

Integrated Science: Florida Manatees and Everglades Hydrology



Manatees (Sirenia Project photo)

Introduction

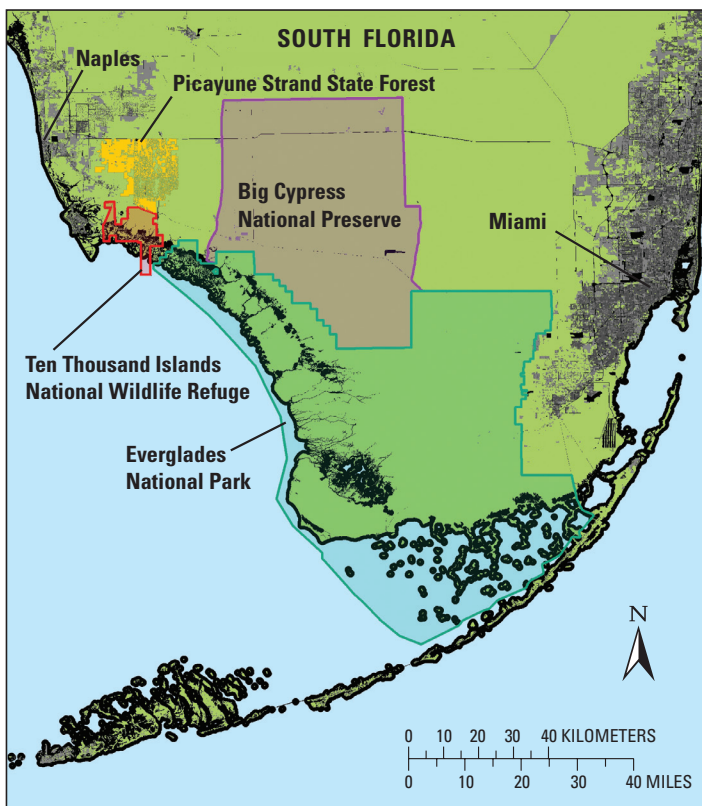
Restoration of the Everglades requires the implementation of dozens of separate construction components staggered over time and across the landscape; thus, effects on habitat and species will be realized on different time and spatial scales. Predicting and monitoring restoration effects on Florida manatees, which are known to make extended movements, will be incomplete if modeling and monitoring are limited to the smaller areas defined by the various restoration components. U.S. Geological Survey (USGS) efforts, thus far, have focused on (1) collecting manatee movement data throughout the Ten Thousand Islands (TTI) region, and (2) developing an individual-based model for manatees to illustrate manatee responses to changes in hydrology

related to the Picayune Strand Restoration Project (PSRP) (fig. 1). In 2006, new regional research was begun to extend an Everglades hydrology model into the TTI region; extend the manatee movement model into the southern estuaries of Everglades National Park (ENP); and integrate hydrology and manatee data, models, and monitoring across the TTI region and ENP. Currently (2008), three research tasks are underway to develop the necessary modeling components to assess restoration efforts across the Greater Everglades Ecosystem.

Linking the Manatee Individual-Based Model with a New Ten Thousand Islands Hydrology Model and an Everglades Model

To evaluate how proposed restoration changes will affect the endangered manatee, it is necessary to (1) apply the Flow and Transport in a Linked Overland/Aquifer Density Dependent System (FTLOADDS) hydrology model to the Everglades area covered by the Tides and Inflows in the Mangroves of the Everglades (TIME) hydrology model, (2) extend the TIME model into the TTI area, and (3) integrate the hydrology model output with an individual-based manatee model. The FTLOADDS model simulates key hydrologic parameters that manatees respond to, including salinity, water level, and water temperature. To improve its value for evaluating manatees across the Greater Everglades, the model is being developed and applied in the TTI region south of U.S. Highway 41, including the PSRP area and the Big Cypress region. This objective is critical because both areas are important to manatees and are identified as priorities in the U.S. Department of the Interior Science Plan. Telemetry data collected from radio-tracked manatees in the region will be analyzed to help calibrate the FTLOADDS model and parameterize the response of manatees to restoration (fig. 2).

Figure 1. Study area, showing general locations of the Ten Thousand Islands and Everglades National Park, south Florida.



