



Another Look from Sanderson's Farm: A Perspective on New England Environmental History and Conservation

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BRIAN DONAHUE

another look from
SANDERSON'S FARM:

A PERSPECTIVE ON NEW ENGLAND
ENVIRONMENTAL HISTORY AND CONSERVATION

ABSTRACT

Hugh Raup's "Sanderson's Farm" essay is remembered for its vivid account of New England land use history, illustrated by the famous Harvard Forest dioramas. But Raup also used that history to argue that natural resource conservation (particularly as attempted at Harvard Forest itself) had proven a failure, because it assumed economic and ecological stability that was naive and untenable. This article reexamines the history of New England farming and forests, and explores ways in which the current understanding of that history and its implications have been used at Harvard Forest to support a renewed call for wide scale land conservation.

I HAVE ALWAYS FELT a bit uneasy about Hugh Raup's classic "View from John Sanderson's Farm," published in the *Journal of Forest History* in 1966. Perhaps the most widely cited article in the history of that journal (which is now merged with this one) it was forcefully written, firmly grounded in New England history, and very persuasive. Conservation, Raup concluded, is out of touch with ecological reality and seldom pays. Was he telling us that conservation is bunk?

Raup raised his challenge after the heyday of the gospel of efficiency in resource management, but before the rise of the modern environmental movement. Safeguarding the land's long-term productivity was the conservationist's creed. Raup rejected that. He denied that the use of nature should be clouded by moral considerations, which he called emotional. Instead, Raup championed laissez-faire: Get it while you can. It is naive to try to save resources for tomorrow, said Raup. Tomorrow's demands will be different, and technologies will change to meet them, thanks to human ingenuity. Raup urged

Figure 1. Hugh Raup.



Courtesy of Harvard Forest Archives, Harvard Forest, Petersham, MA.

Hugh Raup (right, with pipe) listens as Ernest Gould (left, with pipe) talks with University of Syracuse forestry students on Petersham town common, 1965.

landowners to take advantage of current market opportunities, trusting that those who come next will do the same with whatever resources they inherit. Land and trees, he said, merely provide shifting “stage and scenery” to this unpredictable but always progressive human drama.

Hugh Raup was director of the Harvard Forest from 1946 to 1967. His acerbic take on the history of New England land use was even less charitable toward his own institution. Raup’s tenure came in the aftermath of Harvard Forest’s early twentieth-century push to promote conservation of New England’s regenerating forests for sustained timber yield—an effort he declared a “dismal failure.” Raup himself was an Arctic biologist, geographer, and field botanist. Under his guidance, Harvard Forest researchers turned away from forest management and toward study of ecology and history. To this day they devote themselves primarily not to silviculture, but to scientific investigation of the New England landscape.

Yet in spite of Raup, Harvard Forest still promotes forest conservation, and on a grand scale. The urge to conserve just will not die. Perhaps it is time to reexamine Raup’s view of New England’s environmental history, and his nettlesome challenge to conservation.

Figure 2. "Clearing of a Homestead by an Early Settler 1740 A.D."



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA.

One of the famous series of seven Fisher Museum dioramas that show the history of land use in Petersham. In general, these models have stood the test of time.

HUGH RAUP'S HISTORICAL essay had no citations, but his sources aren't far to seek. He clearly drew on Percy Bidwell, Harold Wilson, and John Black.¹ These Harvard and Yale men wrote the seminal works on the hardscrabble history of rural New England, up through the first part of the twentieth century. Theirs was a hard-headed, unsentimental economists' view: The way New Englanders used the land had been driven by large-scale market forces that farmers could scarcely comprehend, much less control. This became the classic account of the rise and fall of New England's agrarian culture and landscape, and the matching fall and rise of its forest.

But the most succinct, vivid, compelling version of that story may belong to Hugh Raup. His account was particularly moving because it evoked not just one place he knew—the Sanderson farm that became Harvard Forest—but simultaneously another: the Ohio farmland of his youth. The farmers who opened that rich country in his grandfather's day had innocently destroyed the agricultural prosperity of their counterparts back in Massachusetts. They shuttered the noble view the Sanderson family and their neighbors had painstakingly cleared, returning leagues of pastures to pines. In Raup's telling, the changing outlook from this New England hillside unfolded in neat, half-century pieces.

First came the founding of Petersham, an upland town in central Massachusetts, in 1733—already four generations into the settling of that colony

Figure 3. "Height of Agriculture 1830 A.D."



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA.

Note the improved farm house, and most of the land converted to pasture. But also note the red cedar and two tall white pines at left, fated to endow much of this landscape with their progeny.

by English farmers. The first Sanderson upon the scene, Jonathan, acquired in 1763 the core of the land that would become Harvard Forest and pioneered a farm. In Petersham, the colonial era was a time of slow development of a "self-contained economy," according to Raup. The inhabitants "lived by a subsistence agriculture. They had no external markets worthy of the name for three generations. They cleared very little land during that time, for they had no need to, nor could they afford to. ... By 1791 only about 15 per cent of the town had been cleared of forest."²

Next, from 1791 to 1850 came a "period of prosperity" in which farmland in Petersham expanded rapidly to about two-thirds of the landscape, opening bright prospects. On the Sanderson farm, which had passed from Jonathan to his son John, clearing may have reached 90 percent. John Sanderson amassed a large holding of 330 acres, grew prosperous as a farmer and tanner, and built a handsome Georgian house. He and his neighbors succeeded, according to Raup, not because of any change in the land or fresh initiative in how to use it, but in response to an external stimulus—the rise of strong demand for their produce in the mill towns of industrializing New England. Farming brought modest but real wealth in spite of the soil's poor quality, thanks to chance proximity to new markets. Raup's argument followed the main lines of Percy Bidwell's "New England agricultural revolution," though judging from the Sanderson example

Figure 4. "Farm Abandonment 1850 A.D."



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA. This is perhaps the most problematic of the dioramas. Although pines, cedars, and brush would surely have been invading many pastures, the picture of farm enterprises in utter collapse is misleading.

that revolution began some decades earlier than Bidwell thought, as historians have since confirmed.³

No matter when it began, this agricultural prosperity did not last. Abruptly, it all fell apart. Again, it was nothing that the Sandersons and their neighbors did wrong—they had farmed and built as well as their technology allowed, and presumably meant to stay. It was people like Hugh Raup's grandfather—a miller, and then a farm implement manufacturer—who had moved on to more fertile, easily worked soils in places like western Ohio, where corn sprang out of the ground without manure, and a man could plow straight to the horizon. It was investors who built the Erie Canal, and then the railroads, bringing inexpensive midwestern foodstuffs to the East Coast. Once this national network of production was in place, the New England farm economy collapsed "rather suddenly and on a large scale over wide expanses of the landscape. Agricultural use of the land was simply abandoned as the Sandersons and others like them sought prosperity elsewhere. Probably at least half the open land, and perhaps more, went out of farming within 20 years after 1850."⁴ Here, Raup echoed Wilson's *Hill Country of Northern New England* along with Black's *Rural Economy of New England*, right down to the maps of the shrinking road net in the shriveling upland town.⁵ During the second half of the nineteenth century Petersham farmers moved away, or fell on hard times, or searched for something new. The Sandersons, either through foresight or good fortune, had already sold

Figure 5: “‘Old Field’ White Pine on Abandoned Land 1910 A.D.”



