

Town Forest and Heidke Land Habitat Assessment
2013-2014



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Land Stewardship Committee

A Sub-committee of the
Carlisle Conservation Commission

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Town Forest and Heidke Land Habitat Assessment

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Preface

In August 2013 the Land Stewardship Committee received consent from the Conservation Commission to assess the habitat of the Town Forest and Heidke Land before the Conservation Commission decides on a new trail proposal. The Town Forest is part of core habitat as designated in the *2012 BioMap2 Report of Carlisle*, a document produced by the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife and the Nature Conservancy's Massachusetts Program. Given this designation, it seemed important to attempt to assess the habitat of the Town Forest/Heidke Land before doing any alterations such as increasing the trail system. Deborah Geltner of the Land Stewardship Committee undertook this habitat assessment.

It should be noted that no funds or professional personnel were assigned to this project. If funds and professional personnel had been available then the assessment protocol set out by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) based on a 1991 Nature Conservancy paper would have been one way to assess the Town Forest/Heidke Land. Following the NHESP protocol would have required examining transects of vegetation communities scattered throughout the Town Forest/Heidke Land noting the following: "1) dominant and/or characteristic species, indicator species, community structure, variants/microhabitat features, unvegetated surface; spatial distribution (i.e., size, number, and separation distance of patches); intact natural processes, geology, hydrology, topography, and soil properties, especially if relevant to the community identification, 2) the landscape surrounding the community, including the natural area. Both within and surrounding the community, descriptions of physical structures and land use practices; natural disturbances; embedded, adjacent, and nearby natural communities including aquatic features; notable landforms; scenic qualities, 3) the anthropogenic disturbances that have decreased the quality and viability of the community such as hydrologic alterations (ditching, damming, etc.), logging, mining, livestock grazing, plantations, orchards, structures, trampling, and exotic flora or fauna within and surrounding the community."¹ Based on the above information collected the habitat would then be ranked as excellent, good, marginal or poor for condition and landscape context.

Funds were not available to perform as thorough or scientific analysis as recommended by NHESP but their assessment protocols were taken into consideration. A considerable effort was made to find resources allowing for an objective exploration of the Town Forest/Heidke Land to the greatest degree possible under the circumstances. This report was produced by on-site observations of plant species and animal activity (tracks, scat, vegetative and soil disturbances) from late fall 2013 through the summer of 2014, referencing official documents such as the *Town Forest Baseline Assessment*, the USDA Soil map, NHESP *BioMap2*, 2012 Open Space and Recreation Plan, reference books, various documents produced by the Executive Office of Energy and Environmental Affairs (EOEEA) and academic articles, and tapping the knowledge of Carlisle' residents and other naturalists.

¹ SwainP, Finton A, Punam N, and Scanlon J, Massachusetts NHESP. Instructions for Habitat Assessments

This endeavor included identifying the Town Forest/Heidke Land's prior historical management and its impact, its current condition, and potential suitability as important wildlife habitat now and in the future. As this project proceeded, the details discovered sometimes presented inconsistencies that led to tangential research. This information was included along with other research considerations, concerns and conclusions. It is hoped that this resulting report will be useful in the Conservation Commission's management of this core habitat while fostering passive recreation.

Sections

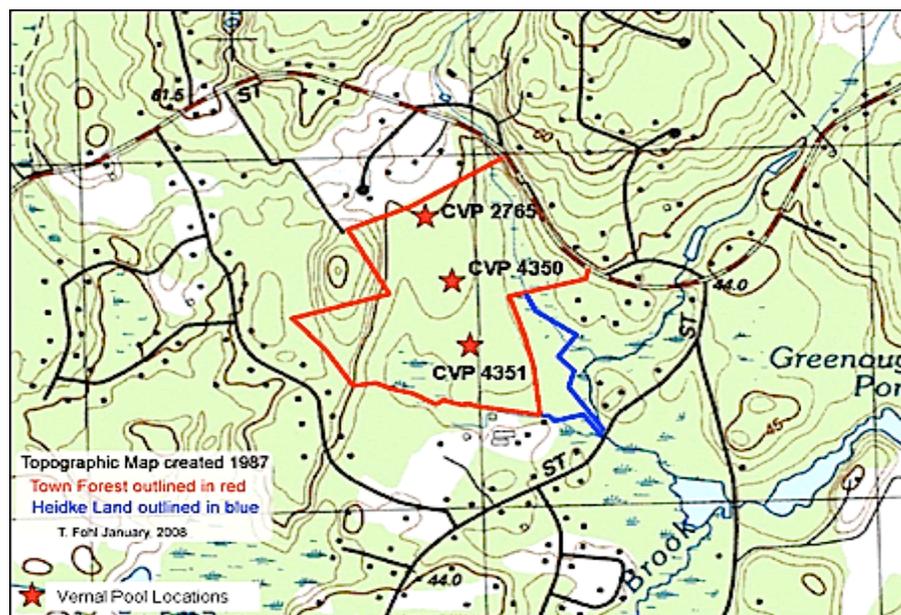
1. Description of the Properties

Town Forest

The Town Forest is approximately 71 acres bordered along its northeast side by East Street, where the only official public access with limited parking exists. The Heidke Conservation Land is along the southeast border. Private residences with a mixture of woodlands and small fields or lawns surround the remainder of the Town Forest. The Town Forest is in close proximity to Greenough Conservation Land, which abuts the Great Meadows National Wildlife Refuge.

The Town Forest/Heidke Land is comprised of wet lowlands that contain pools, an intermittent and perennial stream, swamp hardwoods, shrub swamps, and shallow marshes with surrounding upland forest. Approximately 58 acres of the land is woodland. The rest are wetlands that are primarily in the eastern and southern portions of the parcel except for the perennial stream on the western side. The property has three certified vernal pools. The Town Forest drains from north to south into the Heidke Conservation Land, which in turn drains into the Greenough Conservation Land. The highest elevation points of land are on the western boundary and along East Street.

Figure 1-1. Town Forest and Heidke Land Topography²

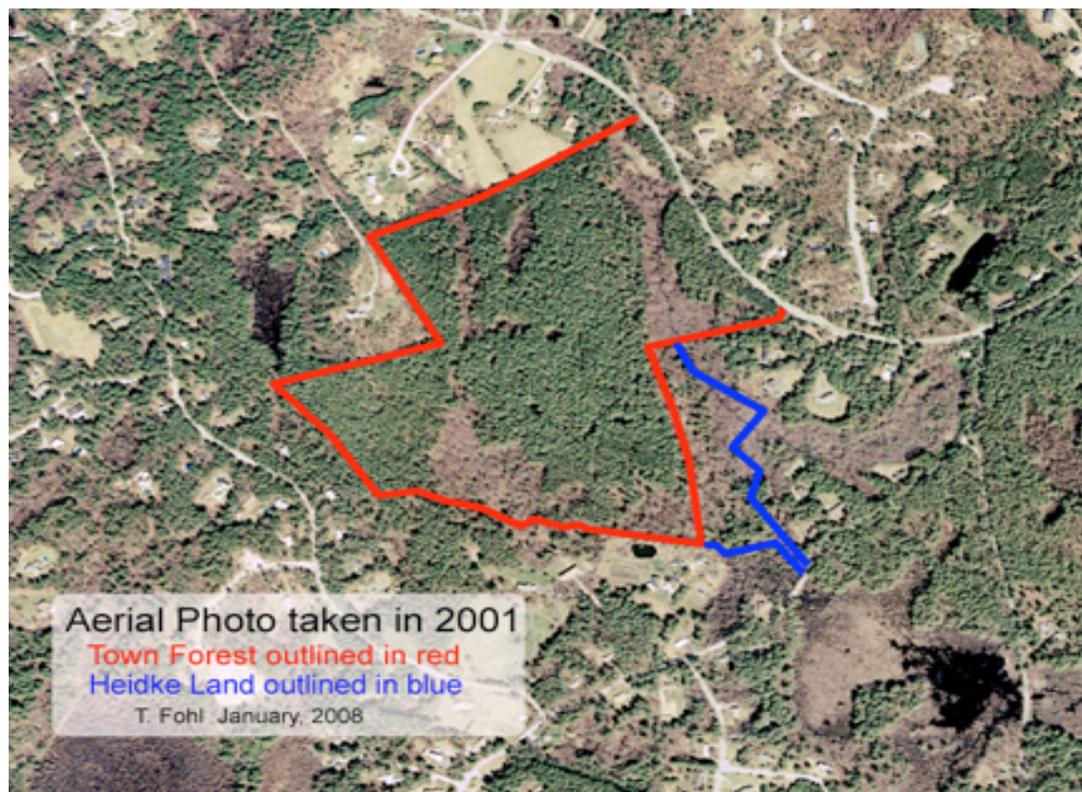


² Carpenter L, *Town Forest/Heidke Land Baseline Assessment* (2009), 4

Heidke Land

About half of the wetlands are in the Heidke Land that is approximately 8.19 acres and is an integral and important part of the Town Forest habitat. It contains a shrub swamp, swamp hardwoods and a shallow marsh. These wetlands have seasonal water levels. The northern part of the parcel contains an intermittent stream and tends to dry out in the summer and sometimes in winter but the southern part receives the slow outflow of a permanent stream on the west side of the Town Forest. Due to a beaver dam on the Greenough Conservation Land, the most southern area of Heidke Land near Brook Street has standing water of approximately 1-2' forming a shallow marsh. It provides valuable wetland habitat in addition to water for wildlife although the area is small from a habitat perspective. The entire parcel is very difficult to access because of the high water table and dense thickets of shrubs. The predominant tree species for this area is red maple with some white pine on the higher (drier) elevations.

Figure 1-2. Aerial View of the Town Forest/Heidke Land³



Vegetation Description

The Town Forest/Heidke Land is on the border between two forest regions, the Transition Hardwoods–White Pine Forest Region and the Central Hardwoods–Hemlock–White Pine Forest Region⁴. The Transition Hardwood-White Pine Forest Region is mainly comprised of

³ Carpenter L, *Town Forest/Heidke Land Baseline Assessment* (2009), 6

⁴ Braun EL, *Deciduous Forests of Eastern North America* (1950), 596

yellow and paper birches, beech, and sugar and red maple. In this region oaks and hickories will grow on the warmer and drier sites whereas hemlock will grow on the cooler sites and white pines are dominate on the well-drained, sandy sites. The Central Hardwoods–Hemlock-White Pine Forest Region was formerly populated by American Chestnuts but now the dominate species are red, black and white oaks, hickories, grey, yellow and black birches and beeches. Red maples occur on all the different soil-type sites and especially in stands on wetter areas. Pitch pine is found on the sandy sites. White pine and hemlock are the main conifers⁵.

