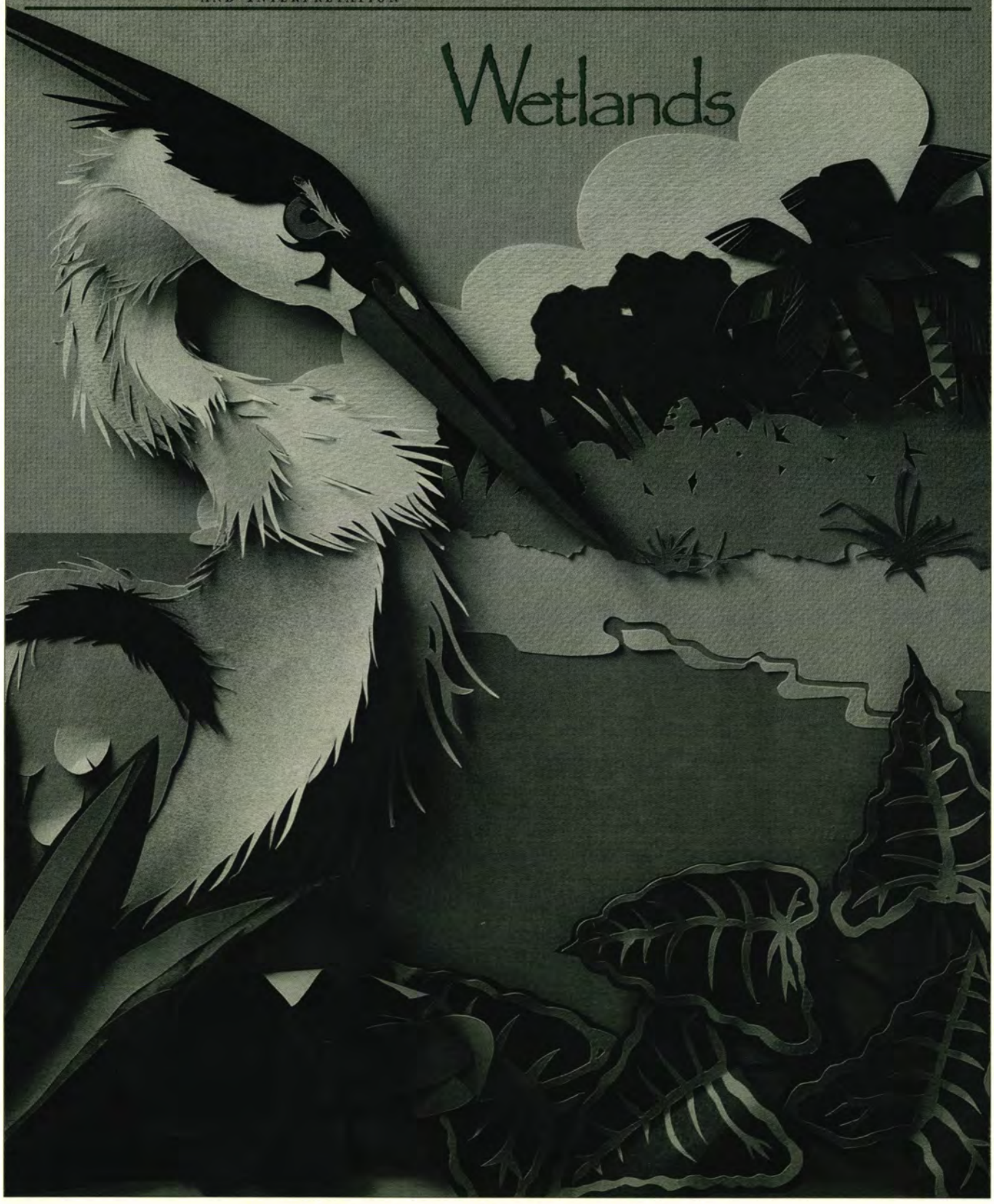
Nature Study

A Journal of Environmental Education and Interpretation



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Special Thanks to Three ANSS Contributors

In searching for material for this Wetlands issue of *Nature Study*, we had the privilege of working with Betty McKnight, Steve Melcher and Candace Cornell. We thank them for making this issue possible.

Guest Editor Betty McKnight earned her Ph.D. at Cornell's Nature Study Department in 1965. Before that, she taught science in elementary and secondary schools. After graduating from Cornell, she taught at New Paltz University. Betty was one of a team of four who prepared a very successful elementary science textbook. Currently retired, she is on the Board of Directors of the Cayuga Nature Center and an active volunteer. For many years she was secretary of the American Nature Study Society.

Steve Melcher, guest editor of this issue of *Nature Study*, is a Board Member and Life Member of ANSS. Originally trained as a wetland ecologist, the majority of his work has been done using benthic macroinvertebrates as water quality indicators. Mr. Melcher taught science at the Dover Air Force Base Middle School, located on the St. Jones River in Delaware, for ten years. While teaching science at the middle school, he received the district's Teacher of the Year Award, as well as the Delaware Nature Education Society's Environmental Educator of the Year Award. His present musical project involves providing the background atmosphere for an African-American storyteller. The stories will focus on Barry Commoner's four laws of ecology.

Candace Cornell is a specialist in wetland advocacy. As we scan a list of some of her activities, we see an extremely busy and successful woman: "Organized a neighborhood association to review developments potentially detrimental to the neighborhood. Successfully promoted the development of neighborhood composting, opposed development of local wetland without required permits, provided evidence on SLAPP lawsuits, edits an environmental newsletter. A participant in the comprehensive planning process, advisor to the planning board on wetland, ecological and water quality issues. Testified at ecological and water quality issues, testified at statewide hearings on wetlands regulations."

Her 1995 Award for Distinguished Leadership as a Citizen Planner given by the American Planning Association recognizes her many contributions, as do other awards, to say nothing of changes in attitudes and policies in her neighborhood and beyond.



Betty McKnight (left) with Helen Ross Russell

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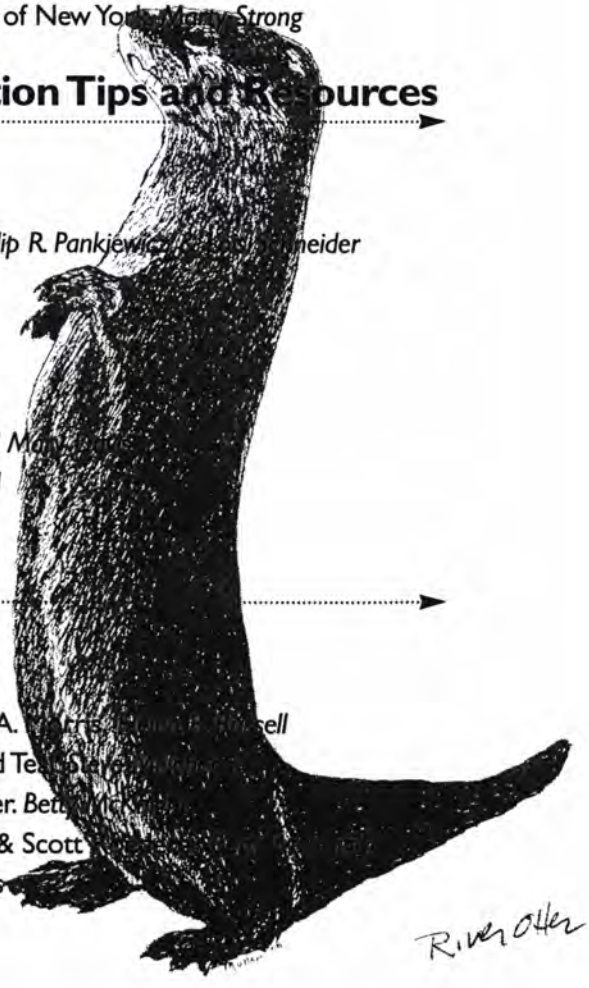




Illustration Courtesy of The National Audubon Society

Wetlands

Steve Melcher

I recently completed composing the music for an educational video about the rainforests. A section described the rainforests as "mother earth's lungs," which I thought called for the wind section. However, while hearing the piece performed, I didn't picture great trees breathing for the earth but rather the rhythmic rising and falling of the tides... and the gentle lapping of water against the shore... and the rustle of wind across the soft cowlicks of salt marsh hay.

This reminded me that I'd never written any music for wetlands. I'd never been asked to write a piece describing salt marshes, bogs or swamps in musical form. I realized that rainforests have claimed all the romance, all the attention, center stage, for the last twenty years.



Illustration Courtesy of The National Audubon Society

Yet wetlands are as important a part of the natural system, to Gaia, as the rainforests. If the rainforests are the lungs of the earth, the wetlands must be the liver, kidney and bladder, indeed maybe the whole gastrointestinal tract! In this issue of *Nature Study* we'll learn that wetlands act as filters, both sediment and nutrient. Studies have shown that flood peaks may increase by as much as 80% in watersheds where wetlands (earth's bladders) have been removed. Ground water, a source of drinking water for many, is recharged by prairie pothole wetlands. Tidal marshes and swamps serve as great food factories exporting huge quantities of detritus to the coastal areas. These unusually productive systems (as much as 10 tons per acre) provide more potential animal food than any other system, natural or manmade.

The wetland also serves as earth's womb, providing a nursery for many species of fish and shellfish. Coastal salt marshes provide a habitat for two-thirds of the commercial fin and shellfish harvested in the U.S. The spotted sea trout and many others come to the marsh to spawn, while their young use the guts and tidal gunkholes as safe-haven nurseries.

Getting our youth interested and involved in environmental issues is very important. I'd like to see more class projects involving wetlands here at home. It's easy to see why schools across America have a Rainforest Week complete with posters, drawings and skits. Jaguars and howler monkeys may be more interesting to draw than muskrats and beavers. The Rufus-tailed Jacamar and Blue- and Yellow-tailed Macaws may be more fun to color than Black Ducks and Canada Geese. This "bias" is not limited to the classroom. Sean Connery played a scientist searching in the rainforest for a cure for some disease — a noble quest — while most movies that include wetlands usually have escaped convicts being followed by howling dogs through a "dismal" swamp.

The kapok trees of the rainforest perhaps appear more fascinating than cattails or tall reed grass. But did you know that the flower heads of cattails, like the kapok, were used as insulation and fill material for life preservers and that cattails are one of nature's "all purpose edibles"? Or that tall reed grass (*Phragmites* sp.) is a close relative of the plant used to make the original paper, and that it serves as a natural absorber of phosphates and is still used in some parts of the world as toilet paper... and that its rhizome contains a

tasty treat — that should get the kids interested!

I spent a few wondrous years mucking through the salt marshes of the Delmarva Peninsula treating the Army Corps of Engineers to the delights of hidden American Bitterns and oysters on the half shell... all in the field. These engineers had a project slated that involved a wetland, and it was my job to enlighten them on the intricacies of swamps, bogs and marshes. Many of those engineers survived my marsh marathon to complete their projects, hopefully with a little more respect for Mother Nature. I understand that the completion of a wetland ecology course is now a requirement for many engineering degrees — so we've made some progress on the college level.

It was our desire to make this issue of *Nature Study* interesting and educational, but most of all inspirational. This is a journal of environmental education and interpretation whose goal is to shed light into otherwise dark and "dismal" areas. There has always been a great deal of confusion about wetlands. After reading this issue, you will be able to tell a fen from a bog, a swamp from a marsh, and meers and moors from mires. In the December 1994 issue, Laurence Pringle reminded us that wolves were once thought of as "bad" terrible creatures. "Now we can buy scores of products that depict wolves in noble poses." Hopefully, through education and exploration, our image of wetlands will also change. Maybe one day soon, I'll be asked (along with R.E.M.) to compose a "Song of the Cypress." I'll wear my "Save the Swamp" sweatshirt while sipping coffee from my "Bogs are the Best" mug. Naturalists across America will be chanting praises of their local wetlands. Swamps and marshes will no longer be thought of as dismal but rather desirable.

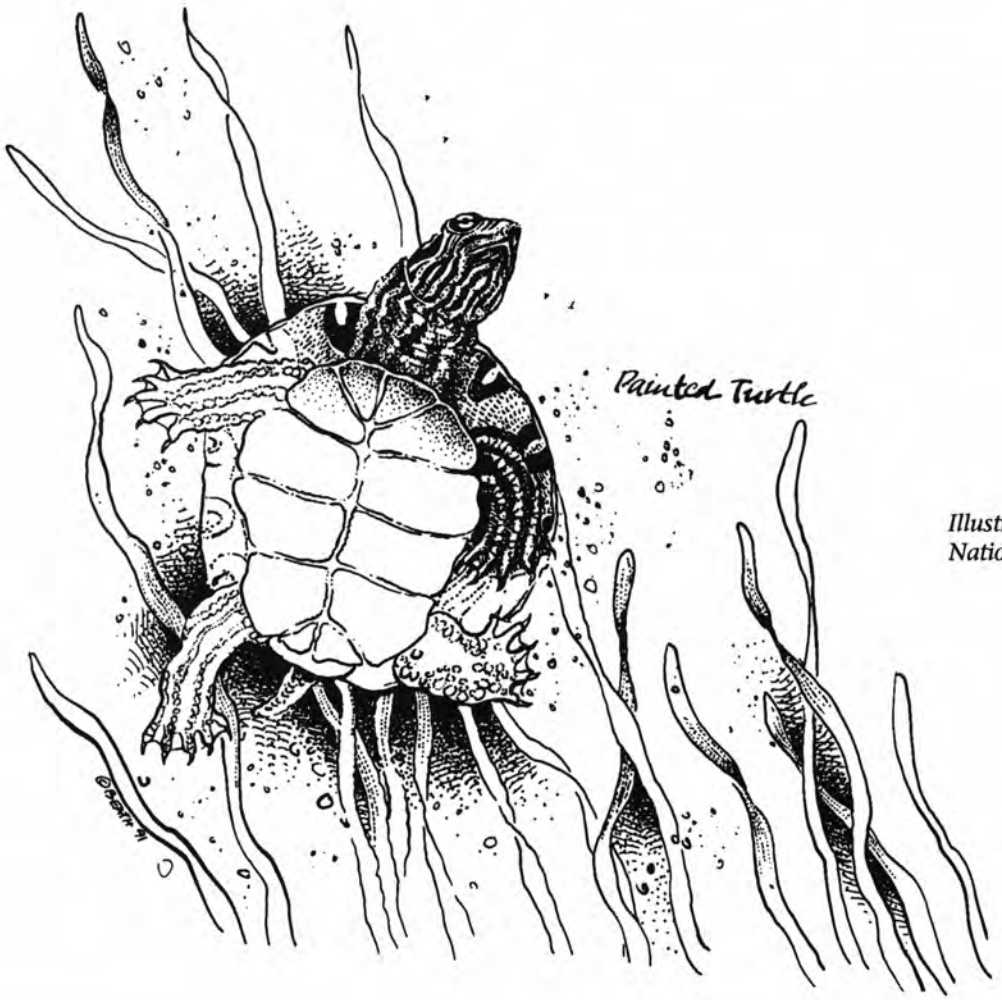


Illustration Courtesy of The National Audubon Society

John W. Brainerd, 1918–1994

Helen Ross Russell



Where does one start a biography of John Brainerd and his impact on the American Nature Study Society and the environmental movement?

According to John, he started his interest in natural history as a boy in a family that shared music, art, gardening and the outdoors. It was during these years that he learned to imitate bird songs and became permanently imbued with an irrepressible joy in the beauty and interrelatedness of Earth, our home.

During World War II John was a conscientious objector to war as a technique for problem solving. He was conscripted to work for the U.S. Fish & Wildlife Service at Patuzent Research Refuge, Maryland, for three years without pay. There he started a career as an illustrator. He worked for ANSS member Herbert Zim and Alexander Martin on the book *American Wildlife & Plants*.

He later taught for thirteen years at Springfield College. He pioneered in Environmental Design and was actively involved in developing and using natural areas at schools and camps. In addition to his role in ANSS (he was our 30th president), he was active in a number of organizations, including the Nature Conservancy, Conservation Education Association and American Camping Association.

When I wrote to John to tell him that I was using one of his drawings in the "First Nations People" issue of *Nature Study*, he answered on the back of a draft of a letter he had written to a former student. The thoughts contained in his letter to that student are worth passing on. In a gentle, informal way they reveal John as a caring, sharing educator and an imaginative teacher who worked with his students and rejoiced in their accomplishments. He saw the world as a wondrous mystery and scientists as people who had a responsibility to share its mystery, magic and beauty. It even includes one teaching tip.

Dear Judy,

It occurs to me that scientists need to recognize and even have the courage to talk about magic, the magical qualities of the world beyond the quantities which we know are important to quantify.

Take the matter of water that runs off the school roof. Architects and other school planners have almost entirely neglected its educational value. That is why I suggest that at least one downspout at each school be made to run into and out of a classroom, with two elbows and one glass piece of pipe between them with a little electric generator inside visible to the children. Wires could go to a light bulb, or to a meter to measure the current, which might be less or greater than that generated by the exercise wheel in a hamster's cage. A rain gauge under the outside end of the downspout could tell more about the quantity of the rain. But the magic of the hydrological cycle should not be neglected, with or without thunderbirds.

And school ground puddles, what joy (immeasurable) can come from them. I remember the little puddle for ducks that you made at Espanola. It was a gem.

Magic is often felt by scientists, perhaps I should say always. A young physicist may be for a scientist when he/she is captured by the mystery of gravity when realizing that things fall. A person elects to study biology because of the motion of an ameba or the beauty of a glen with a shady coolness — as at Elk Creek until the sunlight moves down the cliffs. Choosing to be a scientist involves a decision, conscious or unconscious, to investigate a beautiful mystery. Science teachers need to be more open with their students about feelings, one that cannot be measured. Too often they are scared of appearing non-objective, sentimental, non-scientific.

All that you know, but I had to "get it off my chest."

Love,

Doc

John finished the text and black-and-white illustrations for his fourth book just before his death. One of his students is producing the finished watercolors and his wife, Barbara, is shepherding the book through the publication process. Watch for it!

For some of us this book will renew an old friendship. For others it will be an introduction to a very special person who taught us all to love the Earth and its people.

Donations in the memory of John Brainerd can be sent to the Friends of the American Horticultural Society. Please indicate that your memorial gift is for the publication of the book *Horticultural Therapy*.

Friends of the American Horticultural Society

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They're All Wetlands

Steve Melcher

Wetlands cover vast tracts of land with a variety of colorful names. You'll find moors in Great Britain, mires in Germany, bogs of Maine, prairie potholes of the Dakotas and Minnesota, swamps of Georgia and the vast marshes of the Everglades. Alaska, more celebrated for its mountains and snow, is almost 60% wetlands. 70% of America's wetlands (233 million acres) are in Alaska. Canada leads the world with the greatest number of square miles of peatlands, followed by the former Soviet Union and the U.S.

A bog is a bog is a bog...

A wetland by any other name would smell the same...

So goes our thoughts and prejudices against wetlands...

A swamp is a marsh is a bog is a fen.

So goes our confusion about wetlands...

They're all wetlands, they're all wet, but they're all different.

What is a wetland?

