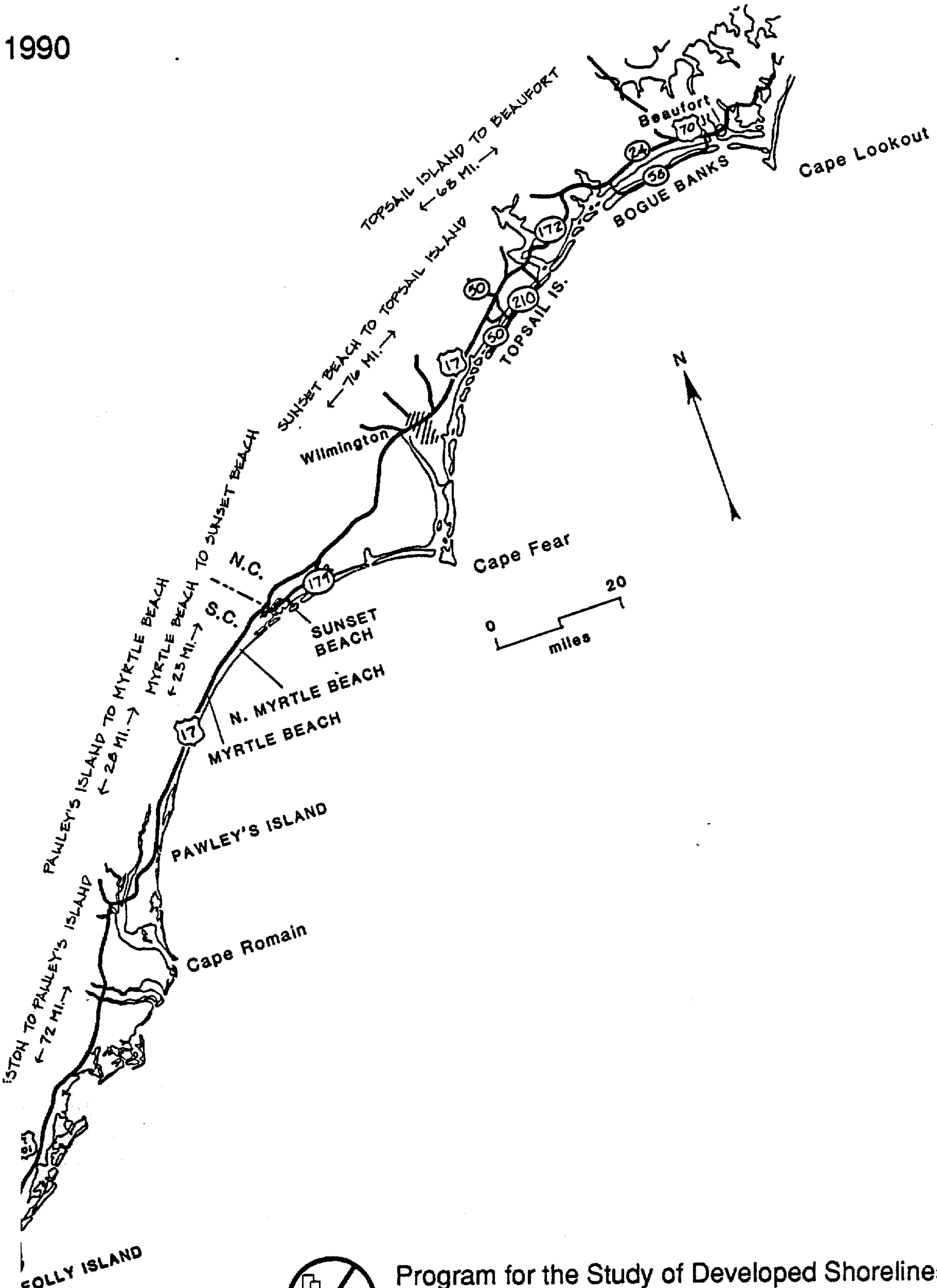
"RECOVERING FROM HUGO: PREPARING FOR HILDA"

Hurricane Damage Mitigation Field Trip Guide
Folly Island, S.C. to Bogue Banks, N.C.

April 1-4, 1990



Program for the Study of Developed Shorelines

Duke University Department of Geology

Guidebook

DUKE UNIVERSITY DEPARTMENT OF GEOLOGY

PROGRAM FOR THE STUDY OF DEVELOPED SHORELINES

****

RECOVERING FROM HUGO: PREPARING FOR HILDA

Hurricane Damage Mitigation
Folly Island, South Carolina to Bogue Banks, North Carolina

****

Trip Leaders / Guide Authors

Orrin H. Pilkey
David M. Bush
Rodney Priddy
Kathie Dixon
Amber Taylor
E. Robert Thieler

Dates: April 1 to April 4, 1990

Guidebook Edited by David M. Bush

CONTENTS

FIELD TRIP LEADERS AND ORGANIZERS

Duke University Department of Geology
Program for the Study of Developed Shorelines

Orrin H. Pilkey, Jr., Director
David M. Bush, Research Associate
Rodney Priddy, Field/Research Assistant
Kathie Dixon, Researcher
E. Robert Thieler, Field/Research Assistant
Amber Taylor, Senior Draftsperson

Duke News Service

Carol McGarrahan, Senior Science Writer
Debbie Selinsky, Assistant Director
Jimmy Wallace, Director of Photography

****

GUEST SPEAKERS

Folly Island:	**H. Wayne Beam**, Executive Director, South Carolina Coastal Council, Columbia
Pawleys Island:	**Gered Lennon**, Coastal Geologist, South Carolina Coastal Council, Charleston
Myrtle Beach:	**Paul Gayes**, Director, Center for Marine and Wetland Studies, University of South Carolina, Coastal Carolina College
Sunset Beach:	**Todd Miller**, Director, North Carolina Coastal Federation, and
	Minnie Hunt, Sunset Beach Town Councilwoman
Topsail Island:	**John Wells**, Associate Professor, University of North Carolina at Chapel Hill, Institute of Marine Sciences, and
	Todd Miller, NCCF

FIELD TRIP OBJECTIVES

1. Foster a new way of thinking about hurricane recovery. That is, instead of simply cleaning up and rebuilding, take active steps to repair the island itself and to enhance the protective characteristics and capabilities of the natural setting.

2. To suggest principles of reducing hurricane property damage in a context of an expected accelerated rate of rise in sea level, increasing rate of barrier island migration, and expected increase in intensity and frequency of Atlantic hurricanes; all due to the greenhouse effect.

3. To encourage an environmentally sensitive approach to reducing property damage in the next hurricane.

4. To examine the reality of our present approaches to coastal zone management on barrier islands in the context of a rising sea level--are we fouling our nest?

   4-A. To examine the impact of coastal zone management regulations in North Carolina and South Carolina on the problem of hurricane damage.

   4-B. To examine the impact of coastal regulations in North and South Carolina on the quality of the coastal environment for future generations.

   4-C. To examine the long-term implications of the North Carolina and South Carolina approaches to the shoreline retreat problem in a context of an accelerating sea level rise.

5. To more fully document the long-term differences in hard versus soft stabilization approaches to shoreline management.

SIMPLIFIED ITINERARY

Sunday Evening, April 1

-meet at Charleston Marriott

Monday, April 2

Folly Island, SC (morning)
- -Holiday Inn seawall, armored shoreline
- -Lighthouse Inlet, severe shoreline erosion
- -The Washout, historic inlet site

Pawleys Island, SC (afternoon)
- -Pawleys Spit, very low elevation
- -Island Center, high dunes and forested
- -Northern end of island, shore perpendicular roads

Tuesday, April 3

-Myrtle Beach, SC (morning)
- -intense oceanfront development
- -beachwalk to Canepatch Swash

-Sunset Beach, NC (morning)
- -accreting shoreline

-Topsail Island, NC (afternoon)
- -Sea Vista Hotel (Topsail Beach)
- -North Topsail Shores (Part of West Onslow Beach?)

Wednesday, April 4

-Bogue Banks (finish by 2 pm)
- -High dunes and forest removed for commercial development (Islander Motor Inn, Emerald Isle)
- -High dunes and forest removed for residential development (Shell Drive, Emerald Isle)
- -Hurricane Hazel Inlet (19th-23rd streets, Emerald Isle)
- -Soundside erosion (Pine Knoll Shores Country Club)
- -Dunes and forest removed for commercial development (Atlantic Beach)

TRAVEL TIMES

Charleston to Folly Beach	30 minutes
Folly Beach to Pawleys Island	2 hr 30 min
Pawleys Island to Myrtle Beach	45 min
Myrtle Beach, SC to Sunset Beach, NC	45 min
Sunset Beach to Shallotte	25 min
Shallotte to Wilmington	45 min
Wilmington to Topsail Beach	1 hr
Total time Sunset to Topsail	2 hr 10 min
Topsail Island to Bogue Banks	1 hr 30 min

DETAILED ITINERARY AND ROAD LOG

SUNDAY, APRIL 1

8 pm Field trip begins with a reception at the Charleston Marriott, at Montague Avenue and Interstate 26 (Exit 213-B). The reception includes heavy hors d'oeuvres and the program runs until 10 pm.

Presentations:

* Welcome by Carol McGarrahan and Orrin Pilkey
* Various Hugo videos will be running
* "Hurricane Processes: Hugo and South Carolina" by Rob Thieler

MONDAY, APRIL 2

We have a lot of ground to cover both Monday and Tuesday so we need to ask people to have had breakfast and be checked out of the hotel and in their cars ready to roll by 7:30 am.

The following is a detailed itinerary and road mileage log. Numbers in parentheses are miles (in tenths) to a landmark or instruction given. Since we are making many stops and some people will be joining us for only part of the trip, there are several instances where the mileage counter is "re-zeroed" usually at the departure site for the next stop.

7:30 am Depart for Folly Beach--main roads: I-26 and SC-171.

(0.0) Exit Marriott parking lot, turn right onto Marriott Road.

Turn left onto Montague Avenue and get immediately in the right-hand lane.

Take Montague Avenue overpass to right entrance onto I-26 East toward Charleston.

(3.2) Exit I-26 at Exit 216-A onto Cosgrove Avenue (SC-171 and 7)

(5.2) SC-171 bears to the left.

(8.4) SC-171 (Folly Road) takes a right turn, then proceeds across US-17.

(17.7) Holiday Inn Folly Beach parking lot, end of SC-171. Restrooms available in Hotel lobby

8:30 am Meet at Holiday Inn Folly Beach parking lot.

Presentations:

* "The Post-Hugo Status of Coastal Management" by Wayne Beam of the South Carolina Coastal Council.

* "Fighting a Losing Battle: Mitigating Hurricane Property Damage at Folly Beach" the first site-specific map for mitigating hurricane damage is presented by Duke University Department of Geology Research Associate David M. Bush.

* "Folly Beach: South Carolina's New Jersey" by Duke University Professor Orrin H. Pilkey.

10:00 am Drive to the north end of Folly Beach

(0.0) Leave Holiday Inn Parking lot go straight back toward traffic light.

(0.1) Turn right at light onto Ashley Avenue East.

(2.0) This is a historic inlet site. Along here the road is frequently overwashed. The road and the rock revetment was destroyed by Hugo and a bigger revetment standing higher and utilizing larger rocks has been emplaced. We'll stop here on the way off the island, time permitting.

(3.4) Proceed through gates onto Coast Guard property. Drive to end of blacktop and park. It's a 10-minute walk to Lighthouse Inlet where we'll see the Morris Island light.

Presentation:

* "The Threat to our Nation's Historic Lighthouses, a Contrast and Comparison of the Morris Island and Cape Hatteras Lighthouses" by Dave Bush.

10:45 am Depart Lighthouse Inlet

(1.4) Historic Inlet site, photo stop, time permitting

(3.3) Turn right at light onto Center Street (SC-171)

11:00 am Depart Folly Island for Pawleys Island

(0.0) Drive toward Charleston on SC-171 (Folly Road)

(9.0) SC-700 to US-17 North stay in left lane, follow signs to Georgetown

(14.5) Hardee's, Wendy's, Melvin's for lunch on US-17N just over the Cooper River bridges a ways, try to be back on the road (17 N to Georgetown) by **12:45 pm.**

(32.6) SC-45 is road to McClellanville. Unfortunately we won't have time to stop here, but this town experienced storm surges in excess of 19 feet, remarkable considering it is over 6 miles inland.

(60.0) Continue through Georgetown on 17 North

(74.4) Bear right on 17 N toward Pawleys Island

(85.0) First sign for Pawleys Island, turn right at Exxon station.

(86.3) Street dead ends at stop sign, turn right. Street dead ends, take a left and an immediate right. Follow this road to the south to the parking lot at the very end of the island.

2:30 pm Arrive Pawleys Island

Presentations:

* "The Emergency Dune and Other Responses to Hugo" by Gered Lennon of the South Carolina Coastal Council.
* "Beach Bulldozing" by Orrin Pilkey
* "Property Damage Mitigation on Pawleys Island" by David Bush

4:00 pm Leave cars parked at spit and load into vans. We'll drive a short distance and go for a 20 minute beach walk to see how dunes and forest lessened the impact of Hugo. Then vans will meet us and drive us to the north end of Pawleys. There we'll see how streets running from the ocean to the sound increased the penetration distance of overwash.

4:45 pm Vans take us back to the parking area on the south end of Pawleys and we Head for Myrtle Beach.

(0.0) Leave Pawleys spit, take first left then first right (the same way we came in).

(1.8) Continue past the southern causeway (the one we came in on) to the northern causeway.

(2.5) Turn left to exit island by northern of the two causeways

(3.5) Junction with US-17 North, turn right toward Myrtle Beach

(13.7) Continue on 17 Bypass, do not take US-501 exit to Myrtle Beach

(30.6) Turn right onto 62nd Avenue North

(31.1) Go through 4-way stop at Calhoun Road

(31.3) Cross King's Highway (Business 17)

(31.6) 62nd Ave dead ends at Ocean Blvd. Turn left. Sheraton Myrtle Beach Martinique is about 1.2 miles up Ocean Blvd at 71st Ave. There is some construction near the hotel so be alert for detour signs.

6:00 pm Arrive Sheraton Myrtle Beach Martinique

Monday evening: Owing to time limitations, we thought it best to combine our dinner and evening presentations and have both at the hotel this night. All activities will take place in the hotel restaurant.

7:30 pm Cocktails; **8:00 pm** Dinner

8:30 pm (approximately) Orrin Pilkey presents "Beach Replenishment: A Cure or a Band-Aid?"

TUESDAY, APRIL 3, 1990

7:30 am Meet in lobby of hotel for optional beachwalk. Those wishing to attend must have had breakfast and be checked out by 7:30 because we need to leave Myrtle Beach promptly at 8:30 am.

Presentations:

* "Beach Replenishment Projects and the Effects of Heavy Development" by Orrin Pilkey

* "The Hazards of Offshore Rubble from Hugo" by Paul Gayes, Ph. D., Director of the Center for Marine and Wetland Studies at the University of South Carolina, Coastal Carolina College.

8:30 am Depart Myrtle Beach, SC for Sunset Beach, NC

(0.0) Leave Sheraton Parking Lot and head north on Ocean Blvd.

(1.5) Merge with US-17 (Business) North

(2.2) Merge with US-17, follow signs to Wilmington

(17.5) Turn onto NC Route-179 to Calabash

(20.5) Turn right at traffic light, stay on NC-179

(22.1) Road dead ends, turn left onto NC-179

(23.9) Turn right at stop sign at Island Grocery. Continue over one-lane drawbridge until road dead ends at stop sign.

(24.9) Take right then left into pier parking lot.

9:15 am Arrive Sunset Beach

Presentations:

* "Why Hugo Caused no Damage At Sunset: More than 50 Years of Shoreline Accretion Helps Mitigate Property Damage on Sunset" by David Bush.

* "North Carolina's Best and Worst Barrier Island Communities" by Orrin Pilkey of Duke University and Todd Miller of the North Carolina Coastal Federation.

* Brief Discussion of plans to widen Sunset's one-lane drawbridge and concerns about development, led by Todd Miller, including comments by Minnie Hunt, Town Councilwoman and member of the Sunset Beach Tax Payer's Association.

11:30 am Depart Sunset Beach for Topsail Island

It is just over 2 hours to our next stop. We have 3 hours budgeted, including lunch. Please try to watch the time so we can meet at the Sea Vista Hotel on the southern end of Topsail Island by 2 pm.

(0.0) Turn right out of pier parking lot, take an immediate left and go back over bridge.

(5.4) Proceed through traffic light, keeping on NC-179 toward Shallotte.

(12.0) NC-179 dead ends at US-17, turn right, proceed north.

(12.3) Hardee's, also McDonald's and Burger King right up the road. It should be only about 11:30 by the time we get here. Those who want to can wait another 45 minutes or so and have lunch in Wilmington. Either way, continue on US-17 North.

(46.1) Follow US-17 North as it winds through Wilmington. It becomes Dawson Street. After crossing the intersection of 3rd street, get in the left lane,following signs for 17 North and 74 East. Turn left at 17th street (at the Amoco Station). Get in rightlane.

(47.9) Turn right onto Market Street, still 17 North.

(50.0) Places to eat on Market Street. Continue on 17 North.

(72.3) Turn right onto NC-210 toward Topsail Island, Surf City.

(75.1) Turn right as NC-210 merges with NC-50.

(77.0) Turn right at traffic light, follow NC-50 to Topsail Beach.

(83.3) Near pier along Ocean Blvd, turn left onto Flake Avenue then right onto Ocean Blvd.

(84.6) Follow road around to Sea Vista Hotel parking lot. Restrooms are available in the office for our use.

2:00 pm Arrive Sea Vista Hotel, Topsail Beach, NC.

Presentations:

* "The Effects of Bulldozing Sand to Build Up Beaches" by John Wells, Associate Professor at the Institute of Marine Sciences at the University of North Carolina at Chapel Hill.
* Discussion of the effects of inlet dynamics on nearby shoreline erosion by David Bush.
* Orrin Pilkey discusses the terminal groin project proposed for the southern end of Topsail Island and, time permitting, other shoreline engineering projects.

3:30 pm Depart for northern end of Topsail Island.

(0.0) Leave Sea Vista Hotel parking lot, take second right onto NC-50.

(7.7) Turn left at light

(7.8) Take first right, onto New River Drive, follow NC-210.

(12.0) Public beach access and restrooms on the right, next to the Yacht Tender sign.

(16.0) Turn right off of NC-210 onto State Route 1568 toward North Topsail beaches.

(20.5) Hotel St. Regis where we'll be spending the night.

(21.0) Road ends, turn right, then left.

(21.4) Road curves left, but continue straight through the Beach Club property entrance to the New River Inlet and park there.

4:15 pm Arrive New River Inlet, northern end of Topsail Island

Presentations:

* Behavior of New River Inlet and impact on property damage mitigation by David Bush
* Stabilizing New River Inlet by dredging and its impact on property damage mitigation by Orrin Pilkey

5:00 pm Depart for short drive back to the St. Regis

6:30 pm There will be a cocktail reception and brief meeting tonight, but no formal presentations are scheduled. The Hugo videotape will be shown during the reception. Be alert for announcement of reception location. Restaurants are scarce on Topsail, the hotel probably has a decent one. We'll ask when we arrive.

WEDNESDAY, APRIL 4, 1990

8:00 am Depart Topsail for Bogue Banks, NC

(0.0) Leave St. Regis, head south on State Route 1568.

(4.5) Turn right at stop sign, junction with NC-210

(14.0) Turn right onto NC-172 at the Sunoco station

(17.9) Entrance to Camp Lejeune Marine Base. Tell guard you're driving straight through.

(26.5) Follow NC-172 to the right

(32.0) Exit Marine Base, stay on NC-172

(36.0) Turn right at traffic light onto NC-24

(47.0) Turn right onto NC-58. Proceed over causeway onto Bogue Banks, town of Emerald Isle

(48.9) Turn right at first traffic light onto Coast Guard Road.

(49.0) Take first left onto Reed Drive

(49.3) Turn right onto Islander Drive and park near the buildings

9:30 am Arrive Islander Motor Inn. While we're waiting for the caravan to arrive, we'll be able to see a location where dunes and forest were cleared for commercial development.

Bogue Banks was not hit by Hugo but is a unique place to study property damage mitigation because of the wide range of environments found on the island. At each of our stops, Orrin Pilkey will give some background and Dave Bush will discuss site-specific mitigation.

10:00 am Depart Islander Motor Inn

(0.0) Turn right out of Islander parking area onto Reed Drive

(0.5) Turn right onto Shell Drive

(0.6) Turn right onto Ocean View Drive, park at end of road.

10:15 am Arrive Bogue Banks Stop 1--High Sand Dunes. Forest and dunes were removed for residential development.

10:45 am Depart High Dunes, Stop 1

(0.0) Turn around and go back on Ocean View Drive, take first left onto Shell Drive

(0.2) Turn left onto Reed Drive, then first right onto Loon Drive

(0.3) Turn right onto NC-58

(5.4) Emerald Isle Mini-Mart (on the right) has restrooms we can use

(6.2) Go past 23rd street and pull over on grass shoulder

11:15 am Arrive Bogue Banks Stop 2--Hazel Inlet. Inlet was formed during Hurricane Hazel in 1954 and was filled artificially.

11:45 am Depart Hazel Inlet, Stop 2

(0.0) Pull back onto NC-58 heading east

(2.1) Site of another Hazel inlet

(9.3) Turn left onto Oak Leaf Drive, road leading to Pine Knoll Shores Country Club

(9.9) Turn right into Country Club parking lot

12:00 noon Arrive Bogue Banks Stop 3--Artificial Marsh. Pine Knoll Shores Country Club has a unique solution to soundside erosion.

12:30 pm Depart Artificial Marsh, Stop 3

(0.0) Turn left out of parking lot

(0.6) Turn left onto NC-58 heading east

(2.6) Hardees on left

(2.9) McDonald's on right

(3.4) Turn right at traffic light and head toward Atlantic Beach Boardwalk area. Take left lane and turn left at the Fun Land Arcade and park anywhere.

12:45 pm Arrive Bogue Banks Stop 4--Atlantic Beach Boardwalk. Dunes and forest removed for commercial structures at the Boardwalk area.

1:15 pm End of Field Trip

Leave Fun Land Arcade parking lot and head back toward NC-58, go straight through the traffic light ahead. The road crosses a causeway over the Intracoastal Waterway and intersects with US-70. Right is east to Beaufort and the Duke Marine Lab. Left is west and the way back to Raleigh and Durham.

PRINCIPLES OF PROPERTY DAMAGE MITIGATION

The accompanying Table I shows some of the initial results of our on-going Property Damage Mitigation Project. The table lists options for reducing the damaging effects of storms on property. The storm effects are mostly all natural processes and we indicate whether a given mitigation option will increase or decrease the storm effect. Table II is a list of the mitigation options showing how they fall into natural groupings.

Response of a given shoreline segment to a given storm is a function of several variables including elevation, sand supply, vegetation, type and degree of development. Geologic processes such as shoreline retreat, storm-surge and storm-surge return, flooding, inlet formation, inlet migration, overwash, dune mobilization and direct wave attack are processes intensifying the hazards of barrier shoreline living. In every case, the over-all shoreline storm response is a combination of natural and man-made factors. It is our goal to suggest ways to lessen the effects of these processes on property on a site-specific basis.

We are looking at property damage mitigation techniques that could be implemented on a pre-storm, immediate pre-storm, and post-storm basis. Pre-storm activities include such things as relocation of structures out of hazard zones, rebuilding or upgrading structures, changing road orientation or elevation, building and vegetating dunes, and updating and enforcing erosion setbacks. Immediate pre-storm activities include sand bagging and removing of mobile structures and objects, if possible. Post-storm activities are essentially reconstruction or implementing property-protection measures such as more conscientious location of development, elevation and orientation of new roads, new setbacks, awareness of overwash passes, density of development considerations for new development, plus incorporating the predicted increase in the rate of sea-level rise into sound shoreline management policies.

We try to approach each study area as a separate entity and observe unique shoreline settings and their unique responses to storms. To each of these storm responses possible mitigation procedures or practices are suggested. The applicability of the mitigation principles as they relate to a specific island setting is noted, applying results gathered from the current principles of property damage mitigation project.

We classify developed portions of the shoreline segment-by-segment as to the type of natural setting, type and degree of development, observed or predicted storm response and potential for damage. For each site, individualized mitigation procedures or practices are offered. The applicability of the

STORM EFFECT	Beach Replenishment	Beach Bulldozing	Raise Frontal Dune Elevation	Plug Dune Gaps	Raise Island Elevation	Replace Interior Dunes	Seawalls	Groins	Jetties	Replace Forest	Stabilize Dunes	Plant Marsh	Retrofit Homes	Curve and Elevate Roads	Active Relocation	Elevate Homes	Setbacks	Site Elevation	Do Nothing
Flying Debris										+			+	+	+		+	+	
Floating Debris				+	+	+				+			+	+	+	+		+	+
Wind Attack										+			+	+	+		+		+
Storm Surge	+	+	+	+	+	+	+	+ -	+ -	+	+			+	+	+	+	+	+
Soundside Shoreline Retreat					+		+ -	+				+							
Existing Inlet Change		+							+ -										
New Inlet Formation				+	+	+			+ -			+							
Direct Wave Attack	+	+	+	+ -	+	+	+		+ -	+	+			+	+	+	+	+	+
Overwash	+	+	+	+ -	+	+	+	+ -	+ -	+	+			+	+	+	+	+	
Ocean Shoreline Retreat	+	+		+ -			+ -	+	+ -										
Sand Supply To Island	+		+	+ -	+	+	+ -	+	+ -	+	+	+							
ENVIRONMENTAL IMPACT	+	-	+	+	-	+	-	-	-	+	+	+			+	+	+	-	+
LONG TERM COST	H	L	L	L	H	L	H	H	H	L	L	L	L	L	L	L	L	L	L

+ Mitigate Storm Effect
- Increase Storm Effect
H= High Long Range Cost
[redacted]ow [redacted]e C[redacted]

Table II: List of Mitigation Options

- Soft Stabilization
  - Adding Sand to Beach
    - Beach Replenishment
    - Beach Bulldozing
  - Increasing Sand Dune Volume
    - Sand Fencing
    - Raise Frontal Dune Elevation
    - Plug Dune Gaps
  - Adding Sand to Main Part of Island
    - Rebuild Interior Dunes
    - Raise Island Elevation

- Hard Stabilization
  - Shore Parallel
    - Seawalls
    - Revetments
    - Offshore Breakwaters
  - Shore Perpendicular
    - Groins
    - Jetties

- Vegetation
  - Replace Forest
  - Stabilize Dunes
  - Plant Marsh

- Development and Infrastructure
  - Retrofit Homes
  - Elevate Homes
  - Curve and Elevate Roads
  - Replace Roads with Interior Dunes
  - Block off Some Roads
  - Active Relocation

- Zoning, Land Use Planning
  - Setbacks
  - Choose Elevated Building Sites
  - Do not Rebuild Destroyed Buildings in Place

mitigation principles is often a function of specific island types and development style.

