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COASTAL PROCESSES OF DAUPHIN ISLAND, ALABAMA

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EXECUTIVE SUMMARY

The physical processes causing erosion of the Gulf of Mexico beaches of Dauphin Island, Alabama were studied. A beach monitoring data collection program was established for one year as part of this study. Beach changes were measured with annual, low altitude air photos and with quarterly, surveyed beach profiles at eight locations. The forces causing these changes were measured with visual surf observations and with a wave gage. Further information obtained during this study included sand size analyses, a search for historical coastal engineering information, and some informal monitoring of the Sand Island shoals. Monitoring of the June 1991 beachfill on the public beach at the fishing pier was a special addition to the data collection program.

Based on the visual surf observation data, the direction of net longshore sand transport was westward during the year. The rate of transport was much less along the beaches in the lee of the Sand Island shoals (the eastern 3 miles). Net longshore sand transport rate was estimated at 200,000 cubic yards per year to the west for the beaches west of Sand Island. In the lee of Sand Island, the net rate was estimated at 40,000 and 20,000 cubic yards per year. Although the magnitudes of such estimates are very rough, the results probably indicate the correct direction of net transport and the relative proportions along the island.

Some of the beaches of Dauphin Island are losing sand and some are gaining sand. The changes observed this year seem consistent with the changes that have occurred during the past decade. The shoreline along the easternmost mile of the island is receding at rates up to 40 ft/year. However, the shoreline between Audubon St. and the country club, is

generally accreting, i.e. the beaches are getting wider. Within this stretch are two large accretionary shoreline bulges with smaller pockets of shoreline recession immediately to the west of each bulge. The shoreline is receding at rates of up to 50 ft./year along the half mile of beaches centered on the fishing pier. Farther to the west, the measured shoreline changes do not show any clear trends. Along these open Gulf beaches, more than one year of data will be needed to reliably measure shoreline change trends. However, within the past decade, these beaches appear to be generally stable.

The shoreline changes on Dauphin Island can be explained in terms of the sand transport paths. The shoreline recession along the easternmost mile of beaches is due to sand starvation of the entire eastern end of the island. The sand which has eroded from these beaches has moved westward via wave driven longshore sand transport onto the accreting beaches between Audubon St. and the country club. The shoreline recession around the fishing pier is caused by the northerly migration of Sand Island during the 1980's. Pelican Passage is being diverted farther north into Dauphin Island than at any time in the past century.

The beaches of Dauphin Island are linked with the ebb-tidal shoals of Mobile Pass. The ebb-tidal shoal system includes Sand Island, the shallow waters extending from Sand Island to the lighthouse, and the Dixie Bar area. Dauphin Island and the Mobile Pass shoals are part of the same littoral system. Sand moves from Sand Island to Dauphin Island via migrating sand bars to the west of the fishing pier. Thus, the shoals provide both sand for the Dauphin Island beaches and wave sheltering to those beaches.

Man's intervention has significantly modified the natural coastal processes of Dauphin Island. The seawall and groins at the east end of the island have successfully protected the sand around Fort Gaines and prevented that sand from moving west. The 1980 beachfill at the eastern end of the island migrated westward and provided some protection to the easternmost mile of beaches during the early 1980's. The dredging for construction and maintenance of the Fort Gaines channel has contributed to the sand starvation at the east end. The dredging practices for the Mobile Ship channel have affected the coastal processes of Dauphin Island several ways. The impacts of the dredging, which has been increasing in rate, may become more severe over the next several decades. The shift of sand from the easternmost mile of beaches to the west has probably been exacerbated indirectly by the dredging. The dredging, through simple sand starvation, probably caused the erosion of the both the shoals around the lighthouse and the Dixie Bar shoals in the last two decades. The Dauphin Island beaches have, thus, been exposed to increased wave energy from the south and southeast.

Dredging of the Mobile Ship Channel has removed about 15 million cubic yards of beach quality sand from the littoral system of the State of Alabama since 1974. Perhaps as much as 50 million cubic yards of sand have been permanently removed this century. The dredging has completely blocked the natural, long-term source of sand for Mobile County (Dauphin Island). Prior to dredging, sand followed a "U" shaped path from the beaches of Fort Morgan Peninsula onto the Dixie Bar shoals across to the Sand Island shoals to Dauphin Island. The sand paths are the same today with one exception. The dredging of the ship channel breaks the "U"-shaped path at the bottom of the "U." The sand is dredged from the bottom of the "U" and dumped in deep water outside the littoral system.

Proper data have not been collected to fully evaluate the environmental impacts of the dredging of the Mobile Ship Channel on the littoral system including the shoals and the adjacent beaches.

Suggestions for the management of Dauphin Island beaches are; 1) fully determine the environmental impacts of historic and future dredging on the littoral system including the beaches of Dauphin Island, 2) consider moving the existing public swimming beaches, 3) relocate the public beach facilities near the fishing pier, 4) place sand dredged from the Ft. Gaines channel on Dauphin Island, 5) Maintain/Improve the coastal structures protecting Ft. Gaines, 6) establish a "feeder beach" at the east end of Dauphin Island, 7) do not encourage encroachment on the beaches, and 8) discourage breaches in the dune line, 9) monitor future beach changes, and 10) consider the development of local and state beach management plans.

PREFACE

This report was prepared under contract (PED-USA-CZM-91-002) with the Alabama Department of Economic and Community Affairs (ADECA) with funding from the Coastal Zone Management Program (Section 306 of the Coastal Zone Management Act of 1972, as amended) administered by the National Oceanic and Atmospheric Administration (NOAA). The Chief of the Coastal Programs Office of ADECA was Mr. Gilford C. Gilder. Mr. Phillip E. Hinesley, Planner, ADECA, was the technical monitor for the contract.

This report was written by Scott L. Douglass, Ph.D., P.E., Assistant Professor of Civil Engineering, and Mr. Daniel R. Haubner, Student Assistant, at the University of South Alabama, Mobile, Alabama. Mr. Randy Oglesby drafted figures for the report.

University of South Alabama Civil Engineering students participating in the data collection were Jake Gibbs, Robert Gunter, Brooks McLeod, Randy Oglesby, Dale Smith, and Antonia Switzer. The summer 1991 Coastal Geomorphology class at the Dauphin Island Sea Lab assisted in a survey of the beachfill and a bathymetric survey. Ms. "Rusty" Henderson, Mr. Roger McCourry, Ms. Nancy Burnett, and Ms. Paula Ward made the daily visual wave observations. The conscientiousness of these wave observers is sincerely appreciated and their day-to-day dedication made this a better study. Mr. Andy Dees provided many oblique air photos of the island and of Sand Island. The discussions with him through the year concerning the rapid shifting of Sand Island are appreciated. Mr. Alan Gunter and Mr. Michael Dardeau of the Dauphin Island Sea Lab provided the diving services for the installation of the wave gage. Messrs. Wilton Ray Barber and Rodney Collier located the sand bars west of Pelican Passage. Messrs. Walter Burdin, Michael Peterson, Wendell Mears, DeWayne Imsand, Dr. Susan I. Rees and many other employees of the Mobile District of the US Army Corps of Engineers provided discussions and promptly answered requests for information related to the historical data search. Discussions with Mr. Edward B. Hands, Coastal Engineering Research Center, US Army Engineers Waterways Experiment Station concerning the coastal processes of Dauphin Island are sincerely appreciated. Mr. Showers provided surveyed elevations on the island.

Chapter 2 of the report briefly reviews the published technical literature on the coastal processes and coastal engineering of the island. Chapter 3 presents the data collected during the year of this study. Chapter 4 discusses the coastal engineering of the island that is affecting the coastal processes. Chapter 5 summarizes the conclusions concerning the coastal processes of Dauphin Island. Chapter 6 provides suggestions for the management of Dauphin Island's beaches and waterways.

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CHAPTER 1. INTRODUCTION

Beaches and boating are important concerns at Dauphin Island, Alabama. Unfortunately, erosion of the beaches and shoaling of the boat launching areas and channels have been persistent problems. Although shoreline movement is a natural coastal process, it can cause significant problems when it affects man-made structures such as historic Fort Gaines on the eastern end of Dauphin Island. Concerns of state and local officials led to the commissioning of this study in the summer of 1990. The next winter and spring of 1991 brought storms that caused some of the worst erosion in modern history along one particular stretch of beach, the public beach near the fishing pier. Also during 1991, several people drowned while swimming off the beaches of Dauphin Island. The resulting media attention emphasizes that long and short-term management decisions concerning public facilities should be made within the context of an understanding of the natural coastal processes.

Coastal processes means, in this report, the movement of the sands and the forces causing the movement including waves, winds, water levels, and currents. Decision-makers, i.e. politicians, managers, and ultimately the citizens of Dauphin Island and Alabama, can work with the natural coastal processes of the island or at least be prepared to pay the cost of working against the natural processes if they so decide.

The primary purpose of this report is to discuss the coastal processes of Dauphin Island. Specifically, this report shows where the sands are shifting along Dauphin Island and what is causing the shifting to occur. The report discusses the coastal processes within a historical context prior to 1990, the coastal processes occurring during the year of this study, and, the changes that can be expected in the future.

The secondary purpose of this report is to present the data collected during this study. The data reporting in Chapter 3 and the Appendices is organized to provide the raw and analyzed data and a clear picture of how the data were obtained for future research efforts.

CHAPTER 2. LITERATURE REVIEW

A comprehensive coastal processes study for Dauphin Island has not previously been published. However, a number of reports have included information on different aspects of the coastal processes.

Otvos (1979) describes the geological framework of this portion of the Gulf coast. US Army Engineer District, Mobile (1978) presents a map of the historic shoreline changes at the east end of Dauphin Island from 1850 to 1957.

Schramm, et al. (1979), Nummendal, et al. (1979), and US Army Engineer District, Mobile (1981) discuss the response of the island to Hurricane Frederic. The hurricane overwashed the entire western end of the island. Sand overwash fans on the Mississippi Sound side of the island were seen on the post-storm air photos. The eastern end of the island experienced high water elevations but the higher dune elevations prevented overwash. Frederic caused Pass Drury to reopen in its historical location through what is now called Little Dauphin Island. Pass Drury had been closed by man prior to Frederic and has since been re-closed by man.

Schroeder and Wiseman (1985) evaluated tide and wind data from the eastern end of Dauphin Island. They found the mean sea level in 1977-1982 was roughly 0.3 ft. above the National Geodetic Vertical Datum (NGVD). The tides are diurnal (one high and one low tide per day) with a mean range of 1.2 feet (NOAA 1990).

Lamb (1987) shows that the shoreline position along the easternmost mile of Dauphin

Island appears to be going through cycles of recession and accretion. Lamb speculates that these shoreline changes on Dauphin Island are controlled by changes in Sand Island.

Hands & Bradley (1990) and Bradley & Hands (1989) discuss the 1987 construction of an underwater berm on the ebb-tidal delta shield by the Corps of Engineers with beach quality sand. The sand was dredged from the Mobile Ship Channel but not dumped in the regular disposal location which is in deep water several miles from the ebb-tidal delta. The berm had moved toward the shallower depths of the Sand Island shoal complex by 1990 (Hands 1991). Thus, the berm construction method appears to have successfully kept the dredged sands in the littoral system. However, the berm may be trapping sand in its lee.

McLellan & Imsand (1989) discuss the creation of a much larger mound of dredged material in deep water offshore of the ebb-tidal delta. The Corps of Engineers created this mound with dredged materials from the deepening of the Mobile Ship Channel including sands from the ebb-tidal delta area and silts from the Bay. McLellan, et al. (1990) show that the large mound may be reducing the wave energy incident on the outer portions of the ebb-tidal delta.

Hummell (1990) reproduces the historic bathymetric charts of the ebb-tidal delta system. Smith & Parker (1990) present beach profile data measured along the beaches of the eastern end of Dauphin Island. Crozier (1987) presents some profile information. Sapp, et al. (1975) evaluated long-term shoreline change of Dauphin Island.

Douglass (1991) presents a summary of available published and unpublished data on various aspects of the engineering, geology, oceanography, and meteorology of Dauphin Island.

CHAPTER 3. DATA COLLECTION AND ANALYSIS

A fundamental goal of this study was to collect original data concerning the coastal processes of Dauphin Island. These original data serve several purposes. One, they provide an in-depth look at the beach changes during the year and the causes of those changes. Two, they provide some benchmark data for future comparisons. Many of the beach changes experienced by Dauphin Island during the last several centuries have developed with time scales of years to decades and centuries. Although, the changes are great when considered over the long term, they are nothing more than the accumulation of many smaller changes. Thus, a one year look can be very enlightening if it captures some of the important processes that drive the longer term changes and if the year is viewed within the framework of the longer-term trends.

Beach changes were measured with air photos along the Gulf of Mexico beaches and with surveyed beach profiles at eight specific locations. The forces causing these changes were measured with visual surf observations and with a wave gage. Further information obtained during this study included sand size analyses and a search for historical coastal engineering information. Monitoring of the June 1991 beachfill at the public beach near the pier was a special addition to the data collection program.

3.1 Visual Wave Observations

Collection

Visual wave observations were made using the low-cost Littoral Environmental Observation (LEO) format developed by the US Army Corps of Engineers (Schneider 1981). The following data were estimated daily (or at least 3 times per week) by observers at the three locations shown on Figure 1:

a. breaking wave height

b. angle of breaking wave to shoreline

c. wave period

d. longshore current speed and direction

e. type of breaker

f. width of surf zone

g. wind speed

h. wind direction

There are limitations to the accuracy and usefulness of LEO data. The value of LEO data lies more in relative comparisons than in absolute numbers. Obviously, the data are only as good as the consistency and conscientiousness of the personnel collecting the data.

The visual wave observation program in this study was conducted with the goal of obtaining the highest quality, most consistent data possible. The LEO observers used in this study responded to an advertisement for "Beach lovers: wanted" and then were trained by the

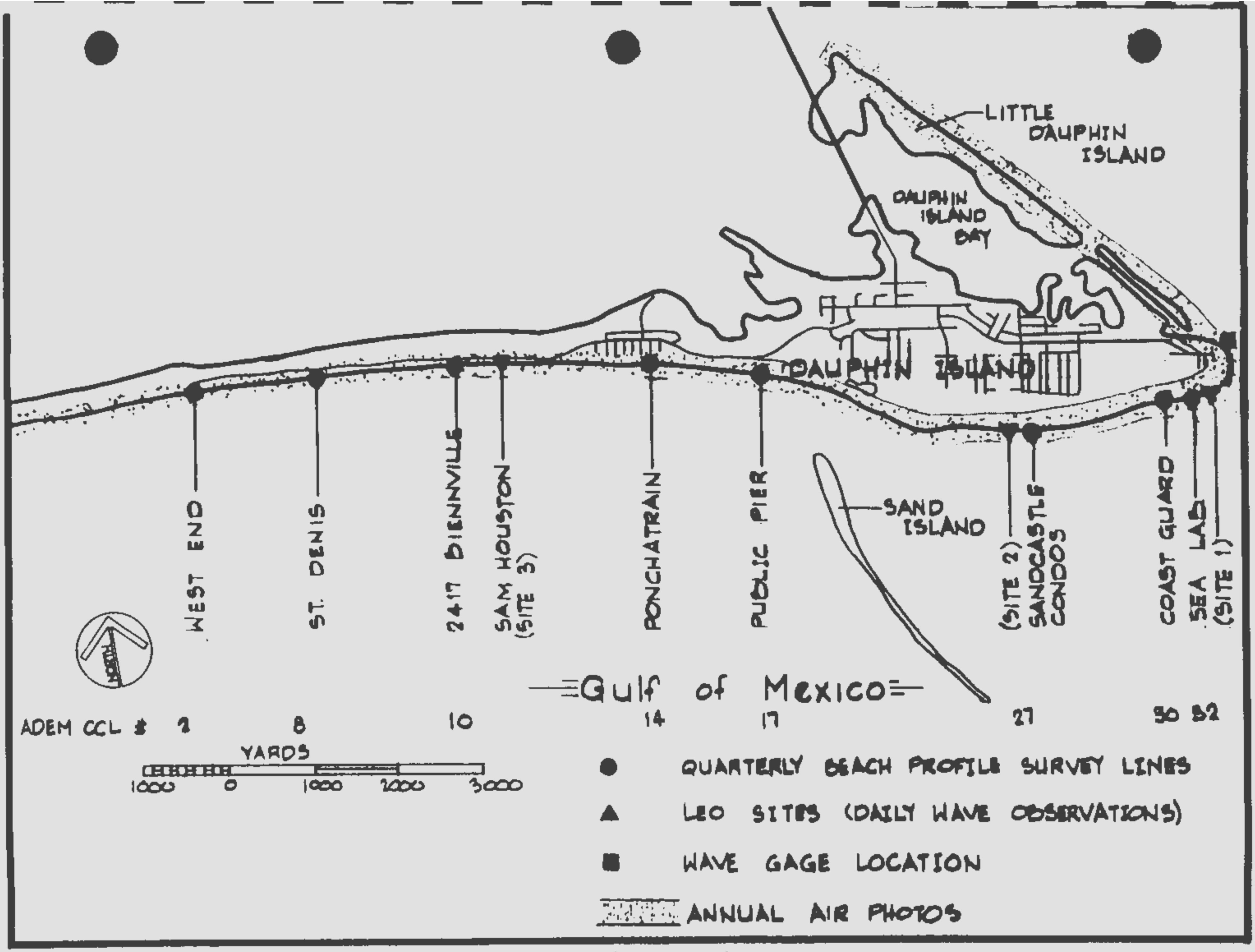


Figure 1. Monitoring program data collection locations

authors with the help of Schneider (1981). They were reimbursed at a nominal ($3.00) rate per observation. The same observer collected the data at two of the sites; site 1, the easternmost site, at the Coast Guard Beach; and site 3, the westernmost site, at Sam Houston St. This observer stayed throughout the whole year. Thus, data at these sites were quantitatively consistent in time and in comparison with each other. The LEO site 2, at the Surf Club Condos had some observer turnover. One observer covered from January through June, another covered July, and a third covered August and September. All observers seemed very conscientious about their data collection.

Analysis

Average monthly wave height, period, and angle at breaking are shown in Figures 2, 3, and 4, respectively. Site 3 clearly had much higher wave heights with longer periods. This clear difference is due to the fact that Site 3 is the only open ocean site. The other two sites are sheltered by the Sand Island shoal complex. Site 1 had smaller waves than Site 2 because it was located immediately in the lee of the flanked groin field and the sand bar which is consistently located through the groin field (see discussion in Section 3.3). The actual observations are tabulated in Appendix A.

