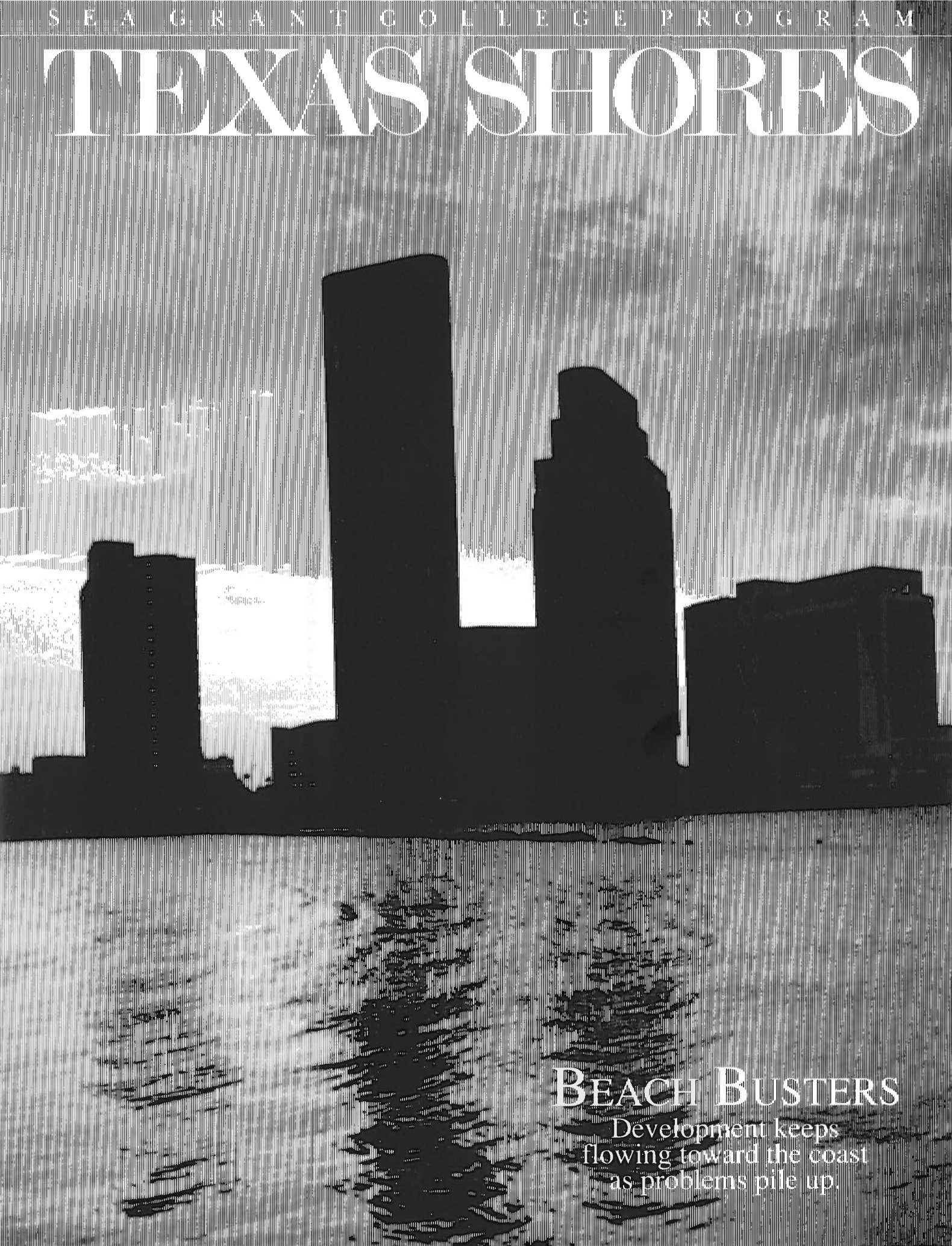
SEA GRANT COLLEGE PROGRAM

TEXAS SHORES



BEACH BUSTERS

Development keeps flowing toward the coast as problems pile up.

Where We Stand

When the Texas Sea Grant Program began publishing a magazine in the early 1970s, our intent was to provide our readers with news about current marine-related research, as well as a forum for discussion of events that affect the marine environment. We believed then — and we still believe — that our overriding objective of cultivating a marine-literate society would best be accomplished by making this material available to the widest possible audience free of charge.

Unfortunately, our belief now must contend with an economic fact of life. Texas Shores is reaching a wide audience — some 6,000 subscribers throughout the United States and in some foreign countries — and we continue to receive requests for new subscriptions weekly. But printing and postage costs have kept pace with the growing number of subscribers, at a time when funding for the Sea Grant Program is being decreased among our various funding sources.

We are faced with two options — discontinue the magazine or change to a paid subscription basis. After numerous discussions, we are opting for the latter alternative. Beginning in September 1988, a one-year subscription to Texas Shores will cost $7.50. This will enable us to continue publishing four issues per year, and, hopefully, to expand both the length and content to accommodate our readers' needs more closely.

A subscription form is attached. We hope that all current subscribers will choose to continue receiving Texas Shores.

Amy Broussard
Head of the Marine Information Service

Texas Sea Grant

AN ORGANIZATION OF PROFESSIONALS DEDICATED
TO THE BETTER UNDERSTANDING OF OUR MARINE ENVIRONMENT

SUMMER 1988

TEXAS SHORES

VOLUME 21, NUMBER 2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Galveston Bay Selected for National Estuary Program


Norman Martin

New funds targeted for Texas.

Because of its designation in the National Estuary Program, Galveston Bay will now begin receiving federal and state funds for a pollution-management program to protect bay estuaries. The agreement between the federal government and the state of Texas has appropriated $150,000 from the Environmental Protection Agency and $72,500 from the state in first-year funding.

Funding for the second-year of the protection and water-quality improvement program will reach $875,000 with EPA funds making up $700,000 of that. Funding will be used to identify sources of pollution. Private industry education officials and public agencies will all be involved in this program aimed at protecting the fragile marine life in our estuaries.

The study team will look at all available pollution-based data on Galveston Bay before making any recommendations. "This study is going to cover the whole spectrum because estuaries are valuable, fragile environmental systems that need to be protected and maintained," says Roger Meacham, an EPA spokesman in Dallas. He described Galveston Bay as "one of the most important estuaries in the country," and said the EPA will work with state officials closely during the length of the study, scheduled to last five years.

Dr. Sammy Ray of Texas A&M University at Galveston is pleased with the estuary designation given the bay and hopes the study will lead to measures ensuring the abundance of the coastal waters. "I think this is a start. We should do a good inventory of what we know about the bay, and then we would know where to start," Ray says. Ray, a specialist on bay and Gulf oysters, says that the drought has damaged the oyster populations significantly in Galveston Bay.

Ocean Debris Linked to Sea Turtle Deaths


Debris linked to strandings.

When you're messing with Texas beaches, you may also be messing with the lives of endangered sea turtles. A high correlation has been found between trash or debris on beaches and debris found in the stomachs of stranded turtles, says a Texas A&M University at Galveston (TAMUG) researcher. Plastic was the worst, occurring in nearly 80 of the turtle stomachs that contained debris and on about 97 percent of the beaches surveyed.

"These figures indicate an impact by man on sea turtles through the deposition of debris on beaches and in the marine environment," says Dr. Andre Landry, a marine biologist. Approximately 85 percent of the debris categories found in turtles were recorded during beach debris surveys, Landry says. These categories include plastic, rubber, fishing line, tar, cellophane, monofilament rope, wax, styrofoam, aluminum cans, string and cigarette filters. Sea turtle strandings along the Texas coast are documented by the National Marine Fisheries Service (NMFS) Southeast Fisheries Center's Sea Turtle Stranding and Salvage Network.

Texas A&M graduate students under the direction of Landry survey more than 100 miles of Texas beach from Sabine Pass to Matagorda Island at least once every two weeks. Stranded turtles that are still alive are taken to the NMFS Galveston Laboratory for care and rehabilitation. Dead turtles are returned to TAMUG for necropsy and food habit analysis, he says, in order to detect patterns of death.

"Necropsies are performed on all turtle carcasses, condition permitting, in an attempt to determine cause of death and gather life history information," Landry explains. Beach debris, defined as any man-made or processed material such as lumber, is also surveyed in conjunction with the stranding surveys, Landry says. Debris is removed from beach sites and identified, counted and weighed. *– Rebecca Adair*

Sub-Antarctic Plateau Once Lush Forest


ODP

Drillship JOIDES Resolution.

One of the world's largest underwater structures is a sunken world that once contained a lush forest but now lies in the remote sub-Antarctic region of the Indian Ocean, say scientists with the international Ocean Drilling Program (ODP) at Texas A&M University.

Scientists aboard the drillship JOIDES Resolution, operated and staffed by Texas A&M crew and researchers along with scientists from other nations, now have a 97-million-year geological record to determine the origin and evolution of the Kerguelen Plateau.

At 2,500 kilometers (1,550 miles) in length, the underwater plateau's size and shape resemble Argentina. Research has revealed a fascinating history of a region that began with a barren land mass, evolved into a lush, primeval forest and underwent a long period of slow subsidence before reaching its present depth more than a half mile below the surface.

Samples examined on board the 470-foot ship show that the rocks had formed either above or very near to sea level, proof that the plateau existed as a land mass during the earliest phases of its history, says Dr. Philip Rabinowitz, ODP director and a Texas A&M oceanographer. The first sediment accumulation occurred on land or in very shallow water, such as in a marsh or flood plain, Rabinowitz says. Fingernail-sized fragments of fossil wood found in the reddish brown, soil-like silts and clays also point to terrestrial conditions existing in a warm, moist climate, he says.

The plateau then began to subside, and continued to do so until about 1.6 million years ago as the water deepened to present-day depths of more than a kilometer. The region's climate also began to cool significantly about 36 million years ago, and from about 1.6 million years ago to the present, blooms of diatoms (microscopic marine algae) and layers of rocks carried by icebergs from Antarctica left a record of the climate changes that occurred during ice ages. Also on this part of the expedition, scientists aboard the drillship will date the track of India's movement toward the Asian continent, and study the behavior of the region's climate patterns over millions of years. *– Rebecca Adair*

Summer Drought Hurts Outlook for Oyster Harvest

Oyster prices expected to climb.

Consumers will probably pay more for oysters this winter because of a dry season that experts and oystermen predict will cause a sharp decline in this year's harvest.

"This is probably the worst situation we've been in in 30 years," says Dr. Sammy Ray, who heads the graduate and special programs department at Texas A&M University's Galveston campus. "Right now, with what the weather forecasters are predicting, I'd say it looks pretty poor."

The problem, experts say, is the lingering drought. And the result will likely be a price increase from the current average of $25–$30 per gallon. "Just like the crops in the Midwest, rain is the lifeblood for oysters," says Tom Hults, president of the Texas Oyster Association. Fresh water is vital to oysters because it dilutes the salt content of the bay, Ray says. That's important because crabs and conchs, which prey on young oysters, invade the bay when salinity levels are high.

Lucky Dolphin Stars in Texas Sea Grant Video

Anti-litter TV spots released.

A dolphin named "Lucky" and popular Texas musician Joe "King" Carrasco have joined the ranks of Lone Star celebrities urging citizens not to mess with nature by messing up the outdoors.

"Lucky," rescued from death after being trapped in a castoff fishing net, throws a discarded bottle back at a boater in a new anti-litter television announcement produced by the Texas A&M University Sea Grant College Program and cosponsored by the General Land Office's Adopt-A-Beach program. The message is that beach trash is ugly and harms wildlife, too, say officials.

"We have all the evidence we need to show marine debris is killing dolphins, turtles and even whales," says Mike Hightower, deputy director of the Texas Sea Grant College Program. The television spot has been sent to more than 250 stations.

Adopt-A-Beach is patterned after the successful state program of recruiting civic groups to adopt segments of a highway so that group members are responsible for keeping the roadside clean. Other roadside anti-litter television spots have also featured popular Texas entertainer Jerry Jeff Walker as well as the Fabulous Thunderbirds.

Record Budget Approved for Texas A&M at Galveston

Dr. James McCloy promoted.

Two key administrative appointments and a record budget – the first to exceed $10 million – have been approved for Texas A&M University at Galveston (TAMUG) by The Texas A&M University System (TAMUS) Board of Regents. The TAMUG budget, effective September 1, represents an increase of more than $1.2 million and the first budget of more than $10 million. The rise of nearly 14 percent is more than double the overall TAMUS average of about 6 percent.

Dr. James M. McCloy was appointed the new vice president of academic affairs for TAMUG, a position he had previously held on an interim basis, says TAMUG President Dr. William J. Merrell. McCloy, who has been with TAMUG since 1971 as a visiting assistant professor, has risen through the ranks as assistant dean for academic affairs, head of general academics, interim dean of the Texas Maritime College and acting vice president for academic affairs. "Dr. McCloy has long been considered a valuable asset to the university and has held many responsible positions including director of the Coastal Zone Laboratory since 1978," says Merrell. McCloy received a bachelor's degree in geography from State College at Los Angeles in 1961 and a doctorate from Louisiana State University in 1969.

Dr. William A. Seitz, who began his career with TAMUG in 1977, was appointed dean of Moody College of Marine Technology, a position he had held on an interim basis. Seitz, who has served as head of marine sciences since 1980, received his bachelor's degree from Rice University in 1970 and his doctorate from The University of Texas at Austin in 1973.

