
Dune Restoration and Management Plan

Gulf State Park Infrastructure Improvements and Restoration Gulf Shores, Alabama



March 2014

Prepared by:

**Volkert, Inc.
316 South McKenzie Street
Foley, Alabama 36535
(251) 968-7551**

Table of Contents

1.0	Introduction and Background	1
2.0	Project Description	8
2.1	Interpretive Center.....	8
2.2	Lodge and Conference Center.....	8
2.3	Natural Resource Damage Assessment (NRDA) Dune Enhancement	9
3.0	Site Description	11
3.1	Hurricane Impacts to Gulf State Park and Infrastructure.....	11
3.2	Habitats Contained Within the Action Area	11
3.3	Current Conditions	12
4.0	Existing Status of Habitat in the Action Area.....	13
4.1	Dune Vegetation Communities in the Action Area	14
4.1.1	Incipient Dune Habitat	14
4.1.2	Primary Dune	15
4.1.3	Interdune Swales	16
4.1.4	Restored Secondary Dunes	17
4.2	Dune Protection and Beach Access.....	19
5.0	Dune Habitat Enhancement Techniques.....	22
5.1	Sand Fencing.....	22
5.2	Re-Vegetation.....	23
5.3	Christmas Tree Recycling	25
5.4	Technological Advancements	26
5.5	Planting Guidelines	27
5.6	Monitoring.....	27
5.7	Control of Invasive Species.....	28
6.0	Management Plan	30
6.1	Dune Manager Requirements.....	30
6.2	Annual Reporting Requirements	31
6.3	Determination of Work Plan	32
6.4	Considerations Specific for Alabama Beach Mouse.....	33
7.0	References	36

FIGURES

Figure 1: Project Vicinity – Gulf State Park Infrastructure Improvements and Restoration.....	2
Figure 2: Action Area Boundary with Permitted Infrastructure Acreages	3
Figure 3: 2013 Trapping Results – Alabama Beach Mouse Recovery Program.	6
Figure 4: Dune Restoration Areas (October 2013).	7
Figure 5: Footprint and Floor Plan for Interpretive Center.....	10

1.0 Introduction and Background

Volkert, Inc. (Volkert) is preparing this document for the Alabama Department of Conservation and Natural Resources (ADCNR). This plan is required to satisfy permit conditions for dune restoration, enhancement and management associated with the Habitat Conservation Plan (HCP) for the Alabama Beach Mouse (ABM) and the resulting Incidental Take Permit (ITP - TE072831-0) (Volkert, 2013). Subsequent modifications were issued by the United States Fish and Wildlife Service (Service) as changes to the planned development were made (Volkert 2013).

This plan is site specific for the activities that have occurred and are planned to occur within Gulf State Park in the defined Action Area (AA) which includes the relocated and rebuilt Fishing Pier, the constructed Beach Pavilion, the planned Lodge and Conference Center (Lodge Complex), and the planned Interpretive Center. Based on a meeting with the Service on October 25, 2013, this management plan will use the existing habitat conditions as the baseline for future restoration/enhancement activities within the AA.

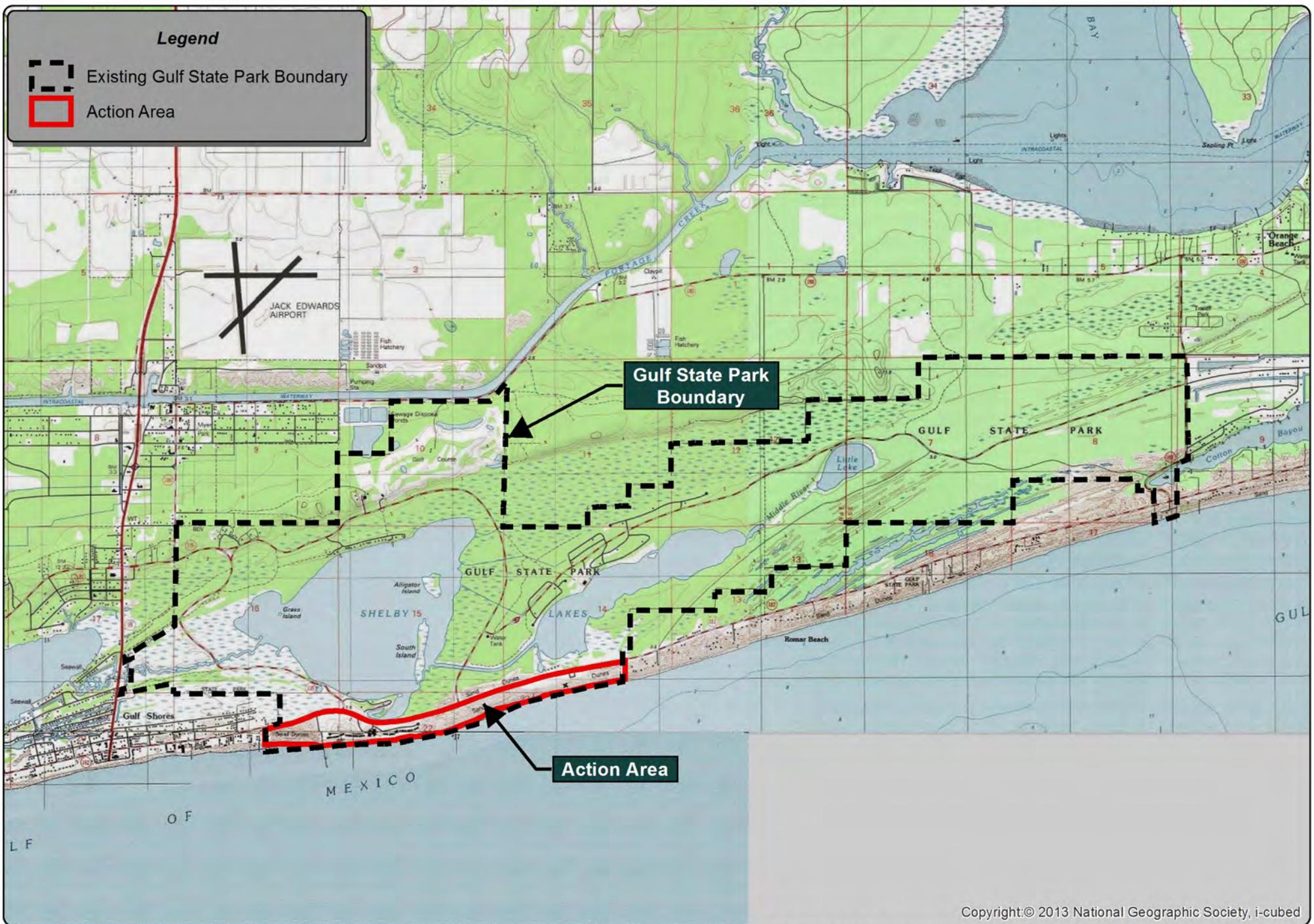
The Service issued an ITP for Alabama Beach Mouse (*Peromyscus polionotus ammobates*) as a result of the completion of the HCP that was developed to address planned development within the Gulf State Park (**Figure 1**). The first ITP was issued December 2004 (USFWS, 2004b; 2004c). Two subsequent minor modifications were issued in 2005 and 2006. The 2005 modification resulted from changes to the location and size of the development of the Beach Pavilion and attendant parking lots (USFWS, 2005). The 2006 modification resulted from the relocation and footprint reduction associated with rebuilding the Fishing Pier (USFWS 2006a; 2006b) (**Figure 2**).

