

ECOLOGY AND CONSERVATION IN THE CULTURAL LANDSCAPE OF NEW ENGLAND: LESSONS FROM NATURE'S HISTORY

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ABSTRACT - As a result of historical and current human impacts on natural ecosystems worldwide, most modern landscapes involve an element of cultural influence. In New England, for example, although the landscape was largely forested prior to European settlement, it was highly dynamic in response to changing climatic conditions, natural disturbance processes, and American Indian activities. European settlement in the 17th and 18th centuries initiated a dramatic transformation, as much of the land was deforested and farmed and the remainder was logged, grazed or burned. Since the mid 19th century, agriculture and forest use have declined, forest area and age have increased, and the land has become more natural than at any time in the preceding centuries. However, despite the natural appearance of many portions of the modern landscape, a legacy of intensive past use remains in vegetation structure and composition, landscape patterns, and ongoing dynamics. Consequently, an understanding of the history of human influence should be an integral part of ecological study and a critical component of conservation planning and resource management.

A major lesson that emerges from historical perspectives is the recognition that there are no static baseline conditions that can be used for experimental control or decision-making. Rather, change is an inherent characteristic of all landscapes and future change is inevitable. Although ecological research can provide insights into the historical and environmental factors that underlie current conditions and that may determine future changes, it does not provide unequivocal guidelines for policy decisions, for these are inherently subjective in nature. The current changes in wildlife populations across the eastern United States, notably an increase in forest interior species and a decline in open-habitat species, underscores the dynamics as well as the policy dilemmas inherent in landscapes that have been strongly modified by human activities. Recent increases in species such as moose, beaver, and bear and a corresponding decline in open-habitat species such as meadowlarks and grasshopper sparrows may be largely understood as a consequence of historical changes in land cover. These dramatic changes pose ethical dilemmas as some native species threaten human property or health, while considerable effort and management may be required to maintain the flora and fauna as well as the conservation and aesthetic values associated with cultural landscapes. Historical perspectives increase our understanding of the dynamic nature of the landscape, the long-term influence of humans as components of functioning ecosystems, and the cultural basis for our conservation decisions.

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"[The land had] a weather-beaten face, and the whole country, full of woods and thickets, represented a wild and savage hue." ... William Bradford, 1620 describing eastern Massachusetts

"[The land is] full of rocky Hills ... and cloathed with infinite thick Woods." ... John Josselyn, 1672 writing about central New Hampshire

"The forests are not only cut down, but there appears little reason to hope that they will ever grow again." ... Timothy Dwight, 1804 reflecting on southern New Hampshire

"Our woods are now so reduced that the chopping of this winter has been a cutting to the quick...There is hardly a woodlot of any consequence left but the chopper's axe has been heard in it this season." ... Henry David Thoreau, 1855 in Concord, Massachusetts

"In many ways the forest landscape of the Appalachians, as well as many parts of the East and South, has come full circle. By the 1960's and 1970s...its appearance is much like it must have been before the American revolution." ... Doug MacCleery, 1992, *American Forests - A History of Resiliency and Recovery*

"This unintentional and mostly unnoticed renewal of the rural and mountainous east — not the spotted owl, not the salvation of Alaska's pristine ranges — represents the great environmental story of the United States, and in some ways of the whole world." ... Bill McKibben, 1995, *An Explosion of Green*, The Atlantic Monthly

INTRODUCTION

As documented in the somewhat hyperbolic quotes above, the landscape of the eastern United States has been utterly transformed in the remarkably short period of time since European settlement (Fig. 1; Cronon 1983, Foster 1995, Whitney 1994). What was once an extensively forested region dominated by large trees, a native fauna, and a widely scattered human population, became largely deforested by the mid 19th century through the development of an agrarian landscape and the endless quest for fuel and building materials of wood (Fig. 2). With the advent of the Industrial Revolution, the opening of Midwestern farmlands, and the discovery of new lands and riches in the western United States, eastern farmlands commenced a process of natural reforestation as people left the world of agricultural toil to concentrate in the emerging cities or to emigrate westward. Through the 20th century, and despite a continuing increase in human population, the area and size of eastern forests have grown; much of the land is now in a more natural state than at any time in the previous 250 years (Foster et al. 1998, Fuller et al. 1998, Williams 1989).

