Mass Audubon
Protecting the Nature of Massachusetts

LOSING GROUND

Planning for Resilience

Patterns of development and their impact on the nature of Massachusetts

Fifth Edition of the Losing Ground *Series*

June 2014

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Acknowledgements

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Introduction

The nature of Massachusetts is rooted in the land. From the shifting sands of the Cape and Islands to the ancient bedrock ridges of the Berkshires and Taconics, each of the plant and animal species that we strive to protect requires sufficient habitat to survive. While the hardworking conservation community continues to protect fields, forests, and wetlands, loss of habitat due to land conversion remains one of the top threats to the nature of Massachusetts. For the past 30 years, Mass Audubon's *Losing Ground* series has tracked and reported on patterns of development and land conservation in Massachusetts, providing an essential snapshot of a changing Commonwealth over time. This latest edition provides updated trends between 2005 and 2013.

Environmental protection ultimately rests on preservation of landscape functions. Seed dispersal, animal movement across the landscape, gene flow amongst a population, the meandering of a stream—each of these is an example of a natural process that requires a landscape of connected natural areas, unconstrained by artificial barriers, in which to operate. Human land use, especially our inclination to build long-lasting structures and to harden our investments against the vagaries of natural processes, tends to interrupt these natural processes and thus reduce overall habitat quality and function.

Development has reshaped the face of Massachusetts in the past 40 years. Earlier editions of *Losing Ground* calculated 775,000 acres of developed land in Massachusetts in 1971, or 15 percent of the state. We now estimate that 1.1 million acres are developed, representing 21 percent of the state. Most of this development has occurred in the eastern half of the state as wooded suburbs have been absorbed by urban expansion and the farm fields of formerly rural exurbs have "grown houses" to meet the demand for commuter housing. In Chapter 1 we report on recent patterns of development across the state.

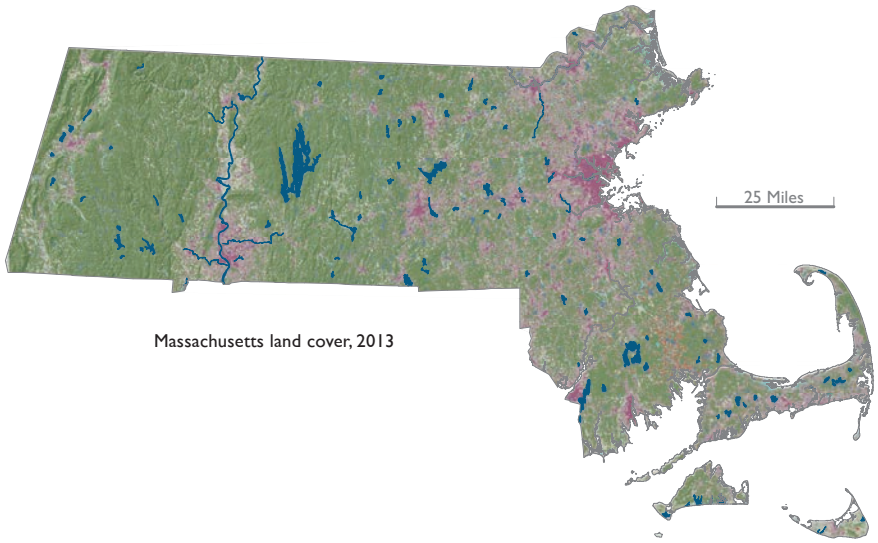
While the amount of developed land has increased, the amount of protected land has increased even more, especially in recent years. The second edition of *Losing Ground* concluded that 890,000 acres were permanently protected as wildlife habitat in 1997. We now estimate that 1,259,075 acres are permanently protected for all purposes. Chapter 2 analyzes the pace of land protection, where the land is being protected, by whom, and for what purposes.

For a glossary of terms, frequently asked questions, and technical report please visit www.massaudubon.org/losingground.

The amount and the location of both development and land protection influence habitat quality. Accordingly, it is critical to track how new development and land protection relate to our most important habitats. In Chapter 3 we look at development impacts on valuable habitat as determined in *BioMap2* and on resilient landscapes as determined by The Nature Conservancy (TNC). Chapter 3 also asks whether we are protecting the *right* land by providing an update on efforts to protect land identified in *BioMap2* and TNC's resilience analysis.

As natural lands are converted to development, it is ever more important to design our built environment to minimize effects on natural processes. Chapter 4 describes important planning tools and programs available to foster "green community" design in the Commonwealth to sustain our economy and environment. We also take an in-depth look at smart growth policies in 37 communities in the I-495 region, which continues to experience some of the highest development rates in the state.

Building activity was dramatically reduced in the period of our analysis, due to the Great Recession and resulting credit crunch; yet development pressure on the land is returning to levels seen in previous years. Recent catastrophic storms in our region have provided a sobering reminder that the era of climate change is upon us, and will require creative and proactive solutions. Planning and zoning for development must be modernized and the pace of land protection must increase even further if we are to maintain a Massachusetts with an interconnected mosaic of forests, fields, and wetlands, including the most valuable land for wildlife habitat and climate resilience.



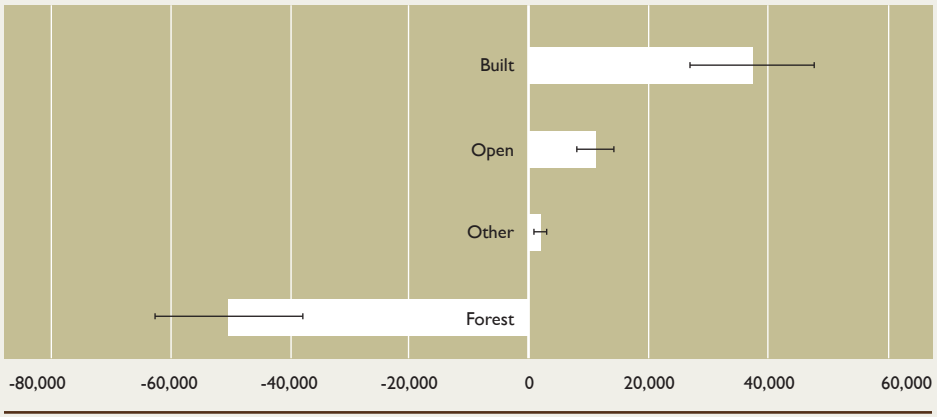
Massachusetts land cover, 2013

Chapter 1 / Land Use Changes in Massachusetts

Land use decisions in Massachusetts are typically made on a parcel-by-parcel basis, within the planning and regulatory frameworks established at the municipal and state levels. The local effects of these decisions may be obvious: businesses or residences spring up in former forest or farmland, for example, contributing to the economic and social capacity of the area. But the cumulative impacts of many such decisions are harder to discern, and questions of long-term community character, sustainability, and resilience come into play. To determine the patterns and trends of development over the period from April 2005 to April 2013, we analyzed a statewide land cover change dataset created by Boston University's Department of Earth & Environment.

From April 2005 to April 2013, approximately 38,000 acres of forest or other undeveloped land were converted to development in Massachusetts, translating to a pace of 13 acres per day through this 8-year period. Figure 1.1 shows that nearly 50,000 acres of forest were lost during this time period, and our "Open" category, consisting of bare land, low vegetation, and agriculture, increased by approximately 10,000 acres.

Figure 1.1: Land use change (acres) in Massachusetts, 2005-2013



LAND USE DATA SOURCES

Land use change analyses in past editions of *Losing Ground* were based on land use data provided by the Massachusetts Office of Geographic Information (MassGIS). Unfortunately, directly comparable, updated land use data were not available for use in this analysis. As an alternative, we turned to the Department of Earth & Environment at Boston University (BU) where researchers use Landsat satellite imagery to map land cover and monitor land cover changes. Landsat TM/ETM+ imagery has a 30-meter resolution, resulting in a land use mosaic consisting of approximately 0.22-acre pixels.

The BU team has developed a change detection and classification approach that accurately determines the timing and location of land cover changes based on changes in the surface reflectance characteristics of individual pixels.[1] This method utilizes all available Landsat TM/ETM+ data from 1985 to the present, and is relatively unaffected by clouds, shadows, satellite error, and other artifacts that challenge land cover analyses based on shorter observation periods. Mass Audubon has worked with the BU team to create and assess a custom, seven-class land cover product. The agreement among our land cover data and an internally generated reference dataset is approximately 86 percent.

Importantly, this new approach to mapping and monitoring land cover change allows us to estimate annual rates of development during the period of our analysis. This information was not available in previous editions of *Losing Ground* and represents a powerful new way to look at changes in the rate of development within our analysis window.

The estimated daily rate of development is markedly lower than the rate reported in previous editions of *Losing Ground*. This is good news from a conservation perspective, yet it is critical to remember that this time period includes the most dramatic and sustained slowdown in building activity to affect Massachusetts in decades. The 2007 global economic crisis and ensuing Great Recession hit Massachusetts' construction sector particularly hard, but the economy and construction are rebounding. Figure 1.2 shows the estimated annual rate of development since 2005 along with permitted housing units in Massachusetts according to the U.S. Census Bureau.[2] While our Landsat-derived development estimates show the economic slowdown, our model captures trends only through April 2013, limiting our ability

to effectively determine the subsequent rebound in development. The housing start data, which is available through 2013, clearly shows that the number of residential units produced per year is trending toward its previous rate. Furthermore, the state passed a law automatically extending for four years all valid state, regional, and local land use-related permits in existence between August 15, 2008, and August 15, 2012. Many projects permitted during this term can simply begin construction without further review, even if local land use rules have changed in the interim. It will be good news if the rate of land lost to development stays low while the number of units produced rises.

Figure 1.2: New development and permitted housing units in Massachusetts

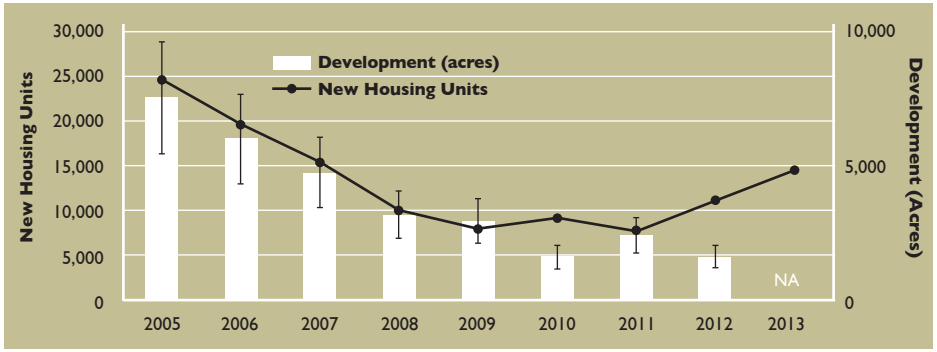
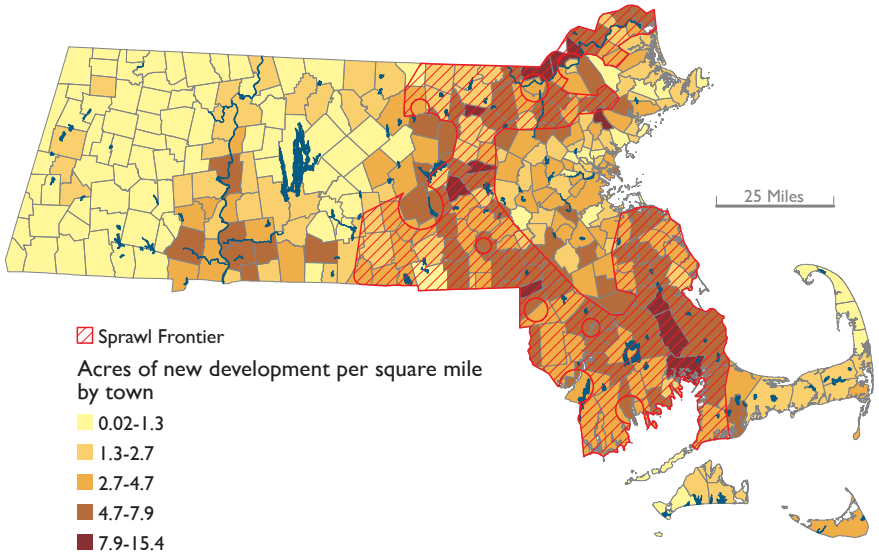


Figure 1.3: Recent development trends in Massachusetts, 2005-2013



The Sprawl Frontier & Danger Zone: How far has it spread?

The reduction in the pace of development since 2005 has mostly affected those communities where high development rates have been previously documented. This makes sense because communities that were experiencing little development pressure before the downturn (such as in the Berkshire highlands) have in general continued to experience little loss of natural land, while those with high development pressure (such as in the Blackstone Valley) generally have declining development rates. A consequence of this statewide slowdown in building activity has been that two development areas identified in previous *Losing Ground* reports, the Sprawl Frontier and the Sprawl Danger Zone, remain substantially similar to their 2005 extents[3] (Figure 1.3).

Most of the towns experiencing the highest rates of development in Massachusetts—the Sprawl Frontier—are within 10 miles of I-495, with an additional cluster in the southern Connecticut River Valley. Within the I-495 zone, municipalities with the highest rates (between approximately 8 and 16 acres of new development per square mile of land area) are located near Plymouth (Plympton, Carver, and Wareham), scattered east of Worcester (Northborough, Hudson, Grafton, and Milford), or along the Merrimack River (Tyngsborough, Dracut, and Methuen), with a few other communities (including Ayer, Lynnfield, and Plainville) also occurring in this class. It is notable that many of these communities include or are near the ends of the MBTA commuter rail system branches (Figure 1.4).

Many towns on the Worcester Plateau and in the Connecticut and Housatonic River valleys were characterized in the previous edition of *Losing Ground* as being in the Sprawl Danger Zone: areas where an increase in development pressure could lead to significant changes in community character and ecological function. The economic downturn has relieved development pressure throughout much of the Sprawl Danger Zone; this situation represents an extended opportunity for land conservation.

COMPARING COMMUNITIES

Massachusetts' 351 municipalities vary greatly in size, from the smallest (Nahant, at 1 square mile of land) to the largest (Plymouth, at nearly 100 square miles of land), so it would not always be meaningful to compare the absolute acreage of development across towns. To provide a common basis for comparison in this report, the area of new development in each town between 2005 and 2013 has been normalized by the town's area, giving a development rate of acres per square mile.

