

## APPENDIX 1C:

### THE STATUS OF SANDY, OCEANFRONT BEACH HABITAT IN THE COASTAL MIGRATION AND WINTERING RANGE OF THE PIPING PLOVER (*Charadrius melodus*)<sup>1</sup>

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The U.S. Fish and Wildlife Service's (USFWS's) 5-Year Review for the piping plover (*Charadrius melodus*) recommends developing a state-by-state atlas for wintering and migration habitat for the overlapping coastal migration and wintering ranges of the federally listed (endangered) Great Lakes, (threatened) Atlantic Coast and Northern Great Plains piping plover populations (USFWS 2009). The atlas should include data on the abundance, distribution and condition of currently existing habitat. This assessment addresses this recommendation by providing this data for one habitat type – sandy, oceanfront beaches within the migration and wintering range of the southeastern continental United States (U.S.). Sandy beaches are a valuable habitat for piping plovers, other shorebirds and waterbirds for foraging, loafing, and roosting.

#### METHODS

In order to evaluate the status of sandy, oceanfront beaches along the coastlines of North Carolina (NC), South Carolina (SC), Georgia (GA), Florida (FL), Alabama (AL), Mississippi (MS), Louisiana (LA) and Texas (TX), several methods were used. Non-sandy oceanfront areas were excluded since they do not currently provide this habitat; these areas occur along marshy sections of coast in Louisiana, the Big Bend Marsh coast of northwest Florida, the Ten Thousand Island Mangrove coast of southwest Florida, and the Florida Keys. The status of sandy, oceanfront beaches were evaluated through an estimation of the length and proportions of shoreline that were developed, undeveloped, preserved, armored and receiving beach fill or dredge spoil placement. Mainland beaches, with the exception of those in Mississippi, were not included unless no barrier islands were located offshore and thus the mainland beaches were located directly on the Atlantic Ocean or Gulf of Mexico (e.g., Holly Beach, Louisiana).

The lengths of developed versus undeveloped sandy, oceanfront beach were assessed primarily by using existing published reports such as the United States Geological Survey's (USGS) *Coastal Classification Atlas* that was recently completed for most of the Gulf of Mexico coast. Existing data were thus located for the coasts of NC, SC, the Gulf coast of Florida, AL, MS, and significant portions of TX and LA (sources are listed under the State-specific Results section). Data gaps were then identified where no existing

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data assessed these parameters. Google Earth was then utilized to calculate the lengths of sandy, oceanfront beaches within the geographic data gaps as well as to distinguish the lengths that were developed versus undeveloped (see Table 1 for a list of the data gaps where Google Earth was utilized). A Microsoft Excel database of all data was created, with the data organized by geographic area. Wherever possible, data were compiled on a county-by-county or shoreline segment basis to facilitate updates and replication of the data.

For geographic areas where Google Earth was utilized to calculate the approximate lengths of sandy, oceanfront beach shoreline that were developed versus undeveloped, no distinction was made as to the level of development. The USGS *Coastal Classification Atlas* categorized developed areas into low, medium, and high density development, but this assessment consolidated those categories into one developed category (for more detailed information on a particular area, consult the individual reports or topographic quadrangles produced by the Coastal Classification Mapping Project at <http://coastal.er.usgs.gov/coastal-classification/>). Undeveloped areas were those where no structures existed adjacent to the beach and that appeared natural in the Google Earth aerial imagery. Individual unbuilt lots that were surrounded by a high number of buildings were not counted as undeveloped areas unless they were of a sufficient size to measure (e.g., greater than 0.1 mile in oceanfront length). Golf courses adjacent to the beach were considered developed areas since they have modified the natural habitat adjacent to the beach and have been protected by armoring (e.g., Sea Island, GA) or inlet relocation and beach fill activities (e.g., Kiawah Island, SC). Parking lots and roads were not considered developed areas unless there was development on the landward side of the road and the road was close to the beach, providing no land for the sandy beach to migrate with rising sea level. Length measurements were made in miles using the “ruler” tool within Google Earth. The individual dates of Google Earth imagery and eye altitude from which measurements were made were recorded; the latter was typically 5,300-5,800 feet above ground level.

The shoreline lengths contained in the database and presented in this report are approximations for several reasons. First, the data on the proportion of each state’s sandy, oceanfront beach that is developed were compiled from a wide variety of sources, each of which utilized its own methodology. Furthermore, the various sources provide an assessment of the percentage of each state’s coast that were measured at different time periods dated from 2001 to 2011, with the southwestern Florida coast studies (Morton and Peterson 2003a, 2003b) conducted with 2001 data being the oldest, and the data gaps filled with Google Earth data using the most recent imagery (2006 to 2011). The South Carolina data were based on a 1988 study (Kana 1988) that was updated in 2009 by the state (SCDHEC 2010). The data sources for each geographic area are listed in Table 1.

The second reason why the shoreline lengths in this assessment are approximations is the dynamic nature of the habitat. Sandy, oceanfront beaches shift in space over time and may grow (accrete) or recede (erode) on a daily, weekly, seasonal or annual basis. Thus the lengths measured are snapshots in time and are not necessarily the same lengths that would be measured on the beach today or tomorrow. Third, only the ocean-facing portions of the inlet shorelines were included, and the demarcation lines were based on professional judgment. Finally, the measurements are approximations

due to mathematical rounding to the nearest mile for statewide figures and nearest tenth of a mile for data within individual states.

The amount of preserved sandy, oceanfront beach (protected to some degree from development) provides an approximation of how much of this habitat may be available as sea level continues to rise and climate changes. If an area is preserved then it was assumed that the habitat retains the potential to migrate inland with rising sea level and provide continuous habitat for the piping plover and other shorebirds and waterbirds over time. Where sandy, oceanfront beaches are developed, it was assumed that the habitat is highly susceptible to being lost or significantly degraded as sea level rises (through erosion or shoreline armoring), providing diminishing value to the piping plover. Currently undeveloped and unpreserved sandy, oceanfront beaches were assumed to be developable.

**Table 1. Data sources for determining the length of sandy, oceanfront beach within each state of the wintering and migration range of the piping plover.**

State	Shoreline segment	Data Sources
NC	Entire state	NC DENR (2011)
SC	Entire state	SC DHEC (2010)
GA	Entire state	Clayton et al. (1992), Google Earth (2010 imagery)
FL Atlantic coast	Entire state	Bush et al. (2004), Google Earth (2010 and 2011 imagery)
FL Gulf coast	Perdido Pass (AL) to St. Andrew Bay Entrance	Morton et al. (2004)
	St. Andrew Bay Entrance to Lighthouse Point	Morton and Peterson (2004)
	Anclote Key to Venice Inlet	Morton and Peterson (2003a)
	Venice Inlet to Cape Romano	Morton and Peterson (2003b)
Alabama	Entire state	Bush et al. (2001), Morton and Peterson (2005a), Google Earth (2008 imagery)
Mississippi	Entire state	Morton and Peterson (2005a), Google Earth (2003, 2006 and 2007 imagery)
Louisiana	Chandeleur Sound to Pass Abel	Google Earth (2010 imagery)
	Pass Abel to East Timbalier Island	Morton and Peterson (2005b)
	East Timbalier Island to Mermentau River Navigation Channel	Google Earth (2009 and 2010 imagery)
	Mermentau River Navigation Channel to Sabine Pass	Morton et al. (2005)
Texas	Sabine Pass to Colorado River mouth	Morton and Peterson (2005c)
	Colorado River mouth to Aransas Pass	Google Earth (2011 imagery)
	Aransas Pass to Mansfield Channel	Morton and Peterson (2006a)
	Mansfield Channel to Rio Grande River mouth	Morton and Peterson (2006b)

Preserved lands in this assessment include the public lands of National Wildlife Refuges (NWR) owned by the USFWS; National Seashores (NS) owned by the National Park Service (NPS); National Estuarine Research Reserves (NERR) owned by the National Oceanic and Atmospheric Administration (NOAA); lands owned by the Bureau of Land Management (BLM); state, county and local parks; state Wildlife Management Areas (WMA); state wildlife refuges and heritage preserves, state recreation areas; and sometimes military bases (if landward areas are undeveloped). Sandy, oceanfront beaches that have been protected by non-governmental conservation organizations, such as Audubon sanctuaries, or that are a part of research preserves such as the University of South Carolina (Beaufort)'s Pritchards Island, were also included. Finally, areas that have known conservation easements (e.g., Dewees Island, SC) were included as preserved beaches. Properties that have habitat conservation plans were not included because these properties typically have some level of development and are not preserved, undeveloped spaces like refuges or parks. Data on the name, location, approximate shoreline length, type of preserved land (e.g., wildlife refuge, park), and data sources were added to the Excel database. Shoreline lengths were obtained from published sources or websites of the individual lands wherever possible, and from Google Earth using the aforementioned methodology for measuring developed versus undeveloped areas. Preserved lands in Florida were measured using the State Parks, Conservation Lands, and Public Land data layers within the Florida Department of Environmental Protection (FL DEP) Beaches and Coastal Systems GIS database (<http://ca.dep.state.fl.us/mapdirect/?focus=beaches>); parcel lengths were measured at 1:12,000 scale and rounded to the nearest tenth of a mile. Due to their diminished habitat value from surrounding development, some preserved lands that were less than one-tenth of a mile in beach length were excluded from the Google Earth and FL DEP GIS analyses when they did not occur near other preserved parcels.

