November

What else is in a watershed?

Atlantic salmon have the unusual ability to live in both freshwater and saltwater **habitats**. During November, ***The Salmon Times*** introduces a variety of surface water habitats in the Northeast. Whether it is a stream, lake, marsh, or tidepool, each of these watery habitats includes a type of **wetland**. Although wetlands are sometimes undervalued, they are crucial habitats and provide many benefits to wildlife and humans. Wildlife count on wetlands for food, shelter, and breeding locations. The benefits to humans can be environmental, economic, aesthetic, recreational, and educational.

Wetland is a term used to describe land that is inundated or saturated by freshwater, salt water, or a combination of the two for at least part of the growing season and is home to specialized plants that grow in saturated soils. In some situations, wetland soils are so saturated with water that there is not enough oxygen within the soil for **aerobic decomposers** to do their jobs. Sometimes under these conditions, organisms must rely on **anaerobic respiration**. Anaerobic bacteria, with the help of sulfur compounds, carry out their metabolic processes producing hydrogen sulfide, a gas that gives marshes a characteristic rotten egg smell.

Wetlands form from a combination of factors including glaciation, climate, agriculture, and hydrologic processes. Beavers are well known for their ability to create wetlands. Each type of wetland is a unique ecosystem with its own inherent values and functions. Wetlands are among the most fertile, productive, and threatened ecosystems in the world.

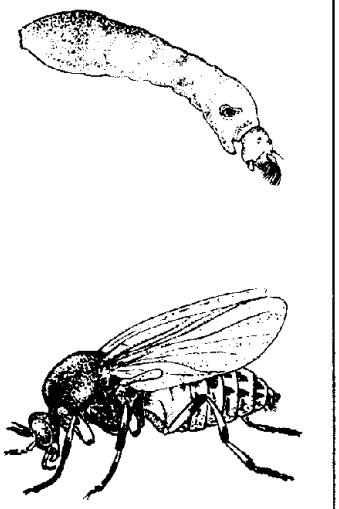
While a technical discussion of wetlands classifications is beyond the scope and purpose of this guide, an introduction to the breadth and value of wetland systems is worthwhile. For the purposes of this guide, **deep water habitats** (portions of wetland areas where water is greater than two meters deep) will be incorporated into the description of each type of wetland. Wetlands are classified for management purposes based upon plant and soil types and frequency of flooding. More detailed descriptions of

Approximately 54% of the wetlands that existed in America 200 years ago have already been lost. Commonly in the past and even today, wetlands are thought of as insect-ridden wastelands that would be of more use if they were drained and filled for agricultural, industrial, and residential development.

"Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." U.S. Army Corp of Engineers

specific wetland types and their inhabitants are located in ***Habitat Values of New England Wetlands***.

The Northeast has both inland and coastal wetland systems. Inland wetlands that incorporate a river or stream are called **riverine** wetlands. Wetlands that include a permanently flooded lake or reservoir are called **lacustrine**. Wetlands that are dominated by trees, shrubs, and emergent vegetation are called **palustrine**. Coastal wetlands that include open ocean and are affected by waves are called **marine** wetlands, while areas that are partially enclosed by land, have negligible wave action, and contain a mixture of freshwater and salt water are called **estuarine**. Palustrine wetland systems often border riverine, lacustrine, and estuarine systems. Each type of wetland is distinguished by its physical and chemical characteristics and the types of plants and animals that live there. However, characteristic plants, animals, and features may pertain to more than one wetland type.



black fly larva and adult

Riverine Wetland Habitats

Water flowing to the sea may take the form of a stream or a river. Streams and rivers belong to the riverine wetlands system. Streams and rivers are unique habitats because flowing water creates conditions that are constantly changing. Headwater streams are particularly important places for Atlantic salmon because they build their **redds** (nests) and lay their eggs in the gravel bottom beds there.

Headwater streams are typically shallow, narrow, clear, and cool. The cool temperatures and mixing action of the fast-flowing water make headwater streams high in dissolved oxygen. The major source of **productivity** in these streams comes from overhanging trees that drop their leaves and associated creatures into the stream below. These bits of decaying leaves and twigs are called **detritus**. As these streams accumulate water and widen, **periphyton** (**diatoms** and other algae clinging to rocks) becomes another important source of primary productivity. As a stream continues to widen downstream, accumulate water, and become a river, **emergent macrophytes** (rooted plants that grow partly in and partly out of water) take over some of the food production role in the stream or river.

Stream inhabitants include animals that graze on periphyton, filter feed from flowing water, shred bits of detritus, and prey on other organisms within the stream. These include snails, protozoans, mussels, blackflies, mayflies, midges, salamanders, and trout. Streams attract a number of terrestrial animals as well. The vegetated edges of streams might include sedges, coltsfoot, watercress, and fountain moss and are used by many streamside critters, such as warblers, beavers, shrews, and black bears.

Rivers, like streams, are characterized by flowing water and changing conditions. However, large rivers are similar to ponds and lakes in a number of ways. Large slow rivers, like lakes, are usually deeper, wider, more turbid, and warmer than fast flowing streams. Mud, silt, sand, or clay, rather than cobble, cover the bottoms of large slow rivers. Along with the emergent macrophytes, **phytoplankton** (free-floating algaes) in the main channel and sunny, still areas of the river are the base of the food chain. Additional nutrients flow in from upstream releases and soil erosion and are washed in from connected wetlands.

There is somewhat less **diversity** (variety of living organisms) in large rivers than in streams because the shifting substrate of sand, silt, and mud reduces the amount of aeration, buries **benthic** (bottom-dwelling) animals, and does not provide adequate stability for rooted aquatic plants. Rivers are home to some zooplanktons, damselflies, leeches, waterstriders, worms, frogs, turtles, and mink. The fish that live in large rivers are

often similar to fish one might find in a pond. Bass, yellow perch, catfish, and carp live in river habitats.

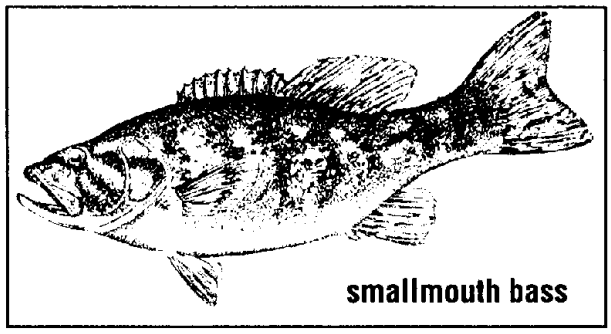
Lacustrine Wetland Habitats

Lacustrine habitats include the wetlands and deep-water habitats of permanently flooded lakes and large reservoirs. They will have some wave action and can be tidal or non-tidal. Large areas of deep open water create a habitat for a variety of fish and wildlife. Fish draw people and wildlife to lacustrine habitats. Northern pike, yellow perch, pickerel, carp, bass, and bluegill live in lakes of the Northeast. These species attract fish-eating birds such as the belted kingfisher, common merganser, common loons, osprey, and bald eagles. These birds will often nest near good sources of food.

