

Thoreau's country: a historical–ecological perspective on conservation in the New England landscape

David R. Foster* *Harvard Forest, Harvard University, Petersham, MA, USA*

Abstract

Our wood-lots, of course, have a history, and we may often recover it for a hundred years back, though we *do* not...Yet if we attended more to the history of our lots we should manage them more wisely. H.D. Thoreau. 16 October 1860.

Henry Thoreau, the great New England writer, thinker and naturalist, devoted his 'career' to observing, describing and interpreting (in some 2 million words in more than three dozen journal volumes) the natural and cultural characteristics of his nineteenth century landscape. Through these writings we not only learn a great deal about our land and its ancestry but we receive an impassioned, although balanced reverence for both the wild and cultural sides of nature. Thoreau also presents a means of interpreting landscapes based on keen observation, a strong awareness of natural history, and a recognition that insights to modern nature often lie in its past [Foster, D.R. (1999) *Thoreau's country. Journey through a transformed landscape*. Harvard University Press, Cambridge].

This paper argues that we take Thoreau's words and approach to conservation to heart and admonishes that we appreciate the historical processes driving long-term ecological changes as we attempt to conserve and restore the vegetation, wildlife and landscape of regions including New England. Over the past four centuries much of the eastern USA has been transformed by human activity as the heavily forested area was settled, cut, cleared and farmed through the mid-nineteenth century and then largely abandoned in haphazard fashion from active use and allowed to reforest naturally [Cronon, W. (1983) *Changes in the land Indians, colonists and the ecology of New England*. Hill and Wang, New York; Whitney, G.G. (1994) *From coastal wilderness to fruited plain*. Cambridge University Press, Cambridge; Foster, D.R. & O'Keefe, J.F. (2000) *New England forests through time: insights from the Harvard forest dioramas*. Harvard Forest and Harvard University Press, Petersham and Cambridge; Hall, B. *et al.* (2002) *Journal of Biogeography*, 29, 1319–1335]. Rather remarkably, the present landscape of New England supports many more natural attributes and processes than at any time since before the American Revolution. As a consequence of its history the region's considerable variation in vegetation, wildlife and appearance is largely explained by the history of human use [Bellemare, J. *et al.* (2002) *Journal of Biogeography*, 29, 1401–1420; Gerhardt, F. & Foster, D.R. (2002) *Journal of Biogeography*, 29, 1421–1437; Hall, B. *et al.* (2002) *Journal of Biogeography*, 29, 1319–1335; Eberhardt, R. *et al.* (2003) *Ecological Applications* (in press)]. Thus, although the region supports a diverse range of species, plant and animal assemblages, and landscapes, successful conservation strategies need to be based on a broad-scale approach that appreciates regional variation in natural and cultural history as well as current conditions [Foster, D.R. & Motzkin, G. (1998) *Northeastern Naturalist*, 5, 111; Motzkin, G. & Foster, D.R. (2002) *Journal of Biogeography*, 29, 1569–1589]. This approach must also work effectively with the general lack of regional planning and regulation and the predominant role of private ownership and control in New England [Berlik, M.M. *et al.* (2002) *Journal of Biogeography*, 29, 1557–1568].

*Correspondence: Harvard Forest, Petersham, MA 01366, USA. E-mail: drfoster@fas.harvard.edu

When a geographical–historical perspective is adopted for this region, three major, and in many ways quite dissimilar, directions for conservation emerge that are consistent with the region’s history and environmental variation, are being actively pursued by conservation organizations and agencies, and might be effectively coordinated on a broad scale today. These directions, as articulated by diverse organizations include: (1) wilderness preservation and the restoration and the conservation of wide-ranging species and broad-scale ecological processes; (2) maintenance of cultural, predominantly agriculturally derived, landscapes; and (3) increased, environmentally sound harvesting and utilization of local forest resources. Individually, when applied in appropriate landscape contexts, each of these approaches can exert positive benefits on biodiversity, environmental processes and quality of life. When applied collectively in a coordinated geographical fashion that acknowledges and accommodates regional variation resulting from physical, biological, cultural and historical factors, these three directions in land management may provide a broad template for proactive conservation that generates local to global benefits.

This paper examines each of these three conservation directions in relation to the region’s history and current ecological condition, attempts to articulate the environmental rationale that supports these activities, and then presents an initial approach at positioning each across this varied region.

Keywords

Conservation, history, New England, wildlands, reserves, cultural landscape, biodiversity, regional planning, sustainability, restoration, harvesting.

INTRODUCTION

Thoreau’s approach to and legacy of historical ecology

As he roamed and studied the nineteenth century countryside, Henry David Thoreau came to recognize that much of what he sought to explain in nature was conditioned by its history, which oftentimes included human activity (Foster, 1999). The woods surrounding Walden Pond and most other New England forests of Thoreau’s day were woodlots shaped initially by Indian activity and natural processes, and subsequently transformed by the heavier European hand of grazing, repeated logging, fire and clearing (Raup, 1966; Cronon, 1983; Hall *et al.*, 2002). As he worked to interpret these stand and landscape patterns, Thoreau investigated vegetation histories, seeking to reconstruct the range of plants and animals supported on specific sites through time and to decipher the environmental, biological and historical forces that had shaped them. His daily course of observation, enquiry and writing led Thoreau to develop a remarkable repertoire of historical–ecological skills, from dendroecology and archaeology to palaeoecology and environmental history. It also gave him a keen eye for disentangling the complex history of process behind botanical form and ecological pattern (Foster, 1999). Application of these skills over a lifetime of observation convinced Thoreau that an understanding of nature’s history, including cultural history, was essential for ecological interpretation and formed a critical basis for anticipating and managing future changes in nature.

Based on this historical perspective, and his deep knowledge of species and habitats, Thoreau forged a series of remarkable ecological insights and offered management and conservation recommendations that span a much broader range of

objectives than is usually attributed to an individual often perceived and characterized as a single-dimensional preservationist of wild nature. For while Thoreau extolled the virtue of old-growth forests, speculated on their unique attributes, and argued for the protection of the few extensive woodlands remaining in his landscape, he also recognized the critical role that farmers played in creating and maintaining the varied meadowlands, pastures, hedgerows, and grazed woodlands that supported the diverse plant, insect and bird fauna that he appreciated. In a similar vein, he applied his knowledge of woodland history and tree biology to make countless, generally unsolicited recommendations for improving forest management and harvesting techniques (Foster, 1999).

Today’s Henry David Thoreau’s place in and sense of history have particular relevance for New England and the eastern USA. The mid-nineteenth century spanning Thoreau’s lifetime (1817–62) represents a defining era and turning point for the region’s landscape (Fig. 1; Cronon, 1983; Merchant, 1989; Whitney, 1994; Irland, 1999; Foster & O’Keefe, 2000; Hall *et al.*, 2002). Across the region, excluding northern Maine, this period marked the peak of intensive agricultural activity and broad-scale deforestation that has left an enduring imprint on subsequent natural environments (Fig. 1; Russell, 1982; Foster *et al.*, 1998, 2003; Motzkin *et al.*, 1999b). Since Thoreau’s day agriculture has shifted to the mid-western and western USA, the rural population of New England has relocated to mill towns, cities and then suburbs where it continues to grow at a rapid pace, and people have stopped living from the land and instead rely on imported goods and natural resources (Raup, 1966; Berlik *et al.*, 2002). Consequently, the landscape of hayfields, pasture, meadow, and woodlots described

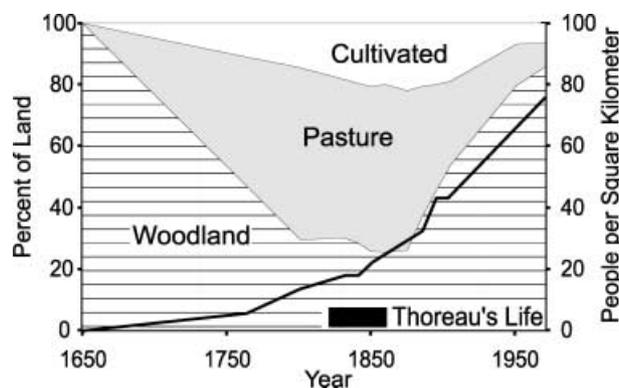


Figure 1 Throughout much of the New England landscape original wooded areas were converted to pasture and cultivated lands through the mid- or late-nineteenth century when agriculture declined, industrial activity (and population growth, dark solid line) increased, and forests re-established through natural succession (cf. Hall *et al.*, 2002). This figure depicts the land cover and population changes for a fifty-town area of central Massachusetts (Golodetz & Foster, 1996). Patterns of intensive nineteenth century land use continue to shape many forest characteristics and processes and can be interpreted through retrospective and historical studies. One insightful perspective on these activities as well as the long-term changes in the landscape is provided by the 2-million word journal of Henry David Thoreau, who devoted his life (1817–62) to describing and interpreting the culturally dominated countryside of New England. Modified from Foster *et al.* (1998) and Foster (1999).

in Thoreau's journals reverted first to shrubland and then young forest, and has gradually emerged as an expansive and maturing forest landscape. Agricultural land is increasingly scarce and is concentrated either in broad river valleys or localized rural areas where it continues to be threatened by housing and industrial development or abandonment from active use (Hall *et al.*, 2002). In contrast, in northern New England the balance of human activity tipped in the opposite direction after 1850 as the wild Maine Woods that Thoreau visited repeatedly for its rawness and insights into natural process became the centre of broad-scale onslaught by private and industrial logging activity that continues to this day (Lansky, 1992; Irland, 1999).