The Property Damage Mitigation Project, involving the states of North Carolina, South Carolina and Florida (project restricted to Florida's east coast), began on July 1, 1989. Field work through February, 1990 has been restricted to North Carolina and South Carolina. Locations studied to date are: in North Carolina: the Town of Nags Head on Currituck Spit; on the island of Bogue Banks the communities of Atlantic Beach, Pine Knoll Shores, Indian Beach, Salter Path and Emerald Isle; the extremities of Topsail Island; and Sunset Beach; In South Carolina: North Myrtle Beach and Myrtle Beach, Pawleys Island, and Folly Island.

The final product for the project will be a book on the principles of property damage mitigation on barrier islands. We are making a series of detailed maps for the specific islands or communities studied from which we will draw our general principles. Large-scale, detailed maps for Folly Island, Pawleys Island and Bogue Banks will be presented on this trip. In addition, generalized mitigation maps and detailed recommendations for some specific locations are included in this field guide.

In addition, several new ideas on property damage mitigation and on conducting the project in general have come to light during the first several months of work. The ideas on mitigating property damage have evolved from working in the field and from discussions with interested individuals and federal, state and local officials. Some traditional mitigation options were sand fencing to trap sand and build dunes; replacing primary dunes and stabilizing with vegetation; beach replenishment; and relocation of threatened structures. All suggestions are "soft" solutions. We will generally not recommend hard stabilization because of its detrimental impact on recreational beach quality and because of state restrictions in both North Carolina and South Carolina.

New mitigation ideas include ten-year relocation plans for large structures whether they are presently threatened or not (the plan would include such things as economic analysis, site studies, location of new site); identifying historic and potential inlet zones and have them designated as inlet hazard areas just as present-day inlets are; replacing of interior dunes or beach ridges that had been excavated for development; protecting all dunes--not just frontal or primary; replace maritime forests just as dunes are revegetated today; changing road elevation and/or orientation; blocking off some roads and replacing with interior dunes; and bringing sand as needed onto an island from the mainland.

We hope to eventually incorporate all our findings into a mitigation atlas for North Carolina and South Carolina covering all developed oceanfront communities. North and South Carolina are the target states for production of a mitigation atlas for several reasons. Obviously, the Program for the Study of Developed Shorelines has a great deal of experience in the two states. Proximity of the study area is another compelling reason. Perhaps the strongest argument, however, is North Carolina's leading role in coastal-zone management. Forbidding of hard structures on the shoreline and the looking to retreat and to soft-stabilization methods such as beach replenishment shows a recognition of the importance and value of the recreational beach. South Carolina has recently enacted strong coastal-management policies, perhaps even stronger than North Carolina's. Summaries of the states' coastal-zone management policies are presented in the appendices of this quidebook.

The atlas will be useful to the general public including planners, developers, politicians and homeowners. It will be the "first of its kind" and will pave the way for production of similar publications for all other hurricane-prone areas. More importantly, the atlas will hopefully lead to improved nationwide efforts to mitigate property damage at our shorelines. The primary emphasis of the project is to incorporate the mitigation maps into a coastal hazards atlas for North and South Carolina useful for the nonscientist.

The impact of Hurricane Hugo in September of 1989 is also very timely. The shoreline from Cape Fear, North Carolina to Folly Island, south of Charleston, South Carolina was significantly affected. Quick development and implementation of mitigation techniques will work to reduce property damage from future storms. A mitigation atlas will help to get the word out in a format that is easy to use.

DETAILED DESCRIPTION OF ISLANDS AND STOPS

The next section of the field guide presents general information on each of the islands we will be visiting plus information about the specific stops we will be making. Also included are several diagrams and figures illustrating points that will be made during the trip.

FOLLY ISLAND

Folly Island trends ENE-WSW, is just over 6 miles long and about 0.5 miles wide at its widest. Lighthouse Inlet is located at the northern end of Folly Island, Stono Inlet at the southern end. The maximum elevation of Folly Island is only about 8 ft, a typical elevation is about 5 ft. Computer models developed by the National Oceanic and Atmospheric Administration (NOAA) called SLOSH models (for Sea, Lake, and Overland Surge from Hurricanes) are used to predict storm surge levels and to what parts of the coast will be flooded by given strength hurricanes. According to the SLOSH model for South Carolina, the storm surge of a Category 1 Hurricane would entirely inundate Folly Island.

Folly sits in the shadow of the Charleston Harbor jetties. Sand that would normally travel southward along the coast is trapped by the jetties and has been causing severe erosion both on Folly Island and on Morris Island just to the north of Folly. The jetties were built in the late 1800's. A 1935 Army Corps of Engineers report to Congress (House Document 156, 74th Congress) indicates that erosion rates were 7 feet per year for the island, and as high as 51 feet per year at Stono Inlet. The present day erosion rates vary from about 1.5 to 6.0 feet per year according to studies done by the South Carolina Coastal Council. The Corps recommended then, as now, hard stabilization to combat erosion. The long-term effects of the Charleston jetties will be discussed and illustrated at Folly Stop 2 at Lighthouse Inlet.

The dune ridges of Folly's interior provide a moderately protected area for development. Maritime forest, shrubbery, modest dune elevation, and a buffer of salt marsh on the soundside typify the interior. Houses built within the forest and dunes suffered little during Hurricane Hugo, except by storm surge flooding and wind damage to trees.

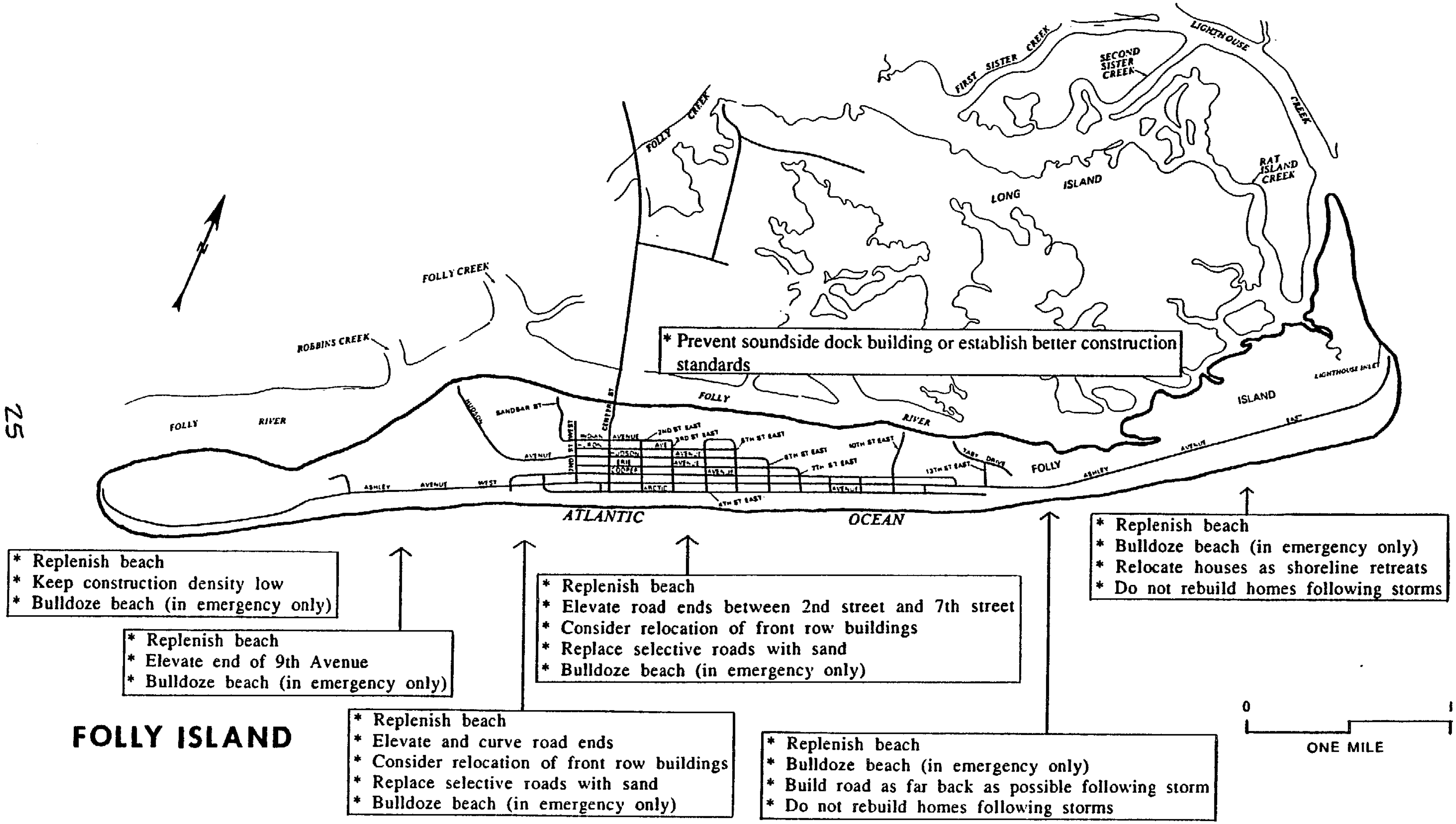
Folly Island is developed along its length and width, with the exception of its extreme ends. The northern end is a U. S. Coast Guard facility; the southern end is a county park. Wood frame, single-family beach cottages and several small commercial buildings comprise the majority of the island's development. The dominant structure on the island is the Holiday Inn located at the end of SC Route 171. The Inn was built in 1985 on the site of the old Folly Beach Pavilion, a popular gathering place since before World War II. The Folly Beach pavilion/pier was opened in the 1920's and burned in 1957. It was rebuilt in 1960 but burned again in 1977 and was not rebuilt.

The community of Folly Beach began developing around 1920. Until 1957 drinking water was brought onto the island from Charleston. A pipeline was completed in 1957 and the year-round population now is about 1200. Erosion control structures such as rubble revetments, groins, and seawalls soon followed. Parts of the state-maintained timber groin system date to the 1940's. At present, the shorefront of Folly Beach is fortified by a field of seawalls, revetment and bulkheads.

Hurricane Hugo caused severe damage along the entire length of the island. A landmark was lost--the Atlantic House, built in 1938, was destroyed. Storm surge elevation has been estimated at between 10 and 12 feet for Folly. After Hugo passed and the surge water started to flow back to the sea, many storm-surge ebb channels were scoured forming several washouts along the length of the island. Consequently, severe house and road damage was sustained in areas. Return waters focused around the ends of the Holiday Inn seawall destroying homes and parts of Arctic Avenue (Stop 1). Also at Stop 1 we will discuss a method to reduce the impacts of overwash and storm-surge ebb by simply blocking off some the roads that run perpendicular to the shore, acting as conduits for storm waters.

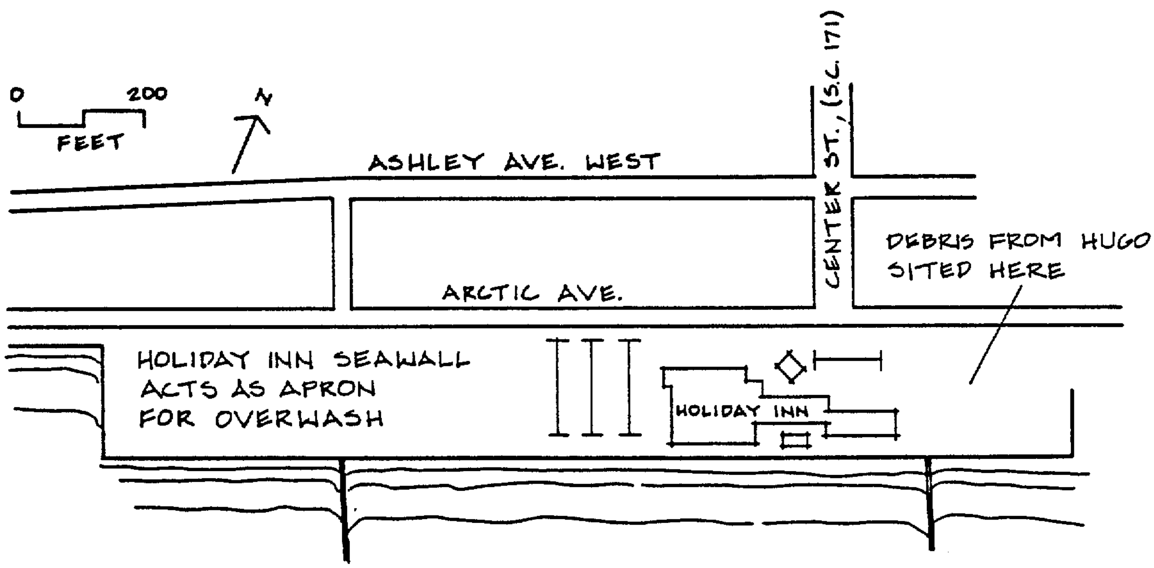
The pattern of erosion on Folly is such that there is an inflection point near its northern end. This is approximately the area of an inlet that was open during the Civil War. This inlet separated Little Folly Island to the north from Folly Island. The low area is frequently overwashed by storms and is now locally referred to as "The Washout". Houses and part of Ashley Avenue were destroyed at another large washout immediately north of the Folly's inflection point (Stop 3). The houses will not be rebuilt because of the new South Carolina coastal regulations. The road has been rebuilt and is located partially in the marsh because of the narrowness of the island in this area. A large revetment was emplaced to protect the road replacing a smaller revetment that was destroyed by Hugo.

For further information, refer to Figure 4.14 on page 96 of Living With the South Carolina Shore. Included therein are descriptions and island safety analysis.



FOLLY ISLAND

FOLLY ISLAND
STOP # 1
HOLIDAY INN AT END of RT 171



<u>PROBLEMS</u>

- Ends of the Holiday Inn seawall responsible for channeling of return water

<u>ASSETS</u>

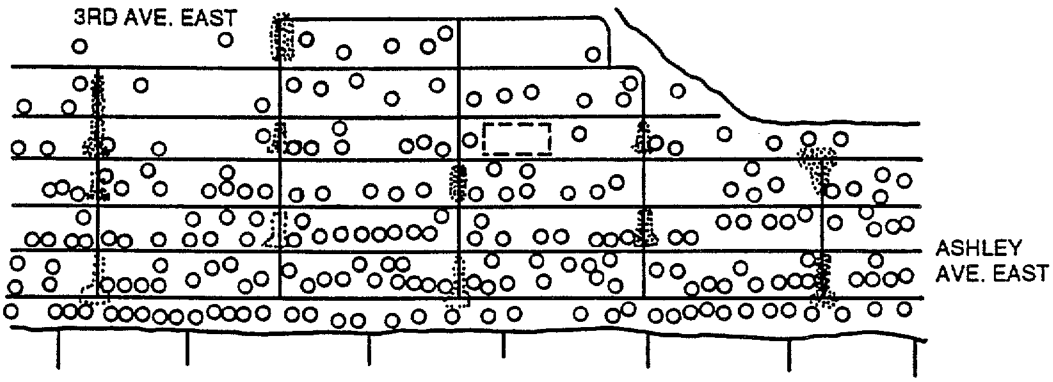
- Island relatively wide
- Construction density low

<u>HUGO RESPONSE</u>

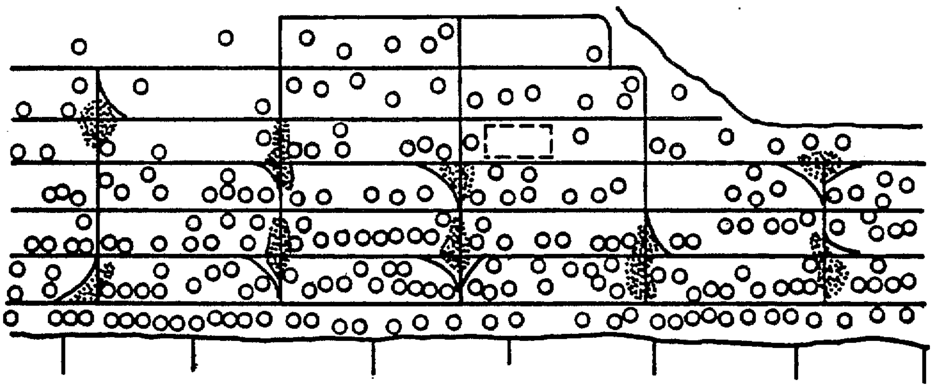
- Artic Road destroyed by storm surge return

<u>RECOMMENDATIONS</u>

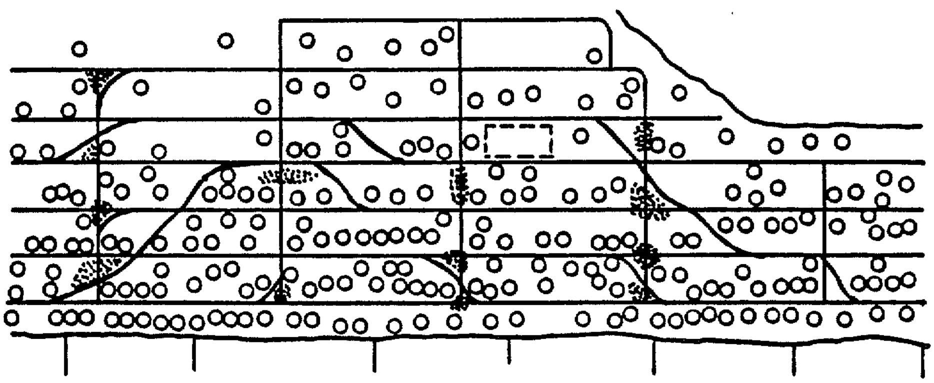
* Rebuild property away from end of seawall
* Raise frontal dune elevation especially at ends of seawall
* Replenish beach
* Curve and elevate road ends



1. DUNE BUILDING AND BLOCKING INTERSECTIONS; NO BUILDINGS MOVED; NO ROAD CONSTRUCTION.

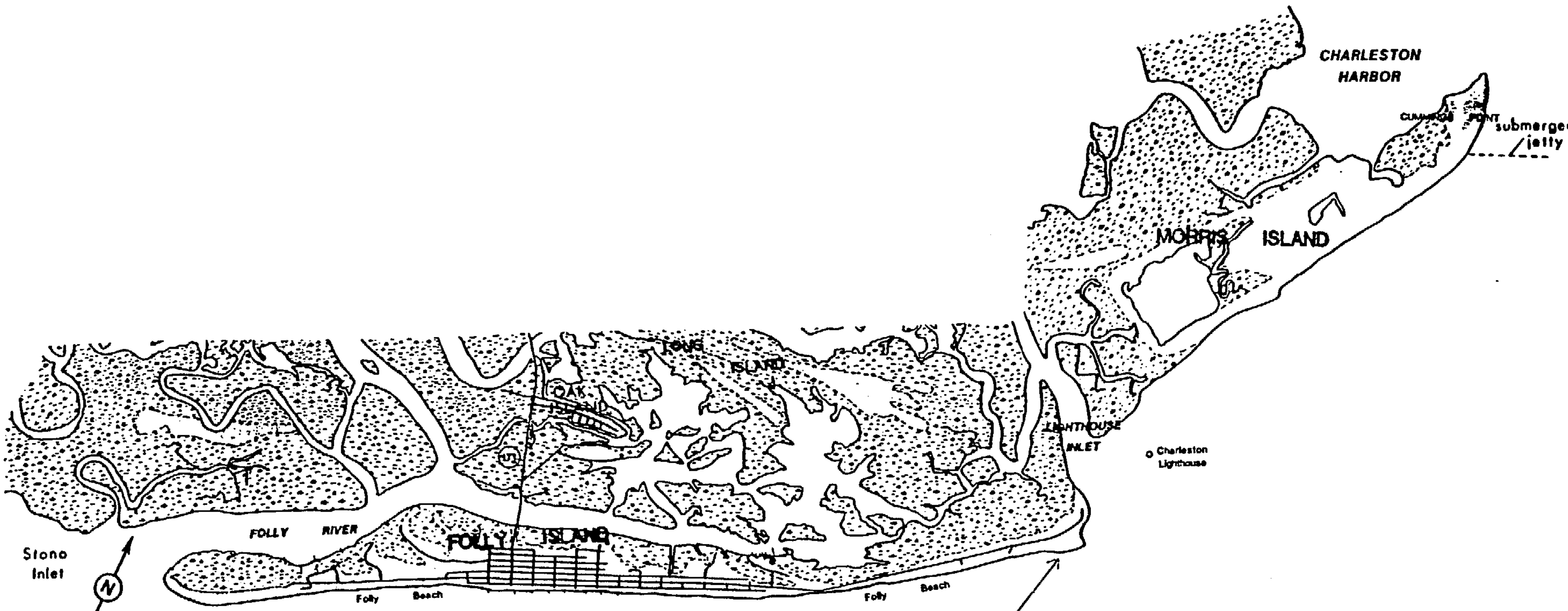


2. MINOR ROAD BUILDING: MOVE PARTS OF SOME ROADS; PUT PILES OF SAND IN SHADED-IN AREAS. REDUCED EASE OF ACCESS IN SOME CASES.

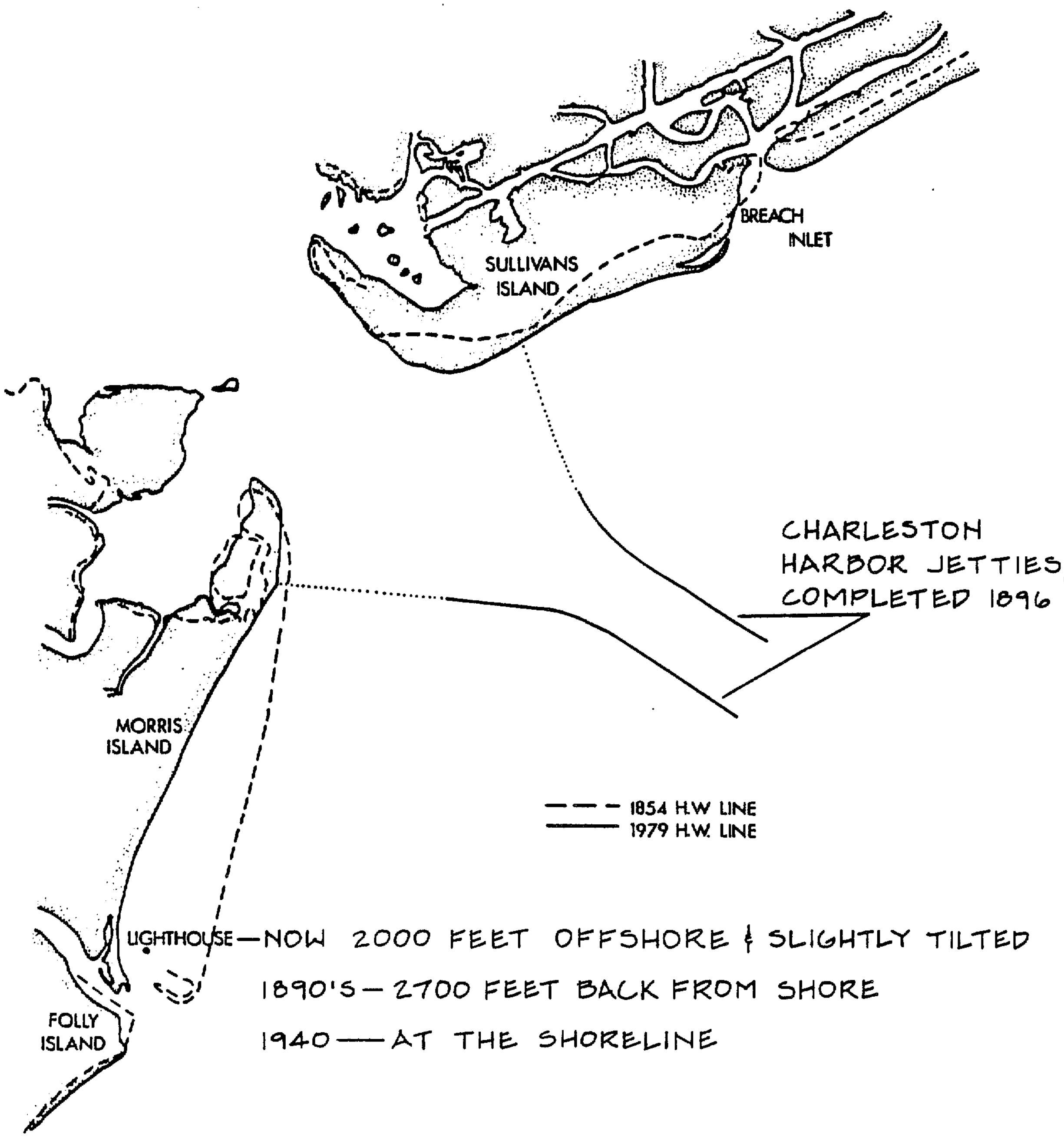


3. SIMILAR TO NO. 1, EXCEPT SOME STREETS ARE MOVED TO MIDDLE OF BLOCKS.

THREE SITE-SPECIFIC PLANS TO REDUCE IMPACT OF OVERWASH AND STORM SURGE EBB ON FOLLY BEACH



LIGHTHOUSE INLET, FOLLY ISLAND- STOP 2



MORRIS ISLAND LIGHTHOUSE AND THE CHARLESTON JETTIES

--Related Issue--

The Case for Relocation of the Cape Hatteras Lighthouse
MOVE IT OR LOSE IT!

As we stand and view the Morris Island lighthouse as it sits some 2000 feet offshore, we have the opportunity to present the issue of the Cape Hatteras Lighthouse located near Buxton, North Carolina, just north of Cape Hatteras. The controversy surrounding the options for preserving the Cape Hatteras Lighthouse is a microcosm of shoreline management issues. Arguably the world's most famous lighthouse, the Cape Hatteras Lighthouse stands 208 feet tall, the tallest brick lighthouse in the United States. For 120 years it has warned mariners of the treacherous waters which have given North Carolina's Outer Banks the nickname "Graveyard of the Atlantic".

