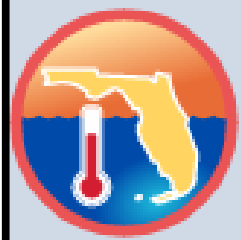




Beth Stys, Florida Fish and Wildlife Conservation Commission



Climate Adaptation Explorer

for Florida



Conservation
Biology Institute

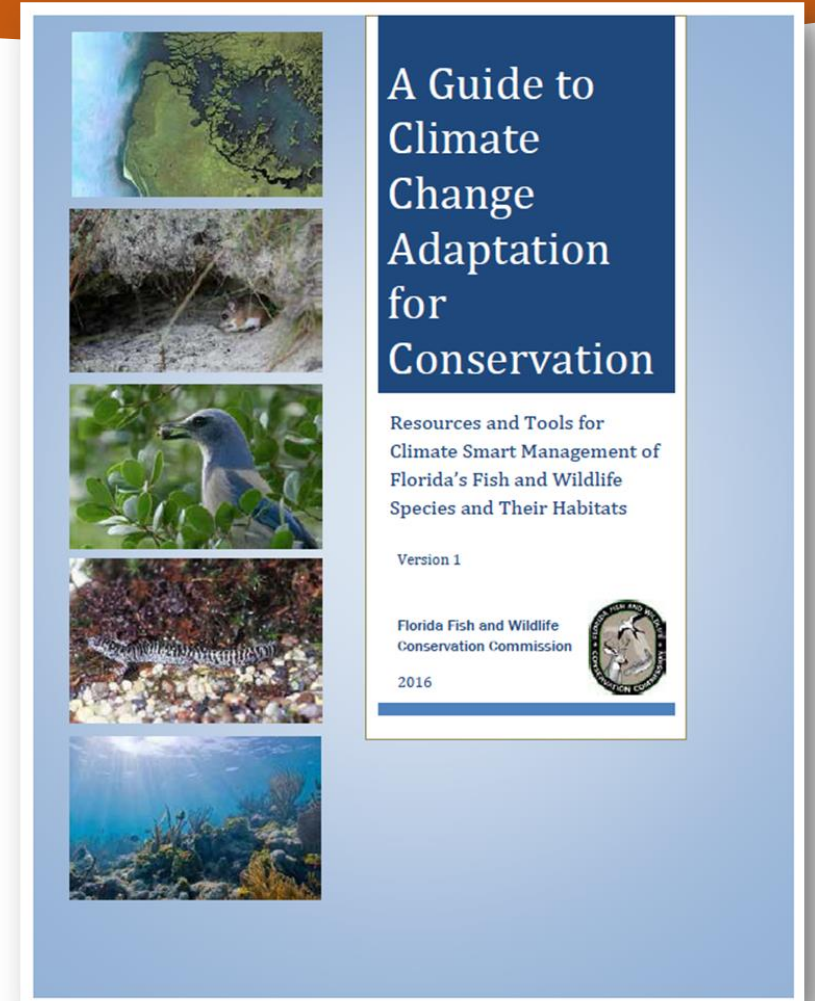


A Guide to Climate Change Adaptation for Conservation - Resources and Tools for Climate Smart Management of Florida's Fish and Wildlife Species and Their Habitats

- Developed By Florida Fish and Wildlife Conservation Commission
- Mainly a Digital document
- Close to 300 pages
- Version 1.0 - 2016
 - Version 2.0 updates ongoing

- Available on FWC webpage

- <https://myfwc.com/conservation/special-initiatives/climate-change/adapt/>



Climate Adaptation Explorer – for Florida

- Web-enabled content from the Adaptation Guide
 - Content plus species profile information
 - Links/cross links
 - Released April 2019
- Development supported by FWC and USFWS
 - Dedicated User Support - FWC
 - Need help: adapt@myfwc.com

<https://climateadaptationexplorer.org/>

<https://flcpa.databasin.org/>

Climate Adaptation Explorer



The Climate Adaptation Explorer provides you a wealth of information about climate impacts to Florida's species and habitats along with actionable adaptation strategies to help mitigate those impacts. Many species, habitats, and conservation assets are included in this tool.



Florida's unique wildlife are at risk from climate change.

