particles.

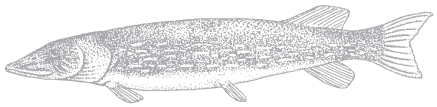
AMPHIBIANS

Filters. Tadpoles have sieve-like filter organs in their pharynx for feeding. They trap food between mouth and gills. They also don't have true teeth but do have beak like structures ("horny jaws").

STRATEGIES continued

FISH

Ability to grasp slippery prey. Predaceous fish, like northern pike, have long jaws and many sharp teeth for grasping their prey. Most bony fish also have a jaw mechanism that produces a suction force as the jaws are rapidly shut. In this manner, the fish essentially suck in their prey!



BIRDS

Filters. Mallards, pintails, shovelers, wigeon, and some other ducks have tiny lamellae (stiff hair-like fringes) on their bills, which they use to strain detritus, insects, mollusks, and other food from water. These bird bills are highly sensitive, as they have more touch-sensitive nerve endings per square millimeter than we have on the tips of our fingers.

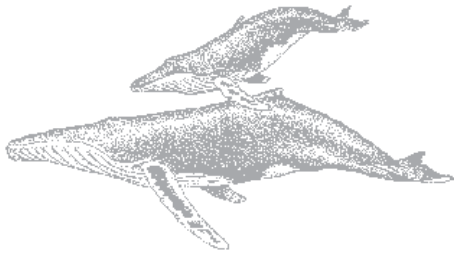
Long, probing bills. Shorebirds have specialized bills adapted for probing deep in the mud. The bills of many are packed with touch-sensitive nerve ending so the birds can distinguish food from mud or sand.

Long legs. Most birds that feed along the shore have long legs for wading in water without getting their feathers wet.

Ability to grasp slippery prey. Fish-eating birds that capture fish with their bills have sharply pointed bills, (loons, grebes, and kingfishers). Many of these fish-eating birds also have backward-slanting projections on their tongues, roofs of their mouths, or throats to help in holding and swallowing slippery fish. Eagles and osprey that catch fish with their feet have long, sharp talons. Ospreys also have special spiny tubercules on the bottom of their feet that help to hold on to slippery fish. Mergansers hold on to slippery prey using bills with saw- tooth edges.

MAMMALS

Filters. Some whales have stiff, hair-like baleen instead of teeth. They use the baleen to strain organisms from water.



Ability to grasp slippery prey. Fish-eating mammals like the river otter have sharp claws and razor sharp teeth for grasping and ripping fish flesh.

CHALLENGE #4

SURVIVING PERIODS OF FROZEN WATER AND MAINTAINING BODY TEMPERATURE

- Animals that live in water or obtain food from water must have a means of surviving periods when water freezes.

- Problems include
  1) avoiding freezing and keeping warm, and
  2) obtaining sufficient oxygen since the oxygen in water covered by ice may be used up by respiration of the animals living under the ice, and
  3) obtaining food.

STRATEGIES

INVERTEBRATES

Dormant periods. Some insects that live in water bodies that freeze solid in winter survive by entering a period of dormancy, called diapause, during winter. During diapause, growth, development, and reproduction cease and the animal's metabolic rate is reduced. Insects may pass through diapause in the egg, larvae, or adult stage.

Burrowing. Many invertebrates burrow into the mud, move into gravel interstices, deep water, or into piles of decaying vegetation. These locations provide protection from freezing because they are slightly warmer microclimates.

AMPHIBIANS

Fast development. Frogs require open water for eggs and tadpoles to develop. Wood frog eggs and tadpoles develop more quickly than those of other frogs. This fast development allows wood frogs to survive at northern latitudes where ponds are frozen solid for 7 months of the year. Only the air-breathing adults overwinter.

Burrowing. Most amphibians overwinter as adults. They bury themselves in mud or soil to avoid freezing. Wood frogs, the northernmost amphibians, burrow into the top organic layer of the soil of a dry site. Snow, leaf litter, and soil then insulate the frog. Wood frogs seek dry sites for burrowing, as these provide better protection against freezing.

Blood changes. Wood frogs have a highly adapted strategy for winter in which they fill their blood with glucose, allowing them to "freeze solid" (see fact sheet on amphibians for more information).

FISH

Adapted life cycle. Many Alaska freshwater fish lay eggs in late summer or fall. The eggs and the alevins (embryos) have a food supply in the yolk and can survive in small amounts of flowing water on the bottom and in gravel interstices of stream bottoms.

Migration. Most Alaskan freshwater fish migrate downstream to overwinter in deep rivers and lakes that have less ice and have sufficient open water or water movement to provide adequate oxygen supplies. Some fish like adult salmon, many whitefish species and some Dolly Varden overwinter at sea.

Use of air holes. Blackfish, capable of breathing air with their specialized esophagus, gulp air from holes or breaks in the ice. They are known to gather around muskrat push-ups, holes in the ice that remain open throughout winter.

STRATEGIES continued

BIRDS

Early nesting. Water birds nest as early in spring as possible so that eggs are hatched early and young are full grown and capable of migrating by fall.

Migration. Almost without exception, Alaska's wetland birds migrate to more hospitable areas for winter. Many move out to sea or to the sea coast (phalaropes, loons, diving ducks, emperor geese, and shorebirds). Others migrate to areas where open fresh water occurs throughout winter (dabbling ducks, most geese, sparrows, swallows, northern harrier, bald eagles, and osprey). Some birds migrate short distances downstream or to the coast, while others make global journeys to reach areas of open water and plentiful food.

Insulation and waterproofing. Birds that swim or dive (loons, grebes, mergansers, and waterfowl) have thicker layers of down and fat and a higher total number of body feathers than other birds. Birds can also insulate their body by fluffing out their feathers and entrapping a layer of air.

Swimming birds have preen glands that are larger and produce more oil than those of land birds. The birds maintain waterproofing by frequently preening the oil on to their feathers.

Specialized circulation. The webbed feet of ducks and geese have no capillaries (the arteries flow directly to veins). This adaptation allows more rapid blood circulation and reduces heat loss through the feet.

MAMMALS

Burrowing and denning. Beaver, muskrat, foxes, otters, mink, and water shrews use dens and burrows during winter. The dens provide protection from winter cold and winds.

Food storage. In fall, beavers store large quantities of branches underwater near their den or lodge. These provide a winter food supply.

Use of airholes. Muskrats maintain air holes in the ice by poking holes in the ice when it is thin and then pushing vegetation up through the holes. These plants cover the hole and insulate it so the hole does not refreeze. Muskrats use their "push-ups" to get air when the pond is frozen over. This allows them to swim under the ice and feed on aquatic plants throughout winter. Ringed seals also maintain breathing holes in sea ice by digging and scraping the ice with their front claws.

Insulation and waterproofing. Most mammals that live in water or swim have thick waterproof fur coats that entrap an insulative layer of air (beaver, water shrews, mink, otter, sea otter, polar bear, and muskrat). Whales and seals are insulated by thick layers of blubber (over 25% of their body weight). The thick white fur coat of the arctic fox can keep it warm at -40°F

Reduced blood flow to extremities. Beaver, seals, and porpoises reduce heat loss by reducing the amount of blood flowing to their extremities. Marine mammals also have relatively smaller limbs than terrestrial mammals, so they have less surface area from which to lose heat.

Greater heat production. Some mammals, like porpoises, have a higher basal metabolic rate than terrestrial mammals of the same size. Others, like the muskrat, are able to increase their metabolic rate, and thus increase heat production before and while swimming.

Wetland Plants

Wetlands adapted. Plants growing in Alaska's wetlands are adapted to very difficult growing conditions. They must grow in waterlogged soils, where oxygen availability is very low. Nutrient availability is often poor, especially in peatlands, where the pH is also low due to the acid-forming sphagnum mosses. As a result, wetland plants often have unique and interesting strategies.

Nifty strategies. Some plants like Great Bulrush *(Schoenoplectus tabernaemontani)* pump oxygen to the roots. Others like bladderwort *(Utricularia intermediais)* have bladders that allow parts of the plant to float on the surface of the water. Some sea grasses have physiological adaptations that allow them to store carbon dioxide, thereby maximizing their photosynthetic potential.

Insect "eaters". One intriguing strategy of wetland plants to compensate for the very poor availability of nutrients is to capture and digest insects. Each of three carnivorous plants in Alaska (**sundew**, **butterwort**, and **bladderwort**) has its own unique technique.

Sundew *(Drosera rotundifolia)* is a small, reddish plant with white flowers. The leaves are covered with sticky hairs that entrap and then fold around the prey, curling inward like a sea anemone. The hairs secrete enzymes that digest the insect and nutrients are absorbed through the leaves. Benefits of the plant's insectivorous habit are greatest in the most nutrient p

Butterwort *(Pinguicula macroceras)* looks much like a violet, with purple flowers. The leaves have a thick, greasy coating, which make for a "buttered" appearance. As with the Sundew, the sticky leaves ensnare insects, most commonly flies, and then fold over them. The insect is digested by enzymes, and the plant absorbs everything but the hard, outer shell of the insect. Phosphorous seems to be the that the plant is most after with this activity. This insectivorous habit does have a cost, as the folding of leaves reduces their surface area, disrupting the ability to carry on photosynthesis. Leaves often die after ensnaring the prey.

Bladderwort *(Utricularia intermediais)* is an aquatic plant with small yellow snapdragon-like flowers that emerge out of the water. The rest of the plant – roots, leaves, stems, and over-wintering buds are all submerged and suspended by bladders attached to small branches. Inside these bladders, small, aquatic invertebrates become trapped. When prey brush by a hair near the bladder's opening, a trapdoor flies open with a rush of water that sweeps the prey inside. The bladder becomes inflated like a balloon, where inside, the prey is trapped and slowly digested. The trap captures aquatic invertebrates in a fraction of a second; it is the fastest trap known to plants.

Historical Perspective

> "Shortly afterwards, began the muskegs, which mostly stood under water; these we had to cross for miles; think with what misery, every step up to our knees. The whole of this land of the Lapps was mostly muskeg, *hinc vocavi Styx*. Never can the priest so describe hell, because it is no worse. Never have poets been able to picture Styx so foul, since that is no fouler"
>
> – Carl Linnaeus, 1732

History of disrespect. In the same manner as Linnaeus, who crossing the Lapland peatlands so adeptly compared those wetlands to the Styx of Hell, wetland areas have historically been thought of as wastelands. Development, drainage and overall destruction of wetlands were thus accepted and encouraged practices, and even government policy (e.g. the Swamp Lands Act of 1849) until relatively recently.

Approximately 50% of the wetlands in the lower 48 states were lost between the time of European settlement and the mid-1970s. Individual states lost as much as 90%. Wetlands were not respected as valuable habitat and providers of ecosystem services until the 1970s, when hunters, anglers, environmentalists, scientists and engineers combined forces to educate people and make policy to preserve wetlands.

Changing of values. By the 1970s, people started working to reverse the trend of wetland destruction. National and state wildlife refuges, parks, and public recreation areas were all created for this purpose. The federal duck stamp program, which actually began in 1934, has been a significant help in the preservation of wetlands. Through this program, waterfowl hunters over the age of 16 are required to purchase the stamp. Revenue is then used to acquire and protect wetlands that are used for hunting. Other nations and states have since enacted similar programs.

New regulations. The 1970s also saw the creation of important regulations that helped to minimize wetland loss. The most significant of these was Section 404 of the Clean Water Act (1972), which governs activities that involve dredging or filling wetlands. Today, Section 404 is still one of the most important regulations relating to wetlands development and preservation.

No net loss policy. A very significant step in wetlands preservation occurred in 1988 when a National Wetland Policy Forum convened to discuss wetland management in the US. The Forum recommended that the federal government pursue a policy of "no net loss". That is, overall wetland acreage should cease to decrease, and restoration and construction of new wetlands should be facilitated where feasible, to replace those that were developed.

President George H. Bush accepted the recommendations and even made the protection of our nation's wetlands a major priority in his environmental program. In an address

to the Ducks Unlimited Sixth International Waterfowl Symposium in June 1989, the President said, "It's time to stand the history of wetlands destruction on its head."

Controversy! The recommended policy was vigorously opposed by building and oil industries, some local governments, and others in Alaska, who believed that the policy would severely restrict development in the state. Opponents argued that Alaska's wetland losses were minimal in proportion to the size of the state, and that losses would continue to be minimal even with continued development.

No restoration required. Opponents also argued that wetland restoration should not be required in Alaska because few alternatives to wetlands development exist in much of the state (especially on the tundra-dominated north slope), and because no technology had been developed for wetland restoration in arctic tundra areas.

Enough land protected. Opponents also believed that a sufficient amount of land had already been protected in Alaska to prevent the kind of loss experienced in the lower 48 states. The wetlands controversy in Alaska illustrates the trade-offs of maintaining habitat and other public values of wetlands while allowing development for economic benefits. Alaska remains exempt from the No Net Loss policy today.

Wetland loss in Alaska. To date, wetland loss in Alaska has been relatively minor in proportion to the large size of the state. Losses have been concentrated in urban areas (Anchorage, Fairbanks, Juneau, etc.), around villages in tundra areas, around communities in the narrow strip of land between mountains and coastal areas of southeastern and southcentral Alaska, and in areas of large industrial development such as oilfields, transportation corridors, and industrial sites.

In urban areas particularly, rates of wetland loss are similar to those nationwide. By 1990, the Anchorage Bowl had lost over 1/2 of its freshwater wetlands, and the Juneau area had lost approximately 1/3 of its freshwater wetlands.

Wetland Pollution and Contaminants

What is it? Water pollution is legally defined in Alaska as any impairment of water quality that adversely and unreasonably affects subsequent beneficial uses of water. Such "beneficial uses" include wildlife habitat, human consumption, irrigation, recreation, and transportation. Water pollution can result from natural events (such as avalanches, forest fires that lead to soil erosion, volcanoes, earthquakes, mineral deposits, and natural oil seeps) and from human activities (including agriculture, logging, mining, oil development, industrial development, sewage disposal, garbage dumps, land clearing, construction, and others).

Why care? The effects of any sort of water pollution depends on the severity of the pollution, the length of time over which the pollution occurs, the time of year, and the presence of other pollutants. Some pollutants directly kill wildlife at high concentrations. Other pollutants, even at low levels, may stress wildlife causing increased susceptibility to parasites, activation of latent bacterial or viral infections and, subsequently, eventual death.

How much can wildlife take? Some animals can survive a short period of exposure to some pollutants, but die if exposed for several days or weeks. Some types of pollution affect only one stage in the life cycle of certain animals; usually eggs and young are less tolerant of pollutants than are adults. Some pollutants interfere with reproductive behavior, but are not toxic to adult animals. Many pollutants cause more severe problems if other kinds of pollutants are also present.

Some of the known effects on wildlife of various kinds of water pollution are listed below. Overall however, we know relatively little about the effects of various pollutants on individual species because of the many variables that influence pollution effects and the vast number of differences in animal and plant species.

Types of Wetlands Pollution and Contaminants "Types of Pollution"

THERMAL POLLUTION

Temperature change. Thermal pollution is essentially water temperature change resulting from the addition of warm or cool waters into a wetland, stream or lake, or increased exposure of the water to heating by the sun due to loss of shading vegetation. Changes are measured using a thermometer above and below a source of pollution, or taking a series of thermometer readings before and after some change in the environment.

Industrial causes. Thermal pollution can be caused by a variety of industrial and construction activities. Water used for cooling in power plants transfers heat into the receiving lake or stream waters, but such thermal pollution can be avoided by cooling the water to the proper temperature before returning it to a river, lake, or the sea. Discharge of some industrial wastes, as well as streamside vegetation removal by logging or urban development can also raise water temperatures.

Water temperatures can decrease when waters are released from the bottom of a reservoir.

Fish Impacts. Above normal water temperatures can kill fish and invertebrates that are intolerant of high temperatures. Eggs and developing embryos are especially sensitive. Most fish are adapted for water temperatures of 0-30° C and most salmonids cannot tolerate water temperatures above 23° C. Increases of only 5-6° C above normal in autumn or winter can cause minnows to lay eggs and insect adults to emerge at an abnormal time of the year. Changes in timing can have major impacts, since timing of egg laying etc. is normally concurrent with factors such as good food availability, absence of predators, and spring runoff.

Oxygen decrease. Increases in water temperature also reduce the amount of dissolved oxygen in water, which has important implications for all the life in the water, from phytoplankton to fish.

TURBIDITY

Murky water. Turbidity is a measure of the suspended particles (such as silt, clay, organic matter, or plankton) in water. Turbidity can be qualitatively estimated by examining the water in a glass cup. If the water is cloudy or murky, the amount of suspended solids is large – turbidity is high. If the water is clear, turbidity is low. Turbidity is quantitatively measured with an instrument called a Secchi Disc.

Causes. Natural causes such as erosion, runoff, and algae blooms (sudden increases in growth, usually due to an addition of nutrients) can all increase turbidity. Human causes include placer and strip mining, gravel washing, land clearing that results in erosion, logging, sewage discharge, placement of unstabilized fill, and pulp and paper mills.

Prevention. The use of settling ponds, whereby water is allowed to stand and the solids settle out can help to prevent or minimize increases in turbidity, as well as the use of soil stabilization methods to prevent soil erosion.

Widespread impacts. The effects of turbidity vary depending on the kind of solids suspended, but may include reduced light, abrasion and damage to fish and invertebrates, and changes to the bottom of the stream, lake or wetland. Reduced light impacts the ability of plants to photosynthesize, which in turn affects food availability for invertebrates and fish. Reduced light and visibility can also impair the ability of animals to locate food. Suspended solids can be abrasive to the leaves of aquatic plants, as well as damaging to gills of fish and invertebrates, especially those that filter-feed. Accumulated sediment can also change stream flow and current patterns, causing flooding, blocking or diverting fish passage, and burying fish eggs and spawning gravels.

ORGANIC POLLUTION/NUTRIENT ENRICHMENT

Types. Organic pollution includes industrial pollution, discharge of sewage that has not been treated or has only had primary treatment, and agricultural runoff, especially in cases where fertilizer has been used. Nutrient enrichment is one of the leading types of water pollution in the U.S.

Oxygen decreases. The major impact of this type of pollution is decreased oxygen availability, because the addition of nutrients causes a bloom in algae or decomposing bacteria (**eutrophication**), which consume oxygen. Dissolved oxygen is measured by using a water chemistry kit.

Few survive. Few organisms other than bacteria, fungi, worms, leeches, and some insect larvae (blackflies) can survive at very low levels of dissolved oxygen (less than 4 milligrams/liter). At low oxygen levels fish may suffer damage to their gills, tissue damage, slowed growth, delayed hatching of eggs, physiological changes that result in brain damage, convulsions, and death.

HYDROCARBONS

You can see it. Hydrocarbons include crude oil, diesel fuel and gasoline. They are very visible pollutants at high concentrations. Since most hydrocarbons are less dense

than water, they float and are often visible as a sheet or sheen on the water surface. Tiny particles of hydrocarbons may be suspended in water that is mixed thoroughly (by wind, waves, or agitation).

Spilled hydrocarbons that "disappear" are often still present in a suspended state or as a coating on the bottom of the water body. Concentration of dissolved hydrocarbons can be measured with advanced chemistry equipment.

Causes. Hydrocarbon pollution can be caused by spills, previous oil spills that were stranded on beaches and are continually washed by the tide and natural oil seeps. Spills of any size can have impacts. Oil spilled from do-it-yourself mechanics annually washes over 50 million gallons into fresh waters of the U.S. – five times that of the Exxon Valdez spill.

Widespread impacts. Hydrocarbon pollution has a wide range of negative impacts. They are very poisonous to fish, crustaceans, birds, and mammals. High concentrations retard algae growth and inhibit algae photosynthesis.

Oil slicks. An oil slick on the water surface blocks sunlight from the water and can thus limit the ability of aquatic plants to carry on photosynthesis. Some oil sticks to the gills of fish, interfering with their respiration. Sticky oil ruins the insulative properties of bird feathers and mammal fur; a spot of oil the size of a half dollar on a bird's feathers is enough to cause a waterbird to die of hypothermia. Oil that settles to the bottom may smother bottom-dwelling invertebrates (including crabs and shrimp) and prevent spawning by some fish.

pH CHANGES

Acid or alkaline. pH is a measure of acidity (low pH) or alkalinity (high pH). Either high or low pH can impact aquatic organisms. pH can be measured using a water chemistry kit or pH litmus paper. Natural fresh water normally ranges from pH 4 to 9 (pH is measured on a scale of 1-14, where 7 is neutral).

Acid rain. Acid (low pH) pollution is more commonly a problem than alkaline (high pH) pollution and is chiefly caused by acid rain and acid mine drainage. Acid rain develops from the combination of water droplets and air pollution (sulfur dioxide and nitrogen oxides) from the burning of fossil fuels. Volcanic eruptions, anaerobic decomposition of organic matter, sea spray, and lightning also contribute to acid rain. Because it is formed from air pollution, acid rain can travel long distances from the source. Some scientists are concerned that pollution of the arctic atmosphere around the world may eventually lead to a serious acid rain problem in Alaska.

Plant and animals affected. Acidification has deleterious impacts on both plants and animals. Most fish eggs cannot survive a pH below 5.0. Salmon are among the first species to be impacted by both acid and alkaline waters. Decreases in pH also affect the solubility of metals and nutrients in soil, decreasing nutrient availability to plants, and causing toxic aluminum to be leached into wetlands, streams and lakes. Aluminum poisoning from acid precipitation has caused dramatic fish kills in hundreds of lakes in the northeast U.S. and Canada.

TOXIC CHEMICALS: PESTICIDES AND HERBICIDES

Chemicals. Pesticides and herbicides include a wide variety of chemicals including organochlorine compounds. DDT and DDE, atrazene, toxaphene, parathion, paraquat, dieldrin, chlorfenvinphos, and menazon are the names of just a few of the hundreds of kinds of pesticides used throughout the world. Pesticide pollution can be measured using advanced chemical analyses, such as gas chromatography.

We put them there. Most pesticides and herbicides are deliberately applied to agricultural fields, forests, along roadsides, in gardens, houses, etc., for the purpose of killing certain unwanted insects or plants. However, of the more than one-half billion tons of pesticides and herbicides manufactured each year for use in the United States, scientists have estimated that less than 1% actually reaches the target organisms. The rest spreads to the surrounding ecosystems, including lakes, rivers, estuaries, and the ocean. Some pesticides decay and break down into non-toxic chemical compounds soon after being applied. Other pesticides, once applied, cannot be removed from the ecosystem using current technology.

Impacts vary. The effects of pesticides and herbicides on wildlife vary widely. In large part, the effects of specific pesticides and herbicides on non-target organisms are poorly known. Pesticides and herbicides are designed to be poisonous, but a few are poisonous to a fairly specific group of insects or plants, while many are poisonous to a wide variety of invertebrates, birds, fish, mammals, and amphibians. The poison may cause illness, interfere with oxygen uptake, impair an animal's ability to escape predators and gather food, or it may kill animals directly.

Reproductive damage. Some pesticides affect the reproductive ability of non-target organisms from invertebrates to predatory birds. Such effects are compounded when the chemicals accumulate in the food chain. DDT is a famous example, where concentrations of the fat-soluble chemical accumulated in predatory birds, resulting in eggshell thinning and eventually major population declines and near-extinction of eagles, falcons, osprey, pelicans, and others. In another example, Atrazene, a widely used herbicide, has been linked to endocrine disruptions in amphibians – causing major impacts to their reproductive abilities.

Indirect effects. In addition to direct poisonous effects on non-target organisms, pesticide and herbicide use can have important indirect effects on the rest of the ecosystem. With predators, parasites, or prey reduced by pesticides, populations of non-targeted organisms can substantially increase or decrease. For example, when predatory mites are killed by chemicals, populations of their invertebrate prey (such as springtails) increase.

HEAVY METALS

Heavy metals pollution includes zinc, copper, cadmium, and mercury. Their concentrations are usually measured by atomic absorption spectrophotometry.

Messy practices. Heavy metals pollution results from improper practices at solid waste disposal sites (including sanitary landfills, modified landfills, and open dumps); discharge of untreated and treated sewage; home septic tank effluents; laundries; paper mills; synthetic fiber, rubber, and dye processing plants; mining; and other industrial processes. Rain and snow transport heavy metals from air pollution to surface waters and groundwater.

Effects vary. The poisonous effects of various heavy metals vary considerably with concentration, water temperature, dissolved oxygen, and pH. To a large extent, the effects are unknown. In general, vertebrates seem to be more sensitive to heavy metal pollution than invertebrates. As with DDT, the metals can accumulate high up on the food chain.

POLLUTION FROM OTHER PARTS OF THE WORLD

All types of pollution can be transported to Alaska from other parts of the world via wind. Sub-arctic and arctic environments are actually pollution "sinks" because evaporation rates in these dry regions are so low. Migratory birds and fish can also pick up pollutants in their travels and deposit them in feces and decaying carcasses.

MYSTERIOUS POLLUTION

One mysterious case of waterfowl die-offs in Alaska remained unsolved for ten years. In 1980, biologists discovered that many birds were dying in the Eagle River Flats area near Anchorage. Over the course of several years, thousands of ducks and swans died. The area had been used by the military as an artillery range since World War II, but no similar die-offs were noted at other artillery ranges.

Biologists were able to eliminate disease as a likely cause, but were still stymied. Mallard ducklings died after they had eaten plants, water, or mud from the area. Some of the birds also died from mere exposure to the area. Birds that were placed in pens on the flats became disoriented

-- stumbling and walking in circles. The birds then went into convulsions, arching their heads and necks over their backs and doing somersaults before dying. Yet, scientists were unable to pinpoint any toxic substance in the blood or flesh of birds that died.

The researchers eventually suspected that the culprit for the bird deaths was very low levels of chemical residues from bomb compounds. These toxic substances were believed to be in the water and in the mud.

An Acute Wetlands and Wildlife Problem: Lead Shot

Widespread poisoning. The use of lead-based shotgun ammunition by waterfowl hunters has resulted in widespread waterfowl lead poisoning. Lead poisoned waterfowl were first documented in 1894, and since then, poisoned waterfowl have been discovered in all the major flyways of the world. In 1989, lead poisoning was estimated to kill as many as 1.5 to 3 million waterfowl every year. In Alaska, the number of birds killed by lead poisoning was estimated to be 10 times the amount taken by hunters.

Many birds, and even humans are susceptible. Waterfowl are susceptible to poisoning by lead shot because they ingest the shot along with other sand, grit and pebbles to grind and crush food in the gizzard. Shotgun loads consist of many small pellets, many of which miss the bird, so thousands of lead pellets end up in the bottoms of wetlands and waterfowl hunting areas every year. Diving ducks (scaup, canvasback, and ring-necked ducks) are more likely to swallow lead pellets than dabblers. Bald eagles and other birds of prey also become lead poisoned when they feed on ducks and geese that have ingested the shot. Humans, who ingest lead-poisoned birds, or even birds with lead shot removed, are also at risk for lead poisoning.

Regulations. In 1991, long-awaited federal regulations banning the use of lead shot for waterfowl hunting were enacted. Hunters are now able to use efficient non-toxic steel shot. However, in Alaska, use of lead shot is still permitted for hunting upland birds like ptarmigan, which use wetland areas during winter.

Problems persist. Lead shot can be much less expensive than steel shot, so the use of lead shot persists today. Additionally, without cleanup efforts, old shot from decades of hunting remains in the bottom of wetlands, where birds can find it. Permafrost also contributes to the problem, as the frozen soil prevents lead pellets from sinking out of reach of birds overtime; instead, the pellets remain near the water surface. Hunters and biologists continue to find sick and/or deceased spectacled and Steller's Eiders that have suffered from lead poisoning. Scientists believe that the use of lead shot is an important reason for the lack of recovery of these species, which are both listed as threatened on the Endangered Species List.

Hope for the future! The use of lead shot for hunting upland birds was officially banned on the North Slope as of March 2006. Additionally, as of the writing of this guide, the USFWS is working on Proposals for State game laws that would ban the use of lead shot for upland birds in other parts of Alaska as well.

Climate Change and Wetlands

What is happening?

Alaska is warming up. Evidence abounds: the climate is changing, with warming in the arctic being some of the most profound changes. Since the 1950s, the mean annual temperature in Alaska's arctic has increased by 3.6 to 5.4 degrees. Meanwhile, the extent of sea ice has decreased by 30%, and glaciers have lost about 108 cubic miles of ice.

Alaska is drying up. Water tables are dropping as the climate warms. Recent research on parts of the Kenai Peninsula shows that the region's wetlands appear to be drying up. Scientists who studied wetlands and water bodies on parts of the Kenai Peninsula lowlands found that almost two-thirds of the wetlands studied had shrunk in size since 1950. Additionally, over 80% of the wetland sites that they examined appeared to be drying. Meanwhile, spruce and birch had recently moved into areas that had been soggy peatlands for the past 8,000 - 12,000 years. In fact, the research showed that forested areas in the region have increased from 57% coverage to 73%. The drying has obvious implications for wildlife, especially migrating waterbirds, which depend on such wetland areas for habitat.

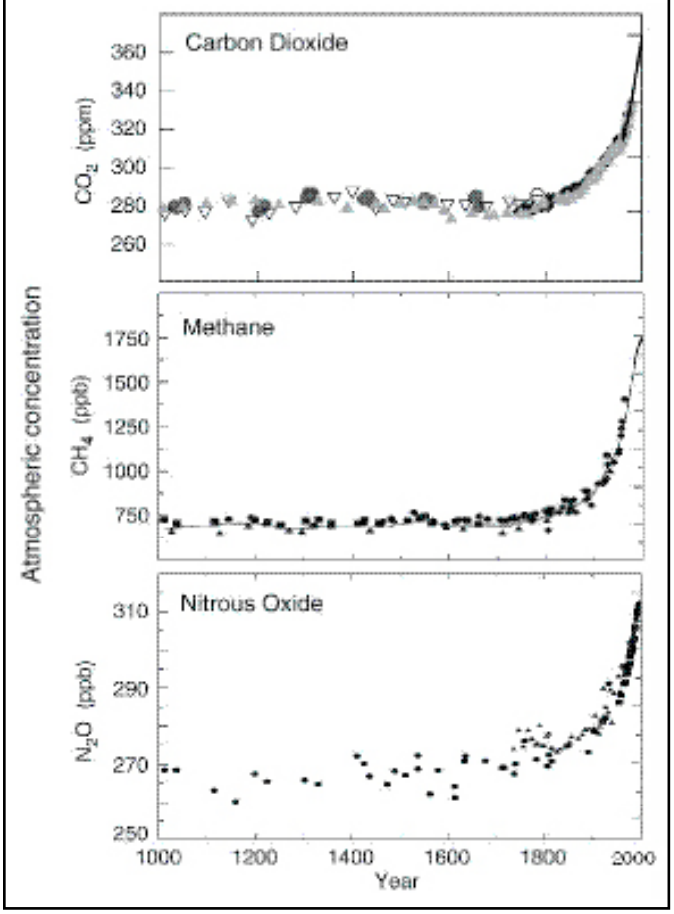
Shrubs are expanding into arctic and wetland areas. Meanwhile, warmer weather and shorter winters have facilitated the expansion of shrubs like dwarf birch, willow and alder into the arctic tundra. Scientists believe that this expansion may have a snowballing effect, because unlike grasses and short plants, which remain covered by snow during winter, the taller and darker shrubs stick out of the snow. In this way, shrubs allow more heat to be absorbed at the ground surface, facilitating warming and melting of permafrost, and creating more habitat for additional shrubs. The cycle then continues.

Why is the climate warming?

What we know: carbon dioxide and other gases have increased in earth's atmosphere.
Since pre-industrial times, atmospheric concentration of gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have skyrocketed. CO_2 concentrations have increased by 31%, while methane has increased 151%. A major reason for the increase in CO_2 concentration is the burning of fossil fuels. Cars and trucks are important contributors, but so are industry and home heating

ATMOSPHERIC CONCENTRATIONS OF THREE GREENHOUSE GASES OVER THE PAST CENTURY.

From the IPCC Third Assessment Report (2001).



especially when coal burning is used. Deforestation is also a major reason for atmospheric CO_2 increases. Trees take up a lot of CO_2 from the atmosphere, but when they are removed, not only is the function of CO_2 absorption gone, but CO_2 is also released as roots die and slash is burned or decomposed. Increases in atmospheric methane are mainly due to agricultural activities like cattle and rice production.

What we know: greenhouse gases trap heat.
Carbon dioxide and methane are both **greenhouse gases**. Just like the glass roof in a greenhouse, they trap the solar radiation coming to earth, releasing a much smaller proportion.

Without greenhouse gases, the earth's surface temperature would only be about zero degrees, not enough to sustain life!

The "guess work": How do all the variables play out?
We know that greenhouse gas concentrations have increased, and we know that they trap heat; the problem is determining how the increased heat will affect earth. Will it cause more evaporation from the sea, creating more clouds? Will melting glaciers and polar ice caps affect ocean currents that control global temperatures? Will warmer weather cause more droughts? Warming may also be occurring naturally; how much of the observed warming can be attributed to such natural trends?

Consensus. Scientists have completed, and are still conducting extensive amounts of elaborate experiments and modeling to study as many complex variables as possible. There is now widespread scientific consensus, that the increased greenhouse gases are responsible at least partially, for the warming that has been observed, and that they will continue to cause major climate changes worldwide.

What is predicted for the future?

Air temperatures in the arctic are increasing at a rate five times those of the rest of the globe. In the arctic, the mean annual surface temperature is expected to increase 3.6°F by 2050 and 8°F by 2100, while the average summer sea ice extent is expected to decrease 50% by 2100 and forests are expected to migrate northward into the tundra. Associated thawing of permafrost and drying of peatlands makes for an even more troublesome situation, since more greenhouse gases are released in the process.

What are implications for Alaska's tundra wetlands?

Frozen soils are mostly impervious to water, thereby creating a perfect situation for the formation of lakes, ponds and bogs. However, if the top layer of soil melts, the result could be either a drying effect, with reduced wetlands, or, an increase in the amount of water pooling – increasing wetlands. Both effects may be occurring in Alaska's tundra.

If it were only that easy!

As if the predictions and modeling were not difficult enough, consider now that not only are things warming up, but plant growth and rates of nutrient uptake are affected by increased concentrations of CO_2. Additionally, enhanced decomposition from increased temperatures can release even more CO_2, creating a positive feedback loop (a snowballing effect) to speed up the arctic warming process.

Invasive Species and Wetlands

What's the Big Deal?

Biodiversity threat. Invasions of non-native species are a global problem. In fact, such invasions are considered to be one of the greatest threats to biodiversity the earth faces today, second only to habitat loss. Invasions also present substantial economic costs.

Threat to Alaska. Alaska's remoteness and climate has helped to keep invasive species from becoming as extensive a problem as in many other parts of the U.S. However, invasive species are entering new habitat in Alaska, and Alaska's ecosystems are at risk. Preventing invasives from spreading is far more cost-effective than trying to eradicate them once they have become established.

How do invasive species affect biodiversity?

- Animal invaders can cause extinctions of vulnerable native species through predation, grazing, competition, habitat alteration and transport of diseases.
- Plant invaders can alter available forage for wildlife, the hydrologic cycle, the fire regime, nutrient cycling, and energy budgets.
- An exotic species can thus affect the **functioning** of **whole ecosystems**!

How do invaders get around?

- Ships carry aquatic organisms in their ballast waters and on their hulls.
- Humans travel extensively and carry these unknown hitchhikers on shoes, clothing, in suitcases, cars, equipment, etc.
- People introduce them for many intentional purposes such as for food (e.g. garlic mustard), sport (e.g. pike in southcentral Alaska), in gardening and landscaping (e.g. bird vetch and purple loose strife), or by dumping aquaria and releasing pets in the wild (e.g. goldfish, starlings, Eurasian milfoil).

What is an invasive species?

A non-indigenous **invasive species** is a species that is non-native to the local ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Non-indigenous invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the **primary** means of invasive species introductions.

Other confusing terms. Other terms you may hear are "introduced", "non-native", "exotic" and "alien". All these term describe species that have potential to be problems, but they are not necessarily invasive.

"Noxious weeds" are plants that are classified by the state or feds, and regulated. They have been determined to directly injure crops, other useful plants, livestock, poultry, other interests of agriculture, (including irrigation or navigation), the fish or wildlife resources of the United States or the public health.

What makes a species invasive?

- Its method of dispersal is very effective. For example, it is easily carried in the wind, in water or in people's clothing.
- Its rate of reproduction is very high.
- It has some strategy that gives it a competitive advantage over native species.
- It no longer has the predators and diseases that kept it in check in its native location.

When are communities most susceptible to invasion?

Disturbance: A disturbed area (e.g., one that has been burned, flooded, or is next to a road or trail) is often vulnerable to invaders because invading species can be faster at colonizing, or adapting to the newly disturbed environment than native species.

Introduced species have made **"The Great Escape":** limiting factors for the introduced species are greatly reduced. That is, there may be no competitors, predators, grazers and parasites. For example, the possum escaped from Australia into New Zealand, where it has only 14 species of macroparasites compared with 76 in Australia. As a result, its population densities are 10 times greater in New Zealand forests.

Vacant niches exist: When a biological community, such as a young or disturbed one, contains only a small number of species (low species richness), it is possible that there are habitats within the community that are essentially not being used, and/or some ecosystem roles are left to fill. In this situation, an introduced species can easily move in and succeed.

When does an invasive species alter an ecosystem?

Invaders have potential to change the ecosystem when they

- differ substantially from native species in the way they get or use resources (e.g. water, food).
- alter the structure of the food web of the invaded area (e.g. more efficiently and expeditiously eat available food, leaving none for the other species that depend on it).
- alter the frequency or intensity of disturbance (e.g. cause more fires because they are fire adapted).

Examples of current problem species in Alaska's Wetlands

Introduced Northern Pike consume and displace salmon and trout. Northern Pike are native to Alaska north of the Alaska Range. However, they have been introduced in Southcentral Alaska, most likely by well-intentioned sport fishers who recognized Pike to be an excellent sport fish. Pike first appeared in the Susitna drainage in the 1950s. By the late 1990s, they had completely wiped out the once healthy trout and salmon populations in some of the area's lakes and streams. Other native fish species have been misplaced as well.

Introduced Pike have been very successful and have had large negative impacts because their native habitat is very similar to the habitats in which they've been introduced. An important difference though, is that the new habitats originally supported mainly salmon. Introduced Pike reproduce quickly and their food demands are huge. They tend to consume all of the available food in their new habitat – they even eat each other. Often within five to ten years after Pike are introduced to a lake, they are the only fish species left, and due to limited food resources, they are too small to interest sport anglers.

The loss of native species to a drainage and/or lake can be both ecologically and economically detrimental. Native fish like Rainbow Trout are highly prized sport fish, and their loss has important impacts to Alaska's sport fishery. Native salmon not only are important as a sport and commercial fishing species, but their spawned out carcasses provide valuable food and marine-derived nutrients to the watershed. When adult salmon do not return to a drainage because Pike have eaten all of the juveniles, all of the organisms in the watershed are negatively affected, including invertebrates, other fish, mammals like bears, and birds.

Fish farm escapees may introduce diseases
Atlantic Salmon (*Salmo salar*) have made their way into Alaska's fresh waters by escaping from fish farms in British Columbia and Washington. Biologists are concerned that the introduced fish could compete with native fish for resources and introduce diseases and parasites not currently present.

Japanese Knotweed displaces Important wetland plants

Japanese Knotweed (*Polygonum cuspidatum*) is currently spreading in Southeast communities including Sitka and Juneau. Once it spreads along stream banks, it has potential to displace native plants that stabilize stream banks, prevent erosion, and provide a source of woody debris and other litter that is food and shelter for fish and aquatic insects. In this manner, the invasion of Japanese Knotweed can have far reaching effects on the local ecosystem.

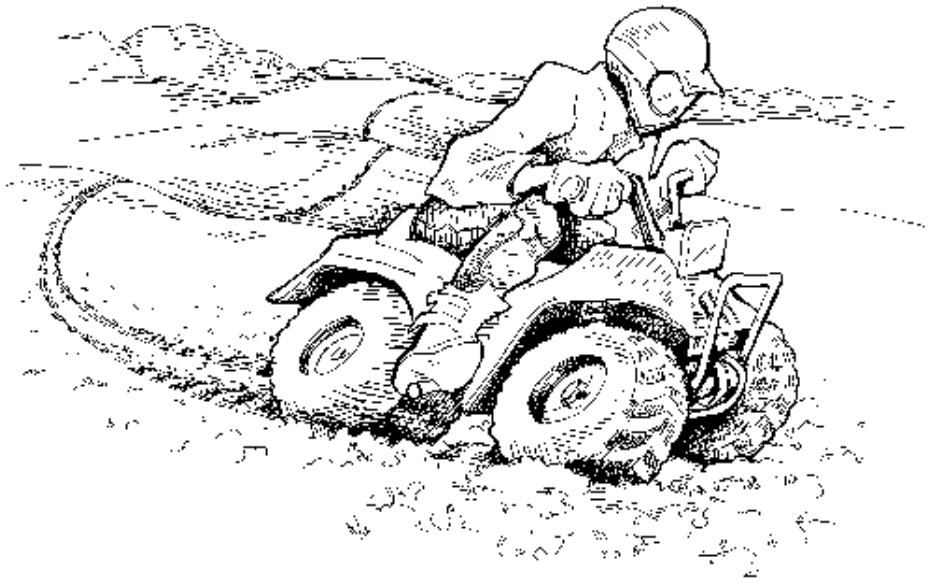
Reed Canary Grass chokes streams

Reed Canary Grass (*Phalarus arundinacea*) is an invader of wetlands and small streams. It grows vigorously, forming dense stands of tall grass, which can choke out native vegetation and slow or stop stream flow.

Introduced pathogens are killing amphibians

Introduced diseases, parasites and fungi are thought to be one potential reason for the observed Wood Frog malformations in Alaska, as well as worldwide amphibian declines. One vector for this introduction is the release of aquaria pets such as frogs and amphibians that harbor diseases. Also, when people collect tadpoles, place them in an aquarium with other pets, and then release the frogs back into the wild, diseases and pathogenic fungi from the aquarium are potentially released with the frogs. These pathogens are then spread through the water to other frogs and tadpoles in the population.

Disturbance of Wetlands



Many human activities impact wetlands. Many types of human activities can have serious negative impacts on wetlands. Physical alterations can include the placement of fill and other materials in wetlands, excavation, drainage or flooding, the diversion of water sources or the disruption of natural supplies of sediment needed to maintain their elevation. Chemical alterations are caused by water pollutants. Biological alterations result from clearing wetland vegetation.

Some changes have larger impacts than others. Alterations can occur at different rates. While filling wetlands is usually a relatively rapid event, the construction of a dam and other flood control structures can reduce the amount of sediment that flows downstream over a long period of time and eventually cause permanent submersion of downstream wetlands. The effects of some changes are more temporary than others. Disturbed marsh vegetation may grow back. The effects of filling wetlands are likely to be permanent.

Non-industrial activities have large impacts too! Most agricultural and industrial activities such as mining, construction and road building require permits. However, other recreational and subsistence activities are virtually unregulated in much of Alaska. While adverse impacts of any one such activity may be relatively minor, collectively they can have major long-term consequences for wetland hydrology and ecosystems.

Human activities near or at wetlands can also disturb important waterbird nesting sites. Disturbance often flushes females from nests during incubation, which can expose eggs to cold or heat. Disturbance can even cause nesting pairs to permanently abandonment their nests. After eggs have hatched, human disturbance can separate the mother from her young, exposing them to predators. Repeated disturbance can discourage animals from important food resources.

Boats

Convenient travel. Airboats are used for travel in waters that are too shallow for conventional types of watercraft, but too deep for reasonable travel on foot. They provide an easy method for summer access to cabins, hunting areas

and other subsistence resources. Airboats are also employed by some commercial sightseeing operations.

Widespread impacts. Studies in Alaska have shown that airboat travel can destroy floating mats of vegetation, creating channels through wetland areas. Such channels can alter the hydrology, consequently upsetting the water table, nutrient balance and successional stage of the wetland. Boating in general (including airboats, jet skis, canoes, rowboats, etc.) is cited as being one of the top sources of waterbird disturbance in Alaska.

All Terrain Vehicles (ATVs)

Use has increased. The use of ATVs in Alaska, as well as their impacts has increased profoundly in Alaska since the 1990s. As with airboats, ATVs are a popular method of travel for subsistence, hunting, and recreation. ATV riders are encouraged to remain on trails, especially on tundra and near wetlands.

Long-term and profound impacts. ATVs have potential for large long-term impacts on wetlands because they have deep traction tires, which uproot plants, shear and compress soil, and churn shallow waters. Such impacts can occur with even a single passage of an ATV. Increases in turbidity can damage fish gills, impair photosynthesis by aquatic plants, and disrupt activities of bottom-dwelling organisms, thereby disrupting the entire food chain.

Water flow affected. Ruts created in the soil by ATVs can affect the way the water flows through a wetland, altering the water depth, nutrient balance and species composition, as well as the wetland's ability to filter water. Additionally, ruts deepen with each use, creating the potential for riders to become high-centered. Consequently, riders often create new paths, and the eventual result is a wide series of parallel paths covering an entire wetland area.

Sensitive permafrost. ATV impacts are greatest in permafrost soils, because the water displaced by the tire activity cannot drain. Moderate to high ATV activity in permafrost soils may even cause long-term thawing of the upper portion of the soil.

Hidden nests. ATVs can also directly harm wildlife by crushing eggs and nests, especially since many birds build well-concealed nests on the ground, where they are usually not noticed until they are destroyed.

The Players in Wetland Policy and Management

Many different state and federal agencies have important roles in wetland policy and management. Public agencies are listed below. Many non-government organizations also play key roles in protecting wetlands. They are not included in this list.

ALASKA DEPARTMENT OF FISH & GAME (ADFG)

Overall mission: management and protection of Alaska's fish and wildlife resources

Responsibilities:

- Provide information on the importance of wetlands as fish and wildlife habitat.
- Recommend steps developers can take to minimize impacts to fish and wildlife and their habitats.
- Manage several areas of the state that have been set aside as Alaska State Refuges, Sanctuaries, and Critical Habitat Areas to protect important wetland habitats.
- Survey fish habitat, assess and manage fish and game populations.
- Assist landowners with stream restoration.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION (ADEC)

Overall mission: improvement and protection of Alaska's air and water quality

Responsibilities:

- Certify whether activities requiring Clean Water Act authorization will violate State water quality standards.
- Work with industry to develop technologies that reduce or eliminate pollution.
- Enforce laws to protect water quality.
- Oversee the clean up of spills or illegal discharges of pollutants such as oil.
- Monitor water quality
- Establish standards necessary to support beneficial uses of the State's waters.

ALASKA DEPARTMENT OF NATURAL RESOURCES (ADNR)

Overall mission: management, protection and development of Alaska's natural resources

Responsibilities:

- Inventory and assess state lands, including wetlands.
- Formulate land use plans for state lands.
- Recommend steps developers can take to minimize impacts on fish and wildlife and their habitat.
- Determine whether activities proposed in the coastal zone are consistent with the Alaska Coastal Management Program.
- Administer permits and leases for all state-owned lands, including all tidal and submerged lands within 3 miles of state-owned lands.
- Issue all water rights permits.
- Issue and enforce permits for activities in or across fish streams.
- Manage sales and releases of oil and gas and minerals on state lands.

U.S. FISH AND WILDLIFE SERVICE (USFWS)

Overall mission: conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

Responsibilities:

- Recommend steps developers and Federal projects can take to minimize impacts, primarily on migratory birds, fish and endangered species.
- Conduct research and provide information on habitat values of specific wetlands.
- Produce maps showing wetland areas of the State.
- Manage 16 federal wildlife refuges in Alaska.
- Manage polar bear, sea otter and walrus populations and habitats.
- Protect and recover threatened and endangered spices and work to ensure that at-risk species do not become threatened or endangered.
- Work with landowners and others to restore, protect and improve the management of fish and wildlife habitat.
- Monitor, assess and resolve fish, wildlife and habitat contaminant issues.
- Monitor and assess potential invasive species threats.

NATIONAL MARINE FISHERIES SERVICE (NMFS)

Overall mission: conservation, protection and management of living marine resources in the U.S.

Responsibilities:

- Recommend steps developers and Federal projects can take to minimize impacts on commercially harvested fish and shellfish species, endangered marine mammals and their habitats.
- Provide information to the public on the importance of wetlands to fish and other marine species.
- Conduct research on the effects of different activities on marine species and their habitat.
- Protect and recover populations and habitats of most marine mammals (i.e. seals, sea lions, whales and porpoises).
- Work with landowners and others to restore and manage estuarine habitat.

U.S. ARMY CORPS OF ENGINEERS (COE)

Overall mission: administration of the Federal regulatory program to balance protection and reasonable use of aquatic resources.

Responsibilities:

- Determine whether to permit projects that involve filling, dredging or clearing in wetlands, based on an evaluation of the likely benefits and adverse impacts of such projects.
- Distribute permit application to state and federal agencies and perform public reviews to evaluate potential environmental impacts.
- Evaluate benefits to development in a wetland versus environmental impacts.
- Assist landowners in determining whether or not an area is wetland and whether a proposed activity requires a wetland permit.
- Enforce wetland permit terms and conditions.
- Monitor for and resolve unpermitted activities.
- Work with local governments and others to restore degraded aquatic ecosystems.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Overall mission: protect human health and the environment

Responsibilities:

- Issue and enforce permits for the discharge of stormwater and wastewater (e.g. sewage, industrial effluent) into wetlands and other waters. Work with local governments and others to reduce such discharges.
- Respond to accidental releases of hydrocarbons and other hazardous chemicals
- Set and enforce standards for water quality for wetlands and other waters. Work with State and local governments to monitor pollutant levels and establish Total Maximum Daily Loads for pollutants of concerns in specific waters.
- Apply guidelines to ensure that projects requiring Corps of Engineers authorization comply with the requirements of the Clean Water Act. The EPA can deny or restrict (i.e. veto) discharges that will have an unacceptable adverse effect on shellfish beds and fishery areas (including spawning and breeding areas), wildlife, municipal water supplies, and/or other recreational areas)
- Provide technical and financial assistance to State, tribal and local governments to develop and improve wetland programs and science. Provide assistance to landowners, schools and other non-profit entities for environmental education and wetland/stream restoration projects.
- Work with other countries to address marine pollution, international transport of contaminants, and climate change issues.
- Regulate the storage, transport and disposal of solid and

hazardous wastes that could infiltrate groundwater, and facilitate the rehabilitation of contaminated groundwater.
- Evaluate pesticides for safety and work with landowners and others to assist them in using pesticides wisely, reducing their use and finding suitable alternatives to chemicals and pesticides.

U.S. NATURAL RESOURCE CONSERVATION SERVICE (NRCS)

Overall mission: Help private landowners conserve water and soil resources on private lands.

Responsibilities:
- Identify wetlands on agricultural land.
- Provide technical assistance as well as financial assistance for participating landowners.
- Provide expertise and leadership in soil surveys and for National Resources Inventory, which assesses natural resource conditions in the U.S.

FEDERAL LAND MANAGERS

The Bureau of Land Management (BLM) and the National Park Service (NPS) of the U.S. Department of Interior; and the U.S. Forest Service (USFS) of the U.S. Department of Agriculture all manage federal lands. Both BLM and the USFS allow development on their lands under a policy of multiple use. Development projects on Federal lands generally require and Environmental assessment or Environmental Impact Statement, depending on the extent of the impact. If such projects involve clearing excavating or filling in wetlands, or the discharge of stormwater or wastewater into them, they also require a Corps of Engineers and/or EPA permit.

Wetland Regulations

Until the late 1960s, there were no regulations protecting wetlands. In fact, the U.S. policy had been to drain wetlands and make room for agriculture or development. Today, wetlands are valued for their many ecosystem services, and many different laws and regulations exist that are used for wetland protection and mitigation. Ironically however, there is still no specific national wetland law intended primarily for wetland protection. Rather, to protect wetlands many different state and federal agencies apply laws intended for other purposes, such as the Clean Water Act. Relevant laws and regulations are summarized below.

Rivers and Harbors Act, Section 10 (1899)
Section 10 of the Rivers and Harbors Act regulates activities that obstruct or alter any navigable waterways, including dredging, placement of fill, construction of structures in or over the waterway, or any other work affecting its course, location, condition, or capacity. A permitting system is administered by the Army Corps of Engineers.

Fish and Wildlife Coordination Act (1967) requires that all water-use projects that might affect fish and wildlife populations or habitats consult with the U.S. Fish and Wildlife Service and the state agencies that manage fish and wildlife and their habitats (ADF&G and ADNR). These agencies review Environmental Impact Statements, Corps of Engineers permit applications, and other federal permits that affect wetlands and provide recommendations to mitigate the impacts to fish and wildlife.

The National Environmental Policy Act (NEPA) (1969) requires detailed evaluations of potential environmental impacts of development projects planned for federal lands or requiring major federal actions such as permits. Decisions of whether to protect or develop wetlands are weighed according to societal values. Key concepts of assessing activities in wetlands mitigation involve determining whether there are opportunities to avoid negative impacts, minimize impacts that cannot be avoided, and restore and rehabilitate areas that are damaged.

Coastal Zone Management Act (1972) and the **Alaska Coastal Management Program** requires that states review and certify that proposed activities affecting the coastal zone, including many activities in wetlands, will be consistent with environmental requirements imposed under state law. The Alaska Coastal Management Program establishes the standards against which activities are reviewed and includes standards for the maintenance of wetland functions.

Clean Water Act (1972, 1977)
Section 301 (Discharge Prohibitions and Effluent Limitations) prohibits the discharge of any pollutants into wetlands or other waters without a permit. It also requires the establishment of effluent limitations for a variety of pollutants.

Section 303 (Water Quality Standards) requires states to develop water quality standards for all uses of the state's waters, such as consumption, fish habitat, and recreation. The Alaska Department of Environmental Conservation is responsible for determining appropriate water quality standards in Alaska.

Section 401 (Water Quality Certification) requires applicants for projects that may result in the discharge of pollutants to obtain from the State, a certification that such discharges would not violate water quality standards

or effluent limitations. The Alaska Department of Environmental Conservation is responsible for reviewing permit applications for purposes of certification.

Section 402 (National Pollutant Discharge Elimination System, NPDES) requires the Environmental Protection Agency to regulate pollutant discharges such as industrial wastes, sewage and stormwater runoff to wetlands, streams and other waters. Permits for such discharges carry conditions necessary to ensure that water quality standards and effluent limitations are not violated.

Section 404 (Dredge-and-Fill Permit Program) regulates activities that would place dredged or fill materials in all wetlands, streams and other waters. A permitting system is administered by the Army Corps of Engineers and overseen by the Environmental Protection Agency. Examples of the types of activities that can require permits include land clearing, road fills, bank and shoreline stabilization projects, utility line crossings, and shoreline structures such as bulkheads and piers requiring fill.

The permit process requires projects to take appropriate steps to avoid, minimize and offset adverse impacts. With such steps in mind, the final permit decision is based on whether the project is contrary to the public interest, which includes factors such as water quality, water supply, wetlands, fish and wildlife, navigation, flooding, shoreline erosion and accretion, recreation, aesthetics, energy needs, economics and property ownership.

The **Food Security Act** "swampbuster" provisions (1985) (reversal of earlier U.S. policy) denies federal subsidies to farm owners who knowingly convert wetlands to farmland. The provisions also encourage acquisition of wetlands for protection of fish and wildlife habitat, with the help of the NRCS. Wetlands on private lands can also be set aside in conservation easements in exchange for debt relief to landowners.

Emergency Wetlands Resource Act (1986) provides for the collection of fees at national wildlife refuges. These fees and funds from the Lands and Water Conservation Act are deposited into the Migratory Bird Conservation Fund for use in the acquisition of privately owned wetlands.

No Net Loss Policy (1988) is not a law, but merely a policy that was adopted by the first Bush administration. However, Alaska is exempt from this national policy. The policy goal is essentially that wetlands should be conserved wherever possible, but not that individual wetlands should be sacred. Rather, acres of wetlands converted to other uses must be offset through restoration and creation of wetlands, maintaining or increasing the wetland resource base.

Alaska Fish Way Act (Alaska Statute 41.14.840) and **Alaska Anadromous Fish Act** (Alaska Statute 41.14.870) require permits from "the Alaska Department of Natural Resources for activities that would affect streams, lakes, and rivers that are important for the spawning, rearing, or migration of anadromous fish. Activities that require permits are those which would divert or use water; obstruct, pollute, or change the natural flow or bed; or use of certain types of equipment in the bed. The department reviews permit applications and assures protection of fish and wildlife before issuing the permit.

Important Migratory Bird Regulations

Migratory bird regulations are also relevant for wetland conservation, as wetlands are critical habitat for waterfbirds. Relevant regulations are summarized below.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act and its amendments between the U.S. and foreign governments –1916 U.S. and Great Britain (for Canada), 1936 U.S. and Mexico, 1973 Convention U.S. and Japan, and 1976 U.S. and U.S.S.R.– provide mandates for protecting and managing species and critical habitats for species that migrate between the U.S. and foreign countries. The Act also provides the authority to control the taking, selling, transporting, and importing of migratory birds, their nests, eggs, parts, and products.

National Wildlife Refuges Act (1903)

The National Wildlife Refuges Act established the refuge system primarily to conserve valuable habitat for migratory birds (especially waterfowl), large game animals, and endangered species. The national refuge system includes more than 430 units of land in 50 states, including 16 in Alaska.

North American Waterfowl Management Plan (1986)

The North American Waterfowl Management Plan provides general guidelines for waterfowl habitat protection and management actions for 29 species of ducks, 27 populations of geese, and four species of swans. Waterfowl habitat areas of major concern are identified in the U.S. and Canada, including seven in Alaska (Izembek Lagoon, Upper Alaska Peninsula, Yukon-Kuskokwim Delta, Upper Cook Inlet, Copper River Delta, Yukon Flats, Teshekpuk Lake). The plan has been signed by the United States and Canada.

Migratory Bird Management

Involvement is widespread. In North America since 1952, states and provinces have participated in flyway councils to cooperatively manage waterfowl harvests. Four flyway councils manage four regions of the U.S. Each council management area includes several states and Canadian provinces with common boundaries. Areas managed by a council include the entire migration route of species that migrate in a north-south direction. Species that follow east-west routes may cross flyway boundaries and receive management attention and coordination from one or more councils.

Alaska is especially important. Alaskan representatives of the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service participate as members of the Pacific Flyway Council. However, because the waterfowl that breed in Alaska migrate in all four flyways, Alaskan researchers and managers provide information to all four flyway councils. Information on production in Alaska is especially important to the Central Flyway Council during drought years for the prairie-pothole area.

The Alaska Migratory Bird Co-Management Council is another group, unique to Alaska, that develops recommendations for the spring and summer subsistence hunting of migratory birds.

Flyway councils make harvest recommendations. Flyway councils meet annually to review population information and to agree on a strategy for managing the following year's harvest based on a review of information gathered by research biologists. Members of the flyway councils recommend hunting regulations to the Secretary of the Interior, who has the authority to adopt them into law. The Alaska Board of Game also adopts the regulations. Both state and federal enforcement officials are responsible for enforcing the laws.

Councils are important for exchanging research. Flyway council members also exchange information on waterfowl research and management needs, law enforcement problems, and overall coordination among agencies, private groups, and citizens. Technical committees that are part of the councils coordinate waterfowl census, banding, migration, and harvest studies. Finally, the councils develop management plans for individual species of waterfowl as needed.

For over a decade, all four councils have worked together to implement the North American Waterfowl Management Plan adopted by the U.S. and Canada in 1986. Regulation of harvests is the second key element of this plan after habitat preservation and enhancement.

Developing Alaska: A Wetlands Challenge

Much of Alaska is wetlands. Presently Alaska has about 274,000 square miles of wetlands, which is more than the rest of the other 49 states combined. Alaska has approximately 9% of the nation's coastal wetlands, and 64% of the nation's inland wetlands. Wetlands are in fact, about 45 - 60% of the land in Alaska.

It's hard to avoid a wetland! The vast acreage of wetlands in Alaska, poses a challenge for different types of development that aim to avoid and minimize wetland losses. In some areas, few alternatives to developing wetlands exist. Fortunately, overall wetland losses in Alaska are relatively small to date (i.e. less than 1% of the state's acreage). However, losses are much higher (greater than 50%) in localized areas, such as the North Slope oilfields, and urban areas, especially along the coast. The creation of new wetlands has succeeded only in a few instances. The technology to create new wetlands and to restore the functions of degraded wetlands in Alaska's harsh climate is a subject of ongoing research.

Filling – one way to allow development in a wetland. Filling is one of the most common ways wetlands are altered in Alaska to provide foundations for buildings, roads, and airports. Wetlands have been filled along the coast to provide shipping platforms for transferring minerals, and other resources to market, moving retail goods to shore, and for developing waterfront residences and businesses. In tundra areas, almost all development necessarily occurs in wetlands. In these and other permafrost areas, thicker layers of fill are needed for insulation.

Filling effects. Gravel fill covers fish and wildlife habitat and eliminates cover, food, and water sources. Wildlife may still make some use of these areas if higher, dry sites are preferred and if the animals can tolerate the human activity associated with the fill. Fill in permafrost areas may also result in the damming of shallow surface water drainage. Without proper culverts and bridges to maintain cross-drainage, areas upstream of the fill become flooded while those downstream dry up.

Controversy is often unavoidable. With reason, there are many challenges associated with trying to conserve wetlands and mitigate their loss, while at the same time developing Alaska. Controversy often arises between those that aim to provide economic opportunities (e.g. development of oil and gas, mineral, and timber resources) and those that see wetland conservation as a priority, especially since there are few alternatives and techniques to restore Alaska's wetlands following development.

New Strategies in Wetlands Development and Conservation

Historically, wetlands were routinely drained and filled, without concern for the loss of habitat and ecosystem services that ensued. Today however, the adverse impacts of wetlands loss are better understood, and it's not so easy to develop wetlands due to many protective regulations. Nonetheless, wetland development is often unavoidable in Alaska, due to the fact that so much of the state is wetlands, and that wetlands are often in the choice places to live or run a business. Fortunately, there are new strategies for developing wetland areas.

Creative solutions. In Alaska, the oil industry avoids and minimizes impacts to tundra wetlands through the use of directional drilling and ice roads. Travel and exploration is thus restricted to the winter season. Ice has also been used to make drilling pads to avoid filling in wetlands. (A trend of warmer temperatures, however, is beginning to reduce the length of time that ice roads and pads will last). In another example, pedestrian boardwalks have been constructed along riparian corridors, and in other wetland areas to minimize disturbance by visitors who come to the wetland to fish, view wildlife and recreate.

Wetland mitigation is another approach to the problem of conserving or minimizing impacts to wetlands, while allowing for development. Mitigation measures might involve rating wetlands for their functions and values, and moving projects from a wetland with high values to a wetland area with lower values, or making the project smaller, or requiring treatment of pollutants before allowing them to be discharged into a wetland.

Mitigation can also include restoring the degraded (e.g. filled, dried out, or denuded) wetland, or creating a new wetland elsewhere. Mitigation measures often increase the cost of developing a project, but maintain a larger share of the wetland values.

