

# OUR CAPE COD SALT MARSHES



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PRESERVATION OF CAPE COD  
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## ACKNOWLEDGEMENTS

Cape Cod is fortunate not only in its extensive unspoiled salt marshes, but in the large number of resident scientists who are experts in the field. This pamphlet owes much to John and Mildred Teal's "Life and Death of the Salt Marsh," the classic account of the tidal wetlands of the Atlantic coast, to recent papers by Dr. Teal and his colleague, Dr. Ivan Valiela, and to Mildred Teal's thoughtful reading of my manuscript. Dr. A. C. Redfield whose studies of the Barnstable marshes are basic to an understanding of all Cape marshes took time to talk with me and to read and criticise the manuscript. Dr. Norton Nickerson gave me the benefit of his broad experience in conservation work throughout the state as well as his findings on the relation between salt marshes and the Cape's ground water supply. I am also indebted to Don Schall of the Cape Cod Museum of Natural History, Priscilla Bailey of the Massachusetts Audubon Society, Brenda Boleyn of Cape Cod Community College, and to Allison Snow of the University of Massachusetts. Whatever usefulness this pamphlet can be judged to have is greatly enhanced by the perceptive drawings contributed by Marcia and Edward Norman.

D. S.

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## TRICENTENNIAL SUMMER

*In generations before mine, the salt marshes had been the great Environmental Outlet (you can dump it here wholesale) for the offal of our civilization. A marsh was a place to stumble over old rubber tires, corrosion-resisting beer cans, shards of glass and Unidentifiable Plastic Objects. It was a place to be defiled by raw sewage and chemical wastes. Or it was a place to be "reclaimed" from the sea by filling it solid and sterile, for personal convenience or profit. It was not until my time that people learned to appreciate the resources and, yes, even the beauty, of marshlands. In my time it was too late.*

*The geofoil bus crept along Route 6. "All Out for The Marsh!" our robot driver chirped. Across the road a fleet of sightseeing buses from the mainland was discharging passengers. Now that skyscrapers shadowed the beaches, The Marsh was the Cape's most popular tourist attraction. Each summer people came from all over the megalopolis to visit the last salt marsh in the Northeast.*

*At a distance we could see the high stockade fence that enclosed the marsh. Once there had been no fence and people walked around without supervision. But so many tourists had collected so many grass blades, crabs and snails as souvenirs that the marsh's existence was threatened. Two decades earlier, the New England Society for the Preservation of Salt Marshes had erected the fence and the National Seashore had taken on the job of policing the area, night and day.*

*Park Rangers herded us into line, four abreast. As the gate swung open to admit us, there was a spontaneous "Ah!" from the visitors. Five acres of lush green grasses rippling in the breeze, creeks of blue water winding their way to the bay. Many of us had never seen so much open space before. We took deep breaths of the salt air, savoring its freshness, as we followed the path around the marsh's perimeter.*

*My daughter grabbed my hand when we reached the first exhibit. A long-legged blue-gray bird was perched on a sign. "Is it real?" she asked. Poor child! The only birds she knew were gulls and English sparrows.*

*"It used to be." I pointed to the sign which read "Great Blue Heron. Last sighted on Cape Cod in 2037. A small flock survives in the Florida Everglades."*

*Every few steps we paused to look at another mounted bird, read another sign: "Canada Goose. Small numbers still breed on the Arctic coast and winter around the Gulf of Mexico. Occasional visitor to Cape Cod dur-*

ing migrations.” “Black Duck. Last seen on Cape Cod in 2047.” “Seaside Sparrow. Believed extinct.” “Marsh Hawk. Believed extinct.” My daughter couldn’t tear herself away, but I was beginning to find the signs monotonous.

Slowly we followed the trail to the display of animals that had once inhabited the marsh . . . Diamond-backed Terrapin -- “Last sighted on Cape Cod in 1987” -- raccoon and muskrat, meadow mouse and shrew. Even a Norway Rat had a place in the lineup, although goodness knows they weren’t extinct. Close to the fence, at the high tide line, beer cans and plastic bottles which had washed in from the bay were scattered about. I thought this touch of realism in dubious taste, but it brought a chuckle from some of the other tourists.

Then the trail led to a creek. Standing on a duck-board platform at the water’s edge, we could see movement on the opposite shore. Scores of little crabs scuttled across the mud, waving oversized claws. “Uca Pugnax,” a sign above them said. “Once abundant, they are now the only known colony of fiddler crabs on Cape Cod.” Arrows pointed to other displays -- ribbed mussels at the base of the grasses and tiny brown snails climbing the stalks.

“They’re living!” a boy shouted. He reached out his hand to touch a snail, but a ranger stopped him.

As we approached the bay, an exhibit of fish that used to swim in the marsh creeks drew everyone’s attention. My daughter was fascinated by a flat flounder while I gazed longingly at a big bluefish whose legend read “Caught in Cape Cod Bay, August 21, 2016. Believed to be the last bluefish in Atlantic coastal waters.” One elderly tourist blew his nose audibly. “When I was a boy, I caught bluefish,” he told his wife.

At the end of the trail there was a display of the shellfish formerly found on the tidal flats . . . Oysters, clams, quahogs, and the delicately fluted shells of scallops . . . It was like studying a fossil record from a bygone day. We had read about Cape Cod oysters and quahogs, of course, but few of us had ever tasted an old-fashioned chowder or clam pie. I had tried to make a chowder once, using canned clams from China, but the family pronounced it a disaster and even the cat turned up her nose at it.

From the bay, the trail doubled back to the exit. We paused at the gate to gaze across the salt meadow, storing up the memory to take home with us. I was feeling glum as I thought of the richness and variety of life in the past, but my daughter’s eyes suddenly lit up with mischief. A buzzing insect had landed on her arm. She slapped it smartly, then looked up. “Greenhead fly. Last seen on Cape Cod on July 12, 2076. Believed extinct.”

## SOME HISTORY, ANCIENT AND OTHERWISE

Since the first Europeans settled in North America, millions of acres of salt marsh have been filled, dredged, diked or used as dumping grounds. The rate of destruction has accelerated in recent decades. Massachusetts still had sixty thousand acres of salt marsh at the end of World War II. Today it has a little over forty thousand. A quarter of the marshes along the New Jersey coast, from Atlantic City to Cape May, were destroyed during the same period. Connecticut has lost almost half of its salt marshes. Long Islanders have seen thirty per cent of theirs buried under fill and blacktop in a single decade.



In Massachusetts, filling a salt marsh is a time-honored custom dating back to the Puritans. Bostonians began it in 1641. Now more than half of the city — including Back Bay, Fenway Park and the Public Garden — is built on filled-in land. But while Boston's colonists attacked the wetlands, other settlers were sailing across the bay from Plymouth to build their homes alongside the marshes of Cape Cod.

To those transplanted English families the salt meadows which bordered the Cape's bay shore must have seemed like Eden. The great stretches of green grass meant unlimited pasture land for their cattle. Cows and sheep were turned loose to graze on "the hay grounds" during the warm months of the year. In winter the salt hay, dried on wooden staddles on the marsh, provided the animals with bedding and fodder. The tall grasses which grew close to the water were used as thatch for the settlers' roofs; rushes from the marsh's landward border supplied caning for chairs.

The tidewater creeks teemed with fish and shellfish. The colonists caught herring as they swam upstream in the spring and set traps for the eels that

swam down to the sea in fall. Tens of thousands of ducks and shorebirds lingered on the marshes to feed during their semi-annual migrations; even a flintlock could bring down three or four birds with a single shot.

The immense flocks of birds are gone, some driven close to extinction by overhunting in the 19th century, but Cape Cod's marshes are still among the most extensive and least spoiled in New England. The marshes are young, as geological time is reckoned. Egypt's Great Pyramids were under construction when the first grass seeds sprouted on a tidal flat in Cape Cod Bay. No observer was there to record the event for the last of the glaciers that formed the Cape had only recently receded and few plants and animals had colonized the inhospitable shores. Fortunately, however, the history of the marshes has been painstakingly reconstructed by Dr. Alfred C. Redfield of Woods Hole Oceanographic Institution who has spent many years studying the Great Marshes of Barnstable.<sup>1</sup>

Barnstable's marsh, four thousand acres of waving grasses and winding creeks, lies west of Barnstable Harbor in an enclosure formed by Sandy Neck, a six-mile long barrier beach which roughly parallels the bay shore. Underlying the grasses are beds of peat, many feet deep. Formed over the centuries by decaying plants and sediment from the tidal waters that wash over them, these beds contain the story of the marsh, for those who know how to read it.

After sounding the marsh with a rod to determine the depth of the peat beds, Dr. Redfield used Carbon-14 dating to establish the ages of the deposits. Samples of peat taken from a bed 23 feet below the present mean high water level were found to be about 3,660 years old. In another area where the peat was sounded to a depth of 30 feet, the deposits go back to a probable 4,000 years. Carefully mapping the underlying topography of the marsh and its relation to sea and shore, Dr. Redfield was able to reconstruct its development.

The level of the sea was 18 feet lower than it is now, and Sandy Neck was only a mile long when the first clumps of marsh grass appeared on its inner shore. As Dr. Redfield's drawings show, the sandspit slowly grew, affording protection to the developing marsh. A thousand years later when it was half of its present length, the grasses formed a continuous border around the margins of the enclosure. Sand and silt trapped by the grasses kept pace with the rising seas, enabling the marsh to invade the harbor and to spread over the inundated upland which surrounded it.

