Species Status Assessment for the

Florida Clamshell Orchid
(*Prosthechea cochleata* var. *triandra*)

Version 1.1

Photo by Keith Bradley

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EXECUTIVE SUMMARY

Florida clamshell orchid (*Prosthechea cochleata* var. *triandra)* is an orchid endemic to south Florida. The entire range of the species is one representative unit. The Florida clamshell orchid is listed as endangered by the State of Florida. The species is listed as 'imperiled' in Florida by the Florida Natural Areas Inventory ([FNAI] 2018, entire).

Florida clamshell orchid is a distinct taxon, differentiated morphologically from the widespread (West Indies, Central and South America) *Prosthechea cochleata* var. *cochleata* due to the presence of three anthers instead of one, as is typical in *P. c.* var. *cochleata*. Throughout the rest of the distribution of *P. c.* var. *cochleata*, 3-anthered, abnormal individuals seldom occur, and no populations have been reported.

The Species Status Assessment presents a compilation of the best available scientific and commercial data for the Florida clamshell orchid. Historically, the species was relatively abundant at larger sites in suitable habitats in southern Florida from Ft. Lauderdale south, but populations (particularly in accessible places) have been depleted by decades of illegal poaching. This species currently has 15 populations, which occur on 14 conservation areas in 5 counties (Martin, Hendry, Lee, Miami-Dade, and Collier County); there are also two known populations that have been extirpated.

Recent (post-2015) abundance data for the species is available for only 4 populations. Nine more populations have been verified during site inventories recently (post-2015). Lacking abundance data for 11 of 15 populations, we used site acreage as a surrogate for population size and resiliency. There are currently 15 resilient populations of Florida clamshell orchid (see Table 3-1 for details).

The stressors on the species and its habitats are habitat loss and modification due to sea level rise (SLR), hurricanes, and increasing storm surge impacts. Loss of habitat to development, poaching, and predation by insects are factors for the species but do not rise to the level of stressor for the purposes of this SSA. We analyzed 3 scenarios–A (decreasing greenhouse gases (GHG) in 2060), B (decreasing GHG in 2080), and C (Business as Usual)–incorporating projected rates of SLR from National Oceanographic and Atmospheric Administration ([NOAA] 2017, pp. 21-28), and projected increase in hurricane intensity to forecast the future viability of the species for 10 generations or approximately 80 years (to 2100). In all of the scenarios, the main driver of species viability is habitat loss and modification due to sea level rise.

Scenarios A, B, and C (SLR of 3.3 feet (ft), 4.9 ft, and 6.6 ft, respectively, do not differ in that they all result in 3 extirpated populations and 12 extant populations at 2100. The effects of SLR outstrip all other stressors in all scenarios and has the greatest influence on population resiliency and redundancy. In all of the scenarios, 3 populations are extirpated (ENP Coastal, Rookery Bay NERR, and Pond Apple Slough Preserve) by the effects of SLR while 9 populations will not experience severe effects (>15 percent habitat loss) from SLR until after 2100. The other 3 populations will lose 17 to 50 percent of their habitat to SLR by 2100 with a concomitant decline of the Florida clamshell orchid population resiliency at these sites. Representation is not affected by any of the three scenarios.

CHAPTER 1: INTRODUCTION

Florida clamshell orchid (*Prosthechea cochleata* var. *triandra*) is endemic to south Florida. The U.S. Fish and Wildlife Service (Service) was petitioned to list the Florida clamshell orchid as endangered or threatened under the Endangered Species Act of 1973, as amended (Act) on April 20, 2010, by the Center for Biological Diversity. In September of 2011, the Service found that the petition presented substantial scientific or commercial information indicating that the listing of the species may be warranted. The Species Status Assessment (SSA) framework is intended to be an in-depth review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA Report to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from Candidate Assessment to Listing to Consultations to Recovery. As such, the SSA Report will be a living document upon which other documents, such as listing rules, recovery plans, and 5-year reviews, would be based if the species warrants listing under the Act.

This SSA Report for Florida clamshell orchid is intended to provide the biological support for the decision on whether to propose to list the species as threatened or endangered and, if so, whether to and where to propose designating critical habitat. Importantly, the SSA Report does not result in a decision by the Service on whether this taxon should be proposed for listing as a threatened or endangered species under the Act. Instead, this SSA Report provides a review of the best available scientific and commercial information strictly related to the biological status of Florida clamshell orchid. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed decision will be announced in the Federal Register, with appropriate opportunities for public input.

For the purpose of this assessment, we generally define viability as the ability of the species to sustain populations in its range of native habitats beyond a biologically meaningful timeframe, in this case, 80 years. We chose 80 years because of the generation time of Florida clamshell orchid (~8 years) encompasses approximately 10 generations, allowing enough time to detect the species response to stressors. Additionally, it is within the range of the available climate change models (see NOAA 2017, entire). Using the SSA framework (Figure 1.1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation (Wolf et al. 2015, entire).

- **Resiliency** is having sufficiently large populations for the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, birth versus death rates and population size. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

- **Redundancy** is having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. The greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events.

- **Representation** is having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations

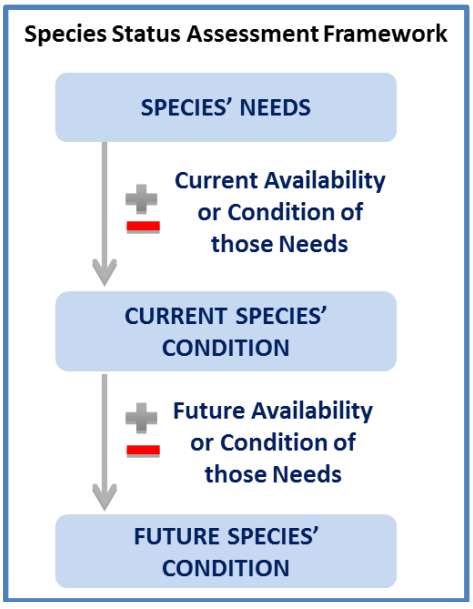


Figure 1.1 Species Status Assessment Framework

and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics within the geographical range.

To evaluate the biological status of Florida clamshell orchid both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation (together, the 3Rs). This SSA Report provides a thorough assessment of biology and natural history and assesses demographic risks, threats, and limiting factors in the context of determining the viability and risks of extinction for the species. For the purposes of this SSA, we consider the Florida clamshell orchid a single representative unit.

The format for this SSA Report includes: (1) the resource needs of individuals and populations (Chapter 2); (2) historical distribution of Florida clamshell orchid and a framework for what the species needs in terms of the distribution of resilient populations across its range for species viability (Chapter 3); (3) a review of the likely causes of the current and future status of the species and which risk factors affect the species' viability and to what degree (Chapter 4); and (4) a concluding description of the viability in terms of resiliency, redundancy, and representation (Chapter 5). This document is a compilation of the best available scientific and commercial information and a description of past, present, and likely future risk factors to Florida clamshell orchid.

CHAPTER 2: SPECIES RESOURCE NEEDS AND POPULATIONS

Species Description

Florida clamshell orchid (*Prosthechea cochleata* var. *triandra*, Orchidaceae – Orchid Family) is an epiphytic herbaceous plant with erect, leafy stems, up to 12 inches (in) (30 centimeters (cm)) long. One to three lance-shaped leaves arise from ovoid-shaped pseudo-bulbs that form the base of the plant. The flowering shoots also arise from the apex of the pseudo-bulb. Each stem may carry 1 to 15 flowers. The individual flowers are 0.3 to 1.2 in (1 to 5 cm) long, and have sepals and petals that are similar, being lance-shaped and yellow-green in color, with a few purple spots near the base. The lip petal is broadly heart-shaped, concave, and is purple to brown in color with prominently colored veins radiating from the base. Each flower possesses three anthers, as opposed to the typical Orchidaceae pattern of just two, resulting in the varietal name '*triandra'* (Long and Lakela 1971, p. 332, Luer 1972, p.202; Brown 2002, p.224, 2009, p.6;).

Outside the USA, the closely-related clamshell orchid (*Prosthechea cochleata* var. *cochleata*) is widely documented throughout tropical Central and South America and the Caribbean. *Prosthechea cochleata* var. *cochleata*, with a single, central anther containing two pairs of pollinia surrounded by three teeth, was described by Linnaeus in 1763. All populations outside Florida are of this form, while all plants native to Florida are distinctly different, possessing a pair of smaller anthers adjacent to an extra tooth on either side of the apex of the column. Each additional anther has its own pair of pollinia, raising the total number of pollinia to eight in four pairs (Luer 1972, p.202). The three-anthered Florida clamshell orchid is a Florida endemic thought to have spread within Florida from a single incidental introduction of this otherwise common tropical species (NatureServe 2018, entire). The Service does not discuss *Prosthechea cochleata* var. *cochleata* further in this SSA.

Taxonomy

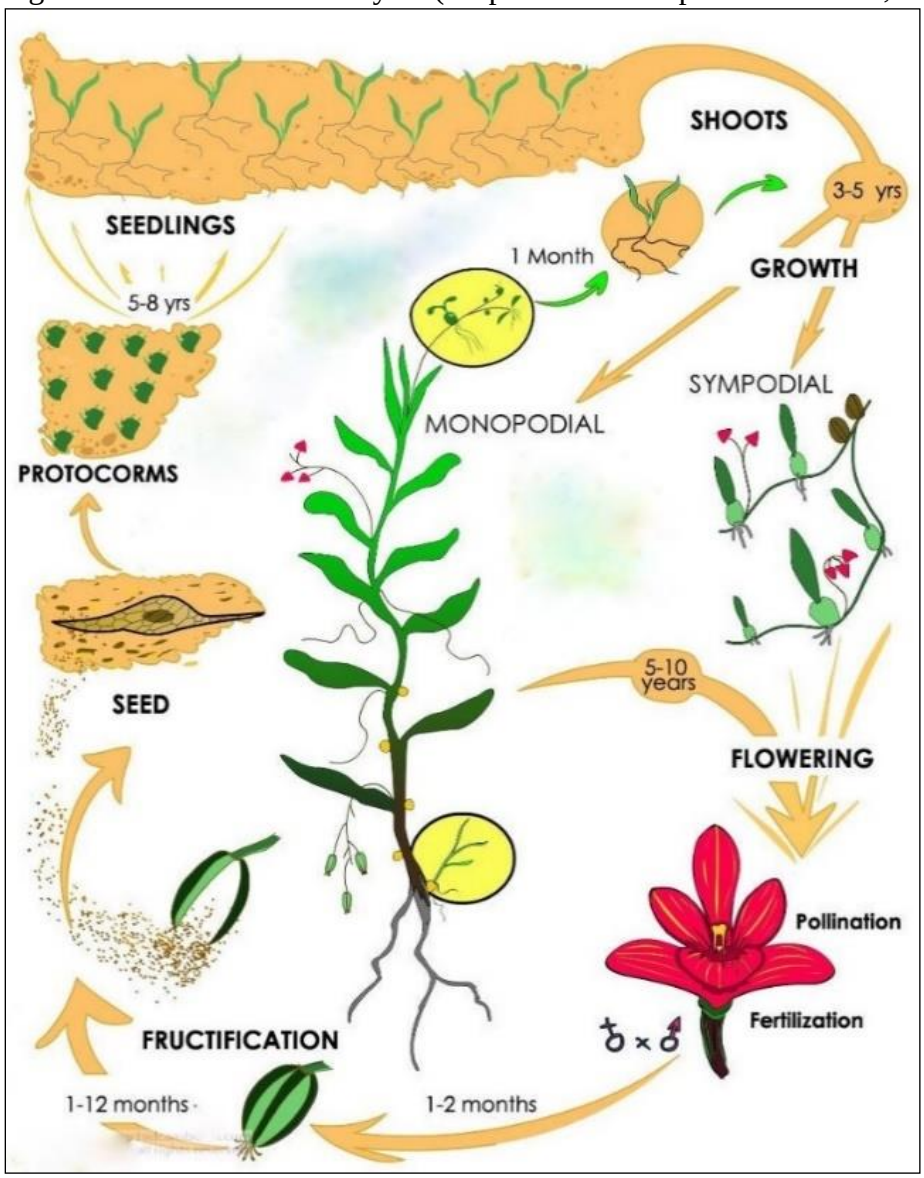
The name *Prosthechea cochleata* var. *triandra* (Ames) W.E. Higgins is the accepted name for the taxon in Integrated Taxonomic Information System (ITIS 2017, entire) and the Florida Plant Atlas (Wunderlin *et al*. 2017, entire). The Flora of North America uses *Prosthechea cochleata* var. *triandra* (Ames) W.E. Higgins (Flora of North America 2018, p.614).

Life History

Florida clamshell orchid is a long-lived perennial with a typical orchid life cycle (Figure 2-1). Mature Florida clamshell orchid plants usually produce flowers in fall through spring, but they may flower at any time of year (Brown 2009, p. 6). The plants can self-fertilize, but may also be pollinated by arthropods (North American Orchid Conservation Center (NAOCC) 2017, p.2). Seed capsules have been observed on the plants in March (Brown 2002, p.224). All orchids produce capsules containing thousands of miniscule seeds that are dispersed by wind.

For successful recruitment, seeds require a suitable host fungus to be present where they land. After successful germination on a suitable host tree (see Habitat, below), seedlings grow for several years before reaching maturity (monopodial growth). The exact number of years is not known, but likely depends on resource availability (principally light and water). After approximately 10 years, adult plants may consist of many stems arising from leaf axils and the plant's base. Individual plant lifespan is unknown, but is likely many years to decades (perhaps many decades), due to continuous vegetative generation of pseudo-bulbs (sympodial growth).