Wetlands are simply areas where water is the controlling factor for associated plants and animals. The water table is at or near the surface, or the land is covered by shallow (6 feet or less) water. Wetlands are dominated by plants that don't mind getting their feet wet (hydrophytes) and are able to tolerate frequent flooding or total long-term inundation. Wetland ecologists of the U.S. Fish and Wildlife Service recognize five major wetland systems: marine, estuarine, lacustrine, riverine, and palustrine. These systems are further divided into a more precise hierarchical system enabling the ecologists to map and describe the wetland with reference to vegetation, flooding patterns, water chemistry and soils.

How Wetlands Formed

Wetlands are being formed as you are reading this. Some are manmade (in response to the no net loss mitigation), some caused by rising sea level. There are wetlands in the world that are thousands of years old, having their beginnings following the retreat of the last ice age. Huge buried ice cubes of glacier melted to form kettle lakes, or scoured-out valleys became clogged by glacial debris, later forming wetlands.

Salt marshes form in the lee of barrier islands along our eastern coast. Protected from the high-energy waves of the ocean, the turbid water slows, allowing the sediments to settle, forming the substrate for the plants of salt marshes.

Wetlands form in the protected areas between dunes in the Sandhills of Nebraska. The Everglades of Florida cover a vast shallow basin formed from eroded limestone bedrock. Limestone plays an important part in the formation of other wetland areas by allowing water to percolate through forming sinkholes and eventually wetlands.

Earthquake activity was responsible for the formation of the Reelfoot Lake National Wildlife Refuge in Tennessee.

Beavers, Nature's engineers, form wetlands by damming streams. The pond, eventually abandoned by the beavers, becomes the foothold for a wetland.

Value of Wetlands

Ecologists have shown that wetlands play a very important, though hidden, role in maintaining a stable environment. The three most important roles of wetlands are as Nature's sponge, as a nursery, and as a food export factory.

Sponge and Filter

Wetlands retain and release vast quantities of water during times of flooding. When hurricanes move along our East Coast, much of the water is absorbed in the marshes and swamps and gradually released back to the sea. Wetlands help minimize flood damage by lowering the flood peaks and storing water. Six inches of water over one acre of wetland places

150,000 gallons of water temporarily in a natural sponge. Mangrove swamps help to slow waters and stabilize shorelines. The loss of 30,000 to 50,000 lives during the 1970 Bangladesh typhoon was directly related to the conversion of thousands of acres of mangrove swamps into rice paddies. Although the rice paddies are very productive, they cannot absorb the vast flood waters caused by the seasonal typhoons.

Some of that water is absorbed into the ground, becoming an integral part of our water supply. Amherst, Massachusetts, depends on a water supply that is recharged at a rate of 8 million gallons daily from the nearby 2,000-acre Lawrence Swamp.

The U.S. Army Corps of Engineers made a sound investment when they decided to acquire (or protect by easements) 8,000 acres of wetlands along the Charles River in Massachusetts instead of building dams to control flood damage. The average annual cost for saving the wetlands was just over $600,000, but the annual benefits averaged nearly $2.5 million. Dams have to be built, maintained and, in terms of nature's time clock, fill in quickly. Wetlands maintain themselves if we choose not to interfere by filling or draining.

The dense vegetation of wetlands slows the outflowing water, trapping sediments... sediments that would clog the engineers' dams and the feeding mechanisms of filter feeders like clams and oysters. The vegetation can also act as a nutrient trap, absorbing abundant phosphates and nitrates from agricultural and backyard runoff. Heavy metals may also be absorbed by wetland plants. A project in Florida takes advantage of this by using the plants as heavy metal filters and then harvesting and disposing of the "contaminated" plants. The quality of Philadelphia's sewage is improved by flowing through the 500-acre Tinicum Marsh. Researchers found significant reductions in B.O.D. (Biological Oxygen Demand), nitrates and phosphates, which in high levels can wreak havoc farther downstream if left unabated. In California, the Humboldt Bay is kept cleaner by a small 100-acre marsh. The town of Arcata runs its sewage through that 100-acre filter. The water entering the bay is cleaner than if it had been run through a conventional sewage treatment plant.

Wetlands as Nursery

When you think of ducks, beavers, alligators, or muskrats, you think of wetlands. There are many other animals that depend on wetlands — animals that as adults you may only see in the open ocean or estuaries.

Wetland ecologists estimate that over 150 kinds of birds and 200 kinds of fish depend on the wetland during some part or all of their life cycle. Two million Americans harvested over 600,000 Mallards, Pintails and Greenwing Teals from the prairie potholes of the Midwest alone between 1967 and 1969.

Several species of freshwater fish use the shallow protected waters of the wetlands for breeding and feeding. The doormat-sized flounder that was caught out at sea was born many miles away in a salt marsh. The chicken that the family said grace over at Sunday dinner may have been raised on rough fish harvested from the fertile prairie pothole wetlands.

Food Export Factory

Wetlands are the most biologically productive ecosystems on the planet, rivaled only by the sugarcane fields of Hawaii (the sugarcane fields can only approach this achievement by being heavily fertilized). Wetlands are experts at capturing the sun's energy. Primary productivity is the rate at which photosynthesis produces energy or stores sugar in plants. The total amount of energy produced is called its gross productivity. Net productivity is the amount of energy left after the organism uses enough to maintain itself. Cattail (*Typha* sp.) marshes may yield over twelve tons of biomass per acre per year. The energy is used in situ by the millions of waterfowl and other wildlife that claim the wetland as their home or rest stop. Any net "left over" energy may be exported by rivers, streams or tidal flow to be consumed by the wildlife in bays, estuaries and coastal waters.

Loss of Wetlands

Most Americans believed wetlands were wastelands. You could not farm the fen, swamps were the territory of crocodiles, and marshes held slithering moccasins and monster-sized mosquitoes. So the thing

to do was to drain those useless wastelands, control them — control nature — because "man knows best." The Virginia Assembly chartered the Dismal Swamp Company to drain 400,000 acres of the Great Dismal Swamp in 1764. The timber that was cut was floated on barges down a canal named after one of the members of the Assembly: George Washington Ditch. The plan to farm the drained land failed, and today a large portion of the swamp is a national wildlife refuge. The developers' cry of the '50s was to "Dig a ditch and get rich!," draining thousands of acres of marshes to build condos and trailer parks with "your own dock in your front yard for your fishing boat." We now can see, enlightened by years of floods and failing fisheries, the value of those wetlands. The vacationers that brought their fishing gear to those ditch-front homes made an important ecological discovery. The flounder and oyster the vacationers and retirees were coming to the shores to enjoy were becoming more scarce as the wetlands disappeared... the wetlands that used to be where their fishing boats are now docked.

The loss of wetlands has slowed in the last 20 years. George Washington and Thomas Jefferson lived in a nation of 215 million acres of wetlands. Our children will know less than 90 million acres. Each year another 300,000 acres are lost. Over one-third of the almost 600 species of threatened or endangered plants and animals require wetlands for their survival. Congress discovered that agriculture was responsible for over 80% of wetland destruction, prompting them to create the 1985 Farm Bill. The bill included a provision called Swampbuster intended to encourage farmers to protect wetlands by eliminating the subsidies received when they produced crops on filled or drained wetlands. The stronger 1990 Farm Bill included a Wetlands Reserve Program, in which farmers are paid to permanently protect the wetlands once drained for crop production.

Legislation is not the only way to protect wetlands. New strategies are being developed by the U.S. Fish and Wildlife Service and the Bureau of Land Management that will protect and restore wetlands.

What You Can Do

Activists are raising wetland awareness worldwide, from Anne LaBastille's work with the reeds of Guatemala's Lake Atitlan to Bruce Fellman's work with the "whistles of whitewinged tree ducks echoing through the reeds of Laguna de Jocotal" in southeastern El Salvador. Volunteers have built a wetlands nature center at Lake Ichkeul in Tunisia. Vast shorebird reserves have been set aside in North and South America. The flood plains of the Inner Niger Delta of Mali are being preserved. Students stenciled storm drains in Baltimore and surrounding cities, notifying residents about the fate of the water that enters those conduits to the Chesapeake Bay. In 1971, 54 nations joined to form the Rarnsar Convention, which includes over 400 sites covering 74 million acres. Mike Mosey, former director of the International Waterfowl and Wetlands Research Bureau in England, attributes the worldwide interest in wetlands to "migratory birds which have played a tremendous role in stimulating worldwide cooperation in wetlands conservation."

A recent surf on the Internet showed a project being carried out by students in Canada. The subject was wetlands. They concluded,

> As we drain our wetlands and kill our natural resources, we find it leads us to a path of destruction. As we take resources from the earth, we make it harder and harder to live. If we continue to do this, it is most likely all the wetlands will disappear. In our search for a totally technological world, we have made obstacles that slow us down. There are many things we can do for the wetlands, but we just don't do it. We can stop destroying the wetlands just because we need the land, we also can join environmental groups like Ducks Unlimited or our most local group PLEA and give them our support. Sometime you may want to take a walk through a wetland and look at the wonderful plants and the helpless creatures that live there. After that could you let such an "awesome" sight be destroyed?

To learn about or support the BLM and USFWS wetlands programs, write to the BLM Director and/or the USFWS Director in the Department of the Interior, Washington, DC 20240.

Who Owns and Protects Wetlands?

Helen Ross Russell

One of the most famous and important wetlands, the Everglades in Florida, is a part of the National Parks system. About 200 wetlands are managed by the U.S. Fish and Wildlife Service, a branch of the Department of the Interior. Some wetlands are controlled by states, others by counties and municipalities. Some wetlands are administered by schools and colleges. Some are maintained by a local society that has been founded with its sole purpose the preservation of that particular swamp, bog or marsh.

Wetlands have been purchased and protected by the Nature Conservancy. Many of the 53 National Audubon Society sanctuaries, located in 26 states, are wetlands. In addition, many local chapters of the Audubon Society own nature centers and sanctuaries ranging in size from one or two acres to hundreds of acres. And of course, there are small patches of wetlands on individual farms.

The Migratory Bird Hunting and Conservation Stamp, better known as the duck stamp, is a required purchase for all waterfowl hunters 16 years of age and older. Through these $15 stamps, enough money has been raised to purchase more than 4 million acres of wetland habitat for addition to the National Wildlife Refuge System since its inception in 1934.

Ducks Unlimited, founded in 1937, has more than a half million members in the United States, Canada and Mexico. Last year it raised $71 million, 80% of which was distributed to projects on the local level for wetland habitat restoration and preservation. Most of the work of Ducks Unlimited is done by volunteers through the states. Membership begins at $25 a year.

All of these contribute to the health and well-being of the Earth. All wetlands need to be protected from abuse and greed.



Types of Wetlands

Steve Melcher

Marshes and swamps are the most confused of the wetlands... most of us don't bother differentiating a mire from a moor. In England, the nomenclature is even more confusing — lakes, lochs, fens, reed swamps and willow carrs, meers, moors and mires are all different types of wetlands. The simplest factor differentiating a marsh from a swamp on this side of the pond is vegetation type. Here's a poem I taught the folks of the Army Corps of Engineers when I marched them through the salt marshes of Wallops Island on the Eastern Shore of Virginia:

A marsh has grass and a swamp has trees,
if you walk through either,
you get wet up to your knees!

Or you can choose to remember it:

A swamp has trees and a marsh has grass,
if you walk through either,
...you get wet up to your knees.

...which doesn't rhyme as well.

Sedges have edges,
rushes are round,
both can be found,
where water abounds.

Marshes

Freshwater Marshes

Freshwater marshes are the most abundant of our wetland types. Swaying, tufted, tall reed grass, cattail sentinels and the "gurrga-leeee" of the Red-winged Blackbird are what I picture when I think of freshwater marshes. Cattails' (*Typha* sp.) intolerance to salt water (they can tolerate about 6 0/00) makes them good indicators of fresher waters. Cattails, like corn plants, have separate male and female flowers on the same stalk. The male spike is on top, holding the flowers, which fall away after producing the pollen. The fluffy ball you see in the marshes are the thousands of tiny seeds waiting to be carried away by the breeze. Cattails, like the tall reed grass (*Phragmites* sp.), can also propagate by underground rhizomes. The young shoot of the cattail, once a staple for Native Americans, is still considered a delicacy. America's most famous freshwater marsh, the Florida Everglades, formed from the rising and falling of sea levels during the Luratian ice age.

Prairie Pothole Marshes

The waterfowl migration route that stretches from Alaska and northern Canada to the southern wintering grounds of Mexico and Central America is freckled with the resting places and nutrient-rich wetland restaurants called prairie pothole marshes. These marshes extend over 300,000 square miles of northern Iowa, the Dakotas, Minnesota and into Manitoba, Saskatchewan and Alberta. Most of these potholes are smaller than 10 acres but are frequented by thousands of American widgeons, gadwalls, green-winged teals, lesser scaup, grebes, northern shovelers... to name a few. Most of the potholes are now found in land used for agriculture, and from the sky they look like the work of Degas. Potholes are believed to naturally come and go in five- to ten-year cycles. Like the Everglades, however, prairie potholes are suffering from human manipulation.

Salt Marshes

Many eastern marshes are dominated by the tough and salt-tolerant salt marsh cordgrass (*Spartina alterniflora*) while a related species (*S. foliosa*) can be found on the West Coast. The plant actually has salt glands which help to rid the plant of excess salts.

The tides and salinity are two major factors in determining the types of plants and animals in the tidal marshes. There are nine major groups of coastal marshes recognized worldwide. Three of these occur in our part of the world: the Arctic, Atlantic and Pacific. The Arctic group extends from northern Alaska into Canada and has very low species diversity, primarily sedges. The Pacific group runs from Washington to southern California. The largest is the Atlantic group, large enough in fact to have three distinct subtypes. Tidal range and underlying sediments distinguish the three types, with the most extensively developed marshes occurring along the Gulf of Mexico, where over half of the total acreage can be found.

Chincoteague National Wildlife Refuge is an example of a salt marsh.

Swamps

Mangrove Swamps

In the warmer climes of Florida, the coastal salt marshes disappear, being replaced by subtropical mangrove swamps. Once the sanctuary of the Seminole Indians, alligators and water moccasins, these wetlands have been relentlessly destroyed. The Army Corps of Engineers would have been destroying a nursery (the young of the Florida pink shrimp depend on mangrove swamps) as well as a sanctuary if their permit to convert a mangrove swamp on an island into oceanfront condos was granted. Fortunately that permit was denied, but the pressure remains to "develop" and "improve" the wetlands.

One of the many roles these swamps plays is that of a nursery to the Florida pink shrimp. There are some 40 different salt-tolerant types of trees called mangroves. Red, white, and black are the most common, with red being the more salt tolerant. Red mangroves, which can grow to be 80 feet tall, are evergreens and have a darker green foliage than the lighter green leaves of the black and white mangroves.

Ding Darling National Wildlife Refuge on Sanibel Island is one of several mangrove swamps easily available to interested people.

Cypress Swamps

The Big Cypress Swamp is one of the largest wetlands in North America. This wetland covers over 2,000 square miles of western Florida and is home to the bald cypress.

Tucked in the crooks of the cypress branches are beautiful bromefiads, some weighing as much as 75 pounds. The 900,000 acre Okefenokee Swamp in Georgia is famous for its cypress and black gum forests and floating islands of vegetation called batteries. Batteries are formed from organic matter that has risen to the surface riding on methane gases... the same swamp gas that may be responsible for the many UFO sitings in the dark recesses of the Okefenokee.

Corkscrew Swamp, administered by the National Audubon Society, has the largest stand of bald cypress in North America.

Peatlands

Bogs and Fens

Bogs and fens are underlain with partially decomposed plant material. This material, called peat, is the first stage in the formation of coal. Bogs and fens do have differences. Fens are less acidic and are found in nutrient-rich areas where sedges replace sphagnum moss as the dominant plant type.

Wetland ecologists recognize over 35 distinct forms of bogs and fens. The word *bog* comes from the Celtic *bocc* meaning "soft." Bogs are low in oxygen and pH, making them great for preserving pollen and people. The former is valuable in determining the biotic history of the bog, and the latter the cleverness of our ancestors. Bog peat is like a time machine of plant history. Pollen grains left in peat over the years become microfossils that tell the history of vegetation during the 12,000-15,000 years since the last glaciers.

Bogs are atmospherically fed and therefore poor in minerals and water flow. Fens receive their water from surface waters and ground water and are richer in species. In boreal Maine and upper New York, alternations of ridges and wet depressions or pools occur concentrically with raised bogs and parallel on sloping fens. The ridges are called ribs or strings and the pools flarks. Some other local terms to confuse the issue are *heath* (pronounced *hayth* in southern New Hampshire and coastal Maine), which is used to describe large, usually raised treeless bogs. A *spong* is a New Jersey Pinelander's onomatopoeic name for bog. *Cripple* is their local term for a cedar peatland or swamp. *Pocosins* occur on the coastal plain from the Eastern Shore of Virginia south to South Carolina. These boggy shrub wetlands are covered with evergreen hollies and bayberry bushes. There may be scattered copses of short Pond Pine (*Pinus semolina*). Because they are underlain with peaty deposits, pocosins are close cousins to bogs. Up north in Alaska and upper reaches of Canada, you'll find the *muskeg*, an Algonquian word meaning "great bog."

Did you know: Canada has the most bogs with 626,200 square miles, followed by the former USSR and the USA with 579,000 and 115,800 respectively.

Lives in Wetlands

Barbara Munkres

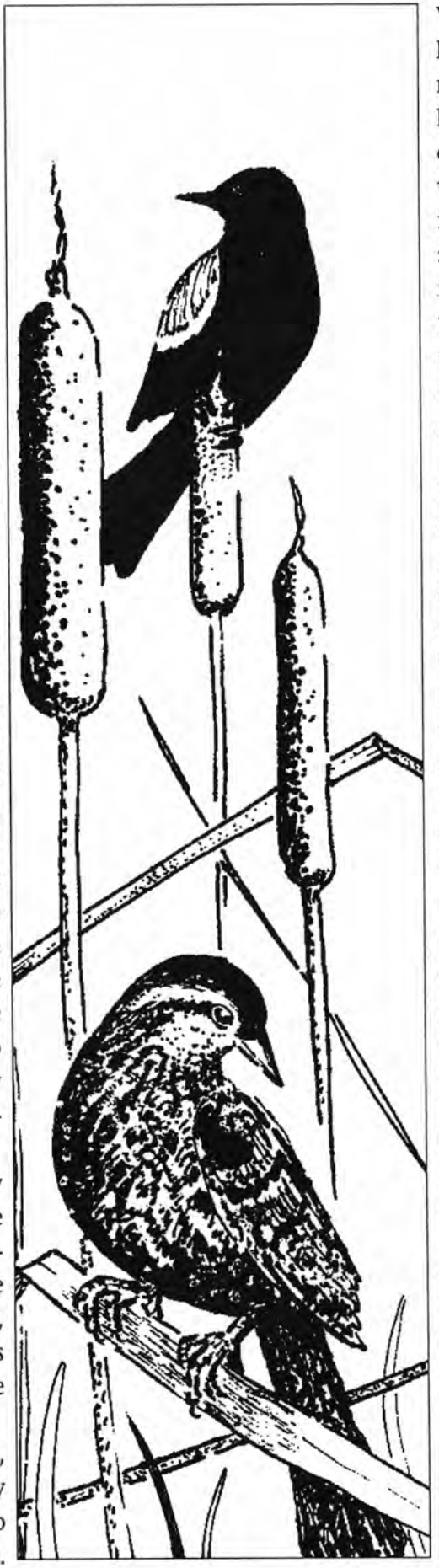
1. Notes from the Marsh

For many of us, there is no pleasanter reminder of returning spring than the song of the Red-winged Blackbird. Just when we think winter will last forever, we pass by the marsh and hear the colorful splash of notes from the male redwing: "kon ka reeeee." It is this last note, almost a trill, that we hear most clearly, especially from a distance.

