A Simple Model of Suitable Habitat for Leafy Spurge Invasion within the Fishlake National Forest

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Abstract

Leafy spurge (*Euphorbia esula* L.), an invasive weed, occurs in a few small patches within the Fishlake National Forest in central Utah. To prevent this weed from spreading throughout the forest, new infestations must be detected and eradicated, or at least contained, before they become well established. However, budgetary constraints limit the time and effort that can be spent on early detection. To help the forest increase the efficiency of its early detection efforts, the Remote Sensing Steering Committee provided funding to develop a map of suitable habitat for leafy spurge establishment. The map was created using a simple habitat-distribution model and can help resource managers focus their early detection efforts in areas where leafy spurge is most likely to flourish. Approximately 17 percent of the forest was predicted to be highly or very highly suitable for leafy spurge. Although limited data make it impossible to validate the accuracy of the map at this time, the results are promising. Of 16 known patches of leafy spurge in the Fishlake National Forest, 15 are situated in areas that the study predicted as highly or very highly suitable for establishment.

Key Words

Leafy spurge, invasive species, remote sensing, model, *Euphorbia esula*, habitat distribution

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Introduction

Leafy spurge (*Euphorbia esula* L.) is an aggressive invasive weed that out competes and eliminates native plant species in areas where it becomes established (figures 1 and 2). This weed now occurs throughout much of the United States and continues to spread rapidly. Within the Fishlake National Forest in central Utah, however, leafy spurge is a relatively recent invader. Currently, there are only 16 known small patches, each less than 15 acres in size and most smaller than 1 acre. Because the patches are small and uncommon, the forest is in a good position to prevent leafy spurge from spreading and can possibly eradicate it.

However, to be successful, forest personnel must detect and destroy new infestations before they establish themselves. Unfortunately, a tight weed-management budget limits the time and resources that the Fishlake can devote to early detection.

To assist Fishlake personnel in their early detection efforts, a predictive map of habitat suitability for leafy spurge was created using a simple habitat-distribution model. The map was intended to make early detection efforts more efficient by focusing them in areas where leafy spurge is most likely to become established. The USDA Forest Service Remote Sensing Steering Committee provided the funding for this project.

Model Development

Ecological models are valuable tools for predicting susceptibility to invasive weeds and their potential distribution (Guisan and Zimmermann 2000; Gillham and others 2004; Guisan and Thuiller 2005). One type of ecological model, habitat distribution, predicts the locations of preferred or suitable environment for weed invasion (Guisan and Zimmermann 2000). The weed invasion susceptibility prediction (WISP) model, a simple habitat-distribution model, has successfully predicted habitat suitability for several weeds, including leafy spurge (Gillham and others 2004). This basic modeling approach was adopted to predict the...
distribution of leafy spurge habitat within the Fishlake National Forest.

The WISP model characterizes geographic features such as soil texture or proximity to water using a binary suitable (value=1) or unsuitable (value=0) classification based on the specific characteristics of these features in areas where a weed population already exists. Summing the suitability values of a specific location’s geographic features determines its relative suitability ranked from low to high.

Hunt (2006a and personal communication, 2006b) determined suitability criteria for four geographic data layers by applying the WISP model to a large, well-established leafy spurge infestation (table 1). Similar geographic data layers were obtained for the Fishlake National Forest and imported into ArcGIS as shapefiles. The drainage network, buffered by 100-meters, was created from 10-meter spatial-resolution digital elevation models (DEMs).

A habitat-suitability field was added to the attribute tables of all four data layers. Each feature was assigned an appropriate habitat-suitability attribute of either 1 (suitable) or 0 (unsuitable). The layers were then converted to grids based on this attribute and summed in ArcInfo to create a raster map of relative suitability.

