COASTAL RESILIENCE & SUSTAINABILITY STRATEGIES

Tyndall Air Force Base
Draft, 30 September 2020

Aerial View of Tyndall Peninsula

INTRODUCTION

Tyndall Air Force Base (AFB) was devastated by Hurricane Michael in October 2018. Due to its critical geographic position on the Gulf of Mexico and its value as an economic engine in Northwest Florida, the Air Force vowed to rebuild the base as the Installation of the Future. Improved standards for flood elevation and wind speed are guiding new construction. The landscape master plan elements in Tyndall AFB's *Installation Facilities Standards* promote sustainable development, multimodal mobility, and enhanced stormwater management. Nature-based coastal resilience pilot projects have been conceived and funding is being secured from an engaged stakeholder community.

Restoring a dynamic coastline after a shock as severe as Hurricane Michael is complex and takes time, energy, and resources. Recovery solutions require both human intervention (such as dune restoration, living shoreline construction, and marsh enhancement) and natural processes. This guide provides an overview of the frameworks and strategies intended to improve the area's natural coastal defenses against extreme weather threats, reduce exposure of surrounding infrastructure, and protect surrounding infrastructure from crippling storm surge and flooding.

This document presents concepts and strategies for achieving coastal resilience and sustainability at Tyndall AFB. The strategies in this document are pre-decisional and address elements of resilience beyond coastal storm surge, and including erosion mitigation, rainfall-driven flooding, water quality and integration of all these elements achieving resilience and sustainability outcomes. Although the strategies don't represent recommendations for specific locations, they do point to areas of opportunity for resilience and sustainability.

The ***Coastal Framework*** introduces you to the base's coastal resilience districts (CRDs), which represent the geography discretization framework. CRDs have been defined based on major areas of coastal flood exposure and the natural stormwater flows and elevations common to smaller areas within the overall peninsula. The CRDs help us focus our strategies for enhancing and protecting the natural order of the native land and water elements. By understanding this framework and working with the natural systems, we can improve resilience to coastal erosion, extreme storm events -creating exposure to potentially both coastal surge flooding and rainfall-driven flooding- and create community co-benefits, such as a restored ecosystem and improved recreational and mobility experiences.

The ***Revegetation Strategy*** introduces the coastal systems, vegetation, and wildlife that thrive at Tyndall AFB. Here you will find natural coastal vegetation typologies and their roles in resilient landscapes. The typologies include salt marshes, coastal grasslands, beach dunes, sand beaches, interdunal swales, coastal scrub, and tidal flats. Case studies for similar recovery initiatives are provided for inspiration and guidance.

The framework and revegetation strategies come together in five ***Demonstration Areas***. The demonstration areas focus on coastal resilience improvements—both short term and long term—within a CRD to leverage the natural features of the area and accelerate risk reduction. Demonstration area opportunities include proper dune placement, berm construction, stormwater management, ecosystem restoration, wetland and marsh preservation, erosion control, and overall base connectivity.

As pilots and demonstrations progress, the environmental permitting process can be daunting and complex. To let navigate this process, ***Environmental Requirements*** highlights the state and federal permits and typical timeframes needed for compliance. This easy guide helps plan projects and avoid delays.

Simply stated, improving coastal resilience requires that we understand and work with nature, not against it. The revegetation strategy, framework, and permitting guidance are valuable aids for building resilience to climate risks in this vulnerable area. This guide will assist the Tyndall Working Group broaden their understanding of the work ahead and pursue funding for the pilots and demonstrations. In addition to mission assurance and climate risk reduction, these improvements will help create a sustainable environment throughout the Tyndall Peninsula and the communities of northwest Florida.

East Bay at Tyndall AFB

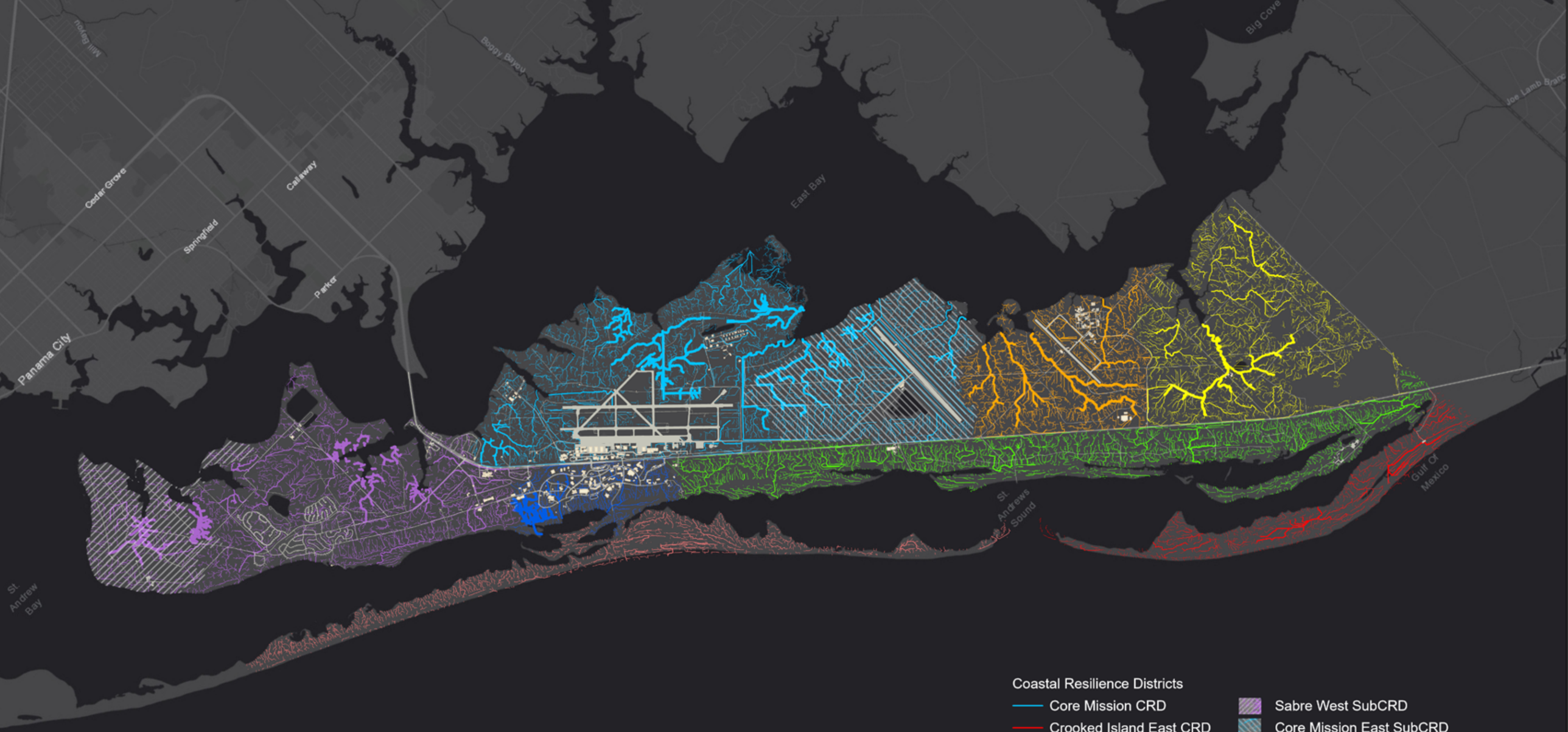
TABLE OF CONTENTS

Page intentionally left blank

DRAFT

COASTAL RESILIENCE AND SUSTAINABILITY STRATEGIES

Coastal Framework


Millville
Bayou
Boggy Bayou
Big Cove
Joe Lamb Branch
Cedar Grove
Springfield
Callaway
Parker
Panama City
East Bay
St. Andrew Bay
St. Andrews Sound
Gulf Of Mexico
Coastal Resilience Districts
Core Mission CRD
Crooked Island East CRD
Farmdale Bayou CRD
Sabre CRD
St. Andrew Sound CRD
Shell Island CRD
Strange Bayou CRD
Support CRD
Sabre West SubCRD
Core Mission East SubCRD
2
Miles
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

COASTAL FRAMEWORK

Water, weather, and ecological systems do not obey administrative boundaries. They respond to and act in accordance with the physical aspects of the land, especially the terrain. To better understand the impact of rainfall and storm surge on Tyndall AFB's resilience, a series of coastal resilience districts (CRDs) and subdistricts were defined based on their common natural processes, like terrain elevation, flood hazard, and stormwater flow.

The CRD framework establishes areas where coastal resilience interventions can be more clearly identified and implemented. The CRD framework defines risk-based areas where coastal resilience interventions can be consistently identified and implemented. By overlaying opportunities and constraints within the CRDs, short-term actions were identified in specific districts. When combined with the nature-based and longer term interventions of the coastal resilience pilot projects, the initiative becomes a dynamic restoration project that will strengthen and protect the surrounding geographies, ecosystems, and coastline well into the future.

Developing the CRD Framework

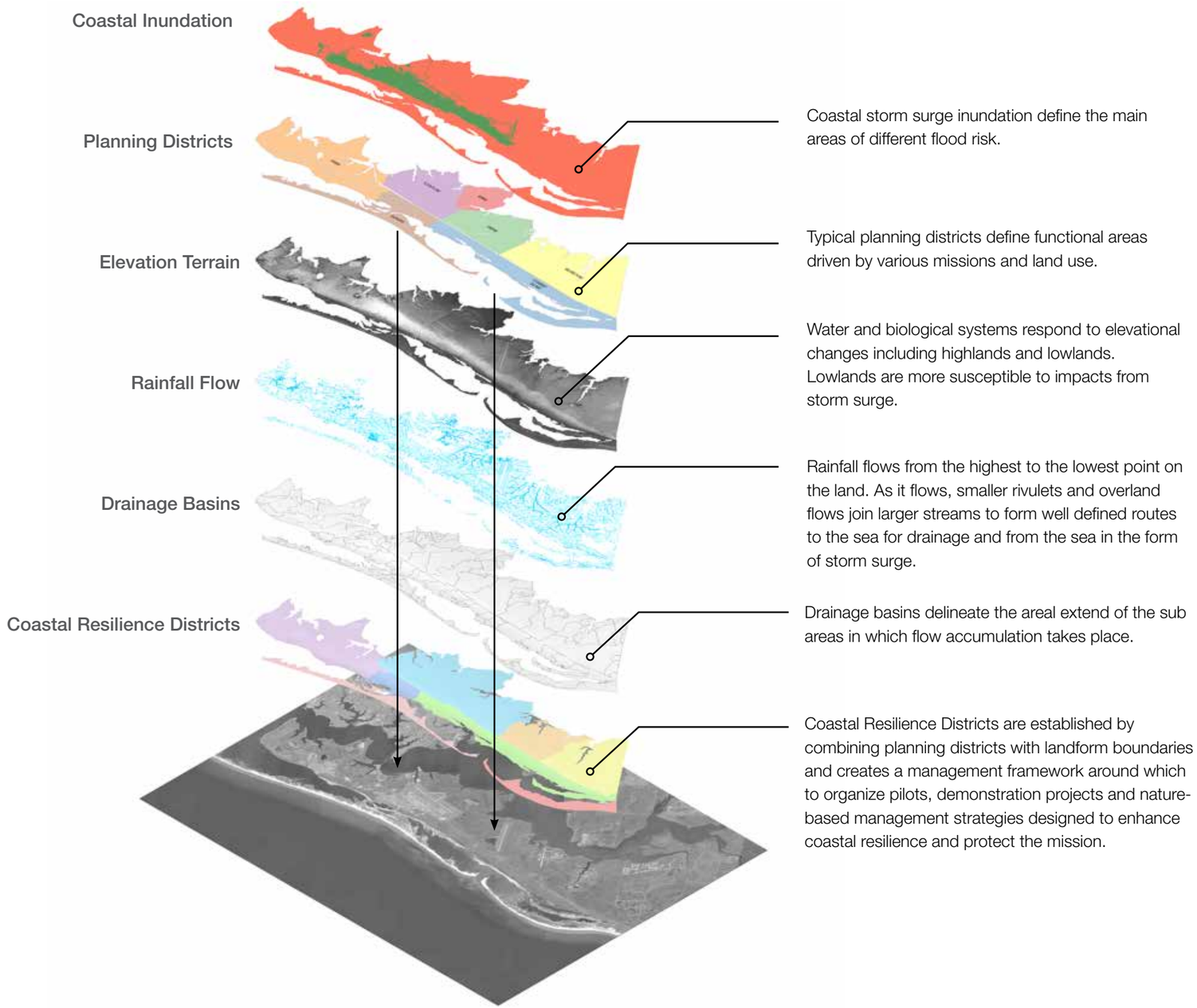
The map to the right illustrates the physical characteristics that influenced the delineation of each CRD.

Coastal Resilience Districts. Each drainage basin was delineated using a rainfall flow accumulation model and a terrain and elevation model, which are methods to determine where rainwater would accumulate and flow over the surface of the land and where it might drain into the Gulf of Mexico or St. Andrew Bay.

The resulting basins were then overlaid with the planning districts that represent mission-related land functions. The framework was then overlaid with the broader coastal area to form the eight resulting the CRDs.

