National Park Service
U.S. Department of the Interior

South Florida Natural Resources Center
Everglades National Park

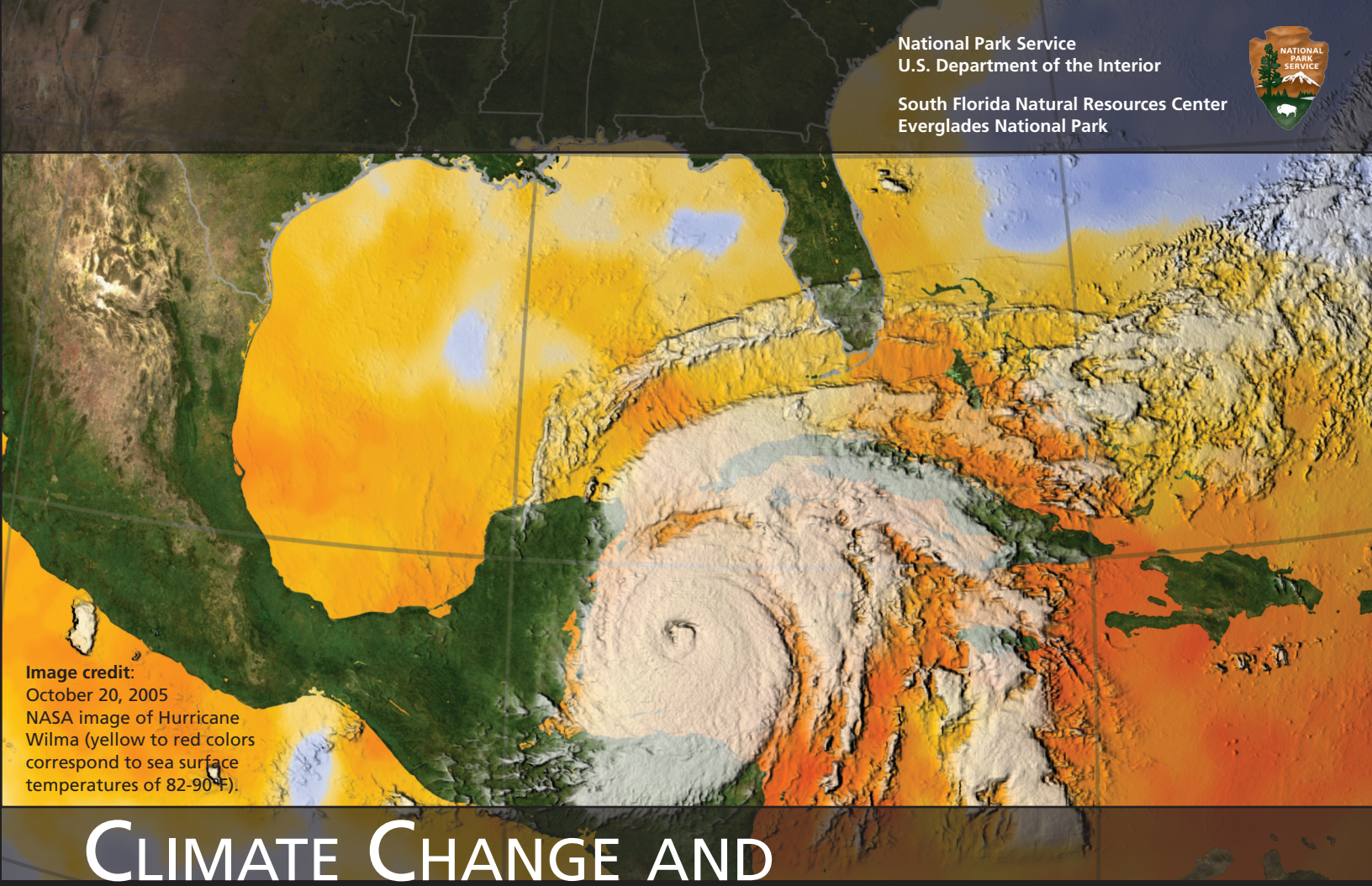


Image credit:
October 20, 2005
NASA image of Hurricane Wilma (yellow to red colors correspond to sea surface temperatures of 82-90°F).