– Rebecca Adair

Abrupt Climate Changes Influence Species Survival

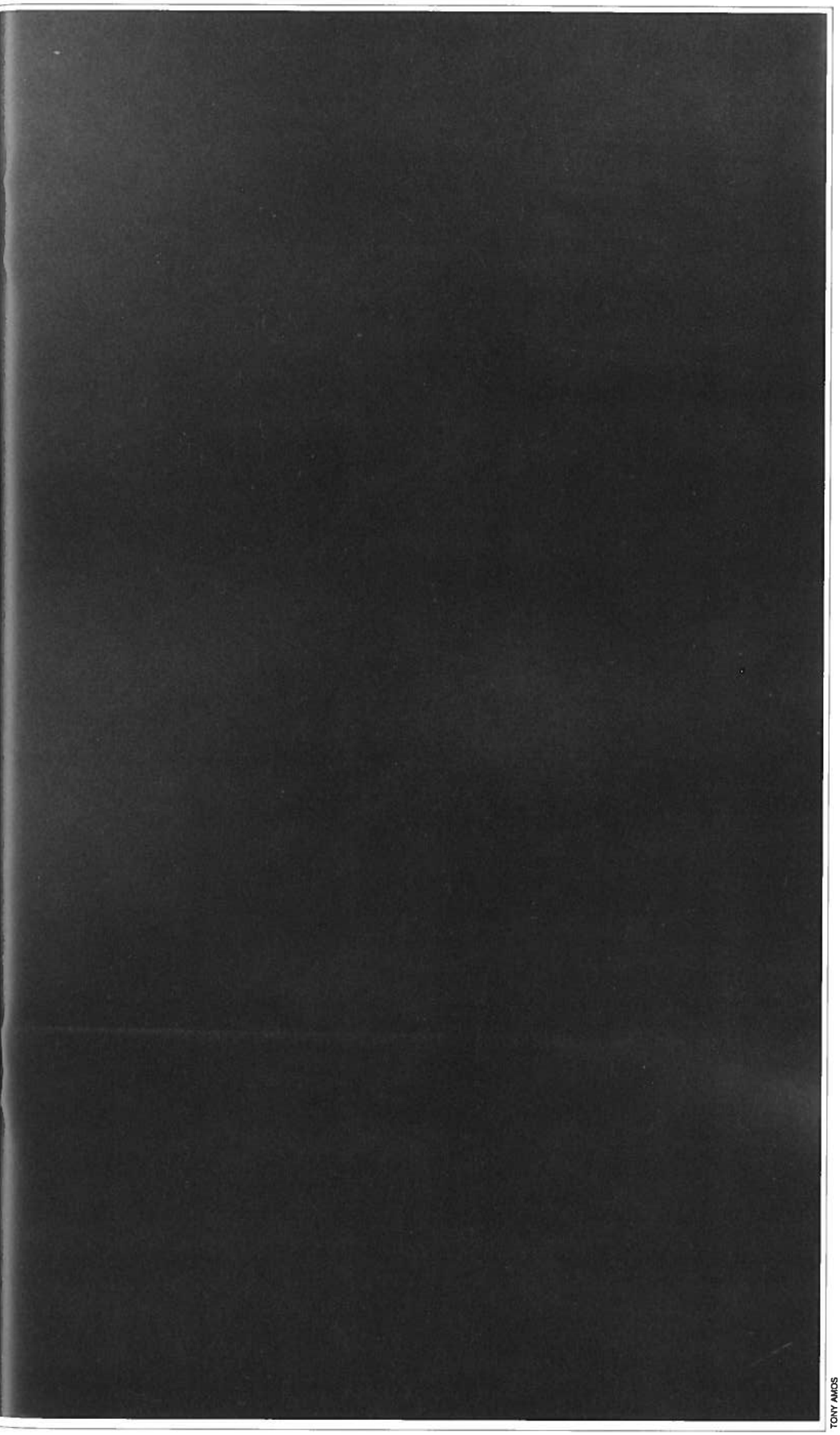
The occurrence of ice ages and closely timed extinction of certain species is more than coincidence, say Texas A&M University researchers. Climate-life comparison also suggests that ecosystems may be more sensitive to outside influences during the early stages of evolution from an ice-free to a glacier state, Texas A&M scientists say. Evidence suggests that abrupt climate changes can be just as influential in leading to mass extinction as other suspected causes such as disease or collisions with meteors, explains Dr. Gerald North, a distinguished professor of oceanography and meteorology.

The findings are not a new clue to what killed the dinosaurs, caution North and Dr. Thomas Crowley, an adjunct professor of oceanography. "We can't explain dinosaurs because we don't see evidence of an abrupt climate change connected to their disappearance," says North. "Our research suggests that the movement of continents and the resulting climate instability could cause rapid environment change and possible extinction," he says. "But the relation is not so strong that other causes can be ruled out in every case."

Throughout the millions of years of Earth's history, there have been certain periods when mass extinctions occurred, such as the well-known end of the dinosaur period, and periods with changes that led to massive coverings of the Earth with ice sheets. The research pointing to the possible influence of climate has looked at when such extinctions occurred, their magnitude and the number of species which disappeared, says Crowley, director of the Applied Research Corp. branch in College Station.

– Rebecca Adair

Living in the Coastal Zone



TONY AMOS

Texas is sitting on the sidelines in the battle for the beach. But we'll join the fray just as soon as somebody figures out who's the coach of this wave-taming team.

By Norman Martin

OF 30 STATES WITH COASTS, 29 HAVE adopted coastal zone management programs since 1971. Guess which state, where the stars are big and bright, isn't listed on this roll call?

That's right, Texas is the lone holdout. So far, efforts to prevent beach erosion and stem development in high-risk areas have, for the most part, run aground on the shores of Texas.

The history of coastal issue legislation in Texas is spotty at best. But behind the scenes, it's chaos. At least 10 state and federal agencies are now involved in coastal matters, and not one serves as a consistent lead agency, coordinating overall program efforts. In this decade alone, marine councils have been created and cut. Recommendations made, then ignored.

"Since much of the Texas coast is undeveloped, we have a unique opportunity to develop a plan which will provide for an orderly development of the coastal zone," says Dr. John Herbich, an ocean engineer at Texas A&M University.

But too often control of coastal development and erosion is a hit-and-miss affair, depending on the particular state or local governmental body. "There's a vacuum in the state of Texas in terms of managing our coastal resources on the beachfront," says Assistant Attorney General Ken Cross in Austin. "We're not taking care of that resource."

A special state committee report on coastline rehabilitation was completed in 1987. Among the many recommendations spotlighted in the report, the highest priority went to resurrection and implementation of a coastal zone management program. The coastal zone program – a compilation of rules, regulations and standards – was written in the

With so much of its coast undeveloped, authorities say Texas has a marvelous opportunity to develop a plan for an orderly development of the coastal zone.

Norman Martin

Many coastal residents believe living close to the water is relatively risk free. And, why shouldn't they? They're still protected by programs that minimize the risk to individuals.

mid-1970s, following an extensive series of studies.

But efforts to bring the program on board have not been successful. Texas was on a hot streak, in terms of coastal issues, in the late 1960s and early 1970s. Among the legislation coming out of that period was the Texas Sea Grant Program, 1968; Gulf Coast Waste Disposal Authority, 1969; Texas Coastal and Marine Council, 1971; Public Right to Freshwater Inflow, 1971; Dune Protection Act, 1971; Coastal Public Lands Management Act, 1973; Wetlands Protection Act, 1973; and Texas Energy and Natural Resources Council, 1978.

"Today there is no such thing as a coordinating mechanism in Texas," says Sharron Stewart, president of Quintana Environmental Services in Lake Jackson. The only thing that even comes close, she says, is the Sea Grant College Program through the marine advisory system. One of the state's last coastal issue organizations, the Texas Coastal and Marine Council, fell victim to sunset legislation in 1985 and disbanded.

"After that there was no mechanism left to deal with coastal issues whatsoever," Stewart says.

Critics of escalating coastal over-development argue that too many residents continue to believe living close to the water is relatively risk free. And, why shouldn't they? They're still protected by programs that minimize the risk to individuals. In the past they've come to depend on federal flood insurance for at least partial reimbursement in case of disaster. Opponents believe such programs actually encouraged building in high-risk locales. A new law is changing that idea. Federal flood insurance now offers an option to reimburse owners for tearing down their homes or relocating houses to safer ground.

Some coastal experts believe much of Texas' coastal development would have been held in check if knowledge of the high risk associated with shore life were more common. Says Dr. Carlton Ruch, a disaster researcher at Texas A&M: "Building near the shore, in an area susceptible to erosion, is asking for trouble." All too often, beach homeowners build immediately behind vegetation lines, even when they've room to spare. "People want to see that water," says Jim McCloy, a marine safety specialist and vice president for academic affairs at Texas A&M at Galveston.

Another problem is simply getting the message about hazards of shore life to new residents. When developers apply for permits, they frequently receive warnings about the property's vulnerability to erosion and storms. But very often, these warnings never reach the homeowner, since the eventual homeowner is often not the homebuilder. "It's a game of cat and mouse," says Mel Russell, a Sea Grant Marine Advisory Service agent at Galveston. "The person purchasing the property is the one who's taking the real risk."

But the risks of erosion don't stop in the suburbs. Texas marine industry, one of the most diversified in the world, continues as a major contributor to both coastal development and economic growth. From oil exploration to recreational development, the picture looks the same – more jobs, more facilities and more economic stimulus. "Few coastal areas in the United States have the tremendous potential for marine industry development that Texas does," says Dewayne Hollin, a Sea Grant Marine Advisory Service business specialist. To be sure, these industries must be taken into account when considering a coastal development plan.

Perhaps the simplest and most effective response to coastal erosion would be to prevent people from living at the edge of the sea. A provocative idea. Also controversial. "Retreat is the ultimate solution," says Dr. Orrin Pilkey, a geologist at Duke University. "Property owners must pack up and move."

That is not likely. Galveston Bay, for instance, is almost completely developed. Certainly, tourism and commercial shipping along Galveston Bay are simply too valuable an income source to jettison. Says Dr. Robert Morton, a coastal geologist at The University of Texas Bureau of Economic Geology: "We can't turn our back on the problem – development will go on."

As much as authorities say they may hate the idea of coastal erosion, there are apparently few rules of thumb for coastal communities. A solution that works on one beach can be a staggering blunder on another. Every coastal site is different. As a result, many coastal specialists believe each site should be treated

Tony Amos

The simplest response to coastal erosion is to prevent people from living at the edge of the sea. A provocative idea, but not likely, especially on highly developed Galveston Bay.

as a unique problem calling for specific plans.

"Controlling erosion is part of a national problem that needs a measured and considered approach to the problem," says Capt. Austin Yeager of the National Oceanic and Atmospheric Administration in Olney, Maryland. Some 70 of the 295 barrier islands that rim the Atlantic and Gulf coasts have been developed. About 80 other islands have been bought by state and local governments for recreation areas and nature preserves and 120 more are privately owned and largely undeveloped. Fifteen of the largest islands have been acquired by the federal government for wildlife refuges and national seashores.

Unfortunately, for many coastal residents, the approach to controlling development is seldom clear. Methods of controlling coastal development vary from state to state – a fact that can be confusing to coastal residents.

North Carolina has chalked up a solid record of controlling coastal development. The state's coastal regulatory method is the setback.

Small oceanfront structures like single-family cottages and duplexes must be set back a minimum of 60 feet from the vegetation line. For larger structures like condominiums and hotels, the minimum setback from the vegetation line is 120 feet.

Authorities justify the setback on the belief that when buildings are placed too near the ocean the result is increased cost to the general public. This comes in the form of expensive disaster relief, flood insurance, erosion control, and the repair and replacement of public services such as water and sewer.

North Carolina authorities also believe that building too close to the ocean can increase the risk of loss and the public beach. This is one of the reasons for the state's law on permanent seawalls and other man-made barriers along the oceanfront, a policy referred to as "fall back or fall in."

But not all developers are happy with North Carolina's regulatory program. Some have accused it of setting back not only the buildings, but local economies as well. Several have questioned the validity of methods used to determine long-term erosion rates, on which the setback is based.

Part of what's ailing the shoreline is coordination between states. In South Carolina, there are few limits to where builders can build. But even South Carolina, hardly a progressive leader in coastal development control, has finally chalked up some provisions for setbacks, along with prohibitions on seawalls and bulkheads.

In Florida, all new buildings permitted seaward of a *coastal control line* must meet very stringent construction standards for durability and storm-resistance. The Sunshine State controls seaside construction by requiring approval by the governor and state cabinet for any new building closer than about 300 feet to the water's edge.

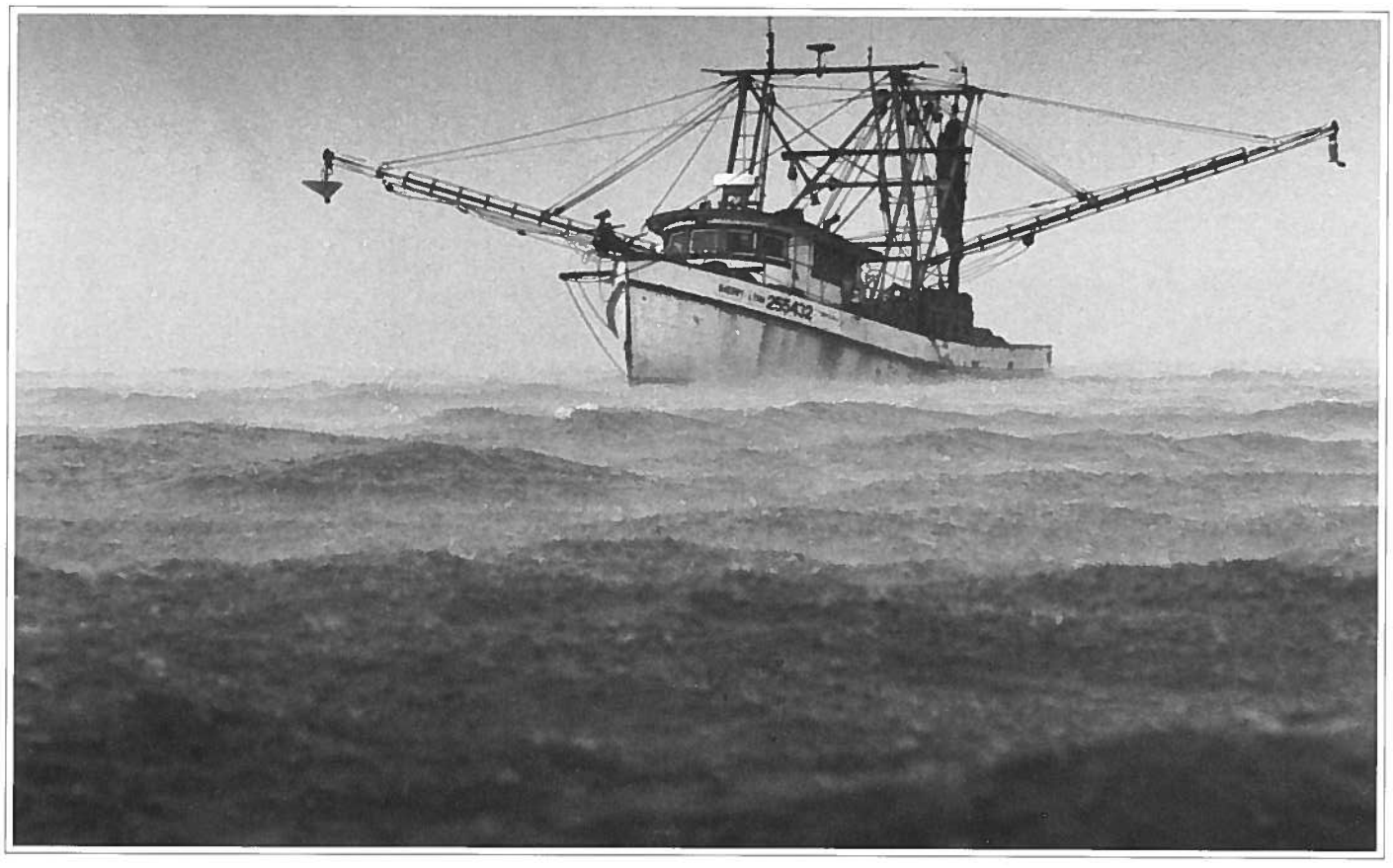
Moreover, Florida residents are willing to financially back their beaches. The Florida legislature approved a record $17.7 million for the state's beaches for fiscal year 1988-89. The budget includes $13.3 million for six beach restoration projects – by far the largest work program in the state's history, says Stan Tait, executive director of the Florida Shore and Beach Preservation Association in Tallahassee. When federal and matching funds are added, the total will near $30 million in beach nourishment projects.

Some critics of coastal over-development contend the federal government is responsible for many of the problems, especially since it has shown a tendency to offer subsidies for public development. One high-profile example is federal support for the construction of bridges. Bridges have been targeted as the first step toward the urbanization of barrier islands.

Of course, Uncle Sam shouldn't shoulder all the blame. Barrier islands like Galveston were well on the way to development before many of these federal programs were initiated.

Not all is bleak. After years of political slumber, the concept of controlling coastal development is slowly awakening. Officials, like state Sen. Chet Brooks (D-Pasadena), who headed a interim legislative committee that investigated coastline rehabilitation, are beginning to conclude the state must adopt a coastal plan and then try pilot projects.

