

# **Creating Connectivity**

Mapping Tools for North County Land Trust

**North Central Massachusetts**

The Conway School - Winter 2019

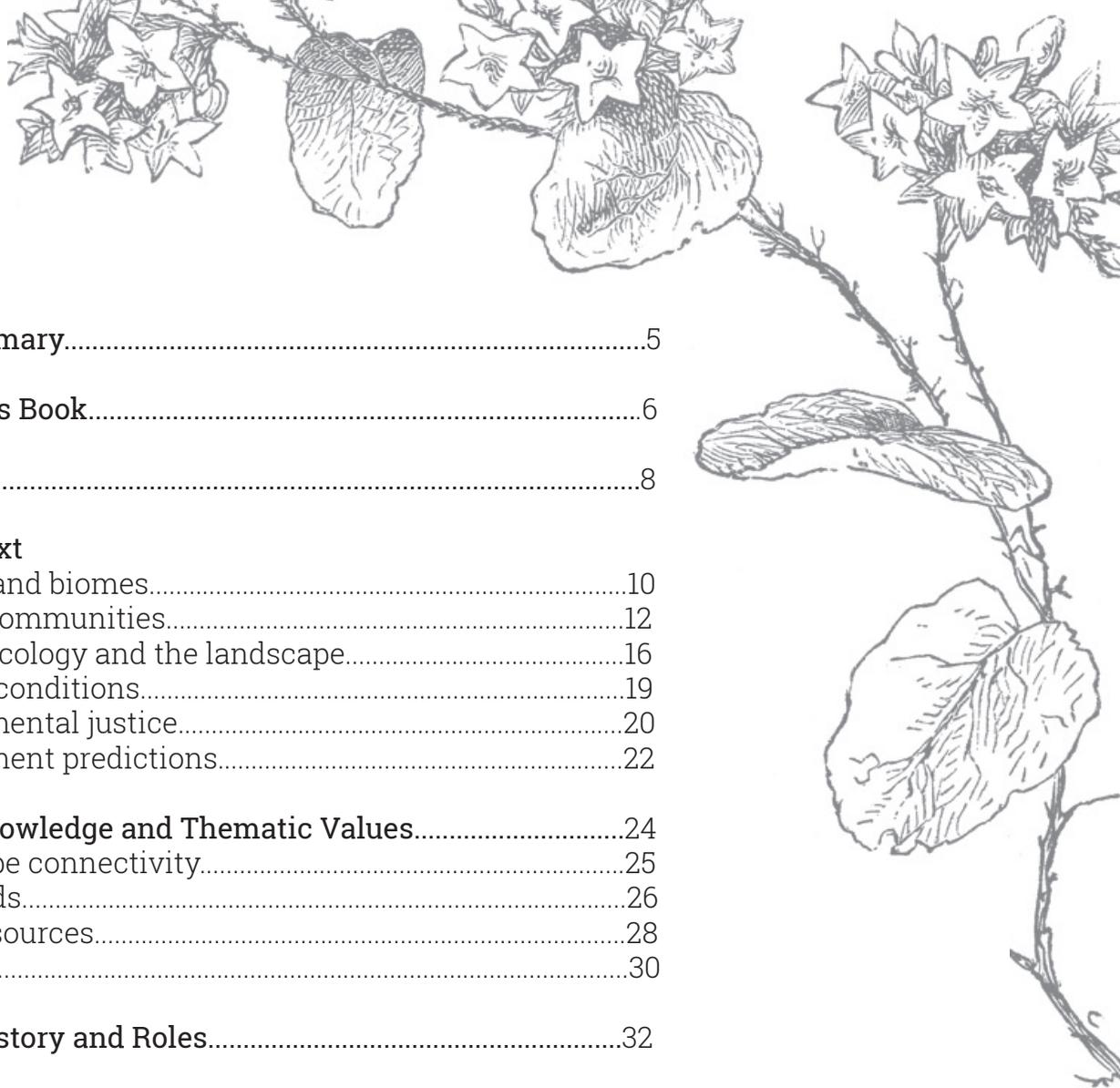
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We are inspired by your work.



Mayflower, *Epigaea repens*  
Massachusetts State Flower

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# Executive Summary

North central Massachusetts is an ecologically and demographically diverse area with an array of wetlands and water resources, varied forest communities, and both small towns and urban centers. This region has worked to conserve many of its ecological assets; yet the work of conservation here is more critical than ever, at a time when exurban sprawl threatens natural resources and quality of life in the region. North County Land Trust (NCLT) serves a 14-town area within this region and is one of the key conservation organizations at work. NCLT began its work in 1992, and since its inception, has partnered with the Department of Conservation and Recreation (DCR), Mass Audubon, Mount Grace Land Trust, and dozens of other organizations (as well as municipalities) to conserve thousands of acres.

Currently, NCLT is undergoing a strategic planning process to further define its conservation goals and to determine where to focus its resources. NCLT has not previously had a means of quickly identifying and ranking unprotected parcels across its region, which has posed problems when landowners approach with offers to sell or place a conservation restriction on their land, leaving NCLT with a great need for tools to assist in evaluating parcels on an as-needed basis. In order for NCLT to fulfill its mission of protecting the areas of “highest priority,” it needs a system in place. Beyond a parcel scoring system, NCLT is looking for the means to map the areas of highest conservation priority alongside permanently protected parcels throughout the region to form, in partnership, a regional network of conservation areas. To support this process, NCLT commissioned the Conway School to identify priorities for conservation at the parcel level within their region.

As a starting point, the project sought out stakeholder input, as NCLT relies on its stakeholders to determine conservation priorities. NCLT stakeholders are conservation professionals from a broad coalition of state agencies, non-profit organizations and town conservation commissions. Stakeholders identified four values— landscape connectivity, trail connectivity, farmland, and water resources— as those that best represent their highest conservation priorities. These thematic values form the basic parameters for the

models that *Creating Connectivity* uses to analyze resources within the NCLT service area.

*Creating Connectivity* presents a series of tools for prioritizing conservation areas at the regional and parcel level through a GIS-based analysis series. In the first regional analysis, theme-driven maps identify prioritized parcel selections. In the second analysis sequence, the datasets used in the theme-driven maps combine within a scoring matrix to generate a weighted map that scores each parcel in the NCLT region. This map can be used to identify the resources present within and the ecological integrity of any given parcel in the NCLT service area. Together, these tools allow NCLT and its partner organizations to act both reactively and proactively to parcel availability in the service area. Further input from stakeholders is needed for a robust assessment of priority parcels, and this report recommends that NCLT develop the weighted parcel map as an interactive web-based tool so that stakeholders can augment the GIS-informed assessment of each parcel of interest with local knowledge.

*Creating Connectivity* can only recommend the use of the datasets and criteria that form the basis for these analyses so long as they continue to represent the organization’s goals, mission, and values, and so long as they are relatively up to date. If these datasets and criteria are no longer aligned with organizational needs, the methods within this report can be used to guide the process of making adjustments to the model. The process developed for this project is designed to be replicable, with potential applications for any conservation organization in the Commonwealth and beyond. The maps and metrics resulting from this project, however, are specific to one organization at one moment in time. Rather than making recommendations as to which parcels NCLT should target for conservation, *Creating Connectivity* recommends the use of these analyses in conjunction with stakeholder input and ground-truthing.

# How to Use this Book

This report is intended for a number of audiences. It presents information about many facets of conservation in Massachusetts and about North County Land Trust's work.

The report proceeds from sections that are descriptive and easily accessed by the casual reader to more analytical and technical material. Sections are connected by a narrative that allows the book to be read from cover to cover. Alternately, the document can be read by "jumping around" to different topics, depending on the reader's interest. Below is a summary of the sections and to which audience they may likely appeal.

## Introduction

An introduction to North County Land Trust and to the contents of this report. Intended for an audience unfamiliar with NCLT's work.

## Regional Context

This section begins with a survey of the natural communities of north central Massachusetts, illustrating some of the most important forest types and ecosystems in the region. A discussion of the history of the area follows, and traces changes on the land from the glaciers to the present day, with some glances into the future. Here, three key reports that help frame today's conservation work are highlighted. This section is easily accessed by a casual reader interested in how the north central Massachusetts landscape has changed over time, and the effects of land use changes on today's conservation conversation.

## Stakeholder Values

Four essays explore the values guiding North County Land Trust's conservation work. A conceptual discussion of landscape connectivity, trails, water resources, and farmland can be found here and is intended for a wide audience.





## Thematic Analysis

This section describes the GIS process used to map the values discussed in the preceding essays. Maps on the right-hand side of the page are summarized in broad terms in paragraphs below them. A more technical description of how the analysis was performed is in the “Methodology and Indicators” section. This content is slightly more technical than that of the preceding sections, but an intrepid reader interested in GIS should find this section accessible.

## Weighted Parcel Map

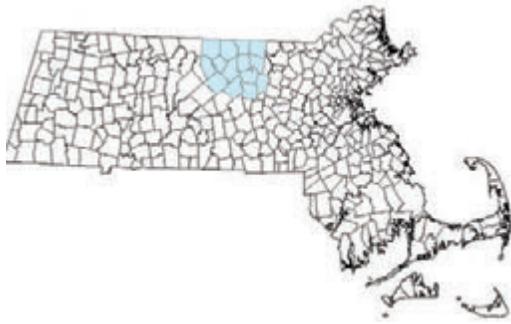
The culmination of the thematic analyses, this section discusses the creation of the weighted parcel map, a tool intended to help NCLT evaluate any given parcel within its service area based on a number of criteria. This section describes in technical detail the use of this tool for conservation planning and its possibilities for future development. A deep dive into the world of mapping, this section is for readers hoping to understand the nuts and bolts of GIS as applied to parcel mapping for land conservation.

## Appendix A-D

Appendix A describes how to use the Weighted Parcel Map, and Appendix B describes the maps created using stakeholder input. Appendix C includes a profile of each town within NCLT’s service area. An overview of some of the groups and programs related to conservation at the town level are included as a precursor to the profiles. Each profile includes a map of the town and an assessment of the town’s conservation capacity via relevant statistics and information. Written to highlight each town’s character, this section is palatable to any reader looking to learn more about specific towns within north central Massachusetts.

Appendix D contains Additional Resources including a description of some of the digital resources that may be useful to conservation-minded individuals, as well as an overview of Regional Conservation Partnerships, which provides an overview of the work being done by coalitions of conservation organizations in the Northeast. This appendix is likely to interest readers who wish to deepen their understanding of conservation work as it is practiced today. Appendix E is an index of all of the maps presented in this book, for easy reference.

# Introduction



The NCLT service area encompasses eleven towns and three cities in north central Massachusetts.

## North County Land Trust

**N**orth County Land Trust (NCLT) is a non-profit conservation organization firmly rooted in north central Massachusetts. Its mission is “to conserve the farms, forests, and landscapes that define the character of our region,” and its philosophy is to conserve land of “the highest priority” in perpetuity, while engaging communities in “appreciation of the natural environment.” Since its founding in 1992 around the protection of a single Fitchburg parcel, NCLT has expanded substantially and now serves eleven towns and three small cities, with a focus on providing access to natural spaces for all communities within its diverse region. Land trusts often facilitate the permanent protection of parcels owned by other organizations, municipalities and private landowners, along with making direct purchases and overseeing conservation areas that are open to the public. NCLT is no exception, and seven of its properties, covering 539 acres, are public-access conservation areas with trails. In total, NCLT has protected 647.5 acres through direct purchase, conserved 383 acres through conservation restrictions and facilitated the permanent protection of 3,294 additional acres both independently and through conservation partnerships.

Conservation work of this nature requires collaboration between many different partners, and NCLT partners with municipalities, state agencies and other land trusts. Conservation partnerships across the region today work to expand upon conserved areas in order to build a network of ecologically intact conservation areas. NCLT is an organization in transition, moving from protecting parcels when landowners approach with offers, to developing a strategic plan for regional conservation. In order for NCLT to fulfill its mission of protecting the areas of

“highest priority,” it will need to have a prioritization system in place. Until now, NCLT has not had a means of identifying and ranking unprotected parcels of ecological integrity across its region. NCLT is looking for the means to map the areas of highest conservation priority alongside permanently protected parcels throughout the region to form, in partnership, a regional network of conservation areas.

## Introduction to Project

The purpose of this project is to craft a scientifically informed parcel prioritization system. The model that results from this work can determine, alongside local knowledge, the areas of greatest priority for NCLT and can rate all parcels across the region using ranking that’s based on organizational priorities. Over the course of 11 weeks, this project collected general information about the context of conservation work in north central Massachusetts, including current studies and partnerships. Stakeholders provided insight into conservation priorities at the town and regional level, information which informed the selection of datasets and criteria for creating parcel prioritization maps. Finally, the project developed a weighted scoring matrix for the entire NCLT service area, which has the potential, with a little further coding, to serve as an interactive online map, merging the power of GIS-based information with the insight and lived experience of stakeholder knowledge.

The process developed throughout this project was designed to be replicable, with potential applications for any conservation organization in the Commonwealth and beyond. The maps and metrics resulting from this project; however, are specific to one organization at one moment in time. To better understand the unique facets of this region, with its particular natural resources and the threats they face, it’s important to consider north central Massachusetts. Understanding the current state of conservation in the region requires understanding the context of its ecological and human history and how they are entwined.



the **Conway** School

Graduate Program in Sustainable Landscape Planning + Design

“We envision a future that connects our communities through conservation — where physical, ecological, recreational and economic interconnections are embraced — enriching the unique character of each community.”

- NCLT Vision, 2019



## Ancient bedrock and a new plateau



**An exaggerated topographic map of the Northeast highlights post-glacial, north-south running geographic formations which influence movement and flow of biotic communities.**

**N**ew England's underlying bedrock and associated mountains are ancient, but much of the landscape patterns present today result from the retreat of a giant glacier, reaching over a mile thick at the end of the last Ice Age, nearly 14,000 years ago (Lothrop et al). As the glacier retreated northward, a result of a warming northern climate, it formed the north-south running ridges and valleys and the rolling plains of the Worcester Plateau.

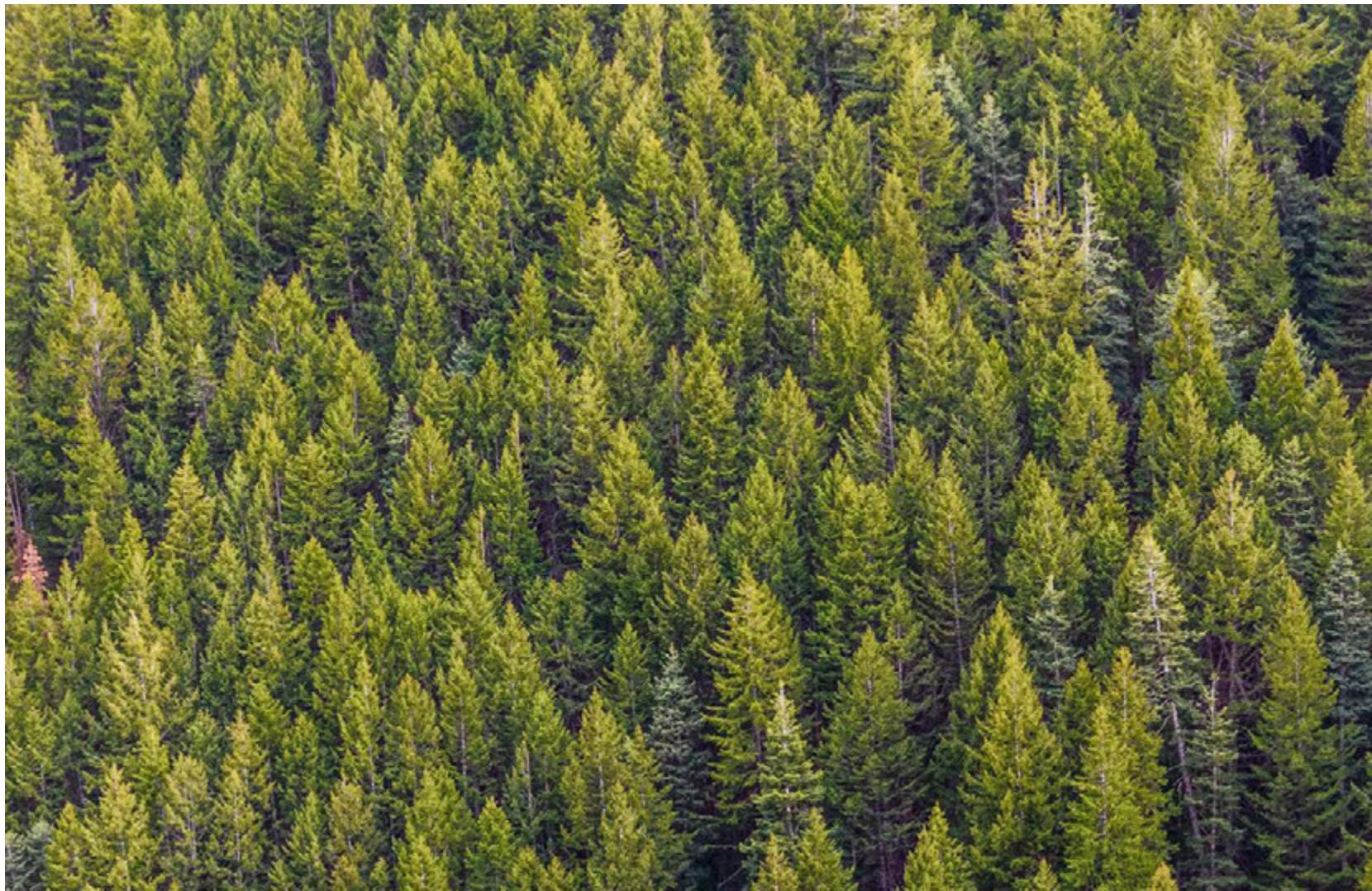
At a local level, the churning of rocks and cascading sediment left behind the glacial till, rocky soils, kettle ponds and alluvial basins typical of north central Massachusetts. This landscape shapes wildlife corridors for many species today and will likely direct the northward migration that ecologists expect from many species in response to the unprecedented climate change that this century faces. This glacial north-south-trending landscape informs forest composition and vegetative patterns today, supporting the present-day complex of biodiverse natural communities.

# Biomes and bioregions

At a continental scale, the planet divides into biomes, with New England transitioning from a temperate deciduous forest in the southern and central portions into a boreal forest in its northern reaches. Moving in closer, at a regional scale, the landscape reveals itself in a language of volcanic and glacial formations. North central Massachusetts falls within two ecoregions: to the west the Worcester Plateau uplands, an area defined by glaciated hills and an abundance of streams, and to the east, the sandier lowlands of the Northeast Coastal Plain. Within these broad ecoregions, a wealth of varying natural communities can be found. The structure of each of these communities is different and as such, each hosts a distinct web of life, from tiny insects to large predators. All together, these natural communities provide an array of spaces for retreat, study, play, fishing, hunting, exploring, physical exercise, and imparting a sense of wonder.

**“Young children instinctively find what is most obviously attractive in nature: a banquet of sensuous delights. Butterflies and starfish for the eyes; skunk and honeysuckle for the nose; the feel of icy brook water and mole’s fur; the taste of wild berries and sorrel; each in its place and all blending into a nameless thrill... This ideally is how we should learn about the natural world and our place in it, not from books. But as a species we are compulsive organizers, constantly assembling what we think we’ve learned into groups and lists and categories and priorities.”**

-Leahy et al, *The Nature of Massachusetts*, p. 24



# Dominant natural communities in the North County region



## Successional Northern Hardwood Forest

**Composition:** Successional hardwood, and mixed hardwood/softwood forests are common after large scale disturbances, either from major storm events or the widespread clearing efforts of humans. Disturbance on this scale stimulates a sequence of growth patterns, from the emergence of the saplings of one dominant species to what constitutes a more diverse and established forest with varied undergrowth.

In earlier stages, this community might include aspen, white and grey birch, red maple, and black cherry, with much lower numbers of white pine or red spruce often present. As the forest matures, the initial canopy may be replaced with sugar maple, red maple, white ash, yellow birch, American beech, and red oak. These forests typically mature into a hemlock- white pine- northern hardwood composition.

**Conservation status:** This is an upland forest type and where temperatures are cooler, this community is threatened, in its current range, by climate change.

**Associated fauna:** In its early stages, these forests are home to ruffed grouse, woodcock, and if the shrub layer is sufficiently dense, the endangered New England cottontail.

**Conserved example in central Massachusetts:** Mt. Watatic, Ashburnham and Ashby, MA (DCR, MassWildlife, Ashby Land Trust, Ashburnham Conservation Trust)

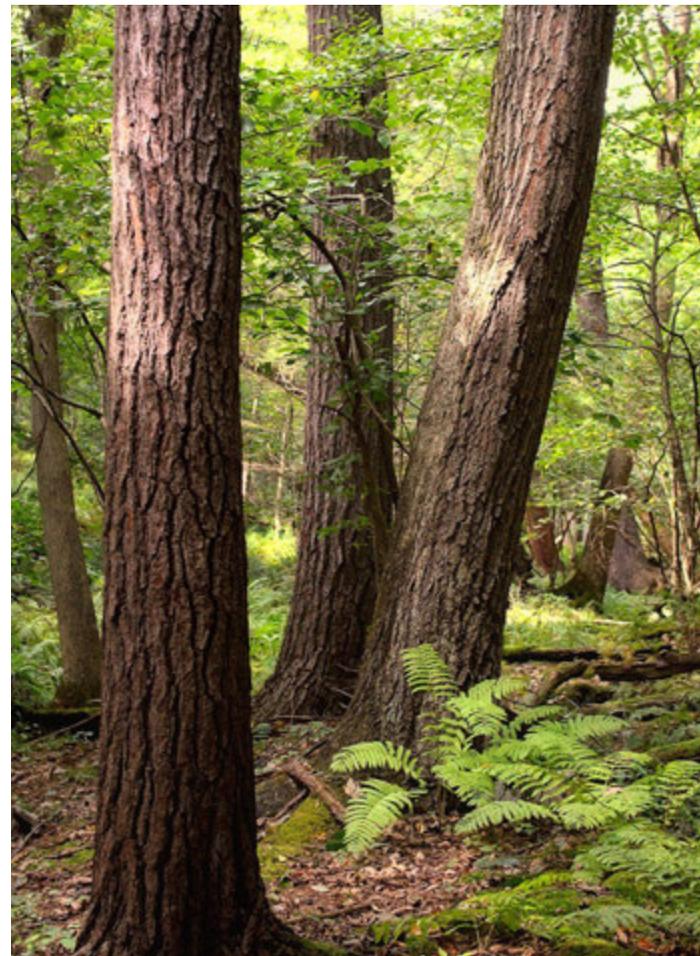
## Hemlock - White Pine Forest

**Composition:** Currently this community is the dominant transitional forest of the Worcester Plateau peneplain in Massachusetts. As a forest community, it's extremely common and highly variable. White pine and hemlock stands may be dense or scattered and sometimes alternate with endless combinations of oaks, maples, ash, beech, birches, and occasionally, bitternut hickory. The shrub layer and herbaceous understory are often sparse, due to the acidic soil generated by coniferous leaf litter.

**Conservation status:** The introduction of the invasive hemlock woolly adelgid insect is causing a steep decline in the hemlock population over the extent of their North American range, with untold consequences for New England forest composition and an uncertain outlook for the many species that prefer hemlock-dominated forests.

**Associated fauna:** These forests, also referred to as oak-conifer (along with many other names), vary widely enough that they tend to host a wealth of generalist species, from salamanders to squirrels to moose.

**Conserved example in central Massachusetts:**  
Peabody Conservation Area, Lunenburg, MA (NCLT)





## Oak - Hickory Forest

**Composition:** These are hardwood forests dominated by oaks and a scattering of hickories. Occasional other trees include white ash, black birch, sassafras, and red maple. This community is the dominant forest of southern New England and the mid-Atlantic region with some tree species adapted to warmer, drier conditions and thus, reaching the northern limits of their range here in Massachusetts. It's no surprise then, that this is a forest community of warmer microclimates, often found on south-facing slopes.

**Conservation status:** As the climate warms, oak and hickory communities are expected to proliferate in central New England, eventually expanding to new areas.

**Associated fauna:** Oak-hickory forests are preferred by ovenbirds and scarlet tanagers, with mature communities providing nesting cavities for southern flying squirrels.

**Conserved example in central Massachusetts:** Edmund Hill Woods Natural and Cultural History Trail, in nearby Northborough, Massachusetts (Northborough Trails Committee)

## Red Maple Swamp

**Composition:** Five distinct layers of vegetation are typical within this flooded forest community: mature trees and understory saplings, shrubs and vines, an herbaceous layer of sedges, ferns and wildflowers, and finally, the mosses and clubmoss that form a continuous groundcover. Red maples are dominant, but overall biodiversity at every vegetative layer is very high. Red maple swamps often remain flooded or saturated for much of the year, but they may experience dry spells towards the end of summer.

**Conservation status:** A common community in Massachusetts, red maple swamp has not historically been a high conservation priority, but many conservationists now look to the incredible richness within this community and to its global rarity. Conservation efforts are now moving to study and protect red maple swamps further (Mass Audubon, 1996).

**Associated fauna:** 119 bird species and 49 mammals recorded here (Mass Audubon, 1996) include mink, green heron and spotted turtle.

**Conserved example in central Massachusetts:** Underwood Road Conservation Area, Hubbardston, MA, (NCLT)





## Lakes and Ponds

**Pond composition:** Beaver populations have rebounded from their near-extinction during colonial settlement and their ponds are a common sight once more. The word “pond” originally refers to an artificial body of water, and in colonial America, these were frequently constructed for agricultural purposes. The kettlehole ponds typical of the region were formed by glacial ice blocks lodged within outwash plains. Millponds for grain mills were also created during this time by damming streams. Ponds are small and shallow enough that they often experience succession over time. Herbaceous species taking hold at the edges can usher in the growth of shrubs; given the right conditions, ponds sometimes transition to red maple swamps.

**Lake composition:** Although there’s no definitive way to distinguish between ponds and lakes, lakes are generally deeper, darker, and more biologically complex, with at least two stratified temperature zones beneath the surface, allowing turtles and other aquatic species to continue feeding and to navigate in the warmer zone below after the surface has frozen solid.

**Associated fauna:** Lakes and ponds are host to an astonishing diversity of invertebrates, amphibians, reptiles and fish, along with beaver, muskrats and raccoons.

**Conservation status:** Lakes and ponds are sensitive ecosystems and are adversely affected by many human excesses, including nitrogen runoff from fertilizers used in agriculture, and the havoc wreaked by the introduction of exotic species.

**Conserved example in central Massachusetts:** Dunn Pond State Park, Gardner (Department of Conservation & Recreation)

# Examples of rare natural communities in the North County region

## Cultural Grasslands

**Composition:** In New England, grasslands occur naturally only in narrow riverine habitats and wetland areas. The majority of today's grasslands, the fields and meadows associated with scenic views in much of the region, are typically composed of the exotic grasses and other herbaceous sun-loving species that took hold immediately upon their colonial-era arrival. Another type of grassland here is referred to as an old field, and these are formerly cultivated areas of infertile soil dominated by native grasses (typically little bluestem) and juniper.

**Conservation status:** MA grasslands are not strictly considered natural communities, but old fields can harbor some of the rarest meadow-dwelling native species.

**Associated fauna:** Dozens of rare butterflies (old fields), swallows, sparrows, Eastern cottontail, fox

**Conserved example in central Massachusetts:**



## Ridgetop Pitch Pine - Scrub Oak Community

**Composition:** This rare community is commonly found on acidic bedrock, often on exposed ridgetops and steep mountain slopes growing in severe climatic conditions. It's a community well-suited to drought: pitch pines are fire-adapted (they can resprout at the base after a severe burn), and they need fire to reproduce; their closed cones only open to disperse seeds upon exposure to extreme heat. Fire produces a chain of events here that includes bursts of wildflowers in response to the nutrient-rich ash, followed by a flurry of insect activity and the arrival of birds.

**Conservation status:** Pitch pine -scrub oak communities are often threatened by careless housing development planning and fire suppression. Some of the rarest species in the state are in residence within the pitch pine - scrub oak community

**Associated fauna:** Deer, bear, wood turtles

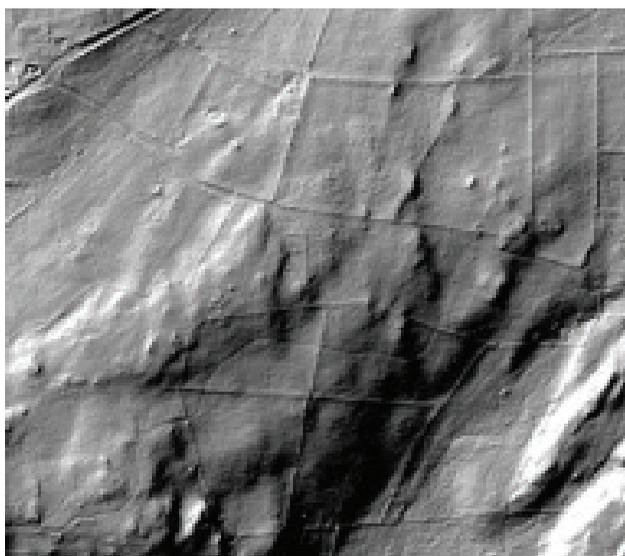
**Non-conserved example in central Massachusetts:**

Fort Devens and Devens South Post, towns of Shirley, Ayer, Lancaster, MA

# Human ecology and the central Massachusetts landscape

**“The landscape of New England has undergone one of the most remarkable histories of transformation worldwide.” -Foster et al., *New England’s Forest Landscape***

The natural communities in the region represent just one facet of land cover in Massachusetts, which is one of the most heavily forested and densely populated states in the country. As the organization MassWoods states, “There are few places on earth where so many people live among so many trees!” North central Massachusetts is not continuously forested today: a mosaic of post-industrial cities, small towns, woodlands and wetlands characterize the landscape, but it was not always so. Current research places the first humans here around 13,000 years ago (Fagan and Durrani), arriving into a boreal climate supporting patchy forests of firs and spruces within a greater tundra. As the climate continued to warm, the floral and faunal diversity of life increased, and human populations had a hand in altering the landscapes they encountered and the gene pool of wild species they foraged: controlling forest undergrowth through seasonal burns and selecting for desired traits in wild plants (Foster, Donahue, et al.). Inland villages established by the Nipmuck, Pocumtuck, and Pennacook peoples afforded access to woodland areas that served as foraging and hunting grounds. Outside of these delineated spaces, much of the forest was likely unmanaged, although many indigenous groups within the larger region cleared more extensively along rivers, planting beans, squash, maize, and other crops



Lidar imaging reveals an intricate network of stone walls and roads, now hidden by forests. -K. Johnson and W. Ouimet

within these rich riparian zones (Russell).

Here in Massachusetts in the seventeenth century, as European settlers moved westward from their first villages along the coast, colonial governments offered indigenous land to groups of individual European “proprietors” to establish settlements throughout inland Massachusetts, which resulted in the broad scale destruction of native societies, and a near-complete displacement of indigenous populations (Chen). The influx of settlers left very different marks on the landscape. One of the biggest shifts in vegetative composition and ecosystem processes came as a result of the human removal of key species. Colonial settlers’ hunting practices drove the passenger pigeon to extinction and caused the critical endangerment of wolves, while the burgeoning market in furs made trapping a commercially viable enterprise, bringing beavers to the brink of extinction in the region (Foster et al., 2002).

## An agrarian culture takes hold

While initial colonial settlements integrated indigenous crops such as maize and squash with Old World farm animals, the market economy of the nineteenth century allowed for farming on a commercial basis. This was a time of extensive clearing for agriculture: during this period the landscape of north central Massachusetts, along with southern New England as a whole, was utterly transformed by clear cutting for sheep, beef, and dairy operations. A patchwork of croplands, small woodlots, fields for grazing and hay, and villages of growing populations became the signature of land use across the Commonwealth. By the early 1800’s, all of the towns of north central Massachusetts had been incorporated into the Commonwealth, and an agrarian culture of pasturelands, neighborly trade, and small town life established itself across central Massachusetts and New England as a whole. The remnants of these agrarian landscapes and traditions play a crucial role in regional rural identity today and provide a model for the contemporary local foods movement.



17th-century colonial depiction of indigenous territories

## Reforestation, industrial nation

With the rise of farming in the Midwest, however, where fields were more fertile, less rocky, and much flatter, a gradual shift away from agriculture occurred in the NCLT region. Secondary-growth forests reclaimed much of the previously cleared agricultural lands, often regrowing into dense white pine stands, which in turn were frequently cleared to meet growing need for shipping crates to package the new products of the Industrial Revolution. The industrialization of Massachusetts accelerated through the mid-nineteenth century, reaching its peak by the early twentieth century, when the practice of damming rivers for mill factories was commonplace. The power of the region's rivers (their stream beds deepened millenia ago in the glacial exodus) was harnessed for the large-scale manufacturing of paper, woodworking, textiles, and machinery. Railroad companies laid tracks from Boston to Fitchburg, and immigrant populations in this burgeoning urban center, and in Leominster and Gardner, swelled to meet factories' demand for workers. The large-scale deforestation that spread across north central Massachusetts as a result of development generally mirrored deforestation patterns during the agrarian period in terms of pace and prevalence of clearing. The loss of forests and other natural landscapes to development; however, are perhaps the most difficult type of land transition to reverse.

### Food Solutions New England: A New England Food Vision

(Published in 2014)

A New England Food Vision is the result of a collaboration between American Farmland Trust (AFT), Conservation Law Foundation (CLF), and Northeast Sustainable Agriculture Working Group (NESAWG), which addresses the environmental and humanitarian harms implicit in a globalized food network. New England imports 90% of the foods it uses currently, creating undue burdens on the environment and economic uncertainty in many parts of the region. This report addresses the state of New England's food network and lays out scenarios for a stronger, more resilient local foods system that could bring New England to 50% food self-reliance.



# Existing conditions: Demographics and development



Aerial view of Nashua River, Fitchburg - ESRI World Imagery

## Circuits of highways

By the mid-twentieth century, the popularization of the automobile created emphasis on building more extensive road systems (with a subsequent de-emphasis on railroad travel), and new highways cut deep lines across the state. Roads served as effective connectors for towns and cities, but their construction carved up habitat cores, fragmenting forests and drastically increasing the spread of impervious cover over the landscape.

**Increased impervious surfaces lead to reduced ecological integrity as stormwater runoff collects the motor oil residue on roadway surfaces, feeding polluted water into rivers and oceans.**

Route 2, an east-west running highway that follows sections of a pre-colonial trail (known today as the Mohawk Trail), cuts through the region's north-south running ridges, bisecting the NCLT region. Leominster served at mid-century as a regional transportation hub, with a network of new turnpikes connecting the north central region of the state to the metro Boston area (Gilbert, 2006). Leominster, at its industrial peak, became known as the "Premier Plastics City," a place where products using new petroleum-based materials were devised and manufactured. As with previous eras in New England's history, the industrial

## Mass Audubon's Losing Ground

(The series began in 1987, and published its 5th edition in 2014)

Losing Ground reports on the state of conservation in Massachusetts through the lens of habitat loss to development: which lands have been recently conserved and which areas remain the most threatened. It's been instrumental in advancing the concept of a sprawl frontier, denoting areas where "an increase in development pressure could lead to significant changes in community character and ecological function." As sprawl advances westward from the Boston metro area, it threatens to eventually encompass the entirety of the state if conservation efforts are not increased. The latest edition notes that many towns along the Worcester Plateau that were seen as facing imminent "sprawl danger" in 2004, are not seen as facing quite the same threat level today, due to effects from the Recession of 2008, giving the NCLT region an "extended opportunity for land conservation" (pg 4). Losing Ground provides excellent conservation-based data for Massachusetts. It does not, however, address how towns' economic problems and the potential for ecological crisis presented by development threat might be addressed in tandem by land trusts.

era was short-lived. Both Leominster and Fitchburg, formerly two of the most bustling cities in the area, faced declining economies in the latter half of the twentieth century as globalization took hold and most manufacturers moved their businesses out of the region or closed altogether.

# Environmental Justice

**E**quity is now a mainstream topic in city planning across Massachusetts after decades of environmental justice advocacy advanced by people of color citing the direct link between racist planning policies and environmental degradation. Communities of color are exposed to six times the amount of nitrogen dioxide air pollution than white communities, and are four times more likely to be the site of power plants, according to Sara Dewey, a legal fellow at the Conservation Law Foundation (Capeloutu).