The prodigious rate and extent of change in the Eastern landscape has left an unmistakable imprint on the forested and open lands of the entire region (Foster 1999, Motzkin et al. 1996). Relics of old houses, stone walls, mills and laneways add a distinctive colonial character to

our woods and streams, and the forests themselves exhibit a legacy of this history in their composition of plants and animals, their physical structure and arrangement in the landscape, and even in the characteristics of their soils. As a consequence of this cultural history and its influence on modern ecosystems, any interpretation of the New England landscape and any attempt to manage the land, whether for conservation values, natural resources, or economic development, are best based on a thorough understanding of this history of past use and landscape change. In fact, attempts to incorporate a historical perspective into the interpretation of forest landscapes have yielded many insights into approaches for conservation and protection of the land as well as forest management and the understanding of fundamental ecological processes (Fisher 1918, 1933, Spurr and Cline 1942, Dunwiddie 1989, 1992, Hunter et al. 1988, Foster et al. 1990, 1996, Golodetz and Foster 1996). This paper highlights some of the broader findings from such retrospective studies and identifies some of the insights that emerge for understanding and managing the landscape of the northeastern U.S. General examples are provided in order to emphasize fairly broad principles and approaches and to pave the way for detailed application of a historical approach to both research and policy. Above all, this paper seeks to underscore our basic belief that investigations of land-use history form an integral aspect of ecological study and a critical component of conservation planning and natural resource management (Motzkin et al. 1996).

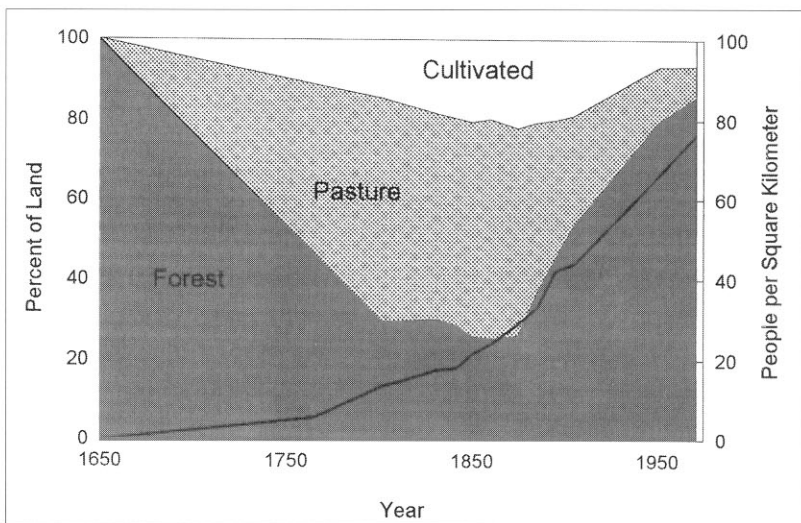


Figure 1. Historical changes in land cover and population for the central Massachusetts region (see Fig. 2 for area covered). Similar trends in population and changing area of forest cover are typical of the entire New England region outside of northern Maine. Data from Foster et al. (1998).

