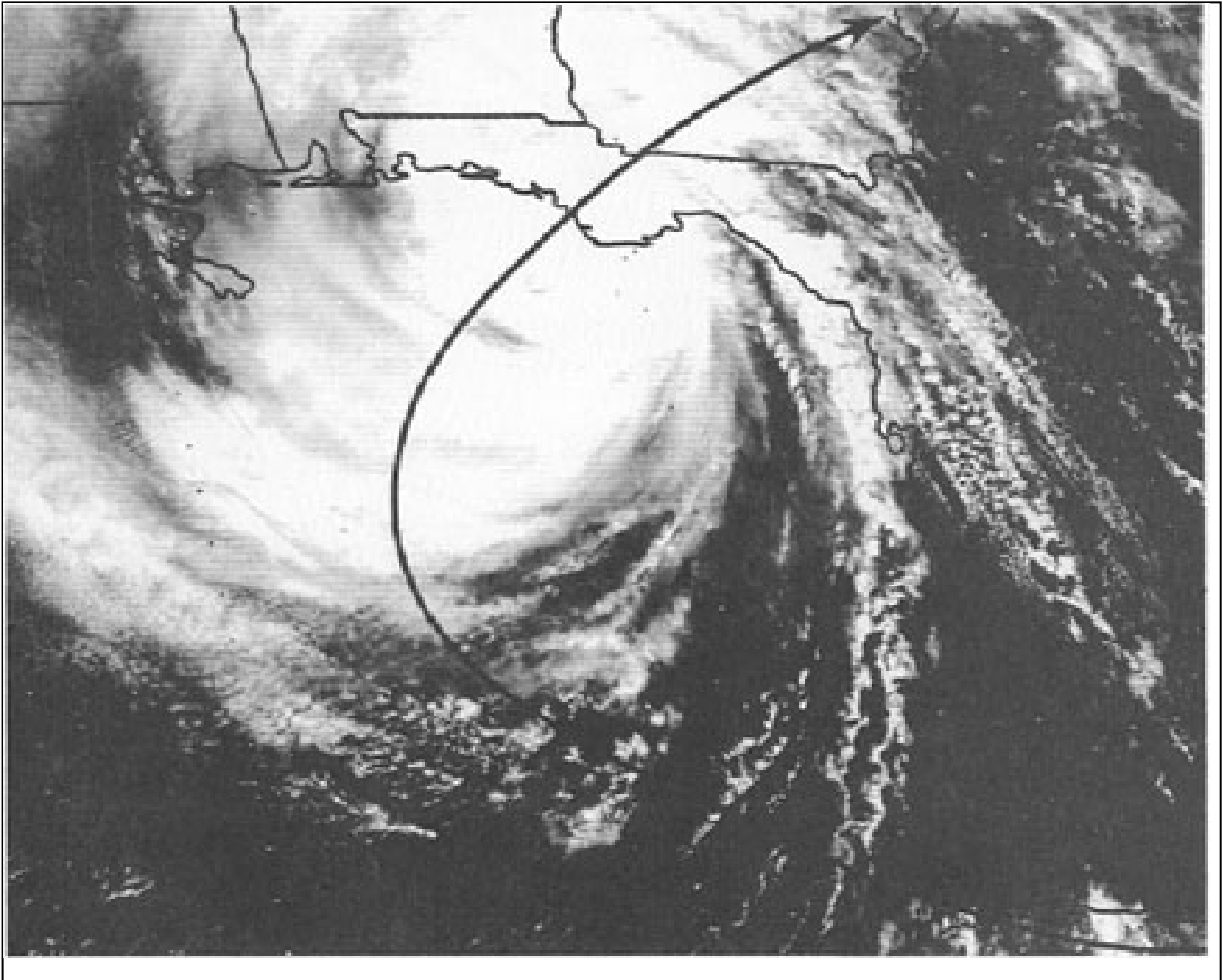


Hurricane Kate

November 15-23, 1985



Department of Natural Resources
Division of Beaches and Shores
Post Storm Report No. 86-1
September, 1986
By Ralph Clark

FOREWORD

This work describes the impact of hurricane Kate on the coast of Florida. The meteorological data was provided by the National Weather Service, the National Hurricane Center, and the Satellite Data Services of the National Oceanic and Atmospheric Administration. Tide data was provided by the National Ocean Survey, storm surge and high water mark data were provided by the Coastal and Oceanographic Engineering Department, University of Florida, and beach profile data was obtained and graphically presented by the Bureau of Coastal Data Acquisition, Division of Beaches and Shores. Post-storm photographs of Mexico Beach near the eye were taken by Brett D. Moore, P.E., and aerial photography of Cape San Blas and Sike's Cut before and after the storm were contributed by Kevin R. Bodge of the University of Florida. The manuscript was typed by Sarah C. Papin and the cover was created by Peggy M. Riedell.

CONTENTS

	Page
INTRODUCTION	5
CUBA AND THE FLORIDA KEYS	9
PANAMA CITY BEACH AND MEXICO BEACH, BAY COUNTY	11
PORT ST. JOE, ST. JOSEPH PENINSULA, CAPE SAN BLAS, AND INDIAN PENINSULA, GULF COUNTY	17
APALACHICOLA AND WESTERN FRANKLIN COUNTY	29
ST. GEORGE ISLAND, FRANKLIN COUNTY	37
DOG ISLAND, FRANKLIN COUNTY	55
ST. GEORGE SOUND SHORELINE AND COMMUNITIES OF EASTPOINT, CARRABELLE BEACH, CARRABELLE, LANARK, ST. JAMES, AND ST. TERESA, FRANKLIN COUNTY	61
ALLIGATOR POINT TO OCHLOCKONEE BAY, FRANKLIN COUNTY	77
MASHES SANDS, PANACEA, SPRING CREEK, OYSTER BAY, WAKULLA SHELL POINT, BEACH, AND ST. MARKS, WAKULLA COUNTY	90
LIVE OAK ISLAND, WAKULLA COUNTY	102
REFERENCES	114

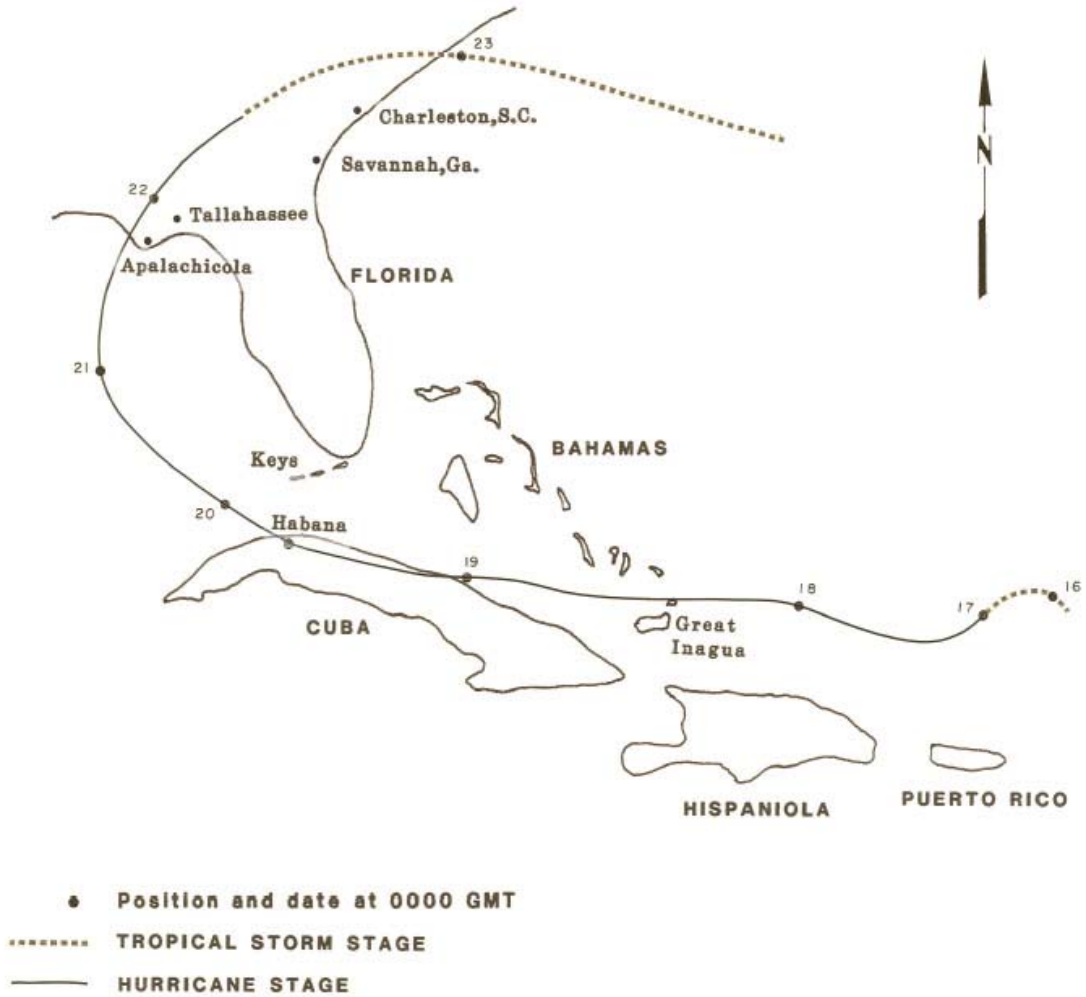


FIGURE 1. Track of Hurricane Kate, November 16-23, 1985.

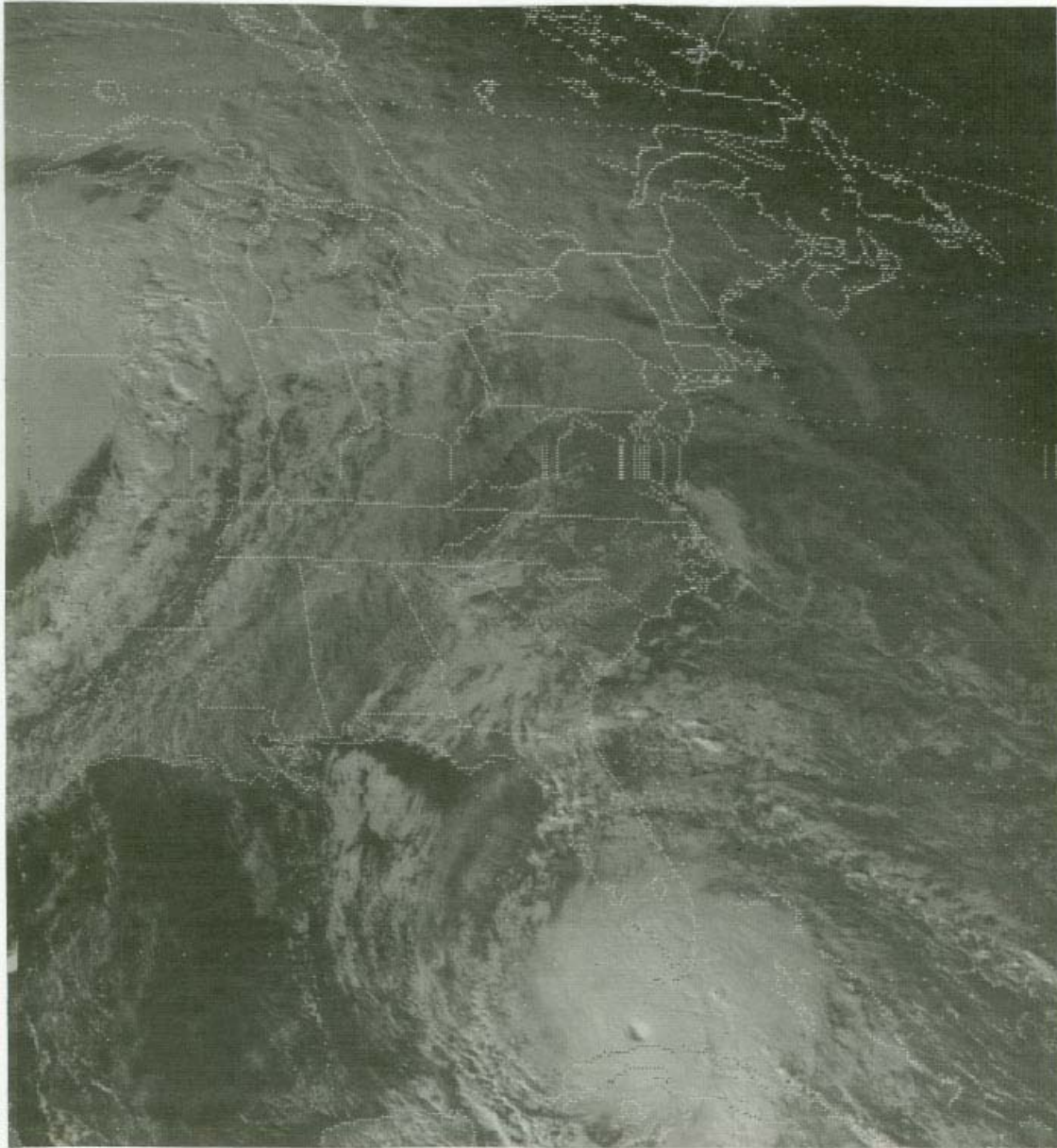


FIGURE 2. Hurricane Kate Impacting the Florida Keys at 2030 EST, November 19, 1985 (Satellite Data Services, NOAA)