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA.

Here the pine that sprang up on the old farm has been felled, and lumber can be seen issuing from a portable sawmill at the lower left. A few hardwoods have been left standing, and many more would sprout from stumps faster than pines could re-seed and grow—giving rise to a stand dominated by black birch, red maple, and red oak.

the farm back in 1845, extricated their capital, and started a bank.

The next era in Hugh Raup’s chronology was the pine box-board boom, lasting from the turn of the century until 1940, at best. Abandoned farmland had quickly seeded to white pine, which is supremely well adapted to colonize old pastures. As this pine matured, its owners discovered it could be profitably converted into containers to ship goods throughout the nation. Again, none of this—and here is the lynchpin of Raup’s argument—was by design, or by good long-term management. The pine just happened to be there because of the earlier collapse of farming, the market just happened to be there because no one had invented cardboard yet. But they had invented the portable sawmill, and landowners responded with alacrity to another unforeseen economic opportunity. And so Petersham’s pines were swiftly cut and milled, and some of them made their way to Ohio in the form of pine buckets packed with salt mackerel, which young Hugh brought home from the store for his mother. He didn’t much care for mackerel, himself.

That bucket gives Raup’s story its special flavor. Just as his grandfather’s implements had spelled doom for Sanderson’s farm back in Massachusetts, now the boy was holding the pine that followed—cut (figuratively, at least) from the very place where he would one day work for himself. For at that moment, in

1907, as the portable mills were proliferating, Harvard Forest was born. These pioneering conservationists were led by Richard Fisher, an early student of Gifford Pinchot. They saw the pines of Petersham as more than a happenstance of history. They saw the forest as an imperiled resource to be conserved by careful management. The pasture pines were being harvested at the climax of the great cut-over of the primary forests of the eastern half of the United States, half a century of concerted devastation. The boom had swept first across the North Woods from Maine to Minnesota, picking out the towering old-growth pines to build cities like New York and Boston. Now the lumber barons were clear-felling the remainder of the same forests, taking spruce for pulp and hemlock for tanbark.

With the advent of logging railroads they had moved on to strip the longleaf pines from the South, and the grand oaks, maples, chestnuts, and tulip poplars up and down the rugged Appalachian mountain chain. Everywhere, in the wake of unscrupulous logging, came scourging fires. With this feverish consumption of natural capital showing no sign of abating, and nothing left standing but the West Coast, the nation seemed headed for a timber famine. As the Harvard foresters looked around at the knotty second-growth pines being cut in Petersham, and the younger trees springing up on more recently abandoned farm land, they set about learning how to provide for the future by managing the rebounding New England forest for sustained yield.

They were wrong, said Hugh Raup. Their fundamental mistake was that while they were trying to manage trees on a sixty-year planning horizon (which proved difficult enough in itself), they did not consider the "human element." They did not understand that "the human mind produces changes in uses of wood several times faster than trees can grow." By the middle of the twentieth century sawn-wood packaging had been replaced by cardboard and plastic, and the world had entered a long era of timber glut. Just as the New England agrarian landscape didn't provide the permanence that the nineteenth-century farmers who laboriously cleared it had expected, the forests that recovered those pastures proved not to have the lasting value assumed by twentieth-century foresters. In fact, by the second half of the twentieth century, the land in places like Petersham possessed little productive value of any kind, but was instead coming to be appreciated mainly for its aesthetic value as a nice place to live—mere stage and scenery. Indeed, said Raup, the guiding assumption of the whole conservation movement, that "the land and its productivity must be preserved at all costs," was "in serious conflict with reality."⁶

Conservation, said Raup, "has been plagued by stresses originating from deep cleavages between theory and reality, the former often clouded by emotions." Conservation theory was muddled by "moral issues, whether they belong there or not."⁷ By framing the issue this way Raup was apparently (again, he cited no one) invoking Aldo Leopold's land ethic, and firmly repudiating it. Leopold's plea was precisely that human society should extend moral consideration to the entire biotic community. Leopold, too, had spoken of a deep

“cleavage” in American society: between those who saw land as something from which to extract commodities as cheaply as possible and those with a budding “ecological conscience” who saw land as a community within which human beings were “plain members and citizens” with not just privileges but responsibilities.⁸

Surveying the conservation movement itself, Leopold placed most foresters on the economic side of the divide, “content to grow trees like cabbages” instead of managing natural forests for broader biotic values. But for Hugh Raup, the cleavage was between ecological theory and the real world. Conservation theorists like Leopold accused humans of sinning against nature in moral terms that made no sense to farmers like John Sanderson, who were just trying to produce what people needed to live. Even Leopold’s mercenary production foresters were too idealistic for Raup, because their long-term plans assumed both economic and ecological stability that didn’t exist. The John Sandersons of the world had no practical way of implementing such plans, without going broke.

Raup frequently delivered his view from Sanderson’s farm as a public lecture. Addressing a general audience, he concentrated on the economic flaws of conservation. He developed that in a parallel essay called “Some Problems in Ecological Theory and their Relation to Conservation,” published in the *Journal of Ecology* in 1964. Among ecologists, Raup was a mid-century pioneer of the idea that North American vegetation had never enjoyed the predictable march of succession to a stable climax state theorized by the likes of Henry Cowles, Frederick Clements, and Lucy Braun, but had always been marked by disturbance.⁹ The forests of New England were open systems heading for uncertain futures. Yet conservationist thought had been pervaded by the false ideal that forests and grasslands were closed, self-replicating systems, slowly returning to normal after the unusually harsh disturbances brought upon them by the invasion of European farmers and lumbermen. That idea was wrong too: Disturbance and change were normal. The problem with the Harvard foresters was not that they tried to grow trees like truck crops, without listening to their biotic conscience. It was that they had been misled by half a century of fuzzy ecological thinking, and were trying to induce sustained yield from managed versions of stable ecosystems that had never been there in the first place.