Climate Change and South Florida's National Parks

...portrait of a changing landscape

The 2005 hurricane season produced several powerful storms fueled by abnormally-warm ocean waters. Hurricane Wilma – the strongest Atlantic storm ever recorded – was one of four major hurricanes to strike Florida that year. For days, this Category 5 cyclone sat off the coast of the Yucatán Peninsula, pounding the region with record-setting 185-mph winds. By the time Wilma made landfall over Florida, its fierce winds had quelled to 120 mph – still strong enough to topple trees and rip off roofs. In total, 62 deaths and $16- to $20-billion in damages were blamed on this storm.

Some scientists predict that intense storms like Wilma – which strengthen over warm water – will be more common in the future as a result of rising temperatures. Research has documented an unprecedented rise in atmospheric carbon dioxide (CO_2) and near-land air and sea surface temperatures. But while hurricanes receive much attention, sea level rise is another anticipated consequence of rising temperatures – one that may have dramatic ecological impacts on coastal areas worldwide. South Florida, in particular, will be affected by sea level rise due to its low elevation and flat landscape.

Preparing for a future with climate change

What are scientists predicting?

How will ecosystems respond?

What is the National Park Service doing?

Although it is important to consider the impact of climate change on developed areas, effects of this phenomenon on the natural environment also deserve attention. As stewards of some of south Florida's most unique natural areas, Everglades, Biscayne, and Dry Tortugas National Parks and Big Cypress National Preserve play an important role in conservation. Together, they protect over 2.4 million acres of habitat and harbor more than 14 endangered species. While scientists remain uncertain about how the effects of climate change will manifest, their research suggests that low-lying south Florida and its extraordinary ecosystems are vulnerable.

Physical Changes...

Atmospheric CO_2 concentrations are higher today than in any other period within the last 420,000 years. Scientists have found that natural causes alone cannot account for this rapid rise. Instead, they believe human activities also are responsible. Deforestation and fossil fuel burning, in particular, have caused a 31% increase in atmospheric CO_2 since 1750. When gases like CO_2 build up in the atmosphere, they prevent heat from escaping. It's this greenhouse effect that is responsible for the earth's rising temperatures.

Sea Level Rise

The United Nations Intergovernmental Panel on Climate Change (IPCC) predicts a 7- to 23-in rise in global sea level in 95 years due to the expansion of warming seawater and the contributions of melting glaciers. IPCC also notes that sea level rise may exceed these predictions if rapid dynamic changes in polar ice flow occur.

Low-lying coastal regions will be particularly susceptible to inundation. Most of Dry Tortugas and Biscayne National Parks, and two-thirds of Everglades National Park, have an elevation lower than 3 ft. Yet, even more important than the extent of sea level rise may be the rate of rise. For example, mangrove trees – which stabilize sediments – might be able to keep pace with slowly rising sea levels by accumulating soil and effectively raising ground elevation. However, if sea level rise is rapid, coastal freshwater habitats could be inundated by rising sea water. A June 2006 report by the National Wildlife Federation and the Florida Wildlife Federation highlighted these potential impacts and suggested that sea level rise would harm the world-class recreational fishery in Florida Bay for bonefish, yellowtail snapper, permit, redfish, snook, spotted sea trout, and tarpon.

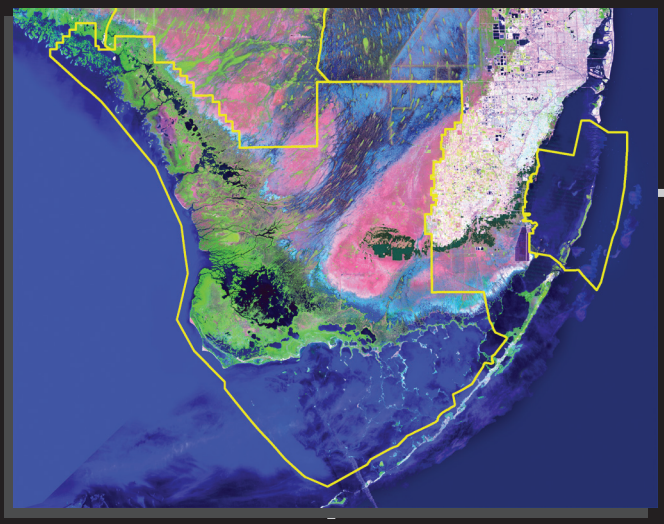
Warming Oceans

According to the IPCC, sea surface temperatures may increase 2° to 5°F by 2100. While the most obvious impact of such a trend could be an increase in hurricane frequency and intensity, a lesser known fact is that abnormally-warm water can adversely affect coral reefs. In 2005, the same warm waters that triggered Hurricanes Katrina and Wilma badly damaged coral reefs in the eastern Caribbean, including coral reefs in the Florida Keys.