Where readily available information existed, notations about habitat modifications within the preserved lands were noted in the database. These habitat modifications could include:

- the presence of jetties, groins or other shoreline armoring within or adjacent to the preserved land;
- dredging activities at an inlet within or near the preserved land;
- beach nourishment or dredge disposal activities on beaches in the preserved land;
- the presence of off-road vehicle (ORV) or recreational vehicle usage;
- campgrounds, recreational facilities, and/or camping allowed on the beach;
- the maintenance and protection of coastal highways (e.g., North Carolina Highway 12 within Cape Hatteras National Seashore or Texas Highway 87 within Sea Rim State Park);
- the artificial creation and/or maintenance of dunes;
- artificial opening or closure of inlets, including inlet relocations;
- vegetation plantings;
- the presence of feral horses, hogs or other animals that can damage vegetation and dunes;
- waterfowl impoundments;
- the presence of private inholdings or retained rights agreements that preclude some management options; and

- the presence of historic sites or structures (e.g., historic forts on the Fort Morgan peninsula in Alabama, Egmont Key NWR in Florida, or Fort Massachusetts in the Mississippi portion of Gulf Islands NS).

An assessment to estimate the length of each state's sandy, oceanfront beach that has been armored with hard structures was conducted using data derived from published sources. Armoring structures are shore-parallel seawalls, revetments, riprap, geotubes and sandbags, but also may include groins, offshore breakwaters, and jetties. A description of the different types of stabilization structures typically constructed at or adjacent to sandy, oceanfront beaches can be found in Appendix 1A (Rice 2009) as well in the *Manual for Coastal Hazard Mitigation* (Herrington 2003, online at [http://www.state.nj.us/dep/cmp/coastal\\_hazard\\_manual.pdf](http://www.state.nj.us/dep/cmp/coastal_hazard_manual.pdf)) and in *Living by the Rules of the Sea* (Bush et al. 1996). The lengths of shoreline affected by armoring included in this report should be considered a minimum since the published sources are not necessarily current and short structures may protect only individual houses or buildings. Furthermore, Google Earth could not be readily utilized to update or fill data gaps due to the difficulty in identifying structures that may be hidden by vegetation, dunes, or beach fill. The entire length of Miami Beach, for example, is armored with a seawall that is not readily visible due to a large-scale beach nourishment project that replaced the beach in front of the seawall (Bush et al. 2004).

An estimate of the length of sandy, oceanfront beaches that have received or continue to receive beach fill or dredge spoil placement was also compiled. This information serves two purposes: 1) a basis for cumulative effects to sandy, oceanfront beaches resulting from soft stabilization and dredge disposal activities, and 2) an assessment of the length of coastline where sandy beaches will attempt to be "held in place" as sea level rises. The latter increases the risk of further degrading habitat quality over time as the adverse impacts of these activities continue, perhaps in perpetuity (for a discussion of the potential adverse ecological impacts of beach nourishment and dredge disposal activities, between which "there is little to no difference" (Bush et al. 2004, p. 90), see Peterson et al. 2000, Peterson and Bishop 2005, Defeo et al. 2009, and/or Rice 2009). Again, published sources were compiled wherever available to compile the length of shoreline affected by beach nourishment and dredge disposal placement activities in each state (e.g., Lott et al. 2009, FL DEP 2011). For the coast of Florida, the GIS database of Lott et al. (2009) was used to measure lengths of individual projects compiled from all sources; where adjacent projects overlapped, their individual lengths were trimmed to eliminate overlapping areas from the Excel database. Where readily available published sources were absent for a geographic area, the beach nourishment database of the Program for the Study of Developed Shorelines (at <http://www.wcu.edu/1038.asp>) was consulted and an inventory of projects within that geographic range was added to the Excel database.

## RESULTS

Altogether there are approximately 2,119 miles of sandy, oceanfront beach within the U.S. continental wintering range of the piping plover at present (Table 2). Florida contains the highest number of miles of this habitat. The Mississippi mainland and Florida coasts have the highest proportion of sandy,

oceanfront beaches that are currently developed (80% and 57%, respectively), while the barrier island coast of Mississippi (0%), Louisiana (6%), Texas (14%) and Georgia (17%) are the least developed. Altogether, 856 of 2,119 miles (40%) of sandy, oceanfront beaches in the continental wintering range of the piping plover are developed. A nearly equal amount (898.6 miles, 42%) have been preserved, with Georgia (76%) and the barrier islands of Mississippi (100%) having the highest proportions of sandy, oceanfront beach in preservation.

**Table 2. The lengths and percentage of sandy, oceanfront beach in each state that are developed, undeveloped and preserved. Note that the miles of shoreline in the last column that have been preserved generally overlap with the miles of undeveloped beach but may also include some areas that have been developed with recreational facilities or by private inholdings (from Rice 2012b, Appendix 1C).**

State	Approximate Shoreline Length (miles)	Approximate Miles of Beach Developed (percent of total shoreline length)	Approximate Miles of Beach Undeveloped (percent of total shoreline length)	Approximate Miles of Beach Preserved (percent of total shoreline length)
North Carolina	326	159 (49%)	167 (51%)	178.7 (55%)
South Carolina	182	93 (51%)	89 (49%)	84 (46%)
Georgia	90	15 (17%)	75 (83%)	68.6 (76%)
Florida	809	459 (57%)	351 (43%)	297.5 (37%)
Alabama	46	25 (55%)	21 (45%)	11.2 (24%)
Mississippi barrier island coast	27	0 (0%)	27 (100%)	27 (100%)
Mississippi mainland coast	51 <sup>†</sup>	41 (80%)	10 (20%)	12.6 (25%)
Louisiana	218	13 (6%)	205 (94%)	66.3 (30%)
Texas	370	51 (14%)	319 (86%)	152.7 (41%)
<b>TOTAL</b>	<b>2,119</b>	<b>856 (40%)</b>	<b>1,264 (60%)</b>	<b>898.6 (42%)</b>

<sup>†</sup> The mainland Mississippi coast along Mississippi Sound includes 51.3 miles of sandy beach as of 2010-2011, out of approximately 80.7 total shoreline miles (the remaining portion is non-sandy, either marsh or armored coastline with no sand). See the Mississippi state-specific results for details.

For nearly every state, data were located on the amount of sandy, oceanfront beaches that have been armored with hard erosion control structures (Table 3). The armoring data for North Carolina and South Carolina do not include shoreline length, but the total number of armoring structures is provided in their respective state summaries below. The length of armored shoreline on the Atlantic coast of Florida is

uncertain, with only one county (Volusia) having complete data available. Therefore the total length of shoreline within the continental wintering range of the piping plover that has been armored is unknown but constitutes at least 230 miles (11% of the total shoreline length). Regardless of the missing data, the Florida coast has the highest lengths of armored oceanfront beach.

There are at least 684.8 miles (32%) of sandy beach habitat in the continental wintering range of the piping plover that have received artificial sand placement via dredge disposal activities, beach nourishment or restoration, dune restoration, emergency berms, inlet bypassing, inlet closure and relocation, and road reconstruction projects (Table 3). In some locations like Louisiana, where sandy beach habitat has been lost due to erosion and sea level rise (see the Louisiana state-specific discussion below), “sediment placement projects are deemed environmental restoration projects by the USFWS, because without the sediment, many areas would erode below sea level” (USFWS 2009, p. 34). In most areas, however, sand placement projects occur in developed areas or adjacent to shoreline or inlet hard stabilization structures in order to address erosion, reduce storm damages, or ameliorate sediment deficits caused by inlet dredging and stabilization activities. The Atlantic coast of Florida has the highest proportion of sand placement activities on oceanfront beaches (at least 51%), but the mainland coast of Mississippi has had at least 85% of its sandy beaches modified with fill placement.

**Table 3. Approximate shoreline miles of sandy, oceanfront beach that have been modified by armoring with hard erosion control structures and sand placement activities for each state in the U.S. continental wintering range of the piping plover. Note that these totals are minimum numbers, given missing data for some areas.**

State	Known Approximate Miles of Armored Beach	Known Approximate Miles of Beach Receiving Sand Placement
North Carolina	Length Unknown (see state discussion below for numbers of structures)	91.3
South Carolina	Length Unknown (see state discussion below for numbers of structures)	67.6
Georgia	10.5	5.5
Florida Atlantic coast*	58.1*	189.7
Florida Gulf coast	59.2	189.9
Alabama	4.7	7.5
Mississippi barrier island coast	0	1.1
Mississippi mainland coast	45.4	43.5
Louisiana	15.9	60.4
Texas	36.6	28.3
<b>TOTAL</b>	<b>230.4+</b>	<b>684.8+</b>

\* Florida Atlantic coast armoring totals are partial, with no data from Brevard, Indian River, St. Lucie and Martin Counties; Volusia County is the only county with complete armoring data (Ecological Associates 2005) and the remaining counties have partial data from Bush et al. (2004).

## State-specific Results

### North Carolina

There are approximately 159 miles (49%) of the North Carolina sandy, oceanfront beach that are developed; 167 miles are undeveloped (NC DENR 2011). Currituck and Brunswick Counties are the most developed, while Hyde and Carteret Counties are the least developed, due to the presence of Cape Hatteras and Cape Lookout National Seashores respectively (Table 4).

**Table 4. The approximate length of sandy, oceanfront beach within each county of North Carolina and the proportions that are developed and undeveloped (NC DENR 2011).**

County	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Currituck	23	18 (78%)	5 (22%)
Dare	89	44 (49%)	45 (51%)
Hyde	17	3 (18%)	14 (82%)
Carteret	85	25 (29%)	60 (71%)
Onslow	27	14 (52%)	13 (48%)
Pender	14	9 (64%)	5 (36%)
New Hanover	31	16 (52%)	15 (48%)
Brunswick	40	30 (75%)	10 (25%)
<b>TOTAL</b>	<b>326</b>	<b>159 (49%)</b>	<b>167 (51%)</b>

Preserved sandy, oceanfront beaches account for roughly 55% of the North Carolina coastline (Table 5). The longest of these is found within Cape Hatteras and Cape Lookout National Seashores (NS), although the former has been extensively modified by the protection and maintenance of a coastal highway, several inholding communities, off road vehicles (ORV), and the construction and maintenance of a continuous dune ridge. As a result of the inholding developed communities adjacent to the oceanfront within Cape Hatteras NS, the amount of land considered preserved within the state (55%) exceeds the amount undeveloped (51%).