Mitigation banks are a creative strategy to accompany the **"no net loss"** policy (see "Wetland Regulations" fact sheet). Essentially mitigation banks are wetlands that are created or restored in exchange for multiple developments elsewhere. Bank owners receive "mitigation credits" when they restore or create wetlands. They can then use those credits for wetland development elsewhere, or sell the credits to other developers.

Along similar lines, **In-lieu fee mitigation** programs allow wetland areas to be developed in exchange for the restoration and/or preservation of high value aquatic areas. In Alaska, the Great Land Trust in Anchorage, the Kachemak Bay Heritage Trust, the Southeast Alaska Land Trust and the Alaska Conservation Fund work as this kind of sponsor. The wetlands developer pays an in-lieu fee to the land trust, which then uses the money to purchase wetlands for preservation and/or to fund aquatic restoration projects.

For both mitigation banking and in lieu fee programs, wetlands and restoration projects are assessed using a sometimes complicated system based on many factors that may include evaluations of existing and potential habitat, type and abundance of wetland, ability of wetland to carry out essential functions, location, size and cost.

Nothing is perfect! The uses of mitigation banks and in lieu fee programs are not without problems and controversies. Some argue that the processes still allow valuable wetlands to be developed, and that conservation or creation of new wetlands elsewhere does not or cannot replace lost functions. Land trusts also may have difficulties finding

willing sellers and/or reasonable prices. In some cases the land trusts have large sums of wetland conservation funds in their coffers, but nothing to spend it on. Another problem is that to some extent, ratings of wetland "value" are subjective. Wetlands provide many different services, and depending upon perspective, different people might weigh each one differently.

Mitigation through in-lieu fee also usually results in at least temporal loss of wetland function, because in-lieu fee programs usually must accumulate funds from numerous developers before being able to purchase land or pay for restoration. At the same time, developers typically may begin construction as soon as they have paid their individual fee.

WETLAND ACTIVITIES

Section 1
WHAT IS A WETLAND?

Section 2
WETLAND ECOLOGY

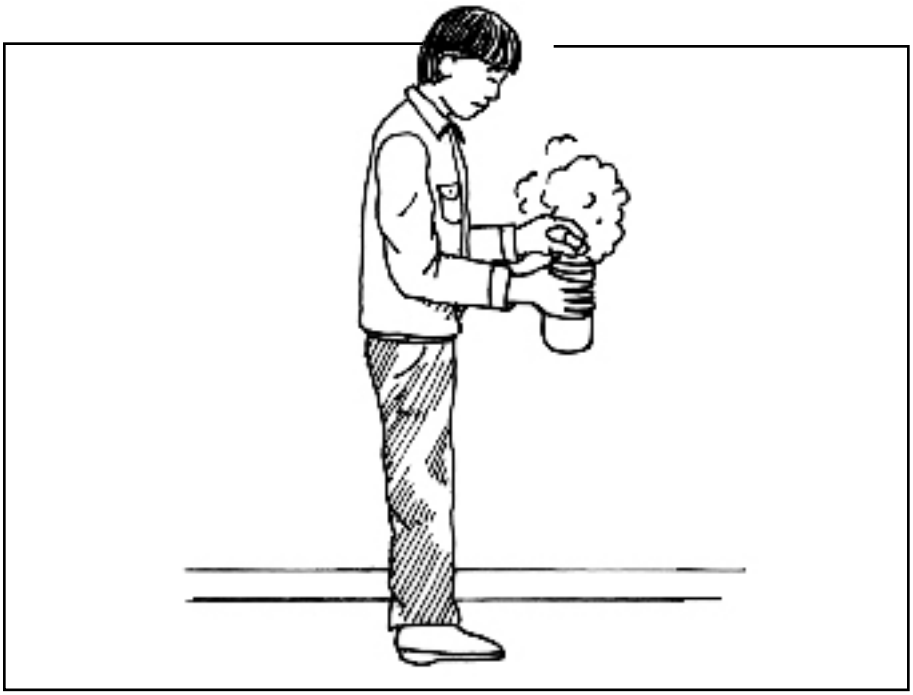
Section 3
WETLAND INHABITANTS

Section 4
OUTDOOR WETLAND INVESTIGATIONS

Section 5
WETLANDS IN A CHANGING WORLD

Section 6
WETLANDS POLICY AND MANAGEMENT

Water Cycle Discovery



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade Level: K - 6
State Standards: Art A-1; Geography C-1; Science B-2; LA SL.1.4
NGSS: K-ESS2-1, 2-ESS2-2, 2-ESS2-3, 5-ESS2-1, MS-ESS2-4
Subjects: science, language arts
Skills: observing, inferring, predicting, drawing, writing
Duration: one to two class sessions
Group Size: whole class, small groups
Setting: schoolyard, classroom
Vocabulary: evaporation, vapor, condensation, precipitation, transpiration

Objective:
Students will describe the water cycle.

Teaching Strategy:
Students will observe how water evaporates and how clouds are formed in order to understand parts of the water cycle.

Complementary Activities:
Water Wonders

Materials:
construction paper and markers, glass of water, wet sponge, hot plate, pan with a glass lid, canning jars (liter or quart size), ice cubes

Background:
See INSIGHTS Section 1, Wetland Ecosystems *"The Water Cycle".*

Procedure:
Part 1.

1. Write and have someone deliver to the class a note labeled "URGENT!" on the outside. The note reads "Wanted - Information pertaining to the whereabouts of WATER. Warning - it may be in disguise." A second note tells students they will be going on a WATER HUNT.

2. Divide the class into detective teams of 2-3. Give each team construction paper and markers.

3. Ask the teams to find five different examples of where to find water in the schoolyard. Tell the students to be creative and look for it in places that may not be obvious. For each example, the students should describe or draw a picture of where they discovered the water. (Have the students use a full or half sheet of paper to draw their pictures).

4. Back in the classroom, give teams some time to refine and color one of their pictures and then tape it to the board or wall.

5. Once all student pictures are on the wall, discuss each picture and if needed, move it around the board to create a diagram of the water cycle. You may need to furnish missing components such as groundwater, or ocean.

6. Discuss with the students how the water changes and moves from one state to another.

Part 2.

1. Show students a glass of water and tell them that it could possibly have been the same water splashed about by a woolly mammoth or sipped by Alexander the Great (use a famous character from their history books). Discuss how this "reusing" of water could be possible.

2. Discuss evaporation with the students: Have a student put a wet spot on the blackboard with the sponge or make a wet handprint and watch it. It will disappear because the water evaporates. Where does the water go? (Into the air.) Discuss how the water changes to a vapor (gas). This process takes place at the surface of all bodies of water, large or small. Ask if there is any way to make water evaporate faster. Allow students to try out a few ideas. They will probably try fanning it or heating it. Both wind and heat speed up evaporation.

3. Discuss condensation with the students: Ask the students if they think they could get the lid of a pot wet without dipping it in water? Put the lid in a freezer or refrigerator (for best effect use a glass lid). Place a small amount of water in the pot. Place it on a hot plate. As the dish starts to warm, place the cooled lid on it. Students will be able to observe water droplets forming on the lid.

4. Discuss precipitation. The condensation droplets should drip back into the pot, mimicking precipitation from clouds.

5. Discuss why the condensation droplets formed on the glass lid. (Water vapor contained in the warm air condensed as the air cooled against the cold lid.) Point out that evaporation and condensation are opposite processes. Discuss the cooling of air as it rises from the earth. You may want to point out that land obstructions such as mountains force air to rise, cool, and drop some of its moisture.

6. Ask the students that now that they've seen water condense out of the air, can they duplicate this process by forming microscopic droplets (fog or clouds)? Fill a bottle or jar with hot water (the hotter the better). After about one minute, remove all water to a depth of about two inches. Hold an ice cube in the mouth of the bottle. You may want to use a dark background to observe more easily the resulting "fog". Discuss why warm air at the bottom of the bottle rose and what happened when it neared the ice cube. As the air cooled, some of it condensed into water droplets and the fog was formed.

Evaluation

Students describe the possible movements of a water droplet, starting with rain on a plant.

Credits

Water Water Everywhere - Now You See It . . . Now You Don't. Oregon State University and Oregon Department of Education Sea Grant program.

Curriculum Connections:

(See Appendix for full citations)

Books:

The Drop in my Drink: The Story of Water on Our Planet. (Hooper, 1998).

Water Water! (Johnston, 1998).

Music:

The Water Cycle Boogie, song from *Slugs at Sea.* (Banana Slug String Band. 2000).

Website:

USGS site on the water cycle for teachers and students
http://ga.water.usgs.gov/edu/watercycle.html

Water Wonders

Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade Level: 4 - 8
State Standards: LA SL.1.4 W.4.3a,W.5.3a Geography C-1, C-2; Science C-3
NGSS: 5-LS2-1,5-ESS2-1,5-ESS2-2. MS-LS1-6, MS-ESS2-4.
Subjects: science, language arts, social studies
Skills: organizing information, predicting, comparing and contrasting, inferring.
Duration: 1-2 class sessions
Group Size: any size
Setting: classroom
Vocabulary: condensation, cycle, evaporation, molecule, precipitation, transpiration, vapor, watershed

Objectives:

1. Students will describe the various components of the water cycle and the path a water molecule might take on its way through this cycle.

2. Students will explain how the water cycle is important to all living things.

3. Students will describe how plants affect the movement of water in a watershed.

Teaching Strategy:

Students play a game and conduct an experiment that introduces them to the various steps of the water cycle and how the water cycle and all living things are connected.

Complementary Activities:

Water Cycle Discovery

Materials:

Part A: station sections cut from student page, copies of student page: Water Cycle Score Card, seven dice, label for each of seven stations, watch or stop watch.

Background:

See INSIGHTS *Section 1 Wetland Ecosystems: "The Water Cycle" Fact Sheet.*

Procedure:

Before class:

- Make one copy of the Water Cycle Score Card for each student
- Copy the Water Cycle Stations Sheet and cut the stations apart.
- Make a large label for each of the seven stations: cloud, glacier, stream, groundwater, plant, ocean and animal. You may want to draw or cut out pictures from magazines to accompany each label
- Use the labels to set up seven stations around the room. At each station put a die and the station section designated for that station.

1. Ask students whether they have heard of the water cycle before. Divide the class into pairs. Ask pairs to write down words that describe the water cycle. Ask volunteers to share their descriptions with the whole class.

2. Share with your students the data showing the Earth's water distribution from the chart below. Then make a drawing on the board of the water cycle. Make sure that students understand the terms evaporation, groundwater, transpiration, etc. Use the following questions to focus their attention:

a. If every living thing needs so much water, why isn't it used up?
b. Where does the water go when a puddle dries up?
c. Why don't oceans and lakes dry up the way puddles do?
d. Where does rain come from?
e. Do you think water always follows the same path, as shown in the water cycle?

3. Explain that the water cycle is really a simplified model for looking at the "journey" of a water molecule. Invite students to play a game in which they each will be a water molecule. Have students use the score card to record the path they followed in the game.

4. Divide students into seven approximately equal groups, and have each group begin at one of the stations.

5. Have each student roll the die and read the statement at his or her station corresponding to the number on the die. On the water cycle score card, students should write their current station stop, what happens to them, and their destination. When you call out "cycle," students should go to the next station as directed by the paper.

6. Repeat Step 5 about 10 times or until most students have cycled through the Cloud station a couple of times.

7. Ask students to write a brief story from the perspective of a water molecule. The story describes the journey the molecule just took through the water cycle. For example, a student whose journey was Glacier – Stream – Ocean– Cloud – Stream – Animal – Cloud – Glacier – Ocean might start a story "I was a lonely water molecule frozen in a glacier on top of a mountain. When the spring came and the ice thawed, I melted into a stream. Down the mountain the stream roared going over large boulders. After the long journey, I reached the ocean". (Visit www.plt.org and click on "curriculum" for a sample story."

8. On the board, write the names of the seven stations. Beginning with Cloud, ask students to share all the different ways they got to Cloud. (For example, they evaporated from the ocean or they transpired from the plant). On the board, show each response by drawing arrows to Cloud. Repeat with the other stations.

9. Discuss the following questions:

a. Even though individual molecules took different paths, was anything similar about the journeys they took?
b. In the game, which stations seemed to be visited by the most water molecules, regardless of their particular journey? What can we infer from this?
c. Can you think of other parts of the water cycle that were not included in the game? (wetlands, reservoirs, lakes, rivers, wells, puddles). Where might they be included in the cycle?
d. The water cycle is often shown like a neat circle drawing where water goes in one direction. Do you think this sort of drawing is a useful way to show the cycle, even if the drawing does not include all the paths water might take?

WATER SOURCE	**WATER VOLUME IN CUBIC MILES**	**PERCENT OF TOTAL WATER**
Oceans	317,000,000	97.24%
Ice caps, glaciers	7,000,000	2.14%
Groundwater	2,000,000	0.61%
Freshwater lakes	30,000	0.009%
Inland seas	25,000	0.008%
Soil moisture	16,000	0.005%
Atmosphere	3,100	0.001%
Rivers	300	0.0001%
TOTAL WATER VOLUME	**326,074,400**	**100%**

e. What makes water move through the cycle? (sun, gravity, physical properties of water). What would happen if the sun's energy were blocked from Earth?
f. What might happen if all of Earth's water stayed in the oceans? In the clouds?
g. How is the water cycle important to plants and animals? (It moves water to them; it makes water available at different times).

Evaluation:

Student water molecule stories can be evaluated according to how well all stops are included, how many details are included in the journey, and how well the story conveys the importance and cyclical nature of the water cycle.

Critical Thinking:

Ask students what components of the water cycle are wetlands involved in? Are all wetlands involved in all of the same components? (Groundwater recharge is more important in some than others, evaporation might occur more in wetlands where temperatures are warmer, water in bogs comes from precipitation, whereas water in fens comes from groundwater).

Curriculum Connections:

(See Appendix for full citations)

Books:

The Drop in my Drink: The Story of Water on Our Planet. (Hooper, 1998).

Water Water! (Johnston, 1998)

A Drop of Water: a Book of Science and Wonder. (Wick, 1997)

The Secret Language of Snow. (Williams, 1984)

Water Music: Poems for Children. (Yolen, 1995).

Music:

The Water Cycle Boogie, song from *Slugs at Sea*. (Banana Slug String Band. 2000).

Extension:

Build a terrarium to observe the water cycle in action. Put a small cup filled with water (to simulate a pond) in the center, and surround it with a 2" layer of soil. Place small potted plants (like ferns or house plants) in the soil. Then moisten the soil and plants lightly, using a spray bottle. Cover the container tightly with plastic wrap and place the terrarium in indirect sunlight. Students can observe change happening as time passes. Plants should thrive. Moisture should condense on the underside of the plastic, and the side of the container. The water level in the pond may rise if water drips into it. If possible, build a second terrarium to the same specifications. Cover the second terrarium with aluminum foil and as time passes, have students observe what is happening. The students can compare the two experiments to investigate what role the sun has in the water cycle.

Credits:

Tools: Water Cycle Stations Sheet

Station 1 CLOUD
1. You fall as rain onto an ocean. Go to OCEAN.
2. You fall as rain onto an ocean. Go to OCEAN.
3. You fall as rain onto a stream. Go to STREAM.
4. You fall as snow onto a Glacier. Go to GLACIER.
5. You fall as snow onto the ground. Go to GROUNDWATER.
6. You fall as rain onto a parking lot. Go to STREAM.

Station 2 GLACIER
1. You evaporate into the air. Go to CLOUD
2. You stay frozen in ice. Stay at GLACIER.
3. You stay frozen in ice. Stay at GLACIER.
4. You melt and become part of a stream. Go to STREAM.
5. You melt and become part of a stream. Go to STREAM.
6. You break off from the glacier and fall into the ocean. Go to OCEAN.

Station 3 OCEAN
1. You are one of countless water molecules in an ocean and you stay there. Stay at OCEAN.
2. You are one of countless water molecules in an ocean and you stay there. Stay at OCEAN.
3. You are one of countless water molecules in an ocean and you stay there. Stay at OCEAN.
4. You evaporate into the air. Go to CLOUD.
5. You evaporate into the air. Go to CLOUD.
6. You evaporate into the air. Go to CLOUD.

Station 4 STREAM
1. You evaporate into the air. Go to CLOUD.
2. You evaporate into the air. Go to CLOUD.
3. An animal comes to the stream and licks you up. Go to ANIMAL.
4. You continue rolling down hill and become part of an ocean. Go to OCEAN.
5. You continue rolling downhill and become part of an ocean. Go to OCEAN.
6. A human drinks from the stream. Go to ANIMAL.

Tools: Water Cycle Stations Sheet

Station 5 GROUND WATER
1. You move slowly underground and eventually flow into an ocean. Go to OCEAN.
2. You move slowly downward and become part of an aquifer. Stay at GROUNDWATER.
3. You move slowly underground between grains of sediment and eventually flow downward into a wetland and from there into a stream. Go to STREAM.
4. You move slowly underground between grains of sediment and eventually flow downward into a wetland and from there into a stream. Go to STREAM.
5. A plant takes you in through its roots. Go to PLANT.
6. You are pumped out of the ground from a well to irrigate a farm. Go to PLANT.

Station 6 ANIMAL
1. After using you to process food, the animal urinates and you end up in the ground. Go to GROUNDWATER.
2. After using you to process food, the animal urinates and you end up in the ground. Go to GROUNDWATER.
3. You are exhaled from an animal's lungs into the air as vapor. Go to CLOUD.
4. You are exhaled from an animal's lungs into the air as vapor. Go to CLOUD.
5. A person uses you for brushing his or her teeth and you end up going through a sewage treatment plant and then put into a stream. Go to STREAM.
6. After using you to quench their thirst, a person urinates and you end up going through a sewage treatment plant and then put into a stream. Go to STREAM.

Station 7 PLANT
1. The plant transpires you through its leaves and you evaporate into the air. Go to CLOUD.
2. The plant transpires you through its leaves and you evaporate into the air. Go to CLOUD.
3. The plant transpires you through its leaves and you evaporate into the air. Go to CLOUD.
4. The plant uses you to grow. Stay at PLANT.
5. The plant stores you in its edible fruit. Go to ANIMAL.
6. The plant stores you in its edible leaves. Go to ANIMAL.

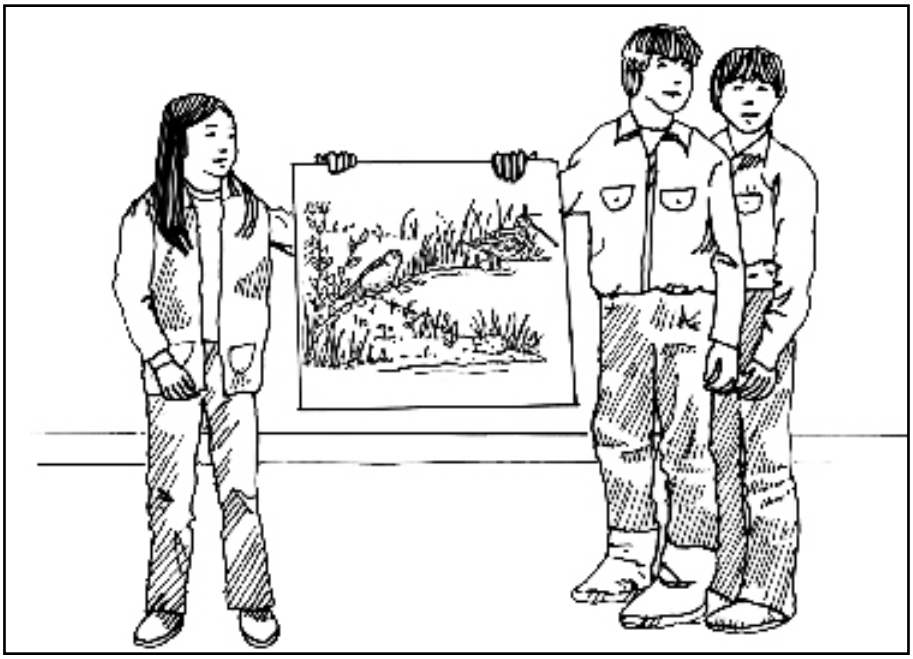
Tools: Water Cycle Score Card

Student's Name_____

STATION STOP	WHAT HAPPENS	DESTINATION
Example: CLOUD	Fall as Rain	OCEAN
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Describe your entire journey on the back of the score card.

Waterlogged Worlds



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade: 4 - 6
State Standards: Art A-1, A-5; English/LA B-1; Geography C-1, C-3;. Science C-3
NGSS: 5-LS2-1. ,5-ESS2-1. MS-LS2-1, MS-LS2-5.
Subjects: science, art, language arts, drama
Skills: comparing similarities and differences, drawing, group cooperation, listening, reporting, research
Duration: two to three classes
Setting: classroom
Vocabulary: wetland, coastal, saltwater, marsh, bog, tundra

Objectives:

Students will:
1. Recognize that a diversity of wetlands occur in Alaska.

2. Be able to describe at least two characteristics of five different kinds of wetland areas.

Teaching Strategy:

Students brainstorm words associated with wetlands, review definitions of wetland words and communicate them to the class through pantomimes. Students then create a mural depicting an Alaska wetland area.

Complementary Activities:

Wetland Metaphors, Locating a Wetland

Background:

See INSIGHTS: Section 1, Wetland Ecosystems, *"What is a Wetland"* and *"Profiles of Alaska's Wetlands"* Fact Sheets.

Materials:

Wetlands Visual Vocabulary Cards, container, pencil, paper, butcher paper, colored markers, Water Logged Worlds Student Fact Sheets, reference books on wetlands (see Curriculum Connections Appendix) and/or internet access for research.

Procedure:

Activity 1: Visual Vocabulary

1. Have Wetland Visual Vocabulary Cards cut, folded, and in a container ahead of time.

2. Explain that wetlands include different types of areas where the soils become waterlogged. Only certain types of plants that can tolerate flooding, wet soil and low oxygen availability can grow there. Ask students to name local examples of areas they might consider wetlands according to this definition. List their ideas.

3. Divide students into groups of 3-4. When you say "Go," each group will have 90 seconds to write as many words as they can think of that are associated with the word "wetland". Words can be verbs, nouns, or adjectives (for example, squish, berries, rain, damp, etc.). Words are legitimate as long as the writer can justify the association with wetlands.

4. Before groups start, have them decide who will start out as the writer. The writer writes just one word and then passes the paper and pencil to the next person in the group. This next person now becomes the writer. The writer must write only others' suggestions - not his/her own ideas.

5. After the time is up, have each group share their lists with the class.

6. Tell the students that they will now get a chance to act out some wetland words that you've already prepared.

7. Pass around the hat containing the "Wetland Visual Vocabulary Cards" and have each group draw one card.

8. Give each group 5 minutes to prepare how they will act out their wetland definition without talking.

9. When all groups are ready, have them take turns acting out their definitions. Other groups may earn points for guessing the correct wetland word being defined.

Activity 2

1. Explain to students that Alaska has many wetlands of different kinds. Give examples such as marshes, bogs, mudflats, etc. Tell them that they will be learning more about what a wetland is and about five types of wetlands in Alaska: coastal areas, riparian wetlands, freshwater marshes, peatlands, and tundra. (You may want to choose local wetland types to start.)

2. Divide the class into five groups. Explain to students that each group will become "experts" on one of the wetland types and will share their findings with the rest of the class. It may be helpful to designate or let the group decide on specific roles for each member: procurement officer (gets materials or asks questions), facilitator (organizes group), spokesperson (organizes presentation), encourager (keeps group interactions positive), etc.

3. Each group will be given a different "Water Logged Worlds Student Fact Sheet." They will carefully read the fact sheet together and use library books and other wetland references to learn more about the different types of plants and animals and other characteristics of the wetland type assigned to them. Groups will use butcher paper and colored markers to illustrate their wetland.

4. Each group will present their illustration to the rest of the class.

5. After presentations are completed hang each illustration in the classroom. You may want to show students the wetland posters in INSIGHTS section "Profiles of Alaska's Wetlands."

6. Discuss local wetland areas and whether they are like any of the five wetland types discussed.

Evaluation:

1. Students list at least one animal and one type of plant that may exist in each of the five different wetland types.
2. Students match the name of a wetland from a list on the left side of a page, with the appropriate wetland description or characteristics from a list on the right side of the page.

Critical Thinking:

Could each of the five types of Alaska wetlands exist anywhere in Alaska? If not, what types of conditions must be present for the wetland type to exist?

Credits

Curriculum Connections:

(See Appendix for full citations)

Books:

A Journey into a Wetland. (Johnson, 2004).

Here is the Wetland. (Dunphy, 2004).

Lily Pad Pond. (Lavies, 1989).

Squishy, misty, damp & muddy: the in-between world of wetlands. (Cone, 1996).

Video:

Alaska Wetlands: A Matter of Choice. (EPA,1988).

STUDENT FACT SHEET

Tools: Waterlogged Worlds

Freshwater Marshes

On a windy day you can hear the rustling of the plants that grow in a freshwater marsh. The plants that grow in a marsh are special. Their **roots are under water**. Their stems and leaves rise out of the water into the air and sunlight.

Plants that grow in **fresh water marshes** are **adapted** to living in water, and in soils that don't have much oxygen. Examples of plants you might see are buckbean, yellow pond lily, and horsetail.

Marshes can fill broad, flat areas or in the shallow edges of ponds and lakes. Marsh plants can grow where water is shallow and slow moving. Marshes often dry out during parts of the year, exposing the soil and plant roots to air.

Many kinds of birds like ducks, swans, and geese make their nests in freshwater marshes. Marshes are also important homes for beavers, wood frogs, muskrats, and fish.

STUDENT FACT SHEET

Tools: Waterlogged Worlds

Tundra

Grab your parka and boots for a walk in this waterlogged world. The temperature is mighty cold in winter and cool even in summer. The wind almost always blows. Because of the **cold and wind, no trees** grow here. Instead, all the **plants hug the ground** where it's warmer.

Many people think the tundra is flat. Once you've walked on the tundra, you know there are lots of little ups and downs. Many of the high spots are mounds of old and new grasses and sedges growing together. All the low spots hold water. There are squishy soils, big and little puddles, ponds, and lakes. Even where the ground looks high and dry, it isn't. Just try sitting down for a few minutes.

The tundra can be called a northern desert. Very little rain or snow falls on the tundra each year and most of the rain and melted snow stays on or near the surface. Water that falls as rain or melts from snow can only sink a few inches or maybe a few feet because the ground is permanently frozen. This permafrost causes plants that live in tundra wetlands to grow **roots sideways**, instead of down.

STUDENT FACT SHEET

Tools: Waterlogged Worlds

Riparian wetlands

Riparian wetlands are the **floodplains** of Alaska. In some watersheds, water levels in rivers rise just after spring breakup and **floodwaters** rush downstream. The flooding waters overflow and fill wetlands all along the banks of rivers with nutrient rich waters. Rivers that are fed by glaciers and snowfields also flood their wetland corridors but not until mid summer, when hot temperatures cause snow and ice to melt.

Stream and river corridors slowly begin to dry in fall. All the plants in these wetland corridors must therefore be adapted to live in both **wet and dry conditions.**

Beavers can increase the size of riparian wetlands when they build dams. Huge complexes of beaver ponds and dams exist along many of Alaska's streams and rivers. Beavers cut down large trees, opening up the area to more light. Willows commonly grow in these areas.

STUDENT FACT SHEET

Tools: Waterlogged Worlds

Coastal Wetlands

Life in coastal wetlands has both challenges and rewards. Plants and animals that live in these areas must be able to deal with changes in **tides** and **salinity** (how salty the water is) several times a day. Plants and animals adapted to such dynamic conditions thrive because the waters of coastal wetlands are rich in important **nutrients** due to the mixing of river and ocean waters. Coastal wetlands are one of the most productive living areas on earth!

Coastal wetlands are extremely important to the survival of many types of animals such as migratory birds. In fact, the flight paths of these birds often follow the coastline so that birds can stop and feed and rest in the wetlands during long migrations north or south. The birds need quick, fattening energy for nesting and flying thousands of miles; their next stop could be wetlands in Canada, Mexico, or even Russia.

Migratory fish use coastal wetlands too. All young salmon start their lives in fresh water; some near the sea, and others thousands of miles inland. Coastal wetlands are the perfect place to allow young fish to adapt to salt water before they head out to sea.

STUDENT FACT SHEET

Tools: Waterlogged Worlds

Bog

If you've wandered off trail in many parts of Alaska, you've probably had the experience of stepping into spongy dark muck, thinking you were on solid ground. Hopefully your socks didn't get too wet! You were lucky to wander into a type of **peatland** wetland called a **bog** (sometimes called muskeg in some parts of Alaska).

Bogs are found throughout Alaska in areas where glaciers once passed or where there are areas of **permafrost** — permanently frozen ground under the surface. Water in bogs comes from rain and snow and cannot drain away due to the permafrost or another soil type that does not allow water to drain. Some bogs are surrounded by forests, but few trees can live right in bogs. Black spruce, tamarack, and lodgepole pines have adaptations that allow them to grow in some bogs.

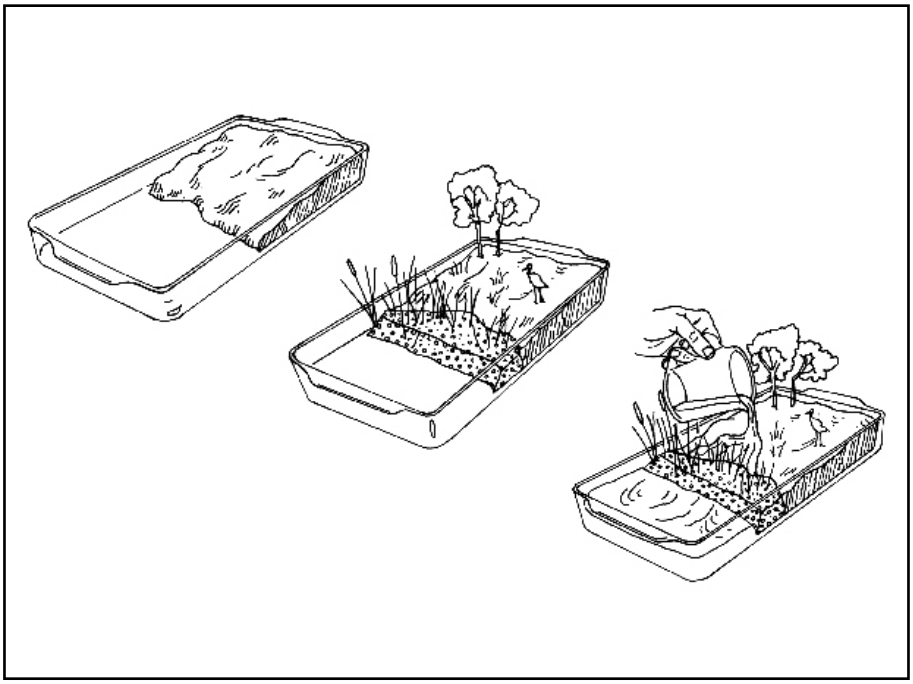
The most abundant live plants in bogs are mosses, mainly **sphagnum moss**. This moss can soak up to 200 times its weight in water. What a sponge! Labrador tea and bog rosemary are other common plants you might find in bogs.

Bog plants that die do not **decompose** the way plants do everywhere else. The water is too cold, and too acidic. Instead, the dead and half decayed plants build up over time as layers of **peat**.

TOOLS: WETLAND VISUAL VOCABULARY CARDS

DABBLING DUCKS use shallow marshes, ponds, and rivers and "tip up" to feed leaving only their tails above the water. They do not dive, and they take off straight up into the air when startled. They are also called "puddle ducks."	**SPAWNING** is the act of producing or depositing eggs. This term usually refers to fish.
ANADROMOUS (a NAH drum us) FISH are fish that start out their lives in fresh water, spend the greater share of their lives in salt water, and return to freshwater streams to spawn. Salmon, whitefish, and some trout are examples of anadromous fish.	**FOOD CHAIN** is the transfer of energy from a primary source, (usually the sun), to plants, to an animal that eats plants, to another animal that eats the first animal, and on through a series of animals. For example, a green plant, a leaf-eating insect, and an insect-eating bird is a very simple food chain. Any one species can be part of many different food chains.
WATER CYCLE describes the movement of water through the environment. As water cycles it **evaporates** from the ocean and the land, **condensates** to become clouds and fog, precipitates from clouds as snow and rain, **runs off** the surface of the ground into lakes and streams, and **percolates** into the ground.	**ECOSYSTEM** All living and non-living things and their environment in an area of any size.
TIDES are the daily change in ocean level caused by the influence of the moon and the sun's gravity upon the earth.	**INSECTIVOROUS PLANT** A plant that is adapted to capture and digest insects.
FLOOD A flood is an unusually high water event caused by precipitation, tides, or storms. Floods can occur in all types of wetlands.	**MIGRATION** The annual movements of birds or other animals. For example, the birds migrate between their nesting areas and their wintering areas in spring and fall. Migrations can cover very large distances or very short distances, depending upon the type of animal.
WATERFOWL Waterfowl are water birds that have webbed feet and are good swimmers. Ducks, geese, and swans are all **waterfowl**.	

Wetland Model



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade: 4 - 12

State Standards: Art A-4, A-5; Geography C-1, C-2, C-3, E-3, E-5; Science A-1, A-2, A-3, D-2, E-1.

NGSS: 4-ESS2-1.,5-ESS2-1, MS-LS2-4.MS-ESS2-2. MS-ESS3-3. HS-LS2-7. HS-LS2-7. HS-ESS3-4

Subjects: science, art

Skills: Scientific inquiry, model-building, public speaking

Duration: one to two class sessions

Group Size: 3 - 5

Setting: classroom

Vocabulary: wetlands, filter

Objectives:

1. Students will describe two functions of wetlands.

2. Students will identify potential effects of human changes to wetlands.

Teaching Strategy:

Students will build a wetland model and use their model to answer questions about the ability of wetlands to filter pollution, sediments and store water. Students also investigate what happens when changes are made to the wetland.

Complementary Activities:

Soaker Tester, Investigating Wetland Soils.

Background:

See INSIGHTS: Section 1, Wetland Ecosystems, *"What is a Wetland", "Profiles of Alaska's Wetlands", "Wetland Functions", "Wetland Soils"*, and Section 2, Wetlands in a Changing World *"Disturbance of Wetlands"* fact sheets.

Materials:

For each group: large roasting pan; box of modeling clay; florists' foam, large sponge or small piece of indoor/outdoor carpet; pitcher of clear water; pitcher of muddy water; pitcher of water colored with food coloring; gravel; model-building materials such as: tree needles, twigs, grass, moss, plants, cotton swabs, toothpicks, craft sticks, pipe cleaners, cardboard, glue, scissors, paint, markers, etc.

Procedure:

1. You will need your own model as a demo for the students. Build one before class, or alongside the students.

2. Introduce, or remind students of the different types of wetlands that exist in Alaska. Students can develop lists of plants and animals that might exist in each type of wetland.

3. Divide the class into groups of 3-5. Tell the students that they will construct a model wetland, and that beforehand, they need to choose what type of wetland they would like to build.

4. Give each group some time to think about what are the components of their type of wetland. When they are ready, a representative from each group can go select the appropriate materials for their type of wetland.

5. Have the students begin creating their model by spreading a sloping layer of modeling clay in half of the pan to represent land (see the picture at the beginning of the activity). The empty half will represent a body of water. Make sure that students seal the clay to the pan on the edges.

6. Meandering streams that lead to the body of water may be formed in the clay.

7. To represent the wetland buffer between dry land and open water, have students cut a piece of the indoor-outdoor carpeting (or florist foam or sponge) to completely fill the space across the pan along the edge of the clay.

8. Students can then add plants, animals, etc. using the model-building materials.

9. Have each group present their model to the rest of the class, explaining the different features. Have the students to tell a little bit about what it would be like to walk through their wetland – soggy, spongy etc.?

10. Discuss with the students some of the ecosystem functions of wetlands, how some may reduce flooding by soaking up excess water, filter sediments and pollutants, and/or recharge underground water supplies.

11. Tell students that you are going to simulate a rainstorm into the wetland and that they should closely observe what happens.

12. Slowly pour water onto your model and discuss with the class what occurs (*some of the water is slowed down by the "wetland" carpeting, and the excess slowly flows in the body of water*).

13. Ask the students if they think the same thing would occur without the "wetland"? Pour out the water from the model, remove the "wetland" and pour the same amount of water on the model as before. Once again, discuss what happened with the class (*this time the water should fill the body of water much more quickly than before. The wetland serves as a buffer because it collects water and slows the water flow. This slowing process helps reduce flooding and helps prevent soil erosion.*)

14. Tell the students that they will do the same procedure with their model except they will be using polluted and/or muddy water. Students can use the colored water to represent polluted water, and the muddy water to represent silty flood water or water from increased erosion. Have each group study their wetland and write down hypotheses for how well they think their wetland will filter out muddy water and pollution.

15. A recorder for each group should record the methods of the experiment (i.e., how fast they poured the water, how much water they used, etc.) and the group's observations.

16. Have each group develop other questions about their wetland, and conduct a new experiment. Possible questions are:

1. What would happen if the wetland was completely paved or filled with gravel?

2. What if only a small portion of the wetland was paved?

3. What could happen to areas downstream if wetlands are filled or paved? *(Increased flooding, increased pollutants in the water, increased sedimentation - depending on the degree of wetland function lost.)*

17. Discuss with the students the implications of paving or filling a wetland.

Evaluation

Students present a report of their scientific experiment, including ideas of what they could do to improve the quality and objectivity of their experiments.

Critical Thinking:

Do all Alaska's wetlands serve all of the ecosystem functions? (See the Wetland Ecosystem Functions Fact Sheet in the INSIGHTS section.) Can you think of situations where the wetland may not actually help to recharge the groundwater? How about situations where the wetland may not control flood waters?

Credits:

Ranger Rick's Naturescope. 1986. *Wading into Wetlands. National Wildlife Federation*.

Curriculum Connections:

(See Appendix for full citations)

Books:

Our Endangered Planet: Groundwater. (Hoff, 1991)

Our Endangered Planet: Rivers and Lakes. (Hoff 1991)

Keeping Water Clean. (McLeish, 1988)

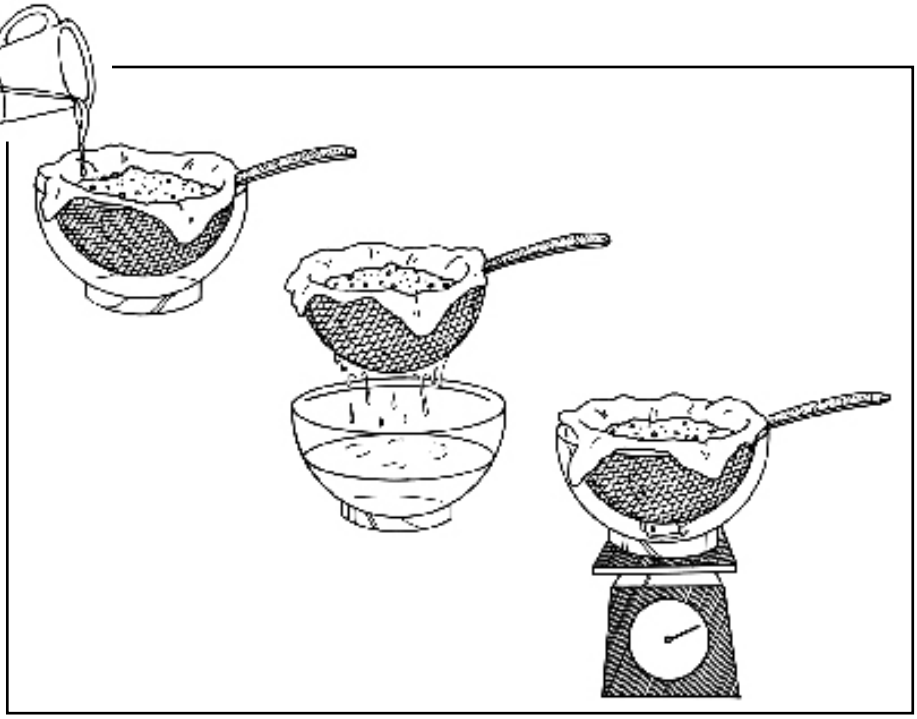
Rivers, Ponds and Lakes. (Ganeri, 1992).

Wetlands (Finlayson and Moser 1991).

Video:

Alaska Wetlands: A Matter of Choice (video recording) (EPA,1988).

Soaker Tester



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade: 4 - 8

State Standards: 4.NBT.4.
NGSS: 4-ESS2-1.,5-ESS2-1. MS-ESS2-2. ,MS-LS2-2

Subjects: science, math

Skills: analysis, drawing conclusions, graphing, interpreting data, calculating percentages.

Duration: one to two class sessions

Group Size: 2

Setting: classroom

Vocabulary: water holding capacity, peat moss, waterlogged

Objectives:
Students will determine how well five different soil types retain water and relate their findings to wetland soils.

Teaching Strategy:
Students will test how much water different soil types will hold. They will summarize their results in a bar graph.

Complementary Activities:
Investigating Wetland Soils, Wetland Model.

Background:
See INSIGHTS Section 1 *Wetland Ecosystems, "What is a Wetland", "Profiles of Alaska's Wetlands"*, and *"Wetland Soils"* fact sheets.

Materials:
For each group: funnel, cheesecloth, bowl (large enough to hold sieve), graduated cylinder, water, beaker or measuring cup, stop watch, Soaker Tester Data Sheets (at the end of the activity), 250 ml (or one cup) each of: live sphagnum moss, dried peat moss (found in any plant store, nursery or bog), sand, gravel, glacial silt (if not available, use silt from a river or creek), and 500 ml (or 2 cups) of soil collected by students or you around your homes.

Procedure:
1. You may choose to place samples of each soil type at different stations around the room, or have samples for each group to work with at their own tables.

2. Before class, make permafrost for each group: place 250 ml of the soil collected by students in a bowl, preferably with similar dimensions as the bowls that students will be given. Add enough water until the soil is wet, but not muddy, and place the bowl in a freezer over night. Remove the "permafrost" from the bowl shortly before class.

3. Discuss with students how the ability of soils to hold water has an important effect on whether or not a wetland is created.

4. Show students how to build their "soaker tester" by placing the cheesecloth inside the sieve inside the bowl.

Tell students that they will use their soaker tester to test a few types of soils for water retention. The students will test gravel, sand, glacial silt, soil from around their homes, "permafrost", live sphagnum moss and peat.

5. Have students work in pairs. Before they begin to test their soils, students should make predictions about the **water holding capacity** of each type of soil. Younger students can just rank their soils in order of 1-6, by how well each holds water. Older students can write a qualitative prediction for how well they think their soils will hold water.

6. Students will place 500 ml of soil in their soaker tester, slowly pour 250 ml of water through the soil and wait 3 minutes. *Because of this wait, you may want to provide each team with several soaker testers so that they can do more than one at one time, or students can complete their calculations (see next step) during each progressive wait.*

7. After 3 minutes, students should remove the sieve and measure the amount of water in the bowl using the graduated cylinder. Have the students record the volume in the data sheet. Students then subtract the volume of water that was in the bowl from 500 ml to determine the total amount of water that was absorbed by the soil. Students may then determine the percentage of water that the soil held. The data sheet will guide students through this process.

8. ***Alternative method:*** *Rather than use equal volumes of soil, have students use equal weights of soil by weighing out 50 g of each type of a soil with a balance.*

9. Students may create bar graphs, showing the percentage of water absorbed by each type of soil.

10. Discuss the results with the class. Did their results surprise them? Which type of soil might they expect to find in various Alaska wetlands? Compare each group's data. If there are differences, what could account for them? Since the mosses are found in wetlands and hold the most water, what is one function of a wetland? (*They soak up water and temporarily store it*). How might this storage function affect the surrounding land? (*It may prevent flooding by releasing water gradually over time, some water may trickle through the soil and add to the groundwater supply).*

Evaluation

Students can present their findings and analyses either written or orally.

Critical Thinking

Discuss with the students whether all Alaska's wetlands perform the same ecosystem functions? How might Alaska's wetlands differ from those found in other parts of the United States? Should all regulations designed for conserving wetlands in the Lower 48 always apply to Alaska' wetlands as well? Why or why not?

Credits

Newton, David E., Slesnick, Earl L., 1981. *Hanging on to the Wetlands - Book I.* Western Washington University.

Quinlan, Susan. 1988. *Alaska Wildlife Week, Unit 6. "Alaska's Living Tundra, Permafrost Puzzles,"* Alaska Dept. of Fish and Game.

Curriculum Connections:

(See Appendix for full citations)

Books:

Down to Earth (Stewart, 2004).

Soil (Stewart, 2002).

Our Endangered Planet: Groundwater (Hoff, 1991)

Keeping Water Clean (McLeish, 1988)

Out of the Earth: Civilization and the Life of the Soil (Hillel, 1991).

Soils: A Resource Our World Depends On (Graham, 2005).

Wetlands (Moore, 2006).

Video:

Wetlands (Nye, 1996).

WORKSHEET: SOAKER TESTER DATA SHEET

Soil types: gravel, sand, glacial silt, soil from your around your home, permafrost, sphagnum moss, peat moss.

1 Write down your predictions for how well each soil type will hold water.

2. Rank your soils in order of which you expect to hold the most water to which will hold the least.

3. Put your soaker tester together using the sieve, bowl and cheese cloth.

4. Place either 250 ml or 50 g of each soil type in the soaker tester. Record the amount in the table below under column **B**.

5. Slowly add 500 ml of water and start your stop watch.

6. After 3 minutes, remove the sieve (with the soil in it), being very careful not to squeeze the soil or moss inside.

7. If there is water in the bowl, measure the amount using a graduated cylinder and record the amount in the table below under column **D**.

8. Subtract this amount from 500 to determine the amount of water held by the soil and record this volume in column **E**.

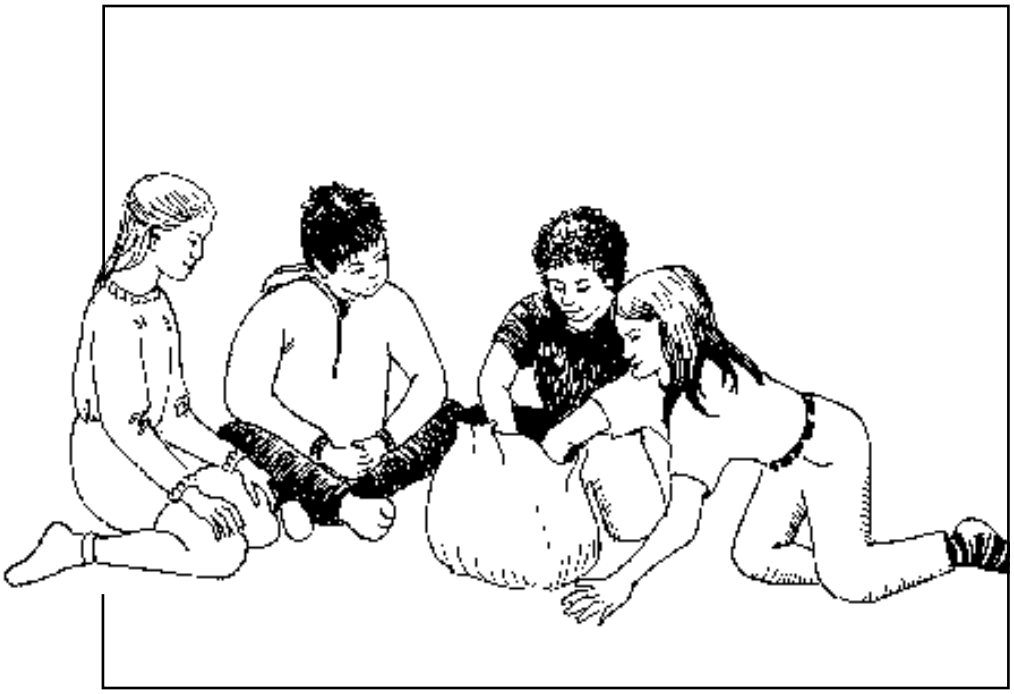
9. Determine the percentage of water held by the soil by dividing the amount of water held by the soil by the total amount of water poured and multiplying by 100 and record this value in column **F**.

A **SOIL TYPE**	**B** Vol. Or Wt of soil (ml or g)	**C** Vol. Water poured (ml)	**D** Vol. Water in bowl (ml)	**E** Vol. (ml) water held by soil **C - D**	**F** % Water Held by Soil **E/C X 100**
gravel		500			
sand		500			
glacial silt		500			
soil from home		500			
permafrost		500			
sphagnum		500			
peat moss		500			

10. Rank your soils in order of which held the most water to least water. Does your ranking match your predictions in question #2?

11. Which type of soil do you think is most likely to create a wetland. Explain your answer.

Wetland Metaphors



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade: 4 - 8
State Standards: English/LA A-1, A-6, B-1, B-2; Geography C-1, C-2, C-3; Science C-3, D-2
NGSS: 4-ESS2-1.,MS-LS2-1., MS-LS2-2,-LS2-4
Subjects: science, language arts
Skills: analysis, application, classification, comparing similarities and differences, description, generalization, identification, inference, interpretation, public speaking, recognition, reporting, small group work, synthesis,
Duration: one to two 30-60 minute sessions
Group Size: any
Setting: indoors or outdoors
Vocabulary: wetland, functions

Objectives:
Students will be able to create and use metaphors to help them understand the basic conditions and processes in a wetland.

Teaching Strategy:
Students compare familiar objects to wetland functions.

Complementary Activities:
Wetland Model.

Materials:
Large pillowcase, bag, or box, sponge, small pillow, egg beater, cradle, sieve or strainer, can of soup, 3" X 5" cards with pictures that show wetland habitat.

(Pictures can be included in the Mystery Metaphor Container that illustrate other important comparisons such as: gardens/food production for animals and people, airports/landing and take-off places for migrating birds, etc.)

Object	Metaphoric Wetland Function
Sponge	absorbs excess water, for example, flooding.
Pillow or Bed	is a resting place, for example, for migratory birds.
Egg Beater	mixes, for example, nutrients and oxygen into fresh and saltwater wetlands.
Cradle	shelters and protects, for example, like a nursery for young fish, insects, mammals, and birds.
Sieve or Strainer	strains, for example, debris and suspended material out of the water.
Can of Soup	provides food.

Procedure
1. Prepare the "Mystery Metaphor Container" (pillowcase, bag or box). Ideally, it should be possible for each student to put his or her hand into the container and pull out an object at least once. Put the container aside to use soon.

2. Read "Dream Journey" to the class or make copies and

have the students read it together in class.

3. Encourage discussion and sharing of wetland functions that the story mentioned. The following may be included:

- Sponge Effect - provides runoff control.
- Filter Effect - takes out silt, toxins, wastes, etc.
- Nutrient Control - absorbs nutrients from fertilizers and other sources that may cause contamination downstream.
- Natural Nursery - provides protection and nourishment for newborn wildlife.
- Habitat - provides a home and/or resting place and food for resident and migratory wildlife populations.

Suggest that these activities and many more that they could probably think of are taking place in wetlands all the time.

4. Discuss with the students how objects can be used to represent wetland functions. Metaphors offer a dramatic way of drawing a comparison. A metaphor gives a vivid image through direct comparison. For example: "Frank is a chip off the old block" or "She's a barrel of laughs."

5. Bring out the "Mystery Metaphor Container" and explain that everything in the container can be a metaphor that relates to the functions of wetlands. Divide the students into groups of four. A representative from each group will draw one object from the container.

6. Groups then work among themselves to discern and describe the relationships between their object and the wetland. Encourage the students to build on each other's ideas.

7. Groups can then present their metaphors to the entire class.

Evaluation:

When each group has presented, ask the students to summarize the major roles that wetlands perform in contributing to a healthy habitat for wildlife. Ask them if their own attitudes about wetlands are different as a result of doing this activity. If yes, how?

Extensions

1. Visit a wetland to verify and discuss the appropriateness of the metaphors explored in the classroom. Identify the most compelling attributes of the metaphors that help you understand the characteristics and nature of the wetland.

2. Expand your understanding of these metaphors. Identify new and appropriate metaphors.

4. Have students write a poem or essay about wetlands using metaphors.

Credits:

Curriculum Connections:

(See Appendix for full citations).

Books:

Lily Pad Pond (Lavies, 1989).

Story: Dream Journey

I am drifting. Surrounded by murky and swirling glittering particles, white, black, and gold. A strong current carries me swiftly downstream. Log ahead! I quickly duck my head to avoid the log, which completely straddles the stream. Now I peer, as through goggles, at the underwater world. A young salmon watches me pass from its safe hiding place under tree roots hanging down from an undercut bank. The brightness is blinding every time I'm tumbled above the water's surface.

My ride is fast. Suddenly, a small dark form hurtles through the water at my head. I recognize the sharp beak of a kingfisher, which swerves when it decides I'm not its fishy dinner.

A large dark shape looms in my path! It's too late to avoid hitting it! I smash into the rock, pushing against it with all my might. I plunge through the rapids between two more boulders. I'm thrust into swirling, angry water. The river rages downward, carrying me prisoner to an unknown fate. The water is brown, a soup of soil and plants ripped from the river's banks. Ahead, I see a huge cottonwood tree, slanting over the river, its roots dangling where the river washed away all the dirt that kept the tree upright and proud. I hear a creaking, then a groan. The tree crashes into the river, barely missing my head. I'm engulfed in a tangled web of leaves and soil as I continue my journey.

The river relaxes. I poke my head cautiously up and see I'm now traveling through a wide valley. The river loops like a snake through a green meadow. I relax, and begin to hear a whispering by the grass-like plants that I am floating through. "Filter…filter… we sedges, filter," hushed voices chant in unison. I notice that the water is no longer brown, but crystal clear. The green wall of sedge plants is stopping the mud and twigs and leaves like a giant filter, letting only clear water through.

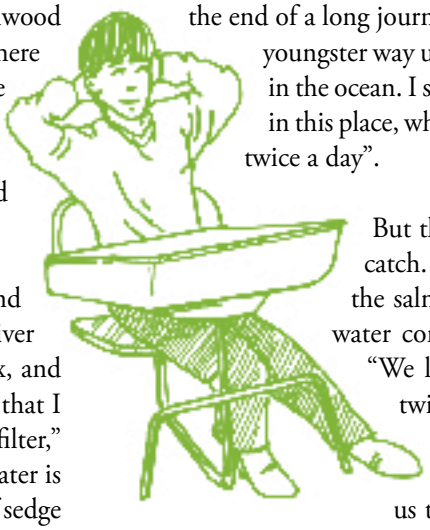
It is a splendid peaceful ride now. Floating on my back, I see an eagle circling high in the sky. I turn to float face down and laugh when I see small silvery fish below scatter when my shadow darkens their world.

I'm thirsty. I take a mouthful of the inviting water. It's salty! I spit it out. Suddenly, I'm thrust into darkness as the water below me disappears. I fall down to the watery horizon and gasp for air, then I'm thrust up in a spout of water. Below in the darkness, I hear a deep, resonant song. "Mixing…mixing! I can just barely make it out, and then a chorus of many voices joins it. Very clearly, I hear "The Time of Mixing Has Come!"

As my eyes adjust to the darkness, I see monstrous creatures with legs and jaws that can pinch and crush. "Mixing… Mixing," chant the crabs. "Mixing, mixing" echo the schools of silvery fish. The feathery tube-like worms wave their see-through arms in celebration.

My movement ceases abruptly. Then, I feel a powerful tug from the direction I have just come. Back and forth, back and forth, I feel like I'm inside a giant washing machine. Faster and faster, then I'm spit out onto a small island surrounded by swirling water.

Now I am fishing, my shimmering line snaking into the currents with each toss. I feel a tug and pull out a large fish.



"I have come to feed you", says the salmon. "I'm at the end of a long journey, which I began as a mere youngster way up this river. I've been far out in the ocean. I spent a wonderful childhood in this place, where the Great Mixing occurs twice a day".

But the fish is not the end of my catch. Another line stretches from the salmon. I pull until out of the water comes a school of small fish. "We live in this place too", they twitter. "It's a nursery for us, where only small fish can go". Big fish can't catch us there. And there are lots of shady places to hide and lots of food. We especially like those crunchy tidbits with lots of legs". The line stretched on and some shiny, many legged creatures are soon hopping about on the bank.

"We live here too!" they say between jumps. "There's lots of green, yummy goo in the water to eat when we're not running away from fish".

I keep tugging and green, slimy masses emerge. "We make food from the air and minerals that are left after things die", bubbles the mass of algae. "Fall means the feast of dead

Dream Journey, CONTINUED

salmon and leaves are delivered to us by the river. But we need one other thing", the clump says mysteriously.

"Now what…?" I say, tugging and tugging. A blazing yellow ball comes up from the depths.

"It … all…starts…with…me," the blazing sun states ponderously. "I am the source for all that lives in this place".

"The Source… the Source!" chant the creatures on the bank, flopping about in their tangled web of connections.

The line winds on past the ball. I tug and see that it is connected to the whispering sedges. "We love wet places", they chorus. "Life is wonderful, except for-"

"Complaints, complaints," mutters a large goose flying overhead. I give the line a hard tug and the bird is pulled out of the sky. "Just because my friends and I stop here on our way north, and just love to munch on tender young green sedges. Such a restful place after all that flying," says the goose as it tumbles down.

Despite the warm ball blazing at my feet, the sky seems to darken. I look up and see a large dark shape gliding, and then swooping toward the feast on the bank. A crunching sound sends sharp pains jolting through my shoulder. Strong talons pierce my flesh and dig in, tugging my web of connected things and me skyward.

"Terry will now tell us about the functions of wetland", a loud voice booms into my right ear. My eyes jolt open, and I jump, but my shoulder is held fast by Mrs. Fitch who is jerking me upright from my nap".

"Uh, kind of like a mixer. Or, uh, a washing machine", I say groggily, emerging from the dream of Great Mixing. "…And a filter". The class was laughing, but I kept on dreamily. "Lots of food for different kinds of things. And, Uh, … all tangled up like, uh,… a fish net".. I am awake now, and everyone in the class is laughing.

My teacher lets go of my shoulder. Her face has a funny look on it. "Actually, Terry's right in a way," she says finally. "Wetlands do function like mixers. In estuaries, places where the river meets the sea, soil and dead plants and animals get mixed with what's being brought in and out by the tides. And that means lots of food for all kinds of organisms, food that gets moved around kind of like in a washing machine. The wetland plants strain out the silt that comes downstream and, sometimes, pollution too. And we've just been talking about a food web". She still looks suspicious.

She points at the board. I see the fishing lines of my dream connecting a salmon with a school of herring with some many-legged creatures named copepods to algae, to sedges,

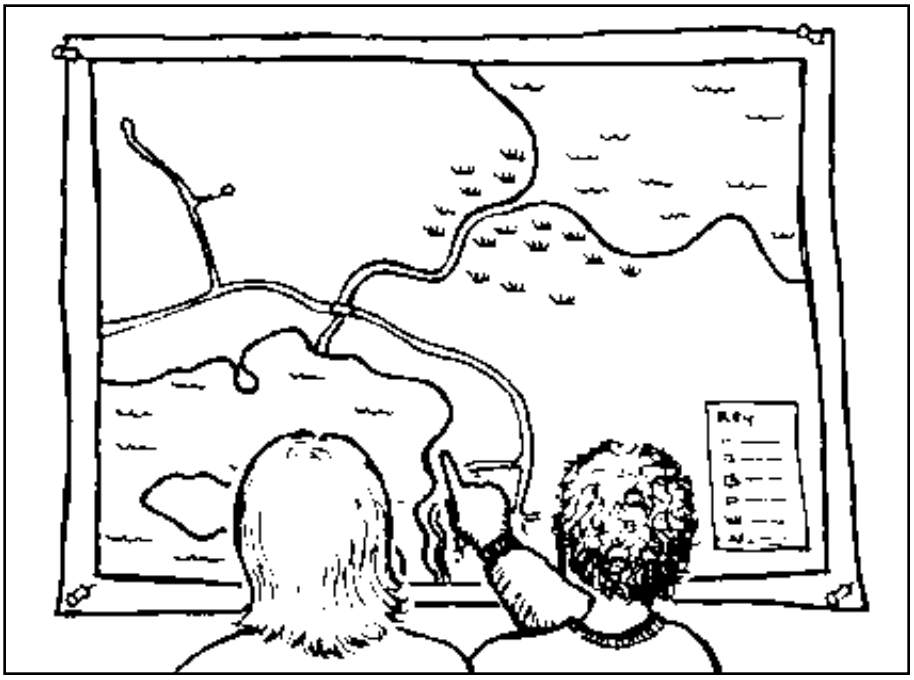
to a goose, and the eagle of the grasping talons. The sun is up there too, as the source of energy for all plants. "A WETLAND FOOD WEB" is written in big letters.

I smile proudly like I have been paying attention all along.

"Wetlands have one other important function", Mrs. Fitch says. She looks at me expectantly, but my mind is now a blank. "Kind of like Terry's desk", she adds. Birds use them to rest from long journeys".

The other kids laugh. They all know I have been asleep once again at my desk. But I don't care. I've had a wonderful trip to a mysterious world.

Locating Local Wetlands



Section 1
Wetland Activities
WHAT IS A WETLAND?

Grade: 4 – 8

State Standards: Geography A-1, A-5, E-3, E-5; Science C-1, C-2, C-3.

Subjects: geography, social studies

Skills: map reading, classification, observation, analysis

Duration: one to two class sessions

Group Size: 2 - 4

Setting: classroom

Vocabulary: aerial, infrared, topographic

Topics: wetlands, maps, human impacts on habitat

Objectives:

Students will:

1. Locate local wetlands.

2. Explore the relationship of wetlands to other features of the land.

3. Explore the interrelationships of wetlands and human uses of wetlands.

Teaching Strategy:

Students will locate wetlands on maps and aerial photographs and make interpretations by filling out a worksheet.

Complementary Activities:

Wetland Exchange

Background:

See INSIGHTS Section 1 *Wetland Ecosystems, "What is a Wetland", "Profiles of Alaska's Wetlands"*, and Section 3 *Wetlands in a Changing World "Disturbance of Wetlands"* fact sheets.

Materials:

Topographic maps, aerial photographs (color infrared, if available) and/or wetland maps of your local area or a nearby area with wetlands. You may elect to use the maps provided in the activity "Wetland Exchange". Information on ordering aerial photographs and wetland maps is given at the end of this activity. Your students may also enjoy doing this activity using Google Earth.

Procedure:

1. Review the five types of wetlands in Alaska – coastal, riparian wetlands, freshwater marshes, peatlands and tundra. Discuss with the students what types of wetlands occur in your local area.

2. Have them research the meanings of: **aerial**, **infrared**, and **topographic**.

3. Divide the class into small groups and give each one a topographic map, an aerial photograph, and/or a wetlands map. Give each student a Locating a Wetland Worksheet (at the end of this activity).

4. Give the groups time to try to locate wetlands on their

topo maps and photographs, comparing the same areas on both maps.

5. Pause the groups and ask them if they discovered the wetland map symbols shown or described. Share tips on how to locate wetlands on aerial photographs. On black and white photographs, any standing water will appear dark. Water will appear dark blue or black on color infrared photographs, and may be brownish around rivers and lakes. You can "ground truth" photographs by looking at a lake, pond, or stream that you already know exists, and seeing how it appears on the photographs.

6. Have the students complete the worksheets. When they are completed, review them together. The following questions may help guide your discussion.