Coastal Resilience Subdistricts. In areas with unique land use or mission attributes, a subdistrict was defined. For example, based on physical proximity and a similar coastal influence, the main airfield, the munitions storage area (MSA), and drone airfield were grouped in a single CRD. However, from a management perspective, the drone area is considered its own subdistrict. As illustrated on the map, two subdistricts have been defined.

Coastal Resilience District Framework



Page intentionally left blank

DRAFT

COASTAL RESILIENCE AND SUSTAINABILITY STRATEGIES

Revegetation Strategy

Buck Beach at Tyndall AFB

REVEGETATION STRATEGY

Introduction

This revegetation strategy builds upon the Tyndall AFB Landscape Master Plan to provide focused approaches in restoring the coastal systems at Tyndall AFB. These approaches are meant to leverage greater mission readiness and storm resilience, as well as the many co-benefits that historical, predevelopment landscapes inherently provide. This information is meant to provide an understanding of coastal "typologies" or the Natural Community Types at Tyndall AFB, as defined by the Florida Natural Area Inventory. In addition to understanding the diversity of the typologies themselves, this revegetation strategy also examines how individual typologies are interrelated, learning about the complexities of the coastal landscapes at Tyndall AFB, and understanding the roles of the flora and fauna found on the installation's coast.

The coastal systems within the Florida Panhandle, specifically on Tyndall AFB, comprise beach dunes, grasslands, wetlands, and scrub that provide critical habitat for endangered and rare endemic plant and wildlife species found nowhere else in the world. Because these systems host unique plants and wildlife that require interrelated components for shelter, nesting, resting, and food sources, they must be fully understood so the revegetation strategy can provide the vital habitats for these species to flourish.

Coastal System Vegetation

The coastlines around Tyndall AFB include a range of open coast and back bay areas. Open coasts tend to be wave dominated and mainly composed of sandy sediments, while back bay areas are more sheltered from waves and contain finer grained sediments such as muds and silts. These areas support a range of vegetated coastal habitats including dunes, beaches, salt marshes, intertidal flats, and coastal grasslands. Vegetation is a key part of a number of these environments.

For dunes and marshes there are feedback loops between the vegetation, coastal processes and landform topography. Above ground level, vegetation slows both wind and currents, encouraging the deposition of sediment and lessening erosion. Below ground level, root systems help bind the sediment making it more resistant to erosive forces of waves and currents.

The health of the base's vegetated coastal systems will be an important consideration in the management of flood risk under ongoing sea level rise. A proactive approach to managing sand dune, salt marsh, coastal grassland vegetation, and vegetated dunes will help ensure these environments continue to contribute to reducing the impacts of storm surges and allowing the continued mission readiness of Tyndall AFB.

Tyndall AFB's Vegetation Typologies

The Florida Panhandle is home to several species of flora and fauna endemic to the region. The existing coastal systems at Tyndall AFB—as well as the species who inhabit these areas—are found only in limited areas around the world. These precious areas are threatened by sea level rise and storm surge and must be protected.

While this section focuses on the coastal revegetation opportunities at Tyndall AFB, the coastal components of sand, sediment, hydrology, and the natural forces that shape these coastal environments must be planned, implemented, and managed to function and thrive as an integrated system. A revegetation strategy must balance all coastal system components to maximize the base's natural coastal defenses against erosion and weathering, and against more frequent and intense storms and sea level rise.

The following vegetative community typology descriptions are taken from Florida Natural Areas Inventory's (FNAI.org) *Guide to the Natural Communities of Florida: 2010 Edition.* FNAI is Florida's Natural Heritage Program and state member of the NatureServe network. They are housed within the Florida Resources and Environmental Analysis Center at Florida State University. They manage a database of current information on Florida's rarest species, maintain an inventory of the state's conservation land holdings, and conduct ecological surveys and analyses to support conservation planning and land management.

East Bay at Tyndall AFB

Welcoming Wildlife

Wildlife habitat is an important outcome of healthy vegetative areas. Tyndall AFB's coastal habitats are home to federally and state protected species, including the Choctawhatchee Beach Mouse (*Peromyscus polionotus allophrys*) and St. Andrew Beach Mouse (*P. polionotus peninsularis*), nesting habitat for the green sea turtle (Chelonia mydas) and loggerhead sea turtle (*Caretta caretta*), and wintering habitat for rare birds like the piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*). Migratory pollinators rely on the base's coastal habitats. The monarch butterfly (*Danaus plexippus*) relies on milkweed (*Asclepia* ssp.), found at Tyndall, for egg deposition and larvae food sources. The Florida Panhandle coastal system is also home to three rare beetles that rely on dune habitats for shelter, as well as a rare ground-dwelling bee (*Hesperapsis oraria*) that is typically found along the Gulf coast.

Sanderling at Tyndall AFB

Beach Dunes

General Description and Location at Tyndall AFB

Beach dunes form when plants and other debris capture wind-blown sand. Dunes need suitable space to accumulate, a plentiful supply of sand from a fronting beach, and onshore winds to transport the sand. At Tyndall AFB, dunes occur on barrier islands and on the southern side of the mainland.

During storms, waves erode sand from the dunes and carry it onto the fronting beach, where it helps dissipate wave energy. Between storms, onshore winds can move sand from the beach back to the dune. Severe storm waves may overtop, breach, or completely erode dunes. As sea levels rise, barrier island dunes may migrate landward as they are overtopped and overwashed by repeated storm events. Although tides regularly inundate low-lying sand beaches that front dunes and waves rework the beach, beaches are important in dissipating wave energy and reducing wave action on dunes.

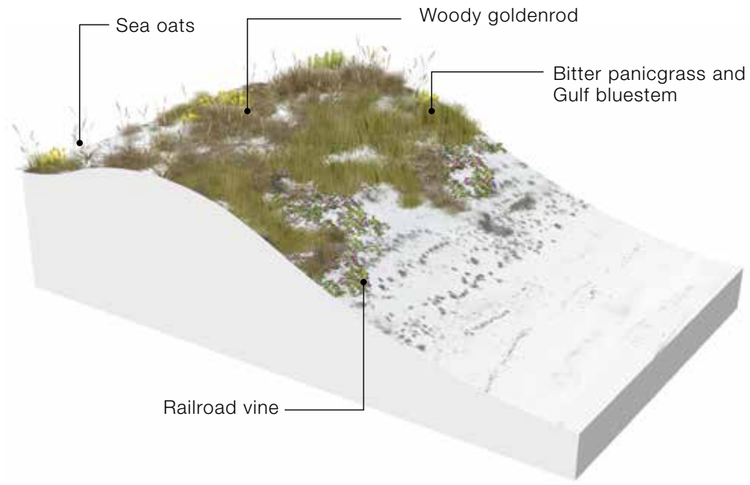
Beach dunes are a herbaceous community of wide-ranging coastal specialist plants on the vegetated upper beach and foredune, usually built by sea oats (*Uniola paniculata*), a perennial rhizomatous grass whose stems trap the sand grains blown off the beach. Seacoast marshelder (*Iva imbricata*), a succulent subshrub, is found at the seaward base of the foredune. These species occupy the seaward face and crests of backdunes and areas where sand has not stabilized.

Role in Resilient Landscapes

Coastal dunes can act as barriers to storm-generated waves and high water levels, protecting the assets behind them. Dune vegetation helps reduce overtopping and erosion. Dunes vary in size and extent over time, with sand moving from dunes to beaches and back. Dune and beach habitats are home to rare and protected species, including migratory birds, endangered beach mice, and imperiled sea turtles.

Beach Dune Plant Palette and Successional Species

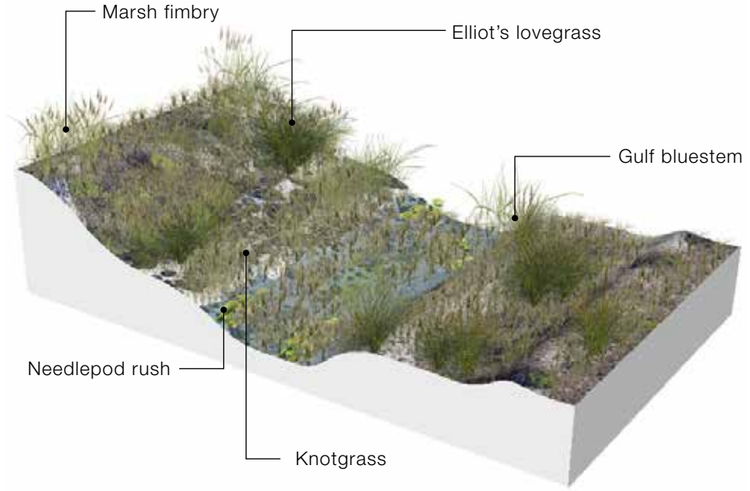
Botanical Name	Common Name
Uniola paniculata	sea oats
Panicum amarum	bitter panicum
Schizachyrium maritimum	Gulf bluestem
Balduina angustifolia	Coastalplain honeycombhead
Chrysoma pausiflosculosa	woody goldenrod
Chrysopsis godfreyi	Godfrey's goldenaster
Crocanthemum arenicola	coastal sand frostweed
Ipomoea stolonifera	beach morning glory
Ipomoea pes caprae	railroad vine
Iva imbricata	seacoast marsh-elder
Oenothera humifusa	seabeach evening primrose
Paronychia erecta	squareflower
Polygonella polygama	October flower
Heterotheca subaxillaris	camphorweed
Chamaesyce bombensis	dixie sandmat



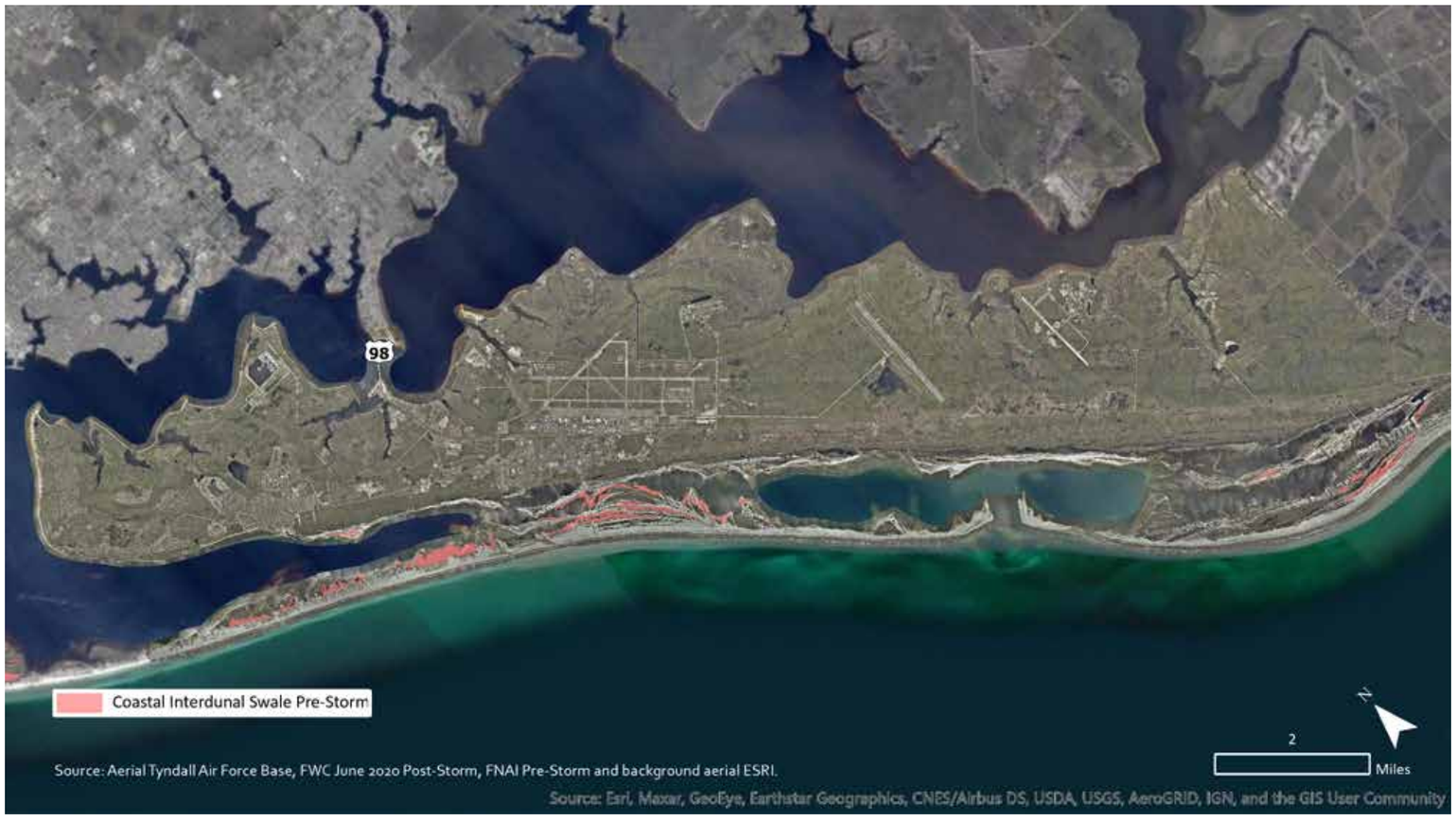

Beach Dune at Tyndall AFB

Beach Dune Locations at Tyndall AFB

Coastal Interdunal Swales at Tyndall AFB



Coastal Interdunal Swale Locations at Tyndall AFB



Coastal Interdunal Swale

Coastal interdunal swales are marshes, moist grasslands, dense shrubs, or damp flats in linear depressions formed between successive dune ridges. The barrier islands off Tyndall AFB have a number of areas that have multiple dune ridges separated by interdunal swale areas. These swale areas are more protected from blowing sand and seawater intrusion, which allows for successional plant species—from herbaceous to woody—to establish in the low area (Johnson 1997). Salt water intrusion and increased sand movement following storms can set this successional process back to its initial stages, or storm surge and storm waves may obliterate the ridge-swale topography completely, leaving a level plain (Johnson et al. 2000), which is in turn colonized by the dune grassland communities.