As a consequence of this lengthy history of human use nearly every part of the New England landscape is shaped by its cultural past as much as, and in most cases much more than, its history of natural disturbance or environmental change (Motzkin *et al.*, 1996, 2002a,b; Fuller *et al.*, 1998; Bellemare *et al.*, 2002; Gerhardt & Foster, 2002; Motzkin *et al.* 2002; Parshall & Foster 2002). Each forest has a singular, although oftentimes complex history as woodlot, pasture, or tilled field that shapes the modern vegetation in distinct ways (Motzkin *et al.*, 1999b). The remaining grasslands, shrublands and heathlands in this wooded and developed land are largely the legacy of intensive and often environmentally abusive land use, including deforestation, burning, cultivation or intensive grazing (Dunwiddie, 1989; Foster & Motzkin, 1999; Motzkin & Foster, 2002). At a site to landscape scale the modern presence and distributional

pattern of plant species is a major legacy of this history (Foster *et al.*, 2003). Consequently, in order to interpret vegetation structure, composition and function, and to anticipate or manage for future changes, knowledge of land use and vegetation history must be incorporated into every study, analysis or plan. Thoreau not only provides an approach for conservation and management based on history, but his detailed daily journal observations on land-use practices, vegetation and wildlife, capture essential information for modern conservationists and ecologists as they seek to interpret and manage the New England landscape (Cronon, 1983; Foster, 1999) (Figs 2 & 3).

Modern conservation in New England: opportunity and imperative

From a conservation perspective, regional history has placed the modern New England landscape at a critical and opportune juncture (Leahy *et al.*, 1996; Steel, 1999; Bio-Map, 2001). Forest area has reached a historic maximum but is beginning to decline as a result of development; many forests are older, wilder and more natural than any time in the last 200 years (Irland, 1999); and native wildlife, from bears and beaver to moose, fisher and ravens have increased rapidly. These conditions signal the potential for preserving and promoting extensive wildlands and restoring many formerly extirpated species (Klyza, 2001; Sayen, 2001; Foster *et al.*, 2002a,c). In contrast, as agriculture continues to decline the open-land plants and animals that thrived in Thoreau's day have become much less common, may be threatened with extirpation, and are oftentimes conservation priorities (Leahy *et al.*, 1996; Barbour *et al.*, 1998; Askins, 2000). Undeveloped land is increasingly threatened and fragmented by industrial and residential activities and continues to decline rapidly, especially in southern states [Fig. 4; Irland, 1999; The Trustees of Reservations (TTOR), 1999]. A prosperous and environmentally conscious population is financially and emotionally supportive of conservation, and land prices are relatively low, especially in northern and rural areas (Allen, 1999; Bateson & Smith, 2001). However, recent analyses suggest that current conservation activity (e.g. of land protection and forest harvesting) forms a haphazard and relatively ineffective spatial pattern because of a lack of coordination among organizations and public agencies and the absence of a coherent regional framework for planning (Golodetz & Foster, 1996; Berlik *et al.*, 2002; D.B. Kittredge, unpublished data). Clearly the time is propitious to develop New England's conservation future.

Intriguingly, New England currently supports at least three distinct conservation movements. On first glimpse these may appear incongruous and incompatible, for they include: (1) a movement to restore vast areas of wilderness, to re-introduce large mammals and natural processes, and to forge a broad and connected network of wildlands (Klyza, 2001); (2) efforts to maintain species, habitats and attributes of Henry Thoreau's cultural landscape, including assemblages from heathlands, grasslands, shrublands and early successional forests (Dunwiddie & Sferra, 1991; Foster



Figure 2 Historical changes in land use and land cover across the eastern USA have led to a broad-scale transformation of the extensive agricultural landscapes of the nineteenth century to widespread forests today, as depicted in two views of the Swift River Valley in Petersham, Massachusetts in the 1880s (top) and 1990s (bottom). As a consequence of these changes plant and animal assemblages characteristic of open habitats have shown a sharp decline and are often-times uncommon or even endangered, whereas woodland species and forest processes have increased. Extensive woodlands across the region provide opportunity for the restoration of wildlands and forest ecosystem processes as well as increased production of wood resources. In the autumn landscape scene depicted here (bottom) forests dominated by white pine (green) have established extensively across old agricultural fields, whereas areas that have been continuously in forest through the colonial period are dominated by broadleaf species including oaks, red maple and birches. Photographs from the Harvard Forest archives and D.R. Foster.

& Motzkin, 1998; Dunwiddie, 1999; Motzkin & Foster, 2002); and (3) a call for increased management of New England's forests in order to provide a greater share of the region's natural resources from local sources, reduce the global impact of New England's affluent lifestyle and maintain species dependent on historic patterns of logging (Berlik *et al.*, 2002; Foster & Motzkin, 1998; DeGraaf & Yamasaki, 2001; Donahue, 2001). On close inspection each of these directions in conservation link closely to and are quite compatible with the historic changes in the land itself.

In order to move towards a historically based and geographically coherent approach to conservation in New England this paper: (1) provides a brief overview of these three major conservation directions and their relationship to the changes in the land; (2) offers an initial attempt at melding these disparate activities into a regional approach to conservation based on this landscape history and variation; and (3) identifies some of the constraints on restoration and conservation in a cultural landscape like New England.

THREE DIRECTIONS FOR CONSERVATION IN NEW ENGLAND

Wildlands and wilderness restoration

The extent and intensity of agricultural land-use activity has declined over the past century and a half and many parts of the New England landscape have become wilder and more strongly dominated by natural processes (McLachlan *et al.*, 2000). Forest area increased dramatically through the mid-twentieth century and, with forest growth exceeding harvests (a fact still true for most of the eastern USA except northern Maine and portions of the southeast; Irland, 1999), a vast expanse of maturing forest covers much of the land. The countless stonewalls, ancient cart roads and woodland paths, and abandoned railroad beds that traverse this forested countryside bear testimony to the history of use and change, but only begin to convey the enormity of the environmental recovery that has occurred (Dunwiddie, 1989;

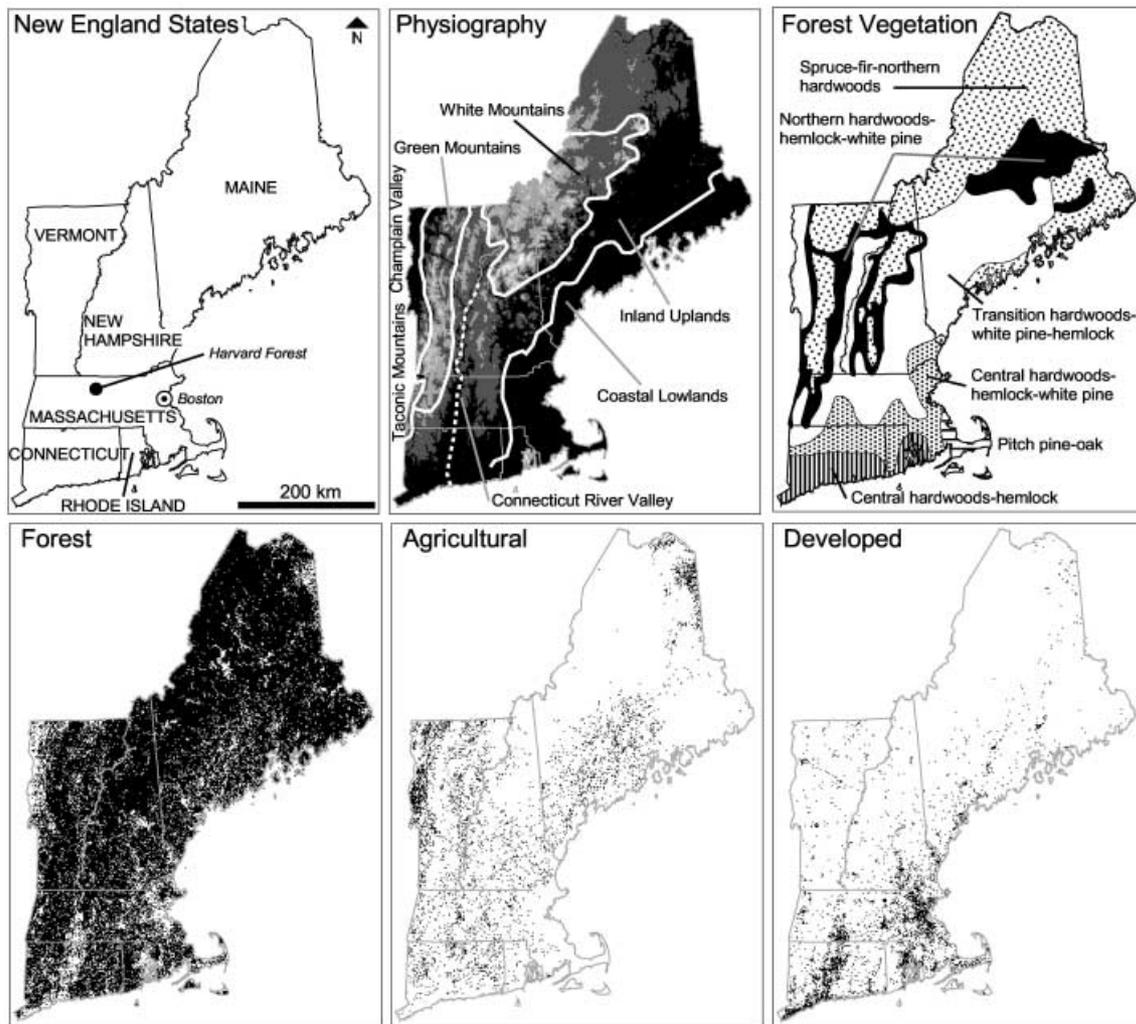


Figure 3 Physical and land-cover characteristics of the modern New England region, including political boundaries, physiographic regions, forest vegetation types, forest cover, agricultural land and developed land. Forest vegetation from Westveld *et al.* (1956) and land cover from Vogelmann *et al.* (2001).