Figure 1.4: Hot spots of development—20 towns with the highest development rates in Massachusetts

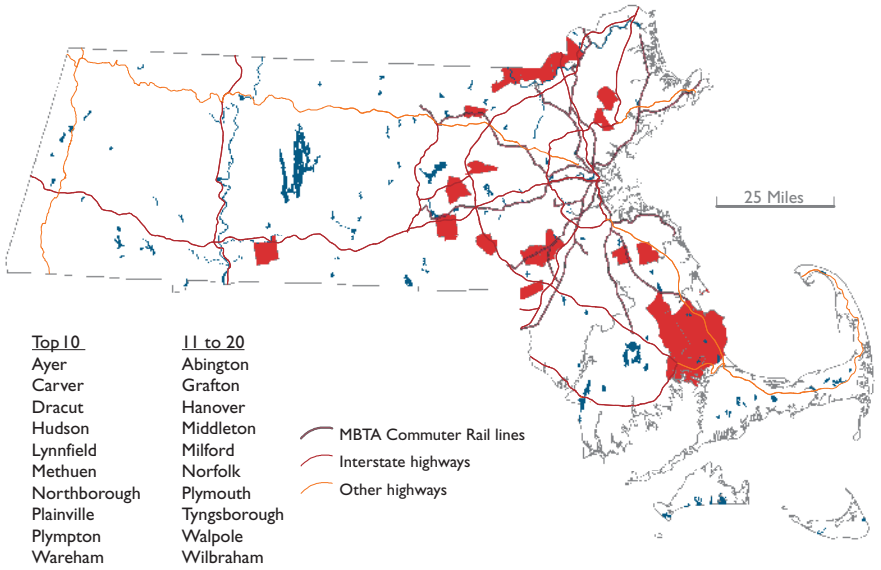
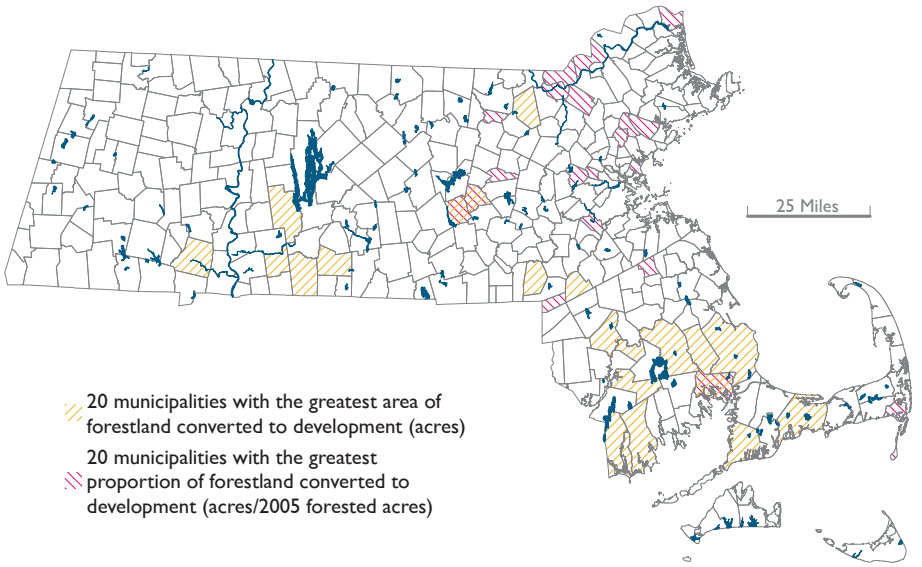


Figure 1.5: Forest conversion in Massachusetts, 2005-2013



What types of land are being developed in Massachusetts?

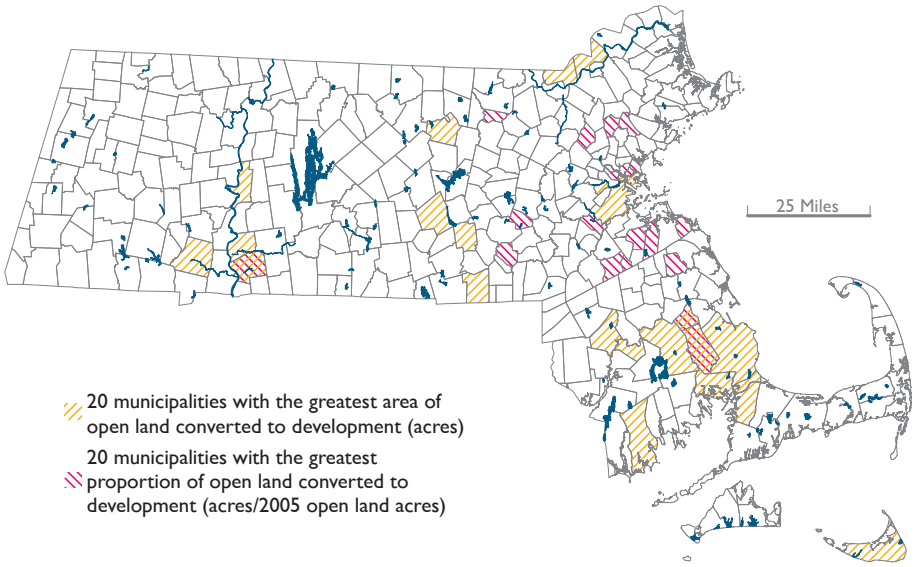
In *Losing Ground* we are primarily addressing the issues surrounding *new* development—the conversion of a previously undeveloped area to residential, commercial, industrial, or other built land uses—rather than changes in use on previously developed sites (e.g., brownfield redevelopment). The conversion of forestland to low-density residential housing accounts for the great majority of land development in Massachusetts between 2005 and 2013; conversion of open land to other types of housing and/or commercial development is also substantial.

Figure 1.5 shows the 20 municipalities with the greatest amount of forest conversion to development between 2005 and 2013, both as absolute area and relative to the amount of forest in each town present in 2005; three municipalities are in the top 20 of both categories. Regions experiencing the greatest area of forest conversion include southeastern Massachusetts and the inner Cape, as well as a cluster of towns south of the Quabbin Reservoir. Each town in the top 20 of forest conversion has lost more than 100 acres of forest to development between 2005 and 2013; Plymouth, at number one, has lost more than 400 acres of forest.

In contrast, most of the towns developing the greatest proportion of 2005 forest area are in the greater Boston area or the Merrimack River valley. It is important to consider that in communities such as Revere, Belmont, Lowell, and Wakefield—the top four communities in the latter class, which each have less than 1,000 acres of forest (and Revere has less than 100 acres)—even a relatively small development can impact a large proportion of the community's forest area, dramatically altering neighborhood character and local ecological function.

Forest, including forested wetland, remains Massachusetts' primary land cover type, occurring on more than 3.2 million acres (more than 60 percent) of the state and forming the matrix in which all other land uses occur. In addition to its aesthetic, recreational, and wildlife habitat values, this forest cover provides crucial ecosystem services, including filtering water and air, sequestering carbon, and buffering the effects of severe storms; forestland also supports the state's economy as a source of renewable fuel, food, and fiber. Maintaining the integrity of this forested matrix is critical for the long-term well-being of both human and natural systems.

Figure 1.6: Open land conversion in Massachusetts, 2005-2013



DATA LIMITATIONS

Landsat-derived land cover classification offers many advantages, including its continual and frequent updating (new images of Massachusetts are acquired approximately every 16 days), but existing methods for analyzing these data are challenged to accurately classify some important land use/land cover types. Agricultural areas in particular, with somewhat irregular patterns (both spatially and through time) of field preparation, crop production, and fallowness, do not fit neatly into a single classification label as readily as a stable forest, for example. Within a single growing season, a cropland area could be classified as bare soil, row crops, and herbaceous growth/pasture, sometimes multiple times. Due to the high incidence of categorization error among nonforested, undeveloped land use types, we decided to aggregate these categories into a single "Open Land" class. The tradeoff, however, is that all open lands, including quarries, beaches, urban vacant lots, and forests cleared for development but not yet developed, are also within the Open Land class, limiting our ability to draw from these data specific conclusions regarding agricultural land.

Figure 1.6 shows the 20 municipalities with the greatest amount of open land conversion to development between 2005 and 2013, both as absolute area and relative to the amount of open land in each town present in 2005; three municipalities occur in the top 20 of both categories. The open land class includes cropland, pasture, and hayfields, as well as areas of bare soil, low woody vegetation, and recreational fields; importantly, this class also includes areas that have been cleared in preparation for development. As such, this map should not be interpreted as representing conversion of agricultural land alone. (See box on Landsat data limitations.)

The broad geographic pattern of the municipalities experiencing the greatest absolute areas of open land conversion to development is similar to those experiencing forest conversion: a cluster of southeastern/inner Cape municipalities, several municipalities in the southern Connecticut River valley, and more scattered around Worcester. These top 20 communities also include Nantucket and, surprisingly, Boston. Approximately 100 acres or more of open land have been converted to development between 2005 and 2013 in each of the top 20 communities, with Plymouth again placing first at more than 300 acres.

The top 20 municipalities with the greatest proportion of 2005 open land area converted to development are mostly concentrated in the greater Boston area, with a few towns near I-495, and the city of Springfield. In general, the proportion of open land conversion in these communities is high because they had relatively small areas of open land in 2005.

The maintenance of agricultural capacity has been an important economic, social, and conservation goal in Massachusetts for many years. A preliminary report released in February 2014 by the USDA National Agricultural Statistics Service indicates that the number of farms and acreage of farmland in Massachusetts increased modestly between 2007 and 2012, to nearly 7,800 farms and over 520,000 farm acres (farm acres in this tally includes buildings and noncultivated areas of a farmed parcel, such as forest or wetlands; the actual area in active agricultural use is substantially smaller).[4]

Chapter 2 / Land Conservation between 2005 and 2013

Land conservation in Massachusetts has reached a major milestone since the last edition of *Losing Ground*: thanks to the tireless work of a dedicated public and private land conservation community, more than one-quarter of the state is now permanently protected. As of April 2013, permanently protected land for all purposes totals 1,259,075 acres, representing 25.2 percent of the land area of the state. Of these acres, 91 percent are conserved as natural and agricultural land, with the balance protected for recreational, cultural, historic, and other values. This milestone is especially impressive considering that Massachusetts is the third most densely populated state in the country. Meeting this threshold is a moment for celebration and reflection, but only a moment; the pace of development is likely to accelerate again, and to meet the goals for land conservation expressed in documents such as Harvard Forest's *Wildlands and Woodlands*[5] our efforts to protect land must be redoubled.

Land is protected by many entities and for many reasons in Massachusetts. The largest conservation landowners are state environmental agencies, cities and towns, various not-for-profit organizations including land trusts, and the federal government. In addition, nearly 200,000 acres are protected by thousands of private landowners who have restricted use of their land via permanent conservation restrictions and other legal mechanisms limiting development potential.

The extensive network of protected land in Massachusetts contributes in many ways to our quality of life and supports the rich heritage of outdoor recreation that is an important part of life for so many in the Commonwealth. Land is protected for agriculture, the basis of the local food movement that is redefining how we shop and eat, and for forest products including fuelwood and lumber. Land is also protected expressly for drinking-water protection, most notably around the Quabbin Reservoir, Ware River watershed, and Wachusett Reservoir; but also around the lakes, reservoirs, and wells maintained by cities and towns throughout the state. Careful stewardship of these acres offsets the vast sums that would be needed to build or enhance water treatment systems.

Land is protected for active recreation in our parks and playgrounds, for preservation of historic structures and landscapes, and for our final resting places in cemeteries and churchyards. From the water we drink to the air we breathe to the space we need from cradle to grave, protected and well-tended land is essential to nearly every aspect of our modern lives.

Land is protected for the ecosystem services that undeveloped acres provide including plant and wildlife habitat, soil retention, air purification, water filtration, attenuation of storm runoff, and carbon sequestration. The Trust for Public Land's *The Return on Investment in Parks and Open Space in Massachusetts*[6] reported that every dollar invested in land conservation returns four dollars in economic value of natural goods and services.

A 20-year investment of $130 million for land protection around the Quabbin and Wachusett Reservoirs has avoided a cost of $280 million for water filtration.[7]

PROTECTED AND RECREATIONAL OPEN SPACE DATASET

The best source of information on the state of land protection in Massachusetts continues to be the Protected and Recreational OpenSpace data available from MassGIS. This is a Geographic Information Systems (GIS) database, continually updated by the Executive Office of Energy & Environmental Affairs staff to improve completeness and spatial accuracy. Our calculations are based on all lands coded as permanently protected in this dataset (minus land under water). As useful as this database is, it requires constant input from the land protection community. All entities involved in land protection should work closely with the Executive Office of Energy & Environmental Affairs to ensure that their holdings are up-to-date and accurately depicted. For more information on submitting information, contact Benjamin Smith at benjamin.smith@state.ma.us.

Who owns our protected lands?

Keeping these various landowners and purposes for land protection in mind, it is instructive to look at which entities are protecting which type of land. Table 2.1 presents the total permanently protected acreage in Massachusetts by type of ownership and primary purpose of protection. Land set aside for conservation purposes is far and away the largest category. These properties include most state parks and state forests, wildlife management areas, town forests, land trust holdings, and large federal sites such as the Cape Cod National Seashore. These properties are usually managed for multiple values including passive recreation, forestry, and wildlife habitat.

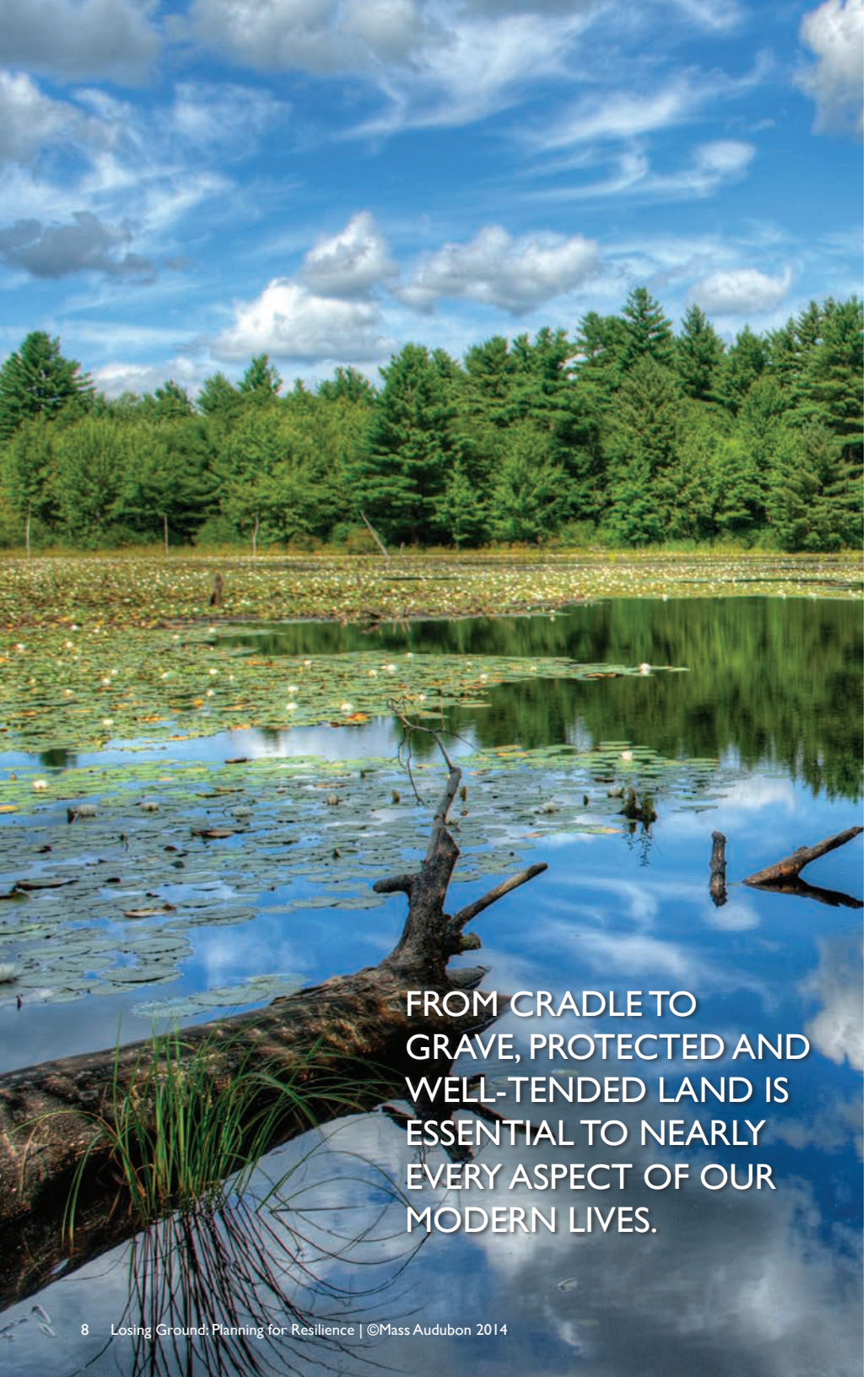


Table 2.1: Type of ownership and primary purpose of all permanently protected land in Massachusetts as of April 2013, in acres

	State	Municipal/ County	Private w/Restriction	Not-for-profit	Federal	Other	All Owners
Conservation	465,768	166,049	110,587	131,117	52,809	297	926,627
Water Supply	100,542	99,156	5,891	396	2,282	6,460	214,726
Agriculture	1,158	817	66,155	3,440		34	71,605
Recreation	3,826	27,522	1,016	1,015	881	15	34,276
Historic/Cultural	31	612	421	536	832		2,433
Other	1,942	2,299	133	278	4,755	1	9,408
All Purposes	573,268	296,456	184,203	136,782	61,559	6,806	1,259,075

The water supply category includes state holdings around the Quabbin and Wachusett Reservoirs and the Ware River watershed with nearly equal acreage held in widely distributed municipal lands. The recreation category includes actively used parks and playgrounds. Historic and cultural acres include cemeteries, heritage parks, and Minuteman National Historical Park, among other sites. The "Other" category of land type includes urban parks and some U.S. Army Corps of Engineers holdings.

