

By Gary Davis

How did Hurricane Andrew affect the resources of NPS units in South Florida? Immediately after the storm a team of 25 scientists conducted a rapid appraisal of hurricane effects in Biscayne Bay NP, Everglades NP, and Big Cypress National Preserve. They made field observations for one week and gathered information from colleagues who were also active in the field before and after the storm.

Teams were formed for Marine Resources (James Tilmant, team leader), Freshwater Resources (Charles Roman, team leader), Upland Resources (Lloyd Loope, team leader), Archaeology (George Smith, team leader), Air Quality (Brian Mitchell, team leader), and GIS (Donald Myrick, team leader).

Chronic anthropogenic stresses, such as habitat fragmentation, non-native species, altered water resources, and air pollution have affected ecosystem stability in south Florida. Can such stressed ecosystems recover to pre-storm conditions before the next major disturbance? Do storm clean-up activities threaten resources and human health and safety in the parks? These questions needed to be addressed immediately to protect park resources and to develop long-term strategies that assured their perpetuation.

Impacts

Hurricane Andrew was a small, intense hurricane. When it made landfall in southern Florida at 5 a.m. on Aug. 24, 1992, it was a category 4 hurricane, one of the most intense storms ever recorded in Florida. The National Weather Service estimated the maximum sustained wind speed at 150 mph.

The storm hit near the time of high tide. It produced a large but localized storm surge in the coastal portion of southeastern Dade County, 15 miles south of Miami. Storm surge overtopped coastal water control structures and levees. The USGS estimated Hurricane Andrew's maximum storm surge at 16.2 feet. A 105-foot boat was blown from its deep water anchorage and transported inland.

Coastal flooding was minor, but high winds caused extensive damage throughout the 25-mile wide storm path across the state. Rainfall from the storm was low, presumably in response to the storm's rapid forward move-



Before Hurricane Andrew struck everglades NP, this was a tropical hardwood hammock in Long Pond key near Royal Palm.

ment. Rainfall and water levels were above normal throughout most of southern Florida before Hurricane Andrew arrived. Inland flooding was a problem primarily in southeastern Dade County, where saltwater inundated a large portion of farming areas.

The assessment team documented resource conditions immediately after the storm and identified actions needed to avert additional resource damage and recover irreplaceable information. While storm effects on natural resources were dramatic, initial ecosystem responses appeared normal.

Trees sustained severe damage, especially mangroves and tropical hardwoods. Many defoliated trees resprouted within weeks of the storm, and rare plants in hammock and forest understories were relatively unaffected. Coastal wading bird rookeries, eagle nests, and red-cockaded woodpecker cavity trees were damaged, but no major mass mortality of wildlife occurred.

Hurricane winds and water spread non-native plants. Exotic animals escaped from storm damaged facilities and entered the parks. Some freshwater fish populations declined dramatically after the storm. Storm damage to the South Dade water delivery system interrupted normal freshwater flow into Florida Bay. The storm scoured shallow marine communities and altered marine water quality. An artificial reef broke up and

moved into Biscayne NP. Sea turtle nesting beaches may have been enhanced by storm overwash, and seagrass beds survived remarkably intact. Windthrown trees and storm-scour exposed previously unknown archeological artifacts on ship wrecks and upland sites. Disposal of urban debris from the hurricane threatens air and water quality in the parks.

Short-term Recommendations

The storm destroyed most of the NPS hydrologic, meteorologic, and air quality monitoring networks in the parks. They need to be replaced and activated to measure the potential effects of post-hurricane cleanup on air and water quality and to evaluate short-term ecological responses.

Historic shipwrecks exposed by the storm need to be surveyed, stabilized, and monitored to enhance site protection. Backcountry patrols need to be increased over normal levels to detect and remove non-native animals before they become established in the parks. Removal techniques for exotic animals may need to be developed and tested in conjunction with other agencies. Short-term ecological storm effects need to be determined, and boat warning signs protecting manatees should be replaced.