McKibben, 1995; DeGraaf & Miller, 1996; Hall *et al.*, 2002).

Pond shores and stream banks that were trampled and eroded by livestock or gouged by log drives have stabilized and revegetated, grassy lowland meadows shorn annually for centuries have reverted to shrub wetlands, alder thickets and forested floodplains, and endless rocky pastures have gradually transformed into red maple swales or hillside stands of white pine, paper birch, oaks and maples (Robinson, 1976; Dunwiddie, 1989; Foster, 1999). After a century or more of recovery, forests with a lengthy history of intense logging or other land use may share many structural and compositional traits with mature or even old-growth forests and may bear little to no visible evidence of these historical transformations (Patterson & Foster, 1990; McLachlan *et al.*, 2000). In concert with the resurgence of forest habitat and the change in human attitudes, native wildlife has

recovered, albeit unevenly and incompletely (DeGraaf & Miller, 1996; Foster *et al.*, 2002c). Through expansion from small populations in nineteenth century refugia, immigration from adjoining regions and intentional re-introductions, a great diversity of woodland and interior mammals, birds and other species now occur in this newly reforested landscape (Foss, 1992; Trombulak, 2001).

This resurgence of naturalness, accompanied by popular interest in the environment has stimulated broad-based interest in the restoration and preservation of wildlands and old-growth landscapes (Davis, 1996; Klyza, 2001). Indeed, the historical recovery and current condition of the land make the preservation of extensive wild areas or even the development of an interconnected reserve system a reasonable and attainable goal in many parts of the region. In addition, low land prices in many rural areas make the preservation of large forest tracts feasible for private individuals



Figure 4 Private ownership and a lack of stringent land-use zoning or regional planning in the eastern USA leads to the common scene of residential or industrial development fragmenting (top) agricultural land (note barn and silos in upper left) and (bottom) forests. Photographs by D.R. Foster.

or public entities. Efforts to support this goal are diverse but span all the New England states and involve many organizations. In the south, for example, the Massachusetts Audubon Society (MAS) has initiated legislation to protect scattered old-growth forests and extensive buffer areas on public lands. Along with regional groups like RESTORE: The North Woods, MAS has called for a halt to most forest harvesting in the 70,000-acre Quabbin Reservation in the western part of the state in order to promote old-growth characteristics across this largest tract of public land in southern New England (R. Hubley and K. DeBoer, pers. comm.). The private Sweetwater Trust, based in Boston, actively supports the protection of large forest tracts as 'forever wild' throughout the region and is developing a comprehensive map of truly 'protected' (i.e. protected from harvesting as well as development) lands in order to guide this activity (Bateson & Smith, 2001).

Across the eastern USA there is increasing effort to identify, protect and study the remaining old-growth and virgin forest areas (Davis, 1996; Orwig *et al.*, 2001; Motzkin *et al.*, 2002). In addition, there has been a shift in focus among mainstream conservation organizations from the simple protecting of individual 'hotspots of diversity' to the identification and protection of extensive matrix landscapes that support natural processes (Anderson, 1999). 'Wilderness areas' (this term is used with the full understanding that essentially all areas have been affected by human activities, directly or indirectly) or similarly designated lands have been created on portions of the region's federal and state lands.

The preservationist movement's most ambitious goal centres on the so-called Northern Forest that stretches from northern New York state through Vermont and New Hampshire to northern Maine and for which there are various calls for the establishment of extensive reserves along

with the restoration of populations of large predators, especially wolves, but including lynx, marten, and even cougar (RESTORE, 2000; Klyza, 2001; Sayen, 2001). Among core areas for such proposed reserves are extensive old-growth and second-growth areas in the Adirondacks State Preserve (NY), the Green and White Mountain National Forests (VT, NH, ME), and Baxter State Park (ME), along with smaller state forests and parks. Reserves, including a national park proposed by RESTORE, might also be created from extensive industrial forestlands where intensive harvesting, short-sighted management, and recent sales of large tracts have created great environmental, economic and public concern (Lansky, 1992; Dobbs & Ober, 1996; Irland, 1999; Rolde, 2001). The relatively low value of much of this land for near-term timber harvest and the high turnover in ownership yields great opportunity for the purchase and restoration of future old growth.

The move towards wilderness preservation and restoration has been especially well received by portions of the region's large suburban population that has been nurtured on the American ethic of wilderness and is currently sustained by an economy based on imported natural resources (Irland, 1999; Berlik *et al.*, 2002). Rural populations, often more closely connected to the land and natural resource production exhibit a more ambivalent reaction and numerous conflicting visions for this region exist. The means to establishing extensive wildlands include federal purchase, public and private acquisition of conservation restrictions (deed restrictions on development or other activities) of large contiguous blocks and modification of current management plans for national and state lands.

Restoring and conserving New England's cultural landscape

Despite media attention on old-growth forests, large mammals and interior forest birds that are associated with intact forest areas and preserves, the plant and animal species that are declining most rapidly across the north-eastern USA do not reside in deep woods but depend on grasslands, shrublands and other early successional habitats (Leahy *et al.*, 1996; Askins, 1993, 1997, 2000; DeGraaf & Yamasaki, 2001; Litvaitis, 2001; Motzkin & Foster, 2002). As abandoned pastures, hay fields and lowland meadows have become wooded and as coppice scrublands and woodlots have grown into mature forests over the past 150 years, there has been a steady long-term decline in open-land plant and animal species (Foster, 1999; Foster *et al.*, 2002c). The species involved are varied, but range from small mammals (e.g. eastern cottontail) and reptiles and amphibians (e.g. bog turtle, smooth green snake, leopard frog) to vascular plants (e.g. Shrubby cinquefoil, *Potentilla fruticosa*). However, the most pervasive and apparent declines have occurred in birds (e.g. bobolink, meadowlark, woodcock, whippoorwill) and insects (e.g. regal fritillary, great spangled fritillary, some tiger beetles and dung beetles). Species including the Upland sandpiper, grasshopper sparrow and savanna sparrow are now restricted to a handful of scattered locations

and highly reduced populations, and some occur on state or even federal lists of protected, threatened or endangered species (Jones & Vickery, 1995, 1997). As a consequence, protection for these species and restoration of their habitats have emerged as top priorities for conservation organizations (e.g. Leahy *et al.*, 1996; Steel, 1999; Normont, 2002; TNC, 2002a, b), and for state wildlife and conservation agencies (Barbour *et al.*, 1998).

The changing status of most of these species over the past century is best understood as a direct consequence of the effects of land-use and land-cover change on habitat availability (Dunwiddie, 1989; Vickery & Dunwiddie, 1997; Budd, 2000; Litvaitis, 2001; Foster *et al.*, 2002c). For example, in the late nineteenth century shrubby cinquefoil, currently an uncommon species was widespread and abundant across Massachusetts. Its aggressive and rapid spread across wet pastures and meadows led to its historic description as a 'noxious weed' and prompted farmers and agricultural societies to share information on its control (Motzkin *et al.*, 2003). In related fashion, blue lupine, an uncommon herb currently prized for its colourful appearance and role in sustaining the rare Karner blue butterfly, carpeted sandy agricultural lands such as North Haven Sand Plain in southern Connecticut in the late nineteenth and early twentieth centuries (N. Barnes, pers. comm.). Today, the wet meadows are wooded or drained; cities, factories, gravel pits and trees occupy the sand plains, and cinquefoil and lupine are restricted to small populations. As we read through Henry Thoreau's journals the enormity of the historical changes emerge; his daily jottings are filled with descriptions of meadowlarks, bobolinks, whippoorwills and bitterns roaming hay fields, pastures and lowland meadows, along with the cattle and phalanxes of farmers who mowed and maintained them (Foster, 1999).

Many techniques are currently employed to retain or restore the open habitats that these species require and to counteract the natural tendency of succession towards a forested (and inhospitable) condition (Jones & Vickery, 1995; Budd, 2000). Whether acknowledging it or not these approaches largely seek to reproduce the earlier effects of countless farmers and their domesticated animals and to maintain cultural elements of the historical New England landscape (cf. Birks *et al.*, 1988, 1996; Dunwiddie, 1989). In its Biodiversity Initiative, the Massachusetts Division of Fisheries and Wildlife may have the largest such programme in New England for it employs timber cutting, brush cutting with an immense tracked vehicle (the 'Brontosaurus'), and mowing to create and expand complexes of grassland, shrubland and thickets (J. Scanlon, pers. comm.).

A similarly ambitious programme of mechanical treatment is underway on the Nantucket moors by MAS in conjunction with the Nantucket Conservation Society (E. Steinauer, pers. comm.). The moors, like many coastal heathlands and grasslands world-wide, are the product of forest clearance, soil disturbance and intensive sheep grazing (Gimingham, 1972; Dunwiddie, 1989; Tiffney, 1992; Foster *et al.*, 2002b). With elimination of the sheep, which once exceeded 15,000 animals on the island, the moors have grown

increasingly rank as shrubs, scrub oak and pitch pine have expanded prodigiously (Dunwiddie, 1989). Attempting to reverse the deterioration of open-land habitat, the conservation groups are mowing many hundreds of acres, producing patches of young growth dominated by actively sprouting herbs and shrubs. Controlled burning has been employed on adjacent areas. Meanwhile, a proposal to establish a small sheep flock is based on the notion that grazing is historically consistent and is the management treatment that is most likely to produce a diverse and heterogeneous grassland and heathland habitat (W. Tiffney, E. Steinauer, pers. comm.).