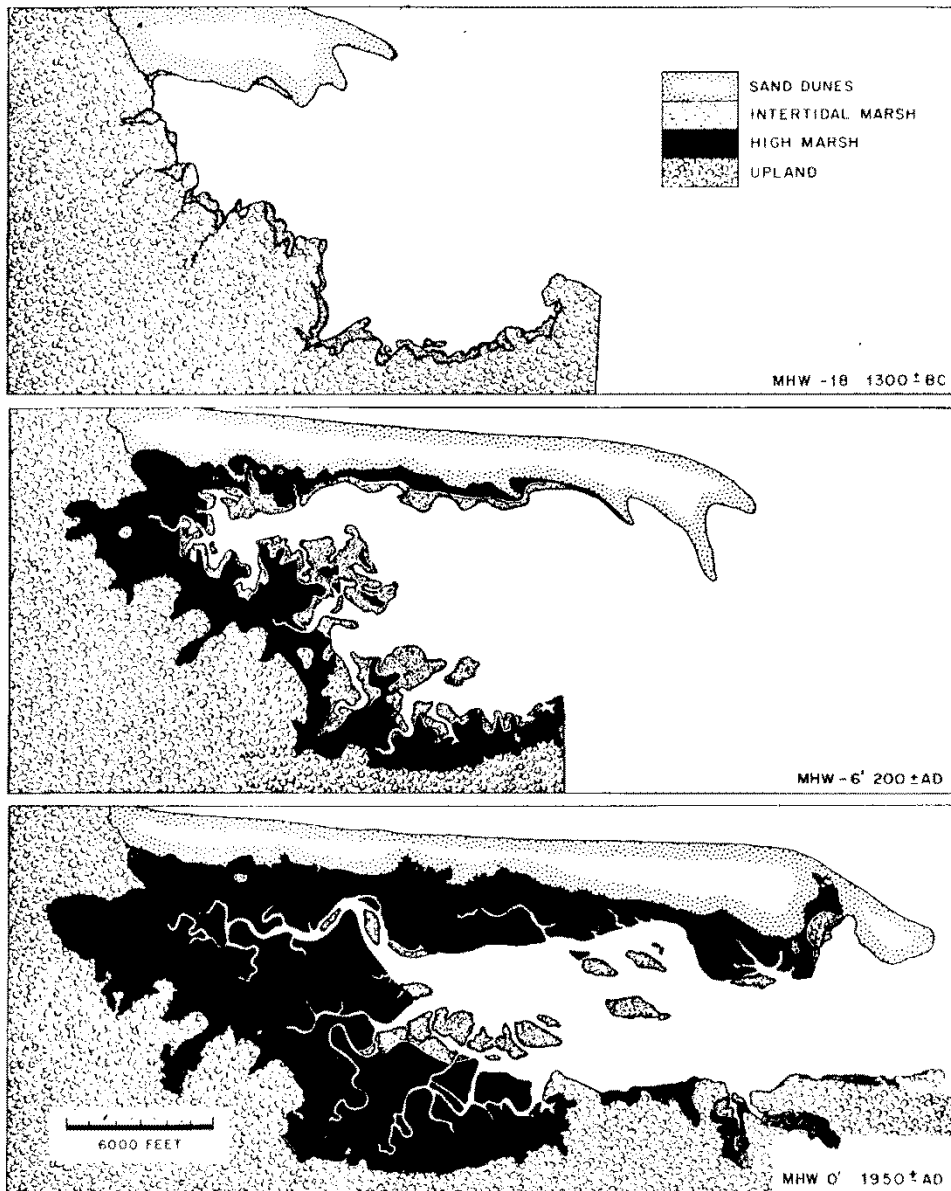
Today, two-thirds of the area enclosed by Sandy Neck is salt marsh. The marsh is still growing, although at a slower rate than in the past. In another thousand years, Dr. Redfield predicts, it may fill almost all of Barnstable Harbor.

Other Cape marshes are much younger than the Great Marshes. In 1605 after explorer Samuel Champlain visited Eastham, he drew a detailed chart of Nauset Harbor. His map shows a broad expanse of open water punctuated by "bancs de sable" (sand banks), with only one small pocket of marsh. Now

<sup>1</sup> (1) "The Barnstable Marsh", Proc. Salt Marsh Conference, Marine Institute, Univ. Georgia, March 25-8, 1958.

(2) "Ontogeny of a Salt Marsh Estuary", Science, Vol. 147, pp. 50-5, 1965.

(3) "Development of a New England Salt Marsh", Ecological Monographs, vol. 42, No. 2, pp. 201-237, 1972.



Dr. Redfield's reconstruction of the development of Barnstable's Great Marshes, from 1300 B.C. to 1950 A.D.

some five hundred acres of marsh grasses cover the "bancs de sable" and the entrance to the harbor has shifted to Orleans.

In the 1720s when Wellfleet was first settled, many of its fishermen-farmers built their homes on Bound Brook, Merrick, Griffin and Great Islands. These were true islands then with harbors deep enough for a whaling fleet. Gradually the harbors filled in and a barrier beach growing southward from Truro linked the islands to the mainland and to each other. By the 1850s, the islands were sealed off from the sea except at the mouth of the Herring River. Marsh grasses took over the once-deep harbors and the whaling fleet moved elsewhere. When geologist Nathaniel S. Shaler studied the "Sea-Coast Swamps



In Champlain's map of Nauset Harbor, drawn in 1605, "M" indicated sand banks and shoals. The only marsh shown was the small grass-covered area, lower right.



of the Eastern United States”<sup>2</sup> in 1886, he reported that Wellfleet’s Herring River marshes covered 3,416 acres.

However, the history of Cape Cod’s marshes has not been all in one direction. Natural forces encouraged their growth, but there was also heedless destruction by men. In the early years, the destruction was piecemeal. A corner of a salt meadow was filled to provide a site for a barn; a creek was dredged to permit the passage of boats, with the spoil dumped on the marsh. When the hunting of shorebirds for the Boston market brought income to Cape farmers, marshes were diked to create salt ponds to attract more birds. After the days of market-gunning were over and cranberries became a cash crop, marshes were diked to create fresh-water bogs where the red berries could be grown.

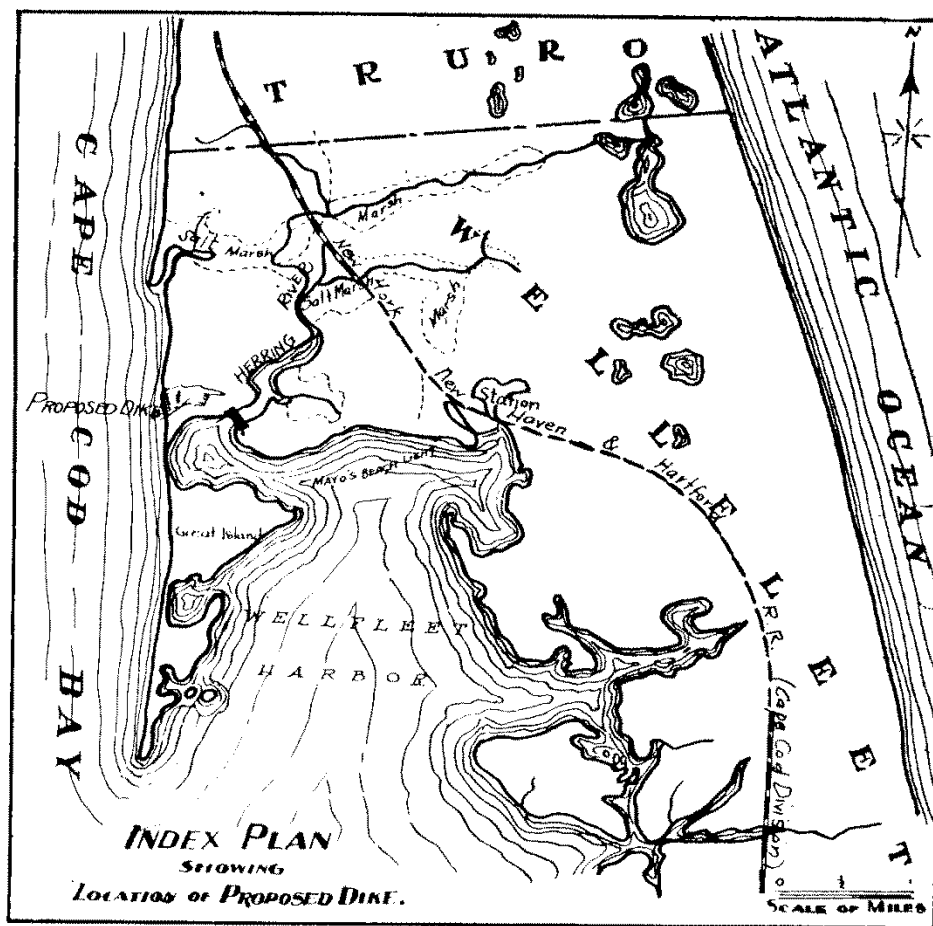
Probably the largest salt marsh to be destroyed in the 19th century was the marsh at East Harbor, between Truro and Provincetown. The annual yield of salt hay was once so valuable that six acres were set aside for the support of Truro’s minister; when men from other towns came by boat to cut the hay, Truro charged the “foreigners” six shillings a sloop load. But East Harbor was shoaling in and the townspeople feared that sand blowing in from the north would wash into Provincetown Harbor as well. In 1868, a massive dike, 1400 feet long and 75 feet wide was built. This earthen dam, which underlies the present highway to Provincetown, sealed off East Harbor from the sea. The harbor’s open waters became a brackish pond, Pilgrim Lake. The salt marsh was drowned and a cattail swamp grew up along its edges.

Then came the railroad. Pushing down-Cape from 1848 to 1873, it crossed and re-crossed marshlands, cutting off hundreds of acres of salt meadow from their supply of salt water. If you walk along a stretch of abandoned track in many places today, you can still see a flourishing salt marsh on the bay side of the roadbed and the cattails, reeds and shrubs of a fresh marsh on its landward side.

