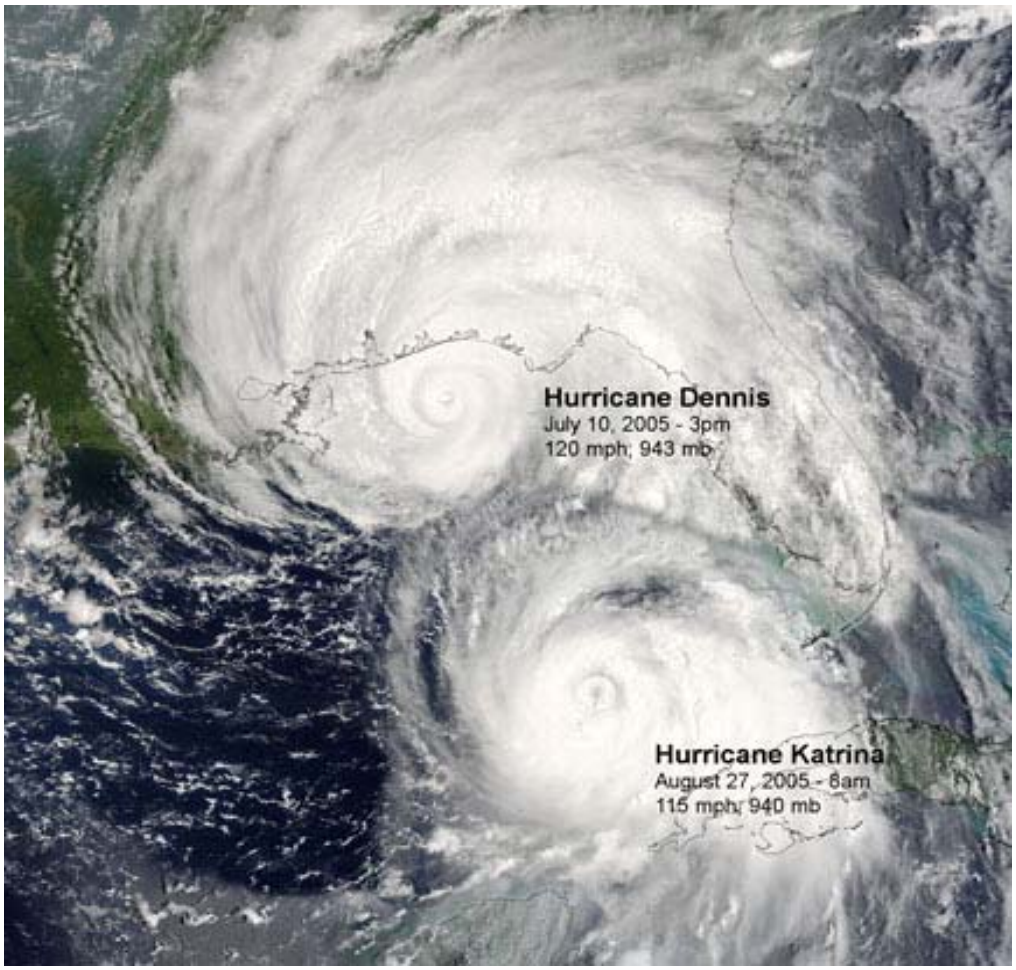
Hurricane Dennis
&
Hurricane Katrina

Final Report on 2005 Hurricane Season
Impacts to Northwest Florida



Florida Department of Environmental Protection
Division of Water Resource Management
Bureau of Beaches and Coastal Systems
April 2006

Foreword

The Bureau of Beaches and Coastal Systems of the Florida Department of Environmental Protection is responsible for protection and management of Florida's sandy beaches fronting the Gulf of Mexico, the Atlantic Ocean and the Straits of Florida, and the regulation of coastal development adjacent to those coastal beaches. The monitoring and assessment of hurricane impacts to Florida's beaches and coastal construction and the preparation of post-storm recovery responses and management strategies are important elements of the Bureau's responsibilities.

This report provides documentation of the impacts of Hurricanes Dennis and Katrina on the coast of northwest Florida. The report also provides recommendations for post-storm response activities. This report was prepared by the Coastal Engineering Section for the Bureau of Beaches and Coastal Systems. The report was written by Ralph R. Clark, P.E., P.L.S., with major contributions and preparation of graphics by James LaGrone, Coastal Engineer. Field data of beach and dune erosion and structural damage were obtained by Ralph Clark, James LaGrone, Robert Brantly, P.E., and Junaid As-Salek, P.E. Post-storm high water surveys and beach and dune surveys were obtained by Thomas Watters, P.L.S., Ernest Besse, Guy Weeks, and James LaGrone. Aerial videography and oblique aerial photography were provided by Stacey B. Roberts of PBS&J and Camera Copters, Inc.

STATE OF FLORIDA, DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Michael R. Barnett, P.E., Chief
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Hurricane Dennis

July 4 – 11, 2005

Hurricane Dennis, the first hurricane of the 2005 hurricane season for the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, formed as a tropical depression over the southeastern Caribbean Sea on Monday, July 4. In its initial advisory, the National Weather Service, Tropical Prediction Center (National Hurricane Center, Miami, Florida) located this depression near latitude 12.5 degrees north, longitude 63.1 degrees west, or about 100 miles west-northwest of Grenada. Movement was west-northwest near 17 miles per hour (mph). Figure 1 illustrates the track history of Hurricane Dennis combined with satellite imagery. This composite was developed by the Cooperative Institute of Meteorological Satellite Studies (CIMSS) at the University of Wisconsin - Madison.

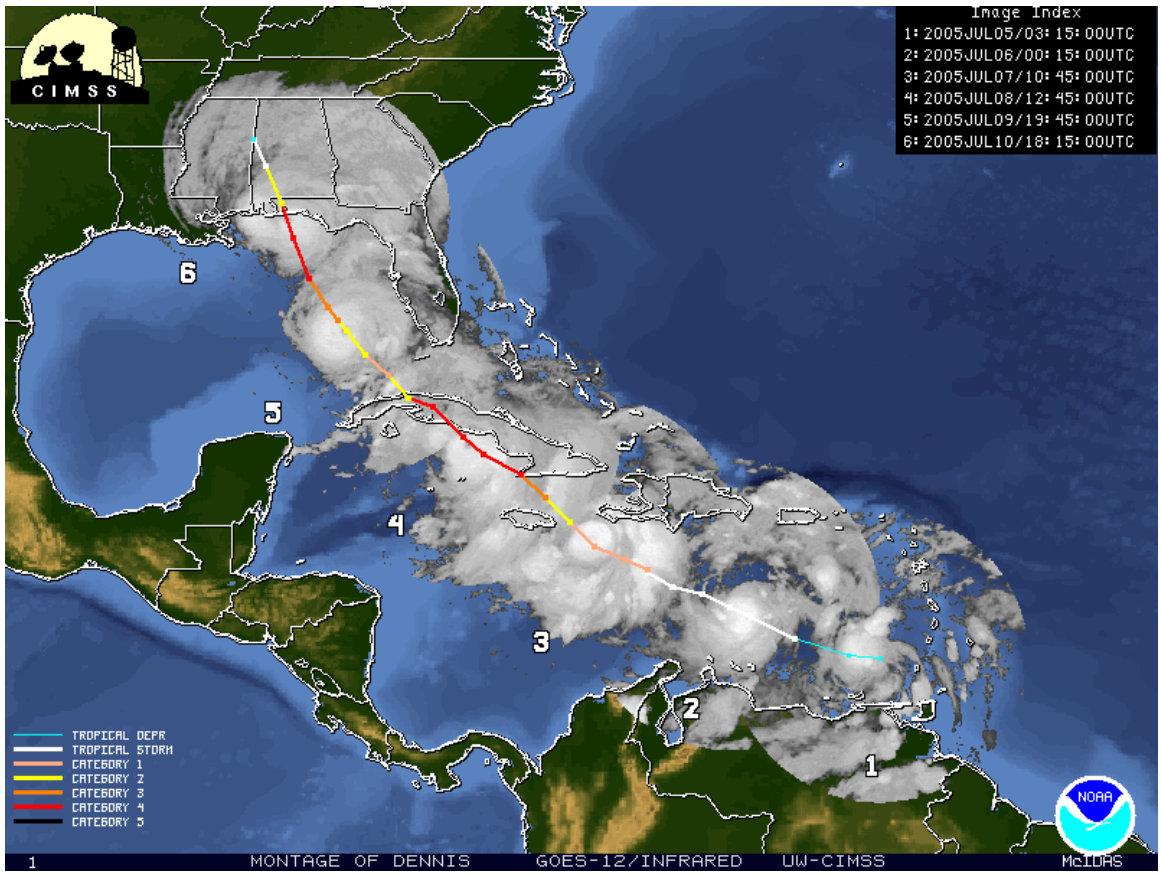

Figure 1. Hurricane Dennis storm track with landfall on the northwest coast of Florida (Source: CIMSS/Univ. of Wisconsin-Madison via NOAA / NCEP / TPC).

At 11:00 a.m. on Tuesday, July 5, the National Hurricane Center's (NHC) third advisory upgraded the depression to a tropical storm naming it Dennis and locating it near latitude 13.3 degrees north, longitude 66.6 west, or about 355 miles south of San Juan, Puerto Rico. Movement was west-northwest near 18 mph. This became the earliest date on record for a fourth named tropical storm to have formed in the Atlantic basin.

At 6:00 p.m. on Wednesday, July 6, the NHC's ninth advisory upgraded Dennis to a hurricane locating it about 335 miles south-southeast of Guantanamo, Cuba. Dennis was moving west-northwest near 14 mph with winds near 80 mph.

Hurricane Dennis strengthened to a major hurricane and at 5 p.m., Thursday, July 7, the NHC's 13th advisory upgraded Dennis to a category three hurricane on the Saffir-Simpson hurricane intensity scale. At this time Dennis was located near latitude 19.0 north, longitude 76.6 west, or about 90 miles southeast of Cabo Cruz in southeastern Cuba. Dennis was moving northwest near 15 mph with maximum sustained winds of 115 mph. At 11 p.m., the NHC upgraded Dennis further to a category four hurricane with maximum sustained winds of 135 mph. Dennis was near Cabo Cruz, Cuba.

Thursday night and Friday morning, July 8, Hurricane Dennis crossed the Cuban barrier islands known as the Archipelago de la Reina. At 2 p.m., the NHC announced that Dennis had made landfall on the south-central coast of Cuba near the city of Cienfuegos. Dennis was a strong category four hurricane with maximum sustained winds of 150 mph and was moving northwest near 17 mph across central Cuba.

After midnight, Saturday, July 9, Dennis moved into the Straits of Florida after crossing Havana, Cuba. Dennis weakened to a category two hurricane after crossing Cuba. Throughout Saturday morning Dennis continued on a northwest track, passing the Florida Keys about 125 miles west of Key West. Waves propagating from the winds of Dennis caused minor to moderate beach erosion impact along the lower keys. By 7 p.m., Saturday, the 22nd advisory of the NHC reported that Dennis had re-strengthened to a major category three hurricane with winds of 115 mph. Movement across the Gulf of Mexico remained northwest at about 14 mph. Hurricane warnings were posted across the northeastern gulf coast from Louisiana through the Florida Panhandle.

Throughout Saturday evening, Dennis continued to strengthen over warm gulf waters. The 24th advisory of the NHC, at 4 a.m. Sunday, July 10, reported Dennis was a strong category four hurricane with winds of 145 mph. The center of Hurricane Dennis was located about 170 miles south of Panama City, Florida, and movement was north-northwest near 15 mph. On July 10, 2005, at 2:25 p.m. CDT, Hurricane Dennis made landfall on Santa Rosa Island, Florida, between the beach communities of Pensacola Beach and Navarre Beach. Some weakening of the storm occurred before landfall and Dennis was a category three hurricane with winds of 115 to 120 mph.

Hurricane Dennis moved northward into Alabama and eventually dissipated after bringing flooding rains throughout north Florida, Alabama, and Georgia. Rain from the remnant tropical system continued for several days into the western Tennessee valley.

Hurricane Katrina

August 23 – 29, 2005

Hurricane Katrina, the fourth hurricane of the 2005 hurricane season for the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, formed as a tropical depression over the Bahamas on Tuesday, August 23. In its initial advisory, the National Weather Service, Tropical Prediction Center located this twelfth tropical depression of the season near latitude 23.2 degrees north, longitude 75.5 degrees west, or about 175 miles southeast of Nassau. Movement was northwest near eight miles per hour (mph). Figure 2 illustrates the track history of Hurricane Katrina combined with satellite imagery. This composite was developed by the Cooperative Institute of Meteorological Satellite Studies (CIMSS) at the University of Wisconsin – Madison.

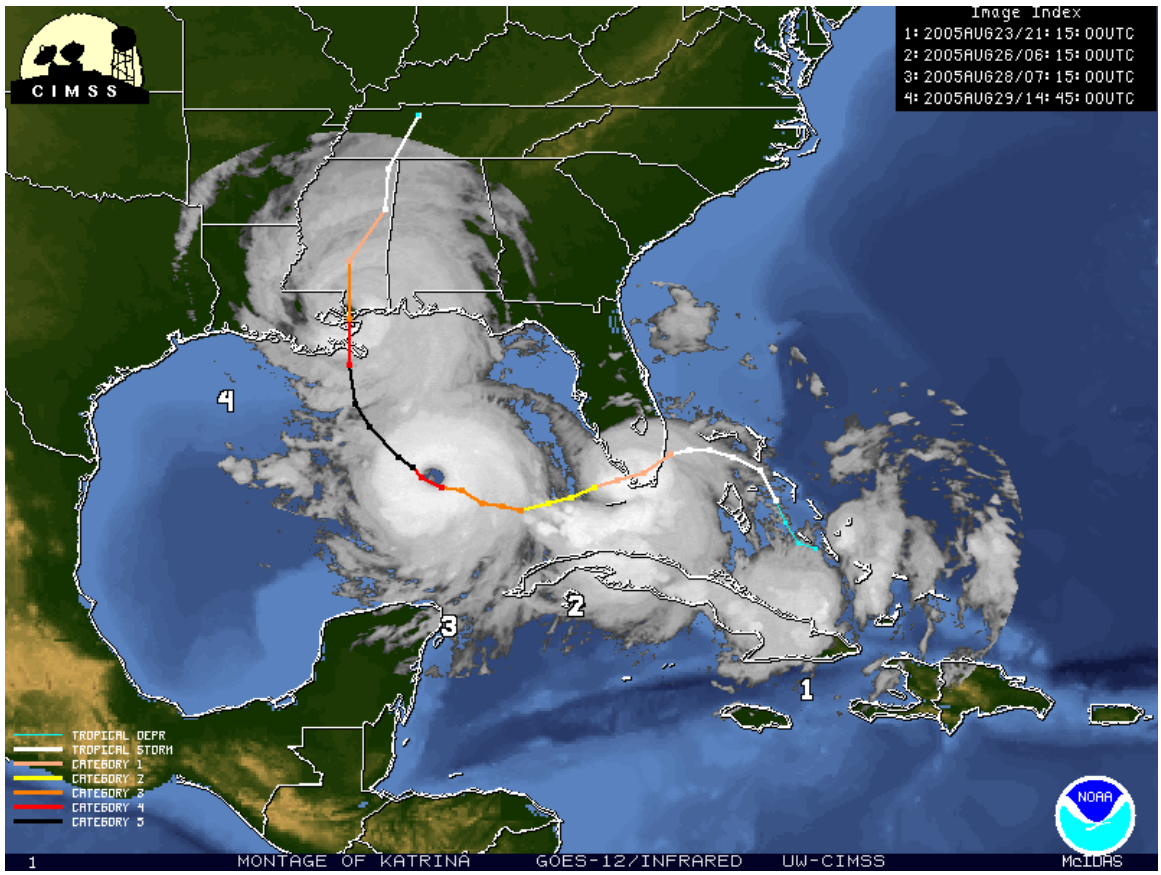

Figure 2. Hurricane Katrina storm track with landfall on the Louisiana/Mississippi coast. (Source: CIMSS/Univ. of Wisconsin-Madison via NOAA / NCEP / TPC).

At 8:05 a.m. on Wednesday, August 24, a special update by the National Hurricane Center (NHC) advised that Air Force Reserve Unit reconnaissance aircraft measured winds exceeding 40 mph indicating that tropical depression 12 had strengthened into Tropical Storm Katrina. At 11:00 a.m., the NHC's fourth advisory located Tropical Storm Katrina near latitude 24.7 degrees north, longitude 76.7 degrees west, or about 50 miles east-southeast of Nassau and about 230 miles from the southeast coast of Florida.

A tropical storm warning and a hurricane watch was issued for southeast Florida from the northern Florida Keys to Vero Beach.

At 11:00 p.m., August 24, the NHC's sixth advisory indicated that the storm was strengthening and had turned toward the west with a forward speed of eight mph and maximum sustained winds of 50 mph. At 2:00 a.m., Thursday, August 25, hurricane warnings were posted for southeast Florida.

At 5:00 a.m., August 25, the NHC's seventh advisory indicated Katrina was passing south of Grand Bahama Island. The center of Tropical Storm Katrina was located at latitude 26.2 degrees north, longitude 78.7 degrees west, or about 20 miles south-southeast of Freeport, Grand Bahama Island, and about 90 miles east of Fort Lauderdale, Florida.

At 3:35 p.m., August 25, a special update from the NHC advised that reconnaissance aircraft reports and NOAA (National Oceanic and Atmospheric Administration) Doppler radar data from Miami indicated maximum sustained surface winds had increased to 75 mph upgrading Katrina to a category one hurricane on the Saffir-Simpson hurricane intensity scale. At 5:00 p.m., the center of Hurricane Katrina was located at latitude 26.1 degrees north, 79.9 degrees west, or about 15 miles east-northeast of Ft. Lauderdale with movement to the west at six mph. A wind gust of 64 mph was reported from Boca Raton, 25 miles north-northwest of the hurricane's eye. Hurricane warnings were in effect from Jupiter Inlet (Palm Beach County) south to Florida City (Dade County).

At about 6:30 p.m., August 25, the center of Katrina's eye made landfall on the southeast coast of Florida in Bal Harbour, north of Miami Beach, with 80 mph winds. The geographic center of Katrina's eye was located about midway between the Department of Environmental Protection reference monuments R29 and R30, just south of Bakers Haulover Inlet in Dade County. Katrina was moving southwest and intensifying at landfall bringing storm tides of two to four feet above normal along the coast of Dade and Broward Counties. A maximum wind gust of 92 mph was reported in Port Everglades. The NOAA weather station at Fowey Rocks off south Dade County reported maximum sustained winds from the southwest at 56 mph with a peak gust to 61 mph. The NOAA office on Virginia Key measured a peak gust of 95 mph. By 11:00 p.m., Katrina was located 35 miles southwest of Miami with continued southwesterly movement at eight mph. The Miami National Weather Service forecast office reported a gust to 87 mph and the Tamiami Airport reported a gust of 81 mph. Heavy rainfall was sustained over Dade County.

In the early morning hours of Friday, August 26, Katrina moved off the mainland of Monroe County and into the open waters of the Gulf of Mexico. Katrina spent only about seven hours over land, most of which was the wet Florida Everglades, and therefore only slight weakening occurred. Heavy rain squalls occurred across the Florida Keys and northwestern Cuba. By late morning, the NHC advised that a NOAA vessel in port at Key West had reported sustained winds of 59 mph and a peak gust to 86 mph. The NHC's 13th advisory at 11:30 a.m., reported that Katrina was moving away from

southwest Florida and the Florida Keys and was strengthening to a category two hurricane with 100 mph winds.

At 5:00 a.m., Saturday, August 27, the NHC's 16th advisory located Katrina at latitude 24.4 degrees north, longitude 84.4 degrees west, or about 165 miles west of Key West and 435 miles southeast of the mouth of the Mississippi River. Movement was west near seven mph and maximum sustained winds had increased to 115 mph making Katrina a major category three hurricane. Through Saturday night and Sunday morning, Katrina passed over the warmer waters of the Loop Current in the Gulf of Mexico causing continued and rapid intensification. At 1:00 a.m., Sunday, August 28th, the NHC's 20th advisory upgraded Katrina to a powerful category four hurricane with 145 mph winds. At 7:00 a.m., the NHC's 22nd advisory upgraded Katrina to a potentially catastrophic category five hurricane with maximum sustained winds of 160 mph. Movement was west-northwest near 12 mph and Katrina was located about 250 miles south-southeast of the mouth of the Mississippi River. By 10:00 a.m., Katrina's winds had increased to 175 mph and the northern gulf states from Louisiana to the Florida Panhandle were evacuating this extremely dangerous storm.

At 4:00 p.m., Sunday, August 28th, the NHC's 24th advisory reported that a NOAA hurricane hunter aircraft had measured a minimum central pressure of 902 millibars or 26.64 inches of mercury, making Hurricane Katrina the fourth most powerful hurricane ever recorded in the Atlantic basin. At 4:00 a.m., Monday, August 29th, the NHC's 26th advisory reported Katrina was located about 90 miles south-southeast of New Orleans, Louisiana. Katrina weakened to a still powerful category four hurricane with maximum sustained winds of 150 mph. Movement was north near 15 mph. At 6:10 a.m., Katrina made landfall between Grand Isle and the mouth of the Mississippi River with the eye passing over Buras, Louisiana. Maximum sustained winds were about 145 mph.

Powerful category four Hurricane Katrina passed over the Mississippi River delta and northward across Breton Sound and Lake Borgne to the east of New Orleans during the next few hours. New Orleans was within the western eye wall of the large storm. At 8:00 a.m., the Pascagoula Civil Defense reported a wind gust to 118 mph. The Gulfport, Mississippi Emergency Operations Center reported sustained winds of 94 mph and a gust to 100 mph. The New Orleans Lakefront Airport reported a gust to 86. The NHC issued storm surge flooding advisories of 10 to 15 feet, or near the tops of the levees.

At 10:00 a.m., Monday, August 29th, the NHC's 27th advisory reported the center of Hurricane Katrina again moved ashore near the Louisiana-Mississippi state line with maximum sustained winds of 125 mph. Katrina was now a category three hurricane with hurricane force winds extending up to 125 miles from its center and tropical storm force winds extending up to 230 miles from its center. NWS stations reported maximum wind gusts reaching 102 mph on Dauphin Island, Alabama, 83 mph in Mobile, Alabama, and 69 mph in Pensacola, Florida. Pensacola reported sustained winds of 52 mph.

Katrina moved north through Mississippi throughout the day at between 17 and 18 mph. At 4:00 p.m., the NHC's 28th advisory reported the center of a weakening Hurricane Katrina about 30 miles northwest of Laurel, Mississippi, which is located over 90 miles

north of Gulfport. The Jones County Emergency Management Office, in Laurel, reported a peak gust to 110 mph at 2:00 p.m., before their anemometer failed. The south and central Mississippi cities of Hattiesburg, Laurel, and Meridian, and surrounding communities and rural areas, sustained major wind damage along Katrina's path of destruction.

By 10:00 p.m., the NHC had downgraded Katrina to a tropical storm with 60-mph winds and located near Columbus, Mississippi, about 220 miles inland of the coast. Throughout Monday evening strong winds and heavy rainfall spread through Mississippi, Alabama, northwest Florida, Georgia, and Tennessee. Katrina spawned 33 tornados, including one in north Florida, one in the Florida Keys, and a maximum of 17 in Georgia. Through the morning, Tuesday, August 30th, Katrina continued to weaken to a tropical depression over Tennessee, and rapidly moved northward through the day becoming extratropical.

Hurricane Katrina was one of the most devastating natural disasters in the United States due primarily to its extreme storm surge flooding along the coast of Mississippi and southeast Louisiana. The storm surge was observed to inundate the Mississippi coast for as much as six miles inland. The Hancock County Emergency Operations Center, located in Gulfport on the Mississippi Sound, reported a peak storm tide level of +28 feet. The levee system surrounding the City of New Orleans, Louisiana, was overtopped and breached in a number of locations resulting in roughly 80 percent of the city being inundated by flooding. While the overall damage costs and number of fatalities may never be accurately determined, the estimates are considerable. The Federal Emergency Management Agency has reported nearly 1,400 confirmed fatalities and the American Insurance Services Group has provided an estimate of $38.1 billion in insured losses alone attributed to Katrina.

Florida Coastal Storm Data

Eight northwest Florida coastal counties with beaches fronting on the Gulf of Mexico sustained significant beach erosion during the 2005 hurricane season. Three hurricanes – Dennis (July 10), Katrina (August 25), and Rita (September 20) – caused erosion and flooding along the coastal beaches of Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, Franklin and Wakulla Counties. Figure 3 presents the combined tracks of Hurricanes Dennis, Katrina, and Rita, and their proximity to the northwest coast of Florida.

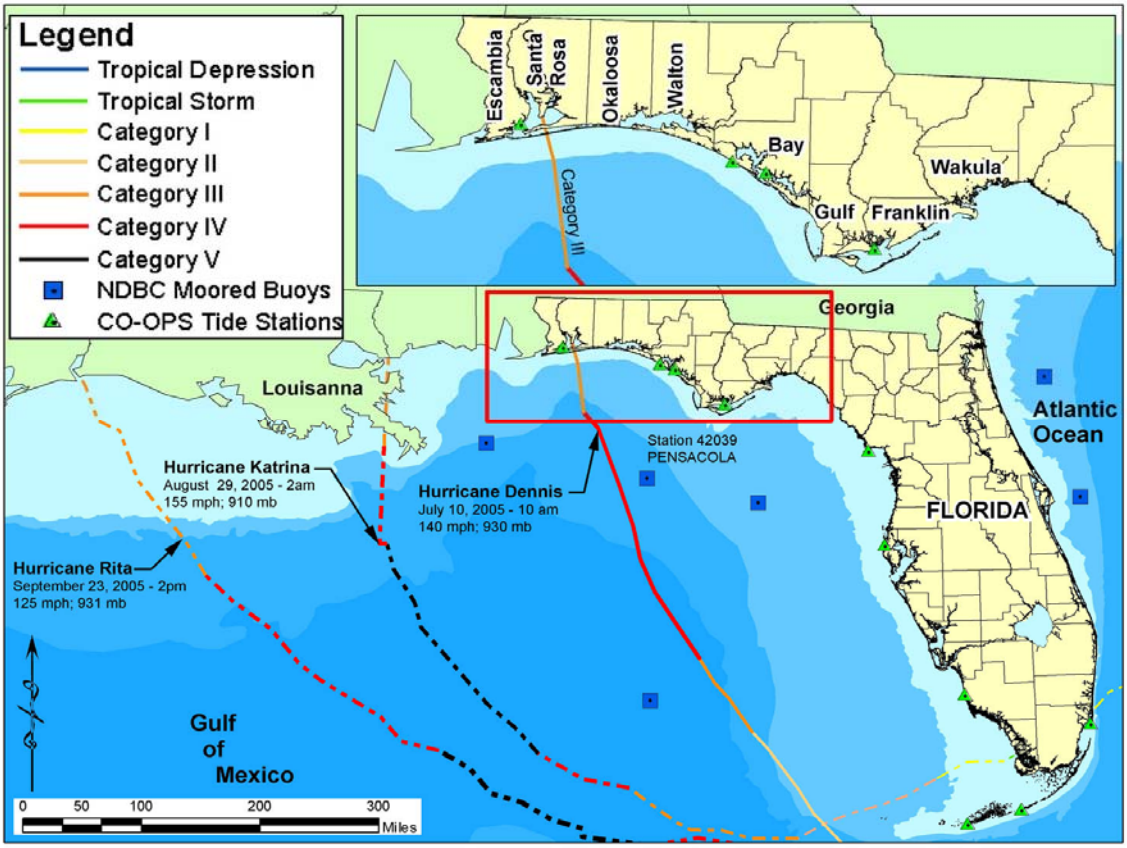

Figure 3. Combined tracks of Hurricanes Dennis, Katrina, and Rita.

The winds of Hurricane Dennis are graphically presented in the wind swath map shown in Figure 4. The data was prepared and provided by the Hurricane Research Division (HRD) at the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the National Oceanic and Atmospheric Administration (NOAA).

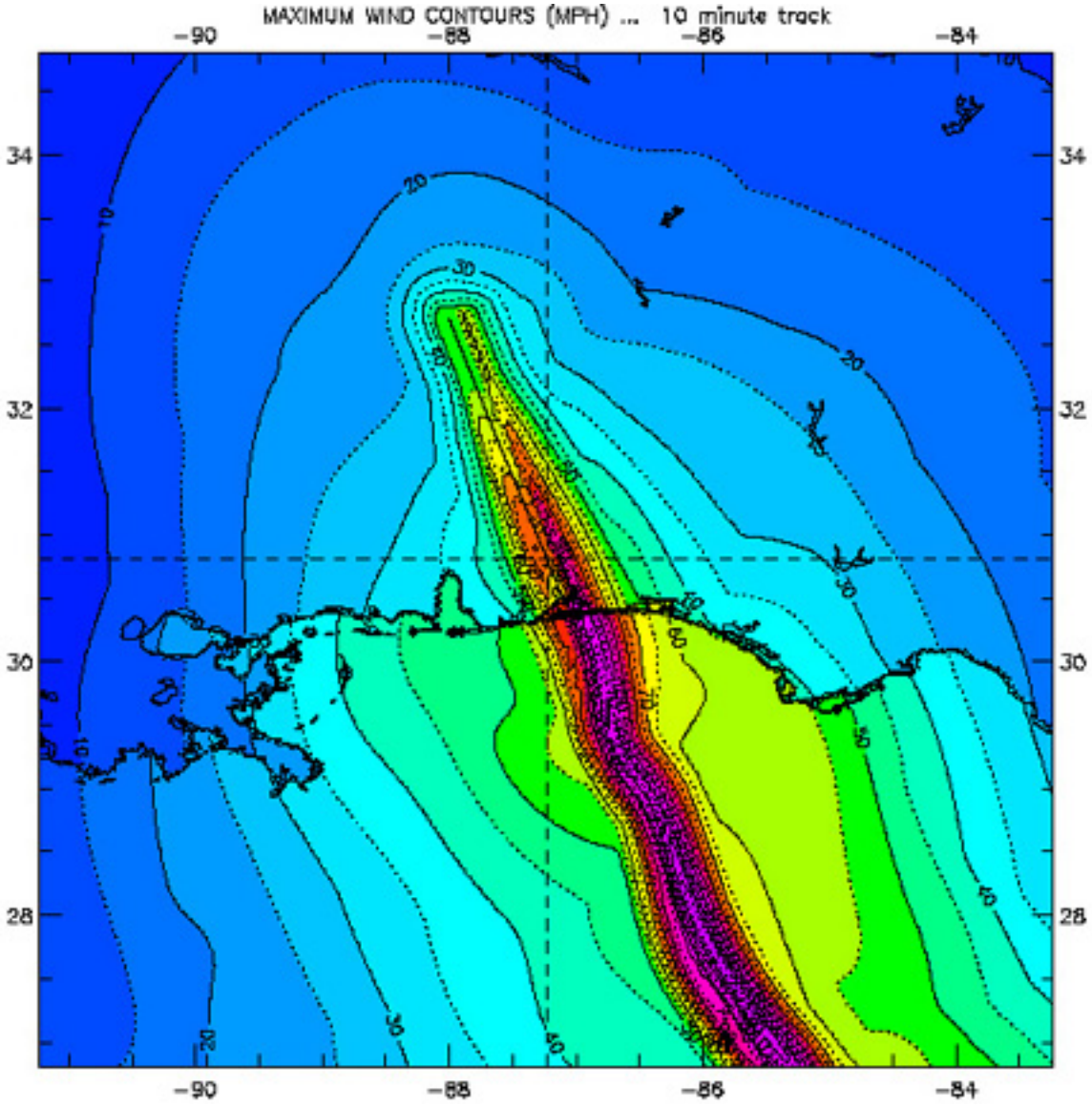

Figure 4. Surface wind fields associated with Hurricane Dennis (NOAA, AOML).