Aquatic plants in lakes attract waterfowl such as mallards, black ducks, and common goldeneyes. Moose are also attracted to lakes and ponds in northern regions during the summer when they are searching for aquatic plants to eat. Bullfrogs, red-spotted newts, and snapping turtles live in and near New England lakes. Sometimes mink and river otters will live in dens adjacent to lakes that have enough fish and other types of aquatic prey.

Palustrine Wetland Habitats

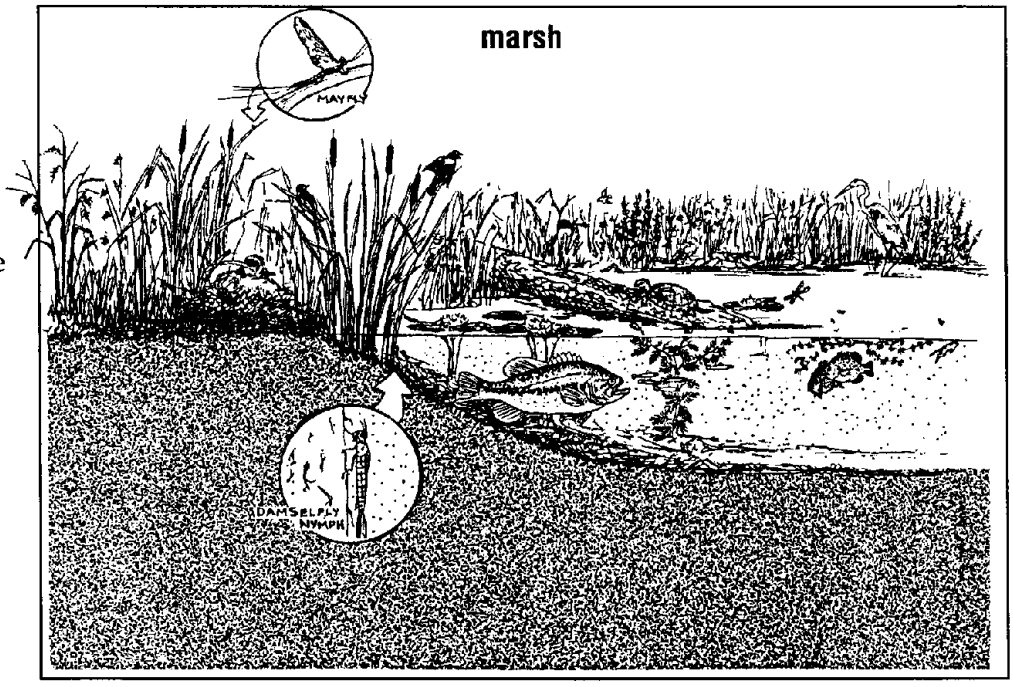
The most common type of wetlands in the Northeast are palustrine. Palustrine habitats are non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Palustrine wetlands include **marshes**, **swamps**, **bogs**, **wet meadows**, **fens**, and **wet prairies**.


smallmouth bass

Small, shallow ponds are also considered palustrine wetlands. Palustrine wetland habitats are characterized by a diversity of plant species and structural features that provide feeding, breeding, nesting, overwintering, and migration habitat for wildlife. There are several classes of palustrine wetlands.

Forested palustrine wetlands are dominated by trees and are sometimes called wooded swamps or, in the South, bottomlands. Red maple, white cedar, and fir trees are often found in a palustrine forested wetland. Typical shrubs include highbush blueberry, swamp azalea, and silky dogwood. Cinnamon and sensitive fern, as well as skunk cabbage, spotted jewelweed, sphagnum moss, and goldthread, inhabit the forested palustrine wetland.

Animals that use the forested palustrine



wetlands of New England include the black-throated blue warbler, wood thrush, raccoon, beaver, barred owl, big brown bat, wood duck, hairy and downy wood peckers, spotted salamander, and wood frog. **Snags** or dead trees are used by a variety of wildlife for feeding, nesting, denning, roosting, and perching. **Vernal pools** in the forested palustrine wetlands are depressions in the earth that fill up with water during wet seasons, but dry up at other times. Vernal pools are important breeding areas for amphibians such as salamanders and frogs. Fairy shrimp also rely on vernal pools. They lay drought-resistant eggs that hatch when the pool fills with water. Vernal pools are extremely productive, valuable ecosystems that are often overlooked and undervalued.

Palustrine scrub-shrub wetlands are dominated by woody species in the sapling and shrub stages. Vegetation in these wetlands includes the highbush blueberry, sweet pepperbush, willow, alder, and meadowsweet. Associated herbs often include cinnamon fern, spotted jewelweed, sphagnum, sedges, rushes, and **hydrophytic** (grow well in wet conditions) grasses. Scrub-shrub wetlands frequently flood in the spring or contain pockets of standing water.

Wildlife use the palustrine scrub-shrub wetlands for feeding, nesting, breeding, and cover. Songbirds, for example, may nest in the same dense shrubs in which they feed on berries or insects. A sampling of birds found in scrub-shrub wetlands include alder flycatcher, Canada warbler, and American woodcock. Amphibians such as the spring peeper and gray tree frog use flooded shrub swamps as breeding ponds in the spring. They, in turn, attract predators such as the great blue heron, raccoon, and mink.

Palustrine emergent wetlands are dominated by herbaceous or non-woody vegetation and usually have either surface water or saturated soils year-round. Marshes and wet meadows are two familiar palustrine emergent wetlands. Cattails, blue flag, water willow, and other sedges, rushes, and grasses are common in freshwater marshes. Plants such as pickerelweed, smartweeds, and arrow-leaved tearthumb are common to marshes. Wet meadows tend to be somewhat drier than marshes. Plants such as bulrush, soft rush, wool grass, spotted jewelweed, joe-pye weed, sensitive fern, meadowsweet, steeplebush, goldenrod, tussock, and other sedges, rushes, and hydrophilic grasses are typical in wet meadows.

In an attempt to compensate for wetlands that are destroyed during construction, people have developed methods of creating wetlands. Some believe that the created wetlands adequately serve the functions of destroyed wetlands and others believe the former functions of destroyed wetlands can never truly be replaced by human-made wetlands.

Purple loosestrife and common reed are two species of non-native vegetation that are often found in palustrine emergent wetlands. They are sometimes refered to as "invasive" plants because they become fairly easily established in disturbed soils growing and spreading quickly. The effects of these two invasive species are diminished biological diversity and loss of food and habitat for diverse wildlife.

