

*Preliminary Hurricane Michael Post-Storm
Beach Conditions and Coastal Impact Report*

**Division of Water Resource Management
Florida Department of Environmental Protection
November 2018**



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I. Introduction

Hurricane Michael made landfall on October 10, 2018, in Northwest Florida near Tyndall Air Force Base. At landfall, Michael was a strong Category 4 hurricane on the Saffir-Simpson hurricane intensity scale. Hurricane Michael substantially impacted the coast from Panama City Beach to St. Marks. This report documents the impact of Hurricane Michael on the beaches, dunes, and coastal construction. It will assist the Florida Department of Environmental Protection (Department) and local governments to identify areas where storm erosion has left upland development and infrastructure vulnerable to imminent damage from future storms, where beaches and dunes may be restored, and where expedited permitting procedures are needed to assist homeowners with repairs and reconstruction.

The Department developed this Post-Storm Beach Conditions and Damage Assessment Report to quantify the damages caused by Hurricane Michael. This report provides an assessment of storm impact, beach and dune erosion, and structural damages to the coast of northwest Florida. Although extensive structural damage occurred well inland of the coast, the damage assessment in this report specifically focuses on damage within the coastal building zone, as defined in Chapter 161, Florida Statutes.

Following the impact of Hurricane Michael, damage assessment teams from the Department collected field data in Bay, Gulf, Franklin, and Wakulla Counties. Detailed damage assessments were conducted of all construction within the coastal building zone. The damage assessment teams from the Department included Ralph Clark, P.E., Coastal Engineer; Mike Manausa, Coastal Engineer; Guy Weeks, Planning Manager; Tyler Boland, Surveyor; Peter Bacopoulos, P.E., Coastal Engineer; Shane Duinkerken, Surveyor; Jennifer Steele, P.G., Coastal Geologist; Kevin Smith, Surveyor; and Keith Davie, Engineer.

In addition to the field data assessments, post-storm vertical aerial photography provided by the National Oceanic and Atmospheric Administration (NOAA) assisted the assessments of coastal conditions.

This post-storm report provides photographs taken by the damage assessment teams of some of the damage and beach erosion conditions relevant to the hurricane impact discussions. For additional Hurricane Michael photography obtained by the damage assessment teams, readers are referred to the Department's "Collection of Aerials and Shoreline Trends System" (C.O.A.S.T.S.) webpage at <http://prodenv.dep.state.fl.us/DwrmCoasts/search>.

II. Hurricane Michael, October 7-12, 2018

Hurricane Michael, the thirteenth storm of the 2018 hurricane season for the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, spawned from a tropical depression in the northwestern Caribbean Sea off the coast of the Yucatan Peninsula on October 7, 2018. At 11:55 AM CDT, satellite wind data indicated that the depression had strengthened into the season's thirteenth tropical storm. The maximum sustained winds were estimated to be 40 mph with higher gusts. At 10:00 PM CDT, Michael was moving slowly toward the north near 5 mph over the Yucatan Channel between the coast of Mexico and Cuba with maximum sustained winds near 60 mph.

Overnight, Michael intensified, and at 10:00 AM CDT on Monday October 8, Michael became a Category 1 hurricane on the Saffir-Simpson hurricane intensity scale with maximum sustained winds of 75 mph. Hurricane-force winds extended outward to 30 miles from the center and tropical-storm-force winds extend outward to 175 miles. Michael continued to move northward near the western tip of Cuba and into the southeastern Gulf of Mexico. The estimated minimum central pressure based on Air Force Reserve reconnaissance data was 982 millibars.

Michael continued to intensify throughout the evening and into Tuesday, October 9. By 7:00 AM CDT, Michael had intensified to a Category 2 hurricane with maximum sustained winds near 100 mph. The minimum central pressure reported by NOAA aircraft was 968 millibars and the hurricane was moving toward the north-northwest near 12 mph. Hurricane-force winds extended outward to 40 miles from the center and tropical-storm-force winds extended outward to 195 miles. In the southern Gulf of Mexico, NOAA buoy 42003 reported one-minute mean winds of 47 mph and a wind gust of 54 mph. Michael intensified throughout the day and by 7:00 PM CDT, the maximum sustained winds were reported to be near 120 mph with higher gusts as Michael had become a Category 3 hurricane. The minimum central pressure based on data from an Air Force Reserve Hurricane Hunter aircraft was measured to be 953 millibars.

Rapid intensification continued Tuesday evening as Michael tracked northward across the Gulf of Mexico at about 12 mph. Early Wednesday morning, October 10, at 1:00 AM CDT, data from Air Force Reserve and NOAA Hurricane Hunter aircraft indicated that the maximum sustained winds had increased to near 130 mph with higher gusts. Michael had become a dangerous Category 4 hurricane. The minimum central pressure was estimated to be 945 millibars. Hurricane-force winds extended outward to 45 miles from the center and tropical-storm-force winds extended outward to 175 miles. Landfall on the northwest coast of Florida was imminent. By 10:00 AM CDT, Michael had intensified

further and had accelerated toward the north-northeast near 14 mph. Data from the Air Force Reserve Hurricane Hunter aircraft indicated that the maximum sustained winds were near 145 mph with higher gusts. The minimum central pressure had fallen to 928 millibars.

At 12:30 PM CDT, Wednesday, October 10, the eye of Hurricane Michael made landfall just northwest of Mexico Beach, Florida, across Crooked Island. Michael continued to intensify at landfall with maximum sustained winds near 155 mph and higher gusts. A wind gust of 130 mph was reported at a University of Florida/Weatherflow observing site near Tyndall Air Force Base before the instrument failed. A wind gust to 129 mph was reported at the Panama City Airport. The minimum central pressure based on data from an Air Force Reserve reconnaissance aircraft was 919 millibars, making Hurricane Michael the third strongest hurricane to landfall in the continental United States in recorded history dating back to 1851.

Michael maintained its intensity as it crossed the Florida Panhandle and entered Southwest Georgia. After Michael was downgraded Wednesday afternoon, it became the first Category 3 hurricane to hit Georgia since 1898. A wind gust of 102 mph was measured at the airport in Marianna, Florida near the state line. To the east, a wind gust of 71 mph was measured at the Tallahassee airport. Michael continued across Georgia Wednesday evening and Thursday before moving out into the Atlantic Ocean and dissipating October 12.

Figure 1 illustrates the track history of Hurricane Michael combined with satellite imagery. This composite was developed by the Cooperative Institute of Meteorological Satellite Studies (CIMSS) at the University of Wisconsin – Madison.

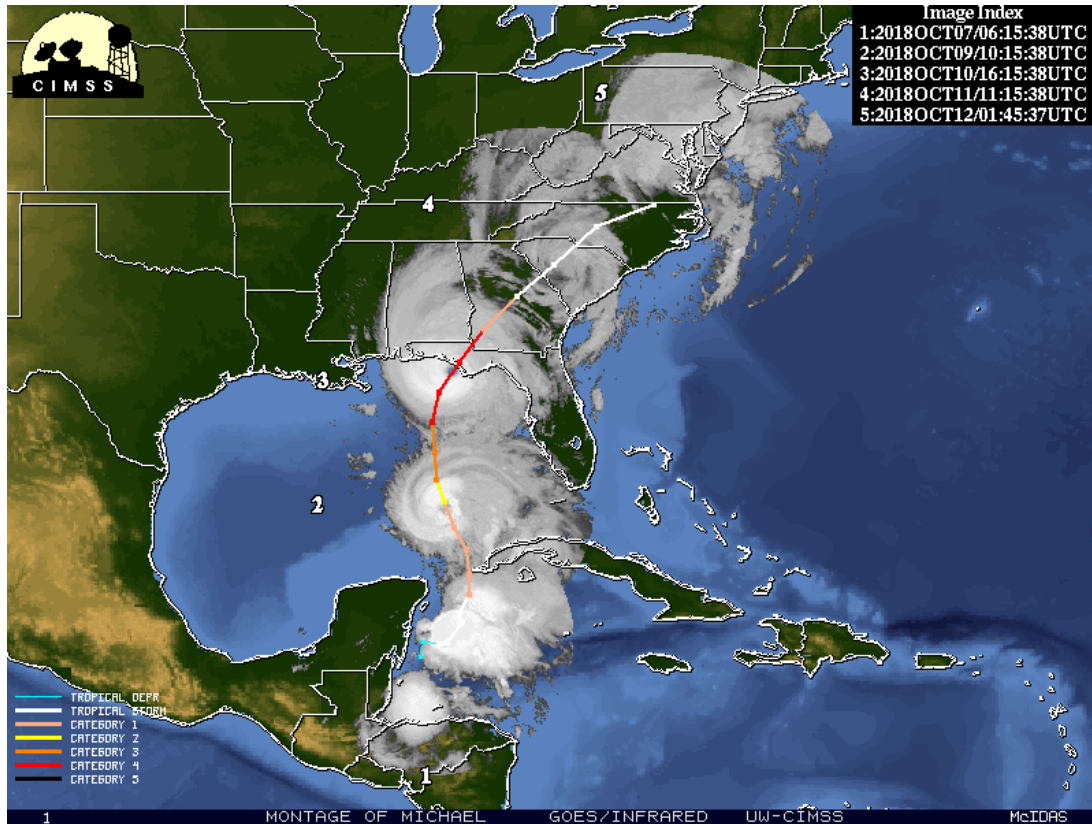


Figure 1. Hurricane Michael track with landfall in Bay County, Florida (Source: CIMSS/Univ. of Wisconsin-Madison).

Closer views of GOES-16 Visible and Infrared images (**Figure 2**) showed Michael made landfall near Mexico Beach, Florida, around 12:30 PM CDT as a strong Category 4 hurricane with maximum sustained winds of 155 mph and a minimum central pressure of 919 millibars.

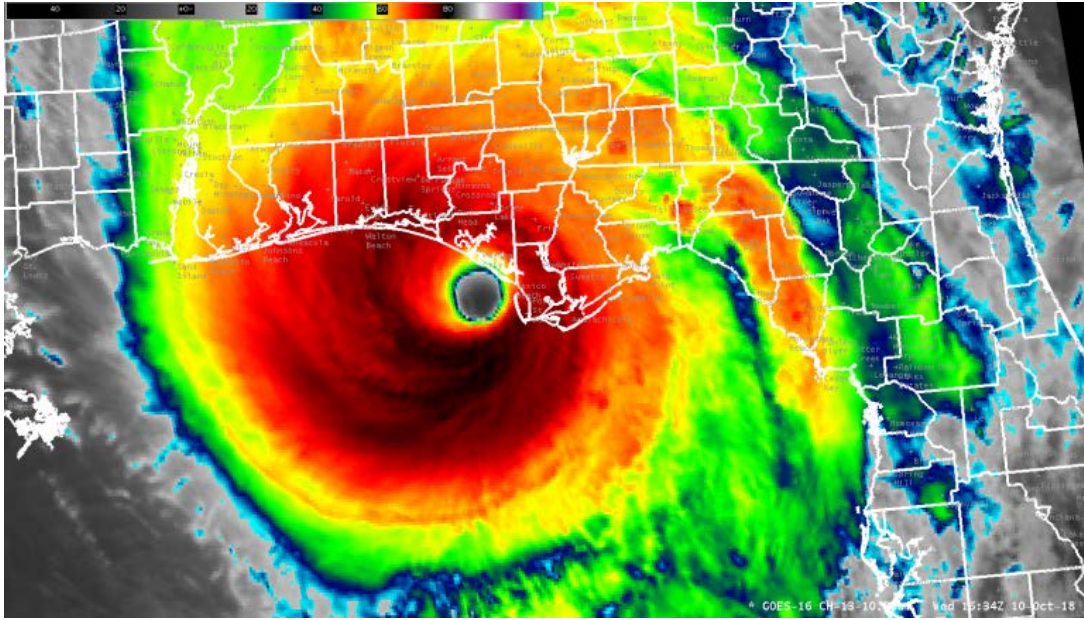


Figure 2. Hurricane Michael wind field during landfall in Bay County, Florida
(Source: CIMSS/Univ. of Wisconsin – Madison).

