Research on the Impacts of Past and Future Hurricanes on the Endangered Florida Manatee

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U.S. Geological Survey (USGS) research on Florida manatees (Trichechus manatus latirostris) from 1982 through 1998 identified lower apparent survival rates for adult manatees during years when Hurricane Elena (1985), the March "Storm of the Century"(1993), and Hurricane Opal (1995) hit the northern coast of the Gulf of Mexico. Although our analysis showed that a significant number of our monitored individual manatees failed to return to their winter homes after these storms, their actual fate remains unknown. With the aid of new satellite technology to track manatees during storms and new statistical techniques to determine survival and emigration rates, researchers are working to understand how hurricanes impact the endangered species by studying manatees caught in the path of the destructive hurricanes of 2004 and 2005.

Introduction

The federally endangered Florida manatee (*Trichechus manatus latirostris*) (hereafter, manatee) is a large marine mammal that lives in coastal rivers, bays, and nearshore waters of the Southeastern United States, where hurricanes are common. The species is protected under the Endangered Species Act, the Marine Mammal Protection Act, and the Florida Manatee Sanctuary Act. It feeds on seagrasses and freshwater plants that grow in shallow coastal waters, earning it the nickname "seacow." As a tropical species subject to death from cold stress, when winter cold descends on Florida, it seeks refuge in the natural warm water springs or artificial warm water outflows of industrial plants along the Florida coast. Females can give birth to one calf (occasionally twins) once every 2 to 3 years. Because of this slow birth rate, it is critical to the recovery of the species that adult survival rates are high.

Gathering Baseline Data

Prior to the unusually active hurricane seasons of 2004 and 2005, we had analyzed 18 years of data from one of our long-term monitoring programs, the Manatee Individual Photo-identification System (MIPS). The sighting histories of individuals in MIPS (fig. 1 and sidebar, this article) are used to estimate adult apparent survival rates in four manatee regional subpopulations in Florida. These estimates, along with other population indicators, are used by the U.S. Fish and Wildlife Service to assess population recovery. The estimates are called apparent survival rates because the statistical analysis relies on the sightings of live individuals; thus, the survival rate is the outcome of both mortality and permanent emigration of live animals out of the study area.

In the analysis, we found lower apparent survival rates for adult manatees along the northwest coast of Florida during 3 years when major hurricanes or an extreme winter storm occurred (Langtimm and Beck, 2003). The causes of the drops in apparent survival rate are unknown. A few manatees have been stranded and rescued after hurricanes, including a female named "Fergie" that was stranded by Hurricane Andrew in a pond on a Miami golf course in 1992 and a young manatee stranded on the main road to Fort Myers Beach after Hurricane Charley in 2004. Nonetheless, Florida's Manatee Carcass Salvage Program documented no increase in the number of carcasses in years with extreme storms. Langtimm and Beck (2003) proposed several mechanisms that could cause reduced survival: stranding on shore, injury from debris in the water, being fatally swept out to sea, and permanent movement out of our study area to escape a storm or a degraded habitat.

Although large die-offs and movements of a closely related species, the dugong (*Dugong dugon*), were observed with cyclones in Australia (Marsh, 1989; Preen and Marsh, 1995), our research was the first to provide empirical evidence for storm-related effects on manatees in Florida (Langtimm and Beck, 2003). The finding of lower apparent survival rates was cause for concern because 1995 was the beginning of a much more active hurricane cycle that was expected to last for the next 25–40 years (Goldenberg and others, 2001). The higher hurricane activity cycle could mean higher mortality, a result that could slow or stall population growth and the recovery of the endangered manatee.

Storm Effects on Manatees

In 2004, four major hurricanes impacted three of the four manatee subpopulations in Florida, and in 2005, three major hurricanes struck again (fig. 2). These storms have provided us with a series of natural experiments to further study hurricane effects on manatees. The primary objectives of our research are to gather data before, during, and after hurricane strikes and to use the information to (1) assess the magnitude of impact of each storm to manatee apparent survival rates, (2) determine what specifically causes the lower apparent survival rate and understand what physical forces within a hurricane are involved, and ultimately (3) develop predictive models to describe impact under different storm scenarios and the consequences to the recovery and survival of the manatee population.

