Planning for Climate Change in South Florida: Climate Envelope Modeling for Threatened and Endangered Species[1]

Laura A. Brandt, Stephanie S. Romañach and Frank J. Mazzotti[2]

The University of Florida, U.S. Fish and Wildlife Service, U.S. Geological Survey, and National Park Service are working in partnership to develop methods and tools that will allow natural resource managers to examine potential effects of climate change on species' geographic ranges in the context of ecosystem and landscape planning.

Climate envelope models describe relationships between species' occurrences and bioclimate variables derived from temperature and precipitation data to define a species' climate niche (envelope). Relationships derived from contemporary climate conditions and distributional data can be projected to the future using estimates of anticipated climate change. Models describing hypothesized changes in a species' future climate envelope then may be used in association with spatially explicit projections of land use change and sea level rise to estimate how species' distributions may respond to multiple interactive drivers of global change.

We will compile available climate information from sources that provide reliable data at the appropriate resolution (e.g., National Climatic Data Center, Worldclim database). In addition to using data obtained from global databases at a resolution of 1 km^2, our flexible framework will allow us to incorporate a variety of climate projections for forecasting potential future species' distributions. We will be able to
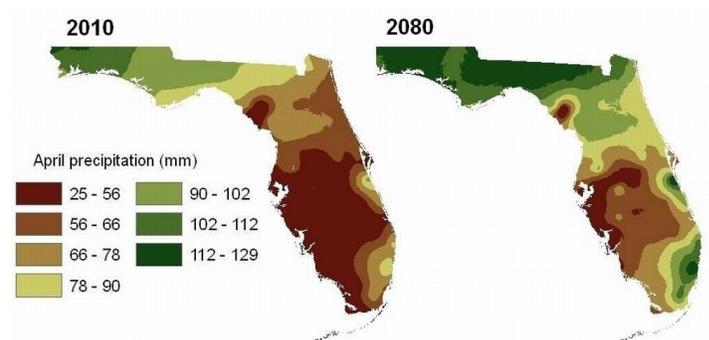

Figure 1. *As climate change alters precipitation patterns, species' ranges may shift depending on physiological tolerances.* Data source: Worldclim (http://www.worldclim.org/)

Climate Envelope Models

Climate envelope models, used since the 1980s, describe the climate of a species' or ecosystem's current distribution (the climatic "envelope") and then map the geographic shift of that envelope under a climate change scenario. These models serve as initial screening tools to detect potential ecological changes resulting from climate change, and can identify priority areas for future study.

— Intergovernmental Panel on Climate Change

Figure 2.

take advantage of the most recent downscaled climate data from U.S. Geological Survey and others involved in regional climate downscaling efforts as they become available.

This project will use existing information on 21 threatened and endangered, non-marine vertebrate species in south Florida, augment it with up-to-date data, identify critical limiting factors directly and indirectly influenced by climate change, and identify information gaps in the following areas:

- Sensitivity of species to temperature and precipitation changes
- Species' phenological responses to changing seasonal temperature and precipitation

Figure 3. *Species such as the wood stork that rely on freshwater wetlands may be more sensitive to changes in precipitation than to changes in temperature.* Photo: U.S. Fish and Wildlife Service

Modeling Approach

We will use a modeling approach that will incorporate the following elements:

- The most biologically relevant climatic variables for each species (e.g., temperature during breeding season vs. annual minimum temperature)
- The most appropriate methods for species that have different types of environmental tolerances
- The most appropriate methods for different types of management decisions

Partnerships

A key aspect of the project will be collaboration among managers and researchers from multiple agencies and organizations. This partnership will avoid duplication of effort and ensure both scientific rigor and management relevance of products.

Funding

This is a three-year project with the first year supported by the following federal agencies:

- National Park Service, Critical Ecosystems Study Initiative
- U.S. Fish and Wildlife Service, Vero Beach Office
- U.S. Geological Survey, Greater Everglades Priority Ecosystems Science Program

Products

We will produce a synthesis of existing information in databases, models, maps (including digital range maps), documentation, and fact sheets. This information provides the foundation for updating recovery plans, assessing vulnerability of species to climate change, and examining alternative futures. This project also provides methods that can be applied to other species and areas.
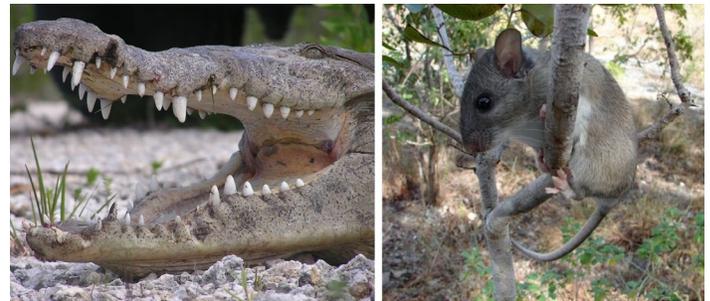
Figure 4. *The American crocodile and the Key Largo woodrat are expected to have different responses to changing temperature because of their different life history characteristics.* Crocodile photo: Mike Rochford, University of Florida, Woodrat photo: Clay DeGayner, Friends and Volunteers of Refuges (FAVOR) Florida Keys

Table 1. Twenty-one threatened and endangered terrestrial vertebrate species in south Florida are the focus of this project.

Common Name	Scientific Name
Mammals	
Key deer	*Odocoileus virginianus clavium*
Key Largo cotton mouse	*Peromyscus gossypinus allapaticola*
Southeastern beach mouse	*Peromyscus polionotus niveiventris*
Florida panther	*Puma concolor coryi*
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*
Silver rice rat	*Oryzomys palustris natator*
Key Largo woodrat	*Neotoma floridana smalli*
Birds	
Audubon crested caracara	*Polyborus plancus audubonii*
Florida scrub jay	*Aphelocoma coerulescens*
Everglades snail kite	*Rostrhamus sociabilis plumbeus*
Piping plover	*Charadrius melodus*
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*
Florida grasshopper sparrow	*Ammodramus savannarum floridanus*
Wood stork	*Mycteria americana*
Red-cockaded woodpecker	*Picoides borealis*
Roseate tern	*Sterna dougallii dougallii*
Reptiles	
American crocodile	*Crocodylus acutus*
Bluetail mole skink	*Eumeces egregius lividus*
Sand skink	*Neoseps reynoldsi*
Atlantic salt marsh snake	*Nerodia clarkii taeniata*
Eastern indigo snake	*Drymarchon corais couperi*

For more information contact:

Laura A. Brandt, U.S. Fish and Wildlife Service - laura_brandt@fws.gov

Stephanie S. Romañach, U.S. Geological Survey - sromanach@usgs.gov

Frank J. Mazzotti, University of Florida - fjma@ufl.edu