The base's coastal interdunal swales are dominated by herbaceous species such as umbrella sedge (*Fuirena* spp.), rushes (*Juncus* spp.), hatpins (*Eriocaulon* spp.), and milkworts (*Polygala* spp.). Hurricanes and tropical storms can flood swales with salt water, after which they are colonized for a time by more salt-tolerant species such as needle rush. Loose, blowing sand prevalent after storms favors the spread of cordgrass, which tolerates burial better than the other grass species (Johnson et al. 2000).

Role in Resilient Landscapes

Interdunal swale habitat has the potential to assist in reducing coastal flooding by helping to dissipate waves and reduce sediment erosion. Swales tolerate both flooding and dry conditions, and can hold stormwater run-off and storm surge. This habitat is important part of the broader dune complex.

Interdunal swales provide wildlife foraging and refuge habitat as well as water quality benefits through filtering pollutants and sediments.

Coastal Interdunal Swale Plant Palette and Successional Species

Botanical Name	Common Name
Paspalum distichum	knotgrass
Fimbristylis castanea	marsh fimbry
Eragrostis elliottii	Elliott's lovegrass
Dichanthelium aciculare	needleleaf witchgrass
Fuirena scirpoidea	southern umbrellasedge
Andropogon virginicus	broomsedge
Muhlenbergia capillaris	muhly grass
Centella asiatica	Asiatic pennywort
Panicum amarum	bitter panicum
Schizachyrium maritimum	Gulf bluestem
Hyrocotyle bonariensis	beach pennywort
Juncus scirpoides	needlepod rush
Juncus polycephalus	manyhead rush
Rhynchospora divergens	spreading beaksedge

Coastal Scrub

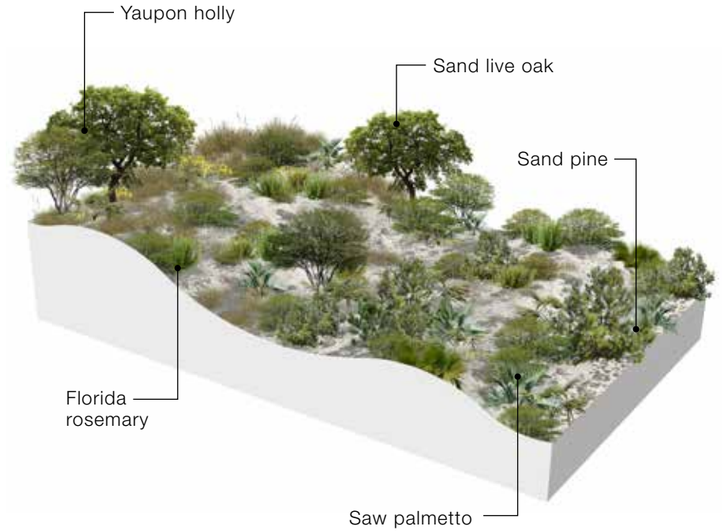
General Description and Location at Tyndall AFB

Coastal scrub is the most imperiled ecosystem in Florida and is found on older stabilized dunes that consist of dry, infertile soils within sandy ridges. It consists of dense shrubland of shorter tree canopy, shrubs, and sometimes taller pine species. Open sandy areas among thickets of vegetation are common to coastal scrub. These open sandy areas provide corridors for wildlife. The signature scrub species—three species of shrubby oaks, Florida rosemary (*Ceratiola ericoides*), and sand pine (*Pinus clausa*)—are common to scrubs throughout the state. The dominance of these species, however, varies from site to site. Oaks form a dense cover interspersed with patchy openings that consist of bare sand with a sparse cover of herbs and ground lichens. Coastal scrub is a prevalent upland habitat at Tyndall AFB, found broadly along the coast of the peninsula and in small patches on the barrier islands.

Role in Resilient Landscapes

Scrub habitat has the potential to assist in reducing coastal flooding by providing additional dissipation of waves and reducing the erosion of sediments. These features could help preserve the integrity of dunes which act as a barrier to flood waters.

Scrub habitats also support a wealth of species endemic to Florida, many of which are considered rare. Scrub acts as an important habitat for several varieties of beach mice, scrub lizard, scrub-jay, and gopher tortoise.



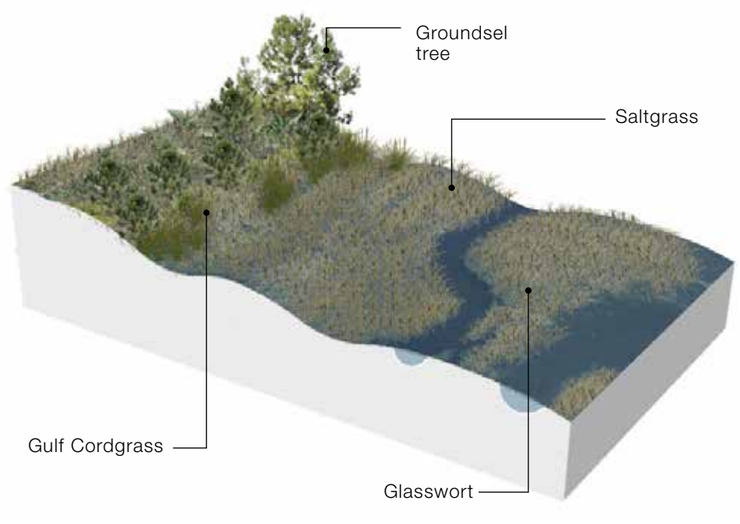

Coastal scrub at Tyndall AFB

Coastal Scrub Locations at Tyndall AFB

Coastal Scrub Plant Palette and Successional Species

Botanical Name	Common Name
Ceratiola ericoides	Florida rosemary
Pinus clausa	sand pine
Quercus germinata	sand live oak
Sabal minor	dwarf palmetto
Lyonia ferruginea	rusty staggerbrush
Pinus elliottii	slash pine
Quercus virginiana	southern live oak
Ilex vomitoria	yaupon holly
Serenoa repens	saw palmetto

Salt Marsh at Tyndall AFB



Salt Marsh Locations at Tyndall AFB

Salt Marshes & Intertidal Flats

Salt marsh is an herbaceous community found in intertidal areas along bays, tidal rivers, and estuaries. The width of the intertidal zone depends on the shore slope and the tidal range. Salt marshes may have distinct vegetation zones dominated by a single species of grass or rush. Salt marsh cordgrass (*Spartina alterniflora*) dominates seaward edges and borders of tidal creeks and areas often inundated by tides. Needle rush (*Juncus roemerianus*) dominates higher, less frequently flooded areas. Marshes can accrete sediment (organic and mineralogic) and increase their elevation to keep pace with sea level rise. However, marshes may fail to keep up with rapid sea level rise, leading to a progressive drowning and a decrease in area. Tyndall AFB's salt marshes are found extensively around East Bay and around coastal areas of the peninsula and barrier islands facing St. Andrew Bay and St. Andrew Sound.

Salt marshes are commonly fronted by intertidal flats—low-gradient non-vegetated intertidal areas of mud or sand. Often, salt marshes evolve from the gradual siltation of tidal flats. This increases the marsh's elevation and allows vegetation to colonize. Intertidal flats help dissipate wave and current energy in front of salt marshes and, during storms, can supply sediment to the marsh surface that increases its elevation.

Role in Resilient Landscapes

Salt marsh vegetation is highly effective at reducing wave energy. Large salt marshes can help reduce surge water levels in some settings. Although wave reduction is lower under high water levels, salt marshes can help protect landwards areas even during storm conditions (Möller et al. 2014; Narayan et al. 2017). Salt marshes encourage sediment build-up, reduce erosion, filter for nutrients, remove carbon dioxide from the atmosphere, maintain water quality, and provide critical habitat for wildlife. Tidal flats help dissipate wave energy and reduce erosion to landward habitats. Intertidal flats support complex estuarine food webs for invertebrates and fish and provide resting and feeding areas for indigenous and migratory birds.

Salt Marsh Plant Palette and Successional Species

Botanical Name	Common Name
Juncus roemerianus	black needle rush
Spartina spartinae	Gulf cordgrass
Baccharis halimifolia	groundsel tree
Iva frutascens	marsh elder
Sarcocornia ambigua	glasswort
Spartina patens	saltmarsh cordgrass
Distichlis spicata	salt grass
Symphyotrichum tenuifolium	saltmarsh aster
Sesuvium portulacastrum or maritimum	sea purslane
Sporobolus virginicus	seashore dropseed
Spartina alterniflora	smooth cordgrass
Spartina bakeri	Sand cordgrass

Vegetation in Coastal Resilience Projects

In the correct location vegetation can assist in coastal resilience by dissipating wave and surge energy, reducing sediment susceptibility to erosion and helping to trap sediment. Given the importance of vegetation this section examines the possible approaches that can be used to restore vegetation.

Because Tyndall AFB's coastal systems are dynamic and ever-changing, restoration approaches must consider and incorporate nature and the natural processes that form these typologies and provide a greater level of resilience. These natural systems cannot be restored overnight—the typologies depend on long-term processes that work with wind, water, and soils to establish the structure, stability, and plant diversity for the base's coastal systems. The typical succession in which these coastal system typologies exist is not driven by a proximity or relationship to each other solely, but rather the frequency in which they are disturbed as well as water salinity levels and tidal presence. More diverse and mature vegetation can establish when land disturbances are less frequent and forceful. The typologies also exist within a functioning coastal system where typologies on the seaward side of a coastal environment are disturbed far more frequently than, and provide protection for, landward typologies. This allows increased woody vegetation species to establish amongst pioneering and successional herbaceous varieties that provide the necessary foundation of a coastal system structure.

Tyndall AFB's coastal systems have both coastal bay and Gulf systems, which have some of the same vegetation types, but some differences in compositions and diversity due to varying winds, tides, waves, and sediment types.

Dune Restoration

Natural Revegetation

After a large storm event the first action in restoring dune systems is to determine the potential for natural dune development with minimal to no assistance. At Tyndall AFB, such low intervention approaches are only likely to apply to the barrier islands where the extensive fronting beaches have the potential to supply sand to allow dunes to rebuild naturally. Elsewhere, where dunes might not rebuild naturally or where dunes form a critical flood defense, mechanical reinstatement may be needed.

Sea oats and other beach plants are naturally resilient to storm damage. If not buried too deeply by sand or left exposed for too long, sea oats will regrow. Removing and discarding uprooted sea oats during clean up after storms hinders the dunes' ability to recover naturally.

Wrack is also an important resource for the resilience of dune systems. Wrack contains vital wildlife resources and aids in the development of beach dunes. The wrack materials have a rough surface that catches dune plant seeds and sand carried by the wind. Trapped seeds germinate and grow with the help of wrack. As wrack decays, it supplies nutrients, protection, and moisture to the plants, potentially increasing their survival and growth. Seagrasses and algae commonly found in wrack provide nitrogen and phosphorous for dunes (Williams and Feagin 2010). For these reasons, wrack has an important function in beach ecology and should be left in place. Although wrack can sometimes be removed and placed around the base of newly planted dune vegetation as a natural plant supplement, it is recommended that wrack remain in place, particularly after larger storm events.

After large storms, sea oat stands can become uprooted and may found scattered on the beach or piled up against debris and other vegetation. After a storm, seagrass stems can be buried in the sand a minimum of 6 inches, but no deeper than 12 inches. If seagrass stems are buried within approximately 1 week immediately after disturbance, they will likely re-established by the following summer season. Plants may have to be supplemented with new plants to ensure proper establishment.

Augmented Approaches

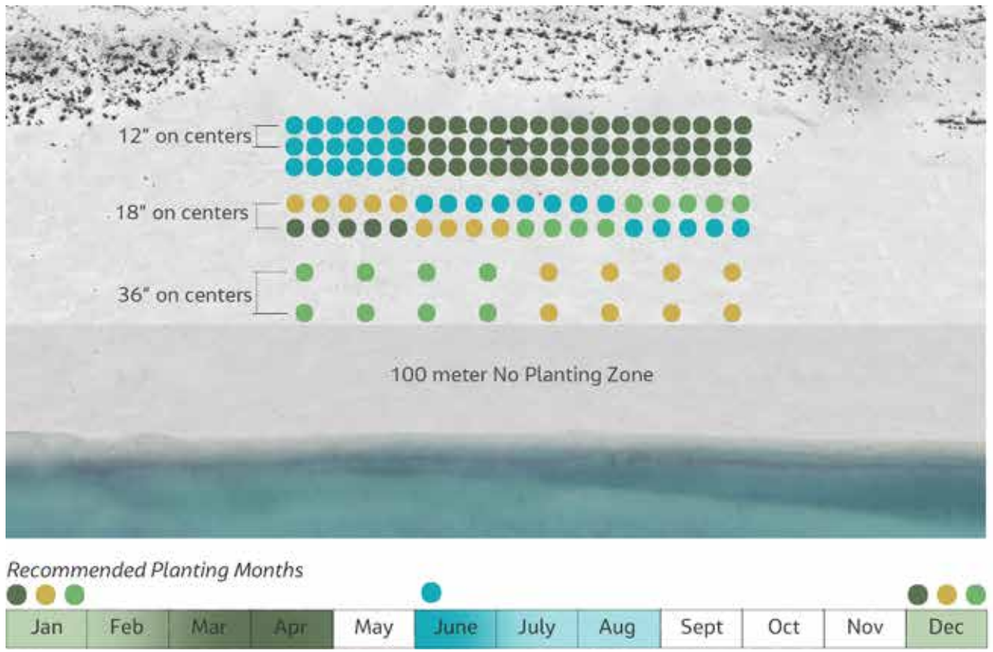
When existing natural materials have been completely disturbed or removed by a large storm, applying sand fencing (or alternatives such as woody debris) and nursery-supplied plant material may provide the initial foundation for sand to form.