The 2012 *Biomap2* describes Carlisle as lying “within the Southern New England Coastal Plains and Hills Ecoregion, an area comprised of plains with a few low hills. Forests are mainly central hardwoods with some transition hardwoods and some elm-ash-red maple and red and white pine. Many major rivers drain this area.”⁶

The 2009 Town Forest/Heidke Land Baseline Assessment includes a partial plant inventory done by Elizabeth Loutrel in 2008 (Appendix A). The trees listed in that inventory are eastern white pine, red pine, spruce, white oak, northern red oak, red maple, sugar maple and one American beech. A 2014 inventory adds some paper birch, multiple sized grey birch (a.k.a. silver birch, swamp birch or yellow birch⁷), several more beeches, several shagbark hickories, and a couple of hawthorns. These trees from the two inventories are mostly present in the understory but there are some canopy red oaks, red maple, grey birch, hickory and beech. The primary canopy species spread throughout the Town Forest woodlands is still sawtimber-sized eastern white pine sometimes mixed with small groves of pole-sized red pine and oak. There is also a pure Norway spruce canopy near the eastern wetlands, several mixed maple-oak-birch hardwood canopies in the south central area, multiple pure white pine/red pine canopies, and pure maple canopies in the wetland areas.

There is a healthy, well-distributed understory of the above-mentioned hardwoods mostly comprised of maple and red and white oak with scattered white pine saplings, except for a part in the center of the Town Forest and the southwest corner where there are thickets of age stratified white pine saplings. Most of the white pine saplings represent two different seed years, one from about 12 years ago and one from about five years ago, although 20+ year old white pine trees are also present in other parts of the Town Forest. There are a few weak, young red pines and multiple young red pine snags. The oaks are primarily on the upland areas with the maples in the wetter lowland areas. There are many hardwood seedlings and saplings distributed throughout the Town Forest. Numerous large white pines have been windthrown or snapped over the last several years due to wind and remain on the ground. These large pines will take 50-75 years to completely decay but will serve a useful purpose for wildlife as they decompose. As a result of this wind damage, the center part of the Town Forest contains sawtimber-sized white pine and oak snags.

Knowing the tree canopy composition of the Town Forest/Heidke Land allows it to be classified according to the forest cover-types within the above mentioned forest regions. The forest cover-type can be used to indicate the potential wildlife in the area.

⁵ DeGraaf RM and Yamasaki M, *New England Wildlife; Habitat, Natural History and Distribution* (2001), 7

⁶ BioMap2, Mass Div. of Fisheries & Wildlife (2012), 8

⁷ http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/betula/alleghaniensis%20.htm

2. Identifying the Town Forest and Heidke Land Forest Cover-Types

Forest regions are separated into 11 types of forest covers as specified in *Forest Cover of the United States and Canada* (Eyre 1980). The *New England Wildlife: Management of Forested Habitats* (DeGraaf et al. 1992) organizes these 11 types of forest cover into 6 cover-type groups to “reflect similarities in wildlife species composition”.⁸ The 6 cover-type groups include aspen-birch, northern hardwood, swamp hardwood, spruce-fir, hemlock, and oak-pine. In evaluating the Town Forest/Heidke Land, these same parameters were used.

Given the tree species found in the Town Forest, the swamp hardwood and oak-pine cover-type groups are the most representative of the Town Forest/Heidke Land. The Swamp hardwood group contains only the one subgroup, Red maple. The Oak-pine group is subdivided into three subgroups of which two are relevant: 1) White pine/Northern red oak/Red maple and 2) Eastern white pine.

The above subgroups that pertain to the Town Forest/Heidke Land are described in detail below⁹:

Swamp Hardwoods (subgroup Red maple). Red maple (*Acer rubrum*) is pure or dominant. In New England red maple and associated species are common on wet sites; the type is essentially pure in southern New England. Associate species are yellow birch (*Betula alleghaniensis*), balsam fir (*Abies Balsamea*), and sugar maple (*A. saccharum*) in northern New England, and black gum (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*) and silver maple (*Acer saccharinum*) in southern New England. In New England it occupies moist to wet muck or peat soils in swamps, depressions, or along sluggish streams, often found as an inclusion in northern hardwoods on wetter sites. The absence of beech and the increased proportion of yellow birch and red spruce can readily differentiate it from northern hardwoods.

Oak-Pine (subgroup White pine/Northern red oak/Red maple). Northern red oak (*Quercus rubra*), eastern white pine (*Pinus strobus*) and red maple predominate; white ash (*Fraxinus americana*) is the most common associate species, but others include paper (*B. papyrifera*), yellow and sweet birches (*B. lenta*), sugar maple, beech (*Fagus grandifolia*), hemlock (*Tsuga canadensis*), and black cherry (*Prunus serotina*). This type occurs across southern and central New England to elevations of 1,500 ft, generally on deep, well-drained fertile soils. This type is common in the transition between northern hardwoods and spruce-fir in northern New England, and northern hardwoods and oak types (characteristic of central types) in southern New England. The type often follows “old field” white pine in New England, where hardwood seedlings and saplings form the understory. Common understory shrubs include witch hazel (*Hamamelis virginiana*), alternate-leaf dogwood (*Cornus alternifolia*), maple-leaf viburnum (*Viburnum acerifolium*), and mountain laurel (*Kalmia latifolia*).

Oak-Pine (subgroup Eastern white pine). Eastern white pine is pure or predominant. This includes red pine (*Pinus resinosa*), which has a spotty distribution throughout New England on sandy, gravelly, or sandy loam soils, and white pine/hemlock, a common subtype in southern New England, where it occupies a range of soil types in cool locations such as ravines and north slopes (in the southern part of its range). These other pines are included primarily because they support similar wildlife communities.

Eastern white pine frequently occurs in pure stands; common New England associate species on light soils are pitch pine, gray birch, quaking aspen (*Populus tremuloides*), bigtooth aspen (*P. grandidentata*), red maple and white oak (*Q. alba*). On heavier soils, paper, yellow and sweet birches, white ash, black cherry, northern red oak, sugar maple, hemlock, red spruce (*Picea rubens*),

⁸ DeGraaf RM and Yamasaki M, *New England Wildlife; Habitat, Natural History and Distribution* (2001), 383

⁹ Ibid., 385-388

and northern white cedar (*Thuja occidentalis*) are associated in New England but none are characteristic. This type is widespread from central New England to elevations of 2,500 ft. This type occurs over a wide range of sites and conditions; establishment is often easier on poor sites because hardwood competition is less. Once established on better sites, white pine will usually grow faster than hardwoods.

Eastern white pine is a common pioneer of abandoned agricultural land in New England. The type seldom succeeds itself but on dry, sandy soils it may persist for a long time and even approach permanence. On heavier soils, northern hardwoods, white pine/hemlock, or white oak usually succeeds white pine.

In pure or almost pure white pine stands, the understory is primarily composed of ericaceous shrubs such as blueberries (*Vaccinium sp.*), huckleberries (*Gaylussacia sp.*), azaleas and mountain laurel. In New England, common lady-slipper (*Cypripedium acaule*) is found on light soils and highbush blueberry on wetter sites.

There are 27 nonforest types specified in the *Fisheries & Wildlife Habitat Management Handbook*. The *New England Wildlife: Habitat, Natural History and Distribution* (DeGraaf et al. 2001) organizes these 27 nonforest types into 7 nonforest groups to reflect similarities in wildlife species composition. The nonforest type of habitat group that pertains to the Town Forest/Heidke Land is wetlands/deepwater, which has 3 subgroups that are relevant, 1) palustrine (shallow marsh), 2) palustrine (shrub swamp), and 3) lacustrine (stream).¹⁰

The above 3 subgroups that pertain to the Town Forest are described in detail below.¹¹

Palustrine (shallow marsh). This subgroup is characterized by persistent emergent herbaceous hydrophytes and water depths to 1.5'; tends to maintain same appearance as the years pass.

Palustrine (shrub swamp). This subgroup is dominated by woody vegetation less than 20' tall; soil seasonally or permanently flooded to a depth of 1'. Typical woody species include alders (*Alnus sp.*), buttonbush (*Cephalanthus occidentalis*), and red osier dogwood (*Cornus stolonifera*).

Lacustrine (stream). This subgroup is characterized as intermittent or permanent upper perennial streams with unconsolidated bottom and shore, aquatic bed, and emergent, scrub and forested wetlands, up to 30 ft per cubic feet per second at high flow.

The Town Forest/Heidke Land shares many of the attributes of the above 6 subgroups for forest cover-types and nonforest habitat although it is not perfectly aligned. Some of the associate species are missing or only present in small quantities. While it is not expected that every forest would exactly match the above descriptions, it is important to try and discover the reason for the differences. All forests reflect the soil on which they grow and examining the soil types could reveal the basis for the differences. Therefore, in order to better understand the Town Forest/Heidke Land's forest current and future composition and its potential for wildlife habitat, the soil types present were examined.

3. Soil Types of the Town Forest/Heidke Land

The ideal method for analyzing the soil composition would be to acquire multiple deep core soil samples. These samples could be analyzed for "pH, acidity, Modified Morgan extractable

¹⁰ DeGraaf RM and Yamasaki M, *New England Wildlife; Habitat, Natural History and Distribution* (2001), 389

¹¹ *Ibid.*, 390

nutrients (P, K, Ca, Mg, Fe, Mn, Zn, Cu, B), lead, and aluminum, cation exchange capacity, percent base saturation and organic matter”¹². But, lacking the tools for extracting core samples or the budget for the analysis, the NRCS Soil Survey was used.

NRCS Soil Survey

The Soil Survey for Middlesex County, Massachusetts is a part of a publication of the National Cooperative Soil Survey that was published in 1991. This part of the survey was a cooperative effort by the federal Natural Resources Conservation Service (NRCS) and the Massachusetts Agricultural Experiment Station that was completed in 1988. The information in this survey is based on information gathered in 1988 unless otherwise specified. Detailed descriptions of each Town Forest soil type can be found on the NRCS website under Middlesex County, Massachusetts.¹³

The NRCS Web Soil Survey was used to create a map and detailed legend of the soil survey that covers the Town Forest/Heidke Land is contained in Appendix B. The numbers labeling various soil sections on the map correspond to different soil types described in the legend. The labels “good”, “fair”, and “poor” on the map refer to the potential ability of the corresponding soil type for woodland or wetland wildlife habitat where applicable.

Table 3-1 NRCS Wildlife Habitat Ratings is a subset of a table from the Soil Survey for Middlesex County, Massachusetts, page 313. Each soil type is rated on different aspects of that soil which impact habitat quality. The ratings are in two main categories, 1) potential for supporting certain habitat elements and 2) potential for various types of habitat. The ratings of the elements affect the ratings for different wildlife habitat potential. This is due to the fact that “soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water.”¹⁴

Table 3-1 below lists the possible ratings of “good”, “fair”, “poor”, or “very poor” for the habitat elements and habitat potential. It is possible to have some “good” or “fair” ratings in some of the habitat elements but only have “fair” or “poor” ratings for wildlife habitat if some important elements are significantly insufficient. The definitions of the seven elements of wildlife habitat, the three types of wildlife habitat, and the four possible ratings used by NRCS are listed in Appendix C.

There are seven different soil types in the Town Forest that are highlighted in grey in Table 3-1. Of the seven, 405B and 405C are rated good for open land and woodland wildlife habitat, 51A is rated good for wetland wildlife habitat, 71B is rated fair for wetland and woodland wildlife habitat, 302C is rated fair for woodland wildlife habitat, and 253B and 253C are rated poor for woodland wildlife habitat. These are the best ratings for the various soil areas of the Town Forest.