The monthly average wave angle is a very crude estimate of which way the waves are driving sand. Most often, waves were approaching from east of south. This trend is very consistent at Sites 1 and 2, the sites sheltered from waves from the west by Sand Island. The trend reversed for the summer months at Site 3. During the summer months, the average

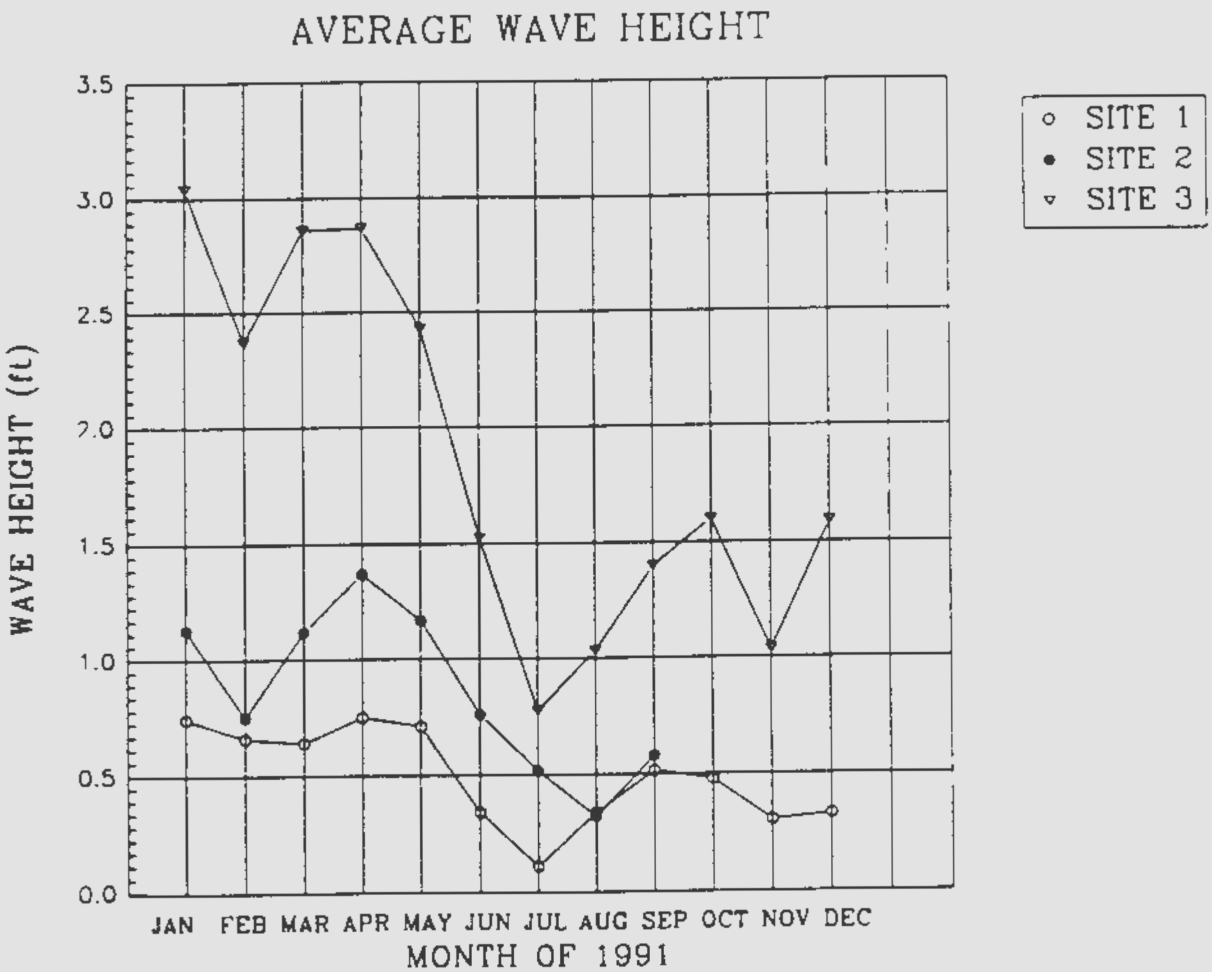


Figure 2. Average Monthly Wave Heights (1991)

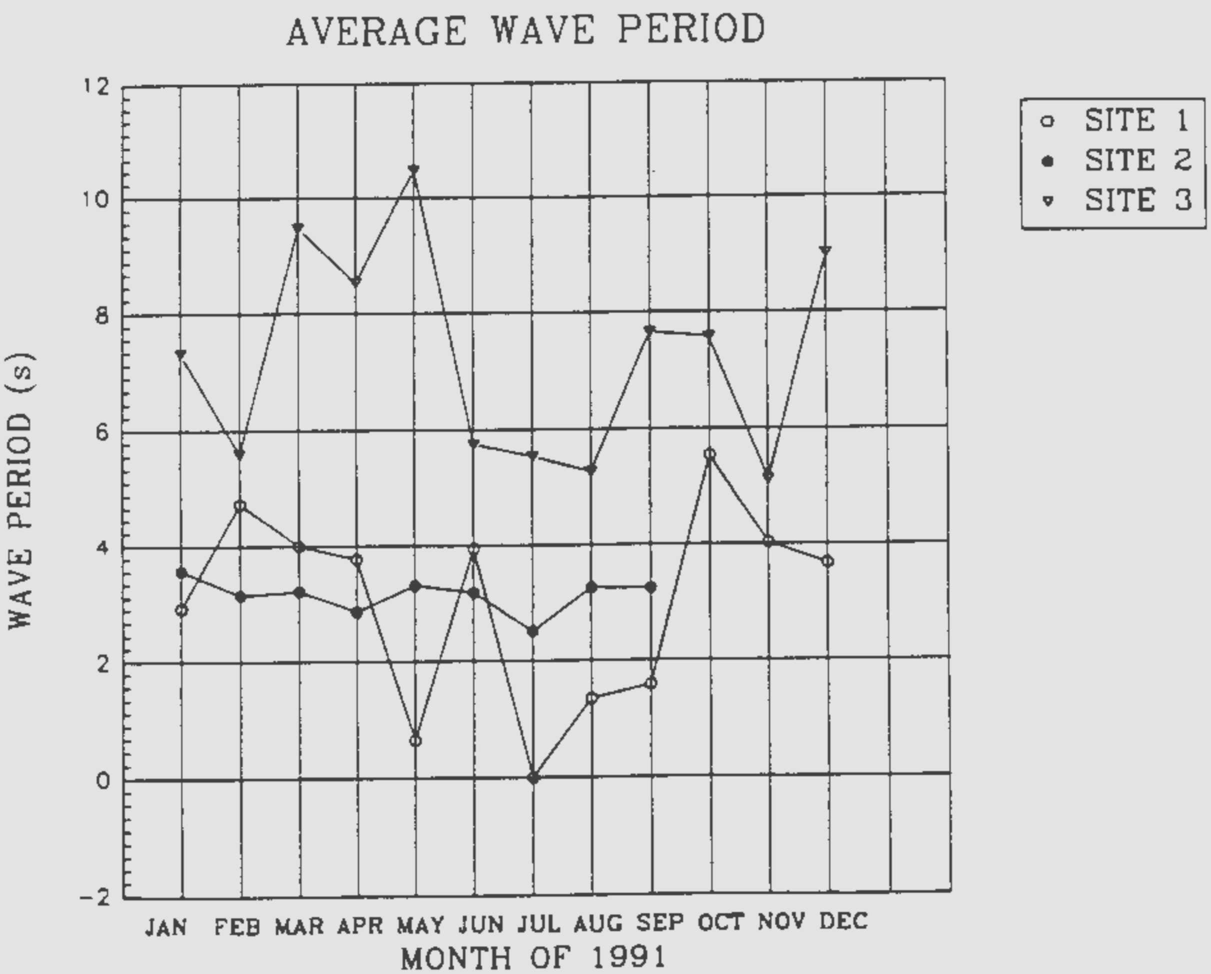
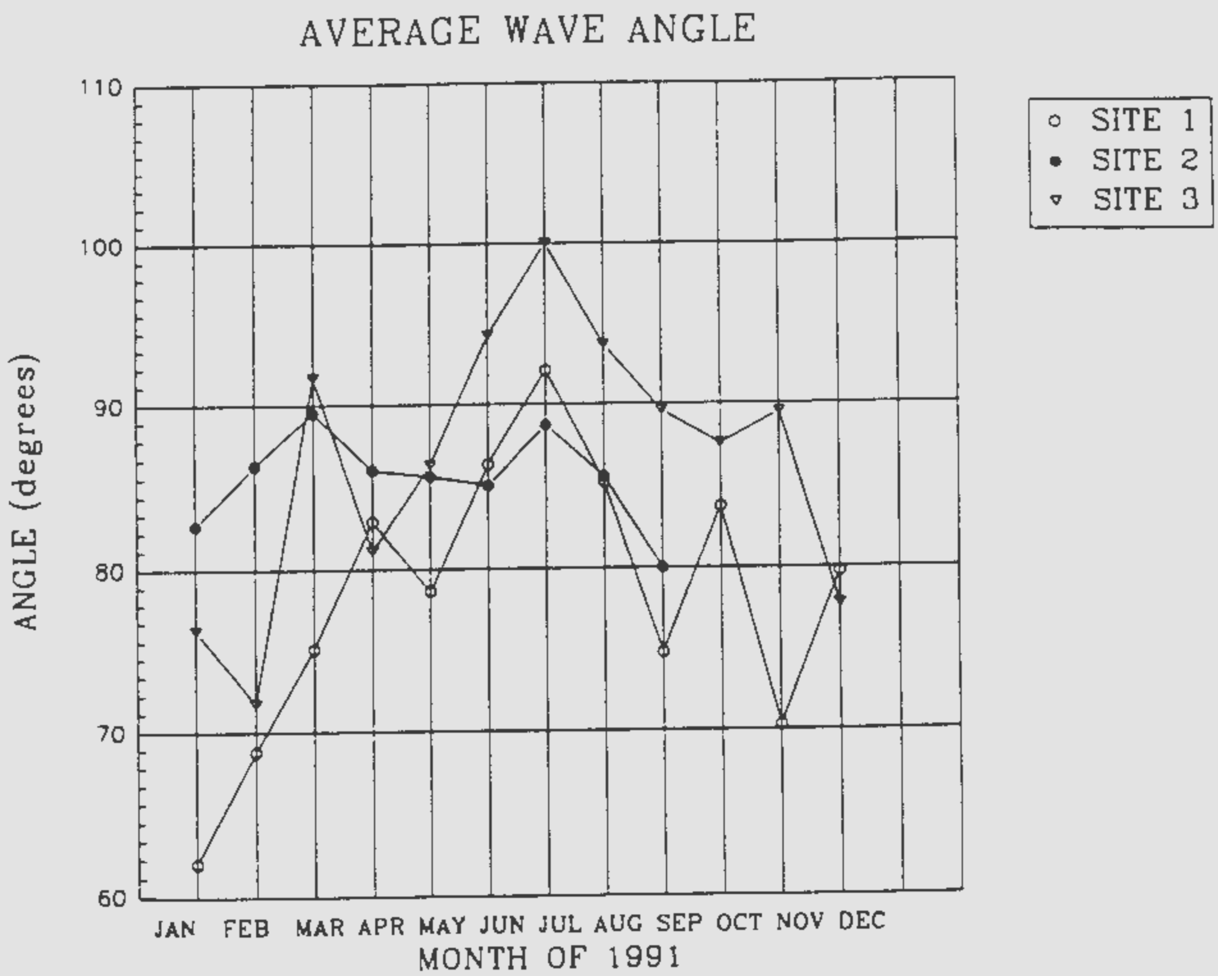


Figure 3. Average Monthly Wave Periods (1991)



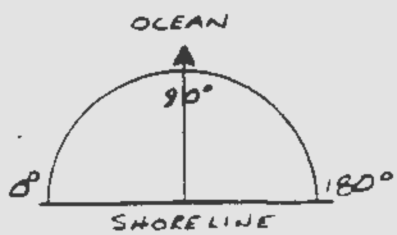


Figure 4. Average Monthly Wave Angles (1991)

wave angle to the shoreline was from the east. This implies that the calmer summer months may be periods of longshore sand transport reversal. A better method for using the wave data to estimate longshore sand transport direction is presented below.

Longshore sand transport, or littoral drift, rates were estimated from the LEO data using the breaker height and angle measurements. A second available technique using the current measurements was not used because it was felt that the current measurements at all three locations were significantly biased by tidal currents from Mobile Bay. The methodology calculates longshore energy flux and uses the "CERC equation" (US Army 1984) to estimate the sand moving potential of the waves.

The estimates of net sand transport rates and directions from the LEO data are shown on Figure 5. Although the actual numerical rate estimates are not very precise, the relative comparisons between sites is probably representative of the relative wave climate along Dauphin Island. At all three sites, net sand transport for the year was to the west. The estimated rates are 20,000; 40,000; and 200,000 cubic yards per year to the west at Sites 1, 2, and 3, respectively. At site 3, the rate of westerly net transport of sand was an order of magnitude greater than at either of the other two sites.

Sites 1 and 2 are sheltered from much of the wave energy coming in the Gulf by the Mobile Pass ebb tidal shoals. The relative sheltering is greater for waves from the west because of Sand Island. All transport is reduced, but the easterly transport is reduced more than the westerly transport. In other words, along the stretch of beach from the eastern end of the island to the golf course, sand is free to move west when waves are coming from the east of south. But when the waves come from the west, these beaches are sheltered by Sand

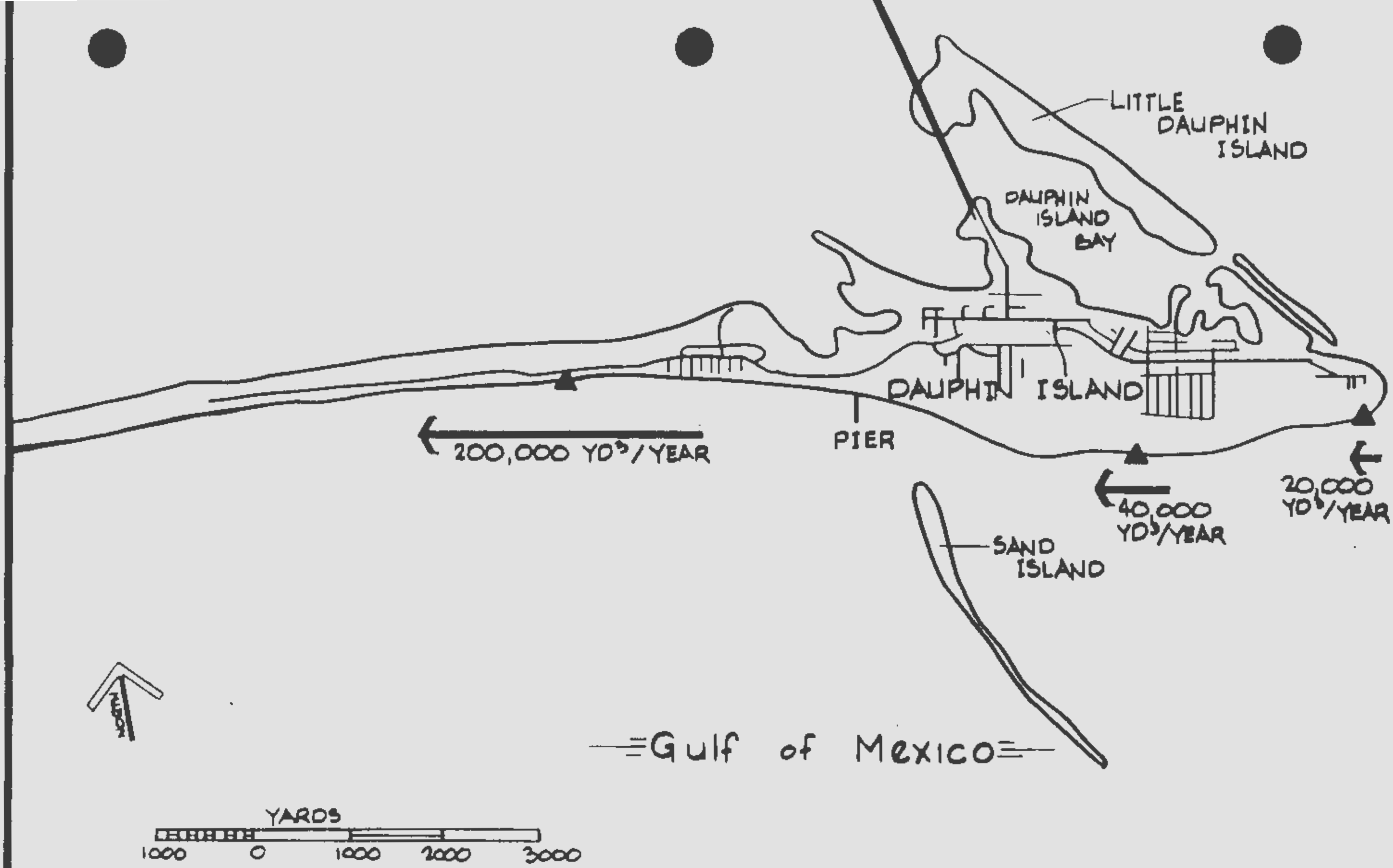


Figure 5. Longshore sand transport estimates from visual wave data (1991)

Island. Therefore, with the present configuration of Sand Island, significant amounts of sand can only move in one direction along this stretch of beach, to the west.

3.2 Wave Gage

Collection

An electronic wave gage was installed for roughly two weeks at the eastern end of Dauphin Island in late summer 1991. Initially, the purpose of the wave gage was to provide an estimate of the wave attenuation across the ebb-tidal delta by comparing with wave heights measured by the Corps of Engineers five miles south of Ft. Gaines. The Corps gaging program, which had been monitoring the wave climate incident on the 1987 experimental sand berm, ceased at the same time this study began. Therefore, there was no opportunity for overlapping data sets and the wave gage data was not emphasized.

Wave gaging for an extended time period at the eastern end of the island would provide very useful data for future coastal engineering design. However, an annual gaging program was well beyond the scope and budget of this report. The gage was used to measure wave heights during a single storm period.

The gage was deployed from August 26 to September 6, 1991. During the deployment, strong southeast winds generated waves which caused beach erosion along the Alabama coast. Essentially, the gage captured the first significant storm of the fall season.

The gage was mounted on the NOAA tide station pier at the eastern tip of Dauphin

Island (Figure 1). The depth of the water at the end of the pier is about 10 ft.. The gage was mounted on the southern most pile of the pier by the Dauphin Island Sea Lab divers. At this location, the gage was directly exposed to waves from the south and east.

The gage is a self-contained pressure recording type wave gage. It was programmed to turn on every hour and record pressure at a 2 Hz sampling rate for about 8 minutes (1024 samples).

Analysis

The resulting raw data were analyzed with standard spectral analysis software to estimate tide stage and wave height every hour. The largest waves generated had a height of 2 ft. (H_{mo}) and a period of 5 seconds (T_p). These wave heights were locally generated sea waves due to the 15 knot east-southeasterly winds.

3.3 Beach Profile Surveying

Collection

Surveying of the beaches was the largest single component of the data collection program for this investigation. During the year, elevations were surveyed quarterly along eight different lines (Figure 1). Each line began at one of the existing Alabama Department of Environmental Management (ADEM) Construction Control Line (CCL) monuments. The monuments selected were ADEM CCL #2, #8, #10, #14, #17, #27, #30, and #32. The corresponding colloquial names of the profiles (for street ends, nearby buildings or general descriptions) used for further identification in this study are given on Figure 1.

The original ADEM monument descriptions and horizontal state plane coordinates are given along with further descriptions and notations from this study in Appendix B. The vertical elevations of the monuments were surveyed as part of this study and are included in Appendix B.

The profiles were surveyed from the monument, usually in the sand dunes, across the beach to a convenient wading depth, usually about 4 ft. deep. The elevations were obtained with a precision surveying level and rod. Distances were measured by tape on the dry beach and estimated by pacing in the water.

Figures 6 through 13 show the profile plots. The plots show profiles from seven or eight surveys. Five of these were the quarterly surveys taken as part of this study. The profile plots also show three other historical surveys in the same area for comparison. Two of the profiles, 1975 and 1979, were measured by the Corps of Engineers and the third was done by the Geological Survey of Alabama.

The Mobile District of the Corps of Engineers surveyed the island beaches at 200 ft. intervals in October 1979 after Hurricane Frederic. These 1979 surveys were done with standard engineering land surveying techniques, like the present study, down to the waterline. The Corps used air photo mapping techniques to generate an estimate of profile elevations in February 1975. They compared the two sets of profiles, February 1975 and October 1979, to quantify the erosion caused by Frederic. The profiles used by the Corps do not correspond precisely with the profiles surveyed in this study. However, since the Corps' survey coverage was so dense, the profiles surveyed in this study were never more than 60 ft. from an old Corps profile. The Corps' data were adjusted in station to correspond with the CCL baseline and plotted as an estimate of the general beach width and shape at the CCL profile locations in the 1970's. Although corrections in stationing were made, some small error is introduced because the bearing of the lines surveyed by the Corps was sometimes slightly different than the bearing of the lines surveyed in this study. Much of the Corps' 1979 baseline remains intact today and the profile lines could be re-surveyed for precise comparison between the 1970's and 1990's.

The Geological Survey of Alabama (GSA) surveyed three of the profile lines adopted in the present study in 1989 (Smith & Parker 1990). The GSA did not extend their profiles into the water and did not use the same surveying technique as this study. They used a stadia system to measure distance and a horizon method to measure elevation. They did not survey elevations at a consistent spacing but rather only at major feature locations across the profile. Thus, the GSA surveys have as few as five elevations across the profile to the waterline and do not contain as much information as the other surveys.

Analysis

The profile plots in Figures 6 to 13 show some clear trends in the beaches from 1975 through 1991. Some of the locations are clearly eroding over the longer 15 year period and continuing to erode today. Some of the beaches are clearly experiencing tremendous growth over the longer and shorter term. Some of the beaches are relatively stable over the longer term but may presently be experiencing recession or accretion.

Elevations on the profile plots are referenced to the National Geodetic Vertical Datum (NGVD). This very roughly corresponds with the mean water level. Schroeder and Wiseman (1985) found the mean water level is several inches above NGVD.

The following discussion evaluates the changes found at each individual profile location.

- Sea Lab Beach (ADEM CCL Monument #32)

The Sea Lab Beach (ADEM CCL Monument #32) profile changes are plotted on Figure 6. This beach has experienced obvious erosion and shoreline recession since 1989. The recession continued through the end of this study, September 1991. This profile line is in the groin field which has been flanked (i.e. they are surrounded by water). The beach changes are clearly affected by the presence of the groins. The alignment of the surveyed profile line was chosen for this study to pass halfway between the third and fourth westernmost groins. The groins are about 300 ft. offshore from the monument. The sand bar shown on the profiles at around 300-350 ft. is a sand bar that was always obvious to the surveyors. The sand bar is aligned east to west along the line of the flanked groin field.