The present light at Cape Hatteras was first lighted in 1870. It replaced a smaller lighthouse that had far less illuminating power. Since the present light was first seriously threatened by shoreline erosion in the 1930's until 1981, the National Park Service (NPS) spent about $15 million on interim protection methods. It should be noted that many of the shoreline protection methods were primarily for protection of a U. S. Navy facility located just to the north of the lighthouse. These include groins, beach nourishment, and sandbagging. In 1980 when the light was almost lost to a winter storm, NPS began investigating methods of "long-term" protection in order to find a "solution" to the erosion problem.

NPS was directed by the Department of the Interior to find a protection method that would meet three criteria: (1) The lighthouse will be saved, (2) the solution will be permanent, and (3) there must not be major recurring costs. Despite all the swirling controversy, an examination of all facts clearly shows that only moving the lighthouse satisfies each of these criteria. That conclusion was reached by the Move The Lighthouse Committee which, in 1987, helped convince NPS to re-examine the issue. The same conclusion was also reached by the Committee on Options for Preserving the Cape Hatteras Lighthouse, formed by the National Research Council (NRC) in July, 1987, at the request of NPS.

Details of the issue are too lengthy to get into in this guide. Listed below are some important facts and dates. Following that list is a recent newspaper article which seems to indicate that NPS has decided to let the lighthouse fall in, contrary to what they have publicly stated. Much of the chronology below is taken from NPS's Environmental Assessment for the Lighthouse Protection Plan, published in 1982.

1870: existing lighthouse opened, at 208 feet it is the tallest brick lighthouse in US. Original distance from the sea: 1500 feet.

1919: shoreline within 300 feet of lighthouse

1935: shoreline migration brings the sea to within 100 feet

1936: Coast Guard abandoned lighthouse. Light moved to steel skeleton tower in Buxton Woods, one mile west. Erosion control attempted with construction of sheet steel piling.

late 1930's: CCC begins dune-building project, hopefully to prevent overwash and to allow future development behind it.

1950: Shoreline stabilized (naturally and temporarily) and Cape Hatteras Lighthouse reactivated by Coast Guard. Ownership of the structure had been transferred to NPS.

1966: 312,000 cubic yards of sand pumped from Pamlico Sound to stabilize shoreline.

1967: Nylon sand-filled bags emplaced in front of lighthouse to stabilize. Some still remain today.

1969: U. S. Navy builds three groins to protect Naval facility and lighthouse. They were destroyed by storms and rebuilt in 1975.

1971-1973: Two replenishment projects emplaced 1.5 million cubic yards of sand from Cape Hatteras Point to the Lighthouse area. September, 1973 found the sea 175 feet from the old lighthouse ruins and 600 feet south of the present lighthouse.

1978: Water reaches old lighthouse ruins.

1980: March storm washed away remaining ruins of the original lighthouse and water reaches within 70 feet of present lighthouse.

1980: During the summer, NPS received results of study of Cape Hatteras erosion problem, and asked the U. S. Army Corps of Engineers (ACOE) for evaluation.

1982: Public workshop held April 1-2 in Manteo, NC to discuss alternatives for protecting lighthouse. Options included a seawall revetment, offshore breakwaters, beach nourishment, additional groin, relocation and no action.

1985: NPS selects seawall revetment as best option.

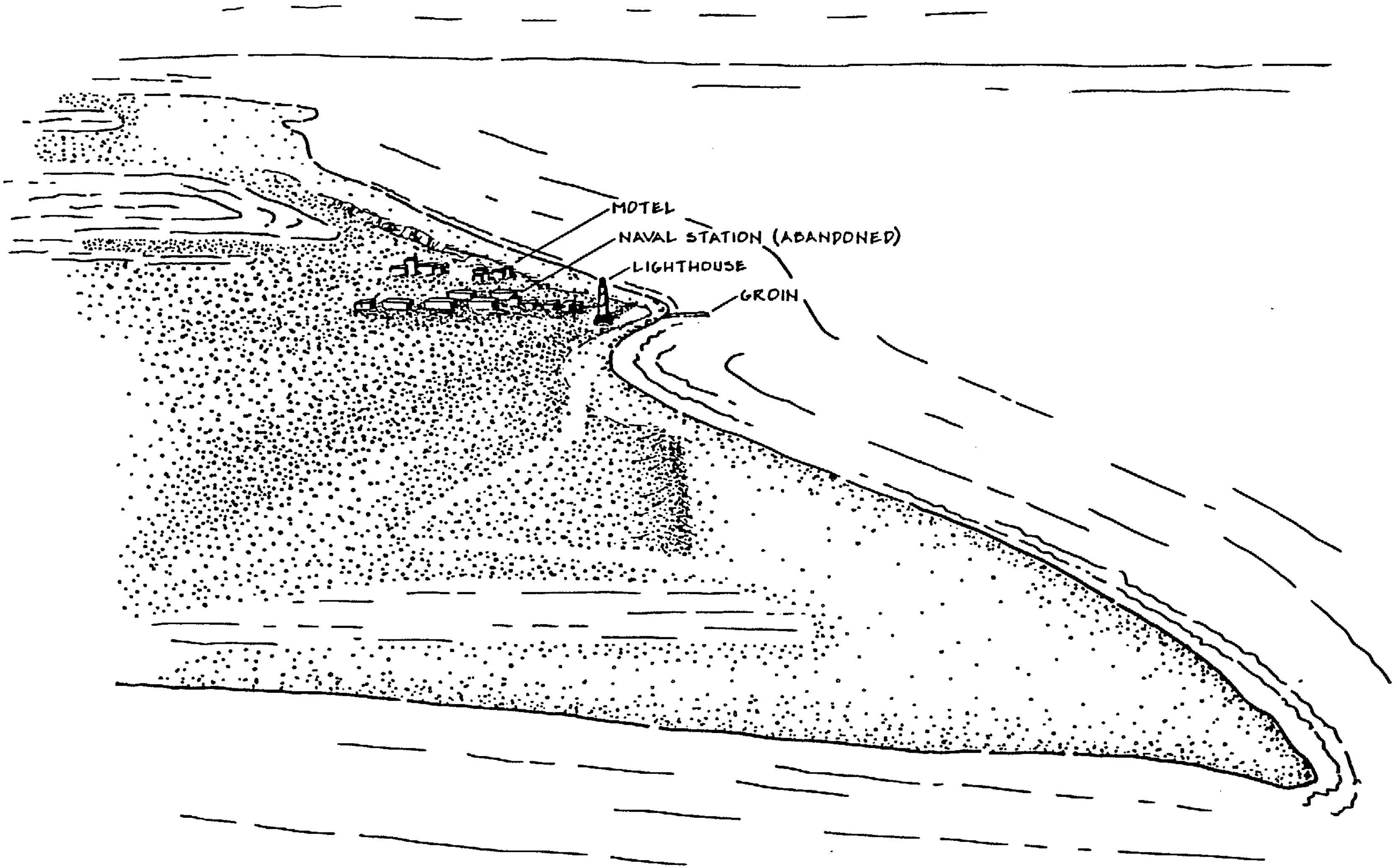
1986: Move the Lighthouse Committee organizes.

1987: NPS decides to review options, asks NRC for help.

1988: NRC final report unanimously selects relocation as the best option.

1989: NPS announces in early summer that relocation is the preferred alternative, and again asks for public input. In December NPS announces that relocation of the lighthouse is the best way to preserve it.

1990: Looks like NPS is blowing smoke and will let the lighthouse fall in.



CAPE HATTERAS

BULGE IN SHORELINE AT LIGHTHOUSE IS A RESULT OF SHORELINE STABILIZATION EFFORTS AT AND NEAR THE CAPE HATTERAS LIGHTHOUSE.

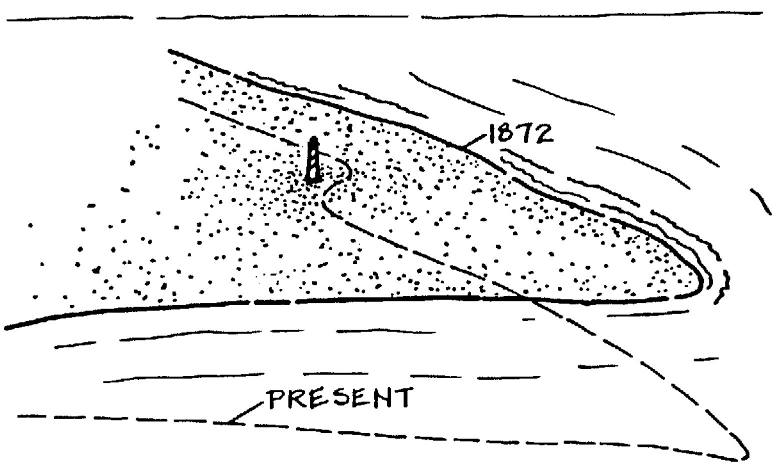
CAPE HATTERAS

LIGHTHOUSE AND SHORELINE

A. LIGHTHOUSE ORIGINALLY WAS 1500 FT. FROM SHORE.

B. GROIN TRAPS SAND, PROTECTS STRUCTURES TO NORTH; CREATES EROSION TO SOUTH.

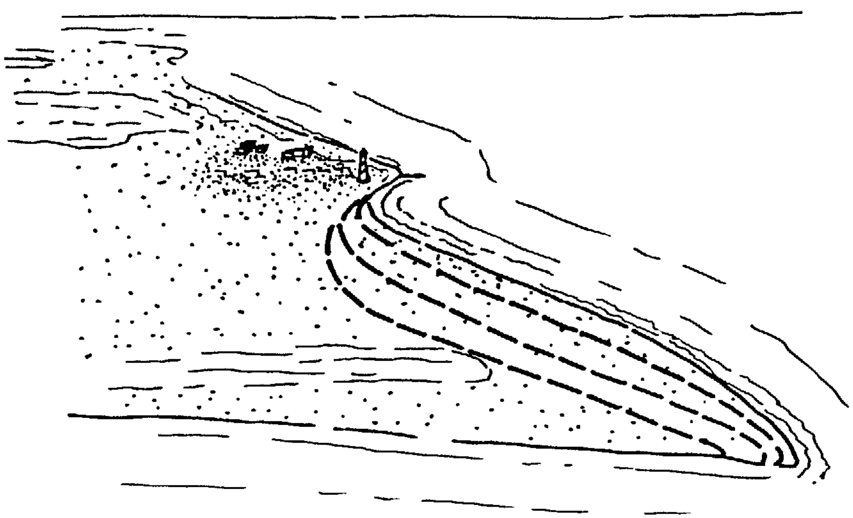
C. NEW LOCATION OF LIGHTHOUSE WILL RE-ESTABLISH ITS ORIGINAL RELATIONSHIP TO SHORELINE.
DETERIORATION OF GROIN WILL ALLOW RE-FORMATION OF NATURAL SHORELINE, CAUSING MOTELS TO FALL IN.



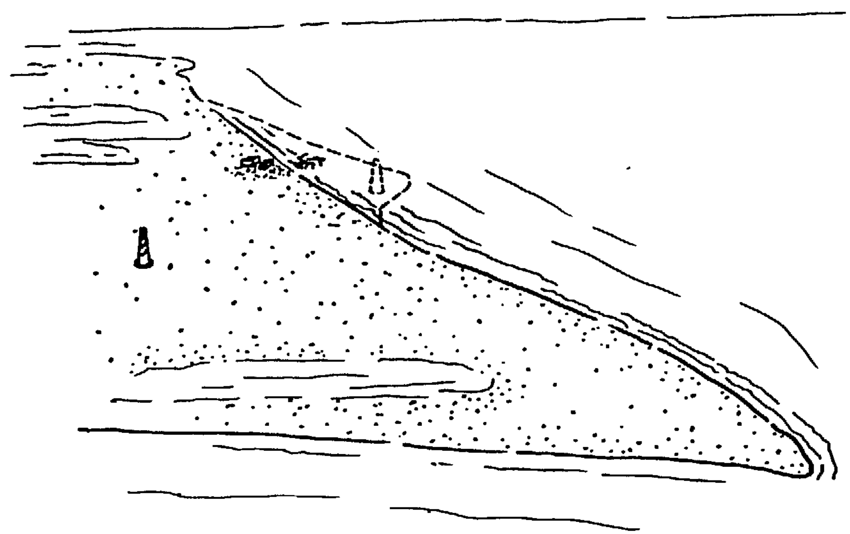
A. COMPARISON OF 1872 AND PRESENT SHORELINES

34

B. WHAT WILL HAPPEN IF LIGHTHOUSE STAYS IN PLACE



C. WHAT WILL HAPPEN IF LIGHTHOUSE IS MOVED



Lighthouse Preservation Best Option

After ten years of studying the problem of erosion around the Cape Hatteras Lighthouse, there is still firm disagreement from all competing sectors on what is the best way to proceed. So for the present the Park Service is going to concentrate on preserving the historic structure, maintaining the beach and strengthening the groins around it to preserve the lighthouse in its present place, Tom Hartman, Superintendent of the Cape Hatteras Seashore, told the Manteo Commissioners at Wednesday night's board meeting.

The original Park Service decision about 10 years ago was to allow the sea to claim the lighthouse as rising ocean waters advance against the point where the lighthouse stands, but opposition arose within two weeks of this announcement and a group of citizens at a workshop called to study various options agreed that a sea wall would be the best protection.

The idea was funded by Congress, but three years ago, just before the Park Service was slated to receive the money, a group of engineers and scientists forming the "Move the Lighthouse Committee" proposed relocating the lighthouse to a site about 1,500 feet from the point. They contended that constructing a wall was a violation of state and national policy against building hardened structures on the beach, and that relocation would cost very little in comparison with the $5 million cost of building a sea wall.

Eventually, the National Academy of Sciences studied the proposals and agreed that moving the lighthouse was the best way to protect it for a long period of time, but during the time it took for this study to be done opposition to the plan arose from residents of Hatteras Island who preferred beefing up the point with more traditional methods of protection, from a national group which wanted to save the lighthouse, and from Rep. Walter B. Jones who also expressed opposition.

Hartman said that at present the Park Service has money for preservation and maintenance, but none for moving the lighthouse. "Maybe someday the public will be ready to move the lighthouse," he said. For the present though, "I am committed to doing the best I can to preserve it where it sits. We're going to do what the citizens want," he said.

FROM: THE COASTLAND TIMES, FEB 10 1990.

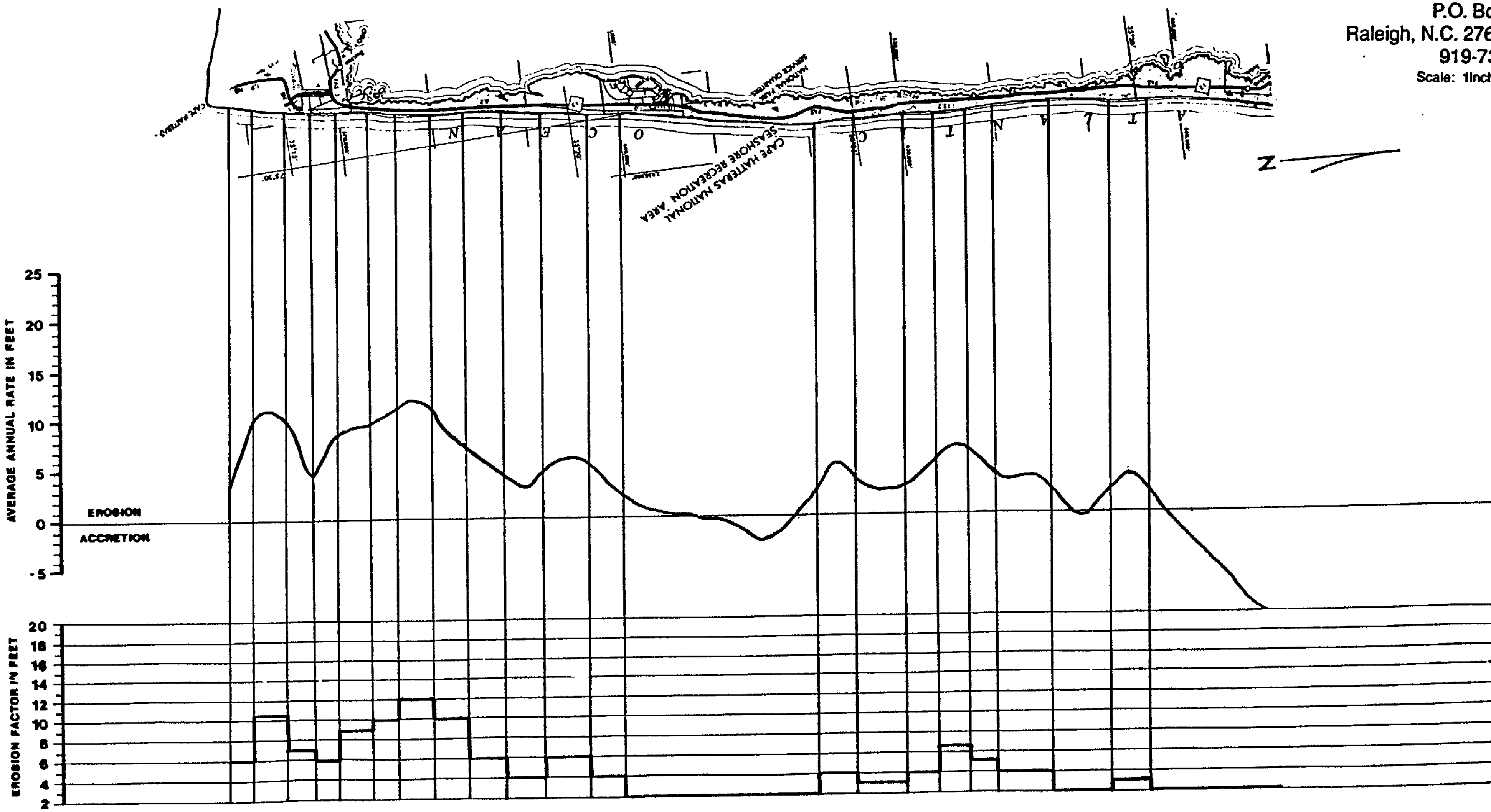
Cape Hatteras to Salvo

Long Term Average Annual Erosion Rates Updated Through 1986

North Carolina
Division of Coastal Management

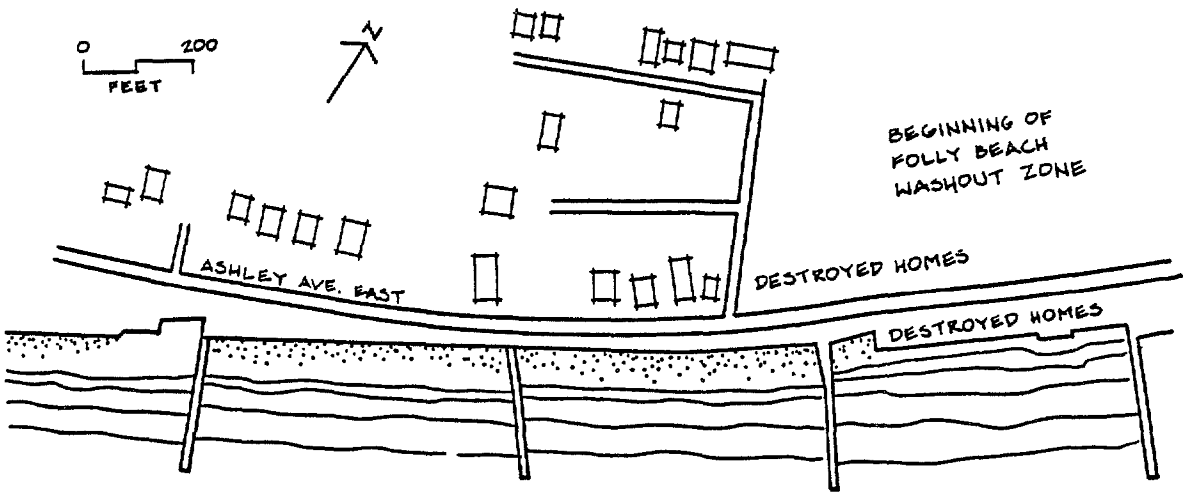
For more information contact us at:
P.O. Box 27687
Raleigh, N.C. 27611-7687
919-733-2293

Scale: 1inch = 2 miles



FOLLY ISLAND

EAST END OF FOLLY BEACH
"WASHOUT ZONE"



PROBLEMS

- Island very narrow
- Ashley Avenue too close to water
- Historical inlet site

HUGO RESPONSE

- West end of Ashley Avenue washed away
- Area of most intense property damage

RECOMMENDATIONS

* Build Ashley Avenue as far back as possible following storms
* Replenish beach
* Do not rebuild following storms

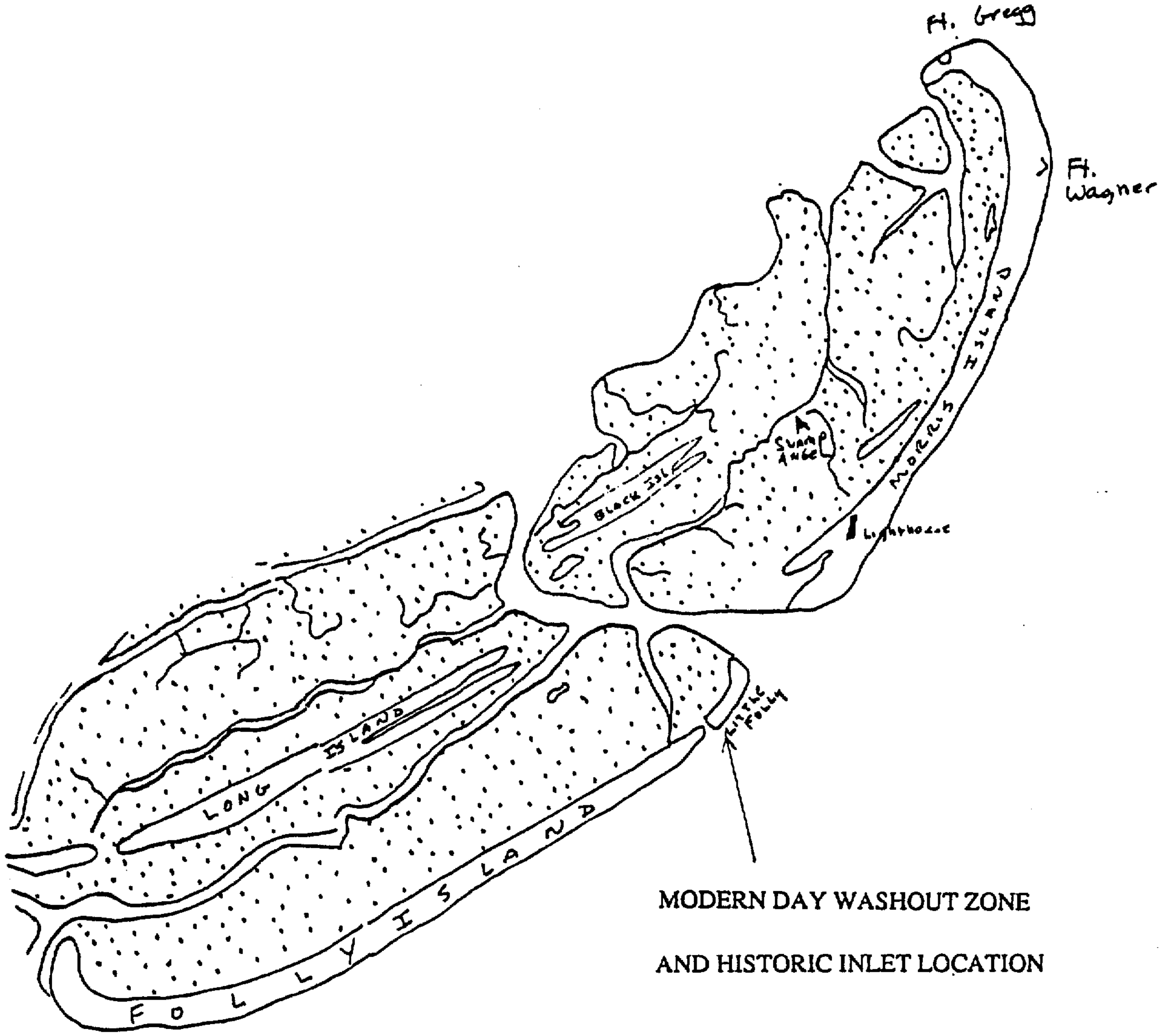


FIGURE SHOWING FOLLY ISLAND AND LITTLE FOLLY. (FROM TIME AND TIDE ON FOLLY BEACH, S.C : BY G. STRINGER- ROBINSON)

PAWLEYS ISLAND

Pawleys Island is a narrow, low-lying island trending NNE-SSW and developed over its 3.5 mile length and 0.5 mile width by single-family primary residences and second homes. Construction type is primarily wood frame. The island's permanent population is about 700 with over 3000 people living there during the summer. The real crowding of development started when the island's two causeways were built. Several condominiums have attracted more residents to Pawleys.

Midway Inlet lies to the north and Pawleys Inlet to the south. Maximum elevation on the island is about 11 feet. SLOSH models indicate that storm surge from a category 1 hurricane would flood both ends of the island, a category 3 surge would flood the entire island. Long-term erosion rates have averaged about 2 feet per year between 1872 and 1966. Range of erosion rates is from 7 feet per year to places where accretion is actually occurring and the island is building out. The groin field is evidence of efforts to battle oceanfront erosion.

About 25% of the island is covered with high dunes and dense maritime forest. The other 75% consists of low-lying spit, and areas where protective dunes and vegetation have been flattened for development. Both Pawleys Inlet to the south and Midway Inlet to the north are unstable, migrating inlets and both exert an influence over this short island. New inlet formation is likely, and occurred on the southern spit during Hugo. The Hugo inlet has been filled in artificially.

Hurricane Hugo left the island with extensive property damage, overwash and the new inlet. Examination of the island following Hugo revealed a spectrum of property damage that appears to have been a function of the presence of protective dunes, setback and vegetation. Relatively little damage occurred where houses are well elevated, well back from the beach, behind the frontal dune, and enveloped by dune and maritime forest. The most severe damage is found where the interior dunes and maritime forest had been removed for roads, houses, driveways and parking areas.