Figure 2-1. The orchid life cycle (adapted from Telapova et al. 2018, entire).



Habitat

Florida clamshell orchid occurs as an epiphyte high on the branches or trunk of canopy trees and occasionally standing dead wood (snags) in habitats classified by FNAI as pond apple slough, strand swamp, dome swamp, rockland hammock, coastal buttonwood hammock, and mesic and hydric prairie hammock (FNAI 2000, entire; Sadle pers. comm. 2012; Gann et al. 2017, entire). All but rockland hammock and mesic hammock are annually flooded fresh water or slightly brackish communities, subject to tidal influence, particularly at coastal sites. Beyond these habitats lie mangroves and open water. Habitats found at each site are identified for each population in Table 3-1.

Wooded Sloughs and Strand Swamps

Wooded sloughs and strand swamps are broad, shallow channels with peat over mineral substrate, which are seasonally inundated with flowing water. They differ in that sloughs are dominated by pop ash (*Fraxinus caroliniana*) and/or pond apple (*Annona glabra*) trees, while strand swamps are dominated by bald cypress (*Taxodium distichum*) and/or coastal plain willow (*Salix caroliniana*) trees (FNAI 2010, pp. 154, 167). The hydroperiod (period of inundation) is an important component of this habitat. For example, the hydroperiod of the central slough of Fakahatchee Strand Preserve State Park (FSPSP) ranges from 9 to 11 months, which provides the frost and drought protection essential to the survival of epiphytic orchids in Florida, including Florida clamshell orchid (Owen pers. comm. 2017).

Dome Swamps

Dome swamps are isolated, shallow, depressional woodlands dominated by pond cypress (*Taxodium ascendens*) and swamp tupelo (*Nyssa sylvatica* var. *biflora*). The normal hydroperiod for dome swamps is 6 to 9 months per year. Dome swamps derive much of their water through surficial runoff from surrounding uplands. Water levels in dome swamps naturally fluctuate with seasonal rainfall change. They may also be connected directly to the aquifer, where groundwater influences the hydrological regime, especially during periods of drought. Fire is essential for maintaining the structure and the species composition of a dome swamp community. The normal fire cycle might be as short as three to five years along the outer edge and as long as 100 to 150 years towards the center (FNAI 2010, pp. 157-160). Water depth in these habitats is critical to maintaining humid conditions and protection from frost under the canopy, both of which are required by Florida clamshell orchid for survival and reproduction.

Rockland Hammock

Rockland hammock is a species-rich tropical hardwood forest on upland sites in areas where limestone is very near the surface and often exposed. Rockland hammocks typically have larger, more mature trees in the interior (FNAI 2010, pp. 29-32). Rockland hammock occurs on a thin layer of highly organic soil covering limestone on high ground that does not regularly flood, but it is often dependent upon a high water table to keep humidity levels high. Rockland hammocks are frequently located near wetlands; in the Everglades they can occur on organic matter that accumulates on top of the underlying limestone. Rockland hammocks rarely flood (except in cases of storm surge) and typically do not retain standing water except in sinkholes.

Rockland hammock is susceptible to fire, frost, canopy disruption, and ground water reduction. Rockland hammock can be the advanced successional stage of pine rockland, especially in cases where rockland hammock is adjacent to pine rockland. In such cases, when fire is excluded from pine rockland for 15 to 25 years, it can succeed to rockland hammock vegetation. Historically, rockland hammocks in south Florida evolved with fire in the landscape. Fire most often extinguished near the edges when it encountered the hammock's moist microclimate and litter layer. However, rockland hammocks are susceptible to damage from fire during extreme drought or when the water table is lowered. In these cases, fire can cause orchid and host tree mortality and consume the organic soil layer. Rockland hammocks are also sensitive to the strong winds and storm surge associated with hurricanes. Canopy damage often occurs, which causes a change in the

microclimate of the hammock causing more exposed, hotter, and drier conditions. Decreased relative humidity and drier soils make rockland hammocks more susceptible to fire (FNAI 2010, p. 29-32).

Buttonwood Hammock

Forests dominated by buttonwood (*Conocarpus erectus*) often exist in upper tidal areas, especially where mangrove swamp transitions to rockland or coastal hardwood hammock. These buttonwood forests have canopy dominated by buttonwood and often have an understory dominated by sea oxeye daisy (*Borrichia frutescens*), Christmasberry (*Lycium carolinianum*), and sea lavender (*Limonium carolinianum*). Temperature, salinity, tidal fluctuation, substrate, and wave energy influence the size and extent of buttonwood forests. The system is brackish and may be flooded daily to monthly during high tides. Salinity limits the seaward expansion of buttonwood forests. Buttonwood forests often grade into salt marsh, coastal berm, rockland hammock, coastal hardwood hammock, and coastal rock barren (FNAI 2010, p. 203).

Prairie Mesic Hammock

Isolated patches of trees that occur within a larger matrix of pyrogenic vegetation, usually dry prairie or mesic flatwoods, but occasionally on higher rises within a basin marsh, wet prairie, or wet flatwoods. These hammocks may experience low intensity fires on a regular basis, leading to a somewhat species-poor canopy of cabbage palm (*Sabal palmetto*), live oak (*Quercus virginiana*), or a mixture of the two species, with saw palmetto (*Seranoa repens*) common in the understory (FNAI 2010, p.25).

Prairie Hydric Hammock

Isolated patches of trees that occur within a larger matrix of pyrogenic vegetation, usually floodplain marsh. Dominant trees are cabbage palm, live oak, and red cedar (*Juniperus virginiana*) with an open, sparse understory. Prairie hydric hammock burns frequently and is often completely dominated by cabbage palm (FNAI 2010, p.181).

Historical Range and Distribution

Florida clamshell orchid is endemic to south Florida (see Figure 3-1), and the entire distribution of the species is one representative unit. The species' historical range consisted of Martin, Lee, Hendry, Broward, Palm Beach, Miami-Dade, Monroe, and Collier Counties. Experts believe populations reported in Hillsborough County were an introduction (Brown 2009, p.6). Luer (1972, p.202) described the species as common in damp forests of South Florida. The species was once relatively abundant in suitable habitats from the latitudinal line at approximately Ft. Lauderdale south (NatureServe 2018, entire). As with many of Florida's native orchids, populations of Florida clamshell orchid were decimated by plant poachers before the establishment of protected areas.

SPECIES' ECOLOGICAL NEEDS

INDIVIDUAL NEEDS

Microsites for Growth and Reproduction

All life stages of Florida clamshell orchid require host trees, partial sun exposure, nearly continual high humidity, and the absence of freezing temperatures. These conditions are found in epiphytic microhabitats in swamps, sloughs, buttonwood hammock, and rockland hammock habitats described above. The plants grow on tree trunks or high branches of canopy trees. Seeds must germinate on a suitable host tree species. Known host trees include red maple (*Acer rubrum*), pop ash, buttonwood, live oak (Brown 2002, p.6), and *Ilex cassine* (Dahoon holly) (Zettler 2012, p.129). As with most orchids, germinating seeds require the presence of symbiotic fungal species in order to grow to maturity.

POPULATION NEEDS

Delineating Populations
For the purposes of this analysis, we treat each conservation area with an extant occurrence of Florida clamshell orchid as a population in our analysis of resiliency, redundancy, and representation. There are two notable exceptions – 1) Fuchs Hammock Preserve and Meissner Hammock are adjacent contiguous small parcels (totaling 34 acres (ac)), both owned and managed by Miami-Dade County. As such, we count these two properties as a single population; and, 2) north and south (coastal) populations at Everglades National Park (ENP), are considered separately, given the large size of the site, long distance between the two populations, and the greater risk to the coastal population.

Undisturbed Natural Areas
Sites where Florida clamshell orchid is extant are largely undisturbed natural areas (or areas that were logged in the past but are now protected), which range in size from 50 to 1,507,850 ac. All sites under 300 ac are located in the greater Miami area where they are isolated fragments consisting of nearly 100 percent rockland hammock. Larger contiguous areas (especially ENP and Big Cypress National Preserve (BCNP) areas have a smaller proportion of the suitable habitat types compared to their overall area. FSPSP, Florida Panther National Wildlife Refuge (FPNWR), Pond Apple Slough Preserve, Corkscrew Swamp, and Six Mile Cypress Preserve are largely dominated by habitat that supports Florida clamshell orchid.

Hydrology
The hydrology of swamps and sloughs in the species' range is a critical factor in maintaining moist, frost-free conditions the species requires. Epiphytic species that primarily meet their water needs from the atmosphere are adversely affected by decreased environmental moisture levels,lower temperatures during freezing events, and more intense and penetrating fires are both linked to lowered humidity (Gann 2015, p.101).

Pollinators
Florida clamshell orchid can automatically self-pollinate, and populations apparently do not necessarily rely on insect pollinators (NAOCC 2017, entire). Although the plants can self-pollinate, insect pollinators provide beneficial genetic mixing within and between populations, and generally increase seed production and progeny vigor in self-compatible plant species. There have been no studies of the population genetics of the Florida clamshell orchid. There is no data to suggest that lack of pollinators is a threat to the Florida clamshell orchid.

SPECIES' NEEDS

Habitat and Species Migration Corridors and Translocation
To persist in Florida throughout its historical range, the species requires suitable habitats as described above, at sites that are large enough to withstand small scale disturbances (stochastic events) and support larger (more resilient) populations. Habitat loss due to development is a minor stressor because most known populations are within public or private conservation lands. However, the species faces an uncertain future with regard to habitat loss due to sea level rise. Accelerated rates of sea level rise and corresponding changes in vegetation (due to sea water encroachment) may outpace the habitat and species ability to migrate, and reduce the number of suitable host trees for Florida clamshell orchid. Buttonwood hammocks in ENP where elevations are currently about 2.5 to 3.3 ft (0.8 to 1 m) above sea level are already receding and transitioning to tidal saltmarsh, a transition that is projected to continue and accelerate over the next 50 years (Sadle pers. comm. 2012; Saha 2011, p.103-105).

CHAPTER 3: CURRENT CONDITIONS

Current Distribution

Florida clamshell orchid currently has 15 extant populations on 14 conservation sites in 6 counties (Martin, Palm Beach, Lee, Miami-Dade, Monroe, and Collier County). All sites are publicly-owned conservation areas where the species and its habitat are protected. In addition, three populations known from suburban Miami rockland hammock sites are now extirpated (Deering Estate at Cutler, Hattie Bauer Hammock Preserve, and Castellow Hammock Park) (Gann *et. al.* 2017, entire) (See Figures 3-1, 3-2, and Table 3-1).

Figure 3-1. The current and historical range of the Florida clamshell orchid.