¹² Mass Extension Center for Agriculture, Soil and Plant Tissue Testing Laboratory, Soil Test Request Form

¹³ http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/massachusetts/MA017/0/middlesex.pdf

¹⁴ NRCS Soil Survey for Middlesex County, MA (1991), 180

The ratings indicate that there is good potential for wetland wildlife habitat extending north and south on both the east (including the Heidke Land) and west sides of the Town Forest as well as in the lower southern area. There is good potential for woodland and open land wildlife habitat in the southwest corner and a small area in the northwest corner of the Town Forest. There is fair potential for woodland wildlife habitat in the upper northwest corner and the upper northeast corner of the Town Forest. The center of the Town Forest has poor potential for woodland wildlife habitat.

Table 3-1. NRCS Wildlife Habitat Ratings¹⁵

Map symbol and soil name	Potential for habitat elements							Potential as habitat for		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hard- wood trees	Conif- erous plants	Wetland plants	Shallow water areas	Open- land wild- life	Wood- land wild- life	Wetland wild- life
30. Raynham	Poor	Poor	Fair	Fair	Fair	Good	Poor	Poor	Fair	Fair
51A. Swansea**	Very poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good
71B. Ridgebury**	Very poor	Very poor	Fair	Fair	Fair	Good	Fair	Poor	Fair	Fair
103C. Charlton	Very Poor	Poor	Good	Good	Good	Very poor	Very poor	Poor	Good	Very poor
Hollis	Very poor	Poor	Fair	Poor	Poor	Very poor	Very Poor	Poor	Poor	Very poor
253B. Hinckley**	Poor	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor
253C. Hinckley*	Poor	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor
254B. Merrimac	Fair	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
302C. Montauk*	Very poor	Very poor	Good	Good	Good	Very poor	Very poor	Poor	Fair	Very poor
405B. Charlton*	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
405C. Charlton*	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
420B. Canton	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
420C. Canton	Fair	Good	God	Good	Good	Very poor	Very poor	Good	Good	Very poor
422B. Canton	Very poor	Very poor	Good	Good	Good	Poor	Very poor	Poor	Fair	Very Poor
422C. Canton	Very poor	Very poor	Good	Good	Good	Very poor	Very poor	Poor	Fair	Very Poor

* Indicates a soil of the Town Forest/Heidke Land

** Indicates soil of the Town Forest/Heidke Land and GBFSP

The center of the Town Forest supports a variety of cover-types as well as a diverse understory of woody and herbaceous plants. There is an abundant number of plant species present as well as considerable amount of woody debris and a thick layer of leaf litter. Analyzing the soil types yielded an unexpected result of a large central portion of the Town Forest being rated as poor for woodland wildlife habitat (soils 253B and 253C). These soils were rated as poor across all the habitat elements. The NRCS website describes these soils as too prone to dryness due to rapid drainage and consequently being insufficient in nutrient

¹⁵ NRCS Soil Survey for Middlesex County, MA (1991), 313

content to support a diverse set of plant species. This discrepancy prompted a look at how the NRCS soil survey was performed.

Soil Survey Methodology

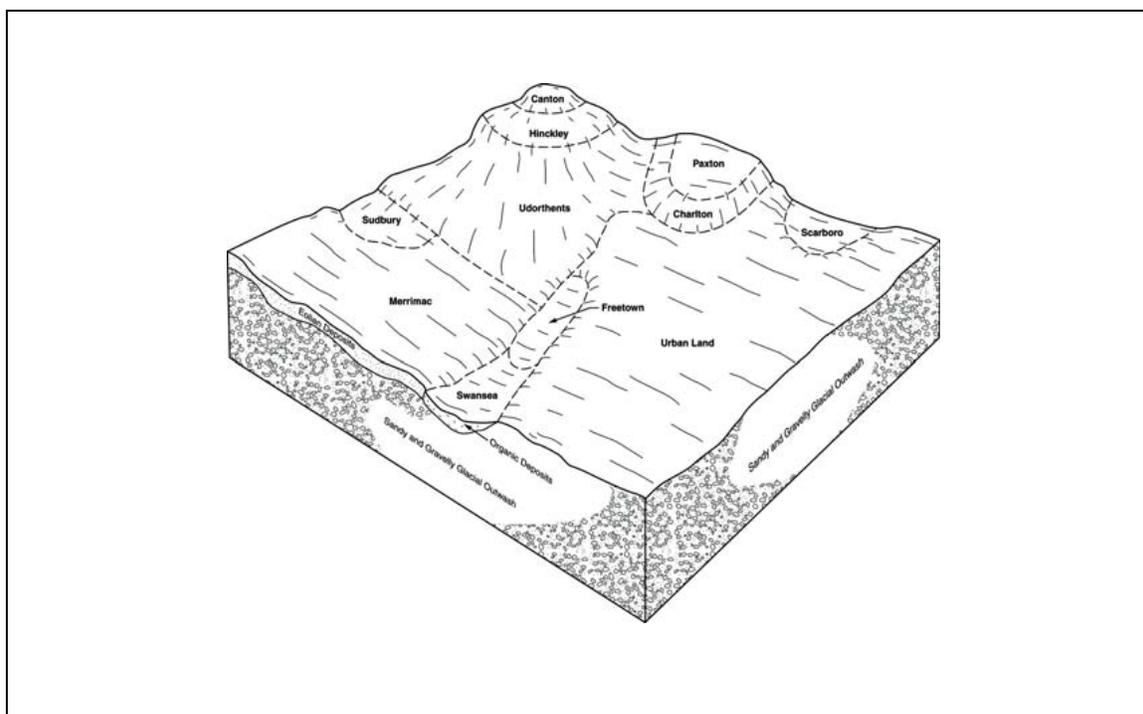
The soil survey done in 1988 used a modeling technique to predict soil types across areas with similar topography and geology. The “survey area” used in the referenced NRCS document is Middlesex County. The NRCS website states, “...the soils and miscellaneous areas in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of that landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how the soils were formed. This model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area that will be found at a specific location on the landscape. Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must establish boundaries between the soils, even though they can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries of the map unit polygons.”¹⁶ Figure 3-1 shows an example of a typical pattern of the soils and their underlying material created using the modeling techniques described above.

The NRCS states that the model they used combined with other data is sufficient to determine with accuracy the soil types. However, the website did include a cautionary note relative to the maps that can be retrieved from their Web Soil Survey. These NRCS maps are most accurate at a 1:25,000 scale but it is not possible to select that scale meaning that the maps that were used for this habitat assessment may have some inaccuracy in the soil line placement and the small areas of contrasting soils are not shown but they are listed in the soil descriptions. It is not known how significant the differences in soil line placement may be.

These small areas of contrasting soils are another consideration of what may be influencing soil composition and consequently plant composition. The NRCS soil description for Hinkley soils includes the contrasting soils of Carver (259B – Poor), Merrimac (254B - Fair), Windsor (255B – Poor), Canton (420D – Good), and Quonset (262B – Poor) soils in similar landscape positions as the Hinkley soils, and Sudbury (260B – Good) and Deerfield (256B – Poor) soils in the depressions. Minor soils comprise about 20 percent of the Hinkley map unit and may make a small difference in plant composition. Given that the central part of the Town Forest does support a diverse type of woodland plants and other soils are only a minor influence, further research into other factors influencing the forest composition was pursued.

¹⁶ NRCS Soil Survey for Middlesex County, MA (1991), 7

Figure 3-1. Example of Typical Pattern of the Soils and Underlying Material Model Used by NRCS¹⁷



4. Other Factors Impacting Forest Composition in the Town Forest

Individual plant species will react uniquely to the various environmental (wind, fire and pathogens) and historical influences (agriculture and logging) on the land creating a variety of vegetative patterns across a landscape. Understanding a modern forest requires a long-term perspective. Forests have always been and continue to be dynamic environmental ecosystems where changes occur in their plant composition, function and structure resulting in unique combinations of plants and animals due to the forces enacted upon them. The current plant composition of the Town Forest today is partly a reflection of whether the land was a continuously wooded (never disturbed) site or actively farmed land or some combination of both. The three key elements that influence modern forest composition in New England are historical land use, soil drainage and the carbon to nitrogen ratio.¹⁸

Farming and Logging History¹⁹

In 1754 a farmstead was established on the land and productively managed before the Town purchased the land and dwellings in 1852 to be used as a farm to care for the poor. It functioned as a poor farm until 1923. From 1754 through 1923 the land was probably some combination of pasture, cropland and a small woodlot as was typical during that period. When the farmstead was first established in 1754 the land would have been cleared and burned over using the white pine and hardwood sawtimber for boards and posts to build the

¹⁷ NRCS Soil Survey for Middlesex County, MA (1991), 13

¹⁸ Foster D and O'Keefe J, *New England Forests Through Time* (2000), 177-178

¹⁹ Carpenter L, *Town Forest/Heidke Land Baseline Assessment* (2009), 12-21

dwelling. Smaller-sized cleared hardwoods would be used for cordwood and fencing. The excess forest clearing material would have been piled and burned. It was the common practice of that time that the resulting charcoal and potash from the burning was combined with forest leaf litter and spread over the cropland for fertilizer. Farmers would typically raise some beef cattle, plant orchards and vegetable gardens and essential crops such as oats, rye, barley, corn and wheat. "Across much of New England, 60 to 80 percent of the land was cleared for pasture, tillage, orchards and buildings. Most of the cleared land supported grazing animals; generally less than 10 percent was actively plowed for crops."²⁰ In this period of intensive agriculture, wood eventually became scarcer resulting in wood fencing being replaced by stone walls and the remaining woodlots being subjected to frequent cutting, burning and grazing. The scarcity of wood was still a problem in the first part of the 20th century even though natural reforestation had already been occurring on abandoned farmland since the mid-1800s.

The Town converted a portion of the above-mentioned poor farm to a woodlot in 1923 (46 acres which was comprised of 20 acres of wood and meadow and 26 acres of eastern pasture) and again in 1925 (an additional 25 acres of woodland in the south was added) establishing the current 71-acre Town Forest. The land was managed as a tree plantation with the forest cleared of weeds and shrubs, sawtimber and pole-sized timber periodically harvested, planted with desired species, and thinned numerous times to produce revenue for the Town. The Town records indicate that the species of trees planted were eastern white pine and red pine and sometimes spruce. The entire Town Forest, except for the very wet areas, was a tree plantation based on an aerial photo from 1937 (Figure 4-1).

The Town Forest was last actively managed for wood production in 1936 when trees were cut, trimmed and thinned plus 5000 more white pines and spruce were planted. The 1938 Hurricane damaged some of the white pines in the Town Forest but the downed trees were left on the ground since it was deemed they were not large enough to be of economic value. Even though it was a forest when it was no longer used as a source of cordwood and lumber in the 1940's, it was not diverse woodland with a diverse understory, it was primarily red and white pine with some hardwood trees. It is not surprising that the dominant canopy species is currently eastern white pine. Many of the larger white pines that are there today were present when the farming efforts were abandoned in the 1940's and served as seed trees. This is evident by counting the tree rings of the recently windthrown white pines, which indicate that some of the trees are around 100+ years old.