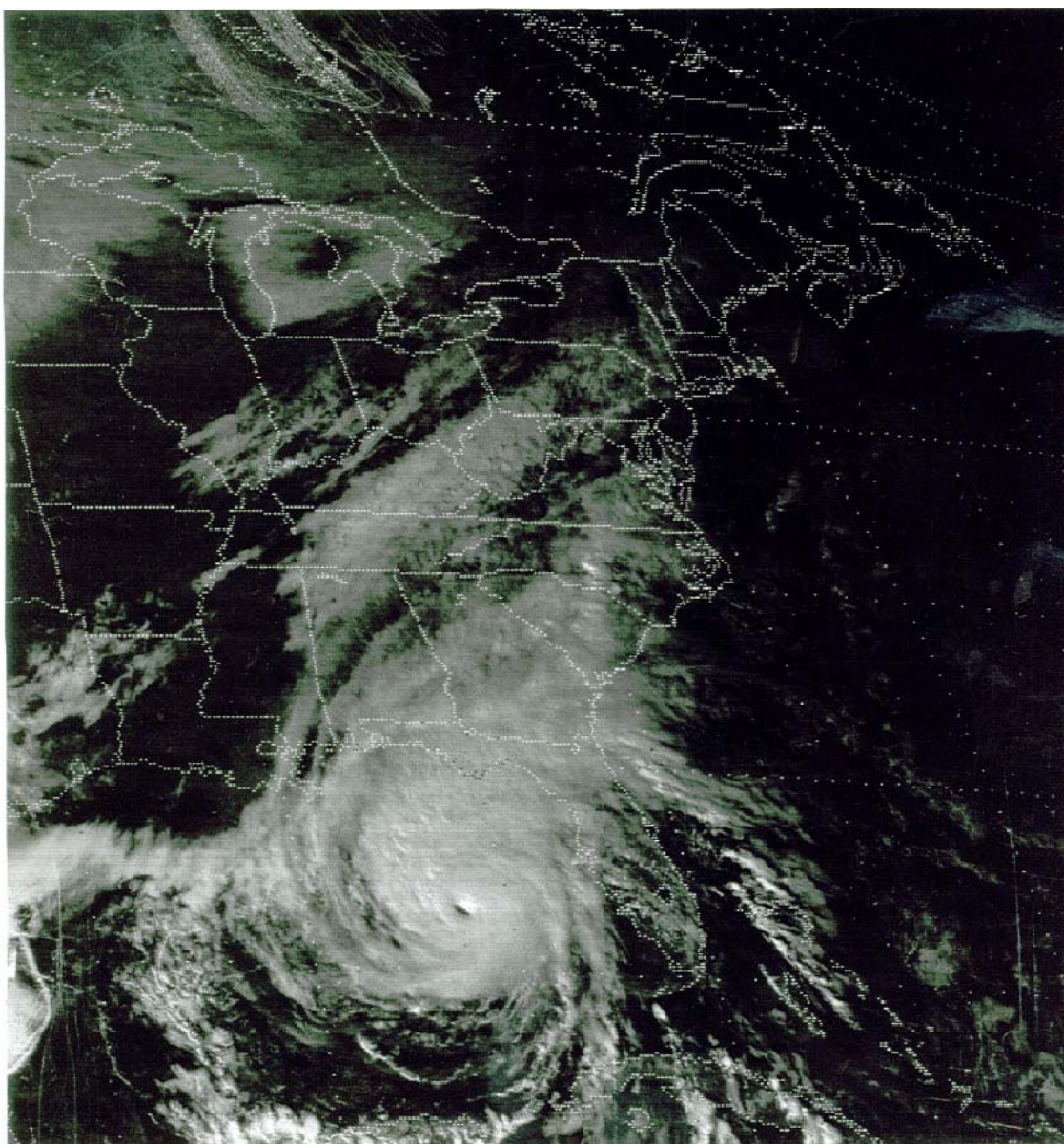


FIGURE 3. Kate at maximum intensity in the southeastern Gulf of Mexico at 2031 EST, November 20, 1985 (Satellite Data Services, NOAA)

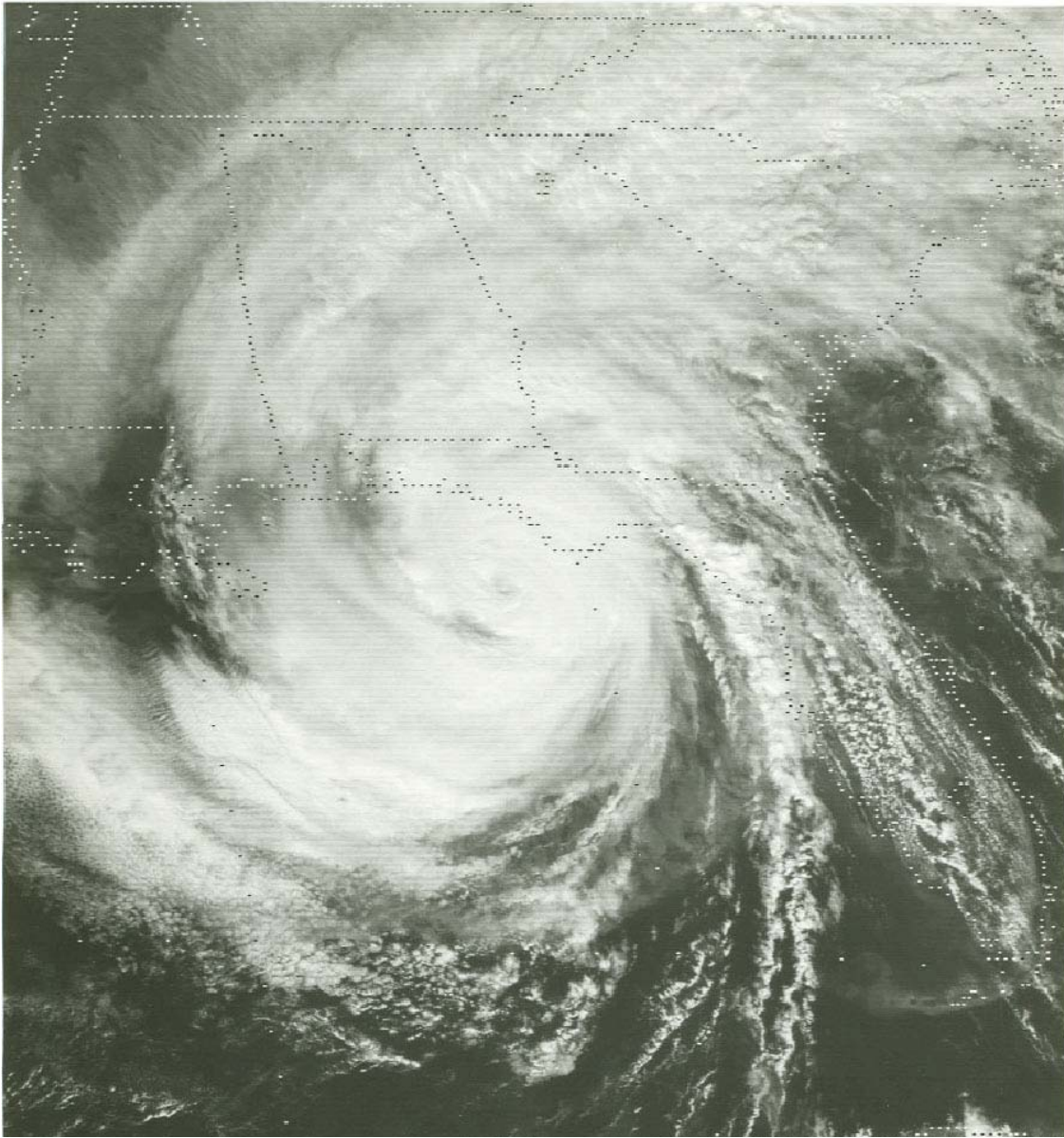


FIGURE 4. Kate at maximum intensity in the southeastern Gulf of Mexico at 2031 EST, November 20, 1985 (Satellite Data Services, NOAA)

INTRODUCTION

On November 21, 1985, the State of Florida experienced its first shore-incident hurricane in ten years. Not since hurricane Eloise crossed the coast near Panama City on September 23, 1975 had Florida experienced a shore-incident hurricane. The shore parallel brush of hurricane David and the fringe impact of hurricane Frederic, both in 1979, did not provide the magnitude of impact to Florida, which accompanies a shore-incident hurricane. The damage resulting in Florida from those storms was considerably less than was sustained by either hurricane Agnes in 1972 or Eloise in 1975, which were Florida's only two direct hits during the 1970's.

The 1985 tropical storm season produced eleven tropical storms in the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Seven of these storms reached hurricane strength. For an in-depth meteorological summary of these storms, readers are referred to the report of the National Hurricane Center, National Oceanic and Atmospheric Administration entitled "North Atlantic Tropical Cyclones, 1985" by Robert A. Case and Harold P. Gerrish

Kate, the eleventh and last tropical storm of the 1985 season, spawned a couple hundred miles northeast of Puerto Rico and the Virgin Islands before reaching tropical storm strength on November 15 (Figure 1). For three days Kate moved westerly passing nearly one hundred miles north of Hispaniola and across Great Inagua Island in the southern Bahamas. Kate attained hurricane strength during the late afternoon of Saturday, November 16. During the morning of Tuesday, November 19, hurricane Kate crossed the central north coast of Cuba. During the late morning of the 19th, Florida felt its first significant impact from Kate with the weather station in Miami Beach reporting a maximum sustained wind of 37 miles per hour, a peak wind gust of 78 miles per hour, and a minimum barometric pressure of 1014.6 millibars.

Although the eye of Kate remained over land for most of Tuesday while passing westward along the Cuban coast, it maintained a weakened hurricane strength. During the late afternoon, the weather station at Conch Key, Florida, reported a maximum sustained wind of 50 miles per hour and a peak wind gust of 78 miles per hour. When Kate emerged off the Cuba coast near Havana, the weather station at Key West reported a maximum sustained wind of 47 miles per hour, a peak wind gust of 69 miles per hour, and a minimum barometric pressure of 1006.8 millibars. Figure 2 is a satellite photograph showing the circulation of the hurricane while affecting the Florida Keys as the eye moved off Cuba and into the Gulf of Mexico on Tuesday evening, November 19.

Case and Gerrish (National Hurricane Center) reported, "After Kate emerged over the waters of the southeastern Gulf of Mexico

it strengthened at a rate of nearly 1 mb (millibar) per hour, reaching a minimum pressure of 953 mb by 2000 (Greenwich mean time) on November 20. Three hours earlier a NOAA data buoy in the east central Gulf reported averaged winds of 94 knots (108 mph) with a peak gust of 118 knots (135 mph) and sea heights of 10.7 meters (35 feet)." Figure 3 shows Kate near maximum intensity on Wednesday, November 20, while centered over the southeastern Gulf of Mexico.

Throughout Wednesday, Kate followed a northwesterly arc along approximately the same path across the southeastern Gulf of Mexico as hurricane Elena took on August 29. Although both the storms' tracks for those days were in remarkable alignment, little comfort was felt in predicting Kate's landfall point at that time given the eventual erratic track taken by Elena. In contrast to Elena's abrupt eastward turn and stall off Cedar Key, Kate gradually curved northerly on Thursday morning November 21. With hurricane warnings spread across the northeastern Gulf coast between Grand Isle, Louisiana and St. Marks, Florida, Kate slowed its forward speed and weakened in the early morning. Even though Kate had flexed its strength in the Gulf as a category 3 hurricane (classified by the National Weather Service using the Saffir-Simpson Hurricane Scale), it had weakened to a category 1 just prior to landfall (Figure 4).