Figure 1. Calculating manatee (*Trichechus manatus latirostris*) survival rates is based on monitoring uniquely marked individuals. Contact with a boat propeller injured this manatee. The healed scar is one of the "naturally occurring" marks used to identify this individual. Annual resightings of uniquely scarred manatees provide the data to estimate annual survival rates. Photographs are used to document the sightings and to verify identifications of individuals in the scar-catalog database. This female, BS107, has been photographed regularly since 1988 and gave birth to twins in 1991.

Behavior During Storms

One discovery we made during the most recent hurricane season advanced our understanding of manatee behavior during storms (Langtimm and others, 2006). As a tropical species, manatees have likely evolved behaviors to cope with these kinds of storms, either fleeing or finding protective

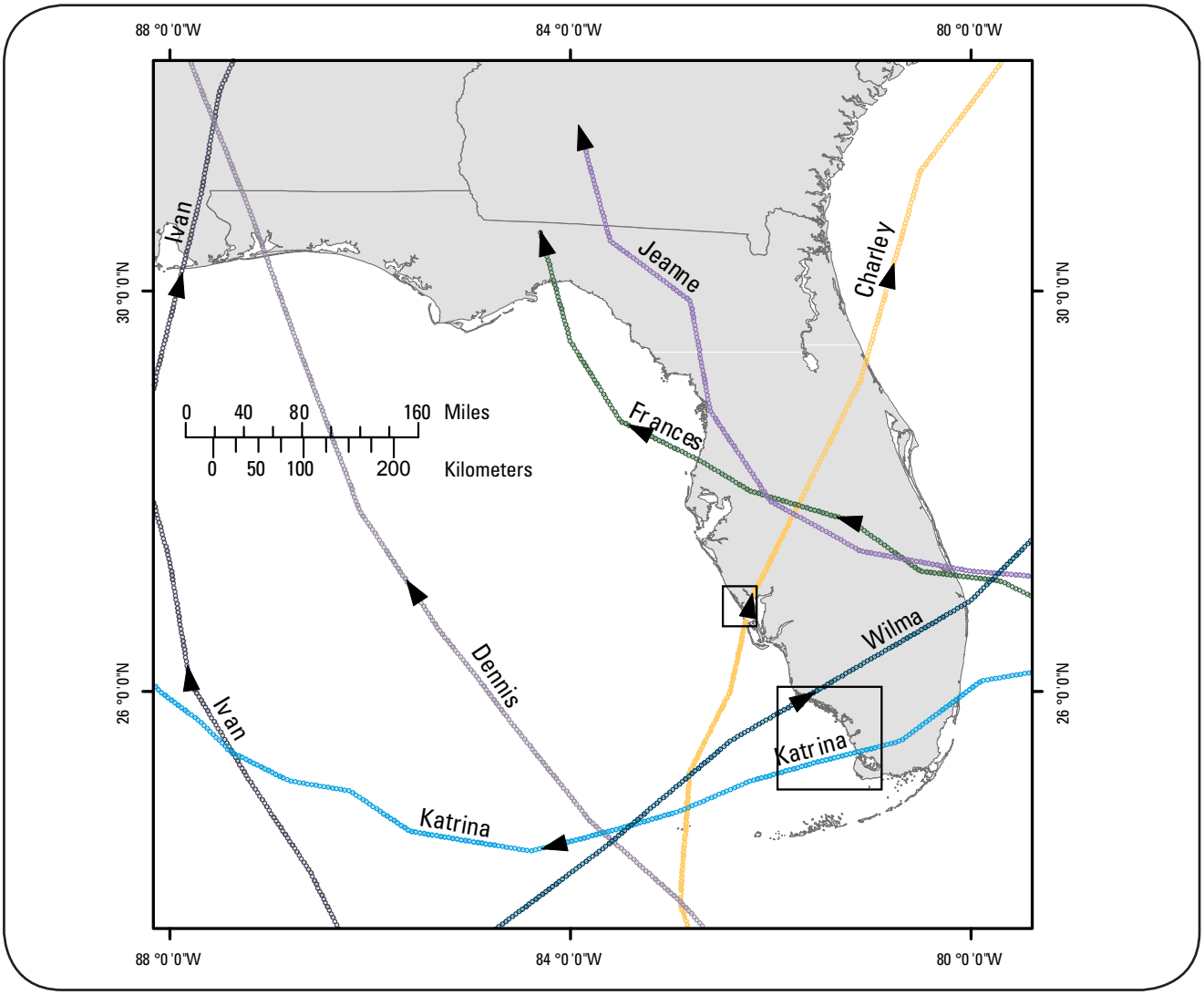

Figure 2. Seven hurricanes ploughed through manatee (*Trichechus manatus latirostris*) habitat in 2004 and 2005. This map depicts the tracks of the hurricanes that impacted manatee habitat. The general areas of the tagged manatees monitored during three of the hurricanes are outlined by the two rectangles. Hurricanes Charley, Frances, Ivan, and Jeanne hit in 2004, and Hurricanes Dennis, Katrina, and Wilma hit in 2005. The names of all seven of these storms have been retired by the World Meteorological Organization (*http://www.nhc.noaa.gov/retirednames.shtml*) because of the extensive devastation they caused.

places within the habitat. During the 2004 and 2005 seasons, we tracked a number of individual manatees with satellite-monitored radio tags (fig. 3) (Deutsch and others, 2003) as part of a study to model and predict the effects of the Everglades hydrological restoration on manatees (Stith and others, 2004).