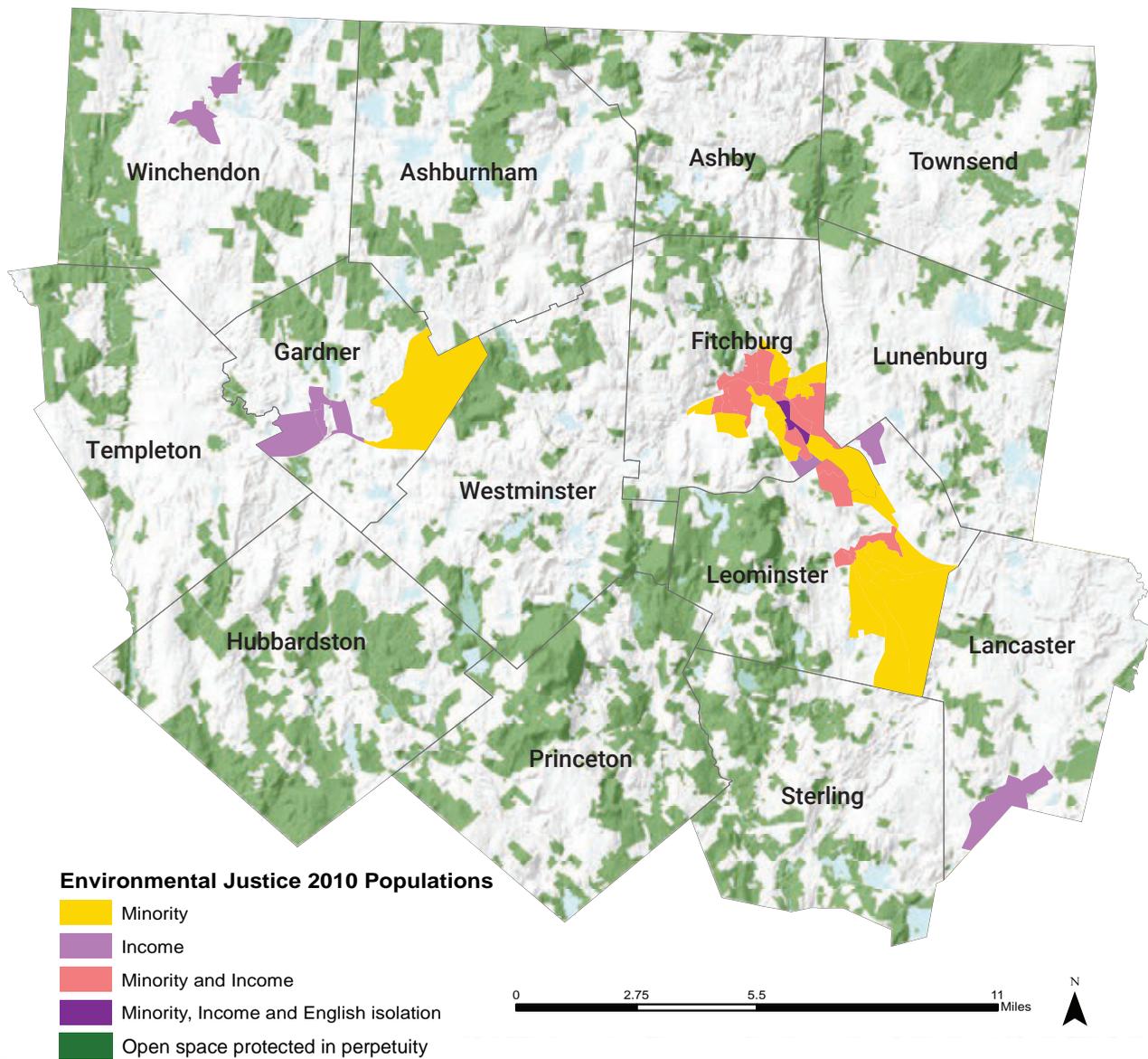
Inequity, wherein the most marginalized people bear the burden of living near the most contaminated city sites with the fewest environmental assets is persistent in U.S. cities. Environmental Justice (EJ) policy is designed to address this imbalance and to support community involvement in planning and environmental decision-making. In Massachusetts, the Executive Office of Energy and Environmental Affairs (EEA) developed a policy in 2002 to address these issues. EJ policy does not, however, stem from politicians and planners, but comes as a result of tireless community organizing. Environmental Justice, as a movement, was first championed by poor communities of color faced with the pervasive structural racism that persists today.

## 2017 Environmental Justice Act

The idea of environmental justice currently “has no meaning” to state officials, Rep. Rose Lee Vincent, D-Revere stated in 2017 (Capeloutu). Last year, the Environmental Justice Act was signed into law in Massachusetts, in an attempt to hold city managers and state officials accountable for the statements they make supporting EJ. Communities across Massachusetts are waiting to see if new measures will create real and meaningful change.

As a federal and state policy, EJ uses census data to identify vulnerable populations and to map where these populations coincide with environmental hazards. Designated populations are included within categories based on lower-than-state-average median income, race (minority status), and immigrants (referred to as English-isolation populations), or any combination of these factors.





## Environmental Justice Communities

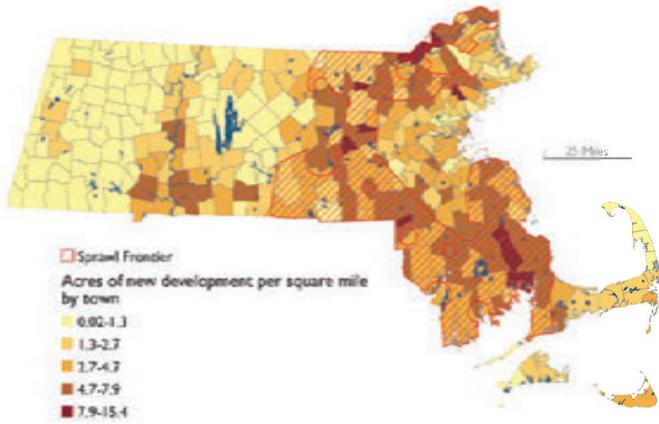
EJ communities within north central Massachusetts are primarily concentrated in the urban cores of Leominster and Fitchburg, with other communities scattered across rural towns. Urban cores represent areas of maximum development, where few, if any, pockets of open space remain. The demographics of the region's urban and rural EJ communities tend to differ.

Oftentimes, EJ communities living in urban areas do not have sufficient access to the open spaces that may be present in more affluent neighborhoods or outside the urban core. In other words, the low-income white EJ census block in Winchendon does not have the same barriers to accessing open space as the low-income English-isolation census group in Fitchburg, but the first group may face other barriers to quality of life.



**Nashua River, Fitchburg:** Pollution from textile and paper mills in the 1960s (left), contrasted with the river in the 1980s after extensive cleanup (right). - EJAtlas.org (a source for mapping EJ communities)

# On the edge: development predictions and the urgency of now



Acres of New Development per Town from 2005-2013  
- Mass Audubon's *Losing Ground*

**North central Massachusetts is on the outermost edge of a wave of development radiating out from Boston, and other urban centers in the region.**

The Integrated Probability of Development model, part of the UMass Amherst Designing Sustainable Landscapes project (DSL), bases its projections for the next few decades on current and former land use patterns and population shifts (see map on page 23). This DSL model predicts that rural towns on the fringes of Boston, Worcester, Lowell and Nashua will face increasing development pressure in the coming decades. As populations grow, and people continue to seek out cities for work, cities that have reached maximum development (indicated in green) will expand by pushing beyond their current extent, creating a larger web of "bedroom communities," places where most of the residents commute out of town to work in larger cities where housing prices are higher. The commuter rail connecting Leominster and Fitchburg to Boston could further incentivize a new wave of commuters and residential developments. For some towns within the region, landscapes will be disproportionately impacted by suburbanization in the years to come.

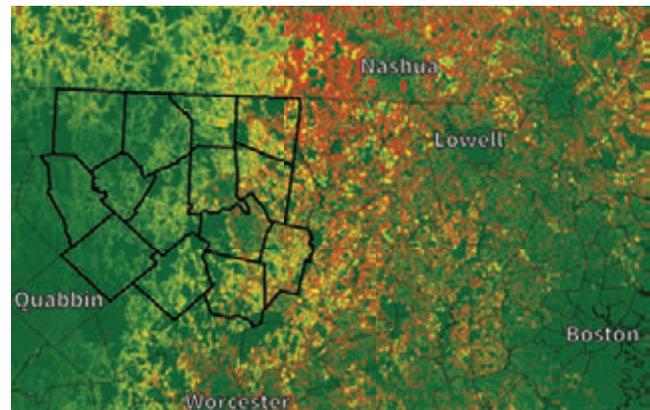


## Harvard Forest's Wildlands and Woodlands

(Published first in 2002, updated in 2017)

Harvard Forest's Wildlands and Woodlands project published its findings in 2017: Massachusetts is losing 65 forested acres a day. Wildlands and Woodlands frames the urgency of conservation in New England and it does so by discussing the land clearing practices that devastated forest communities while stressing the dire consequences of insufficient planning. It's a conservation report that considers strategies for forest preservation and for working forests, a strategy that holds the possibility of bringing economic benefits as well as ecological ones into the region through conservation work. Perhaps the single most important statement emerging from Wildlands and Woodlands however, is the revelation that New England's forests, the northern temperate landscape so familiar to this region, is a globally rare, precious biome, a vast forested corridor in a larger continental context, where north central Massachusetts' forested landscape plays a crucial role.

Unplanned, short-sighted development threatens the ecological systems that we depend on to provide clean air, water, timber and reprieve from the bustle of urban life. Population growth for small towns associated with this increase in residential development will place increased pressure on watershed systems and on local food production, further straining natural systems. Conservation organizations play a critical role in helping to slow down the creep of pavement across the landscape. Land trusts in particular are poised as key players in determining which areas are of highest priority for local communities and in advocating for ecological resources at the regional scale.



**Integrated Probability of Development Model:**

Projected development from 2010 to 2080 - UMass DSL





## Stakeholder Knowledge and Thematic Values

**N**CLT stakeholders include board members and other conservation professionals within the region. Many stakeholders hold positions on conservation committees, and within state conservation agencies, while others are involved in regional planning, trail associations, watershed protection organizations, and local land trusts.

Stakeholders recently identified four values, landscape connectivity, trail connectivity, farmland and water resources as those that best represent the highest thematic conservation priorities within the region.

NCLT stakeholders' thematic values form the parameters for the models developed for this project to analyze resources within the NCLT service area.

### Stakeholder Identified Values



Landscape Connectivity



Farmlands



Water Resources



Trails



## Thematic Values: Landscape Connectivity

**“Achieving connections for wildlife requires forging connections with people... Corridors and connections are often in the spaces between preserves, the mixed use spaces occupied by human communities. Bridging barriers for wildlife means bridging the needs of the people living in that landscape. It means working with communities to find solutions that are practical, and possible... not just from the perspective of science, but also residents, farmers and industry.” (Rudnick et al.)**

While the networks of towns, roads and diverse land uses on display in the landscape of contemporary New England indicate the speed and facility of our way of life, these patterns are also indicative of the significant barriers we’ve created for other species and the difficulties they encounter as they move across the landscape. In central Massachusetts, the north-south trending ridges and valleys of the Worcester Plateau form natural wildlife corridors which today have become fragmented by highway construction. The construction of Route 2 dividing the NLCT region is a prime example. Decades ago, ecologists and conservationists addressed habitat degradation by targeting individual endangered species in their conservation efforts. These days the field has shifted to a broader approach, one that links the quality of life of human communities directly to ecosystem health, with its complex biotic interactions. Much of regional conservation work now focuses on identifying areas with potential to offer movement and flow between fragments of intact habitat.

Landscape connectivity addresses whether a landscape facilitates or impedes the movement of species (Taylor et al.). In this sense, connectivity doesn’t just describe the proximity of landscape features, but also whether the landscape is conducive to travel for wildlife and other organisms, such as plant life. Creating greater landscape connectivity increases the size of critical habitat cores, giving plants and fungi more space for dispersing their seeds and spores, and ensuring genetic diversity and species survival. For wildlife, genetic diversity and species survival means the ability to access sufficient space within a healthy ecosystem to allow for foraging and nesting, along with travel routes for successful mating and migration.

The linkages between habitat fragments are sometimes referred to as corridors, but connectivity need not be linear. Every species is distinct in its requirements and habits, and to respond to this diversity of needs, landscape connectivity often

resembles a network or a web, rather than a corridor. A commonly used GIS technique for identifying the most ecologically valuable connections within a large region is the least-cost pathway analysis, a model that devises optimal paths for animals traveling across a landscape from one habitat patch to the next. Least-cost models can help conservation professionals make strategic decisions about land protection. When used alongside on-the-ground local knowledge, these models can assist in the identification of the most critical barriers for wildlife, areas that ecologists can target for intervention. The current thought is that small measures, like installing culverts, can greatly increase regional connectivity through assisting wildlife passage, if strategically sited.

One current program applying this model is the Berkshire Wildlife Linkage, a collaboration between the Massachusetts chapter of The Nature Conservancy (TNC), the Berkshire Environmental Action Team (BEAT), and the Massachusetts Department of Transportation (MassDOT). This Berkshire Wildlife Linkage in its totality covers roughly 2.4 million acres of western Massachusetts, southern Vermont, eastern New York, and northern Connecticut. It connects the Green Mountains in Vermont to the Hudson Highlands in New York, and is itself a small piece in a much bigger connectivity puzzle. This initiative uses critical linkages analysis to identify core forest habitat fragments and priority parcels connecting these fragments, along with priority road segments where culvert installation would provide the most regional benefit to wildlife. Berkshire Wildlife Linkage’s GIS-based modeling phase was followed by a ground-truthing phase to collect data verifying the presence and pathways used by wildlife within select nodes targeted by the analysis. The work continues with outreach to landowners and education about land management strategies that benefit wildlife passage ([climateactiontool.org](http://climateactiontool.org)).

With the addition of resiliency data, connectivity models address fragmentation by selecting corridors that could assist wildlife with northern migration as temperature zones shift north in response to global warming. This is a complex issue. Gauging how animal and plant species will respond to a warming climate, along with more frequent and severe weather events, is hard to predict, especially as landscape connectivity is species dependent. Corridors will look different for beetle species than for birds, much different for seed or spore travel than for moose.



## Thematic Values: Farmlands

Farmland protection goes directly to the heart of how a community lives, how communities see themselves, and the extent to which local economies are self-reliant. In 2018, NCLT stakeholders ranked agricultural lands as their single highest priority. The broad appeal of farmland may stem, in part, from the multitude of separate but related lands that qualify as farmlands: from fields of scenic interest that have not been farmed in generations, to iconic local farmhouses, to working farms. Even though farmers today rely on spreadsheets and credit card transactions, farming is a link to old ways of living. New England's agrarian past is still deeply embedded in its current culture of roadside farm stands, antique tractors and neighborly favors, and preserving this cultural history, for many small towns, takes the shape of maintaining former pastured land through annual mowing or gathering volunteers to restore historical stone walls. Along with a low density

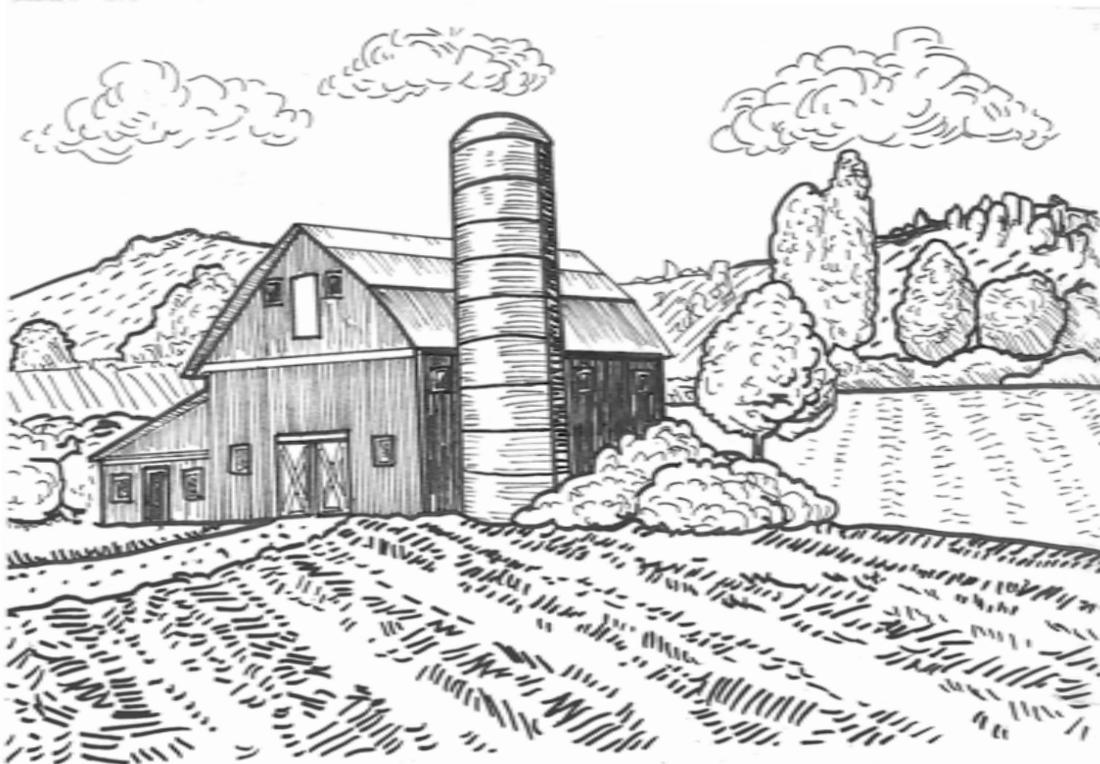
residential profile, the residual effects of living in a place that was heavily farmed in the past, is what, for many small town residents in this region, provides that elusive essence known as rural character. Many towns have placed a high priority on the preservation of their rural character, raising the question of how food production fits in with preservation efforts in the NCLT region. In the ongoing discussion about what to protect and save within rural towns, what role do working farms play?

While New England has seen dramatic shifts in land use patterns over the past three hundred years, from farming as a subsistence operation in the early colonial period to the market economy-driven livestock enterprises that swept across the region in the mid-1800's, the central Massachusetts countryside is still known for its small family farms. Dairy farms in particular, with their big red barns,

grain silos and rolling pastures, evoke the agrarian landscape that so many towns now seek to preserve. Nowadays, dairy farms are facing tough times. According to American Farmland Trust, nearly half of the dairy farms in New England went out of business between 1992 and 2007, as milk prices dropped well below operational costs (Farragher). New England's farmers find themselves in this precarious state at a time when local food is celebrated in the U.S. These days, farmers are expected to meet the demands of ever-growing populations with very few support systems in place, and any plan to increase the viability of small farms nests within a larger conversation of how to forge a path to a more secure future for small-scale farming.

To better understand the range of farming activities present in the region and the nature of the threats posed to both historical farms and working farms, NCLT and Mount Grace Land Trust (a conservation partner with a service area that overlaps somewhat with the NCLT service area) have been conducting agricultural inventories. An inventory of working farms and historical farmlands can provide land trusts with a clearer picture of the region's existing agricultural conditions, along with the biggest assets local farms provide and the biggest obstacles they face. With more insight into the state of farming in the region, NCLT will be better positioned to assist farmland

owners in protecting their land and achieving financial stability. Conservation organizations can play a crucial role in saving farms and farmlands. One of the paired tools available for this purpose is the Agricultural Preservation Restriction (APR) and Option to Purchase at Agricultural Value (OPAV). The APR program lets farmland owners place a permanent restriction on their land, which effectively removes the land in question from the mainstream market, to be kept in agricultural use in perpetuity. The APR program seeks to increase farmers' land equity and provide big-picture assistance, especially for individuals and families whose finances have spurred them to consider selling their farm or closing their agricultural business. OPAV is an extra measure of agricultural protection to ensure that protected farmland is more affordable for farmers. So far, the data show that OPAV is mostly benefiting established farmers with access to capital rather than assisting the entry into farming of landless farmers or beginning farmers as many people had hoped (Wagner et al.). These are nonetheless powerful tools that can be used to create more equitable circumstances for farmers. Landowners can involve land trusts in these transactions, both in holding agricultural restrictions and in assisting with OPAVs. Ensuring the future of agriculture in the region is a daunting, worthwhile, and achievable task.





## Thematic Values: Water Resources

“The cycle of life is intricately joined with the cycle of water.” - Jacques-Yves Cousteau

**N**CLT stakeholders identified the preservation of water resources, including drinking water, surficial water, and aquatic habitat, as a top conservation priority. Population growth, climate change, and urbanization pose distinct threats to water resources in the service area, and conservation of both land and aquatic resources can strengthen the region in face of these challenges.

Historically, industrial cities like Fitchburg, Leominster, and Gardner ran on water-powered mills. These mills created paper, tools, furniture, clothing, and firearms,

and drew thousands of workers to the urban centers, rapidly increasing population growth and demand for water resources. Large reservoirs and groundwater sources in the service area provide the water for these cities, but water demand is likely to increase as surrounding towns continue to grow.

Climate change may spur population growth in the area as populations migrate from environmentally stressed regions, further increasing demand of water resources in the service area. Globally, coastal areas are projected to become uninhabitable as sea levels rise and inundate

shoreline infrastructure, forcing coastal communities to migrate inland. Areas currently reliant on steady rainfall for agricultural production may see large-scale human migrations as droughts desertify once arable lands. To date, nearly one in three people live in a country facing a water crisis (Perlman). Inland migration and population growth heightens the importance of preserving water resources. The proximity of NCLT's service area to coastal populations, and as a region with substantial precipitation, indicate it may hold potential to serve future populations migrating from climatic stressors.

Climate change is expected to profoundly impact the global water cycle by making dry regions drier and wet regions wetter. The precipitous New England landscape, including NCLT's service area, is expected to experience increases in heavy precipitation and storms (EPA). Impervious surfaces amplify the cumulative effects of heavy rains, by increasing urban flooding and overflow of sewer systems. Urbanization within watersheds reduces infiltration and results in rapid water accumulation in rivers and low-lying areas (EPA).

Wetlands help mitigate flooding by acting as giant sponges, absorbing surficial water and replenishing groundwater, supplying an essential source of drinking water in Massachusetts. Wetlands also absorb greenhouse gases via plant growth, thereby mitigating climate change, and purifying contaminated water. As water filters, in fact, wetlands require little to no maintenance and provide valuable habitat for species and natural space for humans. While wetlands are crucial in Massachusetts, they cover only about 10% of the state (Patrick et al.). In Massachusetts, from 1991 to 2005, over 1250 acres of wetlands were lost or altered by human development, a 3% reduction in under 15 years ("Wetlands Loss Maps Q&A," Mass.gov).

Preservation of water resources can help NCLT reach its vision to enhance and embrace the ecological, social, cultural, and economic interconnections in each of the communities they serve. Natural water systems benefit local economies by supporting local businesses through fishing, swimming, and boating, and through their aesthetic value for near-water recreation like hiking, picnicking, and photography. Aside from recreational benefit, property values increase in proximity to clean, natural water systems like wetlands, rivers, and lakes (Wilson and Carpenter).

Stewardship of water resources can improve the quality of life for current and future generations. Opportunities to steward and conserve water include reducing water consumption, reducing water pollution (e.g., sewer dumping, litter in ecosystems), limiting soil erosion, and educating others about water conservation and pollution. Individuals can also serve as advocates in

their community to preserve aquatic habitat by reaching out to policymakers, joining water-resource protection organizations, and supporting land trusts.

But stewardship does not end with reducing consumption and pollution and educating others.



Humans live directly above groundwater, and actions and development on land can directly affect the quality of groundwater. Reducing the amounts of pesticides and fertilizers used on lawns, replacing unneeded impervious parking spaces with water-filtering plants, collecting rainwater into rain gardens and using rain barrels are all methods to preserve the quality and quantity of available groundwater. Protecting and conserving vegetation and land in any region, but particularly in areas with surficial or groundwater resources, are powerful tools to protect this precious resource.



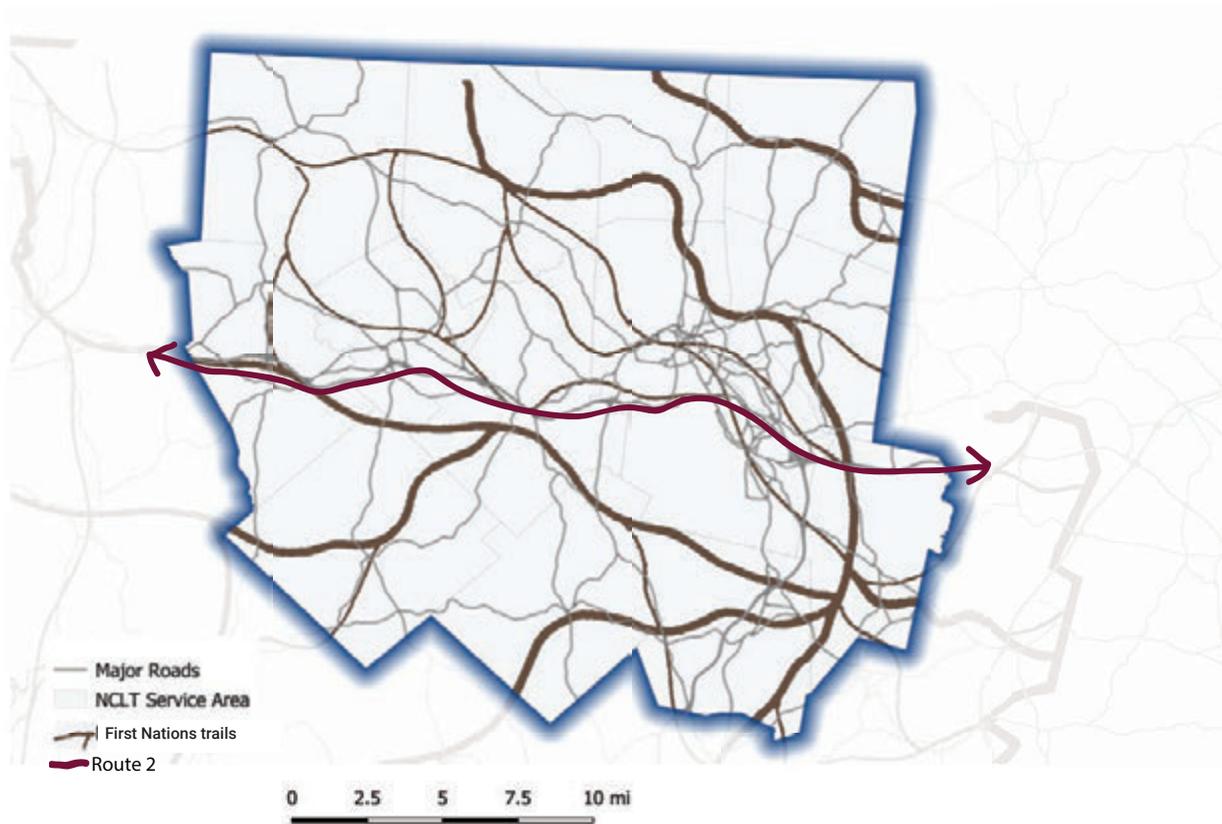
# Thematic Values: Trails

**N**CLT works to increase accessibility to the outdoors for the communities it serves. Some of the NCLT’s conservation areas are open to hikers, and the organization hopes to expand its trail network for the purposes of both preservation of natural resources and increasing human access to nature.

Trail use is embedded in the DNA of social mammals, from domesticated animals like cows and goats, to wild animals like deer, foxes, and rabbits. Humans are no different. Historically, the First Nations people created the first overland trails in Massachusetts, likely over 13,000 years ago (Fagan). These trails extended along ridgelines and riparian drainage lines and linked important natural resources like ponds and lakes (Steinitz et al.). Colonial expansion pushed

through the landscape for several hundred years, to the detriment of the First Nations people, who were ultimately removed and displaced, and colonists began to trade and travel along established First Nations trails. These colonial trade routes frequently became roads and highways (Steinitz et al.). The map below illustrates the comparison between First Nations’ trails (1500-1675) and present day major roads.

Today, trails and greenways provide numerous benefits to individuals and communities. They strengthen local economies, encourage physical fitness, make cities more sustainable by preserving open and green space, and protect historically and culturally valuable areas (Little). The Surgeon General found that over 60% of American adults are not



**Historic Trails and Modern Roads:** Illustrative map highlighting First Nations trails overlaid on present-day road networks in the service area

regularly active, and over 25% do not exercise at all. Promoting trail usage, maintenance, and preservation allows for one avenue to increase physical activity in American communities (Shalala). Aside from physical well-being, hiking and outdoor activities can heal the mind. Research shows that hiking can increase creativity and mental performance by up to 50%, temporarily reversing the over-stimulation caused by technologically saturated lifestyles (Atchley et al.).

The Mass Central Rail Trail is a regional organization working on an extensive east-west trail connecting Massachusetts to Boston. Its work is focused on converting the historical 104-mile line of railroad tracks that connect the state capital to Northampton into one continuous multi-use public trail. This work involves partnering with 24 communities and various organizations to excavate buried portions of the old rail line and make them available to joggers, cyclists, tourists, locals, thru-hikers, and parents out for a stroll with babies in carriages. Over 47 miles are now open, and completing the project will require further collaboration between the state, towns and cities, and the owners of both commercial and residential properties.

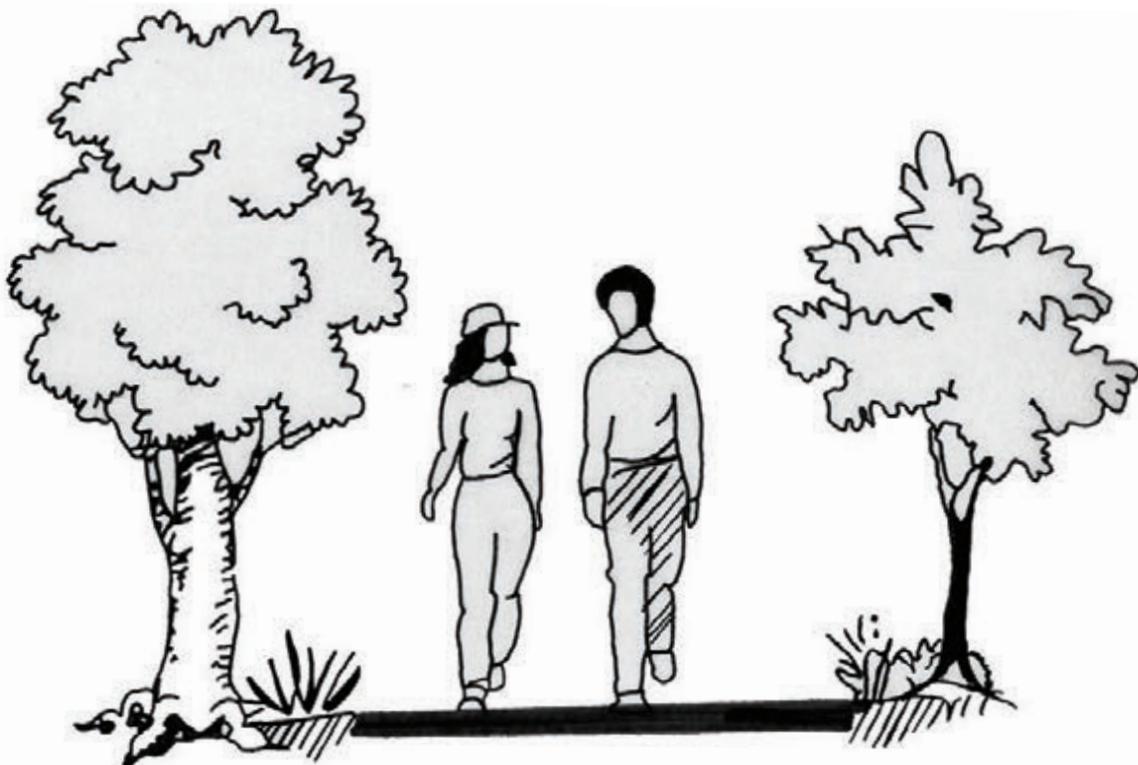
Though hiking and trail use provide numerous benefits to humans and communities, the same is generally not true for wildlife. Trail users can disturb wildlife, introduce pollution, and damage habitat. Taylor and Knight, of the University of Boulder, Colorado, found that hikers and bicyclists create an estimated

100-meter zone of disturbance on each side of the trail. Deer, for example, have been observed within this buffer. Animals expend energy to flee human presence that could otherwise be used foraging, mating, or escaping predation. This zone of disturbance is hypothesized to impact a variety of other animals similarly (Taylor and Knight).

When considering potential locations for trail routes, the impact on wildlife should be assessed. Counterintuitively, many animals feel most stressed when they can sense humans over greater distances across open spaces. This means that, rather than intersecting open areas, trails should potentially be sheltered within topography and vegetation and only cut through exposed areas when needed (Taylor and Knight).

Conserving land for both humans and wildlife is possible. Larson et al. recommends conservation organizations and parks adopt the following measures:

- Spatial restrictions: Preserving buffers around important core habitat
- Visitor education: Educating visitors about leave-no-trace principles and the human impact on wildlife
- Limiting visitation: Limiting access during crucial nesting/mating/foraging times
- Enforcement of existing rules: Leash rules, pollution reduction, camping rules
- Staff training: Recognize signals of habitat disturbance.





## Land Trusts: History and Roles

**“Land trusts... are the most successful and exciting force in U.S. land conservation today and perhaps the most effective component of the whole environmental movement.”**

- Richard Brewer, *Conservancy: The Land Trust Movement in America*



## What is a land trust?

A land trust is a non-profit organization with the goal of conserving land that's deemed ecologically valuable or important. Conservation work is accomplished by a variety of means, including outright purchase of suitable lands, receiving donations of land, and managing stewardship of land by holding restrictions for a landowner on their land. As of 2015, the total number of acres under easements for all accredited land trusts within the United States was more than double the acreage owned outright (National Land Trust Census, Land Trust Alliance). This statistic does not, of course, take into account the number of acres owned or restrictions held by numerous smaller land trusts that are not accredited.

## Land Trusts, then and now

The first land trust, The Trustees of the Reservations (TTOR) was formed in Massachusetts in 1891. Conservation efforts had already begun nationally during the late 1800s with the birth of the public land movement in which the government began managing natural places of exceptional beauty and character, with the explicit purpose of protecting them for public access. Initially, however, the majority of these efforts were concentrated in the western portion of the United States with the designation of the first National Parks. The Trustees was formed as a reaction to the lack of government action around preserving lands of importance in the East. Founding members looked to conservation as a means of mitigating rapid changes in land-use patterns and the increasing trend toward industrialization (The Trustees of Reservations).

Since the 19th century, the number of land trusts in the United States has steadily increased, with a notable rise in the late 1950s to early 1960s, coinciding with the birth of the modern environmental movement (Brewer, *Land Trusts and The Land Trust Movement*). "New England launched the original land trust movement as an effective strategy primarily to help local residents and landowners conserve individual parcels of land. As ecological awareness grew, land trust/agency partnerships emerged to protect larger or connected parcels. In the 1990s, land trusts started establishing ongoing collaborations to move beyond 'random acts of conservation' and to protect larger landscapes including watersheds," The RCP Network Overview, *Wildlands & Woodlands*. As of today, there are 1,363 land trusts active in the U.S. and they've conserved over 56 million acres of land (National Land Trust Census).



All these places and many more are doubtless worthy of preservation in the collection of Massachusetts landscapes and memorials which this Board has been empowered to establish and maintain. On the other hand, this Board does not possess either the money or the authority to enable it to snatch real estate out of the hands of anybody. Like the trustees of a public art museum, this Board stands ready to undertake the care of such precious things as may be placed in its charge. It exists "to facilitate the preservation of beautiful and historical places in Massachusetts," by providing an efficient and permanent organization through which individuals and bodies of subscribers may accomplish their several desires.

Photo of Charles Eliot, founder of the Trustees of Reservations, and excerpt from the "First Annual Report of the Standing Committee of the Trustees." Illustration in upper left is of Virginia Wood in Stoneham, MA, the first property gifted to the Trustees in the early 1900s (Eliot).

# Introduction to Analysis

The following sections translate stakeholder values into conservation tools that can help NCLT identify which parcels should have priority for conservation.

This GIS-generated analysis moves from maps based on a single theme in the **Mapping Thematic Values** section, to the **Weighted Parcel Map** section. The Weighted Parcel Map combines the datasets used in Mapping Thematic Values into a single scoring system that allows map users to rank and score the entire service area based on NCLT values.

There are several **Conservation Area Highlights** throughout the analysis section, showcasing NCLT-owned protected open space areas in terms of their general profile and as examples of key analysis concepts.

The analysis concludes with a breakdown of: the top-scoring parcels within the service area, within each town, and the largest parcels within each town as identified by the Weighted Parcel Map, demonstrating just a few of the analyses possible using these tools.





## Mapping Values with GIS Analysis

On-the-ground knowledge about parcels from stakeholders helps ensure that a given parcel is significant at the local level, and worthy of a community's conservation resources. This local knowledge can be bolstered with large-scale data that contextualizes parcels within broad-scale patterns of significant areas at the regional scale. By mapping the values identified by stakeholders as important for conservation using GIS, a number of landscape patterns emerge.