Also contributing to the plan is the federal government. Erosion-threatened homes along the Texas coast are beginning to benefit from a recent change in the National Flood Insurance Program. A new provision allows building owners to move endangered structures and



The problem of coastal erosion isn't solely environmental. Loss of the state's shoreline means the loss of homes and jobs, too.

receive compensation to help cover the cost of relocation.

U.S. Rep. Walter Jones (D-NC), chairman of the House Merchant Marine and Fisheries Committee, says the law authorizes the payments for the relocation or demolition of structures "in imminent danger of collapse."

Up to 40 percent of the insured value of a structure or the costs of relocation, whichever is lower, is allowed for moving cost. For demolition the law provides up to 110 percent of the insured value with the 10 percent add-on designed to cover the costs associated with tearing the building down. To qualify, a building must have been covered by the National Flood Insurance Program by June 1, 1988.

At the national level, Congress passed the Coastal Barrier Resources Act in 1982 and removed about 600 miles of coastline and 187 islands from eligibility for federal flood insurance on new construction.

One facet in getting the federal government involved in coastal management is that there is no single responsible government agency.

The U.S. Army Corps of Engineers usually has this burden to bear. But the Corps is hampered by a dual mission of protecting vulnerable wetlands while keeping waterways navigable. "We can manage both," says Bill Wooley, planning chief for the Corps' Galveston office. "It's a matter of how much we want to spend."

Environmentalists criticize the Corps for relying on hard anti-erosion methods – seawalls, jetties and groin fields – that often cause erosion problems adjacent to these structures.

Dr. Jeffery Paine, a geologist at The University of Texas Bureau of Economic Geology, says one-fourth of the shores of Galveston Bay have been altered by coastal projects.

There are 251 miles of deep draft and intracoastal channels that crisscross the bay within the massive Galveston Bay system. The effort has come at the cost of almost 40 square miles of the bay impaired by channel creation and spoil disposal. That's nearly 6 percent of the bay bottom. And, if proposed projects are completed, 9 to 10 percent of the bay bottom – one in every 10 acres – will have been dredged or impacted by dredge material disposal.

More than 188 million square yards of sediment have been dredged from the bay, but much of the material has been redeposited near the banks of the channels, either below water level or as a series of spoil islands and peninsulas. Paine says because spoil islands erode, these deposits are only temporarily removed from the bay system.

Worse yet, dredging can increase the likelihood or severity of shoreline erosion by deepening water, allowing the formation of larger and more erosive waves because of decreased bottom drag.

On the other hand, Paine says, placement of dredge spoil can reduce the likelihood or severity of erosion in several ways. One, if spoil is deposited over a broad area in an open bay, water depth is slightly decreased, as is wave energy. Two, erosion of spoil deposits contributes material to adjacent shorelines, either decreasing erosion or causing accretion of those shorelines. And, three, spoil mounds can compartmentalize a bay system, effectively dividing a bay system into numerous smaller bays.

It's hard to imagine that the Texas coast is so endangered by the force of wind and wave. Yet the problem is complex and urgent. With coastal populations rising, there is immense pressure on local officials to build and develop parts of the Texas coast. The problem of coastal erosion isn't solely environmental. Loss of the state's shoreline means the loss of homes and jobs too.

Coastal experts concede that solutions will not come from any one group or community. Rather they call for effort from a variety of resources, including the Texas legislature, academic community, experts on soil conservation and public officials. Gone are the days when man-made structures, like seawalls, were the first and best solution.

Use of such devices has proven ineffective over the long term. But there are measures coastal Texans might consider. Among them are greater use of setbacks, which control construction near the shore and protect property owners, and land use controls, rather than man-made structures. So the answer thus far: There are no easy answers. But Texans know that in the end, predictably, the tide of time is on the side of the sea. ■

BEATING THE BEACH

Look out, erosion. A team of coastal experts has been mobilized to give an edge to erosion control using everything from seawalls to sand. Let's see if one of these better ideas fits your situation.

BY NORMAN MARTIN

FROM CONSTRUCTING SEAWALLS to supplying new sand for recreational beaches, Texas coastal residents are scrambling to devise a way to stabilize transient shorelines.

Unquestionably, some engineering projects have been able to solve local problems over short periods of time, especially when applied consistently on a regional scale with periodic maintenance. "We've seen benefits to our three beach parks where we've simply put up dune fencing," says Bob Duke, a landscape architect at the Galveston County Parks Department.

But critics reject such methods, saying the benefits of protection and restoration are usually short-lived and often expensive. Moreover, there is a paradox in that some man-made structures don't merely fail to protect beaches. They may actually work to destroy them.

Corpus Christi's North Beach – June 1977.

Same beach – March 1978. The project restored 1.4 miles of beach.

A distinction should be made between coast and bay erosion. While beach erosion tends to grab headlines, a large number of Texans live on bays. There is good anti-erosion potential for bayfront property with the tried-and-true method of planting marsh grass from the low water tide mark to the high water mark. Says Richard Tillman, a Sea Grant marine advisory agent at Rockport: "Of course, no two areas of the Texas coast have the same problem. But we're going to find that Mother Nature can do a heck of job, if we just give her a chance."

Saving the sandy beaches of the state is another story. It wasn't long ago that Texas beaches had little trouble covering the tracks of erosion with a fresh layer of sand. There was a free exchange of sediment as it drifted along the coast. Today, much of the state's shoreline is compartmentalized with man-made structures. And it's these sand traps that are causing some of Texas' erosion problems.

For instance, jetties have been built at the entrance to important harbors in Texas. These jetties make shipping safer and more efficient, but they also trap sand that would normally feed beaches. And that loss translates into greater danger for beach residents.

While scientists and public officials grapple with the immediate problem of how to improve the guidelines for coastal construction, most agree that no computer model, building code or setback rule can guarantee a beach house safety.

Why aren't they getting a bigger bang for their technology buck? So far, it seems the forces behind beach erosion are simply greater than the means for understanding them.

Of course that hasn't slowed efforts to halt erosion. In general, coastal erosion control falls into two categories – *hard* structures and *soft* engineering. Hard structures include breakwaters, groins, seawalls and revetments. Soft methods call for beach nourishment, replacing sand that has washed away, or the use of naturally occurring or planted vegetation.

Coastal authorities differ on what should be done. Hard structures like seawalls share a common problem: the beach seaward of the wall almost inevitably disappears. Wave energy that would normally be absorbed on the ramp-like slope of the natural beach is instead deflected, eroding sand from the base of the wall and also from adjacent property. "With the exception of the seawall in Galveston, I've not seen one that doesn't eventually fail," says Dr. Robert Morton, a coastal geologist at The University of Texas Bureau of Economic Geology at Austin.

Texas can ill afford to lose expensive beach barriers. As a result some of the pizazz has gone out of building hard structures. Now the trend in coastal engineering has shifted to the soft approach – fresh sand, pumped onto eroding beaches.

Many coastal experts consider beach restoration the best long-term public structural solution. The method is an old hope, which burns brighter than ever because it has the advantage of providing a beach for recreation, while protecting the area behind the beach. But over the years, like the sand it replaced, the new sand will disappear. There are other drawbacks. It's expensive. In high-erosion areas, sand has to be replaced often.

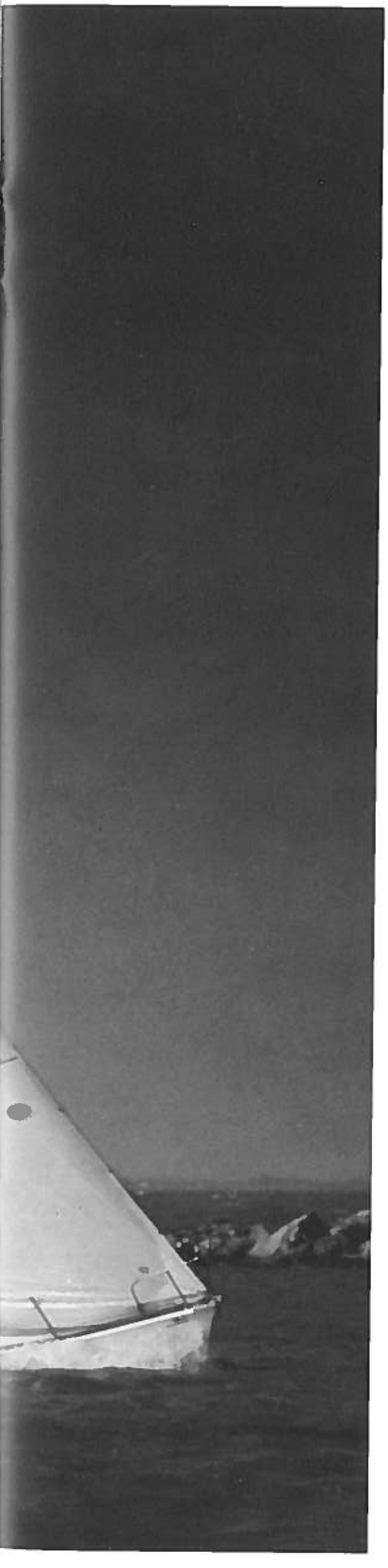
In 1985, a 750-foot stretch in front of Galveston's seawall was rejuvenated with a brand-new beach. The San Luis Hotel piled 1,500 cubic yards of sand onto the beach in front of the hotel in hopes that it would draw more tourists. Price tag: $21,000. In part, the experiment failed. Dr. Robert Bednarz, a geographer at Texas A&M University, says 17 months after dumping the sand, the beach had retreated 174 feet and 16 percent of the material was lost.

Dr. Orrin Pilkey, a geologist at Duke University, says coastal residents have good reason to worry. He advises people to design to live with the flexible island environment. Don't fight nature with a "line of defense." Also consider all man-made structures near the shoreline temporary, and accept as a last resort any engineering scheme for beach preservation, and then only for metropolitan areas.

If a community has money, then erosion can be stopped in the short-run. But, in the long-run, the erosion can't be stopped except at the price of losing the beach. In the end, the sea wins. That's why the race is on to find stronger and cheaper ways to stop erosion. Looking ahead, a better understanding of the relation between beach characteristics and potential (Continued on Page 32)

PHOTOGRAPHY BY CORPS OF ENGINEERS

Island activities vary from sailing and fishing to surfing and watching sunsets.



THE GUARDIANS

TEXAS HAS AN ANCIENT COASTAL BARRIER THAT CARRIES CLOUT. ITS FIVE ISLANDS HARBOR A STAGGERING MIX OF BOATS, BIRDS AND BUCKS. FROM THE TEEMING HEART OF GALVESTON'S SEAWALL TO THE HARDY WINDS OF SOUTH PADRE, THEY'RE A SPECIAL 215 MILES OF SAND AND SURF.

This is a tale about an ancient shield for Texas, a front-line check against the Gulf's powerful scouring force. This is a tale about the Texas barrier islands. Stretching from Galveston to Brownsville, these long, narrow strips of sand parallel the mainland, endlessly shifting as they absorb the eroding energy of wind and water.

Composed of a complex system of sand dunes, beaches and submerged bars, their movement is, to say the least, dynamic. When left alone, they gradually move up the broad, gently sloping Gulf coastal plain. But coastal experts say there's little doubt that development has changed their natural track somewhat.

Since the rise of better transportation links in the 1950s, construction on the Texas islands has sharply increased. For good reason: From a recreational point of view the Texas barrier islands provide a number of natural features. Ken Pagans, a marine recreation specialist with Texas Sea Grant's Marine Advisory Service, points out that tourism is the state's second largest source of income, a $17 billion industry. "Thirty-five percent of the total state tourism indirectly occurs along the Texas Gulf Coast and 80 percent of the winter Texan industry."

STORY AND PHOTOS BY NORMAN MARTIN

Dune protection is advised.


South Padre visitors head for the surf.


Condo project on hold in Galveston.

Large tracks of undeveloped lands exist on every island.

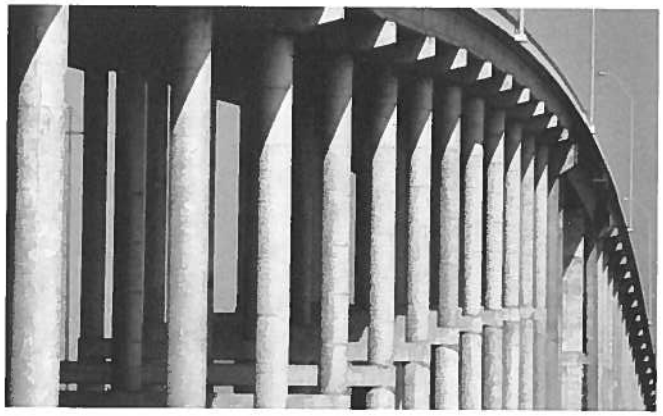
It's easy to understand, then, why activities vary from sailing and fishing to swimming and surfing.

Of the 365 beachfront miles on the Texas coast, about 59 percent, or 215 miles, are on five islands – Galveston Island, Matagorda Island, St. Joseph Island, Mustang Island and Padre Island. Physically, they're similar. Relatively low in profile, the islands are all too susceptible to storm damage. Still, a wide variety of environments from vast marshes to dense blankets of grass and well-developed dunes survive, and in some cases, flourish.

Scientists say most theories on barrier formation are linked to changes in sea level caused by the freezing and thawing of great ice sheets during the ice ages. The latest rise in sea level began about 18,000 years ago as glacial icecaps began melting in Greenland and Antarctica. As the level of the sea rose 400 feet, coastlines retreated. Researchers say they have discovered evidence that most of the barrier islands along the Gulf coast formed about 4,000 to 6,000 years ago. Then, over the next few thousand years, the islands migrated slowly to their present positions.

Once sea level stabilized, waves, currents and winds combined to form Texas beaches and barrier islands. Both continued to build seaward until an (Continued on Page 30)

Mild winters and wide open spaces make the Texas barrier islands a hot property.



Improved transportation links have boosted development.

DUNE CONTROL:

A NEW IDEA TAKES ROOT ON THE COAST

BY LAURA MURRAY

Christmas is a special time of the year. But for Brazoria County marine agent Charles Moss, Christmas' end is just as special. It marks the time when he and hundreds of other volunteers can begin collecting pine and fir trees for another round in the dunes restoration project he started 10 years ago.

Like in many coastal counties, Brazoria County was losing valuable property along its beachfront to erosion. Moss and Eddie Seidensticker, district conservationist for the U.S. Soil Conservation Service, decided they needed to do something about the problem there. The county's beaches were losing dunes and Moss knew they were the barrier to saltwater intrusion and hurricane-force winds so the two decided to try an experiment done in Florida that utilized Christmas trees to help form new dunes in washed-out areas.

LAURA MURRAY

Left: Brazoria County marine agent Charles Moss heads a project to slow dune loss using discarded Christmas trees. **Far Left:** Texas dunes take a steady pounding from Gulf waves.

Various barriers had been tried in other areas from putting car bodies to snow fences into the sand to catch grains and form dunes. Snow fences are effective in trapping sand, but are costly and attractive to people for bonfire and construction material, Moss says. Members of the Pearland Action 4-H Club headed by Chuck and Beverly Moore assisted Moss with planting the first dunes in Brazoria County along a 1,000-foot stretch of Bryan Beach State Park after securing permission and aid from several governmental agencies.

The group lined up discarded trees from landfills in West Columbia and Freeport and secured the trees with stakes to keep them in place. In a matter of days and in some cases, a few weeks, the trees would be completely covered with sand and on their way to forming a dune that would provide storm protection, slow erosion and prevent the filling of lagoons which are valuable spawning areas. The purpose of the dunes restoration program is not to fight erosion, but, rather, to control it, Moss says. "We went in knowing we were going to fail. In the long run, you cannot stop the eroding and subsiding process. What you're able to do is reduce the impact and cut the loss over a long period of time."