Wind gust data is available from reporting stations throughout Northwest Florida. **Figure 3** maps strategic wind data reports along the coast of Florida by presenting peak wind gusts from selected weather monitoring stations.



Figure 3. Hurricane Michael wind gusts data from recording stations [Data sources – NOAA and National Weather Service].

Storm tide data along northwest Florida is available from several of NOAA’s recording tide gauges. **Figure 4** shows a peak tide level from Michael of +8.6 feet NAVD was measured at the bay entrance of the Apalachicola River. In addition to NOAA tide gauges, special storm-tide sensors that can measure the height, extent, and timing of the storm tide were deployed by the U.S. Geological Survey (USGS). The storm tide, +15.6 feet above NAVD, was measured at the USGS Sensor Gauge tide station located at Mexico Beach shortly after Hurricane Michael’s landfall at St. Andrew Sound (**Figure 5**). Additional storm tide data from surveyed seaweed wrack lines and mud lines inside of buildings are available at some sites. The highest high-water mark, +21.2 feet NAVD, was recorded at the west end of Beacon Hill. Wave data from the National Data Buoy Center (NDBC) buoy station 42039, located offshore of Pensacola, was available prior to gauge failure. A graph depicting the peak storm tide levels and wave height during Michael is presented in **Figure 6**.

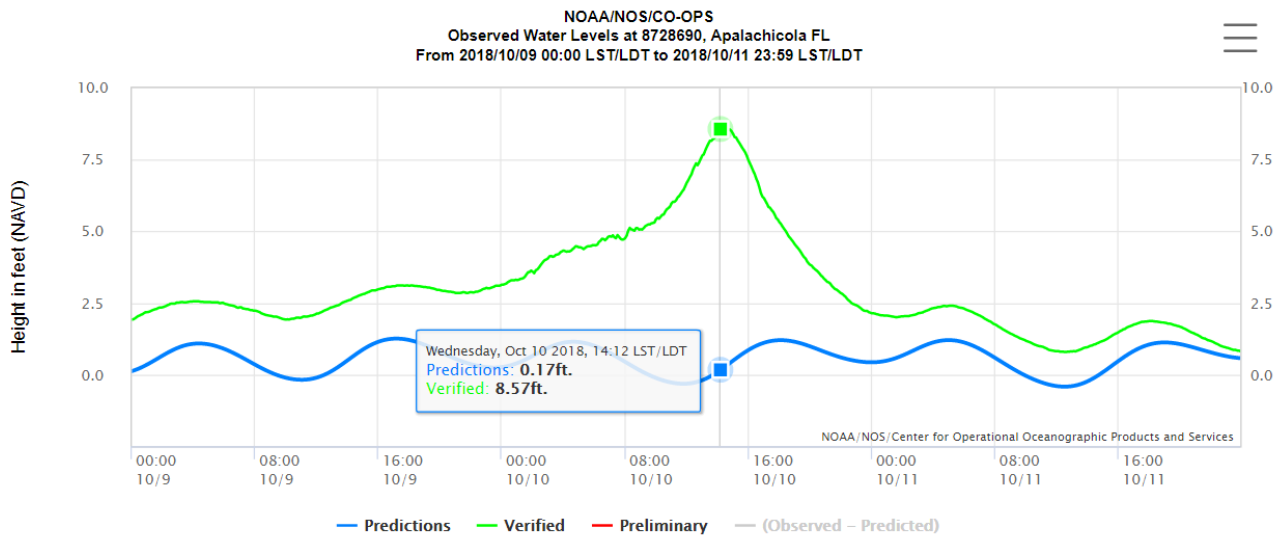


Figure 4. Measured storm tide levels at Apalachicola Bay during Hurricane Michael [Data from NOAA].

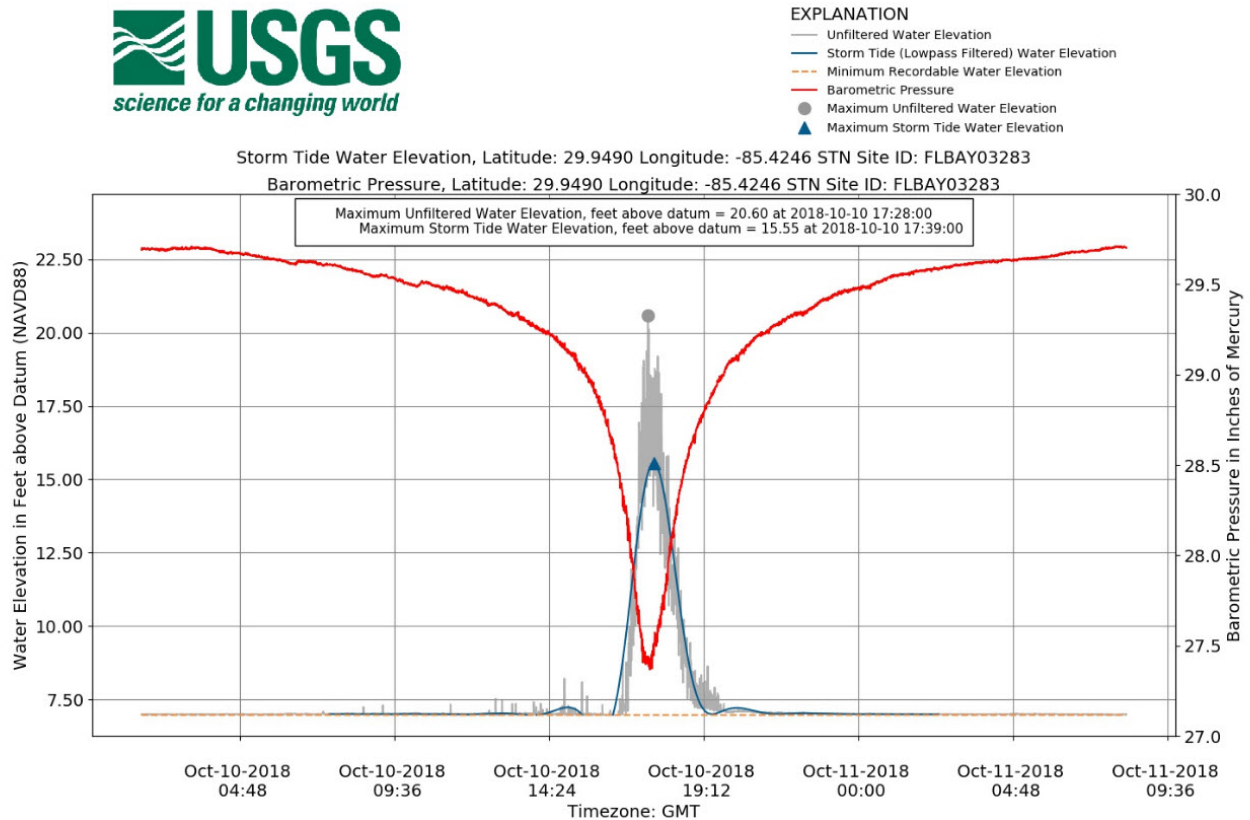


Figure 5. Measured storm tide levels at Mexico Beach during Hurricane Michael [Data from USGS].



Figure 6. Hurricane Michael peak storm tide levels and the maximum offshore wave height [Data sources – NDBC, NOAA and USGS].

III. Hurricane Michael Impact Summary and Overview

This section provides a summary of the beach and dune erosion, and structural damage, that occurred in the four substantially affected coastal counties: Bay, Gulf, Franklin and Wakulla. **Table 1** lists beach and dune erosion conditions starting with Bay County and continuing eastward to Wakulla County. Areas with no erosion are listed as [-]. Reference or Range (“R”) monuments are historical survey markers established by the Department that are spaced approximately every 1000 feet to measure beach erosion. A graphic depiction of the classification of beach erosion conditions is provided in **Figure 7**.

Table 1. Post-Storm Beach and Dune Erosion Summary.

Bay County

Locations	Reference Monuments	Erosion Condition
Panama City Beaches	R0 – R91	I
St. Andrews State Park	R92 – R97	III-IV
Shell Island	R98 – V009	IV
Crooked Island	V009 – R127	IV
Mexico Beach	R127 – R144	IV

Gulf County

Locations	Reference Monuments	Erosion Condition
Beacon Hill	R1 – R13	IV
Windmark	R14 – R31	II
St. Joseph Peninsula, including State Park	R32 – R105	IV
Cape San Blas – west shore	R106 – R118	IV
Cape San Blas – east shore	R119 – R133	II
Indian Peninsula	R134 – R159	II
Indian Pass	R159 – R161	IV

Franklin County

Locations	Reference Monuments	Erosion Condition
St. Vincent Island	V301 – V345	IV
Cape St. George Island State Preserve	R1 – R51	IV
St. George Island Plantation	R52 – R73	IV
St. George Island, including State Park	R73 – R148	IV
Dog Island	R150 – R192	IV
Alligator Point	R195 – R209	II
Southwest Cape	R209 – R217	III
Lighthouse Point to Bald Point	R217 – R239	II

Wakulla County

Locations	Reference Monuments	Erosion Condition
Mashes Sands – south beach	N.A.	IV
Mashes Sands – east beach	N.A.	II
Shell Point – west beach	N.A.	-
Shell Point – east beach	N.A.	I

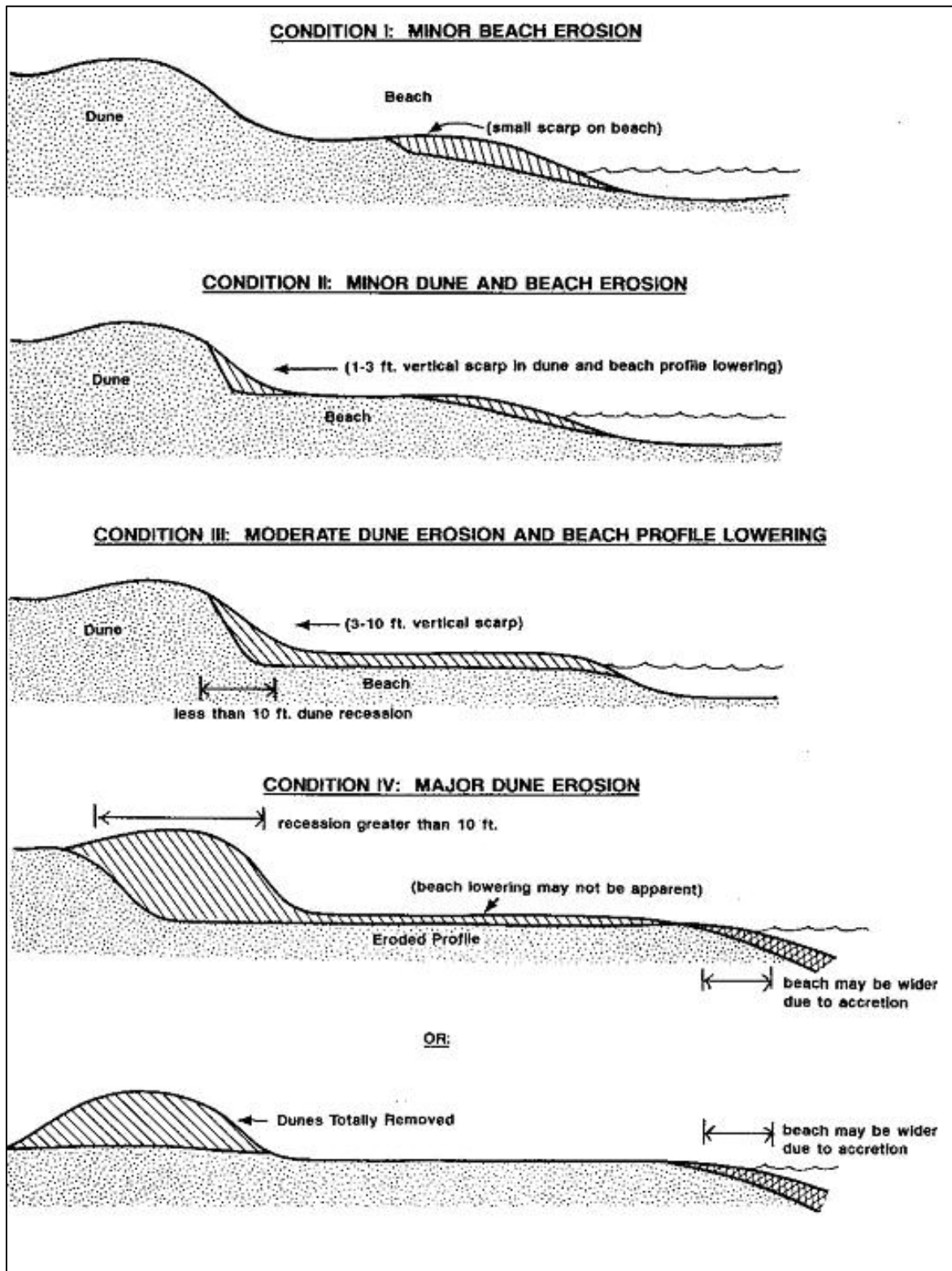


Figure 7. Post-Storm Beach and Dune Erosion Conditions (I to IV).