Substantial wind data was available from reporting stations throughout northwest Florida. Figure 5 maps strategic wind data reports by presenting peak wind gusts and maximum sustained winds from selected weather monitoring stations.

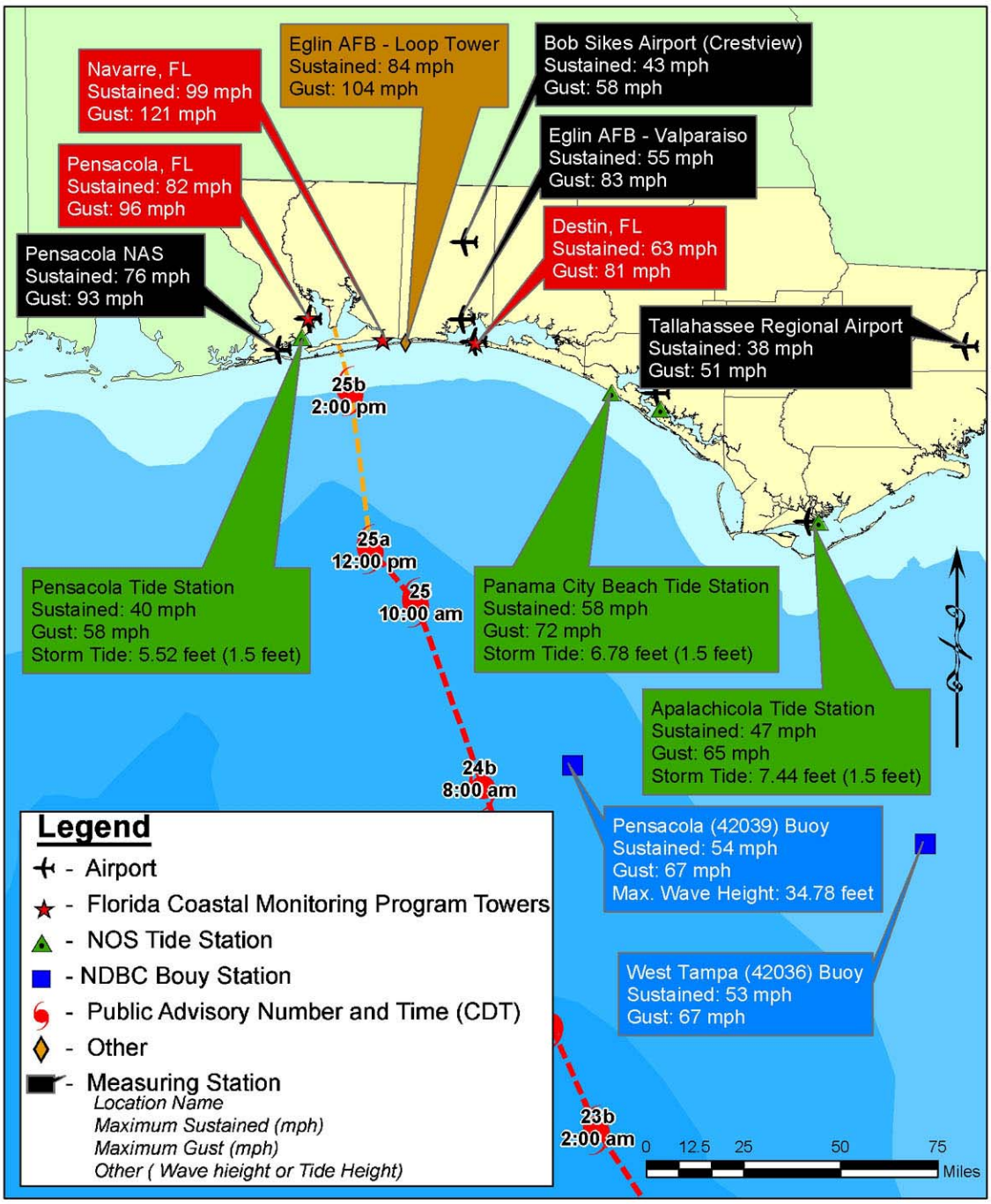

Figure 5. Hurricane Dennis wind data from recording stations.

Wave data for Hurricane Dennis is fairly scarce; however, the National Data Buoy Center, NOAA, Station 42039, located 100 miles east-southeast of Pensacola, measured a significant wave height of 10.6 meters (34.8 feet) on July 10th (Figure 6).

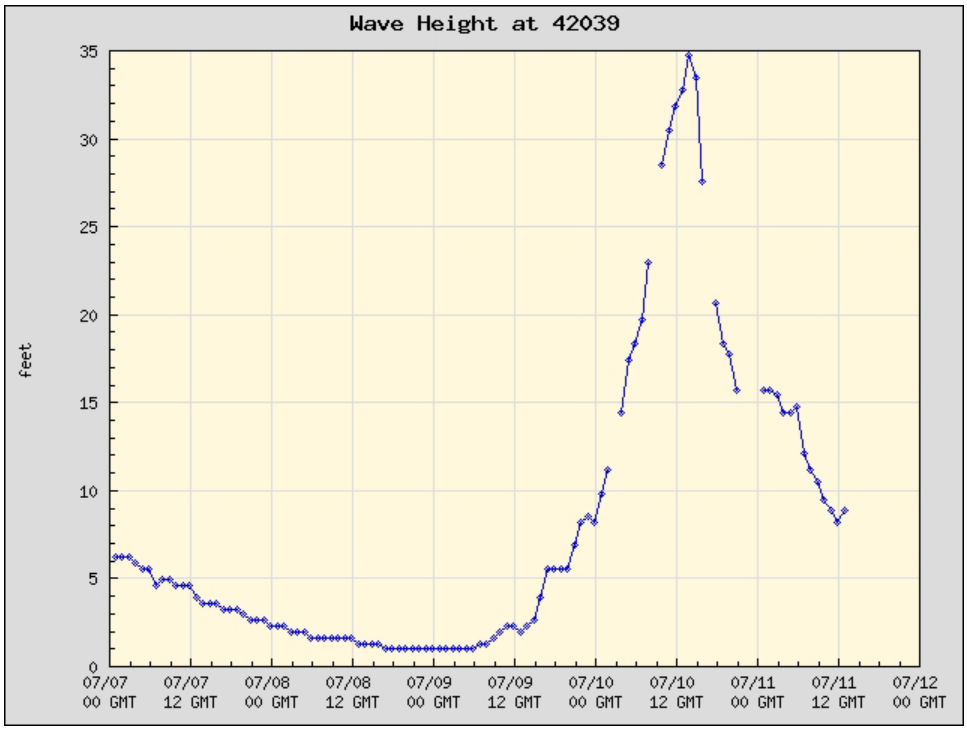

Figure 6. Significant wave height data at Buoy No. 42039 (NOAA, NBDC).

Storm Tide data for Hurricane Dennis is available from at least three sources. The Bureau of Beaches and Coastal Systems surveyed storm tide elevations at Navarre Beach and at a few other locations. Under contract with the Federal Emergency Management Agency, URS Group, Incorporated collected coastal high water marks throughout northwest Florida (URS, 2005). The most applicable of the Bureau storm tide data and the URS high water marks are mentioned in this document. Each location map, found at the beginning of the chapters discussing the impacts in each county, presents these storm tide elevations and their locations on the coast. In some areas storm tide data was not surveyed, so field observations of estimated tide heights were provided by the Bureau staff engineers.

In addition, water level data from recording tide gages is provided by the National Oceanic and Atmospheric Administration (NOAA, 2005) in a preliminary water levels report for Hurricane Dennis. The following NOAA tide data charts are from operating tide gages at Clearwater (Figure 7), Cedar Key (Figure 8), Apalachicola (bay interior tide) (Figure 9), Panama City Beach (Figure 10), and Pensacola (bay interior tide) (Figure 11).

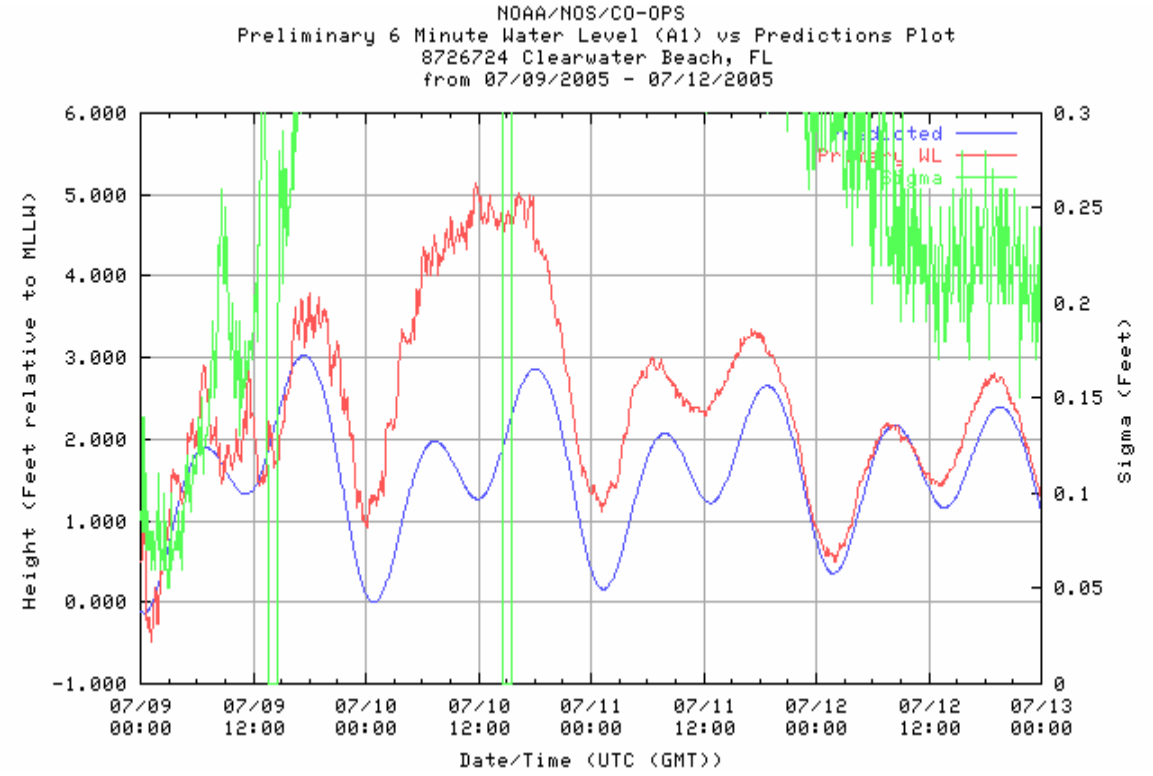

Figure 7. Clearwater NOAA tide station during Hurricane Dennis.

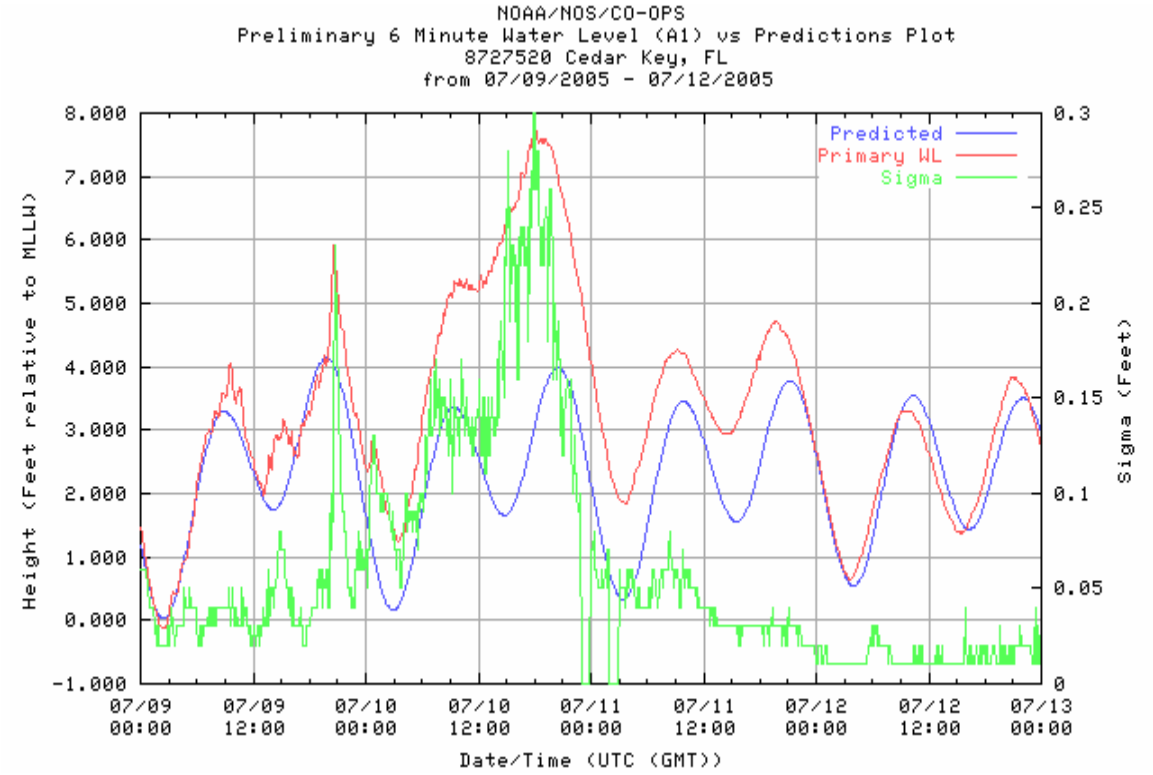

Figure 8. Cedar Key NOAA tide station during Hurricane Dennis.

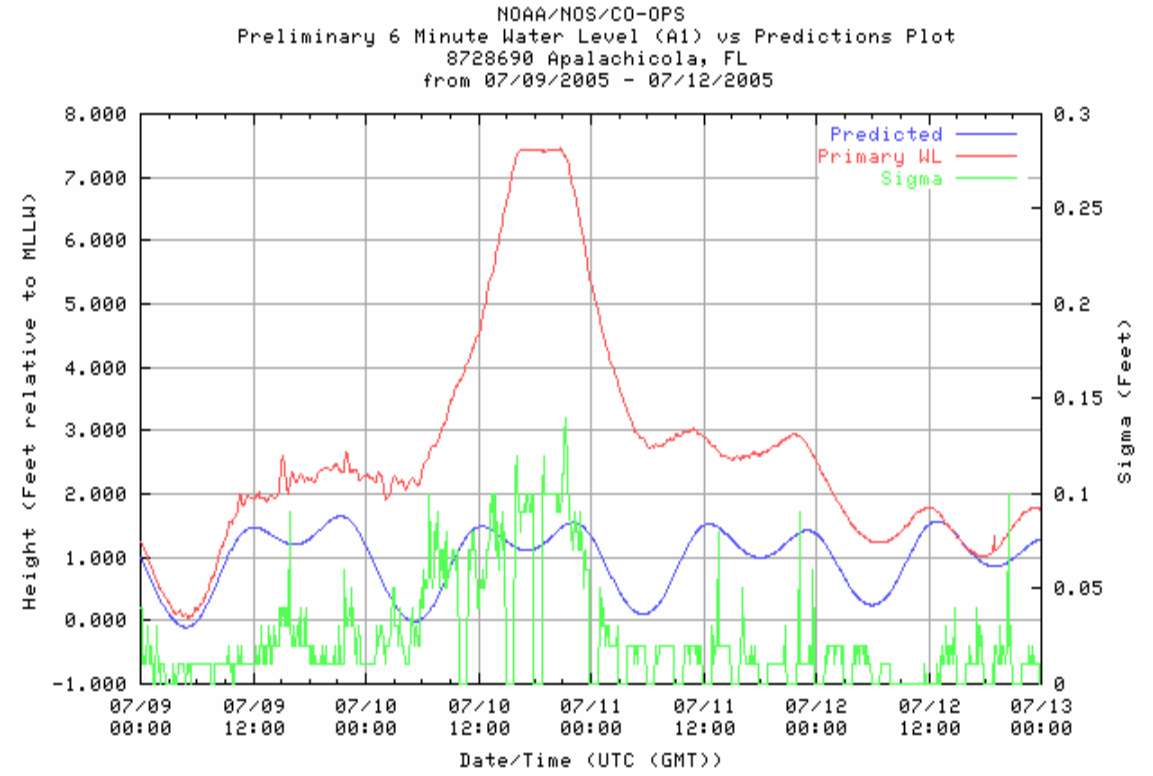

Figure 9. Apalachicola NOAA tide station during Hurricane Dennis.

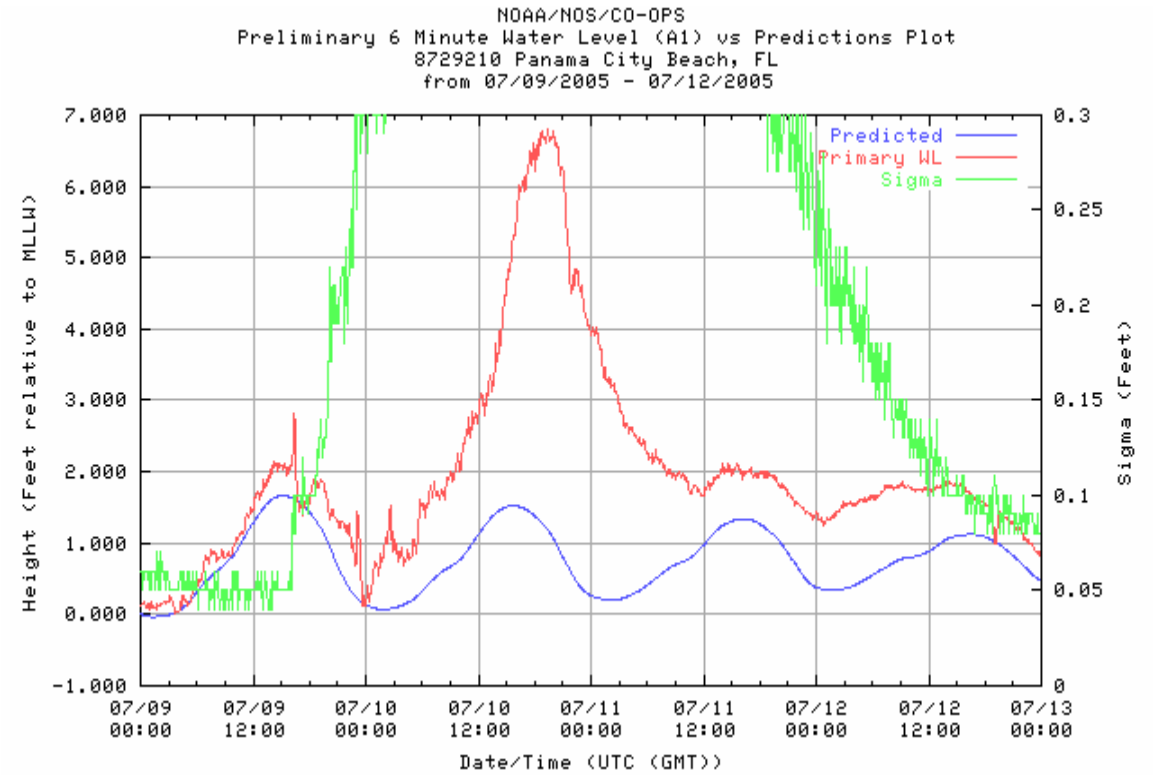

Figure 10. Panama City Beach NOAA tide station during Hurricane Dennis.

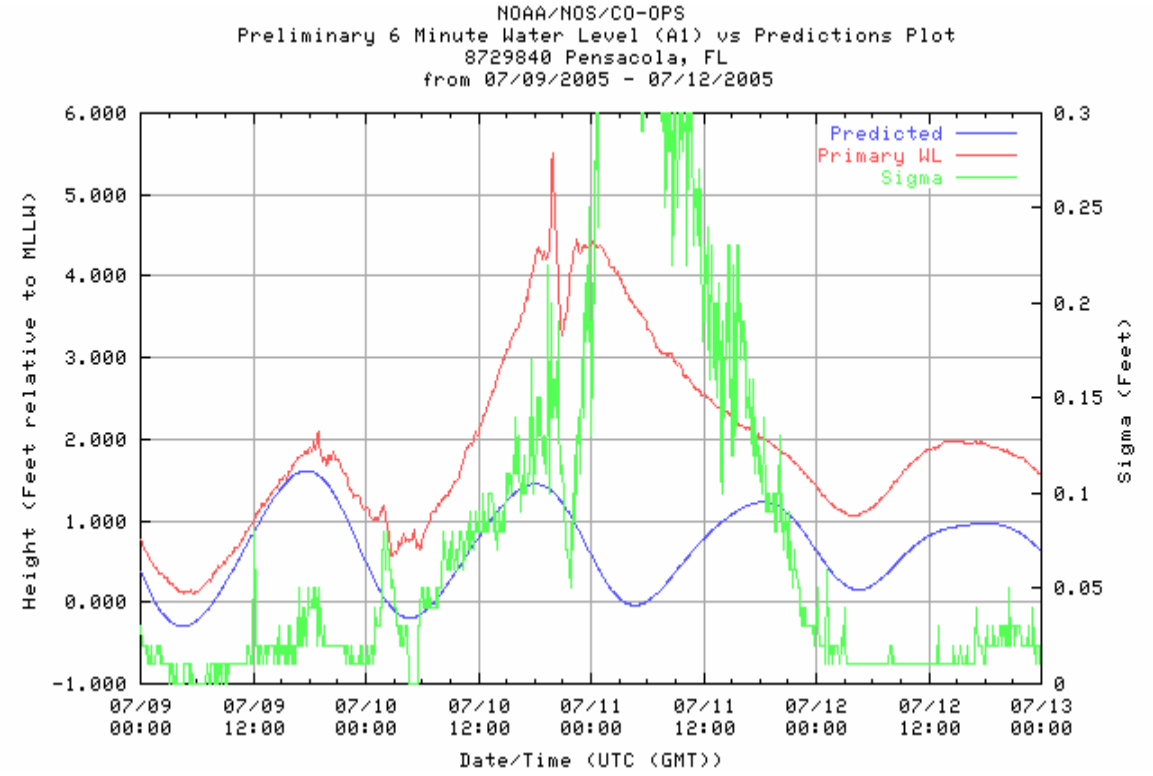

Figure 11. Pensacola NOAA tide station during Hurricane Dennis.

Post-storm Beach Conditions and Coastal Impact

Severe beach and dune erosion as well as damage to coastal construction was sustained throughout northwest Florida during the 2005 hurricane season. Using the qualitative scale shown in Figure 12, Hurricane Dennis caused the beach and dune erosion conditions summarized in Table 1.

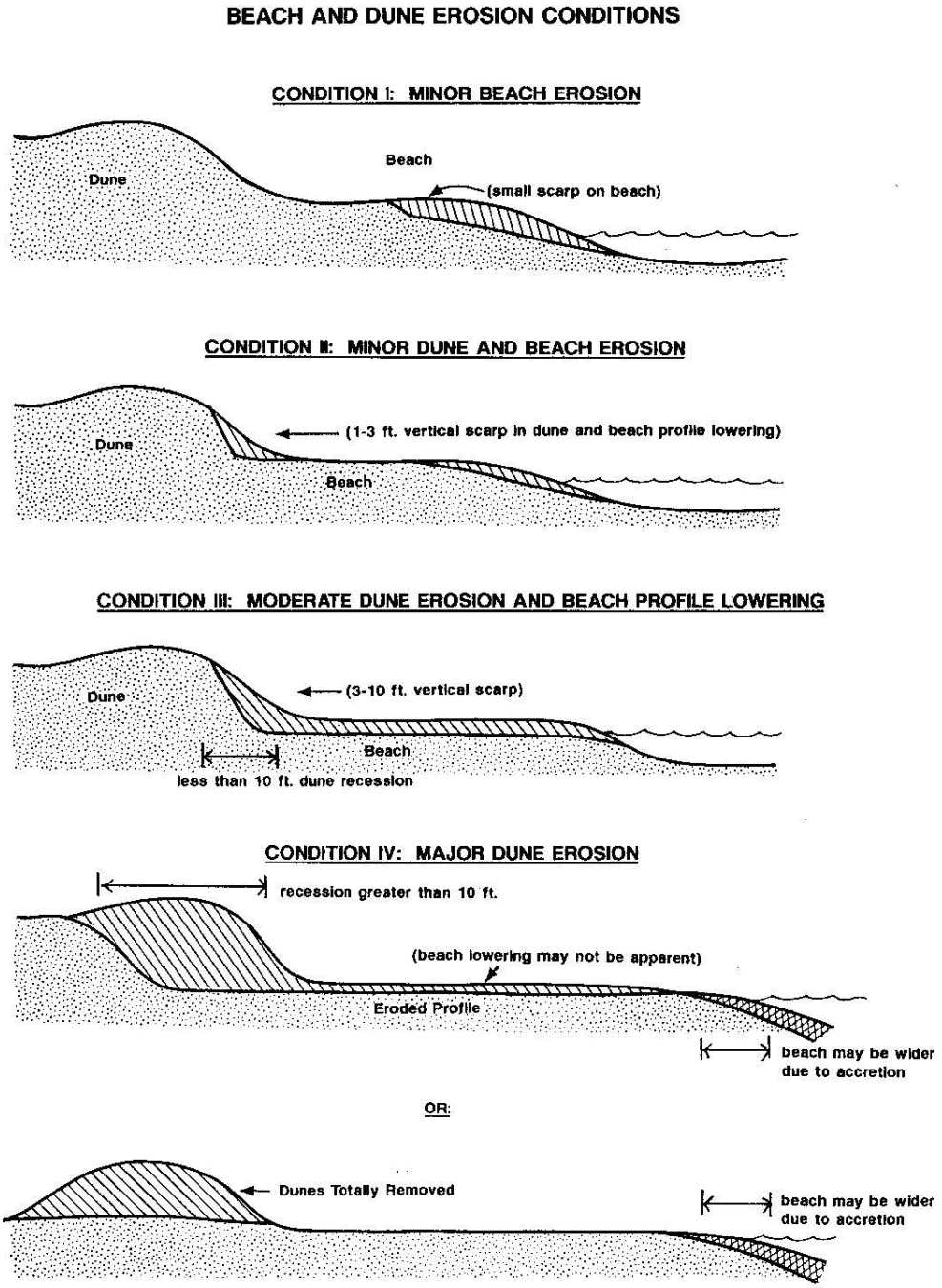

Figure 12. Qualitative scale of beach and dune erosion conditions (Clark, 1980).

Table 1. Hurricane Dennis Beach and Dune Erosion Summary.

County	Erosion Condition
Escambia	
Perdido Key	I (Minor)
Gulf Islands Natl. Seashore, Ft. Pickens	IV (Major)
Pensacola Beach (R107-R151)	III-IV (Major)
Gulf Is. Natl. Seashore, Opal Beach	IV (Major)
Santa Rosa	
Navarre Beach (R192-R210)	IV (Major)
Eglin Air Force Base	IV (Major)
Okaloosa	
Eglin Air Force Base (V501-V553)	IV (Major)
Ft. Walton Beach (R1-R16)	IV (Major)
Eglin Air Force Base (V601-V621)	IV (Major)
Destin & Holiday Isle (R17-R50)	IV (Major)
Walton	
County-wide (R1-R127)	IV (Major)
Bay	
Panama City Beaches (R1-R37)	IV (Major)
Panama City Beaches (R37-R77)	II-III (Moderate)
Panama City Beaches (R77-R93)	III (Moderate)
St. Andrews State Park (R91-R97)	II (Minor)
Shell Island (R98-V9)	IV (Major)
Western Crooked Island (V9-V30)	IV (Major)
Eastern Crooked Island (V36-R127)	IV-III (Major)
Mexico Beach (R128-R144)	II (Minor)
Gulf	
Beacon Hill, Port St. Joe Beach (R1-R30)	II (Minor)
St. Joseph Peninsula (R32-R105)	IV (Major)
Cape San Blas (R105-R127)	IV (Major)
Indian Peninsula (R127-R159)	III (Moderate)
Indian Pass Beach (R159-R161)	IV (Major)
Franklin	
St. Vincent Island (V1–V45)	IV (Major)
Cape St. George Island (R1-R18)	II-III (Moderate)
Cape St. George to Sikes Cut (R18-R51)	IV (Major)
St. George Island (R52-R149)	IV (Major)
Carrabelle Beach (adjacent East Pass)	II (Minor)
Dog Island (R150-R193)	IV (Major)
St. James Island (Lanark to St. Teresa)	II-III (Moderate)
Alligator Point to Bald Point (R194-R239)	IV (Major)
Wakulla	
Mashes Sands	IV (Major)
Shell Point	II (Minor)

A summary of substantial damages to major structures on the open coast of Florida is provided in Table 2 for Hurricane Dennis and Table 3 for Hurricane Katrina. Tables 2 and 3 summarize damages for major structures sited seaward of the established Coastal Construction Control Line (CCCL) and for all major structures within the Coastal Building Zone as defined by Chapter 161, Florida Statutes.

Table 2. Summary of Major Structural Damages by Hurricane Dennis.

	Seaward of CCCL's				Coastal Building Zone			
Location	**SFD**	**MFD**	**OMS**	**Total**	**SFD**	**MFD**	**OMS**	**Total**
Escambia County								
Perdido Key	0	0	0	0	0	0	0	0
Pensacola Beach	11	3	1	15	97	14	12	123
Opal Beach	0	0	0	0	0	0	3	3
Santa Rosa County								
Navarre Beach	29	26	3	58	80	37	14	131
Eglin AFB	0	0	0	0	0	0	2	2
Okaloosa County								
Eglin AFB	-	-	-	-	0	0	1	1
Ft. Walton Beaches	2	5	1	8	4	6	1	11
Destin	5	17	4	26	8	23	4	35
Walton County	24	3	7	34	24	5	7	36
Bay County	0	4	4	8	0	4	4	8
Gulf County								
St Joseph Peninsula	5	4	0	9	5	4	0	9
Franklin County								
St. George Island	5	0	5	10	5	0	6	11
Dog Island	15	0	0	15	15	0	0	15
Alligator Pt. to Bald Pt.	23	0	3	26	23	0	3	26
Wakulla County								
Mashes Sands	-	-	-	-	6	0	4	10
Spring Creek	-	-	-	-	4	0	0	4
Shell Point	-	-	-	-	13	0	0	13
Live Oak Island	-	-	-	-	1	0	1	2
Total	**119**	**62**	**28**	**209**	**285**	**93**	**62**	**440**

SFD – Single-family dwellings
MFD – Multifamily dwellings including condominiums, townhouses, apartments, hotels, and motels
OMS – Other major structures including commercial buildings (restaurants, stores, beach bars, etc.), recreation buildings, and nonhabitable major structures (piers, pools, pavilions, bridges, and towers)
Note – Not included in this summary are minor structures (i.e., walkways, decks, driveways, patios, etc.), coastal and shore protection structures (i.e., seawalls, revetments, sills, groins, jetties), roads and highways, or minor damage to major structures.

Table 3. Summary of Major Structural Damages by Hurricane Katrina.

	Seaward of CCCL's				Coastal Building Zone			
Location	**SFD**	**MFD**	**OMS**	**Total**	**SFD**	**MFD**	**OMS**	**Total**
Pensacola Beach	1	0	0	1	2	0	0	2
Navarre Beach	0	0	0	0	2	0	0	2
Destin	1	1	0	2	1	1	0	2
Walton County	11	1	1	13	11	1	1	13
Total	**13**	**2**	**1**	**16**	**16**	**2**	**1**	**19**

A listing of damages to coastal protection structures from Hurricane Dennis is provided in Table 4.

Table 4. Coastal Protection Structures Damaged or Destroyed by Hurricane Dennis.