Fish, wildlife and plants provide jobs, food, clean water, storm protection, health benefits and many other important ecosystems services that support people, communities and economies across the nation every day. The observed changes in the climate are already impacting these valuable resources and systems. These impacts are expected to increase with continued changes in the planet's climate system. Action is needed now to help safeguard these natural resources and the communities and economies that depend on them.

-- National fish, wildlife, and plants climate adaptation strategy (2012)

Purpose

- Provides a starting point from which to address the predicted impacts of climate change on Florida's fish, wildlife, and ecosystems.
- A resource for:
 - understanding potential impacts
 - development of adaptation strategies
 - Florida Fish and Wildlife Conservation Commission (FWC) and
 - other natural resource management agencies and groups
- Provides the tools for:
 - better integration of adaptation actions and tasks into broader policies and programs
 - natural resource managers and others understand and address the current and future impacts of climate change on Florida's ecosystems



Photo: Ray Hennessy

Florida's unique wildlife are at risk from climate change.

Fish, wildlife and plants provide jobs, food, clean water, storm protection, health benefits and many other important ecosystems services that support people, communities and economies across the nation every day. The observed changes in the climate are already impacting these valuable resources and systems. These impacts are expected to increase with continued changes in the planet's climate system. Action is needed now to help safeguard these natural resources and the communities and economies that depend on them.

-- National fish, wildlife, and plants climate adaptation strategy (2012)



Overview

- ▶  Climate 101
- ▶  Impacts of Climate Change in Florida
- ▶  Impacts on Florida's Species
- ▶  Impacts on Florida's Ecosystems and Habitats
- ▶  Interactions with Existing Stressors
- ▶  Vulnerability to Climate Change
- ▶  Other Tools
- ▶  Additional Resources

Impacts of a Changing Climate



Photo: NPS.

Changes in environmental conditions are one of the main drivers of changes in biodiversity. It will impact biodiversity at multiple scales, ranging from an individual to a population, community, and ecosystem.



Overview

[Climate 101](#)

 Sea Level Rise

 Changes in Temperature

 Changes in Precipitation

 Changes in Air and Water Chemistry


 Climate Models

 Impacts of Climate Change in Florida

 Impacts on Florida's Species

 Impacts on Florida's Ecosystems and Habitats

 Interactions with Existing Stressors

 Vulnerability to Climate Change

 Other Tools

 Additional Resources



Climate 101

In recent decades, changes in the global climate impacted natural and human systems on all continents and across the oceans. Evidence of impacts from climate change is strongest and most comprehensive for natural systems.



Photo: R. Cammauf, NPS.

The main changes expected for North America include:

- sea level rise
- rising temperatures
- regional increases or decreases in precipitation
- changes in the frequency and severity of extreme weather events

Increased knowledge of the risks of climate change can be a starting point for understanding the opportunities for possible solutions.



Overview

- ▶ Climate 101
- ▼ **Impacts of Climate Change in Florida**
 - ▼ **Sea Level Rise**
 - Sea Level Rise Map
 - Changes in Temperature
 - Changes in Precipitation
 - Changes in Extreme Events
 - Changes in Water Chemistry
 - Social and Economic Impacts
 - ▶ Impacts on Florida's Species
 - ▶ Impacts on Florida's Ecosystems and Habitats
 - ▶ Interactions with Existing Stressors
 - ▶ Vulnerability to Climate Change
 - ▶ Other Tools
 - ▶ Additional Resources



Sea Level Rise in Florida



Sea level rise (SLR) will not impact the coastal areas of Florida to the same degree. Multiple variables will influence the type of changes and impacts, including location, coastline complexity, elevation, habitat type, and the presence of barriers to inland migration.

Across Florida, sea levels are expected to rise by 0.25 - 0.34 meters by 2080. However, this amount varies for different areas within the state. For example, Key West is expected to experience 0.31 meters SLR by 2080, whereas St. Petersburg is

expected to have 0.35 meters, Pensacola is expected to have 0.34 meters, and Fernandina is expected to have 0.25 meters within that same timeframe.

Sea level rise is often modeled in defined increments such as feet or meters. This tool includes an analysis of impacts of SLR at 1 and 3 meters.