The areas that have been permitted and the remaining infrastructure construction activities are within the defined AA that was discussed in the HCP. There are two related enhancement projects that are proposed within the AA for the construction of an Interpretive Center and for dune enhancement. These actions are part of the Natural Resource Damage Assessment process that resulted from the 2010 Deepwater Horizon oil spill.

The Interpretive Center construction will occur within the permitted footprint for the Beach Pavilion. The proposed enhancement of coastal dune habitat is expected to enhance approximately 50 acres of dune habitat within Gulf State Park. Much of the area available for this enhancement exists within the AA. Both projects will be constructed within the areas already detailed in the HCP and permitted for incidental take of ABM.

Legend

-  Existing Gulf State Park Boundary
-  Action Area



Copyright© 2013 National Geographic Society, i-cubed



0 2,000 4,000 Feet
1 inch = 4,000 feet



Note: This map is for presentation use only and not to be used for construction purposes.

Figure 1
Project Vicinity - Gulf State Park
Infrastructure Improvements & Restoration



Note:
Action Area Boundary is at SR182 Right of Way

Legend

-  Fishing Pier - 10.3 Acres
-  Interpretive Center / Beach Pavillion - 9.2 Acres
-  Lodge Complex ITP - 21.6 Acres
-  Updated Action Area - 137.9 Acres
-  Baldwin County Parcels - 179.0 Acres

bing™

VOLKERT

0 600 1,200 Feet
1 inch = 1,200 feet



Note: This map is for presentation use only and not to be used for construction purposes.

Figure 2
Updated Action Area
Boundary with Revised Acreages
(2012 Aerial)

The ITP and modifications for the former Hotel and Convention Center, Fishing Pier, and Beach Pavilion required a dune management plan identifying appropriate dune conservation, restoration, and management measures. This plan addresses planting of vegetation and placement of sand entrapment devices along the primary and secondary dunes within the AA. This revised Dune Management Plan includes updates for the Lodge Complex being planned, the proposed construction of the Interpretive Center and the Dune Enhancement Projects.

With the issuance of the initial HCP and the defined areas of construction and habitat restoration, ADCNR was required to restore 22.7 acres of degraded coastal dune habitat within the AA. The purpose of the dune restoration was to increase the availability of suitable habitat within the designated Critical Habitat for the Alabama Beach Mouse (ABM). Following the passage of Hurricane Ivan, the available suitable habitat within the AA was reduced from approximately 90.3 acres to zero (0) acres. Hurricane Ivan is believed to have extirpated the ABM from Gulf State Park and destroyed all suitable Critical Habitat in the AA providing Primary Constituent Elements (PCE) for the growth and reproduction of the ABM.

Service efforts to reintroduce the ABM within the Gulf State Park were initiated in 2010 with the transplant of eleven (11) mating pairs of ABM from an existing population. The Service has been monitoring the population regularly and has concluded that the success criteria for repopulation have been met. At this point, there are no population estimates. However, the USFWS has concluded from recent trapping information and track tube monitoring that the ABM population is occupying most likely any and all available habitat at Gulf State Park (Pers. Com. - Bill Lynn, USFWS) (**Figure 3**).

The remainder of this report will describe the results of the dune restoration that have occurred to date and will provide some information on the proposed Natural Resource Damage Assessment (NRDA) Dune Restoration and Enhancement Projects and the plans for dune management and monitoring associated with the remaining projects.

Within the AA approximately 36.8 acres of dune habitat capable of providing Critical

Habitat PCE has now been restored (**Figure 4**). This meets the required restoration associated with the original ITP issuance (and modifications) and fulfills ADCNR's obligation for dune habitat restoration associated with the ABM. There are plans to enhance 50 acres of dune habitat that could increase the potential suitable ABM habitat availability within the AA. These plans for NRDA Dune Restoration and Enhancement are supplemental to the requirement for ADCNR dune restoration detailed in the HCP.



GULF STATE PARK ABM CAPTURES

- NO
- YES
- ~ CCL

Note: This map is for presentation use only and not to be used for construction purposes.



2.0 Project Description

The project AA is located in Sections 21/22, Township 9 South, Range 4 East, along Alabama State Highway 182 (SR 182) in Gulf Shores, Alabama. As of the writing of this report the Beach Pavilion and the Fishing Pier projects are constructed and operational.

2.1 Interpretive Center

One additional project associated with the Beach Pavilion site remains to be constructed. The Interpretive Center is planned to provide a stand-alone educational center that will explain many coastal processes, contain a dynamic restored dune habitat, and allow participants to enjoy the displays at their pace (**Figure 5**).

The Interpretive Center would be built within the undeveloped area that was part of the ITP modification for the Beach Pavilion (ITP-TE-072831-1). Of the 9.2 acres covered in the ITP, only 7.4 acres were built out for the pavilion and parking areas. With the buildings for the Interpretive Center accounting for approximately 0.1 acre, the remaining footprint for the center would include the elevated gathering deck and the elevated walkways around the interior display area. The overall footprint of the buildings and dune restoration exhibit area would be 1.8 acres.

2.2 Lodge and Conference Center

At the area retained for the construction and development of the Lodge Complex, the potential development would include a Lodge with approximately 350 guestrooms, a conference center capable of accommodating approximately 1,500 people, approximately 1,209 parking spaces, two pools, and other associated amenities. The proposed buildings will be founded on pilings with the first inhabitable floor beginning at 25 feet above mean sea level (AMSL). Recreational areas south of the buildings will be on slab at 16 feet AMSL.

The proposed Lodge would be elevated and retain an open first floor beneath the main building that will not impede sand movement. This would aid in the

development of sand dune habitat near the lodge and should also improve conditions for ABM within the areas of development. Final plans are being developed as part of the proposed Gulf State Park Enhancement Project associated with the NRDA restoration program from the Deepwater Horizon oil spill.

The final site development plan will include the planned infrastructure (parking and associated roadways, support buildings and amenities) and planned open areas. The open areas would be landscaped with native vegetation and maintained with a semi-natural appearance that will blend with the surrounding undeveloped areas.