Red-winged blackbirds breed and nest in cattail marshes. Other songbirds that nest and/or feed in marshes and wet meadows include the song sparrow, common yellowthroat, and marsh wren. Wading birds, such as the American bittern, great blue heron, and common snipe use marshes to find food and shelter. Waterfowl, such as mallards, use the emergent vegetation of these wetlands for feeding and nesting. Mammals that feed or hunt in marshes include raccoons, mink, and muskrats. Small mammals that burrow in the soft soils of marshes and wet meadows include the short-tailed shrew, star-nosed mole, and meadow jumping mouse. Some reptiles and amphibians feed, breed, and overwinter in palustrine emergent wetlands.

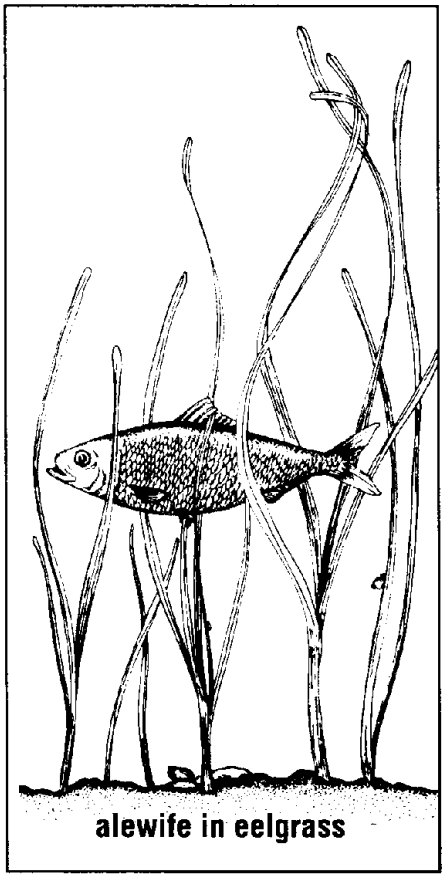
Marine Wetland

Marine ecosystems and estuarine ecosystems, which include **saltmarshes, tidal flats,**

and **rocky shores,** are all examples of coastal wetlands. Tide waters flood coastal wetlands. They are extremely valuable systems to fish and other wildlife species as well as to humans.

Marine systems consist of open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to ocean waves, currents, and tides. Salinity is at least 30 parts per thousand.

Plants and animals living in the marine environment must be well adapted to survive in the churning waters of the open ocean. Algae are the dominant aquatic plants and range from microscopic diatoms to huge seaweeds. Some seaweeds have a **holdfast**, a root-like structure that helps them attach to hard surfaces. Other algae float in big mats or as tiny phytoplankton. Phytoplankton are food for many marine invertebrates. Eelgrass is an important marine plant in New England. It helps stabilize sediments and provides food and shelter for animals such as ducks, invertebrates, and young fish.



alewife in eelgrass

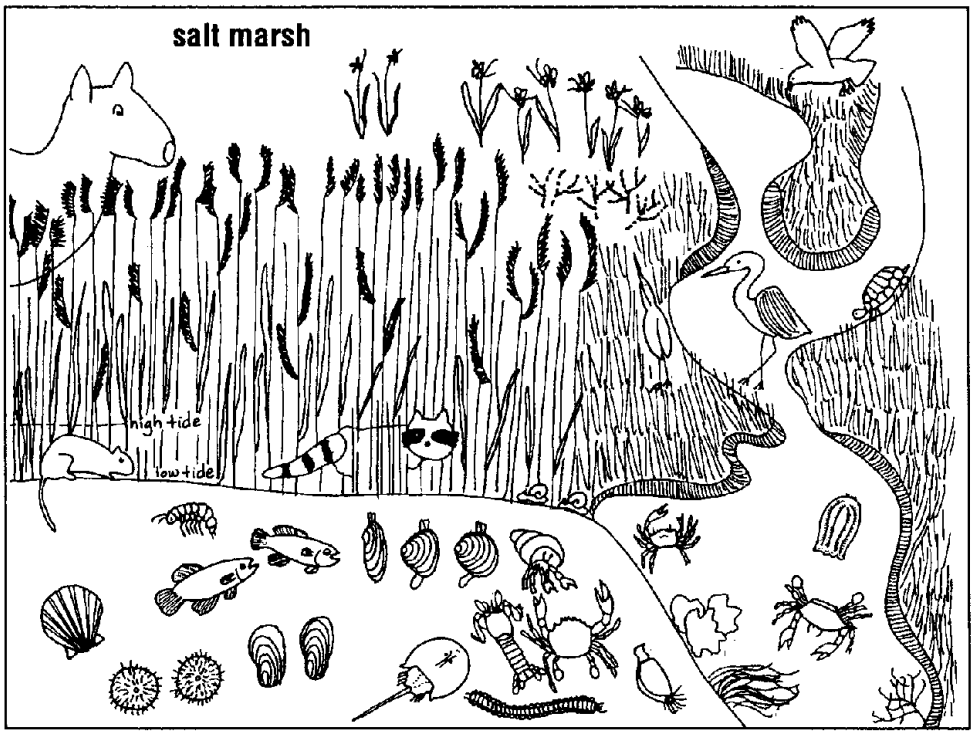
Animals have adapted to the turbulent marine environment in a variety of ways. Some animals, such as barnacles, sea anemones, and corals, attach themselves to surfaces to survive. Other animals, such as clams and periwinkles, have hard shells for protection. Marine worms burrow into narrow spaces for protection. Striped bass, flounder, cod, and mackerel live in the ocean, feeding on marine invertebrates. In turn, they serve as food for birds such as the pied-billed grebe, cormorants, gulls, and osprey. The ocean is home part of the time to fish such as the alewife, American shad, American eel and shortnose sturgeon. Humans enjoy eating fish as well as shellfish, which include lobsters, clams, crabs, and mussels. Sea ducks feed on mollusks, crustaceans, insects, fish, and aquatic plants. Marine mammals found off the Atlantic coast include the Atlantic bottlenose dolphin, harbor seal, humpback whale, and right whale.

Estuarine Wetland Habitats

An estuary is a very special type of wetland where freshwater flows into and mixes with salt water on the way to the ocean. Saltmarshes, tidal flats, and rocky shores can be estuarine habitats. Estuarine wetlands include deep-water tidal and adjacent tidal wetlands that are usually semienclosed by land but have some access to open ocean. The ocean water is at least occasionally diluted by freshwater runoff. Estuaries and lagoons belong to the estuarine habitat system. Estuaries are strongly influenced by their association with land. They have much less energy than marine wetlands in terms of waves and great productivity in terms of plants and wildlife. Coastal wetlands serve as nurseries for fish and as nesting and feeding areas for shorebirds, and they regularly add tons of organic matter to marine ecosystems.

A **saltmarsh** is a type of estuarine wetland that usually occurs behind sandy beaches at the mouth of tidal rivers. They are dominated by specialized grasses, rushes, and other soft plants that are salt tolerant, such as cordgrass, sea lavender, and glasswort. When these plants die, they form large amounts of detritus, which is colonized by microorganisms called **zooplankton** or is eaten by forage fish such as the alewife. These species then become food for larger fish like striped bass and bluefish. The great blue heron, green backed heron, and swamp sparrow feed and nest in saltmarshes. Predatory birds such as the Northern harrier nest and hunt in marshes. Muskrats, mink, and voles feed and nest in coastal marshes as well.

