Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1984 Volume VI: Geology and the Industrial History of Connecticut

The Marsh Land as a Changing Environment

Curriculum Unit 84.06.04
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To the average person a tidal marsh may appear as an uninviting and uninteresting expanse of wasteland. If you take a closer look, it reveals an intricate and fascinating community of plants and animals that adjust to an ever-changing environment. Their habitat is a complex one, one that includes some of the most productive acreage on earth. The tidal ebb and flow brings about interesting zones of plant life from the edge of the marsh to the upper borders that are occasionally inundated. Along with the many common grasses, some of the most striking wild flowers may be found there—sea lavender, marsh mallow, purple gerardia and sea goldenrod. One can observe spectacular water birds—herons, ducks, rails and many others that feed and nest in this habitat. Marshes serve as a vital resting and feeding area for migrating waterfowl, as well as a wintering sanctuary. These marshes also contribute to the productivity of adjacent waters by providing the basic nutrients that start the food chain that supports the large numbers of fish and shell fish in the area waters.

This fascinating world of plants and animals that are alternately flooded by seawater and exposed to air by the rise and fall of the tides opens up a new world to a unique ecosystem that involves a complex food web.

Course of Study

This unit is intended for use with 6th grade students throughout the school year as a part of the social studies unit on Connecticut. The first of many periodic observations at Lighthouse Point Park (Morris Creek) will take place in the early fall. During these visits, observations of salt water plants, bird, invertebrate and vertebrates will be made. Specimens will be collected and classified. The students' observations will be illustrated on charts to show the varied life sustained during the different seasons. Photographs and slides available at the Yale-New Haven Teachers Institute will also be used to help students with the identification process prior to each first-hand observation.

Lighthouse Point Park

Lighthouse Point Park (Figure 1), at the mouth of New Haven Harbor with Morris Cove forming the northern boundary and Long Island as the southern boundary, will be the basic resource of the 6th grade amateur naturalists.

In 1958 a groin was constructed at the western end of the beach and rebuilt in 1977. For a number of years the wind and waves have carried the sand back on to the beach during the winter forming a dune along the

front of the beach. In early spring each year, the city of New Haven bulldozes the beach and flattens it, basically, for the safety of swimmers. A seawall was built in the 1950's at the eastern side of the beach. The mean tidal range in the New Haven area is 6.2 feet with slightly greater Spring tidal range of 7.1 feet. [1]

Morris Creek

Morris Creek that flows on the eastern side of the park will be examined and explored to better understand and appreciate the balanced and continuing life of the marsh. As one follows the creek from the mouth (eastern side of the seawall), the land on the left is elevated and on its upper borders is found Phragmites (Common Reedgrass) that is especially common where there has been a disturbance on the marsh such as tidal gates or dredge spoils. This plant will quickly replace the cordgrass that is restricted to intertidal zones of a marsh. This western side of the creek along with the wooded area of the park are a bird sanctuary. Directly across from this area is a marina (East Haven side). In this immediate area there are culverts that run off the creek to the east under the existing dirt roads and behind Shell Beach.

North of the marina can be found *Spartina patens* (Saltmeadow cord-grass) which often dominates the high marsh. It is this grass that formed the salt marsh hay that was harvested extensively by the early colonists and today is still mowed on some marshes.

Tide gates are farther up the creek. They are located west of Townsend Avenue (Rt. 142) on the Long lsland Sound side of this road. These gates prevent tidal water from getting into the airport and industrial park area that is just to the north. They also allow the fresh water flowing from the ponded area by the industrial park to flow down the Morris Creek.

The Morris Creek branches off and runs along the western side of the Tweed-New Haven Airport bounded by Dean Street in New Haven. This area is presently under study by the Coastal Area Management Program, Connecticut Department of Environmental Protection concerning the flooding of the creek in this area. The eastern branch of the creek goes along the eastern side of the airport and industrial area in East Haven. It is bounded on the east by Ora Avenue in East Haven. This area was a former salt marsh until the installation of the tide gates prevented the flow of salt water into the area. Dredge spoil material from the New Haven Harbor was at one time deposited in this Ora Avenue area and has naturally disturbed the area. It is now designated as an inland wetland. To the north is a fresh water ponded area that drains down the Morris Creek. Waters of this creek flow into Long Island Sound and are all part of the Southcentral Shoreline.

The inwelling or influx of sediment into the creek is caused by incoming tides, and wind and wave action. The adjacent upland is the principal source of the sediment that is accumulating. The Army Corps of Engineers at one time deposited dredge spoils behind dikes east of the airport. After a period of time the dikes broke and the sediment spilled into the creek.

The filling of salt marsh wetlands around the creek has also affected the creek. It has reduced the water capacity of the land. Since the land no longer can absorb as much of the water as it used to, it runs off into the creek carrying sediment with it.

Morris Creek as a Food Source

Morris Creek is a valuable natural oyster habitat. The oysters spawn in the creek during the summer months when the water is between 68°F-72°F. The male releases its sperm and the female releases its egg into the creek.

