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Interpreting and conserving the openland habitats of coastal New England: insights from landscape history

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Abstract

Maintenance and restoration of grasslands, heathlands, and shrublands are high priorities for conservation due to their diversity of uncommon species and assemblages and their ongoing decline resulting from invasion by shrubs and trees. Much of the literature and management concerning openlands emphasizes burning to control woody growth, based on the interpretation that these habitats and their species assemblages were widespread during the pre-European period as a consequence of natural disturbance and Native American land use. By focusing on the coastal region of New England–New York, which harbors excellent examples of these habitats, is characterized by many natural disturbances (e.g. hurricanes, fire, salt spray), and supported relatively dense Native American populations, we assess the paleoecological, archaeological, historical, and modern ecological evidence supporting this perspective.

We conclude that: (1) pre-European uplands, including coastal areas, were predominantly forested and that openland habitats were uncommon because natural and human disturbance was infrequent and local; (2) extensive openland vegetation developed only with widespread European forest clearance and land use; (3) assemblages occupying grasslands, shrublands, and heathlands apparently have no lengthy history and are comprised of species that combined opportunistically over recent centuries; (4) the decline of grasslands, heathlands, and shrublands is a century-old phenomena related to a decline in agricultural land use, especially grazing, mowing, plowing and burning; (5) effectively all conservation areas supporting these openland assemblages experienced intensive historical land use; and (6) the modern distribution, composition, and structure of these habitats are largely determined by European land use.

Recognition that openland assemblages have cultural origins does not diminish the biological, cultural, or aesthetic value of these habitats. However, it does suggest that grasslands, heathlands and shrublands may be best managed using a combination of approaches that replicate the effects of historical land use. Conservationists should recognize that most of these landscapes have cultural origins and are inherently dynamic; that some vegetation structures and communities cannot be maintained continuously on a given site; and that management is most effective when based on historical and ecological studies leading to clearly defined objectives and rigorous long-term measurement and re-evaluation.

Keywords: Coastal landscape; Cultural landscape; Disturbance; Early successional forest; Fire; Heathlands; Grasslands; Land use; New England; Shrublands

1. Introduction

Across the northeastern United States, openland species and habitats are declining at a precipitous rate (Lavers and Naines-Young, 1993; Fuller et al., 1998;

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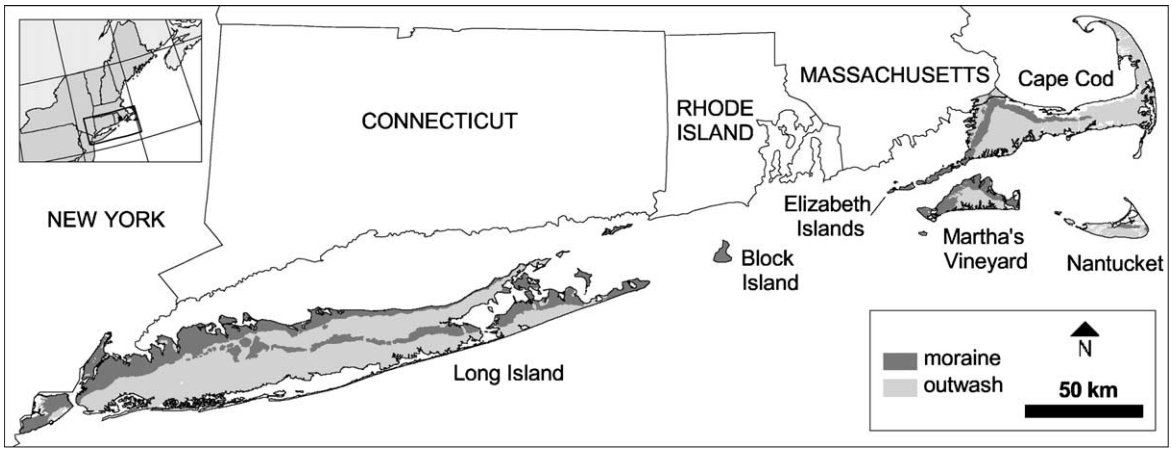

Fig. 1. Surficial geology in coastal New England and Long Island, NY and major locations discussed in the text. Although nearly all of the landscape is derived from materials deposited during the last glaciation, the region supports two contrasting formations that vary in relief and soil characteristics and that influence vegetation, fire, and human land use: outwash areas are predominantly level or low relief and are dominated by coarse textured and extremely dry soils, whereas morainal areas are gentle to rolling topography supporting finer textured soils (cf. Fletcher and Roffinoli, 1986).

MNHESP, 2001). Although much environmental literature emphasizes conservation of interior forest species and their habitats (Foss, 1992; Allen, 1999; Steel, 1999; Apsey et al., 2000), many less noticeable taxa in grasslands, heathlands and shrublands are in even greater jeopardy of extirpation (Lawton, 1997; Pärtel et al., 1999; Olsson et al., 2000; OECD, 2001). In this region, the greatest conservation interest in these habitats focuses on the coastal area stretching from Cape Cod, Massachusetts to Eastern Long Island, New York, and including Nantucket, Martha's Vineyard, Block Island and the Elizabeth Islands (Fig. 1; Patterson et al., 1983; Dunwiddie, 1992a; Dunwiddie and Adams, 1994). This varied landscape is unified by geological and human history, environment, soils, and biota (Fletcher and Roffinoli, 1986; Bragdon, 1996; Stevens, 1996; Dunford and O'Brien, 1997; Chilton, 1999). Importantly, open sandplain habitats in the region are priorities for local to national conservation organizations and public agencies (Barbour et al., 1998; TTOR, 1999; Steel, 1999; MNHESP, 2001).

Despite aggressive protection of remaining coastal landscapes from housing and industrial development, many characteristic species and uncommon habitats continue to decline (Askins, 1993). In large measure, this deterioration is due to the spread of aggressive, native woody plants (Dunwiddie, 1989, 1992b, 1994). Similar successional trends are noted on many openlands worldwide (cf. Watkins, 1993). This pattern of habitat deterioration and corresponding decline in population viability raises questions regarding the underlying drivers of change and the long-term history of the habitats and assemblages. Interpretations of ecological history, especially the nature of the pre-European landscape, are major drivers of modern conservation policy and practice (Rivers, 1997; cf. Landres et al., 1999; MNHESP, 2001; TNC, 2002a,b). Consequently, a long-term perspective on the dynamics of physical, cultural, and biological systems in this region provides critical background for conservation and management (Patterson and Sassaman, 1988a,b; Dunwiddie, 1999; Fig. 2).

2. Openland species in peril: interpretation and management

Openland habitats are important, if under-appreciated, priorities for conservation due to their high biodiversity and aesthetic value (Vickery, 1994; Leahy et al., 1996; Barbour et al., 1998; MNHESP, 2001). The ongoing decline in the extent and quality of protected openlands due to increasing woody cover has prompted many conservation organizations to complement their land protection programs with

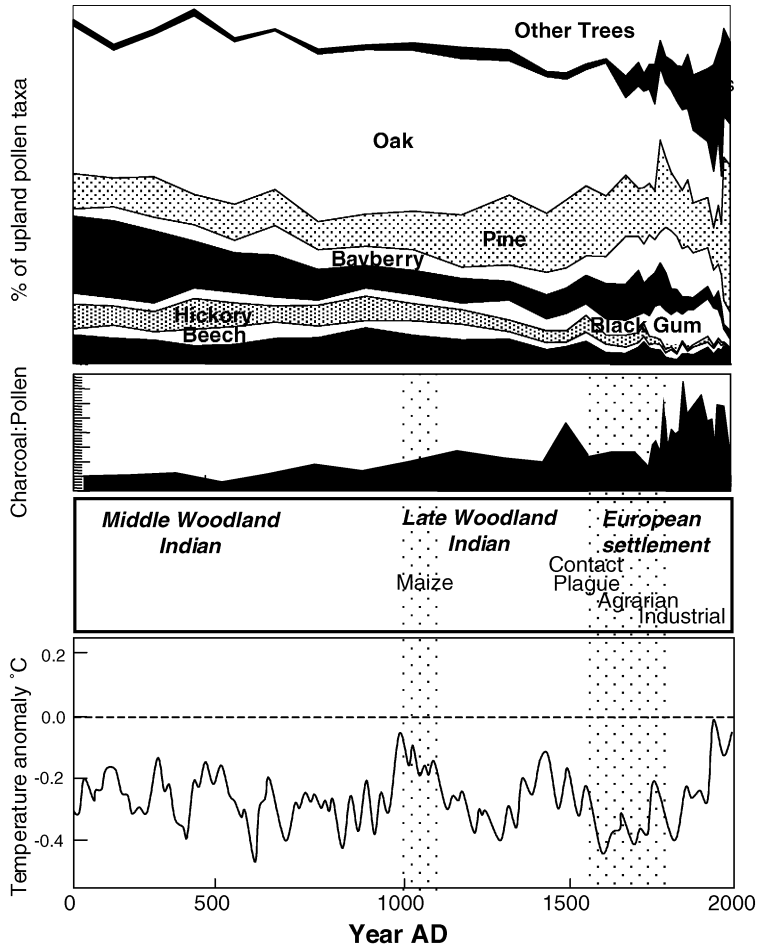

Fig. 2. Long-term perspective on climatic, cultural and vegetation change in the coastal region. The pollen and charcoal data come from Icehouse Pond, a small kettle hole pond on outer Cape Cod surrounded by numerous archaeological sites (see Fig. 1; Parshall et al., 2003). Changes in forest cover and fire regime beginning approximately 1500 years ago correspond to regional climate change and include a decline in hickory, beech, and oak, and increase in pine and charcoal influx. Despite a relatively high density of Native Americans in the area charcoal values are low in the outer Cape and the landscape remained wooded until European settlement when grass and weeds increased and oak, beech and hickory declined. Fire increased substantially with forest clearance.

active land management (TNC, 2002a,b). In particular, great effort has been expended at developing techniques to maintain, reclaim and recreate openland habitats and to adapt artificial habitats as substitutes for semi-natural vegetation (Patterson and Sassaman, 1988; Jones and Vickery, 1997). These efforts are largely focused on enhancing biodiversity and habitat quality. However, one underlying motivation is the belief that upland grasslands, shrublands, and heathlands are native habitats with a millennial history of Native American land use and fire management and that many openland species are pyrogenic (Patterson and Sassaman, 1988; Patterson and Backman, 1988a; Askins, 1990, 2000; Vickery, 1994; Jones and Vickery, 1995; Stevens, 1996). However, as a review of the literature suggests, there are substantial differences in interpretation regarding the nature of the pre-European landscape and the dynamics of openland and successional habitats through time.