1. Could you determine what kind of wetland you were looking at just by its location?
2. Was it easier to locate wetlands on the topo map or on the aerial photos? Why?
3. Were any of the wetland you looked at close to human activities? If so, could part of the wetland have been filled in? What makes you think so? (Look for wetland areas whose boundaries are straight lines, which may indicate that part of the wetland has been filled in along a survey line, property boundary, drainage ditch, railroad grade, aiport runway, or road bed.)
4. Follow watercourses in the photos. Can you find examples where water has been diverted from the wetland by a ditch or other structure? Can you see areas where discharges of treated wastewater or other types of discharges are occurring? Are there changes in the color of water in streams, for example where a glacial stream enters a clearwater stream?
5. Locate settlements, fish camps, or special use areas. Which areas in the future are most likely to be settled? Give your reasons based on present situations.
6. What natural resources (minerals, timber, oil, and gas) are found in your map and photo areas? Will use of these resources affect local wetlands?
7. Have areas with low elevations been filled or used for buildings, roads, or 4-wheeler trails? Do you think these may have been wetland areas at some time? How could you find out?
8. Some Interior Alaskan villages have been moved because of changes in the flow of rivers; examples include Tanana, Nenana, and Ruby. Find these villages if they are on your map. Valdez was moved following the 1964 earthquake and resulting tsunami. What part do you think low-elevation and wetland areas played in the selection of a new site for these towns and villages?
9. Does the map show permafrost areas? A large portion of Alaska is underlain with permafrost. What is the effect of frozen ground on water flow and runoff from rain and melted snow?
10. Brainstorm about the animals and plants that would be found in your local wetland.

Curriculum Connections:

(See Appendix for full citations)

Books:

Maps and Mapping (Chancellor, 2004).

Wetlands (Moore, 2006).

Wetlands in Danger: A World Conservation Atlas. (Dugan, 1993).

Websites:

Google Earth http://earth.google.com/ allows viewers to look at satellite images of anywhere in Alaska. (Free).

How to Order Aerial Photographs

Write or call the National Cartographic Information Center, Geological Survey, USDI, 4230 University Drive, Anchorage, AK 99508-4664 (271-4159), or the Remote Sensing Data Center, Geophysical Institute, UAF, Fairbanks, AK 99775-0800 (474-7558).

Send for information on ordering aerial photographs. You will need to know the geographic coordinates of the area, or send in a USGS topographic map with the area indicated. Standard print sizes are 9" X 9" with a variety of enlargements available. Preferences for black and white, color, or color-infrared (best for distinguishing vegetation and water differences), for viewing specific features, for time of year, and for high or low altitude photography can be specified. If you live in Fairbanks or Anchorage you

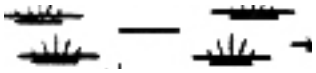
can go to the photo libraries in each agency and preview photos for ordering.

How to Order Wetland Maps

Contact the National Wetlands Inventory Program (NWIP) - U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99503 (786-3403), for copies of detailed wetland maps at the same scale as USGS topographic maps (available for most urban and many other areas of Alaska). NWIP can also provide wetland plant lists and information on wetland functions and values.

WORKSHEET: LOCATING LOCAL WETLANDS

Streams, lakes, and ponds are shown in blue on topographic maps. Here are samples of symbols used on topographic maps to identify wetland areas.

Marsh 

Intermittent Lake 

Aerial photography provides a bird's eye view of the land and water. Lakes, streams, and marshy areas with standing water are easily identifiable as are buildings, roads, and other structures. Infrared aerial photography uses a special kind of film. Areas with water generally appear black or a dark shade of blue on the infrared photos and darker than other areas on both color and black-and-white aerial photos because less light is being reflected back to the camera where there is water on the ground. However, substances in the water, such as glacial or human-caused silt discharge can increase reflection and the water will appear lighter and may even be whitish.

Using the map and the photograph and your knowledge of the area, answer the following questions:

1. Which of the five different types of Alaska wetlands (Coastal, Riparian, Freshwater Marshes, Tundra, and Peatlands) did you find on your maps?

   What clues did you use to find them?

2. Are all the wetlands found in only one area of the map?

3. Are all the wetlands found close to a major source of water?

4. During what season was the aerial photo taken?

   What clues did you use to decide the season?

5. What is the range of elevation of the wetland areas on your map?

6. Find other areas of similar elevation on the map. If the areas of similar elevation are not wetlands, have they been developed?

   Could they have been wetlands at one time?

   If so, what other clues besides elevation led you to that decision?

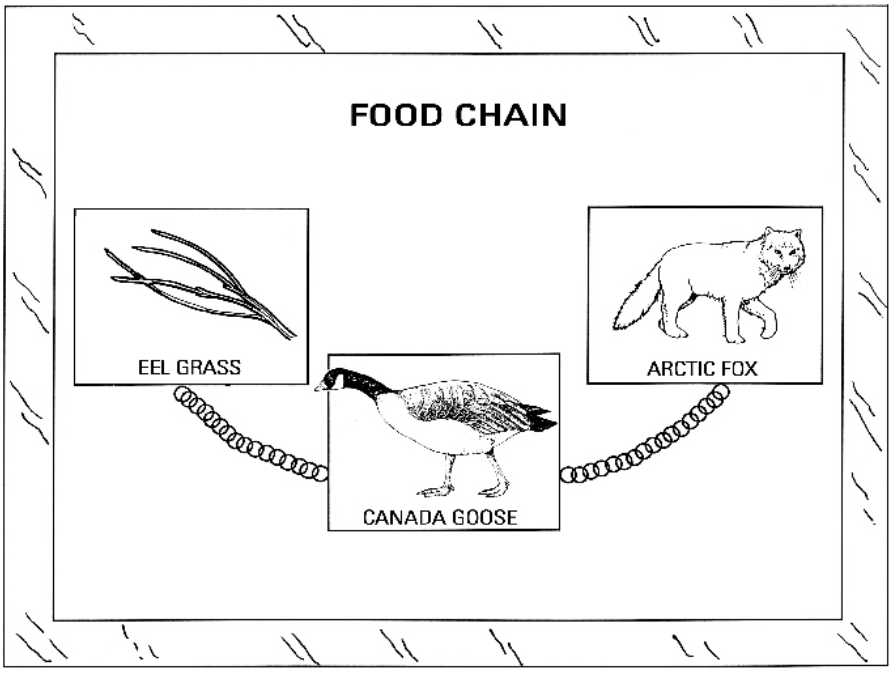
7. How have wetland areas been used in your own community?

8. Have any wetlands near your community been changed by human use or development?

9. Have any wetlands near your community been set aside or protected?

I'm Not Mean, Just Hungry!

ECOLOGY CARDS OPTIONAL



Section 2
Wetland Activities
WETLAND ECOLOGY

Grade: 2 - 5

State Standard: Geography C-1; Science C-2, C-3
NGSS: 2-LS4-1., 5-LS2-1.

Subjects: science, art

Skills: cutting, drawing, analysis, group, cooperation, synthesis

Duration: one to two class sessions

Group size: 3 - 4

Setting: classroom

Vocabulary: food chain, predator, prey

Objectives:

Students will understand that wetland animals depend on each other for food by putting a simple food chain in order.

Teaching Strategy:

Students place four cards with pictures of wetland organisms in food chain order.

Complementary Activities:

Energy Flow in an Alaskan Wetland

Background

See INSIGHTS: Section 3. *Wetland Inhabitants.*

Materials:

For each group: Food Chain Sheet, scissors, markers or crayons. OPTIONAL: Use Ecology Cards showing the appropriate organisms instead of the following food chain sheet.

Procedure:

1. Ask students what they ate for lunch or supper. What kinds of plants and animals do we depend on for food? Using a food example from a student response, choose students to role-play a simple food chain. One example using salmon might be to have several students pretend to be a school of herring, have another student pretend to be a salmon catching and eating one of the herring and another student fishing and catching the salmon. Tell students that they will be learning about wetland animals that depend on each other for food.

2. Divide students into groups of 3-4 and give each group one Food Chain Sheet. Have the students color and cut the sheet into cards. When their cards are colored, have the students put the four cards in order of who eats whom. Groups may come up with more than one answer. Make sure groups can justify their reasoning.

3. Groups can then trade card sets with the others, until each group has had a chance to put all four sets in order.

4. Discuss what might happen if one of the links in the chain becomes missing. *Organisms can sometimes find some other similar species to take the place of the missing organism, but that usually creates extra pressures on that organism.*

Food Chain Answers

Algae is eaten by
Tadpoles who are eaten by
Sandhill Cranes who are eaten by
Mosquitoes

Eel grass is eaten by
Geese who are eaten by
Arctic Fox

Algae is eaten by
Caddisfllies who are eaten by
Arctic grayling who are eaten by
People.

Sedge is eaten by
Lemmings who are eaten by
Mink who are eaten by
Snowy Owls.

Arrow grass is eaten by
Midges who are eaten by
Pintails who are eaten by
Mink.

5. Discuss student feelings about animals killing and eating other animals. Are animals mean when they kill other animals?

Evaluation

Give each student an ecology card. Ask them to draw an organism that might be a food source for the organism depicted on the card, and an animal that might eat the organism depicted on the card.

Credits

Title "I'm Not Mean, Just Hungry" from a song by Billy B.

Curriculum Connections:

(See Appendix for full citations)

Books:

Food Chains (Silverstein, 1998)

The Hunt for Food (Ganeri, 1997)

The Magic School Bus Gets Eaten: A Book About Food Chains (Relf, 1996)

What Are Food Chains and Webs? (Kalman and Langille 1998)

Who Eats What? (Lauber, 1995)

Media:

All Things are Connected (Video) (North Carolina Wildlife Commission)

Into the Forest, Nature's Food Chain Game. (Card game) (Ampersand Press)

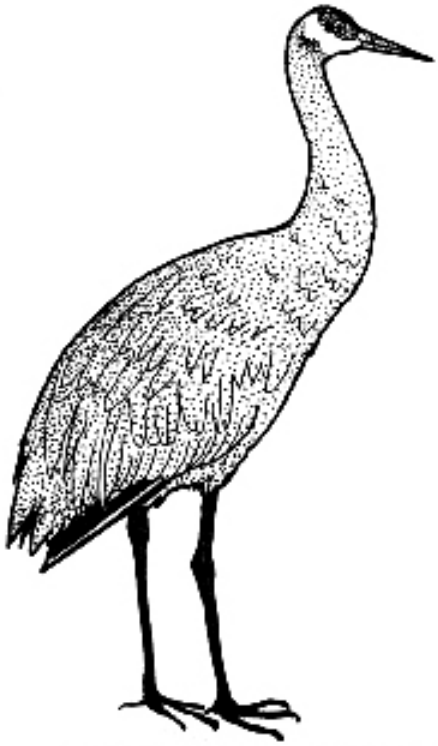
The Magic School Bus Gets Eaten (Video).

Extensions

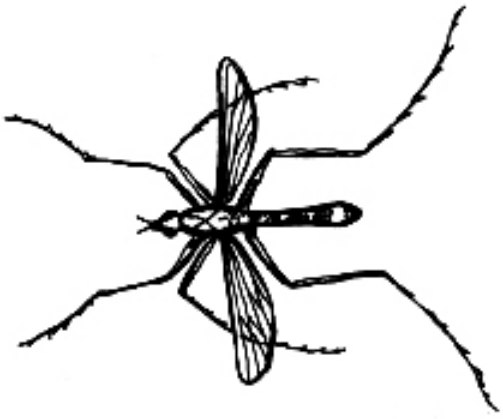
Create a bulletin board using food chain examples. Have students make paper chains to connect the different links.

CUT ALONG
DASHED LINE

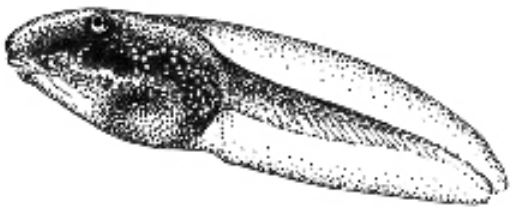
FOOD CHAIN



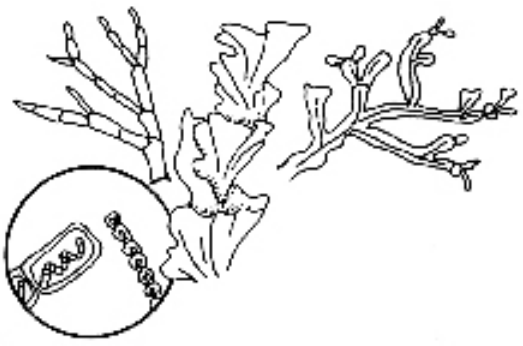
SANDHILL CRANE



MOSQUITO



TADPOLE



ALGAE

CUT ALONG
DASHED LINE

FOOD CHAIN

LEMMING

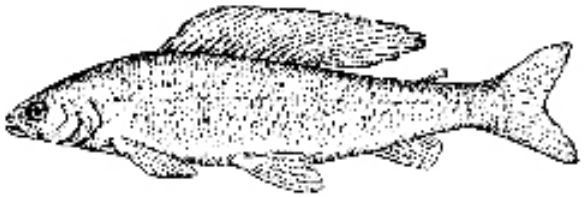
SNOWY OWL

SEDGE

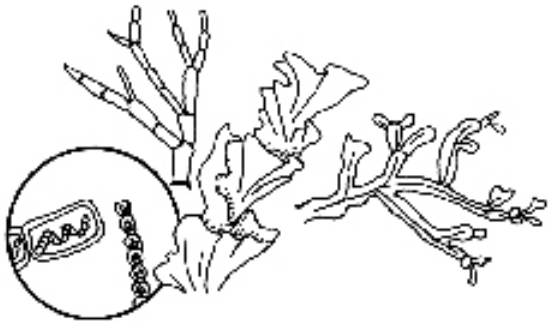
MINK

CUT ALONG
DASHED LINE

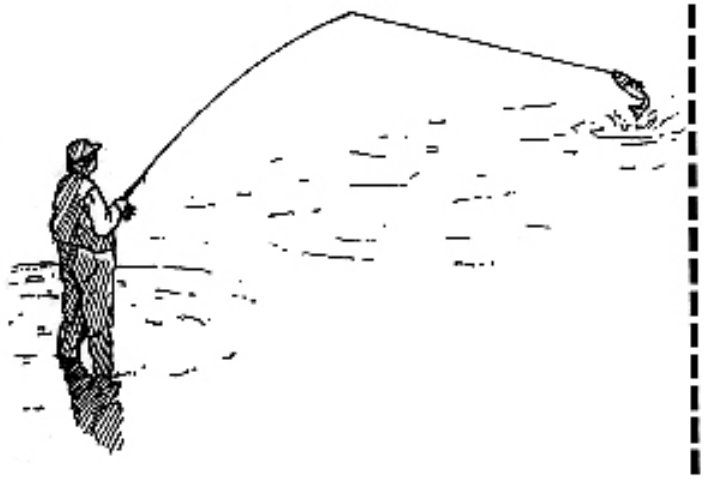
FOOD CHAIN



ARCTIC GRAYLING



ALGAE



PERSON

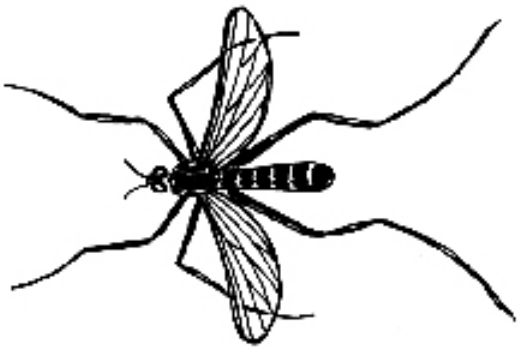
CADDISFLY

CUT ALONG
DASHED LINE

FOOD CHAIN

PINTAIL DUCK

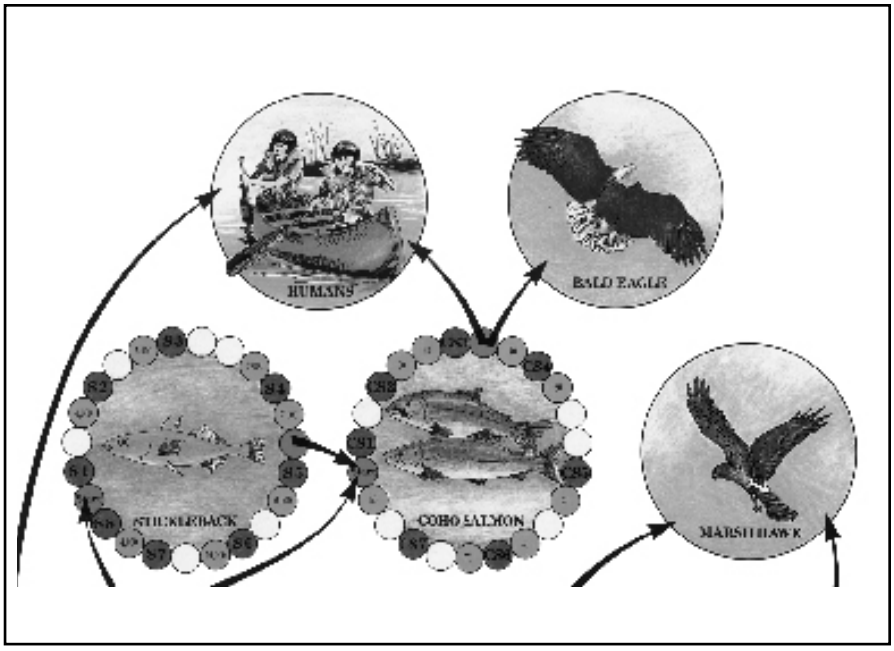
MINK



MIDGE

ARROW GRASS

Energy Flow in an Alaska Wetland ALASKA'S ECOLOGY CARDS REQUIRED



Section 2
Wetland Activities
WETLAND ECOLOGY

Grade: 7 - 12
State Standard: Math A-1a; A-3
NGSS: MS-LS1-6. ,MS-LS2-1. MS-LS2-2,MS-LS2-4,MS-ESS3-4. HS- LS2-2, HS-LS2-3.,HS-LS2-4
Subjects: science, math

Skills: analysis, classification, computation, inference

Duration: two class sessions

Group Size: small groups (2 - 6 can play the game)

Setting: indoors

Vocabulary: food chain, food web, producers, consumers, herbivores, carnivores, decomposers, detritivores, photosynthesis, energy

Objectives:
Students will construct wetland food webs and trace energy flow through the system.

Teaching Strategy:
Students will play a board game illustrating energy flow.

Complementary Activities:
Energy Flow in an Alaskan Wetland

Background
See INSIGHTS: Section 1 Wetland Ecosystems *"Profiles of Alaska's Wetlands"* fact sheet, and Section 3 Wetland Inhabitants fact sheets.

Materials:
For each group: Energy Flow in an Alaska Wetland board game, Energy Flow in an Alaska Wetland game rules and Energy Use Charts (see following pages), one die, markers, scratch paper or calculator, Selected Ecology Cards listed below.

Procedure:
1. Post the Energy Flow in an Alaska Wetland board game where the students can see it as you introduce the game.

2. Discuss the concepts of producers, consumers, herbivores, carnivores, omnivores, detritivores, and decomposers. Have the students identify which of the plants and animals on the poster fit into each category.

3. Discuss with the students how organisms at each stage of the wetland food chain are able to store only 10% of the energy available. *Animals are generally not efficient at eating all the food available to them. If they were, plants would soon be scarce, and animals more scarce! Animals must use energy when they move, sense and respond to the environment, grow, and reproduce. Also, not all of the food consumed can be digested and stored; some is excreted as waste products.*

4. Discuss with the students how even though the energy is not used, it is not wasted. *The energy that is not captured by plants remains in the form of light and heat, but it is mostly lost to the living system. Some of the energy lost as waste products in each link of the chain can be used by detritivores and plants. Many plants and animals die without being eaten, but this*

stored energy is also recycled by the decomposers. Wetland food webs often have much more energy flowing through the detrital food chains and webs than through the webs composed of producers and consumers. Still, the energy stored in the living system constantly decreases and much cannot be recaptured.

5. Discuss how these energy facts at each link of the food chain limit the number of living things that can exist. *Carnivores are less numerous than herbivores, etc.*

6. Divide the class into four groups and distribute the Ecology Cards, as follows:

Group #1: Freshwater marsh: bacteria, green algae, water smartweed, water flea, mosquito, dragonfly, wood frog, sandhill crane, grayling, arctic fox, human

Group #2: Bog: bacteria, sedge, black spruce, sphagnum moss, muskrat, mosquito, bladderwort, little brown bat, human

Group #3: Riparian wetland: black fly larvae, willows, moose, horsetails, Eskimo potato, springtails, shrews, wolverine, wolf, brown bear, human

Group #4: Coastal wetland: amphipod, bacteria, eelgrass, arrowgrasses, black brant, Canada goose, bald eagle, pink salmon, brown bear, human

7. Have students in each group take turns reading aloud the portions of their card "Food" and "Eaten by." The group will then work together to diagram the food chain connections among the organisms. Post these diagrams next to the posted board game.

8. Play the "Energy Flow in an Alaska Wetland" game. Rules are on the following page. For large classes, small groups can each represent one player and be responsible for making the calculations for each move.

Evaluation

After playing the game, discuss the following:

1. In your own words, tell what a food web is.
2. What happens to most of the sun's energy that reaches a wetland?
3. Tell why or why not you agree or disagree with the statement: "A wetland is not a productive area because so much energy is wasted in the food web."
4. How can you explain the fact that organisms at the end of the food chain get the least amount of energy? Doesn't that mean that they are all going to starve to death?

Curriculum Connections:

(See Appendix for full citations)

Books:

Wetlands (Moore, 2006).

Extensions

1. Students write a short story from the viewpoint of a unit of energy moving through a wetland food web.

2. Students research ecology books to determine if other types of ecosystems (for example, forests, grasslands, savannahs, oceans) do a "better job" than wetlands of capturing and storing the sun's energy. (Consider this: can producers capture more than 3 percent and consumers store more than 10%?) They can also research comparisons between colder areas nearer the poles and warmer areas nearer the equator.

Energy Flow in an Alaska Wetland
GAME RULES

The winner of this game is the one who gets to the top of the food chain (where he or she is eaten by the marsh hawk, bald eagle, or human being) with the greatest number of calories left.

A player can quickly exhaust the calories allotted as he or she meets calorie-consuming situations and events in the lives of organisms on the food chain. Merely staying alive uses up energy (in the form of respiration).

The game has been designed to illustrate the complexity of a wetland ecosystem, the interdependence of living things, and the importance of the sun's energy in making the ecosystem work. The calorie counts for a given situation are estimates and have been calculated to make events in the game as realistic as possible. However, they should not be considered complete and accurate measures of all energy consumed.

The materials you will need for this game are:
1. The Energy Flow in an Alaska Wetland Poster Game
2. The Energy Use Charts
3. A die

Here are the rules for the game:

1. Two to six can play at once.

2. Each player places a marker on the sun and starts the game with solar energy equal to 10,000,000 calories.

3. Players move in turn on the throw of a die. Each player follows a sunbeam to a plant (orange start circle).

4. When moving from the sun to a plant, players lose 97 percent of their energy, so they must subtract 9,700,000 calories from the 10,000,000 with which they started the game. Players are thus left with 300,000 calories, or 3 percent of their initial energy.

5. Players advance through the food web with each roll of the die, moving as many spaces as the die indicates.

6. Players landing on green spaces must pay the respiration tax indicated on the circle. For example, if a player with 150,000 calories lands on a green space marked 15,000, the player must give up 15,000 calories. The player would then have 135,000 calories remaining.

7. When a player lands on a tan space, he or she must check the Energy Use Chart to find out what energy-consuming event has occurred and how many calories it has used. For example, CT 1 (meaning cattail space #1 on the chart) reads "fungus infection on leaves, use 100,000 calories". This means that the organism has contracted a fungus infection, and any player landing on CT 1 must subtract 100,000 calories from his or her supply.

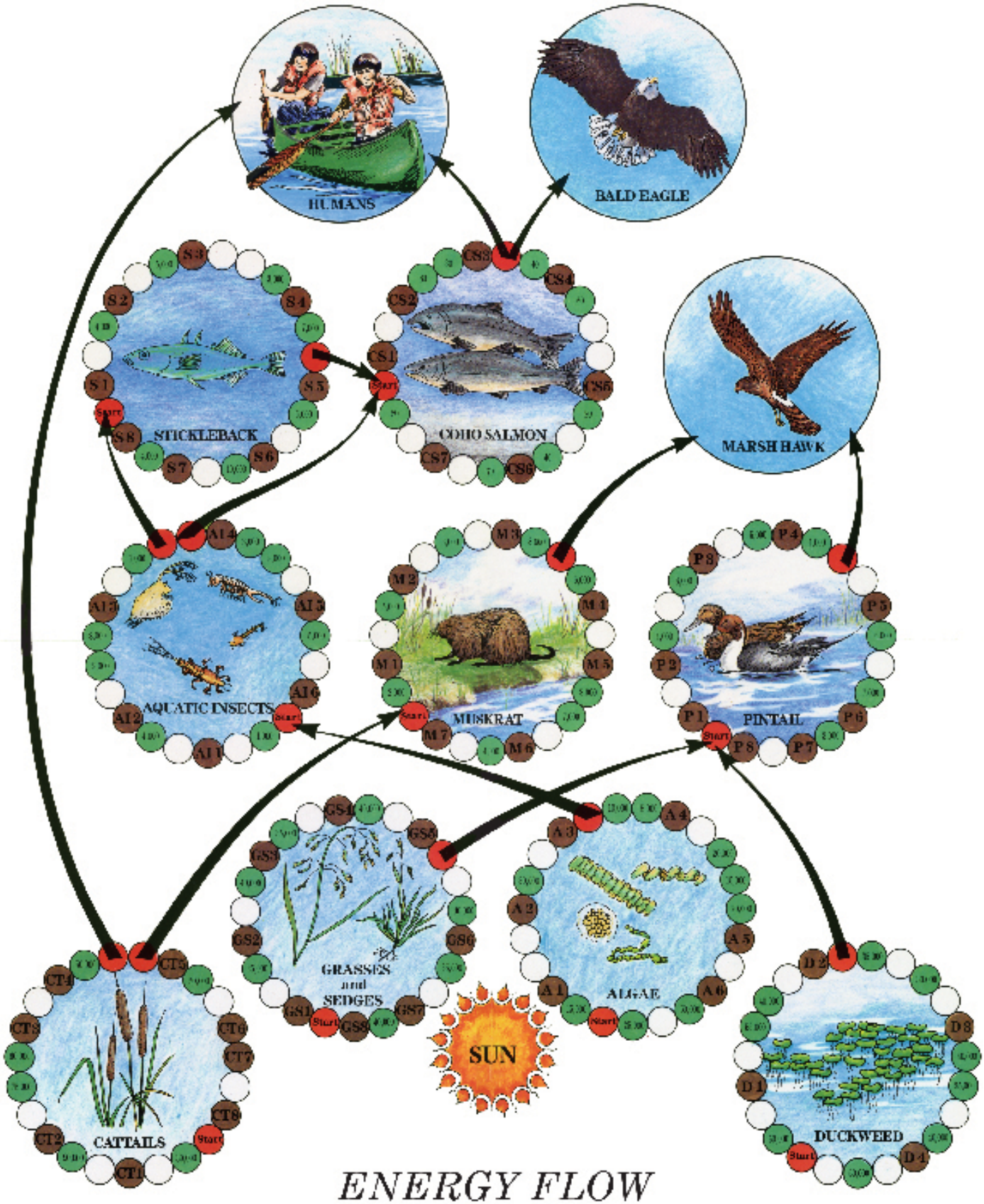
8. When a player lands on a white space, no calories are lost.

9. When a player lands on an orange space, which allows him or her to move from one organism to another, the player becomes food for the new organism. Whenever that happens, 90% of the players remaining calories must be surrendered. (A player keeps 10%). Percentages can be figured on the scratch paper or with a calculator.

10. Players enter a new organism on its start orange circle. A player must stop on the circle; give up the 90% described in Rule 9, and wait until the next turn before advancing through the organism.

11. A player who uses all of his or her calories before reaching the top of the food chain (the marsh hawk, bald eagle, or human being) has burned out and is no longer in the game.

12. The player reaching the marsh hawk, bald eagle, or the human being with the most calories remaining is the winner. If every player burns out, there is no winner.

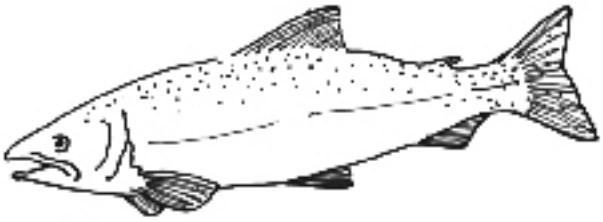


ENERGY FLOW
in an Alaska wetland

Energy Use Chart

Stickleback

S 1	Courtship ceremony. Use 800 calories.
S 2	Migrate by stream to lake. Use 600 calories.
S 3	Develop infection of scales. Use 500 calories.
S 4	Produce eggs. Use 850 calories.
S 5	Population explosion. Heavy competition for food. Use 500 calories.
S 6	Fin torn. Repair tissue. Use 600 calories.
S 7	Hot spell increases water temperature. Metabolism increases. Use 400 calories.
S 8	Narrowly escapes attack by coho salmon by swimming rapidly. Use 800 calories.



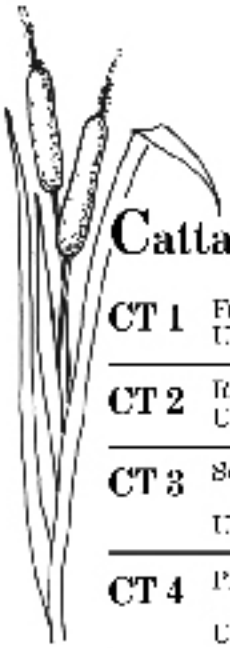
Coho Salmon

CS 1	Gill disease. Use 86 calories.
CS 2	Chase other males from territory. Use 60 calories.
CS 3	Migrate upstream. Use 100 calories.
CS 4	Hooked by fisherman but broke his line. Use 10 calories.
CS 5	Swim up wrong tributary stream. must return. Use 50 calories.
CS 6	Chased by beaver boat. Use 40 calories.
CS 7	Stressed by crowding during migration. Use 40 calories.

Aquatic Insects

AI 1	Grow new exoskeleton. Use 5,000 calories.
AI 2	Bacterial disease. Use 3,000 calories.
AI 3	Change into adult insect. Use 2,500 calories.
AI 4	Repair wounds to body. Use 2,000 calories.
AI 5	Chased by stickleback. Use 1,500 calories.
AI 6	Time to lay eggs. Use 3,500 calories.

Energy Use Chart



Cattail

CT 1	Fungus infection on leaves. Use 100,000 calories.
CT 2	Replant tissues eaten by moose. Use 80,000 calories.
CT 3	Seawater floods marsh destroying much tissue. Use 60,000 calories.
CT 4	Produce new plants by underground buds. Use 50,000 calories.
CT 5	Humans gather underground stems for food, throwing away leaves and flowers. Use 40,000 calories.
CT 6	Chemicals seep into marsh causing abnormal growth. Use 25,000 calories.
CT 7	Spring fire damages new growth. Use 10,000 calories.
CT 8	Burrowing mammal destroy roots. Use 50,000 calories.

Grasses and Sedges

GS 1	Drought dries out ground around roots. Use 26,000 calories.
GS 2	Produce seeds. Use 30,000 calories.
GS 3	Partially covered by road construction. Use 36,000 calories.
GS 4	Shaded by taller growing cattails. Use 20,000 calories.
GS 5	Storm floods marsh and covers leaves with water. Use 26,000 calories.
GS 6	Fungus disease. Use 30,000 calories.
GS 7	Underground stems trampled by animal trail. Use 30,000 calories.
GS 8	Leaves used to build duck's nest. Use 26,000 calories.

Duckweed

D 1	Fertilizers seep into marsh causing abnormal growth. Use 50,000 calories.
D 2	Shaded by shrub. Use 30,000 calories.
D 3	Attacked by fungus. Use 25,000 calories.
D 4	Repair damaged tissue shredded by propeller. Use 20,000 calories.

Algae

A 1	It's time to reproduce. Use 40,000 calories.
A 2	Repair tissue damage caused by storm. Use 30,000 calories.
A 3	Mold grows into tissues and takes food. Use 20,000 calories.
A 4	Sewage spill stimulates abnormal growth. Use 10,000 calories.
A 5	Viral infection. Use 40,000 calories.
A 6	Water hormones drop. Grow longer branches. Use 60,000 calories.

Energy Use Chart

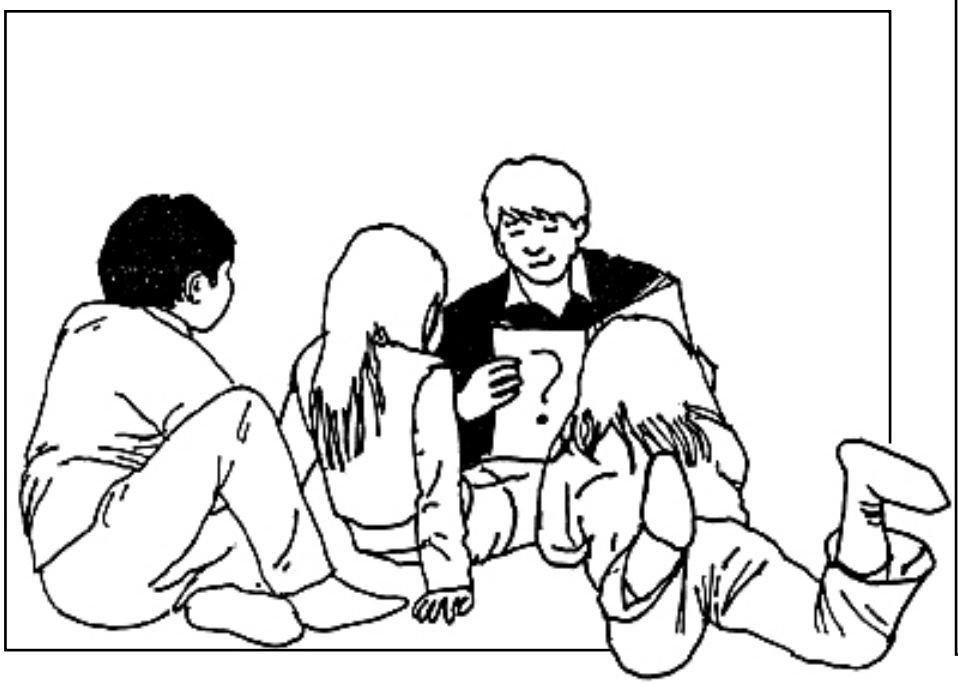
Muskrat

M 1.	Produce and nurse two offspring. Use 7,000 calories.
M 2	Shed winter coat. Use 7,000 calories.
M 3	Grow winter coat. Use 6,000 calories.
M 4	Build house on bank of stream. Use 5,000 calories.
M 5	Attacked by marsh hawk. Dive and swim to safety. Use 5,000 calories.
M 6	Population explosion. Battle for territory. Use 3,000 calories.
M 7	Late summer fire destroys habitat. Move to new location. Use 3,000 calories.

Pintail

P 1	Habitat destroyed. Migrate 100 miles. Use 3,500 calories.
P 2	Viral infection with high fever. Use 2,500 calories.
P 3	Replace lost feathers. Use 2,000 calories.
P 4	Overpopulation. Heavy competition for food. Use 7,000 calories.
P 5	Build nest. Use 6,000 calories.
P 6	Courtship ceremony. Use 5,500 calories.
P 7	Search for new food supply. Use 5,000 calories.
P 8	Predator attack. Defend nest. Use 5,500 calories.

Wetland Ecology Puzzlers



Section 2
Wetland Activities
WETLAND ECOLOGY

Grade: 6 - 12

State Standard: English/LA B-1, B-2, B-3; Geography C-1;
NGSS: MS-LS1-4, MS-LS2-1. MS-LS2-4.,MS-ESS3-4
HS- LS2-2,
Subjects: science, social studies

Skills: data analysis, inference, problem-solving

Duration: one class session

Group Size: individuals or small groups

Setting: classroom

Vocabulary: ecology, limiting factors, carnivorous

Objectives:
Students will recognize that human activities can have far-reaching effects on wildlife.

Teaching Strategy:
Students will use information in the Ecology Puzzlers to make conclusions about how, through ecological connections, certain human activities can have long-lasting effects on ecosystems.

Materials:
Copies of Ecological Puzzler sheets (without the solutions!) on following pages.

Procedure:
1. Photocopy the puzzlers so each student can have a copy of one puzzler. Students may work in groups (all with the same puzzle) or individually.

2. After handing out the puzzlers, explain that students are to use the facts provided on the study sheet to figure out the answer to the puzzle. To solve each puzzle, students will need to read each puzzle carefully, look for connections in the information, and apply their knowledge of ecology.

3. Review each puzzler with the class. Have those who worked on each puzzler explain the puzzler and the solution or prediction at which they have arrived based on the facts provided. Have the class discuss the puzzler, then read the solution or prediction of the scientists.

Have students describe why scientists are often unable or unwilling to precisely predict the effects of human activities on ecosystems.

Curriculum Connections:
(See Appendix for full citations)

Books:
The Beaver (Ryden, 1986).

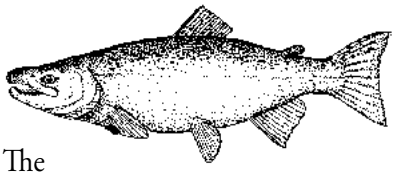
The Beaver (Nentyl, 1983).

Insectivorous Plants (Darwin 1893).

ECOLOGY PUZZLER #1

Dammed Ponds

THE FACTS:



More Coho salmon adults spawn, and more fry rear in streams where beavers have made ponds and dams than in streams where there is no beaver activity. The Coho salmon are found in the ponds as well as downstream from the ponds.

Streams and riparian wetlands with beaver activity also have more waterfowl than streams without beavers.

Beaver dams provide beavers with good habitat for their lodges where predators cannot get them.

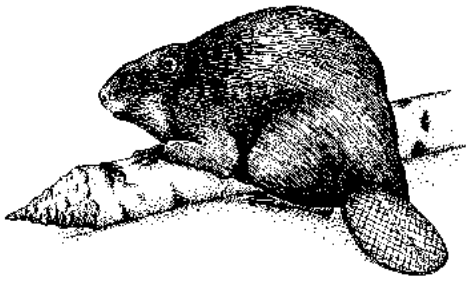
The dams also slow down the movement of water, slowing erosion and trapping sediment. Water below the dams often runs clear as a result. Streams with no beaver activity are often laden with more silt and mud.

Alaska's Coho salmon spend 1-2 years in freshwater streams before they head out to sea. When they return to spawn, they choose rocky or gravelly areas to deposit their eggs. Any sediment that settles out of a stream afterwards can smother and kill the eggs. Coho salmon fry then prefer to winter in deep pools.

Beavers build their dams and lodges using tree branches, bark, and woody plants. Once placed in the stream the plant material decomposes slowly.

THE PUZZLE:

Why may fish and waterfowl be more productive in streams with beaver activity than in streams with no beavers?



ECOLOGY PUZZLER #2

Mummies in the Bogs

THE FACTS:

A dead man was excavated from a bog in Manchester, England. The corpse showed relatively few signs of decay; the face and body were well preserved. The skin was dark-brown and felt like leather that had been tanned. Hair, nails, and teeth were all stained brown as well. The bones had not decayed, but were shrunken and hollow. The teeth remained, but their enamel was gone. Most surprising of all, even the stomach content had not decayed. Scientists could recognize the food to be cake. They could even tell that the cake had been burnt!

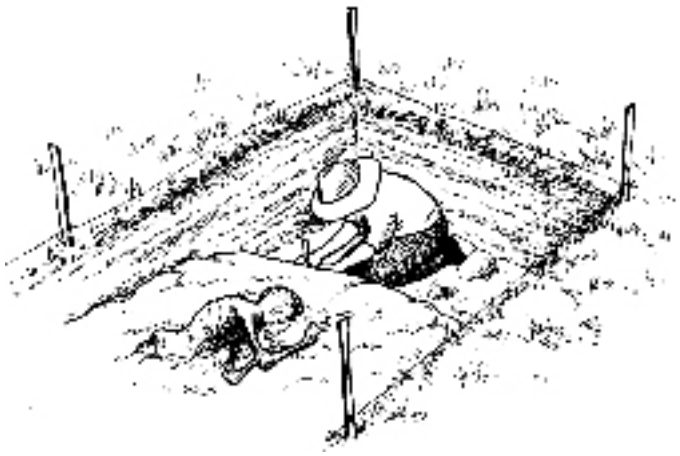
When the scientists analyzed tissue from the corpse, they found out the man had been dead for 2,000 years.

Several bodies have been found in a wetland in Florida. Scientists used aging techniques to determine that the bodies were from 5,000 B.C. Shrunken brains were still in the corpses, and the DNA was still in intact enough for scientists to be able to analyze it. The Florida bodies were all found in one place and were in a flexed position. They appeared to have been placed in a foot-deep pond at death. The bodies were wrapped in grass mats and covered with peat and wood.

Over 2,000 corpses have also been found in bogs in Europe. All the bodies had been preserved in a similar way to the Florida bodies. A 2200-year-old corpse found in a bog in Denmark had a noose around its neck.

THE PUZZLE:

Why are corpses in bogs so well preserved?
Why have so many bodies been found in bogs in Europe?



ECOLOGY PUZZLER #3

Chowing Down in a Wetland

THE FACTS:

Three types of plants that live in Alaska's peatlands have an interesting habit. The sundews, butterworts, and bladderworts are insectivores. They trap and digest insects in a variety of ways.

The leaves of insectivorous plants are very small and some are very pale green.

Most plants make their own food by photosynthesis - using the energy of the sun, water, and minerals from the soil, and carbon dioxide from the air to produce their own food.

Plants that carry on photosynthesis have chlorophyll in their leaves. Chlorophyll is a pigment that reacts to sunlight, and that gives plants their green color.

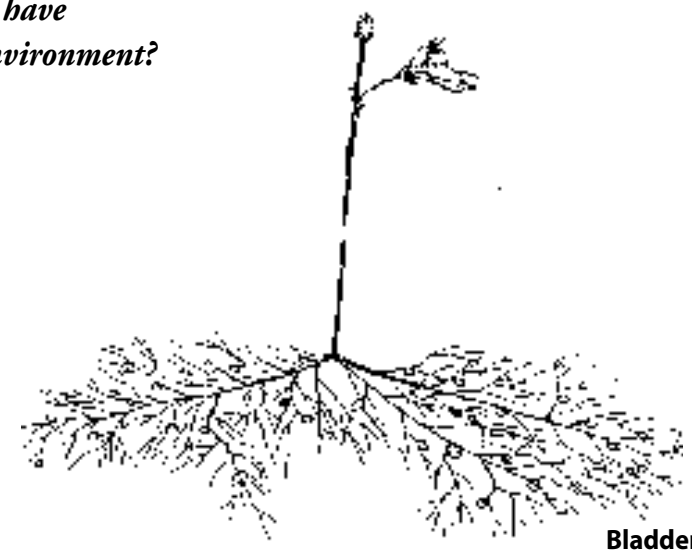
Bacteria and fungi are decomposer organisms that can break down dead material into minerals that are essential to plants for carrying on photosynthesis. This process of decomposition occurs very slowly when the temperature and available oxygen in the soil is low, and when acidity is high.

Insectivorous plants grow in open places where they are not shaded by taller plants or trees.

Peatland soils are often very acidic. Often there is also very little oxygen available in the soil.

THE PUZZLE:

Why are these plants insectivorous?
What advantage might they have
over other plants in a bog environment?



Bladderwort

DAMMED PONDS

The Solution:

Ecologists use the term "ecosystem engineers" to describe beavers because they not only modify their environment, but also change the habitat for many other organisms like moose, waterfowl, aquatic invertebrates and fish.

Scientists who studied the role of beavers in streams found that damming water channels changes the way nutrients are cycled in the stream and affects the food chains and webs in the ecosystem. The beavers' constant injections of woody materials move much more material into the stream that would otherwise have eventually died and decomposed in the forest. However, so much material is added to dams and lodges that decomposition of the materials becomes very slow. Thus, minerals and nutrients are released slowly, fertilizing the pond and areas downstream. These nutrients provide more raw materials for photosynthesis by plants than are present in streams without beavers, benefiting the entire food web. Salmon, waterfowl, muskrats, minks, and moose are all affected by the beaver dams.

One way in which beavers engineer their environment is by slowing the water, limiting the erosive force of streams and trapping sediment behind dams so that different types of vegetation are able to grow. The trapping of sediment benefits fish by creating clear spawning habitat downstream of dams. Silty or muddy areas do not provide good spawning or rearing habitat because silt can cover spawning gravels, damage gills, and obscure food for young fry.

Deep pools created by beavers are also an important benefit to Coho salmon. Alaska fish biologists learned that winter is a very critical time for fish because so many streams freeze. Deep pools that do not freeze to the bottom are thus very important to fish survival. Even in Southeast Alaska, where some streams do not freeze during winter, slow water and deep pools prevent young fish from being washed downstream by swift currents.

Lastly, beavers add important nutrients to streams by loading up the stream with organic material. Beavers supply the water with branches, leaves, twigs, bark, and beaver scat, all which decompose slowly, fertilizing the pond with nutrients. These inputs of nutrients affect the entire food web within the pond ecosystem.

MUMMIES IN THE BOGS

The Solution:

Scientists tested the conditions of the bogs in which the bodies were found. While wetlands characteristically have low levels of oxygen in waterlogged soils, they found that the bogs where preservation of the bodies occurred were nearly devoid of oxygen. The lack of oxygen stopped the growth of any bacteria or other microorganisms that would have decomposed the bodies.

The acid waters that are characteristic of most bogs were probably the reason for the brown staining of the skin, hair, nails, and teeth. These acids are responsible for turning bog waters brown. These **tannic acids** are produced by the leaching of plant compounds. Bog acids actually work much like the acids that are used today to tan furs. These acids in the bogs probably also ate away the enamel on the teeth of the bodies that were discovered.

Acids probably also explain the reason for the hollow nature of the bones in the corpse found in England. Scientists hypothesized that the dead body had sunk into the water slowly, and as it became waterlogged, the acid waters leached out calcium and minerals from bones and teeth.

However, the acid should also have eaten away the soft tissues of the body, so the preserved brains found in the bodies in Florida were a puzzle. Scientists then figured that brains were protected by the skull and thus not exposed to the acidic waters that dissolved other soft body parts. (These brains contain the oldest-known DNA and provide important data to scientists about the evolution of humans).

After scientists determined the ages of the bodies, they still had to solve the puzzle about how the people died and why so many bodies were found in bogs or wetlands. The site where the bodies were found in Florida is believed to be an early common burial ground for a group of people who lived as hunters and gatherers. The site provided important information on how these people lived. One of the bodies was a teenager with a spinal disorder that would have left him crippled. The fact that he survived to the age he did is evidence that as long ago as 5,000 B.C. humans took care of people who were relatively unproductive in producing food.

The European bodies were more puzzling. The burnt cake in the 2,000-year-old corpse turned out to be an important clue. Anthropologists had evidence of a religious ritual practiced in England at that time that involved a human sacrifice. Druid priests would cook a certain type of cake for exactly 8 minutes, burn it in one place, break it into pieces, then place the pieces in a bag. The bag was passed among several priests, each of whom removed one of the pieces. The priest who got the burnt piece was sacrificed 1/2-hour later.

Chemists determined that the cake in the dead man's stomach was the same type as that used used in the Druid ritual, that it had been cooked eight minutes, and that the cake had been eaten 1/2-hour before the man had been killed!

The noose around the Denmark corpse was another clue regarding human sacrifice. Scientists believe that the bogs in Europe must have been considered mysterious and sacred sites and therefore suitable for religious ceremonies.

CHOWING DOWN IN A WETLAND

The Solution:

Why have some wetland plants evolved to be insectivorous? The first scientist who tried to answer this question for sundews was the author of the theory of evolution, Charles Darwin. Darwin knew from the work of other scientists that sundews could survive without eating any insects, so it was clear they could photosynthesize. What extra benefit, he asked, did catching and eating insects provide the plants? Developing such elaborate eating methods requires precious energy – why is it worthwhile?

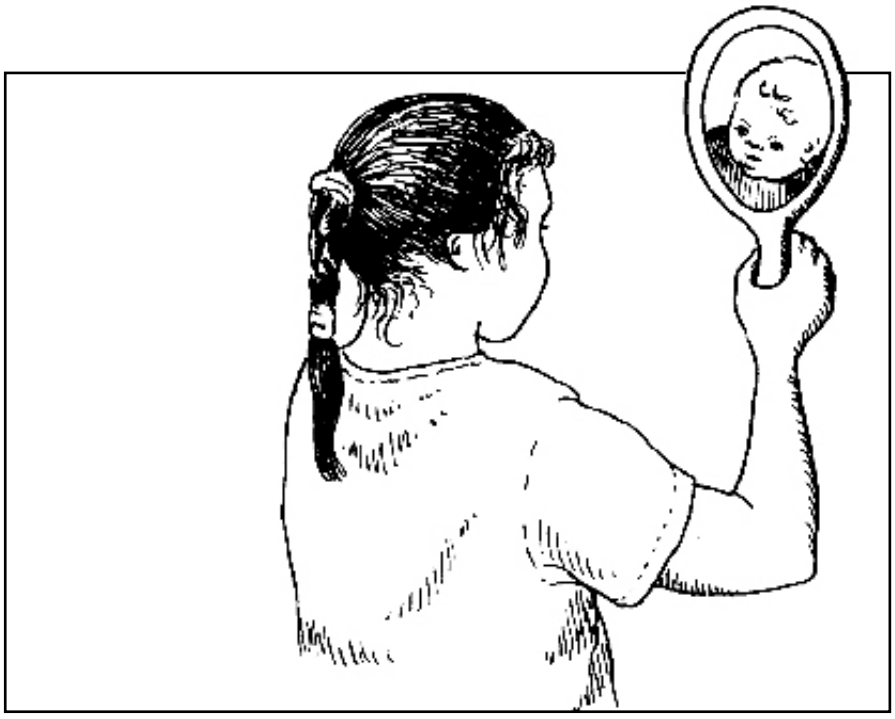
To find out why it might be an advantage for plants in bogs to digest insects, Darwin set up an experiment where he compared the growth of sundews that were fed insects to sundews that never received insects. He collected data and found out that the insect-fed plants grew taller, produced more flowers, and set more seed. In short, something the insects provided allowed the plants to make more food and grow faster and better. Other scientists later found the same results after similar experiments with butterworts and bladderworts.

Scientists still needed to find out what it was that helped the plants grow. What important growth factor was missing in bog environments that the plants could get from insects? The scientists ruled out water, sunlight and carbon dioxide, as all of these essential components to plant growth exist in abundant quantities in Alaska's bogs. The only thing that remained was nutrients. The scientists measured the nutrients in bog soils and found them to be very scarce indeed – especially nitrogen and phosphorous. In this manner, an insectivorous habit that supplied a plant with insect nutrients could be a fantastic advantage in a bog!

The scientists used radioactive isotopes of different nutrients to confirm that nutrients were the factor that was limiting the growth of butterworts. The isotopes acted as "tracers". Scientists "fed" the labeled nutrients to leaves of butterworts, and were able to measure the movement of the nutrients to areas on the roots and stem. The new growth using the labeled nutrients was occurring in less than 12 hours.

So, why do insectivorous plants occur in wetland areas but not in other types of habitats? The specialized insectivorous habit requires lots of energy and a plant will be much better off if it can avoid using up precious energy catching flies. However, nutrients are not always readily available to plants in wetland ecosystems, so insectivorous plants have developed this mechanism to get the nutrients they need by catching insects. If nutrients are more readily available in the soil, as they are in non-wetland ecosystems, it is not necessary or worth the energetic cost to be insectivorous. That's why we don't find insectivorous plants in non-wetland ecosystems!

Are You Me?



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: K - 6
State Standard: English/LA C-1, C-5; Geography C-1
NGSS: 1-LS1-2,1-LS3-1., 3-LS1-1 3-LS3-1.
Subjects: science
Skills: analysis, classification, communication, comparing similarities and differences, matching, recognition, small group work
Duration: one or two 20-minute periods, preparation time for students to bring family pictures to class
Group Size: 3 - 4
Setting: indoors
Vocabulary: nymph, larvae, pupa, metamorphosis

Objectives:
Students will be able to recognize various young stages of aquatic animals and match them with corresponding adult stages.

Teaching Strategy:
Using picture cards, students match pairs of juvenile and adult aquatic animals.

Complementary Activities
I'm Not Mean, Just Hungry! Who's In the Water?, Mystery Creature

Materials:
"Are You Me?" cards cut and laminated (enough so that there is one for each student, and a match for each card), overhead transparency of the "Are You Me" card sheets. For older students, cut off the names of the organisms on the cards.

Background
See INSIGHTS: Section 1 Wetland Inhabitants *"Aquatic Invertebrates"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheets.

Procedure:
1. Ask the students to bring two pictures to class: one of an adult, and one of the same person as a child. *For example, a student might bring in pictures of her mother as a child and an adult, another could bring in photos of himself as an infant and his school picture.*

2. Divide the class into small groups of three or four students each and assign each group a single table or station. Ask students to stand in a circle around that station, holding their own set of paired pictures in their hands.

3. Students at each station place their pairs of pictures on the table and mix them randomly. Once the adult-child pictures are mixed at each table, have the entire group shift to a different station. There should not be any student at a station where his or her own pictures are placed.

4. Working together as a group, students then attempt to match pairs of adult/child or student and infant photos.

5. When the students at each table have completed their efforts to match the pairs, ask all of the groups to return to their original station — the station where they left their

own pairs of pictures. Are the matches correct? Ask the students to change any pairs that are not correctly matched.

6. Discuss how difficult or easy it was to correctly match pairs. Introduce the idea that many animals look remarkably different as adults than they appeared in younger forms. Tell the students that they are about to learn how to match young and adult forms of many different kinds of aquatic animals.

7. Introduce the aquatic animal cards and divide the class in half. Designate one half of the students "adults" and the other half "young animals." Give each student in the "adult group" an "adult" animal image. Give each student in the "young animal" group a young animal image. Make sure there is a corresponding match, adult or juvenile, for each card.

8. Instruct the students to "swim" or "fly" around the room and search for their "match" — pairing the appropriate adult and juvenile forms. Note: You can attach each animal card to a string loop so the pictures can be hung around the students' necks as they try to match the pictures.

9. When all the students have made their choices and think they have a match, stand or sit in a circle, with pairs next to each other. You can interview each pair to see if their match is correct. If not, have others in the class help to fix it. Some matches (especially the aquatic invertebrates) are more difficult than others and may be confusing.

10. Show students the correctly matched pairs on an overhead. Look at similarities and differences in how different kinds of aquatic animals grow and change. Note: This activity can be repeated several times by shuffling the adult and young images and passing them to new "animals" so that each student becomes familiar with a wider array of animals.

Evaluation

Pick two aquatic animals. Draw a picture of each animal as an adult, and another picture of each animal as it looks when it is younger.

Curriculum Connections:

(See Appendix for full citations)

Books:

Water Insects (Johnson, 1989).

Insect Metamorphosis: From Egg to Adult (Goor, 1990).

Frog in a Bog (Himmelman, 2004).

Aquatic Insects and How They Live (McLung 1970).

Wetlands (Rood 1994).

Credits:

Extensions

1. Find out as much as possible about some of the habitats in which these animals live.

2. If possible, visit some of the habitats where the animals are actually found.

3. Pick a pair of images and find out more about the life cycles of the animals shown.

4. Discuss and/or pantomime the concept of metamorphosis.

ARE YOU ME ?

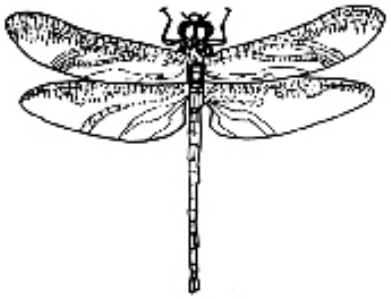
WHIRLIGIG BEETLE

WHIRLIGIG LARVAE

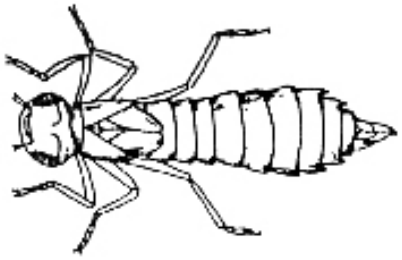
CADDISFLY

CADDISFLY LARVAE

DRAGONFLY



DRAGONFLY NYMPH



BEAVER

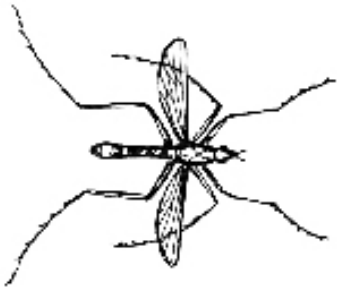
YOUNG BEAVER

ARE YOU ME ?

OSPREY

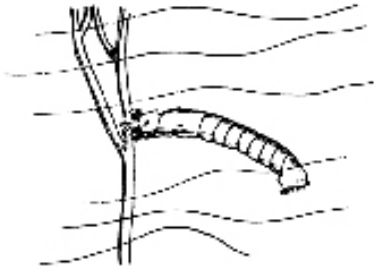
OSPREY HATCHLINGS

CRANEFLY



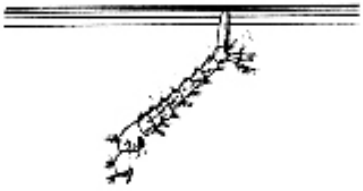
CRANEFLY LARVAE

BLACK FLY



BLACK FLY LARVAE

MOSQUITO



MOSQUITO LARVAE

TOOLS: INVERTEBRATE CARDS

ARE YOU ME ?

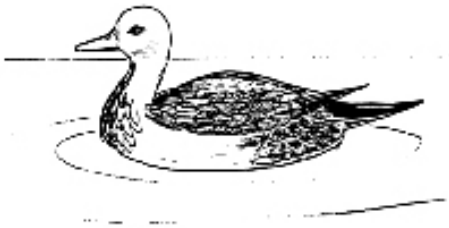
MAYFLY

MAYFLY NYMPH

BUTTERFLY

BUTTERFLY LARVAE

DUCK



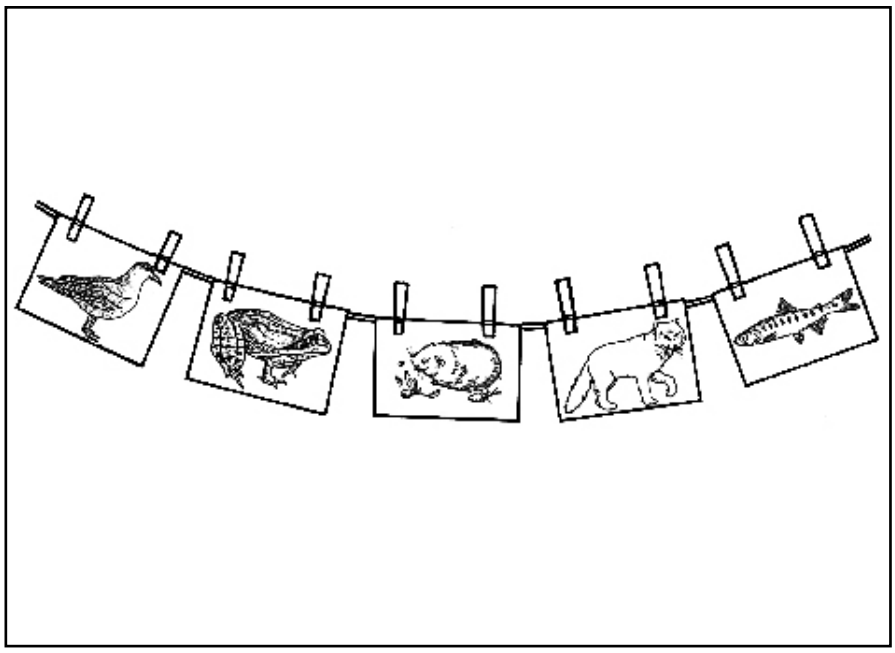
DUCKLINGS

WOOD FROG

TAD POLES

Mystery Creature

ALASKA'S ECOLOGY CARDS REQUIRED



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: K - 4

State Standard: Art A-1; English/LA A-1, A-3, A-4, A-6, B-1, B-2; S

NGSS: K-LS1-1., 2-LS4-1.,4-LS1-1.

Subjects: science, language arts, art

Skills: analysis, classification, description, drawing, identification, listening, memory, reading, reporting, research, visualization, writing

Duration: 1-2 class periods

Group Size: whole group, individuals

Setting: classroom, outdoors

Objectives:

Students will develop a wetland animal "mystery story" that describes the animal's habitat as well as what it eats, how it sounds, how it moves, how it looks, and where it lives.

Teaching Strategy:

Students will listen to a Mystery Creature description and then draw a picture of it in its habitat based on the descriptions in the story. Students will then create their own mystery wetland plant or animal description based on the Wetlands Cards and their research.

Complementary Activities:

Who Is In The Water? Are You Me?

Background

See INSIGHTS Section 2 Wetland Inhabitants *"Aquatic Invertebrates"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheets.

Materials:

Mystery Creature Story, Mystery Creature picture, 4" x 6" index cards, heavy string, clothespins, Wetlands Cards, research materials (field guides, Alaska Wildlife Notebook Series, etc.)

Procedure:

1. Tell students that they are going to take a trip to see a very unusual creature. Students should listen very carefully and pay close attention to everything they "see" because they will have to create a "field report" on the animal and its environment afterwards.

2. Read the Mystery Creature Story, or memorize it and give a dramatic presentation.

3. Pass out 4" x 6" index cards and have students draw a picture of the Creature for their field report. Allow a set amount of time — about 5 minutes. While they are drawing, tie a heavy string across the room. When students are finished, have them attach their pictures to the line with clothespins to display them for an informal "art exhibit."

4. After students have had a chance to look at the cards, ask if they would like to see a picture of the Mystery Creature. Show the Mystery Creature picture.

5. Tell students that they will have the opportunity to write a description of a mystery animal that occurs in wetlands. They can look through the Ecology Cards for an animal that they would like to describe. Mystery stories should include information about its habits and habitat: what it eats, how it sounds, how it moves, how it looks, where it lives, etc.

6. When students have completed their stories, have them attach their cards on the string. Students can read their descriptions or memorize them and give a dramatic reading of their mystery animal. The class can try and guess which animal it is by looking at the pictures on the string.

Evaluation

The class identifies Mystery Animals from stories written by students.

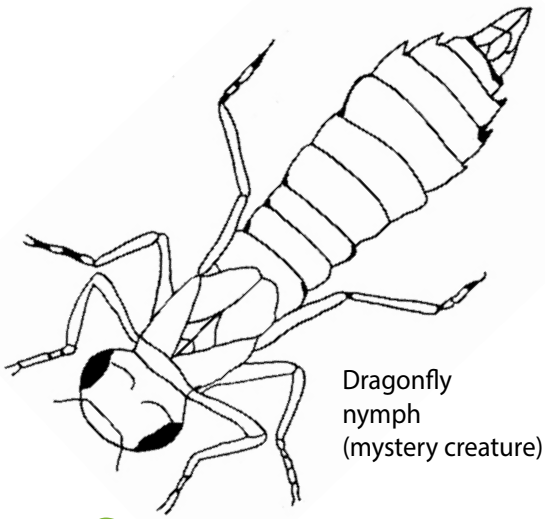
Credits:

Sharing the Joy of Nature (Cornell, 1989).

