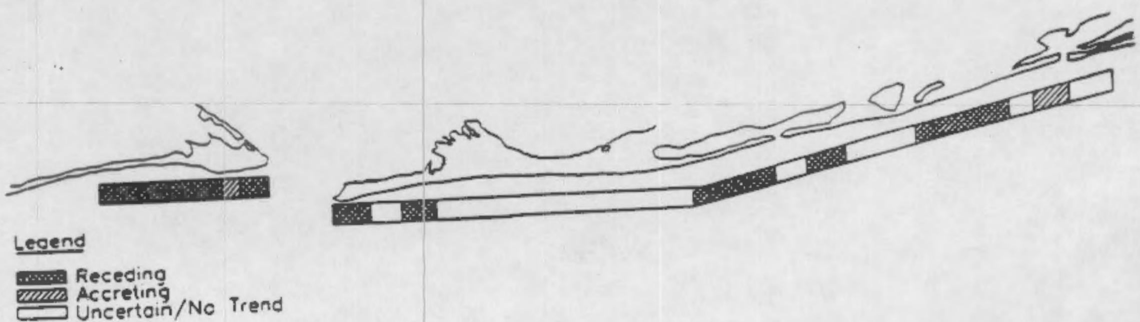
"State-of-the-beaches" of Alabama: 1998



"Some of the fondest memories of many Alabamians are of trips to the beach."

University of South Alabama
and
Alabama Department of Economic and Community Affairs

"State-of-the-beaches" of Alabama: 1998

by

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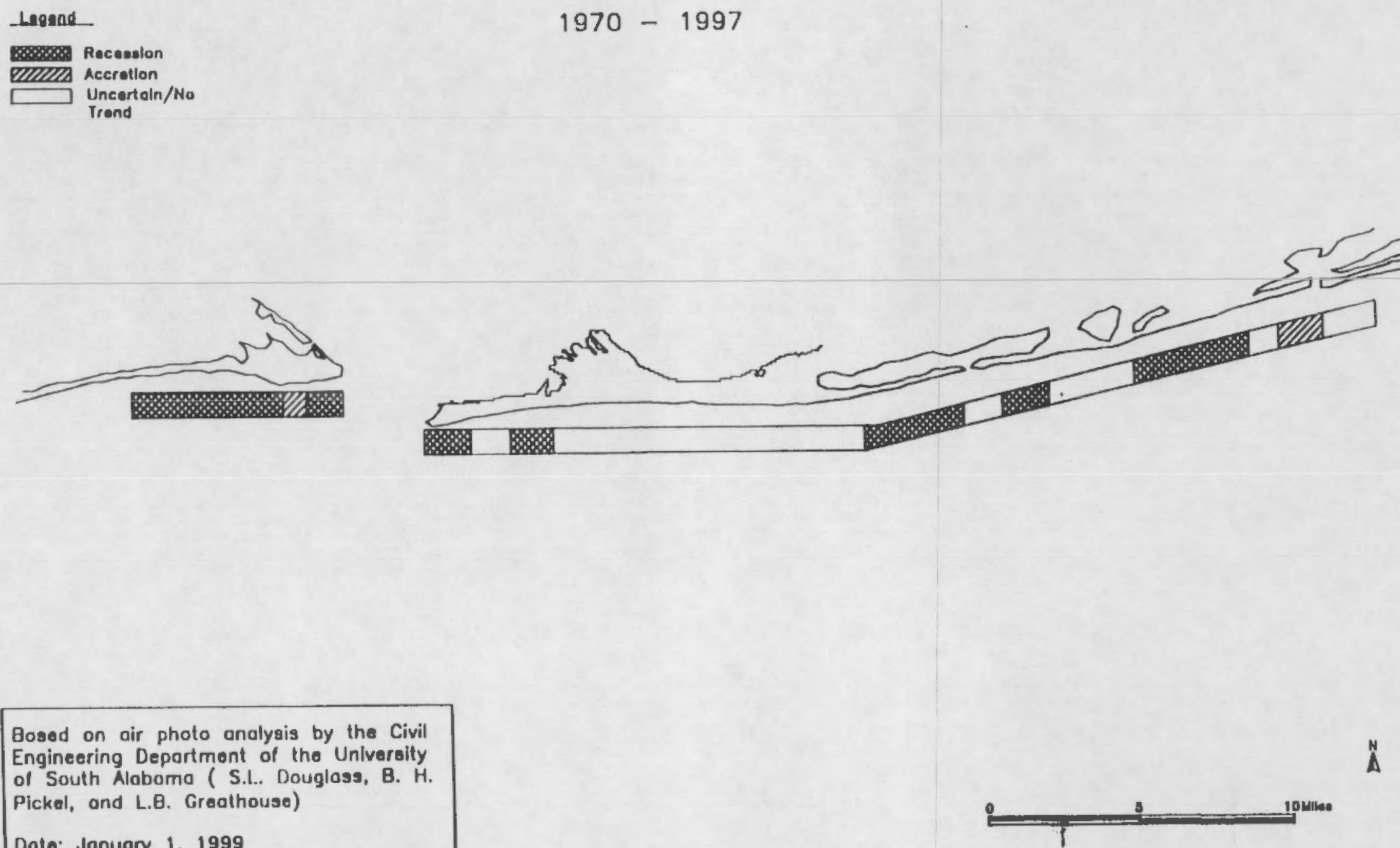
Figure 1.