Conservation had been dominated from the start by a moral ideal of economic and ecological stability that Raup believed had no basis in fact. Conservationists like Leopold held that human society should strive to achieve harmony with nature, and some degree of permanence (or at least decent long-term planning) in our relation to the land, by imposing ethical restraints on economic behavior. Raup responded that rather than planning for a future that was unknowable, we would be better off meeting immediate economic demands—the history of New England proved that, he said. Human innovation makes long-term planning impossible: If you have valuable trees, cut them now. Tomorrow, they may be worth nothing. Luckily, the land is capable of recovering

from such treatment—the New England forest proved that also. It had been preconditioned by its long history of adapting to natural disasters to be cut hard and bounce back.¹⁰

Hugh Raup was surely right about many things. The half century since he wrote has proven as unpredictable as he predicted. The value of forest products in Massachusetts has gone up and down, with oak often unexpectedly topping pine, and with an unexpected firewood boomlet in the 1970s. But in general the market for wood has been soft, making sustainable forestry (as we now call it) as difficult to practice as Raup said it would be. The land has gained much higher market value for housing development, and that high price has sometimes been met by a new kind of conservation that reflects new social values. Meanwhile, among scientists Raup's position that ecosystems are frequently disturbed, open systems as much a product of their unique histories as of pre-determined, self-replicating internal dynamics has gone mainstream. Many ecologists now caution that trying to restore forests to their pre-European condition is a chimera. Harvard Forest researchers have published a great deal of work in support of Raup's position that the New England forest will never develop back toward what it once was, but only forward along a new trajectory influenced by its history of disturbance and by the unknown impact of changes to come.¹¹

And yet, the modern community of scientists at Harvard Forest has drawn a very different lesson from that history of landscape change, and has advanced a conservation initiative as ambitious as any its founders a century ago could have imagined: *Wildlands and Woodlands*, a call for the stewardship of fully one half of the state of Massachusetts in permanently protected forest. In this proposal prominent roles are granted both to large reserves that closely resemble pre-European conditions, and to sustainable forestry.¹² This is a long way from Hugh Raup, even though the past half century has played out much as he foretold. It sounds positively Leopoldian. What changed? Does New England environmental history allow for a different interpretation—a new view from Sanderson's farm—that can support these conservation ideals?

IN RAUP'S HISTORY of New England, both human culture and the land in little Petersham responded reflexively to a larger driving force: the market. The market changed repeatedly because of technological progress in people's ability to extract and transport natural resources throughout an expanding industrial economy. In the colonial era there was little outside demand for produce and therefore little farm development, but in the first half of the nineteenth century there were strong markets and therefore rapid clearing. When the farm market collapsed, the forest quickly returned; when a market for pine appeared, it was quickly cut; when that market in turn collapsed it became impossible to sustain long-term forestry, in spite of the best efforts of conservationists. The rise of the automobile by the mid-twentieth century foretold a new market for land in Petersham, for residential development.

Only a fool would deny the power of these market forces. But one might ask,

first, whether people in Petersham had so little ability to adapt their relation with the land to changing demands; and second, whether the response of the land itself was as simple as Raup proposed. Beyond that, of course, one might ask whether the overarching economic and technological changes that Raup described are as eternally progressive or sustainable as he seemed to assume. Maybe Raup was right about the power of the market, but wrong about the corresponding need for conservation. A New England story retold along other lines might again make conservation seem to be a worthy goal. It surely won't make it seem easy.

Raup's sharp contrast between a stagnant Petersham in the colonial era and a vigorously expanding commercial Petersham in the nineteenth century captured an important transformation in New England, but in a way that exaggerated and distorted it. Eighteenth-century Petersham was not so isolated and lethargic as Raup made it seem—things were moving right along. Raup's figure of only 15 percent of the town cleared of forest in 1791 was impossibly low, as he knew.¹³ In fact, Petersham was something like 12 percent cleared in 1771, and already about 25 percent cleared by 1791, after only two generations, not three. Population was growing and farm settlement was expanding fast, repeating a pattern of town making long familiar in Massachusetts. Had agricultural development continued to replicate mother towns such as Concord and Lancaster, Petersham (along with all the similar towns surrounding it) would have been full of farms after three or four generations. Half to two-thirds of the landscape would have been cleared by the mid-nineteenth century, increased outside stimulation or not. These hill towns might have wound up with somewhat more woodland and pasture, and somewhat fewer farmsteads than earlier lowland towns, but not a lot. Raup may have been correct in calling Petersham's economy at this early stage largely "self-contained," although no doubt it had connections with older towns and the coast, principally in pasturing beef cattle. But he was wrong in suggesting that little land was being cleared. New England yeomen and goodwives had proven themselves capable of converting forest to a working agrarian landscape by sheer demographic force, long before they were fully engaged in a larger market economy.¹⁴

But something did change in Petersham during the first half of the nineteenth century, as Raup suggested. Population growth in the town slowed, reaching a peak during the century's second quarter. At the same time cleared land jumped to 61 percent by 1831 and kept on climbing for another half century. New farm creation stumbled, while clearing went on leaping ahead. The great majority of this farmland—about two-thirds of it—was pasture, and most of the rest was hay. The number of acres in tillage scarcely grew at all and never rose above 4 percent of all the land in town. New England was in the midst of the rapid expansion of a commercial grazing economy. Much of the clearing was for wool, but Petersham was not really part of the Merino sheep boom that stripped the forests of hill towns farther west and north with lightning speed. Petersham pastured hundreds of sheep, for example, while in the Berkshire hills

across the Connecticut River valley the town of Ashfield pastured thousands. In Petersham farmers raised beef cattle, followed by butter and cheese. It was a cow economy.

Hugh Raup was correct that stronger markets and a more commercial approach to farming accelerated agricultural expansion in Petersham and brought new prosperity to some, like John Sanderson. But, again, there are caveats to Raup's simple argument. First, market opportunities did not strike Petersham farmers like a bolt from the blue, sparking those who were still breathing into belated activity. The market revolution sprang as much from within rural society as from outside it, and did not follow industrialization so much as drive it. After all, the entrepreneurs setting up shop along every brook in New England were often the brothers and cousins of these farmers, if not the farmers themselves. John Sanderson was not just a farmer—he was a real estate speculator, a cattle drover, and a successful tanner. The vertical integration among those enterprises isn't hard to imagine. Second, not everyone prospered in the new commercial environment—farmers were much more likely to go bankrupt than they had been in the past. John Sanderson acquired the bulk of his 330 acres from neighbors who had downsized, or left—his expansion by definition accounted for two new 100-acre farms that were never created, or existing farms that failed. Failure did not have to await western competition, but was woven into the new economy.¹⁵ Finally, there was an underlying ecological problem: New England farmers never figured out how to keep all those rapidly cleared pastures productive. They were skinning the land, and they knew it.

This is crucial to understanding what happened next: the centerpiece of Raup's anti-planning parable, the fabled collapse of New England farming between 1850 and 1900 at the hands of western competition. It just didn't happen like that. Half of the farmland in Petersham was *not* "simply abandoned" to forest in the twenty years after 1850, as Raup asserted. In fact, the amount of cleared farmland there kept rising until it peaked at 70 percent in 1885, and *then* went into steep decline. That consumes most of Raup's supposed period of collapse, but the issue is not just about three or four decades difference in timing. The real point is what was going on within those pastures. For decades, Massachusetts farmers had been aware that they had a problem with their upland pastures and hayfields, the basis of their grazing economy. In the first place, continuous grazing and haying with no effective return of manure (which was consigned to tilled land) along with the weak performance of clover in those acid granite soils led to a steady drain of nutrients and hence declining yields.