Through the early afternoon on Thursday, November 21, Kate continued on a relatively straight north-northeast track towards the Florida Panhandle coast near Panama City. Fortunately for the Panama City area residents, many of whom remembered Eloise, Florida's last shore-incident hurricane in 1975, and most of whom remembered the recent scare of hurricane Elena's offshore pass only eleven weeks earlier, Kate's geometric center made landfall on Crooked Island east of Panama City near Mexico Beach. The weather station in Panama City reported a maximum sustained wind of 40 miles per hour, a peak wind gust of 78 miles per hour, and a minimum barometric pressure of 973.1 millibars. The weather station at Apalachicola which was located within the maximum wind field region of Kate reported a maximum sustained wind of 62 miles per hour, a peak gust of 85 miles per hour, and a minimum barometric pressure of 985.3 millibars.

As night fell over north Florida, Kate veered northeast and the eye passed over northern Gulf County, Calhoun County, northwest Liberty County, and western Gadsden County. Residents of Quincy, Havana, Tallahassee, and their surrounding areas felt the maximum wind field to the right of Kate's eye. The weather station in Tallahassee reported maximum sustained winds of 46 miles per hour, a peak wind gust of 68 miles per hour, and a minimum barometric pressure of 992 millibars. However, a review of the

sporadic heavy wind damage throughout Gadsden and Leon Counties provided evidence of widespread microbursts or downbursts of

localized higher wind gusts which may have reached 100 miles per hour. Weakened to tropical storm status, Kate continued northeastward through South Georgia and coastal South Carolina before exiting the mainland. On Friday, November 22, the weather station in Albany, Georgia reported an early morning maximum sustained wind of 51 miles per hour and a peak wind gust of 67 miles per hour, and the weather station in Savannah reported near mid-day a maximum sustained wind of 40 miles per hour, a peak wind gust of 62 miles per hour, and a minimum barometric pressure of 1001.4 millibars. Once back in to the Atlantic Ocean, the remnants of Kate veered east and then southeast on Saturday, November 23, before dissipating.

Five deaths were attributed to Kate in the United States. In the Keys, a 28 year old man and a 62 year old woman drowned when their small boat capsized and another man was electrocuted by stepping on a downed power line. In north Florida, a 38 year old man was killed by a fallen tree on his truck, and near Thomasville, Georgia, a 22 year old man was killed when a tree fell on a wrecker truck. The total damage estimate for the United States was three hundred million dollars.

Kate brought rainfall totals averaging between 4 to 6 inches in the major impact areas of north Florida and southwest Georgia. Kate apparently spawned at least one small tornado on Live Oak Island, Florida, although numerous downbursts were apparent throughout Gadsden and Leon Counties in north Florida. The inland areas of north Florida and South Georgia sustained widespread wind damage to buildings and utilities and countless tree damage, many of which caused damage to adjacent structures when they fell (Figure 5).

It is not, however, within the scope of this document to discuss these inland storm damages. It is the intent of this discussion to qualitatively present the storm's impact on coastal construction based upon the author's observations of the damage. These observations were made during the immediate three week period after impact between November 22 and 25 in Wakulla County, November 25, 27, December 2, 4, 5, and 11 in Franklin County, December 5 and 12 in Gulf County, and December 12 in Bay County. A discussion with accompanying photography is presented by geographical coastal areas commencing in eastern Bay County near the landfall of Kate's eye and continuing eastward along the maximum wind field through Gulf, Franklin, and Wakulla Counties. Most of the discussion will be limited to the impact to major structures in these coastal areas. A preceding discussion will be made of Cuba and the Florida Keys.



FIGURE 5. Tree Damage on Lanier Road, Gadsden County

CUBA AND THE FLORIDA KEYS

On Tuesday, November 19, Kate passed westward along north central Cuba, forcing the evacuations of about 360,000 residents and causing 10 deaths and at least 50 serious injuries. Havana, the capital city of about 2 million residents, sustained widespread damage to telephone and electrical power lines. Cuban Radio Rebelde reported the collapse of numerous buildings in the city. Outside the city, sugar mills were damaged and much of the sugar cane crop was destroyed. A Radio Rebelde broadcast reported that Moron, a city in north-central Cuba, sustained substantial damage with numerous dwellings and buildings being destroyed.

While Kate passed over northern Cuba, the Florida Keys felt the fringe impact of less than hurricane force winds. Damage throughout the Keys was slight; however, numerous power lines were blown down and the lower Keys between Key West and Big Pine Key had lost its electrical power. Only minor flooding of low areas in the Keys occurred from wind generated tides, and the Keys shorelines fronting the Florida Straits sustained only minor erosion of intermittent beaches. Two mobile homes, one on Conch Key and another on Summerland Key, were destroyed by fire; the latter was touched off by a downed power line. Only one mobile home, located on Rockland Key, was actually destroyed by Kate's winds. And on Sugarloaf Key, the 300 foot tall radio tower which broadcasts the WKWF-AM and WAIL-FM radio stations collapsed during a high wind gust.

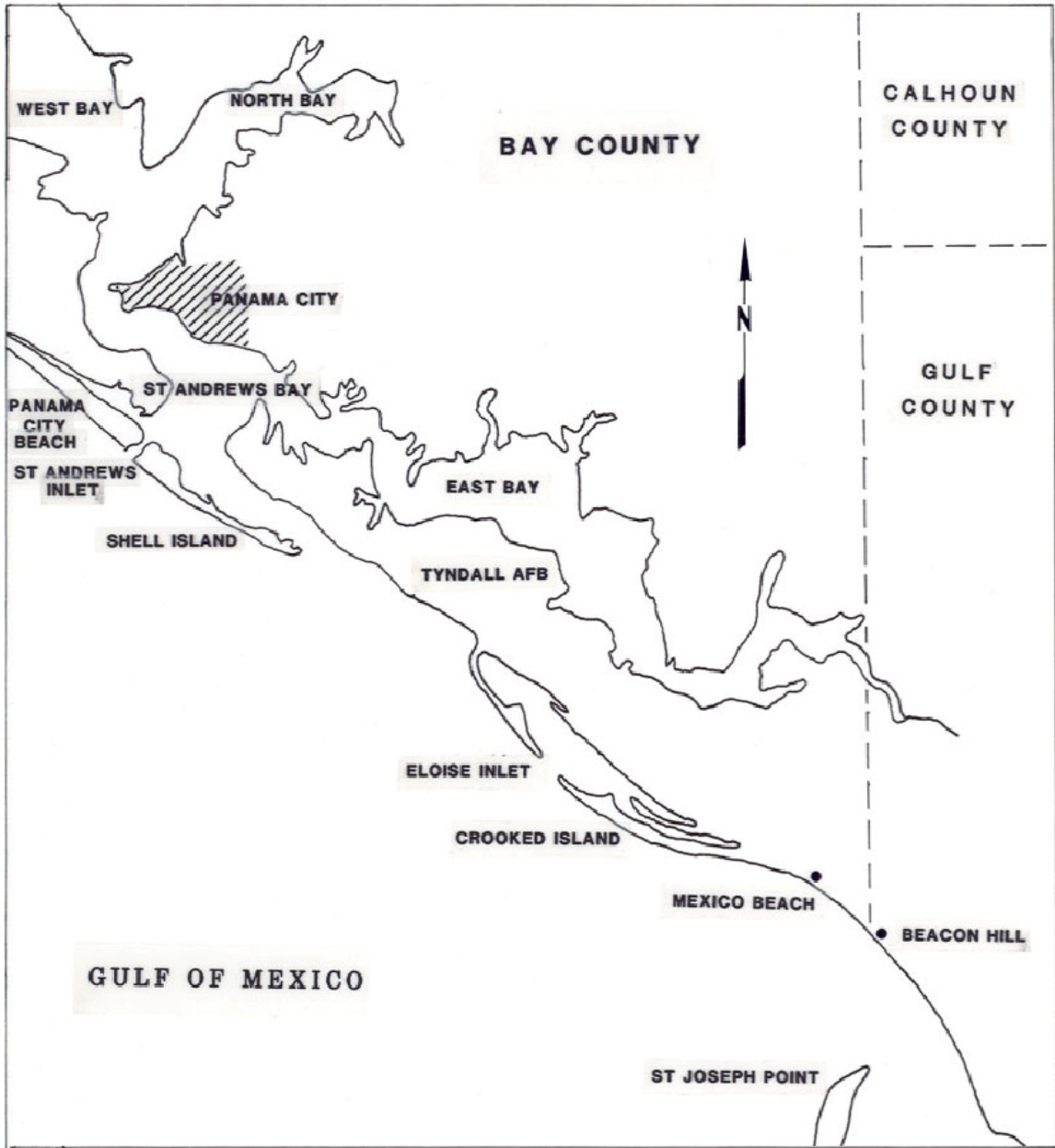


FIGURE 6. Bay County area Impacted by Kate

PANAMA CITY BEACH AND MEXICO BEACH, BAY COUNTY

In 1975, Eloise, the last shore-incident hurricane to hit Florida, crossed the coast at Phillips Inlet to the west of Panama City. Eloise caused severe beach and dune erosion and substantial damage to coastal construction along Panama City Beach. Fortunately for this area, Kate made its landfall to the east of Panama City and therefore Bay County escaped most of the storm's impact.

Generally, only light wind damage to signs, trees, and roofing was sustained in the Panama City area; however, the roof of the Federal Building sustained heavy damage. Panama City Beach had minor beach erosion in contrast to the heavy erosion sustained a decade earlier in Eloise. The worse damage from Kate was sustained along Spyglass Drive at the east end of Panama City Beach. The shoreline in this area has been receding at a rate in excess of five feet per year due in part to the longshore sediment transport deficit caused by the dredging of St. Andrews Inlet, located 1.7 miles to the east. All the inlet maintenance dredging material prior to the 1970's was hauled offshore and deposited in deep water.

At the Treasure Island Motel, the seaward projecting concrete bulkhead at the east end of the property had been destroyed during tropical storm Juan on Halloween. The storm wave activity from Kate caused substantial damage to the motel building by undermining the foundation and destroying four of the motel units (Figure 7). Reconstruction of at least 150 feet of concrete bulkhead will be necessary to provide a reasonable level of protection to the remaining building. A landward relocation of the bulkhead will increase its chances of survival during future minor storms and will reduce the impact of the structure on the longshore transport of sediment.

Two single-family dwellings to the east of the Treasure Island Motel were also impacted by Kate. The dwelling nearest the motel sustained foundation and wall cracks from settlement and 130 feet of its concrete bulkhead and return wall sustained damage from wave impact loads and undermining. Heavy dune erosion between this dwelling and the motel has flanked the return wall and threatens to undermine this slab-on-grade dwelling which is now highly exposed to future storm damage (Figure 8). The adjacent dwelling had its 50 foot return wall destroyed. The southeast section of the large slab-on-grade dwelling was undermined and destroyed (Figure 9). Although the remainder of the house may be sealed off and made habitable, this structure will remain in danger of being destroyed in another major storm. The only other major damage in this area was sustained by the Panama City Beach fishing pier.

To the east of St. Andrews Inlet minor beach and dune erosion was sustained along both Shell Island and Crooked Island. The eye of hurricane Kate passed directly over Crooked Island; however, unlike the typical shore-incident hurricane which would have a peak surge and impact nearest the eye, Kate's surge and impact increased with distance to the east of the eye. Such an anomaly proved to be good fortune for the Town of Mexico Beach which found itself immediately adjacent and to the right of the eye. Such a location is often the critical site of severe storm impact.

Numerous dwellings in Mexico Beach sustained light wind damage, primarily to screen porches and roofing. Signs and power lines were down and minor flooding from the storm surge was experienced. Along the shoreline, minor to moderate beach and dune erosion was sustained resulting in numerous dwellings being threatened from continued erosion conditions (Figure 10). Approximately 50 feet of the end of 30th Street and 25 feet of the end of 27th Street were destroyed.

Adjacent 27th Street, 35 feet of concrete block wall was destroyed. Between 20th Street and 19th Street, 250 feet of concrete wall was undermined and destroyed (Figure 11). Another 75 feet of concrete block retaining wall and the front room of a slab-on-grade single-family dwelling was destroyed between 14th Street and 13th Street (Figure 12). To the west of 14th Street, a wood pile-supported dwelling was undermined and leaning from foundation settlement. At 13th Street, 35 feet of wooden bulkhead was damaged and 300 feet east of 12th Street, 75 feet of sloping concrete wall was substantially damaged. About 500 feet east of 12th Street, 60 feet of concrete block wall was destroyed at the Buena Vista Motel.



FIGURE 7. Treasure Island Motel Damage, Panama City Beach.



FIGURE 8. Heavy Dune Erosion adjacent Spyglass Drive has flanked a return wall and threatens a dwelling.



FIGURE 9. Slab-on-grade dwelling partly destroyed, Panama City Beach.



FIGURE 10. Mexico Beach Dwellings Threatened by dune erosion (Brett D. Moore)



FIGURE 11. Concrete wall destroyed, Mexico Beach (Brett D. Moore).



FIGURE 12. Seaward room destroyed on Mexico Beach dwelling.