Fire is increasingly employed in the maintenance of open, cultural landscapes, motivated in large part by historical documents (including Thoreau's journals; Foster, 1999) which indicate that brush burning as well as accidental fires were common during the Colonial period (Cronon, 1983; Patterson & Backman, 1988; Whitney, 1994). The fire crew of The Nature Conservancy (TNC) burns historically mowed, grazed and burned areas in an attempt to restrict woody growth and promote openlands (TNC, 2002a,b). A hallmark project is Katama Plains on Martha's Vineyard, a series of historically plowed and mowed fields that support a high diversity of herbs and grassland birds and insects. Elsewhere on New England's coastal landscapes TNC crews burn scrub oak and oak woodlands to maintain the low sprouting vegetation that resulted from over 200 years of repeated burning, cutting and grazing (Foster & Motzkin, 1999; Foster *et al.*, 2002b).

Motivations for the maintenance and restoration of open and early successional vegetation are diverse. In many settings conservation of these habitats is based on aesthetic and nostalgic considerations as landowners and managers attempt to sustain an attractive, although increasingly scarce landscape that forms a cherished part of New England's heritage and cultural memory. This desire to maintain a semi-natural countryside parallels the widespread appreciation for cultural landscapes in Britain and north-western Europe (Birks *et al.*, 1988; Peterken, 1977; Rackham, 2000, 2001). It also has direct links to Henry Thoreau's poetic appreciation of the pervasive human element in his agrarian landscape (Gleason, 1917; Allen, 1936; Buell, 1995; Foster, 1999).

For many conservationists protection of open-land habitats is tied to the fundamental desire to maintain biological diversity, especially that represented by uncommon species and assemblages (cf. Jones & Vickery, 1997; BioMap, 2001). Although many uncommon species in New England occur more abundantly elsewhere, a number of the open-land species are globally rare and thus the effort to protect habitats in this region takes on heightened importance (Askins, 2000). In other cases loss of habitat across the broader range of a species' distribution has made marginal habitats in New England more valuable. For example, the historical destruction of mid-western prairies threatens some grassland species that occur on remnant successional land in the east. Ironically, in New England hotspots for grassland species, which include extensive areas of short grass, are increasingly provided through the careful management of completely artificial habitats such as

military bases, air fields or land fills (Leahy *et al.*, 1996; Jones & Vickery, 1997; Vickery & Dunwiddie, 1997; Askins, 2000). In a period of declining agricultural activity and agrarian landscapes a new and albeit less romantic human landscape is providing important habitat.

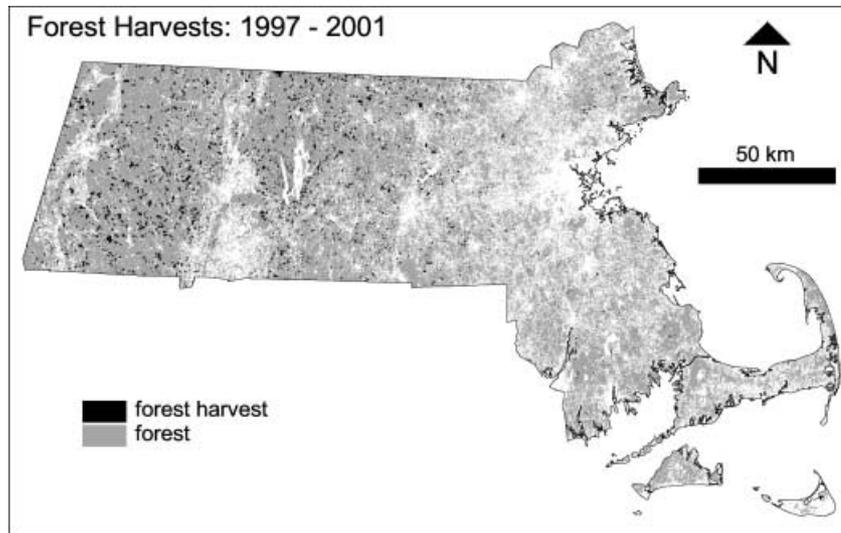
Importantly, restoration of successional habitat through burning is also motivated from a variant on the wildland ethic. Specifically, many groups promote the notion that extensive areas of grassland, shrubland, young forest and savannas prevailed before European settlement and were maintained by natural disturbance (e.g. wind and wildlife, especially beaver) and Indian activity including horticulture, village clearing and purposeful burning (cf. Patterson & Sassaman, 1988; Askins, 2000). However, in New England there is scant historical or palaeoecological evidence to support the notion of extensive openlands (cf. Foster *et al.*, 2002b; Motzkin & Foster, 2002; Parshall *et al.*, 2003). Indeed, most evidence suggests that open upland habitats, especially the heathlands and grasslands that support diverse species and assemblages, were almost exclusively the product of European land-use practices (Motzkin & Foster, 2002). Nonetheless, understanding the long-term changes in fire and human activity associated with the development and the changing abundance of these habitats provide conservationists with the tools necessary to maintain or restore them.

The environmental argument for increased forest management

One bridge between the desire to restore wildlands and the interest in conserving cultural and early successional landscapes is the argument for an increase in responsible and sustainable forestry. One important fact to bear in mind is that landowners in New England have great latitude in the treatment of their land and no governmental compulsion to operate under a long-term or regional plan or to manage for specific habitats. As a consequence, long-term protection of productive forestlands is frequently uncertain and the pattern, intensity, and environmental soundness of timber harvesting are often haphazard and highly variable (Berlik *et al.*, 2002). The result is that forest growth exceeds harvests across the region and low intensity harvesting is dispersed across the region, interfering with the development of extensive wildlands (Fig. 5).

The call for increased forest management and harvesting is a response to this history and is based on diverse arguments that harvesting is economically feasible; societally desirable to improve woodlands that have arisen through a history of neglect and abuse; essential for generating specific wildlife habitats; and desirable from a global environmental perspective (Irland, 1999; Foster & O'Keefe, 2000; Donohue, 2001; Berlik *et al.*, 2002). Although timber harvesting has been a traditional land-use activity over past centuries, the calls for increased harvesting are fairly consistent in their insistence that the actual practices involved should be more intensive, but also should be conceived, supervised and regulated more effectively. Unfortunately, too much of the current logging is short-sighted and essentially unmanaged

Figure 5 Forest area (grey) and harvesting pattern (black) in the state of Massachusetts over the period 1997–2001. One consequence of management decisions being made by tens of thousands of landowners is a haphazard and highly disorganized pattern of selective cutting. Regionally, harvesting is most intense in rural areas with low population densities. An alternative approach might involve a regional scheme leading to a pattern of broad reserves and large areas of focused timber harvesting. Unpublished data from the Massachusetts Department of Environmental Management collected by J. Burk and archived electronically at the Harvard Forest.



and therefore is poorly planned in terms of spatial patterns, future conditions or long-term goals.

The organizations and agencies involved in promoting increased environmentally-sound harvesting are remarkably diverse, ranging from small land trusts and community organizations (e.g. Mount Grace Conservation Land Trust; Golodetz & Foster, 1996; Donahue, 2001), regional and national conservation organizations (e.g. Vermont Land Trust, New England Forestry Foundation, The Nature Conservancy, Society for the Protection of New Hampshire Forests), municipal, state and federal agencies to private industry groups (Irland, 1999). For example, major efforts at developing environmentally sound harvesting regimes based on natural disturbance regimes have emerged recently from academic, industrial and conservation organizations. Other efforts link harvesting practices directly to the habitat requirements of individual wildlife species, especially game animals (DeGraaf & Yamasaki, 2001). One important development has been efforts to establish permanent conservation protection (i.e. legally binding conservation restrictions) on forestlands in order to ensure that these areas may be kept in active management and contribute to the broader goal of controlling development and land conversion (K. Ross, pers. comm.) Nonetheless, there remains major public mistrust and general antipathy towards timber harvesting, especially in suburban regions (Donahue, 2001).

In part to counter this public sentiment, a recent environmental argument for logging has been forwarded. This argument cites the fact that the second-growth forests of New England could supply a meaningful percentage of local consumption on a sustainable basis (perhaps as much as 50% if combined with effective conservation and recycling) and argues that to do so would ease the environmental pressure on more fragile and natural landscapes elsewhere in the world that are currently exporting products to the USA (Berlik *et al.*, 2002). Local wood production from an environmentally conscious region like New

England, where it would be subject to public scrutiny should ensure better oversight and longer-term objectives. Local management also provides incentives for landowners to retain and improve their land holdings over time thereby thwarting the tendency to develop, sell or harvest for immediate gain. Local harvesting *might* even promote conservation of resources by the consumptive New England population by drawing a clear connection between resource production and consumption. The increased use and focus on the value and attributes of the region's forests might also become part of an initiative to reconnect the New England population with the land and to promote local, town-based conservation (Donahue, 2001).

A REGIONAL CONSERVATION PLAN FOR NEW ENGLAND

Challenges and opportunities

The challenges to effective conservation in New England are formidable: the population is growing and utilizing prodigious quantities of (largely imported) resources; conversion of woods, fields and farms to industrial and residential use is proceeding rapidly; indiscriminate harvesting activities are damaging the remaining forestlands; regional thinking and planning are uncommon, leading to uncoordinated and counterproductive activity; vast quantities of forestland lie in a kaleidoscope pattern of thousands of small non-industrial private ownerships; and emerging patterns of conservation activity are generally haphazard and less effective than they might be (Steel, 1999). However, there are many auspicious characteristics of the current situation (Figs 6 & 7): there is strong public interest in the environment and substantial public and private resources to support initiatives; interesting broad-scale thinking and conservation planning is emerging; satellite and GIS technology facilitate management and conservation at regional scales and across ownerships and political boundaries; the current base of conservation land provides



Figure 6 Expansive forested areas present diverse opportunities for the development of large reserves and the restoration of natural forest processes, structures and species across New England. Proposals for such wildland development range from populated southern areas (top – Quabbin Reservoir watershed in Massachusetts) to extremely remote Northern Forest lands in Maine, New Hampshire and Vermont (bottom – the Northeast Kingdom of Vermont). Photographs by D.R. Foster.