In the past, landowners have often initiated transactions with the NCLT in the form of donating or requesting a conservation restriction be placed on their land. Because of this, there is a great need to provide NCLT with the tools to help evaluate any given parcel within their service area. These tools should be based on criteria that are both stakeholder-informed (see previous section) and scientifically driven (Hardy and Fowler). The following sections describe the methods used to map stakeholder values using GIS. These previously identified values were expanded upon as pertinent datasets related to conservation were identified during the mapping process. In addition to the values of landscape connectivity, trail connectivity, water resources, and farmland, the values of "ecological integrity" and "climate resilience"

were added to the GIS analyses. These additional values are important indicators of regional ecological intactness, and the land capacity for climate resilience in the future.

In order to map these values and make parcel assessments based on them, criteria for each value is defined. Criteria are further split into indicators, which informed what GIS data layers are used, modified, or combined to represent the value in question as accurately as possible.

The following sections map trail connectivity and landscape connectivity in a process where parcels are thematically isolated based on criteria and indicators. Additionally, an analysis of water resources, farmlands, and ecological integrity and climate resilience are also included as thematic maps. Due to the nature of these data sets, and the large number of parcels they identify as significant based on a given theme's criteria and indicators, they were not used in the thematic parcel isolation analysis. Instead, the service area as a whole was mapped, showing the abundance of water resources, farmlands, areas of relative ecological integrity, and climate resilience.

# Landscape Connectivity

## Summary

North County Land Trust's service area may see increased development within the next decades. This translates to an increase of impervious surface cover on the landscape, and what is currently intact forest or natural habitat may eventually be developed. To preserve ecological functioning, it is thus important to preserve linkages between ecologically significant areas. Landscape connectivity is defined here as an animal's ability to move through the landscape at a regional scale. By identifying protected nodes of core habitat and running a cost connectivity model, corridors are generated representing "paths of least resistance" for animal movement. Areas with a high percent of impervious surface cover translate to a lower potential for animal passage than areas of intact forest, for example. Parcels intersecting paths of least resistance for animals were then identified as potential landscape connectivity corridors.

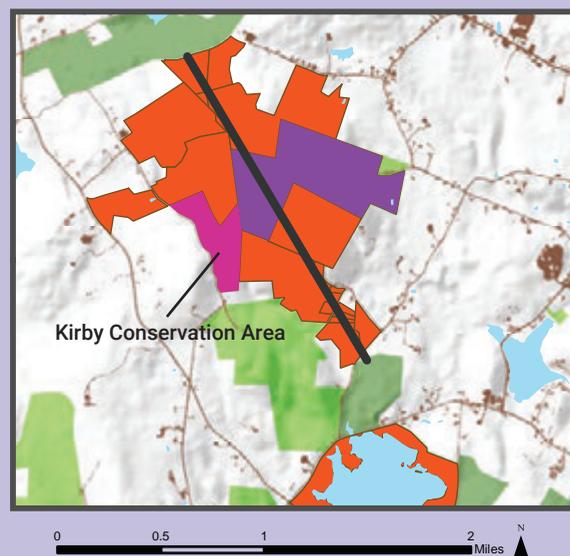
## Methodology and Indicators

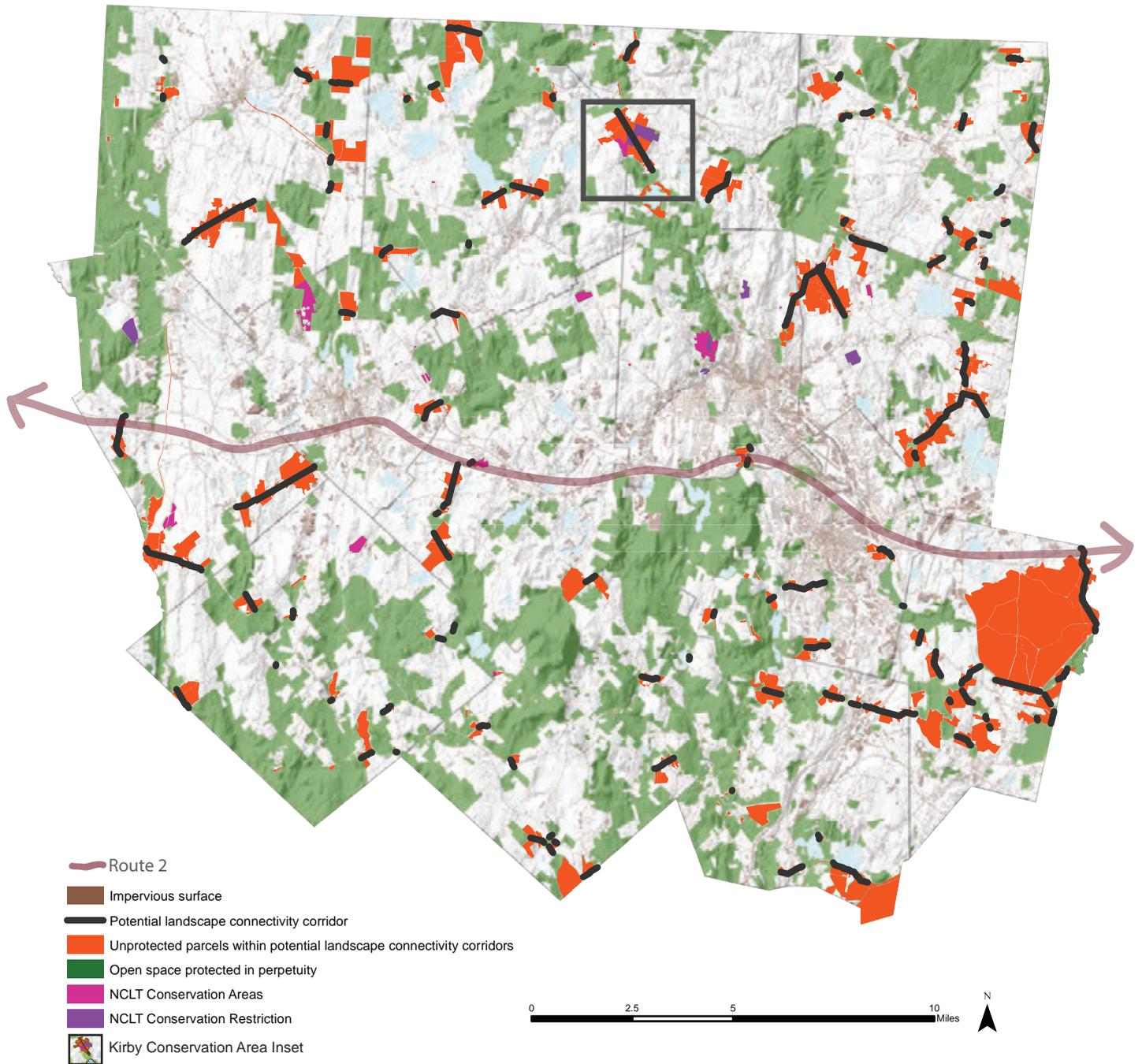
In this analysis, existing linkages, or corridors, are identified between ecologically significant areas, or nodes. Nodes are all BioMap2 Core Habitat areas (see page 38 for details about BioMap2) within the service area that are permanently protected as open space, and the linkage analysis connects these nodes. This ensures that the nodes bookending corridors contain valuable habitat and are guaranteed to be preserved forever. In order to determine the potential corridors between nodes, UMass Amherst's Conductance dataset is employed (see page 38 for details about Conductance). Conductance is a function of the permeability of a given area to wildlife movement (McGarigal, B. Compton, et al.); the higher the conductance of an area, the higher the ability of an organism to travel through the landscape. A cost connectivity analysis is run using conductance, or landscape permeability, as the friction layer between these nodes. This results in linkages that show the path of least resistance that an animal could potentially use to travel between nodes. Parcels that intersect with these paths are then isolated as potential conservation corridors. The resulting corridors are sorted by size, and corridors spanning less than 350 feet in length are excluded, as most of these excluded parcels are glitches in the data where corridors linked two adjacent parcels that are actually contiguous. Impervious surfaces have been included on the map to highlight the relationship between ecological flow and human fragmentation of the land.

### Kirby Conservation Area Highlighting a potential landscape connectivity corridor

The 53-acre Kirby Conservation Area is located along the Ashby and Ashburnham town border. A looped trail system meanders through a forest of mostly oak and white pine and skirts a stream and hidden pond. The stream flows into the Fitchburg Reservoir, an important regional drinking water source. Several additional conservation areas surround the Fitchburg Reservoir, serving as a natural filter for the community's water source. The other lands surrounding the reservoir (163 acres in total) are owned by or protected by a conservation restriction held by the City of Fitchburg Water Division.

The Kirby Conservation area, denoted in pink, is situated between a BioMap2 Core Habitat area around Fitchburg Reservoir (southern node) and a BioMap2 Core Habitat around the Ashby Wildlife Management Area (northern node). NCLT also holds a conservation restriction on a property just north of Kirby (designated in purple), further building the case for the creation of a landscape connectivity corridor in this area. This corridor could protect forested land which actively filters water heading towards the Fitchburg Reservoir. Kirby is further classified as an important area for climate change resiliency based on its natural and geologic features, according to The Nature Conservancy's Resilient and Connected Lands data.





## Potential Connectivity Corridors

105 corridors identified, ranging in length from 0.6 miles to just over 2 miles with an average length of half a mile. Corridors are fairly evenly distributed across the region, however few cross major roads such as Route 2 or areas of high impervious surface cover. These corridors can be used to guide conservation efforts to develop a regional network of connected open space.

Parcels are identified as within potential landscape connectivity corridors (in orange) if they:

- Connect nodes where BioMap2 Core Habitat and permanently protected Open Space overlap and,
- Contain areas of high conductance and are part of a corridor with a cumulative length greater than 350 feet

## BioMap2: Data set details



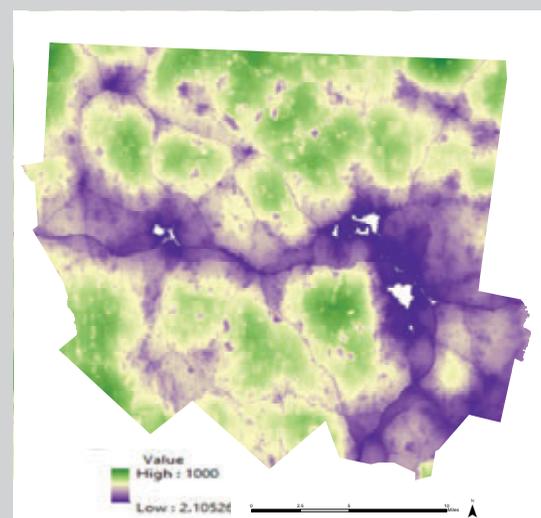
BioMap2 is the result of a collaboration between the Massachusetts NHESP and The Nature Conservancy. BioMap2 was designed to inform land conservation by identifying areas important for preserving biodiversity and increasing resilience to climate change within the Commonwealth (Patrick et al.). BioMap2 identifies two main features within Massachusetts, Core Habitat and Critical Natural Landscape, which cumulatively cover over two million acres of land. Core Habitat are areas that are important for rare or threatened species, as well as intact habitats and natural communities of exemplary value. Critical Natural Landscapes (CNL) has a wider scope and delineates both areas essential to supporting a wide range of species, and areas which can maintain functionality in the face of disturbances. Critical Natural Landscapes was not used in the development of the landscape connectivity analysis for NCLT. Instead, Core Habitat was used, as these areas are considered more ecologically significant habitat and may support higher biodiversity than the areas surrounding these cores designated as CNL.

## Additional Considerations

This analysis used the ecologically relevant layers of conductance, BioMap2, and open space as inputs into a computer model. A computer, however, cannot predict exactly where maximal animal movement does and will occur. Corridors should thus protect as many parcels as possible and not be limited to the parcels identified in order to increase the overall potential natural, unobstructed areas through which wildlife may travel.

## Local Conductance: Data set details

Local conductance is a product of the UMass Amherst Landscape Ecology Lab and was updated in 2017. Local conductance measures “ecological flows across the local landscape,” (McGarigal, B. Compton, et al.). Conductance represents the degree within a given area to which flow is facilitated, also referred to as the “permeability” of the landscape. Local conductance is based on the “ecological similarity of a focal [area] to the ecosystems in the neighboring [areas]” (McGarigal, B. Compton, et al.). Areas of high local conductance tend to be those that are far from roads, and close to or contain intact core habitat. Areas of low conductance tend to be developed, with high percentages of impervious surface cover.





# Trail Connectivity

## Summary

A large number of trails thread the 14 towns in NCLT's service area. The extension and linking of these trail systems could strengthen the trail network throughout north central Massachusetts. In this analysis, enhancing trail connectivity is interpreted as the expansion of pre-existing trail systems. Parcels are thus prioritized based on whether they are adjacent to trail-containing lands. By focusing on adjacency of land as the key element to increase trail connectivity, parcels that offer the potential for extension of existing trail systems are highlighted.

## Methodology and Indicators

A data layer provided by the Montachusett Regional Planning Commission called "existing formal trails," maps all of the trails within NCLT's service area. First, all parcels containing an existing formal trail are isolated. To account for parcel boundary misalignments and small roads between parcels, a buffer of ten feet is applied to all trail-containing parcels and all parcels intersecting this buffer are isolated. From these trail-adjacent parcels, all parcels of open space preserved in perpetuity are removed. The resultant parcels are sorted by size and parcels five acres and smaller are removed, in order to eliminate areas too small to support significant trail extensions.

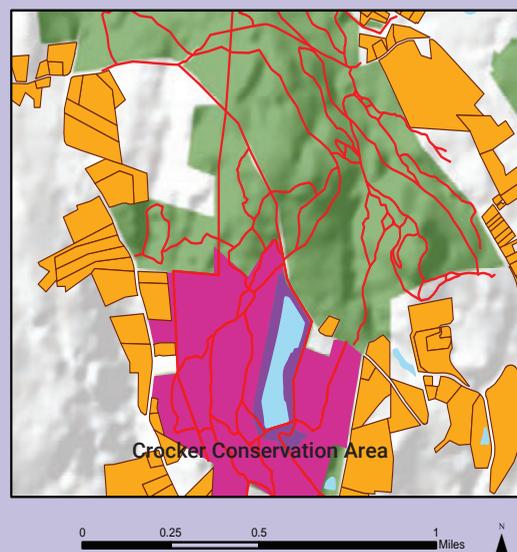
## Additional Considerations

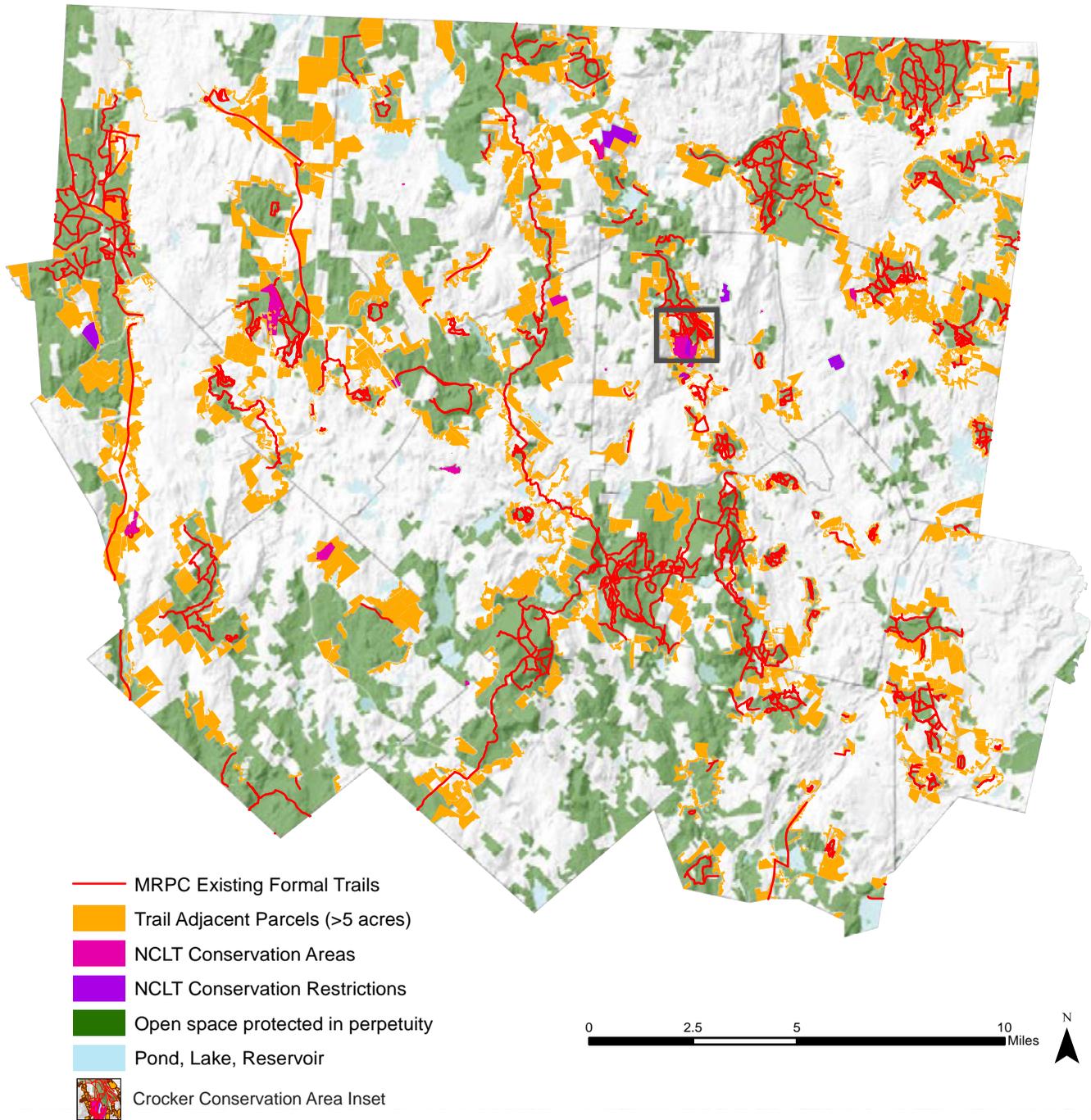
This analysis looks only to expand existing trail networks by prioritizing parcels adjacent to areas already containing a trail. This method has implications for the different populations within the service area. An expansion of current trail networks is most likely to benefit people who already use the existing network and those who live near the new trail sections, and may not benefit people who live further from trails. Hence, this analysis may not take into account the potential for the creation of new trail networks in areas where there are currently none. This is especially pertinent in or near the urban cores of Gardner, Fitchburg, and Leominster, where numerous Environmental Justice communities live. These communities may not have day to day access to open space and so may benefit from the implementation of a trail system near them. Further analysis that focuses on greening the urban core is necessary, however, if expanding trail systems within these areas becomes a focus of NCLT.

## Crocker Conservation Area Highlighting existing trail systems

The central feature of the Crocker Conservation Area is the beautiful Overlook Reservoir. Walking the relatively flat trails around its perimeter is a favorite loop for many local people. For those who wish to explore further, there are 4 miles of trails ranging from cart roads to single track trails, which cover a wide variety of terrain and provide many options for outdoor recreation.

The 149-acre Crocker Conservation Area is ideally located less than a mile from Fitchburg Common, and serves as a gateway from an urban area to over 2,500 acres of protected land and an extensive trail network just to the north in the Mass Audubon Flat Rock Wildlife Sanctuary. Overlook reservoir is dammed at the southern end and flows out to a tributary which eventually drains into the Nashua River. The Crocker Conservation area is an excellent example of an area used for both human trail use, water filtration and storage, and wildlife habitat. The potential to expand the already existing trail network within Crocker through acquisition of adjacent parcels is pictured below, where parcels in orange show lands abutting Crocker in which trails could be built in the future.





## Trail Connectivity Parcels

6,049 potential trail expansion parcels, encompassing 37,352 acres. These parcels are evenly distributed throughout the service area, and some north-south running corridors can be deciphered. The selected parcels highlight the potential to build upon existing trail systems, through acquisition of lands adjacent to trail-containing parcels.

Parcels are identified as priority areas for trail connectivity if they:

- Are within 10 feet of a trail-containing parcel, and
- Are not already Open Space preserved in perpetuity, and
- Are greater than 5 acres.

# Farmlands

## Summary

Many farms dot the landscape throughout NCLT's service area, hearkening to the agrarian past of the region. These farms feed many people and animals and continue the traditions deeply rooted in New England's history. Protecting farmland helps retain the rural character of the region, and identifying areas of prime farmland for preservation may encourage the expansion of local food production in the future as new farmers move into the area. This analysis identifies priority agricultural lands for conservation.

## Methodology and Indicators

To identify prime farmlands within the NCLT's service area, a process laid out by the Tufts Data Lab was used. This process uses GIS data to identify potential farmland in Groton, Massachusetts for the New Entry Sustainable Farming Project (NESFP). The NESFP is an organization whose mission is to "strengthen local food systems by supporting new farmers" (Tufts University). While this project looked at parcels in Groton specifically, the process it used can help determine suitable agricultural lands within any town to which the data layers apply. To generate the farmlands map, any area with the land uses including cropland, pasture, orchard, nursery, cranberry bog, brushland/successional, and very low density residential areas, were identified and merged using the MassGIS land use layer. All prime farmland soils were merged with the above land uses (MassGIS NRCS SSURGO data layer). Next, to exclude wetlands from the agricultural analysis, a 100-foot buffer around all existing wetlands was created, (MassGIS Hydrography) and any areas that intersected with this buffer were removed. From the remaining areas identified, those not classified as prime farmland were removed. The resultant areas are considered lands suitable for agriculture.

## Additional Considerations

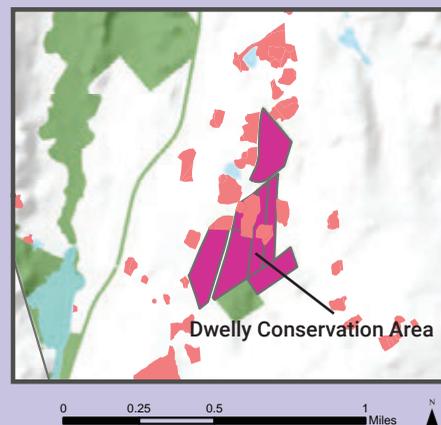
This analysis is the first step in a lengthier process to identify priority agricultural areas, and should include consultation with organizations dedicated to farmland conservation, to glean local knowledge about potential, working and historical farms. An analysis of prime agricultural lands based on soil, land use and wetlands data layers alone is unlikely to accurately reflect the realities of the land on the ground, as land-use patterns are constantly changing, and data collection methods are subject to human

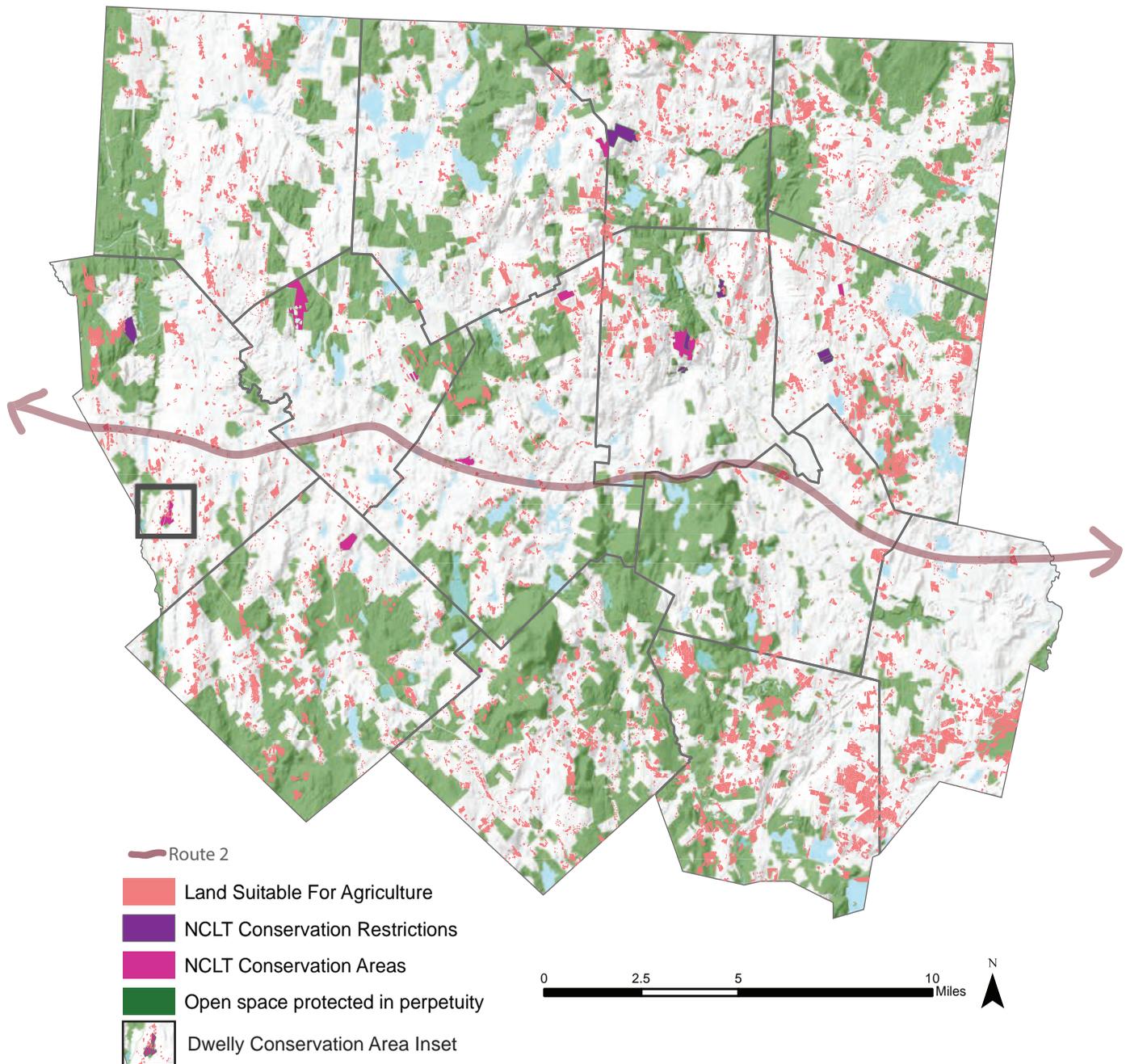
error. Furthermore, working and historical farms may not always be located where prime agricultural soils are mapped. To protect the agricultural resources within the service area, local knowledge and community contacts are necessary for understanding where these resources are located and which may be amenable to conservation in the near-term. GIS can supplement these resources, but not replace them.

### Dwelly Farm Conservation Area Highlighting farmland preservation

The 68-acre Dwelly Farm in Templeton was donated to NCLT by the estate of David Dwelly. Located in the town of Templeton, the Dwelly Farm is a patchwork of open fields and forested lands of hemlock, pine, and successional birch forest. The Dwelly family originally purchased the land in 1912 and operated a dairy farm for many years, maintaining pasture for their dairy cows. The dairy industry began to falter in the 1960s, and by the end of the decade, the family had sold their remaining cows.

Prime agricultural soils underlie both cleared and overgrown areas of Dwelly Farm, suggesting that much of the land could be put back into agricultural production in the future. NCLT currently maintains approximately six acres that are cleared and open for potential agricultural use. The rest of the property is forested and contains wetlands and habitat for wildlife. Barre Road bisects the area, and trails east and west of the road are easily accessed by hikers and outdoor enthusiasts. Dwelly Farm is an example of farmland conservation that helps to preserve the agrarian history of the region.





## Farmlands

21,230 acres of farmlands are identified. These lands are fairly evenly distributed across the service area, with a slightly higher concentration in the easternmost towns, and southernmost towns, with a lower concentration in the central band, corresponding with Route 2 and the cities of Fitchburg, Gardner, and Leominster.

Areas are identified as prime farmlands if they:

- Contain prime farmland soils (NRCS, Nov. 2010)
- Exclude areas of prime soils that overlapped with a 100-foot buffer around all existing wetlands
- Are classified within the following land uses: cropland, pasture, orchard, nursery, cranberry bog, brushland/successional or very low density residential (MassGIS land use 2005)
- Are not already Open Space preserved in perpetuity
- Are greater than 5 acres

# Ecological Integrity and Climate Resilience

## Summary

Ecological integrity is a measure of the ability of an area to support biodiversity and the ecosystem processes that support biodiversity over long timescales (McGarigal, B. Compton, et al.) Similarly, the climate resiliency of a landscape is defined by its ability to support plants and animals in a changing climate over the long term, where its features ensure the continuation of a diversity of habitat types, despite the shifting of these patterns across the landscape in the short term.

## Methodology and Indicators

This is mapped using the Index of Ecological Integrity (IEI) from the UMass Conservation Assessment and Prioritization System (CAPS). The IEI looks at various landscape metrics for urbanized and natural areas and determines which natural communities have the most integrity compared to those of similar types in a given focus area. Unlike other data sets, the IEI assigns a value to every pixel (each representing a 30

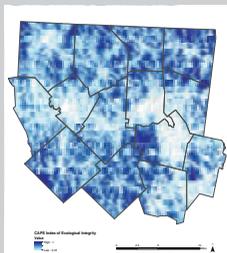
by 30-meter area) within Massachusetts and can be used to determine the relative conservation value of any area. This data set is clipped to the 14-town service area. Instead of thematically isolating parcels based on their integrity and/or climate resilience, mapping this data illustrates a broad scale pattern across the 14-town region. Overlaid onto this map are the areas classified as resilient from The Nature Conservancy's Resilient and Connected Lands data set.

## Additional Considerations

The IEI and TNC's Resilient and Connected Lands illustrate a broader pattern of areas of high ecological value and resilience across the 14-town region. These data represent a portion of much larger data sets (Massachusetts-wide for IEI, and Northeast-wide for Resilient and Connected Lands). As a result, they have not been used to identify individual parcels of conservation priority to NCLT, but are used in an analysis of the service area as a whole in a later section of this document.

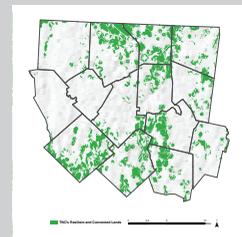
### Index of Ecological Integrity: Data set details

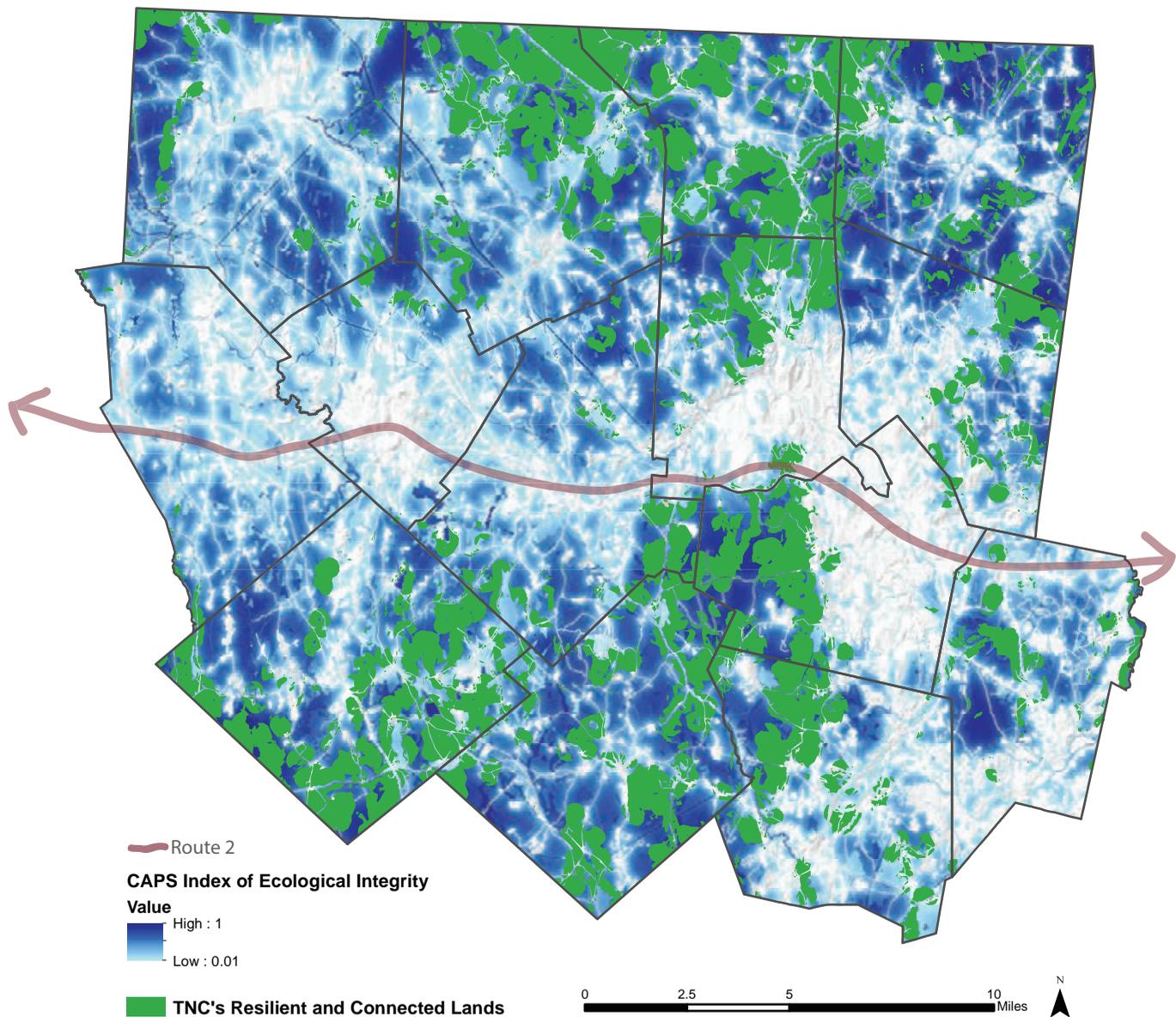
The Index of Ecological Integrity (IEI) is the key product from CAPS, the Conservation and Assessment Prioritization System developed by UMass Amherst and released in 2011. The IEI aims to give every 30 by 30-meter area within Massachusetts a score from zero to one, based on up to 21 landscape metrics calculated for specific natural and human-made features. These scores measure both the intactness of the land (based on metrics like road traffic intensity, percent imperviousness) as well as its resiliency (based on metrics like ecological similarity and connectedness). Areas with high integrity are considered those that are natural and relatively undisturbed, whereas areas of low integrity constitute heavily developed and fragmented areas (McGarigal, B. Compton, et al. "CAPS"). CAPS is considered a foundational analysis, and its methodology, as well as elements from the IEI, have been used in the creation of other datasets of statewide importance such as BioMap2 and TNC's Resilient and Connected Lands (Patrick et al.).



### TNC's Resilient and Connected Landscapes: Data set details

The Resilient and Connected Landscapes dataset was developed by The Nature Conservancy, and an update was released in 2016. The data cover the eastern U.S., across 22 states, encompassing 106 million acres. This dataset maps "resilient sites," which are areas of unique topography, geology, microclimates, and habitat variety that are not significantly fragmented by urbanization. Diverse geomorphic settings have the capacity to support a diversity of ecosystem types over time, regardless of short term shifts of habitat composition due to climate change. The dataset also includes "climate corridors" (i.e., narrow conduits of concentrated movement of plants and animals like riparian areas), and "climate flow," areas (i.e. larger, more diffuse areas of species movement, often intact forest). These areas highlight lands and waterways that connect the resilient sites and may provide passage on regional and continental scales for species migration in response to climate change. The focus area includes many acres of resilient lands, only a few acres of climate corridors, and no climate flow zones.





## Ecological Integrity and Climate Resilience

Areas of lowest ecological integrity are clustered in the center of the service area, corresponding with the three cities of Leominster, Fitchburg, and Gardner, with scattered patches in the northwestern portion and southeastern portion, highlighting widespread fragmentation. Areas classified as resilient have a high degree of overlap with areas of high ecological integrity. These areas, in the north-central, south-central and southwestern portions of the service area are of high importance for conservation, as they are both intact ecologically *and* resilient.

Note: The IEI is a model and therefore subject to the limitations of both the imperfect data it uses, as well as the incomplete understanding of the complex phenomenon it attempts to describe. IEI should be considered a "partial assessment of short-term, local ecological integrity" of a given area (McGarigal, B. W. Compton, et al. "CAPS") rather than a comprehensive depiction of that area and its capacity for long-term resiliency.