The state of North Carolina prohibited the use of hardened erosion control structures on oceanfront beaches in 1985 but in 2011 authorized by legislation up to 4 terminal groins to be constructed (locations to be determined). Sandbag revetments, which are constructed of very large geotextile bags several feet in length, are permitted for temporary protection of oceanfront property, however. The



**Table 5. Preserved sandy, oceanfront beaches in North Carolina, the county in which they are located, and approximate shoreline length.**

Preserved Land	County Location	Approximate Length in Miles
Swan Island Unit, Currituck NWR	Currituck	2
Monkey Island Unit, Currituck NWR	Currituck	1
Pine Island Sanctuary	Currituck	0.3
Pea Island NWR	Dare	12
Cape Hatteras NS	Dare	68
Cape Lookout NS	Carteret	56
Fort Macon State Park	Carteret	1.4
Hammocks Beach State Park (Bear Island)	Onslow	4
Brown's Island, Camp Lejeune	Onslow	3.3
Onslow Beach, Camp Lejeune	Onslow	7.3
Lea-Hutaff Island	Pender	3.8
Mason Inlet Waterbird Management Area	New Hanover	0.4
Masonboro Island NERR and Masonboro Island State Natural Area	New Hanover	7.7
Freeman Park	New Hanover	1.3
Fort Fisher State Recreation Area	New Hanover	6
Smith Island, Bald Head Island State Natural Area	Brunswick and New Hanover	3
Cape Fear Point, Bald Head Island State Natural Area	Brunswick	0.3
Bird Island NC Coastal Reserve	Brunswick	0.9
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>178.7 (55%)</b>

North Carolina Beach and Inlet Management Plan found that there is one jetty system in the state, 2 rock revetments, 2 sets of groins and 2 terminal groins. In addition there are approximately 350 sandbag revetments along the state's sandy, oceanfront beach, each of which is supposed to only be in place for 2 to 5 years, but most have been in place for much longer and their fate is controversial (NC DENR 2011). The length of these armoring structures is unknown.

Approximately 28% (91.3 miles) of North Carolina's sandy, oceanfront beaches have been or continue to receive beach fill as part of authorized beach nourishment or dredge disposal activities, many of them multiple times (Table 6). The Wrightsville Beach beach fill project is one of the oldest in the country, beginning around 1939 and receiving renourishment approximately every 3 years.

**Table 6. The known approximate authorized length of constructed beach nourishment and dredge disposal placement projects on North Carolina beaches (from NC DENR 2011, PSDS 2012 and USFWS files).**

Location	Project Length (miles)
Kitty Hawk	Unknown
Kill Devil Hills	Unknown
Nags Head	10
Pea Island	3.0
Hatteras Island	0.3
Hatteras Island, Isabel Inlet closure	0.3
Cape Hatteras	1.5
Ocracoke Island	0.6
Core Banks	2.0
Atlantic Beach / Fort Macon	7.4
Bogue Banks	16.8
Hammocks Beach State Park (Bear Island)	1.0
West Onslow Beach	1.6
Topsail Island	3.5
Figure Eight Island North	1.8
Figure Eight Island South (Mason Inlet)	2.8
Wrightsville Beach	3.0
Masonboro Island	2.5
North Carolina Beach (Carolina Beach Inlet dredge disposal)	0.8
Carolina Beach	3.0
Kure Beach	3.8
Bald Head Island	4.7
Oak Island	9.6
Long Beach Sea Turtle Habitat Restoration Project	2.3
Holden Beach	5.7
Ocean Isle Beach	3.3
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>91.3 (28%)</b>

### South Carolina

The South Carolina *Adapting to Shoreline Change* report found that 51% (93 miles) of the 182 miles of sandy, oceanfront beach in the state has been developed. Approximately 89 miles (49%) are undeveloped, of which just over 13 miles are considered developable (SC DHEC 2010). No data are available comparing the level of development within individual counties or shoreline segments in South Carolina.

Preserved sandy, oceanfront beaches account for 46% of the 182 miles of sandy, oceanfront beach coastline in South Carolina (Table 7). The longest of these is found within Cape Romain NWR, which protects 22 miles of sandy, oceanfront beaches.

**Table 7. Preserved sandy, oceanfront beaches in South Carolina, the county in which they are located, and approximate shoreline length (Lennon et al. 1996, USFWS 2010a, and multiple online websites for individual preserved lands).**

Preserved Land	County Location	Approximate Length in Miles
Waites Island	Horry	3
Briarcliffe Acres Conservation Area	Horry	0.7
SC Wildlife Sanctuary, Meher Spiritual Center	Horry	1.2
Myrtle Beach State Park	Horry	1
Huntington Beach State Park	Georgetown	3
Hobcaw Beach, Hobcaw Barony	Georgetown	2.3
North Island, Tom Yawkey Heritage Preserve	Georgetown	8.2
Sand and South Islands, Tom Yawkey Heritage Preserve	Georgetown	5.5
Cedar Island, Santee Coastal Reserve	Georgetown	3
Murphy Island, Santee Coastal Reserve	Charleston	6
Cape Romain NWR	Charleston	22
Capers Island Heritage Preserve	Charleston	3.3
Deweese Island, north end	Charleston	1.4
Isle of Palms County Park	Charleston	0.1
Morris Island	Charleston	4
Lighthouse Inlet Heritage Preserve	Charleston	0.4
Folly Beach County Park	Charleston	0.8
Bird Key Stono Seabird Sanctuary	Charleston	0.8
Kiawah Beachwalker Park	Charleston	1.2
Deveaux Bank Seabird Sanctuary	Charleston	2.3
Botany Bay Plantation WMA	Charleston	2.5
Edisto Beach State Park	Colleton	1.3
Hunting Island State Park	Beaufort	5
Pritchards Island	Beaufort	2.5
Turtle Island WMA	Jasper	2.5
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>84.0 (46%)</b>

SC DHEC (2010) summarized an inventory of armoring in South Carolina and found that 933 out of 3,850 (24%) beachfront habitable structures were fronted by shore parallel erosion control structures. The lengths of these structures are unknown. Fripp Island had 100% of its beachfront parcels armored, while Folly Beach had 99% of its parcels armored. The Grand Strand area (North Myrtle Beach, Myrtle Beach, Surfside Beach and Garden City Beach) is also significantly armored. Dewees Island, Kiawah Island and Hunting Island were the only developed areas without any shore parallel armoring structures, although Hunting Island has shore perpendicular groins (SC DHEC 2010; Melissa Bimbi, USFWS, pers. Communication, 4/20/12).

In addition to the 933 shore parallel armoring structures (seawalls, revetments, etc.), as of 2006 there were 165 oceanfront groins in South Carolina (SC DHEC 2010). Pawleys Island, Folly Beach, Edisto Beach and Hilton Head Island have the majority of these groins (125 of the 165). Of the 165 groins, 6 of them are terminal groins. Other armoring in South Carolina includes 6 jetty systems and one offshore breakwater. Finally, since 1985 there have been 111 Emergency Orders issued by the state and local governments for sandbag revetments, beach scraping and minor nourishment projects using upland sand sources. SC DHEC (2010, p. 95) found that “the number of Emergency Orders has been increasing in recent years and may continue to increase if sea level continues to rise, storms become more frequent, and funding for renourishment becomes more intermittent.”

Approximately 37% (67.6 miles) of South Carolina’s sandy, oceanfront beaches have been or continue to receive beach fill as part of authorized beach nourishment or dredge disposal activities, many of them multiple times (Table 8). The Grand Strand has one of the longest lengths of beach nourishment in the country, with 26 miles of continuous beach fill modifying the sandy, oceanfront beaches of the northern part of the state.

**Table 8. The approximate length of known beach nourishment and dredge disposal placement projects on South Carolina beaches (from SCCC 1992, USFWS 2006c, SC DHEC 2010, PSDS 2012, and USFWS files).**

<b>Location</b>	<b>Project Length (miles)</b>
Grand Strand (North Myrtle Beach, Myrtle Beach, Surfside Beach and Garden City Beach)	26
Huntington Beach	1.9
Pawleys Island	2.8
Debidue (Debordieu) Island	1.8
Isle of Palms	2.7
Sullivans Island	0.5
Folly Beach	5.3
Folly Beach County Park and Bird Key	0.5
Kiawah Island	2.5
Captain Sam’s Inlet Relocation	0.6
Seabrook Island	3.4
Edisto Beach	3.5
Hunting Island	3.8
Hilton Head Island	8.8
Daufuskie Island	3.5
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>67.6 (37%)</b>

## Georgia

There are approximately 90 miles of sandy, oceanfront beach in Georgia, of which only 17% is developed. Nine of 13 barrier islands are “uninhabited places of coastal wilderness” that are completely undeveloped, while others like St. Simons and Sea Islands are 100% developed (Clayton et al. 1992, p. 1). Approximately 76% (68.6 miles) of the sandy, oceanfront beaches in the state have been preserved (Table 9). The longest of these is the Little Cumberland Island – Cumberland Island NS complex with

**Table 9. The approximate length of sandy, oceanfront beach within each county of Georgia and the proportions that are developed and undeveloped (Clayton et al. 1992, Google Earth 2010 imagery).**

County	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Chatham	24.6	3.5 (14%)	21.1 (86%)
Liberty	10	0 (0%)	10 (100%)
McIntosh	15.2	0 (0%)	15.2 (100%)
Glynn	20.7	11.6 (56%)	9.1 (44%)
Camden	19.5	0 (0%)	19.5 (100%)
<b>TOTAL</b>	<b>90</b>	<b>15.1 (17%)</b>	<b>74.9 (83%)</b>

**Table 10. Preserved sandy, oceanfront beaches in Georgia, the county in which they are located, and approximate shoreline length.**

Preserved Land	County Location	Approximate Length in Miles
Little Tybee Island Nature Preserve	Chatham	5
Williamson Island	Chatham	1.5
Wassaw Island NWR	Chatham	5.5
Ossabaw Island Heritage Preserve	Chatham	9.1
Saint Catherine's Island	Liberty	10
Blackbeard NWR	McIntosh	6.4
Richard J. Reynolds State Wildlife Refuge (Cabretta Island)	McIntosh	2
Sapelo Island NERR	McIntosh	3.8
Wolf Island NWR	McIntosh	3
Jekyll Island State Park	Glynn	2.4
Little Cumberland Island	Camden	2.4
Cumberland Island NS	Camden	17.5
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>68.6 (76%)</b>

nearly 20 miles of beach preserved. Little St. Simons Island is virtually undeveloped but unpreserved at present, although its private ownership maintains a “commitment to sustainable-use ecotourism” with a small resort on the backside of the island (<http://www.littlestsimonsisland.com/greenpractices.html>).

