Ecological Modeling and Simulation Using Error and Uncertainty Analysis Methods

Conservation
CS-1097

Background:

Ecological models increasingly are becoming spatially-explicit and often are used in conjunction with geographical information systems. Error and uncertainty in spatial data and processes are important contributors to overall model uncertainty. These different sources of uncertainty are not well understood and basic research is needed to understand them and to provide techniques for evaluating the propagation of uncertainty in spatial data throughout the modeling process.

Objective:

This project seeks to 1) identify and assess methods for quantifying and evaluating the propagation of uncertainty in spatial data in ecological models and 2) incorporate and test a combined geostatistical and Monte Carlo framework for uncertainty and error analysis of spatial data using case studies.

Summary of Process/Technology:

This project focuses on issues of uncertainty and error in spatial data following an error budget approach designed by Dr. George Gertner of the University of Illinois through work associated with SERDP project CS-1096*: Error and Uncertainty Analysis for Ecological Modeling and Simulation*. Initially, the sources of error and uncertainty in spatial data (maps) will be identified and the methods used to generate the maps will be determined. How the maps were generated strongly influences the techniques for characterizing spatial error and uncertainty through the ecological model. An integration of geostatistical and Monte Carlo techniques will then be used to propagate spatial uncertainty and analyze its contribution to uncertainty in model output. This error budget approach gives an overall analysis of all sources of model error and uncertainty and identifies where additional measurements might optimally reduce prediction uncertainty. Case studies will be used to develop, test, and demonstrate the methodology and software.

Benefit:

Applications of existing ecological models will be made more accurate by decreasing the amount of known error and uncertainty in model input.

Accomplishments:

A literature survey of existing methods dealing with error and uncertainty in spatial data revealed that stochastic simulation is the most broadly applicable approach. Categorical spatial data was selected and sequential indicator simulation was identified as the most appropriate method of stochastic simulation for categorical data in ecological models. The black-capped vireo and golden-cheeked warbler populations at Fort Hood, Texas, were chosen as case studies using habitat and population models developed at Fort Knox, Kentucky. The case study with the golden-cheecked warbler has been completed and has demonstrated the usefulness of the approach for spatial sensitivity analysis and for addressing uncertainty in mapping the edges of habitual patches.

Golden-Cheeked Warbler (left) and Black-Capped Vireo (right).

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