For many coral species, several weeks of warm water just 2°F more than peak summer temperatures can wreak havoc. When this happens, the symbiotic algae that live within the coral's cells are ejected, leaving behind the animal's skeleton. Known as "bleaching," the phenomenon can have severe impacts on the entire marine ecosystem.

Pinelands
Everglades National Park (ENP) contains most of the remaining pineland habitat in south Florida. Under some sea level rise scenarios, this small but critical area is projected to disappear (see maps). Upland species like the Wild Turkey and Eastern Bluebird would suffer from this reduction in habitat.

Everglades National Park
photo: Vincent DiFrenna, ENP



South Florida's habitat types and coastline in 1995.

Dry Tortugas National Park
photo: William Perry, ENP

Beaches
Green sea turtles nest on the beaches of Everglades, Biscayne, and Dry Tortugas National Parks. If these beaches erode, valuable sea turtle habitat could be lost (see maps).

Everglades National Park
photo: Lori Oberhofer, ENP

Shallow Marshes
The shallow marshes of Everglades National Park and Big Cypress National Preserve provide the only existing habitat for the endangered Cape Sable Seaside Sparrow. Sea level rise is expected to shrink these areas under some model scenarios (see maps).

Biscayne and Dry Tortugas National Parks are home to many of south Florida's most pristine coral reefs. Park managers are working to protect the reefs from those risks over which we have control, including pollution and damage from boat anchoring. Managers believe that this strategy will lead to a healthier reef that will better withstand the effects of climate change. A newly established Research Natural Area in Dry Tortugas National Park will help ensure the continued existence of this important ecosystem.

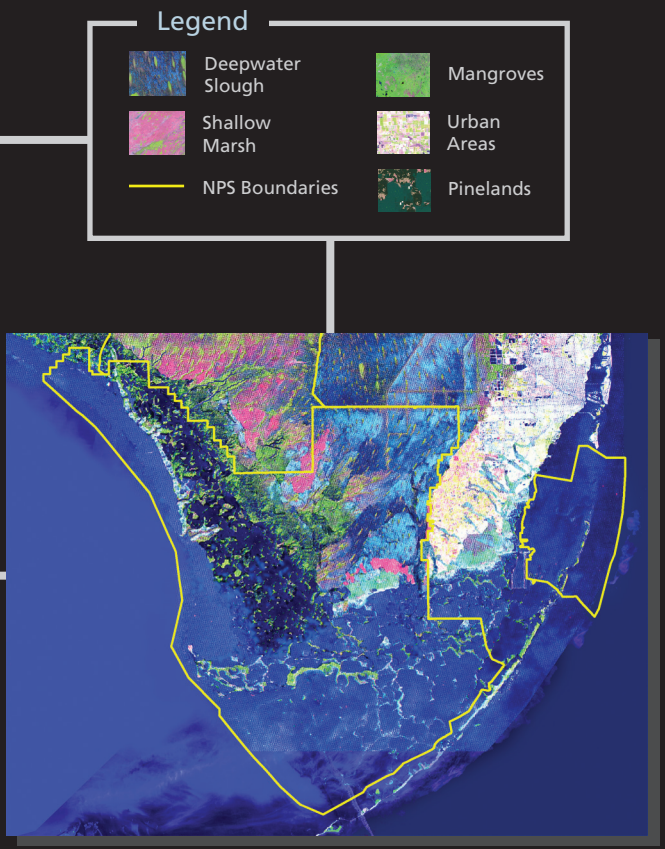
Scientists have also linked high sea surface temperatures to seagrass die-offs, and higher sea temperatures could fuel algal blooms or promote marine diseases.