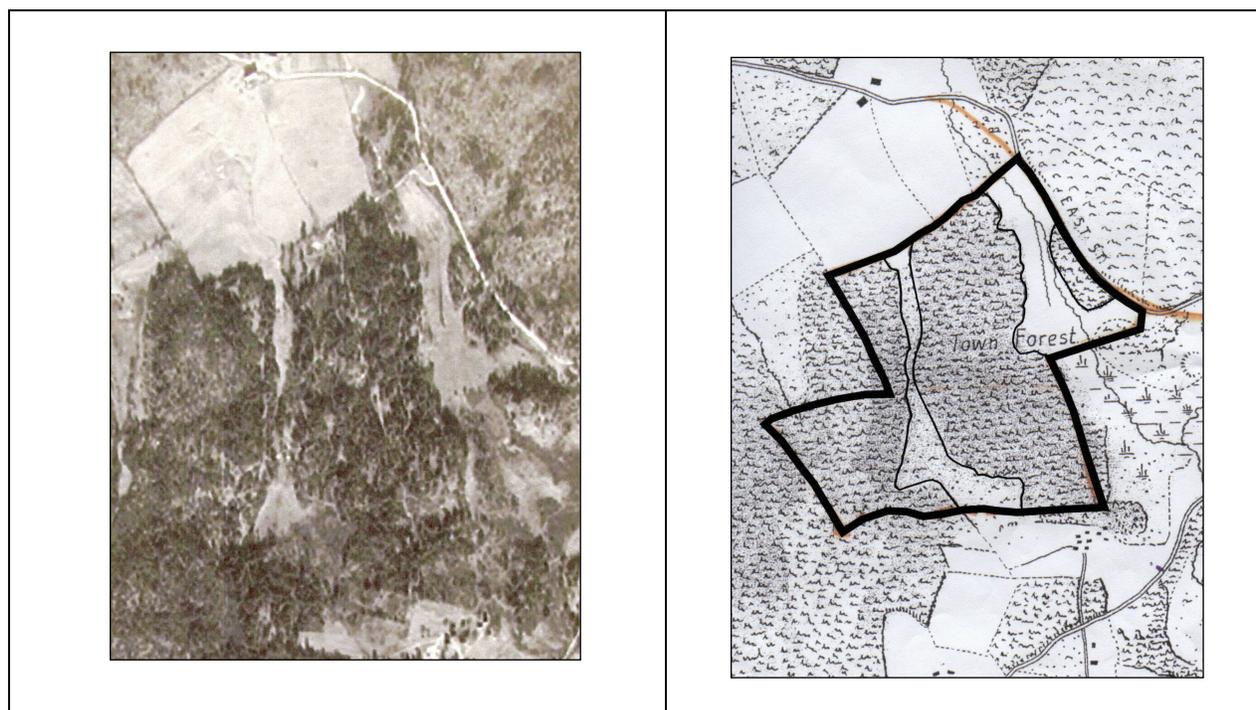
The prior land use of the Town Forest/Heidke Land has definitely had some impact on the current plant composition because research has shown that "historical land use activities in New England such as plowing, pasturing, and logging have persistent impacts on composition and structure of our forests."²¹ The kind of historical alteration done to the Town Forest affects the present amount and availability of nutrients in the soil, in particular carbon and nitrogen, the quality of organic material, microbial function, and the mineralization of nutrients from organic matter. Extensive studies done at the Harvard Forest in Petersham, MA have shown that "the number of bryophyte (mosses and liverworts) species does not differ according to historical land use, whereas the number of trees, shrubs, and herbaceous species does differ, with the fewest species on continuously

²⁰ Foster D and O'Keefe J, *New England Forests Through Time* (2000), 8

²¹ *Ibid.*, 189

forested stands.” These same studies have also concluded that “the current vegetation is strongly related to land-use history with...red maple stands mainly on old, unimproved pastures or woodlots, oak-maple stands on former pastures and some tilled fields, and pine-oak stands on old pastures, plantations and plowed fields but generally not on continuously wooded sites”.²²

Figure 4-1. Town Forest in 1937²³



Because we do not have an exact accounting of the year-to-year activities occurring on this land from 1754 to the present, it is not possible to know or accurately estimate the degree or exact kind of impact. We can only assume that given the discrepancy between the soil type indication for poor woodland habitat in the central area and the present day forest composition that there must have been some kind enhancement to allow for the present forest.

Soil Drainage

The main drawback of some of the Town Forest soils, particularly in the central part of the forest, is its propensity to rapidly drain. This characteristic would tend to allow nutrients to leach out if there isn't substantial plant cover to provide organic debris and appropriate microbial soil activity to process it. A dry soil can also reduce microbial activity and hamper germination of seeds and survival of saplings of some trees species until they are well established. However, the sandy, well-drained soil composition in the central part of the Town Forest/Heidke Land is not restrictive to white pine seedlings and saplings. Hardwood

²² Foster D and O'Keefe J, *New England Forests Through Time* (2000), 178

²³ Carpenter L, *Town Forest/Heidke Land Baseline Assessment* (2009), 19

seedlings or saplings are more vigorous on relatively wetter soils.²⁴ This plant pattern is evident in the Town Forest today although the oaks are slowly encroaching on the previously white/red pine dominated areas.

One factor that may have helped to promote the current forest composition in areas of excessive drainage, are the activities from 1900 to the 1940s followed by a 70-year absence of human activity that allowed forest litter to accumulate creating a layer of moisture retaining duff and the development of a robust microbial community. Prior to the establishment of the Town Forest for the first 20 years of the 20th century, the poor farm was not intensively managed due to a shortage of farm workers and decreasing need for such a farm. This probably would have resulted in yearly sprouting of pines and deciduous trees and shrubs and deposition of needle and leaf litter on the ground in addition to senescent herbaceous plants. We know more details about how the land was managed once the Town Forest was established from the historical research done for the 2009 Town Forest/Heidke Land Baseline Assessment. The plantation was planted, pruned, thinned and weeded periodically and hardwoods were harvested for cordwood. Below is a chronology of the plantation activities that occurred:

- 1923 – Town Forest Committee recommendation of reserving 46 acres as a Town Forest and letting nature take care of it was passed at Town Meeting. This area of the poor farm was selected because of its potential to be a Town Forest.
- 1926 - A small amount of lumber was sold indicating that harvestable trees existed on the property.
- 1929 - A large area was cleared of weed trees and brush, hundreds of small trees were pruned to promote growth, and 4,000 white pines and 2,000 red pines were planted in the cleared area.
- 1932 – Sixty cords of hardwood were harvested. The white pines, that had sprouted after the hardwoods were cut in 1923, were thick and in need of thinning.
- 1933 – Red pine and birch were harvested for cordwood, white pines were thinned and pruned, and 5,000 pine trees were planted.
- 1934 – Birch and red pine were harvested, unwanted small sprouts were grubbed, pines were trimmed, brush was burned and seedlings planted.
- 1936 – Cutting, trimming and pruning of existing trees plus 5,000 pine and spruce seedlings were planted. The forest was reported to be in very good condition.

Given the limited budgets during the above 13-year time period and the absence of any comments about removing the forest litter, it is unlikely that this was undertaken. It is also obvious from the harvesting, the 1937 aerial photo, and the reporting of the forest being in good condition in 1936 that the plantation was successful and properly managed to be productive. This would have required allowing hardwoods (most likely grey birch) to sprout along side the planted pines saplings creating a shelterwood to help protect the pine saplings from major infestations of the pales weevil and white pine weevil beetles. These hardwoods would subsequently be cut when they reached 15' to allow the pines to grow, possibly leaving the stumps. The harvesting of both these hardwoods and eventually the pines combined with the weeding activities would have disturbed the leaf litter and the top layer (A horizon) of the soil below, slightly mixing the two layers. The decomposition and incorporation of leaf litter into the soil would have helped to improve the water retention

²⁴ DeGraaf RM and Yamasaki M, *New England Wildlife; Habitat, Natural History and Distribution* (2001), 388

abilities of the soil and provide nutrients in the soil for both the plants and the soil microbes. The Town Forest Committee reports of the above period never mentioned problems with the Town Forest soils or the investment of time and money not being worthwhile. It is not exactly known why the Town Forest management ceased after 1936 but it was most likely from economic and cultural changes and world pressures rather than failure of the land to produce.

Starting in the 1940s the Town Forest was allowed to evolve in a more natural way without substantial human disturbance, building up a significant layer of debris on the forest floor that has been slowly decomposed and deposited in the top layer of soil. Over time, that decomposed litter that was incorporated into the A soil horizon was completely decomposed resulting in a by-product called humus which is rich in nutrients. The incorporation of organic material into any soil, but especially dry, loamy sand type soils, increases the bulk density of the soil, improves the water retention ability and provides important nutrients. Also, the increasing shade of the growing pines would have reduced the evaporation of moisture in the soil. This long, 70-year period of unintentional soil enhancement has probably impacted the plant composition trajectory of the entire Town Forest consequently affecting the carbon to nitrogen ratio.

Carbon-Nitrogen Ratio

There is a vital three-way connection between carbon, nitrogen and water in any ecosystem in the production of organic material (biomass), creating a complete cycle. The rates of water evaporation through transpiration and the fixing of carbon from the atmosphere are partly determined by the soil's microbial mineralization rate of nitrogen that turns organic nitrogen into inorganic nitrogen, which can be used by plants. The relative demand for nitrogen by plants in each ecosystem for the production of biomass (fixing carbon), as measured by the nitrogen concentration in plant tissues, varies between systems and can be expressed as a ratio of carbon to nitrogen (C:N ratio)²⁵. The carbon-nitrogen-water cycle is completed by the fact that the nitrogen mineralization rates in soils are governed by the relative content of carbon and nitrogen in the soil organic matter that comes from the plant litter and dead fine roots, combined with the amount of water available to plants and microbes. Nitrogen availability was historically the most frequently limiting factor in natural New England settings and it impacts modern forests as well.²⁶

According to the USDA Natural Resources Conservation Service, soil microbes have a C:N ratio of 8:1 and require a diet of organic matter with a C:N ratio of 24:1 in order to remain alive. If the plant residue has a greater C:N ratio (i.e. 35:1), then some of the carbon will not be consumed by the microbes unless another nitrogen source is available. If the C:N ratio is less (i.e.18:1), then some of the carbon will be consumed leaving some organic nitrogen in the soil. The U.S. Forest Service 2003-2004 report on Massachusetts soils lists a C:N ratio for Eastern White pine forests as 24:1, Red oak forests as 23:1 and lowland red maple forests as 30:1. These ratings are an average for the entire state and can vary from year to year, sometimes resulting in a higher C:N ratio for these three forest types. This would indicate that the Town Forest plant composition is sufficient to support a microbial community that

²⁵ Foster D and O'Keefe J, *New England Forests Through Time* (2000), 35

²⁶ *Ibid.*, 300-315

can generate the inorganic nitrogen that plants need but nitrogen could be limited in years of high C:N ratios.