Rather than evaluating these sources again, we assess the interpretation of a humanized and open pre-historical landscape based on the following

considerations: (1) Is this interpretation consistent with independent assessments of pre-European landscape conditions and vegetation composition? (2) Do archaeological studies support the ethnographic interpretation that Native American activity created extensive treeless areas? (3) Are there alternative explanations for the history, distribution, dynamics and modern patterns of openland vegetation?

3. Linking historical interpretation, conservation, and land management

Linkages between historical interpretation and land management abound in New England. Three examples related to openland and successional habitat emerge from initiatives by Massachusetts state agencies. The Department of Environmental Management (DEM—the agency responsible for forests and parks) Project in Ecosystem Management operates on "assumptions that grasslands, heathlands, shrublands and savannah's are natural vegetation types with significant rare species assemblages . . . in presettlement times" (Rivers, 1997); the Ecological Restoration Program of the Massachusetts Department of Fisheries and Wildlife (DFW; the state agency responsible for wildlife and biodiversity) manages for open and early successional habitat based on the interpretation that "many of our dry forests, shrublands and grasslands were managed with fire for thousands of years by Native Americans. Now, lack of occasional fire has caused significant changes in those communities, decreasing habitat for many of our rare plants and animals." (http://www.state.ma.us/dfwele/dfw/nhesp/nhrest.htm); and the Biodiversity Initiative of the Natural Heritage and Endangered Species Program of DFW cites that "Fires were not only used [by Native Americans] to create and maintain agricultural fields but also to drive game. In using fire, many fire-adapted natural communities, such as grasslands and scrub oak barrens were created and maintained." (http://www.state.ma.us/dfwele/dfw/bdi/Landuse3.htm). In each case, management seeks to maintain habitats that are interpreted as predating European history (Anonymous, 1997a,b).

A similar management context emerges from private organizations. The Nature Conservancy (TNC) is burning and cutting to reduce shrubs and pitch pine

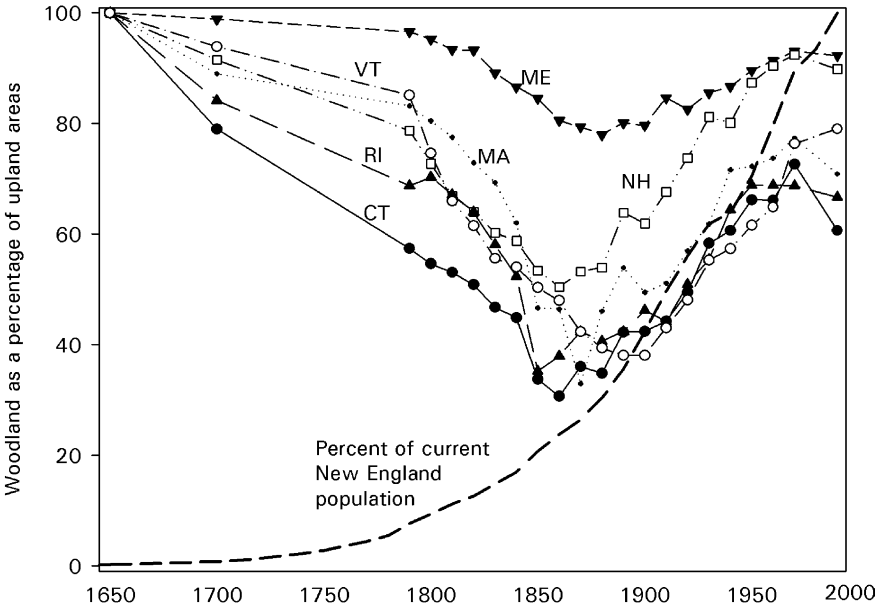

Fig. 3. Historical changes in forest cover and human population across New England. Despite major differences in climate, vegetation, and soils the individual states (except northern Maine) underwent similar land cover trends, with rapid deforestation leading to extensive open agricultural land in the mid- to late 19th century. Reforestation through natural succession led to extensive forest cover in the modern landscape and an ongoing decline in openland vegetation (from Foster, 1995).

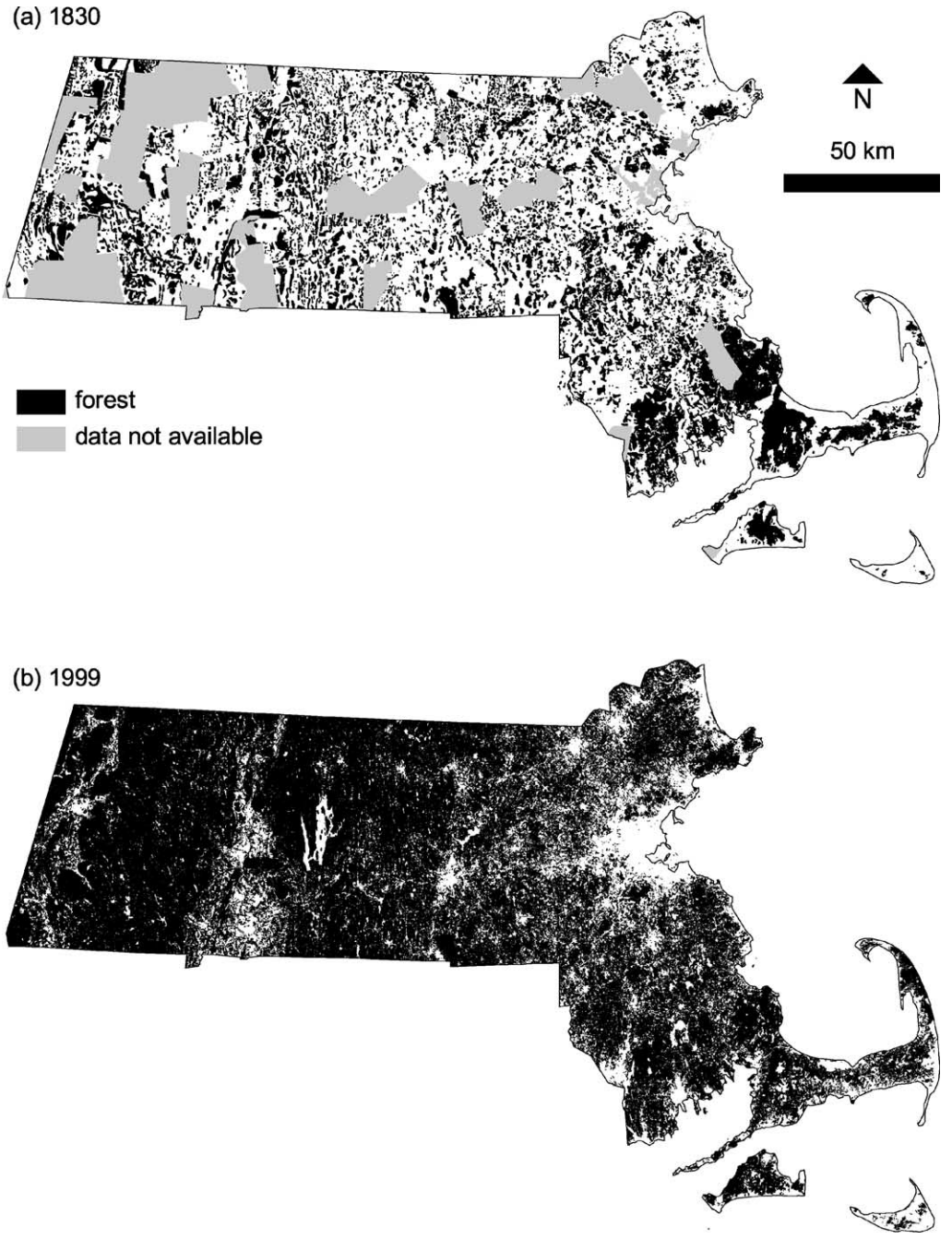

Fig. 4. Massachusetts forest cover at the approximate height of agriculture in 1830 (a) and in the late 1990s (b). Although forest pattern varied geographically in the 19th century the landscape was a matrix of open pasture and other agricultural lands with scattered woodlots, in contrast to the more continually forested matrix today. Modified from Hall et al. (2002).

on the Katama grassland because ''this reserve is the largest example of native sandplain grassland left on Martha's Vineyard'' (http://nature.org/wherewework/northamerica/states/massachusetts/preserves/art5320.html). A few miles away, TNC and DEM are collaborating to burn oak forest as ''restoration of the property's original grassland and woodland habitat'' (http://nature.org/wherewework/northamerica/states/massachusetts/preserves/art5334.html). TNC–Massachusetts has developed a prescribed fire program that works closely with groups on coastal and inland sites with an emphasis on openland and scrub vegetation (TNC, 2000).