[Explore interactive sea level rise map.](#)



Barriers to inland migration include anthropogenic structures such as seawalls, dikes, and coastal development, as well as natural biophysical factors such as different soils or available groundwater. These barriers may make it difficult or impossible for species and habitats to migrate inland with increasing sea levels.



Overview

- ▶ Climate 101
- ▶ Impacts of Climate Change in Florida
- ▶ [Impacts on Florida's Species](#)
 - Altered Community Dynamics
 - Altered Habitat Suitability
 - Altered Survival
 - Altered Phenology & Physiology
 - Altered Disturbance Regimes
 - Loss of Keystone Species
- ▶ Impacts on Florida's Ecosystems and Habitats
- ▶ Interactions with Existing Stressors
- ▶ Vulnerability to Climate Change
- ▶ Other Tools
- ▶ Additional Resources

Climate Impacts on Florida's Species






Ibis & Spoonbill. Photo: S. Zenner (NPS)

Florida has more than 16,000 species of native fish, wildlife, and invertebrates, including 147 endemic vertebrate species and approximately 400 terrestrial and freshwater endemic invertebrates. There are currently 82 species designated as federally endangered or threatened in Florida. An additional 59 species are listed as endangered or threatened by the state, including 21 birds, 8 mammals, 13 reptiles, 4 amphibians, 9 fish, and 4 invertebrates.

[See species profiles for more about how climate change will impact each species.](#)

Overview

- ▶  Climate 101
- ▶  Impacts of Climate Change in Florida
- ▼  **Impacts on Florida's Species**
 -  Altered Community Dynamics
 -  Altered Habitat Suitability
 -  Altered Survival
 -  Altered Phenology & Physiology
 -  Altered Disturbance Regimes
 -  Loss of Keystone Species
- ▶  Impacts on Florida's Ecosystems and Habitats
- ▶  Interactions with Existing Stressors
- ▶  Vulnerability to Climate Change
-  Other Tools
-  Additional Resources

Impacts of Salinity Shifts:

- Changes in competition and predator/prey relationships due to de-coupling of mutualistic relationships as salt-intolerant plants and animals are reduced and/or replaced by salt tolerant species
- Changes in species composition as a result of salinity stress related shifts
- Shifts in species presence and abundance due to changes in plant community structure as vegetation responds to changes in groundwater and soil salinity

Impacts of Warming Temperatures:

- Shift in fish communities from sportfish to rough fish
- Changes in community composition
- Reduction of threatened species due to temperature increases exacerbating existing stressors
- Altered food web dynamics
- Altered composition of parasite community
- Range expansion of euryhaline marine species further into inland waters
- Range expansion of invasive exotic species
- Loss of keystone species

Impacts of Increased Cold Events:

- Shift in species distribution
- Decoupling of predator/prey relationships of fish
- Limit northern extent/expansion of exotic species range (potentially beneficial change)
- Reduced competitive ability

Overview

- ▶ [Climate 101](#)
- ▶ [Impacts of Climate Change in Florida](#)
- ▶ [Impacts on Florida's Species](#)
- ▶ [Impacts on Florida's Ecosystems and Habitats](#)
- ▶ [Coastal Ecosystems](#)
- ▶ [Freshwater Ecosystems](#)
- ▶ [Marine & Estuarine Ecosystems](#)
- ▶ [Terrestrial Ecosystems](#)
- ▶ [Interactions with Existing Stressors](#)
- ▶ [Vulnerability to Climate Change](#)
- ▶ [Other Tools](#)
- ▶ [Additional Resources](#)



Climate Impacts on Florida's Ecosystems and Habitats



Sweetwater Strand, Big Cypress National Preserve. Photo: NPS.

Florida's unique landscape is one of the most rapidly changing and climate-vulnerable within the United States. It is extremely vulnerable to sea level rise and impacts from severe storms due to low elevation, geographic location, and landscape configuration. Many habitats and species are highly sensitive to changes in temperature and precipitation.