2.3 Natural Resource Damage Assessment (NRDA) Dune Enhancement

Within the AA there are several areas of dune habitat that have been restored using various restoration techniques (see Sections 4 and 5). The restoration was completed in fulfillment of the Service requirement for issuance of the original ITP and subsequent modifications. This is based primarily on the geomorphologic location within the AA and less on the vegetative communities.

Plans are being developed as part of the impending NRDA program to enhance approximately 50 acres of dune habitat within the Gulf State Park with the majority of the restored or enhanced habitat taking place within the AA. The enhanced dune habitat is expected to increase suitable habitat for use and eventual supply of PCE for the reintroduced ABM population as it expands within Gulf State Park. Dune restoration and enhancement that result from this program will be in addition to the already completed restoration required by the issued ITP.

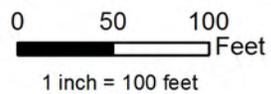
Legend

-  Interpretive Center Floor Plan
-  Interpretive Center - 1.8 Acres
-  Pavillion Area



bing

VOLKERT



Note: This map is for presentation use only and not to be used for construction purposes.

Figure 5
Footprint & Floorplan for Interpretive Center

3.0 Site Description

The AA described in this document consists of approximately 179.0 acres of Gulf of Mexico shoreline and dune habitat areas south of SR 182. The AA includes previously developed lands as well as undeveloped lands within the confines of Gulf State Park.

3.1 Hurricane Impacts to Gulf State Park and Infrastructure

Gulf State Park has been affected by many hurricanes resulting in severe damage to the resort facilities and park grounds. Hurricane Frederic, which made landfall on the Alabama coast in 1979, was the most damaging. Accounts from the storm damage report show the park was submerged by a 5 to 8-foot storm surge, which flooded all of the park facilities and caused extensive structural damage. The fishing pier also suffered extensive structural damage and the primary dunes fronting the park's coastal property were completely leveled.

Other significant hurricanes include: Kate, Juan, Elena, Opal, and Erin. Opal and Erin were particularly damaging storms that once again flooded the resort and convention center facilities. The beach pavilion was damaged so badly that it was condemned and closed to the public in 2001.

In 2004, Hurricane Ivan nearly demolished the existing Pavilion, the Hotel and Convention Center, and the residential cottages that occupied the developed areas of Gulf State Park. In 2005, Hurricane Katrina also hit the Alabama Gulf Coast doing further damage to the remainder of the hotel and other developed areas. In 2006, The ADCNR had the remnants of the hotel and pavilion demolished. The former hotel site has remained vacant. The pier and pavilion and their associated parking lots have been successfully reconstructed.

Hurricane Ivan's impacts to Gulf State Park also included the extirpation of the ABM from the lower elevations of the park, which included the entire AA associated with this report (USFWS, 2006a).

3.2 Habitats Contained Within the Action Area

The area within the AA has been declared Critical Habitat for the Alabama Beach

Mouse. Those areas that have been already covered by the HCP and its related ITPs will be, or are already, developed and will not be available for ABM use.

Inland from the Gulf of Mexico shoreline, the natural environment in the AA contains the following coastal ecotones: wet beach, incipient dunes, primary dunes, interdune swales, and secondary dunes. The secondary dunes are behind the engineered berm and are being considered for the proposed NRDA Dune Enhancement Project that is still being developed. Because it is within the defined AA, the NRDA Enhancement Project will be subject to the details of the HCP for ABM and will aim to improve suitable habitat for ABM.

3.3 Current Conditions

Within the AA, Gulf State Park is primarily undeveloped natural coastal habitat along the Alabama Gulf Coast that lies between the developed areas of Orange Beach to the east and Gulf Shores to the west. The AA includes vacant disturbed land where the previous Lodge Complex stood prior to Hurricane Ivan and a small area west of the existing Pavilion. The fishing pier was built within the original footprint for the Lodge Complex and takes up 10.3 acres of the initial 33.5 acre footprint for the Lodge Complex and Pier. The planned Lodge complex will be developed on the remaining 21.6 acres of an overall reduced footprint of 31.9 acres for both structures. With the final completion of construction, the developed areas account for 41.1 acres of the total 137.9 acres found within the AA.

Some of the remaining 98.6 acres have already been restored for primary and secondary dune habitat. The engineered berm that is in the geomorphologic location of the primary dune line accounts for approximately 13.6 acres of dune habitat. Efforts by ADCNR to restore dune habitat have resulted in an additional 15 acres of dune habitat that is comprised of planted dune habitat and constructed Christmas tree dunes (see Section 5.3). Approximately 8.2 acres of dune habitat were restored as part of the required restoration associated with the relocation of the Fishing Pier.

4.0 Existing Status of Habitat in the Action Area

Long term study of the Alabama Gulf Coast determined that the beaches at Gulf State Park had been undergoing a slight accretion in the period from 1970 to 1993 (Douglass and Sanchez, 1994). The surrounding beaches were indeterminate for an accretion or recession trend (Douglass, Pickel, and Greathouse, 1999).

Based on subsequent beach erosion, the City of Gulf Shores determined that a beach nourishment project was required for their community. The first beach nourishment at Gulf Shores was completed in 2001.

This initial nourishment was followed in 2005 with nourishment that included Gulf State Park. Hurricane Katrina caused extensive damage to the newly constructed beach. The damaged beach was restored in 2012 with a renourishment project. Most of the placed sand remains.

The long shore current direction and littoral drift of sediments along the subject property trends from east to west. As sand migrates to the west, the shape and location of the shoreline on the subject property is likely to fluctuate.

An engineered berm was constructed as part of the 2005 renourishment following the passage of Hurricanes Ivan and Katrina to protect infrastructure landward of the beach (see **Figure 4**). These hurricanes also destroyed most of the remaining dunes within the lower elevations of Gulf State Park south of State Road 182.

The sand mounds that made up the engineered berm were placed in the approximate geomorphologic location of natural primary dunes. Sand fencing installed as part of the protection and enhancement of the berm has resulted in a tall primary dune field. In some cases the height of the dune line has meant less sand being deposited just behind (north) the primary berm dune.

The engineered berm was planted with native vegetation in an effort to retain the dune line and to improve dune habitat within Gulf State Park. As of late 2013, the berm appears to be maintaining position and filling in with dune vegetation regrowth. There

is now evidence of habitation by ABM in this restored dune habitat.

Dune habitat restoration that has been completed by ADCNR within the AA has fulfilled the requirements of the ITP (and modifications) issued for the Gulf State Park projects to date. These restoration areas will be used as baseline conditions for the planned restoration and enhancement projects being developed as part of the NRDA process.