The 20th century brought the automobile. As farms gave way to filling stations and summer visitors promised to be more lucrative than salt hay, people began to look at marshes in a new way. One of the first to believe that they could be converted into valuable real estate was Lorenzo Dow Baker of Wellfleet. Captain Baker, who had pyramided a cargoload of bananas into the giant United Fruit Company, was convinced that the Cape’s future lay in the tourist trade. But if Wellfleet was to become a booming summer resort like the winter resorts he had visited in Florida, something would have to be done about its marshes. Not only did they occupy too much of the town’s waterfront, they also bred mosquitoes which were anathema to summer visitors.

To a man of action like Captain Baker, the solution was obvious — dike and drain the marshes. In the real estate market of his day, salt meadowland had dropped from \$80 to \$5 an acre. He owned an extensive tract of salt marsh along the Herring River. Once freshened, this “useless” land could become at the very least a productive cranberry bog. Soon the warrant for every town meeting included articles asking approval for dikes in different parts of Wellfleet. There were four under way at the time of Captain Baker’s death in 1908 and voters were asked to complete them in his memory. Speaking at town meeting the following year Baker’s eulogist said, “His ideal was to

<sup>2</sup> Shaler, N.S. “Sea coast Swamps of the Eastern United States”, U.S. Geological Survey, Annual Report, 6, 1886.



A 1906 map of Wellfleet shows the proposed Herring River Dike.

reclaim the marshes and rid the town of the mosquito pest.”<sup>3</sup>

The most important of the “reclamation” projects inspired by Captain Baker was the dike which cut off the Herring River marshes from the sea. A portion of the vast marsh had freshened after the advent of the railroad, but some two thousand acres of salt meadow bordered the river and its tributary creeks. As an example of well-intentioned tampering with nature whose results are still being debated, the story of the dike is worth telling in some detail.

Even though Captain Baker gave Wellfleet the land on which the dike was built, construction costs came to \$20,000, with the state paying half and the town raising its share by the sale of bonds. Ten thousand dollars was an enormous sum for a town whose annual expenses averaged only \$15,000. However, the Boston engineers who designed the dike assured voters that there would be no tax increases because the town would save the money formerly spent for mosquito control. Not only would the dike “mean the extermination of a large percentage of the mosquitoes which now infest the town,” it would also bring “an increase generally in the values of both marshlands and uplands, because there is a general demand for the former for Cranberry, Hay,

<sup>3</sup> Wellfleet Town Meeting Records, 1903-1909.

Vegetable, and Fruit growing . . . The uplands, especially those near the seashore and ponds, would at once be in demand for sites for summer residents, were mosquitoes reduced to a normal quantity, and every homestead would have a greater selling value."<sup>4</sup>

Not all of Wellfleet's voters favored the dike. Twelve citizens had even brought suit in Superior Court in Barnstable in a fruitless attempt to stop it, perhaps fearing that it would interfere with the valuable herring run. For almost two centuries, townspeople had been harvesting the herring (more properly called alewives) when the fish came in from the bay each spring and swam up the Herring River to spawn in the ponds. In the early days, whole families used to gather on the river banks to net tens of thousands of the silver-sided fish. In a later period, rights to the herring fishery were auctioned off to the highest bidder each year, providing a welcome supplement to the town treasury.

To protect the run the engineers provided a gate valve which could be opened to allow the fish to swim upriver in the spring and return to the bay in fall. After a few years, however, the iron valve rusted, leaving the gate in a closed position, with the herring outside, looking in. Rights to the herring fishery had been auctioned for \$355 in 1906. They brought \$70 in 1910. After that there were no more auctions -- because there was nothing left to sell.

The dike-builders had also installed two flapper valves to permit a one-way flow of water from the river to the bay. With the river virtually dammed at its mouth, the marshes were less well drained than before, and the mosquitoes worse. In 1910, two years after the completion of the dike, the town spent \$3,000 "to establish proper outlets for the water in the meadowlands." Soon the Dike Committee became a Drainage Committee which was concerned for many years thereafter with abating "the mosquito pest."<sup>5</sup>

The dike did succeed, however, in cutting off all salt water from the marsh. One immediate result was the disappearance of many kinds of fish that had formerly used the lower reaches of the river and the creeks as nursery grounds. Since this included several species whose main diet was mosquito larvae, it is not surprising that the town's annual outlay for mosquito control was on the increase.

The oysters and clams in the area behind the dike quickly died. So did the extensive beds of eel grass where scallops and mussels had found shelter and huge flocks of black ducks used to feed in winter. The marsh grasses were killed too, throughout the river valley. In 1913 a resident of Bound Brook Island sued the town because the dike had damaged his salt meadow, and still another town committee was appointed to decide how much to pay him.<sup>5</sup> No one then realized that this cost was miniscule when compared to the long-range damage done to the fish and shellfish of the coastal waters by the destruction of two thousand acres of productive salt marsh.

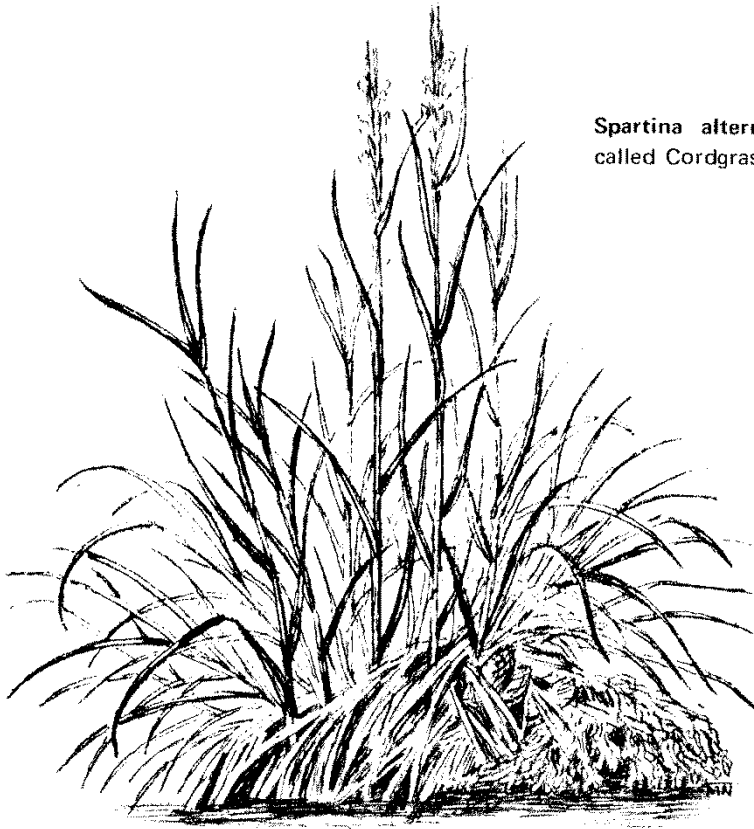
On the plus side there was little to report. Cattails and other fresh-marsh plants soon covered the scars left by the dead marsh grasses. The upper reaches of the closed-off marsh gradually filled in with trees and shrubs, but the water table remained too high for farming and the soil was too poor. The anticipated

<sup>4</sup> Wellfleet Town Reports, 1907, as quoted in Snow, Allison "Herring River Marsh Study", 1974.

<sup>5</sup> Wellfleet Town Meeting Records, 1910-1916.

demand for home sites on the "reclaimed" marsh never materialized. Decades later, a golf course and two cottages were built along the borders of the marsh, but that was all.

Wellfleet's tourist boom did not begin until after World War II. By then the Cape's population growth was reshaping its landscape. Twenty-seven thousand people lived year-round on Cape Cod in 1920. The figure rose to 47,000 by 1950. Today the Cape has 126,000 year-round residents and a peak summer population of almost half a million. The quadrupling population has brought urban sprawl to parts of the upper Cape. Shopping centers, motels, restaurants have increased beyond even Lorenzo Baker's imagining and so have real estate prices. An acre of land along the water which sold for \$500 in 1940 -- if it sold at all -- now brings \$50,000.



*Spartina alterniflora*, commonly called Cordgrass

Inevitably, the soaring population has affected the marshes. Aerial photographs show 16,142 acres of salt marsh in Barnstable County in 1951. Twenty years later there were only 13,184.<sup>6</sup> What happened to those lost acres? In one mid-Cape town, a developer with a vision of Venice -- or Florida dredged a marsh creek and sold lots along its course. In other places marshes were destroyed to build marinas and beaches. Individuals filled in bits of salt meadow here and there to create land for summer cottages. But marshes which present problems of water supply, waste disposal, and wet basements, are

<sup>6</sup> "Remote Sensing: 20 Years of Change In Barnstable, Dukes and Nantucket Counties", University of Massachusetts, 1974.

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costly to develop except on a large scale, and the Cape has so far been spared the kind of despoliation that has plagued Long Island and the Jersey shore.

Most of the salt-marsh acreage which disappeared in the 1950-60s was destroyed by highway construction. As the railroad had done a century earlier, a network of new roads cut across tidal marshes, barring them from salt water. The wetlands are still there, but they are covered with cattails and reeds, marsh elder and sumac, steplebush and ironweed. As lovely in their way as the lush green salt meadows, these fresh marshes contribute far less to the chain of energy which supports life along the shore and in the coastal waters.

## THE PRODUCTION LINE

When the first wave of tourism broke on the shores of Cape Cod, few people recognized the value of a salt marsh. Now, thanks largely to the new science of ecology, we know it as a complex energy factory. The salt-marsh production line starts with the grasses. In a quiet cove, on a sand flat behind a barrier beach, along the edge of a tidal creek, a few seedlings of *Spartina alterniflora* establish a beachhead. This sturdy broad-leaved grass, commonly called thatch or cordgrass, is one of a group of salt-tolerant plants. It cannot survive underwater as eel grass does, but it thrives on a salt-water bath twice each day. Growing above the mid-tide level, it sends out underground stems. New shoots grow from its rootstock until a small island of cordgrass has formed. The grass blades slow down the tidal currents so that the water releases some of the sediment it carries and the cordgrass island grows higher, broader. Each fall, when the grass dies down, its leaves add to the accumulation. Soon the surface of fine sand where the original seedlings sprouted becomes a mixture of mud and plant debris. Eventually it will be a peat bed many feet thick.

