This book provides sampling designs for measuring species richness and diversity, patterns of plant diversity, species-environment relationships, and species distributions in complex landscapes and natural ecosystems. Part I introduces the problem: plant diversity studies are difficult to design and conduct in part because of the history and baggage associated with the evolution of plant ecology into a quantitative science. Issues of scale, resolution, and extent must be effectively commandeered. Part II implores the practitioner to take an experimental approach to sampling plant diversity with a clear understanding of advantages and disadvantages of single-scale and multi-scale techniques. Part III focuses on scaling plant diversity measurements from plots to landscapes. Part IV provides a brief introduction to modeling plant diversity in relation to environmental factors. Examples of common non-spatial (correlative) and spatial analyses are explained. Part V introduces the concept of measuring temporal changes in plant diversity at landscape scales and follows with a case study designed to collect the necessary baseline data to monitor plant diversity. Part VI discusses research needed to understand better changes in plant diversity in space and time. Specific objectives are to: (1) provide a basic understanding of the history of design considerations in past and modern vegetation field studies; (2) demonstrate with real-life case studies the use of single-scale and multi-scale sampling methods, and statistical and spatial analysis techniques that may be particularly helpful in measuring plant diversity at landscape scales; and (3) address several sampling questions typically asked by students and field ecologists.
This chapter considers the difficulties in designing the plant diversity component of monitoring programs designed to report the condition and production of the nation's forests, including changes in understory plant diversity. The methods were modified to be flexible enough to work equally well in a variety of forest types, yet standardized enough to allow for highly comparable data on plant diversity across the United States. The US Department of Agriculture's Forest Health Monitoring program accomplished this task. It is a national program that makes annual evaluations of the condition, changes, and trends in the health of forest ecosystems in the US. The monitoring program consists of a nationwide, uniform distribution of sample plots providing a large, unbiased sample of the nation's forests (1 plot/63,942 ha).

This chapter discusses the urgent need to assess rapidly the vulnerability of natural landscapes and specific habitats to plant species invasion. Systematic surveys of where non-native species have successfully invaded are needed to guide research, control, and restoration efforts. Since only a small portion of any large landscape or region can be affordably surveyed, modeled information on native and non-native plant diversity, soil characteristics, topography, and climate may be needed to guide the management of invasive species in the larger, unsampled areas. This is a case study that carefully considered current theories, experimental evidence, and various sampling design strategies before initiating the field studies.
In arid environments, the patterns of native and non-native plant diversity may be affected by cryptobiotic crusts. This chapter is a detailed case study designed to: (1) quantify patterns of native and non-native plant species, cryptobiotic crust habitats, rare/unique habitats, and soil characteristics at landscape scales; and (2) determine which habitats in the southeast portion of the Grand Staircase-Escalante Monument, Utah, were more invaded by exotic plant species. It provides an opportunity to evaluate the interactions between various components of vascular plant diversity, with non-vascular plants (crusts) in complex arid soil environments.