Clayton et al. (1992) found that approximately 10.5 miles of the sandy, oceanfront beaches of Tybee, Sea, St. Simons and Jekyll Islands in Georgia was armored. Two islands have been or continue to receive beach nourishment or dredge spoil placement and a third has been proposed (Table 11).

**Table 11. The approximate length of known beach nourishment and dredge disposal placement projects on Georgia beaches (from PSDS 2012).**

Location	Project Length (miles)
Tybee Island	3.5
Sea Island	2
St. Simons Island	Proposed
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>5.5 (6%)</b>

## Florida

The approximately 809 miles of sandy, oceanfront beach in Florida is roughly 57% developed and 43% undeveloped, with the Atlantic coast more developed (63%) than the Gulf coast (51%) (Tables 12 and 13). The most developed counties on the Atlantic coast are Flagler, Palm Beach, Broward and St. Johns, where 79% or more of each is developed. Along the Gulf coast, the central and southern coast are considerably more developed than the Panhandle coastline.

Preserved sandy, oceanfront beaches account for 37% (297.5 miles) of Florida coastline’s sandy, oceanfront beaches (Tables 14 and 15). The Atlantic coast accounts for over 132 miles of the preserved beaches and the Gulf coast the remaining 165 miles. The longest of the preserved lands are the Gulf Islands NS (23.5 miles) and Tyndall Air Force Base (AFB) on the Gulf coast (16.5 miles) and the Cape Canaveral NS – Cape Canaveral Air Force Station complex (43.4 miles) and the Archie Carr NWR Partnership (20.5 miles altogether) on the Atlantic coast.

**Table 12. The approximate length of sandy, oceanfront beach within each county along the Atlantic coast of Florida and the proportions that are developed and undeveloped (Bush et al. 2004, Google Earth 2010 and 2011 imagery).**

<b>County</b>	<b>Approximate shoreline length in miles</b>	<b>Developed shoreline miles (% of total)</b>	<b>Undeveloped shoreline miles (% of total)</b>
Nassau	15	9.5 (63%)	5.5 (37%)
Duval	15	9 (60%)	6 (40%)
St. Johns	40	31.6 (79%)	8.4 (21%)
Flagler	19	15.9 (84%)	3.1 (16%)
Volusia	51	32.6 (64%)	18.4 (36%)
Brevard	72	32.3 (45%)	39.8 (55%)
Indian River	28	17.2 (61%)	10.9 (39%)
St. Lucie	21	9.1 (43%)	11.9 (57%)
Martin	24	12.2 (51%)	11.8 (49%)
Palm Beach	42	34.7 (83%)	7.3 (17%)
Broward	24	19.3 (80%)	4.7 (20%)
Miami-Dade	21	12.9 (61%)	8.3 (39%)
<b>TOTAL</b>	<b>372</b>	<b>236 (63%)</b>	<b>136 (37%)</b>

**Table 13. The approximate length of sandy, oceanfront beach within each segment of the Gulf coast of Florida and the proportions that are developed and undeveloped (Morton et al. 2004, Morton and Peterson 2003a, 2003b, and 2004).**

<b>Shoreline Segment</b>	<b>Approximate shoreline length in miles</b>	<b>Developed shoreline miles (% of total)</b>	<b>Undeveloped shoreline miles (% of total)</b>
Perdido Pass to St. Andrew Bay Entrance (Escambia, Santa Rosa, Okaloosa, Walton and Bay Counties)	113.7	53.6 (47%)	60.1 (53%)
St. Andrew Bay Entrance to Lighthouse Point (Bay, Gulf and Franklin Counties)	129.2	38.7 (30%)	90.5 (70%)
Anclote Key to Venice Inlet (Pinellas, Hillsborough, Manatee and Sarasota Counties)	84.5	59.2 (70%)	25.3 (30%)
Venice Inlet to Cape Romano (Sarasota, Charlotte, Lee and Collier Counties)	110.0	71.3 (65%)	38.6 (35%)
<b>TOTAL</b>	<b>437.4</b>	<b>222.8 (51%)</b>	<b>214.6 (49%)</b>



**Table 14. Preserved sandy, oceanfront beaches along the Atlantic coast of Florida, the county in which they are located, and approximate shoreline length. Note that only lands that exceed 1 mile in length are listed here by name, but the contribution of 41 additional preserved areas with lengths less than 1 mile to the overall length of preserved beaches is included in the total (therefore the total listed is greater than the sum of the individual parcels listed).**

<b>Preserved Land</b>	<b>County Location</b>	<b>Approximate Length in Miles</b>
Little Talbot Island State Park	Duval	4.2
Huguenot Memorial Park	Duval	1.3
Kathryn Abbey Hanna Park	Duval	1.5
Guana Tolomato Matanzas NERR	St. Johns	13.1
Anastasia State Park	St. Johns	3.6
North Peninsula State Park	Volusia	2.8
Cape Canaveral NS	Volusia and Brevard	24
Cape Canaveral Air Force Station	Brevard	19.4
Archie Carr NWR Partnership	Brevard and Indian River	20.5
Sebastian Inlet State Park	Brevard and Indian River	2.8
Avalon State Park	St. Lucie	1.4
John Brooks Park	St. Lucie	1.7
Blind Creek Natural Area	St. Lucie	1.4
St. Lucie Inlet Preserve State Park	Martin	2.4
Jupiter Island Tract, Hobe Sound NWR	Martin	3.5
Blowing Rocks Preserve	Martin	1
John D. MacArthur State Recreation Area	Palm Beach	1.6
Red Reef Park & South Beach Park	Palm Beach	1.2
John H. Lloyd State Park	Broward	2.2
Haulover Beach Park	Miami-Dade	1.4
Crandon Park	Miami-Dade	1.9
Bill Baggs Cape Florida State Recreation Area	Miami-Dade	1.4
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>132.4 (36%)</b>

**Table 15. Preserved sandy, oceanfront beaches along the Gulf coast of Florida, the county in which they are located, and approximate shoreline length. Note that only lands that exceed 1 mile in length are listed here by name, but their contribution to the overall length of preserved beaches is included in the total (therefore the total listed is greater than the sum of the individual parcels listed).**

Preserved Land	County Location	Approximate Length in Miles
Perdido Key State Park	Escambia	1.6
Perdido Key Area, Gulf Islands NS	Escambia	6.7
Fort Pickens Area, Gulf Islands NS	Escambia	7.5
Santa Rosa Island Area, Gulf Islands NS	Escambia	9.3
Eglin Air Force Base <sup>†</sup>	Santa Rosa	17
Henderson Beach State Park	Santa Rosa	1.3
Topsail Hill Preserve State Park	Walton	3.3
Grayton Beach State Park	Walton	1.8
St. Andrews State Park	Bay	4.6
Tyndall Air Force Base	Bay	16.5
St. Joseph Peninsula State Park	Gulf	9.9
Eglin Air Force Base, Cape San Blas Satellite Property	Gulf	1.5
St. Vincent NWR (St. Vincent Island)	Franklin	8.7
Cape St. George State Preserve (Little St. George Island)	Franklin	9.6
St. George Island State Park	Franklin	8.8
Jeff Lewis Wilderness Preserve	Franklin	4
John S. Phipps Preserve	Franklin	1.5
Bald Point State Park	Franklin	1.8
Anclote Keys State Preserve State Park	Pasco and Pinellas	5.7
Honeymoon Island State Park	Pinellas	2.9
Caladesi Island State Park	Pinellas	2.2
Shell Key Preserve	Pinellas	2.3
Fort DeSoto Park	Pinellas and Hillsborough	2.8
Egmont Key NWR	Hillsborough	1.8
North Lido Public Beach	Sarasota	1.4
Brohard Park	Sarasota	1.3
Caspersen Beach County Park	Sarasota	2
Stump Pass Beach State Park	Charlotte	1.2
Don Pedro Island State Park	Charlotte	1.2
Cayo Costa State Park	Lee	9.3
Bowman's Beach Regional Park	Lee	1.7
Lovers Key State Park	Lee	1.7
Barefoot Beach Preserve County Park	Collier	1.4
Delnor-Wiggins Pass State Park	Collier	1.1
Rookery Bay NERR (Kice Island / Cape Romano complex)	Collier	11.6
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>165.1 (38%)</b>

<sup>†</sup> Note that Eglin Air Force Base (AFB) contains several segments of shoreline that have been armored or developed, which is likely to result in those segments not providing high quality habitat as sea level rises.

Approximately 59.2 miles (14%) of the sandy, oceanfront beach between Perdido Pass near the Alabama-Florida state line and Cape Romano on the Gulf coast of Florida are armored (Morton et al. 2004, Morton and Peterson 2003a, 2003b, 2004). Data on the length of armoring along the Atlantic Florida coast is incomplete, with Volusia County the only area with complete data (see Table 2 footnote). Outdated data from 1991 found that 145 miles of the entire Florida coast were armored (NMFS 1991a and b as cited within Ecological Associates 2005). Some communities are 100% armored, such as Miami Beach (Bush et al. 2004).