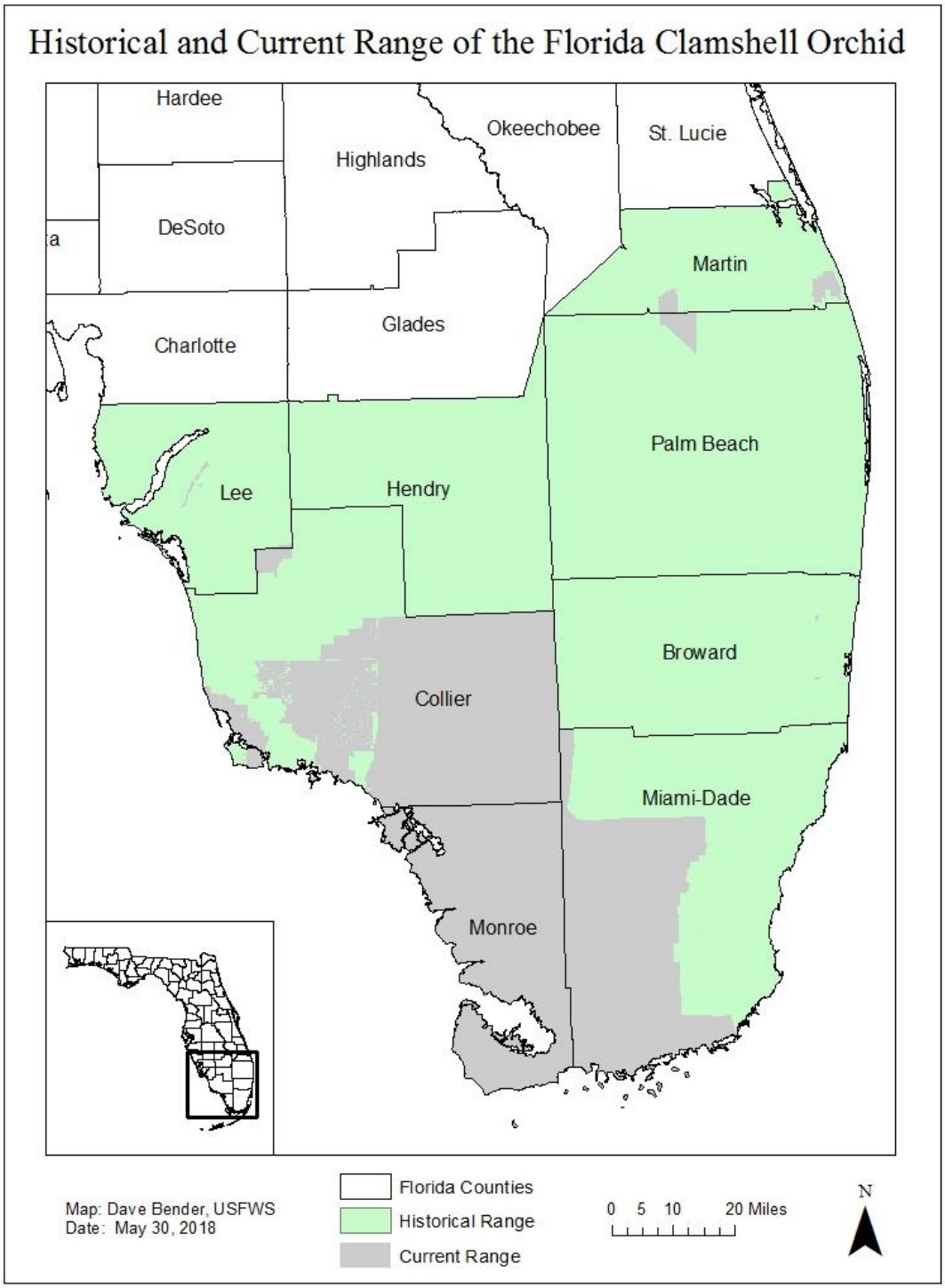
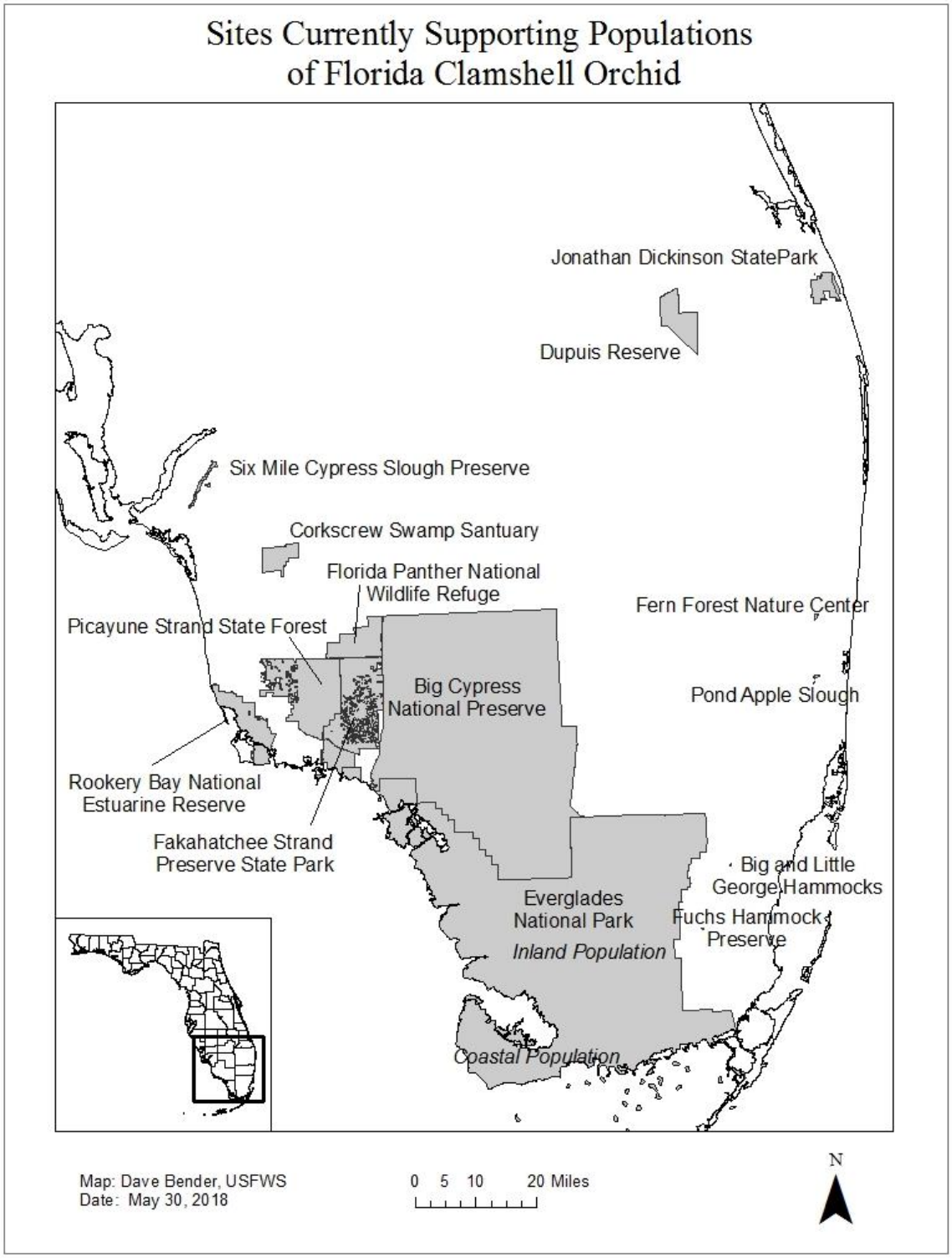


Figure 3-2. The 14 conservation areas that support populations of the Florida clamshell orchid.



How This SSA Defines a Resilient Population of Florida Clamshell Orchid

For the purposes of the SSA, we define a resilient population of the Florida clamshell orchid as a site occupied by the species where the habitat characteristics described above are present (i.e., adequate hydrology and moisture regime, presence of host trees). Thus, Florida clamshell orchid currently has 15 resilient populations, and a total estimated population in Florida of 6,450 plants (see Table 3.1).

Table 3-1. Known populations of Florida clamshell orchid (15 total; 'Present' means the species was observed but abundance is unknown).

Site	Most Recent Observation	Status	Citation	Site Summary
Extant Populations - 15				
Florida Panther National Wildlife Refuge	2015	Present	Gutting et al. 2015, p.402.	Collier County Size: 26,605 acres Managing Agency: US Fish and Wildlife Service Habitat: Dome Swamp, strand swamp, slough
Big Cypress National Preserve	2018	2,000 (estimated)	Pernas pers. comm. 2018	Collier County, Miami-Dade County, Monroe County (Mainland) Size: 72,9000 acres Managing Agency: United States National Park Service Habitat: Dome Swamp, strand swamp, slough
Corkscrew Swamp Sanctuary	2018	Present	Downing, pers. comm. 2018.	Lee County, Collier County Size: 10,895 acres Managing Agency: National Audubon Society Habitat: Dome Swamp, strand swamp, slough
Dupuis Reserve	sans date	Present	Gann 2017, entire	Martin County, Palm Beach County Size: 21,875 acres Managing Agency: South Florida Water Management District Habitat: Dome Swamp, strand swamp, slough
Everglades National Park – Inland	2015	4,000 (estimated)	Sadle 2012 pers. comm	Miami-Dade County, Monroe County (Mainland), Collier Size: 1,507,850 acres (entire park) Managing Agency: United States National Park Service Habitat: Interior: slough, rockland hammock, prairie hammock (hydric and mesic); Coastal: buttonwood hammock
Everglades National Park – Coastal				

Fakahatchee Strand Preserve State Park	2016	450 +	Owen pers. comm. 2017.	Collier County Size: 70,375.88 acres Managing Agency: Florida Department of Environmental Protection, Division of Recreation and Parks Habitat: Dome Swamp, strand swamp, slough
Fern Forest Nature Center	sans date	Present	Gann et al. 2017, entire	County: Broward County Size: 247.1 acres Managing Agency: Broward County Habitat: Rockland hammock
Jonathan Dickinson State Park	sans date	Present	Gann et al. 2017, entire	Martin County, Palm Beach County Size: 11,458 acres Managing Agency: Florida Department of Environmental Protection, Division of Recreation and Parks Habitat: Dome Swamp, strand swamp, slough
Pond Apple Slough	1996	Present	Gann et al. 2017, entire	Broward County Size: 214.7 acres Managing Agency: Broward County Habitat: Dome Swamp, strand swamp, slough
Rookery Bay National Estuarine Research Reserve	1998	Present	Gann et al. 2017, entire	Collier County Size: 83,107 acres Managing Agency: Florida Department of Environmental Protection, Office of Coastal and Aquatic Managed areas Habitat: Dome Swamp, strand swamp, slough
Six Mile Cypress Slough Preserve	1997	Present	Gann et al. 2017, entire	Lee County Size: 2,089.51 acres Managing Agency: Lee County Habitat: Dome Swamp, strand swamp, slough

Picayune Strand State Forest	2001	Present	Gann et al. 2017, entire	Collier County Size: 65,435.79 acres Managing Agency: Florida Department of Agriculture and Consumer Services, Division of Forestry Habitat: Dome Swamp, strand swamp, slough
Fuchs Hammock Preserve / Meissner Hammock	1991	Present	Gann et al. 2017, entire	Miami-Dade County Size: 10.32 acres Managing Agency: Miami-Dade County: Miami-Dade County Size: 39.83 acres Managing Agency: Miami-Dade County Department of Parks and Recreation Habitat: Rockland hammock
Big and Little George Hammocks	1980	Present .	Gann et al. 2017, entire	Miami-Dade County Size: 114.79 acres Managing Agency: Miami-Dade County Department of Parks and Recreation Habitat: Rockland hammock
Extirpated Populations - 3				
Deering Estate at Cutler	1992	Extirpated	Gann et al. 2017, entire	Miami-Dade County Size: 441.23 acres Managing Agency: Miami-Dade County Habitat: Rockland hammock
Hattie Bauer Hammock Preserve	1992	Extirpated	Gann et al. 2017, entire .	Miami-Dade County Size: 15.01 acres Managing Agency: Miami-Dade County Habitat: Rockland hammock
Castellow Hammock Park	1993	Extirpated	Gann et al. 2017, entire	Miami-Dade County Size: 114.79 acres Managing Agency: Miami-Dade County Department of Parks and Recreation Habitat: Rockland hammock

Population Trends

Everglades National Park (ENP)
Loope and Avery (1979) considered the species to be moderately common at ENP. In 1985, Florida clamshell orchid was reported as "very abundant" near West Lake in ENP growing on buttonwood and red mangrove. (McCartney 1985, entire). Currently, the species is considered to be widespread with many scattered occurrences in localized areas of suitable habitat throughout ENP (Sadle pers. comm. 2012.). Florida clamshell orchid is known from both coastal and inland populations (Gann 2015, p. 101). No data has been collected in an effort to estimate the population size at ENP. Botanists at the park estimate the population in ENP consists of at least few thousand individuals (Sadle pers. comm.2012). Gann (2015, p. 100) did not consider the species a 'species of management concern' in ENP.

Big Cypress National Preserve (BCNP)
Florida clamshell occurs throughout BCNP in strand and cypress dome swamps. It is locally abundant in some areas. The population estimate for BCNP is 2,000 or more individuals (Pernas pers. comm. 2018).

Fakahatchee Strand Preserve State Park (FSPSP)
Managers documented 450 Florida clamshell orchids during 34 days of surveying the central slough of the FSPSP (Owen pers. comm. 2017).

Florida Panther National Wildlife Refuge (FPNWR)
Florida clamshell orchidis a locally common orchid at FPNWR. Scattered plants and small populations can be found throughout slough and strand swamp habitat on the refuge.

Other
No population size or trend data are available for any other Florida clamshell orchid populations at this time.

CHAPTER 4: FACTORS AFFECTING THE VIABILITY OF THE SPECIES

STRESSORS

Known stressors include habitat modification and destruction due to sea level rise, saltwater intrusion, and hurricane storm surge. Other factors include nonnative plant species, insect predation, poaching, and climate change-associated factors, including prolonged droughts, increased wildfire risk, and increased freeze risk.

Habitat Destruction and Modification
Destruction of rockland hammocks has occurred in south Florida since the beginning of the 1900s. Extensive land clearing for human population growth, development, and agriculture in Miami-Dade and Monroe Counties has altered, degraded, or destroyed thousands of acres of these once abundant ecosystems. Habitat destruction is a factor in the decline of many epiphytic orchids in the Southern U.S., including Florida clamshell orchid (McCartney 1985, p.1). All known populations of Florida clamshell orchid occur on public and private conservation lands and are generally protected from habitat loss or modification. However, infrastructure improvements within parks and on their boundaries may cause sporadic, usually small-scale habitat loss and modification.

Habitat Fragmentation
Habitat fragmentation reduces the size of plant populations and increases spatial isolation of remnants. The remaining rockland hammocks in the Miami metropolitan area are severely fragmented and isolated from each

other by vast areas of development. Fragmentation also alters other ecosystems' functions and disturbance regimes. Fragmentation results in an increased proportion of "edge" habitat, which has a variety of effects, including changes in microclimate and community structure at various distances from the edge (Margules and Pressey 2000, p. 248), increased pressure from nonnative, invasive plants and animals that may out-compete or disturb Florida clamshell orchid, and ultimately reduced population viability (Rathcke and Jules 1993, p. 275; Goverde et al. 2002, pp. 297–298; Harris and Johnson 2004, pp. 33–34).

A looming, more significant threat is that the existing fragmented landscape will complicate the migration of plant communities in response to climate change, because of surrounding development. The City of Naples lies directly inland of Rookery Bay population, while the Curry Island community lies just north and inland of Picayune Strand State Forest population. These populations, along with those at Fuchs Hammock Preserve, Meissner Hammock, Big and Little George Hammocks, and Fern Forest Nature Center, will face the greatest challenge as they retreat towards these problematic zones for species and habitat migration.

Hydrologic Modification

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006, p. 4). Anthropogenic modifications of the historical hydrological patterns in south Florida have affected Florida clamshell orchid habitat, leading to generally drier conditions and lower humidity levels. Drainage may continue to have a negative effect on moisture-loving orchids, including Florida clamshell orchid (Gann 2015, p. 169).