Overview

- ▶ Climate 101
- ▶ Impacts of Climate Change in Florida
- ▶ Impacts on Florida's Species
- ▶ Impacts on Florida's Ecosystems and Habitats
- ▶ **Interactions with Existing Stressors**
 - Habitat Loss
 - Invasive Species**
 - Pathogens, Pests, Pollution
 - Competition & Overexploitation
- ▶ Vulnerability to Climate Change
- ▶ Other Tools
- ▶ Additional Resources



Invasive Species



Invasive green iguana. Photo: Carol Parrish, FWC.

Florida has a well-documented list of invasive plants and animals—a list that is expected to increase as temperatures warm, number of frost/freeze nights decrease, intensity and/or frequency of storm events increase, and Florida's human population increases and responds to climate change.

More than 170 species of ferns and flowering plants are naturalized in southeastern Florida and hundreds of exotic plants have been introduced into the region. Some of these species are not currently invasive or have not spread beyond South Florida; however, with climate change, these species may become invasive in the future or expand their current range into other regions of the state. Category I plants, defined as invasive exotics that are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives include species such as Melaleuca, Australian Pine, Water-hyacinth, and old world climbing



Overview

- ▶ Climate 101
- ▶ Impacts of Climate Change in Florida
- ▶ Impacts on Florida's Species
- ▶ Impacts on Florida's Ecosystems and Habitats
- ▶ Interactions with Existing Stressors
- ▶ **Vulnerability to Climate Change**
 - Scenario Planning
 - Climate Change Vulnerability Index
 - Standardized Index of
 - ▶ Vulnerability and Value Assessment
 - Gulf Coast Vulnerability Assessment
- ▶ Other Tools
- ▶ Additional Resources



Vulnerability to Climate Change



Mangrove Island, Gulf Coast. Photo: NPS.

Awareness that change is likely to happen is critical to planning for the future. However, there is a high degree of uncertainty as to the extent and speed of climate change, as well as the ability of species and habitats to adapt. Vulnerability assessments and scenario planning can both help reduce some of the uncertainties.

A critical step in analyzing the potential impacts of current and future climate change is the assessment of the vulnerabilities of species and natural communities. Determining the relative vulnerabilities of habitats and species can lead to the development of more effective management actions and adaptation strategies to enhance resiliency. Additionally, assessing the vulnerability of species or habitats to climate change provides insight into which aspects of climate change may affect a species or community the most. Uncertainty of various types is an important factor to consider when implementing the results of a vulnerability assessment. For example, a high vulnerability to a particular threat, such as altered precipitation patterns, should be modulated by the relatively high uncertainty in precipitation projections relative to the more predictable change in temperature and sea level rise.



Overview

- Amphibians
- Birds
- Fish
- Invertebrates
- Mammals
- Reptiles

Climate Impacts and Adaptation Strategies for Florida Species









Photo: NPS.

This tool includes species profile for 138 species.

Species were chosen based if they were federally or state listed, had a state management plan (State Species Action Plan, State Management Plan, State Imperiled Species Management Plan), had habitat models, or had a vulnerability score.

Overview

-  Amphibians
-  Birds
-  Fish
-  Invertebrates
-  Mammals
-  Reptiles

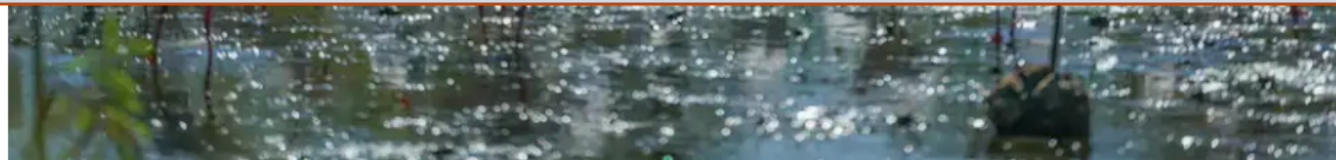


Photo: NPS.