When used with planting, sand fencing can be a successful method of dune restoration. When installing sand fencing, avoiding wildlife requires careful consideration, particularly for sea turtles during their on-beach nesting cycles from May 1 until October 31. Any sand fencing at Tyndall AFB must follow state and federal regulations to protect sea turtles. Sand fencing using plants and the natural forces of wind overtime will help ensure greater beach stabilization.

Replanting

Sea oats are usually a dominant species within newly formed coastal dunes, particularly the close to the water after dune establishment. In initial planting efforts, sea oats are not dominant in numbers, but they will spread and increase in number. Replanted sea oats must be incorporated within two to three other species such as bitter panicgrass (*Panicum amarum*), beach elder (*Iva imbricata*), and sometimes Gulf bluestem (*Schizachyrium maritimum*). Once these initial plants are established additional species can be added.

Dune Restoration Planting Approach



Gulf Bluestem
Schizachyrium maritimum

Sea Oats
Uniola paniculata

Bitter Panicum
Panicum amarum

Seacoast Marsh Elder
Iva imbricata

Sea oats can be obtained from commercial nurseries. It is best practice that the stock originate from the Gulf Coast because local varieties have adapted well to Gulf conditions and will establish and flower most successfully.

Plants must be placed as far landward as possible during times of the year when rainfall is consistent and temperatures are moderate. Typically pioneering species should be planted from December through April when soil has more moisture. October and May are typically the driest months at Tyndall AFB and planting should be avoided during these times. Planting Gulf bluestem is an exception to these planting timeframes, and planting between June to August is acceptable, with June being the optimum planting month.

Beach Dunes at Tyndall AFB

References

- Broome, S.W. 1990. Creation and restoration of tidal wetlands of the southeastern United States. Pages 37-72 in Kusler, J.A. and M.E. Kentula, eds. Wetland creation and restoration: the status of the science. Island Press; Washington, D.C.
- Johnson, A.F. 1997. Rates of vegetation succession on a coastal dune system in northwest Florida. Journal of Coastal Research 13:373-384.
- Johnson, A.F., H.E. Horne, and C.E. Kindell. 2000. Status of rare plant and lichen species and natural communities on Eglin Air Force Base, Santa Rosa Island, Florida. Unpublished report to Eglin Air Force Base. Florida Natural Areas Inventory, Tallahassee, Florida.
- Möller, I., Kudella, M., Rupprecht, F. et al. 2014. Wave attenuation over coastal salt marshes under storm surge conditions. Nature Geosci 7, 727–731. October. https://doi.org/10.1038/ngeo2251
- Narayan, S., M.W. Beck, P. Wilson, et al. 2017. The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Sci Rep 7, 9463. https://doi.org/10.1038/s41598-017-09269-z
- NOAA. 2020. "Living Shorelines." NOAA Habitat Blueprint. Accessed September 20, 2020. https://www.habitatblueprint.noaa.gov/living-shorelines/
- Williams, A., and R. Feagin. 2010. "Sargassum as a natural solution to enhance dune plant growth." *Environmental Management*. 46(5):738–747. https://doi.org/10.1007/s00267-010-9558-3

Living Shoreline

"Living shoreline" is a broad term that encompasses a range of shoreline stabilization techniques along estuaries, bays, tributaries, and other sheltered shorelines. Living shorelines are not typically used on beaches on the open ocean. A living shoreline has a footprint that is made up mostly of native material. It incorporates natural vegetation or other living, natural soft elements alone or in combination with some type of harder shoreline structure, like oyster reefs, rock sills, or anchored large wood for added stability (NOAA 2020). East Bay, St. Andrew Bay, and St. Andrew Sound are possible locations for a living shoreline implementation at Tyndall AFB. Constructing oyster reefs within the East Bay or "living breakwaters" in St. Andrew Bay and St. Andrew Sound could help dissipate wave energy before it reaches the shore.

Living shoreline treatments could also include planting marsh and submerged aquatic vegetation within the coastal zone, as well as riparian enhancements throughout the base within existing stormwater channels and stormwater inlets. Installing organic materials like bio-logs and organic fiber mats can be effective in stabilizing low-energy coastal and riparian shorelines. Constructing oyster reefs or "living breakwaters" within the base's coastal areas can dissipate wave energy before it reaches the shore. Maintenance activities include debris removal, replanting vegetation, adding additional sand fill, and ensuring that the organic and structural materials continue to stabilize the shoreline.

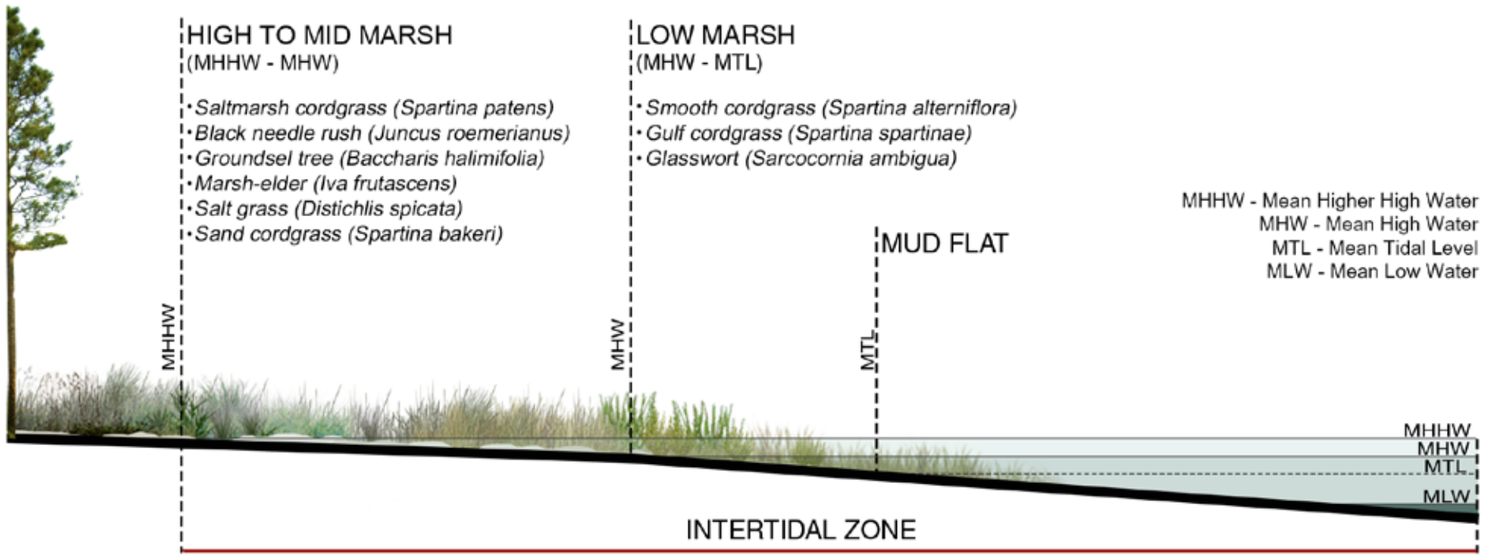
Marsh Enhancement

There are a range of approaches to restoring and enhancing marshes including:

- Providing wave protection measures at the edge of existing marshes to reduce erosion and encourage sedimentation
- Adding sediment to the marsh to raise levels and increase lateral extent
- Adding sediment to shallow subtidal or intertidal areas to create new areas of marsh
- Removing flood defenses and allowing tidal conditions to return to former intertidal areas that have been reclaimed from the sea (managed realignment)

The above techniques may be accompanied by replanting vegetation to speed up the development of the newly created salt marsh. The graphic at the bottom of the page shows the range of species that could be planted at different levels in the tidal frame. Optimal planting dates for marsh grasses such as smooth cordgrass (*Spartina alterniflora*) are between April 1 and June 15 (Broome 1990). The presence of special status species may also affect the timing of enhancement activities, with activities designed and timed to avoid impacts on protected species, their habitat, and breeding or nesting activities.

Salt Marsh Planting Zone



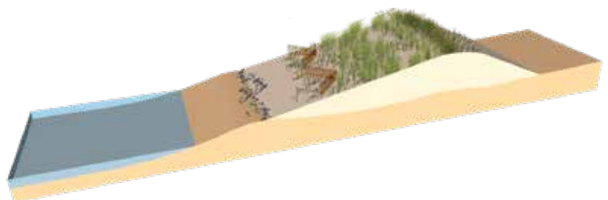
Benchmarks

Tyndall AFB's coastal zone provides critical natural infrastructure to support mission readiness, enhance the overall resilience of the built infrastructure, and conserve a wealth of natural resources. This unique coastal area provides numerous year-round recreational opportunities that are vital to the health and wellbeing of Airmen and their families. The preservation and enhancement of these critical coastal ecosystems positively supports the many aspects of the base's current and future missions through a more resilient natural infrastructure. In addition to decreasing coastal erosion, living shoreline and restoration projects provide benefits such as improved water quality through oyster and marsh plant filtration; habitat for native plants, fish, and wildlife; and increased recreational opportunities.

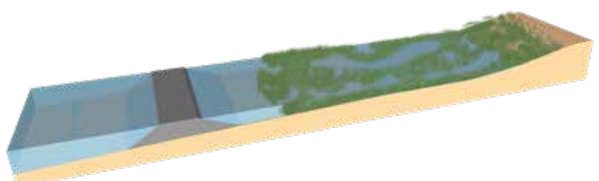
The following nature-based coastal resilience project examples are from locations with similar ecosystems and conditions as Tyndall AFB: Eglin AFB, RiverCamps on Crooked Creek, Naval Support Activity Panama City (NSA PC) living shorelines, and the Perdido Key Dune Restoration project.

Nature-based Coastal Resilience Typologies

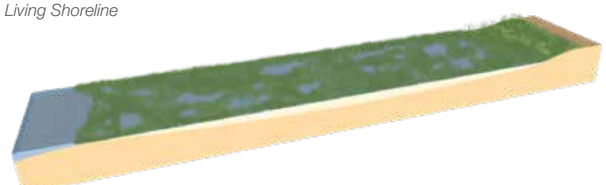
Numerous nature-based coastal resilience strategies and techniques are being implemented across the United States, exploring the emerging technologies of using nature's systems. Further analysis and study will ultimately determine appropriate recommendations for Tyndall AFB.



Dune Replenishment / Restoration



Living Shoreline



Marsh Enhancement

Eglin AFB, FL

Typology

Salt marsh enhancement with oyster reef breakwater

Location/Setting

The living shoreline is located along the northern shore of Choctawhatchee Bay in the Alaqua Bayou on the Florida Panhandle.

Summary

A living shoreline concept was used to establish oyster bar and salt marsh habitat that served to stabilize the severely eroded shoreline.

The Eglin AFB living shoreline project has helped stabilize approximately 1,970 linear feet of shoreline habitat at the site designated Alaqua Area A. This living shoreline consists of oyster bars placed in shallow water habitat and salt marsh habitat that was established along the eroding shoreline. The project also provided for opportunities for ongoing public education about estuarine habitat and community stewardship.

Choctawhatchee Bay - Bay Flats in Walton County
Photo provided by Joe Meyer

Project Details

The project was implemented by the Choctawhatchee Basin Alliance (CBA), which constructed 60 oyster reef breakwaters at the Alaqua restoration site, using more than 150 tons of bagged recycled and fossilized oyster shell to restore 1.7 acres. The project took 7 months to complete and was supported by 135 volunteers.

- **Salt Marsh Enhancement:** Salt marsh vegetation was planted shoreward of the oyster breakwaters and included 200 smooth cordgrass (*Spartina alterniflora*), 50 saltmeadow cordgrass (*Spartina patens*), and 50 common rush (*Juncus effusus*) plants in burlap bags. Small (4-inch) plants were spaced 1-foot apart. Cordgrass was planted closest to the breakwaters and common rush and saltmeadow cordgrass were planted along the eroded shoreline. Temporary coconut fiber coir logs were installed in some areas to protect the newly planted salt marsh grasses.
- **Oyster Breakwaters:** Standard oyster-bagging methods were used to install fossilized and recycled oyster shell bags. Shells were placed in tubular mesh (3/4 inch) net bags to create the building blocks for the breakwaters. Oyster breakwaters were hand placed in 20-foot sections parallel to the shoreline, 10 feet from mean high water, with 5-foot gaps between each breakwater to allow for sediment and water flow, as required by Florida Department of Environmental Protection. The breakwaters were built in a pyramid style, with a wider base tapering to a narrower top. The reef bases were constructed from bags of the lighter recycled oyster shells and the top two rows from heavier fossilized shell bags. The oyster breakwaters height was determined based on observations of tide and mean wave height. The height leaves approximately 6 inches of reef exposed at mean high water to provide for maximum wave attenuation.

