SIMSPAR Model Simulates the Impact of Hydrology on the Cape Sable Seaside Sparrow

SIMSPAR is a spatially-explicit, individual-based model designed as a management and evaluation tool for the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), an endangered subspecies of seaside sparrow that lives exclusively in the southern Everglades. The model is designed to simulate how changes in hydrology across the nesting area of the sparrow are likely to affect the reproductive success and, therefore, the population viability of the Cape Sable sparrow. SIMSPAR has been developed at the University of Tennessee under the USGS's Across Trophic Level System Simulation (ATLSS) Program.

Why the Cape Sable Seaside Sparrow is in Danger

The Cape Sable seaside sparrow has a current population level of only a few thousand individuals and its total habitat occupies only several hundred square kilometers of the southern Everglades. The sparrows nest during the dry season in the sparse sawgrass and Muhly grass of the marl prairies of the southern Everglades. Nesting begins only when water depths approach ground level. Re-flooding of nesting areas during nesting can lead to nest abandonment. Unfortunately, an important part of the sparrows' habitat, called the "western area" because it is west of Shark Slough, is in the path of water released from the Water Conservation Areas (WCAs) north of Everglades National Park. When water levels are high in the WCAs, large releases of water are often made during the dry season as a precaution against flooding in the next rainy season. During the high rainfall years of the 1990's, reproduction in this western habitat was severely disrupted on several occasions due to such releases, with the result that the sparrow population in the western area declined during that decade from about 3000 to only several hundred.

What the SIMSPAR Model Is Designed to Do and How it Works

SIMSPAR is a spatially-explicit computer simulation model that uses either empirical data or model output on hydrology levels through time across the landscape to simulate daily water depths in the Cape Sable sparrow habitat through the year, including the sparrow's breeding season. SIMSPAR also simulates the population of sparrow on this landscape. Development of the model relied on a variety of sources of information, including high spatial resolution hydrology, topography, and vegetation data, and a detailed knowledge of the Cape Sable sparrow. Information on the life history and behavior, including nesting habitat preferences, was needed for the model and were supplied by extensive field observations of the species. In particular, field data showed that water level depth should be below 5cm to allow breeding to start, while, if the nesting area were re-flooded to about 16 cm depth, nests would be abandoned.

SIMSPAR includes GIS landscape layers of habitat and topography at 500 x 500 meter resolution over the western breeding area. SIMSPAR is an individual-based model in that it simulates each individual sparrow in the population. It simulates their actions, including movement, mating, and mortality, in response to the changing landscape and to other individuals. To simulate water depths on a 500 x 500 meter resolution, the model can utilize either a hydrologic model, such as ATLSS's High Resolution Hydrology model, or empirical data. For historical data, water levels were determined by the gauging stationmarker located at NP205, close to the western area, and then adjusted according to local elevation data. Spatial and temporal patterns of breeding success are determined by daily water levels acting upon the landscape. The processes of mortality, mate choice, and dispersal are expressed stochastically; hence the model was implemented as a Monte Carlo simulation. The basic flow diagram of the model can be seen in Figure 1.

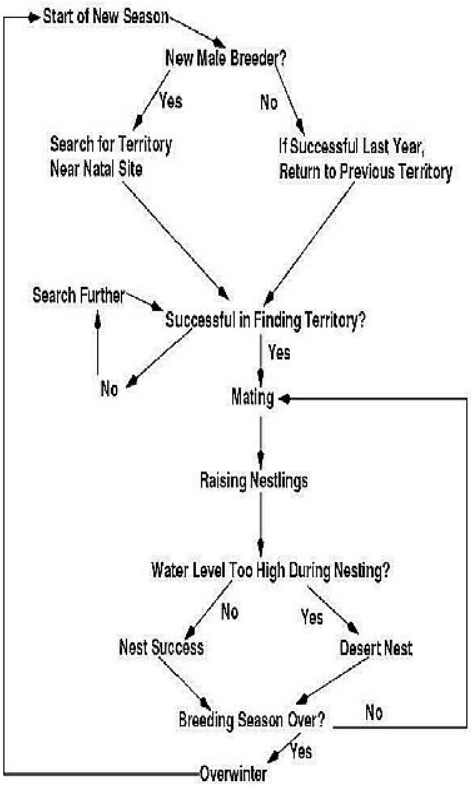

Figure 1. Flow diagram for SIMSPAR model of Cape Sable seaside sparrow reproduction

SIMSPAR has been calibrated and corroborated against field data on the Cape Sable sparrow population. This has been done with a 31-year run using historical hydrologic data. Calibration was accomplished by choosing an initial population of several hundred individual sparrows at the start of the run, in 1976, the number chosen such that the model population agreed with 1981 survey data. The model projections were shown to be in good agreement with the subsequent empirical data, from 1992 to 1996, particularly showing the sharp decreases in the western breeding area, shown in Figure 2.

