# 1 Why Plant Population Viability Assessment?

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## 1.1 Introduction

As Conservation Biology has matured into its role as an integral and applied branch of the Ecological Sciences, there are several topics that have fallen clearly under its umbrella. Assessing the likelihood that a population will persist, a population viability analysis (PVA) is one of several critical central questions of Conservation Biology. PVA has been a popular tool in research and management of populations since its inception. Recently, the number of PVAs performed for plants has increased radically (Menges 2000). Although there has been a long-standing interest in population dynamics in plants (e.g., Silvertown 1987), the issues involved in understanding the population dynamics of rare plants has acquired a recent urgency due to the large numbers of rare plants currently on the endangered species list and threatened worldwide.

Using PVA with plants presents a number of unique challenges. Many aspects of plant life histories present unique challenges to modeling viability (e.g., long-lived stages, hidden life stages). Furthermore, PVA requires an understanding of the threats to plant species and the effects of these threats on population dynamics. These data are unavailable for many endangered species.

This volume addresses three main themes in plant population viability. First, what are the threats and issues facing rare plant populations? Second, what are the modeling approaches available to model plant population viability? And third, what are the peculiarities of plant life histories that make plant models different from animal models and how can these life history attributes be addressed in a modeling framework? Throughout the book, contributing authors have sought to combine discussions of plant biology and natural history with modeling approaches and management considerations. This volume should be useful to those considering plant population viability from a purely theoretical context as well as those faced with managing rare plant populations and seeking guidance in modeling population dynamics.

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One of the key concepts to emerge from the PVA literature in recent years is that PVAs may not be as reliable as we may have initially hoped (e.g. Beissinger and Westphal 1998; Doak and Morris 1999; Fieberg and Ellner 2000). As a consequence, researchers need to have a clearly defined suite of goals and objectives prior to investing the cost of data collection and analysis for a PVA (Beissinger and Westphal 1998). Not all projects will have the resources to conduct an adequate PVA. Not all plants at risk require a PVA before proceeding with either listing or recovery actions. Nonetheless, ecologists and environmental managers would like to support conservation decision-making with quantitative estimates of the likelihood of population persistence. Hence, a common decision process for endangered species management has been the decision whether to invest the resources in order to conduct a formal PVA. As PVA has entered the conservation biologists' toolkit, it has become important to use the tool judiciously with specific goals in mind. With the general objective of providing guidance on when and how to conduct a PVA in mind, we offer this edited volume to aid researchers conducting research in support of plant species conservation.

### 1.1.1 Book Structure

The book is divided into three sections. The first section outlines threats to plant population viability and evaluates methods of addressing these threats by PVA. The second section discusses broad modeling approaches and how these approaches might be applied to plants. The final section addresses specific problems of modeling plant populations and how these might be dealt with within the framework of a PVA.

In this first chapter we discuss how plants differ from animals and the unique challenges ecologists and conservation biologists face in trying to understand and manage plant populations. This introductory chapter sets the stage for this edited volume by elucidating several reasons for a book dedicated to plant PVAs: differences in life history attributes; unique conservation challenges; and differences in data issues in plants. These overarching themes are carried through the volume and emerge repeatedly in the different chapters presented within the book. Chapter 2 is a broad overview of threats facing plant populations and includes a categorization of threats as well as a brief assessment of the interactions between threats and viability modeling. Chapter 3 takes an in-depth look at four specific threats, genetic effects, competition, pollination, and herbivory, and evaluates the evidence for their impacts on rare species and the necessity of including them in population viability models. Plant disease is an issue that has rarely been addressed in considerations of population viability but is one that is likely to become more important. This issue is addressed in Chapter 4. Chapter 5 addresses the specific issue of hybridization, which has become more important as agricultural crops and weeds interact with wild populations.

In the second section, we specifically address how to model population viability in plants. The chapters in this section tackle problems associated with modeling the complex life histories of plants. The first chapter in this section, Chapter 6, is an overview of modeling approaches that have been applied to plants and highlights the strengths, weaknesses, and data needs of each of these methods. One type of population viability modeling that has seldom been applied to plants is that of diffusion approximation. This approach holds great promise for modeling plant population viability because it requires only count-based data, the type of data most frequently collected for plants (Morris et al. 1999). The potential and limitations of this approach are addressed in Chapter 7 by Eldred et al. Chapter 8 discusses another type of modeling approach for PVA, that of habitat modeling. This approach holds great promise for plants since many features of plant demography are often driven by habitat factors.

The final section of the book tackles problems of plant life histories head-on. In this section, there are chapters on modeling species with extreme longevity (e.g., many trees and other long-lived perennial; Chap. 9), incorporating biotic interactions into PVA (Chap. 10), addressing disturbance and spatial heterogeneity (Chap. 11), and finally, using PVAs to investigate the future of plant restoration projects (Chap. 12).

Understanding persistence in plants is an issue with more relevance now than ever before. Efforts to manage rare plant populations, design reserves, respond to global climate change, preserve biodiversity, and proactively manage populations all rely on an understanding and an ability to predict population dynamics. This volume provides a state-of-the-art look at population viability in plants. By addressing issues in life history, threats to species, and modeling approaches, we supply the tools needed to advance our knowledge and application of PVA in plants.

## 1.2 Why Plants Differ

The first question we had to address was whether a volume specifically focused on PVAs for plants was needed. After all, a series of PVA books and reviews have appeared over the past several years that provide thorough background and guidance on PVA (e.g., Soulé 1987; Tuljapurkar and Caswell 1997; Beissinger and Westphal 1998; Groom and Pascual 1998; Sjögren-Gulve and Ebenhard 2000; Caswell 2001). Nonetheless, the need for a PVA book specifically on plants remains for several reasons. First, there are fundamental life history attributes unique to plants that make the challenges inherent in PVA slightly different than for animals. These differences are manifest in the types of data that are available with which to assess plant population viability. Second, the conservation challenges for plants appear to be fundamentally focused on different attributes than for animals. This introductory chapter focuses on these two reasons in detail below.