# Water Resources

## Summary

The abundance of water resources within the service area means that close to 16,000 parcels either abut a water feature (e.g., lakes, ponds, reservoirs) or contain a surface water feature (i.e. wetlands and perennial streams). When parcels that are significant for groundwater protection are added to the parcels that contain or abut surface water, the number becomes even higher. The large quantity of water resource-containing parcels prohibited a thematic isolation analysis, as displaying this data rendered the map unreadable. Instead, the following map illustrates all of the water resources within the service area.

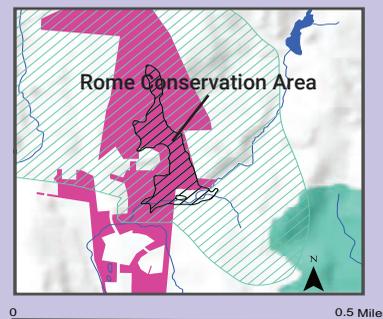
## Methodology and Indicators

Water resources are divided into the two categories of drinking water and all other surficial water sources. Drinking water resources can be divided into groundwater and surface water sources. Surficial water has been defined as all lakes, ponds, reservoirs, perennial streams (including rivers), and wetlands, and was mapped using the MassGIS Hydrography layer. Certain hydrological features from this layer, such as inundation zones and intermittent streams were not included in this map, either due to their lack of regulatory protection (inundation zones) or their nature as ephemeral on the landscape (intermittent streams).

MassDEP has identified Zones I and II and Interim Wellhead Protection Areas (IWPA) as important for conserving groundwater resources. Zone I is “the protective radius required around a public water supply well or well-field” which is typically 400 feet, but can be smaller depending on the yield of a given well (MassGIS). Zone I’s are almost always contained within Zone II’s. Zone II is defined as the “area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions.” In the absence of a delineated Zone II, an IWPA may be established to protect the recharge area for a public groundwater source. IWPA’s are circular areas around a well, with a radius length based on the pumping rate of the well. The lands within all of these areas are considered critical to maintaining the quality of drinking water and are included in the water resources map.

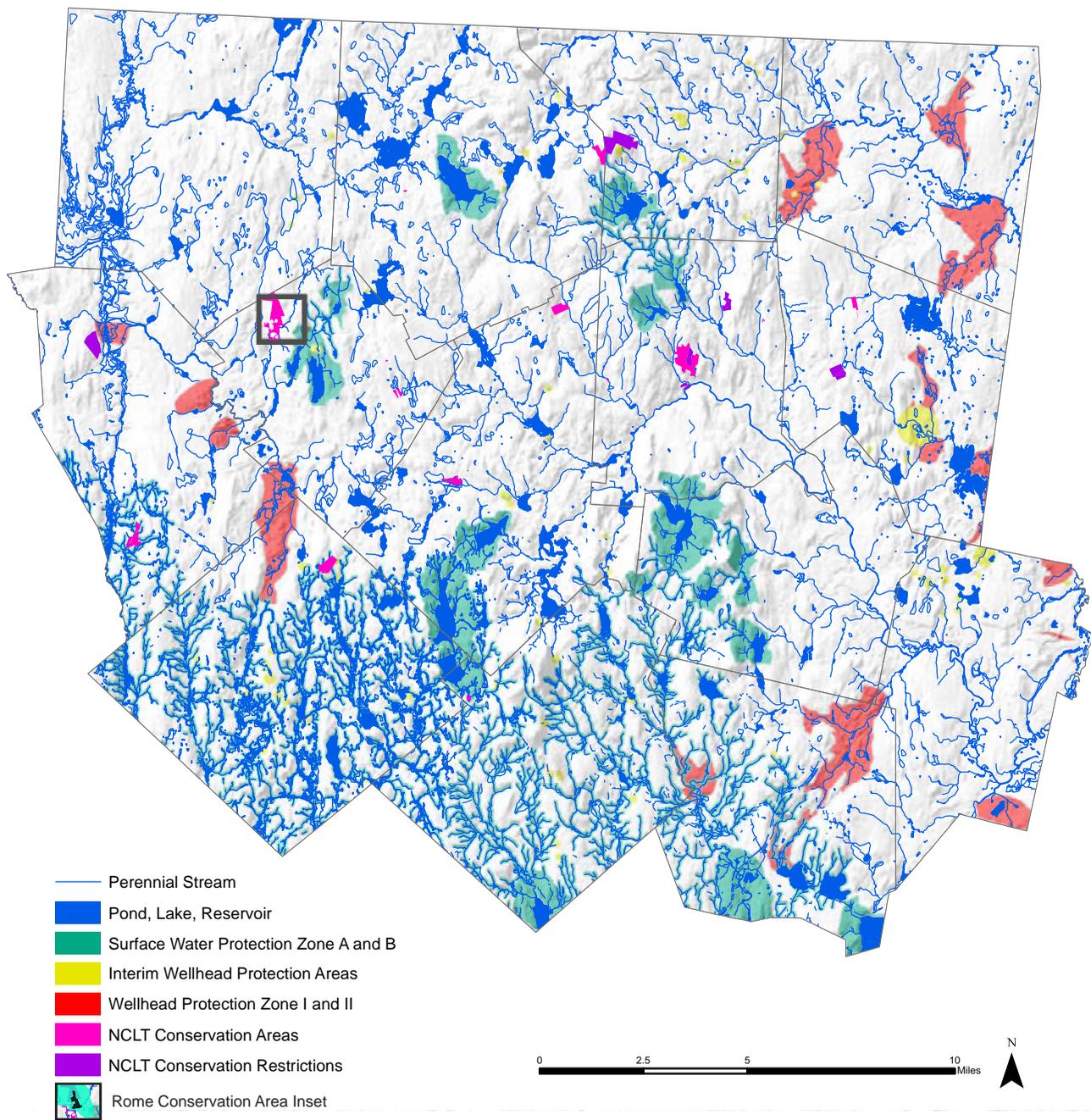
MassDEP identifies three surface water supply protection areas, Zones A, B, and C, two of which are mapped as important resources for conservation.

Zone A represents the land within a 400-foot buffer of a primary surface water source (Class A), or a 200-foot buffer for a tributary or associated water body (MassGIS). Zone B encompasses the land within a half mile of a primary (Class A) surface water source. Zone C represents all of the non-Zone A and B land within a watershed and has been omitted here for clarity as it encompasses almost the entire lower third of all land in the service area. The lands within Zones A and B are included in the water resources map due to their importance for the conservation of surface drinking water resources.



## Rome Conservation Area Highlighting a wetland core

The 158-acre Rome Conservation Area is a beautiful place to bike, hike, or cross-country ski. Located less than a ten-minute drive from downtown Gardner, Rome Conservation Area provides a refuge in nature to busy city dwellers. In addition to providing recreational opportunities and natural beauty, Rome Conservation Area protects important wetland habitat: over 14% is considered Wetland Core Habitat as identified by BioMap2 (in black hatch above, Core ID 2506). The Wetland Core Habitat in Rome is just under 30 acres, most of which is within the boundary of the Conservation Area. Because of its size and relative intactness, this wetland is more likely to support critical wetland functions and ecosystem services such as stormwater catchment and filtration, groundwater recharge, and habitat for numerous aquatic and terrestrial species (BioMap2). Additionally, over half (54%) of Rome Conservation Area is designated by BioMap2 as a Critical Natural Landscape buffering the wetland core (green hatch). This area encompasses the forest within Rome, and provides a buffer for this sensitive environment while preserving intact upland areas.

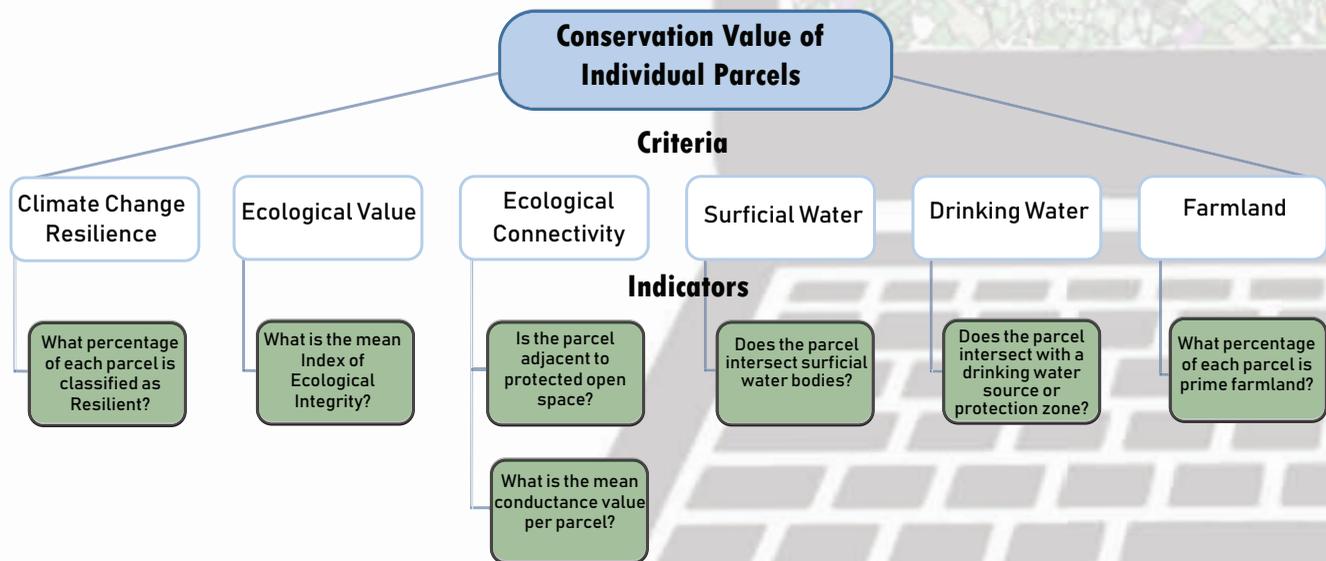
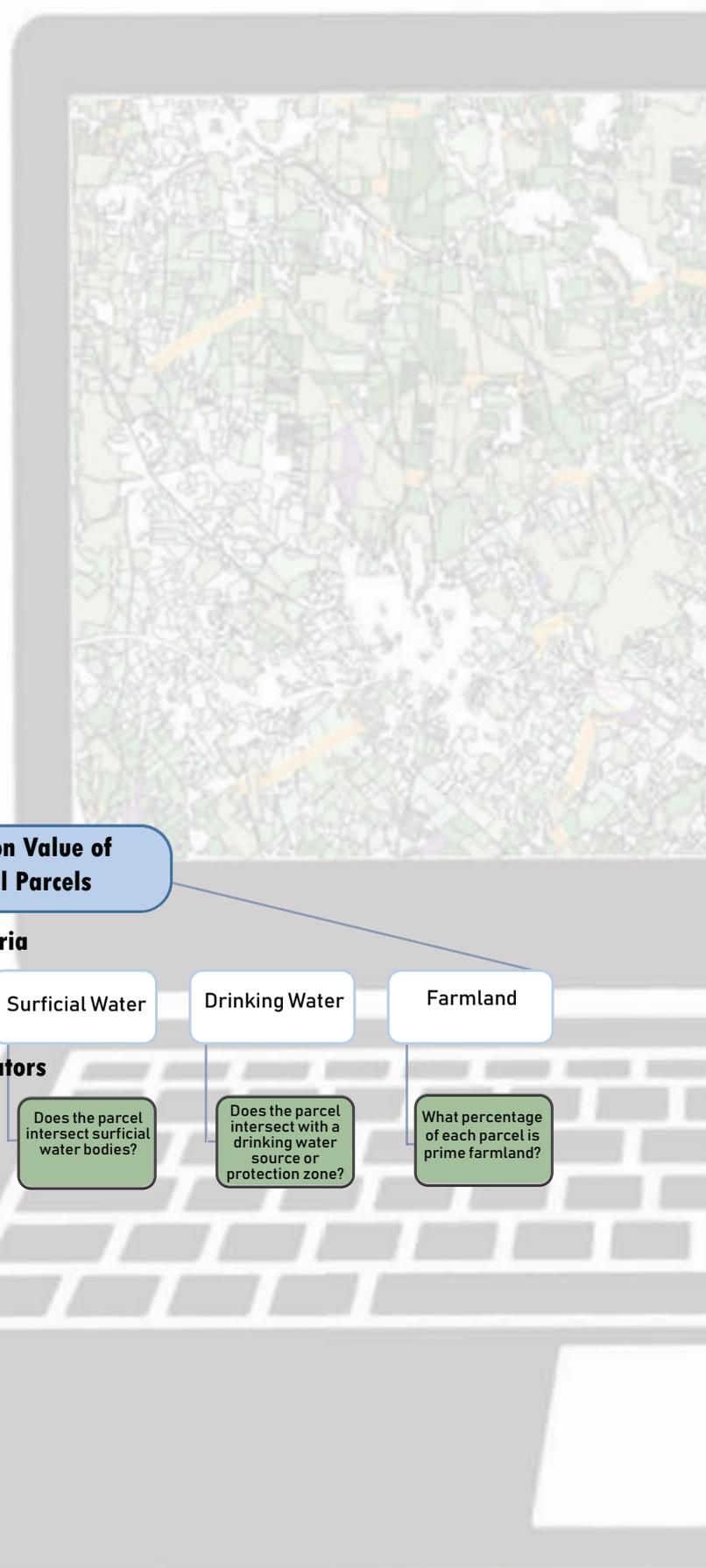


## Water Resources

Surficial water bodies permeate the service area with higher concentrations in the southwestern portion, which feeds into the Ware and Wachusett Watersheds, important statewide drinking water sources. Lakes, ponds, perennial streams, and groundwater protection zones are evenly distributed throughout the area, suggesting opportunities for conservation of water resources in any town in the service area.

# Weighted Parcel Map

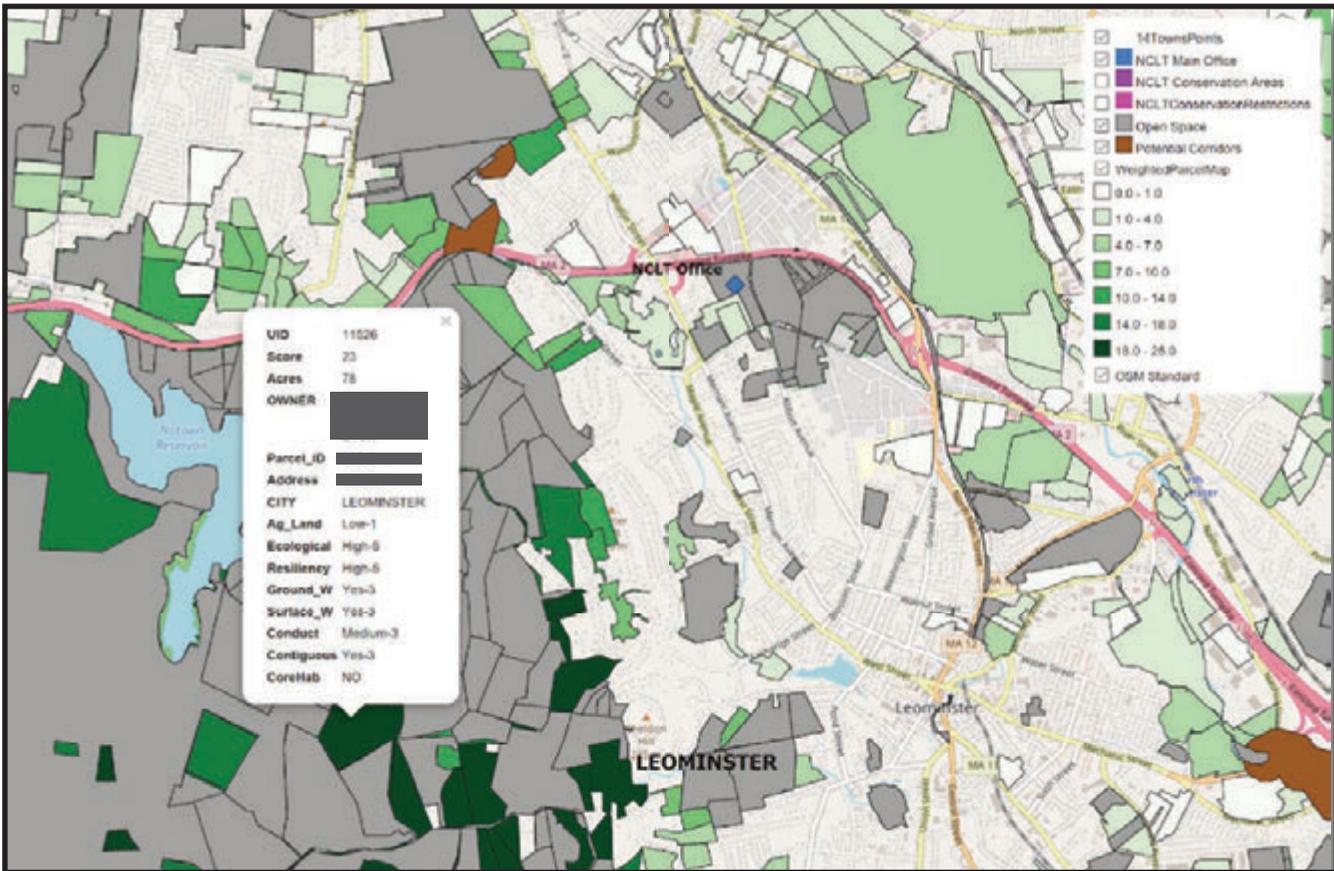
The maps in the previous section of this report identify specific parcels of conservation interest based on their thematic value (landscape and trail connectivity). The weighted parcel map in this section assigns a conservation value to each parcel in the service area. This capability is missing in the thematic parcel isolation maps, each of which identifies between 100-200 of the 75,000 parcels in the service area as distinct units. These maps and identified parcels are valuable as they allow land trusts and conservation organizations to quickly identify parcels that align with specific interests. Such interests are dynamic and may be reflective of the political, social, and cultural environment. Identification of values and resources represented in any parcel could be an asset in time, resources, and management for NCLT. The tool developed for this purpose is described in following section and analyses. Before spending resources hiring an ecologist, visiting a site, and identifying features and resources within a parcel, the land trust now has the opportunity to identify which values are represented up front and from there, determine whether additional investigation is worthwhile.



**Conservation Value of Individual Parcels:** Flow chart illustrating the method for scoring individual parcels. Values were first broken down into criteria, and these criteria were assessed based on indicators.



# Weighted Parcel Map: User interface

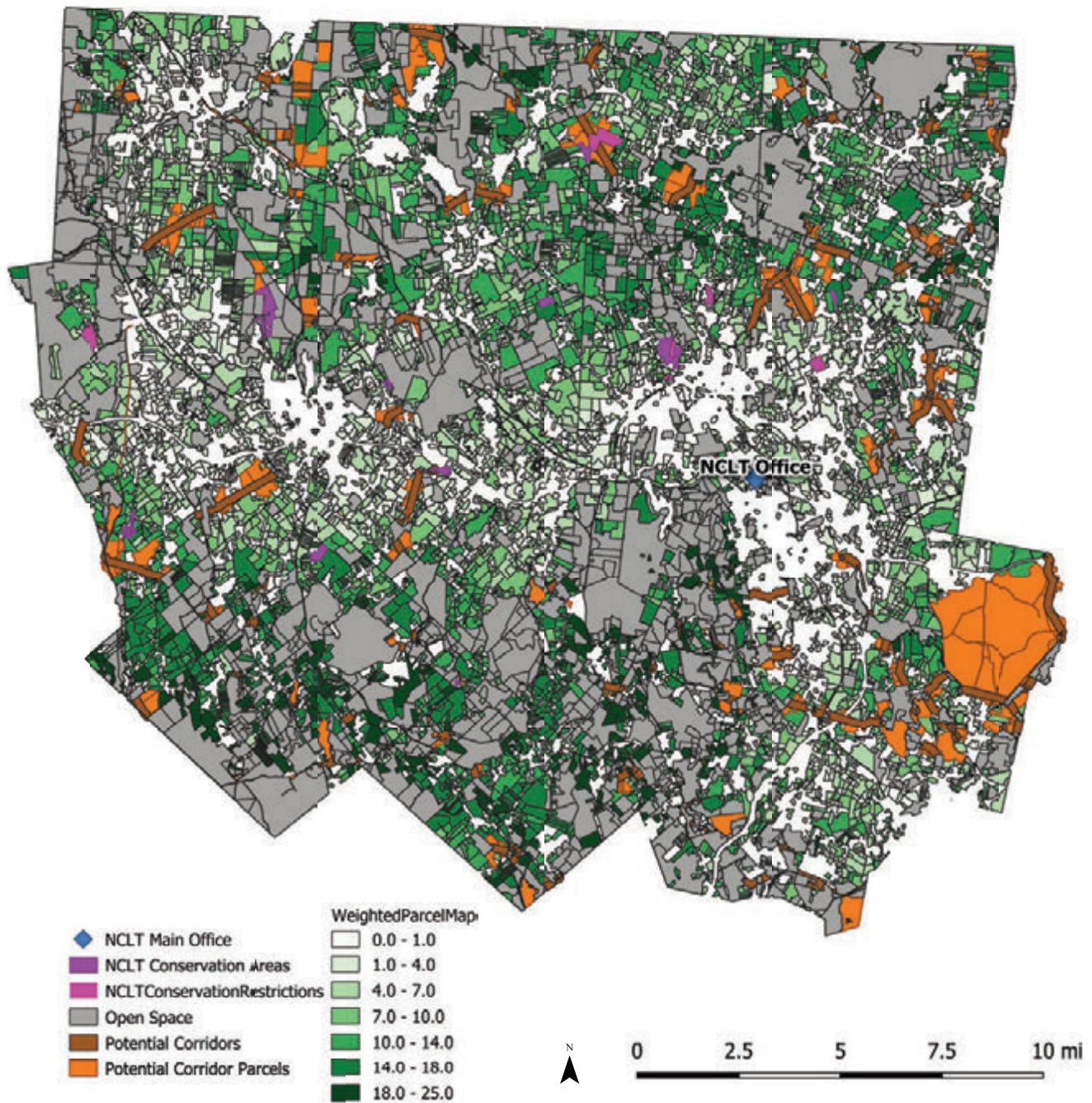


Screenshot of a portion of Leominster from the Weighted Parcel Map user interface in a web browser. Darker green parcels are those with a higher conservation value, and grey indicates protected open space. When a parcel is selected a box pops up with detailed information about that parcel (the owner's name and address have been obscured here for privacy).

Due to limited funds and resources, it's essential for land trusts to undertake conservation projects that are significant within a larger ecological context and that are aligned with the mission of the organization. Digital Weighted Parcel Maps are an easy-to-use tool for conservation groups to assess the conservation value of any parcel within their service area. The primary goal of this tool is to depict priority parcels for conservation visually, based on the score from a weighted matrix of conservation indicators. This weighted parcel map is intended to be used as a tool for instances in which landowners approach a land trust with an interest in conserving their land. The land trust can then refer to the map to determine the conservation values represented in a landowner's parcel. The tool is designed to allow NCLT to identify info such as the owner, parcel size, relevant conservation criteria indicators (low to high), and much more, using the browser interface. See Appendix A for more information on how to use this tool. The product was designed to be simple to use. It was

developed using complex criteria and robust data, but should not replace other means of parcel assessment. Instead, it should complement other methods, such as on-the-ground analysis by ecologists and community input. Community input could involve speaking with neighborhood residents about the value of conserving land in their community, or garnering information from community members using pGIS or another digital map survey tool.

**Of the 75,000 parcels within the service area, which to conserve?**



## Weighted Parcel Map: At a glance

The darkest green areas appear in the southwest and northeast sections of the service area. These areas have a lower population density and have been less fragmented by development. Any area in white is composed of either parcels smaller than five acres or lakes that have no distinct owner. The largest white space clusters in the weighted parcel map are centered

around Leominster, Fitchburg, Gardner, Winchendon, and Sterling. Greater populations in these towns have increased the amount of subdivisions and decreased the average parcel size. As a general trend, these areas are also more developed and fragmented, and parcels within and near urban cores have lower conservation value.

# Weighted Parcel Map: How it was developed

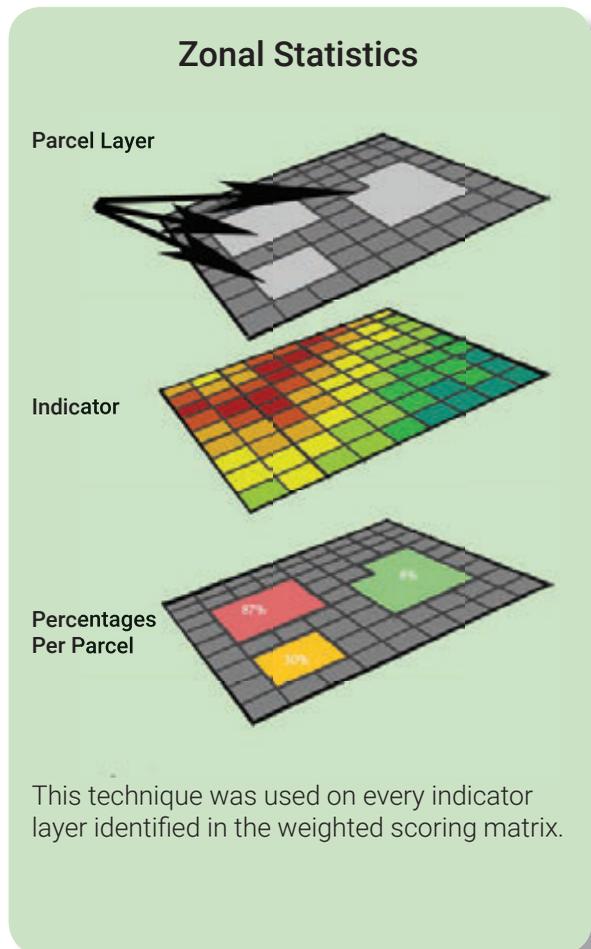
In this analysis, overlap is the primary factor in scoring parcels for conservation value. If several criteria overlap within a parcel, that parcel's conservation score increases. To illustrate, a parcel might receive points for containing a water resource such as a stream, more points if that stream feeds into a drinking water source, and even more points if the parcel contains a high level of ecological intactness. If, according to The Nature Conservancy's Resilient and Connected Landscapes dataset, this hypothetical parcel is also located in a region with diverse geology and topography, it would receive additional points. To determine these resource-parcel overlaps, the percentage or mean overlap of the indicators within each parcel was determined using the ArcMap Zonal Statistics tool.

These averages were then put into a scoring matrix, and each average was assigned a score. The scores for each indicator within a parcel (i.e. ecological integrity, climate resilience, farmland, etc.) were then added together to determine a "total score" per parcel. It is important to note that parcel prioritization can be modified with the inclusion or exclusion of certain indicators. The focus of NCLT may change over time, and the Weighted Parcel Map's scoring system may be amended to reflect a change in conservation values.

The way in which indicators are scored depends upon the type of data and the implications of each assigned score. For example, the Index of Ecological Integrity and conductance data layers assign individual values to each 30 X 30 meter unit of area within Massachusetts, meaning that whether a place is an urban center or a nature preserve, the area receives a value. Because each parcel contains a degree of conductance and ecological integrity, percentages would be "100%" for each parcel. Instead, the average was measured, and scores were assigned from low to high. For contiguity to open space, a "yes" or "no" was assigned to each parcel, with "yes" parcels receiving three points.

The amount of land categorized as resilient by the TNC's Resilient and Connected Lands layer is relatively low in the service area, so parcels with between 0-50% overlap are given three points, and parcels with greater than 50% overlap are given five points. This is because all resilient land is particularly valuable, and protection of even a small amount of land may enhance resilience to climate change.

Agriculture is scored by breaking the percentage overlap of potentially farmable land within a parcel into four categories, 0%, >0-33%, 33-66%, and 66-100%. Lastly, parcels are not scored based on percentage overlap with water resources but on their intersection, or bordering with water resources. This is because wetland, well head, and groundwater zones delineate areas for protection, but water that enters these sites likely comes from outside their delineated bounds. Additionally, calculating the percentage of surficial water in a parcel led to disproportionately higher scores for smaller parcels. Rivers and streams have little surface area, and their intersection with a small parcel would translate to a proportionally higher percentage, and score, than their intersection with a large parcel. To score water resources more equally, parcels that intersected or border surficial water features were given three points, and parcels without intersection were given zero.



## Weighted Parcel Map: The scoring matrix

Criteria	Indicators	Indicator Overlap With Parcel	Score
Ecological Value	Index for Ecological Integrity (CAPS)	0 very low medium highest	0 1 3 5
	Contiguous to Open Space preserved in perpetuity	No Yes	0 3
Connectivity	Conductance (ecological permeability)	0 very low medium highest	0 1 3 5
	The Nature Conservancy's Resilient and Connected Landscapes	0% 0-50% 50-100%	0 3 5
Climate Change Resilience	Agricultural Land (using Tuft's Data Lab process for identifying prime agricultural lands)	0% 1-33% 33-66% 66-100%	0 1 3 5
	Drinking Water (Surficial drinking water protection, Zones A and B; groundwater protection, Zones I and II; and IWPA's)	Does not intersect with feature Intersects with feature	0 3
Farmlands	Surface Water (Wetlands, Perennial Streams, Lakes, Ponds, Reservoirs)	Does not intersect with feature Intersects with feature	0 3

**Total Score Per Parcel**



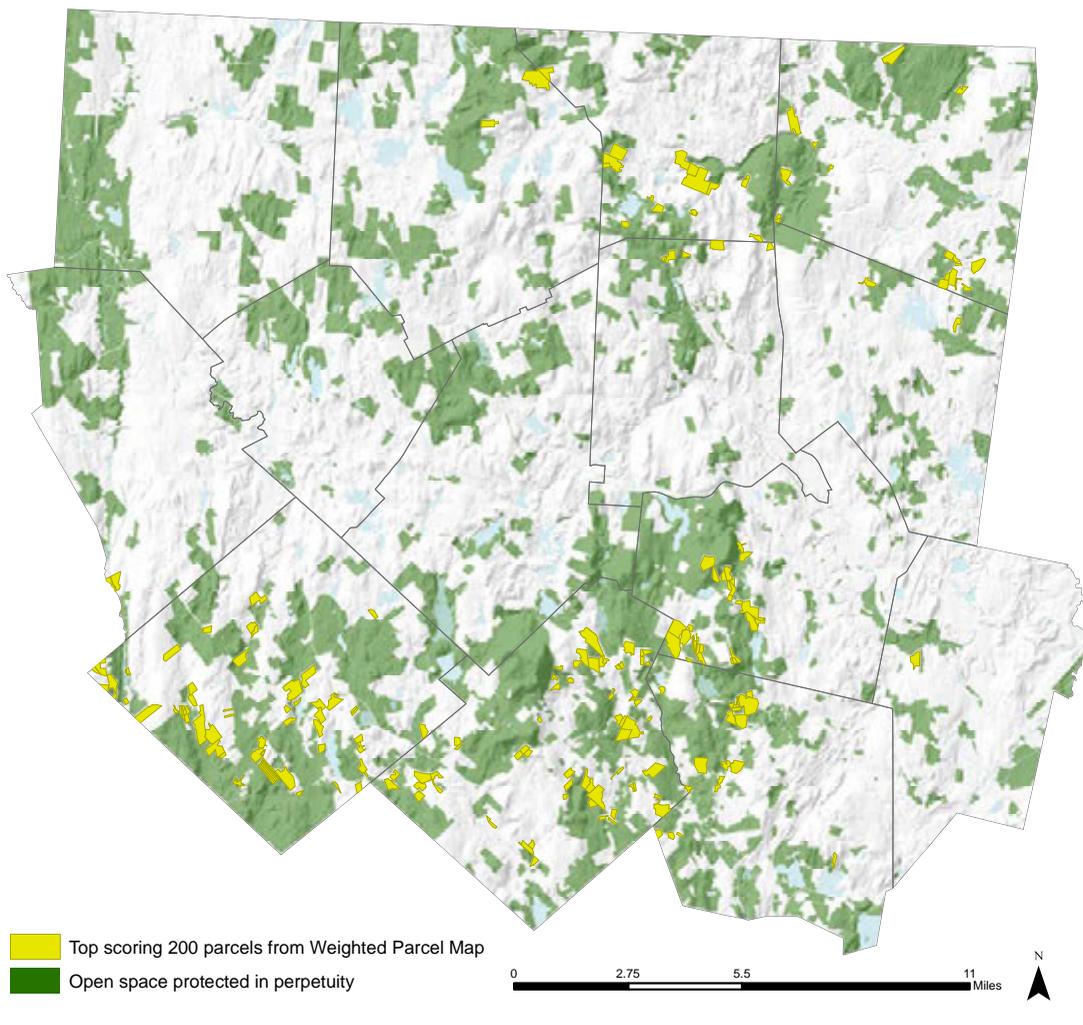
**Weighted Scoring Matrix:** This matrix helps to visualize how total scores for parcels were developed. Criteria were identified and broken down into specific indicators based on available data and relevance. For each parcel the amount of indicator overlap is assigned a score, and the scores are added together to reach a total score per parcel.

# Parcel Distribution Implications: Top 200 Highest Scoring Parcels in the Service Area

This section uses the Weighted Parcel Map to extract the top scoring parcels within the service area based on score and size. Generally, larger parcels are of higher conservation value. NCLT has not established a minimum parcel size for conservation. This is, in part, because smaller parcels could serve as crucial links in conserving corridors, and smaller parcels could be particularly valuable in urban centers. For wildlife, different species require different sizes of habitat, ranging from .001 acres to 550,000 acres (Kennedy). To make the data in this analysis manageable, parcels smaller than five acres were

removed, which reduced the total number of parcels from 75,000 to 11,000.

The map below illustrates what happens when these 11,000 parcels are reduced to the 200 highest-scoring parcels. These top-200 parcels comprise 5,162 acres with conservation potential within the service area. For comparison, NCLT currently owns 647.5 acres of conserved land, and conserving all 5,162 acres would increase the total conserved land in the service area appreciably.



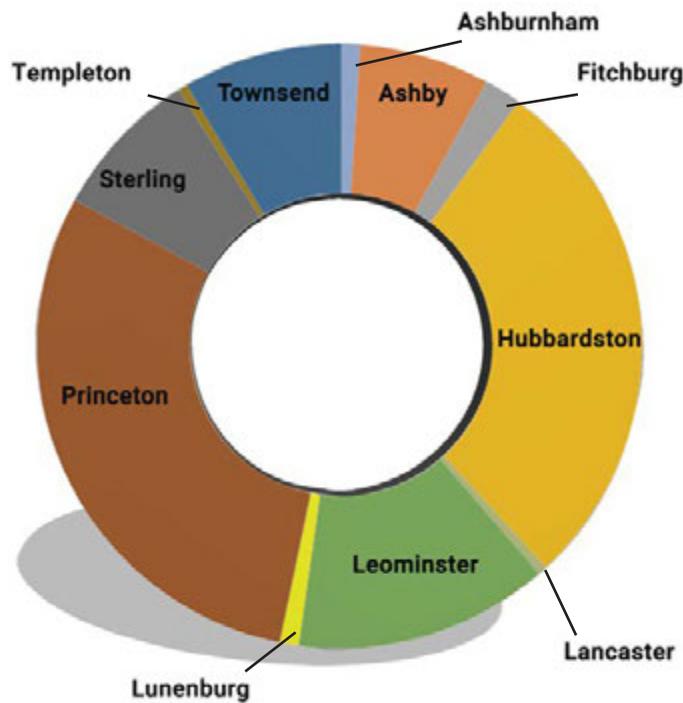
**Top 200 Highest Scoring Parcels in the Service Area:** The majority of the top 200 scoring parcels are found in the southwest and northeast portions of the service area. The southwest has a large amount of overlap with the Ware and Wachusett Watersheds.