Although researchers recognize that European land use greatly increased the extent of openlands (cf. Figs. 3 and 4; Patterson and Backman, 1988a; Dunwiddie, 1989, 1990a, 1999; Askins, 1997; Jones and Vickery, 1997), there is a persistent belief that many remaining openland areas are natural (Jones, 1995; Hammond, 1999; cf. Askins, 2000). In this view, the modern decline of open areas represents the loss of native, not historically cultural, habitat. For example, Vickery (2002) cites sources that >90% of the native grassland in New England has been lost since European arrival (cf. Niering, 1992; Noss et al., 1995).

Ethnohistorical evidence is often cited to support the notion of widespread grassland, heathland or shrubland vegetation in pre-European times (Whitney, 1994; Askins, 2000). Accounts of early explorers and settlers are interpreted as suggesting that: extensive open areas occurred in coastal areas and major river valleys (Little, 1981; Cronon, 1983; Doolittle, 1992); shifting or permanent maize agriculture supported sizable Native populations in established villages across southern New England (Cronon, 1983); and fire was used to clear forests, improve hunting, and revitalize fallow areas (Bromley, 1935; Day, 1953; Pyne, 1982). In this interpretation, purposeful burning, shifting agriculture, and intensive wood gathering maintained a dynamic landscape mosaic of fields, grasslands and successional forests (Cronon, 1983; Patterson and Sassaman, 1988). Consequently, as European contact decimated Indian populations, it curtailed established land use practices and initiated an increase in forest cover and stature (cf. Droge, 1998; Degraaf and Yamasaki, 2001).

The concept of pre-European New England as a humanized landscape shaped by cultural as well as natural processes is part of a broad re-evaluation of the environmental impacts of indigenous populations that has transformed ecological interpretation and conservation practice across the Americas (Burden et al., 1986a,b; McAndrews, 1988; Butzer, 1992; Denevan, 1992; Gomez-Pompa and Kaus, 1992; McCann, 1999; cf. Apsey et al., 2000). In the northeastern US, this movement builds on work by Bromley (1935), Day (1953), Martin (1973) and others. However, the greatest intellectual influence on ecological interpretation and conservation in coastal New England comes from historians.

> Selective Indian burning thus promoted the mosaic quality of New England ecosystems, creating forests in many different states of ecological succession. When Verrazano found twenty-five to thirty leagues of treeless land in Narragansett Bay, or Higginson spoke of thousands of acres in a similar state near Boston, they were observing the effects of agricultural Indians returning to fixed village sites and so consuming their forest energy supply. (Cronon, 1983)
>
> In the Northeast, Midwest and Southeast, pre-European agricultural activity and burning had converted much of the forest into successional (fallow) growth and into semi-permanent grassy openings (meadows, barrens, plains, savannas and prairies). (Denevan, 1992)
>
> There was little in the [Northeastern] forest to attract Indians, and they succeeded wherever possible in replacing forests with a mosaic of sites more to their liking . . .. In many cases the combination of clearing and fires stripped off the forests altogether. 'Barrens', 'clearings', and 'deserts' were among the most common sights reported by early explorers. Undoubtedly, Indians maintained these deliberately as hunting grounds. Many of the clearings probably represented abandoned agricultural fields subsequently sustained as grasslands by annual broadcast burning. Whatever their origin, they were common at the time of discovery and were among the chief victims of settlement.
>
> Not all of the Northeast was converted to 'desert' or savannah. The upper mountains, the river bottoms, the swampy lowlands, and the denser boreal forests were more or less spared annual firings . . .. Lacking domestic livestock, Indians depended on wildlife for meat, and these anthropogenic fire plains were

> their pastures. Ironically, many of the forests that occupied the great pine and oak belt of southern New England and across the Appalachians were a byproduct of European settlement ... suppression of Indian fire practices made possible the accidental and deliberate reforestation of the Northeast. Not only was there frequently no virgin forest to clear, but the forest that was cleared was often itself a product of the act of settlement. (Pyne, 1982)

The original documents shaping these interpretations were written by individuals with varied knowledge of the landscape, describe limited portions of New England or the coastal landscape, and cover more than a 200-year period. This literature has been evaluated critically (Russell, 1983; cf. Whitney, 1994; Bragdon, 1996; Motzkin and Foster, 2002). Among the conclusions of these evaluations is the observation that few early references exist to grasslands, heathlands, or other openlands along the southeastern coast of New England (Motzkin and Foster, 2002). In addition, early references to fire generally describe burning of the forest understory, rather than open vegetation or the process of land clearance.

4. Evaluating the evidence for openland vegetation and its drivers

Despite the accepted notion for extensive open uplands areas in pre-European times, there is limited paleoecological, archaeological, or historical evidence for such vegetation or for the disturbance factors necessary to maintain it. In contrast, the preponderance of data suggests that most of the landscape, including many conservation areas currently or historically supporting open vegetation, were wooded and that upland grasslands and shrublands were quite restricted. In addition, historical and field evidence indicate that essentially all high priority conservation areas currently supporting openland assemblages were intensively managed under European agricultural or other land use regimes.

4.1. The wooded New England landscape

Although providing a crude tool for interpreting vegetation composition and pattern, paleoecological data provide one of the only perspectives on long-term changes in landscape condition. Most importantly, pollen and charcoal diagrams provide the only continuous record over past millennia in which the perspective and biases remain largely constant. These biases include under-representation of small (e.g. herbaceous) and insect pollinated plants, over-representation of a handful of species that produce large amounts of wind-dispersed pollen (e.g. some trees and weeds), and relatively little ability to distinguish landscape level patterns or vegetation structure. However, the continuous nature of the record enables us to compare pollen and charcoal values through time with modern and historical data so that we can judge the relative extent of woody versus openland vegetation.

Vegetation reconstructions have been widely undertaken across New England (Patterson and Backman, 1988b; Fuller et al., 1998; Russell and Davis, 2001). When the pre-European pollen data are compared with values through the historical period the extremely low values for herbs, grass, shrubs and other non-arboreal plants suggest that the region was heavily forested (Fig. 5; McAndrews, 1988; Foster et al., 1998; Parshall and Foster, 2002). Historical data and studies of disturbance regimes suggest that mature forests were predominant (Whitney, 1994; Lorimer and White, 2003; Parshall et al., 2003) and that the region experienced a natural disturbance regime of frequent, low intensity events (wind, ice, insects, etc.) and infrequent broad-scale or higher-intensity disturbances, primarily hurricanes, tornadoes, and down bursts (Boose et al., 2001; Parshall and Foster, 2002). Across the coastal region, including Cape Cod, Nantucket, and Martha's Vineyard, woodlands dominated by oak, pine, and other hardwoods were widespread, although little is known of vegetation structure (Figs. 2 and 6; Patterson and Backman, 1988a,b; Eberhardt et al., 2003; Foster et al., 2003; Parshall et al., 2003). Indeed, Dunwiddie (1989), Stevens (1996) and Baldwin (1928) suggest that even islands supporting dense Indian populations, such as Nantucket and Martha's Vineyard, were forested and that heath and grassy areas were largely restricted to the coastal fringes.

On Cape Cod, Parshall et al. (2003) and Eberhardt et al. (2003) found no paleoecological or historical evidence for grassland, shrubland, or heathland even in areas with concentrated archaeological sites