More beach nourishment and dredge disposal activities occur within Florida than any other state in the continental wintering range of the piping plover, with FL DEP (2011) stating that over 218 miles of sandy beaches have been “restored” or “maintained” under the state Ecosystem Management and Restoration Trust Fund since 1998. For Fiscal Year 2011/2011, 81 projects requested state funding for feasibility, design and/or construction of beach nourishment projects and another 13 for inlet sand bypassing or inlet management plan activities (FL DEP 2011). Almost 51 contiguous miles from Boca Raton to Key Biscayne south of Miami Beach receives beach nourishment, by far the longest beach nourishment project area in the continental wintering range of the piping plover (FL DEP Beaches and Coastal System GIS Beach Nourishment Data Layer). Approximately 43% (over 189.9 miles) of the Gulf coast in Florida has received beach nourishment or dredge disposal placement activities, while half (51% or at least 189.7 miles) of the Atlantic coast has done so, many of the areas multiple times and with multiple types of projects (Tables 16 and 17).

These distances of habitat modification are minimum distances, however, because other known sand placement projects exist but did not have sufficient location data (i.e., Florida R-Monuments) to be included without potentially overlapping other project areas. The lengths listed in Tables 16 and 17 are also minimum measurements because distances between R-Monuments did not include partial monuments but were calculated to the nearest R-Monument (e.g., if a project’s start point was R-33.8, the measurement started at R-34; if its endpoint was R-101.5, the measurement ended at R-101).

**Table 16. The approximate length of known sand placement projects on Florida's Atlantic coast beaches (from Lott et al. 2009, FL DEP 2011, PSDS 2012, USFWS files and the FL DEP Beaches and Coastal System GIS Beach Nourishment Data Layer). Projects are listed by county from north to south, and then by increasing R-Monument within each county. RM-Start refers to the known starting Florida R-Monument location and RM\_End refers to the known endpoint R-Monument for the project; start and endpoints may have been trimmed to eliminate overlaps with immediately adjacent projects. Note that projects denoted with a P are currently proposed.**

County	Project Name or Area	RM_Start	RM_End	Length (in miles)
Nassau	Fernandina Harbor dredge disposal	R-1	R-9	1.52
Nassau	Nassau County (Amelia Island) Beach Erosion Control	R-9	R-34.5	4.30
Nassau	South Amelia Island Beach Restoration Project	R-50	R-80	3.40
Duval	Duval County Beach Erosion Control	R-31	R-80	8.99
Duval	Jacksonville Harbor Expansion	V-501	V-505	0.79 P
St. Johns	Vilano Beach and Summer Haven	R-109	R-117	1.61 P
St. Johns	St. Johns County Shore Protection Project at St. Augustine	R-132	R-152	3.80
St. Johns	Summer Haven	R-197	R-209	2.29
St. Johns	Anastasia State Park (St. Augustine Inlet dredge disposal)			3.79
Flagler	State Road AIA Shoreline Stabilization Project			unknown
Volusia	Volusia County	R-40	R-145	18.92
Volusia	Ponce de Leon Inlet dredge disposal	R-158	R-161	0.56
Volusia	Volusia County	R-161	R-208	8.50
Brevard	Brevard County Beach at Cape Canaveral	R-1	R-4	0.56
Brevard	Brevard County Shore Protection Project- (North Reach)	R-4	R-53	8.98
Brevard	Patrick Air Force Base	R-53	R-75	4.05
Brevard	Brevard County Shore Protection Project- (Mid Reach)	R-75	R-118	7.60
Brevard	Brevard County Shore Protection Project- (South Reach)	R-118	R-139	7.80
Indian River	Ambersand Beach (Indian River County Sectors 1 & 2)	R-3	R-17	2.63
Indian River	Indian River County, Sector 3 and Wabasso Beach	R-19	R-55	6.76
Indian River	Vero Beach	R-71	R-86	2.89
Indian River	South County Beach (Indian River County Sector 7)	R-97	R-115.7	3.40
St. Lucie	Avalon	R-1	R-10	1.69
St. Lucie	Fort Pierce Harbor Dredged Material Disposal	R-31	R-33	0.38
St. Lucie	Fort Pierce Shore Protection Project	R-33.8	R-46	2.27

<b>County</b>	<b>Project Name or Area</b>	<b>RM_Start</b>	<b>RM_End</b>	<b>Length (in miles)</b>
St. Lucie	South St. Lucie County Beaches	R-88	R-90	0.38
St. Lucie	South St. Lucie County Beaches	R-97.7	R-115	3.18
Martin	Martin County Shore Protection Project - Hutchinson Island	R-1	R-25.6	4.20
Martin	Bathtub Beach Park	R-34.5	R-36	0.24
Martin	Sailfish Point Marina Channel dredging with beach placement	R-36	R-39	0.66
Martin	St. Lucie Inlet dredge disposal	R-59	R-69	1.69
Martin	Jupiter Island Beach Restoration Project	R-75	R-117	7.18
Palm Beach	Coral Cove Park	R-5	R-7.6	0.29
Palm Beach	Jupiter Inlet Bypassing	R-12	R-13	0.15
Palm Beach	Jupiter-Carlin Park Beach Nourishment Project	R-13	R-19	1.10
Palm Beach	Juno Beach Restoration Project	R-26	R-38	2.45
Palm Beach	Singer Island	R-60	R-69	1.91
Palm Beach	Palm Beach Harbor dredging with beach placement	R-76	R-79	0.65
Palm Beach	North End Palm Beach Restoration (Reach 2)	R-79	R-90	2.30 P
Palm Beach	Mid-Town Beach Restoration Project (Reaches 3 & 4)	R-90.4	R-101.4	2.40
Palm Beach	South of Mid-Town Beach Restoration Project	R-101.4	R-110	1.75 P
Palm Beach	Town of Palm Beach, Phipps Ocean Park and South End Palm Beach Reach 8	R-116	R-134	5.54
Palm Beach	Palm Beach County	R-135	R-138	0.68
Palm Beach	Palm Beach Harbor / South Lake Worth Inlet Bypassing	R-151	R-152	0.16
Palm Beach	Ocean Ridge Beach Restoration Project	R-152	R-160	1.58
Palm Beach	Delray Beach Restoration Project	R-175	R-188.5	2.71
Palm Beach	Boca Raton (North) Beach Restoration Project	R-205	R-212	1.42
Palm Beach	Boca Raton (Central) Beach Restoration Project	R-216	R-222.9	1.50
Palm Beach	South Boca Raton (South) Beach Restoration Project	R-223	R-227.9	1.00
Broward	Hillsboro Beach Restoration Project	R-6	R-12.5	1.40

<b>County</b>	<b>Project Name or Area</b>	<b>RM_Start</b>	<b>RM_End</b>	<b>Length (in miles)</b>
Broward	Segment II Broward County Beach Erosion – Hillsboro Inlet to Port Everglades	R-25	R-72	8.87
Broward	Segment III Broward County Beach - John U. Lloyd SP, Dania Beach, Hollywood, and Hallandale Beach	R-86	R-128	8.11
Miami-Dade	Dade County Shore Protection Project - Sunny Isles	R-7	R-19	2.43
Miami-Dade	Dade County Shore Protection Project - Haulover Beach Park	R-19	R-26	1.35
Miami-Dade	Dade County Shore Protection Project - Bal Harbor	R-27	R-31	0.79
Miami-Dade	Dade County Shore Protection Project - Surfside	R-31	R-38	1.43
Miami-Dade	Dade County Shore Protection Project - Miami Beach	R-38	R-74	7.12
Miami-Dade	Fisher Island	R-75	R-78	0.52
Miami-Dade	Virginia Key Beach	R-79	R-88	1.75
Miami-Dade	Key Biscayne Beach Erosion Control	R-92.5	R-96	0.59
Miami-Dade	Key Biscayne Beach Erosion Control	R-99	R-101	0.38
Miami-Dade	Key Biscayne Shore Protection Project	R-101	R-113.7	2.32
<b>TOTAL</b>				<b>189.7+</b>

**Table 17. The approximate known length of beach nourishment and dredge disposal placement projects on Florida's Gulf coast beaches (from Lott et al. 2009, FL DEP 2011, PSDS 2012 and USFWS files). Projects are listed by county from west to east / north to south, and then by increasing R-Monument within each county. RM-Start refers to the known starting Florida R-Monument location and RM\_End refers to the known endpoint R-Monument for the project; start and endpoints may have been trimmed to eliminate overlaps with immediately adjacent projects. Note that projects denoted with a P are currently proposed.**

County	Project Name or Area	RM_Start	RM_End	Length (miles)
Escambia	Perdido Key	R-1	R-34	6.50
Escambia	Pensacola Navigation Channel (dredge disposal)	R-34	R-64	6.30
Escambia	Santa Rosa Island (dredge disposal)	R-85	R-107	4.19 P
Escambia	Pensacola Beach	R-107	R-151	8.20
Escambia	Navarre Beach	R-192.5	R-213.5	4.10
Santa Rosa/Okaloosa	Eglin Air Force Base	V-551	V-609 (selected sites)	5.00
Santa Rosa/Okaloosa	Eglin Air Force Base	V-608	V-512 (selected sites)	2.65
Okaloosa	Ft. Walton Beach	R-1	R-15	2.80
Okaloosa	Okaloosa County- Destin, Holiday Isle	R-17	R-32	3.06
Okaloosa/Walton	Destin - Walton County	R-39	R-49	2.13
Walton	Western Walton County- Beach Restoration	R-1	R-23	4.92
Walton	Walton County Beach Nourishment, Phase 2	R-41	R-67	5.20
Walton	Gulf Trace	R-67	R-68	0.21
Walton	Walton County- Beach Restoration	R-68	R-78	1.95 P
Walton	Walton County Beach Nourishment, Phase 2	R-78	R-98	3.86
Walton	Walton County- Beach Restoration	R-98	R-105	1.59 P
Walton	Walton County Beach Nourishment, Phase 2	R-105	R-127	3.86
Bay	Panama City Beaches	R-0.5	R-92	17.40
Bay	Panama City Harbor (dredge disposal)	R-92	R-97	0.85
Bay	Mexico Beach	R-127	R-138.2	2.45
Gulf	St. Joseph's Peninsula	R-67	R-105.5	7.50
Gulf	Stump Hole	R-105.5	R-112	1.56
Franklin	St. George Island State Park	R-106	R-128.5	4.26
Franklin	Alligator Point	R-210	R-225	0.47 P
Pinellas	Honeymoon Island	R-8	R-12	0.82
Pinellas	Sand Key - Bellair, Indian Shores, Redington Beach, N. Redington Beach	R-51	R-107	10.57
Pinellas	Treasure Island	R-126	R-143	9.50
Pinellas	Long Key	R-144	R-148	0.76