4.1 Dune Vegetation Communities in the Action Area

With the construction of the engineered berm, the development of natural dune fields has been modified slightly. The berm is located in the geomorphologic location of the primary dune field. It is not close enough to the wet beach to develop pioneer dune vegetation, but it does function as the primary dune habitat preferred by ABM. This Dune Management Plan is expected to provide the methods for helping to diversify the dune types located in the AA south of SR 182.

4.1.1 Incipient Dune Habitat

Along the Alabama Gulf Coast, this dune type is the first collection of plants that develops between the wet beach and the primary dune field. Generally, the pioneer species found in this habitat include: Sea oats (*Uniola paniculata*), Sea rocket (*Cakile constricta*), Seashore elder (*Iva imbricata*) and Coastal panicgrass (*Panicum amarum* var. *amarulum*).

These plants help to accumulate sand which spurs the growth of sea oats and coastal panicgrass and leads to the formation of the primary dune. This dune type is found in small infrequent locations within



the AA. As part of the Christmas tree recycling initiative, (photo above

and see Section 5.3) tree-based dunes have been placed in this geomorphologic location to modify the engineered berm behind it and promote more sand movement to the interior sand flat area.

4.1.2 Primary Dune

The engineered berm constructed along the entire Gulf State Park shoreline currently occupies the geomorphologic position of the primary dune. The engineered berm is a nearly straight-line mound of vegetated sand that extends for the length of the Gulf State Park AA and was erected as part of the beach nourishment project.



To improve the sand trapping capability usually provided by vegetation and in some instances to replace the vegetation, sand fencing was erected at the base of the engineered berm to aid in the height increase of the

berm. In some areas the sand fence has been completely subsumed by the growing sand dune. However, sand movement has exposed sand fence in many areas.

The vegetation that has been planted on the berm was specifically selected to provide a vegetation community closely resembling the natural primary dune habitat. Sea oats and Coastal panicgrass are



the dominant planted species found on the berm. As this habitat develops

other species will be recruited through seed movement and capture by the existing bunches of grass.

4.1.3 Interdune Swales

Generally, interdune areas are typified by low vegetation density. The flat interdune areas are developing scattered concentrations of Rustweed (*Polypremum procumbens*) and Squareflower (*Paronychia erecta*) which are indicator species for this habitat (Gibson and Looney, 1992; Looney, et al, 1993).

Once developed, the interdune swales can become either dry or wet. Wet swales usually indicate a close conjunction with groundwater and increased moisture from rain ponding.

Developed interdune swales are generally bare sand but when vegetated are characterized by the presence of Saltmeadow cordgrass (*Spartina patens*), Yaupon (*Ilex vomitoria*), and various Sedge species (*Cyperus* spp., *Fimbristylis* spp.). The wetter swales will also have small patches of Black needle rush (*Juncus roemerianus*), and Umbrella grass (*Fuirena scirpoidea*).



Few areas of Gulf State Park within the AA appear to be developing toward wet swales.

Dry swales can contain elements of the adjacent dune habitat. For the majority of the interdune swale areas, the Gulf State Park swales contain Saltgrass (*Distichlis spicata*), Beach elder, and Seaside bluestem (*Schizachyrium maritimum*) in addition to the Rustweed and Squareflower.

The areas that currently contain large expanses of interdune swale will eventually be the location of the proposed NRDA dune enhancement.

4.1.4 Restored Secondary Dunes

Within the AA the dunes behind the engineered berm lie within the geomorphologic location usually occupied by secondary dunes. In their



natural state, this dune type is typified with higher elevations and the presence of woody vegetation. However, with the hurricane destruction of the existing dune field habitat within the AA, the dune vegetation has not had enough time to

develop the stability and full complement of natural vegetation typical of this habitat.

Some of the area between the engineered berm and SR 182 has been restored with pioneer dune vegetation (Sea oats, Beach evening primrose (*Oenothera humifusa*), Beach elder, and Coastal panicgrass). These areas are also seeing some recruitment of Camphorweed (*Heterotheca subaxillaris*), a natural component of the primary dune system.

Over time, the undisturbed dunes can be expected to also grow woody vegetation which would indicate more stability. Typical secondary dune vegetation would include Groundsel tree (*Baccharis hamilifolia*), False rosemary (*Conradina canescens*), Beach rosemary (*Ceratiola ericoides*), Greenbrier (*Smilax* sp.), Woody goldenrod (*Chrysoma pauciflosculosa*) and Saw palmetto (*Serenoa repens*).

4.1.4 Remnant Scrub Dunes

Within the Alabama coastal dune system, the geomorphologic position of

the scrub dune habitat is north of the secondary dune. Within GSP, this habitat is not as widespread as it was prior to Hurricane Ivan. Most of the existing scrub dune habitat is located north of SR 182 and outside the AA for this project.

Generally, this habitat is isolated in the dune system and consists of scattered, discontinuous dunes up to twelve to fifteen feet above mean sea level (msl). Where the dune system has been allowed to develop without being destroyed by storms or development, these dunes are characterized by tree and bush species that are longer lived than the herbaceous species found in the secondary dunes.

These dune systems are typically the remnants of earlier periods of dune building along the Gulf coast. Many show the scars of storm surge and recent hurricane events that have reduced their overall area through erosion.

Scrub dunes, especially at their peak elevations, are vegetated predominantly by dwarf tree species, including sand live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), Chapman's oak (*Q. chapmanii*), and scattered sand pine (*Pinus clausa*). The shrub species commonly found in these dune areas can include false rosemary (*Ceratiola ericoides*), gopher apple (*Licania michauxii*) and laurel leaf greenbriar (*Smilax laurifolia*).

Within the GSP AA, this dune type has been reduced to very little acreage. There are small dunes that usually consist of one of the tree species anchoring sand and with a depauperate community of the characteristic vegetation species. None of these have the elevation described above that is typical of the habitat. Nor do they have the other constituent species. There is a small pocket of scrub dune that is located within the area formerly occupied by the beach cottages. Also, there is a small area within the proposed footprint for the Lodge and Conference Center.

Outside the proposed construction area, some consideration will be made to try to rebuild this dune habitat type as part of the NRDA restoration effort. No final plans have been developed for the area of scrub dune within the Lodge footprint. Consideration for this the conservation of this habitat type will be part of the overall site planning. However, the area is not considered to be available for ABM as it is in the ITP.