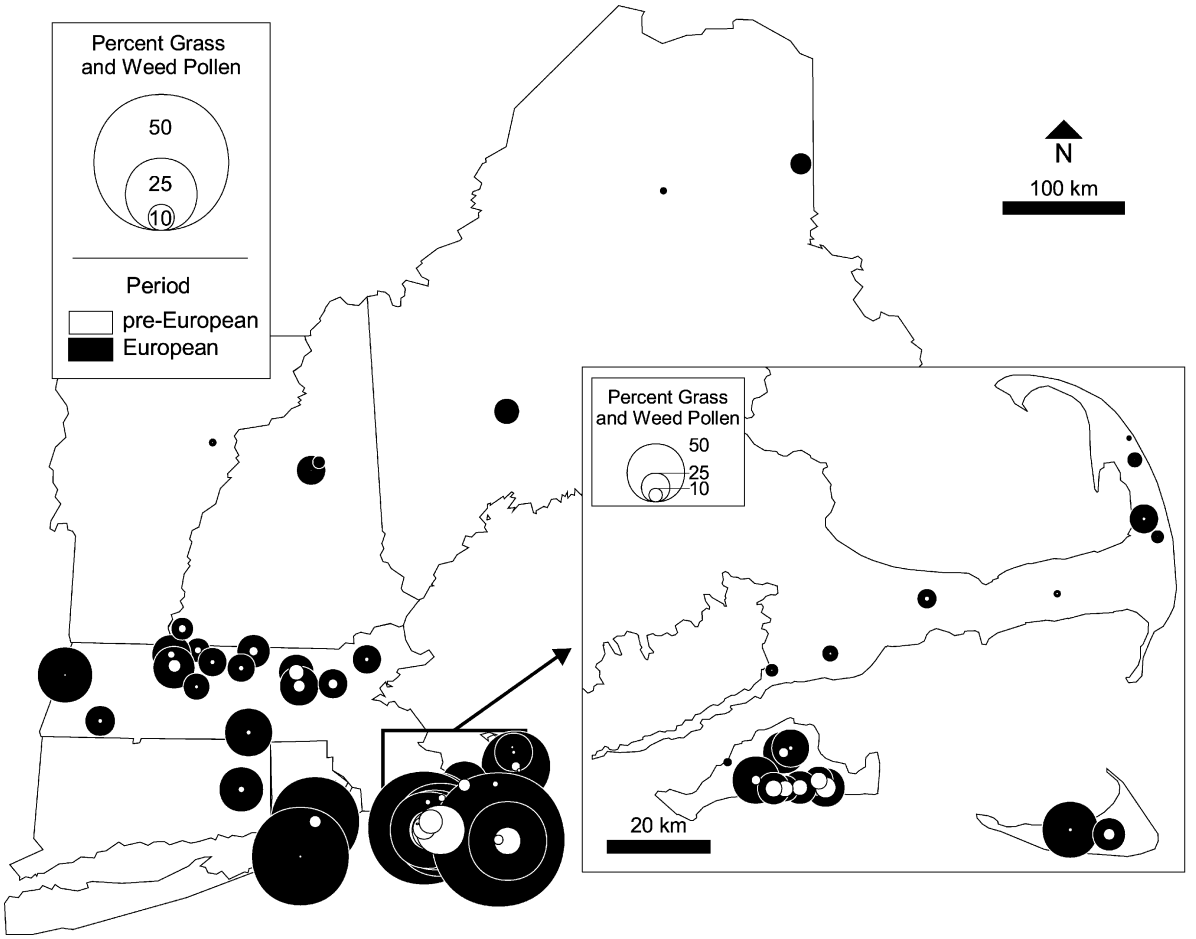

Fig. 5. Maps of paleoecological data depicting the relative abundance of grass (Gramineae) and weed (*Ambrosia*, *Plantago*, *Rumex*) vegetation in the pre-European (white, open symbols) and European (closed, black symbols) agricultural periods. For the pre-European period values represent the average of the five samples immediately preceding settlement as identified by the author of the study. For the European period values represent the maximum levels observed, typically in the mid- to late 19th century. Values are much higher in the European period due to the widespread development of extensive openland vegetation. During pre-European times values were consistently low (ca. <5%) with the exception of sites on the outwash plain of Martha's Vineyard. Data are from Parshall et al. (2003), Fuller et al. (1998), Foster et al. (2002b), Stevens (1996), Dunwiddie (1990a), Harvard Forest (unpublished) and the North American Pollen Data Base.

(cf. Fig. 2). They interpret the peninsula in 1600 A.D. as covered with forest that varied geographically with soil texture and moisture-holding capacity, fire frequency, and exposure. On Martha's Vineyard (Ogden, 1958, 1961; Dunwiddie, 1994; Foster and Motzkin, 1999; Stevens, 1996) current grass and shrub-dominated areas seem to have been tree covered, albeit with vegetation that was more diverse and included more hickory and beech than today (Foster et al., 2002b). Relatively high values for grass pollen along the south coast and on the central plain during pre-European times may be attributable to: (1) woodlands with open understories of grass, (2) interspersed open areas in a woodland matrix, or (3) mixing of the pollen of wetland grasses with that of upland tree species (Stevens, 1996; Foster et al., 2002b).

Evaluation of coastal (and inland) pollen sequences through time highlight one critical fact: in all cases the amount of pollen indicative of open vegetation (i.e. pollen of grasses, weeds, shrubs, and cultigens) is lowest before European settlement; rises to a peak in the middle or second-half of the historical period

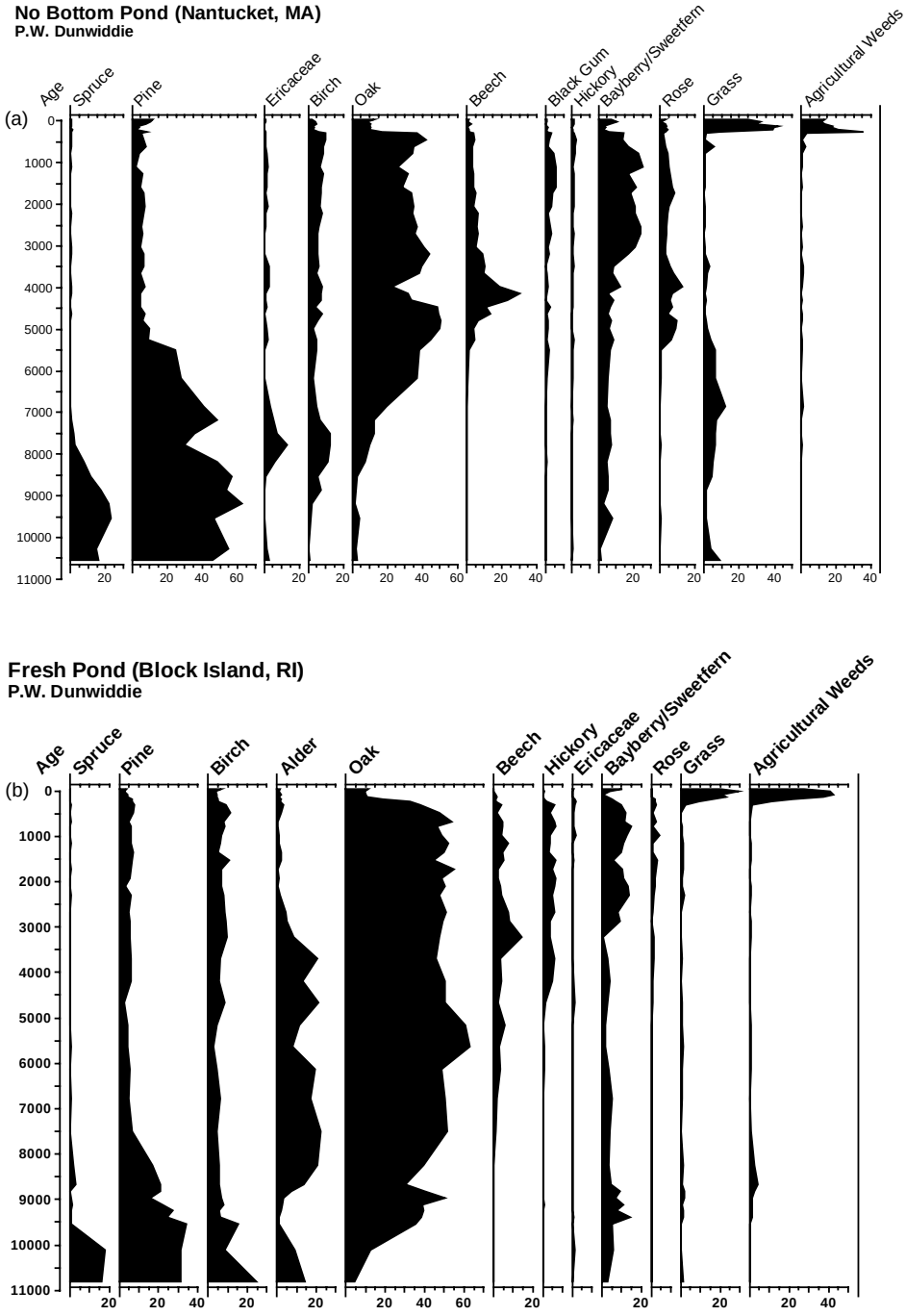

Fig. 6. Pollen diagrams from the coastal islands of Nantucket and Block Island depicting the continuously wooded character of the pre-European vegetation and low amounts of grass, Ericaceous plants or weeds before European settlement. Although openland assemblages and species are being invaded or crowded out by woody growth on these islands today, they remain strikingly more open than in pre-European times. The development, expansion, and decline of grassland and disturbed habitat is very much a consequence of ''recent' historical land use. Pollen data from Dunwiddie (1990a).

(i.e. the 19th century), and declines towards the present, but to values still exceeding those before European arrival. These results, which are consistent across New England, confirm that openland vegetation was limited before European activity. They suggest that historical land use, rather than natural disturbance or Native Americans has controlled the long-term dynamics of openlands.

4.2. Requisite disturbance processes

Given the moist, temperate conditions in New England, ecologists agree that disturbance is necessary to prevent the development of woody vegetation on most uplands (Whitney, 1994; Foster and O'Keefe, 2000; Motzkin et al., 2002a,b; Lorimer and White, 2003). The natural disturbance regime of wind, fire, ice and pathogens, seems incapable of maintaining large open areas or a substantial fraction of the upland landscape in successional vegetation (Fuller et al., 1998; Boose et al., 2001; Lorimer and White, 2003). Although there is a latitudinal and regional gradient of natural disturbance that increases towards the coast, the disturbances involved would likely generate mosaics of forest and successional vegetation rather than open, non-forested areas. Exceptions might include the activity of beavers (Askins, 2000) and large grazing animals. However, the open vegetation mosaics generated by beavers are confined to wetland sites that do not support many upland plants and there is no evidence that New England supported grazing animals capable of generating open vegetation.

Recent archaeological and paleoecological results also question the interpretation that Native Americans generated sizable grasslands or openland (Bragdon, 1996; Chilton et al., 2000a,b; Foster et al., 2002a,b). The fundamental issue is interpretation of the lifestyle, subsistence pattern, and population characteristics of Native American societies. Discussions arguing for extensive open vegetation depict Late Woodland Indians occupying semi-permanent villages with concentrated populations subsisting heavily on maize agriculture (Braun and Braun, 1994). Only through focused agricultural and collecting activities, reinforced by fire, could extensive areas be kept forest-free (cf. Cronon, 1983; Denevan, 1992). However, archaeological support for this once favored interpretation of Native American organization is surprisingly weak (Ceci, 1977; Luedtke, 1988; Carlson et al., 1992). Indeed, there is major disagreement between the historical–ethnographic and archaeological interpretations of Native American activity (Thorbahn, 1988; Doolittle, 1992; Bernstein, 1993; Bragdon, 1996; Chilton, 1999, 2000b).