County	Project Name or Area	RM_Start	RM_End	Length (miles)
Pinellas	Mullet Key	R-173	R-179.5	1.16
Pinellas	Mullet Key (dredge disposal)	R-181	R-191	1.74
Hillsborough	Egmont Key	R-2	R-10	1.52
Manatee	North Anna Maria Island	R-1	R-2	0.11 P
Manatee	Anna Maria Island	R-2	R-41	4.20
Manatee/Sarasota	Longboat Key	R-44	R-29.5	9.92
Sarasota	Lido Key	R-31	R-44.2	2.31
Sarasota	North Siesta Key	R-46	R-48.4	0.36 P
Sarasota	South Siesta Key	R-64	R-77.2	2.46
Sarasota	Casey Key	R-81	R-96	2.93 P
Sarasota	Venice	R-116	R-133	3.30
Charlotte	Manasota Key	R-14.4	R-20	0.92
Charlotte	Charlotte County Shore Protection Project	R-22	R-25.5	0.46
Charlotte	Knight Island	R-27.5	R-40	2.20
Lee	Gasparilla Island	R-10	R-26A	3.20
Lee	North Captiva Island	R-81	R-81A (+208 ft)	0.23
Lee	Captiva Island	R-83	R-109	5.06
Lee	Northern Shore Sanibel Island	R-109	R-118	1.69
Lee	Gulf Pines, Sanibel Island	R-129	R-133	0.77
Lee	Sanibel Island	R-174A	Bay 1A	0.25
Lee	Estero Island	R-175	R-199	4.72
Lee	South Estero Island	R-208	R-210	0.41
Lee	Lover's Key	R-214	R-222	1.54
Lee	Big Hickory Island	R-222.3	R-223.8	0.47
Lee	Little Hickory Island- Bonita Beach	R-225.5	R-230	0.80
Collier	Barefoot Beach (dredge disposal)	R-11.4	R-14.2	0.39 P
Collier	Delnor-Wiggins State Park	R-18	R-20.5	0.39 P
Collier	Vanderbilt Beach	R-21	R-37	3.12
Collier	Clam Bay (dredge disposal)	R-37	R-48	2.13
Collier	Park Shore	R-48	R-55	1.42
Collier	Naples	R-58	R-79	3.70
Collier	Naples (Gordon Pass dredge disposal)	R-79	R-83	0.83
Collier	Keewaydin Island (Gordon Pass dredge disposal)	R-90	R-93	0.76
Collier	Marco Island- Hideaway Beach (North)	R-135	R-139	0.83
Collier	Marco Island- Hideaway Beach (South)	R-143	R-148	0.90
<b>TOTAL</b>				<b>189.9+</b>



## Alabama

The approximately 46.3 miles of sandy, oceanfront beach in Alabama is roughly 55% developed, with Dauphin Island (Mobile County's shoreline) 42% developed and the Baldwin County shoreline of the Fort Morgan peninsula, Gulf Shores and Orange Beach 61% developed (Table 18). Dauphin Island is currently split into Dauphin Island West (0% developed) and Dauphin Island East (82% developed) by Ivan/Katrina Cut, an inlet opened by Hurricane Ivan in 2004 and expanded to 2 kilometers wide by Hurricane Katrina in 2005. There are at least 4-5 preserved lands along the Alabama coast, totaling over 11 miles of sandy, oceanfront beach (Table 19). The longest stretch of preserved sandy, oceanfront beach is within Gulf State Park, although the park is partially developed with recreational facilities and public recreation appears to be the primary purpose of the land.

**Table 18. The approximate length of sandy, oceanfront beach within each county of Alabama and the proportions that are developed and undeveloped (Bush et al. 2001, Morton and Peterson 2005a, USFWS 2005a, Google Earth 2008 imagery).**

County	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Mobile	15.3	6.5 (52%)	8.8 (58%)
Baldwin	31	18.9 (61%)	12.1 (39%)
<b>TOTAL</b>	<b>46.3</b>	<b>25.4 (55%)</b>	<b>20.9 (45%)</b>

**Table 19. Preserved sandy, oceanfront beaches in Alabama, the county in which they are located, and approximate shoreline length.**

Preserved Land	County Location	Approximate Length in Miles
Dauphin Island Audubon Bird Sanctuary	Mobile	0.6
Fort Morgan State Historic Site / Bon Secour NWR, Fort Morgan Unit	Mobile	1.8
Perdue Unit, Bon Secour NWR	Baldwin	4
Gulf State Park	Baldwin	3.5
Bureau of Land Management	Baldwin	1.3
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>11.2 (24%)</b>

Approximately 4.7 miles (10%) of the Alabama coast is armored with hard erosion control structures (Morton and Peterson 2005a). Dauphin Island, Gulf Shores, and Orange Beach have conducted beach nourishment projects, an unknown amount of sandy, oceanfront beaches near Perdido Pass have received dredge spoil placement, and up to 1,000 feet of littoral zone receives maintenance dredge spoil on an as needed basis from Little Lagoon Pass (Table 20). Altogether at least 7.4 miles (16%) of Alabama's oceanfront coastline has received fill material, some areas multiple times.

**Table 20. The approximate length of known beach nourishment and dredge disposal placement projects on Alabama sandy, oceanfront beaches (from Froede 2007, PSDS 2012, and USFWS files).**

Location	Project Length (miles)
Dauphin Island	4
Gulf Shores	3.3
Perdido Pass area dredge disposal	Unknown
Little Lagoon Pass area dredge disposal	0.2
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>7.5 (16%)</b>

## Mississippi

### Mississippi Barrier Island Shoreline

Mississippi's Gulf of Mexico shoreline consists of a series of offshore barrier islands that, with the exception of a dredge spoil island owned by the U.S. Army Corps of Engineers (USACE), are entirely contained within the Gulf Islands NS. These islands currently contain approximately 27.3 miles of sandy, oceanfront beach, of which none is developed. Preserved sandy, oceanfront beaches account for 100% of the Mississippi barrier island coastline (Table 21). The longest of these (~11.8 miles) is found on Horn Island within Gulf Islands NS. The mainland coastline of Mississippi, landward of the barrier islands, includes many miles of sandy beaches that were assessed separately (see below) since these beaches include several critical habitat units and provide habitat for the piping plover; the mainland beaches front Mississippi Sound and not the Gulf of Mexico, however, as they are located landward of the barrier islands.

**Table 21. The approximate length of sandy, oceanfront barrier island beach within each county of Mississippi and the proportions that are developed and undeveloped (Morton and Peterson 2005a, Google Earth 2003, 2006, and 2007 imagery).**

County	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Harrison	8.1	0	8.1 (100%)
Jackson	19.2	0	19.2 (100%)
<b>TOTAL</b>	<b>27.3</b>	<b>0</b>	<b>27.3 (100%)</b>

**Table 22. Preserved sandy, oceanfront barrier island beaches in Mississippi, the county in which they are located, and approximate shoreline length. Note that private inholdings remain on some of the barrier islands, and therefore the NPS does not have full ownership of all the islands.**

Preserved Land	County Location	Approximate Length in Miles
Petit Bois Island, Gulf Islands NS	Jackson	6.4
Sand Island	Jackson	1
Horn Island, Gulf Islands NS	Jackson	11.8
East and West Ship Islands, Gulf Islands NS	Harrison	4.5
Cat Island, Gulf Islands NS	Harrison	3.6
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>27.3 (100%)</b>

There is no shoreline armoring of the barrier island beaches of Mississippi (Morton and Peterson 2005a). The Mississippi oceanfront coast has not received much beach nourishment or dredge disposal, with only a small intermittent beach nourishment project to protect Fort Massachusetts on West Ship Island and dredge disposal activities on Sand Island. The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan to protect and restore the Mississippi barrier island coast proposes to add fill material to East and West Ship Islands, closing the inlet that separates them, and to place nearshore fill deposits near the other islands of Gulf Shores NS (USACE 2009).

**Table 23. The approximate length of known beach nourishment and dredge disposal placement projects on Mississippi's sandy, oceanfront barrier island beaches (from PSDS 2012).**

Location	Project Length (miles)
Sand Island	0.9
West Ship Island	0.2
<b>TOTAL MILES (% OF STATE BARRIER ISLAND SHORELINE)</b>	<b>1.1 (4%)</b>

#### Mississippi Mainland Shoreline

There are approximately 51.3 miles of sandy, soundfront beaches along the approximately 80.7 mile long mainland Mississippi coast (Table 24). USACE (2010a) states that there are 60 miles of sandy beach along the Mississippi Sound shoreline of Mississippi, but using 2010 and 2011 Google Earth imagery only 51.3 miles were currently found. The amount of sandy beach along the soundfront, mainland shoreline of Mississippi fluctuates with the placement and subsequent erosion of beach fill and dredge disposal projects. Non-sandy shoreline segments were included in this area due to the presence of extensive shoreline armoring (i.e., seawalls, bulkheads and groins). Some of which currently have no sandy beaches in front of them, but beach fill and dredge disposal projects periodically recreate beaches in

these locations. Highly irregular estuarine shorelines not directly facing Mississippi Sound were excluded. With the exceptions of the approximately 6 miles of non-sandy shoreline within Hancock County Marshes Preserve in Hancock County and approximately 6.8 miles of non-sandy shoreline within Grand Bay NERR in Jackson County (Table 25), virtually the entire remaining 67.9 miles of soundfront, mainland coast in Mississippi could periodically have sandy beach habitat given the extensive degree of habitat modifications resulting from beach fill and dredge disposal activities (Table 26).