In 1975, a sand dune existed behind the groin field as shown on the Feb 75 data with a crest of about +7 ft NGVD about 200 ft. from the monument. Either Hurricane Frederic or the daily wave climate from Feb 1975 to 1979 removed this dune and left the 0 NGVD shoreline at about 170 ft. from the monument with a gradual slope up to about +5 ft NGVD

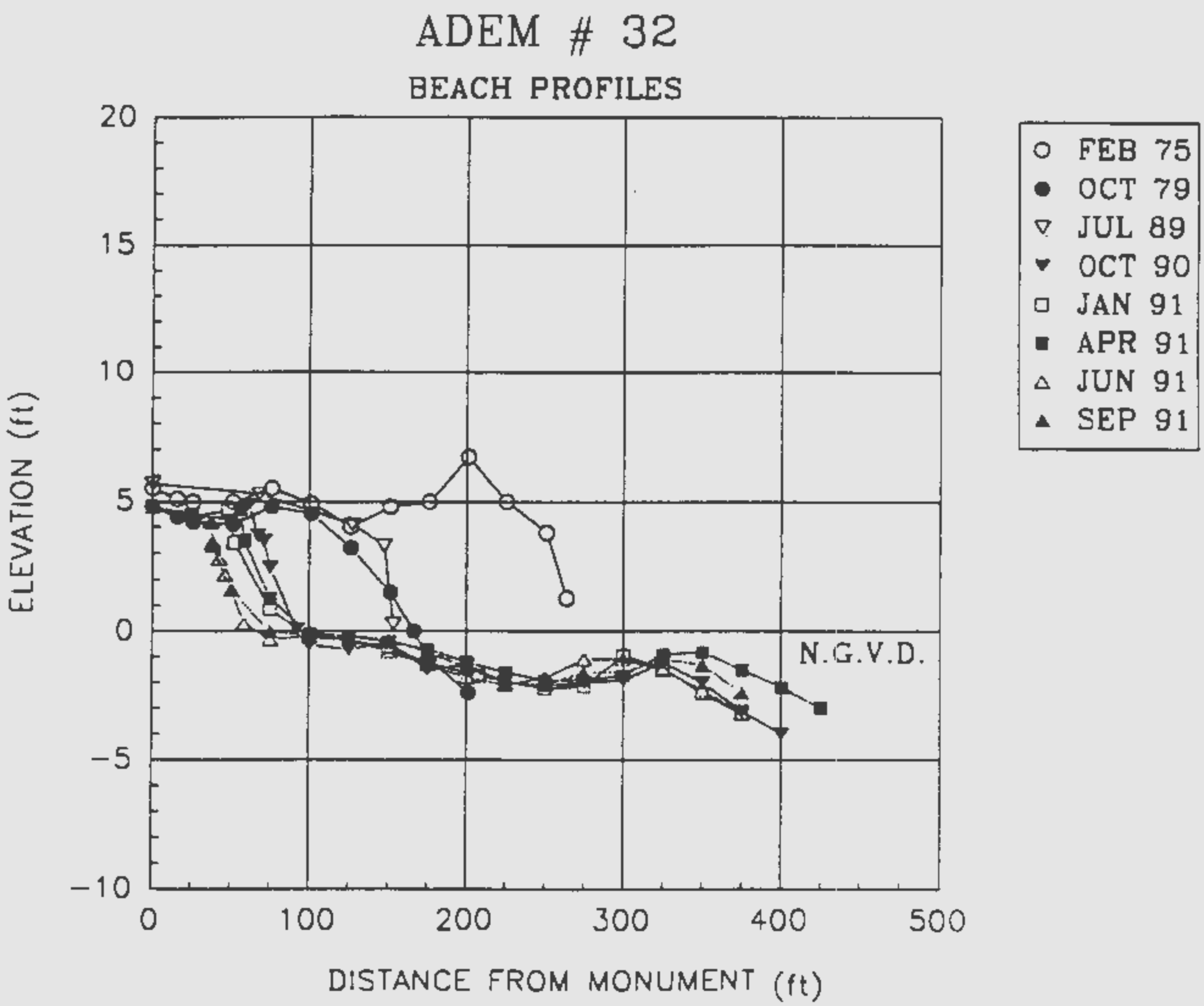


Figure 6. Sea Lab beach (ADEM CCL#32) profiles

at about 100 ft. from the monument. Ten years later, the beach looked about the same. The 0 NGVD shoreline was at about 150 ft. but the beach slope was much steeper. The comparison between the 1979 and 1989 data could be misleading because the shoreline position actually changed dramatically during that decade. In particular, sand from a 1980 beachfill to the east of this location moved into the groin field and caused shoreline accretion to the location of the groins, 300 ft. from the monument (see Section 4.2). By 1985, the groin field was starved for sand again and the shoreline on this profile began receding. In 1989, the shoreline was, coincidentally, near where it was in 1979. The steepness of the beach face indicates active bluff erosion was occurring in 1989.

From July 1989 to October 1990, the shoreline receded about 75 ft. During the year of this study, October 1990 to September 1991, the shoreline receded about another 40 ft. The erosion extends vertically from the top of the bluff at about +4 or +5 NGVD to 0 NGVD. However, below 0 NGVD, the profile shows little change. There is a flat, planar surface from the base of the bluff, 0 NGVD, out to around 150 ft. from the monument. This flat area is between 0 and -0.5 ft NGVD. Continuing seaward, the elevations drop to about -2 ft NGVD and then increase to about -1 ft NGVD between the groins (station 300 to 340). In other words, the entire profile is not eroding. Only the visible, or dry, beach and bluff are eroding. The sand below the waterline is not eroding.

The probable explanation for the absence of erosion farther out on the profile is the presence of the engineering structures, the groin field. The groin field is still trapping some longshore sediment transport immediately between the piles of rock in a sand bar. The sand bar and the rocks are providing some shelter to the beaches. The groins are apparently effectively anchoring the vertical bottom of the beach profiles in the area. The loss of bluff on this profile is also clearly affected by the structures to the east.

- Coast Guard Beach (ADEM CCL Monument #30)

The Coast Guard Beach (ADEM CCL Monument #30) profile changes are plotted on Figure 7. This beach has experienced bluff erosion during the past year. The erosion appears to be a fairly continuous process since 1975.

In 1975, a sand dune of elevation +6 ft NGVD was located about 300 ft. from the location of the present-day ADEM CCL monument. The waterline was about 375 ft. from the monument. Either Hurricane Frederic or the daily wave climate from Feb 1975 to 1979 removed this dune and left the waterline at about 300 ft. from the monument. Also, immediately after Frederic, there was a sand bar with a top elevation of +1 ft. NGVD about 400 ft. from the monument. By 1989, the waterline had receded over 200 ft. to within 100 ft. of the monument. The steepness of the bluff immediately behind the waterline indicates bluff erosion was active in 1989. By October 1990, the water line had receded another 25 ft. and the bluff crest had receded about 15 ft.

During this study, the bluff crest receded another 21 ft. The bluff recession rate was not constant through this study year. The greatest bluff recession, 11 ft., occurred from April to June 1991. This time period coincides with several strong storms from the east.

A small sand bar was always present during this study at about 200 to 225 ft. from the monument. This sand bar is a continuation of the sand bar that forms along the centerline of the flanked groin field to the east. The sand bar comes off the westernmost groin toward

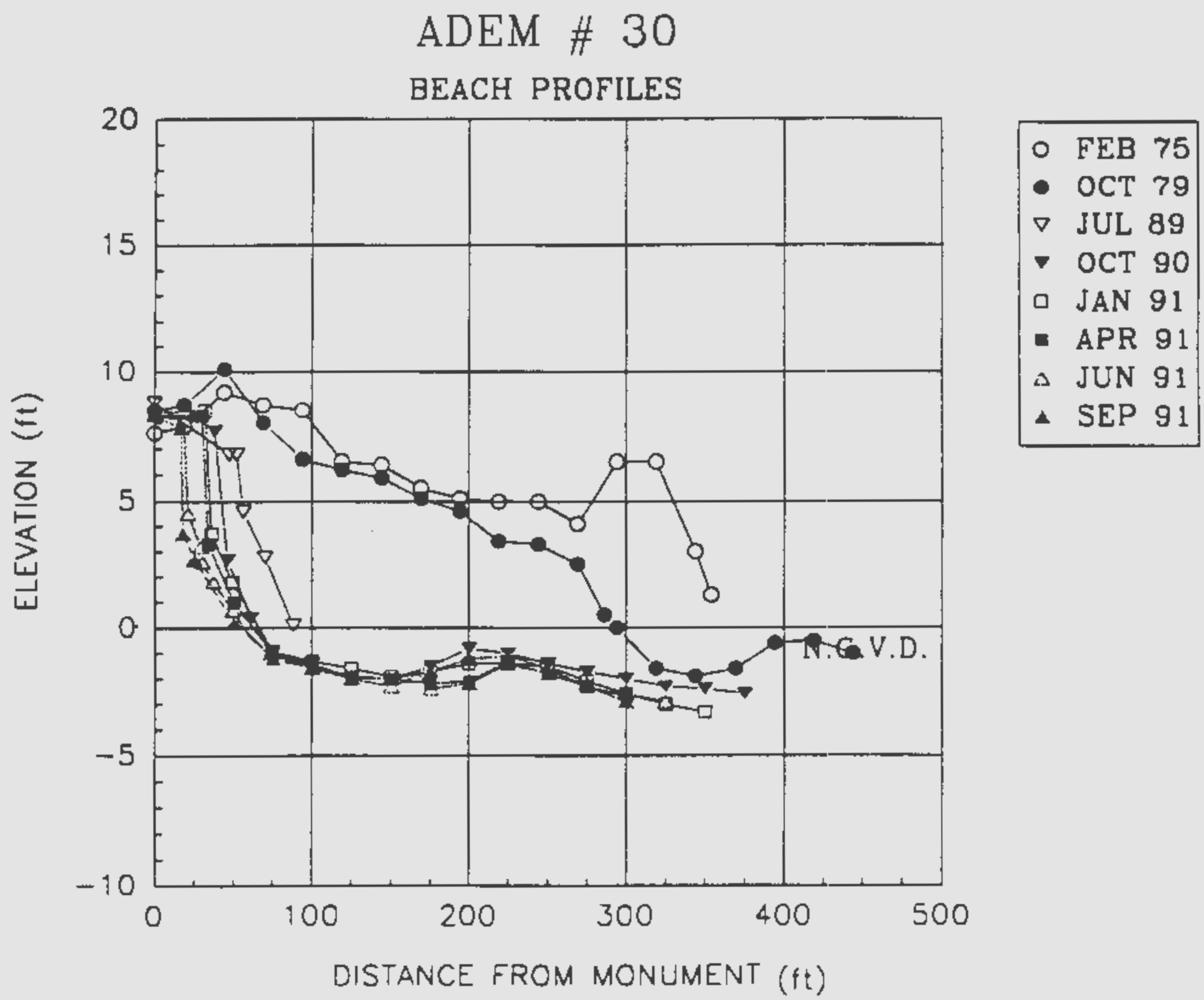


Figure 7. Coast Guard beach (ADEM CCL#30) profiles

the shoreline to the west of the Coast Guard Beach Profile. The elevation of this sand bar decreased during this study. This indicates that it may have been starved for sand from the groin field.

This beach profile has experienced erosion along the entire active profile. Unlike, the Sea Lab Beach Profile, the sand elevation is decreasing across the entire profile. This trend is clear from 1975 to 1990 and was continuing up through 1991. The erosion along this stretch of beach is due to littoral sand starvation.

The probable cause of this starvation is a change in relative longshore sand transport rates due to changes in wave climate caused by changes in the ebb-tidal delta shoals. Preferential sheltering during the past two decades has increased the westward transport along this beach while decreasing the eastward transport. This phenomenon is discussed in more detail in Chapter 5.

- Sandcastle Condos Beach (ADEM CCL Monument #27)

The Sandcastle Condos Beach (ADEM CCL Monument #27) profile changes are plotted on Figure 8. This beach has experienced substantial accretion and deposition since Hurricane Frederic.

It appears that from 1975 to immediately after Hurricane Frederic this profile experienced very little change. This may not be the case though. Considering the strength of Frederic, another scenario which is just as possible is that the beach widened significantly prior to the hurricane and was brought back to 1975 locations during the hurricane.

Figure 8 clearly shows beach sand deposition and shoreline accretion from the 1970's

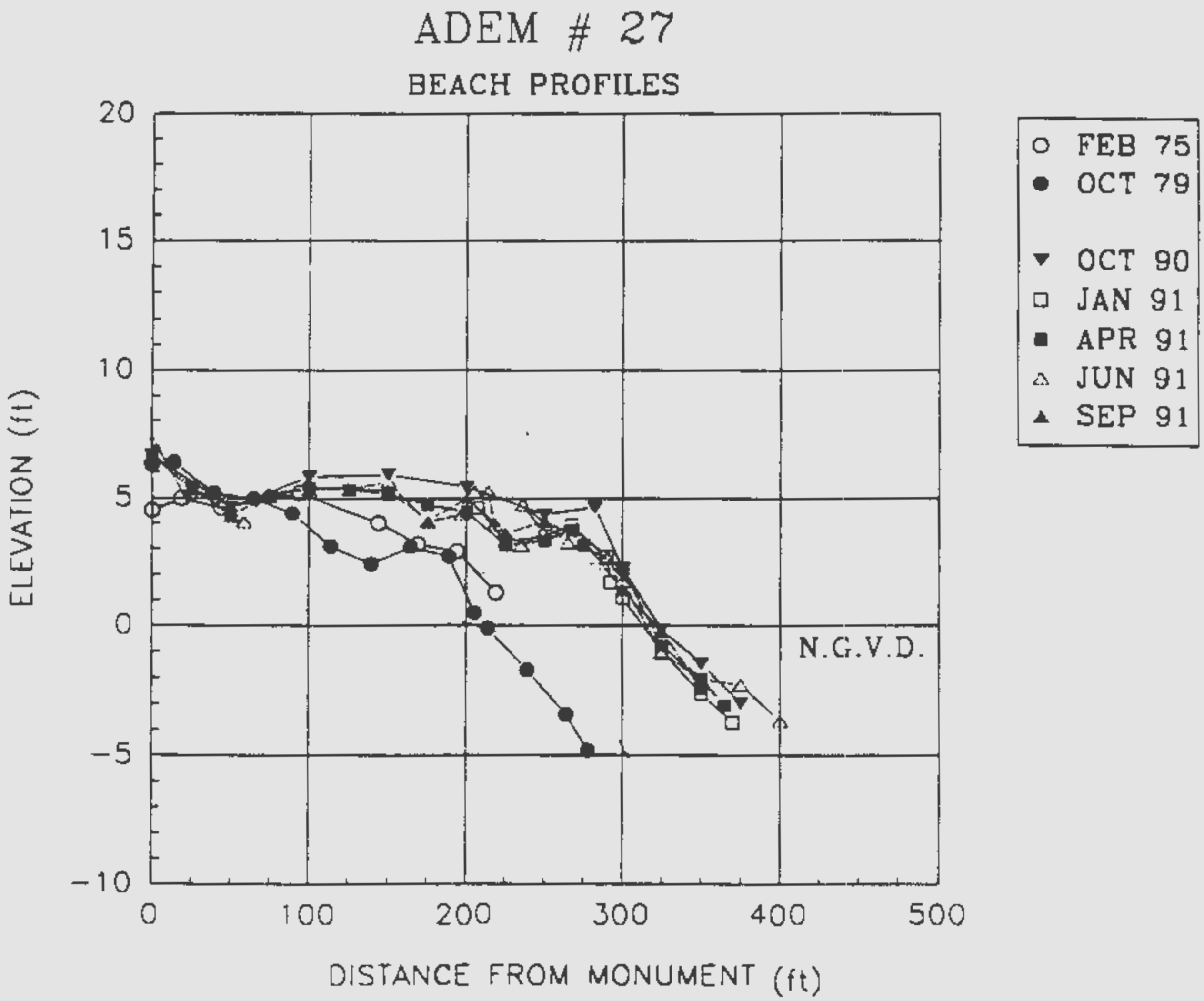


Figure 8. Sandcastle Condos beach (ADEM CCL#27) profiles

to 1991. There has been over 100 ft. of shoreline accretion. The entire profile has gained sand. The profile has experienced 2 to 9 ft. of vertical deposition between 100 and 300 ft. from the monument. The shoreline accretion and sand deposition has caused the formation of a low dune field at an elevation between +3 and +5 ft NGVD. This dune field at these elevation is about 200 ft. wider than it was after Frederic. In other words, the accretion of the 0 and +4 NGVD contours is about 100 and 200 ft. respectively from 1979 to 1991.

The beach changes measured during the year of this study are small. Figure 8 presents some weak evidence that this trend of shoreline accretion was continuing during 1990-1991.

- Public Beach (ADEM CCL Monument #17)

The Public Beach (ADEM CCL Monument #17) profile changes are plotted on Figure 9. This profile line is about 750 ft. west of the public fishing pier on the public beach maintained by the Dauphin Island Park and Beach Board. This beach has experienced steepening of the profile and shoreline recession since 1975. This trend continued during this study.

The stretch of shoreline from this profile to the fishing pier has been receiving media attention throughout the past year. The attention is due to the danger posed by the shoreline recession to the Park & Beach Board facilities including a bathroom, several picnic pavilions, and timber walkways located on the top of the sand dunes. The landward end of the fishing pier may be in danger of being flanked by the shoreline and the structural integrity of the landward end of the pier may be in jeopardy due to erosion around the piles (Henderson,

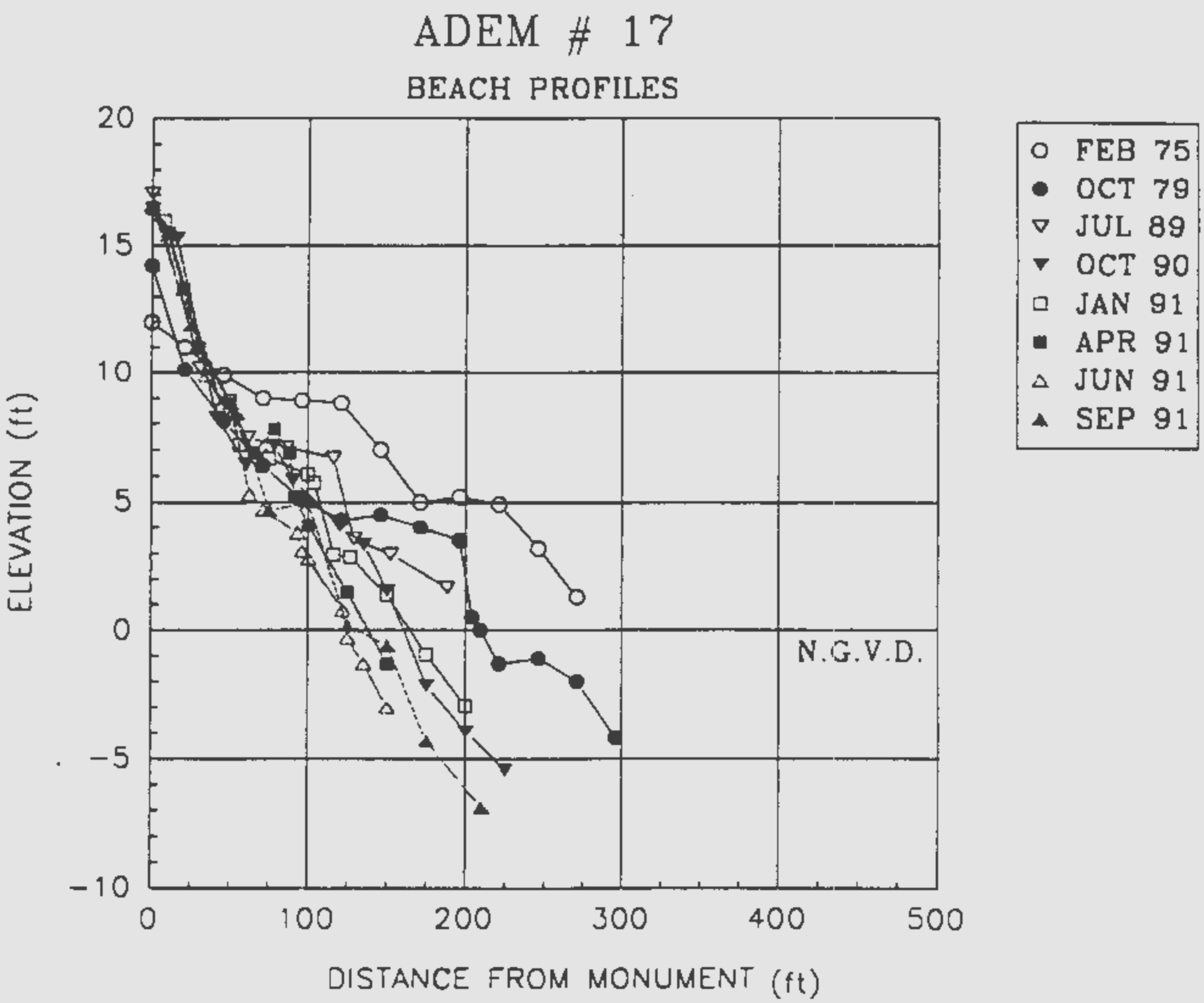


Figure 9. Public Beach (ADEM CCL#17) profiles

personal communication 1991). A small, 15,000 cubic yard, beachfill was placed on this beach in June 1991. The characteristics and behavior of the beachfill is discussed in detail in Section 3.6 of this report. The beachfill did not extend to the profile line shown in Figure 9 but ended about 200 ft. east of the profile line.

