National Park Service
U.S. Department of the Interior

South Florida Natural Resources Center
Everglades National Park

Impact of ISOP/IOP on Aquatic Ecosystem Function: Assessment Update

Background

Starting in December 1999, water deliveries into Everglades National Park (ENP) were modified to better protect nesting habitat of the federally designated endangered Cape Sable Seaside Sparrow during the spring nesting season by way of the Interim Structural and Operational Plan (ISOP) and later by the Interim Operational Plan (IOP). Structural and operational changes were designed to move water away from western Shark Slough, which was too wet for successful sparrow nesting. We used our assessment protocol developed with CESI funding to identify the effects of this change in delivery on aquatic ecosystem function. In 2003, park managers identified the period of December 1996 through November 1999 as a reference period for assessing any impact in the first three years of implementing ISOP/IOP. We have now updated the assessment through April 2006 and expanded the hydrologic reference period back to 1993.

Drainage of the Everglades has diminished seasonal concentrations of important wading bird prey—small fish and crustaceans—leading to a decline in wading bird nesting and displacement of birds from their traditional nesting locations. Based on the assumption that seasonal prey concentrations were key to historical wading bird success, a trophic hypothesis was developed for the Monitoring and Assessment Plan which supports the Comprehensive Everglades Restoration Plan (Fig. 1). The trophic hypothesis predicts that restoring historical hydrologic patterns to pre-drainage conditions will in turn restore the timing and location of seasonally concentrated prey, ultimately restoring wading bird foraging and nesting to the southern Everglades.

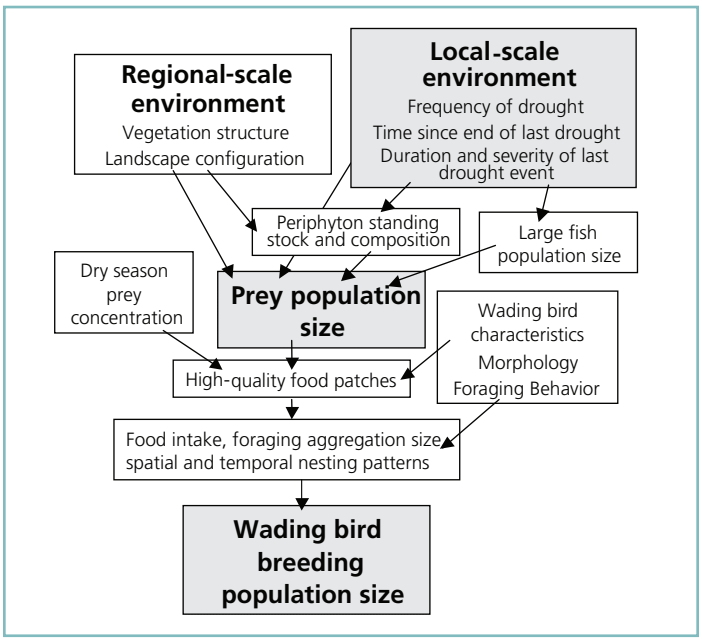

Figure 1. Conceptual model illustrating linkage of environmental conditions to prey species performance measures, and linkage of prey populations to wading bird populations. Components highlighted in grey were the focus of this study.

A set of small fish and crustaceans was selected as indicators of management success in regaining suitable wading bird foraging habitat. Key components of the Everglades food web that are sensitive to hydrologic management, these species can be used to track hydrologic history with little time lag and can be studied at the landscape scale.

To account for the variable hydrology of the Everglades in this assessment, we developed dynamic hydrologic targets that respond to changes in prevailing regional rainfall. We also derived statistical relationships between prey density and hydrologic drivers for prey species representing four different life-history responses to drought. Finally, we used these statistical relationships and hydrologic targets to set restoration targets for prey density.