The soundfront shoreline is well developed with the communities of Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, Belle Fontaine, Gautier and Pascagoula. The precise shoreline length is difficult to calculate given the irregular shape of the non-sandy shorelines within the Hancock County Marshes Preserve and the Grand Bay NERR. When non-sandy and sandy shoreline segments are combined, 66% of the soundfront shoreline is developed and 34% is undeveloped (Table 24). Harrison County, stretching from Pass Christian to Biloxi, is the most developed (86%), with Deer Island just off the Biloxi shoreline the only undeveloped segment within the county. When just the sandy shoreline segments of the mainland, soundfront coast are considered, 80% of the sandy beaches are developed and 20% are undeveloped (Table 2).

**Table 24. The approximate length of soundfront mainland shoreline within each county of Mississippi and the proportions that are developed and undeveloped (Google Earth 2010 and 2011 imagery).**

County	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Hancock	15.0	7.0 (47%)	8.0 (53%)
Harrison	32.6	28.0 (86%)	4.6 (14%)
Jackson	33.2	18.2 (55%)	14.9 (45%)
<b>TOTAL</b>	<b>80.7</b>	<b>53.2 (66%)</b>	<b>27.5 (34%)</b>

Although several segments of the soundfront, mainland Mississippi shoreline are preserved, very little of this preserved shoreline contains sandy beaches as of September 2010 (Table 25). Deer Island Coastal Preserve is a state-owned island located just offshore Biloxi that has been undergoing restoration with beneficial use of dredged material (Paul Necaie, USFWS, pers. Communication, 4/17/12), and as of November 2011 has 4.6 miles of sandy beach habitat. Grand Bay NERR has a few natural pocket beaches along its soundfront shoreline in Jackson County (Paul Necaie, USFWS, pers. Communication, 4/17/12). The beneficial use of dredged material has been proposed to add additional habitat to Round Island (Paul Necaie, USFWS, pers. Communication, 4/17/12), and other areas are proposed for preservation and ecosystem restoration under the MsCIP (USACE 2009), but the amount of sandy beach habitat included in those efforts currently is unknown.

**Table 25. Preserved sandy, soundfront mainland beaches in Mississippi, the county in which they are located, and approximate shoreline length. Note that the total of 25% is based upon the proportion of sandy beaches present in 2010 and 2011 Google Earth imagery (of 51.3 miles).**

Preserved Land	County Location	Approximate Length in Miles
Hancock County Marshes Coastal Preserve	Hancock	0 (no sand)
Buccaneer State Park / Grand Bayou Coastal Preserve	Hancock	1.1 <sup>1</sup>
Deer Island Coastal Preserve	Harrison	4.6 <sup>2</sup>
Davis Bayou Coastal Preserve	Jackson	2.1 <sup>3</sup>
Bellefontaine Marsh Coastal Preserve	Jackson	1.7 <sup>3</sup>
Graveline Bay Coastal Preserve	Jackson	0.8
Pascagoula River Marshes Coastal Preserve	Jackson	0 (no sand)
Round Island Coastal Preserve	Jackson	1.6
Grand Bay NERR	Jackson	0.7 (sandy portion)
<b>TOTAL MILES (% OF STATE SANDY MAINLAND SHORELINE)</b>		<b>12.6 (25%)</b>

<sup>1</sup> Buccaneer State Park had only 0.2 miles of sandy beach as of 2010 but was scheduled for a federal beach fill project that would restore all 1.1 miles of its shoreline.

<sup>2</sup> Deer Island recently had its sandy beaches restored through the beneficial use of dredged material.

<sup>3</sup> Sandy beaches along these shorelines typically are narrow strips of intermittent pocket beaches.

Historically there was a narrow sandy strip along most of the Mississippi mainland shoreline, with freshwater inlets, grasses and trees along the water's edge (Cathcart and Melby 2009). Following a series of storms, the shoreline between Pass Christian and Biloxi was modified with a seawall constructed between 1923 and 1927, which later allowed the construction of U.S. Route 90 just landward of the seawall (Cathcart and Melby 2009). Altogether there are roughly 45.4 miles of armored shoreline along the soundfront, mainland Mississippi coast, primarily consisting of seawalls and groins.

The majority of the present soundfront, mainland shoreline of Mississippi is manmade, with 26 miles of artificially created beach between Pass Christian and Biloxi alone (Douglass 2002, Cathcart and Melby 2009). Approximately 85% (43.5 of 51.3 miles) of the sandy, soundfront, mainland Mississippi coast has been modified with beach nourishment and dredge disposal placement projects (Table 26). The Hancock County Beach Dunes Project in Waveland and Bay St. Louis is placing 6.0 miles of beach fill and restoring 19 acres of dunes along the western soundfront, mainland shoreline (USACE Mobile District, [http://www.sam.usace.army.mil/mscip/Hancock\\_County\\_Beach\\_Dunes.htm](http://www.sam.usace.army.mil/mscip/Hancock_County_Beach_Dunes.htm)). With the completion of the federal Hancock County Beach Dunes Project, virtually the entire soundfront, mainland shoreline of Hancock County outside of the Hancock County Marshes Coastal Preserve will have received beach fill or dredge spoil placement. Similarly, the entire Harrison County soundfront, mainland shoreline has received beach fill.

The MsCIP has proposed to modify and restore many habitats along the mainland Mississippi shoreline, including roughly 30 of 60 miles of beach and dune habitat (USACE 2010a). The interim Pascagoula Beach Boulevard Restoration Project recently repaired a seawall, reconstructed 7,700 feet of geotubes, placed beach fill excavated from the Pascagoula federal navigation channel along 7,700 feet of

Pascagoula shoreline, and installed riprap and vegetation to protect the beach fill and geotubes from erosion (USACE 2010b). The addition of the riprap and tidal marsh vegetation along the toe, or waterfront, edge of the beach fill limits the potential for the fill to become valuable sandy beach habitat, however.

**Table 26. The approximate length of known beach nourishment and dredge disposal placement projects on Mississippi's soundfront, mainland shoreline (from USACE 2010b, PSDS 2012, and the USACE Mobile District website).**

<b>Location</b>	<b>Project Length (miles)</b>
Hancock County Beach Dunes Project <sup>1</sup>	6.0
City of Bay St. Louis <sup>2</sup>	2.7
Harrison County (Pass Christian to Biloxi)	26
Deer Island	4.6
Ocean Springs, Front Beach	1.1
Ocean Springs, East Beach	1.1
Pascagoula Beach Boulevard Restoration Project	1.5
Pascagoula, Front Beach	0.5
<b>TOTAL MILES (% OF STATE SANDY, MAINLAND SHORELINE)</b>	<b>43.5 (85%)</b>

<sup>1</sup> The federal Hancock County Beach Dunes Project overlaps previous beach fill projects along Hancock County Beach and Waveland.

<sup>2</sup> A portion of the 6.0 mile long Bay St. Louis area previously receiving beach fill overlaps with the Hancock County Beach Dunes Project, which has been deducted from the length listed here.

## **Louisiana**

Louisiana's coast is a mix of sandy and non-sandy, oceanfront beaches. There are currently roughly 217.5 miles of sandy beaches, but they are not continuous and large sections of coastline are characterized by a series of small pocket beaches interspersed with non-sandy, marshy shoreline. Of the sandy beaches, only 6% are developed (Table 27), primarily the areas of Holly Beach, Constance Beach, and Grand Isle. Preserved sandy, oceanfront beaches account for roughly 30% of the Louisiana coastline (Table 28). The longest of these is found within the state Rockefeller Wildlife Refuge (26.5 miles).

**Table 27. The approximate length of sandy, oceanfront beach within each shoreline segment of Louisiana and the proportions that are developed and undeveloped (Morton et al. 2005, Morton and Peterson 2005b, Google Earth 2009 and 2010 imagery).**

<b>Shoreline Segment</b>	<b>Approximate shoreline length in miles</b>	<b>Developed shoreline miles (% of total)</b>	<b>Undeveloped shoreline miles (% of total)</b>
Sabine Pass to Mermentau River Navigation Channel	51	6.9 (14%)	44.1 (86%)
Mermentau River Navigation Channel to Joseph Harbor Bayou	16.1	0	16.1 (100%)
Joseph Harbor Bayou to Flat Lake	12.1	0	12.1 (100%)
Flat Lake Entrance to Freshwater Bayou Canal	7.2	0	7.2 (100%)
Freshwater Bayou Canal to Vermilion Bay	10.1	0	10.1 (100%)
Vermilion Bay to Atchafalaya Bay	2.4	0	2.4 (100%)
Atchafalaya Bay to Caillou Bay	18.6	0	18.6 (100%)
Caillou Bay to East Timbalier Island	23.7	0	23.7 (100%)
East Timbalier Island to Pass Abel	26.7	5.9 (22%)	20.8 (78%)
Pass Abel to Bay Coquette	19.5	0	19.5 (100%)
South West Pass to South Pass	14.6	0	14.6 (100%)
South Pass to Chandeleur Sound	15.6	0	15.6 (100%)
<b>TOTAL</b>	<b>217.5</b>	<b>12.8 (6%)</b>	<b>204.8 (94%)</b>

Approximately 15.9 miles (7%) of sandy, oceanfront beach are armored with hard structures in Louisiana (Morton et al. 2005, Morton and Peterson 2005b, Google Earth). Beach restoration projects are much more extensive, with at least 60.4 miles of sandy, oceanfront beach receiving beach fill or dredge spoil placement (Table 29). Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) projects have restored sandy beaches that have eroded or been lost due to sediment starvation, local subsidence and sea level rise (see <http://lacoast.gov/new/Projects/List.aspx> for a list of projects and their details). Numerous other beach restoration (nourishment) projects are planned as part of the Louisiana Coast 2050 effort (see <http://www.coast2050.gov/> for more information).