It appears that from 1975 to immediately after Hurricane Frederic this profile experienced significant erosion. The shoreline receded about 100 ft. and the entire profile up to +10 ft NGVD experienced erosion. However, by 1989, the shoreline position was not very different from 1979.

The shoreline receded about 50 ft. from July 1989 to October 1990. During the fall of the 1990, the beach profile changed little. By April 1991, however, the shoreline receded 30 ft. By June 1991, the shoreline receded another twenty ft. The total shoreline (0 NGVD) recession for the year of this study was 50 ft. Thus, the shoreline recession rate for the two year, 1989-1991, period was 50 ft. per year.

The erosion on this profile extends across the entire profile. Every contour line from the +7 ft NGVD contour out to the -5 ft NGVD contour has receded northward. Seaward of 50 ft. from the monument location, the entire profile has lost elevation since 1979. Most of this lost elevation probably occurred since 1989. For example, the elevation of the sand 175 ft. south of the monument was roughly +4 ft NGVD in 1979, +2 ft NGVD in 1989, -1 ft NGVD in January 1991, and -4 NGVD in September 1991. In other words, 6 ft of vertical erosion occurred from 1989 to 1991 with half of that erosion, 3 ft, occurring each year.

- Ponchatrain St. (ADEM CCL Monument #14)

The Ponchatrain St. Beach (ADEM CCL Monument #14) profile changes are plotted on Figure 10. This beach experienced shoreline accretion during the year of this study.

Between 1975 and immediately after Hurricane Frederic this profile may have gained a little elevation while experiencing very little net shoreline position change.

Since Frederic, a large sand dune has formed with a crest elevation of about +10 ft NGVD. The shoreline position was roughly the same in October 1990 as it was immediately after Frederic. During the year of this study, however, the profile gained sand below the +5 NGVD contour.

The profile survey results from this study indicate that sand is moving onto this profile via the onshore welding of sand bars from offshore. Most of this deposition of sand on the profile occurred during the spring and summer, from April 1991 to September 1991. The April 1991 survey showed a small loss of material near the waterline relative to the two previous surveys but by June this deficit was gone and a large offshore bar was found. The bar was at depth of -2 ft NGVD and beyond. The -2 ft NGVD contour moved almost 100 ft. seaward from April to June. From June to September, the profile showed deposition from -1 ft to +4 ft NGVD while showing erosion offshore of -1 ft NGVD. Such behavior indicates that the bar welded onto the shore. The shoreline accreted a net 30 ft. during the year of this study.

Chapter 5 of this report explains the presence of welding sand bars along these beaches as part of the natural transport of sand from Sand Island. As sand is driven into Pelican Passage from Sand Island, the daily ebb tidal currents move the sand westward to this

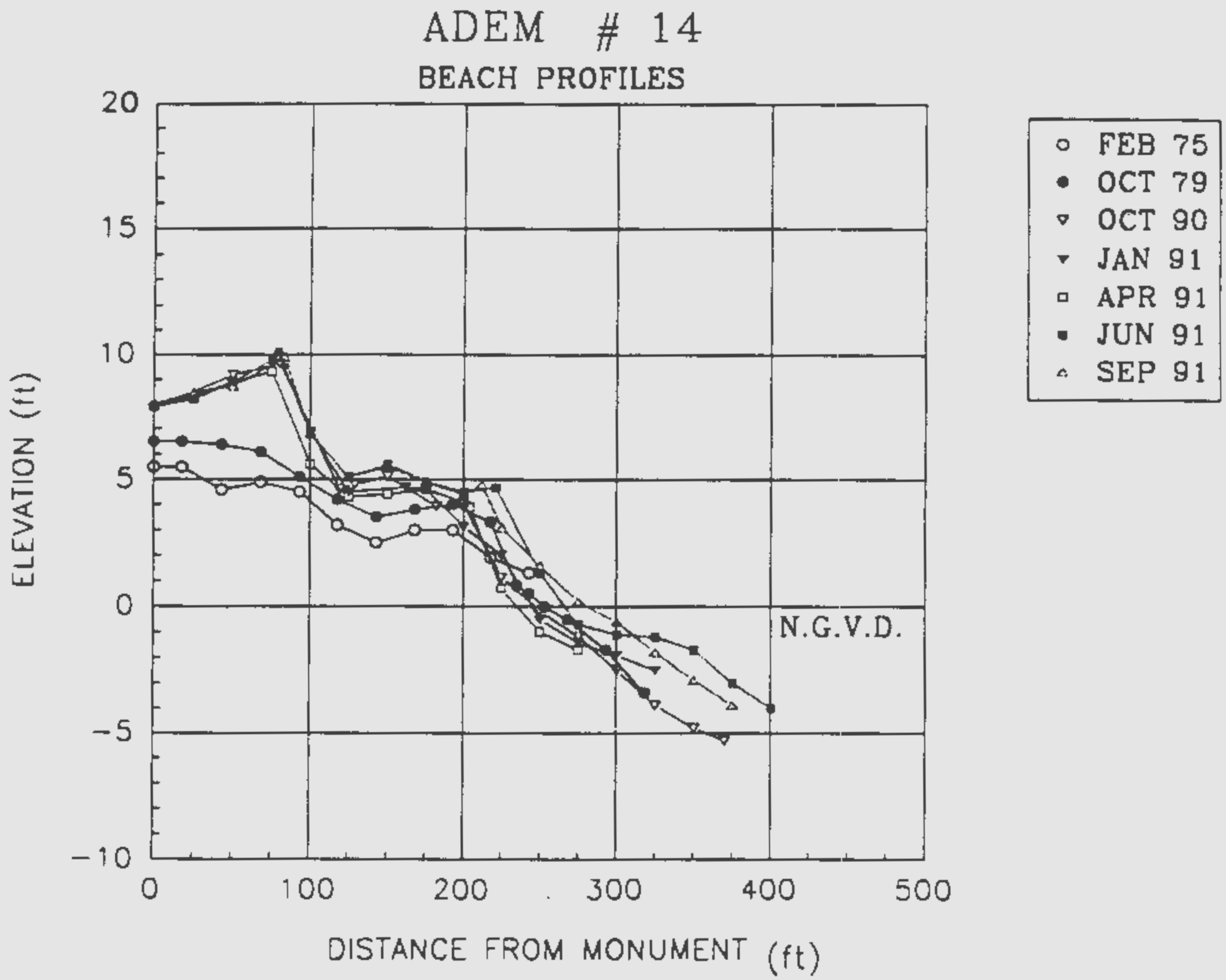


Figure 10. Ponchatrain St. beach (ADEM CCL#14) profiles

stretch of beach. As the tidal currents diffuse into the Gulf, the sand form into bars and is driven onto Dauphin Island by waves. This profile plot provides some documentation of the last part of this scenario, the welding of the sand bars onto Dauphin Island.

Since only one year of quarterly surveys was available, it is not known if this welding onshore is a recurring process.

- 2417 W. Bienville Rd. (ADEM CCL Monument #10)

The beach along the 2400 block of Bienville Rd. (ADEM CCL Monument #10) profile changes are plotted on Figure 11. This beach has lost sand during the past year but not over the past decade.

It appears that from 1975 to immediately after Hurricane Frederic this profile experienced accretion. The post-Frederic shoreline is about in the same location as in 1975.

Between 1979 and 1990 two sand dunes formed above the +5 elevation.

During the year of this study, the beachface lost a significant amount of sand. The shoreline (0 NGVD) retreated about 50 ft. However, the sandbar gained sand. It is likely that the offshore gains in the sandbar roughly equal the losses on the beachface. Thus, sand was pulled offshore into the bar system. This beachface retreat and sandbar formation is consistent with the air photo analysis for beaches along the western half of Bienville Blvd. (see Section 3.4). Profiles surveyed to a deeper depth (-10 ft NGVD) would be needed to confirm that sand was not lost.

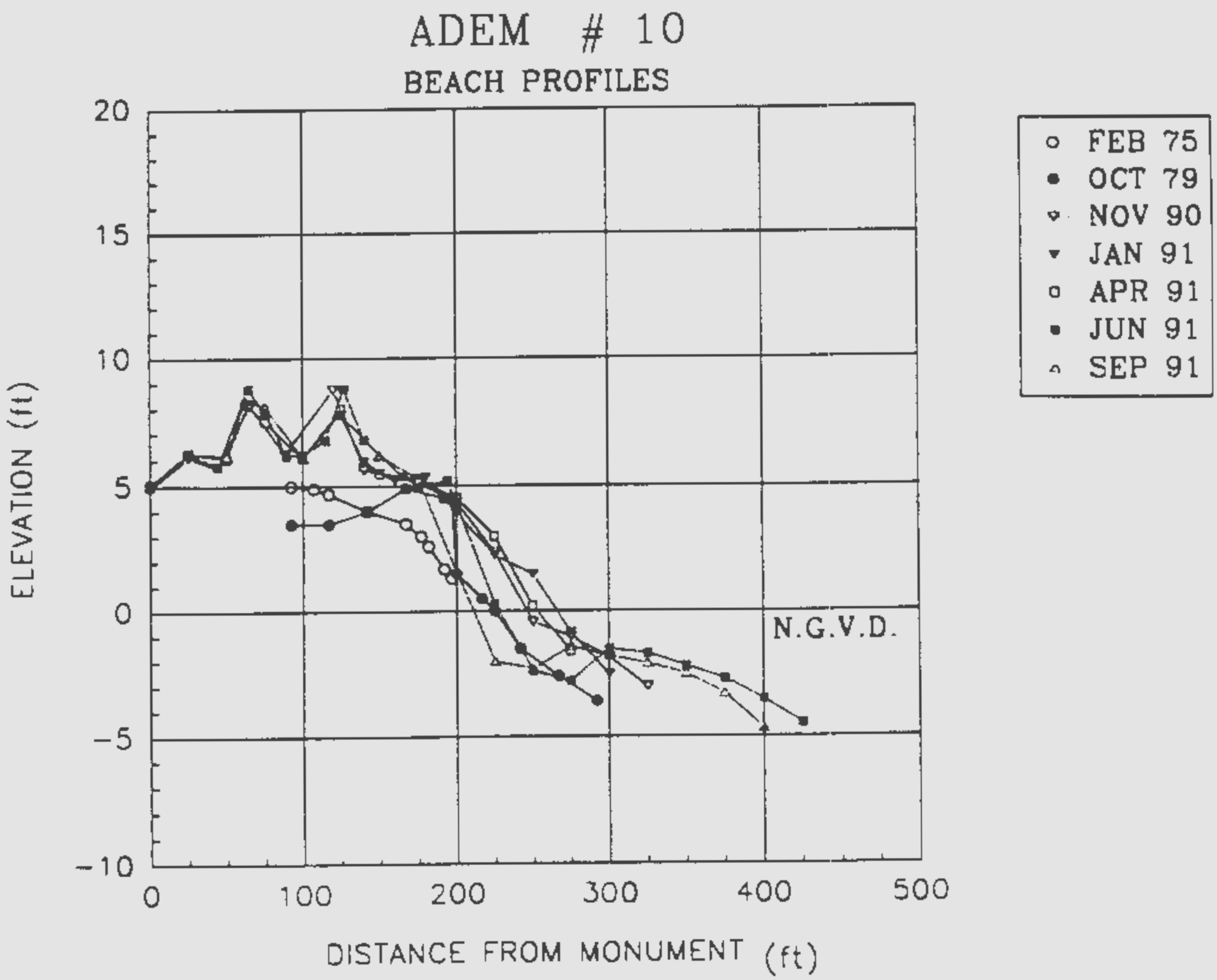


Figure 11. 2417 W. Bienville Rd. beach (ADEM CCL#10) profiles

- St. Denis Rd. Beach (ADEM CCL Monument #8)

The St. Denis Rd. Beach (ADEM CCL Monument #8) profile changes are plotted on Figure 12. This beach has behaved very similarly to the beach at 2417 Bienville Blvd. The beach has been fairly stable over the past decade.

During the year of this study, the shoreline (0 NGVD) receded about 50 ft. Most of this recession occurred between April and September 1991. The appearance of the sandbar indicates that the sand lost from the beachface is immediately offshore in a sandbar. Inspection of the September 1991 air photo shows that this profile is affected by rhythmic topography of the sandbar and beach system described in Section 3.4. This profile is located where the beach is at its narrowest. Thus, this recession is really not true sand starvation-caused erosion but is probably just due to the severe storm activity during the spring of 1991 that pulled sand offshore into the bar system along the beaches of the western half of Bienville Blvd.

- West End Beach (ADEM CCL Monument #2)

The West End Beach (ADEM CCL Monument #2) profile changes are plotted on Figure 13. This beach has been very stable.

It appears that from 1975 to immediately after Hurricane Frederic this profile experienced some gain in sand on the dry beach. The shoreline was in roughly the same location after Frederic as it was in 1975.

The beach was very stable during the year of this study. The and beachface moved less than 30 ft. during the year. The present profile is in much the same location as in 1975

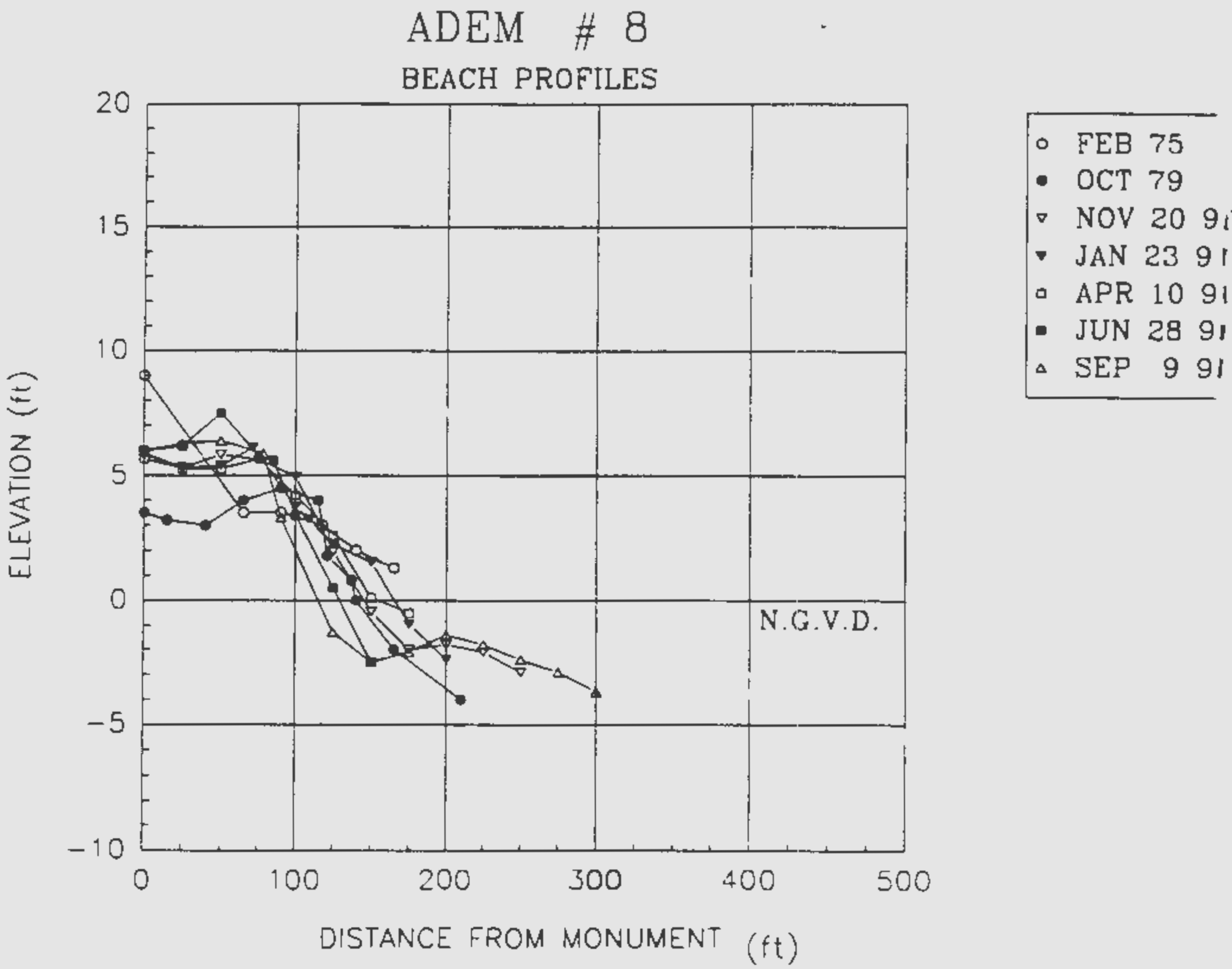


Figure 12. St. Denis St. beach (ADEM CCL#8) profiles

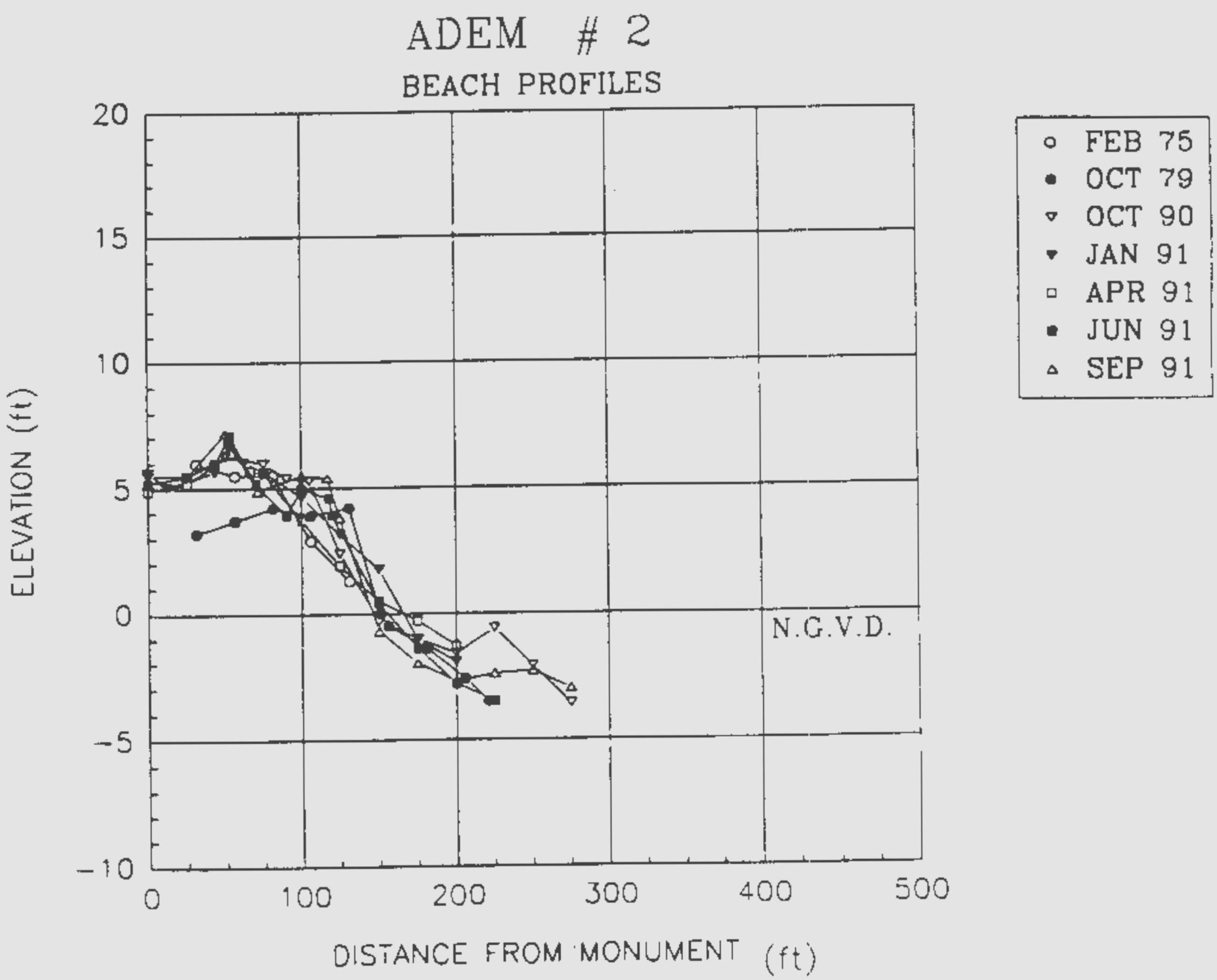


Figure 13. West End beach (ADEM CCL #2) profiles

and 1979.