Navarre Beach, Santa Rosa County		
Type Structure	**Location**	**Length (ft.)**
Vinyl wall	R193	250
Vinyl wall	R193	1400
Vinyl wall	R197.6	115
Concrete retaining wall	R205.15	100
Vinyl wall	R208.1	100
Wood retaining wall	R208.8	100
Vinyl wall	R208.9	300
		2365
Santa Rosa Island, Okaloosa County		
Concrete seawall	V518	100
Concrete seawall	V528.5	100
Concrete seawall	V548	350
Concrete wall	R1	115
Concrete retaining wall	R4.5	40
Wood retaining wall	R4.9	15
Concrete seawall	V608	100
		820
Destin, Okaloosa County		
Wood retaining wall	R19.5	525
Concrete block wall	R22.2	150
Concrete seawall	R24.7-R25.25	800
Vinyl wall	R26.4	150
Concrete block wall	R26.75	100
Wood retaining wall	R28.8	100
Wood retaining wall	R30	50
Concrete block wall	R40.3	100

Table 4 continued. Coastal Protection Structures Damaged or Destroyed by Hurricane Dennis.

Type Structure	Location	Length (ft.)
Destin, Okaloosa County (cont.)		
Concrete retaining wall	R40.7	75
Wood retaining wall	R41	30
Concrete wall	R42.5	100
Concrete wall	R45	150
Wood retaining wall	R49.5	75
		2405
Walton County		
Wood retaining wall	R10	250
Wood retaining wall	R11	200
Wood retaining wall	R22	600
Vinyl wall	R61	105
Wood retaining wall	R93.9	50
		1205
Gulf County		
Rock revetment	R105	500
St. George Island, Franklin County		
Rock revetment	R72.5	100
Dog Island, Franklin County		
Wood bulkhead	R171	200
Wood bulkhead	R176	100
Wood bulkhead	R180.5	100
		400
Alligator Point (Southwest Cape), Franklin County		
Wood bulkhead	R210.1	125
Wood bulkhead	R210.2	100
Wood bulkhead	R210.6	150
Rock revetment	R210.9	400
Rock revetment	R211	300
Wood retaining wall	R211	200
Rock revetment	R211.3-R214.1	2700
Rock revetment	R214.5	300
Wood retaining wall	R214.6	400
		4675
Shell Point, Wakulla County		
Wood retaining wall	N.A.	50
Total number of walls and revetments damaged		***47***
Total length of damage		***12,520 ft (2.37 miles)***

Escambia County

The coast of Escambia County includes most of the barrier island of Perdido Key and the western half of the barrier island of Santa Rosa Island (Figure 13). These islands front on the Gulf of Mexico and are backed by Big Lagoon, Pensacola Bay, and Santa Rosa Sound. There are 38.9 miles of gulf fronting beaches in Escambia County.

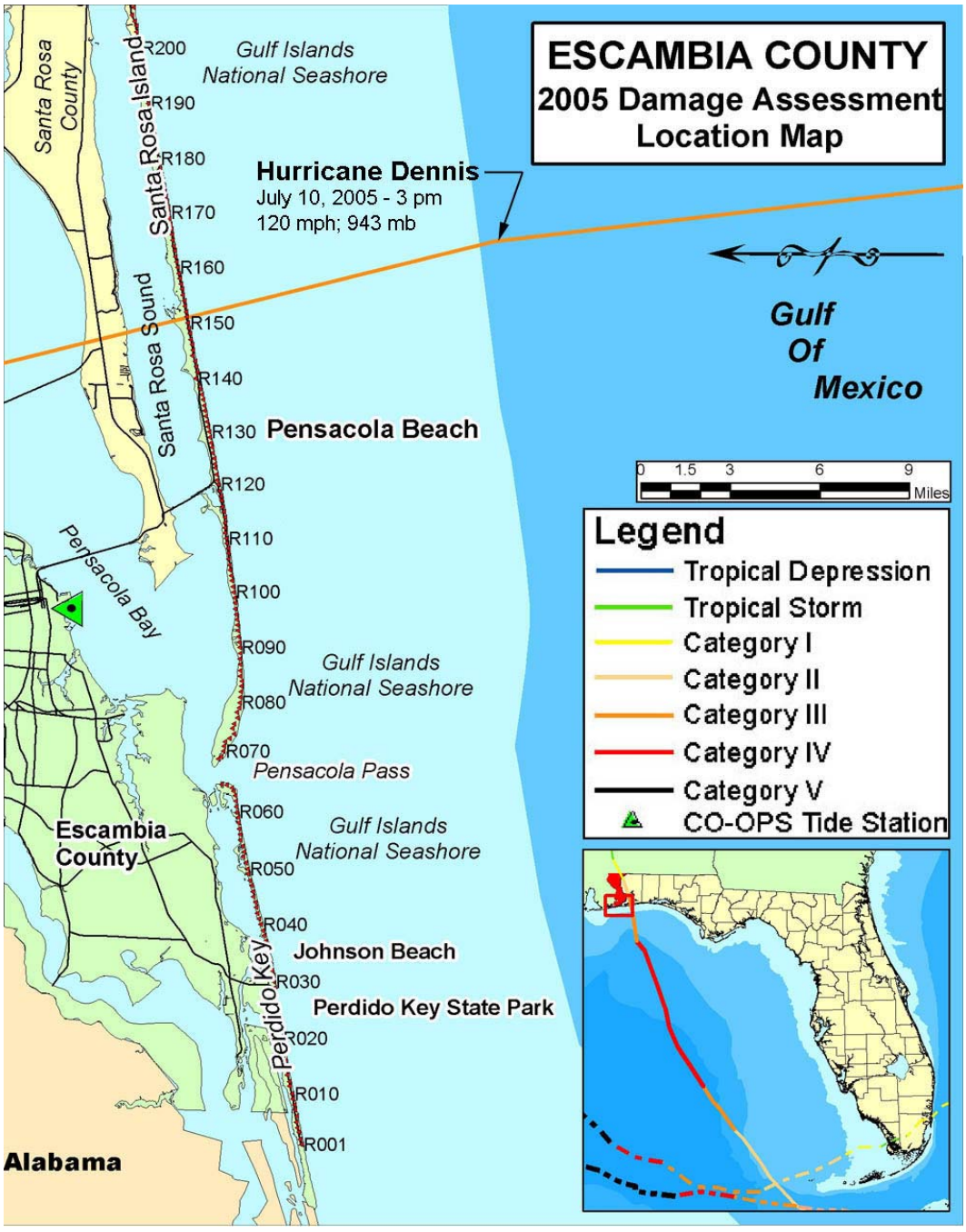

Figure 13. Escambia County location map.

Prior to the 2005 hurricane season, Escambia County had two designated critically eroded areas (9.8 miles) and two noncritically eroded areas (11.2 miles) (FDEP, 2005). The eastern 7.5 miles of Perdido Key is eroded, of which 1.6 miles are critically eroded (R26-R34) threatening development and recreational interests, and 5.9 miles (R34-R65) are noncritically eroded along the Gulf Islands National Seashore. The entire 8.2-mile length of Pensacola Beach (R107-R151) is critically eroded threatening development and recreational interests. Dune restoration was conducted in Pensacola Beach after the storms of 1995, 1998, and 2002, beach restoration was completed in 2003, and nourishment was completed in February 2006. There is also a natural coastal inlet, Pensacola Pass, between Perdido Key and Santa Rosa Island. Pensacola Pass has a federal navigation channel that is periodically maintained for navigable access to the U.S. Naval Base in Pensacola.

Hurricane Dennis Storm Effects and Erosion Conditions

Perdido Key

Unlike the severe impact experienced during Hurricane Ivan (2004) when 131 buildings sustained major structural damage, Perdido Key sustained negligible damage and only minor erosion during Hurricane Dennis. The impact of Dennis was similar to that experienced during Hurricane Opal (1995), which likewise had its eye make landfall on Santa Rosa Island to the east. Being west of the point of landfall of the eye of Dennis substantially protected Perdido Key from the significant impact of the storm. The storm tide was observed to be about +5 feet.

Pensacola Pass

Pensacola Pass sustained moderate shoaling from Hurricane Dennis. Having a federal navigation channel requiring periodic maintenance, Pensacola Pass can be expected to be dredged to provide the authorized design depths of the channel. This dredged shoal material will likely be made available to nourish Perdido Key and Santa Rosa Island beaches within the adjacent Gulf Islands National Seashore.

Fort Pickens, Gulf Islands National Seashore

Hurricane Ivan (2004) destroyed five miles of park road and dunes on western Santa Rosa Island between Pensacola Beach and Fort Pickens. Post-storm reconstruction of the park road had just been completed when Tropical Storm Arlene damaged a quarter-mile segment of park road on June 11, 2005. One month later, Hurricane Dennis destroyed much of the new park road and buried most of it under sand overwash deposits for most of its seven-mile length (Photo 1).

Photo 1. Fort Pickens Road before and after Hurricane Dennis.

The current exacerbated erosion conditions at this National Seashore began in 1979, when Hurricane Frederic destroyed the protective barrier dunes along the island. No dune restoration was conducted; however, through the years, natural dune recovery partially restored a low barrier dune system. This partial dune recovery was not sufficient as demonstrated when Hurricane Opal completely destroyed the dunes and the park road in 1995. After another nine years of unassisted partial natural recovery, the low barrier dunes again were totally destroyed by Ivan. The beach erosion of Hurricane Dennis is shown by a representative comparison of profiles provided by Olsen Associates, Inc., at Department of Environmental Protection reference monument R105 (Figure 14). Periodic tropical storms and gulf hurricanes will continue to adversely impact, and possibly destroy, the road along this island unless a major effort is conducted to restore a significant barrier beach and dune system along the five-mile segment where no dunes currently exist.

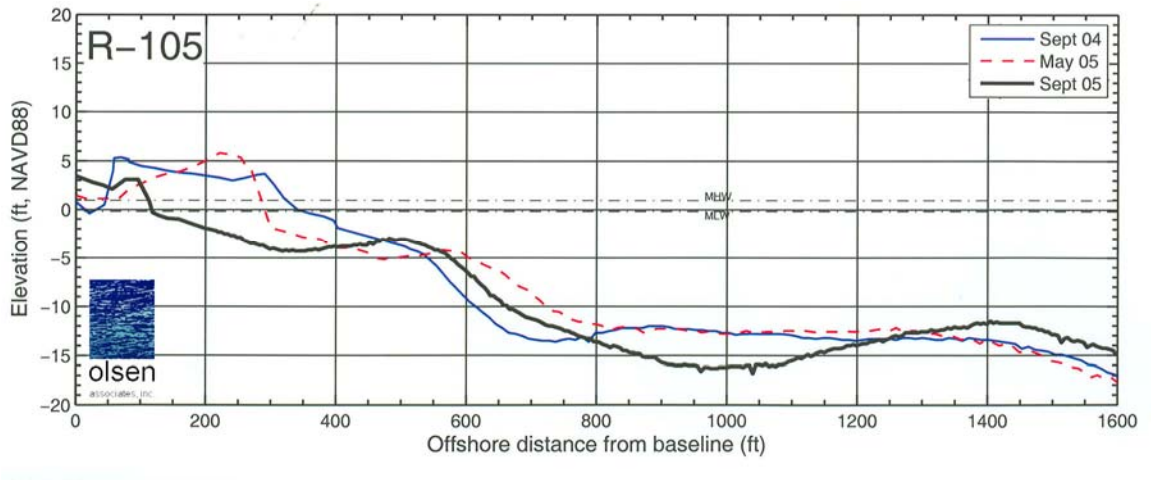

Figure 14. Comparative profiles at Gulf Islands National Seashore, Fort Pickens (R105).

Pensacola Beach, Santa Rosa Island

On July 10, 2005, the eye of Hurricane Dennis made landfall approximately two miles east of Pensacola Beach near Big Sabine Point on Santa Rosa Island. Pensacola Beach was generally in the weaker leeside eye-wall and experienced winds in the category two hurricane intensity range (95-115 mph). A peak wind of 96 mph was measured in Pensacola by the National Weather Service. The strongest winds appeared to have occurred from the northwest immediately following landfall of Dennis's eye. Storm tides of eight to ten feet affected the area with wave energy both from the Gulf of Mexico and the Santa Rosa Sound. Overall, the storm tide likely corresponded with that of a 50-year event or about 9.4 feet (BSRC, 1986).

Moderate to major beach erosion (condition III-IV) was sustained along Pensacola Beach, where a beach restoration project was completed in 2003. The erosion did not leave any scarping, but approximately 450,000 cubic yards of sand were lost from the project area (Browder, 2005). The beach erosion of Hurricane Dennis is shown by a representative comparison of profiles provided by Olsen Associates, Inc., at the Bureau's reference station R128 (Figure 15).

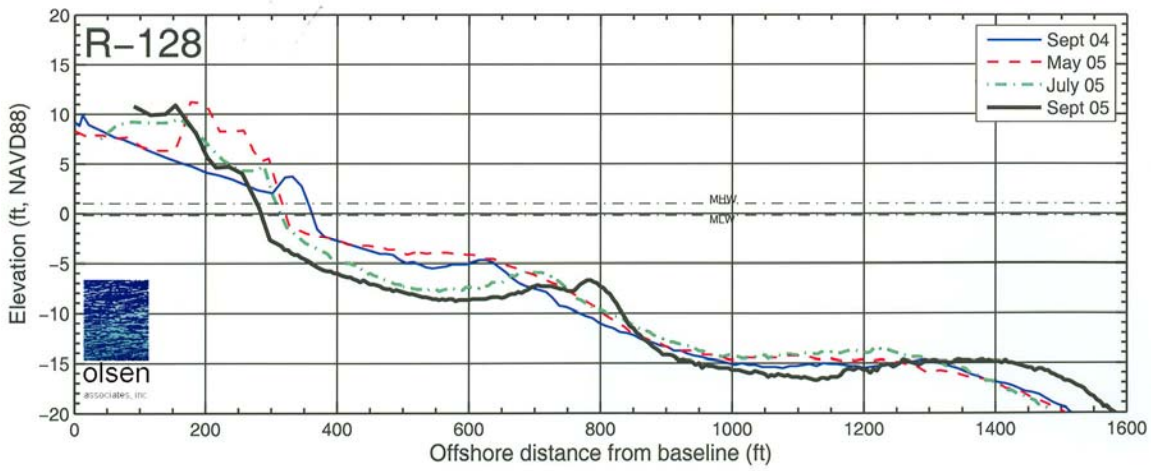

Figure 15. Comparative profiles at Pensacola Beach (R128).

Gulf Islands National Seashore, Santa Rosa Island (R151-R192.5)

The eye of Hurricane Dennis made landfall within this area of the Gulf Islands National Seashore near R153 (Figure 16). Santa Rosa Island was particularly vulnerable for gulf to bay flooding from any significant storm tides following the severe erosion and island deflation caused by Hurricane Ivan (2004). Throughout the Gulf Islands National Seashore, Dennis flooded the island with an approximately +10-foot storm tide. Significant beach and dune erosion losses were sustained through the overwash of sand across the island and into Santa Rosa Sound.

J. Earl Bowden Way, the island road between Pensacola Beach and Navarre Beach that was substantially damaged and destroyed by Ivan, was further damaged by Dennis. Between R142.3 and R192.5, about 10 miles of road has been destroyed. At Opal Beach (the public access park named for its destruction during Hurricane Opal in 1995), Ivan had damaged the three bathhouses, 28 picnic shelters, and six parking lots. Dennis completely destroyed the three bathhouses and six parking lots, and further damaged the 28 picnic shelters.

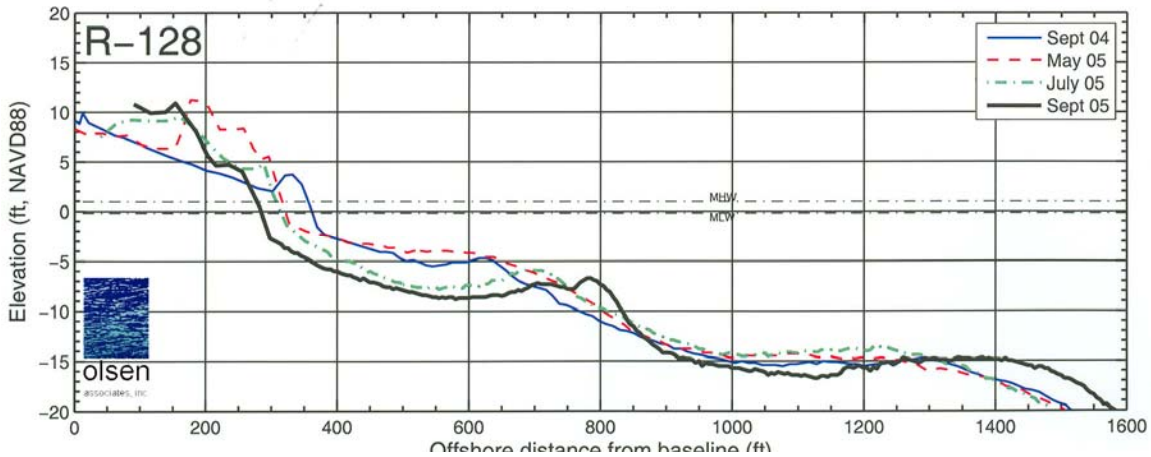

Figure 16. Comparative profiles at Gulf Islands National Seashore, Big Sabine Point (R128).

Hurricane Katrina Storm Effects and Erosion Conditions

Perdido Key

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was approximately 125 miles west of Perdido Key, or at about the limit of hurricane force winds. The maximum wind gust reported in Pensacola was 69 mph, which was just under hurricane strength. Perdido Key and the rest of northwest Florida sustained only a fringe impact from Katrina; however, the gulf beaches rendered vulnerable after Hurricane Ivan (2004) sustained significant additional erosion. Generally, only minor beach erosion (condition I) was sustained along Perdido Key, although some overtopping of the berm occurred with minor inland flooding.

Gulf Islands National Seashore, Fort Pickens

Not surprisingly, western Santa Rosa Island was particularly vulnerable for gulf to bay flooding from any significant storm tides following the severe erosion and island deflation caused by Hurricane Ivan, Tropical Storm Arlene, and Hurricane Dennis. There was no additional road damage although the road bed was further scoured by the storm tide of Katrina. The island segment between R94 and R100 was awash four days after the storm. Tides subsided late Wednesday morning, August 31, 2005, leaving over one mile of quick conditions along the island from gulf to bay.

Pensacola Beach

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was about 150 miles west of Pensacola Beach. Only tropical storm force winds affected this area. In a few areas where a dune existed, there was minor scarping. The storm tide with wave uprush overtopped the berm and caused significant flooding seaward of Via del Luna, the main road through Pensacola Beach. Quantitative erosion losses were determined by the beach restoration project engineer, Olsen Associates, Inc., based upon post-storm surveys. Approximately 650,000 cubic yards of sand were lost from the project area in addition to the losses previously sustained during Hurricane Dennis (Browder, 2005).

Hurricane Dennis Storm Damage in Pensacola Beach

Moderate to severe wind damage was experienced throughout Pensacola Beach during Hurricane Dennis with the damage being greater towards the eastern end of the community, closer to the storm's eye. Most wind damage was caused by northwesterly winds, as typically, the north and west facing sides of structures revealed the greatest damage. Over one half of the structures having major damage sustained major wind damage.

Storm surge flooding was not as severe during Dennis as occurred during Hurricanes Opal (1995) and Ivan (2004). During Opal the storm surge averaged +10 feet through Pensacola Beach (Leadon et al, 1998), which is slightly less than a 100-year frequency event (BSRC, 1986). During Ivan the storm tide was measured between +9.5 and +12.4 feet at varied distances from the beach, with +12.2 feet being the most reasonable tide level observed along the beach front (Wang and Manausa, 2005). This elevation is equivalent to a 200-year frequency event (BSRC, 1986). Most of the gulf-front structures susceptible to storm surge damage had been destroyed and removed following Opal and Ivan. A number of structures flooded and damaged by prior storms and located in the second or greater row of construction landward of the beach were damaged again by Dennis. A number of sound-side structures, located on-grade towards the east end of the community, were destroyed by the northwest waves from the sound on top of the storm surge (Photo 2). The 1470-foot gulf fishing pier remained structurally intact; however, the breakaway pier deck panels at +26 ft. NGVD were blown out by wave uplift forces along much of the pier's length (Photo 3).

Throughout Pensacola Beach within the Coastal Building Zone, 123 major structures sustained major damage, including 23 structures that were destroyed. Of these, 15 major structures located seaward of the established Escambia County Coastal Construction Control Line sustained major damage. In addition, 15 major structures sustained damage to nonhabitable understructure areas.

Photo 2. Destroyed dwelling, Pensacola Beach.

Photo 3. Pensacola Beach Pier before and after Dennis.

Hurricane Katrina Storm Damage

Only sporadic minor wind damage was sustained along Perdido Key and Pensacola Beach during Hurricane Katrina's tropical storm strength winds. The most significant damages occurred due to the storm tide of about six feet and storm wave uprush and overtopping.

On Perdido Key, at least three swimming pools were filled with sand and at least five multifamily dwellings (condominium buildings) were flooded and partially inundated

with a layer of sand. Also on Perdido Key, one single-family dwelling sustained understructure damage seaward of the established Escambia County Coastal Construction Control Line. The strikingly minimal damage was specifically related to the complete loss and removal of the last of the nonconforming gulf-front major structures during and after Hurricane Ivan (2004), which severely impacted Perdido Key.

Likewise, Pensacola Beach had few remaining major structures that had not already been damaged or destroyed by both Hurricanes Ivan and Dennis. In contrast to Dennis's minimal gulf-front damage, Katrina did affect many dwellings with its storm tides and waves. Along Pensacola Beach, two single-family dwellings sustained major structural damage. One of these dwellings was seaward of the Coastal Construction Control Line and the other was in the second tier of construction immediately landward of the line. Perhaps more significantly, 34 single-family dwellings and one multifamily dwelling sustained understructure damage (Photo 4). Numerous dwellings were flooded and many were inundated with layers of sand.

Photo 4. Dwelling with understructure damage, Pensacola Beach (R126.3).

Santa Rosa County

The coast of Santa Rosa County along a central segment of Santa Rosa Island includes the beach community of Navarre Beach and a western segment of Eglin Air Force Base (Figure 17). Prior to the 2005 hurricane season, the entire community of Navarre Beach (4.1 miles) was designated as critically eroded (FDEP, 2005). There are no coastal inlets in Santa Rosa County connecting Santa Rosa Sound with the Gulf of Mexico.

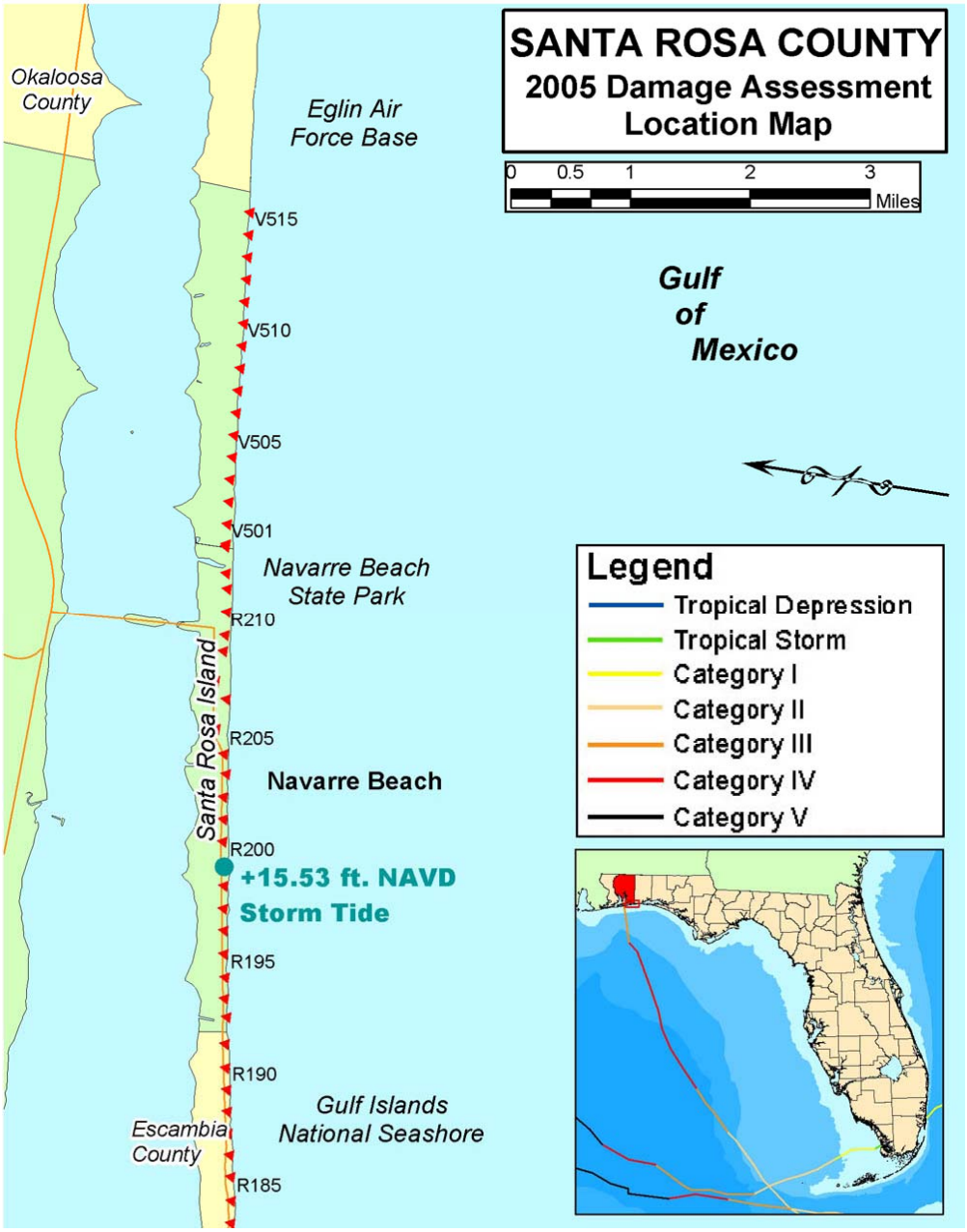

Figure 17. Santa Rosa County location map.

Hurricane Dennis Storm Effects and Erosion Conditions

Navarre Beach

The center of the eye of Hurricane Dennis made landfall about 7.5 miles west of Navarre Beach, placing this Santa Rosa Island community within the eye-wall of highest winds. A maximum wind velocity of 121 mph was measured at Navarre Beach and 110 mph at the Loop Tower on Eglin Air Force Base, 5.3 miles east of Navarre Beach State Park. The maximum winds impacted Navarre Beach from the south-southeast. A measured storm surge with dynamic wave setup of +15 feet NAVD along the gulf-front structures caused extensive flooding and overwash across the island.

Figure 18 provides a composite profile for R195, R200, and R203, and locates measured storm tide levels with respect to this composite profile. The +15-foot storm tide was measured by Bureau surveyors at the seaward line of beach-front construction. The +12.3-foot storm tide was measured within the second tier of construction landward of Gulf Boulevard and is representative of a 200-year frequency storm event (BSRC, 1986). The +7.1-foot storm tide elevation was measured in the third tier of construction seaward of White Sands Boulevard. The blue dashed line in Figure 18 connecting these storm tide measurements provides an estimated storm tide across Santa Rosa Island revealing a significant attenuation in the storm tide progressing landward of the beach. The significant water level differential (about eight feet) revealed by this graphic would suggest a hydraulic head capable of forcing a very high velocity flood current across the island, which would be capable of transporting a substantial quantity of overwash sediments.

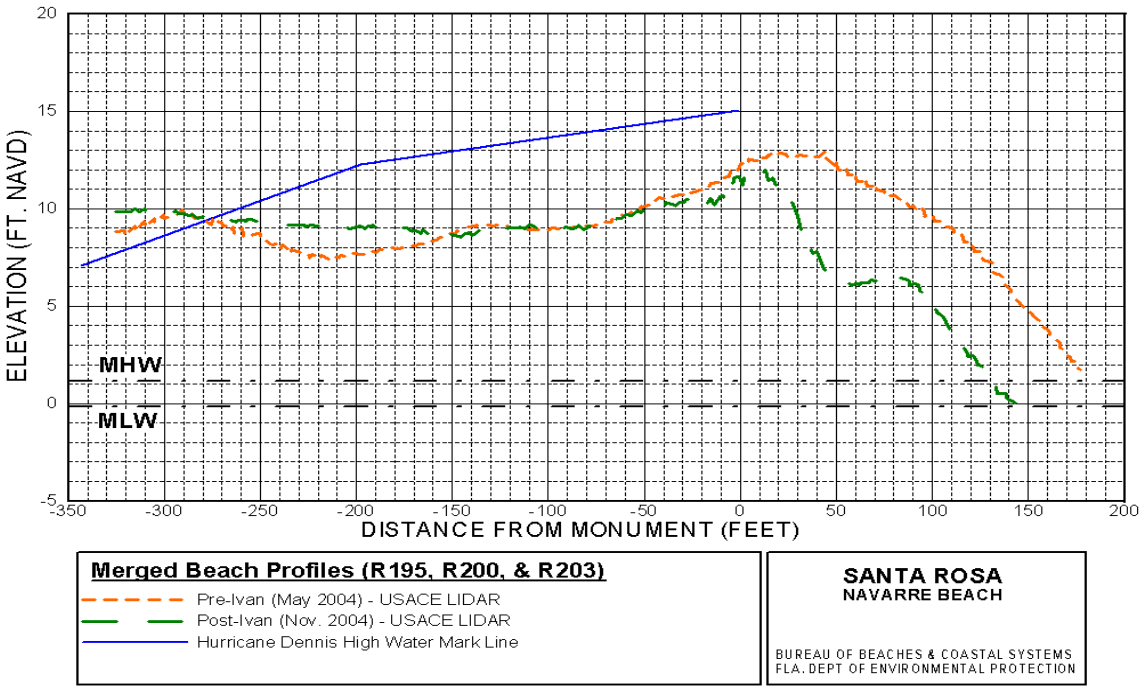

Figure 18. Hurricane Dennis consolidated storm tide profile, Navarre Beach.

Major beach and dune erosion (condition IV) was sustained throughout Navarre Beach and adjoining areas. Few dunes, natural or man-made, survived the impact of Dennis. The beach and upland elevations were significantly lowered by a typical scour of three to six feet. The beach has become very narrow throughout Navarre Beach and a number of beach-front structures were encroaching on the foreshore slope of the beach very close to normal high tides after Dennis.

After 1995, beach management planning initiated sand search and feasibility studies for a beach restoration project along Navarre Beach. This project was designed prior to the landfall of Dennis. Construction of the project commenced in March, 2006.

Eglin Air Force Base

Major beach and dune erosion (condition IV) was sustained throughout the county east of Navarre Beach. Few dunes survived the impact of Dennis. An estimated storm tide of +10 to +12 feet caused extensive flooding and overwash across the island.

Hurricane Katrina Storm Effects and Erosion Conditions

Navarre Beach

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was over 160 miles west of Navarre Beach. Only tropical storm force winds affected this area. After Ivan and Dennis impacted Navarre Beach, no viable dunes existed to erode and therefore no scarping was observed; however, it is reasonable to attribute the erosion throughout this area due to Katrina as minor beach and dune erosion (condition II). The cumulative effect of the erosion of Katrina added to that of Erin, Opal, Georges, Isidore, Ivan, Arlene, and Dennis, has been significant. Generally speaking, most of the gulf-front line of construction was located at the high waterline, with some structures in the water at high tide after Katrina. There is no dry sand beach on Navarre Beach in front of the seaward line of construction.

A storm tide of about six feet plus wave uprush did overtop the berm and caused significant flooding across the island and into the sound. The elevation of Gulf Boulevard is generally +9.5 feet NAVD and at least one to two feet of water overtopped the road.