Much of the work of the first dune-builders was wiped out with (Continued on Page 28)

TONY AMOS

BUREAUCRATIC BARRIERS

The opening salvos of a stunning war on new coastal development are landing close to home.

BY LONA DEARMONT

To some Texans, the Coastal Barrier Resources Act of 1982 imposes a strict "no-growth" policy on parts of the Texas Gulf coast. To others, the act is helping to save Texas' fragile, flood- and hurricane-prone coastal barrier islands from the threat of over-development.

The law prohibits federal subsidy of new development, including federal flood and disaster insurance, on parts of the nation's coastal barrier islands. Only portions of the barriers designated as "undeveloped" are included under the act. The definition of "developed" land is more than one walled and roofed structure for every five acres.

In Texas, where most coastal barrier islands are undeveloped, many landowners and local public officials woke up one day to find their options severely limited. What many federal lawmakers saw as a clean, simple way to save taxpayers' money and protect valuable natural resources is a kind of "Catch-22" for some coastal landowners.

If your undeveloped property happened to fall within the Coastal Barrier Resources System, you still own it and you still pay taxes on it (although the tax is reduced because the land value decreased). But because you can't get federal flood and disaster insurance, nor most kinds of federal financial assistance, doing much of anything with the land is no longer feasible. This is a "taking without compensation," say opponents of the law.

But Congress sees the law as a way of handing back some of the financial risks of coastal barrier development to the private sector. Federal lawmakers reasoned it was time to stop subsidizing development that would only be caught up in the inevitable cycle of destruction by erosion, floods and hurricanes on coastal barriers.

In Texas, there are 181,565 acres and 161 miles of shoreline in the Coastal Barrier Resources System. The entire Barrier System includes 186 undeveloped and unprotected coastal barrier units, comprising 452,834 acres and 666 miles of ocean-facing shoreline, or about 25 percent of Gulf and Atlantic coastal barrier island shoreline.

Now the U.S. Department of the Interior wants to substantially increase the area in the Barrier System. In Texas, the proposal would add some 245,000 acres, more than doubling the current area to a total of 426,400 acres.

The Interior Department originally released a draft report to Congress in late 1985, which recommended the expansion of the entire Atlantic and Gulf Coastal Barrier System by 7.8 million acres. But by March 1987, when the agency released its second and latest draft report, the recommended additions had dropped to just over 1.4 million acres nationwide.

Under the act, the Interior Department can recommend additions or deletions to the Barrier System every three years, but it takes an act of Congress to make any actual changes. But the agency has yet to present its final recommendations for congressional action. The sheer number of public comments the agency has received on its proposals created delays during the long process of review and revision.

Also, the agency may be balking at the prospect of losing ground, says Mike Hightower, deputy director of the Texas Sea Grant College Program and a coastal specialist.

"The act says Congress may add *or delete* areas from the barrier system," he says. Intense lobbying efforts aimed at Congress may succeed in getting some areas currently in the Barrier System designated as "developed" and therefore eligible for federal financial aid.

"Economics will drive," says Hightower, pointing out that Texas coastal communities and the private sector are continually under pressure to keep growing as populations migrate coastward.

"Unfortunately, you cannot completely stop growth on coastal barriers," he says. "Tourism is the second-highest revenue producer in Texas, and our coastal areas are a major contributor. We will need more facilities to support this industry."

Tony Amos

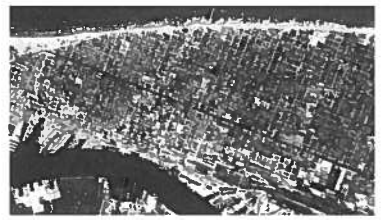
A comprehensive no growth policy is enforced

Tony Amos

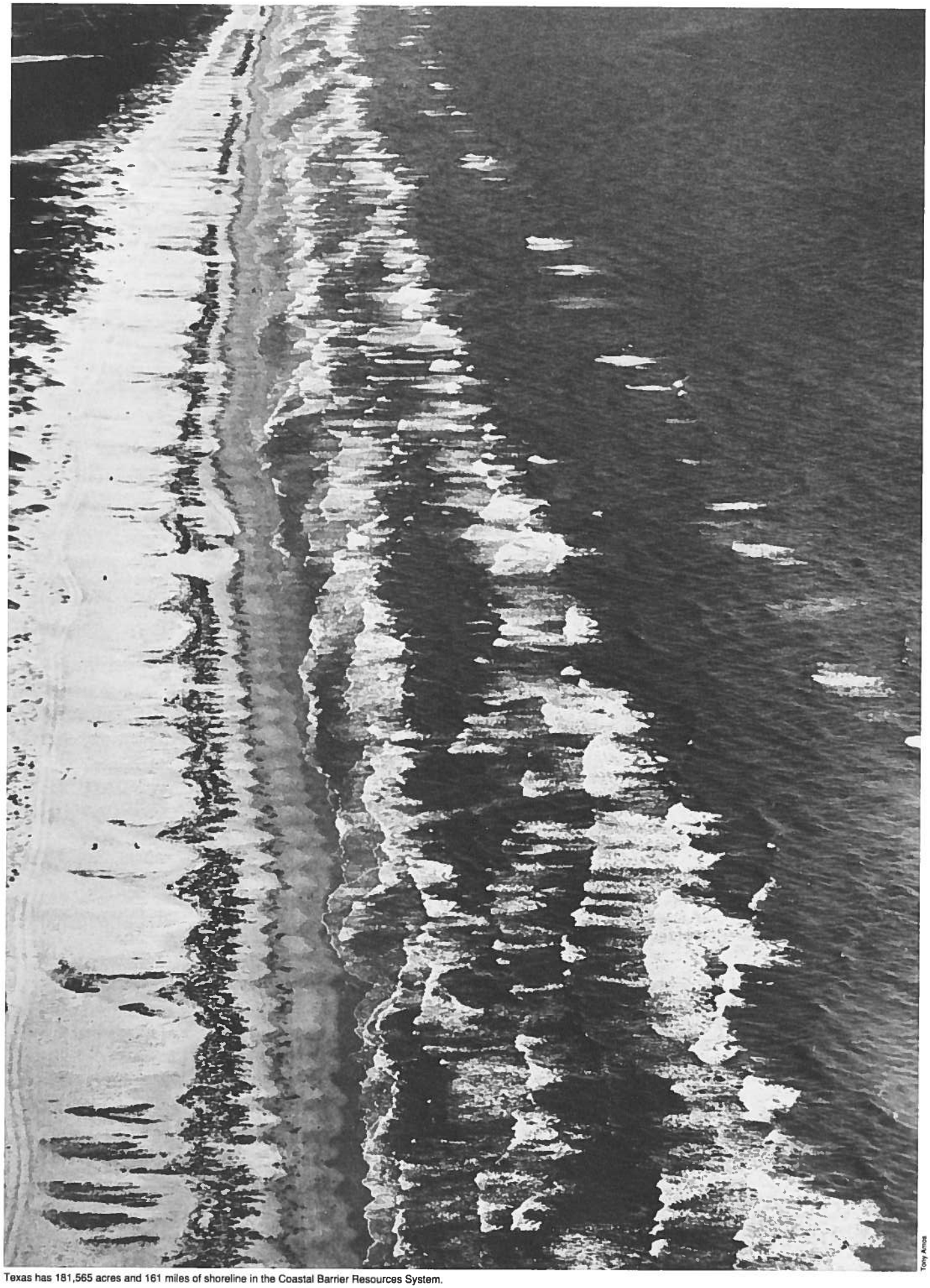
Development has skyrocketed in the last 40 years.

Tony Amos

In Texas, 11 coastal barrier units have been named.



Too many people are sitting ducks for a hurricane.



Tony Amos

Texas has 181,565 acres and 161 miles of shoreline in the Coastal Barrier Resources System.


Norman Martin

The Coastal Barrier Resources Act is sweeping.

If growth must continue on coastal barriers, it has to be well-managed, Hightower says. Management methods include tougher building standards, improved planning, set-aside areas for preserves and wildlife, mandatory set-back lines, improved incentives for relocation, and education on the hazards of coastal development.

But the Interior Department's proposal would limit the state's role in managing undeveloped coastal barriers. Most of the proposed additional 245,000 acres are state-owned lands adjacent to current Barrier System tracts, says Dr. Hal Irby, environmental specialist with the Texas General Land Office's coastal division.

Those "lands" are what the General Land Office calls submerged lands – the wetlands and embayments surrounding the coastal barriers now in the Barrier System. In fact, 98 percent of the land managed by the state along the coast is submerged lands, Irby says. The state also controls the area from mean high tide line out to 9 nautical miles.

The Interior Department proposes to add all aquatic habitats associated with the current Barrier System units. In general, the agency is recommending adding five miles of open water and wetlands behind the existing barrier units.

"We do not want state lands in the system," says Irby. In hopes of showing the federal government that state submerged lands are in good hands, the General Land Office beefed up its regulations to better conform to the aims of the Coastal Barrier Resources Act, he says.

The goals of the General Land Office and the Interior Department are much the same, Irby says – to protect valuable wetlands and coastal resources, and to prevent over-development of the coast. Leaving state lands out of the Barrier System would prevent unnecessary overlap of authority, he says.

It's just a matter of trust, Irby says. That is, can the Interior Department trust the three members of the Texas School Land Board to make the right decisions about the use of coastal barrier wetlands?

Many Texans oppose expansion of the Barrier System because they feel that existing laws and policies regulating coastal development are more than adequate. They feel that the federal government shouldn't interfere with the current balance of state and local authority to manage coastal areas.

"There are already laws on the books, that if they're being applied correctly and enforced, will protect these environmentally sensitive areas," says Willie Younger, marine agent for Sea Grant's Marine Advisory Service in Matagorda County.

Younger says that supporters of Barrier System expansion have a point when they say the law will prevent development that would all be wiped out in a hurricane someday.

"But how far can you take it?," he asks. "What's to stop them from saying someday that there should be no more development for a mile on either side of the Mississippi River because of floods, or that people shouldn't live in the desert because of drought. Those areas are just as environmentally sensitive as the coast."

Opponents also take issue with the Interior Department's assertion that inland population subsidizes development on the coast by paying higher federal insurance premiums.

"Most of the population of the U.S. lives on the coast, so you could argue that people on the coast are paying for their own insurance programs," Younger says.

Another aspect of the proposal that upsets people in Younger's county is that it seems to single out mid-coastal Texas.

"A big share of the proposed new area is between Rockport and Freeport," Younger says. Matagorda County would have more land in the Barrier System than 11 other states have total, he says. The county now has 88,000 acres in the Barrier System, or 48 percent of the Texas total. And the proposal would add about 22,000 acres.

Norman Martin

Critics say Interior has gone beyond its mandate.


Tony Amos

Protecting habitats is another purpose of the act.


Tony Amos

Lawmakers sought to minimize loss of human lives.

Other areas in Texas, such as Nueces County and South Padre Island, have been successful in getting some lands reclassified as "developed" before Congress passed the act and also during the review of the Interior Department's first draft proposal.

Opponents such as the South Texas Barrier Island Task Force, a group of public officials, state governmental agencies, civic organizations and private interests, continue to fight the proposed additions to the Barrier System. They say the law costs Texas jobs and revenue for education, among other things. Adding certain areas to the Barrier System would cut into the tax base of school districts by reducing the value of private property. And, the Task Force wants the state to be able to use some coastal state lands, essentially upland areas, to help finance public education.

In Texas there are 11 coastal barrier "units." These are Sea Rim, High Island, Bolivar Peninsula, Follets Island, Brazos River Complex, Sargent Beach, Matagorda Peninsula, San Jose Island Complex, North Padre Island, South Padre Island, and Boca Chica. "Units" in the Barrier System are not necessarily whole barrier islands. They can be parts of islands, or not islands at all.

The areas that the Interior Department now proposes to add were part of the Barrier System as originally proposed in the legislation, but were later excluded. Most are tidal flats, swamps, marshes, lagoons, estuaries, coves, inlets and nearshore waters. Some are "secondary barriers," which the Interior Department defines as large, well-defined embayments formed of unconsolidated sediments that also protect fish and wildlife habitats and protect the mainland during major storms. Nine proposed new coastal barriers units in Texas are secondary barriers, such as Galveston Bay, Matagorda Bay and Baffin Bay.

Critics of the Interior Department say the agency has gone far beyond its original mandate by proposing such an ambitious expansion. They say the agency's definition of "coastal barrier" is more broad than the law intended.

But the agency maintains that the units of the Barrier System now include only minimum aquatic habitat because Congress adopted boundaries drawn for an earlier law that prohibited the sale of federal flood insurance. That prohibition was later incorporated into the more sweeping Coastal Barrier Resources Act.

"These delineations focused on the undeveloped fastland portion of the barriers, where residential development might occur," says Interior Department assistant secretary William P. Horn in the 1987 draft report to Congress. The act defines "undeveloped coastal barriers" to include all associated aquatic habitats, the report says.

The Interior Department argues that if the federal government were to extend its current development programs to the remaining undeveloped coastal barriers, the cost would be more than five times greater than if the government simply bought the land.

The agency stresses that coastal development has taken place at a rate three to four times the national average over the past four decades. Now one of out every two Americans in the continental U.S. lives within an hour's drive of the coast.

And, there are over seven million people exposed to potential hurricane storm surges and flooding along the Atlantic and Gulf coasts, according to the Interior Department. No property on a coastal barrier is completely safe from the destructive power of a hurricane. Hurricanes caused an average annual property loss of $400 million in the decade between 1961 and 1970. The previous decade saw an average annual property loss of $250 million. In 1985, federal insurance payouts as a result of Hurricanes Danny, Elena, Gloria, Juan and Kate were an estimated $1 billion along the Atlantic and Gulf coasts.

The Coastal Barrier Resources Act was a response to growing concerns of both environmentalists and fiscal conservatives that further development of coastal barriers was an unwise use of taxpayers' money and a threat to valuable natural resources. Besides curbing wasteful government spending, lawmakers sought to minimize loss of human lives by discouraging further population build-up on coastal barriers. Too many people are already sitting ducks to hurricanes now, say coastal experts.

Protecting unique aquatic habitats and wetlands around coastal barriers is another purpose of the act. These habitats are vital feeding, spawning, nesting, nursery and resting areas for fish and wildlife, but coastal development menaces their survival.

In limiting the legislation to largely undeveloped coastal barriers, Congress intended not to penalize existing landowners or communities by preventing development already underway. The ban on financial assistance applies only to "new" development; that is, if no money for construction or purchase was appropriated before October 18, 1982, or if no legally binding commitment for the expenditure was made before that date.

The legal definition of a coastal barrier is a depositional geologic feature (such as a bay barrier, tombolo, barrier spit, or barrier island) which:

- consists of unconsolidated sedimentary materials;
- is subject to wave, tidal and wind energies;
- protects landward aquatic habitats including the adjacent wetlands, marshes, estuaries, inlets and nearshore waters.

The actual boundaries of the undeveloped, protected lands in the Barrier System were drawn up by the Interior Department after years of data-gathering. The maps were incorporated by reference into the act.

The government first began to take a serious look at the costs of developing coastal barriers in 1977. For several years, Congress and the Interior Department studied ways they could redirect some of the economic risks of development back to the private sector.