Major Structural Damage

An overall summary of structural damage to major structures is given in *Table 2*. A summary of damage to coastal armoring, including seawalls, bulkheads, retaining walls, revetments, sills, or other rigid coastal protection structures, is provided in *Table 3*. Not included in this table is damage to rigid shore-protection structures like groins and breakwaters, or navigation structures like jetties. A more detailed description of these impacts by specific location is provided in Section IV of this report. *Figure 8* provides an aerial photo comparison of the worst impacted segment of coastal damage as seen in Mexico Beach, Bay County.

Table 2. Summary of Major Structural Damage to Major Structures in the Coastal Building Zone by Hurricane Michael in Northwest Florida.

County	# Single-Family Dwellings Damaged	# Multi-family Dwellings ¹ Damaged	# Other Major Structures ² Damaged	Total # Damaged ³
Bay	1,324	128	118	1,570
Gulf	840	88	56	984
Franklin	160	3	2	165
Wakulla	4	0	2	6
TOTAL	2,328	219	178	2,725

- 1) Multi-family dwellings include condominiums, townhouses, apartments, hotels and motels.
- 2) Other major structures include commercial buildings (restaurants, stores, beach bars, etc.), recreational buildings and non-habitable major structures (i.e., piers, pools, pavilions and parking lots).
- 3) 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), minor damage to major structures, structures located inland of the coastal building zone, or structures with hydrostatic flooding damage caused by the storm surge or storm water runoff.

Table 3. Summary of Coastal Armoring Damage Caused by Hurricane Michael.

County	Armoring Damage in Feet
Bay	1,460
Gulf	1,870
Franklin	4,670
Wakulla	100
TOTAL	8,100



Figure 8. Aerial photo comparison of the severe damage in Mexico Beach (R127-R132).

IV. Detailed Damage Assessment by County

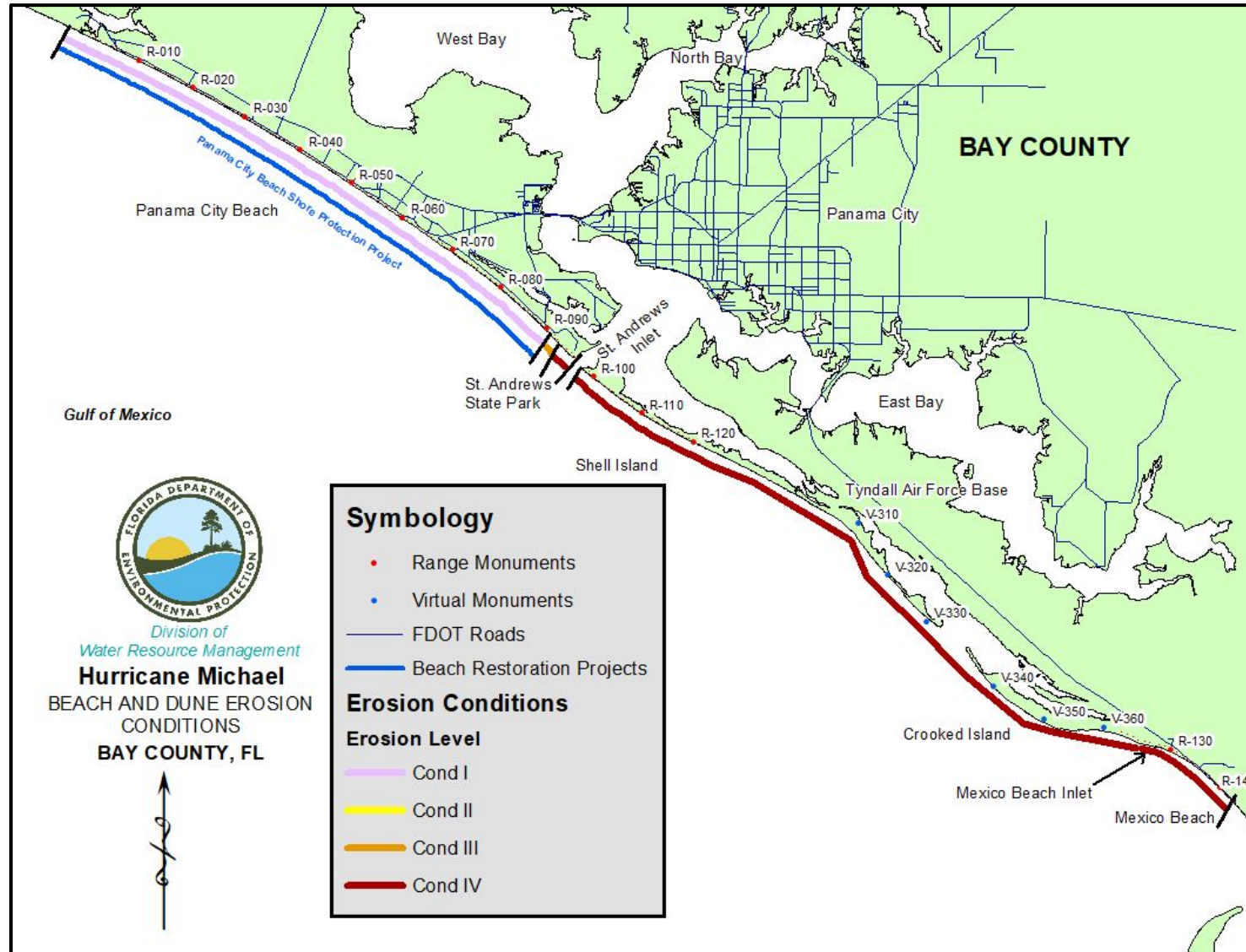


Figure 9. Bay County Beach and Dune Erosion Conditions from Hurricane Michael.

Bay County

The Bay County coast extends for 41.2 miles between Walton and Gulf Counties, and includes the barrier beach communities and major park systems of Sunnyside, Panama City Beach, St. Andrews State Park, Tyndall Air Force Base, and Mexico Beach (**Figure 9**). The western coast of Bay County along the Panama City Beaches is a federal beach restoration project extending for 18.6 miles between the Walton County line to St. Andrews State Park. St. Andrews Inlet to the east of St. Andrews State Park has a federal navigation project, which likely experienced significant shoaling due to Hurricane Michael. To the east of St. Andrews Inlet extends Shell Island, a barrier island now connected to the mainland due to the closure of the old natural eastern entrance to St. Andrews Bay. East of the closed inlet extends Crooked Island, a former barrier island that is now likewise attached to the mainland near the closed inlet and at its eastern end near the City of Mexico Beach. Crooked Island, which is part of Tyndall Air Force Base, is split by an inlet that was created by Hurricane Eloise in 1975. Shell Island and Crooked Island have relatively broad, gradually sloping beaches and large dynamic dune fields. At the east end of Bay County, there is an upland canal system at Mexico Beach that connects with the Gulf of Mexico through a jettied inlet. Substantial shoaling was observed at Mexico Beach Inlet, which also provided a conduit for the ebb flow of Michael's storm surge.

The direction of longshore transport along the Bay County coast is both to the west and to the east. West of St. Andrews Inlet, the net direction of longshore transport is generally to the west, whereas to the east of St. Andrews Inlet, the net direction of longshore transport is generally to the east. This longshore transport reversal to the east is substantially affected by the orientation of the shoreline, which trends to the southeast and by the wave sheltering created by Cape San Blas and St. Joseph Peninsula to the southeast.

There are two critically eroded beach areas (19.5 miles), three non-critically eroded beach areas (10.1 miles) and one critically eroded inlet shoreline (0.2 mile) in Bay County. The entire western half of Bay County extending 18.6 miles between the Walton County line and St. Andrews Inlet (R1–R97) is critically eroded, threatening development and recreational interests. Inlet sand transfer is periodically conducted at St. Andrews State Park and the Panama City Beach Shore Protection Project has been constructed from the western county line to St. Andrews State Park. The western shoreline of St. Andrews Inlet adjacent to Gator Lake is critically eroded requiring periodic fill placement. A shoreline stabilization project of nearshore detached breakwaters has been constructed to extend the fill placement interval. To the east of St. Andrew's Inlet along the western 6.1 miles of Shell Island (R9–V9), the

beach is non-critically eroded without any threatened interests. East of Shell Island along Crooked Island, there are two non-critically 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 0.9 mile of Bay County (R132–R137.8) along the City of Mexico Beach is critically eroded. Inlet sand transfer is periodically conducted at Mexico Beach Inlet and dune restoration has been conducted following Hurricanes Opal (1995) and Dennis (2005).

Storm Effects and Erosion Conditions

The storm tides of Hurricane Michael in Bay County generally ranged between five and nineteen feet above sea level. USGS measured a storm surge in Mexico Beach with a surge gauge mounted to the fishing pier to be +15.6 feet NAVD. Based on storm surge modelling by the Beaches and Shores Resource Center (FSU, 2007), this surge elevation is comparable to a one in 230-year return interval storm surge event. However, roughly 750 feet landward of the surge gauge, USGS measured a high-water mark from a seed line on the interior of a grade level concrete building to be +17.6 feet NAVD. Further, additional high-water marks were measured by USGS in Mexico Beach, ranging from +17.9 feet NAVD near the west end of town to +19.1 feet NAVD near the east end of town. The latter mark was located near DEP reference monument R137.

Michael's impact along the eastern coast of Bay County east of St. Andrews Inlet was particularly severe. From St. Andrews State Park through Mexico Beach, including Shell Island and Crooked Island, major beach and dune erosion (Condition IV) was sustained. West of St. Andrews State Park, along the Panama City Beaches, minor beach erosion (Condition I) and minor beach and dune erosion (Condition II) was sustained. Along the Panama City Beaches and Mexico Beach, the storm erosion left upland properties vulnerable to flooding from future storm events. Along Shell Island and Crooked Island, major washover fans were developed due to the storm surge that flooded these barrier islands and leveled dunes. An unquantified large volume of beach and dune sediments were transported into St. Andrews Bay. A relatively smaller volume of washover sediments were transported landward along Mexico Beach across U.S. Highway 98.

Note: Given this document is a preliminary report, quantitative erosion effects cannot yet be determined. A post-storm survey of the Panama City Beaches Shore Protection Project is expected to be conducted, which will quantify the erosion losses along the western half of Bay County. In addition, the U.S. Army Corps of Engineers (USACE) has recently flown a LIDAR survey of the coast, which will also provide

data to compute volumetric changes due to Michael. Quantitative volumetric data will be provided in a final post-storm report when available.

Storm Damage

By all accounts, Hurricane Michael was an epic storm event for the northern Gulf of Mexico coast. The most severe damage occurred to the right of the hurricane's eye at landfall. Mexico Beach in Bay County and Beacon Hill in Gulf County sustained the greatest impact from the storm's surge, waves, and winds. The eye made landfall at Tyndall Air Force Base and caused major damage to nearly every major structure throughout the base. To the left of the eye at landfall, substantial wind damage was also sustained throughout Panama City and adjacent communities, as well as the eastern half of Panama City Beach. The severe wind damage from Michael extended inland across the county leveling pine forests and devastating inland structures. Within the Coastal Building Zone fronting on the Gulf of Mexico, Bay County sustained major damage to 1,570 major structures. In contrast, Bay County had only seen major damage to 514 major structures in the Coastal Building Zone from all the Northwest Florida hurricanes dating back to, but not including, Hurricane Eloise in 1975.