Tidal flats or mud flats are particularly important habitats for shorebirds like the



sandpipers and plovers who depend on them for nesting and breeding, and for feeding during migration. The tidal flats are home to worms, crustaceans, mollusks, and insects that shorebirds and other birds such as the herons and yellowlegs eat.

The **rocky shore** is characterized by exposed bedrock cliffs and is within the **intertidal zone**. In order to survive the rigors of intertidal life among rocks, many of the organisms like periwinkles, barnacles, and blue mussels attach themselves to the rocks. Algae, in the form of seaweeds such as rockweed and kelp, are attached to rocks at the lower part of the intertidal zone. They provide food and shelter for many invertebrates such as sponges, hydroids, and small fish. Rocky shores are prime nesting and feeding habitat in New England for colonial sea birds such as the Atlantic puffin and Northern gannet.

Because wetlands plants have the ability to absorb toxics and excess nutrients, they are being used in waste management and pollution control experiments.

Wetland Functions

Aside from the richness and diversity of life that wetlands bring to our planet, they perform other very important roles in protecting both natural and human resources. As the previous descriptions illustrate:

- Many different types of ***wildlife*** use wetlands at some time during their life cycles. Migratory birds use wetlands as stopovers. Nesting waterfoul take advantage of the cover provided by wetland vegetation. Many fish depend on wetlands for feeding and spawning, and as nursery areas for their young. Some species such as walleye, yellow perch, and bluegill move from open lake waters to spawn in shallow water wetlands. Many of the commercial marine fish harvested along the Atlantic coast need coastal wetlands in order to survive and reproduce.

- Wetlands play several important roles in preserving ***water quality***.

  Sedimentation can create water quality problems in freshwater systems by decreasing water clarity,

"Of approximately 400 species of mammals, birds, reptiles, and amphibians that occur in New Hampshire, 90 use wetlands during some stage of their life cycle and 50 prefer or require wetlands for breeding or feeding habitats."
From *Study Guide to New England's Freshwater Wetlands*

adding excess phosphorus, and smothering aquatic insect larvae. Wetlands reduce the sediment loads of water entering rivers and streams. When water flows through a wetland, vegetation slows it down, allowing much of the sediments to settle out. As much as 80-90% of sediments in water may be removed as it moves through wetlands. This process results in cleaner, clearer water entering a larger waterbody.

Excess nutrients (phosphorus and nitrogen) also create water quality problems by promoting excessive algal growth. When large amounts of algae die, aerobic bacteria use up massive amounts of dissolved oxygen during decomposition, robbing fish and other wildlife of necessary oxygen. Wetlands improve water quality by removing excess nutrients in runoff from agricultural lands or waste disposal. Wetland plants trap sediments containing nutrients, absorb some of these nutrients, and release nitrogen gas to the atmosphere. Also, plants, algae, and micro-organisms remove nitrates and phosphates from the system by absorbing them or converting them into usable products.

Wetland plants have the ability to absorb and temporarily hold pesticides, heavy metals, and other toxics in their tissues. The thick organic soils of wetlands also help trap harmful chemicals and heavy metals in runoff and prevent them from flowing into other surface waters.

"In Massachusetts, the Army Corps of Engineers found it more economical to purchase and protect 8,100 acres of wetlands along portions of the Charles River outside of Boston than to create additional flood control structures."
From *Study Guide to New England's Freshwater Wetlands*

- Estuaries and coastal marshes are among the most productive ecosystems in the world and play an important role in ***aquatic food webs***. When wetland plants die, specialized bacteria and fungi break down the plant tissues into minute fragments of nutrient-rich detritus. The tide flushes out these bits of decaying material, making them available to finfish, shellfish, and invertebrates in the coastal and marine environments. These animals also serve as food for larger wetland inhabitants such as herons, beavers, muskrats, and water fowl.

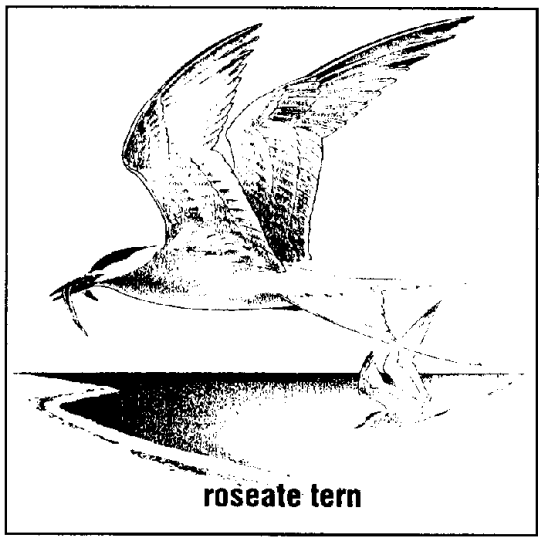
- Wetlands are important ***groundwater discharge*** points, where springs and groundwater seep to the surface. The groundwater discharging into a wetland helps maintain minimum flows in many rivers and streams. The role of wetlands in recharging (or adding water) to groundwater supplies is less clear. Many wetlands are situated over impervious soils, which prevent water from percolating down into the groundwater. However, if the wetland is hydrologically connected to the groundwater system, it may help replenish groundwater.

- Wetlands ***reduce flood damage*** by storing flood water, slowly releasing it into downstream areas, and lowering flood peaks. The large surface area of wetlands allows precipitation and surface runoff to accumulate in a temporary holding basin. Wetland vegetation slows down water flowing into a waterbody and prevents it from draining into the waterbody all at once.

- Wetlands often act as a ***buffer zone*** between open water and land areas. Vegetation, such as *spartina* grasses, in coastal wetlands, helps stabilize the shoreline against erosion and helps protect it from the impact of waves and storms. Inland, wetland vegetation alongside rivers and streams also serves to stabilize the banks, filter nutrients and reduce erosion and subsequent sedimentation.