The egg is fertilized in the water and changes into a free swimming larva. It swims and drifts about for two to three weeks and then settles to the bottom on to a clean surface such as an oyster shell or shell fragment to begin growing. Some of the larvae go out of the creek and may settle on shell in the New Haven Harbor.

Planting of the oysters takes place north of the marina and south of the tide gates. This area is designated as a State Spawning Sanctuary.

If the shell base is covered with silt the larvae cannot settle on a shell. If this silt covers the oyster after it has settled on a shell it will suffocate.

Salinity is less conducive to long term growth of the oyster. Oysters prefer a salinity of 15 parts per thousand. At the mouth of the creek the salinity is about 25 parts per thousand.

Soft clams (steamers), blue mussels and hard clams (quahog), are abundant at the mouth of the creek. Ribbed mussels are found further up the creek.

Eastern Flyway

Lighthouse Point Park is very important to birds migrating along the Eastern flyway. From the end of August through October the second largest number of hawks migrate over the coastal area along the Eastern flyway. The two most common hawks in migration over Lighthouse are the Sharp-shinned Hawk and Kestral Falcon.

Ten or more other species fly over and all are listed below in 5 groups.

I. Accipiters—all bird hawks, with short wings, long tails and are basically woodland hawks
    A. Sharp-shinned Hawk
    B. Kestral Falcons
    C. Cooper’s Hawk
    D. Goshawk
II. Buteo Hawks—wide wings, wide tail, and are basically inland migrants
    A. Broadwinged Hawk
    B. Red tail Hawk
    C. Red shouldered Hawk
III. Falcons—long tails and long wings
    A. Kestral Hawk
    B. Merlin Falcon—endangered species
    C. Northern Harrier—third most common bird going over marsh
    D. Marsh Hawk
IV. Eagles
    A. Bald Eagle—Endangered species
V. Others
    A. Osprays (common migrant)
    B. Turkey Vultures (Occasional, rare on coast)

Lots of song birds also come through during the spring and fall migration.

Mr. Frank Gallo, Edgewood Park Ranger with the Department of Parks, Recreation and Trees is a registered bird bander and coordinator of the Bird Banding-Migration Program. The classroom activities include a discussion on migration and the basic concepts of bird banding. A week later the children go to Lighthouse Point Park and participate in net-lanes, bird-banding and hawk-watching. This program will be incorporated into this unit as the first activity in the early fall.

Objectives

Upon completion of the unit the students should be able to: 1) understand what a salt marsh is, 2) identify some of the salt water plants, 3) identify some of the birds of the salt marsh, 4) identify some of the invertebrates that inhabit the salt marsh, 5) identify some of the vertebrates that inhabit the salt marsh, 6) to understand and appreciate that many forms of life can only live because of the presence of other forms of life, 7) understand the importance of the marsh to marine animals in Long Island, 8) identify some ways in which man is destroying the productive lands of the salt marshes, 9) use aerial photographs of Morris Creek and compare with topographical maps.

Salt Marshes

Salt marshes are grass-dominated tidal wetlands that fringe the land-water interface of many temperate regions throughout the world. [2] The New England tidal marshes are relatively recent land forms that have developed in the last 3000-4000 years. Their development is the result of interactions of tidal marsh vegetation and a gradually rising sea level. As the post-glacial rise in sea level slowed to about one millimeter per year approximately 4000 years ago, sediment deposition within stands of salt water cordgrass was able to keep pace with the rise and thus marsh development.

Once established, a marsh may maintain its position near mean high water level and may shift gradually landward if sea level rises. During the rise of water level, the thickness of salt peat may increase by upward growth.

Geological Aspects

The coast of Connecticut has been enormously influenced in its later geologic history by the advances of a continental glacier with concomitant lowering of sea level. [3] The advancing glacier, which reached southward to Long Island laid down a carpet of unsorted material called till which ranges in grain size from clay to huge boulders. The southern margin of the retreating glacier had moved considerably northward before the sea gained access to the depression that is now occupied by the waters of Long Island Sound about 8000 years ago. Valleys which probably had been deepened and enlarged by glacial erosion were then occupied by meltwater streams which drained southward away from the glacier. After the sea entered the Sound and continued to rise, the gradients of these meltwater streams were progressively lowered, and the deep bedrock valleys were filled by sand and gravel. In addition, waves began to work on the carpet of till and to sort out the finegrained components. These were put into suspension and carried away by currents. Some of it found its way via the tide into coastal indentations, where it eventually formed mudflats on which salt marshes grew. The coarser components of the till remained in place as a washed lag residue of sand and gravel.

After coastal salt marshes were established on the mudflats, they encroached landward as sea level rose. The marshes locally covered the earlier-formed stream deposits of sand and gravel which originated during still earlier phases of sea level rise.

If the rise in sea level is slower, the rise in the surface of the marsh will be slower or temporarily stop. If sea level rises slightly faster than the plant growth can add to the surface of the marsh, the surface will be flooded more frequently with sediment-laden waters. The accumulation of mud on the surface will increase and keep the marsh level in harmony with sea level.