PERMANENTLY PROTECTED OPEN SPACE IN MASSACHUSETTS

State and municipal conservation properties are usually accorded protection through Article 97 of the State Constitution, which prohibits conversion to other uses without legislative and town approval. The "private with restriction" lands included here are all protected by some form of perpetual easement or restriction held by another entity. The most common forms of these protections are the conservation restriction (CR) and the agricultural preservation restriction (APR). In either case, conservation goals can be achieved without requiring a transfer of ownership or removal from the tax rolls. Under these "less-than-fee" protection mechanisms, the landowner agrees to limit use of the land to activities agreed upon in the restriction, which is a legal document approved by the state Secretary of Energy and Environment and the municipal Board of Selectmen or City Council where the property is located, and then recorded in the registry of deeds. The restriction is granted (sold or donated) to a conservation entity such as a land trust, state agency, or municipality, which then has responsibility to regularly monitor the land to ensure that its use over time is consistent with the restriction. The land is permanently protected by the restriction, even when it is sold to another party.

Tables 2.2a and 2.2b present the information in Table 2.1 as percentages. Table 2.2a illustrates how the acres in each primary purpose category are distributed among the various types of landowner. Table 2.2b shows how each type of landowner's acres are distributed among the various categories.

Table 2.2a: Percentage of each primary purpose category by ownership type

	State	Municipal/ County	Private w/Restriction	Not-for-profit	Federal	Other	All Owners
Conservation	50%	18%	12%	14%	6%	0%	100%
Water Supply	47%	46%	3%	0%	1%	3%	100%
Agriculture	2%	1%	92%	5%	0%	0%	100%
Recreation	11%	80%	3%	3%	3%	0%	100%
Historic/Cultural	1%	25%	17%	22%	34%	0%	100%
Other	21%	24%	1%	3%	51%	0%	100%
All Purposes	46%	24%	15%	11%	5%	1%	100%

As seen in the "All Purposes" totals row of Table 2.2a, the Commonwealth owns the largest share of conserved land, nearly half (46 percent) of all permanently protected land in the state, mainly through the Department of Conservation and Recreation (state parks, water supply protection areas, recreation areas, etc.) and the Department of Fish and Game (primarily wildlife management areas). Agencies protect 50 percent of all land held primarily for conservation purposes. Ownership of water supply land is dominated by and nearly evenly divided between the state and municipalities. Protected agricultural land is almost entirely privately owned with restrictions held by the Massachusetts Department of Agricultural Resources. The "Other" category of land includes urban parks and land owned by the U.S. Army Corps of Engineers for flood control.

Table 2.2b: Percentage of each ownership type by primary purpose

	State	Municipal/ County	Private w/Restriction	Not-for-profit	Federal	Other	All Owners
Conservation	81%	56%	60%	96%	86%	4%	74%
Water Supply	18%	33%	3%	0%	4%	95%	17%
Agriculture	0%	0%	36%	3%	0%	0%	6%
Recreation	1%	9%	1%	1%	1%	0%	3%
Historic/Cultural	0%	0%	0%	0%	1%	0%	0%
Other	0%	1%	0%	0%	8%	0%	1%
All Purposes	100%	100%	100%	100%	100%	100%	100%

As shown in Table 2.2b, nearly three-quarters of permanently protected land is intended for conservation and passive recreation. State agencies are clearly protecting land for conservation and passive recreation as well as for water supply. Municipalities acquire land for largely the same purposes, with a bit more emphasis on water supply, as well as a substantial fraction for recreation. Not-for-profit and federal lands are also predominantly held for conservation. Restrictions over privately held lands are primarily intended for conservation and agricultural purposes.

Land Protection, 2005-2013

According to the MassGIS open space dataset, from April 2005 through April 2013, the same period as our land use change analysis, 120,389 acres of land were permanently protected, or *10 percent of all land that has ever been conserved in the state*. This represents a pace of 41 acres per day, more than three times the estimated pace of development.

Table 2.3: Newly protected acres by type of ownership and primary purpose from April 2005 to April 2013

	State	Municipal/ County	Private w/Restriction	Not-for-profit	Federal	Other	Total
Conservation	29,510	25,070	34,385	12,838	10	21	101,834
Agriculture		125	11,838	604			12,567
Water Supply	914	1,889	2,263	37			5,103
Recreation		835	2				837
Other		27	3				30
Historic & Cultural	1		7	10			18
Total	30,425	27,946	48,498	13,489	10	21	120,389

Table 2.3 shows that placing a restriction over privately owned land has become the most common form of land protection. This is likely due, at least in part, to the significant federal income tax incentives that have been in place for most of this period for conservation of private land through donation or bargain sale of some form of restriction. Conservation restrictions are also highly practical and flexible documents; they do not require a transfer of title, and they accommodate a variety of sustainable land uses, including forestry, agriculture, and even limited development. State agencies, cities and towns, and not-for-profits make up the other major forms of ownership. Conservation and passive recreation continue to be the dominant primary purposes; and the proportion of land being protected in this category is increasing: where 72 percent of all land protected before 2005 is in this category, between 2005 and 2013, over 84 percent of all protected acres were in this category. Agricultural land, almost all in the form of private land covered by an agricultural preservation restriction, is the second most common primary purpose for land protection in this period.

Figure 2.1: Newly protected acres by primary purpose expressed as acres per day, April 1, 2005*, to April 30, 2013**

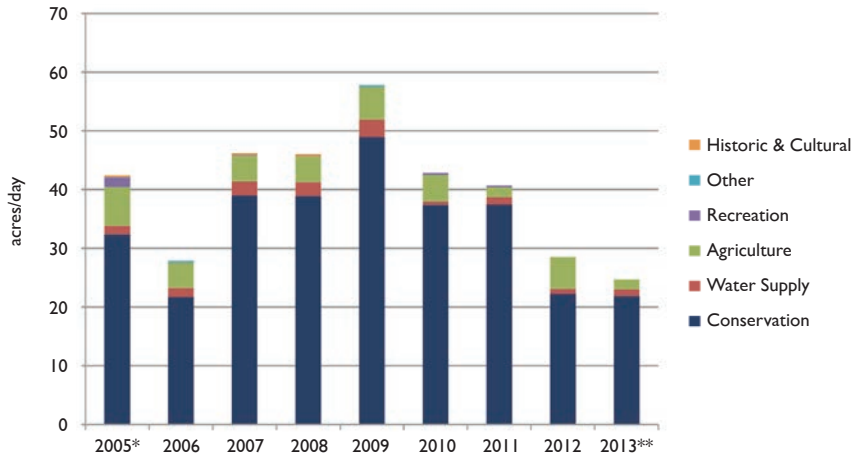


Figure 2.1 shows that the rate of land protection is not constant within the period of our analysis. The pace picked up dramatically in 2007, reflecting a renewed commitment to land protection at the state level under the administration of Governor Deval Patrick. Between 2007 and 2013, the administration's investment of $280 million in land conservation resulted in the permanent protection of 100,000 acres of land and the creation of 150 new parks across the Commonwealth. The Executive Office of Energy & Environmental Affairs (EEA) provided 1,200 grants to municipalities and land trusts and EEA's agencies—Department of Agricultural Resources, Department of Conservation and Recreation, and Department of Fish and Game—completed hundreds of conservation acquisitions.[8]

Figure 2.2: Newly protected acres by type of owner expressed as acres per day, April 1, 2005*, to April 30, 2013**

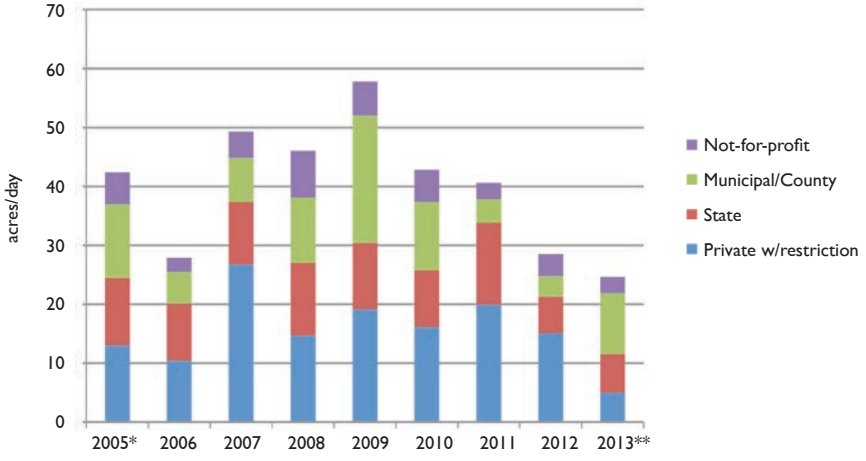


Figure 2.2 illustrates the relative importance of restricted private land and land protection by cities and towns in recent years. The 2009 peak in land protection activity was largely driven by a doubling of municipal acres from the previous year. While presenting this data as acres per day allows us to include only portions of 2005 and 2013 on the same scale, it is important to remember for 2013 that many projects are completed toward the end of the state's fiscal year in June or at the end of the tax year in December.

Figure 2.3: Ownership of land protected between April 2005 and April 2013. Bars indicate percent of all land protected through restrictions held by the various entities.

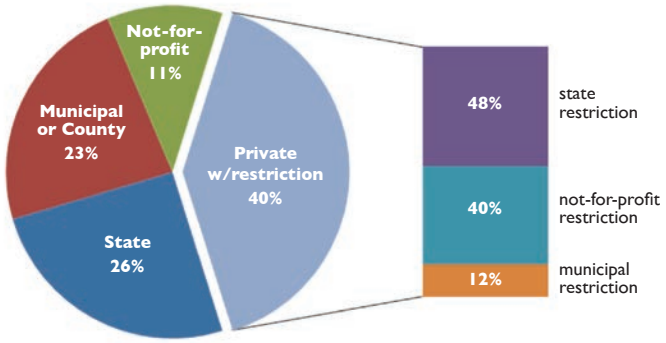


Figure 2.3 shows that restrictions over private lands represent 40 percent of all acres protected within the period of our analysis. Of those restricted acres, the largest share (48 percent) is protected by state agencies, with not-for-profits holding a nearly equal share (40 percent), and cities and towns holding a smaller proportion (12 percent). State agencies and municipalities were most active in direct acquisition of protected land, each representing roughly a quarter of all activity between 2005 and 2013.

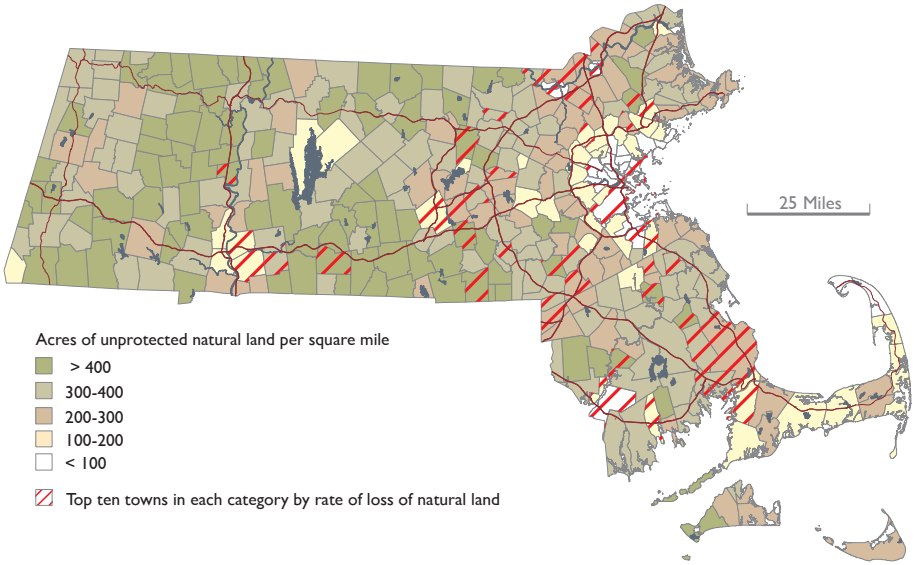
Where is natural land most under threat?

While the impressive rate of land protection between 2005 and 2013 is an encouraging sign, many acres remain at risk of being developed. Figure 2.4 shows that many towns in northern and southern Worcester County and the Berkshire hilltowns have more than 400 acres of unprotected natural land per square mile of town area. The red hatching in Figure 2.4 indicates that the towns in this category seeing the most rapid rates of development largely fall within the I-495 belt, each actually one town removed from the highway itself. Rapid development in these towns threatens opportunities for relatively large-scale land protection within each community.

Towns with 200 to 400 acres of unprotected natural land per square mile include suburban towns that retain a rural character and smaller towns in western Massachusetts, many of which already have large state forests or other protected areas. Those seeing the highest rate of development are clustered along the I-495 belt west of Boston. Municipalities with fewer than 200 acres of unprotected natural land include the inner suburbs of Boston and Springfield, small towns throughout the state, and towns on the outer Cape with large proportions protected by the Cape Cod National Seashore.

The land conservation community in Massachusetts, with exemplary leadership and funding support by Governor Patrick, the state legislature, and the Executive Office of Energy & Environmental Affairs, has made impressive gains in land conservation since 2005. More than one-quarter of the state is now permanently protected from development. These acres provide wildlife habitat, farmland, recreational opportunities, and critical ecosystem services and will continue to do so for generations to come. However, we cannot rest on the laurels of these accomplishments, because there are still more than 2.5 million acres of undeveloped, unprotected land across the state. As the Great Recession abates and development picks up, sustained and targeted land protection work remains critical.

Figure 2.4: Massachusetts towns classed by acres of unprotected natural land per square mile of town area. Towns with the highest rates of development in each class are indicated with red hatching.



Chapter 3 / Critical Landscapes: Resilience and *BioMap2*

The pattern and pace of development in Massachusetts influence the state's long-term ecological integrity and constrain opportunities for effective land management and protection. Land use planning can direct development and conservation toward the most appropriate locations for each and can guide decisions when conflict occurs. To be successful, however, planning frameworks must include the best available information on a range of factors, spanning social, economic, and biological domains.