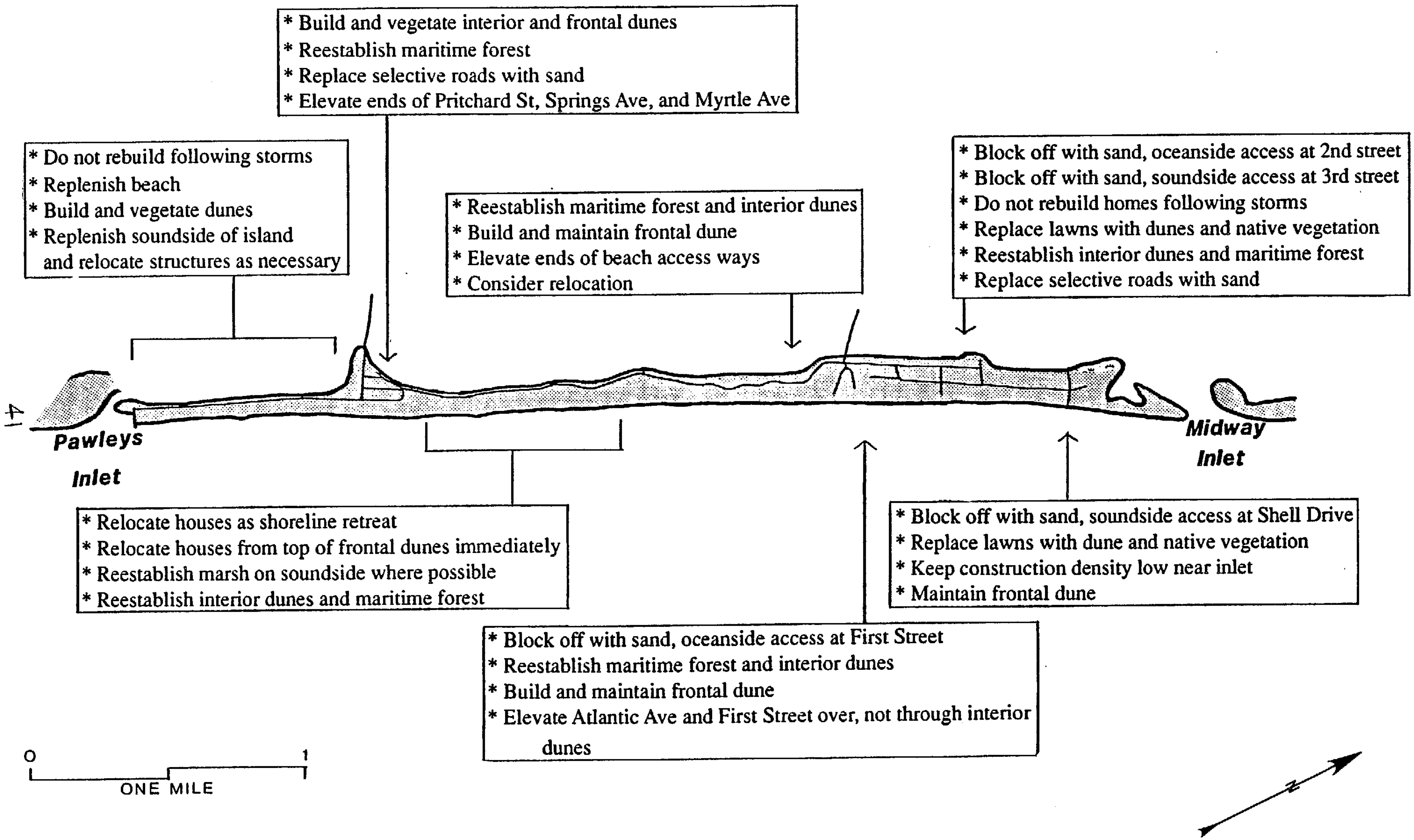
Water, sand and debris carried to the interior of the island along roads such as First Street and Shell Drive was another cause of a great deal of property damage. The roads that lie perpendicular to the shore link the beach to the sound. Pawleys' boat ramps provide ideal conduits for the return of storm waters (termed storm-surge ebb). Storm-surge ebb caused scour channels which undermined roadways and damaged houses and property. If the direct line created by straight perpendicular roads could be interrupted as in the plan presented and discussed on Folly Island, the amount of damage done by storm-surge ebb waters could be reduced.

Backbarrier marshes help to contain flood waters, dampen soundside wave energy, and add width and elevation to the island. In some areas of Pawleys, marshes have been removed or filled for construction. The "restoration" of backbarrier marsh wherever possible would help Pawleys (and other islands) face future storms and sea-level rise. We'll see some good examples of this on the trip, especially on Bogue Banks on Wednesday.

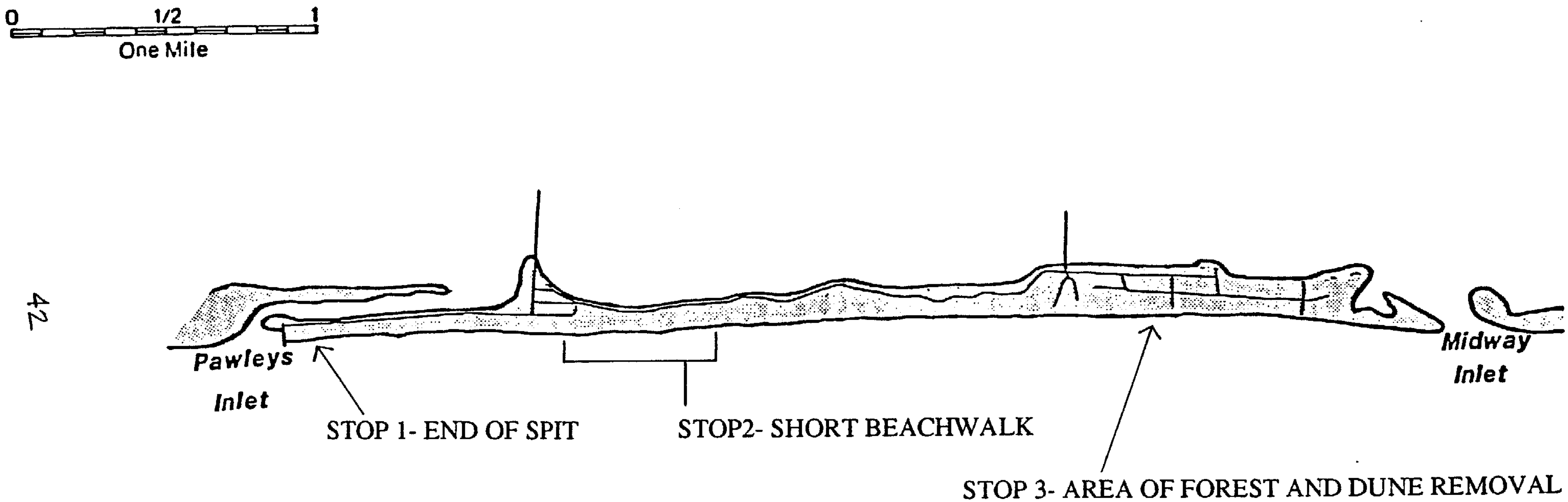
A plan of beach replenishment, re-establishment of maritime forest and low interior dunes, and relocation of buildings as they are threatened would serve Pawleys well. Several houses are located on deep lots and thus have a lot of "room to move". Unfortunately, the common situation on Pawleys (and elsewhere) is one of overcrowding--too many buildings on too little land. The only type of relocation possible for many structures is to demolish and rebuild elsewhere.

On this trip we will make three stops on Pawleys. We will stop first on the southern tip of the island, on Pawleys spit and observe a very low elevation part of the island and the location of an inlet formed by Hugo that has since been filled in. Then we will go for a short beach walk to see how forest and dunes protected some property from severe damage. Finally we will go to the northern end of the island to observe an area where the dunes and forest had been removed and where roads run perpendicular to the shoreline and all the way from ocean to sound.

See Figure 4.11 on pages 84 and 85 of <u>Living With the South Carolina Shore</u> for Pawleys Island site description and safety analysis.



PAWLEYS ISLAND



PAWLEYS ISLAND

MYRTLE BEACH AND THE GRAND STRAND

This northernmost portion of the South Carolina shoreline is not a barrier island but is technically part of the mainland shoreline. From Little River Inlet at the North Carolina/South Carolina state line to the community of Garden City Beach is a stretch of almost 50 miles of continuous wide beach known as the Grand Strand. It is one of the most popular resort areas in the United States.

According to an Army Corps of Engineer report, there is $1.4 billion worth of development on the oceanfront in this area. The beach-front property is in severe danger from storms. The high-risk area is restricted to a narrow zone, however, for a variety of reasons. First, the mainland is very steep compared to barrier islands, so storm surge waters won't penetrate very far inland, meaning the zone of overwash and storm-surge wave impact is very limited. Second, the erosion rate is relatively low, about 3 feet per year. Also, there are no inlets, thus no inlet hazard areas.

A great deal of beach was lost during Hugo and extensive beach replenishment projects are already completed or underway for the various communities located along the Grand Strand. In an effort to restore the recreation beach the City of North Myrtle Beach undertook a $1.8 million beach nourishment project. Over 370,000 cubic yards of sand were placed along sections of the beach that experience the most erosion. The nourishment project was designed to help protect oceanfront property from future storms and to provide a safe and attractive recreational beach for residents and visitors.

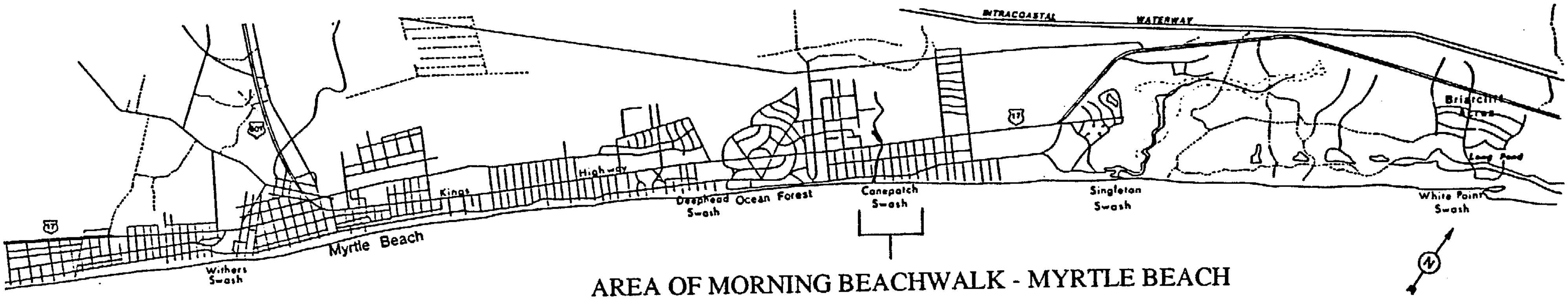
The City of North Myrtle Beach had no emergency replenishment plan in place before Hugo. Seeing the degraded state of their beaches they were advised to take sand for their replenishment project from a large shoal that was said to have formed at Hog Inlet (to the north) during the storm. Operating nearly around the clock, trucks were loaded to haul sand along the beach to the appropriate locations. Nearly one-half of the city's nine-mile long beachfront received sand from this nourishment project.

The drawback at North Myrtle Beach is that Hog Inlet now suffers from an erosion problem! Although some sand did build up here during and soon after the storm, the inlet was still changing to accommodate the changing configuration of its channel. Conditions at that stage had not reached an equilibrium state and have since altered again causing erosion on the southern side of the inlet.

The City of Myrtle Beach has more foresight. They had purchased a large sand pit located inland, near the intersection of US-17 and US-501. They have taken over 100,000 truckloads of sand from that source to replenish their beaches.

No site-specific mitigation maps were made for the Grand Strand Communities. General mitigation recommendations for the entire shoreline section include: Emergency bulldozing after storms; continued replenishment with sand source from far inland; development of long-term relocation feasibility studies and plans; recognition of the swashes (such as Canepatch Swash which we will see on our beach walk Tuesday morning) as hazard areas, needing specialized restrictions on building and possibly some unique engineering solutions to get storm water flows safely back out to sea; and recognition of offshore rubble from Hugo as a real hazard, necessitating a "Potential Debris Inventory" done immediately so that potential hazards can be recognized and removed.

See Figures 4.4 and 4.5 on pages 72 through 75 of Living With the South Carolina Shore for description and safety analysis of the entire Grand Strand.



AREA OF MORNING BEACHWALK - MYRTLE BEACH

MYRTLE BEACH

NORTH MYRTLE BEACH

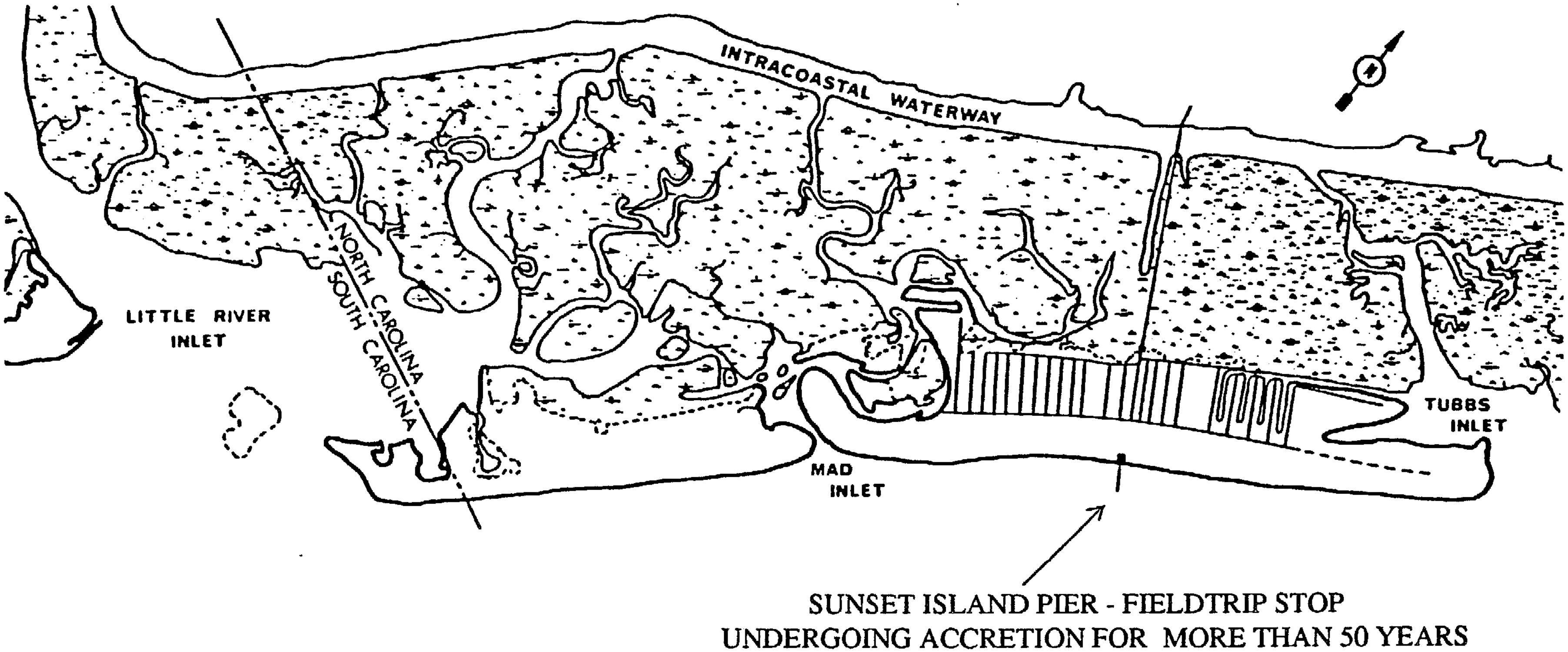
SUNSET BEACH, NC

Sunset Beach is experiencing accretion along the central part of the island. The maximum long-term average annual shoreline change as calculated by the North Carolina Division of Coastal Management is over 8 feet of accretion per year for the past 50 years. Accretion rates tail off on either side of the central part of the island, and the ends have actually undergone long-term erosion.

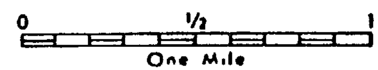
So much sand has built up at the pier that the space underneath it filled up with sand and the pier had to be extended. Accretion has led to a wide dune field of relatively low elevation. This dune field was almost completely destroyed by Hugo. The point here is that the dunes did exactly what they are supposed to do. They were sacrificed to dissipate wave energy sparing the homes behind them. The present situation is one of a flat beach, but sand fencing is underway and will build up the dunes in the near future though it will take years for an appreciable volume of sand to accumulate.

No site-specific mitigation map was produced for Sunset Beach. Its best asset is the long-term history of accretion. Continued sand fencing and limiting of development to the central parts of the island are strongly recommended.

See Figure 61 on page 129 of From Currituck to Calabash for island description and safety analysis.



SUNSET BEACH



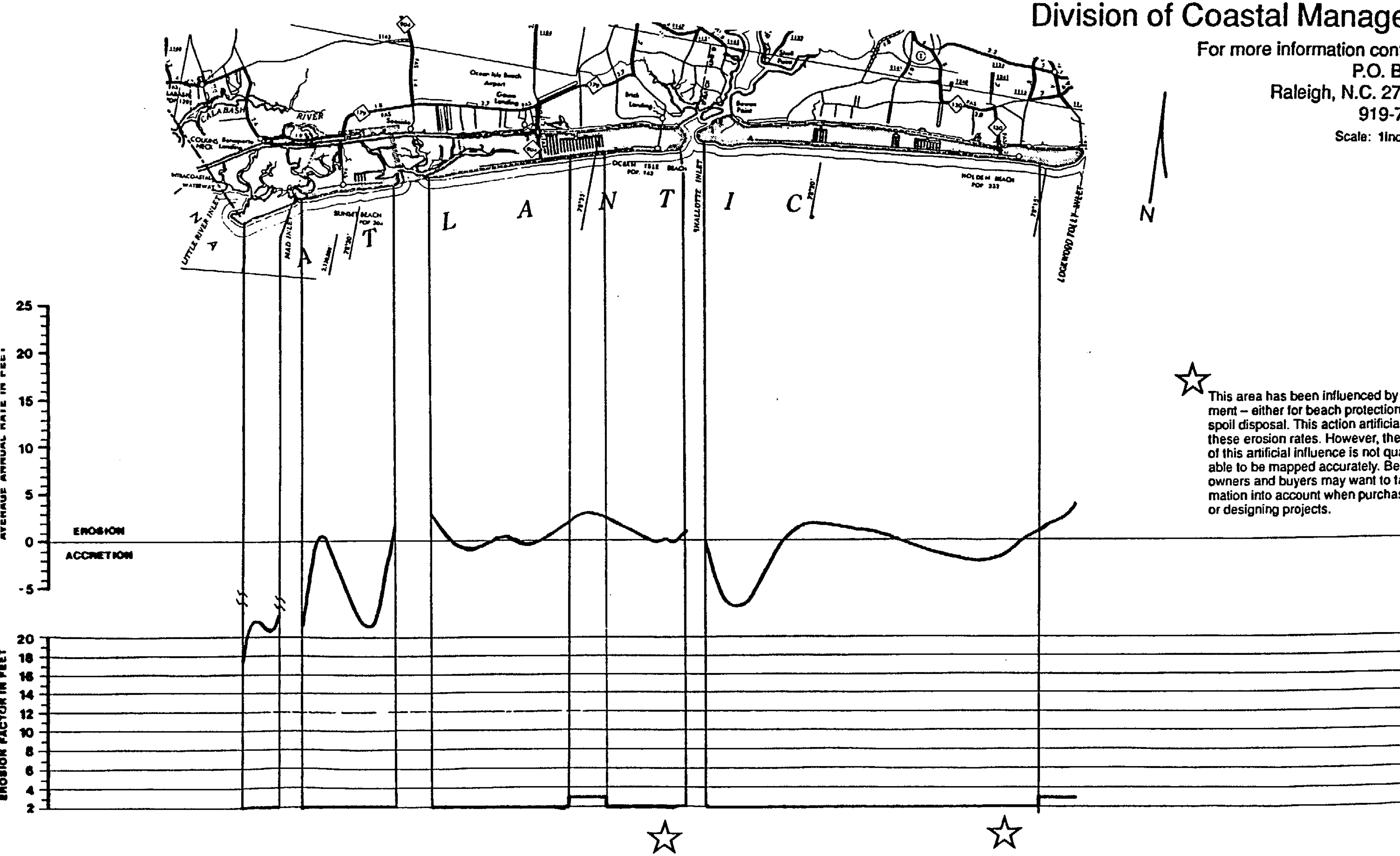
S.C. Line to Lockwood Folly Inlet

Long Term Average Annual Erosion Rates Updated Through 1986

North Carolina
Division of Coastal Management

For more information contact us at:
P.O. Box 27687
Raleigh, N.C. 27611-7687
919-733-2293

Scale: 1inch = 2 miles



☆ This area has been influenced by beach nourishment – either for beach protection or dredge spoil disposal. This action artificially lowers these erosion rates. However, the exact extent of this artificial influence is not quantifiable or able to be mapped accurately. Beachfront owners and buyers may want to take this information into account when purchasing property or designing projects.

TOPSAIL ISLAND

Topsail Island is a 22 mile long NE-SW trending barrier island bounded by New River Inlet to the NE and New Topsail Inlet to the SW. It is a relatively low-elevation island, and would be almost completely inundated in a category 1-2 hurricane storm surge. A category 3 hurricane storm surge would completely cover the island. One of the most distressing aspects of Topsail from a property damage mitigation viewpoint is that most of the new development is taking place near the inlets each of which has a history of instability.

Wood-frame single family houses typify construction on Topsail. In the town centers, larger buildings--hotels, stores, offices--are also mostly wood-frame. The seaside of Topsail has many piers, with associated entertainment arcades and restaurants. The most recent structures on Topsail are, among more single-family homes, large condominiums. These large structures impose themselves on the natural low profile of the island, and place more people and property at risk.

New Topsail Inlet is migrating to the south. Bill Cleary, a Geology Professor at the University of North Carolina at Wilmington has studied extensively the habits of North Carolina inlets. He has found that as the inlet migrates, a bulge of sand forming the northern margin of the inlet occurs on the beach, and moves as the inlet moves. Once the bulge moves on, rapid erosion occurs in areas where there was once a wide beach. As the inlet channel migrates within the inlet, the location of the bulge of sand also changes accordingly.

The artificially maintained inlet channel of New River Inlet determines the position of inlet-associated shoals, which provide protection for North Topsail Shores. As maintained, the inlet channel makes several sharp turns between ocean and sound. Left to its own devices, the channel would create a more direct, less winding link. A storm is likely to realign the inlet through a narrow section of West Onslow Beach. Once the inlet shifts, rapid erosion will occur on the north end of Topsail, no longer in the lee of the inlet shoals.

In between the two inlets, the communities of Topsail Beach, Surf City and parts of the newly incorporated city of North Topsail Shores are at risk from erosion on the beach and in some areas of the soundside. The community response to oceanfront beach erosion on Topsail has been soft stabilization. That is, beach replenishment, bulldozing and sand bagging. These methods should be continued. However, rather than using beach and intertidal sand for replenishment and bulldozing, an off-island source of sand should be located and purchased by the island communities.

Bulkheading has been the response to soundside erosion. Yet, this ultimately decreases the island's width, and in a scenario of rising sea level, could weaken Topsail's defenses. Backbarrier marsh should be re-established wherever possible.

The interior of the island is open and flat, a topography typical of younger barrier islands. The frontal dune protects the interior "grasslands" and maritime forest. Overwash events carry sand to the interior of the island, increasing and maintaining the island's elevation as sea level rises. Topsail's opportunities for maintaining elevation have been altered through development, because the frontal dune must remain fixed. The elevation of Topsail might be artificially maintained through a program of replenishment in the island's interior. Several methods by which replenishment might be accomplished include sand fencing, building and stabilizing through vegetation small dunes, and establishing maritime forests.

Every community on Topsail should prohibit the construction of any new structures seaward of the main road. In addition, the population density on the northern end of Topsail is getting to a critical point. We will see how easily State Route 1568 can be overwashed, cutting off the only evacuation route from the northern end of the island. Moreover, the newly built section of the road, where it has been relocated landward, is in danger from flooding because of its low elevation.

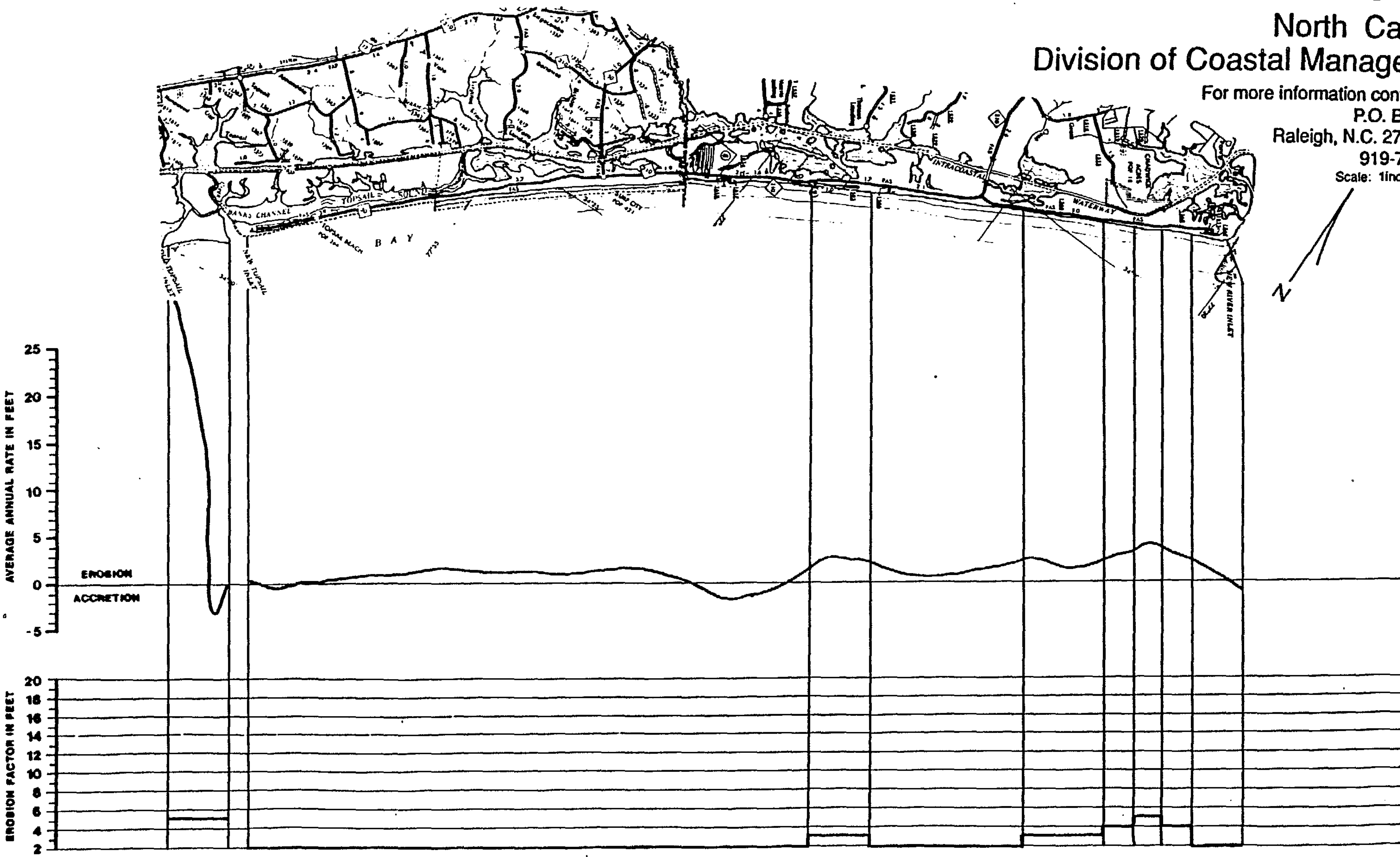
Figures 45 and 46 on page 102 of From Currituck to Calabash contain island description and site analysis for Topsail Island.

