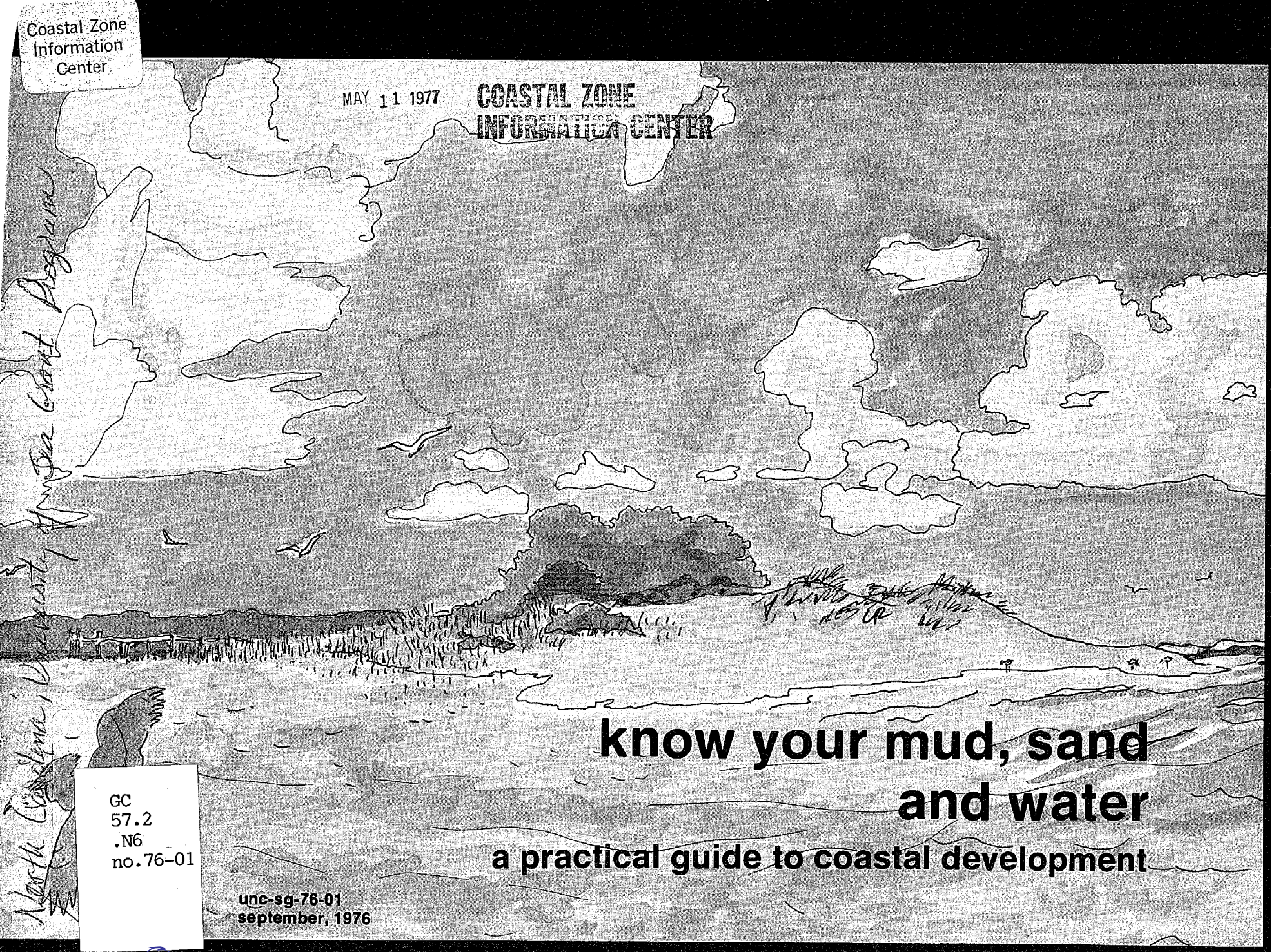
Coastal Zone
Information
Center

MAY 11 1977 COASTAL ZONE
INFORMATION CENTER



know your mud, sand and water

a practical guide to coastal development

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Know Your Mud, Sand and Water,
a practical guide to coastal development

Written and designed by
K. M. Jurgensen, UNC Sea Grant

Based on *Ecological Determinants of Coastal Area Management*, UNC Sea Grant, April, 1976

Illustrations by Christie Rucker

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know your mud, sand and water

a practical guide to coastal development

MAY 11 1977

"The rampaging Atlantic claimed more than a dozen cottages between Kitty Hawk and Oregon Inlet; the Arlington Hotel, a landmark . . .; three motels in the Buxton area; and thousands of feet of highway in many areas along the entire strip of sand known far and wide as the Outer Banks. . . ."

—The Coastland Times
Manteo, February, 1973

"County officials this morning made a visit to the western end of Bogue Banks where a new inlet has been cut through, east of the Bogue Inlet Coast Guard Station, Swansboro. . . . The cut has developed within the past week or two. At present it is 75 yards wide."

—The Carteret County News-Times
Morehead City, August, 1972

"Trailer park septic tanks are the major cause of the pollution which in 1974 forced the closing of shellfishing waters at coastal Surf City, a researcher who helped write a 200-page study on the problem said Thursday. . . . The report's major recommendation is that Surf City build a central sewer system, according to Tyndall Lewis, a state Department of Natural and Economic Resources scientist and one of the authors of the report."

—News and Observer
Raleigh, March, 1976

This pamphlet is offered in the belief that people *can* live in harmony with nature.

along our sounds . . .

Picture a dancer with long flowing scarves in her hands. As she twirls and sways and dips and bends, the scarves move with the rhythm of her body. The graceful moves flow one into another, a twist of the hand here and the scarves move ever so slightly in a different direction. All is grace and motion—scarves and dancer move together as one.

If we could see the forces of nature working to make the coast what it is, they might look a little like that dancer.

Winds and waters roll against the shore and the scarves that are the barrier islands shift and give. Salt and fresh water meet in the sounds and the scarves that are the lagoon-estuary swirl and mix. All is grace and motion—wind, waves, salt and fresh water move together as one.

In the lagoon-estuary, the mixing of waters creates a rich, concentrated environment, like a good thick broth. To this "broth" the ocean adds sandy sediments and salty waters. Rivers contribute fine-grained sediments, vitamins, minerals, plant and animal materials, and fresh water from land runoff.

The lagoon-estuary, which is nursery ground for most of the state's commercially important seafoods, takes many forms: salt marshes, swamp forests, oyster reefs, mud and sand flats, brackish and saltier waters each contribute to the productiveness. Plants and tiny organisms flourish in this rich, varied environment. They in turn are eaten by larger organisms.

Always, the uses and natural processes are intertwined: bacteria feed on fallen marsh grass, they, in turn, are eaten by tiny organisms which are then eaten by larval shrimp which are then eaten by larger fish on their way to deeper waters. So it goes.

and our beaches . . .

North Carolina's lagoon-estuary forms thousands of miles of coastline and millions of acres of estuarine habitats. But the tranquility and shelter of the estuary would not be possible without the barrier islands.

Those islands absorb the force of ocean-driven wind, waves, currents and tides. They protect the mainland and provide safe navigation channels for man.

Yet, they open just enough—at inlets—to allow "flooding" of the estuary with salty ocean water at high tide and "flushing" of the estuary at low tide when mixed waters pass out into the ocean. This water flow also carries seafoods into and out of estuarine breeding and nursery areas.

Barrier islands roll with the punches: sand shifts readily from place to place, water is rapidly absorbed. This flexibility allows the islands to bend without breaking. Under normal circumstances, an equilibrium is reached: sand grains move from offshore bars, to channels, to beaches, to dunes and back again in response to winds, waves, tides and currents.

Despite this equilibrium, some areas are, by nature, less stable than others. All it takes sometimes is a rattling good storm for inlets to close or open, beaches to erode or build up dramatically, sand dunes to form or disappear, shoals to shift, channels to fill in, or marshes to build up on the sound side.

Overall, the barrier islands are:

—moving westward conveyor-belt fashion as sand moves toward the mainland;

—gradually "sinking" as sea level creeps upward;

—and changing in profile as a result of daily, seasonal and storm alteration.

...growth goes on—

It can be done wisely

When allowed to function naturally, these processes ensure the continued maintenance of the barrier islands and, therefore, the continued protection of the estuary and man's endeavors.

Unfortunately, people sometimes interfere with the natural processes in both the estuary and barrier islands. This interference threatens the functioning of those vital systems, and in turn people's safety and well being.

Houses fall in the frequent hurricanes that strike our coast. Septic tanks dangerously pollute limited drinking water supplies. Pollution from mainland runoff closes thousands of acres of shellfish waters and other changes threaten commercially important seafoods. "Stabilized" dunes and shorelines sometimes create more problems than they solve.

But really, the coast isn't such a bad place to build if we consider how and where we're building. Development and the coastal environment are not necessarily in conflict. We **can** have development and still protect the environment people enjoy and depend on.

It's a matter of deciding on the quantity, quality and location of development to be allowed. Too much development, or development of the wrong sort or in the wrong place, can contribute to the destruction of our beautiful coast.

The aim of the 1974 North Carolina Coastal Area Management Act is to encourage the coastal counties to reflect on the heritage they want to leave future generations, to give competing demands a fair airing, and to plan for desired growth.

The Act calls on the 20 coastal counties to prepare plans which reflect the objectives they hope to achieve. The state/local-appointed Coastal Resources Commission reviews the plans to ensure that they adequately reflect state objectives and to help resolve conflicts between planning areas.

The Coastal Resources Commission also designates Areas of Environmental Concern (AECs) as part of its duties. The AECs are defined by the Act and include, for example, coastal wetlands, estuarine waters, frontal dunes, and hazard areas such as inlets. The Commission asks the localities to help discharge this duty by nominating areas which they think should be designated. Development is not prohibited in the AECs, but a permit, based on sound resource management, must be issued by the Coastal Resources Commission before any major changes can be made.

Another major responsibility of the Coastal Resources Commission is the coordination of existing federal-state-local regulations pertaining to development in the coastal area. Probably the most critical permits to be coordinated under the Act are Dredge and Fill statutes, Water Pollution Control Amendments, and local septic tank and sand dunes protection ordinances. So, existing and future local, state and federal regulations must form the basis of the Coastal Area Management Act and ultimately of the protection of the coast.