Project Objectives

1. Document effects of ISOP/IOP on aquatic ecosystem function in relation to the trophic hypothesis for wading birds. Identify presence of any ecological impacts, both positive and negative.
2. Use operations from the mid to late 1990s as a reference for assessing impacts and account for differences in rainfall during the reference and ISOP/IOP periods.
3. Develop a list of performance measures (linking an environmental driver to a desired management endpoint) that capture key linkages in the trophic hypothesis and illustrate their use in an assessment protocol that controls for temporal variation in climatic drivers of the ecosystem that are outside the control of water managers.

Key Findings and Management Implications

Several patterns of population-level responses to marsh drying in wading bird prey species were identified and are believed to represent different life-history strategies for coping with drought stress. Indicator species were selected to represent groups of species with similar strategies. Three patterns have been observed in fish and grass shrimp: 1) slow recovery following marsh drying, taking years to regain pre-drought density (typical of bluefin killifish, least killifish, and grass shrimp); 2) maximum density attained soon after drying events and lower densities a year or longer after drying (typical of flagfish and marsh killifish); and 3) a moderate relationship between density and time since drying at a regional site, presumably because of medium-scale movement (tens of kilometers) from areas that are drying (unique in the

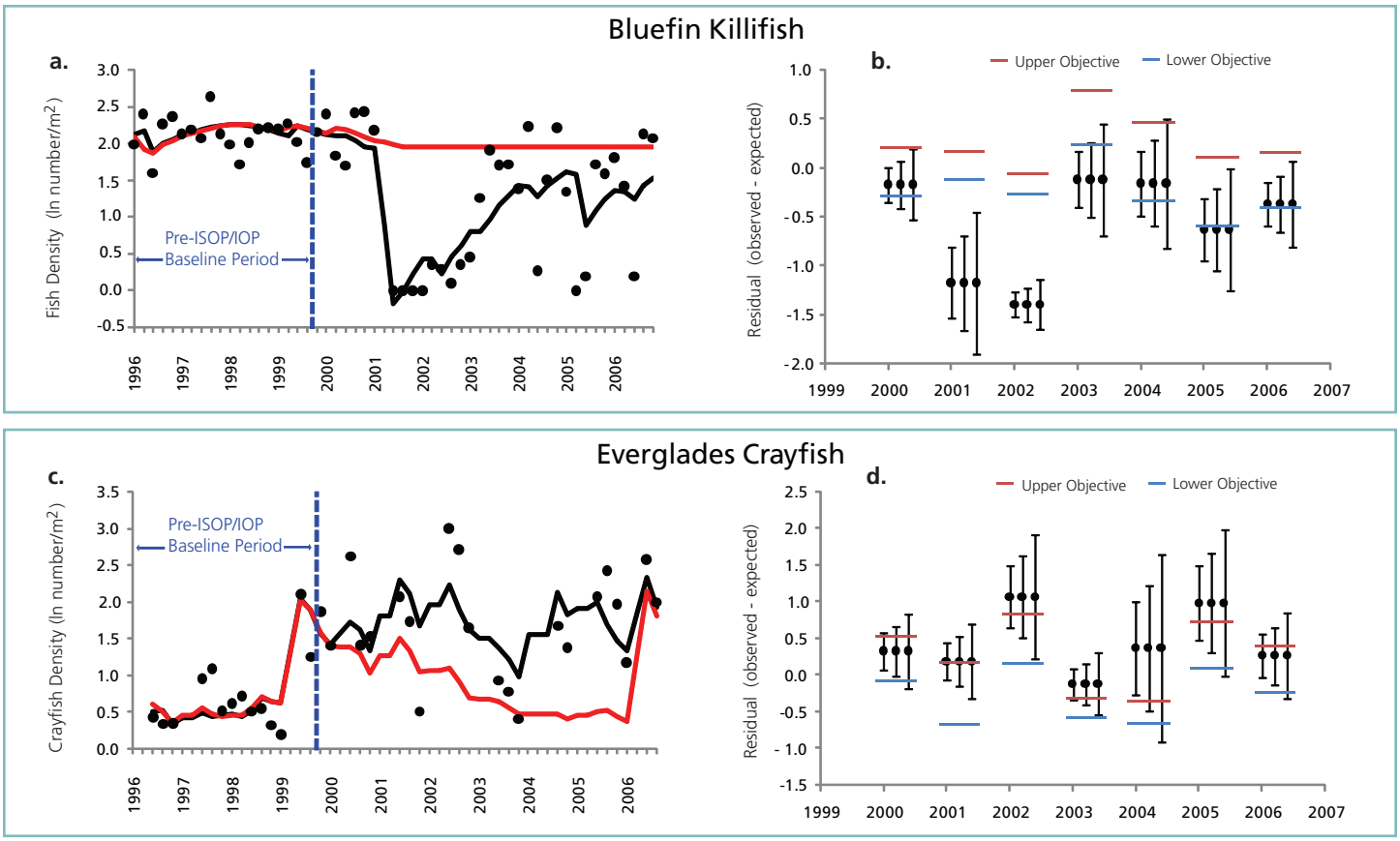

Figure 2. Time series data illustrating the assessment process. Observed prey density time series data (black dots and line) and model predictions (red line) are shown in graphs a and c. In each case, data shown represent one long-term monitoring site in ENP. Reflecting different life-history adaptations to drought, bluefin killifish showed a long recovery from marsh drying following implementation of ISOP/IOP, while Everglades crayfish densities increased under drier conditions. Objective limits and targets of corresponding performance measures are shown in graphs b and d. Upper and lower objective limits are 95% confidence limits from our ecological targets. The widths of the intervals (1.5, 2.0, and 3.0 standard errors) correspond to different criteria for assessment. Crayfish densities met or exceeded performance targets each year, while bluefin killifish densities in some years failed to meet even the lower bound of the ecological target, even at the least strict assessment criterion.