- Wetlands are home to a number of ***protected species***. Destruction of habitats,

particularly aquatic habitats, is a major threat to plants and animals and therefore to **biodiversity**. One-third of the endangered species in North America rely on wetlands. The piping plover and roseate tern are listed as threatened and endangered respectively and depend upon the preservation of fragile coastal wetlands.


roseate tern

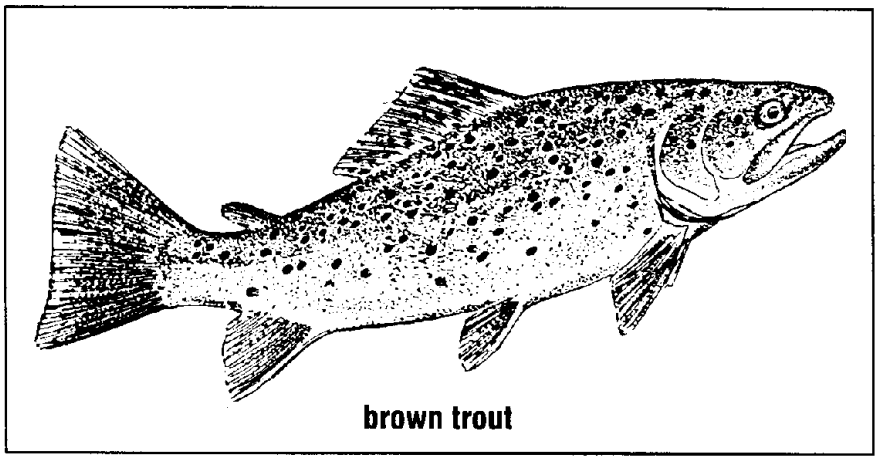
- Wetlands provide valuable ***aesthetic, educational, and recreational assets***. Anyone who has been boating, fishing, birdwatching, walking, or photographing in wetland areas understands these aspects. Wetlands offer a rich and diverse landscape for education, research, and enjoyment. Wetlands that are managed for preservation and education are often made accessible to beginning and experienced naturalists.

Historically, many of the functions of wetlands were neither recognized nor valued. However, more people are learning to see wetlands as productive and valuable ecosystems that perform important roles in the environment.

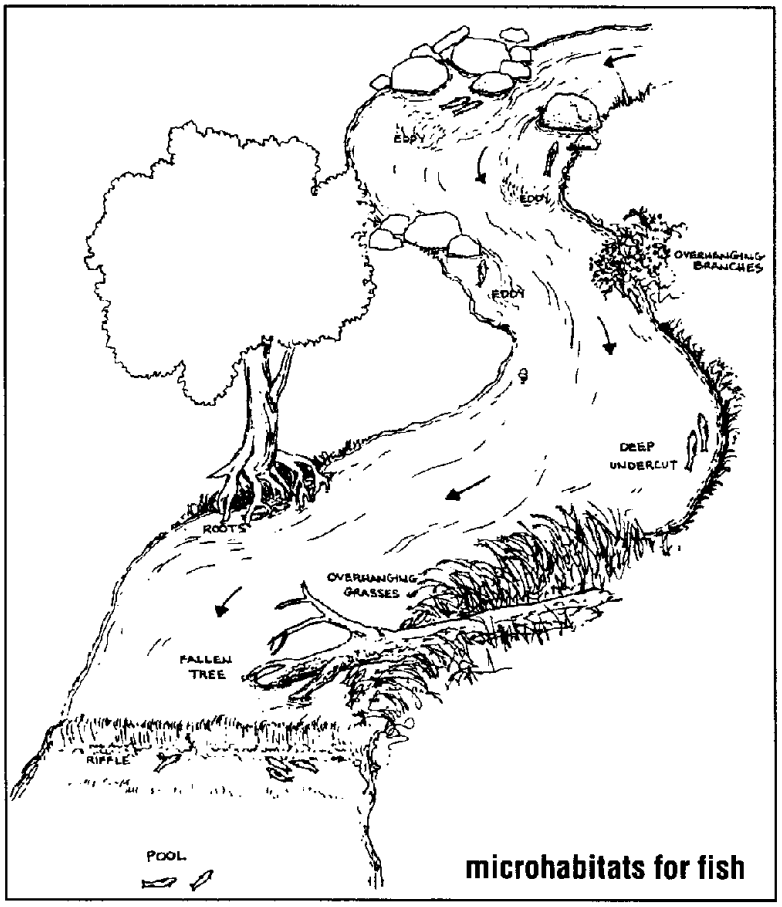
Rivers for Atlantic Salmon and Other Wildlife

Clean rivers are especially important habitats for Atlantic salmon and other **salmonids**. Most rivers in the Northeast were formed many years ago by glaciers and continue to be shaped and carved by moving water. In New England, most river valleys are U-shaped, having been carved out by glaciers. River valleys such as those in the western United States tend to be more V-shaped as a result of having been cut into rock by water rather than having been carved by glaciers. As rivers age they **meander**, or turn, as water erodes the streambank on one side and deposits sediments on the opposite.

The dynamics of moving water create small specialized habitats called **microhabitats** within rivers. Deep undercuts of the stream bank form when water erodes one bend in the river after another. Sometimes fish will rest in these undercuts away from the fast-flowing current in the main channel. Water flowing over rocks and cobble create **riffles, runs,** and **pools**. Riffles attract small fish because they offer places to hide between rocks and an abundance of aquatic insect larvae. Larval aquatic insects and other **macroinvertebrates** often secure themselves to rocks at the **boundary layer**, a layer of slowly moving water between the rock and the swiftly moving water above it. Macroinvertebrates also cling to the undersides of rocks. (Your students will release their salmon fry in freshwater riffles next spring.) A snail might find a home or a fish may take refuge in the calm **eddies** that form on the downstream sides of rocks. Fish will also take advantage of deep still pools in rivers for rest and protection.


brown trout

Streamside vegetation is responsible for many other riverine microhabitats. Large streamside trees perform many of the wetland functions



microhabitats for fish

Word Power

*alevin
*artificial spawning
*erosion
*estuary
*fry
*glaciers
*meltwater
*milt
*mud flat
*outlet
*saltmarsh
*species
*swamp
*terrestrial
*wetlands
aerobic decomposer
amphibious
anaerobic respiration
benthic
biodiversity
bog
boundary layer
deep water habitat
detritus
diatom
eddies
emergent macrophyte
estuarine
fens
fungi
holdfast
hydrophilic
intertidal zone
macroinvertebrate
marine
marsh
meander
microhabitat
oxbow lake
palustrine
periphyton
phytoplankton
pools
prairie
productivity
redd
riffles
riparian corridor
riverine lacustrine
rocky shore
runs
salmonids
saltmarsh
sedimentation
snag
tidal flat
vernal pool
wet meadow
zooplankton

discussed earlier in the chapter when they are standing and provide valuable protection and pools when they fall into a stream. Willows, cattails, wild celery, arrowhead, pickerel weed, and tussock sedge growing along the edges of a river also serve as habitat for **amphibious**, terrestrial, and aquatic organisms. Further up the bank, trees, shrubs, and vegetation alongside streams and rivers provide very important protected areas for terrestrial wildlife. Sometimes these strips of trees and plants along rivers are called **riparian corridors**. They allow animals to access water and migrate within the protection of their usual forests or fields and provide a continuous stretch of habitat. Eliminating riparian corridors fragments and threatens plant and wildlife habitats.