Local governments and citizens must work at setting priorities and protecting what they

care about. Planning requires an understanding of the natural systems and the management tools available. So, what's offered here is a brief explanation of the natural processes shaping the coast, paired with some of the management tools governments and individual citizens have at their disposal. This pamphlet is a condensation of the findings of a University of North Carolina Sea Grant-supported study group which examined federal, state and local management tools and the ecological systems at work on the coast.

The complete work, *Ecological Determinants of Coastal Area Management*, offers a whole cafeteria line of management possibilities. What's offered here are the appetizers, especially the local options. Not included here are some of the less well-known, but promising, management alternatives such as more sophisticated controls which combine a variety of tools; impact assessment and zoning; public or private land banking, and aquisition of development rights.

Sea Grant's work is part of an effort to indicate what can be done to develop North Carolina's coast within the limits of the resources that make the coast a special place. There is much to protect:

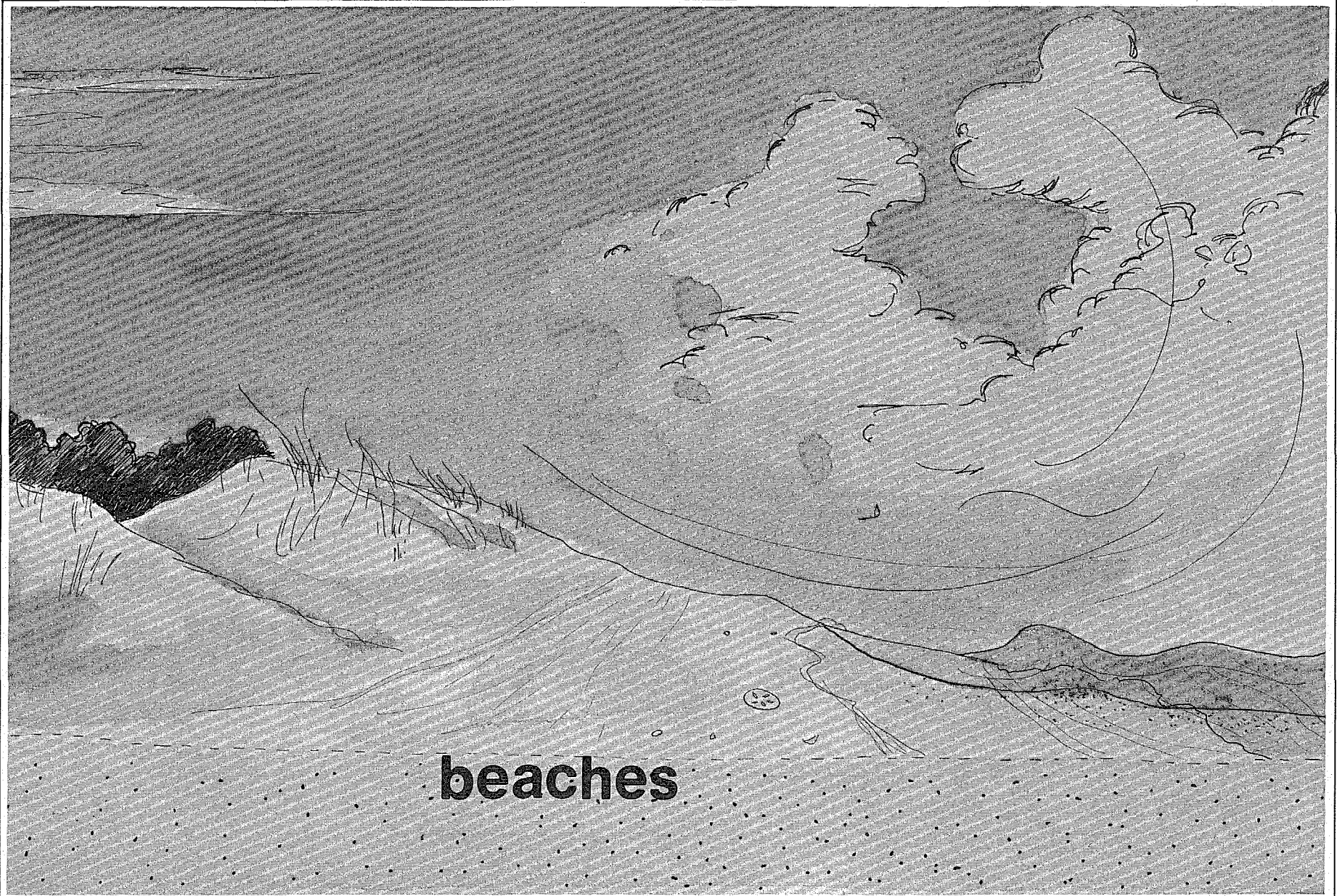
—Along the barrier islands, governments own roughly one third of the land. About half of the area not owned by government is still undeveloped but development is undoubtedly planned for virtually all of that land.

—Along the mainland shoreline, about five to 10 percent of the land has been developed in the northern and largest section. (The other 90 percent is not subdivided or subject to concentrated development.) In the southern area, south of Pamlico Sound, 30 to 35 percent of the shoreline is developed.

With careful planning, management tools can be used to protect the complicated ecosystems as development takes place. There are also ways to discourage reconstruction where development has occurred in hazard areas—and has been destroyed by nature. In other cases where construction has occurred; undesirable side effects can be reduced, for example, simply by installing public facilities to replace septic tanks.

For more detailed information—to get a look at the entire cafeteria line—write UNC Sea Grant, Box 5001, Raleigh, N. C. 27607, and ask for *Ecological Determinants of Coastal Area Management*, Volume I or II. Volume One is an overview; Volume Two includes detailed scientific and legal information.

Nobody likes going to a dirty beach. Nobody will fish if there are no fish to catch. The aesthetics and the economics are really not separable. If the ecosystem is destroyed, the economic value is destroyed. So, though we've concentrated here on laws and scientific values, always in the back of the mind are images of a pink-red sunrise over Jockey's Ridge, birds hovering for handouts over a ferry as it glides toward shore, ducks winging gracefully over tall, straight marsh grasses, and white trawlers with their net arms spread wide over the glistening dark waters. ■



Beaches are built up — on a bed of sand — as fine grains are washed in by the waves.

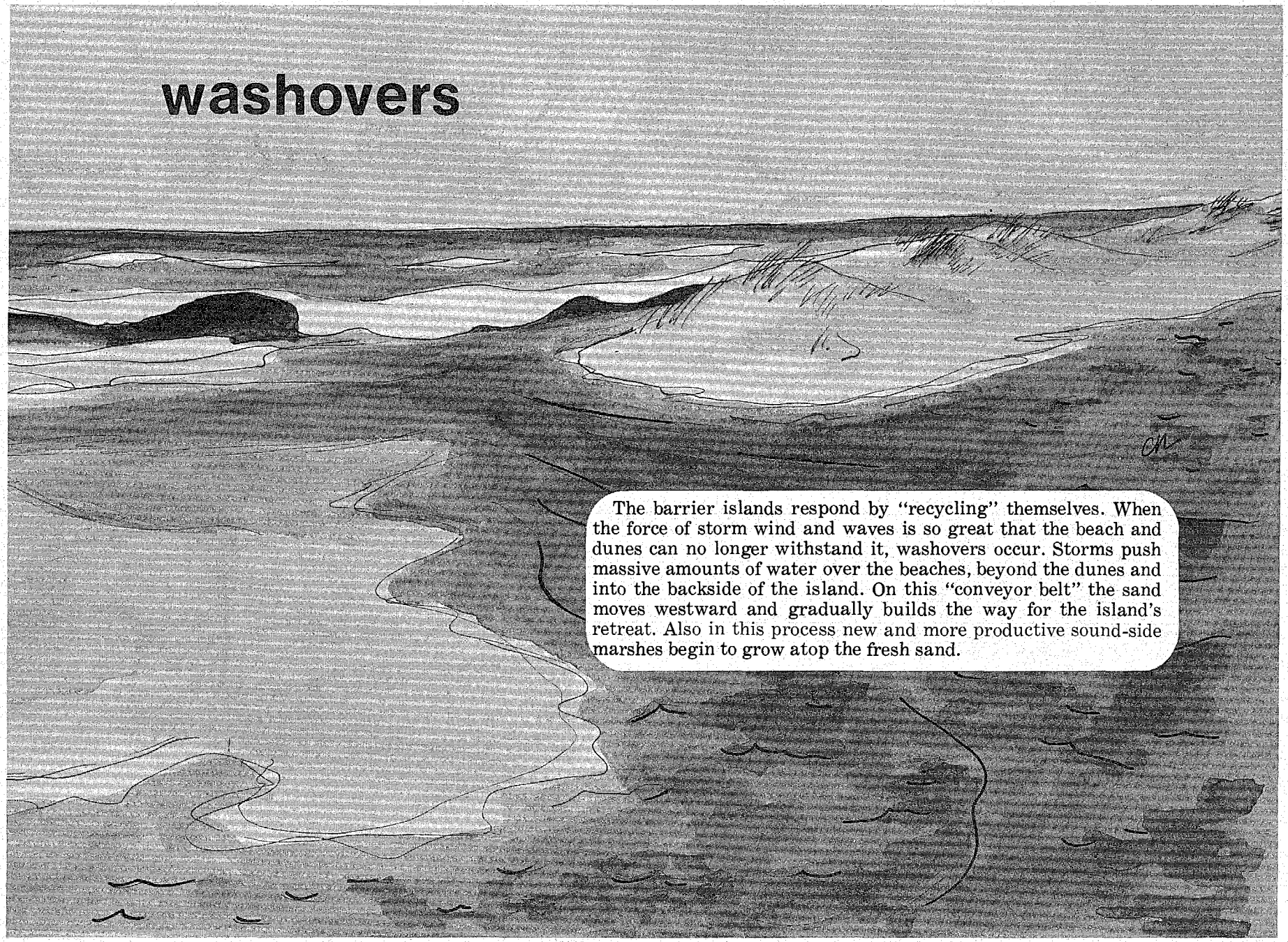
the barrier islands:

As a rule, North Carolina's barrier islands are eroding and moving westward. Though the rate varies from place to place, erosion can range up to as much as 80 to 100 feet a year on the ocean side. While sound-side buildup varies markedly from place to place, since 1940 it has ranged from 75 feet at sites along the southern barrier islands to 200 feet along the northern barriers.