One way was contained in the Omnibus Budget Reconciliation Act of 1981 (OBRA). It prohibited the issuance of new federal flood insurance coverage after October 1, 1983, for any new construction or substantial improvements on undeveloped coastal barriers.

Also, the act made the Interior Department responsible for drawing up maps of undeveloped coastal barriers and reporting to Congress any recommendations for defining the term "coastal barrier."

But before the OBRA flood insurance provision could go into effect, Congress considered a new comprehensive bill, the Coastal Barrier Resources Act. It would incorporate the prohibition on federal flood insurance and additionally prohibit most other kinds of government assistance for new coastal barrier development.

The main purpose of the legislation was to end federal subsidization without interfering with land use decisions of private property owners or state and local governments. The act is based on one main principle: People who build on fragile, flood-prone coastal barriers should assume the inherent financial risks.

The bill enjoyed widespread support. Some groups, such as the National Association of Realtors and the National Association of Home Builders, argued that the bill discriminated unfairly against coastal landowners. But Secretary of the Interior James Watt, often viewed as a champion of private property rights, denied that the law infringed on the rights of private property owners.

Still, opponents urged the government to single out only the areas on coastal barriers that were hazardous and therefore unsuited to development. They believed the government shouldn't tie up remaining areas that could support development. But many experts testified that while coastal barriers vary in their degree of stability, all are sooner or later going to be affected by the inevitable destructive hurricanes, floods and erosion.

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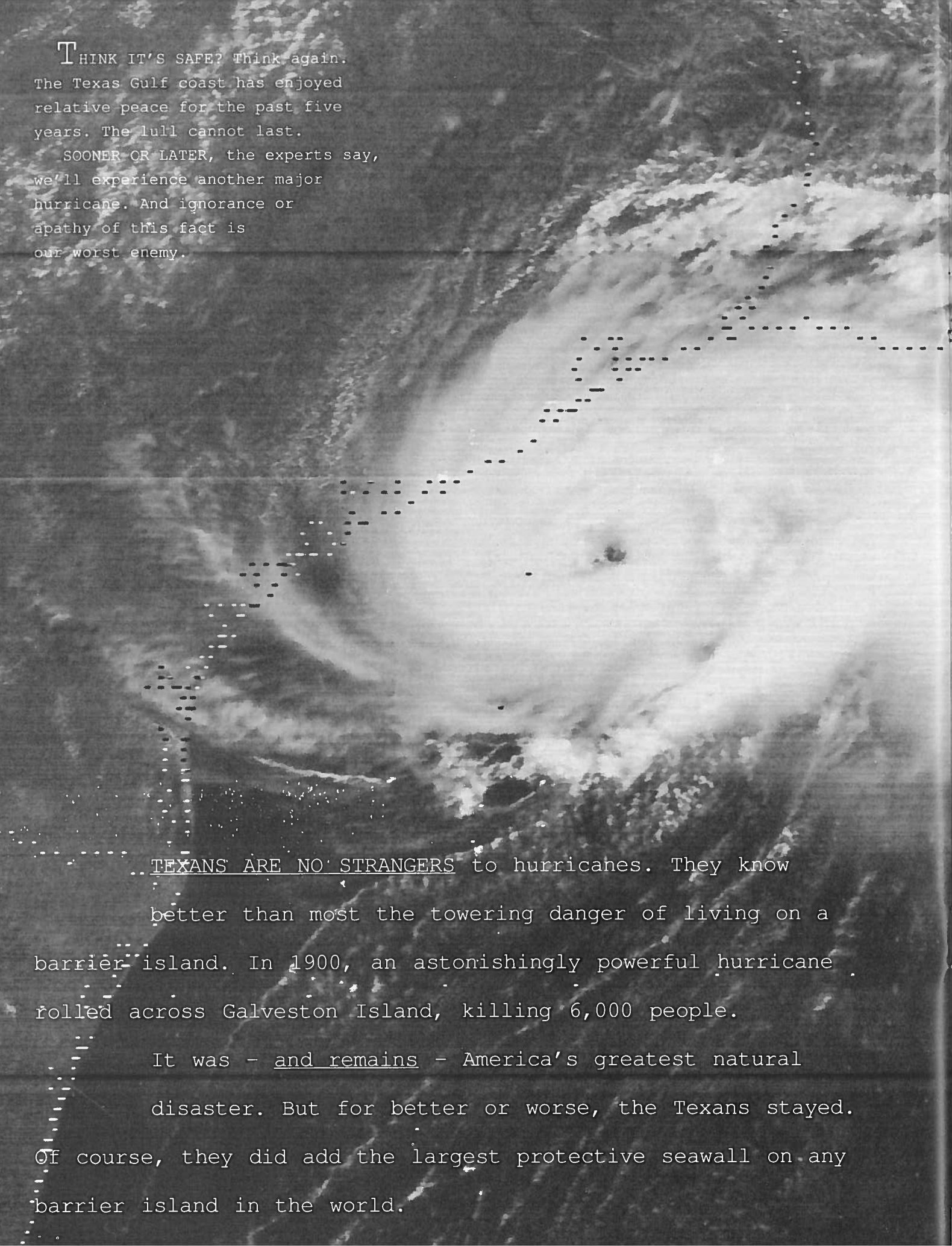


THINK IT'S SAFE? Think again. The Texas Gulf coast has enjoyed relative peace for the past five years. The lull cannot last.

SOONER OR LATER, the experts say, we'll experience another major hurricane. And ignorance or apathy of this fact is our worst enemy.

TEXANS ARE NO STRANGERS to hurricanes. They know better than most the towering danger of living on a barrier island. In 1900, an astonishingly powerful hurricane rolled across Galveston Island, killing 6,000 people.

It was - and remains - America's greatest natural disaster. But for better or worse, the Texans stayed. Of course, they did add the largest protective seawall on any barrier island in the world.

This is a warning.

By Norman Martin

U.S. Weather Service:
Hurricane Alicia 1983

TODAY, millions of people live in vulnerable areas along Texas' coast and barrier islands. Some officials privately despair that another major weather-related disaster could happen again, and fear for an unprepared public.

"Hurricane Alicia should have pointed the way to salvation for a number of people, but they chose not to see the warning signs," says Dr. Jim McCloy, a water safety specialist and vice president for academic affairs at Texas A&M University at Galveston.

Now there's a new fear making the rounds – the fear of complacency. Consider the Texas coast. It's been five years since residents huddled in fear while a hurricane roared overhead. And despite hard times in the oil fields, coastal populations have swollen during the lull in hurricanes.

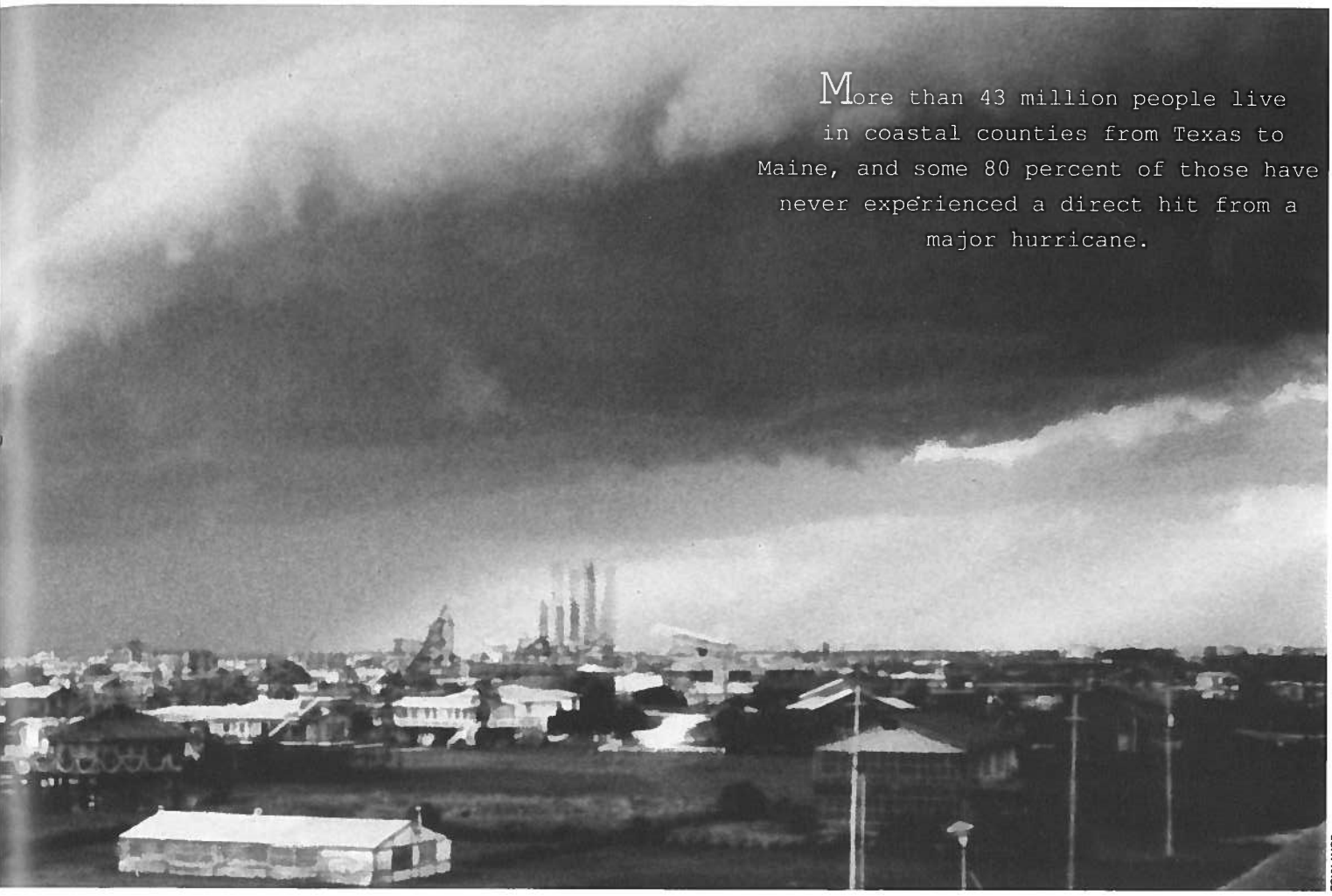
The notion is plausible enough. More than 43 million people live in coastal counties from Texas to Maine, and some 80 percent of those have never experienced a direct hit from a major hurricane. "We're building toward a real hurricane disaster in the United States, not just on the Texas coast," says Max Mayfield, a hurricane specialist with the National Hurricane Center.

Evacuation is the cheapest insurance someone living along the Texas coast can have when a hurricane heads for shore, but moving inland for a few days is considered an inconvenience for some. "I don't understand the attitude of people who are disappointed when a hurricane doesn't hit their town," says Dr. James Scoggins, head of meteorology at Texas A&M. "The attitude is that evacuation was for naught. They ought to be thankful it was for naught."

What can Texans expect this year? Dr. William Gray, an atmospheric scientist at Colorado State University, believes that about six Atlantic hurricanes are expected to strike the nation this year. That's been the average number for the last 40 years, but it is above average for the 1980s. Hurricane season officially began June 1, and the most active period usually begins August 1.

"We're more vunerable to the hurricane than we have ever been in our history, and it's probably a people problem," says Houston-based Dr. Neil Frank, KHOU-TV's chief meteorologist and former director of the National Hurricane Center. "We're locating thousands and tens of thousands of people on islands that historically have gone underwater."

According to U.S. Weather Bureau records, 70 tropical cyclones



TONY AMOS

have either struck or affected the Texas coast during this century (1900 to 1987), which is an average of 0.8 storms per year. Coastal scientists say each year in the Galveston area there is an 18 percent probability of a tropical storm, a 14 percent probability of a hurricane, and a 4 percent probability of a catastrophic hurricane.

No discussion of erosion damage on Texas shorelines is complete without reviewing Hurricane Carla, one of the worst hurricanes to rip the Lone Star's coast. By any standard, Carla was a hefty hurricane, covering almost the entire Gulf at times. Its large size and slow forward movement allowed winds to whip across long stretches of open water, resulting in high waves. Slow forward speed also allowed time for bays to fill, raising the storm surge to 22 feet in some cases.

When the hurricane came ashore on September 11, 1961, hurricane force winds of at least 75 mph stretched from near Brownsville eastward to beyond Port Arthur into Louisiana. High winds, acting on raised water levels in the bays, caused huge waves that severely damaged unprotected bay shores and demolished a large part of existing bayshore protection.

Carla eroded the shoreline of Matagorda Peninsula as much as 800 feet in a few hours, says Dr. Joe McGowen, an oil industry geologist, formerly with The University of Texas Bureau of Economic Geology. "A hurricane just speeds up the erosion process," adds Mel Russell, a Sea Grant marine advisory service agent at Galveston. "It's like having five or six years of erosion hit at once."

Studies of beach erosion are usually based on data obtained from ground surveys, maps, charts and a sampling of the changes recorded by repetitive aerial photography.

Nine years after Carla, on Monday, August 3, 1970, a dark surf pounded the dunes on Mustang and Padre Islands. Wind gusts of 162 mph were clocked before the recorder broke. The sky was steadily turning black. Celia was about to make her Texas appearance. The storm is blamed for killing 24 people, injuring more than 500 and leaving some $453 million in property damage.

Texas A&M University researchers say that despite large-scale erosion by Texas-bound hurricanes, the damage isn't always permanent. When Hurricane Allen rolled ashore in 1980, the storm caused spectacular erosion damage to Padre Island, including 38 breaches with overwash deposits and severe structural damage. Hurricane Allen was the biggest storm of this century while it was in the Gulf of Mexico but decreased by landfall.

In earlier research, Texas A&M scientists, led by geomorphologist Dr. John Giardino, found the Texas coastline had a long-term annual erosion rate of 8.25 feet. But they learned that short-term coastline change caused by Hurricane Allen was 12.21 feet in approximately 48 hours.

Fortunately, Giardino says, "As soon as the violence of the hurricane subsides, daily wave action regains control of the shoreline." The waves don't simply pick up at the place the hurricane left off. Instead, as if dissatisfied with the hurricane's work, the fair-weather events reversed the general order of change, repaired the damage done to the beach area by the hurricane, then patiently resumed their own processes of alteration of the shoreline at about the points where they had been interrupted.

The last major hurricane to crash and bash the Texas coastline was Alicia in 1983. Early on the morning of August 18, Alicia crossed the upper Texas Gulf coast near San Luis Pass. Alicia wasn't really so big, barely 3 on the 5-point Saffir/Simpson damage-potential scale. Still, it was tough enough. Near the center of the storm, maximum wind speeds were estimated at about 115 mph. Gulf storm surges within the Galveston Bay area ranged from about (Continued on Page 29)

WE'RE IN HOT WATER NOW

By Norman Martin

Scientists say Texas coastal residents are caught between the devil of development and an ominous rise of the deep blue sea.

Don't scoff. During the past 100 years, the ocean has risen more than a foot, a rate faster than at any time in the past millennium. And, perhaps more worrisome, there is little evidence to suggest that the warming trend will reverse in the foreseeable future. "The water is coming. It's just a question of when," says Dr. Robert Morton, a coastal geologist at The University of Texas Bureau of Economic Geology.

Sure, sea-level fluctuations are part of a natural cycle, but scientists believe the current rise is magnified by a fundamental change in world climate caused by a phenomenon called the greenhouse effect.