As artificial drainage became more widespread in south Florida, regional groundwater supplies declined, causing drier conditions in habitats that support Florida clamshell orchid. A growing human population in Miami-Dade County will continue to deplete groundwater and likely increase the rate of depletion over the next two decades.

Projects designed to restore the historical hydrology of the Everglades and other natural systems in southern Florida, such as BCNP, (collectively known as the Comprehensive Everglades Restoration Plan (CERP)) are beneficial to the Everglades ecosystem, and may produce collateral effects to habitats within the region through inundation or increased hydroperiods. Increased and longer-duration hydroperiods may help reduce the effects of saltwater intrusion and produce higher ambient moisture levels. However, it is unclear to what extent this may occur, if at all (Gann 2015, p. 169).

Small Population Size and Isolation

Endemic species whose populations exhibit a high degree of isolation are extremely susceptible to extinction from both random and nonrandom catastrophic natural or human-caused events. Species that are restricted to geographically limited areas are inherently more vulnerable to extinction than widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change, stochastic events, and localized catastrophes such as hurricanes and disease outbreaks (Mangel and Tier 1994, p. 607; Pimm et al. 1998, p. 757). These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 24–34).

Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby decreasing the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Isolated individuals have difficulty achieving natural pollen exchange, which limits the production of viable seed. The problems associated with small population size and vulnerability to random demographic fluctuations or natural

catastrophes are further magnified by synergistic interactions with other threats, such as those discussed above and below.

Nonnative Plant Competition
Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and modify native plant communities where Florida clamshell orchid grows. Old World climbing fern (*Lygodium microphyllum*), shoebutton ardisia (*Ardisia elliptica*), and Brazilian pepper (*Schinus terebinthifolius*) are common invasives in habitats that support Florida clamshell orchid (Gann et. al. 2002, pp. 251, 687).

In ENP and BCNP, invasives tend to be fewer due to the insularity of these sites and the National Park Service (NPS) control programs. Nevertheless, most areas require annual treatments to remove incipient invasions. Management of nonnative invasive plants in rockland hammocks in Miami-Dade County is complicated because the vast majority of rockland hammocks are small, isolated fragments bordered by urban development. Overall, active management is necessary to control for nonnative species and to protect unique and rare habitats where Florida clamshell orchid occurs (Snyder et al. 1990, p. 273). Ongoing conservation measures discussed below are aggressively addressing this threat. At present, nonnative plant competition appears to be a minor factor in the viability of the Florida clamshell orchid.

Insect Damage
In a study at FPNWR (Collier, County, Florida), 118 orchids were surveyed and 15 percent (18 plants) had mealybug, while 14 percent (16 plants) had scale (Gutting et al. 2015, pp. 401-404). Of the Florida native orchid taxa harboring scale insects (Coccoidea), heaviest infestations were noted on Florida clamshell orchids (9 of 22 or 41 percent). The host trees (pop ash and Dahoon holly) were also heavily infested with scale. On one Florida clamshell orchid plant, wandering big-headed ants were observed tending brown soft scales (Zettler et al. 2012, pp. 129-133). While the presence of these pestiferous insects in remote natural areas is worrisome, there is not enough data to determine if these insects are having population level impacts on the Florida clamshell orchid.

Over the next decade, plant conservationists plan to cultivate Florida's native epiphytic orchids from seed in vitro and reintroduce the greenhouse-grown seedlings into conservation lands (see Ongoing Conservation Actions below). Considering that greenhouses are known to harbor scales, mealybugs, and other serious orchid pests (e.g., mites), the movement of seedlings from greenhouse to field sites has the potential to exacerbate the spread of orchid pests into natural areas unless preventative measures are devised (Gutting et al. 2015, p. 404). Research is needed to assess insect impacts on the Florida clamshell orchid. At present, insect predation appears to be a minor factor in the viability of the Florida clamshell orchid.

Poaching
Multiple sources report poaching as a threat to the species (FNAI 2000, entire; FTBG 2018, entire). Clamshell orchid (*Prosthechea cochleata* var. *cochleata*), the closest relative of Florida clamshell orchid, is one of the most popular species among hobbyist growers (Brown 2002, p. 224).

In the late 1800s, as the Florida East Coast Railroad extended southward, orchids were among the first natural resources to be exploited. Millions of flowering orchids were ripped from the trees and packed into railroad cars, destined to be sold as disposable potted plants in northern flower shops. Orchid populations dwindled rapidly to catastrophically low levels. Urban development and agriculture further eliminated nearly all remaining orchid habitat (FTBG 2018, entire).

At ENP, poaching was extremely common and contributed to the extirpation of at least three orchid species that formerly occurred there. From 1900 to at least the 1960s, epiphytic orchids were impacted by heavy collecting pressure, including from commercial collectors prior the establishment of the park and later from poachers.

Some poaching pressure surely still exists despite the best efforts of the NPS, but NPS does not believe it occurs at significant levels. At least three known instances of poaching have occurred in ENP between 2007 and 2012. While Florida clamshell orchid was not one of the species involved in any of these instances, this does indicate that the problem still poses a threat to orchid species in general. Overall, ENP does not consider poaching to pose a significant threat to the population of Florida clamshell orchid at ENP (Sadle pers. comm. 2012). At BCNP, orchid poaching occurs primarily along roads and trails that are in close proximity to suitable habitat. Overall, BCNP does not consider poaching a significant threat to the Florida clamshell orchid population (Pernas pers. comm. 2018). At present, poaching appears to be a minor factor in the viability of the Florida clamshell orchid.

CLIMATE CHANGE-ASSOCIATED FACTORS

Scenarios, Models, and Uncertainty

This climate change information is critical when conducting required Service analyses, conservation planning, and decision-making. Released by the White House on May 6, 2014, the National Climate Assessment (NCA 2014, entire) was prepared by a Federal Advisory Committee based on requirements of the Global Change Research Act of 1990. Our analyses under the Act include consideration of observed or likely environmental effects related to ongoing and projected changes in climate. Information for the United States at national and regional levels is summarized in the NCA. Because observed and projected changes in climate at regional and local levels vary from global average conditions, rather than using global scale projections, we use "downscaled" projections. When they are available and have been developed through appropriate scientific procedures, such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species and the conditions influencing it. In our analysis, we use expert judgment to weigh the best scientific and commercial data available in our consideration of relevant aspects of climate change and related effects.

Increased Temperature

Projected increases in average annual temperature by 2100 vary from +3 to +7° F. State-wide temperature increases will change levels of humidity and rates of evapotranspiration leading to changes in vegetation growth seasons and location. Increased temperatures may also lead to increased wildfires. However, except for SLR, the effect of these changes on the Florida clamshell orchid are difficult to quantify and will be likely a minor factor in the viability of the Florida clamshell orchid.

Sea Level Rise

The rate of global SLR has been measured at approximately 0.3 cm (0.12 in)/year since 1993 (NOAA 2017, p. 1), and southeast Florida has shown a similar rate. However, the projected rate of global and regional SLR is not expected to continue on this same rate or trend but will accelerate (NOAA 2017, p. 11-13) have projected possible trajectories of SLR in the south Florida landscape under different scenarios and timeframes.

SLR varies locally depending primarily on land subsidence or uplift in response to historic glacial activity across the continent. Storm surges and tides combine with SLR to increase flooding, erosion, and salt deposition in many areas. SLR impacts coastal erosion, changes in sediment transport and tidal flows, more frequent flooding from higher storm surges, landward migration of barrier shorelines, fragmentation of islands, and saltwater intrusion into aquifers and estuaries.

SLR is expected to continue for many centuries at rates equal to or higher than those of this century due to past, current, and future emissions of GHGs (greenhouse gasses) related to human activities. GHGs result in warmer air which contributes to additional expansion of warmer ocean water and additional melt of ice sheets and glaciers. Vertical land movement is also incorporated in the recent NOAA update for relative sea level

(RSL) changes (NOAA 2017, pp. 11-13).

Storm Surge

It is important to consider storm/tidal surge (pulse events) in combination with SLR, as storm/tidal surge impacts can be more substantial than SLR alone. The latest tidal information from NOAA Florida gauges indicates that the 5-year recurrence interval (20 percent chance of occurring in any given year) for the medium-high high-tide is 20 inches (1.6 ft.) higher than historically. This equates to the National Weather Service's definition of moderate flooding at NOAA tidal gauges and currently leads to an issuance of a coastal flood warning of a serious risk to life and property. This 5-year frequency increases 25-fold and becomes the annual frequency by the year 2035 (NOAA 2017, p.37-40). Salts from ocean water deposited during storm surge remain in place for long periods (months), causing damage and mortality of salt-intolerant species, including host trees for Florida clamshell orchid.

Saltwater Intrusion

Past studies have focused primarily on ground surface inundation of ocean water to determine effects to vegetation. However, saline groundwater will cause root zone inundation of flora significantly before ground surface inundation (2040-2080 vs. 2060-2100) and will exacerbate and accelerate SLR effects. Saltwater intrusion is influenced by rainfall and regional hydrology that affect the size of the freshwater lens. If the freshwater lens shrinks, as it does in droughts, saline groundwater can come into contact with roots of upland, salt-intolerant plants. These events along with storm surges will accelerate change in plant communities that support the Florida clamshell orchid in ENP (Saha 2011, p. 100-105).

Sea Level Rise Scenarios

The SLR projected by NOAA in 2017 ranges by scenario, from 1.0 to 8.4 ft global SLR by 2100. The basis of the scenarios are future trends in global GHG emissions, where lack of reduction results in the highest SLR. The revised scenarios by NOAA utilized improved climate information regarding shifts in oceanic circulation, changes in the flexing of the Earth's mantle and crust, vertical land movement due to glacial melting, and groundwater and fossil fuel withdrawals. Latest findings indicate that Florida is subsiding at a rate of -0.04 in/year. Historical and projected SLR is compiled in Table 4-1 below (NOAA 2017, p. 8-13).

Table 4-1: Historical and projected sea level rise (SLR) through 2100 (NOAA 2017, p. 8-13).

SLR since 1880	Global	+8 to 9 inches
SLR by 2100	Global	+12 to +98 inches (+1 to 8.2 feet)
SLR by 2100	Florida	+12 to 101 inches (+1 to 8.4 feet)

According to statistical analyses from the NOAA (2017, p. 22) report, the probability of exceeding the 'Low' scenario (1 ft. SLR by 2100) is 100 percent. The probability of exceeding the 'Intermediate-Low' (1.6 ft SLR by 2100) is 96 percent. Thus, these two scenarios have been eliminated from the current range of SLR scenarios. Although significant discussion is aimed at global emissions reduction, emissions continue to escalate and presently there is no clear socioeconomic driver to depart from a carbon-based energy infrastructure. As long as this fact remains, the 'High' or 'Business as Usual' projection of 6.6 feet is currently the most probable future scenario. New evidence suggests the melting of the Antarctic ice sheet, if sustained, will significantly increase the probability of the 'Intermediate-High', 'High', and 'Extreme' scenarios. The ice sheets hold huge amounts of ice (21 ft. of sea level equivalent for Greenland and 90 ft for Antarctica). Even losing a small fraction (<2 percent) would raise sea level by 3 ft (NOAA, pp.10-16).

Ecological Implications for Sea Level Rise

Sea level rise will increasingly lead to inundation of coastal wetlands in the region, exacerbated bysaltwater intrusion through inland waterways and aquifers. Most sites supporting populations of Florida clamshell orchid occur at elevations less than 6.6 ft (2 m) above sea level, making the species' entire range highly susceptible to soil salinization from increased storm surges and SLR. Areas of the Miami Rock Ridge in Miami-Dade County (located to the east of ENP and BCNP) are higher elevation (maximum of 7 m [22 ft] above sea level) than those in ENP, BCNP, and FSPSP (FNAI 2010, p. 62).

SLR impacts to plant communities are expected to occur decades before actual surface flooding from ocean water. The change in the extent of habitats occupied by the Florida clamshell orchid will be brought about by a decline in freshwater recharge volume in conjunction with an increase in salinity, which will push the hardwood species to the edge of their drought (freshwater shortage and physiological) tolerance. Along with the hammocks and buttonwood forests, scores of critically imperiled and or endemic species will be jeopardized, and possibly be extirpated from the United States.

Plant communities along South Florida's low-lying coasts are organized along a mild gradient in elevation, transitioning from mangroves at sea level to salinity-intolerant interior habitats, including hardwood hammocks within an elevation change of 6 ft (2 m) above sea level. As a result, a rise of 3 ft (1 m) in sea level is expected to render coastal systems susceptible to increased erosion and cause these areas to transition from upland forest habitats to saline wetland habitats. Prior to the onset of sustained inundation, there will be irreversible changes in vegetation composition within these habitats. Shifts in habitat toward hydric and saline ecosystems will occur decades in advance of full inundation, rendering the habitat unsuitable for salt intolerant species including Florida clamshell orchid and its host trees (Saha *et al.*2011, p. 82). As interior habitats become more saline there will be a reduction in freshwater inflows to the estuarine portions of the Everglades and BCNP, accelerating losses in salinity-intolerant coastal plant communities (Saha *et al.* 2011, p. 105). SLR impacts are expected to occur before actual surface flooding from ocean water. In the decades prior to the fully anticipated SLR, reduction of the water table, along with increased soil salinity from partial inundation and storm surge will result in vegetation shifts within BCNP, ENP, and conservation lands on the southern Miami Rock Ridge. Inundation will result in rockland hammocks losing upland tree species in favor of wetland plants. As a result, Florida clamshell orchid and its host trees will gradually decline as these habitats eventually disappear.