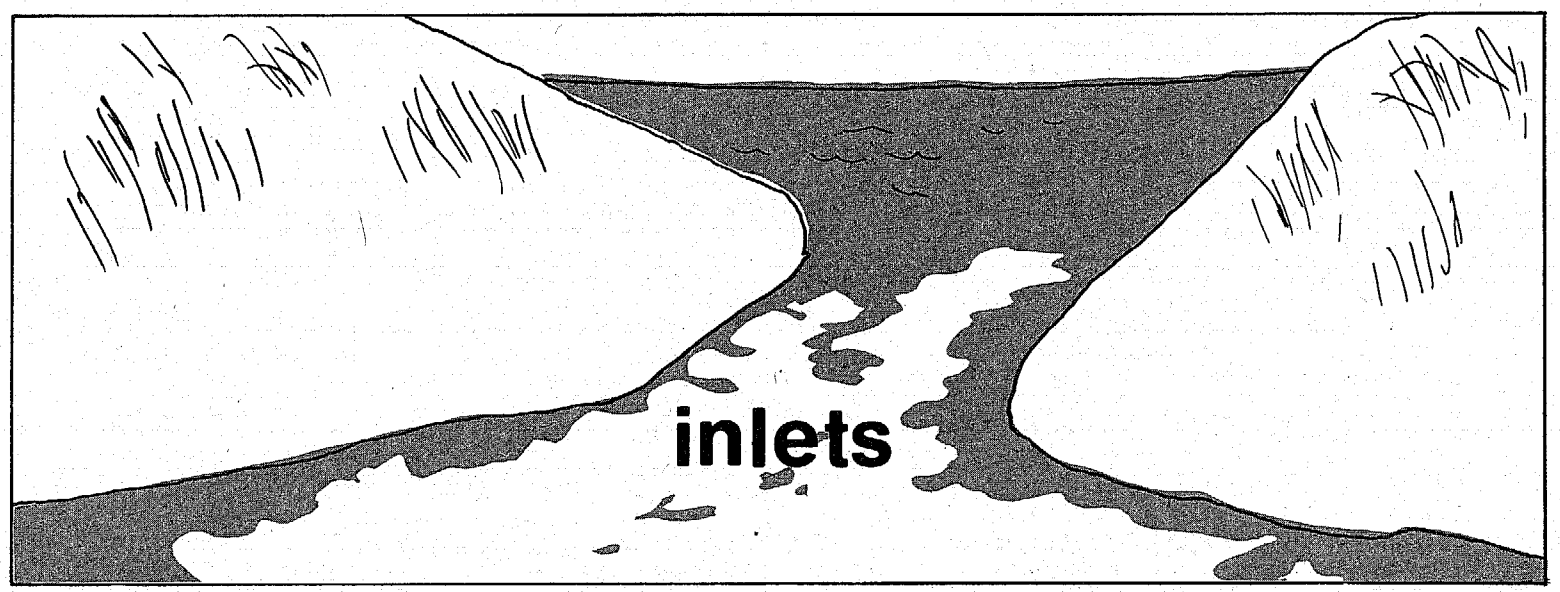
Sand is generally carried by currents moving along the shore in a southerly direction taking fine grains away here, depositing them there. But periodic storms and hurricanes can speed sand along its way, as in the case of the 1973 storm when Nags Head and Kitty Hawk lost 35 feet of beach in one fell swoop.

The continuing rise in sea level, which has already swallowed up an island or two in the last century, only makes things worse.

washovers

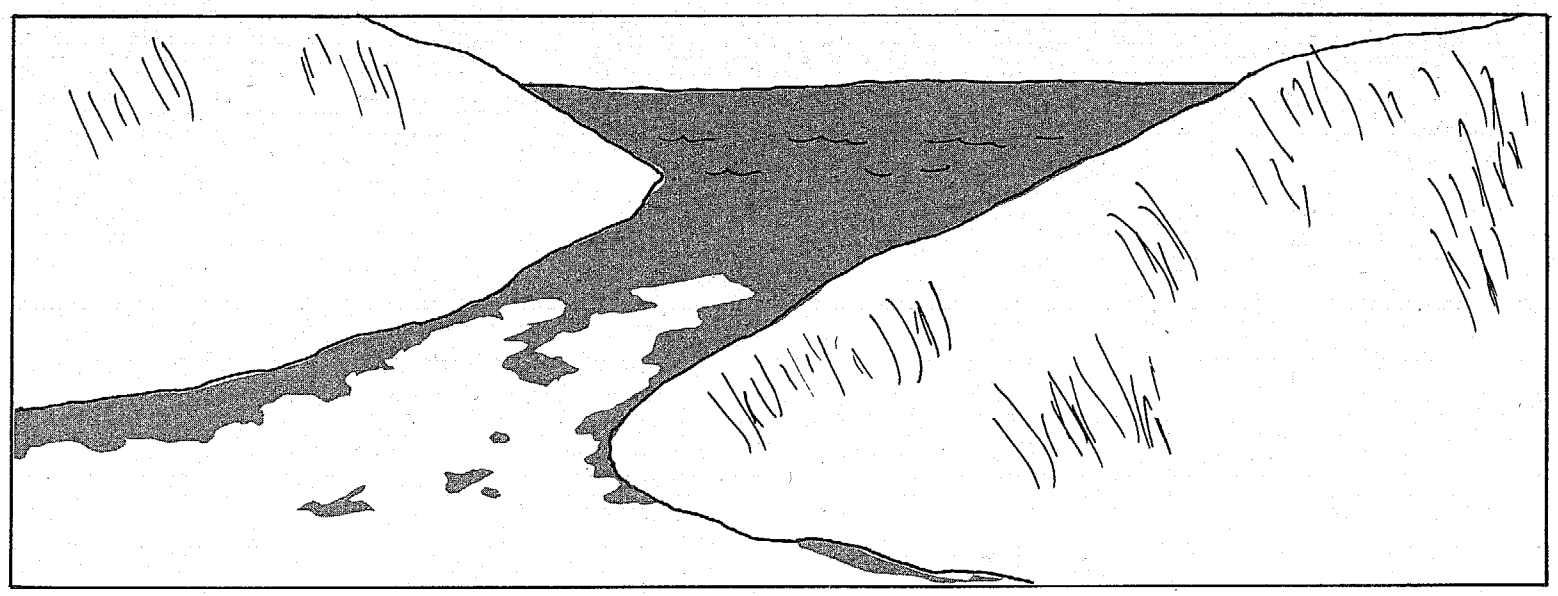


The barrier islands respond by "recycling" themselves. When the force of storm wind and waves is so great that the beach and dunes can no longer withstand it, washovers occur. Storms push massive amounts of water over the beaches, beyond the dunes and into the backside of the island. On this "conveyor belt" the sand moves westward and gradually builds the way for the island's retreat. Also in this process new and more productive sound-side marshes begin to grow atop the fresh sand.



Another way in which the barrier islands give without breaking and manage to rebuild themselves is through inlets. Tides moving through inlets also help to move sands to the back side of the barrier islands where, like the sands carried in washovers, they are left for the island to build on.

As a rule, new inlets open during storms. Day to day, an inlet is generally eroded on the south side and built up on the north side. Eventually, the ever more angled inlet reaches a point where it closes itself. Later, the inlet will usually re-open at less of an angle.



Erosion, then, is not really a "problem" unless people build in the path of shifting sands. Much of what people have done to "control" erosion has often not worked and, in some places, has even helped erosion along:

- Groins—rigid structures built out from shore to trap sand and build up beaches—have often succeeded in starving beaches farther down the line. Likewise, seawalls and bulkheads often rob Peter to pay Paul.
- Despite millions spent to halt erosion, the Cape Hatteras Lighthouse is less than 100 yards from the water's edge. When it was first built in the 1860s, it sat back from the shore about 1,000 yards.

Beach, dune or washover development, then, is best done in harmony with the ecosystem—in a way that accepts and accommodates the natural processes rather than opposes them.

On the beaches, keeping an eye on how public money is spent is an important management tool since the wet sand—land below the mean high tide line—is public. Think twice about investing public money in such things as groins, seawalls or sand-moving projects which might interfere with natural processes.

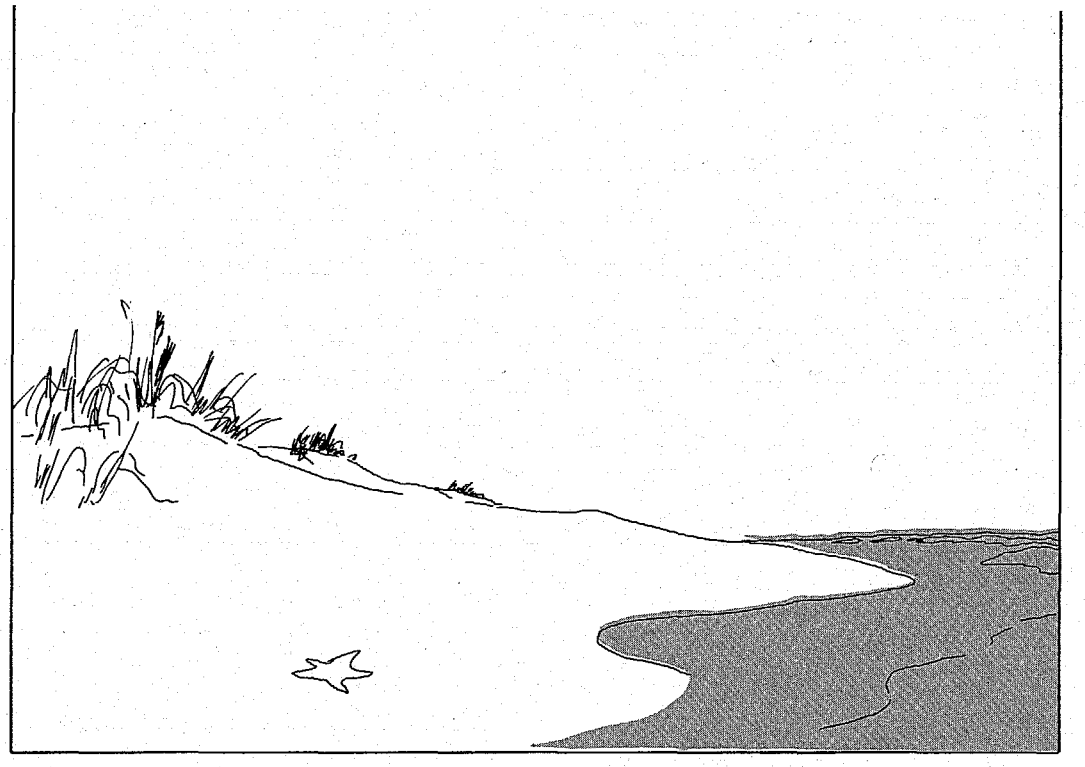
Also, many states designate a "set-back line," beyond which it is illegal to build, to keep construction out of harm's way. The set-back line can be incorporated in local subdivision regulations or sand dunes protection ordinances.