# Breakdown By Town

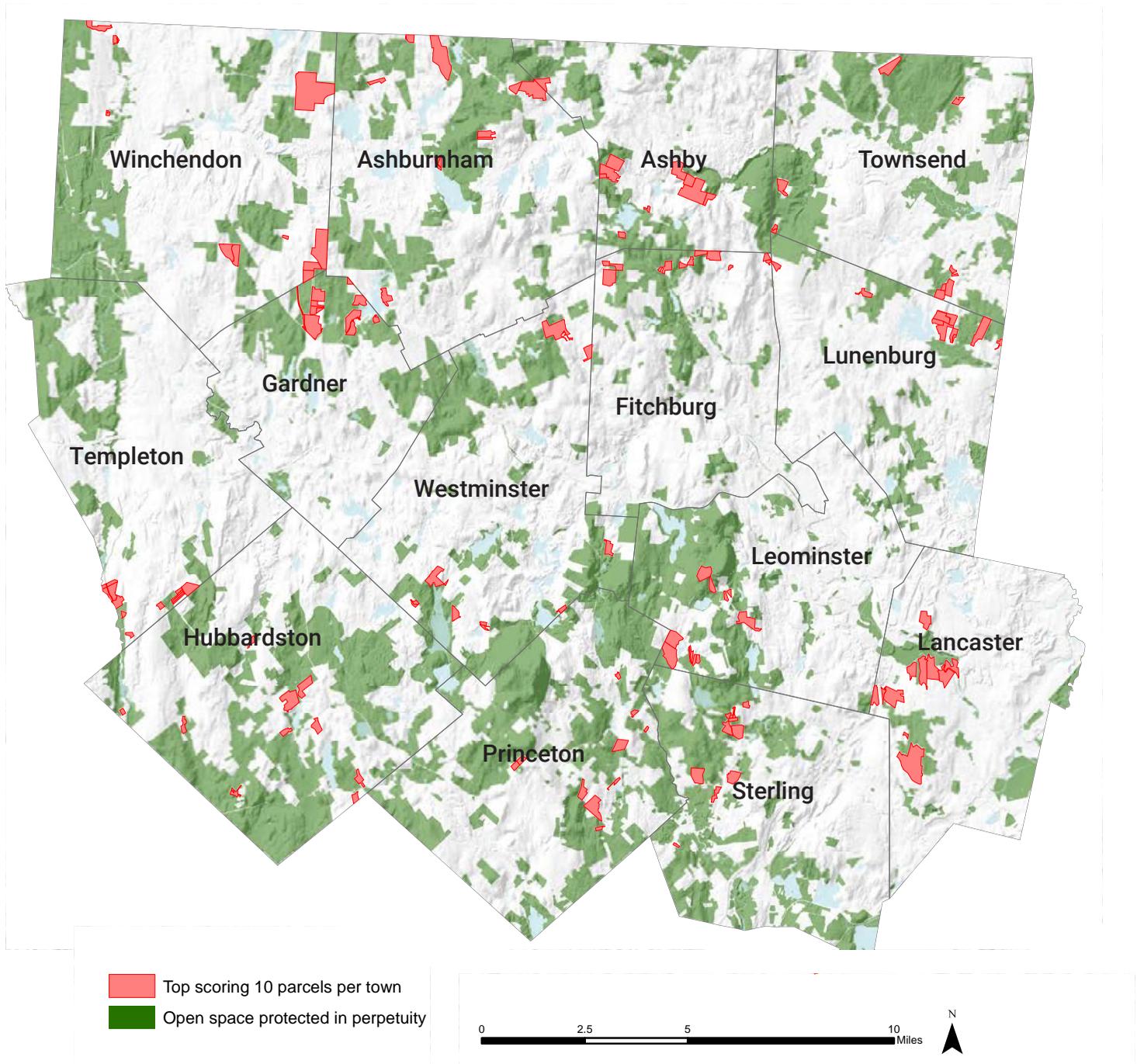
Leominster, Hubbardston, and Princeton have the highest concentration of the 200 top-scoring parcels in NCLT's service area. These three towns are almost entirely within the Ware and Wachusett Watersheds, meaning land use within these towns has the potential to impact the drinking water of hundreds of thousands of people in Boston, and in the service area. Not surprisingly, these towns also have a high percentage of open space protecting these water resources. In the Weighted Parcel Map, parcels in Leominster, Hubbardston, and Princeton receive higher scores for surficial water, drinking water, and contiguousness to open space. The abundance of open space in these towns is also correlated with the increased ecological integrity and conductance in the area, as more habitat has been protected. Many unprotected parcels in these three towns provide multiple benefits of surficial and drinking water purification, connectivity of open space, conductivity of wildlife movement, and ecological habitat.

The diagram depicts eleven of the NCLT's fourteen towns. Gardner, Lancaster, and Westminster have no parcels within the top-scoring 200 in the Weighted Parcel Map, and Lunenburg, Sterling, and Fitchburg have very few. The diversity in distribution highlights some of the patterns in the distribution of natural resources in the service area.

NCLT conservation goals will determine whether efforts are made to prioritize towns with fewer high-scoring parcels. Taking an ecological and water-preservation approach, conservation efforts should primarily work to conserve parcels of high priority, particularly in towns with more intense projected urbanization (see development map on page 23). An alternative approach may entail prioritizing the highest scoring parcels in towns like Gardner, Lancaster, or Westminster, that have fewer parcels within the top 200. The latter approach may be effective in preserving some of the last remaining valuable and unprotected parcels in regions with fewer natural resources.

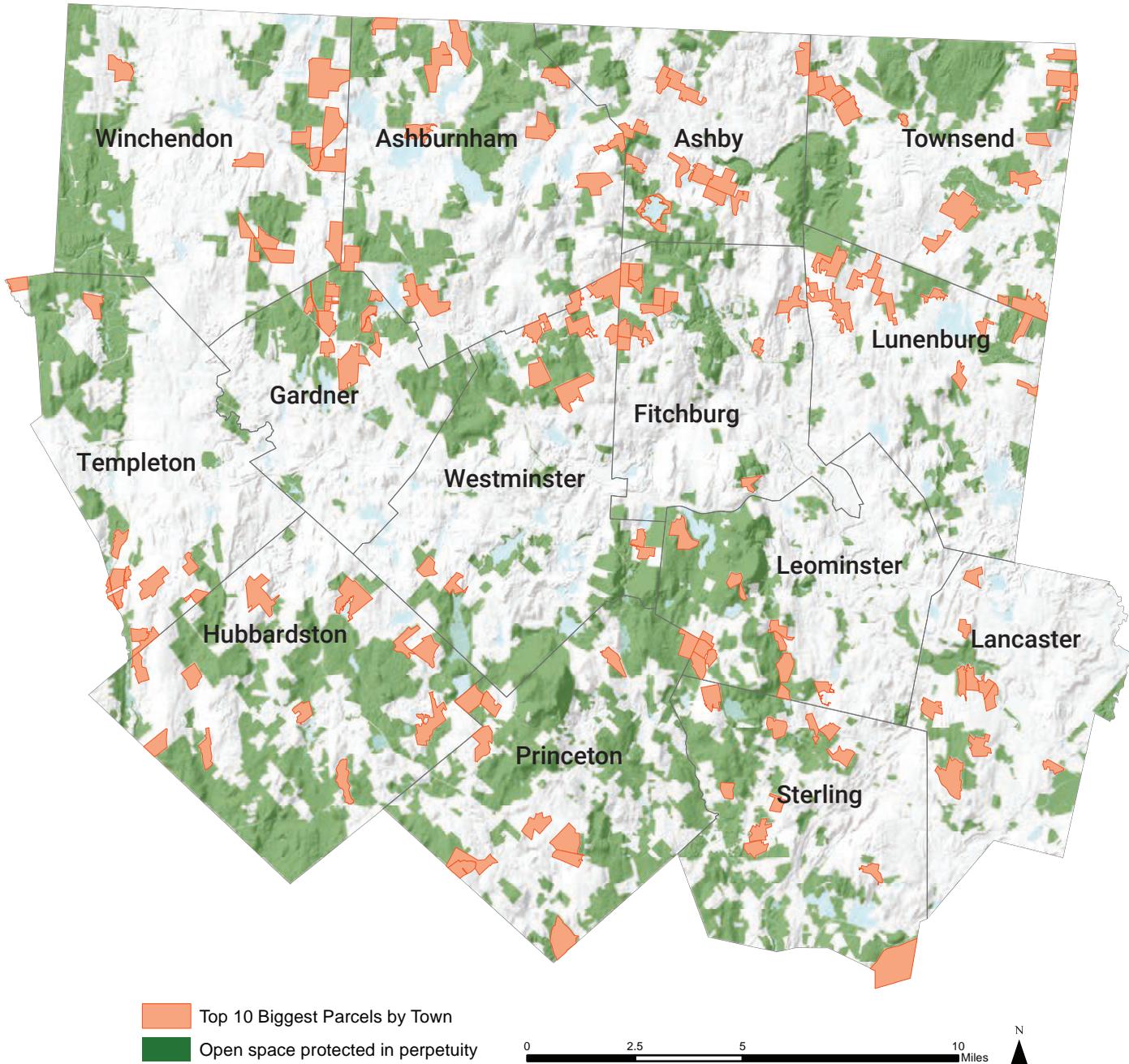


# Top 10 Highest Scoring Parcels Per Town



**Top 10 Highest Scoring Parcels Per Town:** To consider all municipalities equally, this map applies an alternative approach by identifying the top 10 highest scoring parcels within each town. Targeted outreach to these landowners may increase the likelihood of landowner interest, as residents of different towns have varying degrees of interest in conservation. By looking at the top parcels in each town, NCLT can serve as a resource for towns and town-level land trusts.

# Top 10 Largest Parcels Per Town



**Top 10 Largest Parcels Per Town:** This dataset may become helpful if NCLT decides parcel size is a high priority. This map illustrates the ten largest parcels per town regardless of score. NCLT staff can use this dataset to identify which of the largest parcels within this list contain values and resources of interest, and target these parcels for conservation. These parcels make up 16,469 acres, with an average parcel size of 111 acres. This analysis excluded the single parcel that makes up Devens South Post in Lancaster, as the parcel was an outlier at 4,696 acres in size.

# Recommendations

Rather than making recommendations as to which parcels NCLT should target for conservation, this report recommends a process that NCLT can use to identify these priorities. This process involves parcel isolation analysis, conservation value analyses, and the weighted scoring matrix in conjunction with local knowledge and ground-truthing. These tools allow NCLT to act both reactively and proactively when a parcel becomes available. However, the datasets and criteria that form the basis for these analyses are only appropriate so long as they continue to represent the organization's goals, mission, and values, and so long as they are relatively up to date. If these datasets and criteria no longer align with organizational needs, they should be updated. The basic methodology presented in this report can be repeated with revised information.

## Recommendation 1: Thematic Parcel Isolation

Use the thematic parcel isolation maps to visualize broad-scale distributions of resources in the service area. These maps are designed to guide regional conservation planning; they are not intended to identify or select individual parcels of interest. These maps can be referenced in collaboration with other groups working on goals specific to the themes mapped.

## Recommendation 2: Weighted Parcel Map

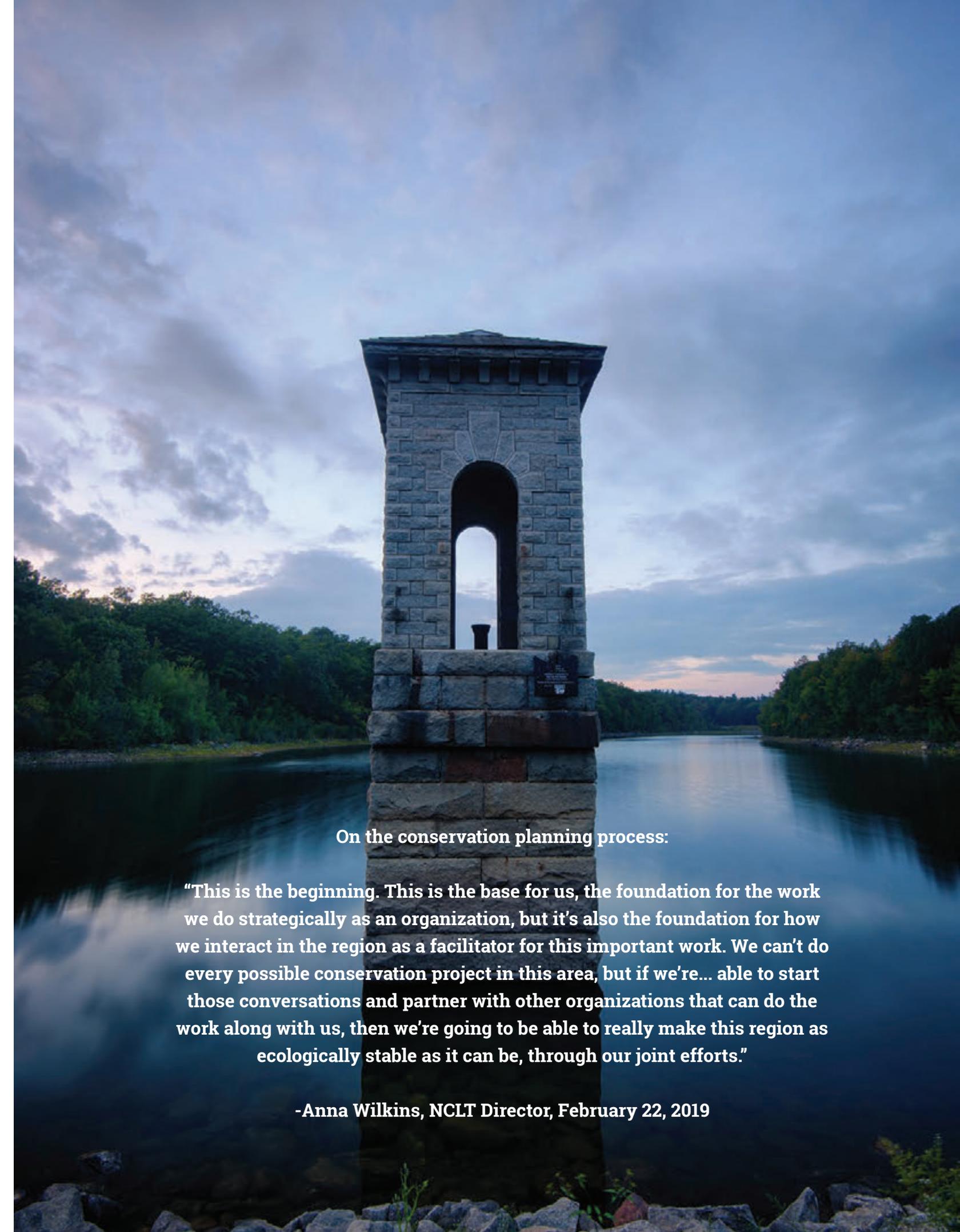
Use the Weighted Parcel Map to gain a deeper understanding of the service area and to assess the conservation value of any parcel. The weighted parcel map is intended to be used by any NCLT staff or board member with an interest in better understanding the region and specific parcels. The map is accompanied by an Excel spreadsheet which can be sorted by parcel score, size, specific resources, and location. This feature may be valuable if conservation values change (e.g. parcel size requirements for projects).

The map can be used as a neutral resource to help reach consensus about the conservation value of parcels and can help NCLT serve as a reference for other land trusts who do not have the resources or tools to identify priority areas within their service areas. Most importantly, it is not designed to replace on-the-ground surveying by NCLT staff and board, ecologists, and community input. Rather, it should supplement and increase the efficiency of these other methods.

## Recommendation 3: Participatory GIS

Develop a web-based interactive map that can be shared with other stakeholders, conservation professionals, and land trusts, to initiate regional collaborative conservation projects. This participatory GIS (pGIS) map should be password protected and allow commenting and parcel identification. This system should also be simple to use, such that even individuals with limited GIS experience can easily access it.

The pGIS interface can be developed in QGIS, an open-source GIS software, by uploading the Level Three Assessor's Parcel Data layer or the weighted parcel matrix and its data layers. These layers can be exported into a web browser using the open-source service "qGIS-2-web." Using JavaScript coding, this map can be encoded into the NCLT website with password protection and commenting ability. Password protection will ensure the system is only used by those intended. As a result, the amount of data and feedback incorporated into this system will be smaller and more manageable, and more specific to conservation efforts, than if the system were open to the general public. If NCLT chooses to, it may remove password protection and initiate public feedback, for example, in environmental justice areas, urban cores, and rural towns, about areas that community members would most like to see conserved. This should be considered a later step, as public input could present challenges in terms of sheer volume and privacy issues.



**On the conservation planning process:**

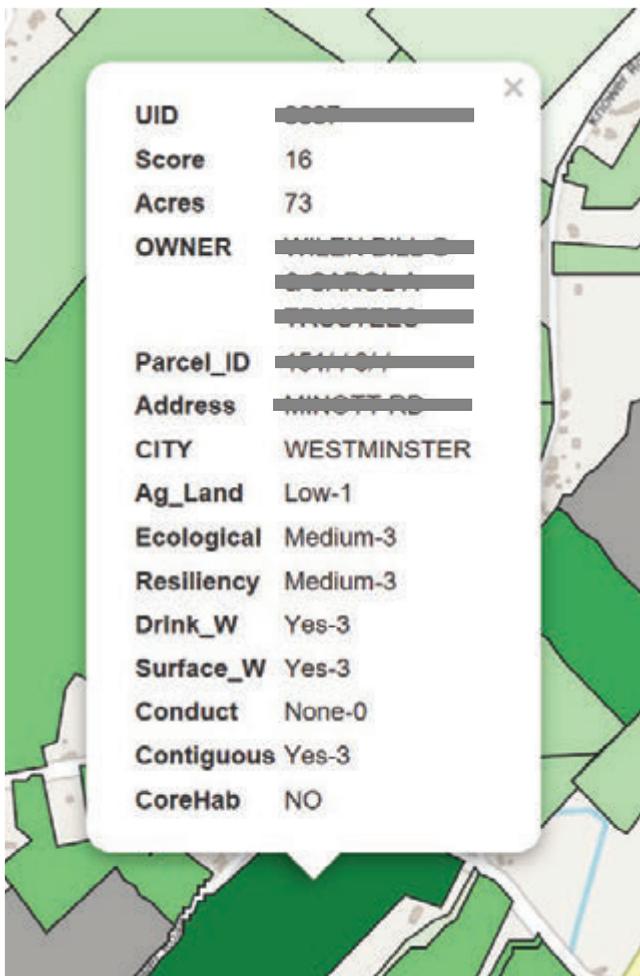
**“This is the beginning. This is the base for us, the foundation for the work we do strategically as an organization, but it’s also the foundation for how we interact in the region as a facilitator for this important work. We can’t do every possible conservation project in this area, but if we’re... able to start those conversations and partner with other organizations that can do the work along with us, then we’re going to be able to really make this region as ecologically stable as it can be, through our joint efforts.”**

**-Anna Wilkins, NCLT Director, February 22, 2019**

# Appendix A: Using the Weighted Parcel Map

The Weighted Parcel Map is in a file format that uses a browser (Internet Explorer, Google Chrome, Safari, or Firefox, for example), but does not require internet access for its functioning. The file is provided in a folder which includes the browser interface itself, along with several additional folders which encode the data. Double-click the Weighted Parcel Map file to open it in your browser. To format the map differently (e.g. adding the ability for users to comment, password protection, modifications for increased load speeds, or embedding the map on a website, etc.) the other folders can be modified, but will require a basic understanding of JavaScript.

The functionality of the Weighted Parcel Map includes scrolling to zoom, searching by either a location or Parcel ID, zooming to the user's location, and toggling on and off individual layers. Upon clicking any Weighted Parcel Map parcel, an attribute table appears with the fields, each of which is described below.

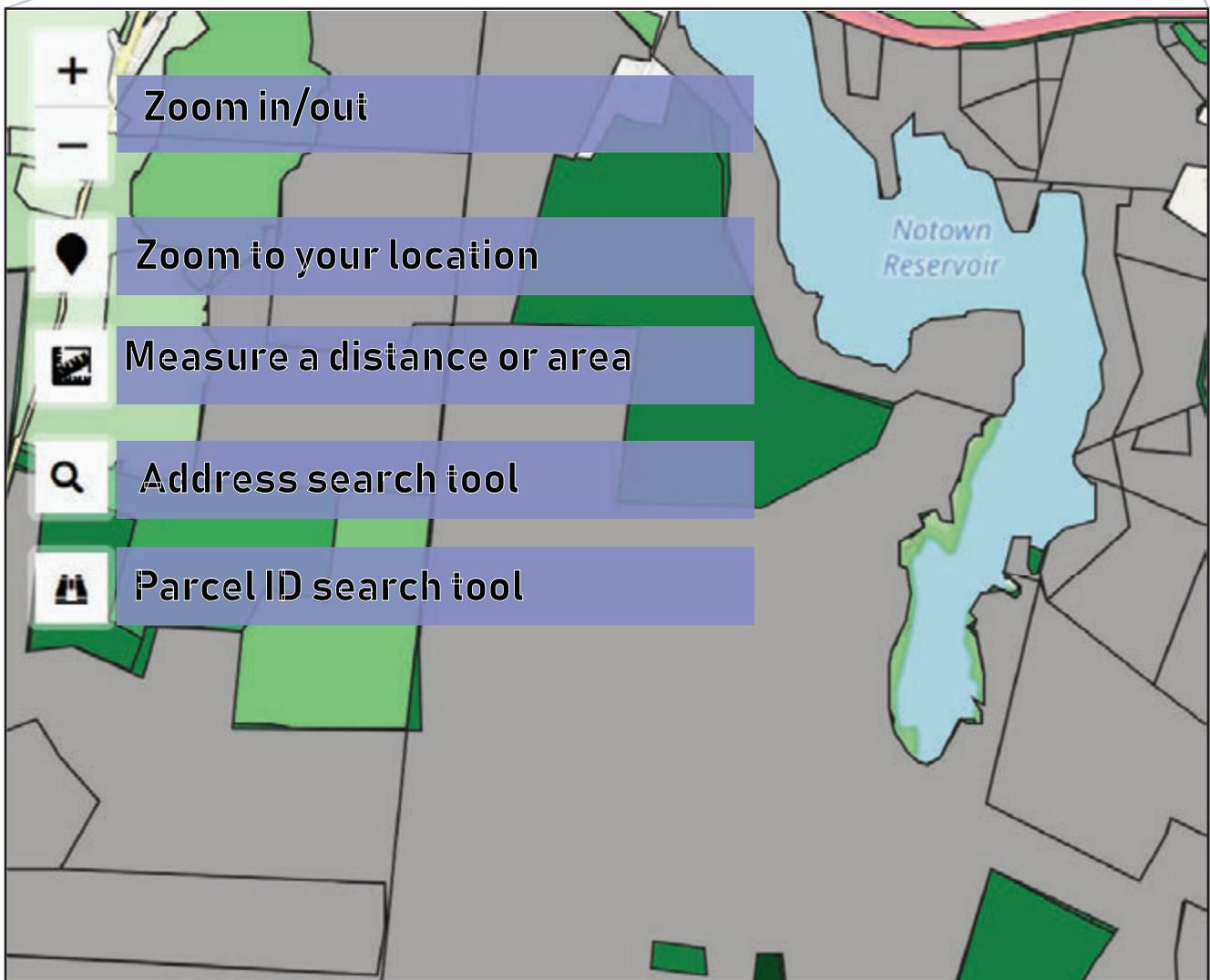


**Screenshot from the Weighted Parcel Map:** Showing the many attributes available for viewing for any parcel greater than five acres in size. Parcel ID, owner, and address have been obscured for privacy.

## Fields Identified per Parcel:

- UID :** An unique ID associated with each individual parcel. This allows the computer to recognize and associate distinct information for each parcel.
- Score:** This is the cumulative score of the parcel derived from the weighted scoring analysis
- Owner:** The registered owner of the parcel
- Address:** Parcel address
- City:** City in which parcel is located
- Ag\_Land:** The percentage of the parcel identified as agriculturally significant (ranges from "None-0" to "High-5")
- Ecological:** This is a metric of average Index of Ecological Integrity using the UMass CAPS datalayer (ranges from "None-0" to "High-5").
- Resiliency:** This is a score based on the percentage of a parcel's overlap with TNC's Resilient and Connected Lands layer. Parcels with a "Low-1" score still have resilience value.
- Conduct:** This a mean value assigned to each parcel based on its ecological conductivity or permeability (ranges from "None-0" to "High-5").
- Contiguous:** Parcels contiguous to Open Space are assigned three points ("Yes-3") and zero points if they are not contiguous ("No-0").
- Drink\_W:** Parcels that fall within a groundwater AND/OR surficial drinking water protection zone are given three points and labeled "Yes-3". Parcels not intersecting a ground and/or surficial drinking water source are given zero points and labeled "No-0".
- Surface\_W:** Parcels that are intersected by a wetland or perennial stream, or that are within 50 feet of a surficial waterbody are given three points and labeled "Yes-3". Parcels not intersecting a water feature are labeled "No-0" and are given zero points.
- CoreHab:** A "Yes/No" designation was made for parcels that overlap with BioMap2 Core areas. These areas are not given an additional score, to prevent double weighting with the Index of Ecological Integrity dataset, a dataset used to identify BioMap2 Core Habitat areas.

Features located in the top left corner of the window include zooming to parcels, user location, a measurement tool, zooming based on address, and zooming based on Parcel ID.



**Weighted Parcel Map Interface:** Screenshot of the Weighted Parcel Map with illustrated tool functions, which include zoom in/out, zoom to user location, measurement of distance or area, address search, and Parcel ID search.

# Appendix B: Mapping Stakeholder Knowledge

NCLT facilitated a stakeholder meeting of conservation professionals from its service area in December of 2018. During this meeting, stakeholders identified the regional conservation values and goals of their respective organizations. The outcome of this process highlighted four key values: landscape connectivity, trail connectivity, farmland, and water resources.

Identifying broad values is helpful for honing in on what guides conservation at a conceptual level, however translating this to conservation work as it is practiced on the ground is complex. In February of 2019, The Conway Team facilitated a second stakeholder meeting in Leominster, MA, where conservation professionals from a wide range of organizations were in attendance, including regional and local land trusts, such as Mount Grace Land Trust, and state conservation organizations such as Mass Wildlife, and the Department of Conservation and Recreation.

Stakeholders were given town-level maps of trails, farmlands, and water resources, and a parcel-level map with instructions to think about the town's

resources worthy of conservation within these thematic categories. By circling areas related to water, agriculture, trails and "Perfect World" parcels on paper maps, stakeholders translated their conservation interests into data. These were broadly conceived of as the first areas stakeholders might choose to protect if no barriers to acquisition or protection were in place; in other words, the most valuable parcels.

The coarseness of the data can be attributed to the process, in which hand-drawn circles on paper maps grouped numerous parcels together, instead of isolating parcels of interest. The rough data were then aggregated and digitized in a process where parcels were hand-selected in GIS and attribute information for each parcel was saved.

These data are included here, by theme, and can be drawn on for land evaluation processes, as points of reference for future conservation potential and to identify potential conservation partners. Because significantly fewer areas were identified on the water resources maps, these responses were included in the "Perfect World" aggregation.



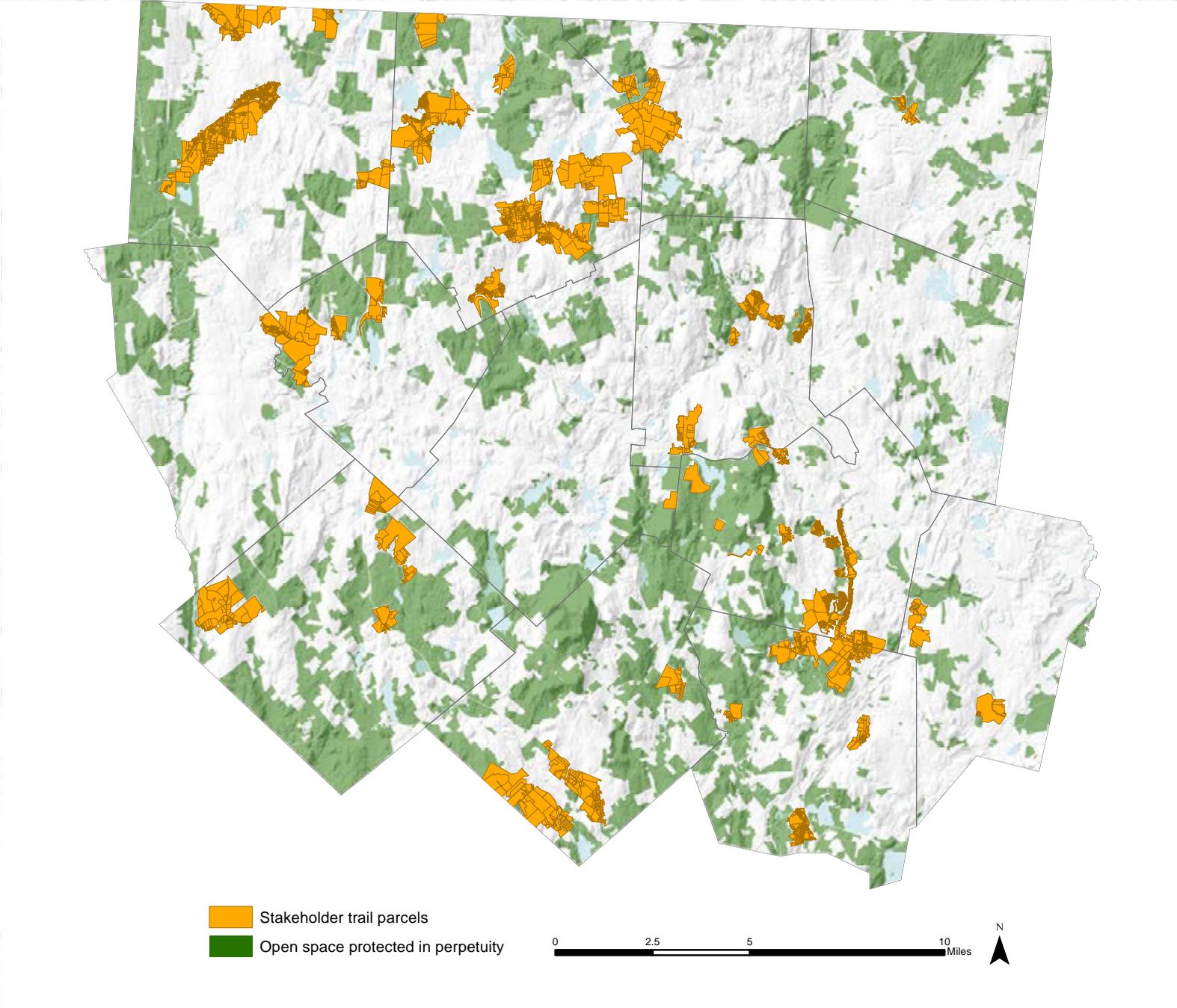
Stakeholders study maps at the February 2019 meeting in Leominster, MA.



Aggregated stakeholder responses, pre-digitization. From top to bottom: trails, agriculture, "Perfect World" parcels.

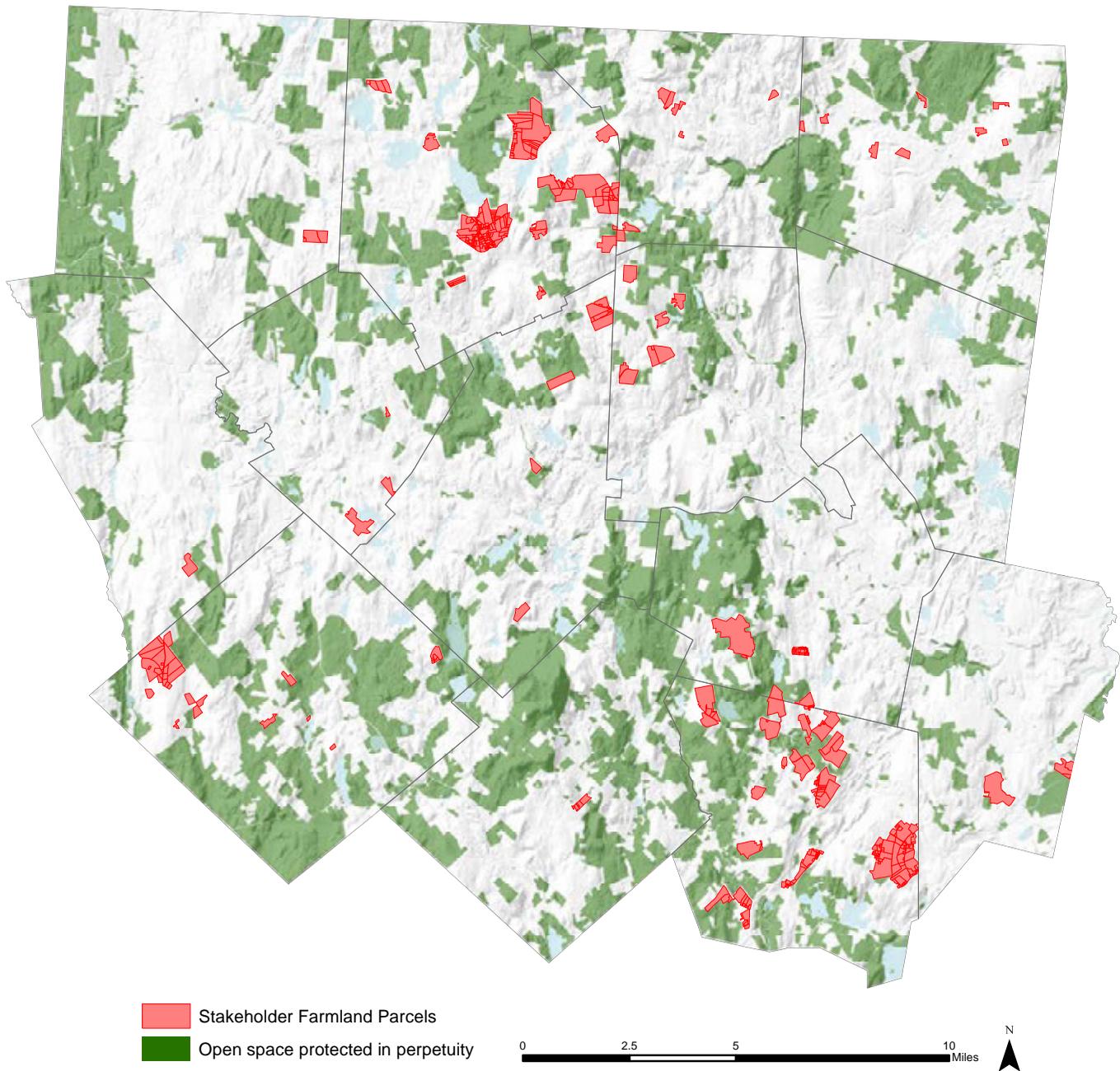
Examples of stakeholder responses on thematic, town-level maps. Responses for trail maps are pictured here.

# Mapping Stakeholder Knowledge: Trails



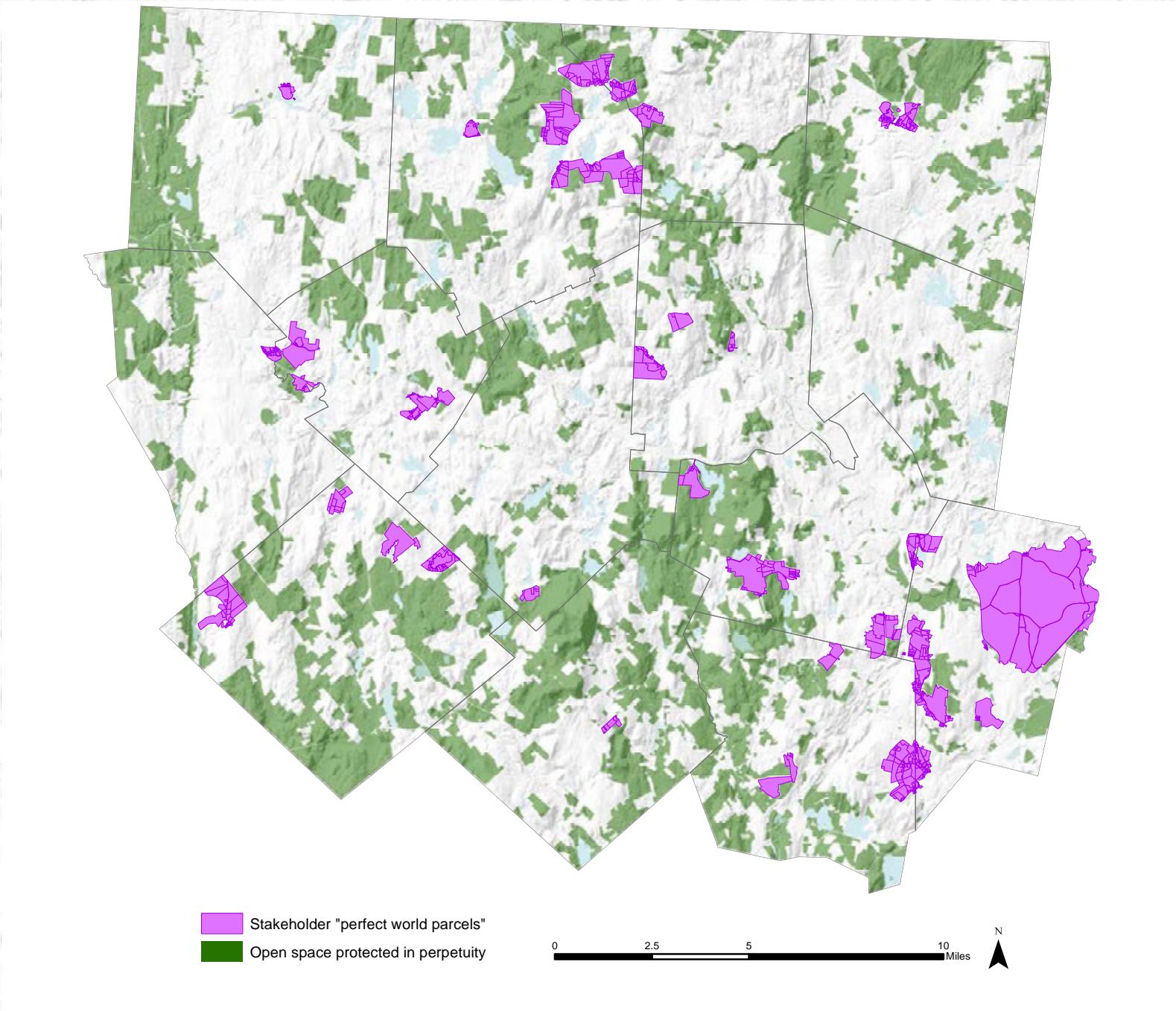
**Trail Parcels:** Parcels (and general areas) identified by stakeholders as important for trail connectivity, extension, or establishment.