Eglin Air Force Base

As with Navarre Beach to the west, the impacts attributable to Hurricanes Ivan and Dennis resulted in the elimination of viable dune features, and therefore no scarping was observed; however, it is reasonable to attribute the erosion throughout this area due to Katrina as minor beach and dune erosion (condition II).

Hurricane Rita Storm Effects and Erosion Conditions

Hurricane Rita made landfall a few hundred miles west of Navarre Beach; however, significant wave activity caused additional minor beach erosion (condition I) to the

northwest Florida beaches. The cumulative effect of the erosion of Rita added to that of prior storms has been significant. Several gulf-front dwellings were in the gulf seaward of the beach after Rita (Photo 5). Post-storm beach profile surveys are shown in Figure 19.

Photo 5. Dwelling with roofing and understructure damage, Navarre Beach (R192.6).

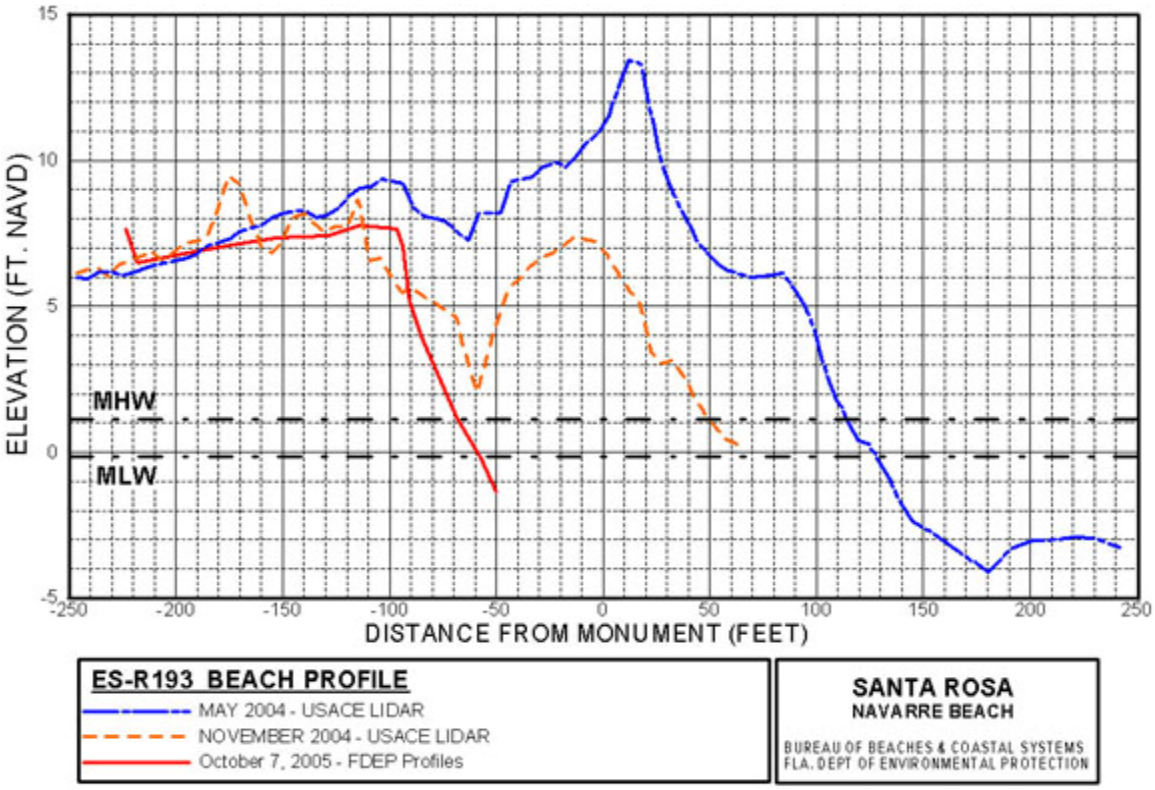

Figure 19. Comparative erosion profiles, Navarre Beach.

Hurricane Dennis Storm Damage

Navarre Beach

Moderate to severe wind damage was experienced throughout Navarre Beach. About three-fourths of the damaged structures sustained major wind damage. Substantial damages were sustained due to the storm surge and waves in addition to the wind loads and erosion/scour. Many pile supported structures have lost a significant embedment depth of their foundation piles. Inadequate embedment depth was associated with the damage to several structures.

With greater wind velocities during Hurricane Dennis (121 mph at Navarre Beach and 110 mph at the Loop Tower), there were more wind damaged structures than during Hurricane Ivan (2004), yet less storm surge related damage than seen in Ivan notwithstanding the greater storm surge of +15 feet during Dennis. The lower number of storm surge related damages during Dennis was substantially related to the fact that virtually all the gulf-front nonconforming structures had previously been destroyed or removed during or following Hurricanes Opal (1995) and Ivan. However, Hurricane Dennis did damage pile supported structures (Photo 6). The continued severe erosion conditions from each storm have had a cumulative effect on the adequacy of pile foundations of gulf-front structures, including those that may have originally been designed to conform to the coastal building standards for a 100-year storm event. An adequately designed pile foundation for a 100-year frequency event built before August,

1995, in Navarre Beach would have now experienced three storm events equal to or greater than a 100-year event (Opal, Ivan, and Dennis), plus one 35-year event (Georges), and two 25-year events (Erin and Isidore) in a 10-year period. Many pile supported structures also sustained damage to their nonhabitable understructure areas (Photo 7).

Photo 6. Non-conforming pile supported dwelling destroyed, Navarre Beach (R193).

Photo 7. Understructure and siding damage, Navarre Beach (R194).

In addition to the damages to dwellings throughout Navarre Beach, extensive flooding and overwash from Dennis severely damaged the infrastructure including the island roads and utilities (Photo 8). Beach access walkways have been destroyed throughout the community. The 30+ year old concrete Navarre Fishing Pier sustained complete destruction to two sections (Photo 9). In addition, the recently completed Navarre Beach State Park was severely impacted. All the dunes, roads, paved parking areas, boardwalks, beach access walkways, and one large bathhouse/concession building were destroyed within the state park (Photo 10).

In total, throughout Navarre Beach, 131 major structures sustained major damage, including 26 major structures that were destroyed. Of these, 58 major structures located seaward of the established Santa Rosa County Coastal Construction Control Line sustained major damage. In addition, 98 major structures sustained damage to nonhabitable understructure areas. Also destroyed were 2,365 feet of retaining walls and bulkheads and 2.35 miles of Gulf Boulevard. An additional length of White Sands Boulevard was also damaged, but not destroyed.

Photo 8. Infrastructure damage along Gulf Boulevard, Navarre Beach (R192.5).

Photo 9. Damage to Navarre Fishing Pier (R209).

Photo 10. Bathhouse destroyed at Navarre Beach State Park (R213).

Hurricane Katrina Storm Damage

Only minor wind damage was sustained along Navarre Beach during Hurricane Katrina's tropical storm strength winds. The most significant damages occurred due to the storm tide of about six feet and storm wave uprush and overtopping. Along Navarre Beach, two single-family dwellings sustained major structural damage. One of these dwellings, located only 200 feet from the shoreline, was destroyed by the storm surge and flooding, yet was located immediately landward of the Santa Rosa County Coastal Construction Control Line (Photo 11). The other dwelling, located about 250 feet from the shoreline was also in the second row of construction landward of the Coastal Construction Control Line.

Photo 11. Dwelling destroyed, Navarre Beach (R196.2).

Gulf Boulevard, the seaward road, was destroyed by Dennis between R192.5 and R205. After the additional erosion associated with the passage of Hurricane Katrina, Gulf Boulevard was sited within the backshore of the beach. White Sands Boulevard, the second road inland from the gulf, has been buried by sand during both storms and sustained north pavement edge damage along much of its length between R194 and R205. Post-Dennis sand removal along White Sands Boulevard created levies that forced the retention of some of Katrina's flood waters. Dwellings seaward of White Sands Boulevard had experienced significant removal of understructure sand after Dennis that created pockets of flooding at each dwelling after Katrina (Photos 12 and 13).

Photo 12. Dwelling with understructure flooding, Navarre Beach (R198.9).

Photo 13. Dwelling with understructure flooding, Navarre Beach (R201.4).

Okaloosa County

The coast of Okaloosa County includes the eastern approximately 17 miles of Santa Rosa Island backed by Santa Rosa Sound and Choctawhatchee Bay and the western nearly 7 miles of Moreno Point peninsula, lying between Choctawhatchee Bay and the Gulf of Mexico (Figure 20).

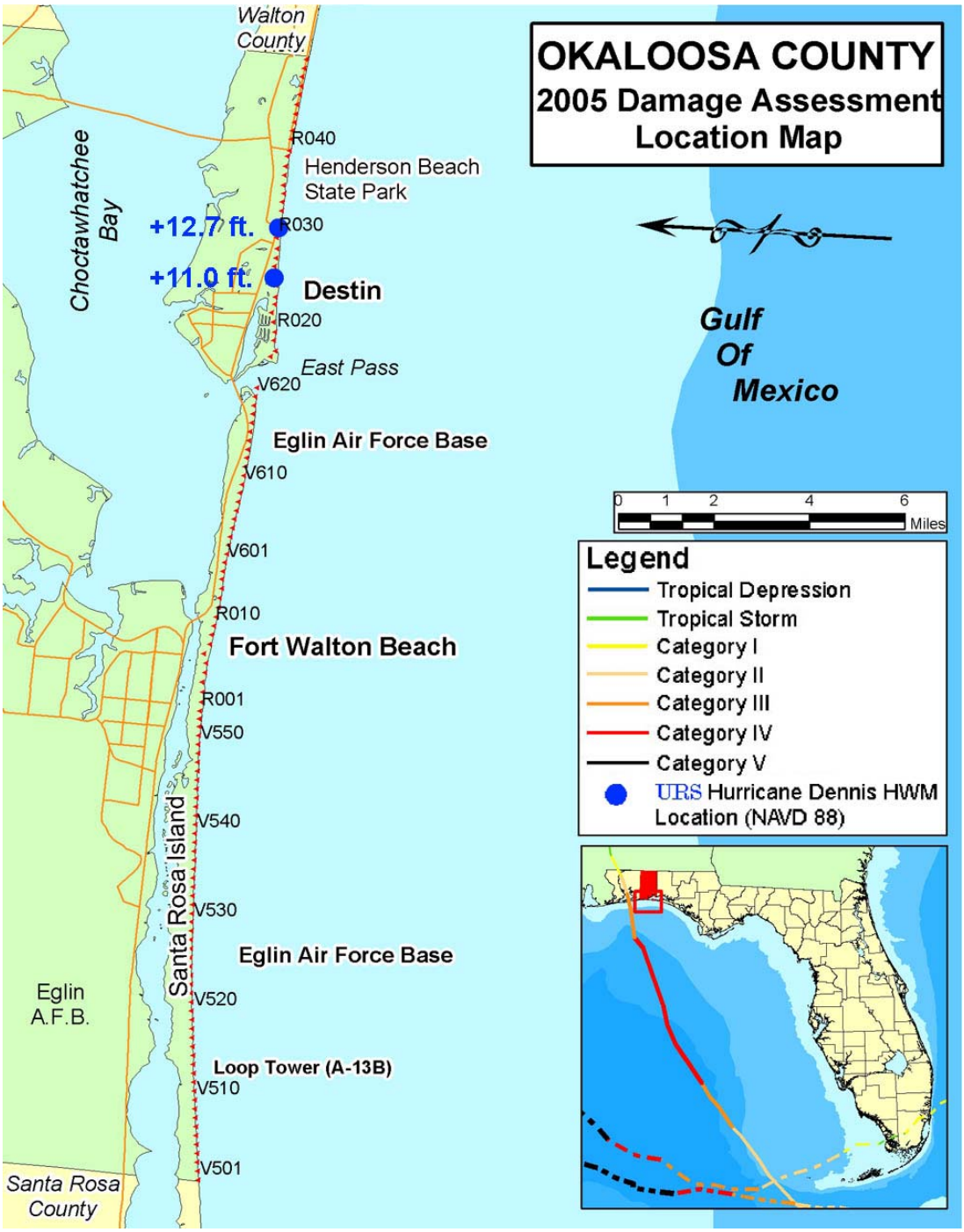

Figure 20. Okaloosa County location map.

There are 23.9 miles of gulf fronting beaches in Okaloosa County, which includes Eglin Air Force Base and the developed beaches near Ft. Walton Beach on Santa Rosa Island, and the City of Destin and Henderson Beach State Park on Moreno Point. There is also a coastal inlet stabilized with jetties, East Pass (Choctawhatchee Bay Entrance), between Santa Rosa Island and Moreno Point. East of East Pass and on Moreno Point is a barrier sand spit that extends 2.3 miles to the east, known as Norriego Point, and includes the Holiday Isles area of the City of Destin.

Prior to the 2005 hurricane season, Okaloosa County had two critically eroded beach areas (4.9 miles), one noncritically eroded beach area (1.7 miles) and one critically eroded inlet shoreline area (0.8 mile) (FDEP, 2005). The 2.8 miles of developed Santa Rosa Island (R1-R15) near Ft. Walton Beach is critically eroded. The east end of Santa Rosa Island (V612-V621) within the Eglin Air Force Base extending 1.7 miles west of Choctawhatchee Bay Entrance (East Pass) is noncritically eroded. Also, the eastern 2.1 miles of Destin (R39-R50) is designated critically eroded threatening development and the coastal road. This area is part of a beach restoration project which is being constructed in the spring of 2006. East Pass has a federal navigation channel that is periodically maintained for navigable access. The east shoreline of East Pass along Norriego Point has sustained critical inlet shoreline erosion prior to Hurricane Dennis. This erosion has threatened development and recreational interests.

Hurricane Dennis Storm Effects and Erosion Conditions

Eglin Air Force Base (V501-V553)

The western nearly 10 miles of Santa Rosa Island beaches in Okaloosa County are part of Eglin Air Force Base. The island along this coastal segment was substantially flooded by the storm tide of Dennis that probably reached or exceeded +10 feet and was comparable to a 50-year frequency event (BSRC, 1991). Most of the military facilities are sited a reasonable distance from the beach; however, a couple installations with concrete seawalls sustained impact from the storm surge and waves of Dennis. Near the middle of this coastal segment, at a radar installation (V518), a 100-foot segment of a 400-foot concrete seawall was destroyed. At another installation (V528.5), a 100-foot long

Photo 14. Destroyed seawall and damaged building foundation.

concrete seawall was destroyed, a steel sheet-pile seawall sustained minor damage, and a building foundation was damaged (Photo 14). Approximately one mile west of the developed beaches near Ft. Walton Beach, another 350 feet of concrete seawall was totally destroyed (V548.2). Much of the island road along this 10-mile segment was either covered with overwash sand or in some areas destroyed.

This area was previously impacted by the 200-year storm tide of Hurricane Opal (1995), which caused severe flooding and erosion with substantial overwash deposits, and destroyed at least 20 major military structures. Hurricane Ivan (2004) caused additional flooding and erosion with less structural damage.

Ft. Walton Beaches (R1-R16)

The developed beach area of Okaloosa County adjacent to Ft. Walton Beach was 25 miles east of the eye of Hurricane Dennis at landfall. A maximum wind velocity of 102 mph was recorded nearby in Mary Esther. Storm tides are estimated to have reached +10 feet along this area of Santa Rosa Island, causing moderate flooding and overwash. The extensive flooding and overwash seen in this area during Opal and Ivan did not occur during Hurricane Dennis. Unlike after Opal and Ivan, the roads were not covered with sand except for street ends in close proximity to the beach.

Major beach and dune erosion (condition IV) was sustained throughout this area; however, the beach remains wide and will support post-storm recovery dune restoration projects like those conducted after Opal, Georges (1998), and Ivan. A profile obtained at R2, two months after the storm, graphically shows the beach erosion sustained by Dennis compared with prior recent profiles (Figure 21).

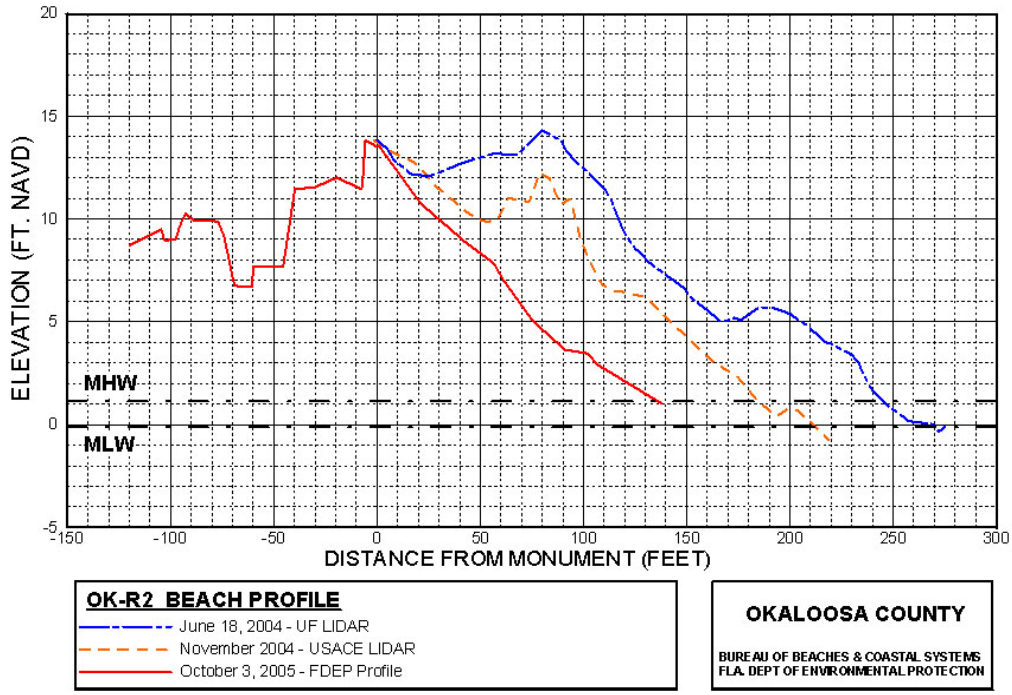

Figure 21. Comparative erosion profiles, Santa Rosa Island.

Eglin Air Force Base (V601-V621)

Along the eastern 4.7 miles of Santa Rosa Island between the Ft. Walton Beach area and East Pass, the storm tides of Dennis overtopped and flooded the island. Hurricane Opal (1995) flattened large areas of barrier dunes throughout this stretch of coast. Dunes areas that had been emerging through natural recovery were once again leveled by Hurricane Ivan (2004). No assisted recovery had occurred through the restoration of dunes, and the storm tides of Dennis flooded and transported additional large quantities of overwash sediments across the island.

East Pass and Norriego Point

East Pass sustained moderate shoaling from Hurricane Dennis. As a federal navigation channel requiring periodic maintenance, the shoal material can be expected to be dredged to provide the authorized design depths of the channel. This material will likely be used to nourish Okaloosa County beaches.

The critically eroded east shoreline of East Pass along Norriego Point is armored with bulkheads and retaining walls in front of private development, and a seawall and boulder mound T-groins along the undeveloped segment to the north. The flooding within East Pass during Dennis was not as severe as during Opal or Ivan. There was no damage along the pass shoreline of Norriego Point where Opal caused a severe impact. The winds and wave attack from Dennis originated from the southeast in this area, and the east jetty to East Pass sheltered the Norriego Point development inside the inlet from any significant damage.

City of Destin, including Holiday Isles and Henderson Beach State Park

The City of Destin was 32 miles east of the eye of Hurricane Dennis at landfall. A maximum wind velocity of 74 mph was measured in Destin, indicating the winds were generally below hurricane strength in the area. In western Destin, storm tides of +11 ft. NAVD (+11.4 ft. NGVD) at R26, and +12.7 ft. NAVD (+13.1 ft. NGVD) at R31, were measured (URS, 2005). Significant flooding was sustained in the Lands End Drive area, a lagoonal depression of Holiday Isle, partly due to the high wave uprush from the southeast. This flooding was comparable to the flooding sustained during Hurricane Ivan.

Major beach and dune erosion (condition IV) was sustained throughout Destin (R18-R33 and R39-R50). Major beach and dune erosion (condition IV) was also sustained along Henderson Beach State Park (R33-R39). The road and development within the critically eroded area of eastern Destin between R39 and R50 was critically imperiled following Dennis and in need of the authorized beach restoration project (Photo 15). A profile obtained at R39, two weeks after the storm, graphically shows the beach erosion sustained by Dennis compared with prior recent profiles (Figure 22).

Photo 15. Destin erosion damage (R43.5).

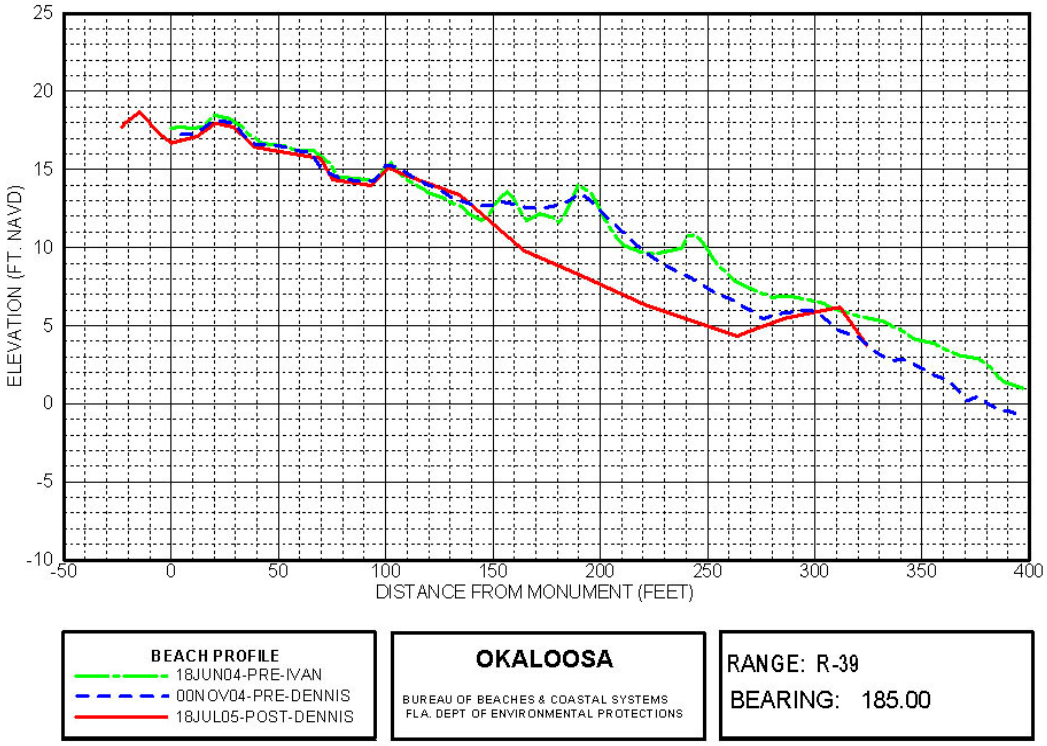

Figure 22. Comparative erosion profiles, Destin.

Hurricane Katrina Storm Effects and Erosion Conditions

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was over 180 miles west of Ft. Walton Beach. Only tropical storm force winds affected this area. Throughout Okaloosa County minor beach and dune erosion (condition II) was sustained. Small emergency sand berms constructed after Dennis using overwash material that was returned to the beaches, were deflated by the storm tide that ranged between five and six feet. There was minor flooding to Santa Rosa Boulevard along Santa Rosa Island and to U.S. Highway 98 in Fort Walton Beach adjacent the city hall complex. Between Ft. Walton Beach and Destin, U.S. Highway 98 was flooded between the Department of Environmental Protection virtual reference stations V602 and V607 with only minor damage. In Destin, several sections of Gulf Shore Drive were flooded on Holiday Isles.

Hurricane Dennis Storm Damage

Ft. Walton Beaches (R1-R16)

Only minor to moderate wind damage was sustained throughout the Ft. Walton Beaches. A few nonconforming structures (not conforming to current coastal building standards for elevation and foundation design) sustained first floor damages due to the storm surge. A number of structures were flooded and partially filled with sand on their first floor interiors. Several swimming pools were filled with sand (Photo 16). The Okaloosa County fishing pier sustained no apparent damage.

Photo 16. Pool filled with sand (R5.5).

Throughout the developed Santa Rosa Island section of Okaloosa County, 11 major structures sustained major damage. Of these, eight major structures located seaward of the established Okaloosa County Coastal Construction Control Line sustained major damage. No major structures were destroyed. In addition, 170 feet of retaining walls were destroyed.

Eglin Air Force Base (V601-V621)

At a military installation at V608, a 100-foot segment at the east end of a 700-foot concrete seawall was destroyed. Significant scour occurred behind the destroyed wall, exposing a former radio tower foundation and undermining the southeast corner of a building. Other major damage from Dennis in this area was to U.S. Highway 98 near V606 (Photo 17). The damage from Dennis was substantially less than that which occurred during Hurricane Opal (1995) and Ivan (2004). The +14-foot storm tide measured after Hurricane Opal in this area had destroyed about 2.5 miles of the highway, plus seven major military structures along with 1330 feet of concrete seawall at an officers club and a beach club. Ivan's storm tide of +8 to +9 feet through this area destroyed a smaller segment of the highway as well as the beach club facilities (V618).

Photo 17. Damage to U.S. Highway 98 between Ft. Walton Beach and Destin (V606).

City of Destin, including Holiday Isle

Only minor to moderate wind damage was sustained throughout Destin. Several structures were damaged by the storm tide and erosion. A number of the same nonconforming structures, damaged by Opal or Ivan and subsequently repaired, sustained major damage from Dennis, including one that was destroyed (Photo 18). Some major structures had their seaward decks or porches destroyed and were rendered imminently threatened by the erosion conditions (Photo 19). Seven swimming pools were either damaged or were filled with sand. In addition, most of the retaining walls throughout Destin were destroyed (Photo 20).

In total, throughout Destin, 35 major structures sustained major damage, with only one destroyed. Of these, 26 major structures located seaward of the Okaloosa County Coastal Construction Control Line sustained major damage. In addition, 18 major structures sustained damage to nonhabitable understructure areas, and 2,405 feet of retaining walls were destroyed or damaged.

Photo 18. Destin dwelling destroyed (R49).

Photo 19. Multifamily dwelling undermined, Destin (R44.5).

Photo 20. Concrete wall failure and building undermined, Destin (R45).

Hurricane Katrina Storm Damage

Along the Santa Rosa Island beaches of Okaloosa County, Hurricane Katrina caused no major damage. There were some minor damages due to the storm tide and waves to beach access walkways and fences, plus some minor damage to U.S. Highway 98 between Ft. Walton Beach and Destin. A number of gulf-front structures were flooded and sanded on their first floor interiors and several swimming pools were filled with sand. In addition, the Okaloosa County fishing pier sustained no apparent damage.

The most significant damages within Destin occurred due to the storm tide of between five and six feet with storm wave uprush and overtopping. On Norriego Point fronting on East Pass, sand was scoured from behind bulkheads at a few condominiums. Along the gulf-front in Destin, two habitable major structures sustained major structural damage. One of the western-most dwellings on Lands End Drive, sustained ground floor damage by the storm surge and flooding, and was located 1,200 feet seaward of the Okaloosa County Coastal Construction Control Line. Beach walkway ends were damaged and Gulf Shore Drive sustained minor flooding damage in Holiday Isles. Throughout Destin, several swimming pools and several buildings had their ground floors sanded. A multifamily dwelling structure (condominium) at R45 sustained first floor damage to its west end unit. This structure had become more exposed when Dennis destroyed its concrete bulkhead wall. Also in Destin, two small segments of wood retaining walls were destroyed totaling 27 feet in length.

Walton County

Walton County is located along the central region of northwest Florida between Okaloosa County to the west and Bay County to the east (Figure 23). There are no barrier islands in Walton County, which has 25.6 miles of gulf fronting beaches. The western two thirds of the county's beaches are located on a coastal peninsula and the eastern third is defined as a mainland beach.

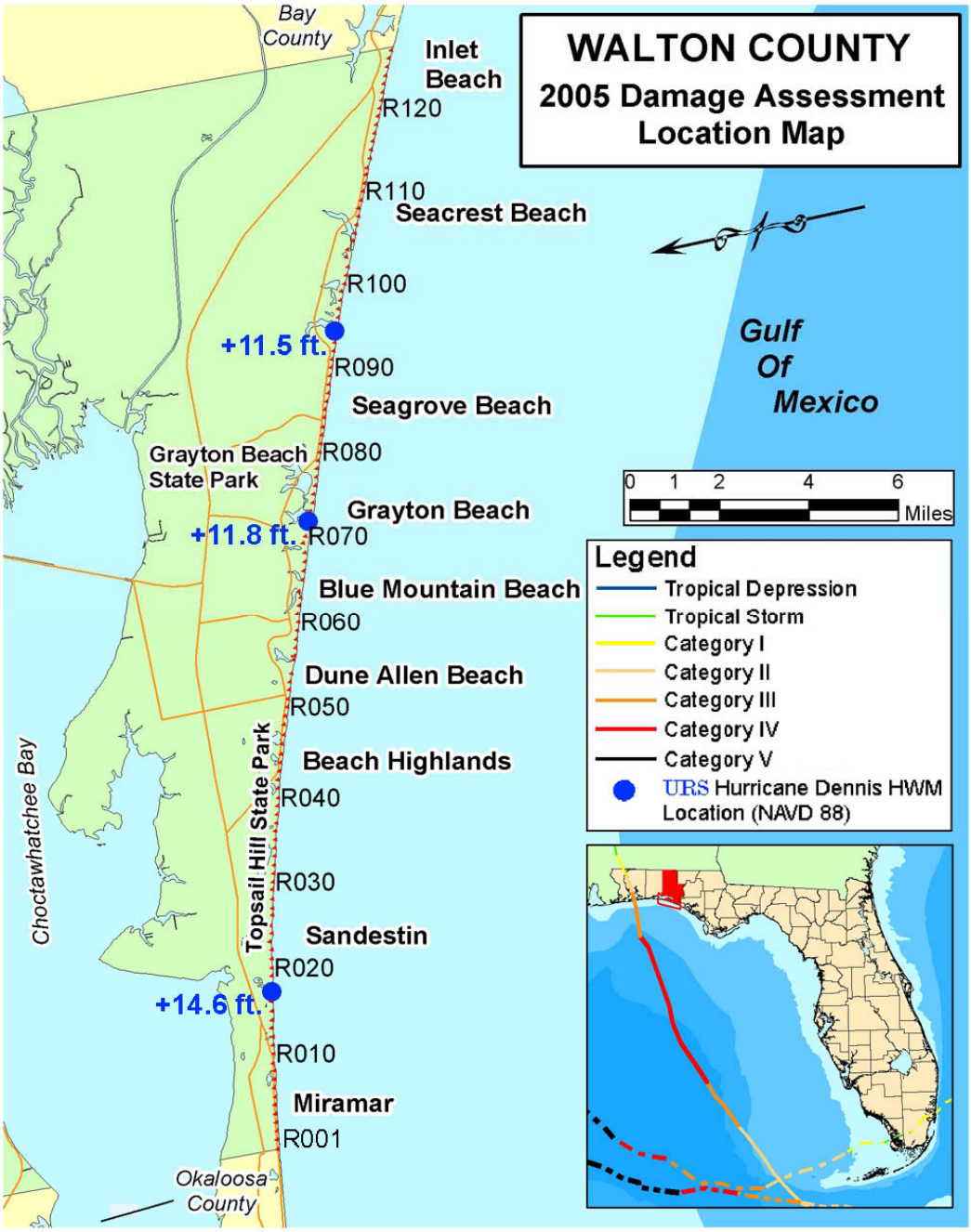

Figure 23. Walton County location map.