Curriculum Connections:

(See Appendix for full citations)

Books:
Wetlands (Rood, 1994).



Dragonfly nymph (mystery creature)

Mystery Creature Story

You are swimming underwater in a pond, looking at the variety of life in the shallow water. A school of small fish swims by, and green water plants wave back and forth. A slight movement on the muddy bottom catches your eye. What is that brown mystery creature? It is hard to see in the muddy bottom. The creature is moving very slowly with six long legs. Huge, dark, scary eyes catch your attention; they take up most of the creature's head. Mystery creature keeps creeping forward. You squint and notice two short wings lying flat on the creature's back. Your eyes follow the rest of the body and you see that different sections of the back are marked by lines. Two very short, sharp tips protrude from the very end of Mystery Creature's body.

Mystery Creature keeps moving slowly through the mud. You now see that a sort of mask covers its face almost up to its eyes. Suddenly, an arm leaps out of its face!! No, wait, that's not an arm. It is Mystery Creature's lower jaw! Two claws make up the masked jaw. The jaw shoots out like an arm reaching out from an elbow. The claw-like jaws grab a small mosquito larva and then the lower jaw snaps back into place. Mystery Creature's mouth easily chews up the soft body.

You shiver and wonder if you are seeing things, it all happened so fast! The school of fish swims by again, not knowing that Mystery Creature waits silently nearby. With a fast flick of the lower jaw, one of the fish is gobbled up. Frightened, the rest of the school swim away quickly. Mystery Creature continues its slow hike through the mud in search of another meal and you decide you've seen enough.

Wildlife Language

ALASKA'S ECOLOGY CARDS SUGGESTED

My footsteps are heavy
My shoulders are wide.
I walk the wide tundra
With a slow rolling stride

My cubs practice fishing
And hunting for fun.
They roll and frolic
Under mid-summer sun.

Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: K - 8

State Standard: Art A-1; English/ LA A-1, A-5

Subjects: science, language arts,

Skills: spelling, writing, comparing similarities and differences, description, reading, research, poetry

Duration: one or more class sessions

Group Size: 2-6, whole class.

Setting: classroom

Vocabulary: alliteration, riddle

Objectives:

Students will:

1. Write rhymes and think up alliterative phrases using ecology cards and/or wetland organism names.

2. Use the dictionary and thesaurus.

3. Play two word games that require speaking and listening.

Teaching Strategy:

Students will learn about wetland inhabitants through various language arts activities, including games, puzzles, and poems.

Complementary Activities:

Wetland Sounds, Mystery Creature, Waterlogged Worlds

Background

See INSIGHTS, Section 2 Wetland Ecosystems *"Profiles of Alaska's Wetlands"* and Section 2 Wetland Inhabitants fact sheets.

Materials:

Ecology Cards or lists with names of wetland organisms for every pair of students.

Procedure:

Activity 1
WILDLIFE WORDS

1. Divide the class into pairs of students. Hand each pair several Ecology Cards (with wetland organisms). Alternatively, provide them with a list of names of Wetland Organisms.

2. Each pair of students will then develop alliterative phrases describing each organism on their list or cards as follows: (An alliterative phrase contains words that begin with the same consonant or sound). The first student states one alliterative adjective and the organism's name. For example, if goose was at the top of the list, then the first student could say "gray goose"). The partner then tries to add another alliterative adjective ("grazing gray goose"). If he/she succeeds, the play passes back to player 1, who tries to add a third word to the alliterative phrase.

3. The last player to successfully add a word to the phrase wins the round and one point. Each team player plays a round for each animal on the poster or Wetlands Cards. (You may want to have the winners of each team play each other and end up with a Class Champion Wildlife Word Wizard.)

Activity 2
RIDDLE RHYMES

1. Each student writes a riddle rhyme describing one of organisms pictured on the Ecology Cards, or one of the terms in the glossary (at the end of this guide). The riddle rhyme should have as many rhyming words as possible, but should also include factual clues to the animal name or word meaning. The riddle can include a line that ends in a word that rhymes with the animal name or clue. Some examples:

Topics: *wildlife*

My name rhymes with loose
You see me on the wing
I'm here in the spring
I'm an Aleutian Canada *[goose]*

My name rhymes with sea gull,
but I am more regal.
Dead fish are my dish.
Who am I? *[bald eagle]*

Predators want me to stay,
but I run away.
What am I? *[prey]*

Students can also write riddles that rhyme but don't provide a rhyming clue. Some examples:

My legs are quite lanky, my hooves are so shiny,
My fur-covered body is anything but tiny,
My most favorite food is a willow you can see,
And most of you've met the likes of me.
(moose)

I soar through the air and I search for my prey,
My wings span 8 feet as I swoop toward the bay,
A tasty small fish is what I have found,
I cry a high screech as I fly heavenbound.
(eagle)

I came from an egg in the gravel below,
I'm still very little, but I'll grow and I'll grow,
I'll turn bright and silver and head out to sea,
But then I'll come back to
make fish just like me.
(salmon)

I am a house builder that has hard, sharp teeth,
I chew on tall trees that I move with webbed feet,
When startled or mad my tail starts to flap,
When it hits the clear water,
you hear a loud slap! *(beaver)*

Encourage students to use the dictionary and thesaurus to help them think up rhyming words - but require them to know the meaning of any word they use in their riddle.

1. Divide the class into teams. Have them play a game to see how many riddles they can solve during a 3-minute round as follows: team 1 first asks Team 2 a riddle rhyme. Team 2 gets 1 chance to answer the riddle correctly. If they do so, they get one point. The teams then exchange roles, going back and forth until all the riddles have been used.

2. Members of the team with the most points can then challenge other teams in a Wildlife Riddle Tournament. Other classes can join in as well. Or you can have a Wildlife Riddle Off where each classroom selects the best riddles from all those written by their classmates. The super riddle challenge can be to write a riddle rhyme that includes an

alliterative phrase.

Activity 3
WILDLIFE POETRY
Students write a poem about their favorite Alaskan wetland organism, or one pictured on an Ecology Card that you have given them. Encourage students to write poems that convey information about the animal and its habitat.

Poem ideas:
Haiku (pronounced Hi-koo) - an unrhymed Japanese verse consisting of three lines containing five, seven, and five syllables, respectively.

Example:

Caribou and calf
walking through many tussocks
follow green northward

Cinquain (pronounced sin-kain) – a five line poem. The first line consists of one word, the second line two words, and so on until the fourth line which contains four words. The fifth line is a one word summary. Your students can use the name of the organism for the first line, two adjectives describing it for the second line, three action words or words ending in "ing" for the third line, a four word phrase for the fourth line and a one word synonym for the last line.

Example:

Dragonfly
Voracious, Bristly
Darting, Chasing, Chomping
Jaw that shoots forward
Nymph

Limerick - light humorous poems consisting of five lines of verse. Lines one, two, and five consist of roughly three metrical feet while lines three and four contain two metrical feet. (A metrical foot consists of two short, not accented syllables followed by one long accented syllable.) Lines one, two, and five rhyme with each other, and lines three and four rhyme together.
Example:

There was a young brant from Goose Bay
In fall, he flew south every day
The wind blew him off course
But he found a food source
And resting spots on the flyway.

(You may want to put the poems written by students in a display, compile them into a class book, or ask your local newspaper to publish the best ones in the next edition.)

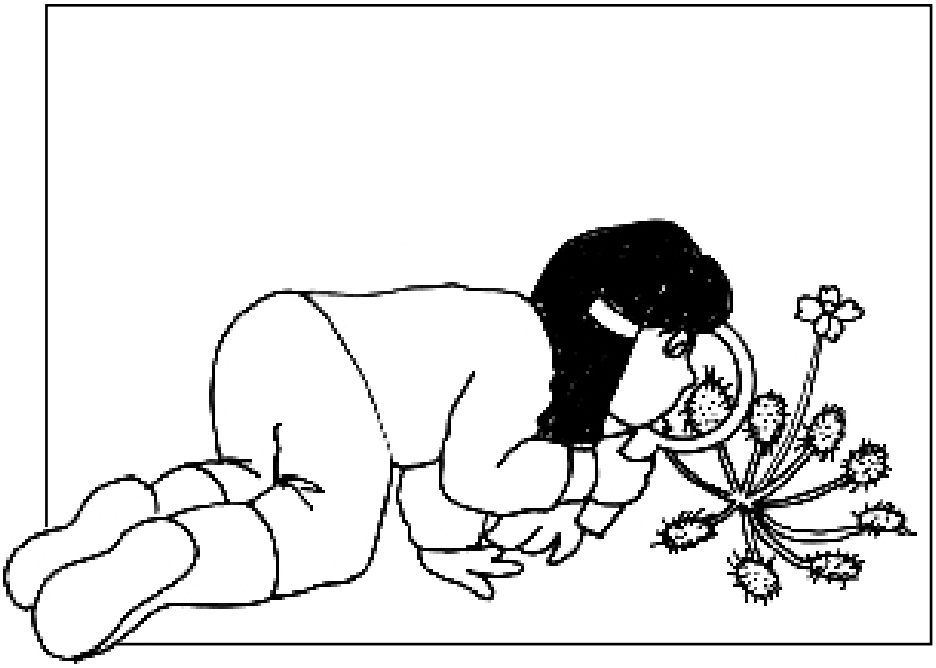
Extension
Do the activities using names of animals or words in your local Alaska Native language or a foreign language.

Curriculum Connections:
(See Appendix for full citations)

Books:
Lily Pad Pond (Lavies, 1989).

Squish! A Wetland Walk. (Luenn 1994).

Green Gobblers



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: K - 6

State Standard: Art A-1, A-5.
NGSS:K-LS1-1.,2-LS4-1.
Subjects: science, drama, art

Skills: classification, role playing, designing

Duration: 1-2 class sessions

Group Size: 3, whole class

Setting: classroom or outdoors

Vocabulary: carnivore, carnivorous, sundew, butterwort, bladderwort

Objectives:

Students will:

1. State the definition of an insectivorous plant.

2. Distinguish among three insectivorous plants.

Teaching Strategy:

Students will learn about and name different types of insectivorous plants. Volunteers will demonstrate how three types of insectivorous plants catch and eat their prey. Students will work in groups to devise and present their own insectivorous plant.

Background

See INSIGHTS: Section 3 Wetland Inhabitants *"Wetland Plants"* fact sheet.

Materials:

For each group: materials box containing velcro, cotton swabs, pipe cleaners, construction paper, tape, glue, scissors, foam balls, paper clips, socks, etc.; insectivorous plant illustrations.

Procedure:

1. Ask students if they know what a carnivore is. Explain that a carnivore is an animal that eats mostly meat. Have students name animals that are carnivores (lynx, wolf, owl). Ask students what insectivorous means? Develop examples (birds, ant eaters, larger insects, spiders). Ask students if plants can be insectivorous. Tell them that in special wetland areas there are insectivorous plants that trap and digest insects. Share ideas of what an insectivorous plant might look like.

2. Explain and show pictures of each type of insectivorous plant in Alaska: sundew, butterwort, and bladderwort. While you are describing each plant, choose several students to model each – one can be the plant stalk, one can hold out his/her arms for leaves, one can be the insect, etc. Explain that many insectivorous plants can also produce their own food from the sun's energy like other plants.

3. Divide students into pairs or groups of three. Have them construct one of the three insectivorous plants found in Alaska using the materials box.

4. Each group then presents and demonstrates their plant to the rest of the class. The other students can guess which one of the three insectivorous plants the construction represents.

Evaluation

• Students explain what is an insectivorous plant
• Students demonstrate plants with abilities to both eat and digest insects, as well as to make food from sun's energy.

Extensions

1. Students can develop a play or write a story from the viewpoint of an insectivorous plant or an insect being digested by one.

2. Students can develop an imaginary insectivorous plant and write about and/or draw what it looks like, what it eats, where it lives, etc.

Curriculum Connections:

(See Appendix for full citations):

Books:

Bladderworts: Trapdoors to Oblivion. (Gentle, 1996)

Butterworts: Greasy Cups of Death. (Gentle, 1996).

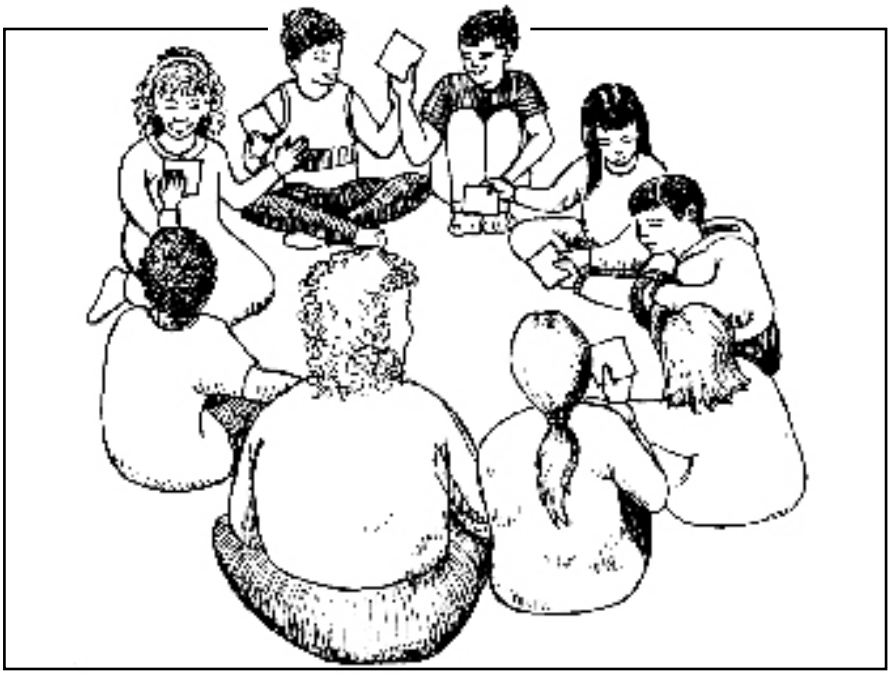
Insect-Eating Plants (Kite, 1995).

Plants that Eat Insects: A Look at Carnivorous Plants. (Dean, 1977).

Sundews: a Sweet and Sticky Death. (Gentle, 1996).

Sundew Stranglers: Plants that Eat Insects. (Wexler 1995).

Cycle of Life



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade Level: 4-8

Grade Level: 2-5

NGSS: 2-LS4-1.,3-LS1-1., 4-LS1-1.

Subjects: Science

Skills: Synthesizing facts

Duration: 20 minutes

Group Size: 7-30

Setting: Indoors

Vocabulary: Amphibian, metamorphosis, breeding, gills, lungs

Objectives:

1. Students will learn what an amphibian is.
2. Students will learn the life cycle of the wood frog.

Teaching Strategy:

Students sitting in a circle pass around pictures of successive stages of a frog's life cycle with increasing speed. The teacher interrupts the cycling to ask questions.

Complementary Activities:

Swimmers and Hoppers; Slimy Skin; Changing World Puzzler: Five–Legged Frogs; Are You Me?; I'm not Mean, Just Hungry.

Background

See INSIGHTS, Section 3 Wetland Inhabitants *"Amphibians in Alaska"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheets.

Materials:

Wood frog life stages cards (at the end of the activity) cut and laminated, one large version of each card.

Procedure:

Before class: make 3-5 copies of the wood frog life stages cards sheet. (There are eight cards on the sheet and you will need one card for each student.) Also, if possible, copy a large version of each card. After making your copies, cut the cards, laminate them, and put them in order.

1. Sit with your students on the floor in a circle.

2. Discuss with the students the unique life history of **amphibians**, whereby they start out in water breathing like a fish, and then end up on land, breathing like a human.

3. Introduce each stage of the Wood Frog's life cycle. Discuss the habitat, what the frog or tadpole eats and possible dangers. As you introduce each stage, show the students the large picture of the stage, and then pass the associated life cycle stages card to the student at your left. *Make sure students look at the pictures before they pass them on, because they will need to be familiar with them.*

- Just as with many organisms, they start out as **eggs** in spring (April).

- Eggs hatch within 10-30 days, and out swim **tadpoles.** They breathe using gills as well as through their skin. They also have sieve like filter organs in their pharynx, which allows them to trap food like bacteria, protozoa, floating algae, pollen grains and other small particles suspended in water between their mouth and gills.

- After several weeks, the **tadpoles** usually grow **legs**. They are still breathing using gills, but are starting to go through changes like developing true jaws, teeth and a tongue.

- At about 2-4 months, they are looking more like frogs and are called **froglets.** They still have tails, but now can breathe using lungs. Other changes include:
  • Moveable eyelids form
  • Lungs develop
  • Skin glands develop
  • Gut assumes adult form – including stomach
  • Bones harden
  • Intestine changes
  • This is a very risky time, so they also become more poisonous (less tasty to predators).

- The **young adult frog** no longer has a tail, and everything is developed, but it is still growing.

- After one to two years, the **mature frog** is fully grown.

- **Overwintering frog**: wood frogs have an amazing survival story to allow them to over winter; they freeze solid! (See the "Amphibians in Alaska" fact sheet in the INSIGHTS section for the whole story.)

- In April, frogs thaw out, and the first thing on their mind is **breeding**, where the female deposits thousands of eggs into the water, and the male fertilizes them. All of the breeding happens in just a couple of days.

4. Continue to pass around more pictures of the life cycle (in the appropriate order), so that every student has a picture.

5. Tell the students to continue to pass around the pictures until you yell "Stop!" Ask the students who has a picture of an egg mass. The students who do should raise their hands or stand up. Ask the students what season must it be in the picture? *(Spring – April or May).*

6. Resume passing, with increasing speed until you yell "Stop!" again and ask an additional question. "Who has a tadpole?" "What does the tadpole eat?"

7. Continue in this fashion of starting and stopping and passing with increasing speed until you feel you have asked enough questions. Possible questions are:
   - Who has an overwintering Wood Frog? What is it eating? *(nothing).*
   - Who has a picture of a breeding frog? When will this happen? *(mid April – early May, depending on the area).*
   - Who has a picture of an organism with lungs?
   - Who has a picture of an organism with gills?
   - Who has a picture of an organism breathing through its skin?
   - Who has a picture of an organism that helps to maintain oxygen content in the wetland? *(tadpoles, through eating algae).*
   - Who has a picture of something that would be good food for a bird?

8. Ask the students to make sure that the cards are still in the right order. Ask 7 students in a row to stand up and tell what they are holding. Ask the class if it is the right order. If it's not, fix it.

Evaluation:

1. Students identify different stages of a frog's life cycle

2. Students identify habitat requirements for the Wood Frog.

Critical Thinking:

1. Students discuss what might happen if there is a three week thaw in March, during which all the snow melts and there is no ice, followed by a long cold snap, during which it is zero degrees for 2 weeks.

2. Students discuss the consequences of an old car dripping antifreeze on to a road and subsequently washing into a nearby wetland.

Curriculum Connections:

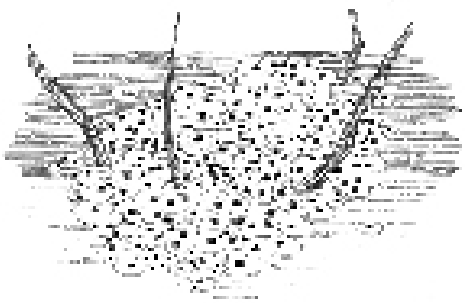
Books:

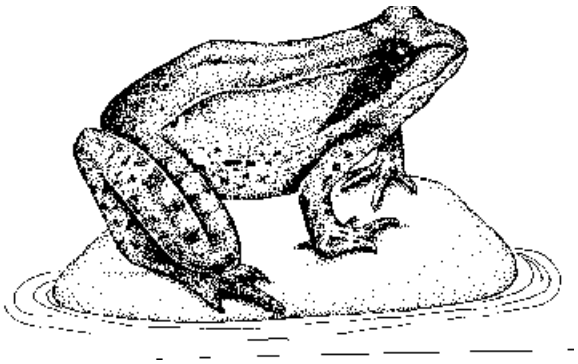
Wood Frog (Schwartz, 1999).

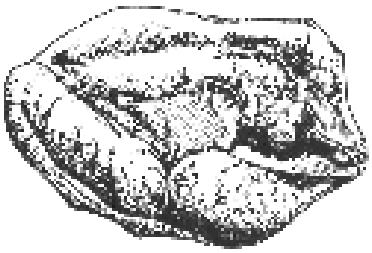
Wood Frogs (Wechsler, 2002).

The Reptiles and Amphibians of Alaska (McDonald, 2003).

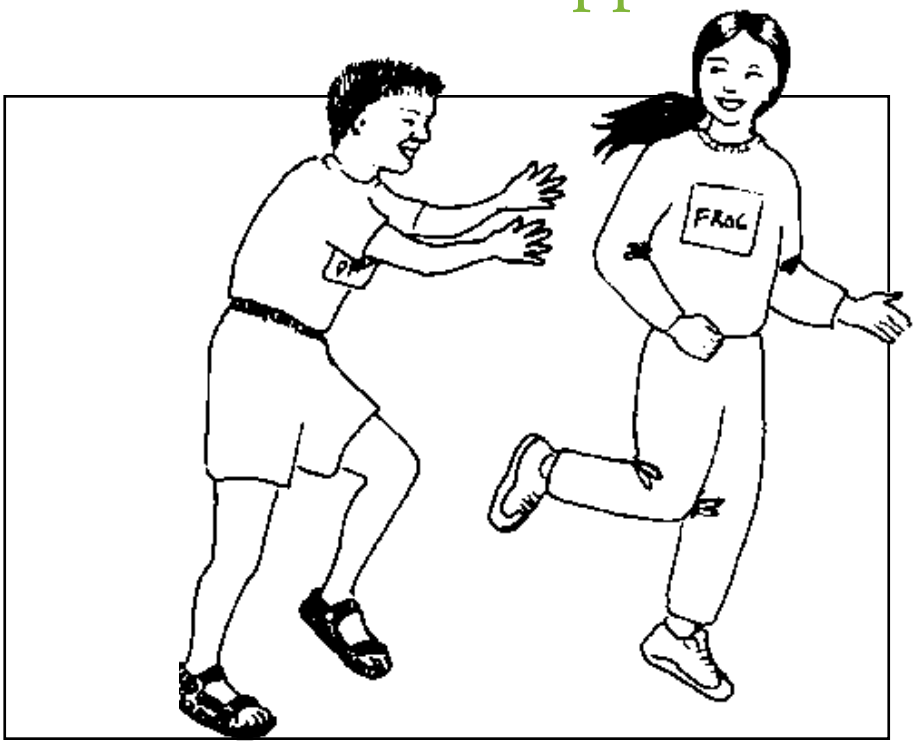
TOOLS: WOOD FROG LIFE STAGES CARDS







Swimmers and Hoppers



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade Level: 4-8

State Standard: Geography C-2, E-5

NGSS: MS-LS1-4.,MS-LS1-5 MS-LS2-2., MS-LS2-4. MS-ESS3-3.

Subjects: Science,

Skills: synthesizing facts, observing rules of a game, running, hopping.

Duration: 30-60 minutes

Group Size: 20-30+ students

Setting: Outdoors or large indoor area

Vocabulary: life cycle, metamorphosis, population, reproductive strategy, contaminants, limiting factor

Objectives:

1. Students will learn the life cycle of the wood frog.
2. Students will learn some of the limiting factors affecting wood frogs as they complete their life cycles.
3. Students will learn that there are two reproductive strategies by which organisms maintain their populations.

Teaching Strategy:

Students, pretending to be wood frogs, travel through a hazardous course representing the life cycle of the frog. Only a few students survive to become "over wintering frogs".

Complementary Activities:

I'm Not Mean, Just Hungry!; Slimy Skin, Cycle of Life.

Background

See INSIGHTS, Section 3 Wetland Inhabitants *"Amphibians in Alaska", "Summary of Animal Adaptations for Wetland Living"* and *"Wetland Contaminants"* fact sheets.

Materials:

Large playing area (100 feet X 50 feet), about 500 feet of rope or string or six traffic cones for marking boundaries (can use masking tape if indoors), two cardboard boxes, 100 poker chips.

Procedure:

1. Discuss with your students how every type of living organism has strategies to ensure that the species survives over many generations. *In general, there are two strategies to ensure that offspring (babies) survive and live to have their own offspring, thus propagating the success of the species. The first strategy is to have a very small amount of offspring (low "clutch size"), but to take the best care possible of the offspring (high "parental care").* Ask the students to think of examples of this first strategy. (Humans, bears, moose, coconuts, peaches). The second strategy is to have very low parental care, but so many offspring that at least one is guaranteed to survive. Ask students for examples of this second strategy (fish, frogs, voles, lemmings, dandelions, grass).

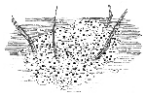
2. Tell students that this latter strategy is the way the wood frog species has survived, even though it has so many challenges to its existence.

3. Discuss the concept of **limiting factor** with your students. *(A limiting factor is a reason or cause that reduces the population of an organism. Limiting factors can be natural such as weather, food and predators, or human caused such as pollution and agriculture).*

4. Ask the students what they remember about the life cycle of frogs. Review the life cycle of the wood frog, asking the students for ideas of limiting factors at each stage. It may help to have the students help you fill in the table on the board similar to the one below with illustrations from the Life Stages cards in the "Cycles of Life" activity.

5. Set up a playing field as shown in the diagram at the end of the activity, including pond, land, and shoreline for over wintering. Place tokens on either side of the back end of the playing area.

6. Tell the students that they are going to be frogs, starting out as eggs and going through their whole life cycle. Remind the students that each pair of frogs produces 2000 - 3000 eggs, and that there are many limiting factors to the population. Ask the students to guess how many frogs from their class of frogs will survive their first year of life.

LIFE STAGE	HABITAT	FOOD SUPPLY	LIMITING FACTORS, POSSIBLE CHALLENGES
Egg 	Any type of wetland area	yolk inside the egg	Predators – small fish, invertebrates (dragon fly larvae); water temperature changes.
Tadpole 	Any type of wetland area	bacteria, protozoa, algae, pollen grains, small particles suspended in water	Turbulence from spring runoff, predators – small fish, invertebrates (dragon fly larvae); water temperature changes.
Tadpole with legs 	Any type of wetland area	Same as above	Predators – fish; wetland contaminants – pollution and salt from road runoff, herbicides; disease – from fish stocking, releasing pet frogs; turbulence from ATV or boat disturbance.
Young frog 	Forests, meadows, bogs, muskeg, tundra	Insects	Predators – birds, small mammals; Pollution – air, pesticides, herbicides, acid rain; UV radiation
Mature frog 	Forests, meadows, bogs, muskeg, tundra	Insects	Same
Over-wintering frog 	Nest in duff, insulated by snow	Does not eat	Cold!

7. Assign roles to each of the students as follows:

- Two students will be a turbulence team, which will operate a jump rope.
- One student will be an aquatic invertebrate predator such as a dragon fly larva.
- One student will be a fish predator.
- One or two students (depending on class size and playing field area) will be predatory birds.
- Either the teacher, or a student who is not able to be physical can operate a timer (or just count down) to let frogs know when it is winter.
- All remaining students begin as tadpoles hatching from eggs.
- Additionally, as the game develops, all students who are "caught" by the predators or the turbulence will become pollution molecules (e.g. air pollution, acid rain, pesticides). Pollution molecules are able to move only one leg; the other leg remains firmly in one place.
- All predators must tag prey with two hands, and then escort the caught prey over to the pollution area.
- Pollution molecules must also tag frogs with two hands. Frogs that are "killed" by the pollution also become pollution molecules.

These numbers are based on a class size of 25 – 30 students. You may need to adjust the numbers if your group size is larger or smaller.

8. Begin the activity with students representing **tadpoles** hatching from eggs on the edge of the pond. Tadpoles must swim out into the pond but first have to avoid **turbulence** caused by spring runoff entering the water body. They swim through the jump rope. Any tadpole that gets hit by the turbulence dies. They must go represent a **pollution molecule** *(let students know that this is a new role, that the pollution does not have anything to do with the dead tadpole)*. The tadpoles cannot go around the jump rope swingers, but they can slip underneath swingers' arms if they do not get touched while doing so.

9. Tadpoles that have successfully made it through the turbulence then have to avoid the **aquatic invertebrate predator.**

10. Successful tadpoles develop into **tadpoles with legs**. As they swim into deeper areas of the pond, they must avoid **predatory fish.** If your playing area is small, you may want to give predators some limitations. For example, they must keep one foot in a cardboard box at all times.

11. Tadpoles with legs who do not get caught by the fish then develop into young frogs. These young frogs are now on land, and are no longer swimming – they must hop.

12. Hopping young frogs hop back and forth between either side of the playing field collecting food. They must collect 3 tokens from either side (one at a time) before they have enough stored to survive the winter.

13. Hopping frogs must avoid **predatory birds**.

14. Once frogs have obtained enough food, they are **mature frogs** that need to go make a nest to hibernate in. But first, they must make it through the **pollution**. If frogs get caught, they become pollution too.

15. Finally, all frogs must make it to their nests and freeze solid (to become **over-wintering frogs**) by October 31. (Either have a timer going, or just count down when there are a few frogs left gathering food).

16. After the simulation is complete, engage students in a discussion:

- How many frogs survived? Did the numbers surprise them? Did it seem realistic?
- Which limiting factor seemed most "dangerous" to them? Which took out the most tadpoles or frogs?
- Do frogs seem to have a "harder life" than other organisms?
- What would the consequences be on other components of the ecosystem if no tadpoles survived to maturity?

Evaluation:

1. List and describe stages in the wood frog's life cycle.
2. List and describe limiting factors to the wood frogs' population.

Critical Thinking:

1. List some limiting factors that might affect other populations.
2. Even though dragon fly larvae are not directly limiting factors to birds, how might they affect bird populations?

Credits:

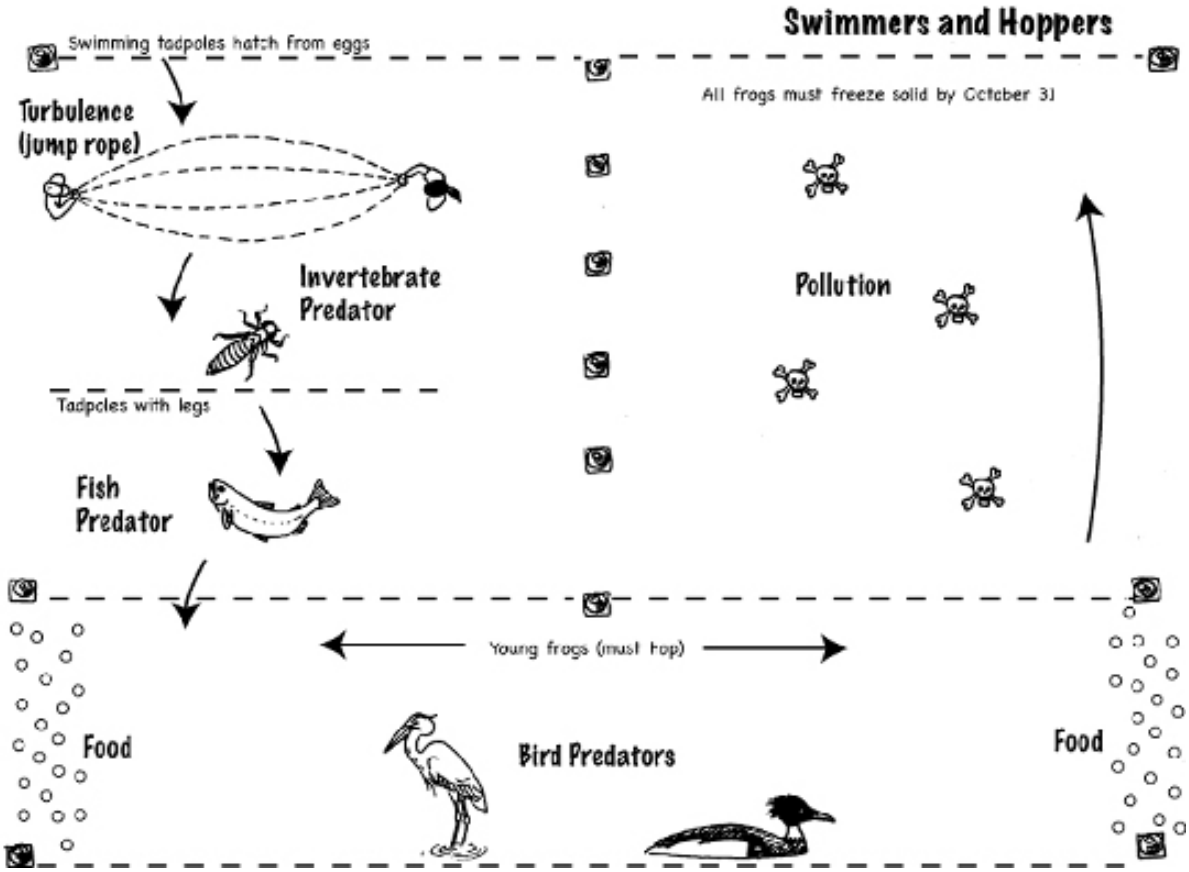
Curriculum Connections:

Books:

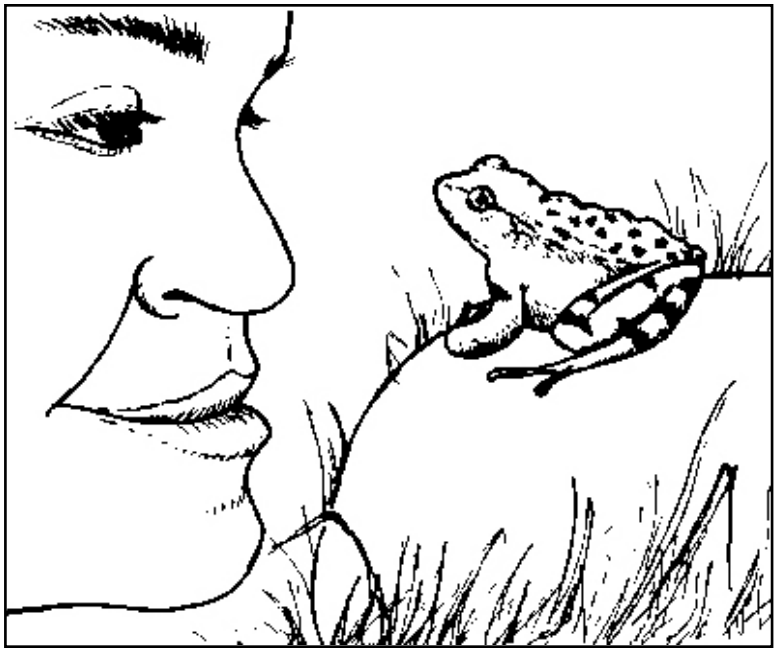
Wood Frogs (Wechsler 2002).

The Reptiles and Amphibians of Alaska (McDonald, 2003).

Amphibians and Reptiles in Alaska, the Yukon, and Northwest Territories (Hodge, 1976).



Slimy Skin



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade Level: K-4

State Standard: Geography E-5
NGSS: K-ESS3-3., 1-LS1-1.,2-LS4-1. 4-LS1-1.

Subject: Science

Skills: Scientific inquiry – observing, asking questions, developing a hypothesis, developing an experiment and making conclusions.

Duration: 20-45 minutes.

Group Size: 2-4

Setting: Indoors

Vocabulary: Amphibian, Wood frog, skin, protection, pollution, permeable, hypothesis, biological indicator.

Objectives:

1. Students will learn that amphibians breathe through their skin, and are thus very sensitive to pollutants.
2. Students will learn the process of scientific inquiry.

Complementary Activities:

Five–Legged Frogs, Wetland Model, Cycle of Life, Swimmers and Hoppers.

Background

See INSIGHTS, Section 3 Wetland Inhabitants *"Amphibians in Alaska"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheets.

Materials:

Plastic wrap, paper towels, markers, bowls, glasses of water.

Procedure:

1. Ask the students to name some functions of their own skin (protection, cooling through sweating, warming through hair, water proofing, holds things in, etc.)

2. Ask the students to come up with some similarities and differences between their skin and what they know about amphibian skin. (Both protect, both hold things in; with humans water can come out through sweat, but does not go in, whereas amphibians absorb water through skin – they don't even need to drink).

3. Give each group a piece of plastic wrap and a paper towel. Tell the students that one more closely resembles frog skin, and one more closely resembles human skin. *(Tell students that the plastic wrap and paper towels are not perfect examples, as they will discover.)*

4. Give each group a few moments to record observations of each type of "skin". They can see how well it protects, etc.

5. Have each group develop a **hypothesis**, for which type of skin goes with which animal (frog or human). *Make sure they do not shout out their answers, but keep them within the group.*

6. Give each group a bowl and a glass of water. Have each

group develop an experiment that would allow them to prove or disprove their hypothesis.

7. Students can discuss orally, or write down their hypothesis, procedure, results, and conclusions. *Students should observe that the paper towel absorbed water and therefore was more like frog skin than human skin.*

8. Have each group develop a list of reasons why the plastic wrap and paper towel were not perfect examples of animal and frog skin. *E.g., plastic wrap was completely impermeable, whereas human skin actually does breathe and excrete sweat.*

9. Ask the students to develop a hypothesis for which type of skin does a better job protecting the animal from pollution. Give each group a marker, representing exhaust from an old truck that has not passed emissions in ten years, and have them once again develop an experiment that would allow them to prove or disprove their hypothesis. *Students should observe that ink from the marker will permeate to the other side of the paper towel, whereas the plastic wrap is impermeable to the ink. (**Note:** you may want to mention that human skin can also absorb many types of contaminants through skin, but not as easily as a frog).*

10. Discuss the implications of the students' findings. Ask the students what they think might happen if they had insect repellent on their hands and they picked up a frog. Discuss how amphibians are so sensitive to pollution, that they are in fact **indicators** of how much pollution is in the environment.

11. Based on what students know about frog skin, have them come up with some ideas of other things that may negatively affect frogs.

- UV radiation
- Changes in water temperature
- Acid rain

Evaluation

1. Students list ways in which human skin and frog skin are different and similar.
2. Students write a report of their scientific study (hypothesis, procedure, results, and conclusions).
3. Students draw a picture of a human and a frog, diagramming and labeling differences in their skin.

Critical Thinking:

See Changing World Puzzler: Five-legged Frogs.

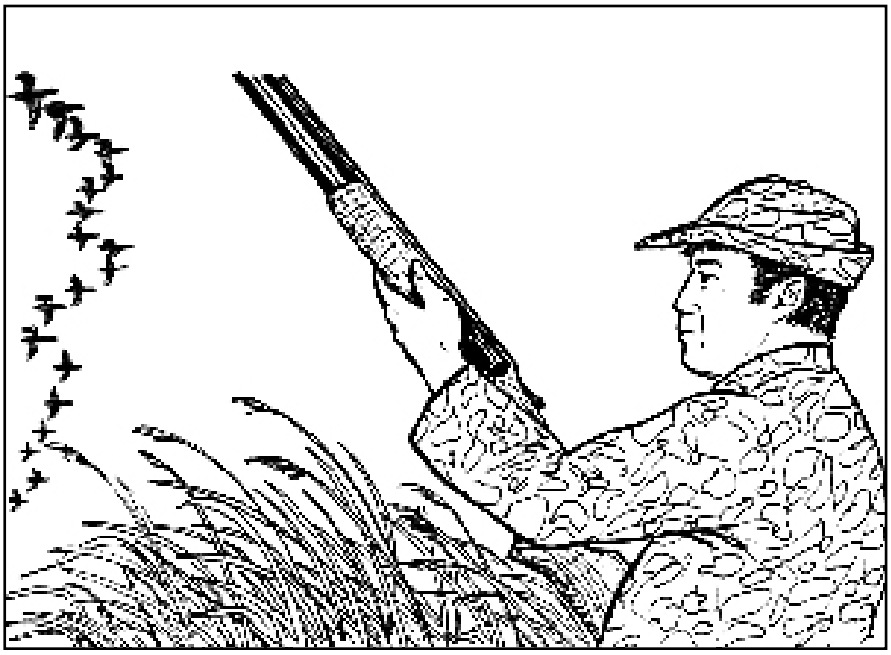
Curriculum Connections:

Books:

Wood Frogs (Wechsler, 2002).

Frog in a Bog (Himmelman, 2004).

Birds Now or Later



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: 7 - 12

State Standard: Math A-3, A-4
NGSS: MS-LS2-4.,MS-LS2-5. MS-ESS3-3,MS-ESS3-4.,HS-LS2-7. HS-LS4-6.

Subjects: science, mathematics, social studies

Skills: computation, interpreting data, problem-solving, synthesis

Duration: one class session

Group size: whole class or half class.

Setting: classroom

Vocabulary: population, management

Objectives:

Students will learn that limiting the allowable harvest of migratory birds helps to ensure that populations remain viable into the future.

Teaching Strategy:

Participants make decisions about how many pennies or crackers (representing birds or bird eggs) they take from a common source. By adjusting their "take" each turn, the students find the highest number they can take each time and still increase the total number of pennies.

Background

See INSIGHTS, Section 3 Wetland Inhabitants *"Amphibians in Alaska"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheets.

Materials:

About 500 small duck-shaped crackers, popcorn or pennies, pencil and paper for each student.

Procedure:

1. Form a circle around a table or on the floor.

2. Explain that pennies or crackers are birds and the students are hunters of the birds.

3. Place 45 birds in the middle of the group.

4. Explain to the students that they will hunt the birds every year for several years. They can hunt as many birds as they want in the first year. Pick a student to start the take, and go around the circle, with each student taking birds. Have students keep a tally on their paper of the birds they take.

5. At the end of the year, any birds that are remaining reproduce. For this game, every pair produces one young (not a realistic birth rate, however other factors other than hunting may affect the survivability of young). So if 10 birds remain in the circle, 5 young are produced and the starting population for the next year will be 15.

6. In the first year, unrestricted hunting will likely greatly reduce or eliminate the population, leaving none for future

years. At the end of the round, discuss with the students ways that they could ensure there are birds left each year. Students should come up with some kind of hunting restriction or bag limit.

7. Try several more years, using the students' suggestions for bag limits. Students may want to experiment with different limits to maintain a sustainable population.

8. Try to reach the goal of keeping as many birds as the habitat can support (250), while at the same time allowing hunters to take as many birds per person each year.

Discussion Questions

1. Did you get more birds after 10 years by hunting heavily the first years, or by waiting for the population to increase? What are the benefits of waiting to take eggs and birds for a few years? (Population increases, everyone gets more geese) If one person takes all the birds now, will there be any for the future? If we take no birds now, we can all take many later. Discuss the concept of delayed gratification.

2. If there were no hunting of birds, would the population increase beyond the limits of the habitat? (Natural predators, bad weather, etc. would likely limit the populations).

3. If you were a refuge manager and wanted to increase the size of the bird population, how would you do it? (Restore or improve wetland habitat, transplants, reduce predators, reduce bag limit etc.)

4. As human populations increase, what happens to hunting? (Must increase regulation in order to sustain yield and maintain populations. With more hunters, regulations go from voluntary to mandatory compliance.) Why do we have regulations? What happens when towns grow larger? (More traffic problems, crime, need more streetlights, laws, and regulations, more people want to hunt wildlife for food).

5. What if there were no hunting regulations and everyone could catch anything at any time?

6. How do you think traditional knowledge has been used to determine harvest levels?

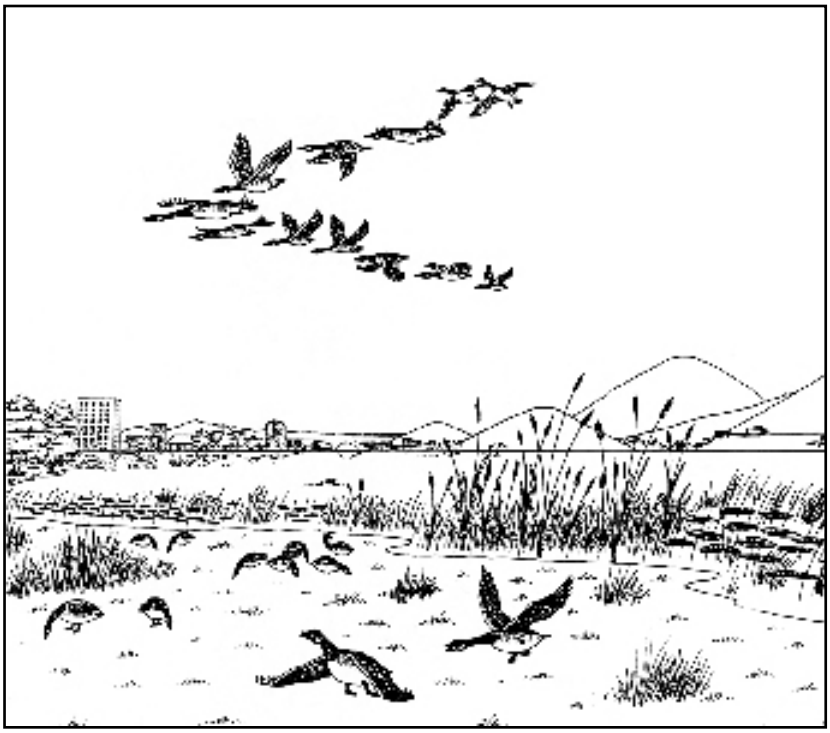
7. How should bag limits and regulations be determined if there are only a limited number of birds and a larger number of people who want them? (Biggest person takes all, absent kids don't get any, use as a reward for behavior or inherent characteristics such as tallest person or shortest hair?)

8. How does the State of Alaska or federal government set sport and subsistence hunting regulations today? Contact a state or federal wildlife manager to learn more.

Evaluation:

- Students present graphs showing changes in bird populations with different management techniques.
- Students write a proposal to the Alaska Board of Game with suggestions for how to manage the upland bird hunting in their area. (See Alaska Wildlife Curriculum: Wildlife for the Future activity I Propose! page 179).

Migration Headache



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: 4 - 8
State Standard: Geography E-5
NGSS: 5-ESS3-1.,MS-LS1-4.,MS-LS2-1 MS-LS2-4.,MS-LS2-5.,MS-ESS3-4.
Subjects: science, language arts, math, social studies, physical education
Skills: analysis, classification, comparing similarities and differences, computation (limited), discussion, evaluation, generalization, hypothesizing, inference, interpretation, listing, observation, prediction, psychomotor development, synthesis, using time and space
Duration: one 45-minute session
Group Size: 20-40 students or more
Setting: gymnasium or large outside area
Vocabulary: migration, habitat, wetlands

Objectives:

Students will:

1. List limiting factors affecting populations of migrating water birds.

2. Predict the effects of such limiting factors.

3. Describe the effects of habitat loss and degradation on populations of migrating water birds.

4. Make inferences about the importance of suitable habitat for migrating water birds.

Teaching Strategy:

Students role-play migrating water birds traveling between nesting areas and wintering grounds. The birds are subject to hazards at either end of the migration path as well as along the way.

Background

See INSIGHTS: Section 2 Wetland Inhabitants *"Alaska's Waterbirds and Wetlands"* fact sheet, Section 3 Wetlands in a Changing World fact sheets, and Section 4 Wetland Policy and Management *"Important Migratory Bird Regulations"* fact sheet.

Note: this activity simplifies the events of migration in order to keep the simulation manageable. In actuality, many of the hazards faced by migrating waterbirds are hazards en-route. We guide the teacher to emphasize these in discussion rather than during the simulation. Each student (assuming a class size of thirty) represents thousands if not tens of thousands of waterbirds. 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 the survival of migratory waterbird populations.

Materials:

Large playing field or gymnasium, two paper plates for every three students (clearly mark the plates to differentiate top from bottom).

Procedure

1. Select a large outside area about 70 feet in length or mark off an area in the gym. Place the paper plates on either end of the playing field so that there is one plate for every three students at each end of the field. Designate one end of the field as the "wintering habitat" and the other the "nesting habitat." *Please see diagram at end of this activity.*

2. Explain to the students that they are waterbirds and will migrate between wintering and nesting habitats at your signal. Tell them that the paper plates represent important wetland habitat for the "waterbirds". In order to survive, students must have one foot on a paper plate at the end of a migration (up to 3 students can have their foot on one plate). If a student is unable to find suitable habitat, that is he or she cannot get a foot on a plate, he or she dies and has to move - at least temporarily - to the sidelines and watch. During migration, the birds may want to "flap their wings," moving like birds in flight.

3. Discuss with the students how many factors limit the survival of populations of migrating waterbirds. Some involve changes in the wintering and nesting habitats. There will be times of abundant food, water, shelter, and space 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 survival. Sometimes the area of available habitat is reduced.

4. Begin the activity with all the students at the wintering habitat. Announce the start of the first migration. Have the students migrate in slow motion until they become familiar with the process. Then they can speed up. On the first try, all the birds will successfully migrate to the nesting habitat.

5. Explain that there has been no loss in available nesting habitat. Thus, a successful nesting season is at hand.

6. Before the students migrate toward the wintering habitat, turn over one plate from the wintering region. Explain that a large wetland area has been drained and used for agricultural purposes. Repeat the instruction to migrate and send the birds to the wintering habitat. Have the three students that will be displaced stand on the sideline. Tell the students that these three have died as a result of loss of habitat. Remind any "dead birds" that they will have a chance to get back into the activity. They can come back as surviving hatchlings when favorable conditions prevail and there is habitat available in the nesting ground.

7. Record the changes in population, so that students can analyze and graph the data when the simulation is complete.

8. Before the next migration to the nesting region, turn over four plates in the nesting habitat. This represents a catastrophic loss. Tell the students that this is the result of a period of unusually heavy rain during nesting which flooded many of the nests. Instruct the students to migrate. *This flooding may result in a large number of students waiting on the sidelines to reenter the nesting habitat. Before many cycles are repeated, provide them with an opportunity for reentry.*

9. Two students can be made permanent monitors to turn the paper plates over as you instruct them.

10. Repeat the process for eight or ten migration cycles to illustrate changes in habitat conditions with resulting effects on the birds. Give examples of factors that might affect the wetland habitat. (See following page for suggestions.)

11. You may want to add "stop over" sites in between the migration. Birds that do not use a stop over site reach the habitat, but become exhausted and start the return trip a few seconds later than the other birds.

POTENTIAL FACTORS REDUCING WETLAND HABITAT

- wetland drainage
- drought
- shrub expansion due to climate change
- pollution and contamination of water (e.g., oil or chemical spill)
- urban expansion
- industrial development
- conversion of wetlands to farm land
- increased runoff and turbidity from fire
- conversion of natural waterways to canals
- invasive species
- lead shot in the wetlands
- disturbance from boats, ATVs, and snow machines

POTENTIAL FACTORS IMPROVING WETLANDS HABITAT

- preservation of wetlands
- high rainfall
- creation and restoration of wetlands
- creative construction that maintains wetlands – such as boardwalks.
- mitigation of invasive species
- cleanup or elimination of lead shot
- dynamic balance with predators
- limiting 4-wheelers and snow machines to set trails

Some limiting factors are a natural and dynamic part of any environment, however overall, the availability of suitable habitats for migrating waterbirds are diminishing. This decrease can be illustrated by ending the activity with fewer areas of available habitat than can accommodate all the birds. There is general agreement that the greatest long-term threats to the survival of populations of migratory waterbirds are the loss and degradation of habitat.

12. What kinds of things can and should be done to protect and restore habitats for migrating waterbird populations? Discuss potential tradeoffs related to any recommendations.

Evaluation

1. Students identify human activities and environmental factors that might interfere with waterbird migration, distinguishing between effects on individual birds and effects on populations of birds and whether the effect is short or long term.

2. Students discuss why suitable habitat is important for migrating waterbirds? Include in your response a description of the different kinds of habitat that are needed by migrating waterbirds.

Credits:

Extensions

1. Explore local factors affecting habitat loss and degradation, or gain and restoration. Contact a wildlife biologist or manager and research the causes for long-term habitat loss, as well as any major efforts underway to prevent these increasing losses.

2. Visit a National Wildlife Refuge, state wildlife area, bird observatory, private sanctuary, seashore, or other habitat for migratory waterbirds.

3. Research other animals that migrate. Are the problems they face similar to those of migratory birds?

4. Ask an Elder to share changes to local wetlands that they've seen through their lives.

Curriculum Connections:

(See Appendix for full citations).

Books:

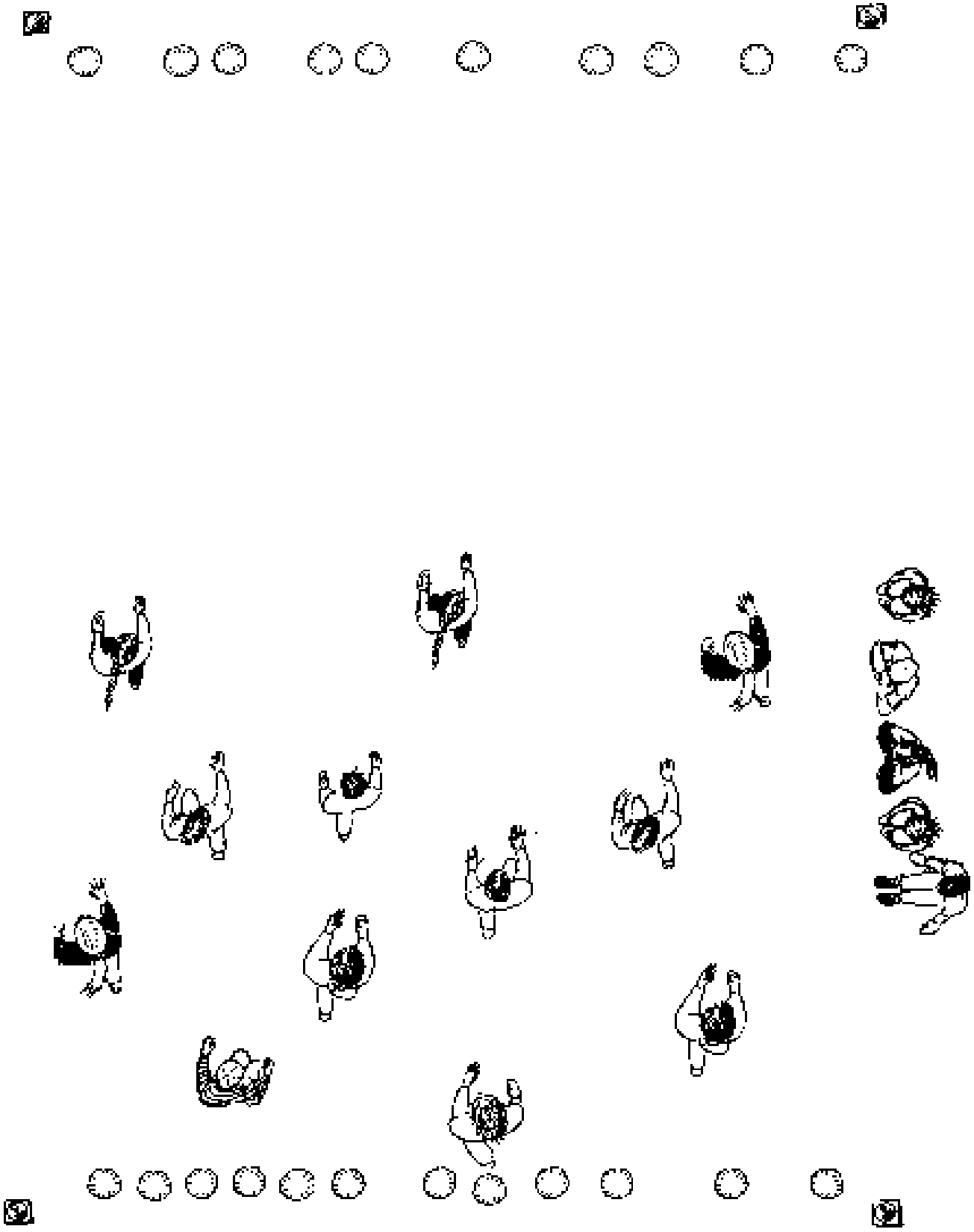
The Atlas of Bird Migration: Tracing the Great Journeys of the World's Birds. (Elphick, 1995).

Winged Migration (Perrin 2003).

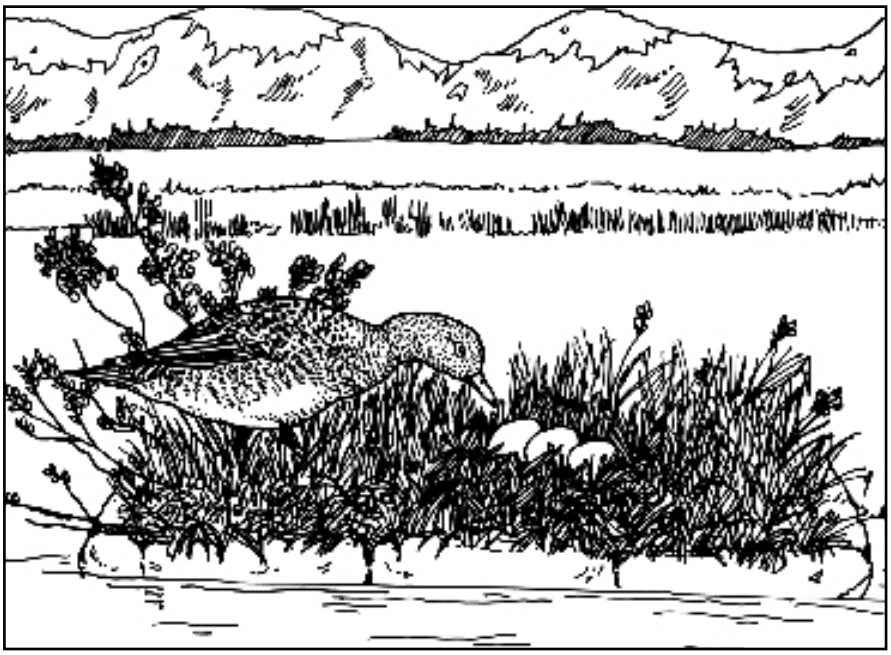
Video:

Winged Migration (Perrin 2000).

MIGRATION HEADACHE DIAGRAM



Migration Cycles



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: 6 - 9

State Standard: Math A-3, A-4
NGSS: MS-LS1-4.,MS-LS2-4.
MS-LS2-5.,MS-ESS3-4.
HS-LS2-1

Subjects: science, mathematics, language arts

Skills: addition, subtraction, multiplication, division, calculating percentages

Duration: one class session

Group Size: small group

Setting: indoors

Vocabulary: predator, prey, habitat, wetlands, migration

Objectives:

Students will:
1. Learn about the population dynamics of migrating birds.
2. Learn about problems birds face during migration and nesting.
3. Learn that birds need wetlands as migration stopovers.
4. Use basic math skills to calculate changes in population size.

Method:

Students play a board game that simulates bird migration from the nesting area in Alaska to the wintering area and back again.

Complementary Activities:

Migration Headache

Background

See INSIGHTS, Section 3 Wetland Inhabitants *"Amphibians in Alaska"* fact sheet.

Materials:

Migration Game board (xeroxed larger), Migration Game directions, die, markers, score sheet.
(see p. 161)

Procedure:

Groups of 2 – 5 can follow the directions to play the board game.

MIGRATION GAME DIRECTIONS

1. Each player needs one die, a pencil and paper, and a marker.

2. All players begin the game with a flock of 15 young birds. Each player should record the initial number of birds in their flock on their paper.

3. The player who rolls the highest value gets to have the first turn.

4. A player rolls the die to determine how many squares to advance. The square on which the player lands will then require that the player either add or subtract from their total number of birds in their flock. The player must then

record the number of birds lost or gained, the reason for the population change and the ending number of birds, on the sheet of paper.

5. If a player lands on a Weather Chance or Predator Chance, he or she needs to roll the die again to determine his or her fate. See the Fate Table below.

Fate Table

Roll of Die	*Weather Chance*	*Predator Chance*
1	Storm (-1)	Fox (-1)
2	High Winds (-1)	Gull (-1)
3	Fair Weather (0)	Mink (-1)
4	Low visibility (-1)	Fox didn't see you due to your camouflage (+1)
5	Tailwind (+1)	Humans disturbed your nest (-1)
6	Sleet (-1)	Fought off predator (+1)

6. Players travel twice around the board. At the completion of year 1, each player calculates how many young are produced, and determines the final number of young birds in his or her flock as follows:

STEP 1. Calculate the number of nesting pairs in your flock. Divide the number of birds in your flock by two (one male and one female are needed for each nest). (*Note:* if the number in your flock is odd, then use the closest lower even number. For example, if you had 7 birds in the flock, the number of nesting pairs would be 6 ÷ 2 = 3.*)*

STEP 2. Roll the die to determine the average number of young in each nest (clutch size).

STEP 3. Calculate the number of young produced. Multiply the number of nesting pairs by the average number of young produced per nest.

STEP 4. Calculate the new size of your flock. Add the number of young produced to the total number of birds in your flock.

For example, say at the end of the year there were 8 birds in the flock, so there were 4 nesting pairs. You rolled the die and obtained a value of 3 for an average clutch size. 4 X 3 = 12, so there were a total of 12 young produced at the end of the year. 12 + 8 = 20, so the final size of the flock is 20.

8. The winner of the game is the player who gets the largest flock.

ADVANCED VERSION

A. Early Nesters Have Higher Success: Due to short summers in northern areas, only a short time is available for nesting. Birds that arrive on the nesting grounds and nest early in the season have a higher nesting success than later nesting birds. Nests built later in the summer also mean that young may not have enough time before freeze-up to store up fat required for the long migration south.

To incorporate this factor, limit the time available for northward migration. If it takes more than five turns for the flock to reach the nesting area, nesting success is reduced. Subtract 10% of the young reproduced for every turn over five. For example, if it takes 7 turns to reach the nesting area, subtract 20%. If originally you would have had 12 young produced, subtract 2.4 (.20 X 12), for a final number of young produced of 11.6. *(In this exercise, each bird represents hundreds of birds in reality, thus the relevance of the decimal).*

B. Not all birds nest: Some of the birds in the flock may not be mature or healthy enough to breed. Account for this reduction in potential nesters as follows: toss the die once and multiply the number on the die by 5. This is the percentage of birds in the flock that do not nest. Determine the total number of nesting pairs from your calculation of the number of birds that DO nest.

For example, say you rolled a 6. Then 30% of the birds in your flock do not nest. Or, 70% of the birds DO nest. If there were 8 birds in your flock at the end of the year, then 5.6 (=.70 X 8) birds nest, and you have 2.8 pairs (= 5.6 ÷ 2).

Evaluation

- Students present bar graphs showing the number of birds that died, and number of birds born for each flock.
- Students write a story detailing the year in the life of their flock and the challenges to survival the birds faced.