Example of Living shoreline, Choctawhatchee Bay, in Walton County facing southwest
Photo provided by Joe Meyer

RiverCamps on Crooked Creek, Panama City, FL

Typology

Salt marsh enhancement with oyster reef breakwater

Location/Setting

The living shoreline project is located in the West Bay section of St. Andrew Bay, near the mouth of Crooked Creek.

Summary

The RiverCamps living shoreline project is a combination oyster reef and salt marsh installation completed by the St. Andrew Bay Watch, a non-profit organization. The area contains salt and brackish marshes, dunes, beaches, and barrier islands. Cordgrass and saltgrass are common in protected intertidal zones, while xeric coastal strand and pine scrub vegetation occurs on parts of the dunes, spits, and barrier islands.

Project Details

The 300-linear foot living shoreline was created between October 2015 and April 2017. Each step of the project (grass growing, oyster bag filling, reef construction, grass planting) was completed by students. Volunteers placed stacked bags of oyster shells to create crescent shaped breakwaters at the waterline. Each crescent unit was constructed of approximately 200 bags of shells, weighing approximately 4,000 pounds.

Reefs were installed with approximately 5-foot gaps between the breakwaters to allow for large animal passage and water circulation. Permits required for the project stipulated that the shoreward edge of the reef be placed less than 10 linear feet below mean high water. Salt marsh grass was planted on the shore side of the oyster breakwater.

RiverCamp Living Shoreline
Photo provided by St Andrew Bay Watch

Naval Support Activity Panama City, FL

Typology

Salt marsh enhancement with oyster reef breakwater

Location/Setting

NSA PC is a Naval installation in Panama City along St. Andrew Bay. The project area is exposed to a long fetch (more than 5 miles). The waves travel across a broad, shallow coastal shelf, attenuating wave energy so that the shoreline does not usually experience high wave energy.

Summary

The NSA PC living shorelines consists of salt marsh and oyster reef breakwaters. The nature-based project replaced earlier plans to install rip-rap to stabilize a 900-foot stretch of eroding shoreline. The living shoreline project received the EPA Gulf Guardian Partnership Award in 2013.

Project Details

This project included three segments of shoreline that were 800, 900, and 1,400 feet long. Approximately 200 oyster reefs were installed using loose, unconsolidated shell. The project began with debris removal, including downed trees, exposed roots, and a concrete slab. Reefs were constructed in October and December 2010. Plants were established in order of wetland to dryland (including smooth cordgrass, black needle rush [*Juncus roemerianus*], saltmeadow cordgrass, and saltbush [*Baccharis halimifolia*]). The plants were thriving by June 2011, and had filled in completely by September 2013.

More than 600 civilian and military volunteers worked nearly 3,000 hours to complete the project, and two high schools helped grow more than 21,000 plants required.

NSA Panama City Living Shoreline Benchmark
Photo provided by NSA Panama City

Perdido Key Dune Restoration

Typology

Beach dune restoration

Location/Setting

The dune restoration project is located along the Florida coastline near the Alabama state line. It runs from approximately 2.2 miles east of Perdido Pass at the Florida/Alabama state line for about 6 miles to the east. Perdido Key is located primarily in Escambia County, is approximately 15 miles long, and extends from Pensacola Pass in the east to Perdido Pass in the west.

Summary

This project restored appropriate dune vegetation to degraded beach dune habitat in Perdido Key, including habitat used by the federally endangered Perdido Key Beach Mouse.

Project Details

Approximately 20 acres of degraded beach dune habitat was restored along 5.1 miles of Perdido Key. The project consisted of planting dune vegetation approximately 20 to 60 feet seaward of the existing primary dune to provide a buffer to the primary dune and enhance dune habitats. In addition, gaps in existing dunes within the project area were revegetated to provide a continuous dune structure. Plants included sea oats, panic grasses, cord grasses, sea purslane, and beach elder. All plants were grown from seeds or cuttings from the Alabama or North Florida coast to ensure appropriate genetic stocks were used in the project.

Perdido Key Dune Restoration
Photo provided by Matt Posner

Page intentionally left blank

DRAFT

COASTAL RESILIENCE AND SUSTAINABILITY STRATEGIES

Demonstration Areas

Page intentionally left blank

DEMONSTRATION AREAS

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation	Wildlife Habitat Enhancement/ Ecosystem Restoration	Recreation (MWR)/ Education	Pedestrian & Commuter Mobility
Specific Actions					
▪ Dune restoration ▪ Revegetation/ marshland restoration ▪ Coast line protection ▪ Living shoreline	▪ Establish plantings on islands and first line of defense ▪ Establish plantings in all open areas and barrier islands ▪ Plant native species ▪ Upland landscape and revegetation	▪ Capture small rain events locally versus base-wide ▪ Provide larger base-wide retention/detention ponds ▪ Regrade vulnerable areas ▪ Naturalize channels	▪ Create wetlands and marshes ▪ Create dunes ▪ Preserve habitats	▪ Provide passive recreation areas via paths and boardwalks ▪ Provide educational signs and markers ▪ Provide observation areas ▪ Provide activity areas such as volleyball nets and play structures	▪ Include bike lanes on roads ▪ Provide direct point-to-point transportation network ▪ Connect to multimodal facilities
Resulting Benefits					
▪ Protects missions ▪ Protects investments	▪ Complies with INRMP ▪ Improves water absorption ▪ Reduces impacts to storm surge ▪ Increases biodiversity ▪ Improves water quality ▪ Creates and preserves habitats ▪ Provides erosion protection ▪ Reduces urban heat island effect ▪ Creates shade and reduces energy	▪ Controls flooding ▪ Filters pollutants ▪ Reduces peak flow in stormwater system ▪ Protects wetland habitat ▪ Provides erosion protection ▪ Reduces surge and loading on coastal areas ▪ Complies with stormwater permit	▪ Protects coastal habitat ▪ Protects upland habitat ▪ Provides erosion protection	▪ Expands educational opportunities ▪ Improves mental health ▪ Improves physical health ▪ Provides leisure opportunities	▪ Reduces “big infrastructure” needs ▪ Provides nature-based tertiary pathways ▪ Improves mental health ▪ Improves physical health

The CRD framework establishes areas where coastal resilience interventions can be more clearly identified and implemented. The nature-based coastal resilience pilot projects are anticipated to be implemented over the next 5 years in small areas of the base. Using constraints mapping, the coastal resilience pilot project areas were chosen due to their limited environmental constraints.

When opportunities and constraints were overlaid with the CRDs, potential short-term coastal resilience actions were identified within a given area referred to as a “demonstration area.” The main criteria for defining demonstration areas include the ability to implement actions in the short-term, mission criticality and ability to support the mission, synergy with overall revegetation strategy and coastal resilience pilot projects, clear opportunities to leverage existing features, potential to achieve flood mitigation benefits, and overall interest from the Air Force, other agencies, and the community to engage during implementation. As explained in the introduction to this document, the strategies and actions presented here represent pre-decisional concepts. They are not recommendations for projects in the specific locations mapped; rather, they are areas of opportunity to explore and further develop to achieve coastal resilience and sustainability goals. This also applies to the mobility connection concepts that were defined for pedestrian features within and between the demonstration areas to enhance commuting options, including a potential water ferry.

Unlike the coastal resilience pilot projects, the demonstration areas are in early the conceptual phase. While further detailed analyses and surveys are required to propose definitive details for the pilot projects, the pilots are proceeding into implementation phase in the short-term.

Coastal Resilience Project Themes

The CRDs provide a geographic framework that drives the discrete and appropriate resiliency planning into coastal management actions and projects. With coastal resilience as an overarching goal, landscape and land management decisions can be integrated with the physical measures that improve coastal protection. Areas of opportunity include coastal flooding mitigation measures, revegetation and sustainable landscape, stormwater management including wetlands as management options, wildlife habitat enhancement and ecosystem restoration, recreation and educational opportunities, and pedestrian and commuter mobility and linkage solutions.

These planning and implementation opportunities help us accrue benefits in environmental, social, and economic spheres. By integrating these actions, we create synergies that help us achieve even greater co-benefits, such as enhanced environmental aesthetics and reduced greenhouse gas emissions.

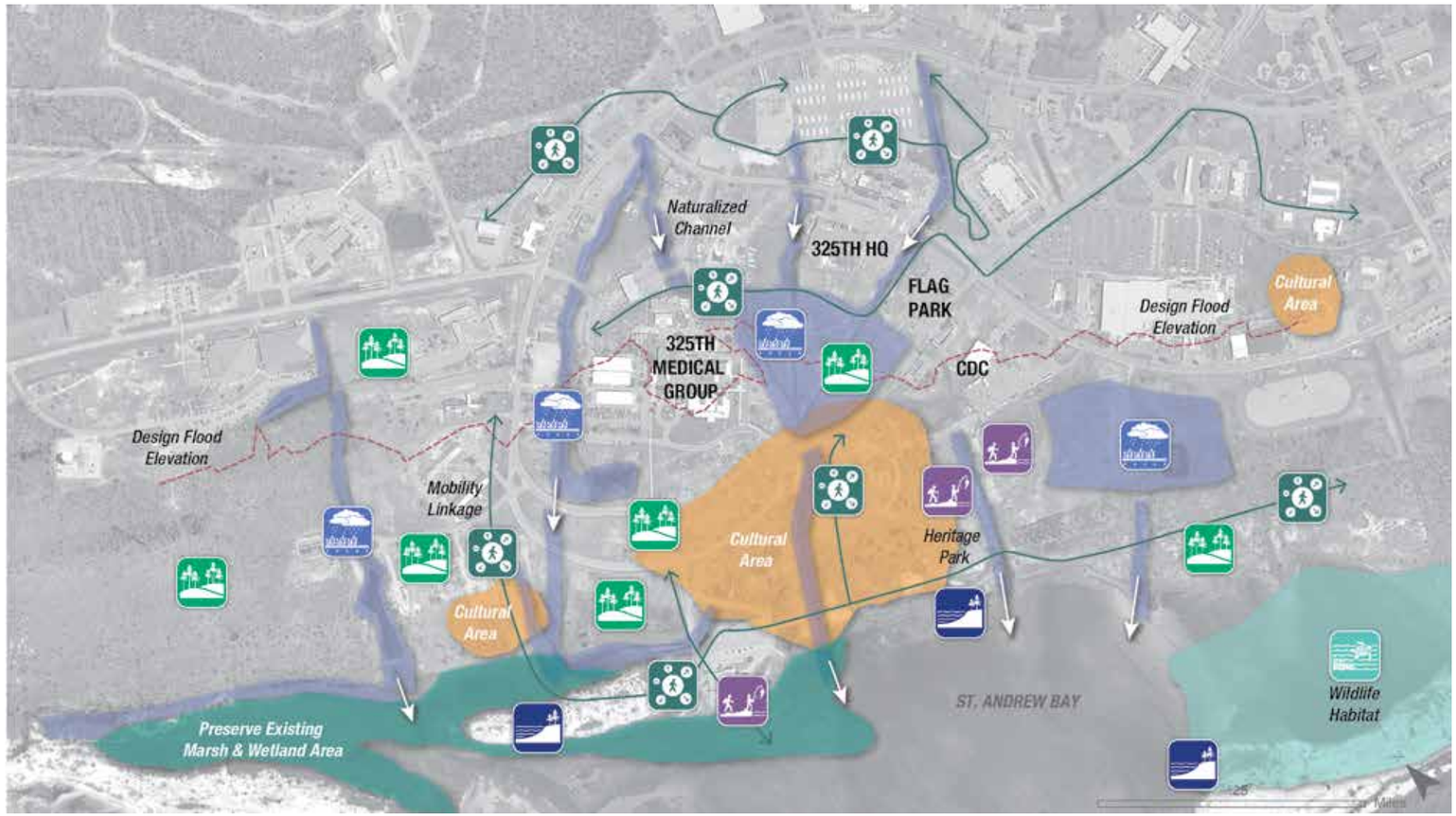
Demonstration Area 1

Support CRD:
325th Medical Group & 325th HQ Facilities

The Support CRD is a vibrant district with ongoing MILCON-funded projects to rebuild the facilities and assets, all of which will require pluvial and coastal flood protection and significant stormwater management. The area offers great potential for integrated land management solutions that can further protect critical district facilities. Portions of the 325th Medical Group facility are vulnerable to coastal flooding under the DFE requirements, and there are known flooding issues during heavy precipitation events. A pilot project for dune restoration is planned in this CRD and full-scale coastal restoration measures are planned for south of Mississippi Road in the long term. These opportunities and features will be leveraged in this demonstration area.