Figure 7 Remaining agricultural land in New England is focused in areas such as the Connecticut River Valley in Massachusetts where it provides a striking contrast to the adjacent wooded uplands rising in the distance. Photograph by D.R. Foster.

a strong starting point; and the abundance and availability of quality lands provides considerable opportunity for action.

In many ways preservation and restoration in the eastern USA is immensely easier than in the temperate landscapes of Britain and Europe. New England is currently 60–90% forested; much of the forestland outside the industrial north is in a condition that would be considered 'excellent' and might warrant special protection in many European countries (G. Peterken, K. Kirby, pers. comm.). The diversity of native species is great, few species have been driven extinct, current wildlife assemblages include many large mammals and birds, and although there are problems with introduced species, there are no taxa comparable with the introduced deer or immense monocultures of Sitka spruce, Douglas fir and lodgepole pine that have a strong impact on ecological conditions across broad portions of the English and Scottish landscape. The period of intensive land use in New England has also been comparatively brief and simple by European standards. Thus historical–ecological sources can provide informative insights into the changes and processes that have shaped these landscapes and their plant and animal populations since pre-settlement times (Oliver & Stephens, 1977; Foster & Zebryk, 1993; Fuller *et al.*, 1998; cf. McLachlan *et al.*, 2000; Motzkin *et al.*, 2002).

These studies indicate that a substantial percent of the New England landscape remains in 'primary' forest (British 'ancient woods'): areas that were cut or burned but never cleared, plowed or intensively grazed (Foster *et al.*, 1998; Hall *et al.*, 2002). Importantly, these areas retain much of their native floras and thus have and may continue to serve as large reservoirs for the restoration of natural landscapes (Motzkin *et al.*, 1996, 1999a,b; Foster & Motzkin, 1999; Bellemare *et al.*, 2002; Gerhardt & Foster, 2002). Meanwhile, New England's cultural history has produced a delightful array of agrarian landscapes and corresponding traditions including meadows, pastures, arable lands, heathlands, and scrublands that diversify the landscape ecologically and visually (Figs 8 & 9). Agriculture is generally small scale and relatively low intensity due to the small size and topographic unevenness of most holdings. Consequently, landscape eutrophication and loadings of herbicide and pesticide that present problems in many parts of Europe are generally minor issues. In secondary woodlands across the region the relics of the agrarian past – stonewalls, ancient fence-line trees, woodland paths and dirt roads, and abandoned mill ponds, dams and cellar holes – add an intriguing historic and cultural element to the natural growth of trees, shrubs and herbs (Wessels, 1999; Foster & O'Keefe, 2000).

Weaving conservation directions geographically and historically

The real challenge looming for conservationists in New England is how to weave a coherent and comprehensive approach that integrates the diverse landscape histories, modern characteristics and cultural attitudes in this heterogeneous region. How do we reconcile the cultural, the wild

and the semi-natural elements of the land, the very different rates of ecological change in different systems and their environmental drivers, and the urge for preservation and restoration, with environmentally and socially responsible natural resource management? Sketched below is an admittedly simplistic and broad-brush outline that is intended to initiate a discussion that recognizes, embraces, and begins to incorporate the very different directions for conservation discussed in the text. The approach is historical, ecological and geographical. And, it includes people, the land and the past, with an eye towards the future.

The approach begins with recognition of the interaction between history and environmental conditions in shaping current ecological conditions and trajectories. It then identifies regions supporting and amenable to the three very different objectives and management regimes discussed above: the restoration and maintenance of wild semi-natural, resource-management and cultural landscapes. It argues for placing each of these regimes in the land based on landscape history and current condition and then closes with a strong plea for pursuing these objectives through a comprehensive plan based on science, historical research, clear objectives and long-term measurement and re-assessment (cf. Sutherland & Hill, 1995; Foster *et al.*, 2002b).

Natural landscapes and broad-scale ecological processes

Across much of northern New England and extending south through the White and Green Mountains into western and central Massachusetts and western Connecticut lie extensive forestlands that are thinly populated and oftentimes held in large public and private ownerships. Much of this area has been heavily logged or even farmed historically, but it includes expanses of primary forest, wetlands and water bodies. Although some of these areas, notably in the Berkshire, Taconic and Green Mountains, are recognized for their diverse woodland flora, most of the region supports fairly common and low-diversity assemblages of plants. As a result of its historical, ecological and socioeconomic setting, this region is well-suited to the maintenance and restoration of broad-scale ecological processes and species that require extensive and unbroken areas of natural landscapes (cf. Golodetz & Foster, 1996; Anderson, 1999).

Within this region it appears desirable and quite feasible to couple two complementary management approaches: the protection of truly wild and unmanaged lands in extensive core reserve areas, surrounded by substantial forested tracts under long-term, environmentally sound management for timber products. Logically, the wild preserves should focus on regions of lowest human population, continuous forest, and primary and old-growth woodlands. These might principally embrace large portions of the Northern Forest (cf. Dobbs & Ober, 1996), including the Adirondacks of New York, Green Mountains and North-east Kingdom of Vermont, White Mountains of New Hampshire and adjoining Maine and large portions of the Maine Woods. Select areas in the south could also be so designated. A recent proposal to develop core areas with the structural and biological characteristics of old-growth forests within a matrix of managed



Figure 8 Extremely important habitat for uncommon species and diverse plant and insect assemblages is provided by coastal grasslands, heathlands and shrublands such as the (top) central moors of Nantucket (middle) Katama Plains of Martha's Vineyard, and (bottom) Wellfleet Massachusetts Audubon Sanctuary on Cape Cod. These lands were deforested and subsequently grazed intensively by sheep and oftentimes plowed for pasture improvement before abandonment. Consequently, over the long-term active management is required to prevent the encroachment of woody vegetation including ericaceous shrubs, scrub and tree oaks, and pitch pine. Photographs by D.R. Foster.

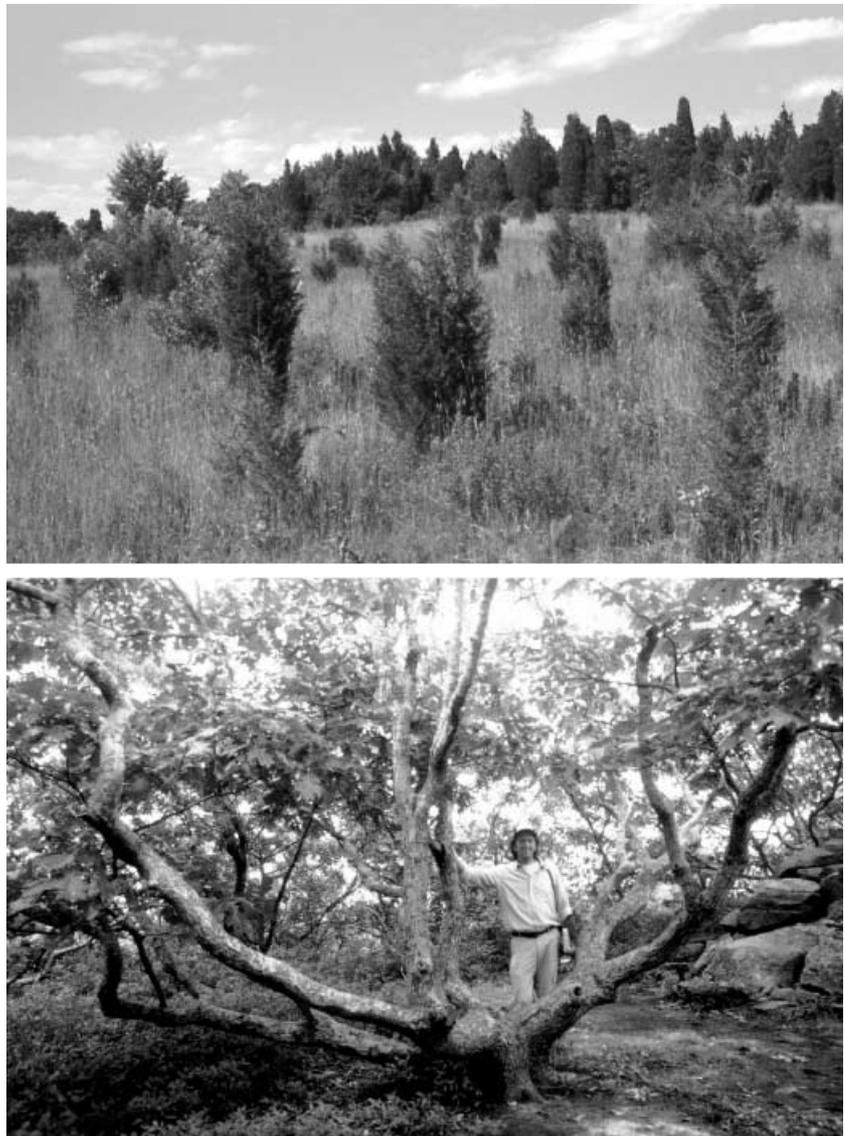


Figure 9 Examples of transient vegetation structures in the New England landscape include (top) red cedar (*Juniperus virginiana*) in an abandoned field and (bottom) open-grown and wind-shaped oaks on the Menemsha Hills of Martha's Vineyard. Through succession the old-field vegetation will become forested and the cedars will be replaced by more shade tolerant hardwood species. New trees growing in the shelter of the forest of highly contorted stems will develop straight growth forms. Photographs by D.R. Foster.

forest on the Quabbin Reservoir Watershed in Massachusetts provides such an example in a more densely populated setting. These core areas would be established to incorporate (but not be restricted to) areas of primary woodland (i.e. land continually in forest) in an attempt to promote natural conditions with intact species assemblages (B. Spencer, pers. comm.).