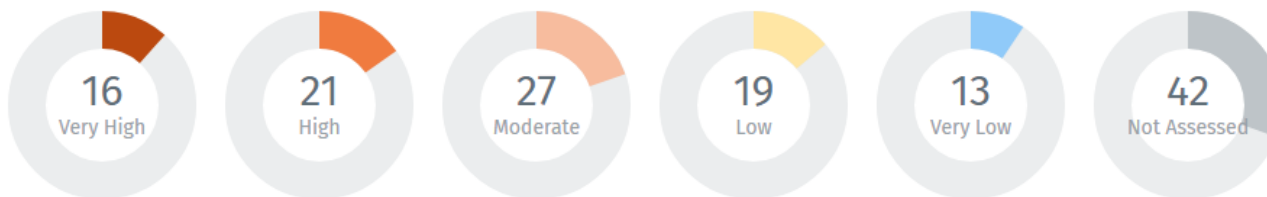
This tool includes species profile for 138 species.

Species were chosen based if they were federally or state listed, had a state management plan (State Species Action Plan, State Management Plan, State Imperiled Species Management Plan), had habitat models, or had a vulnerability score.

Select species based on taxonomic group:



Select species based on vulnerability level:

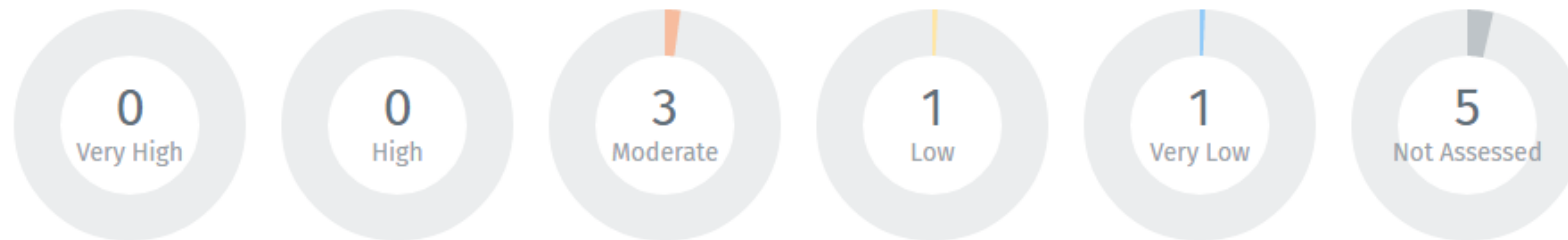



Click on one or more of the taxonomic groups or vulnerability levels above to select species.

Select species based on taxonomic group:



Select species based on vulnerability level:



 Striped newt


 Reticulated flatwoods salamander

 Gopher frog

 Frosted flatwoods salamander

 Squirrel treefrog

 Georgia blind salamander

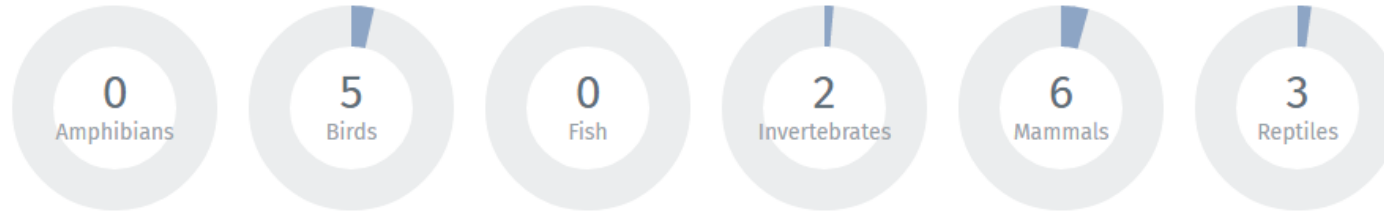
 Tiger salamander

 Seal salamander

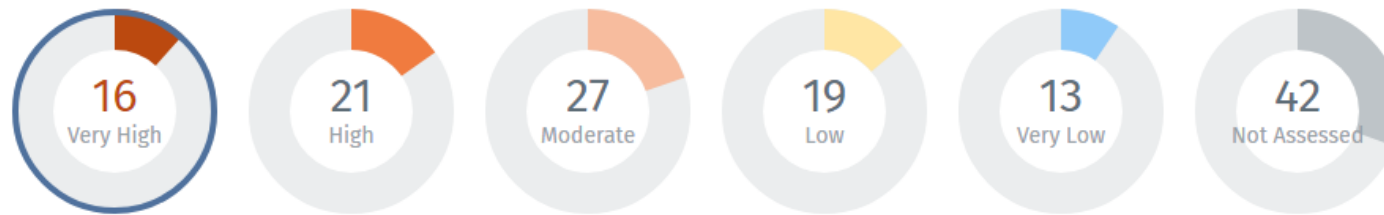
 Pine barrens treefrog

 Florida bog frog


Select species based on taxonomic group:




