Chapter 6
Temporal Management of Invasive Species

Catherine S. Jarnevich and Thomas J. Stohlgren

Abstract Successful management of invasive species requires using spatial models of current distributions and forecasts of spread with explicit consideration of the effects of time on the invasion. Forecasts must also include components contributing to the spread rate such as invasion stage and Allee effects. There are several different analysis techniques available for spatial models and forecasting, and the appropriate technique will depend on the particular research or management question. Many of the best forecasting examples with time as a parameter exist for insect species, but the same techniques are useful in forecasting the spread of plant species. Often, data availability is a limiting factor in doing this, so we need to change the data being collected. Inclusion of this temporal information in prioritization of resources for control/eradication efforts will help them be effective and efficient.

Keywords Forecasting • Invasions • Spread rates

6.1 Introduction

Invasion ecology must progress from a reactive science to a proactive science (Lodge et al. 2006). That’s because the likelihood of eradicating or containing an infestation decreases as the size of the infestation increases (Rejmanek and Pitcairn 2002)

An important component of prevention and control of invasive species is forecasting where invasions are most likely to initially occur, and where they are likely to spread once local populations are established in a country, region, or locally. Many “predictions” to this point have involved “hinde-casting” past invasions or spatially extrapolating patterns of nonnative species, based on environmental
attributes or their relationship to native species (Jarnevich et al. 2006; Stohlgren et al. 2006; Stohlgren et al. 2003). Additionally, modeling approaches commonly attempt to predict the potential distribution of individual invasive species using snap-shot-in-time datasets, meaning a dataset collected over a short time for a specific location (Elith et al. 2006). Although useful, these models generally provide no estimate of when a species may arrive at a particular location – only that it may at some unknown future point. Predictions for individual species’ potential abundance or rates of spread are less common, often due to lack of data. As technology has advanced over the past couple of decades, spatial models have become more sophisticated and accurate. These models have proven valuable in the management of invasive species. The increased availability of geographic positioning system (GPS) technology has also helped data collection. However, these forecasting tools are still limited by gaps in the field data being collected and synthesized to calibrate or independently validate their predictions. There are also still limitations in our ability to model natural systems where nonnative species establish and spread.

In a recent survey of existing invasive species databases in the United States, Crall et al. (2006) found that 38% of the 254 databases discovered contained data covering 10 or more years. This survey covered databases, so groups collecting field data stored in a less technologically advanced system were not included. Thus, this number ignores many collections, but is probably somewhat reflective of reality, with less than half of the datasets holding long-term data. Additionally, 82 of the datasets covered an area equal to a county or smaller. Even the datasets that do exist may not always be readily available and in the same format. Data integration would help solve some of these limitations. To effectively manage invasions, we need information across broad spatial extents and over long time periods as invasions occur over these scales.

Partly due to the lack of these data, predictions including a specific temporal component are much rarer in the literature than spatial predictions (i.e., a species’ potential habitat). A literature search in Web of Science including the terms spatial, modeling, and invasive revealed many articles, while one including temporal or time, modeling, and invasive revealed a dearth of articles published in peer reviewed journals.

Invasive species management involves many concepts and careful consideration of analysis techniques. There are several important points to keep in mind when creating predictions of species spread in addition to specific individual species traits. Range expansion of a species will be a function of the number and spatial arrangements of introductions, time since invasion, propagule pressure (frequency of propagules), a vector for dispersal, seeds being dispersed to a favorable location, hybridization, and many other factors. Forecasting invasions including richness, distribution, and abundance of invasive species with a temporal component as opposed to species distribution models that predict potential distribution regardless of time can be accomplished with several different methods. The most appropriate analysis method for forecasting a particular invasion may vary depending on the spatial resolution, the species, and the stage of invasion. Additionally, managing species effectively through time involves assessing the long-term potential