If the high tides do not flood the marsh regularly, there will be periods without rains when the mud will dry out. [4] The salinity will increase, due to the concentration of salts, as the water evaporates. The marsh plants will die and no longer hold the mud in place. Subsequent rains or extra high tides will reduce the level of the marsh again, by increased erosion, until it is about at the level of mean high tide.

It is common to find this kind of balance struck between the forces of the environment and the plants that live in that environment, each modifying the effects of the other.

Zones

Typically, salt marshes will contain three zones of flowering plants and their associated communities. [5] At the lowest levels a sparse growth of a few species forms the pioneer zone or low marsh. This intergrades at higher levels with the richer flora of the mature zone of middle marsh. Finally, the species of the mature zone are partially replaced at the highest level of the salt marsh or high marsh by species of nonsaline habitats or facultative halophytes which can only withstand brief and infrequent submergence in sea water (Figure 2).

Seasonal Changes

The moderation of climate produced by the sea results from the slowness of the water temperature to change with the seasons. [6] The moderation of the water temperature makes abrupt changes in marsh temperature when the tide rises and falls. All animal life in the marsh must adjust to these changes. It adjusts by physiological, chemical and structural adaptations, as well as behavioral adaptations made to cope with the seasonal changes.

Winter

Animals

The more northern the marsh, the less difference the tide makes to animals in the winter. They are all resting, made torpid by the cold, or have departed to take refuge in warmer places. Crabs have retreated down into the mud, too cold to respond to any stimuli. Insects rest as eggs or larvae in the mud, or are burrowed in the ground above the high tide mark as adults. The birds have gone south.

Plants

Not only the animals, but the plants are affected by the cold. If the winter is severe enough to freeze the seawater and there are storms to push cakes of ice up onto the frozen mud, anything protruding above the surface will be ground to bits or sheared off and carried out to decay in the sea. Even if there is no ice damage, the stems and blades of the grasses are killed. Only the underground parts can resist freezing. They remain protected in a blanket of wet or frozen mud, until the spring sun warms the marsh.

Birds

Birds must have a continuous supply of food to keep their bodies warm. [7] The northern bird population is restricted to ducks that feed in the water. They chase the fish slowed by cold and they poke and dab in the mud, sifting out the little worms and clams hiding there.

Animal life in the water eases itself out of the marsh. Some inhabitants move away. Some burrow down deep. A quietness settles everywhere. There are no loud territorial disputes between birds. The fiddler crabs do not rustle through the plant stems.

Spring

As the season changes, spring seems to come while the tide is out and winter creeps back with the cold water of high tide. [8] The marsh mud is warmed at low tide, for there is no tall grass to shade the surface. When the tide turns, heat stored in the thin warmed layer of mud passes into the cold water that creeps up. The water is slightly warmed but then goes back and mixes with the great reservoir of cold water at the edge of the sea. Many sunny days must pass before the heat penetrated very far into the water.

Most intermediate-sized animals are safely buried some inches under the mud or the water and will not come out into the world until the warmth of spring penetrating slowly deeper and deeper into the ground, finally arouses them to the surface.

But most of the activity of the marsh takes place at the surface of the mud. Animals, plants, and bacteria concentrate at the mud surface and are subject to the full force of the sudden changes of temperature, salinity and water level that occur there.

Plants

Plants, one-celled diatoms and flagellates, grow in full sunlight on the solid surface where fertilizing nutrients are concentrated. [9] The ideal spot to find food, light, and the necessary nutrient elements for plant growth is at the surface of the mud where any food settling from the water must come to rest. But it is also the place most subject to change in temperature as the sunlight comes and goes and the tides ebb and flow.

In spite of cold nights, gray, cold and rainy days, the mud does thaw and gradually warms up. Plants begin to grow again. The mud on the creek banks turns a rich brown in the morning sun as the diatoms and dinoflagellates become abundant on the warm mud. Spartina seeds, that escaped the birds and insects and fell into the mud the preceding fall, sprout. Later, the shoots in the high marsh manage to push their way through the cover of last year’s grass. The marsh begins to green up.

Animals

The animals are also warmed and begin to be active again. Their food needs increase. The fiddler crabs suddenly appear above ground when the temperature reaches about 60°F in their holes.

Birds

The sun continues to warm the edge of the land and the ribbon of green marshes is seen again along the

coast. Male marsh wrens move in to the fast growing Spartina along the creek banks and begin staking out their territorial claims building nests one after another. The marsh rails begin their nests hidden among the Spartina, but the nests are too heavy to be supported by the grass and rest on the ground. [10] The birds collect their food and for their nestlings on the marsh. Insects from the Spartina and snails and crustaceans from the mud are taken.

The tempo of life speeds up in the spring in the marsh as it does on land, except that it is complicated by the tides, by the slowness with which the water warms ups in comparison with air, and by the changes in temperature and salinity as a result of spring rains. As the summer advances, the activity of the marsh reaches its maximum. Growth of new plants and decay of old vegetation proceed at their greatest rates.