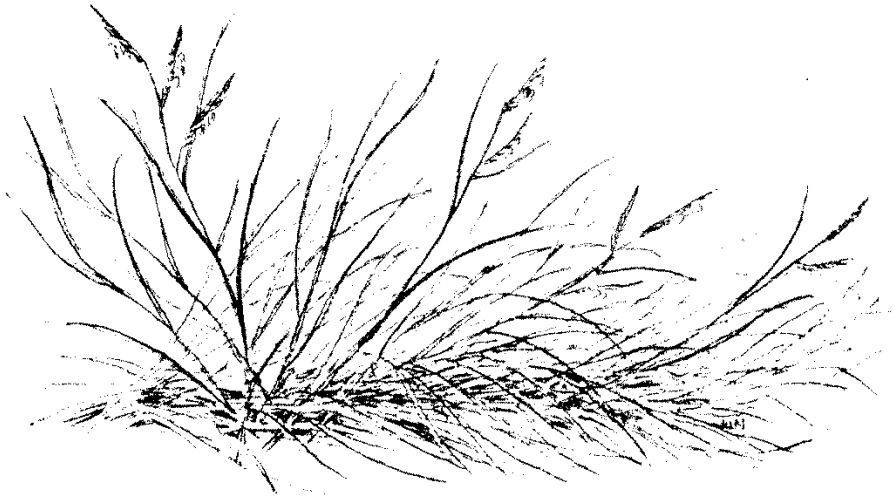
Season after season, the cordgrass continues to grow. Invading the shallow waters of the bay or following a tidal creek inland, it traps more and more sediment. Over the years, the surface of the marsh rises higher, higher, until it is above the high tide level. The cordgrass survives at the edge of the bay and along the borders of a creek, but its place on the marsh proper is taken by *Spartina patens*, a shorter, finer grass known as salt-meadow grass. Salt-meadow grass is bathed by salt water only when the high spring tides flood the marsh, around the times of the new and full moon.

The vigorous *Spartinas* are the most important plants in the salt marsh, but a small number of others have also adapted to the salty, peaty soil. *Distichlis spicata*, whose common name is spike grass, grows alongside salt-meadow grass. Closely resembling its neighbor, it can be recognized by its shorter leaves which grow close together along its stem. *Juncus Gerardi* — actually a rush although commonly called black grass — takes its stand near the salt-meadow spike grass community, and along the landward edges of the marsh.

Occasionally, the marsh surface develops shallow depressions known as pond holes or pannes where water collects at the highest tides. In the pond holes and along the salt-rimmed sandy borders of the marsh are the *Salicornias*, stubby plants with scalelike leaves, and sea lavender (*Limonium carolinianum*). The *Salicornias*, known as salt-wort, glasswort and chicken toe, store excess salt in their fleshy stems, as you can tell by tasting them. Wild-food enthusiasts

pickle them or use them fresh in salads, as the early settlers did. Sea lavender, also called marsh rosemary, gets rid of salt through its leaves which grow in a rosette on the ground. As the leaves turn brown and die, a stalk topped with clusters of tiny lavender flowers makes its appearance. These are so popular for winter bouquets that the plant is threatened with extinction in some places.<sup>7</sup>

Looking out over a salt marsh for the first time you may see only an expanse of green. But as you look more closely, you can distinguish the indi-



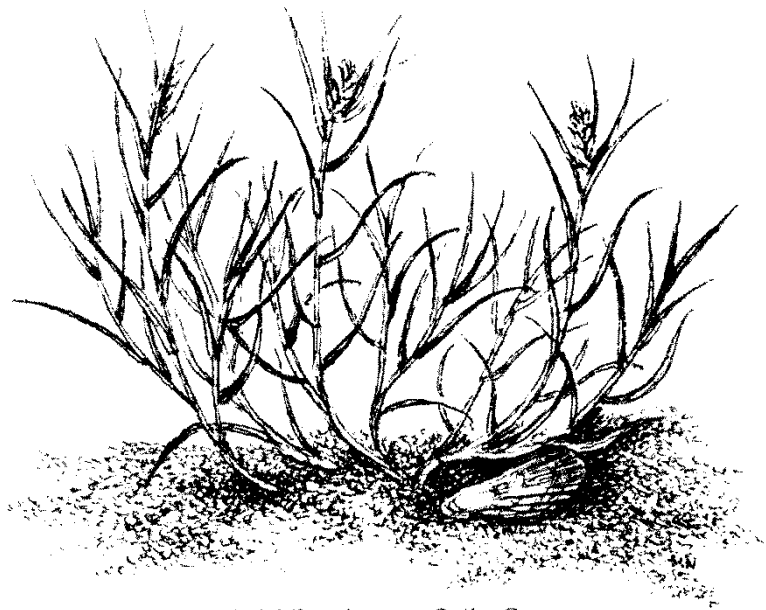
***Spartina patens*, the familiar Salt-Meadow Grass**

vidual kinds of vegetation that make up the marshland community. At the water's edge, the cordgrass is a dark-green border which sways gently on a rising tide. Up to six feet tall where conditions are favorable, it becomes a ribbon of deep green as it snakes through the marsh, following the curves of the creeks. One to two feet high, salt-meadow grass and its companion, spike grass, are an apple-green carpet on the surface of the marsh. By midsummer, the slender stems of salt-meadow grass have bent at their bases to form flattened swirls known as cowlicks.

Red-brown patches near the landward side of the marsh are stands of black grass, their distinctive color coming from their buds and flowers. Beyond these, on the high dry edge of the marsh are the soft grey-greens of the *Salicornias* and the purple mist which indicates sea lavender in bloom. In the fall, when Cape Codders travel to New Hampshire to see the autumn foliage, the marshes put on their own subtle display. Then the brilliant greens of the salt-meadow turn to tawny and rust and the stubby *Salicornias* become strawberry-red.

Hidden by their tall neighbors are still other groups of plants – primitive algae lacking roots, stems and leaves, and the even more primitive microscopic bacteria. If you part the tangled blades of salt-meadow grass, you can see colonies of algae growing as flat green mats on the surface of the mud. Other algae float in the creeks, moving in and out of the marsh with the tide. Tiny though they are, they make a significant contribution to the energy chain of the marsh.

<sup>7</sup> The wiry stalks are difficult to break without uprooting the whole plant, but if you cut them with garden clippers, the plant will live to bloom another year.



**Distichlis spicata** or Spike Grass

## WHO EATS WHAT?

An old marsh grass recipe says: take carbon dioxide from the air and hydrogen from the water. Cook with energy from the sun until you have sugar. The recipe, of course, describes the process of photosynthesis, which means “putting together with light.” Molecules of chlorophyll, the plants’ green coloring matter, absorb energy from the sun and use it to transform carbon dioxide and hydrogen into glucose, a basic food. In the leaves of the plant, the sun’s radiant energy is converted into chemical energy. Stored in the glucose molecules, it permits the plant to grow and to manufacture other foods: carbohydrates, fats, proteins. These in turn support the animals that feed on the plants and, ultimately, the humans who feed on both. Milk and eggs, hamburgers and bluefish, bread and chocolate cake all derive from the photosynthetic activity of plants.

Ecologists speak of green plants as “producers” and all other living things as “consumers.” Some of the creatures who live in the marsh are “primary consumers” because they feed directly on the producing plants. These vegetarians are then eaten by “secondary consumers” – who are in turn eaten by “tertiary consumers,” and so on. The flow of energy continues even when the plants and animals die. Their decaying bodies, broken down into detritus, provide food for other marsh-dwellers as well as nutrients for the grasses.

The chain of energy flowing through the marsh is actually a web whose strands must be followed one by one in order to understand their convolutions. One primary consumer, for example, is the salt-marsh snail (*Melampus bidentatus*), a small, shiny brown snail found in great numbers under bent stalks of salt-meadow grass. Sometimes called a coffee-bean snail because of its size and color, it feeds on decaying grasses. An air-breather, equipped with lungs rather than gills, it climbs the stems of salt-meadow grass when the tide is high. There it is highly visible to such secondary consumers as the sharp-

tailed and seaside sparrows, black ducks and clapper rails. All of these birds nest in the marsh and feed on snails. The sparrows in turn may fall prey to marsh hawks, or to owls who are night visitors to the marsh. For ducks and rails, the food chain leads to the ultimate consumer, humankind.

Thus the energy flows from salt-meadow grass to snail to seaside sparrow to hawk, or from grass to snail to duck to man. But it is more complicated than that. Black ducks are also primary consumers who eat the seeds and peck at the rootstocks of salt-meadow grass. Clapper rails eat insects, small fish and crabs; the sparrows are insect-eaters, too.

And that's not all. Although they are essentially land creatures, salt-marsh snails are linked to the sea by their young. The snails lay their eggs at the base of the grass stems after a high spring tide. Two weeks later when the eggs hatch, another spring tide carries the young away. As shell-less swimming creatures they live in the marsh creeks or in the waters just offshore. There they are part of the zooplankton on which fish and shellfish feed. After a fortnight, those who survive return to the marsh to settle down to slow-moving snail life.

Other snails of the marsh follow slightly different pathways along the energy network. Living on the ground floor of the cordgrass jungle, the rough periwinkle (*Littorina saxatilis*) feeds on algae and decaying grasses and is eaten by ducks, rails and shore birds. But its young are tiny snails, complete with shells when they are born, and never spend time in the sea.

Mud snails (*Nassa obsoleta*) on the other hand, lay their eggs on shells and rocks below the tide line and their young join the zooplankton during

**Juncus Gerardi**, a rush, is known as Black Grass.



their first days of life. As adults, living on the seaward edge of the marsh, they are both primary and secondary consumers. A part of their diet consists of diatoms, golden-brown algae which grow on the mud. But they are also carnivores who devour dead crabs, fish and occasionally other snails.