3.4 Air Photos - Shoreline Change

Collection

Aerial photographs of the beaches were taken at the beginning and end of this study to document the shoreline changes between the eight surveyed profile lines. The information which is most easily visible on the air photos are the vegetation line, the wet line, and the actual waterline. The vegetation line, the point on the beach profile beyond which grasses don't grow, is always easily visible along the Dauphin Island beaches because of the lightness of the native sand and the darkness of the native vegetation. The wet line, the point of maximum wave runup within the last tidal cycle, is usually fairly visible. The waterline is a function of the tide stage when the photograph was taken. Air photos and the surveyed profiles discussed above complement each other since the photos only capture information about the shoreline at all points and the surveyed profiles capture information about the entire profile including the underwater portions at a few points.

The photographs commissioned as part of this study were flown at an altitude low enough to see the yearly changes on the beaches. The photographs were taken at a scale 1:4800. One inch on the photo print equals 400 ft. on the ground. Standard, mapping-quality air photo equipment, including a camera with 9 by 9 inch negatives, was used.

The two flights were September 24, 1990 and September 26, 1991.

The coverage of the flights included the entire Gulf of Mexico beaches of Dauphin Island and the Mobile Bay beaches of Little Dauphin Island as shown on Figure 1. The Gulf of Mexico beaches of the entire state of Alabama, including Baldwin County, were also flown at the same time to save money. The following analysis focusses on the developed, eastern, half of Dauphin Island.

The analysis of only two sets of air photos is, unfortunately, of limited value. In essence, the photo sets are two snapshots of the beaches. These snapshots were intentionally chosen to be at the end of the summer season one year apart. The end of the summer season is typically a time when the beaches are least affected by storms. A storm will pull sand off the dry beach and move it onto offshore sand bars which begin to migrate back to the beach after the storm. Since the object of air photo analysis is to measure net shoreline changes, the immediate effect of individual storms on short-term location of the shoreline should be avoided. This storm profile or seasonal effect on profiles can be best avoided by taking photos in September. However, occasionally, storms occur during September. Unfortunately, a storm occurred in early September 1991 which may have pulled much sand off into the bar system on the open Gulf coast portions of Dauphin Island. Thus, the shoreline change data may be skewed toward an apparent shoreline recession which is not necessarily due to long-term erosion. The optimum way to avoid erroneous conclusions is to use many different sets of air photos to filter out the seasonal or storm changes from the background long term shoreline trends. Douglass (1991) found over two dozen sets of air photos of the eastern end of Dauphin Island but a comprehensive analysis of these photos for shoreline changes was beyond the scope of this study.

s

Inspection of the photos verifies the shoreline changes found on the eight surveyed lines and provides an estimate of the shoreline changes elsewhere on the island. of the limitations of analysis based on only two sets of photos as discussed above, d quantitative analysis of these two sets was not undertaken. Such an analysis would rected for scale errors due to tilt and altitude and would have digitally rectified the with ground surveys to estimate the distance from an arbitrary baseline to the on line, wet line and waterline.

nstead, quantitative measurement of the beach width changes during the year were ff the photos. The nominal scale of the photos, 1 in.=400 ft., was assumed accurate. ht difference in scale between the two sets of photos due to altitude was corrected. location was measured from the same arbitrary fixed points; e.g. houses, roads, or both sets of photos.

horeline changes are summarized on Figure 14. Areas of shoreline recession and for the year are plotted. Shoreline recession and accretion distances for the year to the nearest 10 ft.

1 the eastern half of the inhabited Town, shoreline change trends from the air photos sive. For discussion purposes, a total of four reaches of beach are considered. The es are defined on Figure 14. From the eastern end of the island, the reaches are to D. Reach D is the western half of the inhabited portion of the island. The ithin each of these four general reaches of beach can be explained in term of the

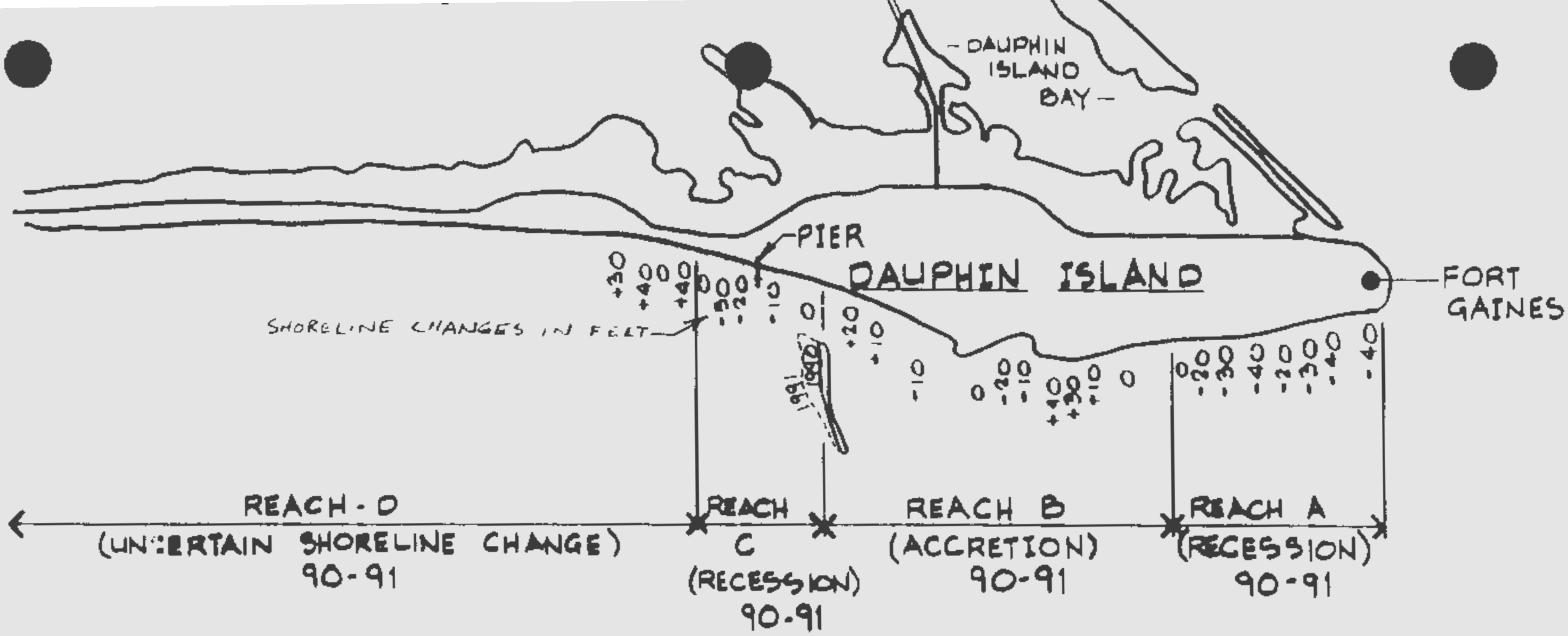


Figure 14. Dauphin Island shoreline changes from Sept. 1990 to Sept. 1991

cess

tends from the groin compartment just east of the flanked groin field to
Ave. area. This one mile reach has experienced shoreline recession of
. with maximums of about 40 ft. Two surveyed profiles, Sea Lab Beach
Beach, fall within this reach and confirm the recession values.

n reach from A to B with no significant shoreline change extends from
e vicinity of the condos.

tends from the condos 1.5 miles to a location roughly 1500 ft. east of the
in reach B, the general trend is one of beach accretion. Two accretionary
eatures, bulges in the shoreline planform, dominate the reach. Inspection
cal air photos shows that the bulges have been gaining sand and widening
e. T bulges appear to be instabilities in the shoreline in the sense that
mselves. Such bulges are not common on open ocean coasts because wave
t tends to smooth them out. However, many of the sandy capes of the
pe Canaveral Florida can partially be explained as similar instabilities.

ilges along Dauphin Island are probably due to the sheltering of the wave
Island. In particular, the formation of the bulges is probably due to the
ing over the last decade. The location of the exposed part of Sand Island
west and north during the last decade. Thus, less and less wave energy
been hitting reach B during this decade. However, the wave energy from
bly increased this decade due to the westward migration of Sand Island and
hs across Dixie Shoals to the east. Thus, more and more wave energy from

east has been hitting the beaches of reach B during this decade. The net longshore sand sport is to the west and this westward dominance has increased during this past decade.

The bulges are geomorphological evidence of the dominance of westward transport r eastward transport. Both bulges migrated westward during the year of this study. Both he bulges are moving like sand waves to the west. The longer, lower, eastern bulge grew ut 70 ft. westward. In this growth area, the beaches gained 200 ft. of width as measured g a north-south line. The point of the western bulge has grown 80 ft. and is beginning eal off the embayment to the west. The sand that formed the growth of each bulge has e from the beaches immediately to the east of the bulge. The sand eroded from reach ncluding the Coast Guard Beach area, has moved to the eastern bulge. The sand that ed from around the golf course tee has moved to the western bulge.

Within reach B, immediately to the west of each of the two bulges there is a stretch horeline recession. These areas are being starved by the growth of the bulges ediately to their east. Within the overall coastal processes picture, these recession area ninor ramifications of the two bulges. However, the recession area between the two es is not so minor to the owners and managers of the golf course because it threatens one Some form of shore protection structure has been used for at least the past decade to ct the tee. Remnant pilings and cross-bracing are visible. During the year of these graphs, an improved bulkhead or seawall was constructed on the beach. Although the ous shore protection structures have failed, they have provided some limited land ction.

The western end of reach B has experienced shoreline accretion along about 1000 ft.

shoreline. This stretch of accretion is south of the Isle Dauphine Club House. This stretch of beach is also just slightly east of due north from the tip of Sand Island. Accretion in this stretch averages between 10 and 20 ft. The sand in this accretionary stretch probably has two sources, the beaches to its immediate east and west. This stretch of beach is being sheltered by the northern end of Sand Island about 2000 ft. to the south. Waves from the west probably transport sand along the beach face into this area from the beaches around the fishing pier.

Reach C is experiencing shoreline recession. Reach C is roughly 3000 ft. long and is centered on the fishing pier. To the west, Reach C extends to roughly the old Holiday Inn site. The shoreline recession along Reach C varies from 10 ft. on the east side of the pier to almost 50 ft. about 700 ft. west of the pier. This area of maximum recession is at the surveyed beach profile at the Public Beach (ADEM CCL #17). The survey results confirm the shoreline recession and show that the entire beach profile is eroding. The decreased recession rates in the vicinity of the 1990 beachfill indicate the beachfill effectively slowed the recession rate. The beachfill had only been in place for four summer months at the time of the second air photos flight.

The 3000 ft. stretch of beach from the old Holiday Inn site to the end of Ponchatrain St. is where sand bars from Sand Island are welding onshore (see Section 3.7).

The shoreline change for the western portion of the inhabited island, Reach D, is listed as uncertain on Figure 14 for the following reasons. The limitation of only two sets of photographs is critical in the stretch of beach which is not in the lee of the Sand Island shoals. Offshore bars are very clearly seen on the 1991 photos and are not visible on the

1990 photos. The bars are attached to the beach every 100 to 700 ft. and the result is a very rhythmic topography of the nearshore. This rhythmic topography is very indicative of a beach which is recovering from a storm. Indeed, a storm hit the Alabama coast several weeks before the September 26, 1991 flight. The beach may even have never fully recovered from the severe winter and spring storms of earlier in 1991.

The September 1990 photos show no offshore bar along the western portion of the island. The rhythmic topography of the second of the two sets of photos resulted in shoreline change data that depended on whether a specific location along the beach. For those locations behind a bar, there was an apparent loss of up to 40 ft. of dry beach width between the two flights. However, for those locations on the horn or mini-headland where the bar was welding onto shore, there was no apparent shoreline change during the year. The air photos are inconclusive regarding long-term shoreline change because sand could have just been moved offshore into the typical post-storm profile. There may indeed be long-term erosion trends along this stretch of beach. More photo sets are needed to separate out the long-term trends.

At the eastern end of the island, unlike the exposed beaches to the west, shoreline change trends from the air photos are conclusive. The rhythmic topography is not evident probably because these beaches are sheltered by the Sand Island shoals and influenced significantly by tidal currents. Essentially, on these beaches, it appears that the storm-to-storm and longshore variation in shoreline position is small relative to the overall changes measured during the year.

3.5 Sand Samples

Collection

Sand samples were obtained at the eight beach profiles for size distribution analysis. The samples were taken by hand at the top of the berm on the profile. The samples were obtained in September 1991.

Analysis

The sand size distribution of each sample was determined by sieve analysis in the Department of Civil Engineering Geotechnical Engineering laboratory at the University of South Alabama. Samples were dried (at 103 degrees C) overnight and sieved through a full complement of ASTM mesh sieves with a rotap machine. Retained sand was weighed with an electronic scale.

The summary results of the seive analysis are given in Table 1. The full sediment size distributions are plotted in Appendix C. The median diameters ranged from 0.28 mm to 0.43 mm. Using the Wentworth phi scale units, the median diameters ranged from 1.84 to 0.86. This size of sand is classified as medium size sand according to the Wentworth Classification and as fine-to-medium size sand according to the Unified Soils Classification.

The sand was very well sotted. Each sample had a small range of sand sizes in the distribution. Inman's standard deviation in the phi scale is shown in Table 1. Since all

TABLE 1

Sand Size Analysis Data
Dauphin Island Coastal Processes Study

Location:	d(50) [mm]	d(16) [mm]	d(84) [mm]	phi50	phi16	phi84	s.d. [phi]
ADEM #32	0.28	0.34	0.21	1.84	1.56	2.25	0.35
ADEM #30	0.31	0.37	0.24	1.69	1.43	2.06	0.31
ADEM #27	0.28	0.33	0.21	1.84	1.60	2.25	0.33
ADEM #17	0.28	0.35	0.21	1.84	1.51	2.25	0.37
ADEM #14	0.34	0.44	0.26	1.56	1.18	1.94	0.38
ADEM #10	0.43	0.55	0.32	1.22	0.86	1.64	0.39
ADEM #8	0.35	0.47	0.26	1.51	1.09	1.94	0.43
ADEM #2	0.37	0.46	0.28	1.43	1.12	1.84	0.36
eastern 4 ave.	0.29	0.35	0.22	1.80	1.53	2.20	0.34
western 4 ave.	0.37	0.48	0.28	1.43	1.06	1.84	0.39

values are less than 0.5, the samples are very well sorted. This can be confirmed by looking at the entire size distributions plotted in Appendix C.

The size analysis results indicate two different populations of sand on the Dauphin Island beachface. The median diameter is smaller at the eastern end of the island than at the western end. The average of the easternmost four samples is a median diameter of 0.29 mm. The average of the western four samples is a median diameter of 0.37 mm. One of the western samples, ADEM CCL #10 (2417 Bienville Rd.), had a larger sand size than the other three. This may be an isolated pocket of larger sand. A more comprehensive sampling regime in the longshore and cross-shore directions would be required to identify more trends in sand size distribution along the beaches.

The two populations of median sand size discussed above are probably due to the sheltering effect of Sand Island and the associated ebb-tidal shoals. As shown in Figure 1, the four easternmost sites with the smaller grain sizes are behind the shoal complex. These four sites experience a much milder wave climate due to the presence of the shoals. Section 3.1 shows that the day-to-day wave climate this year was much smaller in the lee of the shoals than to the west. The four western sites are exposed to much larger day-to-day wave heights. A greater percentage of small sand grains are able to remain on the beachface in calmer wave conditions. On the more energetic beaches to the west, the finer grain material gets winnowed out of the beach sands.

3.6 1991 Beachfill Monitoring

In June 1991, Mobil Exploration & Producing U.S., Inc. placed 15,000 cubic yards of sediment along a 900 ft. stretch of beach around the fishing pier. During the spring of 1991, shoreline and duneline recession was threatening the structural integrity of the Park & Beach Board facilities including a bathroom, several picnic pavilions, and timber walkways located on the top of the sand dunes. There was concern that the landward end of the fishing pier was in danger of being flanked by the shoreline and concern for the structural integrity of the landward end of the pier due to erosion around the piles (Henderson, personal communication 1991). Coincidentally, Mobil was preparing to dredge material from the sound almost directly on the other side of Dauphin Island from the public beach. Mobil was dredging the material to float a drilling rig into place in shallow water. At the request of the Dauphin Island Park & Beach Board, the owner and manager of the public beach, Mobil placed the material on the public beach. The Park & Beach Board did not pay for the material or any of the financial costs of dredging and moving the material.

Mobil's dredging contractor used a mechanical (clamshell and crane) dredge to remove the material from the bay. The dredging site was in the Aloe Bay area of Mississippi Sound. The dredge contractor hauled the material around the island by barge and placed it onto the beaches directly by clamshell and crane. The crane operator placed the material up against the existing dunes to try to simulate the recently eroded dune template. Most of the material was placed above the existing water level. The dredging and beachfill took about two weeks to complete. The contractor began about June 4 and finished about June 18, 1991.

Mobil engineers claimed that test borings showed that most of the material to be dredged was sand but that some of the material was silt. The test borings showed silt contents ranging from a few percent to as high as 20% in one sample.

This coastal processes study was expanded to include the monitoring of fate of the beachfill through its first summer. The beachfill monitoring program included profile surveys, visual wave observations, sediment size analysis, and oblique photography. Most of the data are given in Appendix D.

Beachfill Sediment Size Analysis

Four samples were taken of the native beach sand immediately before the beachfill began. Fill samples were taken on three days during the two week period of beachfill placement. A total of six samples were collected to get a representative estimate of the fill material size characteristics.

A sediment size analysis was done on each of the ten samples. The native material was sand with a median diameter of 0.31 mm with no silt or shell content.

The fill had a median diameter of 0.38 mm. Thus, the fill material was slightly more coarse than the native material. The fill had measurable amounts of both silt and sea shells. The silt content ranged from 5% to 12% by weight. The average silt content in the beachfill material was roughly 8%. The shell content ranged from 1% to 11% by weight. The average shell content in the beachfill material was 5%.

Beachfill Profile Surveying

The fate of the beachfill was surveyed along ten beach profiles. As shown on Figure 15, three profiles (plus the pier centerline) were in the fill area, two were at the edges of the fill and four were beyond the fill area. The profiles were surveyed four times; immediately before the fill, immediately after, one month after fill, and three months after fill. The resulting beach profiles are plotted in Appendix D.

The total fill volume was about 15,000 cubic yards. This volume is a rough estimate based on the three profiles across the fill. No fill was placed immediately under the pier by the crane operator.

Figure 16 shows one of the beachfill profiles. The elevations are from a temporary baseline in the dune field out across the dune face into the water. The fill is clearly shown. The fill widened the dune over 50 ft. at the +7 ft NGVD contour. The fill moved the waterline (0 NGVD) about 20 ft. seaward. The two subsequent profiles show that the fill is being removed by scarp or bluff erosion. As waves act on the base of the bluff, material slumps off into the water. Within three months, the bluff had been cut back about 25 ft.

The profiles immediately beyond the ends of the fill showed some small amounts of deposition around the waterline. This indicates that the some of the fill material lost to bluff erosion went both to the east and to the west along the beach.