# Mapping Stakeholder Knowledge: Farmlands



**Farmland Parcels:** Parcels (and general areas) identified by stakeholders as important for agricultural preservation.

# Mapping Stakeholder Knowledge: "Perfect World"



**"Perfect World" Parcels:** Parcels (and general areas) identified by stakeholders as the highest priority for conservation - if no barriers to acquisition or protection were in place. In other words, parcels that stakeholders identified as having the highest value for conservation.

# Appendix C: Town Conservation Capacity Profiles

The following pages contain profiles of the 14 towns in NCLT's service area. These profiles provide a detailed map of each town, and assess the town's conservation capacity by providing information related to various factors that influence land use.

This information was primarily gleaned from each town's Open Space and Recreation Plan (OSRP), and hence it is only as up to date as the OSRP itself. U.S. Census data (2010) and the town's websites were also used. The amount of data and/or details provided in each profile varies, reflecting the information that was highlighted within the OSRPs, itself a commentary on the town's individual character and priorities.

## Included in Town Conservation Capacity Profiles:

- Town Overview includes its size, population, the most up-to-date version of its OSRP, whether or not the town has adopted the Community Preservation Act (more information on opposing page), the relevant committees related to conservation, a snapshot of the town's character, and a key conservation concern.
- Open Space and Sustainability Data may include the percentage protected Open Space within the town, the percentage of BioMap2 Core Habitat or Critical Natural Landscape within the town (see page 38 for more information on BioMap2), statistics related to where residents of the town work, and their transportation to and from work, the percentage of the town that is covered in surficial water (lakes, ponds or wetlands), and the percentage of lands in Ch.61 programs (see opposing page for details).
- Growth and Development Data may include the median household income, and home value, the sectors of highest employment and the employers within the town, the state of the roads and/or sidewalks, and the percentage of the town covered in impervious surfaces.
- Agriculture data may include the number of acres enrolled in Ch.61A, and the type of farms within the town.
- Natural and Scenic Resources provides a brief description of the landscape as a whole, and highlights particular areas of high scenic value.
- Alternative energy is only mentioned for a few towns and describes any initiatives that may exist within the town.
- Environmental Hazards describes any brownfield, Superfund sites, or other concerns related to

contamination of natural resources within the town.

- Zoning and Bylaws gives an overview of the zoning designations within the town, and bylaws or overlay districts that may be in place.
- Municipal Services describes the town's drinking water resources, sewer system and trash removal services.

## Conservation Commissions

Massachusetts was the first state in the nation to draft legislation establishing a municipal body to oversee the planning of open space for conservation purposes. Prior to 1957, when the state Conservation Commission Act (CCA) was signed into law, land protection was largely the provenance of private clubs and associations, entities which tended to focus on allocating land for recreational purposes, rather than working to preserve a certain landscape character, scenic environment or habitat type. With the creation of conservation commissions, towns gained the authority and dedicated personnel needed for open space protection. With the introduction of the Wetlands Act in 1972, conservation commissions gained the mandate necessary to oversee the protection of previously vulnerable wetland resources. By the 1980's every town and city in Massachusetts had established a conservation commission.

## Responsibilities and duties

One of conservation commissions' central roles, laid out in the CCA, is to take inventory of its town's natural resources and to prepare corresponding maps as part of a larger plan. These plans have come to be known as Open Space and Recreation Plans (OSRPs), documents that must be kept as relevant as possible and thus, updated every 7 years. OSRPs are vital in their own right, as catalogs of a town's assets and potential liabilities. Although they serve as a means of goal-setting and a record of progress in town projects, they are also a prerequisite in securing funds for open space acquisition.

Conservation commissions are able to impose rules and regulations on the use of conservation land, with these regulations bearing the full force of law. Much of commissions' resources are allocated to the review of wetlands permit applications, called Notices of Intent (if a notice passes review, the commission issues a permit called an Order of Condition). This work is time-consuming, and staying on top of the permitting process can leave them with

little time or personnel available for pursuing high-priority conservation work outlined in the OSRP's.

While the Conservation Commission Act establishes the basic criteria for committees, many of the specifics are left up to individual towns. The CCA allows for 3-7 commission members and makes no requirements as to age, level of expertise, or term limits for serving members. Some towns are able to offer paid positions to conservation commission staff with expertise who are often supported by volunteer commission members, and occasionally asked to fill in on other town's commissions. Conservation commissions are considered to be more effective when their members are diverse in their backgrounds (Massachusetts Association of Conservation Commissions).

### **The Community Preservation Act (CPA)**

The Community Preservation Act emerged from the ways towns saw their landscapes altering in the 1980's, shifting away from what many communities perceived to be healthy mixes of farms, forests and downtowns towards places that looked and felt overdeveloped. As communities came together to discuss protection, unsurprisingly, many different priorities surfaced: "Some wanted to protect working farms, others desired to protect historic buildings from being razed, and still others strived to provide affordable housing to enable the next generation of long-time residents to remain close to home" (CPA History | Community Preservation Coalition).

"Property taxes traditionally fund the day-to-day operating needs of safety, health, schools, roads, maintenance, and more. But until CPA was enacted, there was no steady funding source for preserving and improving a community's character and quality of life. The Community Preservation Act gives a community the funds needed to control its future." (CPA History | Community Preservation Coalition)

The CPA works bilaterally, on a local as well as a state level. Communities who adopt the CPA have access to their town "land bank" as well as annual funding disbursed through the state Community Preservation Trust Fund, administered by the Department of Revenue. Communities must adopt the CPA through a ballot referendum. Once in place, the CPA raises funds through a tax of no more than 3% of the price of real property. Additionally, adoption of the CPA calls for the establishment of a local Community Preservation Committee of 5-9 members who undertake the work of identifying potential conservation projects to the community and its legislative body. The CPA is powerful because it gives each town or city the full support of the state and the full freedom to act independently on

local interests. The public is often not aware of the range of quality of life issues that can be addressed through CPA projects, particularly the creation of affordable housing.

### **The Chapter 61 Program**

Geared towards individual land owners, this program nonetheless strives to protect land in order to provide communities with "clean water, wildlife habitat, rural character, and local food and wood products." -Masswoods.org

#### **Chapter 61: Forestry**

Provides temporary protection and a reduced tax rate on privately owned forested land. Enrolling involves a partnership with a certified local forester, who drafts an ecologically oriented forest management plan in step with landowner requests and the specifics of the individual forest (considering factors such as forest age and composition). Management plans are designed to encourage responsible and economically viable wood harvesting, as well as forest preservation.

#### **Chapter 61A: Agriculture**

Provides temporary protection and a reduced tax rate on working farmland for landowners who enroll. Chapter 61A is designed to assist farmers through tax abatement, preserve the status of working farmlands, and prevent farmlands from being converted into commercial or housing developments. Requirements: a minimum of 5 acres of working farmland already operational for at least two years and grossing at least \$500.

#### **Chapter 61B: Open space and recreational land use**

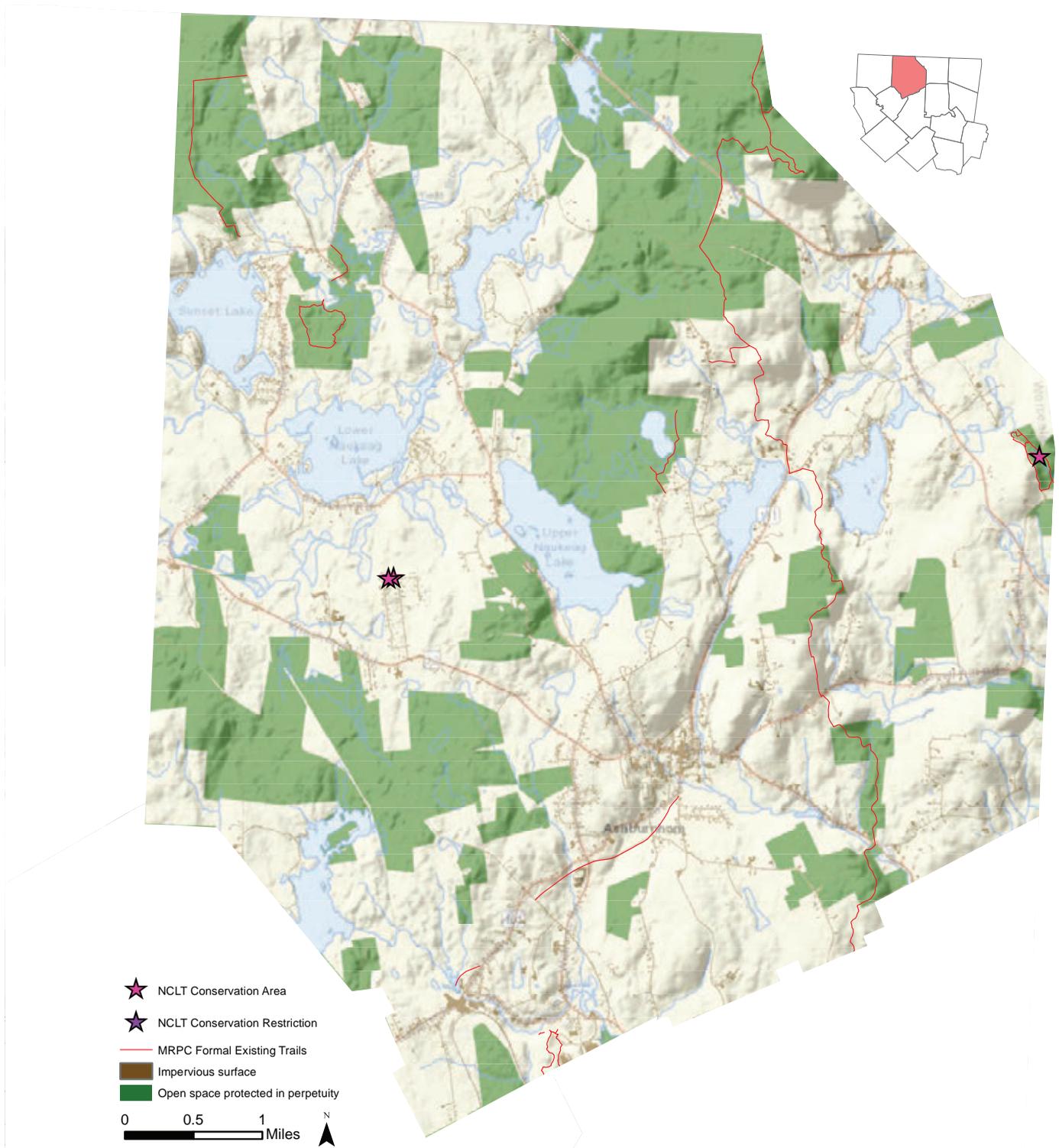
Provides temporary protection and a reduced tax rate for lands that meet the requirement for open space or recreational purposes.

Requirements: Land is open space and a minimum of 5 acres (does not need to be made accessible or available for public use). Open space is defined as:

- A "substantially wild state"
- In a landscaped or pastured state, or
- Forest under a state-approved management plan
- Recreational land can be any land that is deemed appropriate for recreation, and must be made available for public use or for use by non-profit organizations. Owners are permitted to charge the public a fee.

In all three programs, if owners choose to exit the program through the sale of their property, the town has the first right of refusal, during a special 120-day period. During this time, a town can choose to purchase the parcel in question, or transfer their right of first refusal to a land trust.

# Ashburnham



# TOWN CONSERVATION CAPACITY

## Town Overview



- Size: 26,240 acres // 41 square miles (one of the largest towns by area in central MA)
- Population: 6,081 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2017
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town Committees: Conservation Committee, Rail Trail Committee, Parks and Recreation Committee, Agricultural Commission
- Town character snapshot: Ashburnham has a small population and a large number of lakes, streams, and forests, giving the town a scenic and rugged character. This draws tourists and part-time residents during the summer.
- Key conservation concerns: A town wide survey found that land protecting water and drinking water sources was of highest priority.

## Open Space and Sustainability



- 28.4% of the total town area is permanently protected open space.
- 50% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 90.9% of people drive alone to work.
- 23.6% of commuters travel for 60+ minutes to work, one-way.

## Growth and Development



- Median household income: \$81,690.
- Median home value is \$230,600.
- The sectors of highest employment are agriculture, forest and fisheries; mining; construction; manufacturing; transportation, communications, and utilities; wholesale and retail; finance, insurance, and real estate; and services and public administration.
- Sidewalks and bike lanes are limited in town, with the majority concentrated around the town center and schools.
- 3% of the town is covered in impervious surfaces.

## Agriculture



- The town has 500 acres enrolled in Chapter 61A.

## Natural and Scenic Resources

- Most of Ashburnham's topography consists of rolling, hilly terrain. Mount Watatic is the highest point at 1,832 feet and Phillips Brook flows into Fitchburg at the lowest point of 840 feet.

## Zoning and Bylaws

- Ashburnham has numerous bylaws and plans in place to preserve its natural resources and rural character such as a Water Supply Protection Plan, a Wetlands and Watershed Protection District, a Wetlands Protection Bylaw, a Scenic Roads Bylaw, an Open Space and Residential Development Bylaw, the Right to Farm Bylaw, and the Low Impact Development Bylaw.

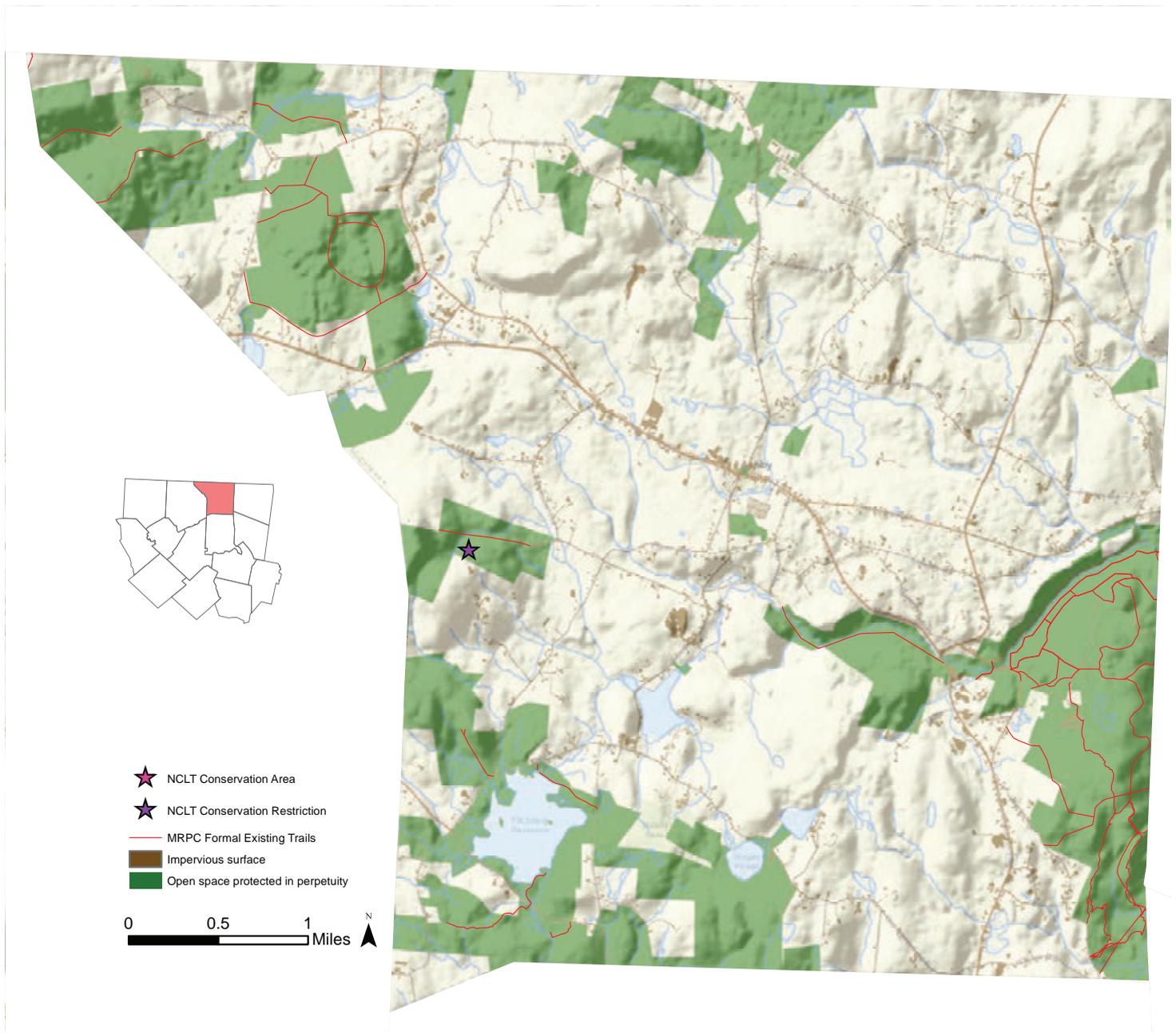


## Municipal Services

- Well water and Upper Naukeag Lake, the only lake in Ashburnham protected as a Class A lake, serve as the town's primary water supply sources. Public water supply only extends around the center and southern portions of town and the town as a whole uses an estimated 485,000 gallons of water daily. The majority of residents use septic systems, and because both septic and well systems are prevalent throughout the town, water resource protection is a top priority.

Source: Ashburnham OSRP (2017), US Census Data (2010), <http://www.ashburnham-ma.gov/>

# Ashby



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 15142 acres // 23.66 square miles
- Population: 3,178 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2018
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town committees: Agriculture Commission, Conservation Commission, Cultural Council
- Town character snapshot: Ashby was known for the production of various specialized items throughout history such as clocks, church organs and palm-leaf hats.
- Key conservation concerns: Creating a recreational corridor connecting Ashburnham, the Midstate Trail and Willard Brook State Forest. Preserving working lands and areas of ecological value, including Stock Farm, Caton Hill, S. Branch of the Souhegan River, and the Great Meadow.



## Open Space and Sustainability

- 26.2% of the total town area is permanently protected open space.
- 23% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 24.7% lands in Chapter 61, 61A or 61B.



## Growth and Development

- Between 2000 and 2010 the population rose 8%.
- Annual median income is \$89,924.
- Median home value is \$247,000.
- No bike paths on public roads.
- 3.7% of the town is covered in impervious surfaces.



## Agriculture

- Numerous family farms including maple sugaring, Christmas trees, and mixed vegetables. The two largest farms are the Stock Farm and the Crocker Farm, which mainly produce hay. The town predicts an increase in the prevalence of hemp farms due to recent legalization of cannabis.

## Natural and Scenic Resources

- The Fitchburg Reservoir is home to loon nesting sites, the South Branch of the Souhegan River and numerous cold water fisheries are home to diverse wildlife.

## Environmental Hazards

- Drinking water quality is a concern when private septic systems are in close proximity to private wells.

## Zoning and Bylaws

- All of Ashby is zoned for residential/agricultural use, with the exception of two areas zoned as residential/commercial, and one area zoned as industrial. Ashby has adopted an Open Space Residential Development bylaw that requires development with stipulations about preserving open space. The town also passed a Rate of Development bylaw that limits the number of residential building permits per year to no more than 20.

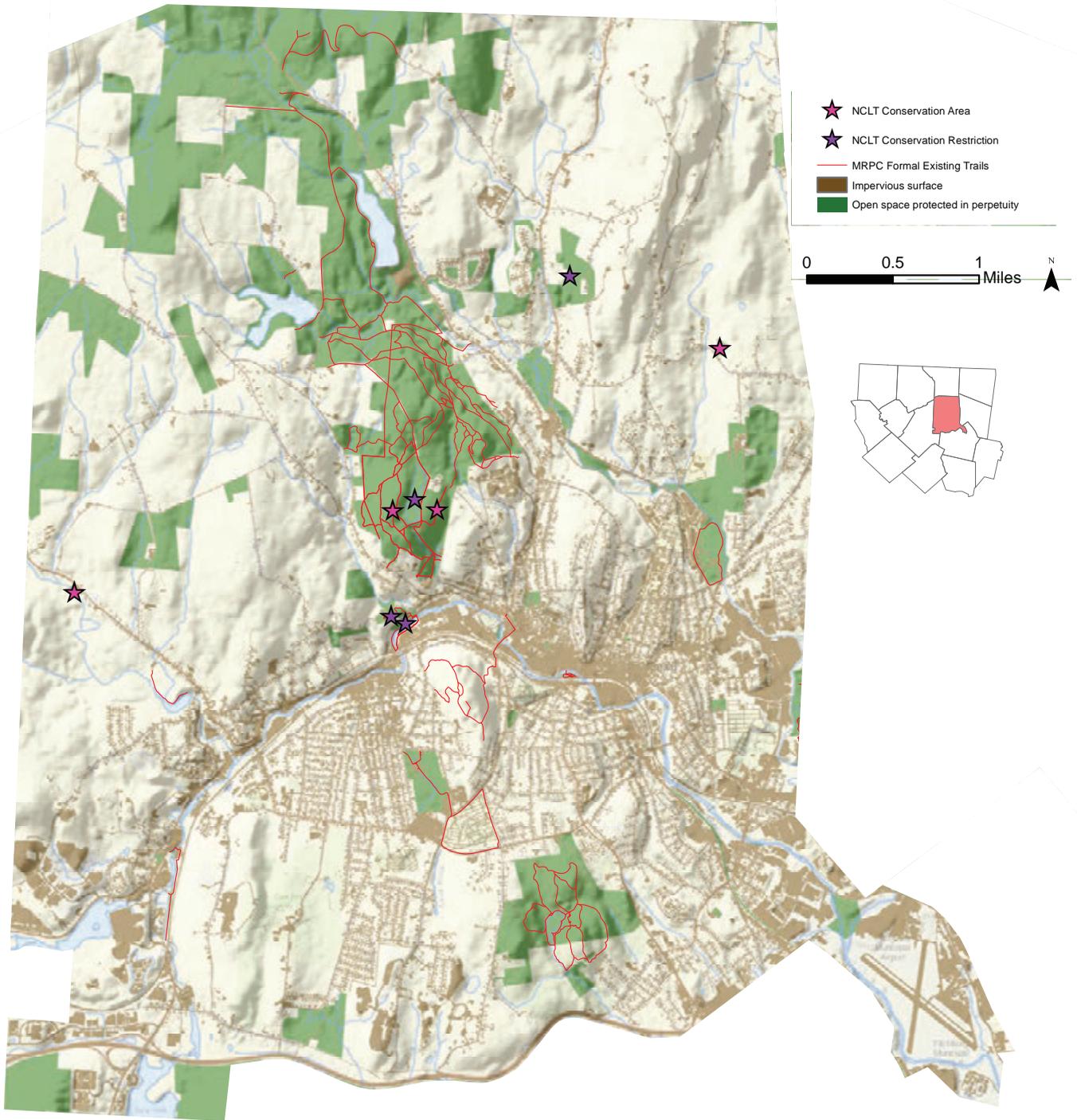


## Municipal Services

- There is no public water supply in Ashby, all residents have private wells. Ashby falls primarily in the Nashua River watershed, though a portion of the northwest corner of the town is within the Souhegan River watershed. There is no municipal sewer in Ashby, all residents have private septic systems. The DEP mandated closure of the town's landfill, but there are still concerns about the landfill contaminating abutting wetlands. Currently, residents make use of a transfer station for trash and recycling that is disposed of out of town.

Source: Ashby OSRP (2018), US Census Data (2010), <http://www.ci.ashby.ma.us/>

# Fitchburg



# TOWN CONSERVATION CAPACITY



## Town Overview

- Area: 14,145 acres // 22 square miles
- Population: 40,318 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2014-2021
- Community Preservation Act (CPA) status: Not adopted
- Relevant committees at work: Agricultural Commission, Conservation Commission
- Town character snapshot: Post-industrial, "Gateway City" with a stark juxtaposition of green and open space and densely settled urban centers with large populations of environmental justice communities.
- Key conservation concerns: Development and maintenance of a safe park system that provides a variety of recreational activities for all residents, including walking and biking paths. Promotion of green space in the urban core.



## Open Space and Sustainability

- 32.9 % total acres in open space, 17.2 % open space is protected in perpetuity.
- 5.4% of the area is BioMap2 Core Habitat or Critical Natural Landscape.



## Growth and Development

- Between 2000 and 2010 the population rose 3.1%.
- The median household income was \$47,019 (though this varies widely across city: in the northern part of the City the average is \$71,194, and in the central part of the City it is \$31,075).
- Median home value is \$183,400.
- 16.1% of the town is covered in impervious surfaces.



## Agriculture

- Prime agricultural soils are found in many areas of Fitchburg. Because steep slopes in many of the upland areas of the City are unsuitable for development and most agricultural lands are located in flat areas, many of Fitchburg's farms have been lost to development.

## Natural and Scenic Resources

- Hilly, upland terrain, bisected by the Nashua River and surrounding floodplain.

## Environmental Hazards

- Numerous brownfield sites from dilapidated industrial properties have contaminated soil or groundwater. A number of these sites are located along the Nashua River. Additionally, in June of 2012, an unexpected release of oil into the Nashua River from the former Central Steam plant occurred. Since this time, plans have been underway to demolish the building and remove underground pipes and other hazards.



## Zoning and Bylaws

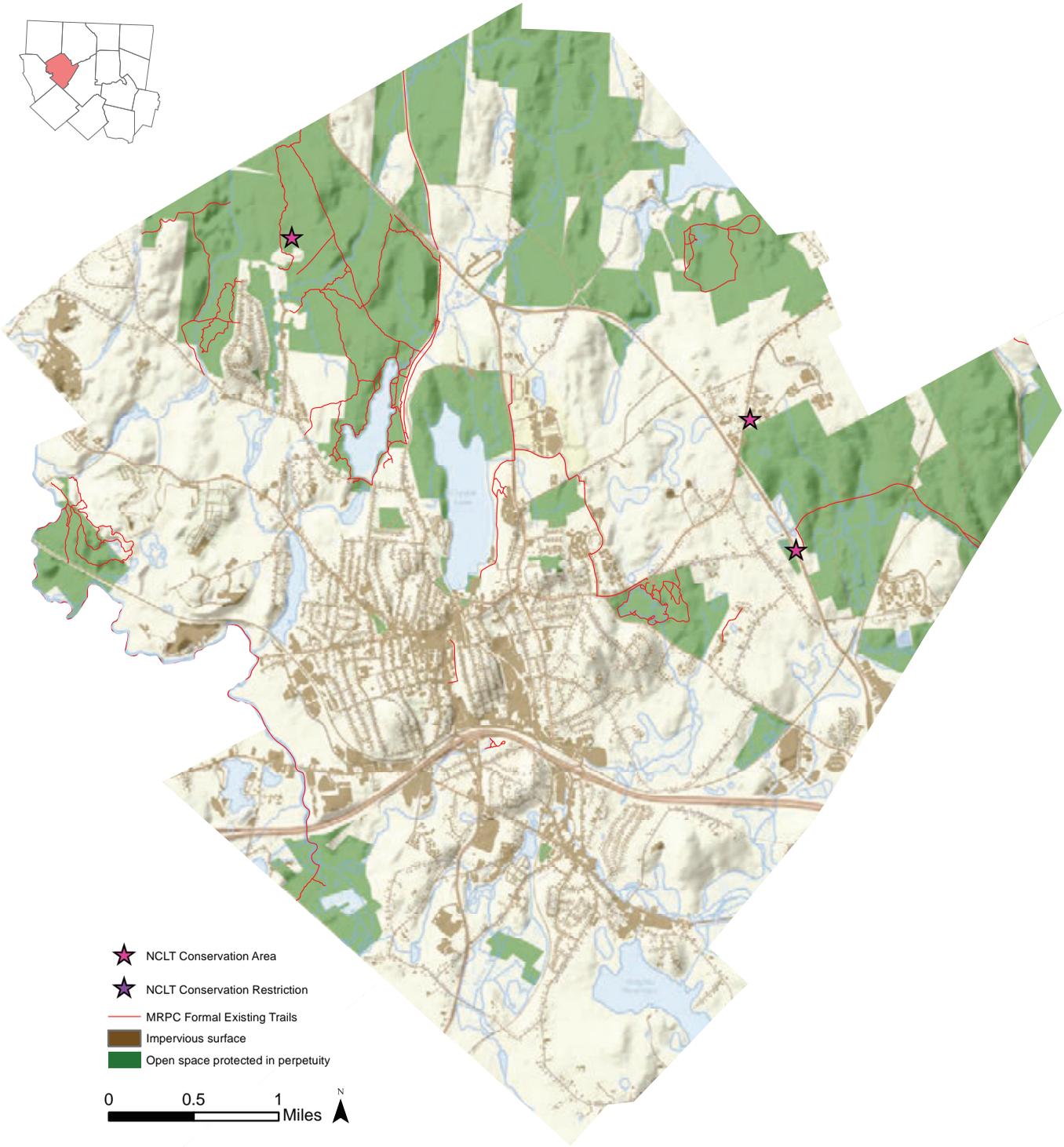
- Twelve zoning districts, five of which are different types of residential, reflecting diversity of neighborhoods within the city. A number of ordinances contain provisions to promote efficient growth such as the Cluster Development and Planned Unit Development provision.

## Municipal Services

- Fitchburg's drinking water supply comes from seven local reservoirs including five sources within the city limits and numerous other surface water sources in nearby towns (Westminster and Ashby). The older areas of the city are served by municipal sewer, and sewer extensions are built to accommodate subdivisions in outlying areas. A number of residents also have private septic systems.

Source: Fitchburg OSRP (2014-2021), US Census Data (2010), <http://www.ci.fitchburg.ma.us/>

# Gardner



- ★ NCLT Conservation Area
  - ★ NCLT Conservation Restriction
  - MRPC Formal Existing Trails
  - Impervious surface
  - Open space protected in perpetuity
- 0 0.5 1 Miles

# TOWN CONSERVATION CAPACITY

## Town Overview



- Area: 14,145 acres // 22 square miles
- Population: 20,228 (2010 Census), stagnant growth
- Current Open Space and Recreation Plan (OSRP): 2015-2022
- Community Preservation Act (CPA) status: Goal of adoption by 2020
- Relevant committees at work: Conservation Commission lead by a conservation agent, Community Development & Planning
- Town character snapshot: The chair city: between the 18th and early 20th centuries, Gardner's small woodworking shops grew into a major chair manufacturing industry. Today, Gardner is has a low population density and high unemployment.
- Key conservation concerns: The majority of the land mass of Gardner lies within a rural residential zoning designation, which is not equipped to address the stresses to the aquifer and groundwater recharge zone that major storms pose.

## Open Space and Sustainability



- 59% total acres in open space, 31% of the total town area is permanently protected open space.
- Nearly 31% protected: 12% have limited protection, 17% have no protection.
- 15% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 469 acres in Chapter 61 (Forest).
- Total percentage open space protected similar to neighboring towns, but unlike others, the majority of open space is owned by the town, rather than the Commonwealth.

## Growth and Development



- Between 2000 and 2010 the population rose 17%.
- The median household income is \$48,915.
- Median home value is \$185,900.
- Biggest employers are Mt Wachusett Community College, Heywood Hospital and NCCI.
- 11.1% of the town is covered in impervious surfaces.

## Agriculture



- 302 acres enrolled in Chapter 61A. Founded in 1904, the Gardner State Colony was a mental health facility with an integrated farm. It closed in 1975 and its grounds today are occupied by North Central Correctional Institute (NCCI), a minimum to medium security prison.

## Natural and Scenic Resources

- The hills of Gardner are a natural barrier between the Millers River and the Nashua River Watersheds, with most of the town, including the formerly industrialized center, within the Millers River portion. The northeastern and eastern portions of the town within the Nashua River Watershed are more rural.

## Alternative Energy

- A wind energy initiative promotes the use of turbines in industrial districts.



## Zoning and Bylaws

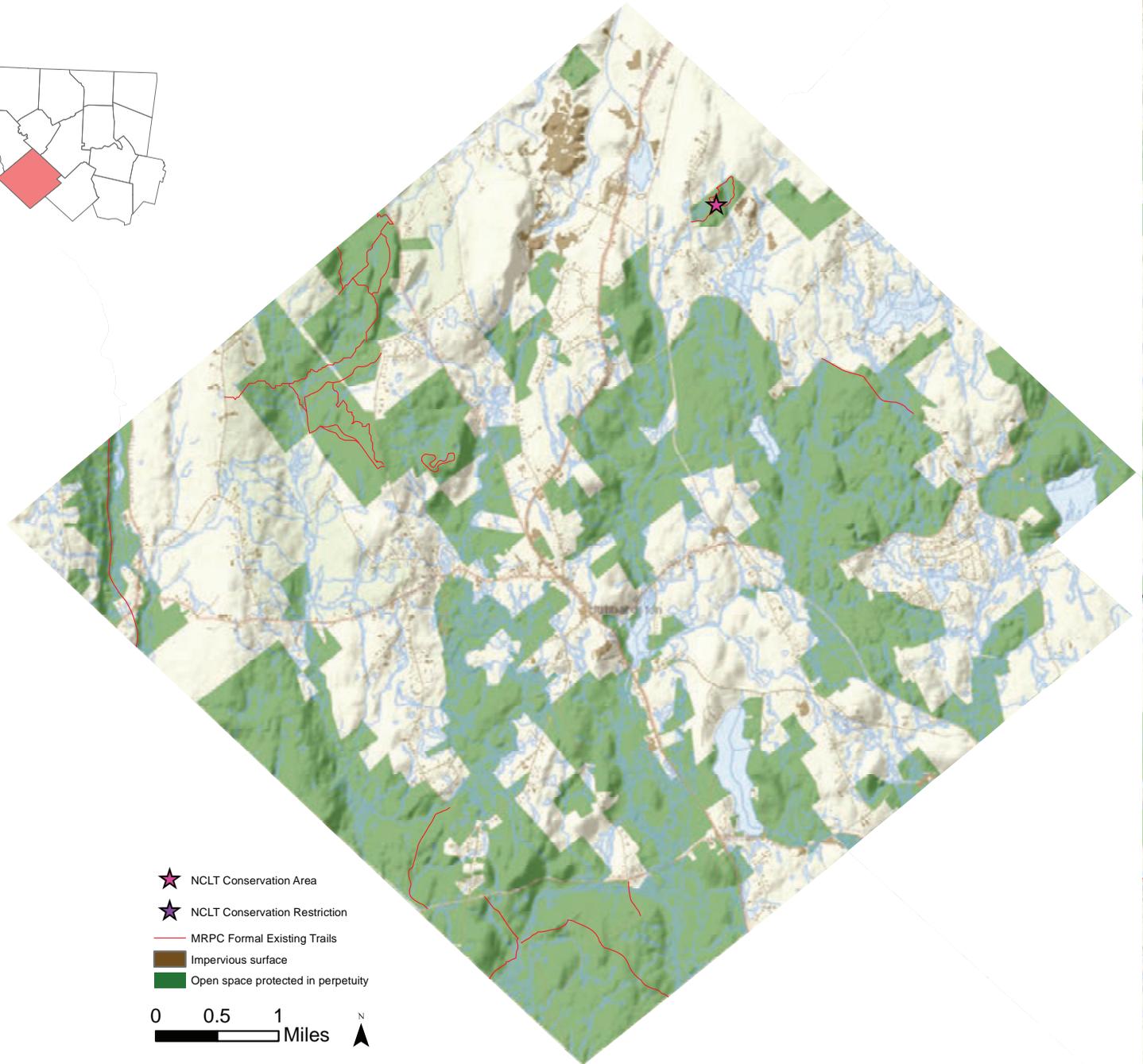
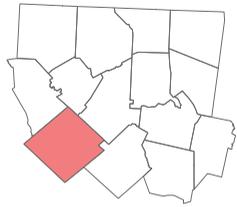
- Gardner has implemented a Open Space Residential Development bylaw.

## Municipal Services

- Crystal Lake and its water treatment plant provides 30 to 40% of residents with drinking water from April to November, backed up by the Snake Pond groundwater treatment center. These same residents are also within the sewer service region. Beyond central Gardner, town services are not provided.