In our area, male redwings are among the first of the migrating birds to return, arriving around the first week of March. They move north in flocks and begin to stake out their territories, usually in a wetland: marsh, bog, or river floodplain. And that is what all the singing is about: establishing which bird gets what portion of the marsh. If you move close enough to watch, you'll see the visual display that accompanies the song. And a lovely sight it is, for the male raises and spreads his wings so that his bright orange and yellow shoulder patches gleam in the sunlight.

These brilliant patches may signify beauty to us, but to the male redwing, they are a badge of authority. Biologists have found that if these patches are darkened experimentally, the male more often than not loses his territory to other males who have the normal coloration.

The female redwing blackbird, moving north in a flock that may include juvenile birds, arrives two to three weeks later than the male.



With her brown stripes, she hardly seems related to the male. Yet her larger size and longer, sharp-pointed bill help distinguish her from sparrows that frequent the marsh. The female redwing apparently selects not a male, but a territory; but she often does not have it to herself. Male redwings usually mate with several females, and each of them nests within a subdivision of his territory.

Down among the cattails, the female weaves her nest of grasses, sedges, and rootlets. She suspends it above the water or the ground using plant materials, often milkweed. She incubates the eggs herself and feeds the nestlings with little or no help from the male. This arrangement is fairly common among birds that are sexually dimorphic, that is, for which the male is strikingly different in coloration from the female. Ornithologists speculate that this situation is a protective adaptation common especially among birds that nest in open areas such as fields or marshes. A brightly colored, conspicuous male is likely to lead predators directly to the nest. So while the female redwing is busily raising the family out of sight, the male sits on top of a cattail or tree and defends the territory against other males, and against hawks, crows, and owls. Sometimes the males of a marsh band together to drive away an intruder, even a human one! If you are the intruder, you will hear the birds utter loud calls and descending

whistles: "Chuck!" and "Tseeer!"

Insects are the preferred food for the young birds, and there are plenty of them in the marsh. Newly emerged aquatic insects climbing up the cattail stalks are likely to be snatched up by the parent birds.

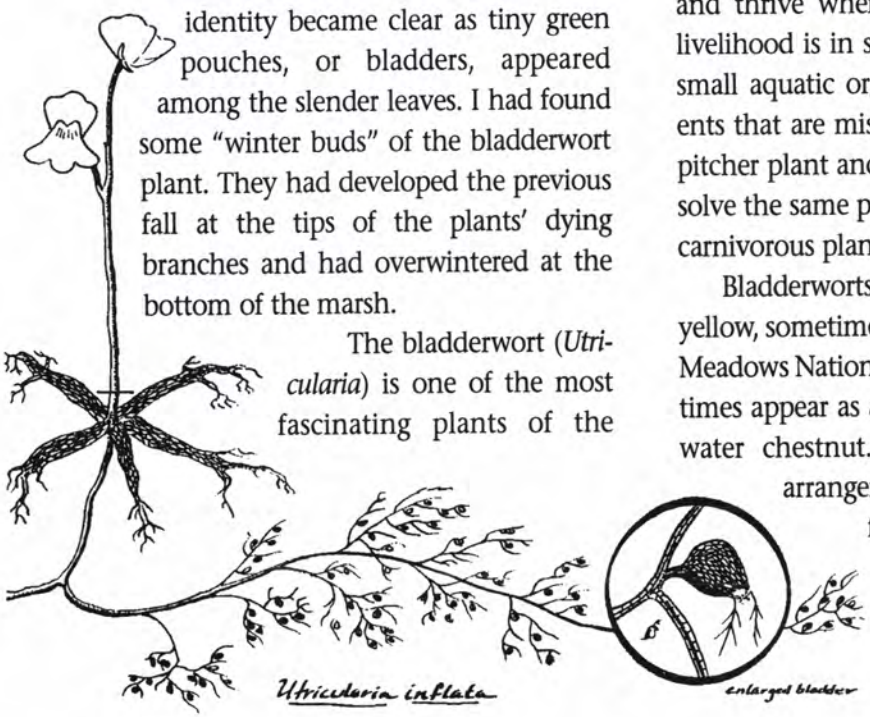
When the young fledge, or climb out of the nest, the male helps with feeding them. Eventually the young are on their own and begin feeding with other juvenile redwings in flocks.

Around midsummer, after the usual two broods are raised, the territories break down, and the redwings enter a molting period when they are less conspicuous in the marsh. They make an appearance again in September in new plumage and enliven the marsh until they depart for the winter in early November. The marsh seems overly quiet when they are gone.

2. Hidden Traps

It was a sunny warm day in early March; I stood on the edge of a lovely marsh and watched spring beginning to unfold. At my feet, gentle waves, released from winter's ice, were washing up some small green balls of plant matter. Curious, I picked up two or three of them and put them in my pocket. Eventually, they found their way to my indoor freshwater aquarium. Over the succeeding days, I watched each tightly curled ball unfurl and grow into a vine-like plant floating just under the surface of the water. Their identity became clear as tiny green pouches, or bladders, appeared among the slender leaves. I had found some "winter buds" of the bladderwort plant. They had developed the previous fall at the tips of the plants' dying branches and had overwintered at the bottom of the marsh.

The bladderwort (*Utricularia*) is one of the most fascinating plants of the marsh or bog. The bladders they bear vary in shape among the different species of bladderwort, but they all have the same function: to trap unwary animals that swim near them. At a size of 3 mm (about one-eighth inch), these traps do not threaten anything much bigger than the head of a pin. Among those who become victims are Daphnia and other little crustaceans, small roundworms, and even microscopic plants, such as diatoms.



The bladder itself is quite ingenious. A transparent, watertight trap door covers the opening of the bladder. Small hairs that surround the opening act as a trigger for the trap door. When a Daphnia brushes against the hairs, the trap door opens briefly and water rushes in, bringing the Daphnia along with it. The victim tries to find the way out, but there is no escape. Gradually, over several days, enzymes secreted into the bladder will dissolve the prey, and what remains will be absorbed by the plant. Specialized cells will also absorb the water in the bladder, creating a vacuum and pulling the walls of the bladder close together. The trap is set once more.


winterbud

But why would a plant develop such an elaborate trapping mechanism? Bladderwort often grows in acid waters, waters which are poor in nutrients, especially nitrogen. The traps are a response to a problem that all bog or "acid loving" plants must solve: how to grow and thrive when an important ingredient for their livelihood is in short supply. For the bladderwort, the small aquatic organisms provide the necessary nutrients that are missing in its habitat. The more familiar pitcher plant and the little sundew are bog plants that solve the same problem in different ways. All three are carnivorous plants.

Bladderworts produce attractive flowers, usually yellow, sometimes purple. At the Concord unit of Great Meadows National Wildlife Refuge, bladderworts sometimes appear as a golden patch out among the mat of water chestnut. In some species (see sketch), an arrangement of inflated tubes radiates out from the base of the flower stalk, supporting it above the water. The filamentous leaves and bladders are found on an underwater stem below this flotation device.

The bladderwort is further proof that our wetlands are home to some of nature's most intriguing plants and animals, all the more reason to treat these endangered places with respect.

3. Insect Mobile Homes

We are in the classroom-laboratory at Weir Hill. It is a spring day, and several fifth graders are gathered around a large white pan looking at water and plants they have collected from the Sudbury River a few minutes earlier. One youngster is probing gently among the plants with a spoon to see what she can find. There are the usual snails, insects, and small crustaceans; everyone's attention is fastened on the swarming life in the pan. Suddenly, from the bottom of the pan, a small pile of twigs rears up, insect legs under it scramble, and the pile of twigs moves off to hide under a leaf!



empty case made of gravel

What have we here? Looking more closely, the children find that the moving pile of twigs is a carefully constructed tube, made of tiny pieces of plant material. They have found a caddis fly larva, and the tube is its protective case. Their newly discovered insect is slender, about one inch long, and it has hooks at the end of its body for holding on to its mobile home. It also has legs that slant forward and can protrude out of the case to allow the insect to move about.



caddis fly larva and case



empty case with gravel for ballast

Caddis fly larvae are common in marshes, ponds, rivers, and even fast-moving mountain streams. They build their cases using materials from their surroundings: sand, gravel, small twigs, leaves, and even snail shells. One observer reports watching as one caddis fly larva made its case out of snail shells whose owners were still inside! Experimenters have found that the insects will use paper, eggshells, or even small pieces of glass to construct their cases if they are deprived of their usual material.

I once watched in fascination as a caddis fly larva in my home aquarium worked at repairing its damaged case. It first tried to cut pieces of the leaves of a water plant, but was unsuccessful in spite of much tugging and pulling. Eventually the larva succeeded in cutting off a tiny piece of a plant root. Then it licked the root all over, coating it with a special glue, tried placing the piece in several locations, and finally attached it carefully at the forward edge of the case. The whole procedure took an hour or so. Slowly, during an entire morning, the larva added several more pieces to its case. It was tedious work!

Back at the Weir Hill laboratory, the children are asking such questions as "What good is the caddis fly larva, anyway?" This question can be answered at several levels. One answer is that the larvae are often eaten by fish (case and all). Frogs and dragonfly larvae are also among their predators. In turn, caddis fly larvae eat a variety of things. Some are carnivores feeding on small crustaceans or worms. Others are "grazers," eating algae and organic material that coats underwater plants and rocks. Still others are "shredders," who in their feeding habits shred dead plants and make this material more available to microorganisms. The microbes decompose it further, releasing raw materials for reuse in the food and energy cycle of which all living things are a part.

But besides their niche in the food web, caddis fly larvae remind us of a whole world of fascinating events and unlikely stories that we seldom notice. We can capture the excitement of this world by our own observations of the varied life around us.

4. Surviving under Ice

Skating or tramping across a frozen pond or marsh in winter, we are aware of a great stillness that contrasts with the lively sounds of summer. It is hard to imagine that there is any life at all below the ice. Yet, if we are on the pond when it is covered with clear, or "black," ice, we can peer into the watery world below. We may see fish moving slowly near the bottom, or such insects

as diving beetles (db) coming to the air pockets under the ice to replenish their breathing supply.

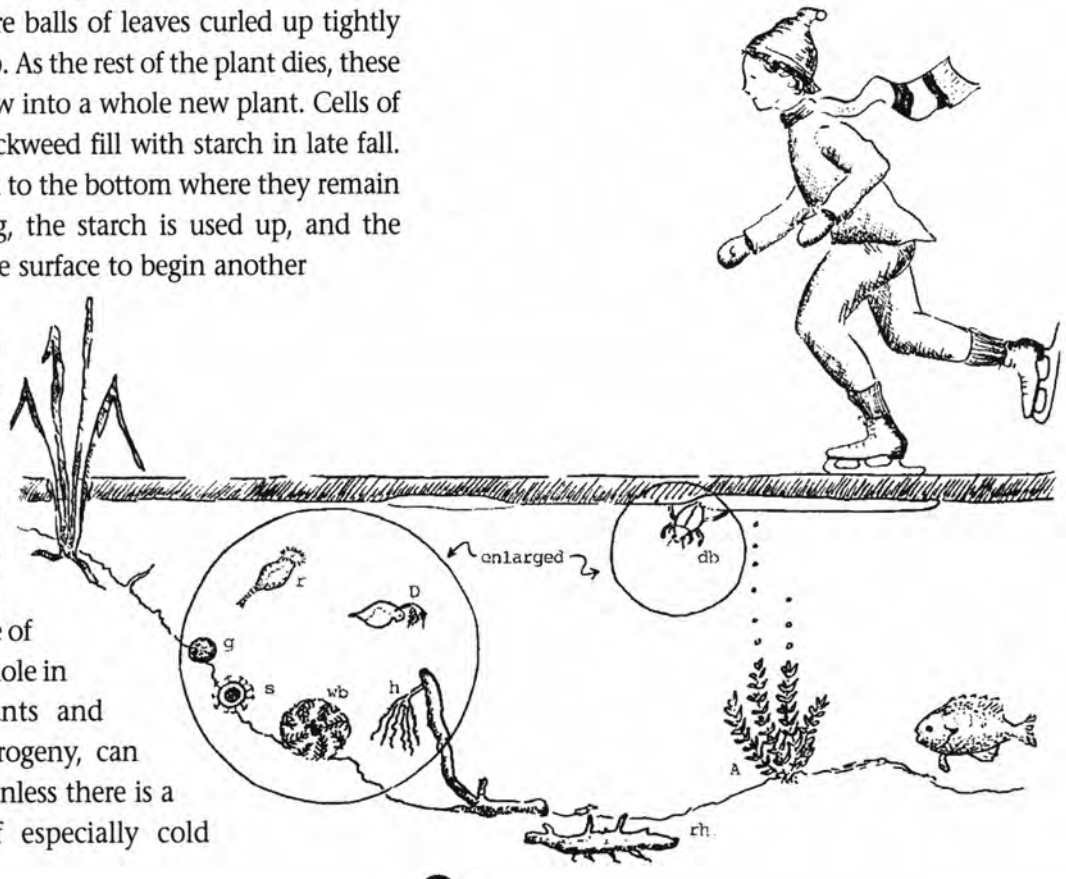
As long as the ice remains free of heavy snowcover, life goes on in the pond. Sunlight passes through the ice to plants such as Anacharis (A), or Canadian water weed, allowing photosynthesis to occur. The oxygen released is usually enough to sustain the plants and animals because of their reduced numbers and requirements.

Many small animals rely on special inventions to aid in the survival of their species through the cold season. As fall approaches, one-celled protists develop cysts around themselves and become dormant. The moss animals, or bryozoans, produce statoblasts (s) with thick coverings that survive in the mud or debris. Freshwater sponges produce hard coated gemmules (g) before they die in the fall. Daphnia (D) and the microscopic rotifers produce "winter eggs" which are able to withstand freezing temperatures. These, too, sink to the bottom of the pond to wait out the cold weather.

Plants have their own inventions for surviving winter. Algae produce weather-resistant spores. Water lilies die back except for an underground stem, or rhizome (rh), which is thick with stored starch. Other plants such as bladderwort produce "winter buds" (wb) in autumn. These are balls of leaves curled up tightly around a growing tip. As the rest of the plant dies, these buds unfurl and grow into a whole new plant. Cells of the tiny floating duckweed fill with starch in late fall. The plants then sink to the bottom where they remain all winter. By spring, the starch is used up, and the plants float up to the surface to begin another season of growth.

In spite of these prudent measures to conserve life, a few active rotifers (r), crustaceans, hydra (h), diatoms, and other organisms can be found in a sample of water taken from a hole in the ice. These plants and animals, or their progeny, can survive the winter unless there is a prolonged spell of especially cold weather, in which the water freezes to the bottom of the pond. Another hazard for aquatic life occurs when there is a deep layer of hard packed snow on top of the ice; sunlight reaching the plants is reduced, resulting in low oxygen levels and "winter kill" of many organisms. Should that happen during a cold winter, we can be sure that spores, gemmules, statoblasts, cysts, winter buds, rhizomes and other special inventions of plants and animals will replenish the pond when spring returns.

Barbara Munkres is a volunteer at Great Meadows National Wildlife Refuge in Sudbury, Massachusetts. She conducts teacher workshops there and leads field trips for children. She also writes a quarterly article for the Great Meadows Messenger, *material from which is included in this journal with their permission.*



A Visit to a Salt Marsh

Steve Melcher

Find a friendly cowlick of salt marsh hay near the edge of a cordgrass-bordered gut to watch the endlessly changing show of the tidal marsh unfold. Each tide, coming and going, brings new players onto the stage. If a play were written about the tidal marshes, it would have to be a brash Bernsteinian musical on the lines of West Side Story, for the gangs of killifish cruising the guts and the wolf spiders of the marsh hay represent a tough neighborhood.

The play would have to star the tough Spartan-like Spartina grasses *Spartina alterniflora* (saltmarsh cordgrass) and the gentler *Spartina patens* (saltmarsh hay). The soft grass you're resting on has a hinge at the base. This hinge causes the grass to bend and form the cowlicks of the salthay meadows. Spread some of the blades of grass, working your fingers through the grass. You'll find layer upon layer of saltmarsh hay. This part of the marsh is building in elevation and may only be flooded by the highest spring tides. While you're probing through the fine strands of marsh hay, be prepared for a wolf spider, crab spider or jumping spider to come rushing out in search of prey. You're a bit large for the spider, but not the long horned grasshopper or the myriad of other insects that make their home under the protection of the *Spartina patens*.

The tiny snail *Melampus* may also be searching in the dark moist meadow. *Melampus* can also be found out in the saltmarsh cordgrass, where it displays a most interesting trait. A pulmonate (having a primitive lung) snail, *Melampus* will browse its way up a stalk of cordgrass, feeding on the abundant epiphytic algal growth. It does this browsing in anticipation of the tides climbing the stalks before the water actually reaches it. The snail has a built-in alarm clock that goes off after a little more than twelve hours pass. This corresponds to the time between tides. *Melampus* will even display a biological clock when brought into the classroom aquarium, rising every twelve hours, resting and descending again. *Melampus* has no horny plate, called an operculum, to close tightly to keep from drying out in the hot sun.

Another snail found feeding on the cordgrass is the marsh periwinkle, a relative of *Melampus*, which does have an operculum. The periwinkle can draw the operculum shut into the opening of their shells to seal themselves against drying during low tides. I found some periwinkles once in my pants pockets while getting out change for Parodi cigars (great mosquito repellent). They must have been in there for at least a week and then had gone through the wash... and were still alive!

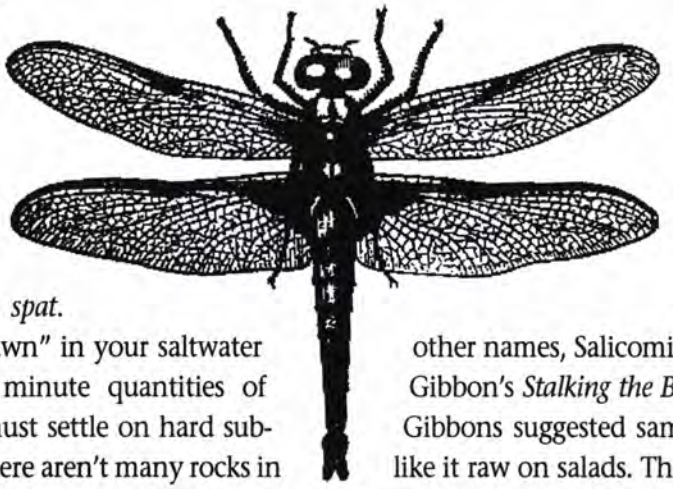
As the play further unfolds and the rising tide moves in, fiddler crabs (*Uca* sp.) shuffle to their burrows. Males, with one claw enlarged like a fiddle, will play sirenic tunes to passing females, moving their "fiddle" up and down with amorous intent. Schools of fish, adult and fry, dart up the gut occasionally, flashing silver. Around the bend we can see what they were hurrying from: a snowy egret using its yellow sneakers to chase the fish from the shadows. Many of those fish will remain in the marsh. Most will become food for wading birds or crabs or one of the many predators of the marsh. Some will seek the deeper coastal waters to reach adulthood and become part of the multimillion-dollar fishing industry. Two-thirds to three-quarters of the fish, shellfish and crustaceans harvested are dependent on tidal wetlands.