Fiddler crabs are also primary consumers. Three species of these lively little crabs — *Uca pugilator*, *Uca minax* and *Uca pugnax* — live in the grass thickets and along the banks of Cape Cod marshes. At high tide they stay in their burrows which are slanting tunnels up to three feet long. When the water retreats from the marsh they come above ground to eat algae, decomposing grasses and



the remains of animals. They scoop up the mud with their claws – the male using only his small claw, the female both – and put it into the mouthlike openings to their digestive tracts. There they sort through the sediment, swallowing the small particles and spitting out the larger bits. Like earthworms in a garden, their tireless reworking of the mud, both in feeding and in digging burrows, serves to aerate the waterlogged soil and to break down plant and animal remains, thus making the latter more accessible to other detritus feeders.

And that's not all. Fiddler larvae (young) also spend their first weeks of life in the creeks and bay as part of the zooplankton. Female fiddlers carry the eggs on their abdomens until they are ready to hatch. Then they bring them to the banks of a creek so that the larvae can float away with the current. Those who escape from the plankton-eaters come back to the marsh to start new fiddler crab colonies.

Fiddlers are important in the diet of ducks, herons, and other wading and shore birds. Whimbrels seem to be especially adapted for fiddler-catching as they poke their long curved bills into the crabs' burrows to seize the big claw of a hapless male. During the fall migration season, flocks of whimbrels visit Cape salt marshes.

Blue crabs which swim in the marsh creeks and lurk in the mud at low tide also prey on fiddlers. So do the diamond-backed terrapins which still nest in some Cape marshes. These handsomely sculptured turtles are protected now but a century ago their position in the energy chain was a springboard to the soup-pot.

More than four hundred kinds of insects have been found in salt marshes. Grasshoppers, crickets, ants, stink bugs, and caterpillars feed directly on the grasses. Plant hoppers and aphids pierce the grass blades with their sharp beaks to suck the juices. The larvae of tiny flies live in the stems of the plants and feed on them. Springtails, sowbugs, mites and small beetles find food under the decaying leaves of last year's grass crop, and mosquito larvae take nourishment from plant and animal matter in pools of standing water.

A host of other insects – beetles, flies, dragonflies, wasps, spiders – eat these primary consumers. Among the fiercest of the insect predators are the larvae of greenhead flies. Female greenheads lay their eggs on the grass stems in mid-summer. Their young are inch-long maggots, who winter in the mud at the base of the plants, feeding on insects, worms, snails and other greenhead larvae. Usually the following summer, when the weather is warm and dry, they emerge as buzzing two-winged flies. Then the females seek the mammalian blood that they need to develop their eggs. The cows and horses which formerly satisfied this need have disappeared from the marsh environment but bikini-clad mammals are in good supply on neighboring beaches.

If you have been a blood donor for a greenhead, you can get some grim satisfaction by visiting a marsh in late July and watching the swallows as they line up on nearby telephone wires. Almost in unison the birds wheel and dip over the tops of the grasses, catching greenheads in midflight. They are not alone. When the insect population explodes in summer, scores of other birds – kingbirds, robins, redwings, yellow-throats – come to the marshes to feed.

For a few weeks in spring and fall, the marsh birds seem to have their own population explosion. Cape Cod is on the Atlantic flyway, the route

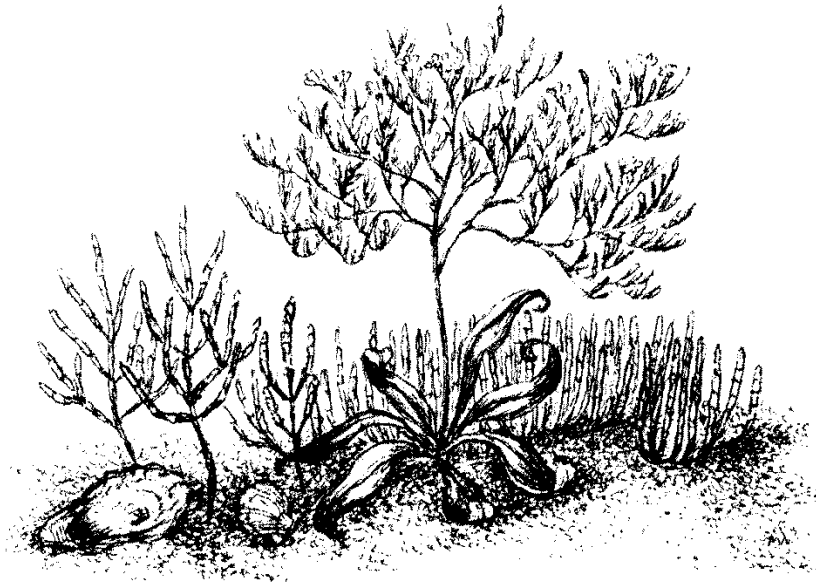
which migrating birds of the East follow to and from their nesting grounds. At the peak of the fall migrations, thousands of water-fowl and shore birds stop in the marshes to rest and feed. Yellowlegs wade in the pools, catching fish and aquatic insects. Ducks paddle along the creeks eating submerged plants, and sandpipers probe the banks for worms and crabs.

Many of these birds winter over on the marshes. The majestic Canada geese are primary consumers, feeding on *Spartina* rootstocks and stems. Great blue herons fish in the tidal pools or hunt salt-marsh snails. Small bufflehead ducks find safe harbor on the creeks in stormy weather. Fresh-water ducks and kingfishers fly from the frozen ponds on the coldest days to feed in the open waters of the marsh.

The changing seasons bring changing diets — and new links in the energy chain are forged. The sparrow hawk pursues baby birds in spring and insects in summer, but spends the cold months of the year catching mice. A large population of meadow and deer mice live in tunnel-like runways under the cowlicks of salt-meadow grass. Prodigious eaters, they consume great quantities of grass stalks and seed and are in turn consumed by hawks and owls, crows and blue jays, and an occasional fox.

Only a small number of mammals are marsh-dwellers. Shrews and moles tunnel in the damp soil at the edge of the marsh and muskrats build lodges near its borders. The shrews and moles eat insects; the muskrats use their sharp teeth to gnaw the rootstocks of the grasses. Raccoons are creatures of the uplands who raise their young in hollow trees and in the chimneys of vacant summer cottages, but they feed on mussels, crabs and fish during nighttime visits to the marshes.

The ribbed mussels (*Modiolus demissus*) that raccoons eat start life as members of the zooplankton, then half-bury themselves in the mud at the base of clumps of cordgrass. Like their relatives, the oysters and clams who live at the mouths of the creeks and on the tidal flats, the mussels are filter



**Salicornias and *Limonium carolinianum* (Sea Lavender)**

feeders. On a rising tide, they take in great quantities of sea water, as much as a gallon an hour per mussel. Their gills act as filters, extracting small food particles and passing them along to their digestive systems, returning larger ones to the surface of the marsh. These pseudofeces, as they are called, are rich in phosphates - so rich, in fact, that the mussels renew the total phosphorus in the waters of the marsh every fourteen days. Some of the phosphorus is taken up by the grasses, enabling them to grow taller, stronger. Other portions of the energy-rich sediment provide food for shrimp, fish and shellfish.

Sand shrimp swim in the waters just offshore, burying themselves in the mud at low tide or when pursued by schooling bluefish and striped bass. Their smaller relatives, the common prawns (*Palaemonetes vulgaris*) live on the muddy bottoms of marsh creeks and pools. Tiny transparent creatures with long curving antennae, they are difficult to see in the water. But if you poke around below the overhanging blades of cordgrass with a dip net or kitchen strainer, you can catch great quantities of them. They provide food for a wide variety of fish.

As many as sixty different kinds of fish have been found in the waters of the marsh. Killifish, silversides and sticklebacks spend their lives in the creeks. Striped bass swim in to feed. Young male eels, flounder, mullet and menhaden use the shallow protected waters as nursery grounds. Blackback flounder and weakfish spawn in the creeks and schools of alewives travel through them to reach their spawning grounds in the ponds. All summer there is a constant ebb and flow of fish as adults journey back to the sea after spawning and bluefish and other predators hunt the fingerlings who linger behind. Since tuna and swordfish feed on the smaller fish of the coastal waters, it is no overstatement to say that almost the entire catch of Cape fishermen is supported by the salt marshes.

A complete diagram of the interdependence which binds all these forms of marsh life has not been drawn, even by ecologists who use computer-aided research techniques. What *is* clear, however, is the *fact* of interdependence. What is *not* clear is which bonds can be severed, which patterns disrupted, without ultimate damage to humankind.

### **"ALL FLESH IS GRASS"**

When the prophet Isaiah said "All flesh is grass" he could have been thinking of the *Spartinas*. On an acre of a southern salt marsh, the grasses produce up to ten tons of organic matter each year. The best hay lands in the United States yield only four tons; a productive corn field little more than two tons; an average wheat field one and one-half tons. The salt marsh yield of potential animal food is surpassed only by the sugar-cane plantations of the tropics.

Moreover, the farmer who grows corn or wheat must plant his crop each year, cultivate and harvest it, and ship it to market. He has to buy seed, fertilizer, insecticides, heavy agricultural machinery.

The marsh crop needs neither labor nor machinery. Winds, water and birds sow the seeds; once established, the grasses never need replanting. The tides water and cultivate the plants. Fertilizers? The marsh community manufactures its own. Bacteria are constantly at work breaking down last year's crop into useful nutrients. Insects, snails, fiddler crabs augment the recycling

process. Nothing is wasted. Animals add their droppings and eventually themselves to the organic buildup. The shrimp and fish in the creeks, the mussels and crabs in the mud, the oysters and clams on the flats all contribute to the compost. And the tides ceaselessly stir the mixture, spreading it over the surface of the marsh, then carrying it back to the sea.

