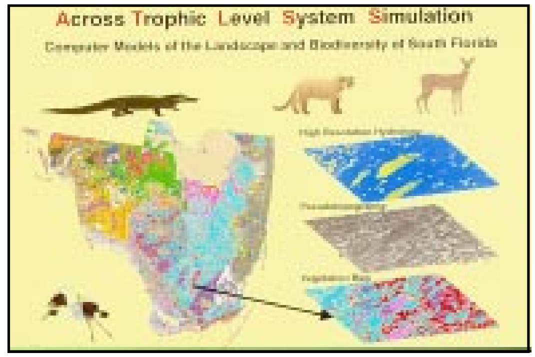
Across-Trophic-Level-System Simulation (ATLSS) Program

The USGS Florida Caribbean Science Center's Restoration Ecology Branch has developed a set of landscape level computer simulation models (ATLSS). These models can provide a detailed understanding of several key species on the Greater Everglades landscape under changing environmental conditions. These models have played a role in assessing Everglades restoration plans.



An essential component of restoration planning in South Florida has been the development and use of computer simulation models for the major physical processes driving the system, notably models of hydrology incorporating effects of alternative human control systems and non-controlled inputs such as rainfall. The USGS's ATLSS (Across Trophic Level System Simulation) Program utilizes the outputs of such physical system models as inputs to a variety of ecological models that compare the relative impacts of alternative hydrologic scenarios on the biotic components of South Florida. The immediate objective of ATLSS is to provide a rational, scientific basis for ranking the water management scenarios as part of to the planning process for Everglades restoration. The longer term goals of ATLSS are to help achieve a better understanding of components of the Everglades ecosystem, to provide an integrative tool for empirical studies, and to provide a framework monitoring and adaptive management schemes.

ATLSS is constructed as a multimodel, meaning that it includes a collection of linked models for various physical and biotic systems components of the Greater Everglades. The ATLSS models are all linked through a common framework of vegetative, topographic, and land use maps that allow for the necessary interaction between spatially-explicit information on physical processes and the dynamics of organism response across the landscape. This landscape modeling approach is the work of USGS scientists and collaborators from several universities.

The South Florida Water Management Model provides hydrology for ATLSS models at a 2 x 2 mile spatial resolution. The ATLSS multimodeling approach starts with models that translate this coarse-scale hydrology output to a finer resolution appropriate for biotic components. This is achieved through use of GIS vegetation maps and empirical information relating hydroperiods with vegetation types, to develop an approximate hydrology at 500 x 500 m resolution from the 2 x 2 mile hydrology model.

The simplest ecological models in the ATLSS family are the Spatially-Explicit Species Index (SESI) models, which compute indices for breeding or foraging potential for key species. These models use the fine resolution hydrology output, combining several attributes of hydrology that are relevant to the well-being of particular species to derive an index value for every spatial cell in the landscape. This can be done for hydrology data for any given year under any alternative water management scenario. SESI models have been constructed and applied during the Central and Southern Florida Comprehensive Review Study (Restudy) to the Cape Sable seaside sparrow, the snail kite, short- and long-legged wading birds, the white-tailed deer, and the American alligators.

Considerably more detailed models have been developed for the distribution of functional groups of fish across the freshwater landscape. This model considers the size distribution of large and small fish as important to the basic food chain that supports wading birds. It has been applied to assess the spatial and temporal distribution of availability of fish prey for wading birds. This modeling is being extended to crayfish.

Individual-based models, which track the behavior, growth and reproduction of individual organisms across the landscape, have been constructed for the Cape Sable seaside sparrow, the snail kite, The white-tailed deer, the Florida panther and various wading bird species. The models include great mechanistic detail on the behavioral and physiological aspects of these species. An advantage of these detailed models is that they link each individual animal to specific environmental conditions on the landscape. These conditions (e.g., water depth, food availability) can change dramatically through time and from one location to another, and determine when and where particular species will be able to survive and reproduce. ATLSS models have been developed and tested in close collaboration with field ecologists who have years of experience and data from working with the major animal species of South Florida.

