Modeling Fish Population and Biomass on the Everglades Landscape (ALFISH)

ALFISH is a model created under the Across Trophic Level System Simulation (ATLSS) Program of the U.S. Geological Survey (USGS). Its purpose is to describe fish functional groups in freshwater marshes of the greater Everglades area of southern Florida. In particular, it is intended to assess the spatial pattern of fish densities through time across freshwater marshes. This model has the capability of providing a dynamic measure of the spatially explicit food resources available to wading birds. ALFISH simulates two functional groups-large and small fish-where the larger fish can prey on the smaller fish. Both functional groups are size-structured. The marsh landscape is modeled as 500-m × 500-m spatial cells on a grid across southern Florida. The ATLSS High Resolution Hydrology model is used to provide water levels in the spatial cells on 5-day intervals. Fish populations spread across the marsh during flooded conditions and either retreat into refugia (alligator ponds), move to other spatial cells, or die if their cell dries out.

ALFISH has been applied to the evaluation of alternative water regulation scenarios under the Central and South Florida Comprehensive Project Review Study. The objective of this Review Study has been to compare alternative methods for restoring historical ecological conditions in southern Florida. ALFISH has provided information on which hydrological scenarios are most likely to increase fish biomass and its availability to wading bird populations. The model also provides the opportunity for stakeholders with interests in particular subregions of the landscape to contrast the effects of alternative hydrologic plans on the availability of fish biomass in these subregions. As a demographic model, ALFISH also keeps track of the history of the effects of dry, normal, and wet hydrologic conditions on fish population size structure.

How ALFISH Works:

ALFISH considers two fish functional groups: Small Fish, which includes all fish species with a maximum possible length of 7 cm, and Large Fish, which includes all fish species with maximum lengths greater than 7 cm. ALFISH treats the fish functional groups as an age-size structured model. The fish in each functional group grow in size every 5 days. The age of maturity and the fecundity are unique to each functional group. Four causes of mortality are included: (1) Background mortality, or the natural mortality of an uncrowded population, which is dependent on fish age class but is independent of population size; (2) Density -dependent mortality from starvation; (3) Loss due to predation from other functional groups; and (4) Death resulting from dry-down, in which some fish do not successfully reach deeper water as a spatial cell dries.

Movement in ALFISH has two phases: First, within-cell movement takes place, allowing fish density to shift between the pond and the marsh areas of various depths within a particular cell. Second, fish density can shift between the marsh areas of adjoining cells according to differences between water depth and fish densities in these cells (Figure 1).

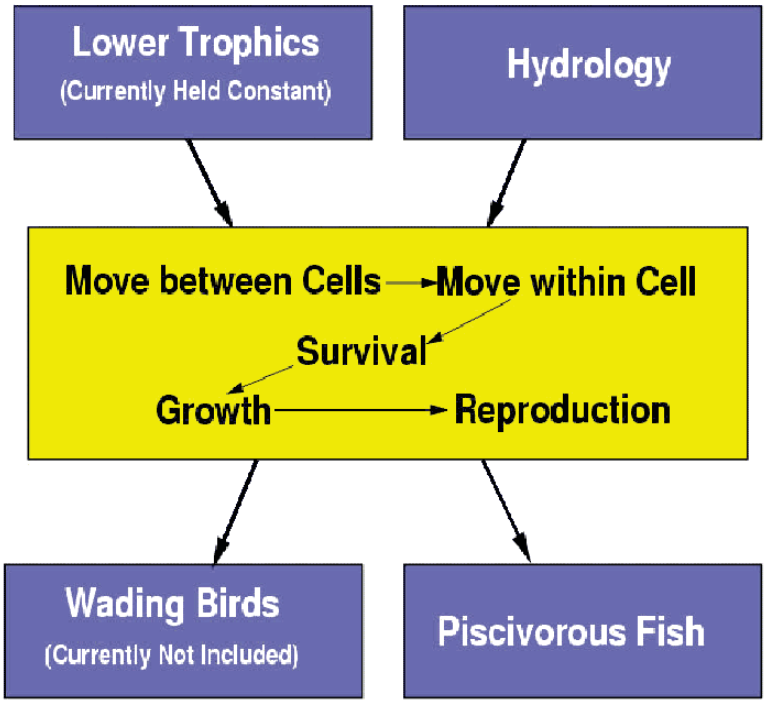

Figure 1. Flow chart for the seasonal dynamics of fish in the model ALFISH.