SUMMARY OF ALABAMA SHORELINE CHANGE TRENDS

1970 – 1997



Based on air photo analysis by the Civil Engineering Department of the University of South Alabama (S.L. Douglass, B. H. Pickel, and L.B. Greathouse)

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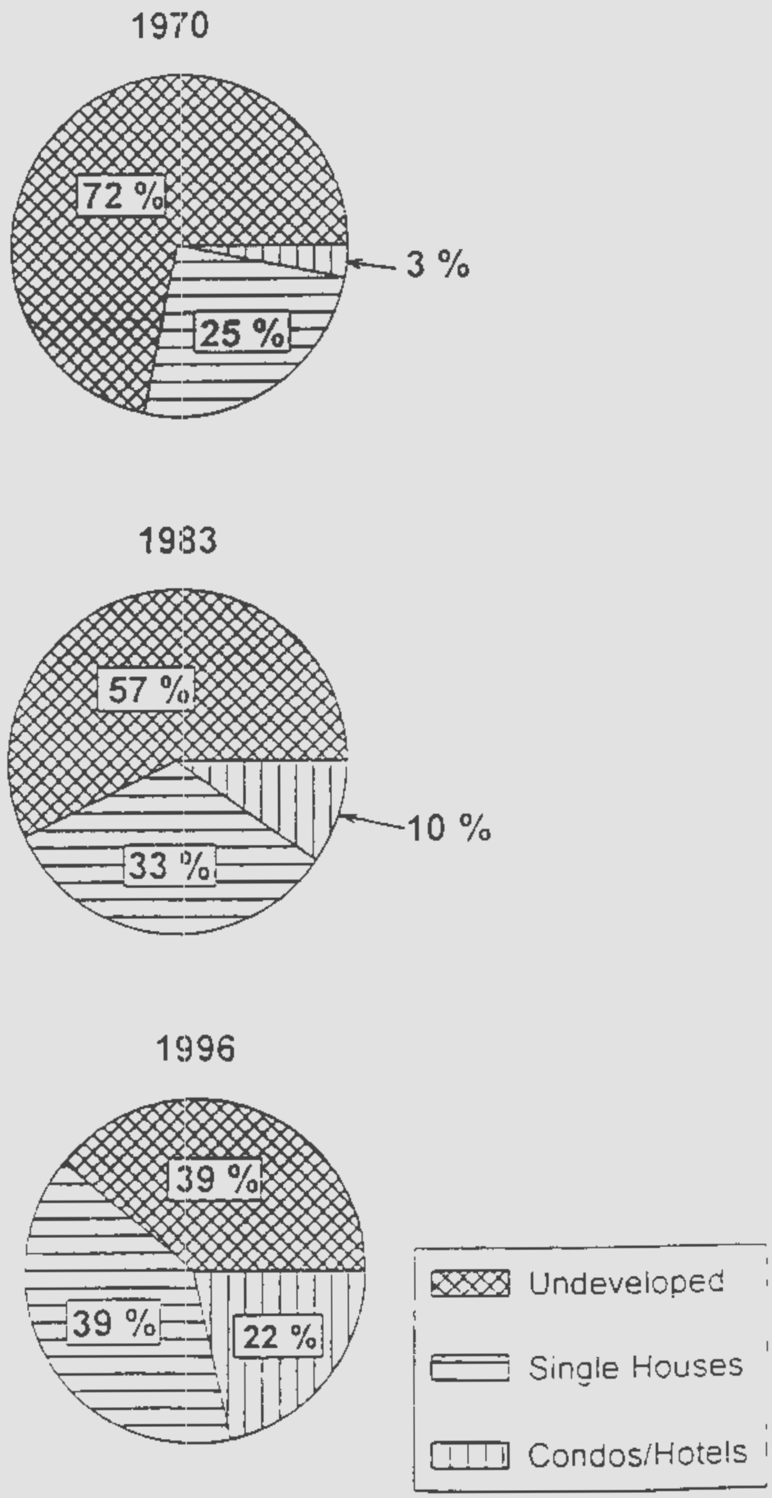

