EXHIBIT 26

U.S. Geological Survey Program on the South Florida Ecosystem: 2000 Proceedings

Presentations made at the Greater Everglades Restoration (GEER) Conference, December 11-15, 2000, Naples, Florida

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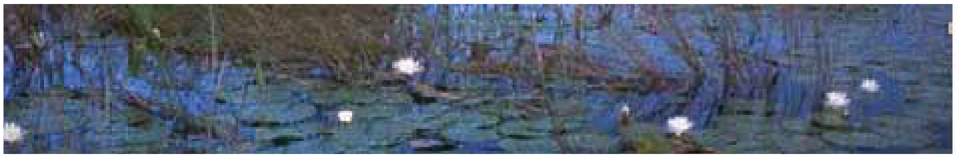
SOUTH FLORIDA ECOSYSTEM RESTORATION TASK FORCE AND WORKING GROUP



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Photographs:

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U.S. DEPARTMENT OF THE INTERIOR
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Computer Simulation Modeling of Intermediate Trophic Levels for Across Trophic Level Systems Simulation of the Everglades/ Big Cypress Region

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The project has three primary components: (1) modeling of the snail kite population in Florida; (2) modeling of wading bird populations in the Everglades; and (3) modeling of the reptile and amphibian food web in the Everglades.

Snail kite modeling: The snail kite is a raptor whose distribution in the United States is limited to the freshwater marshes of southern and central Florida, including the Everglades. The snail kite is listed as an endangered species in the United States. Although its numbers have appeared to increase in recent years, total population size is probably still below 2000. Because of its endangered status, the snail kite is among the species being given specific attention in the ongoing Everglades restoration project (Bennetts and others, 1994, Davis and Ogden 1994). It is the objective of this work to develop an individual-based, spatially-explicit model of the snail kite population that includes the response of the snail kite population, both in its spatial patterns and its survival to drought conditions. The model is being applied to both historical data on the spatial pattern of water levels throughout the snail kite's range as well as the pattern of water levels projected from models for changed water regulation conditions.

The spatial structure of the model consists of several disjunct habitat areas, which we will refer to as wetland habitat sites. Following Bennetts and Kitchens (1996), fourteen major wetlands in southern and central Florida were identified as suitable snail kite habitat: Everglades National Park, Big Cypress National Preserve, Water Conservation Areas 3A, 3B, 2A, 2B, and 1 (Loxahatchee National Wildlife Refuge Preserve), Loxahatchee Slough, Holey Land Wildlife Management Area, Lake Okeechobee, Upper Saint John's Marsh, Lake Kissimmee, Kissimmee Chain of Lakes, Lake Tohopekaliga, and East Lake Tohopekaliga. A fifteenth habitat area was added to the model, representing the scattered pieces of peripheral habitat in the agricultural areas, as a refugium for the kites during a system-wide drought.

The hydrology of individual wetland habitat sites in particular years is critically important to whether that site can be used for nesting by snail kites. Their sole food supply, apple snails, die or become unavailable when a site becomes dry. After drydown, a particular site may not be good habitat for a few years, until the apple snail population recovers. For purposes of modeling, the water levels in each wetland habitat site can be defined by a historical record estimated from a single water gauge near the core habitat of the snail kites on the wetland site, or these water levels can be produced from hydrologic models applied to forecast future water levels under different water regulation conditions. Each modeled kite goes through a fixed set of life stages. These life stages affect the probabilities with which the demographic processes of breeding, movement, and mortality occur. Each individual kite is simulated in the model on a weekly basis. Figure 1 shows sample model predictions of the relative effects of different hydrologic scenarios on the growth rates of the snail kite in a particular wetland over the 31-year period.

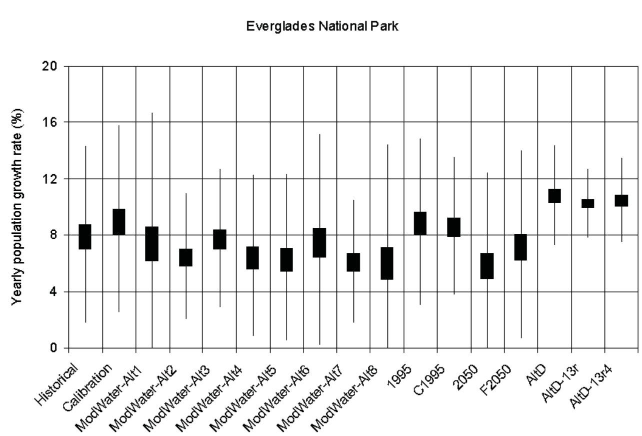

Figure 1. Output of the ATLSS snail kite model. The output compares the mean annual growth rate of the snail kite population in one particular breeding site, Everglades National Park, under a number of different water regulation scenarios.

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Wading bird modeling: The purpose of the wading bird model is to investigate the dynamics of colonies and nesting success in relation to different hydrologic scenarios and the resulting spatial and temporal distribution of their prey. The model uses an individual-based approach and simulates the activities of potential nesting adults for a period of time immediately preceding the formation of a nesting colony and then through the entire nesting season. The model will enable wading bird ecologists to assess the effects of changes in the volume, timing, and spatial distribution of water flows on wading bird colonies sited at various locations in the Everglades.

Each individual wading bird in the model is described by a set of species-specific rules that govern their behavioral activities. A model wading bird does not operate on a fixed time scale, because its behavioral activities are of different duration. Instead, the wading bird model uses an event-driven approach, in which each bird sets its own time scales depending on its current activities. In its current version, the wading bird model operates on spatial grid of 500 m x 500 m grid cells.