There are other potential sources of nitrogen in the soil. The microbial decay of organic matter is an incomplete process that results in a byproduct called humus. As stated in the above section, humus adds nutrients. As humus very slowly decomposes, one of the nutrients it releases is ammonium, a mineral (inorganic) form of nitrogen, which is dissolved into the soil solution and can be taken up by plants or microbes. Plants primarily use inorganic nitrogen but recent research has shown that plants can also take up the dissolved organic forms of nitrogen directly from soils in addition to inorganic forms of nitrogen produced by microbial activity.²⁷ These two facts mean an additional source of nitrogen may be available in years when the C:N ratio exceeds the microbial requirements.

Summary

In considering the three elements stated above that affect forest composition (historical land use, soil drainage and the carbon to nitrogen ratio) it would seem that the historical land use did not negatively impact the soil and may have inadvertently improved it by increasing the water retention capability and nutrient levels of the soil. Any enhancement to the soil definitely impacts the plant composition which in turn affects the C:N ratio. This effect could help to explain the existing Town Forest and why the Natural Heritage and Endangered Species Program currently specify it as Core Habitat in their *BioMap2* report.

5. The 2012 *BioMap2* Report

The entire Town Forest/Heidke Land is part of Core Habitat 2378 as designated in the 2012 *BioMap2*. The parcel 2378 includes parts of Carlisle, Concord, Bedford and Billerica. It is described as “an 8,090-acre Core Habitat featuring Forest Core, Wetland Core, Aquatic Core, Priority Natural Communities, and Species of Conservation Concern”.²⁸ Figure 5-1 shows the core habitat location.

The *BioMap2* report does not specifically state the role that the Town Forest/Heidke Land has in the core habitat 2378 but in general such a specification is meant to “identify key areas that are critical for the long-term persistence of rare species and other Species of Conservation Concern, as well as a wide diversity of natural communities and intact ecosystems across the Commonwealth. Protection of Core Habitats will contribute to the conservation of specific elements of biodiversity.”²⁹ In the *BioMap2 Executive Summary* (page 56-57) it states, “core habitats in *BioMap2* are based on rare species habitat mapped from actual observations, habitat for wildlife of conservation concern, exemplary natural communities, least disturbed wetlands, forest interior habitat, clusters of potential vernal pools, and other conservation targets...simple land protection may be the best conservation strategy within most areas of core habitat.”

²⁷ Foster D and O’Keefe J, *New England Forests Through Time* (2000), 39-40

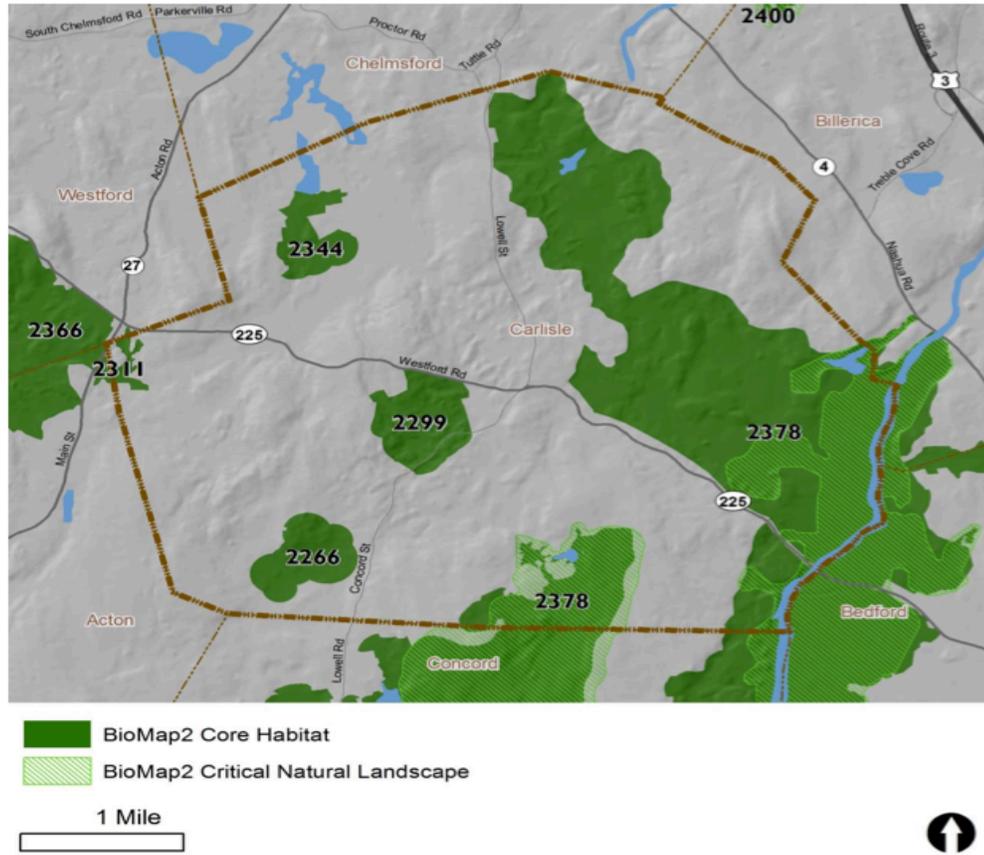
²⁸ *BioMap2 Carlisle Report*, Mass Div. of Fisheries & Wildlife (2012), 10

²⁹ *Ibid.*, 4

Figure 5-1. Map of Core Habitat 2378 Including the Town Forest/Heidke Land³⁰

BioMap2 Core Habitat in Carlisle

Core IDs correspond with the following element lists and summaries.



The seven components of core habitat are rare species, other species of conservation concern, priority natural communities, vernal pools, forest cores, wetland cores, and aquatic cores. A detailed description of all *BioMap2* core habitat components can be found in Appendix D. The five components present in the Carlisle portion of habitat 2378 are the forest core, aquatic core, wetland core, priority and exemplary natural communities, and species of conservation concern.

For two of the five components in parcel 2378, the *BioMap2 Technical Report* gives further descriptions of the Forest Cores and Wetland Cores (pg 54, and pg 64 respectively). From these more detailed descriptions we can learn more information about why the least fragmented forests and wetland complexes are essential to wildlife habitat. Those descriptions are as follows:

Forest Cores

Forests are the dominant vegetation type in the eastern United States, and Massachusetts has nearly three million acres of various forest communities (Figure 12). The Commonwealth’s extensive forests provide valuable habitat for a wide range of woodland plants and animals. *Forest-*

³⁰ *BioMap2 Carlisle Report*, Mass Div. of Fisheries & Wildlife (2012), 11

interior habitat—identified in BioMap2 as Forest Core—is widely recognized as critically important for species sensitive to forest fragmentation and is becoming increasingly scarce in highly populated regions of the country like Massachusetts. Forest-interior habitats are the areas least impacted by roads, residential and commercial development, and other fragmenting features. [Italics added] Many bird species that breed in Massachusetts are sensitive to forest fragmentation, including Ovenbirds, Scarlet Tanagers, and many woodland warblers. Negative results of fragmentation include edge effects such as nest predation by species associated with development such as skunks, raccoons, and house cats; and nest parasitism by species such as the Brown-headed Cowbird that lay their eggs in the nests of other bird species and reduce their reproductive success. Our analyses were designed to identify the largest and least fragmented forest-interior habitats across Massachusetts, the most important as priorities for protection.

With this approach, *BioMap2* Forest Cores include, for example, beech-birch-maple forests in western Massachusetts, oak-hickory forests in central Massachusetts, and oak-pine forests in eastern Massachusetts. By identifying important forested areas, we can protect both known and unknown biodiversity, serving as a “coarse filter” for biodiversity conservation.

Massachusetts’ nearly 3,000,000 forested acres provide numerous values, including wildlife habitat and biodiversity. *BioMap2* includes a conservative subset, just over 10%, of Massachusetts’ forests that provide the highest quality forest-interior habitat across Massachusetts. Additional and more expansive forest areas are included in the Landscape Block component of *BioMap2*. Forest Cores, as the most intact forest-interior habitats in Massachusetts, are crucial areas for the long-term persistence of forest-interior species and other species and ecological processes. They are a relatively rare and diminishing feature of the Massachusetts landscape, as roads and development fragment some of our last remaining intact habitats. Forest Cores are therefore high priorities for land protection.

Wetland Cores

BioMap2 Core Habitat includes a statewide assessment of the most intact wetlands in Massachusetts. *This analysis identified the least disturbed wetlands—Wetland Cores—those with the most intact buffers and little fragmentation or other stressors associated with development. These wetlands are most likely to support critical wetland functions (i.e., natural hydrologic conditions, diverse plant and animal habitats, etc.) and are most likely to maintain these functions into the future.* [Italics added] The analysis combined individual wetland types (e.g., shrub swamps, forested wetlands, marshes, bogs) into contiguous wetland complexes. To enhance the biodiversity value of selected wetlands as Core Habitat, further analyses were conducted to represent wetlands within the varied ecological settings found in Massachusetts, determined by geology and elevation, as different plant and animal assemblages occur in these unique settings. By mapping the most intact wetlands in each ecological setting, *BioMap2* identifies wetlands that support the broadest spectrum of wetland biodiversity, both currently and into the future, which will help prioritize conservation of wetland diversity in the context of climate change.

Even though *BioMap2* does not designate the Town Forest/Heidke Land as having a vernal pool component, there are three officially designated vernal pools that are known habitat for spotted salamanders and wood frogs. *BioMap2* was very selective in their vernal pool designations and only included the top 5% of interconnected clusters of potential vernal pools. But that does not mean that we should dismiss the importance of the Town Forest/Heidke Land ecosystem. A vernal pool’s “short period of intensive growth cycles the nutrients and energy from fallen leaves on the pool bottom into the frogs and salamanders of the adjacent woodlands; these animals make up a significant portion of the wildlife of the forest.”³¹ The in-depth description of vernal pool core component from the *BioMap2 Technical Report* (Chapter 3, page 52) also explains the important role of the surrounding upland forest for

³¹ Kenney L and Burne M, *A Field Guide to the Animals of Vernal Pools* (2001), 5

this kind of habitat, which should be a part of our assessment of the Town Forest/Heidke Land and considered in our management decisions. Therefore, it is included below:

Vernal Pools

Vernal pools are small seasonal wetlands that provide important wildlife habitat, especially for amphibians and invertebrate animals that use them to breed. *The persistence of populations of vernal pool-breeding species, such as the Blue-spotted Salamander, relies not only on the presence of the vernal pool itself, but also on adjacent upland forest habitat for foraging, overwintering, and successful migration of individuals among pools.* [Italics added] Individuals breeding at the different pools interact over time and maintain the overall population as breeding success shifts among pools with changing environmental conditions. For this reason, *BioMap2* analyzed not only the vernal pools, but also the quality of the habitat surrounding the pools and the connections among them.

Table 5-1 Components of BioMap2 Core Habitat 2378 ³²

This table lists all elements of BioMap2 Cores that fall entirely or partially within Carlisle.