Second, continuous grazing encouraged the spread of pasture weeds such as hardhack, juniper, red cedar, and (notably) white pine—whatever the cows wouldn't eat. Controlling these native woody invaders of an alien sward took hard labor with the brush whack, in the face of diminishing returns. Not just George Perkins Marsh and Henry David Thoreau worried about excessive clearing and ecological degradation in New England—farmers themselves were

wrestling with this problem throughout the middle decades of the nineteenth century. In the end, they decided that the only sensible thing to do was to let most of their spent pastures go, and stop clearing new ones. Pastures were not filling up with pines because farms had been abandoned. Even on prosperous farms, pastures were abandoned because they were filling up with pines.¹⁶

This startling transformation in the landscape was made possible by the arrival of cheap feed grains from Raup's Ohio, and points west. It was a godsend to New England farmers. The idea that Midwestern grain could have caused the collapse of New England farming is an odd one, considering how little of New England farmland was committed to tillage to begin with. Cheap grain did cause a decline in tilled land—in Petersham between 1850 and 1900 it plummeted from 4 percent of the landscape to 2 percent, for example. But what cheap grain enabled was a surge in dairy production. Cows were fed a richer diet, greatly increasing their year-round yield of milk. They also increased their yield of fertilizer, which farmers devoted to their best hay and silage, most of which was run back through the cows. These changes in stock feeding and nutrient flow gave rise to statistical paradoxes: Between 1880 and 1910, the acreage in agricultural production in Massachusetts fell in half—the vast majority of that loss was pasture. During the same thirty years, the value of agricultural production doubled. New England farming was undergoing dramatic change, but it was hardly collapsing.¹⁷

The peak of Massachusetts agricultural production was not in fact around the time of the Civil War, as standard accounts like Raup's would have it, but about 1910. The leading sector in this late nineteenth-century New England farm boom, if I may call it that, was dairy; followed by advances in production of hay, vegetables and fruits, and poultry. New England farmers purchased cheap grain from Raup's Ohio, which they knew very well came from soil mining with which they could not compete, and turned it into what they called "concentrated products" for nearby urban markets. The number of farms in Massachusetts during the second half of the nineteenth century stayed basically flat—by and large, farmers adapted to the new commercial environment and maintained their way of life. In the process they brought themselves some ecological relief as well, as forest rebounded to about 50 percent of the landscape.

I don't want to paint too rosy a picture of this difficult passage. Rural people made these changes under great social, economic, and ecological stress, searching for their place in an emerging urban, consumer society, and many of them did lose out. Population in hill towns like Petersham fell in half between 1860 and 1910, as much of the old village economy that had accompanied farming was replaced by mass-produced industrial goods, and by services rendered in larger towns.¹⁸ Remote from a rail connection, Petersham's farm production only rose to a gentle plateau between 1874 and 1905, whereas across the Connecticut valley Ashfield rode a dairy boom to a tripling of production over the same period. It may indeed have appeared to the residents of Petersham as if the burgeoning pines were eating their town. But in many cases, even the

Figure 6. "Third Thinning, White Pine and Hardwoods."



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA.

This diorama is one in a longer series showing careful management of re-grown forest stands, aimed at producing high-quality timber. Lower-value trees have been removed over several decades, leaving straight, vigorous specimens of more valuable species.

release of those pines may have been a calculated cropping decision: Farmers simply recognized that with grain readily available to feed their stock, pines were likely to make a better return than patchy grass—and so it proved, half a century later.¹⁹ These farmers were looking ahead in much the same way as their fathers and grandfathers who had cleared those pastures, and in much the same way as the foresters who would come along later to try to manage the pine. It just happens that the generation that traded grass for pines guessed right, over a time-scale that benefited their own children. Raup was wrong to separate the very human impulse to plan for the future from rural culture and ascribe it solely to muddle-headed, impractical conservationists. It might be more useful to look into the particular circumstances of why long-term stewardship of the land sometimes succeeds and sometimes fails, rather than writing it off as inevitably doomed because of the dynamism of the American economy.

Into this turn-of-the-century Petersham, thick with pines, came the Harvard Foresters—determined to manage the forest for the long haul. No doubt, by their own terms, they did fail. It seems worth noticing, though, that they failed not in the same way as the farmers before them, but at the same time as the farmers around them. This suggests that farming and forestry in Petersham may have been not serial but parallel ongoing enterprises that eventually failed together, for distinctly twentieth-century reasons. What Richard Fisher and his fellow

Figure 7. Dr. Richard Fisher (circa 1908).



Courtesy of Harvard Forest Archives, Harvard Forest, Petersham, MA.

Dr. Richard Fisher was director of the Harvard Forest from its inception in 1907 until his death in 1934. A Harvard English major, Fisher went to work for Gifford Pinchot and the Division of Forestry in 1898 before graduating with the first class of the new Yale School of Forestry.

conservationists set out to accomplish, and where they went wrong, is all laid out quite nicely at Harvard Forest itself, in the famous models that line the walls of the Fisher Museum.

The dioramas were constructed during the 1930s, and most of them were designed by Fisher before his death in 1934. The first half dozen dioramas are world famous, and have been endlessly reproduced. They depict the death and re-birth of the Petersham forest, the rise and fall of New England farming. These models were at the heart of Raup's article, and served to illustrate it. But around the rest of the hall are more models—three-quarters of the exhibit that few but museum visitors ever see. These dioramas display the vision of conservation that flowed from an understanding of that history. The hope was that visitors would take the lessons home and apply them to their own farms and woodlands.²⁰

Those lessons were hard won. At first, the foresters had aimed to harvest mature white pine at a slow rate that could be renewed indefinitely. This would provide steady income, and underwrite the regeneration and management of young pine stands to increase their ultimate value. Good forestry would pay as it went, as Pinchot had insisted it should. Only gradually did Fisher and his

colleagues learn that the pine forest they had inherited was historically contingent and transient, and could not so easily be renewed. Many upland pine stands had a strong tendency to succeed to hardwoods when cut—something noticed by Henry Thoreau (and for that matter, by legions of farmers) half a century earlier. By the 1930s, the museum displayed this deepening understanding of the New England landscape. Five dioramas show the improvement of hardwood stands that often followed pine; another five the re-establishment and care of pine on sandier soils. Other models depict fire protection, control of erosion on farm land, and wildlife management—all the pillars of good conservation stewardship.