Demonstration Area Context

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation	Wildlife Habitat Enhancement/ Ecosystem Restoration	Recreation (MWR)/ Education	Pedestrian & Commuter Mobility
▪ Low-impact dune restoration along the relic dunes that uses fencing or debris can minimize impact, permitting complexities and timelines, and cost within and near cultural sites. ▪ An “early phase” naturalized structure south of Mississippi Road can be studied to provide coastal surge protection to the 325th Medical Group facilities.	▪ The future coastal protection can advance goals for using naturalized forms and improving viewsheds of the coast. ▪ Naturalized channels balance Longleaf pine restoration efforts with typical riparian plant communities. ▪ Naturalized channels and stormwater management features create an “ecological campus” that leverages the associated benefits of the Longleaf pine installations.	▪ Consider the visual impact of coastal barriers on Support District viewsheds. ▪ Consider coastal barriers and advance goals around naturalized forms to avoid conflict with Longleaf pine restoration areas. ▪ Naturalized channels balance Longleaf pine restoration with typical riparian vegetation. ▪ Naturalized channels and stormwater management can be ecological extensions of the MILCON projects.	▪ Riparian wildlife habitat along the St. Andrew Bay shoreline and dune beach are protected and enhanced in accordance with Florida Fish & Wildlife Commission policy. ▪ Pollinator-friendly vegetation is incorporated along naturalized channels, stormwater management features, and coastal restoration efforts. Pollinating corridors provide connectivity to larger stormwater management and revegetation areas.	▪ Rebuilding MWR’s recreational components in the Heritage Park aligns with the coastal strategy. ▪ The recreation node in the coastal zone is designed to unify the boardwalk elements (material, form, and slope) and dune formation (sand capture), creating a cohesive boardwalk structure. Biomimicry principles maximize co-benefits.	▪ Aligning with the Support District’s proposed Multi-Modal Spine optimizes pedestrian views and transit experiences. ▪ The locations of the boardwalk and naturalized channel crossing enhance the mobility links between facilities and districts. ▪ A new network of tertiary coastal pathways links to the Multi-Modal Spine and existing pedestrian network.

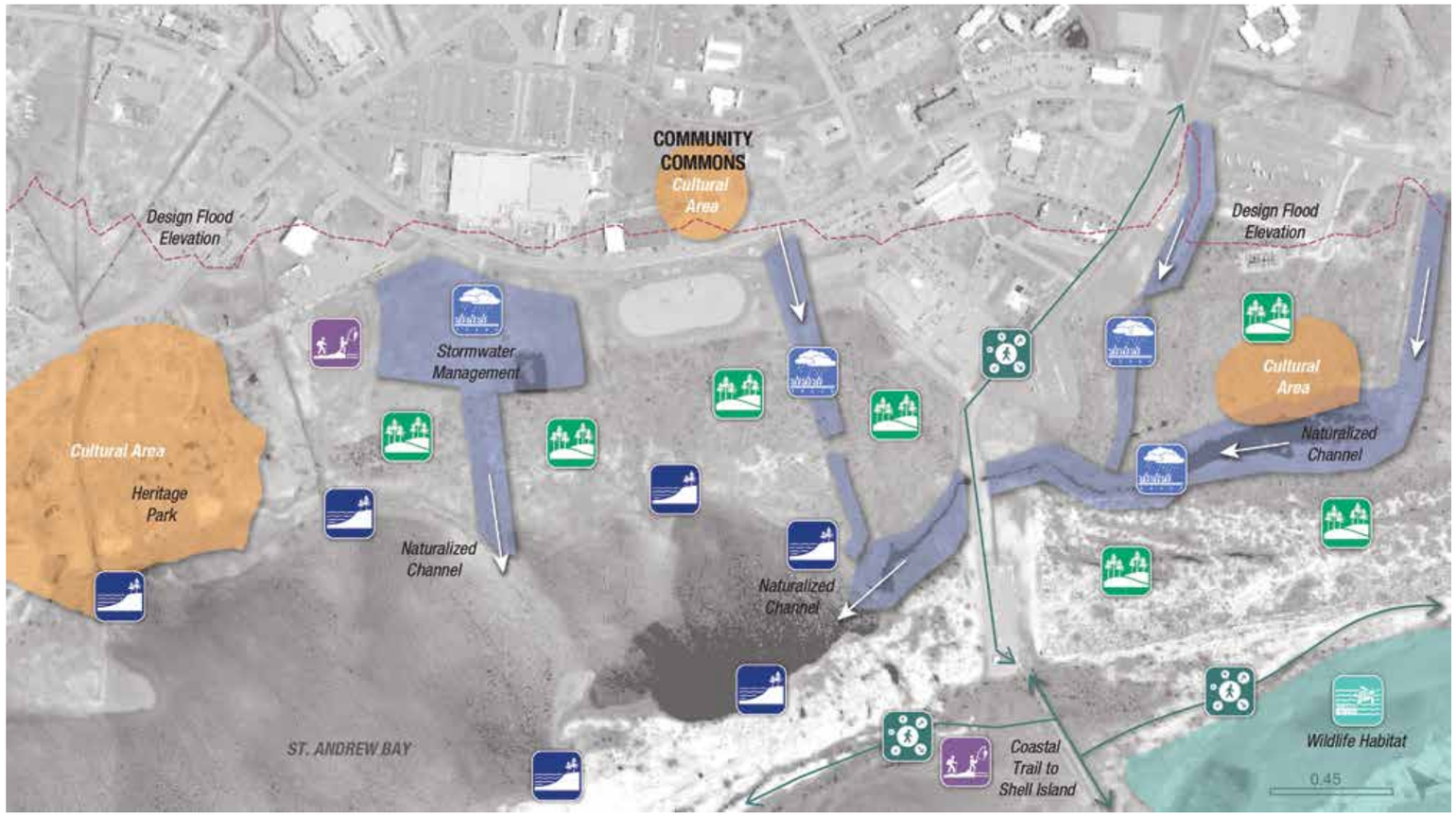


Demonstration Area 2

Support CRD:
Oasis Conference Facility & Fitness Center

Located in the Support District CRD, the Oasis Conference Facility and Fitness Center are vulnerable to coastal surge under the DFE scenario. These buildings and assets are currently not planned to be elevated. Full-scale coastal flood protection is necessary, which will include multiple interventions. In addition to coastal interventions, a pilot project to use woody debris to promote dune development is planned in this CRD's general area. These opportunities and features will be leveraged in this demonstration area.

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation	Wildlife Habitat Enhancement/ Ecosystem Restoration	Recreation (MWR)/ Education	Pedestrian & Commuter Mobility
▪ The coastal protection structure south of the Fitness Center and Oasis Conference Facility will be studied to provide a natural land form that marries a natural berm, riparian environment of the naturalized channel, and the Longleaf pine restoration.	▪ The Lounge and Community Common are designed as a seamless park/ecological campus that maximizes coastal and forest views and incorporates nature-based infrastructure into naturalized channels.	▪ The large stormwater management area south of Mississippi Road incorporates vegetated islands and switchback flows to accommodate increased stormwater. ▪ The large stormwater pond provides the required regulatory stormwater quality while enhancing the overall natural environment and habitat. ▪ Installing gravity-flow culverts and other drainage structures through the coastal berm should be studied..	▪ Stormwater management areas include vegetated islands and tree snags to maximize species diversity and habitat potential. ▪ Relic dunes are restored with low-impact restoration. Fencing or debris can be used within and near cultural sites to limit impact, permitting complexities, timelines, and cost.	▪ Recreation design treats naturalized stormwater management features as amenities. ▪ The coastal trail and boardwalk are reconstructed or expanded to maximize sand capture and mimic dune form. Biomimicry principles maximize the co-benefits.	▪ The coastal berm is designed for use as trail or at-grade boardwalk. The berm could also be designed as a dune to optimize its potential to capture sand. Berm and trail designs seamlessly reflect the context of revegetation areas. ▪ The berm near the Fitness Center and Oasis Conference Facility is sited and sized to incorporate a trail or boardwalk as well. ▪ Design trails to be close to naturalized channels and other natural features to maximize natural shade and their views of nature.




Demonstration Area Context

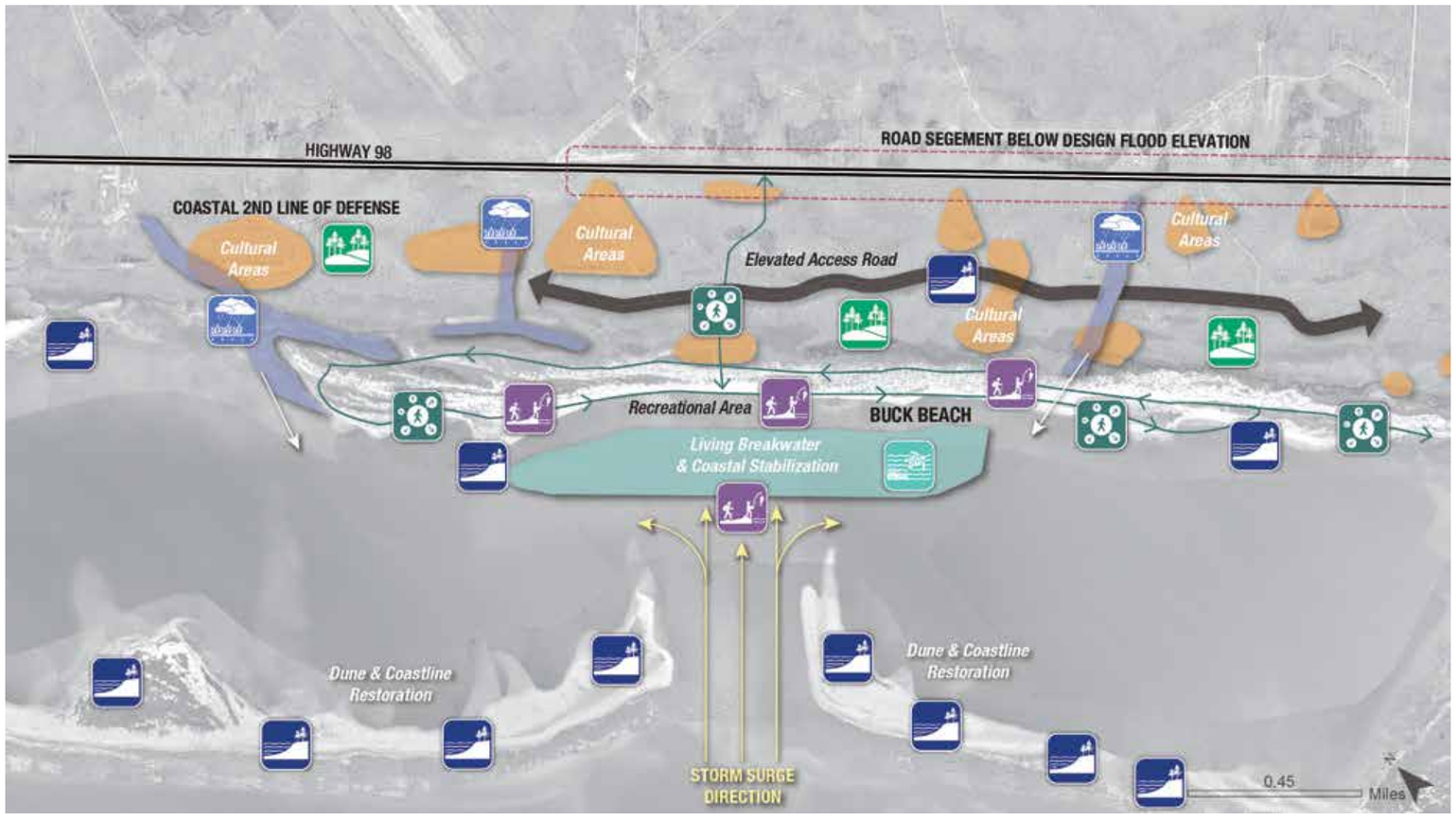
Demonstration Area 3

St. Andrew Sound CRD: St. Andrew Sound Inlet & Buck Beach

The St. Andrew Sound CRD runs along the south side of U.S. Highway 98 (US 98) with a long shoreline that is mostly protected by the Crooked Islands. Healthy vegetation communities exist along the CRD and relic dunes are present at multiple reaches. The Crooked Island mouth that connects the sound to the open Gulf is an area that offers significant potential for recreation, revegetation, pedestrian corridors and boardwalks, and dune and coastline restoration. From a coastal flooding risk perspective, it is critical to provide physical barriers in this area because large surges could potentially flood the north side of US 98, exposing the Core Mission CRD to inundation. A pilot project is planned to construct a living shoreline to stabilize the coast of Buck Beach. In addition, the dirt road that runs parallel to US 98 (to the south) in this demonstration area would be elevated to the DFE level.