Preserving habitat is one very good way of preserving species. If a problem within a habitat affects one plant, animal, or microorganism, it is likely to affect several others because all organisms within an ecosystem are interrelated. The December issue of the ***Salmon Times*** and ***Teacher's Guide*** looks at interrelationships within ecosystems.

Treatment Plants

Concept: Many wetlands plants have the ability to absorb and temporarily hold excess nutrients and toxins in their tissues.

Objectives: Students will be able to
1) describe how plants remove pollutants from the water;
2) discuss the limitations of this ability when overburdened with pollutants from land.

Materials:
- celery stalks
- 2 beakers or jars
- food coloring
- water
- paring knife

Subject: Science

Preparation and Procedure:

Many people do not realize that plants are vital to the health of our water supply. In fact, wetlands and their plants are an increasingly popular alternative for filtering wastewater from homes, schools, factories, and businesses. Why? Because the plants growing in a wetland filter pollutants out of rainwater and runoff (and wastewater) before it enters bodies of water.

The tangle of stems, leaves, and roots in a densely vegetated wetland trap particles of sediment and even trash -- these things stay in the wetland, while the cleaner water moves on. And as water moves through a wetland, the plants remove and take up excess nutrients and toxic pollutants. Nutrients are used by the plant for growth and metabolism; other substances are simply stored in the plants' tissues.

In a natural system, plants are fairly efficient at keeping the system in balance, even when naturally occurring excess nutrients flow from upstream. But when human activites on land and in the water add sediment, nutrients, and toxic pollutants, plants cannot clean it all up, though they certainly do help. We need to be very careful that our activities will not send pollutants into the water; at the same time, we need to maintain and even add to the wetlands that help keep those pollutants that we miss or can't control.

Prepare the demonstration (steps 1 and 3) one day prior to the lesson. Repeat steps 1 and 3 in front of the class to show how the demonstration was prepared.

1.) Prepare a solution in a beaker by adding several drops of food coloring to water. Explain that the food coloring represents pollution by a toxic substance (for example, a pesticide -- or let students offer examples.)
2.) Ask the students to imagine water flowing through a wetland with many plants. Tell them that the celery stalks are like the plants growing in a wetland (cattails, sedges, grasses, etc.)
3.) Cut off the bottom half inch of the celery stalks and place them in the water overnight. Over time the colored water will visibly travel (via capillary action) up the stalks, showing how plants can absorb pollutants in the water. The colored water may or may not be visible on the outside of the stalk. Cut off one-inch pieces of the celery and hand them out for students to study closely -- they will see colored dots on the cut surface which are water-filled channels in the celery cross section.
4.) Ask the following questions:

How do wetland plants help to purify water?
-- by taking up pollutants from the water

Why is the water remaining in the beaker still polluted?
-- plants can only do so much. As new water (hopefully, clean) flows into the system, the pollutants will be somewhat diluted and the water a bit less polluted. If the water continues to flow on to other parts of the wetland, other plants will continue to remove pollutants; wetland soil also helps filter out some pollutants.

Where does the water go after uptake into the plant?
--it is transpired out through the pores (stomata) in the plants' leaves and usually evaporates.

What happens to the pollutants?
-- some are used in the plants' metabolic processes, some are transformed into less harmful substances, while others are stored in the plants' tissues and could be re-released into the environment if the plants die.

Why can't we dump all of our waste into wetlands?
-- wetlands can only do so much; many pollutants still end up in the water. Too many pollutants will harm or destroy a wetland. The best solution is to reduce pollution.

As appears in *WOW!: The Wonders of Wetlands,* Environmental Concern, Inc., Maryland with credit to *Discover Wetlands* , Washington State Department of Ecology, Mail Stop PV-11, Olympia, WA 98504-8711, 1988

Runoff Race

Concepts: Wetlands slow the flow of water entering a waterbody and thus reduce erosion and sedimentation. Wetlands also help reduce the likelihood of floods because of their ability to slow flow and release water gradually over time.

Objectives: Students will be able to discuss some functions of wetlands and what they mean in terms of water quality.

Materials:

- quart jar with lid
- pebbles, sand, dirt, clay, crushed leaves, etc.
- piece of artificial grass (doormat) or real sod
- 2 sheets of wood or plastic similar in size to the doormat, hammer, nails OR runoff demo boxes from UNH Cooperative Extension county office
- two shallow aluminum pans
- 2 equal containers of water
- something to prop up the models so they tilt

Subject: Science, social studies

Preparation and procedure:

See background information in November chapter of the AASF Teacher's Guide about the functions of wetlands.

Set up the demonstration ahead of time.

1. Explain that flowing water carries sediments of different sizes. The faster the flow, the larger the sediment particles that can be transported in suspension. As the water slows, the larger particle settle out first. In still water, the finer sediments (clay and silt) will settle to the bottom.

2. Mix the different sediments (sand, dirt, etc.) together in the jar, filling it 1/2 to 3/4 full. Top off the jar with water, and put the lid. Have a student shake the jar well until thoroughly mixed and set the jar on the table in front of the class.

3. As the class watches the sediments settle, explain that muddy water can be harmful to wildlife.
Can you think of reasons why?
-- clogs filter feeders such as clams, clogs and abrades fish gills, smothers fish eggs, blocks sunlight impairing plant growth, "blinds" sight-feeding animals, etc.

Would more sediments settle to the bottom if the water was flowing quickly or slowly?
-- slower flow means smaller particles will settle out.

4. ***Describe how the particles are settling in the jar***
-- in layers, largest or heaviest first, fine or light particles may remain in suspension.

5. Describe how wetlands and their plants can slow the flow of water by simply "being in the way." Use the model to demonstrate. Secure the doormat to one of the sheets of wood or plastic and leave the other uncovered. Prop both models up on one end so water will flow down them when poured. Place the aluminum pans at the drainage end of the sheets to catch the flowing water.

6. Explain that the model with the doormat is a healthy wetland, filled with plants, and that the piece of wood is an unhealthy wetland where the plants have died or been removed. In both wetlands, water enters through a stream, flows through the wetland, and eventually into a lake (the pans).

7. Hand equal containers of water to two volunteers and have them pour water simultaneously into the high end of each.

8. ***In which wetland model does the water flow through fastest?***
-- the bare, unhealthy one

In which wetland would more sediments settle out?
-- the healthy one with plants

Which one would have cleaner water flowing from it?
-- healthy

How would digging a ditch through a wetland affect water quality downstream?
-- it would create a path for water to flow through quickly, without passing through the wetland plants. This would mean that the filtering action of the wetland would be diminshed, and water quality downstream would be degraded.

Why might someone dig a ditch through a wetland or channelize (change the course of) a stream?
-- There are several reasons, but usually ditching is done to drain a wetland to make the land more useful for farming or building, or sometimes for mosquito control (ditches allow small fish to come up into a marsh to eat mosquito larvae). People may channelize a stream to move it out of the way of some development.

How would the negative effects of these activities affect people?
-- may decrease fisheries, drinking water quality, swimming, and other recreational uses, aesthetics, etc.