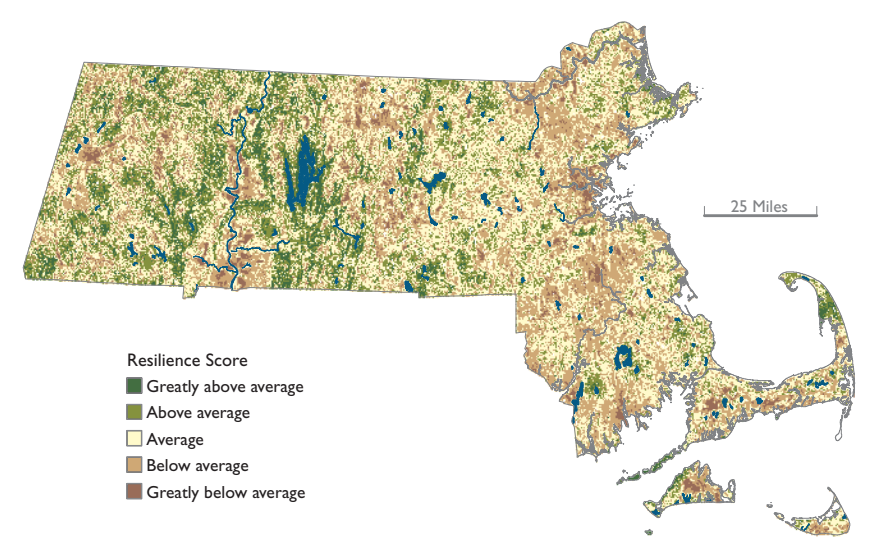
Human-caused climate change has emerged as one of the greatest environmental issues of our time, but currently few tools are being applied to incorporate climate change adaptation into land use decisions at the municipal level, where most land use decisions are made in Massachusetts. *BioMap2*,[9] a joint project of the Massachusetts Natural Heritage and Endangered Species Program and The Nature Conservancy (TNC), and a new TNC terrestrial climate change resilience model[10] address this gap. These two complementary approaches identify areas of the state that are—and are likely to remain—the most important for ensuring the long-term ecological health of the Commonwealth.

Although the Great Recession slowed the pace of development between 2005 and 2013 relative to preceding years, land continued to be developed in Massachusetts through this period at a rate of approximately 13 acres per day. Some of this development can be considered "smart growth"—for example, compact residential and commercial building concentrated around transportation hubs and brownfield sites that have been redeveloped. Another portion of this development, however, has occurred within areas that are critical for the conservation of Massachusetts' biodiversity. Across the Commonwealth, more than 2,500 acres of *BioMap2* Core Habitat, 2,400 acres of *BioMap2* Critical Natural Landscape, and 1,600 acres of highly climate-change resilient land were developed between 2005 and 2013 (some of these areas overlap), reducing the state's long-term ecological health and diminishing residents' quality of life. Additionally, the previous edition of *Losing Ground* showed that for each acre developed, the ecological integrity of several more acres of natural lands was diminished.

CONSERVATION IN A CLIMATE CHANGING WORLD

A long-standing approach to land conservation has rested on the idea of a *fine filter*, which means that parcels of land hosting populations of one or more rare species would be acquired by a conservation entity and managed for the benefit of those populations. The fine filter approach has been complemented by the *coarse filter*—rather than targeting individual species, acquisition and management have targeted natural communities, or assemblages of species and their habitats. Climate change challenges both the fine and coarse filter approaches because species ranges are generally shifting in latitude and/or elevation in response to increased temperature; even if managed skillfully, a specific parcel may no longer be able to host a species of conservation interest as a result of a fundamental change in climate. Recognizing this difficulty, TNC ecologists are turning to a new conservation approach based on relatively stable landscape features that are important for biodiversity, regardless of climate. This *enduring features* approach maintains that certain areas of the landscape, characterized by bedrock type, surficial geology, landform diversity, landscape connectivity, and other factors, inherently host diverse ecosystems with the flexibility to adapt. Conserving these areas will protect a wide range of species come what may.

Figure 3.1: TNC Resilient Landscapes (scaled to Massachusetts)

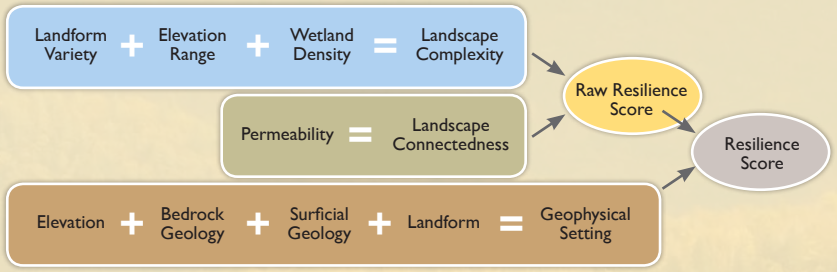


MASSACHUSETTS TERRESTRIAL CLIMATE CHANGE RESILIENCE

Resilience is the ability of a system to continue to recover from disturbance. Many factors influence the resilience of any particular system, and in ecology two main factors are diversity and connectivity. The Nature Conservancy's Eastern Conservation Science Center has developed a complex geographical analysis to model the most resilient landscapes in the Northeast, Mid-Atlantic, and Southeast regions of North America. This analysis provides a tool for focusing conservation efforts on the areas where conservation is most likely to have long-term success in a climate changing world. The regional resilience analysis covers 22 states in the eastern United States as well as Canada's Maritime Provinces. For this edition of *Losing Ground*, we worked with TNC's Massachusetts Program to downscale the regional analysis to the state scale, using more detailed information than in the regional analysis when it was available.

At its core, the resilience analysis combines measures of landscape diversity—called complexity in this context—and connectedness to indicate patterns of long-term ecological function. Resilient areas are expected to be those that offer a range of well-connected microhabitats along an elevation gradient, allowing organisms to move among and seek out new areas in response to changing conditions. Importantly, to create the final statewide resilience model, raw results were scaled within each geophysical setting, defined by landform, elevation, and geologic information. This ensured that the model captures the full breadth of geophysical settings (places like limestone valleys, mid-elevation granitic landscapes, and sandy coastal plains) that are represented in Massachusetts, and are the underlying drivers of biodiversity. The final analysis therefore estimates the resilience of lands relative to all results within each geophysical setting. A conceptual map of the resilience model is presented in Figure 3.2.

Figure 3.2: Conceptual map of the TNC resilience model



While the specific details of calculation inputs, processing steps, and other decisions are provided in the *Losing Ground* technical document, the basic method for developing the Massachusetts resilience dataset included defining a set of 20 geophysical settings, creating Massachusetts-specific landscape complexity and landscape connectedness layers, calculating resilience scores, and stratifying resilience scores by geophysical setting . (TNC's report *Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region* more fully describes the concepts and methods used in the resilience analysis.) The land use dataset that was used to generate the permeability/connectedness data was from 2006, early in our 2005 to 2013 analysis window; development prior to 2006 is therefore already accounted for in the resilience model.

Figure 3.3: Development within Resilient Lands, 2005-2013

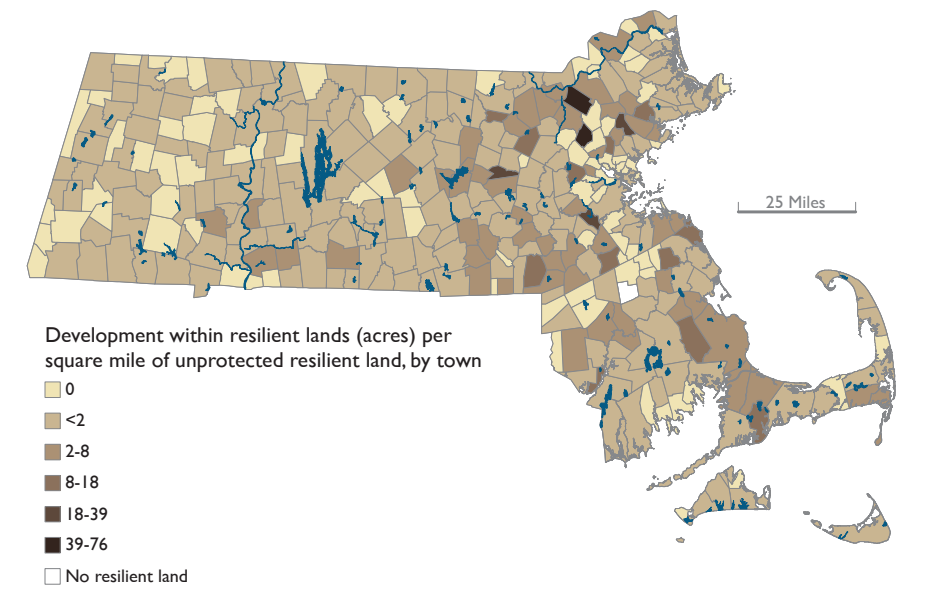
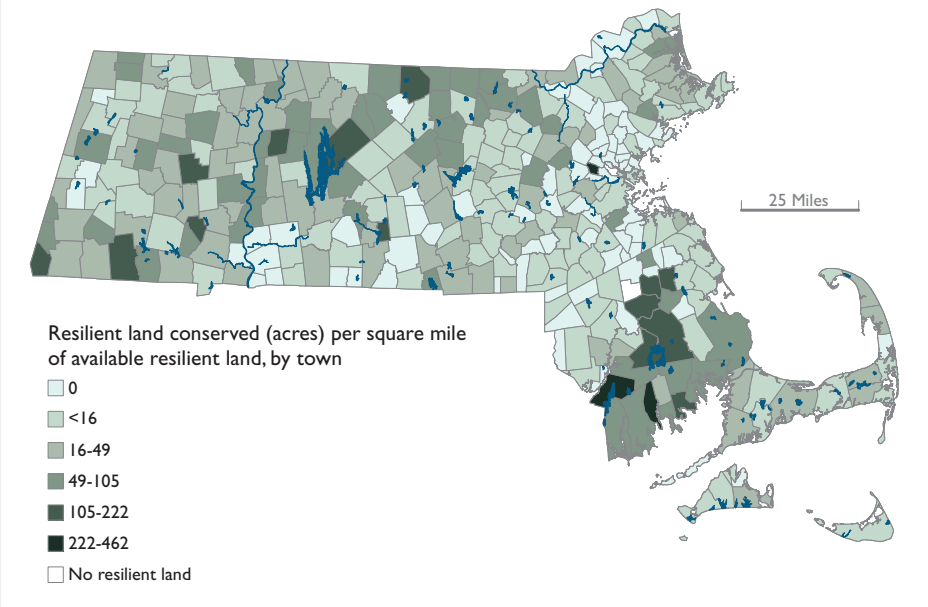


Figure 3.4: Land Protection within Resilient Lands, 2005-2013



Based on the land use change analysis described in Chapter 1, development within potentially developable highly resilient land has generally been minimal between 2005 and 2013 (Figure 3.3). Only 1,600 acres of highly resilient land were lost to development out of approximately 1.4 million highly resilient acres in the state. The general pattern of resilient land development largely echoes that of natural land conversion: most of the municipalities with higher rates of resilient land loss are within 10 miles of I-495. On an absolute basis, southeastern Plymouth County—Plymouth, Carver, Middleboro, and Plympton—had the greatest concentration of development on resilient land developed during this period.

It must be noted that the reported number of resilient acres lost to development should be considered a conservative estimate rather than an absolute. Inherent limitations in the land use change analysis, as well as a straightforward method of assessing the effects of development on resilience, likely result in an underestimate of the true impact of development on terrestrial resilience. Nevertheless, assuming that errors are spread evenly across the state, comparisons between communities and regions in the state are informative. This qualification also applies to the following analyses of *BioMap2* Core Habitat and Critical Natural Landscape.

The examples of Tewksbury and Burlington—the two communities with the highest rate of resilient land development during the 2005 to 2013 period—serve to illustrate the general pattern of greater resilient land development in eastern Massachusetts relative to western Massachusetts. In each of these communities, a single development (a residential subdivision and commercial development, respectively) affected a substantial portion of the small total area of resilient land in that town. The development of these areas marks an important transition: the remaining natural areas in these towns are less likely to be able to support a high level of biodiversity and certain ecosystem processes in the long term because they are insufficiently complex and/or connected in the landscape to function as they did in the past.

In contrast to the modest pace of development of highly resilient lands from 2005 to 2013, the pace of land protection of highly resilient lands was tremendous, with more than 48,000 acres of highly resilient land permanently protected. Newly conserved resilient land is scattered around the Commonwealth, but a large portion of the permanently protected acreage is associated with relatively few transactions, most of which involve augmenting existing state landholdings. The cooperation among municipalities, land trusts, and other partners with the state

Figure 3.5: Undeveloped and Unprotected Resilient Land, 2013

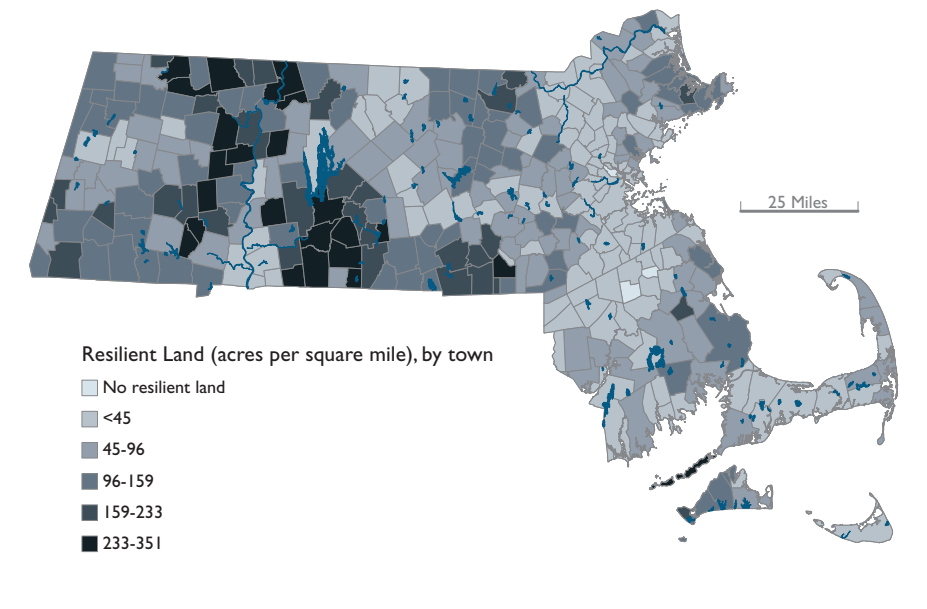
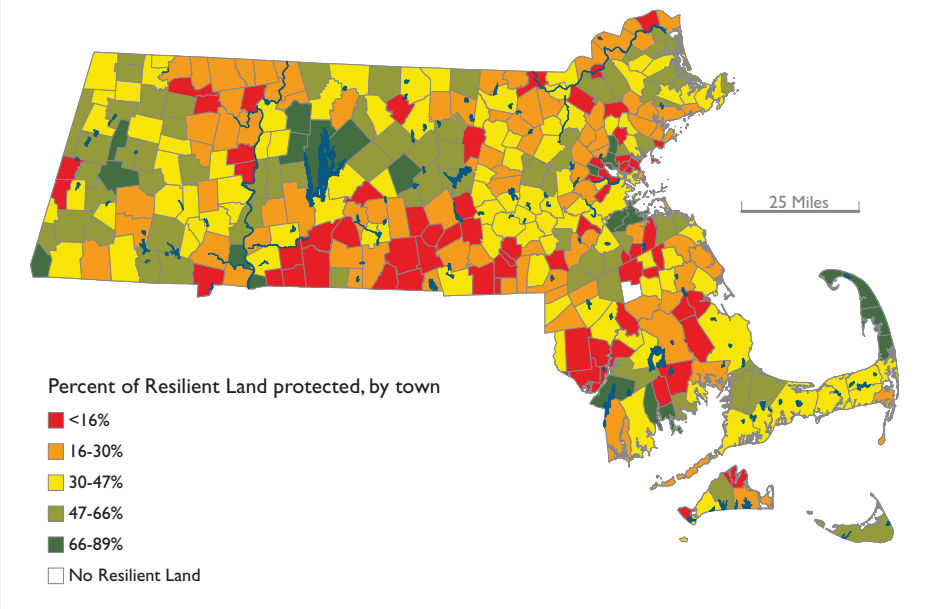


Figure 3.6: Protected Resilient Land, 2013



in this effort is also notable. For example, the two projects resulting in the greatest amount of newly conserved resilient land—the Southeastern Massachusetts Bioreserve (Fall River) and the Brushy Mountain/Paul C. Jones Working Forest (Leverett)—exemplify how many partners can work together toward landscape-scale conservation successes.

