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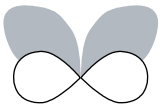

From bobolinks to bears: interjecting geographical history into ecological studies, environmental interpretation, and conservation planning

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ABSTRACT

In these days of supercomputer-based global climate models, large ecosystem experiments including Biosphere II, and aircraft-borne sensors of ozone holes it is often overlooked that many fundamental insights into ecological processes and major environmental issues come not through reductionist or high-tech studies of modern conditions but from thoughtful consideration of nature's history. In fact, it is foolhardy to make any ecological interpretation of modern landscapes or environments or to formulate policy in conservation or natural resource management without an historical context that extends back decades, at least, but preferably centuries or millennia. Oftentimes, the ecological and conservation communities, in their search for more detail on the present and simulation of the future, appear to have forgotten the value of a deep historical perspective in research and application. However, the willingness of the geographical sciences to embrace broad temporal and spatial perspectives and to consider cultural as well as natural processes is worth emulating as we address environmental subjects in the new millennium.

Keywords

History, ecological history, landscape history, historical geography, cultural processes, conservation.

GENERAL EXAMPLES FROM WILDERNESS TO CULTURAL LANDSCAPES

Examples of historical processes that control modern ecosystem pattern and process abound in wilderness settings as well as cultural landscapes. Any attempt to interpret the structure, function or landscape pattern of Northern Hemisphere conifer forests is fruitless without a millennial-scale appreciation for natural disturbance, particularly fire (Mooney *et al*., 1980). In landscapes from the Pacific Northwest to northern Scandinavia downed wood, scarred trees, and stand age-structure are legacies of past fires that are critical forest attributes in terms of ecosystem function and habitat value (Franklin & Halpern, 1989; Foster, 1983; Zackrisson, 1977). Since the fire regimes that generated modern landscape patterns were oftentimes quite unlike those prevailing today it is critical not only to recognize the role of history but also to reconstruct and interpret it in detail (Clark, 1988). Failure to grasp this lesson has led to misguided efforts to preserve ecosystems that are, in fact, inherently dependent on continual dynamics (Heinselman, 1996).

In quite contrasting regions, ranging from oceanic heathlands to tropical forests in Latin America, a history of human activity has produced cultural landscapes that are dependent on people for their structure, composition, and function (Birks *et al*., 1988; Foster *et al*., 1999; Gomez-Pompa & Kaus, 1992; Bush & Colinvaux, 1994). In many cases current conditions may be linked to ancient, oftentimes forgotten land-use practices or people that are apparent only in archaeological remains (Denevan, 1992). Failure to appreciate the human element in these lands certainly leads to erroneous ecological interpretations, misdirected research emphases, and misguided approaches to management (Gomez-Pompa & Kaus, 1992; Foster *et al*., 1999). However, it also misses an opportunity to address major ecological questions with important conservation ramifications. As one stands atop a Mayan temple and gazes across seemingly endless and continuous forest in the Southern Yucatan intriguing questions abound that are central to modern environmental debate. How rapidly do tropical forest landscapes recover from widespread assault of land clearance and intensive agriculture? In the thousand years since the enigmatic decline of the Maya to what extent have forests and aquatic ecosystems recovered towards their earlier condition? And, How do we differentiate these ancient secondary forests from so-called primary forests that have not been so intensively disturbed—what are the legacies of this landscape's cultural origins? Ecologists and conservationists have only recently joined forces with geographers and archaeologists to investigate such issues.

BOBOLINKS, BEARS, AND CARBON STORAGE IN THE NORTHEASTERN UNITED STATES

Over the next century in many landscapes, including the Northeastern U.S., the history of the land will continue to control ecological processes and influence future changes more than much-debated global climate change (Foster, 1999). This region's history of landscape transformation—from forest to agriculture and back to forest—determines modern ecosystem structure, composition, process, and response to new human impacts. Thus, this largely forested area provides not only a paradox of a natural appearing, though completely cultural, landscape but it offers important insights into the ways in which history controls modern conditions and will determine future trajectories. These are lessons that geographers, ecologists, environmentalists, and policy managers should all appreciate (MacCleery, 1992; McKibben, 1995).