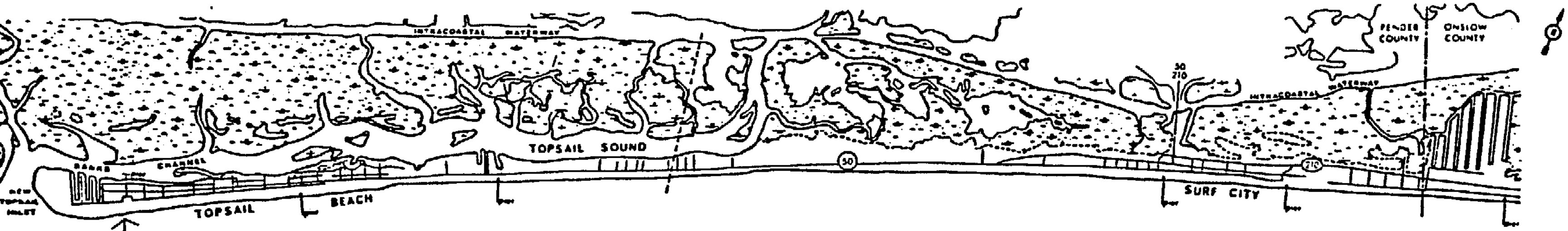
Old Topsail Inlet to New River Inlet

Long Term Average Annual Erosion Rates
Updated Through 1986

North Carolina
Division of Coastal Management
For more information contact us at:
P.O. Box 27687
Raleigh, N.C. 27611-7687
919-733-2293

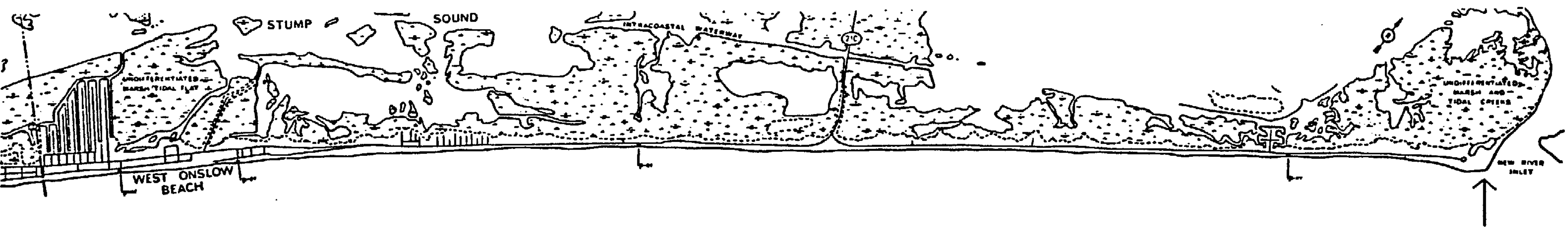
Scale: 1inch = 2 miles





SEA VISTA HOTEL- STOP 1

TOPSAIL ISLAND - SOUTH



NEW RIVER INLET, NORTH TOPSAIL SHORES- STOP 2

TOPSAIL ISLAND - NORTH

INLET DYNAMICS AND TOPSAIL ISLAND

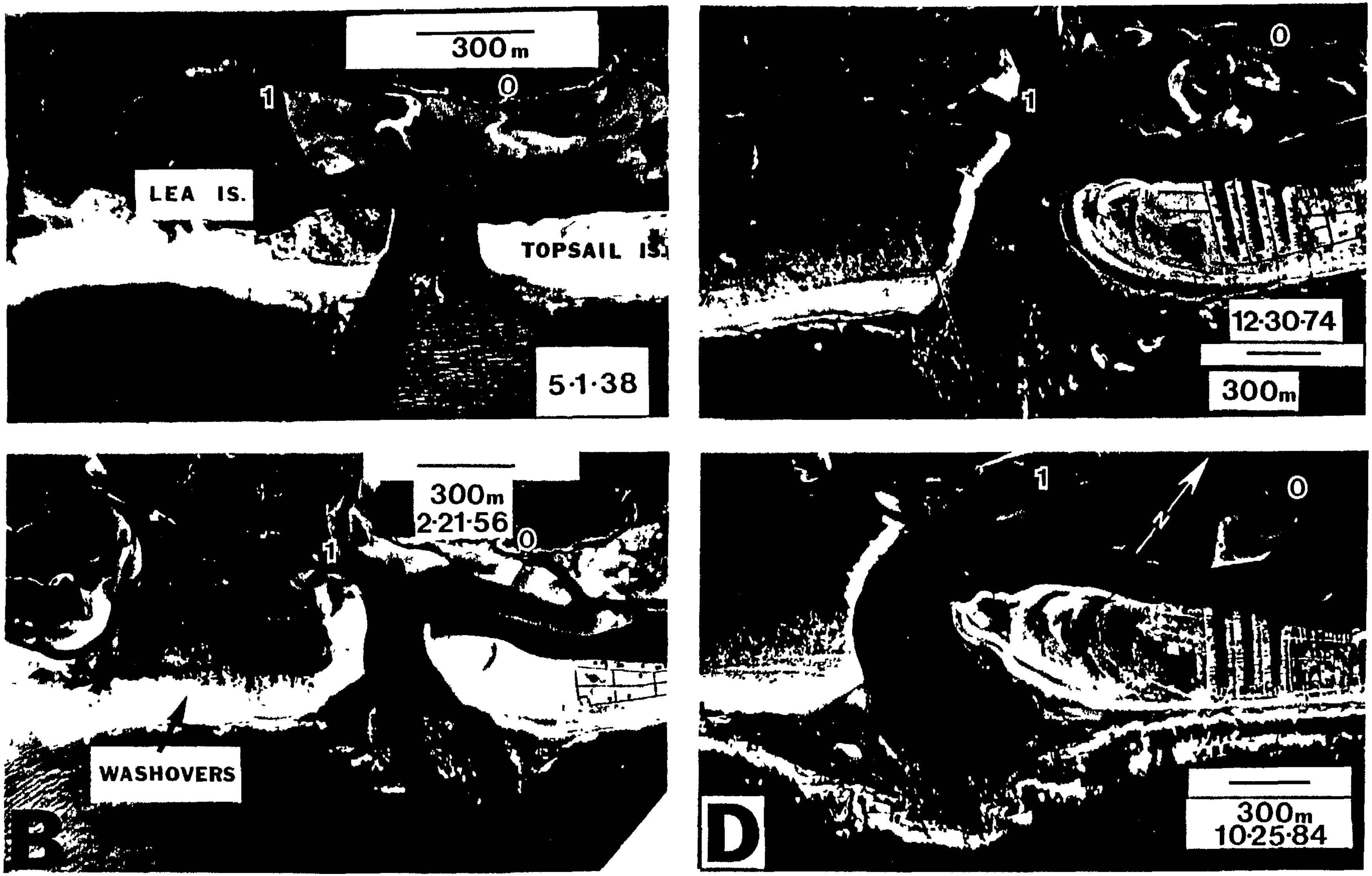
As mentioned in the brief introduction of Topsail Island, Bill Cleary of UNC-Wilmington has extensively studied the dynamics of both New Topsail Inlet and New River Inlet. The following several figures are presented courtesy of Dr. Cleary.

The figure on page 54 (Shape Changes at New Topsail Inlet) is a photo-collage of long-term shape changes of New Topsail Inlet. Points labeled "0" and "1" are fixed so southerly (to the left) migration of the inlet can be visualized. The figure also shows how changing shape and orientation of the inlet channel changes the shape of the ebb tidal delta shoals, and the corresponding change in shoreline erosion. In addition, the channel itself can impact the shoreline inside the inlet and cause significant erosion.

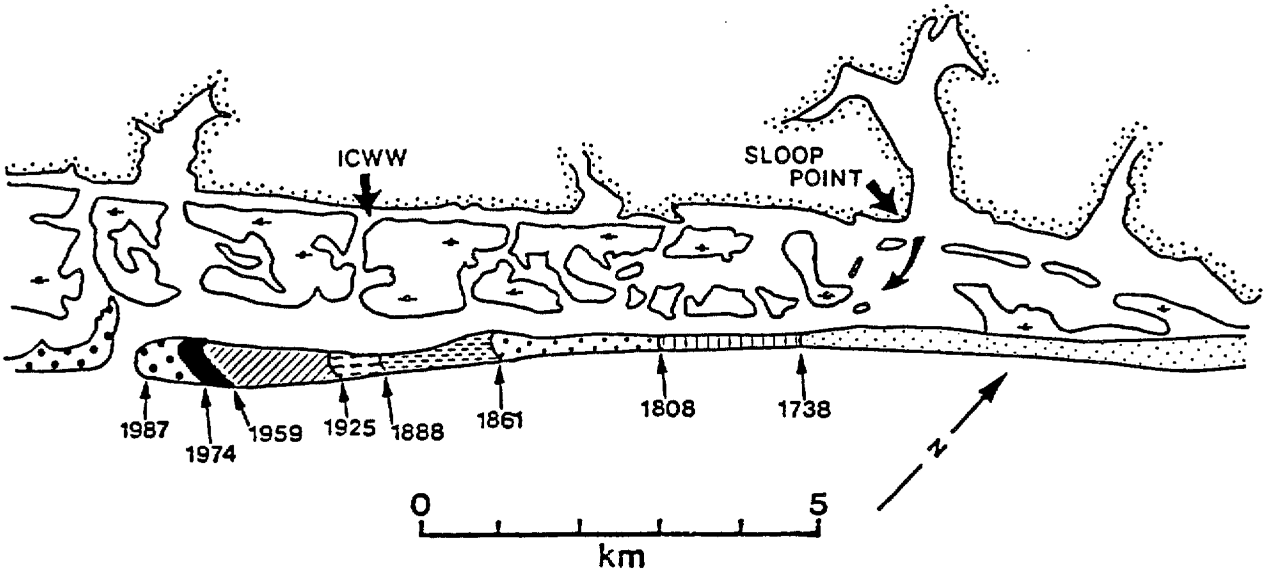
The top figure on page 55 shows the history of the southerly migration of New Topsail Inlet. The dates refer to the year in which the inlet was at a given position. ICWW is the Intracoastal Waterway. The bottom figure on page 55 is a cartoon of a close-up look at New Topsail Inlet showing the shoreline positions for the years 1856 (stippled shoreline), 1972 (diagonal pattern) and 1981 (no shading). Also given are erosion rates for given locations (black dots) along the oceanfront. The main point of the figure is to show that, as the inlet migrates, the "drumstick" shape of the end of the island is translated in space. The "fat" end of the drumstick can be thought of as a bulge in the shoreline that is temporary at any one location. As the inlet migrates, the bulge moves causing erosion at its previous location. The Sea Vista Motel in Topsail Beach is located in just such an area. The table in the center of page 55 lists inlet migration rates for given time periods.

The figure on page 56 shows several photographs of the area around the Sea Vista Motel, all taken prior to beach replenishment. Photo A is from 1975, B is from 1978, C is from 1984, D is from 1985, E is from 1986 and F is from 1987. The arrow in photos A, C and F points to the Intracoastal Waterway.

SHAPE CHANGES

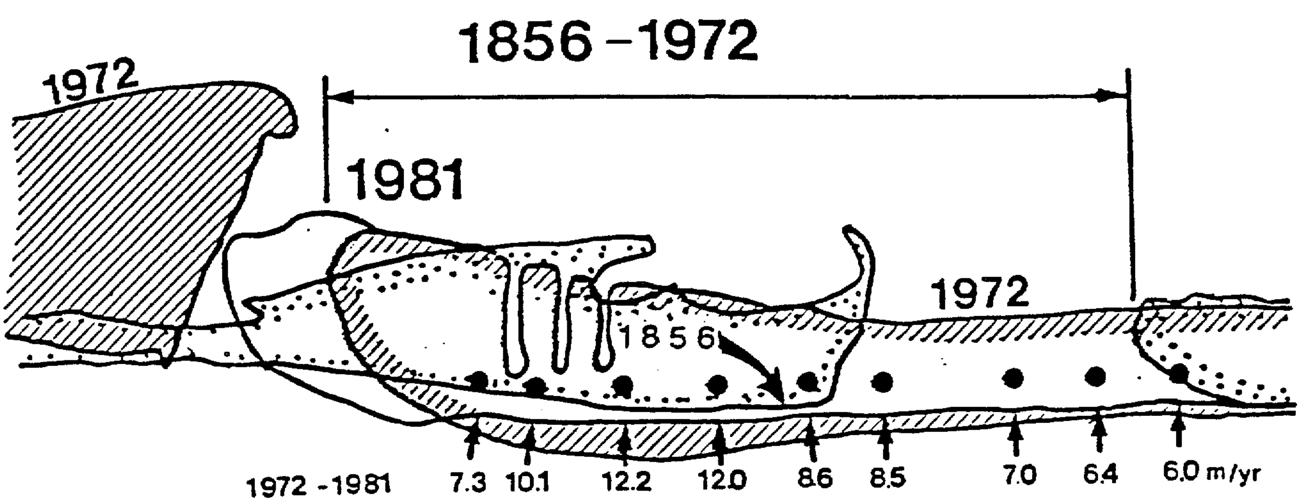


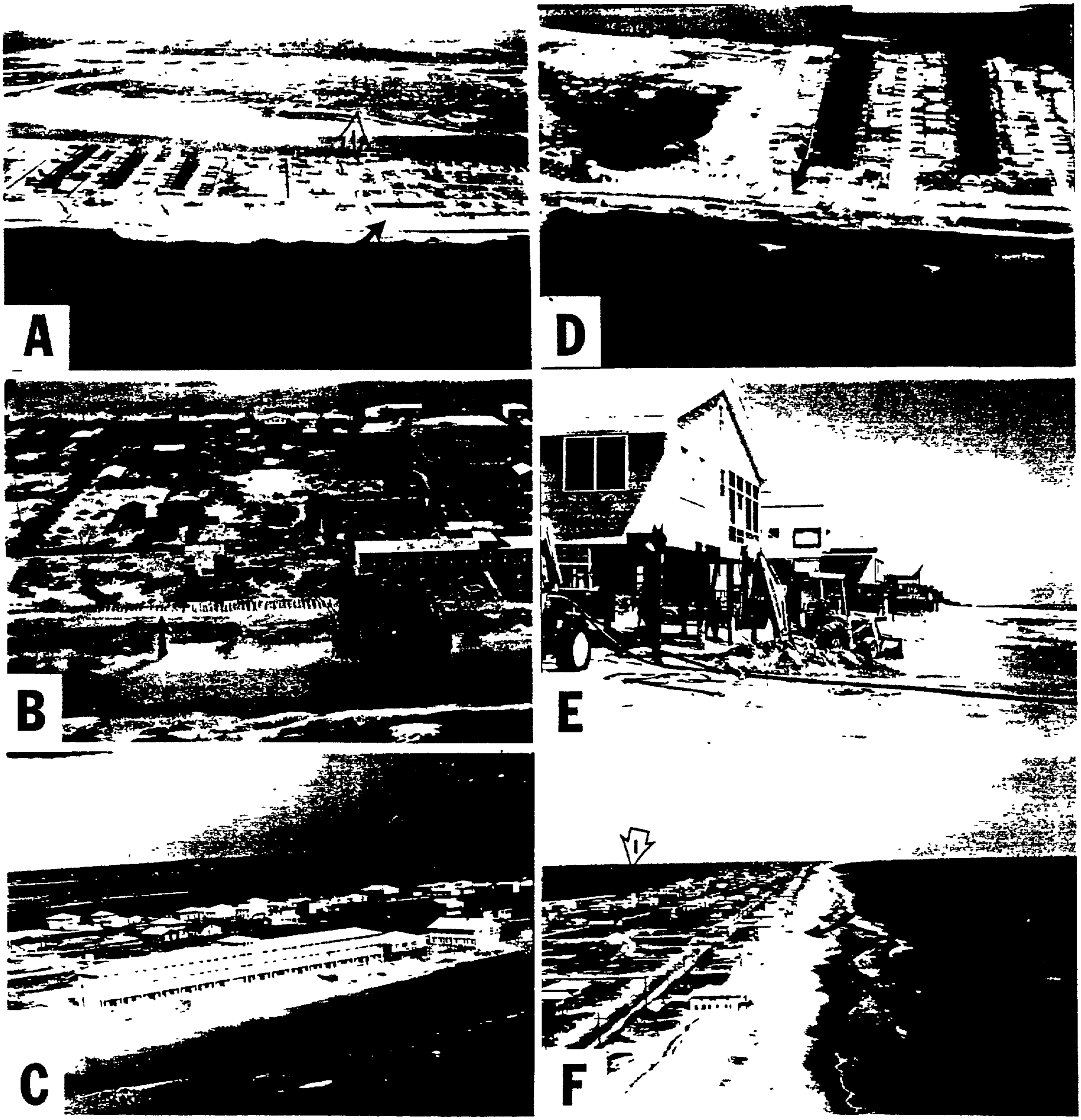
NEW TOPSAIL INLET



Inlet Migration Summary

Years	Distance (m)	Rate (m/yr)
1738 - 1986	9450m	38m/yr
1856 - 1963	2070m	19m/yr
1963 - 1981	680m	34m/yr



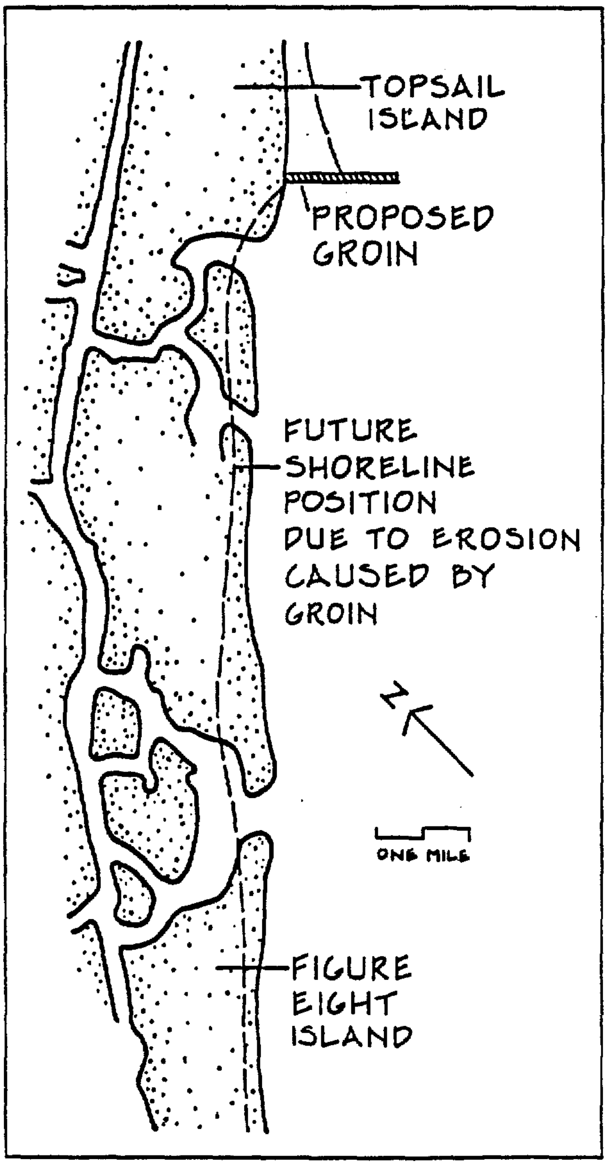

A
D
B
E
C
F

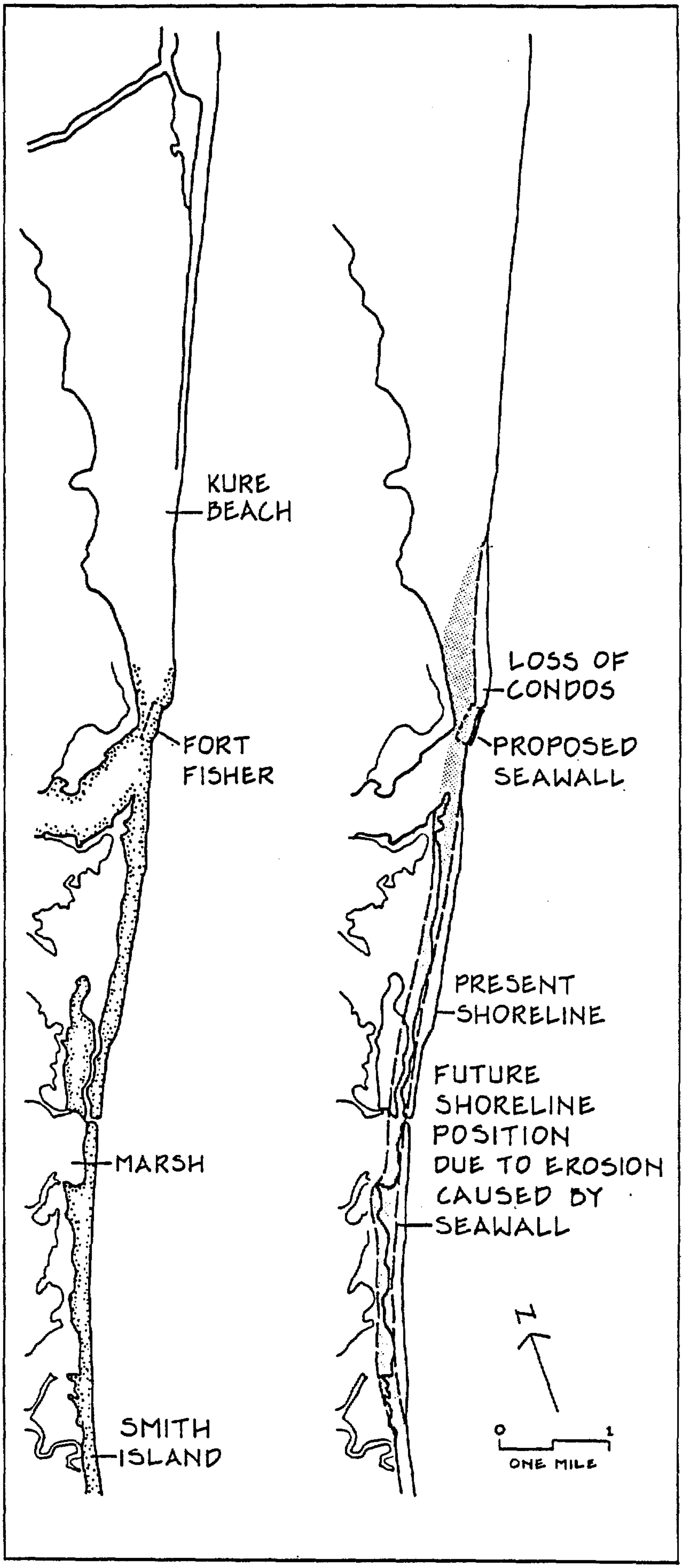
--Related Issue--

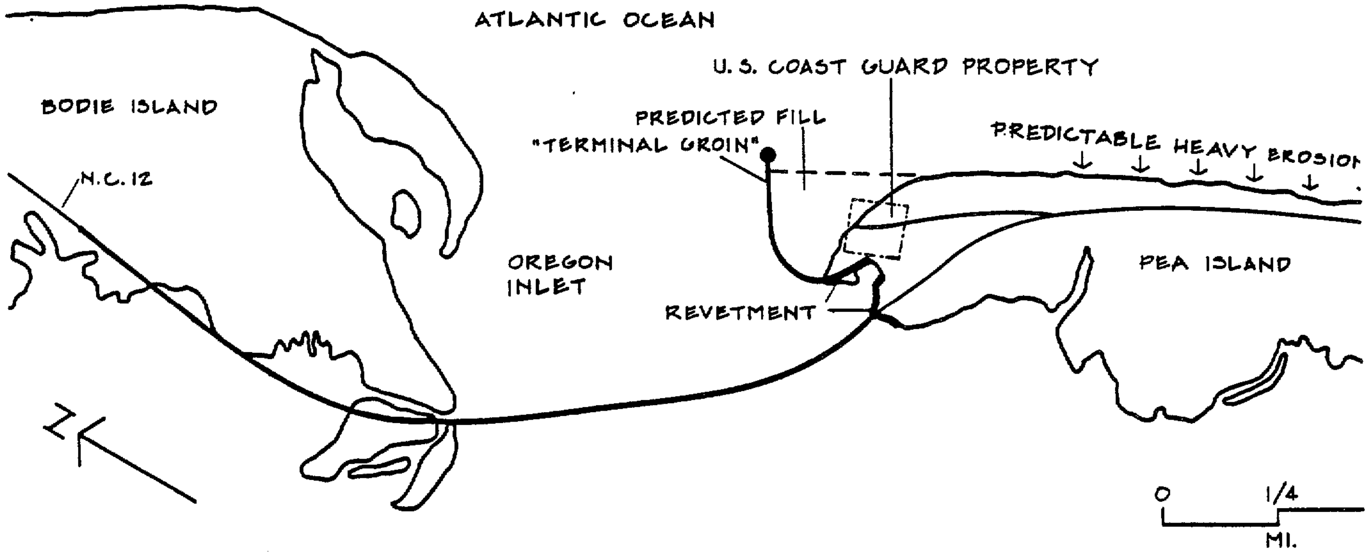
The Folly of Shoreline Engineering

Now that we've gotten a little background in inlet dynamics (and we'll see more at the northern end of Topsail Island) it is a good time to talk about some shoreline engineering projects proposed for the North Carolina coast, two of which are located within inlet zones. Recall that hard stabilization of the shoreline is not permitted in North Carolina, but we are seeing increasing pressure to do so as more and more development is met head-on by the migrating shoreline.