Figure 2. Development trends on Alabama Gulf beachfront

engineering has influenced much of it. Alabama has 3½ tidal inlets: Perdido Pass, Little Lagoon Pass and Mobile Pass break through the barrier island system of the state. Petit Boit Pass is at the western end of Dauphin Island and straddles the Mississippi-Alabama border. Each of the three passes in the state has a significant impact on the beaches in the vicinity of the pass. Each of the passes has engineered jetty or seawall structures and regular dredging to maintain adequate water depths. The sand that is dredged from these passes is sand that came off the adjacent beaches. It is also sand that was on its way back to the beaches before it was removed by dredging operations. That sand is part of the same littoral system as the sand on the beaches. The details of our understanding of the relationship between the beaches and passes are discussed below.

Littoral drift

Along the Alabama Gulf beaches, the dominant direction of longshore sand transport, or littoral drift, is from east to west. However, often and for sustained periods of time, significant amounts of sand move toward the east. The dominant processes, or mechanism, for moving sand in the littoral system is longshore sand transport. Longshore sand transport is the *wave-driven* movement of sand along the coast. As waves approach a beach at an angle, they break and move sand in that direction. Thus, when waves approach the beach from the other direction, the longshore sand transport direction reverses. Some of the long-term shoreline change trends in Alabama can be explained in terms of changes in longshore sand transport.

wetline; water level fluctuations due to tides, winds, barometric pressure, and waves; and photogrammetric errors of tilt and lens distortion.

The data were evaluated using linear regression analysis to determine the shoreline change trend. Confidence intervals, at the 80% and 95% level, were computed for the trend. These confidence intervals can be considered to be analogous to the "margin of error" that typically is presented with polling data.

The results, the annual shoreline change rate in feet per year, are shown in Figure 3. The vertical bars represent the shoreline change trend at each location. They range from an accretion rate of over 20 feet/year at one location on Dauphin Island (on an accreting bulge on the golf course) to a recession rate of over 20 feet/year at another location on Dauphin Island (near the Coast Guard facility). Positive trends indicate shoreline accretion: i.e. the beach was getting wider. Negative trends indicate shoreline recession: i.e. the beach was getting narrower.

Figure 3 only includes that data through 1997. Data were collected for 1998 prior to Hurricane Georges using a GPS. These data were not included in the statistical analysis. However, inspection of the 1998 data indicated that the behavior of the beaches in 1998 was generally consistent with the data of the past few years.

It is obvious from Figure 3 that the answer to the question "is the beach eroding" depends greatly on which Alabama beach is being considered. The interpretation of the locations of the bars with the open star (80% confidence interval includes zero) is that there is no trend. The beaches fluctuate but there is no trend. Some exceptions to this interpretation are appropriate at places where, because of man's manipulations, the changes are not linear.

The general summary Figure 1 was generated from the data in Figure 3 using three basic assumptions. One, that there is no trend in the data if the 80% confidence interval for the trend included 0 feet/year. Two, a single location with a significant trend is ignored if the adjacent locations showed no trend. Three, the beaches behaved consistently between data locations.

The report also contains a few beach profiles. 22 beach profiles in the state have been surveyed repeatedly since the early 1990's (see Figure 4 for locations). Some older beach profiles are available for Dauphin Island. The beach profile data were obtained using standard surveying techniques. Elevations along a line perpendicular to the shoreline are surveyed from a fixed benchmark across the dunes, beach, into the water and out to and sometimes across the sand bar (for an example, see Figure 7).

