CARS - Project List

Application of Species Analyst Model to Predict Establishment and Potential Dispersal of Nonindigenous Fishes

Project # 2070B9G, Task 4

Task Leader: Bostick, Sherry L. sherry_bostick@usgs.gov

Statement of Problem:

In a 1993 report to U.S. Congress, the Office of Technological Assessment summarized the present day frustration with the failure of federal and state laws and regulations to control the continued importation and introduction of nuisance nonindigenous species, including fishes. It is generally recognized that it is not possible nor practical to stop the importation of nonindigenous species into the United States and at present there is no effective system to limit or screen further introduction of nuisance species into the Nation's open waters. With the current international trade agreements in place it is likely that the pressure to maintain or increase the present level of importation of aquatic species, including fishes, will continue. Our current laws and regulations are inadequate and when combined with existing loopholes and inconsistencies in regulations future invasive species importations are almost a certainty.

Objectives:

Resources are not currently available to perform a thorough risk assessment on each and every species, genus or family of fishes, that are currently being imported into the United States. We believe a new approach is needed to assist resource managers in identifying those species that are most likely to be invasive. Our objective is to identify fishes that are currently or are likely candidates to enter the United States for various purposes. We will use a newly developed model, the Species Analyst Model, to predict the probability of establishment and possibility of these fishes becoming invasive. We will apply the new technique of ecological niche modeling to the challenge of predicting potential distribution of nonindigenous fishes, based on the ecological characteristics of each in its native range and in its potential range in the United States.

Methodology:

Occurrence data for the 80 species of foreign fishes will be obtained from the published literature, primarily from major taxonomic revisions. This will not only provide good geographic diversity to the data set, but will also provide the highest quality data available. To supplement systematic studies and to provide more recent data we will search Fishnet, a distributed biodiversity data resource which is linked to more than 25 natural history museum databases. From these sources we will obtain 15 to 80 unique occurrence points for each species. Point localities will be georeferenced using the Findme georeferencing tool. Given severe geographic biases in sampling intensity for some species, we will subsample areas or countries with high densities of points to the average density of points in remaining geographic areas prior to analysis.

We will use diverse ecological-environmental geographic data sets (coverages) as the dimensions of ecological niches to be modeled. Topographic data (elevation, slope, aspect, topographic index) were obtained from the Hydro-1K dataset (1 km spatial resolution raster coverages). ArcAtlas (ESRI 1996) supplied vector coverages summarizing temperature, precipitation, and solar radiation, whereas data from the Intergovernmental Panel on Climate Change (0.5 x 0.5 spatial resolution raster coverages) provided data on annual mean cloud cover, windspeed, temperature (maximum, minimum, average), precipitation, solar radiation, daily temperature range, and freeze-days predictions. All coverages will be clipped to the appropriate regions where the species occur.

Ecological niches and potential geographic distributions will be modeled using the Genetic Algorithm for Rule-set Prediction (GARP) (Stockwell and Noble 1992, Stockwell 1999, Stockwell and Peters 1999). In general, the procedure focuses on modeling ecological niches (the conjunction of ecological conditions within which a species is able to maintain populations) (Grinnell 1917). Specifically, GARP relates ecological characteristics of known occurrence points to those of points randomly sampled from the rest of the study region, seeking to develop a series of decision rules that best summarize those factors that are associated with the species presence.