Not all of the ten-ton crop is available for harvesting. Each member of the marsh community from Canada goose to lowly bacterium takes its portion of energy in order to grow and reproduce. But when all the consumers have supped at the marsh table there is still a surplus. Scientists who have studied salt marshes in Georgia report that marsh plants and animals consume 55 per cent of the marsh energy crop. The remaining 45 per cent – four and a half tons of organic matter – is exported from the marshes by the tides.

This food/energy surplus enriches the waters along the coast, making them ten times as productive as the waters of the open ocean. Quahogs, clams,



Salt-Marsh Snails (*Melampus bidentatus*) on leaves of Cordgrass.

scallops, small fish feed directly on floating particles of detritus from the marsh. Microscopic aquatic plants – the phytoplankton – utilize the dissolved nutrients to speed their growth. The zooplankton feeds on the phytoplankton and together they provide the basic food for oysters and for the larger creatures of the continental shelf – lobster, crab, shrimp, fish. More than two-thirds of the fish and shellfish harvested along the Atlantic coast are dependent, directly or indirectly, on salt marshes.

Forests, grasslands, fresh marshes also support a variety of life. The cattail-reed-shrub community of a fresh marsh provides food and shelter for land and water birds, turtles and frogs, rabbits and deer. However, its diversified plants are not as productive as the *Spartinas* in tons per acre, and the community has a less efficient mechanism for transporting surpluses. The

ability of a salt marsh to trap the nutrients of both land and sea and to ship the energy surplus beyond its borders, is what gives the tidal marsh its unique value.

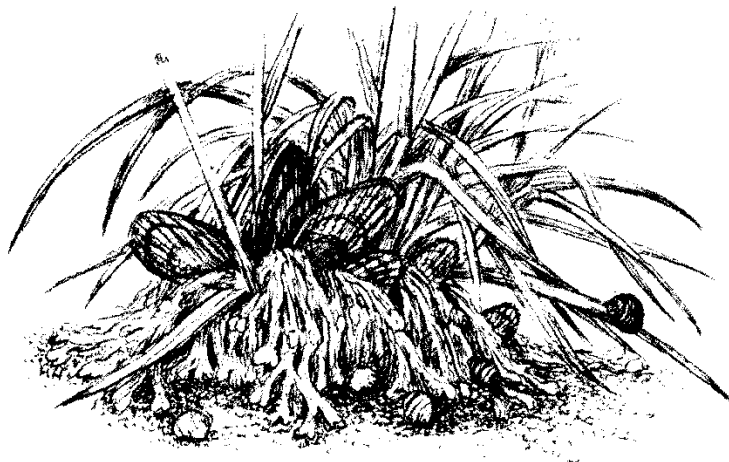
### THE COMMON GROUND

Salt marshes are a vital zone of mediation between sea and land. To seaward they absorb wave energy and protect the higher, drier ground beyond their borders. To landward, they are barriers against the loss of fresh water from the natural underground supplies on which humans draw. Between salt water and fresh, they operate as two-way filters to trap chemical pollutants and to break down organic wastes.

The low banks of the marshes take the brunt of breaking waves and cushion a storm's fierce impact. Waves that breach a solid bulkhead will do only temporary damage to a marsh whose peat substratum is bound together by springy, intertwining grass roots. Here and there a chunk of peat may break off, but the grasses, growing again, will repair the damage. By small-scale analogy, the blow that will break a window pane, will leave a wet sponge undamaged.

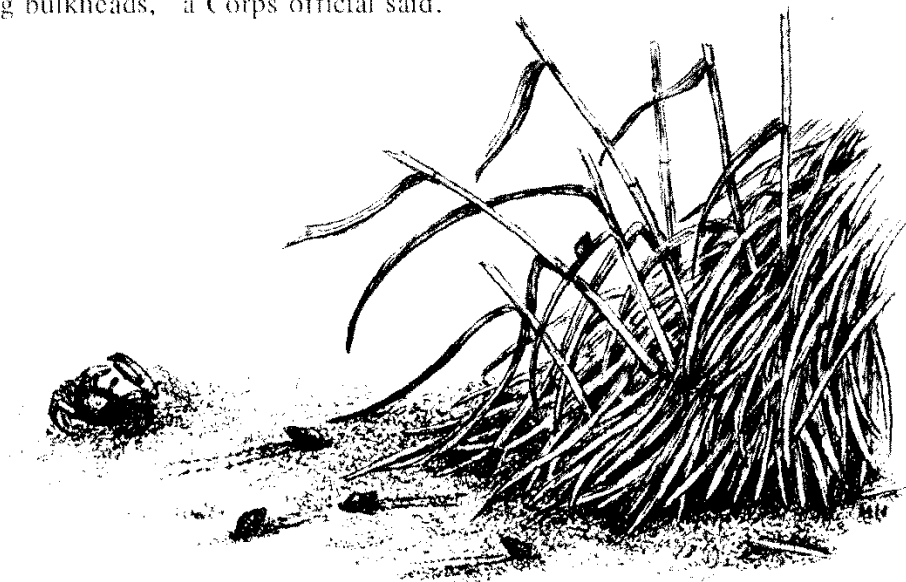
During severe storms when abnormally high tides flood low-lying areas, the marsh contains the flood waters and keeps neighboring land dry. If a marsh is filled or paved with blacktop its protective capability is destroyed and the filled-in land is a special target for storm damage. A dramatic example of this occurred in 1962 when a storm along the New Jersey shore washed away row after row of homes that had been built on barrier beaches and marsh. The cost of disaster relief was, of course, paid by taxpayers everywhere.

The ability of marsh grasses to trap sand and silt, thus stabilizing shorelines and controlling erosion, is now bringing a different kind of improvement to coastal areas. Since 1971, Environmental Concern, Inc., a nonprofit scientific organization based in Maryland, has been developing man-made marshes. Near Hambleton Island, a rapidly eroding island in Chesapeake Bay, staff members dumped bargeloads of sand to create tidal flats, then planted laboratory-grown seedlings of the *Spartinas*. At the end of one growing season the grasses had multiplied many times over and the once sterile flats supported a variety of animal life.



Ribbed Mussels and Rough Periwinkles

Environmental Concern's success at Hambleton Island and at other places along the mid-Atlantic coast has attracted the attention of the Army Corps of Engineers. In the past, the Corps which dredges millions of tons of sediment each year to keep harbors and waterways navigable, has dumped its spoil on productive marshes or tidal flats, destroying oyster and clam beds and damaging fisheries. Last year the Corps placed dredging spoil in selected tide-water areas in Maryland and Virginia, to provide sites where Environmental Concern could plant marsh grass. Now it is considering creating salt marshes elsewhere along the coast where erosion is a problem. "It's cheaper than building bulkheads," a Corps official said.



Fiddler Crab and Mud Snails

Man-made and natural marshes are also being studied as filters for waste water. When sewage that has received secondary treatment is pumped into a marsh, the grasses trap excess nutrients and utilize them in their own biological processes. In the course of a series of experiments in Falmouth's Great Sippewisset Marsh, John M. Teal, co-author of "Life and Death of the Salt Marsh," and his associate, Ivan Valiela of the Marine Biological Laboratory, have treated plots of *Spartina* with sewage sludge.<sup>8</sup> Tests of the tidal water as it ebbed from each plot have shown only small amounts of nitrogen and phosphorus. Most of the nutrients, and particularly the nitrogen, were taken up by the grasses which grew taller, heavier and greener than the *Spartina* in untreated plots. This ability of marshes to remove and assimilate excess nitrates from waste water means that they can take the place of expensive tertiary-treatment sewage systems in many coastal areas, other than Cape Cod.

Here, where every drop of water is precious and waste water must be returned to the ground after treatment, marshes have a different function. Our water supply comes from an underground reservoir of water which is replenished only by rain and snow. This ground water moves slowly from the center of the peninsula, where the water table is highest, toward either shore.

<sup>8</sup> Teal, John M. and Ivan Valiela "Nutrient Limitation in Salt Marsh Vegetation". Ecology of Halophytes, Academic Press, 1974.

THE SUN IS THE SOURCE OF MOST OF THE AVAILABLE ENERGY ON EARTH. 1% TO 2% OF THAT ENERGY REACHING THE EARTH'S SURFACE IS TRAPPED BY GREEN PLANTS AND PHYTOPLANKTON. OTHER FRACTIONS OF THE SUN'S ENERGY WARM THE LAND AND WATER AND CREATE THE WIND CIRCULATION PATTERNS. ALL ENERGY IS EVENTUALLY LOST AS HEAT IN SPACE.

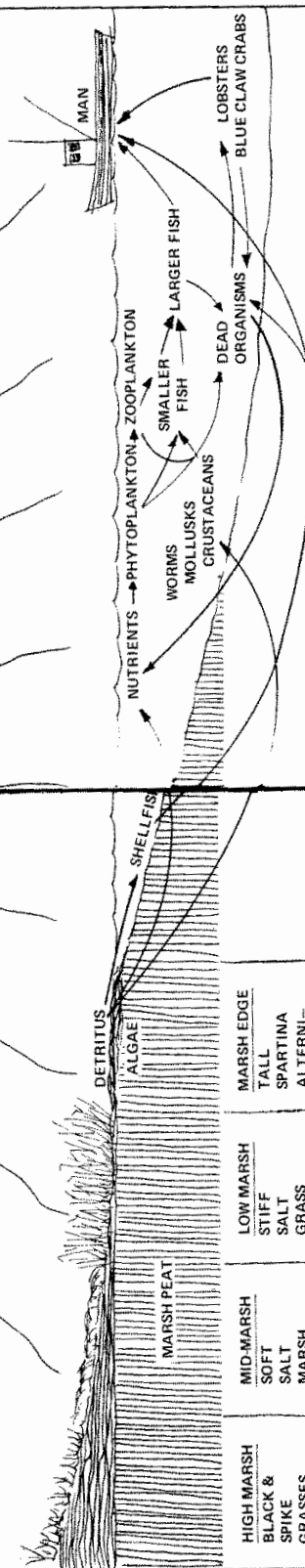
MINERALS ARE RECYCLED FOR RE-USE ONLY BY FURTHER ENERGY FROM THE SUN.