Beach by Beach results

The following discussion summarizes the results of the monitoring data described above on a beach by beach basis. The individual beach reaches discussed are shown on Figure 5. The discussion also attempts to explain the results in terms of the authors' understanding of the coastal processes of that area based on a decade of research on the Alabama coast and general principles of coastal science and engineering. There is an incomplete understanding of the Alabama coastal processes because of the short duration and limits of our research. We do have a better understanding, through site-specific research, of the coastal processes affecting some portions of the Alabama coast than others. For example, the causes of the dramatic changes on the east end of Dauphin Island are fairly well understood due to several years of focussed research. We do not have as clear of an understanding of the coastal processes of Perdido Pass, which have a great influence on the beaches of Orange Beach. Also, relatively little is known about the coastal processes of the Gulf Shores beaches.

Perdido Key

The western two miles of Perdido Key are in Alabama. The analysis of the air photos, Figure 3, shows no significant trend. Figure 6 shows an example of the full database on Gulf shoreline position at a location opposite the bridge to Ono Island. There are significant fluctuations, over 150 feet, in shoreline position. However, there is no significant trend in the data. The slope of the trendline is –0.2 feet per year +/- 2 ft. Thus, the 80% confidence interval, analogous to margin of error, includes no trend. The beach profile data (not shown) here also have no trends.

