Western North American Naturalist 64(3), © 2004, pp. 312–323

USING SAMPLING AND INVERSE DISTANCE WEIGHTED MODELING FOR MAPPING INVASIVE PLANTS

Elizabeth A. Roberts[1], Roger L. Sheley[1,2], and Rick L. Lawrence[1]

ABSTRACT.—Accurate time- and cost-efficient mapping is central to successful rangeland invasive plant management. In this study sampling together with Inverse Distance Weighted (IDW) interpolation modeling was tested as a mapping alternative to expensive full-coverage delineation survey mapping methods. Our objective was to examine accuracies of presence/absence maps generated from 18 sampling strategies (3 sampling methods × 6 sample densities) using IDW. Invasive plant field survey maps with known accuracies were used to generate samples and to test interpolation results at 2 sites. Site 1 was approximately 6.0 km^2, dominated by Russian knapweed (*Acroptilon repens* L.). Site 2, an upland area of approximately 13.5 km^2, was dominated by spotted knapweed (*Centaurea maculosa* Lam). Sampling method × sample density combinations were gathered from field survey infestation maps using repeated computer-based sampling methods. IDW modeling was applied to each of the sample data sets. Accuracies of the IDW interpolation results were calculated by re-referencing field survey maps. We determined that sampling at density of 0.25% (about 1 point per ha) using a systematic sampling method was the preferred sampling strategy for both sites. This combination of sampling density and method yielded 85% accurate presence/absence maps. We conclude that sampling combined with IDW interpolation modeling can generate accurate invasive plant maps and is a potential alternative to current delineation survey methods.

Key words: invasive plant mapping, sampling, interpolation modeling, inverse distance weighting, IDW, Russian knapweed, spotted knapweed.

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 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. It is commonly used to predict continuous variables such as density, but it can also be used for predicting categorical data. In this study we used IDW to predict presence/absence of invasive plants by classifying ranges of values into separate groups. Of the various interpolation methods, IDW is a technique easy to use and highly accessible. Like other methods IDW uses linear combinations of weights at known points to estimate unknown location values. In interpolation models, $Z(s_0)$ equals the values at unknown locations and is determined by the weighting value (λ_i) and values at known locations $Z(s_i)$.

$$Z(s_o) = \sum_{i=1}^{n} \lambda_i Z(s_i)$$

In the IDW equation, $d(s_i,s_o)$ is the Euclidean distance between s_i and s_o. P is a power

$$\lambda_i = [d(s_i,s_o)]^p / \sum_{i=1}^{n} [d(s_i,s_o)]^p$$

value that controls how fast the weights tend to zero as the distance from the location increases. The higher the exponent, the more influence nearby data will have on the predicted values (Boman et al. 1995).

Interpolation modeling techniques such as kriging have proven to be effective for mapping invasive plants in agricultural systems (Donald 1994, Heisel et al. 1996). Due to the

[1]Department of Land Resources and Environmental Sciences, Montana State University, Box 173120, Bozeman, MT 59717.
[2]Corresponding author.