A shadow passes over the marsh meadow, causing you to look up. Overhead, another bird of the tidal wetlands, the osprey, swoops by with a fish dangling from its talons. The Osprey juggles the fish in midair into a headfirst position to reduce air resistance. The endangered bird continues on to a huge nest where its mate and two young offspring wait. The adults meet with the high-pitched, squeaky voices of birds of prey, one congratulating the other, then taking off for its turn at the hunt. A final call perhaps to warn of the eagle nearby who, given the chance, will steal the fish from the more successful fishers. Back in the nest, the fishhawk shares its prize with the young, tearing off bits of flesh to feed to the hungry open mouths.

Not long ago, those eggs would never have hatched into these beautiful birds at the top of the food pyramid. DDT, a pesticide widely used to control mosquitoes, was found to have detrimental side effects, and is no longer in widespread use. Although it was only sprayed in wetlands, it can now be found in the fatty tissue of penguins in Antarctica and fish of the deepest oceans. The DDT is stored in the fat of the

birds and not excreted, interfering with steroid metabolism, which in turn affects calcium metabolism. The birds lay eggs with thinner shells than usual. The thin-shelled eggs easily crack and break by movements of the adult. The birds of prey would not recognize the broken bits of egg shell and yolk as their eggs any longer and eat the makings of their progeny. Fortunately, with the banning of DDT in the U.S., the osprey, eagle and peregrine falcon numbers are increasing. DDT is, however, still exported to countries where it is legal.

Reach down and grab that dark clump of shells... bringing with it a mass of the rich marsh mud. The ribbed mussels have beards of bissel threads, used to help them hold fast to the bottom stalks of cordgrass. A neighbor of the mussel, fellow filter feeder oyster, also needs something to hold fast to. The delectable oyster starts out as planktonic larvae called *spat*. (You can get oysters to "spawn" in your saltwater aquarium by introducing minute quantities of ionized copper.) The spat must settle on hard substrate in order to prosper. There aren't many rocks in the tidal marshes of the Eastern Shore of Virginia, so the spat settle on the next best substrate: other oysters. Rarely do you find a single oyster.



In Chincoteague (pronounced "Shengtek"; natives have developed a method of speaking without moving their lips in order to keep out mosquitoes; oyster is pronounced "erster"), oysterers will put rows of shells out for the spat to settle and grow. These rows of shells are tended like gardens, raked to break apart the clumps, and "weeded" to remove predators like the oyster drill. The holes in the oyster shell on your mantle were probably made by an oyster drill, a snail that drills a hole with its radula and then sucks out the contents of the oyster.

In the not-so-distant past, oyster beds were guarded with shotgun in hand. Whole families would stay in shacks on stilts to protect the prized oyster from would-be poachers. Maryland oysters from the Chesapeake Bay with an average salinity of 11 ppt (parts per thousand) are sometimes brought to the saltier waters of Chincoteague for a visit long enough to impart that special Chincoteague flavor. Today, oysters are grown on long ropes dangling in the water, Japanese style. To harvest, simply haul in the line.

The tide still rising has a raft of detritus called tidal wrack (mostly *Phragmites,* tall reed grass) floating upstream. If the tide goes high enough (during a spring tide) and the wrack is deposited on the cordgrass or marsh hay, it will cover the area, blocking the sunlight and killing the grasses. This eventually may leave a slightly depressed zone known as a *panne.* Pannes are the toughest neighborhoods in the tidal salt marshes. With salinities of 70 ppt and higher (cattails, *Typha* sp., won't tolerate salinities over 6 ppt), not even the Spartina can survive. The succulent Salicomia rules here. Known as chickenfoot, saltwort, glasswort and a dozen other names, Salicomia can even be found in Euell Gibbon's *Stalking the Blue Eyed Scallop* as samphire. Gibbons suggested samphire should be pickled... I like it raw on salads. The salt pannes can turn a brilliant red in the fall of the year when the Salicomia changes color from green to crimson. Watch closely and you may see the fiddler crab *(Uca pugilator,* the boxer) scurrying across the panne dancing amongst the beautiful salt tolerant Sea Lavender (*Limonium caroliniarum*).

The best view of the crimson pannes is from a high bridge crossing the inner-coastal waterway or from the air. A low-altitude flight in a small plane reveals the simplicity of the marsh. Man's intervention into the marsh with mosquito control in mind is etched across the marsh. Many of the public works projects of the past involved digging a straight grid of ditches in an attempt to drain the marshes and thus destroy the breeding grounds of the mosquito.

The dominant Spartina, the border or edge of shrubs and the meandering creeks and guts are also visible from the air. One can see why the smaller tributaries are called *guts*. These guts represent the bowels

of the marsh system, draining and flooding the marsh. Guts are not to be confused with the Dutch word for stream or creek which is "Kill." (It's no wonder the marsh has such a bad reputation with names like Murderkill River, Slaughter Beach and Taylor's Gut.) The stream's path reveals the topography of the land, a very gentle slope. The current seldom reaches more than four knots. This constant pacific flow of water is a key to the tidal marsh's success. The sessile organisms of the marsh don't need to expend the tremendous energy on holdfast mechanisms that other organisms of the wave-struck surf intertidal zone do. Waste products are certain to be removed continuously (except from the pannes). A constant supply of food in the form of tidal soup floods into the marsh with each incoming tide, and indeed also on the outgoing tide.

"A'ways keep ya 'but' (boat) to the inside," I was told by an experienced boat captain. When streams meander, the water moves faster coming around the outside of the curve. When a high school marching band moves around a corner, those on the inside of the curve are taking small steps while the folks with the tubas on the outside are moving faster and taking giant steps to keep the line straight. Because the water is moving faster on the outside of the curve, more erosion occurs on that side, so the curve has a tendency to keep growing outward. The curve may move outward far enough that it actually curves back into itself. An oxbow lake is formed when the curve forms a loop that is cut off from the rest of the creek.

These oxbows occur wherever the water is flowing slowly due to the gradual slope of the land. There is the story of a small town that was once on the banks of the Mississippi River. Paddle-wheel boats traded their goods and plied the waters to New Orleans. Today that town is 80 miles away from the main flow of the Mississippi River with only the reminder, an oxbow lake, of the abundant trade that once took place.

The rich sediments carried by the meandering streams of the tidal marsh can become their eventual downfall. Like the woodland pond that was engineered by beavers, the tidal marsh may eventually fill in and become dominated by upland plants. Salt marshes may also be destroyed by wave action when they lose the protection of a barrier island. Rollers of peat, the size of a lion's head, may be found on the beaches... evidence that somewhere the waves are ripping away at an ancient marsh.

One way of defining the boundaries of marshes is by using aerial photography. The land that is only a few inches higher in elevation is not flooded by even the higher spring tides. This border, known as the bush zone, is dominated by marsh elder, a member of the sunflower family also known as high tide bush (*Iva frutecens*) and Groundsel Bush (*Baccharis halimifolia*). These are two of the many plant species used to delineate a salt marsh. Bushwhacking through the bush zone and the *Phragmites* may find you under the sun-spackled canopy of Loblolly pines. Time to rest on the soft needles of the maritime forest.

No one really knows how much of the east coast of America was once tidal marsh. Today many of those marshes of the past are covered by airports and even large parts of cities like Boston. "The dangers to salt marshes stem from human activities," say John and Mildred Teal in *Life and Death of a Salt Marsh*. We have destroyed wetlands directly by dredging, filling and building. Indirectly we destroy them by pollution. We've come a long way since the marsh filling and the "dig a ditch and get rich" days. Most states now have their own wetland laws, backed by federal laws, to protect the marshes.

The bottom line is for the public to reintroduce themselves to the marshes. A salt marsh should no longer be thought of as wasteland. Tidal marshes serve as nurseries for fish, some of which stay in the marsh, while others we associate with the coastal ocean; marshes act as massive natural sponges, soaking up flood waters of hurricanes and Noreasters; and tidal marshes are food export factories producing more biomass per acre than any other natural system.

A trek to the marsh, if one is properly prepared, will involve the visitor in an unsurpassed learning experience... and the more we learn about our wetlands, the more we'll realize the importance of their preservation.

Amphibians' Emergence a Sign of the Return of the Season

John Serrao

An ancient ritual is repeated each year in Pocono wetlands, at a time when humans prepare to mark the arrival of the spring equinox. It usually begins during the first half of March, when temperatures still drop below freezing at night and ice remains on the lakes. But there are also the unmistakable signs of spring in evidence, as dormant senses are reawakened by sights, sounds, and smells of the changing season.

Daytime temperatures now rise into the 40s or even 50s, and slowly the snow cover disappears to reveal the forest floor once again. Chickadees and cardinals begin to sing, woodpeckers drum messages on resonant branches, and the air is suddenly balmy and heavy with the aromas of damp earth and freshly sprouting vegetation in the wetlands.



The stage is set for the arrival of spring's earliest breeders in these swamps and woodland ponds. Their internal "biological clocks" and the newly warmed earth tell them that winter is ending and the time to emerge is near. Only one more environmental signal is required to bring these creatures out of hiding — the first March rains, which soak through the thawed ground where they have spent the winter months in suspended animation. Then they emerge en masse — thousands of frogs and salamanders hopping and crawling across the moist earth, usually at night. Guided by wetland odors, celestial cues, and even perhaps an imprinted memory of their own place of birth, they move in the direction of the same waters where they were spawned in previous years. And I, too, migrate to the wetlands on these special evenings, with flashlight and hip boots, to witness one of spring's earliest and most fascinating annual rites.

As signs of spring, amphibians are usually not afforded the status of woodland wildflowers or migrating birds. However, the breeding activities of frogs and salamanders in the northeastern United States often precede the arrival of the first robin from the south, and almost certainly occur before the emergence of all wildflowers except the skunk cabbage. In 1989, the first frogs were heard calling from wetlands on top of the Pocono Plateau in Tobyhanna on March 18, and last year it was on March 12. In 1987, a cold spring delayed their emergence until March 27. In the Hudson River Valley of northern New Jersey and southern New York, where I recorded the dates of nature's events from 1972 to 1986, the average date for the beginning of the amphibians' breeding season was March 16.

Reproduce in the Water

Returning to the water to reproduce has apparently been a condition of their lives for over 300 million years, ever since amphibians first evolved from fishes to become the earth's first air-breathing, land-dwelling vertebrates. Despite all those millennia, and their divergence from those first primitive forms into today's 2,500 worldwide species of frogs, toads, and salamanders, amphibians as a group still depend on the earth's wet places. Because of their thin, permeable skins and varying degrees of cutaneous respiration, they are relegated to ponds, swamps, damp soil, and rotting wood. And although many tropical species

have developed interesting exceptions to the rule, the great majority of this country's amphibians must return to the water each year to lay eggs. From these eggs develop tiny larvae or tadpoles which breathe with gills. After an underwater existence which varies from a few weeks to a couple of years, depending on the species, our Pocono amphibians emerge into the air with lungs as adult frogs, toads, or salamanders.

A visit to a Pocono wetland on a mild evening in late March or early April, when the breeding activities of the early amphibians are at a peak, will assault one's senses. The sounds produced by the frogs are deafening, and many a time I have returned home after such an excursion with my ears ringing. The water boils with the movement of frogs on the surface and salamanders under the water. Yet, just a few yards away, watching television or reading newspapers within their warm homes, a great majority of people are completely unaware of one of nature's most dependable annual spectacles. Through the mist, darkness, and moving windshield wipers, passing motorists fail to see the hundreds of amphibians attempting to cross roads to reach their breeding ponds, and the numerous bodies of the unfortunate ones crushed by tires during these instinctive journeys.



Four Species Involved

The players involved in these earliest acts of March include four species here in the Poconos. Our largest salamander at eight or nine inches in length, the spotted salamander resembles a thick, black rubber toy decorated with bright yellow spots. Its breeding performance is a series of unusual underwater "nuptial dances," performed by groups of up to 40 or 50 individuals. Males gyrate their bodies, fan their tails, and nudge and rub against the females, in an attempt to arouse their interest, possibly with the aid of some stimulatory chemicals which they secrete into the water.

If sufficiently excited by this foreplay, a receptive female then follows a male as he swims away from the group and deposits spermatophores — small, gelatinous packets of sperm — onto the underwater debris. Taking one of these into her genital opening, the female becomes fertilized. Within a few days she leaves attached to underwater sticks one or two jelly-like clumps, each containing about 100 black eggs and swelling almost to the size of a tennis ball. Within two or three weeks, these salamanders leave the water and return to the woods for an underground, mole-like existence until next year's March rains bring them out again. In the water, their eggs hatch in five or six weeks into tiny, allied larvae which feed on aquatic life, metamorphose into miniature spotted salamanders, and leave the water by fall.

A second species of salamander, the small red-spotted newt, is also breeding at this time, in permanent lakes as well as temporary woodland ponds. Unlike its larger relative, the male newt actually grasps the female during his courtship act. The pair may remain in this position beneath the icy waters for hours, the male clasping the female from above with his two hind legs, fanning his tail, undulating his body, and rubbing his mate's snout with special mating glands on his face. Like the spotted salamander, fertilization results if the released female follows the male and picks up his spermatophore. Eggs are deposited

singly rather than in clumps, and they hatch into tiny, gilled larvae which transform by summer's end into the familiar, terrestrial, bright orange "efts" often seen walking in the woods on rainy days. After two or three years on land, efts return permanently to the water to become greenish newts like the parents which produced them several springs ago.

Frogs rely on voice rather than dance in their breeding activities, the males of each species possessing a unique mating call which attracts only the females of their own kind. The two earliest frogs in the Poconos have completely different calls. That of the three-inch wood frog sounds remarkably like a quacking duck, and a pond full of these brown, black-masked frogs in March has probably fooled many people into believing a flock of mallards had arrived for spring. The only frog found as far north as Alaska and Labrador, the wood frog is truly a species of the north woods. Often the first amphibian to arrive in the icy waters in March, the wood frog only remains two weeks, returning to the woods after leaving large, tapioca-like clumps of eggs attached to sticks just beneath the surface. Unlike salamanders, frogs fertilize their eggs externally, with the male clasping onto the female's waist from the back and spreading sperm onto the eggs as she voids them into the water. As many as 1,000 tiny black eggs are contained in a single wood frog clump, and they hatch in two or three weeks into tadpoles, which transform into frogs in July.



The spring peeper, our smallest frog at only an inch in length, is also our loudest. Its high-pitched, bird-like whistle can be heard a half-mile away. The peeper's loudness results from its ability to distend its throat into a huge bubble almost as big as the frog itself, essentially creating its own sound amplifier to attract a female. Finally spotting one of these shy tiny tree frogs by the light of a flashlight while thousands of others produce an ear-ringing chorus is certainly one of the thrills of visiting a Pocono wetland on an evening in early spring.

Unlike the wood frog and spotted salamander, the peeper continues its breeding activities until the end of Spring, when it finally returns to the woods. As a result, it shares its aquatic habitat with other species of Pocono amphibians which follow in an orderly, predictable sequence as water temperatures warm up and become more conducive to each species' specific temperature preferences. In mid-April, the spotted pickerel frogs begin breeding, the males soliciting their mates via low, "snoring" calls. By the end of April, after a few 70-degree days, the American toads enter the waters for just a few days, filling the air with musical, sustained, bird-like trills created in their huge throat bubble. In May, the shorter, melodious trills of the gray tree frogs burst through the air, especially on humid or rainy nights. Finally, the last two frogs to breed, the green frog (which sounds like the plunking of a banjo string) and the big bullfrog (named for its deep, loud bellowing calls), don't reproduce until the water temperature is in the 70s, bringing the progression of the amphibians to a close in June.

Effect of Pollutants

Because of their thin, permeable skins, amphibians are greatly affected by pollutants with which they come into contact. Scientists have recently detailed declines of some species in our country, and some believe that pollutants in the air and chemicals entering the wetlands and ponds are to blame. Acid rain is said to be a factor contributing to decreases in populations of spotted salamanders and wood frogs in New England and New York's Adirondack Mountains. The destruction of wetlands, which these amphibians require for reproduction, has historically been the most serious threat to their survival.

John Serrao is a freelance teacher and author.

Wetlands as Natural "Sewers"

Lenore Miller

History shows us that the development of civilization is dependent on a source of fresh water. But over the centuries, as people began to live together in large numbers, the need for fresh drinking water became intertwined with the need to also remove the wastewater of that civilization.

As large numbers of people overloaded natural systems and waterborne diseases turned into epidemics, the need for better ways to protect water sources from wastewater became apparent. Civil engineers emulated the self-cleansing ability of waterways in nature, and sewage treatment facilities evolved. Most such facilities collect the wastewater and allow the natural bacteria of decomposition to "digest" the organic material, thereby cleansing it. They use various techniques to speed up the process, making it more efficient, and may even treat it chemically before discharging it into a convenient waterway.

Sewage treatment plants are expensive to build, and often the wastewater treatment facility must also handle stormwater run-off. This creates a burden on the plant, which often cannot cope with the sudden overwhelming amount of water that pours into the combined system. After a heavy rain, raw sewage bypasses the treatment process and pours directly into the river, bay or ocean.

Consequently, many municipalities look for better ways to deal with waste and storm water. One solution may lie in using preexisting wetlands, ponds and marshes. On Staten Island, for example, a long-term project, which is called the Bluebelt, has been constructed and is still being expanded to serve the needs of parts of the island. By using local ponds as "water holding" areas and a system of culverts and ditches, stormwater is diverted into these preexisting ponds where, as nature intended, the waters are absorbed or released slowly.

The crucial word is *preexisting*. The secret is not to sell these wetlands to private developers who would drain them, cover and build on them. The city of New York had to acquire some of this land. Even though this was expensive, it was still cheaper (and better) than having to dig up roadways, install sewer pipes, construct treatment plants, use chemicals, and so on.

Other areas of the island, where streams were paved over, are still subject to devastating floods after major storms; when it rains, the water has to go somewhere. By working with nature and not against it, wetlands perform their vital water-holding function. It is a most remarkable and clever system. As an extra bonus, the area where the ponds are located gets a beautiful natural habitat for aquatic species.

In some parts of the country, wetlands are being used for treatment of sewage. Although not suitable for every wetland system (it could seriously destroy or degrade the other purposes for the marsh), there are some selected locations for which a natural or an artificially constructed wastewater treatment system uses natural processes that also tap the abilities of the plants, soils and microorganisms to remove contaminants from wastewater.

In the 1980s, I visited such a marsh in the town of Arcata in California, about 280 miles north of San Francisco. The population of 15,000 supports the concept which has served as a model for other communities who wish to promote this route to sewage treatment. There, holding ponds and lagoons use native plants, soils and microbes to do the work of turning the sewage water into clean water.