Something else had entered the foresters' consciousness by then: the value of wildness. Opposite the museum entrance is a double-sized diorama of an old-growth forest on the property, Professor Fisher himself stands deep within the scene, enjoying the view across a wild pond at sunset. Toward the end of his career Fisher sought out stands of old growth throughout New England and led a campaign to purchase the superb Pisgah tract in New Hampshire, protecting it as a reference to study for the better management of woodlands. Taken together, the dioramas depict an autumnal New England landscape of farms and forests—one that is clearly changing from what it had been, yet still attractive and diverse. There are some wild places and many more where people are actively engaged with the land. These foresters were not interested in growing pines like cabbages, but stood well over on Aldo Leopold's side of the conservation cleavage.

What went wrong? As Raup reminds us, the timber famine never came. Demand for box boards softened after 1920 as new packaging materials appeared, so the incremental harvest of pasture pines did not yield the steady annual income upon which the foresters had counted.²¹ But they were not aiming to grow box boards forever—they were managing for high-quality timber. Unfortunately, that market never emerged in the way that the foresters expected, either: Demand for timber in the United States throughout the twentieth century stayed essentially flat. New energy-intensive construction materials like concrete and steel dominated the upward urban surge of the era of oil. Lumber did play a major role in outward suburban sprawl, but demand was met by new sources—first private lands in the Pacific Northwest, then National Forests, then Canada and beyond—with many environmentally problematic consequences. Demand for pulp did increase dramatically, but, again, sources have so far proven more than adequate. Hugh Raup was correct: The twentieth century turned out to be an era not of wood scarcity, but of embarrassing surplus. This, and rising land values, has made it next to impossible to profit from careful, long-term forestry on small parcels in southern New England.²²

Even as Harvard Forest was slowly learning these painful economic truths, nature itself turned against them. Upstairs at the Fisher Museum is a smaller room, which not even many visitors chance upon. Tucked away in one corner is an exhibit on the pivotal event in the history of Harvard Forest. On September

Figure 8. A Model of Richard Fisher in an Old-growth Stand.



Photograph by John Green, courtesy of Harvard Forest Dioramas, Fisher Museum, Harvard Forest, Petersham, MA.

This stand, the Tom Swamp tract, was severely damaged by the Hurricane of 1938 a few years after the diorama was completed, but was left without added human disturbance to study its process of recovery.

21, 1938, an unnamed category 3 hurricane came across Long Island and rampaged north through central New England. The storm obliterated some 70 percent of Harvard Forest's white pine inventory, along with large chunks of the surrounding forest from the Connecticut River valley east to Boston. This event punctuated the foresters' dream of equilibrium, shredding their sustained-yield management plan and leaving it a "sorry spectacle," to quote Hugh Raup again.²³ The storm delivered the final blow to Harvard Forest's program of active silviculture, and precipitated a more reflective era of research into ecological science and landscape history.

The Hurricane of 1938 certainly had a profound impact on Raup's thinking. Curiously, he never mentioned the storm in his Sanderson piece, but it did figure prominently in his essay on problems in ecological theory and conservation. The storm had a lasting influence on many ecologists, as it drove home the lesson of disturbance at a prominent center of twentieth-century forest research in America. But while no one today would deny the importance of disturbances in regenerating many ecosystems, we should not get the idea that every century or so all forests are routinely blown flat. While this may be true along the coast, as one moves inland storms capable of toppling significant numbers of trees

Figure 9: The Tom Swamp Tract.



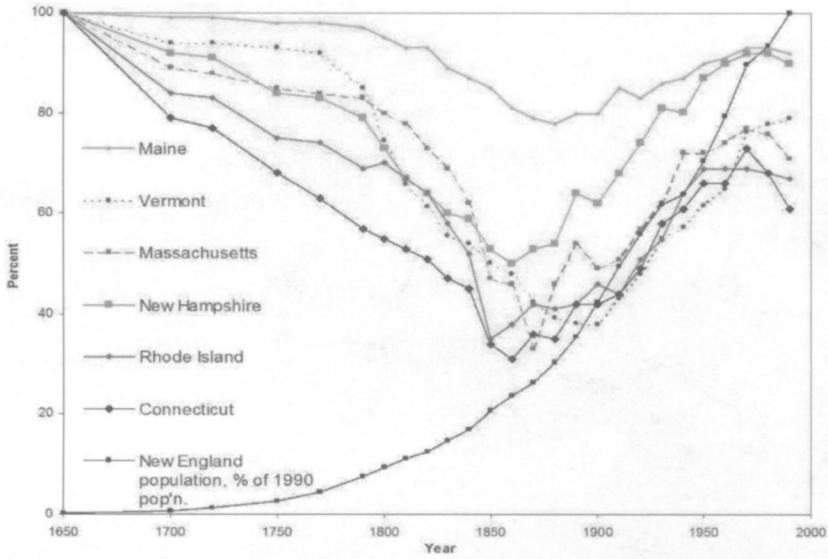
Courtesy of Harvard Forest Archives, Harvard Forest, Petersham, MA.

The sign withstood the Hurricane of 1938, but many of the large old trees in the Tom Swamp tract did not. The distinctive “pit and mound” topography left by this storm is still visible in many forests in southern New England. Although this stand was labeled “old growth,” the sign suggests that it had been high-graded in the nineteenth century.

become less frequent, and their effects more spotty on the landscape. Large parts of inland New England have pollen records that reveal forest composition persisting in a steady state for many centuries at a time, even for intervals of a thousand years, before a disturbance initiates change.²⁴ It is also important to remember that the extraordinary devastation wrought by the 1938 hurricane was in part a cultural event: Because of pasture abandonment, the landscape was more full than it had been for perhaps eight thousand years of vulnerable white pine, just waiting to be blown over like that.²⁵

Foresters have drawn contrasting lessons from hurricanes. While some in the forest industry use the existence of these storms to justify frequent clear-cutting, others take a more moderate stance.²⁶ A measured rate of harvest that diversifies forest age classes and composition can closely mimic the patchiness

Figure 10. Forest Cover and Population Trends in New England.



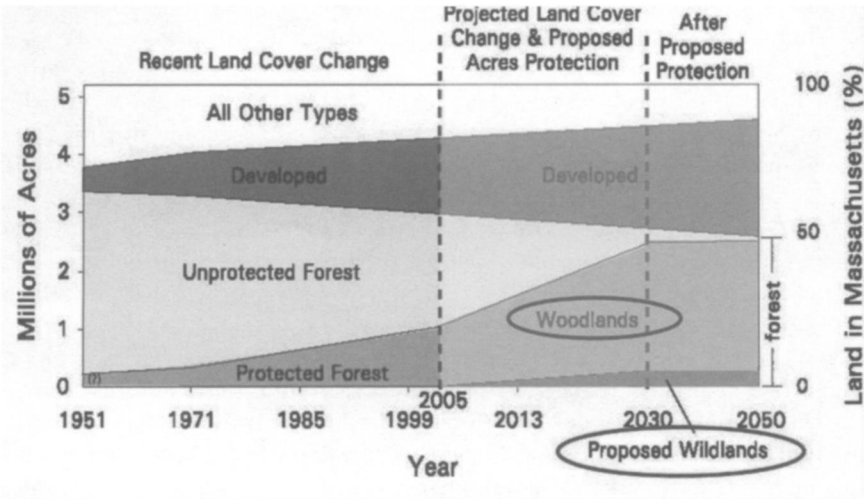
From David Foster et al., *Wildlands and Woodlands: A Vision for the Forests of Massachusetts* (Petersham, MA: Harvard Forest, 2005).