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation	Wildlife Habitat Enhancement/ Ecosystem Restoration	Recreation (MWR)/ Education	Pedestrian & Commuter Mobility
▪ A protective earthen berm along the dirt road parallel and south of US 98 mitigates storm surge and inundation from the Gulf due to the relative low elevation (below DFE) at this stretch of the road. Alternatively, the road could be elevated. ▪ A living shoreline will stabilize and restore the coastline at the inlet along Buck Beach. ▪ Restoring the dunes and shorelines on the Gulf side barrier islands reinforces the coastal area's first line of defense.	▪ Consider the visual impact of the elevated road when looking from the Drone District runway to the upland coastal areas. ▪ Consider the context of the coastal protection structure to advance goals around naturalized forms; many segments are located within Longleaf pine restoration areas. ▪ Stormwater channels are designed to balance the Longleaf pine restoration efforts with typical riparian plant communities.	▪ The natural character of stormwater drainage is maintained in this area. ▪ Grading or culverts through the elevated road facilitates stormwater gravity flow.	▪ Breakwater and coastal stabilization structures may provide aquatic substrate for increased habitat.	▪ Buck Beach can be accessed from US 98 via a dedicated and demarcated vehicular corridor that runs through the vegetative buffer zone to the MWR recreational ground.	▪ Recreation design treats naturalized stormwater management features as amenities. ▪ The coastal trail and boardwalk are reconstructed and expanded to maximize sand capture and mimic dune form. Biomimicry principles to maximize co-benefits. ▪ A nature-based tertiary pathway or trail network links to Crooked Island Beach to the east along the designated shoreline loop corridor.

Demonstration Area Context

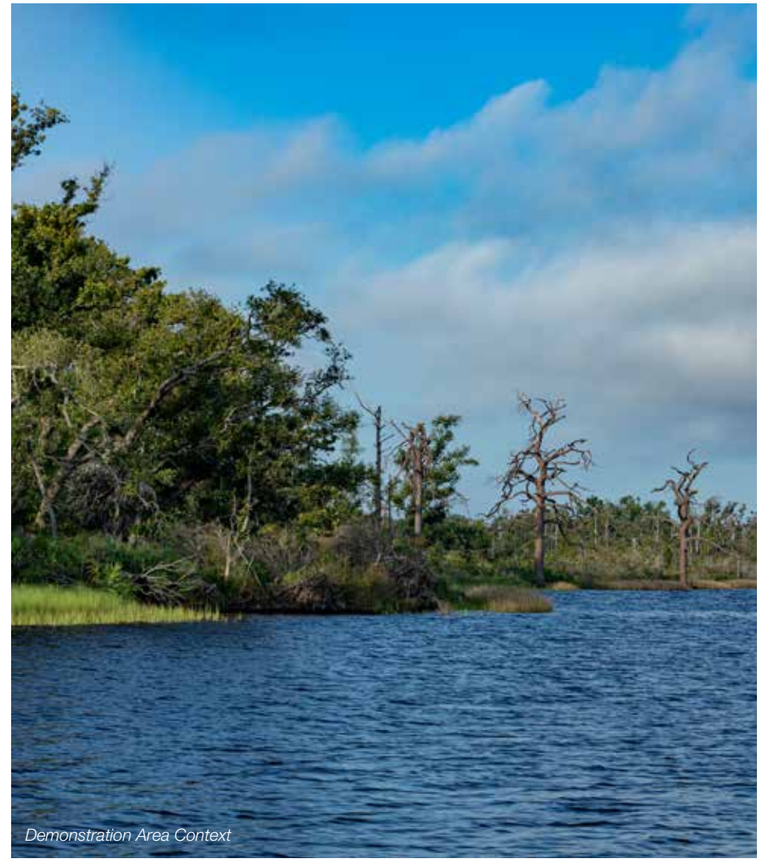


Demonstration Area 4

Core Mission CRD: AMMO/Munitions Storage Area (MSA)

In the Core Mission CRD, the small peninsula on the northeast side of the flightline contains some of the healthiest wetlands and marshes along the shoreline of Tyndall AFB. The MSA includes an in-progress MILCON project that is located at an elevation well below the DFE requirement. While the current design's flood resilience elements are being verified, an engineered solution around the perimeter of the MSA would harden the facility against coastal flooding without disrupting the downgradient ecosystem. Forest restoration will enhance the forested area immediately around the MSA. To comply with the base's stormwater permit requirements, stormwater channels will be protected and enhanced. Although the MSA's engineered solution can provide short-term flood protection, the flightline needs a long-term solution, which could be provided by constructing a horizontal levee (not included in this demonstration area).

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation
▪ Rock revetments help stabilize and protect the growing marshes. ▪ The MSA's flood risk prevention measures (an earthen berm around it) are coordinated with the current design, including the stormwater management approach. ▪ Protect the existing vegetation in the marsh that does not require wide-scale enhancement. Only a few small pockets of the marsh area require additional protection.	▪ The existing healthy wetlands and marsh are preserved. ▪ Small pockets of marsh in the tidal flats and existing salt marsh are restored and enhanced. ▪ The forested area upgradient from the marsh/wetland and surrounding the MSA is restored.	▪ The gravity flow on the existing outfalls is maintained and the natural character of the channels is preserved. ▪ Reliable and redundant stormwater pumps are installed if the MSA engineered solution is needed for flood protection (to be verified with the existing design).


Demonstration Area Context

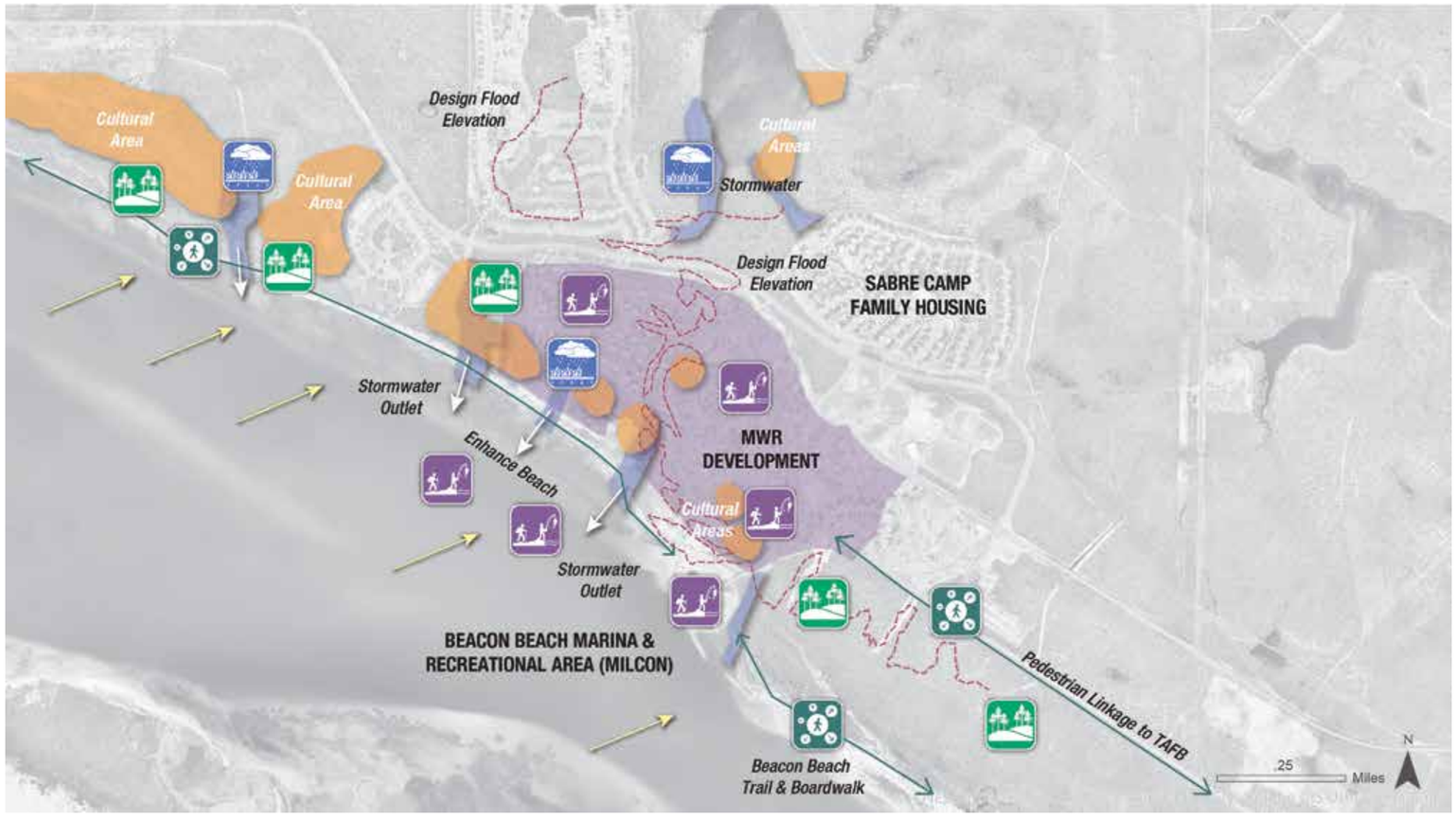
Demonstration Area 5

Sabre CRD:
Sabre Housing & Beacon Beach Recreation Area

The Sabre CRD includes large extensions of undisturbed terrain, residential areas, and active recreational areas that are programmed to be rebuilt. The Beacon Beach site, however, will not be reconstructed as a residential area and represents a great opportunity to provide a large coastal park that would link to the MILCON marina project. Significant revegetation of Longleaf pine installations and associated benefits are possible in the park as well as an expansive beach on the west side of the marina. Restored vegetation along the shoreline and the pedestrian mobility network can provide naturalized links to the marina and its surrounding park. The park can serve as a central recreational and natural space for residents within the Sabre CRD. Coastal protection with physical barriers is very limited, which makes retreat and relocation real options to be explored as part of the rebuild. Stormwater drainage in the park area would be restored from the current system in the residential area, to natural creeks. Peak flows in rainfall events will be lower in magnitude from the removal of significant impervious area.

Demonstration Area Context

Coastal Flood Risk Reduction	Revegetation/ Sustainable Landscape	Stormwater Management/ Wetland Mitigation	Wildlife Habitat Enhancement/ Ecosystem Restoration	Recreation (MWR)/ Education	Pedestrian & Commuter Mobility
▪ Coastal enhancement initiatives are promoted for erosion control and habitat. ▪ Flood risk prevention measures can include moving the housing units to higher ground (partially being completed), elevating buildings, armoring buildings, and changing the land use to relocate housing units.	▪ Revegetate along the coastline with Longleaf pine installations and associated benefits. Restore vegetation on tidal flats, sand beach, beach dune, and adjacent forest area. ▪ The abandoned housing area on Beacon Beach is revegetated consistent with the proposed park/recreational area. ▪ Appropriate vegetation is provided to daylight the creek, if feasible for stormwater management.	▪ The gravity flow on the existing natural and engineered channels and systems (in the housing areas) is preserved. ▪ The stormwater strategy reduces the impervious area resulting from the demolition of legacy housing near the coastal zone. ▪ Daylight major stormwater pipelines in the existing drainage system that will no longer serve the abandoned housing area.	▪ Coastal wildlife habitats are preserved and protected. ▪ The Sabre residential community is encouraged to support the habitat and nature ecosystem enhancement policies of Tyndall AFB and Florida Fish & Wildlife Commission.	▪ Access to the Beacon Beach Recreational Area is restored along with the MILCON projects to rebuild the marina and commercial facilities. ▪ The linear boardwalk system parallel shoreline is restored and rebuilt to link the Support District with Sabre Housing District. ▪ Recreational nodes are provided at key locations along the narrow beachfront north of the Beacon Beach Marina. ▪ New and integrated MWR recreational facilities are developed where the old Sabre housing area is being demolished.	▪ A new or expanded mobility network provides pedestrian linkage to the Support District using the existing road network or tertiary pathway or nature-based pathway system. ▪ The coastal area boardwalk network links various recreational nodes and facilities. ▪ The existing Sabre Camp community center and recreational facilities link with the existing or rebuilt pedestrian network and coastal zone recreational area.



DRAFT

COASTAL RESILIENCE AND SUSTAINABILITY STRATEGIES

Environmental Requirements for Coastal Projects

Page intentionally left blank

ENVIRONMENTAL REQUIREMENTS FOR COASTAL PROJECTS

Introduction

The coastal resilience program will benefit the environment through restorative activities designed to reduce the potential for long-term damages from storm events and comply with applicable environmental laws, regulations, and executive orders (EOs). This section outlines the laws and regulations that may be applicable to the coastal resilience activities at Tyndall AFB, describes the compliance process for both the pilot projects and the demonstration areas, and proposes early actions the coastal resilience team can initiate to complete the compliance requirements. This overview divides the coastal resilience program into two focus areas: Coastal Resilience Pilot Project Compliance and Demonstration Area Compliance.

Overview of Laws and Regulations

This section discusses the applicability of the following laws and regulations to Tyndall AFB's coastal resilience program and provides a typical timeline for obtaining permits or authorizations.