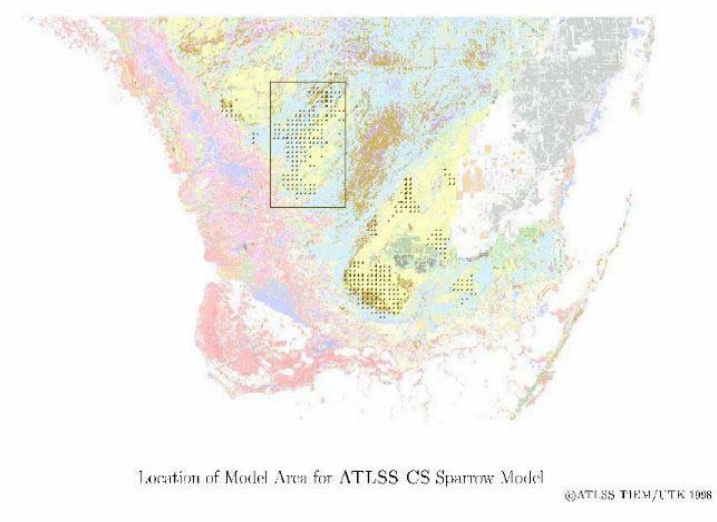

Figure 2. Map of the model area (denoted by the rectangular box) currently used for SIMSPAR, consisting of the western CSS Sparrow population. Illustrated by dots are the extant ranges of CSS Sparrow populations.

Some output of the Monte Carlo runs can be seen in Figure 3 from which a population viability analysis can be performed. This allows estimates to be made of the probability that the population falls below some threshold level over the time period of the projection. Thus probabilities of extinction can be estimated and compared between different hydrologic scenarios.

How SIMSPAR Has Been Useful

SIMSPAR model output was produced during the scenario evaluations of the Central and Southern Florida Project Comprehensive Review Study (Restudy) conducted from September 1997 through June 1998. The model compared the viability of the Cape Sable seaside sparrow population under the various proposed Restudy water regulation plans.

Sensitivity analysis on SIMSPAR had also produced important results of a more general nature. It has shown that the sparrow population is highly sensitive to changes in habitat quality, individual mortality rates, and a female's ability to locate unmated males with territories. These can, therefore, be considered crucial factors affecting the survival of the Cape Sable seaside sparrow in a dynamic landscape. An important aspect of the SIMSPAR model is that it also simulates the population monitoring process. In the case of the sparrow, helicopter surveys are made of singing males during the breeding season. SIMSPAR, by simulating a "virtual" helicopter, provides the best possible way of estimating actual population size from counted individuals.

Predicted Population Size

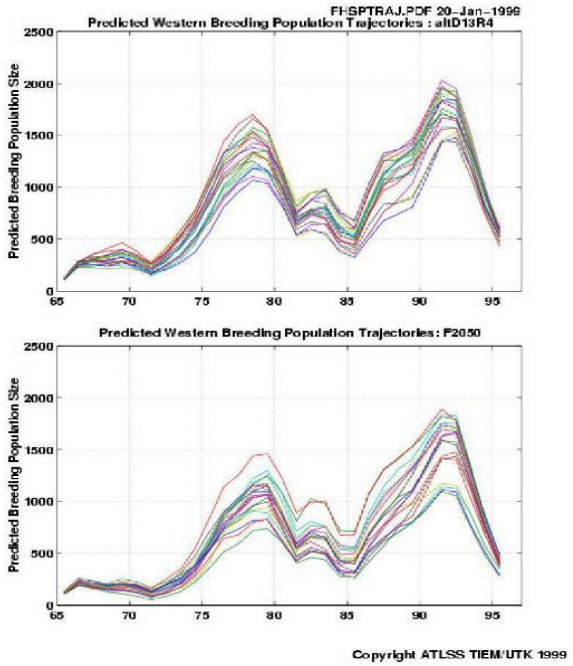

Figure 3. Example output of SIMSPAR illustrating the projected dynamics of the western population, using 20 different model runs, taking account of stochastic factors. The upper figure uses hydrologic scenario ALTd13R4 and the lower one uses the base scenario, F2050. In both cases, historical rainfall patterns are assumed.

At present, SIMSPAR model is being upgraded to make it faster and more flexible while allowing for a better integration of the model with the ATLSS modeling general format. This will allow for expanded ability to run over different hydrological data sets and expansion of SIMSPAR beyond the western area of sparrow breeding habitat to which it is currently restricted.

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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