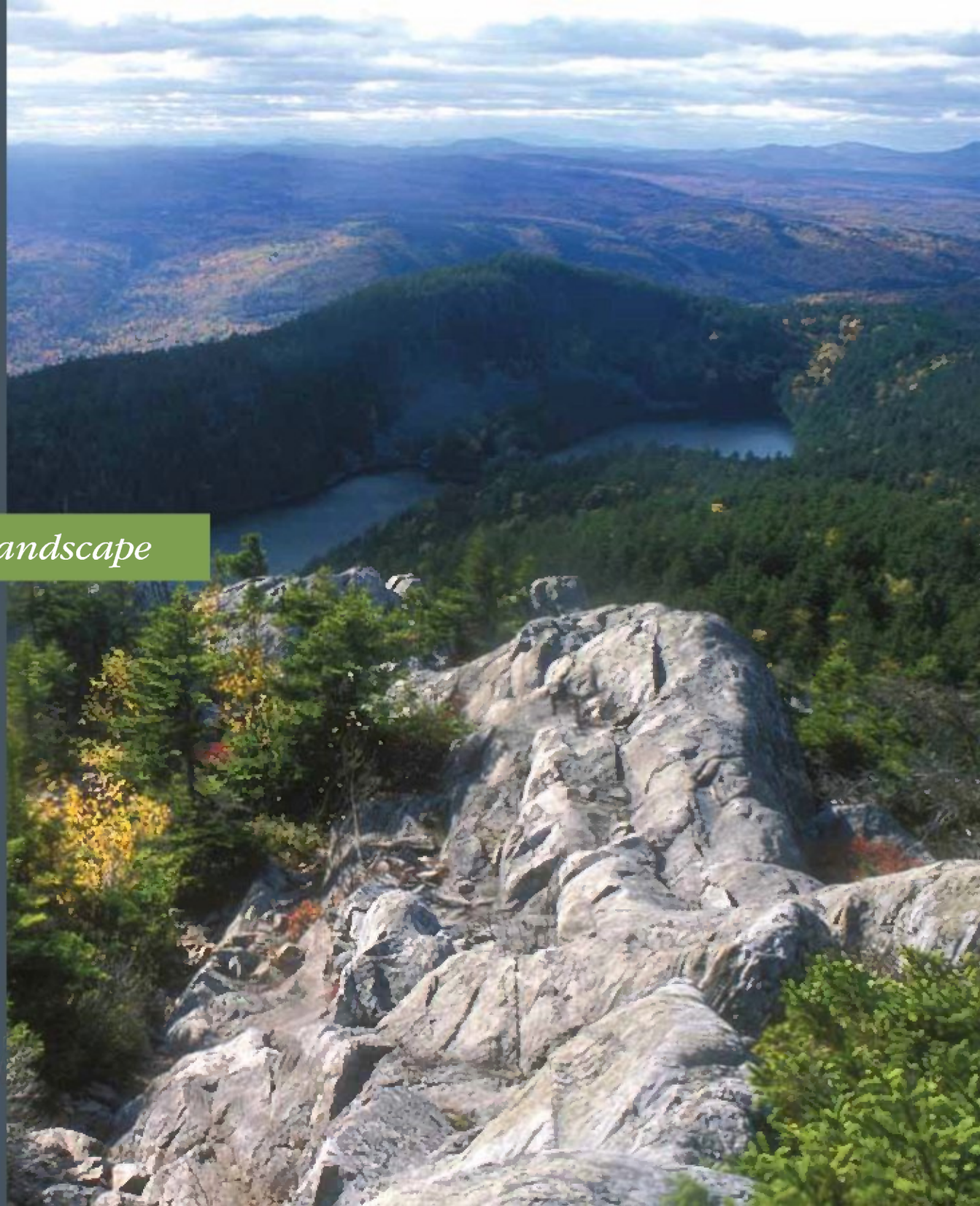
Wildlands and Woodlands

A Vision for the New England Landscape

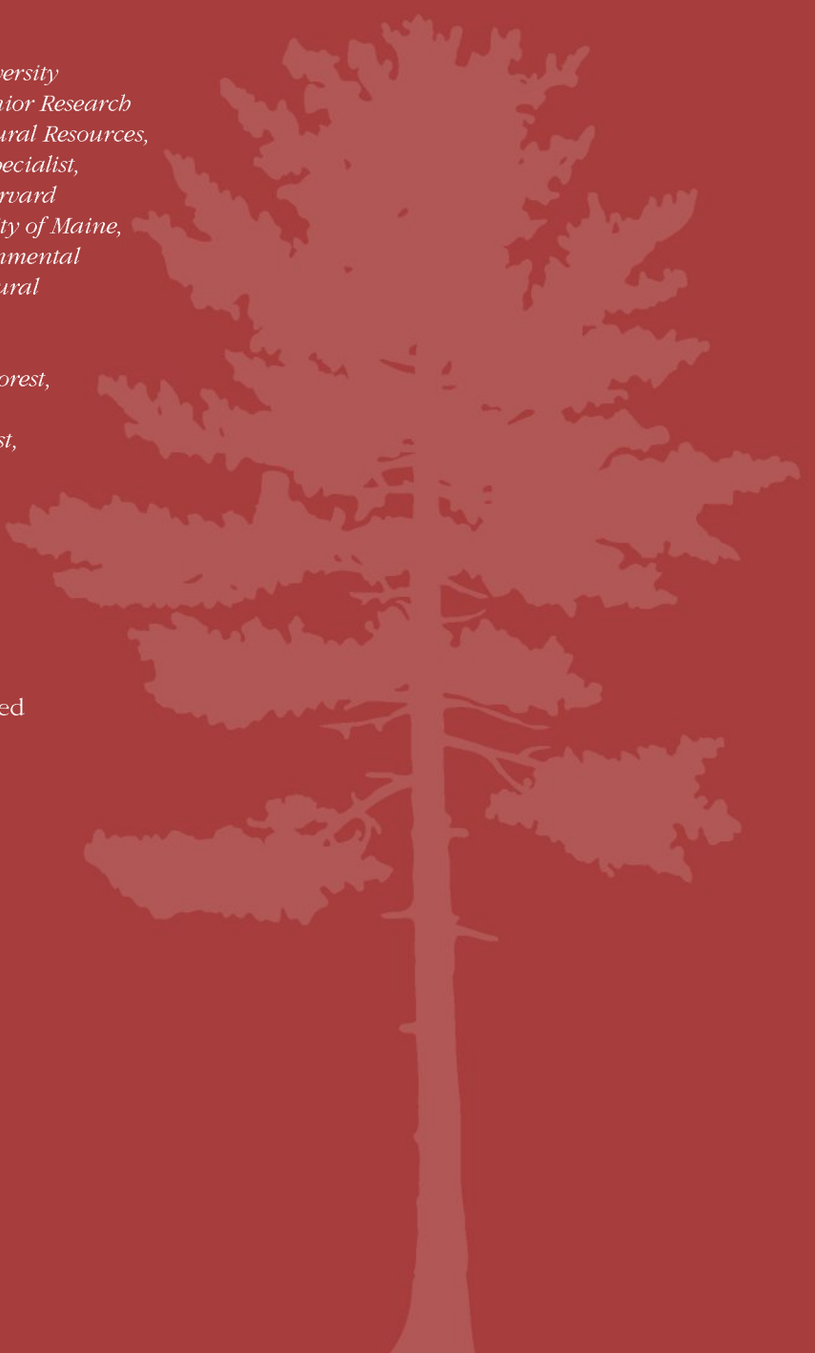


WILDLANDS AND WOODLANDS AUTHORS

John D. Aber, *Provost, Vice President for Academic Affairs and University Professor, University of New Hampshire;* **Charles V. Cogbill,** *Ecology Faculty, Sterling College;* **Elizabeth A. Colburn,** *Aquatic Ecologist, Harvard Forest, Harvard University;* **Anthony W. D'Amato,** *Professor, Department of Forest Resources, University of Minnesota;* **Brian M. Donahue,** *Professor of American Environmental Studies, Brandeis University;* **Charles T. Driscoll,** *University Professor of Environmental Systems Engineering, Syracuse University;* **Aaron M. Ellison,** *Senior Ecologist and Senior Research Fellow, Harvard Forest, Harvard University;* **Timothy J. Fahey,** *Liberty Hyde Bailey Professor, Department of Natural Resources, Cornell University;* **David R. Foster,** *Director, Harvard Forest, Harvard University;* **Brian R. Hall,** *GIS Research Specialist, Harvard Forest, Harvard University;* **Clarisse M. Hart,** *Outreach and Development Manager, Harvard Forest, Harvard University;* **Malcolm L. Hunter,** *Libra Professor of Conservation Biology, Department of Wildlife Ecology, University of Maine, Orono;* **Lloyd C. Irland,** *Irland Group and Lecturer and Senior Research Scientist, School of Forestry and Environmental Studies, Yale University;* **William S. Keeton,** *Professor of Forest Ecology, Rubenstein School of Environment & Natural Resources, University of Vermont;* **David B. Kittredge,** *Professor, Department of Natural Resources Conservation, University of Massachusetts, Amherst;* **Kathleen F. Lambert,** *Science and Policy Integration Project Director, Harvard Forest, Harvard University;* **James N. Levitt,** *Director, Program on Conservation Innovation, Harvard Forest, Harvard University;* **Robert J. Lilieholm,** *E. L. Giddings Professor of Forest Policy, University of Maine, Orono;* **David A. Orwig,** *Forest Ecologist, Harvard Forest, Harvard University;* **Jonathan R. Thompson,** *Research Ecologist, Conservation Ecology Center, Smithsonian Institution.*

ABOUT THE HARVARD FOREST

Located in the picturesque hill town of Petersham, Massachusetts, the Harvard Forest has served as Harvard University's rural laboratory and classroom for ecological research and education since 1907. The Forest comprises 3,500 acres of forests, ponds, streams, wetlands, and agricultural fields that provide diverse natural ecosystems and cultural landscapes for study and enjoyment. The Forest is protected from development and operates under a long-term management plan designating specific areas for active forest management, long-term scientific experiments, and wildland reserves. Since its founding, the Forest has been a pioneer in applying the lessons from human and natural history to the interpretation of ecological systems and the conservation management of landscapes. Scholars at the Harvard Forest collaborate with conservation organizations and state and federal agencies to protect landscapes locally, regionally, and globally. The Forest is also home to the Fisher Museum, which contains world-renowned dioramas depicting the history of landscape changes in New England since colonial settlement. Major support for the Forest comes from Harvard University and from the National Science Foundation through its Long Term Ecological Research Program (LTER), National Ecological Observation Network (NEON), and Research Experience for Undergraduates Program (REU). For additional information, please visit http://harvardforest.fas.harvard.edu.



Wildlands and Woodlands

A Vision for the New England Landscape




Harvard Forest, Harvard University
Petersham, Massachusetts

David R. Foster, Brian M. Donahue, David B. Kittredge, Kathleen F. Lambert, Malcolm L. Hunter, Brian R. Hall, Lloyd C. Irland, Robert J. Lilieholm, David A. Orwig, Anthony W. D'Amato, Elizabeth A. Colburn, Jonathan R. Thompson, James N. Levitt, Aaron M. Ellison, William S. Keeton, John D. Aber, Charles V. Cogbill, Charles T. Driscoll, Timothy J. Fahey, Clarisse M. Hart

May 2010

EXECUTIVE SUMMARY

Seldom does history provide us with second chances. Seldom does an investment in the infrastructure that supports both nature and human activity offer the promise to yield so much.

New England's distinctive landscape is a testament to the resiliency of the land and the conservation ethic of its people. The remarkable return of the region's forests following an early history of forest clearing and intensive logging offers an unprecedented opportunity to secure a more sustainable future. Today there is more forest cover between Long Island Sound and the Canadian border than at any time in the past two centuries. The 33 million acres of trees, waters, and wetlands that blanket New England provide areas for recreation, hunting, and other traditional uses; wood and other forest products; clean and abundant water; a continental-scale habitat corridor; and a globally important source of renewable energy and carbon storage—key factors in slowing the rate of climate change. It is an expansive landscape worthy of a vision commensurate in its ambition and reach.

The *Wildlands and Woodlands* vision calls for an unparalleled, long-term conservation effort to retain at least 70 percent of the region in forestland, permanently free from development. This three-fold increase in conserved land—spanning tree-lined communities to rural farm woodlots and vast forestlands—would be achieved through easements from willing private land owners paired with strategic conservation acquisitions and enhanced economic incentives to retain forestland.

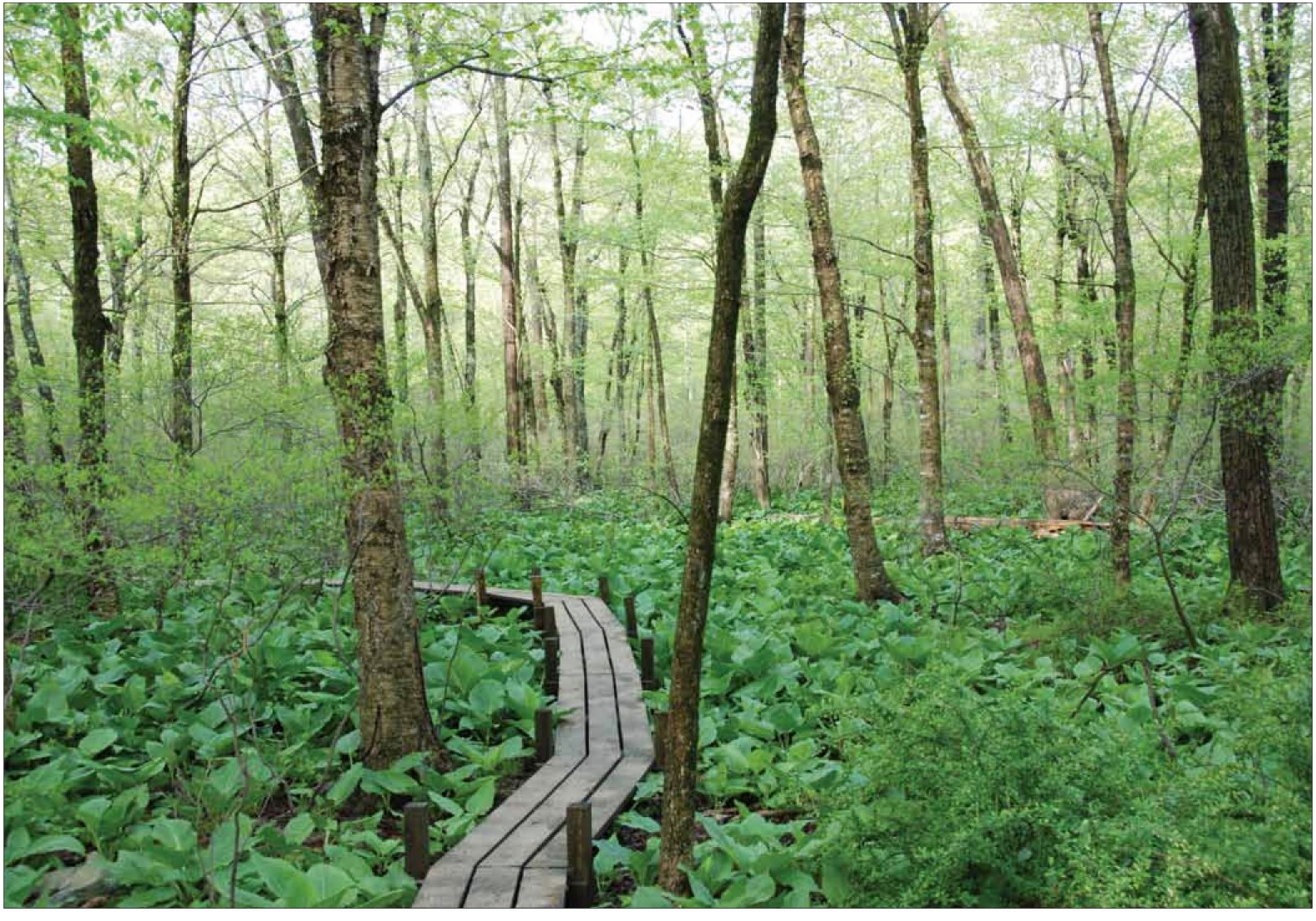
The *Wildlands and Woodlands* vision strikes a balance between active, long-term forest management and preservation. Ninety percent of forests would be expansive "Woodlands" that are voluntarily protected from development and managed for forest products, water supply, wildlife habitat, recreation, aesthetics, and other objectives. Ten percent of the forestland, or seven percent of the region, would be "Wildlands" that are established as large landscape reserves subject to minimal human impact and shaped by natural processes.

The *Wildlands and Woodlands* vision builds on decades of planning and leaves room for continued growth and development—as much as a doubling in the amount of developed land. Though bold, the vision is achievable and financially prudent. It ensures, at reasonable cost, that New England will retain the natural qualities and resources that shape its identity and support local economies, communities, and quality of life. In conserving its natural infrastructure, New England can maximize resilience to changes in climate, land use, and the economy. In so doing, the region will provide national leadership in the integration of economic prosperity, natural resource conservation, and energy and resource efficiency. Conservation today will pay lasting dividends that will only increase in value.

***Wildlands and Woodlands* addresses a quiet but pressing challenge—the growing instability of the forest base that supports human livelihood and biodiversity in the region.** Following 150 years of natural reforestation, forest cover is now declining in every New England state. Each year, thousands of acres of forests and farms are bulldozed for houses and lawns, commercial buildings, roads, and parking lots. Meanwhile, in the northern forest region, properties that were long managed under enduring family and industry ownerships are being sold, fragmented and transformed. These dynamics yield uncertainty and threaten the integrity of the landscapes and communities they support. But that volatility may also present opportunities. Change could include new options for the conservation of forests, farms, waters, wetlands, as well as green space in cities and towns; policies that provide greater stability to landowners and local economies; growth of local forestry and agriculture to enhance regional self-sufficiency; and an expanded focus on more sustainable forms of development.

Achieving this 50-year vision will require that we reimagine our landscape and act deliberately toward a shared vision of the future. *Wildlands and Woodlands* relies on private landowners—the primary stewards of New England lands—partnering with communities, businesses, regional organizations, and state and federal collaborators. It is an effort that must be anchored in local knowledge and matched with public and philanthropic resources. It demands significant expansion of current approaches to conservation and the engagement of thousands of landowners and other partners across the region to reweave parcelized landscapes, conserve large areas of intact forest, expand conservation finance strategies, and promote resource-efficient land use.

***Wildlands and Woodlands* is not just a forest conservation plan and it is not written for a specific political moment—it is a vision for the next half century and beyond.** It is intended to safeguard the basic green infrastructure and natural services we need in the face of significant economic and environmental stresses we face now and those sure to come. Seldom does history provide us with second chances. Seldom does an investment in the infrastructure that supports both nature and human activity offer the promise to yield so much.



A VISION FOR THE NEW ENGLAND LANDSCAPE

The historic return of New England's forests offers a second chance to determine the future of this remarkable landscape. When colonial settlers first viewed the region's vast forests, they saw challenge and opportunity; they responded by clearing and farming large areas to support growing settlements while cutting much of the rest. Then, during the nineteenth and twentieth centuries, the eastern U.S. experienced an "explosion of green" (McKibben 1995) as large-scale agricultural production shifted westward and a burgeoning conservation movement reinforced forest recovery (Foster and Aber 2004; Figure 1). This history has positioned New England as the nation's most forested region (33 million forest acres of 42 million total acres) and, in its southern reaches, one of the most densely settled (Figure 2).

Today's landscape again presents us with great challenge and opportunity. The *Wildlands and Woodlands* vision seeks to meet this challenge by crafting a regional future notable for its sustainable balance of thriving forests, farms, and human communities. In an era of uncertainty, when changes in the environment, economy, and energy pose great threats to society and nature, the six New England states—Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine—should take a bold, yet prudent and economically conservative step to protect their woodlands, farmlands, waters, coastlines, and wetlands.

Wildlands and Woodlands offers a vision of New England that triples the amount of land remaining free from development; a future in which more than 70% of the land across the region would remain forested, punctuated only by waters, wetlands, and farmland (Figure 3; Box 1 describes the importance of farms in New England). The proportions of conserved land would vary regionally, depending on current conditions, development pressures, and conservation opportunities. Forest cover would encompass 50% of the land to the south and across agricultural areas, and up to 80% or more in the north. In regions with large forest areas, fully 90 to 100% of the landscape would remain forested.