Summer

Animals

Summer is the season when the large biting greenhead flies abound in such numbers that they can be heard buzzing and bumping through the grass long before they are visible. [11] It is the spawning time for the salt marsh minnows and the breeding season for the crabs. You can watch the dance of the fiddlers for hours. The cumbersome large fiddle sported by the males, which is useless for eating and awkward for locomotion suddenly becomes useful. With it the male attracts the female and defends his territory.

As the summer wears on, the baby crabs have drifted with the tides, eaten or been eaten. [12] Those that survived return to the marsh as tiny crabs to replace the adults that have fallen victim to rails, herons, and other crab eaters.

Late summer and autumn rain combine with the high tides to wet the highest areas of the marsh more frequently than they did in the summer. During the alternating wilting and drying, the salt marsh mosquito, becomes more abundant than at any other time of the year.

Plants and Birds

In late summer the grasses slow their growth of leaves and begin to elongate the stalk that will raise the flowers and seeds up into the air. [13] The baby birds are now grown and are chasing their own insects or catching their own crabs.

Autumn

All the organisms make their preparations for the slowing of activities, that is to follow. They do not know what is to follow, nor can they make plans for the future. They simply feel that the days are growing shorter and the nights cooler. They respond automatically with the built-in system that has assured the survival of their species through countless winters.

Autumn starts in the north and moves south during September and October. The grasses mature their seed

heads. Some of the more adventurous aquatic animals of the marsh, worms and mud crabs turn toward the sea where the water never goes below freezing beneath its surface.

Birds

The birds fly south. The swallows start almost before summer is over. They hawk their way over the ribbon of marshes, feeding on insect swarms as they move along. The rails with their young migrate south, hiding their ungainly flight at night. The herons that feed on the small fish also go south to eat where the fish are still abundant in shallow water. [14]

When the marsh creeks get colder than the offshore waters, the high tides are warmed by waters coming from offshore. The fish move out and leave the marshes for the winter.

Plants

The plants die down. The remaining marsh animals burrow into the mud below the frost line and retreat toward the low water level. The living activities in the marsh slow and almost stop.

Ecosystem

Estuaries, (where the tide meets the current of the river), in general and salt marshes in particular are unusually productive places. Marshes are productive for several reasons, all of which are a result of the meeting of land and sea. The tides continually mix the waters and, by their rise and fall, water the plants. Harmful accumulations of waste products are diluted and removed. Nutrients are brought in continuously.

Clams, oysters and mussels help from the sediment which acts as a nutrient trap because of their method of feeding. They remove all the particles from a large volume of water as it passes over their gills and deposit most of them in neat pseudofeces bundles. [15] Although marshes concentrate the nutrients, they do not create them. They must also be brought in from some place. Some of the necessary nitrate is actually extracted from the air by way of nitrogen-fixing blue-green algae that live on the marsh mud. Nutrient concentrations in soils are thousands of times greater than those in waters. As a result, plants growing in soils are more productive than those floating in the water.

Another reason for high marsh productivity is the quick rate of turnover of nutrients. The algae replace themselves in a matter of days and the abundant bacteria of the marsh in a matter of hours.

Finally, the marshes are productive because there is almost no time during the year, even in the north, when there is not some plant growth taking place. In the north, where the land plants and Spartina cease activity during the winter, the algae in the marshes continue to grow throughout the year.

The marsh plants are the most important consumers of the energy they capture from the sunlight. [16] Bacteria are the next most important group and consume about one seventh as much as the plants. Moving down, animals are only about one seventh as important as the bacteria. When all this consumption is added together, however, we have account for only fifty-five percent of the energy that remained after we allowed for use by plants.

The tide giveth and the tide taketh away. It is the tide that makes the high production possible and the removes half of it before animals of the marsh get a chance to use it. But what is denied the animals of the marsh is given to the abundant animal life in the estuarine waters around the marsh.

The tides continually wash a part of the marsh production into the creeks and bays where fish and oysters lie in wait. Without the marsh, these animals could not survive.

The science textbook, *The New Exploring Science, Red Book* , Laidlaw Brothers, 1982 will be used as a part of this unit. Unit I, “Ecosystems”, pages 16-47, is used to reinforce the students’ understanding of the balance of nature, the many kinds of ecosystems and the food webs.

Marsh Plants

Listed below and briefly described are some of the plants of the salt marsh that will be identified and discussed (Figure 3).

Saltwater Cordgrass (*Spartina alterniflora*). [17] The tall form of this smooth grass ranges from three to seven feet in height and is restricted to the intertidal zone of the marsh. It is the most productive of the marsh grasses. The plants provide cover for many species of marsh birds and the rootstocks make up a large part of the diet of Canadian geese wintering along the shore.

Saltmeadow Cordgrass (*Spartina patens*). This is the fine, twelve to eighteen inch high grass that often dominate the high marsh.

Spikegrass (*Distichlis spicata*). This highly salt-tolerant plant, eight to fifteen inches in height, is a widely scattered species on the high marsh.