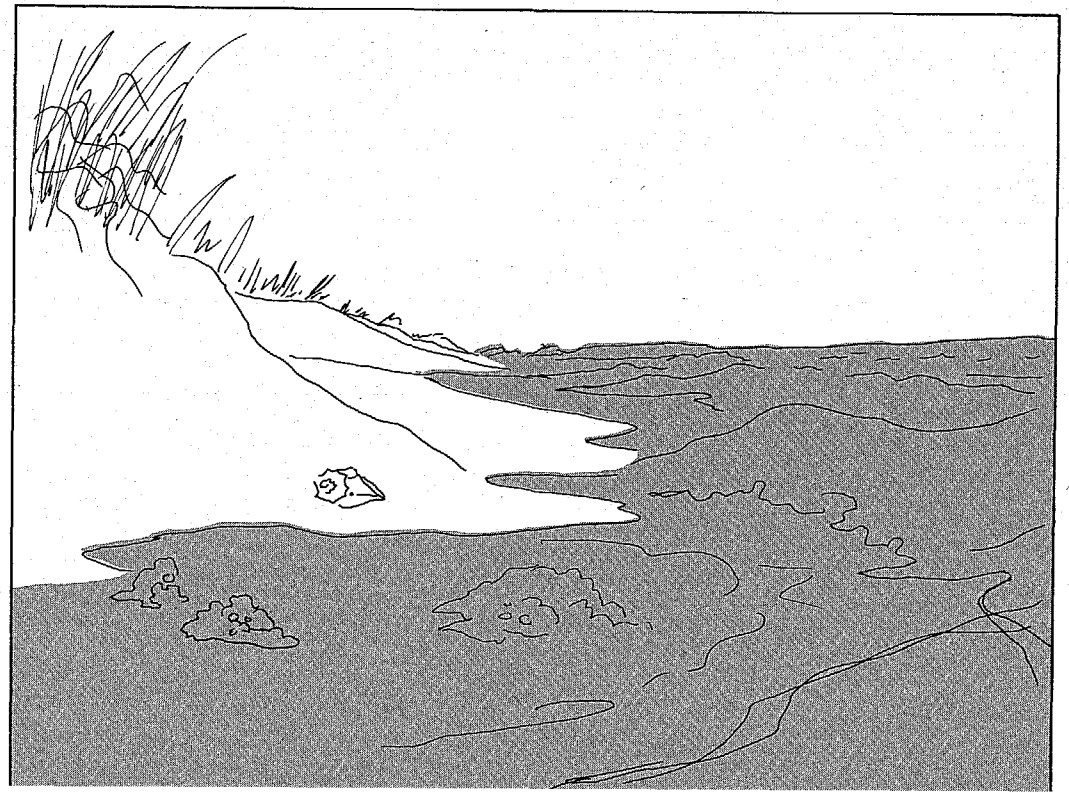
Though caution is advised, washovers can be used. To keep development ecologically sound and as safe as possible, local zoning and building codes can be modified to require that construction be done (1) at the owner's risk, (2) in such a way as to allow the storm surge to pass through, and, (3) in low density. Building codes can require stilts for houses, for example, to avoid plugging up the gap.

Public expenditure in hazardous areas such as washovers and land adjacent to inlets should be discouraged. Because these areas are regularly disturbed, any public investment in them is liable to be short-lived and, therefore, questionable. A policy such as this would discourage private development by not making water, sewer, roads and other amenities available. Some washovers might be good candidates for public aquisition. They could serve the double function of allowing beach access to the public and avoiding the hazards of construction.

Another way to protect people from the hazards of inlets is through local subdivision set-back lines. These can help keep people's houses and businesses out of the paths of moving inlets.■

In summer, long, low waves create a wide, flat beach.





But winter's steep, frequent waves eat away the beach creating steeper, narrower shores.

Though dunes are second only to beaches in their instability, they provide a front-line of defense against wind, waves and weather. In the calmer areas behind and between dunes, maritime forests form another line of defense. Both dunes and maritime forest are also crucially important to the maintenance of underground freshwater supplies which in places may form a thin lens under the barrier islands.

Dunes are formed as wind-carried sand bounces across the beach and is trapped in patches of vegetation. As the sand accumulates more plants grow and more sand builds up. Eventually, the growing dunes merge to form continuous lines of the tiny sand mountains which then grow more rapidly.

Dunes migrate and shift position frequently through continuous wind erosion and sand build up on the back side. While these are gradual changes, a storm can cause dune blowout or buildup in much shorter periods of time.

As vegetation grows, sand and water are trapped and held . . .

. . . Gradually, increasing amounts of sand and plants build a dune.

maritime
forests

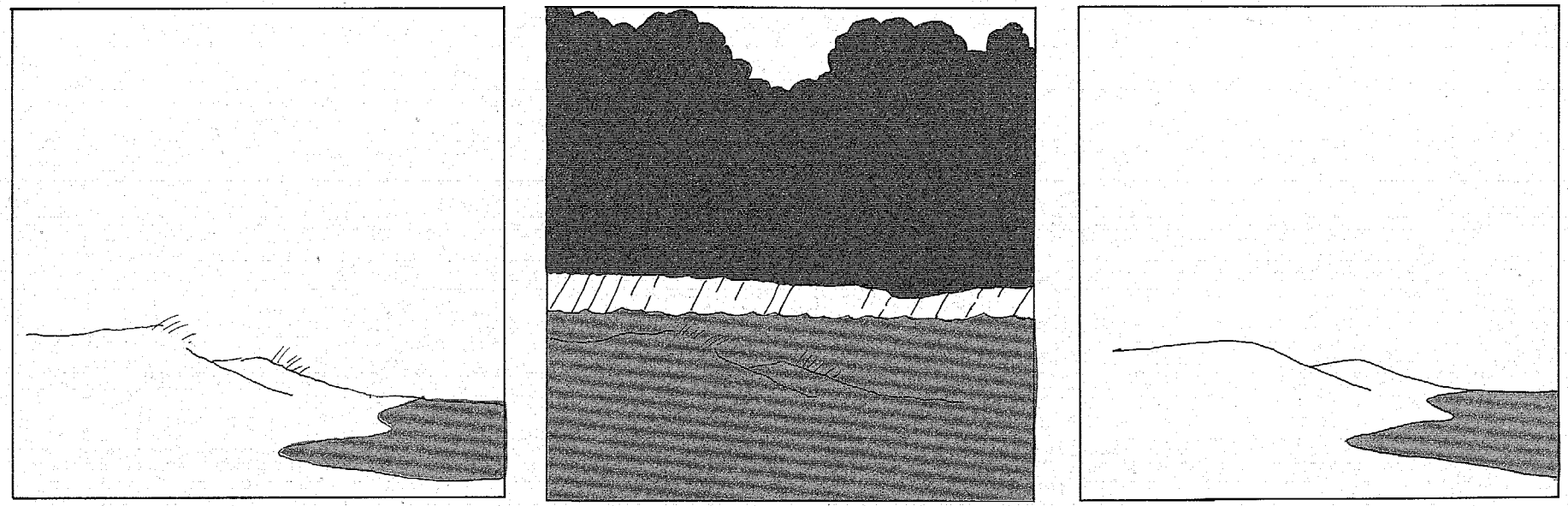
The safety of the second line of defense, the maritime forest, has long been recognized. Amid the live oaks, palmettos and cabbage palms, old timers built their houses. Ocracoke, Portsmouth, Old Nags Head were all nestled among the trees because such places were high, safe and not subject to the extremes of temperature found elsewhere.

Beaten by wind and salt spray, the trees of the maritime forest form a thick, dense canopy of leaves which can withstand even hurricanes. Molding by the forces of nature gives the trees their sculptured look.

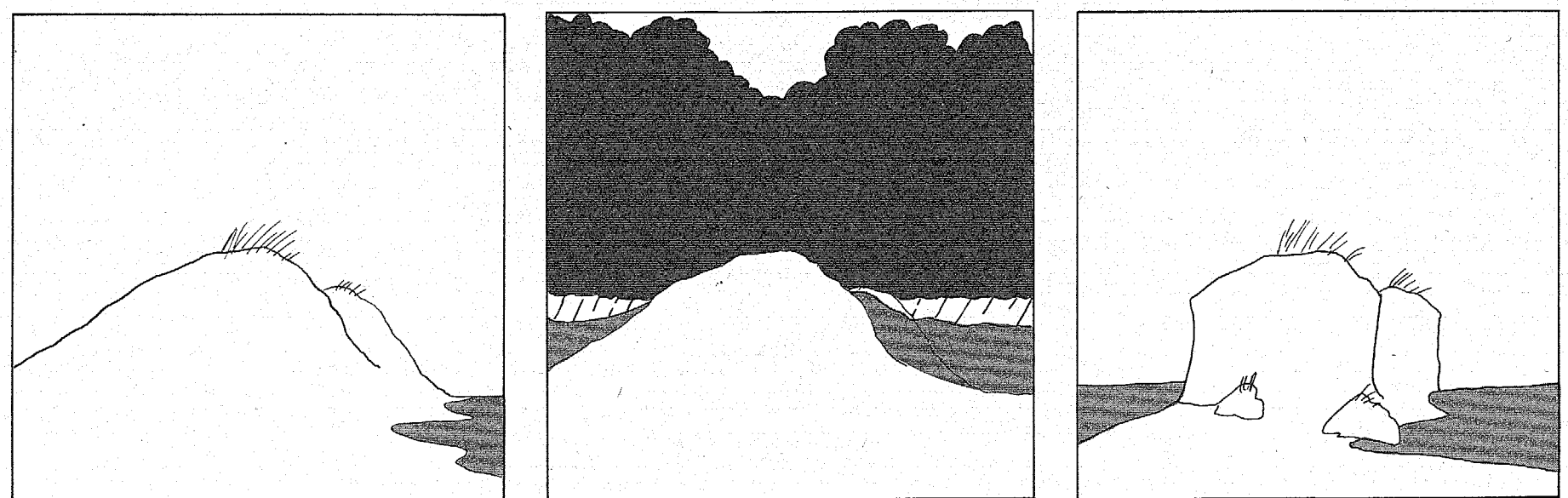
The fine filigree of leaves does allow the rain to pass through. Once in the forest, water is retained in the thick ground cover of forest debris as well as in the soil beneath the forest. This recharge of the water table is what helps keep wells wet.