This vision, with its emphasis on conserving and managing vast acreages of forest as Woodlands and Wildlands, is a legacy of American conservation history. Its goals are rooted in the conservation philosophy shared by Henry David Thoreau, Gifford Pinchot, John Muir, Bob Marshall, Aldo Leopold, and others—that active management and preservation are *complementary,* not conflicting objectives. The vision is also grounded in the modern understanding that intact forests provide essential infrastructure for society, supporting diverse human needs for work, health, resources, and enjoyment.

Retaining forests as Woodlands and Wildlands would sustain all life by preserving the forests' natural filtration and production of clean air and water, as well as the storage of carbon that helps to mitigate climate change (Smail and Lewis 2009). Protecting these natural benefits comes at a fraction of the cost of manufactured infrastructure that seeks to replace them, such as water treatment plants (Fausold and Lilieholm 1999, Ginn 2005). Moreover, the forested landscape provides economic benefits, including natural resource production, tourism, outdoor recreation, and local and sustainably produced food and forest products (Brookings Institution 2006). Locally, this natural infrastructure sustains jobs and communities; regionally it defines New England as a beautiful place to live, visit, and explore.

Today, there is great opportunity, and pressing need, to couple New England's conservation capacity and shared land ethic with a vision for the next century, in which forests and farmlands remain an integral part of our landscapes and livelihoods.

The *Wildlands and Woodlands* vision would leave up to 18% of New England—*twice the area developed today*—potentially free for future development (Figure 3). Of course, we do not advocate that nearly one-fifth of the land area ultimately be developed. But New England has always been a peopled and working land; the region, and this vision, needs viable communities and strong citizen engagement to succeed. Development with a *Wildlands and Woodlands* approach would emphasize healthy human enterprise, including energy-efficient redevelopment of houses, urban centers, roads, airports, schools, and playing fields, supported by sustainable, resource-efficient, and thriving economies (Stein et al. 2005).

New England has long been a leader in conservation and today boasts perhaps the greatest capacity for conservation in the world. This capacity takes many forms: individual and family landowners; local land trusts, town conservation commissions, and town forests; regional, statewide and national organizations for conservation, hunting, recreation, forestry, and farming; state and federal natural resource agencies; and a philanthropic community dedicated to preserving communities, livelihoods, and landscapes. Motivating this capacity for action is a land ethic marked by those who care for forests and farms, and communities that work to maintain their quality of life and distinctive local character. Recent efforts by states and regional conservation partnerships have mobilized this capacity into action, working across geographic borders to ensure that New England's greatest resource—its vast network of forestlands, farms, and water—remains intact.

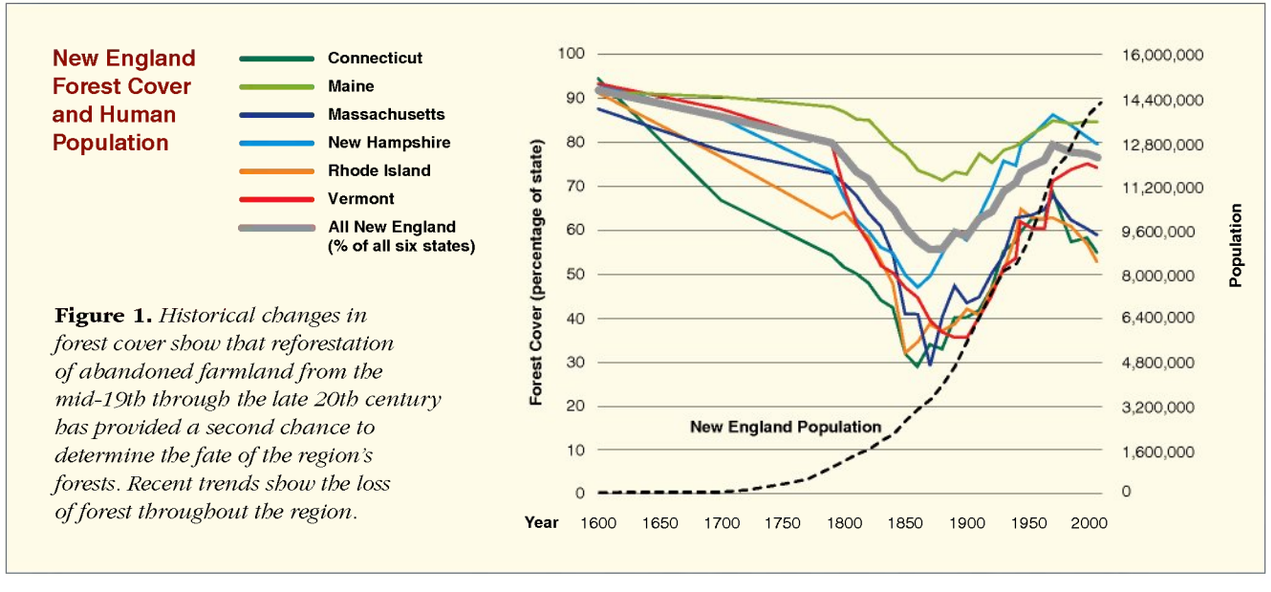


Figure 1. *Historical changes in forest cover show that reforestation of abandoned farmland from the mid-19th through the late 20th century has provided a second chance to determine the fate of the region's forests. Recent trends show the loss of forest throughout the region.*

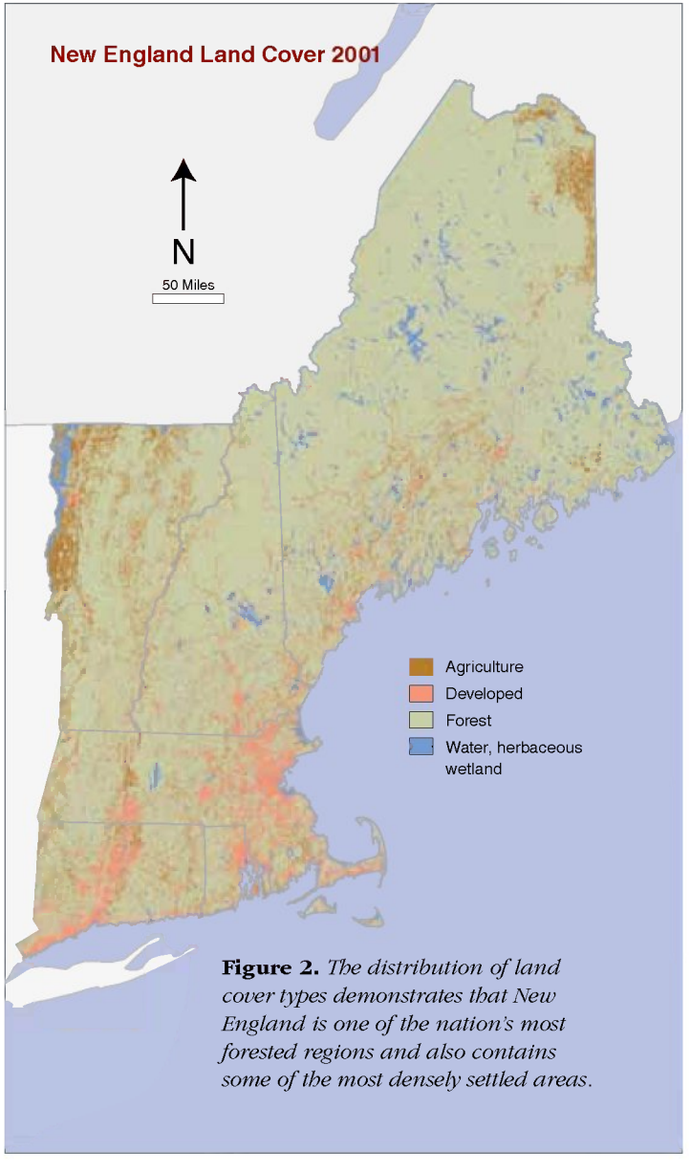
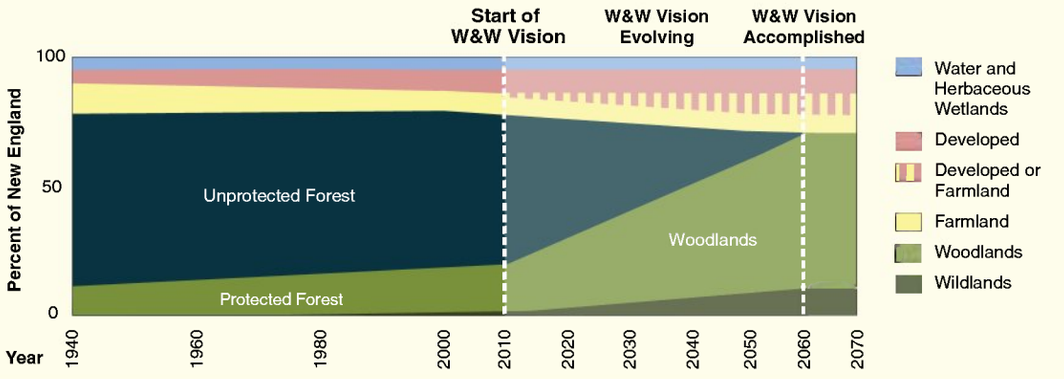


Figure 2. *The distribution of land cover types demonstrates that New England is one of the nation's most forested regions and also contains some of the most densely settled areas.*

New England Land Cover: Past, Present, and Future

Figure 3. *Projections for the implementation of* Wildlands and Woodlands *demonstrate that roughly a doubling in the rate of forest conservation over current levels is needed to achieve the vision within 50 years.*



BOX 1 FARMLAND IN A WILDLANDS AND WOODLANDS LANDSCAPE

Conserving and sustaining farmland is important to achieving the *Wildlands and Woodlands* vision and a sustainable future for New England. Farms and forests have always been intertwined in New England's cultural history—each has risen and fallen in turn (Foster and O'Keefe 2000). Although farmland has shrunk to less than 7% of the region's landscape, this long decline may have bottomed out. Recent data suggest that farm incomes and the number of farms have begun to rebound, although with smaller average acreage per farm (USDA 2007). The *Wildlands and Woodlands* vision promotes retention of this local capacity for production and engagement in human sustenance; it provides room for sustainably managed farm land to grow to 10% or even 15% of the landscape.

There are many benefits to farming and growing food in New England, even if local production can never meet all our needs (Donahue 1999). The region's soils and climate are well-suited to fruits, vegetables, and cool-season grasses for pasture. However, traditional New England agriculture has long been pressed to compete with industrial agriculture elsewhere. This dynamic may reverse as rising fossil fuel costs and carbon impacts foster the transition to a "bioeconomy" based on renewable resources. But global market forces should not be the sole determinants of local food production. Besides providing a foundation for our rural economy, local farms give people opportunities to engage with their source of food through Community Supported Agriculture, pick-your-own enterprises, farmers' markets, agricultural tourism, and farm internships.

Farmland can also provide critical habitat for open-land plants and animals such as meadowlarks, bobolinks, and many butterflies, grasses, and wildflowers. These species thrived in New England when farmland expanded; many are now in decline due to development and industrial agriculture (Bernardos et al. 2004). Pastoral landscapes also offer a backdrop to a lifestyle that is distinctly New England. As much as we embrace deep forests, many residents also cherish woods broken by open fields, a stone wall, and a row of sugar maples. Farm and forest conservation are inextricably linked. Farm lands are ecological and economic assets that draw people to live in New England; they invite conservation investments that keep this diverse landscape alive and well.

THE CHANGING NEW ENGLAND LANDSCAPE

The long lens of environmental history offers insights into the trajectory of the New England landscape and yields important conservation lessons. Before European settlement, New England supported magnificent ancient and varied forests. These ranged from pitch pine, oak, hickory, and chestnut in the south; through white pine, hemlock, birch, beech, and maple over the central and northern uplands; to spruce, fir, and paper birch farther north and on mountains throughout (Cogbill et al. 2002). Natural disturbances—insects, disease, wind, ice, and occasional fire—periodically regenerated patches of forest, but most new growth occurred in openings created by the death of one to many trees (Seymour et al. 2002, D'Amato and Orwig 2008). Following the retreat of the glaciers, changes in climate initiated gradual shifts in species composition and distribution over thousands of years (Foster and Aber 2004). Native people, combining complex foraging and hunting systems with horticulture, cleared limited areas along rivers, wetlands, and the coast, and influenced the land through their collecting, hunting, and understory burning (Chilton 2000). Although a peopled land, for more than 10,000 years, New England was overwhelmingly a forested land.

Less than four hundred years ago, colonists began arriving in growing numbers. Through the nineteenth century, settlers displaced native people and transformed the land, steadily converting forest to farms up into northern Vermont, New Hampshire, and Maine and to the base of rugged mountains throughout the region (Cronon 1983; Figure 1). New England outside of the far north became an agrarian landscape of pastures, fields, woodlands, many towns, and a few small cities. Remaining forests were cut for fuelwood, charcoal, potash, lumber, furniture, pulp, and paper. Streams and rivers were degraded by deforestation, log drives, erosion, dams, and, as industry and populations increased, by pollution and sewage. Habitat conversion, hunting, and trapping decimated many native species, including turkey, deer, beaver, moose, cougar, lynx, wolf, and passenger pigeon, whereas deforestation created open land for early successional plants, insects, birds, and small mammals (Bernardos et al. 2004, DeGraaf and Yamasaki 2001). The land was reshaped by a thriving but increasingly unsustainable rural economy and an emerging industrial and urban one.

Even as farming peaked in the mid-to-late nineteenth century, the agrarian landscape had already begun to return to forest through a process that Henry David Thoreau witnessed and called "the succession of forest trees" (Foster 1999). New England was increasingly becoming part of an expanding national economy. Farmers began importing Midwestern grain for their cows, using their best land to supply growing urban populations with milk, fruit, and vegetables, and abandoning scrubby pastures to an influx of red cedar, birch, pine, and spruce (Donahue 2007). In the twentieth century, as transportation systems improved, New England farmers found it increasingly difficult to compete with large-scale food production from across the nation and around the world (Donahue 1999). Thousands of farms and millions of acres of farmland were abandoned, accelerating reforestation. As the forest grew back, timber harvesting and forest industries peaked and then gradually declined due to outside competition (Hall et al. 2002).

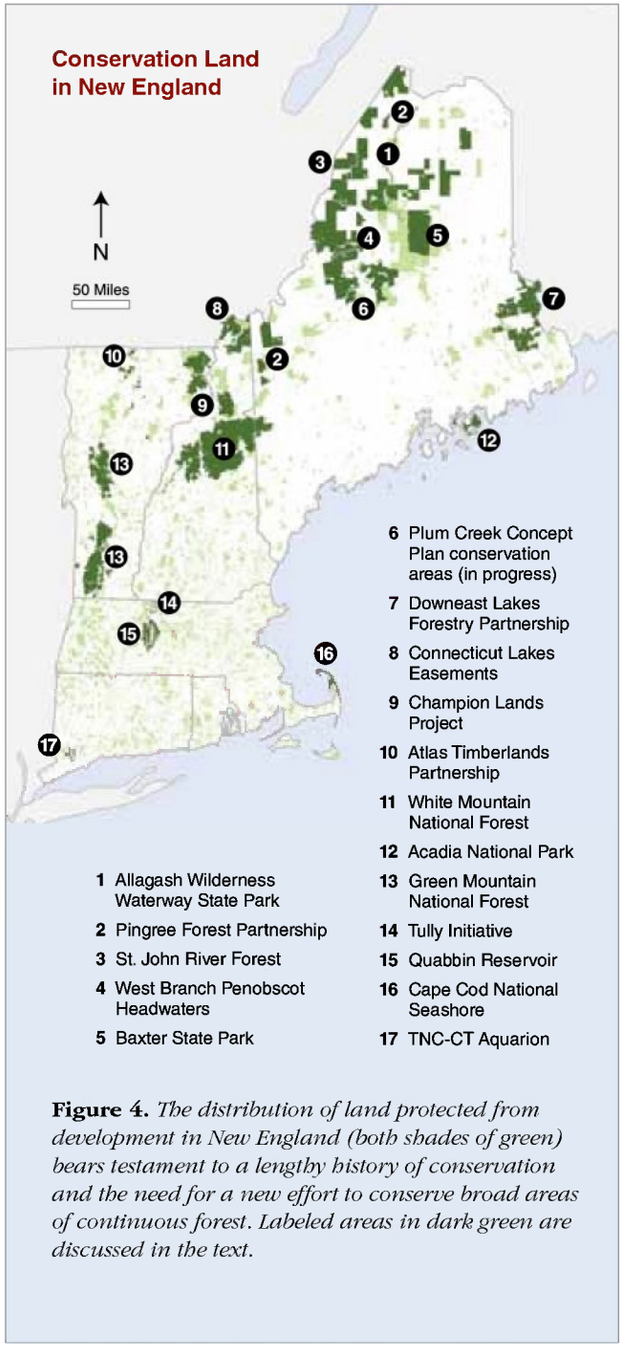


Figure 4. *The distribution of land protected from development in New England (both shades of green) bears testament to a lengthy history of conservation and the need for a new effort to conserve broad areas of continuous forest. Labeled areas in dark green are discussed in the text.*

In contrast, in the vast "North Woods" across northern Vermont, New Hampshire, and Maine, a harsh climate, rugged terrain, and relative inaccessibility limited settlement and forest conversion (Irland 1999). Old stands of spruce, fir, pine, and northern hardwoods were felled and often cut again, regenerating to provide a growing source of raw materials for the region's sawmills and tanneries, and later, its extensive pulp and paper industry (Irland 2004). The area's physical environment and its dependence on wood resources created forests that differed, and still differ substantially in structure, composition, and expanse, from those to the south. These northern forests have strongly shaped northern economies and communities. Large expanses of forest—especially the 8 million acres in northern Maine—exist today in large parcels owned by a small number of generally absentee landowners (Hagan et al. 2005). Despite falling employment in the forest products sector, Maine's timber harvest levels remain near their maximum sustainable level; paper production—the state's largest and most valuable forest product—is near all-time highs (Maine Pulp and Paper Association 2009).

In response to the impacts of deforestation, cutting, and burning on the region's land and water, in the nineteenth century New England began to emerge as a pioneer in conservation. Indeed, conservation leadership and innovation became part of the region's identity (Foster 1998, 2009; Irland 1999; Figure 4). Although New Englanders had been protecting local woodlands since the mid-1600s, George B. Emerson, Henry David Thoreau, and George Perkins Marsh were among the first Americans to decry the wider consequences of deforestation. They famously called for the replanting of trees; the thoughtful, long-term stewardship of woodlands; controls on hunting, fishing, and trapping; and the preservation of wild areas (Judd 1997). Much of the region, with its political divisions into more than a thousand towns, developed a deep tradition of community land stewardship, extending from the early town commons, through the town forest movement, into current open-space programs. In the north, where large private ownerships have prevailed, so too has a long tradition of public access for recreation, hunting, and trapping.

The national conservation movement grew from the early visions of New England conservationists who formed groups such as The Trustees of Reservations, the world's first regional land trust; the Appalachian Mountain Club and Massachusetts Audubon Society, conservation advocacy organizations; and the New England Forestry Foundation, a promoter of the sustainable management of private forest lands. The Weeks Act of 1911 authorized the establishment of national forests in the eastern U.S. and led to the creation of the White Mountain National Forest in New Hampshire and adjacent Maine, and the Green Mountain National Forest in Vermont. In 1919, John D. Rockefeller and other benefactors were instrumental in creating Acadia National Park along Maine's rugged Downeast coast. This regional tradition of private conservation was extended in the 1930s when Maine's former governor Percival Baxter donated the land around Mount Katahdin to the state, with the stipulation that the majority be "used for public park and recreational purposes," "forever left in the natural wild state," and "kept as a sanctuary for wild beasts and birds." Today, New England continues to advance this legacy of conservation innovation and leadership through its hundreds of local land trusts and broader efforts at national and global scales (Levitt 2005, Fairfax et al. 2005).

This history of forest conservation has bestowed many benefits on New England, including flourishing natural ecosystems and the continuing return of native wildlife species (Foster and O'Keefe 2000). Most cities and towns can count on dependable water supplies from forested watersheds, although development and groundwater contamination are growing problems. Many formerly polluted waterways are also recovering, thanks to reforestation and state and federal water quality legislation in the early 1970s. Today, at more than 33 million acres, the renewed and expansive New England forest provides the region with an invaluable natural infrastructure, a cultural legacy, and many resources for the future (Likens and Franklin 2009, Barringer et al. 2009). *Wildlands and Woodlands* seeks to build on this history and, in collaboration with many efforts by other groups, to chart a sustainable path forward for the people and landscapes of the region.