In 1854, after years of walking the Massachusetts countryside, Henry David Thoreau, one of North America's great natural historians and writers, made an observation that seems incredible today: 'Is not [the muskrat] the heaviest animal found wild in this township?' For while he reveled in the open agrarian landscape of 19th C New England, entertained by meadowlarks, whippoorwills, bobolinks, and bitterns, Thoreau lamented the loss of what he called the 'noble animals': the cougar, bear, moose, fisher, and turkey (Foster, 1999). Deer, he observed had not been seen in central Massachusetts for 80 years and beaver had been extirpated in the early 1700s. Indeed, he even despaired that the black fly and 'no-see-um', two irritating insects that are the bane of modern hikers, had disappeared before the hand of civilized man.

Today, coyotes wander the Boston suburbs and moose-crossing signs line the highways just west of Thoreau's hometown of Concord, Massachusetts. Deer are abundant and increasing across the eastern U.S. and are routinely maligned for their impact on forest regeneration and their role in spreading Lyme disease. Beavers dam streams to flood roads and housing, bears are a common sight among birdfeeders throughout northern and western New England, and confirmation of cougar in more than half of the New England states and wolf in a few indicate the potential for re-establishment of large predators. Meanwhile, the open-land birds of Thoreau's day—the bitterns, meadowlarks, bobolinks, and upland sandpipers—are declining or disappearing and are major priorities for conservation (Vickery & Dunwiddie, 1997).

An explanation for these ongoing wildlife transformations across the Eastern U.S. does not lie in global climate change and will not be revealed through intensive study of modern conditions at any scale (O'Keefe & Foster, 1998). Rather it must be sought in the history of the land and its people and in the decision, some century and a half ago, of a rural population to relocate from the farm into cities and suburbs. As agriculture shifted to the Midwestern U.S., Thoreau's landscape of extensive pastures, meadows, and grainfields reforested naturally and small and isolated woodlots, such as the one at Walden Pond that provided him with inspiration, became part of a vast, regional forest. The rate and extent of this ecological transformation are staggering and its environmental ramifications are difficult to overstate (McKibben, 1995). Since 1900, forest area in the northeastern U.S. has increased more than 50% to over 70 million acres (Irland, 1999), with increases greatest in states like Vermont, Pennsylvania, Massachusetts, and Rhode Island (65–85%), somewhat less in New Hampshire and New York (45–55%), and least in Connecticut and Maine (15–20%). This new forest continues to grow and mature precisely because the expanding, but 'environmentally concerned' population obtains its natural resources from other parts of the globe (Berlik, 1999): a recent survey in Massachusetts documented a 19% increase in wood volume from 1985 to 1998 and an even greater increase (41%) in larger, sawtimber trees.

This forest recovery has environmental repercussions at local, regional and global scales. As mature woodland habitat has increased forest-dwelling animals have returned through migration (e.g. bear, moose, pileated woodpecker, fisher), population growth following re-introductions by wildlife agencies (e.g. beaver, turkey, eagle), or expansion of native ranges (e.g. coyote, opossum, vulture). However, the new forests and their wildlife form a very cultural landscape controlled in most aspects by prior, and ongoing human impacts (McLachlan *et al*., 2000; Foster *et al*., 1996). For example, the single factor that best explains the age, height, and composition of modern woodlands is the history of past land-use (O'Keefe & Foster, 1998). Adjoining forests differ strikingly in appearance depending upon whether they remained as woodlots through time or experienced a short-term bout as farmland, which eradicated the original plant cover. Due to the differential ability of species to disperse and spread across the landscape, coupled with the inherent inertia in ecological systems once they are established, such land-use legacies are extremely long lasting (Motzkin *et al*., 1998). Similarly, wildlife communities have only the

appearance of being natural: many are undergoing extremely rapid changes in size and distribution and most are poorly controlled by either natural predators or human intervention (Foster & Motzkin, 1998).