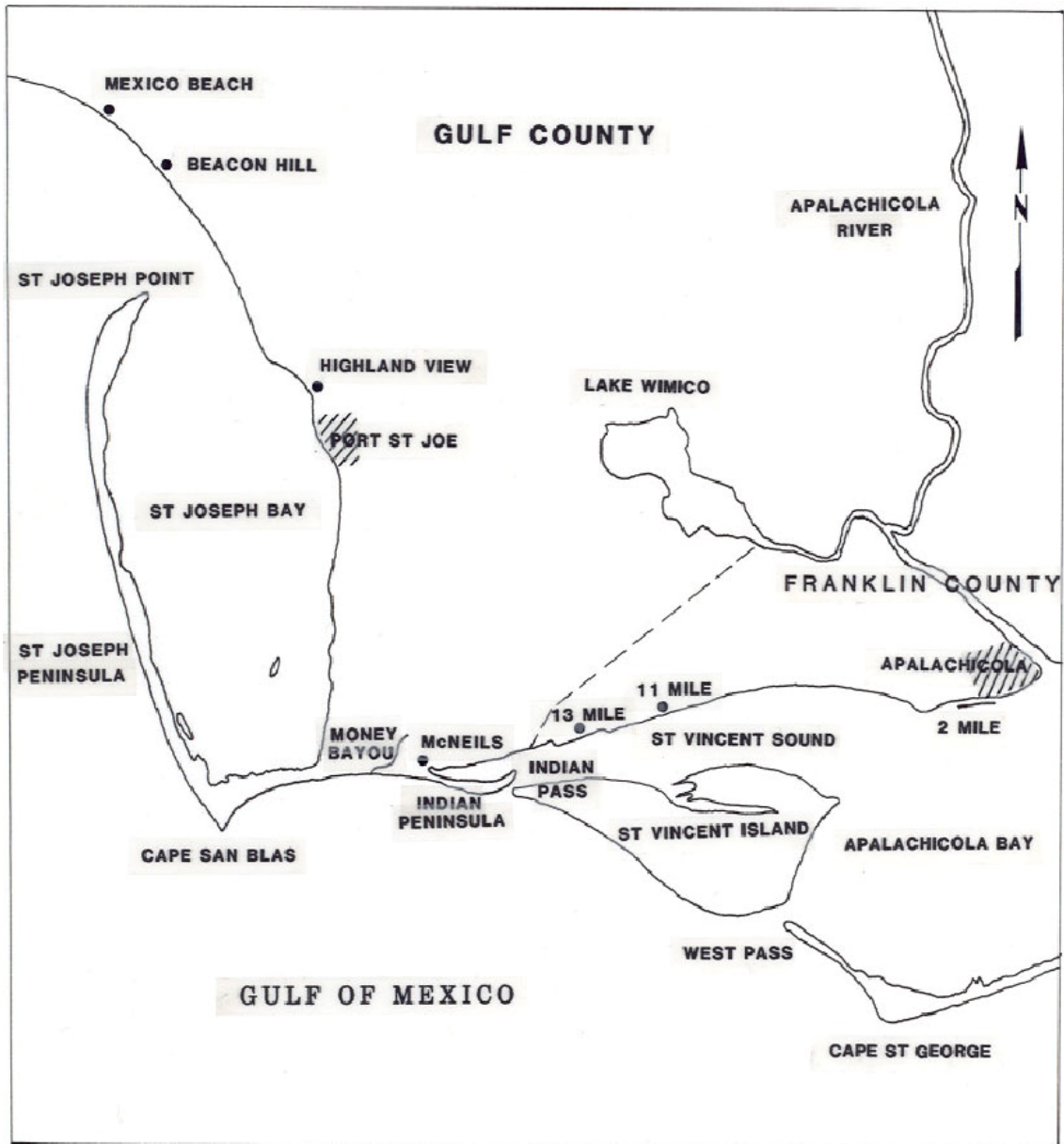


FIGURE 13. Gulf County and western Franklin County.

**PORT ST. JOE, ST. JOSEPH PENINSULA, CAPE SAN BLAS, AND
INDIAN PENINSULA, GULF COUNTY**

Gulf County, located to the right of the eye's landfall, was substantially impacted by hurricane Kate. The severity of the impact appeared to increase to the east, that is with distance away from the point of landfall of the eye. Kate's impact to Gulf County was the most substantial since hurricane Agnes in June, 1972. Overall, 31 major structures (exclusive of roads) were destroyed or sustained major structural damage along coastal Gulf County by Kate. Only the damages of Franklin and Wakulla Counties exceeded that of Gulf County.

The Gulf of Mexico shoreline along U.S. Highway 98 in western Gulf County sustained only minor beach and dune erosion. There was no major damage in Beacon Hill, Yon Subdivision, or St. Joe Beach. In Highland View fronting St. Josephs Bay, approximately 100 feet of U.S. Highway 98 was damaged and 90 feet of the sloping concrete slab revetment was destroyed. A high water mark of +6.8 feet NGVD was measured by the Coastal and Oceanographic Engineering Department, University of Florida, near this site. A small restaurant structure was also destroyed. The City of Port St. Joe experienced widespread light wind damages with power lines down and roofing and sign damage heavy. At the industrial complex of the St. Joe Paper Company, six buildings had major wind damage. These structures typically had metal roofing and large surface areas and were highly exposed to winds off St. Josephs Bay. Although there was no apparent bulkhead damage to the 75 foot long steel sheet-pile bulkhead at the St. Joe Paper Company facility, a 65 foot section of steel bulkhead was damaged at the adjoining property's wharf. In Port St. Joe, a Gulf County school building for bus maintenance sustained major wind damage, and at the airport a hanger building was completely destroyed by wind with a single engine airplane inside. Along U.S. Highway 98 between Port St. Joe and Ward Ridge was minor waterfront damages and flooding of low areas west of the highway. Near St. Joseph Drive, about 200 feet of Constitution Drive was damaged and 1,275 feet of sloping concrete slab revetment was destroyed and another 25 feet damaged.

Offshore from the mainland, St. Joseph Peninsula is a 16 mile long coastal barrier fronting St. Josephs Bay and aligns generally north and south between St. Josephs Point at its north tip and Cape San Blas to the south. Moderate to heavy beach and dune erosion was experienced along the entire length of St. Joseph Peninsula. At T. H. Stone Memorial State Park along the peninsula's north end the beach access walkways were destroyed and heavy dune erosion was experienced. Figures 14 and 15 are computer graphics of topographic survey data obtained by the Bureau of Coastal Data Acquisition, Division of Beaches and

Shores. two weeks after the impact of Kate. Figure 14 reflects a typical profile of the heavy dune erosion experienced in the park. This profile data reflects horizontal dune recession of nearly fifty feet in comparison to a July, 1984, profile. Figure 15 reflects profiles obtained a few days after hurricane Elena's offshore pass and a couple weeks after Kate in comparison with an earlier profile in November, 1983. The barrier dune which reached an elevation of nearly +22 feet NGVD was completely destroyed by Kate after it was substantially eroded by Elena. The University of Florida measured a storm surge elevation of +5.6 feet NGVD near the entrance to the park. Along the southern half of the peninsula between the park and Cape San Blas nearly all of the beach access walkways had their seaward ends destroyed. This area is currently only sparsely developed although a major boom in residential construction has recently been taking place primarily adjacent to the beach. Nearly all the dwellings and condominium buildings in this area sustained roofing damage.

Midway between Cape San Blas and the State Park two single-family dwellings were totally destroyed by erosion, flooding and wave loads (Figures 16 and 17). Approximately 2,000 feet to the south, an inappropriately sited swimming pool was also destroyed. As recently as November, 1983, aerial photography showed these dwellings to be located about 40 feet landward of the beach and the pool to be located about 70 feet from the beach. Profile data obtained by the Bureau of Coastal Data Acquisition adjacent to these dwellings before and after Kate reflected horizontal dune recession of approximately 35 feet due to Kate and a total of 80 feet since November, 1983. A nearby house aligned with the destroyed houses was relocated by house moving equipment inland about 150 feet the day before hurricane Kate struck. This area extending southward to Cape San Blas has been experiencing substantial historical erosion with a shoreline recession rate estimated between 10 to 20 feet per year. At the curve of Gulf County Road C30E where it approaches the Gulf shoreline near Cape San Blas, the storm surge completely overtopped the road and the washover deposit was carried into St. Josephs Bay. This area is known as Stump Hole due to the numerous remnant pine tree stumps in the surf zone left as monuments to the erosion of past storms. This area previously experienced overwash during hurricane Agnes in 1972, but perhaps the most erosion in recent years occurred during the siege of El Nino storms in the winter and spring of 1983.

The large coastal feature known as Cape San Blas was substantially destroyed by the impact of both hurricanes Elena and Kate in the fall of 1985. As reported in The Impact Of Hurricane Elena And Tropical Storm Juan On Coastal Construction in Florida (Beaches and Shores Post-Storm Report No. 85-3, March, 1986), approximately 1,500 feet of the exposed south tip of the

Cape disappeared after Elena passed by approximately 30 miles offshore on the evening of September 1. Another approximately 1,000 feet of the Cape was removed by hurricane Kate on November 21. Figure 18 shows Cape San Blas from the air in November, 1984 and Figure 19 taken on November 24, 1985, shows the remains of the Cape, three days after Kate 's impact and after nearly one half mile of the Cape was lost to the two hurricanes. The exposed southwest shore of Cape San Blas sustained heavy beach and dune erosion. About 200 feet of the end of the beach access road was destroyed (Figure 20). Profile data obtained by the Bureau of Coastal Data Acquisition adjacent to this beach access road revealed the barrier dune which had had a peak elevation of about +13.5 feet NGVD had been completely destroyed. An elevation of +3 feet NGVD remained at the site of this barrier dune after Kate. The entire barrier dune along the southern one mile of Gulf front beach south of the beach access road to the south tip of the Cape was totally destroyed. Most of the Cape is federally owned and extensive roofing damage was sustained by the several government buildings. In addition numerous equipment structures were damaged and a tall radio antennae was destroyed.

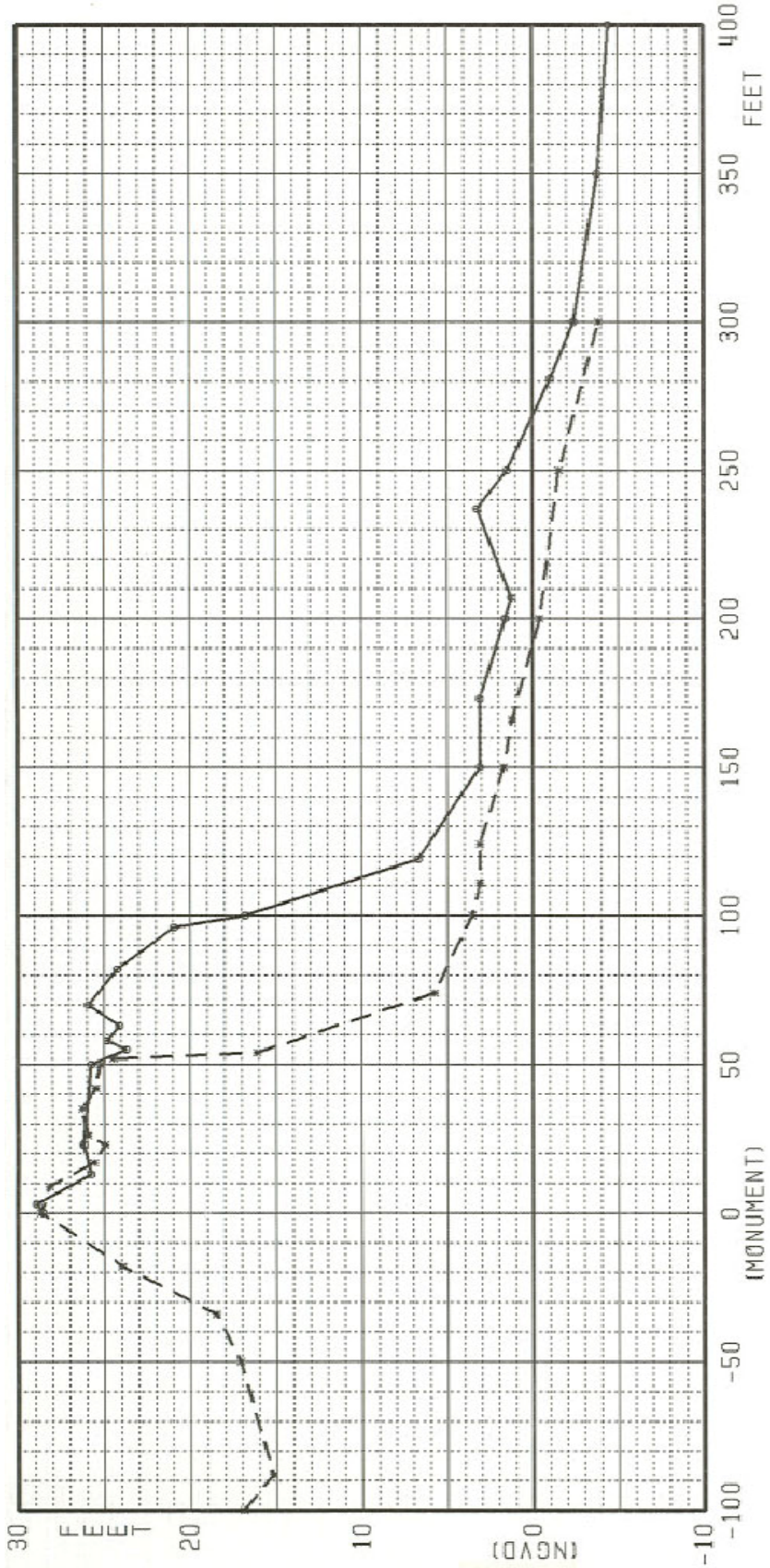
Along the connecting peninsula between Cape San Blas and the mainland, the Gulf fronting shoreline has generally been accreting in recent years. This area is relatively sheltered by the Cape and its outer shoals, and although substantially flooded by the storm surge of Kate, only very minor beach and dune erosion was sustained. In this area, one dwelling was totally destroyed by the winds of Kate (Figure 21). As was typical of any other dwellings destroyed by wind, this structure did not have adequate roof to wall and wall to floor connections.