Blackgrass (*Juncus gerardi*). This dark green, grass-like plant, ten to fifteen inches in height, is actually a rush. It grows most commonly near the upland. Blackgrass is less tolerant of high soil salinity than other marsh species such as spikegrass.

Salt-marsh Aster (*Aster tenuifolius*). This straggly, few-flowered perennial aster has whitish or pale purple flowerheads and is found scattered in the saltmeadow cordgrass or in openings on the marsh where it is associated with sea lavender and purple gerardia. The plant flowers from late August into fall.

Sea Lavender (*Limonium carolinianum*). This is one of the most beautiful of the tidal marsh plants. Its tiny, funnel-shaped flowers are pale purple and occur in many one-sided clusters. It is frequently found on the high marsh in association with arrow-grass and seaside plantain.

Arrow-grass (Triglochin maritima). This is a grass-like plant with long, sword-like leaves which are a foot or more in length. Its small flowers are scattered along a flowering stalk that rises above the leaves. It is frequently associated with depressions on the high marsh and found with sea lavender and seaside plantain.

Narrow-leaved Cattail . This species is found in brackish marshes. It has narrow leaves and a gap between the yellow male flowers (stamens) toward the top of the spike and the female flowers (pistils) below. The starchy rootstocks of these plants are edible and were ground into meal by Indians and early colonists.

Common Reedgrass (*Phragmites australis*). This tall grass has a distinctive feathery flower that is initially reddish, then silver, and finally tan in color. In viable marsh it is found along the upper border, especially where there has been disturbance. With the installation of tidal gates or other restrictions to tidal flooding this aggressive plant can replace the cordgrasses.

Marsh Mallow: Swamp Rose Mallow (*Hisbiscus palustris*). This tall, coarse plant blooms from late July to

September with large showy pink flowers and is most typical along the upland edge of the marsh.

Birds of the Salt Marsh

Of all the wildlife associated with the marsh, birds are the most conspicuous. Listed below are some of the most common birds that the students will discuss and identify (Figure 4).

Clapper Rail (Rallus longirostris). The rails are narrow birds uniquely adapted for slipping between the dense vertical stems of the grasses and reeds. Its long, slender bill is used for probing for worms in the mud or fetching out snails and insects from the dense marsh grass. It is found in salt and brackish marshes. [18]

Song Sparrow (*Melospiza melodia*) and *Sharp-Tailed Sparrow* (*Ammospiza Caudacuta*). The periphery of the tidal marsh provides an ideal habitat for the song sparrow. It has heavy streaking on the breast and side.

The sharp-tailed sparrow can be found among the Spartian grasses and mosquito ditches. It is rather shy and usually allows no more than a quick glimpse of itself.

It generally nests in higher portions of the marsh where salt marsh hay and spike grass predominate and tidal flooding does not frequently occur.

Great Blue Heron (*Ardea herodias*). Its color is more steel-grey than blue, with a buff neck and streaked throat. A black crown patch on the predominantly white head of the adult usually bears a few ornate plumes. [19]

This bird is often seen by the grassy edges of the tidal creek or wading in the shallows waiting for a stray fish.

Northern Harrier (*Circus Cyaneus*). These are agile birds with long wings “V” shape and the bird frequently rocks from side to side as it glides over the marsh. Relying on sound as well as sight, they pounce on unsuspecting prey from just a few feet.

Herring Gull (*Larus Argentatus*). In adult plumage this species sports a grey mantle (back and wings) with black wing tips. The heavy yellow bill is marked with a red spot on the lower mandible.

Red-winged Blackbird (*Agelaius phoeniceus*). This bird is black with orange-red shoulder patches (epaulets) bordered by yellow or buff. Males rely not only on their song to proclaim territory, but depend on visual effects as well. The classic rediving stance is to perch at the edge of its territory while singing, thrusting out its shoulders to expose the bright epaulets. [20]

Invertebrates of the Salt Marsh

Listed below and briefly described are some of the invertebrates that will be identified and discussed (Figure 5).

Mud Snail (*Nassarius obsoletus*). On the tidal mud flats of the estuaries bordering the marshes and in muddy tidal creeks and mosquito ditches the mud snail is often very abundant. This snail has a conical shell of dark gray or brown or black, and is often covered with a slippery layer of algal growth and debris. Mud snails leave groove-like trails behind them as they travel through the mud, and wave their siphons back and forth as they search for their odors. [21]

Rough Periwinkle (*Littorina Saxatiks*). This snail is most frequently found in the saltwater cordgrass of the low

marsh. It carries its eggs in a brood pouch until the young are fully formed and able to meet the demanding conditions of marsh life.

Salt Marsh Snail (*Melampus bidentatus*). This is one of the most abundant and interesting high marsh animals. The shells of the young are always shiny and vary in color from light to dark brown. There are from one to six transverse bands. The shell is ovoid, with a short conical spire.

Its usual habitat is the saltmeadow grass or spikegrass of the high marsh, between the mean high water level of neap tides and the mean high water level of spring tides. Adult snails are not aquatic since they possess an air sac and must breathe air in order to survive. Therefore, they cannot be submerged for long periods of time.