Select species based on vulnerability level:





 Whooping crane

 Florida scrub jay


 Florida grasshopper sparrow


 Everglade snail kite


 Cuban snowy plover


 Schaus swallowtail butterfly

 Miami blue butterfly

 Perdido Key beach mouse


 Key Largo woodrat


 Key Largo cotton mouse

 Lower Keys marsh rabbit

 Florida salt marsh vole

 Key deer

 Mangrove diamondback terrapin

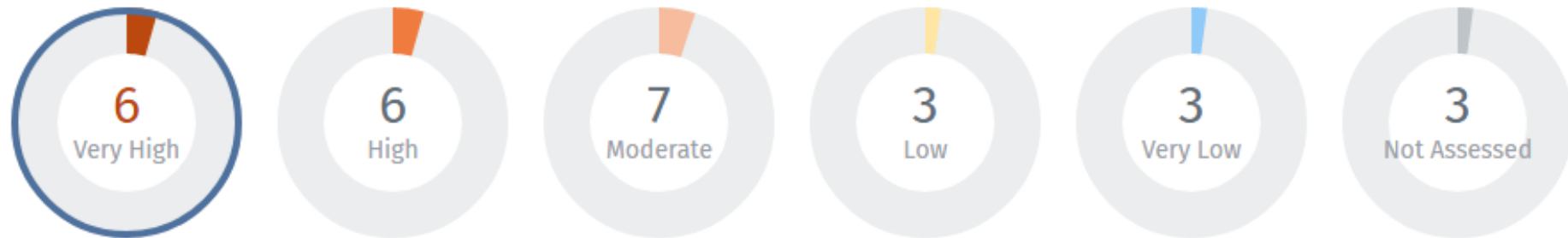
 Loggerhead turtle

 Atlantic salt marsh snake

Select species based on taxonomic group:





Select species based on vulnerability level:




 Perdido Key beach mouse

 Key Largo woodrat

 Key Largo cotton mouse

 Lower Keys marsh rabbit

 Florida salt marsh vole

 Key deer



Overview

- ▶ Amphibians
- ▼ **Birds**
 - ▶ Cranes
 - ▶ Game Birds
 - ▼ Perching Birds
 - Black-whiskered vireo
 - Florida grasshopper sparrow
 - Florida prairie warbler
 - Florida scrub jay
 - Louisiana seaside sparrow
 - Louisiana waterthrush
 - MacGillivray's seaside sparrow
 - Mangrove cuckoo
 - Marian's marsh wren
 - Painted bunting
 - Red-cockaded woodpecker
 - Scott's seaside sparrow
 - White-crowned pigeon
 - Worthington's marsh wren
 - ▶ Raptors
 - ▶ Shorebirds and Seabirds
 - ▶ Waterbirds

Birds









Approximately 377 species of native birds make their home in Florida's skyways, including 15 federally listed and 17 state listed species. Many of these species inhabit the state year-round including large populations of shorebirds, seabirds and cranes.



Audubon's crested caracara. Photo: NPS.

While the long-range and ability to move across a fragmented landscape in flight may increase the resiliency of some bird species in the face of climate change, many birds are still highly vulnerable. Florida's shorebirds largely depend on fragile estuarine habitats that are likely to be dramatically altered by sea level rise. Many birds, especially beach nesting species, are also highly vulnerable to the increased severe storm events anticipated with climate change.