The ecosystem function of forests in this region, including their response to novel forms of stress, is also strongly conditioned by cultural history. For example, one of the greatest environmental threats to northeastern forests is the regional deposition of nitrogen resulting from fossil fuel combustion (Aber, 1992). Initially, the addition of a limiting nutrient like nitrogen has a fertilizing effect that leads to increased productivity. However, through time excess nitrogen may leach from forest soils, depleting other nutrients and generating adverse ecological and health effects on aquatic ecosystems (Aber *et al*., 1998). Studies indicate that the ability of Northeastern forests to store nitrogen and cope with this threat is not explained as well by the type of forest or trees as whether prior land-use activity altered original levels of nitrogen in the soils (Aber & Driscoll, 1997). At an even broader scale, the growing eastern forests store massive amounts of carbon and are a globally-important sink for some of the excess carbon dioxide added to the atmosphere by fossil fuel combustion and land clearance worldwide (Houghton, 1999). Consequently, the 19th C decision by farmers to abandon their land will continue to influence the character and function of the northeastern landscape for decades to come (Wofsy *et al*., 1993).

HISTORY IS ALWAYS MORE COMPLICATED

And yet, as we look at these forests their dynamics are not a simple matter of response to European impacts, but rather a more complicated, and poorly understood, story of broad-scale environmental change interacting over the last millennium with changing cultural activities by Native Americans and their successors. A regional analysis of modern forest composition in central New England reveals no consistent variation in forest composition across a subtle, but well-defined climatic gradient (Foster *et al*., 1998). However, at the time of European arrival the same region displayed variation in forest composition that was strongly correlated with this gradient in growing season length. A simple matter of rather homogeneous land-use activity and reforestation leading to regional homogeneity in vegetation, it would appear. In fact, a deeper look into the past reveals that hundreds of years before the arrival (in 1620) of the Mayflower the regional vegetation was changing substantially and becoming more homogeneous (Fuller *et al*., 1998). This early shift was apparently driven by climate change associated with the Little Ice Age and perhaps also by changes in Indian fire regimes (Campbell & McAndrews, 1993; Bragdon, 1996). The substantial changes in forest composition since European arrival are thus a consequence of many factors: rapid decline in species such as beech and hemlock, which were already in decline due to climate change, selective reduction of species like chestnut, elm, beech (and now hemlock) due to the introduction of new pathogens, and broad-scale increases in weedy species that proliferate with intensive land use and early successional conditions.

Thus, as ecologists initiate new research projects and address environmental concerns, as conservationists turn to protect or restore species, as the larger population tries to understand the wildlife in its backyards, and as we debate future environmental change, let us not forget to look back to understand the forces and changes that shape the ecosystems we seek to understand. Trees and clonal species have extremely long lifespans. Significant lags exist in ecosystem response to changing conditions or in species ability to re-invade sites from which they have been eradicated (Davis & Botkin, 1985). Soils and many below-ground processes are slow to recover from past changes in physical or chemical characteristics (Motzkin *et al*., 1998). For all of these reasons and more, past processes in the landscape condition the present and loom as legacies in modern and future landscapes. For us to succeed in our science, our environmental interpretations and predictions, and our management objectives we must heed the past.

For, as Henry Thoreau put it so well in 1860 '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.'

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REFERENCES

Aber, J. D. (1992) Nitrogen cycling and nitrogen saturation in temperate forest ecosystems. *Trends in Ecology and Evolution*, 7, 220–223.

Aber, J. D., McDowell, W. H., Nadelhoffer, K. J., Magill, A. H., Berntson, G., Kamekea, M., McNulty, S. G., Currie, W., Rustad, L. & Fernandez, I. (1998) Nitrogen saturation in temperate forest ecosystems: hypotheses revisited. *BioScience*, **48**, 921–934.

Aber, J. D. & Driscoll, C. T. (1997) Effects of land use, climate variation and N deposition on N cycling and C storage in northern hardwood forests. *Global Biogeochemical Cycles*, **11**, 639–648.

Berlik, M. (1999) *The illusion of natural resource preservation: an environmental argument for the local production of wood in Massachusetts*. Thesis, Harvard College. Cambridge.