So, how hot is it now? Well, the news is chilling. Average global temperatures in the 1980s are the highest measured since reliable records were first kept more than 130 years ago. Temperatures have been rising more or less steadily for much of the last century. But, in the view of some scientists, a sharper rise detected in the 1980s is the most persuasive evidence yet that carbon dioxide and other industrial gases are trapping heat in the atmosphere and warming the earth as if it were a greenhouse.

Dr. James Hansen, a weather scientist at the National Oceanic and Atmospheric Administration, says that it is 99 percent certain that this summer's warming trend was not a natural variation, but the result of the greenhouse effect.

Feeling a bit panicky? There's no need to run for cover just yet. Says John Griffiths, state climatologist at Texas A&M University: "We've had no data over oceans for most of those 130 years." There's simply not enough data now from the earth's oceans to generalize on a global perspective, he says.

Since the Industrial Revolution, there's been an explosion in the use of fossil fuels, such as coal, oil and gas. One by-product is carbon dioxide, which has entered the atmosphere in ever-increasing amounts. While carbon dioxide allows the warming rays of the sun to reach the earth, it blocks the excess heat that would normally radiate out into space. These layers of trace gases are similar to adding blankets to your bed on a cold night. The more blankets, the warmer it is, except in this case when morning comes, there's no way to take the blankets off. The result, according to some researchers, is a gradual warming of the atmosphere, which leads to melting the polar ice caps and eventually to a rise in sea level.

At the Ocean Drilling Program (ODP), based at Texas A&M, international teams of scientists in Texas are looking for *ground truth* evidence of the rise and fall of sea level by examining the ocean's geologic history. Using sediment cores drilled from the bottom of the Earth's oceans, these scientists usually work on time scales measured in the thousands to millions of years.

"There have been global fluctuations in sea level for a whole variety of reasons," says Dr. Audrey Meyer, manager of science operations with the ODP. "The problem with trying to document the greenhouse effect in the geologic record is that you're looking for something that's probably only been happening for the last 100 years or so."

Indeed, despite the stream of recent findings, climatologists and meteorologists engaged in plotting global climate trends warn that caution is advised when considering greenhouse effect predictions. Forecasting global heating consequences, just like gauging tomorrow's weather, is not an exact science. There are a multitude of variables.

Global sea level has shifted several times in the past half-million years. During warmer interglacial periods, continental ice melted, the oceans expanded and shorelines moved inland. During cooler glacial periods, as water was withdrawn from the oceans and stored on the continents in the form of glacial ice, shorelines moved seaward. When the last period of glaciation, the Wisconsin, came to an end between 12,000 and 14,000 years ago, sea level was some 350 feet lower than it is today. The Gulf shoreline was from 20 to 75 miles seaward of its current position.

Scientists say with the change from glacial to interglacial conditions, the world's oceans and seas began to rise. They continued to do so for 8,000 years, reaching within a few feet of the present level between 4,000 and 6,000 years ago. As the sea level rose and the shoreline progressed across the continental shelf, large masses of sand were moved with the migrating shore zone and deposited as beaches.

Researchers who worry about the greenhouse effect say the pace can be slowed by lowering production and making more efficient use of energy from fossil fuels. Another possibility is completely switching from fossil fuels to hydrogen. Says Dr. A. John Appleby, director of Texas A&M's Center for Electrochemical Systems and Hydrogen Research: "Hydrogen is the only possible fuel for the long-term since it is the only fuel that does not put CO_2 (carbon dioxide) into the atmosphere." Hydrogen is among the most safe (Continued on Page 28)

At Texas A&M University's

Ocean Drilling Program,

international teams of scientists

in Texas are looking for ground truth evidence of the

rise and fall of sea level by examining the ocean's

geologic history.

ROY DAVIS – ODP

ADVISOR

BY LAURA MURRAY

New Hangs Book

Most commercial fishermen won't leave home without it, or at least they shouldn't.

A copy of the "Hangs and Bottom Obstructions of the Texas/Louisiana Gulf" book has become a part of most shrimpers' essential gear as they venture into the Gulf these days.

Knowing where they may encounter a hazardous obstruction on the sea bed could save them thousands of dollars in damages and lost production, says Marine Fisheries Specialist Gary Graham, who has compiled the guide to nearly 5,000 of these obstructions.

The 1988 edition of the Hangs book came out in time for most shrimpers to obtain a copy before the opening of the season in the Gulf July 16. The book contains the Loran C coordinates for numerous types of obstructions from rockpiles to shipwrecks to a sunken Datsun station wagon.

More than 150 Texas shrimp boat captains have reported the coordinates for the obstructions to Graham since he started gathering the data for the first Hangs book published in 1973. In the late 1960s, many fishermen began taking advantage of the Loran navigation system and started their own logs of obstructions, Graham says.

He began interviewing fishermen in 1972 to see if they would share their information with him so that he could consolidate it into one publication. Graham found many fishermen were reluctant to provide the information, but once the first edition was published, they were more cooperative.

"The effort snowballed," Graham says. "People could see it was a benefit. There was no way one person could account for the thousands of obstructions that were in the Gulf."

The Hangs book has become an even more important tool over the years as shrimpers must travel farther and farther because of the increased fishing effort.

The book went through a significant transition in 1978 when the Loran A system was terminated and the Loran C system was introduced. Graham worked with the U.S. Coast Guard on a program to convert the Loran A readings to Loran C at that time. However, those conversions have been dropped from the latest edition of the book.

The high cost of hitting an obstruction or being "hung up" accounts for the popularity of the book, he says, adding that nearly a quarter of the first-run printing of 5,000 copies were pre-sold. A typical shrimp trawler may have $10,000 worth of nets, doors and cable which could be damaged or completely pulled off if the vessel strikes an obstruction

"When you're dragging and you hit an obstruction, you don't always get it back and it's very common for a fisherman to lose his gear on the obstruction," Graham says. But even more devastating is the lost production time a shrimper experiences, especially if it is during the height of the season, he says.

However, an area that may be dangerous and costly to a shrimper is often a good area to a recreational fisherman or the commercial reef fisherman. Red snapper and grouper tend to congregate around reefs, Graham says, adding that many of the shipwrecks become artificial reefs.

The design of the 1988 edition, which costs $15 per copy, has been modified, making the coordinates more legible with greater distinction between separate hangs.

The book is available through the Texas A&M University Sea Grant College Program offices in Galveston (409/740-4460) and College Station (409/845-3856). Mail orders should be sent to Sea Grant Program, Texas A&M University, College Station, Tex. 77843.

Tony Amos

Vessel Safety

A proposal to develop a fishing vessel safety training program for the Gulf coast would enable the Marine Advisory Service to utilize the Gulf Coast Fishing Vessel Safety Manual that is currently being revised, Marine Business Management Specialist Dewayne Hollin says.

The National Council of Fishing Vessel Safety and Insurance approved a $34,625 grant to revise the manual this year. Texas Sea Grant has applied for another $34,625 grant to develop and implement a training program.

Under the proposal, Marine Advisory Service personnel along the Gulf coast would conduct a series of 20 safety training programs in 10 ports from Texas to Florida beginning in late 1989 or early 1990.

The Gulf Coast Fishing Vessel Safety Manual represents the first component of a Gulf coast-wide fishing vessel safety training effort, Hollin says. The manual, scheduled for completion in early 1989, will provide the basic information for training and educational programs.

The components of the fishing vessel safety training program could include vessel safety orientation, basic rules of the road, hands-on crew training, medical emergency and survival training, firefighting and vessel safety inspections, according to the proposal.

Videotapes would be used where available and videotapes could be made of appropriate training activities while in progress, the proposal says.

Hollin anticipates good industry support for a safety training effort, but feels better cooperation would be found if the training was required. The training could be required for compliance with government regulations or industry-supported safety efforts, such as a requirement for insurance coverage, he says.

"What's going to happen is the industry is going to be hit with these safety requirements – rather than being voluntary like they are now – and there's not going to be anybody there to provide the training that's going to be required."

A study by the National Transportation Safety Board in 1986 found that the fishing industry in the United States had the poorest safety record of all the country's industries.

National statistics provided by the Coast Guard in testimony before the U.S. Congress indicated:

– Annual losses of documented fishing vessels averaged nearly 250 between 1981 and 1984 compared to losses ranging from 150 to 200 for the previous 10 years.

– The death rate for fishermen is seven times the national average for all industry groups. An average of 75 lives per year were lost in

fishing vessel casualities from 1981 to 1984.

The need to establish minimum safety training standards and the need to require uninspected commercial fishing vessel captains/owners to provide minimum safety training to all crew members were among the recommendations included in the safety board's report.

Hollin believes that training in three areas – fishing vessel safety orientation, basic navigation principles and medical emergencies at sea – is the key to improving the safety record of the Gulf coast commercial fishing industry.

"By providing this training through the Sea Grant Marine Advisory program network along the Gulf coast, we can foster a better-trained commercial fishing fleet and a safer industry," he says. Sea Grant officials should learn by early fall whether the grant application has been approved.

Shrimp Farm Study

A study to compare the effects of underwater circulators with two types of surface aerators on water quality and power consumption at a commercial shrimp farm is under way in Rockport, Marine Fisheries Specialist Russ Miget says.

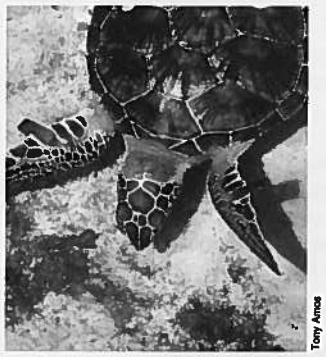
Water quality data will be collected throughout the growing season, along with power consumption for each type of circulator/aerator, he says. The information will be evaluated with respect to harvest and shrimp survival data to determine the optimal water quality management regime for shrimp farmers who wish to increase their stocking density.

Shrimp culture is a rapidly developing industry worldwide and in recent years, the trend has been to increase the stocking density in order to maximize crop yield, Miget explains. Increased density, however, usually requires aeration to maintain water quality, he says. Floating paddlewheels currently are used to maintain water quality, but are relatively expensive to operate and require extensive maintenance when used in saltwater.

Current research indicates that underwater circulators (basically large, slow-moving fans) may be as effective as paddlewheels in maintaining pond water quality, but at a substantial savings of power and maintenance costs, Miget says.

The project, which began in June and will be completed in November when the shrimp are harvested, is being funded by the Behmann Foundation in Corpus Christi. Equipment is being furnished by Aeration Industries Inc.

Miget, Aransas and San Patricio counties Marine Agent Richard Tillman and Aquaculture Specialist George Chamberlain are conducting the study.



Tony Amos

TEDs Update

Shrimpers will have to use turtle excluder devices in their nets beginning Sept. 1, a federal appeals court has ruled.

The 5th U.S. Circuit Court of Appeals in New Orleans confirmed in July a lower court's dismissal of a suit filed by the state of Louisiana and Concerned Shrimpers of America challenging the federal TEDs rules, which originally went into effect March 1.

The Louisiana Attorney General's office argued the TED law discriminated against shrimpers by singling them out for action, saying dredging and beachfront development kill more turtles than shrimp nets do. The regulations, which are designed to protect sea turtles, were put on hold in April when U.S. District Judge Patrick Carr issued an injunction prohibiting their enforcement until a ruling by the appeals court.

Shrimpers have argued that TEDs are too expensive, dangerous and allow shrimp to escape their nets.

Environmentalists have charged shrimpers are one of the major reasons for the decline of the endangered sea turtle population, including the Kemp's ridley. They have said that the turtles drown after being caught in shrimpers' nets.

All shrimp boats fishing within 15 miles of shoreline in the Gulf of Mexico must have a TED on each net in the water and shrimp boats fishing in the bays must either use TED or limit their tow times to 90 minutes. At press time an amendment that would delay implementation of the TEDs rule for one year in offshore waters and two years in inshore waters was under consideration in the U.S. Congress.

Training Videos

Production of three training videos relating to commercial red drum culture, saltwater shrimp farming and evaluating fish freshness has begun, officials say.

Marine Fisheries Specialist Russ Miget says the red drum culture video will include topics such as site selection, basic pond design, maturation and spawning of brood stock, larval rearing techniques, grow-out systems and product marketing.

The saltwater shrimp farming video will cover site selection, maturation and spawning technology, larval rearing methods, intensive and semi-intensive grow-out systems, processing and marketing.

The emphasis in the shrimp farming video will be placed on the new technology developed for intensity grow-out systems, Miget says.

Both the red drum and shrimp farming videos are being done through Texas A&M University's Extension Wildlife and Fisheries project group and are being funded by the U.S. Department of Agriculture Southern Regional Aquaculture Program.

Both videos should run about 30 minutes and will be available in the fall through the Texas A&M Agricultural Communications Department.

For more information on the videos, call the department at (409) 845-2211 or write Agricultural Communications Department, Texas A&M University, Reed McDonald Bldg., Rm 229D, College Station, Tex. 77843-2112.

Galveston County Marine Agent Mel Russell says the video on evaluating fish freshness is being produced primarily for fishing tournament directors and judging staff, although the video will be available to the general public as well.

The approximately 10-minute video will include how to conduct an organoleptic evaluation – using the senses to evaluate fish freshness, how the torrymeter is used to back up freshness evaluation, how to handle, care, store and charge the torrymeter, how to detect spoiled and frozen fish and how to examine the fish to see if the red cells are intact.

The video will be included in a kit supplied by the Tournament Directors Foundation of Texas. In addition to the video, the kit will include a microscope, torrymeter and stains for checking the blood slides.

To obtain the kit, contact Dick Hensley, Tournament Directors Foundation of Texas, P.O. Box 75231, Houston, Tex. 77034 or call him at (713) 943-7043.

BUREAUCRATIC

(Continued From Page 19) Realizing that some kind of coastal barrier legislation was imminent, opponents turned their efforts toward restricting the geographical area to be affected by the bill.

The result was a compromise. The larger-area maps developed by the Interior Department for the OBRA prohibition on federal flood insurance were scrapped for the smaller-area but more restrictive Coastal Barrier Resources System. The major types of federal funds no longer available for use on protected coastal barriers are federal flood insurance, Veterans' Administration and Federal Housing Administration loans, and federal assistance for the construction of sewer systems, highways, water supply systems, airports, bridges, and jetties. The Army Corps of Engineers can't fund new or expanded navigation projects, nor assist in beach erosion control, hurricane protection and flood control works.

Federal assistance is permissible on coastal barriers in some cases. Those exceptions are exploration, extraction or transportation of energy resources; maintenance of existing channel improvements and public roads, structures and facilities; military activities; construction and operation of Coast Guard facilities; and miscellaneous activities including projects relating to fish and wildlife management and scientific studies. ■

IN HOT WATER

(Continued From Page 24) and abundant chemical compounds produced. But it's more than simple arithmetic. Hydrogen, Appleby says, has clear advantages over limited solar usage or all too dangerous nuclear power.

Beyond these choices there is little choice but to prepare to cope with effects of higher temperatures. "The inhabitants of planet Earth are quietly conducting a gigantic environmental experiment," says Dr. Wallace Broecker, the Newberry Professor of Geology at Columbia University. "We're playing Russian roulette with the climate and no one knows what lies in the active chamber of the gun."

Jim Lyle - Photographic Services

Dr. John Appleby calls for a shift from fossil fuels to hydrogen.