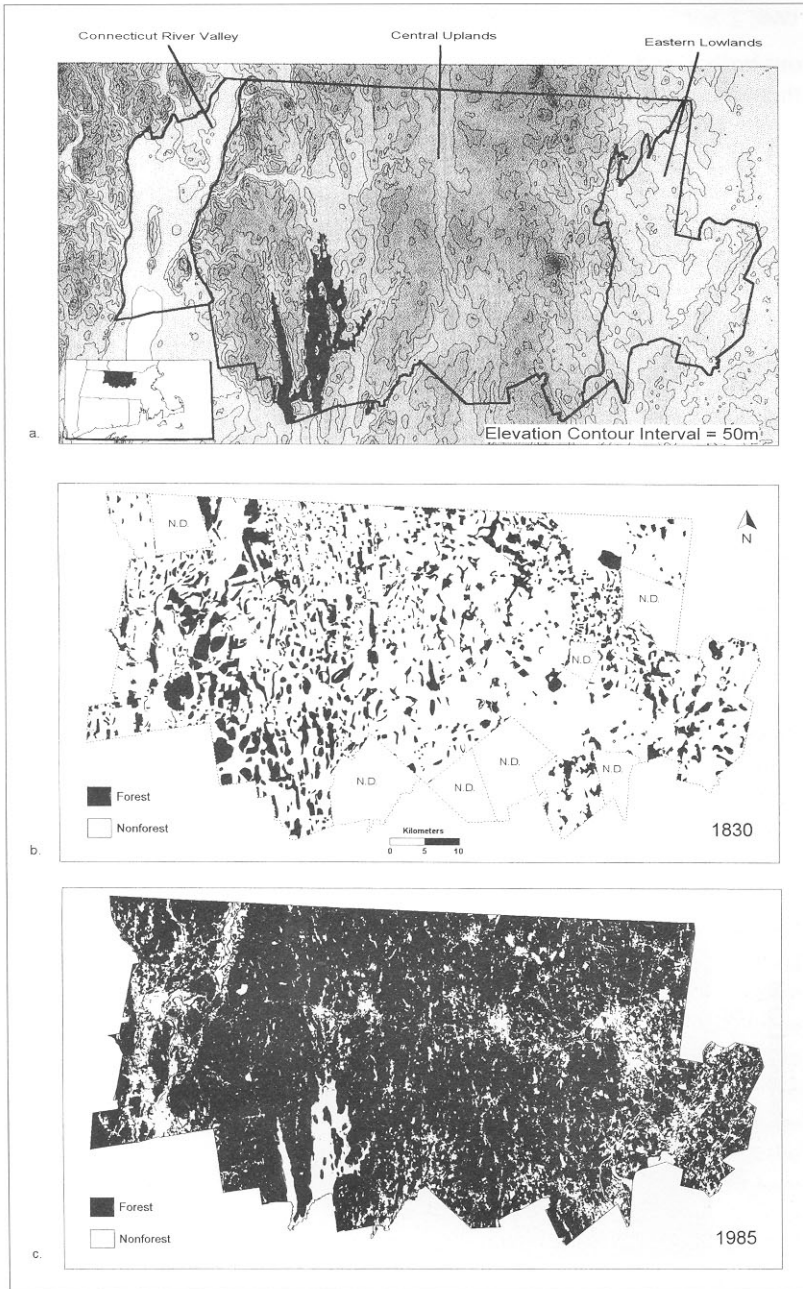


Figure 2. The central Massachusetts region showing (a) topography and physiographic areas, (b) forest pattern in 1830, when the landscape was extensively deforested for agricultural activity, and (c) forest pattern in 1985, following extensive natural reforestation. Variation in forest pattern during the two time periods is associated with physiography, the formation of the Quabbin Reservoir in the south-central region, and the formation of industrial towns along the major east-west highway and railroad. N.D. indicates that data for 1830 are not available. Data from Foster et al. (1998).

FOREST DYNAMICS, RATES OF CHANGE AND CONTINUITY OF VEGETATION THROUGH TIME

One of the major ecological lessons that inevitably emerges from a long-term perspective is that natural ecosystems are inherently dynamic (Davis 1986, Whitlock and Bartlein 1997). Importantly, however, a variety of studies that have assessed vegetation change over very long time-scales have found that the rates of compositional change for both terrestrial and aquatic ecosystems have been, and presumably will continue to be, greater since European settlement than at any time since the last Ice Age (Jacobson et al. 1987, Foster and Zebryk 1993, Fuller et al. 1998). In pre-history, climate and associated environmental change, as well as disturbance by pathogens, wind, ice storms, fire, and American Indians, produced changes in vegetation composition and presumably in its structure and pattern as well. Plants and animals responded individually, rather than in any concerted, group response to the unique combinations of environments and biotic factors that resulted. Consequently, as recently noted by Lawton (1997), although there is a relatively long fossil record of stability in the morphology of most individual plant species, the actual combinations and assemblages of species that form communities, ecosystems, and landscape patterns have no record of long-term coherency. The massive and very rapid change in land cover and land-use practices within the recent 300 to 400 years in the eastern U.S. have accelerated this process of natural change and recombination (Jacobson et al. 1987). The result has been a series of transient assemblages derived from a relatively constant regional flora (Fuller et al. 1998).