Ribbed Mussel (*Modiolus demissus*). This gets its name from the many radiating ribs on the shell and is abundant in the mud of the low marsh and along the banks of mosquito ditches. Several mussels are usually found clumped together, attached to each other with byssal threads which are secreted by the foot. The shell of this bivalve is dark blue or greenish-blue in color. It can only feed when submerged and therefore is found only in areas which are covered by water for part of each day.

Blue Crab (*Callinectes sapidus*). The blue crab is found only in the tidal creeks and mosquioto ditches except during periods of high tides when it invades the area of the high marsh which are submerged. They are active and pugnacious predators. Their diet includes small living bivalves and crabs, live plants, and dead animal material.

Green Crab (*Carcinus maenas*). It is often found in the tall saltwater cordgrass areas of the low marsh. It is even more common in the tide pools or hidden in the seaweed of the intertidal areas along rocky shores.

It is chiefly a scavenger and feeds on any dead animal material.

Fiddler Crabs (*Uca pugnax*). This crab is very abundant on Connecticut tidal marshes. The truly distinguishing feature of these crabs is the very large first claw of the male. The claw is used during breeding season to attract the female to threaten and fight other males.

These fiddler crabs generally dig their burrows in the mud of the tall saltwater cordgrass areas of the low marsh and along the mosquito ditches, but they will also excavate burrows among any other type of marsh vegetation where soft mud occurs. The crabs remain inactive in these burrows during periods of high tides but emerge to feed at low tides. They are most active during the night or during the early morning hours. This activity pattern affords them some protection from predators and from the higher daytime temperature which they cannot tolerate.

Spiders . All spiders feed on living prey. On the tidal marshes they are probably the chief predators on small invertebrates. In turn, they are eaten by birds, some kinds of insects, and by other spiders.

Vertebrates of the Salt Marsh

The vertebrates are the major predators on the smaller animals and form an important part of the marsh food chain. These are the American eel, the common mummichog, and the diamond-back terrapin(Figure 6).

American Eel (*Anguilla rostrata*). The small eels found in the upper reaches of tidal creeks and in the mosquito ditches of Connecticut salt marshes are immature American eels. Although a few immature eels can be found in intertidal salt waters, the majority work their way up the brackish tidal creeks and mosquito

ditches and on to fresh water streams and ponds.

Common Mummichog (*Fundulus heteroclitus*). The mummichog is abundant in the tidal creeks and mosquito ditches of Connecticut salt marshes. They prefer brackish water, but appear to tolerate both the high salinities and low oxygen levels found in shallow tidal pools left behind by outgoing tides.

Northern Diamond-Back Terrapin (Malaclemys terrapin terrapin) . It is a relatively small turtle. It can apparently tolerate waters of varying salinities and is often found quite far up rivers.

Protection of Marsh Land

Tidal marshes are valuable to us as an indirect source of food as a stabilizing protection to our eroding shoreline, as open space enjoyed by millions of boating, fishing, hunting and birding enthusiasts and as an important part of our aesthetic heritage.

Within the last half century Connecticut's tidal marshes have been disappearing at an average rate of about one percent per year. This rate of attrition gives every indication of accelerating in the face of increasing population pressure. If this destruction continues we can look forward to their total loss early in the next century. Once a piece of tidal marsh has been destroyed, it is gone forever. It cannot be restored. An effective conservation program is needed to prevent or reduce further loss. [22]

Immediate steps need to be taken to get as much of the land as possible into the hands of suitable organizations and agencies. The State Board of Fisheries and Game, a nature preservation and governmental agency, owns the largest acreage of tidal marshes in Connecticut.

Private land owners can be alerted to the problem and appealed to to cooperate in various ways in a conservation program. Action must be taken to protect acreage in public ownership. This includes state land and land to be acquired for park purposes. Marshes adjacent to the beaches must be preserved. Parking areas must be located on the higher ground.

Town-owned land must also be given attention. All too frequently dumps, sewage disposal works and other encroachments are permitted by aldermen who do not understand the vital importance of tidal marshes. A small dump may exert far-reaching effects upon adjacent marshland.

Action should be taken to control the dredging and filling of the marshes. The dredging of privately-owned marshes for small marinas will continue to be a most difficult problem as the pressure for increased boating facilities continues to grow. This problem might be solved by conservation agencies acquiring these private wetlands. [23]

Tidal marshes should be zoned against real estate development. It is in the public interest to keep housing and factories out of low-lying areas that are subject to periodic flooding by hurricane tides.

It should be evident that our salt marshes are one of our most valuable resources and should be preserved wherever possible.