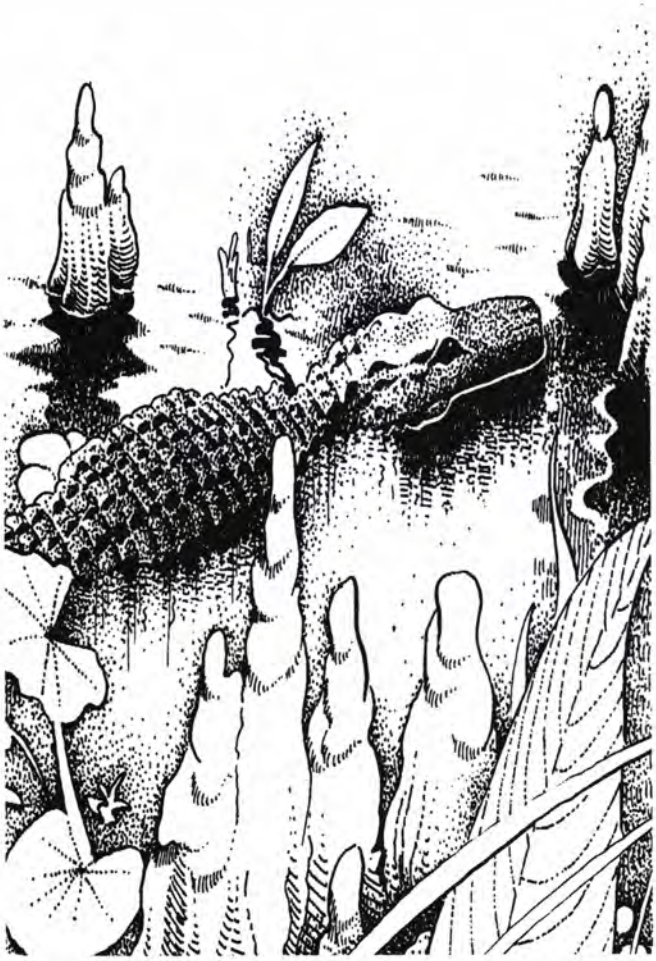
The town also ended up with a beautiful natural habitat for birds (over 200 species) that's a major stop on the Pacific flyway. Because it has been so successful, an interpretive center will be built there to further explain and expand the marsh as wastewater disposal ideal.

This technique is relatively new (two decades) and probably wouldn't work where population numbers are too large. Nevertheless, such systems are being carefully studied by municipalities all over the world. Each site must be custom designed for the locale and the specific water drainage, terrain, population, current and proposed industry, etc.

If you are interested in learning more about these wetlands-as-wastewater-treatment facilities or to teach about them (high school or college level), contact your regional EPA office and request publication #EPA 832-R-93-005 (published September 1993), *17 Case Studies:*

Constructed Wetlands for Wastewater Treatment and Wildlife Habitat. Find out if there are any facilities within field-trip distance (California has four sites; Oregon, Michigan, Arizona and Florida have two; Nevada, Illinois, South Carolina, Alabama and Mississippi each have one). There may be others under development too.

Like any other applied technology involving natural systems, it is far easier (and cheaper) to protect rather than to restore degraded ecosystems. That is another argument in favor of protecting the existing wetlands — if we destroy them in the name of progress, the cost to restore them may be prohibitive.



Montezuma National Wildlife Refuge

Restored Wetlands — for Ducks and Other Birds

Margaret A. Barker

Never have I seen so many Great Blue Herons in one place at one time than at the Montezuma National Wildlife Refuge this past summer. As I drove the auto route, I noticed these grand, gray-blue, long-legged waders lining the marsh edges while hunting for fish. Sometimes I'd spy them in flight, sailing in their crooked-neck, prehistoric style over the still and shallow water. I watched several fly straight to the heron rookery, a twelve-year-old nesting area in deciduous trees on the refuge's north end, where they landed on and in their individual big stick nests — an incongruous and rather humorous sight.

Great Blue Herons are doing well at Montezuma. And so are plenty of ducks and other birds and a diversity of living things. But that's only because the lands, or wetlands, have been able to make a comeback of sorts.

Montezuma National Wildlife Refuge (MNWR), in the heart of central New York's Finger Lakes region, is one of the earliest examples of wetlands restoration. Situated 35 miles west of Syracuse at the north end of Cayuga Lake, it is bordered on the southeast and north by segments of the New York Barge Canal System. For a couple of decades, the refuge area, known as the Cayuga Marshes or Montezuma Swamps, was a nearly waterless section of that canal system.

Between 1910 and 1915, as part of a Barge Canal extension, a lock was built at the north end of Cayuga Lake. A dam was also constructed at the lake's outlet, the Seneca River, the source of replenishing water for the Cayuga Marshes. The two projects drastically altered the area. With its water supply mostly cut off by the dam, and with the marshes drained, farmers moved in to try to cultivate crops on the new muck-lands, but their efforts failed in the deeper southernmost portion of the marsh; water tables were high there and muck levels shallow.

Those southern marshes were unproductive mucklands for a little over twenty years. Two events in the 1930s, the "great drought" and the Great Depression, indirectly got water back on the swamp site again.

North American waterfowl populations, especially those of ducks, had suffered severely during the Dust Bowl drought in the early 1930s. Duck breeding grounds — marshes and potholes — had dried up. Following on the heels of a popular duck conservation movement, the U.S. Fish and Wildlife Service created duck stamps to sell to duck and goose hunters. The revenue bought millions of acres of prime wet waterfowl breeding habitat — the best way to ensure future duck and goose populations.

Between 1937 and 1941, using duck stamp funds, the U.S. Fish and Wildlife Service purchased 6,432 acres of the former Cayuga Marsh and created the Montezuma National Wildlife Refuge. At the same time, the Depression-era public works organization, the Civilian Conservation Corps (CCC), was able to lend invaluable helping hands. For the sake of waterfowl, the mucklands needed to be restored to wetlands. The CCC crews built low dikes to impound waters of local brooks, and in turn re-flood at least part of the former marsh lands.

By 1943, waterfowl were using the newly created pools of water. Even so, refuge manager Gene Hocutt admits, "We've been able to bring back only a vestige of what was lost during the canal-building era."

Imagine what the refuge area was like in those days before human manipulation and attempted re-creation.

The area's geology is pure glacial history. Over ten thousand years ago, an ice sheet cut slowly southward along the valley of the old Cayuga River. When the ice melted, it left behind a huge, vast natural impoundment, a system of lakes including the Finger Lakes. An extensive 80-mile area of wetlands was created too, by the waters of the Seneca and Cayuga rivers at the north end of Cayuga Lake up to Lake Ontario.

Records from Jesuit missionaries, working among the Cayuga Indians before the canals, describe fall migration at the marsh lands as a time when ". . . sunlight over the marshes was shut off by clouds of duck and geese." More recently, Steve Kelling, Central New York editor of the New York State Federation of Bird Clubs publication, *The Kingbird,* put it this way: "Montezuma goes nuts in fall! The diversity of birds is a spectacle, a biological paradise."

Despite its duck stamp beginnings, MNWR doesn't manage the 6,432 acre site today only for ducks, but also has in place a plan exclusively for shorebirds. Refuge manager Hocutt says not all refuges do this, but that it "makes sense" to manage for these birds who "probably have the single most limiting habitat." Hocutt adds, "Shorebirds should be a special concern. Those shallow zones that they like are the first to go dry, to be dammed, and to be filled. We make sure they have habitat here — 220 acres worth right now — during fall and spring migration."

Inland migratory shorebirds show up in late summer and early fall. They are the small- to medium-sized group of wading birds that include the plovers, sandpipers, curlews, godwits, dowitchers, and dunlins, birds that probe for food in mud or shallow water. They stop to feed and rest before heading to wintering grounds in the West Indies or South America. If conditions at the refuge weren't just right, these birds would have a tougher time making their southerly trips.

The legacy of locks and dams and subsequent dike-building has left the refuge with six major impoundments. One of them, May's Point Pool, is an excellent shorebird site. Water levels at May's Point are deliberately manipulated to expose those bountiful, food-filled mud flats which attract migrating shorebirds. Another site, Benning Marsh, was created in 1991 specifically to provide seven additional acres of shorebird habitat. Future plans call for creating even more shorebird stopover habitat, and to acquire and protect many additional acres of wetlands.

Bald Eagles have called Montezuma home since a 1976 eagle reintroduction program — the first of its kind on the North American continent. With the exception of two years, starting in 1987, young eagles have fledged in Montezuma nests. Adults built a second successful nesting territory in 1994.

Other birds call the refuge a temporary home, a stop along the Atlantic Flyway. The numbers are impressive: up to 65,000 Mallards and Black Ducks in

the fall; over 65,000 Canada Geese and thousands of Snow Geese each spring.

Regional *Kingbird* editor Steve Kelling recalls one dawn in the fall of 1994 when he saw tens of thousands of swallows leave their marsh roosts in the early light, and counted sixteen species of shorebirds, twenty species of ducks, herons, egrets, Sandhill Cranes, and three species of falcons. He marvels, "I don't believe there is a location around with that kind of diversity, with that concentration of waterfowl at that time of year. Enjoy it." Hard to believe that for a while during this century, migratory birds, including thousands of ducks, found only muck at their stopover feeding and resting grounds. Now they return to this Central New York site each spring and fall and find habitat to their liking, at a place recreated for them in the second part of the 1900s: the Montezuma National Wildlife Refuge.

Margaret Barker is a lifelong naturalist who spent over a dozen years as a radio/TV news reporter before returning to school to study natural history and environmental education. Currently she serves as the Coordinator for Project FeederWatch at the Cornell Lab of Ornithology.



Illustration Courtesy of The National Audubon Society

Corkscrew Swamp Sanctuary

Helen Ross Russell

Corkscrew Swamp Sanctuary is one of the best known and most visited of National Audubon Society's one hundred sanctuaries scattered over the United States. This is partly due to its location, just north of the Everglades near a main tourist highway and in a section of Florida that attracts "snow birds" (winter residents) in great numbers.

It is also an exceptionally beautiful site with a variety of ecological areas, including the pine flatlands, the wet prairie (a grassed and herbaceous area too wet for pines and too dry for cypress), areas of pond cypress (a small version of cypress limited by habitat) and finally the giant bald cypresses, often 500 or more years old with cypress knees arising around them. Other plants and animals differ according to these different locales. One can safely watch a water moccasin from the boardwalk or, if you move quietly and slowly, see a limpkin treading across large patches of water lettuce searching for snails.

Remains of crayfish scattered on the boardwalk tell of feeding of racoons, opossums, wading birds and other animals. The flash of bright blue as the southeastern blue-lined skink dashes down the boardwalk,



the call of a tiny cricket frog or the grunting of the large pig frog (whose legs are a commercial item in areas outside the sanctuary) all are special events, along with countless others, to people from outside the swamp.

The annual nesting of the wood storks is another cause of Corkscrew's fame. This nesting site is extremely important because wood storks are habitat specific and need large areas to congregate for nesting. The nesting colony at Corkscrew is the largest in North America for this endangered species.

Factors that threaten the Wood Stork are:

- Drought in the wet season will impact fish reproduction.
- Heavy rain during the dry season will disperse the fish and make hunting difficult.
- Strong winds can blow down nests.
- Manipulation of water levels by water management programs (channels, dikes and impoundments).
- Drainageof wetlands for agriculture and development removes large areas of feeding habitat.
- Water pollution can contaminate fish, and toxins become more concentrated in the storks because they are at the top of the food chain.
- Noise pollution: human disturbance in the nest area may cause both parents to flee.
- Decline in suitable nesting areas. CSS is especially important in providing the large cypress trees preferred by wood storks.
- Habitat destruction in general has made survival very difficult. Since 1900 over half of the wetlands in southwest Florida have been drained.

As we read this list, it becomes obvious that wetlands do not stand alone. Corkscrew Swamp is named for the winding, twisting river that flows into it. The swamp itself is a shallow, very slow moving part of that river. Obviously it is both dependent on and serves as a reservoir for the land surrounding it.

As First Nations Peoples said long ago and as we are also beginning to recognize, all life is a circle, and wetlands are a big piece of that circle.

Florida has exceptionally many wetlands, and

from earliest times of European settlement they were considered a liability. The philosophy of "drain it, straighten it, use it for a dump, fill it in" has dominated real estate, Army engineers, agriculture and political thinking. To some extent this thinking still goes on. Only a drop in sugar prices stopped the onslaught on the water being diverted from the Everglades for irrigation and saved this unique area from total destruction.

The Crew Trust (Corkscrew Regional Ecosystem Watershed Trust Inc.), initiated in part by Corkscrew director Ed Carlson and ANSS board member Bill Hammond (long-time director of the Lee County Schools Environmental Education program), was formed to purchase wetlands and surrounding areas in Collier and Lee counties. It is an advocacy, educational and land acquisition group. Land acquired is held in the South Florida Water Management District. More land is purchased in Lee than in Collier County because the citizens of Lee passed a 2 mil tax on real estate sales for that purpose and have a more positive outlook on wetlands. This may well be a reflection on the Lee County Schools educational program which has brought students out to the Fort Myers swamp area for more than two decades.

Teachers in Lee County have also been educated on using the school grounds and local areas for teaching before they go to the swamp area with its boardwalk and teaching stations. Places like Corkscrew and the Fort Myers school boardwalk are important tools for educating the community. Children bring their parents to these sites and pass on their knowledge and enthusiasm. Children grow up to be voting citizens.

No article about Corkscrew would be complete without mentioning the Living Machine. This state-of-the-art sewage system is the type of development described in Lenore Miller's article on wetlands as sewers. At Corkscrew human waste moves through two tanks of anaerobic bacteria, into two aerobic ones, and from there, as a pathogen-free, odorless clean affluent into a planted area. There in beds of ferns, orchids and other swamp plants the remaining solid particles are removed. Ultimately the water is drawn off the end of the beds, tested and chlorinated. (Florida law requires all water going into buildings to be chlorinated.) It then re-enters the building to be used in flush tanks. The total process is silent and odorless. Only one problem; it must be fed. During the rainy season, when few people come to the swamp, it is fed dog food.

Helen Ross Russell is an environmental educator and author who has edited the ANSS journal for the past fifteen years.



The Okefenokee Swamp: A Letter – A Journal Entry – Thoughts

Helen Ross Russell

Statesboro, Georgia
August 1952

Dear Mother,

The daily "quacking" of *Hyla versicolor* in the bush just outside the open window of my classroom was not only a source of amusement and a subject for teaching (more than half of my class had never seen this little tree frog) but amazingly it opened doors for a trip I had dreamed of after studying Herpetology at Cornell under A. H. Wright. A trip to the Okefenokee!!

When I went to Cornell in 1946 Dr. Wright and some of his students had just completed the recording of frog and toad songs in that swamp. After we made the acquaintance of *Hyla versicolor* I played the records and asked how many of my class had been at this wondrous place. None had but one was the daughter of the director there. From him Frieda and I received a letter of introduction to take to the Steven Foster fishing camp. Along with the letter Mr. Peagler told us about a three day trip that would be conducted into the heart of the swamp next week for a group of Penn State professors. Unfortunately, as ladies we could not join the group (even though we were professors). Ladies by definition wear frilly clothing, are afraid of insects and avoid mud and swampy places. So this weekend we set forth to see as much of the swamp as possible. To do this Frieda and I drove over 20 miles of the worst road I have ever encountered. The ruts were so deep that the bumper plowed sand; the sand so loose that to get out of the ruts meant skidding and sticking as in snow. The bridges were boards laid lengthwise across streams and ditches with space in the middle, empty space! For 10 miles no humans at all, no houses, no nothing but frogs and palmettos.

Then a hunting and fishing camp — and another seven Man-forsaken miles. Then the Steven Foster fishing camp. We arrived with our note of introduction from Mr. Peagler, which was probably just as well — Mrs. Barton, the operator of the restaurant, was dumbfounded. Apparently two "girls" alone were unheard of in the heart of the Okefenokee! It had happened once before, two middle aged women from N.C., but they were lost. Mrs. Barton gave them her bed because they refused to stay in a cabin.

The next morning we rose at 6 and breakfasted. We decided that this was one of the spots that the "How to get a Man" articles referred to. There were four women in the D.R. — two wives and us and probably twenty men. Then at 7:00 we boarded the boat with our guide and rode 15 miles into the swamp. Some places we had to duck under vegetation but most places the runs were fairly wide and clear overhead. We saw dozens of alligators, fish jumping all over the place, no snakes. Landed on an Island in Big Water and rested until a boat of fishermen and Mr. Barton joined us. Talked a while then back to home base. It started to rain just as we got in, so we landed at 1:00 p.m. drenched to the skin and considerably sunburned, having eaten man-sized Bacon, Tomato and Lettuce sandwiches on the boat.

The day before we had stopped at the Waycross side of the tourist entrance and gone on a short boat trip. Our guide there had served as a double for one of the outlaws in *The Lure of the Wilderness* and had lived at Waycross all his life — so we had an interesting 1/2 hour with him. We also walked out into the swamp on the 3,200 ft. Boardwalk. Waycross and the fishing camp are about 30 miles apart, across the swamp, but we had to drive 80 miles to get there — 60 miles around the edge of the swamp and 20 over the dirt road into the swamp.

The swamp birds were magnificent! Egrets, herons and storks, we even saw and heard Whooping Cranes, something most of my ornithological friends cannot claim. They are almost extinct except for a few remote regions like the Okefenokee.

Now I must dress for supper. We're having company: Fielding Russell, the brother of the honorable Richard Russell, who may be the next Democratic candidate for V.P.

Love,
Helen

Journal Entry

August 1973

Getting into Okefenokee was certainly not the challenge that it was when Frieda and I made the trip in 1952. Today Bob and I drove over a two lane macadam road, bridges crossed the Suwannee River and its tributaries. A few families had joined the men in the Steven Foster fishing camp, but it still is basically a place where fishermen take off for some of the best fishing in the East, both in terms of numbers of species and numbers of individuals. With the new road many cars arrived in early morning.

Our five hour boat trip duplicated the one I had taken 21 years ago, except that we were shocked and depressed when we arrived at Billy's Lake, the place where fishermen congregate partly because of its many fish and also because it is the limit where boats can go without a guide. The shore and surface of the lake is littered with beer and soft drink cans, aluminum foil pans, Styrofoam containers and plastic bags.

Thoughts

August 1995

If people who have traveled many miles to see this place of rare beauty and/or to harvest fish from its waters thoughtlessly destroy the beauty, contaminate the water and endanger the fish and birds, what hope is there for our wetlands? And the problem is not confined to the Okefenokee, it is universal.

The last time we canoed in the Pine Barrens, we picked up two big bags of trash at the site where we stopped to picnic and were upset by the debris along both sides of the Batsto River, detracting from the beauty and frequently covering some of the very special vegetation of this remarkable ecosystem. When we arrived at the canoe landing, we asked what could be done and they replied, "We do our best. We put garbage cans out and on the one day each week that we do not rent canoes every staff person goes out in a canoe and picks up along the banks." The weekly collection is mind-boggling.