While the maritime forests are a major source of recharge for the water table, development anywhere on the barrier islands can affect water supply and quality. The problem is, no one knows exactly where water supplies are (they are thought to lie mid-island roughly where the forests are) or how extensive they are. Some fear that cutting down too much of the maritime forest will reduce the amount of water available, or that over-pumping will deplete the supply and allow salt water to seep in.

Roots of trees and dune plants trap sand, too. This equilibrium is not something that man can readily re-create. Trees in the maritime forest, once cut or destroyed by unaccustomed exposure, are difficult to replace.



Natural dune erosion, above, allows sand to migrate as storm waters wash over. Major "stabilized" dunes, below, interfere with that natural process by trapping water which then erodes both sides of the high dune.



Large "stabilized" dunes don't renew themselves. In fact, the sand dunes built during the Depression along the Outer Banks on Hatteras, Pea and Bodie Islands have created a false sense of security and encouraged development in not-so-secure places which will eventually give way. Worse still, these dunes have interfered with the natural washover transport of sand so that now those islands are eroding on *both* the ocean and sound sides.

The rate of development-related dune destruction exceeds the ability of the dunes to mend and rebuild. Even a few foot or dune buggy trips across dune vegetation can kill the plants and eventually open a gap which will not only wear the dune down but invite washover as well. (While washovers are a vital part of the system, there's no point in inviting them in areas that have already been developed.) Leveling the dunes for parking lots and trailer parks extends the zone of salt impact back into the maritime forest.

There are ways to take advantage of nature's protections while protecting nature at the same time.

Set-back lines in local subdivision ordinances can be used to insure that development takes place without damaging critical dunes.

Strict enforcement and broadening of existing county ordinances under the state Sand Dunes Protection Act can also help. Generally, the ordinances prohibit changing the contours of sand dunes. But counties have the authority to broaden requirements to include, for example, beach access via elevated walkways and other measures to protect stabilizing vegetation.

Another alternative to protect this valuable vegetation would simply be to adopt local vegetation protection ordinances.

Most of North Carolina's maritime forests are privately owned and subject to increasing development. Ecologically sound development might entail: large-lot zoning coupled with low maximum ground use requirements; limits on the amount of land that can be cleared through local vegetation protection ordinances; protection of the parts of the forest necessary to maintain the basis of the dune itself under local sand dunes protection ordinances.

Roadways and public services can follow the natural contours of the land. Private development can be required to respect the contours by subdivision control ordinances. And, in cases where the forest is truly unique, these might be good candidates for public purchase.

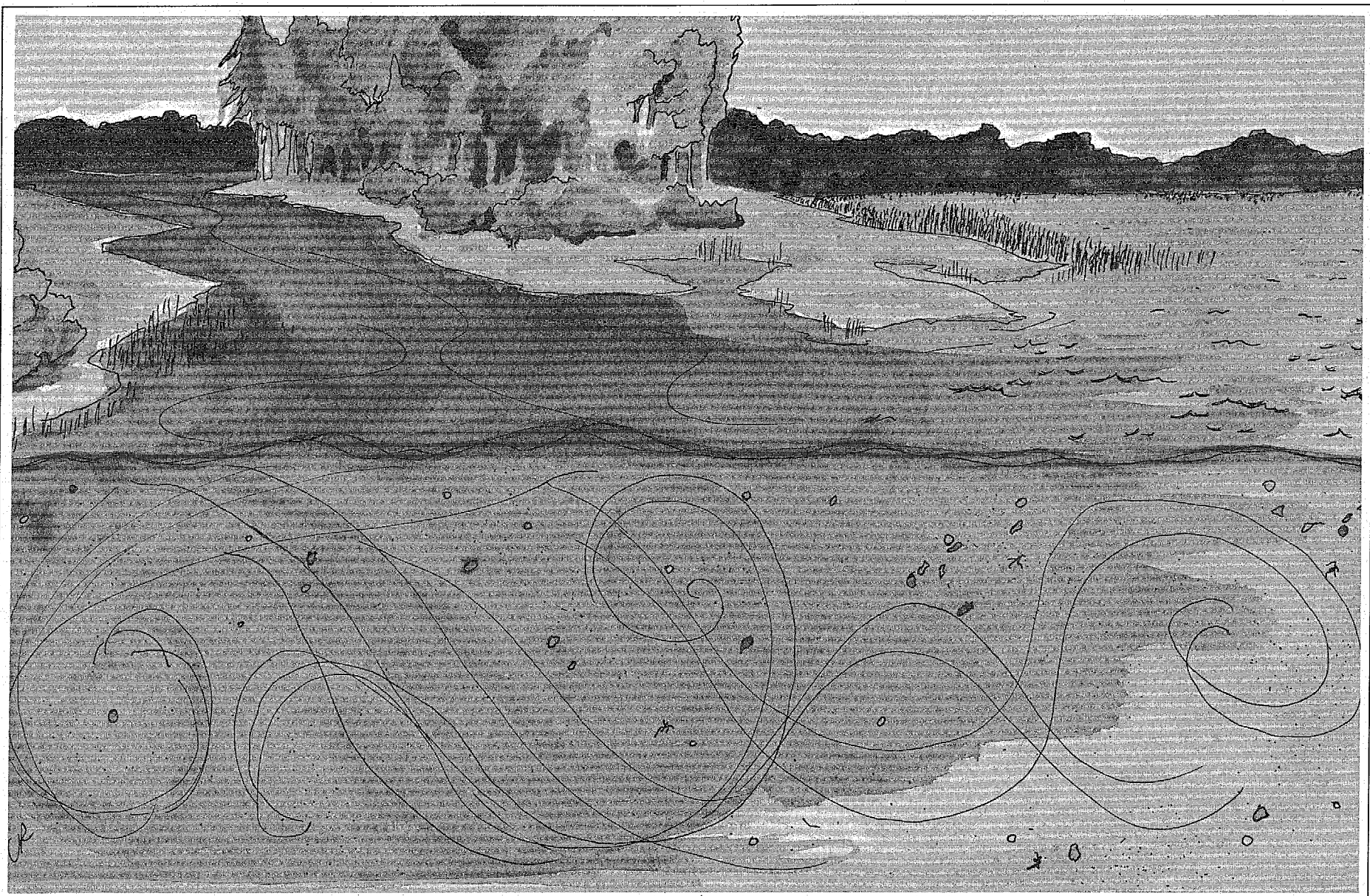
Protecting aquifers—water-bearing strata of permeable rock, sand or gravel—involves two rules of thumb: avoid covering over too much land, and watch out for pollutants. Depending on the kind of development desired, there are a number of tools that can be used to accomplish these goals:

—Local zoning ordinances can keep density low and require single family use. Extensive paving and large-roofed structures should be discouraged. Septic tanks, too, should be discouraged. If allowed, the systems should be designed to insure that wastes will not rush through sandy soils and into the shallow water table before being purified.

—Alternatively, high-density development might be allowed, if local adequate public facilities ordinances require highly efficient sewage treatment systems.

—Planned unit development ordinances might encourage builders to concentrate development on a relatively small part of a site while preserving other parts.

Preserving water supplies calls for looking at systems in their entirety and careful planning. Cummulative effects of septic tanks, for example, can be far-reaching. Supplies of water should be assessed and extraction monitored. In a real pinch, rapid change can be halted by interim moratoriums on building to allow time for research and planning.■



Fresh water from inland rivers mixes with salt water from the ocean to create the unique environment of the lagoon-estuary.

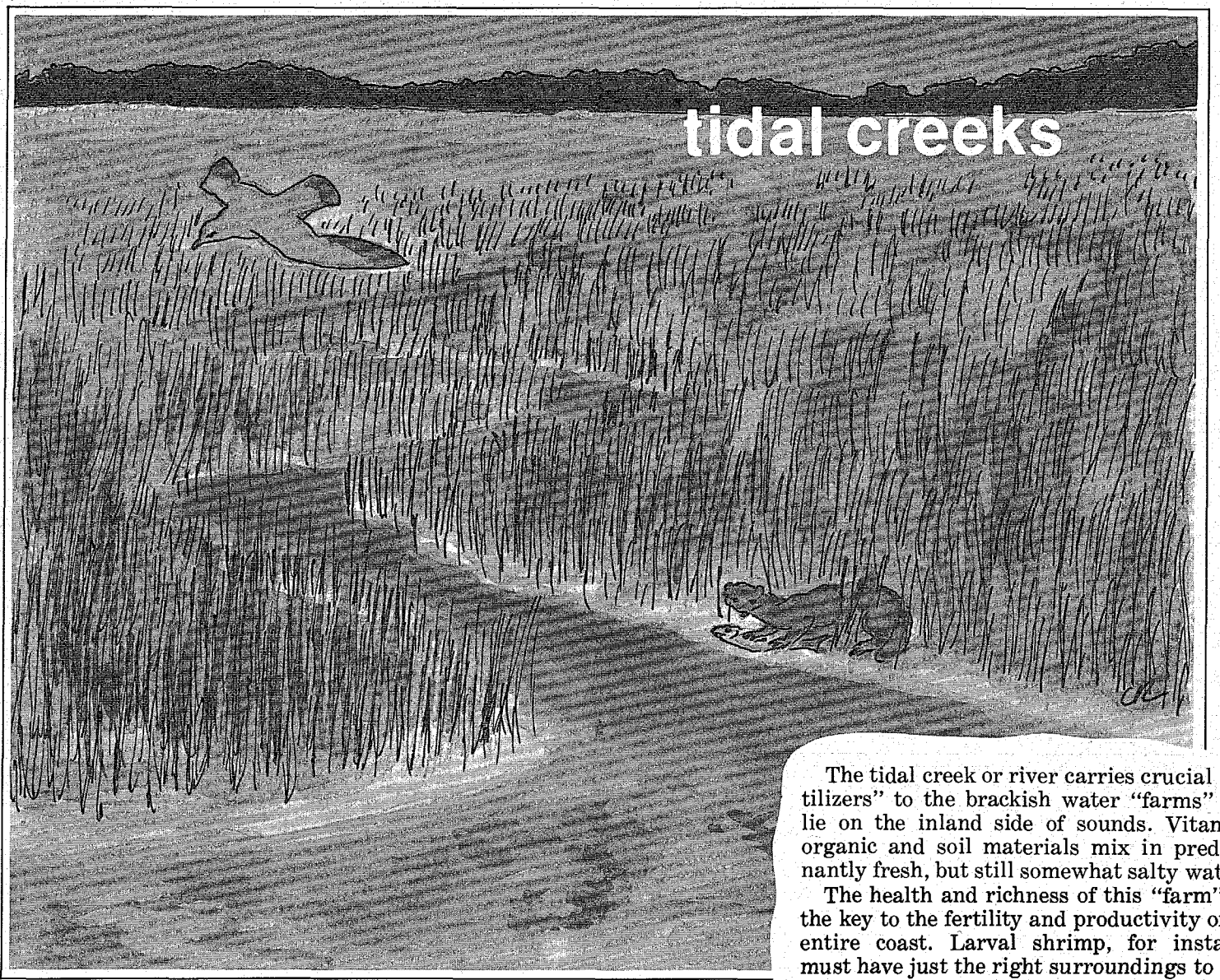
the lagoon-estuary:

The lagoon-estuary is a different sort of animal altogether. Its day-to-day controls are physical and biological rather than geological. Fresh and salt water mix to varying degrees, forming a variety of habitats and nurturing thousands of living organisms.