Large forested areas supporting long-term management would surround these cores, providing both a buffer and a bridge to adjacent semi-natural forests and cultural landscapes. The managed forests would provide many benefits. As extensive wooded regions they would extend many of the attributes of the wildland cores in terms of wildlife habitat, ecological process, scenery and recreation. As a substantial source of reliable and sustainable natural resources they would diminish New England's emphasis on imports and lessen the region's burden on other forest areas (including

old-growth forests) world-wide. A forest-based economy that included finished products as well as raw materials could sustain rural communities and lifestyles, maintain or even increase society's connectedness to the land, and lead to a stronger conservation ethic (see below). As many of New England's forests have been high-graded and poorly managed historically, initiating effective long-term management could improve forest habitat diversity, productivity and appearance. However, in order to develop this approach effectively there is a need for strong coordinated effort on the acquisition of extensive, continuous forest areas across this region, development of conservation restrictions on broad areas of managed lands, and coordination of management plans. The emphasis on coordination across ownership, political boundaries and current management patterns clearly looms as the major challenge in promoting a long-term coherent plan for these regions.

Semi-natural Woodlands in New England's Backyard

Across much of southern New England in both suburban and rural areas, a range of forests from fairly large expanses to backyard woodlots are fragmented by the residential, industrial and agricultural activities of a dense human population. Although these woodlands are unsuited to support broad-scale ecological processes or wide-ranging large mammals they do harbour an extensive array of forest types, woodland flora and fauna, and native habitat, which in turn provide a diverse range of ecological, societal and economic benefits (Donahue, 2001). From the ecological side are biodiversity and ecosystem services including clean water and air and a healthy environment. For a dense population there are recreational and amenity benefits in close proximity to work and home. These areas can also serve as important centres for environmental education that link the surrounding population to its natural and cultural heritage. Finally, long-term management of these semi-natural woodlands offers an environmentally responsible means of yielding substantial additional resources while reinforcing the connections among people, their land, its husbandry and resource consumption. Thus, areas that are less suitable for supporting broad-scale ecological process could provide many essential environmental benefits by becoming the foci of management and resource production.

Protection of these areas from development is an essential first step that can also serve as an important buffer against the sprawl of residential, suburban and industrial development. Management, although currently limited by the fragmented structure and diverse ownership pattern of these areas could be undertaken in a coordinated or community basis (Donohue, 2001). Many communities currently own town forests, watershed lands, and other open spaces and these could be expanded on and actively managed in conjunction with private lands while enhancing their role in education and local connectedness (Donahue, 2001).

The cultural landscape – our Agrarian legacy

Scattered throughout New England and especially in the broad valleys of the Connecticut River and Lake Champlain, in the rural uplands of the region, and along the coastal area of the Cape and Islands lies a remarkable array of active or abandoned agricultural landscapes that harbour a diverse and declining set of habitats and assemblages of plants and animals. The strong imprint of human activity on these areas accentuates their importance by adding an intriguing element of New England cultural history to their biologically unique quality. Most of the landscapes and parcels are small and two processes threaten essentially all of them – development and succession. More positively, few of the uncommon plants and animals of these areas require vast expanses. Thus, the potential exists to restore many of these landscapes and to maintain many populations on a fairly local scale.

In the coastal region, e.g. Cape Cod, Nantucket, Martha's Vineyard, Elizabeth Islands and Block Island, extensive parcels are currently protected and little potential exists for

major expansion because of exorbitant land prices and finely dissected ownership patterns. However, consolidation of existing holdings and key small parcels could protect more continuous larger tracts. Elsewhere, especially in the agricultural regions of New England there remains great potential and need to protect land through acquisition or conservation restrictions because of the weak land-use regulations and zoning in most regions. Beyond restrictions, there is a need to assess agricultural and related land-use practices, as the tendency towards modernization and intensification of farming practices is just as damaging to many habitats as is the abandonment of the land and subsequent forest succession. Importantly, the resurgence of wildlife in some of these regions may present an additional concern in terms of overgrazing by deer or moose. In the absence of effective predation or hunting and with excellent available habitat, these populations will pose a major threat to forest regeneration and herb species diversity.

In both coastal and rural agricultural areas major impediments to effective conservation include inadequate historical–ecological information and the lack of long-term management and planning. In contrast to many wooded areas where management is more of an opportunity than a necessity, in the cultural landscapes of grassland, heathland, shrubland and young forest the retention of the vegetation and its value as habitat is completely dependent on active management. Recognition of this fact relies on the incorporation of the type of historical–ecological enquiry advocated and pursued by Henry Thoreau. Results from such enquiry leads to an appreciation of the historical practices, including mowing, grazing, plowing, planting, repeated cutting or burning that created and sustained the landscape through time (Foster *et al.*, 2002b; Motzkin & Foster, 2002). In some cases such studies indicate that the vegetation or its specific structures are completely transient and are impossible to sustain or restore on the same spot. This would be true of some successional communities such as white pine forests or particular physiognomic types, like the contorted oaks of Menemsha on Martha's Vineyard, which were produced through succession in an open, wind-blown landscape as opposed to the heavily forested conditions that prevail today. In other cases it may become immediately apparent which agricultural practices were important; at that point the management question becomes one of retaining or re-introducing these, attempting to simulate them with other means (e.g. using mowers as opposed to grazing animals), or allowing the vegetation to change. In any case this research and subsequent decisions and planning become part of a framework for conservation.

A long-term framework for conservation and management

Given the wide range of historical conditions of the land and the diverse interests of conservationists there can be no simple and objective decision-making process in identifying the goals for restoration or management. Defining objectives, whether they are to mimic pre-European conditions,

promote natural processes, restore elements of Henry Thoreau's nineteenth century landscape, retain existing habitats, or encourage new assemblages of organisms, will always be a subjective enterprise. However, there is a framework for restoration that combines historical study and long-term measurement and planning that can assist in the decision-making process, help in conveying goals and encourage the assessment of results and completion of objectives. It consists of five steps.

1. *Conduct extensive historical and ecological studies on the landscape, habitat and organisms of interest.* This research may be archaeological, palaeoecological, dendrochronological, pedological, historical, sociological or other depending on the ecosystem and landscape and available resources (Birks *et al.*, 1988; Foster & Motzkin, 1999; Hall *et al.*, 2002). These studies will help to define the past conditions of the land including the range of past plant and animal assemblages; identify some of the critical processes controlling these dynamics and the formation of present conditions; assess the rate of current and future change; and define some of the limits of management or restoration (Foster *et al.*, 1996; Foster & Motzkin, 1998). Importantly, a historical–ecological perspective may provide useful guidance in identifying appropriate management tools for restoration as well as key variables for assessment (Motzkin *et al.*, 1996, 1999a, 2002). Included in this assessment should be a thorough consultation of literature on analogous communities and conservation activities world-wide. This is particularly critical in the area of cultural landscape restoration where, for example, European expertise far outshines that in American (e.g. Peterken, 1977, 1996; Birks *et al.*, 1988; Rackham, 2000, 2001).
2. *Define explicit goals and rationale.* Based on historical and ecological studies, geographical considerations and articulated management objectives clearly define specific goals for the proposed management and restoration, whether this is focused towards populations, species assemblages, habitat structure and appearance, ecological process or landscape pattern. Equally important, they clearly explain the rationale underlying these long-term objectives. Are goals based on historical condition, aesthetic interests, production concerns, recreational opportunity, or other factors? Together the goals and rationale will provide a clear explanation of the activity to the larger community and future managers, and will allow the development of a robust framework for assessing progress.
3. *Develop an objective, scientific framework for measuring management impacts and progress towards goals.* Management and restoration without an appropriate scientific monitoring protocol are irresponsible. A good programme of measurement will enable assessment of results and progress towards goals; will provide an effective base for communicating the activity to other land managers, scientists and local constituencies; and, in the long-term, it will yield invaluable scientific data. Such a protocol

should mimic that of any large-scale scientific experiment or manipulation, including measurement of pertinent ecological variables in advance of management to determine baseline conditions, and regular measurement beyond the management period. Measurements should be made on true controls (similar unmanaged areas) and on managed areas and should be based on a statistically appropriate design. Measurements should be made on key variables that are commensurate with the goals.

4. *Ensure the long-term integrity of the restoration activity and measurements.* Landscape conditions develop over long periods of time and management regimes necessarily need to be long-term, as should be the measurements that accompany them. Therefore, restoration or other conservation activities should not be undertaken without the prospect for sustained, ongoing interest and financial support. Many restoration activities are intensive consumers of time and money and their novelty may wear thin before objectives can be met or maintained. Consequently, part of the decision-making process and goal-setting activity should hinge on sustainability of active involvement.
5. *Reassess and revisit the entire project frequently over time.* At appropriate intervals, results from the long-term measurements should be used to assess progress and to amend goals or management regimes. None of the landscapes that we seek to conserve in New England is static, as environmental conditions, human activities and natural disturbance regimes have changed through time. Although management regimes should be focused on long-term results it would be foolhardy to anticipate that they will not change or be modified through time.