Source: Vance, Matthew, et al. Gardner 2015 Open Space and Recreation Plan. 2015. US Census Data (2010), <https://www.gardner-ma.gov/>

# Hubbardston



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 23,872 acres // 37.3 square miles
- Population: 4,382 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2018-2025
- Community Preservation Act (CPA) status: Adopted 2006
- Relevant Town committees: Agricultural Commission, Conservation Commission, Parks Commission, Open Space Committee
- Town character snapshot: Hubbardston's abundant water resources contribute to the drinking water supply for a large percentage of the population of Massachusetts as a part of the Quabbin Reservoir watershed.
- Key conservation concerns: Protecting water quality, wildlife habitat, and agricultural parcels, and supporting balanced, "green development."



## Open Space and Sustainability

- 43.7% of the total town area is permanently protected open space.
- 41% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 18.9% of residents work in town.
- 78.5% of residents drive a car to work.
- 5.2% of town acreage is open water or wetlands.
- 13.6% lands in Chapter 61, 61A or 61B.



## Growth and Development

- Between 2000 and 2010 the population rose 12.1%.
- Annual median income is \$83,333.
- Median home value is \$288,204.
- Unemployment rate in 2011: 8.2%.
- Majority of roads are quiet and lend themselves to walking/biking.
- 3.3% of the town is covered in impervious surfaces.



## Agriculture

- Numerous farms and livestock and poultry operations exist within Hubbardston, but only one farm is permanently protected in the town, and another farm in process for protection with APR.

## Natural and Scenic Resources

- Rolling topography, majority forested, plentiful water bodies, streams and wetlands.

## Zoning and Bylaws

- Zoning Bylaws comprise four districts; Residential-Agricultural, Town Center, Commercial, and Light Industrial. In 2006 the town adopted The Open Space Residential Bylaw that allows clustered housing on small lots and sets aside lands for conservation as per Smart Growth policies and a Rate of Development bylaw. The town considered implementing a Low Impact Development bylaw, but upon further study decided against it due to the existence of a number of bylaws that rendered the LID redundant.

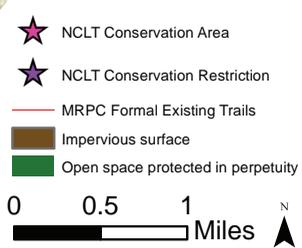
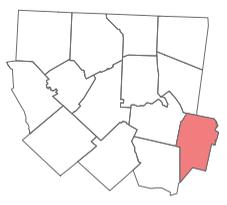
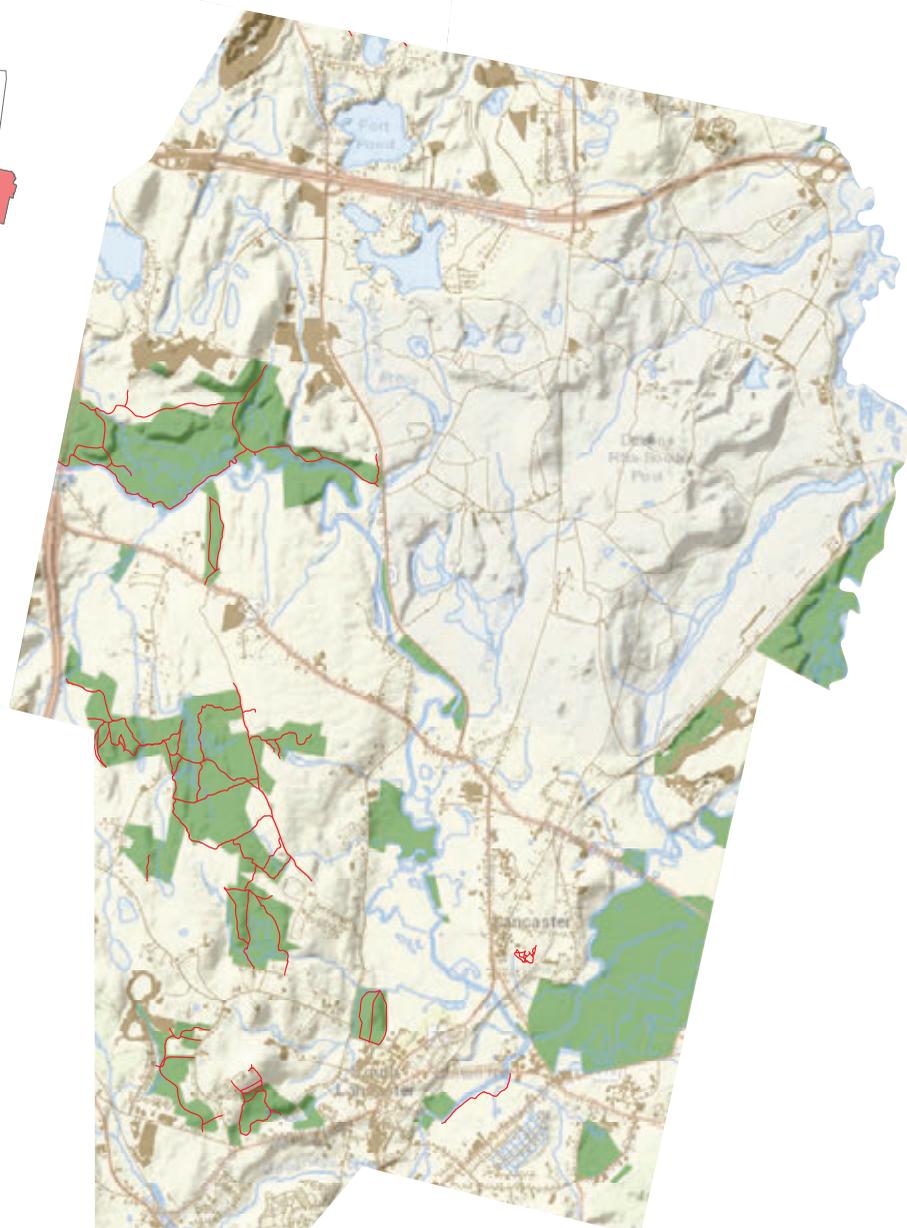


## Municipal Services

- There is no public water supply in Hubbardston, all residents have private wells which draw from bedrock aquifers in the town. A zone II is delineated around the drainage basin for Hubbardston Brook which contains a medium-yield aquifer. In addition to supplying some water to Gardner and Fitchburg, most of the town lies within a Class A surface water protection zone that protects waters that eventually feed the Quabbin, Wachusett, Fitchburg Mare Meadow and Bickford Pond Reservoirs. Hubbardston falls primarily within the Chicopee Watershed, though the northern part of the town is within the Miller's River watershed. There is no municipal sewer in Hubbardston, all residents have private septic systems. Residents pay for town-approved services for soil waste removal. The town operates a recycling facility that is open April through November.

Source: Hubbardston OSRP (2018-2025), US Census Data (2010), <https://www.hubbardstonma.us/>

# Lancaster



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 17,899 acres // 27.9 square miles
- Population: 8,055 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2000
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town committees: Agricultural Commission, Conservation Commission, Cultural Council, Town Forest Committee, Trail and Bikeway Coalition
- Town character snapshot: The Nashua River and its tributaries define much of the community character.
- Key conservation concerns: Protecting the town's public water supply and conserving agricultural lands and farming viability.



## Open Space and Sustainability

- 12 % of the total town area is permanently protected open space.
- 45.3% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 89% of residents drive a car to work.
- 5.2% of town acreage is open water or wetlands.
- 6.9% lands in Chapter 61, 61A or 61B.



## Growth and Development

- Between 2000 and 2010 the population rose 9.4%.
- Annual median income is \$99,207.
- Median home value is \$300,000.
- Designated as a Complete Streets community and plans to repair sidewalks, and add or improve accessibility features and bike lanes.
- 7.9% of the town is covered in impervious surfaces.



## Agriculture

- Numerous farms, orchards and livestock operations exist within Lancaster, many of which are enrolled in a Chapter 61A program.

## Natural and Scenic Resources

- The Nashua River threads its way through the town, and is a major landmark.

## Alternative Energy

- A town-owned solar array was constructed on the site of a former landfill on Lunenburg Road.

## Environmental Hazards

- The South Post of Fort Devens is an active military training area with several historical disposal sites. A brownfield site on the Lancaster/Clinton town line with old industrial structures was razed, and cleaned of debris and contaminated soils. The property is now maintained as open space.



## Zoning and Bylaws

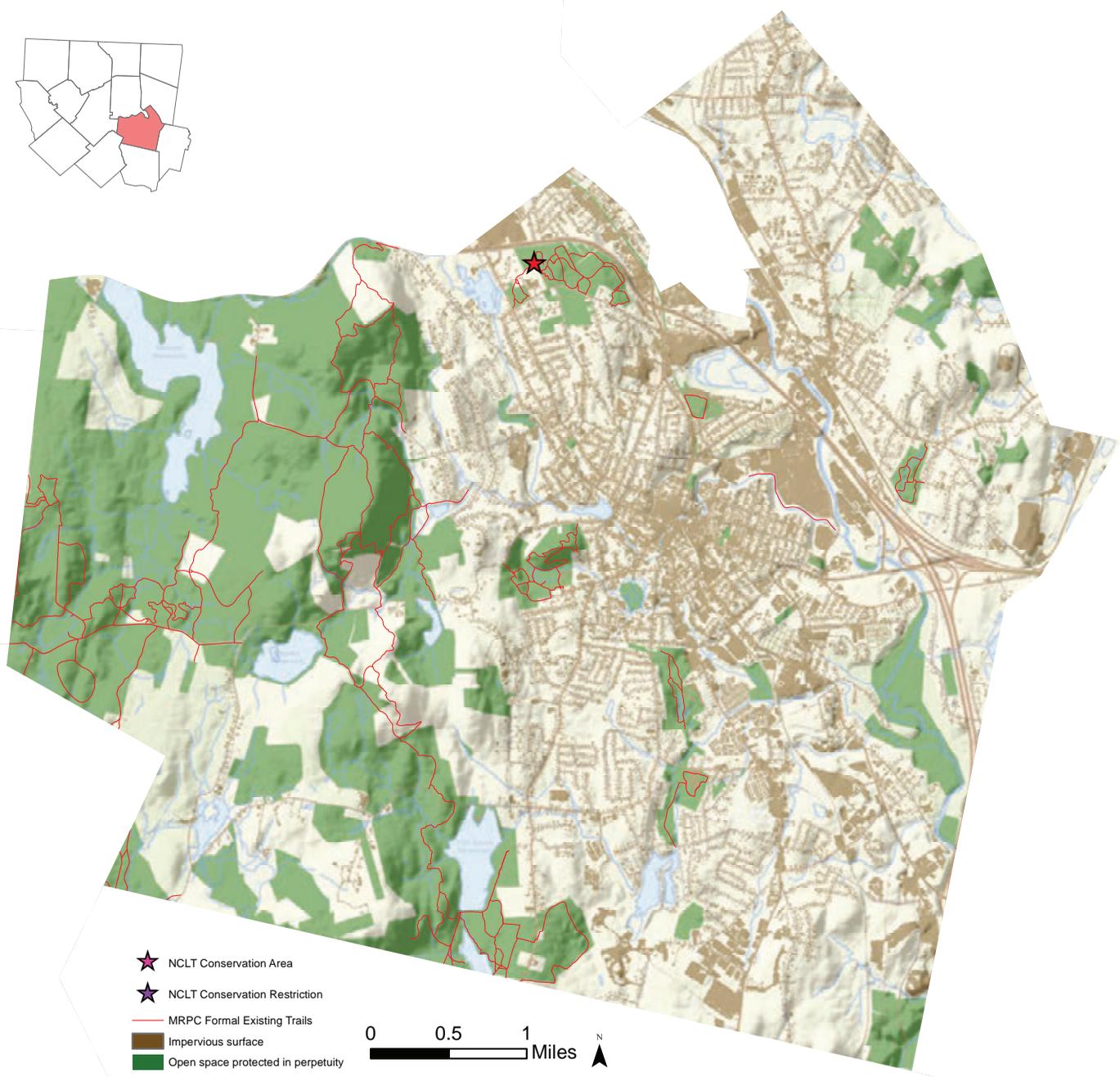
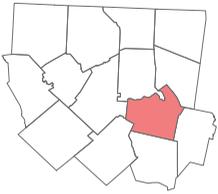
- Lancaster has recently developed a number of different zoning bylaws that encourage mixed-use development, preservation of open space, stringent stormwater management, wetland and water source protections, and agricultural preservation. In addition to these, community programs such as complete streets, green communities, expedited permitting, and landfill reuse studies for alternative energy are also in effect.

## Municipal Services

- The municipal water supply consists of two artesian wells in the southeastern portion of the town and supply 90% of Lancaster's residents. The remaining ten percent have private wells. Most of the southern portion of Lancaster where the majority of commercial and residential development is located is served by a municipal sewer system and the rest of the town has individual septic systems. The town does not offer solid waste disposal, but the Board of Health contracts private companies to service individual residences and businesses.

Source: Lancaster OSRP (2000), US Census Data (2010), <https://www.ci.lancaster.ma.us/>

# Leominster



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 18,496 acres // 28.9 square miles
- Population: 40,759 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2014
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town Committees: The city has an active conservation commission and stormwater committee.
- Town character snapshot: The city is characterized both by dense urban core and the large Leominster State Forest. The city was the birthplace of James Gordon Carter, the “Father of the Massachusetts Public School System,” and John Chapman, also known as Johnny Appleseed. The city is known as the “Pioneer Plastics City” as it housed more than 100 businesses devoted to developing plastics or the plastic industry.
- Key conservation concerns: The top priority identified by the OSRP committee was to make their recreational areas more attractive and accessible to encourage increased use by local residents.



## Open Space and Sustainability

- 29.7% of the total town area is permanently protected open space.
- 34.99% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.



## Growth and Development

- Between 1985-1989 the population rose by 10%.
- The median household income is \$75,958.
- Median home value is \$231,700.
- Over half of the city’s residents live in an environmental justice neighborhood.
- An aggressive Growth Management Plan limited population growth and prioritized preservation of land, and there was little population growth from 2000-2010.
- HealthAlliance Hospital, Market Basket, and International Rectifier are the three largest employers in the town.
- 17.1% of the town is covered in impervious surfaces.



## Agriculture

- The city has 548.33 acres of Chapter 61A farmland.



## Natural and Scenic Resources

- The Leominster State Forest consists of 4,264 acres of protected land, and the north Nashua River winds through the city.

## Zoning and Bylaws

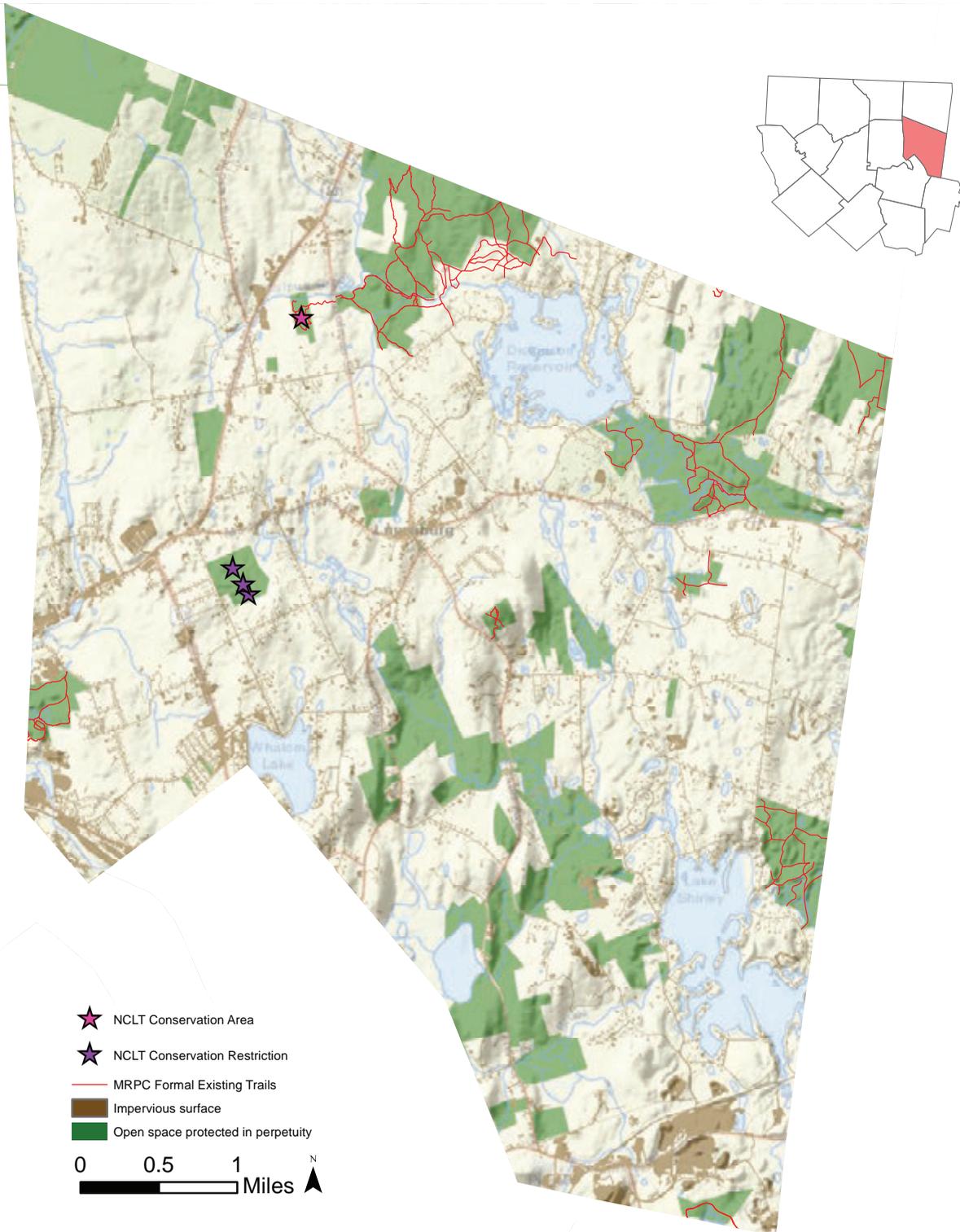
- The city has recently undergone a complete overhaul of its zoning ordinance. This has included modifications to the Water Supply Protection District, Open Space Community Development section, Subdivision Regulations, and Growth Management, among others. The city continues to pursue land to acquire to protect its reservoirs and wellfields and encourages landowners to classify their land with the state as Chapter 61A or 61B.

## Municipal Services

- The City of Leominster uses water from seven surface reservoirs and three groundwater wells all within the city limits. Sewer systems serve the majority of the city but do not extend to the easternmost portions of the city. This has limited development in this area.

Source: Leominster OSRP (2014), US Census Data (2010), <http://www.leominster-ma.gov/>

# Lunenburg



# TOWN CONSERVATION CAPACITY

## Town Overview



- Size: 17,721.6 acres // 27.69 square miles
- Population: 10,086 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2019-2026
- Community Preservation Act (CPA) status : Not adopted
- Relevant Town Committees: Agricultural Commission, Conservation Commission, Open Space Committee, Green Community Taskforce, Cultural Council.
- Town character snapshot: The town is both an agricultural community and a bedroom suburb of Fitchburg, Leominster, Worcester, and Boston.
- Key conservation concerns: The top priority identified by the OSRPs includes enhancing and promoting existing open space, preserving critical natural resources, expanding access to conservation areas, and diversifying funding sources.

## Open Space and Sustainability



- 17.4% of the total town area is permanently protected open space.
- 28.39% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 1,265 acres of land in Chapter 61A, and 750 acres conserved with APRs.
- 28.39% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.

## Growth and Development



- The median household income is \$113,816.
- Median home value is \$285,300.
- The town has experienced steady growth from 1950 to 2017, growing in population from 3,906 to 11,312 residents, with an estimated build out of 22,318 residents. The number of building permits issued annually grew from 40 in 2016 to 1040 in 2017, the highest number of permits ever issued in one year.
- 8.2% of the town is covered in impervious surfaces.

## Agriculture



- The city has 548.33 acres of Chapter 61A farmland.

## Natural and Scenic Resources

- Open fields, wooded areas, tree-lined roadways, and scenic views from Lancaster Avenue. A large grassland area in the northeastern portion of the town adjacent to Hunting Hill is a highlight.

## Zoning and Bylaws

- The town adopted a water-supply protection bylaw, which is written to protect not only wells but also aquifers and aquifer drainage areas.

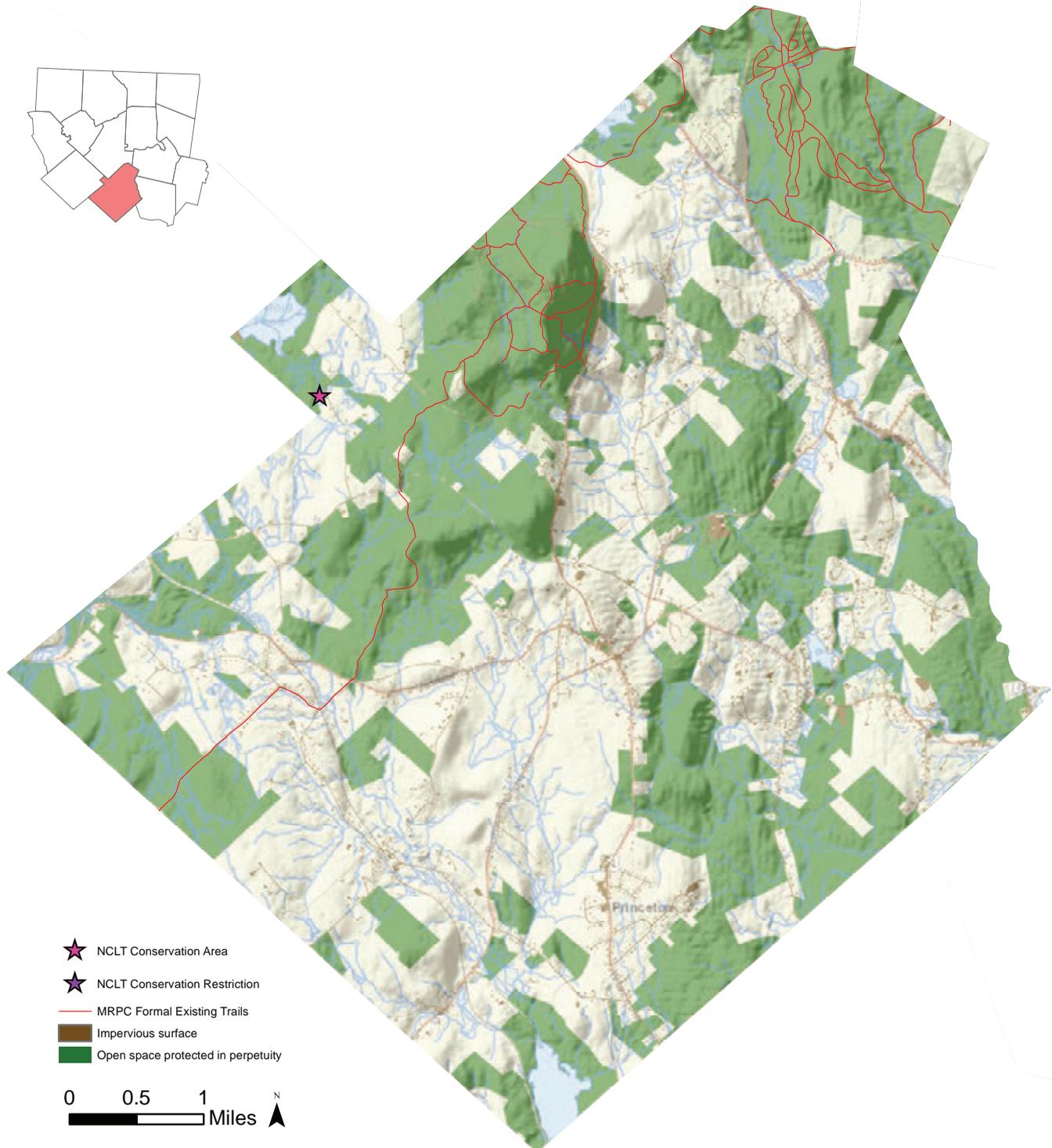
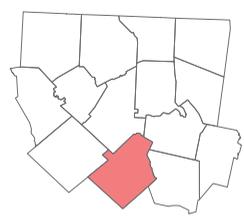


## Municipal Services

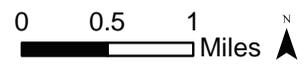
- The Lunenburg Water District draws its water from seven wells and provides water to 70% of the town. Approximately 7.6% of Lunenburg parcels are connected to the sewer system, which discharges to water treatment facilities in Leominster and Fitchburg, and an additional 9.6% of parcels are entitled to become connected to the network. Much of the town is situated on a shallow ledge or high groundwater, meaning it is undevelopable without sewer lines. Expansion of sewer systems could profoundly impact the character of the town.

Source: Lunenburg OSRP (2019-2026), US Census Data (2010), <https://www.lunenburgma.gov/>

# Princeton



- ★ NCLT Conservation Area
- ★ NCLT Conservation Restriction
- MRPC Formal Existing Trails
- Impervious surface
- Open space protected in perpetuity



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 22, 939 acres // 35.85 sq. miles
- Population: 3,413 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2014-2021
- Community Preservation Act (CPA) status: Voter base is opposed, town is ready to act when more support is visible.
- Relevant committees at work: Agricultural Commission, Conservation Commission (volunteer-run), Cultural Council, Environmental Action Committee. The Land Conservation Committee was formed, met, and ended their work in 2007 of setting guidelines for acting on parcels coming out of Chapter 61 protection.
- Town character snapshot: A skiing and hiking destination in a very quiet setting.
- Key conservation priority: Continuing to protect large, uninterrupted parcels preventing landscape fragmentation, and seeking to acquire parcels that strengthen connectivity.



## Open Space and Sustainability

- 89% total acres in open space, 43.3% of the total town area is permanently protected open space.
- 50.74 % of the total area contains BioMap2 Core Habitat or Critical Natural Landscape
- 5% of the town is a residential area.
- 4900 acres enrolled in Chapter 61, Chapter 61A, Chapter 61B.



## Growth and Development

- Annual median income is \$128,006.
- Median home value is \$370,400.
- Largest employer is the Wachusett Mountain Ski Area (seasonal).
- Less than 55 acres are currently used by businesses.
- The town doesn't expect much development of open space, as most is wetland or abuts wetlands or steeply sloped.
- 2.8% of the town is covered in impervious surfaces.



## Agriculture

- 4% of the town land is farmland. Of the upwards of 70% of the land that was cleared in the mid-19th century, most areas are reforested.



## Natural and Scenic Resources

- Princeton's three main peaks anchor this geologic wonderland, in which so many of the post-glacial features found scattered across the Northeast are represented. Narrow, winding roads afford scenic views and this viewshed is managed through regular mowing of selected fields.

## Environmental Hazards

- Two capped landfills pose a potential leaching hazard to watersheds.



## Zoning and Bylaws

- There is very little business or development in Princeton, and some residential neighborhoods are currently sited in areas zoned for business. The three business/industrial zones are described as "oddly situated" in the town's OSRP and unlikely to attract quality businesses. Zoning is being reexamined and possibly updated to reflect current and desired use. Nearly all of Princeton lies within the Watershed Protection Zone.

## Municipal Services

- Princeton lies between 4 watersheds. Water and sewer services hookups are not provided by the town; residents install and maintain private wells and septic systems. Fitchburg, Worcester, and the Department of Conservation and Recreation (DCR)'s Division of Water Supply Protection all own watershed parcels and reservoirs within Princeton. The DCR-owned land totals 3,434 acres. Residents contract with one of three city-approved hauling companies.

Source: Princeton OSRP (2014-2021), US Census Data (2010), town.princeton.ma.us

# Sterling



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 20,230 acres // 31.6 square miles
- Population: 7,808 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2010
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town Committees: The town has one conservation agent in addition to six board members on the conservation commission. The Recreation Committee and Agricultural Commission are also active committees in the town.
- Town character snapshot: The citizens of Sterling highly value the rural character of the town.
- Key conservation concerns: Protecting water resources is described as the top goal of the Open Space and Recreation Plan, with 88% of respondents indicating protection of water resources as a high priority.



## Open Space and Sustainability

- 35.2% of the total town area is permanently protected open space.
- 30.5% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- Percent of lands in chapter 61A or B: 2,709 acres.



## Growth and Development

- Annual median income is \$102,500.
- Median home value is \$340,500.
- From 1980-2000, 1,354 acres were converted from forested land to developed land.
- 6.8% of the town is covered in impervious surfaces.



## Agriculture

- Orchards are the most common source of agricultural income in the town, but farms are diverse and include dairies, nurseries, a goat farm, and several tree farms. The town has 2,709 acres in Chapter 61A land.

## Natural and Scenic Resources

- Abundant water resources including the Stillwater River and Wekepeke Brook, and numerous lakes, ponds and wetlands.

## Zoning and Bylaws

- Commercial and industrial zoning districts are relatively small and located in water protection zones which control the uses permitted there, and ensure industry practices are compliant with public drinking water protection regulations. Furthermore, Sterling has implemented a number of zoning bylaws and overlay districts that aim to preserve the rural character of the town, such as the Scenic Roads General Bylaw, the Agricultural Districts General bylaw, the Floodplain Overlay District, the Stillwater River Protection Overlay District, the Aquifer and Watershed Protection Overlay District, and the Rate of Development Limitation.

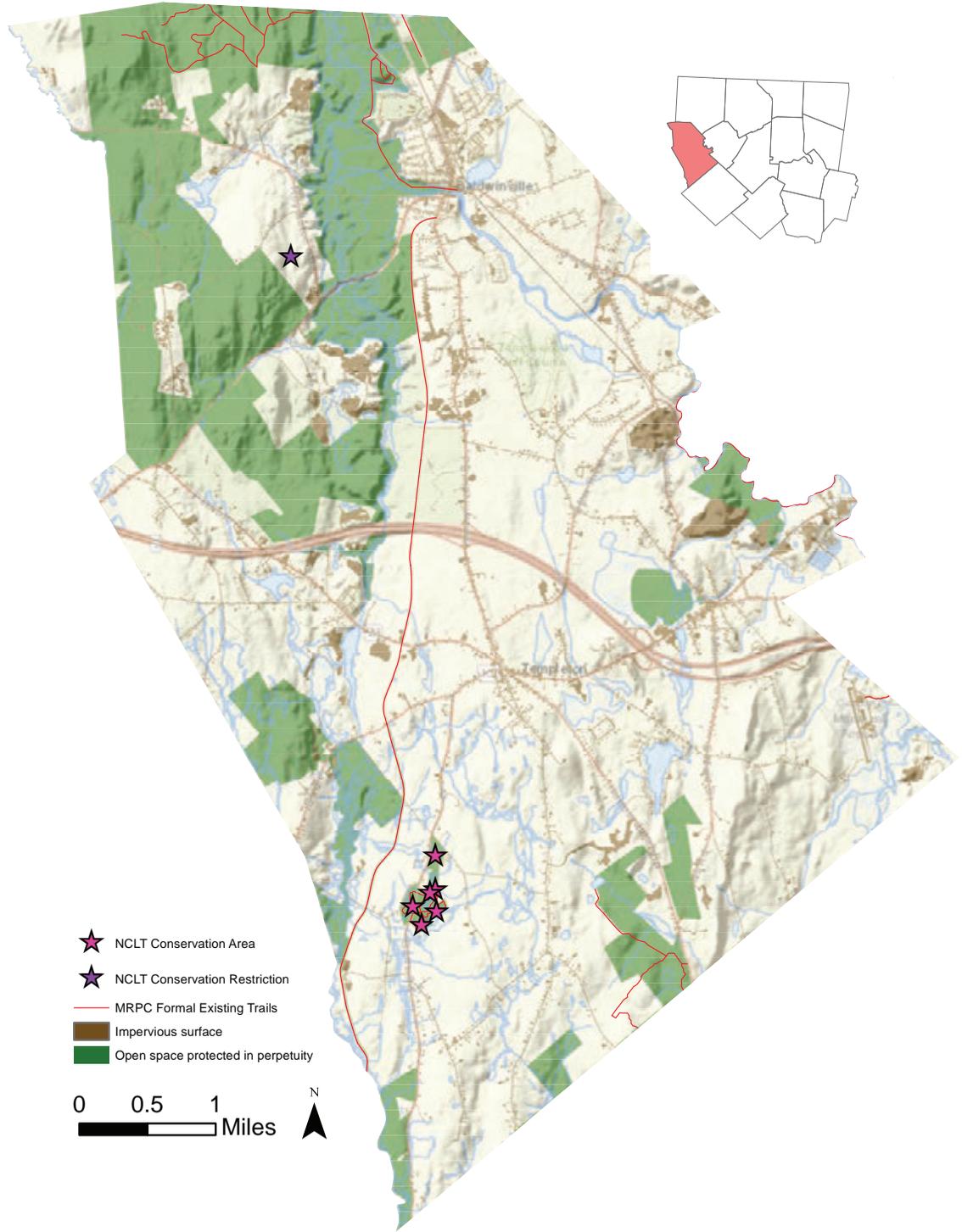


## Municipal Services

- The primary water resources are drawn from the Stillwater and Wekepeke Brook, which are part of the Wachusett Watershed, as well as from residential wells. Development pressure has already affected these water resources. All wastewater in the town is treated in septic systems, and the town offers curbside trash and recycling at no additional cost.

Source: Sterling Amory, Amanda, and Jason Stanton. Sterling 2010 Open Space and Recreation Plan. US Census Data (2010), <https://www.sterling-ma.gov/>

# Templeton



# TOWN CONSERVATION CAPACITY

## Town Overview



- Size: 20,000 acres // 32 square miles
- Population: 8,001 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2017-2024
- Community Preservation Act (CPA) status: Adopted in 2007
- Relevant committees at work: Agricultural Commission, Community Preservation Committee, Conservation Commission, Templeton Cultural Council.
- Town character snapshot: Former home to paper mills. Templeton's residents enjoy easy access to open space. Most residents commute out of town for work.
- Key conservation concern: The Templeton Development Center is currently unprotected and has been identified as a high conservation priority.

## Open Space and Sustainability



- 21% of the total town area is protected Open Space.
- 14% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 7% of residents work in town.
- 96% of residents drive a car to work (the highest percentage in the region).
- 5% of town acreage is open water or wetlands.

## Growth and Development



- Between 2000 and 2010 the population rose 17%.
- Annual median income is \$67,513.
- Median home value is \$206,000.
- 62 homes unoccupied, no housing developments currently planned.
- Sidewalks are lacking in many residential areas, and there are no designated bike lanes in town.

## Agriculture



- 869 acres enrolled in Chapter 61A/APR. Templeton Farm Colony, a mental hospital on 1,600 acres of farmland (established in 1876), closed and taken over by the state in 2015, is now called the Templeton Development Center, and includes critical habitat. Dwelly Farm is a historic farm acquired by NCLT in 2012 as protected open space; it's a community farm project still in the works.

## Natural and Scenic Resources

- 9 out of every 10 acres is forested or open space
- Post-glacial topography provides excellent scenic overlooks, one example is the Otter River overlook behind the Gardner Airport in Templeton.

## Environmental Hazards

- In 2001, a Superfund removal program was enacted for the Temple Stuart site, former home of American Tissue Mills.