Beachfill Visual Wave Data

LEO data as described in Section 3.1 was collected on a volunteer basis by the same observer for sites #1 and #3. The observation was taken at the road/path about 700 ft. west

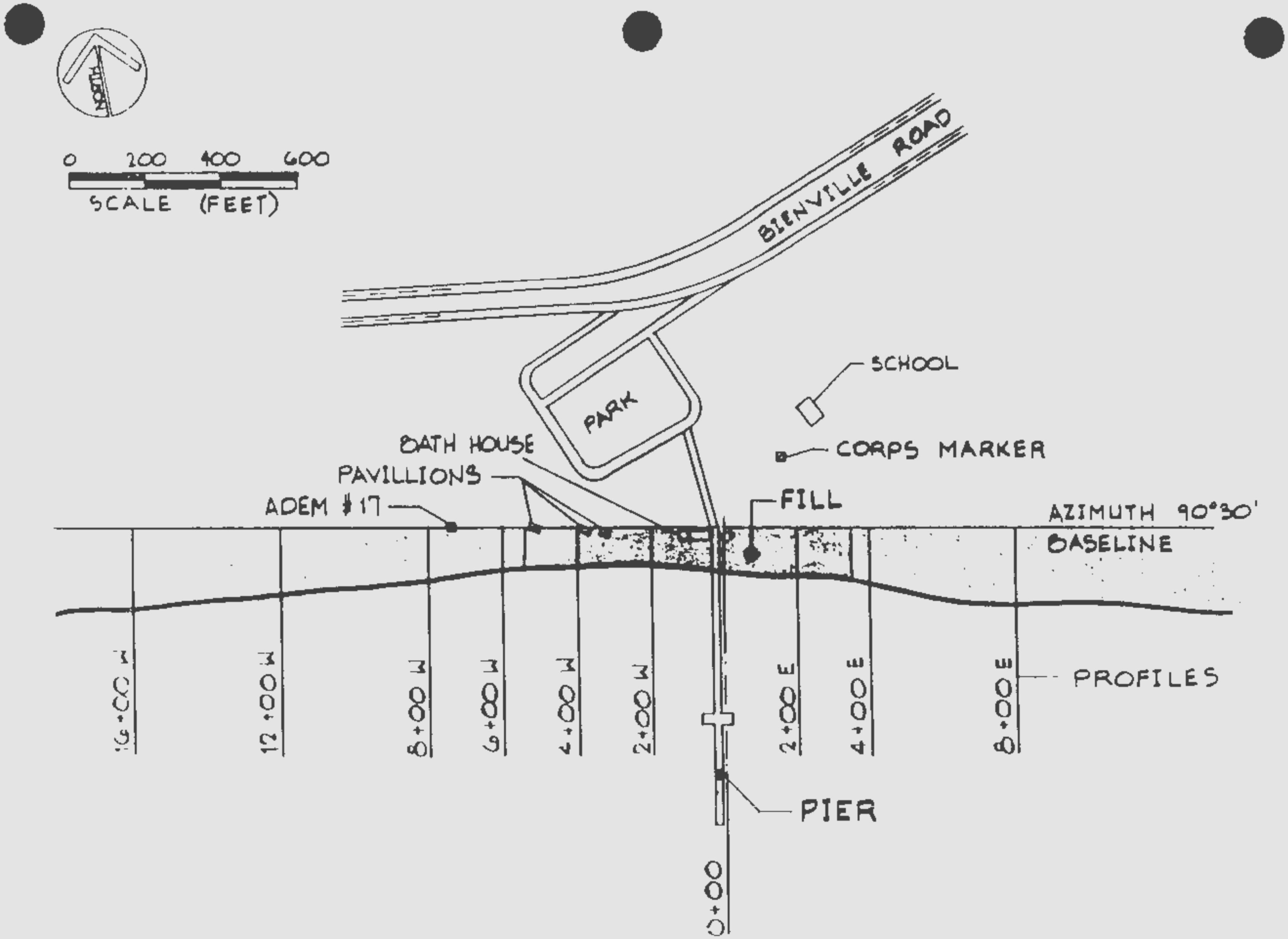


Figure 15. Beachfill monitoring profile locations

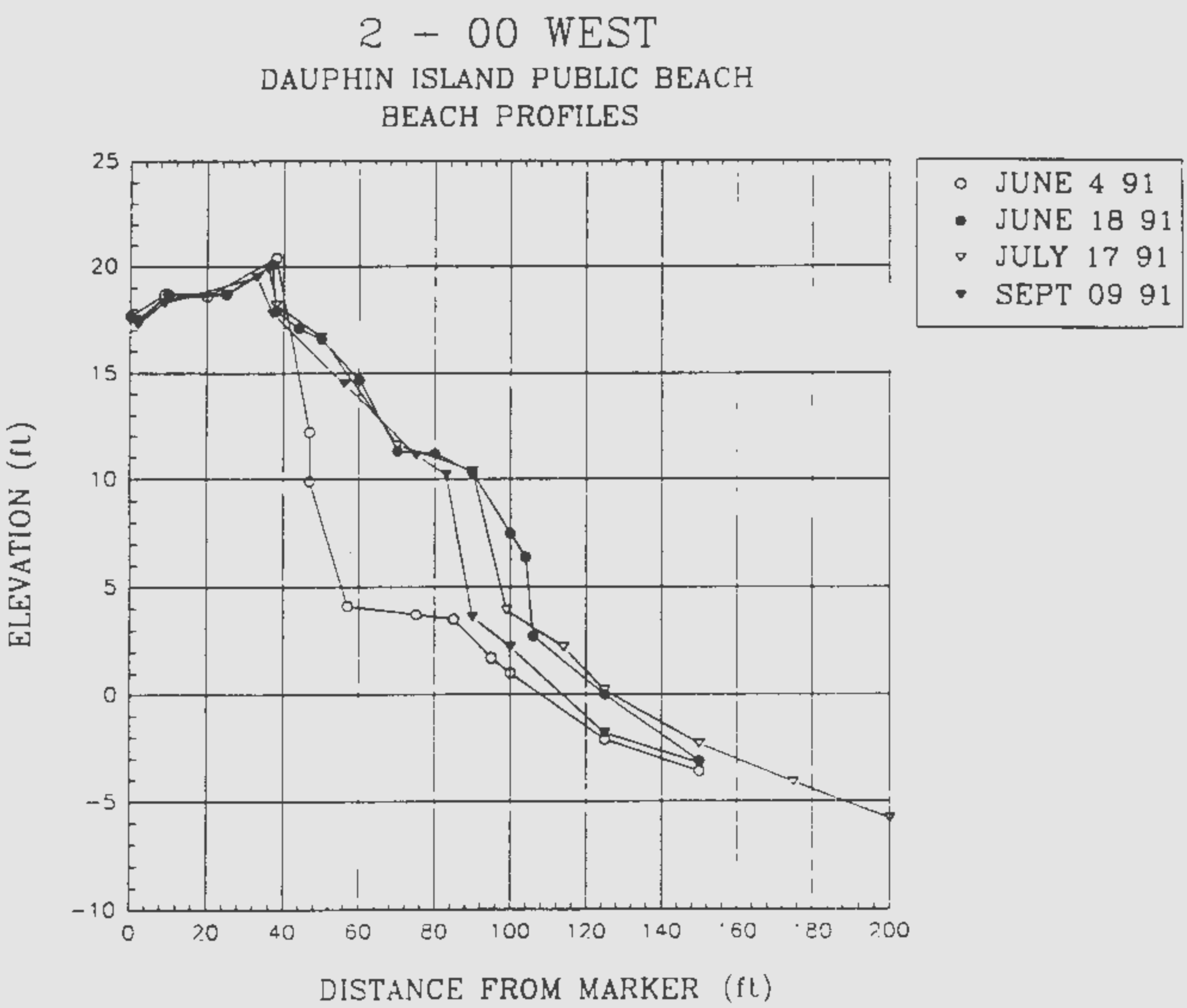


Figure 16. Typical 1991 Beachfill profile

of the pier. The most interesting results are that the direction of average wave approach and the net longshore sand transport was to the east, i.e. opposite to those found for the year at the other three sites. This location is clearly sheltered from waves from the southeast by Sand Island.

Beachfill Photography

Photographs were taken from the same location on the pier to the east and the west during the monitoring program. Five sets of photographs were taken. The photographs (not included in this report) show several important features of the fill as discussed below.

The color of the fill was initially much different than the native material. In particular, the fill was much darker than the native material. By early August, however, the visible top layer of the fill had bleached to nearly the shade of the native sand.

The shells present in the fill armored the top surface of the fill within a few weeks of the completion of the fill. Apparently, the upper layer of the fill was changed by heavy rainfall which washed away the silt and sand. The shells in that layer did not wash away but lagged on the surface. Thus, the upper layer of the fill became almost all oyster shells. It was very difficult to walk on the fill without shoes or sit on the fill after this shell lagging occurred. Although not captured by the photography, it was also very difficult to walk or sit on the fill for another reason immediately after the fill, i.e. before the shell lagging became the problem. For the first few weeks after the fill, it was very difficult to stand on the fill because ones feet sunk into the material. In other words, the bearing capacity of the material could not support a human. In summary, people couldn't use the fill for the first few weeks because it was too soft and couldn't use it after that because of the oyster shells.

3.7 Other Observations

Two informal sets of observations of Sand Island and its related shoals were made during the study year.

A crude bathymetric survey of sand bars to the west of the north end of Sand Island was made in August 1991. Figure 17 shows a sand bar extending west from the north tip of Sand Island. The vessel used in this survey was not able to operate in water shallower than 5 ft. deep. Just north of the sand bar the water depth increased to 16 ft. deep in Pelican Passage. The bar extends about a mile to the west with an average depth of about 10 ft. (relative to NGVD). At its western end, the bar becomes as shallow as 5 ft. deep.

The sand bar is apparently fed by sand driven north off the tip of Sand Island into Pelican Passage where the ebb-tidal currents from Mobile Bay move it westward. As the sand moves westward, the tidal currents lessen and the waves increase. Thus, the sand is driven onshore. The bathymetry shown on Figure 17 and the beach profiles shown on Figure 10 indicate that sand bars are migrating onshore. This is probably the mechanism that moves sand from Sand Island to Dauphin Island.

Changes in Sand Island were aperiodically monitored by a volunteer with oblique air photos. During the year of this study, there were rapid changes to the exposed portion of the Sand Island shoal complex. During one storm, much of Sand Island was overwashed and breached. The breach sealed itself off briefly but then was reopened several weeks later.

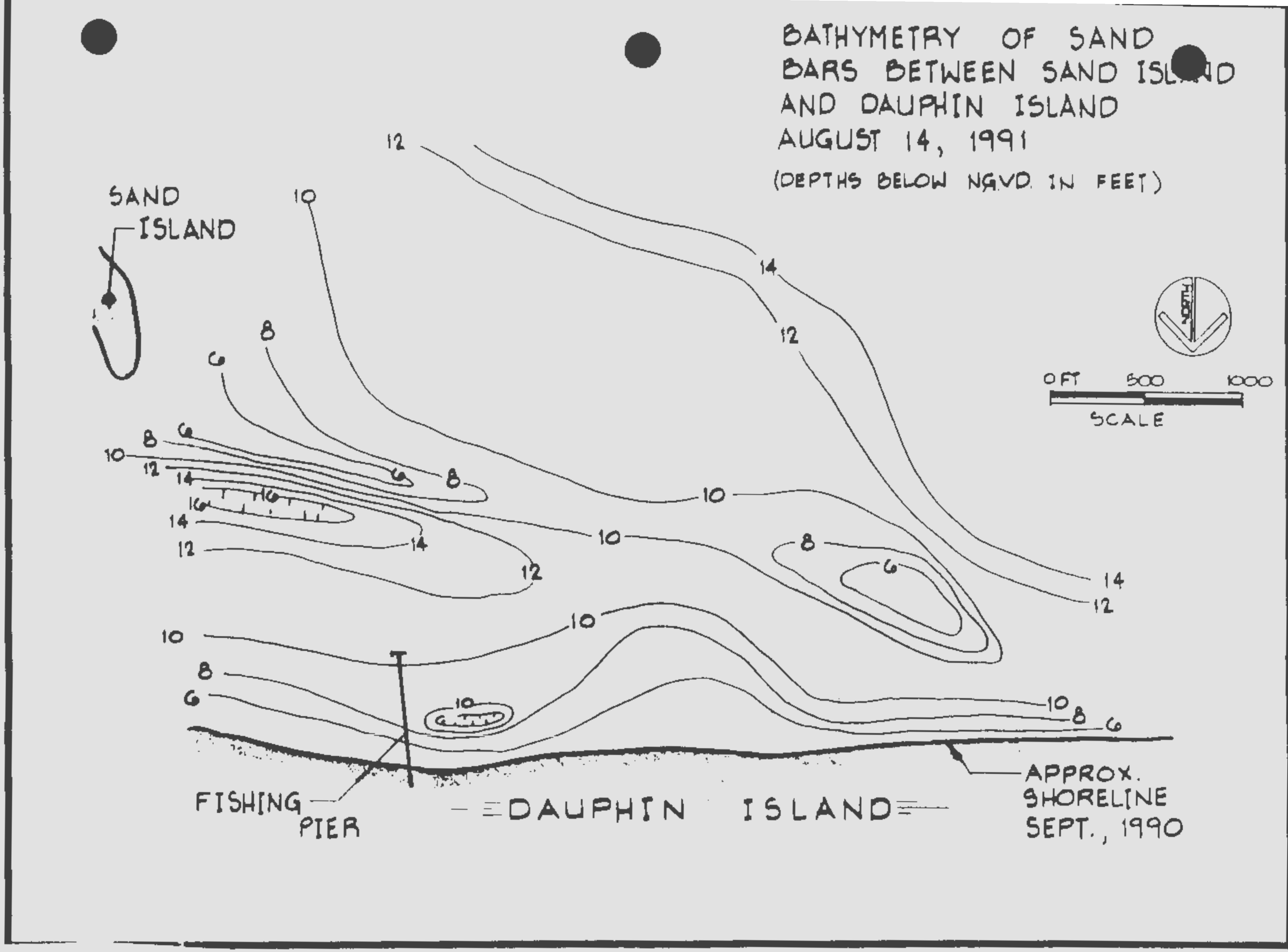


Figure 17. Bathymetry of sand bars between Sand Island and Dauphin Island (Aug. 14, 1991)

Along all of Sand Island, the shape of the Island and shoals varied greatly from month to month and even from week to week depending on the storm activity.

CHAPTER 4. COASTAL ENGINEERING HISTORY OF DAUPHIN ISLAND, ALABAMA

Coastal engineering of the beaches and waterways of Dauphin Island probably began over three centuries ago. However, coastal processes are presently being affected by engineering projects completed within the last century. This chapter outlines the history of the coastal engineering projects which are visible today and are affecting the present-day coastal processes on the beaches of Dauphin Island. These coastal engineering projects include rubble-mound coastal structures (groins, jetties and seawalls) around the east end of the island; a 1980 beachfill project which affected shoreline position at the east end during the 1980's; dredging of Dauphin Island's waterway system; and dredging of the Mobile Ship Channel.

4.1 Coastal Structures

The coastal structures on Dauphin Island are concentrated at the eastern end of the island (Figure 18). The functional purpose of most of the structures was land protection. The functional purpose of a few of the structures was to improve navigation.

The present groins and seawall at the eastern tip of the island were built around the turn of the century. Much of the following is based on research in the historical map files in the Mobile District of the Corps of Engineers. An 1894 map of shoreline positions in 1856, 1873, 1878, 1892, and 1893 shows that the shoreline east of the fort progressively

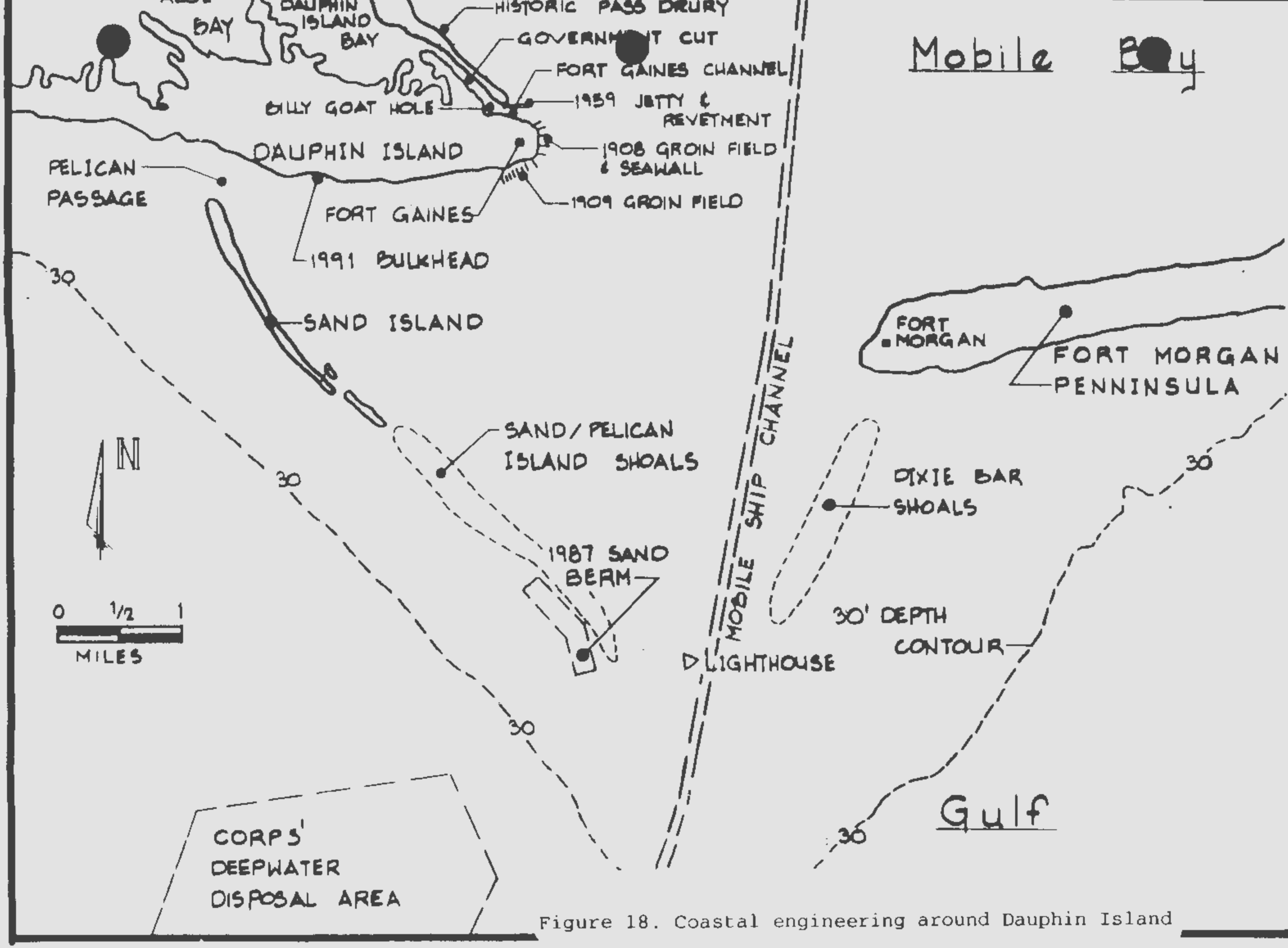


Figure 18. Coastal engineering around Dauphin Island

receded about 200 ft. during those forty years. The map shows a remnant of an old concrete wharf 300 ft. northeast of the fort. This location is now over 200 ft. from shore and under about 10 ft. of water.

In 1894 plans were drawn up to place a series of groins at the east end to protect the fort. Apparently, these groins were not effective because in 1897 plans were drawn up proposing a riprap seawall and six larger rubble-mound groins to armor the east end of the island. A map of 1902 gun installations shows the seawall and groins in place, indicating that they had been built sometime between 1897 and 1902. Without further information, it is assumed that they were built in 1897. Later maps show minor realignments and repairs to the original groins.

In 1908 and 1909, plans were drawn up to lengthen the seawall and groin system to wrap around to the southern beach face. These plans and partial "as-built sketches" are plotted on two cloth plans drawn by W.S. McNeill and signed by S.J. Jeremy, Major, U.S. Army Engineers. At least part of the construction was done by a contractor named Christie & Lowe. Part of these plans included the repair and extension of several of the 1897 groins.

The present day groin locations correspond with groins built in 1909. All five of the present day groins on the east tip of Dauphin Island, including what is now the east entrance jetty to Little Billy Goat Hole, were built in 1908-1909 (according to plan dated July 28, 1909). Based on the plans, the seawall was probably constructed with a design seaward slope of 1:3, crest elevation of 7 ft relative to "mean low water, fortification elevation," crest width of 6 ft, and landward slope of 2:3. Rubble-mound stone weight requirements are not shown on the old plans.

The groin field on the south facing beach was probably built in 1909. Ten rubble mound groins were designed with a spacing of 100 ft. between groins. The existing groin field consists of nine groins evenly spaced across the same 900 ft. Since the nine existing are located exactly where the 1909 plans called for the construction of ten groins, it is assumed that the plans were modified during construction. The 1909 plans for the rubble-mound groins had design slopes of 1:3, crest elevations of 5.5 ft relative to "mean low water, fortification datum," and crest widths of 4 ft. No records were located concerning any subsequent repair and maintenance of the groins.

Considering the functional purpose of the coastal structures designed and built in 1908 and 1909, they have been a success. The fort has been protected from shoreline recession. Without this protection, it is highly probable that the shoreline of the eastern end of Dauphin Island would have continued to migrate westward through the fort. The groin field to the south of the fort was a functional success until the 1970's. In the last two decades, it has not maintained the shoreline in its 1909 location. The shoreline has receded behind the groins and thus "flanked" the groin field at least twice. The groin field was flanked by Hurricane Frederic and was flanked by more gradual recession in the 1980's. At present, eight of the nine groins are flanked.