LESSON ONE

The first major concepts to explore with the students is to discuss New Haven, the New Haven Harbor, Lighthouse Point and Morris Creek on maps and to discuss the surficial geology of the central lowland. The following topics to be covered are: bedrock geology, glacial geology, postglacial sediments, erosion, and flow of water. Geological terms are explained in map Number One listed below. Students will locate the Morris Creek and Lighthouse Point Park on maps and aerial photographs Numbers 1-5 below. Materials to be used are:

1. *The Surficial Geology of the New Haven and Woodmont Quadrangles with Maps* —Quadrangle Report No. 18 by Richard Foster Flint
2. *United States Department of Interior Geological Survey* —Woodmont Quadrangle and New Haven Quadrangle topographic map.
3. Nine 30” x 36” Cronoflex(aerial photograph obtained from the Engineers Office, City of New Haven.
4. 5 section maps(200 scale) 18” x 24” of Lighthouse Point and the Morris Creek. These were also obtained from the Engineers Office, City of New Haven.
5. 3 aerial photographs (1” = 1000 feet) completed for the State of Connecticut in the Spring 1980. Obtained from Aero Graphics Corp., Box 248, Bohemia, N.Y. 11716 $4.00 each.
6. Map— *Shoreline Changes* . New Haven and Woodmont Quadrangle. This map was prepared by the Coastal Area Management Program, Connecticut Department of Environment Protection. It can be obtained for $1.50. This is to be used to show the shoreline changes that have occurred along the Lighthouse Point Park area during the past century or more.

Since map reading is a very important skill and an integral part of the sixth grade curriculum, initially two weeks will be spent on the above topics which will also be a continuing part of the unit. The maps and aerial photographs used in Lesson One are available at the Yale-New Haven Teachers institute.

The trips to Lighthouse Point Park and Morris Creek will first explore the area from the groin across the beach over to the seawall and up the Morris Creek to the area across from the marina. During these trips throughout the school year the children will carefully note the periodic accumulation of sand along the beach front, the tide lines and the plant life along the mouth of the creek.

These changes will be noted on the worksheet: “Lighthouse Point Park and Morris Creek” (Figure 7).

LESSON TWO

Identifying Plants of the Salt Marsh

1. Teacher-made slides, charts and diagrams will be used in the classroom to thoroughly acquaint the children with the existing plants in Morris Creek which have been discussed above.
2. Periodic trips will take place to observe the marsh plants living during each season. Seasonal changes will be carefully noted.
3. Students will identify the Marsh plants they observe and label them on the worksheet: “Plants in Morris Creek” (Figure 8). The students will also draw the plants observed and indicate on the worksheet where they were found.
4. When the class returns to school all specimens will be examined and classified and their natural habitats will be indicated on a class map of the creek.

LESSON THREE

Identify the Mud Snail, Rough Periwinkle, Salt Marsh Snail, and Blue Mussels

1. Teacher-made charts, slides, and diagrams will be used in the classroom to thoroughly acquaint the children with the snails, periwinkles, and mussels in the Morris Creek discussed above.
2. Periodic trips will be made to observe the marsh invertebrates living during each season. The children will carefully observe seasonal changes.
3. Children will identify the invertebrates in the marsh that they observe and label them on their worksheet: “Mud Snails, Rough Periwinkles, Salt Marsh Snail and Blue Mussels” (Figure 9). The children will also draw the invertebrates observed and indicate on the worksheet where they were found.
4. Upon returning to school, all specimens will be closely examined and classified. Their natural habitats will be indicated on a class map of the creek.

A following trip will cover the crabs in the creek. A worksheet:. “Crabs in Morris Creek” (Figure 10) will be used by the children.

Notes

1. The Connecticut Coastal Area Management Program, *Shoreline Erosion Analysis and Recommended Planning Process* , (June, 1979), p.11.
2. William A, Niering and R. Scott Warren, *Salt Marsh Plants of Connecticut* (New London: The Connecticut Arboretum, 1980), p.3.
3. John E. Sanders and Charles W. Ellis, “Geological Aspects of Connecticut’s Coastal Marshes,” *Connecticut Coastal Marshes: A Vanishing Resource* (New London: The Connecticut Arboretum, 1961), p.I7.
4. John and Mildred Teal, *Life and Death of the Marsh* (Boston and Toronto: Little, Brown and Co., 1969), pp.76-78.
5. S.P. Long and C.F. Marsh, *Saltmarsh Ecology* (Glasgow and London: Blackie and Son, Ltd., 1983), p.12.
6. Teal, p.157.
7. Ibid., p.160.
8. Ibid., p.161.
9. Ibid., p. 164.
10. Ibid., pp. 170-171.
11. Ibid., p. 178.
12. Ibid., p. 178.
13. Ibid., p.179.
14. Ibid., p. 181-182.
15. Ibid., p.198.
16. Ibid., pp. 199-201.
17. William Niering and R. Scott Warren, pp.9-26.
18. John S., Ranking, Jr., “Salt Marshes as a Source of Food,” *Connecticut’s Coastal Marshes: A Vanishing Resource* (New London: The Connecticut Arboretum, 1961), p.14.
19. James Stone, *Birds of Connecticut Salt Marshes* (New London: The Connecticut Arboretum, September 1981), pp.41-43.
20. Ibid., pp. 17-20.
21. Nancy C. Olmstead and Paul E. Fell, *Tidal Marsh Invertebrates of Connecticut* (New London: The Connecticut Arboretum 1974), pp.8-35.
22. Richard H. Goodwin, “The Future: A Call to Action,” *Connecticut’s Coastal Marshes: A Vanishing Resource* (New London: The Connecticut Arboretum, 1961), pp. 31-32.
23. Ibid., pp. 33-34.