One major question that concerns the reforested northeastern landscape is whether these "new" forests are similar in composition to those that occupied the same land areas at the time of European settlement (Raup 1964, Whitney 1994). A range of studies across New England suggest that modern plant (and animal) assemblages in upland, wetland, and lake ecosystems, are historically anomalous, differing from those of four centuries earlier (Engstrom et al. 1985, Patterson and Backman 1988, Russell et al. 1993). Not only do the modern groupings of species show little resemblance to their antecedents, but they also show little tendency to revert in that direction as time passes and forests mature (Fuller et al. 1998). At a regional scale, for example across central Massachusetts, the forests that have formed following agricultural abandonment are remarkably more homogeneous than those of four centuries earlier and they include more sprouting and shade-intolerant species and fewer long-lived mature-forest tree species (Foster et al. 1998). Modern forests also exhibit much weaker relationships to regional variation in physiography, climate and soils (Fig. 3). At a landscape-scale, the arrangement and structural and compositional characteristics of plant communities are largely the consequence of species-specific response to

land-use histories and edaphic factors (Motzkin et al. 1996, 1998; Foster 1995, Whitney and Foster 1988). At a stand level, it has been possible to use the analysis of pollen from soils and small topographic depressions to interpret vegetation composition and disturbance histories over many centuries or even millennia and thereby assess the extent of change (Bradshaw and Miller 1988, Foster et al. 1992, Foster and Zebryk 1993). Although limited in number in New England, these studies confirm that even the least disturbed sites, for example forests that were cut early in colonial history but never cleared, have been dramatically changed by human disturbance. Thus these sites have often supported two or three distinctly different types of vegetation over the past 350 years and the current forests generally bear little compositional resemblance to those that occurred when the land was first settled by Europeans.

These conclusions concerning the historical rates and types of vegetation change have many ramifications for conservation biology and the development of management policies. Primary among these is the recognition that there are no static baseline conditions that exist or have existed for comparison with current conditions or for use as a target for restoration

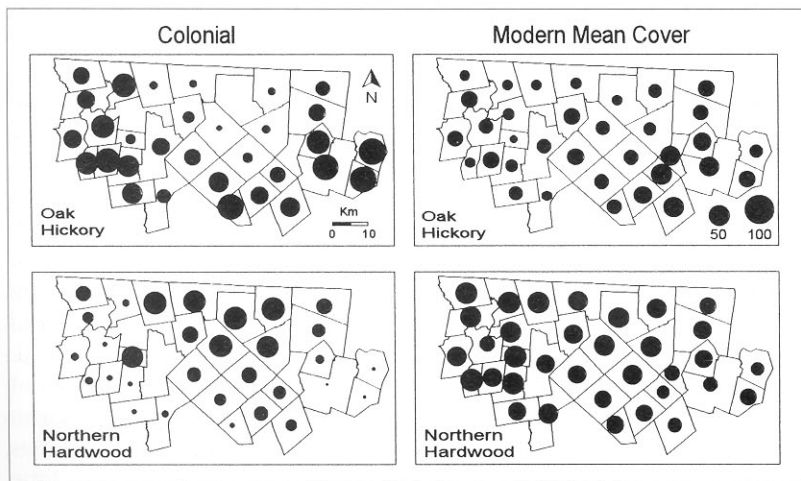


Figure 3. Changes in the relative abundance of two groups of tree species, oak-hickory and northern hardwood (maple, birch, beech) - hemlock, from the time of colonial settlement and the present in north-central Massachusetts (see Fig. 2 for area covered). At the time of European settlement the vegetation varied strongly with elevation and regional climate, with oak-hickory abundant in lower, warmer areas such as the Connecticut River Valley and northern hardwoods-hemlock more abundant on the cooler, higher elevations of the Central Uplands. Following the sequence of deforestation and natural reforestation that occurred through the 19th and 20th centuries, the forest composition has become much more homogenized on a regional scale and no longer varies as much with climate or elevation. From Foster et al. (1998).