Curriculum Connections:

(See Appendix for full citations)

Books:

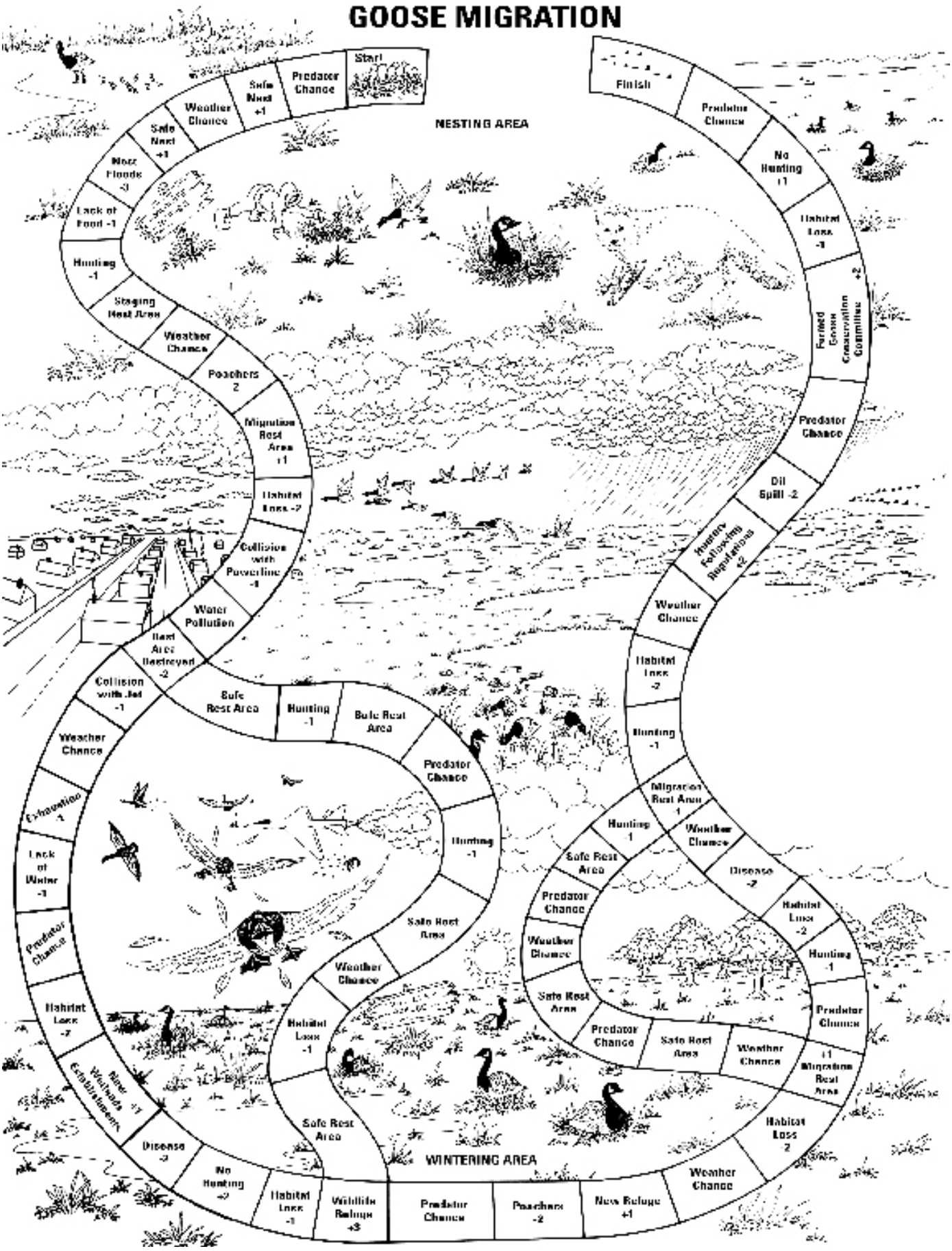
The Atlas of Bird Migration: Tracing the Great Journeys of the World's Birds. (Elphick, 1995).

Winged Migration (Perrin 2003).

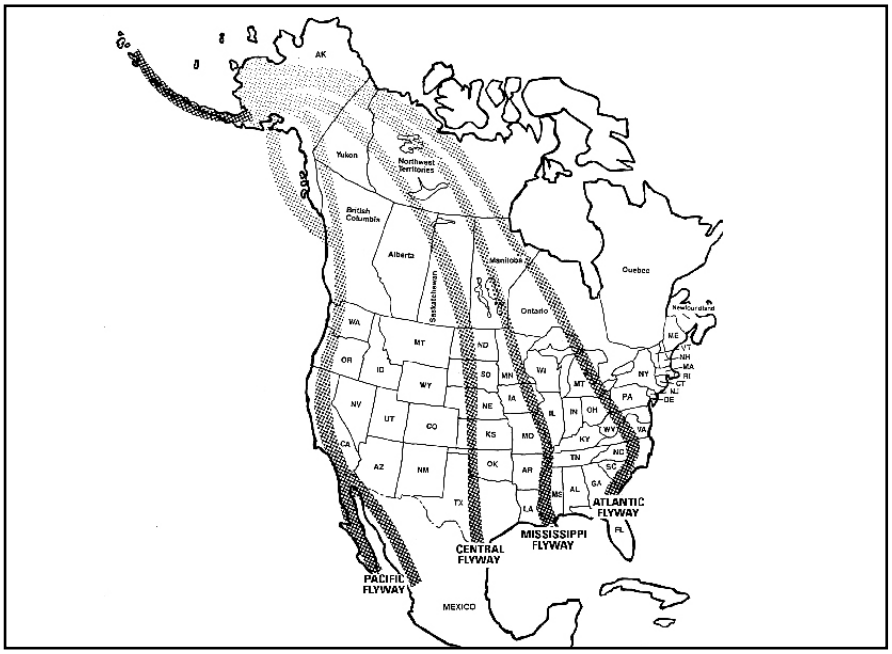
Wetlands (Finlayson and Moser 1991).

Video:

Winged Migration (Perrin 2000).


GOOSE MIGRATION
Start
Predator Chance
Safe Nest +1
Weather Chance
Safe Nest +1
Nest Floods -1
Lack of Food -1
Hunting -1
Staging Rest Area
Weather Chance
Poachers -2
Migration Rest Area +1
Habitat Loss -2
Collision with Powerline -1
Water Pollution
Nest Area Destroyed -2
Collision with Jet -1
Weather Chance
Exhaustion -1
Lack of Water -1
Predator Chance
Habitat Loss -2
Hurricane Weather -1
Disease -2
No Hunting -2
Habitat Loss -1
Wildlife Refuge +3
NESTING AREA
Finish
Predator Chance
No Hunting +1
Habitat Loss -1
Formed Goose Conservation Committee +2
Predator Chance
Oil Spill -2
Nesting Following Reproduction +2
Weather Chance
Habitat Loss -2
Hunting -1
Migration Rest Area +1
Weather Chance
Disease -2
Habitat Loss -2
Hunting -1
Predator Chance
Habitat Loss -1
Hunting -1
Safe Rest Area
Predator Chance
Safe Rest Area
Weather Chance
Safe Rest Area
Predator Chance
Safe Rest Area
Weather Chance
Habitat Loss -1
Safe Rest Area
WINTERING AREA
Predator Chance
Poachers -2
New Refuge +1
Weather Chance
Habitat Loss -2
Predator Chance
+1 Migration Rest Area
Weather Chance
Habitat Loss -2

Migratory Mapping



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: 6 – 12

State Standard: Geography A-1, A-2, A-3
NGSS: HS-LS2-8.
Subjects: science, social studies, geography.

Skills: mapping, interpreting data.

Duration: two class sessions

Group Size: whole class, then small groups

Setting: indoors

Vocabulary: migration, banding, flyway, wintering and breeding grounds

Objectives:

Students will:
1. Map the migration route of geese based on band and neck collar recovery reports.
2. Define the terms "wintering grounds" and "breeding grounds."
3. List two uses of band reports.
4. List the four major flyways in North America.

Teaching Strategy:

Students analyze information from band and neck collar recovery reports. With this data they chart the four major North American flyways.

Complementary Activities:

Migration Headache, Migration Cycles

Background

See INSIGHTS Section 2 Wetland Inhabitants *"Alaska's Waterbirds and Wetlands"* and Section 4 Wetland Policy and Management *"Migratory Bird Management"* fact sheets.

Materials:

Large classroom map of North America or overhead, copies of the map for each student, Goose band reports – copied on different colors of paper for each fly way, cut and laminated into cards, four boxes, "dots" or push pins for marking the map, string or thread, colored pencils, Map of North American Flyways (one for each student, or just one overhead).

Optional: National Geographic produces a wall map that is excellent for this activity if students plot their data on mylar overlays. Copies of the 30" X 23" "Map of North America" can be obtained from National Geographic Society, http://www.nationalgeographic.com.

Procedure

1. Beforehand, place all the goose reports for each flyway in four boxes, so that there is one box for each flyway.

2. Explore the topic of migration with the students. Why do birds come to Alaska to nest? *(To take advantage of vast food sources and large areas for nesting.)* Why do they spend

all that energy migrating south? *(Warmer wintering grounds provide sufficient food.)* How do biologists find out where all the birds in Alaska go and where they stop along the way?

3. Introduce students to the idea of **flyways**, which are generalized north-south migratory corridors. Although species' actual migrations do not strictly conform with these flyways, they are a useful way of generalizing migration routes.

4. Explain that recoveries of bands from birds can help to indicate along which flyways birds migrate. Use the large map of North America or an overhead projection and ask students to guess where geese go in the winter and which routes they take. You may want to show your students a picture of a leg or neck collar, or have a student or biologist bring one in.

5. Hand out copies of the North American maps to each student. Each map should have all of the states and Canadian Provinces (including the Northwest Territory islands). Help students speculate which routes geese might take as they move south from Alaska. In pencil, they can draw a **hypothetical** flyway map based on these speculations.

6. Tell students that they are wildlife biologists compiling recovery data. The Goose Reports are band numbers and neck collar observations that people have given to wildlife biologists so that they can track where the geese have been. Each report gives the following information which the students will mark on the map:

a) A band number *(explain to students that actual band numbers would be longer).*

b) Where the goose band and/or neck collar was found or seen.

c) Where the goose was banded (in "File Data"). Occasionally, someone will report seeing a band or neck collar more than once.

7. Take an example Goose Reports from one of the four boxes. Have a student read about where the goose band was found. Have the class help you find the geographic area where the bird was found and pinpoint it (with contact paper dots or push pins) on your map at the front of the class. (An overhead projection of the blank North America map works just as well.)

8. Have students follow along and do the same on their own map. They can make a circle on their maps and fill in the band number. Then have a student read the "File Data" from the Goose Report. Find the area where the goose was banded and mark that area with the same band number. Stretch a string or a thread, or draw a line between the two points on the large map in front of the class. Have students draw a straight line between the two points on their maps. (If possible, use the same color as the Goose Reports.)

9. Have students count off from 1-4. Tell all the "ones" that they will mark the Pacific Flyway; all the "twos" will mark the Central Flyway and so forth. Each student can select one to three reports (depending on how many are available) from the box for their flyway.

10. Have each student mark their reports on their individual maps the way you did in step 7. When they are done, they can place the information on the large map in the front of the class. The final result should be a set of straight lines that suggests a funnel leading from Canada, Alaska and the northern states to the central and southern states.

11. You may want the students to designate the four species of geese on their map and make a legend. For example, a brant may be designated by a triangle and Canada geese by circles, etc.

12. Students can draw and label the flyways on their own maps with crayons or colored pens.

13. Pass out actual North American Flyway maps so that the students can compare their maps with the key and determine which of the four flyways (Pacific Flyway, Central Flyway, Mississippi Flyway, and Atlantic Flyway) their bird traveled.

14. Take the opportunity to point out different circumstances of band recovery (accidents, hunters, observing live birds, finding dead birds, etc.).

15. Discuss with the students the variation in Fall vs. Winter Migration: While bands are recovered year-round, the information students receive will be mainly from late summer and fall migration periods. (Students can think about why more bands might be recovered at these times of the year). Students can look at the dates and determine which migration it is: spring migrations generally occur between February and April and fall migrations between September and December. Reports from January, May June, July and August indicate non-migrating times of the year. During summer months, geese are at their breeding grounds; during January they are wintering in more southern areas.

16. Students can use different colors for migration dates, and for dates indicating presence on wintering grounds. For example, reports turned in during the fall migration could be entered in brown pencil, winter reports in gray, summer banding in red, etc.

17. Engage students in a discussion of the following questions and topics:

a) Where in Alaska have bird bands been recovered? Are any of the band returns from near where we live? If not, do you know if geese migrate through your area? How do you know?

b) Where are geese banded and when? (Geese are usually banded in their nesting areas while they're molting and can be easily captured.)

c) Are there any areas where band recoveries are concentrated? What types of habitat would you find there?

d) Which flyways do geese in Alaska use?

e) Which birds were reported on spring migration (March- May), breeding season (June-August), fall migration (September-November), or wintering grounds (December-February)?

f) How old were your reported birds? Do most live long? Of all the reports, what percentage of birds survived more than one year?

g) What is the shortest time a bird took to get from a nesting area in Alaska or Canada to a wintering area in California, Louisiana, or North Carolina?

h) Do white-fronted geese from southern Alaska winter in different areas than those from northern Alaska?

i) Do Canada geese from Alaska winter east of the Rocky Mountains?

j) What can people learn from band returns and information about bird migration?

Evaluation

1. Students list several states that geese fly through on each flyway.
2. Students write a short story from the perspective of a migrating goose.

Extensions

Through research and observations made throughout the school year, students can note the varying numbers, types, and varieties of birds in the area and determine which species migrate and which do not. They can then study one migratory species they have identified in the area and use maps and bird guides to examine where the species migrate. Research could include the route and timing of migration, obstacles encountered, and traditional habitats used during the migration.

If possible, have a Fish and Wildlife Service employee, local bird bander, or hunter bring in samples of actual bird bands and/or mounted birds with bands to discuss banding in greater detail.

Students can research information about the wintering and nesting habitat for each flyway. For example, temperature ranges, ecosystem type, human populations etc.

Credits:

Issue Pac. "Hunting and Wildlife Management." U.S. Fish and Wildlife Service.

Curriculum Connections:

(See Appendix for full citations)

Books:

The Atlas of Bird Migration: Tracing the Great Journeys of the World's Birds. (Elphick, 1995).

Winged Migration (Perrin, 2003).

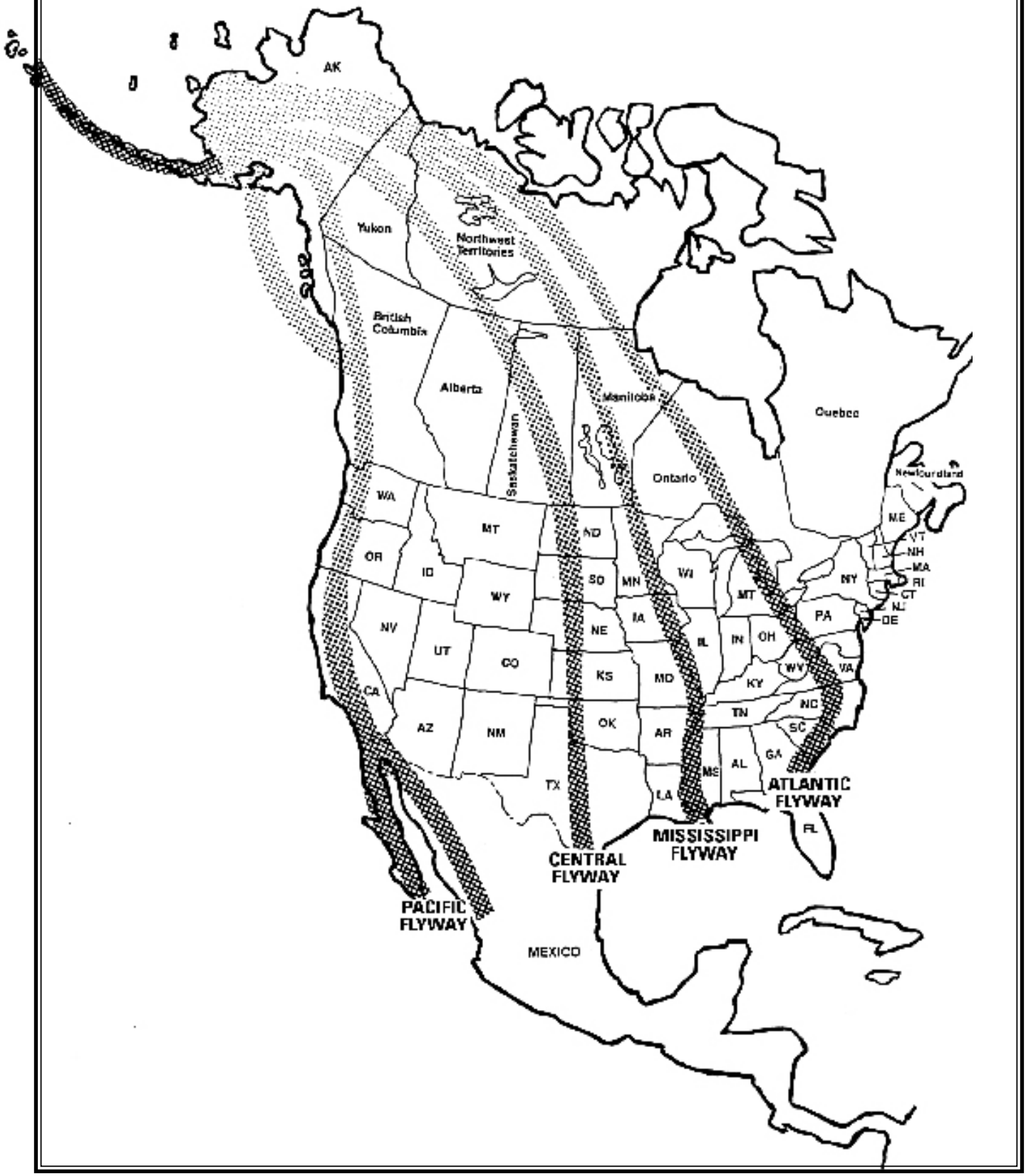
Wetlands (Moore, 2006).

Wetlands in Danger: A World Conservation Atlas. (Dugan, 1993).

Video:

Winged Migration (Perrin, 2000).

TOOLS: NORTH AMERICAN FLYWAYS



TOOLS: GOOSE REPORTS

(Note: if you have a small class, you may choose to select just a few samples from each flyway.

PACIFIC FLYWAY

1. A banded brant was found dead on the shore of Puget Sound in western Washington state on April 29, 1984.
FILE DATA: Banded July 11, 1963 near Hooper Bay on the west coast of Alaska when it was one year old.
(Hint: This goose is a brant and doesn't fly in a straight line; brant fly only over the ocean).

2. A British Columbia hunter shot a banded brant near the border between Washington and Canada at Boundary Bay on March 2, 1988.
FILE DATA: Banded July 13, 1963 near Hooper Bay on the west coast of Alaska. *(Hint: This goose is a brant and doesn't fly in a straight line; brant fly only over the ocean).*

3, 4, & 5. Biologists trying to describe the wintering ground of dusky Canada geese look for geese with red neck collars. They find 2 in southwest Washington state, 16 near Portland in northwestern Oregon, 27 in western Oregon, and none in California during December, 1990.
FILE DATA: The Alaska Department of Fish and Game put 100 red collars on dusky Canada gees during July 1989 near Cordova, Alaska where all dusky Canada geese nest.

6 & 7. During December 1990, geese crowded into a newly flooded rice field near Sacramento in central California. Disease spread by a sick snow goose killed 150 geese including a banded white-fronted goose and a banded cackling Canada goose.
FILE DATA: The cackling Canada goose was banded July 23, 1989 at the mouth of the Kuskokwim River in southwestern Alaska. The white-fronted goose was banded just south of King Salmon on the Alaska Peninsula on August 6, 1988.

8, 9, & 10. Whale-watchers in Baja California (Mexico) saw a flock of brant in Scammon's Lagoon in west central Baja on January 15, 1990. Three birds had yellow leg bands.
FILE DATA: Biologists put yellow leg bands on 300 brant near Hooper Bay on the west coast of Alaska in July, 1990. *(Hint: This goose is a brant and doesn't fly in a straight line; brant fly only over the ocean).*

11 & 12. A snow goose with a brown neck collar was seen at Kenai, Alaska on April 20, 1991. Its mate wore a red collar.
FILE DATA: These birds winter in Puget Sound in northwestern Washington state where brown collars were put on in December 1988. They nest in Siberia across the Bering Strait from the Seward Peninsula in Alaska where red collars were put on in July, 1990.

13. Commercial fishermen found a fresh Canada goose skeleton with a yellow neck collar on the beach near Pilot Point on the north side of the Alaska Peninsula in September 1990. It was found with many other bones where eagles like to perch.
FILE DATA: This was a cackling Canada goose banded July 27, 1986 near Hooper Bay in western Alaska. Students from the University of California reported seeing this yellow collar number on November 16, 1989 near Sacramento (central California).

14. A banded snow goose was shot by a hunter near Wrangell in southeast Alaska on October 14, 1990. It had an American band on its left leg and a Russian band on its right leg.
FILE DATA: The American band was put on near the northern border of California at Tule Lake in November 1, 1986. Still waiting for information about the Russian band but it is presumed to be from someplace in Siberia across the Bering Strait from the Seward Peninsula in Alaska.

15. A farmer on Queen Charlotte Island, British Columbia, sees 3 Canada geese with red neck collars land in his hay field on April 17, 1991.
FILE DATA: Collar numbers indicate that these birds were banded near Cordova, Alaska in 1987. One was seen on March 26, 1990 in a Seattle park in northwestern Washington.

16. While hunting at Cold Bay on the Alaska Peninsula, a hunter from Anchorage shot a brant with a blue leg band on October 20, 1990.
FILE DATA: Blue bands were put on 50 brant on (Banks Island which is northwest of the mainland in Northwest Territories) on July 20, 1989.
(Hint: This goose is a brant and doesn't fly in a straight line; brant fly only over the ocean).

17, 18, & 19. A biologist was checking all the hunter records at a state hunting area west of Portland in northwestern Oregon. On October 16, 1990, he noticed that three marked geese were shot: a large Canada goose with a red leg band, a small Canada goose with a yellow neck collar, and a medium-sized Canada goose with a metal leg band.
FILE DATA: The large goose was a dusky Canada goose that was banded August 2, 1986 near Cordova, Alaska (Prince William Sound). The small cackling Canada goose was banded near Hooper Bay in western Alaska on July 26, 1989. The medium-sized Taverner's Canada goose was banded at Cold Bay on the Alaska Peninsula on September 23, 1978.

CENTRAL FLYWAY

20. A banded white-fronted goose was found dead by a hunter in central Oklahoma near Oklahoma City, October 16, 1990.
FILE DATA: Banded in north central Northwest Territories at Coronation Gulf on July 22, 1983.

21 & 22. A wildlife refuge manager reported that he collected bands from a snow goose and a white-fronted goose that were found in a group of dead birds that died from disease outbreak in Southern Nebraska 12, 1991.
FILE DATA: The snow goose was banded on July 13, 1989 on Banks Island in northern Northwest Territories. The white-fronted goose was banded on December 26, 1990 near Houston, Texas, on the Gulf of Mexico.

23. A banded white-fronted goose was shot by a hunter in western Nebraska, November 11, 1990.
FILE DATA: Banded at Fort Yukon, Alaska July 20, 1988.

24. A hunter reported a banded white-fronted goose that was taken by his party in central North Dakota near Bismarck, October 12, 1990.
FILE DATA: Banded on the west side of Great Slave Lake in southern Northwest Territories on July 28, 1990.

25. A banded white-fronted goose was found sick in a field of moldy peanut plants on December 16, 1990 in the central part of the Texas panhandle.
FILE DATA: Banded on fall migration in central Saskatchewan on September 4, 1989.

26. A white-fronted goose with a red neck collar was shot by a hunter in Barrow, Alaska on September 3, 1990.
FILE DATA: Banded near Prudhoe Bay, Alaska on July 26, 1987. This bird was seen near Houston, Texas on the Gulf of Mexico during the winter of 1988.

27. A banded snow goose was spotted by bird watchers near Corpus Christi in southern Texas on January 12, 1990.
FILE DATA: Banded at Banks Island in northwest Northwestern Territories on July 23, 1990.

28. A rancher in northeast Montana saw a coyote catch a banded snow goose and chased the coyote off his kill, September 25, 1990. .**FILE DATA:** Banded at Banks Island in northwest Northwestern Territories on July 23, 1990.

29. A banded Canada goose was killed by a hunter near Pierre in central South Dakota on November 23, 1990.
FILE DATA: Banded on the west side of Great Slave Lake in southern Northwest Territories on July 28, 1978. Recaptured at Edmonton in central Alberta on August 30, 1986.

30. A banded Canada goose hit a radio station antenna at night near Dallas in central Texas, October 29, 1990.
FILE DATA: Banded in northwest Nebraska on July 15, 1990.

31. The neck collar number of a Canada goose was read from a distance by an observer in west Texas on March 9, 1991.
FILE DATA: Banded on August 1, 1989 in central Wyoming.

32. A banded Canada goose was caught after being forced down by a tornado in western Oklahoma on September 15, 1990.
FILE DATA: Banded in western South Dakota on July 20, 1981.

33. A Canada goose band was sent from northeast Colorado with no information about cause of death September 24, 1990.
FILE DATA: Banded July 26, 1988 east of Great Bear Lake in central Northwest Territories.

34. A hunter reported a banded Canada goose in western Kansas on November 12, 1990.
FILE DATA: Banded on the north slope at the Yukon and Alaska border on August 2, 1990.

35. A banded Canada goose was killed in a hailstorm in northwest Missouri near Kansas City on September 11, 1990.
FILE DATA: Banded at Lake Winnipeg in central Manitoba July 15, 1990

MISSISSIPPI FLYWAY

36. A hunter reported that a banded Canada goose was taken by his party in central Iowa October 13, 1990.
FILE DATA: Banded at Lake Winnipeg in central Manitoba on July 15, 1990.

37. A Canada goose was trapped in a fenced yard August 8, 1990, almost a year later near the same place where it was banded in northeastern Wisconsin.
FILE DATA: Banded near Green Bay, northeastern Wisconsin on August 16, 1989 as part of a flock that stays in the city park all year long.

38. A snow goose was banded in northeastern Manitoba and shot three months later on November 8, 1990 in southern Louisiana, near Lafayette.
FILE DATA: Banded in northeastern Manitoba, near Churchill on August 8, 1990.

39. A giant Canada goose was accidentally killed when it was recaptured in a banding trap near Moorhead in northwestern Minnesota on July 26, 1990.
FILE DATA: Banded at Moorhead Minnesota, July 11, 1990. A Canada goose band was sent in from southwestern Ontario with no information about the band recovery or the cause of death of the goose, August 4, 1990.
FILE DATA: Banded in northeastern Manitoba, near Churchill on July 12, 1990.

41. A Canada goose was identified by its neck collar and reported from Eau Claire in western Wisconsin, September 19, 1990.
FILE DATA: Banded in central Iowa, July 16, 1987.

42. A banded Canada goose was accidently caught by a fur trapper near southwestern, Manitoba on October 10, 1990.
FILE DATA: Banded on December 16, 1989 in southeast Minnesota near Minneapolis .

43. A Canada goose was caught in central Illinois after being hit by car, November 29, 1990.
FILE DATA: Banded on July 6, 1990 near James Bay in northeastern Ontario.

44. A Canada goose was shot in Aberdeen, South Dakota, October 20, 1990, almost 17 years after it was banded.
FILE DATA: Banded on January 6, 1974 in northwestern Arkansas near Fayetteville.

45. Men at a remote mining camp near Dubawnt Lake in southeastern Northwest Territories saw white-fronted geese moving north on April 26, 1990. One goose had a neck collar.
FILE DATA: Banded and marked July 17, 1988 on the north central coast of Northwest Territories.

46. A banded snow goose that was sick from lead poisoning was found in northeastern Iowa at Dubuque on October 23, 1990.
FILE DATA: Banded on Southampton Island in eastern Northwest Territories on July 3, 1984.

47. An Eskimo hunter on King William Island in northeastern Northwest Territories reported that he shot a white-fronted goose with a collar on May 20, 1990.
FILE DATA: Banded December 14, 1988 in a rice field in southern Louisiana near Baton Rouge in a rice field

48. On February 8, 1991, a banded snow goose was taken from 3 men in southwestern Louisiana, when a game warden arrested them for illegal hunting
FILE DATA: Banded at Cambridge Bay in southeastern Victoria Island, Northwest Territories on July 3, 1989.

49. A banded Canada goose was found entangled in a fish net near Traverse City on the northwestern shore of the lower peninsula of Michigan, April 5, 1990.
FILE DATA: Banded July 20, 1989 at James Bay in northeastern Ontario.

50. A banded Canada goose was caught by hand near Bangor, Maine, August 18, 1990. The goose was molting and the flight feathers were not yet grown.
FILE DATA: Banded August 12, 1989 in southcentral Maine near Augusta.

51. A banded snow goose was found dead by a hunter in southcentral Maine on October 16, 1990.
FILE DATA: Banded July 12, 1990 in northern Quebec at Ungava Bay.

ATLANTIC FLYWAY

52. A hunter reported a Canada goose band from northeastern Pennsylvania, November 12, 1990.
FILE DATA: Banded July 15, 1990 at James Bay in northeastern Ontario.

53. A Canada goose was shot by a hunter 10 years after it was banded in eastern Maryland near Baltimore on November 12, 1990.
FILE DATA: Banded January 2, 1980 near Baltimore, Maryland.

54. A banded snow goose was found dead at a fox den in northeastern Massachusetts, October 27, 1990.
FILE DATA: Banded July 12, 1990 in northern Quebec at Ungava Bay.

55. A banded Canada goose was found injured on the northern coast of North Carolina, December 28, 1990.
FILE DATA: Banded July 21, 1984 in north central Labrador at Goose Bay.

56. A neck-collared Canada goose was seen by person in central New Jersey, November 28, 1990.
FILE DATA: Banded July 19, 1989 on the Bay of Fundy in southwestern Nova Scotia.

57. The band number of a Canada goose was read by people feeding geese in a city park near Montreal in southeastern Quebec, July 9, 1990.
FILE DATA: Banded on January 15, 1987 in southern Maryland on Chesapeake Bay.

58. A banded Canada goose was caught after being forced down and weakened by bad weather in southeastern Pennsylvania, December 30, 1990.
FILE DATA: Banded July 8, 1990 in southeastern Ontario.

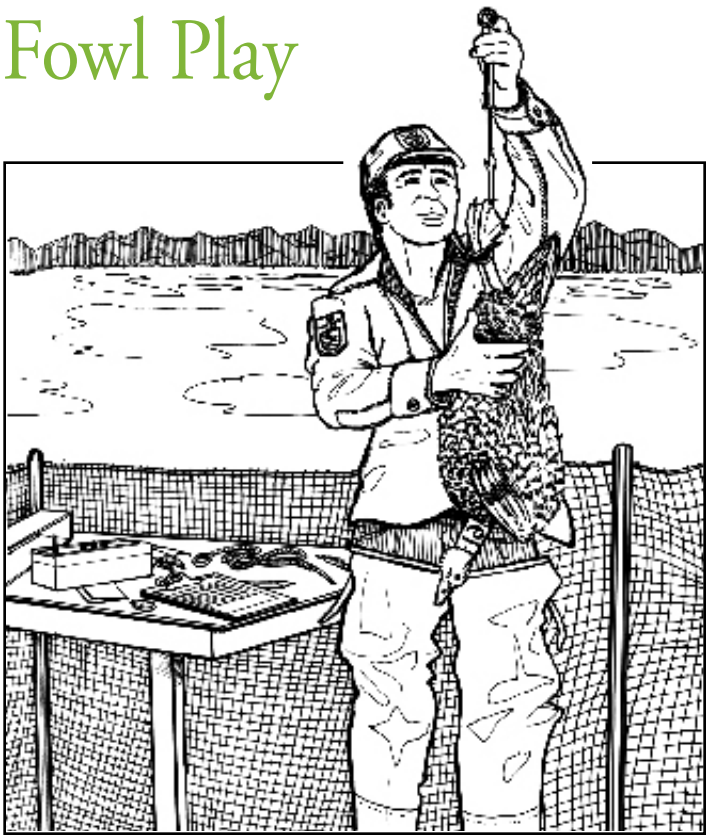
59. A Canada goose was shot on October 21, 1990 in southeastern Virginia in a farmer's field 3 months after it was banded.
FILE DATA: Banded at Moonsonee at the southern tip of Hudson Bay in Ontario on August 15, 1990.

60. A banded Canada goose was found injured in Flint near the southeastern border of Michigan, September 4, 1990
FILE DATA: Banded in near Wilmington in southeastern North Carolina on June 30, 1989.

61. A Canada goose was recaptured at the place of banding one year later in southeastern Ontario, June 22, 1990.
FILE DATA: Banded near Sudbury, Ontario on June 18, 1990.

62. Two neck-collared Canada geese were seen together near a highway at Norfolk in southeastern Virginia, January 5, 1991.
FILE DATA: Banded July 23, 1988 at east James Bay in west central Quebec.

Fowl Play



Section 3
Wetland Activities
WETLAND INHABITANTS

Grade: 6 - 12

State Standard: English/LA B-1;

NGSS: MS-LS2-1,MS-LS2-4.
MS-ESS3-4.,HS-LS2-6. ,HS-LS4-5.

Subjects: science, language arts, environmental studies

Skills: analysis, problem- solving, group interaction, research, discussion

Duration: 1 class period

Group Size: small groups

Setting: indoors

Topics: wildlife research, environmental impact

Objectives:

Students will learn:

1. Some ways in which wildlife biologists and ornithologists conduct and analyze field research.
2. That there may be several causes for one problem.

Teaching Strategy:

Students will employ wildlife survey techniques to determine the cause of a drop in a waterfowl population.

Background

See INSIGHTS Section 2 Wetland Inhabitants *"Alaska's Waterbirds and Wetlands"* and Section 4 Wetland Policy and Management *"Migratory Bird Management"*, and Section 3 Wetlands in a Changing World fact sheets.

Materials:

Copies of Puzzle Information Sheets for each of three groups; Survey Data Cards for each group in envelopes (need 9 envelopes total); Student Research Page for each group.

Procedure

The activity employs the following data cards:

Habitat Survey Data Cards include information collected from food analysis, and from studies on other animals trapped in the area.

Nest Survey Data Cards include information collected during migration and egg-laying, during incubation, and while the young are in the nest.

Bird Survey Data Cards include information collected from stomach content analysis, age and sex distribution analysis, and autopsy results.

1. Before class: Label three envelopes "Puzzle # 1 Dusky Canada Goose", three "Puzzle #2 Pintail Duck", and three "Puzzle #3 Aleutian Islands Canada Goose". Label one of each Habitat Survey Data Cards, one Bird Survey Data Cards, and one Nest Survey Data Cards.

2. Make copies of the pages containing the Survey data cards; cut and laminate them; and place them in the appropriate envelopes. Keep the envelopes at your desk.

3. Students will work in groups. Make enough copies of each puzzle information sheet so that several students in each group have one.

4. Tell the students that they are going to be wildlife biologists trying to solve important puzzles regarding the bird populations in Alaska. You may want to spend some time introducing the scientific method, and the importance of objectivity and replication.

5. Divide the class into three groups, one for each of the three puzzles: Dusky Canada goose, Pintail Duck, and Aleutian Canada goose. If the class is large, you may want to divide the class into six groups, and have two of each. Give students copies of the Puzzle Information Sheets and the Student Research Page. Ask student to designate a note-taker for filling out the Research Page.

6. Introduce students to the puzzles by reading the following information:

> Here are the puzzles: Populations of different types of geese and ducks in three locations in Alaska dropped dramatically during different time periods. The population declines at each location may or may not be related to each other. You must discover the reason for the decline at your location. *(Note: the population of the geese or duck in your area may have increased since the puzzle was "solved" by the biologists)*.
>
> You can use three different kinds of surveys to help you solve the puzzle: Habitat Survey, Nest Survey, or Bird Survey.
>
> Habitat Surveys can tell you the condition of food and water supplies and of other animals within the habitat. Nest Surveys can show whether or not adults are laying eggs, if the young are hatching out of the eggs, and if the young are surviving to adulthood. Bird Surveys may detect the presence of diseases, parasites, or poisons, and tell if the age and sex distribution (ratio of young to adult, male to female) of the population is normal or unusual.

7. Have each group first work together in their groups to develop five hypotheses for why the bird population dropped so dramatically at their location.

8. For each hypothesis, groups should decide and write down which of the three types of surveys they would like to use to start to gather information to prove the hypothesis.

9. Each group then decides which of the following three surveys they would like to conduct first: Habitat Survey, Nest Survey, or Bird Survey.

10. When groups are ready to "conduct a survey", they can come to you and ask for one of the three types of survey data cards. Avoid giving groups more than one survey card envelope at a time. Rather, guide them to exhaust the analyses possibilities of one survey before they move on.

11. When students think they know what has caused the population drop, have them present their hypothesis to you. You can peek at the solutions to see if students are correct. You may need to tell the students to go back and re-analyze the data so that they can revise their hypothesis, or develop new hypotheses. Once the students seem to be honing in on the correct reason, show them the solution, which will tell them what they need to know to verify their hypothesis. The Student Research Page should help guide their investigations.

12. When all the students have solved their puzzles, engage in a class discussion:

- What was the first step each group decided to take to solve the problem? Why did each group choose that particular step?

- Now that you know what most likely caused the population decline, what clues do you see that you may have missed initially? How might you have conducted your study differently?

- What other tools do you wish had been at your disposal?

- Why is it important to try to solve puzzles such as this one?

Evaluation

Students describe the challenges biologists come up against when conducting wildlife studies, and the tools biologists can use.

Critical Thinking

Discuss with students the pros and cons of conducting studies in a laboratory (controlled) situation, where variables can be isolated one at a time.

Credit:

CLASS Project. 1986. "Fowl Play." National Wildlife Federation.

Curriculum Connections:

(See Appendix for full citations):

Books:

Wetlands (Finlayson and Moser, 1991).

TOOLS: STUDENT RESEARCH PAGE

Names of group members _____

Puzzle _____

Hypothesis	Supporting Data (from cards)	Negating Data (from cards)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PUZZLE # 1 Dusky Canada Goose

The Dusky Canada goose *(Branta candensis occidentalis)* is a medium sized, dark brown sub species of the Canada goose. It nests in Alaska's Copper River Delta, and winters in the central valleys of Oregon and California.

THE PUZZLE YOU NEED TO SOLVE:

The population of Dusky Canada goose increased following the 1964 earthquake to near 25,000 due to short-term benefits of the habitat change. Their population declined in the early 80s, and since then has hovered between 10,000 and 18,000 individuals. **Why did their population decline?**

RESEARCH METHODS YOU CAN CHOOSE TO USE:

1. Habitat studies, which may involve the following three surveys:

- Collection and analyses of samples of that particular animal's food
- Collection and analyses of the water that the particular animal is drinking
- Collection and analyses of other types of organisms that share the animal's habitat

Analyses of the above studies may tell biologists whether or not there are pathogens some where in the habitat.

2. Nest surveys. A wildlife biologist studying nesting success of birds might examine the nest at three different times:

1. during mating and egg-laying;
2. during incubation of the eggs;
3. while young are in the nest.

Examining nests during mating and egg-laying will illuminate whether or not eggs are even being laid. If there are no eggs, one conclusion could be that the females are infertile.

If eggs were laid, but were missing during incubation, one possible conclusion could be that a predator has stolen the eggs.

If eggs were successfully incubated and hatched, but young did not survive, then biologists may conclude that there is something affecting the ability of young to survive.

3. Bird Surveys. You have the ability to study your bird using three different studies:

1. analyses of the bird's stomach contents,
2. autopsies of birds that have recently died,
3. population analyses – looking at the age and ratio of males to females.

You will need to trap the birds to study their ages and sex. Abnormalities in the sex ratios are important clues because abnormal sex rations could make it difficult for the population of birds to reproduce.

Autopsies and stomach analyses may tell you whether or not the birds have been poisoned, or if they have been afflicted with a parasite or disease.

WHAT YOU MUST DO:

Work as a group to develop and write down 5 different hypotheses that solve the puzzle.

Decide which of the three kinds of research listed above you want to do first, pick the corresponding Data Card. Discuss the information on the card and look for clues that may support your hypothesis.

You may find that you need to study all three data cards in one survey envelope to solve the puzzle. If you do not have all the data you need after you review the three data cards from one envelope, go to a different survey envelope.

PUZZLE # 2 Pintail Duck

This medium-sized duck has narrow, pointed wings, a long neck, and very long and tapering tail. Pintails usually inhabit shallow freshwater marshes and open areas with ponds and lakes. They breed throughout the U.S. and Canada, from the northcentral U.S. as far west as the Aleutian Islands and north to Alaska's North Slope. They winter at wetlands throughout much of the United States. You are conducting your study at Minto Flats, a wetlands complex located in Interior Alaska (about 35 miles from Fairbanks) along a loop of the Tanana River.

THE PUZZLE YOU NEED TO SOLVE:

Pintail ducks *(Anas acuta)* declined to an all time low in 1991 – 50% of the population average for 1955 - 1988. **Why did their population decline so dramatically in 1991?**

RESEARCH METHODS YOU CAN CHOOSE TO USE:

1. Habitat studies, which may involve the following three surveys:

- Collection and analyses of samples of that particular animal's food
- Collection and analyses of the water that the particular animal is drinking
- Collection and analyses of other types of organisms that share the animal's habitat

Analyses of the above studies may tell biologists whether or not there are pathogens some where in the habitat.

2. Nest surveys. A wildlife biologist studying nesting success of birds might examine the nest at three different times:

1. during mating and egg-laying;
2. during incubation of the eggs;
3. while young are in the nest.

Examining nests during mating and egg laying will illuminate whether or not eggs are even being laid. If there are no eggs, one conclusion could be that the females are infertile.

If eggs were laid, but were missing during incubation, one possible conclusion could be that a predator has stolen the eggs.

If eggs were successfully incubated and hatched, but young did not survive, then biologists may conclude that there is something affecting the ability of young to survive.

3. Bird Surveys. You have the ability to study your bird using three different studies:

1. analyses of the bird's stomach contents,
2. autopsies of birds that have recently died,
3. population analyses – looking at the age and ratio of males to females.

You will need to trap the birds to study their ages and sex. Abnormalities in the sex ratios are important to clues because abnormal sex rations could make it difficult for the population of birds to reproduce.

Autopsies and stomach analyses may tell you whether or not the birds have been poisoned, or if they have been inflicted with a parasite or disease.

WHAT YOU MUST DO:

Work as a group to develop and write down 5 different hypotheses that solve the puzzle.

Decide which of the three kinds of research listed above you want to do first, pick the corresponding Data Card. Discuss the information on the card and look for clues that may support your hypothesis.

You may find that you need to study all three data cards in one survey envelope to solve the puzzle. If you do not have all the data you need after you review the three data cards from one envelope, go to a different survey envelope.

PUZZLE # 3 Aleutian Cackling Goose

The Aleutian cackling goose *(Branta hutchinsii leucopareia)* is one of the smallest of the Canada geese. It breeds on the Aleutian Island chain, and winters in Oregon, Washington, and California.

THE PUZZLE YOU NEED TO SOLVE:

The Aleutian cackling goose population dropped to perilous numbers by the 1970s, and the animal was placed on the endangered species act. Since the onset of recovery efforts, the population has increased – so much that the species was removed from the endangered list in 2001. **What made their population plummet in the 1970s?**

RESEARCH METHODS YOU CAN CHOOSE TO USE:

1. Habitat studies, which may involve the following three surveys:

- Collection and analyses of samples of that particular animal's food
- Collection and analyses of the water that the particular animal is drinking
- Collection and analyses of other types of organisms that share the animal's habitat

Analyses of the above studies may tell biologists whether or not there are pathogens some where in the habitat.

2. Nest surveys. A wildlife biologist studying nesting success of birds might examine the nest at three different times:

1. during mating and egg-laying;
2. during incubation of the eggs;
3. while young are in the nest.

Examining nests during mating and egg laying will illuminate whether or not eggs are even being laid. If there are no eggs, one conclusion could be that the females are infertile.

If eggs were laid, but were missing during incubation, one possible conclusion could be that a predator has stolen the eggs.

If eggs were successfully incubated and hatched, but young did not survive, then biologists may conclude that there is something affecting the ability of young to survive.

3. Bird Surveys. You have the ability to study your bird using three different studies:

1. analyses of the bird's stomach contents,
2. autopsies of birds that have recently died,
3. population analyses – looking at the age and ratio of males to females.

You will need to trap the birds to study their ages and sex. Abnormalities in the sex ratios are important to clues because abnormal sex rations could make it difficult for the population of birds to reproduce.

Autopsies and stomach analyses may tell you whether or not the birds have been poisoned, or if they have been inflicted with a parasite or disease.

WHAT YOU MUST DO:

Work as a group to develop and write down 5 different hypotheses that solve the puzzle.

Decide which of the three kinds of research listed above you want to do first, pick the corresponding Data Card. Discuss the information on the card and look for clues that may support your hypothesis.

You may find that you need to study all three data cards in one survey envelope to solve the puzzle. If you do not have all the data you need after you review the three data cards from one envelope, go to a different survey envelope.

TOOLS: DATA CARDS FOR SURVEY ENVELOPES

PUZZLE #1 Dusky Canada Goose DATA CARDS

HABITAT SURVEY ENVELOPE for Dusky Canada Goose Puzzle

FOOD ANALYSIS DATA CARD

An analysis of the favorite kinds of food of the geese shows nothing unusual.

However, a review of aerial photographs shows that shrubs and trees have expanded into the nesting area by 20% since 1964.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle, Habitat Survey Envelope

WATER ANALYSIS DATA CARD

The water survey shows that the oxygen content is normal and the pH (acid level) is within acceptable ranges. There are no unusual chemicals in the water.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle, Habitat Survey Envelope

OTHER ANIMALS DATA CARD

Since 1964, the gull population has increased by 40%, the bear population has increased by 25%, and the coyote population has increased by 34%.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle, Habitat Survey Envelope

NEST SURVEY ENVELOPE for Dusky Canada Goose Puzzle

DURING MATING AND EGG-LAYING DATA CARD

The geese are breeding. Fertile eggs are being produced at the normal rate, five to eight per nest.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Nest Survey Envelope

DURING INCUBATION DATA CARD

Most nests show a 50 percent decline in the number of eggs over the four-week incubation period. Broken shells are found in close proximity to many of the nests.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Nest Survey Envelope

GOSLING DATA CARD

The nest has fewer young than normal. However, the goslings that are there are healthy and doing well.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Nest Survey Envelope

BIRD SURVEY ENVELOPE for Dusky Canada Goose Puzzle

STOMACH CONTENTS ANALYSIS DATA CARD

Nothing unusual is found in the stomachs of the geese. They are consuming the food common to geese.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Bird Survey Envelope

AGE AND SEX DISTRIBUTION ANALYSIS DATA CARD

Surveys show a very high number of adult birds and very few immature (young) birds. The sex distribution of the birds is normal.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Bird Survey Envelope

AUTOPSY RESULTS DATA CARD

An autopsy of several birds reveals nothing unusual.

If you did not get the information you need from this analysis, perform another analysis.

Dusky Canada Goose Puzzle Bird Survey Envelope

TOOLS: DATA CARDS FOR SURVEY ENVELOPES

PUZZLE #2 Pintail Duck DATA CARDS

HABITAT SURVEY ENVELOPE for Pintail Duck Puzzle

FOOD ANALYSIS DATA CARD

An analysis of the ducks' favorite kinds of foods shows nothing unusual. Vegetation and small insects are plentiful and show no diseases.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck Puzzle Habitat Survey Envelope

WATER ANALYSIS DATA CARD

The water survey shows that the oxygen content is normal and the pH (acid level) is within acceptable ranges. There are no unusual chemicals in the water.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck Puzzle Habitat Survey Envelope

OTHER ANIMALS DATA CARD

A live-trapping survey shows that the populations of other duck species in Minto Flats, prime habitat for Pintails, has increased. Populations of other animals in the area are relatively stable and none are shown to be unusually large or small.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck Puzzle Habitat Survey Envelope

NEST SURVEY ENVELOPE for Pintail Duck Puzzle

DURING MATING AND EGG-LAYING DATA CARD

Surveys taken right after egg-laying show that females have laid eggs, but the average clutch size (the number of eggs in a nest) is less than normal. The eggs are normal.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck puzzle Nest Survey Envelope

DURING INCUBATION DATA CARD

During the four-week incubation study, it is found that the adults are behaving normally and the female is sitting on the eggs.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck Puzzle Nest Survey Envelope

DUCKLING DATA CARD

During the duckling-rearing period, brood surveys show that the number of ducklings corresponds to the number of eggs laid.

If you did not get the information you need from the analysis, perform another analysis.

Pintail duck Puzzle Nest Survey Envelope

BIRD SURVEY ENVELOPE for Pintail Duck Puzzle

BREEDING GROUND SURVEY

The number of adult birds is much higher than average. You compare data with a refuge in the central U.S. and find out that the Minto Flats area has a much higher proportion of the total North American population of nesting Pintail Ducks than normal.

If you did not get the information you need from the analysis, perform another analysis.

Pintail duck Puzzle Bird Survey Envelope

STOMACH CONTENTS ANALYSIS DATA CARD

Nothing unusual is found in the stomachs of the ducks. They are consuming the food common to ducks.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck puzzle Bird Survey Envelope

AGE AND SEX DISTRIBUTION ANALYSIS DATA CARD

Surveys show a very high number of adult birds and very few immature (young) birds. The sex distribution of the birds is normal.

If you did not get the information you need from this analysis, perform another analysis.

Pintail duck puzzle Bird Survey Envelope

TOOLS: DATA CARDS FOR SURVEY ENVELOPES

PUZZLE #3 Aleutian Cackling Goose DATA CARDS

HABITAT SURVEY ENVELOPE for Aleutian Cackling Goose Puzzle

FOOD ANALYSIS DATA CARD

An analysis of the favorite kinds of food of the geese shows nothing unusual. Vegetation and small insects are plentiful and show no diseases.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Habitat Survey Envelope

WATER ANALYSIS DATA CARD

The water survey shows that the oxygen content is normal and the pH (acid level) is within acceptable ranges. There are no unusual chemicals in the water.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Habitat Survey Envelope

TRAPPING OTHER ANIMALS DATA CARD

Populations of other seabirds in the area have declined as well.

Some arctic foxes were discovered living on the islands. These animals are not native to the area.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Habitat Survey Envelope

NEST SURVEY ENVELOPE for Aleutian Cackling Goose Puzzle

DURING MATING AND EGG-LAYING DATA CARD

The geese are breeding. Fertile eggs are being produced at the normal rate, five to eight per week.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Nest Survey Envelope

DURING INCUBATION DATA CARD

The number of eggs in nests declined by an average of 50% during the four-week incubation period. Broken shells were discovered nearby many of the nests.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Nest Survey Envelope

GOSLING DATA CARD

Nests on average have fewer young than normal. Goslings that are present are healthy and doing well.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Nest Survey Envelope

BIRD SURVEY ENVELOPE for Aleutian Cackling Goose Puzzle

STOMACH CONTENTS ANALYSIS DATA CARD

The geese were consuming the food most common to geese.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Bird Survey Envelope

AGE AND SEX DISTRIBUTION ANALYSIS DATA CARD

Surveys showed that the number of adult and immature (young) birds is lower than normal. The ratio of male birds to female birds is normal.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Bird Survey Envelope

AUTOPSY RESULTS DATA CARD

An early summer autopsy of several birds reveals nothing unusual.

If you did not get the information you need from this analysis, perform another analysis.

Aleutian Cackling Goose Puzzle Bird Survey Envelope

DUSKY CANADA GOOSE

The Copper River Delta is located to the east of Prince William Sound. It consists of a large intertidal estuary system at the mouth of a large glacial river. In 1964, a large earthquake occurred, uplifting the area as much as six feet. Portions of the delta were uplifted beyond the reach of the tide. The wetlands dried out and shrubs and trees moved into the former wetlands. The new habitat is ideal for coyotes, bears, gulls, and jaegers who prey on eggs and goslings, and not so good for the Dusky Canada Goose, whose nests are vulnerable to such predators.

PINTAIL DUCK

Pintail ducks breed throughout the U.S. and Canada, from the northcentral U.S. up to the Aleutian Islands. However, habitat in the central prairie states has declined rapidly as humans have converted wetland habitat for other uses. Migration studies have shown that when habitat is limiting, some of the ducks that normally nest in the Central U.S. will fly all the way to Alaska to find good habitat. Unfortunately, not all of the birds are equipped to migrate the long distance, and they exhaust their fat reserves, compromising reproductive success. The result is a toll on the entire Pintail duck population. Meanwhile, important prairie wetland habitat for Pintails continues to be degraded in the central U.S. and Canada.

ALEUTIAN CACKLING GOOSE

In the 1930's, fox farmers introduced arctic foxes on the Aleutian islands for the fur trade. Formerly, the Aleutian cackling goose population had had no natural predators, but the introduced foxes preyed on the adult goose, as well as the goslings and the eggs. The Aleutian cackling goose has no defense against this introduced predator. Removal of foxes has since allowed the goose population to recover.

Overview

WHAT ARE THE OUTDOOR WETLAND ACTIVITIES?

The activities listed in this section are designed to spur students out of the their classroom seats and engage them in a discovery of the wetland environment. The activities are designed to promote critical thinking and elicit responses to higher order questions.

The activities offer a multi-sensory experience with kinesthetic learning opportunities. Students are encouraged to synthesize what they know and make new discoveries.

HOW DO I USE THE ACTIVITIES?

1. Each of the fourteen activities is written as a stand-alone lesson plan, so that it can be used independently, one or more at a time.

2. The activities can also be easily adapted for use on a multi-station trail. They can be combined in this manner to be a culmination of classroom learning in wetland ecosystems, organized as a field trip, or an initial exploration of wetlands.

3. The final activity called "Rate a Wetland" involves closely studying many components of the wetland to develop a quantitative and qualitative measure of the wetland's value. This activity can be a stand alone, or it can employ each of the other thirteen activities as steps to help rate the wetland.

TIPS FOR SUCCESS: an exciting wetland field trip.

1. Select a local wetland for a field trip. Try a slough, pond, or bog near your school if one is available, or go to a nearby marsh. If a wetland is within walking distance, consider planning short trips rather than one long one.

2. Most of the activities in this section are best suited to small supervised groups. Arrange to take along assistants such as parents, older students, and biologists or education specialists from natural resource agencies.

3. If at all possible, visit the field trip site ahead of time with your assistants and show them what they will be doing.

4. Prepare your students ahead of time. You might want to familiarize yourself and your students with wetland birds, animals, and plants before going into the field. You can also develop students' observation skills: bring a pet animal or house plant into class and let them practice. How many parts does the plant or animal have? What does the plant or animal feel like? What else can they tell you about it?

5. Minimize your impact in the field. Before hand you can discuss with your students how they can help take care of animals and plants they encounter in their field and classroom studies. Students can help develop some guidelines for minimizing disturbance of wetland homes. Here are some suggestions: step softly and quietly while observing animals, replace rocks or logs after looking underneath (to keep the roofs on the animal's homes), handle animals gently, fill in holes after looking for worms or clams (to prevent suffocation of the animals next door), and don't take live animals or plants away from their homes. Be careful not to approach animals closely, and back away if it appears that animals are scared or being discouraged from obtaining food.

6. So that other people can enjoy and learn from the area, too, it is a good idea to discourage personal collections of any natural items, living or nonliving. Limit collections to educational purposes such as art projects or aquarium study — and return any living animal to their natural habitats as soon as possible. For classroom specimens, preserve only those animals already dead.

7. Encourage students to leave the beach, river, or wetland cleaner than when they arrived.

8. Review safety with the children, especially around the water. Wear life jackets while near the bank of a large stream. Avoid tidal mudflats with sticky mud where people can get stuck.

9. Students are likely to get wet. Students who wear non-cotton clothing in layers are best suited for damp and cold conditions. Take extra clothes and rain gear (plastic trash bags will do in a pinch).

10. Remind students not to taste anything without adult supervision. Some wetlands contain poisonous plants, and some people are allergic to plants that normally are harmless.

11. Have each student make a "Wetland Field Journal" using blank sheets of paper folded and stapled to make a book. Students can design their own covers. The journal will be used to record observations during many of the activities.

12. Practice the field trip. The day before the actual trip, have students bring appropriate clothes and gear. On the playground, simulate the field trip to familiarize students with equipment.

Who's in the Water?

ALASKA'S ECOLOGY CARDS SUGGESTED

Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 4 -12

State Standard: Art A-1; Geography C-1, C-2, C-3
NGSS: 4-LS1-1. ,5-LS2-1.,5-ESS3-1 MS-LS1-5., MS-LS2-1.,-LS2-2. MS-LS2-3.,MS-LS2-4,-ESS3-3. HS-LS2-7.

Subjects: Science, Math, art

Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating,

Duration: 30-90 minutes

Group Size: 3-4

Setting: Outdoors/indoors

Vocabulary: invertebrates, larvae, pupae, sediments

Objectives:

1.Students will learn that many different types of invertebrates live in wetlands in various habitats.

2. Students will identify some aquatic invertebrates and learn their ecosystem function.

Teaching Strategy:

Students use various sampling devices to explore aquatic invertebrates in the water. Students can sort and count the insects to make quantitative comparisons.

Complementary Activities:

Energy Flow in an Alaska Wetland, Are You Me? Mystery Creature

Background

See INSIGHTS Section 2 Wetland Inhabitants *"Aquatic Invertebrates"* and *"Summary of Animal Adaptations for Wetland Living"* fact sheet.

Materials:

For each group, (or groups can trade materials and share data): underwater viewer, collecting screen, kick sampler, sweep net (see how to construct them on following pages), aquatic invertebrate cards (page 188), 4 ice cube trays, hand lenses or magnifying glasses, 4 light-colored dish tubs, forceps, two sizes of plastic eye droppers, field notebooks, waders or rubber boots.

Procedure

1. Review some of the ecosystem functions of aquatic invertebrates (e.g. shredder, collector, important food for larger animals like fish). Discuss the different possible habitats of these animals, e.g. beneath rocks; grazing microscopic organisms off of algae and leaf litter, etc.

2. Discuss with the students how aquatic invertebrates can be important indicators of water quality – "water canaries" like canaries in the coal mine. For example, caddisflies do not reside in polluted water – they are an indicator of high water quality, whereas tubifex worms tolerate very low oxygen conditions – they are an indicator of very poor water quality.

3. Explain to the students that some of the animals they will see are the larval form of insects they are very familiar with (e.g. mosquitoes, dragonflies).

4. Begin by having students place the **underwater viewer** in the water so that the plastic is just below the surface, and then look down through the top of the can. Have students look for insect larvae, worms, or other creatures and describe what they see in their field notebooks.

5. Students turn over rocks both at the water's edge, and in the water and look for invertebrates on the underside. *Remind students to be sure to put rocks back in the same place, so the animals that live there will still have their home.*

6. Two students spread out the **collecting screen** by holding the two poles apart. Be sure they hold it so that the extra screen is lying on the bottom upstream from where they stand. A third student walks upstream and kicks up the stream bottom while walking back toward the net. Avoid disturbing the stream bottom too much, and avoid muddying the water if others are working downstream. Wash what collects on the screen into the dish tub. Label the tub "In the Water"

7. The **bottom kick sampler** is used similarly. One student places the kick sampler on the bottom of a stream or wetland channel so it faces into the current. Gently the student turns over rocks and stirs the gravel and sediments in front of the net, and then lifts the net out of the water. Once again, rinse the net into the dish tub. Label the tub "On the bottom".

8. **Core samplers** will allow students to look for invertebrates in the sediments. Place the core sampler open end down on the stream or pond bottom and twist it down into the sediment. Put fingers over the nail hole, then pull the sampler straight back up. When the bottom of the sampler is at the sediment surface, slip the jar lid or a flat piece of wood beneath the can, and then lift it out. Rinse the sediment into the dish tub. Label the tub "In the Sediments".

9. Sweep the **collecting net** through areas of shallow water where there are plants. Turn the net inside out and empty a small amount of its contents into the bottom of the dish tub. Label the tub "In the plants". Sweep the net through areas of deeper water and look for different types of organisms

10. Have students look for invertebrates in each dish tub. Label the ice cube trays the same way as the dish tubs. Using the eyedroppers, students can sort individual organisms into the ice-cube trays for easier viewing. **Return animals to the water within 30 – 60 minutes or they will die.**

11. Have students describe and/or draw organisms they find, being sure to label the habitat (in the riffles, on the bottom, in the sediments, in plants, in deep water, or beneath rocks). Have the students also describe the type of wetland habitat they are in.

12. Have students try to identify their invertebrates using the cards, field guides and what they know about the organism's habitat. If they can identify the animal, ask them to make an inference about the quality of water in the wetland, based on what they know about the invertebrates.

Evaluation:

1. Describe what sorts of food for fish and larger animals exist in the water.
2. Describe the different sorts of habitats and ecosystem roles of aquatic invertebrates.
3. Create an index of water quality, using aquatic invertebrates.

Curriculum Connections:

(See Appendix for full citations).

Books:

Aquatic Insects and How They Live (McLung, 1970).

Freshwater Invertebrates of North America (Voshel, 2002).

Wetlands (Rood, 1994).

Websites:

Download a complete stream monitoring manual *"Alaska Stream Team"* at: http://aquatic.uaa.alaska.edu/pdfs/EducationLevelBioMonitoringMethods.pdf

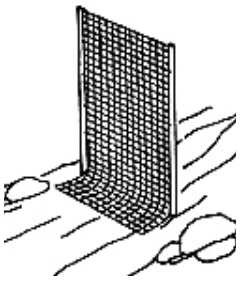
How to Make an Underwater Viewer:

Materials: large can or plastic container, clear heavy-duty kitchen wrap or other clear plastic, large rubber band.

1. Cut out the top and bottom of a large round can or plastic container. Be sure there are no sharp edges.

2. Stretch a sheet of clear plastic across the bottom and hold tightly in place with one or more large rubber bands.

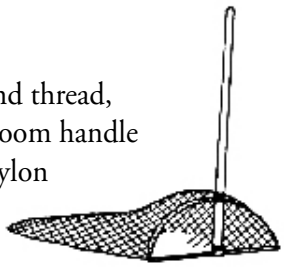
How to Make a Collecting Screen:



Materials: 2-3 foot length of 18 to 22 inch fiberglass screen, 2 dowels or sturdy willow sticks about one-half inch in diameter.

Attach the ends of the fiberglass screen to 2 dowels. The screen must be attached so several inches extend beyond the ends of the poles (it will lay on the bottom). The dowels should be shorter than the student ho will use them. The screen should be even with one of the ends of the dowels, as illustrated, and may be tucked or stapled.

How to Make a Bottom Sampler:



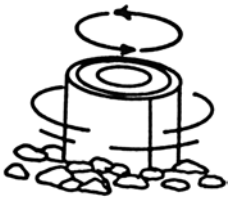
Materials: coat hanger, needle and thread, wire, 12-inch wooden dowel, broom handle or 3-foot long wooden dowel, nylon stocking or lightweight nylon (1 mm mesh or less).

1. Constructing a net: cut off the top hook of a coat hanger and shape the triangle into a half circle, leaving the bottom wire flat.