Components	Species Scientific Name	Classification
Forest Core		
Aquatic Core		
Wetland Core		
Priority & Exemplary Natural Communities Small-river floodplain forest		S2
Species of Conservation Concern		
Britton's Violet	<i>Viola brittoniana</i>	T
Engelmann's Umbrella-sedge	<i>Cyperus engelmannii</i>	T
Few-seeded Sedge	<i>Carex oligosperma</i>	E
Long's Bulrush	<i>Scirpus longii</i>	T
Violet Wood-sorrel	<i>Oxalis violacea</i>	E
Creeper	<i>Strophitus undulatus</i>	SC
Eastern Pondmussel	<i>Ligumia nasuta</i>	SC
Triangle Floater	<i>Alasmidonta undulata</i>	Non-listed SWAP
Two-striped Cord Grass Moth	<i>Macrochilo bivittata</i>	Non-listed SWAP
Arrow Clubtail	<i>Stylurus spiniceps</i>	Non-listed SWAP
Umber Shadowdragon	<i>Neurocordulia obsoleta</i>	SC
Blue-spotted Salamander	<i>Ambystoma laterale</i>	SC
Four-toed Salamander	<i>Hemidactylium scutatum</i>	Non-listed SWAP
Northern Leopard Frog	<i>Rana pipiens</i>	Non-listed SWAP
Blanding's Turtle Eastern	<i>Emydoidea blandingii</i>	T
Ribbon Snake	<i>Thamnophis sauritus</i>	Non-listed SWAP
American Bittern	<i>Botaurus lentiginosus</i>	E
Common Moorhen	<i>Gallinula chloropus</i>	SC
King Rail	<i>Rallus elegans</i>	T
Least Bittern	<i>Ixobrychus exilis</i>	E
Pied-billed Grebe	<i>Podilymbus podiceps</i>	E
Sora	<i>Porzana carolina</i>	Non-listed SWAP

Key:

- E Endangered
- T Threatened
- SC Special Concern
- S1 Critically Imperiled communities, typically 5 or fewer documented sites or very few remaining acres in the state.
- S2 Imperiled communities, typically 6-20 sites or few remaining acres in the state.
- S3 Vulnerable communities, typically have 21-100 sites or limited acreage across the state.
- SWAP State Wildlife Action Plan

³² *BioMap2 Carlisle Report*, Mass Div. of Fisheries & Wildlife (2012), 12

BioMap2 designated the Town Forest/Heidke Land as important habitat and it also gives some indication of what species might be present in the Town Forest/Heidke Land but one of the goals of this assessment was to attempt to create a more complete potential wildlife list. For that reason, in addition to referencing the *BioMap2* list of species to determine potential Town Forest/Heidke Land inhabitants, numerous visits were made to the Town Forest/Heidke Land from the fall of 2013 through the summer of 2014. The goal of these trips was to observe the plant composition and distribution, to find and follow animal tracks, locate and identify scat, and note vegetation and soil disturbances in an effort to add some validity to the list of potential wildlife inhabitants. Those visits resulted in the observation of wildlife tracks (mice, birds, squirrels, chipmunks, a porcupine, a raccoon, coyotes, and deer), scat (coyote and deer) and owl pellets. Many birds and a garter snake were also observed. There were several trees, snags and logs that displayed animal activity as well as the multiple holes of the Pileated Woodpecker (*Dryocopus pileatus*) in a snag. The detection of Pileated Woodpecker activity is noteworthy because the Pileated Woodpecker is an important keystone habitat modifier (a.k.a. an ecosystem engineer) species. Abandoned woodpecker nest-holes become nests or roosts for small owls, cavity-nesting ducks, swifts, bluebirds, swallows, wrens, and other birds, as well as many small mammals.³³ In addition to providing nest-holes for secondary cavity nesters, the Pileated Woodpecker excavates for invertebrates into sapwood and heartwood allowing other foragers of invertebrates a resource they would otherwise be unable to access. Their feeding and nesting habits also help to control insect outbreaks and accelerate decomposition and nutrient cycling.

These sightings of animal signs are only a small representation of the many animals that could occupy or use the Town Forest/Heidke Land. Locating and identifying all the various animal species is beyond the abilities of the LSC. In addition to actual observations and the species listed in *BioMap2*, the committee used other reference sources to estimate what species could potentially inhabit the Town Forest/Heidke Land.

6. Potential Wildlife Species for Town Forest/Heidke Land

Forest wildlife scientists have conducted research in New England over long periods of time and the results of that research has been compiled into reference manuals for the general public to aid them in land management. Given the soil types, plant surveys and the forest cover-type subgroups, it is possible to project potential wildlife species of the Town Forest/Heidke Land. While this is only theoretical, it does give an idea of the land's possible wildlife inhabitants and an opportunity to explore whether or not the potential ecological community is robust and how it may vary across space and time as the forest changes.

To build a potential wildlife community the reference book, *New England Wildlife: Habitat, Natural History and Distribution* (DeGraff, Yamasaki, 2001), was used. This book was the source for the forest cover-type and nonforest habitat definitions described above in section 2. It also contains matrices of potential species by forest cover-type and nonforest habitat according to their respective subgroup. For each relevant species group there is a designation as to whether the habitat is for breeding activity, nonbreeding activity, breeding

³³ The Cornell Lab of Ornithology. http://www.allaboutbirds.org/guide/pileated_woodpecker/id

shelter, breeding feeding, winter shelter, and/or winter feeding. For forest cover-types there are also further subcategories for uneven-aged, large sawtimber, sawtimber, sapling through poletimber, and regeneration through saplings. The notations are color coded for preferred habitat or utilized habitat. The species represented in the matrices are amphibians, reptiles, birds and mammals. The book also includes detailed species descriptions of the range, distribution, habitat, special habitat requirements, reproduction, home range, densities, food habits, informational comments on each species, and other species-specific information. Careful examination of these descriptions helped to refine the potential wildlife list for the Town Forest/Heidke Land.

The process of selecting amphibian, reptile, bird and mammal species from the matrix included examining each species home range size requirements, especially breeding range, and that the selected species preferred or utilized the cover types of the Town Forest/Heidke Land. The above reference yielded 10 amphibians, 7 reptiles, 17 mammals and 40 birds. A list of the potential wildlife can be found in Appendix E. The Town Forest/Heidke Land list was compared to the wildlife lists that are in the 2012 Open Space and Recreation Plan (OS&RP) and the *BioMap2 Carlisle Report* species list. The OS&RP represents all of Carlisle and not just the Town Forest/Heidke Land. The three lists matched except for deer mouse was included in the Town Forest/Heidke Land list. Some species were also verified by sightings, scat and/or tracks including owls (pellets), coyote, deer, porcupine, raccoon, opossum, eastern chipmunk, gray squirrel, mice, vole, garter snake and thirty-four bird species.

The selections in these lists were made with the surrounding area habitat taken into consideration since wildlife is notorious for ignoring civil boundaries. Many species require a combination of habitats such as open areas and woodlands or open areas and wetlands but some only use one habitat type. If there was some minor doubt that a species would inhabit the Town Forest/Heidke Land, it was included because this is a potential species list and not an actual species list.

7. Other Factors Impacting Potential Wildlife Species

Simply identifying potential species using forest cover-types and nonforest habitat types is not enough. There are other factors to take into consideration. The four wildlife habitat aspects of food, cover, water and spatial relationships affect all species and each species has unique requirements.³⁴

Food

There must be a wide variety of foods available. Each species has its preferred food but will consume other food as a staple or on an emergency basis. Many foods for herbivores are seasonal and therefore periodically unavailable, potentially for long periods of time. If herbivores don't have enough food sources then their numbers will decrease and carnivores and omnivores may also decrease.

³⁴ DeGraaf RM, Yamasaki M, Leak WB, Lester AM, *Technical Guide to Forest Wildlife Habitat Management in New England* (2006), 14-19

Water

Water is essential for all species, usually on a daily basis. In Carlisle water is readily available for terrestrial species but has the potential to be problematic for aquatic and semi-aquatic species due to droughts and drawdowns of impoundments.

Cover

Cover can take many forms and provides protection from weather and predators, areas for reproduction, escape, roosting, sleeping, travel and resting. Examples of cover would be cavity trees, dense brush or seedling stands, fields, grassy areas, water, logs, rocks, rock walls, etc. Cavity trees provide different cover to different species in its many stages of decay. Cavity trees, snags and logs are used by roughly a third of New England forest species. Dense brush or seedling stands are often missing in unmanaged woodlands leaving a gap in fulfilling a wildlife requirement. Without dense brush or sapling stands, certain species will not be present.

It should be noted that one type of cover that is rapidly disappearing in New England are fields in early successional habitat of at least 20 acres or more. Blowdowns in forests provide small clearings but these are not adequately sized to accommodate certain species, especially birds. In heavily forested New England, the most effective way to provide this type of habitat is with even-aged management in very large tracts of forest. This means clearcutting 20-50 acre swaths in multiple areas of a very large forest. These areas are allowed to fill in as others areas are clearcut over time. This must be done in a consistent and timely manner to be effective so as one open area progresses from cleared to vegetated there is another more appropriate area for wildlife to move to. It is also possible to judiciously manage the same open area. Without this type of management important species are lost from the wildlife food web.

Spatial Relationships

How many species are present in an area is dependent on the spatial relationship of the above factors of food, water and cover. The abundance, location and availability of these factors determine whether species reside in a given forested and nonforested area. A woodland or nonforest area with successional stages of different types of plant species will provide a wider array of food, cover and water habitat. Essentially, a diversity of habitat translates into a diversity of species residing there.

Another aspect of spatial relationships is the size of the overall habitat. Different species have different range size needs and those different ranges often overlap. These range sizes can fluctuate greatly depending on conditions throughout the year and over longer spans of time as forest and nonforest conditions evolve. Also, ranges vary greatly between male and female, or juvenile and adult. It is possible to classify species according to their generalized range area required. All the home ranges of the species in the potential Town Forest/Heidke Land's species list (Appendix E) are within the Town Forest/Heidke Land and/or the surrounding conservation land as defined in the *BioMap2 Carlisle Report, Core Habitat 2378*. The home range of these species is listed in Appendix F.

Habitat structure also impacts spatial relationships. The horizontal and vertical diversity within a habitat governs the diversity of habitat communities. Horizontal diversity "refers to the complexity of the arrangement of plant communities and other habitats. The greater the range of size classes of plants present, the greater the potential that more wildlife species

will be present.”³⁵ Given that many species utilize different forest cover-types and nonforest types, then open and wetland habitats help to greatly increase the diversity within a wildlife community. This is why the Heidke Land is a very important part of the Town Forest habitat.

Vertical diversity “refers to the extent to which plants are layered within a stand. The degree of layering is determined by the arrangement of growth forms (trees, vines, shrubs, herbs, and moss and lichens), by the distribution of different tree species having different heights and crown characteristics, and by trees of different ages of the same species.”³⁶ Birds are mostly impacted by vertical diversity whereas horizontal diversity is more important to open land birds and mammals. There are also species that require both such as turkeys, white tailed deer and bears.

Species preferences also are impacted by overall total space. Some species are area sensitive in that their individual territories may be small but they only inhabit much larger areas. Area sensitivity of a given species results in an individual or pair not inhabiting an appropriate sized range in a suitable habitat because no other individuals of the same species are also present which would require a much larger area. For instance, bobolinks have territories of a few acres in size but will not nest in fields smaller than 25-50 acres³⁷ and hairy woodpeckers have territories of about 10 acres but only inhabit extensive forests.³⁸ Individuals are parts of populations that are present in the surrounding area; an overall habitat region needs connectivity to be suitable to support movement between patches of habitat for a population of species. The Town Forest/Heidke Land (79 acres) is connected to Greenough Conservation Land (255 acres), which is connected to the Great Meadows National Wildlife Refuge (321 acres). In close proximity to the Town Forest/Heidke Land is a portion of the Great Brook Farm State Park (GBFSP) that is also considered important habitat. All together they represent 655 acres, plus an unknown quantity of acreage in GBFSP, of horizontally and vertically diverse habitat.