Consideration of long-term climate change resilience is a relatively new factor in land protection prioritization. Figure 3.5 depicts the patterns of undeveloped yet unprotected resilient land—essentially, the resilient land that remains "in play" for development or conservation—as of 2013. This highly resilient land totals nearly 790,000 acres, or approximately 60 percent of all resilient land. Two main concentrations of this resilient land are obvious: the region south of the Quabbin Reservoir to the Connecticut border, including Ware, Palmer, Monson, and several other communities; and the flanks of the Connecticut River valley, especially the western side extending loosely from Russell to Colrain. These areas, with the Berkshire highlands generally and sections of the Worcester Plateau, are the most important for building additional terrestrial resilience beyond the present conserved land network.

Figure 3.6 shows the status of conservation of resilient land across the state as of April 2013. Communities of the outer Cape, the Quabbin and Ware River watershed area, and the Berkshire highlands, and scattered elsewhere, stand out as protecting more than two-thirds of their resilient land. Many more communities, however, have protected less than one-sixth of their resilient lands; these communities must increase the pace of conservation to maintain the adaptive capacity of their landscapes. General regions with low proportions of conserved resilient land include the area south and southeast of the Quabbin Reservoir, the northern Connecticut River valley, and much of Plymouth County. Statewide, approximately 40 percent of resilient land (more than 490,000 acres) has been protected through April 2013.

BioMap2

In 2010, the Natural Heritage and Endangered Species Program and The Nature Conservancy released an updated guide for strategic biodiversity conservation in Massachusetts. *BioMap2* incorporates elements of the fine filter and coarse filter approaches to conservation, identifying the areas of the state that are most important for the suite of species, natural communities, and ecosystems that comprise the nature of Massachusetts. *BioMap2* designates a total of 2.1 million acres as key to conserving the state's biodiversity, separated into two categories: Core Habitat (1.2 million acres) is focused on specific conservation elements, including habitats for species of conservation concern, high-priority natural communities, high-quality

Figure 3.7: Development within *BioMap2* Core Habitat, 2005-2013

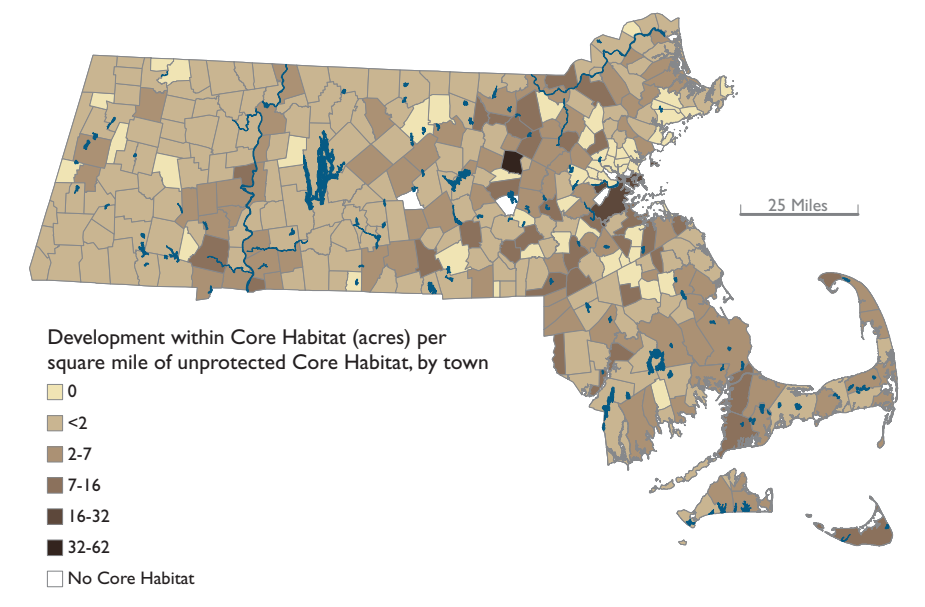
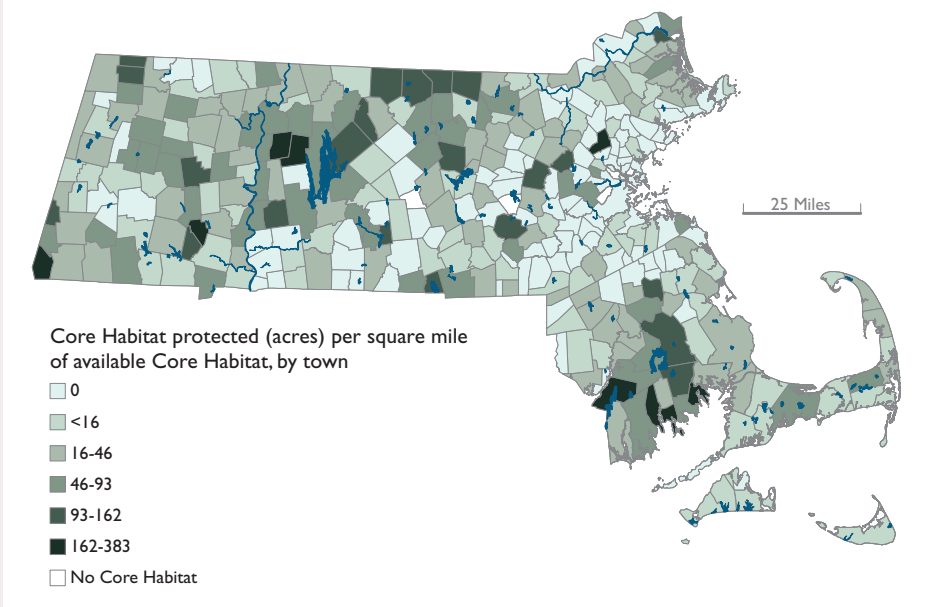


Figure 3.8: Land Protection within *BioMap2* Core Habitat, 2005-2013



aquatic and wetland habitats, and large forest blocks; and Critical Natural Landscape (1.8 million acres) addresses landscape-scale biodiversity elements such as the largest intact landscape blocks within each ecoregion and terrestrial buffers of high-quality aquatic and wetland habitats. Core Habitat and Critical Natural Landscape overlap in some areas: approximately 0.9 million acres of land are designated as both. Core Habitat and Critical Natural Landscape are complementary, and together they comprise a comprehensive conservation strategy. Although *BioMap2* was released in 2010, many of the input datasets used to create it are based on information collected in 2005 (e.g., statewide land use/land cover data), so it largely reflects conditions before or early in the period of analysis for this edition of *Losing Ground*.

Figure 3.7 depicts the pattern of development in unprotected Core Habitat between 2005 and 2013. The I-495 belt hosts most of the communities with higher rates of development, with others on the Worcester Plateau and in the Connecticut River valley. The checkerboard pattern in eastern Massachusetts partly occurs because many communities in this region either do not have much Core Habitat, or do not have much unprotected Core Habitat. Relatively small developments in these communities with little Core Habitat available can affect a large proportion of the remaining Core Habitat. This is almost certainly the case with Stow, the highest scoring community by this metric: less than 50 acres of Core Habitat were unprotected in 2005, but a single development converted 5 acres, or 10 percent, of that Core Habitat. While a community such as this has done a commendable job protecting much of its important habitat, the analysis illustrates the closing window of opportunity for conservation of important habitat in some towns.

What the last edition of *Losing Ground* labeled the Sprawl Danger Zone—the central area of the state under threat of increasing development—is reflected in Figure 3.7. Towns between I-495 and Quabbin Reservoir and towns along the Connecticut River are seeing moderate loss of Core Habitat resulting from development.

Figure 3.9: Undeveloped and Unprotected *BioMap2* Core Habitat, 2013

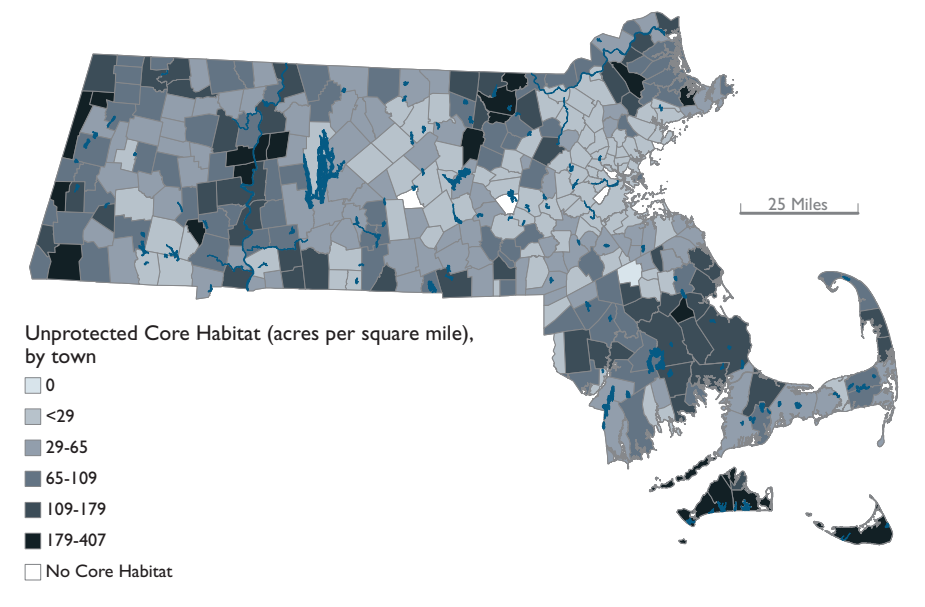
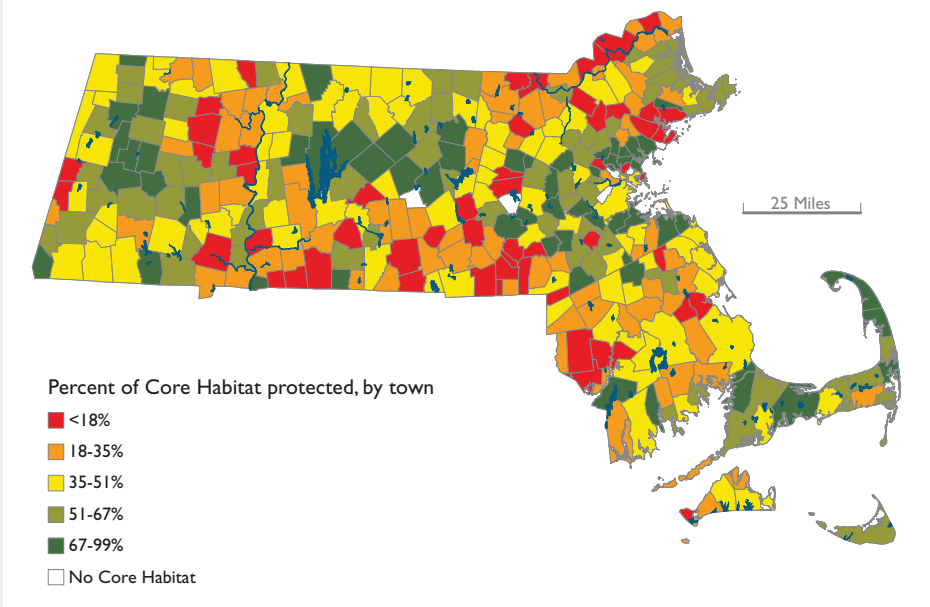


Figure 3.10: Protected *BioMap2* Core Habitat, 2013



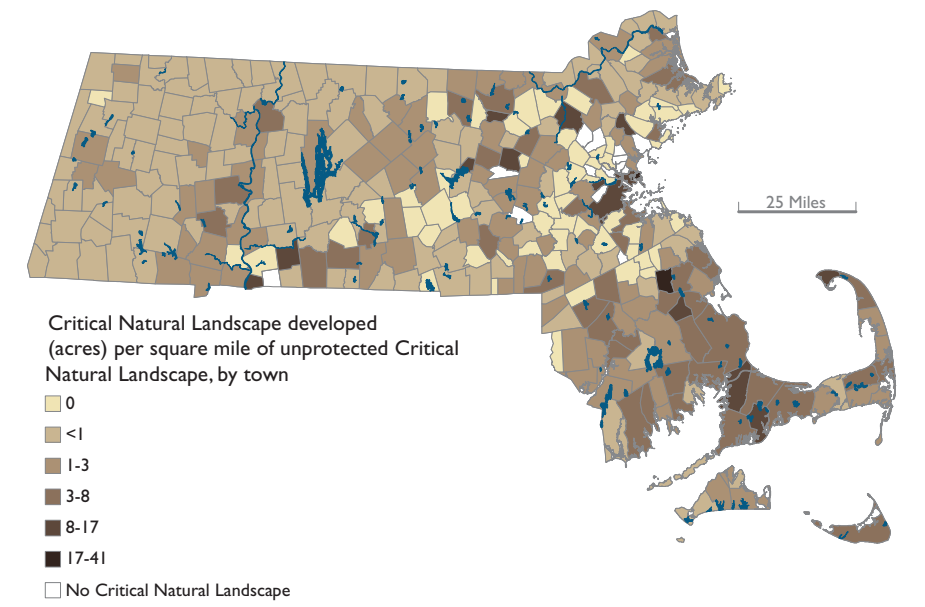
Between 2005 and 2013, a total of 44,200 acres of Core Habitat were protected across the state. Communities protecting the greatest proportion of their previously unprotected Core Habitat include the northern Worcester Plateau towns of Winchendon, Ashburnham, Ashby, and Townsend; other standout communities are scattered through the Buzzards Bay region and western Massachusetts. Several greater Boston suburbs are also included in this category. Remarkably, despite the relatively high total area of Core Habitat protected across the state since 2005, more than 100 municipalities conserved no Core Habitat. This lack of conservation action during this period, when rates of development have been lower than in previous periods, represents a lost, though potentially remediable, opportunity.

Core Habitat that remained both unprotected and undeveloped in 2013 occurs throughout the state, but is concentrated in Plymouth County and the Islands, in the area around Groton, the central Connecticut River valley, and the Taconic region (Figure 3.9). Some of these areas, especially in the eastern portion of the state, coincide with those experiencing the highest development rates. Strong municipal planning tools and continued conservation action in these areas are needed to ensure that these critical lands are protected before development overwhelms their conservation value.

Figure 3.10 shows the status of Core Habitat protection as of 2013 in each municipality. Over 540,000 acres of Core Habitat was protected as of April 2013. Similar to the resilient land protection status map, areas that stand out as requiring additional conservation effort include the area south and southeast of the Quabbin Reservoir, Plymouth County, and the northern Connecticut River valley. Additionally, this map emphasizes the opportunity to protect Core Habitat in the Merrimack River valley, where some of the highest development rates in the state are also occurring. In contrast, the central Berkshire highlands, the Ware River watershed lands, much of Cape Cod, and many suburbs in the greater Boston area have already conserved the majority of their Core Habitat.