Whereas, some ethnohistoric accounts describe concentrated Native American settlements with large permanent dwellings, extensive corn fields, and fortified village centers, archaeological evidence from the coast and other New England locations depict small semi-permanent encampments with temporary shelters with light wood frames (Holmes et al., 1997; Mulholland et al., 1998, 1999; Herbster and Cherau, 2000). In New England, there is no evidence of large structures comparable to the long houses and lodges of eastern New York and Ontario, where broad-scale land clearance and agriculture greatly modified forest extent and composition (Burden et al., 1986a,b; McAndrews, 1988; Campbell and Campbell, 1994; Byrne and Finlayson, 1998). Excavations in New England also provide no signs of fortified structures or intertribal warfare preceding European contact (Chilton, 1999, 2000a,b). In contrast, one prevailing archaeological view describes broad-based hunter-gatherer subsistence patterns varying in subtle fashion across coastal, riverine, and upland areas of southern New England (Bendremer, 1993; Bernstein, 1993; Bragdon, 1996). In this interpretation, coastal populations were seasonally mobile and relied predominantly on upland and marine wildlife and plant resources, supplemented by horticulture of squash, beans, corn and other crops. Rather than depicting these people as intensive agriculturists this lifestyle is described as "mobile farming" (Chilton, 1999, 2000b), "conditional sedentism" (Bragdon, 1996; Dunford and O'Brien, 1997), "broad spectrum and seasonally mobile" (Carlson et al., 1992), "tethered mobility" (Heckenberger, 1990), and "dispersed and non-nucleated" (Luedtke, 1988). Widespread skepticism among archaeologists of the existence of large agriculturally-based populations prompted a conference devoted to the question "Where are the Late Woodland Villages in southern New England?" The consensus was that they may well have never existed (Little, 1988; Luedtke, 1988).

Interpretations of native subsistence patterns are important because these would strongly influence

the human imprint on the environment. Although small mobile bands of individuals might be responsible for setting fires that would alter forest composition and structure, it is unlikely that they would have the opportunity or motivation to clear sizeable areas of woody vegetation. Indeed, even small-scale slash and burn agriculture, which might be employed by mobile hunter-gatherers, would be more likely to produce a fine mosaic of successional areas rather than extensive grasslands or heathlands.

The disparity between ethnohistoric and archaeological interpretations is based, at least in part, on the rapid changes in Native American lifestyle precipitated by European contact beginning in the 16th century (Bragdon, 1996; Mulholland et al., 1998). Considerable evidence suggests that due to rapid societal transformations initiated by European contact, the distribution, land use practices, and economic structure of Native Americans recorded by early European observers differed markedly from those of their Middle (ca. 0–1000 A.D.) and Late Woodland (ca. 1000–1500 A.D.) ancestors (Tveskov, 1992; Chilton, 1999; Mulholland et al., 1998). Consequently, it is important to question ethnohistories, precisely because they only capture a snapshot view of a landscape and people in dynamic transition.

The profound consequences of European contact included the introduction of new materials, trading opportunities, and diseases, and the development of novel political hierarchies (Ceci, 1977; Carlson et al., 1992; Bragdon, 1996). European exposure initiated social transformations, intertribal hostilities, and economic changes that precipitated dramatic shifts in geographic distributions, hunting patterns and land use activities (Ceci, 1977; Dunn, 1993; Bragdon, 1996). By definition, ethnohistoric descriptions are derived from the period after European impacts on Native American society; consequently, they record many novel conditions (cf. Cronon, 1983; Bendremer, 1993; Bragdon, 1996). For example, the concentration of people into more permanent settlements may be a reaction to increased trading opportunities or hostilities (Ceci, 1977); increased maize agriculture may represent the production of a useful trading item and a necessity for feeding the newly concentrated populations (Bragdon, 1996; Chilton, 1999, 2000a,b); and fortified villages may have developed in response to new intertribal and interracial tensions resulting from trading conflicts (McBride, 1990). The magnitude of changes caused by contact and the late arrival of corn to New England (ca. 1100 A.D.) suggests that the village and agricultural model may have been a novel development, rather than a long-standing tradition (Ceci, 1977; Bendremer, 1993; Bernstein, 1993; Chilton, 1999).

Despite questions regarding agricultural impacts, there is indirect paleoecological support and widespread archaeological acceptance for the use of fire by Native Americans for land management. Across the region deer represent the most abundant faunal remain in archaeological sites; humans were clearly a major predator of deer for millennia (Ritchie, 1969; Bendremer, 1993; Bernstein, 1993; Bragdon, 1996; Dunford and O'Brien, 1997; Chilton, 1999). Management of forest understory habitat and structure to promote large deer populations is consistent with the hunter-gatherer subsistence pattern. However, there is little evidence that fire was used to generate sizable areas of open habitat. Nearly all references to Indian burning refer to various types of woodlands; there are few references to fire in grasslands, shrublands or even in early successional forests (Motzkin and Foster, 2002). Moreover, on a landscape level there is little agreement between the distribution of human populations, abundant fire, and pollen signals for openland species (Parshall and Foster, 2002; Foster et al., 2002b). In addition, fire in the New England landscape is not generally conducive to the development of grass or heathland vegetation, although it may be useful in maintaining these cover types or generating sprout woodlands when applied intensively (Patterson et al., 1983; Patterson and Backman, 1988a,b; Dunwiddie and Caljouw, 1990).

Finally, there are few specific and geographically identifiable references to grasslands, and none to heathlands during the early settlement and colonial periods. References to ''barrens'', ''plains'' and open woodlands are ambiguous as they may refer to sandy, flat, and unproductive woodlands, scrub oak openings, or an open forest structure with varied understories that were not clearly described. Many descriptions of grassy and open expanses may refer to lowlands and wetlands. Indeed, many modern readers confuse the colonial use of the word ''meadow'' for field or upland grassland, when in fact it was specifically employed

to describe grassy wetlands, including salt marshes (Foster, 1999). In fact, the only substantial area of upland grassland described early in the settlement period is the Hempstead Plains on Long Island, and these observations come some three decades after local settlement (cf. Motzkin and Foster, 2002).

4.3. Biological evidence for the persistence of openland vegetation

The historical decline of plant and animal species that occupy open habitats today is often interpreted as evidence that these habitats must have been more common pre-historically (cf. Askins, 1993, 2000; Vickery, 2002). One rationale cited is that over long periods of time the species have evolved finely tuned affinities and adaptations to habitats like grasslands and heathlands. However, there are few autecological studies documenting the nature of these adaptations and many questions regarding the abundance of these species in the pre-European landscape. Many of these species exhibit general adaptations to disturbance; the relative importance of fire versus other disturbances in controlling species distributions is not well-established.

One classic example is the heath hen (*Tympanuchus cupido cupido*), a subspecies of the prairie chicken that formerly occurred in coastal New England, New York and New Jersey and beyond but that declined in the 19th century and went extinct in the 1930s (Gross, 1928). Protection of the species in the early 20th century prompted intensive research and the establishment of a state reservation on Martha's Vineyard. The last population collapsed following harsh winters and depredation by goshawks and feral cats on what is now the Manuel F. Correllus State Forest (Gross, 1928, 1932; Foster and Motzkin, 1999). The heath hen is widely cited as having been grassland dependent and, therefore, proof of the existence of extensive grasslands in the pre-Columbian landscape (Jones, 1995; Askins, 2000). Some early colonial descriptions suggest an abundance of the bird and later descriptions are even more striking (albeit describing a bird of shrubby or wooded habitat).

> Heath hen ... was formerly so common on the ancient bushy site of the city of Boston that laboring people or servants stipulated with their employers not to have the Heath Hen brought to table oftener than a few times in the week. (Townsend, 1905; Birds of Essex County, Massachusetts)

The dual interpretation of the heath hen as abundant and a prairie species has prompted the assertion that grassland was extensive and widespread. Nonetheless, there are major questions regarding this interpretation. Gross (1928), the preeminent expert on the species, is joined by other authorities in contrasting the heath hen to prairie chicken as preferring open sandy woods and scrub oak barrens rather than grassland: "[Heath Hen] will be much more likely to succeed [in the coastal landscape], on account of its woodland habits and narrow range, than the Prairie Hen [chicken], which requires a more open country, and usually does not take refuge in the woods." (*Biological Survey Bulletin* No. 24, cited in Gross, 1928).

Supporting data for the claims of heath hen abundance is also weak. For example, Gross (1928) indicates that although the species was widely distributed along the coast, its abundance in the early historical period is uncertain. Meanwhile, the repeated quote that heath hen was shunned by laborers is totally unsubstantiated. Identical language was applied to the Atlantic Salmon, another species that was most likely uncommon (if present) in southern New England before European settlement (Carlson, 1988, 1992).

> According to one account, the fish [Atlantic Salmon] was so common that indentured servants who worked in lumbering camps of the day had written into their contracts a limitation on the number of times per week they would be served Salmon. (US House of Representatives, 1981; HR 2062. Bill to Establish the Connecticut River Atlantic Salmon Compact)

No original documents containing such proscriptions for either species have ever been located (Carlson, 1988).