Obviously, an educational system is needed: A Contract with All Users of Recreational Areas, a contract signed by all persons who use any corner of Planet Earth — wet or dry — a promise to love, to care, to protect, to leave the site in as good or in better condition than when they arrived. Once we develop this attitude to Mother Earth, The Good Earth, to Earth, our home, many other problems would be solved.

"Once you build a highway through a wild place you have lost the wilderness."

— Ansel Adams

How to Save a Wetland

Candace E. Cornell

With the ever-expanding urban sprawl, most undeveloped areas around our towns and cities are wetlands. These swamps and marshes are targeted by developers for tract housing, landfills and industrial parks. My hometown in central New York is no exception. Recent local controversies over the siting of a landfill, a housing development, an airport expansion and an industrial complex all involved wetlands and were prompted by environmentally concerned citizens.

The "Briarwood" wetland lies between my house and the Cornell Laboratory of Ornithology's Sapsucker Woods Sanctuary (most of which is also a wetland). This wet woodland has long been a favorite neighborhood site for birding, collecting butterflies and exploring nature. When we moved into our house ten years ago, we were told that a local developer owned the 24 acres behind our house and planned to develop it in a few years. At that time, I was engrossed in my job and raising a young family. My reaction was to plant a border of trees along our property line. It wasn't until a few years later that the sound of bulldozers alerted me to the fact the wetland was about to be decimated.

A quick look at a topographic map of this area showed that this seemingly isolated wetland (approximately 6-7 acres), like many other small wetlands, was a part of a larger wetland mosaic stretching for several square miles. This mosaic encompasses a number of wetlands of varying sizes and is recorded on state and national wetland maps. Research has shown that in mosaic systems, all of the wetlands are degraded if parts of the complex are destroyed. Clearly this small wetland was important for its own sake as well as its hydrological relationship to the water table in Sapsucker Woods Sanctuary wetlands. Soil survey maps indicated that a hard, impermeable fragipan of soil below the ground created a perched water table near the surface supporting the wetland hydrology of this mosaic. The survey also confirmed the presence of hydric soils in this area. I felt strongly that any development in this sensitive area would destroy the wetland at the Briarwood site and possibly jeopardize parts of the Sanctuary.

A little research in Town Hall revealed that the property owner had been granted a subdivision permit by the town four years earlier. I read the State Environmental Quality Review (SEQR) section of the subdivision application and found there was no mention of any wetlands in or nearby the development site. There were also several other key questions regarding drainage answered incorrectly. Quite surprisingly, the town planning board had issued a sub- division approval without a detailed Environmental Impact Study.

My frustration mounted when I learned that the four-month statute of limitations for legally challenging the subdivision approval had long since passed. I found it hard to believe that this approval could not be reevaluated in light of new information on the existence of wetlands on the property. Without quite knowing what I was in for, I plunged into a long saga of dealings with the U.S. Army Corps of Engineers, the New York State Department of Environmental Conservation (DEC), the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, state and federal representatives, the town board and planning board and legal counsel to explore the options available. I emerged with a hearty lesson in civics, a working knowledge of our federal and state wetland regulatory programs and very strong opinions on how to improve wetland preservation.

The Corps has responsibility, under Section 404 of the Clean Water Act, for issuing or denying applications to fill wetlands. In 1986, the Corps dispensed with small wetlands en masse by issuing nationwide permits. Unless state or local laws are more restrictive, these nationwide permits grant blanket approval to anyone who wants to fill up to one acre of wetlands.

Isolated wetlands of one to ten acres may still fall within the provisions of the Corps' nationwide permits provided the developer sends the Corps a letter of intent to fill these larger areas. The Corps then decides if there will be a significant impact warranting a full-scale project review.

A full inter-agency review requires notification of the U.S. Fish and Wildlife Service, EPA and the state's fish and wildlife agency. The EPA shares responsibility with the Corps for administration of Section 404 and

can impose heavy penalties on anyone filling a wetland without a permit. The seriously understaffed Corps has to spend its limited time and budget on large projects and rarely conducts on-site inspections of wetlands less than ten acres. Unless there are objections from state or local governments, this usually clears the way for the developer. In most years, 90 percent of the nationwide permit applications are uncontested.

The Corps also issues individual permits for discharges or fill activities that will result in major impacts, involve more than 10 acres of wetlands or occur in the headwaters of navigable streams. Individual permit applications require in-depth inter-agency review with opportunities for public comment. Decisions are based on whether the societal benefits of the project outweigh the impact on the wetlands

With every passing day, the developer's bulldozers plowed more of the fern-covered wetland behind my home. I repeatedly called the regional Corps regulatory and enforcement office, telling them that the wetland was being destroyed illegally. Meanwhile, I took photographs of the area to document the wetland in the event the bulldozers finished their job before the Corps arrived. Although my nagging did not help me win a popularity contest at the regional office, it did result in Corps field workers investigating the site. The Corps declared the Briarwood site a wetland under their jurisdiction and cited the landowner for illegally filling a wetland without a federal permit. They ordered the developer to cease and desist construction activities and file for a wetland permit.



With the support of my neighbors and student members of the "Cornell Greens," we collected over 3,200 signatures of local residents requesting that this subdivision approval be reevaluated based on new information concerning the wetland and other environmental information. I sent copies of the petitions to the Corps, the DEC, the governor and state and federal representatives to demonstrate the intense local opposition to any further development in the Briarwood area. We also presented the petitions to the Town Board and Town Planning Board at one of the many local government meetings we attended. I gave each board member an information package containing a cover letter highlighting the errors in the subdivision application, the local soil map showing the hydric soils, and copies of the state and federal wetland maps showing the wetlands. The packet also included articles explaining the importance of wetlands and letters of support from the community and biologists at Cornell University.

We barraged the local newspapers with letters to the editor and opinion pieces about the value of wetlands and asking for support to save this one. We seized every opportunity to present our case to local environmental community groups, service organizations and outdoor recreation clubs. Good use was made of any available local radio and television talk shows. Being chronically shy, speaking at public meetings was a challenge. However, I quickly realized that my determination to save this wetland overshadowed my shaking knees. This had truly become a crusade for me aimed at educating the public about the vital functions and values of wetlands.

Protecting our environment is a high-stakes game. During this controversy, the developer had my husband arrested for trespassing, although charges were later dismissed with condolences from both the district attorney and the judge. The developer then used a more direct approach by serving me with a 15 million dollar lawsuit. This type of civil lawsuit, nicknamed "Strategic Lawsuits Against Public Participation" or "SLAPP" suit, is an increasingly popular defense used by developers to quiet citizen opposition. (The New York State Assembly has since passed legislation to thwart "SLAPP" and other frivolous lawsuits intended to silence activists.) The lawsuit initially was a shock. True to the nature of SLAPP suits, it was intended as a threat and was never brought to court.

As is the case with many other environmental controversies, our opposition was voiced too late. To be effective watchdogs, the public must become involved early in the decision-making process. The primary

reason why this and other projects slated to fill in wetlands are approved is that local officials and the public are not aware of the values of wetlands, especially small ones. In the case of this project, the town planners thought wetlands had to be at least 12.4 acres in size to be regulated — the jurisdictional minimum for the state wetland regulatory agency.

In reality, the Corps' primary function is to grant development permits, not preserve small wetlands. The developer was granted a wetland fill permit with conditions to spare sections of the wetlands. Curiously, the developer was never penalized by the Corps for filling a wetland without a permit.

A tremendous amount of good came out of this controversy. My neighbors and our student supporters learned they had a voice in local government. The town is now keenly aware of the importance of its local wetlands and has adopted a wetland protection policy. Numerous other wetlands have been saved from the bulldozer. Perhaps most importantly, the community and local officials have developed an appreciation for our local wetlands. Our wetlands are now seen as assets rather than swamps to be filled and forgotten.

The lawsuit only served to fuel my conviction to fight for wetlands. I was appointed to serve on both the town's and county's environmental advisory boards and authored the wetland policy adopted by the town. Turning the tables around, I now serve on the town planning board and strive to safeguard the environmental quality of our town with every planning decision we make.

Protecting our environment is in the hands of our citizens. Public sentiment, used wisely, strongly influences the decisions of local elected officials. Environmental advocates must band together and speak out at public governmental and planning meetings. Citizens need to scrutinize development proposals presented to their local governments (available under the federal Freedom of Information Act) and fight vehemently to promote ecologically sound decisions.

The best way to permanently preserve local wetlands is to enact protective municipal ordinances in your own community. Most states allow such regulation provided that the ordinances are at least as restrictive as the state and federal laws. Local residents have the most to gain by protecting their wetlands and the most to lose if the wetland functions are destroyed. Municipal wetland ordinances give communities full responsibility for wetland management and allow them to tailor restrictions to specific wetland types.

Residents and local public officials are in a position to closely analyze the present and future needs of the community and plan for the wise conservation of the town's irreplaceable wetland resources. Municipal ordinances also facilitate accurate wetland mapping and delineations, integrate resource management with land use planning, streamline wetland protection permit procedures for residential and commercial proposals and help in designing site plans that integrate wetlands into the landscape.

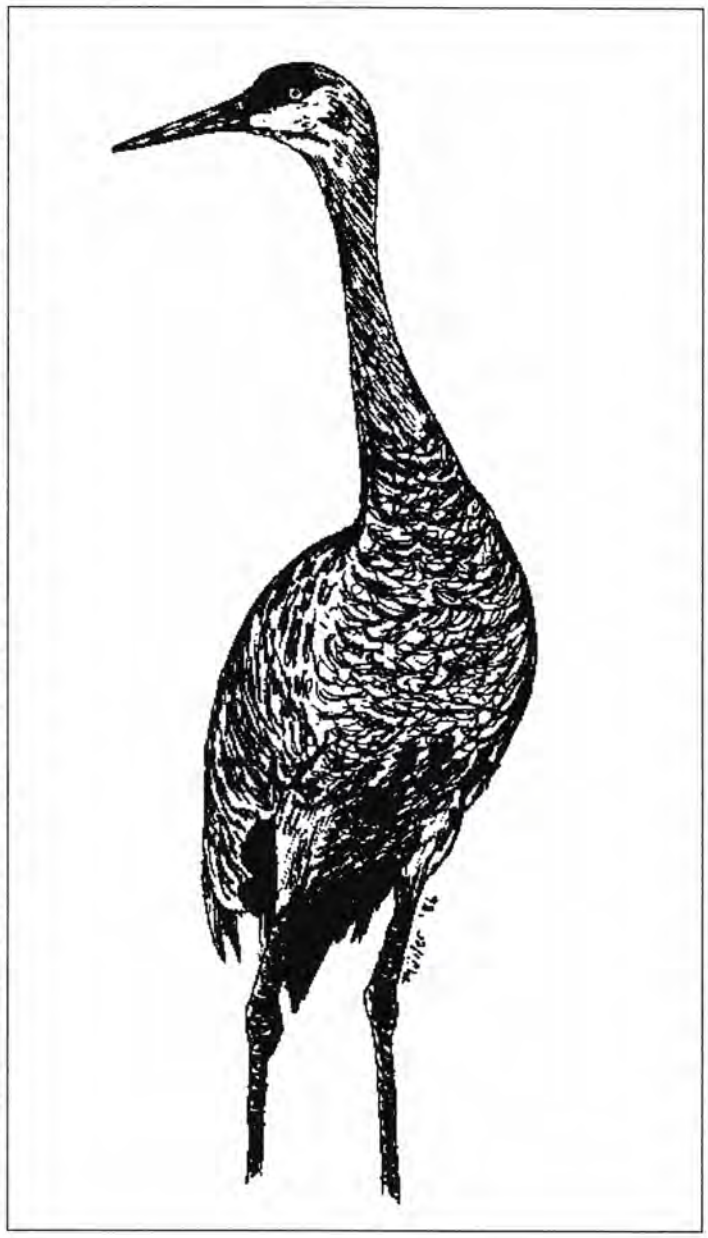
There is no single guideline for saving wetlands except to address the issue early and use every tool available. Wetland advocates should be wary of concessionary offers to mitigate impacts by purchasing other wetlands or creating new wetlands elsewhere. Mitigation is a last resort, an answer only when nothing else works and the wetland will be lost anyway. If a developer agrees to purchase another wetland for preservation, it must be one of similar but higher function and value. Most proposals to create new wetlands have minimal odds for success. There are too many variables and too little scientific monitoring data to indicate that restored or created wetlands will succeed. Clearly, there is no substitution for the original natural wetland system. If mitigation is accepted, the "replacement" wetland should be more productive than the one being lost and should be closely monitored for many years.

Small wetlands continue to be drained. Developers, driven by economic pressures, match their building plans to any scrap of open space. Nothing will be gained by automatically opposing all development — some projects are necessary for the benefit of society. In spite of growing development pressures, environmentalists can further wetland conservation by working for sound wetland laws and zoning regulations. We can campaign for environmentally conscious representatives on planning boards and in legislatures. As long as citizens are willing to stand up for their beliefs, wetlands will no longer be sacrificed.

Wetlands and the Constitutional Balance

Candace E. Cornell

With over half of the wetlands in the continental United States destroyed, the arrival of the 1972 Clean Water Act (CWA) signaled an end to this national tragedy. The CWA, considered one of the most successful federal environmental programs ever passed by Congress, went a long way toward cleaning up our nation's waters and protecting our remaining wetlands. The CWA prohibited industries and municipalities from dumping raw sewage, toxic chemicals, animal waste, oil, and other pollutants into the nation's lakes, wetlands, and rivers. The CWA also recognized the vital role that wetlands play in flood control, water purification, and providing habitat for fisheries, waterfowl, and an estimate 43% of our nation's threatened and endangered species.



Although riddled with its share of loopholes, the effects of the CWA were dramatic. With federal assistance, cities and industries built modern wastewater treatment plants. Waterways once chocked with weeds from phosphates and nitrates reopened. "Dead zones," such as New York Harbor and Lake Erie, once again became productive fisheries. The rate of wetland loss and destruction even decreased substantially from 1982 to 1992. We finally were moving closer to fulfilling the true spirit and intent of the CWA: "to restore and maintain the chemical, physical, and biological integrity of the nation's waters."

That is, until May 16, 1995, when Congress, under fire by developers, oil and gas industries, private interest groups, and lumber companies, passed legislation (Bill H.R. 961) to reauthorize the CWA with provisions to substantially weaken its scope and strength. Now the ball is in the Senate's court. Chances are good that the Senate will not reauthorize the CWA this year and that H.R. 961 will be laid to rest. However, the Senate has proposed a wetland reform bill S.851, which incorporates many of the same assaults on wetland protection programs proposed in H.R. 961. If the Senate approves S.851 and it is ratified by the Congress, this legislation would amend the wetland protection aspects of the CWA.

If this amendment is passed, the integrity of the CWA as well as most federal and state wetlands regulatory programs will be seriously threatened. The current wetland and water quality guidelines and standards emphasize public health and environmental considerations. In contrast, the proposed legislation reverses these scales by making costs to industry more important than protecting our health and the environment.

This new pro-industrial legislation will mean the end to wetland protection. An impending narrowing

of the definition of "wetlands" would simply eliminate half of our remaining wetlands from federal regulation. Wet meadows, woodland wetlands, bogs, floodplains, and Alaskan moist tundra could become exempt, resulting in a tremendous loss of habitat for hundreds of wildlife species and their beneficial functions as sponges for flood water storage and in groundwater filtration. The remaining wetlands would be classified according to their values. This costly and imprecise scheme would throw away lower-valued wetlands and weaken standards for activities that would destroy the medium- and high-valued wetlands. To ice the cake, a "takings" clause would force taxpayers to reimburse wealthy corporations and other landowners any time a condition or a denial of a wetland fill or dredging permit reduced the value of "the affected portion" of a piece of property more than 20%.

What difference does a day make? While the congressional representatives were putting the final touches on H.R. 961, a group of legal and scientific experts convened by the National Academy of Science's National Research Council was finishing their report on the science of identifying and delineating wetlands. Congress had requested this report in 1993 to resolve the confusion about wetlands. Although the National Research Council's committee had aimed for a December 1994 completion date, the report was not given to Congress until May 9 of this year. Efforts to postpone wetland reform until after the National Research Council's report had been studied were thwarted. Had the Congress taken the time to read this report and incorporate its findings into their CWA reauthorization, the product might have been dramatically different. The National Research Council's report supports and slightly expands the wetland definitions currently embodied in federal regulations. The committee also advocates, with a few critical additions, the current regulatory practices for characterizing and delineating wetlands.

As it stands, the current attempt to reauthorize the CWA, especially the sections addressing wetland regulation and preservation, is unscientific and threatens our hard-won progress to protect wetlands, water quality, and wildlife habitat. What can you do? Write or call your congressional representatives and senators in Washington, D.C., urging them to study the National Research Council's report on the science of wetland delineation and defeat S.851 and any other legislation that threatens to weaken protection of our nation's wetlands. Wetland legislation usually originates from the Senate's Environment and Public Works Committee. Send encouragement to Senator John Chafee, Chair of the Environment and Public Works Committee, to continue his efforts to protect our nation's wetlands. Also, urge President Clinton to uphold his promises not to compromise our nation's wetland protection policy. To obtain the telephone numbers and address of legislative officials, call the Capitol switchboard at (202) 224-3121.

Defining Wetlands

The definition of wetlands in the National Research Council's report is: "A wetland is an ecosystem, that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development." This report also emphasizes the importance of hydrology: "Of the three factors that characterize wetlands, water has special status because neither the characteristic substrates nor the characteristic biota of wetlands can develop in the absence of specific hydrologic conditions."

Wetlands Laboratory at Horseheads School District of New York

Marty Strong

The Horseheads School District recently received a Project Wild Action Grant. The funds are being used to enhance a wetlands area located on school grounds. The students have set goals and will be involved with completing those goals. A "Wild School Site" will enable the students to experience hands-on learning which will reinforce classroom instruction. My fifth grade students and I have been visiting the wetlands at least once a week. They look forward to our visits and look for clues as to the day we'll go. On our visits, we usually pick up litter along the way. Everyone really gets into the wetlands experience. Future plans include planting wildflowers, more trees, bird feeding stations and bird houses.

Some goals of the Wetlands Laboratory Project are to promote in each student an understanding of the important role that wetlands play in flood control, erosion control, wildlife habitat and water purification.

The four main objectives of the project are:

1. to provide access to a marsh that will serve as an outdoor laboratory
2. to plant native New York vegetation and install nesting sites that will attract and support birds and other wildlife
3. to conduct science classes in the marsh to identify plants and wildlife
4. to conduct hands-on science activities

The project is focused on a small marsh located behind the High School and Center Street Elementary School. Wooden walkways and docks will be constructed to provide access to the area. Nesting sites will be constructed. Students in grades nine through twelve have helped design the access areas. These students are enthusiastically planning to build the docks and walkways, select and label appropriate vegetation, and develop nesting areas. Fifth grade students will design a planting plan and contribute to planning for hands-on projects. The Horseheads Youth Bureau is building an "Ecology Walk" on adjacent town property. By coordinating our projects, both the schools and the community will have a larger and more ecologically diverse area for the study and enjoyment of natural habitats. The Community Foundation of the Elmira-Corning area has offered money in matching funds for our Wetlands Laboratory. Both the Community Foundation's funding and the Youth Bureau's collaboration represent valuable community involvement and commitment to the success of this project.