Hurricanes

A sea surface temperature of 80°F or more – combined with favorable humidity and wind conditions – is enough to fuel powerful hurricanes. Some scientists expect that in the future, as ocean temperatures continue to rise, hurricanes will be more frequent and intense. Others warn that long-term trends analyses can be potentially biased because monitoring and detection capabilities have improved over time. For example, detection improved substantially with the advent of geostationary satellite imagery in the mid-1960s so more storms can be identified now than in the past (*Eos Transactions*, 2007). However, Webster et al. (*Science* 2005), using relatively recent data, found that the number of intense tropical storms has risen by 80% worldwide during the last 35 years. And 2005 broke records for its numerous powerful hurricanes – four of the 28 named storms reached Category 5 strength. Still, since hurricane patterns do fluctuate naturally over multi-decadal periods, the authors of the paper indicated that, without additional data, they are reluctant to attribute recent trends in hurricane frequency and intensity to warming sea water.

Recent climate simulations for this century published by scientists at NOAA and the University of Miami (*Geophysical Research Letters* 2007) illustrate the complexity of the ocean/atmospheric system and how difficult it can be to reach generalizable conclusions about the relationship of climate change and hurricanes. For example, their work suggests that warming ocean temperatures in the tropical Atlantic will alter existing ocean circulation patterns in such a way as to increase wind shear – a dominant controlling factor in hurricane activity – and thus serve to inhibit hurricane development and intensification in this region. However, their models also identify regions, such as the western tropical Pacific, where warming does appear likely to produce conditions which favor hurricane development. One thing is certain, when intense hurricanes do occur, storm surge flooding that often accompanies such storms will be exacerbated by sea level rise, placing both natural ecosystems and man-made facilities at even greater risk.

... and Ecological Responses



Projected habitat shifts with 2 ft of sea level rise. Courtesy: Harold Wanless, University of Miami.

Florida Bay
Sea level rise, coupled with warmer air temperatures, may change Florida Bay's salinity by increasing evaporation and concentrating salt. Seagrass beds would be adversely affected by such an increase.

Everglades National Park
photo: Quan Dong, ENP

Mangrove Forest
If sea level rises too quickly, mangroves, which protect shorelines from storm surge, may not be able to keep pace and this important community could be lost. Mangroves along the southwest coast of Everglades National Park and in Biscayne National Park are projected to shrink and shift inland due to sea level rise (see maps).

Biscayne National Park
photo: Brett Seymour, ENP

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What are the National Parks Doing?

Managers and scientists working in south Florida's national parks are planning ahead for climate change. They believe that by protecting pristine natural areas from pollution and over-harvesting; restoring already-damaged ecosystems; and improving park facilities, the parks will endure despite the added threat of climate change.

Restoration

Beginning in the late 1800s, the natural sheet-flow of the "River of Grass" was altered to provide flood control and water supply to a growing population. Everglades ecosystems suffered as a result and restoring the Everglades has since become paramount. The Comprehensive Everglades Restoration Plan (CERP) was enacted with a goal of reestablishing the natural flow of water by removing barriers to flow, such as some key canals and levees. This restoration is even more important in the face of climate change, since a restored Everglades will be healthier and more resilient to climate change.

Visitor Facilities

Park officials are taking an adaptive approach to climate change with regard to park facilities. For example, they are preparing for problems associated with storm surge through innovative efforts, such as elevating existing facilities, constructing mobile buildings that can be relocated inland during hurricanes, and replacing fixed docks with floating or removable platforms. Through prudent planning, the National Park Service is protecting the American taxpayer's investment.

Protecting Natural Areas

The Research Natural Area in Dry Tortugas National Park is one example of the National Park Service commitment to protect south Florida's ecosystems. The 46-square mile no-take marine protected area will reduce human impacts to coral reefs in the park. Many scientists believe that a healthier marine ecosystem will be more resilient to the effects of climate change. Managers plan to use the area to monitor the impacts of climate change on coral reefs over time.

Climate Friendly Parks

While some impacts to national parks are likely unavoidable, park managers across the country are doing what they can to minimize the effects of climate change. In some cases, they may be forced to reconsider standard approaches to resource management. For instance, if sea level rise threatens to cause the extinction of species, managers must then decide if they should allow "nature" to take its course, or if they should attempt to relocate these plants and animals. Although scientists can anticipate such dilemmas, they aren't able to predict all of the challenges climate change will bring.

National Park Service personnel are taking the issue seriously by preparing for a future with climate change. As participants in the "Climate Friendly Parks" program – a voluntary effort to respond to climate change – south Florida's national parks are doing their best to minimize their contribution to this problem by reducing the production of greenhouse gases in parks. The National Park Service mission to preserve park resources "unimpaired for future generations" rings true now with greater-than-ever urgency.

photo: Joy Brunk, ENP