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A series of papers discuss the creation and restoration of ecosystems. Chapter 2 deals with “Atlantic Coastal Marsh”.

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A testimony of various authorities as to the value of our tidal marshes and a suggested action program.

Connecticut Aquaculture: A Preliminary Report . State of Connecticut: Department of Agriculture-Aquaculture Division, February 1984.

This report outlines the current status of aquaculture within the state, defines some areas of concern and includes initial recommendations.

Hoyt, Joseph B., *The Connecticut Story* , New Haven: Readers Press, 1961.

Connecticut’s physical geography is the theme of this book, It discusses the intricate interrelationships that develop between men and their environment.

Kochiss, John M. *Oystering from New York to Boston* . Mystic: Mystic Seaport Museum, 1974.

Handbook on oystering. Tells story of decline of oystering due to pollutants in Long Island Sound.

Long, S.P. and C.F. Marsh. *Saltmarsh Ecology* . Glasgow and London; Blackie and Son, Ltd., 1983.

A good source book concerned primarily with coastal salt marshes and it ecosystem dynamics and species distribution.

Long Island Sound; An Atlas of Natural Resources . Connecticut: The Coastal Area Management Program, Connecticut Department of Environmental Protection, November 1977.

A basic resource guide that discusses the physical oceanography of Long Island Sound; shoreline features and the forces that create and influence them; and the numerous plant and animal species found in and along the Sound.

Longwell, Chester R. and Edward S. Dana, *Walks and Rides in Central Connecticut and Massachusetts* , Hamden: The Shoe String Press, Inc. 1932 and 1961.

This book was designed as a guide to localities in central Connecticut and Massachusetts to explain various geologic features and to outline the geologic history of the region.

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A series of papers that discuss the creation and restoration of ecosystems. Chapter 2 deals with “Atlantic

Coastal Marshes".

Niering, William A. *The Life of the Marsh: the North American Wetlands.* New York: McGraw-Hill Book Company, 1966.

Source book of North American wildlife, conservation, marsh ecology and wetlands. Beautiful photographs and diagrams.

Niering, William A. and R. Scott Warren. *Our Dynamic Tidal Marshes: Vegetation Changes as Revealed by Peat Analysis* , Bulletin No. 22. New London: The Connecticut Arboretum, January 1977.

This pamphlet presents the methodology employed in sampling the tidal marsh peat and in identifying the plant remains.

Niering, William A. and R. Scott Warren. *Salt Marsh Plants of Connecticut* , Bulletin No. 25. New London: The Connecticut Arboretum, June 1980.

Illustrated guide to 22 different plants that grow in our tidal wetlands.

Olmstead, Nancy C. and Paul E. Fell. *Tidal Marsh Invertebrates of Connecticut* , Bulletin No. 20. New London: The Connecticut Arboretum, October, 1974.

Descriptions and illustrations of over 40 species of mollusks, crustaceans, arachnids, and insects found on our tidal marshes.

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Contains a study of salinity in the salt marsh and the drought near the upper limits of the marsh. It also studies the drought effects in the dunes.

Shoreline Erosion Analysis and Recommended Planning Process . State of Connecticut: Department of Environmental Protection, Coastal Area Management Program, June 1979.

A planning report that discusses the geological properties and form of Connecticut's coastline, and its interaction with winds, waves and tides. Contains statistics on the nature and extent of shoreline erosion and discusses the erosion control alternatives.

Stone, James. *Birds of Connecticut Salt Marshes* , Bulletin No. 27. New London: The Connecticut Arboretum, September 1981.

Illustrations and descriptions of 24 birds commonly seen on tidal marshes.

Teal, John and Mildred. *Life and Death of the Salt Marsh* . Boston and Toronto: Little, Brown and Company, 1969.

A source book about the marshes of the East Coast of North America; how they were formed; why they continue to exist; the interplay of plants and animals; and the effect man has on the marsh.

Figure 1—New Haven Harbor, New Haven, Connecticut
(figure available in print form)
Figure 2—Life on a Marsh
(figure available in print form)
Figure 3—Marsh Plants
(figure available in print form)
Figure 4—Bird of the Salt Marsh
(figure available in print form)
Figure 5—Invertebrates of the Salt Marsh
(figure available in print form)
Figure 6—Vertebrates of the Salt Marsh
(figure available in print form)
Figure 7—Lighthouse Point Park and Morris Creek
(figure available in print form)
Figure 8—Plants in Morris Creek
(figure available in print form)
Figure 9—Mud Snails, Rough Periwinkle, Salt Marsh Snails, and Blue Mussels
(figure available in print form)
Figure 10—Crabs in the Morris Creek
(figure available in print form)

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