Chapter 125
Modeling Species Distribution

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ABSTRACT

There are many methods for modeling species distribution in the landscape. In this chapter, the authors elaborate on the concepts of species modeling and present three popular techniques to generate species distribution: cartographic overlay, logistic multiple regression and maximum entropy (MAXENT). The cartographic overlay method is relevant to generate a habitat suitability index. Logistic multiple regression generates the probability of distribution based on presence and absence of data in relation to habitat factors. The authors use pseudo absence data selected randomly from low suitability classes, because real absence data were not available. The third technique, maximum entropy method (MAXENT), uses presence-only data. The Asian elephant (Elephas maximus) was selected as a proxy species for this study. The study was conducted in Bun Tharik-Yod Mon, a proposed wildlife sanctuary in northeast Thailand.

The results show that among the three approaches, the potentially suitable habitats derived from cartographic overlay cover the largest area and are likely to overestimate existing occurrence areas. The logistic regression model predicts approximately 56% as suitable area, while maximum entropy results covers approximately 9% of the sanctuary. Although the results show large differences in the suitable areas, it should not be concluded that any one method always proves better than the others. Utilization of any method is dependent on the situation and available information. If species observations are limited, the cartographic overlay or habitat suitability is recommended. The logistic regression method is recommended when adequate presence and absence data are available. If presence-only data is available, a niche-based model or the maximum entropy method (MAXENT) is highly recommended.

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1. INTRODUCTION

Science currently recognizes around 1.8 million species on Earth (out of an estimated total of five million to 30 million). The IUCN Red List of Threatened Species 2009 revealed that 17,291 species out of 47,677 assessed species, or 36 percent, are threatened with extinction (IUCN, 2009). Currently therefore, a lot of attention is focused on the conservation of nature. For example, the Convention on Biological Diversity, established after the Earth Summit in Brazil in 1992, has been ratified by nearly 200 countries. Beside the three broad objectives of the Convention, the Conference of the Parties (COP) adopted the Convention's Strategic Plan and committed themselves to a more effective and coherent implementation of the Convention objectives, to achieve a significant reduction of the current rate of biodiversity loss at the global, regional and national level by 2010 and thus to contribute to poverty alleviation and to the benefit of all life on Earth. The broad scope of biodiversity conservation is well represented in the Global Biodiversity Strategy (WRI *et al*., 1992).

In addition, a number of publications have focused upon the most practical and effective strategies for the conservation of nature in addition to the policy and strategy issues related to the conservation of biodiversity. For example, Sayer *et al*. (2000) proposed a Rapid Ecological Assessment (REA) method, which was developed by The Nature Conservancy, to provide comprehensive and reliable information about biodiversity resources in situations where time and financial resources are limited. REAs utilize a combination of remote-sensed imagery, reconnaissance overflights, field data collection, and visualization of spatial information to generate useful information for conservation planning. It provides researchers with the essential tools and techniques they need to conduct an REA, and offers valuable advice about the planning and implementation aspects. Moreover, Miller (1994) published a book on Mapping the Diversity of Nature. This book presents approaches used by some of the foremost active conservationists to map the patterns of species and habitat at local, regional and global scales during 1990s-2000s. Another book (Haines-Young *et al*., 1993) reviews the application of GIS to landscape ecology. The approaches presented in this book show applications of GIS developed with the intention of influencing the design, planning and implementation of programs to protect species and their habitats. In recent years, many species modeling techniques have been developed by scientists to predict species distribution in the natural landscape.

The objectives of this chapter are to present various methods for species modeling in a forested landscape and to describe briefly the elements of each approach with an example of biodiversity conservation in Bun Tharik-Yod Mon, a proposed wildlife sanctuary in Thailand. In addition, the authors also discuss some strengths and weaknesses, as well as when and how to use each method and draw perspectives of species modeling in the future.

2. CONCEPTS

2.1 Sources of Species Distribution Data

Species distribution data can be obtained either from primary data or secondary data. Sources of primary data include inventory data and field observations, while secondary data include herbarium collections, taxonomic literature and ecological communities.

2.1.1 Herbarium Specimen and Museum Collections

A *herbarium* is a collection of preserved plant specimens. These specimens may be whole plants or parts of plants. These will usually be in a dried condition, mounted on a sheet, but depending upon