The ATLSS integrated suite of models has been used extensively in Everglades Restoration planning. Restoration goals include recovery of unique Everglades species, including snail kites and Florida panthers. The quantity, quality, timing, and distribution of deliveries of water to the Greater Everglades are keys to the restoration of natural functions. The challenge is to provide the hydrologic conditions needed by communities of plants and animals, while maintaining water supplies and flood control for a large and expanding human population. The role of USGS's ATLSS Program is to predict the effects of changes in water management on Greater Everglades species and biological communities, as an aid to identifying and selecting those changes most effective for the restoration effort.

To date, the focus of ATLSS to date has been on the freshwater systems, with emphasis on the intermediate and upper trophic levels. ATLSS will be extended estuarine and near-shore dynamic models once physical system models for these regions are completed. Modeling of the mangrove vegetative community, estuarine fish, crocodiles, and roseate spoonbills is now underway. Additional species, such as the manatee, may be added. Future plans for the ATLSS Program also include development of vegetative succession models for important community types. In addition, to make the outputs of the ATLSS models easy to view and analyze in a variety of ways, one of the ATLSS projects is developing an Internet based GIS visualization tool.

Ongoing Research and Collaborations:

Computer Simulation Modeling of Intermediate Trophic Levels for Across Trophic Level System Simulations of the Everglades/Big Cypress Region, Michael Gaines, University of Miami

Development of Selected Model Components of an Across-Trophic Level Systems Simulation (ATLSS) for the Wetland Ecosystems of South Florida, Dr. Louis J. Gross, University of Tennessee

Network Analysis of Trophic Dynamics in South Florida Ecosystems, Dr. Robert E. Ulanowicz, University of Maryland

A Multimodeling Integration and Implementation Supporting ATLSS: Across Trophic Level System Simulation, Dr. Paul Fishwick, Department of Computer & Information Science and Engineering, University of Florida

Development of an Internet Based GIS to Visualize ATLSS Datasets for Resource Managers, Dr. James B. Johnston, USGS-National Wetlands Research Center

Effects of Hydrology on Wading Bird Foraging Parameters, Dr. Dale Gawlik and Dr. Fred Sklar, South Florida Water Management District

Critical Model Development for the Restudy: Additional DOI Restudy Needs and ATLSS Production Runs for Various Hydrologic Evaluations, Dr. Lou Gross, University of Tennessee

Individual-Based Spatially Explicit Model of the Cape Sable Seaside Sparrow Population in the Florida Everglades, Dr. M. Philip Nott, The Institute for Bird Populations

Parameter Estimation and Population-Based Simulation Modeling of American Alligator Population in Support of ATLSS, Dr. Ken Rice, USGS Florida Caribbean Science Center

Mangrove Modeling of Landscape, Stand Level, and Soil Nutrient Processes for the ATLSS Program and Everglades Restoration Project, Dr. Tom Doyle, USGS National Wetlands Research Center

Developing and ATLSS/ELM Lower Trophic Level Model, Dr. Quan Dong, Florida International University

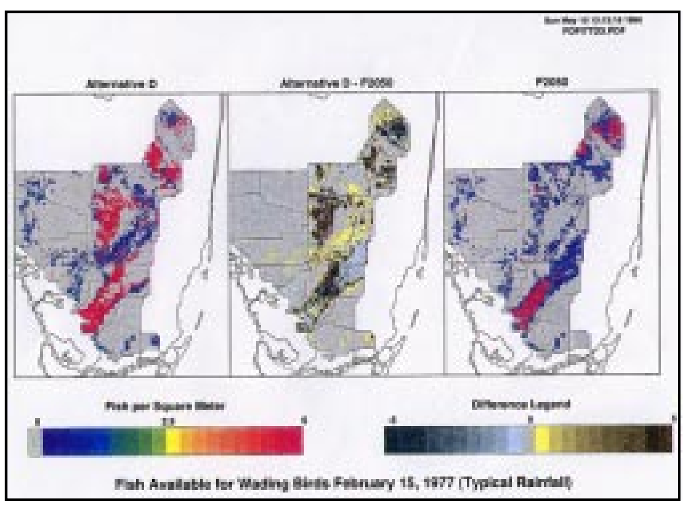


Figure 2. ATLSS output comparing Everglades restoration plans. Fish densities for a base scenario (F2050) and an alternative plan (Alternative D) are shown.

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