Along the mainland shoreline west of Money Bayou, light to heavy wind damage was sustained and minor beach and dune erosion occurred. East of the junction of Gulf County Roads C30E and C30 two mobile homes were destroyed, one mobile home was substantially damaged and two concrete block dwellings sustained major damage. Most of the dwellings in this area west of Money Bayou sustained light to extensive roofing damage and had screens blown out, antennas blown down, decks damaged and walkways destroyed. One dwelling had a one room addition destroyed. One dwelling under construction sustained major wind damage and another dwelling sustained major roof damage due to wind.

Money Bayou was opened to tidal flow by the storm surge of Kate. In this area the Coastal and Oceanographic Engineering Department, University of Florida, measured a high water mark of +8.4 feet NGVD. East of Money Bayou, extensive flooding and wind damage was sustained (Figure 22). The first dwelling east of Money Bayou, a two-story structure, sustained major flood damage to the ground floor and major roof collapse due to wind loads (Figure 23). The adjacent dwelling to the east, a manufactured

home, was destroyed by winds, waves, and flooding (Figure 24) and the next dwelling to the east was floated completely off its short pile foundation and sustained wind and flooding damage (Figure 25). The fourth dwelling east of Money Bayou sustained major roof damage and two others sustained minor roofing damage. A quarter mile east of Money Bayou a mobile home was destroyed by wind and flooding (Figure 26) and three-quarters of a mile east of Money Bayou a dwelling sustained major structural damage to the lower floor due to wave impact loads (Figure 27). Profile data of the Bureau of Coastal Data Acquisition reflected about 5 feet of vertical scour to the foredunes in this area due to Kate.

In eastern Gulf County, Indian Peninsula extends two and one-half miles in length between Money Bayou and Indian Pass. Minor to moderate beach and dune erosion was sustained along this peninsula and widespread roofing and screen damage was sustained by the dwellings in this area. Most of the older dwellings in this area are set back a substantial distance from the Gulf beach and are actually closer to the Indian Lagoon shoreline. One dwelling landward of Gulf County Road C30B sustained major roof damage due to wind. The 500 foot long Indian Peninsula fishing pier was destroyed by the storm surge and waves. Along the Gulf County Road C30 fronting on Indian Lagoon, the Indian Pass Trading Post sustained roofing and water damage and a single - family dwelling sustained major damage due to waves and wind.



BEACH PROFILE
 —○— 10 JUL 84
 -x- 07 DEC 85

COUNTY: GULF
 DIVISION OF BEACHES & SHORES
 FLA. DEPT. OF NATURAL RESOURCES

RANGE: R-51 1/2
 MONUMENT ESTABLISHED: JUN 1983*
 BEARING: S 85°00' W (MAG.)

* NOTE R-51A WAS ESTABLISHED -100.0 FEET FROM ORIGINAL MONUMENT

FIGURE 14. Heavy dune erosion on St. Joseph Peninsula

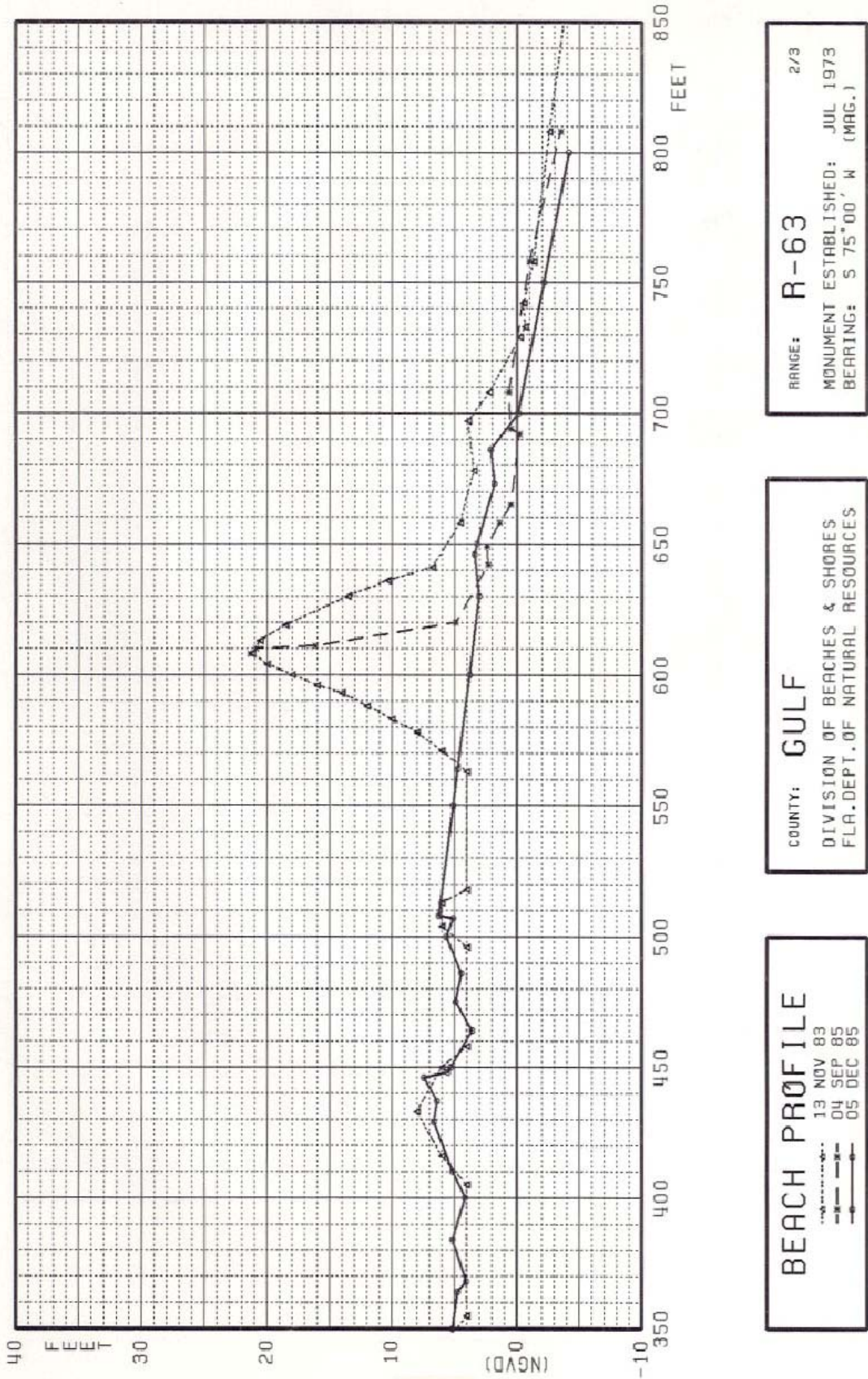


FIGURE 15. After hurricane Elena the seaward half of the barrier dune. Kate destroyed the remainder



FIGURE 16. Dwelling destroyed, St. Joseph Peninsula.



FIGURE 17. Dwelling destroyed, St. Joseph Peninsula.



FIGURE 18. Cape San Blas, November, 1984 (Photograph provided by Kevin R. Bodge, University of Florida)



FIGURE 19. Cape San Blas, November, 1984 (Photograph provided by Kevin R. Bodge, University of Florida)



FIGURE 20. Cape San Blas beach access road destroyed.



FIGURE 21. Dwelling by wind near Cape San Blas.



FIGURE 22. Flooded area east of Money Bayou.



FIGURE 23. Dwelling damaged by wind and flooding.



FIGURE 24. Manufactured dwelling destroyed by winds, waves, and flooding.



FIGURE 25. Damaged dwelling floated off its short pile foundation.



FIGURE 26. Mobile home destroyed by wind and flooding.



FIGURE 27. Dwelling damaged by wave impact loads.

APALACHICOLA AND WESTERN FRANKLIN COUNTY

During the late afternoon and early evening of Thursday, November 21, the City of Apalachicola huddled in the darkness as the maximum wind field of hurricane Kate impacted the area of western Franklin County. At the airport west of Apalachicola the National Weather Service reported a peak wind gust for north Florida of 78 miles per hour. While St. Vincent Island was sustaining heavy beach and dune erosion and flooding, the storm surge of Kate propagated through the constricted St. Vincent Sound and caused substantial flooding of the mainland shoreline area south of Franklin County Road 3022 and U.S. Highway 98. In Apalachicola and western Franklin County, 39 major structures, excluding roads, were destroyed or sustained major structural damage.

At an area known as 14 Mile, two mobile homes were destroyed by the flooding. These structures were the St. Vincent National Wildlife Refuge offices. Substantial tree damage made many of the refuge trails unpassable on St. Vincent Island. At an area known as 13 Mile, three structures were destroyed by the flooding. A concrete block slab-on-grade seafood processing plant located on the St. Vincent Sound shoreline was totally destroyed by storm waves propagating on the storm surge. About 2,000 feet inland from the sound a frame single-family dwelling and a mobile home were destroyed by the flood waters. Nearby a large steel hull boat strapped to a trailer was floated further inland about 100 feet by the flood. Just west of the junction with U.S. Highway 98, about 350 feet of Franklin County Road 3022 was substantially damaged due to erosion from St. Vincent Sound (Figure 28).

Extending along the Apalachicola Bay shoreline west of the City of Apalachicola is the Two Mile Breakwater constructed of dredge material by the U.S. Army Corps of Engineers. This breakwater provided substantial protection to the upland properties; however, flood damage was extensive at the gap in the breakwater where the navigation channel extends offshore. Behind the breakwater segment west of the navigation channel gap, seven major structures sustained major structural damage. Of these, four seafood processing houses and one metal warehouse building sustained major roof and siding damage due to wind. Behind the damaged warehouse a mobile home was damaged from the building's debris. Additionally, a carport attached to a single-family dwelling was destroyed and a mobile home was damaged from flooding near the shoreline.

At the gap in the breakwater for the navigation channel, evidence existed indicating how substantial the damage would have been without the breakwater (Figure 29). A large concrete block

former seafood house which was being used as a storage building was totally destroyed by wave impact loads (Figure 30). Nearby, but only partially sheltered by the breakwater, another concrete block commercial building was damaged by waves and gutted by flooding (Figure 31). Across the street one mobile home was destroyed and another damaged by wind (Figure 32).

East of the navigation channel gap in the breakwater four major structures were destroyed and ten others were substantially damaged. One small mobile home was destroyed by flooding and another was destroyed by wind. Two other mobile homes were damaged by flooding, waves, and foundation scour. Three single family dwellings were substantially damaged by flooding, waves, and wind damage, one of which had its roof blown off and a detached bedroom damaged. Additionally, five seafood processing buildings sustained substantial wind and water damage. At the breakwater's east end the storm surge and storm waves broke over a bulkhead and destroyed a 50 foot segment of concrete block retaining wall and destroyed the eastern portion of the Hut Restaurant (Figure 33). Adjacent to the Hut Restaurant a mobile home was destroyed by waves and floating debris (Figure 34).