The damage from Michael was sporadic in western Bay County. Roughly five miles from the Walton County line, damage became more prevalent and continued to become more wide-spread about 10 miles from the western county line. Storm tides generally ranged from five to six feet above sea level along Panama City beaches and winds of the western eye wall typically gusted from 80 to 100 mph. The Panama City Beach Shore Protection Project adequately protected all beach fronting development and infrastructure along Panama City Beach. In contrast, prior to the beach restoration project, Hurricane Opal (1995) caused damage to 471 buildings and numerous seawalls along Panama City Beach. All the major damage along Panama City Beaches was due to the high winds, with major damage being sustained to 466 major structures, including six that were destroyed.

East of St. Andrews Inlet, along Shell Island and Crooked Island, two major structures were damaged including one single-family dwelling that was destroyed. The eye of Michael crossed the coast at these largely undeveloped coastal barriers. However, as previously noted, severe wind damage was sustained throughout Panama City and Tyndall Air Force Base immediately landward of these islands.

To the east of Crooked Island, the most severe damage from Michael was sustained along the mainland coast of eastern Bay County at Mexico Beach (*Figure 8*). On top of the storm surge, breaking waves caused the most severe damages. Many exterior water marks to 30 feet above sea level suggest the wave setup and wave uprush caused the severe damage that resulted in most of the development being

destroyed seaward of U.S. Highway 98. These extreme storm tides and the high winds of Michael greatly exceeded the hurricane resistant coastal construction standards of the Florida Building Code. Of the 210 buildings in Mexico Beach with major damage seaward of the Coastal Construction Control Line (CCCL), 180 buildings were destroyed, or roughly 85%. In addition, landward of the CCCL to the landward limit of the Coastal Building Zone, roughly 45% of the damaged buildings were destroyed. Within the Coastal Building Zone in Mexico Beach, 1,102 major structures sustained major structural damage, including 595 that were destroyed. See *Figure 10* through *Figure 38* for examples of damage in Bay County.



Figure 10. Bank with severe wind damage on 23rd Street, Panama City.



Figure 11. Dry storage marina with wind damage on Thomas Drive, Panama City Beach.



Figure 12. Beach erosion near R57, east of M.B. Miller Pier, Panama City Beach.



Figure 13. Wind damages on a multifamily dwelling near R73, Panama City Beach.



Figure 14. Wind damages on the Sunbird Condominiums near R67, Panama City Beach.



Figure 15. Roof damage and destroyed dwelling near R82, Panama City Beach.



Figure 16. Roof damage on a single-family dwelling near R86, Panama City Beach.



Figure 17. Collapsed pavilion near R97, St. Andrews State Park.



Figure 18. Beach and dune erosion near R97, St. Andrews State Park.



Figure 19. Mexico Beach Canal, R128.



Figure 20. Aerial photo comparison of severe damage in Mexico Beach (R127.5-R130).



Figure 21. Debris and damages at Mexico Beach Canal, R127.5.



Figure 22. Rows of beach houses destroyed and removed by the storm surge, R127.5.



Figure 23. Beach dwellings north of U.S. 98 lifted off their foundations, R128.



Figure 24. Remains of typical beach house destroyed near R128, Mexico Beach.



Figure 25. Mexico Beach pier destroyed near R129.



Figure 26. Multifamily dwelling destroyed near R129, Mexico Beach.



Figure 27. Pile-supported dwelling destroyed near R129, Mexico Beach.



Figure 28. Pile-supported multifamily dwelling destroyed near R129, Mexico Beach.



Figure 29. Buildings transported several hundred feet landward by the flood across U.S. 98 and deposited on 15th Street, R130, Mexico Beach.



Figure 30. Beach dwelling transported across U.S. 98 by the storm surge.



Figure 31. Dwellings destroyed by storm surge near R132, Mexico Beach.



Figure 32. Dwelling transported across U.S. 98 by the storm surge near R136.



Figure 33. Roof of dwelling transported across U.S. 98 by the storm surge near R138.



Figure 34. Segment of U.S. 98 destroyed near R139, Mexico Beach.



Figure 35. Debris transported by the storm surge inland, Mexico Beach.



Figure 36. City water tower collapsed under high winds near R134, Mexico Beach.



Figure 37. Over 700 feet of reinforced concrete seawall destroyed at R135.



Figure 38. Storm surge transported debris and sand overwash across U.S. 98 near R135, Mexico Beach.

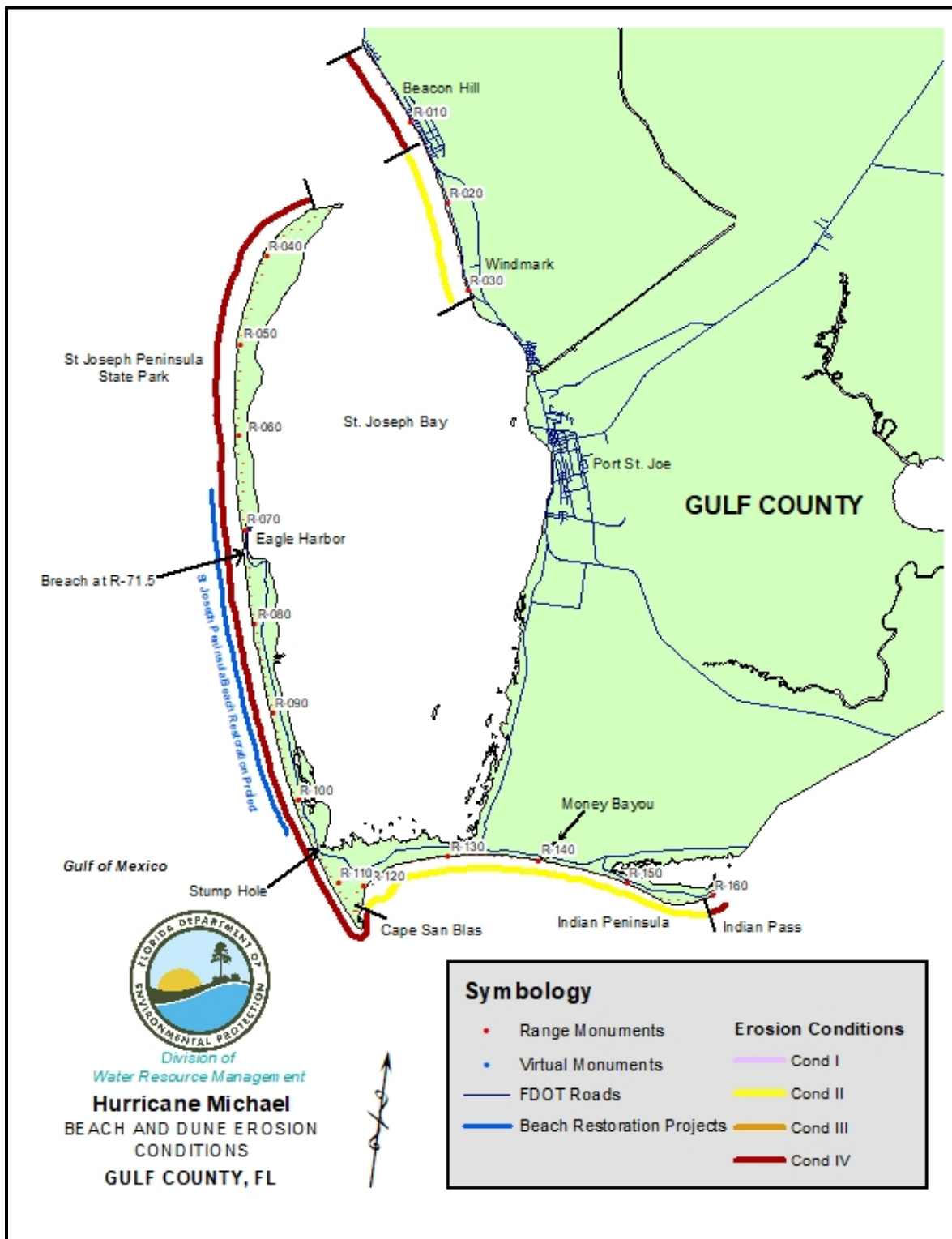


Figure 39. Gulf County Beach and Dune Erosion Conditions from Hurricane Michael.

Gulf County

The Gulf of Mexico fronting beaches of Gulf County extend for 28.8 miles between Bay County and Franklin County, that include the following communities and major parks: Beacon Hill, Windmark, T.H. Stone Memorial St. Joseph Peninsula State Park, William J. Rish Recreational Park, and Eglin Air Force Base at Cape San Blas (**Figure 39**). At the northwestern reach of Gulf County is a mainland stretch of coast along the community of Beacon Hill. Offshore from the mainland is St. Joseph Peninsula, a north-south trending barrier spit, which is separated from the mainland by St. Joseph Bay. At the entrance to St. Joseph Bay is a federal navigation project that is part of the Port St. Joe Harbor Navigation Project. Michael caused substantial shoaling in the navigation channel adjacent the northern tip of St. Joseph Peninsula. To the south of St. Joseph Peninsula and separated by a narrow barrier segment called Stump Hole is Cape San Blas, where the shoreline takes an abrupt change in alignment. East of Cape San Blas the coast trends in a general east-west direction with a mainland beach extending to Indian Peninsula, which extends east to Indian Pass at the eastern Gulf County line.

The net direction of longshore transport along the mainland coast at Beacon Hill is to the east due to the wave sheltering created by St. Joseph Peninsula and Cape San Blas to the southeast. St. Joseph Peninsula extends for approximately 17 miles with primary dunes ranging in height from five to nearly 40 feet. With widths ranging from 600 to 4,600 feet, the barrier spit is subject to storm surge overwash. The net direction of longshore transport is northerly along St. Joseph Peninsula and the erosion rates reach a maximum to the south at Stump Hole, which is a drift divide for longshore transport. The west shore of Cape San Blas has the highest erosion rate on the Florida Gulf Coast (approximately 40 feet per year), while longshore transport is generally southward with sediments being carried onto shoals off the cape. Sensitivity of shoreline change to storm tides and wave conditions was witnessed during two hurricanes in 1985 when approximately 2,500 feet of the southward projecting cape disappeared. Over the past 40 years, all the Eglin Air Force buildings and infrastructure as well as the Cape San Blas Lighthouse and associated buildings gulfward of County Road 30E have been lost or relocated off the cape.

There are two critically eroded areas (8.3 miles) and three non-critically eroded areas (8.6 miles) in Gulf County. Most of St. Joseph Peninsula is eroded between R41–R106. A segment of T.H. Stone Memorial St. Joseph Peninsula State Park (R41–R69) is non-critically eroded for 5.5 miles, and a segment of St. Joseph Peninsula (R69–R106) is critically eroded for 7.2 miles due to threatened development and recreational interests. The St. Joseph Peninsula Beach Restoration Project (R67-R105.5) was completed

in the winter of 2009. The severely eroded west shoreline of Cape San Blas (R106-R111.5; 1.1 mile) is designated critically eroded for 1.1 mile south of Stump Hole. An engineered boulder mound structure was constructed in 2009 at Stump Hole to replace an earlier rock mound to provide major storm protection to County Road 30E, which connects St. Joseph Peninsula to Cape San Blas. South of the Eglin Air Force Base facilities, Cape San Blas (111.5-R114) has sustained severe but non-critical erosion for an additional 0.5 mile. Indian Peninsula (R150-R162) at the eastern end of the county is also designated non-critically eroded for 2.6 miles.