Orrin Pilkey will discuss the terminal groin proposed for the southern end of Topsail Island, the proposed seawall to protect Fort Fisher (figures on page 58), and the Oregon Inlet "terminal groin" project (figure on page 59).

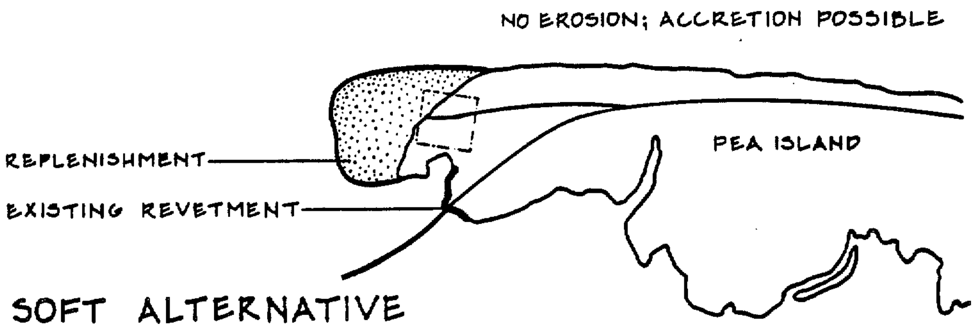

TOPSAIL ISLAND
PROPOSED GROIN
FUTURE SHORELINE POSITION DUE TO EROSION CAUSED BY GROIN
N
ONE MILE
FIGURE EIGHT ISLAND


KURE BEACH
FORT FISHER
MARSH
SMITH ISLAND
LOSS OF CONDOS
PROPOSED SEAWALL
PRESENT SHORELINE
FUTURE SHORELINE POSITION DUE TO EROSION CAUSED BY SEAWALL
N
0
1
ONE MILE



OREGON INLET "TERMINAL GROIN" PROJECT

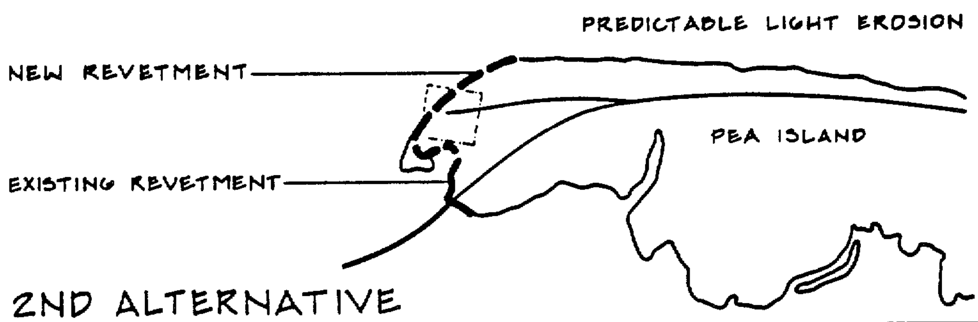
COST: $20,000,0



SOFT ALTERNATIVE

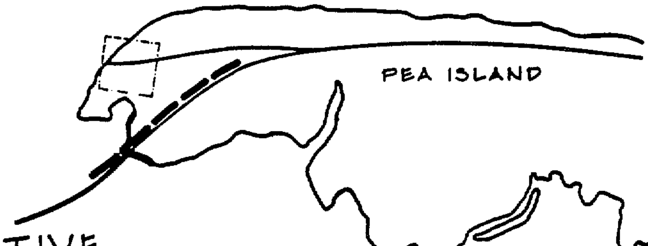
BEACH REPLENISHMENT: USE SAND FROM CHANNEL MAINTENANCE, PRESENTLY BEING DUMPED OFFSHORE.

COST:
POSSIBLY NO ADDITIONAL COST



2ND ALTERNATIVE

COST: $1-2,000,000



3RD ALTERNATIVE

ARMOR ROAD AS INLET MIGRATES

COST:
$1,000,000 PLUS INCREMENT AS INLET MIGRATES

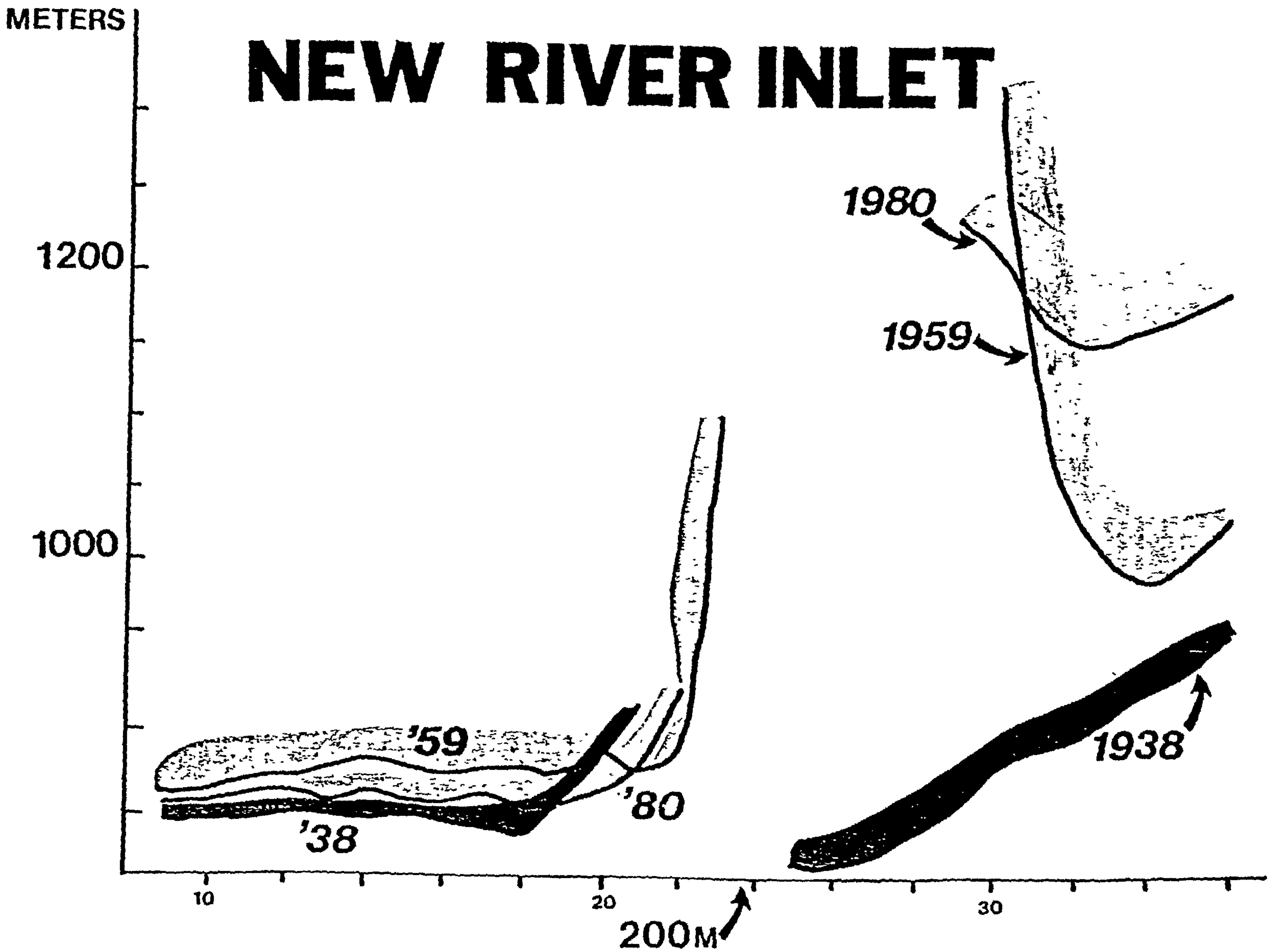
Topsail Island Stop 2: New River Inlet

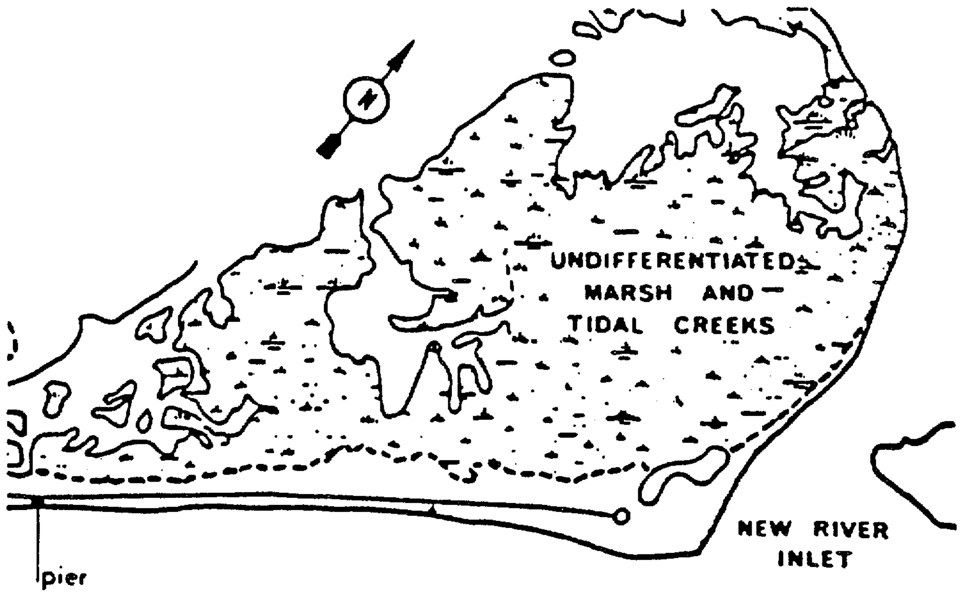
The next two figures, again courtesy of Bill Cleary, are from New River Inlet, at the northern end of the island. The figure on page 61 shows photographs from 1938 and 1986, before and after the Army Corps of Engineers began maintaining the channel by dredging. White triangles on either side of the inlet in each photograph give reference points. It is easy to see the change in the size of the ebb tidal delta (the offshore sand shoals delineated by the breaking waves), the change in the width of the inlet channel, and the relative change in offset of the two island shorelines.

The figure on page 62 shows graphically the position of the shoreline on either side of New River Inlet in 1938, 1959 and 1980. An overall sense of rotation of the inlet is seen.

The ramifications of maintaining the channel by dredging are: (1) the beach on the Marine Corps island to the north (right in the photos) is eroding and steepening making it difficult for beach-landing vehicles and exercises; and (2) The northern end of Topsail Island is out of equilibrium as the inlet wants to migrate to the south, presenting a severe danger from flooding and inlet channel switching during the next major storm.

NEW RIVER I.


METERS
NEW RIVER INLET
1200
1000
1980
1959
'59
'80
'38
1938
10
20
30
200M



PROBLEMS

- Inlet hazard area includes everything within a mile of inlet
- Large structures close to beach- overdevelopment
- Road washouts make evacuation difficult
- Shift in inlet will cause high erosion rates

ASSETS

- Beach presently accreting due to ebb channel position
- Extensive backbarrier marsh

RECOMMENDATIONS

* Do not rebuild following storm
* No new construction seaward of road
* Establish frontal dune

Mitigation Strategies for the New River Inlet area of north Topsail Island

BOGUE BANKS, NC

Bogue Banks is over 25 miles long and over 1 mile wide at its widest. It is oriented essentially east-west. It is an extremely high elevation island, with dunes reaching over 35 feet high in the western end. Even the relatively narrow, low elevation central part of the island is higher elevation than any other island we've seen on this trip. The storm surge from a category 5 hurricane would flood only about one-half of the western end of the island, though all of the eastern half would be covered. We will be making four separate stops on Bogue Banks, the locations of which are shown in the figure on page 66.

An interesting point about Bogue Banks is that there are five separate communities on the island, each with a different philosophy about "Living with the shoreline". In addition, the island can be divided up into three distinct parts geologically. The eastern one-third is low-to-moderate elevation and wide. The central one-third is low elevation and narrow. The western one-third is extremely high elevation and very wide.

Bogue Banks was not touched by Hugo, but is an important island to study because of its high elevation, large amount of sand in the system, and relative "safety" in places compared to other islands we have visited.

We will not see the extreme eastern end of the island, Fort Macon to Money Island Beach (near Atlantic Beach town limits). Much of the eastern end is a state park and is largely undeveloped. Much of this area is a high-hazard zone. Fort Macon State Park will not be developed much beyond its present status, and its dunes, beach and forest will remain in a relatively natural state. The actual fort area has been damaged by past storms. In fact, the earlier stone Fort Hampton, which protected the inlet during the War of 1812, was destroyed by a severe hurricane of the early 1800's. Private property between the park and the Atlantic Beach town limits also suffered in past storms. The large area subject to either overwash, a high rate of shoreline erosion, storm-surge flooding, or active sand dunes, minimizes the number of sites safe for development. Safe Sites are located near the center of the island where shrub stands and maritime woods indicate island stability. Any structures above the 100-year storm-surge level are safe from flooding.

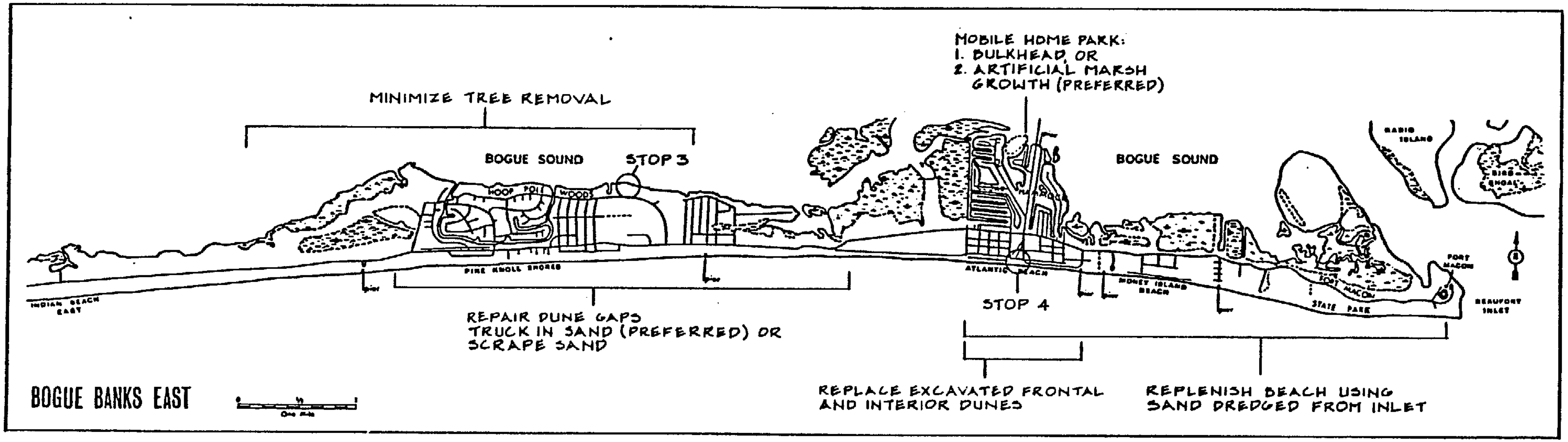
Atlantic Beach will be our last stop and represents the portion of the island most modified by man. The natural contours and environments have been highly altered or obliterated. Marsh fill, finger canals, and septic tanks further detract from the island's natural character.

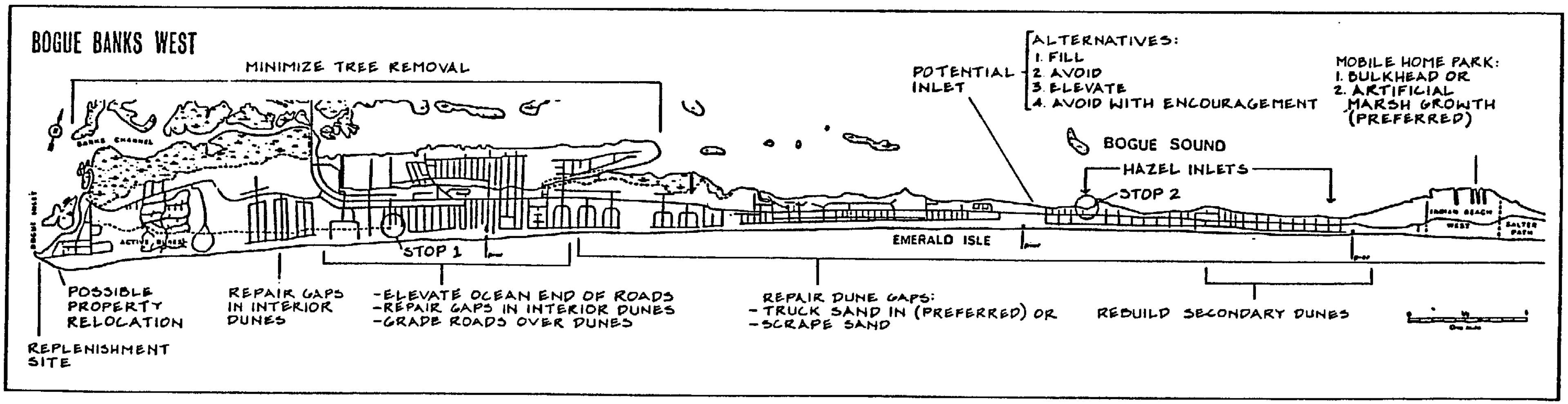
Pine Knoll Shores to Salter Path includes some of the highest, widest and most stable areas of the island. Much of this areas is suitable for development so long as the natural environment, especially the high-forested, middle-to-back areas of the island, is maintained. Although the frontal dune is high and continuous, it is narrow and eroding. Therefore, the beach front is not suitable for development. Buildings on the ocean side of the island should be set back from the frontal dune and trough-like depressions behind parts of the dune line.

The narrow portion of the island, essentially the eastern part of the town of Emeraldsle, is generally a poor area for development. Most of this part of the island is low, narrow and lacks protective dunes, vegetation and backmarsh. Consequently, this zone is highly vulnerable to inlet formation. Locally, black-shell sediment is indicative of sediment that was dredged from the lagoon to fill inlets that were cut during hurricane Hazel. Nearby, dune removal for development has probably increased the likelihood of inlet formation and complete overwash in some parts of this zone. The combined threats of storm flooding, inlet formation, and overwash burial of roads make this a prime danger area for evacuation in case of a hurricane warning.

Near the western end of the island, as mentioned, are the highest sand dunes we will see on this trip, testimony to the large volumes of sand moving ashore in this area.

Figures 43-44 on page 101 in From Currituck to Calabash describe the island and safety analysis for Bogue Banks.


MOBILE HOME PARK:
1. BULKHEAD OR
2. ARTIFICIAL MARSH GROWTH (PREFERRED)
MINIMIZE TREE REMOVAL
BOGUE SOUND
STOP 3
HOOP POLE WOODS
BOGUE SOUND
PINE KNOLL SHORES
ATLANTIC BEACH
STOP 4
INDIAN BEACH EAST
FORT MACON
STATE PARK
BEAUFORT INLET
REPAIR DUNE GAPS
TRUCK IN SAND (PREFERRED) OR
SCRAPE SAND
BOGUE BANKS EAST
REPLACE EXCAVATED FRONTAL AND INTERIOR DUNES
REPLENISH BEACH USING SAND DREDGED FROM INLET

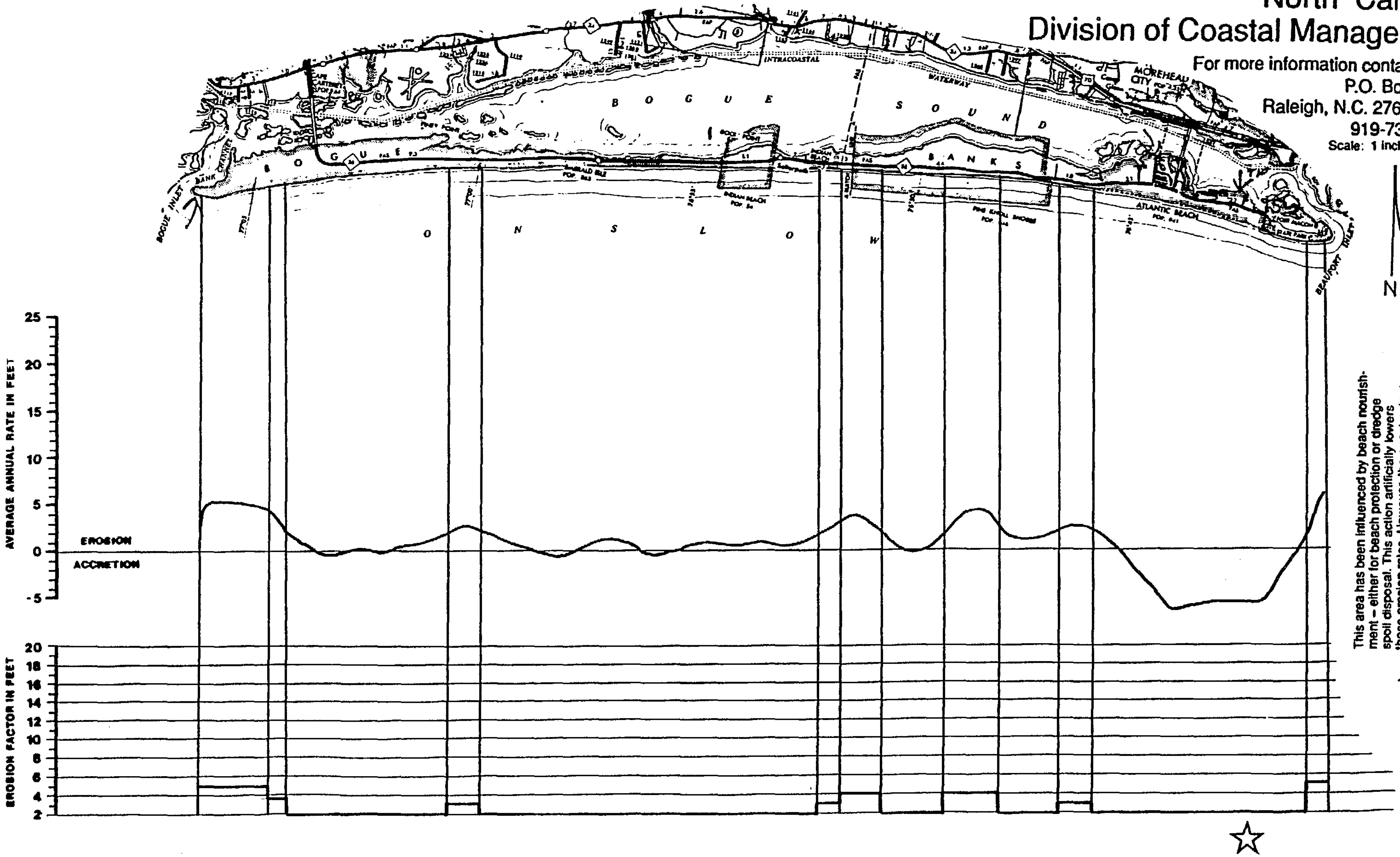

BOGUE BANKS WEST
MINIMIZE TREE REMOVAL
ALTERNATIVES:
1. FILL
2. AVOID
3. ELEVATE
4. AVOID WITH ENCOURAGEMENT
POTENTIAL INLET
MOBILE HOME PARK:
1. BULKHEAD OR
2. ARTIFICIAL MARSH GROWTH (PREFERRED)
BOGUE SOUND
HAZEL INLETS
STOP 2
BANKS CHANNEL
ACTIVE DUNES
STOP 1
EMERALD ISLE
SALTER PATH
POSSIBLE PROPERTY RELOCATION
REPLENISHMENT SITE
REPAIR GAPS IN INTERIOR DUNES
-ELEVATE OCEAN END OF ROADS
-REPAIR GAPS IN INTERIOR DUNES
-GRADE ROADS OVER DUNES
REPAIR DUNE GAPS:
-TRUCK SAND IN (PREFERRED) OR
-SCRAPE SAND
REBUILD SECONDARY DUNES

Long Term Average Annual Erosion Rates
Updated Through 1986

North Carolina
Division of Coastal Management

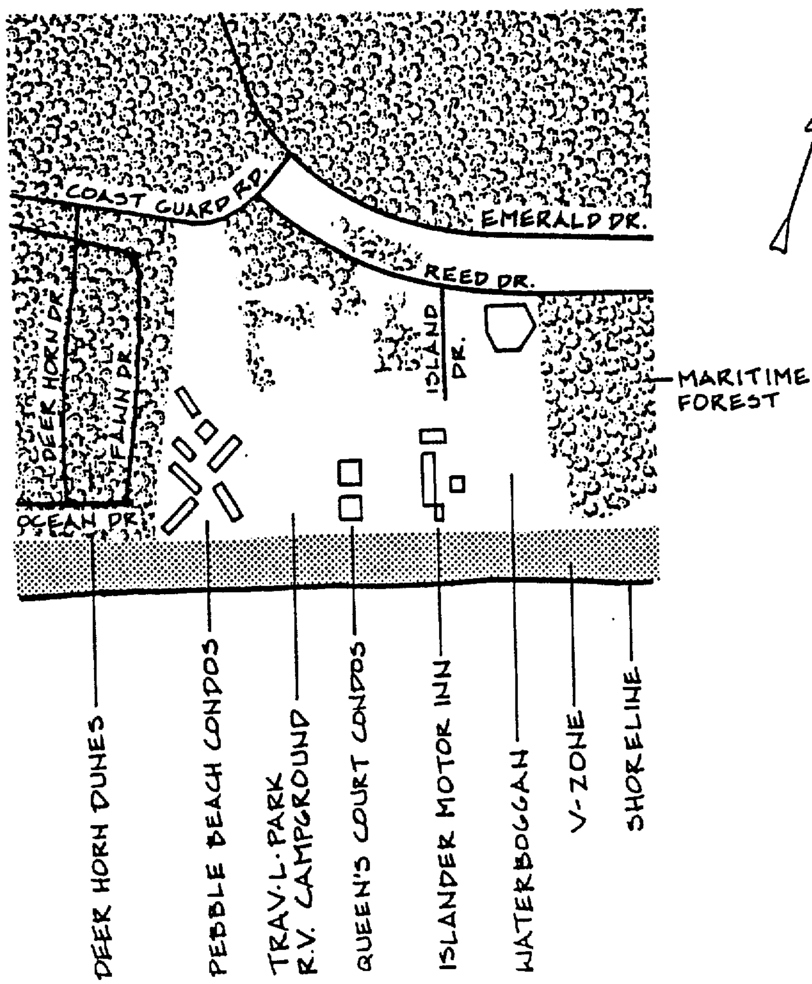
For more information contact us at:
P.O. Box 27687
Raleigh, N.C. 27611-7687
919-733-2293

Scale: 1 inch = 2 miles



This area has been influenced by beach nourishment – either for beach protection or dredge spoil disposal. This action artificially lowers these erosion rates. However, the exact extent of this artificial influence is not quantifiable or able to be mapped accurately. Beachfront owners and buyers may want to take this information into account when purchasing property or designing projects.