MODERN THREATS TO THE NEW ENGLAND LANDSCAPE

The incredible ecological, social, and economic opportunities in New England's forested landscape are accompanied by threats of equal magnitude (Kittredge 2009). For the first time since agricultural abandonment in the mid-1800s, all six New England states are experiencing a decline in forest cover (Figure 1). This second wave of deforestation poses far greater challenges than the previous episode. The permanent development and landscape fragmentation of today, often involving asphalt, concrete, and steel, are much harder to reverse than the historic clearing of land for farms and pasture.

The drivers and impacts of modern day forest loss vary geographically. The steepest declines in forest cover occur across the south, where exurban and rural forests are rapidly being fragmented by roads and residential and commercial development. Across the far north, forests are subject to increased parcelization and perforation due to a region-wide transition from traditional family and industrial ownership to investment ownership coupled with leisure development along lakes and ridgelines.

These regional dynamics have created three major areas of concern: a large band reaching from Rhode Island and Connecticut to coastal Maine that is vulnerable to dense development, rapid forest conversion, and sprawl; a transition area in central New England, subject to dispersed but increasing suburbanization and second home development; and a northern tier where rapid turnover and parcelization of large forest tracts will increasingly lead to more fragmented management and dispersed development (NEFA 2005, Cousins and Tyrell 2009). A look to the future suggests that forest conversion and development will intensify on private lands throughout New England—in some areas up to 63% of private forestland may be developed by 2030 (Stein et al. 2005; Figure 5).

Deforestation and development. While environmentally damaging, historical clearing comprised a "soft" deforestation; abandoned farms readily reverted to forest. In contrast, today's development is a "hard" deforestation that converts land forever. These pressures are greatest in southern New England, although considerable pressures for vacation homes are affecting remote lake-, river-, and ocean-front parcels in the north (White et al. 2009). With development comes a host of threats including habitat loss and fragmentation, disruption of natural processes, changes in local climate and hydrology, reduced viability for natural resource management, and degradation of the natural infrastructure that supports all life and human enterprise (Seymour and Hunter 1999, Barten et al. 2008, Radeloff et al. 2010).

Perforation. While development is often glaringly evident, as in vast forest clearance for commercial complexes, ski resorts, or multi-unit residential developments, the subtle insinuation of houses and human activities into natural landscapes is more widespread and can be similarly disruptive. The envelope of human influence surrounding each new building and paralleling every road undermines ecosystems, threatens wildlife, and hinders many productive forest uses (Forman 2002). Although development pressures are far greater in southern New England, scattered amenity-based developments in remote northern regions also contribute to habitat fragmentation and environmental degradation (Klyza and Trombulak 1994).

Climate change. Rapid changes in temperature, rainfall, snowfall, and length of growing season are exerting their effects on every forest. Across the region, there have been shifts in the seasonal behavior and distributions of many organisms. These changes are exacerbating outbreaks of certain pests and pathogens, triggering population declines in many plant and animal species and increasing the abundance of others. In northern New England, the changes are both environmental and economic: for example, plant species are moving upwards in elevation as temperatures increase, and the timing and duration of maple syrup season are changing (Beckage et al. 2008).

Adverse forest practices. Following centuries of impact, most forests today are younger in age and simpler in structure than their early predecessors (Foster and Aber 2004). Though maturing in some areas, many forests remain over-utilized or otherwise mismanaged (Irland 1999, Elliot 1999). From a wood production standpoint, many small private parcels and large areas of forest in the south fall well below their productive potential (D'Amato et al. 2010). Economic pressures to maximize short-term profits contribute to poor practices such as high-grading and clearcutting (Lansky 1992). Erosion from improperly constructed forest access roads contributes tons of sediment to streams each year. And despite regulations, there has been too much "liquidation" harvesting in which parcels are purchased, stripped for timber, and split into poorly planned subdivisions (Lilieholm et al. 2010). In large industrial ownerships in the north, falling financial investments and shorter harvest cycles may reduce future yields. Rising pressures for wood-based bioenergy to supply the region and other countries may intensify adverse harvesting practices and substantially change the timber economy (Evans and Perschel 2009, Damery et al. 2009, Benjamin et al. 2009, Cronan et al. 2010).

In the face of all current and future threats, the single most important action that we can take is to maintain forested landscapes on a scale that allows natural and human communities to flourish.

Recent Population Change and Future Development of Forest Land

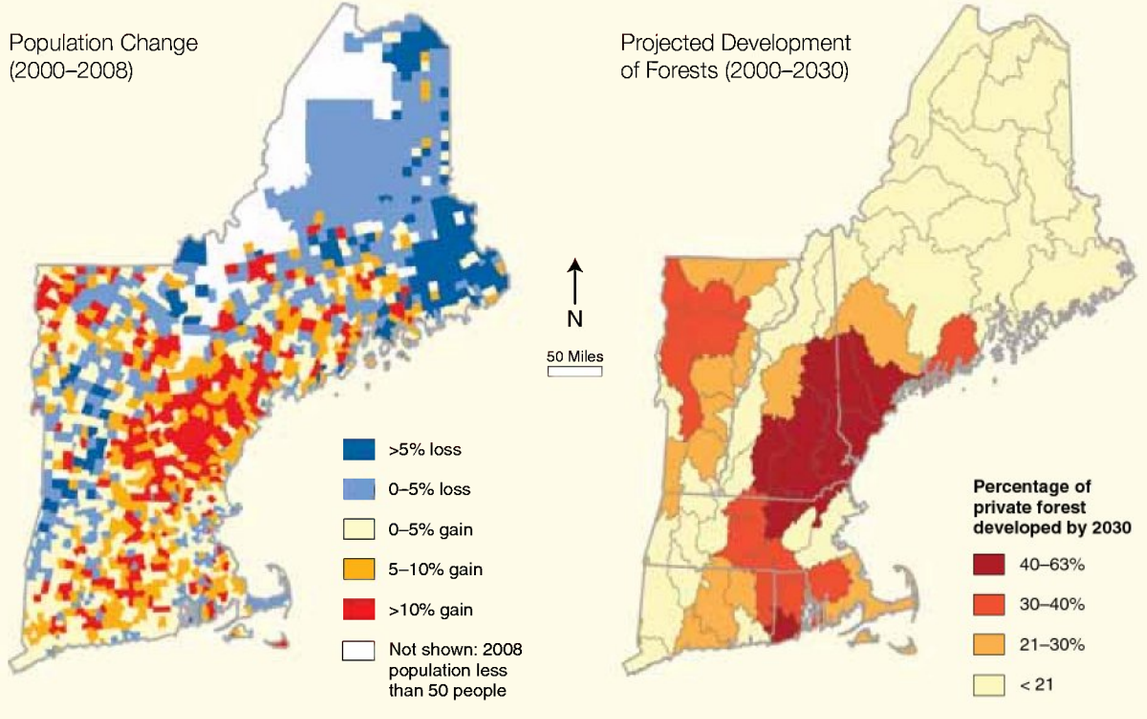


Figure 5. *All six New England States are expected to experience dramatic rates of forest loss over the next 20 years. The areas of most intense future development overlap with those that underwent the greatest increase in population in recent years. These include the suburbanizing region that stretches from north of Boston to southern Maine and the area adjacent to Burlington, Vermont.*

Parcelization. In 1994, the Northern Forest Lands Council issued an alert that sales of vast northern tracts, historically owned by a few families and timber companies, were facing fragmentation, liquidation, and haphazard development. Fifteen years later, longtime landowners have largely been replaced by new players—TIMOs (Timber Investment Management Organizations), REITs (Real Estate Investment Trusts), and other institutional investors (Hagan et al. 2005, Lilieholm et al. 2010; Figure 6). Across New England, the age and number of landowners is increasing, tract sizes are decreasing, and more owners are absentee. This legal fragmentation hinders management, sets the stage for deforestation, and threatens the long tradition of public access to forests (Lilieholm 2007, Wiersma 2009).

Invasive organisms. Largely by accident, human actions have introduced pests, pathogens, and plants that are transforming many forests (Foster and Aber 2004, Ellison et al. 2005, Orwig et al. 2008). Facilitated by global transportation, forest fragmentation, roads, and other regional corridors, invasive species regularly colonize our forests. Pests and pathogens, both exotic and native, exert significant economic consequences through resource loss and the cost of inspecting, removing, and replacing trees. Invasive species have eliminated chestnut as a familiar tree, decimated beech and elm populations, and are now threatening hemlock, ash, and other hardwoods across their ranges (Dukes et al. 2009).

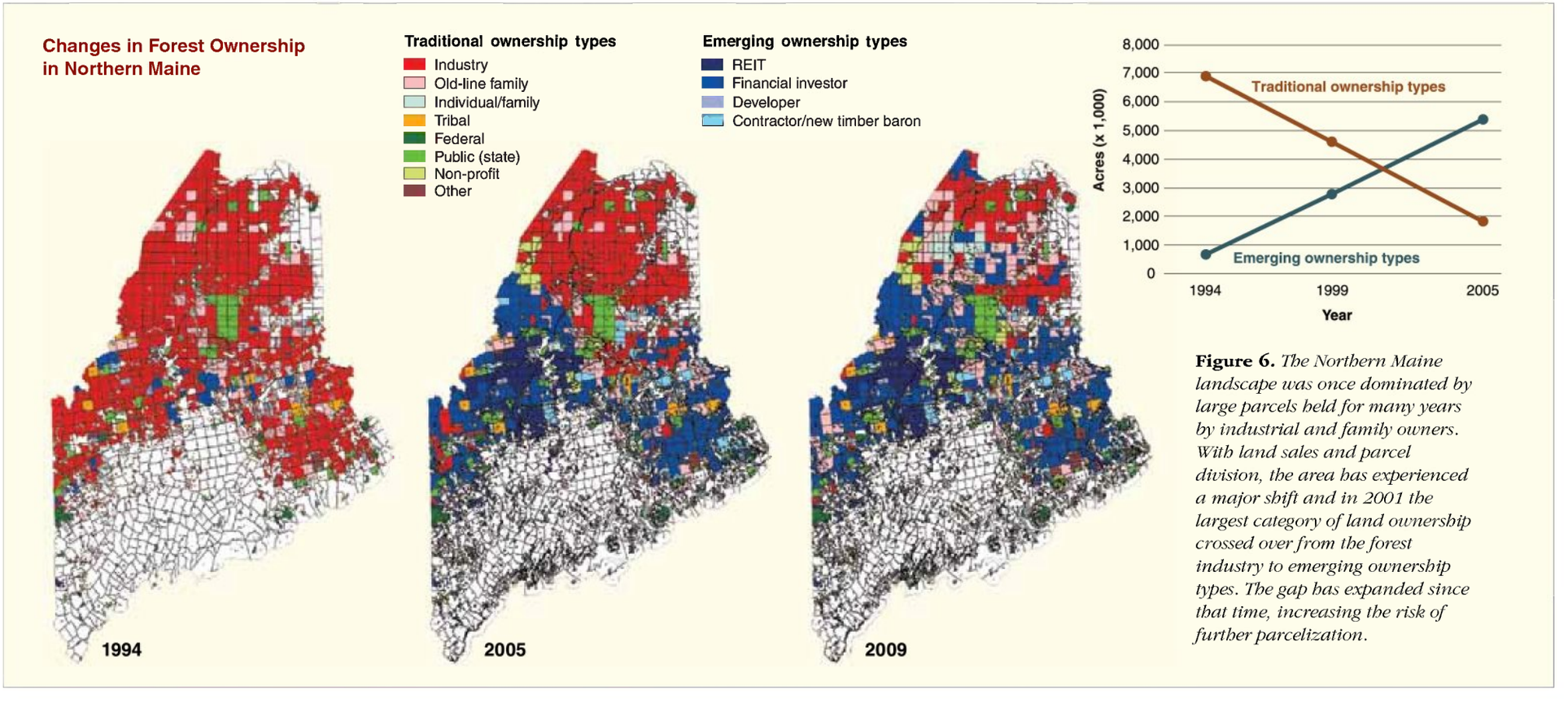


Figure 6. *The Northern Maine landscape was once dominated by large parcels held for many years by industrial and family owners. With land sales and parcel division, the area has experienced a major shift and in 2001 the largest category of land ownership crossed over from the forest industry to emerging ownership types. The gap has expanded since that time, increasing the risk of further parcelization.*

The *Wildlands and Woodlands* vision calls for a two-pronged strategy in which managed Woodlands and Wildland reserves *together* form continuous expanses of forest that provide a full range of ecological, economic, and social benefits. Under this approach, the vast majority of forest lands would be **Woodlands**—managed for wood production and other objectives, largely in private ownership and protected from development and fragmentation by conservation easements. Woodlands in public ownership would be managed by town, state, and federal entities. Collectively, Woodlands would comprise about 90% of regional forest cover and encompass about 63% of New England, or nearly 27 million acres.

Smaller in total acreage but equally important would be **Wildland** reserves—comprising roughly 10% of forests (7% of New England) or 3 million acres overall. Largely free from active management, these landscapes would be shaped by natural forces, the ambient environment, and legacies of prior history. While substantial Wildlands already exist on public lands, private landowners can also choose to establish reserves on their lands through "forever-wild" easements.

Conserving extensive Woodlands and managing them sustainably allows the permanent dedication of large Wildland tracts. Protected Wildlands, in turn, offer more flexibility to forest managers—not less—by minimizing risk associated with reliance on any one approach, and by providing insights into management approaches and natural dynamics (Keeton 2007). Together, Woodlands and Wildlands would support a greater range of habitats, biodiversity, ecological processes, and human experience than either could alone.

WILDLANDS AND WOODLANDS: AT A GLANCE

OBJECTIVE: Permanently retain 70% of the New England landscape in forests that will benefit current and future generations.

Managed Woodlands: 63% of New England (27 million acres)

Woodlands vary in both ownership and management types. They strive to accomplish five objectives:

- Bolster New England's economy by providing a dependable local resource base for sustainable wood products and future ecosystem-service mitigation markets;
- Enhance the natural benefits that forests provide: clean water and air, flood and erosion control, and carbon sequestration to combat climate change;
- Maintain access to continuous landscapes for nature-based tourism, recreation, and enjoyment;
- Provide extensive connected forest habitats for plants and animals pressured by development, natural disturbance, and climate change; and
- Expand the cover of trees in and around town centers, suburbs, and cities.

Wildland reserves: 7% of New England (3 million acres)

Wildlands, protected based on local considerations and ranging in size from 5,000 to 1 million acres. They strive to accomplish four objectives:

- Slow the pace of climate change by supporting complex, aging forests that can store twice as much carbon as young forests;
- Provide rare habitats for a diverse array of plants, animals, and micro-organisms;
- Safeguard lands of natural, cultural, and spiritual significance; and
- Serve as unique scientific reference points for evaluation and improvement of management practices elsewhere.

Woodlands and Wildlands work together. A New England mosaic of Wildlands, Woodlands, working farms, and sustainable development would support a greater diversity of habitats, ecosystem services, and human experience than any one of these could alone.

Managed Woodlands in New England

Woodlands (definition): ***Well-managed forests of diverse age, species, and structure that are permanently protected from conversion to development and fragmentation and provide a wide array of economic and environmental benefits. These lands would comprise 90% of protected forests, or 63% of the landscape under the* Wildlands and Woodlands *vision.***

Whether privately owned or publicly held, sustainably managed woodlands are an extraordinarily valuable resource. In aggregate they have provided the foundation for human, plant, and animal life in New England for centuries. Traditional estimates of timber resources, and even recent attempts to estimate the value of ecosystem services delivered by forested landscapes, place an insufficient price tag on what forests mean to New England. The specific values of New England woodlands are many and depend on their geography, context, and use.

Local forest products. Sustainably managed woodlands support a central part of New England's economy and could provide a much larger fraction of our timber and energy needs if coupled with reduced resource consumption, effective conservation, and expanded marketing (Lilieholm 2007, Keeton 2007; Figure 7). Locally, responsibly produced wood can also decrease the burden of harvesting in fragile ecosystems, old-growth forests, and less-regulated landscapes elsewhere in the world. Importing wood diverts economic benefits from our rural towns, reduces local awareness of resource use and impacts, and transfers environmental costs to distant lands. The simplistic inclination to increase prohibitions on local management in order to protect nature, rather than keeping our forest free from development and using much of it in a prudent manner for a broad array of resources, is rightly called "the illusion of preservation" (cf. Berlik et al. 2002).

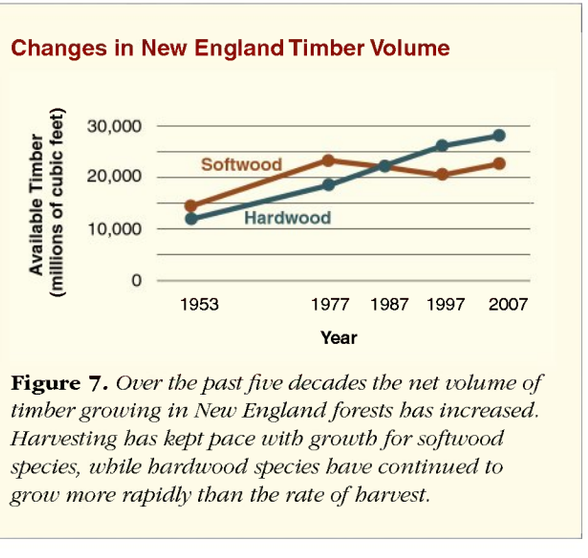


Figure 7. *Over the past five decades the net volume of timber growing in New England forests has increased. Harvesting has kept pace with growth for softwood species, while hardwood species have continued to grow more rapidly than the rate of harvest.*

Recreation and tourism. Regionally connected woodlands provide infrastructure for a strong nature-based tourism and recreation economy. For hiking, paddling, riding, hunting, fishing, and winter sports, New England residents and visitors alike depend on access to the region's forests, which has been provided by private landowners and public agencies for centuries (TTOR 1999, SPNHF 2001, Barringer et al. 2009; Figure 8).

Habitat connectivity. A network of Woodlands would support biodiversity and facilitate the successful migration of plant and animal species pressured by development, natural disturbance, and climate change (Hunter et al. 1988, Thompson 2002, Day et al. 2009). New England provides local- to continental-scale linkages within the forest cover extending from the southern Appalachian Mountains to the vast boreal region of Canada (Trombulak et al. 2008; Figure 13).

Ecosystem services. Woodlands have tremendous non-extractive values, including water supply, nutrient retention, carbon sequestration, and climate stabilization. Intact forests support groundwater recharge, sustain summer streamflows, and provide abundant clean water for a growing human population (Barten et al. 2008). Given their extent and capacity for growth, managed woodlands are a major part of strategies to mitigate climate change through the uptake and storage of carbon dioxide (Nunery and Keeton 2010; Figure 10).

Urban and suburban trees. Expanding the cover of trees in and around town centers, suburbs, and cities is an important objective of *Wildlands and Woodlands.* Tree canopies contribute immeasurably to the health, comfort, and enjoyment of all residents (Platt 2006), making more densely populated areas more livable and relieving development pressure on surrounding rural forests and farms (Szold and Carbonell 2002, Platt 2006).

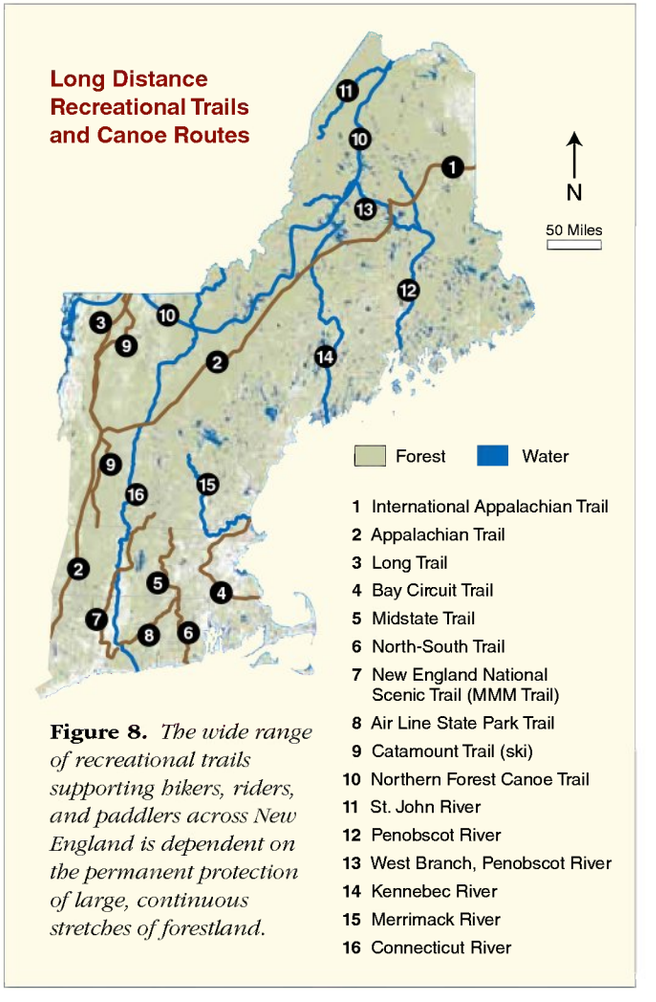


Figure 8. *The wide range of recreational trails supporting hikers, riders, and paddlers across New England is dependent on the permanent protection of large, continuous stretches of forestland.*

Human connection. Managed woodlands forge important connections between people, nature, and responsible resource use (Berlik et al. 2002) by offering citizens the opportunity to be involved in their own sustenance, to understand the connections between patterns of consumption and their environmental consequences, and to witness the link between forested habitats and biodiversity (Louv 2006). Given their great extent, accessibility, and tolerance for human influence, Woodlands readily enable residents and visitors to explore and appreciate the connections between nature and our livelihoods.