In our projections of future conditions for the Florida clamshell orchid, we analyze outcomes of SLR and saltwater intrusion for each population using modelling NOAA scenarios projecting 3.3 ft (Scenario A - GHG reductions by 2080), 4.9 ft (Scenario B - GHG reductions by 2060), and 6.6 ft (Scenario C - no GHG reductions, 'business as usual')of SLR in south Florida. We incorporate the effects of SLR into all scenarios in Chapter 5.

STOCHASTIC EVENTS

Extreme events are expected to increase in strength and frequency with accelerated climate change. Hurricanes winds and freezes can cause direct mortality of orchids and their host trees. Wildfires can severely damage hammocks causing direct mortality of orchids and host trees, and degrading habitat (Gann 2015, p 101). Storm surges can cause extreme erosion and soil salinization, accelerating plant community transitions toward salt marsh or mangroves. Little can be done to reduce the frequency or severity of these events. Increasing the size and number of populations may reduce the species vulnerability to extirpation by these natural events.

Hurricanes and Storm Surge

Florida is considered the most vulnerable state in the United States to hurricanes and tropical storms (Florida Climate Center, *http://coaps.fsu.edu/climate_center*). Based on data gathered from 1856 to 2008, Klotzbach

and Gray (2009, p. 28) calculated the climatological probabilities for each State being impacted by a hurricane or major hurricane in all years over the 152-year timespan. Of the coastal States analyzed, Florida had the highest climatological probabilities, with a 51 percent probability of a hurricane (Category 1 or 2) and a 21 percent probability of a major hurricane (Category 3 or higher) in any given year. From 1856 to 2015, Florida experienced 109 hurricanes and 36 major hurricanes. Given the few isolated populations and restricted range of Florida clamshell orchid in locations prone to storm influences, all 15 known populations are at substantial risk from hurricanes and storm surges.

There has been a substantial increase in most measures of Atlantic hurricane activity since the early 1980s, the period during which high-quality satellite data are available. These include measures of intensity, frequency, and duration as well as the number of strongest (Category 4 and 5) storms. The recent increases in activity are linked, in part, to higher sea surface temperatures in the region that Atlantic hurricanes form in and move through. Numerous factors have been shown to influence these local sea surface temperatures, including natural variability of the Atlantic Multi-decadal Oscillation (AMO), human-induced emissions of heat-trapping gases, and particulate pollution.

Tropical storms and hurricanes are projected to be fewer in number but stronger in force, with more Category 4 and 5 hurricanes. These increases are linked, in part, to higher sea surface temperatures in the region where Atlantic hurricanes form and move through. Heavier rainfall rates and higher wind speeds are expected with a 20 percent increase in both near the center of the storms, which will increase storm surge heights, and the extent and duration of inundation during these events.

Hurricanes cause mortality by defoliation, mechanical injury, or uprooting of host trees and individuals, leading to irreversible desiccation. All individuals in affected areas would be subject to impacts, with smaller plants and seedlings being most vulnerable. Storm surge physically washes away plants and substrate and leads to salinization of soils. These pulses of salinization will exacerbate salt water intrusion to accelerate habitat modification and loss.

Drought

Dry consecutive days are expected to increase 10 to 20 percent for most of Florida with up to 30 percent for South Florida over the next century. Drought events lower water levels in sloughs and swamps and can create moisture stress in orchids, causing injury or mortality. Drought can also increase saltwater intrusion. We lack the data to model drought effects on the species and its habitat, but know that it is a factor in the overall viability of the Florida clamshell orchid and its habitat.

Wildfires

Wildfire can devastate rockland hammocks under dry hot conditions, consuming all plant life in their path. In some areas, prolonged periods of record high temperatures associated with droughts contribute to dry conditions that are driving wildfires. Wildfires can cause drastic changes in species composition, changes in tree density, increased flooding and erosion risks. The effects of climate change weaken the natural protections ecosystems have against these extreme events, making them more vulnerable. We consider wildfires to be a minor factor in the overall viability of the Florida clamshell orchid.

Freeze Events

Occasional freezing temperatures that occur in south Florida pose a risk to individual plants, either through damage or mortality Under normal circumstances, occasional freezing temperatures would not result in a significant impact to populations of these plants; however, the small size of some populations means the loss from freezing events of even a few individuals can reduce the viability of the population by causing a significant demographic shift. However, freezes are becoming less frequent in south Florida and this trend is

expected to continue. We consider freezes to be a minor factor in the overall viability of the Florida clamshell orchid.

Ecological Implications for Stochastic Events

Hurricanes, storm surge, drought, wildfire, and freezing are natural events that can have adverse impacts on Florida clamshell orchid and may change in frequency or duration with a changing climate (Golladay et al. 2004, p. 504; McLaughlin et al. 2002, p. 6074; Cook et al. 2004, p. 1015). Our analysis focuses on SLR, saltwater intrusion, and storm surge, the three most critical threats to the Florida clamshell orchid. Hurricanes can modify habitat and cause direct mortality (e.g., mechanical damage from wind) and have the potential to destroy entire populations. Storm surges also have the potential to destroy entire populations, physically washing them away or leaving soil too saline for their host trees to persist. The species experienced these disturbances historically but had the benefit of more abundant and contiguous habitat to buffer populations from extirpation. With much of the historical habitat having been destroyed or modified, smaller populations are particularly vulnerable to local extirpations due to these events.

ONGOING CONSERVATION ACTIONS

Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES)

The entire orchid family, including all orchids native to the United States and its territories, is listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Most of the family is listed in Appendix II, including the Florida clamshell orchid, so that exports require a CITES permit. Orchids can be grown in nurseries using methods that are not harmful to wild populations, helping to satisfy the international demand for these beautiful plants and reducing collection pressure on wild populations.

State Listing

Florida clamshell orchid is listed in the State of Florida on the Regulated Plant Index (Index) as endangered under chapter 5B-40, Florida Administrative Code. Florida Statutes 581.185 sections (3)(a) and (3)(b) prohibit any person from willfully destroying or harvesting any species listed as endangered or threatened on the Index, or growing such a plant on the private land of another, or on any public land, without first obtaining the written permission of the landowner and a permit from the Florida Department of Plant Industry. The statute further provides that any person willfully destroying or harvesting; transporting, carrying, or conveying on any public road or highway; or selling or offering for sale any plant listed in the Index as endangered must have a permit from the State at all times when engaged in any such activities. The statute provides little or no habitat protection beyond the State's development of a regional impact process, which discloses impacts from projects, but provides no regulatory protection for State-listed plants on private lands. Florida Statutes 581.185 section (8) waives State regulation for certain classes of activities for all species on the Index, including the clearing or removal of regulated plants for agricultural, forestry, mining, construction (residential, commercial, or infrastructure), and fire-control activities by a private landowner or his or her agent. As such, this statute provides no substantive protection of habitat or protection of potentially suitable habitat at this time.

Everglades National Park and Big Cypress National Preserve

Populations of Florida clamshell orchid within ENP and BCNP are protected by NPS regulations at 36 CFR 2.1, which prohibit visitors from harming or removing plants, listed or otherwise, from ENP. However, the regulations do not address actions taken by NPS that cause habitat loss or modification. The NPS General Management Plans (GMP) for ENP (NPS 2015, entire) and BCNP (BCNP 2008, entire) serve to protect, restore, and maintain natural and cultural resources at the ecosystem level. Although these GMPs are not regulatory, and their implementation is not mandatory, the Plans include conservation measures for Florida clamshell orchid.

Florida Panther National Wildlife Refuge

The National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd note) and the Fish and Wildlife Service Manual (601 FW 3, 602 FW 3) require maintaining biological integrity and diversity, require comprehensive conservation planning for each refuge, and set standards to ensure that all uses of refuges are compatible with their purposes and the Refuge System's wildlife conservation mission. The comprehensive conservation plans (CCP) address conservation of fish, wildlife, and plant resources and their related habitats, while providing opportunities for compatible wildlife-dependent recreation uses. An overriding consideration reflected in these plans is that fish and wildlife conservation has first priority in refuge management, and that public use be allowed and encouraged as long as it is compatible with, or does not detract from, the Refuge System mission and refuge purpose(s). The CCP for the FPNWR provides specifically for maintaining and expanding populations of native orchids, including Florida clamshell orchid. This species has been the subject of an intensive propagation and reintroduction program on the FPNWR, which has resulted in a number of plants being successfully reintroduced into sloughs and cypress domes throughout the refuge (Stewart and Zettler 2008, p.97).

State of Florida Sites

Jonathan Dickinson State Park, Picayune Strand State Forest, and FSPSP are public conservation areas owned and managed by the State of Florida and managed by Florida Department of Environmental Protection, Division of Recreation and Parks.

Miami-Dade County Sites

Big and Little George Hammocks, Castellow Hammock Park, Dupuis Reserve, Fern Forest Nature Center, Fuchs Hammock Preserve, Hattie Bauer Hammock, Meissner Hammock, Rookery Bay National Estuarine Research Reserve, Pond Apple Slough, Corkscrew Swamp Sanctuary, Six Mile Cypress Slough Preserve are managed by the Miami-Dade County Environmental and Ecological Lands (EEL) program.

Conservation efforts in Miami's EEL Preserves have been underway for many years. In Miami-Dade County, these conservation lands are monitored by FTBG and IRC, in coordination with the EEL Program, to assess habitat status. Impacts to habitat (e.g., canopy) via nonnative species and natural stochastic events are monitored and actively managed. These programs are long-term and ongoing in Miami-Dade County; however, programs are limited by the availability of annual funding.

Nonnative Plant Control

NPS, the Service, Miami-Dade County, and the State of Florida have ongoing nonnative plant management programs to reduce threats on public lands, as funding and resources allow. ENP implements periodic control efforts through their exotic plant management program to minimize the impacts of nonnative plants throughout the park (Sadle pers. comm. 2012). In Miami-Dade County, nonnative, invasive plant management is very aggressive, with a goal to treat all publicly owned properties at least once a year.

Propagation and Reintroduction

This species has been the subject of an intensive propagation and reintroduction program on the FPNWR. This program has resulted in numerous plants being successfully reintroduced into sloughs and cypress domes throughout the refuge (Stewart and Zettler 2008, p. 97).

Commercial Availability

Many of the orchid species native to Florida are now common in cultivation, including Florida clamshell orchid, and there are many commercial sources to supply hobby growers. This helps reduce the need to obtain specimens from the wild.

CHAPTER 5: SPECIES' FUTURE CONDITION

In the following analysis, we analyzed stressor variables including SLR, increased hurricanes and storm surge, and saltwater intrusion as described above into three scenarios (Table 5-1). To project stressors we used the following approaches: 1) we used projections from the NOAA Special Report on Sea Level Rise (NOAA 2017, pp. 20-23), adopting three scenarios (Table 5-2) projecting SLR increase in 10 year increments out to 2100, and 2) we used projected trends for Atlantic hurricanes through 2100 for the Florida peninsula to include projected storm surge increases in each scenario. Available data do not include a range of projections for storm surge and saltwater intrusion. As such, these are not variables in the analysis. However, the mean sea level at the time of these events will exacerbate storm surge and saltwater intrusion effects.

Table 5-1. Scenarios used to analyze the future viability of the Florida clamshell orchid.

Scenario	Increased Rate of Sea Level Rise (NOAA 2017)	Increased Hurricanes / Storm Surge	Saltwater Intrusion
A	+3.3 ft (+1 m) at 2100 'Intermediate' projection GHG reductions by 2060	Increased intensity and duration (precipitation and wind speeds +20 percent)	Increased frequency and duration of saltwater intrusion events
B	+4.9 ft (+1.5 m) at 2100 'Intermediate-High' projection GHG reductions by 2080	Increased intensity and duration (precipitation and wind speeds +20 percent)	Increased frequency and duration of saltwater intrusion events
C	+6.6 ft (+2.0 m) at 2100 'High' projection Business as Usual - No GHG reductions	Increased intensity and duration (precipitation and wind speeds +20 percent)	Increased frequency and duration of saltwater intrusion events

Table 5-2. Summary of projected SLR in feet (ft) and meters (m) by decade to 2100.