Islander Motor Inn, Bogue Banks: Dune and forest removal for commercial development.



At this location, maritime forest and sand dunes were removed for siting of large commercial structures. These buildings sit on top of what amounts to a sandy bluff, 12 feet or so high, eroding at a long-term average rate of 2 feet per year. In addition, roads run perpendicular to the shore and the dunes are notched which allow for increased overwash penetration and storm-surge ebb flow.

Recommendations for this area are to add new sand on top of the bluff to increase the elevation and to replace sand dunes that were removed. Interior dunes should be replaced as well. The maritime forest should be re-established, although that is a longer-term project. Ocean ends of roads should be curved and elevated where possible.

Bogue Banks Stop 1: Massive Dune Removal for Residential Development, Ocean View Drive and Shell Drive, Emerald Isle.

There is no site-specific map for this location, but it is similar in many respects to the Islander Motor Inn stop, though here the dunes are much higher and excavation was done for siting of residential development. The simplified mitigation map on page 66 shows the location of this stop.

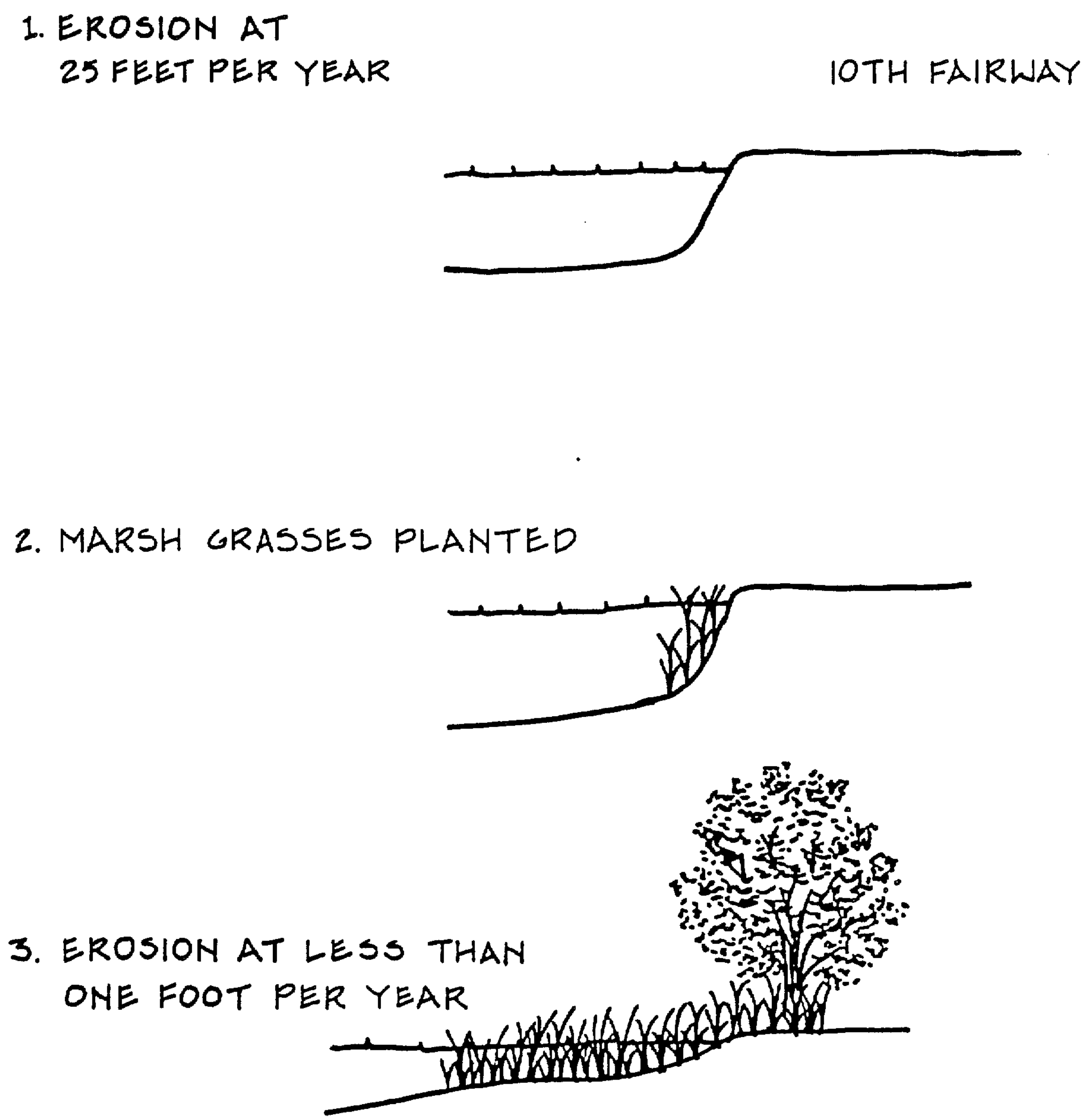
The original dunes here were very high and have been largely removed. The highest dunes, just to the west of the end of Ocean View Drive, are over 35 feet high. Here one can see the sharp bulldozed edge of the natural dune field and can get an idea of the magnitude of sand removal. In terms of storm damage mitigation, dune removal is a very serious flood and storm surge wave hazard. Fortunately, property construction here was set back far enough so that sand fencing has been effective in trapping sand and rebuilding dunes to afford some protection for property owners from the threat of hazardous overwash. The new dunes are nowhere need the volume of the original dunes, however. Continued sand fencing and even addition of sand from an off-island source are good options here. Sand fencing is most effective when property is set back far enough so that there is enough space for dunes to build and stabilize. It helps that Bogue Banks is a very high sand-supply island, meaning that geologic conditions are right for a lot of sand to be moving onshore. This is evidenced by the enormous sand volume of the island in contrast to some of the other islands we have visited.

Bogue Banks Stop 2: Hurricane Hazel Inlets

The simplified mitigation map on page 66 shows, near the right hand side of the lower figure, the location of two inlets opened during Hurricane Hazel in 1954. We will be stopping near the western of the two inlets. The inlet was filled in by dredging of sand from the lagoon. As we walk along this area, look for characteristic black-stained shells mixed in with the regular sand. Black staining is common in the lagoonal environment and is testimony that sediment was dredged from the lagoon to fill the inlet and raise the island's elevation. The island is very narrow in this area and extremely low in places. A small flood tidal delta was formed in the sound. Its size was probably limited by the length of time the inlet was open. Across the street an extremely low depression remains, in the vicinity of which a new house has recently been built.

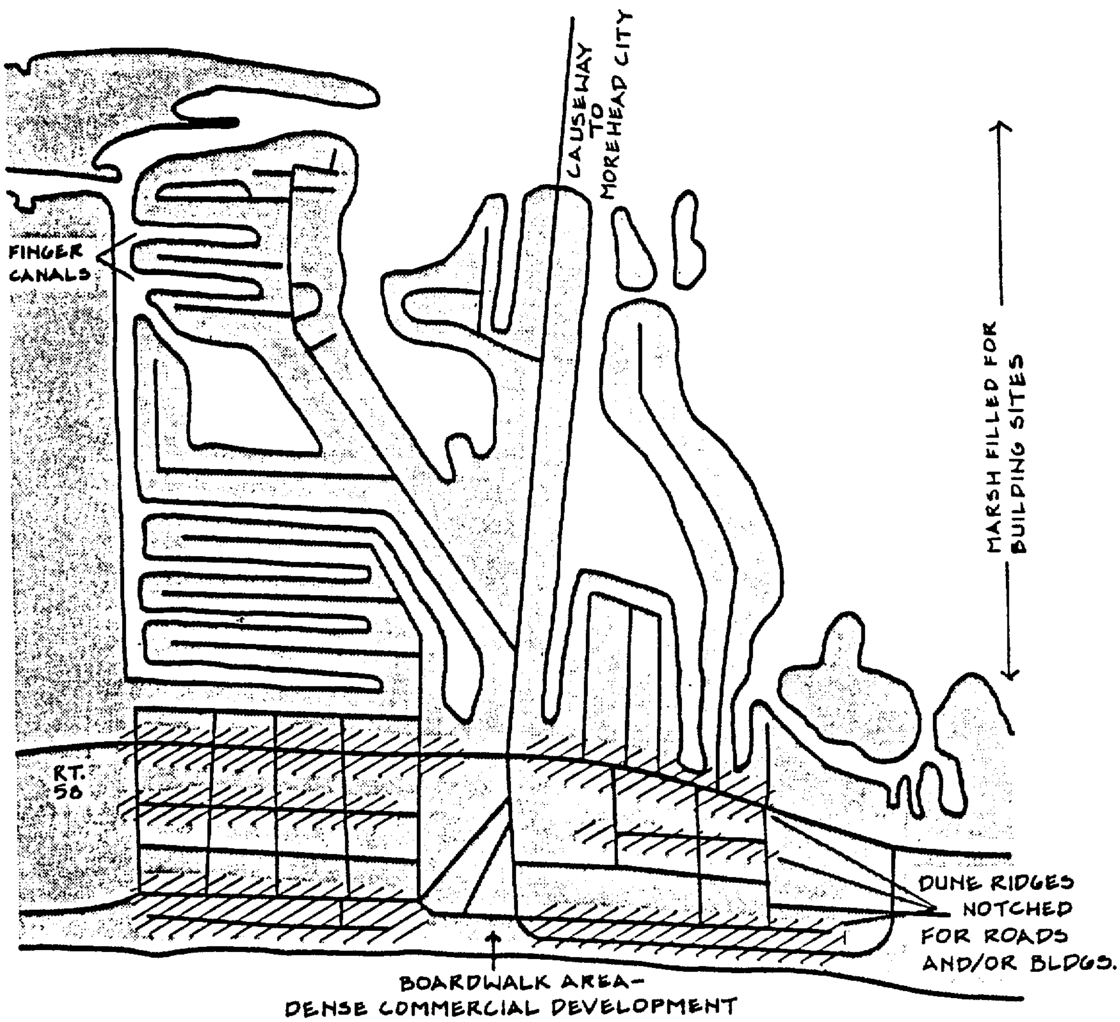
In terms of storm damage mitigation, this area of the island should be treated as if it were a present day inlet. It should be designated as an inlet hazard area. There are several options for any site on a barrier island where inlet formation has occurred historically or can be predicted. These include: (1) add elevation with off-island sand to make it a less likely location for a new inlet; (2) stabilize the area as if it were an inlet giving a degree of predictability of location of a new inlet; (3) prevent property development in the area.

Bogue Banks Stop 3: Controlling Soundside Erosion, Pine Knoll Shores Country Club.



A salt marsh was successfully cultivated here to stabilize a shoreline which was eroding at a rate of more than 20 feet per year. The salt marsh acts as buffer to wave action and is a simple way to build up the soundside shore and reduce the effects of a major storm.

Bogue Banks Stop 4: Giant Notches in Dunes at the Atlantic Beach Boardwalk.



Atlantic beach is very densely developed. Several dune ridges were excavated for siting of all the commercial establishments and even for Morehead Avenue, the main road leading to the causeway and the mainland. This area will allow penetration of overwash waters, putting a great deal of property at risk that otherwise would have been safe behind several rows of high dunes.

Recommendations for this area are to build interior dunes behind the buildings and to build Morehead Avenue up over a rebuilt dune.

APPENDICES

HURRICANE HUGO
GENERAL SYNOPSIS

Hurricane Hugo was the strongest storm to make landfall in the mainland U.S. in 20 years (since hurricane Camille).

Date: September 9 - 24, 1989.
Hugo made landfall in South Carolina on Sept. 22, 1989 at midnight.

Path: Leeward Islands; Virgin Islands; Puerto Rico; South Carolina; North Carolina; western Virginia; West Virginia; eastern Ohio; Erie; Pennsylvania.

Damage: 49 people died (21 on U.S. mainland)
$10 billion ($7 billion on U.S. mainland).

Maximum Intensity: (east of Leeward Islands) 27.5 inches of mercury, 160 mph surface winds. Category 5.

Intensity at U.S. Landfall: (Sullivan's Island) 28.02 inches of mercury, 140 mph surface winds. Category 4. Eye moving NW at 25 mph.

Normal barometric pressure at sea level is 30 inches of mercury.

Storm Surge:

south end Bull's Bay, SC	+19 feet
McClellanville, SC	+14 feet
Myrtle Beach, SC	12.5 feet
Sullivan's Island, SC	+13 feet
Pawleys Island	12 feet
Folly Beach, SC	+ 11 feet
Winyah Bay, SC	7 feet

Rainfall: Hugo's relatively rapid forward movement reduced the potential for much rainfall; therefore, there was no severe flooding associated with the storm.

Edisto Island, SC	10.28 inches
Mt. Pleasant, SC	8.10 inches
Boone, NC	6.91 inches
Savannah, GA	6.10 inches
Myrtle Beach, SC	2.30 inches
western VA to W.VA.	2 to 4 inches
Jacksonville, FL	"a trace"

Saffir/Simpson Scale of Hurricane Intensity

STORM CATEGORY	STORM SURGE (FEET)	MEAN WIND SPEED (mph)
1	4 - 5	74 - 95
2	6 - 8	96 - 110
3	9 - 12	111 - 130
4	13 - 18	131 - 155
5	18 -	156 -

Prepared March 1990.
References available upon request.

HURRICANE HUGO
STRUCTURAL DAMAGE

151 buildings were "destroyed beyond repair" in South Carolina (as defined by the 1988 amendments to the South Carolina Coastal Zone Management Act of 1977).

Charleston

65 buildings collapsed
672 buildings had structural damage
80% of all buildings had roof damage

Folly Beach

8% of all buildings destroyed
over 65% of front row buildings destroyed
30 buildings were "destroyed beyond repair"

Pawleys Island

34 buildings were "destroyed beyond repair"

McClellanville

34 of 40 fishing boats destroyed

Myrtle Beach

50% of buildings damaged
14 motels declared unsafe
$10 million damage estimate from erosion and other damages

Garden City: 65 buildings were "destroyed beyond repair"
Surfside: 11 buildings were "destroyed beyond repair"

The total number of claims made to the National Flood Insurance Program through February of 1990 as a result of Hugo was 16,598 for a cost of nearly $300 million (including claims from the Virgin Islands, Puerto Rico, North Carolina, and South Carolina).

North Carolina: (through 2/90) 1,087 claims, $5,911,000.

South Carolina: (through 2/90) 14,621 claims, $283,358,000.

Prepared March 1990.
References available upon request.

SOUTH CAROLINA COASTAL ZONE MANAGEMENT

South Carolina Coastal Zone Management Act passed in 1977. The 1988 amendments (effective July 1, 1988) made several changes:

-- **expands the State's area of authority on the coast;**

-- **prohibits construction of new seawalls and other hard stabilization structures;**

-- **requires deed disclosure;**

-- **requires shorefront management plans.**

The **South Carolina Coastal Council** (SCCC) administers the Act and its amendments.

The State's area of authority is defined by **setbacks**. Setbacks vary with the erosion rate, and are calculated as 40 times the erosion rate, in keeping with the State's 40 year retreat policy. Within the setback area, land can be developed by permit from the SCCC. Setbacks are measured landward from a baseline, which is defined as the "crest of the ideal dune."

Determination of the **baseline** is a five step process which begins by determining an idealized natural beach profile using actual natural beach profiles from the shoreline in question. A volume of sand is calculated for the area between the +10 ft. and -5 ft. contours of the idealized profile. This "magic triangle" is overlain on actual profiles of the area to place the ideal dune. The end result is a volumetric rather than a linear determination of baseline.

Within each setback area is the **no construction zone**, a standard 20 feet measured landward from the baseline. The only permittable activities in a no construction zone are: dune building; dune walkovers; and maintenance of existing structures.

Seawalls are also part of the 40 year retreat policy. After 40 years, no repairs will be allowed to seawalls.

The new law also requires full deed disclosure with the sale of coastal property, so that any purchaser is knowledgeable of erosion rates, setbacks, etcetera.

Each coastal community will have a shorefront management plan by July 1, 1991. The management plan will include the community's plan in case of hurricane, plan for pre-disposal storage of hurricane debris, assessment of location and position of sand dunes. The State will provide plans for those communities that opt not to draw up their own.

Prepared March 1990.
References available upon request.

Folly Beach (SCCC monitoring stations 2801-2895). (*Positive distances are measured seaward from SCCC monuments.)

Erosion Zone	Monument	Distance* (ft) Baseline	No Construction	40-year Setback	Erosion Rate (ft/yr)
Unstabilized Inlet	2801	121	101	61	-1.5
	2803	81	61	21	-1.5
	2805	70	50	10	-1.5
	2810	234	214	174	-1.5
Standard Zone	2813	167	147	107	-1.5
	2815	145	125	85	-1.5
	2818	160	140	100	-1.5
	2820	131	111	71	-1.5
	2823	171	151	111	-1.5
	2825	-3	-23	-79	-1.9
	2828	132	112	40	-2.3
	2830	116	96	-0-	-2.9
	2833	6	-14	-126	-3.3
	2835	126	106	-14	-3.5
	2838	84	64	-60	-3.6
	2840	127	107	-21	-3.7
	2843	112	92	-48	-4.0
	2850	158	138	-50	-5.2
	2855	111	91	-129	-6.0
	2860	55	35	-185	-6.0
	2865	-10	-30	-250	-6.0
	2868	-10	-30	-250	-6.0
	2870	104	84	-136	-6.0
	2873	149	129	-91	-6.0
	2875	153	133	-87	-6.0
Unstabilized Inlet Zone	2878	205	195	-35	-6.0
	2880	220	200	-20	-6.0
	2883	234	214	-6	-6.0
	2885	126	106	-114	-6.0
	2890	-56	-76	-296	-6.0
	2895	3	-17	-236	-6.0

DLH:0565DSB

TABLE 21. Pawleys Island. [*Not actual +10 ft contour]

Station	Zone	Distance to +10 ft Contour	Actual +10 to -5 Volume	Smoothed +10 to -5 Volume	Ideal Volume	Volume Surplus (+) or Deficit (-)	Deficit Offset	Distance from IPP +10 to IPP Dune Crest	IPP-Derived Baseline	Actual Dune Crest	BL	NCL	Annual Erosion Rate (ft/yr)	SBL
4200	S	0*	56.6	56.6	70.3	-13.7	-28.5	-26	-55	0	-55	-75	-1.3	-107
4205	S	0*	52.9	54.0	70.3	-16.3	-35.0	-26	-61	0	-61	-81	-1.3	-113
4215	S	12.6	60.8	61.8	70.3	-8.5	-17.0	-26	-30	0	-30	-50	-1.3	-82
4230	S	26.7	77.0	74.1	70.3	+3.8	0	-26	1	0	1	-20	-1.3	-52
4245	S	60.3	68.7	70.1	70.3	-0.2	-0.4	-26	34	35	34	14	-1.3	-18
4260	S	50.4	69.0	68.4	70.3	-1.9	-3.7	-26	21	24	21	1	-1.3	-31
4270	S	38.0	65.9	68.1	70.3	-2.2	-4.2	-26	8	21	8	-12	-1.3	-44
4280	S	35.6	86.9	86.1	70.3	+15.8	0	-26	10	22	10	-10	-1.3	-42
4290	S	51.4	100.5	102.3	70.3	+32.0	0	-26	25	8	25	-12	-1.3	-44
4295	S	11.6	160.6	157.7	70.3	+87.4	0	-26	-14	6	-14	-34	-1.3	-66

TABLE 31. Myrtle Beach. [*Not actual +10 ft contour]

Station	Zone	Distance to +10 ft Contour	Actual +10 to -5 Volume	Smoothed +10 to -5 Volume	Ideal Volume	Volume Surplus (+) or Deficit (-)	Deficit Offset	Distance from IPP +10 to IPP Dune Crest	IPP-Derived Baseline	Actual Dune Crest	BL	NCL	Annual Erosion Rate (ft/yr)	SBL
5300	S	375.9	83.4	83.4	73.0	+10.4	0	-12	364	368	364	344	-0.68	337
5310	S	330.2	73.4	73.8	73.0	+0.4	0	-12	298	318	318	298	-0.68	291
5320	S	320.6	64.7	65.9	73.0	-7.1	-14.3	-12	294	295	294	274	-0.68	267
5330	S	340.0*	70.3	69.8	73.0	-3.2	-5.9	-12	322	340	322	302	-0.68	295
5340	S	457.3	70.7	70.2	73.0	-2.8	-5.2	-12	440	456	440	420	-0.68	413
5350	S	159.1	61.6	66.5	73.0	-6.5	-12.9	-12	134	157	134	114	-0.68	107
5400	S	279.0*	82.2	79.4	73.0	6.4	0	-12	267	279	267	247	-0.68	240
5405	S	237.2	78.5	79.4	73.0	6.4	0	-12	225	217	217	197	-0.68	190
5410	S	192.7	82.5	81.5	73.0	8.5	0	-12	181	179	179	159	-0.68	152
5415	S	164.4	77.5	79.7	73.0	6.7	0	-12	152	121	121	101	-0.68	94
5420	S	24.2	91.2	87.3	73.0	14.3	0	-12	12	0	0	-20	-0.68	-27
5425	S	29.8	72.6	73.8	73.0	0.8	0	-12	18	0	0	-20	-0.68	-27
5430	S	13.6	65.2	66.7	73.0	-63.0	-12.4	-12	-11	0	-11	-31	-0.68	-38
5435	S	32.9	80.8	77.7	73.0	4.7	0	-12	21	11	11	-9	-0.68	-16
5440	S	6.5	70.0	72.8	73.0	-0.2	-0.4	-12	-6	0	-6	-26	-0.68	-33
5445	S	12.9	82.8	84.9	73.0	11.9	0	-12	1	0	0	-20	-0.68	-27
5450	S	11.8	109.4	104.6	73.0	31.6	0	-12	0	0	0	-20	-0.68	-27
5455	S	54.9	82.7	83.7	73.0	10.7	0	-12	43	46	43	23	-0.68	16
5460	S	8.0	70.5	73.3	73.0	0.3	0	-12	-4	0	-4	-24	-0.68	-31
5465	S	39.8	89.5	88.3	73.0	15.3	0	-12	28	15	15	-5	-0.68	-12
5470	S	15.3	88.9	87.7	73.0	14.7	0	-12	3	0	0	-20	-0.68	-27
5475	S	55.8	77.5	78.9	73.0	5.9	0	-12	44	40	40	20	-0.68	13
5480	S	9.1	73.9	80.0	73.0	7.0	0	-12	-3	0	-3	-23	-0.68	-30

SOUTH CAROLINA COASTAL ZONE MANAGEMENT

CONTINUED

On undeveloped coastal lots, permits required within the setback include:

-- building placed as far landward on the lot as possible;
-- no part of the building is within the no construction zone:
-- building is within 5,000 sq.ft. limit, including porches, decks, and garages;
-- no hard stabilization structures may be built.

For existing structures seaward of the setback:

-- buildings damaged beyond 66% are "destroyed beyond repair;"
-- rebuilding must place building as far landward on lot as possible;
-- building size may not be increased;
-- no part of the building will be within the no construction zone;
-- "recreational amenities" may not be rebuilt:
-- seawalls damaged beyond 50% are "destroyed beyond repair;"
-- replacement seawalls must be as far landward as possible, and the toe/bottom of the wall may be no further seaward than the crest of the top of the preceding wall (unless a building makes this impossible);
-- anyone rebuilding a seawall must annually renourish the fronting beach with a volume of sand equal to 1.5 times the volume of sand lost there annually (unless the beach is part of an on-going beach replenishment program).

South Carolina Coastal Council
Suite 300
4280 Executive Place North
Charleston, SC 29405
(803) 744-5838

Prepared March 1990.
References available upon request.

NORTH CAROLINA COASTAL AREA MANAGEMENT ACT (CAMA)
TITLE 15, SUBCHAPTER 7H, SECTION .0306 OF THE NC ADMINISTRATIVE CODE

Passed: 1974

Objectives:
- -- avoid loss of life and property due to storms and long-term erosion;
- -- prevent encroachment of permanent structures onto the public beach;
- -- reduce costs that poorly designed structures impose.

CAMA designates **Areas of Environmental Concern** (AEC). Anyone wishing to build within an AEC must apply for a special permit. AEC's cover about 3% of coastal land and all coastal waters in North Carolina. The four categories of AEC are: the estuarine system, ocean hazard system, public water supplies, and natural and cultural resource areas.

The **ocean hazard system** is divided into three areas: ocean erodible areas; high hazard flood areas; and inlet hazard areas. **Ocean erodible areas** are defined as an area from the mean low water mark landward to 60 times the long-term average annual erosion rate for that location. The width of the ocean erodible area ranges from 145 ft. to over 700 ft.

High hazard areas are the equivalent of the Federal Flood Insurance Rate Map (FIRM) "V-zone."

Inlet hazard areas extend landward from low mean water to cover the area where the inlet "can be expected to migrate." The delineation is based on : statistical analysis of inlet migration; previous inlet locations; the influence of man-made structures (jetties) or human activities (dredging). The range of inlet hazard area width is from about 250 ft. to about 4,000 ft.

Within the ocean hazard system, any construction must put buildings as far landward as possible. Buildings must be behind the erosion setback line, the crest of the primary dune, or the landward toe of the frontal dune, whichever is farthest landward.

The **erosion setback line** is landward of the first line of stable vegetation to a distance of 30 times the average annual erosion rate at that location. The **primary dune** is the first mound of sand landward of the beach with an elevation of the mean flood level plus six feet. The **frontal dune** is a vegetated dune large enough to offer protection from ocean storms.

Large buildings are defined as anything greater than four dwelling units or 5,000 sq. ft. The setback for large buildings is from the first line of stable vegetation to a distance 60 times the average annual erosion rate, to a maximum distance of 105 feet beyond the basic setback for smaller buildings.

All buildings must be built to withstand the "100-year" storm. The bottom must be equal to or greater than the 100 year flood level. The building's pilings must be a minimum of 8 in. in diameter if round or to a side if square. Pilings must be buried 8 ft. below the lowest ground elevation beneath the building.

Prepared March 1990.
References available upon request.