Ultimately, the path of three hurricanes (Charley in 2004, Katrina in 2005, and Wilma in 2005) crossed or came near the location of six of these individuals (fig. 2). Four manatees were in the path of the large eye of Wilma as it came ashore in south Florida as a category 3 storm; these same individuals were also in the vicinity of Katrina as it exited Florida after its first landfall before devastating the Louisiana and Mississippi coasts. We plotted their locations for a 2-week period prior to and then during passage of each storm.

Overall, no tagged manatee demonstrated any movement away from its 2-week prehurricane home range, with the exception of a short 1-mi (about 1.6-km) move by one individual. Our analysis of manatee movements during hurricanes suggests that, despite having knowledge of a larger area of coastline, these individuals stayed where they were to ride out the storm rather than flee inland or further offshore to deeper water. This strategy may work for tropical storms and minor hurricanes, where storm surge that can strand manatees and longshore and rip currents that can sweep manatees out to sea are not generally as severe; however, when extreme

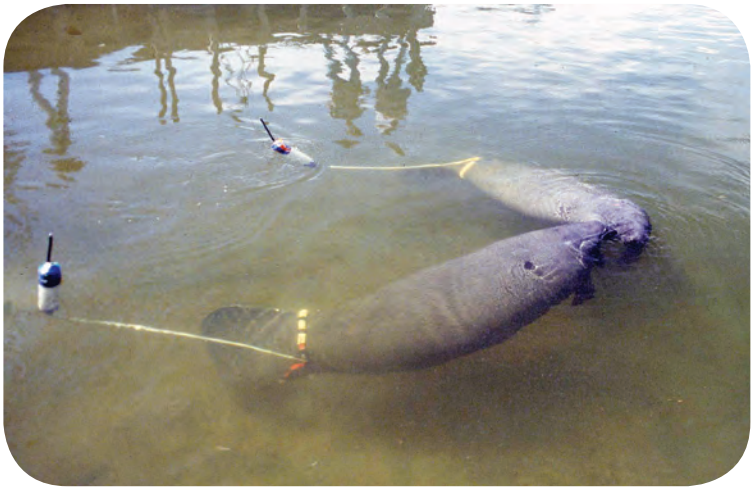

Figure 3. Individual manatee (*Trichechus manatus latirostris*) movements are tracked from space using satellite-monitored radio tags. The tags (buoyant cylinders tethered to belts around the manatees' tails) contain electronic devices that allow the manatees' locations to be tracked remotely by satellite-based Service Argos system. Manatees were fitted with either Argos transmitters or Argos-linked Global Positioning System (GPS) tags; these devices provide location updates approximately every 6 hours or 30 minutes, respectively. The Argos-linked GPS tag contains a GPS receiver that uses the satellite Global Positioning System to determine its precise location and to record the position at regular intervals. Researchers can remotely download near real-time GPS locations from Argos processing centers or can download all the stored GPS locations from the tag after it has been retrieved from the manatee.