activities. Ecologists, conservation biologists, and the public frequently use the pre-European period as a convenient benchmark for comparison with modern or historical conditions, as we have done above; however, this period was clearly characterized by change and flux in forest composition and structure, even if less dramatic than in the recent past. As we interpret modern landscapes or evaluate restoration and management approaches, we therefore need to recognize that vegetation has always been dynamic and that there is no single, ideal state to which plant and animal assemblages should be restored. Nature changes and frequently people are a factor in this change. Thus, in our search for goals and objectives in conservation management we should not be thinking of saving or restoring static examples of what nature is, was, or should be — these are transient entities, unreal concepts and futile objectives (Foster et al. 1996, Motzkin et al. 1993).

THE INEVITABILITY OF FUTURE CHANGE

The extent of human disturbance coupled with the ongoing change in global environments (climate, atmospheric composition, disturbance regimes, biota) result in the inevitability of future change in all landscapes. As a consequence, land managers of all types need to acknowledge change and anticipate future dynamics. Most New England landscapes are still in the process of recovering from past land-use activity while also responding to new changes in the physical or biotic environment, ranging from subtle stresses associated with changes in the atmospheric concentrations of nitrogen and carbon dioxide to defoliation by the gypsy moth and hemlock woolly adelgid (Aber 1993, Bazzaz 1996, Foster et al. 1998, Orwig and Foster 1998). Paleoecological studies (e.g. Foster and Zebryk 1993) and modeling approaches (Pacala et al. 1996) suggest that forest stands may take up to 500 years to recover from moderately severe disturbance such as fire, pathogens, or substantial cutting and thus we should anticipate that all vegetation, even if effectively protected from recent or future disturbance, will continue to change as it adjusts to its history of past impacts. In addition, natural disturbance and natural variation in environment will inevitably promote future, unexpected dynamics in all ecosystems.

WILDLIFE DYNAMICS AND FEEDBACKS IN PERSPECTIVE

Recent changes in many wildlife populations comprise one important, though often under-appreciated, component of landscape change in the eastern U.S. that has strong implications for conservationists, natural resource managers, and many residents. As a consequence of historical variation in the relative extent and type of land cover along with cultural and economic changes that have encouraged conservation,

wildlife introductions, and regulation of hunting, the New England region is undergoing a major transformation in wildlife abundance and composition (Fisher 1929, Hosley 1935, DeGraaf and Miller 1996). Although many large mammals and forest birds were eliminated in the 17th to 19th centuries and were replaced by the open-land species of meadows, fields and shrublands, we are currently witnessing a major resurgence of native woodland species. Some of these animals have been resident throughout the historical period and are simply expanding from small residual populations, others were locally or regionally eliminated and are immigrating from northern and western regions, while others have appeared as a consequence of successful programs of re-introduction. Whereas many of these species were important throughout the Northeast at the time of European settlement, others, such as the coyote, were originally native in other parts of the country and represent new arrivals that have been able to capitalize on changing landscape conditions and the absence of competitors or predators such as the wolf.

The recent increase in woodland species is often heralded, quite rightly, as an environmental success, but the burgeoning populations of woodland wildlife are also bringing many unexpected and occasionally undesired consequences to the landscape and to the largely suburban human population of New England. Beavers impound water, creating wetlands, killing trees, and flooding roads, yards, and sewage systems, while also creating important habitat for other animals and plants that utilize the resulting ponds, wetlands or dead trees. There is evidence that the population of beavers in some regions are flooding areas such as old-growth swamp forests that have not been inundated in the previous 300-400 years (P. Lyons and B. Spencer, pers. comm.). Deer, largely unchecked by hunting or major predators in many suburban and even rural areas, may impede forest regeneration, browse ornamental and vegetable gardens, and create automobile hazards. Larger mammals such as moose and bear create even greater concerns due to their potential for major impact on human safety as well as natural ecosystems. Each of these wildlife species and scenarios presents natural resource agencies and landowners with major control problems and generate ethical dilemmas for society.