Everglades to eastern mosquitofish). A fourth pattern is seen in crayfish and probably differs from fish and grass shrimp parameters due to the ability of crayfish to burrow and tolerate moderate amounts of marsh drying. Everglades crayfish display little or no relationship between local time since flooding and density, but regional drying and average water depth over the past 6 months do explain moderate amounts of variability in density (Fig. 2).

A hydrologic model, developed using reference period (November 1, 1993, to November 1, 1999) rainfall data and surface-water depths, was used to predict surface-water depths in the assessment period (January 1, 2000, to December 31, 2006) assuming water management operations in place during the reference period had been maintained. The models predicted wetter marshes and fewer drying events in many areas south of Tamiami Trail than were actually observed during the assessment period, suggesting that the ISOP/IOP operations were responsible for the hydrologic changes, not differences in rainfall.

Prey densities were projected into the assessment period by using the predicted water depths from the hydrologic model and the parameter estimates from the ecological model and provided an estimate of aquatic consumer densities if water-management activities were consistent with the goals and targets as defined for this assessment. Many instances were observed where prey density deviated substantially from predictions (Fig. 2), suggesting that the deviation in the relationship between rainfall and water depth in the assessment period translated to a change in aquatic fauna densities that resulted from water-management activities.

Our assessments indicate that Taylor Slough and some areas of Shark River Slough have been drier than expected on the basis of rainfall since the implementation of ISOP/IOP and that this has altered ecosystem function relevant to the trophic hypothesis. Aquatic species that are less abundant in drier conditions, as well as those that are more abundant in drier conditions, responded in ways to support this conclusion. The ultimate consequence of these and other changes at the aquatic trophic level on wading bird populations remains to be investigated.

Recommendations for Future Studies

At present, most hydrologic scenarios are run using rainfall data from some past date until the year 2000. However, ecological monitoring in the Everglades was not well established prior to 2000. To make the best use of available ecological monitoring data, there is a need for hydrologic models run through present time so that the output can be used to expand the interpretation of field data to aid in assessment of management impacts.

Related Publications:
See http://nps.gov/ever/naturescience/cesimon03-1.htm

Principal Investigators: Joel Trexler and Charles Goss; Florida International University, http://www.fiu.edu/~trexlerj/publications.htm