2. Use a nylon stocking or a square of lightweight nylon material. Fold the square in half diagonally, then stitch up one of the open sides of the triangle forming a cone. Wrap the open end of this cone (or the nylon stocking) around the half circle of wire, and then stitch in place.

3. Strengthen the straight edge of the half circle by wiring a 12-inch wooden dowel along it. Attach a wooden broom handle or long dowel to the center of this dowel and across the opening of the net.

How to Make a Core Sampler



Materials: juice or coffee can, jar lid or flat piece of wood, sorting tray.

Cut one end completely out of a tin can, then punch a hole in the other end with a large nail.

How to Make a Collecting Net:

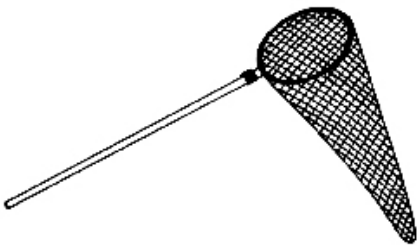
Materials: needle and thread; old nylon stocking or an 18-inch square of lightweight, fine-mesh (1 mm or less) synthetic material; broom handle or 3-foot dowel; coat hanger or other stiff wire.

1. Bend a wire coat hanger or some other heavy wire so that you have a hoop 12 inches in diameter. Twist the ends of the wire together. (Cover all sharp points with heavy tape.)

2. Use an old nylon stocking or cut out an 18-inch square of lightweight, fine-mesh (1 mm or less) material. Fold the square in half into a triangle, then stitch along one side of the triangle to make a cone.

3. Wrap the edges of the open end of the cone (or nylon stocking) around the wire hoop, then stitch in place.

4. Twist the remaining wire around an old broom handle or a long dowel.

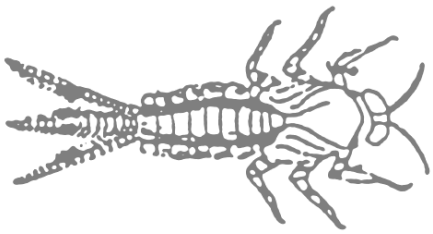


AQUATIC INVERTEBRATE CARDS

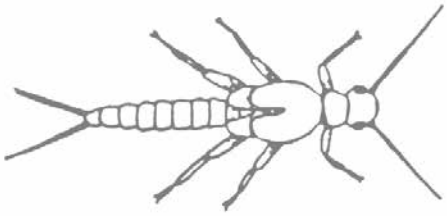
Organisms you are very likely to find include: mayfly nymphs, stonefly nymphs, blackfly larva and mosquito larva.

You may also find caddisflies, cranefly larvae, dragon fly nymphs, damselfly nymphs, midges, water pennies, water boatmen, diving beetles, water striders, aquatic earthworms, water mites, planarians, and leeches. If you are lucky, you might also find freshwater clams, mussels or snails. Most of these organisms are depicted and described in the Ecology Cards.

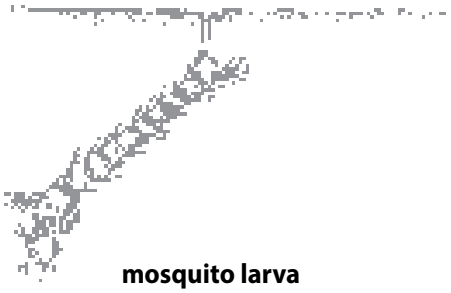
For a complete stream monitoring manual visit "Alaska Stream Team" at
http://aquatic.uaa.alaska.edu/pdfs/EducationLevelBioMonitoringMethods.pdf



mayfly nymph



stonefly nymph

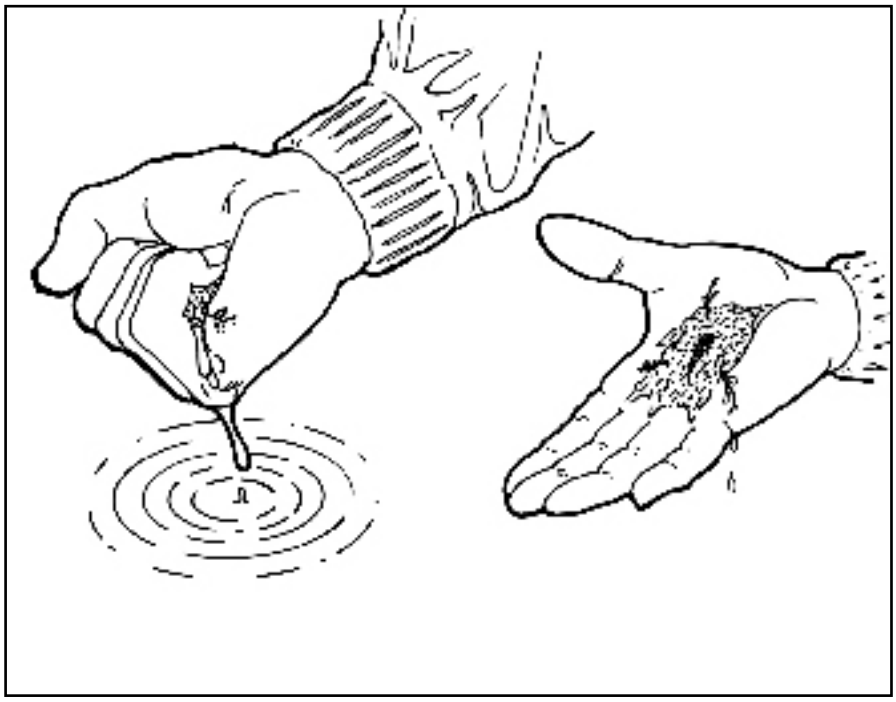


mosquito larva

blackfly larva

mosquito pupa

Investigating Wetland Soils



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 6 -10

State Standard: Geography C-1, C-2, C-3
NGSS: MS-ESS2-1,MS-ESS2-2. MS-ESS3-1.,MS-ESS3-3,HS-ESS2-5

Subjects: Science

Duration: 25 min + two class periods (if doing Part II)

Group Size: 1-5

Setting: Indoors/Outdoors

Objectives:

1. Students will qualitatively determine the texture of the soils in their wetland.

2. Students will quantitatively determine the texture of the soils in their wetland.

Teaching Strategy:

Students collect and observe soils. They then determine soil texture using two different techniques: one in the field and one in the classroom.

Complementary Activities:

Wetland Model, Soaker Tester

Background

See INSIGHTS Section 1 Wetland Ecosystems *"Wetland Soils"* fact sheet.

Materials:

Field: bottom dredge, shovel, meter stick, soil texture triangles, zip lock bags, sharpie markers.,
Class: soil texture triangles, graduated cylinders, distilled water, detergent, plastic wrap, watch.

Procedure

1. *Before the field trip:* introduce students to the soil triangle, showing that soil texture is characterized by its percentage of silt, sand, and clay. Discuss the different properties of the three types of soil.

2. You may elect to divide the class into teams: one team will collect soil from the bottom of the wetland using the bottom dredge, the others will collect soil from different areas of the wetland by digging holes (be sure to get permission first!). Students should try to dig down to 50 centimeters.

3. Ask the students to collect and label 1/2 cup samples and place them in labeled zip lock bags for analyses later in the classroom.

4. Ask students to describe the color and texture of soil they collect in their field notebooks.

5. Students should also observe whether the soil has a bad smell like rotten eggs.

6. Ask students to look for presence of woody materials (old shrub roots and stems, tree stumps, etc.) below the surface. *(Woody material within the layers of peat would indicate that the area was at one time drier, and colonized by shrubs and trees. Woody material on the surface of the wetland would indicate that the wetland is becoming drier and that shrubs and trees are moving in).*

7. Have the students who dug the holes draw a side view of each hole, labeling different layers where the color or texture of the soil changes. Ask them to measure the distance from the top of the hole to the top of each layer and then measure how wide (deep) each layer is. Students should stop digging if they encounter water and measure the distance to the water (have students note whether the water rose to fill the hold or just stat at the bottom of the hole).

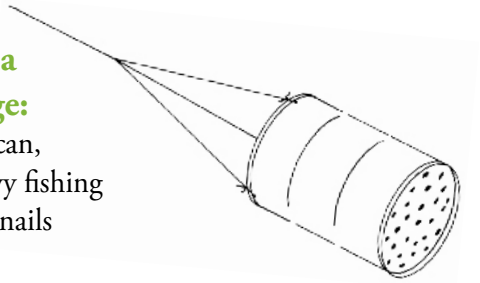
8. Students can then evaluate the texture of their soil using the Soil Texture by Feel Worksheet. In this method, students will run the soil through their fingers, attempting to make "soil snakes". Once they have determined what texture of soil they have, they can estimate the percentages of each type of soil (clay, silt, sand) using the soil triangle.

9. Back in the class, students can determine the texture of their soil using the Soil Texture by Volume Worksheet and the soil triangle.

Critical Thinking:

Ask the students how the soil might change with the construction and/or destruction of a beaver dam, a large storm, a drought, widespread removal of wetland vegetation, erosion upstream, dredging and filling. If the soil texture changes, how would that change affect the way water moves through the soil?

How to Make a Bottom Dredge:



Materials: coffee can, heavy string, heavy fishing weight, hammer, nails

1. Poke holes in the bottom of the coffee can with a nail and a hammer.

2. Use the same method to poke holes at the rim of the can to attaché a bridle with which to drag the can through the water.

3. Put a heavy fishing weight on the bridle and attaché the bridle to a tow line.

Curriculum Connections:

(See Appendix for full citations)

Books:

Out of the Earth: Civilization and the Life of the Soil (Hillel 1991).

Wetlands (Moore, 2006).

Video:

Wetlands (Nye, 1996).

WORKSHEET: SOIL TEXTURE BY FEEL

A. What texture of soil do you have? Follow the steps below to find out! When you have figured out what type of soil your sample is, go to B.

1. Have a partner put 2 spoons of soil from one of the samples in the palm of your hand. Be sure to keep track of which number sample you have.
2. Using the eyedropper, slowly add water drop by drop until the soil is damp, like putty. If your soil gets runny, have your partner add more.
3. Try to squeeze the soil in your hand. If it is too dry to squeeze into a ball, add more water.
4. If the soil is so wet that it runs through your fingers, it was too wet and you have to start over again from 1. Once you have the right amount of water, go to the next question.
5 Does the soil stay in the shape of a ball when you squeeze it? If no, **STOP!** Your soil is **SAND**. If yes, continue to next step.
6 Hold the ball of soil in the palm of your hand and work it with your fingers to try to make a "soil snake" or a ribbon of soil.
7. Does the ball fall apart when you try this? If yes, **STOP!** Your soil is **LOAMY SAND**. If no, continue on.
8. Can you make a snake more than 1 inch long? If no, then skip to number 14. If yes, then continue to the next question.
9. Can you make a snake more than 2 inches long? If no, then skip to number 17 . If yes, then continue to the next question.
10. Wow! You can make a long snake! Your soil has a lot of clay in it. To find out how much, go to the next step.
11. Add more water to your soil to make it really wet.
12. Rub the soil between your thumb and forefinger. Does it feel very gritty? If yes, **STOP!** Your soil is **SANDY CLAY**. If no, continue on.
13. Does the soil feel very smooth? If yes, **STOP!** Your soil is **SILTY CLAY**. If no, your soil must feel neither really gritty nor really smooth. **STOP!** Your soil is **CLAY**.
14. Add more water to your soil to make it really wet.
15. Rub the soil between your thumb and forefinger. Does it feel very gritty? If yes, **STOP!** Your soil is **SANDY LOAM**. If no, continue to next question.
16. Does your soil feel very smooth? If yes, **STOP!** Your soil is **SILT LOAM**. If no, your soil must feel neither really gritty nor really smooth. **STOP!** Your soil is **LOAM**.
17. Add more water to your soil to make it really wet.
18. Rub the soil between your thumb and forefinger. Does it feel very gritty? If yes, **STOP!** Your soil is **SANDY CLAY LOAM**. If no, continue to next question
19. Does your soil feel very smooth? If yes, **STOP!** Your soil is **SILTY CLAY LOAM**. If no, your soil must feel neither really gritty nor really smooth. **STOP!** Your soil is **CLAY LOAM**.

B. Enter the texture of soil you have for each sample in the table below. Then use the soil triangle to provide possible percentages of each sand, silt and clay that your soil could be.

Sample	Soil Texture	Possible % SAND	Possible % SILT	Possible % CLAY
1				
2				
3				
4				
5				

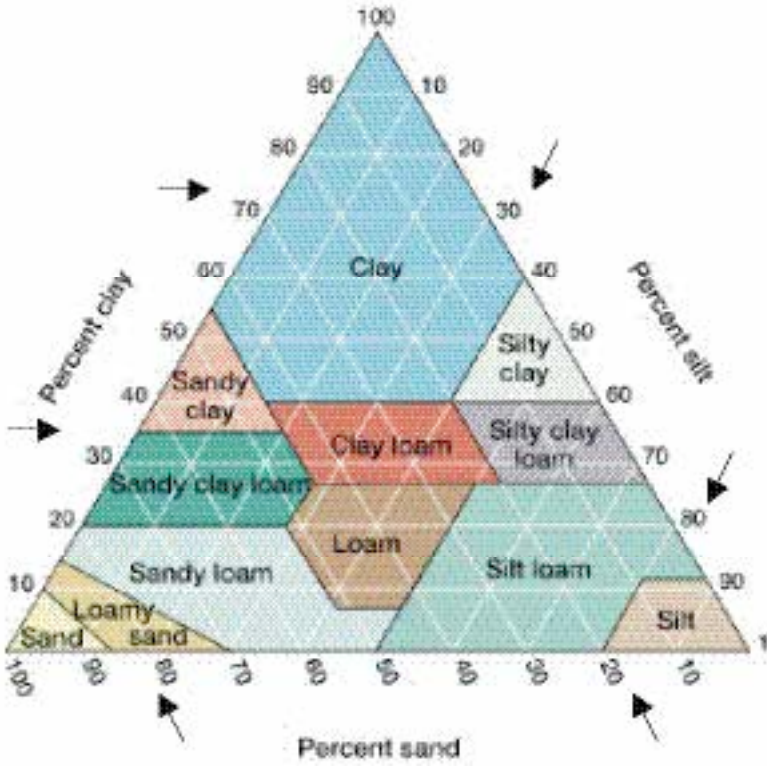
WORKSHEET: SOIL TEXTURE BY VOLUME

What type of soil texture do you have? You can determine the percentage each of sand, silt and clay in your sample by measuring the volume of each:

1. Place 30 ml of soil into a graduated cylinder
2. Fill the cylinder to the 100 ml mark with distilled water
3. Add a pinch of detergent
4. Cover tightly with plastic wrap and shake for 1 minute
5. When you are done shaking, start your stopwatch.
6. Wait 12 minutes
7. At exactly 12 minutes, measure how much sediment is on the bottom. This sediment is SAND. Record the volume of sand in the data table below.
8. You can determine the percentage sand in your sample by dividing the amount by the total amount of the sample (30ml).
9. The next day, see how much silt has settled out. The amount of sediment in the bottom = SAND plus SILT. Therefore, you can determine the total amount of silt by subtracting it from the total amount of sand.
10. Assume that the remaining amount of sediment is clay.
11. You can determine the volume of clay in your sample by subtracting the combined volume of sand plus silt from the total volume (30ml).
12. Now that you know the percentage of each sand, silt and clay, look on the soil triangle to determine what type of soil you have.

	Volume SAND	**Volume SAND divided by 30**	**Multiplied by 100 = Percentage SAND**
Volume SAND + SILT	**Volume SILT only**	**Volume SILT divided by 30**	**Multiplied by 100 = Percentage SILT**
30 – Volume SAND + SILT	**Volume CLAY**	**Volume CLAY divided by 30**	**Multiplied by 100 = Percentage CLAY**

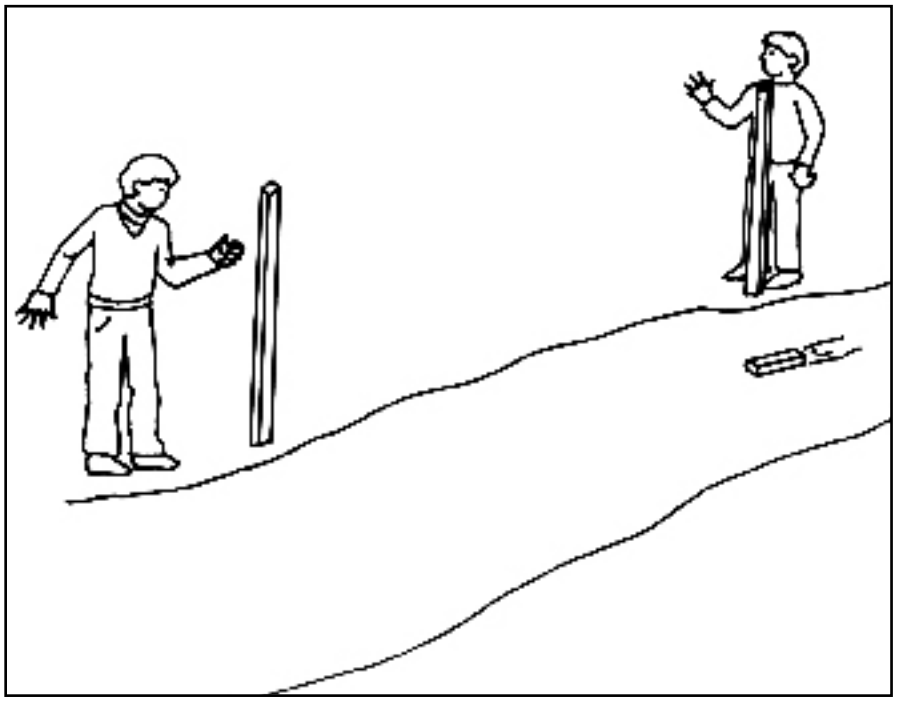
TOOLS: SOIL TEXTURE TRIANGLE



Here's how to use the soil texture triangle to determine what the texture of your soil is called:

1. Find the appropriate clay percentage along the left side of the triangle.
2. From this point on the left side, draw a horizontal imaginary line parallel to the base of the triangle.
3. Now find the appropriate percentage of sand along the triangle's base.
4. From this point, along the base, draw an imaginary line up into the triangle, parallel to the side labeled "percentage silt". The small arrows outside the triangle tell you in which direction to draw the imaginary lines.
5. Find the shaded section in which the two imaginary lines intersect. Now you know the texture of the soil. For example, a soil that is 30% clay, and 60% sand and 10% silt is called a sandy clay loam. (All you need is the percentage of two of the three soil sizes to use the triangle.)

How Fast is the Stream?



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 5 - 12

State Standard: Math A-3

NGSS: MS-ESS3-3.,HS-ESS2-5.

Subject: Science

Skills: Observing, Scientific method, Calculating rate and velocity ,critical thinking.

Duration:10-25 minutes

Group Size: 3

Setting: Indoors/Outdoors

Vocabulary: velocity, replication, scientific method, instream flow.

Objectives:
Students will measure the surface velocity in various sections of a wetland.

Teaching Strategy:
Students are given time to develop a method for determining surface velocity of a stream. You evaluate, and if needed, perfect their method before they try it themselves in the field.

Complementary Activities:
Stick race

Background
See INSIGHTS Section 1 Wetland Ecosystems *"Instream Flow"* fact sheet.

Materials:
Block of wood, stopwatch, meter stick or measuring tape, two stakes.

Procedure
I. In the classroom before hand (can be done in field if time permits):

1. Discuss with the students the importance and relevance of instream flow.

2. Tell the students that they will measure the surface **velocity** of the wetland or stream they are going to visit. Remind them that velocity is the speed per unit time. *You may wish to discuss with the students that large streams are often measured in terms of volume/ time (e.g. cubic feet/second).*

3. Discuss with the students how the velocity of a stream can change with terrain, friction, depth, bedrock type etc.

4. Ask the students for some ideas as to how they could measure the **velocity** of the stream. Elicit the idea that to get the best estimate, they will need **to replicate** their test at the same site several times and

take the average. A careful scientific study would also replicate the test at several locations on the stream.

5. Divide the class into groups of three. Have the group develop a procedure for determining the velocity of the water. Have them write the procedure and a list of materials in their field journals. They should also create a data sheet (or use the data sheet provided on the next page). Make sure each group determines who will be the recorder for the group.

6. Evaluate the student's procedures and data sheets before you go out into the field. Essentially, students should come up with the procedure outlined below.

II. Outdoors:

1. Have each group guess the velocity of the stream. Write three hypotheses in the field journals.

2. Ask the students to find a fairly straight stretch of stream and place one stake in the ground next to the stream. Place a second stake exactly 10 meters downstream from the first stake. Post one person at each stake.

3. The third person carries the stopwatch and the block of wood and walks upstream a short distance (about 3 meters) from stake #1, then places or gently tosses the block of wood into the current. This person must be prepared to start and stop the stopwatch as the others call out.

4. The student at stake #1 yells "START!" just as the block of wood passes his or her stake. The person at Stake #2 yells "STOP!" just as the block passes his or stake.

5. The recorder reads how much time has elapsed between the START and STOP on the stopwatch. The elapsed time is the amount of time it took for the block of wood to move the distance between the two stakes.

6. Calculate the velocity at the surface of the water as the distance between stakes (in meters or feet) divided by the time elapsed (in seconds).

7. Conduct the same procedure five to ten times and take the mean.

8. Move to different sections of stream or wetland and repeat steps 2-7.

9. Determine the average velocity of the stream by taking the mean of all the means.

10. When the students are finished, gather them together and discuss their findings. Were they surprised with their results?

Evaluation:

Students write a scientific report, summarizing their question, hypotheses, methods, results and conclusions.

Critical Thinking:

Students discuss the implications of the construction and/or destruction of a beaver dam upstream, a large storm, a drought, widespread removal of wetland vegetation, upstream dredging and filling.

How Fast is the Stream?
DATA SHEET

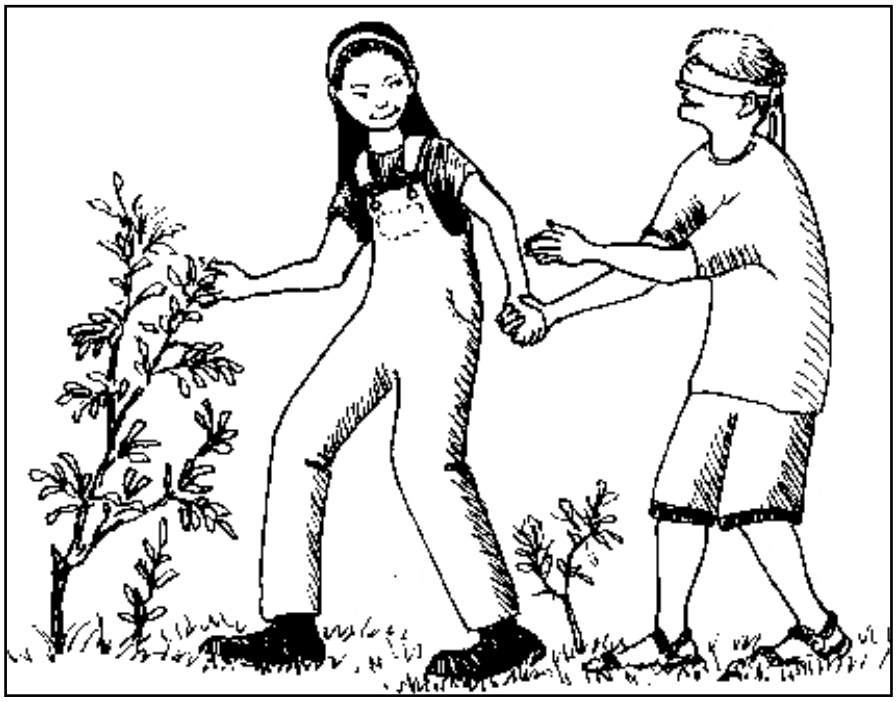
Recorder _____ Group Members_____

Date _____

Location_____ Weather_____

STREAM SECTION	TRIAL	START time	STOP time	TIME ELAPSED (sec)	VELOCITY =10 m/sec
A	1				
A	2				
A	3				
A	4				
A	5				
A	AVERAGE				
B	1				
B	2				
B	3				
B	4				
B	5				
B	AVERAGE				
C	1				
C	2				
C	3				
C	4				
C	5				
C	AVERAGE				
STREAM					
AVERAGE					

Meet a Plant



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 3-6

NGSS: 4-LS1-1.

Subject: Science

Skills: Observing, asking questions, distinguishing characteristics.

Duration: 10-25 minutes

Group Size: 2

Setting: Indoors/Outdoors

Objectives:
Observing, asking questions, distinguishing characteristics.

Teaching Strategy:
Students work in pairs. One student leads a blindfolded student to a wetland plant, where the blindfolded student gets to know it by asking questions about it.

Complementary Activities:
Ecology Puzzler #3: Chowing Down In a Wetland, Green Gobblers, Wetland Plants

Background
See INSIGHTS, Section 1 Wetland Ecosystems *"Profiles of Alaska's Wetlands"* and Section 2, Wetland Inhabitants *"Wetland Plants"* fact sheets.

Materials:
Blindfold, plant specimens (can be dried and laminated for indoor use).

Procedure
1. Divide the class into groups. Give each group two or more different plants.

2. Give the students a sheet of paper and have them draw a line down the center. At the top of one column, have them write "differences"; on the other, "similarities". Ask the students to come up with at least 10 similarities and 10 differences between the plants.

3. Ask the students to share what they came up with. They should have discovered some of the different types of features that can be used to identify a plant. For example, whether the leaves come in groups or singly on the stem, the number of petals on a flower, the length of the stem, hairiness on the stem or leaves, the leaf margin – pointy or smooth etc.

4. Divide the students into pairs.

5. Have one student tie a blindfold around the other's eyes.

6. Have the other student lead the first to a plant.

7. The blindfolded student asks the other questions about the plant. The blindfolded student can also touch the plant, but he or she cannot remove the blindfold.

8. When the blindfolded student feels like he or she has gotten to know the plant, the other student leads him or her away again.

9. Have the blindfolded student remove the blindfold and go find the plant. (It does not have to be the same individual plant, but should be the same species).

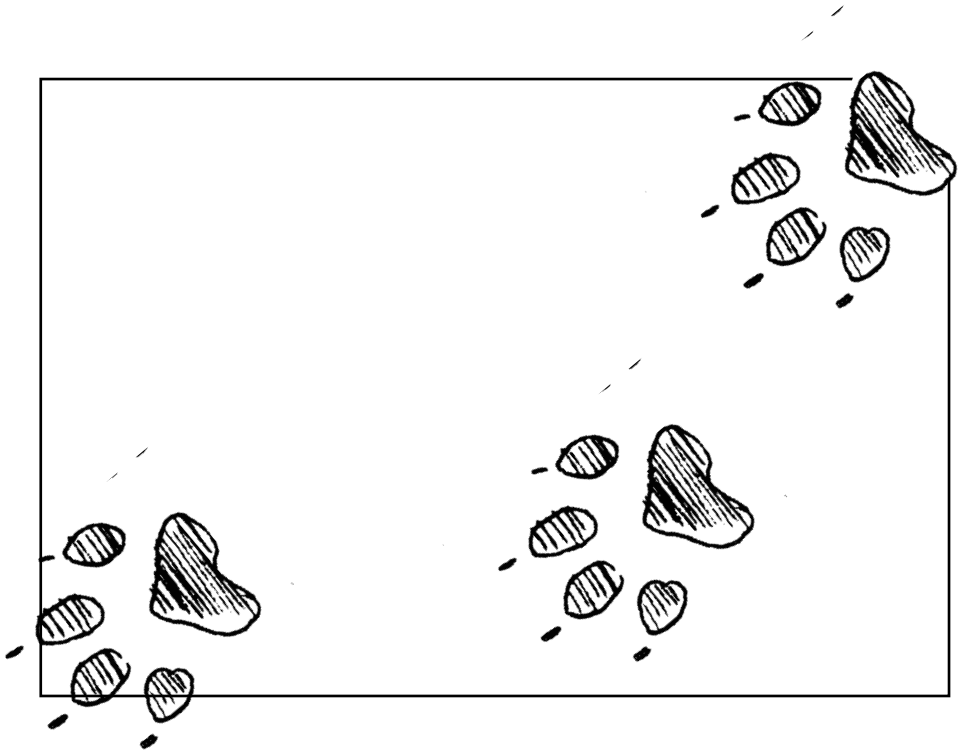
10. Have the students trade roles and do it again.

11. Bring the students back together in a large group again and have them share what they learned. Were they surprised by their ability or inability to find the plants? What sorts of different questions would they have asked next time?

Evaluation:

1. Students identify some plants using a plant key.
2. Students draw, color and label a picture of their plants.

Tracks in the Mud



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 5 - 12

NGSS: 5-ESS3-1.,MS-LS2-1. MS-LS2-2.

Subjects: Science, art

Skills: Observing, following instructions

Duration: 2 40-minute sessions

Group Size: 2-4

Setting: Outdoors & Indoors

Objectives:
Students will make a plaster of Paris cast of an animal track.

Complementary Activity:
OUTDOOR: "Mammal Signs" *in Section 2, Ecosystems.*

Materials:
IN THE WETLAND – Clipboards and writing paper or field note books, pencils or pens for each student. For each pair of students: 1 /2 cup of plaster of Paris, one jar of water, 1-inch wide lightweight cardboard strip, toothbrush, forceps or tweezers, a pail of wash water, one empty jar.

IN THE CLASSROOM – Playdough (homemade from flour, water, salt, oil, cream of tartar, and food coloring), a flat box, rolling pin, felt tip pens and cards.

OPTIONAL: Sample casting as example.

Procedure:
IN ADVANCE, locate a forest site where tracks of mammals or birds are easy to find. If you are unable to locate reliable tracks, consider making tracks using a dog or pre-made tracks.

Place the Science Card and the materials at the site. You may want to set up a sample casting as an example.

IN CLASS, depending on the grade level, guide the students through the activity or send them out to follow the instructions on the Science Card.

Classroom Follow-Up:
1. Students make a track display using homemade PLAY DOUGH:

For each track combine 2 cups flour, 1 cup salt, 2 cups water, 3 teaspoons cream of tartar, 2 tablespoons cooking oil, and a few drops of food coloring in saucepan. Cook until stiff.

2. Students roll out a 3/4-inch thick pancake of dough. Press each track print into the dough to make replicas of the tracks found in the forest.
3. Students make labels for their replica tracks and a title sign for their display, such as "Forest Tracks." Display for other students in the school to see.

NOTE: Rubber tracks are available for loan throughout the state. If locating tracks is difficult near your school, you may choose to borrow tracks and "salt" the area with them prior to doing this activity. Contact Wildlife Education at Alaska Department of Fish and Game in Anchorage for more details. (907) 267-2168.

Curriculum Connections:

(See Appendix for full citations)

Books:

Animal Tracks of Alaska (Stall, 1993)

Animal Tracks of Alaska (Sheldon and Hartson, 1999)

SCIENCE CARD

Track Casting

Choose a partner to work together.

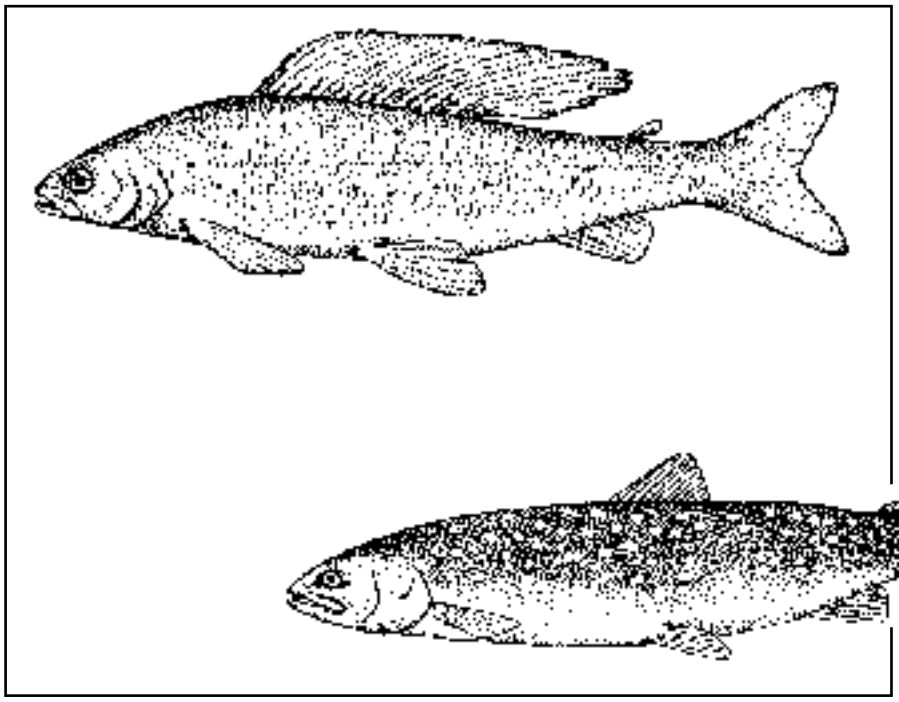
1. Be careful not to step on the animal tracks in this area so that other students will be able to see and use them. Select the track of one animal from this area.

2. Carefully remove sticks and leaves from the animal track with forceps or tweezers. Press a strip of cardboard in the snow or mud around the track.

3. Using the empty jar, mix a half cup of plaster powder with enough water to make a thick batter. If the track is in snow, mix snow with the water before you mix up the batter. This cold batter will be less likely to melt the snow and ruin your track. Pour the batter inside the cardboard strip over your track.

4. It will take about 20 minutes or longer for your track casting to dry. Wash out the mixing jar so others can use it. Carefully pick up your track casting and gently clean off any dirt using the toothbrush. Then take the track casting back to class.

Wetland Fish



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: K-4

NGSS: K-LS1-1.,2-LS4-1,4-LS1-1.

Subject: Science

Skills: Observing, inferring

Duration:10-20 minutes

Group Size: 2-4

Objectives:
Students look for fish in the water and learn about their habitat.

Complementary Activities:
Stick Race, How Fast is the Water?

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; "Wetlands Fish Science Card" *(following)*.

Procedure
1. IN ADVANCE, choose sites along the wetland area that are safe and comfortable for students to sit and observe.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. In class, discuss their observations

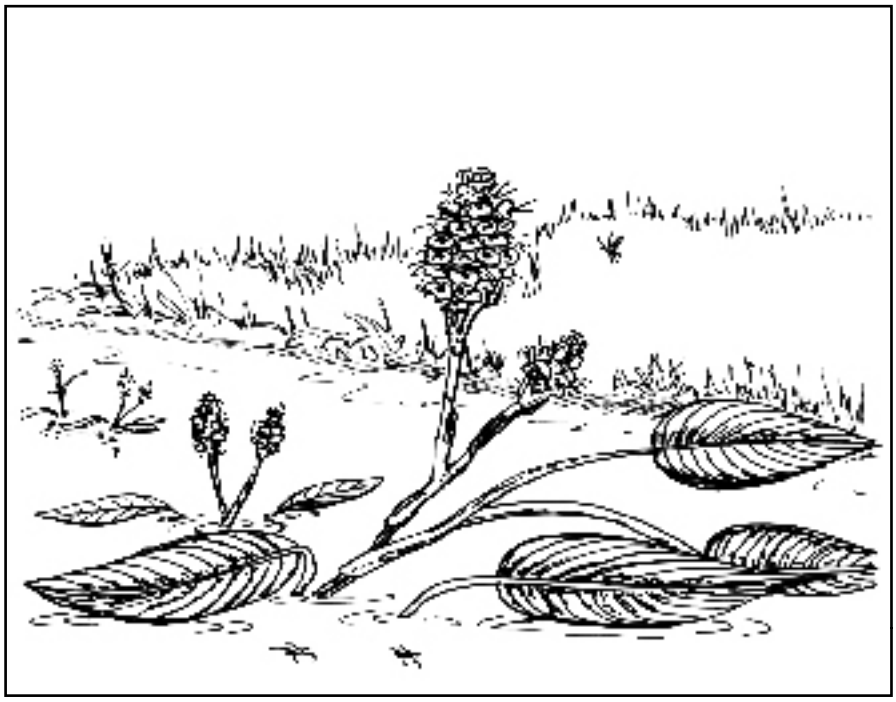
Curriculum Connections:
Alaska Department of Fish and Game Salmonids in the Classroom Curriculum
http://www.adfg.alaska.gov/index.cfm?adfg=educators.salmonclassroom

SCIENCE CARD

Wetland Fish

1. Write the heading "Wetland Fish" at the top of a page in your field notebook.
2. Look for fish in the shallow water.
3. How many fish can you see? Try to keep track in your field journal by making a tick mark for each different fish you find.
4. Watch where the fish hide when they sense danger. What kinds of places make good shelter for these fish?
5. Who do you think eats these fish?
6. What do you think these fish eat?
7. Where do you think these fish fit along a food chain? Can you come up with some other plants and animals that are part of the chain?

Wetland Plants



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 2-5

State Standard: Art A-1

NGSS: 2-LS4-1,4-LS1-1, K-2-ETS1-2

Subject: Science

Skills: Observing, inferring

Duration:10-20 minutes

Group Size: 1-3

Setting: Outdoors

Vocabulary: Diagram, dominant.

Objectives:
Students observe and describe wetlands plants.

Complementary Activities:
Meet a Plant, Green Gobblers.

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; sticks, large enough to be seen easily, but not too heavy; "Wetlands Plants Science Card" *(following)*.

Procedure
1. IN CLASS, introduce the idea of a **diagram** to your students. A diagram is a drawing, where important parts of the drawing are labeled to provide information. Show the students some examples of diagrams from a field guide.

2. IN ADVANCE of the field trip, choose sites along the wetland area that are safe and comfortable for students to sit and observe.

3. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

4. In class, share observations and drawings. Students may want to finish drawings with colored pencils.

5. Find out if all the students got the same answer for which type of plant is most common. You may want to ask students for some ideas of how they could determine which plants are **dominant** in a scientific fashion.

Curriculum Connections:
(See Appendix for full citations)

Books:
The Art of Field Sketching (Leslie 1995).

SCIENCE CARD

Wetland Plants

1. Write "Wetland Plants" at the top of a page in your field journal.

2. Do you see plants rooted in the water? How about growing along the bank? Record your observations in your field journal.

3. Does one type of plant seem to have more insects around it than a different type of plant?

4. Choose a plant and describe it in your field journal. How long is the stem? Does it have a flower? How many petals does it have? What color is it? How many leaves are there? What do the leaves look like? Are they pointy, hairy, smooth? Where is it growing?

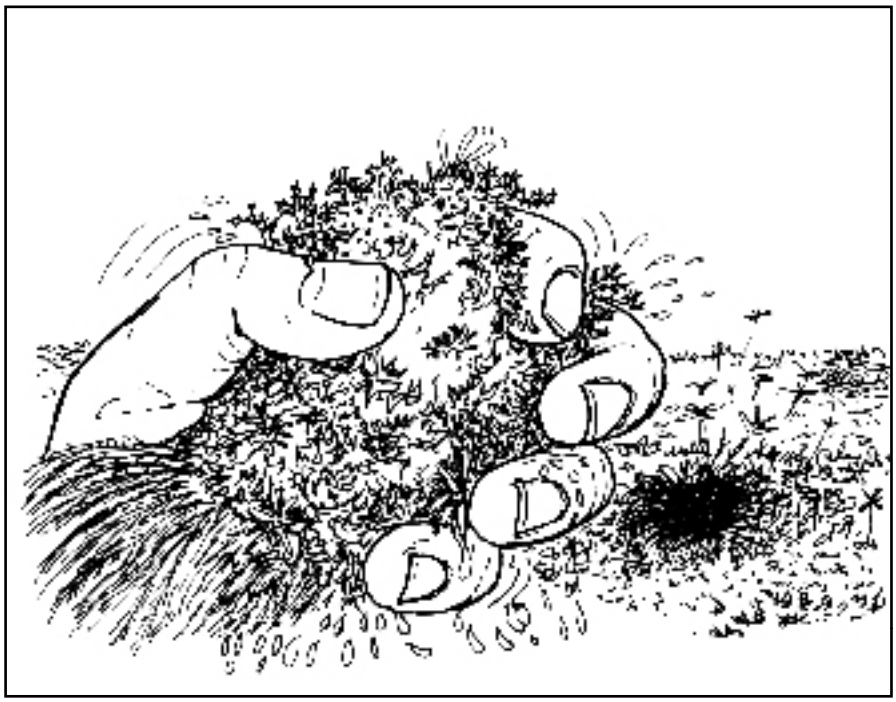
5. Draw a picture of your plant. Try to diagram the descriptions you made in Step 4.

6. Thinking carefully about what your plant looks like, come up with a name for your plant.

7. How many different types of plants can you find?

8. Is there one type of plant that seems more common than the others? What would you name it?

Sphagnum Moss



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: K-4

State Standards: Art A-3, C-2

NGSS: K-LS1-1.,2-LS4-1,4-LS1-1.

Subjects: Science,

Skills: Observing, inferring, measuring

Duration: 10-20 minutes.

Group Size: 2-4

Setting: Outdoors

Vocabulary: Sphagnum moss

Objectives:
Students learn qualitative information about a wetland by observing the sphagnum moss.

Complementary Activities:
Wetland Soils, Soaker Test

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; meter or yard sticks or measuring tape "Sphagnum Moss Science Card" *(following).*

Background Information:
See INSIGHTS Section 1 Wetland Ecosystems *"Profiles of Alaska's Wetlands"* and Section 3 Wetlands in a Changing World *"Climate Change and Wetlands"* fact sheets.

Procedure:
1. IN ADVANCE, choose sites along the wetland area that are dry enough for students to investigate the moss.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. In class, share observations and results. Discuss what might happen to this wetland area if it is hot and sunny and/or if it rains for several weeks.

Curriculum Connections:
(See Appendix for Full Citations).

Articles:
Shrub invasion shows recent drying of ancient Kenai peatlands. (Berg, 2005). Available [online] at http://kenai.fws.gov/overview/notebook/2005/sept/16sept2005.htm (2006).

SCIENCE CARD

Sphagnum Moss

1. Write "Sphagnum Moss" at the top of a page in your field journal.

2. Look for the spongy moss growing on or near the wetland.

3. What color is it? How thick is it? Can you stick your hand in it and feel hard ground?

4. Can you put a stick through the moss? Using a pencil or marker, mark where the stick touches the top of the moss and pull the stick back out. Use your meter stick or measuring tape to measure the distance between the end of the stick and your mark. Record this number, which is the depth of the moss in your field notebook.

5. Put your hand in the moss and squeeze it. Does water come out of the moss? Based upon your observation, do you think the wetland is wet or dry, or just sort of damp?

6. Is the wetland changing? Look for shrubby plants like Labrador Tea and Dwarf Birch growing at the top of your moss. Presence of these types of plants may indicate that your wetland is drying up over time!

Stick Race

Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: K-4

NGSS: 2-ESS2-2.

Subjects: Science

Skills: Observing, inferring

Duration: 10-20 minutes

Group Size: 2-4

Setting: Outdoors

Vocabulary: velocity, erosion, current

Objectives:
Students observe the wetland waters and learn that different parts of a stream move faster than others.

Complementary Activities:
How Fast is the Water?

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; sticks, large enough to be seen easily, but not too heavy; "Stick Race Science Card" *(following)*.

Background:
See INSIGHTS Section 1 Wetland Ecosystems *"Instream Flow"* fact sheet.

Procedure:
1. IN ADVANCE, choose sites along the wetland area that are safe and comfortable for students to sit and observe.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. In class, discuss their observations and results of their race. See if the students were able to figure out that sticks in the middle of a stream, and on the inside of a bend move faster.

SCIENCE CARD

Stick Race

1. Write "Wetland Waters" at the top of a page in your field journal.

2. Find a comfortable and safe place along the water and take a look.

3. Is the water still, slow, or fast moving? Is it clear or cloudy? Is it warmer or colder than the air? Write down your observations.

4. Does the water look like it is moving at the same speed everywhere?

5. Find a friend to race sticks from one spot in the stream to another.

6. Which stick won?

7. Why do you think the stick that won the race won? Write your guesses down in your field journal.

8. Where is the fastest spot in the stream?

Wetland Sounds

Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 2 - 6

NGSS: 2-LS4-1,5-ESS3-1. MS-LS2-1.,MS-LS2-2.

Subjects: Science

Skills: Observing, using field guides

Duration: 20 minutes

Group Size: 1

Setting: Outdoors

Objectives:

Students will listen for and map wetland sounds.

Materials:

Clip boards and writing paper, or field journals, pencils or pens for each student; "Wetland Sounds Science Card" *(following)*.

Procedure

1. IN ADVANCE, choose sites along the wetland area that are safe and comfortable for students to sit and observe, and which are far from distracting noises of traffic, parking lots, or playgrounds.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. Back in class, have the students share their imitations of the sounds they observed.

SCIENCE CARD

Wetland Sounds

1. Write the heading "Wetland Sounds" at the top of a page in your field notebook.

2. Move to a spot where you can still be seen from by your teacher or group leader, but you are at least 10 feet away from the others. Sit so that you face away from other students. Be very quiet, close your eyes, and listen carefully to the sounds of the wetland.

3. Listen to the water, insects, birds, shrubs, ground and animals for a few moment. Then, slowly open your eyes. If you were very quiet, a wetland animal may just be poking its nose out at you. Keep listening and quietly make a map of the sounds around you in your notebook. Label each sound and place it on your map.

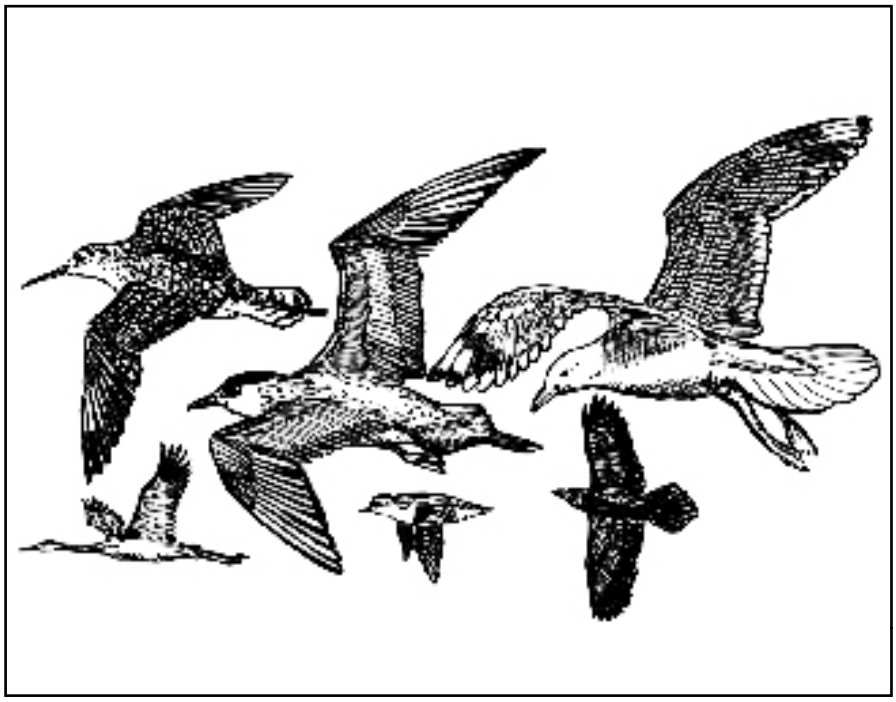
4. Do you hear more students coming? Imagine if you were an animal and heard all the noises that people often make. Would you stay out in the open where you could be seen, or try to be so quiet that people would not notice you?

5. Try listening again for a little longer.

6. What did you hear this time?

7. Try to remember these sounds so your class can have a wetlands concert when you get back to school.

Wetland Birds



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 4 - 9

NGSS: 4-LS1-1.,4-LS1-2

Subjects: Science

Skills: Observing, using field guides

Duration: 30 minutes

Group Size: 1

Setting: Outdoors

Vocabulary: Diagram

Objectives:
Students observe and describe wetland birds.

Complementary Activities:
Energy Flow in an Alaska Wetland

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; "Wetland Birds Science Card" *(following)*, binoculars.

Background:
See INSIGHTS, Section 2 Wetland Inhabitants *"Alaska's Waterbirds and Wetlands"*, *"Other Birds and Wetlands"* fact sheets.

Procedure
1. IN CLASS, introduce the idea of a diagram to your students. A diagram is a drawing, where important parts of the drawing are labeled to provide information. Show the students some examples of diagrams from a field guide.

2. IN ADVANCE of the field trip, choose sites along the wetland area that are safe and comfortable for students to sit and observe.

3. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

Curriculum Connections:
(See Appendix for full citations)

Books:
The Art of Field Sketching (Leslie 1995).

SCIENCE CARD

Wetland Birds

1. Write "Wetland Birds" at the top of a page in your field journal.

2. Look for birds in the shrubs and trees, along the bank, in or on the water, in the sky, and along the ground.

3. When you see a bird, try to describe it in your field journal. How is the beak shaped? Is it pointy, rounded, sharp, long, short, skinny? Does your bird have big wide wings, or small wings? Are the wings crooked or straight? Look for any colors on the bird's head, breast and rump. You might even see stripes along its side. Can you see its legs? Are they long or short?

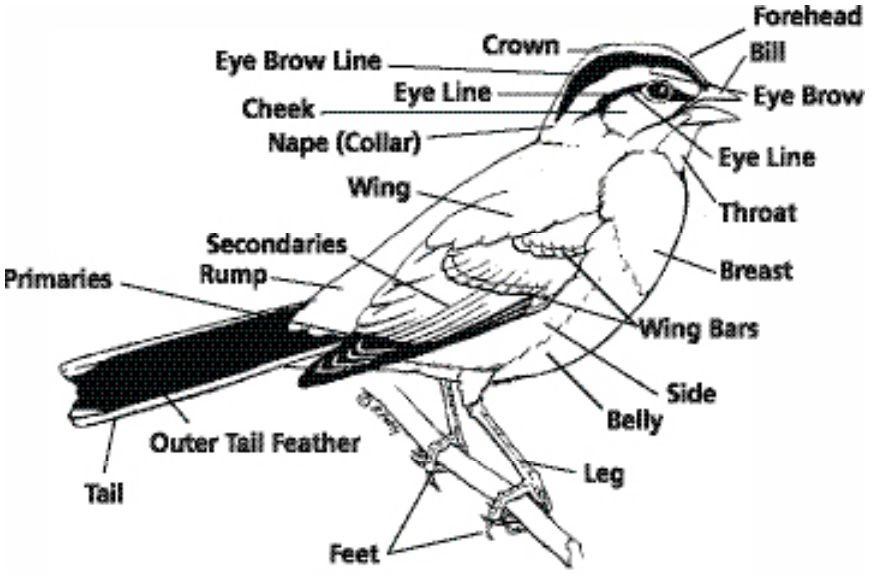
4. Is the bird running, flying, swimming, or standing still? What else do you think the bird is doing?

5. Why do you think the birds like it where you see them? Write down some ideas.

6. What do you think this bird eats? Write down some ideas.

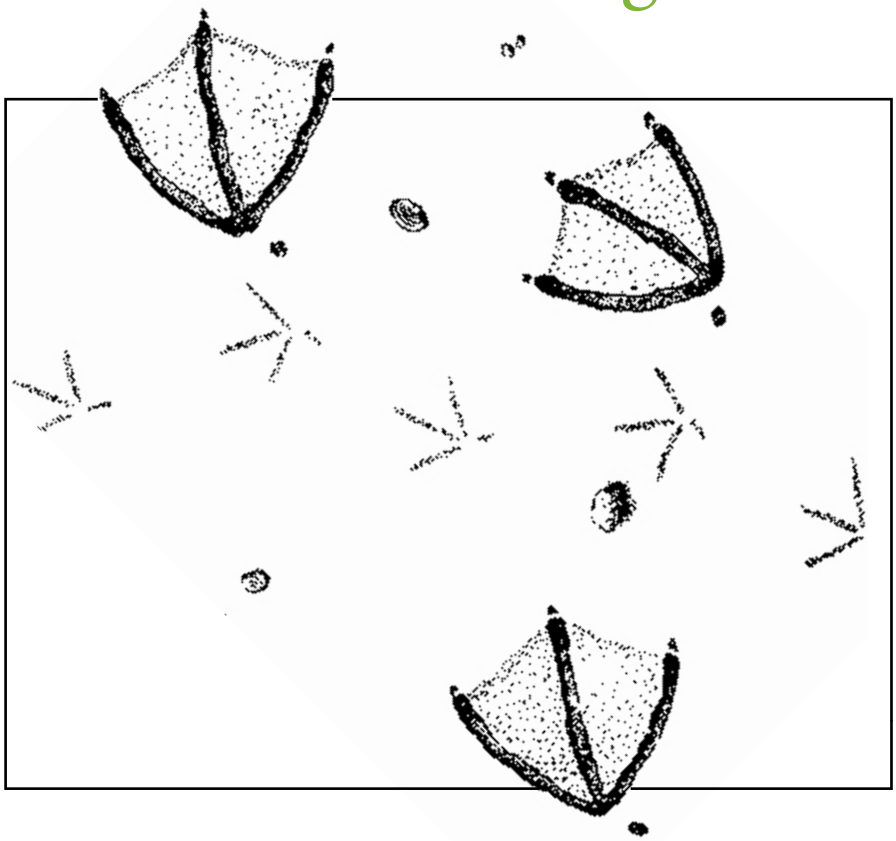
7. Where would you hide if you were a bird and heard a fox or a lynx sneaking up?

8. If you have time, try to draw a picture of your bird. Don't worry about making it look realistic. More importantly, diagram the descriptions you made in step 3.



The Parts of a Bird

Wetland Animal Signs



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 2-5

NGSS: K-LS1-1., 2-LS4-1, 5-ESS3-1.

Subjects: Science

Skills: Observing, inferring

Duration: 15-30 minutes

Group Size: 2

Setting: Outdoors

Objectives:

Students will look for and compare different types of animal signs found in the wetland area.

Complementary Activities:

Tracks in the Mud

Materials:

Clip boards and writing paper, or field journals, pencils or pens for each student; measuring tape or meter stick; "Wetlands Animal Tracks Science Card" *(following).*

Procedure:

1. IN ADVANCE, choose safe sites along the wetland area where signs of mammals or birds are easy to find.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. In class, share student observations, drawings and diagrams.

Curriculum Connections:

(See Appendix for full citations)

Animal Tracks of Alaska (Stall, 1993)

Animal Tracks of Alaska (Sheldon and Hartson, 1999).

SCIENCE CARD

Wetland Animal Signs

1. Write "Wetland Animal Signs" at the top of a page in your field journal.

2. Do you see any animal signs? Look for tracks, holes and dens, droppings, gnawed twigs and hair. Muddy places (like the edge of a pond) are good places to find tracks. Write down what you find in your field journal.

3. Does it look like anybody came for a drink to the wetland recently?

4. Find a track and try to figure out who it belongs to. Is the track bigger or smaller than your hand? How many toes does it have? Are the feet webbed? Can you see any claw marks? Can you tell any differences between front and back feet? How far apart is it between each track?

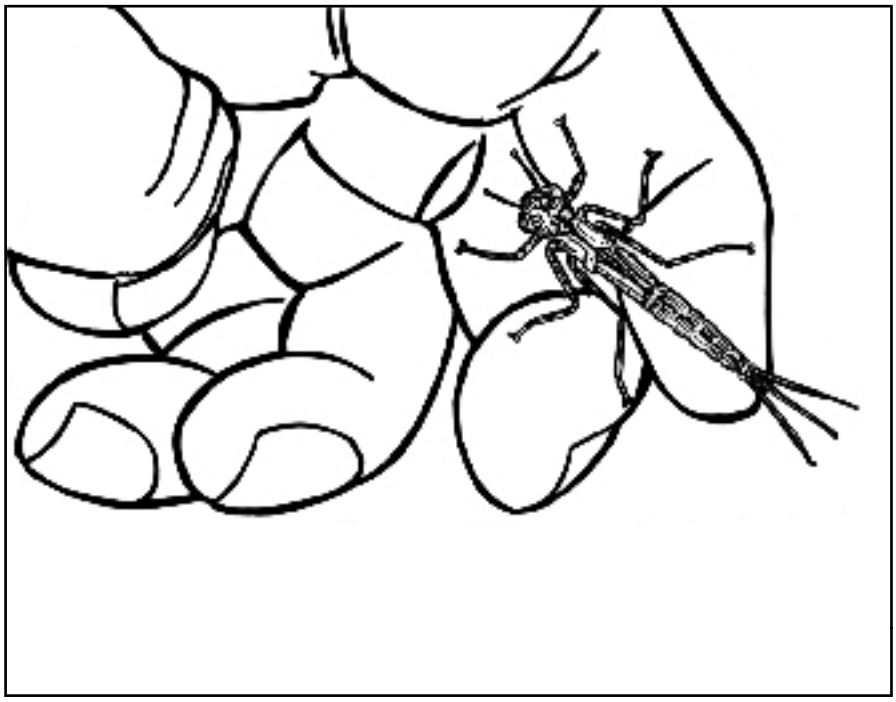
5. Measure the length and width of the track. If you do not have a measuring tape, estimate it using your knuckles: the distance between the two knuckles on your index finger is roughly an inch.

6. Draw a picture of the animal track in your field journal. Include the measurements you made for the length and width.

7. Walk through the mud yourself and see what tracks you leave. Can you tell your tracks apart from those of other kids in your group?

8. Ask a friend to walk around in the mud for a few minutes while your eyes are closed. Then open your eyes and see if you can tell where your friend went by looking at his or her tracks.

Who Has Six Legs?



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 3 - 5

State Standard: Art A-1

NGSS: 4-LS1-1, 5-ESS3-1.

Subjects: Science

Skills: Observing, drawing

Duration: 20 minutes

Group Size: 1-3

Setting: Outdoors

Skills: Observing, drawing

Objectives:
Students will observe and draw insects.

Materials:
Clip boards and writing paper, or field journals, pencils or pens for each student; magnifying glasses or hand lenses; "Who Has Six Legs? Science Card" *(following).*

Background:
See INSIGHTS, Section 2 Wetland Inhabitants *"Aquatic invertebrates"* and *"Animal Adaptations for Wetland Living"* fact sheets.

Procedure
1. IN ADVANCE, choose sites along the wetland area that are safe and comfortable for students to sit and observe.

2. Depending on the grade level, guide the students through the activity, or send them out to follow the instructions on the science card.

3. Back in class, have the students share their drawings.

Extension:
Have students write a story about the daily life of their named insect. Their story could include where the insect woke up, how and where it got its food, what it did when a predator tried to eat it, and who that predator was.

Curriculum Connections:
(See Appendix for full citations)

Books:
The Art of Field Sketching (Leslie 1995).

SCIENCE CARD

Who Has Six Legs?

1. At the top of a page in your field journal, write down "Wetland Insects".

2. Look for insects beneath plant leaves, driftwood and rocks, remembering to put everything back where you found it. Let the insects crawl on your hands.

3. Count the insect legs. Are there six?

4. Look for the insect's head, with eyes and antennae. Look for the body (thorax) and the abdomen and the wings.

5. Write down where you found your insect. What do you think its food source is?

6. Where do you think your insect gets its shelter? Write down some ideas.

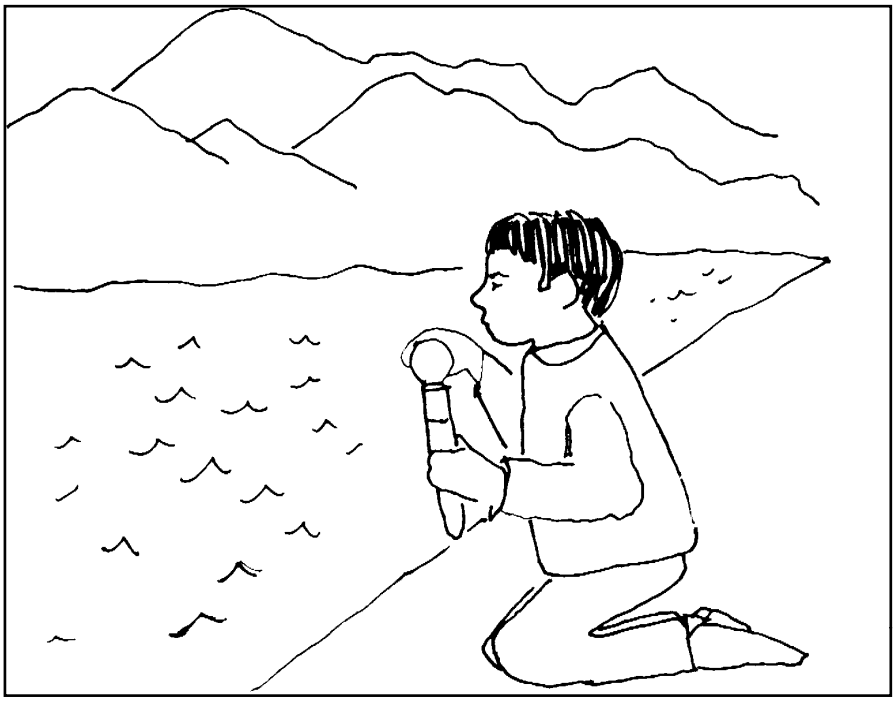
7. How does your insect move. What parts of its body does it use to move?

8. Draw a picture of your insect.

9. Think carefully about what your insect looks like. What do you think is a good name for your insect?

10. Release the insects and see where they hide.

Rate a Wetland



Section 4
Wetland Activities
OUTDOOR WETLAND INVESTIGATIONS

Grade Level: 7 - 12
State Standards: Geography C-1, C-3, E-3, E-5, F-3
NGSS: MS-LS2-1, MS-LS2-4. MS-ESS3-3.,MS-ESS3-4 HS-ESS3-4
Subjects: science, social studies
Skills: observation, comparing and contrasting, evaluation, discussion, synthesis
Duration: one class session or longer
Group Size: 2-4
Setting: outdoors and indoors
Vocabulary: hydrology, recreation, transportation, purification, habitat, filling, aesthetics

Objectives:

Students will:
1. List three functions of wetland areas.

2. Distinguish between activities dependent on wetlands and activities that could be located elsewhere.

Teaching Strategy

Students will conduct a field survey of wetland uses and use a chart to evaluate the wetland. They will present their evaluation and participate in a discussion about wetland uses and values.

Complementary Activities:

Wetland Exchange

Materials:

For each group: one or more Wetland Field Study Worksheets and the materials indicated on each worksheet, Wetlands Evaluation Chart, hand lens or magnifying glass (optional), camera and film or video camera (optional), maps or aerial photograph of local area (optional), rubber boots or hip waders.

Background:

See INSIGHTS Section 1, Wetland Ecosystems *"Profiles of Alaska's Wetlands"*, *"Wetland Ecosystem Functions"* and Section 3, Wetlands in a Changing World and Section 4 Wetland Policy and Management *"New Strategies for Wetland Conservation and Development"* fact sheets.

Procedure

1. All of the prior activities in this section may be combined to create a class wetland evaluation. This activity also includes additional worksheets that may be useful to your classroom surveys.

2. Ideally students can compare two or more wetlands. You may be able to locate two or more in close proximity. Comparing a disturbed wetland with an undisturbed one can be interesting. If you plan to survey just one wetland,

choose one with as much variety as possible (for example, one that has both natural and disturbed areas). If you will survey more than one wetland, choose different kinds (for example, open marsh versus bog, or developed versus undisturbed).