NORTH CAROLINA COASTAL AREA MANAGEMENT ACT (CAMA)
TITLE 15, SUBCHAPTER 7H, SECTION .0306 OF THE NC ADMINISTRATIVE CODE

CONTINUED

Allowable erosion control measures:

-- beach replenishment;
-- relocation;
-- sandbag structures;
-- beach bulldozing.

Prohibited erosion control structures:

-- wooden bulkheads;
-- seawalls;
-- rock/rubble revetments;
-- wooden, metal, concrete, or rock jetties;
-- groins and breakwaters;
-- concrete-filled sandbags and tire structures.

Beach bulldozing

--"the process of moving natural beach material from any point seaward of the first line of stable vegetation to create a protective sand dike or to obtain material for any other purpose."

-- may not hinder public use of the beach;
-- bulldozing may not go deeper than one foot from "pre-activity surface elevation;"
-- must be done within the landowner's property;
-- requires a "CAMA Major Development and State Dredge and Fill Permit."

North Carolina Department of Environment, Health, and Natural Resources
Division of Coastal Management
P.O. Box 27687
Raleigh, N.C. 27611-7687
(919) 733-2293

Prepared March 1990.
References available upon request.

NORTH CAROLINA ENVIRONMENTAL AGENCIES

Department of Environment, Health, and Natural Resources (EHNR)--formally the Department of Natural Resources and Community Development (NRCD)--EHNR is responsible for state environmental regulation. The Secretary of EHNR (currently, William Cobey) is appointed by the NC governor. (919-733-4984).

Division of Coastal Management (DCM)--DCM is the regulatory division of EHNR responsible for enforcement of the Coastal Area Management Act (CAMA). The DCM is involved in permitting within AEC's, land use planning, and land acquisition. DCM also contracts special studies outside the agency. DCM oversees each of NC's 20 coastal counties as they forge land-use plans and update them every five years, as required by CAMA. DCM's land acquisition efforts include Permuda Island, and are currently turned towards Masonboro Island and Buxton Woods. DCM shares responsibility with the DEM in the in-state enforcement of U.S. Environmental Protection Agency programs, such as the Clean Water Act. Roger N. Schecter is the current director.

Offices of the DCM

Raleigh	Rich Shaw	919-733-2293
Wilmington	Jim Herstine	919-256-4161
Morehead City	Charles Jones	1-800-682-2362
Washington	Terry Moore	919-946-6481
Elizabeth City	David Griffin	919-264-3901

Coastal Resource Commission (CRC)--The CRC is the thirteen member oversight committee of the DCM and the CAMA. Appeals to the CAMA are heard by the CRC. The governor appoints members from various fields related to coastal management. Dan Besse is the current chairman.

Coastal Area Management Act (CAMA)--The CAMA is the North Carolina coastal protection program. The CAMA was established in 1974 following the federal enactment of the Coastal Zone Management Act which provided federal funds to states that set up coastal protection programs. The CAMA establishes Areas of Environmental Concern (AEC) areas which, once set aside, require stringent permitting control.

Division of Environmental Management (DEM)--The DEM is a regulatory division of the EHNR responsible for ground and surface water as well as air quality management. (919-733-5083).

Environmental Management Commission (EMC)--EMC is the seventeen member oversight committee of the DEM. The governor appoints members to the commission from various interests, such as science, development, law, and environmental advocacy.

Prepared March 1990.
References available upon request.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)
PROGRAM DESCRIPTION

Established by the National Flood Insurance Act of 1968.

Administered by the Flood Insurance Administration (FIA), part of the Federal Emergency Management Agency (FEMA).

Purpose:

-- identify and map all flood-prone areas;

-- provide affordable flood insurance to the public through a federal/private industry program;

-- encourage land-use planning in flood-prone areas in order to minimize the need for disaster relief;

-- reduce expenditures for federal disaster relief.

Participation in the NFIP is voluntary, but communities who wish to receive federal funds, including disaster relief must participate in NFIP and adopt floodplain management regulations meeting minimum criteria set by FIA.

A community must participate in the NFIP and flood-prone property owners must purchase flood insurance in order to receive mortgages from federally insured lending companies.

Property owners may purchase flood insurance from a licensed property insurance agent, state-approved broker, or an agent with a "Write Your Own" (WYO) company specializing in flood insurance. The policy term is one year (three years under WYO). A single-family dwelling may carry a maximum of $185,000 on the building and $60,000 on the contents. The average cost of coastal flood insurance is $262, and $469 in the high hazard zone.

The NFIP's revenues come from: receipts from program operations; policy premiums; and Treasury borrowings and Congressional appropriations. Money is kept in the Flood Insurance Fund.

Coastal High Hazard Areas, according to the Flood Insurance Rate Maps (FIRM):

-- *V Zone*: Floodplain subject to storm-driven waves;

-- *A Zone*: 100-year flood zone; a ≥1% chance of flood reaching or exceeding a predetermined area in any given year;

Structures built within coastal high hazard areas are evaluated for their impact on the base flood level, and must be built to withstand storm waves, currents, and hurricane wave wash.

Prepared March 1990.
References available upon request.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

-- FEMA estimates that one catastrophic storm year could result in $3.5 to $4 billion in losses on existing policies;

-- Before Hugo, there was about $5 million in the Flood Insurance Fund. Payment of claims made from Hugo through February, 1990 amounted to nearly $300 million.

-- Of the $170 billion in policies in force, more than $5 billion worth are in effect in coastal high hazard areas;

-- 82% of NFIP policies in force are along open ocean and Great Lakes coasts;

-- In a 1981 NOAA review, the FIA stated, "what is indisputable is that the NFIP has not restricted coastal development to any measurable degree;"

-- The number of households in high hazard areas (coastal and riverine) rose 40% from 1966 to 1989;

-- NFIP is the second largest domestic program after the Social Security System;

-- FIRM's identify about 8 million structures that qualify for NFIP, but only 2.1 million federal flood insurance policies have been purchased;

-- "...by and large, the NFIP mandate to steer development out of the hazard zone has been interpreted as only requiring a set of building codes and other so-called 'flood-proofing' steps." Beth Milleman, The Coast Alliance;

-- The FIA Administrator testified at a May 1989 Congressional hearing that many lenders probably are not advising property owners of the NFIP requirements to buy flood insurance;

-- From 1978-1987, the NFIP operated at a $652 million deficit; from 1987- September of 1989, a period relatively free of storms, the program operated in "the black."

-- From 1978-1987, the average loss on a policy in coastal areas equaled $6,907, along the Great Lakes equaled $3,589, and in coastal high hazard areas equaled $8,260;

-- From 1978 through February of 1986, over $5 million in federal flood insurance was paid to coastal North Carolina; this was half of the total federal flood insurance payments made to North Carolina;

-- In the 10 years prior to NFIP, there were 186 deaths and $2.2 billion in damages on the coasts; in the 10 years after the inception of NFIP, there were 411 deaths and $4.7 billion in damages;

-- An NFIP general adjuster's initial survey found 96 buildings damaged, an estimated $3 million in damage on the Outer Banks following the March 7 -10, 1989 storms. Of the 96 buildings, 48 were in Nags Head, 44 in Kitty Hawk, and 4 in Kill Devil Hills.

Prepared March 1990.
References available upon request.

THE JONES-UPTON AMENDMENT
Section 1306(c)

The Jones-Upton Amendment applies on any shoreline with documented erosion and provides:

-- **40% of a building's value for relocation** (moving, setup, and cleanup costs);

-- **110% of a building's value for demolition** (100% for demolition, 10% for cleanup).

Buildings may be moved landward on the lot or to another lot.

Land value is not insured.

Buildings are qualified if they have flood insurance under the National Flood Insurance Program on or before June 1, 1988, for two years prior to the amendment, or for the term of ownership if that is less than two years.

Jones-Upton Claims from 1987 to March 1989:

	NFIP Direct	"Write Your Own" companies
Total Claims	130	55
average	5	
NC	21	8
Total $ Value	$1,860,176	$1,875,290
average	$77,507	
NC	$526,921	$330,632
Average Claim	$14,309	$34,096
NC		$41,329

The cost to the Flood Insurance Administration (FIA) of implementing the Jones-Upton provision from February 1988 to March 1989 was $1,209,928 for administrative expenses and data collection.

The average relocation cost in 1980 on the Outer Banks was $15,000 for a single family house, including the mover, new foundation, septic tank, utilities, and permit fees.

Prepared March 1990.
References available upon request.

COASTAL BARRIER RESOURCES ACT (CBRA)

Public Law 97-348

The CBRA denies federal subsidy of development-related projects on "undeveloped coastal barriers" on the U.S. Atlantic and Gulf of Mexico coasts. Coastal areas included become part of the **Coastal Barrier Resources System** (CBRS). CBRS includes 666 miles of the Atlantic and Gulf coasts.

Passed: 1982 (effective October 18, 1982).

Administered by: Department of Interior

Purpose:

- -- minimize loss of life;
- -- stop wasteful expenditure of federal funds;
- -- minimize damage to natural resources.

CBRA does not prohibit development, but shifts the financial responsibility to state, local, and private coffers. CBRA represents an effort to stop the federal subsidy of development in erosion- and flood-prone areas.

An undeveloped coastal barrier -- a depositional geologic feature that consists of unconsolidated sedimentary materials subject to wave, tide, and wind, and protects landward aquatic habitats, as well as backbarrier environments (adjacent wetlands, estuaries, inlets, and nearshore waters). Undeveloped areas contain few manmade structures none of which "significantly impede geomorphic and ecological processes." Land already considered protected through federal, state, or local law (*e.g.* as a wildlife refuge or park) is not included.

No federal funding within the CBRS for (including, but not limited to):

- -- infrastructure;
- -- roads;
- -- airports;
- -- boat docks/landings;
- -- bridges;
- -- causeways;
- -- shoreline hardening;
- -- flood insurance.

Topsail Island, NC

- -- 1,200 acres within CBRS;
- -- presented the first legal challenge to the CBRA:
    - -- *Bostic v. United States*; 581 F. Supp. 254 [E.D.N.C. 1984];
    - -- *Bostic v. United States*; 753 F. 2d 1292 [4th Cir. 1985];

Both courts decided against Bostic.

Existing area in the CBRS in:

North Carolina: 31,913 acres;

South Carolina: 26,885 acres.

Prepared March 1990.
References available upon request.

SUMMARY OF INTERIOR'S RECOMMENDED ADDITIONS TO THE COASTAL BARRIER RESOURCES SYSTEM IN THE SOUTH ATLANTIC

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN VIRGINIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
K01	Assawoman Island	Accomack	1	4.2	4,691
Recommendation: Add wetlands to existing CBRS unit					
K03	Cedar Island	Accomack	1	6.6	16,222
Recommendation: Add wetlands to existing CBRS unit					
K04	Little Cobb Island	Northampton	1	0.7	384
Recommendation: No change to existing CBRS unit					
K05	Fishermans Island	Northampton	1	2.3	2,242
Recommendation: Add wetlands to existing CBRS unit					
VA-09	Elliotts Creek	Northampton	1	0.3	106
Recommendation: Add to CBRS					
VA-10	Old Planta-tion Creek	Northampton	1	0.4	248
Recommendation: Add to CBRS					
VA-11	Remus Creek	Northampton	1	1.7	484
Recommendation: Add to CBRS					
VA-12	Church Neck	Northampton	1	2.6	396
Recommendation: Add to CBRS					
VA-13	Westerhouse Creek	Northampton	1	0.4	161
Recommendation: Add to CBRS					
VA-14	Shooting Point	Northampton	1	0.3	21
Recommendation: Add to CBRS					
VA-15	Horse Island	Northampton	1	0.6	357
Recommendation: Add to CBRS					

(VIRGINIA CONT.)

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN VIRGINIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
VA-16	Scarborough Neck	Accomack	1	2.7	359
Recommendation: Add to CBRS					
VA-17	Craddock Neck	Accomack	1	2.6	1,233
Recommendation: Add to CBRS					
VA-18	Bluff Point	Accomack	1	2.5	1,010
Recommendation: Add to CBRS					
VA-19	Parkers Island	Accomack	1	1.4	962
Recommendation: Add to CBRS					
VA-21	Beach Island	Accomack	1	1.0	156
Recommendation: Add to CBRS					
VA-22	Russell Island	Accomack	1	0.5	87
Recommendation: Add to CBRS					
VA-23	Simpson Bend	Accomack	1	1.6	708
Recommendation: Add to CBRS					
VA-24	Drum Bay	Accomack	1	2.0	2,104
Recommendation: Add to CBRS					
VA-25	Fox Islands	Accomack	1	1.4	1,293
Recommendation: Add to CBRS					
VA-26	Cheeseman Island	Accomack	1	2.3	1,448
Recommendation: Add to CBRS					
VA-27	Watts Island	Accomack	1	1.9	1,799
Recommendation: Add to CBRS					
VA-28	Tangier Island	Accomack	1	2.3	772
Recommendation: Add to CBRS					
VA-29	Elbow Point	Westmoreland	1	3.6	1,376
Recommendation: Add to CBRS					

(VIRGINIA CONT.)

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN VIRGINIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
VA-30	White Point	Westmoreland	1	1.2	399
Recommendation: Add to CBRS					
VA-31	Cabin Point	Westmoreland	1	0.7	117
Recommendation: Add to CBRS					
VA-32	Glebe Point	Westmoreland	1	0.7	225
Recommendation: Add to CBRS					
VA-33	Sandy Point	Westmoreland	1	0.3	46
Recommendation: Add to CBRS					
VA-34	Judith Sound	Northumberland	1	0.8	254
Recommendation: Add to CBRS					
VA-35	Cod Creek	Northumberland	1	0.7	175
Recommendation: Add to CBRS					
VA-36	Presley Creek	Northumberland	1	0.4	108
Recommendation: Add to CBRS					
VA-37	Cordreys Beach	Northumberland	1	0.5	146
Recommendation: Add to CBRS					
VA-38	Marshalls Beach	Northumberland	1	0.3	83
Recommendation: Add to CBRS					
VA-40	Gaskin Pond	Northumberland	1	0.3	83
Recommendation: Add to CBRS					
VA-41	Owens Pond	Northumberland	1	0.8	126
Recommendation: Add to CBRS					
VA-42	Chesapeake Beach	Northumberland	1	0.4	37
Recommendation: Add to CBRS					
VA-43	Fleet Point	Northumberland	1	0.4	31
Recommendation: Add to CBRS					
VA-44	Bussel Point	Northumberland	1	0.5	41
Recommendation: Add to CBRS					

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN VIRGINIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
VA-45	Harveys Creek	Northumberland	1	0.3	27
Recommendation: Add to CBRS					
VA-46	Ingram Cove	Northumberland	1	0.3	20
Recommendation: Add to CBRS					
VA-47	Bluff Point Neck	Northumberland	1	2.1	643
Recommendation: Add to CBRS					
VA-48	Barnes Creek	Northumberland	1	1.5	263
Recommendation: Add to CBRS					
VA-49	North Point	Lancaster	1	1.4	320
Recommendation: Add to CBRS					
VA-50	Windmill Point	Lancaster	1	0.4	18
Recommendation: Add to CBRS					
VA-51	Deep Hole Point	Lancaster	1	1.6	343
Recommendation: Add to CBRS					
VA-52	Sturgeon Creek	Middlesex	1	0.3	139
Recommendation: Add to CBRS					
VA-53	Jackson Creek	Middlesex	1	0.4	46
Recommendation: Add to CBRS					
VA-54	Stove Point	Middlesex	1	0.3	70
Recommendation: Add to CBRS					
VA-55	Rigby Island/ Bethel Beach	Mathews	1	10.4	5,401
Recommendation: Add to CBRS					
VA-56	New Point Comfort	Mathews	1	0.8	454
Recommendation: Add to CBRS					
VA-57	Ware Neck	Gloucester	1	0.3	55
Recommendation: Add to CBRS					

(VIRGINIA CONT.)

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN VIRGINIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
VA-57A	Severn River	Gloucester	1	6.5	4,542
Recommendation: Add to CBRS					
	Total - CBRS as Recommended			80.5	52,831
	Existing CBRS			13.8	11,298
	Net Change in CBRS			+66.7	+41,533

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN NORTH CAROLINA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
L01	Currituck Banks	Currituck	1	8.4	9,243
Recommendation: Delete federally (FWS) protected area from and add wetlands to existing CBRS unit					
L03	Hatteras Island	Dare	1	0.0	329
Recommendation: No change to existing CBRS unit					
L03A	Shackleford Banks	Carteret	1	---	-----
Recommendation: Federally protected (NPS); delete from CBRS					
L05	Onslow Beach Complex	Onslow	3	---	-----
Recommendation: Military (Marine Corps); delete from CBRS					
L06	Topsail	Onslow	3	6.9	5,742
Recommendation: Add new area to existing CBRS unit					
L07	Lea Island Complex	Pender New Hanover	3	5.1	5,839
Recommendation: Add wetlands to existing CBRS unit					

(NORTH CAROLINA CONT.)

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN NORTH CAROLINA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
L08	Wrightsville Beach	New Hanover	7	1.0	567
Recommendation:	Delete developed segment from CBRS; add wetlands to existing CBRS unit				
L09	Masonboro Island	New Hanover	7	9.1	6,651
Recommendation:	Add wetlands to existing CBRS unit				
M01	Waites Island Complex	Brunswick	7	2.1	1,370
Recommendation:	Add wetlands to existing CBRS unit				
	Total - CBRS as Recommended			32.6	29,741
	Existing CBRS			54.6	31,913
	Net Change in CBRS			-22.0	-2,172

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN SOUTH CAROLINA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
M01	Waites Island Complex	Horry	6	3.0	2,885
Recommendation:	Add wetlands to existing CBRS unit				
SC-01	Long Pond	Horry	6	1.2	197
Recommendation:	Add to CBRS				
M02	Litchfield Beach	Georgetown	6	1.1	399
Recommendation:	Add undeveloped area to the north and wetlands to existing CBRS unit				
M03	Pawlelys Inlet	Georgetown	6	1.1	150
Recommendation:	Add wetlands to existing CBRS unit				

(SOUTH CAROLINA CONT.)

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN SOUTH CAROLINA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
M04	Debidue Beach	Georgetown	6	2.2	6,244
Recommendation: Add wetlands to existing CBRS unit					
M05	Dewees Island	Charleston	1	1.5	6,869
Recommendation: Add wetlands to existing CBRS unit					
M06	Morris Island Complex	Charleston	1	3.4	7,563
Recommendation: Add wetlands to existing CBRS unit					
M07	Bird Key Complex	Charleston	1	4.1	6,250
Recommendation: Add wetlands, but not Coastal Plain remnants abutting the mainland, to existing CBRS unit					
M08	Captain Sams Inlet	Charleston	1	1.9	1,037
Recommendation: Add wetlands to existing CBRS unit					
M09	Edisto Complex	Charleston	1	5.5	4,026
Recommendation: Add undeveloped coastal barrier to the north and wetlands to existing CBRS unit					
M10	Otter Island	Colleton	1	5.7	9,415
Recommendation: Add wetlands, but not Coastal Plain remnants abutting the mainland, to existing CBRS unit					
M11	Harbor Island	Beaufort	1	0.9	2,997
Recommendation: Add wetlands to existing CBRS unit					
M12	St. Phillips Island	Beaufort	1	7.1	22,203
Recommendation: Add wetlands to existing CBRS unit					
M13	Daufuskie Island	Beaufort	1	3.7	5,895
Recommendation: Consider deleting portions of the island not subject to wind, wave, and tidal energy; add wetlands in Calibogue Sound					
	Total - CBRS as Recommended			42.4	76,130
	Existing CBRS			38.4	26,885
	Net change in CBRS			+4.0	+49,245

SUMMARY OF RECOMMENDATIONS FOR COASTAL BARRIERS IN GEORGIA

Unit ID Code	Unit Name	County	Congress Dist.	Shoreline Length (miles)	Total Area (acres)
N01	Little Tybee Island	Chatham	1	6.8	18,216
Recommendation:	Add wetlands to existing CBRS unit				
N01A	Wassaw Island	Chatham	1	0.2	314
Recommendation:	No change to existing CBRS unit				
N03	Little St. Simons Island	Glynn	1	6.7	15,617
Recommendation:	Adjust landward boundary and add wetlands to existing CBRS unit				
N04	Sea Island	Glynn	1	1.6	1,404
Recommendation:	Adjust Sea Island Road boundary to delete filled and elevated area; add wetlands to existing CBRS unit				
N05	Little Cumberland Island	Camden	1	2.2	11,998
Recommendation:	Add undeveloped inholdings and wetlands to existing CBRS unit				
N06	Cumberland Island	Camden	1	2.4	16,706
Recommendation:	Delete military (Navy) land and add wetlands to existing CBRS unit				
	Total - CBRS as Recommended			19.9	64,255
	Existing CBRS			16.2	33,073
	Net Change in CBRS			+3.7	+31,182

Recommended Net Changes For All Of the South Atlantic	52.4	119,788
Total Existing CBRS In South Atlantic	123.0	103,169
Total South Atlantic CBRS as Recommended	175.4	222,957

COASTAL "FUN FACTS"

-- 75% to 85% of marine pollution is traceable to land-based sources.

-- Over 50 federal programs underwrite coastal development (including the U.S. Army Corps of Engineers, the Department of Transportation, the Federal Housing Administration, the Department of Agriculture, Health, and Human Services).

-- By the year 2000, the average property losses from storms will equal $5 billion per year.

-- Two major hurricanes in one year on the Atlantic and Gulf of Mexico coasts could result in $14 billion in wind damages, alone.

-- As of 1980, nearly 80% of U.S. coastal residents on the Atlantic and Gulf of Mexico coasts had never experienced a direct hurricane strike.

-- The line between private property and the public beach varies from state to state:

> the mean high water mark in North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Mississippi, Texas, Maryland, New Jersey, New York, Rhode Island, California, Oregon, Washington, and Alaska.
>
> the mean low water mark in Virginia, Delaware, Massachusetts, New Hampshire, and Maine.
>
> the vegetation line in Hawaii (and the Virgin Islands).

-- Coastal property damage due to storms (or any other "sudden, unexpected, or unusual" event) is tax-deductible as a casualty loss on federal income tax.

-- Federal Insurance Rate Map (FIRM) "V zones" are defined by the 100-year flood zone; the federal measurement of this zone may be up to 5 feet too low.

Prepared March 1990.
References available upon request.

BIOGRAPHIES OF PROGRAM PERSONNEL

Orrin H. Pilkey, Jr.

A geologist who has studied the world's shorelines for almost 30 years, Orrin H. Pilkey, Jr. is one of the world's foremost philosophers of shoreline erosion, sea-level rise and the effects of coastal development. For decades, Pilkey has led a crusade against irresponsible shoreline development that has earned him an international reputation. A strong advocate for retreat from the shoreline, he warns of beach degradation.

Pilkey has travelled to South America, Portugal, Colombia and Jordan to conduct geological studies. In 1983 he was named James B. Duke Professor of Geology, and in 1987 was awarded the Francis Shepard Medal for excellence in marine geology. He has published more than 100 research papers and is author, with Wallace Kaufman, of "The Beaches are Moving; the Drowning of America's Shoreline," which argues that the beaches will continue to migrate and destroy man-made structures. He has co-edited and co-authored 16 books in the Duke University Press "Living With the Shoreline" series, volumes about the shores of various states.

Since 1985, Pilkey has been the Director of the Duke University Program for the Study of Developed Shorelines, a program that provides a solid research base for evaluating shoreline changes. Pilkey's argument that hard stabilization of the beaches is a futile and costly attempt to protect property has led to legislation in North Carolina, South Carolina, New Jersey and Maine that prohibits the construction of seawalls.

Born in New York City, Pilkey received his undergraduate degree from Washington State University, His Master's from Montana State University and his doctorate from Florida State University. He came to Duke in 1965.

David M. Bush

David Bush is a Research Associate in the Duke University Geology Department's Program for the Study of Developed Shorelines. He is finishing up his PhD under Dr. Pilkey in marine geology studying modern storm deposits on the northern shelf of Puerto. He has been a member of the National Academy of Sciences Committee on Natural Disasters Post-disaster Field Study Teams the last two years, studying the effects of Hurricane Gilbert on the Yucatan Peninsula of Mexico in 1988 and of Hurricane Hugo on Puerto Rico in 1989. He is authoring the *Living With the Shoreline of Puerto Rico* book. Bush received a BS degree in geology from the State University of New York, College at Oneonta in 1975; an MS in geology from Duke University in 1977, and worked for six years in oil and gas exploration for Pennzoil Company in Houston, Texas before returning to Duke to begin his doctoral work.

Rodney Priddy

Rodney Priddy is a Field Researcher for the Project on Hurricane Hazard Reduction. He is presently completing his master's degree in geology at Duke University under Orrin Pilkey. His thesis is a synthesis of the past year's work, mapping and application of principles of hurricane damage reduction on the barrier islands of North and South Carolina.

Priddy's recent projects while under the auspices of the Program for the Study of Developed Shorelines include: Heavy mineral resource potential of the Rio de la Plata, Puerto Rico and a geological assessment of the damage wrought by Hurricane Hugo in South Carolina. Priddy studied geography at the University of London and received his BS in geology from the University of Oklahoma.

Kathie Dixon

Kathie Dixon is a Researcher with the Duke University Program for the Study of Developed Shorelines. She has recently completed a Masters of Environmental Management at the Duke University School of Forestry and Environmental Studies where she studied beach replenishment along the U. S. coast of the Gulf of Mexico. She received her BA from the College of William and Mary.

E. Robert Thieler

Rob Thieler received a B.A. from Dickinson College in 1987. His majors were Political Science and Environmental Studies. He has been working for Duke's Program for the Study of Developed Shorelines since Fall, 1987. He is currently pursuing his M.S. degree under Orrin Pilkey studying the application of computer mapping to coastal erosion problems in Puerto Rico. Thieler participated in the National Academy of Sciences Post-Disaster survey of Hurricane Gilbert processes and damage on the Yucatan Peninsula of Mexico in 1988. Thieler has published several papers and given many talks regarding Hurricanes Gilbert and Hugo and lessons learned from them.

(over for order form)

Living with the Shore

_____Subtotal (from the front)

_____Postage and handling (Please add $2.00 for the first book, plus $0.95 for each additional book to cover postage and handling).

_____TOTAL

_____I attach my check for $_____ (U.S. currency only) OR

_____Please charge my _____Visa _____MasterCard

Credit card number________________________________Expires________

Signature____

Ship to:

Name (please print)____

Address____

____

City/State/Zip____

(The convention discount on books will be honored for thirty days after the convention).

Duke University Press/6697 College Station/Durham NC/27708