Storm Effects and Erosion Conditions

The storm tides of Hurricane Michael in Gulf County generally ranged between 7 and 21 feet above sea level. In Beacon Hill, USGS measured storm surge high water marks ranging from +21.2 feet NAVD (*Figure 6*) at the west end of town to +12 feet NAVD at the eastern end of town, which was somewhat more protected in the lee of St. Joseph Peninsula. To the east with greater protection from St. Joseph Peninsula, the Windmark development experienced storm tides ranging from +11.2 feet NAVD to +10.6 feet NAVD. The storm tide maintained its elevation along the shoreline leading into and along the City of Port St. Joe, where high-water measurements were obtained between +10.1 feet NAVD and +12.1 feet NAVD.

USGS measured a storm surge on St. Joseph Peninsula with a surge gauge strapped to a beach walkway piling at William J. Rish Park to be +7.8 feet NAVD. The storm surge along the northern half of the peninsula appeared to be substantially greater than eight feet, as observed from overwash deposits. Within the T.H. Stone Memorial St. Joseph Peninsula State Park, a debris line was measured in the dunes to be +17.3 feet NAVD. Wave uprush undoubtedly contributed to the higher water levels observed with the overwash deposits along the peninsula. Along the southern half of St. Joseph Peninsula, the USGS measured high water marks ranging between +9.3 feet NAVD and +10.9 feet NAVD. No high-water data was measured on Cape San Blas; however, along the isthmus connecting Cape San Blas to the mainland, USGS measured several high-water marks ranging between +10.9 feet NAVD and +11.7 feet NAVD. These high-water marks likely represented the storm surge setup at the upper south reach of St. Joseph Bay with flow across the isthmus. This phenomenon was also observed previously with Hurricane Kate in 1985.

Along the eastern gulf shore of the county extending to Indian Peninsula, USGS measured high-water marks ranging between +10.0 feet NAVD and +11.4 feet NAVD. The storm surge caused significant flooding along Indian Peninsula and major flood impacts were observed in the vicinity of Money Bayou,

near DEP reference monument R141. Just west of Money Bayou, USGS measured a high-water mark of +12.2 feet NAVD inside a shuttered hurricane door of a building's understructure. Inside Indian Pass at the eastern end of Indian Peninsula a high-water mark of +9.5 feet NAVD was measured.

Michael's erosion impact throughout Gulf County was severe given the county's location to the right of the hurricane's eye at landfall. Major beach and dune erosion (Condition IV) was sustained on the mainland at Beacon Hill as well as along the entire gulf shoreline of St. Joseph Peninsula and the western shore of Cape San Blas. East of Beacon Hill along the Windmark development, minor beach and dune erosion (Condition II) was sustained for a shoreline segment substantially protected in the lee of St. Joseph Peninsula. The eastern shore of Cape San Blas and the isthmus connecting Cape San Blas to the mainland, as well as much of Indian Peninsula, was somewhat sheltered from Michael's most extreme wave energy and sustained minor beach and dune erosion (Condition II). This stretch of coast has a very wide beach backed by a low wide dune field and the slope across the beach/dune system extending offshore is very gradual. This naturally gradual slope likely contributed to significant dampening of storm waves propagating shoreward. However, major dune erosion (Condition IV) was also observed along the terminus of Indian Peninsula at Indian Pass between DEP reference monuments R159-R161, as the storm tide surged into St. Vincent Sound and strong currents scoured the toe of the primary dunes.

The greatest geomorphological change to the Gulf County coast caused by Hurricane Michael was a barrier breach near the midpoint of St. Joseph Peninsula. The barrier breakthrough occurred generally between DEP reference monuments R71 and R72, at a place called Eagle Harbor just north of the marina within T.H. Stone Memorial St. Joseph Peninsula State Park (**Figures 53-54**). A primary breach of approximately 900 feet in width resulted in the scouring of a tidal channel approximately 200 feet wide by an average of six to eight feet deep. A maximum depth of around 10 feet was reported by Florida Fish and Wildlife Conservation Commission (FWC) officers at the site. A smaller and less hydraulically stable breach was also created immediately to the north of the larger breach near DEP reference monument R71. The significant effect of these breaches is to truncate the peninsula as well as the state park, isolating all the campgrounds, cabins, park administration facilities and much of the park's infrastructure from vehicular access. Should the breach remain open, a significant long-term impact to the adjacent park beaches may be expected. Longshore sediment transport may be expected to remove a large volume of sand from the adjoining beaches and carry the material into the aquatic preserve within St. Joseph's Bay.

Note: Given this document is a preliminary report, quantitative erosion effects cannot yet be determined. A post-storm survey of the St. Joseph Peninsula Beach Restoration Project is expected to be conducted, which will quantify the erosion losses along the southern half of St. Joseph Peninsula between DEP reference monuments R67-R105. In addition, USACE has recently flown a LIDAR survey of the coast, which will also provide data to compute volumetric changes due to Michael. Quantitative volumetric data will be provided in a final post-storm report when available.

Storm Damage

Hurricane Michael caused major damage throughout Gulf County, which was located within the strongest wind field to the right of the hurricane's eye at landfall. Gulf County was subjected to the maximum storm surge, greatest wave energy, and strongest winds during Michael. The severe wind damage from Michael extended inland across the county leveling pine forests and devastating inland structures, including the northern county community of Wewahitchka. Along the coast, damage was particularly severe from Beacon Hill to Indian Pass, including St. Joseph Peninsula and Cape San Blas. Within the coastal building zone fronting on the Gulf of Mexico, Gulf County sustained major damage to 984 major structures. In contrast, Gulf County had only seen major damage to 71 major structures in the coastal building zone from all the Northwest Florida hurricanes dating back to 1975.

The greatest impact from Michael was sustained along Beacon Hill, including the sparsely constructed Windmark development to the east of Beacon Hill. This mainland segment of coast sustained the greatest damage within the county with major damage being sustained to 588 major structures, including 149 that were destroyed. Most of the major damage was caused by the storm surge and waves, which inflicted severe flood damage extending as much as 500 to 700 feet inland of U.S. Highway 98. The severe wind loads added to the flood damage throughout the coastal building zone. Many structures, regardless of foundation type, were floated inland with the storm surge and deposited on roads or neighboring properties. Most of the structures seaward of U.S. Highway 98 were destroyed. Typically, the pile-supported, state-authorized structures seaward of the highway and seaward of the established CCCL, fared well structurally and only sustained some roof and siding damage from the winds, as well as understructure damage to breakaway elements below the habitable floor level.

The flood and wind damage continued eastward along the mainland coast of Gulf County into the city of Port St. Joe fronting on St. Joseph's Bay. The Department's damage assessment teams did not conduct detailed damage assessments along the St. Joseph Bay shoreline; however, major damage was observed throughout this area. The public marina facilities were particularly hard hit in Port St. Joe with docks,

roads, and shoreline armoring sustaining major damages. Vessels within the marina were either sunken, impaled on top of dock pilings, or floated onto adjacent upland areas. Churches, office buildings, banks and various commercial buildings within the city's center sustained major wind damages. Flood damages to residential neighborhoods east of downtown Port St. Joe were particularly severe as most of the single-family dwellings were constructed on-grade with many dating to the 1950s and 1960s.

Much of the Gulf County coast is dominated by St. Joseph Peninsula, and with the eye of Michael passing laterally just offshore, major damage was incurred along the barrier. The northern 6.6 miles of the barrier (R32-R67) has no development, but substantial development is between DEP reference monument R67 within the state park south to R105 at Stump Hole. St. Joseph Peninsula sustained major damage to 279 major structures, including 22 that were destroyed. In addition, another 64 major habitable structures sustained understructure damage to breakaway walls, parking slabs, and utilities due to the storm surge and waves. A number of structures that predated the Department's coastal building standards were destroyed or severely damaged by the storm surge and waves, but much of the damage was caused by the extreme wind loads to roofs and siding. Of note, nourishment of the St. Joseph Peninsula Beach Restoration Project was to have started at the time Michael made landfall. While the project certainly assisted in the protection of many structures along the peninsula, the project's design template was substantially depleted along its southern end, and therefore, was not able to provide its full protective benefit. The upland properties and development along St. Joseph Peninsula are now vulnerable to the flooding and dune erosion of future storms.

A narrow armored isthmus called Stump Hole divides St. Joseph Peninsula from Cape San Blas. After years of progressive erosion stress at this longshore sediment drift divide, and multiple storms that damaged the road and rock rubble protection, a 1,550-foot-long boulder mound structure designed to withstand a 50-year storm event was constructed by Gulf County to protect County Road 30E in 2012-13. This coastal protection structure provided substantial protection to the road from Michael's storm surge and waves. However, the ends of the structure proved particularly vulnerable, and 900 feet of road was destroyed to the north and 300 feet was destroyed to the south of the boulder mound structure.

Cape San Blas is substantially federal land, which is part of Eglin Air Force Base. An entire complex of Air Force buildings and infrastructure along with the historic Cape San Blas lighthouse was previously removed over the years due to the extreme erosion stress. No development remained to be affected by Hurricane Michael. To the east along the isthmus connecting Cape San Blas to the mainland, 21 major structures sustained major damage. This area was somewhat sheltered from the storm waves and

substantial flooding occurred from the St. Joseph Bay shore over the isthmus. Most of the major damage was due to the extreme wind forces, but two dwellings also had understructure damage from the storm surge.

Along the mainland east of Cape San Blas and along Indian Peninsula, 96 major structures sustained major damage, including five that were destroyed. The high-water mark measured by USGS at Money Bayou was just under a 100-year storm surge event, and 127 dwellings sustained understructure damage from the storm surge and waves. In addition, many buildings also had wind damage to roofs and siding. At Money Bayou, 150 feet of bulkheads sustained Level 3 major damage, and a timber pile bridge was destroyed along with 170 feet of road. See **Figures 40** through **68** for examples of damage in Gulf County.



Figure 40. High water mark of +21.2 feet NAVD along U.S. 98 and S.R. 386 near R1, Beacon Hill.



Figure 41. Aerial photo comparison in Beacon Hill (R1).



Figure 42. Dwellings along U.S. 98 destroyed near R3, Beacon Hill.



Figure 43. Dwellings destroyed along U.S. 98 near R3.5, Beacon Hill.



Figure 44. Dwelling transported by storm surge onto Trade Winds Dr. near R6, Beacon Hill.



Figure 45. Dwelling transported across U.S. 98 by the storm surge, Beacon Hill.



Figure 46. Aerial photo comparison in Beacon Hill (R7).



Figure 47. Townhouses destroyed near R7, Beacon Hill.



Figure 48. Major damage to dwelling due to high winds and fallen trees, Beacon Hill.



Figure 49. Marina damage due to the storm surge, Port St. Joe.



Figure 50. Ship carried onto upland by the storm surge, Port St. Joe.



Figure 51. First Baptist Church with major wind damage, Port St. Joe.



Figure 52. Dwelling destroyed by the storm surge from St. Joseph Bay, Port St. Joe.



Figure 53. Breach of St. Joseph Peninsula between R71 and R72.

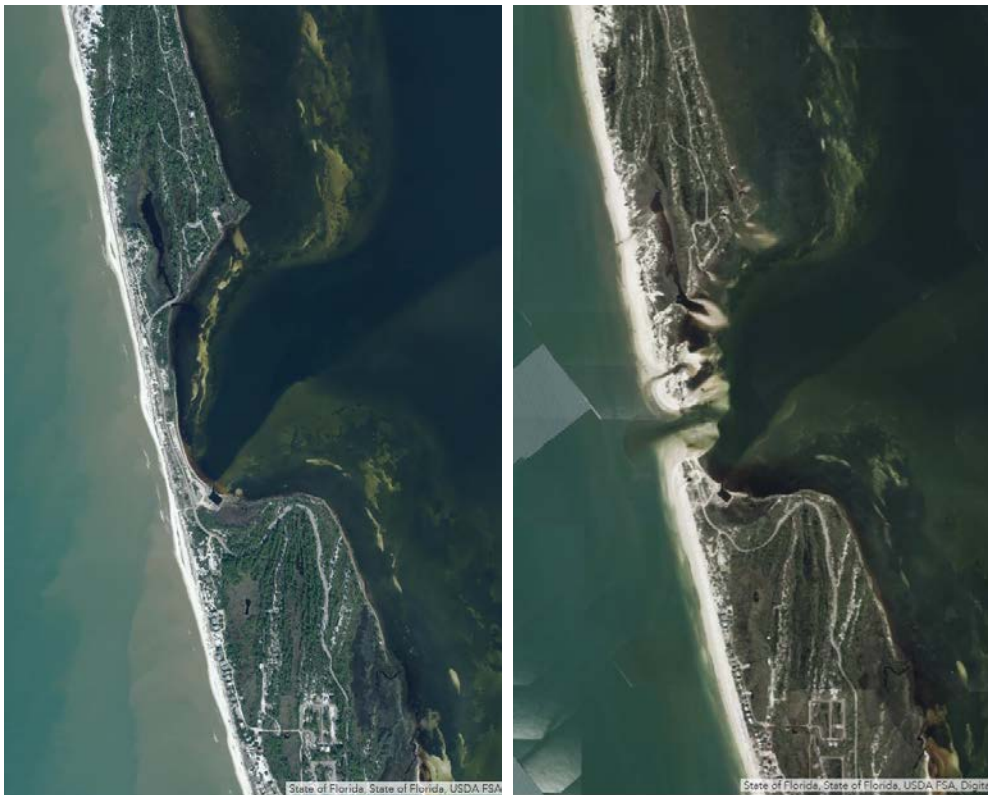


Figure 54. Before and after of breach across St. Joseph Peninsula between R71 and R72.