4.2 Dune Protection and Beach Access

Land disturbance activities for the proposed project are landward of the coastal construction control line. Dune vegetation is now being protected from pedestrian impacts through the use of elevated dune walkovers. Dune walkovers exist at the Beach Pavilion (3) and across from the intersection of State Park Road 2. Both of these locations are east of the planned Lodge Complex. The planned Interpretive Center will share a walkover with the Pavilion area. Previous plans for the Lodge Complex had three additional walkovers incorporated into the infrastructure. The final plans for the Lodge Complex are not complete at this time but will include similar dune protection walkover structures. Existing walkovers on GSP installed after the hurricane seasons of 2004 and 2005, were installed in accordance with all state and local laws (i.e., usually 5 feet above grade). However, the pre-hurricane heights of local dunes were not taken into account during the rebuilding of boardwalks and the grade was fairly flat due to the hurricanes. Subsequently, several boardwalks require sand maintenance where dune elevation has overtaken walkovers. To minimize impacts of existing walkover maintenance: (1) consider raising the boardwalks such that maintenance isn't needed; (2) until boardwalks are raised, and prior to maintenance, surveys for mice burrows and tracks will be conducted in the area needing maintenance. Burrows and tracks will be flagged and avoided where possible. If avoidance isn't possible, a permitted biologist will relocate the mice from the area during maintenance; and (3) until the boardwalks are raised, upon the initial maintenance action, the area will be kept free of sand (using hand tools) such that it doesn't begin to encroach upon the boardwalk and no additional maintenance with heavy equipment is needed thereby avoiding future take. In addition, the existing dune height (or desired height of dunes) will

be recorded. When boardwalks need to be repaired or replaced, they will be installed in accordance with state and local laws and using the existing or desired dune height as a baseline to apply the clearance above grade requirement. This measure will avoid the future need for take during sand maintenance adjacent to walkovers.

Access to the beach at the Fishing Pier is through a cut in the engineered berm with wooden walkways that also serve as vehicle access to the beach on either side of the ramp to the pier. West of the pier at the western Park boundary, the engineered berm stops short of the edge of the Park property and is used for public access to the beach from nearby parking areas and housing. There are no plans to close that direct beach access. However, habitat preservation planning will include a means to reduce pedestrian access to the adjacent dunes.

Where necessary, approved fencing, or signage will be installed to funnel pedestrian traffic to utilize existing vehicular trails, thereby avoiding impacts to dune habitat at boardwalks or existing vehicular access points. Any fence installed on the perimeter of developed portions of the property will be of a vertical



lattice, split rail design, shadowbox design, or other design incorporating openings along its entire length of an adequate width to permit unimpeded movement of beach mice through the fence. Fences shall not be installed that could also impede sea turtle or nesting birds. The design of the fence shall be such that accumulation of windblown sand at the base of the fence will provide no impediment to such movement.

Signs regarding pedestrian use of dune walkovers and protection of Alabama Beach Mouse habitat areas are currently in place at the dune walkovers and other

beach access points. There are several signs within and adjacent to the existing dune and berm areas that describe the efforts for dune enhancement that have already taken place.

Dune erosion control measures on the subject property to date have included the placement of sand fencing, supplemental planting of native plant species, and the use of Christmas trees in an attempt to expedite the dune-forming processes.

5.0 Dune Habitat Enhancement Techniques

The current methods being employed in gulf state park for dune habitat enhancement include re-vegetation, placement of sand fencing, and Christmas tree recycling. Each of these methods has worked with the existing restriction to sand movement represented by the engineered berm.

Future enhancement work is expected to include the areas currently occupied by the incipient and the secondary dune fields. The proposed NRDA Dune Enhancement Project would improve sand movement to the area immediately north of the berm and contribute to the development of interior, secondary dune habitat through development of sand movement corridors. The final plans for the planned corridors have not been developed. Dune enhancement for the NRDA Enhancement Project would be coordinated with the Service to position and design the corridors in a manner that could improve sand movement beyond the engineered berm while retaining the primary reason for the engineered berm, the protection of infrastructure. While the attempted restoration methods have been successful, efforts will be made to provide for the adaptation of other promising technologies in the completion of the NRDA Dune Enhancement Project.

5.1 Sand Fencing

The placement of sand fencing to create or enhance dune habitat has a history of success along the beaches of the northern Gulf of Mexico. The pattern for placement of the sand fencing is one of the most important components to the success of this enhancement technique.

When used, the fencing will be positioned approximately normal to typical prevailing wind direction with a general trend of 50 degrees. Fencing will be positioned as dictated by site conditions. Placement of sand fencing will be conducted without the use of heavy equipment. It is expected the materials will be transported to the frontal dune area by using the existing dune walkovers or existing breaches in the engineered berm. Sand fencing will consist of slatted, wood "snow-fence". The fence will be fastened to wood posts. Posts will be buried approximately two feet in the ground as determined by site conditions.

Sand will be applied along the bottom of the fence such that the bottom of the fence is not exposed. Hay bales will not be used as methods of sediment accretion on the incipient, primary, or secondary dunes due to the potential for the introduction of invasive plant species or fire ants.

In Gulf State Park, the successful restoration of the dune habitat using sand fencing has been accompanied by the planting of suitable dune plants. For the most part the mix of plant species has been 70 percent sea oats and 30 percent of the following species: Railroad vine (*Ipomea pes-caprae*), Seaside evening primrose, and Coastal panicgrass. Other pioneer species found in this habitat naturally could be added to the mix (Sea rocket, Seashore elder). Seeds from these plants are known as food items for the ABM.

For the establishment of incipient dunes, sand fencing is usually placed seaward of the primary dune in areas with low elevations and lacking in natural vegetation. The normal development of these incipient dunes is in small unconnected individual locations. Successful enhancement of the incipient dunes can help move the primary dune line seaward as the dune field develops.

Sand fencing has also been used within Gulf State Park to some success in the area of the secondary dunes. These secondary dunes also appear to succeed as individual mounds of planted sand rather than long straight-line dunes.

Sand movement in both locations does present the issue of exposed sand fence as the dune moves beneath and beyond the initial position. Care should be taken when using this technique to reduce the potential for re-exposure of sand fencing. Possible removal after the establishment of vegetation could help in this matter.

5.2 Re-Vegetation

Vegetation is a natural agent to stabilize sand within the coastal dune environment. Salt and sand-resistant species grow upward through the sand and spread laterally forming a dense mat of roots and rhizomes that, in conjunction with their associated mycorrhizal fungi help lessen erosion of dune habitat due to

wind and water (Koske and Polson, 1984; Clements, et al., 2010; Kamble, Sayed, and Qureshi, 2012). Dune vegetation must be hardy and well adapted to the frequent salt-spray, flooding, drought, heat, low nutrient supply, and sand accumulation.

For the re-vegetation of dune habitat, transplanting is the preferred method since under normal coastal conditions seed germination is not high and seedling survival is low (Craig, 1984).



Re-vegetation of dune habitat within Gulf State Park has been primarily the result of transplanting native species into areas of sand accumulation that were depauperate of vegetation. Where planting has occurred, successful areas have become active dune systems that continue to expand as sand accumulates. With the same 70/30 mix of sea oats and other native vegetation as has been used with sand fence restoration, the replanting efforts have been successful. Most of the re-vegetation has been done within the engineered berm and in the landward areas where secondary dunes could develop from the sand movement across the interior of the AA north of the berm.