This graph from the 2005 Harvard Forest “Wildlands and Woodlands” report shows New England population steadily increasing, while forest cover in all six states fell to a low point in the second half of the nineteenth century. After recovering for about a century, most states have entered a fresh stage of forest decline in recent decades.

of a natural landscape, while still allowing most stands to grow to maturity. That, in essence, is what the Harvard Forest management program might have eventually achieved—unfortunately they were caught early in the game by an extreme event. Much the same approach has been employed since the 1930s by the Metropolitan District Commission on fifty thousand acres surrounding nearby Quabbin Reservoir, to guard against the possibility of wholesale destruction of a mature forest. Ironically, this was inspired largely by the same catastrophe that caused Harvard Forest to give up.²⁷ All in all, the early conservationists at Harvard Forest had noble aims, and were not as naïve about change as Raup made them appear—but their timing was bad.

While the Harvard foresters were failing to show that sustainable forestry was economically viable, farming, too, was declining all around them—and for many of the same reasons. New England farmers had mostly been able to adapt to the changing market conditions of the nineteenth century; not so to those of the twentieth. There was no sudden collapse, but a long descent over roads paved for the automobile. Dairy farming, which had become the keeper of the pastoral landscape in places like Petersham, succumbed farm by farm to competition from larger herds on cheaper land elsewhere—the amount of milk produced in Massachusetts in 1900 has never been surpassed. Production of fruits and

Figure 11. Wildlands and Woodlands Report.



From David Foster et al., *Wildlands and Woodlands: A Vision for the Forests of Massachusetts* (Petersham, MA: Harvard Forest, 2005).

A quickened pace of land protection will be needed to protect half the forest in Massachusetts over the next several decades. The “Wildlands and Woodlands” proposal calls for 10 percent of the protected forest to be set aside in large wild reserves, while the balance is managed in diverse ways for a wide range of social and ecological benefits.

vegetables followed the same generally downward path after peaking in the early twentieth century. Farmers far away began to grow perishable foods on an unprecedented scale, refrigerate them, and ship them with great speed—a transformation made possible by abundant oil. The conversion from horses to automobiles and trucks also wiped out most of the regional hay market. New England farming was done in not by Raup’s canals, railroads, virgin prairie soil, and mechanical reapers, but by fertilizers, pesticides, massive irrigation, trucks, and airplanes—by industrial agriculture. Today, farmland covers just 7 percent of the land in Massachusetts, and we are working hard to protect what is left. But what we mainly have to work with is the returned forest.

From about 50 percent at the turn of the century, forest cover increased until it reached 70 percent of Massachusetts in 1970. The story is about the same in other New England states. In many hill towns such as Petersham, forest cover is increasing still, and has reached nearly 90 percent. The forest is growing up as well as out, because harvesting has slowed to infrequent, widely scattered high grade trees. Timber volume in Massachusetts has increased by a factor of ten since 1950, as the forest matures almost unmolested. But the trees aren’t gaining ground anymore. Since 1970 forest cover has declined to just a bit over 60 percent, thanks to suburban sprawl. During the twentieth century, but particularly since 1950, the sprawl frontier has surged out from Boston in just the way the agricultural frontier expanded during the colonial era. The

reforested landscape has acquired a new value for residential development, as Hugh Raup foresaw.²⁸

This onslaught of “hard deforestation” by conversion to lawns and parking lots has given birth to the modern forest conservation movement. Conservation since Raup’s time has been driven not by the old ideal of sustained wood yield, but by a simple desire to protect the forest itself as an essential part of the landscape. By this measure, twentieth-century conservation in Massachusetts hasn’t done so badly. Between the acquisition of state forests and water supply protection lands in the first half of the century, and the expansion of municipal conservation lands and easements held by land trusts and the state in the second half of the century, about 1 million acres (or 20 percent) of Massachusetts is protected from development. The vast majority of this protected land is forest. The *Wildlands and Woodlands* report, published by Harvard Forest in 2005, suggests that an achievable goal is to protect 2.5 million acres of forest, or one half of the state. If current rates of forest conversion were to continue unabated, two to three decades remain in which to achieve that goal. This puts a different spin on the lesson of history than Hugh Raup did. Raup saw the forest’s recovery as a temporary artifact of shifting market forces that ought to be allowed to go on running their course and dictating land use. We argue that history has afforded us a rare second chance to get it right, and that the public ought to intervene in the private land market on behalf of a set of larger social and ecological values.

As its title implies, the *Wildlands and Woodlands* proposal doesn’t choose between the two traditional, often warring strains of conservation, wilderness preservation and efficient resource management. Instead, it argues that by expanding the scale of forest protection, both wild lands and woodlands can be accommodated and work together. They are joined in support of a broader set of benefits conferred by the forest as a whole: biological diversity, water protection, carbon sequestration, and a nice place to live. Biodiversity is desirable because species have an intrinsic right to exist, make for a richer world, and provide Leopold’s “cogs and wheels” that keep ecosystems functioning under changing conditions. The report argues that biodiversity can never be adequately protected within wild reserves alone, but only across a diverse, changing, continuous forest. Similarly, both unmanaged and well-managed forests can do a fine job of supplying clean water for healthy aquatic ecosystems and for human consumption, another social and ecological benefit long touted by conservationists. Carbon sequestration to help moderate the rapid buildup of greenhouse gasses and resulting climate change can be accomplished by either working woodlands or untouched old growth, and may soon provide a major new source of funds for forest protection on a large scale. An adequately forested landscape that combines wild places and places of cultural engagement with nature provides a “natural infrastructure” that enables and enhances all other human activity, and ought to be protected on that account, across at least half of the landscape.