The coast of Walton County is characterized by a continuation of the Pleistocene barrier complex that is found along the mainland of the coastal counties to the west (Balsillie and Clark, 2001). Barrier dune elevations average between +20 and +30 feet along Walton County beaches, and elevations to +45 feet are not uncommon. The Walton County coast includes the following beach communities and major parks: Miramar Beach, Tang-O-Mar Beach, Gulf Pines, Sandestin, Four Mile Village, Topsail Hill State Park, Beach Highlands, Dune Allen Beach, Blue Mountain Beach, Gulf Trace, Grayton Beach, Grayton Beach State Park, Seaside, Seagrove Beach, Seacrest Beach, Dana Beach, Rosemary Beach, and Inlet Beach.

There are no coastal inlets in Walton County, which is located between East Pass (Destin) located 6.5 miles to the west, and Phillips Inlet, located roughly 0.2 mile to the east of the Walton/Bay County line. Walton County does have a number of coastal lakes formed by gulfward flowing freshwater streams. Eleven of these coastal lakes have intermittent outlets that convey storm water through meandering streams crossing breaches in the coastal dunes. These outlets are located at the following coastal lakes: Morris Lake (R29), Stalworth Lake (R41), Oyster Lake (R46), Draper Lake (R55), Big Redfish Lake (R64), Little Redfish Lake (R65), Alligator Lake (R69), Western Lake (R73), Eastern Lake (R95), Deer Lake (R99), and Camp Creek Lake (R104).

Prior to the 2005 hurricane season, Walton County had seven critically eroded areas (11.9 miles) (FDEP, 2005). The western 5.0 miles (R1-R22.8), including Miramar Beach, Tang-O-Mar Beach, Gulf Pines, Sandestin, and Four Mile Village, threaten development, recreational interests, and the coastal road (Old U.S. Highway 98). Most of this area is part of an authorized beach restoration project that commenced in February 2006. A 2.7-mile critically eroded segment at Beach Highlands and Dune Allen (R41-R54.5) threatens development, Fort Panic Road, and County Road 30A. A 1.0-mile segment of Blue Mountain Beach (R58-R63) is critically eroded where development is threatened by the eroded bluff. To the east, erosion of a 0.2-mile segment of Gulf Trace (R67.3-R68.3) also threatens development. A 1.6-mile segment of critical erosion threatens development along Seagrove Beach (R82-R90.1). To the east along Seacrest is another 1.0-mile segment (R109.5-R114.7) where development is threatened by the eroded bluff. And near the county's east end, a 0.4-mile segment at Inlet Beach (R122-R124) is designated critically eroded due to its post-storm vulnerability threatening development interests.

Hurricane Dennis Storm Effects and Erosion Conditions

The Walton County coastline is located between 39 and 65 miles east of where the center of the eye of Hurricane Dennis made landfall. The maximum winds along the coast were generally below hurricane strength, yet storm tides with wave uprush were generally between +9 to +12 feet. The entire coast of Walton County sustained major beach and dune erosion (condition IV) from Dennis. The erosion impact was comparable to the impact of Hurricanes Eloise (1975), Opal (1995), and Ivan (2004). The impact of Dennis exacerbated the severe beach and dune erosion conditions which had not recovered from Hurricane Ivan. As the case has been since the impact of Ivan, the existing eroded condition of the beach and dune system has left many private structures and public

infrastructure vulnerable to damage from the impact of high-frequency coastal storms. Figure 24 compares beach and dune profiles obtained within the Walton County Beach Restoration Project (R16) following Hurricanes Dennis and Ivan.

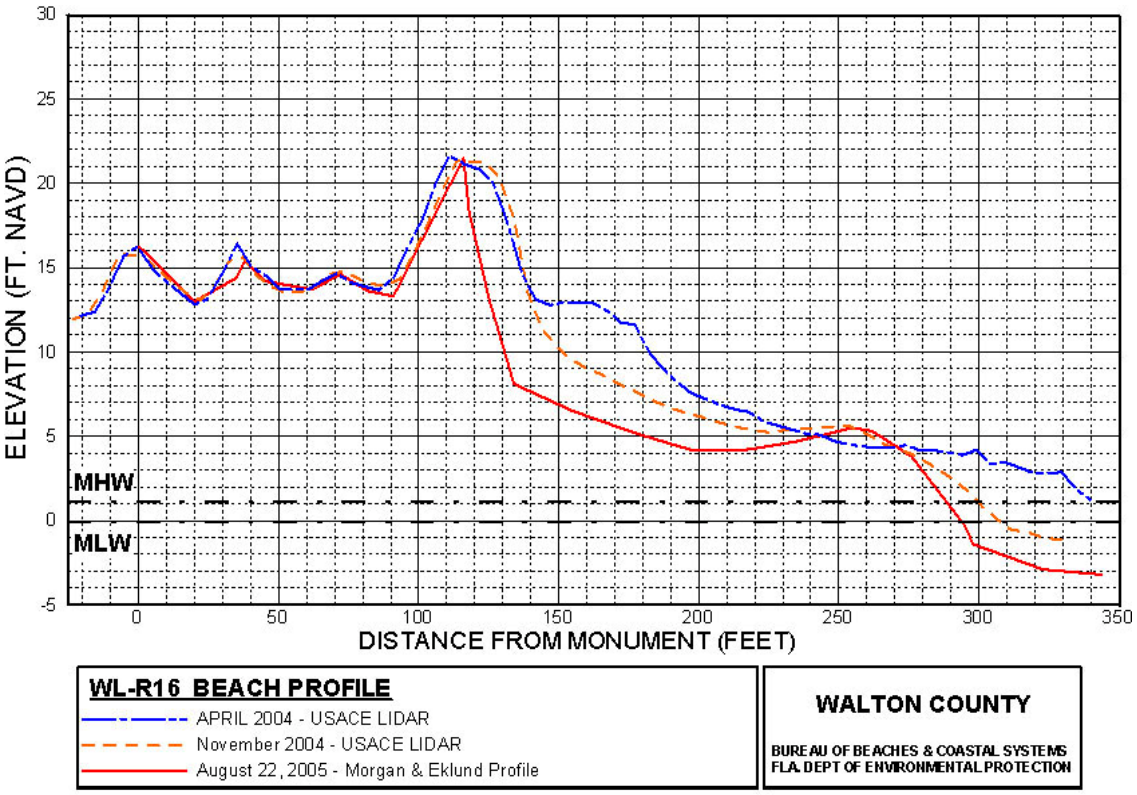

Figure 24. Comparative erosion profiles, Tang-O-Mar Beach.

Following Hurricane Dennis, as also occurred following past hurricanes, most all of the coastal lake outlets were flowing freely into the gulf. The exception was the channelized outlet at Oyster Lake where overwash sand and debris filled in the channel and box culvert located under County Road C-30. Erosion from the westward migrating outlet from Eastern Lake continued to threaten beach development seaward of Eastern Lake Drive and the Walton County Public Works Department conducted emergency operations to relocate the outlet channel eastward immediately after the storm.

Following Hurricane Ivan in September 2004, 5.1 miles of beaches in Walton County were added to the 6.8 miles of beaches that were previously designated as critically eroded. A critically eroded area is a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. Specific locations where development appears to be within close proximity (less than 10-20 feet) to the dune bluff and thus in a vulnerable condition are listed by reference monument locations below. This list is essentially an expansion of the areas designated as critically eroded following Hurricane Ivan due to the additional erosion of Hurricane Dennis.

Western Walton County (R1-R22.8)
Beach Highlands/Dune Allen (R41-R54.5)
Blue Mountain Beach (R58-R63)
Gulf Trace (R67.3-R68.3)
Grayton Beach (R70.95-R71.4)
Seagrove Beach (R82-R98)
Seacrest Beach (R105.5-R114.7)
Inlet Beach (R122-R124)

Within the above described areas, the newly threatened coastal segments following Hurricane Dennis that have not previously been designated as critically eroded include –

Grayton Beach (R70.95-R71.4)
Seagrove Beach (R90.1-R98)
Seacrest Beach (R105.5-R109.5)

Hurricane Katrina Storm Effects and Erosion Conditions

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was on the average 200 miles west of the beaches of Walton County. Only tropical storm force wind gusts affected this area. Throughout Walton County minor beach and dune erosion (condition II) was sustained. Following the severe erosion of Dennis, additional minor dune erosion from Katrina further destabilized the eroded bluff. Post-Katrina beach profile surveys obtained by Morgan & Ekland for Walton County and compared to USACE LIDAR surveys are shown in Figures 25-27. The September, 2005, profiles reveal the combined erosion of Dennis and Katrina.

A beach scraping project was conducted in a number of areas following Dennis, and Katrina's storm tides and wave uprush substantially eroded these scraped foredune berms. In some areas where development was in imminent danger of being undermined by storms after Dennis, isolated large dune fill projects had been constructed by trucking sand to the beach from upland borrow pits. These newly constructed dunes sustained major erosion effects, but served their purpose of providing emergency protection to the upland development.

Following Katrina all coastal lake outlets were substantially closed and not flowing. This was contrary to the situation following Dennis, when all the coastal lake outlets were flowing to the Gulf of Mexico. The storm tide along Walton County was observed to be about four feet, with additional wave uprush reaching the eroded dune bluff. Little inland flooding was observed, including through the existing dune breaches.

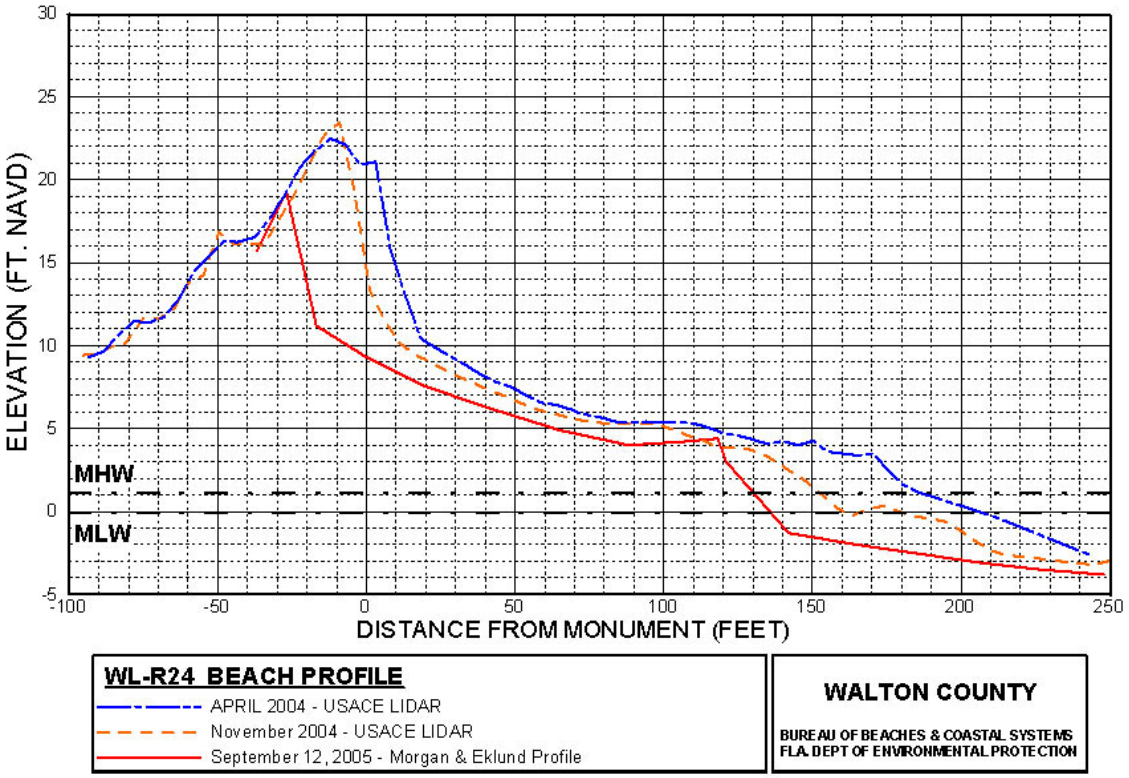

Figure 25. Comparative erosion profiles, Topsail Hill State Park.

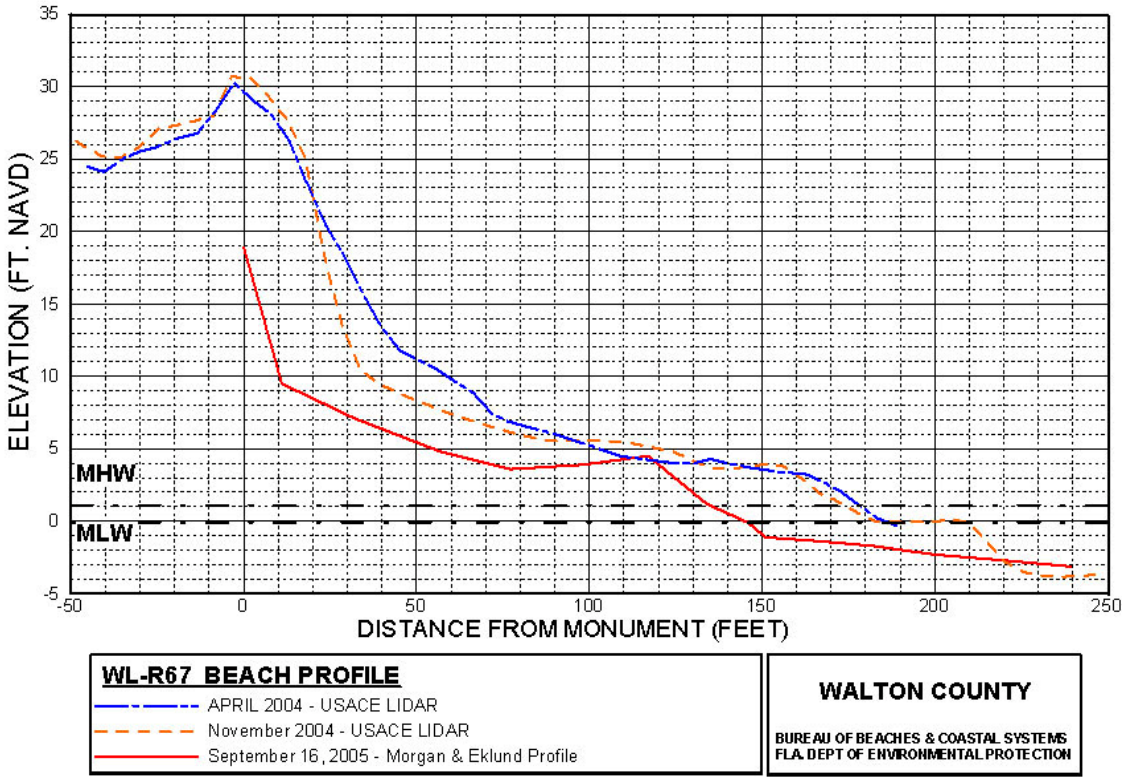

Figure 26. Comparative erosion profiles, Gulf Trace.

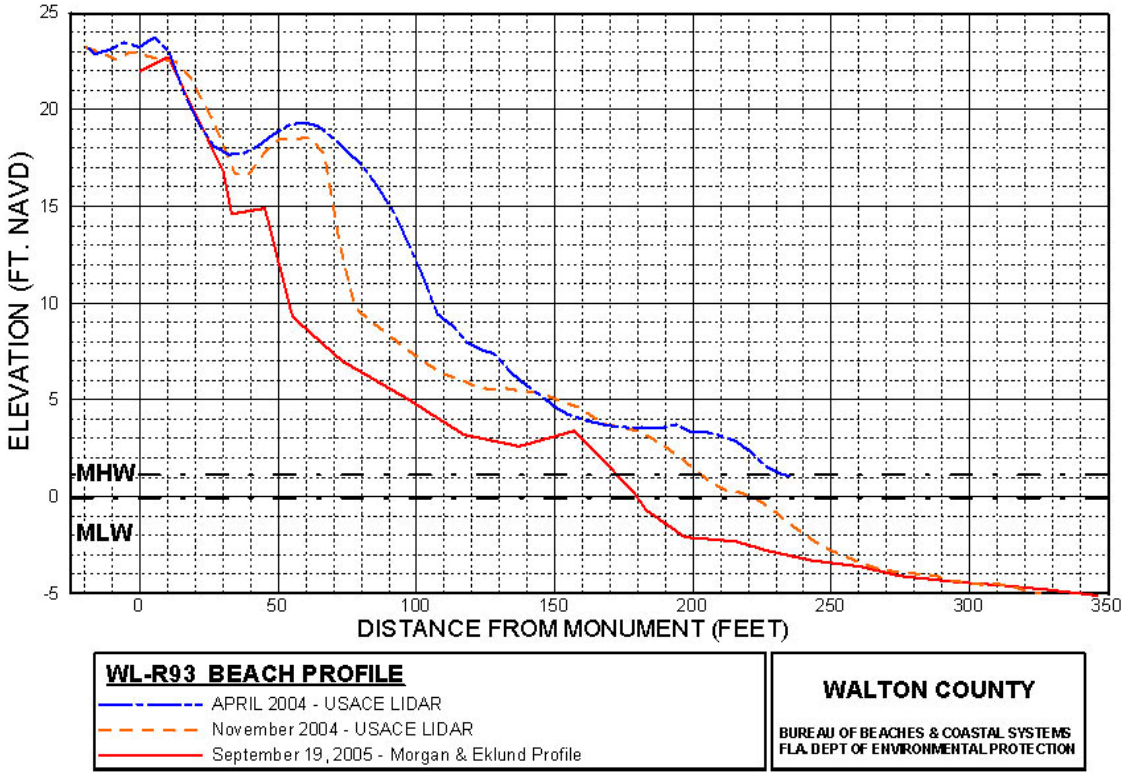

Figure 27. Comparative erosion profiles, Seagrove Beach near Eastern Lake.

Hurricane Dennis Storm Damage

Major structural damage was sustained along Walton County's coast and was related to storm tide and waves undermining dwellings supported on foundations that do not conform to current coastal building standards. Major damage to nonhabitable understructure enclosures and appurtenant structures was also due to the storm tide and waves. Wind damage to structures was rarely observed. In addition, many older dwelling structures that are located at the top of the steep, eroded dune bluff are in imminent danger of structural damage as the soil beneath the concrete slab foundations sloughs down the unstable slope. Along several areas, the dune bluff recession leaves many pile-supported dwellings sited on the beach. Erosion now threatens the upland access and utility connections to these gulf-front properties, as well as the upland public infrastructure. Seacrest Beach (R105.5-R115) was critically eroded and could have sustained greater impact had an underlying peat strata not been present (Photo 21). These peat deposits are approximately 42,000 years old based upon carbon dating conducted by the Department.

Photo 21. Peat strata exposed by erosion, Seacrest Beach (R108.8).

In total, throughout Walton County, 36 major structures sustained major damage, including 17 major structures that were destroyed. Of these, 34 major structures located seaward of the established Walton County Coastal Construction Control Line sustained major damage. A total of 10 single-family dwellings and seven nonhabitable major structures (six swimming pools and one garage) were destroyed. Another nine single-family dwellings and two multifamily dwellings sustained major damage to their nonconforming foundation. Five other single-family dwellings and three multifamily dwellings sustained major wind damage. Additionally, 25 dwellings supported on nonconforming foundations are in imminent danger of structural damage as the soil beneath the concrete slab foundations slips down the unstable slope of the eroded dune bluff. In addition, a total of 24 habitable structures sustained moderate to major damage to nonhabitable understructure enclosures. Also, 1,205 feet of retaining walls and bulkheads were destroyed or sustained major damage. Throughout Walton County, about 50 public beach access walkways were destroyed. Examples of the damages along Walton County's beaches are shown in photos 22-30.

Hurricane Dennis Storm Damage Discussions by Beach Community

Miramar Beach

Western Walton County has been designated critically eroded since 1995, after Hurricane Opal's impact. The coastal reach between R1 and R10 is characterized by a narrow dune ridge seaward of County Road 2378 (Old U.S. Highway 98). A 1000-foot long parking lot (R3) was destroyed at the county's beach access park. To the east, the Sand Dollar condominium (R4.5) sustained understructure damage and the Costa del Sol (R4.6-R5), an 18-unit condominium, sustained first flood flooding. Near the end of Alamo Street (R9.3), a pile-supported single-family dwelling was destroyed (Photo 22). The adjacent two pile-supported dwellings sustained understructure damage. At R10, a swimming pool was destroyed by erosion undermining the structure and a 250-foot wood bulkhead was destroyed (Photo 23).

Further east at Murmuring Surf (R11), another 200-foot wood retaining wall, built after Opal, was destroyed. In comparison, Ivan (2004) destroyed the same county parking lot at R3, damaged a four-unit condominium at R1.7, damaged six units at the Sand Dollar Condominium (R4.5), damaged 27 units at the Costa del Sol (R4.6-R5), damaged the Whale's Tail Restaurant (R7), and destroyed 210 feet of retaining walls. In contrast, Opal destroyed eight buildings, including four motels, and substantially damaged 17 other major structures. Following Hurricane Dennis, this area was in critical need of the authorized beach restoration project to prevent another storm from causing damage to Old U.S. Highway 98. The beach restoration project commenced in February 2006, with fill placement along Miramar being conducted substantially in April 2006.

Tang-O-Mar Beach

During Hurricane Dennis, four swimming pools were destroyed by erosion undermining the structures between R12 and R14. These were located seaward of the Huntington Condominiums (R12), adjacent the Edgewater Condominium (R12.6), at R13.1, and at the end of Norwood Drive (R13.4). Between R13 and R14, a couple single-family dwellings lost their seaward decks and also sustained understructure damage, where in contrast, Opal (1995) destroyed 16 dwellings and substantially damaged five others. In similar contrast, no major damage was observed following Dennis between the Mainsail Condominium (R14) and Sand Trap Road, in a segment where Opal destroyed five dwellings and substantially damaged two others.

Photo 22. Single-family dwelling destroyed, Miramar Beach (R9).

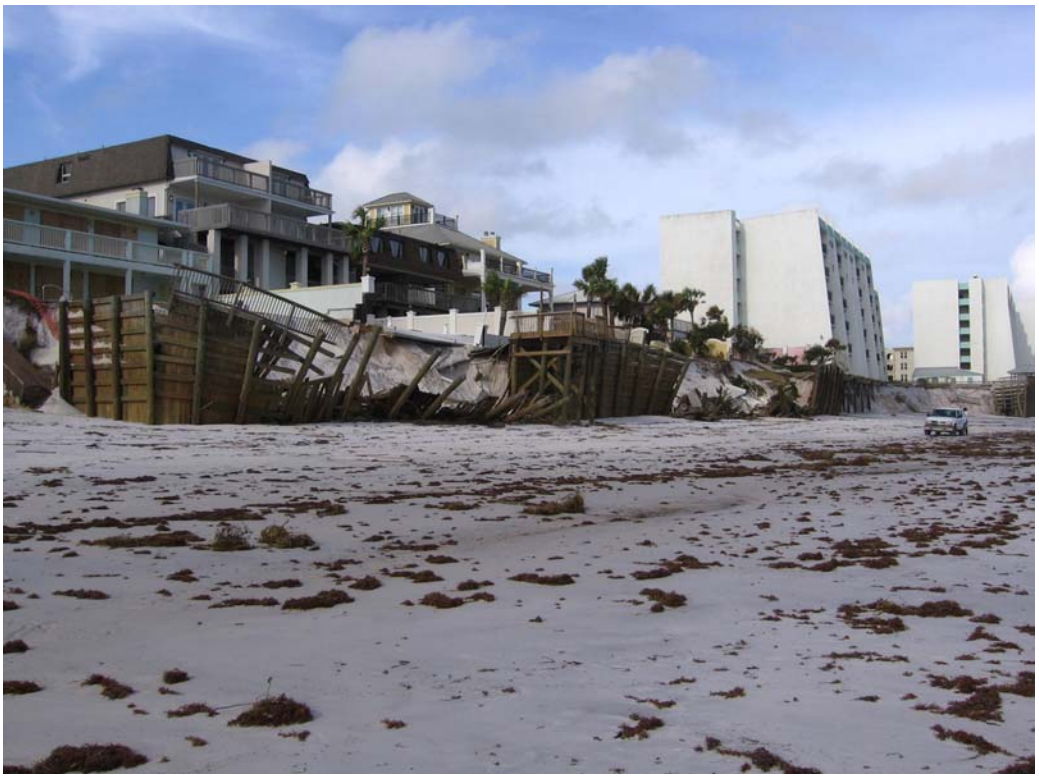

Photo 23. Wood bulkhead destroyed, Miramar Beach (R10).

Gulf Pines

A peak storm tide with wave activity of +14.6 ft. NAVD (+15 ft. NGVD) was measured near R18 (URS, 2005). Between R17 and R18, nine single-family dwellings sustained understructure damage and a vehicle garage (R17.6) was destroyed by Dennis. In contrast, in this same segment, Opal destroyed eight dwellings and 170 feet of wood retaining wall.

Sandestin

The development of Sandestin, located between R19 and R21, sustained no major structural damage from Hurricane Dennis.

Four Mile Village

In this gated community with nine gulf-front dwellings sited seaward of the Walton County Coastal Construction Control Line, one dwelling was destroyed (R22.7) and 600 feet of wood retaining wall (including returns) were destroyed (R21.9-R22.4) by Dennis.

Topsail Hill State Park

No major structural damage was sustained between R23 and R41. At the upper reaches of Lake Stalworth near R41, URS, 2005, measured a storm tide of +9.2 ft. NAVD (+9.6 NGVD). This high water mark was located approximately 1,200 feet landward of the Gulf of Mexico and 950 feet landward of the Walton County Coastal Construction Control Line.

Beach Highlands

This area has been designated as critically eroded since Opal's impact in 1995. Before Opal, between 70 and 100 feet of vegetated dune existed seaward of development between R41 and R44. Prior to Dennis, typically 10 to 20 feet of dune existed, if at all. Between R41 and R45, Dennis destroyed one single-family dwelling (R43), one swimming pool (R43.8), and substantially damaged the foundation of another dwelling (R42.7). In contrast, in this same area, Opal destroyed six dwellings and substantially damaged five other dwellings.

Dune Allen

Most of the gulf-front development is threatened following the erosion impact of Dennis between R45 and R54.5 at Draper Lake. The segment of beach between R45 and R48 was designated as critically eroded after Opal in 1995, and the segment between R48 and R54.5 was designated critically eroded in 2005 after Ivan's impact. Dennis inflicted foundation damage to one dwelling near R47 and two dwellings near R50, and destroyed two single-family dwellings at R52. Another dwelling near R47 lost a roof section. In addition, beach access walkways were damaged at Ed Walline Park (R51.2). In contrast, in this same area, Opal destroyed 14 dwellings and substantially damaged 11 others.

Blue Mountain Beach

This beach community between R58 and R63 was designated as critically eroded in 2005 following the impact of Ivan (2004). Continued major beach and dune erosion (condition IV) from Dennis has exacerbated this critical erosion and now most of the development is critically imperiled. The impact of another major hurricane in the eroded post-storm situation will likely destroy many of the buildings sited near the bluff and perched on-grade with soil bearing foundations (Photo 24). As it was, Dennis destroyed two single-family dwellings (R60.85 and R62.75), 105 feet of vinyl retaining wall (R61), and substantially damaged the foundation of another dwelling (R62.65) and a multifamily dwelling (R60.2). Another dwelling sustained wind damage (R60.8).

Photo 24. Imminently threatened building, Blue Mountain Beach (R60).

Gulf Trace

This beach community between R67.3 and R68.3 was designated as critically eroded in 2005 following the impact of Ivan (2004). Of the 18 single-family dwellings seaward of Gulf Shores Drive and the Coastal Construction Control Line, Dennis destroyed one dwelling (R67.6) and damaged the pile foundation of two others (R67.7 and R68) (Photo 25). Four other dwellings sustained understructure damage due to the storm tide and waves of Dennis. A porch deck, 40 feet of wood retaining wall, and at least six septic tanks were also destroyed.

Grayton Beach

URS, 2005, measured a storm tide wrack line of +11.8 ft. NAVD (+12.2 ft. NGVD) at R72. A covered deck of a single-family dwelling was destroyed and its foundation was damaged seaward of the Coastal Construction Control Line at R71. The remainder of this community between R71 and R73 was largely not impacted by Dennis, as most of the development is sited landward of the Coastal Construction Control Line. This was not the case during Opal's flooding in 1995 where a high water wrack line was surveyed at an elevation of +16.6 feet NGVD. In contrast to the lack of community flooding from Dennis, Opal destroyed four single-family dwellings and substantially damaged nine others, all located between the Coastal Construction Control Line and up to 800 feet landward.

Photo 25. Damaged structure, Gulf Trace (R68).

Grayton Beach State Park

Other than a beach access walkway, there were no major structural damages along the state park between R73 and R78.

Water Color and Seaside

No major damage was sustained in these large developments between R78 and R82. It is noted that, other than dune walkovers and other appurtenant structures, the majority of

the development in this coastal segment is sited landward of the Walton County Coastal Construction Control Line.

Seagrove Beach

Part of this beach community (R82-R90.1) was designated as critically eroded in 2005 following the impact of Ivan (2004). Continued major beach and dune erosion (condition IV) from Dennis has exacerbated this critical erosion and now threatens the remainder of Seagrove Beach (R90.1-R98). Much of the development is imminently threatened and the impact of another major hurricane will likely destroy many of the buildings sited near the bluff and perched on-grade with soil bearing foundations. A storm tide wrack line of +11.5 ft. NAVD (+11.9 ft. NGVD) was measured near R94, approximately 400 feet from the Gulf of Mexico (URS, 2005). The Leeward I Condominium seaward of Eastern Lake Drive sustained major damage to three ground floor units and one second floor unit (R93.8) in Dennis. Next door, the Eastern Shores Condominium lost a 50-foot wood retaining wall (R93.9). In addition, Dennis damaged the understructures of two dwellings, and destroyed porch decks in front of three other dwellings. Six other major structures sustained major wind damage (four seaward and two landward of the Coastal Construction Control Line).

Seacrest Beach

Part of this beach community (R109.5-R114.7) was designated as critically eroded in 2005 following the impact of Ivan (2004). Continued major beach and dune erosion (condition IV) from Dennis has exacerbated this critical erosion and now threatens the remainder of Seacrest Beach (R105.5-R109.5). Dennis destroyed a single-family dwelling at R111.8. Much of the development between R111.8 and R114.7 is now imminently threatened (Photo 26).

Photo 26. Imminently threatened structure, Seacrest Beach (R112.4).

Dana Beach and Rosemary Beach

No major damage was sustained in these communities located between R116 and R122 that are mostly sited landward of the Walton County Coastal Construction Control Line. Major beach and dune erosion (condition IV) was sustained during Dennis.

Inlet Beach

The segment of beach between R122 and R127 was designated as critically eroded after Opal in 1995. Following several years of recovery, most of Inlet Beach was removed from the critical erosion list in 2003, except for the 0.4-mile segment between R122 and R124, which had not recovered from the hurricanes of 1995 and 1998. Major beach and dune erosion (condition IV) was sustained by Dennis throughout Inlet Beach. Dennis destroyed two single-family dwellings (Photo 27) and three paved driveways at R123 seaward of Pompano Street. A foundation slab of another dwelling was damaged at the end of Emerald Cove Lane South (R125.5) and three dwellings sustained understructure damage at the end of Walton Magnolia Lane (R126.1-R126.3). These pile supported dwellings east of R126 and up to 170 feet seaward of the Walton County Coastal Construction Control Line are now sited on the active beach berm.

Photo 27. Dwelling destroyed, Inlet Beach (R123).

Hurricane Katrina Storm Damage

A total of 12 single-family dwellings and one multifamily dwelling sustained major structural damage along Walton County's beaches from Katrina. All were seaward of the Walton County Coastal Construction Control Line. In addition, one nonhabitable major structure (a swimming pool) was destroyed, along with two small segments of wood retaining walls totaling 45 feet in length.

In Miramar Beach, a swimming pool was destroyed at R9.9 and two single-family dwellings had their foundation slabs undermined at R11 (Murmuring Surf). A porch also collapsed seaward of one dwelling. Along Tang-O-Mar, two pile-supported dwellings were undermined near R13, and a single-family dwelling sustained first floor damage at R13.6. Elsewhere within the authorized beach restoration project area, new dunes constructed along Sandestin were eroded leaving three to five-foot escarpments.