Figure 55. Major dune erosion (12-foot escarpment) near R74, St. Joseph Peninsula.



Figure 56. Major dune erosion, R77, St. Joseph Peninsula.



Figure 57. Major roof damage due to high winds near R85, St. Joseph Peninsula.



Figure 58. Remains of four destroyed townhouse buildings on Nassau Lane near R90.5, St. Joseph Peninsula.



Figure 59. *Pile-supported dwelling destroyed near R97.5, St. Joseph Peninsula.*



Figure 60. *Dwelling destroyed near R99.5, St. Joseph Peninsula.*



Figure 61. Over six feet of vertical loss of grade beneath structure near R104.



Figure 62. Major damage to bulkheads and swimming pools near R104.



Figure 63. County Road 30E destroyed north of the Stump Hole revetment, R105.



Figure 64. County Road 30E destroyed south of the Stump Hole revetment, R107.



Figure 65. Severe beach and dune erosion at Cape San Blas, R110.



Figure 66. Storm surge damages at Money Bayou, R140.



Figure 67. Bridge destroyed across Money Bayou, R140.5.



Figure 68. Bulkhead on Money Bayou damaged, R141.

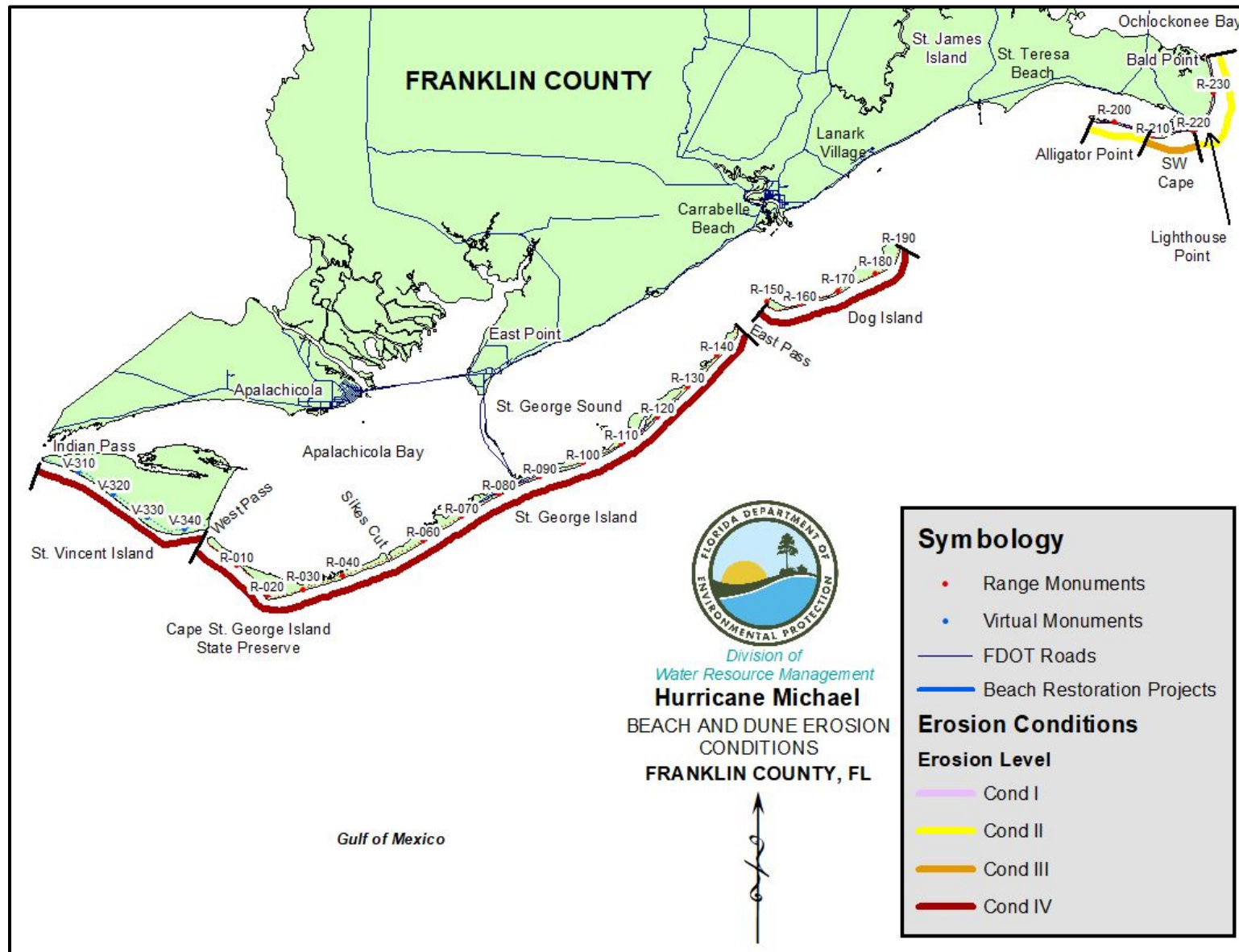


Figure 69. Franklin County Beach and Dune Erosion Conditions from Hurricane Michael.

Franklin County

The Gulf of Mexico fronting barrier beaches of Franklin County extend for 54.6 miles between Gulf and Wakulla Counties. There are additional mainland beaches along the Franklin County coast that are not included in the Department's coastal construction regulatory program. Franklin County includes the following barrier beach communities and major parks: St. Vincent National Wildlife Refuge, Cape St. George Island State Preserve, St. George Island Plantation, Dr. Julian G. Bruce St. George Island State Park, and Bald Point State Park (**Figure 69**).

There are four barrier islands and a barrier spit in Franklin County. At the west end of the county to the east of Indian Pass lies St. Vincent Island, a triangularly shaped barrier island about 7.5 miles long, which is comprised of a unique complex of multiple beach ridges trending generally southeast to east-southeast. St. Vincent Island is an undeveloped federal wildlife refuge. To the east, and separated by West Pass is the barrier island complex of Little St. George Island and St. George Island, which is about 29 miles long and ranges from 1,100 feet to a mile in width. From West Pass to Cape St. George, the shoreline has the same southeasterly orientation as St. Vincent Island. Little St. George Island was once a separate island prior to closure of a natural pass in the early 20th century. At Cape St. George, the island changes orientation trending in a northeasterly direction. Little St. George Island, which includes Cape St. George, and the historic west end of St. George Island, are now part of the Cape St. George Island Preserve, which extends from West Pass to Bob Sikes Cut. Bob Sikes Cut, the only federally owned inlet in Florida, is a man-made channel across St. George Island and is part of a federal navigation project between the Gulf of Mexico and the town of Apalachicola on the mainland fronting Apalachicola Bay. St. George Island extends east of Sikes Cut to East Pass, a two-mile-wide natural inlet. There is a federal navigation project at East Pass; however, the channel has never required dredging. The mainland coast landward of East Pass fronting St. George Sound includes the beach community of Carrabelle Beach. To the east of East Pass lies Dog Island, the easternmost barrier island on the northern Gulf Coast. Dog Island is approximately 6.9 miles long and has two narrow segments along the western portion of the island that are subject to frequent inundation during even minor storm tides. The easternmost segment of the Franklin County coast is a mainland peninsula, known as St. James Island, which lies between the gulf and Ochlockonee Bay. The eastern end of the peninsula extends in a north-south orientation for about 3.4 miles from Bald Point southward to Lighthouse Point. From Lighthouse Point, a barrier spit extends for five miles to the west past the Southwest Cape and terminating in Alligator Point. The coast of St. James Island between Dog Island and Alligator Point includes the beach communities of St. Teresa Beach and Lanark.

There are six critically eroded beach areas (11.1 miles), nine non-critically eroded beach areas (19.7 miles), and one non-critically eroded inlet shoreline area (0.5 mile) in Franklin County. St. Vincent Island has a 3.2-mile long non-critically eroded area along its most gulfward protruding midsection (V317–V334). To the east, a 0.9-mile segment of St. Vincent Island (V334–V339) is critically eroded into the maritime forest resulting in the loss of beach wildlife habitat. Severe erosion exists at Cape St. George on Little St. George Island, resulting in the loss of the historic pre-Civil War lighthouse. This critically eroded area (R18.5–R22.5) extends along a 0.6-mile length of shoreline and is adjoined at both ends by a 0.7-mile non-critically eroded segment to the west (R15–R18.5) and a 0.3-mile non-critically eroded segment to the east (R22.5–R24). The west end of the historical length of St. George Island west of Sikes Cut (R34–R51) is non-critically eroded for 3.3 miles. Both interior shorelines of Sikes Cut also have non-critical erosion for 0.5 mile. East of Sikes Cut, the St. George Island Plantation (R53–R69) is designated non-critically eroded for 3.3 miles. After Hurricane Dennis (2005) severely impacted Dr. Julian G. Bruce St. George Island State Park, the entire developed stretch of the park (R106–R128.5) was designated critically eroded for 4.5 miles due to the impact to recreational interests and park infrastructure. The undeveloped eastern 3.8 miles (R128.5–R147) is considered non-critically eroded. Most of Dog Island is eroded, including the western 2.6 miles (R154–R168) which is non-critically eroded. To the east, a 3.6-mile segment (R168–R187.2) is designated critically eroded. The undeveloped historic west end of Alligator Point (R194–R196) is severely eroded for 0.4 mile and designated noncritically eroded. The eastern end of Alligator Peninsula (R210–R216) between the Southwest Cape and Lighthouse Point is designated critically eroded for 1.1 miles, where past storms have destroyed and continue to threaten private development and a county road. The southeastern end of St. James Island is critically eroded extending north from Lighthouse Point (R220–R222) for 0.4 mile, threatening residential development. Further north from Lighthouse Point (R222–R232), a non-critically eroded area extends for 2.1 miles.

Storm Effects and Erosion Conditions

The storm tides of Hurricane Michael in Franklin County generally ranged from 8 to 12 feet above sea level. USGS measured high-water marks along St. George Island ranging between +8 feet NAVD and +10.6 feet NAVD (*Figure 4*). At Apalachicola on the mainland shore of Apalachicola Bay, storm tides were experienced of 8 to 9 feet above sea level. At the bay entrance of the Apalachicola River, a NOAA tide gauge measured a peak tide level from Michael of +8.6 Feet NAVD. At East Point on the mainland shore of St. George Sound behind St. George Island, USGS measured high water marks ranging between

+8.6 feet NAVD to +10.6 feet NAVD. These elevations were comparable to those measured along the gulf shore of St. George Island. At the eastern end of St. George Island, a debris line was measured at +9.7 feet NAVD, and along the mainland beach adjacent to East Pass, a high-water mark was measured inside a storage shed to be +11.8 feet NAVD. No high-water marks have yet been measured on Dog Island, but storm tides of 9 to 10 feet above sea level were measured along the shoreline at Carrabelle fronting on St. George Sound. Likewise, storm tides of 9 to 11 feet above sea level were measured along the gulf fronting shoreline of St. James Island. USGS measured high-water marks along Alligator Peninsula, including the Southwest Cape and Lighthouse Point, ranging between +8.8 feet NAVD and +10.7 feet NAVD.