Perhaps more compelling than the heath hen example is the occurrence of several openland plant taxa that are endemic to the Northeast suggesting that habitats capable of supporting these species may have occurred prior to widespread land clearing by Europeans. However, the nature, abundance, and extent of such habitats are largely conjectural. Although it is likely that many of the uncommon plant species that are characteristic of openlands occurred in the region prior to European settlement

(Dunwiddie et al., 1996), there is no evidence to suggest that that they occurred on the same sites or in similar abundances and assemblages as those in which they occur today.

4.4. Field evidence for the antiquity of grasslands and other open vegetation

A final line of evidence that has been employed to verify the great age of openland habitats is soil profiles. In his classic description of the North Haven, Connecticut sand plains, Olmsted (1937) characterized the area as native grassland based on his interpretation of soil structure. In areas that he interpreted as undisturbed by human activity, he described the soils as having developed under ''a persistent grassland cover prior to white colonization'' with a profile consisting of a 20 cm dark brown A (upper) horizon terminating in a sharp, lighter colored lower boundary. Olmsted likened this to tall-grass prairie soils, in which a dark and deep A horizon arises from the decomposition of grass roots over millennia. Interestingly, he also speculated that Indian fires had maintained the grassy growth.

However, Olmstead apparently misinterpreted the soil profile and failed to recognize that the upper soil profile actually comprised a deep plow (Ap) horizon that was homogenized through repeated mixing. Recent work throughout the Connecticut Valley north of Olmstead's sites confirms that such profiles predominate on open as well as pitch pine dominated areas (Motzkin et al., 1996, 1999). These profiles may easily persist for more than a century after agriculture ceases and natural-appearing vegetation has developed. However, the homogeneity of the dark A horizon and sharp transition to light B horizon distinguishes these disturbed profiles from the deep but gradual transitions in true prairie soils.

4.5. Historical development, expansion and decline of openland habitats

Studies across New England document that open vegetation developed and varied in structure, composition, and distribution in parallel with European land use (cf. Figs. 3–5; Foster, 1999). Across the region, settlers transformed the forested uplands to pasture, hay fields and crops by applying technology unavailable to Native Americans in unparalleled intensity (Russell, 1982). Grazing, an activity foreign to Native Americans prior to European contact was a critical element in developing open landscapes due to the relentless stress that it applied to woody species and the manner in which it favored graminoid species. Almost any land could be and was grazed; the result was an agrarian countryside in which wetland meadow, hayfield, pasture, wood pasture, and tillage land predominated over scattered and intensively cut forests (Fig. 7; McCalley, 1981; Foster, 1999; Foster and O'Keefe, 2000; Eberhardt et al., 2003). On coastal islands, deforestation and overgrazing proceeded rapidly and quickly depleted wood supplies, forcing the mining of peat for fuel and importation of timber and firewood from the mainland (Banks, 1911; Dunwiddie, 1990a).

The intensive and oftentimes degrading land use generated novel habitats, vegetation types, and structures that were dependent on ongoing disturbance. Logging on short rotation, burning, and grazing transformed remaining woodlands into young, coppice woods or open, grassy forests with scattered trees. Forest composition shifted to sprouting species tolerant of repeated disturbance (Whitney, 1994). Selective grazing induced a variable cover of grass, forbs, shrubs and bare ground depending on the animal species, intensity and seasonal cycle of use. Along the coast, where mild climates allowed year-round pasturage and the number of sheep was the highest in New England in the early historical period, overgrazing led to a loss of vegetation cover, wind erosion, and even dune development (Thoreau, Torrey and Allen, 1962; Dunwiddie and Adams, 1994). Intensive agriculture also caused major losses of nutrients (Tiffney, 1997). In modern and even contemporary views, the coastal landscape could be described as degraded, barren, rutted, eroded, and wasteland (Thoreau, Torrey and Allen, 1962; Dwight, 1821).

Grassland and shrubland species were major benefactors of this land use and land cover shift (Marks, 1983; cf. Jones and Vickery, 1995) that resulted in the development of approximately six million acres of grassland habitat in New England by the mid-19th century (Sharp, 1994). Midwestern birds, including the bobolink (*Dolichonyx oryzivorus*) and eastern meadowlark (*Sturnella magna*) extended their range to become naturalized in the humanized Northeast,

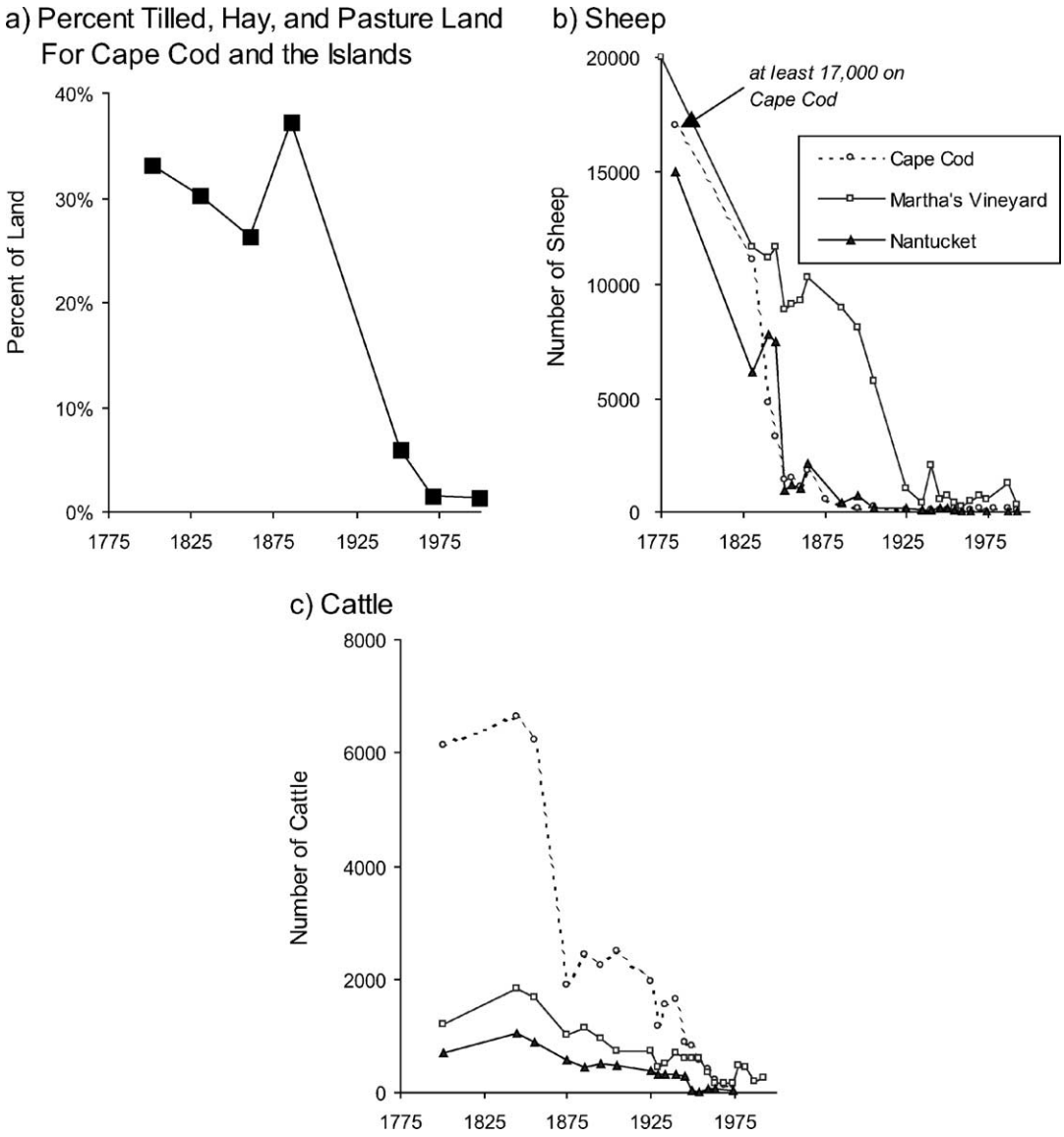

Fig. 7. Historical changes in (a) open agricultural land, (b) sheep, and (c) cattle on Cape Cod and the islands of Nantucket and Martha's Vineyard since the late 18th century. Broad-scale abandonment of agriculture produced a major decline in openland vegetation and initiated successional changes leading to increased shrub, woodland, and forest cover.

whereas species like the song sparrow (*Melospiza melodia*), upland sandpiper (*Bartramia longicauda*), and New England cottontail (*Sylvilagus transitionalis*), which are uncommon today, became widespread and even abundant (Litvaitis, 1993, 2001; Foster, 1999; Petersen, 1999). Although less widely appreciated, openland plant species also increased, and several characteristic grassland species may have become most abundant in the coastal region only during or shortly after the agricultural period (Jenkins, 1982).

Increasingly after the mid-19th century, the decline in agriculture led to gradual development of brushland and successional woodlands (Figs. 3 and 7). The rate of reforestation varied considerably depending on soils, exposure, propagule availability, and ongoing

disturbance. In inland areas, white pine (*Pinus strobus*) was a common early successional species, whereas near the coast pitch pine (*Pinus rigida*) and scrub (*Quercus ilicifolia*), white (*Quercus alba*) and black oak (*Quercus velutina*) were more abundant (Eberhardt et al., 2003; Foster et al., 2003; Parshall et al., 2003). Although many coastal grasslands and heathlands became overgrown by shrubs and trees, windy conditions, salt spray, and absence of seed sources slowed succession in exposed coastal areas (Dunwiddie, 1990a; Raleigh, 2000).