## Zoning and Bylaws



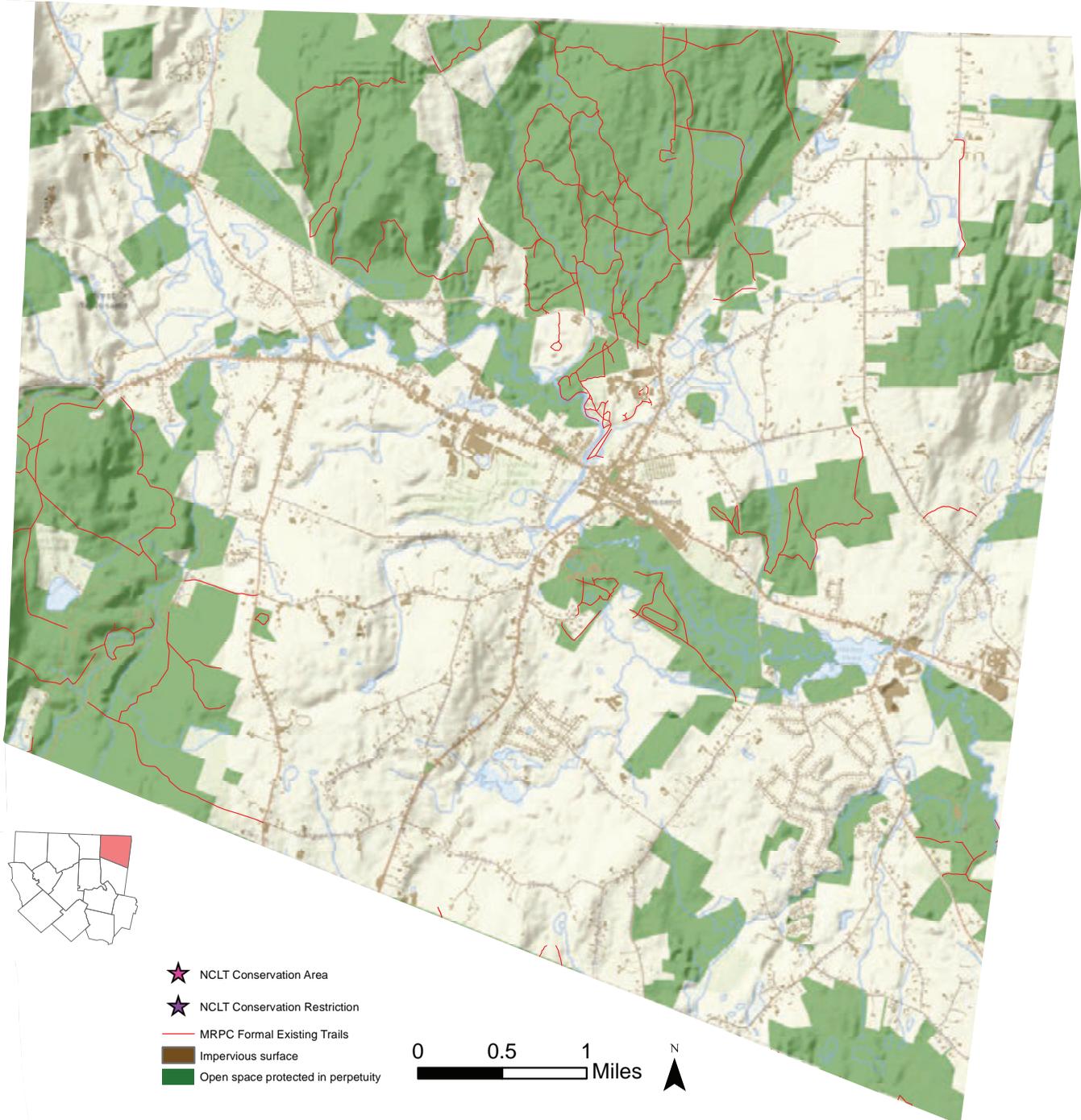
- Prior to 2006, Templeton was one of two MA towns with no zoning districts by use.
- Most of the town is within the Residential/Agricultural district. An Open Space district with large minimum lot sizes was adopted into town bylaws in 2008 in order to encourage open space protection and efficient and sustainable development, but it has not yet been used. Also adopted in 2008: a bylaw allowing for wind energy system conversion by special permit.

## Municipal Services

- 4 public wells tap 2 shallow aquifers, with the addition in 2001 of a 750,000 gallon water tank.
- 81% of the town falls within the Mill River Watershed, 19% in the Chicopee River Watershed. Eastern side of town is served by town system, western side connects to Gardner's treatment plant. Twelve-acre town landfill was capped in 1996. Recycling services are limited and residents must contract within the private sector for curbside waste removal.

Source: Dwyer-Huppert, Caitie, et al. Templeton 2017 to 2024 Open Space and Recreation Plan. The Conway School, US Census Data (2010), [www.templeton1.org/](http://www.templeton1.org/)

# Townsend



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 21,011 acres // 32.83 square miles
- Population: 8,926 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2012- 2019
- Community Preservation Act (CPA) status: Not adopted
- Relevant town committees: Agricultural Commission, Conservation Commission with an administrator and an agent.
- Town character snapshot: Coopering was the town's largest industry. Townsend's borders have changed many times in the past. Townsend describes itself as formerly quiet, now a growing bedroom community.
- Key conservation concerns: Many development projects are underway, and open space development bylaws can guide new projects, but extreme care must be taken to site new developments to protect the town's groundwater from contamination, which could occur easily given local geology.



## Open Space and Sustainability

- 37% Open Space permanently protected.
- 66% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 1,307 acres in Chapter 61.



## Growth and Development

- Annual median income is \$84,630.
- Median home value is \$248,492.
- The creation of the tech business park at Fort Devens nearby has driven up demand in Townsend for more housing.
- The town is bisected in all directions by major roads, and sidewalks are only present in the town center.
- The biggest employers are the North Middlesex Regional School District, Deluxe Corp (support services for international banks) and Sterillite (plastic housewares manufacturing).
- 4.8% of the town is covered in impervious surfaces.



## Agriculture

- 1119 acres in Chapter 61A (2011).



## Natural and Scenic Resources

- Townsend lies within the Nashua River Watershed and almost the entire town is considered an exceptional water resource area. The Squannacook River is crucial wildlife habitat and provides opportunities for canoeing and fishing. Townsend is home to a state forest and two state parks. These are popular with cross country skiers and snowmobiling groups, while in the summer, visitors stop less frequently, passing through Route 199 on their way to Vermont.



## Zoning and Bylaws

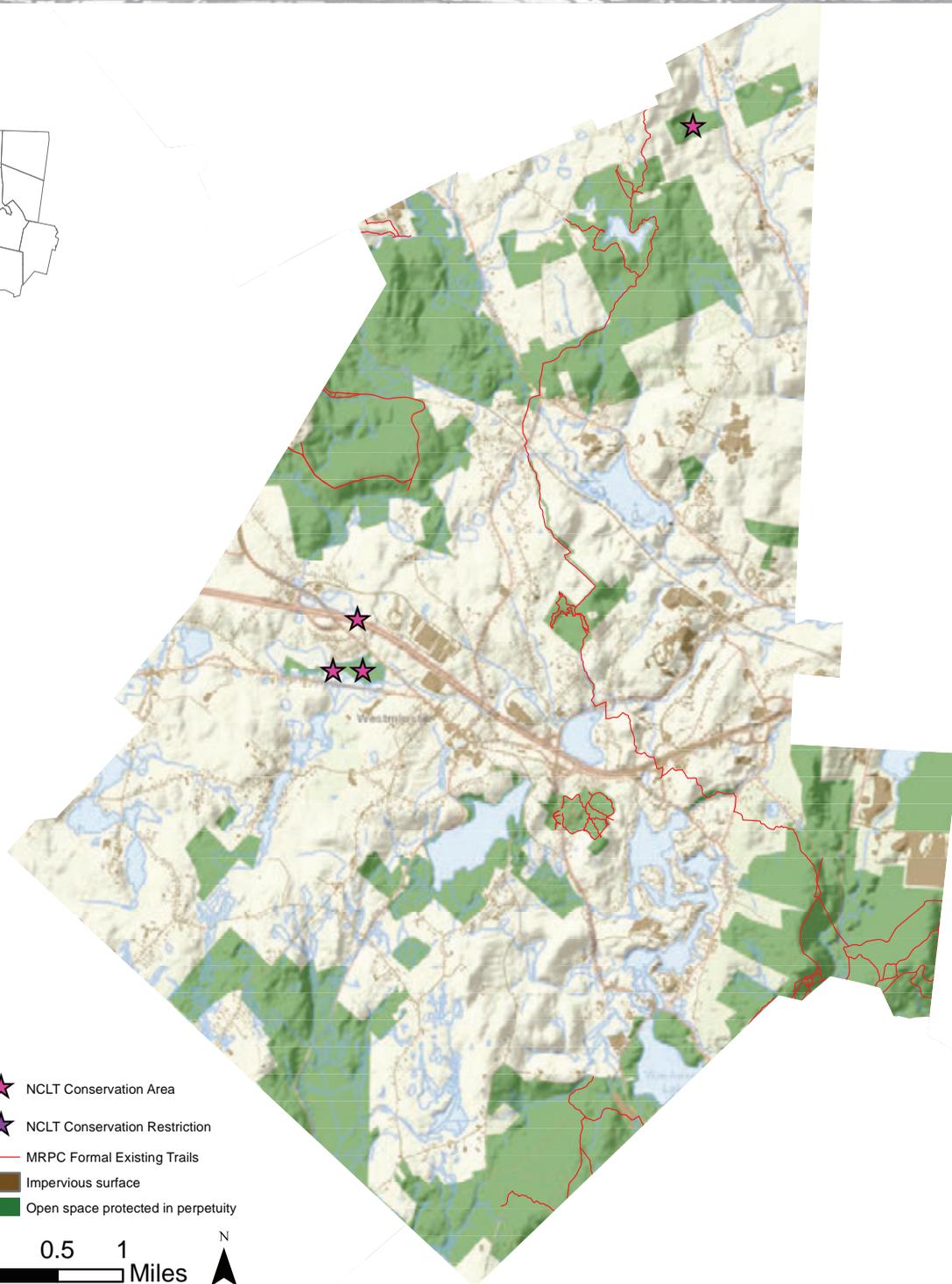
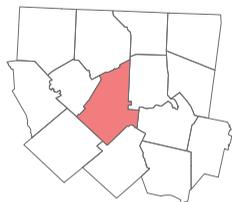
- 43% of the residential zoning falls within the aquifer protection zone. In the late 1980s the town adopted the Open Space Preservation Development and Open Space Multifamily Development bylaws, which call for development in line with natural resource protection.

## Municipal Services

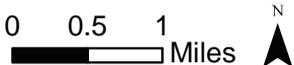
- The town derives all of its drinking water from groundwater sources (the aquifer runs southeast, following the Squannacook River). Private wells are used by some residences. These often run below the subsurface accessed by the town's well and run a higher risk of containing undesirable minerals. All homes are on private septic systems. As the town grows, a public sewer may soon be necessary, which is sparking debates about zoning and density. Trash removal is a municipal curbside service.

Source: Townsend OSRP (2012-2019), US Census Data (2010), <https://www.townsend.ma.us/>

# Westminster



- ★ NCLT Conservation Area
- ★ NCLT Conservation Restriction
- MRPC Formal Existing Trails
- Impervious surface
- Open space protected in perpetuity



# TOWN CONSERVATION CAPACITY



## Town Overview

- Size: 23,872 acres // 37.3 square miles
- Population: 7,277 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2014
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town committees: Agricultural Commission, Conservation Commission, Cultural Council, Crocker Pond Recreation Area Committee
- Town character snapshot: Mt. Wachusett is a landmark for outdoor recreation, including skiing in winter.
- Key conservation concerns: Protecting and conserving “working lands” that are vital to the town’s rural character and providing a broad range of recreational opportunities for all age groups.



## Open Space and Sustainability

- 29.2 % of the total town area is permanently protected open space
- 20% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 18.9% of residents work in town.
- 78.5% of residents drive a car to work.
- 13% of town acreage is open water or wetland.
- 13.6% of the total lands are in Chapter 61, 61A or 61B.



## Growth and Development

- Between 2000 and 2010 the population rose 5.4%.
- Unemployment rate in 2011 was 8.2%.
- Annual median income is \$82,596.
- Median home value is \$270,457.
- There are no designated bike lanes in town.
- 5.9% of the town is covered in impervious surfaces.



## Agriculture

- Three large scale farms are located within Westminister (Jarvenpaa, Johnson’s Egg Farm, Otter Farm) and 46 small scale farms are also in operation.

## Natural and Scenic Resources

- Wachusett Mountain is a prominent peak in the region, and provides recreational and scenic value. Rolling farmland and abundant waterways characterize the region.

## Zoning and Bylaws



- Zoning Bylaws have been periodically updated since the 1970’s, but they are still antiquated and do not incorporate any of the Smart Growth or other tools for clustered and mixed use development promoted at the state level. As is, the zoning bylaws delineate eight districts. These districts cluster dense residential areas near the town center and encourage commercial and industrial development near major highways (Rte 2 and 140). Updating the bylaws to accommodate any mixed-use zoning in the village center could benefit the vitality of the town.

## Municipal Services

- Westminister’s water supply is derived from surface water sources owned by the City of Fitchburg, Meetinghouse Pond, Mare Meadow Reservoir, and Bickford Pond. The majority of Westminister falls within the Nashua River Watershed, though portions of it also fall within the Chicopee and Miller’s River Watersheds. Town wastewater and sewage is sent to Fitchburg for treatment and disposal. Waste from the drop-off center in town is deposited at Fitchburg-Westminister Landfill (to close in 2026).

Source: Westminister OSRP (2014), US Census Data (2010), <https://www.westminister-ma.gov/>

# Winchendon



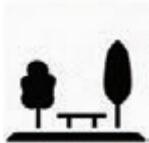
# TOWN CONSERVATION CAPACITY

## Town Overview



- Size: 28,230.4 acres, 44.11 square miles
- Population: 10,358 (2010 Census)
- Current Open Space and Recreation Plan (OSRP): 2007
- Community Preservation Act (CPA) status: Not adopted
- Relevant Town committees: Agricultural Commission, Conservation Commission, Cultural Council
- Town character snapshot: Nicknamed “Toy Town” and “Shingle Town” due to vibrant wood-working industry.
- Key conservation concerns: Protecting water resources for drinking and recreational uses, potentially through the upgrading or replacing of failed septic systems, and/or expansion of the sewer system.

## Open Space and Sustainability



- 27.7% of the total town area is protected open space in perpetuity.
- 41% of the total area contains BioMap2 Core Habitat or Critical Natural Landscape.
- 25% of the total lands are in Chapter 61, 61A or 61B.

## Growth and Development



- Between 1990 and 2000 the population rose 9%.
- Annual median income is \$43,750.
- Median home value is \$198,000.
- 4.6% of the town is covered in impervious surfaces.

## Natural and Scenic Resources



- Post-glacial topography provides wooded hills, open fields, rivers, streams and ponds. Upland soils are rocky, poorly drained and shallow to bedrock. Because of this, development is limited due to poor capacity for on-site septic systems.

## Zoning and Bylaws

- Zoning bylaws were amended in 2006 and divided the town into seven districts. The Planned Development District and the Flexible Residential Development provision allow for mixed use in village centers and increased site density, while maintaining open space areas. Various overlays spanning districts protect resources such as historic areas, wetlands, waters supplies, and flood prone areas.

## Municipal Services



- Winchendon has considered establishing ground water supplies within the town to replace the town’s surface source of drinking water in Ashburnham, but as of 2007 potential sources were deemed insufficient. Two community public water supply wells are within the town, and one Zone II, for a drinking water supply located in neighboring Templeton. Winchendon falls within the Miller’s River Watershed. Winchendon’s village center is served by a town sewer system, but areas of moderately dense development outside the center are not connected to the facility. Percolation capacity presents a limiting factor for on-site septic systems for future developments. The town landfill was capped in 1999. A transfer station is now located at the site of the former landfill, and a mandatory recycling system is in place.

Source: Winchendon OSRP (2007), US Census Data (2010), <https://www.townofwinchendon.com/>

# Appendix D: Additional Resources

## Digital Tools

### North Atlantic Aquatic Connectivity Collaborative (streamcontinuity.org)

The North Atlantic Aquatic Connectivity Collaborative presents a set of tools that look at aquatic organism passage or “fish passage,” as well as projects that address the fragmentation of river and stream ecosystems. Much of the work here is similar to The Nature Conservancy’s Berkshire Wildlife Linkage project (see page 26), using broad-scale landscape connectivity models to identify high-priority site-specific areas for intervention, in other words, targeting where dam removal might prove the most ecologically effective.

### FarmOS (farmos.org)

Open source software for data collection and storage using affordable equipment like heat sensors and low-cost drones, designed for integration with current GIS technology. The farmer who developed this tool seeks to increase democratized access to environmental data.



Photo source: farmOS.org

### Environmental Justice Screen Mapper (ejscreen.epa.gov/mapper)

This tool, developed by the EPA, maps dozens of factors including, water quality, proximity to toxic waste sites, and demographic patterns like minority population, income distribution, linguistic isolation, and population distribution. This tool can potentially be used to target conservation areas, if environmental justice becomes a top priority for NCLT.

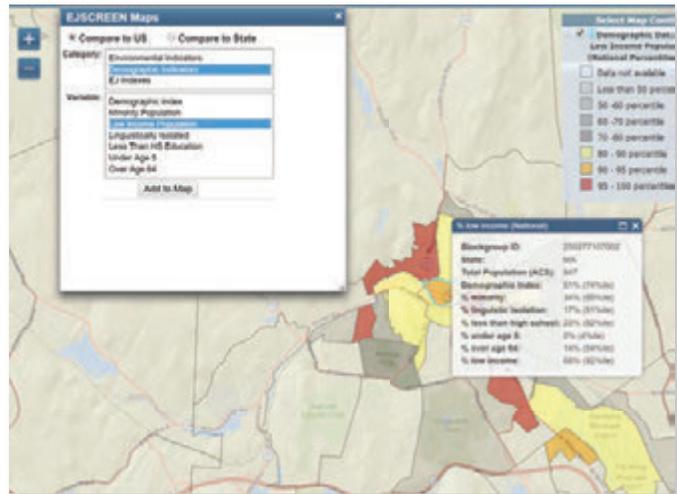


Photo source: EJScreen.epa.gov

# Additional Resources

## Regional Conservation Partnerships

### Quabbin to Wachusett

Regional Conservation Partnerships (RCPs) were first conceived as part of Harvard Forest's *Wildlands and Woodlands* report. *Wildlands and Woodlands* calls for 70% of New England to be protected as "forest permanently free of development" by 2060, which requires a doubling in the amount of land currently conserved. This is an ambitious goal, and achieving it will most likely require a high level of collaboration. Once the groundwork for a regional partnership network was laid, the Connecticut-based Highstead Foundation agreed to act as network coordinator. In 2007, Highstead convened the first meeting of regional conservation organizations as they entered into the work of conservation coordination across New England and eastern New York ([rcpnetwork.org](http://rcpnetwork.org)).

The initial years of the partnership network were funded in part by the Jessie B. Cox Charitable Foundation. The Cox Foundation offered multilateral funding. One approach was awarding seed funds to RCPs, which allowed organizations to enter into negotiations with owners of priority lands. The second approach came in the form of awards to RCPs that facilitated capacity building, including engaging in strategic planning work, launching capital campaigns, and facilitating new projects. The Cox Charitable Foundation closed in 2017, and now the RCP network is actively looking for donors to fill this void.

NCLT is situated within the North Quabbin Regional Landscape Partnership (NQRLP), an umbrella group that describes itself as a "voluntary association of public and private groups focused on conserving land and our rural lifestyle" (North Quabbin Regional Partnership: About Us). Formed in 1997, North Quabbin Regional Landscape Partnership was one of the first to emerge in the wake of the *Wildlands and Woodlands* report, bringing 23 organizations together (North Quabbin Regional Partnership).

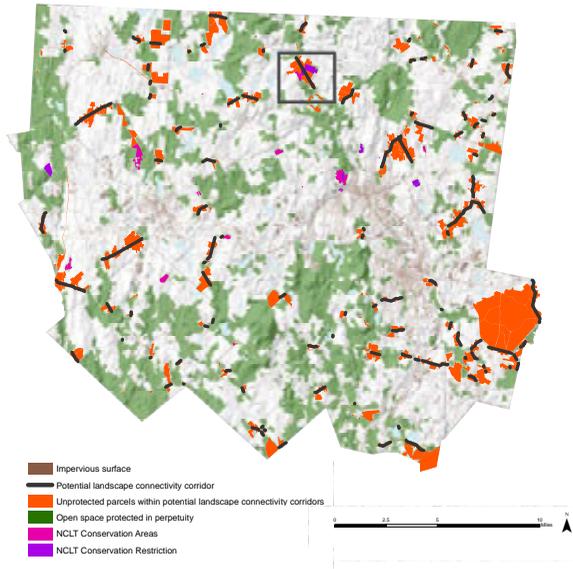
The partnership has just completed a major first project, the Quabbin to Wachusett (Q2W) Forest Legacy Initiative, a corridor conservation plan that permanently protects the 20-mile greenway between the Quabbin Reservoir and Wachusett Mountain. The project proceeded thanks to a federal grant approved in 2013 by President Barack Obama through the federal Forest Legacy Program, a valuable funding source for conserving lands of high ecological value.

Completing Q2W involved coordination between NCLT, three other land trusts, the Massachusetts Department of Conservation and Recreation (DCR), Nashua River Watershed Association, seven towns, and more than 23 landowners. Areas were protected through a combination of land purchases and conservation restrictions. "We prioritized tracts that linked or added to conserved land, protected water supplies, secured habitat for threatened species, and allowed public access, while maintaining working forests," says Sarah Wells, NQRLP coordinator (Partnership: Quabbin to Wachusett Grant Ranks Second in Nation, [mountgrace.org](http://mountgrace.org)). This has been perhaps the biggest recent project in the U.S. to rely on the use of GIS-driven data to strategically identify areas providing multiple layers of benefits: The Quabbin Reservoir, the Ware River, and the Wachusett Reservoir Watersheds provide myriad ecosystem services and core habitat, along with supplying the water to more than 2.5 million people across the greater Boston area. Some of these forested areas will continue to be accessible to loggers acting within an approved forest management plan, and will also provide an abundance of recreational opportunities (Burk).

### Planning for a Thriving Landscape

North Quabbin Regional Landscape Partnership is also using GIS as a tool for climate change mitigation. In 2014, members of NQRLP met for several workshop sessions with Harvard research assistant Brian Hall to create the Strategic Biodiversity Map. This project integrated datasets that conservation professionals are familiar with, such as MassGIS BioMap2, with newer, less familiar datasets, including The Nature Conservancy's Resilient and Connected Landscapes and the Open Space Institute (OSI)'s Underrepresented Geophysical Settings, to help participants arrive at a better understanding of which areas within the NQRLP region might be better equipped to handle the stressors associated with a changing climate. This project came about as a result of New York-based OSI and the Land Trust Alliance's "Catalyzing Change for Land Trusts" project, which, with funding from the Doris Duke Charitable Foundation, seeks to equip land trusts with tools and training to engage with climate change issues in their region.

# Appendix E: Map Index



## Landscape Connectivity

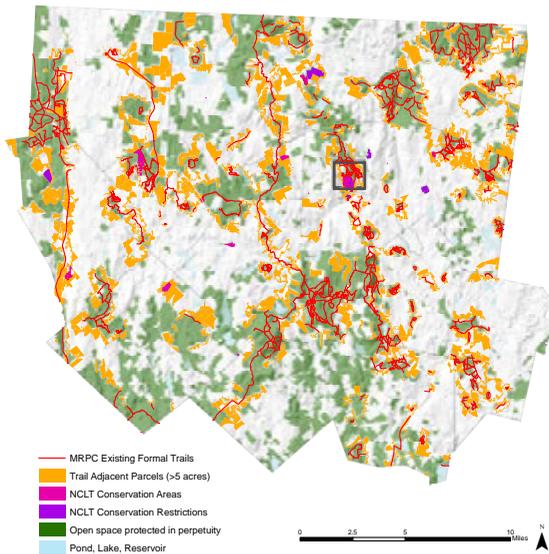
Page 37

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 Standardized "Level 3" Assessors' Parcels (2019)  
 NHESP BioMap2 (2010)  
 MassDEP Hydrography (1:25,000) (2017)  
 Impervious Surface (2005)  
 Shaded Relief (1:5,000) (2005)

UMass Designing Sustainable Landscapes:

Conductance (2017)



## Trail Connectivity

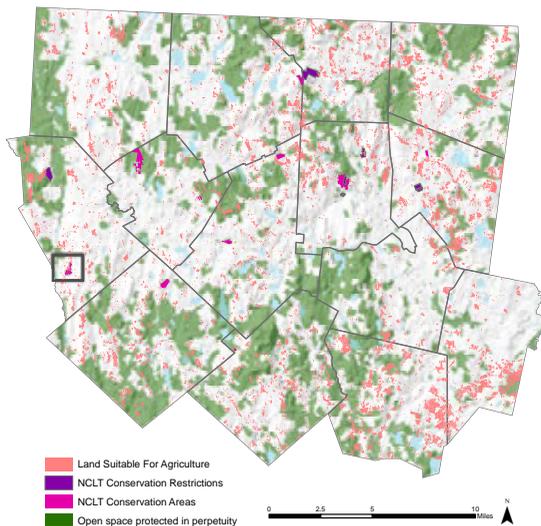
Page 41

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 Standardized "Level 3" Assessors' Parcels (2019)  
 MassDEP Hydrography (1:25,000) (2017)  
 Shaded Relief (1:5,000) (2005)

Montachusset Regional Planning Commission:

"Existing Formal Trails"

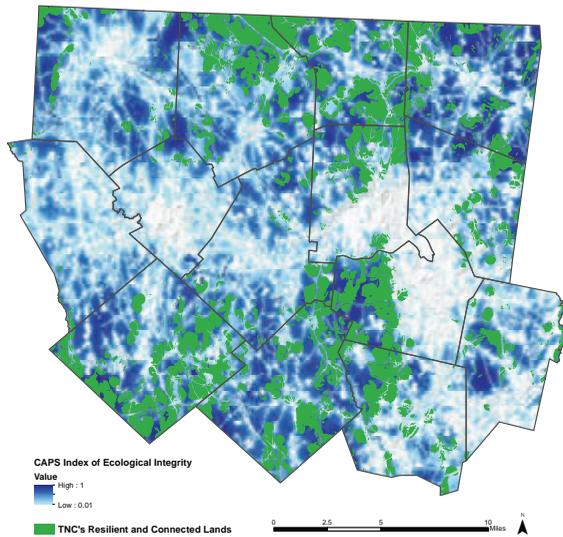


## Farmlands

Page 43

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 MassDEP Wetlands (2005)  
 Land Use (2005)  
 NRCS SSURGO-Certified Soils (2012)  
 MassDEP Hydrography (1:25,000) (2017)  
 Shaded Relief (1:5,000) (2005)



## Ecological Integrity and Resilient and Connected Lands

Page 45

Massachusetts Office of Geographic Information (MassGIS):

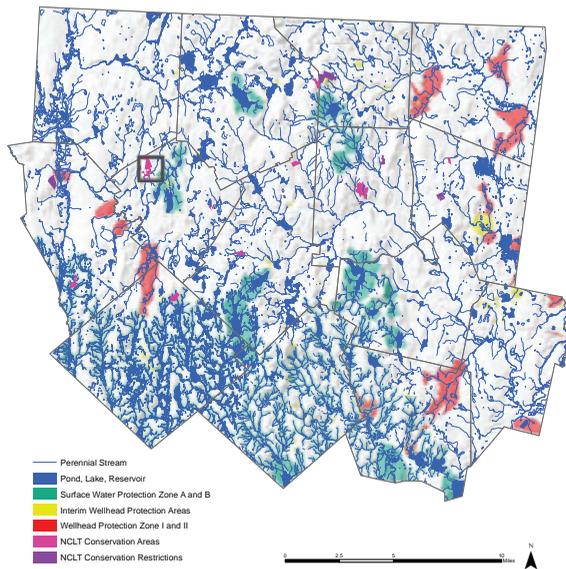
Shaded Relief (1:5,000) (2005)

UMass Designing Sustainable Landscapes:

Index of Ecological Integrity (2011)

The Nature Conservancy:

Resilient and Connected Lands: 6 Classes (2016)



## Water Resources

Page 47

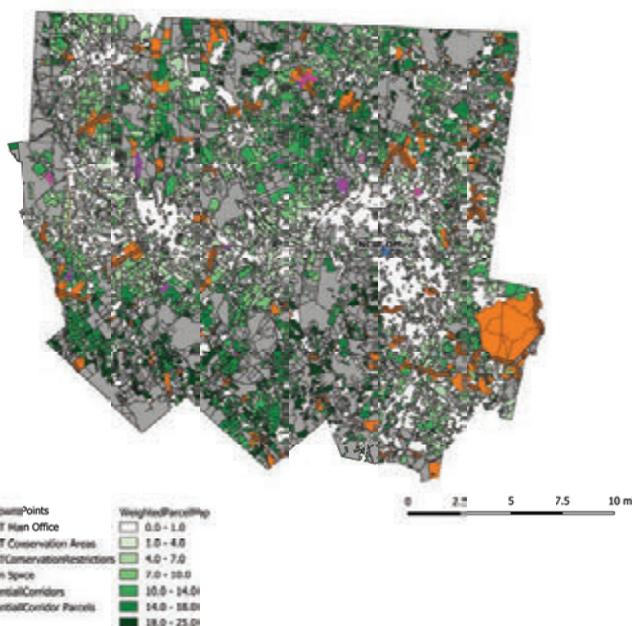
Massachusetts Office of Geographic Information (MassGIS):

MassDEP Hydrography (1:25,000) (2017)

MassDEP Wellhead Protection Areas (Zone II, Zone I, IWPA) (2019)

Surface Water Supply Protection Areas (ZONE A, B, C) (2017)

Shaded Relief (1:5,000) (2005)



## Weighted Parcel Map

Page 51

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)

Standardized "Level 3" Assessors' Parcels (2019)

MassDEP Hydrography (1:25,000) (2017)

MassDEP Wellhead Protection Areas (Zone II, Zone I, IWPA) (2019)

Surface Water Supply Protection Areas (ZONE A, B, C) (2017)

MassDEP Wetlands (2005)

MassDEP Hydrography (1:25,000) (2017)

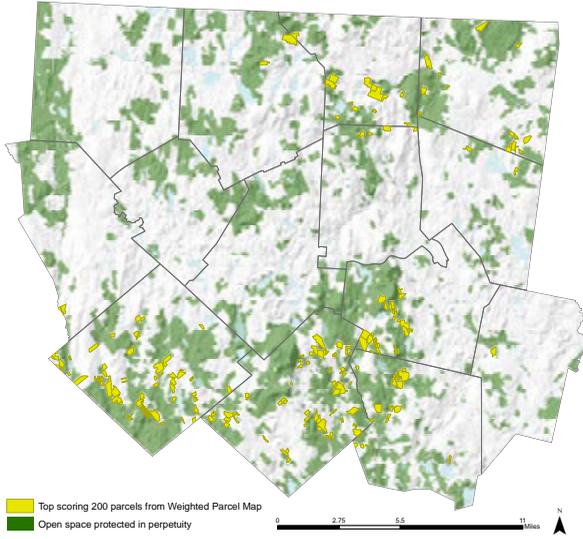
Land Use (2005)

NRCS SSURGO-Certified Soils (2012)

NHESP BioMap2 (2010)

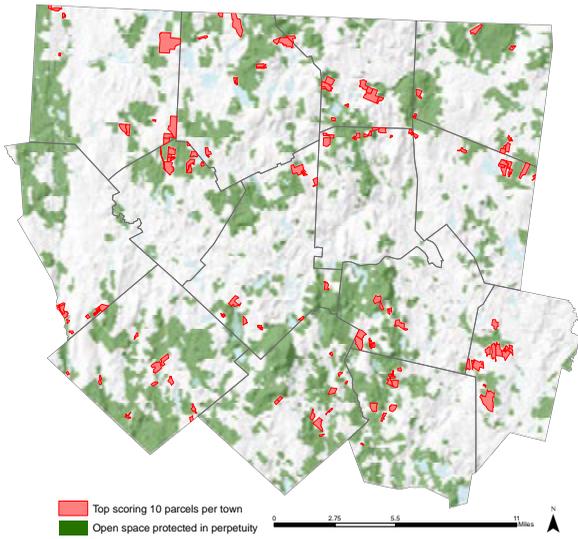
Shaded Relief (1:5,000) (2005)

UMass Designing Sustainable Landscapes:  
 Conductance (2017)



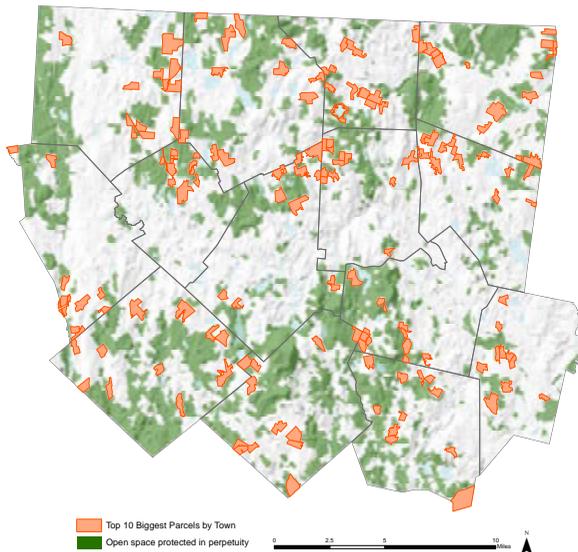
**Top 200 Scoring Parcels**  
Page 54

See layers used in “Weighted Parcel Map”



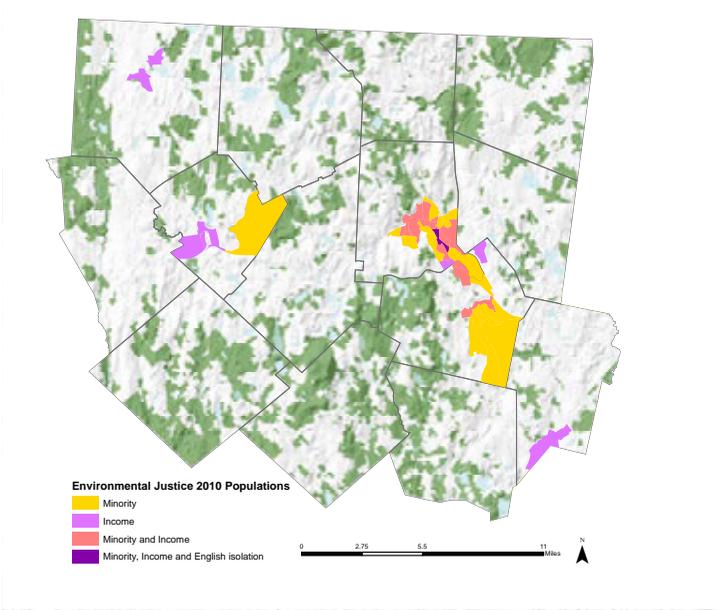
**Top 10 Scoring Parcels by Town**  
Page 56

See layers used in “Weighted Parcel Map”



**Top 10 Largest Parcels by Town**  
Page 57

See layers used in “Weighted Parcel Map”

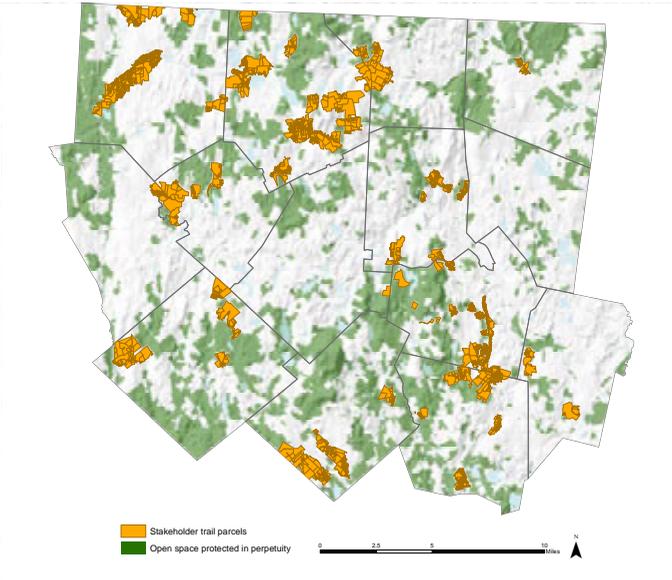


## Environmental Justice Communities

Page 21

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 2010 U.S. Census Environmental Justice Populations (2012)  
 Shaded Relief (1:5,000) (2005)



## Stakeholder Knowledge: Trails, Farmland, "Perfect World"

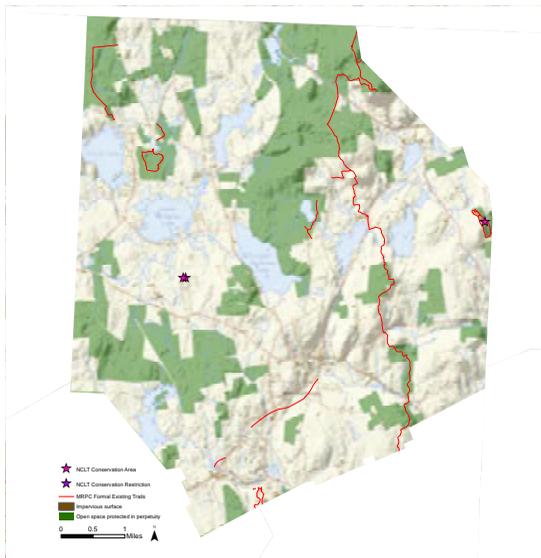
Page 63-65

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 Shaded Relief (1:5,000) (2005)

Conway Team

Aggregated, digitized stakeholder responses by theme (2019)



## Town Conservation Capacity Maps

Page 69-95

Massachusetts Office of Geographic Information (MassGIS):

Protected and Recreational Open Space (2019)  
 MassDEP Hydrography (1:25,000) (2017)  
 Impervious Surface (2005)  
 Shaded Relief (1:5,000) (2005)

OpenStreetMap

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