As appears in *WOW!: The Wonders of Wetlands*, Environmental Concern, Inc., Maryland with credit to *Discover Wetlands* , Washington State Department of Ecology, Mail Stop PV-11, Olympia, WA 98504-8711, 1988

Pond Exploration

Concepts:

A pond is
a. a body of standing water
b. shallow enough that rooted water plants with leaves floating on the surface can grow throughout the pond (usually not more than 12 -15 feet deep.)

There are four life zones in a pond. Each contains a different set of plants and animals.
a. The surface film - occupied by plants and animals that walk, swim, or float on the surface or hang underneath it.
b. The open water - occupied by free swimming animals (like fish) and tiny, free-floating plants and animals (plankton).
c. The pond bottom - a calm, sandy or mucky habitat occupied by animals that burrow into it.
d. The sides, tops, and undersides of plants, stumps, branches, and rocks constitute a zone that supports a unique population of crawling animals.

What sorts of plants and animals are found in a pond?
Look for examples of these types of *plants*.
a. *Aquatic* - Plants that grow principally on or below the surface of the water for most of the growing season. e.g. duckweeds, water lilies or algae.
b. *Emergents* - Bottom rooted plants with stems and leaves that project above the surface. e.g. cattails and pickerel-weed.
c. *Scrub-shrub* - Plants include true shrubs, young trees, and trees or shrubs that are small (less than 6 meters i.e. 20 feet tall) or stunted because of environmental conditions. e.g. alders, bog laurel, and pond pine.

Look for these types of *animals or evidence of animals*.
a. Invertebrates - e.g. insects, crustaceans, molluscs
b. Amphibians - e.g. salamanders, newts, frogs
c. Reptiles - e.g. turtles, snakes
d. Birds - e.g. ducks, herons, geese
e. Fish - e.g. sunfish, bass, minnows
f. Mammals - e.g. muskrats, beavers, bats

Objectives:

1. Students will use simple equipment to help them make observations on a visit to a pond.
2. Students will use the Activity Sheets to record these observations.
3. Students will evaluate a wetland in terms of its wetland functions and provide evidence for their responses.

Materials:

- notebook or clipboard with paper and pencil for each student
- a plankton net
- dip nets (one for every 2-3 students)
- thermometer
- bottom sampler
- secchi disk and line
- boat or dock
- eyedropper and soft forceps to pick up small animals
- assorted small containers - small transparent jars are ideal
- a white enamel pan or plastic basin for displaying specimens
- hand lens (10X is powerful enough)

Subjects:

Science

Preparation and Procedure:

Make sure students are prepared to "dig in" with this activity. They will need comfortable clothing, protective foot wear and outer clothing and an old towel to keep their hands clean. This lesson is designed to encourage the exploration and investigation of a wetland. Ponds are ideal because of their small size and accessibility. The activities are also suitable for a lake, marsh, bog, or swamp.

1. Visit a pond, marsh, swamp or lake.
2. Characterize the conditions, plants and animals that you find in each of the following zones using student worksheet I. Have students use the thermometer, plankton net, hand lenses, bottom sampler, secchi disk, dip nets or other materials to help them explore.

    6 feet from the shore on shore
    at the water's edge
    at the water surface
    in the open water
    on the pond bottom

Don't forget to look on the sides, tops and undersides of plants, stumps, branches, and rocks.

2. After students have had a chance to muck about, have them evaluate the wetland in terms of its ability to fulfill any of the following values of wetlands. Use worksheet II.

    Serving wildlife by providing food, homes, or nurseries
    Preserving water quality
    Storing flood waters
    Serving people by providing valuable aesthetic, educational and recreational assets.

Then, have students provide evidence of the values they believe this wetland fulfills. Questions are provided to guide students' thinking. Evidence of the ability of wetlands to reduce sedimentation of adjacent waterbodies might be demonstrated by digging up and observing the network of roots and organic material present in the soil. Evidence that wildlife use wetlands might be present in the form of an animal home, shell, bone, scat, feather or live specimen!

Use your senses and equipment that your teacher loans you to explore the following places in and near the pond you are visiting. Write descriptions of the abiotic (non-living) and biotic (living) features you find. Abiotic features include soils, water, and human-made objects. Biotic features include algae, trees, insects, and birds. Make some guesses as to why things are the way they are in that particular environment.

	ABIOTIC FEATURES	BIOTIC FEATURES
ON SHORE 6 FEET FROM THE WATER'S EDGE		
AT THE WATER'S EDGE		
AT THE WATER'S SURFACE		
IN OPEN WATER		
ON THE POND BOTTOM		

Give this wetland a score on how it performs the four following jobs that wetlands do. Use the questions to help you figure out how this wetland performs those functions. Use your observation skills and a topo map of the area if you have one.

Circle the word HIGH, MEDIUM, or LOW to reflect the degree to which you think this wetland fulfills each function.

1. *Serving wildlife by providing food, homes, or nurseries*
   - Does the upland area surrounding the wetland contain mostly natural wildlife habitat?
   - Are there undisturbed travel routes for animals to get to other nearby wetlands?
   - What kind of vegetation is present in the greatest amount? What does that indicate to you about animals that will be present?
   - Are there any threatened or endangered species using this wetland?

   HIGH MEDIUM LOW

What evidence are you using to support your response?

2. *Preserving water quality*
   - Is there a stream, lake, or drinking water reservoir downstream that this wetland can protect by removing or trapping pollutants?
   - Are there many potential sources of soil erosion in this watershed?
   - Is the vegetation surrounding the wetland intact or has it been disturbed?
   - Is this wetland a buffer between land and open water?
   - Are there drinking water wells within 1/2 mile of this wetland?

HIGH MEDIUM LOW

What evidence are you using to support your response?

3. *Storing flood waters*

Use a map and an acreage grid to get figures for this equation.

Wetland size	=	_____ acres
Watershed size	=	_____ acres
Width of wetland outlet	=	_____ feet

Now, make the following calculations:

Ratio "A" of $\frac{\text{watershed size}}{\text{wetland size}}$ =

Ratio "B" of $\frac{\text{watershed size}}{\text{wetland size}}$ =

Flood storage ratings:

	High	Medium	Low
Ratio "A"	<10	10-100	>100
Ratio "B"	>16	4-16	<4

4. *Serving people by providing valuable aesthetic, educational and recreational assets.*
   Is this wetland unusual for the local region because of its type, size, or presence?
   Does the wetland provide a view over open water or vegetation?
   What are the sources of noise at the site?
   Is there much litter at the site?
   Is the area safe to visit?
   Is it accessible for people who wish to visit?
   Is the area on public or private land with cooperative landowners?
   Is the water quality of the wetland a problem?
   Is it possible to canoe, fish or hike there?

HIGH MEDIUM LOW

What evidence are you using to support your response?