Studies to determine the short-term ecological effects of Andrew need to be initiated

Damage at Everglades National Park



After Andrew, the hammered hammock looked like this. (Photos by James R. Snyder)

while the first, most dramatic changes are taking place. Historical data need to be compiled and analyzed to provide a basis for designing studies and establishing monitoring plots stratified by hurricane influence. Opportunities to determine spatial variability of storm effects, examine the roles of storm-altered detritus distribution and nutrient cycling, and to evaluate storm effects on fishery recruitment, subtidal sediments, and heavy metals in hardwood hammocks soon will be lost.

Surveys of seedling non-native plants need to be conducted to assess the extent and magnitude of storm-caused spread, and to determine if new control methods should be developed. The status of mangrove forests and rare plant populations will not be apparent until a year after the storm. The environmental monitoring networks need to be hardened to survive future storms in addition to restoring their pre-storm capability. Additional monitoring sites are needed to evaluate storm effects on park resources and link upland effects to estuarine and marine systems. Detection of storm impacts on fish and wildlife will require intensified surveys during reproductive seasons to document reproductive efforts, success, and recruitment.

Significant park staff time will be required to coordinate debris disposal regulated by

other agencies to assure protection of park interests. The NPS needs to characterize emissions from debris burning, model air quality and visibility, and monitor air quality, visibility and meteorology to establish actual impacts on park resources.

Removal of artificial reef KEVORKIAN debris from natural reefs needs to be initiated before the debris is incorporated into the sediment and overgrown. Its damage to the natural reef needs to be documented to help develop guidelines for future artificial reef placement. Storm breached plugs on Cape Sable permit accelerated saltwater intrusion into coastal marshes and will continue to widen with tidal flushing if not repaired soon. More permanent solutions to restoring the integrity of these marshes need to be found, such as filling in longer sections near the coast, to prevent this kind of damage and repair costs with each hurricane.

Fire management practices need to be verified following storm-altered fuel loads. Impacts of storm cleanup activities on rare plants and opportunities for interpreting hurricane influences on native communities need to be evaluated. The effects of storm-altered shelter for manatee and crocodile populations on protection activities must be considered before public facilities and access are fully restored.

Long-term Monitoring

Long-term monitoring also is needed, to differentiate natural dynamics driven by hurricanes, fires, and freezes from changes caused by chronic environmental stresses. The monitoring program would be designed to (1) determine current and future health of ecosystems, (2) establish empirical limits of variability, (3) diagnose abnormal conditions early enough to implement effective remedial actions, and (4) identify potential agents of ecological change.

Research Agenda

Finally, experimental research is needed to assess the potential of Hurricane Andrew to alter flows of energy and nutrients in South Florida ecosystems. Potential nutrient releases from storm-related detritus and the effect of changes in landscape heterogeneity on large animals need to be measured over time. A variety of approaches will be necessary to address these questions. Past research and restoration efforts have focused on individual species or habitats, usually within limited spatial or temporal scales.

An integrated understanding of the system's response to anthropogenic and natural perturbations such as Hurricane Andrew would greatly refine ongoing restoration and management activities. Several critical hypotheses concerning the ecosystem's productivity and resilience must be resolved to produce a scientific basis for restoration and management.

In the weeks following completion of the resource assessment, a prioritized list of projects was completed, based on recommendations of the assessment team. That list was presented to Southeast Regional Director Jim Coleman for development of funding priorities by the superintendents at Everglades, Biscayne, and Big Cypress. A multipark meeting took place on Jan. 29, 1993, to establish priorities for the funding available for resource recovery activities. Consensus was reached to proceed immediately on several projects for osprey, cape sable sparrow, hydro station repair/upgrade, and documentation of the Fowey site. Other priorities will be set after the various scopes of services are received.

Davis acted as the NPS team leader in this study; he is a Marine Research Scientist at Channel Islands NP.