Climatic Prediction of an Invasive Plant in California: 
*Ulex europaeus* (Gorse)

Jonathan C. Fox and Scott Steinmaus
California Polytechnic State University, San Luis Obispo

**Introduction**

Invasive plants reduce the biological diversity and productivity of all ecosystems. However, not all introduced exotic plants become problems. Climate modeling can be used in predicting which of these exotic plants have the potential to become problems. Also, once introduced, climate models can be used to predict which areas are susceptible to invasion. This information can be used in deciding where to concentrate management efforts.

This project was concerned with taking an invasive plant that already occurs in California and predicting whether or not a currently unoccupied area is susceptible to invasion. This area is San Luis Obispo County and the plant in question is *Ulex europaeus*, more commonly referred to as gorse.

Gorse is native to western and central Europe. It can not survive in arid climates. Nor does it tolerate extremes of heat and cold (Zabkiewicz 1976; Hoshovsky 1986). Gorse was introduced into Marin County 100 years ago from Ireland. The Irish traditionally planted gorse on the graves of their dead and brought this tradition with them to "The New World". Since that time gorse has spread to occupy every coastal county in California from Monterey to the Oregon border (CalFlora Database).

There are several characteristics that make gorse successful as an invasive plant. It has the ability to fix nitrogen from the air into the soil. It can also acidify the soil to increase the site suitability for itself while excluding most other plants. In addition gorse is able to survive on a variety of soil types. Another invasive characteristic is that it produces copious amounts of seed with long term viability. Finally, gorse regenerates rapidly from seeds and stumps after disturbances (Hoshovsky 1986).

The infestations that result from this invasiveness cause several problems. Gorse is an extreme fire hazard. The plant itself has oils that are very flammable and large amounts of dead dry matter are produced. In 1936, the town of Bandon, Oregon burned to the ground. 14 people died and only 16 buildings were left standing. The fire that caused this was fueled by heavy gorse infestations. Also, due to its competitive nature, gorse is able to displace many native plants. It also forms impenetrable thickets that can exclude many forms of wildlife.

**Methods And Materials**

To make my predictions I used a dynamic simulation model called CLIMEX. This is a climatic modeling program that is available through CSIRO in Australia. CLIMEX predictions are based on: (1) Meteorological data from about 2500 different locations worldwide, (2) and
climatic preferences and limitations of a species which can be inferred from an observed distribution. To enhance the program, I added weather data from 328 additional locations to the database. This data consisted of long term averages for precipitation and temperature from locations all over California. It was available through the National Oceanic and Atmospheric Administration (NOAA).

CLIMEX gives its predictions as an ecoclimatic index. An ecoclimatic index describes the climatic suitability of a location for a species, based on population growth, as a single number between 0 and 100: 100 being the most suitable location and 0 being unsuitable for population growth. This number is derived from an interaction of a growth index and a stress index.

The growth index measures the potential for growth at a location based on temperature and moisture preferences of a species. The growth index is what determines the abundance of an organism at a particular location. The stress index measures the potential for death at a location based on the accumulation of stress for a species and determines the distribution of a population.

Results

To obtain predictions a model was fitted that inferred many of the growth and stress parameters. This was achieved by fitting the model to gorse in its native range. The main assumption made was that in its native habitat, gorse has had every opportunity to occupy all its suitable climates in that region. With this in mind a model was fitted by increasing the stress from heat and cold from the original temperate template provided in CLIMEX. The dry stress parameter was also increased. This provided a model that closely resembled the actual distribution of gorse (Flora Europea Database). For the abundance, the temperature preferences was set to match information from a seed germination experiment (Ivens, 1983). The resulting model for Europe (Figure 1) was then run for California using the 328 new locations from NOAA (Figure 2). The final model shows *U. europaeus* able to grow in every coastal county in California from Santa Cruz north to Oregon.

Discussion

Why was Monterey unsuitable for the growth of gorse even though populations are currently found there? Dry stress is what is killing gorse populations for Monterey in my model. Given the location of the majority of *Ulex* populations in Monterey it is safe to assume that they are receiving water from sources other than direct precipitation. One population is an ornamental in somebody’s yard. Another is on the edge of a golf course and yet another is in a drainage ditch. There is also more evidence to support this assumption. These populations have existed for at least 20 years and have not significantly expanded their range.

Conclusions

The above discussion suggests that *U. europaeus* has reached its ecoclimatic limits in Monterey. Earlier in this paper we asked the question: Is San Luis Obispo County susceptible to
invasion from gorse? The results of this research suggest the answer is no. However, because of the diversity of microclimates in S.L.O. County it is possible that there will be some isolated populations occurring in the county, if they don't already exist.

Bibliography


CLIMEX. CSIRO PUBLISHING, PO Box 1139 (150 Oxford St), Collingwood, Victoria 3066, Australia, Tel: +(61 3) 9662 7666, Fax: +(61 3) 9662 7555, Email: sales@publish.csiro.au Webpage: [http://www.publish.csiro.au](http://www.publish.csiro.au)