Woodlands: How much and where?

Retaining the majority of forests and 63% of the region in Woodlands would provide the extensive forest necessary to support a distinctive New England economy and quality of life for future generations of people, plants, and wildlife (cf. TTOR 1999, SPNHF 2001, Thompson 2002, MAS 2003, Wiersma 2009, Barringer et al. 2009). A Woodlands network in New England would build on existing conserved lands and be accomplished largely in two ways: through conservation easements on the land of supportive and compensated landowners, and through strategic purchases by land trusts, timber management interests, and public entities (see Box 6: Understanding Conservation Easements). The size and location of conserved Woodlands would depend in large part on current patterns of forest cover, which vary widely, from as little as 10% of the landscape in densely settled and agricultural areas to nearly 100% in remote areas.

Woodlands in a varied New England landscape

To envision the regional variation in Woodlands under a *Wildlands and Woodlands* future, we have mapped a pattern of *Urban, Suburban, Rural, Connected,* and *Continuous* landscapes that vary across a spectrum of forest cover (Figure 9). Forests in each of these landscapes provide a range of social, economic, and environmental benefits.

Urban forests. Trees should be a central part of a comprehensive revitalization effort to reverse the depopulation of cities and industrial towns and to stem sprawl and forest conversion (Fausold and Lilieholm 1999, Szold and Carbonell 2002, Platt 2006). Small Woodlands would cover 10 to 25% of the land to cool the environment, provide restful shade, clean the air, intercept rainwater, enhance property values, and enliven and beautify residential and commercial spaces.

Suburban forests. Millions of residents would benefit from engagement with nature through walking and biking trails, educational programs, and even small-scale wood harvesting (Donahue 1999, Louv 2006). Forests would cover at least 25% of the land and would ensure human benefits, provide wildlife habitat, and protect waterways.

Rural forests. Here Woodlands and farmlands would provide renewable local products and support a revived rural economy built upon the iconic New England pastoral landscape. Forests would constitute at least 50% of the land, and local conservation and stewardship would limit the rampant sprawl and fragmentation now overtaking much of the landscape (Foster et al. 2005).

Connected forests. 75% or more of the land would be forested and support innovative approaches to forest stewardship, sustainable harvesting, focused development, and increased recreation and tourism. These endeavors would expand economic opportunity and reduce parcelization while also protecting biodiversity, maximizing ecosystem services, and safeguarding the region's water supply (Barten et al. 2008).

Continuous forests. Great forest blocks allow thoughtful and productive long-term management to predominate and provide buffers for Wildland reserves (NFA 2001). Here, more than 90% of the land would remain in expansive forests, providing unparalleled opportunity for sustained natural resource production and economic growth through a resurging recreation and tourism sector (NEFA 2005, Brookings Institution 2006).

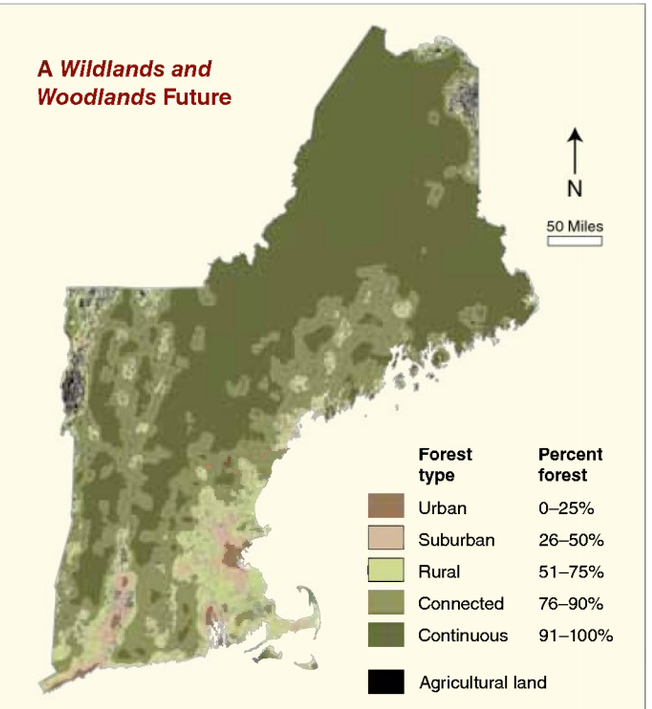


Figure 9. *The range in forest cover across New England strongly influences how conserved woodlands would be distributed across the landscape under a future* Wildlands and Woodlands *scenario.*

How should Woodlands be managed?

Forest management objectives and practices vary widely across New England (Irland 1999). Maintenance of biodiversity, retention of soil and its productive capacity, and the protection of water quality and aquatic environments are all fundamentally important to Woodlands and must be supported through sound stewardship (Colburn 2004). Within continuous and connected landscapes, working woodlands are especially valuable to both the landscape and economy as they can produce high per-acre yields of climate-friendly wood (Seymour and Hunter 1999, Fahey et al. 2009). Sustainable forestry and varied silvicultural approaches would ensure that Woodlands supply a steady stream of quality wood products while maintaining and enhancing widely shared environmental and community values, including carbon sequestration. The *Wildlands and Woodlands* vision recognizes that this is achievable through careful and sustainable approaches across the spectrum of management intensities. Allowing for a wide variety of management approaches underscores the need for active forest management throughout New England's Woodlands.

At one end of the spectrum are large-scale commercial operations, requiring long-term investment in management and infrastructure, generally with increased growth and yields as a payoff. In contrast to large commercial woodlands, many family forests within rural and suburban zones would be harvested less frequently—ideally with the aid of long-term planning and professional advice (Butler 2008, D'Amato et al. 2010). Less intensive management approaches may couple timber production with watershed management, seek to shape wildlife habitat, or promote mature trees and other qualities found in old-growth stands (Keeton 2006). Managing for aesthetics and non-timber forest products is important to many landowners and managers, while others are exploring the profit potential for marketable ecosystem services such as carbon sequestration (Nunery and Keeton 2010).

Woodlands created by neighborhood trees and local parks in the suburban and urban zones present different management challenges. Suburban and even some urban woodlands offer opportunities for active wood harvesting and utilization, which can help defray management costs and demonstrate exemplary silviculture. Although urban forest acreage may be limited, the expanse of tree canopy reaches 40% or more in some affluent suburban neighborhoods today. This should be the goal for *all* New England cities in order to create vibrant communities and lessen the development pressure on surrounding forests.

The future of forest management in New England will not follow past or present trends (Irland 2004). Societal needs will evolve, as will the distribution of plant species, the types and frequencies of ecosystem disturbance, and the productivity of managed stands. Under a changing climate and with the arrival of exotic organisms, environmental conditions that influence sustainable woodland management, such as precipitation, duration of snow cover, and temperature, will also change. It is also likely that forests' contributions to society's need for water will become a priority in the future; as the planet deals with climate change, New England may become increasingly important as an area with abundant water supplies (NHDES 2000, MDEH 2006). Careful management of the region's woodlands, informed by emerging science (North and Keeton 2008), will aid efforts to maintain ecosystem and regional resilience along with economic opportunity in the face of these large-scale changes.

Considerations for sustainably managed Woodlands

- Woodlands managed along a gradient of intensity maintain structural and compositional diversity at landscape and regional scales, providing under-represented plant and wildlife habitats and a spectrum of successional conditions.
- In forests managed sustainably for sawtimber and high-value wood products like veneer, low-value trees can be removed from maturing stands, leaving the high-value trees to grow and flourish. High-quality timber can then be harvested in a planned and sustainable fashion, and ideally processed locally to foster economic development and maximize value-added income.
- In areas harvested intensively, managers should include provisions for the retention of important physical structures and legacies, including large dead and living trees and downed logs, distributed singly and in patches across harvested areas (Elliott 1999).
- In forests managed for biomass/bioenergy, harvest practices should carefully consider the retention of logging residues—branches, bark, and treetops—as well as live and standing-dead trees to maintain nutrient levels, long-term productivity, and site-level diversity (Benjamin et al. 2009). Harvesting methods should minimize soil impacts and promote carbon sequestration.
- Regeneration methods and harvesting intensities employed across much of the region should take into account the bounds of historic patterns of both natural and human disturbance, thus ensuring the range of forest structure and cover upon which native biota rely.
- Use of "disturbance-based forestry," "low impact forestry," and "reduced impact logging," which seek to minimize the damage from harvesting and emulate the scale, intensity, and biological legacies associated with natural disturbances, should be promoted across the full range of management objectives (Lansky 2002, North and Keeton 2008).

Wildland Reserves in New England

Wildlands (definition): *Large forest landscapes permanently protected from development, shaped by natural processes and the prevailing environment to promote conditions largely free from human impact. These lands would comprise 10% of protected forests, or 7% of the New England landscape under the* Wildlands and Woodlands *vision.*

Despite the region's long history of conservation, less than 3% of its 33 million acres of forest is permanently protected from direct human impacts (Lansky 2001, TNC, unpublished data). By some estimates, before European settlement, 70 to 90% of northern hardwood forests were old-growth, whereas young forests comprised only 1 to 3% of these forests. Today, that figure is reversed: amid many young and maturing forests, approximately 53,000 acres of old-growth forest are scattered over perhaps 100 sites—making up less than 0.2% of New England's forest (Davis 2008).

With the exception of a few tracts in northern Maine and New Hampshire, old-growth forests are small (less than 5,000 acres), isolated, and restricted to inaccessible areas with steep slopes, high elevations, rugged mountains, or wetlands. Comprised predominantly of hemlock, spruce, balsam fir, and northern hardwoods, these forests capture only a small fraction of the region's original forest variation (Dunwiddie et al. 1996, Orwig et al. 2001, D'Amato et al. 2006). Furthermore, almost none are large enough to encompass large wetlands or bodies of water, or to accommodate large-scale natural processes and disturbances. When Wildlands are preserved more strategically, their benefits increase.

Carbon Uptake and Storage in a New England Forest

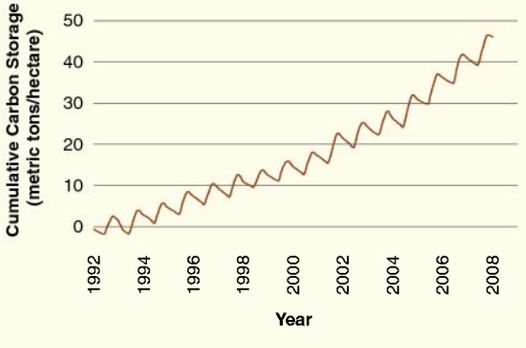


Figure 10. *The rate of carbon uptake and storage measured at a 100+ year old stand at the Harvard Forest is continuing to increase as the forest ages, confirming that old forests in New England have an important role to play in reducing the pace of climate change.*

Ecological benefits. Wildland reserves support ecological processes and patterns that are absent from managed forests. For example, windstorms interacting with large ancient trees generate structures—large dead snags, immense uproot mounds, and tangles of woody debris—that form microhabitats in streams, wetlands, and uplands. These unique habitats increase the diverse array of plants, animals, and microbes in the landscape. Expanding the region's Wildlands to encompass a broader range of geophysical diversity and ecological conditions would help our forest species adapt to climate change and other environmental disturbances over time.

Carbon storage and ecosystem services. The complex, aging forests in Wildland reserves store vast quantities of carbon, helping to reduce the pace of climate change (cf. Pelley 2009, Luyssaert et al. 2008). Research in New England forests over the past quarter century has shown that, counter to the conventional wisdom, many forests do not stop or slow their storage of carbon as they mature and age (Figure 10; cf. Keeton et al. 2010). Instead, as early successional trees decline and longer-lived trees become dominant, carbon uptake actually increases. Many forests could more than double their carbon storage if protected as Wildlands.

Socioeconomic benefits. The values of Wildlands are both ecological and socioeconomic (Wilson 1999, Poiani et al. 2000, Publicover 2001). This fact was underscored by Bob Marshall, Raphael Zon, Aldo Leopold, and other early advocates for national wilderness areas in their efforts to provide an increasingly industrialized society with the solitude and respite that only expanses of untrammeled nature can offer. Protected reserves can also energize nearby communities through tourism and increased property values.

Education and research. Wildlands provide important scientific reference for Woodland management, while also giving insight into the natural dynamics that occur in the absence of direct human intervention (Foster et al. 2010; see Box 2: Tracking Forest Change Through Stewardship Science). To improve sustainable practices in managed forests, it is essential to examine these areas in relationship to changes in adjoining Wildlands. Forests from the tropics to boreal regions have been impacted by and variously recovered from histories that parallel aspects of the intense harvesting, clearance, agriculture, and land abandonment that transformed the eastern United States. Nonetheless, there are no studies of the processes by which natural ecosystem functions return to these forests as they mature. Wildlands can yield new insights into both natural processes and human activities.

Cultural value. As the eastern U.S. becomes increasingly fragmented, a regional array of expansive Wildlands in a matrix of Woodlands would distinguish New England as a destination for the appreciation of natural landscapes and their history. Wildland reserves honor and protect lands with natural, cultural, and spiritual significance, including Native American sacred areas, abandoned colonial settlements, archaeological sites, and relicts of New England history. Whether they focus the mind on science, natural history, photography, cultural history, or aesthetic and spiritual contemplation, reserves are special places for insight, reverential experience, and peaceful enjoyment.

BOX 2 TRACKING FOREST CHANGE THROUGH STEWARDSHIP SCIENCE | http://harvardforest.fas.harvard.edu/wwscience/

Wildlands can yield valuable scientific insights into forest dynamics under a continually changing environment and also provide critical references for all types of Woodland management. Rigorous scientific evaluation based on long-term measurements is erratic or absent for most managed forests and most conservation management, including wetland and forest restoration and the control of invasive plants, pests, and pathogens. As part of the *Wildlands and Woodlands* effort we have developed a simple protocol to facilitate such long-term evaluation. These methods can be applied across variously managed landscapes and utilized by anyone capable of identifying tree species and making simple measurements (Foster et al. 2010). The protocol can be applied to most forest settings; we encourage interested landowners, organizations, scientists, and others to establish monitoring plots on lands of interest. Data can be contributed to the W&W Stewardship Science web site, which will archive and share results from forests across New England. The web site will also highlight the growing number of landowners, agencies, and organizations from Connecticut to Maine that are using this system to advance scientific, educational, and management objectives. Current efforts (Figure 11) include collaborations across adjoining landscapes on lands managed by the following:

Fairfield County, Connecticut. Highstead, Redding Land Trust, Town of Redding, The Nature Conservancy, and private landowners in a heavily wooded but highly suburbanized landscape of forests, fields, and golf courses.

Worcester County, Massachusetts. Harvard University, The Trustees of Reservations, Massachusetts Audubon Society, Town of Petersham, Commonwealth of Massachusetts, and private landowners abutting the Quabbin Reservoir Reservation.

Middlesex County, Massachusetts. In the Boston suburbs, the town of Weston, Land's Sake—a nonprofit community farm and environmental education organization—and the Suburban Ecology Project of Brandeis University.

Dukes County, Massachusetts. Harvard University, Smithsonian Institution, Polly Hill Arboretum, The Nature Conservancy, the Francis Newhall Woods Nature and Wildlife Preserve, and private landowners.

Strafford County, New Hampshire. Blue Hills Foundation, New England Forestry Foundation, and Society for the Protection of New Hampshire Forests in a rural forested landscape experiencing rapid population growth and increasing development pressure.

Caledonia County, Vermont. In a heavily forested part of Vermont's Northeast Kingdom, the Vermont Land Trust, State of Vermont, and a private landowner abutting the Groton State Forest.

Piscataquis County, Maine. The Northeast Wilderness Trust with private landowners in a heavily forested landscape of Woodlands and Wildlands.

Somerset County, Maine. The Forest Society of Maine, State of Maine, and private forestland owners in a landscape of extensive Woodlands and few Wildlands.

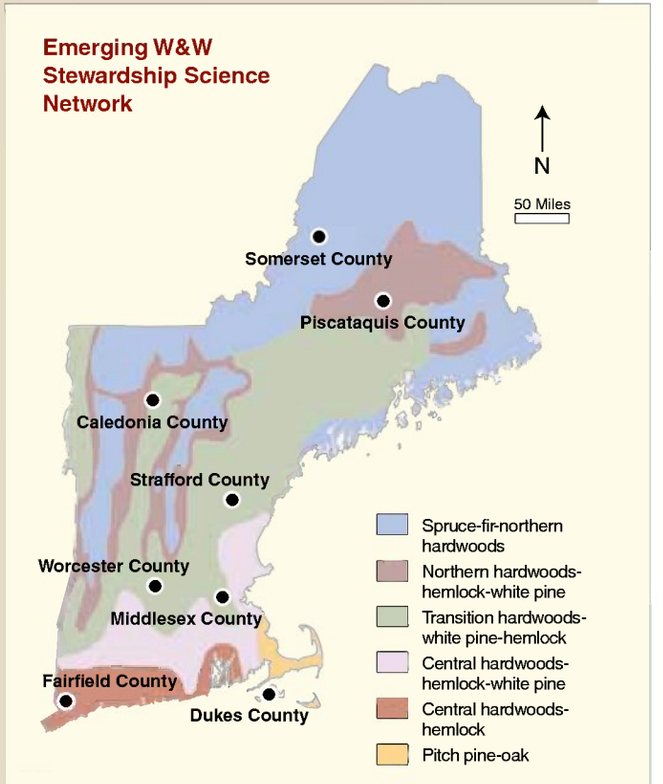


Figure 11. *A growing number of organizations, agencies, and landowners are part of the Wildlands and Woodlands Stewardship Science network, documenting forest dynamics across a wide array of stand types, management regimes, and ownerships.*

Wildlands: How large and where?

The region's existing reserves vary widely in number and size. In the south and along the Maine coast, they comprise small patches. In contrast, the northern region has protected a growing number of larger Wildlands in national forests, parks, and other conservation lands. We propose that Wildland reserves comprise proportionately large landscapes within all settings: from 5,000 to 50,000 acres across the region, and from 100,000 to 250,000 or even 1 million acres in selected areas.

From the perspectives of both biodiversity and human recreation, Wildlands play an important role in regions where the landscape is fragmented by human activity. Small (tens, hundreds, or even a few thousand acres), local reserves are key to the protection of rare species, uncommon habitats, and culturally significant landscapes. Small reserves also provide invaluable educational opportunities and contemplative retreats wherever they occur. However, such small reserves must be augmented with an expansive Wildland network to allow landscape-scale natural processes to unfold (Aber et al. 2000).

Wildlands are also vital in sparsely populated regions that are dominated by sustainably, and often intensively managed forests. Current ownership patterns argue that in southern New England, most Wildlands center on public lands (Foster et al. 2005), often enlarged substantially across adjoining private tracts. In the north, large private lands will continue to offer substantial options for Wildland designation beyond existing federal wilderness areas. There may be opportunities to expand congressionally designated wilderness in the Green Mountain and White Mountain National Forests. However, new wilderness proposals must be considered within the context of recent

designations and multiple-use mandates. All Wildland reserves should be carefully conceived and scaled based on local, landscape, and regional considerations, such as extent of fragmentation, existing ownership patterns and development pressures, and level of local community support. Ideally, all Wildlands would be buffered by surrounding Woodlands (Hunter 1999).

In many places, the most effective Wildland design involves cooperation among abutting landowners, like conservation groups, municipalities, and state or federal government. Individuals may also dedicate their land, protected by appropriate conservation easements, to extend the effective size of an adjoining reserve.