Activity adapted from Wetland Functions Evaluation form in *A Study Guide to New England's Freshwater Wetlands* and *4H Water Quality* - Trip to a Pond.

ACREAGE GRID FOR ESTIMATING AREA OF IRREGULAR SHAPES ON MAPS

The grid on the next page has 1/8 inch square with 64 squares per square inch. To use, make a transparency of the grid, and place randomly over the shape you wish to measure on the map. Count the number of squares within the shape. If squares fall on a boundary line, count every other one.

To get acreage, multiply the number of squares within the shape by the conversion factor in the list on page 41, based on the scale of the map you're using. For scales not shown, use this formula:

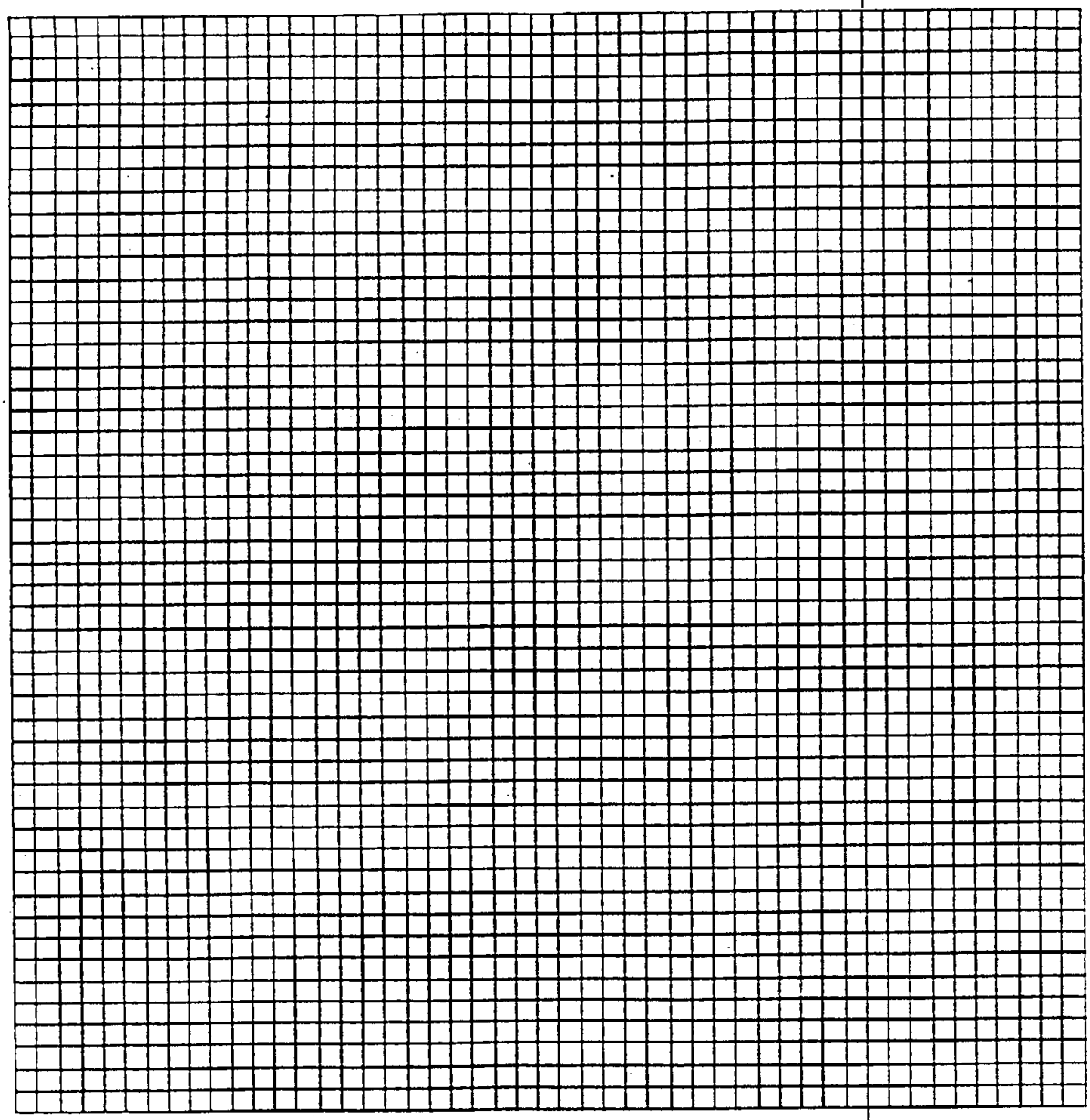
$$A = N \times \frac{D^2}{64 \text{ squares/in.}^2} \div 43{,}560 \text{ ft}^2\text{/acre}$$

A = acres in shape being measured.

N = number of squares in shape.

D = # of feet one inch equals on map.

ACREAGE GRID



SCALE		ACRES/SQUARE
1:7,920	or 1" = 660'	0.156
1:9,600	or 1" = 800'	0.230
1:12,000	or 1" = 1,000'	0.359
1:20,000	or 1" = 1,667'	0.996
1:24,000	or 1" = 2,000'	1.434
1:31,680	or 1" = 2,640'	2.500
1:63,360	or 1" = 5,280'	10.00

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Additional Resources

Education Division, ME Department of Marine Resources. *Estuarine Studies - An Activities Text for Maine Schools.* Augusta, ME: ME Department of Marine Resources, 1989.

New Hampshire's Water, A Youth Water Quality Awareness Program developed by the Water Quality Team of the University of New Hampshire Cooperative Extension and 4-H and Youth Development. Durham, NH: University of New Hampshire. Call 603-862-2180.

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Ruffing, Jenny. *The Estuary Book.* Augusta, ME: Maine Coastal Program, 1991.

Teal, John and Mildred. *Life and Death of a Saltmarsh.* New York: Ballantine Books, 1969.

Wicked Big Puddles - A Guide to the Study and Certification of Vernal Pools, Leo P. Kenney (advisor) Vernal Pool Association Reading Memorial High School, Reading, MA.

Video - *Fabulous Wetlands* with Bill Nye, the Science Guy, available for loan at each county Cooperative Extension Office. Call your local Cooperative Extension Office for more information.

Sources of Information for Maps

USDA Soil Conservation Service soil maps and reports
County Soil Conservation Service office, town or city offices

USFWS National Wetlands Inventory maps
NH Office of State Planning, 21/2 Beacon Street, Concord, NH 03301
(603) 271-2155, town or city offices

Zoning ordinances and maps
Town or city offices

Illustration Credits

Page 2
Black fly
Sayre, Tamara, *Pond and Stream Safari.* Ithaca: Cornell University Cooperative Extension

Page 3, Page 8, Page 9
Smallmouth bass and Marsh, Brown trout, and Microhabitats
Sayre, Tamara, *4H Sportfishing and Aquatic Resources Education Program - SAREP.* Ithaca: Cornell University, Department of Natural Resources.

Page 5
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Page 8
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