Chapter 123
Visualizing Plant Community Change Using Historical Records

Evelyn Brister
Rochester Institute of Technology, USA

Elizabeth Hane
Rochester Institute of Technology, USA

Karl Korfmacher
Rochester Institute of Technology, USA

ABSTRACT

Ecological data from land surveys from 1811 for the 100,000-acre Connecticut Tract in western New York were transcribed and then analyzed using ArcGIS and IDRISI GIS software. The surveys contained both witness tree data and line descriptions, which were analyzed for species composition and community type. Results illustrate that many changes have occurred in species composition. Possible causes of these changes to the mature forests may include introduced pests and diseases or anthropogenic land-use change. Comparisons to the National Wetlands Inventory Database reveal that while some of the wetlands that were present in 1811 still exist today, particularly in the Byron-Bergen Swamp and in the wetlands along the Lake Ontario shoreline, other original wetlands have been lost while new wetlands have replaced some upland forests. This study helps elucidate past causes of temporal and spatial variability, and it provides a reference point for land managers who need to understand the effects of land-use history for ongoing restoration efforts.

INTRODUCTION

By comparing past vegetation with current plant communities, historical studies can elucidate the impacts of human land use, the results of long-term ecological processes, and the degree of change in forest composition and wetland distribution. These types of studies allow us to better understand how and why landscapes have changed through time, taking into account the effect of climate changes, species migrations, disturbance events, and human

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actions (Whitney, 1994). By taking a historical approach, we can examine changes in ecosystems on temporal scales of decades, centuries, and millennia. Land managers can then apply insights from the past to inform management of ecosystems in the present and for the future (Ellison *et al*., 2005; Foster, 2002; Foster & Motzkin, 1998; Swetnam, Allen, & Betancourt, 1999). Recreation of the past state of an ecosystem is not by default the goal of restoration efforts, since contemporary landscapes exist in a new constellation of species, biophysical factors, human needs, and surrounding environments. Rather, determination of historical reference conditions can help planners and land managers to identify how a landscape has been changed by recent human actions and thus focus on a range of conditions that would satisfy restoration goals (Egan & Howell, 2001).

There are at least three ways that historical ecology adds to our understanding of ecosystems. First, historical investigation can reveal mistaken assumptions about the past. For example, Cogbill, Burk, and Motzkin (2002) discovered that township survey records from between 1623 and 1850 showed that beech was more dominant in northern New England forests than had been believed, while pine, hemlock, and chestnut were less abundant. This correction could lead to more appropriate management and conservation decisions.

Second, knowledge of historical conditions allows changes to be tracked. Some ecological changes, such as changes in climate, occur at such a slow rate that they may not be noticed unless there is an established frame of reference for comparison. Hamburg and Cogbill (1988) used witness tree data from historical surveys in New Hampshire to investigate long-term trends in forest composition to examine the decline of red spruce. While it had been suggested that this decline was recent and could be attributed primarily to acid rain, the historical data suggested the declining population trend began decades earlier than is consistent with acid rain as the sole cause, suggesting climatic warming as a significant causal factor.

Third, historical ecology can help to separate natural and cultural causes of variability in ecological patterns. In two cases of shrub and tree invasion in the southwestern U.S., historical research contributed to identifying either natural or cultural causes. In one case, deposits in packrat middens in Owl Canyon, Colorado, showed that pinyon pine invasion followed a pattern of ongoing postglacial expansion. In contrast, historical aerial photographs of northern New Mexico point to livestock grazing and fire suppression, rather than purely natural processes, as causing loss of grasslands (Swetnam *et al*., 1999).

Knowing the history of land use in an area can help to identify changes that may affect the function of ecosystem dynamics, such as the physical, chemical, and biological changes that are imposed on soils by plowing and grazing (Foster *et al*., 2003). By revealing past patterns of ecological change, historical studies can correct mistaken expectations for future change and can identify conditions that may limit the success of land management actions. For instance, when past land use has changed a landscape in multiple ways—altered species assemblages, removed natural disturbances, and changed soil composition—then restoring just one of these elements may not be sufficient to restore historic ecosystem conditions (Foster & Motzkin, 1998). Many studies have illustrated that contemporary forest compositions are greatly altered from presettlement forest composition (Foster, Motzkin, & Slater, 1998; Friedman & Reich, 2005; Hall, Motzkin, Foster, Syfert, & Burk, 2002), largely as a result of past land use, though loss of species due to disease (Ellison *et al*., 2005) and climate change (Hamburg & Cogbill, 1988) also can play a role in change.

Over the last century, much of the formerly agricultural land in the northeastern U.S. has been abandoned and reforested through the process of succession, but not with the original vegetation