In downtown Apalachicola, the 100-year old water tower was toppled by Kate's winds (Figure 35). Widespread light wind damage was experienced throughout the city. One dwelling sustained major roof damage. Along the waterfront of the Apalachicola River, four seafood processing buildings and another metal commercial building sustained wind and water damage. Some dock damage and flooding was sustained along Water Street. At the mouth of the river a concrete block commercial building sustained heavy wave damage (Figure 36). Docks and boats alike were damaged at the marina at Battery Park (Figure 37). Nearby an old wood hotel structure sustained foundation damage due to wave activity.

East of the mouth of the river extends the John Gorrie Causeway which sustained substantial flooding from Apalachicola Bay. Approximately 1,350 feet of U.S. Highway 98 was damaged along the Gorrie Causeway.



FIGURE 28. Franklin County Road 3022 damage from St. Vincent Sound shoreline erosion.



FIGURE 29. Heavy damage at the gap in the two mile breakwater, Apalachicola.



FIGURE 30. Concrete block commercial building destroyed by waves.



FIGURE 31. Heavy wave damage to another commercial building.



FIGURE 32. Mobile home destroyed by wind.



FIGURE 33. Wave damage to the Hut Restaurant on Apalachicola Bay shoreline.



FIGURE 34. Apalachicola Bay shoreline dwelling destroyed.



FIGURE 35. One hundred year old Apalachicola water tower toppled by Kate's winds.



FIGURE 36. Building damaged by waves at the mouth of the Apalachicola River.



FIGURE 37. Marina Damage at Battery Park, Apalachicola.

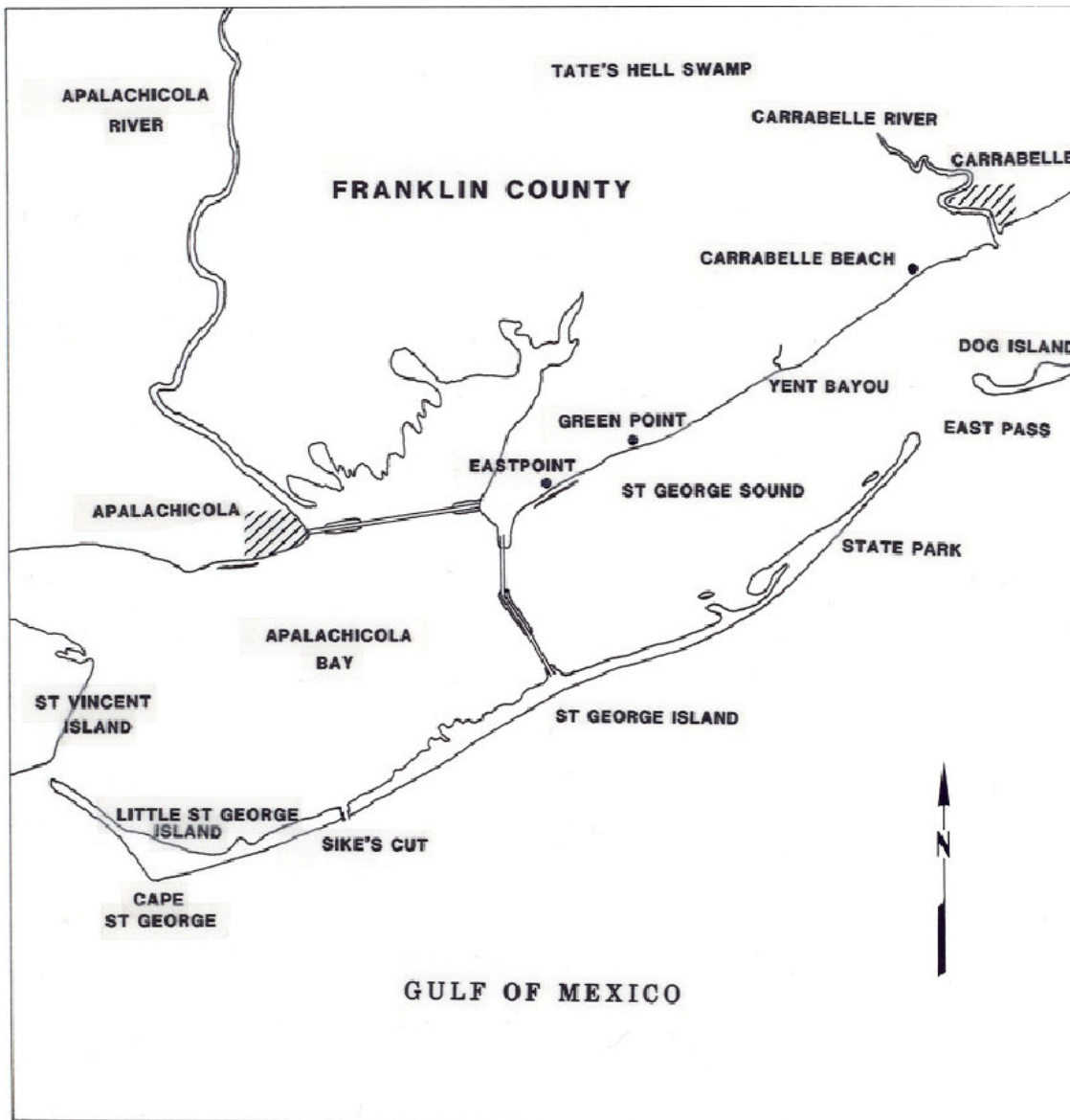


FIGURE 38. St. George Island and Apalachicola to Carrabelle, Franklin County.

ST. GEORGE ISLAND, FRANKLIN COUNTY

The prior chapter discussed the coastal damages along the mainland shoreline of Franklin County fronting on Apalachicola Bay. Of the 156 major structures exclusive of roads which were destroyed or sustained major structural damage on the coast of Franklin County, 110 were located along the mainland shoreline and only 46 were located on the outer barrier coast. Generally, improved siting and construction standards in practice on the barrier coast was a major factor in the reduced number of structures sustaining major damage. All of those structures on the barrier coast which sustained major damage did not meet the current coastal building standards of Franklin County or the State of Florida. On St. George Island, nineteen major structures exclusive of roads were destroyed or sustained major structural damage. Of these, three single-family dwellings and one mobile home were destroyed, and thirteen single-family dwellings and two mobile homes sustained major structural damage.

Between West Pass and East Pass, extends 28 miles of coastal barrier fronting Apalachicola Bay and St. George Sound. The western six to seven miles of this coastal barrier system is historically referred to as Little St. George Island and includes the large coastal feature known as Cape St. George. The former natural tidal pass separating Little St. George Island from St. George Island is now closed; however, the storm surge from Kate substantially inundated this old inlet and carried flood waters into Apalachicola Bay. Between this closed pass and the dredged St. George Island Channel (also referred to as Bob Sike's Cut) is about two and one-half miles of the historical west end of St. George Island. In Post-Storm Report 85-3, heavy dune erosion was reported due to the offshore pass of hurricane Elena along the entire length of Little St. George Island and St. George Island. Hurricane Kate inflicted additional heavy erosion throughout this area. Unfortunately, beach profile data was not obtained west of Sike's Cut, but personal observations of this area after both storms revealed heavy beach and dune erosion. The predominant longshore transport of sediment in this area is westerly toward Cape St. George and the shore line recession west of Sike's Cut reflects the deficit of sediment which typifies numerous other Florida coastal inlets which are dredged to maintain navigable depths.

As reported in Post-Storm Report 85-3, the inlet's rock jetties at Sike's Cut were breached by the substantial shoreline recession caused by Elena on September 1. Figure 39 is an aerial photograph of the inlet prior to Kate. The Mobile District Corps of Engineers conducted an emergency dredging operation in the channel after Elena, removing shoals and placing the material in the breach between the east jetty and the shoreline. Although some erosion did occur in this filled area immediately east of

the inlet by Kate (Figure 40), conditions were substantially better than After Elena. The storm waves of Kate must have been substantially out of the southwest because the black channel buoy normally located directly offshore from the inlet was located one mile east of Sike's Cut after the storm.

The beaches and dunes along the St. George Island Plantation east of Sike's Cut sustained heavy erosion from Kate. The exposed root systems of old sand pine stumps located the former barrier dunes which were destroyed by the combined erosion impact of hurricanes Elena and Kate (Figure 41). None of these former barrier dunes exists for 7,000 feet east of Sike's Cut. The remaining two and three-fourths of a mile of St. George Island Plantation shoreline to the east reflect heavy dune erosion with steep vertical escarpments fronting the beach. Although no storm surge data was obtained in this area from Kate, the surge appeared to range somewhere between approximately +7 feet NGVD and +8 feet NGVD (personal observation). Along the Plantation's beachfront no major structures sustained major structural damage however, most all the beach dwellings sustained light wind damage and all the beach access walkways were destroyed along their seaward extremities. The beach dwellings in the Plantation typically sustained damage to their roofing, screens, and antennas, and a few dwellings sustained wind damage to porches and chimneys. Throughout the Plantation numerous pines were blown down. Near the east end of the Plantation on the beach a 45 foot length of railroad tie retaining wall was destroyed.

Between the St. George Island Plantation and Franklin Boulevard at the St. George Island causeway, two dwellings were destroyed and seven others sustained major structural damage by Kate. The two dwellings which were destroyed, were both pile-supported and sustained only wind damage. One of these, a pile-supported manufactured home, was located about 700 feet inland from the beach at 11th Street West inland of Gulf Beach Drive which is the second paved road inland from the beach (Figure 42). Nearby, on the beach seaward of Gorrie Drive, a slab-on-grade concrete block dwelling sustained major roof damage due to wind (Figure 43). In the four block stretch between 12th Street West and 8th Street West on Gorrie Drive, 29 dwellings sustained roofing damage including nine which sustained extensive roofing damage. A number of dwellings in this stretch had screen damage, a few fences were destroyed, and a screen porch with roof was destroyed. In addition, a dwelling located north of Gorrie Drive between 9th Street West and 8th Street West sustained major structural roof damage due to wind (Figure 44).

Adjacent to the beach to the east of the end of 8th Street West, the older of two adjoining wood frame dwellings sustained major structural roof damage due to wind (Figure 45). The roof damage seen in Figures 44 and 45 reflect the need for stronger roof to wall connections particularly where large roof overhangs are

constructed. On the beach, immediately west of the end of 7th Street West, a pile-supported wood frame dwelling was destroyed by wind (Figure 46). The connection details of this structure did not even comply with the Standard Building Code at the time of construction, let alone the current coastal building codes in effect on St. George Island. Airborne debris from this dwelling was carried over 150 feet inland and a section of the roof knocked out a seaward pile from the neighboring dwelling across Gorrie Drive. Between 8th Street West and Franklin Boulevard, another 28 structures sustained roofing damage including ten with extensive roofing damage and one with a damaged porch and collapsed roof. Several dwellings sustained screen damage, a few antennas were blown down, a fence was destroyed, and a few porches and decks were damaged. A number of beach access walkways also had their ends destroyed.

On the Apalachicola Bay shoreline area of St. George Island west of the causeway, two single-family dwellings and one mobile home sustained major structural damage due to the flooding from the bay. The storm surge and wave activity in Apalachicola Bay from Kate inflicted additional damage to the causeway to St. George Island beyond that damage previously sustained by hurricane Elena. As discussed in Post-Storm Report 85-3, the strong east to southeast winds associated with Elena's west-northwestward track on September 1 caused a significant setup of the storm tide along the causeway's east shoreline. Because of this storm tide and the storm wave activity which propagated westward along the axis of St. George Sound substantial causeway erosion and damage to three bridge abutments were sustained during Elena. Kate's predominant storm wave propagation appeared to be towards the northeast in this area and the northernmost of the four bridge abutments, which had not previously been damaged by Elena, was severely eroded by Kate. In addition, Kate inflicted heavy damage on the other three bridge approaches.

East of Franklin Boulevard along Gorrie Drive, two dwellings were destroyed and eight others sustained major structural damage. Along this eastern segment of Gorrie Drive 47 other dwellings sustained roofing damage including seventeen with extensive roofing damage. Additionally, several dwellings sustained screen and antennae damage and two porches were substantially damaged. To the north of Gorrie Drive about 500 feet west of 5th Street East, a wood frame barrel-shaped dwelling was ripped apart by Kate's winds (Figure 47). This type of construction is not appropriate for the open coast due to the inferior roof and wall connections. Nearby, another dwelling located 200 feet west of 5th Street East sustained major structural roof damage due to wind. On the beach immediately east of the end of 5th Street East, a slab-on-grade concrete block dwelling sustained major structural roof damage due to wind and had its concrete block porch destroyed by wave uprush (Figure 48). At another similar type dwelling located 600 feet east of 6th Street East, the porch

was destroyed and its roof collapsed causing major structural roof damage to the main portion of the structure (Figure 49). Immediately adjacent and to the east, a pile-supported wood frame dwelling sustained major foundation damage due to wind in combination with the scour of sediment around the piles (Figure 50). The structure's inadequate pile to beam connections were damaged and pile penetration was insufficient causing the structure to lean towards the north in danger of collapse from another strong onshore wind.