Michael's storm surge caused extensive washover fans into the dune field and maritime forest of St. Vincent Island generally between DEP virtual stations V317 and V339. All along St. Vincent Island's gulf beach are storm tide runout channels that carried the ebbing flood waters back across the beach. A large developing cusped foreland at the southwestern point of St. Vincent Island experienced substantial growth, enclosing a now entrapped lagoon (**Figure 70**). This lagoon is the seventh and most seaward of a progression of coastal lakes formed in likely similar manner. Immediately offshore, two subaerial shoals have substantially eroded with only a fragment of one now exposed. The sediment of these shoals may have contributed to the avulsive growth of the cusped foreland.

The length of the St. George Island barrier complex experienced storm surge flooding and substantial overwash deposits. Extensive washover fans exist between DEP reference monuments R5 and R13 on Little St. George Island. As was seen along St. Vincent Island, the Cape St. George area has several storm tide runout channels that carried the ebbing flood waters back across the beach. East of the cape between DEP reference monument R29 and Bob Sikes Cut at R51, Michael's storm surge caused extensive washover fans across the island. The western jetty at the cut is separated from the island at high tide. Substantial shoaling appears to have occurred within the inlet with substantial beach material having been removed from the St. George Plantation east of Sikes Cut. At R52 at Sikes Cut, the eastern jetty was breached separating it from St. George Island (**Figure 71**). The eastern and western jetty breaches had previously occurred during Hurricanes Elena and Kate in 1985.

Along St. Vincent Island, Little St. George Island, and the St. George Island Plantation between DEP reference monuments R52 and R73, major beach and dune erosion (Condition IV) was sustained (**Figure 72**). Along the St. George Island Plantation, the vegetation and dunes retreated as much as 50 feet, leaving much of the development of single-family dwellings now fronting a low unvegetated beach.

Some of the higher primary dunes now have vertical escarpments as high as 12 to 15 feet. To the east of the plantation, along the central stable beaches of St. George Island between DEP reference monuments R73 and R99 where low profile foredunes existed, the vegetation line retreated as much as 100 feet and greater, and the low foredunes were completely leveled. Between East Gorrie Drive and East Gulf Beach Drive, generally between DEP reference monuments R87 and R99, an intermittent inland lake existed after the storm due to both the storm surge and the rain fall. These interdunal depressions typically flood during major rain events. Between R99 and R104, behind a higher dune field than to the west, substantial flooding existed along East Gulf Beach Drive. Major dune erosion (Condition IV) was sustained along this area of residential development.

In the Dr. Julian G. Bruce St. George Island State Park, which extends along the eastern 8.4 miles of St. George Island between DEP reference monuments R105 and R149, major beach and dune erosion (Condition IV) was sustained (**Figure 76**). Near the state park entrance at R105.4 and R106, large storm tide runout channels cross the beach and dune region gulfward of the park road. This area was a region of large washover fans where the storm surge flowed across the island into St. George Sound. This same area experienced similar flooding impacts during Hurricanes Agnes (1972), Elena and Kate (1985), and Dennis (2005). Between R110 and R117 at East Slough, extensive washover fans exist where the storm surge flowed across this narrow segment of the island. Similar to along East Gulf Beach Drive, the park segment between the two high public use areas at East Slough (R117.5) and Sugar Hill (R128), has a generally continuous elongated meandering lake both gulfward and landward of the park road left from the entrapment of the storm surge between the primary dune field and a more landward ancient dune field. Several more storm tide runout channels cross the beach and dune region gulfward of the park road along this stretch between East Slough and Sugar Hill. East of Sugar Hill between DEP reference monuments R128 and R149 at the eastern end of St. George Island, there was nearly total inundation of the island during the storm surge, which leveled the dunes and left large washover deposits.

To the east of St. George Island and East Pass, Dog Island (R150-R192) sustained major beach and dune erosion (Condition IV). The two narrow segments of western Dog Island between DEP reference monuments R155-R160 and between R165-R169 were inundated by the storm surge, causing further deflation of these narrow island segments with substantial sediment transport into the St. George Sound side of the island. This overwash and landward beach migration has uncovered historical 19th century shipwrecks and remnants of a commercial dock in the vicinity of R158, which was destroyed in the “Carrabelle Hurricane” of 1899. Along much of the remainder of the island, the vegetation line retreated as much as 50 feet and greater.

The erosion conditions moderated along the coastal barriers further to the east. Alligator Peninsula between Alligator Point (R195) and the Southwest Cape (R209) sustained minor beach and dune erosion (Condition II). Along the barrier peninsula east of the Southwest Cape between DEP reference monuments R209 and R217, moderate beach and dune erosion was sustained (Condition III). From Lighthouse Point (R217) northward to Bald Point (R239), minor beach and dune erosion (Condition II) was sustained. Portions of Alligator Point and Bald Point were completely inundated by the storm surge. Sand was deposited in washover fans between the dune and the road sporadically throughout the length of Bald Point. The dune was leveled with sand being deposited on and across the road near R228.

Storm Damage

Hurricane Michael caused major structural damage to 165 major structures within the coastal building zone on St. George Island, Dog Island, and the coast barrier system between Alligator Point and Bald Point. Past hurricanes impacted less major structures in the coastal building zone of Franklin County, including Hurricanes Elena (22 major structures) and Kate (159 major structures) in 1985, Hurricane Opal (eight major structures) in 1995, Hurricane Earl (eight major structures) in 1998, and Hurricane Dennis (52 major structures) in 2005. Many of the structures damaged by Elena and Kate were located along U.S. Highway 98 between Apalachicola and St. Teresa Beach on St. James Island. The Department's damage survey teams did not conduct a detailed investigation of the damage along U.S. Highway 98 after Hurricane Michael; however, it was noted that a number of major structures were substantially damaged in and near Apalachicola, two commercial buildings were destroyed and five more sustained major damage in Eastpoint, four single-family dwellings were destroyed and two more sustained major structural damage in Carrabelle Beach, and five single-family dwellings were destroyed along St. Teresa Beach.

On St. George Island, 96 major structures sustained major damage. In addition, another 29 single-family dwellings sustained understructure damage, and a number of older grade-level dwellings sustained static flood damage to their interiors. Along the St. George Island Plantation (R52-R73), the damages sustained were predominantly understructure damage to breakaway walls, parking slabs and utilities due to the storm surge and waves, as well as some roof and siding damages. At least three swimming pools were sanded by the storm surge. Along East and West Gorrie Drive, major wind damage was sustained by roofs and siding, and static flood damage was sustained by grade-level dwellings. Siding damage was particularly widespread between R84 and R85. Three swimming pools along East Gorrie Drive were also sanded by the storm surge. Along the developed reach of St. George Island (R52-R104) numerous

beach access walkways were destroyed or sustained major damage. Fences, decks, and gazebos were also damaged.

In the state park, five segments of the park road totaling 625 feet were destroyed between R108 and R114; however, much greater lengths were observed to have sustained minor to moderate damage. Additionally, long segments of the park road are under sand overwash deposits and the condition of the road in these areas was not observable. Likewise, the parking lots at the East Slough and Sugar Hill public access areas are covered with sand, although these paved structures do not appear to have sustained damage. The beach pavilions and bath houses at East Slough and Sugar Hill did not sustain major structural damage, but the beach access walkways were damaged throughout the park.

The damage to major structures on Dog Island from Michael was the greatest of any past hurricane. A major factor for this has been the progressive erosion stress, which continues to deplete the natural beach and dune protection seaward of residential construction that was originally considered sufficiently well sited landward of the beach. Hurricane Kate (1985) caused major dune erosion, but only destroyed one dwelling by the storm surge and erosion along with causing major damage to eight others by the wind. At that time, most dwellings were still substantially landward of the beach. After another 20 years of erosion, Hurricane Dennis caused major damage to 15 single-family dwellings, including seven that were destroyed. All but one of these were damaged by the storm surge and erosion. Following another 13 years of erosion with partial recovery after Dennis, Hurricane Michael caused major damage to 25 major structures, including 12 that were destroyed. A timber bulkhead of 165 feet was also destroyed, and ten dwellings sustained understructure damage. A number of dwellings remain threatened by another storm of comparable intensity as Kate, Dennis, and Michael on Dog Island.

Between Alligator Point and Bald Point, Michael caused major damage to 44 major structures including five that were destroyed. An additional 1,506 feet of walls were damaged along with 3,000 feet of rock revetment that sustained major damage. Alligator Drive paralleling the rock revetment was destroyed including where it connects to Chip Morrison Drive on the west end of the revetment. At the end of Gulf Shore Blvd on Lighthouse Point, the easternmost 175 feet of road was destroyed. These damages compare to those of Hurricane Dennis (2005) when 26 major structures sustained major damage, including 16 that were destroyed. Along Alligator Point and Bald Point, the majority of the damages sustained were predominantly understructure damage to breakaway walls, parking slabs, and utilities due to the storm surge and waves, as well as some roof and siding damages. Fences, decks, and walkovers were also damaged. Within Bald Point State Park, the beach walkovers were damaged and

some of the picnic pavilions were left lightly sanded by the washover of the island. The pier at the end of Bald Point State Park was not damaged. See **Figures 70** through **91** for examples of damage in Franklin County.



Figure 70. Before and after of major coastal changes to St. Vincent Island.

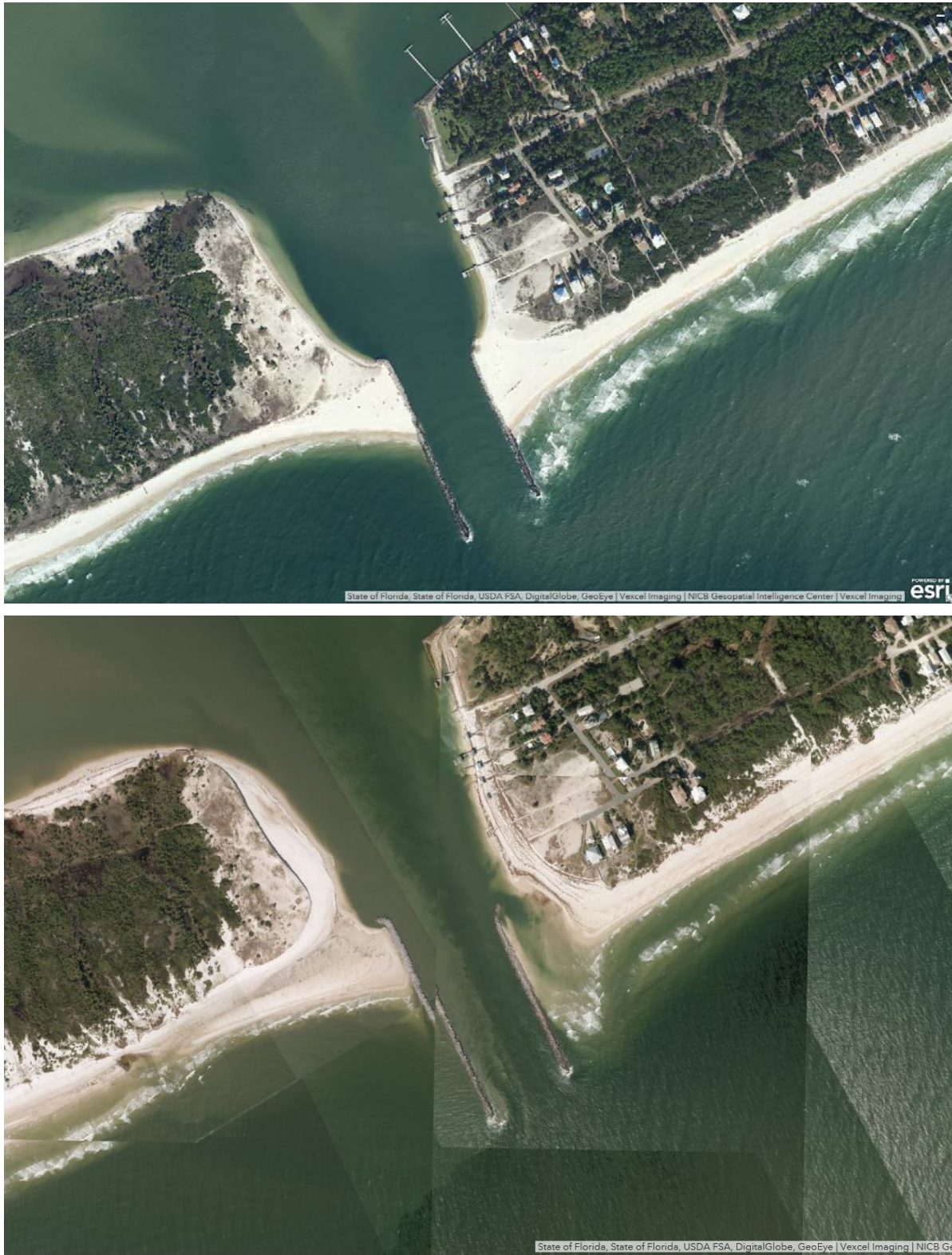


Figure 71. Before and after of breaching of the Sike's Cut jetties from St. George Island, R51-R52.