What ALFISH Produces:

ALFISH is capable of producing detailed comparisons of changes in fish densities and size structure between alternative hydrologic scenarios. ALFISH outputs include the following (Figure 2):

- Maps of the Small Fish functional group total density (number of fish per square meter) in marsh areas within individual cells over the entire region, modeled at a

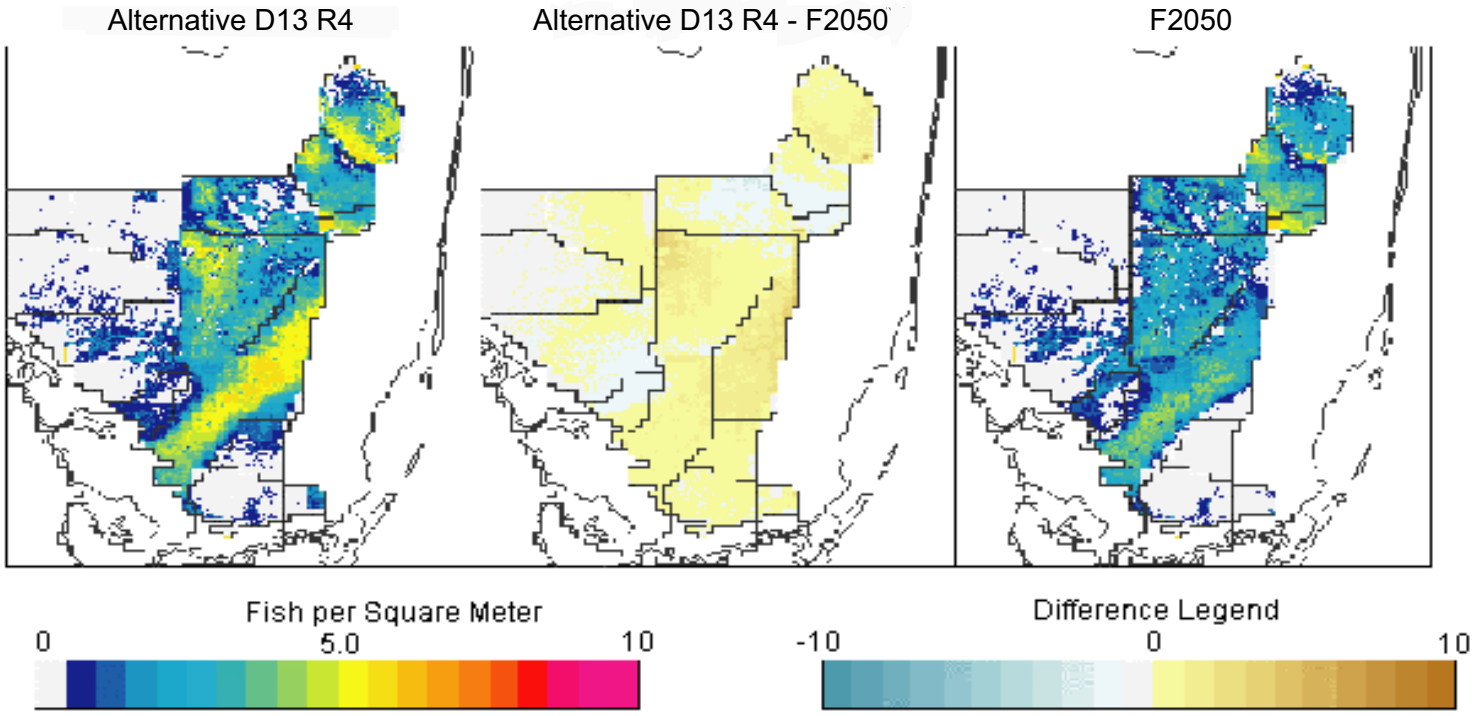

Figure 2. Example of ALFISH output, showing Small Fish density across the landscape, averaged over 31 years, for two scenarios, AltD13R4 and F2050, as well as the difference between them (middle panel).

500-m × 500-m cell resolution generated for a individual day at different days of the year. These maps allow comparisons for years with high, average, and low rainfall.

- Maps of the Small Fish Functional group total density (number of fish per square meter) in the marsh areas, including just cells with appropriate water depth (10-30 cm) for wading bird foraging. These are calculated for 500-m x 500-m cells and displayed for single days at several times throughout the wading bird breeding season. These maps allow comparisons of fish availability to wading birds for years with high, average and low rainfall.

- Maps of the total Small Fish functional group density (number of fish per square meter) in the marsh area of individual cells, for particular days of the year, averaged over the entire 31-year scenario

- Time series showing the average density of the Small Fish functional group, averaged over the entire region, with output every 10 days. Separate time series for fish densities in marsh and pond areas.

- Time series showing the average density of the Small Fish functional group (number of fish per square meter), for fish between 2 and 7 cm long, associated with each of the wading bird breeding season maps in Figure 2.

- Time series of histograms of the size distribution of the Small Fish functional group in various subregions.

- Tables summarizing the total fish densities broken down by basin area and by year. These give estimates of fish per square meter averaged over the entire year.

Reference:

Gaff, H., D. L. DeAngelis, L. J. Gross, R. Salinas and M. Shorrosh. (2000). A dynamic landscape model for fish in the Everglades and its application to restoration. Ecological Modelling 127:33-52.

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The Critical Ecosystem Studies Initiative supports studies conducted to provide physical and biological information, simulation modeling, and planning that are critical for achieving South Florida ecosystem restoration