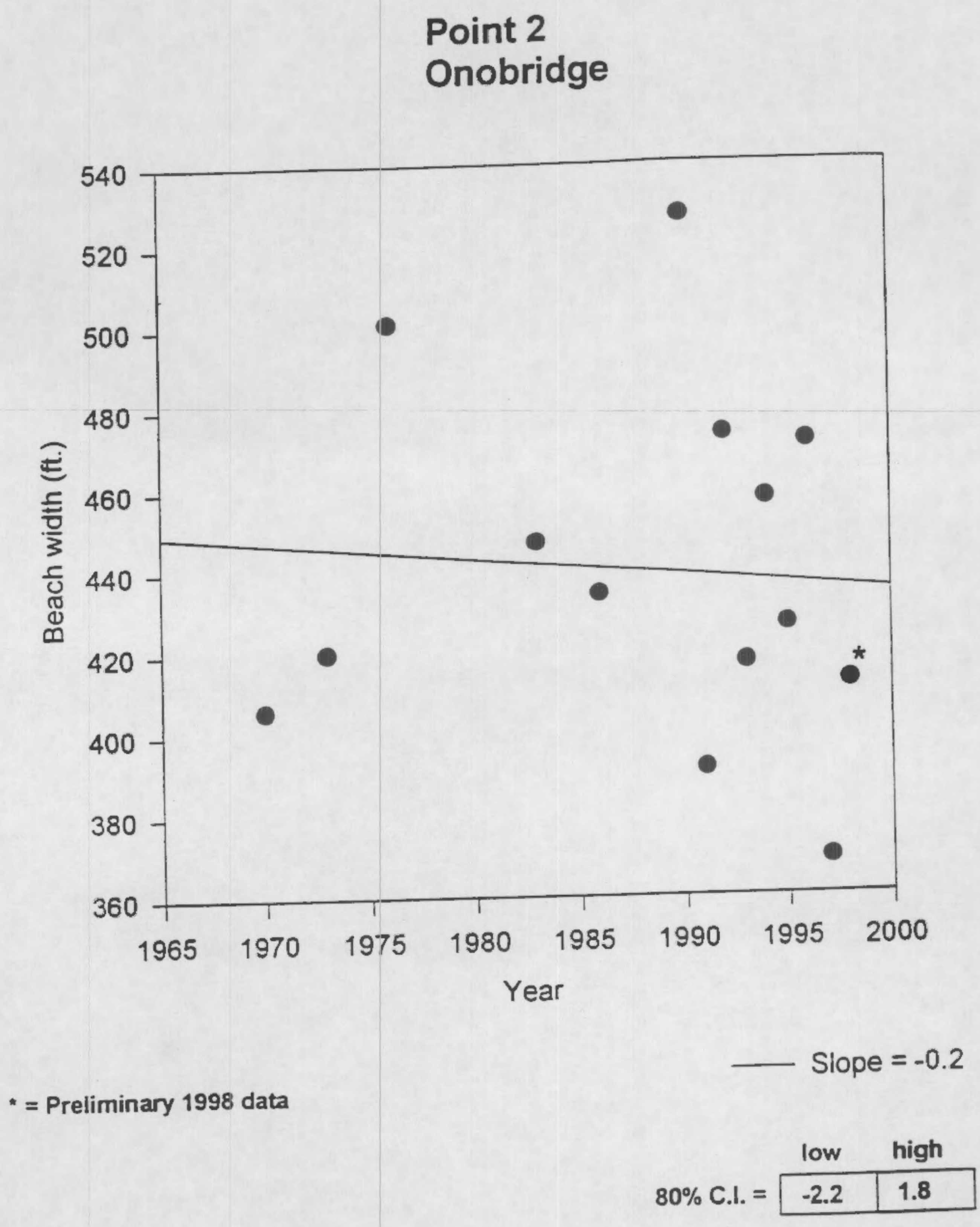

Figure 6. Shoreline location analysis for Perdido Key

planform (shape of the beach as viewed from above) moved toward a new equilibrium position adjacent to the jetty. When waves are approaching the Alabama coast from the southwest and the longshore sand transport is to the east, sand is free to move off the beaches of Orange Beach into this area. However, when waves are approaching the Alabama coast from the southeast and the longshore sand transport is to the west, the sand in this area is partially sheltered by both the rock jetty itself and the shoals around the mouth of Perdido Pass. Essentially, this sand is partially, permanently trapped in this fillet.

The sand fillet is also the location of the disposal area for the sand-bypassing operation at Perdido Pass. Most of the sand dredged from the deposition basin and main channel during the past thirty years has been placed on the beaches within several hundred yards of the jetty or immediately offshore of these beaches. The beaches have fluctuated dramatically in response to sand bypassing episodes. Further research into the correlation of these fluctuations and the dredging/sand-bypassing history is warranted. The bypassed sand has helped the fillet reach its new equilibrium planform or shape since the jetties were built. All of the sand in the fillet is sand that would otherwise have moved east into the channel or west to the other beaches of Orange Beach. Thus, the engineering project has probably permanently widened these beaches but, as explained below, perhaps at the partial expense of the beaches to the west.

West Orange Beach

The beaches of the western portion of Orange Beach appear to be receding from 1970 to 1997 (see Figures 1 and 3). This recessional reach extends roughly from the west end of Cotton Bayou to the western city border at the main unit of the Gulf State Park.

This recession may be due to the engineering of Perdido Pass. In particular, this recession may be due to the sand trapped in the fillet on the west side of the pass. As mentioned above for the wider beaches, this trapping can be explained as an expected

It should also be noted that this portion of the coast has the narrowest beaches in the state. For example, in the September 1995 photos used in this study, the beach widths, defined as the distance between the buildings or bulkheads and the high water line, averaged about 70 feet and varied from 0 to 130 feet along the central 2.5 miles of Gulf Shores beaches. They average over 200 feet and varied from 120 to 700 feet in the rest of Baldwin County. The narrow beaches in Gulf Shores may be due to encroachment of the buildings more than erosion. To the citizen or the tourist, the result is the same... the beaches are narrower.

It is possible that the bulkheads and narrow beaches in this area have slightly biased the analysis used in this report. When water is adjacent to the wall, the beach width is measured at the wall instead of some landward or narrower location. It is known from observations that there are days with no dry beach seaward of the bulkheads in this area. It is not known if the frequency of occurrence of this condition is greater than it bas been historically. Further research, including more detailed surveys of the full beach profile, is recommended to develop a better understanding of the beach sand volume and processes for future management decisions.

Repetitive surveys of a beach profile are shown in Figure 7. Sand elevations in front of the aluminum bulkhead at the Main Beach (the "Hangout" area at the south end of Highway 59) at different times since 1992 are shown. Most of the surveys are near the end of the summer when the beaches are typically at their widest. The figure shows that there is a tremendous amount of sand in the profile that is stored in the sand bar that is offshore.

Lagoon Pass area

The engineering of the pass has impacted the beaches around Lagoon Pass for at least a mile on either side. The inlet was stabilized by jetty construction in 1981. There was no sand bypassing system put into place. In a classic response to jetty construction, the beaches accreted on the eastern side and receded on the western side for about a decade. In the early 1990's a lawsuit settlement included the nourishment of the western beaches and the shortening of the jetties. With the shortening of the jetties, dredging is now needed on a fairly regular basis (about 6 times per year) to maintain depths in the pass. The dredged sand is disposed of on the beaches to the immediate west. Essentially, the current operations are a form of sand bypassing. The coastal engineering has worked. The beaches have been widened on the western side of the pass and the pass has remained open.