The project will benefit both high school and elementary students by actively engaging them in environmental science and by encouraging them to participate in protecting the environment. Hands-on activities require a level of participation that is not always possible in a classroom, and students of all achievement levels benefit from integrating science with language arts, math, art and physical activity. Concepts such as food chains, water cycles and energy flow come alive when learning takes place in a natural laboratory.

Wildlife will benefit from the project, both immediately and in the future. As students build nesting sites and introduce useful native plants that benefit a small wildlife population now, wildlife will gain strong advocates for future preservation and protection.

The schools and the community as a whole will also benefit from this project. By collaborating with the Town of Horseheads to provide an educational resource for adults as well as students, this project brings the value of wetlands to the public's attention. On-going educational projects in future years will remind the community of the importance of preserving wetlands and other natural habitats.

As well as learning about ecosystems, fifth graders will be able to observe prey/predator relationships, the water cycle, food chains and succession. The students will also write and produce an ecology play about wetlands which will be held yearly during Earth Day Celebrations.

Wonders of Wetlands

Steve Melcher

Kettle Hole Ponds

Make your own kettle holes. Place some ice cubes, well spaced, on the bottom of a pie plate or similar dish. Fill the plate with coarse sand and soil covering the ice cubes. Stand the plate on a level surface. As the ice melts, crater-like hollows will form in the cubes, with a mini-mere at the bottom.

Hitchhiker's Guide to Wetlands

If you clean the mud from a pair of boots after wading through a wetland, a number of wetland weeds and organisms will grow if immersed in water. Under normal conditions, *Daphnia* (water fleas) are female and reproduce by parthenogenesis (from unfertilized eggs). If conditions get rough, through overcrowding or the environment drying up, some of the females produce male offspring. These males then fertilize other females, which produce ephippia, or eggs in a resting stage. The ephippia can still hatch after a resting period of several months and can even survive after drying out. Some inhabitants of wetlands like the fairy shrimp (*Chirocephalus*) produce resting eggs which actually require a drying-out period before they will hatch after re-wetting. The fairy shrimp may travel many miles in the mud caked on the feet of wading birds. When the bird lands in her wetlands, the mud flakes off into the water, enabling the fairy shrimp to hatch out in their new home.

A German professor named Dr. Thienemann recorded the animals occurring in a tank of water over four successive summers, starting with fresh water each spring. He found 103 species occurred, only 10 of which were recorded in all four years. Remarkably, 8 of the species that were found were totally aquatic.

You can repeat Thienemann's experiment by placing a 50-gallon tank of water outside and regularly recording the inhabitants with the aid of a hand lens or microscope. Record only the different groups of organisms. Many of the species or genera are difficult to identify.

Survival in the Marsh: All Dried Up

Shrimp may actually depend on a drying time as part of their life cycle, but there are wetland organisms that have adapted other ways to cope with a dry environment. The summer of 1974 was an especially hot, dry summer on the Eastern Shore of Virginia. Some of the ponds in the salt marshes of Wallops Island were drying up. When a land ecologist friend and I poked around in the still damp center of a drying pond, we found a basketball-sized clump of fish. As the water evaporated without any rain, the fish found themselves occupying a smaller and smaller pond until finally there was nothing but a small damp spot in the center of a crater in the marsh. The killifish, which had once occupied the small pond, were now clumped into a drying mass. We took the clump of fish to a larger pond. As we peeled away the outer layer of desiccated fish, a few lucky survivors from the center of the mass fell into the larger pond to swim away.

Tidal Clock: Melampus

Melampus snails are pulmonate (having a primitive lung) that live in the tidal marshes of the East Coast. Since they have a primitive lung and cannot breathe under water, these snails have to "keep an eye out" for the tide. The snails feed on the algae and accumulated debris found on the salt marsh cord grass. As the tide comes in, they are chased up the stalk; as the tide goes out again, they can travel back down the stalk. If you bring a melampus into your home terrarium, you'll find that it goes up the stalk every six hours or so and then back down again, exactly with the tides from the salt marsh from which it came.

Photo Opportunity

One of my favorite photography subjects is the dragonfly. Dragonflies have a territory which they defend prodigiously. You can set up your tripod and camera focused on the flitting predator and be sure that he will return to the same spot in just a short time if you miss the shot the first time. Watch a dragonfly and try to estimate the size of its territory. How many "stations" does it have? How many encounters with other dragonflies does it have?

Life and Death of a Wetland

An old timer once took me by canoe to his favorite beaver trapping spots just over the border in Canada. He wasn't surprised to see that the pond where his winter shelter stood was now a marsh filled with reed grass and cattails (or reedmace as he called it). He had built the cabin just thirty years ago on the shores of a canoeable pond. "It was the fate of Brichman Pond," he said. He then explained how a pond eventually is colonized by emergent, floating and submerged plants. The pond basin is filled in with sediment and reed peat. Sedges invade the shallow margins, followed by willow and alder scrub. The pond basin eventually is completely filled in with sediment and peat from the different stages of colonization. A woodland of oak, willow, maple, alder and hazel is supported on the surface. Water loss through the leaves of these plants further dries out the basin.

Activity: Try to "age" the wetland plant communities by using the number of flowering plant species living together as an index.

1. Use a wire frame 25 cm square. This is called a quadrat.
2. Choose an area where you know there has been some form of management, and the date when it last occurred, to compare with an area whose history you do not know.
3. Sample a small area, about 30 meters square, from each habitat, taking 20 samples from each.
4. Record each flowering plant, as it occurs in each quadrat. If you do not know the plant, make up a name for that type of plant and stick to it throughout the experiment.
5. Check the plants as they occur in successive quadrats.

Then answer the following questions:

1. What are the dominant plants in your habitat?
2. Are they the same in each habitat?
3. How many plants are growing together in each quadrat? Determine the average.
4. Is the answer lower for the managed habitat? if not, try to determine what has happened in the unknown habitat to lower its species diversity.

A Wetland in Your Backyard

Find out about your local wetlands:

1. History: look at old maps to see if areas of wet lands have increased or decreased in the past century. There should be late-nineteenth-century maps marking wetlands available.
2. Present status: look for the wetland's present flora and any indication of their past management such as grazing, drainage channels and ditches.
3. Contact the Nature Conservancy or local natural history society to find out if there are any protected wetlands in your area.

Wetland Math Exercises

1. Salinity

Oceanographers express salinity in parts per thousand. This is abbreviated as ppt or 0/00. We use 0/0 to express percent or parts per hundred. Adding another 0 in the denominator gives us a way to express parts per thousand.

The average salinity of the oceans is 35 ppt. Here are some questions to help you think in terms of parts per thousands.

— A train with 1,000 cars, some with dry rocksalt and some with fresh water, traveled from the coast of India to Delhi. A cow crossed the track just before a huge ravine. The brakeman slammed on the emergency brake, causing the train to jump the track. Later the slurry of salt and water found in the ravine below the train wreck was found to have a salinity of 17 0/00. How many train boxcars were filled with dry rocksalt? How many were filled with fresh water?

— A beaker with 100 ml solution with a salinity of 35 0/00 is left in the hot dry sun for several days. If all the water has evaporated, how many grams of salt are left?

2. Rainfall

Wetlands act as sponges absorbing water that would otherwise flood our homes. This water is released gradually, causing far less erosion damage.

How many gallons of water passes through the storm drains of a 2-acre parking lot after a storm with 1 inch of rainfall? How many gallons of water pass through the storm drains of your town just from the roads?

Right Before Your Eyes: *Muskrats*

John Wiessinger

Muskrats are large rodents, family Cricetidae (cry-SEE-tih-dee), closely related to voles, lemmings and deer mice. (The Beaver, which may appear to be a Muskrat's closest relative, is actually in another rodent family.) The scientific name is *Ondatra* — apparently of Indian origin — *zibethicus*, Latin for "musky-odored." Muskrats have large, partially webbed hind feet and, like Beavers, have lips which close behind their front teeth, permitting them to chew underwater without opening their mouths.

Muskrats prefer water with an abundance of aquatic vegetation. They are mostly nocturnal, feeding largely upon plant roots, bulbs, stems and leaves of cattails, bullrushes, sedges, lilies and pondweeds. Piles of damp vegetation up to almost two meters high, the most obvious sign of their presence, are heaped in shallow water. Not all of these piles are houses; many serve as feeding stations around their territory. The actual muskrat house is usually large, with an inside cavity. As winter approaches, these houses are well insulated with extra mud and plant material. Often these winter retreats are frequented by several Muskrats; their combined body heat may keep the internal cavity as much as 20 degrees C above the outside temperature. Muskrats do not store much food, if any, but forage as necessary under the ice. If food is scarce, they may be forced to feed upon the inner walls of their houses. In areas such as streams, which aren't suitable for mounded-vegetation houses, they burrow into banks to excavate dens, and are much less noticeable.

Muskrats swim buoyantly at the surface, propelled by powerful strokes of their hind feet. The laterally flattened tail provides some propulsion and also acts as a rudder. Mink are probably the Muskrat's most important predator, aside from humans, but River Otters, Coyotes, Red Foxes, large owls and hawks also prey upon them. Like the Beaver, but without the same impact, Muskrats slap their tails on the surface to signal danger. Both sexes have musk glands at the base of the tail and use this odor to communicate with others of their kind. Strategic "hauling-out" places are liberally covered with musk, either to intimidate intruders or to advertise the availability of females. Their musk has considerable staying power and has even been used as a base for perfumes.

Why is it so important for aquatic mammals to be well insulated? Aquatic, warm-blooded animals lose ten or more times as much heat to the water as to the air. Retaining body heat is mandatory if they are to function in cold water. The problem is solved either by a layer of insulating fat just under the skin (whales and seals) or by a water repellent fur which does not permit water/skin contact. (Humans are unable to function long in water as warm as 60 degrees F!)

What are some ways aquatic mammals are "streamlined" for life underwater? Most have small appendages (front and back legs, tails and ears) and short necks. Their bodies are usually torpedo shaped, which makes them clumsy on land but swift in water. Some have flippers. Those with legs tend to have webbed hind (stronger) legs, and swim with front (weaker) legs tucked out of the way. Think of seals, whales, porpoises, beavers, muskrats, otters.

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Soaked to the Skin?

You might think a Muskrat is soaked to the skin most of the time. After all, it is almost always in or near the water, and its fur looks wet and matted. Not so! Except for a few small bare areas, its body is covered by an insulating layer of air trapped by the dense fur. This air layer keeps the Muskrat warm, dry, and buoyant.



Muskrat

"Musk rats" produce a musky odor, which they leave at various locations to stake out their territories. Muskrat is a durable and widely used fur, although it usually goes by a more glamorous name like "Hudson Seal."

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Right Before Your Eyes: *Cattails*

John Wiessinger

One of the most common and widespread plants across North America is the cattail, typically found in standing water near the edge of a pond. North American cattails grow in inland fresh and alkali marshes, and coastal fresh and brackish marshes from Alaska to the southernmost states. The cattail genus, *Typha*, is one of the dominant wetland genera around the world and would have been known to the settlers before they arrived in the New World. It may even have been the bullrushes in the story of Moses!

We don't readily think of the cattail spike as a flower, but that's just what it is. The male flowers at the top of the spike have 3 stamens each and produce clouds of pollen which are carried by the wind to the female flowers. Each of the many female flowers has one ovary. When ripe, the brown female portion, what we call the "cattail," splits, and thousands of fluffy seeds are released to be dispersed by the wind. But it is the vegetative propagation of the rhizomes (root stems) which accounts for most of the cattails' expansion. The long, creeping rhizomes penetrate the mud in all direction and hold the plant upright. Buds produced on the rhizome can each give rise to a new plant, and in quite a short time, a dense area of cattails may be produced.

The lower portions of cattail plants limit water movement and encourage silt accumulation. After their death in the fall, the fibrous leaves decompose slowly, adding an accumulation of debris to the bed and gradually raising the level of the substrate. Cattails grow in waters of various depths. They may be in areas only temporarily wet, at the edges of marshes in shallow water, or in water three feet deep. At depths over three feet, however, all species reach their physiological limits and are unable to grow. The edge between a cattail bed and open water becomes a tension zone. This plant edge–water interface shifts back and forth from season to season with changes in water depth, wind action and animal density.

Indians regularly used the cattail for insulation and perhaps even for diaper material. Some of their names mean "prairie chicken feather," "eye itch" and "roof grass." The early settlers also knew the uses for cattails — the leaves made rush seats, the down stuffed bed quilts, the brown heads served as torches, the pollen could be used to stretch a dwindling flour supply. And in World War II, cattail down filled life jackets and sleeping bags!

ACTIVITIES: If you have access to cattails, keep an eye on their spikes during the winter, and when you see one beginning to disintegrate, bring it into the classroom. Place the spike in a shallow dish of water and keep it moist. Then watch for the seeds to sprout. You should soon have hundreds of tiny cattail plants germinating right before your eyes.

Or gather cattail pollen in late May or early June, when the pollen heads are golden, and mixhalf and half with flour in your favorite pancake recipe!

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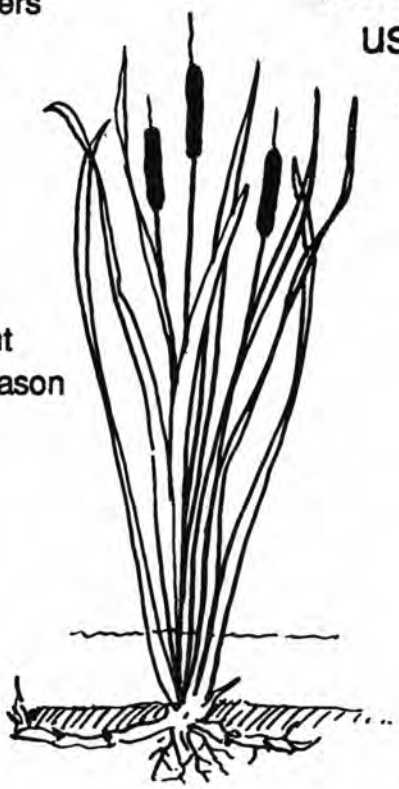
John Wiessinger has produced numerous "Right Before Your Eyes" information sheets. For further information about the series, write to him at 136 Ellis Hollow Ck. Rd., Ithaca, NY 14850.

Cattails



male flowers

female flowers



plant at height of growing season



cattail spike going to seed

Cattails are found in wetlands throughout most of North America, providing food for insects and Muskrats and nesting material for birds and semiaquatic mammals. Indians and settlers ate the roots and used the leaves for weaving baskets and seats. The downy seeds were used as padding for cradle boards and stuffing in sleeping bags and mittens.

In summer, the cattail has 2 parts -- a soft yellowish mass of male flowers above and a firm green or brown mass of female flowers below. The female flowers develop into thick, long-lasting spikes of closely packed, hair-surrounded seeds. These are scattered in spring by the wind.

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Investigating Bogs: An Interdisciplinary Adventure

Philip R. Pankiewicz and Lois Schneider

When the last great glaciers retreated from the continental U.S., they left their legacy on the land. Part of the legacy were large "kettleholes" or ground depressions that formed when huge chunks of ice broke away from the face of the melting glacier and were subsequently buried by glacial debris. In time, the ice melted to form kettleholes that later evolved into unique and fragile ecosystems called "bogs."

Bogs are unique for various reasons. Unlike swamps, bogs have no water inlets or outlets. Thus, bog water takes on some interesting characteristics. The plants and animals associated with bogs are unusual too, for they must adapt to conditions of extreme cold and highly acidity water. Many ecologists, in fact, describe bogs as having tundra-like conditions.



Students at Suny College at Cortland investigate peat accumulation using a peat borer.

Because bogs are so unique, they are ideal sites for hundreds of interdisciplinary lessons that combine chemistry, geology, various branches of biology and wetlands archaeology. Creative teachers will also find ways to incorporate art, history, literature and mathematics into their outdoor bog excursions. The following are some general guidelines to help you begin designing your own interdisciplinary bog studies.

Some Basic Curriculum Guidelines

Chemistry

Students enjoy sampling bog water and comparing it to water collected from various ponds, streams and other sources. They will find that bog water is quite different. It is usually very acidic with a pH of about 4.0, and tends to be brownish in color due to suspended organic material. It also has relatively low dissolved oxygen and nutrient levels.

Botany

Many plants have adapted to bog conditions, including some that are carnivorous and/or endangered. Students should be encouraged to sketch or photograph (not collect) plants and identify them using field guides. Students should focus their attention on sphagnum moss, the most important of the bog plants. This moss is largely responsible for creating, maintaining and altering the bog ecosystem.

Plants commonly found in bogs include:

1. Orchids: Some bogs have as many as 14 types, including yellow-fringed, beard flowers, bog candles, swamp pink, ladies' tresses, grass pink and lady's slipper.
2. Sedges: Cotton grass is usually the most common. Other types such as water sedge, bog sedge and deer's hair sedge can often be found too.
3. The heath family: various plants including highbush blueberry, cranberry, bog rosemary and leatherleaf.
4. Sphagnum (peat) moss: This moss is highly adapted to thrive in an aquatic environment. It can float on

the water surface because it has gas-filled cells and can grow under very cold conditions

5. Carnivorous plants: These can include: bladderwort, pitcher plants and sundews.
6. Bog forest trees: Mainly tamarack (larch) and black spruce.

Zoology

Various animals live within the bog or frequent it in search of food or drink. These can include:

1. Various mice, voles, shrews and lemmings.
2. Various turtles (painted, spotted, bog, etc.).
3. Various frogs (green treefrog, carpenter frog, mink frog, etc.).
4. Various birds (sparrows, warblers, owls, hawks, etc.).
5. Ducks (ring-necked, wood duck, mallards, etc.).
6. Salamanders (four-toed, etc).

As with plants, students should sketch or photograph any animals they observe and then try to identify them using field guides.

Phytoplankton and Zooplankton

Microscopic plants and animals abound in bog pond water, and students should be encouraged to investigate them. This is best done by collecting bog water samples that are returned to the science laboratory and examined under the microscope.

Students can also rear microscopic plants and animals in small aquaria.

Wetland Archaeology

The bog's unique conditions of high acidity and low oxygen levels prevent microbial decomposition. Thus, animals that die in the bog are well preserved. In northwestern Europe, over 700 human corpses were recovered within the last 200 years. Some of the remains have been dated to the pre-Bronze Age (6,000 years ago). Two of the more startling "bog bodies" were given the names Lindow Man and Tollund Man. In addition to human and animal remains, archaeologists have also unearthed wooden railways built by Roman armies, bridges, canoes, dwellings and artifacts of all types.

Students' fascination with "bog people" can be focused into reading assignments. Two books listed in the bibliography are excellent references. They contain remarkable photos of artifacts and remains that were unearthed in bogs. Additional readings can be gathered using a CD-ROM search at your nearest college or university library.

Geology

Geology studies of bogs tend to focus on glaciation since glaciers were ultimately responsible for forming the kettleholes that eventually developed into bogs. Students should be encouraged to read books on glaciers and glaciation and to discover how moraines and kettleholes were formed. They can also look for glacial remains such as eskers, kames, and ventifacts in the surrounding area.