Part of Broecker's apprehension is due to his belief that the warming trend from the greenhouse effect may not be so gradual. In fact, the warming trend could change abruptly. As long as sea level increases, the Texas coast will continue to erode. Says John Fisher, a civil engineer at North Carolina State University: "The rise in sea level is going to eventually magnify our erosion problems." Estimates of the rise in sea level over the next century range from two to 10 feet. Even the lower rise would stress the coastal engineering projects that now help to maintain the beaches in many of the large resort cities; the higher one would be disastrous for most of the world's developed beaches and barrier islands.

Alternatives are limited. Coastal residents can build hard structures, like seawalls. They can add sand in beach nourishment efforts as the sea encroaches. Or they can retreat as the Gulf engulfs developed beaches and barrier islands. It may be years before scientists determine just how significant the greenhouse effect is, but they know temperatures appear to be climbing. NASA's Hansen told the *New York Times* that in one study he used the 30-year period 1950-1980, when the average global temperature was 59°F, as a base to determine temperature variations. His readings showed that the average global temperature rose about as much since the base period as it did from the 1880s to the base period – about half a degree in both cases. But he stresses that these are estimates and that it would take millions of measurements to reach an accurate global average.

Sea level rises because of melting ice caps and glaciers, but also, some scientists believe, because of compaction in undersea sediments or a gradual sinking of the continental land masses.

On the Gulf coast, a process called subsidence, caused in part by the extraction of groundwater and petroleum from subterranean layers of sand and clay, has forced the land, already virtually at sea level, to drop 3 feet a century. Here in Texas there are localized cases - in Baytown and Kemah, for instance - where the loss has been significantly higher in a much shorter period of time. ■

DUNE CONTROL

(Continued From Page 15) Hurricane Alicia in 1983, and volunteers have had to rebuild dunes four or five times in some areas, Moss says. Even if the dunes are in a fault in the formation where water will flow, the dunes serve as a barrier to pounding waters during severe storms, he says. "The force the water spends on digging up the artificial dunes and knocking down the sand and uprooting the plants is force that is not going to be spent back against the levee."

Publicity about the dunes project took hold, so much that U.S. Rep. Ron Paul entered the feats of the dune builders into the Congressional Record in 1980. He bragged that while so many had merely talked about erosion and come up with plans that would cost from $16-48 million, one inventive band had taken the problem and solved it with a few wooden stakes, recycled trees and "an ounce of imagination that was literally worth a million dollars."

The effort grew to a much larger scale in 1980 when Alvin 4-H leader Jay Sims organized trucking companies to bring down some 10,000 unsold Christmas trees from Houston nurseries. The Save Our Beach Association (SOBA) also took up the crusade at that time to salvage beachfront property and has sponsored the annual Dunes Day in January ever since.

"We felt a need to keep the sand down," says SOBA member Burt Strouse. "It was just blowing away and our beaches were becoming barren." Strouse, who also is Surfside mayor, says SOBA members feel that sand dunes are the first line of defense against high water – and residents who live in flood-prone areas see that all the time. "We've built up some very fine sand dune areas," he says, adding that he hopes the project will continue.

SOBA was created to save the beach and Dunes Day has become the group's major project during the year, although it assists in several projects including the Brazoria County Parks Department's annual Baby Dunes Day and beach clean-up in April. Hundreds of volunteers from throughout the county, including 4-H groups, scout troops and church groups, help build dunes in January for Dunes Day and then help stabilize the dunes by planting such vegetation as bitter panicum on Baby Dunes Day in April.

Not only is January the best time for collecting Christmas trees, but it also is a good time for building dunes because of the strong northers that frequent the area then, Moss says. The strong southeast winds that usually precede northers expose sand and speed up the formation of dunes.

Saving the beach from its disintegration is a never-ending problem and is about as ceaseless a struggle as the constant education campaign to stop the public from destroying the dunes so many have worked so hard to save, he says.

The Brazoria County Commissioners Court saw a need to protect the dunes along the county's beaches and approved an ordinance establishing a dune protection line in June 1985. The ordinance requires a dune protection permit from commissioners court for any alternation in elevation or vegetation of the sand dunes in the area from mean high tide landward for a distance of 1,000 feet.

Although the forces of nature are what makes the project work, it also is the cause of the problem, Moss says. "Without the wind, we couldn't build sand dunes and without hurricanes, we wouldn't need to build sand dunes." ■

A WARNING

(Continued From Page 23) 9 feet near High Island to more than 12 feet at the eastern tip of Follets Island near San Luis Pass.

Tide data on Galveston Island from the National Oceanic and Atmospheric Administration indicate that since 1958, only Carla in 1961 had a higher open-coast surge than Alicia.

One clear example of the scale of erosion was the damage to Galveston's vegetation line. Using before and after aerial photographs, geologists at The University of Texas Bureau of Economic Geology determined that retreat of Galveston's vegetation line ranged from 20 to 145 feet and averaged about 80 feet. Alicia eroded more than 2 million cubic yards of sand from West Beach alone.

The scientists note that recovery of the vegetation line two years after the storm was insignificant, primarily because the beach erosion exceeded root depth. Alicia had sliced a 2- to 5-foot-thick layer of sand from vegetation areas. Recovery of the vegetation line depends on the number and severity of future storms, as well as shoreline stability and coastal climate.

Oddly enough, hurricane prediction is not an exact science. So far, no one can predict with confidence the exact path a hurricane will take, much less what effect it will have on the rate of erosion. "Geology responds to the high-energy storm events," says Dr. Stan Riggs, a geologist at East Carolina University in Greenville, North Carolina. "The energy expended day-to-day isn't much compared to what's released in a catastrophic storm."

While the record may show a certain beach eroding two feet a year on average, a single storm might bring 30 years' worth of erosion overnight. And, although much of the sand lost during storms returns gradually with calmer weather, that's little consolation for the beach homeowner whose house has moved offshore.

"We really have no idea how to predict what the short-term erosion is going to be like during a major storm," Riggs says. "In a major hurricane, the barrier island itself becomes the surf zone, with 20-foot waves crashing against the buildings."

Technically a hurricane is defined as "... a storm of tropical origin with a cyclonic wind circulation of 74 mph or higher." In order to rank hurricanes and tropical storms, intensities are measured by flooding, storm surges and wind velocity.

The degree of damage is determined using these three characteristics, plus terrain, population and types of development in the storm's path.

Let's track a hurricane as it moves toward the Texas coast. As the hurricane approaches the coastline, winds act on the water and generate strong currents around the center. These currents *pile* the water up against the coast and cause a high surge. Many deaths in a hurricane are from the storm surge. All of the Texas coast is below 20 feet mean sea level, making it highly susceptible to storm surge damage.

As the hurricane makes landfall, the pattern of water current and wave attack changes with the shifting direction of the storm's counter-clockwise winds. On the left side of the eye, winds begin to force water and sediment out of the bay, and through passes or breaches in the barrier island into the Gulf. At the same time, on the right side of the eye, wind and water continue their coastal attack from the Gulf. As the backside of the hurricane moves ashore, waves and currents attack the beaches at a low angle from the southwest.

Hurricane experts say wave intensity depends on fetch – the distance that the wind travels over the water to reach the site. Wave intensity also depends on the average water depth along the fetch. Another factor in the chewing away of the coastline is wave height. If the wave height remains constant, the shorter the wave period, the more erosion is likely to occur.

When a big storm heads for shore, a number of changes take place. Strong winds and low barometric pressures raise bay levels to extraordinary heights that may last from several hours to several days.

Surge heights and resulting shoreline changes that occur during these peak periods depend on several variables, including:

– Direction of the approaching storm.
– Maximum wind velocities and forward speed of the storm.
– Lowest atmospheric pressure.
– Duration of the storm.
– Distance from the eye of the storm.
– Stage of astronomical tide.
– Configuration of the bay shoreline.
– And, finally, shape and slope of the bay bottom.

Now shore erosion begins in earnest. As this sediment-loaded water races across the beach and flows inland, a layer of sediment is removed from the beach and added to the island's interior. The process transforms the shape and position of dunes, but it also conserves their total mass. During the pounding of a hurricane, the rate of wave erosion increases markedly, especially when high water levels allow storm waves to directly attack usually calm upland regions.

Although many of the highest tides observed on Galveston Island were from storms that crossed the coast at or near the island – storms of 1900, 1915, and Alicia in 1983 – other storms making landfall far from Galveston Island have also caused high tides and beach erosion at Galveston. Carla came ashore in 1961 near Port O'Connor, but still clobbered Galveston.

Alicia's high tide reported at Pleasure Pier on the open coast, 8.8 feet above mean sea level. The 1900 storm tide was estimated to be 11.2 feet. By way of comparison, the highest monthly tides in non-hurricane months average about 2 feet.

So, how does Texas halt the damage?

The first line of defense against storm, wave and longshore current attack are the state's barrier island dunes. These natural, vegetated dunes grow slowly but are surprisingly stout due to continual binding of sand and vegetation.

If a natural dune isn't available, some Texas residents try to build their own. Artificial dune ridges can be created in several ways. One simple technique involves lining the backbeach with sand fences, creating wind shadows. This causes deposition of wind-blown sands that form low dune ridges. Bundled Christmas trees have also been placed on the beach to trap sand blown landward by prevailing onshore winds.

While dunes offer a good defense, they aren't impregnable. Dune erosion is based on several factors, including tide height, magnitude of waves, dune size and amount of dune vegetation. Says Dr. John Fisher, a Sea Grant researcher and civil engineer at North Carolina State University: "Big winds make big waves, and big waves destroy dunes."

Some coastal specialists believe that far too many Texas dunes, both artificial and natural, are doomed; not because of hurricanes, but because of increased development and traffic. Human activities tend to disturb sand-binding vegetation, increasing erosion.

And protection of the dunes is often hampered by tradition and Texas' Open Beaches Act, which is often interpreted to mean unlimited beach access.

Galveston's District of the Corps of Engineers office has done considerable research in connection with the congressionally authorized Texas Coast Hurricane Studies in the 1970s. District Engineer Col. John Tudela stresses that hurricanes are one of the many factors that contribute to erosion. Wave surge experienced on the lower part of the bay and the upper parts are considerably different, as water is literally pushed into the upper reaches, he says. This in turn results in severe erosion of coastal areas.

The Corps' studies developed conceptual plans for protecting long reaches of the Texas coast. Several were found to be economically feasible, but high costs of the systems ultimately resulted in shelving the studies. The protection plans involved a system of levees, floodwalls and tide control measures similar to the hurricane-flood protection systems now in place.

Hurricanes and coastal erosion are inseparably tied. Both events will continue. Nothing can stop them. But what coastal experts fret over the most is a sequel to the giant hurricane that blasted through Galveston at the turn of the century.

The seawall undoubtedly reduced casualties and property loss from subsequent hurricanes. But suburban expansion since has produced major housing developments on low ground well beyond the protection of the seawall. Much of the island's population is now housed in areas that are extremely vulnerable to the onslaught of future storms.

Considering erosion protection provided by the Galveston seawall, Sidney Tanner, chief of the Corps' Coastal and Navigation Planning Branch in Galveston, suggests that if the seawall had not been constructed after the 1900 storm, Galveston Island today would be similar in characteristics to Bolivar Peninsula. ■

(Continued from Page 12) equilibrium was established – an equilibrium achieved through a balance of storm and wave energy, sea level and the amount of sediment in the transport system. After forcing the barrier islands to retreat inland in the Gulf, sea level rise slowed to about one foot per century. Some scientists say that sea level rise may be climbing faster due to environmental factors.

Texas is at one end of America's 295 barrier islands that stretch 2,700 miles from the south shore of Long Island down to Florida and on to Mexico. Barrier islands are vital in the formation of estuaries, which help produce some 80 percent of the nation's fish and shellfish stock. Also, migrating and wintering waterfowl call these islands home during some part of the year. Moreover, nationwide, the barrier islands provide habitat for some 20 threatened or endangered species.

The Texas Gulf coast climate has a lot to do with the popularity of the state's barrier islands, a location some tourism specialists promote as America's third coast. During the winter, average temperatures range from about 58°F at Galveston Island to 64°F in the South Padre Island area. Consequently, the mild winter climate attracts winter Texans, as northern tourists are called. During the summer, the average temperature along the entire Texas coast hovers around 83°F

Texas has some hot tempers to go with its hot weather, though. Critics say that during the past two decades, much of Texas' barrier island development has been underwritten by inland taxpayers. The government helped provide air and auto travel systems that made the barrier islands accessible and profitable to develop. On top of this, federal aid assisted in providing utility service, and federal insurance made it relatively easy to risk construction on the islands. Other tax-related aid included federal and state matching funds for construction of erosion barriers, water lines and bridges.

Development of Texas' barrier islands didn't begin in earnest until the late 1920s, when wooden causeways spanning Laguna Madre connected North and South Padre Island with the mainland. Even then, growth was slow due to the Depression and later, World War II. The first surge of building didn't really come until the 1950s, following completion of permanent causeways on North and South Padre Island. But for the past two decades, the development boom has centered on South Padre, Galveston and Mustang islands.

That's not the half of it, either. Texas' barrier islands are used for other purposes besides being a place to bask in the sun. Ranching has historically occurred on the islands. And, industrial uses range from Galveston's port to commercial fishing fleets on Mustang-South Padre Island. Still, compared to the Atlantic coast areas, Texas' barrier islands are relatively free of development and concentrated human use. The trouble is, Texas shares the threat of hurricanes that pummel the rest of the country. It's almost impossible for a hurricane to move along the Texas coast without crossing or at least affecting a barrier island. Early residents of the Texas shore recognized the hazards and often settled away from the shoreline. But during the past 20 years that pattern has reversed. Despite the threat, construction now takes place as close as possible to the shoreline. That can be very dangerous ground.

To be sure, officials expect that Texas barrier islands will receive increased recreational use and development throughout the remainder of the century. Of course, Galveston Island heads the list of heavy hitters in development. Unless some unforeseen event occurs, tiny St. Joseph Island will remain the least-used and least-developed barrier island along the Texas coast because it is privately owned.

Dr. Bob Ditton, a coastal recreation expert at Texas A&M University, and his colleagues have identified several critical points about Texas' barrier islands. Basically, the researchers found:

– Large tracts of as-yet undeveloped land exist on every barrier island.

– Pressure for recreational use and development of these undeveloped areas will undoubtedly increase.

– The unique natural characteristics of the barrier islands dictate that certain uses are more easily sustained by the resource than others.

The trick is moving into the future, while avoiding the traditionally unplanned, haphazard allocation of resources that has occurred in the past, Ditton says.

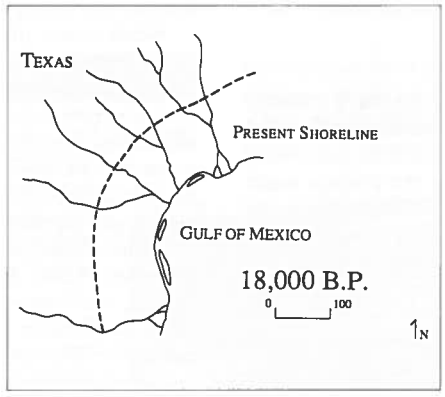
Texas' beaches and barrier islands are constructed of whatever sedimentary material is available to be transported by waves and near-shore currents. The sources of the sediment are rivers, eroded cliffs and shell fragments.