How should Wildlands be managed?

The fundamental principle guiding Wildland management should be to allow natural characteristics, processes, and species to thrive without direct human intervention. To support this objective, the reserves should be legally designated wherever possible. The intent of creating Wildland reserves is not to return to an idealized past or pristine condition. Both are impossible given history and ongoing environmental change. But over time, Wildlands take on an increasingly wild and natural appearance, becoming dominated in many places by immense trees and wide open understories, and populated by diverse plants and interior forest birds (see Box 3: Wildlands, Stonewalls, and Railbeds).

Encouraging the wild character of Wildlands means prohibiting most direct human impacts, notably the extraction of timber and minerals, and the construction of new infrastructure such as roads, dams, powerlines, and towers. The management of existing infrastructure and use would need to be carefully evaluated in the context of current recreation access (e.g., foot, motorized and non-motorized boats, horseback, bicycles, ATVs, snowmobiles, and cars). In many cases it would be appropriate to eliminate existing human structures or convert roads into footpaths. The ecological and human values associated with wilderness would be best served by restricting use to limited, low-impact recreation such as hiking, camping, fishing, and frequently, hunting.

Many other management issues will arise within Wildlands, and guidance can be gained from experiences in other eastern wildlands in New York's Adirondack Park, the Allagash Wilderness Waterway, Baxter State Park, and White and Green Mountain National Forests. These issues include: (1) control of invasive exotic plants, insects, and diseases; (2) regulation of native herbivores such as moose, deer, and spruce budworm; (3) active management with fire; (4) reintroduction of extirpated species; and (5) guidelines for research and educational activities.

Our stewardship of reserves, and indeed of all forests, must acknowledge the limits to our understanding of complex and dynamic ecosystems (Lindenmayer et al. 2004). History underscores the need for healthy skepticism concerning the human ability to protect, repair, or improve upon nature (Foster and Orwig 2006). When confronted with severe wind, ice storms, or insect outbreaks, we must resist instinctive calls for "salvage" or "restoration" in Wildlands and other forests (Foster and Orwig 2006). Similarly, facing invasive organisms, we should question the urge to apply pesticides, introduce biological controls, find replacement species, or remove threatened species preemptively. And, with climate change looming, we must question assertions of our ability to manage nature to adapt to sweeping change. There are good and necessary reasons to manage much of nature sustainably for our own ends. But, in many situations, the best approach may be to do nothing other than watch, document, and learn—accumulating the knowledge to act well in recognition of risk and uncertainty (Aber et al. 2000).

Our stewardship of reserves, and indeed of all forests, must acknowledge the limits to our understanding of complex and dynamic ecosystems.

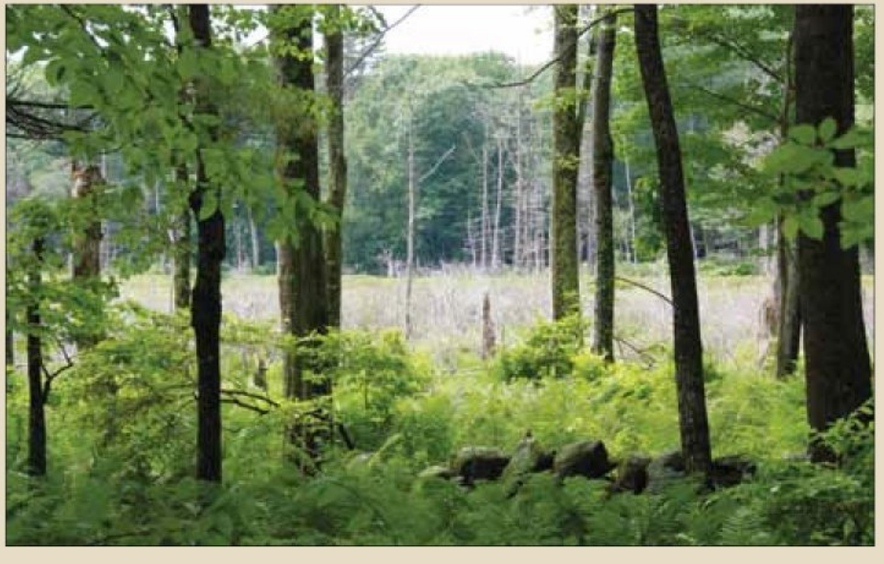
BOX 3 WILDLANDS, STONEWALLS, AND RAILBEDS

The notion may seem incongruous: encouraging natural processes to predominate in New England where four centuries of intense human activity have touched nearly every acre, and where evidence of that history appears in almost every forest. What is the value of creating large reserves that support ancient forests and natural processes driven by wind, ice, and tree death, when all of this occurs alongside stonewalls, cellar holes, woods roads, and rail beds? Can these areas be true Wildlands, and what ecological and social benefits would they provide?

New England has a grand history of supporting wild forests in its humanized landscape and allowing natural and cultural features to intermingle across the land. Henry David Thoreau is perhaps most famous for such a stance, as he relished pastoral life in Concord, Massachusetts, while also seeing in it a native beauty that led to his declaration that "in wildness is the preservation of the world." Thoreau's fascination with the ability of trees and forests to reclaim the agrarian landscape led him to document the initial stages in the nineteenth-century rewilding of New England in "The Succession of Forest Trees" (Foster 1999).

Elsewhere in Massachusetts, The Trustees of Reservations balances the preservation of natural and cultural landscapes. Across New England, many organizations, including the New England Forestry Foundation, The Nature Conservancy, and the Society for the Protection of New Hampshire Forests protect actively managed forests alongside reserves. Meanwhile, New England's expansive federal wilderness areas, comprising more than 100,000 acres in the White and Green Mountains alone, bear many reminders of their intense human use and abuse, including the high grading and clear-cutting of virgin stands and post-logging wildfires. Despite the presence of abandoned roads and rail beds within them, these federal wilderness areas in New Hampshire, Maine, and Vermont promote critical ecological processes and dispersed recreation that make them among the premier conservation landscapes in New England.

Across New England lie countless ancient woodlots that were cut, burned, and grazed throughout their colonial past, but today exhibit little evidence of these impacts to even the careful eye (Foster et al. 1996). Indeed, painstaking studies of soils, tree rings, fossil pollen, and charcoal are often required to reveal conclusive evidence of this history (McLachlan et al. 2000). Left alone and subject to natural processes, these forests develop many old-growth attributes in the span of a few human generations or less; in time, nature reasserts itself, offering testament that visions of future wildness are well founded.



Historical and archaeological research lends support to the establishment of Wildlands in humanized landscapes. Worldwide, studies confirm that few landscapes are truly pristine and that many of our most cherished and diverse forest ecosystems have supported substantial human populations and activity in the past (Denevan 1992). Across the Amazon Basin from Brazil to Bolivia, thick soil layers, "terra preta," are blackened with charcoal and laden with pottery shards—evidence of once thriving civilizations and tumultuous landscape changes. Further north, the expansive forest landscape of the Yucatan peninsula once supported a highly advanced agricultural society (Turner et al. 2003). To even a trained eye, the modern neotropical forests and land appear natural and ageless, but close scrutiny reveals ancient stone walls, house mounds, and magnificent temple sites beneath thick forest canopies. Despite a history of intense human activity, these landscapes support extraordinary biodiversity and thriving natural processes today.

The assumption that nature lacks a human past denies the rich history that precedes us and the legacy of that cultural presence on our land. In creating new wild places in the landscape today, we seek to incorporate, understand, and embrace, rather than deny, this history of the land.

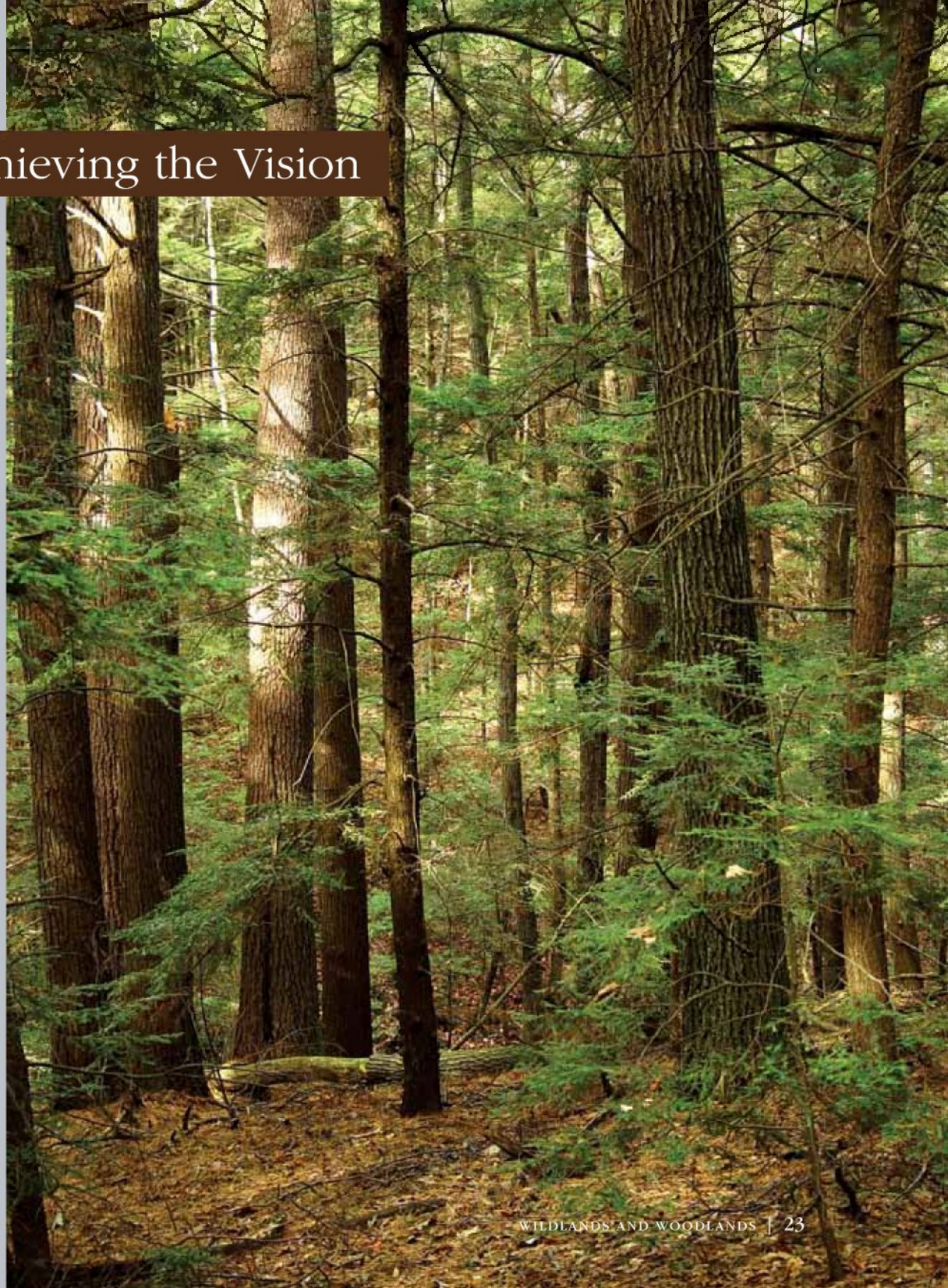
Wildlands and Woodlands: Achieving the Vision

Based on New England conservation trends, roughly a doubling in the rate of land protection will be needed to achieve the *Wildlands and Woodlands* vision of retaining 70% of the landscape as forest over the next 50 years (Levitt and Lambert 2006, TPL 2009). Viewed in the context of major civil works projects, the attendant investment in the green infrastructure of forests has many benefits. For example, the "Big Dig," which reconfigured Boston's highway system, cost taxpayers nearly $15 billion. In comparison, forests extend their benefits across all of New England and work 24 hours a day to filter drinking water, reduce floods, purify air, produce wood products, support the tourism industry, and sequester carbon to mediate climate change. Well-placed conservation also pays additional dividends by reducing the costs of municipal services and ensuring that new development takes full advantage of existing roads, sewers, schools, and other infrastructure (Stein et al. 2010). Moreover, protected working forests support a steady supply of local wood to maintain the region's forest-based economy and the emergence of a sustainable bioeconomy that is less reliant on fossil fuel.

Achieving the *Wildlands and Woodlands* vision will require:

- increased engagement with landowners through regional conservation partnerships,
- expanded approaches to forest conservation,
- development of innovative finance strategies, and
- greater reliance on policy and planning tools.

Together these activities can help build the capacity and resources needed to increase the rate of forest land protection, support forest stewardship and economic opportunity, shepherd sensible development, and decrease forest loss. However, these approaches are only a beginning. This vision must be realized and championed by the individuals, organizations, and communities that depend upon the land and are invested in shaping its future.

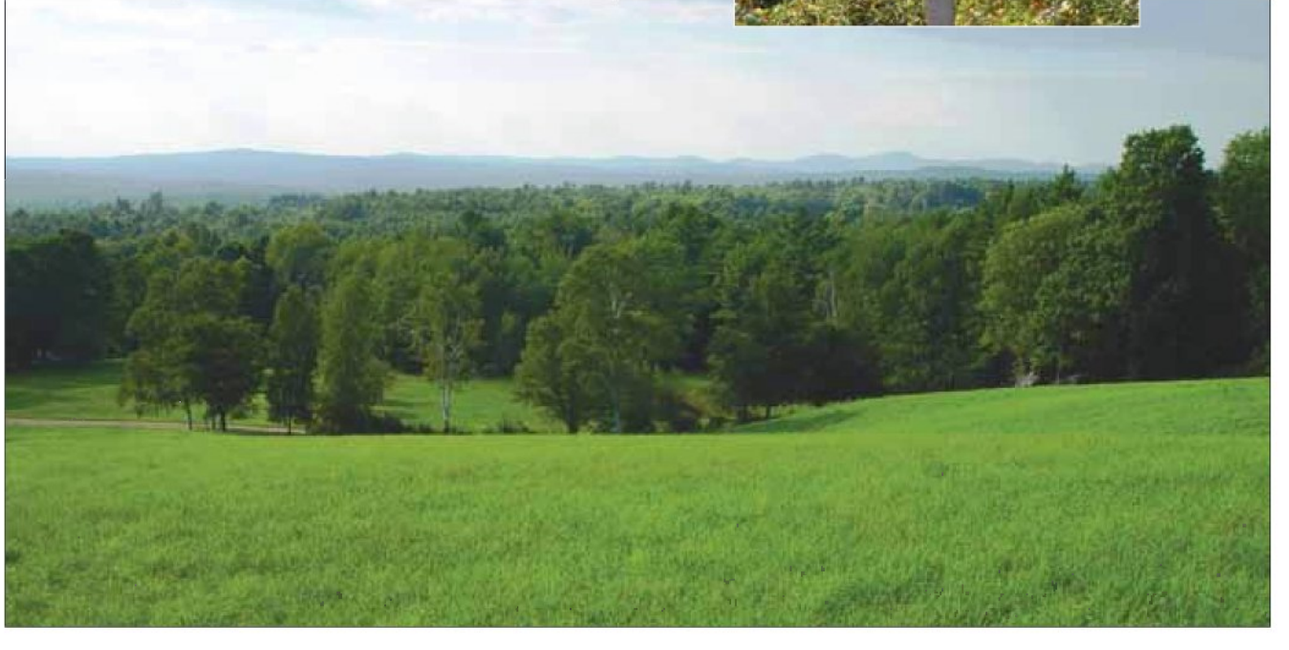


WOODLAND COUNCILS AND REGIONAL PARTNERSHIPS

Purpose: Engage and assist private landowners in improving management and ensuring permanent conservation of their forests.

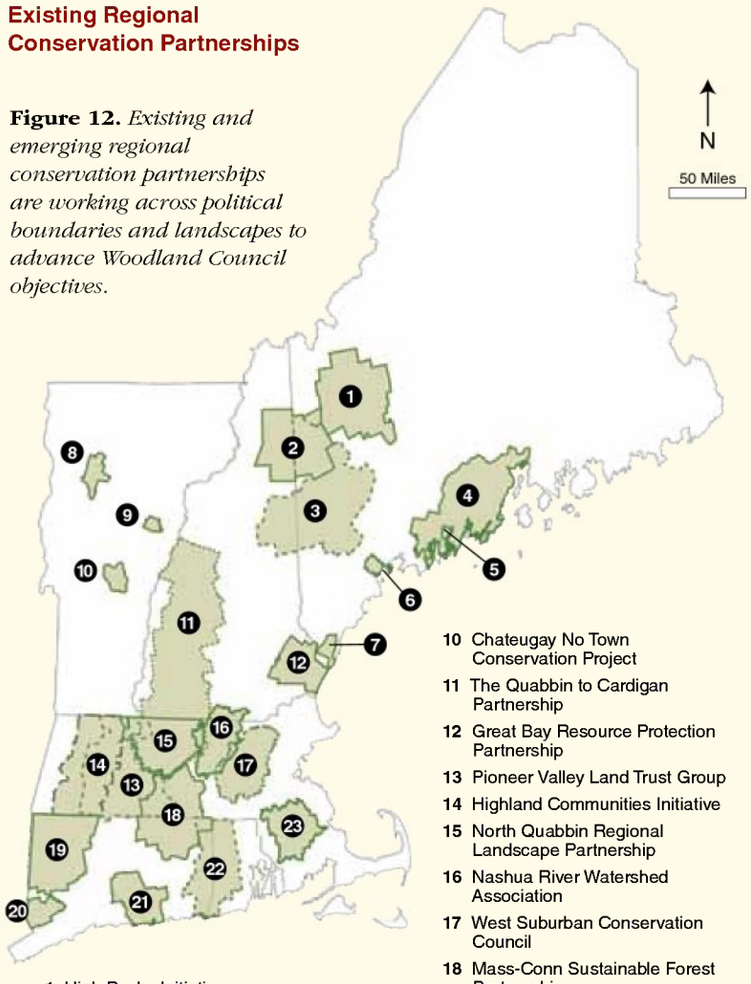
Protecting and sustainably managing millions of acres of forest in thousands of intermingled ownerships is a daunting proposition. This cannot be accomplished by sweeping public acquisition or regulatory fiat. The 2005 *Wildlands and Woodlands* vision for Massachusetts called for the formation of Woodland Councils—regional partnerships of existing groups sharing common interests—to enhance communication and outreach, increase efficiency, advance land protection, and provide networks of support, information, and expertise to landowners and community leaders. Woodland Councils represent a collaborative, bottom-up, and voluntary approach that engages the remarkable conservation capacity of existing organizations, agencies, and individuals to provide structure and guidance for those who aspire to conserve and manage their forests. Our 2005 recommendation was based on the conviction that locally connected groups know their land, communities, and residents best and can thus determine the priorities and solutions likely to succeed in each locale. We also recognized that the public sector could not "buy it all" or "do it all" when it came to a conservation vision at the scale of the *Wildlands and Woodlands* vision.

In the last five years a growing network of such partnerships, with partial funding for their activities, has emerged from Connecticut to Maine (see Box 4; Figure 12). At the time of this publication's writing, more than ten of these regional consortia have begun to meet to compare strategies, identify common challenges, and discuss means of furthering their collective goals. A recent grant to a number of partnerships will support part-time coordinators and educational programs for woodland owners, foresters, and local officials in 105 towns—a significant impetus to the collective work of existing organizations. The *Wildlands and Woodlands* vision depends on extending these efforts and building the capacity to reach hundreds of thousands of private landowners and local decision makers in a consistent and meaningful way.



Existing Regional Conservation Partnerships

Figure 12. *Existing and emerging regional conservation partnerships are working across political boundaries and landscapes to advance Woodland Council objectives.*



1 High Peaks Initiative
2 Mahoosuc Initiative
3 Upland Headwaters Alliance
4 Twelve Rivers Collaborative
5 River Link
6 Portland North Land Trust Collaborative
7 Mt. Agamenticus to the Sea Conservation Initiative
8 The Chittenden County Uplands Conservation Project
9 Orange County Headwaters Project
10 Chateugay No Town Conservation Project
11 The Quabbin to Cardigan Partnership
12 Great Bay Resource Protection Partnership
13 Pioneer Valley Land Trust Group
14 Highland Communities Initiative
15 North Quabbin Regional Landscape Partnership
16 Nashua River Watershed Association
17 West Suburban Conservation Council
18 Mass-Conn Sustainable Forest Partnership
19 Litchfield Hills Greenprint Collaborative
20 Fairfield County Regional Conservation Partnership
21 The Lower Connecticut River and Coastal Region Land Trust Exchange
22 The Borderlands Project
23 Taunton River Coalition

BOX 4 THE WILDLANDS AND WOODLANDS PARTNERSHIP

www.wildlandsandwoodlands.org

The Wildlands and Woodlands Partnership is a growing network of more than 60 organizations that share information, coordinate activities, and collaborate where interests overlap to advance the *Wildlands and Woodlands* vision. Established in the fall of 2006, the group's early leaders came from the Henry P. Kendall Foundation, Massachusetts Audubon Society, The Nature Conservancy, The Trustees of Reservations, the Appalachian Mountain Club, Mount Grace Land Conservation Trust, and Highstead. The Partnership's membership has doubled in the last two years as the group moves from discussion of the vision to its implementation.