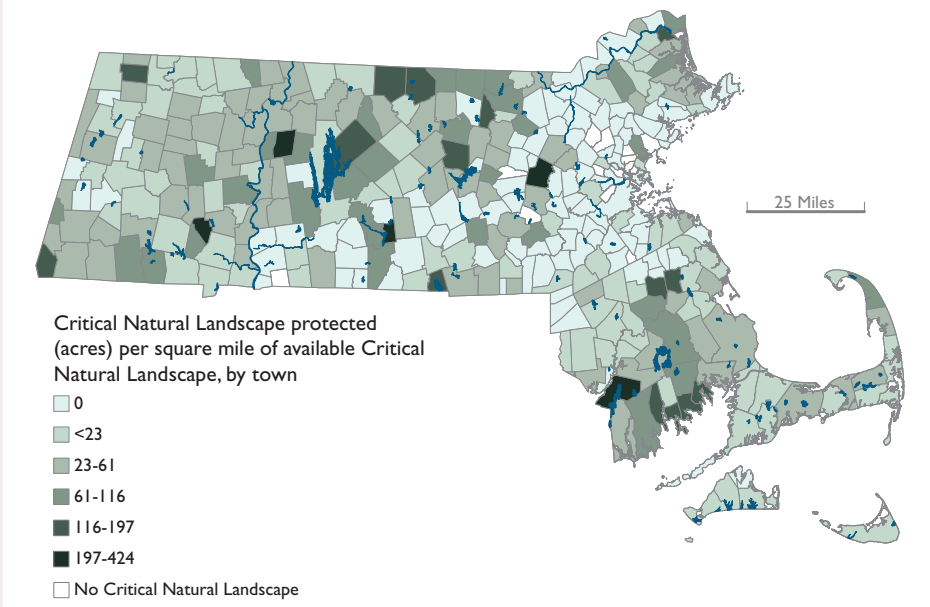
BioMap2: Critical Natural Landscape

Figure 3.11: Development within *BioMap2* Critical Natural Landscape, 2005-2013



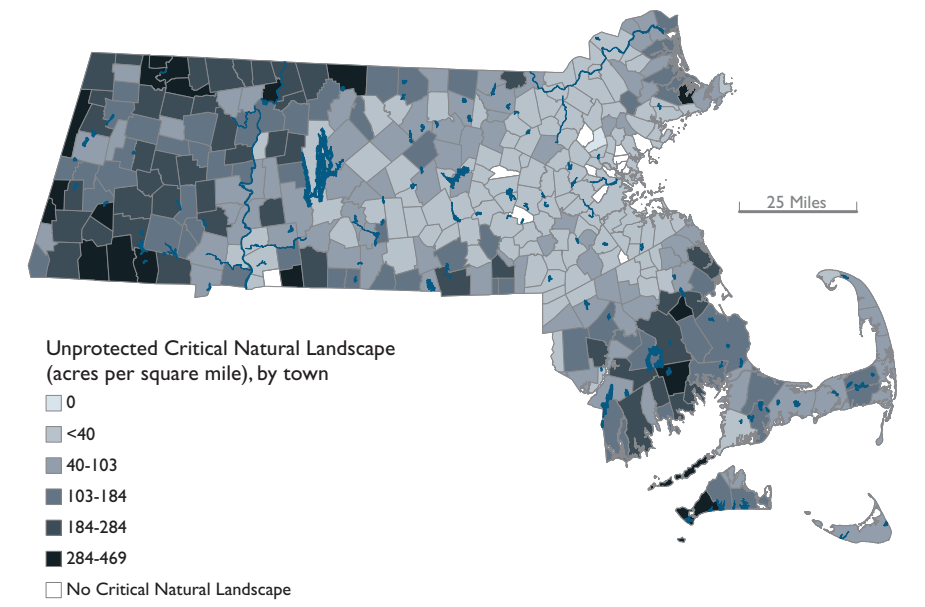
Development within Critical Natural Landscape (Figure 3.11) does not as directly reduce habitat value for species or communities of conservation concern as much as would development within Core Habitat. Nevertheless, loss of Critical Natural Landscape represents injury to the state's long-term ecological health and the values and functions these areas provide, as the piecemeal erosion and fragmentation of large landscape blocks undermines the viability of populations of both common and rare species. Between 2005 and 2013, 2,400 acres of Critical Natural Landscape were developed in the state. The communities experiencing the greatest loss are clustered in southeastern Massachusetts (Plympton, Plymouth, Dartmouth, and Bourne), the I-495 belt, and south of the Quabbin Reservoir (Wilbraham and Monson), echoing previously discussed development patterns.

Figure 3.12: Land Protection within *BioMap2* Critical Natural Landscape, 2005-2013



The communities with the greatest gains in protecting their remaining Critical Natural Landscape are located predominantly in the western counties of the state and northern Worcester County (for example, North Adams, Leverett, and Ashburnham), and with other concentrations in Plymouth County, Essex County, and scattered through the MetroWest region (Figure 3.12). Similar to the pattern with Core Habitat protection, more than 100 communities protected no Critical Natural Landscape during the 2005 to 2013 period, and for many of these communities the window of opportunity to protect these important lands closed further, as they experienced the highest rates of development over the same period.

Figure 3.13: Undeveloped and Unprotected *BioMap2* Critical Natural Landscape, 2013



Critical Natural Landscape remaining available for protection or development as of 2013 is mostly in the state's western counties, and Essex and Plymouth counties (Figure 3.13). Conservation of these lands, especially in the Berkshire highlands, would maintain large-scale connectivity in the landscape that will be increasingly important for population and genetic flows as climate change induces range shifts in a variety of plant and animal species.

Figure 3.14: Protected *BioMap2* Critical Natural Landscape, 2013

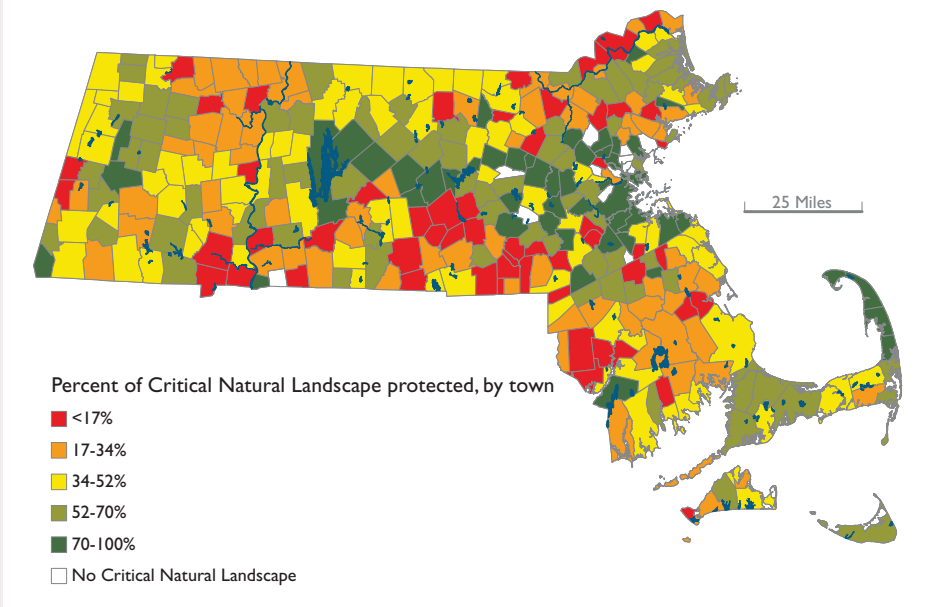


Figure 3.14 depicts the status of Critical Natural Landscape protection in Massachusetts as of 2013. Approximately 760,000 acres of Critical Natural Landscape was protected as of April 2013. The pattern here is similar to that discussed for resilient land and Core Habitat: substantial opportunities for strategic and impactful conservation action—whether through land protection or community planning—occur in certain regions in the state: Plymouth County, the Merrimack and Connecticut River valleys, south of Worcester, and south of the Quabbin Reservoir. Large areas of state or federal landholdings (for example, October Mountain State Forest, the Quabbin and Ware River watershed lands, and the Cape Cod National Seashore) anchor regions in the Berkshire highlands, central Massachusetts, and Cape Cod where Critical Natural Landscape is relatively well protected. Many communities in the greater Boston region have also protected a high proportion of their Critical Natural Landscape.

Chapter 4 / Community Planning for Climate Resilience

Mass Audubon regularly receives calls from individuals concerned about development in their cities and towns and its impact on wildlife habitat, water resources, and farmland. Following the recommendations of the previous edition of *Losing Ground*, we have developed the *Shaping the Future of Your Community* program to promote sustainable community planning, especially in areas of the state undergoing rapid development.

We recognize that economic development, including residential development, will continue to affect natural land, but not all land is the same, and not all development is the same. The *Shaping* program is working with communities to ask: Where is development most appropriate and how can growth be steered so that ecosystem function is maintained for people and wildlife? The way development is designed also plays an important role. Green, energy-efficient buildings in compact multi-use developments; preservation or planting of trees and native vegetation; and treating rainwater as a resource rather than a waste product all contribute to a more sustainable built environment.

Local land use rules determine the location, intensity, and style of development. The vision for a community and the mechanisms for achieving that vision are expressed and codified in documents such as community Master Plans, Open Space and Recreation Plans, zoning and subdivision regulations, and local wetlands bylaws. While these mechanisms can be arcane, they can be harnessed to protect land and promote sustainable forms of development. The challenge lies in creating a set of land use rules and programs that fit with the unique resources and interests of each community.

Planning for Preservation and Development

Over the past several years, state officials and regional planning agencies have developed new planning approaches and initiatives to guide development in a more sustainable manner while preserving important natural assets. The *Losing Ground* series has influenced that work, and Mass Audubon has been a partner in these efforts. The previous edition of *Losing Ground* identified the Sprawl Frontier, an area of rapid development in and along the I-495 corridor. Following the recommendations of that report, Mass Audubon focused on working with state and regional partners to support community planning in this and other fast-growing parts of the state. Collaborations such as the 495/MetroWest Development Compact Plan (495 Plan)[11] and other regional plans for the South Coast and Central Massachusetts regions designate Priority Development Areas that are most suitable for growth and Priority Preservation Areas that should be targets for protection. Most importantly, these plans include extensive input from each community in the region.

HELPING YOU SHAPE YOUR COMMUNITY

Massachusetts' complex land use laws are administered mainly by volunteer local officials. Mass Audubon established the *Shaping the Future of Your Community* program in 2009 to support adoption of local sustainable development techniques through customized workshops, community-based training, and direct assistance to local officials and residents. The program received an Environmental Merit Award from the New England Regional Office of the Environmental Protection Agency in 2013. For more information on how we can help you, visit www.massaudubon.org/shapingthefuture.

Priority Preservation Areas draw on resources such as *BioMap2* and local Open Space and Recreation Plans to identify high-priority lands for protection. Fortunately, many towns are creating funding mechanisms to actually protect these lands through the state Community Preservation Act (CPA). CPA is a local option that provides a combination of state and local funding for open space and recreation, historic preservation, and affordable housing. Since its passage in 2000, CPA has been adopted by 155 communities in Massachusetts and has provided $1.2 billion for over 6,000 projects including protection of over 19,000 acres of open space.[12]

These regional planning efforts highlighted the need to adopt "smart growth" tools to support innovative development in the Priority Development Areas while protecting the Priority Preservation Areas. Smart growth techniques such as well-sited, compact design, walkable neighborhoods, mixed commercial and residential districts, Low Impact Development, and green buildings can meet economic and housing needs while maintaining ecosystem function within a built landscape.

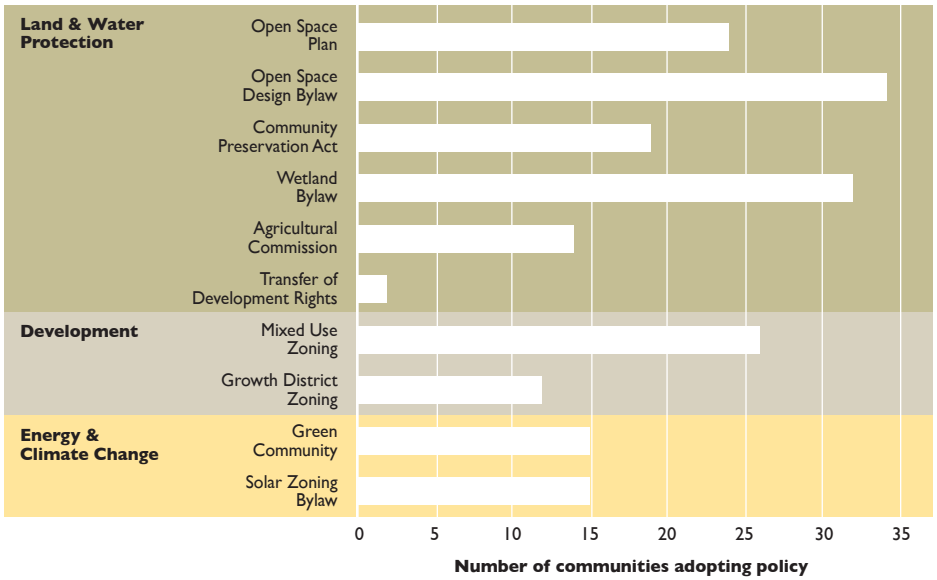
Communities can further direct development to the most appropriate locations through use of incentive-based programs such as transfer of development rights (TDR) and density bonuses. These techniques can be used to redirect growth away from high-value open space areas and toward town centers and/or redevelopment sites where appropriate infrastructure may exist or can be built. As a result, open space can be preserved, and higher density downtown or village center areas can be revitalized while reining in escalating municipal costs associated with sprawling road networks and associated water, wastewater, and stormwater infrastructure. Transforming the typical pattern of development in Massachusetts away from suburban sprawl toward more mixed-use, walkable neighborhoods has many benefits beyond open space protection—including social interaction, recreational opportunities, and healthy lifestyles. The demand for these kinds of living arrangements is growing rapidly.

Smart Growth Tools in the I-495 Region

We analyzed land use regulations in each of the 37 communities in the 495 Plan region, focusing on several smart growth tools that have been widely promoted by the state and regional planning agencies. Smart growth tools were grouped into three categories: Land and Water Protection; Priority Development Techniques, and Energy and Climate Change. Figure 4.1 summarizes the adoption of these tools in the region.

- **Land and Water Protection—**We assessed several tools in this category including whether each community had an Open Space Plan that had been updated and accepted by the state; a Natural Resource Protection Zoning bylaw (or older Open Space Design/ Cluster/Conservation Design Zoning); local passage of the Community Preservation Act (CPA); a municipal wetlands bylaw; a Transfer of Development Rights Zoning Bylaw (TDR); and an Agricultural Commission.

Figure 4.1: Adoption of land use techniques by communities in the 495 Plan region



All but one of the 37 communities have adopted at least one of these measures, but none have adopted all six and only eight have five of the six. The most widely adopted techniques are the local Wetlands Bylaw, Open Space Zoning, and Open Space Plan. Wetlands bylaws generally provide better protection for upland buffers to wetlands and waterways than the minimum state requirements. An updated Open Space Plan is necessary to qualify for state grants for open space and recreation projects. About half of the communities have adopted the CPA, and 14 have established an Agricultural Commission to support local farming. Only two communities use TDR, a tool that is complex to administer, but one that if properly applied can play an important role in supporting smart growth.