Everything works as a whole: the quality of water coming from Piedmont rivers affects the quality of and life in coastal sounds.

Legally, the lagoon-estuary, with its marshes, mud and sand flats, brackish and saltier waters, and swamp forests, is rather different, too. For the most part, the waters and lands are either publically owned or in a kind of limbo. There's a definite need to determine just how much is public because ownership can itself be used as a management tool.

Due to the public ownership and sensitivity of the lagoon-estuary to environmental changes elsewhere, most regulations are federal or state. Therefore, a second major management tool is to insure that federal and state regulations are followed.



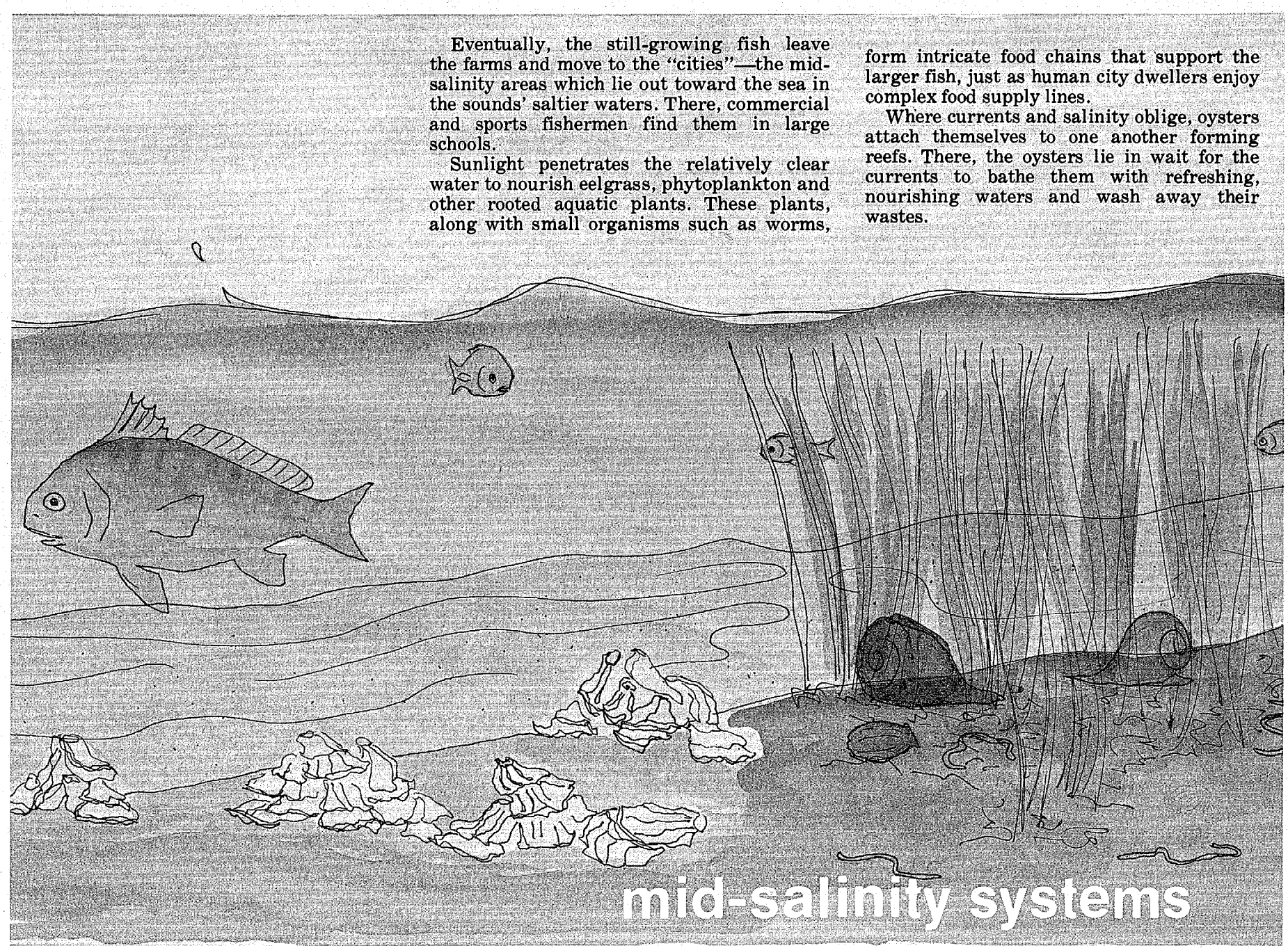
The tidal creek or river carries crucial "fertilizers" to the brackish water "farms" that lie on the inland side of sounds. Vitamins, organic and soil materials mix in predominantly fresh, but still somewhat salty waters.

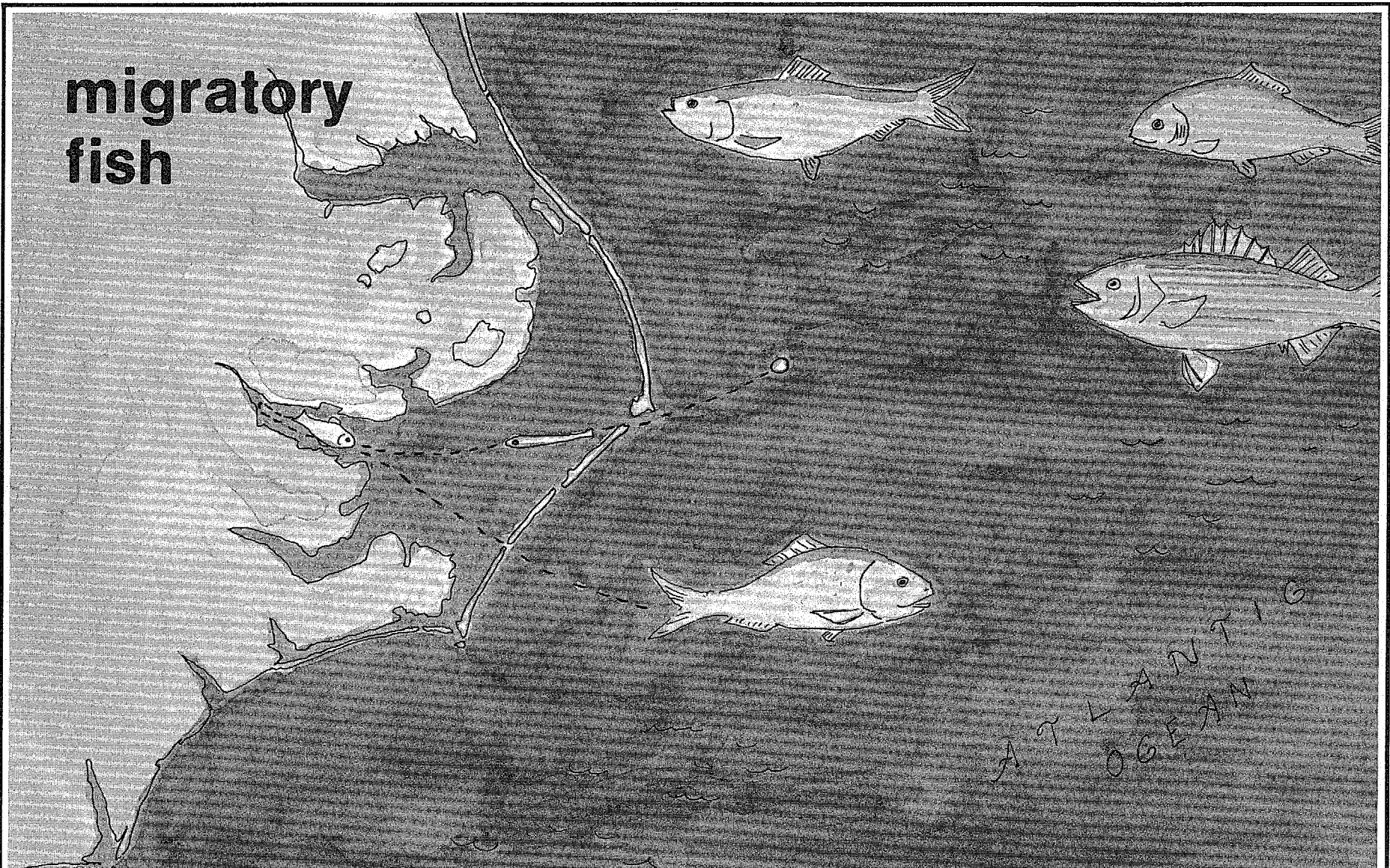
The health and richness of this "farm" are the key to the fertility and productivity of the entire coast. Larval shrimp, for instance, must have just the right surroundings to pass from one stage into another. These nursery grounds serve the young of most of the sports and commercial species found in North Carolina. According to the season, the "farm" may be growing anything from spots, croakers, menhaden, trout to brown or white shrimp.

Eventually, the still-growing fish leave the farms and move to the "cities"—the mid-salinity areas which lie out toward the sea in the sounds' saltier waters. There, commercial and sports fishermen find them in large schools.

Sunlight penetrates the relatively clear water to nourish eelgrass, phytoplankton and other rooted aquatic plants. These plants, along with small organisms such as worms, form intricate food chains that support the larger fish, just as human city dwellers enjoy complex food supply lines.

Where currents and salinity oblige, oysters attach themselves to one another forming reefs. There, the oysters lie in wait for the currents to bathe them with refreshing, nourishing waters and wash away their wastes.