The Partnership is itself a model for collaboration. It serves as a network and catalyzing coalition with flexible leadership, member-led activities, and a horizontal structure in which all partners have equal standing. With the assistance of a part-time coordinator, its steering committee and diverse membership provide a forum for conservationists, scientists, foresters, ecologists, planners, business owners, landowners, and recreationists to explore and promote new alliances. Access to information and opportunities for new initiatives encourages active participation in working groups that advance land protection, regional partnerships, communications, fundraising, conservation finance, scientific inquiry, and climate change policies.

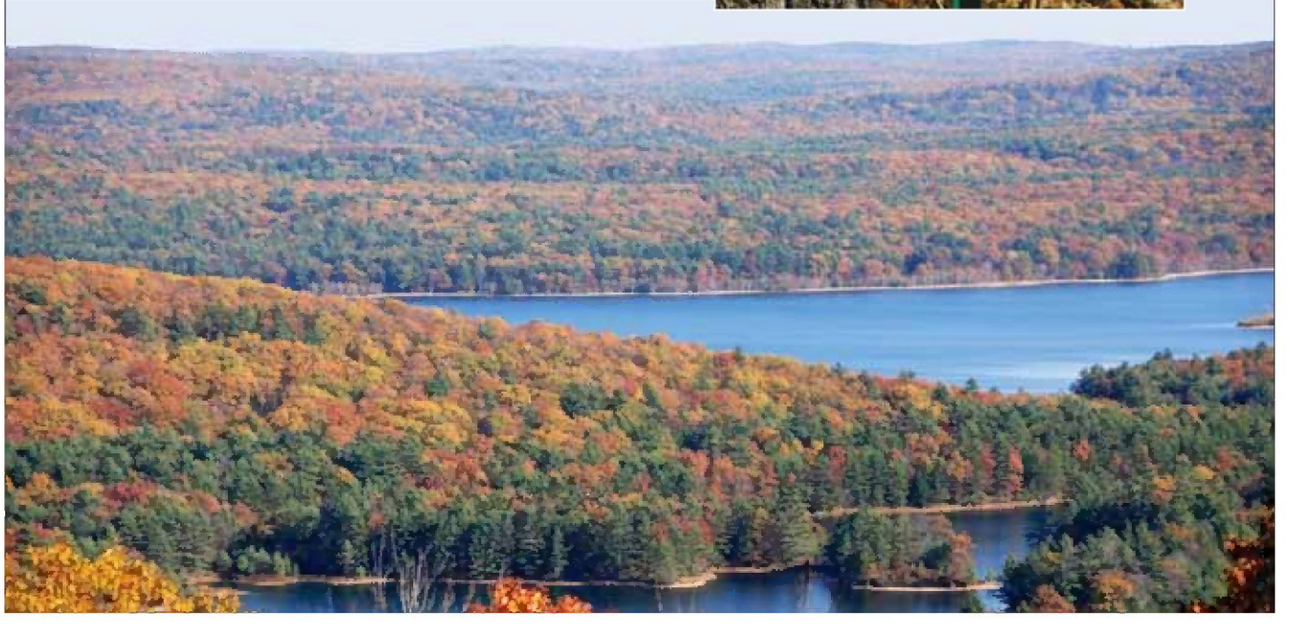
Purpose: Pioneer new conservation mechanisms to ensure that lands remain permanently forested.

Conservation aggregation: from parcels to landscapes

Northeastern forests are comprised of hundreds of thousands of private ownerships ranging from ten to many thousands of acres in size. In many areas, conserving large, continuous forest blocks will require work with dozens of landowners to weave the parcels together. Conservation aggregation refers to the process of working with multiple landowners in a single region to share expertise and resources and to advance conservation across many individual parcels of land simultaneously (see Box 5: Case Studies in Forest Aggregation). Bundling small projects into a shared conservation effort can expand organizational capacity, gain greater economies of scale, and increase the benefits available from the forest products and ecosystem services that the reconnected land may yield.

Benefits of Conservation Aggregation

- *Expanded organizational capacity.* Through aggregation, hundreds of land trusts continue to work locally with landowners with the added benefit of a centrally coordinated professional staff.
- *Increased landowner outreach.* Education to a collection of landowners is more effective and efficient when those landowners are partners in a collaborative effort across the landscape.
- *Reduced project expenses.* Due diligence tasks such as appraisals, legal fees, and baseline documentation cost less when bid collectively. Aggregation can also help strengthen and reduce the cost of easement monitoring with centrally coordinated and funded programs.
- *Enhanced conservation outcomes.* Aggregation of projects across a larger area can enhance the collective project's conservation values (e.g., more intact forest corridors for wildlife habitat) and can also improve markets for forest products and ecosystem services via landowner cooperatives.
- *Improved fundraising success.* Collaboration can improve the likelihood of successful fundraising (i.e., a collective of organizations can reach more donors across a wider range of priorities).



Large-scale conservation

New England's conservation landscape is punctuated by many sizable tracts that demonstrate the important role that large-scale conservation has played in the region and can continue to play in the future. While many of these lands are nationally recognizable and visited by millions (e.g., Acadia National Park, Cape Cod National Seashore), others are better known and cherished regionally (e.g., White Mountain National Forest, Green Mountain National Forest, Baxter State Park). Scores receive intensive local use, and others simply blend into the broad woodland expanse that supports regional resource and environmental needs.

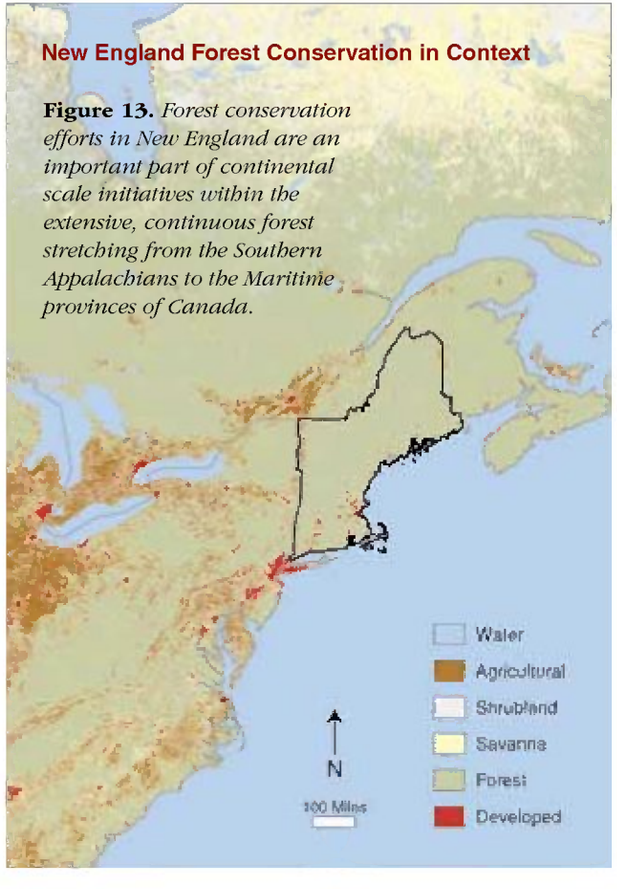


Figure 13. *Forest conservation efforts in New England are an important part of continental scale initiatives within the extensive, continuous forest stretching from the Southern Appalachians to the Maritime provinces of Canada.*

In recent decades, large-scale forest conservation has continued—across the northern region of New England in particular. Concern over the break-up and sale of large industrial ownerships led to the creation of the U.S. Forest Service's Northern Forest Land Study (1988–1990) and the Northern Forest Lands Council (1990–1994), while also spurring increased forest protection through conservation easements. The sizable ownerships in the north have offered great opportunity for large-scale conservation, such as the 750,000-acre Pingree project advanced by the New England Forestry Foundation.

Significant private foundation investments in northern New England have often protected the largest parcels. Maine's greatest conservation accomplishments have been due to philanthropy, including Baxter State Park, Acadia National Park, and the nearly 100,000 acres acquired over the last decade by Roxanne Quimby. The Nature Conservancy's St. John River Forest in Maine provides a large-scale, privately-owned model of the *Wildlands and Woodlands* approach to pairing working lands with wild reserves.

Collectively, these expansive conservation projects testify to the potential for inspired individuals and organizations to drive major advances in large-scale land protection. This approach depends on the focused efforts of individual conservation philanthropists, public agencies, and major conservation organizations, and should continue to help define the conservation future of New England.

BOX 5 CASE STUDIES IN FOREST AGGREGATION

Aggregation—the bundling of many land protection projects into landscape-wide or regional efforts—is a relatively new approach, well illustrated by two successful landscape-level projects involving the Mount Grace Land Conservation Trust and the North Quabbin Regional Landscape Partnership (NQRLP). In the Tully Valley Private Forestlands Initiative, the Massachusetts Executive Office of Energy and Environmental Affairs funded the protection of nearly 100 properties, totaling 9,114 acres (Nudel 2003). Following on that achievement, the Quabbin Corridor Connection project protected more than 20 properties with funding from the Forest Legacy program of the U.S. Forest Service. The NQRLP itself arose from a historical analysis of the pattern of land protection in the North Quabbin region in an undergraduate student thesis. In conclusion the student recommended that conservation would proceed most efficiently if the 25 groups shared information, identified similar objectives, and collaborated on regional projects (Golodetz and Foster 1997).

Today, an innovative aggregation project is being advanced by the New England Natural Resources Center in collaboration with eight land trusts and four private consulting foresters in Western Massachusetts. This project is the first broad-based collaboration in the Northeast in which local, regional, and global conservation organizations are partnering to accomplish landscape-scale conservation across multiple private ownerships. The project involves the purchase and donation of conservation easements on forests owned by 77 families and exceeding 12,600 total acres (http://www.newenglandforestry.org/). Collectively, the lands hold nearly 30 miles of waterfront along ponds, rivers, and streams. Properties were selected by local land trusts based on their familiarity with local and regional conservation priorities and the interests of families who owned land in their area. Each organization secured local funding for appraisals and negotiated 18-month options to purchase conservation easements at 75% of appraised value.

Purpose: Advance innovative approaches to finance land conservation and to enhance the economic return of sustainably managed woodlands.

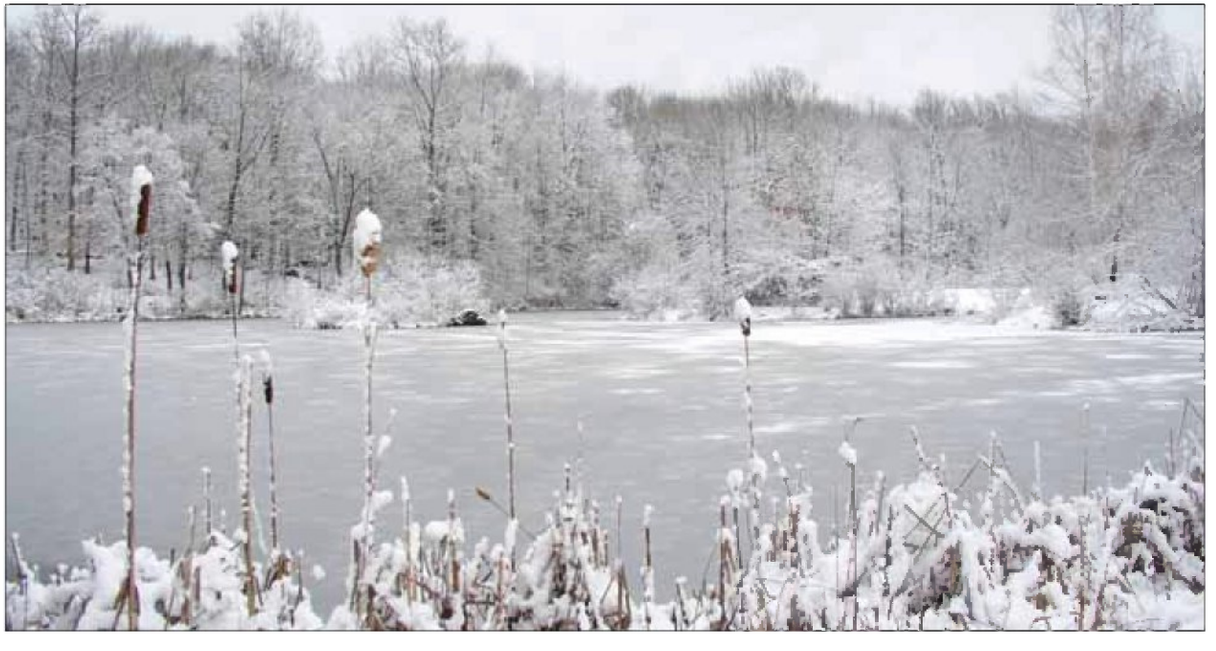
New England has a rich history of conservation but lags many regions in the U.S. in acreage of conserved land per capita. According to the Trust for Public Land, for every person in the region, there are 0.34 acres of land conserved through state and federal funding. Of the seven other major regions in the country, only the Mid-Atlantic has a lower level of conservation, at 0.18 acres per capita (TPL 2009). Fortunately, successful conservation funding programs already exist here in New England, and several initiatives are calling their attention to the future of the region's forests. These include the New England Governors' Conference Blue Ribbon Commission (Barringer et al. 2009) and a legislatively appointed Special Study Commission on Financing Forest Conservation. The ideas outlined here and the examples provided in Table 1 are intended to build on and contribute to these efforts by highlighting some of the emerging opportunities in conservation finance in New England.

Based on New England conservation trends, roughly a doubling in the rate of land protection will be needed to achieve the Wildlands and Woodlands *vision over the next 50 years.*

Public budgets and bonds

Increase bonding authority with dedicated revenues for conservation. State and municipal governments typically finance land acquisition through bonds that are approved by voters as part of larger conservation and economic development packages. Dedicated revenue sources to service conservation bonds could pave the way for more generous and consistent bond programs. Several states have programs that supply dedicated funding that could be emulated or expanded in New England through a variety of means, including real estate transfer tax programs or contributions from a general sales tax on products logically coupled with conservation, like gasoline.

Enhance federal funding for land conservation. While many federal funding programs exist, there remains a several hundred million dollar backlog of unmet conservation funding needs in the six New England states alone (McIntosh 2009). To address this need, Congress could permanently dedicate full funding for the Land and Water Conservation Fund at the authorized level of $900 million. Consideration could also be given to expanding support for forest conservation through the U.S. Department of Agriculture, the Conservation Reserve Program of the Natural Resources Conservation Service, and the Pittman-Robertson Wildlife Restoration Act, which provides federal funds generated by an excise tax on hunting gear for state fish and wildlife habitat restoration efforts.



Tax incentives

Enhance income tax incentives and make them permanent. The donation of a conservation easement is generally considered a charitable contribution, entitling the landowner to an income tax deduction or credit. The federal income tax deduction for conservation easements, enacted in 2006, allows taxpayers to deduct an amount equal to the value of their donation. Given this program's success in accelerating the protection of forests and farms, a case can be made for making it permanent and enhancing the deductions that are allowed. At the state level in New England, only Massachusetts has passed a state income tax deduction for conservation land gifts. This program could serve as a model for other states and perhaps be augmented by making deductions transferable to a third party.

Promote property tax incentive programs. Current use programs reduce tax burdens by taxing forestry and agricultural land based on the value of its use, rather than on its "highest and best use" or development value. Current use programs could be enhanced by keying incentives to the resource protected, level of protection provided, and type of forest management plan adopted. They could also be used to encourage permanent conservation by requiring a right-of-first-offer or right-of-first-refusal provision in the event of future sale. Although forestlands typically incur lower per-acre public service costs than developed lands, taxing these lands at full highest and best use value has made them net revenue generators for many towns. As enrollment in these programs expands, program costs and benefits should be reviewed on a state-by-state basis (Levitt and Lambert 2006) in order to evaluate the extent to which they prevent, rather than simply defer, land-use conversion.

Philanthropic initiatives

Target philanthropic investment. New England has a long history of philanthropic investment in conservation. Building on this tradition, a philanthropic initiative aimed at advancing the *Wildlands and Woodlands* vision could provide critical support for Woodland Councils or similar partnerships. A targeted initiative could highlight and expand existing efforts to provide crucial operating capital and gap funding to organizations conducting direct land conservation through traditional means as well as through aggregation efforts or large-scale projects.

Ecosystem markets and legal settlement funds

Expand mitigation programs. Wetland mitigation is required by federal law for unavoidable impacts to water resources. Mitigation banks facilitate the exchange of funds to wetlands restoration projects to compensate for these impacts. The institution of mitigation banking rules across all six New England states could offer valuable potential revenue streams to landowners. It may also be feasible for New England states to adopt an acreage-based program to mitigate the loss of forests and forest functions associated with some types of development. Protocols have been drafted for a similar program in Maryland. Importantly, one key element of successful mitigation programs is to ensure that they do not promote payments for lands or services that are already legally protected from development (Wilkinson et al. 2009).

Align settlement funds with conservation priorities. In addition to mitigation markets, efforts could be increased to connect environmental penalty settlements and natural resource damage claims with forest conservation priorities in the region. The Natural Resource Damage Assessment and Restoration Program, administered through both state and federal agencies, provides millions of dollars for land conservation to compensate for damage to public resources associated with oil spills or other forms of contamination. Access to funds could be improved by creating intermediaries that connect funding sources from settlement funds and damage claims with land conservation projects.

Develop carbon sequestration markets. Markets are emerging for carbon benefits associated with both afforestation and intentionally-avoided deforestation at the state, regional, and international level. In some cases, forests sustainably managed for biomass and energy might also be eligible to earn additional credits if they offset more carbon-intensive energy sources. Potential investors for carbon and other emerging ecosystem markets could include large institutions, such as universities and health care providers that want to reduce their environmental footprint (Levitt and Lambert 2006, Mater 2009). Currently, markets are limited by the lack of a coherent federal policy. However, given increased public and policy awareness of the risks of climate change and the relatively low cost of forest-based solutions, it is likely that the opportunities for forest carbon markets will expand in coming years.

Forest-based economies

Explore forest banks. Achieving the *Wildlands and Woodlands* vision will require a reduction in development pressure resulting from significant improvements in the economic return on forestlands. The establishment of forest banks could be revisited as an approach to conserving private, non-industrial forestland. In this approach, a landowner places his or her land into the forest bank, ceding development rights in exchange for an annual payment based on the assessed value of the standing timber (Sullivan et al. 2005).

Expand marketing cooperatives. One way to strengthen local, forest-based economies is to form cooperatives to stimulate the growth of markets for locally grown, green-certified products. Effective cooperatives can engage in comprehensive marketing campaigns, attract new forest-based businesses to the region through long-term supply agreements, and catalyze the development of the commercial and industrial infrastructure necessary to support a thriving forest products industry. Land trusts can assist cooperatives by collaborating to promote sustainable forestry and sustainably produced forest products.

Develop portfolios of incentives for forestland owners. Combining revenue streams with other incentives is critical to the long-term economic viability of forest ownership (D'Amato et al. 2010). Many of the programs outlined above could be promoted through extension agents, state foresters, and Woodland Councils (cf. www.massacorn.net/). These entities could expand current efforts to educate landowners about their full range of options and work with them to bundle appropriate economic incentives. The mix in any particular landowner's portfolio would depend on his or her specific interests and objectives, but might include the sale of ecosystem services, federal Forest Legacy funding, enrollment in current use tax programs, forest products certification, sale of conservation easements, and participation in community-based cooperatives or value-added manufacturing.