West Gulf Shores

The western beaches of Gulf Shores, from Lagoon Pass to the end of West Beach Boulevard, have been recessional since 1970. The extent of the recession, shown in Figures 1 and 3, includes almost all of the beaches to the west of Lagoon Pass. Of particular interest is the recession near the west end of Little Lagoon. Figure 8 shows the detailed shoreline change analysis at one location. The trend is one of recession of about 5 feet per year. The 80% confidence interval for the slope of the trend is plus or minus about 2 feet/year. This is analogous to the margin of error commonly used to present polling results as discussed earlier. One interpretation of the statistics is that the recession rate is somewhere between 3 and 7 feet/year. It is clear that there is a significant recessional trend.

The causes of this recession are unclear and require further research. Part of the recession may be due to the engineering at Lagoon Pass. Another possible cause of the erosion along these beaches is the removal of sand from the beach system that occurs when a large storm hits the area. For example, when Hurricane Opal brushed this coast in 1995 on its way to Pensacola, the storm surge crossed over the barrier island allowing waves to move sand from the beaches and dunes across the road and into Little Lagoon. A layer of sand up to several feet deep was deposited on the lots and West Beach

Boulevard at the end of the storm. Little of this overwashed sand was returned to the beaches from which it came. Hurricane Georges resulted in similar overwash. Some portion of the overwashed sand was returned to the beaches but the portion that was on private property, or in Little Lagoon after the storm, was not returned to the beach. Thus, there was a significant removal of sand from the beach and dune system. The volume of sand removed from these beaches via this overwash process during Opal and Georges was very roughly equivalent to 20 to 30 feet of permanent beach width.

West Baldwin County

Most of beaches of western Baldwin County, from the west end of Little Lagoon to the end of Fort Morgan Peninsula, have no shoreline change trends for the past thirty years. Figures 1 and 3 show that most of these beaches have no significant trend. There has been some serious speculation that these beaches may be growing over the past century. These data however do not show any significant accretion in the past three decades. The beach widths along some of these beaches are the widest in the state because the construction was set back so far. The perception of healthy beaches may be partially because they are so wide as measured from the construction line. When the waterline is 300 feet from the buildings, shoreline fluctuations of plus or minus 100 feet are hardly noticeable.

Figure 3 shows that a few locations have recessional trends. The western tip of Fort Morgan Peninsula, in the state park, in particular has extremely large recession rates. These recession rates are probably related to the dynamics of Mobile Pass. The elevations of the shoals offshore of this area have decreased. Part of this decrease may be natural fluctuations but part of it is probably also due to the removal of sand from the outer bar of Mobile Pass. The same problem is influencing the beaches of Dauphin Island.

West Dauphin Island

The west end of Dauphin Island, from the little red schoolhouse to the end of the road, has been receding since 1970. The data analysis for this study stopped at the west end of Bienville Road and did not include the undeveloped portion of the island. The recession rate has averaged 2 to 3 feet per year. The cause of this recession is not as well understood as that at the east end. Clearly, storm overwash during Hurricane Frederic and Elena moved sand from the beach and dune system to the sound. This removal of sand may be contributing to the recession.

Consideration of the natural sand transport paths indicates that another probable cause of the recession of the west end beaches is the removal of sand from the outer bar of Mobile Pass several miles to the east. Sand apparently naturally moves via wave driven processes along the outer edge of the ebb-tidal delta (Sand/Pelican Island) from the area near the lighthouse towards the fishing pier. It then naturally moves from Sand Island to the beaches of Dauphin Island in the form of migrating sandbars between the pier and the general vicinity of Ponchatrain Street. From there, the sand is moved west via wave driven longshore sand transport toward the west end of Dauphin Island. Thus, the "river of sand" that feeds the beaches of the west end of Dauphin Island is being interrupted by the dredging removal of sand several miles to the east. The beach erosion currently being experienced by these beaches is consistent with erosion experienced miles downdrift of other navigation projects that remove sand from the littoral system.

areas had fairly wide beaches before the storm and suffered relatively minor or no wave damage. At the time of the publication of this report, three months after the storm, some Gulf front businesses in the areas with the narrowest beaches immediately before the storm hit were still not open. Businesses that were behind wide beaches were open within days after the storm. Another example is the comparison between the main pavilion and the 2^{nd} St. beach access facilities in Gulf Shores. The former were damaged were as the latter were not. The 2^{nd} St. structures were setback farther from the water. There were many more similar examples. A primary reason for coastal construction setbacks in Alabama is to provide for a "buffer zone" between the waves and structures to account for the natural variability in beach width from week to week to protect the beach. A secondary effect of this "buffer zone" is that in storms, this buffer zone can work to protect structures too. This "buffer zone" concept was validated in Georges.