**Table 28. Preserved sandy, oceanfront beaches in Louisiana, the parish in which they are located, and approximate shoreline length.**

<b>Preserved Land</b>	<b>Parish Location</b>	<b>Approximate Length in Miles</b>
Rockefeller Wildlife Refuge	Vermilion	26.5
Paul J. Rainey Wildlife Sanctuary	Vermilion	0 (no sand)
Marsh Island Refuge	St. Mary and Iberia	0 (no sand)
Terrebonne Barrier Islands Refuge	Terrebonne	13.9
Elmer's Island Wildlife Refuge	Jefferson	2.3
Grand Isle State Park	Jefferson	0.9
Pass A Loutre WMA	Plaquemines	7.1
Breton NWR	St. Bernard & Plaquemines	15.6
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>66.3 (30%)</b>

**Table 29. The approximate length of known beach nourishment (restoration) and dredge disposal placement projects on Louisiana's sandy, oceanfront beaches (from PSDS 2012, Google Earth imagery, CWPPRA project data, and USFWS files). Note that the Chandeleur Island Chain, Pelican Island, Scofield and Shell Island all received fill material during the Deepwater Horizon oil spill response efforts.**

<b>Location</b>	<b>Project Length (miles)</b>
Bay Joe Wise (Pass Chalant to Grand Bayou Pass)	2.25
Chandeleur Island Chain	7
East Grand Terre Island	2.8
East Timbalier Island	2.5
Grand Isle	7.4
Grand Terre Island	4.5
Holly Beach	9.5
Pelican Island	2.4
Raccoon Island (Isles Dernieres)	1
Scofield	2.9
Shell Island	1.6
Timbalier Island	2.2
Trinity and East Islands (Isles Dernieres)	7.5
West Belle Pass Headland	3.1
Whiskey Island (Isles Dernieres)	3.8
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>60.4 (28%)</b>



## Texas

There are approximately 370 miles of sandy, oceanfront beach in Texas, virtually the entire coast except the inlets (Table 30). Roughly 14% of these beaches are developed and 86% are undeveloped. While many long segments of barrier islands and peninsulas are preserved (Table 28), some lengthy, undeveloped islands such as San Jose Island and the west Matagorda peninsula are privately owned cattle ranches with no public access, minimal structures, and private airstrips (Morton et al. 1983, Google Earth 2011 imagery). Padre Island National Seashore is reportedly the longest undeveloped barrier island in the world with nearly 66 miles of preserved sandy, oceanfront beaches (NPS 2011). Altogether, preserved sandy oceanfront beaches account for approximately 152.7 miles (41%) of the Texas coastline (Table 31). Padre Island NS is the longest of these preserved lands, although the Matagorda Island NWR and State Natural Area also protect a substantial portion of the coast (38 miles).

**Table 30. The approximate length of sandy, oceanfront beach within each shoreline segment of Texas and the proportions that are developed and undeveloped (Morton and Peterson 2005c, 2006a, and 2006b, Google Earth 2011 imagery).**

Shoreline Segment	Approximate shoreline length in miles	Developed shoreline miles (% of total)	Undeveloped shoreline miles (% of total)
Sabine Pass to Colorado River	150.7	39.1 (26%)	111.6 (74%)
Colorado River Mouth to Matagorda Ship Channel	23.7	0	23.7 (100%)
Matagorda Ship Channel to Pass Cavallo	4.1	0	4.1 (100%)
Pass Cavallo to Aransas Pass	56	0	56 (100%)
Aransas Pass to Mansfield Channel	93	6.9 (7%)	86.1 (93%)
Mansfield Channel to Rio Grande River	42.4	4.7 (11%)	37.7 (89%)
<b>TOTAL</b>	<b>369.9</b>	<b>50.7 (14%)</b>	<b>319.2 (86%)</b>

Approximately 36.6 miles (10%) of Texas's sandy, oceanfront beach has been armored (Morton and Peterson 2005c, 2006a, 2006b, Google Earth). At least 28 miles (8%) of sandy, oceanfront beach have received beach nourishment or dredge disposal placement, some areas multiple times (Table 32). Galveston Island has the longest reaches of beach nourishment, and the town of South Padre Island – Isla Blanca Park area has 30,000 feet of oceanfront beach that receives dredge disposal and beach nourishment fill.

**Table 31. Preserved sandy, oceanfront beaches in Texas, the county in which they are located, and approximate shoreline length.**

<b>Preserved Land</b>	<b>County Location</b>	<b>Approximate Length in Miles</b>
Sea Rim State Park	Jefferson	5.2
Bolivar Flats Shorebird Sanctuary	Galveston	2.3
East End Lagoon Park and Nature Preserve	Galveston	2.8
Galveston Island State Park	Galveston	1.5
Justin Hurst WMA	Brazoria	1.3
San Bernard NWR	Brazoria	5.8
Matagorda Bay Nature Park	Matagorda	2
Matagorda Island NWR and State Natural Area	Matagorda	38
I.B. Magee Beach Park	Nueces	0.7
Mustang Island State Park	Nueces	5
Padre Island NS, North Padre Island	Kleberg, Kenedy, & Willacy	65.5
Laguna Atascosa NWR, South Padre Island Unit	Willacy & Cameron	9.6
Andie Bowie County Park	Cameron	0.5
Isla Blanca Park	Cameron	1
Boca Chica Tract, Lower Rio Grande River NWR	Cameron	5.5
<b>TOTAL MILES (% OF STATE SHORELINE)</b>		<b>152.7 (41%)</b>

**Table 32. The approximate length of known beach nourishment and dredge disposal placement projects on Texas's sandy, oceanfront beaches (from PSDS 2012, Google Earth imagery, and Morton and Miller 2004).**

<b>Location</b>	<b>Project Length (miles)</b>
Caplen Shores area west of Rollover Pass	1.1
Corpus Christi	1.4
Galveston Island	6.8
Galveston Island State Park	Unknown
Galveston Island west end subdivisions	6.3
Gilchrest Subdivision east of Rollover Pass	1
McFaddin NWR	1
North Padre Island	1
Quintana	1
Rollover Pass area shorelines	2
South Padre Island and Isla Blanca Park	5.7
Surfside Beach	1
Texas Point NWR	Unknown
<b>TOTAL MILES (% OF STATE SHORELINE)</b>	<b>28.3 (8%)</b>

## DISCUSSION

A substantial portion of the sandy, oceanfront beaches within the U.S. continental wintering and migration range of the piping plover have been developed (39%), filled with sediment (at least 32%) and armored (at least 11%). These habitat modifications tend to occur in the same locations, resulting in localized adverse cumulative effects. When combined with the habitat modifications to the tidal inlets within the continental wintering range (results of Rice 2012) significant cumulative loss and degradation of piping plover habitat can be seen, for example on areas like the east coast of Florida. The number of beach nourishment projects is increasing in virtually every state (Trembanis et al. 1998, Bush et al. 2004, USFWS 2009). This assessment did not include other forms of habitat modification, such as dune building and maintenance, vegetation plantings, beach scraping (using bulldozers to push up artificial levees or “dunes” with sediment from the beach), the maintenance and protection of coastal roads, and the use of ORVs on beaches and dunes. All of these activities occur throughout the range, however, and serve to increase the adverse cumulative effects to sandy, oceanfront beaches.

The amount of sandy, oceanfront beaches that have been conserved and protected through preservation and easements totals over 811 miles of the U.S. continental wintering range of the piping plover. These preserved lands are not uniformly distributed throughout the range however. Federal lands have made a substantial contribution to preserving sandy, oceanfront beach habitat. The National Seashores within the continental range – Cape Hatteras, Cape Lookout, Cumberland, Cape Canaveral, Gulf Islands, and Padre Island – contribute over 280 miles of protection. This protection does not equate to pristine, undisturbed, and unmodified habitat, however, as the seashores have been and continue to be modified by beach nourishment and dredge disposal placement (Gulf Islands, Cape Hatteras), ORV (Cape Hatteras, Cape Lookout, Padre Island), protection and maintenance of coastal highways (Cape Hatteras, Gulf Islands), the potential for incompatible activities on private inholdings (Cape Hatteras, Cumberland), artificial dune ridge creation and maintenance (Cape Hatteras, Gulf Islands), and closure of new inlets (Cape Hatteras). National Wildlife Refuges have also preserved sandy, oceanfront beaches throughout the range, most notably Pea Island (NC), Cape Romain (SC), Archie Carr (FL), Breton (LA), and Matagorda Island (TX). Other significant federal lands include those of military bases (Camp Lejeune in NC, Eglin and Tyndall AFBs in FL) and the NERR system (Masonboro in NC, Apalachicola, Guana Tolomato Matanzas and Rookery Bay in FL). Although they are generally shorter in length than the federal lands, state, county, local, and conservation organization owned lands make a collectively important contribution to the total preserved lands inventory.

This inventory of preserved lands can be used to identify geographic gaps where conservation efforts may be prioritized to maintain and increase habitat availability and quality as sea level rises and climate changes. The area with the least modified habitat, retaining the most constituent elements of the wintering critical habitat designation, appears to be in Texas. Long stretches of undeveloped barrier islands and peninsulas, with overwash passes and flats, discontinuous dunes, and sparse vegetation are common in Texas. The Mississippi islands of the Gulf Islands NS and the area of the Florida panhandle protected by the Gulf Islands NS, Eglin AFB and Tyndall AFB provide similar habitat and opportunities for better conservation efforts to avoid higher levels of modification and disturbance as sea level rises. The

beaches and islands of Cape Lookout NS and Cape Romain NWR constitute the only significant analogous lands on the Atlantic coast in terms of habitat features or elements. The undeveloped and preserved islands of Georgia provide a uniquely contiguous suite of inlets and sandy beach habitats. All of these areas are well-suited to allow habitat migration with rising sea level, and indeed are already showing signs of doing so.

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