TABLE 1. CONSERVATION FINANCE: OPTIONS AND EXAMPLES

Category	Programs	Examples
Public budgets & bonds	Increased state bonding authority	• Land for Maine's Future • Massachusetts 2008 Environmental Bond
	Dedicated revenues for conservation	Real estate transfer tax: • Massachusetts Community Preservation Act • Block Island transfer tax • Maryland Open Space program
	Public budgets & appropriations	Independent state-supported funding agencies: • Vermont Housing and Conservation Board • New Hampshire Land and Community Heritage Investment Program
	Full funding for federal programs	• Land and Water Conservation Fund – National Park Service
	Expanded federal programs	• USDA Forest Legacy and Conservation Reserve Programs
Tax incentives	State and federal income tax incentives	• 2006 Federal Pension Protection Act • 2009 Massachusetts Land Conservation Incentives Act
	State property tax incentives	• Current use taxation programs
Philanthropic initiatives	Donations & foundation grants	• Pingree Forest Partnership – easement on 762,000 acres • St. John River Forest project – purchase of 185,000 acres • Western Mass. Aggregation project – seeks to purchase easements on 12,600 acres (77 ownerships)
Ecosystem markets & legal settlement funds	Forest carbon offsets	• California Forest Protocols for forest management, conservation • NE Regional Greenhouse Gas Initiative offsets standards
	Wildlife & wetland mitigation programs	• Maine Natural Resource Mitigation Fund • Maryland No Net Forest Loss Act
	Settlement fund matching programs	• New Jersey Natural Resource Conservation Inc. • Natural Resource Damages Assessment & Restoration programs

BOX 6 UNDERSTANDING CONSERVATION EASEMENTS

Conservation easements, or conservation restrictions, are voluntary, legally binding agreements that limit certain uses (e.g., development) on a parcel of land in order to protect designated ecological or open-space values. The donation or sale of easements represents one of the most cost-effective approaches to conservation and also one of the most common tools for retaining private land in an undeveloped condition (Cronan et al. 2010, Lilieholm et al. 2010). Since easements usually involve a tax break for the landowner, they carry an attendant responsibility to provide public benefit and transparency by disclosing easement details (Pidot 2005). Several organizations have developed proposals to strengthen public trust in conservation easements. Massachusetts has a central registry of all easements and Maine has a new statewide registry. These programs provide information needed to map easements and document the nature of the conservation restrictions, both of which are important to effective easement monitoring. In addition to registries, efforts such as those by the Land Trust Alliance to develop accreditation programs that promote best management practices will strengthen the transparency and effectiveness of conservation easements in the future. Continued attention should be paid to evaluating and refining conservation easements in order to ensure that they meet growing public expectations and demands, and that they remain a vital tool for forest and farmland conservation in New England.

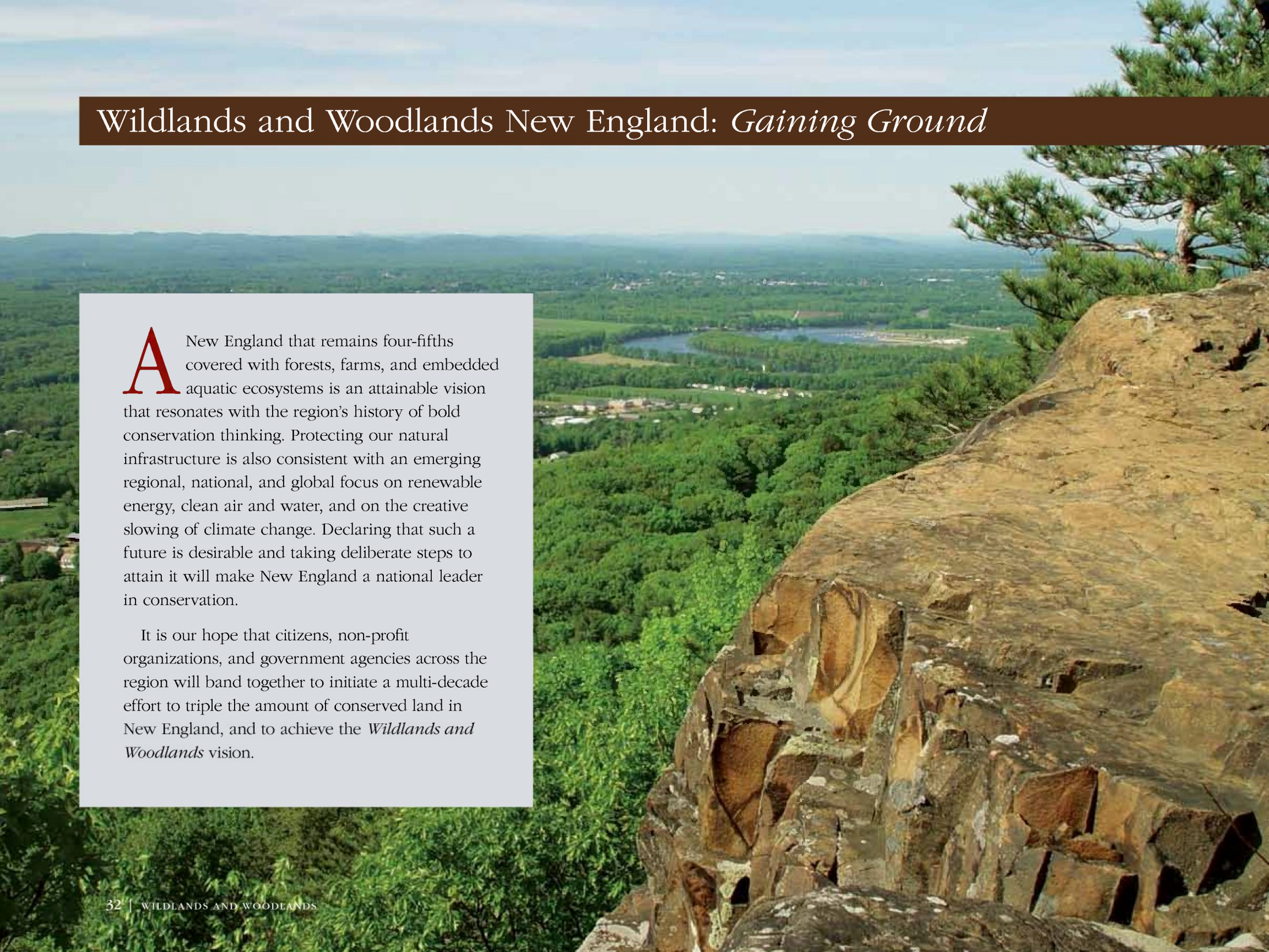
Purpose: Promote non-fee strategies for forest conservation, including alternatives to conventional development.

The *Wildlands and Woodlands* vision will require more than fee and easement acquisitions to succeed. Current zoning ordinances in many communities actually accelerate the loss of forests and farmland by making large lots the default zone and requiring special permits for cluster development. These development patterns can be expensive for states and communities. In Maine, new school construction in areas of sprawling development has cost over $200 million, despite declines in student numbers (Brookings Institution 2006). Policies and planning tools should be aimed at making more efficient use of land, reducing the cost of municipal and state services, and providing fair housing to meet community needs.

Strategically placed acquisitions and easements could be used to redirect growth to less sensitive areas and to complement zoning to create more permanent urban growth boundaries.

Development pressures could be directed in a more ecologically sound manner through land use policies that encourage higher residential dwelling densities, as well as cluster, transit-oriented, mixed-use, and adaptive re-use development. These policies could include: incentives, density bonuses, and regulatory allowances for preserving open space; more flexible road and utility standards within limited development projects; and access to state funds at lower municipal rates when at least 50% of a parcel is conserved as open space (Levitt and Lambert 2006). In some areas of New England, transferable development rights could be used to channel development into suitable growth areas while compensating landowners for lost development rights in other areas (Lilieholm 2007). Strategically placed acquisitions and easements could be used to redirect growth to less sensitive areas and to complement zoning to create more permanent urban growth boundaries.

Wildlands and Woodlands New England: *Gaining Ground*



A New England that remains four-fifths covered with forests, farms, and embedded aquatic ecosystems is an attainable vision that resonates with the region's history of bold conservation thinking. Protecting our natural infrastructure is also consistent with an emerging regional, national, and global focus on renewable energy, clean air and water, and on the creative slowing of climate change. Declaring that such a future is desirable and taking deliberate steps to attain it will make New England a national leader in conservation.

It is our hope that citizens, non-profit organizations, and government agencies across the region will band together to initiate a multi-decade effort to triple the amount of conserved land in New England, and to achieve the *Wildlands and Woodlands* vision.

Wildlands and Woodlands *will require renewed effort across many fronts. Below we outline some of the steps that could be taken over the next five years to help make this vision a reality.*

Landowners and Citizens

- Advocate for the *Wildlands and Woodlands* vision with government officials and take an active role in state forest conservation policy and funding.
- Reflect on the future of your property and its role in the wider landscape. Consider some form of protection from development now, or as part of your estate or succession plan when you pass your land on to the next generation.
- Join or create a Woodland Council or other organization active in fostering local conservation and landowner education.
- Talk with neighbors, friends, and others in your town about the options for the future of their land. Refer them to additional sources of information, including this document and www.wildlandsandwoodlands.org.

State and Local Governments

- Establish targets for retaining Woodlands in each state.
- Propose statutory language and funding for the planning, establishment, monitoring, and preservation of large Wildland reserves on public land.
- Develop dedicated revenue sources for direct conservation or for servicing conservation bonds.
- Support enhanced current-use property tax programs that provide annual tax relief to private owners in return for maintenance of land in forests, farms, and open space.
- Institute policies that expand or facilitate markets for improved forest products and ecosystem services such as carbon sequestration and pollution abatement.
- Adopt economic development strategies that encourage development and redevelopment that is green, clustered, and resource-efficient.
- Establish programs through extension offices or Woodland Councils to work with private landowners to develop incentive portfolios that meet their needs and objectives.
- Expand existing large-scale, cross-border efforts to collaborate on *Wildlands and Woodlands* pilot projects.

Federal Government

- Fully fund the Land and Water Conservation Fund, expand the Forest Legacy Program, and assess the potential to extend the Conservation Reserve Program to forests.
- Make permanent and enhance the 2006 income tax deduction for conservation easements.
- Establish policies that support the development of markets for ecosystem services such as carbon sequestration and pollution abatement.
- Advance efforts at landscape-level conservation.

Non-governmental Organizations

- Advocate for the *Wildlands and Woodlands* vision and develop regional funding and conservation initiatives to implement an action plan.
- Advance best practices and standards for developing and monitoring conservation easements. Continue to purchase, hold, and monitor easements, including those for aggregation and large-scale conservation projects.
- Expand current Woodland Councils and regional partnerships to engage and assist private landowners and to promote the sharing of information, energy, and experience among conservation professionals.
- Advocate policies that will advance the development of ecosystem service markets for carbon and other resources.
- Work with local governments and conservation commissions to develop plans and policies that support limited development.
- Assist in marketing and promotion of sustainable and locally produced wood products.

FROM VISION TO ACTION The historic re-greening of New England offers the opportunity to retain a large portion of the landscape in forest, while at the same time ensuring the protection and long-term viability of the region's remaining farmland, achieving more carefully planned, sustainable development, and reinvigorating cities and towns. Today and in the future these actions will provide vital economic, human, and environmental benefits for the region. Even with a doubling in development and 70% of the land in forest and wetlands, 10% could remain as farms and other open spaces. With *Wildlands and Woodlands,* we seek to honor and advance the efforts of the individuals, organizations, and agencies whose legacy defines our existing conservation landscape, and whose ongoing energy is crucial to conserving the natural infrastructure upon which our future and all human endeavors depend.

REFERENCES

Aber, J., N. Christensen, I. Fernandez, J. Franklin, L. Hidinger, M. Hunter, J. MacMahon, D. Mladenoff, J. Pastor, D. Perry, R. Slangen, and H. van Miegroet. 2000. Applying ecological principles to management of the U.S. National Forests. Ecological Society of America. Issues in Ecology 6:1–20.

Barringer, R. E., P. McGowan, M. Fritz, D. Leff, D. Pizzella, L. Lyford, S. Francher, J. Difley, W. M. Sullivan, J. Coit, J. Wood, and E. O'Leary. 2009. Report of the Blue Ribbon Commission on land conservation of the New England Governors' Conference, Inc. New England Governors' Conference, Augusta, Maine.

Barten, P. K., J. A. Jones, G. L. Achterman, K. N. Brooks, I. R. Creed, P. F. Folliott, A. Hairston-Strang, M. C. Kavanaugh, L. MacDonald, R. C. Smith, D. B. Tinker, S. B. Walker, B. C. Wemple, G. H. Weyerhaeuser, Jr., L. Alexander, E. A. DeGuzman, and J. Vano. 2008. Hydrologic effects of a changing forest landscape. Committee on Hydrologic Impacts of Forest Management. National Academies Press, Washington, D.C.

Beckage, B., B. Osborne, D. G. Gavin, C. Pucko, T. Siccama, and T. D. Perkins. 2008. A rapid upward shift of a forest ecotone during 40 years of warming in the Green Mountains of Vermont. Proceedings of the National Academy of Sciences of the U.S.A. 105(11):4197–4202.

Benjamin, J. G., R. J. Lilieholm, and D. Damery. 2009. Challenges and opportunities facing the northeast bioproducts industry. Journal of Forestry 107:125–131.

Berlik, M. M., D. B. Kittredge, and D. R. Foster. 2002. The illusion of preservation: a global environmental argument for the local production of natural resources. Journal of Biogeography 29:1557–1568 and Harvard Forest Paper 26, Petersham, Massachusetts.

Bernardos, D., D. R. Foster, G. Motzkin, and J. Cardoza. 2004. Wildlife dynamics in the changing New England landscape. Pages 142–169 in D. R. Foster, and J. Aber, editors. Forests in time: the environmental consequences of 1,000 years of change in New England. Yale University Press. New Haven, Connecticut.

Brookings Institution. 2006. Charting Maine's future: an action plan for promoting sustainable prosperity and quality places. Brookings Institution, Washington, D.C.

Butler, B. J. 2008. Family forest owners of the United States, 2006. General Technical Report No. NRS-27. USDA Forest Service Forest Products Laboratory, Madison, Wisconsin.

Chilton, E. S. 2000. The archaeology and ethnohistory of the contact period in the northeastern United States. Reviews in Anthropology 30:55–78.

Cogbill, C.V., J. Burk, and G. Motzkin. 2002. The vegetation of presettlement New England, USA: spatial and compositional patterns based on town proprietor surveys. Journal of Biogeography 29:1279–1304.

Colburn, E. A. 2004. Vernal pools: natural history and conservation. McDonald and Woodward Publishing Company, Granville, Ohio.

Cousins, S., and M. Tyrell, editors. 2009. The future of Maine's North Woods. Yale Forest Forum Review 11(1). Yale School of Forestry and Environmental Studies, New Haven, Connecticut.

Cronan, C. S., R. J. Lilieholm, J. Tremblay, and T. Glidden. 2010. An assessment of land conservation patterns in Maine based on spatial analysis of ecological and socioeconomic indicators. Environmental Management. In press.

Cronon, W. 1983. Changes in the land: Indians, colonists and the ecology of New England. Hill and Wang, New York, New York.

D'Amato, A. W., and D. A. Orwig. 2008. Stand and landscape-level disturbance dynamics in western Massachusetts. Ecological Monographs 78:507–522.

D'Amato, A. W., D. A. Orwig, and D. R. Foster. 2006. New estimates of Massachusetts old-growth forests: useful data for regional conservation and forest reserve planning. Northeastern Naturalist 13:495–506.

D'Amato, A. W., P. Catanzaro, D. T. Damery, D. B. Kittredge, and K. A. Ferrare. 2010. Are family forest owners facing a future in which forest management is not enough? Journal of Forestry 108:32–38.

Damery, D., M. Kelty, J. Benjamin, and R. J. Lilieholm. 2009. Developing a sustainable forest biomass industry: case of the U.S. northeast. Ecology and the Environment 122:141–152.

Davis, M. B. 2008. Old growth in the East: a survey. Online edition. Available from: http://www.primalnature.org/ogeast/survey.html

Day, M., I. Fernandez, G. Jacobson, and R. Jagels. 2009. The meaning of a changed environment: initial assessment of climate change in Maine – forests. Pages 26–29 in Maine's climate future: an initial assessment. Report to the Maine Governor, Augusta, Maine.

DeGraaf, R. M., and M. Yamasaki. 2001. New England wildlife: habitats, natural history and distribution. University Press of New England, Hanover, New Hampshire.

Denevan, W. M. 1992. The pristine myth: the landscape of the Americas in 1492. Annals of the Association of American Geographers 82:369–385.

Donahue, B. 1999. Reclaiming the commons: community farms and forests in a New England town. Yale University Press, New Haven, Connecticut.

Donahue, B. 2007. Another look from Sanderson's farm: a perspective on New England environmental history and conservation. Environmental History 12:9–34.

Dukes, J. S., J. Pontius, D. A. Orwig, J. R. Garnes, V. L. Rodgers, N. Brazee, B. Cooke, K. A. Theoharides, E. E. Stange, R. Harrington, J. Ehrenfeld, J. Gurevitch, M. T. Lerdau, K. A. Stinson, R. Wick, and M. Ayres. 2009. Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: what can we predict? Canadian Journal of Forest Research 39:231–248.

Dunwiddie, P. W., D. R. Foster, D. Leopold, and R. T. Leverett. 1996. Old-growth forests of southern New England, New York, and Pennsylvania. Pages 126–143 in M. B. Davis, editor. Eastern old-growth forests: prospects for rediscovery and recovery. Island Press, Washington, D.C.

Elliott, C. A., editor. 1999. Biodiversity in the forests of Maine: guidelines for land management. University of Maine Cooperative Extension, Orono, Maine.

Ellison, A. M., M. S. Bank, B. D. Clinton, E. A. Colburn, K. Elliott, C. R. Ford, D. R. Foster, B. D. Kloeppel, J. D. Knoepp, G. M. Lovett, J. Mohan, D. A. Orwig, N. L. Rodenhouse, W. V. Sobczak, K. A. Stinson, J. K. Stone, C. M. Swan, J. Thompson, B. Von Holle, and J. R. Webster. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. Frontiers in Ecology and the Environment 3(9):479–486.

Evans, A. M., and R. T. Perschel. 2009. An assessment of biomass harvesting guidelines. The Forest Guild, Santa Fe, New Mexico.

Fahey, T. J., P. B. Woodbury, J. J. Battles, C. L. Goodale, S. Hamburg, S. Ollinger, and C. W. Woodall. 2009. Forest carbon storage: ecology, management and policy. Frontiers in Ecology and the Environment. 2009; doi: 10.1890/080169.

Fairfax, S. K., L. Gwin, M. A. King, L. Raymond, and L. A. Watt. 2005. Buying nature: the limits of land acquisition as a conservation strategy, 1780–2004. The MIT Press, Cambridge, Massachusetts.

Fausold, C. F., and R. J. Lilieholm. 1999. The economic value of open space: a review and synthesis. Environmental Management 23(3):307–320.

Forman, R. T. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. Jones, F. Swanson, A. Turrentine, and T. C. Winter. 2002. Road ecology: science and solutions. Island Press, Washington, D.C.

Foster, C. H. W., editor. 1998. Stepping back to look forward: a history of the Massachusetts forest. Harvard Forest and Harvard University Press, Cambridge, Massachusetts.

Foster, C. H. W., editor. 2009. Twentieth-century New England land conservation: a heritage of civic engagement. Harvard Forest and Harvard University Press, Cambridge, Massachusetts.

Foster, D. R. 1999. Thoreau's country. Harvard University Press, Cambridge, Massachusetts.

Foster, D. R., and J. Aber, editors. 2004. Forests in time: the environmental consequences of 1,000 years of change in New England. Yale University Press, New Haven, Connecticut.

Foster, D. R., and J. O'Keefe. 2000. New England forests through time: insights from the Harvard Forest Dioramas. Harvard Forest and Harvard University Press, Cambridge, Massachusetts.

Foster, D. R., and D. A. Orwig. 2006. Pre-emptive and salvage harvesting of New England forests: when doing nothing is a viable alternative. Conservation Biology 20(4):959–970.

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

Foster, D. R., D. B. Kittredge, B. Donahue, G. Motzkin, D. A. Orwig, A. M. Ellison, B. Hall, E. A. Colburn, and A. D'Amato. 2005. Wildlands and Woodlands: a vision for the forests of Massachusetts. Harvard Forest Paper 27. Harvard Forest, Harvard University, Petersham, Massachusetts.

Foster, D. R., D. A. Orwig, G. Motzkin, B. Hall, E. Faison, J. Thompson, A. D'Amato, E. Boose, J. Pallant, M. Kelty, and R. Van de Poll. 2010. Wildland and Woodland science: long-term forest measurements for ecological and conservation insights. Harvard Forest Paper No. 30. Petersham, Massachusetts. In press.