A PROPERLY PROTECTED TIDAL MARSH CANNOT BE DEPLETED. ITS PRODUCTIVITY PER ACRE (UNAIDED BY FERTILIZER APPLICATIONS) EXCEEDS ALL OTHER AREAS ON EARTH.

## THE \$ALT MAR\$H

(SIMPLIFIED)

## ENERGY & FOOD CHAIN



As more and more people pump more and more water, volume and pressure of the water underground drops and there is increasing danger of salt water intrusion. This has already happened in Provincetown and in scattered wells along the coast. A new study<sup>9</sup> by Dr. Norton Nickerson, Tufts University biologist and Dennis summer resident, has found that the thick layers of semi-pervious peat in the marshes act as a barrier to the landward flow of salt water and the seaward flow of fresh water. Alteration of any part of a marsh — even the digging of a mosquito control ditch — may allow fresh water to drain from the land on an ebb tide.

### SOME NEW MATH

“The best investment in the world is waterfront property — they are not making it any more,” said Will Rogers. The cowboy philosopher’s wry comment can be taken in two ways. To some people, a salt marsh is a piece of waterfront property which, if “improved,” would bring immediate economic benefits to realtors, builders, and building trades people. An increasing number of others see a marsh in terms of its value to society as a whole, now and in the future — a value which will increase because “they are not making it any more.”

To resolve the conflict between these opposing views, ecologists and land-use planners have attempted to estimate the actual dollar value of a salt marsh. What is it worth, not in today’s real estate market, but in terms of its total productivity? One way to arrive at a figure would be to estimate the money which flows into a region because of its marshlands. On Cape Cod where tourism is the major industry, tourist spending amounted to \$164 million in 1974. How much of this comes from sports fishermen, duck hunters, birders, vacationers who gather shellfish and city-dwellers seeking a refreshing change of scenery? If one took an arbitrary figure of one-fourth, the marsh-dependent income would be \$41 million a year. Since the Cape has 13,184 acres of salt marsh, this would mean an annual income of \$3,125 an acre. Assuming an interest rate of five per cent, an acre of Cape salt marsh would be worth \$62,500.<sup>10</sup> To this one could add the value of the Cape’s commercial fish and shellfish exports as they cross the bridge as well as the money spent by commercial fishermen and their families. The role of salt marshes in flood control, water supply protection and so forth should also be included in these computations. And how does one put a price tag on green meadows and blue water which reflects the sky?

No one has broken down Cape Cod’s income figures to get an accurate estimate of the value of its marshes, but scientists at Louisiana State University’s Center for Wetlands Resources have computed the dollar value of southern marshlands.<sup>11</sup> Adding the income from commercial fisheries which are dependent on marshes to an estimate of the potential value of marshes for oyster aquaculture and for waste water treatment, they have come up with a figure of \$80,000 an acre. Because this did not include other functions of marshes — as barriers against floods, habitats for migratory birds and so forth —

<sup>9</sup> Nickerson, Norton H. “Salinities of Ambient and Interstitial Water of Some Cape Cod Salt Marshes.” 1975 (in press)

<sup>10</sup> Value =  $\$3125 \div .05$

<sup>11</sup> Gosselink, James G., Eugene P. Odum, and R. M. Pope, “The Value of the Tidal Marsh”, Louisiana State University, 1974.



the scientists then proposed a new and ingenious approach for determining the total "life-support value" of a marsh.

This approach translates the work of nature into monetary terms by comparing the energy produced in a marsh with other forms of energy consumed by the nation. The scientists' first step was to determine the ratio of the Gross National Product -- the value of all goods and services produced in the U.S. annually -- to the amount of energy reported in the National Energy Consumption Index. Finding that 10,000 kilocalories were consumed to produce one 1973 dollar's worth of goods and services, they then compared this with the rate of energy production in a marsh. Calorimeter measurements have shown that one pound of dried marsh grass is equivalent to 1850 kilocalories. In southern marshes where the annual *Spartina* crop averages 22,000 pounds per acre, an acre of marshland would produce 40,700,000 kilocalories annually -- the equivalent of \$4,070. Capitalized at five per cent, the value of an acre of marshland would be \$81,400.<sup>12</sup>

The *Spartina* crop on Cape Cod marshes is undoubtedly somewhat smaller than the crops in Louisiana and Georgia where the grasses grow year-round. However, the surpluses exported from Cape marshes which contribute directly to the support of one of the world's largest populations of fish and shellfish may make up somewhat in importance for the difference in unit output.

## THE MARSH-WATCHERS

The Louisiana scientists' method of evaluating an acre of salt marsh offers a yardstick which can be applied to any marsh anywhere. By demonstrating that marshlands in their natural state have a substantial dollar value, they have provided a solid answer to those who would "improve" a salt marsh by destroying it. However, there is still a conflict of interests between society as a whole which benefits from the unimproved land and the individual owner of marsh acreage who receives no direct financial return from his property. Although the value of a salt marsh in our protein-hungry world seems indisputable, the marsh owner may well say, "Why ask me to care about society, if I can make a profit by developing my land"?

Land-use planners have suggested several ways to reconcile private interest and public necessity: wetland "banks," similar to soil banks, which would pay an owner *not* to develop his marsh; tax abatements for those who preserve their land; increased assessments for those who alter theirs. The most effective solution, of course, is the acquisition of coastal wetlands by the government and by conservation groups. The U.S. Fish and Wildlife Service owns salt marshes all along the coast, financing them with the revenue from duck-hunters' stamps, and maintaining them as refuges for migratory birds and other wildlife. On Cape Cod, the National Seashore, the Massachusetts Audubon Society, the Chatham Conservation Foundation, and the Conservation Commissions of a number of towns have taken thousands of acres of salt marsh off the real estate market.

The Conservation Commissions were established as official town bodies in 1957, after a fight to save a marsh in Ipswich. Appointed by the selectmen and serving without pay, Commission members' duties, at first, were largely

<sup>12</sup>  $1850 \text{ kcal/lb} \times 22,000 \text{ lb/acre} \div 10^4 \text{ kcal/\$} = \$4070 \text{ per acre per year. Capitalized:}$   
 $\$4070 \div .05 = \$81,400$

educational. They were empowered to keep an index of the marshes in their town, to advise the selectmen and the state Department of Natural Resources on ways to utilize the wetlands, and to receive gifts of land which they would manage. Later legislation enabled the Con Coms to purchase land for conservation, with substantial financial help from the state and federal government.

Under this program, Barnstable, the first Cape town to establish a commission, was able to protect the Great Marshes and the Sandy Neck dunes from any possibility of real estate development. Barnstable's success spurred enlightened Conservation Commissions in half a dozen other Cape towns to acquire land through gifts and purchase. In Dennis which had lost a considerable chunk of marshland to housing development in the 1950s, a carefully planned educational program included a brochure titled "Choose While a Choice Remains." Convinced of the importance of preserving wetlands and other open areas, voters, at a town meeting in 1967, appropriated \$625,000 to buy 1,400 acres of marsh, dune, woodland, swamp and meadow.

Involving local citizens in a voluntary program to preserve natural resources was a forward step, but it didn't work everywhere. In some communities, real estate interests who opposed the idea of taking land out of circulation and voters fearing an increase in taxes resented the activities of "those bird-watchers" on the Conservation Commission. It soon became apparent that in addition to holding out the carrot of a sweeter environment, conservationists also need the stick of legislation and enforcement.

In 1962, Massachusetts became the first state to pass a law protecting its coastal wetlands. The Jones Act said that "no person shall remove, fill or dredge any bank, flat, marsh, meadow or swamp bordering on coastal waters" without the approval of his Board of Selectmen, the State Department of Public Works and the Director of Marine Fisheries. Before beginning the work he had to file a notice of his intention, then appear before the selectmen at a public hearing. If it was found that his project was not "in the public interest" or would damage shellfish or marine fisheries, the selectmen or the state



Ribbed Mussels at base of Cordgrass

department could restrict or prohibit it. Violators of the law could be punished by a \$100 fine or six months in prison.

On Cape Cod, which has long prided itself on its rugged individualism, the law was often ignored. Marsh owners who didn't want to be told what to do with their property, followed a policy of "fill first, file later." Once the marsh was filled, what could anyone do about it? Not very much, it seemed. Certainly no one was ever made to remove the fill after it was in place, nor were violators fined or sent to jail.

On the other hand, the existence of the law encouraged a growing number of people who had come to appreciate both the natural beauty and the economic importance of salt marshes to set themselves up as marsh-watchers. Forming *ad hoc* committees, sometimes under the leadership of Conservation Commissions, they were ready to ride and spread the alarm whenever they spotted violations of the Jones Act.

This swing in public opinion, which was felt across the state, brought into being a far more rigorous Wetlands Protection Act. Passed in 1972 and amended in 1974 and 1975, it covers both coastal and fresh-water marshes, land bordering (within one hundred feet of) ocean, bay, river or pond, and land subject to tidal action or flooding. Anyone wishing to fill, dredge or alter such land must file with the Conservation Commission of the town and the Department of Environmental Quality Engineering (formerly the Department of Natural Resources) a plan describing the proposed work, with an analysis of the impact it will have on the environment. The Conservation Commission is responsible for holding a public hearing to determine how the work will affect water supplies, flood control, shellfish and fisheries. It must then issue an order of conditions to regulate or prohibit the activity. If this order is appealed the Department of Environmental Quality Engineering must then issue a superseding order. Violators of the law can be punished by a fine of \$1,000 for each day that the violation continues and up to six months imprisonment.