In Beach Highlands, a multifamily dwelling structure sustained undermining foundation damage to its five condominium units at R43.2 (Photos 28 and 29). At the seaward west end of Fort Panic Road, a 25-foot section of wood retaining wall was destroyed (R44). To the east between Lake Allen and Oyster Lake, a single-family dwelling (R45.5) sustained undermining damage to its slab foundation and had its screened porch destroyed. Nearby, a 20-foot section of vinyl retaining wall was destroyed (R45.8). To the east in Dune Allen, another single-family dwelling (R49.9) sustained undermining damage to its slab foundation and also sustained major roof damage (Photo 30). Between R50 and R51, a concrete slab porch was destroyed, a covered porch was undermined and a pile-supported dwelling was undermined.

Near the east end of Blue Mountain Beach, two single-family dwellings sustained major damage near R63. One of these dwellings sustained foundation pile damage during Dennis and sustained additional damage due to Katrina. In Gulf Trace Beach between R67 and R68, three single-family dwellings sustained major damage. One of these dwellings had previously been damaged by Dennis and sustained additional damage by Katrina. In addition, another Gulf Trace dwelling sustained understructure damage. To the east in Grayton Beach, another single-family dwelling at R71 sustained major damage.

No major damage attributable to Hurricane Katrina was observed in eastern Walton County. Throughout the county, many recently constructed beach access stairs sustained various levels of damage.

Photo 28. Condominium undermined by Dennis, Beach Highlands (R43.2).

Photo 29. Condominium further undermined by Katrina (R43.2).

Photo 30. Dwelling undermined by Katrina, Dune Allen Beach (R49.9).

Bay County

Bay County is located along the central region of northwest Florida between Walton County to the west and Gulf County to the east (Figure 28).

Figure 28. Bay County location map.

Generally, the western half of the county's coast is characterized as a mainland beach and the eastern half are barrier islands and spits. Bay County has 41.2 miles of gulf-fronting beaches. The Bay County coast includes the following beach communities, military base, and major parks: Camp Helen State Park, Sunnyside, Laguna Beach, Panama City Beach, St. Andrews State Park, Tyndall Air Force Base, and Mexico Beach.

There are five coastal inlets in Bay County. At the west end of the county near R1 is Phillips Inlet, which is a meandering natural inlet connecting the Gulf of Mexico with Lake Powell. Because this inlet periodically closes, Bay County under the direction of the Florida Park Service is authorized to periodically reopen the channel. Near the middle of the county is a man-made inlet, St. Andrews Inlet, which is stabilized with jetties and has a federal navigation channel that is frequently maintained and recently deepened to provide commerce to the Port of Panama City. Separating Shell Island, east of St. Andrews Inlet, and Crooked Island, is the historic east entrance to St. Andrews Bay. St. Andrews Bay East Entrance was maintenance dredged several times prior to the construction of the current federal navigation channel at St. Andrews Inlet in 1935. The historic east entrance closed in 1998, and in its vicinity, a new inlet opening was dredged in 2001. This new artificial cut closed in late 2003 but Hurricane Ivan reopened it in September, 2004. To the east between V30 and V34 is a three quarter mile wide inlet that breached Crooked Island during Hurricane Eloise in 1975, and is referred to as Eloise Inlet. This is a natural inlet that continues to grow in width. One other inlet, Mexico Beach Inlet, is located at the east end of the county at R127.8. Formerly a natural drainage outlet, Mexico Beach Inlet has been channelized and maintained for small craft navigation by the Town of Mexico Beach.

Prior to the 2005 hurricane season, Bay County had two critically eroded beach areas (20.6 miles), three noncritically eroded beach areas (10.1 miles), and one critically eroded inlet shoreline (0.2 mile) (FDEP, 2005). The entire western half of Bay County extending 18.6 miles between Phillips Inlet and St. Andrews Inlet (R1-R97) is critically eroded, threatening development and recreational interests. Inlet sand transfer has been conducted at St. Andrews State Park and a beach restoration project has been constructed for nearly the entire critically eroded area. Numerous concrete and wood bulkheads and retaining walls also exist throughout the area of private development. The western shoreline of St. Andrews Inlet adjacent to Gator Lake is critically eroded requiring periodic fill placement to protect wildlife habitat in St. Andrews State Park. A shoreline stabilization project to construct nearshore detached breakwaters is planned for this western shoreline of St. Andrews Inlet adjacent to Gator Lake. Along the western 6.1 miles of Shell Island (R98-V9) east of St. Andrew's Inlet, the beach is noncritically eroded without any threatened interests. On Crooked Island there are two noncritically eroded areas split by Eloise Inlet. The western segment (V16-V30+2000) extends 2.8 miles to the west and the eastern segment (V36-V41) extends 1.2 miles to the east. The eastern 2.0 miles of Bay County (R127.8-R137.8) along the Town of Mexico Beach is critically eroded. Inlet sand transfer is ongoing from Mexico Beach Inlet to the eroding beach.

Hurricane Dennis Storm Effects and Erosion Conditions

The coast of Bay County is located between 65 and 108 miles east of where the center of the eye of Hurricane Dennis made landfall. The maximum winds along the coast were generally below hurricane strength, and storm tides were generally between +8 to +11 feet. Storm tides with wave run-up of +13.1 ft. NAVD (+13.5 ft. NGVD) were measured at R5 in Carillon Beach near the west county line and +8.5 ft. NAVD (+9.0 ft. NGVD) at R97 in St. Andrews State Park at St. Andrews Pass (URS, 2005). Generally, major to moderate beach and dune erosion (condition IV-III) was sustained along most of Bay County's beaches, with the exception of Mexico Beach at the county's east end.

Pinnacle Port and Carillon Beach (R1-R5)

The approximately one-mile segment of shoreline immediately adjacent to the Walton County line (R1-R5) sustained major beach and dune erosion (condition IV). In 2004, the beach sustained moderate erosion from Hurricane Ivan's impact that left it vulnerable to the impact of Hurricane Dennis (Photo 31).

Photo 31. Major beach and dune erosion, Carillon Beach (R2.5).

Panama City Beaches Restoration Project (R5-R93)

In April 1999, a large-scale beach and dune restoration project was completed from the Walton/Bay County line (R1) east to St. Andrews State Park fishing pier (R93). Erosion of the restored beach and dune system by Hurricane Dennis was significant. With the

prior impact of Hurricane Ivan (2004), the added impact of Dennis left the beach and dune system in a severely eroded condition along much of this segment of coast (Figure 29). In response to the erosion caused by Ivan, an interim beach nourishment project began in April 2005 (and was subsequently completed in March 2006) to partially restore the project. Prior to the impact of Dennis, approximately 4.6 miles of beach in western Bay County (R5 to R30) had been replenished with sand from offshore borrow areas. Much of this material was removed from the beach during Dennis. This severely eroded condition of the beach extended eastward to approximately R37 (Photo 32).

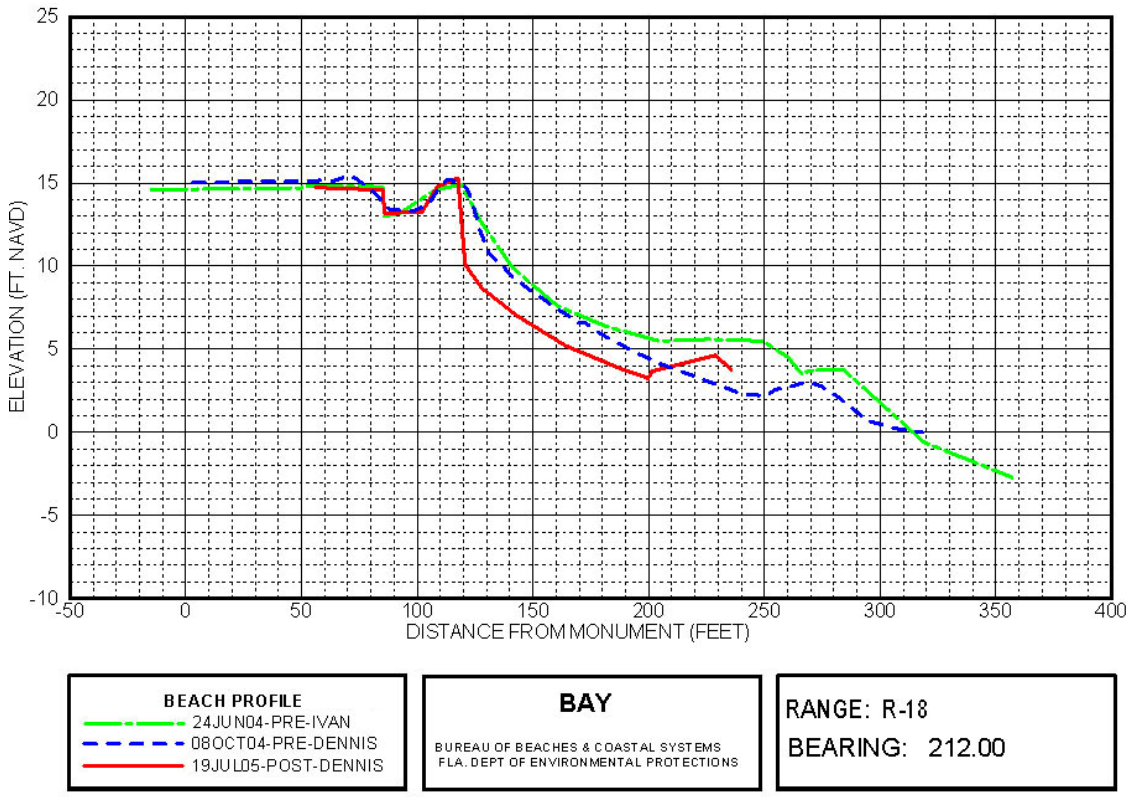

Figure 29. Comparative erosion profiles, Panama City Beach.

Photo 32. Severe dune erosion (R13).

The central segment of the Panama City Beaches Restoration Project (R37 to R77) experienced moderate beach erosion. Although the beach width became narrower, the post-storm elevation of the berm did not appear to be significantly lower than the construction elevation, and still provided a measure of storm protection to the upland development against high-frequency storm events.

The eastern segment of the Panama City Beaches Restoration Project (R77-R93) also experienced moderate beach erosion in terms of beach profile lowering during Dennis. The post-storm elevation of the berm became significantly lower than the 1999 constructed elevation, which is partially attributable to the cumulative impacts of Ivan and Dennis. Interim beach nourishment was under construction in early July 2005 to partially restore the project. Prior to the impact of Dennis, nearly one mile of beach (R87-R92) had been replenished with sand from offshore borrow areas, which included Spyglass Drive. Had this area not been nourished it is likely that structural damage to dwellings and Spyglass Drive itself would have occurred. Photos 33 through 35 show the progression of beach conditions adjacent Spyglass Drive from before the nourishment project to after the nourishment project and after Dennis.

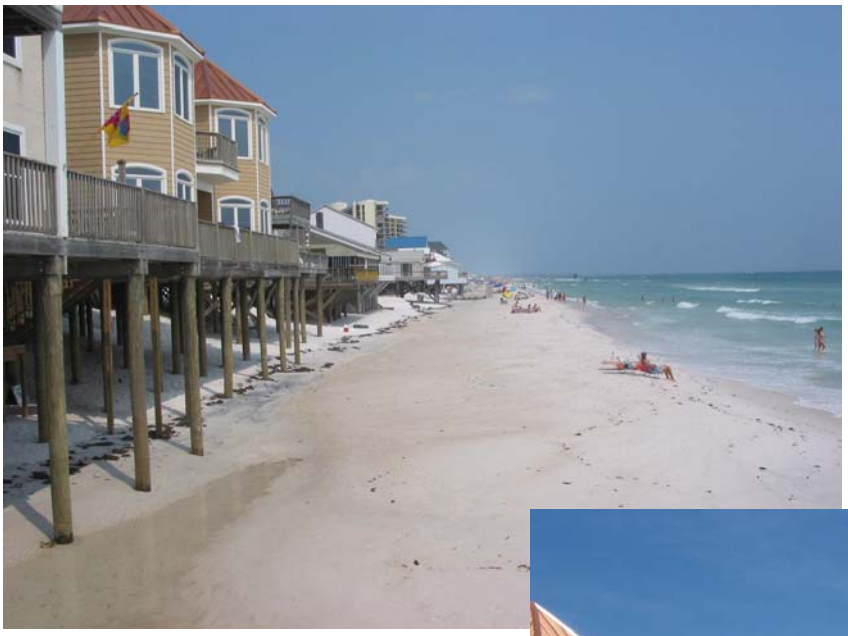

Photo 33. Before nourishment (R89).

Photo 34. After nourishment (R89).

Photo 35. After Dennis (R89).

Photos Courtesy of Bay County Tourist Development Council

St. Andrews State Park (R91-R97)

The state park sustained minor beach and dune erosion (condition II) from Hurricane Dennis. A major navigation channel deepening project had just been completed in 2003 that included the placement of material from the entrance channel of St. Andrews Inlet onto the beach and nearshore along the state park. Nearshore depths along the park were significantly reduced, providing substantial additional protection to the park's beaches and dunes.

There was significant flooding at the park in the vicinity of the west jetty where an overwash and high tide breach occurred. The overwash west of the west jetty caused significant shoaling in the "Kiddy Pool," the inlet's interior embayment between the west shoreline and the jetty. A protective sand berm along this western St. Andrews Inlet shoreline prevented erosion of upland park property and adverse impact to Gator Lake.

Shell Island (R98-V9)

To the east of St. Andrews Inlet, the barrier island coast of Shell Island sustained major beach and dune erosion (condition IV) from Dennis. Most of Shell Island is critically eroded for 6.1 miles (R98-V9). Shell Island is predominately public land with most of the western 4.3 miles of the island being part of the St. Andrews State Park and most of the remaining 1.8 miles being part of Tyndal Air Force Base. A number of private properties exist on the island and two dwellings exist seaward of the Bay County Coastal Construction Control Line at R112 and R115.65. Shell Island was significantly impacted by the storm tides of Ivan (2004), and Dennis exacerbated the beach and dune erosion conditions with additional overwash processes. Numerous overwash fans (the deposition of sediment transported across the barrier island into St. Andrews Bay) were created by both Hurricanes Ivan and Dennis. Ivan did not cause any breaches in Shell Island but Dennis caused a new breach at R115. Normal flood tides were flowing through this small breach a few days after the storm, but the breach was rapidly closing.

After the historic east entrance to St. Andrews Bay closed in 1998 resulting in a connection between Shell Island and Crooked Island, a reopening project was planned and a new artificial cut was completed in December, 2001. The new cut remained open for two years before closing in late 2003. Ivan reopened this inlet to tidal flow in September, 2004. Considerable shoaling has subsequently taken place, but the storm tides of Dennis appeared to have once again flushed out shoaled sediment helping to maintain tidal flow. By November, the inlet was again closed.

Crooked Island

The beaches of Crooked Island are perhaps the most dynamic, yet least studied, in northwest Florida. With the exception of the easternmost 5,750 feet, no survey monumentation exists along the Crooked Island barrier complex, and all the land is part of Tyndal Air Force Base. The Crooked Island barrier complex extends roughly 11.5 miles between the new cut separating Shell Island to the west and Mexico Beach Inlet to the east, including about three quarters of a mile of the shallow water breach at Eloise Inlet. The west half of the western segment of Crooked Island (west of Eloise Inlet) has been accreting from westward sediment transport (V9-V16) toward Shell Island. The

east half of the western segment of Crooked Island has been severely eroding to the point where a one-mile stretch of the island between V20 and V25 is completely disintegrating. A large cuspate foreland (probable shoaled remnant of a former coastal inlet) between V25 and V29 may soon become a separate and distinct island with Eloise Inlet to its east. The 2.8-mile stretch between V16 and V30 is designated noncritically eroded in recognition of its severe erosion that is currently not a threat to any specific interests.

Both Hurricanes Ivan and Dennis have caused a significant impact on this coastal barrier complex. The western segment of the Crooked Island complex sustained major beach and dune erosion (condition IV) from Dennis. Ivan caused seven breaches to the Crooked Island complex. Six of the breaches were to the western segment. One of these breaches at V15 remains a flowing inlet after Dennis, but significant shoaling has taken place. The other five breaches due to Ivan were located east of V20 and had closed prior to the impact of Dennis. Dennis caused more overwash and retreat to the gulf shoreline, but no more breaches.

The eastern segment of the Crooked Island complex sustained major to moderate beach and dune erosion (condition IV-III) due to Dennis, with the erosion lessening toward the east. The 1.2-mile stretch between V36 and V41 is designated noncritically eroded in recognition of its severe erosion that is currently not a threat to any specific interests. Ivan caused one breach located close to and east of Eloise Inlet, but the breach closed prior to Dennis' impact. Dennis caused no new breaches to the eastern segment of the Crooked Island complex.

Mexico Beach and Inlet

Mexico Beach Inlet (R127.7) at the west end of the Town of Mexico Beach was about 105 miles east of the eye of Dennis at landfall. Winds possibly reached tropical storm strength in this community; however, very little impact was sustained due to the wind. An estimated storm surge of +8 to +9 feet affected this area, which was generally sheltered by St. Joseph Peninsula from the southeast waves and wind of Dennis. A storm surge high water mark of +8.7 ft. NAVD (+9.1 ft. NGVD) was measured along the Mexico Beach shoreline (URS, 2005). Minor beach and dune erosion (condition II) was generally sustained throughout Mexico Beach. The beach remained wide and capable of supporting post-storm recovery dune restoration or revegetation projects. Throughout Mexico Beach no major damage was seen; however, the entrance to Mexico Beach Inlet was completely shoaled and essentially closed, obstructing any navigable access to or from the harbor (Photo 36). The outlet at the east end of Mexico Beach (R137) was likewise inundated with sand.

Photo 36. Entrance shoaling in Mexico Beach Inlet (R127.7).

Hurricane Katrina Storm Effects and Erosion Conditions

The eye of Hurricane Katrina at landfall on the Louisiana-Mississippi state line was on the average 240 miles west of the beaches of Bay County. Generally less than tropical storm force wind gusts affected this area. Throughout Bay County only minor beach erosion (condition I) was sustained.

Hurricane Dennis Storm Damage

Hurricane Dennis spared Bay County the widespread damage seen in counties both to the west and to the east. The existence of the Panama City Beaches Restoration Project prevented extensive damage along the developed western county coast. At the west end of the county, where post-Ivan nourishment of the beach had not taken place, four condominium buildings and one recreational building at Pinnacle Port sustained major damage (R1-R2). One swimming pool was also destroyed at R4. These damages were seaward of the Bay County Coastal Construction Control Line.

Along the western half of the county, first floor apartments of ten multifamily dwelling structures (total of 31 units) were flooded and sustained water damage to drywall and contents. Numerous storm water outlet structures (a free-standing concrete dispersion box attached to the end of an outfall pipe), that are sited on the backshore beach, were toppled and sustained damage (Photo 37).

Photo 37. Outfall system damaged (R11).

The concrete Dan Russell Pier in Panama City Beach (R40.5) lost its T-head end section (100 feet wide and 16 feet long) during Hurricane Ivan (2004). The impact of Hurricane Dennis resulted in the loss of another 50 feet off the seaward end of the pier, major damage to another 250 feet of pier, and moderate to minor damage to an additional 400 feet (Hemphill et al, 2005). The shorter, wooden M.B. Miller Pier (Bay County fishing pier at R57.3) sustained no major damage. The state fishing pier at St. Andrews State Park (R92.8) sustained damage to its seaward cross-bracing. In addition, a geotextile sand-filled tube groin on the west shoreline of St. Andrews Inlet, north of Gator Lake, was destroyed.

Hurricane Katrina Storm Damage

No significant damages attributable to Hurricane Katrina were observed along the coast of Bay County.

Comments on the Protective Benefits of Beach Restoration

The existence of the Panama City Beaches Restoration Project has played an important role in mitigating storm damages. Figure 30 illustrates a comparison of the effects of four major hurricanes that have impacted Panama City Beach over the past 30 years. Hurricane Eloise (1975) was a major hurricane that severely impacted Panama City

Beach, with the eye making landfall to the immediate west in Walton County. Eloise destroyed 275 buildings along the coast (U.S.Army Corps of Engineers, 1976) and was estimated to have eroded 1.3 million cubic yards of sand from above mean sea level (Chiu, 1977). Likewise, Hurricane Opal (1995) severely impacted Panama City Beach as a major hurricane that made landfall further west in Pensacola Beach. Along the beach, Opal destroyed or substantially damaged 471 major structures and was estimated to have eroded 2.9 million cubic yards of sand above mean high water (Leadon, Nguyen, and Clark, 1998).

Following Opal, beach restoration planning was prioritized, and the Panama City Beaches Restoration Project was constructed during 1998-99. The project involved the placement of 9.1 million cubic yards of sand to restore the critically eroded beach and dune system. Subsequently, Hurricanes Ivan and Dennis (both major hurricanes making landfall in Gulf Shores, Alabama, and Santa Rosa Island, respectively) caused storm tide and erosion conditions comparable to those of Opal. Keehn and Armbruster (2005) reported 2.5 million cubic yards of erosion to the restoration project above the -20-foot contour due to Ivan; however, Leadon et al, 2004, only report 12 major structures damaged by Ivan. Post-2005 hurricane season surveys of the Panama City Beaches Restoration Project show erosion losses of 2.96 million cubic yards above the -18-foot contour. Most of this erosion loss is attributed to Dennis and some (possibly as much as 20 percent) may be attributed to Katrina. Notwithstanding the volumetric losses from the project, as previously discussed, Dennis only substantially damaged eight major structures.

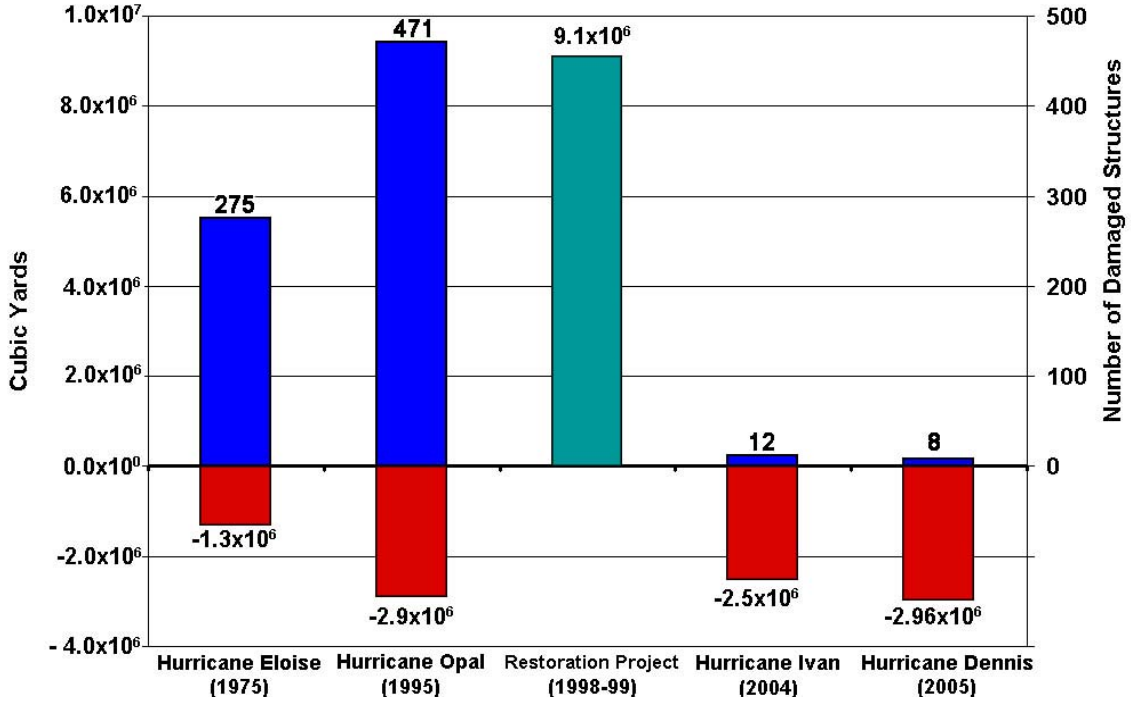

Figure 30 Comparison plot of erosion and major damages, Panama City Beaches.

Ivan and Dennis inflicted only a small fraction of the coastal construction damage that had previously been so severe during Opal and Eloise. Erosion losses from each of these storms, before and after restoration, have been substantial. The significant difference in damage reduction has been the existence of the protective beach restoration project.

Gulf County

Located along the central region of northwest Florida, Gulf County is located between Bay County to the west and Franklin County to the east (Figure 31).

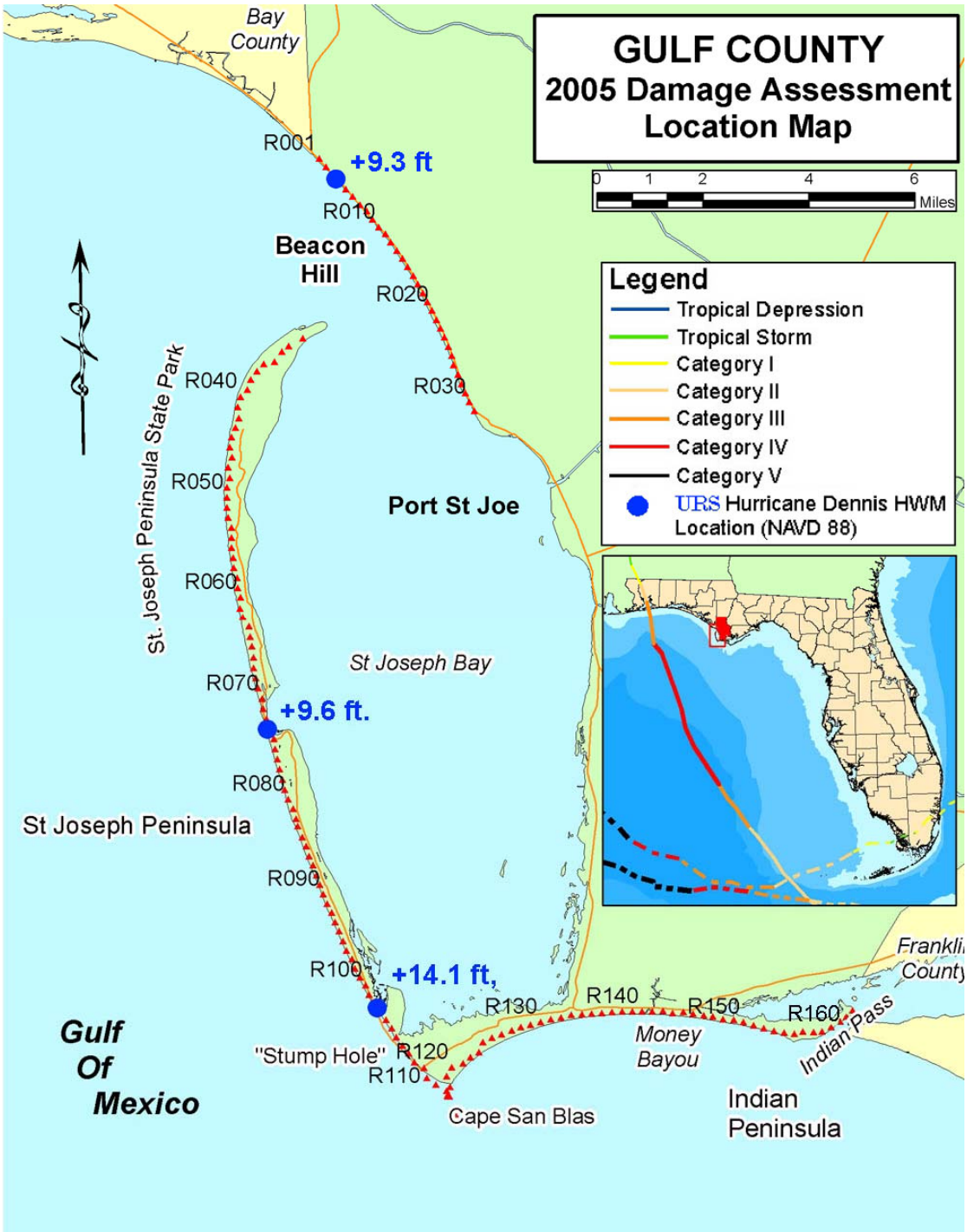

Figure 31. Gulf County location map.

The coast of Gulf County, with 28.8 miles of gulf beaches is comprised of two segments of mainland beaches, two barrier peninsulas, and one cape. From the west county line, there is a mainland beach extending for 5.7 miles to near the Town of Port St. Joe on St. Joseph Bay. Sheltering St. Joseph Bay on a north-south alignment is St. Joseph Peninsula extending 15.2 miles from St. Joseph Point (2,800 feet north of R32) south to Stump Hole (R106). To the south is Cape San Blas, the western portion of an east-west aligned basal peninsula roughly three miles long and connected to the mainland. To the east are approximately three miles of mainland beach to Indian Peninsula, another nearly three-mile long barrier spit.

There are two coastal inlets in Gulf County and one tidal outlet. Between the western mainland beaches and St. Joseph Peninsula is the nearly two-mile wide entrance to St. Joseph Bay. A federal navigation channel exists, passing near the peninsula's north tip at St. Joseph Point that provides access and commerce to Port St. Joe. At the east end of Gulf County, between Indian Peninsula and St. Vincent Island, is the natural tidal inlet, Indian Pass, which connects the Gulf of Mexico with Indian Lagoon and St. Vincent Sound. There is also a tidal outlet, Money Bayou, at R141.

Prior to the 2005 hurricane season, Gulf County had three critically eroded areas (4.2 miles) and five noncritically eroded areas (12.7 miles) (FDEP, 2005). Most of St. Joseph Peninsula is eroded between R41 and R114. The northern half of St. Joseph Peninsula (R41-R81) is noncritically eroded for 7.9 miles and two middle segments (R85.5-R90.1 and R91.3-R95.5) are considered noncritically eroded for 1.7 miles. Two central segments (R81-R85.5 and R90.1-R91.3) of critical erosion on St. Joseph Peninsula extend for 0.9 mile and 0.2 mile respectively and threaten private development and recreational interests. A longer segment (R95.5-R111.5) extends for 3.1 miles and threatens private development as well as County Road C30 at Stump Hole. South of Stump Hole to the threatened and damaged U.S. Air Force facilities on Cape San Blas, the erosion has destroyed nesting sea turtle habitat. The remainder of the west shoreline of the cape south of the U.S. Air Force facilities (R111.5-R114) has sustained severe but noncritical erosion for 0.5 mile. Indian Peninsula (R150-R162) at the east end of the county is also eroded for 2.6 miles with no threatened interests at this time.

Hurricane Dennis Storm Effects and Erosion Conditions

Gulf County was over 100 miles east of the center of the eye of Hurricane Dennis at landfall. The maximum winds along the coast were generally below hurricane strength and storm tides with waves were generally between +8 to +10 feet.

Beacon Hill to Port St. Joe

East of Mexico Beach, the mainland coast of Gulf County sustained very little impact from Dennis. Minor beach and dune erosion (condition II) prevailed in this area and no major damage to buildings was sustained. This area was sheltered from Dennis's southeast waves by St. Joseph Peninsula. URS, 2005, measured a storm tide with waves of +9.3 ft. NAVD (+9.8 ft. NGVD) seaward of U.S. Highway 98 near Beacon Hill. A shoreline segment of U.S. Highway 98 sustained road shoulder and revetment damage

immediately west of Port St. Joe at a location where no protective beach width exists. This area fronting St. Joseph Bay experienced storm tides between +5 and +6 feet.