Ginn, W. J. 2005. Investing in nature: case studies of land conservation in collaboration with business. Island Press, Washington, D.C.

Golodetz, A., and D. R. Foster. 1997. History and importance of land use and protection in the North Quabbin region of Massachusetts. Conservation Biology 11:227–235.

Hagan, J. M., L. C. Irland, and A. A. Whitman. 2005. Changing timberland ownership in the Northern Forest and implications for biodiversity. Report to the National Commission on Science for Sustainable Forestry. Report No. MCCS-FCP-2005-1. Manomet Center for Conservation Sciences: Forest Conservation Program, Brunswick, Maine.

Hall, B., G. Motzkin, D. R. Foster, M. Syfert, and J. Burk. 2002. Three hundred years of forest and land-use change in Massachusetts, USA. Journal of Biogeography 29:1319–1335.

Hunter, M. L., Jr., editor. 1999. Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, UK.

Hunter, M. L., Jr., G. Jacobson, and T. Webb. 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. Conservation Biology 2:375–385.

Irland, L. C. 1999. The northeast's changing forest. Harvard Forest and Harvard University Press, Cambridge, Massachusetts.

Irland, L. C. 2004. Maine's forest industry: from one era to another. Pages 363–388 in R. E. Barringer, editor. Changing Maine, 1960–2010. Tilbury House, Gardiner, Maine.

Judd, R. 1997. Common lands, common people: the origins of conservation in northern New England. Harvard University Press, Cambridge, Massachusetts.

Keeton, W. S. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235:129–142.

Keeton, W. S. 2007. Role of managed forestlands and models for sustainable forest management: perspectives from North America. George Wright Forum 24(3):38–53.

Keeton, W. S., A. A. Whitman, G. G. McGee, and C. L. Goodale. 2010. Late-successional biomass development in northern hardwood-conifer forests of the northeastern United States. Forest Science. In press.

Kittredge, D. B. 2009. The fire in the East. Journal of Forestry April/May:162–163.

Klyza, C. M., and S. C. Trombulak. 1994. The future of the northern forest. Middlebury College Press and the University Press of New England, Hanover, New Hampshire.

Lansky, M. 2001. An ecological reserve system for Maine: are we really making progress? Maine Environmental Policy Institute, Hallowell, Maine. Available from: http://www.meepi.org/files/ml051901.htm.

Lansky, M. 1992. Beyond the beauty strip: saving what's left of our forests. Tilbury House Publishers, Gardiner, Maine.

Lansky, M. 2002. Low-impact forestry: forestry as if the future mattered. Maine Environmental Policy Institute, Hallowell, Maine.

Levitt, J. N. 2005. From Walden to Wall Street: frontiers of conservation finance. Island Press and Lincoln Institute, Washington, D.C.

Levitt, J. N., and K. F. Lambert. 2006. Report on the Woodlands and Wildlands conservation finance roundtable. A research publication of the Program on Conservation Innovation at the Harvard Forest, Harvard University, Cambridge, Masachusetts.

Likens, G. E., and J. F. Franklin. 2009. Ecosystem thinking in the northern forest – and beyond. BioScience 59:511–513.

Lilieholm, R. J., L. C. Irland, and J. M. Hagan. 2010. Changing socio-economic conditions for private woodland protection. In S.C. Trombulak, and R. Baldwin, editors. Multi-scale Conservation Planning. Springer-Verlag, New York, New York. In press.

Lilieholm, R. J. 2007. Forging a common vision for Maine's North Woods. Maine Policy Review 16:12-25.

Lindenmayer, D., D. R. Foster, J. F. Franklin, M. L. Hunter, R. F. Noss, F. A. Schmiegelow, and D. Perry. 2004. Salvage harvesting policies after natural disturbance. Science 303:1303.

Louv, R. 2006. Last Child in the Woods: saving our children from nature-deficit disorder. Algonquin Books, Chapel Hill, North Carolina.

Luyssaert, S., E. D. Schulze, A. Borner, A. Knohl, D. Hessenmoller, B. E. Law, P. Ciais, and J. Grace. 2008. Old-growth forests as global carbon sinks. Nature 455:213–215.

Maine Pulp and Paper Association. 2009. The Maine paper industry: facts about the industry, Policy Recommendations for Competitiveness. Maine Pulp and Paper Association, Augusta, Maine.

MAS (Massachusetts Audubon Society). 2003. Losing ground: at what cost? Massachusetts Audubon Society, Lincoln, Massachusetts.

Mater, C. 2009. Linking forest health and human health on America's private woodlands. The Pinchot Letter, Summer:11–12. Pinchot Institute for Conservation, Washington, D.C.

McIntosh, R. W. 2009. Financing New England land conservation in the twenty-first century. Pages 39–42 in R. Barringer et al. Blue Ribbon Commission on Land Conservation. 2009. A lasting legacy: recommendations of the New England Governors' Blue Ribbon Commission on Land Conservation. New England Governors' Conference, Inc., Augusta, Maine.

McKibben, W. 1995. An explosion of green. Atlantic Monthly April:61–83.

McLachlan, J., D. R. Foster, and F. Menalled. 2000. Anthropogenic ties to late-successional structure and composition in four New England hemlock stands. Ecology 81: 717–733.

MDEH (Maine Division of Environmental Health, Drinking Water Program). 2006. Integrating public water supply protection into the state of Maine's vision. The Report of the Resolve 029 Task Force. Submitted to the Joint Standing Committee on Natural Resources. Maine Department of Health and Human Services, Center for Disease Control.

NEFA (North East State Foresters Association). 2005. Northern Forest Lands Council 10th anniversary forum. Apr 25; Concord, New Hampshire. Available from: http://www.nefainfo.org/publications/nflc10thforumfinal.pdf.

NFA (Northern Forest Alliance). 2001. Protecting northern forest wildlands: landscape conservation for the 21st century. The Northern Forest Alliance, Montpelier, Vermont.

NHDES (New Hampshire Department of Environmental Services). 2000. Model rule for the protection of water supply watersheds. New Hampshire Department of Environmental Services. Report No. NHDES-WD-00-3. Concord, New Hampshire.

NLCD (National Land Cover Database). 2001. Multi-Resolution Land Characteristics Consortium. Available at: http://www.mrlc.gov/nlcd_multizone_map.php.

North, M. P., and W. S. Keeton. 2008. Emulating natural disturbance regimes: an emerging approach for sustainable forest management. Pages 341–372 in R. Lafortezza, J. Chen, G. Sanesi, and T. R. Crow, editors. Patterns and processes in forest landscapes: multiple use and sustainable management. Springer, the Netherlands.

NRCS NRI (National Resources Inventory). 1982. Available at: http://www.nrcs.usda.gov/technical/NRI/.

Nudel, M. 2003. Better conservation through partnerships. Exchange: The Magazine of the Land Trust Alliance 22:17–21.

Nunery, J. S., and W. S. Keeton. 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. Forest Ecology and Management. In press.

Orwig, D. A., C. V. Cogbill, D. R. Foster, and J. F. O'Keefe. 2001. Variations in old-growth structure and definitions: development and dynamics of forests on Wachusett Mountain, Massachusetts. Ecological Applications 11:437–452.

Orwig, D. A., R. C. Cobb, A. W. D'Amato, M. L. Kizlinski, and D. R. Foster. 2008. Multi-year ecosystem response to hemlock woolly adelgid infestation in southern New England forests. Canadian Journal of Forest Research 38:834–843.

Pelley, J. 2009. Old growth forests store a treasure trove of carbon. Environmental Science and Technology 43:7602–7603.

Pidot, J. 2005. Reinventing conservation easements: a critical examination and ideas for reform. Policy Focus Report. Lincoln Institute of Land Policy, Cambridge, Massachusetts.

Platt, R., editor. 2006. The humane metropolis: people and nature in the 21st century city. University of Massachusetts Press and Lincoln Institute of Land Policy, Amherst, Massachusetts, and Cambridge, Massachusetts.

Poiani, K. A., B. D. Richter, M. G. Anderson, and H. E. Richter. 2000. Biodiversity conservation at multiple scales: functional sites, landscapes, and networks. Bioscience 50(2):133–146.

Publicover, D. 2001. Creating a large reserve system in the Northern Forest. Available from: http://www.thenorthernforest.org.

Radeloff, V. C., S. I. Stewart, T. J. Hawbaker, U. Gimmi, A. M. Pidgeon, C. H. Flather, R. B. Hammer, and D. P. Helmers. 2010. Housing growth in and near United States protected areas limits their conservation value. Proceedings of the National Academy of Science 107:940–945.

Redman, C. L., and D. R. Foster, editors. 2008. Agrarian landscapes in transition: comparisons of long-term ecological and cultural change. Oxford University Press, New York, New York.

Seymour, R. S., and M. L. Hunter, Jr. 1999. Principles of ecological forestry. Pages 22-61 in M. L. Hunter, Jr., editor. Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, UK.

Seymour, R. S., A. S. White, and P. G. deMaynadier. 2002. Natural disturbance regimes in northeastern North America—evaluating silviculture systems using natural scales and frequencies. Forest Ecology and Management 155:357–367.

Smail, R. A., and D. J. Lewis. 2009. Forest land conversion, ecosystem services, and economic issues for policy: a review. General Technical Report PNW-GTR-797. USDA Forest Service, Washington, D.C.

Smith, W. B., P. D. Miles, C. H. Perry, and S. A. Pugh. 2009. Forest resources of the United States, 2007. General Technical Report No. WO-78. USDA Forest Service, Washington, D.C. Available from: http://www.treesearch.fs.fed.us/pubs/17334.

SPNHF. 2001. New Hampshire everlasting: an initiative to conserve our quality-of-life. Society for the Protection of New Hampshire Forests, Concord, New Hampshire. Available from: http://www.spnhf.org/aboutus/nh-everlasting.asp.

Stein, S. M., R. E. McRoberts, R. J. Alig, M. D. Nelson, D. M. Theobald, M. Eley, M. Dechter, and M. Carr. 2005. Forests on the edge: housing development on America's private forests. General Technical Report No. PNW-GTR-636. USDA Forest Service, Washington, D.C.

Stein, S. M., R. E. McRoberts, L. G. Mahal, M. A. Carr, R. J. Alig, S. J. Comas, D. M. Theobald, and A. Cundiff. 2010. Private forests, public benefits: increased housing density and other pressures on private forest contributions. General Technical Report No. PNW-GTR-795. USDA Forest Service, Pacific Northwest Research Station.

Sullivan, J., G. S. Amacher, and S. Chapman. 2005. Forest banking and forest landowners forgoing management rights for guaranteed financial returns. Forest Policy and Economics 7:381–392.

Szold, T. S., and A. Carbonell, editors. 2002. Smart growth: form and consequences. Boston (MA): Lincoln Institute of Land Policy.

Thompson, E. 2002. Vermont's natural heritage: conserving biological diversity in the Green Mountain State. A Report from the Vermont Biodiversity Project. Montpelier, Vermont.

TPL (The Trust for Public Land). 2009. Conservation almanac. Available from: http://www.conservationalmanac.org/secure/.

Trombulak, S. C., M. G. Anderson, R. F. Baldwin, K. Beazley, J. C. Ray, C. Reining, G. Woolmer, C. Bettigole, G. Forbes, and L. Gratton. 2008. Two Countries, One Forest: The Northern Appalachian/Acadian ecoregion. Special Report No. 1. 2c1f, Warner, New Hampshire.

TTOR (The Trustees of Reservations). 1999. Conserving our common wealth: a vision for the Massachusetts landscape. TTOR, Beverly, Massachusetts.

Turner, B. L., J. Geoghegan, and D. R. Foster. 2003. Integrated land change science and tropical deforestation in southern Yucatán: final frontiers. Oxford University Press, New York, New York.

USDA (United States Department of Agriculture). 2007. 2007 Census of Agriculture, Volume 1, Chapter 2: State Level Data. USDA National Agricultural Statistics Service. Available from: http://www.agcensur_2_US_State_Level/index.asp.

U.S. Forest Service. 2009. Forest Inventory and Analysis: Research Work Unit NRS-05. USDA Forest Service, Washington, D.C. Available from: http://www.nrs.fs.fed.us/fia.

Westveld, M. V. and N. E. S. 1956. Natural forest vegetation zones of New England. Committee on Silviculture, Society of American Foresters. Journal of Forestry 54:332–338.

White, E. M., R. J. Alig, S. M. Stein, L. G. Mahal, and D. M. Theobald. 2009. A sensitivity analysis of "Forests on the Edge: Housing Development on America's Private Forests." General Technical Report PNW-GTR-792. USDA Forest Service, Pacific Northwest Research Station. Available from http://www.treesearch.fs.fed.us/pubs/33267.

Wiersma, G. B. 2009. Keeping Maine's forests: a study of the future of Maine's forests. Center for Research on Sustainable Forests, University of Maine, Orono.

Wilkinson, J. B., J. M. McElfish, R. Kihslinger, R. Bendick, and B. A. McKenney. 2009. Future mitigation programs with state wildlife action plans and other state and regional plans. The Nature Conservancy and the Environmental Law Institute.

Wilson, E. O. 1999. A personal brief for the Wildlands Project. Wild Earth Special Issue 33:3–4.

DATA SOURCES FOR FIGURES

Figure 1: Modified and updated from Foster and Aber (2004).

Figure 2: Modified from the National Land Cover Database (NLCD), 2001.

Figure 3: Data from Foster and Aber (2004), Irland (1999), Redman and Foster (2008), NRCS NRI (1982), NLCD (1992, 2001), Wilkinson et al. (2008).

Figure 4: Data from The Nature Conservancy, Harvard Forest, Vermont Land Trust, and Maine Land Use Regulation Commission.

Figure 5: Population map is based on data from the U.S. Census Bureau, Population Division, Washington, D.C. To represent meaningful changes, only sub-county areas with a 2008 population of 50 people or more are shown. Projected forest development map is reprinted from the *Forests on the Edge* research project, sponsored by the U.S. Forest Service (USFS), which used Census data and past trends in housing development to project patterns of future development in rural areas. Figure courtesy of S.M. Stein and USFS (Stein et al. 2005, 2010).

Figure 6: Maps reprinted from Lilieholm et al. (2010) with data from the James W. Sewall Company. Line graph reprinted from Hagan et al. (2005).

Figure 7: Reprinted from Smith et al. (2009).

Figure 8: Forest cover from NLCD (2001).

Figure 9: Developed from the NLCD (2001). Note: The values for "percent forest" are based on the natural land classification of the NLCD and include: deciduous forest, mixed forest, evergreen forest, woody wetlands, open water, scrub/shrub, emergent herbaceous, wetland, grassland/herbaceous, barren land, shrubland, and estuarine wetland.

Figure 10: Figure based on the world's longest continuous record of carbon uptake in a forest, recorded using the eddy flux technique in a mature, 100+ year-old oak, red maple, and white pine stand at the Harvard Forest (Foster and Aber 2004). Data from the Harvard Forest Long Term Ecological Research program, courtesy of William Munger and Steven Wofsy of the Department of Earth and Planetary Sciences, Harvard University.

Figure 11: Information from Foster et al. (2010) and http://harvardforest.fas.harvard.edu/wwscience; Forest type map is modified from Westveld et al. (1956).

Figure 12: Map information from Highstead Regional Conservation Program.

Figure 13: Data from MODIS Land Cover (2008 Images), U.S. Geological Survey Earth Resources Observation and Science (EROS) Center (www.lpdaac.usgs.gov).

PHOTOGRAPHS

Front Cover: Borestone Summit, Maine Audubon (Hundred-Mile Wilderness, ME)

p. 3: Red maple swamp, Highstead (Redding, CT)

p. 4: View from Mount Holyoke of the Connecticut River Valley, looking north (Hadley, MA)

p. 6: View of the Holyoke Range from the Connecticut River Valley (Hadley, MA)

p. 9: Houses perforating oak forests (Martha's Vineyard, MA)

p. 13: Family woodlot (Hampden, ME)

p. 15: Fifty-year-old red pine plantation (Hampden, ME)

p. 16: Harvesting pines, Harvard Forest (Petersham, MA)

p. 17: Tributary of Red Brook (Groton, VT)

p. 20: Peacham Bog Natural Area (Northeast Kingdom, VT)

p. 21: View of the White Mountains from Jerry Lund Mountain (Groton, VT)

p. 22: Stone wall and shrub swamp, Harvard Forest (Petersham, MA)

p. 23: Slab City Tract Wildland Reserve, Harvard Forest (Petersham, MA)

p. 24: Southerly view, Strafford, NH

p. 25: Regional Conservation Partnership discussion, Harvard Forest

p. 26: View of Quabbin Reservoir (New Salem, MA)

p. 28: Cattail marsh (Redding, CT)

p. 29: Drumlin field landscape (Redding, CT)

p. 31: Houses outside Hartford, CT

p. 32: View from Mount Holyoke of the Comnnecticut River Valley, looking north (Hadley, MA)

Back Cover: Vermont farm

Many individuals provided extensive, thoughtful, engaging, and challenging comments on early drafts of this paper, which have helped shape our thinking and improve the work immensely. We offer many thanks for the efforts of Taber Allison, Richard Barringer, Steve Broderick, Phil Burton, Brett Butler, Alice Chamberlin, Tom Colgan, Dan Donahue, Henry Dudley, Elisabeth Dudley, Ed Faison, Elizabeth Farnsworth, Susan Flader, Richard Forman, C. Henry W. Foster, Lee Frelich, Alec Giffen, Tim Glidden, Steven Hamburg, Russ Hopping, Lucy Hutyra, Laura Johnson, Julia Jones, Marianne Jorgensen, Dave King, Ted Koffman, Bill Labich, Nancy Langston, Mitch Lansky, Jessica Leahy, Henry Lee, Michael LeVert, Charles Levesque, Gil Livingston, George Lovejoy, Lynn Lyford, Donald Mansius, Jacob Metzler, Spencer Meyer, David Mladenoff, James Northup, Robert O'Connor, Bill Patterson, Mason Phelps, Nathan Philips, Jeff Pidot, Rutherford Platt, David Publicover, Frank Reed, Heidi Ricci, John Roe, Keith Ross, V. Alaric Sample, Jamie Sayen, John Scanlon, Stephen Schley, Robert Seymour, David Sibley, Tim Simmons, George Smith, Ted Smith, Bruce Spencer, Thomas Spies, Susan Stein, Tom Stone, Patricia Swain, Fred Swanson, Liz Thompson, Karen Tilberg, Bill Toomey, Peter Triandafillou, Jay Turner, Bret Vicary, Barbara Vickery, Robert Wagner, Wesley Ward, Paige Warren, G. Bruce Wiersma, Robert Wilber, and members of the Harvard Forest lab group. Special thanks to Jeannette Bowlen, Laurie Chiasson, Edythe Ellin, and Linda Hampson for their exceptional assistance and administrative support for this project.

In addition we recognize the remarkable support for the initial efforts of the W&W project provided by Elisabeth Dudley, Henry Dudley, Henry Foster, Carolyn Fine Friedman, Dick Goodwin, Perry Hagenstein, Ruskin Hartley, Wayne Klockner, Bill Labich, Kathy Fallon Lambert, Jim Levitt, Bill Libby, George Lovejoy, Merloyd Ludington, Linda Mirabile, Glenn Motzkin, Keith Ross, Nancy Smith, Jim Sterba, Bob Sullivan, the Save the Redwood League, Sweet Water Trust, and the New England Natural Resources Center.

Funding for this publication has been provided by the Fine Family Foundation, Highstead, the Fields Pond Foundation, and many Friends of the Harvard Forest. The science background for the report is based substantially on studies from the Harvard Forest Long Term Ecological Research program, funded by the National Science Foundation.

Design: *RavenMark, Inc.*
Printing: *Queen City Printers Inc.*
Maps: *Brian Hall, Harvard Forest*
Photographs: *John Burk (large front and back cover images); Rob Lilieholm (front cover inset, pp. 6, 13, 15, 24, and 26); Clarisse Hart (p. 36); Brian Adducci (p. 1 moose). All others by David Foster.*

Distributed by the Harvard University Press (Cambridge, MA).

For copies:

Visit the *Wildlands and Woodlands* website at http://www.wildlandsandwoodlands.org (pdf files available).

Visit the Harvard University Press online at http://www.hup.harvard.edu.

Write to Harvard Forest, 324 North Main Street, Petersham, MA 01366.

ISBN 978-1-4507-0603-250500

$5.00
ISBN 978-1-4507-0603-2
50500>
9 781450 706032

Wildlands and Woodlands

A Vision for the New England Landscape