Scenario at 2100	*2020*	*2030*	*2040*	*2050*	*2060*	*2070*	*2080*	*2090*	*2100*
(A) GHG reductions at 2060									
+ 3.3 ft (+ 1.0 m)	0.33 (0.10)	0.52 (0.16)	0.82 (0.25)	1.12 (0.34)	1.48 (0.45)	1.87 (0.57)	2.33 (0.71)	2.79 (0.85)	3.28 (1.00)
(B) GHG reductions at 2080									
+ 4.9 ft (+ 1.5 m)	0.33 (0.10)	0.62 (0.19)	0.98 (0.30)	1.44 (0.44)	1.97 (0.60)	2.59 (0.79)	3.28 (1.00)	3.94 (1.20)	4.92 (1.50)
(C) Business as usual – no GHG reductions									
+ 6.6 ft (+ 2.0 m)	0.36 (0.11)	0.69 (0.21)	1.18 (0.36)	1.77 (0.54)	2.53 (0.77)	3.28 (1.00)	4.26 (1.30)	5.58 (1.70)	6.56 (2.00)

Because abundance data is lacking for most populations, we use the area (in acres) of the conservation areas where each population is located as a surrogate for population size and for considerations of population

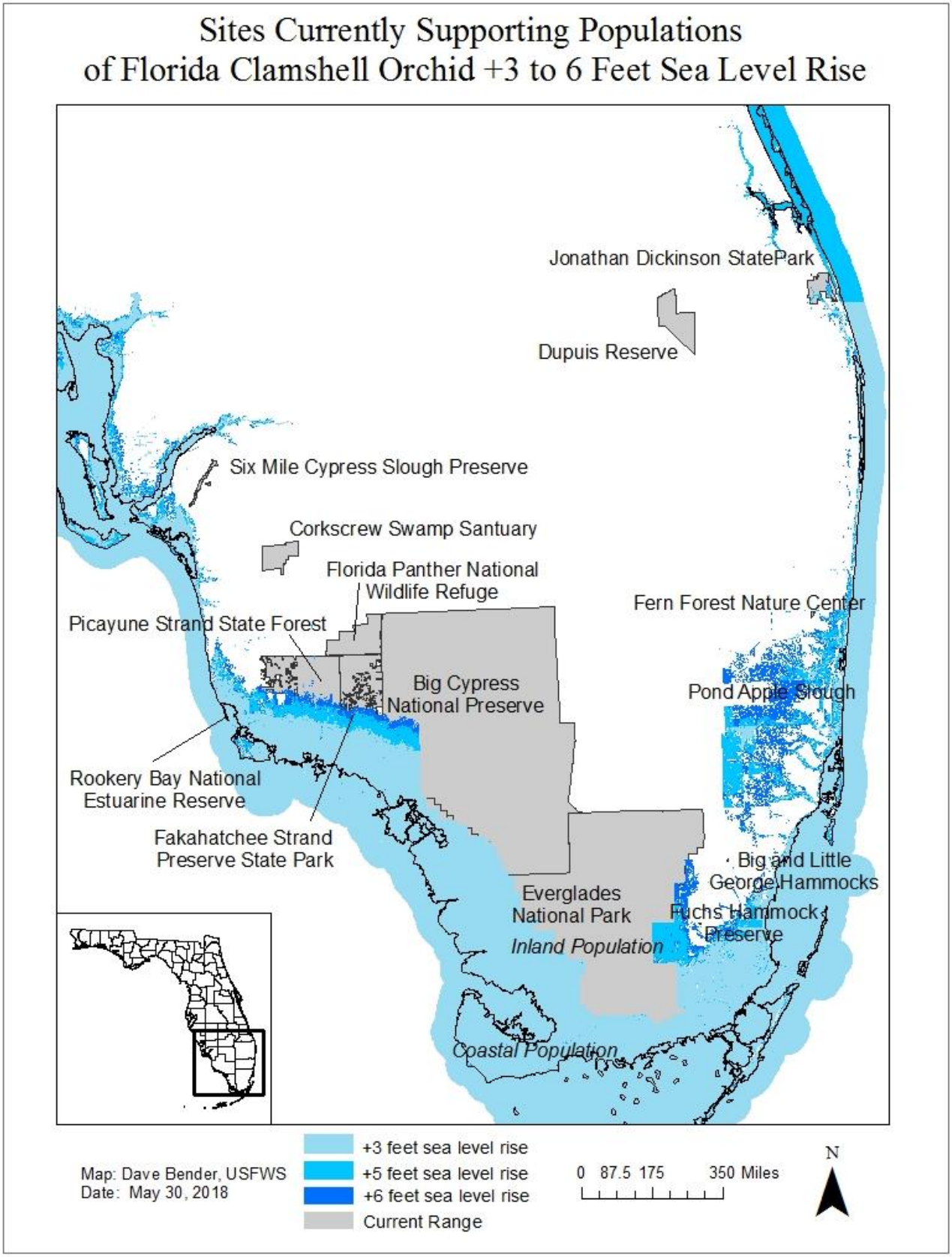
resiliency in our analysis. The NOAA (2017, p.23) SLR projections we use in the analysis are summarized for 2020 through 2100 in Table 5-2. For each scenario below, we present the summary of change in resilient populations through time to 2100, expressed as percent of habitat lost and modified by SLR (Table 5-3). SLR curves for each population under all three scenarios are found in Appendix 1.

Table 5-3. Summary of acreage and percentages of habitat loss at sites that support Florida clamshell orchid from SLR by depth (irrespective of time), and by percentage of site using Scenarios A, B, and C at 2100.

Conservation Site	Elevation Range		SLR depth (ft)(m) by percent habitat loss				Habitat loss by SLR scenario (percent habitat loss) at 2100		
	min	max	25%	50%	75%	90%	3.3 ft (1 m) (A)	4.9 ft (1.5 m) (B)	6.6 ft (2 m) (C)
Pond Apple Slough Preserve	-0.46 (-0.14)	9.61 (2.93)	0.43 (0.13)	0.79 (0.24)	1.38 (0.42)	2.36 (0.72)	94	97	99
Everglades National Park - Coastal	-11.38 (-3.47)	13.7 (4.19)	0.49 (0.15)	0.95 (0.29)	1.51 (0.46)	2.07 (0.63)	95	96	99
Fakahatchee Strand Preserve State Park	-2.82 (-0.86)	17.75 (5.41)	2.59 (0.79)	6.46 (1.97)	9.35 (2.85)	10.66 (3.25)	28	40	50
Big Cypress National Preserve	-4.0 (-1.22)	38.75 (11.81)	2.82 (0.86)	8.17 (2.49)	12.07 (3.68)	13.48 (4.11)	27	34	42
Picayune Strand State Forest	-1.97 (-0.6)	38.02 (11.59)	5.97 (1.82)	7.68 (2.34)	9.5 (2.79)	10.14 (3.09)	7	17	32
Big and Little George Hammocks Preserve	4.4 (1.34)	8.92 (2.72)	6.79 (2.07)	7.15 (2.18)	7.68 (2.34)	7.97 (2.43)	0	1	15
Fern Forest Nature Center Preserve	5.18 (1.58)	19.26 (5.87)	8.36 (2.62)	9.58 (2.92)	10.53 (3.21)	11.61 (3.54)	0	0	3
Fuchs and Meissner Hammock Preserve	-0.07 (-0.02)	14.83 (4.52)	9.15 (2.79)	10.56 (3.22)	11.88 (3.62)	13.09 (3.99)	1.9	2.3	2.5
Florida Panther National Wildlife Refuge	5.31 (1.62)	21.10 (6.43)	11.91 (6.63)	12.53 (3.82)	13.61 (4.01)	13.78 (4.2)	0	0	0
Corkscrew Swamp Preserve	8.04 (2.45)	27.59 (8.41)	no effect by 2100				0	0	0

Rookery Bay National Estuarine Reserve	incomplete LIDAR data
Everglades National Park - Inland	
Dupuis Reserve	
Six Mile Cypress Slough Preserve	
Jonathan Dickinson State Park	

Figure 5-1. Sites currently supporting Florida clamshell orchid, showing SLR projections for Scenarios A (GHG reductions by 2060), B (GHG reductions by 2080), and C (no GHG reductions / business as usual).



SCENARIO RESULTS

All Scenarios

Representation
There is only one representative unit. Representation remains unchanged in all three scenarios.

Resiliency
Hurricanes and storm surges will be a greater source of mortality and habitat modification, reducing population resiliency (see Figure 5-1). SLR will increase the inland penetration and residence time of sea water during storm surge events, accelerating habitat modification. Salt water intrusion and inundation will continue and accelerate rapidly in swamp and slough habitats. Loss of habitat, host tress, and individuals will occur as swamp and slough habitats begin to retreat inland due to increasing salinity. Impacts will occur first along Florida Bay in ENP and BCNP. BCNP, PSSF, FSSP, and PNWR watersheds will likely face increased saltwater intrusion, causing loss of habitat, host trees, and individuals as freshwater swamps and sloughs retreat inland, resulting in reductions in the populations of Florida clamshell orchid at those sites. Populations near the coast and at the lowest elevations will be impacted first, causing the extirpation of the populations at Rookery Bay and the coastal population at ENP. Upland populations in the rockland hammocks of ENP and the greater Miami-Dade area will begin to see substantial changes in habitat, such as loss of canopy trees in low lying areas. Some of these will be host trees and their loss will increase individual mortality, causing a reduction in the resiliency of populations.

Scenario A (GHG reductions by 2060)

Redundancy
Scenario A results in 3 extirpated populations (ENP Coastal, Rookery Bay NERR, and Pond Apple Slough Preserve) and 12 extant populations, resulting in a 20 percent loss in redundancy.

Resiliency
Fakahatchee Strand Preserve State Park will lose 28 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. Big Cypress Preserve National Park will lose 27 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. The remaining 10 populations will not experience severe effects (>15 percent habitat loss) by 2100 under Scenario A.

Scenario B (GHG reductions by 2080)

Redundancy
Scenario B results in 3 extirpated populations (ENP Coastal, Rookery Bay NERR, and Pond Apple Slough Preserve) and 12 extant populations, resulting in a 20 percent loss in redundancy.

Resiliency
Fakahatchee Strand Preserve State Park will lose 40 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. Big Cypress Preserve National Park will lose 34 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. Picayune Strand State Forest will lose 17 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. The remaining 9 populations will not experience severe effects (>15 percent habitat loss) by 2100 under Scenario A.

Scenario C (No GHG reductions by 2100 / business as usual)

Redundancy
Scenario C results in 3 extirpated populations (ENP Coastal, Rookery Bay NERR, and Pond Apple Slough Preserve) and 12 extant populations, resulting in a 20 percent loss in redundancy.

Resiliency
Fakahatchee Strand Preserve State Park will lose 50 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. Big Cypress Preserve National Park will lose 42 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. Picayune Strand State Forest will lose 32 percent of its area to SLR, resulting in a concomitant loss of host trees and reduction of the overall resiliency of this population. The remaining 9 populations will not experience severe effects (>15 percent habitat loss) by 2100 under Scenario A.

Table 5-4. Summary of extant populations at 2100 under Scenario A, B, and C (A = GHG reductions by 2060, B = GHG reductions by 2080, C = No GHG reductions by 2100 ('business as usual').

Species	Total Number of Populations - Florida					Non-U.S
	Historical	Current	A (3.3 ft)	B (4.9 ft)	C (6.6 ft)	
Florida clamshell orchid	18	15	12	12	12	0

SUMMARY AND CONCLUSIONS

The effects of SLR outstrip all other stressors in all scenarios and has the greatest influence on population resiliency and redundancy. Sea level rise will increase the inland penetration and residence time of sea water during storm surge events, accelerating habitat modification. Coastal sites will face increased saltwater intrusion, causing loss of habitat and orchid host trees, as freshwater swamps, buttonwood hammocks, and other habitats retreat inland or are lost due to increasing salinity. Hurricanes and storm surges will be a greater source of mortality and habitat modification, reducing population resiliency. Acting together, these three factors will very likely cause irreversible habitat decline that precedes inundation by 10 to 20 years.

In all of the scenarios, 3 populations are extirpated (ENP Coastal, Rookery Bay NERR, and Pond Apple Slough Preserve) by the effects of SLR while 9 populations will not experience severe effects (>15 percent habitat loss) from SLR until after 2100. The other 3 populations will lose 17 to 50 percent of their habitat to SLR by 2100 with a concomitant decline of the Florida clamshell orchid population at these sites. Representation is not affected by any of the three scenarios.

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Appendix 1: SLR curves and habitat loss for sites that support populations of Florida clamshell orchid.

Figure A1-1. Sea level rise curve for Everglades National Park.

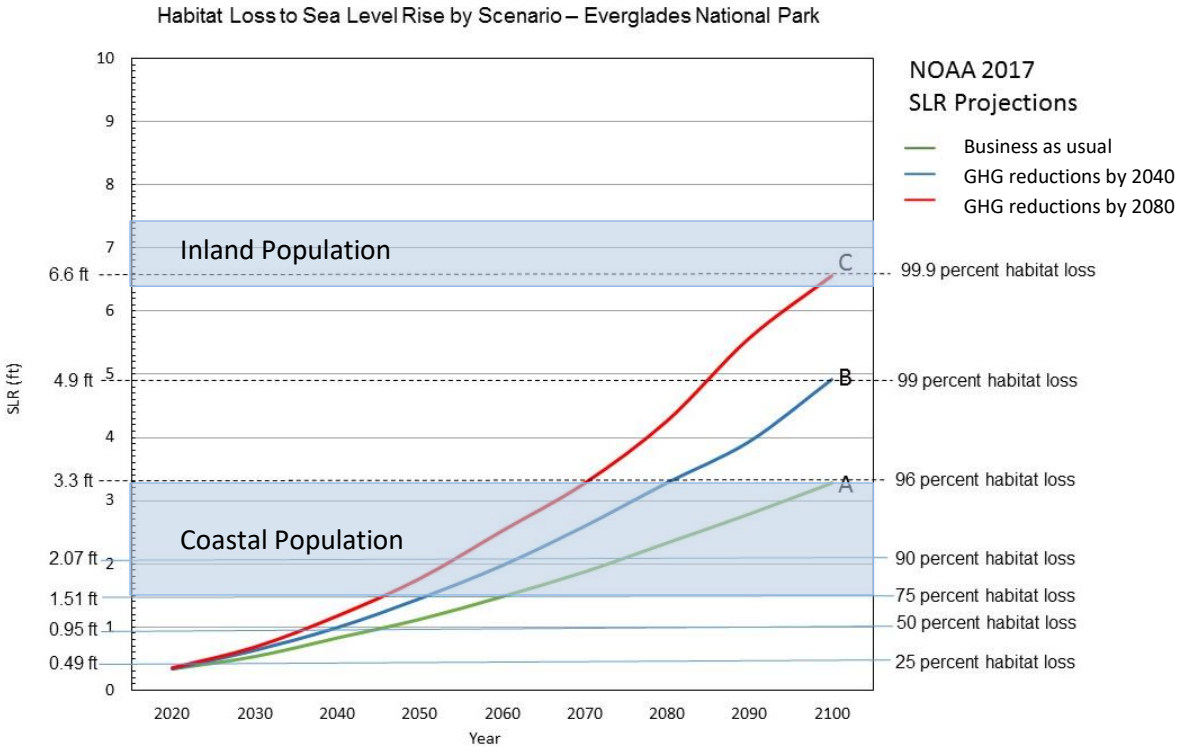


Figure A1-2. Sea level rise curve for Big Cypress National Preserve.