Law or Regulation	Description	Applicability to Coastal Projects at Tyndall AFB	Timeline for Compliance
National Environmental Policy Act (NEPA)	▪ Requires federal agencies to examine the need for, alternatives to, and environmental consequences of major federal actions they propose. ▪ Multiple levels analysis range from categorical exclusions, to Environmental Assessments (EAs), to Environmental Impact Statements (EISs).	▪ Required for the coastal resilience pilot projects and the demonstration areas because the actions have never occurred or been analyzed on base. ▪ Two NEPA analyses are proposed: 1. EA for Coastal Resilience Pilot Project Implementation to analyze the environmental impacts from the four pilot projects. 2. Programmatic EA for Demonstration Areas to analyze the environmental impacts from proposed actions in the five demonstration areas.	▪ 8-12 months
CFR Title 32 Part 989, *Environmental Impact Analysis Process (EIAP)*	▪ Identifies the U.S. Air Force's (USAF's) procedures for implementing NEPA requirements.	▪ Because the coastal resilience initiatives will be implemented on an Air Force Base, the USAF is the lead Federal Agency and will follow USAF's NEPA requirements.	▪ 8-12 months, concurrent with NEPA
Clean Water Act (CWA) Section 404	▪ Regulates the discharge of dredge or fill material into waters of the U.S., including wetlands. ▪ USACE Jacksonville Regulatory Division requires a CWA permit if proposed activities involve placing fill into waters of the U.S. ▪ Florida Department of Environmental Protection (FDEP) and Florida's five water management districts jointly regulate wetlands and surface waters through the Environmental Restoration Program (ERP).	▪ The coastal resilience pilot projects and demonstration areas are proposed in potential jurisdictional waters of the U.S./regulated state waters and must be delineated. ▪ If waters of the U.S. are impacted, a Section 404 permit will be required. ▪ If regulated state waters are impacted, an ERP permit will be required.	▪ 3-9 months, concurrent with other CWA permitting requirements
CWA Section 401	▪ Ensures material discharged pursuant to a Section 404 permit meets the State of Florida water quality standards. ▪ The State will issue a Water Quality Certification if no violations are expected.	▪ The coastal resilience pilot projects and demonstration areas will require Water Quality Certifications.	▪ 3-6 months, concurrent with other CWA permitting requirements
CWA Section 402	▪ Establishes the requirements for the National Pollutant Discharge Elimination System (NPDES). ▪ Certain construction activities are required to obtain a Generic Permit for Stormwater Discharges from Large and Small Construction Activities (FDEP Form 62-621.300(4)(a)) under Florida's NPDES stormwater program.	▪ The coastal resilience pilot projects and demonstration areas will require NPDES permits.	▪ 3-6 months, concurrent with other CWA permitting requirements
Rivers and Harbors Act of 1899	▪ Regulates activities in navigable waters of the U.S. ▪ Any proposed activities that involve placing fill into navigable waters of the U.S. require permitting through the USACE Jacksonville Regulatory Division under the Rivers and Harbors Act.	▪ If waters of the U.S. are impacted, a Rivers and Harbors Act permit will be required.	▪ 3-6 months, concurrent with other CWA permitting requirements
Endangered Species Act (ESA), as amended	▪ Provides a means for conserving endangered and threatened species and the ecosystems in which they live. ▪ Implemented jointly by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries Office of Protected Resources. ▪ Level of consultation depends on the project's potential to impact listed species or designated critical habitat	▪ Consultation with USFWS and NOAA Fisheries is required under ESA Section 7. ▪ Consultation is required even if the effects of an action are expected to be beneficial. ▪ Consultation with USFWS and/or NOAA Fisheries may include either informal or formal consultation.	▪ Informal consultation: 2 months, concurrent with NEPA ▪ Formal consultation: 4-5 months, concurrent with NEPA

Law or Regulation	Description	Applicability to Coastal Projects at Tyndall AFB	Timeline for Compliance
Marine Mammal Protection Act (MMPA)	▪ Protects all marine mammals and prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters. ▪ Consultation under MMPA may be combined with ESA consultation if all potentially affected species are protected under both acts.	▪ The coastal resilience pilot projects and demonstration areas propose actions that require MMPA consultation.	▪ 2-5 months, concurrent with ESA and NEPA
Migratory Bird Treaty Act (MBTA) of 1918	▪ It is illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird, except under the terms of a valid permit issued pursuant to federal regulations. ▪ Exempts incidental take from otherwise lawful activities where the intent is not to take migratory birds. ▪ As of May 18, 2020, the MBTA protects 1,093 species of birds, as listed in 50 CFR 10.13.	▪ Tyndall AFB implements measures to minimize adverse effects to migratory bird species protected under the MBTA. ▪ Measures include seasonal restrictions on construction activities within or in proximity to areas where these species nest and rear their young. ▪ Consultation with USFWS is unlikely for activities proposed under the coastal resilience program; however, all projects must follow Tyndall AFB MBTA requirements.	▪ Potential seasonal restrictions on work
National Historic Preservation Act (NHPA)	▪ Protects cultural resources. ▪ Requires federal agencies to consider the effect of federal undertakings on historic properties that are listed on or eligible for the NRHP. ▪ The Section 106 process includes identifying and evaluating historic properties, assessing the effects of the undertaking on those properties, consulting with the State Historic Preservation Officer (SHPO) regarding these effects and any actions that might be taken to address them, and providing the Advisory Council on Historic Preservation with an opportunity to comment. ▪ Requires the agency to consult with any Native American tribe that attaches religious and cultural significance to historic properties that may be affected by an undertaking.	▪ Tyndall AFB has extensive archaeological and cultural resources. ▪ The coastal resilience pilot projects are avoiding known cultural resources, but additional surveys may be required as directed by the 325th CES. ▪ The demonstration areas are proposed in known cultural sites with the intent to aid in cultural resource preservation. ▪ Additional surveys will be required for work in these areas. ▪ Both coastal efforts will require consultation with SHPO and Tribes during the NEPA process.	▪ 6-12 months, concurrent with NEPA* ▪ *If significant resources are found, projects may have longer delays to allow more extensive consultation with SHPO and/or Tribes
Coastal Zone Management Act (CZMA)	▪ Provides for the management of coastal resources. ▪ Florida Coastal Management Program implements 24 statutes that protect and enhance natural, cultural, and economic coastal resources. ▪ Any proposed projects must be consistent to the extent practicable with the enforceable policies of the Florida Coastal Management Program, as demonstrated by a coastal consistency determination.	▪ All coastal resilience efforts will require a coastal consistency determination due to the proximity to coastal resources.	▪ 2 months, concurrent with NEPA
Magnuson-Stevens Fishery Conservation and Management Act	▪ Provides for establishing and managing essential fish habitat (EFH). ▪ EFH is regulated through the NOAA Fisheries Office of Habitat Conservation.	▪ The base's nearshore waters have been designated as EFHs for one or more species or species groups. ▪ Any actions that would adversely affect EFH require authorization under the Act. ▪ Further surveys will be required for projects proposed in EFH and consultation will be required separate from ESA consultation, although a single document can present the analyses as long as it meets the requirements of each consultation.	▪ Informal consultation: 2 months, concurrent with NEPA ▪ Formal consultation: 4-5 months, concurrent with NEPA
Clean Air Act (CAA)	▪ Requires federal agencies to ensure emissions from any activity do not exceed regulatory thresholds or pose a potential risk to human health.	▪ The base is in an attainment area, so proposed actions are exempt from the general conformity rule and need not undergo a general conformity analysis.	▪ No affect to project timeline
EO 11988, *Floodplain Management*	▪ Directs federal agencies to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities.	▪ A finding of no practicable alternative (FONPA) must be prepared for the coastal resilience pilot projects and the coastal demonstration areas as part of each NEPA analysis.	▪ 8-12 months, concurrent with NEPA
EO 11990, *Protection of Wetlands*	▪ Directs federal agencies to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands.	▪ Because some projects are proposed within wetlands, a FONPA must be prepared. ▪ The FONPA will be prepared for both the coastal resilience pilot projects and the coastal demonstration areas as part of each NEPA analysis.	▪ 8-12 months, concurrent with NEPA
EO 13112, *Invasive Species*	▪ Directs federal agencies to prevent the introduction and spread of invasive species, and support efforts to eradicate and control invasive species that are established.	▪ Any activities proposed must be consistent with invasive species management on the base. ▪ As long as the Integrated Natural Resources Management Plan is adhered to, the coastal resilience pilot project will be in compliance with this EO.	▪ No affect to project timeline

Compliance Actions

All projects within the coastal resilience program will follow a typical compliance process from the early scoping phases through project implementation. The timing of each step will ultimately depend upon final project definition and survey results that will drive the NEPA, consultation and permitting requirements. Many of these steps can be accomplished concurrently in coordination with applicable government and agency stakeholders.

Conduct Environmental Studies and Surveys

As part of a project's scoping phase, it is critical that the coastal resilience team conduct the required environmental studies and surveys in order to fully understand the potential environmental and schedule constraints. The potential additional studies and surveys required for both the coastal resilience pilot projects and demonstration areas include:

- Habitat assessment survey
- Threatened and endangered species survey, including critical habitat determinations
- Delineation of U.S./State-regulated wetlands and surface waters
- Archaeological Phase I or II surveys

Early Engagement with Regulators and Agency Stakeholders

A critical component of both coastal resilience efforts is the required engagement with regulators and agency stakeholders. Both the coastal resilience pilot projects and the demonstration area projects will require coordination and consultation with key stakeholders including USACE Jacksonville Regulatory Division, USFWS, NOAA Fisheries, FDEP, SHPO, and federally recognized Native American tribes.

USACE-Regulatory, USFWS, NMFS & FDEP

An early agency stakeholder coordination meeting should be initiated separately for both coastal resilience efforts. This early coordination with agencies gives them the opportunity to preview data they will be asked to formally review and comment on during both the NEPA and permitting processes. During this early preview they can potentially identify critical issues that could stop the projects from moving forward and propose mitigating measures to prevent significant impacts.

SHPO & Tribes

Early consultation and coordination with SHPO and Tribes is critical given the extensive sensitive resources on Tyndall AFB. A SHPO/Tribal consultation plan created in coordination with both stakeholders would help identify key concerns and help establish early trust.

Step 1: Scoping and Definition	Step 2a: NEPA	Step 2b: Agency Consultation	Step 2c: Permitting & Mitigation	Step 3: Project Implementation
▪ Threatened and endangered species survey, including critical habitat determinations ▪ Habitat assessment survey ▪ Delineation of U.S./State regulated wetlands and surface waters ▪ Archaeological survey (Phase I or II) ▪ Description of the Proposed Action and Alternatives (DOPAA) ▪ Agency stakeholder coordination meeting	▪ EA	▪ USFWS ▪ NOAA ▪ USACE ▪ FDEP ▪ FWC ▪ Florida Clearinghouse ▪ SHPO ▪ Tribes	▪ ERP permit ▪ NPDES Construction Generic Permit (stormwater construction permit) ▪ CWA Section 404 Permit ▪ Perform mitigation measures	▪ Perform mitigation monitoring ▪ Begin construction
		Concurrent Steps		

Beach Dunes at Tyndall AFB

NEPA Consultation and Permitting

Coastal Resilience Pilot Projects

The coastal resilience program has identified four coastal resilience pilot projects to explore the viability of nature-based coastal resilience solutions at Tyndall AFB. Pilot Project 1 includes oyster reef construction, sand dune construction, horizontal levee construction and marsh enhancement. Pilot Project 2 includes sand fencing, wood debris placement, and vegetation. Pilot Projects 3 and 4 are in the feasibility stage and include proposed strategic placement of subtidal sediments and sand to enhance natural environments in the East Bay and Gulf Coast and implementation of nature-based options for the East Bay.

The coastal resilience pilot projects are anticipated to be implemented in 0-5 years in small areas of the base. Using constraints mapping, the coastal resilience pilot project areas were chosen due to their limited environmental constraints which potentially decreases the complexity of the required NEPA and other regulatory processes. Due to the limited scope and constraints of the pilot projects, the four projects can likely be analyzed in one EA separate from the demonstration areas and upscaled coastal development.

The coastal resilience pilot project EA will analyze the environmental effects from implementing all four pilot projects. To begin the coastal resilience pilot projects on schedule, it is recommended that outside agency funding be sought for the EA and any associated environmental surveys. Seeking outside funding for this effort would allow the project to proceed without having to compete for Air Force funding, which could potentially take 1-2 years. Once a description of the coastal resilience pilot projects and alternatives is accepted by the Air Force, an alternatively funded EA could be completed within 6-8 months.

Consultation with agencies can begin once surveys are complete for the coastal resilience pilot projects. Currently only informal consultation is anticipated due to the limited scope of the projects. Permitting and mitigation requirements will be identified during the consultation and NEPA processes and finalized once NEPA is complete.

Demonstration Areas

The demonstration areas are larger scale projects designed to mitigate potential loss of base infrastructure and provide aesthetic and functional coastal zone usage for a host of base activities. The creation of sustainable coastlines benefits the natural communities present on the base as well as provides long-term protection against storm surge.

Unlike the coastal resilience pilot projects, the demonstration areas are still in the concept phase. Further detailed analyses, surveys, and planning are required to propose definitive projects in these areas. However, the installation can still pursue early NEPA analysis for the proposed demonstration areas through a Programmatic EA.

A Programmatic EA addresses an entire program and serves as the basis for subsequent focused environmental analysis of site-specific projects as they are developed. The subsequent analyses would likely entail both categorical exclusions and focused addendum EAs tiered from the Programmatic EA. Once the description of the Proposed Action (activities to be implemented and general locations), including a range of reasonable alternatives, is developed, a Programmatic EA could be developed within 12 months. For subsequent site-specific projects, focused addendum EAs could be completed in 4 months or less.

Consultation with agencies can begin once surveys are complete for the demonstration areas. Formal consultation with some agencies may be required in some demonstration areas. Permitting and mitigation requirements will be identified during the consultation and NEPA processes and finalized once NEPA is complete.

Vegetation at Tyndall AFB

Sea Turtle at Tyndall AFB
Photo by: Airman 1st Class Alex Echols

Coastal Line of East Bay

East Bay at Tyndall AFB