Challenges and limitations to restoration and conservation in New England

From studies of community and landscape history, experience with ongoing restoration and conservation activities, and the considerable research and expertise of our European colleagues, we can outline some of the realities of ecological systems and New England landscape history that will provide challenges and constraints on our future conservation activities. Probably the single greatest impediment is social and psychological: acceptance of the fact that most of our most precious habitats and highest conservation priorities are in some ways artefacts of the cultural activity of Henry Thoreau's contemporaries. Although adjustment to this reality may be difficult for a population geared largely towards wilderness values, it is essential if a range of species and landscape attributes are to be conserved effectively. It also provides a strong argument for the active support by conservationists and the environmental community for maintenance and expansion of a wide range of land-use activities, including agriculture and logging in a region where these have been declining steadily.

The landscape, individual habitats, and species populations in this region have undergone continual changes over

time in the pre-European and especially the historical period. This ongoing change results from disturbance, environmental shifts, and changing human culture and activities and it presents conservationists with many challenges and restrictions:

1. It is impossible to retain or return exactly to historical conditions.
2. There is a wide range of conditions to choose from at any ecological scale (population to landscape) and all of them are transient. There is no single, ideal state for restoration for any given site or area.
3. Future change is inevitable. As a consequence of ongoing recovery from past human activity and disturbance, and future changes in wildlife, the environment, and introduced organisms, all protected areas will continue to change.

Finally, some habitats, plant and animal assemblages, and vegetation structures may simply be difficult or impossible to maintain or restore. This results from the fact that many assemblages are successional and transient entities that were produced by unique sequences of historical events. Examples would include old-field red cedar, pitch pine or white pine forests and coastal oak woodlands filled with wind-swept and contorted trees. Although the sequence of events that gave rise to these may be replicated on an array of sites, it is impossible to maintain these assemblages in place as the growth of the plants and vegetation has changed the environment that allowed their formation.

The mid-nineteenth century, essentially the period spanning Henry Thoreau's lifetime, represents a critical reference period for much of New England. This period of most extensive deforestation and intensive agricultural land use represents an ecological bottleneck through which the landscape has passed. Consequently, determining the landscape pattern and land-use history at and since that time provides essential information for all conservationists.

When I walk in the fields of Concord and meditate on the destiny of this prosperous slip of the Saxon family, the unexhausted energies of this new country, I forget that this which is now Concord was once Musketaquid, and that the *American race* has had its destiny also. Everywhere in the fields, in the corn and grain land, the earth is strewn with the relics of a race which has vanished as completely as if trodden in with the earth. I find it good to remember the eternity behind me as well as the eternity before. Henry D. Thoreau 19 March 1842.

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REFERENCES

- Allen, F.H. (ed.) (1936) *Men of Concord and some others as portrayed in the journal of Henry David Thoreau*. Houghton Mifflin, Boston.
- Allen, S. (1999) Bring back mother nature. *Boston Globe*, October 17, 10–17.
- Anderson, M.G. (1999) *Variability and spatial assessment of ecological communities in the northern Appalachian ecoregion*. PhD Thesis, University of New Hampshire, Durham NH, USA.
- Askins, R.A. (1993) Population trends in grassland, shrubland, and forest birds in eastern North America. *Current Ornithology*, **11**, 1–34.
- Askins, R.A. (1997) History of grasslands in the northeastern United States: implications for bird conservation. *Grasslands of northeastern North America: ecology and conservation of native and agricultural landscapes* (eds P.D. Vickery and P.W. Dunwiddie), pp. 119–136. Massachusetts Audubon Society, Lincoln, MA.
- Askins, R.A. (2000) *Restoring North America's birds: lessons from landscape ecology*. Yale University Press, New Haven.
- Barbour, H., Simmons, T., Swain, P. & Woolsey, H. (1998) *Our irreplaceable heritage – protecting biodiversity in Massachusetts*. Massachusetts Natural Heritage and Endangered Species Program and the Massachusetts chapter of The Nature Conservancy, Boston.
- Bateson, E. & Smith, N. (2001) Making it happen: protecting wilderness on the ground. *Wilderness comes home. Rewilding the northeast* (ed. C. Klyza), pp. 182–210. Middlebury College Press and University Press of New England, Hanover.
- Bellemare, J., Motzkin, G. & Foster, D.R. (2002) Legacies of the agricultural past in the forested present: an assessment of historical land-use effects on rich mesic forests. *Journal of Biogeography*, **29**, 1401–1420.
- Berlik, M.M., Kittredge, D.B. & Foster, D.R. (2002) The illusion of preservation: a global environmental argument for the local production of natural resources. *Journal of Biogeography*, **29**, 1557–1568.
- BioMap (2001) *BioMap. Guiding land conservation for biodiversity in Massachusetts*. Massachusetts Natural Heritage and Endangered Species Program, Boston, MA.
- Birks, H.J.B. (1996) Contributions of quaternary palaeoecology to nature conservation. *Journal of Vegetation Science*, **7**, 89–98.
- Birks, H.H., Birks, H.J.B., Kaland, P.E. & Moe, D. (eds) (1988) *The cultural landscape: past, present, and future*. Cambridge University Press, Cambridge.
- Budd, B. (2000) Cows and conservation. *Newsletter of the Ecological Society of America*, **71**, 2.

- Buell, L. (1995) *The environmental imagination*. Harvard University Press, Cambridge, MA.
- Cronon, W. (1983) *Changes in the land. Indians, colonists and the ecology of New England*. Hill and Wang, New York.
- Davis, M.B. (ed.) (1996) *Eastern old-growth forest. Prospects for rediscovery and recovery*. Island Press, New York.
- DeGraaf, R.M. & Miller, R.I. (1996) The importance of disturbance and land-use history in New England: implications for forested landscapes and wildlife conservation. *Conservation of faunal diversity in forested landscapes* (eds R.M. DeGraaf and R.I. Miller), pp. 3–35. Chapman & Hall, New York.
- DeGraaf, R.M. & Yamasaki, M. (2001) *New England wildlife. Habitats, natural history and distribution*. University Press of New England, Hanover, NH.
- Dobbs, D. & Ober, R. (1996) *The northern forest*. Chelsea Green Publications Co., New York.
- Donahue, B. (2001) *Reclaiming the commons: community farms and forests in a New England town*. Yale University Press, New Haven.
- Donohue, K., Foster, D.R. & Motzkin, G. (2000) Effects of the past and the present on species distributions: the influence of land-use history on the demography of *Gaultheria procumbens*. *Journal of Ecology*, **88**, 303–316.
- Dunwiddie, P.W. (1989) Forest and heath: the shaping of the vegetation on Nantucket Island. *Journal of Forest History*, **July**, 126–133.
- Dunwiddie, P.W. (1999) Ecological management of sandplain grasslands and coastal heathlands in southeastern Massachusetts. *Fire in ecosystem management: shifting the paradigm from suppression to prescription* (eds T.L. Pruden and L.A. Brennan), pp. 83–93. Proceedings of the 20th Tall Timbers Fire Ecology Conference. Tall Timbers Research Station, Tallahassee, FL.
- Dunwiddie, P.W. & Sferra, N. (1991) Loss of rare butterfly and plant species in coastal grasslands. *Natural Areas Journal*, **11**, 119–120.
- Eberhardt, R., Foster, D.R., Motzkin, G. & Hall, B. (2003) Conservation of changing landscapes: vegetation and land-use history of Cape Cod National Seashore. *Ecological Applications*, in press.
- Foss, C.R. (1992) Wildlife in a changing landscape. *At what cost? Shaping the land we call New Hampshire* (ed. R. Ober), pp. 14–22. Historical Society and Society for the Protection of New Hampshire Forests, Concord, NH.
- Foster, D.R. (1999) *Thoreau's country. Journey through a transformed landscape*. Harvard University Press, Cambridge.
- Foster, D.R. & Motzkin, G. (1998) Ecology and conservation in the cultural landscape of New England: lessons from nature's history. *Northeastern Naturalist*, **5**, 111–126.
- Foster, D.R. & Motzkin, G. (1999) *Historical influences on the landscape of Martha's Vineyard – perspectives on the management of Manuel F. Correllus State Forest*. Harvard Forest Paper no. 23. Harvard Forest, Petersham, MA.
- Foster, D.R. & O'Keefe, J.F. (2000) *New England forests through time: Insights from the Harvard forest dioramas*. Harvard Forest and Harvard University Press, Petersham and Cambridge.
- Foster, D.R. & Zebryk, T.M. (1993) Long-term vegetation dynamics and disturbance history of a *Tsuga*-dominated forest in New England. *Ecology*, **74**, 982–998.
- Foster, D.R., Orwig, D.A. & McLachlan, J. (1996) Ecological and conservation insights from retrospective studies of old-growth forests. *Trends in Ecology and Evolution*, **11**, 419–424.
- Foster, D.R., Motzkin, G. & Slater, B. (1998) Land-use history as long-term broad-scale disturbance: regional forest dynamics in central New England. *Ecosystems*, **1**, 96–119.
- Foster, D.R., Clayden, S., Orwig, D.A., Hall, B. & Barry, S. (2002a) Oak, chestnut and fire: climatic and cultural controls of long-term forest dynamics in New England, USA. *Journal of Biogeography*, **29**, 1359–1379.
- Foster, D.R., Hall, B., Barry, S., Clayden, S. & Parshall, T. (2002b) Cultural, environmental and historical controls of vegetation patterns and the modern conservation setting on the island of Martha's Vineyard, USA. *Journal of Biogeography*, **29**, 1381–1400.
- Foster, D.R., Motzkin, G.M., Bernardos, D. & Cardoza, J. (2002c) Wildlife dynamics in a changing New England landscape. *Journal of Biogeography*, **29**, 1337–1357.
- Foster, D.R., Swanson, F., Aber, J., Burke, I., Brokaw, N., Tilman, D. & Knapp, A. (2003) The importance of land-use and its legacies to ecology and environmental management. *BioScience* (in press).
- Fuller, J.L., Foster, D.R., McLachlan, J.S. & Drake, N. (1998) Impact of human activity on regional forest composition and dynamics in central New England. *Ecosystems*, **1**, 76–95.
- Gerhardt, F. & Foster, D.R. (2002) Physiographic and historical effects on forest vegetation in central New England, USA. *Journal of Biogeography*, **29**, 1421–1437.
- Gimingham, C. (1972) *Ecology of heathlands*. Chapman & Hall, New York.
- Gleason, H.W. (1917) *Through the Year with Henry D. Thoreau: Sketches of Nature from the Writings of Henry D. Thoreau, with Corresponding Photographic Illustrations*. Houghton Mifflin, Boston.
- Golodetz, A. & Foster, D. (1996) Land protection in central New England: historical development and ecological consequences. *Conservation Biology*, **11**, 227–235.
- Hall, B., Motzkin, G., Foster, D., Syfert, M. & Burk, J. (2002) Three hundred years of forest and land-use change in Massachusetts, USA. *Journal of Biogeography*, **29**, 1319–1335.
- Ireland, L.C. (1999) *The Northeast's changing forest*. Harvard University Press, Cambridge.
- Jones, A. & Vickery, P. (1995) *Conserving grassland birds. Managing large grasslands including conservation lands, airports, and landfills over 75 acres for grassland birds*. Massachusetts Audubon Society, Lincoln, MA.
- Jones, A. & Vickery, P.D. (1997) Distribution and population status of grassland birds in Massachusetts. *Grasslands of northeastern North America* (ed. by P.D. Vickery and P.W. Dunwiddie). Massachusetts Audubon Society, Lincoln, MA.
- Klyza, C.M. (ed.) (2001) *Wilderness comes home: Rewilding the Northeast*. Middlebury College Press and University Press of New England, Hanover, NH.
- Lansky, M. (1992) *Beyond the beauty strip: saving what's left of our forests*. Tilbury Publishing, Gardiner, ME.
- Leahy, C., Mitchell, J.H. & Conuel, T. (1996) *The nature of Massachusetts*. Addison-Wesley Publishing Co., New York.