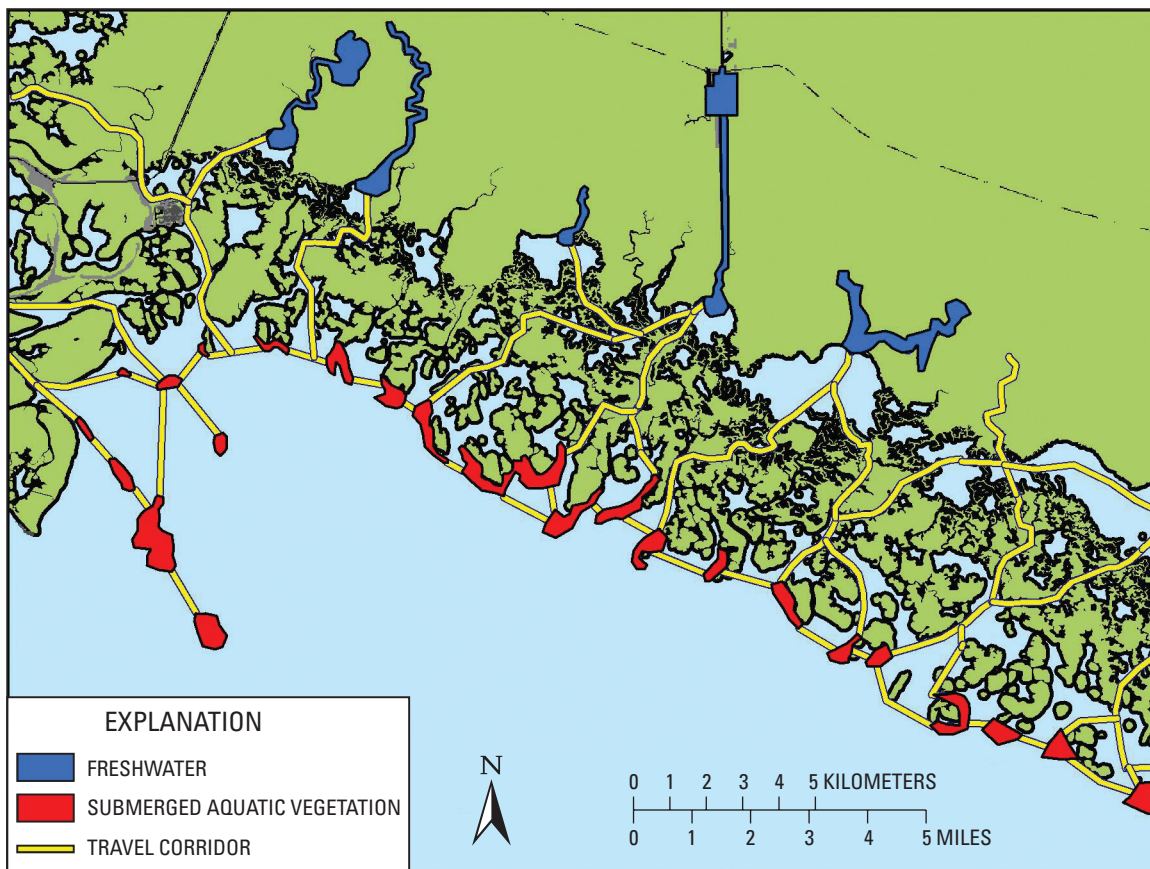


Figure 2. A network of destination nodes is used to parameterize the manatee model. Nodes are determined by tracking manatees via Global Positioning System transmitters, and are typically associated with critical resources (submerged aquatic vegetation and freshwater) and connecting travel corridors.

The coupling of the FTLOADDS model and the manatee model will allow researchers to study the relations between hydrologic conditions and variables, such as manatee movement and habitat use. Coupling the FTLOADDS and Across Trophic Level System Simulation (ATLSS)-style models will provide a useful tool for comparing the response of manatees to different hydrologic restoration scenarios.

Modeling Hydrology and Thermal Properties of Canals and Basins Used by Manatees as Winter Refuges

Cold stress is a major source of winter mortality for Florida manatees. Previous USGS research has shown that during cold periods, satellite-tagged manatees increase their use of the inshore canal systems that serve as passive thermal refuges (figs. 3, 4). During much of the winter season, vertical profiles at these sites indicate a halocline of warmer saltwater trapped below a cooler freshwater

Figure 3. Modeled temperature output during warm and cold winter periods. The black dots represent field data from one manatee tracked with a Global Positioning System transmitter during periods when the model predicted (A) overall warm water in the region, and (B) an inshore warm area during a period of overall cold water.