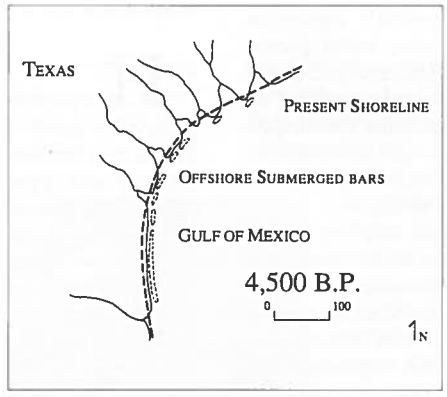
The mysteries of the barrier island movement have been thoroughly dissected, and researchers say sand dunes, indeed, play a major role in protecting Texas shores. When the Gulf breaks through, dunes tend to roll over on themselves. What was the secondary dune becomes the primary dune. Such free movement isn't without its problems, especially when a house or some other permanent structure blocks the dune's forward path. There's simply no place for the dune to go. So it's often destroyed.

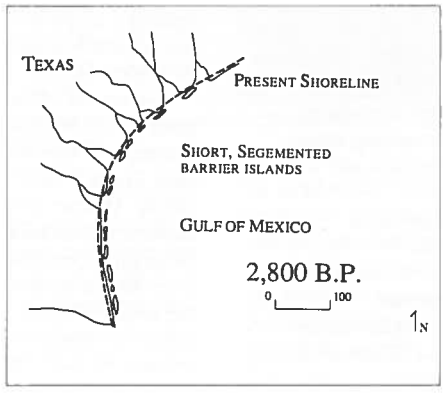
Sand dunes are lost in other ways. Sand must somehow be trapped for a dune to form in the first place. Dune grass generally provides the trap. After the dunes form, roots anchor the sand in place. Dune grass is fairly resistant to salt spray and high winds, but it can't take heavy pedestrian or vehicle traffic. A single pass of an off-road vehicle can kill dune grass and initiate erosion or dune loss.

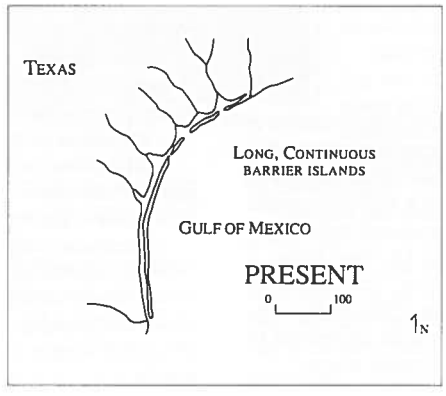
In another instance, just as sands can be washed across coastal barriers, they can also be transported along their beaches. Waves that approach the beach at an angle not only suspend sand in the surf zone but also induce longshore currents. As a result, the beaches become virtual flowing rivers of sand. Even though the direction of this longshore sediment transport, called littoral drift, may reverse with daily, weekly or monthly changes in wave direction, the net rates of littoral drift can reach 1 million cubic yards a year.

Scientists can't accurately predict the future of Texas' barrier islands. That question is largely up to individual communities and how they respond to their eroding shores. ■









TEXAS BARRIER ISLANDS

GALVESTON ISLAND


Norman Martin

Length: 32 miles
Width: Varies from 1 to 2 miles
Size: About 27,000 acres
Location: Texas' northernmost barrier island, 50 miles south of Houston.
Permanent Population: Approximately 70,000
Separated From Mainland By: Galveston Bay and West Bay

The history of Galveston Island is a long and, in some instances, tragic one. European explorers were cruising past Galveston Island in the 16th century, but significant colonial activity didn't start until the early 1800s. The city of Galveston, founded in 1836, soon established itself as a port of entry for the Republic of Texas. During those early days, Galveston was the largest and most affluent city in Texas. The city is no longer among the state's leaders, still it has a metropolitan population of about 60,000 on the eastern third of the island and 8,000 on the westem two-thirds. Today, tourism is the major industry, with hotels, restaurants and condos dotting the city's seawall. Pelican Island, a man-made island built from dredge material, is north of the port. It serves as home for several shipping interests and Texas A&M University at Galveston.

MATAGORDA ISLAND

Length: 27 miles
Width: Averages 2 miles
Size: 50,900 acres
Location: Approximately 5.5 miles off the mainland in Calhoun County. Cavallo Pass is northeastern boundary. Cedar Bayou is the southeastern boundary.
Separated From Mainland By: Espiritu Santo Bay, San Antonio Bay and Mesquite Bay

While the first historical mention of Matagorda Island dates back to 1519, there was little activity until the 19th century. Prior to 1940, ranching was the primary use of Matagorda Island. In 1940, the federal government acquired thousands of acres on the island by condemnation and by leasing from the General Land Office of the State of Texas.

The rest of the island, about one-third of its total area, remained in private ownership. The federal property was used for a bombing range and military base. The bombing range and base were deactivated in 1945. Both were reactivated in 1949 by the Strategic Air Command and used until November 1974, when the Air Force closed the base and bombing range. The island is now under the control of both the federal and state government.

ST. JOSEPH ISLAND

Length: 17 miles
Width: Between 1 and 5 miles
Size: Approximately 28,000 acres
Location: From Cedar Bayou at Matagorda Island on the northeast to Aransas Pass at Mustang Island on the southwest.
Separated From Mainland By: Aransas Pass

St. Joseph, one of the smallest barrier islands on the Texas coast, is unusual in that it is privately owned by one individual. It's used for ranching. For the most part, the island is largely unknown to the general public due to its long history of private ownership, limited public access and low use levels. As a result, development on St. Joseph Island is negligible. Concerned conservationists say a positive aspect of the island's under-development is that island has kept most of its primitive qualities.

MUSTANG ISLAND AND NORTHERN PADRE ISLAND


Tony Amos

Length: 22 miles
Width: Average 2 miles.
Size: Approximately 32,600 acres
Location: Approximately six miles seaward of the mainland in the central portion of the Texas coast.
Separated From Mainland By: Corpus Christi Bay

From the early 1800s, Mustang-North Padre Island was used for ranching. About the only exception to grazing was the town of Port Aransas, where a harbor and port facility were underway by 1830. The port served Corpus Christi during the mid-1800s. But when channels were dredged to Corpus Christi, Port Aransas shifted to commercial fishing as its industrial base. A new age dawned on Mustang-North Padre Island when the Don Patricio Causeway opened in 1927.

Alas, the sun set all too quickly. A hurricane splintered the wood causeway in 1933. It wasn't until 1950, when the Padre Island Causeway, later named the John F. Kennedy Causeway, opened that development came to the island in earnest. The tide of building activity peaked in 1967 with the opening of the "Million Dollar Inn," which was part of a 3,800-acre planned subdivision development, called Padre Isles.

Now, two small population centers make their home on Mustang-North Padre Island. Except for condos, the land between Port Aransas and Padre Isles is largely undeveloped.

SOUTH PADRE ISLAND


Tony Amos

Length: 34 miles
Width: Ranges from one-quarter to 4 miles
Size: Approximately 40,000 acres
Location: Directly south of Padre Island National Seashore.
Separated From Mainland By: The Laguna Madre

South Padre Island wasn't a quick starter. Its remote location limited development until 1954, when the first Queen Isabella Causeway was completed. When the causeway opened auto access to South Padre for the first time, there were still barriers to development – prospective landowners and builders were unable to get insurance coverage. The reason: The island's susceptibility to flooding and hurricane damage. The availability of insurance coverage didn't arrive until 1971. Two years later, a small community at the south end of the island incorporated, and the town of South Padre Island was born. In 1974, construction of a new Queen Isabella Causeway was finished, and South Padre Island had a new link to the state's growing tourist market. The town of South Padre Island occupies the southernmost five miles of the island. The rest is largely undeveloped and primarily in private ownership.

PADRE ISLAND NATIONAL SEASHORE


Tony Amos

Length: 66.5 miles
Width: From one-quarter mile to 3 miles
Size: Approximately 134,000 acres
Location: Extends from about ten miles south of the John F. Kennedy Causeway south to the Port Mansfield Ship Channel.
County: Included within Kleberg, Kenedy and Willacy Counties
Separated From Mainland By: The Laguna Madre

Signs of emerging development were apparent on the seashore portion of Padre Island in the early 1800s in the form of a Spanish cattle ranch. Ranching was the dominant activity on the island for more than a century. Then in the 1950s, the National Park Service conducted several field studies of the island, and, in 1958, recommended that the central portion of Padre Island be acquired for the national seashore system. Congress agreed in 1962 to create the Padre Island National Seashore. It officially opened in 1968. Today, Padre Island National Seashore remains largely primitive, both visually and in terms of services. Lately, the National Parks Service has been caught in a financial bind, forcing a drop in services. – *n.m.*

Beating The Beach

(Continued From Page 9) storm surges is needed. In that way, buildings can be constructed with an expectation of wave damage in coming years.

Consider the suggestions of Rogers at North Carolina:

– Before building on the beach, find out estimated erosion rates for the lot and build on the site that affords the greatest protection.

– Build on pilings sunk deeply enough to support the house in case short-term erosion removes the dunes and some of the beach profile.

– Plan buildings so that they can be moved when erosion threatens them. Many beach houses constructed on pilings can be moved for a fraction of their construction costs.

– Practice dune conservation.

Many experts say while the erosion fight continues, the tide of battle – for some – has shifted to retreat from the shore. Says Assistant Attorney General Ken Cross, the state lawyer handling many coastal cases: "We're letting people build too darn close to the beach. The state needs a better grip on the problem and to do a better job of managing coastal development."

Experience has taught engineers and scientists alike that coastal barriers are dynamic features, always moving, widening at some spots and thinning at others. The upshot: At some point, Texas coastal residents must consider the idea that man-made structures near the shoreline are temporary. And, those who choose to live near the Gulf must be prepared to deal with the consequences. Sobering advice.

"We've got to face the fact that the coast is retreating," says Sharron Stewart, president of Quintana Environmental Services in Lake Jackson. "We're just buying time."

The Corps' coastal engineers state that most of Texas' deepwater channels collect some beach-type material that could be used for restoring beaches. "If the material is of beach quality and if the additional cost of placing that material on beaches during channel maintenance operations could be picked up by non-federal government entities, that material could be available," says the Galveston District's Sidney H. Tanner.

Tanner says material removed during dredging also could be used for creation of underwater berms, as is being considered on an experimental basis by the Corps at Brownsville. "The thought is to reduce the size of waves and the corresponding wave energy reaching the Gulf shoreline, which in turn reduces the erosion rate," he says. Current estimates are that 60 percent of the Texas coast is eroding, 7 percent is increasing and 33 percent is in equilibrium.

What follows is a capsule of the most common methods of erosion control.

Bulkheads

Bulkheads are vertical or near-vertical concrete, wood or metal walls embedded firmly in the underlying soil and tied back into the upland. A bulkhead allows the elevated upland surface to be retained and used right up to the water's edge. They're less expensive than seawalls, but they're also less durable. Bulkheads and seawalls stop shoreline retreat during the life of the structure. However, water turbulence can erode the seaward toe of a bulkhead, increasing the likelihood of its failure. A second disadvantage is the concentration of wave energy at the ends, which causes rapid shoreline retreat along nearby unprotected waterfront. Many bulkheads in the Galveston Bay system have been built lot by lot, increasing erosion of adjacent unprotected property.

Breakwaters

Another type of barrier located in the water is a breakwater. It's designed to reduce wave and current action on the landward side of the barrier. Usually a breakwater is made of a rubble mound of rock, covered by a layer of armor stone or cast concrete units. Breakwaters are relatively expensive per foot of shoreline. They're commonly used to improve navigation rather than to prevent erosion.

Groins

The purpose of a groin is to provide an obstruction that retains a beach, or at least retards its erosion. Made up of short piers extending from the beach and spaced 100 yards or so apart, they can slow erosion by trapping sand carried by crosscurrents. Groins are made with a variety of materials, including sandbags, riprap, and closely spaced posts of wood or concrete, at a range of costs. Groins are sometimes an effective means of rebuilding the beach immediately *upstream*, but a price must be paid. Groins cause even faster erosion on their downdrift sides. Frequently sand accumulates on the side facing the movement and erodes on the other side. A series of groins tends to give the shoreline a serrated shape. To work, groins must cross the public beach and extend well into the surf. There have been reports of strong rip currents forming along the downstream side of groins.

Jetties

Extending even farther out into the sand-sharing system, and typically on both sides of an inlet, are jetties. Long concrete or rock structures, they jut out into the water to keep inlets and harbors navigable by keeping sand and silt from drifting. Sometimes that's a problem. Unfortunately, meeting the needs of navigation is not always compatible with minimizing beach erosion. Like groins, jetties can keep sand from replenishing beaches down current, which leads to wider beaches on one side of the inlet, while increasing erosion on the other side. Even so, jetties perform several useful functions.

Beach Nourishment

Another anti-erosion technique is beach nourishment. This *ongoing* method involves simply replacing sand that has washed away. Beach nourishment is expensive and it must be maintained. For the technique to work, a community must have an economic base broad enough to adequately maintain increasingly expensive beach-nourishment projects. Success also depends on good engineering, a ready source of suitable sand and favorable wave and weather conditions. Even the size of the new sand plays a role in how long the beach stays put. If too fine, sand will very quickly wash from the beach. Much of the new sand, even if the correct size, will soon be lost because renourishment unnaturally steepens the beach profile. Erosion accelerates as the beach attempts to return to a natural shape. Very little beach replenishment has been carried out along the Texas coast. This is, in part, due to the lack of a suitable supply of offshore or bay sand.

Seawalls

The most drastic measure to protect property is the seawall, a rigid mass of rock and steel-reinforced concrete built parallel to the shoreline to take the impact of waves. Normally, seawalls are well anchored in the underlying soil, and often have a crest elevation higher than the mainland behind it. They're the hardest of devices for stopping erosion of a shoreline. A seawall can serve both as a dike against the flooding of storm surge, and as a wall to reflect or dissipate storm waves. They are expensive. The U.S Army Corps of Engineers estimates that a seawall similar to Galveston's would cost about $14 million a mile in today's dollars. Constructing a seawall is usually considered an irreversible act.

Riprap

Yet another technique used to prevent shoreline retreat is the placement of coarse rubble, called riprap, along a shoreline in the wave attack zone. Because these materials are readily available and no construction is required, placement of riprap is considered one of the least expensive and most common methods of shoreline protection. But, like a seawall, riprap can also hasten erosion.

Dunes

One of the damaging aspects of development is the removal of dunes to build houses, condominiums, hotels, shopping centers and roads. Without dunes, it's abundantly evident that the beach cannot effectively absorb large waves, nor can it supply the sand needed for the sand-sharing system to adjust the beach profile during storms. Just walking across the dunes may harm the stabilizing vegetation. Off-road vehicle travel in dunes may be even more damaging. As dunes are destroyed and people develop the shore, the normal processes of island migration become problems of erosion. Many engineering solutions have been sought.

Vegetation

One method is a natural. Naturally occurring or planted vegetation along the shoreline helps control erosion in several ways, including serving as a baffle for nearshore currents, reducing their velocity and decreasing their erosion potential. Plant roots bind the substrate, reducing its susceptibility to erosion. Artificial seaweed is another method. In theory, the artificial seaweed is supposed to act as an underwater sand fence that builds sandbars. But tests in the United States and Europe have consistently shown that it's not effective in controlling wave-induced shoreline erosion. In addition, artificial sea grass has in general proven to be ineffective in an ocean-wave environment.

Fabric

Two man-made materials have raised some hope of slowing erosion. One is an artificial sea grass designed to be installed in the surf zone. The grass is supposed to help trap and collect sand. The other is a fabric that a major oil company claims will protect shorelines from erosion. The fabric is used behind walls, where it can help retain sand while allowing water to move. But the fabric itself does not control beach erosion. ■

P R E S S

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