major hurricanes do occur, with their large storm surges and associated strong water currents, manatees could be more vulnerable.

Determination of new survival rates for the 2004 and 2005 hurricane years is ongoing. Two to three more years of photoidentification data after the storms are needed to properly estimate these new rates by using our statistical techniques. In the meantime, we have collected data on various attributes of the 2004 and 2005 storms and made predictions for the magnitude of impact to survival rates that we may expect to find, given the range of storm forces that may be operating (Langtimm and others, 2006).

If the worst conditions for manatees are associated with high-intensity, large, slow moving storms, then we may expect to find reduced manatee survival rates in northwest Florida from Hurricanes Ivan (2004), Dennis (2005), and Katrina (2005) and on the Atlantic coast of Florida from Hurricanes Frances (2004) and Jeanne (2004). We expect to find no detectable effect in southwest Florida with relatively fast moving storms such as Hurricanes Charley (2004) and Wilma (2005) (Langtimm and others, 2006).

Assessing and understanding the frequency and impact of hurricanes on manatee survival rates are critical steps to making sound management decisions regarding the status of this endangered species. As managers have labored to reduce human-related mortality in manatees and moved the species toward recovery, a new cycle of increased hurricane activity is emerging. Management actions and successes in the past may not be enough to ensure the recovery of the species under an increased risk of natural mortality that potentially exists with this new cycle of hurricane activity. New efforts may be necessary to protect the species.

A key element of our analysis is having a baseline of manatee survival data prior to the onset of this new active cycle to allow us to better understand and predict future impacts. Larger issues are the impact of the new active hurricane cycle on coastal ecosystems and the response of management agencies to hurricane-related flooding. Understanding how hurricanes affect the complex aquatic systems of the Gulf of Mexico will require continued long-term monitoring and modeling. The manatee is just one component of this system. Because of the complex interactions of species and habitats, direct and indirect storm effects on animal populations can have important consequences for how habitats and ecosystems respond and recover (Michener and others, 1997). Human modifications to the coastal landscape through coastal development and land use and flood management practices also affect impact and recovery. Integration of all of these components into a larger holistic approach to model and predict hurricane effects in the Gulf of Mexico is needed to determine how to best manage our coastal ecosystems to reduce risk and speed recovery after future hurricanes.

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Manatee Photo-identification Database

The Manatee Individual Photo-identification System (MIPS) is a multiple-institution cooperative computerized database of sighting records, images, and life history information, used to help researchers identify and monitor about 2,000 individual Florida manatees (*Trichechus manatus latirostris*). The MIPS program is used to match newly taken pictures of manatees to known individuals by entering descriptive codes of distinct features (see photograph below of known manatee with scars). After double verification of a match, associated sighting and life history data are entered into the MIPS database.

MIPS database facts:

- The first manatee in the database was documented in 1967.
- The database contains 40,000 sightings for the approximately 2,000 known manatees.
- There are over 250,000 images that document these sightings.

MIPS database uses:

- Assess the impact of hurricanes and red tide on manatee survival rates.
- Estimate manatee survival and reproduction rates to assist State and Federal assessments of status and recovery.
- Estimate scar acquisition rates to evaluate the efficacy of speed zones that were established to reduce watercraft strikes on manatees.
- Examine changes in migration patterns, survival, and reproduction with changes in habitat.
- Provide managers with information on manatee use of natural and industrial warm water sites during cold weather.

For further information, visit *http://cars.er.usgs.gov/Manatees/manatees.html*

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