St. Joseph Peninsula (R32-R105)

Major beach and dune erosion (condition IV) was sustained throughout St. Joseph Peninsula due to Hurricane Dennis. The impact was comparable to past storm erosion impacts from Hurricanes Eloise (1975), Elena (1985), Kate (1985), Opal (1995), Earl (1998) and Ivan (2004). The northward trending longshore transport was substantial during Dennis as is evidenced by the large accretional bar at St. Joseph Point (Photo 38).

At the St. Joseph Peninsula State Park, major beach and dune erosion was sustained from Dennis (Figure 32). A dune breach was sustained near R69 and the storm surge flooding and overwash destroyed between 30 and 40 of the park's camp sites, rendering this area in critical need of a dune breach closure project (Photo 39). A storm tide with waves of +9.6 feet NAVD (+10.1 ft. NGVD) was measured at R73 within the state park (URS, 2005).

Along the developed segment of St. Joseph Peninsula between the state park (R75) and Stump Hole (R105), major beach and dune erosion was sustained from Dennis (Figure 33). This erosion has rendered many dwellings vulnerable (Photo 40). The low elevations of the peninsula between R103 and R105 sustained substantial flooding and overwash of beach sediments.

Photo 38. Storm-built accretional bar, St. Joseph Point.

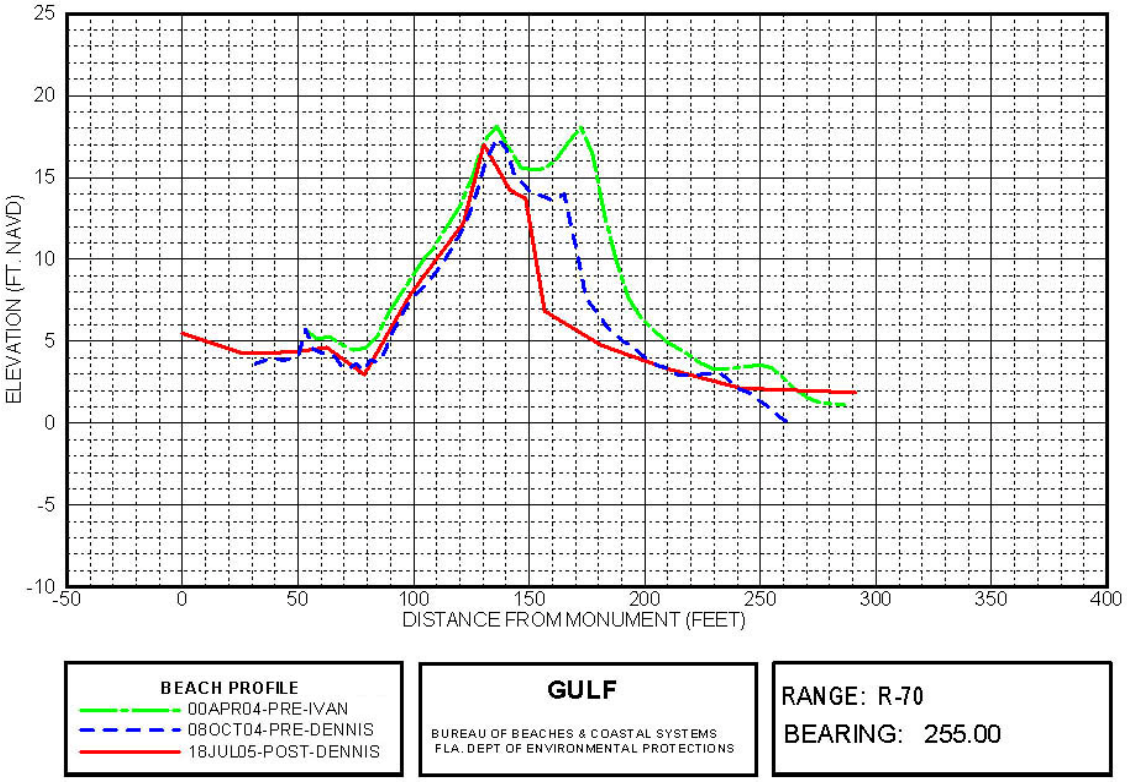

Figure 32. Comparative erosion profiles, St. Joseph Peninsula State Park.

Photo 39. Dune breach at St. Joseph Peninsula State Park (R69).

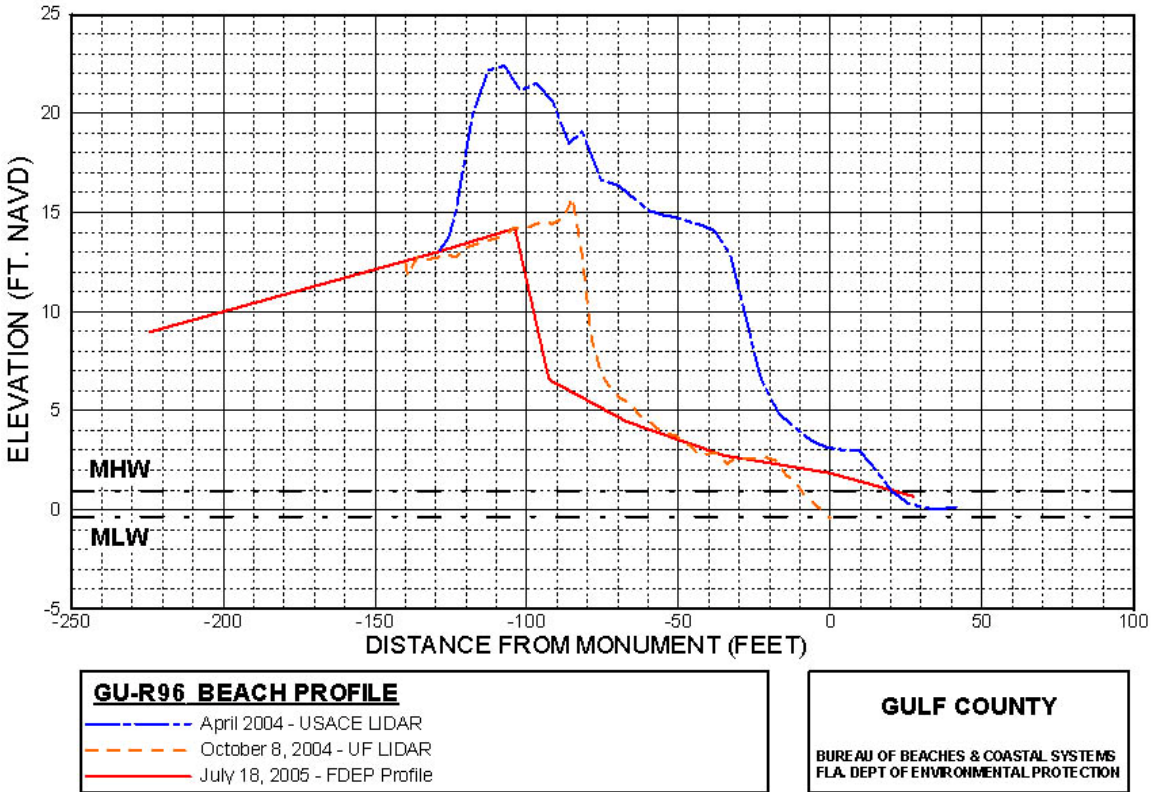

Figure 33. Comparative erosion profiles, St. Joseph Peninsula.

Photo 40. Imminently threatened structure, St. Joseph Peninsula (R91).

Stump Hole and Cape San Blas

At Stump Hole, between Cape San Blas and St. Joseph Peninsula, storm tide flooding occurred during both Tropical Storm Arlene (June 11, 2005) and Hurricane Dennis. Waves from both storms battered the existing road revetment causing rock displacement and damage. Storm tides from both storms flooded County Road C30 and additional road damage was caused by Dennis. A storm tide with waves of +14.1 ft. NAVD (+14.6 ft. NGVD) was measured near R102 (URS, 2005).

Cape San Blas erodes at about 40 feet per year. With every passing storm, severe erosion is experienced. On June 11, 2005, Tropical Storm Arlene inflicted another approximately 25 feet of bluff recession at the Cape San Blas Lighthouse (R111.5). During Hurricane Dennis, another 100 feet or greater of erosion was sustained (Photo 41). This area is the most severely eroding area in Florida.

Photo 41. Severe beach erosion at the Cape San Blas Lighthouse (R111.5). (Structure depicted in photo has been removed.)

Cape San Blas to Indian Pass

As the south tip of Cape San Blas continues to disappear with each major gulf storm, peat deposits are exposed within the foreshore of the beach. A breach to the eastern of two lagoonal depressions is located at the cape's tip near R119. Between Cape San Blas and Indian Pass (R119-R159), moderate beach and dune erosion (condition III) was sustained. Significant flooding also intruded several hundred feet inland (Photo 42). A storm tide between +8.4 and +8.6 ft. NAVD (+8.9 and +9.1 ft. NGVD) was measured along Indian Peninsula (URS, 2005). On the mainland beach near R141, Money Bayou

is open and conveying tidal flow as a tidal inlet. Between R159 and R162 at Indian Pass, major beach and dune erosion (condition IV) was sustained (Photo 43).

Photo 42. Significant flooding near Money Bayou (R141.5).

Photo 43. Dune erosion at Indian Pass (R160.4).

Hurricane Katrina Storm Effects and Erosion Conditions

Generally, St. Joseph Peninsula and Cape San Blas only sustained minor additional erosion due to Hurricane Katrina. However, localized additional major dune erosion between 10 and 20 feet was sustained adjacent the north and south ends of the ProTecTube™ at White Sands Subdivision (R83.6) rendering Dunes Drive in imminent danger of collapse due to undermining (Photo 44).

Photo 44. Dune erosion threatening Dunes Drive, St. Joseph Peninsula (R83.6).

Hurricane Dennis Storm Damage

Along the developed segment of St. Joseph Peninsula between the state park (R75) and Stump Hole (R105), nine major structures sustained major damage from Dennis. All major damage was to the foundation piles due to erosion and wave loads. Approximately 24 major structures sustained understructure damage. All structures were sited seaward of the established Gulf County Coastal Construction Control Line.

Seaward of Secluded Dunes Drive, three pile-supported single-family dwellings sustained foundation damage near R75 (Photo 45). At least five dwellings here also sustained understructure damage.

Photo 45. Foundation damage to dwelling, St. Joseph Peninsula (R75.2).

To the south, in the vicinity of R83, the White Sands Subdivision continued its recent storm history of severe erosion impact. Eight single-family dwellings sustained understructure damage from Dennis. In 2004, Ivan inflicted foundation damage to one of these dwellings and understructure damage to three others. A 300-foot ProTecTube ™ structure at this site was not significantly damaged by either Hurricane Ivan or Dennis. This area had previously been severely impacted by Opal (1995), which destroyed four dwellings.

Further south between R90.4 and R90.7, four pile-supported condominium buildings (17 units) on Nassau Lane sustained foundation damage (Photo 46). The threat to these buildings has increased with each major storm since Opal, when only one of them sustained foundation damage.

Near R96, two dwellings sustained foundation damage from Dennis. A pile-supported single-family dwelling at the end of Seahorse Drive and another at the end of Aruba Drive had piles damaged by the erosion and waves of Dennis. Five dwellings in this area sustained understructure damage. Further south near R100, another pile-supported single-family dwelling sustained damage to its foundation. Three dwellings between R99 and R102 sustained understructure damage. The only other major damage was to approximately 500 feet of the rock revetment fronting County Road C30 at Stump Hole (R105).

Photo 46. Undermined building with piles suspended, St. Joseph Peninsula (R90.8).

Hurricane Katrina Storm Damage

No significant damages were observed along the Gulf County coast attributable to Hurricane Katrina; however, the rock revetment fronting County Road C30 at Stump Hole continued to sustain minor wave damage and the road was overtopped by flood waters again.

Franklin County

Located along the eastern region of northwest Florida, Franklin County is located between Gulf County to the west and Wakulla County to the east (Figure 34). There are four barrier islands and a barrier spit in Franklin County, which has 54.6 miles of beaches on the Gulf of Mexico.

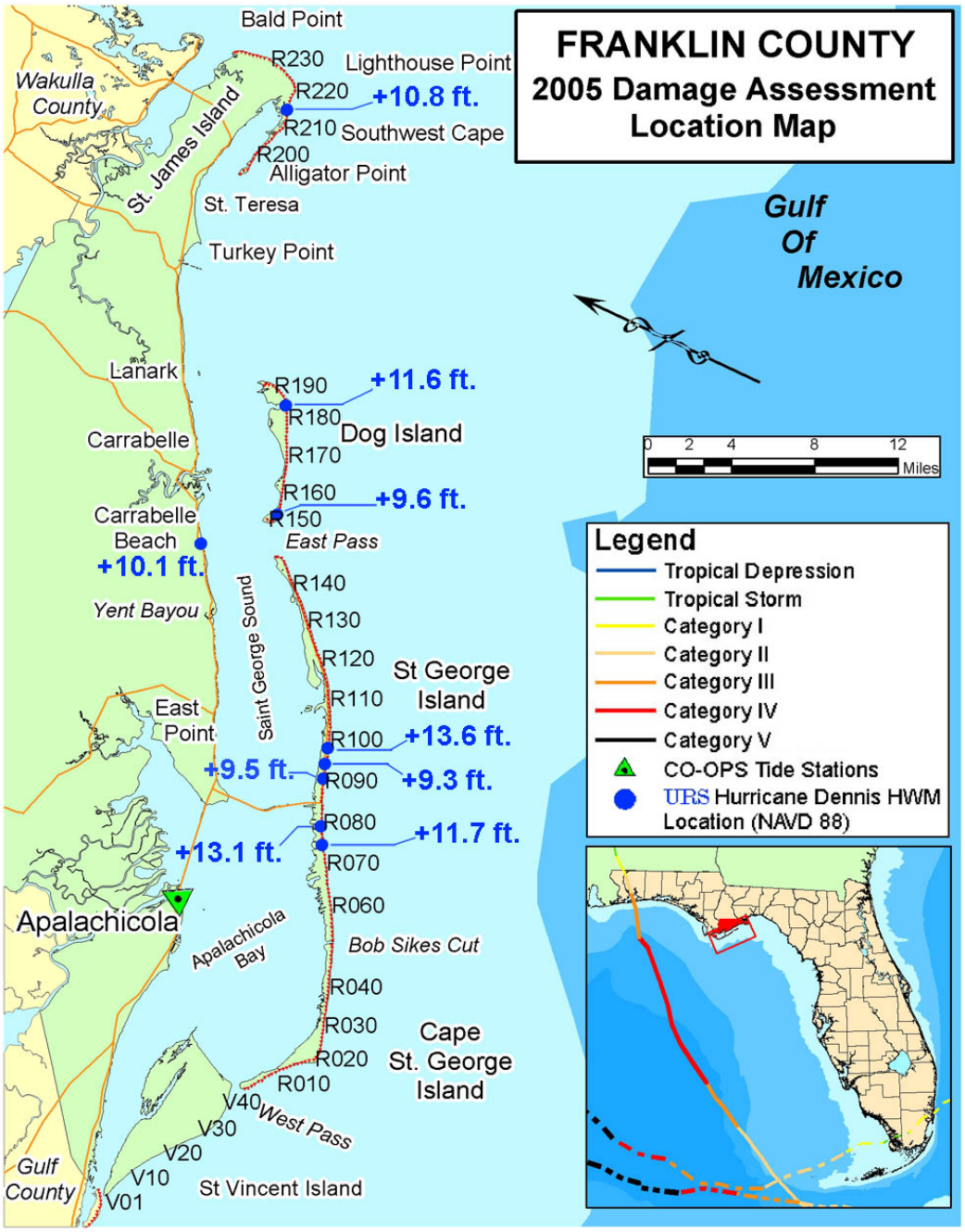

Figure 34. Franklin County location map.

From west to east are St. Vincent Island, Cape St. George Island, St. George Island, Dog Island, and Alligator Point. St. Vincent Island fronts St. Vincent Sound and is a national wildlife refuge. To the east and separated from St. Vincent Island by West Pass, is Cape St. George Island (also called Little St. George Island) fronting Apalachicola Bay. This true barrier island is a state preserve and includes Cape St. George. Historically, Little St. George Island was separated from St. George Island, to the east, by a natural tidal inlet located near R38, which closed in the 1920's. Sikes Cut, a stabilized federal inlet that was dredged in 1954, is located 2.5 miles to the east between R51 and R52. St. George Island extends east from Sikes Cut to East Pass. To the northeast of East Pass is Dog Island, the easternmost true barrier island in northwest Florida. The western half of St. George Island fronts Apalachicola Bay. The eastern half of St.George Island and Dog Island front St. George Sound. A relatively limited segment of beach (Carrabelle Beach) extends along the mainland shoreline west of the town of Carrabelle, which is exposed to the direct gulf wave energy propagating through East Pass between St. George Island and Dog Island.

There are about 10 miles of open water between Dog Island and Alligator Point in eastern Franklin County. This mainland coast supports an eroding narrow beach that is sheltered by small sand bars, sand waves, and a prominent offshore shoal, Dog Island Reef, which is over five miles long fronting St. George Sound. The eastern coast of Franklin County is a mainland peninsula, St. James Island, which is separated from Wakulla County to the north by Ochlockonee Bay. The east end of the peninsula is aligned north to south between Bald Point and Lighthouse Point. From Lighthouse Point, a barrier spit extends westward to Alligator Point. This recent (Holocene) barrier is known as Alligator Peninsula and includes the Southwest Cape. Alligator Peninsula, alternatively called Alligator Point, shelters Alligator Harbor.

Prior to the 2005 hurricane season, Franklin County had six critically eroded beach areas (4.5 miles), 11 noncritically eroded beach areas (24.6 miles), and one noncritically eroded inlet shoreline area (0.5 mile) (FDEP, 2005). St. Vincent Island has a 3.2-mile long noncritically eroded area along its most gulfward protruding midsection (V17-V34). Severe erosion exists at Cape St. George, where a historic lighthouse built in 1853 has been threatened. Also, sea turtle nesting habitat to the west of the lighthouse has been lost as the shoreline has eroded into the maritime forest and the beach has virtually disappeared. This critically eroded area (R19-R23) extends along a 0.7-mile length of shoreline and is adjoined at both ends by a 0.8-mile noncritically eroded segment to the west (R15-R19) and a 0.2-mile noncritically eroded segment to the east (R23-R24).

The west end of the historical length of St. George Island west of Sikes Cut (R34-R51) is noncritically eroded for 3.3 miles. Both interior shorelines of Sikes Cut also have noncritical erosion for 0.5 mile. East of Sikes Cut, the St. George Island Plantation (R53-R69) also is noncritically eroded for 3.3 miles. Some inlet sand transfer of Sikes Cut dredge material has taken place west of the inlet and some material has been placed along the inlet shorelines. Much of St. George Island State Park (R110-R117, R118-R127.5, and R128.5-R147) is considered noncritically eroded for 1.4, 1.9, and 3.8 miles respectively, where the erosion before Dennis was not a threat to recreational interests or park infrastructure. However, two areas are designated critically eroded (R117-R118 and

R127.5-R128.5) where the recreation facilities at the two high-use public access areas have been considered threatened.

Most of Dog Island is eroded, including the western two-thirds (R154-R179) which has 4.7 miles of noncritical erosion. A 1.3-mile segment (R179-R186) at the eastern end of Dog Island is critically eroded where private development has been destroyed and continues to be threatened. The historic west end of Alligator Point (R194-R196) is severely eroded for 0.4-mile; however, this erosion into Phipps Preserve is not considered a threat. The east end of Alligator Point (R210-R216) between the Southwest Cape and Lighthouse Point is critically eroded for 1.1 miles. Erosion at the Southwest Cape has destroyed, and continues to threaten private development and a Franklin County road. The southeast end of St. Teresa Island is critically eroded extending north from Lighthouse Point (R220-R225) for 1.0 mile, threatening development and damaging the Franklin County road. A portion of the road was abandoned and relocated inland. Further north from Lighthouse Point (R225-R232) a noncritically eroded area extends for 1.6 miles.

Hurricane Dennis Storm Effects and Erosion Conditions

Franklin County was over 150 miles east of the center of the eye of Hurricane Dennis at landfall. The maximum winds along the coast were generally below hurricane strength, yet storm tides were generally between +8 to +10 feet, with higher elevations observed along the beaches. A storm tide of at least +8 feet was observed throughout Apalachicola Bay.

St. Vincent Island

St. Vincent Island extends for about 7.5 miles between Indian Pass and West Pass. Major beach and dune erosion (condition IV) was sustained throughout St. Vincent Island due to Dennis. The impact was comparable to past storm erosion impacts from Hurricanes Agnes (1972), Eloise (1975), Elena (1985), Kate (1985), Opal (1995), and Earl (1998). Storm tide overwash was sustained throughout the length of the island. Two storm water outlets were flowing: the Flag Island Lake outlet (V26) and the Oyster Pond outlet (V30). An eastern segment of the island is now severely eroded between V34 and V39, threatening turtle nesting habitat near Sambur Slough (Photo 47). The beach in this area has been substantially lost as the shoreline has eroded into the maritime forest.

Photo 47. Severe erosion, St. Vincent Island (V37).

Cape St. George Island

East of West Pass, Cape St. George Island (also called Little St. George Island) sustained minor to moderate beach and dune erosion (condition II to III) between R1 and R18. The West Pass shoals may have moderated the wave energy into this area, with the erosion effects increasing southeastward towards the cape. At the critically eroded Cape St. George, the historic lighthouse remained sited in the nearshore after Dennis; however, with the increased scour from Dennis and subsequent storms, the lighthouse finally toppled into the Gulf of Mexico on October 21, 2005 (Photo 48). Efforts are underway to remove the remnants of the destroyed lighthouse from the nearshore zone.

East of Cape St. George to Sikes Cut (R23-R51), the island sustained major beach and dune erosion (condition IV). High dunes between R25 and R28 revealed large erosion scarps. Washover fans between R29 and R33 generally extended inland of the Franklin County Coastal Construction Control Line, or roughly 400 feet landward of the beach. Washover fans between R35 and R44 generally extended completely across the island from gulf to bay. Along the historic western end of St. George Island between R45 and R51, washover fans generally extended inland to the Coastal Construction Control Line or roughly 250 feet landward of the beach.

Photo 48. Cape St. George Lighthouse (R22.3).

Bob Sikes Cut

Known by the federal government as St. George Island Channel, and officially named by the Florida Legislature for former Congressman Robert Sikes, this federally owned and maintained inlet was severely impacted by Hurricane Dennis. Both the west and east jetties were breached from their connecting islands by the storm tide of Dennis (Photo 49). These same breaches occurred during Hurricanes Elena and Kate in 1985 (Clark, 1986a; Clark, 1986b). Dennis' storm tide with wave action transported substantial quantities of beach sediments that were eroded off adjacent beaches into the inlet, causing significant shoreline accretion of the designated noncritically eroded inlet shorelines. In addition, a northern segment of the east jetty sustained major damage and settlement, and the inlet channel experienced substantial shoaling.

Photo 49. Detached jetties at Bob Sikes Cut (R51.5).

St. George Island

The developed 10 miles of St. George Island lies between 163 and 173 miles east of the point of landfall of the eye of Hurricane Dennis. Major beach and dune erosion (condition IV) was sustained throughout St. George Island due to Hurricane Dennis. The impact was comparable to past storm erosion impacts from Hurricanes Agnes (1972), Elena (1985), Kate (1985), Opal (1995), and Earl (1998). Along the St.George Island Plantation (R52-R73), the dune line retreated 25 to 75 feet. Four to eight-foot dune erosion scarps were seen between R66.4-R69.3 and R71.5-R72. A storm tide wrack line of +11.7 ft. NAVD (+12.3 ft. NGVD) was measured near R71, approximately 300 feet from the shoreline (URS, 2005). At a more inland location, a storm tide of +7.7 ft. NAVD (+8.2 ft. NGVD) was measured at R63, approximately 500 feet from the shoreline, or about 200 feet landward of the Coastal Construction Control Line (URS, 2005).

Within the older developed area of the island fronting West Gorrie and East Gorrie Drive (R74-R94), the dune line retreated 15 to 45 feet. Along West Gorrie Drive, high water marks varied between +12 and +13 feet with the highest at +13.1 ft. NAVD (+13.6 ft. NGVD) measured near R79, located on the beach about 200 feet from the shoreline (URS, 2005). East of the St. George Island causeway, measured high water marks varied by an even greater range. Storm tide elevations were measured along the beach of +9.5 ft. NAVD (+10 ft. NGVD) at R91, and +9.3 ft. NAVD (+9.9 ft. NGVD) at R94.3, located

approximately 300 feet from the shoreline (URS, 2005). At a more landward location (roughly within the fifth tier of construction inland of the beach) a storm tide was measured to be +8.4 ft. NAVD (+9 ft. NGVD) near R90, approximately 1,000 feet landward of the shoreline, and 500 feet landward of the Coastal Construction Control Line. At R98 approximately 250 feet landward of the shoreline, a much higher storm tide was measured to be +13.6 ft. NAVD (+14.2 ft. NGVD) (URS, 2005).

Major washover fans deposited sand over East Gorrie Drive at R87.4-R87.7 and R89-R91, and the road was damaged between R89.2 and R90.5. Between R87 and R98, the storm tide inundated the island's lagoonal swale leaving over 140 single-family dwellings stranded in contaminated flood waters for over a week after the storm. These dwellings were both seaward and landward of the Coastal Construction Control Line. At R95.2, a lagoonal outlet channel was formed, discharging flood waters after the passage of Hurricane Dennis. At the east end of the island's private development (R104-R105), the storm tide deposited a washover fan roughly 450 feet inland to East Gulf Beach Drive (County Road 300).

St. George Island State Park (R105-R149) lies between 173 and 182 miles east of the point of landfall of the eye of Hurricane Dennis. Storm tides of eight to 12 feet were observed in this area, and major beach and dune erosion (condition IV) was sustained throughout the park. Between Sugar Hill (R128) and the park entrance (R105), all the dunes seaward of the park road were leveled. Most of the beach access walkways were destroyed, and all beach access parking areas and the park road were covered with sand. The large parking lots at the East Slough and Sugar Hill beach access areas were likewise covered with sand (Photos 50 and 51). The eastern four miles of park beyond the Sugar Hill day use area were completely inundated by the storm tide, and severe leveling of the dune system occurred throughout.

Photo 50. Sugar Hill public access, St. George Island State Park, May 2005 (R128).

Photo 51. Sugar Hill public access after Dennis, St. George Island State Park (R128).

Carrabelle Beach

Carrabelle Beach is a natural sandy beach along the mainland shoreline fronting on East Pass between St. George Island and Dog Island. Exposed to the storm waves that propagate from the Gulf of Mexico through East Pass, Carrabelle Beach is affected by all the major gulf storms that impact Franklin County. Due in part to the sheltering effect of Dog Island from Dennis' southeast wave attack, Carrabelle Beach only sustained minor beach and dune erosion (condition II). A storm tide wrack line of +10.1 ft. NAVD (+10.7 ft. NGVD) was measured in Carrabelle Beach (URS, 2005).

Dog Island

Dog Island lies between 184 and 190 miles east of the point of landfall of the eye of Hurricane Dennis. On Dog Island, winds were below hurricane strength and likely in the 40 to 65 mph range. Storm tides of +8 to +10 feet were observed in this area and major beach and dune erosion (condition IV) was sustained throughout the island (Clark, 2005b). Overwash with inland flooding was extensive where the dunes had breached or no longer existed. A storm tide wrack line of +9.6 ft. NAVD (+10.2 ft. NGVD) was measured near R154 on western Dog Island, approximately 300 feet from the shoreline, and another storm tide wrack line of +11.6 ft. NAVD (+12.2 ft. NGVD) was measured near R183 on eastern Dog Island, approximately 200 feet from the shoreline (URS, 2005).

The western Narrows (R156-R160) and eastern Narrows (R163-R168) were inundated by the storm tide and all dunes in these areas were leveled with significant overwash into St. George Sound. The loss of material into the sound at the eastern narrows specifically effectuates a major loss of beach from the reach between R165 and R175. Coupled with westward longshore transport conditions, the storm surge conveyed large quantities of sediment across the island and deposited the material into the sound. The exposed tree stumps in the foreshore slope of the beach, found along the narrows and the connecting island land mass known as Cannonball Acres, reveals the long-term erosion process, northward island migration, and rollover growth of the sound shoreline (Photo 52).

Photo 52. Exposed tree stumps, Dog Island (R165).

St. James Island

The mainland stretch of coast along St. James Island, including Lanark, Turkey Point and St. Teresa Beach, sustained minor to moderate beach and dune erosion (condition II-III). This stretch of coast is exposed to gulf storm tides and waves between Dog Island and Alligator Point. Generally, +8 to +10-foot storm tides were observed in this area.

Alligator Point to Bald Point

The Alligator Point to Bald Point portion of Franklin County (R194-R239) sustained major beach and dune erosion (condition IV) from the impact of Hurricane Dennis. The erosion and damage was comparable to the impacts of Hurricanes Elena and Kate (1985), but substantially less than Hurricane Agnes (1972). Although directly impacted by Tropical Storm Bonnie (2004), little significant erosion was sustained by Bonnie, Hurricane Ivan (2004), or Tropical Storm Arlene (June, 2005). Even though, Dennis made landfall over 200 miles to the west, as did Ivan and Arlene, the path of Dennis (generally from southeast to northwest) and its large outer rain band resulted in a higher storm surge and waves that greatly exceeded those of Ivan or Arlene on this shoreline. East of the Southwest Cape, URS, 2005, measured a storm tide of +10.8 ft. NAVD (+11.5 ft. NGVD) in a beach dwelling at R214.8. Figure 35 shows the major erosion sustained at R210 on the Southwest Cape (on Alligator Peninsula). Figure 36 shows major erosion roughly midway between the Southwest Cape and Lighthouse Point.

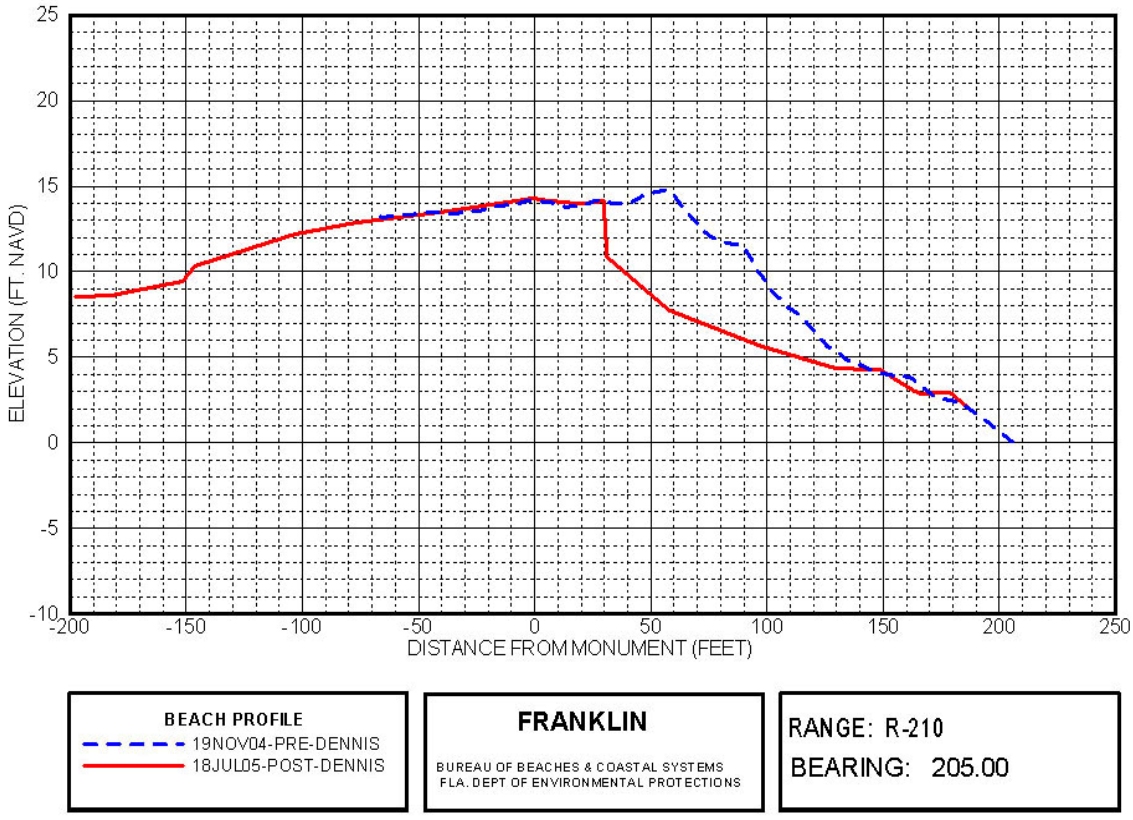

Figure 35. Comparative erosion profiles, Southwest Cape.