Questions Worth Investigating

1. Although bog plants have ample water, they cannot use the bog water due to its acidity and cold temperature. How have different plants adapted to live in this environment?
2. Bogs, like other land areas, continue to undergo "succession." How does a bog change as it ages?
3. What are the factors the have allowed human and plant remains to be preserved in bogs?
4. How economically valuable are bogs? Present an argument that will persuade town officials to preserve a local bog rather than allow it to be developed.

Suggested Experiments

1. If a slender rod is pushed down into peat, methane gas often escapes. Have students design a way to capture and test the characteristics of methane gas.
2. Sphagnum (peat) moss is often added to soil to improve its water-holding capability. Have students design an experiment to test the water-holding capabilities of sphagnum.
3. How slowly do objects decompose in bog water? Is it slower or faster than in distilled water? Tap water? Regular pond water? Have students design an experiment to find out.

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Modeling the Benefits of a Wetland

Janet E. Hawkes

Use a model to help youth see how a wetland can act as a water filter. Discuss how water can hold particles in suspension if the water is moving swiftly. Particles settle out of the water if the flow of the water is slowed. In a wetland, the flow of water is generally slowed by two factors: the relatively level slope and the wetland vegetation. Plants actually form a physical barrier to the flow of water and trap particles as the water flows by them.

To model the filter effects of a wetland, have students create two models, a healthy wetland filled with plants and an unhealthy wetland in which plants have been removed or have died.

1. To simulate the healthy wetland, use a piece of indoor-outdoor carpeting, a doormat, or a sponge.
2. To simulate an unhealthy wetland (or the absence of one), use an item with a flat smooth surface, such as a board, a recycled Styrofoam tray, or a cafeteria tray.
3. To simulate a sediment-carrying stream, use a jar of water with soil added to it. Have your students vigorously shake the jar to get all the particles in suspension.

Place the healthy and unhealthy wetland models at a gentle slope in a pan or tray (to collect the water). Pour the agitated water from the jar into each model, allowing it to flow from the top down into the pan. Watch what happens. Examine the water in each pan.

Which pan has the cleaner water? The pan with the healthy wetland. In which model did the water flow through faster? The pan with the unhealthy wetland. Why would there be more sediment in the pan where the flow was faster? Remember the agitated jar? Water in motion can carry more sediments. Faster flow carries more sediments; with slower flow, more sediments settle out of the water. Also, the textured surface ("plants") filtered the sediments out of the water.

The healthy wetland slows down the flow of water and allows sediments to settle out of the water. Healthy wetlands act as filters and clean the water that flows through them.

Extra activity: When in a wetland, show students the fine sediment that has collected on the plants and the bottom of the wetland. The wetland is an effective water cleaner.

Janet E. Hawkes, Ph.D. Cornell University, is the Executive Director of the Cayuga Nature Center in Ithaca, N.Y. She has 20+ years as a teacher and director of programs in natural history, agriculture education and curriculum. She has published dozens of articles and documents related to these areas.



"When I would recreate myself,
I seek the darkest wood,
the thickest and most interminable
and most dismal swamp.
I enter the swamp as a sacred place —
a sanctum sanctorum.
There is the strength and marrow of
nature."

— Henry David Thoreau



A Discovery Scope

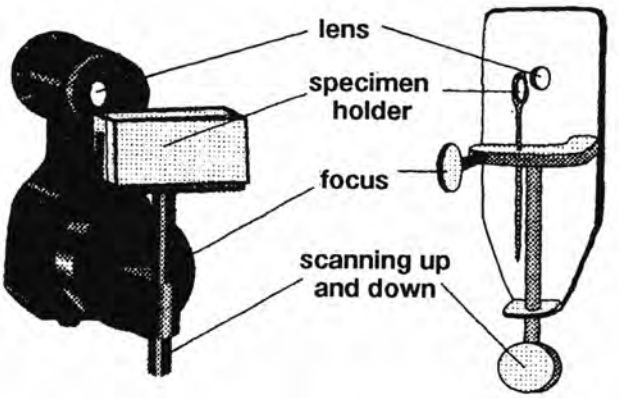
Helen Ross Russell

Going to a wetland? Take a Discovery Scope along; or depending on the size of the group, a number of Discovery Scopes. These versatile, hand-held microscopes provide participants with the opportunity to not only see the little denizens of our waterways but also to watch their behavior. In fact, the inhabitants of a sampling of water may frequently live successfully for weeks in a Discovery Scope chamber with the occasional introduction of small amounts of food, e.g., tropical fish food or a grain of rice.

The excitement of watching a protozoan, a planarian, or an insect larva or nymph move before your eyes is an experience the children will never forget. The basic Discovery Scope Kit comes complete with the viewing scope, clamp, multi-use chamber holder, 2 clear view chambers (2" x 1" x .75"), one dropper, one Bio-in-a-bag and one cardboard slide. It costs $35.00 for a single kit. The price goes down for quantity orders. Additional chambers, slides and bags may all be purchased separately in packs of 10.

There is also a Discovery Scope Camera Adaptor available for single lens reflex cameras for close-up photography, providing the photographer with the opportunity to photograph small living critters from all angles! Other opportunities exist for taping an action sequence, for making video presentations as part of a lab study, or by combining Discovery Scope camera base with a camcorder or small surveillance camera for an entire class to watch.

A variety of pamphlets, including "Investigating Wetlands with a Discovery Scope," are available. Order a price list of available materials from Discovery Scope Inc., P.O. Box 607, Green Valley, AZ 85622.



DiscoveryScope® **Leeuwenhoek Microscope**

Bruce J. Russell

Three hundred years ago a Dutch naturalist named Antony Van Leeuwenhoek made the first recorded observations of micro-organisms. To see them, he devised a series of unique single lens microscopes and specimen holders that allowed him to use natural light and contrasting backgrounds to see his small subjects.

DiscoveryScope® is the modern equivalent of a Leeuwenhoek microscope. It's best described as a wide-field, hand-held microscope, with specimen holders incorporated into the design. Like Leeuwenhoek's instruments, optics and subject are locked together, which eliminates the unsteadiness encountered when viewing objects with a hand lens. Experimenting with lighting is easily accomplished as in Leeuwenhoek's day using either natural or artificial light sources.

What Can We as Individuals Do?

1. Be an advocate. Get protective legislation passed. Guard against changes in legislative protections already in place. Make sure laws are enforced.

2. Join organizations involved in wetland protection, or that manage wetlands and sanctuaries.

3. Donate to organizations that are purchasing wetlands.

4. Do a program on your local radio or TV on the value of wetlands.

5. Write a letter to the editor of your paper.

6. Teach young people about the value of wetlands and expose them to their beauty.
GET INVOLVED!

What You Can Do

• Be sure your personal waste doesn't contaminate. Verify that your sewage treatment plant or your septic tank pumper has the proper permits for disposal.

• Make golf green. Urge course managers to reduce the average 18 pounds of pesticides per acre annually applied, and revert to more natural vegetation.

• Don't feed Canada geese. About 125,000 geese have become resident in Pennsylvania, even though the species typically migrates to more southern climates. They stall here for a variety of reasons, but at least one factor is the number of people who feed them. The result is extended hunting seasons and trap-and-transfer programs. The non-migrating birds become "attractive nuisances" that soil lawns, damage fields and pollute nearby ponds and wetlands. Other northern states face similar goose problems.

(Adapted from suggestions of the Pennsylvania Alliance for Environmental Education.)

Salt Marsh Alphabet

Margaret Nathanson

There are many different ways to end a field trip. Mine is the "wrap-up," hardly original, but one which I still find most effective from fourth grade through high school. Furthermore, it works equally well in any area, be it pond, forest, field, seashore or salt marsh. Since this issue's primary focus is wetlands, we shall use the salt marsh as our habitat.

At the end of our salt marsh safari, I pick a scenic, comfortable spot such as a sandy area in the upper marsh and have the children gather in an informal group. As we have meandered through the marsh, we have already noted the function of phytoplankton, algae and marsh grasses as the primary producers. Hundreds of small circular holes in the mud have sparked our curiosity. Who lives in those tunnels? What happens to these creatures when the tide comes in? How do they survive in the winter? What do fiddler crabs eat? Why do some have one enlarge claw?

At the base of the tall cord grass, we have seen the ribbed mussel tied down by strong threads and learned how their method of filtering food enriches the marsh. We have observed many other species of invertebrates such as crabs, snails, insects and spiders in the grasses and tidal creeks and spoken of the role they play in the total food chain of this unique, self-sufficient, productive system.

To review and reinforce these myriad observations, we conclude our exploration with a "Salt Marsh Alphabet." As we go through the alphabet and each student calls out a word, be it plant, animal or process, I jot it down. Kids love this "game" and come up with many of the words used during the field trip. The completed alphabet is given to the teacher, who may find it useful as a reference or starting point for follow-up projects.

In twenty years as a working naturalist, I have found this to be one of the most simple and successful activities in introducing young people to the language and workings of this or any other habitat.

A - algae, arthropod, arachnid, amphipod, annelids, adaptation, aphid

B - barnacle, bivalve, bacteria, bryozoa, beach hopper, blood worm, beach grass, blue crab

C - cord grass, crustacean, coelenterate, cricket, copepod, clam worm, carnivore, cycle, chlorophill, codium, carageenin, chiton, cactus

D - detritus, decomposer, diatom, dinoflagellate, diamondback terrapin, duck

E - estuary, egret, eel, echinoderm

F - fiddler crab, fucus, flounder, fly (greenhead)

G - gastropod, glasswort, grasshopper, groundsel tree, glacier, geese, great blue heron, goldenrod

H - horseshoe crab, herbivore, high tide bush, hold fast, hawk, heron, hermit crab

I - invertebrates, isopod, insect, Irish moss

J - jellyfish, jingle shell

K - kelp, killifish

L - larvae, ladybug beetle, lobster, lichen

M - mollusk, mussel, mud snail, moon snail, marsh crab, monarch butterfly, metamorphosis, moraine, mullein, mudflats, molt, minnow, mummichog

N - nematode, naupliu

O - omnivore, oyster drill, opuntia, osprey

P - plankton, phytoplankton, prickly pear cactus, poison ivy, producer, predator, prey, periwinkle, preservation, parasite

Q - quahog, quartz

R - rockweed, razor clam, raccoon, rail rabbit, rodent

S - spartina, sink hole, salicornia, samphire, sea pickle, shrimp, scud, sponge, spike grass, sea lettuce, sea star, slipper shell, salt hay, salt meadows, sea urchin, sessile, sea horse

U - univalve, uca

V - vertebrate, Virginia rail

W - whelk, warbler, willet

X - xerophyte

Y - yellowlegs

Z - zooplankton, zonation, zostera, zoea

Margaret Nathanson is a naturalist at the Nassau Board of Cooperative Services, Outdoor & Environmental Education, Caumsett State Park, Lloyd Harbor, New York.

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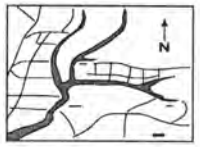
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Useful Tools for Studying Wetlands

Candace E. Cornell



Maps

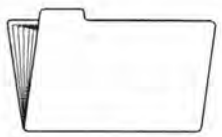
U.S. Geographical Survey quadrangle maps, available in book stores or by calling 1-800-USA-MAPS.

National Wetland Inventory maps, available by calling 1-800-USA-MAPS.

State freshwater wetlands maps.

U.S. Department Of Agriculture Soil Conservation Service county soil survey maps.

National floodplain maps, local wetland maps, and municipal tax maps available at local municipal offices.



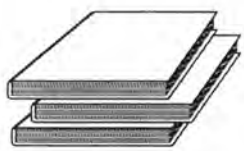
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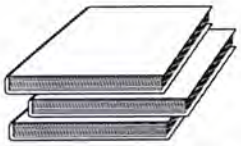
(You do not have to be a wetland scientist to join these organizations.)

Association of State Wetland Managers, Inc. P.O. Box 269, Berne, NY 12023-9746. Legislative updates, general articles, and meeting announcements.

Journal of the Society of Wetland Scientists. P.O. Box 1897, Lawrence, KS 66044. Telephone: (913) 843-1221. Publishes scientific research papers.

National Wetlands Newsletter. Environmental Law Institute, Suite 200, 1616 P Street NW, Washington, DC 20036. Telephone: (202) 328-5150. Legislative updates, general articles, research updates, and meeting announcements.

Society of Wetland Scientists Bulletin. P.O. Box 1897, Lawrence, KS 66044. Telephone: (913) 843-1221. Legislative updates, general articles, research updates, and meeting announcements.



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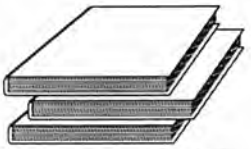
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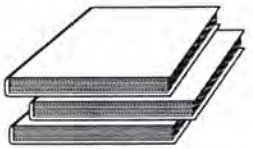
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Book Reviews

Fishes, by Michael Filisky. Illustrated in color by Sarah Landry. A Peterson First Guide. Houghton Mifflin Co., Boston. 128 pp., index, 1989. $4.95.

The 224 most common and conspicuous fishes in North American fresh or salt waters are found in this book. Identification is by matching colored pictures. The accompanying text provides information on size, geographic location and habitat and sometimes includes unusual characteristics or behavior. (Reviewed by Helen R. Russell.)

The Pond Book, by Karen Dawe. Illustrated in color by Joe Weissman. Workman Publishing, New York. 80 pp., index. $14.95.

This little book is accompanied by a transparent bucket with a magnifying lid which is also a plastic "wand" designed for scooping up plants and animals without damage. The first ten pages provide information on collecting, examining, note taking and returning the living things to their environment. Short articles on kinds of wetlands, food chains, and properties of water that make it a home for many organisms provide a background for collecting, identifying and observing many of the plants and animals that may be found in any water study. The next 60 pages contain colored pictures, descriptions of behavior, relationships and habitat of approximately 50 animals, from invertebrates through mammals. Final section, titled "Save the Wetlands," gives suggestions to kids and their teachers for effective action. A good kit for a child, a teacher, a classroom. (Reviewed by Helen R. Russell.)

A Field Guide to Shells of the Atlantic and Gulf Coasts and the West Indies, by R. Tucker Abbott and Percy A Morris. 74 colored plates. A Peterson Field Guide. Houghton Mifflin, New York. 1995. 354 pp. $16.95.

Percy Morris wrote the original edition of this useful guide. This fourth edition, updated by R. Tucker Abbott, reflects the increase in knowledge that the years have brought, along with a selectivity based on availability of specimens in coastal waters. More than 700 of the approximately 1,000 species will be found on the colored plates; most of the others are illustrated with black-and-white drawings. Each family is introduced with a short paragraph. The book has a table of contents, a glossary, a bibliography, a listing of shell clubs and an index. A must for the library of a serious conchologist or a school near the coast. (Reviewed by Helen R. Russell.)

Life and Death of the Salt Marsh, by John and Mildred Teal. Drawings by Richard G. Fish. 1969. Ballantine Books, New York.

"At low tide, the wind blowing across Spartina grass sounds like wind of the prairie. When the tide is in, the gentle music of moving water is added to the prairie rustle . . ." This book is dedicated to the preservation of salt marshes. The Teals have approached this task by writing a book that educates the reader in the intricacies of the salt marsh ecosystem in a style that is both eloquent and beautiful. The drawings by Richard Fish include the flora and fauna of the salt marsh as well as useful graphs and charts. Life and Death of the Salt Marsh is not a compilation of the author's anecdotes. The Teals draw heavily on the scientific work from the Sapelo Island Marine Institute of Georgia, Dalhousie University in Halifax, Woods Hole Oceanographic Institution and other private and government agencies. Written in 1969, the legalities are outdated, but the history and functions of marsh ecology are explained superbly. This book is indexed and can be easily used as a reference for the salt marsh and should be a part of every naturalist's library. (Reviewed by Steve Melcher.)

Toad or Frog, Swamp or Bog: A Big Book of Nature's Confusables, by Lydia Gram & Barber. Illustrations by Alec Gillman. Four Winds Press, New York. 1994.

This is a great resource for young naturalists, parents and teachers. A unique picture book, with an attractive

and informative collection of mural-like paintings of animals in their habitats. These murals transport the reader to the natural environment in which certain common confusables are found. Additional sketch-book-like drawings illustrate specific differences between many pairs of Nature's confusables. A great resource where the reader can get the answers to a great many of the most commonly asked questions almost at a glance. Questions such as, "How are bees different from wasps?"; "What is the difference between a crocodile and an alligator?"; and "How are rabbits different from hares?" A nice reference which the reader will probably return to many times.

An Angler's Guide to Aquatic Insects and Their Imitations, by Rick Hafele and Scott Roederer. Illustrated by Richard Bunse. Johnson Books, Boulder. 180 pp. 1987. $9.95.

The authors bring together an entomological background and trout fishing experience. The result is a book that certainly would be of assistance to trout fishermen. It is also an excellent source for identification of aquatic insects in all their stages with usable keys and excellent drawings. Because knowledge of behavior is important for fishermen who use flies, the book has much more detailed information than is generally included in a book of identification. This would enrich any aquatic study, or would be a wonderful resource for special projects in a secondary school or a good teacher reference anywhere wetlands are located.

Explore New Territory! Create Your Own Adventure!

Assistantships in Outdoor Education
Northern Illinois University

Graduate teaching assistantships* are available in Outdoor Teacher Education at Northern Illinois University for the 1996-97 school year, beginning in early January or Mid-August. The assistantships involve outdoor teaching at Lorado Taft Field Campus, Oregon, Illinois.

Because the teaching is primarily with public school students and university juniors and seniors, priority is given to those applicants who have had several years of experience in the elementary or secondary schools or nature and outdoor centers.



The assistantships pay a stipend of $411/month for 9 months, include a waiver of tuition for 3 semesters, and partial room and board for nine months.

For applications and further information contact Dr. Knapp, Lorado Taft Field Campus, P.O. Box 299, Oregon, IL 61061. (815) 732-2111.

**In order to be awarded the Graduate Teaching Assistantship, you must apply to the Graduate School and be accepted.*



Illustration Courtesy of The National Audubon Society

Naturalist's Notebook

Our Shrinking Wetlands



The nation's wetlands - marshes, swamps, sloughs, ponds, potholes, mud flats and tidal areas - provide indispensable living space for many forms of wildlife. They serve as temporary storage areas for water, thus reducing flood risks. They filter out pollutants and other sediments, and also provide recreational opportunities for many millions of people.



"Duck Factories" - the prairie potholes, ponds, and marshes spotted over 300,000 square miles of south central Canada and north central United States - offer the vital habitat needed for waterfowl production. Through the years, countless thousands of these wetlands have been drained to create cropland.



Coastal wetlands provide essential spawning, nursery, and feeding areas for the majority of our commercial fish species, as well as critical habitat for aquatic birds, mammals, and other wildlife. Every day, thousands of sewage and industrial plants pump billions of gallons of pollutants into these important natural areas.



The Florida Everglades is living space for countless waterbirds and other wildlife species. In 1900 it covered more than 2.3 million acres. Today it has shrunk to less than half that, due to drainage and flood control and irrigation projects. Much of what is left is degraded by agricultural fertilizers and pollution.

In Colonial America there were 220 million acres of wetlands in what is now the lower 48 states. Today, less than 100 million acres remain. The losses continue, year after year.

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