To the east about 400 feet is a mobile home on the south side of Gulf Beach Drive. This grade level mobile home sustained major damage from flooding which was extensive throughout this portion of the island. A couple thousand feet to the east was another site of heavy damage. Two slab-on-grade concrete block duplex units sustained major structural roof damage (Figure 51). The roof to wall connections of these structures could not withstand the uplift forces of the wind against the large roof overhangs. The slab-on-grade concrete block dwelling next door to the east also had its roof blown off as well as its seaward wall destroyed due to wave activity (Figure 52). A half-foot of sand was deposited on the slab of this grade level dwelling and the interior was gutted by the flooding. At the adjacent duplex to the east a 50-foot concrete block wall was destroyed and the understructure area was damaged by the wave uprush. Further east, about 1,200 feet west of the east end of Gorrie Drive another grade level dwelling was substantially damaged by wind and wave loads (Figure 53). The wind blew the entire roof off this wood frame dwelling and the flooding and wave uprush destroyed the front porch, battered the seaward wall and gutted the interior. The dwelling was subsequently removed after the repair cost to the structure's damage was assessed at over fifty percent of the dwelling's value.

In the two miles between the east end of Gorrie Drive and the State Park, heavy dune erosion was sustained and extensive flooding occurred through major dune breaches. Most of the dwellings in this area are recently constructed and are built to improved construction standards. In this area there was no major damage; however, twelve dwellings sustained roofing damage including one with extensive roofing damage. In addition, four condominium buildings near the park sustained roofing damage with one new building sustaining extensive roofing damage. Several beach access walkways were also destroyed in this area.

In addition to the dwelling damage along the private properties of St. George Island, the flooding caused major road damage at three locations. Adjacent to the beach at Franklin Boulevard, approximately 150 feet of road pavement edge was damaged on Gorrie Drive due to hydraulic scour. Between 5th Street East and 6th Street East, a 250-foot segment of Gulf Beach Drive was

substantially damaged and further east another 300 feet of Gulf Beach Drive was damaged.

Road damage was widespread along the St. George Island State Park which includes the eastern eight miles of St. George Island. Post-Storm Report 85-3, the park road damage due to Elena was which includes the eastern eight miles of St. George Island. In Post-Storm Report 85--3, the park road damage due to Elena was discussed. The close proximity of the park road to the beach berm and shoreline in contrast to the remainder of the island's roads was a major factor in the damage sustained by both Elena and Kate. In addition, the barrier dune elevations as well as the average ground elevations along the park road are lower than the rest of the island. These low elevations subject the east end of the island to inundation from storm tides. As reported in Post-Storm Report 85-3, Elena totally destroyed approximately 400 feet of the road at its eastern end. An additional 21,000 feet or nearly four miles of pavement sustained damage to its edge. This pavement edge damage probably left the narrow asphalt road unsuitable for safe driving conditions during normal public park usage. Whether the road safety was questionable is now academic because Kate destroyed much of what was previously only damaged along the east end. Kate totally destroyed approximately 5,120 feet or nearly one mile of road pavement (Figure 54). Another approximately 1,000 feet of road sustained pavement edge damage where it was previously undamaged by Elena. Nearly three miles of the road which had pavement edge damage from Elena sustained minor to moderate additional edge damage from Kate.

The University of Florida obtained two measurements of the storm surge of Kate in the park. The two storm surge gages measured +6.2 feet NGVD and +8.0 feet NGVD. Figures 55 through 57, are computer graphics of topographic survey data obtained by the Bureau of Coastal Data Acquisition, Division of Beaches and Shores, after both Elena and Kate. Figure 55 reflects the dune erosion and threat to the park road at atypical profile between the two high use beach access facilities. The park road is located 50 feet landward of the survey monument. Figure 56 is a profile located at the eastern high use beach access facility and Figure 57 reflects the dune erosion and low ground elevations at the east end of the park road.

The damaged condition of the park road following the impact of the two hurricanes necessitated the closure of the eastern two and one-half miles of road past the eastern high use beach access facility. This eastern segment of road is currently only useable by permitted four-wheel drive vehicular access. The remainder of the park road system which sustained some pavement edge damage has received emergency repairs sufficient to open the facilities for normal public usage. The one mile of road which was destroyed by Kate was made particularly vulnerable to storm damage when Elena destroyed all the protective dune system fronting that

stretch of road. The combined dune erosion of both Elena and Kate left a large proportion of the undamaged and repaired segment of road extremely vulnerable to future storm damage; however, the degree of vulnerability has since been mitigated by the dune restoration activities of the park staff.

A dune stabilization project with the planting of sea oats is needed at both high use beach access facilities in order to provide a sufficient level of protection to these facilities from future storm tides. In addition, where the newly constructed barrier dunes along the park road do not sufficiently revegetate naturally, a program of mulching, seeding, and transplanting, should be considered for enhancing the restoration process.

Whether along the park shoreline or along the private properties of St. George Island, dune restoration and revegetation is highly recommended to enhance the recovery and to ensure the future protection of the island. The beach and dune system along the island provided a major protective function to substantially minimize the damages from the storm surge and storm waves of Elena and Kate. In order to utilize the natural protection best provided by the beach and dune system of St. George Island, the dunes will need to recover from the erosion sustained by Elena and Kate. The strategic placement of sand fencing and the successful establishment of dune vegetation has never been in more critical need throughout St. George "Island.



FIGURE 39. Sike's cut (St. George Island Channel) in November, 1985 prior to Kate (photograph by Kevin R. Bodge).



FIGURE 40. Sike's cut after Kate, November 24, 1985 (Kevin R. Bodge).



FIGURE 41. Sand pine stump on the beach reveals severe erosion. St. George Island Plantation.



FIGURE 42. destroyed dwelling on Gulf Beach Drive.

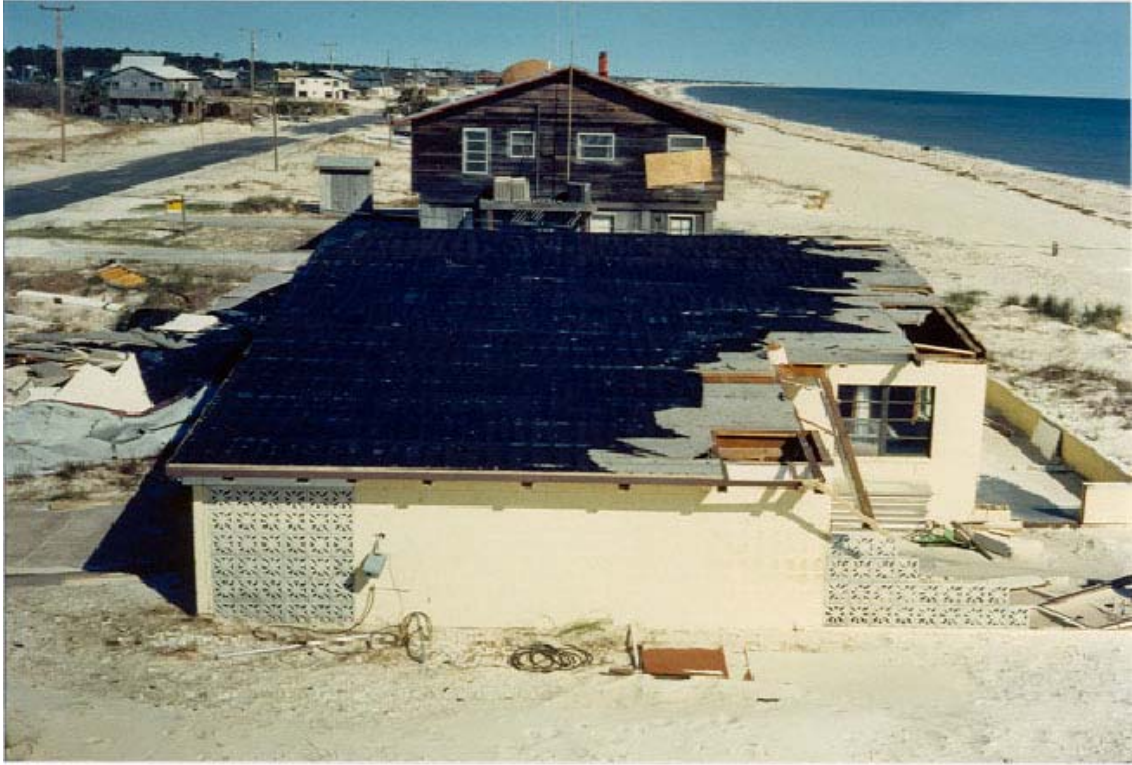


FIGURE 43. Major roof damage due to wind.



FIGURE 44. Gorrie Drive dwelling's roof collapsed.



FIGURE 45. Severe Structural roof damage due to wind.



FIGURE 46. St. George Island beach Dwelling destroyed by wind.



FIGURE 47. Barrel-shaped house destroyed by wind.



FIGURE 48. Structural roof damage due to wind and concrete block porch destroyed by waves.

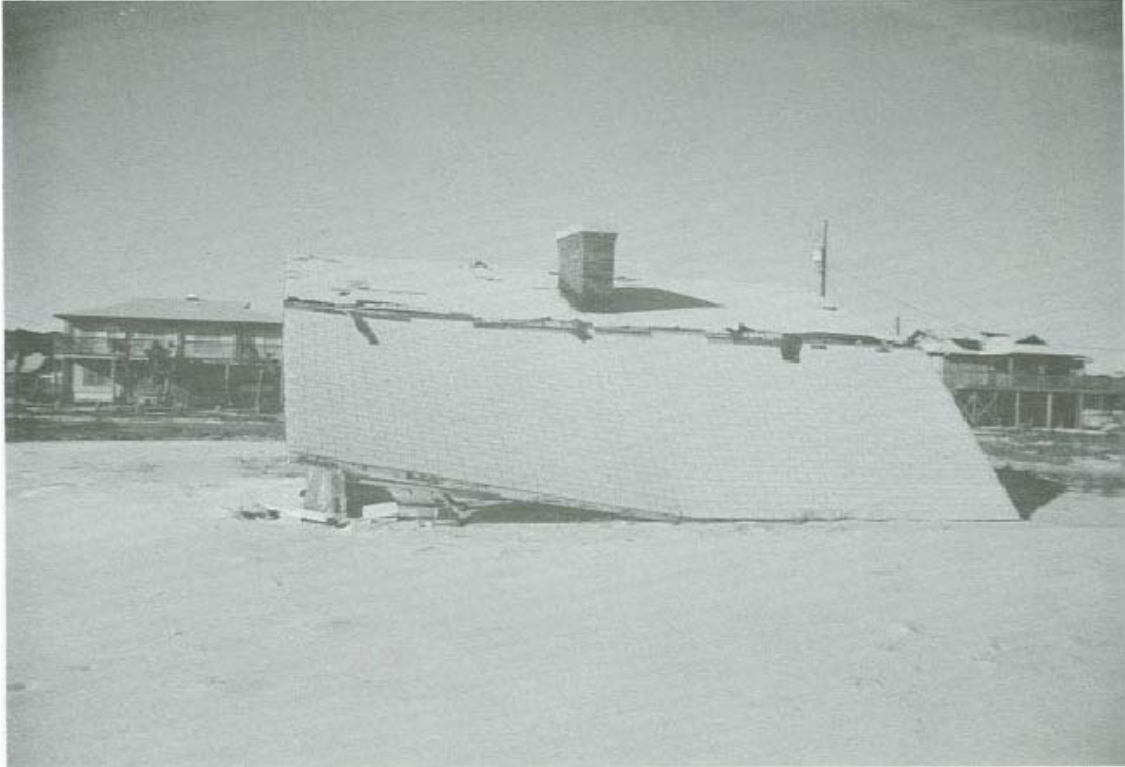


FIGURE 49. Porch destroyed and roof collapsed.



FIGURE 50. Pile-supported dwelling with inadequate pile to beam connections and insufficient pile penetration leans following wind loads and scour.



FIGURE 51. Duplex sustained major structural roof damage.