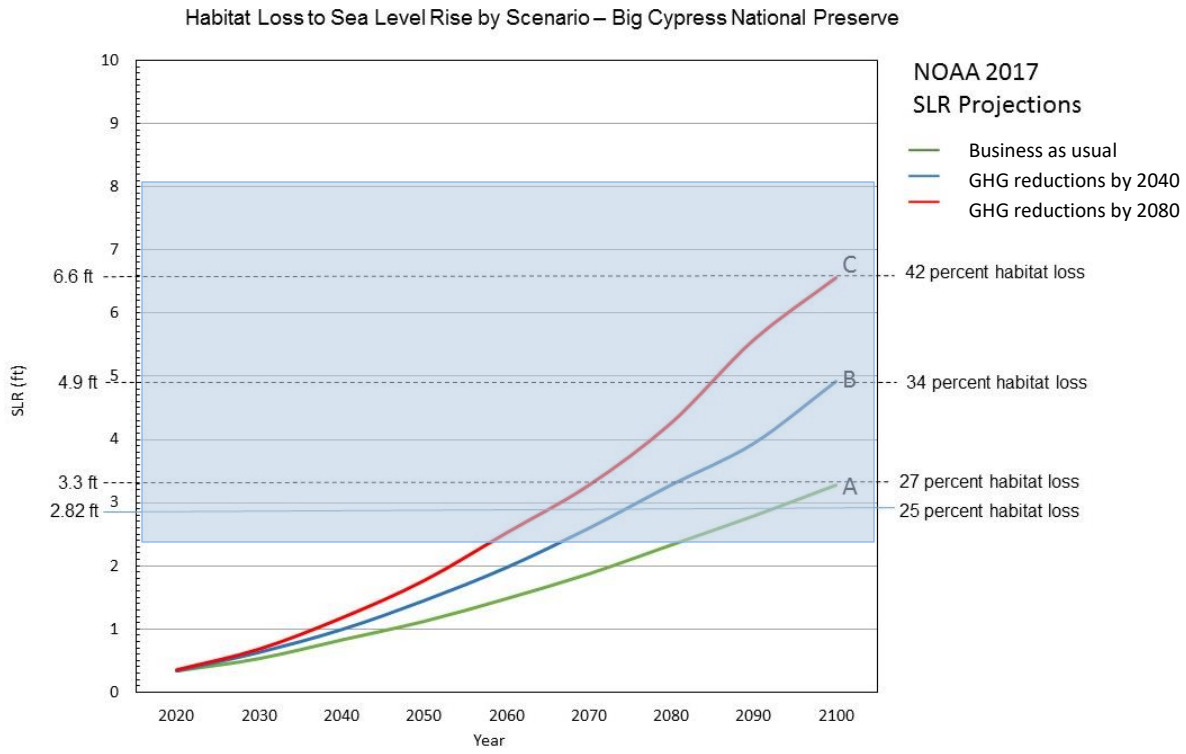


Figure A1-3. Sea level rise curve for Fakahatche Strand Preserve State Park.

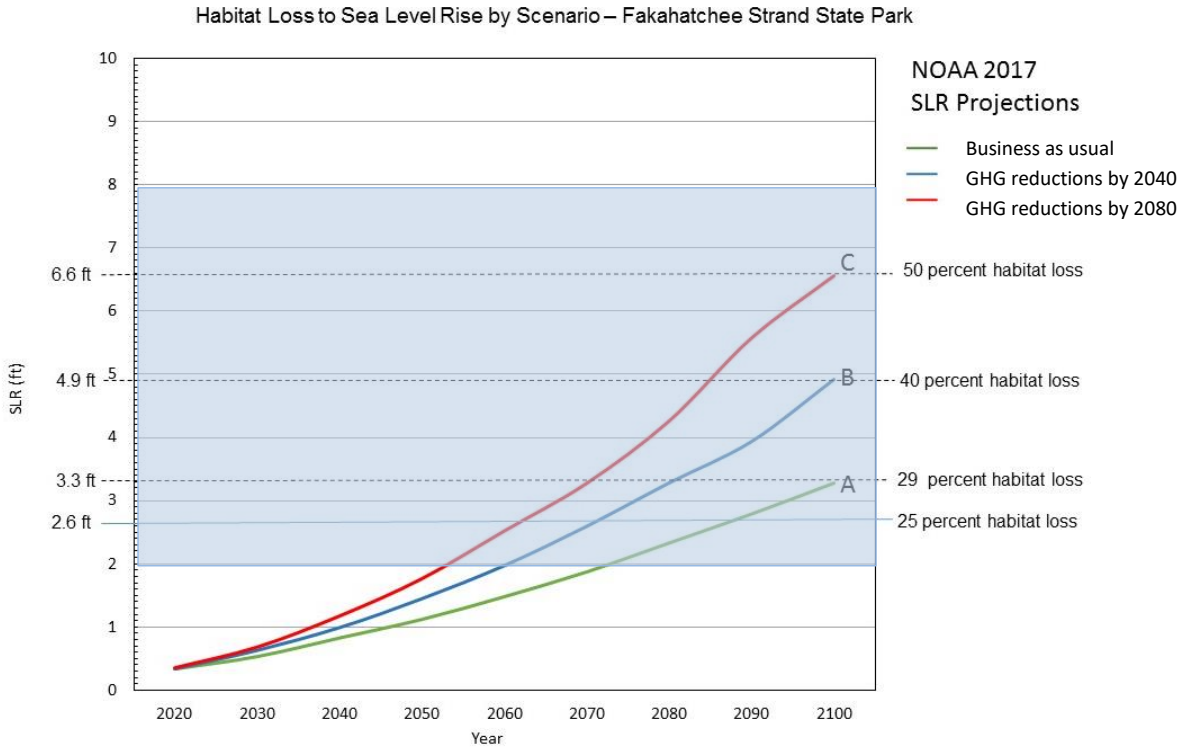


Figure A1-4. Sea level rise curve for Florida Panther National Wildlife Refuge.

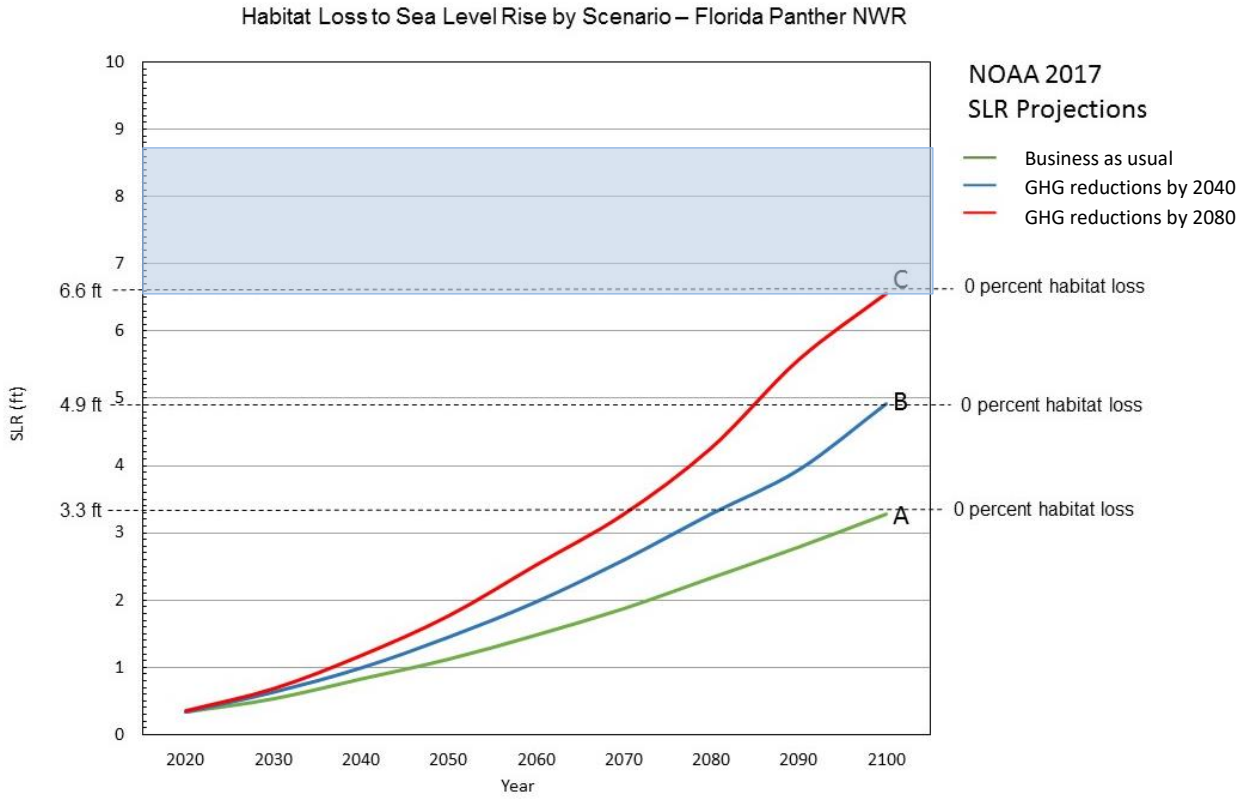


Figure A1-5. Sea level rise curve for Corkscrew Swamp Preserve.

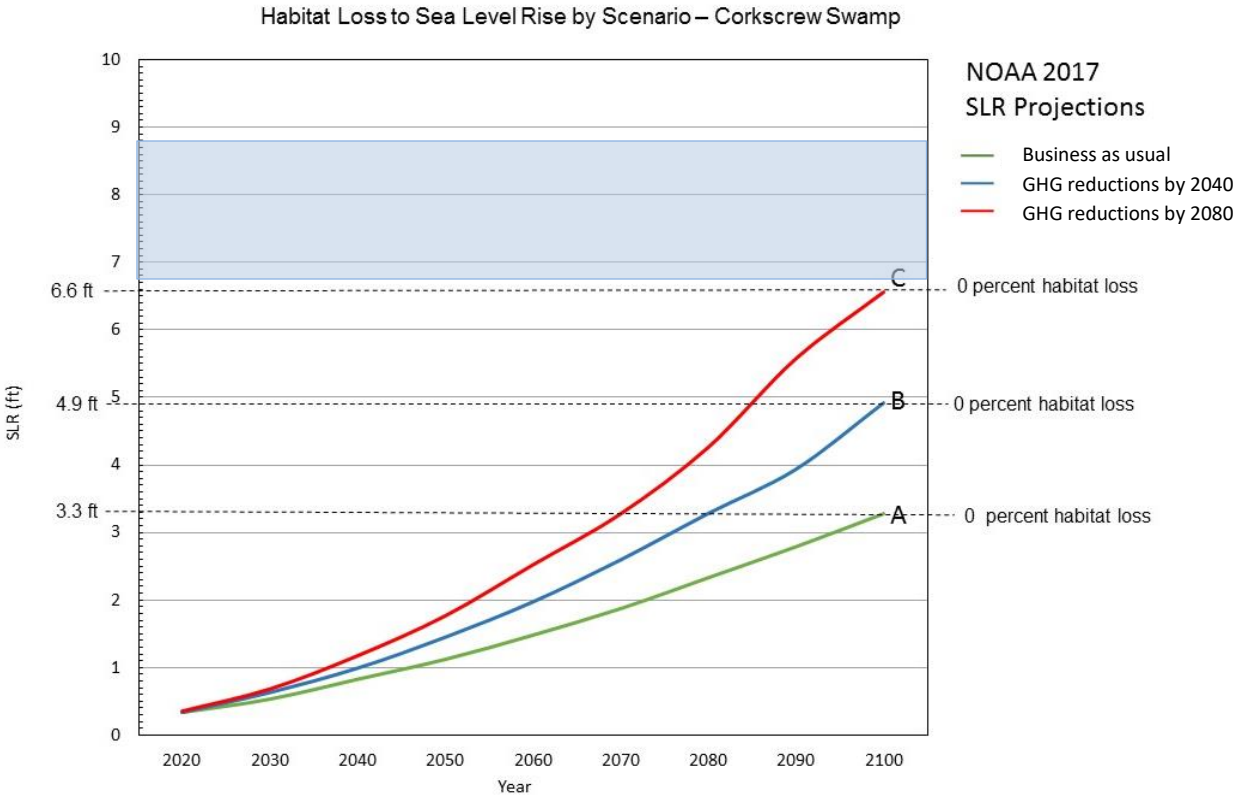


Figure A-6. Sea level rise curve for Fern Forest Nature Center.