8. Future Composition of the Town Forest/Heidke Land

It has only been about 70 years since the Town Forest/Heidke Land has been actively managed. Agricultural and logging activity have a long-term impact on forest composition that may last for more than 100 years by altering the physical characteristics of the site, allowing the establishment of species that then can persist for a very long time and eliminating species that are extremely slow to re-establish.

Many of the New England forests of today are still recovering from the period of intense deforestation that occurred in the 18th, 19th and the beginning of the 20th century. Paleoecological and historical studies have shown the forests prior to European settlement varied in composition according to physiographic and elevational variation across the New England region. These studies have also shown that sometimes areas, which vary in type of soils, physiography and geology, contain the same dominant tree species if the areas have

³⁵ DeGraaf RM, Yamasaki M, Leak WB, Lester AM, *Technical Guide to Forest Wildlife Habitat Management in New England* (2006), 22

³⁶ *Ibid.*, 23

³⁷ <http://www.npwrc.usgs.gov/resource/birds/ohionest/bobolink.htm>

³⁸ DeGraaf RM, Yamasaki M, Leak WB, Lester AM, *Technical Guide to Forest Wildlife Habitat Management in New England* (2006), 24

similar climatic conditions.³⁹ Other factors that influenced pre-settlement forest composition were significant wind damage and fire even if these disturbances were infrequent. The pre-European forest pattern was one where hemlock and northern hardwood species (beech, yellow birch, red oak) dominated the uplands and red, white and black oaks and hickories dominated the lowlands. White pines grew in both regions, as did ash and chestnut. The pioneering species of red maple, grey birch and paper birch would have been unusual. The forests of pre-European New England were mature forests comprised of long-lived species.

Even after major long-term disturbance the forests of New England have proven to be very resilient at regeneration. However, the forest composition is different than pre-European forests. In general, the oaks, red maple and birch are dominant in current forests with lesser amounts of hemlock and white pine and very little beech. Essentially, the impact from the last 300 years of human disturbance is upland forests becoming similar in composition to lowland forests. The forests are now more typical of young, successional forests in that they are comprised primarily of rapid-growing species that are less shade tolerant.

The Town Forest appears to be progressing toward all three of the forest cover-type subgroups described in Section 2 above, in the areas that are suitable for each type. It is likely that the north and middle central area (Soil type 253C and part of 253B) will continue to be predominantly an Oak-Pine (subgroup Eastern white pine cover-type) given the dry, sandy nature of the soil and low water table. Although, as noted in section 4, over a very long period of time (centuries) the forest O and A soil horizons may improve to a point of supporting a more diverse variety of trees, especially hardwoods. The western side and northeast corner (soil type 302C, 405B, and 405C) and the south-central edge (part of 253B) have potential for more diversity and appear to be progressing toward Oak-pine (subgroup White pine/Northern red oak/Red maple). The wetland areas of the Town Forest/Heidke Land have already developed red maple canopies and could be classified as well established Swamp Hardwoods (subgroup red maple) and nonforest habitat (shrub swamp, shallow marsh and stream) in some areas. As noted in Section 3, none of the soil types in the Town Forest are necessarily pristine either in their composition or delineation. There are other soil types mixed in or in pockets that can comprise 5-20% of the total designated soil area. Consequently, the edges or pockets of the soil-type areas may have different plant species than the whole general area.⁴⁰ It is difficult to predict the impact they will have in the overall composition. There are examples of this edge and pocket phenomenon throughout the Town Forest.

Analyzing a forest at a pinpoint in time can be fraught with misinterpretation when trying to predict that forest's future composition. Even if extensive information is available about historical use over the past several centuries, it is impossible to definitively project future forest composition. There is no guarantee that forests in New England will evolve into their former pre-European compositions. Research done over an extensive area in central Massachusetts has shown that studies "...based primarily on records of pollen and other fossils preserved in the sediments of lakes and wetlands, confirm that the environment and vegetation of New England have changed continually through time."⁴¹ The forests that exist today are of a different composition than what existed over the past 8,000 years. The

³⁹ Foster D and Aber J, *Forests in Time* (2004), 108-113

⁴⁰ NRCS Soil Survey for Middlesex County, MA (1991), 19-171

⁴¹ Foster D and Aber, J, *Forests in Time* (2004), 43

variances in climatic patterns greatly impacted plant species that advanced or declined depending on their respective individual capacity via different routes and at different rates. “This history of plant and animal migrations over thousands of kilometers in response to global climate change is one of the great biological stories of our landscape; it offers unusual insights into the selective pressures that have operated on species as well as their remarkable capacity for coping with major changes in the environment. It also underscores the humbling recognition that the conditions and ecosystems that we study today are only a minor subset of the range of possible or even typical conditions.” It also implies that just as the forest of today do not mimic the forests of the past, the future forests are likely to be novel in their composition as well with the current pressures of pathogens, pests and climate change each exacting their toll on the forests just as the pressures in the past. “At a resolution of decades to thousands of years and on a landscape and regional scale, the records of vegetation and environment in New England are one of change. These changes have not involved a single or progressive trend. Rather, they include complex alterations in interrelated environmental factors that trigger independent responses of individual plant and animal species.”⁴²

Regardless of how the Town Forest/Heidke Land’s plant and animal species evolved, the *BioMap2* analysis concluded that the Town Forest/Heidke Land at this point in time is an important part of a larger core habitat that also includes a portion of the Great Brook Farm State Park, Greenough Conservation Land, and the National Wildlife Refuge Area. This land serves not only as important habitat where individual species reside but also as a connector between other core habitats. What passes through the land, whether it is water or animals, is as important as what remains. Which species (wildlife, human or dog) visit the area is also important. Whatever this core habitat future composition may be, it deserves careful management today to preserve this special core habitat as much as possible while balancing its passive recreational use. An important component of preserving the Town Forest/Heidke Land is managing the impact on it, especially by the human species.

9. Impact of Humans and Their Animal Friends

Every trail has a potential zone of influence on the surrounding environment according to David Brown, naturalist, educator, wildlife tracker, habitat assessor and author of two wildlife tracking guides. A rule of thumb given by David Brown is to expect a minimum of 50’ on each side of the trail to be a no wildlife zone in terms of breeding and dwelling sites. An even broader zone of 25-100 meters was reported in 2006 on trails that allowed off-leash dogs in a study done for the City of Boulder Open Space and Mountain Parks in Colorado. Prey species such as deer, rabbits, squirrels and mice were the main species that showed avoidance whereas predator species, such as foxes, increased their markings near trails except for trailheads.⁴³ Factors that can cause the zone of influence to be even greater are when humans are on bikes, or riding horses, or accompanied by dogs that are off-leash and free to roam at will, or when predators use trails to gain access to areas, especially in winter when harassment results in excessive energy expenditures by wildlife. People using trails can trample vegetation, track in invasive species seeds, erode the soil, leave litter behind, and startle wildlife causing avoidance behavior. “Dogs, often as companions to humans, are increasingly recognized as prevalent, wide-ranging stimuli that often evoke particularly

⁴² Foster D and Aber, J, *Forests in Time* (2004), 45-6

⁴³ Lenth B, Brennan M, Knight RL, *The Effects of Dogs on Wildlife Communities* (2006), 13-22

strong and particularly deleterious responses among wildlife.”⁴⁴ Whether they are running unaccompanied or just running loose with their owners, dogs can chase wildlife initiating flight or freezing behavior, sometimes kill wildlife, and potentially spread disease and parasites.⁴⁵

A study done in 2007 on suburban woodland sites, where dogs were allowed to be regularly walked on a leash, showed a 41% reduction in the numbers of individual birds and a 35% reduction in species richness compared to control sites where no walking occurred. Walkers without dogs had half the effect. This same study also found that there was no difference in bird response to disturbance by dogs in both the test site and the control site, implying that birds do not habituate to dog presence.⁴⁶

The reason for this kind of impact by dogs is because wildlife interprets the presence of dogs as potential predators and responds in various ways and to various degrees as mentioned above. Dogs move unpredictably varying their direction and speed and they harass wildlife which, rather than promoting habituation instead promotes sensitization, thus enhancing response intensity with each exposure. Many species use predictability, proximity and speed to judge the degree of threat to them.⁴⁷

Encounters with dogs are important to consider because they are actually a subsidized predator in the sense that we care for them and feed them ensuring the persistence of the species. This results in their numbers being much greater than would naturally occur in the wild. Consequently, this situation has the potential to increase the exposure rate to predators that some wildlife experience depending on the frequency of human-dog or dog visitation to habitat areas.⁴⁸

How much and what type of impact this kind of disturbance has on wildlife depends on the frequency, intensity, location, timing, predictability, and type of activity, as well as the type of wildlife including its size, group size, sex, age and niche (specialized versus generalized). Many types of impacts are indirect and difficult to measure, such as increased risk of disease from physiological stress, but these may be just as damaging as direct impacts. Disturbance by humans and dogs can cause nest abandonment, decline in parental care, shortened feeding times, increased stress, and possibly lower reproductive success.⁴⁹

It has been well documented that some wildlife respond to humans and especially to dogs in a dramatic way but, the effort to put together all the pieces of this puzzle of human and dog interaction with wildlife, has some gaps. For instance, there is little research on how disturbances physiologically impact wildlife, if there is a tolerability threshold, what are the typical roaming patterns of off-leash dogs and exactly what cues dogs give (visual, auditory

⁴⁴ Gompper ME, ed. Weston MA and Stankowich T, *Free-ranging Dogs and Wildlife Conservation* (2014), 94

⁴⁵ Sime, C. A. 1999. Domestic Dogs in Wildlife Habitats. Pages 8.1-8.17 in G. Joslin and H. Youmans, coordinators. *Effects of recreation on Rocky Mountain wildlife: A Review for Montana*. Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society. 307pp.

⁴⁶ Gompper M, ed. Richie EG, Dickman CR, Letnic M, Vanak AT. *Free-ranging Dogs and Wildlife Conservation* (2014), 62

⁴⁷ Gompper ME, ed. Weston MA and Stankowich T, *Free-ranging Dogs and Wildlife Conservation* (2014), 99

⁴⁸ Gompper M, ed. *Free-ranging Dogs and Wildlife Conservation* (2014), 2-4

⁴⁹ Snetsinger S and White K, *Recreation and Trail Impacts on Wildlife Species of Interest in Mount Spokane State Park*, Pacific Biodiversity Institute (2009), Introduction

or olfactory) that elicits responses.⁵⁰ We know from the research done to date that birds, mammals, amphibians and reptiles respond in varying degrees to humans and dogs and in some situations this can cause population declines of some species in an area. What we do not know is exactly how and to what extent human activity and dogs affect the wildlife in the Town Forest/Heidke Land.