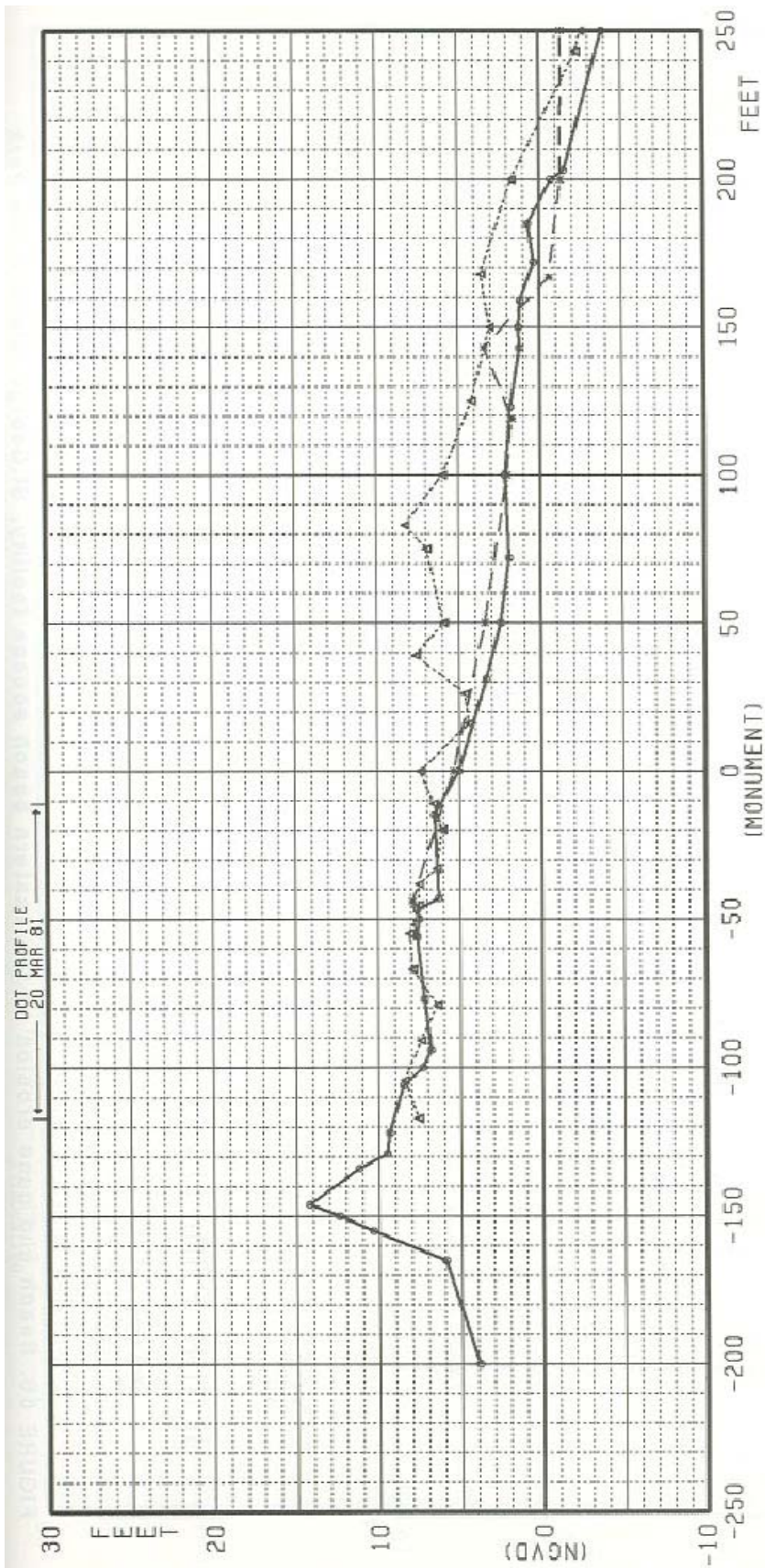
FIGURE 52. Dwelling with roof blown off and seaward wall destroyed by waves.



FIGURE 53. Frame dwelling damaged beyond repair by wind and wave loads.



FIGURE 54. St. George Island State park road destroyed.



NOTE: JUL 81 SURVEY HAS BEEN EXTENDED UPLAND OF THE MONUMENT BY DOT PHOTOGRAMMETRIC CONTOURS
 OCT 85 SURVEY BY FIELD MEASUREMENTS
 JAN 86 SURVEY BY FIELD MEASUREMENTS

BEACH PROFILE
 07 JUL 81
 -x- 16 OCT 85
 -o- 22 JAN 86

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 DIVISION OF BEACHES & SHORES
 FLA. DEPT. OF NATURAL RESOURCES

RANGE: **R-119** 1/2
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 BEARING: S 40°00' E (MAG.)

FIGURE 55. Dune erosion due to Elena and Kate leaves little protection for the St. George Island State Park road between the two beach access facilities.

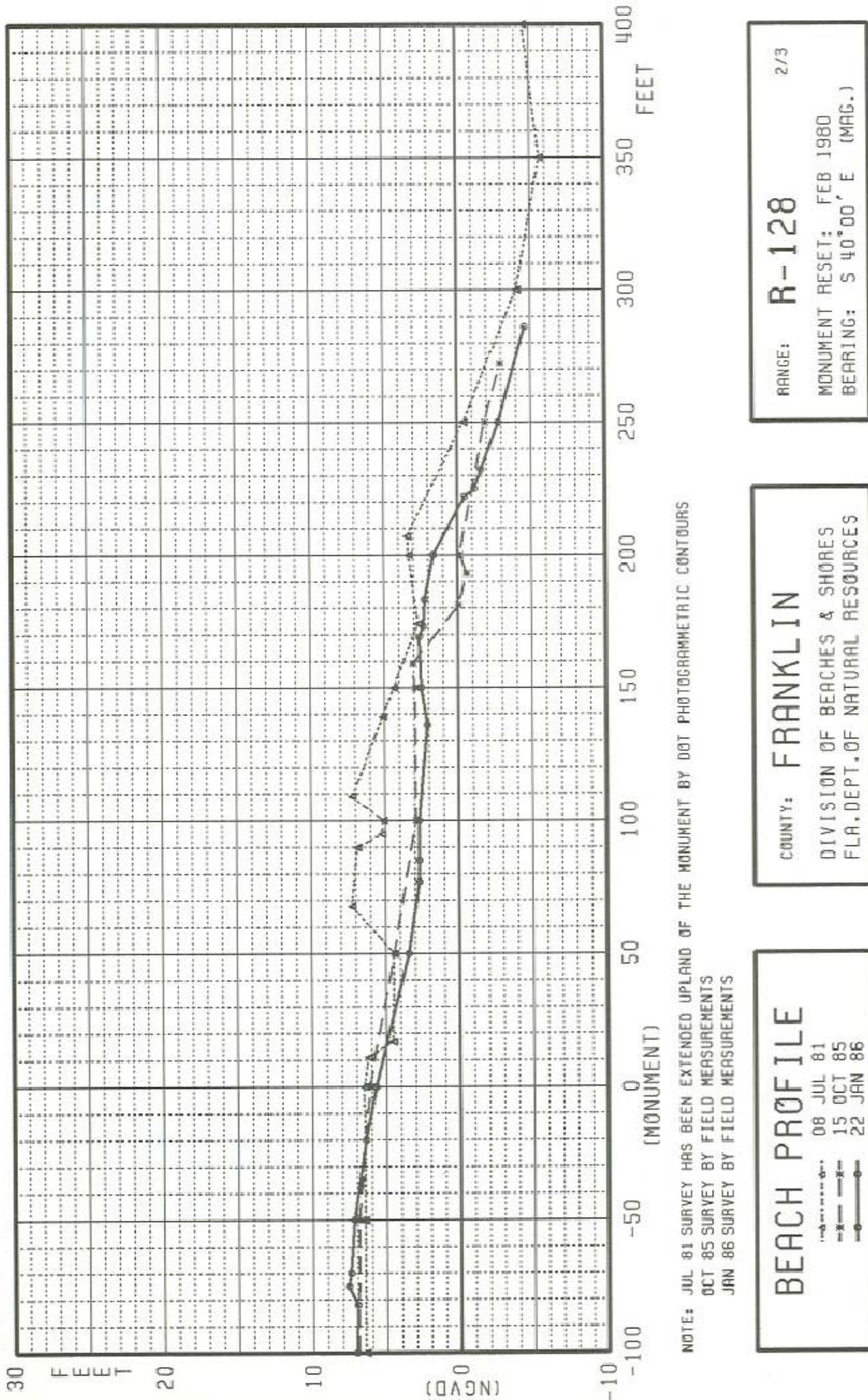
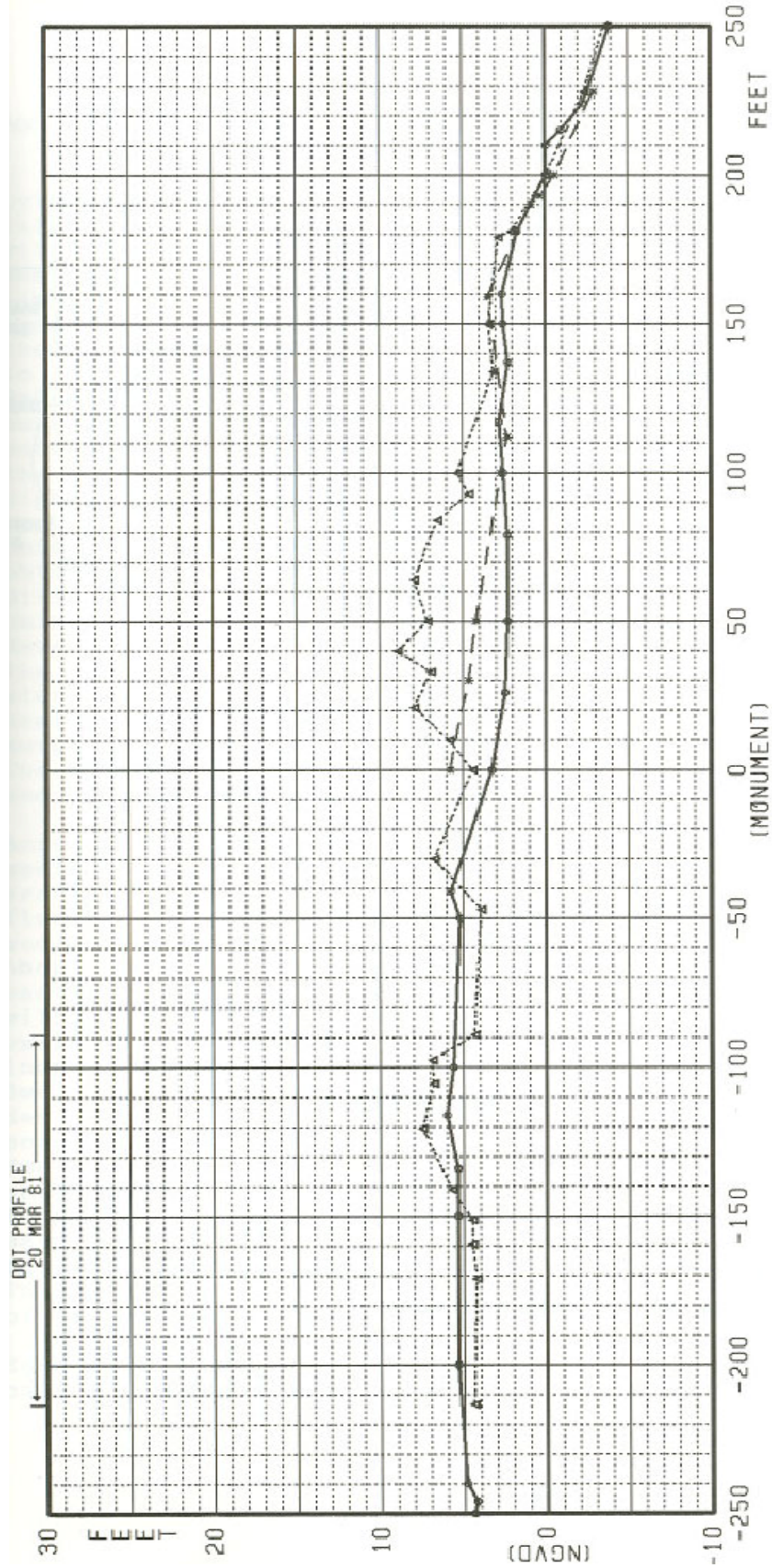


FIGURE 56. Beach and dune erosion at the eastern beach access facility, St. George Island State Park.



NOTE: JUL 81 SURVEY HAS BEEN EXTENDED UPLAND OF THE MONUMENT BY DOT PHOTOGRAMMETRIC CONTOURS
 OCT 85 SURVEY BY FIELD MEASUREMENTS
 JAN 86 SURVEY BY FIELD MEASUREMENTS

BEACH PROFILE
 21 JUL 81
 - - - - - 16 OCT 85
 ——— 23 JAN 86

COUNTY: **FRANKLIN**
 DIVISION OF BEACHES & SHORES
 FLA. DEPT. OF NATURAL RESOURCES

RANGE: **R-142** 1/2
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FIGURE 57. Dune erosion and low ground elevations at the east end of the park road