Overview

- ▶  Amphibians
- ▼  Birds
 - ▶  Cranes
 - ▶  Game Birds
 - ▼  Perching Birds
 - Black-whiskered vireo
 - Florida grasshopper sparrow
 - Florida prairie warbler
 - Florida scrub jay
 - Louisiana seaside sparrow
 - Louisiana waterthrush
 - MacGillivray's seaside sparrow
 - Mangrove cuckoo
 - Marian's marsh wren
 - Painted bunting
 - Red-cockaded woodpecker
 - Scott's seaside sparrow
 - White-crowned pigeon
 - Worthington's marsh wren
 - ▶  Raptors
 - ▶  Shorebirds and Seabirds
 - ▶  Waterbirds



Mangrove cuckoo

Coccyzus minor

Adaptation Strategies

- Conservation of existing mangrove habitat will allow the mangrove cuckoo the best chance of increasing and maintaining a healthy population in Florida as climate change begins to accelerate. This includes controlling existing stressors, such as habitat loss and coastal development.
- Conserving healthy future mangrove habitat as sea levels rise and human communities begin to shift is important for this species.
- Protecting migratory corridors if mangrove habitat migrates inland and northward is an important adaptation strategy for this species. Assisted migration to optimal mangrove habitat northward from the bird's current range in a future climate is a possible strategy.

[More information about adaptation strategies.](#)

Additional Resources

- [Florida Natural Areas Inventory Profile](#)

Overview

- ▶ Terrestrial Ecosystems
- ▶ Coastal Ecosystems
- ▶ Freshwater Ecosystems
- ▶ Marine & Estuarine Ecosystems

Climate Impacts and Adaptation Strategies for Florida Habitats



Photo: NPS.





This tool includes profiles for 31 habitats, grouped into 15 conservation assets.

Conservation Assets were identified by the Peninsular Florida Landscape Conservation Cooperative (PFLCC) as the set of biological, ecological, and cultural features most important for Florida's Landscape. They represent the most significant resources, embody key landscape components, and reflect the mission, vision, common interests, and values of the PFLCC partners.



Photo: NPS.

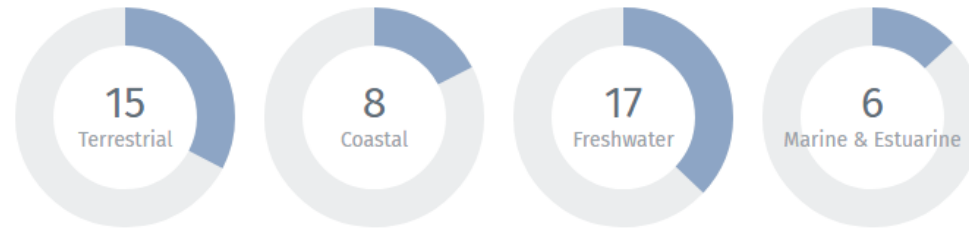
Overview

- ▶  Terrestrial Ecosystems
- ▶  Coastal Ecosystems
- ▶  Freshwater Ecosystems
- ▶  Marine & Estuarine Ecosystems

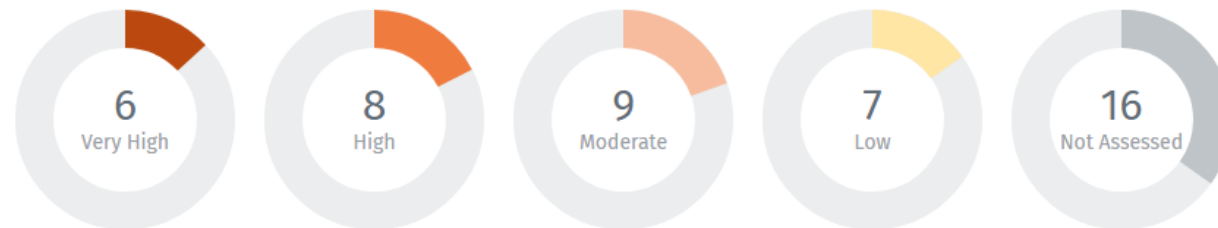
This tool includes profiles for 31 habitats, grouped into 15 conservation assets.

Conservation Assets were identified by the Peninsular Florida Landscape Conservation Cooperative (PFLCC) as the set of biological, ecological, and cultural features most important for Florida’s Landscape. They represent the most significant resources, embody key landscape components, and reflect the mission, vision, common interests, and values of the PFLCC partners.

Select habitats based on ecosystem:



Select habitats based on vulnerability level:



Click on one or more of the ecosystems or vulnerability levels above to select habitats.