From a structural standpoint also, the engineering design of the seawall and groins can be considered a success. The structures have survived with relatively little or no maintenance for the past eighty years. These eighty years included several major hurricanes. At the present time, however, the seawall is showing signs of structural failure. Specifically, the fill material behind the rocks has obviously been pulled out by wave action. Backfill has been needed in recent years to protect the road behind the seawall. The crest of the seawall has probably settled significantly due to scour. The crest elevations of the seawall and groins could be surveyed to document the probable loss in elevation due to scour.

Fort Gaines Channel was stabilized with a rubble-mound jetty on the north side and a rubble-mound revetment on the south side against Dauphin Island during construction around 1959. The entrance to Little Billy Goat Hole was modified at that time.

A new bulkhead was built by the golf course to protect a threatened tee in 1991. Remnants of older, failed structures are visible in that area.

4.2 1980 Beachfill

In February 1980, post Hurricane Frederic, the Corps dredged 180,000 cubic yards of sand from Fort Gaines Channel and placed it directly in front of the fort at the east end of the island. Although this beachfill was not monitored, available air photos show the disappearance of the fill. Much of the sand moved around to the southwest over the next several years and filled the groin field. This sand had left the groin field by 1986. Photos show that in September 1984, the two westernmost groins were flanked. In September 1985 three of the groins were flanked. By October 1986, eight of the groins were flanked. The movement of this sand onto and past the location of the beach profile at the Sea Lab Beach (ADEM CCL #32) is discussed in Section 3.3.

A 15,000 cubic yard beachfill was placed on the public beach around the fishing pier in 1991. This beachfill is discussed in detail in Section 3.6.

4.3 Dauphin Island's Waterways

In the late 1950's the Corps of Engineers constructed a waterway system around the eastern end of the Island (Figure 18). A major feature of the waterway system is a pass, Fort Gaines Channel, which was dredged through the northeastern shore of the Dauphin Island. Prior to dredging of this pass, the shoreline of Dauphin Island was continuous from around the fort to the northeast about a mile to Pass Drury. A 7 acre anchorage basin, Billy Goat Hole, was dredged behind the pass. Fort Gaines Channel and Billy Goat Hole were dredged 7 ft. deep. A channel, Government Cut, was dredged to connect Billy Goat Hole with Dauphin Island Bay. The Government Cut channel was dredged in the estuary immediately behind the barrier beach. Dredge spoil was used to build a sand dune on the barrier beach immediately to the northeast of the channel. Pass Drury, the natural pass from Dauphin Island Bay to Mobile Bay, was closed off with dredged material.

These channels and basins have been dredged eleven times since 1964 with about 600,000 cubic yards of material being removed (Table 2). The majority of this material was placed on the beaches of the barrier island immediately to the northeast of Government Cut. This stretch used to be part of Dauphin Island and is presently, since Pass Drury is closed, part of Little Dauphin Island. Pass Drury reopened in its historical location in 1979 during Hurricane Frederic. During Frederic, the high waters in Dauphin Island Bay forced their way back out through the artificially closed inlet into Mobile Bay. Some of the subsequent dredged material has been placed back in Pass Drury to close it off again.

A beachfill on the eastern end of Dauphin Island was constructed with 180,000 cubic

TABLE 7

DAUPHIN ISLAND WATERWAY SYSTEM
DREDGING RECORDS

YEAR	CUBIC YARDS	LOCATION OF DREDGING	LOCATION OF PLACEMENT
OCT/64	45,000	FORT GAINES CHANNEL & BASIN	
OCT/72	74,000	FORT GAINES CHANNEL & BASIN	
AUG/74	16,000	FORT GAINES CHANNEL & BASIN	
DEC/75	27,000	FORT GAINES CHANNEL & BASIN	LITTLE DAUPHIN ISLAND
FEB/80	180,000	FORT GAINES CHANNEL EXTENSION	EAST END OF DAUPHIN ISLAND
FEB/80	100,000	FORT GAINES CHANNEL BASIN	LITTLE DAUPHIN ISLAND
JUL/84	49,000	FORT GAINES CHANNEL & BASIN	LITTLE DAUPHIN ISLAND
JAN/86	19,000	FORT GAINES CHANNEL & BASIN	LITTLE DAUPHIN ISLAND
APR/89	38,000	PASS DRURY CHANNEL	BREACH ON NO. END OF L.D.I.
DEC/89	42,000	FORT GAINES CHANNEL & BASIN	LITTLE DAUPHIN ISLAND

yards of sand dredged from the Fort Gaines Channel in 1980. The fate of this beachfill was qualitatively described in Section 4.2.

Ft. Gaines channel and the jetties and revetment on both sides have separated the northeast corner of Dauphin Island into two littoral systems. Previously, sand was free to move back and forth across this area. The sand being removed from the channel comes off the adjacent beaches. Probably most of the sand comes from Dauphin Island. By continually moving all the dredged sand to the new Little Dauphin Island, the channel has behaved as a one-way valve draining sand from Dauphin Island but not returning any.

Little Billy Goat Hole, the small boat basin which is also locally called the Ft. Gaines boat ramp or Murphy Bay, is a 0.7 acre basin which is only several feet deep. Mobile County is responsible for the maintenance of the basin. The origin of the basin is unknown to the authors. The basin predates 1940 when it is visible on an air photo.

4.4 Mobile Ship Channel

Dredging of the Mobile Ship Channel is the largest coastal engineering feat in the vicinity of Dauphin Island. This section of the report presents original arguments concerning the environmental impacts of this dredging on Dauphin Islands beaches. The dredging has probably seriously impacted the beaches of Dauphin Island several ways. Almost all of the dredged material, sand, has been permanently removed from the littoral system of the Alabama coast. The littoral system of Dauphin Island has not received any littoral drift from east of Mobile Pass in at least fifty years. Also, the wave climate on Dauphin Island and the hydraulics of the tidal currents through Mobile Pass have probably been changed by the dredging and the effects of the dredging on the Sand Island shoals.

This present study did not focus on evaluating the effects of the dredging on the littoral system. However, within the framework of trying to understand and document the coastal processes of Dauphin Island, it became obvious that the Dauphin Island shoreline position is inexorably linked with changes on the ebb-tidal delta. The following can be considered as a brief, preliminary investigation of the effects of the dredging on the littoral system. The results are alarming enough to indicate that an expanded, comprehensive study of the environmental impacts of the dredging which addresses the issues raised below is warranted.

The Mobile Ship Channel is over 30 miles long. This report discusses only the southern 5 miles of the channel which crosses the ebb-tidal delta system of Mobile Pass. The Corps has been maintaining the channel at progressively deeper depths since at least 1910 and probably longer. Navigation charts from around the turn of the century clearly show a navigation channel. The channel depths have increased from 27 ft. in 1910, to 36 ft. in 1936, to 42 ft. in 1974 and 49 ft. in 1989. The width of the channel is presently 600 ft. in the southern section across the ebb-tidal shoal bar.

Table 3 is an attempt to summarize the Corps' dredging records for Mobile Pass since 1974. Dredging records prior to 1974 were not obtained but may be available. Over 15 million cubic yards of sand have been removed from the Pass since 1974. The average rate of sand removal has thus been about 1 million cubic yards per year during the past 15 years. Almost all of this sand has been removed from the littoral system of Alabama to deepwater

Table 3. Dredging of Mobile Pass

Year	Volume (yd^3)
1974	350,000
1975	980,000
1976	1,360,000
1977	1,270,000
1979	710,000
1980	190,000
1981	610,000
1983	310,000
1984	560,000
1985	1,390,000
1987	660,000
1990	6,760,000

disposal sites.

The magnitude of the sand removal can be envisioned two ways. One, as a volume of sand. For example, 15 million cubic yards of sand would fill a football field two miles high. On the beaches of Dauphin Island, 15 million cubic yards would build a beach over 1000 ft. wide along the entire inhabited portion of the island. Perhaps even more importantly, 15 million cubic yards is roughly 100 times the above-sea-level volume of Sand Island.

Fifteen million cubic yards represents about 1-2% of the total volume of sand in the ebb-tidal shoals. Walton and Adams (1976) have calculated the total volume of sand in the shoals at the mouth of Mobile Bay to be 1.2 billion cubic yards. They calculated this by estimating the bathymetric contours which would exist without the presence of the Pass, and computed the difference between the existing contours. In terms of the total volume of sand removed this century, perhaps 50 million cubic yards, the volume of removal is roughly 5%.

A second way to envision the magnitude of the sand removal since 1974 is in terms of the natural littoral drift rate along this coastline. The dredging is removing sand at a much faster rate than nature moves it along the beaches toward the Pass. A rough estimate of the gross transport rate along the Alabama coast is 200,000-400,000 cubic yards of sand per year. The net transport rate, westward transport minus eastward transport, is probably on the order of 100,000-200,000 cubic yards per year to the west. Thus, the dredging is removing sand at a rate five to ten times that of the net littoral drift along this coast. In other words, 500% to 1000% of the annual net transport is being removed from the littoral system at this location. Almost 7 of the 15 million cubic yards shown in Table 3 were removed in 1990 during the deepening of the Ship Channel to 49 ft. Excluding this volume from the calculation still gives an annual rate of sand removal of over 600,000 cubic yards. Thus, the removal rate is still much higher than the natural littoral drift rate.

In essence, because of the dredging practices, Mobile Pass has functioned as a complete sink for sediment along the coast this century. The "efficiency" of the sink has been much greater than 100% relative to the flowrate of sand towards the sink.

The dredging rates are higher than the littoral drift rates for several reasons. Sand which enters the channel from both sides, east or west, gets dredged and removed to deep water. Thus, the dredge operations should be expected to remove at least the gross littoral drift rate. Also, the long, linear shoals on the edges of the channel allow sand to be driven into the channel along several miles. In particular, Dixie Bar parallels the eastern side of the channel for four miles. During period of waves from the east, sand is driven into this entire length of channel. Thus, the dredging to maintain navigation depths should be expected to remove more than the gross transport rate along the main Alabama coast. The dredging records in Table 3 indicate that this is happening.

The dredging of Mobile Ship Channel has also indirectly affected Dauphin Island by changing the wave climate and the tidal hydraulics of the Mobile Pass. The wave climate on Dauphin Island is strongly controlled by the sheltering provided by the ebb-tidal shoals including the Sand/Pelican Island shoal complex and Dixie Bar shoals. Changes in the position of the shoals and in particular the elevation of the shoals have changed the wave sheltering. It appears that both the Dixie Bar shoals and the southeastern portion of the Sand Island shoal complex have lost elevation. As the top elevations of the shoals have lowered, the wave energy at Dauphin Island has increased. The shoreline changes over the past decade and during the past year of this study can be explained in terms of the changing wave climate on Dauphin Island due to these changes in the shoals. More wave energy from the southeast propagates across the shoals and moves more sand to the west from the eastern end of Dauphin Island.

The tidal hydraulics of Mobile Pass have been affected by the presence of the Ship Channel. The Main Pass is more efficient at allowing water to move out and in Mobile Bay because of the ship channel. Natural depths across the outer bar of Mobile Pass are about 20 ft. Dredging of the ship channel forces these depths to around 50 ft. Simple engineering calculations with Mannings equation indicate that the flowrate through Mobile Pass may be increased from 10% to 100% by the increase in flow area due to the ship channel.

There is some evidence in the bathymetric charts (see either Hands & Bradley 1990 Figure 3 or Hummell 1990 figures) that the delta grew towards the south after the deepening project of 1936. This growth of the ebb-tidal delta is consistent with the increased hydraulic flow scenario. Ebb-tidal delta shoals are in a dynamic equilibrium between the waves pushing the sand shoreward and the ebb currents moving the sand seaward. A major change in the ebb currents due to dredging could cause sand to shoal farther seaward. The southerly growth of the delta into previously deeper water is obvious from 1926 to 1973. From 1973 to 1986, however, the shoals moved northward. This reversal could be due to increased rates of starvation of the entire shoal system as the rates of dredging removal increased. A comprehensive study that correlates the changes in the shoals with the dredging history and storm and wave climate record was beyond the scope of this study. However, such a study is warranted to determine the environmental impacts of the dredging.

In 1987 the Corps disposed of 460,000 cubic yards of dredged material in a different place, in the littoral system. The sand was placed on the edge of the ebb-tidal delta south of the Sand/Pelican Island shoals (Figure 18). The sand was placed as a relatively continuous underwater mound or berm roughly six ft. high and over a mile long (Hands & Bradley 1990). The berm was about 6 miles south of Fort Gaines. By 1988, the berm's upper surface had been planed off by wave activity. By 1990, a portion of the berm had migrated northward up to about 300 ft. (Hands 1991). By the summer of 1991, the berm had migrated back into the ebb-tidal delta and flattened out to the point where it was hard to find a distinctive feature with a fathometer (personal communication, USACE-SAM personnel).

All sand dredged since the construction of this berm in 1987 has been removed to deeper water and not placed in the berm. There are no plans to dispose of dredged sands in the littoral system again (personal communication, USACE-SAM personnel). Based on the historic dredging rates and assuming that the deeper, longer channel will require more maintenance, future dredging can be expected to exceed an average 700,000 cubic yards per year. The actual annual rates will vary greatly about this average due to variation in wave energy from year to year.

The disposal of the sand in deeper water, about 40 ft. deep several miles south of the 1987 berm does not provide any identified benefits to the Dauphin Island beaches. The reported reduction in wave energy across the deeper mound (McLellan, et al. 1990) is more likely to harm, rather than help, the beaches of Dauphin Island. Reducing the wave climate offshore of western side of the ebb-tidal shoal complex will probably result in increasing the volumetric storage in this portion of the shoals. Thus, sand will be short-stopped on its way to Dauphin Island's beaches. The Corps' monitoring program data are inadequate to evaluate whether such trapping is occurring but there is some evidence that such trapping may presently be occurring behind the 1987 berm.

CHAPTER 5. SUMMARY OF THE COASTAL PROCESSES OF DAUPHIN ISLAND

Sand transport paths explain the beach changes presently occurring on Dauphin Island. This chapter summarizes those paths and the resulting shoreline position changes on Dauphin Island. The causes of shoreline change at specific locations are discussed. The interdependence of Dauphin Island's beaches and the larger, overall coastal system including the Mobile Pass ebb-tidal delta shoals is outlined. The influence of man on the coastal processes is also summarized.

5.1 Summary of Sand Transport Paths

Sand transport around Dauphin Island is not a constant process in time or space. Incident waves provide the primary sand-moving force on beaches. Thus, most sand transport occurs during storms. Spatial differences in wave climate affect the sand transport patterns. In particular, wave sheltering by the ebb-tidal delta, including Sand Island, affects the sand transport on the Dauphin Island beaches. The tidal currents into and out of Mobile Pass also affect the sand transport on Dauphin Island. The tidal currents are strong enough to move sand. More importantly, the tidal currents are also responsible for shaping and maintaining the ebb-tidal delta which shelters Dauphin Island from the waves.

The sand transport paths are summarized schematically on Figure 19. Sand is driven westward by waves along the beaches on the eastern end of the island. This westward

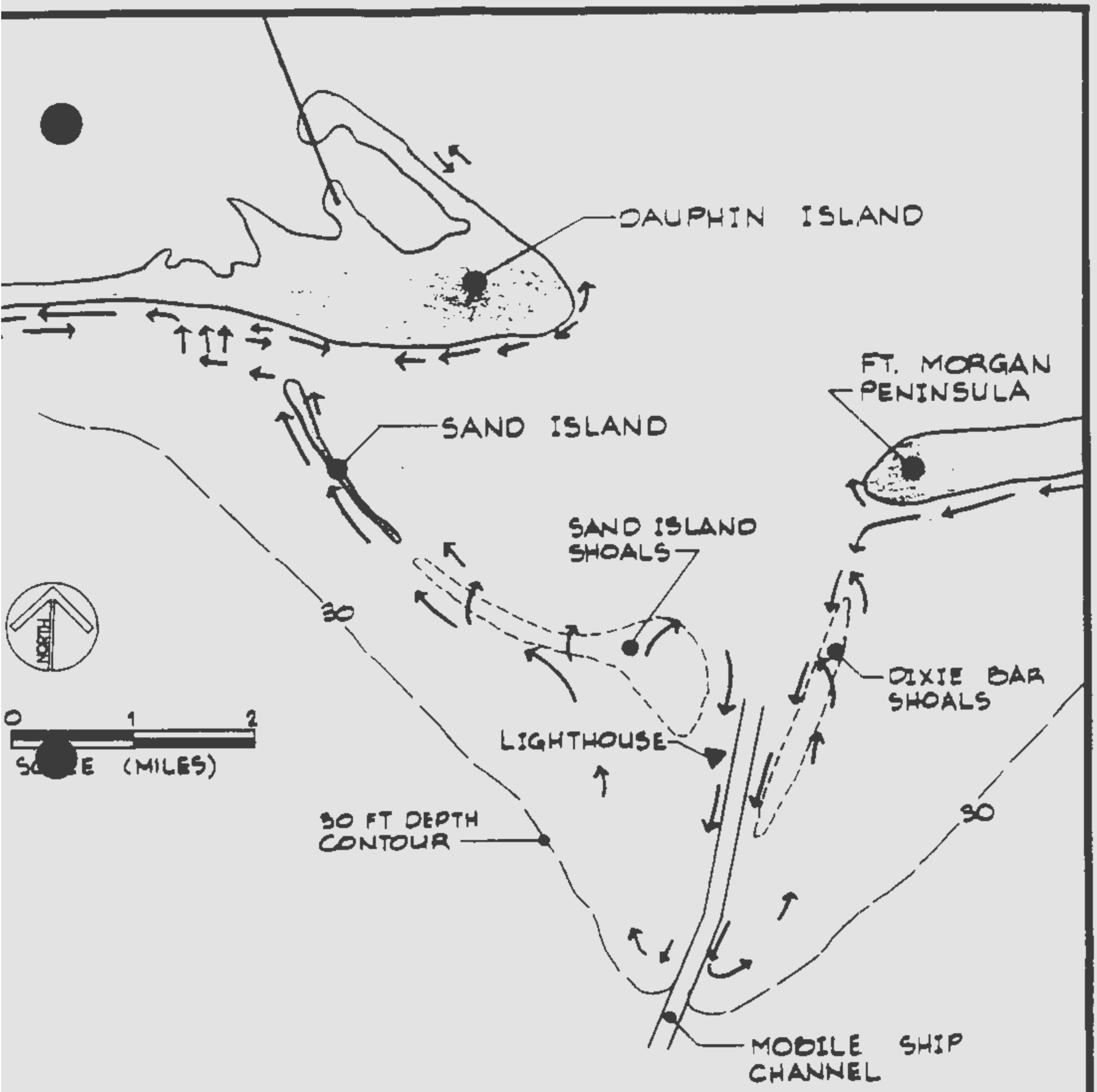


Figure 19. Summary of sand transport paths in the vicinity of Dauphin Island

transport decreases in the lee of Sand Island. Sand is driven northwestward along Sand Island towards Dauphin Island by waves. This sand is driven by waves into Pelican Passage where the ebb-tidal currents from Mobile Bay move it westward. As the sand moves westward, the tidal currents lessen, the wave forces increase, and the sand is driven onshore in migrating sand bars (see Sections 3.3 and 3.7). (Historically, it is possible that breaches in Sand Island have caused Pelican Passage to divert to a new more southern location and thus have driven large amounts of Sand Island onto Dauphin Island.)

Once on the Dauphin Island beaches, most of the sand from the onshore migrating sand bars probably moves westward. Some of it may move eastward into the lee of Sand Island due to flood-tidal currents and waves from the west. The sand moving to the west feeds the littoral system of the west end of the island. These beaches behave very differently since they are not in the lee of the Sand Island shoals and are thus exposed to open Gulf waves. They show much more response to storms and seasons. An offshore sand bar is often present on these beaches. Sand moves both directions along these beaches depending on the direction of wave approach but the net transport is to the west.

5.2 Summary of Shore-line Changes

Some of the beaches of Dauphin Island are eroding and some are gaining sand. Figure 14 characterizes the shoreline changes found during the year of this study based on air photos analysis. Based on historical air photos and surveys, these changes are consistent with the changes that have occurred during the past decade. The easternmost mile of the land, Reach A on Figure 14 is clearly receding. Reach B, the roughly 1.5 miles between Audubon St. and the country club, is primarily accreting, i.e. the beaches are getting wider. Within reach B are two shoreline bulges or progradations that are migrating westward and growing. These two bulges are apparently a form of shoreline position instability. There are two pockets of shoreline recession immediately to the west of each bulge. Overall, however, reach B is gaining sand. The shoreline is clearly receding along reach C, about a half mile reach centered on the fishing pier. Farther to the west, the shoreline changes as measured by the one year of air photos do not show clear trends that are obviously representative of the beaches changes. Along these open Gulf beaches, more than one year of air photo data will be needed to reliably measure shoreline change trends.