Comprehensive as it is, the Wetlands Protection Act should not be a signal for complacency. The law regulates but does not forbid the despoliation of salt marshes. The responsibility for deciding whether or not a particular wetland should be preserved rests with the local Conservation Commissions. Involving them in the decision-making process instead of leaving it all to "big government" has worked well in many places, poorly in others. Commission members know their community better than an outsider could and many have taken time to inform themselves on complex scientific and legal matters. But local administrative bodies are never entirely immune to pressures from outside of their meeting rooms.

The pressures are not inconsiderable. On Cape Cod, they stem not so much from those easily recognizable "villains," the large-scale speculator/developers, as from friends and neighbors who want to fill a strip of marshland to add to their house or to bury a septic tank or who dredge a creek in order to build a dock or beach. But perhaps the greatest threats to our wetlands have come in recent years from government agencies who seem to put their own technology above environmental concerns.

The U.S. Army Corps of Engineers is responsible for maintaining navigable waters all along the coast. In the course of their duties, Corps officials decided to transform Town Cove in Orleans into a "harbor of refuge." To do this would mean dredging a channel one hundred feet wide and seventeen

feet deep, with the spoil to be dumped no-one-said-where, except that Nauset Marsh was right next door. Immediately, the dredging would have destroyed the lobsters, shellfish and finfish in the existing channel and disturbed the great flocks of ducks and shorebirds that make Nauset Marsh and its barrier beach an important tourist attraction. The long-range effect of the \$10 million job would have threatened the marsh's existence.<sup>13</sup>

Massachusetts' Department of Public Works is responsible for building highways and for making them as wide, straight and safe-at-high-speed as possible. In the course of their duties, DPW officials proposed to widen and straighten Route 6 from Dennis to Orleans, and eventually all the way to Provincetown. That the "improved" highway would cut a swathe through wetlands, ponds and wooded areas was not considered an obstacle.

Both projects were put forward in the late 1960s before the Wetlands Protection Act required environmental assessments and hearings before Conservation Commissions. As soon as they were announced, marsh-watchers all over the Cape rallied, held meetings and made their voices heard in Washington and Boston. The projects were halted for lack of funds, but they are still on the books, awaiting the return of a more prosperous era.

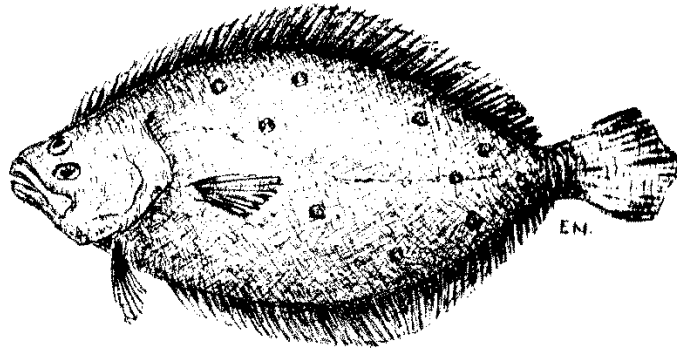
The Massachusetts Department of Public Works has also played a curious role in the latest chapter of the story of Wellfleet's Herring River marsh. In 1968,<sup>14</sup> six decades after the construction of Captain Baker's dike, the old controls were so deteriorated that salt water from the bay once more flowed into the river. By 1970-1 the marsh began to change dramatically. Cattails and other fresh-marsh vegetation were killed by the salt water and *Spartina* grasses took their place. Oysters began to grow above the dike, attaching themselves to the roots of dead trees. Herring and other salt-water fish entered the river again and fiddler crabs scuttled along its banks. In mid-1974, a flourishing bed of soft shell clams - a shellfish increasingly scarce in Wellfleet - was discovered at the river's mouth, just above the dike. But by that time the new/old salt marsh was in trouble.

Faced with the deterioration of the road on top of the dike as well as the loss of sections of the flapper valves, the town had to decide whether to repair the dike or replace it with a bridge. Realizing the impact that a restored salt marsh would have not only in Wellfleet waters but in all of Cape Cod Bay, the Conservation Commission, the shellfishermen and many other townspeople favored a small bridge. But the selectmen, perhaps still doing honor to Captain Baker, wanted to repair the dike and keep salt water out of the river valley. They received strong support from the Department of Public Works which sent representatives to testify at public hearings. After years of debate the bridge proponents lost.

However, it was not possible to turn the clock all the way back to 1908. At the public hearing required by the Wetlands Protection Act, the Conservation Commission considered the impact that the dike would have on the growing salt marsh. Their order of conditions, reaffirmed by the Department of

<sup>13</sup> Conservationists have long been critical of the Army Corps of Engineers. However, a court decision in June 1975 has forced the Corps to redefine "navigable waters" to include almost all U.S. wetlands, and to protect them. Thus the Corps is now cast in the role of environmental protectionist.

<sup>14</sup> By this time, the Herring River estuary was within the boundaries of Cape Cod National Seashore.



Summer Flounder (*Paralichthys dentatus*)

Natural Resources in December 1973, said in part:

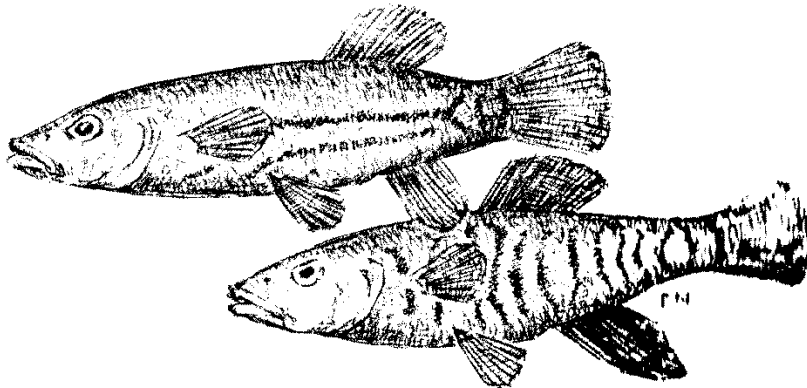
"That the proposed repair . . . be constructed in a way that allows approximately the same amount of salt water now flowing through the present dike . . . to continue to pass into the basin.

"That the proposed repair allow free passage of alewives through the dike and into the Herring River and the spawning ponds that feed it."

The champions of salt marshes sighed with relief. The Herring River marsh could not be returned to its prodigious 19th century productivity, but at least a portion of it would be restored. They soon found out that they were wrong.

The Waterways Division of the Department of Public Works went ahead with the reconstruction, ignoring the DNR order. By the time the dike was completed at the end of 1974, the water level behind it had dropped alarmingly and salinity was at zero. The soft-shell clams - some 500 bushels, estimated to be worth \$15,000 - were dead; other shellfish above the dike were doomed. Five months later when the alewives arrived for their trip upriver to their spawning grounds, most circled on the bay side of the barrier, unable to pass through.

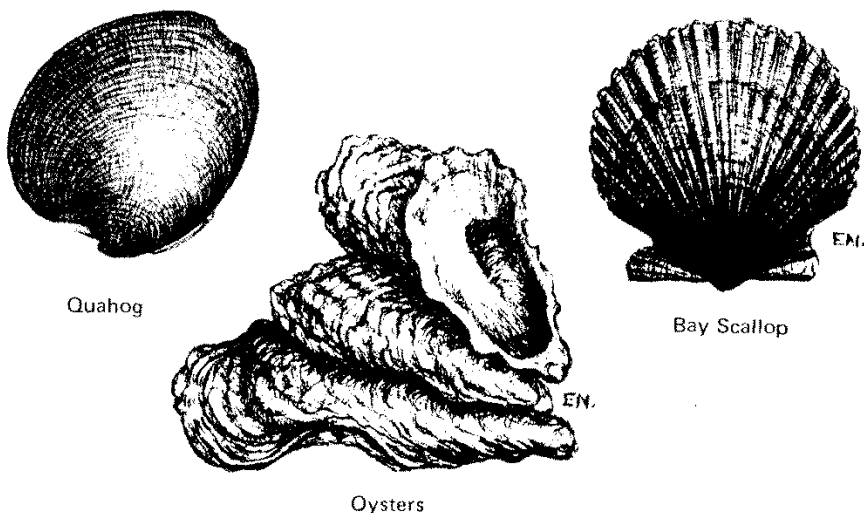
Faced with mounting criticism and a court injunction secured by ten Wellfleet residents, the Waterways Division made some changes, improving the



Killifish or Striped Mummichogs (*Fundulus marmoratus*)

passage of both alewives and salt water. However, the water level behind the dike is still more than a foot lower than it was when the DNR's order of conditions was issued. The drop in water and salinity has killed promising stands of cordgrass, stunted others.

The final chapter in the story of the Herring River marsh, once one of the most productive on Cape Cod, has yet to be written, but the moral is clear. Preservation of salt marshes is not guaranteed by the Wetlands Protection Act or by the agencies established to administer it. Strict enforcement of conservation laws depends on action by concerned people who understand the importance of salt marshes to themselves and to their children and grandchildren. Every citizen ought to be a marsh-watcher, prepared to speak out when even minor despoliation is threatened. Filled marshland is dead forever.



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**Dorothy Sterling**, a Wellfleet resident, has written more than thirty books on subjects ranging from black history to natural history. Her best-known book in the latter field is **THE OUTER LANDS: A NATURAL HISTORY GUIDE TO CAPE COD, MARTHA'S VINEYARD, NANTUCKET, BLOCK ISLAND & LONG ISLAND** (Anchor Press). Other books, written for young readers, include **CATERPILLARS; FALL IS HERE!** and **THE STORY OF MOSSES, FERNS AND MUSHROOMS** (Doubleday).

Residents of Chatham, **Marcia and Edward Norman** have illustrated eight books. Their fine botanical drawings appear in **A BEACHCOMBER'S BOTANY** by Loren C. Petry (Chatham Conservation Foundation, Inc.), **THE SANDY SHORE** by John Hay (Chatham Press) and, most recently, **SEASONS OF THE SALT MARSH** by David Alan Gates (Chatham Press).