2. Elevation of construction – the higher the elevation, the less damage. Examples of damage are the condos on Perdido Key that were built with a base floor elevation at about +8 ft. Most of them suffered severe losses in the lower floor units. Counter examples can be found at the Windrift condo also on Perdido Key and at many sites throughout Baldwin County. Houses and condos elevated above +13ft suffered much less damage.

3. Amount of sand reservoir in the beach and dune system in front of development – the more sand in the reservoir, the less the damage. Examples of very little sand are the west end of Dauphin Island and eastern Gulf Shores. Examples of much sand are the condos on Fort Morgan Peninsula that are set behind the sand dunes. These condos suffered no wave damage from the storm and were open for business within days.

4. Construction methods – pilings and tie downs work. The slab failure of a condo on Perdido Key is an example of why slabs do not work well on the beach. Post-storm inspection indicated the structure failed because the waves and storm surge

elevation was lost between the original waterline and the post-storm dune scarp. Also note that interpretation of the beach width based on water line is not clear. In other words, the actual waterline may not have moved much but the beach and dune above the waterline were severely eroded. The post-storm profile was not extended offshore to a closure depth but focused on the dune portion of the profile.

Beach and dune erosion similar to that shown in Figure 9 undermined many beachfront structures. More condos would have been undermined if condo developers, at the request of the Alabama Department of Environmental Management, had not been recently siting the condos up to 60 feet north of the construction control line on the basis of dune erosion model predictions.

C. Some of the sand eroded from the beach and dune system was overwashed onto (and in some cases across) the barrier island but some of it was pulled offshore into the sand bar system. The existing sandbars were pulled farther offshore during the storm. Figure 10 shows the beach profile changes at a location along the west end of Dauphin Island. This location is in the area with no north/south roads about halfway between the schoolhouse and the west end. The profile begins near the front of the houses. There was obvious overwash of sand from the beach and dune system to the north at this location. A lens of sand between 1 and 2 feet thick buried the roadway.

The pre-storm profile (the dashed line on Figure 10) was Friday before the storm and the post-storm profile (the solid line on Figure 10) was Friday after the storm. Before the storm, the dune field was significant and had an elevation of about 8 feet. Also, note that the profile "closes" in the offshore. In other words, it appears that all of the significant vertical change in the beach system is accounted for in the survey (except the overwash fan).

The survey shows that there was much sand volume moved offshore beyond the pre-storm sand bar location (400 ft). This created an extremely wide flat area from 200 to 500 feet offshore that was essentially neck deep water. The sand in the area between

Mobile Bay. Counter examples are condos that were damaged, the causeway to Dauphin Island (which was exposed to the same wave conditions as the park revetment that survived), and Bayfront Road in Mobile. There are many other examples.

suggestions are based on treating the beach sands of the state as a valuable resource. They deal with technical and management issues. The technical issues are:

(a) bypass sand at inlets

(b) beach nourishment engineering

(c) return overwashed sand

The management issues are:

(a) role of government in beach management

(b) public access

(c) beachfront building codes and practices

<u>Bypass sand at inlets</u>

Sand dredged from inlets should be placed either on the adjacent beaches or in a location where it will migrate rapidly to the beaches. This practice, called artificial sand bypassing, is a common engineering tool to minimize the impact of inlet dredging on adjacent beaches. Essentially, sand bypassing just replaces the natural process that channel dredging interrupts. Sand bypassing is vital to the future health of the beaches of Alabama. The state should consider legislation that requires this. Most of the shoreline recession in the state is due in part to inlet engineering. At present, bypassing of some limited form is occurring at Perdido Pass and Lagoon Pass. However, the operational decisions regarding the bypassing are primarily driven by the need to maintain adequate depths of water in the passes. Bypassing schemes should be adopted which also directly consider the adjacent beach widths.