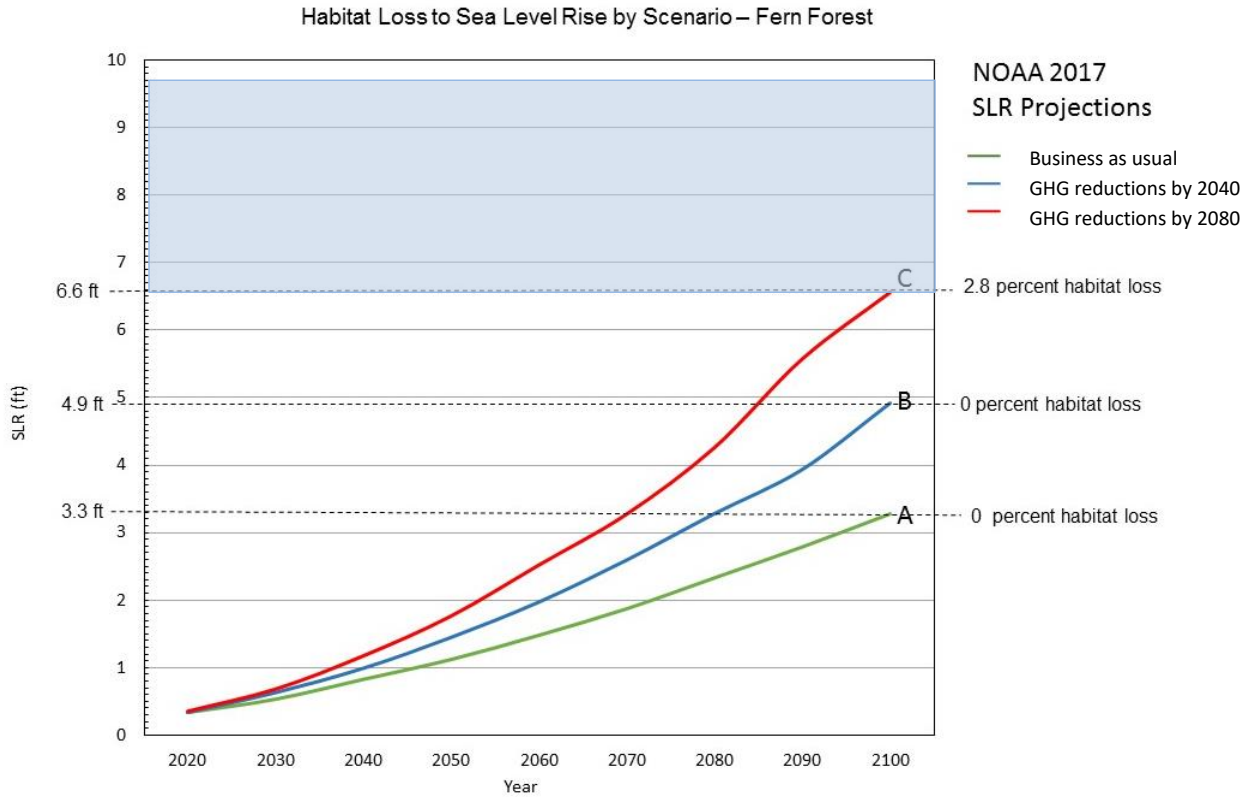


Figure A-7. Sea level rise curve for Pond Apple Slough Preserve.

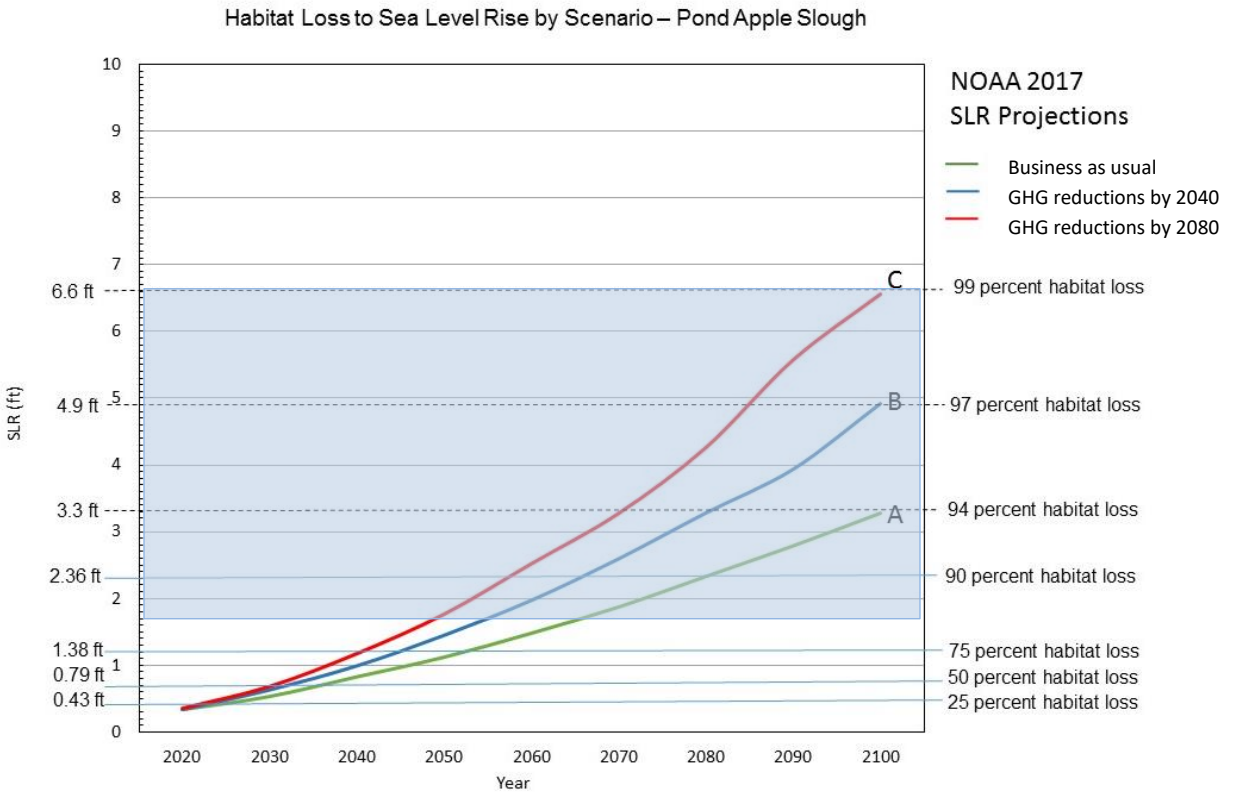


Figure A-8. Sea level rise curve for Picayune Strand State Forest.

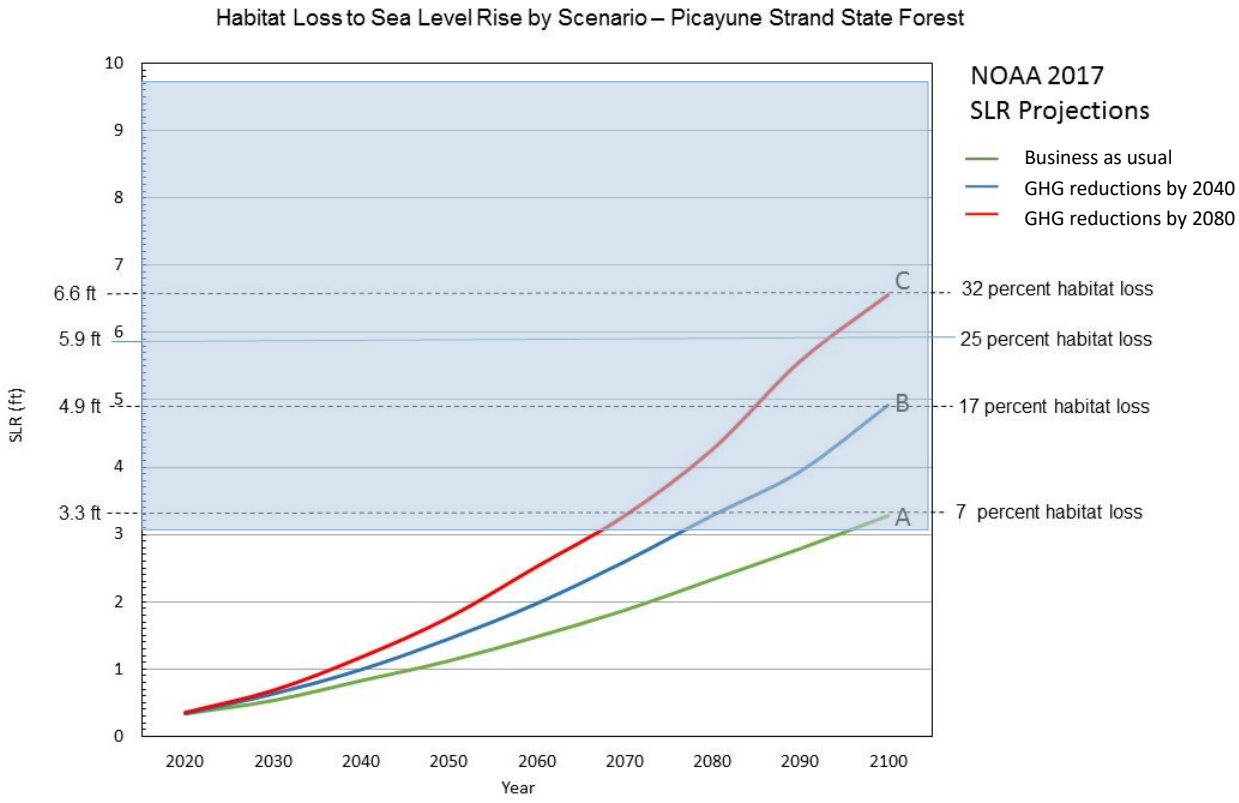
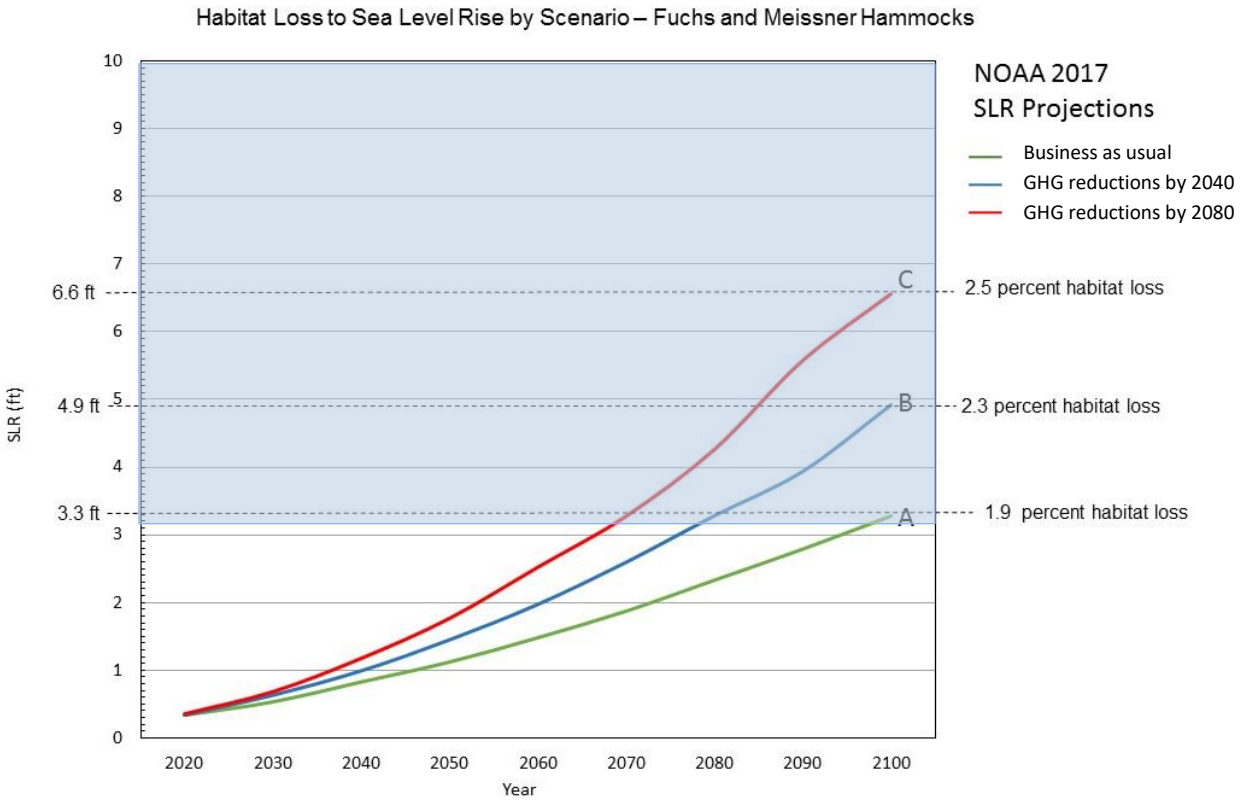


Figure A-9. Sea level rise curve for Fuchs and Meissner Hammock Preserves.



APPENDIX II: SUMMARY OF CHANGES FROM VERSION 1.0 TO VERSION 1.1

Changes from Version 1.0 to Version 1.1 are the following:

- We revised the current estimate for ENP from 4,000 to 2,000 plants. Data was entered incorrectly in Table 3-1, causing us to double-count the number of individuals in the Park.

- We provided more analysis on the effect of the stressors on the resiliency of populations in the Future Conditions section.

- In the Summary and Conclusions, we added text to emphasize the synergistic relationship between SLR, salt water intrusion, and storm surge events.