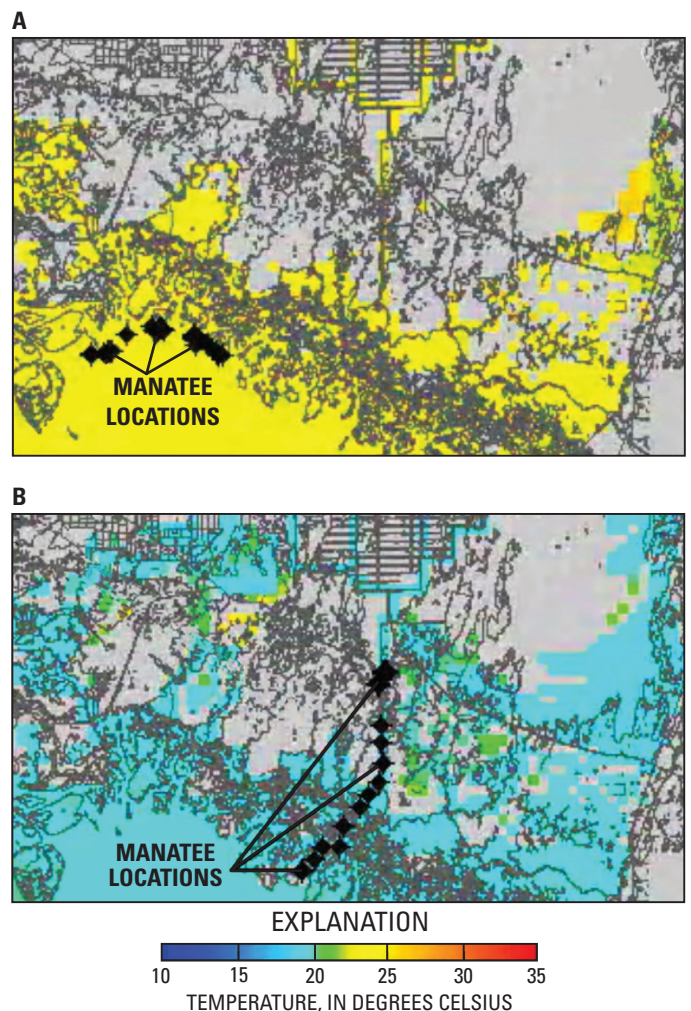




Figure 4. Aerial photograph of the Faka Union (Port of the Islands) basin. This is the main passive thermal refuge in the Ten Thousand Islands area, at times harboring more than 300 manatees during cold winter weather. Photograph by the Florida Department of Environmental Protection.

lens (fig. 5). The resulting thermal inversion is used by manatees to stay warm and avoid potentially fatal hypothermia. The hydrologic process producing the halocline, and how restoration may disrupt its thermal properties, is not well understood. The objective of this task is to measure and model the three-dimensional properties of several of these sites in the TTI. This monitoring and modeling effort will provide important information for characterizing the salinity and temperature regimes of canals used by manatees and other cold-intolerant fauna/biota, such as invasive, exotic fish species.

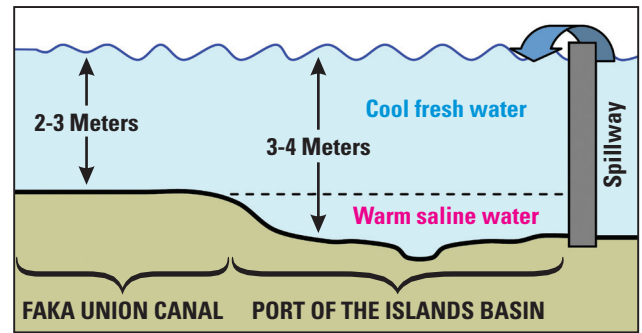


Figure 5. Vertical profile of the Port of the Islands basin, showing the halocline that allows for the pooling of warm water in the deeper parts of the basin.

A related integrated research and monitoring effort is being initiated in partnership with the South Florida Water Management District. The PSRP will attempt to restore sheetflow hydrologic conditions across a broad area by reducing and diverting flow from the four large canals located north of U.S. Highway 41 that drain into the Faka Union canal. USGS researchers will assess the probable effect of planned hydrologic changes on warm-water refuges, freshwater resources, and other critical habitat on manatee movements and exposure to environmental stresses. Monitored patterns of hydrologic change and associated manatee responses will be used to further validate and improve the hydrologic and manatee models.