Birks, H. H., Birks, H. J. B. & Kaland, P. E. (eds) (1988) *The cultural landscape—past, present and future*. Cambridge University Press, Cambridge.

Bragdon, K. J. (1996) *Native people of southern New England, 1500–1650*. University of Oklahoma Press, Norman, Oklahoma.

Bush, M. B. & Colinvaux, P. A. (1994) Tropical forest disturbance: paleoecological records from Darien, Panama. *Ecology*, **75**, 1761–1768.

Campbell, I. D. & McAndrews, J. H. (1993) Forest disequilibrium caused by rapid Little Ice Age cooling. *Nature*, **366**, 336–338.

Clark, J. S. (1988) Effect of climate change on fire regimes in northwestern Minnesota. *Nature*, **334**, 223–235.

Davis, M. B. & Botkin, D. (1985) Sensitiviuty of cool-temperate forests and their fossil pollen record to rapid temperature change. *Quaternary Research*, **23**, 327–340.

Denevan, W. M. (1992) The Pristine Myth: The Landscape of the Americas in 1492. *Annals of the Association of American Geographers*, **82**, 369–385.

Foster, D. R. (1983) The history and pattern of fire in the boreal forest of southeastern Labrador. *Canadian Journal of Botany*, **61**, 2459–2471.

Foster, D. R. (1999) *Thoreau's country. Journey through a transformed landscape*. Harvard University Press. Cambridge, MA.

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. & 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., Fluet, M. & Boose, E. R. (1999) Landscape vegetation dynamics in response to land-use history in eastern Puerto Rico. *Ecological Applications*, **9**, 555–572.

Foster, D. R., Orwig, D. A. & McLachlan, J. S. (1996) Ecological and conservation insights from reconstructive studies of temperate old-growth forests. *Trends in Ecology and Evolution*, **11**, 419–424.

Franklin, J. F. & Halpern, C. B. (1989) *Influence of biological legacies on succession*. USDA, Forest Service, GTR INT-257, pp. 54–55.

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.

Gomez-Pompa, A. & Kaus, A. (1992) Taming the wilderness myth. *BioScience*, **42**, 271–278.

Heinselman, M. L. (1996) *The Boundary Waters Wilderness ecosystem*. University of Minnesota Press, St. Paul, MN.

Houghton, C. (1999) North American land use contribution to global carbon storage. *Science*, **266**, 1111–1118.

Irland, L. (1999) *Northeast's changing forests*. Harvard Forest and Harvard University Press. Petersham and Cambridge.

MacCleery, D. W. (1992) *American forests: a history of resiliency and recovery*. USDA Forest Service, FS-540. 59 pp.

McKibben, B. (1995) An explosion of green. *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*, in press.

Mooney, H. A., Bonnicksen, J. M., Christensen, N. L., Lotan, J. E. & Reiners, W. A. (eds) (1980) *Fire regimes and ecosystem Properties*. USFS, GTR WO-26, pp. 421–444.

Motzkin, G., Foster, D. R., Allen, A., Harrod, J. & Boone, R. D. (1998) Controlling site to evaluate history: vegetation patterns of a New England sand plain. *Ecological Monographs*, **66**, 345–365.

O'Keefe, J. F. & Foster, D. R. (1998) An ecological history of Massachusetts. *Stepping back to look forward: a history of the Massachusetts forest* (ed. by C. H. W. Foster), pp. 19–66. Harvard Forest and Harvard University Press, Petersham and Cambridge.

Vickery, P. D. & Dunwiddie, P. W. (eds) (1997) *Grasslands of Northeastern North America: ecology and conservation of native and agricultural landscapes*. Massachusetts Audubon Society. Lincoln, MA.

Wofsy, S. C., M. L. Goulden, J. W. Munger, B. C. Davbe & S. Bassow (1993) Net exchange of CO_2 in a mid-latitude forest. *Science*, **260**, 1314–1317.

Zackrisson, O. (1977) Influence of forest fires on the North Swedish boreal forest. *Oikos*, **29**, 22–32.