Coincident with a widespread increase in woodlands, there occurred a regional decline in openland plants, insects, birds, and mammals (Fisher, 1933; Hosley, 1937; Foss, 1992; Degraaf and Yamasaki, 2001; Foster et al., 2002b). Focal conservation species that have declined over the past century include the regal fritillary (*Speyeria idalia*; Dunwiddie and Sferra, 1991), grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculus sandwichensis*), bobolink, meadowlark and upland sandpiper, and numerous uncommon plant species (Jones, 1995; Jones and Vickery, 1997; Vickery, 2002).

Although shrublands, early successional forests, grasslands and heathlands are currently much reduced from their 19th century peak, in some areas they apparently remain greater than in pre-European times (cf. Fuller et al., 1998; Foster et al., 2002a; Parshall et al., 2003). The modern composition of these plant assemblages is strongly controlled by the pattern of historical land use (Motzkin et al., 1996, 1999, 2002b; Gerhardt and Foster, 2002). In particular, the coastal grassland, heathland, shrubland and early successional forests that have been studied in detail occupy sites with lengthy histories of intensive land use (Fig. 8; Dunwiddie et al., 1996; Foster and Motzkin, 1999; Motzkin et al., 2002b; Eberhardt et al., 2003). Site evidence of disturbance often includes plow horizons and other disturbed upper soil horizons (cf. Fletcher and Roffinoli, 1986), which suggests that the natural vegetation cover was largely or completely eradicated historically and that the modern plant assemblages developed only since the cessation of these historical disturbances (Fig. 8; Motzkin et al., 2002a). For example, most coastal forests with substantial grass or sedge understories have been shown to be ''secondary'' woodlands that developed on previously cleared sites (Eberhardt et al., 2003; Motzkin and Foster, 2002; Motzkin et al., 2002b). In contrast, oak forests with a thick cover of native ericaceous

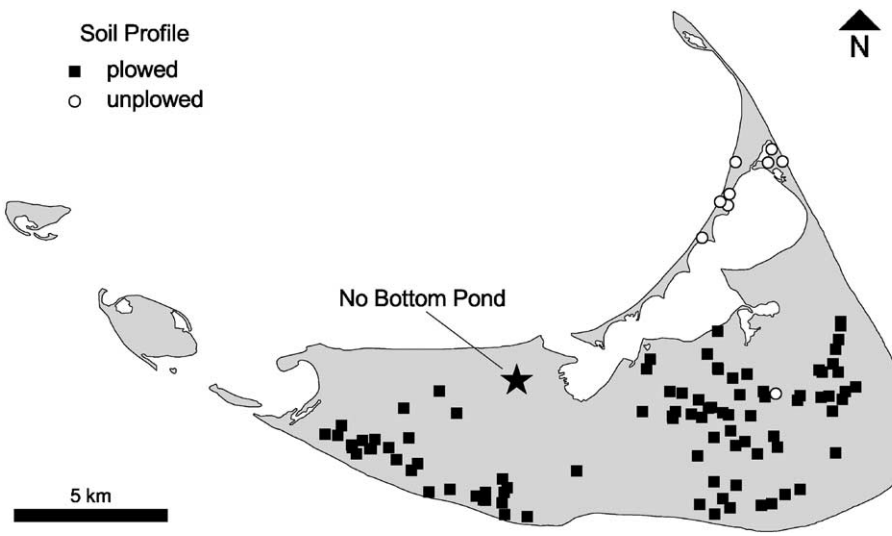

Fig. 8. Map of Nantucket depicting sample locations for vegetation, soils and land use history on the major conservation properties. Soil evidence for disturbance of the upper horizons through plowing, harrowing, or other disturbance (''plowed'') is indicated by closed symbols whereas open symbols indicate undisturbed horizons (''unplowed''). The predominance of anthropogenic disturbance indicates that most conservation areas on this island, which harbors some of the best examples of sandplain grassland and heathland in the northeastern US, have been intensively disturbed and shaped by historical (i.e. 17th to 19th century) land use. Data from *Harvard Forest Archives* (unpublished).

shrubs generally have undisturbed soil profiles and frequently remained forested through the historical period (Eberhardt et al., 2003). Heathland communities frequently arise from deforestation, intensive grazing, soil scarification and nutrient depletion (Tiffney, 1997; Motzkin and Foster, 2002). In light of the duration, extent and intensity of historical land use, the current distribution, abundance, and character of openland species and assemblages are better explained by this recent history rather than the pre-European condition of the landscape (Dunwiddie et al., 1996; Motzkin et al., 2002b).

Table 1
The major grassland and heathland sites for uncommon and rare openland bird species in Massachusetts

Logan Airport	Katama Airfield
Hanscom Military Airfield	South Maple Street Hadley
Cumberland Farm Warehouse	Camp Edwards Base
Fort Devens Parachute Landing Site	Otis Airforce Base Airfield
Clinton Landfill	Barnes Municipal Airport
Worcester Municipal Airport	Turners Falls Airport
Westover Air Reserve Base	Elizabeth Islands
Marconi Barrens (abandoned military area)	

Modified from Jones and Vickery (1993).

5. A perspective on grassland, heathland, and shrubland assemblages

Historical and modern perspectives call for a re-evaluation of the notion that openland communities are long-standing and well-integrated assemblages of plants and animals. Indeed, they appear to include opportunistic species that capitalized on the open conditions provided by forest clearance and intensive agriculture and may have expanded from small and scattered populations in the pre-European landscape (cf. Dunwiddie, 1989, 1990a, 1992a). With the decline of grazing pressure and gradual increase in woodiness and forest cover these species have subsequently declined. Consequently, it is likely that neither the habitats nor the assemblages have long-term integrity or historical coherence (Lawton, 1997). In many ways this interpretation parallels the history and origin of weed floras in northeastern North America advanced by Marks (1983) and is similar to the history of other agricultural and post-agricultural assemblages such as the old-field white pine and red cedar forests or young red maple—*Carex stricta* swales on former wetland pastures. Although these vegetation types, like heathlands and sandplain grasslands, are distinctive features of the modern landscape, they arose in response to novel ecological opportunities and environmental conditions resulting from colonial history. In the absence of a continuation of the land use practices that generated them each of these assemblages is also transient in our landscape.

The development of extensive grasslands, heathlands and shrublands was dependent on widespread disturbance creating openings and eliminating competition for uncommon herbs, grasses and shrubs. Though such disturbance was most commonly agricultural, the ability of many of these assemblages to establish on military bases and along power lines and road edges underscores the opportunistic nature of the species. The persistence of these vegetation types over sizable areas is dependent on maintaining disturbance. Thus, as agriculture has declined historically other disturbances have become important in maintaining similar habitats, including airports, industrial sites, and military training fields subjected to intense vehicular activity, bombing and fire (Table 1; Jones and Vickery, 1993, 1995, 1997).

The nature of openland assemblages and the rate of woody species establishment seem to depend in large part on the type and pattern of land use, especially the quality of site modification. For example, Tiffney (1997) has underscored similarities between North American and European heathlands and the critical role that nutrient depletion plays in the development and maintenance of these assemblages. In this view, which is espoused by many Europeans ecologists (cf. Königsson, 1968), one of the critical consequences of grazing, heath and grass harvesting, litter removal, surface scarification, and fire is to decrease site fertility and the aggressiveness of competing species (Sutherland and Hill, 1995; Bruvn et al., 2001). Under conditions of high nutrient availability, large woody species and aggressive grasses may crowd out the smaller heath plants (Maron and Jeffries, 2001). Consequently, a major goal of heath management is to reinforce the poor quality of site conditions and slow the rate at which a site is able to return to more natural conditions (Tiffney, 1997).

This interpretation applies an opportunistic and individualistic interpretation to these important and unusual assemblages. Rather than viewing them as having a long history of integration, we suspect that the suite of openland plants and animals inhabited a variety of habitats and geographical locations during the pre-European period and came together broadly to occupy their current distribution and assemblages during historical times. Five hundred years ago many of these species likely occupied small areas and distinctly different habitats in which they may have played very different roles than they do today.

6. Conservation implications of the historical dynamics of openland habitats

Historical evidence requires that we rethink our interpretation of many important conservation lands and develop new ways and terminology for discussing them. Indeed, in landscapes like New England, many valued habitats have cultural origins and the abundance and distribution of many plants and animals are tied to human history. For example, artificial habitats including airfields, military training areas, landfills, and former agricultural areas play a predominant role in maintaining grassland bird species (Jones and Vickery, 1993; Table 1). Clearly, these habitats have no lengthy history and the species assemblages that occupy them arrived in opportunistic fashion. However, in the modern landscape these new human environments provide the best substitutes for the formerly abundant agrarian sites that supported them in the past. A notable example is Westover Air Field in southwestern Massachusetts, which comprises more than 1000 acres of anthropogenic grassland supporting the largest concentration of grassland birds in New England, including more than 75% of the region's upland sandpipers (Anonymous, 2000). As documented elsewhere, chronically disturbed landscapes oftentimes provide great hotspots of biodiversity comprised of early successional and novel assemblages of organisms (Schuyler, 1999).

This interpretation suggests the need to adopt new terminology and management approaches for many conservation areas that have been previously described as ''natural'' or ''native''. One example is the Katama Plains, the large grassland on the southeastern corner of Martha's Vineyard jointly managed by The Nature Conservancy, State of Massachusetts, and Town of Edgartown. The area has been variously described as ''native sandplain habitat'' and ''one of New England's largest and best sandplain grasslands'' (Scott, 1989; Liptak, 1998; TNC, http://nature.org/wherewework/northamerica/states/massachusetts/preserves/art5320.html) and its dark soil profile has been interpreted as indicating grassland continuity for thousands of years (Scott, 1989). The area supports an array of uncommon species, including more than 18 birds, invertebrates and plants that are rare and declining. In order to reverse a trend of habitat deterioration, including shrub and tree invasion, the area has been managed through fire, mowing, and stem cutting in recent decades. According to site managers, the use of fire is preferred due to its perceived congruence with the site's native status and history. Nonetheless, despite ongoing management, many species have declined or disappeared over the past two decades, including a wide range of plant, bird, and invertebrate taxa.

