Using Sampling and Inverse Distance Weighted Modeling for Mapping Invasive Plants

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Introduction

Invasive plant distribution maps are a critical component of invasive plant management and periodic repeated mapping is essential for evaluation and adaptive management. Time and cost constraints currently limit the extent, accuracy, and repeatability of invasive plant mapping. Efficient methods of accurately mapping invasive plants are needed. Inverse Distance Weighted (IDW) interpolation modeling is a potential timesaving alternative to current survey methods for generating rangeland invasive plant distribution maps. Interpolation modeling uses sample data sets and spatial relationships among samples to predict values at unknown locations. Of the various interpolation methods, IDW is a very user-friendly technique. The objective of the study is to produce the best map for the lowest cost while choosing a sampling method that results in the best representation of the invasive plants' distribution across the landscape. Specifically, the research evaluated the success of three sampling methods and six sampling densities using IDW to predict Russian knapweed and spotted knapweed distribution patterns.

Experimental Protocol

Prediction success was evaluated for invasive plant distributions at two locations. The Russian knapweed site was a 2.1-mile^2 riparian zone along the Missouri River within the Charles M. Russell National Wildlife Refuge in north-central Montana. The spotted knapweed site encompassed 5.2 miles^2 of upland, mixed forest-rangeland on the Northern Cheyenne Indian Reservation in southeastern Montana. Environmental System Research Institute's ArcViewGIS 3.2 and the Spatial Analyst extension were used to create presence/absence invasive plant distribution maps using IDW interpolation modeling techniques. Eighteen sampling strategies (three sampling methods by six sampling density combinations) were tested to predict Russian knapweed and spotted knapweed distribution patterns for the two Montana rangeland environments. The three sampling techniques were systematic, random, and systematic-random. The optimum sampling density for each sample method was also evaluated. Invasive plant distribution maps were created using full-coverage field survey mapping methods and Global Positioning Systems (GPS). An accuracy assessment of the field survey maps was conducted prior to testing the sampling and IDW interpolation techniques. Invasive plant distribution maps were created from computer-generated samples extracted from the field survey infestation maps. Accuracy of predicted maps were determined by re-referencing the field survey maps.

Results and Discussion

Sampling density had the greatest and most consistent effect on prediction accuracies. However, optimum sample density was not determined because even at the highest sample densities accuracies continued to increase. At the 0.25-percent sample density (the highest tested density), overall accuracies ranged from 78 to 87 percent for the Russian knapweed site and from 92 to 96 percent at the spotted knapweed site (Fig. 1). The accuracy levels for vegetation mapping are suitable for invasive plant management.

Sample method did not have as strong an influence on accuracy values as sample density (Fig. 1). At both study sites, however, systematic sampling performed significantly better than the other sampling methods for some of the accuracy estimates. In contrast, at no time did either the random or systematic-random sample methods perform better than the systematic sampling for any of the accuracy estimates at either site.

Management Implications

This study suggests that sampling and IDW can produce high accuracy presence/absence distribution maps for two invasive species at two study sites. The accuracies meet the United States Geological Survey 85-percent classification accuracy standard for vegetative mapping and are suitable accuracy levels for invasive plant management. Based on experience from invasive plant managers, traditional survey maps rarely exceed these accuracy levels. Since sampling (even at the 0.25-percent density) would take less time than traditional surveys, IDW can be considered a potential alternative to traditional survey mapping.

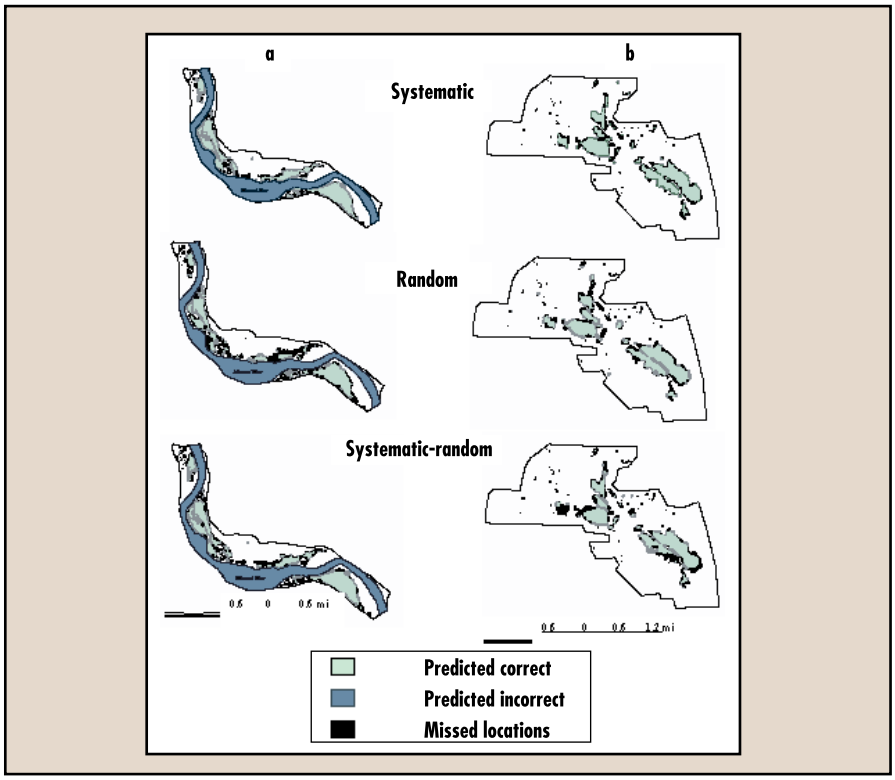

Figure 1. Comparison of predicted infestation maps at 0.25-percent sampling density: predicted correct vs. predicted incorrect vs. missed locations at (a) a Russian knapweed site, and (b) a spotted knapweed site.