The new populations of wildlife may also have unanticipated impacts on other species. Pileated woodpeckers, which have increased partly as a consequence of the greater availability of extensive forest areas and nest sites in large dead trees, create large bole cavities that shelter other animals. The swamps, ponds, and meadows that alternate through the cycle of beaver damming and abandonment provide a highly dynamic environment that presents considerable heterogeneity within a largely forested landscape. The extensive stands of dead trees produced by this flooding also provide nest sites, resulting in the large heron rookeries that have re-appeared across the New England states. The reappearance of

ravens across the New England landscape has been linked to the increase in large carnivores (Heinrich 1993), for by themselves these large scavengers are not capable of penetrating the tough hides and carcasses of dead animals and they rely on other wildlife (as well as automobiles!) to kill the animals and initiate the process of carrion feeding.

Human health may also be indirectly impacted by the changes in land-use, land cover, and wildlife dynamics. For instance, the increase and spread of Lyme disease has resulted, in part, from the increase in mouse and deer populations during the past several decades; a similar connection is noted between the incidence of *Giardia* (a parasitic protozoan) and beaver and other mammal populations in New England (P. Epstein, pers. comm.).

A historical perspective on these wildlife dynamics is necessary to understand them and to anticipate how they may change in the future. Such a perspective is also extremely useful in educating a human population that is increasingly separated from nature about the changes that are occurring throughout the landscape, including their own backyard. Clearly a better understanding of these dynamics and their causes improves the ability of natural resource managers and conservationists to manage them and their consequences.

NEW ENGLAND AS A CULTURAL LANDSCAPE

An evaluation of the past and current dynamics of the northeastern U.S. suggests that we must embrace wholeheartedly and realistically the notion that we live in a landscape that is shaped in broad pattern and controlled in fine detail by a history of human impacts. Recognition of this fact helps us to appreciate that humans have been, and still are, a major force and part of the functioning ecosystems that we call nature. It also helps us to shed the notion that we can somehow preserve or restore a nature independent of human history. On a regional to landscape scale many habitats have been selectively eliminated or converted to some new status. Wetlands have been drained on a widespread basis on inland as well as coastal sites, and changes in local hydrology have left us with distinctly different habitats and vegetation cover than have occurred historically (Tiner 1988). Across New England, upland areas such as the level sandplains that occupy outwash and deltaic deposits, have been extensively converted to industrial and commercial activities, airfields, and landfills (Motzkin et al. 1998). This selective habitat destruction, along with selective elimination of species, leaves us with a highly altered landscape representation of plant and animal communities. At the same time, the history of land-use has increased the abundance and importance of many species and ecosystems, such as open-land and weedy taxa.

On a regional scale, the intensity and type of disturbance that has occurred is highly variable and therefore conservation issues and priori-

ties may vary geographically. For example, across northern New England, a history of logging, large ownerships, low population density, and relatively intact forest cover has led to a recent emphasis on the preservation of continuous, older forest, the re-introduction of large native animals, and the re-establishment of forest processes typical of large, intact ecosystems (Dobbs and Ober 1995). Although many of these same values are embraced in southern and central New England, the history of intense agriculture has been extremely important for the generation of a landscape of open fields and highly fragmented forests. This, in turn, has led to increased focus on rare species in limited habitats and on the maintenance of many open-habitat plants, animals, and landscape characteristics (Dunwiddie 1992).