Historical review provides an alternative interpretation of the site's origins. Located adjacent to Edgartown, Martha's Vineyard's oldest and most prosperous town, the Katama Plain was one of the first sites to be settled by Europeans on the island and was probably originally wooded (Herbster and Cherau, 2000). By 1642, the area was divided into 40 acre lots that were cleared for agriculture. Maps from 1776 onwards depict the area in fields; it was mapped as ''sheep pasture'' by Crevecoeur in 1784; supported dairy cows in the 1880s; and, currently is comprised of varied fields and a grass airfield. As in the case of the North Haven sand plains, the dark soils are Ap horizons that developed through deep plowing of the sandy soils. The site and its assemblage of interesting species are clearly the recent products of human history. Encroachment of woody species is therefore a consequence of historical shifts in management. Whereas the current management regime appears to be largely ineffective in maintaining the habitat and eliminating woody plants, the site might well respond favorably to management that mimics the agricultural practices that gave rise to its historical condition over past centuries.

6.1. Cultural landscapes may require cultural management

The history of colonial land use of many conservation areas suggests that traditional management regimes, or their substitutes, may be effective in maintaining and revitalizing these habitats and species assemblages. Although many agricultural lands were burned, the most intensive disturbances shaping their composition and structure included grazing, cropping, plowing and other soil disturbance. Cessation of these traditional activities has resulted in exactly the changes that the original managers (i.e. 17th to 19th century farmers) fought to prevent: the incursion and growth of rank and woody species (Dunwiddie, 1990a; Budd, 2000). This conclusion parallels the interpretations of European conservationists, including Sutherland and Hill (1995) who state that "the failure to maintain continuity of management within semi-natural habitat is at the heart of most conservation problems . . . traditional management should be maintained wherever possible."

Recognition of the cultural or semi-natural origins of many habitats is emerging across North America (Vickery and Dunwiddie, 1997; Tiffney, 1997; cf. Norment, 2002) and is beginning to reshape approaches to land management. For example, investigation of the decline of the bog turtle, a species of open wetlands, suggests that historical changes in the intensity of cattle grazing paralleled the expansion and subsequent decline of turtle populations, and indicates that grazing creates excellent habitat (Kiviat, 1993; Teasauro, 2001). Consequently, cow grazing has been recommended to "restore" these open and microtopographically diverse habitats (Teasauro, 2001). In a similar fashion, grazing has been advocated to restore the heathlands and grasslands on Nantucket, which are major conservation priorities (Tiffney, 1997; Dunwiddie, personal communication; Steinauer, personal communication). Records from the 18th and 19th century indicate that essentially all of the Island's conservation lands were grazed intensively and physically "improved" by plowing. Indeed, field studies reveal disturbed soil horizons on nearly all sites (Fig. 8; *Harvard Forest Archives*, unpublished). In addition to controlling woody growth, grazing diversifies the landscape through selective impacts, the creation of microtopography, and the redistribution of nutrients (Dunwiddie and Caljouw, 1990; Tiffney, 1997).

Some conservation organizations are experimenting with traditional practices. The Trustees of Reservations, the oldest conservation organization in America, is using sheep to reclaim historical fields in Massachusetts (Anonymous, 2001a,b) and is considering extending this practice to reserves just west of the Katama Plains on Martha's Vineyard (Capece, 2000). On Nantucket, the Massachusetts Audubon Society has a long interest in sheep grazing (Dunwiddie, 1997) and hopes to use grazing and mowing on the 6000 acre Middle Moor heathlands. Elsewhere in New England, one small business rents sheep to landowners to maintain open landscapes, ranging from utility lines to conservation lands.

Traditional agricultural practices are small-scale and variable in intensity and provide many habitats that are missing on modern farms (Budd, 2000). Modern agriculture generally homogenizes and simplifies the landscape by: removing hedgerows, fencelines, and stonewalls; plowing deeply and frequently; applying herbicides, pesticides and fertilizer; and emphasizing stall feeding rather than pasturing of livestock (Bengtsson-Lindsjö et al., 1991). The result is a drastic decline in landscape diversity and habitat quality for wildlife and plants and little benefit to the conservation of biodiversity. In contrast, historical practices or small-scale and economically marginal farms on less productive sites may maintain important historical landscapes as well as plant and animal assemblages (Sherman, 1998).

6.2. Re-examining the objectives of land conservation and management

Given the American emphasis on natural landscapes, recognition of the cultural underpinnings of some habitats may cause some to question their value (Birks, 1996; Peterken, 1996; Norment, 2002). However, there are at least three reasons for valuing and maintaining these habitats: (1) cultural landscapes such as grasslands and heathlands are attractive, distinctive and uncommon; they retain traditional historical value; and they provide social and economic benefits through recreation and tourism (Norderhaug et al., 2000; OECD, 2001); (2) cultural habitats in one region may provide effective substitutes for native

habitats (e.g. Midwestern prairies) that have been destroyed elsewhere in the historical range of these species (Vickery, 1994); and (3) maintenance of biodiversity is a priority in every landscape regardless of the ultimate cause of the diversity (Lawton, 1997).

The conservation of historical landscapes and their species for cultural and aesthetic value has become an important consideration, especially in European countries where humanized landscapes are widespread and more readily appreciated than in North America (Rackam, 1986; Birks et al., 1988). Across northwestern Europe and elsewhere, the loss of many traditional landscapes due to land conversion, agricultural intensification, and reforestation has wrought major impacts on the visual quality of the land as well as its habitat value (Kaland, 1986; Robertson, 1990; Lavers and Naines-Young, 1993; Fuller et al., 1998; Sutherland and Hill, 1995; Watkins, 1993). In some regions, government programs support rural people pursuing traditional lifestyles or applying these practices on important conservation sites (Birks et al., 1988; Anonymous, 1994) as a means of strengthening rural communities, benefiting tourism, and maintaining conservation values. In a country like Norway the maintenance of small-scale farming on steep fjordlands and montane sites has little to do with agricultural production, but rather helps to maintain rural economies and cultural tradition in the broadest sense. One beneficial offshoot of these delightful landscapes is their ecological and conservation value (OECD, 2001). Similar arguments could be easily applied to the coastal grasslands and heathlands of New England.

6.3. Increasing the historical and scientific basis for management

This interpretation of openland dynamics underscores the need for rigorous historical and scientific frameworks for land management. Foremost it is important to commence with a thorough historical–ecological review of the landscape, the long-term dynamics of major species assemblages, and the factors controlling changes in vegetation structure and composition. Such historical background is necessary regardless of whether the landscape is perceived to be controlled by natural or cultural processes (Landres et al., 1999). Just as the identification of the ‘‘natural range of variability’’ is important for understanding and managing systems maintained by natural disturbance regimes and environmental change (e.g. Landres et al., 1999), a similar emphasis on history is required for landscapes in which cultural activity has been a major environmental driver (cf. Swetnam et al., 1999). Of course, in many cases the relative contribution of natural versus cultural processes may be unclear at the outset, as in the situation of the coastal grasslands and heathlands of New England and northwestern Europe.

Once the historical and ecological drivers of the system are well understood, it is essential to establish a clear framework for management, including specific statement of: objectives, motivations, expectations and desired outcomes. Science and history often provide useful background for policy and may become the basis for management once objectives are set, but selecting conservation objectives is always a subjective act (Lawton, 1997). With an objective established it is then essential that a system of adaptive management include clearly stated objectives; an assessment of feasibility; a management prescription based on appropriate methods; long-term monitoring including baseline data collection; application of management under an adaptive framework that allows for assessment and re-evaluation; and a plan for revisiting methods and objectives (Sutherland and Hill, 1995; Dunwiddie, 1997).

7. Concluding thoughts

Conservation and land management are challenging enterprises in landscapes where natural processes have been the predominant force for millennia (Spreugel, 1991; Landres et al., 1999; Swetnam et al., 1999). However, the difficulties of interpretation and application often multiply in the more typical situation where human and natural processes have interacted with changing intensities and characteristics over time. Historical studies can identify many of the influences that have shaped landscapes as well as current conditions that are legacies of prior activities (Foster et al., 2003). However, recognition of cultural influences on modern landscapes introduces complexities to management and ambiguities to policy development. Management of a cultural landscape involves much more than allowing nature to take its course or even

reintroducing natural processes (which may be challenges enough). It may require sustaining human activity that is considered to be outmoded, inefficient, unproductive, or environmentally unsound; or it may suggest the use of artificial alternatives to historical landscapes as the last bastions of defense for some species. Alternatively, in some instances recognition of the cultural and transient nature of particular landscapes may provide the rationale for reducing active management, albeit with the recognition that valued characteristics of the cultural landscapes may be lost.

The insights arising from historical perspectives force us to address quite fundamental questions. What landscapes do we value, and why? Should we attempt to maintain cultural sites and assemblages? Are we seeking to maintain or recreate landscapes and assemblages from specific time periods? Should we use any and all means to support as much of our local biodiversity as possible? Once we have addressed these and related questions we can return to historical information for further insights into management with some expectation of success. While we may open new policy and ethical discussions through historical–ecological studies, we also learn much about ecological process and options for conservation.

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