3. Prior to the field trip, review the ecosystem functions. Tell the students they are going to conduct a survey to gather information on wetlands.

4. At the field site, divide the class into pairs or small groups. Give each group a Basic Observations Field Study Worksheet and one of the other worksheets (or worksheets and/or science cards from the other activities in this section). Provide cameras if possible and tell students to take pictures or videotape the functions and human uses of the wetland.

5. Let the students work in their groups to fill out their Field Study Worksheets.

6. At the end of the field trip or back in the classroom, have each group report on what they observed. Tally the class total of plants and animals observed in the wetland. Did the students consider the wetlands valuable? How might they have found out about other uses they could not see? *(For example, they could talk to a local hydrologist about water storage capacity.)* What kinds of ecosystem services did the wetland provide? How were humans using the wetland?

7. If students surveyed more than one wetland, compare evaluations using the Wetland Evaluation Sheet.

Evaluation

Have the students fill out the Activity Review Worksheet.

Extensions

1. If there is a stream through the wetland, contact a fisheries biologist from the U.S. Fish and Wildlife Service or Alaska Department of Fish and Game to set up a detailed stream survey and to sample the stream for fish.

2. Discuss how to compare wetlands to decide if one is more "valuable" than another. How valuable is it to use comparisons such as the total number of animals or plants observed or comparing the number of ecosystem services provided? Help the students think of how to design long-term studies to make better comparisons.

Curriculum Connections

(See Appendix for full citations)

Books:

Vanishing Wetlands (Duffy, 1994).

Disappearing Wetlands (Challand, 1992).

Wetlands in Danger: A World Conservation Atlas. (Dugan, 1993).

Wetland Evaulation Sheet

I. Checklist of Wetland Functions

_____ Fish Habitat _____ Bird Habitat _____ Mammal Habitat

_____ Flood Water Storage _____ Filter Sediment/Improve Water Quality

II. Human Uses

Type of Use	Evidence of Use Exists	Potential of Use Exists	Could This Type of Human Use Impact Wetland Functions?
Education			
Recreation			
Aesthetics			
Food			
Transportation			
Waste Dumping			
Agriculture			
Conversion			
Other			

Activity Review
RATE A WETLAND

1. Name three human uses of the wetland areas you saw on your field trip.

a.

b.

c.

2. Do any of these uses need to be in a wetland area? Why?

3. Pretend that you live in a village surrounded by tundra wetlands. The village landfill is running out of room. Would you support expanding the landfill into the nearby tundra wetlands?

WETLAND EVAULATION WORKSHEET

Materials: calendar, clock/watch, thermometer, pencil, paper, colored pencils (optional), topographic map of area (optional), labels

Name:

Date:

Time Arrive: **Time Leave:**

Students in group:

Weather Data:

Cloud Cover (percent (%) of sky covered):

Air Temperature:

Water Temperature:

Type of Wetland:

Location of Wetland:

Map/Sketch:

Include dimensions or acreage, areas of open water (ponds, lakes, channels) areas that have plants and type of plants (trees, shrubs, low-growing plants, plants growing in the water), a size scale, a legend, and geographical features.

HYDROLOGY WORKSHEET

Materials: topographic map, compass, block of wood, stopwatch, meter stick, string, thermometer, clear jar or plastic bag, pencil, two vials, labels, pH paper or water chemistry kit.

1. Locate the wetlands on your topographic map. Draw the wetlands onto a blank sheet of paper, using the topographic map for reference. Don't trace the topographic map – your drawing will have to be a much larger scale.

2. Where does the water in this wetland come from? Draw the incoming water source on your map (called an inlet).

3. Where does the water in this wetland go? Draw the outgoing water (called an outlet) on your map.

4. Show how water flows through the wetland by marking the direction of flow with arrows. Are there deep channels in any ponds or lakes? Show the channels on your map.

5. Measure the velocity (see the activity "How fast is the Water?" and depth of flowing water at several locations in the wetland, both at the edge of a channel or pond and in the middle (if it's not too deep).

   Measure each site three times and measure the velocity in channels at more than one location.

6. Map standing water in pools, ponds, lakes, or wet meadows. Measure the depth of water at the edge and in the middle in each different type of wetland.

7. Do you think water would be stored in this wetland if the nearest stream or river flooded? Why or why not?

8. Do you see any indication that the water was higher than it is now? (Look for water stains on trees, leaves and debris deposited on vegetation, soil that was left as the water went down.)

WATER QUALITY WORKSHEET

1. Map the flow of water in the wetland. Show the location of any channels, ponds, lakes, or areas of standing water. Use arrows to show the direction of flow.

2. Observe water flowing through the wetland. Is it flowing fast or slowly?

3. Choose five different areas to sample, beginning at the upstream part of the wetland. Take measurements above and below any ponded water and sample both still and running water. Try to select a variety of conditions.

4. For each site, record:

   Water Temperature (measure three times):

   Appearance of water scooped into a clear jar or plastic bag:
   _____Clear ____Cloudy

   Color of the water:

   What can you see in the water?

   pH of the water:

   Is it acidic, alkaline, or neutral?

   How much dissolved oxygen is in the water?

5. Does the water get less muddy as it flows through the wetland?

6. Did you see any sediments that have settled out of water in the wetlands (fine particles on the bottom, especially around vegetation).

HUMAN USES WORKSHEET

Education
List studies you think need to be completed in this wetland (for example, a study to find out which migrating birds stop here in the fall and in the spring).

Recreation
List recreational uses of the wetland. Are people hiking, fishing, hunting, or bird watching here? Is it a good place to do those things? Why or why not?

Aesthetics
Take photographs or make drawings of plants and animals that you find attractive.

Food Plants
Are any crops being grown in the wetland? Identify any edible plants (greens, berries, nuts) that you can.

Transportation
Are there any roads or developed trails? If you are near a river or the ocean, are there places boats can travel or tie up? Have bridges been built over water channels?

Waste Dumping/Pollution
Look for litter, garbage, sewage pipes, or other waste disposal outlets.

Note any:
- air pollution
- water pollution
- noise pollution

Filling and Draining
List any buildings. Has gravel or rock been placed in the wetland to support them? Have other areas in the wetlands been covered by gravel, rocks, or other materials? Why? Are there any ditches that don't look like natural channels?

Other Uses?

BIRD STUDY WILDLIFE HABITAT WORKSHEET

Materials: binoculars, spotting scope (optional), paper, pencil, clipboard, Field Guide to Birds, and Bird Form.

Take a quick look around the wetland. How many birds do you see? Move a short distance away from the rest of the class and sit down where you can see most of the wetland. Sit as quietly as possible–try not to move a muscle. Listen, and look carefully.

1. Do you hear any sounds? Are any of these bird songs or calls? Try to see the bird(s) making each sound. Do you see any other birds?

2. Use your binoculars (or set up a spotting scope) and scan the water and edges of the pond carefully. Can you see any more birds? Describe them on the Bird Form.

3. Walk quietly along the edge of the wetland. Do you see any other birds? Look at them with your binoculars and fill in the Bird Form for any new kinds you see.

4. Look closely for feathers, tracks, places where birds have probed in the mud, nests and eggshells. Describe any signs of birds that you find.

5. Find an area with small or large shrubs near water. Sit down quietly again. Look and listen again. Now repeatedly make a quiet pshhh-pshhh-pshhh sound--like you were saying shhh (quiet) to someone. Make the sound for 15-30 seconds, then be perfectly quiet for 15-30 seconds. Then, repeat the sound. What happens? Add any new birds you see to your Bird Form.

6. Make a map of the wetlands showing where you saw the birds or signs of birds. Label the places to show where you saw each kind of bird. Did you see more birds in one area than another? If so, why might that be?

7. When you are finished, go back and try to identify each of the birds you saw by using your Bird Form and a field guide to birds.

8. How many kinds of birds did you see in all?

9. How many birds did you see?

10. Draw a detailed picture of the one you liked best.

PLANT STUDY / WILDLIFE HABITAT WORKSHEET

Materials: hand lens, paper, pencil, book on plants or laminated wetland plant cards, underwater viewer, vials, 100 meter tape, string, four stakes, crayons, and labels.

1. What percent of the wetland is covered by plants? (a) 0-5% (b) 5-25% (c) 25-75% (d) 75-95% (e) 95-100%

2. How many different kinds of plants do you see?

3. Are there any plants that live in the middle of the wetland?

4. Are any plants growing along the shore of the wetland?
   Take a closer look at one of these shore plants. Does it have roots? stems? leaves?

5. Are there any plants that seem to be growing out of the water?
   What parts of these water plants are above the water? roots, stems, leaves, or flowers? What parts are underwater?

6. Are there any plants living completely underwater?
   Do the underwater plants have roots? Stems? Leaves?

7. Use your hand lens to look very carefully at some wetlands plants. Draw a detailed picture of a single leaf from five different plants. What pattern is formed by the veins? Are the leaf edges smooth? Does the leaf or stem have any hairs on it? Does the leaf have a stem?

8. Place one of the leaves underneath a sheet of paper and rub crayon lightly over the paper. How does this crayon print compare to your drawing?

9. Use the underwater viewer to look at the underwater stems and leaves of plants. Can you see any insects or other animals on the stems or leaves? Describe them.

10. Determine plant **species richness** along a transect: stretch your 100-meter tape parallel to the shore 2 meters away. Every 20 meters mark out a 1 meter square area string and stakes. Count how many different species of plants are in each 1 meter plot (you do not need to be able to identify each plant). Calculate the average of all five numbers to determine the mean number of species along your transect

11. Draw a vegetation map of the wetland that shows where plants are most abundant. If time allows, describe the different types of plants that are **dominant** (most common) in different parts of the wetland so that you can try to identify these plants when you return to class.

12. Take one last look at the wetland. How many different kinds of plants do you see now?

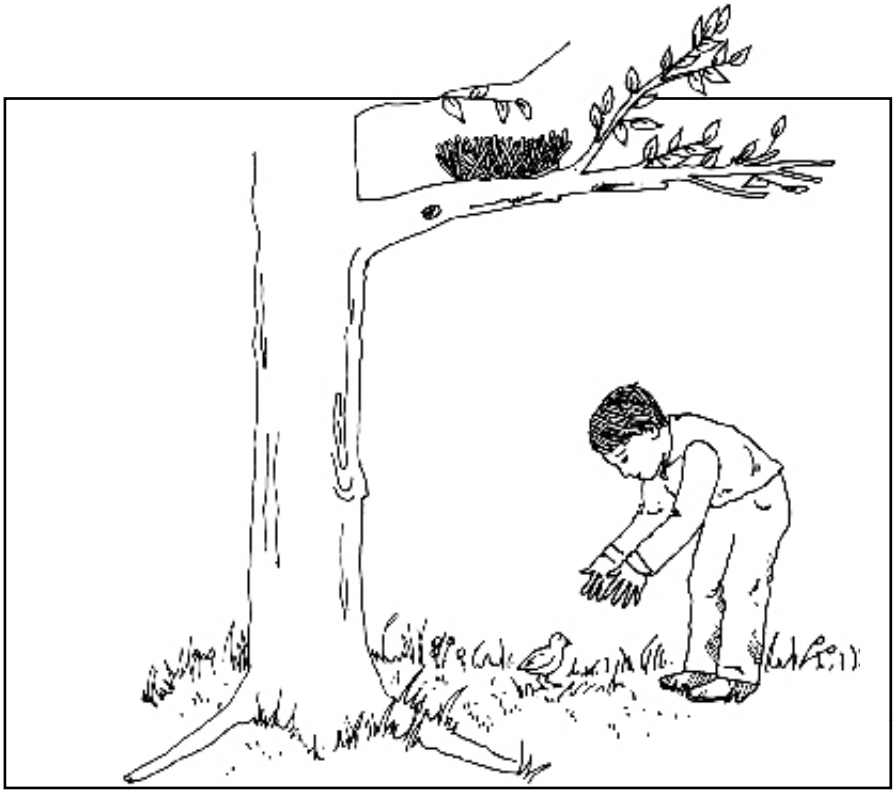
MAMMAL STUDY WORKSHEET

Materials: paper, pencil, book on animal tracks

Move away from the rest of the class and sit down where you can see most of the wetland. Sit as quietly as possible – try not to move a muscle. Listen, look, and smell the area.

1. Do you hear any sounds? Describe them.
2. What do you smell?
3. Do you see any mammals or any signs of mammals? Describe them.
4. Look closely – is there hair on any branches?
5. Do you see anything moving? Any eyes looking at you from amidst the grasses? Describe what you observe.
6. Do any plants look like they have been dug up or bitten off? How about the herbs? grasses? shrubs? Look at the underwater plants.
7. Do you see any holes in the banks near the wetland? If so, how big are the holes (diameter)? What could be inside?
8. Do you see any piles of sticks, grasses, or branches? If so, what might have made them?
9. Walk carefully along the edge of the wetland. Can you find any tracks in the mud or sand? If so, how many different tracks do you see?
10. What kind of animal(s) do you think made the tracks?
    Pick the clearest, best track to study further.
    - How long is the animal's foot?
    - How wide?
    - How far is it between its front and hind feet?
    - Does the animal have claws? Hooves?
    - How many toes on its front feet?
    - How many toes on its hind feet?
    - How deep is the track?
    - Does the animal weigh very much?
    - Does it weigh more or less than you?
    - Can you figure this out by measuring how deep your track is? Why or why not?
12. On a separate piece of paper draw a map of the wetlands showing where you found the different animal signs.
    - Are there more animal signs in one area than another? If so, why might this be?
    - How could you see more of the mammals that live in this wetland?
13. How many different kinds of mammals did you see? How many mammals did you see signs of?

Humans and Wildlife



Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: 2 – 4
State Standards: Art A-1, A-5; English/LA A-4, A-6, B-1, B-2, B-3; Geography E-1, E-5; Government C-2.
Subjects: social studies, science, language arts, art
Skills: analysis, description, discussion, drawing, evaluation, generalization, problem-solving, group cooperation, synthesis
Duration: one or two 20-40 minute periods
Group Size: any
Setting: indoors or outdoors
Vocabulary: harm, wildlife

Objectives:

Students will:

1. Generate a list of activities that can help or harm wildlife.

2. Discuss reasons why harmful activities are inappropriate.

Teaching Strategy

Students will brainstorm activities that are helpful or harmful to wildlife; then, they will break into small groups and use cards to discuss and classify different actions.

Materials:

Art materials to make discussion cards including crayons, construction paper, photos from magazines

Background:

See INSIGHTS Section 3, Wetlands in a Changing World and Section 4, Wetlands Policy and Management *"Developing Alaska – A Wetlands Challenge"* and *"New Strategies in Wetland Conservation and Management"* fact sheets.

Procedure

1. Ask students to help you brainstorm a list of activities that people do in wetlands. For each activity, ask students whether the activity might help, harm or have no affect on the local wildlife.

Examples of helpful activities, or activities that do not harm wildlife might be:

- Leaving bird nests alone.
- Keeping dogs on leashes when walking in the wetlands so they won't scare birds.
- Putting up nest boxes for owls or swallows.
- Walking quietly through wetlands to avoid scaring wildlife.
- Creating board walks to minimize bank erosion and soil compaction.
- Berry picking.
- Hunting and fishing following regulations.

- Following established ATV trails.
- Giving money to conservation agencies that purchase wetlands.

Some examples of harmful activities might be:
- Hunting birds or gathering eggs out of season
- Driving vehicles (cars, four wheelers, other ATVs, airboats) on wetlands.
- Littering, especially with plastic, which animals might swallow.
- Picking up baby wild animals.
- Chasing or scaring animals.
- Building a road or airport that requires the filling in of a bird nesting area with gravel.
- Dumping oil into a wetland.
- Removing plants from their environment.
- Not following hunting or fishing regulations.
- Using lead shot when it's illegal to do so.

2. Have students use cut-out photos or drawings to make these activities into cards with pictures and describing what is happening (or the teacher can prepare cards in advance, laminate, and use again).

3. Collect the cards. Divide the class into groups. Hand out one or more of the cards to each group. Ask them to discuss:

a. What is happening?

b. Does it help, harm or have no effect on wildlife? How?

4. Have the groups communicate to other groups. Ask each group to report to everyone else their feelings concerning what is happening in the picture and any alternatives they identified which would not harm wildlife. Older students can dramatize their alternatives with skits, "commercials," songs, poems, etc.

Credits

Extensions

1. Discuss whether some human activities that may be harmful to wildlife can help people (examples: building a hospital on a gravel fill pad in a wetland where birds nest, building a road to a school across wetlands when there is no other alternative).

2. Ask the students to draw a picture of things they know about or have seen happen that would hurt wild plants or animals. Ask them to describe what is happening in their drawing and what could happen that would not be harmful.

3. Invite local city or village officials or agency personnel to visit your class and discuss issues relating to local wetlands. (E.g. airport expansion, a second channel crossing, landfill seepage, dogs off leashes etc.).

Curriculum Connections

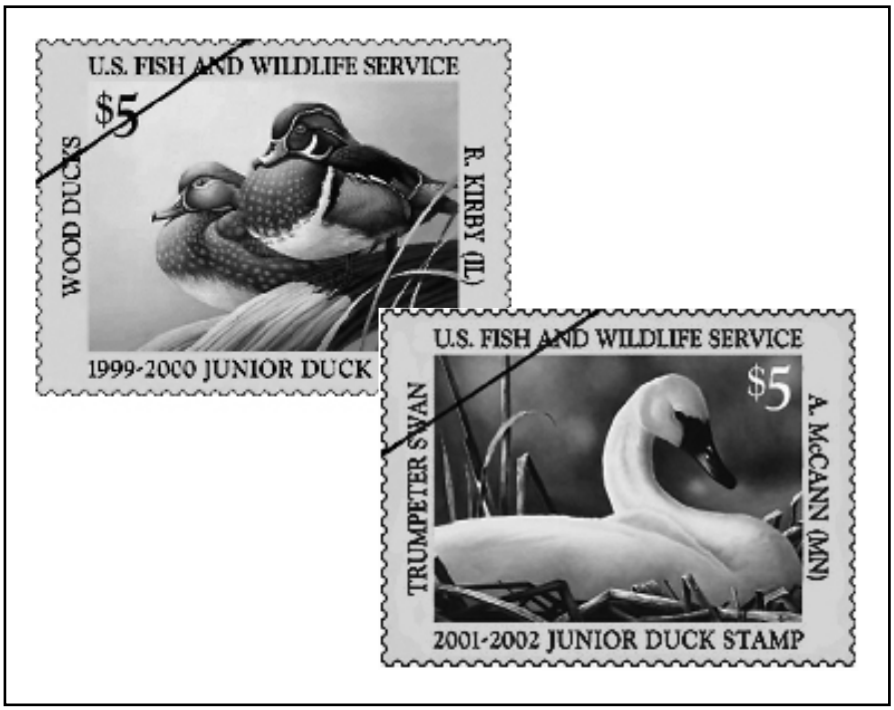
(See Appendix for full citations):

Books:

Wetlands (Finlayson and Moser 1991).

Wetlands (Stone 2004).

Stamps for Birds



Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: K - 8

State Standards: Art A-1, A-5.

Subjects: art

Skills: drawing, use of media

Duration: one class period

Group Size: individual

Setting: indoors

Vocabulary: Duck Stamp, refuge, conservation

Objectives:

Students will learn that federal and state Duck Stamps are a means to raise money to acquire and restore wetlands and manage them as wildlife habitat.

Teaching Strategy

Students will design and create a Duck Stamp and wetlands conservation message.

Complementary Activities:

Migration Headache.

Materials:

- The Duck Stamp Story" film (optional)
- Art materials
- Field guides or books with color pictures of birds

Background:

See INSIGHTS Section 3 Wetlands In a Changing World *"Historical Perspective"* fact sheet.

Procedure

1. Show the film *"Wetlands and Wildlife and You: The Duck Stamp Story,"* if available (see Curriculum Connections).

2. Either show your students a duck stamp or print (federal stamps can be purchased at any post office; state stamps can be purchased from hunting or fishing license vendors) or ask them if they have ever seen a duck stamp or print. (Students older than 16 are required to purchase them if they hunt waterfowl.) Discuss why duck stamps or prints are sold. Ask them how money from the sales could be used to help waterfowl (by providing habitat).

3. Explain that both the federal government and the Alaska Department of Fish and Game hold art contests or artist competitions each year to select the design for Duck Stamps.

4. Have the students draw or paint a bird in a wetland habitat. Students can also design a message about what humans can do to help birds that live in wetlands. Depending on the variety of pictures you can provide for reference, either the class can vote on the bird they want

on their stamp, you can choose a single bird species which could be the current subject of the state competition, or the students can each choose whichever bird they want to draw or paint.

Extensions

1. The class can vote to select a winning picture.
2. The class can promote the sale of Federal and Alaska duck stamps in the community by using their art projects as posters or by recording public service announcements for local radio or television stations.
3. The class can view the video "The Beautiful Collectible Duck Stamp, 1989-1990".

Curriculum Connections:

(See Appendix for full citations)

Video:

Wetlands Wildlife and You: The Duck Stamp Story. (U.S. Fish and Wildlife Service).

The Beautiful Collectible Duck Stamp. (U.S. Fish and Wildlife Service).

Traditional Wetland Plant Use

Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: 7 - 12

State Standards: Art A-1, A-5; English/LA A-1, A-2, A-4, B-1; History A-6, Science C-2, F-1, F-2, F-3

Subjects: science, language arts, social studies, bilingual studies

Skills: science, language arts, social studies, bilingual studies

Duration: two class sessions

Group Size: whole class, small groups

Setting: indoors and outdoors

Vocabulary: ethnobotany, tale

Objectives:

Students will:

1. Name and describe three wetland plants and the way in which they are important to Alaska's Native peoples.
2. Write a story describing how a wetland plant came to be useful to Alaska Natives.

Teaching Strategy:

Students will learn about traditional Alaska Native uses of wetland plants by presenting a group pantomime. They will listen to a story and then create their own story.

Complementary Activities:

Rate a Wetland, Meet a Plant.

Materials:

Group copies of "Traditional Uses of Wetland Plants" (at the end of the activity).

Background:

Alaska's Native peoples have traditionally demonstrated widespread knowledge of a variety of uses of plants and animals. Plants were used extensively by all of Alaska's Natives in a number of different ways. Although plant species and traditional uses varied among Native groups, there has always been an important connection between plants and people.

Ethnobotany is the study of how people use plants. By becoming familiar with the ethnobotany of a culture, one can appreciate the cultural identity and traditions of a particular group of people as well as understand the botany of a specific ecosystem.

Wetlands provided a diverse number of plants which were widely used by Native Alaskans and which continue to have important uses today. Conservation of these plants has important implications for people not only in terms of present uses but for possible future uses.

Procedure

Activity 1

1. Where relevant, ask students what wild plants their families collect, and use for food and medicine.
2. Ask students to imagine how Native Alaskans might have used plants hundreds or thousands of years ago before stores or modern products were available. List the uses that students come up with.

3. Define ethnobotany - the study of how people use plants; "Ethno" = People + "Botany" = Study of Plants.

4. Divide the students into groups of two or three students (there should be eleven groups at the most - one plant for each group). Hand out copies of "Traditional Uses of Wetland Plants." Assign a wetland plant to each group and have them devise a short pantomime involving all members that shows how the plant is used and what it is used for. After each group completes their pantomime, students may guess which plant the group presented.

5. Ask students if they still use these plants in the same way. Do they use the plants in a different way? Students can share stories of how they learned the uses of the plants. Since modern products are now available, why continue to use plants in the traditional way? What reasons might there be for conserving wetland plants?

6. Ask students to interview older relatives and community members about traditional uses of plants.

7. Research to find out how animals may use these plants. Add the information as a fourth column on the worksheet (i.e. beavers harvest great quantities especially when aspen, willow and aspen are scarce).

Evaluation

Students will turn to a partner and name three different wetland plants and a traditional use for each. Or, modern products can be held up and students can write the name of the plant and its traditional use.

Extension

Have students bring in modern products that represent their plant (Nyquil box, waxed paper, throat lozenges, etc.). Create a class bulletin board on ethnobotany of Alaska Natives. Compare or contrast that with how local people use wetland plants today. Invite an elder into the class to talk about traditional Native uses of plants in his or her particular culture.

Activity 2

1. Explain to students that they will create a tale or story about a wetland plant. Explain that in many cultures, tales and stories are passed on from generation to generation. These stories often explain how certain things came to be and may pass on knowledge that helps people to survive (for example, what to eat or not eat) or help them appreciate things in their environment upon which they depend.

2. Show students the picture of a skunk cabbage. Have students listen to the following Kathlamet Indian tale about skunk cabbage (the Kathlamets are a tribe from southwest Washington state).* Point out to students that this myth reveals how the plant was used, why it looks like it does and why it is in a wetlands habitat:

In the ancient days there were no salmon. The Native Americans had nothing to eat except for roots and leaves. One of their most important foods was the root of the skunk cabbage. Finally, after many years, the spring salmon came for the first time. As they passed up the river someone stood upon the shore and shouted:

"Here come our relatives whose bodies are full of eggs. If it had not been for me all the people would have starved."

"Who speaks to us?" asked the salmon.

"Your uncle, skunk cabbage," was the reply.

Then the salmon went ashore to see him, and as a reward for having fed the people the skunk cabbage was given an elk-skin blanket and a war club, and was set in the rich soft soil near the river. There he stands to this day wrapped in his elk-skin blanket and holding aloft his war club.

* This Kathlamet tale was used because the writers were not able to find an Alaskan Native tale about a wetland plant. If you know of such a tale, and are willing to share it, please send it in to us for distribution and inclusion in future revisions.

3. Discuss ideas for writing an Alaska version of a story about a wetland plant. Students will develop a story that explains how a particular wetland plant came to be used by Native peoples using the information on the worksheet, "Traditional Uses of Wetland Plants" or information gained from an elder. Students can also interview local people who are knowledgeable about traditional plant uses. Encourage students to use their imagination by telling them that the plants and animals in their story may walk or talk or do anything else people do.

4. Have students read their stories to the class.

Evaluation

Student stories include information about how the plant was traditionally used.

Extension

Students can illustrate their stories or obtain a sample of their wetland plant and display them with their stories.

Curriculum Connections

(See Appendix for full citations)

Books:

Alaska's Wilderness Medicines. (Viereck, 1987).

Discovering Wild Plants: Western Canada, The Northwest. (Schofield, 1989).

Earth Dyes-Nuunam Qaralirkai: dyes for grass made from natural materials. (Blumenstein, 1984).

Food Plants of Coastal First Peoples (Turner, 2003)

Food Plants of Interior First Peoples (Turner, 1997).

Nauriat Niginaqtuat: plants that we eat. (Jones 1983).

Tanaina Plantlore, Dena'ina K'et'una. (Kari 1987).

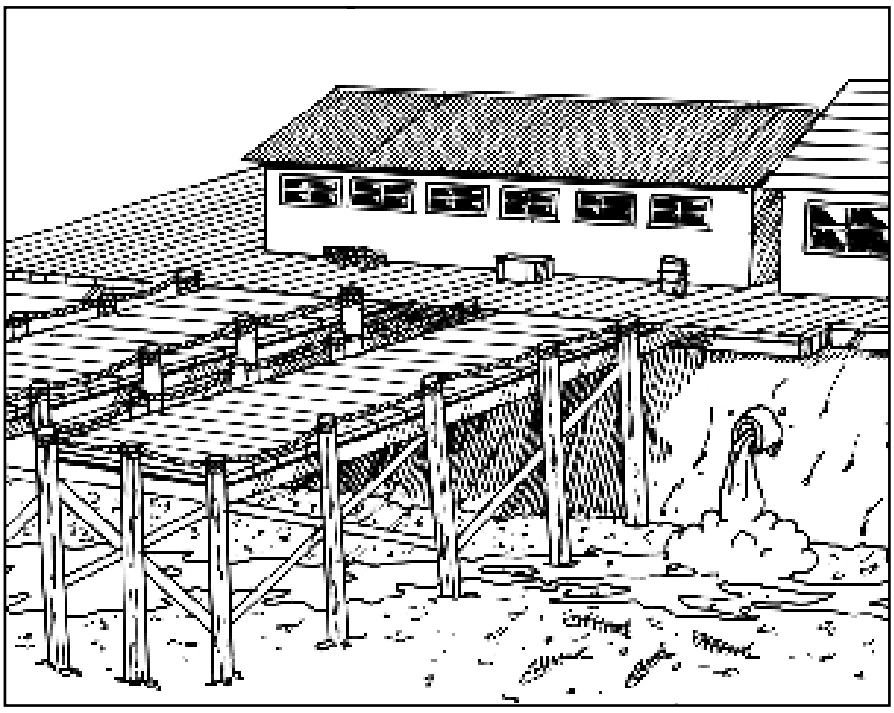
Wild, edible & medicinal plants: Alaska, Canada & Pacific Northwest rainforest: an introductory pocket trail guide. (Biggs, 1999).

Wild, Edible and Poisonous Plants of Alaska. (Heller, 1989).

TRADITIONAL USES OF WETLAND PLANTS

WETLAND PLANT	NATIVE GROUP & USE
Pacific Silverweed *(Potentilla egedii)*	**Coastal Indians** – dug up roots and steamed like potatoes
Labrador Tea *(Ledum palustre)*	**Coastal Indians** – leaves dried & made into a tea, used as medicine for cold, cough and sore throat
Yellow Pond Lily *(Nuphar polysepala)*	**Athabaskan** – large root is collected, warmed and placed on the skin for relief of pain
Skunk Cabbage *(Lysichiton americanum)*	**Coastal Indians** – waxy leaves used for storing food and wrapping fish for steaming
Buckbean *(Menyanthes trifoliata)*	**Aleuts** – roots used as a tonic for relief of gas pains, constipation
Marsh Violet *(Viola epipsila)*	**Athabaskan** – pleasant smelling roots were dried & used as an incense at potlatches
Sea Lovage *(Ligusticum scoticum)*	**Inupiaq Eskimo** – beach plant tastes like celery, provides fiber
Club Moss *(Lycopodium* sp.)	**Athabaskan** – headache remedy, placed on head until headache is gone
Stinging Nettle *(Urtica dioica)*	**Coastal Indians** – fiber used to make ropes and nets
Lowbush cranberry *(Vaccinium vitis idaea)*	**Inupiaq Eskimo** – berries spread as a paste on a cloth & wrapped around the neck for a sore throat
Sphagnum Moss	**Athabaskan** – used for absorbing moisture in baby diapers
Wormwood *(Artemesia tilesii)*	**Yupik** – high in vitamin C. Used in steam baths, and as a cold tonic. Hot wormwood packs are also applied to injuries and achy joints

Deadly Waters



Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: 4 - 8

State Standards: Geography E-3, E-5, F-3; Math A-1, A-4
NGSS: 5-ESS3-1., MS-LS2-4. MS-ESS3-3. MS-ESS3-4

Subjects: science, social studies, health, home economics, industrial arts

Skills: analysis, classification, comparing similarities and differences, computation, description, discussion, identification, inference, interpretation, matching, media construction, observation, psychomotor development, reading, recognition

Duration: 30-45 minutes

Group Size: small groups of three students

Setting: indoors

Vocabulary: pollution, discharges

Objectives:
Students will be able to name and describe different kinds of pollution that can affect water as well as animals and plants that live in water and wetlands.

Teaching Strategy
Students will analyze the pollutants found in a hypothetical river. They will graph the quantities of pollutants and make recommendations about actions that could be taken to improve wetland habitat.

Complementary Activities:
Migration Headache.

Materials:
Two sheets each of eight different colors of construction paper, 4 sheets of blue paper, writing or graphing paper, tape or glue, Pollutant Information Cards (see following), 1 tablespoon (for 1/2-inch square tokens)

Background:
See INSIGHTS Section 1 Wetland Ecosystems *"Ecosystem Functions"* and Section 3 Wetlands in a Changing World *"Wetlands Pollution and Contaminants"* fact sheet.

Procedure:
1. Before the activity begins, make 100 tokens of **each** of the eight colors of construction paper and 200 of the blue paper. The construction paper may be folded in quarters to speed up the process of cutting. Cut the construction paper into 1/2-inch square tokens using a paper cutter. Put all the tokens in a container. Stir them so the colors are thoroughly mixed. Make one copy of the Pollutant Information Cards for each group.

2. Divide the class into groups of three. Pass out the Pollutant Information Cards. Review each kind of pollution with the students.

3. Have students color code each type of pollution (they can tape a token next to each type of pollution on the sheet with all the pollution cards, or write a short description of the pollution on a piece of paper of the color to which it is coded.

4. The blue tokens will represent water that is not polluted.

5. Once all the kinds of pollution have been discussed and the students understand that each kind of pollution will be represented in this activity by one color of paper, explain that each group will be a research team. Each team will analyze the pollution content of a hypothetical stream that flows into a wetland. Distribute the colored paper tokens that have been cut from the construction paper. Provide one tablespoon of the cut 1/2-inch square tokens to each research team. Also provide each team with a piece of graph paper.

6. The teams must separate the colored tokens into piles. Using the color key, they should identify each type of pollutant. Once this is done, they should 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. Tell them to 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 of them has a different river. Their results are not likely to be the same!

7. When they have the bar graphs completed and have compared the teams' results, tell them that any quantity above two units of each kind of pollutant is considered damaging to wildlife or fish habitat. Have the students evaluate whether or not their wetland is polluted.

8. Students can determine the percentage of each kind of pollutant. They may also present their data using a pie chart.

9. To extend this activity with a research project, assign one or more of the pollutants to each group. Have the students brainstorm answers to the following questions: How might the pollutant be harmful or damaging to fish or wildlife? What human or nonhuman activities might be the source of the pollutants? Are there any ways the pollutants might reach high, damaging levels in the absence of human activities?

10. Have each group research answers to the questions in #7 using library references, the internet, interviews with local water quality experts, or answers to letters written to state or local agencies responsible for water quality.

Credits

Extensions

1. List five things people could do to reduce the number of pollutants added to the environment.

2. Take a field trip to a stream or wetland and measure the pollutants. Contact local officials responsible for water quality (representatives of the Alaska Department of Environmental Quality or municipal or city engineers) and ask them to describe how and where they measure water pollution in streams and wetlands near your community.

3. Set up a water quality monitoring program on a local stream or wetland. Download a complete stream monitoring manual at http://aquatic.uaa.alaska.edu/pdfs/EducationLevelBioMonitoringMethods.pdf.

4. Get information about current national laws protecting water quality by writing to the Environmental Protection Agency. Or write to the Alaska Department of Environmental Conservation to get information on state laws.

5. Write the Alaska Department of Environmental Conservation for a unit on safe drinking water in Alaska. (K-3 and 4-6th grade units).

Curriculum Connections:

(See Appendix for full citations)

Our Endangered Planet: Groundwater (Hoff, 1991).

Our Endangered Planet: Rivers and Lakes (Hoff 1991).

Protecting Our Rivers and Lakes (Costa-Pau, 1994).

Water Squeeze (O'Neil, 1991).

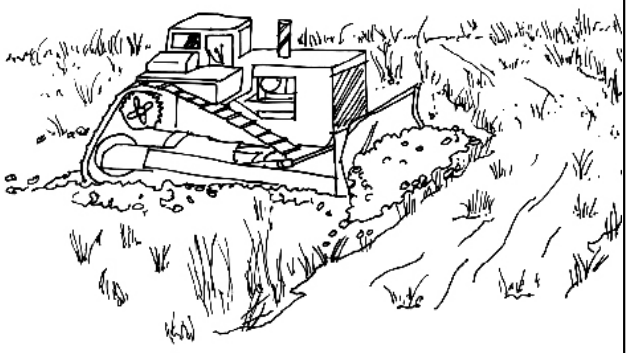
Wetlands in Danger: A World Conservation Atlas. (Dugan, 1993).

TYPE OF POLLUTION: SEDIMENT

Particles of soil, sand, clay, and minerals wash into streams and rivers. In large quantities, these natural materials can be considered a pollutant.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN SEDIMENT POLLUTION: Construction projects that clear land (i.e., building roads, houses, businesses, airports), removal of trees for timber harvest, placer and strip mining, agriculture, building dams or other structures to control water flow.

PREVENTION: Leaving strips of trees and plants around cleared or logged areas, settling ponds.



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SEDIMENT POLLUTION

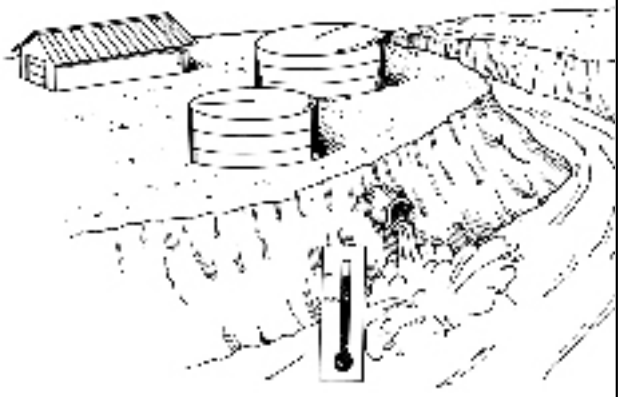
EFFECTS ON FISH AND WILDLIFE: High concentrations of suspended sediment can block sunlight from reaching plants in the water. Plants grow poorly and provide less food for invertebrates, fish, and birds. Reduced light can make it difficult for fish to see and capture their food. Silt can damage or clog the gills of fish and invertebrates. Extremely high levels of silt that drops out of the water cover gravel on the bottoms of rivers and streams with mud. Animals that live on gravel can't survive. Fish such as salmon that spawn on gravel no longer have habitat for laying their eggs. Fish eggs, shellfish, and invertebrates in the gravel can be smothered.

TYPE OF POLLUTION: THERMAL (WATER TEMPERATURE CHANGE)

A change in normal water temperature is considered thermal pollution.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN WATER TEMPERATURE CHANGES: Discharges from power plants, logging of trees along streams that provide shade, discharges from sewage treatment plants during winter, burial of heated or cooled oil or gas pipelines under rivers and wetlands.

PREVENTION: Cooling water before discharge, leaving strips of trees for shade, insulation of heated or cooled pipelines.



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THERMAL POLLUTION

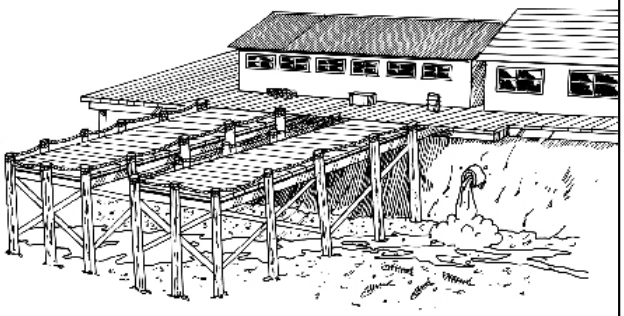
EFFECTS ON FISH AND WILDLIFE: Very hot water can kill some fish such as trout, salmon, grayling, and whitefish and invertebrates that normally live in cooler water. Hot water can kill fish eggs and kill or harm developing embryos. Increases or decreases in water temperature can change the pattern of freezing and thawing, harming animals adapted to a normal pattern. Fish may lay eggs or insects emerge as adults at the wrong time of the year when no food is available or conditions are poor for survival. Water temperature changes can affect the entire food chain if plant growth is affected.

TYPE OF POLLUTION: ORGANIC

Organic wastes consist of materials that were once alive.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN ORGANIC POLLUTION: Direct discharge of sewage into streams or wetlands, discharge of large quantities of fish wastes from processing plants, discharge of logging wastes from harvest areas and pulp mills.

PREVENTION: Treatment of sewage or other wastes or disposal where the water system is not overloaded.



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ORGANIC POLLUTION

EFFECTS ON FISH AND WILDLIFE: Bacteria that breaks down sewage, fish wastes, logging wastes and other organic matter use up the oxygen in the water. Few types of living things can live where levels of oxygen are very low. Fish damage their gills, grow slowly, have delays in the hatch of their eggs, and may die as a result of low oxygen levels. Decay of material without oxygen produces toxic substances that kill many invertebrates and fish. Organic wastes can also act as fertilizers.

EFFECTS ON HUMANS: Sewage that has not been treated may carry harmful bacteria and cause sickness in humans exposed to it by swimming or by drinking the water.

TYPE OF POLLUTION: HYDROCARBONS AND OTHER PETROLEUM PRODUCTS

Hydrocarbons like oil are very visible pollutants. Since most petroleum products are less dense than water, they float and are often visible as a sheet or sheen on the water surface. Tiny particles of oil may be suspended in water that is mixed thoroughly (by wind, waves, or agitation). Spilled oil that "disappears" may often still be present in a suspended state or as a coating on the bottom of a water body.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN HYDROCARBON POLLUTION: Disposal of oil in water or onto wetlands (e.g., draining a car's oil), spills during development, storage, or transportation of oil; leakage from underground tanks.

PREVENTION: Using disposal areas that are not connected to streams or wetlands, avoiding spills, and inspecting underground storage tanks.

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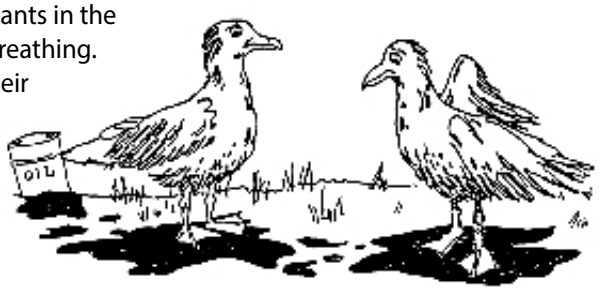
HYDROCARBON POLLUTION

EFFECTS ON FISH AND WILDLIFE: The effects of oil on wildlife vary considerably with the type and concentration of spilled oil. The volatile (gaseous) portions of the oil which evaporate rapidly from spilled oil are very poisonous to fish, some invertebrates, birds, and mammals. High concentrations of oil can slow the growth of plants.



An oil slick on the water surface blocks sunlight and may affect plants in the water. Oil which sticks to the gills of fish can interfere with their breathing. Oil sticks to the feathers of birds and fur of mammals and ruins their insulation and ability to avoid freezing to death in cold water. Some animals which try to clean their feathers or fur swallow the oil and are poisoned. Floating oil can become a coating on sand or soil particles and sink to the bottom as the particles settle. Oil that reaches the bottom of a stream or the ocean may smother invertebrates that live on the bottom (including crabs and shrimps) and prevent fish from spawning. Oil which reaches wetlands and beaches may smother or poison plants and invertebrates and stay around for many years. Oil enters the food chain as predators feed on other animals that were poisoned by oil.

TYPE OF POLLUTION: TOXIC SUBSTANCES

A wide variety of chemicals, including pesticides, herbicides, and waste products, are toxic or harmful to different types of fish and wildlife. Many are also toxic to humans.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN TOXIC POLLUTION: Agriculture, gardening, forest management, clearing land, mosquito control, discharge of detergents, mining, manufacturing.

PREVENTION: Finding and using non-toxic alternatives, using and disposing of chemicals in such a way that they will not enter water.

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TOXIC POLLUTION

EFFECTS ON FISH AND WILDLIFE: Some pesticides and herbicides applied to crops, gardens, forest stands, or other areas of land to eliminate undesirable plants or animals break down into non-toxic chemicals. Others spread to lakes, rivers, and wetlands. While effects vary widely, both pesticides and herbicides are designed to be poisonous. A few are poisonous to a fairly specific groups of insects or plants, while many are poisonous to a wide variety of invertebrates, fish, mammals, and amphibians. The poisons may cause immediate death, cause illness, or interfere with an animal's abilities to survive or to reproduce. Some substances reach higher concentrations as they are passed up the food chain.

Other toxic substances are introduced into waters if they are disposed of improperly. Mining and manufacturing wastes may include highly acidic substances or chemicals such as arsenic used in the mining process.

Wetlands can immobilize some pesticides and other toxic substances and keep them from spreading into the food chain.

TYPE OF POLLUTION: FERTILIZERS

Fertilizers often contain large amounts of nitrogen and phosphorus, which are limiting in most ecosystems.

EXAMPLES OF HUMAN ACTIVITIES THAT CAN RESULT IN FERTILIZER POLLUTION: Agricultural and garden run-off, discharge of nutrient-rich water.

PREVENTION: Preventing run-off into streams and wetlands that will become overloaded by the nutrients.

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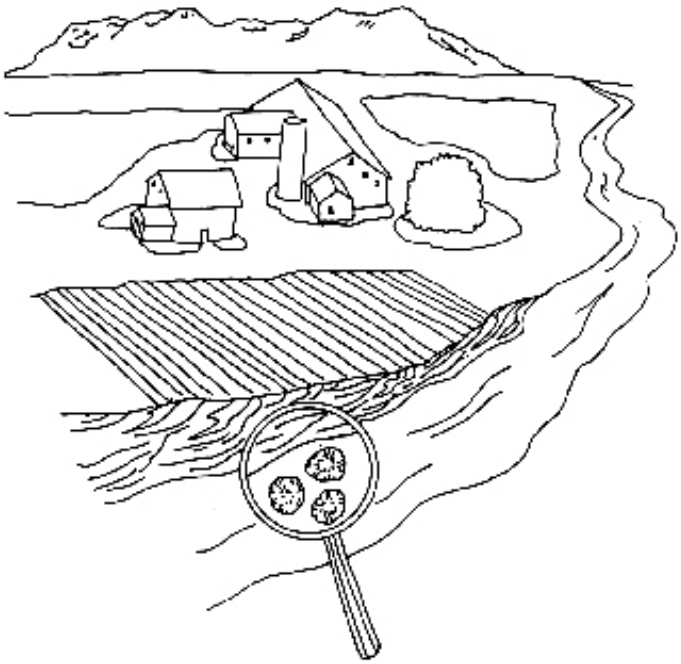
FERTILIZER POLLUTION

EFFECTS ON FISH AND WILDLIFE: Fertilizers contain nitrogen and phosphorus that can cause large amounts of algae to grow. If the large blooms cover the water's surface, the algae die after they have used up all of the nutrients. Once dead, they sink to the bottom where bacteria feed on them. The bacteria increase and use up most of the oxygen in the water. Many animals die without oxygen.

High concentrations of nitrogen in the form of nitrates or ammonia are toxic to young animals.

Wetland plants can absorb excess nutrients and convert nitrogen compounds into non-toxic forms.

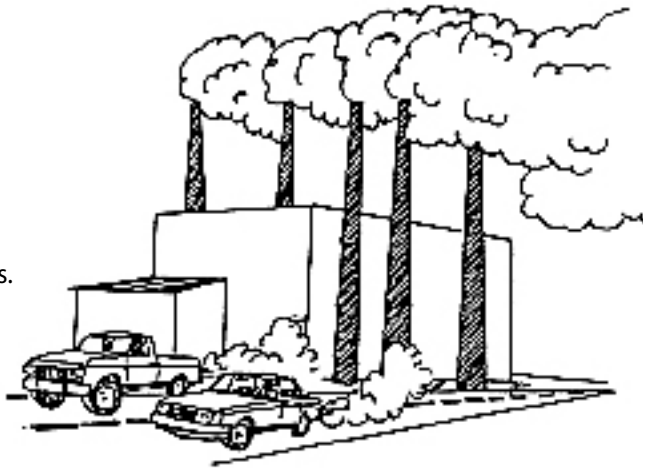


TYPE OF POLLUTION: CHANGES IN ACIDITY (pH)

pH is a measure of the acidity (low pH) or alkalinity (high pH) of waters. Values of either too high or too low pH will affect organisms living in the water.

EXAMPLES OF HUMAN ACTIVITIES THAT MAY RESULT IN ACID PRECIPITATION: Acid rain from air pollution generated by the combustion of fossil fuels.

PREVENTION: Reduce burning of fossil fuels through energy conservation; install pollution control devices on smokestacks.



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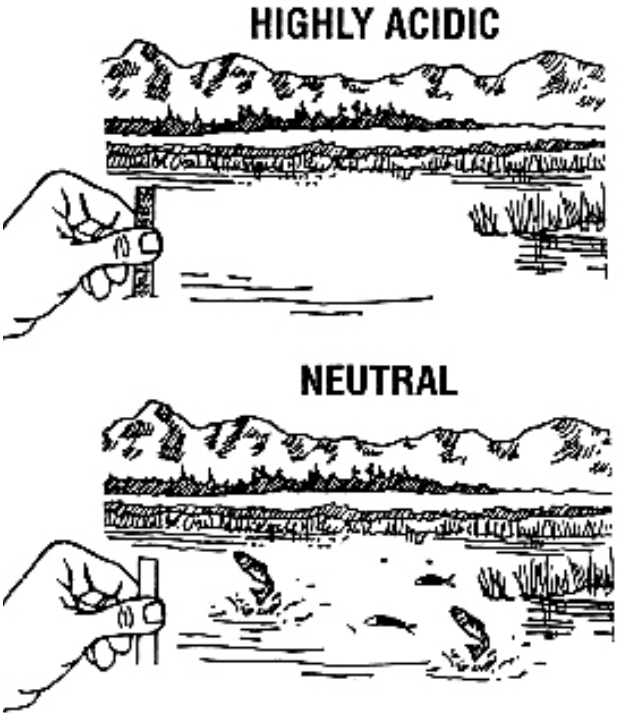
ACID PRECIPITATION POLLUTION

EFFECTS ON FISH AND WILDLIFE: As the acidity of water increases, naturally occurring mercury and other heavy metals can be released, resulting in changed chemical qualities of the water. When water becomes too acidic, some fish and aquatic insects die. Loons and other waterbirds can be poisoned by mercury-contaminated foods.

Acid precipitation and the dying of lakes and forests is becoming a serious problem in Scandinavia, Europe, and eastern Canada. Pollution of the air over arctic Alaska has already been detected.



TYPE OF POLLUTION: HEAVY METALS

Heavy metal pollutants include zinc, cadmium, copper, lead, mercury, and selenium.

EXAMPLES OF HUMAN ACTIVITIES THAT MAY RESULT IN HEAVY METAL POLLUTION: Disposal of mining wastes, agricultural runoff, use of lead shot to hunt waterfowl, garbage dumps, atmospheric pollution.

PREVENTION: Avoid disposal and runoff into streams and wetlands, substitute steel shot for lead shot, treat wastes to remove heavy metals or convert them to less harmful forms.

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HEAVY METALS POLLUTION

EFFECTS ON FISH AND WILDLIFE: The poisonous effect of various heavy metals varies considerably with concentration, water temperature, amount of oxygen in the water, and pH. Vertebrate animals seem in general to be more sensitive than invertebrates which may concentrate the metals in the food chain.

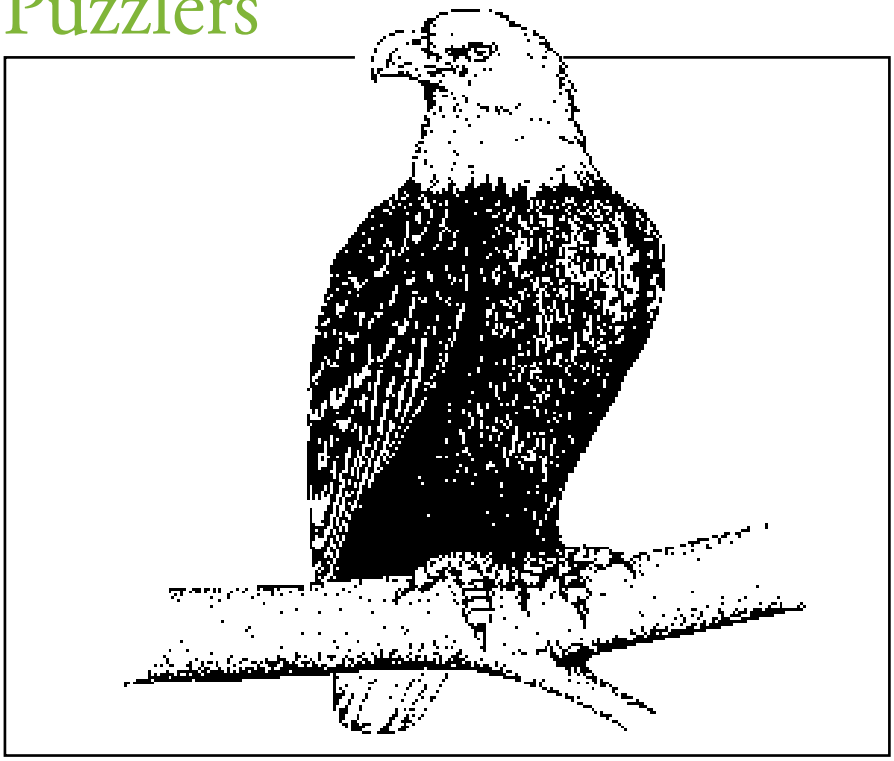
High concentrations of cadmium, zinc, and copper have caused behavior changes and reduced reproductive ability in fish.

Mercury compounds are toxic to most fish and other aquatic life, can be passed up the food chain, and in high concentrations can cause brain damage to humans.

Ingestion of lead can result in poisoning and death of waterfowl and can concentrate up the food chain and cause the death of eagles and other birds of prey. See the brochures "Lead Poisoning in Waterfowl" and "Shoot Steel Shot" for more information.

Selenium pollution has resulted in poor reproduction and abnormalities of embryos of waterfowl.

Changing World Ecology Puzzlers



Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: 6 – 12

State Standards: English/LA B-1, B-2 D-1; Geography C-1, C-2, C-3, E-3, E-5

NGSS: MS-LS2-4.,MS-ESS3-4 HS-LS2-2.

Subjects: science, social studies

Skills: data analysis, inference, problem-solving

Duration: one class session

Group Size: individuals or small groups

Setting: classroom

Vocabulary: ecology, climate change, deformity invasive species, limiting factors

Objectives:

Students will recognize that human activities can have far-reaching effects on wildlife.

Teaching Strategy

Using clues provided, students will develop hypotheses to answer puzzles currently challenging wildlife or wildlife habitat.

Materials:

Using clues provided, students will develop hypotheses to answer puzzles currently challenging wildlife or wildlife habitat.

Procedure:

1. Photocopy the puzzlers so each student or group can have a copy of one puzzler.

2. After handing out the puzzlers, explain that students need to read each puzzle carefully, look for connections in the information, and apply their knowledge of ecology to provide a good hypothesis that would answer the puzzle.

3. Review each puzzler with the class. Have students or groups share their puzzler and hypotheses with the rest of the class.

4. Discuss the difficulties scientists often have precisely predicting the effects of human activities on ecosystems.

Curriculum Connections:

(See Appendix for Full Citations).

Books:

Wetlands in Danger: A World Conservation Atlas. (Dugan, 1993).

Articles:

Shrub invasion shows recent drying of ancient Kenai peatlands. (Berg, 2005).

International Panel on Climate Change (IPCC) Fourth Assessment Report, Summary for Policy Makers. (IPCC, Feb 2007). Available [online] at http://www.ipcc.ch/publications_and_data/ar4/wg3/zh/contents.html

ECOLOGY PUZZLER #1

Bald Eagles and Waterfowl

THE FACTS:

When a dead Bald Eagle is discovered anywhere in the U.S., it is sent to a U.S. Fish and Wildlife Service laboratory in Madison, Wisconsin where researchers can determine the cause of death. Between 1966 and 1990, scientists at the lab discovered that more than 120 of the bald eagles they received had died from lead poisoning. Additionally, over half the deaths from lead poisoning had occurred after 1980. Scientists conducting research on waterfowl also discovered that lead poisoning was a significant cause death. In 1990, researchers estimated that between 1.5 and 3 million birds died each year from lead poisoning.

If waterfowl swallow enough lead to cause lead poisoning, death usually occurs within three weeks.

The stomachs of waterfowl have a muscular portion with horny plates or ridges called the gizzard. The gizzard is used to grind up and crush hard materials that have been swallowed whole.

Lead was banned as an additive to gasoline in 1974. Prior to then, leaded gas was the major source of lead entering the atmosphere as air pollution.

Northern pintails and mallards are more susceptible to lead poisoning than other dabbling ducks. Swans and diving ducks such as the canvasback are also very susceptible to lead poisoning.

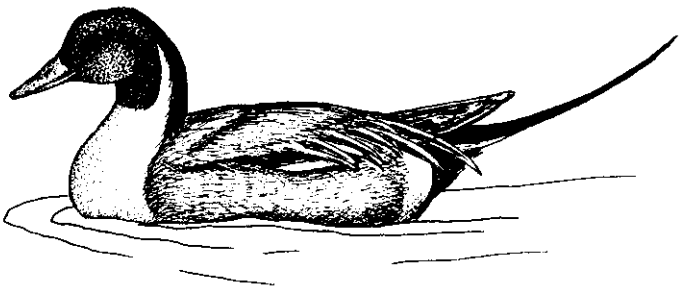
Bald eagle deaths sometimes occurred in areas far from waterfowl hunting and wintering areas.

Unlike other dabbling ducks which feed on plants and invertebrates in the water or on the surface of the water, pintails and mallards often feed on the tubers (fleshy roots) and seeds of aquatic plants, often using their bills to dig 4-5 inches down. Swans dig even deeper, as much as 12-15 inches. Diving ducks dig in search of clams.

THE PUZZLE:

How were waterfowl and bald eagles becoming poisoned by lead?

THE SOLUTION:



Scientists ruled out air pollution as the major cause because the amount of poisoning did not decrease after lead was removed from gasoline. They could find no evidence that birds were swallowing lead batteries, fishing sinkers, or other lead objects in large numbers. Die-offs of birds who fed in ponds polluted by lead mining wastes did occur, but only occasionally.

After examining the gizzards of hunter-killed waterfowl, scientists concluded that the birds were swallowing lead shot which had been deposited in the wetland areas where the hunting occurred and the birds fed. They knew that there are about 280 pellets of lead shot in a typical shotgun shell. On average, six shells are fired for every bird that is shot by a hunter. This would result in about 1400 pellets (about half a pound) that were left in the wetlands for every bird that was harvested. When researchers dug up the bottom of wetlands and waterfowl hunting areas, they found more than 100,000 lead pellets per acre in the upper few inches of the ground.

Ducks differ in susceptibility of lead poisoning according to their feeding habit. Ducks, geese, and swans dig in the bottom of wetlands for plant roots and seeds. Since lead pellets resemble the hard seeds the birds seek, these birds are more likely to swallow lead along with their food than birds who feed in the water or on the surface.

Eagles can inadvertently consume lead shot when they feed on smaller birds (either carcasses, or ones that got crippled but got away). The eagles that were studied only died if they had actually swallowed lead shot, not just the tissues of dead birds. Because Bald eagles are able to fly long distances between swallowing lead shot and becoming sick enough to die from lead poisoning, the eagles often died in areas far from where they had fed on lead-poisoned waterfowl.

The many waterfowl deaths from lead poisoning went undetected for a long time because eagles and other predators are efficient at finding and removing carcasses.

WHAT HAS BEEN DONE:

Wildlife managers worked with ammunition companies and hunters to develop an alternative to lead shot that would not dramatically increase the amount of waterfowl crippled by hunters or change the hunters' success at harvesting waterfowl. Steel shot is an alternative that is not toxic to birds, if swallowed.

Lead shot for waterfowl hunting was banned throughout the United States in 1991. However, in some parts of Alaska, use of lead shot is still permitted for hunting upland birds like ptarmigan, which use wetland areas during winter. Lead shot can be much less expensive than steel shot, so the use of lead shot persists today. Additionally, without cleanup efforts, old shot from decades of hunting remains in the bottom of wetlands, where birds can find it.

ECOLOGY PUZZLER #2

Five-legged Frogs

THE FACTS:

Throughout Alaska, wood frogs have been showing up with malformities and deformities. A malformity is like a birth defect. It is a change in the frog's body, such as a club foot or a missing limb that happened during the frog's development. A deformity is a change that happened sometime during the frog's life. An amputation would be an example of a deformity.

Amphibian deformities and malformities are also a global occurrence.

Amphibians of all species have been declining wordwide. Thirty-three percent of amphibian species worldwide are threatened with extinction.

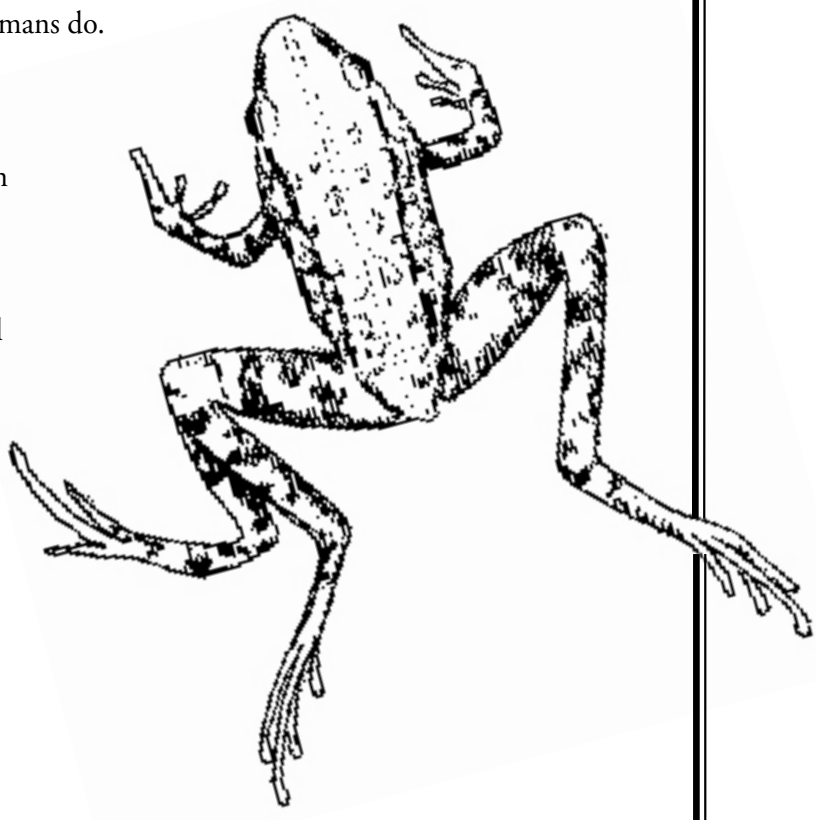
Amphibians breathe and absorb water through their skin.

Unlike mammals, birds, and reptiles, which complete larval development in a protected environment, amphibians complete larval development (growth and metamorphosis of tadpoles) in the water. Metamorphosis is a relatively rapid process, whereby amphibians go through an enormous series of changes in a short amount of time.

Amphibians have the same hormone system that humans do. This system is very sensitive, and can be affected by environmental contaminants.

Amphibians have diverse habitat requirements, often needing wetlands for breeding, but woodlands and grasslands for finding food during adulthood.

Studies have shown that the occurrence of abnormal frogs is increasing throughout the United States.



THE PUZZLE:

Why are scientists finding so many deformed and malformed frogs in Alaska?

THE SOLUTION:

The four characteristics of amphibians mentioned above: 1) permeable skin, 2) exposed development, 3) sensitive hormone system, and 4) diverse habitat requirements make them vulnerable to all sorts of changes in the environment.

Scientists have not one, but many different hypotheses for why frogs are showing up with abnormalities. Hypotheses include parasites and disease, fungal pathogens, loss of habitat, climate warming, UV radiation, chemical contaminants, and introduced species.