Recognition of the selective creation and destruction of habitats and the tendency towards change forces us to acknowledge that the maintenance of species and habitats that were common 50 to 100 years ago will require active management either by encouraging or subsidizing historical practices such as agriculture, or by replacing them with other management regimes (Birks et al. 1988, Dunwiddie 1992). In some cases, such as the conservation of open-land species of plant and animals, we may need to maintain cultural artifacts or legacies that were much less common or even absent from the landscape 300 years ago. Perhaps the best example of this phenomenon lies in the efforts to conserve grassland and shrubland habitat and species across southern and central New England and other parts of the Northeast. Although there is considerable uncertainty regarding the extent of non-forested land in New England prior to European arrival, grassland habitat was probably largely restricted to wet meadows, salt marshes, and scattered areas of extreme environment or disturbance such as coastal dunes or heavily scoured riverine islands, and perhaps areas near American Indian settlements (Russell 1980, Marks 1983, Whitney 1994, Bragdon 1996, Stevens 1996). Presumably, few areas were large enough to maintain some of the highly restricted and rare bird species that are the current focus of major conservation efforts but which may require >50 ha of open grassland for the maintenance of successful populations. However, as a consequence of forest cutting and agricultural activities such as burning, plowing, planting and grazing, extensive upland grasslands, freshwater meadows, shrublands, and heathlands were created in the 18th and 19th centuries, resulting in a dramatic increase in open-land wildlife and plants (Dunwiddie 1989, DeGraaf and Miller 1996). The prominence of these species is quite clear in contemporary descriptions, such as the journal notations from Henry Thoreau in which bobolinks, meadowlarks, and song sparrows are described as common (Fig. 4, Foster 1999). Currently many of these taxa are in decline, which presents an interesting dilemma to land managers and conservationists who are faced with the challenge of restricting tree invasion and growth on open lands and are confronted by the basic question of whether such cultural landscapes should be conserved.

Should these uncommon and presumably historically rare or non-native taxa be allowed to go locally extinct as the extent of forest land increases and agriculture declines? Or should we expend increasing effort on their maintenance, based on the notion that some of these species may be native, that many have become an important or characteristic part of the landscape, and that others may be threatened elsewhere in their range? Over the past decades, grassland and shrubland taxa have emerged as a major priority for conservation organizations such as The Nature Conservancy, Massachusetts Audubon Society, and state Natural Heritage Programs, which are seeking to conserve such birds as the grasshopper sparrow, upland sandpiper, and meadowlark through management programs based on burning, mowing, and grazing (Scheller 1994, Sharp 1994). Ironically, one of the most effective protection strategies for these species has been for conservationists to work with managers of highly artificial cultural landscapes in order to maintain appropriate habitat. The list of top sites for openland bird species in Massachusetts provides an indication of the precarious status of these species and the surprising nature of the remaining "prime" habitat (Jones and Vickery 1993). Among these sites, eight are commercial

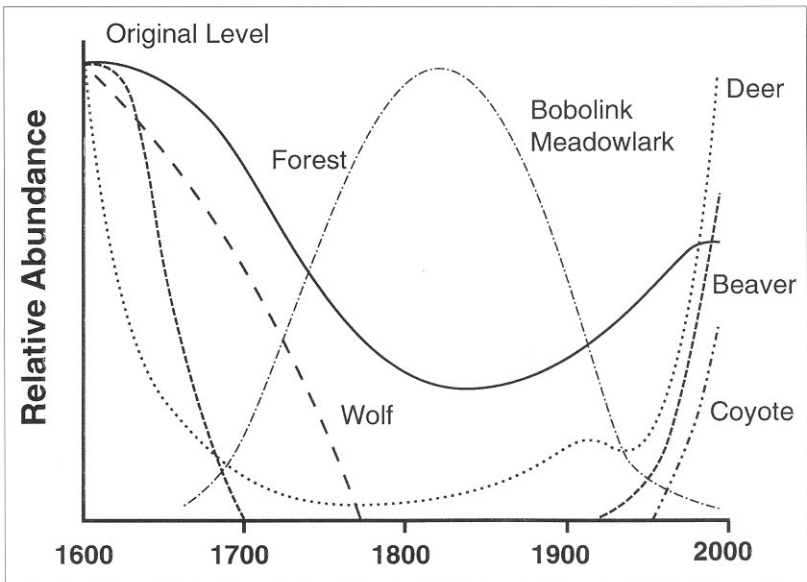


Figure 4. Schematic depiction of the historical changes in representative wildlife species and forest cover through time in New England. Whereas the wolf has been eliminated, open-field species like the bobolink and meadowlark peaked in abundance during the 19th century period of open agriculture, the coyote is a new species on the landscape, and deer, beaver, and bear have recovered greatly since elimination or very low historical abundance. From Foster (1999), modified from Bickford and Dymon (1990).