The transplant of local plant stock is preferred because the stock will not require acclimatization, which can stress and kill plant stock from areas outside the Alabama or Northwest Florida coastal region. Where possible, mycorrhizal fungal inoculations of root material can provide additional survival protection for transplanted rootstock (Sylvia and Will, 1988; Will and Sylvia, 1990).

Within the active sand movement areas of re-vegetated dunes, the most visible method of increasing plant mass is through rhizome spreading. Sea oats also are stimulated by sand burial to spread vegetatively. Other species currently used in re-vegetation efforts have similar capabilities, which make them excellent pioneering species.

For Sea oats and Coastal panicgrass, seed reproduction is limited, especially where sand movement results in significant burial of the seed material. Sea oats can be easily grown from seed and replanted in the same area with little acclimatization required. Sprouting from seed in natural conditions will occur where the existing plant material provides some protection. In the wind shadow of existing plant material, sea oats seed heads and seeds will accumulate and provide the best conditions for seed growth.

The plant mixture already used for dune restoration in Gulf State Park appears to be successful. The mix of low growth (Seaside evening primrose), dense growth (seashore elder) and dense plant material (Sea oats and Coastal panicgrass) provide good conditions for seed protection and growth. The seed gathering also benefits the ABM for their desired food sources.

Sea oats are recommended for planting in the incipient, primary, and secondary dune habitats present in the AA because they are well adapted to conditions of salt spray, lack of water, and sand burial. Sea oats are the most important and widespread grass on the coastal dunes throughout the Alabama Gulf Coast region. Small potted plants are available from local commercial nurseries. When replanting, the stock should be placed on 18-inch centers and packed lightly.

Saltgrass may be another hardy grass species to consider for re-vegetation efforts. Saltgrass is a common plant in the Alabama coastal region. When buried by soil, a stem develops a strong system of rhizomes and roots. Small, first-year seedlings are easily transplanted in spring.

5.3 Christmas Tree Recycling

Successful Gulf State Park dune restoration efforts have also included the recycling of Christmas trees. The trees are grouped to become a sand trap and provide the topographic relief associated with dune restoration. Successful fields of restored dune habitat are visible from aerial photography of the AA. In general, the method used in Gulf State Park produce small round dunes that, if closely spaced, can potentially join and grow larger. Christmas tree restoration

includes the placement and anchoring of tree material; burial with sand; re-vegetation around the periphery using the successful 70:30 mix of species; and providing initial watering and fertilization. Within Gulf State Park, the method for construction of dune habitat using Christmas trees involves the placement of three trees in a semi-circle with the opening facing to the southeast. These trees are buried and the perimeter of the mound is planted with desired plant material.

For Gulf State Park, the Christmas tree recycling and dune building effort has been a successful volunteer activity that has involved community members and contributes to a community interest in the dune restoration/enhancement efforts.

5.4 Technological Advancements

The above mentioned dune restoration/enhancement methods have proven to be successful at Gulf State Park for the improvement of ABM suitable habitat. The development of new technologies for dune restoration will be part of the methodology used in the NRDA enhancement project.

As part of the overall dune management efforts at Gulf State Park, efforts will be made to examine and evaluate dune restoration techniques as they develop. Recent success with Biomimicry building primary dunes at Truro Beach on Cape Cod, Massachusetts could provide another potential methodology for rebuilding the dune habitat within the AA (Peabody, 2013). Recent success of dune



building using Biomimicry holds some potential for natural development of dune structure. The planting of suitable material will still remain the means for keeping sand accumulations in place. Use of the Biomimicry methods to potentially improve burial of rootstock and induce growth and rhizome

spreading could be evaluated as part of the proposed NRDA Dune Enhancement Project.

5.5 Planting Guidelines

Several general guidelines are recommended for the successful establishment of nursery-grown plants (Stout and Hosking 1981).

- The best planting dates for Sea oats are November through April.
- Plants should be planted at a depth of 6 to 10 inches and should be placed 18 inches apart on all sides.
- A mixed planting with more than one species may provide better disease and pest resistance, in addition to improved survival and coverage rates.
- Make graduated plantings with wider spacing of plants (up to 4 feet) around the edges of the enhancement area to allow sands to get to the middle of the planting site and to build a wide dune area.
- Fertilize to aid successful plant establishment. The final determination of fertilizer strength will be made prior to planting and will use the most recent information available for success along this part of the Gulf Coast.

5.6 Monitoring

The Gulf State Park will implement monitoring for the existing dune restoration areas and the proposed NRDA Dune Enhancement Project. The objective of the monitoring effort will be to provide a means for determining successful restoration techniques and to provide a way to identify areas that will need additional effort to meet success criteria.

The monitoring will look at the establishment and survival of transplanted species and the effectiveness of the created dune habitats in providing ABM PCE.

Monitoring of sand fencing will include field locating the approximate center location and elevation of enhancement areas during each monitoring event. This will allow an evaluation of the performance of the enhancement activities and assist in the location of enhancement areas following storm events.

In the case of sand fencing or other methodology that uses non-natural materials in the enhancement methodology, areas where fencing or other material becomes

exposed will need to be evaluated as to whether the sand fencing will remain exposed or removed and a new methodology attempted. Sand fencing will be monitored, maintained, repaired, and replaced as necessary over the five-year monitoring period.

At any of the enhancement or restoration sites, monitoring will be conducted seasonally in spring, summer, and fall for a period of five years to fulfill Alabama Department of Environmental Management (District 8) permit requirements. The growth and extent of coverage of transplants will be documented using an ecologically equivalent method that can allow for inter plot comparisons and seasonal change to be determined.

If comparison data indicates that replanting will be required, a further evaluation of available technology compared with successful methodologies will determine what is used to restore areas deemed not successful. Replanting will be performed if species survival of the original enhancement stock falls below 75 percent. Vegetation cover, species richness, and successful recruitment of native species will be used in evaluating success as well. In addition to ecological comparisons, GPS delineation of successful restoration areas and geo-referenced photographic documentation will be used to record the successful restoration/enhancement locations. These can be used for future restoration/enhancement areas as means for developing more effective success criteria.

The overall success of an enhancement or restoration area will ultimately be determined in association with ABM trapping and population studies to reflect the presence of PCE and established ABM use.

5.7 Control of Invasive Species

Non-native invasive species are considered to be unacceptable in dune habitat within the AA. Especially in areas of restoration and enhancement activities, the monitoring for invasive species and the timely removal of invasive species are considered paramount to the reestablishment of a viable ABM population in Gulf

State Park.