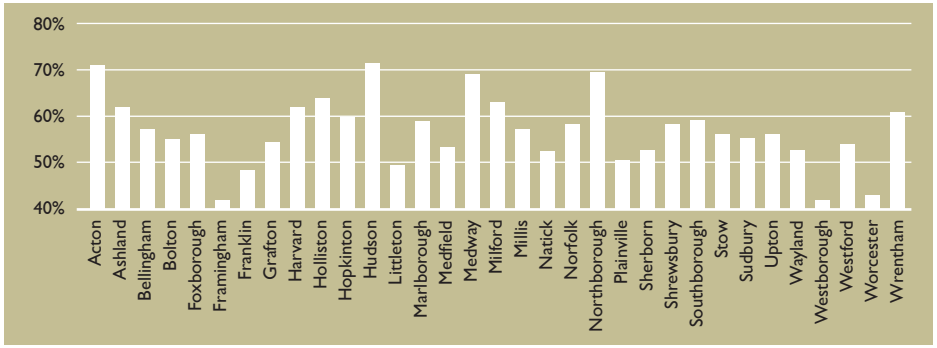
- **Priority Development Techniques—**We examined two techniques that concentrate development in designated locations—Mixed Use Zoning that addresses the increasing popularity and marketability of mixed residential/commercial uses in walkable neighborhoods or to revitalize downtowns; and Growth Districts approved by the state Executive Office of Housing and Economic Development (including 43D and 40R districts). The majority of communities have established one or both of these kinds of districts, with Mixed Use being applicable in at least one location in 26 of the communities.
- **Energy and Climate Change—**We looked at Green Community designation by the state, and adoption of a Solar Zoning bylaw to designate appropriate locations and conditioning of large-scale ground-mounted solar arrays. Solar Zoning bylaws can ensure that forests or areas targeted for future preservation are not vulnerable to solar development. Two-thirds of the communities can count at least one of these measures, although only seven have both. Communities can also promote the integration of renewable energy into buildings and developments, such as roof-mounted solar PV or hot-water and solar parking canopies. Although we did not analyze the extent of municipal regulations that promote such approaches, Green Community designations support appropriately sited renewable energy systems.

Natural Resource Protection Zoning

Not all development projects have the same economic or environmental effects. Traditional subdivisions divide virtually all of the available upland on a site into house lots, resulting in sprawling development. One alternative is Natural Resource Protection Zoning (NRPZ) or Open Space Design (OSD), which provides communities and developers with flexibility in subdivision design, allowing for development that minimizes disturbance to natural features while still providing for new construction. NRPZ offers many benefits to landowners, developers, and municipalities. It enables communities to protect valuable land and water resources without the need to purchase land, it reduces the extent of new infrastructure such as roadways and stormwater systems that a community needs to maintain, and it gives landowners a cost-efficient way to develop their property with an attractive, marketable result. Unfortunately, this innovative approach to site design is not widely used in many communities due to outdated zoning and subdivision rules.

Diving deeper in analyzing land use rules in the 495 Plan region, we took a special interest in the communities that have adopted an NRPZ or similar bylaw. We used criteria adapted from those developed by the Massachusetts Executive Office of Energy & Environmental Affairs, to analyze various elements of each community's bylaw, and ranked each bylaw as Good, Better, or Best in relation to the state's model NRPZ bylaw. This analysis found that all but 3 of the 37 communities have some type of open space or cluster bylaw. However, the majority of these bylaws do not include many of the best practices recommended by the state.

Figure 4.2: Natural Resource Protection Zoning Score for the 495 Plan Communities



We analyzed the bylaws in relation to several provisions (Figure 4.2) including:

- whether Open Space Design is allowed by right or only permitted through special permit
- the minimum amount of open space protection required
- whether it applies to only large developments and a few locations or to large and small projects in many areas of the community
- if the open space is contiguous or not; if important natural resources are conserved
- any relationship to local open space or master plans
- procedural requirements for determining yield and design
- any provisions for monitoring of the protected open space

We assigned points, giving more points to provisions that were better or best practices. The maximum possible point score was 39, and some points were weighted higher because they contribute more directly to resource conservation. Scores were then normalized to produce a percent score. Berlin, Hopedale, and Maynard have not adopted any NRPZ bylaw. Boxborough's open space bylaw only applies to commercial districts and was not comparable for purposes of this analysis.

All but one of the bylaws require a Special Permit for approval of a conservation subdivision design, while allowing traditional cookie-cutter subdivisions "by right." This complicates the process and creates uncertainty for developers. Other issues with older bylaws include inadequate criteria for the selection of the most important areas to conserve from a natural resource perspective, no link between the bylaw and local Open Space Plans, inadequate connectivity among protected open space, and lack of sufficient procedures for securing the permanent protection and proper management of the designated open spaces.

There are good reasons for communities to tailor a bylaw to local needs; however, the bylaw must make it easier for landowners and developers to pursue the community's desired result, rather than being so restrictive or cumbersome that the "easy" path remains conventional, sprawling design. It is also critical that the land protected through NRPZ contributes to the protection of a larger, interconnected network of natural land and trails consistent with the local open space plan. Small pieces of land within or around the border of a development may have local aesthetic value but often do little to support a resilient network of natural areas.

There is great variability from one community to another on use of the land protection and smart growth techniques that state and regional planning agencies have been promoting for several years or even decades. This reflects not only the different interests among communities, but also the local capacity issues associated with updating plans, bylaws, and regulations. Local land use boards are made up of citizen volunteers, and, while some communities have professional planning staff, those staff have many responsibilities. In addition to updating plans, bylaws, and regulations, staff responsibilities also include reviewing and overseeing development projects—which often consumes a great deal of their time. Adopting zoning changes requires a two-thirds majority vote of town meeting or a City Council—which can be difficult to achieve, especially when new and innovative approaches are proposed and people are uncertain of the results. Inevitably, different communities implement adopted tools to varying degrees—for example, some communities create a comprehensive Open Space and Recreation Plan and then immediately start putting it to use, while others may have a good plan but have not been able to follow through with implementation.

Building Community Resilience

Many of the tools initially designed for smart growth or sustainable development will also help communities adapt to the unavoidable impacts of climate change. By minimizing the loss and fragmentation of forests and protecting natural defenses such as vegetated buffers along shorelines, rivers, and wetlands, communities can reduce their vulnerability to impacts of increasingly intense storm events while maintaining the natural capacity of the land to absorb carbon.

On average, an acre of forest in Massachusetts contains about 85 tons of carbon,[13] and with 62 percent of the state covered in forest these lands are capturing about 13 percent of statewide annual emissions.[14] A recent report from Harvard Forest and the Smithsonian Institution, *Changes to the Land*,[15] analyzed several scenarios for future land use in Massachusetts. The "Forests as Infrastructure" scenario focusing on targeted land conservation, smart growth development, and good forest management scored highest on nature-based benefits. By 2060, it results in 25 percent less forest fragmentation, and protects 280,000 more acres of high-priority forest habitat than a continuation of recent trends. It also doubles local production of timber and other forest products while increasing carbon storage by 35 percent over existing levels.

Forests are the best land cover for absorbing and filtering precipitation, slowing runoff, and allowing water to percolate into soils where it recharges groundwater. Climate change is also predicted to increase the frequency of droughts. The capacity of the land to recharge aquifers is vital for water supply, and groundwater is also essential to maintain flow in streams. Many of our rivers and streams already suffer from lack of flow during summer and fall due

WESTFORD CASE STUDY

In 1978, the Town of Westford adopted a Conservation Subdivision bylaw. This bylaw requires submission of two plans for any proposed subdivision—one based on traditional design and another using conservation design. The planning board chooses the plan it prefers, and in most instances that has been the conservation design. Over the past 35 years, this bylaw has been applied to 48 developments, and resulted in the permanent protection of 1,743 acres of land, either through conservation restrictions (CRs), transfer to the town, or application of a special overlay zoning district. The interconnected network of open space created by this bylaw protects extensive wildlife habitat and water resources, and provides approximately 13 miles of hiking trails for public enjoyment.

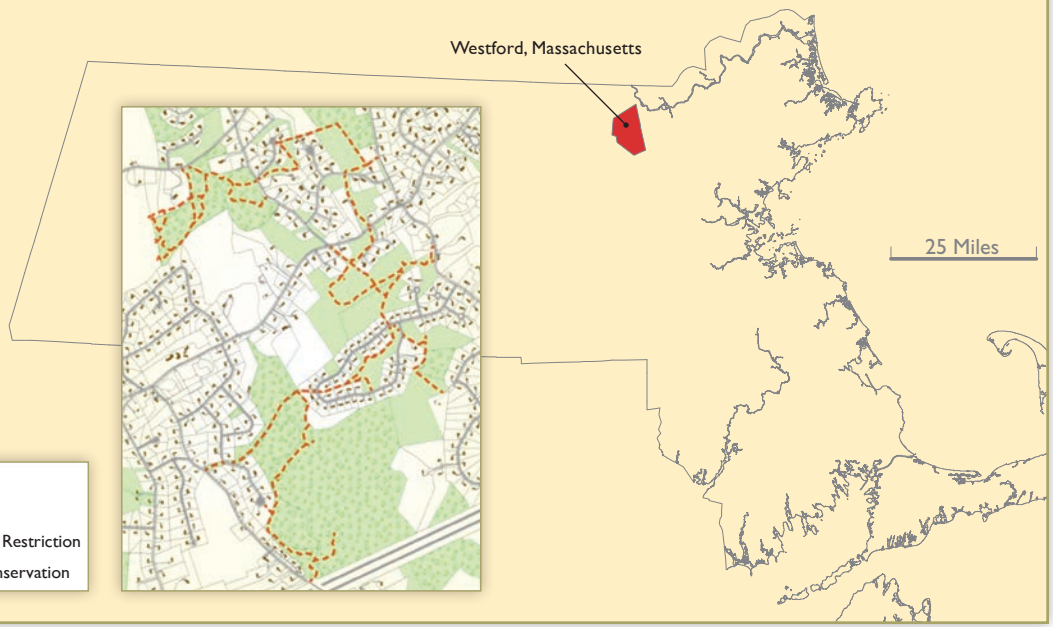


Figure 4.3: An extensive trail system connects two conservation areas and three residential areas in Westford, Massachusetts.

LID CASE STUDY

One example of the successes and challenges in greening development is the Alewife area on the Cambridge/Belmont line. The area suffers from frequent flooding and Combined Sewer Overflows, but also has excellent amenities including a state reservation with unusual urban wildlife habitats, a transit station, and connections to a regional bikeway. Redevelopment of a former manufacturing plant at 165 Cambridgepark Drive in Cambridge will replace a 100 percent impervious surface with a 300-unit Transit-Oriented Development that incorporates a vegetated "green" roof and bioretention systems. These green infrastructure elements will result in a net increase in vegetated area and a net decrease in surface runoff that will aid in reducing flooding in the sensitive Alewife Brook floodplain. Additional green infrastructure improvements have also been undertaken in the Alewife area, including a constructed wetland to collect and treat roadway runoff while enhancing wildlife habitat. Recreational trail improvements and interpretive signage have also been added. However, at the same time a major development is proposed for a nearby property that contains the last remaining tract of forested upland in the vicinity. While green redevelopment can improve existing conditions in some locations, important remaining natural areas must be protected for the ecosystem services they contribute.

Figure 4.4: A green roof and patio, similar to plans for 165 Cambridgepark Drive

Figure 4.5: Constructed wetland complex, Alewife Reservation, Cambridge, Massachusetts

to water withdrawals and impervious surfaces such as pavement and rooftops. The Harvard Forest/Smithsonian report found that protecting our forest infrastructure and growing smarter can keep the increase in runoff from impervious surfaces to below 10 percent in almost all of the watersheds in the Commonwealth. Forest cover around headwater streams is particularly important to protect coldwater fisheries to support trout and other aquatic species that are increasingly stressed by heat waves, reduced stream flows, and hot runoff from roads and rooftops.

But we can do even more than just preserving our natural "green infrastructure." We can use Low Impact Development (LID) techniques including rain gardens, grass swales, and infiltration areas that capture, filter, and infiltrate runoff from roofs, driveways, and roadways. LID can be applied in new developments to maintain existing hydrology, or even to increase the amount of infiltration over existing conditions in an already-stressed watershed. In some cases, LID technologies can also be integrated into existing developments, ameliorating the effects of development on hydrology. Green roofs, well-placed landscaping, and street trees also have energy-efficiency benefits for building heating and cooling. Taken together, these and other green building techniques can make the built environment more attractive and livable, help mitigate climate change by reducing energy demand, and also increase resilience to climate extremes.

Restoration

Even if all new development is built in areas of low environmental sensitivity, using compact, LID design, there are still many features of existing development and infrastructure that make natural and human communities vulnerable to the impacts of climate change. Our rivers and streams are bisected by thousands of dams and culverts that prevent safe passage of fish and other wildlife and present hazards during flood events. Efforts are underway to prioritize removal and retrofitting of these barriers.

Communities are beginning to recognize the value of greening their cities and towns with trees, pocket parks, community gardens, plantings along streambanks, and green roofs. These and other projects can reduce heat island effects, absorb storm runoff, provide locally sourced food, support outdoor exercise and social interaction, and enhance habitat for urban birds and other wildlife. Along the coast, Massachusetts is investing in green infrastructure projects such as beach nourishment, coastal wetland restoration, and even reestablishment of oyster beds. Both coastal and inland restoration and green infrastructure projects provide economic benefits well in excess of the costs. Coastal restoration projects can return as much as $15 in net economic benefit for every taxpayer dollar invested.[16]

Conclusion

Massachusetts has made great progress in recent years toward reducing the rate of sprawl-style development and increasing the pace of well-targeted land conservation and ecological restoration. But there remains a significant risk that these trends may be reversed once again. As updating local land use rules and protecting land can get lost among the many pressing community priorities, the state's continuing commitment to helping communities grow and develop in environmentally sustainable ways is essential. With nimble and responsive zoning and planning tools, local communities are better equipped to achieve a sustainable, vibrant future for the nature and people of Massachusetts.

Chapter 5 / Conclusions and Recommendations

In the period between 2005 and 2013, more than three acres of land were permanently protected in Massachusetts for every acre that was developed. This is an encouraging pace of protection versus development and an increase from the 2:1 ratio cited in the 2009 edition of *Losing Ground* that covered the years from 1999 to 2005. These numbers reflect both the reduced rate of development during our analysis period relative to previous editions of *Losing Ground* and a concerted effort, led by the Commonwealth in partnership with municipalities and private groups, to protect key lands across the state. As encouraging as these figures are, we must recall that the last *Losing Ground* report demonstrated that development has indirect ecological impacts on an area three to four times the size of the built footprint itself.

Building activity was dramatically reduced in the period of our analysis due to the Great Recession (2008-2009) and resulting credit crunch; yet data on new housing indicate that development pressure is returning to levels seen in the years before the economic slowdown. And new construction may increase even more quickly than is indicated in Figure 1.2: the housing start data presented there is based on permitted units; yet the Massachusetts Permit Extension Act[17] means that some of these permitted units haven't yet been built, so the increase in acres developed could take off even faster than new permits.

We must adopt and implement the most innovative approaches to land planning and site design and increase the pace of land protection even further if we are to maintain a Massachusetts with an interconnected mosaic of forests, fields, and wetlands, including the most valuable land for wildlife habitat and climate resilience, while providing for economic growth in an efficient and sustainable manner. The need for these strategies becomes ever more urgent as the climate crisis escalates. In order to achieve these goals, we recommend the following actions.