Decisions made by the birds are guided by various constraints. Each bird must meet its energy demand during each day. If it can not meet this requirement, the bird is assumed to have died or left the system and is removed from the simulation. Colony formation, courtship, nesting, and egg laying are also determined by energetic constraints. The model assumes that nesting will only start if females have acquired sufficient energy reserves to produce eggs. Unless female birds can meet these demands, nesting will not start. Colony formation and nesting is therefore directly tied to the availability of prey and the ability of the birds to obtain enough food in close proximity to their potential colony site.

The model keeps track of colony sizes and the number of nesting adults as well as the number of successfully fledged nestlings after the breeding season is over. Because energetic constraints drive most of their activities, in particular the onset and timing of nesting, different environmental conditions will lead to varying reproductive behavior and recruitment of young wading birds into the population.

Reptilian and amphibian modeling: The herpetological assemblage may play a vital role in sustaining a number of trophic groups and species in the Everglades. The American alligator, an important top predator in the region and a major concern of the Everglades restoration effort, is a good example. A recent study in the central Everglades indicated that reptiles and amphibians make up to 65 percent, on average, of adult alligator diets. In addition, wading birds, raptors, arthropods, mammals, and fish also prey on members of the assemblage. Given the importance of reptiles and amphibians to the freshwater aquatic ecosystems in the Everglades, an estimate was developed of the amount of biomass the assemblage produces that could be available to higher predators, given the internal feeding dynamics between assemblage members, and energetic constraints.

Food web structures were constructed consisting of nine functional groups for each of three general habitat types based on stomach content analyses. Estimates were made of energy gains and losses (fluxes) for each functional group. The model was parameterized using estimates derived from field data and the literature. Linear Programming was used to solve for a better set of estimates of the fluxes, given conditions of mass balance and constraints set by the initially estimated values. Critical to the model were choices of: (1) the relevant natural history of the assemblage and modeling considerations; (2) the choice of three habitat types; (3) decisions for lumping species into functional groups; (4) the mathematical relationships describing energy flow; (5) the linear programming models; and (6) parameter estimation.

Crocodile modeling and empirical work: The American crocodile individual-based model has been developed within the a modeling platform developed at the Netherlands Institute of Ecology (OSIRIS) framework. The purpose of the model is to predict how the American crocodile population will respond to alterations in freshwater flow into the estuary habitat. In the working version of the model individuals grow, interact, breed and suffer mortality dependent upon a static hypothetical landscape, salinity, and interactions with other crocodiles. The most recent work has focused on creating a dynamic landscape dependent upon freshwater input. In support of this modeling effort, the American crocodile radio-tracking project seeks to test for salinity effects upon hatchlings. Based on the literature, it is expected that hatchlings would prefer freshwater and would lose weight in hypersaline habitats.

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The population of American crocodiles is being modeled using a spatially-explicit individual-based approach from the estuary areas of south Florida. The model imports an initial estuary landscape and then runs hypothetical water delivery scenarios which can alter the dominate vegetation types and salinity levels. Figure 2 shows the body condition of a model crocodile hatchling under different salinity conditions due to differences in rainfall for different years. Other work involves model parameterization, which is currently focused on fitting growth data to available models and acquisition of hatchling movement and survivorship data via radio-tracking. During the summer of 1999 11 radio-transmitters were placed on hatchling American crocodiles at the Florida Power and Light Company's Turkey Point Power Plant. Of these, 5 individuals were successfully tracked for up to 82 days in both the hypersaline cooling canal system and in surrounding freshwater and low saline habitats.

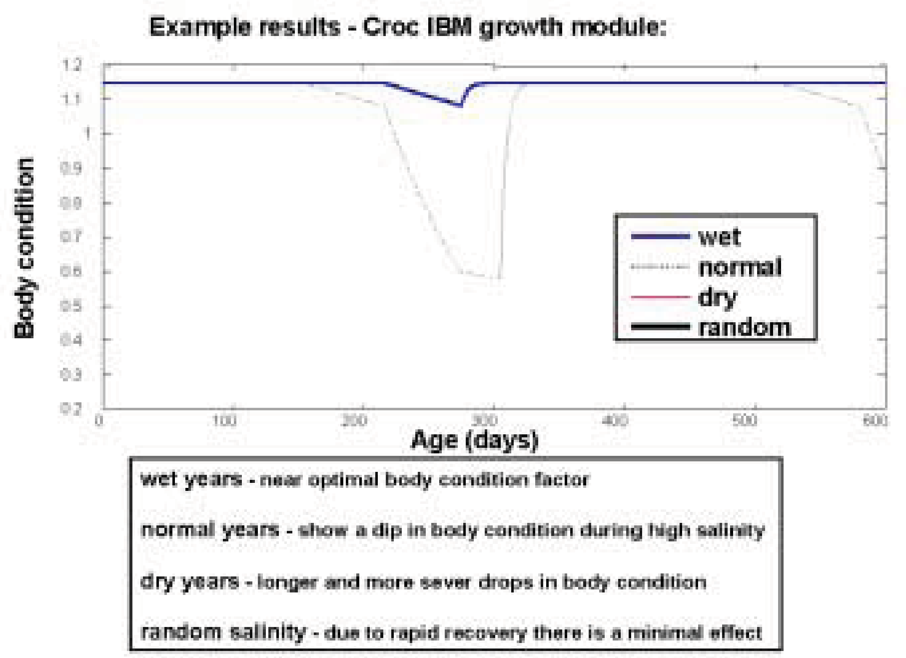

Figure 2. Output from individual-based model of American crocodile. Body condition of a particular crocodile is shown as a function of age under different environmental conditions.