Within Gulf State Park the current species of concern that have become established within dune habitat or adjacent to and potentially reducing ABM habitat value include: Torpedo grass (*Panicum repens*), Cogon grass (*Imperata cylindrica*), and Pampas grass (*Cortaderia selloana*). An invasive species that also poses a threat to Gulf State Park is Beach vitex (*Vitex rotundifolia*). As of this report there is no known infestation of this species in Gulf State Park. The presence of the species in beach habitat in nearby Florida, Gulf Shores, Orange Beach, and on the Ft. Morgan Peninsula is cause for concern. Gulf State Park is monitoring for this species.

Specific treatment methods will be employed to control the invasive species as the specific locations and extent of infestation are known. In small areas the treatment will differ from larger areas of infestation. The most successful methods will be researched and implemented as the control plans are put in place.

Based on the results of coordination efforts with USFWS the success criteria will be developed for invasive control efforts in GSP.

Pathways for introduction and spread of non-native and invasive species in the AA could be construction equipment, personal protective equipment, delivery services, foot traffic, and vehicles. ADCNR will establish methods for control of existing populations of undesirable species and a program for prevention of the introduction of undesirable plants during the enhancement project as well as during the landscaping planned for the Lodge Complex. Species that will be planted as part of the landscaping for the Lodge Complex will include only native species with limited use of non-native, non-invasive species in small ornamental landscaping areas.

6.0 Management Plan

Dune restoration and the infrastructure construction within the AA will result in a required 30-year monitoring project. This will include efforts to adapt to changing conditions, catastrophic events, and compliance with success criteria. Plan protocols will be reviewable to provide ADCNR and the Service with a methodology for adaptive management that can effectively address unforeseen circumstances. The dune management protocols detailed below is adapted from the HCP (Volkert, 2013).

Based on an agreement reached with the Service, the existing dune restoration efforts have fulfilled permit requirements for the ITP and modifications issued to ADCNR in 2004, 2005, and 2006. Proposed Gulf State Park dune enhancement will use the current conditions as a baseline for future activities.

All aspects for the development or modification of this plan for the restoration, enhancement, and repair of dune habitat within the AA will be developed in consultation with the Service.

6.1 Dune Manager Requirements

Gulf State Park will implement a program for monitoring, protecting, enhancing, and maintaining dunes in the AA. This will require the expertise of a qualified dune management consultant with demonstrated expertise in dune management and ecological restoration to oversee this program. The objective of the dune management program will be to identify and implement physical and biological measures for the protection and enhancement of dune conditions. The goal of this management program will be to improve suitable coastal habitat beneficial to the feeding, nesting, and sheltering of the ABM

Dune management, particularly as it may affect plants found in the dune habitat used by ABM for feeding, nesting, and reproduction evolves as more is discovered about ABM. The dune consultant should have expertise in ecology for dune vegetative communities and ABM management. The dune management consultant will stay abreast of current and emerging information in these fields. As new technologies develop or become part of the repertoire for dune

management, the management consultant will summarize the new information including information on physical methods for the restoration of eroded dunes, “blown-out” dunes, dunes otherwise damaged by natural forces or by human influences, and techniques for planting of dune vegetation.

6.2 Annual Reporting Requirements

Prior to the implementation of the overall dune management program for existing and future dune restoration/enhancement projects, the dune management consultant shall prepare an annual work plan for dune management activities for a one-year period. The work plan shall be submitted to and approved by the Service with such reasonable modifications as deemed necessary, subject to funding provisions of this plan. The work plan will be initiated within 60 days of the approval of this Dune Management Plan by the Service.

The annual work plan shall identify and describe the specific dune management measures to be implemented during the work year for the Dune Management Plan. The work plan will describe the beneficial results anticipated as a result of planned activities and set forth a schedule for implementing the planned activities. If at any time during the implementation of planned annual work plan measures, a hurricane or other major destructive storm causes substantial damage to the dune system, the dune management consultant will promptly evaluate the effects of such storm damage and will revise the annual work plan to reflect any dune management and restoration needs that are not sufficiently provided for in the annual plan. Proposed revisions of the annual work plan will be submitted to the Service for review and concurrence before proposed work is commenced.

On the anniversary date of approval of the first year’s annual work plan, and on each successive anniversary date thereafter for 30-years, or other time period as approved by the Service, the dune management consultant shall submit to the Service an annual progress report and a work plan for the coming year’s dune management program. Each such work plan shall include, for the coming year, the basic elements prescribed above for the initial year’s work plan.

The progress report shall describe the following:

- The dune management measures implemented during the previous year;
- The extent to which the beneficial results anticipated from such measures have been, or are being accomplished;
- An explanation of the reason(s) for any failure to complete any activity that was a part of the previous year's work plan; and
- The consultant's recommendations, if any, for modifications of the plan to enhance progress toward plan objects.

The report shall include topographic mapping and photographs as necessary to document any major damage occurring to the dune system during the reporting year. Major damage shall include a comprehensive description of any primary dune system blowout. Also detailed in the report will be any erosion damage that results in an estimated twenty-five percent or greater reduction of the height of any line of primary dunes for a lateral distance of two hundred feet or more. Damage from either tidal scouring or from sand deposition or erosion, that results in a loss of all, or essential all, dune vegetation over any area of 0.25 acre or more of any primary dune will also be detailed.

The Gulf State Park dune management consultant, prior to implementing any specific dune management measures within the AA, shall develop a written dune management protocol for the proposed area to be used to evaluate new dune habitat restoration/enhancement technology.

The dune management program is not intended to supplant or override natural dynamic forces affecting the evolution of coastal dune systems within the AA. These natural forces may be both constructive and destructive.

6.3 Determination of Work Plan

In addition to annual planning and reporting for dune restoration, enhancement, or repair, the Dune Manager will need to develop protocols for determining what activities will be included in the coming year planning documents. This will require that the Dune Manager assess the condition of the dune system within the

AA as a baseline for the planning of dune management measures. This assessment shall include mapping of the dune system as necessary to depict elevation contours, vegetative cover patterns, and indicators of damage (blow-outs, other extensive areas depauperate of vegetative cover, and areas of dead, diseased, or otherwise stressed vegetation). Use of aerial photography and GPS field confirmation will provide accurate determinations of the extent of work required.

The Manager will establish specific objectives for dune management in the AA, including enhancement of elevation differences in areas of suboptimal variation in surface relief; planting and encouragement of a plant species complex favoring species of known preference; and with high food value for ABM, promotion of protection dune configurations in areas deemed potentially most vulnerable to wind and tidal erosion.

In the event of any major damage to the dune system in any monitoring year the dune management consultant shall promptly assess the extent of such damage; report findings to the Service, and implement such measures as are deemed reasonable and necessary by the Service for stabilization and restoration of damaged dune habitat.