Some fish spend part of their lives in the ocean, part in the estuary and, sometimes, part farther up river. Migrating fish shown here are, clockwise, hickory shad, American shad, striped bass and menhaden.

Many of the fish in these waters don't stop at the cities. They are part of a larger world of "migrating subsystems." Those are fancy words for fish which spend part of their lives in the ocean, part in the estuary, and, sometimes, part farther up river. For example, shrimp and menhaden move back and forth seasonally from ocean to estuary; striped bass and shad move between river and ocean.

Just as mixing waters share and concentrate nourishment, they can also share and store up pollutants. And, just as development causes problems for the estuary, the estuary also causes problems for development: Three to 12 feet a year are lost to estuarine erosion, rising ocean levels, and subsiding land.

Unfortunately, these waters don't lend themselves to neat protections. They don't seem to have heard about governmental boundaries. The waters wander back and forth from one jurisdiction into another. The impact of pollution may be felt some distance from its source.

For this reason, ecologically sound growth and protection require local, state and federal cooperation. But there are some things local governments and citizens can do on their own:

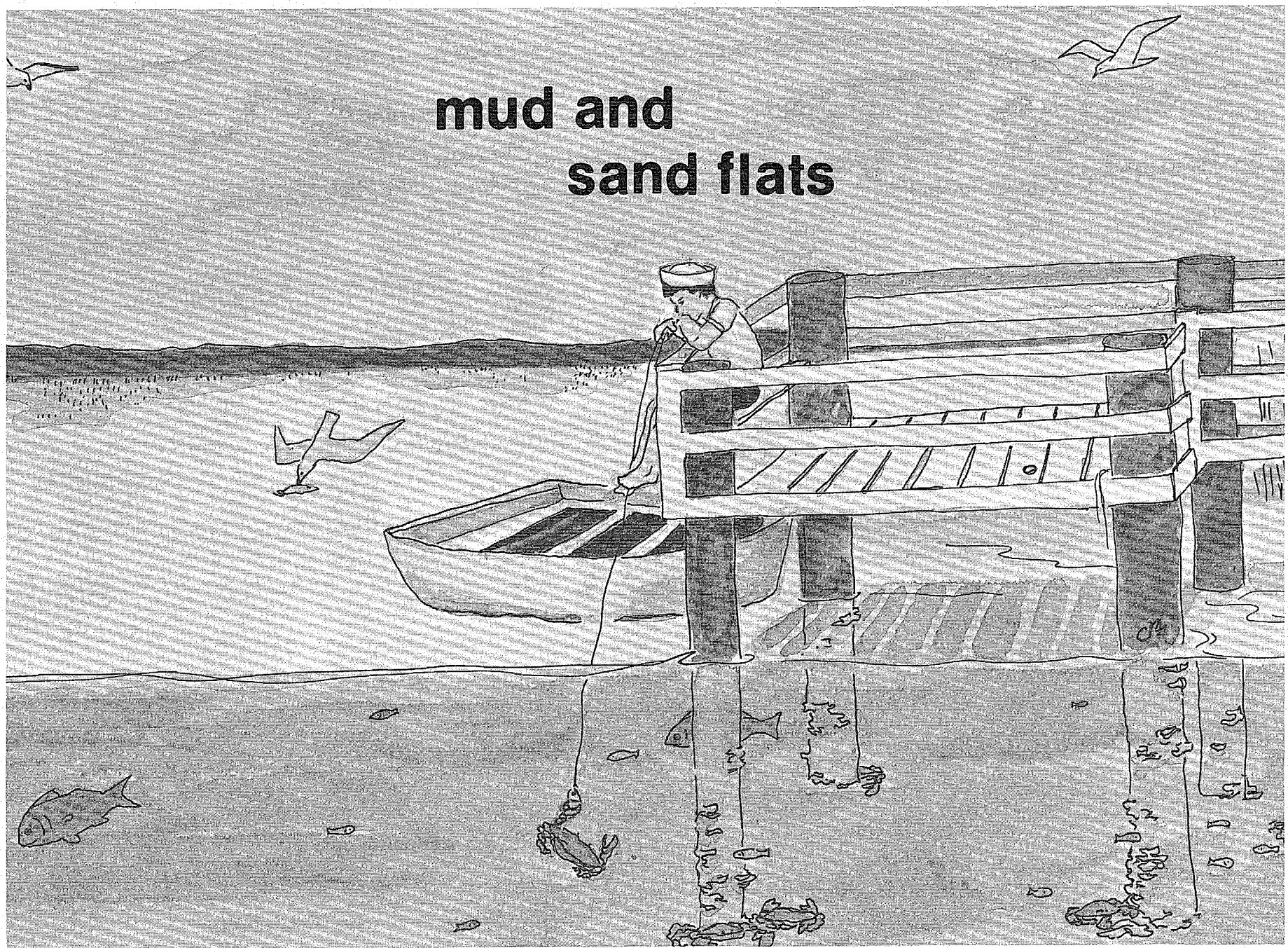
—Set-back lines in local subdivision ordinances can designate the points to which development can take place and still leave a buffer zone around the estuary.

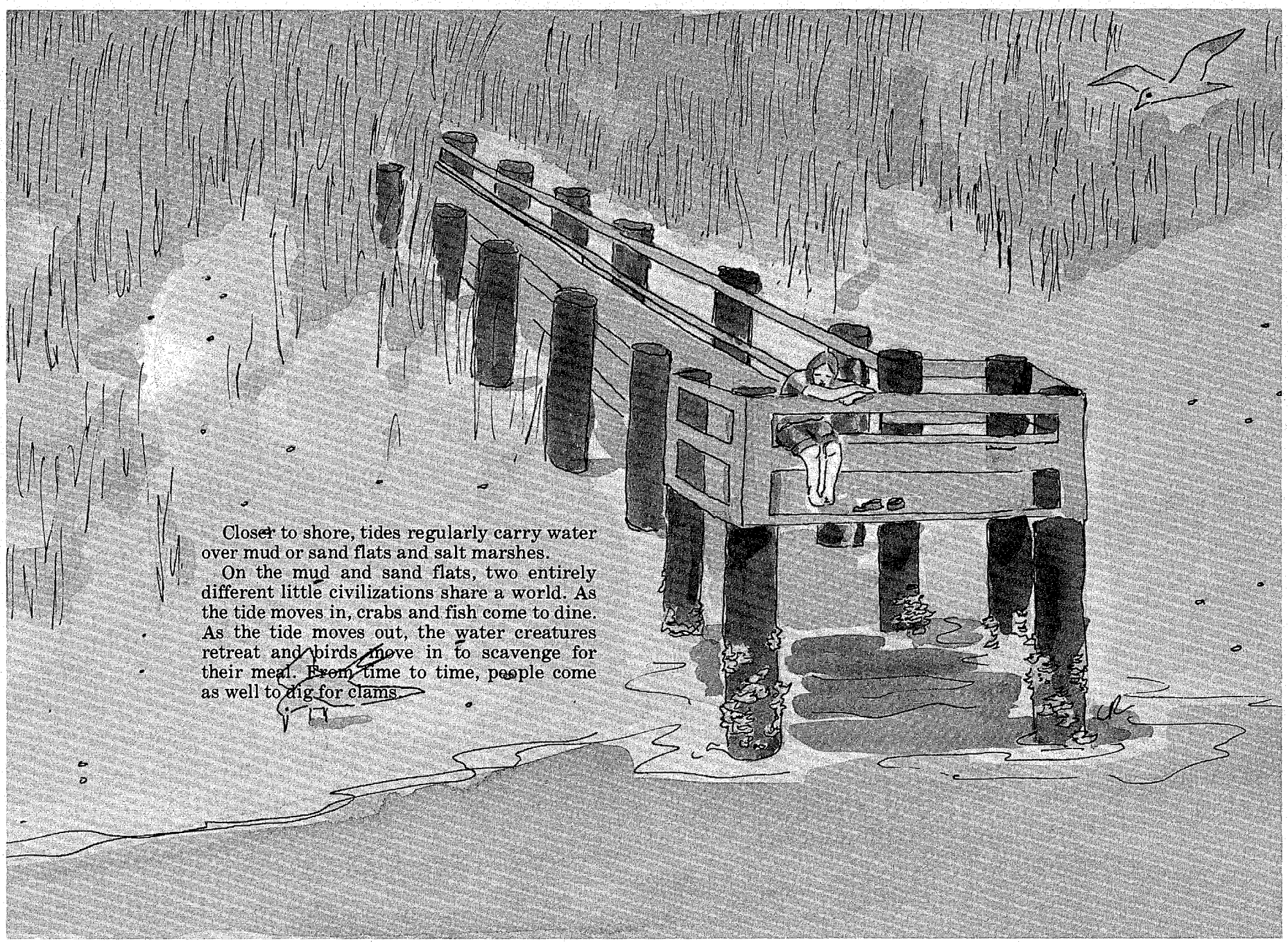
—To avoid creating more erosion next door, existing state or new local bulkhead ordinances should encourage bulkheading which recognizes geographic units such as coves and discourage it for individual lots.

—Local sediment control ordinances can require diking or other methods of sediment containment in new construction.

—Under local adequate facilities ordinances, sewage disposal facilities which do not discharge into the estuary can be required.

—Finally, the fact that a law is on the books doesn't necessarily mean that it's enforced. Inspectors can't be everywhere. So, if violations occur that officials might not be aware of, it might be well to call the violations to their attention.■


mud and
sand flats



Closer to shore, tides regularly carry water over mud or sand flats and salt marshes.

On the mud and sand flats, two entirely different little civilizations share a world. As the tide moves in, crabs and fish come to dine. As the tide moves out, the water creatures retreat and birds move in to scavenge for their meal. From time to time, people come as well to dig for clams.

Minks live there, as do bears, deer, otters, mallards and wood ducks. Shortly before the turn of the century, the Industrial Revolution found a major source of cypress wood there.

It is the swamp forest. Up the rivers from the coast, the trees and animals grow in the dark, cool, mossy wet. Swamps make up half of North Carolina's almost six million acres of wetlands, and are concentrated in the northeastern corner of the state.

Like salt marshes, swamp forests are sponges which absorb nourishment and drainage waters. In place of the marsh's grass, the forest has trees. Like the grasses, the trees filter water before releasing it into the estuary. Water also filters into the water table. The swamp forest is thought to be a major replenisher of coastal water supplies.

Like the marsh, the swamp forest acts as a buffer zone in floods. In addition, people use the swamps for hunting and lumbering.