Funding for Land Protection

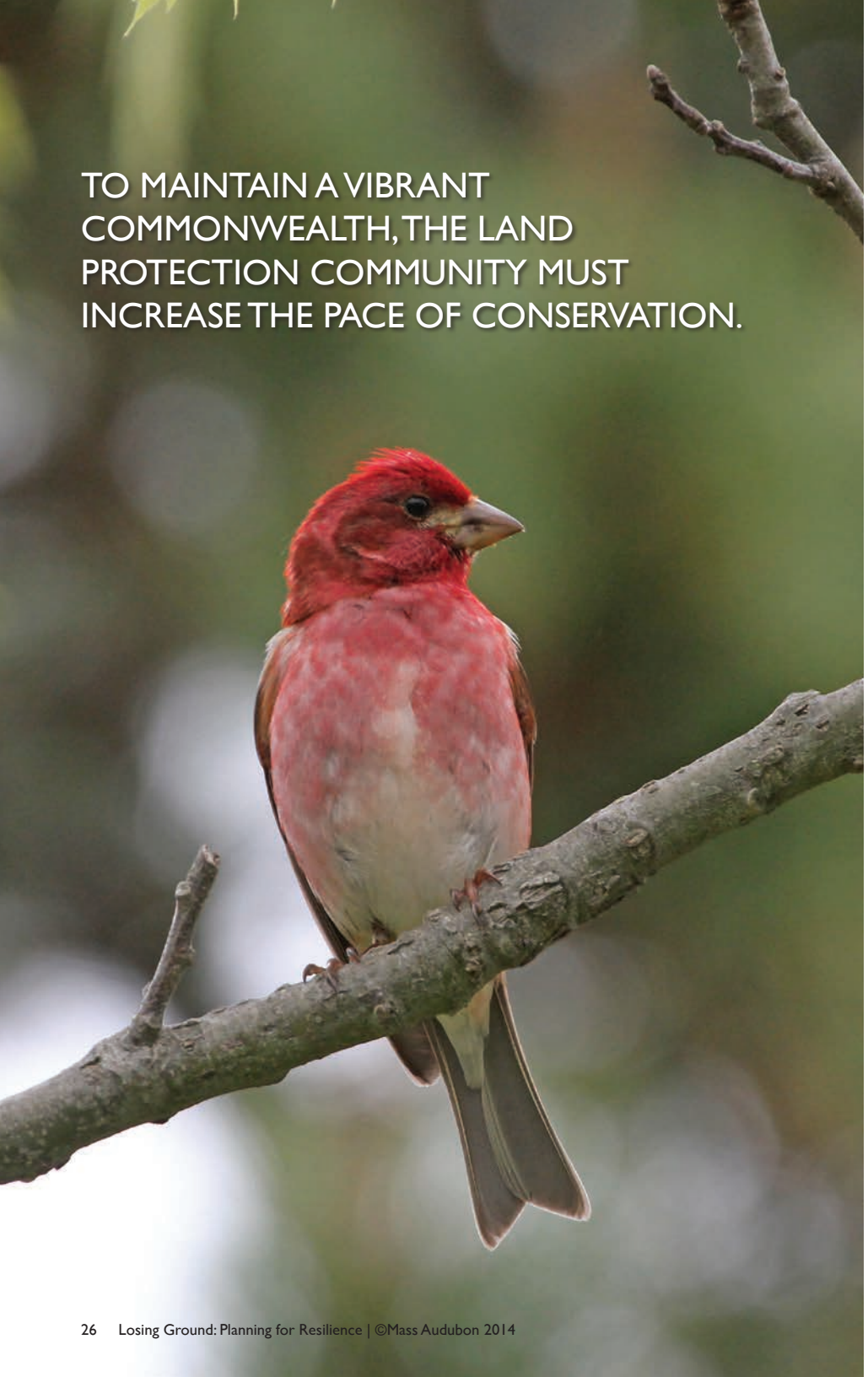
- **One percent for nature**—The state administration and legislature should devote at least 1 percent of the annual state operating budget to environmental programs; the current rate is 0.64 percent.
- **Environmental Bond**—The legislature must complete final passage of an Environmental Bond and the administration must commit to spending no less than $50 million per year for land protection in the Commonwealth.
- **Community Preservation Trust Fund**—The legislature and administration must provide continued support for the Community Preservation Trust Fund by funding the state match for locally raised dollars for open space, affordable housing, historic restoration, and recreation projects.
- **Federal Tax Incentives**—The conservation community should advocate for expansion of federal tax incentives to include gifts of outright ownership of land, also known as *fee interest*. Recently enacted federal and state tax incentives for land conservation have resulted in a rapid increase in the pace and overall magnitude of conservation; however, current federal incentives are limited to gifts of less-than-fee interests only—such as conservation restrictions (CRs). While CRs are a critical part of the land protection toolkit, sometimes a gift or bargain sale of the fee interest is the best outcome, for achieving resource protection goals and the donor's goals. Demographic data suggest that many opportunities for fee transfers of important, unprotected properties will occur in the coming decade. Expanded federal tax incentives will provide conservation practitioners with all of the tools they need to address key opportunities in the years immediately ahead.

Increase the Pace of Land Protection in the Era of Climate Change

- **Commitment to Land Protection**—The new gubernatorial administration must continue and build upon the Patrick Administration's commitment to land protection as detailed in the Executive Office of Energy & Environmental Affairs' recently released report *100,000 Acres of New Conservation Land and 150 New Parks: A Legacy for the Next Generation*.
- **Land Protection Strategy**—The land protection community should develop strategies for increasing the pace of land protection. Table 5.1 shows the pace of land protection necessary to achieve various conservation goals in the coming decades.
- **Targeted Land Protection**—State, local, and not-for-profit land protection and stewardship efforts should continue to focus on the areas of opportunity for protection of important habitat and resilient landscapes identified in Chapter 3. Practitioners should become familiar with and utilize the latest conservation planning tools including *BioMap2*, TNC's resilience model, and UMass Amherst's Conservation Assessment and Prioritization System (CAPS).[18] Table 5.2 shows that we can protect a majority of *BioMap2* Core Habitat in the coming decades if we increase our focus on these lands.

Effective and Innovative Planning

- **Zoning Reform**—The Governor should actively and publicly support and the legislature should pass zoning reform legislation (*An Act Promoting the Planning and Development of Sustainable Communities*[19]). This legislation would update Massachusetts'



antiquated planning and zoning laws and encourage strong community planning and natural resource protection while maintaining a vibrant and competitive Commonwealth.

- **Planning in the Sprawl Frontier—**State and regional planning resources should be focused on the Sprawl Frontier, including more assistance and incentives for communities to adopt innovative, sustainable development and green infrastructure techniques.
- **Massachusetts Endangered Species Act—**The conservation community and the legislature should continue to support the Priority Habitat provisions of the Massachusetts Endangered Species Act[20], which were recently upheld by the Massachusetts Supreme Judicial Court.

Climate Change Adaptation

- **Comprehensive Adaptation Management Plan—**The legislature should pass and the governor should sign the Comprehensive Adaptation Management Plan (CAMP) bill.[21] The bill will require the state to develop an adaptation plan that clearly outlines the Commonwealth's goals, priorities, and principles for resilience, preservation, protection, restoration, and enhancement of the Commonwealth's built and natural infrastructure.
- **Funding for Adaptation Planning—**Funds for climate change adaptation planning and project implementation should be provided through multiple sources including the state operating budget, Environmental Bond, Regional Greenhouse Gas Initiative, the Water Infrastructure Finance bill, and federal sources.
- **Green Infrastructure—**Communities should invest in land protection and restoration of inland and coastal wetlands and upland buffers as green infrastructure to enhance the resilience of our natural and built environments.
- **Restoration Funding—**The state should continue to fund restoration efforts through the Division of Ecological Restoration and UMass Amherst's River and Stream Continuity Project,[22] specifically wetland and buffer restoration, dam removals, and replacement of undersized culverts, to enhance resilience of wildlife habitat and the built environment.

Partnerships

- **Conservation Land Stewardship—**The conservation community must continue to work together to actively uphold the conservation values of permanently protected land.
- **Community Preservation Act—**The conservation community should continue to support cities and towns in adopting and implementing the Community Preservation Act.
- **Land Cover Data—**The Executive Office of Energy & Environmental Affairs and the Information Technology Division of the Administration and Finance Secretariat should ensure the availability of up-to-date, statewide aerial photographs and well-constructed, useful, and timely land cover data for use in this type of analysis. Agencies should explore innovative collaborations with universities and the user community.
- **Maintain Open Space Data—**The land protection community should continue to work closely with MassGIS to maintain a comprehensive and up-to-date Open Space datalayer.

Table 5.1: Land protection outcomes for various rates of land protection over time. Percent is based on total land area of state.

		2020		2025		2050	
acres/day	acres/year	total acres	% of state	total acres	% of state	total acres	% of state
40	14,600	1,361,275	27.2%	1,434,275	28.7%	1,799,275	36.0%
50	18,250	1,386,825	27.8%	1,478,075	29.6%	1,934,325	38.7%
60	21,900	1,412,375	28.3%	1,521,875	30.5%	2,069,375	41.4%
70	25,550	1,437,925	28.8%	1,565,675	31.3%	2,204,425	44.1%
80	29,200	1,463,475	29.3%	1,609,475	32.2%	2,339,475	46.8%
90	32,850	1,489,025	29.8%	1,653,275	33.1%	2,474,525	49.5%
100	36,500	1,514,575	30.3%	1,697,075	34.0%	2,609,575	52.2%

As detailed in Chapter 2, as of April 2013, nearly 1.26 million acres (25.2 percent) of the state's land area has been protected. Table 5.1 shows how many acres and what percent of the state's land area would be protected if we conserved land at the rate shown on the left through the date shown at the top. For example, if we can increase the recent 40 acre/day pace of land protection by 50 percent to 60 acres/day and sustain that rate through 2025, we will have protected fully 30 percent of the state.

Table 5.2: *BioMap2* Core Habitat protection outcomes for various rates of protection over time. Percent is based on total *BioMap2* Core Habitat excluding large water bodies.

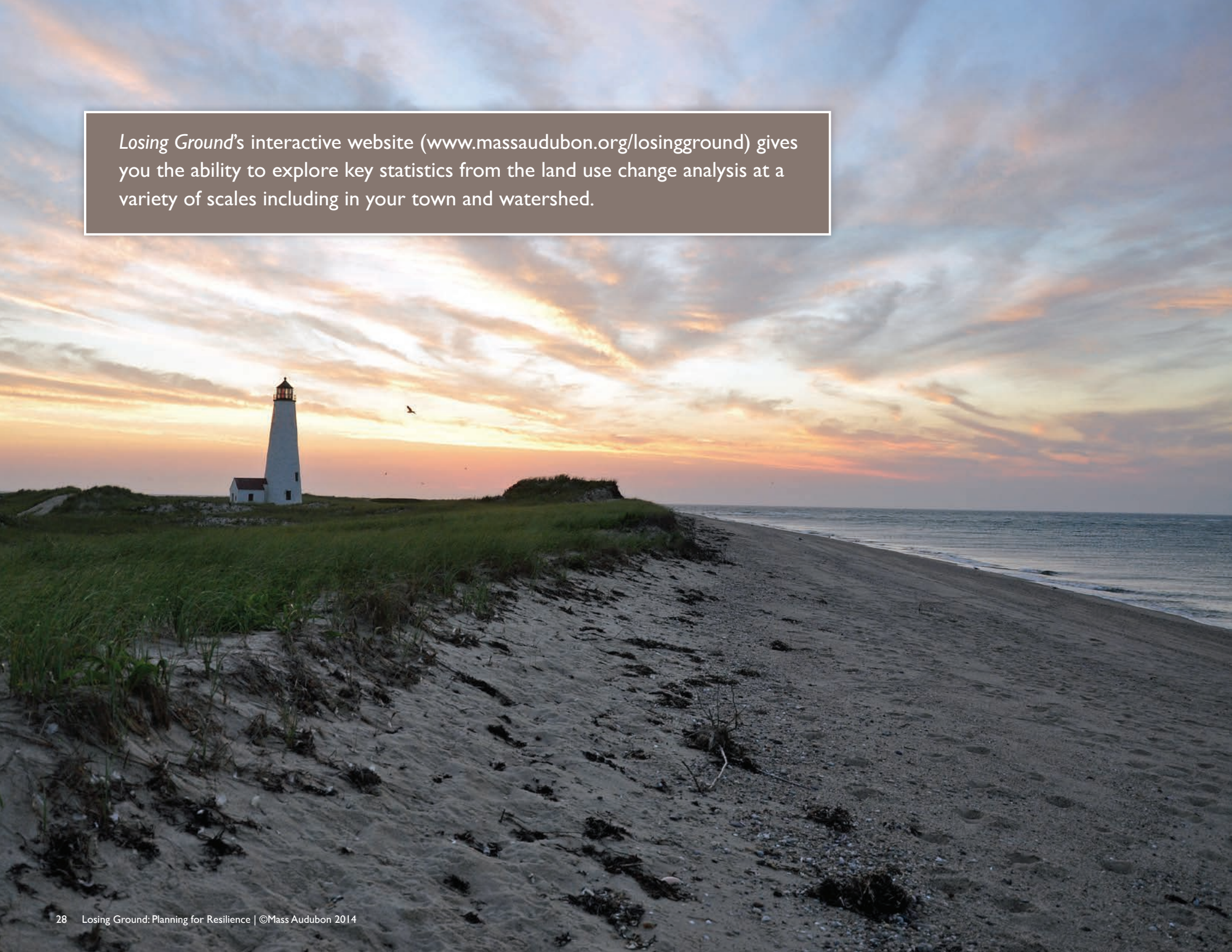
		2020		2025		2050	
acres/day	acres/year	total acres	% of Core Habitat	total acres	% of Core Habitat	total acres	% of Core Habitat
15	5,475	578,667	50.1%	606,042	52.5%	742,917	64.3%
20	7,300	591,442	51.2%	627,942	54.4%	810,442	70.2%
30	10,950	616,992	53.4%	671,742	58.2%	945,492	81.9%
40	14,600	642,542	55.6%	715,542	61.9%	1,080,542	93.5%
50	18,250	668,092	57.8%	759,342	65.7%	1,155,204	100%
60	21,900	693,642	60.0%	803,142	69.5%	1,155204	100%

Table 5.2 shows how much *BioMap2* Core Habitat could be protected at various rates over time. From 2005 to 2013, Core Habitat was protected at a pace of 15 acres/day resulting in over 540,000 acres, or 45 percent of Core Habitat being permanently protected. Roughly one-third of all land protected since 2005 is Core Habitat. If we could further focus land protection efforts and increase the pace of Core Habitat protection to 30 acres/day, we could protect over 58 percent of all terrestrial Core Habitat by 2025.

This report's title, *Losing Ground*, refers to the ongoing conversion of undeveloped land, valued for wildlife habitat, agriculture, forest products, and water quality, among other attributes, to the hard infrastructure of human use. As documented by the *Losing Ground* series, the pace of this conversion has varied over time, and this edition witnesses an ebb associated with the Great Recession. Indications already point to the resumption of higher development rates in 2014 and beyond, but at this point the window of opportunity for progressive and informed land use decisions remains open in many communities. In the lull before boom times return, now is the time to take stock of the forests, wetlands, fields, and rivers that are so important for each community's natural, cultural, and economic health, and chart a deliberate development course that protects these assets over the long term.

The need for such intelligent planning is heightened throughout the Commonwealth by the effects of climate change. As one example, sea-level rise will continue to alter coastal areas and, combined with increased storm intensity, threatens some of the highest valued real estate in the state. Superstorm Sandy and Tropical Storm Irene demonstrated the vulnerability of infrastructure we consider to be permanent, and we would be foolish to ignore their lessons. The value of natural lands—including salt marshes, barrier beaches, and forested floodplains—for mitigating the damaging effects of intense storms is clear, and investments in protecting these natural defenses provide dividends forever. It is a win-win decision when land protection benefits both human and natural communities, yet short-term human interests continue to be powerful considerations.

The recent milestone of protecting fully one-quarter of the land area of the state could not have been accomplished without the dedicated efforts by government, nongovernmental organizations, and private landowners. Yet for the conservation community there is no time to rest on this accomplishment. Action on the recommendations in this report will ensure progress toward a sustainable and vibrant Massachusetts that continues to function for people and nature.



Losing Ground's interactive website (www.massaudubon.org/losingground) gives you the ability to explore key statistics from the land use change analysis at a variety of scales including in your town and watershed.

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