Table 1—Geographic data layers and attributes of suitable habitat for leafy spurge

<table>
<thead>
<tr>
<th>Geographic Data Layer</th>
<th>Attributes of Suitable Habitat</th>
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</thead>
<tbody>
<tr>
<td>Soil (available water capacity)</td>
<td>Moderate (27–35% clay), high (35–50% clay), and very high (&gt;50% clay)</td>
</tr>
<tr>
<td>Existing land-cover community</td>
<td>Riparian, piñon/juniper, aspen, ponderosa pine, mountain big sagebrush*</td>
</tr>
<tr>
<td>Aspect class</td>
<td>North, northeast, northwest</td>
</tr>
<tr>
<td>Drainage network (proximity to water)</td>
<td>100-meter buffer†</td>
</tr>
</tbody>
</table>

*Mountain big sagebrush in the Fishlake National Forest.
†Hunt (2006b personal communication) used a 300-meter buffer.

Figure 2—Close up of leafy spurge showing flower and seed pod. Photo courtesy of USDA APHIS PPQ Archives, www.forestryimages.org
Figure 3—Map of habitat suitability for leafy spurge in the Fishlake National Forest.
Results and Discussion

The map of suitable habitat for leafy spurge ranged in value from 0 (very low) to 4 (very high) (figure 3). Of the 1.4 million acres encompassed by the Fishlake National Forest, only 2 percent (37,000 acres) was assessed as very highly suitable for leafy spurge, with another 15 percent (220,000 acres) predicted to be highly suitable (table 2).

Validating the model for the Fishlake National Forest is difficult because ground reference data are very limited and consist exclusively of locations where leafy spurge is established. No reliable data exist for areas where leafy spurge is not established because its absence may not be due to unsuitable habitat; the plant may simply not have been introduced in that area. Nevertheless, the model does look promising. Of the 16 known leafy spurge patches, 15 inhabit areas primarily mapped with values of 3 or 4 (high or very high suitability). Only one patch occurs in an area mapped primarily with a value of 1, low suitability (figure 4). Based on these 16 locations, the producer’s accuracy is 94 percent. User’s accuracy cannot be calculated because of the lack of data from locations where leafy spurge was introduced but did not become established. Ultimately, only time will tell how well the model works; as new information on habitat requirements for leafy spurge in central Utah becomes available, this model can be fine tuned to make predictions more accurate.

Costs

The cost to create the map of suitable habitat for leafy spurge was minimal. All data layers were available free of charge. Therefore, the only cost resulted from labor to assemble and process the data. An analyst with expertise in geographic information systems (GIS) should be able to complete a model for an area of similar size in less than 2 weeks. The most time-consuming aspect of this type of project is the data processing, which can be lengthy for large areas.

Table 2—Area of the Fishlake National Forest corresponding to suitability levels for leafy spurge establishment

<table>
<thead>
<tr>
<th>Suitability for Establishment</th>
<th>Percentage of Total Area</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—Very low</td>
<td>12%</td>
<td>174,982</td>
</tr>
<tr>
<td>1—Low</td>
<td>35%</td>
<td>502,389</td>
</tr>
<tr>
<td>2—Moderate</td>
<td>35%</td>
<td>499,688</td>
</tr>
<tr>
<td>3—High</td>
<td>15%</td>
<td>220,493</td>
</tr>
<tr>
<td>4—Very high</td>
<td>2%</td>
<td>37,040</td>
</tr>
</tbody>
</table>

Recommendations

While the accuracy of this model has not been assessed quantitatively, the predictions of high habitat suitability do correspond closely with 15 of the 16 known leafy spurge patches. As a result, we recommend concentrating early detection efforts for leafy spurge in areas with habitat-suitability predictions of 3 or 4, with particular emphasis on areas close to existing infestations. However, do not ignore areas predicted to have lower habitat suitability. By concentrating early detection efforts primarily in very highly or highly

Figure 4—Known locations of leafy spurge overlaid on the map of habitat suitability for the Fishlake National Forest. All 16 known patches appear on the map.
suitable areas, Fishlake National Forest resource managers should be able to increase the likelihood of finding new leafy spurge patches, thus making their efforts more efficient.

References and Suggested Reading


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Figure 5—A field of leafy spurge. Photo courtesy of Steve Dewey, Utah State University, www.forestryimages.org