Different reasons may be responsible for amphibian decline in different regions. In a few specific ponds in Alaska, where a certain parasite was present, up to 90% of frogs had malformities or deformities. In another example, scientists discovered that very low concentrations of the widespread herbicide Atrizine affected the hormone system of frogs, impairing their sexual development. The affected frogs were essentially feminized. The Chytrid fungus that is invading waters throughout the world has been blamed for extensive die-offs of many different species of frogs. Increasing temperatures due to climate change may be a factor that is allowing the disease-carrying fungus to thrive. In yet another example, trout introduced to Sierra Lakes in California preyed so extensively on tadpoles of Mountain Yellow-legged frogs that many of the lakes became completely devoid of frogs.

No doubt, amphibians are stressed from a combination of many different environmental stressors. Humans can pay attention to amphibian declines as indications of significant environmental degradation and threats to human health.

ECOLOGY PUZZLER #3

Expanding Forests

THE FACTS:

On parts of the Kenai Peninsula, researchers have noticed that the geographic area covered by forests has expanded. In fact, from 1950 to 1996, some of the region's forested areas increased from 57% to 73%. Scientists have excavated some of these areas where forests have moved in, and discovered deep layers of peat, with absolutely no former evidence of tree stems or roots. They determined that soggy bogs had been there for 8,000 to 12,000 years, and that the young forests are a very recent change. The same researchers also flew over the Kenai Peninsula and mapped out all the lakes and ponds. From the air, they could see that there has been substantial invasion of plants into these wetland areas since 1950.

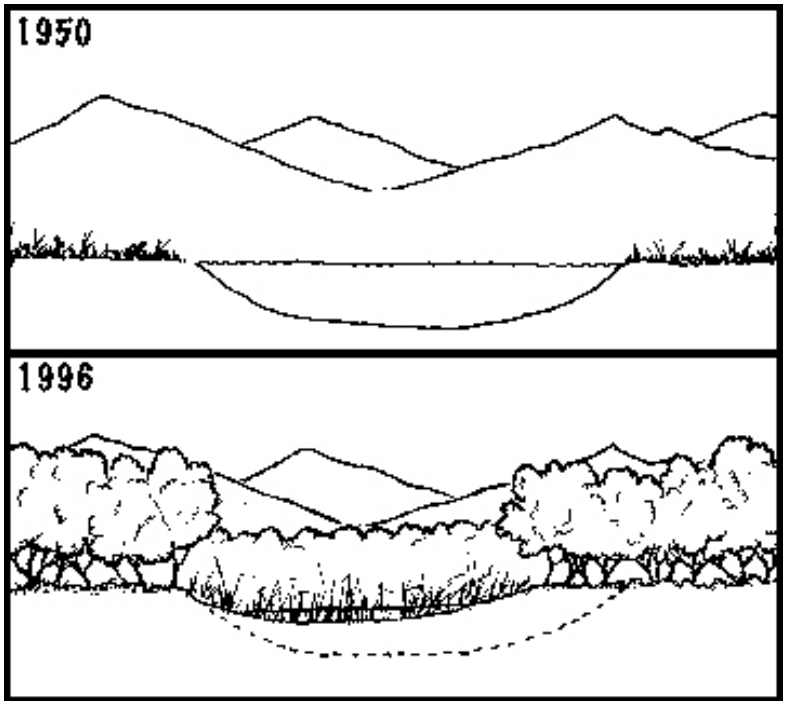
Meanwhile, research in Alaska's arctic shows similar patterns. Shrubs have expanded into the tundra in places where there have not been any trees or shrubs for thousands of years.

Trees and shrubs do not survive well in waterlogged soils. They require fairly well drained soil and a good supply of nutrients.

THE PUZZLE:

Why have forests and shrubs expanded into Alaska's wetlands?

THE SOLUTION:



ECOLOGY PUZZLER #3

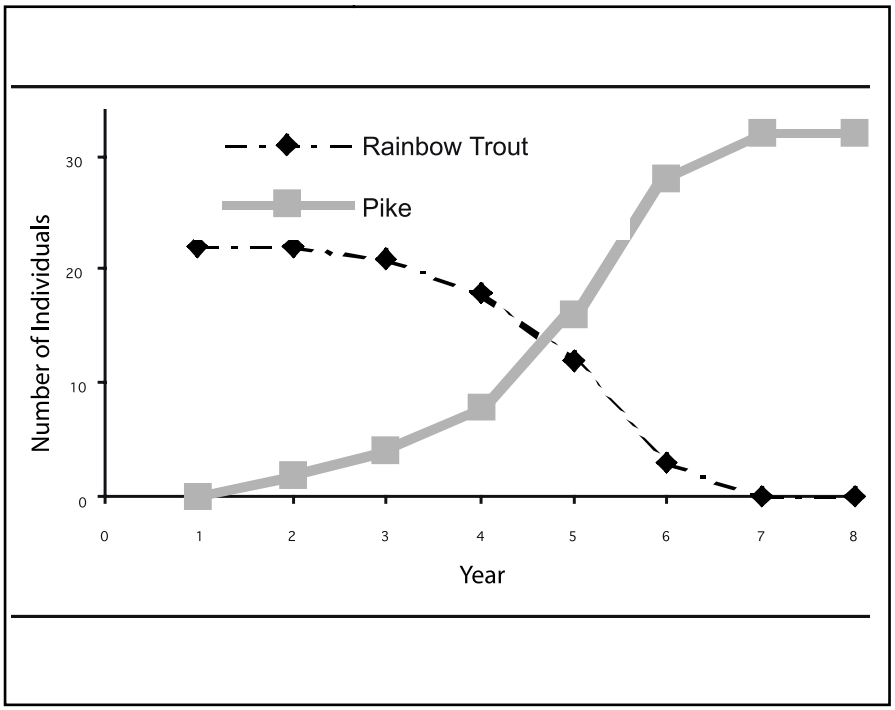
Climate warming has caused water tables to drop dramatically in parts of Alaska – essentially things are "drying up". Shrubs and forests are taking advantage of drier soils and moving in to areas where wetlands formerly existed. The scientists who studied the wetlands and other water bodies on the Kenai Peninsula, found that almost two-thirds of them had shrunk in size since 1950. Additionally, over 80% of the wetland sites that they studied appeared to be drying. The observed declines in wetland areas correspond very closely with weather records, showing that Alaska has been experiencing increasingly warmer temperatures for the past 100 years.

There is now widespread scientific consensus that the widespread warming ("Global warming") is partially due to an increase in the concentration of gases such as carbon dioxide and methane in earth's atmosphere. These greenhouse gases trap the sun's infrared heat when it hits the earth, and prevent most of it from escaping. As a result, earth has a pleasant climate that allows life to flourish. However, concentrations of these greenhouse gases have risen steadily since pre-industrial times as a result of the combustion of fossil fuels as well as deforestation. Every time we drive our cars or snow machines, heat our houses, and use energy generated from oil or coal-driven power plants, carbon dioxide is released in the atmosphere. The concentration of carbon dioxide in earth's atmosphere has increased by 31% since 1950.

As a result of climate warming, wetland areas in parts of Alaska are expected to continue to diminish as drying occurs. What effects do you think such wetland drying could have on wildlife populations? Would the effects be felt only locally?

You can visit a wetland and observe for yourself whether or not shrubs and trees are moving in. Dig a hole in a dry part of the wetland and examine the peat profile. Woody debris (stems and roots etc.) on the surface of the profile only, will indicate a recent change in the vegetation, from Sphagnum peat moss to shrubs.

Invasions Relations



Section 5
Wetland Activities
WETLANDS IN A CHANGING WORLD

Grade Level: 6 -12

Subjects: Math, Science
NGSS: MS-LS2-1. ,MS-LS2-2. MS-LS2-4., MS-ESS3-4 HS-LS2-2.,HS-LS4-4
Math: 8.F.5,12.F-BF.1.
Duration: 30-60 minutes
Group Size: Whole class

Setting: Outdoors or indoors in a large playing area

Vocabulary: birth rates, carrying capacity, competition, ecosystem, habitat, non-native, invasive, introduced, mortality, population trend, survival

Objectives:

Students will learn how the introduction of just one pair of invasive, non-native species can disrupt the entire balance of an ecosystem.

Teaching Strategy:

Students representing Rainbow Trout compete for food each year and observe population trends when two Pike are introduced to the system. After one or two population "experiments" students can develop their own questions, design and carry out a procedure. Older students can analyze results by creating graphs.

The activity employs trout and pike to illustrate the impact of invasive species, but you can substitute any other relevant species.

Complementary Activities:

I'm Not Mean, Just Hungry

Materials:

Large area such as a gym, hallway, or outdoor playground; chalk, tape or cones to create "start" lines; paper plates or pieces of colored laminated paper with HABITAT written on each one, (for 10-15 students use 20 plates, for 15-20 use 32, for 27-35 students use 36 plates); arm bands or vests; flip chart or portable chalk board.

Background:

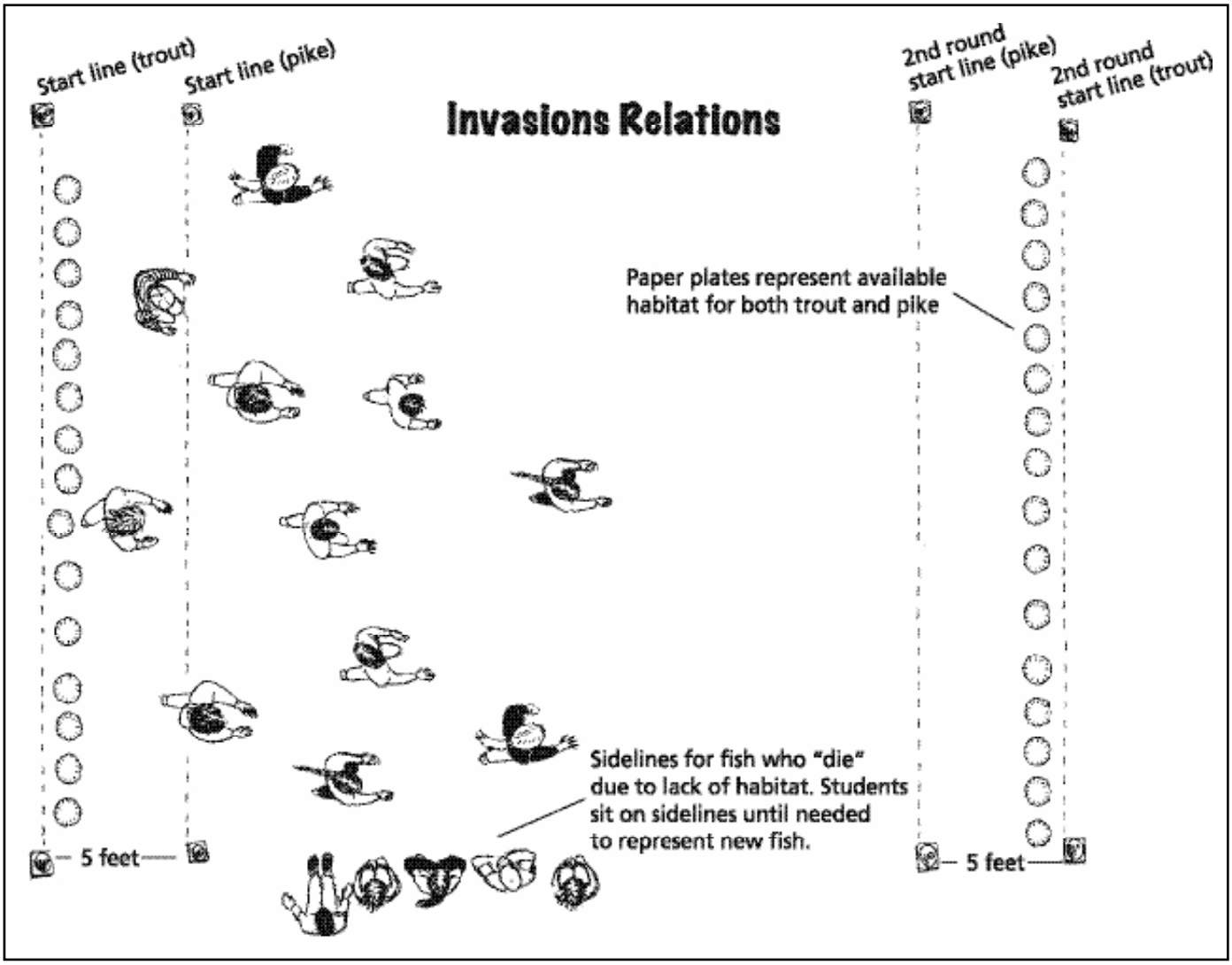
See INSIGHTS, Section 3, Wetlands in a Changing World *"Invasive Species and Wetlands".*

Procedure:

1. Beforehand, discuss with your students the definitions of "introduced", "non-native", and "invasive". Discuss the three different factors that make a species invasive and the three different ways in which invasive species can alter ecosystems.

2. Create a line on either side of the playing area using the chalk, tape or cones for the students to use as a "start" line. On each line, place half of the paper plates. Spread the plates out far apart from each other to minimize over-aggressive competition.

3. Create another line five feet from the starting area on either side. (See diagram below)



4. Draw the following table on the flip chart. *("HABITAT" refers to the number of paper plates available).*

YEAR	SPECIES	START	HABITAT	SURVIVE	DIE	OFFSPRING	END
1	Rainbow Trout		16				
2	Rainbow Trout		16				
3	Rainbow Trout Pike	2	16				
4	Rainbow Trout Pike		16				
5	Rainbow Trout Pike		16				
6	Rainbow Trout Pike		16				
7	Rainbow Trout Pike		16				
8	Rainbow Trout Pike		16				

5. Arrange all of the students along the line. Tell them that they are going to be Rainbow Trout, swimming in a small lake.

6. Ask the students what might make up the Rainbow Trout's habitat. *(Food – aquatic invertebrates and wetland plant materials when young, smaller fish, salmon carcasses, fish eggs, and small mammals when mature; shelter – shallow gravel in small clear water streams, and roots of wetland plants along streams and lakes).* Tell them that for purposes of this activity one paper plate will represent all the elements of suitable habitat for each fish.

7. On the table, record the number of fish in the START column for year 1. When you say "SWIM!", the students are to swim to the other side of the playing area to the habitat. The first "fish" to reach the habitat stands on it. Any "fish" who do not obtain habitat die and must go to the sidelines.

8. Fill in the table with the appropriate numbers of fish who died, and survived.

9. Tell the students that every two fish that survive produce one offspring. (Discuss with the students how Rainbow Trout normally produce 200 – 8,000 eggs, but for purposes of this activity, only one fry shall survive). Have the students calculate how many total fry were produced and fill in the table under OFFSPRING. For example, if 16 fish found suitable habitat, 8 fry would be produced.

10. Add the number of fry to the number of fish that survived to get an END population number and record it in the table. Fry will now become mature fish.

11. Bring enough students in from the sidelines ("fish" that "died" in the first round) so that you can begin a new round (repeat steps 7-10) with the appropriate number of mature fish, starting from this end of the playing field.

12. After a couple of rounds, the population should stabilize (since habitat is constant). Discuss with students that for the amount of habitat that exists, you have reached **carrying capacity**. Ask them what you could do to increase carrying capacity? Add more habitat.

13. Now you will introduce a pair of non-native Pike into the lake. Tell the students that Pike are native to Alaska north of the Alaska Range, but not in other parts of Alaska. However, the native habitat of Pike is very similar to the lake habitat in which you are about to introduce them.

14. Give armbands to two students from the sidelines (so you can easily distinguish the different species). Ask the group if they think one pair of Pike could have any effect on the Rainbow Trout population, and on the ecosystem. Have the students develop some hypotheses.

15. The Pike are faster swimmers, so they get to start on the second starting line. They also reproduce 2x as fast. That means for every pair of Pike, two offspring are produced. For example, if 4 Pike survive, 4 offspring are reproduced for an END population of 8. Remember to give new Pike armbands.

16. Continue doing more rounds and filling in the table until populations are again stabilized.

17. *You may find that the Pike wipe out the Rainbow Trout population in the lake, and that the carrying capacity of the lake is greater for Pike than for Rainbow Trout. Ask the students to think what other sorts impacts these results may have on the ecosystem and on people. The Pike will also eat juvenile salmon in the lake. Ask the students what sort of impact this consumption may have on streams exiting the lake and on the local fishery.*

18. Try the whole process again but with Atlantic Salmon instead of Pike. Instead of reproducing twice as fast, the Atlantic Salmon occupy two habitats instead of one. That is, students who are the Atlantic salmon will need to garnish two paper plates. *You may find this time that again the invasive species wipes out the native population, but the carrying capacity is reduced. Ask the students what sorts of impacts this result may have on other animals that rely on fish for food.*

19. Have the students develop other questions, procedures and hypotheses. Some ideas include

a. Students are juvenile Coho salmon. Every introduced Pike consumes one salmon.
b. Students are wood frogs. Every pet frog released into the wetland area brings in one virus, which also reproduces and dies with available food. Food for the virus can be the native wood frog or both the wood frog and the introduced frog. *(Note: even native wood frogs can bring diseases and viruses to a wetland area if they spent time as a pet in a fish tank).*
c. Students are native wetland plants. Introduced Reed Canary Grass modifies the environment so the reproductive rate of native plants are decreased.

20. Students can summarize their findings with graphs. They can determine which results would be most interesting to present on the graph. For example, they might plot the fluctuations of the populations of each species with time, or just investigate survival, mortality and/or reproduction.

21. *Note, in the first two scenarios, the native populations are wiped out because the introduced population is a superior competitor. The two populations could co-exist if competition among individuals within each species (intraspecific competition) was greater than the competition between the two populations (interspecific competition).*

Evaluation:

Students write or draw about their results, illuminating the long-term effects of the invasive species. Older students present the investigation as a write up of questions, hypotheses, methods, results, and discussion (significance, implications, and conclusions).

Extension:

Students can modify the playing field to add certain aspects of the species' habitat. For example, they may add logs that fish might use for refugia, riffles and rocks. Such "habitat" will add obstacles to the course and increase the challenge of the game.

Curriculum Connections:

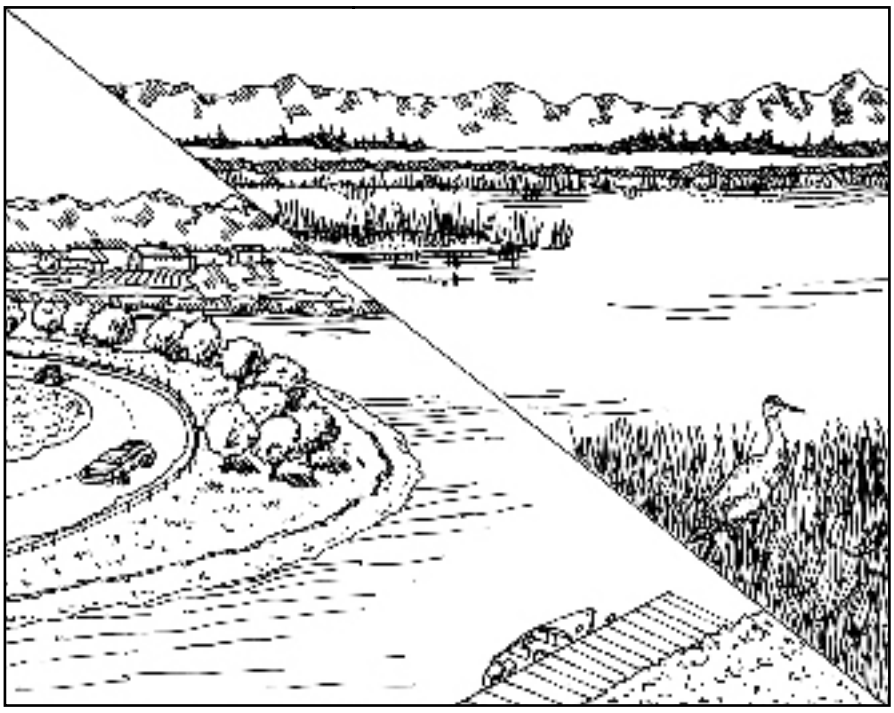
Websites:

Alaska Aquatic Nuisance Species Management Plan http://www.adfg.alaska.gov/index.cfm?adfg=invasive.main Includes specific information about problems related to aquatic species in Alaska.

Union of Concerned Scientsits 2006. *Sound Science Initiative: Invasive species.* http://www.ucsusa.org/ Includes information about the science, what you can do, and a list of web resources about invasive species.

USDA National Invasive Species Information Center. http://www.invasivespeciesinfo.gov/ Everything you want to know about invasive species, including economic impacts, bills regarding invasive species, links to K–12 education resources, and links to lists of invasive species for Alaska.

Wetland Exchange



Section 6
Wetland Activities
WETLANDS POLICY AND MANAGEMENT

Grade Level: 6 – 12
State Standards: Geography A-1, A-4, C-1, C-2, C-3, D-1, D-5, E-3, E-5, F-2, F-3. Math A-3. Government C-1
NGSS: MS-LS2-4., MS-ESS3-3. HS-ESS3-2
Subjects: math, science, social studies
Skills: calculating area, multiplication, synthesizing data, map reading and interpretation, decision making and evaluating
Duration: one to two class sessions
Group Size: 4
Setting: indoors
Vocabulary: development, mitigation, polygons

Objectives:

Students learn the process by which wetlands are conserved and developed through land exchanges.

Teaching Strategy

Students use simplified versions of wetland property maps and criteria guidelines to rate three wetland properties. Using the rating, they then determine which piece of property to purchase in exchange for developing another.

A more complicated version of this activity is provided for older students. (See extension).

Complementary Activities:

Rate a Wetland, Locate a Wetland

Materials:

Wetland property maps (included at end of activity) for each group. [Use wetland property aerial maps without polygons for higher grade level students (see *Extension)*].

Background:

See INSIGHTS Section 1 Wetland Ecosystems *"What is a Wetland"* and *"Profiles of Alaska's Wetlands"* and Section 4 Wetland Policy and Management *"Developing Alaska: A Challenge to Wetlands"*,*"Strategies for Wetland Development and Conservation"* and *"Wetland Regulations"* fact sheets.

Procedure:

1. Tell students that they work for a land trust that manages the exchange of wetlands in an in-lieu fee program. Every time a wetland is developed, the trust receives money to purchase and protect wetlands of equal value. A city needs to build a hospital on a wetland. The students will determine the wetland value of the building site, and then select a wetland to purchase and conserve in exchange.

2. Divide students into groups of 3 - 4. Provide each group with the aerial photos showing the wetland properties. Make sure students know which property is the one where the hospital will be built. (You can choose).

3. Give students some time to become oriented with their wetland properties. Have them locate and/or identify different types of wetlands, uplands, forests, and potential building sites.

4. Explain that wetlands have been rated on the students' maps according to many criteria. Discuss with the students what these different criteria might be *(quality and type of habitat, ability of wetlands to store water, slow erosion recharge groundwater etc.).* What makes good habitat for different types of wildlife? How much habitat do the different types of wildlife need? Is relative geographic area important? *(Consider flyways for migrating birds).*

5. Have the students look for polygons (shapes) on their maps. Explain that the polygons outline areas with the different criteria ratings. The students can find the legends on the maps, which define each type:

- "**A" wetlands** are rated the highest and are given a value of 20. These are areas around streams and ponds. **"A" wetlands** are marked on the map with a double-dashed line.
- "**B" wetlands** receive a value of 15. These are shrub wetlands, and are marked with a single solid line.
- "**C" wetlands** receive a value of 10. They are forested wetlands, indicated with a heavy dashed line.

6. Explain to students that they need to determine the total overall value of the land on each map. They will determine the value of the land where the hospital is to be built, and then determine the value of the three other pieces of property. Using the ratings, students will then determine which piece of property to purchase and conserve in exchange for developing the hospital site.

7. Using the grid that is overlaid on the maps, students must determine the **area** of each polygon on the map. Students can use the scale on the bottom of the map to determine the area of each grid unit ($100m^2$).

8. Using the worksheet as a guide, students then determine the total **value** of each polygon, and then add the total values of every polygon to determine the overall **rating** for each piece of property.

9. Once students have determined a rating for all three pieces of property, they can decide which piece of property to purchase.

10. After groups have completed their evaluations of each property, give them time to discuss the questions below. After a few minutes, open the discussion up to the whole class.

1. Was this a fair trade? Why or why not?
2. For the right to develop the wetland, the land developer paid $54,785 per acre for the two highest wetland ratings, and $13,878 per acre for the third rating (in 2006 dollars). Some wetland property actually costs much more than this value, while some costs less. Is this average cost to the developer fair?
3. This process was a simplified version of what is currently being done in Alaska in a few urban areas. Does this system seem to be a reasonable way to preserve wetlands in the rest of Alaska where 50% of the state is wetlands?
4. Should developers be allowed to build on (and fill) wetlands?

Evaluation

1. Students identify factors by which a wetland may be rated for value.
2. Students are given descriptions or detailed maps of two different wetland areas. They evaluate the two areas and then write about why they would select one over the other for either development or conservation.

Extension (for older students)

In place of the wetland property maps with polygons, give students the wetland property maps without polygons. Students must draw the polygons themselves using the following criteria:

"A" wetlands (20 points): streams, ponds, lakes, marshes with a 30 meter buffer.
"B" wetlands (15 points): shrub wetlands.
"C" wetlands (10 points): forested wetlands.

Students will need to use the scale on the bottom of the map to measure a buffer.

Credits:

Maps provided by Great Land Trust.

Curriculum Connections:

(See Appendix for full citations):

Books:

Maps and Mapping (Chancellor, 2004).

Vanishing Wetlands (Duffy 1994).

Video:

Alaska Wetlands: A Matter of Choice (video recording) (EPA,1988).

Websites:

Google Earth http://earth.google.com/ allows viewers to look at satellite images of anywhere in Alaska. (Free).

TOOLS: WETLANDS EVAULATION WORKSHEET

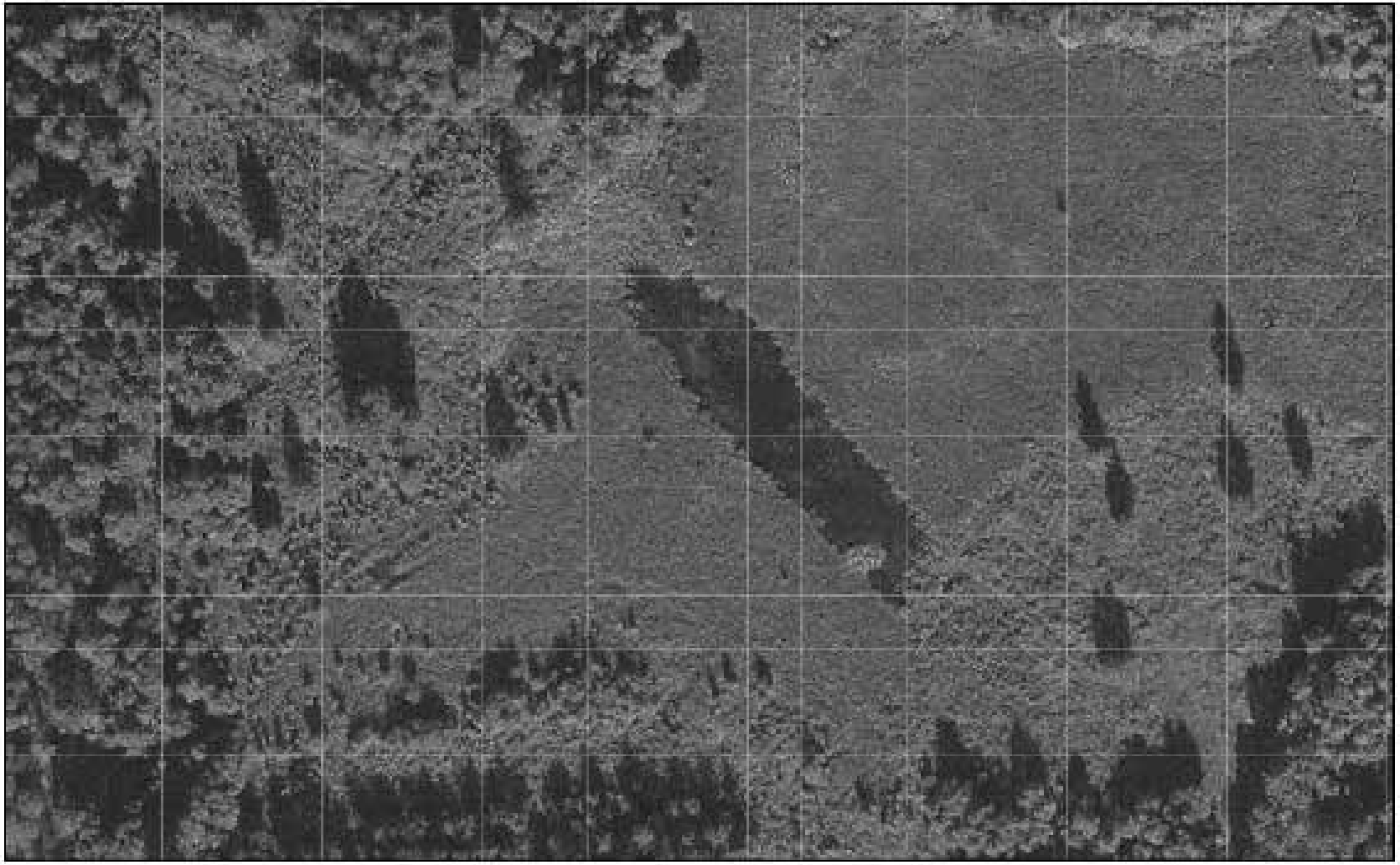
PROPERTY	POLYGON VALUE/m^2	POLYGON AREA (m^2)	TOTAL POLYGON VALUE = value X area
#1	A 20		
#1	B 15		
#1	C 10		
#1			**SUM of all 3 = Map Rating**
#2	A 20		
#2	B 15		
#2	C 10		
#2			**SUM of all 3 = Map rating**
#3	A 20		
#3	B 15		
#3	C 10		
#3			**SUM of all 3 = Map Rating**

TOOLS: WETLAND PROPERTY 1 (WITH POLYGONS)

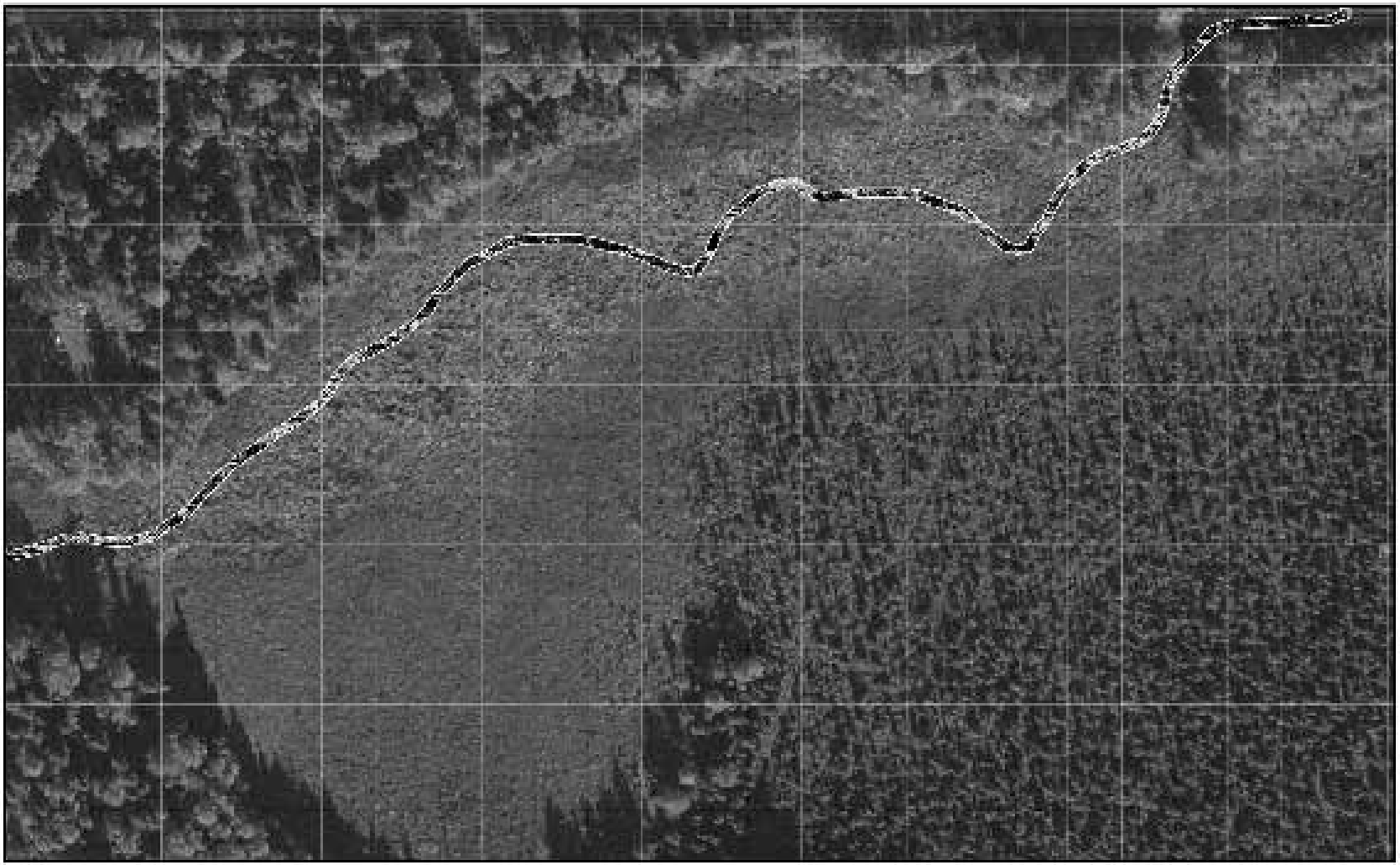
TOOLS: WETLAND PROPERTY 2 (WITH POLYGONS)

TOOLS: WETLAND PROPERTY 3 (WITH POLYGONS)

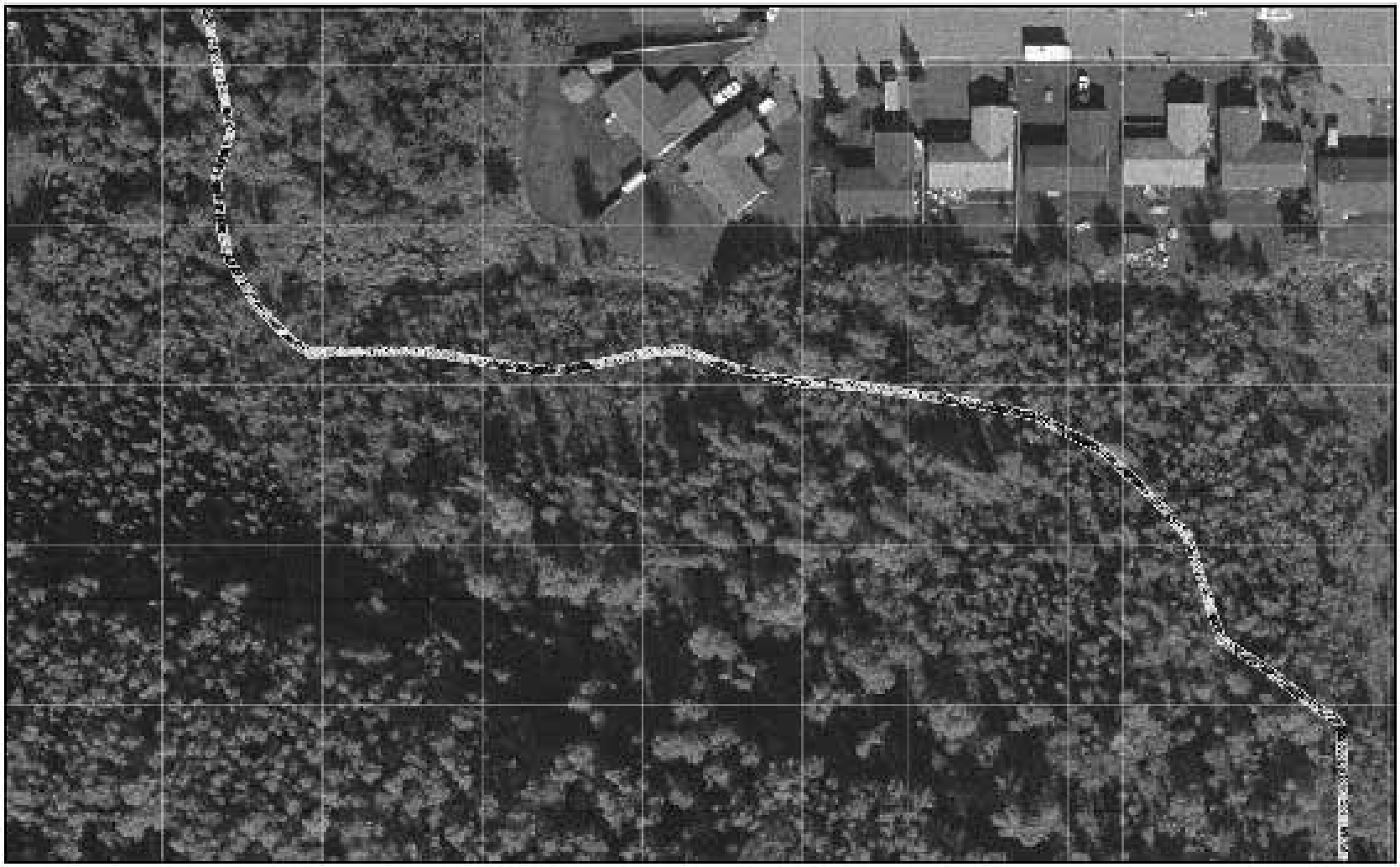
TOOLS: WETLAND PROPERTY 1 (WITHOUT POLYGONS) (for extension)



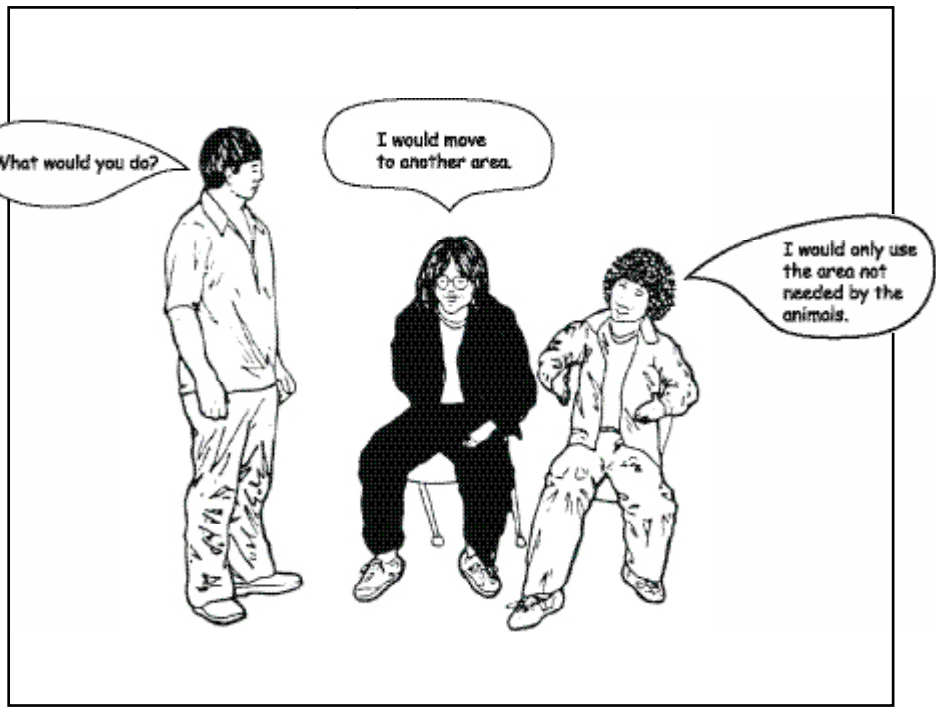
TOOLS: WETLAND PROPERTY 2 (WITHOUT POLYGONS)



TOOLS: WETLAND PROPERTY 3 (WITHOUT POLYGONS)



Decision Dilemmas



Section 6
Wetland Activities
WETLANDS POLICY AND MANAGEMENT

Grade Level: 6 - 12

State Standards: Geography E-1, E-3, E-4, E-5, F-3; Government E-2, E-6, E-7; History D-5
NGSS: MS-LS2-4., MS-ESS3-3. MS-ESS3-4, HS-ESS3-2

Subjects: social studies, science, language arts

Skills: analysis, application, discussion, evaluation, decision-making, problem-solving, group interaction, synthesis

Duration: one class session

Group Size: whole class; 2 - 4

Setting: indoors

Vocabulary: dilemma, responsibility

Objectives:

Students will:
1. Examine their own values and beliefs related to wildlife and other elements of the environment.

2. Evaluate actions and their potential impact on wildlife and the environment.

Teaching Strategy

Students read, discuss, make judgments, and write about hypothetical dilemmas concerning wildlife and/or natural resources.

Complementary Activities:

Wetland Exchange

Materials:

Dilemma Cards

Background:

See INSIGHTS Section 3 Wetlands in a Changing World and Section 4, Wetlands Policy and Management fact sheets.

Procedure:

ACTIVITY 1

1. Read one or more of the following decision dilemmas to the students or adapt them to describe a wetlands permitting dilemma in your community. Do not read the possible solutions provided; they are only for your use in the discussion that will follow.

2. After you have read each situation, ask the students to write down what they would do and why. Encourage creative alternatives that can maintain wetland values and allow human activities to occur. Give students three to five minutes to write their answers.

Dilemma 1
You own land and would like to build your home on it. You will need to place a pad of gravel on the land to provide a stable foundation for your house. You find out it is legally classified as a wetland. What do you do?

Possible answers - FOR TEACHER USE IN DISCUSSION:

a. Find out which part of your land is used by fish or wildlife or has other wetland functions and plan your home for the area that has lower use or fewer functions.

b. Find out whether placing gravel on the wetland requires a permit

c. Apply for a permit.

d. Build your house without getting any permits.

e. Sell your land to someone else and buy another piece of land for your home.

Dilemma 2
Someone is planning to build an asphalt plant in a wetland in your community. They are also proposing to dispose of the oily wastes that the plant would generate in the wetland because taking the wastes somewhere else would be expensive. The plant will provide high paying jobs to members of the community. Because the wetland is on public-owned land, a hearing is being held to hear the concerns of the community. Would you testify in favor or against the project at the public meeting? Can you think of changes in the plan that might change your testimony?

Dilemma 3
You are the owner of an oil company that has leased part of the North Slope of Alaska. You plan to construct a gravel pad and drill an oil well on tundra wetlands. When you apply for a wetlands permit, you learn that the place you want to fill with gravel is very important for nesting birds and feeding caribou in the summer. The gravel will destroy the habitat. What do you do?

Possible answers - FOR TEACHER USE IN DISCUSSION:

a. Study the area to find out if there is an area close by which is not as important for the birds and caribou where drilling the well would cause less harm to wildlife.

b. Find out whether it is possible to drill the well in a different location and how much more that would cost.

c. Follow your original plan and apply for permits

d. Redesign the gravel pad to make it as small as possible.

e. Research to see whether or not an ice pad would work instead of a gravel pad.

e. Follow your original plan but offer to improve wetland habitat somewhere else.

3. After the students have written down what they would do and why, ask them to go back and think about what types of information they would like to have to help them with each decision.

4. Ask the students to describe what they based their decision on. *(Each dilemma should elicit a variety of responses.)* Discuss the spectrum of values, emphasizing to the students that different types of concerns are often raised in trying to make a decision. When a group tries to make a decision together, everyone makes their decision based on an individual set of concerns and beliefs about what they think is true about the situation. Ask students how they would develop a common set of beliefs about a situation. How could they solve a problem if the players do, in fact, possess different concerns which may be in conflict?

5. Explain the process used by the Army Corps of Engineers and Environmental Protection Agency to decide whether or not to allow an activity to occur on wetlands. Their decisions sometimes preserve and sometimes destroy wetlands. To do this, they consult the public and many state and federal agencies in order to get information and advice about the value of a specific wetland in relation to the value of the construction project (i.e., what types of human benefits will occur) being proposed. They then weigh and balance the concerns and benefits. Using information from the table in the Background section, describe which of the reasons given by students for their decisions would be used by the Corps of Engineers to make their decision.

6. Have the students break into small groups of four to six and brainstorm whether or not they would issue a permit for fill of the wetland in each situation. Encourage them to list the benefits of each project to people as well as the negative impacts that might occur to the wetland.

ACTIVITY 2

1. Copy and cut up the Dilemma Cards (following). Other dilemmas could be written that are more specific to problems in your area. Students can also be involved in creating dilemma cards, with each student responsible for one card.

2. Divide the class into groups of four and give each group a stack of dilemma cards. Place the cards face down at the center of the group.

3. The first player draws a card from the top of the stack. The player has two minutes to study the situation, decide what he or she would do, and formulate reasons for the decision.

4. When the allotted two minutes is up, the player reads the situation and the options aloud to the rest of the group. The student gives the decision he or she has chosen and briefly describes the reasoning involved.

5. In turn, each of the other members of the group is invited to comment on the dilemma and what he or she would do in the situation. The discussion of each dilemma by the members of the group should take about five minutes.

6. The person whose dilemma is being discussed should have the opportunity to ask questions of other members of the group, and to offer clarification about his or her decision. The discussion gives the students experience in having ideas examined by peers, and is intended to remind the student of the need to take personal responsibility for decision-making. It is not necessary and may not be desirable for the students to reach consensus; there are legitimate ranging views of the most appropriate and responsible actions to take in many situations. The purpose is to provide students with an opportunity to examine, express, clarify, and take responsibility for their own reasoning.

7. The card is then returned to the bottom of the stack and the next player selects a card from the top of the deck. Continue this process until all students have had the opportunity to express their decision and rationale about a dilemma.

Credit:

Curriculum Connections:

(See Appendix for full citations)

Books:

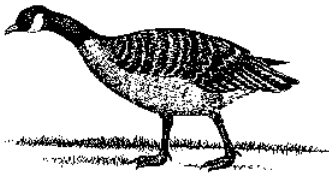
Vanishing Wetlands (Duffy, 1994).

Disappearing Wetlands (Challand, 1992).

TOOLS: DILEMMA CARDS

You are head of a task force created to select the best course of action to attempt to preserve the red-speckled goose. There are 200 birds left in a steadily declining population. Left to their own, it is probable they will all die. Some members of your task force would like you to authorize capturing some of the birds and sending them to zoos to try to propagate them in captivity.

Do you:
- leave them in their natural environment?
- capture some of them for zoos?
- other?



You have found a beautiful spot to build a home. One hillside of the property has a beautiful view and is your choice for your homesite. However, you discover there is an active bald eagle nest on that hillside. Bald eagles are sensitive to high levels of noise during nesting, and also to loss of their nesting sites or nearby perch trees. Bald eagles are highly selective in choosing nest sites and usually return to the same nest year after year. It is a protected species.

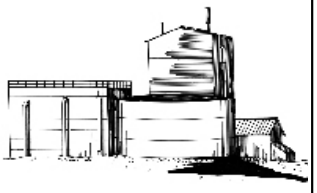
Do you:
- select a different site on the property to build your home?
- sell the property?
- chop down the trees and build your home?
- other?

You are visiting a local wetland with your friends. You see a young mother and her children happily feeding a large gathering of very hungry geese. The children are having a wonderful time. You know that feeding the geese may cause them not to migrate south for the winter, and can also lead to overpopulation and contamination of the wetland by fecal matter. What do you do?

Do you:
- interrupt the mother and children's, tell them that feeding the geese may harm them and the ecosystem and ask the family to stop?
- report the family's behavior to a law enforcement officer?
- ask another adult to ask them to stop?
- do nothing?
- other?

You are logger and live in a remote logging camp. One day, you notice a leak in the large fuel storage tanks in the camp. Oil used for heating and cooking has been leaking for some time into a small marsh and stream next to the camp. When you point it out to your boss, he tells you not to report it or clean it up.

Do you:
- do what your boss tells you?
- insist the spill be cleaned up and volunteer to do it on your own time?
- report the spill anonymously to the Alaska Department of Environmental Conservation?
- report the spill to someone else in the company you work for who has responsibility for environmental protection?
- other?



Can Do! Wetlands

Section 6
Wetland Activities
WETLANDS POLICY AND MANAGEMENT

Grade Level: 4 - 12

State Standards: English/LA C-1, C-2, C-3, C-4, C-5; Geography E-3, E-4, E-5; Government C-2, E-1, E-2, E-3, E-6, E-7
NGSS: 5-ESS3-1,MS-ESS3-3. HS-ESS3-2

Subjects: social studies, language arts, science

Skills: analysis, discussion, evaluation, problem solving

Duration: three class sessions

Vocabulary: problem, authority, compromise, alternatives

Objectives:

Students will:
1. Identify a problem involving wildlife on their own school grounds, in their village, or nearby.
2. Suggest and evaluate alternative means to either solve the problem or improve the situation.
3. Undertake the project to solve the problem.
4. Analyze and describe the process by which they successfully solved the problem or improved the situation.

Teaching Strategy

Students select a school environmental project, conduct research, make plans, and follow procedures to accomplish the project.

Background:

See INSIGHTS, Section 3 Wetlands in a Changing World and Section 4, Wetland Policy and Management fact sheets.

Procedure:

1. Ask the students to think of some ways to improve wildlife habitat in their local area. They could start out by brainstorming a list of activities on their school grounds or in their community that could potentially negatively impact wildlife such as pesticide spraying, littering, removal of plants etc., and then develop a list of ways that such activities could be minimized.

2. Ask students to look over the list and select one that really interests the whole group. They should think about whether they can realistically tackle it and be constructive. If they have difficulty deciding, and reasonable support has been offered for each, the students might vote to decide. Students could also make speeches in support of the problem they want to tackle, in hopes of swaying the class vote.

3. Once the problem has been selected, ask the students to work alone or in small groups to begin to generate ideas for possible solutions to the problem and ways to implement the project. Each individual or small group could come up

with a plan, including written descriptions and sketches illustrating how to accomplish the project, step by step.

4. Ask the groups to present their plans to the rest of the students. Students may ask questions of the students. Once all the plans have been presented, ask the students to select the plan that seems most: a) constructive; b) realistic; c) helpful to wildlife; d) probable to make a lasting contribution.

5. Ask the students to select one or more alternative plans, in case their first choice is not acceptable to authorities at the school or village.

6. Once a plan (with alternatives for "back-up") has been selected, ask the students to select a delegation to present their proposal to the school principal or the appropriate authority. Remember to include janitors, grounds keepers, school board, etc. (anyone who would be physically and/or officially involved). A practice session before the students and any interested parents or other groups of students would be helpful. At the practice session, the student delegation would make their presentation as they plan to do before the principal, (janitor, council, etc.) responding to any questions from their audience that might be raised.

7. The students should make an appointment to present their proposal, make the presentation, and report back to their classmates. If their plan is accepted, they should make sure they know who to contact next in order to successfully complete their project. Making sure they have all necessary permissions secured, the students should proceed to successfully accomplish their project.

8. Once accomplished, ask the students to analyze their results. Did things work out the way the students wanted them to? Were there any surprises? Any unforeseen problems? How might the students have been any more effective?

Can Do list for possible community projects:

* create a wetands plan for the area around your school: map wetlands, evaluate their functions using the Rate a Wetland activity in the Field Manual, map surrounding land uses, determine which wetlands should be conserved, compare this with actual community wetlands plans.

* initiate a water quality testing program for a stream or wetland near your school; problem-solve reducing pollution. (For information about how to set up a monitoring program, obtain the publication *Adopting a Stream*).

* initiate a recycling program in your school to reduce the demand for mineral resources found in wildlife habitat.

* develop an anti-littering campaign or clean-up day for local streams or wetlands.

* sample local wetlands and streams for water quality. Download a complete stream monitoring manual "Alaska Stream Team" at http://aquatic.uaa.alaska.edu/pdfs/EducationLevelBioMonitoringMethods.pdf. Different regions have local watershed councils that offer programs to supply your students with equipment and training. Examples are the Cook Inlet Keeper, the Copper River Watershed Project, and the Yukon River Inter-Tribal Watershed Council.

* grants may be available for local civic groups, government organizations, or sport fishing organizations to help you with a fish stream improvement project. Contact a local sport fish office for more details.

* develop an information program for the community about your wetland and any problems facing it: leaflets, posters, videotapes, newspaper articles, displays at local events.

* develop a wildlife calendar for a local wetland, interview people in the community, or make observations to find out when the different species of migratory birds return and leave, when they nest, when the water freezes over, etc.

* produce a classroom newspaper with articles about wetland habitats and wildlife.

* research water use in your community. (Where does it come from? Where does it go? How is it used? Are things added to it or to sewage before discharging it back into water? Where is pollution occurring?) Have students make personal and household inventories of water use and brainstorm ways to reduce use and pollution.

* undertake a project to improve a stream for fish or a pond for waterfowl. (Contact the Alaska Department of Fish and Game or U.S.D.A. Forest Service for help.)

* survey the community about the abundance of wildlife in local wetland areas, and their use of the wildlife. Be sure to include older people and Native elders to determine how the areas and use has changed over their lifetime.

Credits

Extension

Document the entire process on video tape.

Curriculum Connections:

(See Appendix for full citations)

Books:

Kids with courage: true stories about young people making a difference (Lewis, 1992).

WETLAND APPENDICES

GLOSSARY

CURRICULUM CONNECTIONS
Full Citations
Additional Resources

CROSS REFERENCE
by Grade and Alaska State Standards

GLOSSARY

Adaptation: a trait that improves a plant or animal's ability to live in a particular environment.

Aerial photograph: a photograph, taken from an airplane, that captures important ground features.

Amplexus: process by which male and female frogs mate.

Anaerobic: in the absence of oxygen

Anadromous: like salmon, spending the first part of life in fresh water, most of adult life in the open ocean, and returning to freshwater to spawn.

Aquatic: lives in water.

Bird banding: means of marking birds with bands to obtain data about their flights, migration, and habits.

Bog: a peat-forming ecosystem influenced solely by water, (which falls directly on to it as rain or snow) and generally dominated by sphagnum moss.

Breeding ground: a land area occupied by migratory birds during the nesting season.

Carnivore: an animal that eats mostly meat.

Carrying capacity: the total number of any species that a given area of habitat will support at any given time; the ability of a given unit of habitat to supply food, water, cover or shelter, and necessary space to a wildlife species.

Community: all the plants and animals in a particular habitat that are bound together by food chains or other interrelationships.

Condensation: water changes from a gas to a liquid form.

Conservation: the use of natural resources in a way that assures their continuing availability.

Consumer: a living thing that gets energy (food) by eating other living or dead things.

Contour lines: on a topographic map, lines that connect contiguous points of the same altitude.

Dabbling duck: feeds on insects and crustaceans on surface of water and bottom–dwelling organisms in shallow water.

Decomposition: process by which organic matter decays.

Delta: fan-like deposit at the mouth of a river

Detritivore: a living thing that eats dead things and waste, also called a decomposer.

Dominant: being the most common species in a community.

Ecosystem: all living things and their non-living surroundings in a specific area.

Ecosystem service: fundamental human life-support service offered by natural systems.

Ectotherm: an animal that regulates its body temperature by exchanging heat with its surroundings ("cold blooded"). E.g. reptiles, amphibians, most fish and insects.

Emergent: plants that grow in water but have leaves and flowers above the surface.

Endangered: an "endangered" species is one which is in danger of extinction.

Estuary: where saltwater and freshwater meet, the water is brackish.

Ethnobotany: study of how people of a particular culture or region make use of indigenous plants. Includes botany, medicine, and lore.

Eutrophication: a process where water bodies receive excess nutrients, resulting in excessive plant growth and oxygen depletion.

GLOSSARY CONTINUED

Evaporation: water changes from a liquid to a gas form.

Fen: a type of wetland that accumulates peat deposits and receives most of its water from groundwater.

Flyways: general routes of travel used by birds when migrating between breeding and wintering grounds. For geese and ducks, there are four major flyways in the United States; Atlantic, Mississippi, Central, and Pacific. The actual migratory routes of individual bird species may vary from these general flyway patterns.

Food: energy and minerals in a form living things can use.

Food chain: the path of energy and minerals from the non-living environment through producers and consumers back to the non-living environment.

Food web: all the interconnected food chains within a particular ecosystem.

Fry: a recently hatched fish.

Habitat: the place where an animal lives that provides food, water, shelter, and space in the proper arrangement.

Halophyte: prefers or tolerant of salt water.

Herbivore: an animal that eats plants.

Humus: layer in the soil consisting of partially or completely decomposed organic matter.

Hydrology: study of the dynamics of water, on the earth's surface, in the soil, and in the atmosphere.

In lieu fee mitigation: a sponsor collects money from a developer in exchange for development. The sponsor uses the money to conserve, restore, or create wetlands.

Invasive species: nonnative species that causes economic or environmental harm, or harm to human health.

Lagoon: a shallow body of water separated from the sea by sand bars.

Larvae: the newly hatched, earliest stage of animals that go through metamorphosis (e.g. insects and frogs).

Management: as related to wildlife, the application of scientific knowledge and technical skills to protect, preserve, conserve, limit, enhance, or extend the value of wildlife and habitat.

Marsh: an area periodically wet or continually flooded, but non-peat forming, composed of sedges, rushes, marestail and other soft-stemmed plants.

Metamorphosis: change of body form during growth.

Migration: seasonal or periodic movement between breeding and wintering grounds. Migration varies among species in terms of destinations, time and duration. Generally migration is accomplished to use better feeding areas.

Mitigation: effort to lessen or minimize negative impacts.

Mitigation bank: a wetland that has been created or restored to provide compensation for impacts to a wetland elsewhere.

Niche: the status or function of an organism within its ecosystem that allows its species to survive and thrive.

Nonrenewable resource: nonliving resources such as rocks and minerals; resources which do not regenerate themselves; substances such as petroleum, coal, copper, and gold which, once used, cannot be replaced (at least not in this geological age).

Nutrient cycling: processes by which nutrients are transferred from one organism to another.

GLOSSARY CONTINUED

Oxbow lake: usually a crescent-shaped lake, formed when a meander of a river is abandoned by the main channel.

Passerine: a perching bird or songbird.

Peat: accumulated layers of dead and partly decomposed plants in wetlands.

Peatland: type of wetland that accumulates peat and is characterized by cold soils and slow decomposition.

Permafrost: perennially frozen ground that may or may not contain ice.

Photosynthesis: the process by which plants and algae change sunlight, water, and carbon dioxide into food.

Pollution: harmful substances deposited in the air, water, or land which result in adverse changes to their quality.

Population: the number of particular species in a defined area.

Positive feedback loop: a cause and effect chain in which the effect amplifies the initial cause, thereby creating an unstable runaway cycle. Essentially a snowballing effect.

Precipitation: rain, snow, sleet, hail, ice fog, or any other form of water falling to the ground.

Predator: an animal that kills and eats other animals (prey).

Precipitation: the return of water to the earth from clouds.

Prey: animals that are killed and eaten by other animals (predators).

Primary production: the production of organic material by plants via photosynthesis.

Producer: any living thing that makes it own food, e.g. plants.

Renewable resource: products made from living resources, such as plants and animals, which have the capacity to renew themselves when conditions for survival are favorable.

Riparian: bordering rivers and streams.

Runoff: water from precipitation that flows over the ground's surface instead of percolating into the ground.

Sink: a pool (reservoir) capable of absorption and storage. Commonly used in reference to nutrient cycles, e.g. main carbon dioxide sinks include the ocean and growing vegetation.

Soil texture: the relative proportion of sand, clay and silt in soil.

Species richness: the number of species in a biological community.

Stop over site: resting spot for migratory birds during long migrations north or south.

Threatened: a "threatened" species is one that is likely to become endangered because of a decline in its numbers.

Tundra: treeless area characteristic of northern latitudes. Arctic tundra in the arctic is often underlaid by permafrost. Alpine tundra exists in high mountains at many latitudes.

Topographic map: a map that shows terrain relief and elevations using contour lines.

Turbidity: cloudiness of water caused by suspended solids.

GLOSSARY CONTINUED

Water cycle: the continuous circulation of water in systems throughout the planet.

Waterfowl: a bird that swims and lives near water; ducks, geese and swans.

Wetland: any land area that tends to be regularly wet or flooded during part of the year and has plants that prefer wet soil.

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ADDITIONAL RESOURCES

Teacher Guides and Curricula

Alaska Department of Fish and Game Salmonids in the Classroom Curriculum. http://www.sf.adfg.state.ak.us/region2/ie/sicc/siccurr.cfm.
To find out about rearing salmonids in your classroom, contact Fritz Kraus at ADF&G: (907) 267-2265 fritz_kraus@fishgame.state.ak.us program.

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Websites

Alaska Aquatic Nuisance Species Management Plan www.adfg.state.ak.us/special/sssf/invasiveplan.pdf. Includes specific information about problems related to aquatic species in Alaska.

Alaska Stream Team: download a complete stream monitoring manual at http://aquatic.uaa.alaska.edu/pdfs/EducationLevelBioMonitoringMethods.pdf.

Anchorage watershed info – education site http://wms.geonorth.com/public_education/PublicEducation.aspx

Communicating Ecosystem Services http://www.esa.org/ecoservices/ has tool kits with science fact sheets and outreach tools pertaining to services such as water purification, flood damage control etc.

Ducks Unlimited http://www.ducks.org. Information and news about wetlands conservation and restoration (advocacy organization).

Google Earth http://earth.google.com/ allows viewers to look at satellite images of anywhere in Alaska.

ADDITIONAL RESOURCES

Educational Resources Information Center http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=Home_page. Data base of journal and non-journal education literature.

Municipality of Anchorage Watershed Management page: http://wms.geonorth.com/library/LibraryMapsWetlandsAtlas.aspx. From here you can download wetland maps from the Anchorage bowl

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Union of Concerned Scientsits 2006. Sound Science Initiative: Invasive species. http://www.ucsusa.org/ssi/invasive_species/. Includes information about the science, what you can do, and a list of web resources about invasive species.

National Invasive Species Information Center. http://www.invasivespeciesinfo.gov/. Everything you want to know about invasive species, including economic impacts, bills regarding invasive species, links to K–12 education resources and links to lists of invasive species for Alaska.

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Langley, Andrew 1993. *Wetlands.* Pleasantville, N.Y. Reader's Digest Association. (A real magnifying glass helps nature sleuths solve science riddles, unravel mazes, and search for hidden wildlife--all while learning about the world's wetlands.)

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The Alaska Wildlife Curriculum Cross-Reference

The five books Alaska Wildlife Curriculum series are coded as follows:

Alaska's Ecology	**E**
Alaska's Forests and Wildlife	**F**
Alaska's Tundra and Wildlife	**T**
Alaska's Wildlife Conservation	**W**
Alaska's Wetlands & Wildlife	**WW**

Grade Index

	Book	Page	K	1	2	3	4	5	6	7	8	9	10	11	12
Are You Me?	WW	130	•	•	•	•	•	•	•						
Birds Now or Later	WW	152								•	•	•	•	•	•
Can Do! Wetlands	WW	273					•	•	•	•	•	•	•	•	•
Changing World Ecology Puzzlers	WW	247							•	•	•	•	•	•	•
Cycle of Life	WW	142			•	•	•	•							
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Humans and Wildlife	WW	227			•	•	•								
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