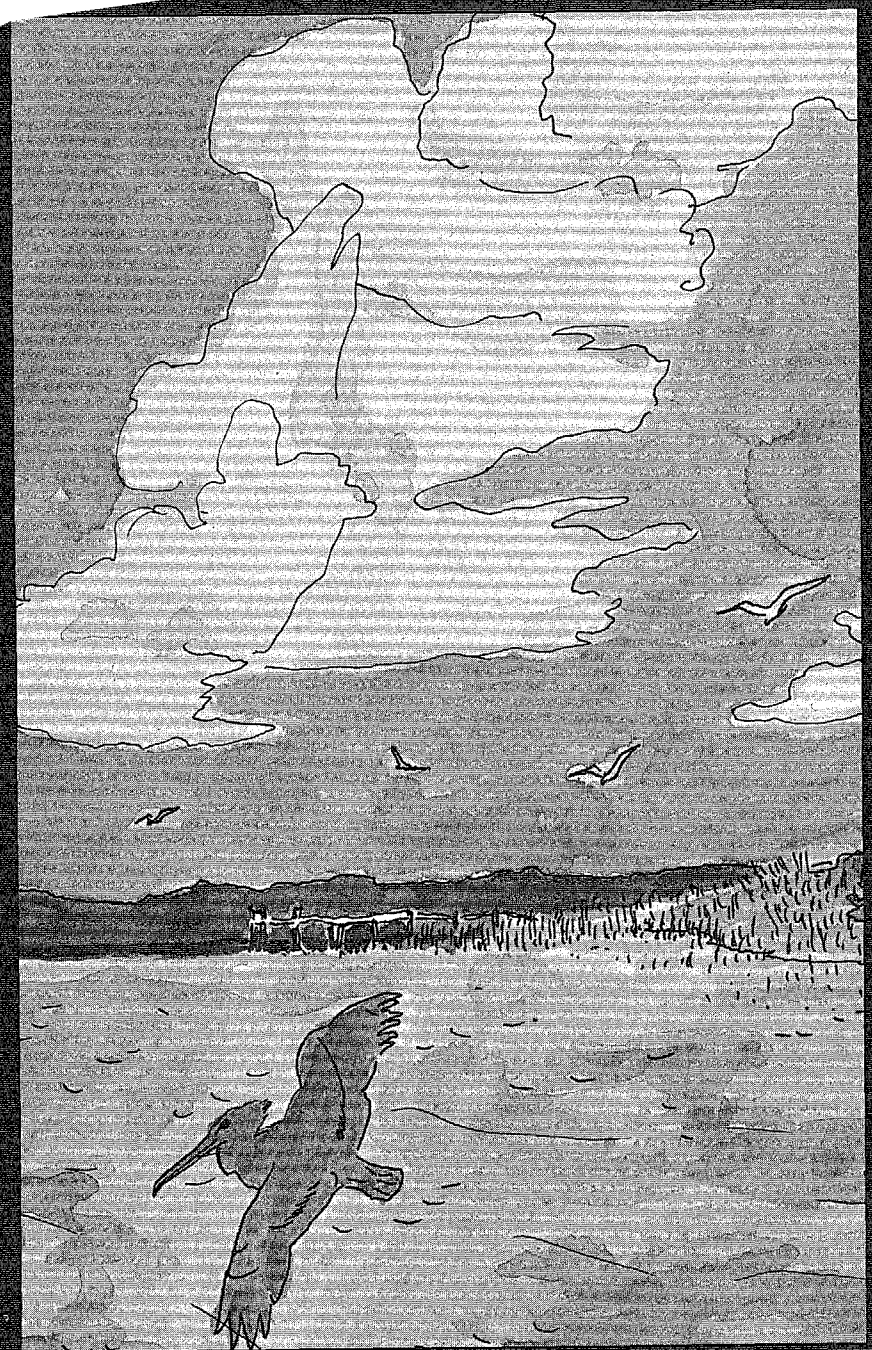
But it is the swamp forest which is falling under the bulldozer as development, including agriculture and forestry, spreads throughout coastal North Carolina. Trees are cleared and channels are cut to speed water off land. Channels are also cut for insect and flood control. But no one knows how much of the swamp forest can be cut without reducing its ability to cleanse water and support wildlife.

Unfortunately, this is an area in which the laws are lagging behind. Dredge and Fill statutes often do not seem to apply. When it goes into effect, the National Pollution Disposal and Elimination System may help. Permits, issued by the state Environmental Management Commission, will regulate the quality of point-source discharges—from a pipe, a ditch—and the water into which they dump. But the potential impact of the regulations on swamp forest development is unclear and far from definite.

The best hope for development is to set priorities on swamp preservation, then make it undesirable and difficult to develop in some areas, while not in others. This can be done by enactment of local vegetation ordinances, careful use of money on utilities extension, large lot and adequate public facilities requirements.■

Unless development is done in a way that takes into account all the natural processes which make the coast a special place, the whole reason for developing it will be destroyed. The unique environment **can** be protected and we **can** live in harmony with it.

It's a matter of understanding what's there and weighing the quantity and quality of development against the consequences. The choice is ours. We can preserve the value, the good. We know how to develop wisely, we know how public law can require it. It's a matter of deciding what we want to leave for future generations.



For more info:

Contact local planning boards and governments as well as the following state and federal offices. These offices are responsible for specific regulations, but they can also provide general information.

SANITATION

N.C. Department of Natural and Economic Resources
P.O. Box 27687
Raleigh, N.C. 27611

or

Southeast Field Office
3143 Wrightsville Avenue
Wilmington, N.C. 28401
919-762-3394

or

Northeast Field Office
1502 North Market Street
Washington, N.C. 27889
919-946-6481

DREDGING, FILLING AND CONSTRUCTION IN COASTAL WATERS

Permit Section
Division of Marine Fisheries
3411 Arendell Street
Morehead City, N.C. 28557
919-726-7021

U.S. Army Corps of Engineers
Princess & Water Streets
Federal Building
(mail: P.O. Box 1890)
Wilmington, N.C. 28401
919-763-9971

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UNC-SG-75-18—Baker, S. Coastal development and areas of environmental concern: Proceedings of a symposium. $2.50

UNC-SG-75-26—Rice, D. "Taking" by regulation and the North Carolina Coastal Area Management Act. $2.00

UNC-SG-75-29—Bellis, V., M.P. O'Connor and S.R. Riggs, Estuarine shoreline erosion in the Albemarle-Pamlico region of North Carolina. $2.50

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UNC-SG-76-09—Schoenbaum, T.J. & Kenneth G. Silliman. Coastal planning: the designation and management of areas of critical environmental concern. $2.00

Reprint #96— Schoenbaum, T., R.H. Rosenberg. The legal implementation of coastal zone management: The North Carolina model. $1.00

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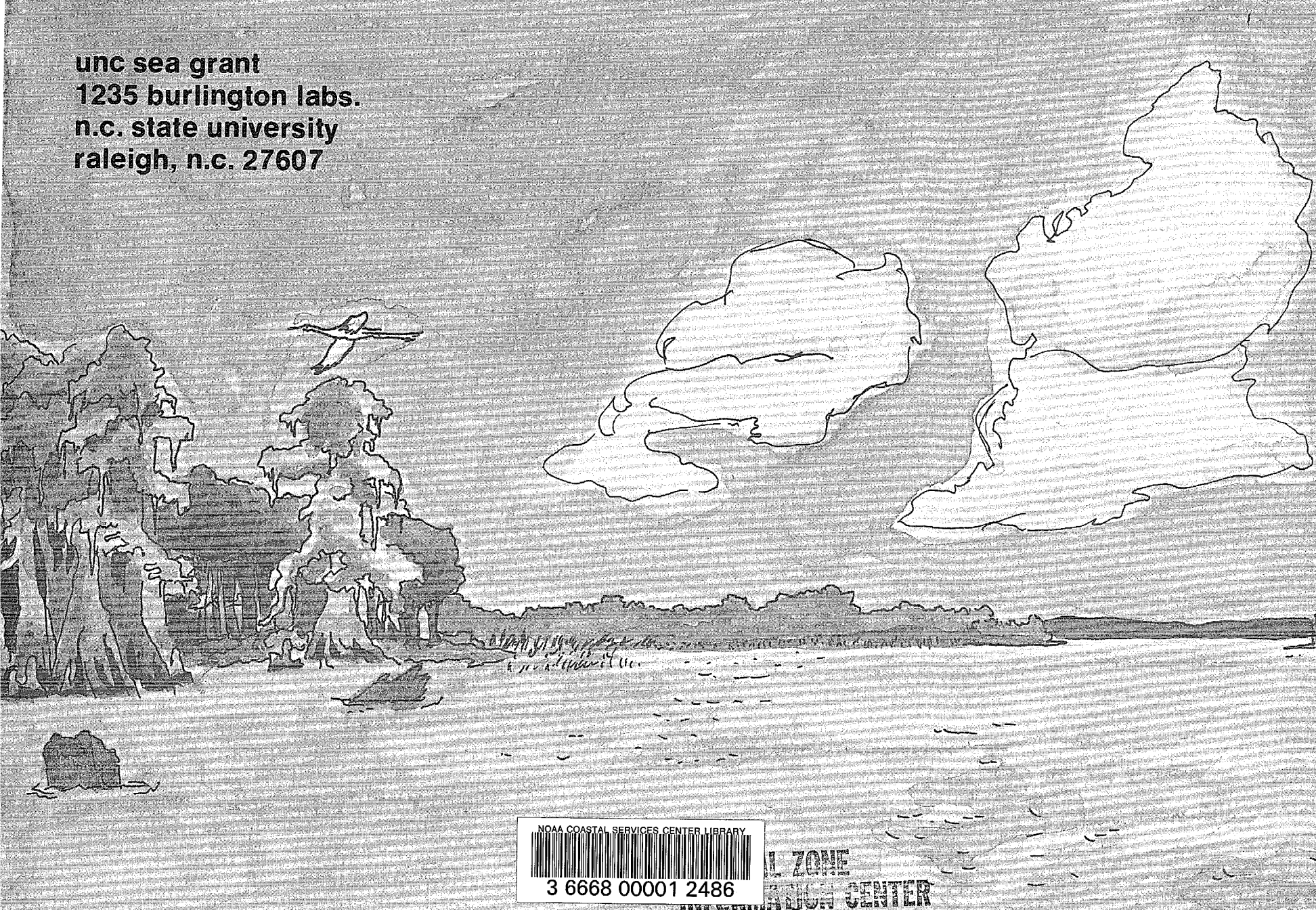

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