Figure 72. Major beach and dune erosion at Sikes Cut at R52, St. George Island.



Figure 73. Major dune erosion at R72, St. George Island.



Figure 74. Dwelling damaged near R78, St. George Island.



Figure 75. Flooded interdunal depression on St. George Island between R87-R99.



Figure 76. *Dunes leveled across St. George Island State Park.*



Figure 77. *State park road destroyed near R108, St. George Island.*



Figure 78. Dunes leveled and park road destroyed at R114, St. George Island.



Figure 79. U.S. Highway 98 damaged near Eastpoint.



Figure 80. 19th century shipwreck uncovered by erosion near R158, Dog Island.



Figure 81. Narrows near R159, Dog Island.



Figure 82. Dwelling destroyed near R173, Dog Island.



Figure 83. Dwelling destroyed near R174, Dog Island.



Figure 84. Dwelling destroyed near R176, Dog Island.



Figure 85. Dwelling destroyed near R178, Dog Island.



Figure 86. Dwelling destroyed near R179, Dog Island.



Figure 87. Pelican Inn destroyed near R183, Dog Island.



Figure 88. 3,000 feet of road and revetment destroyed between R211-R214, Southwest Cape.



Figure 89. Dwelling destroyed near R210, Southwest Cape.



Figure 90. Dwelling destroyed near R211, Southwest Cape.



Figure 91. Dwelling and bulkhead damaged near R214.5, Southwest Cape.

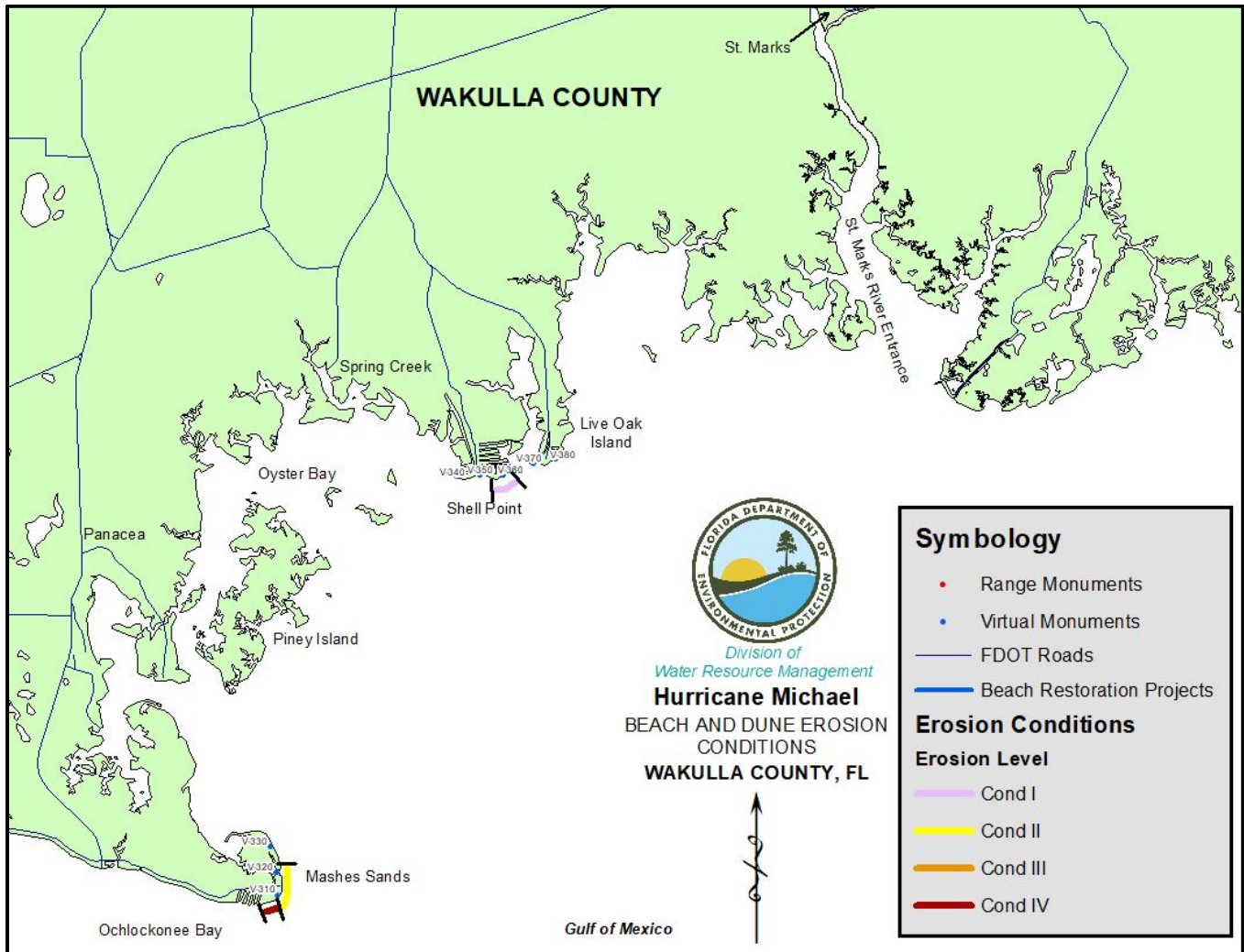


Figure 92. Wakulla County Beach and Dune Erosion Conditions from Hurricane Michael.

Wakulla County

Wakulla County is considered the easternmost county in the Florida Panhandle, with approximately three miles of barrier coastal beaches (Figure 92). It is also considered part of the Big Bend Coast, which stretches for approximately 240 miles from Ochlockonee Bay on its western end, east and south to Anclote Key just north of Tampa. Coastal Wakulla County includes the following communities and parks: Mashes Island Park, Panacea, Spring Creek, Shell Point, Live Oak Island, Wakulla Beach, St. Marks, and the St. Marks National Wildlife Refuge. The Wakulla County coast includes entrances to two major rivers, the Ochlockonee River and the St. Marks River, and numerous tidal creeks, including many that are spring fed.

The most prominent barrier coastal beach in Wakulla County is Mashles Sands (a chenier beach) just north of the entrance to Ochlockonee Bay. The southern shoreline at the bay entrance is severely eroding. The eastern beach to the north of the bay experiences classical chenier migration landward with storm surge overwash into a tidal wetland. The dominant direction of longshore transport along this beach is to the north. To the east, is a beach along Shell Point, a developed headland between tidal creeks and wetlands. Most of Shell Point is now armored with seawalls and rock revetments, except along a county owned public beach.

There are two critically eroded beach areas (1.3 miles) and one non-critically eroded beach area (0.4 mile) in Wakulla County. Mashles Sands is designated critically eroded along its southern end for 0.3 mile threatening recreational interests at the county park. Non-critical erosion extends another 0.4 mile to the north. Shell Point has 1.0 mile of critical erosion threatening development and a county park.

Storm Effects and Erosion Conditions

The storm tides of Hurricane Michael in Wakulla County generally ranged from 9 to 12 feet above sea level. USGS measured high water marks along the shore of Ochlockonee Bay, including at Mashles Sands between 9 and 10 feet above sea level. High water marks between +10.0 feet NAVD and +10.7 feet NAVD were measured at Spring Creek, Shell Point, and Live Oak Island. At the St. Marks lighthouse at the entrance to the St. Marks River, USGS measured a high-water mark of +9.8 feet NAVD. Up river at the Town of St. Marks, high water-marks were measured between 9 and 10 feet above sea level.

Major beach and dune erosion (Condition IV) was sustained along the southern shoreline of Mashles Sands. Generally minor beach and dune erosion (Condition II) was sustained northward along the eastern shoreline of Mashles Sands. No erosion was observed along the western segment of shoreline west of the bath house at the public beach at Shell Point, where most of the community was flooded by the storm surge. East of the bath house, however, minor beach erosion (Condition I) was sustained along the public beach and along the shoreline extending eastward to the entrance to Walker Creek.

Storm Damage

Hurricane Michael caused substantially less coastal building damage in Wakulla County than was sustained during Hurricane Kate (1985; 46 major structures) or Hurricane Dennis (2005; 37 major structures). Michael caused major damage to six major structures on coastal Wakulla County.

On Mashas Sands, two nonhabitable major structures were substantially destroyed. On the southern shoreline, the Mashas Sands timber fishing pier was substantially destroyed by the storm surge and wave forces. Along the same shoreline, 300 feet of elevated timber walkway that provided access to the pier was destroyed. The terminal boulder mound groin at the canal entrance near the pier was undamaged. At the Mashas Sands eastern shoreline, the public bath house was destroyed.

At Shell Point, four single-family dwellings sustained major structural damage, including one grade-level house that was destroyed. Another 12 single-family dwellings sustained understructure damage. Many dwellings throughout Shell Point sustained static flood damage to their interiors. While much of the shoreline at Shell Point is now armored with bulkheads and revetments, only 100 feet of rock revetment at one property sustained Level 3 major damage. Another 240 feet of timber bulkhead has been compromised with Level 1 damage due to the backfill being scoured out behind the wall. See **Figures 93** through **97** for examples of damage in Wakulla County.



Figure 93. Fishing pier and access walkway damaged at Mashas Sands, V303.



Figure 94. Bathhouse destroyed at Mashers Sands, V314.



Figure 95. Dwelling with major damage from the storm surge at Shell Point, V342.



Figure 96. *Minor erosion to public beach at Shell Point, V355.*



Figure 97. *Rock revetment damaged and dwelling with parking slab and bracing damage at Shell Point, V361.*

V. Summary of Hurricane Michael's Impacts

Hurricane Michael was the third strongest hurricane to make landfall in continental United States in recorded history. Michael was an epic storm event for the northern Gulf of Mexico coast of Florida, causing substantial impact from Panama City Beach to St. Marks. The most severe damage, occurring to the right of the hurricane's eye at landfall, was sustained in Mexico Beach (Bay County) and Beacon Hill (Gulf County). Along the coast of Bay, Gulf, Franklin, and Wakulla Counties, a total of 2,725 major structures sustained major structural damage within the Coastal Building Zone.

This document will assist the Department and local governments to identify areas where storm erosion has left upland development and infrastructure vulnerable to imminent damage from future storms, where beaches and dunes may be restored, and where expedited permitting procedures are needed to assist homeowners with repairs and reconstruction. This document is a preliminary report and quantitative erosion effects have not yet been determined. Post-storm surveys of the Panama City Beaches Shore Protection Project and the St. Joseph Peninsula Beach Restoration Project are expected to be conducted, which will quantify the erosion losses along the western half of Bay County and the developed portion of Gulf County. In addition, USACE will provide an upland LIDAR survey of the coast, which will also provide data to compute upland volumetric changes due to Michael. Quantitative volumetric data will be provided in a final post-storm report when available.