Wildness and sustainable wood production are combined in the proposal, as means to larger goals and as ends in themselves. The report makes historical arguments that try to avoid fundamentalist positions. We call for one-tenth of the protected forest, or 250,000 acres, to be devoted to a set of large wild reserves (5,000 to 50,000 acres in size) across Massachusetts.²⁹ These reserves would be left virtually untouched to gradually develop old-growth structure, and would be large enough to accommodate the natural disturbances that periodically destroy such old growth. A similar ratio applied to the 26 million acre Northern Forest that stretches from the Adirondacks to Maine could generate wild reserves an order of magnitude larger, or hundreds of thousands of acres in size. An absolutist reading of ecological history might conclude that “wild” conditions are a Romantic cultural construction of nature that never really existed, and so there is no point in having any, and no practical way of recreating them anyhow. But paleoecological evidence in fact suggests that in spite of natural disturbances and an important degree of human influence, large parts of the upland New England forest actually *were* in old growth condition that changed little in composition and structure for long periods of time. New England may have been not strictly “wilderness” but instead deeply inhabited country for many thousands of years, but what was being inhabited, away from the coast and river valleys, was equally deep forest.³⁰ Allowing representative tracts to grow untouched will surely not return them to unchanging climax communities identical in composition to their prelapsarian state. It will provide new examples of a kind of forest dynamics and structure that was once commonplace across the landscape, and that cannot easily be duplicated in managed woodlands: very large old trees, small gaps, large standing deadwood, and much coarse woody debris. Such reserves will not only have special ecological value, they will provide useful comparisons to managed forests, and will have great appeal as places of respite and spiritual connection to the many Romantics among us.

An opposite absolutist reading might be that if seldom disturbed old growth forest was once the norm, we ought to return most of our forest to that condition. Should we? The deeper paleoecological record indicates that forest species have been capable of dealing with many different climate and disturbance patterns, and persisting in a wide variety of ecosystem assemblages, throughout the unruly Quaternary era. This means there is nothing that precludes maintaining the bulk of the forest in a similar range of managed ecosystems, if we have good reasons to do that. And we do, because there are millions and millions of us. The ecosystem management toolbox includes hunting, doing battle with invasive species, and prescribed burning—tools to be employed in different ways in different places. The biggest hammer in the box is sustainable harvesting of wood products, which can be used to diversify forest composition and to maintain a percentage of brushy, regenerating habitat. Considerable evidence suggests that the great majority of forest species will thrive perfectly well under such a diverse management regime.³¹ Sustainable forestry can serve as an

economic driver for a much broader program of forest stewardship. It doesn't need to produce a competitive return on the full market value of the land to justify itself—the early Harvard foresters set that bar too high. The forest needs to be protected by society at large for the value it provides simply by existing. Forestry just needs to bring a modest return, or at least cover its costs.

Perhaps, one day, it will bring a modest return—it depends on whose reading of history proves more correct. Hugh Raup saw the global expansion of timber supply, and the rise of new technologies, as part of the march of economic progress that makes careful management of local natural resources obsolete. That is the cornucopian view. But many conservationists and environmental historians see the ascendancy of the same economic forces as contingent on heedless disregard for environmental consequences and on extraordinarily cheap oil, and thoroughly unsustainable. If the price of energy rises substantially and stays high for more than a few years; if a carbon market to combat rapid climate change emerges, then it may again make eminent economic sense to increase our reliance on local resources. Another Harvard Forest study entitled “The Illusion of Preservation” calculates that Massachusetts now produces a mere 2 percent of the wood products it consumes—we tend to preserve our forests in a wishfully pristine state while importing our pulp and lumber from places we do not often see, or have to live with. Given conservation, recycling, and an increase in sustainable harvesting, the Massachusetts rate could be improved to 25 percent to 50 percent.³² It remains to be seen whether Raup was correct that we are in the grip of an irresistible tide of economic and technological progress that will dictate wholesale landscape change in every generation, willy-nilly, or whether the past century only marks a temporary evasion of an inescapable requirement to forge a more stable, deliberate relationship with the land we inhabit.

In rural Massachusetts, both nineteenth-century farmers and twentieth-century foresters strove in part for such a lasting relationship, and struggled with economic reality to achieve it. Both were concerned about the health of the land, and both tried to make some provision for the future of human families and communities upon the land. Both made mistakes. The farmers cleared too much forest, and were unable to maintain the productivity of their pastures. They fell back to a more balanced ecological position, but only with the aid of cheap grain being mined from soils in the Midwest—a harbinger of the economic forces that would crush them in the twentieth century. The foresters were false prophets of a twentieth-century timber crisis, and were too narrowly devoted to an inflexible model of sustained yield. What they undertook proved an economic failure. But is the inevitable lesson to be taken from New England's history simply to bow to *laissez-faire* economics, as Raup would have it? The current generation at Harvard Forest has not drawn that conclusion, but has returned to the vision of their founders. The conservation plan they have proposed looks an awful lot like what you see in the dioramas in their own museum. What they have added, I think, is a stronger Leopoldian conviction

that conservation cannot succeed if it is subjected to short-term economic tests. People are not simply creatures of the market. Conservation must rest on the faith, cloudy and emotional though it may be, that some moral brake on economic drives is necessary to ensure greater ecological and social well-being.

This is not to ignore the healthy skepticism of Hugh Raup. In the end, I cannot tell whether Raup really believed that conservation is bunk. He seemed to stop just short of that conclusion, but to remain uncertain about how conservation could be reconfigured to accommodate the reality of repeated, abrupt changes. He presented a problem that he did not solve, and by not solving it he left the impression that perhaps he thought it insoluble. It is best to plan around open, uncertain systems, and to be flexible, he advised. Strive for efficiency in resource management only in the short run, while retaining a wide variety of options for the future.³³ By this Raup seems to have been urging landowners to cash in on new opportunities, avoid getting capital tied up planning to do the same thing forever, and wait to see what the market might call for next that the land might be ready to provide. If technological innovation makes distilling ethanol from cellulose profitable, for example, should we liquidate our returned forest and see what grows in its place?

There may be other, more restrained ways to be economically nimble. Flexibility could also mean conserving the landscape in a broadly beneficial mixture of forests, farmland, and settlements, and within those boundaries responding shrewdly to shifting markets—using biofuel sales to finance timber stand improvement, to use the same example. We might guess which course John Sanderson would take, left to fend for himself in the wilderness of an untrammelled market. To engage the abilities of the Sandersons of the world, while safeguarding the long view from his farm—one that encompasses both an honest look at the past and a sincere concern for the future remains the hard challenge of conservation.