At Mobile Pass, bypassing is not occurring. Millions of cubic yards of sand are being permanently removed from the littoral system by the dredge disposal practices used to maintain the Mobile Ship Channel. From 1974 to 1997, over 16 million cubic yards of sand was permanently removed from the littoral system of the state and dumped offshore in deep water. This is enough sand to widen the beaches of Dauphin Island over 1000 feet. The removal of this sand from the littoral system has contributed to the beach

Return overwashed sand

Sand that is overwashed onto the barrier island during large storms should be returned to the beaches. After passage of hurricanes such as Opal and Georges, deposits of sand must be removed from parking lots, roadways, driveways, and drainage ditches. Beach profile analysis has shown that this sand comes from the beach and dune area. All of this sand should be returned directly south to the beaches. There is essentially a cottage sand-mining industry along the Alabama coast after storms. Entrepreneurial bulldozer operators throughout the southern half of the state converge on the coast and get paid to remove sand from parking lots and roads. Prior to Hurricane Georges, they commonly moved the sand to other private property on the barrier island or hauled it completely off the island to stockpiles. Local and state officials have partially changed this practice to one of returning the sand to the beaches at a few locations. Further efforts along these lines are suggested.

Sand that is partially contaminated with debris can be sifted with commercially available sifters. None of this sand should be moved off the island. Institutional and jurisdictional obstacles including questions of the use of state highway moneys to put sand on private beach property should be addressed now prior to the next storm. Adoption of this suggestion will minimize the long-term adverse impacts of future storms on the beaches of Alabama.

Role of government in beach management

There is no government agency in Alabama with overall responsibility for beach management to which a citizen with a beach erosion problem can turn for assistance. Yet, because of the natural littoral system where others can cause erosion problems at different locations, the citizen has little recourse to address the problem without the assistance of government. A task force on shoreline erosion reported to the 1996

Alabama Legislature give legal authority and funding for beach erosion management to someone in the executive branch of government.

Public Access

Public access to the Alabama Gulf beaches is limited. There are long stretches of beach that have no public access today. Several decades ago, this was not true. Anecdotal evidence indicates that access across private property was common several decades ago but is severely blocked by parking restrictions and fences today. As property values continue to increase, and people from out of the area buy more of this property, Alabama citizens will have less and less access to their own beaches. In the words of the syndicated columnist Rheta Grimsley Johnson in a series of columns about the coast in 1998,

> *"Used to be, eccentrics eddied up to the shore; now it's rich people who relish rules"*

> *"It's the same story again and again, especially if there is a beach involved. We create a traffic jam getting there, raise buildings that block public access and jealously guard the limited turf"*

The limited public access is an insidious threat to the future health of the Alabama beaches. Because of the interconnectedness of the natural littoral system, the most cost-effective solutions to beach erosion problems require government action. The political consensus needed for such proper action will be much harder to obtain when the general public perceives that its access to the beaches is limited. A reasonable analogy is highway construction. Highways are the best solution to many transportation needs, they are usually paid for with public moneys, and they are accessible to all citizens.

designs and techniques for avoiding or resisting the extremely severe wind, water level and wave environment during hurricane landfall. If these engineering and design recommendations were followed, a significant reduction in damages would occur.

Two suggestions for local governments are:

1) Raise the minimum building "flood" elevations to the true 100-year flood level (probably about 12-13 feet).
2) Adopt more stringent building codes for the beachfront properties and other high hazard areas that require hurricane resistant structures.

Adoption of these suggestions would save millions of dollars of damage in future storms. They are probably the two most effective steps that could be undertaken to mitigate future damages along the Alabama coast.

Setting construction of hard structures (bulkheads, buildings, etc) farther back from the water is suggested. Allowing the beach to fluctuate in width without hitting such structures is an excellent approach to insuring adequate beach width. The existing construction control setback lines provide for a small "buffer zone" to accommodate shoreline fluctuations. These should be considered minimal distances. At several locations, these lines could be re-evaluated and perhaps moved north. Local governments and individual developers should consider greater setbacks. Part of the problem is that individual developers attempt to maximize the number of condo units per lot by pushing the buildings as far south as possible to meet local parking ordinances. The beaches are more valuable to the community than parking spaces.

Beach nourishment, suggested above, is a viable alternative to setting construction farther back. A successfully engineered beach will accomplish many of the same goals as a construction setback. For the portions of the coast that have large condominiums on narrow beaches, beach nourishment is an attractive alternative.

understanding of the overall impacts of engineered beach nourishment along the Alabama coast.

The response of the beaches to Hurricane Georges essentially confirmed that the Alabama Coastal Programs management efforts are based on proper concepts. Before the storm, the state's management efforts were based on our best understanding of the complex interactions between the natural and constructed systems. This understanding was developed with input from a decade of focussed, applied coastal research. Future management decisions can be positively influenced by sound research input.