- Litvaitis, J.A. (2001) Importance of early-successional habitats to mammals in eastern forests. *Wildlife Society Bulletin*, **29**, 466–473.
- McKibben, W. (1995) An explosion of green. *The Atlantic Monthly* April, 61–83.
- McLachlan, J., Foster, D.R. & Menalled, F. (2000) Anthropogenic origins of late-successional structure and composition in four New England hemlock stands. *Ecology*, **81**, 717–733.
- Merchant, C. (1989) *Ecological revolutions: nature, gender, and science in New England*. University of North Carolina Press, Chapel Hill.
- Motzkin, G. & Foster, D.R. (2002) Grasslands, heathlands, shrublands in coastal New England: historical interpretation and approaches to conservation. *Journal of Biogeography*, **29**, 1569–1590.
- Motzkin, G., Foster, D., Allen, A., Harrod, J. & Boone, R. (1996) Controlling site to evaluate history: vegetation patterns of a New England sand plain. *Ecological Monographs*, **66**, 345–365.
- Motzkin, G.M., Foster, D.R., Eberhardt, R., Hall, B., Harrod, J. & MacDonald, D. (2002b) Vegetation variation across Cape Cod, Massachusetts: environmental and historical determinants. *Journal of Biogeography*, **29**, 1439–1454.
- Motzkin, G., Foster, D. & Hall, B. (2003) Forest landscape patterns, structure, and composition. *Forests in time. The environmental consequences of 1000 years of change in New England*. (ed. by D. Foster and J. Aber). Yale University Press, New Haven (in press).
- Motzkin, G., Patterson, W.A. III & Foster, D.R. (1999a) A historical perspective on pitch pine-scrub oak communities in the Connecticut Valley of Massachusetts. *Ecosystems*, **2**, 255–273.
- Motzkin, G.M., Wilson, P., Foster, D.R. & Allen, A. (1999b) Vegetation patterns in heterogeneous landscapes: the importance of history and environmental variation. *Journal of Vegetation Science*, **10**, 903–920.
- Norment, C. (2002) On grassland bird conservation in the Northeast. *The Auk*, **119**, 271–279.
- Oliver, C.D. & Stephens, E.P. (1977) Reconstruction of a mixed-species forest in central New England. *Ecology*, **58**, 562–572.
- Orwig, D.A., Cogbill, C.V., Foster, D.R. & O'Keefe, J.F. (2001) Variations in old-growth structure and definitions: forest dynamics on Wachusett Mountain, Massachusetts. *Ecological Applications*, **1**, 437–452.
- Parshall, T. & Foster, D.R. (2002) Fire in the New England landscape: regional and temporal variation, cultural and environmental controls. *Journal of Biogeography*, **29**, 1305–1317.
- Parshall, T., Foster, D.R., Faison, E., MacDonald, D. & Hansen, B.S.C. (2003) Long-term vegetation and fire dynamics of pitch pine-oak forests on Cape Cod, Massachusetts. *Ecology* (in press).
- Patterson, W.A. III & Backman, A.E. (1988) Fire and disease history of forests. *Vegetation history* (eds B. Huntley and T. Webb III), pp. 603–632. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Patterson, W.A. & Foster, D.R. (1990) Tabernacle pines: the rest of the story. *Journal of Forestry*, **88**, 23–26.
- Patterson, W.A. & Sassaman, K.E. (1988) Indian fires in the prehistory of New England. *Holocene human ecology in northeastern North America* (ed. G.P. Nicholas), pp. 107–135. Plenum Publishing Co., New York.
- Peterken, G.F. (1977) Habitat conservation priorities in British and European woodlands. *Biological Conservation*, **1**, 223–236.
- Peterken, G.F. (1996) *Natural woodland – ecology and conservation in northern temperate regions*. Cambridge University Press, Cambridge.
- Rackham, O. (2000) *The history of the countryside*. Phoenix Press, London.
- Rackham, O. (2001) *Trees and woodland in the British landscape*. Phoenix Press, London.
- Raup, H.M. (1966) The view from John Sanderson's farm: a perspective for the use of the land. *Forest History*, **10**, 2–11.
- RESTORE (2000) RESTORE: The North Woods. Fall/Winter Issue, p. 10.
- Robinson, W. (1976) *Abandoned New England*. New York Graphic Society, New York.
- Rolde, N. (2001) *The interrupted forest: a history of Maine's wildlands*. Tilbury House, Gardiner, ME.
- Russell, H.S. (1982) *A long deep furrow: three centuries of farming in New England*. University Press of New England, Hanover, NH.
- Sayen, J. (2001) An opportunity for big wilderness in the northern Appalachians. *Wilderness comes home. Rewilding the northeast* (eds C. Klyza), pp. 124–156. Middlebury College Press and University Press of New England, Hanover.
- Steel, L. (1999) *Losing ground: an analysis of recent rates and patterns of development and their effects on open space in Massachusetts*, 2nd edn. Massachusetts Audubon Society, Lincoln, MA.
- Sutherland, W.J. & Hill, D.A. (1995) *Managing habitats for conservation*. Cambridge University Press, Cambridge.
- The Trustees of Reservations (TTOR) (1999) *Conserving our common wealth – a vision for the Massachusetts Landscape*. The Trustees of Reservations, Beverly, MA.
- Tiffney, W. (1992) The role of nutrient-level control in maintaining and restoring lowland heaths: British and northern European techniques of potential application to northeastern North America. *Grasslands of Northeastern North America* (ed. P.D. Vickery and P.W. Dunwiddie), pp. 69–78. Massachusetts Audubon Society, Lincoln, MA.
- The Nature Conservancy (TNC) (2002a) *State success stories – fire management*. <http://www.tncfire.org/sites.htm>.
- TNC (2002b) *Islands program. Revised management plan for the Katama Plains Conservation Area*. The Nature Conservancy, Vineyard Haven, MA.
- Trombulak, S. (2001) Ecological reserve design in the Northeast. *Wilderness comes home. Rewilding the northeast* (eds C. Klyza), pp. 107–123. Middlebury College Press and University Press of New England, Hanover.
- Vickery, P.D. & Dunwiddie, P.W. (eds) (1997) *Grasslands of northeastern North America*. Massachusetts Audubon Society, Lincoln, MA.
- Vogelmann, J.E., Howard, S.M., Yang, L., Larson, C.R., Wylie, B.K. & Van Driel, N. (2001) Completion of the 1990s National Land Cover Data Set for the Conterminous United States from Landsat Thematic Mapper data and ancillary

data sources. *Photogrammetric Engineering and Remote Sensing*, **67**, 650–662.

Wessels, T. (1999) *Reading the forested landscape: a natural history of New England*. Countryman Press, Burlington, VT.

Westveld, M., Ashman, R.I., Baldwin, H.I., Holdsworth, R.P., Johnson, R.S., Lambert, J.H., Lutz, H.J., Swain, J. & Standish, M. (1956) Natural forest vegetation zones of New England. *Journal of Forestry*, **54**, 332–338.

Whitney, G.G. (1994) *From coastal wilderness to fruited plain*. Cambridge University Press, Cambridge.

BIOSKETCH

David Foster is a plant ecologist and palaeoecologist who combines historical and modern approaches to interpret and conserve natural and cultural landscapes.