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NOTES

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1. Percy W. Bidwell, "The Agricultural Revolution in New England," *American Historical Review* 26 (1921): 683-702; Percy Wells Bidwell and John I. Falconer, *History of Agriculture in the Northern United States, 1620-1860* (New York: Peter Smith, 1941); Harold Fisher Wilson, *The Hill Country of Northern New England: Its Social and Economic History, 1790-1930* (New York: Columbia University Press, 1936); John Donald Black, *The Rural Economy of New England: A Regional Study* (Cambridge: Harvard University Press, 1950).
2. Hugh M. Raup, "The View From John Sanderson's Farm: A Perspective for the Use of Land," *Forest History* 10 (1966): 3.
3. Bidwell, "Agricultural Revolution;" Christopher Clark, *The Roots of Rural Capitalism: Western Massachusetts, 1780-1860* (Ithaca: Cornell University Press, 1990); Charles Sellers, *The Market Revolution: Jacksonian America, 1815-1846* (New York: Oxford University Press, 1991); Winifred Barr Rothenberg, *From Market-Places to a Market Economy: The Transformation of Rural Massachusetts, 1750-1850* (Chicago: University of Chicago Press, 1994).
4. Raup, "Sanderson," 6.
5. Wilson, *Hill Country*; Black, *Rural Economy*, 159-60.
6. Raup, "Sanderson," 7, 9, 11.
7. *Ibid.*, 10. Raup and Leopold did correspond, but their letters in the Harvard Forest archive contain little of substantive interest.
8. Aldo Leopold, *A Sand County Almanac with Essays on Conservation from Round River* (1949; reprint, San Francisco: Sierra Club/Ballantine, 1970), 239-40, 258-61.
9. Hugh M. Raup, "Some Problems in Ecological Theory and their Relation to Conservation," *Journal of Ecology* 52 (Supplement) (1964): 19-28. Cowles stressed dynamic succession and never claimed much for the stability of the climax, as Clements later did. Raup's real argument was with Clements.
10. Raup, "Some Problems," 26-27. In his economic argument Raup leaned heavily upon his colleague Ernest M. Gould, Jr., "Fifty Years of Management at the Harvard Forest," *Harvard Forest Bulletin* 29, 1960.
11. See, for example, David R. Foster, "Insights from Historical Geography to Ecology and Conservation: Lessons from the New England Landscape," special issue of the *Journal of Biogeography* 29 (2002); David R. Foster and John D. Aber, eds., *Forests in Time: The Environmental Consequences of 1,000 Years of Change in New England* (New Haven: Yale University Press, 2004).
12. David Foster, et al., *Wildlands and Woodlands: A Vision for the Forests of Massachusetts* (Petersham, MA: Harvard Forest, 2005). I am among the authors of this report.
13. See Hugh M. Raup and Reynold E. Carlson, "The History of Land Use in the Harvard Forest," *Harvard Forest Bulletin* 20 (1941), 25. Data on Massachusetts and Petersham land use and agricultural production in my paper are drawn from U.S. Census Population and Agricultural returns, Massachusetts state census returns, and Massachusetts tax valuation town aggregates.
14. Joseph S. Wood, *The New England Village* (Baltimore: Johns Hopkins University Press, 1997); David Jaffee, *People of the Wachusett: Greater New England in History and Memory, 1630-1860* (Ithaca: Cornell University Press, 1999); Brian Donahue, *The Great Meadow: Farmers and the Land in Colonial Concord* (New Haven: Yale University Press, 2004); Gloria L. Main, *Peoples of a Spacious Land: Families and Cultures in Colonial New England* (Cambridge: Harvard University Press, 2001); Rothenberg, *Market-Places to a Market Economy*; J. Ritchie Garrison, *Landscape and Material Life in Franklin County, Massachusetts, 1770-1860* (Knoxville: University of Tennessee Press, 2003).

15. Garrison, *Landscape and Material Life*; Clark, *Roots of Rural Capitalism*.
16. See, for example, numerous discussions in the minutes of Concord Farmers Club, Concord Free Public Library, 1865, 1866, 1875, 1883; also numerous discussions in state agricultural reports collected in the volumes *Agriculture of Massachusetts* 1849, 1853, 1859, 1864, 1865. See, also, David R. Foster, *Thoreau's Country: Journey Through a Transformed Landscape* (Cambridge: Harvard University Press, 1999). Townwide tax and census data for Petersham strongly suggest that from the early nineteenth century depleted pastures were being abandoned even as forest was being cleared to create new pastures, but more research on particular farms is needed to pin down the dynamics of these practices.
17. See Brian Donahue, "Skinning the Land: Economic Growth and the Ecology of Farming in Nineteenth-Century Massachusetts," paper presented to the American Social History Society, Chicago, 1988; Michael M. Bell, "Did New England go Downhill?" *Geographical Review* 79 (1989): 450-66; Paul Glen Munyon, *A Reassessment of New England Agriculture in the Last Thirty Years of the Nineteenth Century: New Hampshire, A Case Study* (New York: Arno Press, 1978); David J. Soll, "Milking the Landscape: Reforestation in Norfolk County, Massachusetts, 1850-1900," paper presented to the Boston Environmental History conference, Massachusetts Historical Society, 2006.
18. Hal S. Barron, *Those Who Stayed Behind: Rural Society in Nineteenth-Century New England* (New York: Cambridge University Press, 1984).
19. Soll, "Milking the Landscape."
20. David R. Foster and John F. O'Keefe, *New England Forests Through Time: Insights from the Harvard Forest Dioramas* (Petersham, MA: Harvard Forest, 2000). All the dioramas are shown here, along with an updated interpretation of their historical and conservation meanings.
21. Gould, "Fifty Years of Management."
22. Michael Williams, *Americans and their Forests: A Historical Geography* (New York: Cambridge University Press, 1989); Thomas Dionysius Clark, *The Greening of the South: The Recovery of the Land and Forest* (Lexington: University Press of Kentucky, 1984).
23. Raup, "Some Problems," 24.
24. Foster and Aber, *Forests in Time*, 54, 369.
25. *Ibid.*, 235-58.
26. See, for example, Thomas M. Bonnicksen, "Nature's Clearcuts: Lessons from the Past," in *Closer Look* (Washington, D.C.: American Forest and Paper Association, 1994), 22-28.
27. Many ecologists would argue that such an approach is not strictly necessary to protect water quality, but the Quabbin forest management program has nevertheless been successful on its own terms, and is widely regarded as a model of sustainable forestry of a fairly intensive kind. See Paul K. Barten, et al., "Managing a Watershed Protection Forest," *Journal of Forestry* 96 (1998): 8-15.
28. Foster, et al., *Wildlands and Woodlands*. The report and its detailed figures can be downloaded at <http://www.wildlandsandwoodlands.org/>.
29. This scale is appropriate and achievable in a small, fragmented region such as southern New England. The same proportions applied to heavily forested regions such as northern New England could yield reserves an order of magnitude larger.
30. David R. Foster, et al., "Oak, Chestnut and Fire: Climatic and Cultural Controls of Long-term Forest Dynamics in New England, USA," *Journal of Biogeography* 29 (2002): 1359-79.

31. David Lindenmayer and Jerry F. Franklin, *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach* (Washington, D.C.: Island Press, 2002).
32. Mary M. Berlik, et al., "The Illusion of Preservation: A Global Environmental Argument for the Local Production of Natural Resources," *Harvard Forest Paper* 26 (2002).
33. Raup, "Some Problems," 26-27.