A third reason to focus a book on PVAs for plants emerges from the perception that PVAs are primarily for and about vertebrate animals. Clearly, the literature on PVAs emerged from vertebrate ecologists (Soulé 1987). It took several years before the first viability assessment of a plant population at risk of extinction was published (Menges 1990). The majority of viability studies continues to focus on vertebrates, with most of the PVA literature directed toward vertebrate targets. Nonetheless, the problem of plant species at risk is very large (Stein et al. 2000). In fact, within the U.S. a larger proportion of plants are at risk of extinction than vertebrates (Stein et al. 2000). Plants have increasingly dominated the list of federally protected species within the U.S. ( 1.1). Thus, there appears to be a need to increase the attention of plant conservation biologists toward PVAs. A volume dedicated to the topic, we hope, will stimulate such research attention.

Another compelling reason to focus a volume on plant PVA is that plants, perhaps more so than animals, require continued development of population level conservation strategies. Conservation is moving steadfastly toward a focus on larger-scale, spatially explicit habitat, ecosystem-level studies (Christensen et al. 1996; Pickett 1997; Soulé and Terbough 1999). This focus on larger scales is driving many of the high-profile conservation actions toward remote regions where defensible large reserves may reside. Utilizing large-scale approaches may reduce the need for conservation biologists to use PVA as a tool for assessing conservation needs. Certainly it is hoped that these large-scale projects will preemptively protect resources before they become endangered. Rare plants, however, are often habitat specialists restricted to particular edaphic conditions and often not well captured by these large-scale projects. As a consequence, plant conservation may require species-by species approaches more frequently than vertebrates. We provide several examples to illustrate our point.

Serpentine chaparral is the single habitat that houses the largest number of rare plants in California (Pavlik et al. 1994). The second richest habitat for rare plants is vernal pools (Pavlik et al. 1994). These are both patchily distributed habitats with very restricted distributions. As such, large tracts containing numerous patches have seldom been the target of conservation plans that try to preemptively protecting a wide array of species. Species within these edaphic anomalies are frequently addressed on an individual basis. For example, the Ione manzanita (*Arctostaphylos myrtifolia*) inhabits a single patch of Ione soils (Gankin 1957). A protected area is specifically set aside for this species. Conservation of this species will require recovery on this site and this site alone.

Another example is found in the association of plants with centers of high population density within the US. Schwartz et al. (2002) found that nearly one

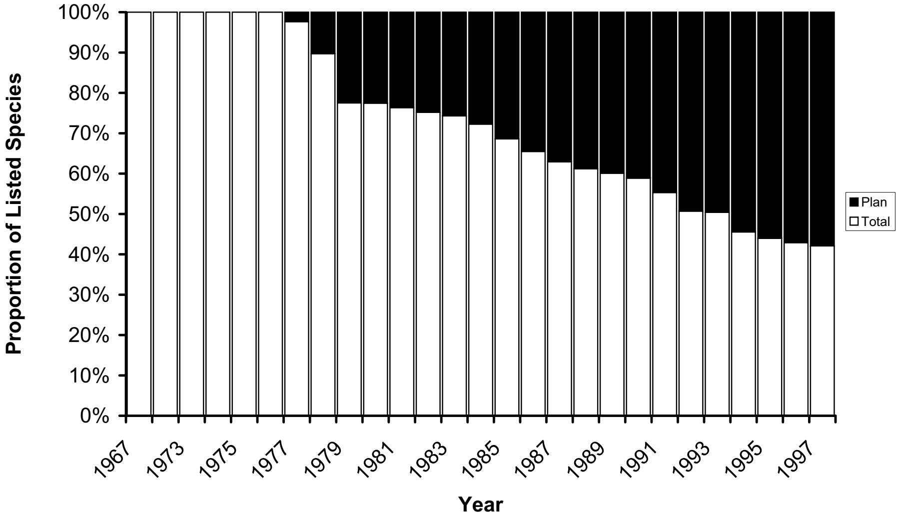


**Fig. 1.1.** A bar graph showing the increasing percentage of plants (*black*) relative to all other species (*white*) on the US Endangered Species List from the inception of the list (1967) until 1997. As of 1997, 754 of the 1,302 (58 %) taxa listed were plants

quarter of endangered plant occurrences are in the 8.4 % of land that comprises the 40 most populous cities in the US, where 50 % of Americans live. These populations are often already on some kind of protected habitat, and at least for San Francisco, Schwartz et al. found that there is currently little monitoring of population performance. Thus, these authors argue for additional monitoring, as management activities in urban areas could help many populations survive. The majority of these sites surveyed were multiple-use sites that were also managed for public recreation or that were in the public service (i.e., water management, defense).

Despite the many advantages of approaching conservation from an ecosystem standpoint, a single-species approach is likely to continue to play a central role in the conservation of diversity for plants. With numerous PVA projects on-going for high profile vertebrates, one has to think that this will also be the case for vertebrates (e.g., Lahaye et al. 1994; Lamberson et al. 1995; McKelvey 1996; Mills et al. 1996). Given that it is often easy, relative to animals, to estimate population size from year to year, it seems likely that species-level plant conservation may entail extensive use of PVA. Thus, it is timely to present advances in plant PVAs so as to promote the further use and development of these tools to critical conservation problems.

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