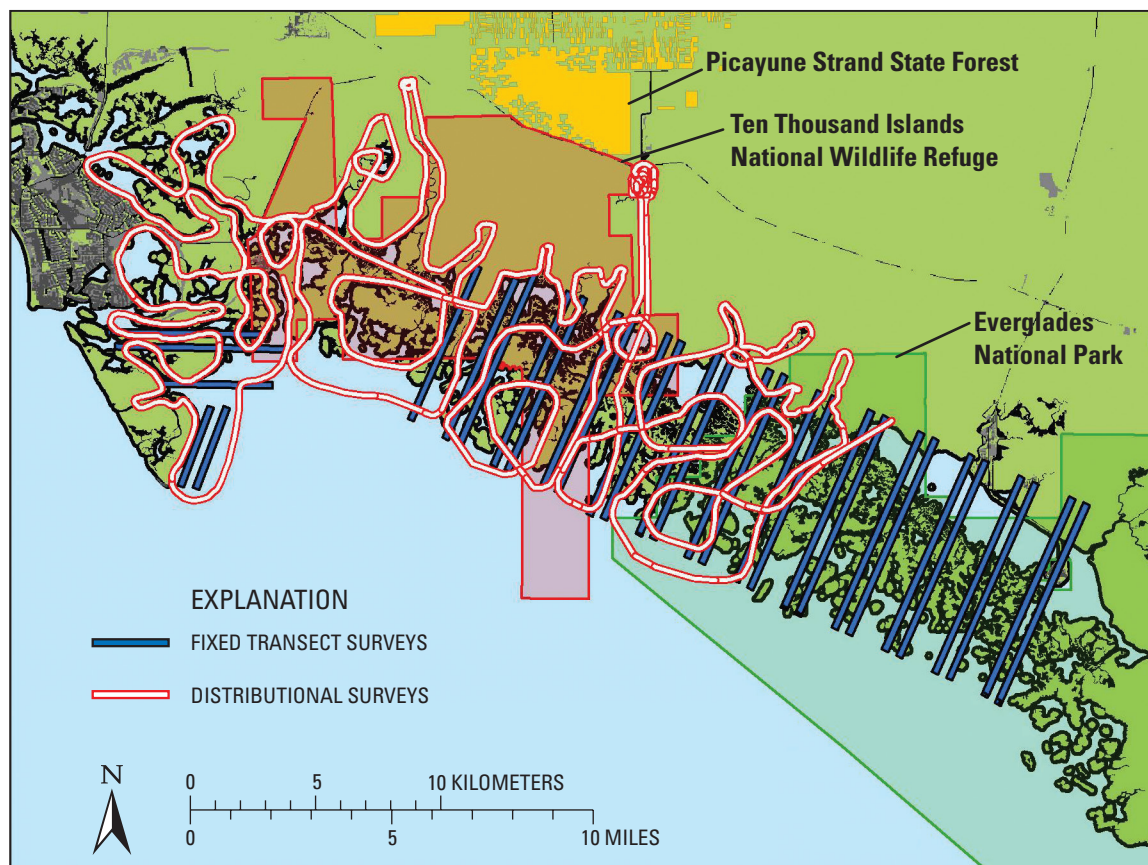
Developing and Implementing a Regional Aerial Survey Monitoring Design that Integrates Ten Thousand Islands with Everglades National Park

Aerial surveys, although often challenging, offer the best opportunity to monitor the population across the entire region in a cost-effective and scientifically robust manner (figs. 6, 7).



Figure 6. Aerial surveys for manatees are a challenge in the Ten Thousand Islands and Everglades National Park. Photograph by the Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission.

Figure 7. Flight paths for fixed-transect (blue) and distributional surveys (pink) being evaluated for monitoring manatee abundance and distribution in the Ten Thousand Islands National Wildlife Refuge.



The main objectives of this study are to:

- Develop valid statistical approaches to document changes in manatee distributions and abundance in association with habitat variables incorporated in the models;
- Develop and implement a regional manatee monitoring design for pre- and post-restoration assessments, integrating TTI with ENP; and
- Provide an independent dataset for validation of the predictive manatee/hydrology models.

Several statistical approaches to estimate habitat-patch occupancy rates and abundance from aerial survey data at TTI are being evaluated, including the proportion of area occupied, based on presence/absence data, hierarchical models, and removal models.

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For more information~~

Comprehensive Everglades Restoration Plan: Home page:
<http://www.evergladesplan.org/>

U.S. Geological Survey Sirenia Project Manatee Research: Home page: <http://fl.biology.usgs.gov/Manatees/manatees.html>

Suggested citation~~

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