Overview

- ▶ Terrestrial Ecosystems
- ▶ Coastal Ecosystems
 - ▶ Coastal Uplands
 - Beach Dune
 - Coastal Berm
 - Coastal Grassland
 - Coastal Strand
 - Maritime Hammock
 - Beach and Surf Zone
 - Keys Cactus Barren
- ▶ Freshwater Ecosystems
- ▶ Marine & Estuarine Ecosystems

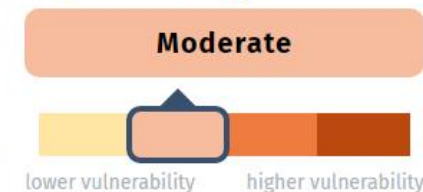


Coastal Strand *within Coastal Uplands*



Photo: Randy Kautz

Vulnerability:



Species:



Anastasia Island beach mouse



Black skimmer



Choctawhatchee beach mouse



Cuban snowy plover



Florida black bear



Gopher tortoise



Southeastern beach mouse

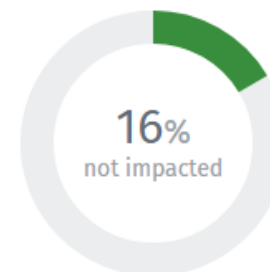
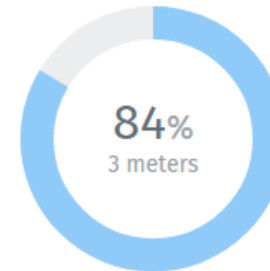
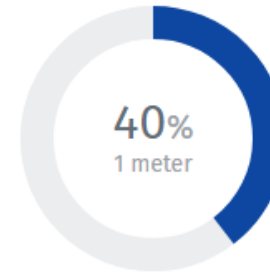


St. Andrew beach mouse

Area

- 2,713 hectares within Florida (modeled)
- 2,316 hectares (85%) is located on public lands






Area impacted by up to 3 meters sea level rise:



[Explore interactive map](#)



Overview

- ▶  Terrestrial Ecosystems
- ▼  Coastal Ecosystems
 - ▼  Coastal Uplands
 - Beach Dune
 - Coastal Berm
 - Coastal Grassland
 - Coastal Strand
 - Maritime Hammock
 - Beach and Surf Zone
 - Keys Cactus Barren
- ▶  Freshwater Ecosystems
- ▶  Marine & Estuarine Ecosystems

Adaptation Strategies

Protection

- Identify areas connected to coastal terrestrial habitats that could receive protection through Florida forever and similar funding mechanisms.
- Protect coastal vegetation to reduce the impact of increased disturbance events (intense storms, increased erosion) and encourage aeolian sand capture.
- Create setbacks or rolling easements.
- Develop conservation easements to protect climate-vulnerable areas.
- Preserve undeveloped and vulnerable shoreline.
- Identify and protect locations where native species may shift or lose habitat due to climate change impacts.
- Maintain corridors and linkages between undeveloped areas.
- Protect potential refugia, corridors, and relocation sites.

Restoration

- Reduce impacts from points of access (e.g., paths, boardwalks).
- Restore native plant communities, using stock that is more likely to persist in future climatic conditions.
- Redesign or mitigate existing physical barriers or structures that impede movement and dispersal within and among habitats.
- Develop corridors and linkages between undeveloped areas.
- Remove shoreline hardening structures such as bulkheads, dikes, and other engineered structures to allow for shoreline migration.
- Restore and/or protect coastal vegetation to reduce the impact of increased disturbance events (intense storms, increased erosion) and encourage aeolian sand capture.

Overview

 How to Create Strategies?

 Species Strategies

 Habitat Strategies

 Common Adaptation Strategies

 Additional Resources

Climate Adaptation Strategies



Big Cypress National Preserve. Photo: NPS.

Using an adaptation approach is vital to offset the increasing impacts from climate change combined with existing anthropogenic impacts to natural communities and species.

Questions

Climate Adaptation Explorer:

<https://climateadaptationexplorer.org/>

<https://flcpa.databasin.org/>

Beth Stys: beth.stys@myfwc.com

Sarah Sharkey: sarah.sharkey@myfwc.com

- Adaptation Guide: <https://myfwc.com/conservation/special-initiatives/climate-change/adapt/>