Summary of Causes of Shoreline Changes

Most of the shoreline changes on Dauphin Island (Section 5.2) can be explained in terms of the sand transport paths (Section 5.1). The most extensive area of shoreline recession and beach erosion is at the east end of the island from the Fort around the Sea Lab and Coast Guard properties to the Audubon Sanctuary (Reach A on Figure 14). The shoreline receded about 300 ft. in some locations between 1975 and the beginning of this study in 1990. The bluffline receded another 21 ft. during the year of this study (see Section 3.3). This recession and erosion is due to sand starvation at the east end of the island. This starvation may be partly due to the natural migration of the island to the west.

However, man has impacted the processes in several ways. The erosion of these ieach has probably increased due to increased south and southeasterly wave exposure due o changes in the ebb-tidal shoal complex since the 1970's. These changes have probably ieen partially caused by dredging practices for the Mobile Ship Channel. Specifically, as and Island moved westward and Dixie shoals eroded in the last two decades, the eroding eaches have been exposed to increased wave activity from the south and southeast. The roins and revetment have prevented the sand at the eastern tip of the island, around the fort, om moving westward to feed the beaches fronting the Sea Lab and Coast Guard properties. beachfill placed on the eastern tip of the island in 1980 fed these beaches in the early 980's. The Fort Gaines channel prevents any sand from moving onto Dauphin Island from ittle Dauphin Island. The two islands were one island at this location until the channel was edged in the 1950's.

The sand which has eroded from the beaches in Reach A has moved into Reach B, e beaches between Audubon St. and the country club.

The other location of extensive recession is around the fishing pier at the public beach each C of Figure 14). This recession is caused by the northerly migration of Sand Island. elican Passage is being diverted farther north into Dauphin Island than at any time in the st century. In 1850, Sand Island extended farther north but at a location about 4000 ft. east its present location. This beach will probably continue to experience high rates of cession and erosion for the next few years. The erosion of Dauphin Island will probably ntinue until the position of Sand Island and Pelican Passage changes dramatically. The ost likely scenario for the change is a relocation of Pelican Passage through a new, more utherly, breach in Sand Island. There is no clear evidence that such a breach occured in the 1850's or 1860's but it is probable. When this breach and relocation of Pelican Passage occurs, a very large volume of sand presently in Sand Island will be driven onto the shores of Dauphin Island.

5.4 Summary of the Dependence of the Dauphin Island Beaches on the Shoals of Mobile Pass

The beaches of Dauphin Island are affected in several ways by the sand shoals of Mobile Pass. The Island and the Pass are part of the same littoral system. The ebb-tidal shoal system includes all of the shoals around the Pass. The delta can be roughly defined by the 30 ft. depth contour in Figure 19. It extends from several miles east of Fort Morgan to west of the northern tip of Sand Island. The shoals extend Gulf-ward in a triangular shape with the apex of the triangle several miles south of the lighthouse. These shoals have been formed over the centuries by the tidal currents through Mobile Pass and the longshore transport of sand along the Alabama coast. Sand Island is part of these shoals. In fact, Sand Island is just the outer edge of the ebb-tidal delta that emerges from the water long enough for vegetation to become established. At previous times, the island has been called Pelican Island. Sometimes it is one continuous island and sometimes it is several islands. The ebb-tidal shoal complex also includes the shoals on the eastern side of the main ship channel, Dixie Bar. At previous times this shoal also was emergent.

The ebb-tidal shoals provide both sand for the Island beaches and wave sheltering to those beaches. This relationship between a downdrift barrier island and the updrift inlet is not unique. A unique aspect of the relationship between Dauphin Island and Mobile Pass is that the inlet is one of the largest inlets in the world with one of the most extensive ebb-tidal shoal systems in the world.

5.5 Summary of Man's Influence on the Coastal Processes

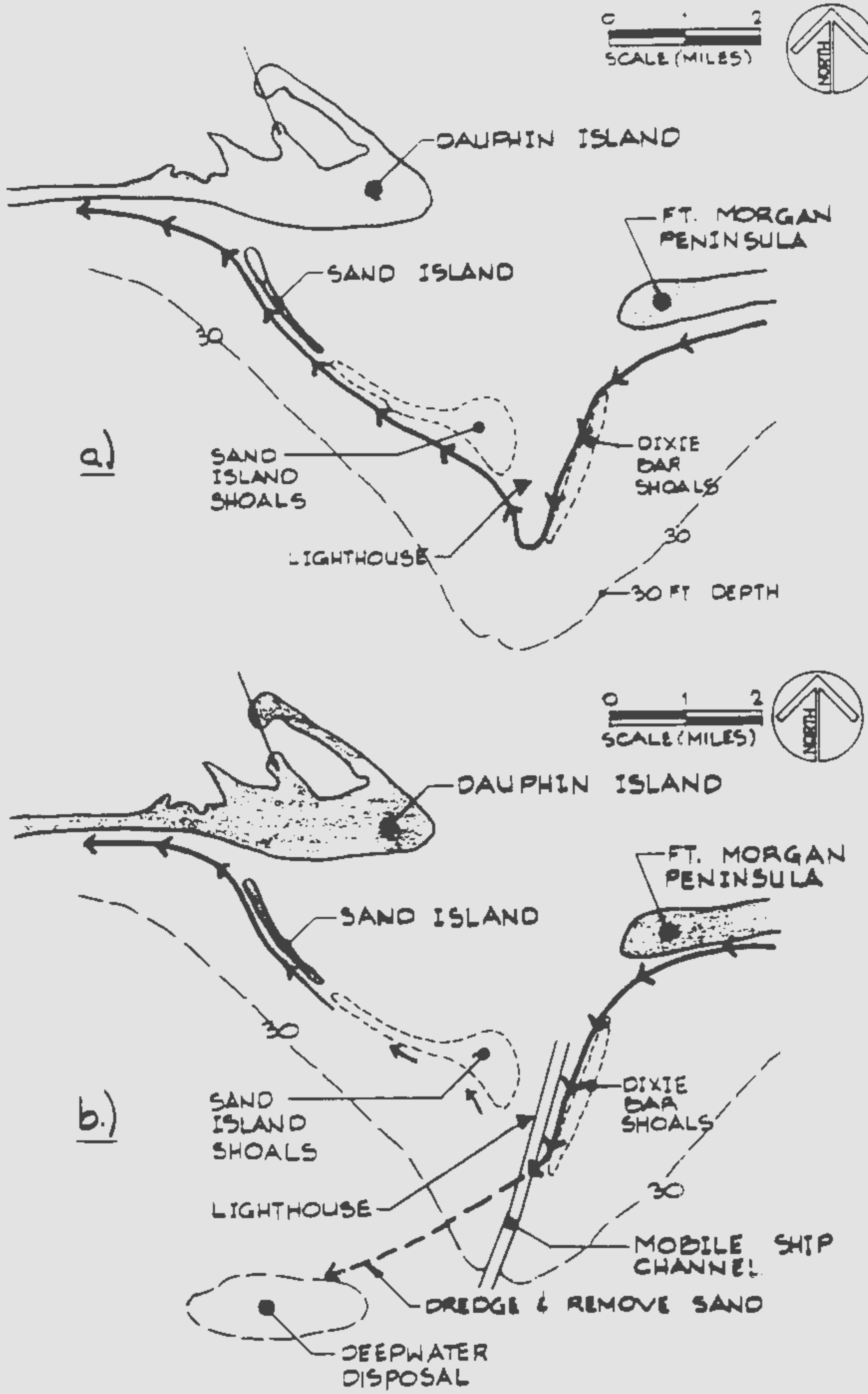
During the past decade or so, some of the beaches of Dauphin Island have gained sand and some have lost sand. These changes can be attributed to natural coastal processes which have been modified by man's activities. Without man's intervention over the past century, the shoreline position today would, undoubtedly, be different. It is equally improper to state either "the erosion has been caused by man's intervention" or "the erosion has been caused by natural processes." The natural coastal processes have been at work on shaping the island for thousands of years. But man has had a significant impact on these processes for at least the past century since the construction of the coastal protection for Fort Gaines in the 1890's and since maintenance dredging of Mobile Pass started.

The seawall and groins at the east end of the island have protected the sand around Fort Gaines and prevented that sand from moving west (see section 4.1). The 1980 beachfill at the eastern end of the island migrated westward and provided some protection to the Sea Lab and Coast Guard beaches during the early 1980's (see section 4.2). Construction of the Fort Gaines boat channel cut the littoral system of the eastern tip of the island into two separate parts (see section 4.3). Channel maintenance dredging is contributing to the sand starvation at the east end of Dauphin Island by placing sand that washed into the channel from Dauphin Island in the now separate littoral system of Little Dauphin Island.

Proper data have not been collected to adequately evaluate the environmental impacts of the dredging practices for the Mobile Ship Channel on the ebb-tidal system including the shoals and the adjacent beaches. However, the dredging practices have probably already caused a significant impact on the beaches of Dauphin Island. The impacts of the sand removal, which has increased in rate recently, may become more severe over the next several decades. The shear size of the inlet-shoal system and its natural fluctuations may mask the man-induced impacts without careful analysis.

The dredging has removed about 15 million cubic yards of beach quality sand from the littoral system of the State of Alabama since 1974 (see section 4.4). Extrapolating to the turn of the century, perhaps as much as 50 million cubic yards of sand has been permanently removed.

The dredging has completely blocked the natural, long-term source of sand for the beaches of Dauphin Island. Figure 20 summarizes the net sand transport paths prior to dredging and at present. Prior to dredging, sand followed a "U" shaped path from the beaches of Fort Morgan Peninsula onto the Dixie Bar shoals across to the Sand Island shoals to Dauphin Island. The same general physical forces, tidal currents and waves, are at work today and the sand paths are the same today with one exception. The dredging of the ship channel breaks the "U"-shaped path at the bottom of the "U." The ship channel is dredged and maintained at a depth of about 50 ft. and a width of 600 ft. through a sand bar that would naturally be only about 20 ft deep. Waves drive sand into the bottom of the "U" from both sides and it is removed by the dredges to maintain navigable depths. The sand is moved



igure 20. Net sand transport path; a) pre-dredging, b) present conditions

from the bottom of the "U" offshore several miles and dumped in deep water outside the littoral system.

The wave and longshore sand transport climate on Dauphin Island has probably been changed by the impact of the dredging on the Sand Island and Dixie Bar shoals. The dredging, through simple sand starvation, may have caused the permanent disappearance of the dry land near the lighthouse, i.e. the eastern end of the exposed part of the Sand Island shoal complex. The dredging may have also caused the loss of elevation of Dixie Bar shoals through simple sand starvation.

CHAPTER 6. MANAGEMENT SUGGESTIONS

This chapter presents suggestions for the management of Dauphin Island's beaches based on the coastal processes findings summarized in Chapter 5. The philosophy underlying these suggestions is that management and development decisions should be made either:

1) to work with the coastal processes, or

2) with an understanding of the costs of working against the coastal processes.

Successful management strategies are not based on technical information alone. They are based on value judgements made by the policy-makers and the decision-makers. The technical information provided by this report is only one input to the decision-making process. Thus, the technical input can be used to come to different management conclusions. The following management strategies are based on a blend of the technical input and (the first author's) perceptions of what is most important to Dauphin Island at this time.

The technical information provided in the first five chapters of this report, however, is independent of this chapter. The technical information can and should be used as a resource to answer management questions by the policy-makers and decision- makers of Dauphin Island.

The management suggestions are:

1). Determine the impacts of historical dredging on ebb-tidal delta dynamics, Sand Island, and Dauphin Island beaches. The environmental impacts of the dredging have not been adequately evaluated even though millions of dollars per year are spent on maintaining the Ship Channel and millions of dollars per year of benefits are realized through the port of Mobile. The economic impacts of dredging-induced beach erosion on Dauphin Island may be significant. The study should pursue the lines of thought and questions raised in Section 4.4. In particular, the impact of dredging on the shoals (in the area of the outer bar) which shelter Dauphin Island must be carefully evaluated. The basic data that must be gathered and evaluated together include the full dredging record with dates and locations of removal and disposal, plots of historic elevation changes on the ebb-tidal delta (based on navigation charts), updated historic shoreline change maps for the area, a bathymetric survey of the ebb-tidal delta, historical air photo and satellite image analysis of the changes on the Sand Island shoals, and historical wave and water level climatology.

A long-term monitoring program to collect the basic data (including periodic air photos and surveys) to document the future changes in the shoals should be initiated.

The State and Town should strongly encourage the Alabama Congressional delegation to instruct the Corps of Engineers to conduct such a comprehensive study. To date, the Corps has done an effective job of doing what it was told to do - "keep the ship channel open". The State of Alabama and the Town of Dauphin Island should now ask that it be told to be as effective in "evaluating the environmental impacts of the dredging on the shoals and beaches of the state". The State and Town should be involved in the study.

Since maintenance dredging will continue to remove sand from the littoral system of the State of Alabama, the State should develop a mechanism that keeps track of these removals. The beach quality sand of Alabama should be managed like a valuable resource. Perhaps the permitting process could be modified to clearly track the removal of this resource from the beach/littoral system of the State. The information should include volumes, dates and clear maps of where the sand was dredged and where the sand was dumped.

The ultimate goal should be to understand the natural changes in the shoals and man's impacts. The solution may be to replace the natural sand bypassing interrupted by the dredging. An obvious alternative solution is to place all dredged sands in the littoral system. The 1987 "experimental feeder berm" showed that this was technically feasible. The study outlined here may show that such a solution is justified for environmental and economic impact reasons.

2). Consider moving the existing public swimming beaches for safety, esthetics, and capital expense protection. The two public swimming locations are in the two most dangerous locations on the island. The beaches east and southeast of Ft. Gaines are exposed to the extremely dangerous tidal currents of Mobile Pass. These currents typically move at speeds around 4 miles per hour. No one can swim against such currents. The tidal currents are much more dangerous than rip currents because the tidal currents can move a swimmer ten miles to the south instead of tens of yards.

The public beach near the fishing pier is unsafe because of the tidal currents, the steepness of the beachface and tree stumps in the surf. Submerged stumps could eviscerate body surfers. The steepness of the beachface causes surging breakers that make the shallow part of the surf unpleasant and dangerous for both adults and children. The tendency of bathers is thus to move beyond the breaker line into the deeper water where the tidal currents dominate. These tidal currents usually move to the left or to the right along this beach and, thus, are not as dangerous as the tidal currents at the eastern end.

Just about any other place on the island is safer and more pleasant for bathing and swimming. Specific examples of safer swimming locations are the Coast Guard Beach and the west end. The southern facing Coast Guard beach on the east end of the island is physically safe and attractive for bathing because of the low wave climate and flat shallows offshore. The Audubon/campground area, just to the west of the Coast Guard beach, may be a safe beach also. However, the steepness of the beach and the strength of the tidal currents were not observed during this study. This overall general area, west of the groin field, is suggested as an alternative for development of a public beach area. Swimming should not be allowed east of the flanked groin field.

The beaches at the west end of Bienville Blvd. are fairly safe and pleasant for swimming. The dangers at the west end beach are the same as for any beach exposed to the open Gulf of Mexico wave climate. Thus, the dangers are not a complete surprise to many bathers. The greatest danger is rip currents through the sand bar system. The west end beach is attractive because of the wave climate and the sand dunes. The west end is suggested as the best alternative for development of a public beach facility for these reasons.

Another alternative is to provide public access to all the Gulf beaches along the island.

At present, parking restrictions prevent the use of most of the island's beaches.

3). Relocate the public beach facilities around the fishing pier. A bathroom and several pavilions were threatened by undermining during the spring of 1991. They are perched on what is now the top of the sand dunes with a rather impressive view of the Gulf. The aspects worth saving here seem to be a public bathroom and the views from the dunetops for picnicking. The bathroom could be located behind the dunes in the parking area. The pavilions could be moved back away from immediate danger. They could be redesigned to provide flexibility in moving them backward or forward.

The process primarily responsible for the beach erosion at the public beach, the northerly migration of Sand Island (see section 5.4), shows little sign of changing within the near future. Perhaps a major storm will cause a breach of Sand Island and relocation of Pelican Passage. Until Sand Island moves farther south, however, the recession will continue. The costs of engineering solutions such as beachfills or structures must be balanced with the worth of the facilities and functions being protected. Public bathing and swimming should not be encouraged here because of the dangers outlined above. The fishing pier, however, is problematical. This location is excellent for fishing. The structural integrity of the pier must be monitored. In particular, pile lengths must be sufficient for scour due to the migration of Pelican Passage. The landward end of the pier can either be extended landward or armored (if legal).

4). Place sand dredged from Ft. Gaines channel on Dauphin Island. Much of the sand that shoals into Ft. Gaines Channel came off the beaches of Dauphin Island. The rest of the sand was moving toward Dauphin Island. All of it should be placed on Dauphin Island. The best place to put it is in the area of the flanked groin field south of Ft. Gaines. From here it will gradually feed the severely eroded beaches along the easternmost mile.

5). Maintain/improve the armoring at the east end around the fort. The seawall and groin field protection for Ft. Gaines has apparently not been maintained since construction in 1909. The stones in the armor layer have settled due to the underlying material being gradually removed. A full rehabilitation of the seawall is suggested to protect the Fort.

6). Establish a "feeder beach" at the east end. The area of the flanked groin field is a logical location for beachfill sand. It will, if placed properly, move to the west to nourish the mile of starved beaches. The rocks in the flanked groin field should be realigned parallel to the design beach to function as offshore segmented breakwaters. The design breakwater and gap lengths can control the rate of sand transport to the west. There are enough rocks to extend the offshore breakwaters to the west along the Coast Guard beach or to use in the rehabilitation of the seawall protecting the fort. The coastal processes causing the shoreline recession along this eastern mile of beach show no signs of changing (until Sand Island moves back to the east and allows waves to drive the sand at the golf course back to the east) Thus, the beaches will continue to recede. This is the logical place to feed the beaches.

7). Do not encourage encroachment. Dauphin Island has not succumbed to one of greatest temptations in the development of barrier islands, encroaching towards the sea. Credit should be given to the original developers for laying out the lots with a beach buffer zone. Serious erosion problems have been minimized by their forethought. All governing entities should continually strive to maintain as wide of a buffer as possible between the surf and buildings. The beaches of the island show a tendency to come and go in response to storm waves and high water levels, particularly on the western end. The buffer zone allows this to proceed naturally without threatening buildings.

8). Discourage breaches in the dune line. The dune fields along the island are the primary defense against storm waves and tides. During Hurricane Frederic, the west end of the island was overwashed. The major overwash channels were located at many of the north-south streets and driveways. Essentially, the streets and driveways became the path of least resistance for storm surge waters because they were straight, flat, and sometimes paved. More property damage will probably occur at these locations during future storms. The high dune field on the eastern three miles of the island was not breached or overwashed in spite of recorded water levels in excess of 15 ft. above normal. Future development should be discouraged from contributing to the breaching of the dune field along the entire island. The goal is to reduce property damage sustained across the width of the island during future large storms. The form of the discouragement could be in term of development regulations, guidelines, or simply education.

A specific suggestion for individual property owners on the west end is to "unstraighten and unflatten" their own private driveways to reduce the probability of overwash channels developing through their property. The goal is to minimize damage to their property and the roadway during the next major overwashing storm. This suggestion applies to property owners on both sides of the road. This "unstraighten and unflatten" idea could also be considered for the north-south streets by the Town.

9). Monitor beach changes. The State and Town are encouraged to begin to monitor the beaches. Quality data concerning shoreline changes and the forces causing the changes are generally not available on Alabama's coast. However, management decisions should be made with a clear understanding of the coastal processes. The data collected during this study was relatively inexpensive compared with the value of the beaches. Hopefully, the value of continued data collection and the understanding of the beach changes is great enough to justify some continued level of monitoring. The least expensive parts of the monitoring are the air photos and the visual wave observations. However, the beach profile data proved invaluable in determining the overall coastal processes of the island. The State is encouraged to continue to pay for the air photos annually. The State is also encouraged to begin a formal beach profile collection along all of Alabama's beaches. The profiles should extend farther offshore than the profiles surveyed in this study. They should extend offshore far enough to measure changes across the entire littoral zone (15 to 30 ft. deep). As the database lengthens, longer term trends will become more clear. In particular, shoreline and offshore changes along the western half of Bienville Blvd. should be watched.

10). Consider the development of local and state Beach Management Plans. Alabama's beaches are valuable to the local citizens and to the entire state for their economic and quality of life benefits. The beaches of the state are clearly a valuable resource. Legally, the beaches, below the high tide line, belong to the citizens of the State. Practically, the value of private property along the beaches is related to the attractiveness of the beaches. It only makes sense that such a valuable resource should be managed to realize its full potential for the long-term benefits of the state and the local community. Alabama needs to develop a comprehensive Beach Management Plan. The plan should identify goals and objectives for the management of Alabama's beaches, identify responsible agencies and recommend funding sources.

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