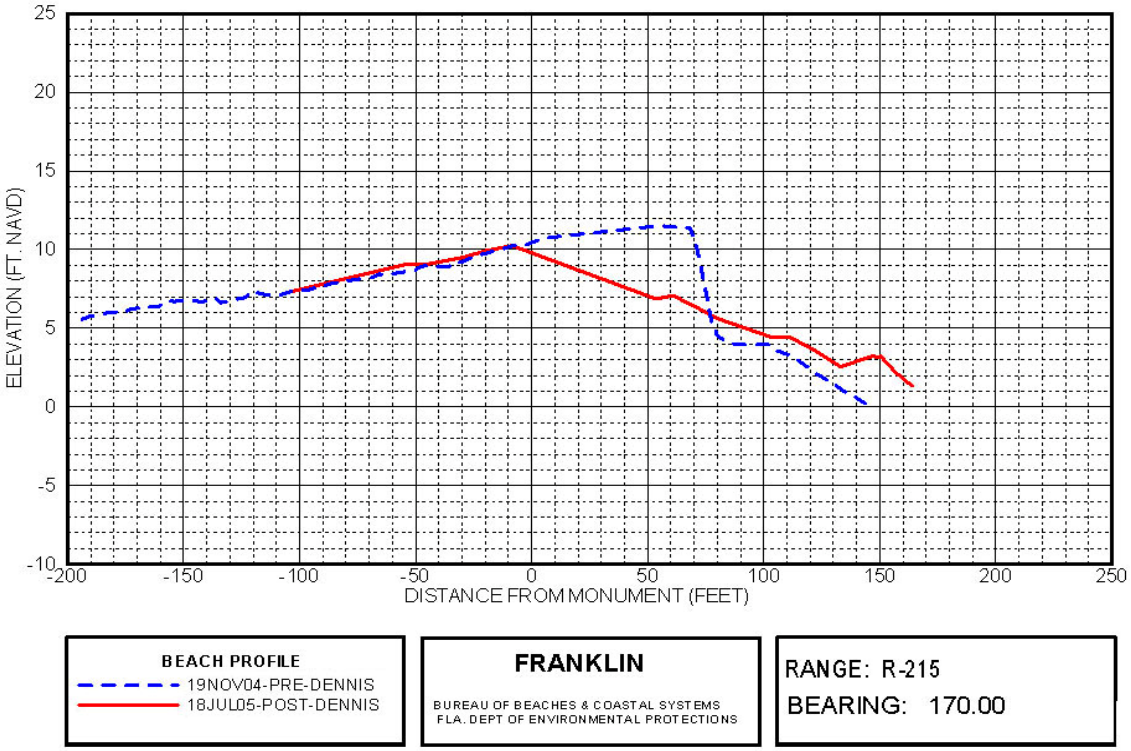

Figure 36. Comparative erosion profiles, between Southwest Cape and Lighthouse Point.

Hurricane Dennis Storm Damage

St. George Island

Along the developed areas of St. George Island, numerous beach access walkways were destroyed or damaged. Along the St. George Island Plantation (R52-R73), one swimming pool was destroyed and four single-family dwellings sustained understructure damage. Fences, decks, and gazebos were also damaged. In addition, a 100-foot rock revetment was substantially damaged at R72.5.

Along West Gorrie Drive (R74-R84), nine major habitable structures sustained major flooding damage. Three single-family dwellings (R80.3-R80.6) sustained major damage to their soil bearing foundations (Photo 53), two other single-family dwellings sustained major flood damage, and four multifamily dwellings were flooded and sanded, including the two buildings of the Buccaneer Inn which sustained flood damage to a number of first floor rooms. Six other single-family dwellings sustained minor wind damage to roofing in the vicinity of R77 and R78. Two additional dwellings are imminently threatened by erosion undermining their soil bearing foundations.

Along East Gorrie Drive (R84-R94), five major habitable structures sustained major flooding damage. One single-family dwelling (R91.9) sustained major damage to its soil bearing foundation, and four other single-family dwellings sustained major flood damage, including one that sustained major side wall damage. Roughly 1,200 feet of East Gorrie

Drive, between East 7th Street and East 8th Street, was damaged. This segment, along with each street between East 7th and 11th Streets, were all flooded for about a week after the storm. To the east, seaward of East Gulf Beach Drive and the Franklin County Coastal Construction Control Line, one single-family dwelling sustained understructure damage and two large gazebos were destroyed. Beach access walkways were destroyed throughout the area.

Photo 53. Foundation damage to dwelling, St. George Island (R80.3).

St. George Island State Park

At the St. George Island State Park (R105-R149), five major structures sustained major damage. At the park entrance (R105.7), the park office building was destroyed by the storm surge. A high water mark of +7.3 ft. NAVD (+7.9 ft. NGVD) was measured by Bureau surveyors at the park shop building located over 1,000 feet landward of the gulf shoreline indicating the storm surge was significant well inland within the park.

Nearly all the park road sustained some level of damage. Most of the boardwalks and decks were damaged or destroyed at the two day use areas at East Slough and Sugar Hill. Four public bathhouses at these day use areas sustained major damage attributable to storm surge inundation and wave uplift forces on the structures. All the beach access walkways were destroyed along the park.

Dog Island

Fifteen (15) single-family dwellings sustained major damage on Dog Island, with seven of these being destroyed (Clark, 2005b). All 15 structures were seaward of the established Franklin County Coastal Construction Control Line. In addition, 200 feet of wooden bulkhead were destroyed and another approximately 200 feet were damaged and rendered functionless.

Single-family dwellings were destroyed, structurally damaged, or imminently threatened throughout Dog Island. Dwellings effectively destroyed were located on or adjacent to the beach at the following locations relative to the nearest DEP reference monument. All these structures were seaward of the Coastal Construction Control Line:

1. R163+50 (pile foundation)
2. R167+350 (pile foundation)
3. R169+700 (Photo 54)
4. R171+50 (soil bearing foundation behind wood bulkhead)
5. R173 (wind damage to superstructure; pile foundation okay)
6. R186+450 (dwelling totally destroyed)
7. R186+550 (dwelling totally destroyed)

Dwellings that had significant structural damage, generally to the foundation were located on or adjacent to the beach at the following locations. All these structures were seaward of the Coastal Construction Control Line:

1. R168+150 (pile damage)
2. R168+350 (dwelling damaged)
3. R170+250 (pile damage)
4. R172+550 (dwelling damaged)
5. R173+750 (1st floor damaged)
6. R176+200 (soil bearing foundation undermined; slab damaged) (Photo 55)
7. R180+350 (foundation piles suspended and damaged)
8. R180+550 (foundation piles suspended and damaged; wood bulkhead damaged)

In addition to the dwellings damaged or destroyed, a number of dwellings are now in imminent danger of damage by a high frequency storm (Photos 56 and 57). In general, all structures that extend seaward of the established Coastal Construction Control Line are currently threatened. Approximately 43 single-family dwellings and one motel are currently threatened from another major storm.

Photo 54. Dwelling destroyed, Dog Island (R169.7).

Photo 55. Dwelling undermined and damaged, Dog Island (R176.2).

Photo 56. Imminently endangered dwelling, Dog Island (R172.5).

Photo 57. Imminently endangered pile-supported dwelling, Dog Island (R175).

Alligator Point to Bald Point

Between Alligator Point and Bald Point (R195-R239), 26 major structures sustained major structural damages, including 23 single-family dwellings (16 dwellings were destroyed), one commercial building, and two nonhabitable major structures (garages), all seaward of the established Franklin County Coastal Construction Control Line (Photos 58 and 59). In addition, 17 single-family dwellings sustained major to moderate damage to nonhabitable understructure areas. Also, 975 feet of wood bulkheads and retaining walls and 3,700 feet of rock revetments were destroyed or sustained major damage. A rock revetment and county road C30 seaward of the former KOA campground sustained major damage. A segment of Chip Morrison Drive was also destroyed. While the granite rock base of the revetment settled in place, concrete rubble and Florida limestone boulders were displaced along the crest of the granite revetment and along an eastern extension of the revetment. The storm surge and waves overtopped the revetment and eroded several vertical feet of the upland property, which destroyed both the asphalt surface and sub-grade roadbed for approximately 2,600 feet (Photo 60).

Photo 58. Dwelling destroyed, Southwest Cape (R210.2).

Photo 59. Dwelling destroyed near Bald Point (R132).

Photo 60. Revetment damaged; road and commercial building destroyed, Southwest Cape (R212.4).

St. James Island (St. Teresa, Turkey Point, Lanark)

The highly exposed segment of mainland peninsula coast of St. James Island sustained significant flooding from the storm surge and gulf waves of Dennis. It is noted that this shoreline segment is not within the regulatory jurisdiction of the Bureau of Beaches and Coastal Systems. Between St. Teresa Beach and Turkey Point there were no major structural damages; however, numerous single-family dwellings sustained flooding damage. Between Turkey Point and Lanark, eight single-family dwellings and one commercial building were destroyed, and seven other dwellings sustained major structural damage.

St. George Sound Shoreline along U.S. Highway 98 (Lanark to East Point)

The stretch of mainland coast between the retirement community of Lanark and the seafood processing community of East Point is substantially sheltered by Dog Island and St. George Island. It is noted that this shoreline segment is not within the regulatory jurisdiction of the Bureau of Beaches and Coastal Systems. A segment of coast west of the city of Carrabelle is directly exposed to gulf waves propagating through the two-mile wide East Pass between Dog Island and St. George Island. The mainland shoreline between Lanark and Carrabelle sustained the full storm surge of Dennis along with storm waves crossing St. George Sound. In this coastal segment, seven single-family dwellings and two commercial buildings were destroyed and numerous pile-supported water-front dwellings sustained understructure damage. East of Carrabelle a water-front motel had five buildings destroyed and eight others substantially damaged. Along the east shoreline of Carrabelle fronting on St. George Sound, four single-family dwellings were destroyed along Gulf Avenue.

West of Carrabelle, along the 5.5 miles of mainland beach between Carrabelle Beach and Yent Bayou, nine single-family dwellings and a garage building were destroyed and three other dwellings sustained major damage. In addition, 150 feet of retaining walls were destroyed and two miles of U.S. Highway 98 were destroyed. Further west, between Yent Bayou and East Point, another five miles of U.S. Highway 98 were destroyed, for a total loss of seven miles of highway. In East Point, 22 seafood processing buildings were substantially damaged or destroyed fronting on St. George Sound seaward of U.S. Highway 98. Between the seafood processing buildings and the St. George Island Bridge, seven single-family dwellings were destroyed by the storm tide and waves crossing St. George Sound.

Wakulla County

At the east end of northwest Florida's beaches, Wakulla County is located between Franklin County to the west and Jefferson County to the east (Figure 37).

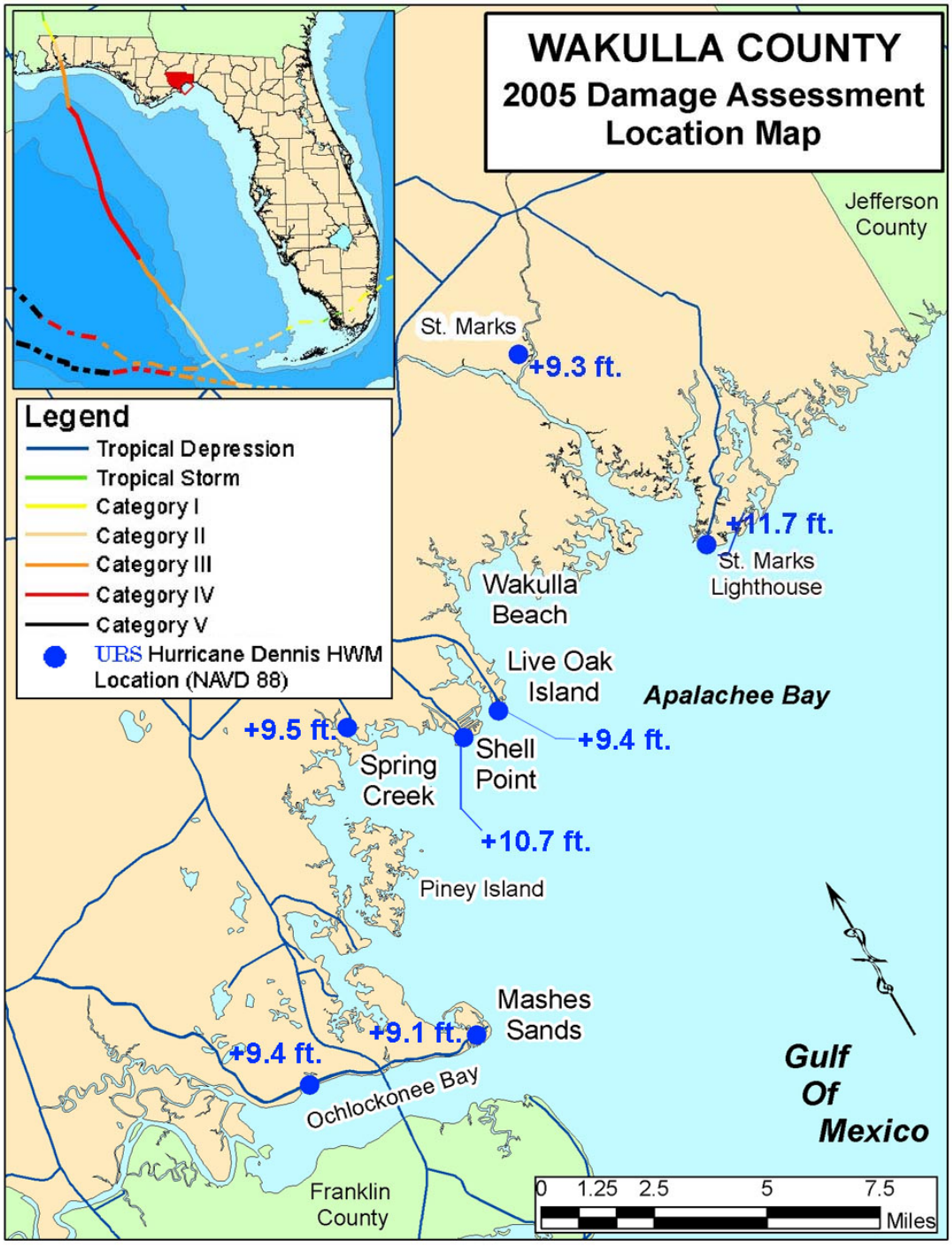

Figure 37. Wakulla County location map.

Most of the Wakulla County's gulf-fronting shorelines are intertidal wetlands on sandy and mud substrate; however, there are a few sandy beaches with a length of roughly three miles fronting the Gulf of Mexico. The most significant beach, a chenier, extends along Mashes Sands to the north of the Ochlockonee Bay entrance (Clark, 1991). The next most significant beach is Shell Point, a southward projecting peninsula near the middle of the county's coast. Most of Shell Point's gulf front has been bulkheaded, so only limited segments of a narrow sandy beach remains. Live Oak Island, immediately east of Shell Point, Wakulla Beach at the head of Goose Creek Bay, and the St. Marks Lighthouse shoreline at the east end of the county, also have sandy shorelines that are generally mostly vegetated with intertidal wetland grasses.

Prior to the 2005 hurricane season, Wakulla County had two critically eroded beach areas (1.3 miles) and one noncritically eroded beach area (0.4 mile). Mashes Sands extending north from Ochlockonee Bay Entrance is critically eroded along its southern end for 0.3 mile threatening recreational interests at the county park. Noncritical erosion extends another 0.4 mile to the north. Shell Point has one mile of critical erosion threatening development.

Hurricane Dennis Storm Effects and Erosion Conditions

Mashes Sands and Ochlockonee Bay

Over 210 miles east of the point of landfall of the eye of Dennis, Mashes Sands sustained major beach and dune erosion with storm tides estimated to be +9 to +10 feet. At Mashes Sands Park, a storm tide of +9.1 ft. NAVD (+9.8 ft. NGVD) was measured (URS, 2005). A one half-mile segment of beach was essentially translated about 50 feet landward revealing a complete roll-over of the beach system into the lagoonal wetlands. This barrier rollover has exposed a projecting terminus of the former asphalt road as a headland. In addition, the canal entrance with the public boat ramp adjacent Ochlockonee Bay has been substantially shoaled with sand. The erosion impact of Dennis was comparable to the impact of Hurricanes Agnes (1972) and Kate (1985).

Shell Point

Minor beach and dune erosion (condition II) was sustained at Shell Point. A storm tide of +10.7 ft. NAVD (+11.3 ft. NGVD) was measured (URS, 2005).

Hurricane Dennis Storm Damage

Mashes Sands and Ochlockonee Bay

All recreation facilities, including parking, picnic shelters, tables, and the concrete bathhouse were destroyed at the Mashes Sands Park. The park's fishing pier on Ochlockonee Bay lost its interior ramp section and a portion of the railing.

Throughout the developed area of Mashes Sands, numerous structures were flooded and sustained interior flood damage. Six dwellings were destroyed or sustained major structural damage. The Wakulla County Building Department reported another 51

dwellings sustained flooding damage. Another pier was destroyed and all the docks along the northern Ochlockonee Bay shoreline were either substantially damaged or destroyed. Adjacent the U.S. Highway 98 bridge crossing Ochlockonee Bay, a waterfront restaurant located over the water sustained significant structural damage (Photo 61). At a marina west of the bridge, a storm tide of +9.4 ft. NAVD (+10 ft. NGVD) was measured (URS, 2005).

Photo 61. Angelo's Restaurant, Ochlockonee Bay, during Hurricane Dennis.

Live Oak Island, Shell Point, Spring Creek, Wakulla Beach

The storm tides of Dennis inflicted the most damage to Wakulla County since Hurricane Kate in 1985. Storm tides of +9 to +12 feet were estimated to have flooded the area. At the community of St. Marks, on the St. Marks River, the county reported 41 homes and several businesses that were flooded and sustained interior flood damage. A storm tide of +9.5 ft. NAVD (+10.1 ft. NGVD) at Shell Island Fish Camp, and +9.3 ft. NAVD (+9.9 ft. NGVD) at the U. S. Post Office, St. Marks (Photo 62) was reported (URS, 2005).

The St. Marks National Wildlife Refuge spans most of the coast of Wakulla County. At the mouth of the St. Marks River, a storm tide of +11.7 ft. NAVD (+12.3 ft. NGVD) was measured inside the St. Marks Lighthouse (URS, 2005). At Wakulla Beach fronting Goose Creek Bay, the existing five dwellings sustained flooding but no major damage. Flooding was observed throughout the Gander Creek Swamp up to two miles inland from Wakulla Beach.

Live Oak Island, severely impacted by Hurricane Kate, was again substantially flooded. A storm tide of +9.4 ft. NAVD (+10 ft. NGVD) was measured on West Point Drive (URS, 2005). Two major structures sustained major damage, nine dwellings sustained

understructure damage, and at least eight others were flooded and sustained interior damage.

Photo 62. U.S. Post Office flooded in St. Marks, Florida (Tallahassee Democrat).

At Shell Point, 21 major structures sustained major damage, including 13 single-family dwellings destroyed (Photo 63). At least nine dwellings had understructure damage and the county reported 178 dwellings sustained flooding damage from the +10-foot storm tide. In addition, 50 feet of wood retaining wall was destroyed.

Photo 63. Dwelling destroyed, Shell Point (URS, 2005).

At Spring Creek, four dwellings sustained major structural damage and the county reported another 40 that sustained flooding damage. In Spring Creek, a storm tide of +9.5 ft. NAVD (+10.2 ft. NGVD) was measured (URS, 2005).

Comments on the Potential Storm Threat in Wakulla County

Wakulla County is particularly susceptible to astronomical tide wave amplification due to its shoreline alignment at the embayment head of Apalachee Bay, and due to the shallow offshore depths. So pronounced is this amplification effect that the St. Marks River hosts the largest astronomical tide range in the entire Gulf of Mexico basin. Likewise, any storm surge effect in Wakulla County is amplified. Figure 38 presents predicted storm tide elevations across northwest Florida for extreme events of 50, 100, and 200-year return intervals, as determined in model studies conducted by the Beaches and Shores Resource Center, Florida State University (BSRC, 1982, 1983, 1985, 1986, 1988, 1991, and 1992).

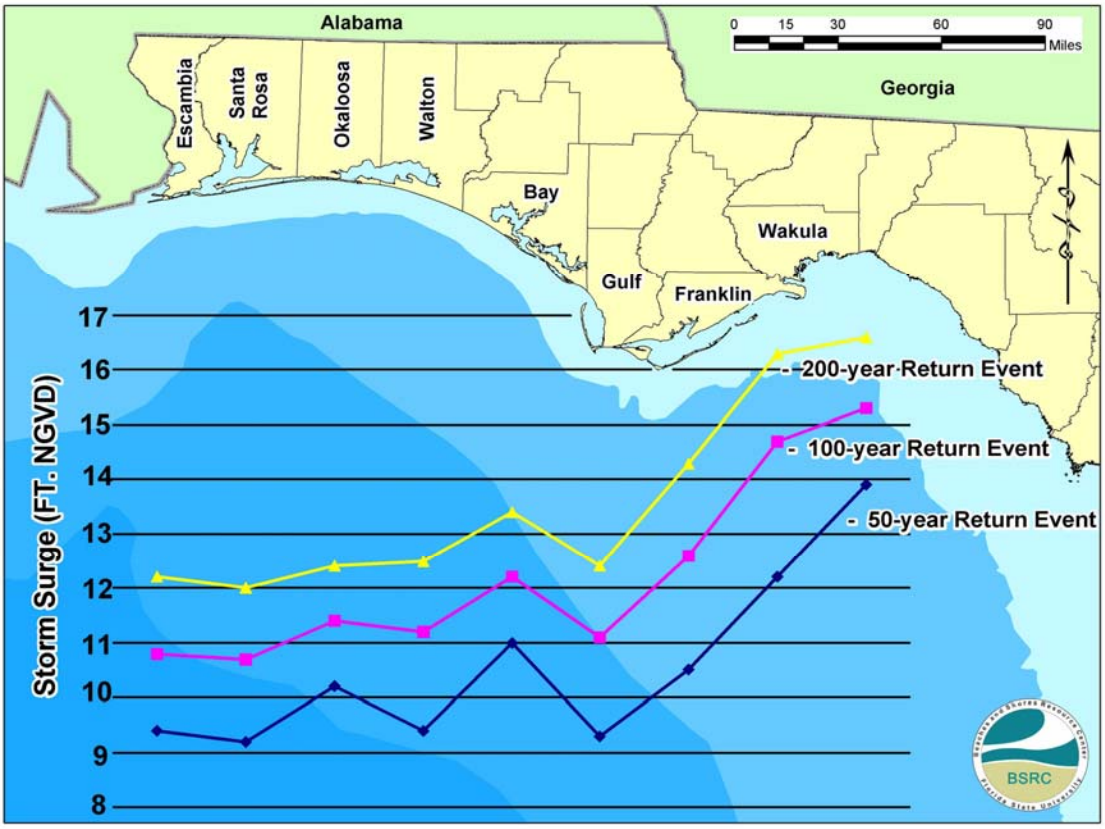

Figure 37. Predicted storm tides for 50, 100, and 200-year return intervals. (Data obtained from model studies conducted by the Beaches and Shores Resource Center, Florida State University, between 1982-1992)

In recent history, only Hurricanes Agnes (1972) and Kate (1985) made landfall near Wakulla County, and neither were major hurricanes, yet damage was equally significant from the distant landfall of Hurricane Dennis, a major hurricane. Prior to Dennis, Hurricane Kate inflicted the most extensive damage along the coast of Wakulla County. The Bureau of Beaches and Shores (predecessor to the Bureau of Beaches and Coastal Systems) measured a storm surge on the beach front of Shell Point to be +8.9 ft. NGVD (Clark, 1986b). Along with 46 major structures that were destroyed or sustained major structural damage due to Kate, over 150 dwellings were rendered uninhabitable due to flooding damage. This compares to 37 major structures substantially damaged by Dennis, with over 318 structures made uninhabitable due to flood damage. Kate caused wind damage to a few structures, whereas Dennis inflicted no significant wind damage. But the significant difference appears to be the slightly higher storm surge of Dennis and the increase in construction over the past 20 years.

While this recent damage data would forewarn that substantial damages may be expected when a major hurricane makes landfall in this area, looking at past history, none of the recent storms were comparable to the hurricane of 1873. The "Great North Florida Storm" of 1873 was reported to have a storm surge of +20 feet at the St. Marks Lighthouse, and +18 feet up the river in the Town of St. Marks (*Tallahassee Weekly Floridian*, September 23, 1873).

Beach Recovery Recommendations and Management Strategies

Area-wide Strategies and Recommendations

- Assist local governments in seeking Federal Emergency Management Agency (FEMA) assistance to repair non-federal beach and dune restoration projects.
- Conduct assisted-recovery activities consisting of dune restoration and re-vegetation, with supplemental beach fill as needed, in areas where a significant contiguous length of upland development or valuable natural resources are vulnerable to damage from the impact of a moderate storm.
- Assist local governments in conducting removal from the active beach and dune system miscellaneous storm-generated debris, including construction debris, derelict retaining walls and foundation piles of beach access walkways.
- Support further sand search studies to locate sufficient upland and offshore sand resources to replenish storm-eroded beaches and dunes.
- Conduct post-storm coastal monitoring to assess beach erosion impacts and to assess beach recovery progress and any additional recovery needs.
- Reevaluate Coastal Construction Control Lines. The impact of five hurricanes and several tropical storms since establishment of the Coastal Construction Control Lines have rendered them inadequate to define the impact zone of a 100-year storm in many areas.

Site-specific Recommendations

Escambia County

- **Pensacola Beach (R107-R151)**
  Complete the maintenance nourishment of the beach restoration project that commenced immediately prior to the impact of Hurricane Dennis.
  Evaluate an increase in the elevation of the crest of the dune feature of the project.

Santa Rosa County

- **Navarre Beach (R192-R213)**
  Expedite construction of the permitted beach restoration project.
  Increase the size of the dune feature in the State Park instead of the width of the beach.

Okaloosa County

- **Ft. Walton Beach (R1-R15)**
  Assist recovery through dune restoration and re-vegetation.
  Initiate a study to evaluate the feasibility of beach restoration.
- **Holiday Isles/Destin/Henderson Beach (R17-R39)**
  Assist recovery through dune restoration and re-vegetation.

Designate Holiday Isles and western Destin (R17-R25.5) as critically eroded (1.6 miles).

- **Eastern Destin (R39-R50)**
  Expedite construction of the funded beach restoration project.

Walton County

- **Western Walton County (R1-R24)**
  Expedite construction of the funded beach restoration project.
- **Topsail Hill (R24-R41)**
  Assist recovery through dune restoration and re-vegetation.
- **Beach Highlands/Dune Allen Beach (R41-R55)**
  Assist recovery through dune restoration with supplemental beach fill.
  Initiate a study to evaluate the feasibility of beach restoration.
- **Blue Mountain Beach (R55-R63)**
  Assist recovery through dune restoration with supplemental beach fill.
  Initiate a study to evaluate the feasibility of beach restoration.
- **Gulf Trace (R67.3-R68.3)**
  Assist recovery through dune restoration and re-vegetation.
  Initiate a study to evaluate the feasibility of beach restoration.
- **Grayton Beach / Grayton Beach State Park (R67-R78)**
  Assist recovery through dune restoration and re-vegetation.
  Designate the segment between R70.95 and R71.4 as critically eroded (0.1 mile).
- **Water Color / Seaside (R78-R82)**
  Assist recovery through dune restoration and re-vegetation.
- **Seagrove Beach (R82-R98)**
  Assist recovery through dune restoration with supplemental beach fill.
  Initiate a study to evaluate the feasibility of beach restoration.
  Designate the segment between R90.1 and R98 as critically eroded (1.5 miles).
- **Seacrest Beach (R105-R115)**
  Assist recovery through dune restoration with supplemental beach fill.
  Initiate a study to evaluate the feasibility of beach restoration.
  Designate the segment between R105.5 and R109.5 as critically eroded (0.8 mile).
- **Dana Beach / Rosemary Beach (R116-R122)**
  Assist recovery through dune restoration and re-vegetation.
- **Inlet Beach (R122-R127)**
  Assist recovery through dune restoration and re-vegetation.

Bay County

- **Panama City Beaches (R5-R93)**
  Complete the maintenance nourishment of the beach restoration project that commenced after the impact of Hurricane Ivan.

Evaluate the project's erosion losses and update the volume needed to repair the damage caused by Hurricanes Dennis and Katrina.

- **St. Andrews State Park (R93-R97)**
  Continue inlet sand transfer from the Panama City Harbor maintenance project.
  Expedite construction of the authorized breakwater project adjacent Gator Lake.

- **Mexico Beach (R128-R144)**
  Implement the planned inlet sand bypassing project.
  Extend and sand tighten the east jetty to the same length as the west jetty at Mexico Beach Inlet.

Gulf County

- **St. Joseph Peninsula State Park (R32-R75)**
  Assist recovery through dune restoration to close the dune breach at R69.
  Designate the segment of St. Joseph Peninsula between R69 and R74 as critically eroded (1.0 mile).

- **St. Joseph Peninsula (R75-R105)**
  Designate the segment of St. Joseph Peninsula between R74 and R81 as critically eroded (1.4 miles).
  Encourage the landward relocation or rebuilding of damaged or threatened structures.
  Assist recovery through dune restoration and re-vegetation.
  Expedite beach management feasibility study for St. Joseph Peninsula and Cape San Blas, to include wave refraction and sediment transport analyses.

Franklin County

- **St. Vincent Island (V1-V45)**
  Designate the beach segment between V34-V39 (0.9 mile) as critically eroded.

- **St. George Island (R52-R105)**
  Assist recovery through dune restoration and re-vegetation.

- **St. George Island State Park (R105-R149)**
  Designate the beach segments R106-R117 (2.3 miles) and R118-R127.5 (1.9 miles) as critically eroded.
  Assist recovery through dune restoration and re-vegetation.
  Restore and enhance beach access and parking to minimize impacts to recovering dunes and vegetation.

- **Dog Island**
  Designate the beach segments R168-R179 (2.1 miles) and R186-R187.2 (0.2 mile) as critically eroded.
  Encourage the landward relocation or rebuilding of damaged or threatened structures.
  Assist recovery through dune restoration and re-vegetation.

- **Alligator Point, Phipps Preserve**
  Monitor natural recovery.

- **Alligator Point (R195-R209)**

Assist recovery through dune restoration and re-vegetation.

- **Alligator Point, Southwest Cape (R210-R218)**
  Encourage the landward relocation or rebuilding of damaged or threatened structures.
  Assist recovery through dune restoration and re-vegetation.
  Expedite planning, design and construction of beach restoration.
- **Lighthouse Point to Bald Point (R218-R239)**
  Monitor natural recovery.

Wakulla County

- **Mashes Sands**
  Assist recovery through beach nourishment using sand from the boat canal entrance dredging and other available sources.
- **Shell Point**
  Assist recovery through beach nourishment of the public beach areas using trucked-in sand.

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