airports or military airbases, one is a landfill, one is a drained cedar swamp that was converted to grassland for agricultural and industrial purposes, one is a military training ground, and only two are in semi-natural condition, albeit one that is strongly shaped by historical land use. A historical perspective reveals the landscape dynamics that enabled the development of these habitats and wildlife assemblages. It also allows us to make the conscious decision, as has been done throughout northwestern Europe, that there may be great value in maintaining diverse cultural landscapes and the aesthetic and biological qualities that they support (Peterken 1981, Birks et al. 1988).

CONSEQUENCES OF THE ENDURING LEGACIES OF HISTORY

Land-use, like other disturbance processes, can generate legacies in terms of ecosystem structure, composition or function that are not easily erased or changed through time or even through subsequent disturbance (Foster et al. 1998). As a consequence, it is often erroneous to conclude that the adoption of a new management regime, even one that follows the presumed natural disturbance or environmental regime, will necessarily lead to the re-creation of "natural" conditions or the vegetation structure and composition that might have developed in the past as a result of such disturbance (A. White pers. comm.). For example, in the study of pitch pine and scrub oak vegetation on sandplains in the Connecticut River Valley, Motzkin et al. (1996) documented that the most important factor controlling many aspects of the modern vegetation and site conditions was the legacy of different land-use across these areas. Modern soil features, such as the presence of a "plow" (Ap) horizon and vegetation characteristics, including species composition and structure, reflected the prior site history even 50 to 100 years after the land-use activity ceased and despite a history of subsequent disturbance by fire. Other studies have shown a similar pattern of persistence of historical legacies in the face of hurricane impacts or other disturbances (Foster 1988; Foster and Zebryk 1993). These observations suggest that even though many management regimes are prescribed for natural areas in an effort to increase their natural character, such as prescribed burning in pine, oak, or grassland dominated landscapes, the vegetation may actually be slow to respond to such disturbances or may change in unexpected and even undesirable ways (Niering and Dreyer 1989; W. A. Patterson III pers. comm.). The outcome of such management may not be an enhancement of "original" attributes of the area (Motzkin et al. 1998), although it may contribute to other objectives, such as the maintenance of rare species habitat and regional biodiversity.

CONCLUSION AND RECOMMENDATIONS

Much of the eastern U.S. has witnessed an increase in forest cover in

this century due to a reduction in agricultural activity and natural resource extraction, which present new opportunities and challenges for conservation planning. These changes in land-use practice have resulted from the fact that the food, energy, building materials, and natural resources for the region are no longer obtained primarily from our local landscapes, but are derived instead from widely distributed global sources. Consequently, although regions like New England are experiencing population growth and historically high levels of residential expansion, they have also reverted to a more natural condition with more extensive cover of maturing forests and more native fauna than at any time in the previous 200 years.

The rapidity and extent of change, the ongoing dynamics in the landscape resulting from recovery from prior land-use as well as ongoing impacts, and the enduring legacy of past land-use necessitates that historical perspectives become an essential part of all ecological study and an important basis for the development of conservation strategies. Using these perspectives we can recognize the inevitability of change and the cultural imprint on most landscapes and on many seemingly natural features. We can also recognize that many plant communities and landscapes that are of great conservation value are actually novel, highly humanized, and of recent development. As we understand the transitory and highly cultural origins of many parts of our land, we can also appreciate the relative roles of science versus social values in determining policy and management objectives. Using both historical and ecological science, we can interpret and understand change, monitor and evaluate conditions and processes, and develop and inform management techniques. Ultimately, however, the decision of what we conserve or restore lies in the cultural values that we bring to this decision-making process. Thus, in New England, we can retain a cultural landscape of fields and forests that support open-land and edge species, or we can allow a culturally-derived forest to develop and age and harbor forest interior species. Science does not give us absolute guidelines for making these decisions but it does inform us that either decision will produce a new landscape with a history that includes people, and that is characterized by features that are not original, nor pristine, but are constantly undergoing change.

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