6.4 Considerations Specific for Alabama Beach Mouse

Employment of proven technologies for erosion control and dune growth and for planting of desirable plant species can be used to accelerate the rate of dune recovery from the impacts of erosive force. This can potentially extend the intervals during which dunes provide high quality support for life functions of ABM, including feeding, nesting, and sheltering.

Such measures for dune stabilization, protection, and enhancement that may be implemented will be completed with an emphasis upon working with natural forces of wind, water, and tidal action while recognizing the dynamic nature of dune systems and the natural forces that shape them. The ultimate goal of all dune restoration, enhancement, or repair efforts will be the pursuit of attainable

adjustments favoring habitat requirements of the ABM.

Enhancements in habitat quality can be achieved by improvements in vegetation and surface topography in the secondary dune/swale area and should increase the ABM population in this habitat zone. By providing higher overall average dune elevations and a larger total number of secondary dunes, the proposed dune management program also will increase protection for the species during periodic higher-than-normal tidal incursions onto the property. The creation and retention of higher dune elevations north of the primary dune line and further north will improve the potential for and number of refugia available during larger “catastrophic” storm events.

Success criteria will be based on the stabilization of the restored dune areas, dune habitats, as well as the positive growth, maintenance and retention of the ABM population in the AA, as determined through the seasonal trapping.

Areas disturbed, but not permanently converted through construction, will be restored to the maximum extent practicable. As a priority, such restoration will emphasize north/south natural corridors between the isolated scrub dunes (located both north and south of Highway 182) and the open sand areas within the AA. Where possible, east/west connectivity corridors across the AA will be maintained and enhanced.

The applicant will retain a professional engineering firm, with recognized competence in protection, restoration, and enhancement of coastal dune systems, for providing planning, construction, and post-construction guidance in the conservation of the scrub dune vegetation and topography. Based on that guidance, the applicant will undertake prescribed dune conservation measures, such as the planting of native scrub vegetation and the selective placement of sand entrapment devices.

These measures will be undertaken with the goal of maintaining and enhancing the physical stability of the scrub dunes and preservation of a natural plant cover

of value for a wildlife habitat and as an aesthetic amenity of the project. The engineering firm responsible for the dune management will be given the goal of enhancement of the primary dune system to increase the value of that habitat for the ABM. An objective of increasing its value for ABM is to raise the level of ABM density on undeveloped portions of the project.

7.0 References

- Clements, A., A. Simmonds, P. Hazelton, C. Inwood, C. Woolcock, A-L. Markovina, and P. O'Sullivan. 2010. Construction of an Environmentally Sustainable Development on a Modified Coastal Sand Mine and Landfill site – Part 2. Re-Establishing the Natural Ecosystems on the Reconstructed Beach Dunes. *Sustainability* 2: 717-741.
- Craig, R.M., 1984. "Plants for Coastal Dunes of the Gulf and South Atlantic Coasts and Puerto Rico," United States Department of Agriculture Soil and Conservation Service, Agriculture Information Bulletin 460, United States Government Printing Office, Washington, D.C.
- Douglass, S. and Sanchez, T., 1994. "Alabama Shoreline Change Rates 1970-1993", College of Engineering Report #94-1, University of South Alabama, Mobile, Alabama.
- _____, B. Pickel, and B. Greathouse. 1999. State-of-the-Beaches of Alabama: 1998. College of Engineering Report No. 99-01. Civil Engineering Department, University of South Alabama, Mobile, Alabama. 21pp. Accessed at: <http://www.southalabama.edu/cesrp/beaches2001.html#summary>.
- Gordon, P. 2013. Making Land from Air: Biomimicry Strategy and Techniques. www.SafeHarborEnv.com.
- Gibson, D.J. and P.B. Looney. 1992. Seasonal Variation in Vegetation Classification on Perdido Key, a Barrier Island off the Coast of the Florida Panhandle. *Journal of Coastal Research* 8(4):943-956.
- Kamble, V.R., B.K. Sayed, N. Qureshi. 2012. Screening of CSDPs for AM Fungal Association from Arnala and Kalamb Beach Maharashtra. *Journal of Pharmacy and Biological Sciences* 2(4): 44-47. July-August 2012.
- Koske, R.E. and W.R. Polson. 1984. Are VA Mycorrhizae Required for Sand Dune Stabilization? *Bioscience* 34(7):420-424. July-Aug. 1984.
- Looney, P.B., D.J. Gibson, A. Blyth, and M.I. Cousens. 1993. Flora of the Gulf Islands National Seashore, Perdido Key, Florida. *Bulletin of the Torrey Botanical Club* 120(3):327-331.
- Peabody, G. 2013. Making Land from Air: Biomimicry Strategy and Techniques. Accessed at: www.SafeHarborEnv.com.
- Stout, J.S. and W. Hosking, 1981. "First Aid for Damaged Beaches and Dunes," Sea Grant Advisory Services and Alabama Cooperative Extension Service, Circular CRD-19, Auburn University, Auburn, Alabama.
- Sylvia, D.M. and M.E. Will. 1988. Establishment of Vesicular-Arbuscular Mycorrhizal Fungi and Other Microorganisms on a Beach Replenishment Site in Florida. *Applied and Environmental Microbiology* 54(2):348-352. February 1988.

- U.S Fish and Wildlife Service .2004a. Environmental Assessment. Proposed Reconstruction of the Gulf State Park Hotel, Convention Center and Pavilion, Gulf Shores Alabama. Daphne Field Office, Daphne, Alabama. 48pp + Appendices.
- _____. 2004b. Biological Opinion for Issuance of an Incidental Take Permit. Daphne Field Office. 39pp. + Figures. December 22, 2004.
- _____. 2004c. Federal Fish and Wildlife Permit. Threatened Species – Incidental Take, TE072831-0. December 23, 2004.
- _____. 2005. Federal Fish and Wildlife Permit. Threatened Species – Incidental Take, TE072831-1. April 6, 2005.
- _____. 2006a. Revised Biological Opinion and Conference Report for Issuance of an Incidental Take Permit Section 10(a)(1)(B) Gulf State Park Hotel and Convention Center Demolition and Reconstruction Gulf shores and Orange Beach, Alabama. Daphne Field Office. November 15, 2006. 13 pp.
- _____. 2006b. Federal Fish and Wildlife Permit. Threatened Species – Incidental Take, TE072831-2. December 22. 2006.
- Volkert, Inc. 2013. Habitat Conservation Plan. Gulf State Park Infrastructure Improvements and Restoration, Gulf Shores, Alabama. Report written for the Alabama Department of Conservation and Natural Resources, Submitted to the US Fish and Wildlife Service. November 2013. 77 pp.
- Will, M.E. and D.M. Sylvia. 1990. Interaction of Rhizosphere Bacteria, Fertilizer, and Vesicular-Arbuscular Mycorrhizal Fungi with Sea Oats. Applied and Environmental Microbiology 54(2): 2073-2079. July 1990.