As human and dog impact is considered in developing the best policies for the management of conservation land meant to serve as habitat for wildlife, the analysis needs to be done in the context of the land as part of an ecosystem and not just on a species by species basis. In the book *Wildlife Habitat Relationships (Morrison, et al. 2006)*, the authors define an ecosystem as follows:

“An ecosystem consists of various taxonomic designations and levels of biological organization, along with their interactions among each other and among abiotic conditions and processes. An ecosystem is more than a mere collection of populations (organisms of the same species in a given area), species assemblages (groups of species of a particular taxa), or communities (species with their interactions). Understanding wildlife in a ecosystem context entails understanding (1) population dynamics, including demographic and genetic variations; (2) the evolutionary context of organisms, populations and species, including the contribution of genetic variation to persistence of species lineages, mechanisms of speciation and hybridization, and selection of adaptive traits; (3) interactions among species that affect their persistence and that influence community structure, including obligate mutualisms such as pollination and dispersal vectors, predation, competition, and other interactions; and (4) the influence of the abiotic environment on vitality of organisms (organism health and realized fitness) and populations (viability), including how disturbance mechanism operate and how organisms respond. Habitat ecology plays a key role in many of these facets of an ecosystem context but itself needs to be subsumed into a broader ecological tapestry. An ecosystem context also necessitates understanding the role of humans in modifying environments, habitat and wildlife populations.”⁵¹

The challenge is to determine how much and in what ways we are willing to impact the habitat we have set aside for conservation. All habitats are part of naturally dynamic ecosystems and all wildlife must adapt to the changing habitat. The question that needs to be addressed, is to what extent do we want to be the cause of those changes?

Because of the significant potential for human impact and the very complicated and highly interrelated nature of ecosystems, a conservative approach to wildlife habitat management may be warranted in the interest of avoiding unintentional short-term and/or long-term harm and to ensure there is a suitable balance between habitat protection and passive recreation. For instance, some examples of a conservative approach would be to avoid placing a trail through areas that are considered high-quality habitat locations even if they are relatively small since these areas of habitat may be vital stepping-stones used by wildlife to move across the landscape, avoid areas that are habitat for threatened or endangered species, especially near ponds or pools because wet areas are more susceptible to soil compaction which can negatively impact vegetation, and avoid encircling bodies of water with a trail to reduce disturbance to water based wildlife, etc.⁵²

As for the Town Forest/Heidke Land, if trail placement and abundance is carefully

⁵⁰ Gompper M, ed. Weston MA and Stankowich T, *Free-ranging Dogs and Wildlife Conservation* (2014), 112

⁵¹ Morrison ML, Marcot BG, Mannan RW, *Wildlife-Habitat Relationships* (2006), 387

⁵² Colorado State Parks Trails and Wildlife Task Force. *Planning Trails with Wildlife in Mind*. (1998), 5-20

considered and the levels and frequency of visitors to the Town Forest/Heidke Land are kept fairly low, then probably a reasonable balance between habitat protection and passive recreation can be achieved and maintained. Some practical ways to manage visitor frequency at the Town Forest/Heidke Land would be to not enhance the parking along East Street and restrict frequent visitations by large groups of people for extended periods of time. Any overnight camping that is allowed could be limited in frequency and duration with very careful selection of the campsite, making sure not to intrude upon the vernal pool areas, especially during breeding season.

10. Concerns, Considerations, and Conclusions

Concerns

1. It should be noted that two non-native plants are present on the Town Forest/Heidke property, glossy buckthorn (*Frangula alnus*) and Japanese barberry (*Berberis thunbergii*). The glossy buckthorn is becoming ubiquitous. Birds readily disperse the buckthorn berries throughout the summer and fall due to its extended period of fruit production. Glossy buckthorn is especially disruptive to wetlands where it will form dense stands that suppress native plants. The Japanese barberry invasion is just beginning along the southern end of the western stream. It is a small number of plants at this point so they can be grubbed out without too much effort.
2. The native hay-scented fern (*Dennstaedtia punctilobula*) is also rapidly spreading around the Town Forest/Heidke Land. It is a potential concern to the long-term health of the forest even though it is a native plant. Hay-scented ferns will spread over areas via rhizomes after an opening has been created in the canopy, producing an impenetrable root mass that prevents seeds from reaching the ground. The very dense cover of the ferns makes the ground level very dark further discouraging germination. This tangled, shady cover is a favorite dwelling place of rodents who are very fond of dining on seeds amongst the protection of the fronds. Even if a seed does manage to reach the ground, germinate and become a sapling, the prospects are not good. Only .6% of red maple and 5% of red oak original seedlings will survive in a hay-scented fern “grove”.⁵³

For the past 50 years the hay-scented fern has been steadily spreading along with white tailed deer and acid deposition from natural (volcanoes, lightning, microbial processes) sources and anthropogenic emissions, with the anthropogenic emissions being twice as much. Pennsylvania researchers William E. Sharpe and Jessica E. Halofsky consider acid deposition more causal than deer in hardwood decline given the sensitivity of certain tree species to acidic soils and the hay-scented ferns propensity for acidic soils.

This phenomenon combined with deer browse of hardwoods can greatly reduce the presence of hardwoods in the understory and eventually the canopy. Deer unfortunately do not browse on hay-scented ferns and insects are not interested in them either. Interestingly, a controlled study at Quabbin Reservoir demonstrated that

⁵³ Barlow V, *Northern Woodlands* (Autumn 2009)

reduction in the deer population does help to partially restore germination of hardwoods even in hay-scented fern dominated areas.⁵⁴

Whatever the cause of this increase of hay-scented fern, one certain fact is that once hay-scented ferns are established they will dominate the understory long after the original disturbance that allowed them to germinate. Hay-scented ferns have already impacted the Town Forest/Heidke Land's trail system by completely covering trails in some areas. These covered trail areas are a major source of ticks, especially deer ticks.

3. Many of the standing canopy white pines have stunted, thin crowns and appear distressed. Acid rain can cause stunted crowns of mature eastern white pines because of excessive nitrogen deposition resulting in important nutrients being leached from the soil. Most diseases of white pine cause stem tip or entire branch dieback. What is puzzling about this phenomenon is the scattered nature of the distribution of stunted white pines. If acid rain were the cause, it would seem that the effect would be more uniform. White pines are an important tree in the Town Forest/Heidke Land and more in-depth research is warranted on this reduced crown phenomenon.
4. There is a small area in the higher elevations of the southwest corner of the Town Forest with a sparse canopy and even sparser understory. The soil in this area is some of the best soil in the Town Forest according to the NRCS Soil Survey. The eastern white pines in this area are the most severely stressed. It is possible that past agricultural practices caused serious erosion in this area or the area has been subjected to heavy deer browse. This area is along one of the pathways used by deer.

Considerations

1. A more in-depth plant community survey would be useful in further analyzing the robustness of the potential wildlife community list, especially noting hard and soft mast producing plants.
2. The Town Forest/Heidke Land forest cover-types and potential wildlife have been identified but an analysis of the food chain and what kind of a food web this might represent would also be useful in further analyzing the robustness of the potential wildlife community list.
3. The above two research results could be combined with the wildlife species home range requirements, typical densities and spatial needs, cover demands, preferred foods for herbivores and omnivores, hibernation habitat, etc. to assess the suitability of the habitat for the potential wildlife community.
4. A more thorough examination of the plants to discover and record the location of invasive plant species.
5. Installing a wildlife camera in key locations would help to verify potential mammal populations.
6. Acquiring and analyzing core soil samples might help to resolve the mystery of the inconsistency between the NCRS Soil Survey and the forest composition.

⁵⁴ Barlow, V. Autumn 2009. *Northern Woodlands*

7. Selecting other similar and dissimilar conservation areas for comparison of wildlife indications and activity might be a useful reference in gauging overall wildlife presence in a wider area. It might also be useful in determining how the intensity of use by humans impacts wildlife activity.

Conclusions

It is important to mention the limitations of this analysis before any conclusions. It is well known that there are inherent risks in projecting what species might inhabit or pass through the Town Forest/Heidke Land by examining vegetation types and structure. Such a supposition can have a significant margin of error. Even if a NHESP-type of analysis was performed, there still would have been considerable shortcomings because habitat studies done based on transecting vegetation plots miss a great deal of the biota, especially soil microbes and the interaction between species. The challenge is studying not just a piece of land that we recognize as having certain civil boundaries but to understand the ecosystem it is a part of and the implications of various perturbations, especially by humans, as we try to formulate appropriate management policies.

Understanding an ecosystem is a massive challenge starting with first defining and delineating the system. In reality, defining an ecosystem as a separate unit with identifiable indicators is impossible because of the complicated interrelatedness without boundaries of plant and animal species that we are faced with. Exactly where does one draw the lines?

This assessment may not have been able to precisely define the ecosystem for the Town Forest/Heidke Land but the concept of an ecosystem is still valuable because the factors that can influence the interactions between plants and animals and the context within which they evolve can still be examined. Even in a complex system, “changes in individual factors can have a cascading effect on the individual as well as the population and the community.”⁵⁵ The more these factors and their impact can be identified, the better the conservation land can be managed. The question is, how much can be truly identified and understood?

The kinds of factors that influence plants are water and nutrient availability, pathogens, pests and climate. The most basic factors that influence animals are food, water, cover and space and how they are perceived and used by wildlife. The predator-prey relationship also has a large influence. We can look at these factors of an ecosystem but that doesn't necessarily tell us how it functions or how well it is functioning. It is the interrelationships and interactions of all the abiotic and biotic elements that determine functionality and quality of an ecosystem. It is possible to have an ecosystem that is not species-rich compared to other ecosystems but is still functionally rich in terms of the functions those species perform. In other words, it is not only the presence of the species; it is also its performance or role that is important. In general, the more diverse and overlapping in functionality the species are, the more resilient ecosystems are to perturbations.⁵⁶

In Section 9 above, an ecosystem definition from the book *Wildlife Habitat Relationships* (Morrison, et al. 2006) was provided. With this as a guideline of how to define an ecosystem, it quickly becomes apparent that an in-depth assessment the Town Forest/Heidke Land

⁵⁵ Morrison, M. Marcot, B. Manna, R. *Wildlife-Habitat Relationships* (2006), 385-386

⁵⁶ *Ibid.*, 389-399

parcel is multifaceted and something that can only be undertaken with time, a substantial budget and a great deal of expertise. But that does not automatically mean that what has been learned to date is of no value. From our assessment we have learned or accomplished the following:

1. The forest cover-types and the non-forest types that exist and what that implies about potential wildlife inhabitants
2. Expansion of the plant list
3. Identification of the understory composition
4. Potential animal species
5. Direct observation of the existence of 48 animal species
6. Detection of invasive plant species and native plant species of concern
7. Issues with some of the white pines
8. Discrepancies between the NRCS soil types and existing vegetation
9. Impact of historical usage on the soils and the current forest plant composition
10. Impact of soil types on wildlife habitat
11. Forest horizontal and vertical structure
12. Possible human impact
13. Importance of core habitat
14. Ideas for furthering our understanding of the Town Forest/Heidke Land

Summary

In order to summarize what this information means it is necessary step back and look at the bigger picture. In Carlisle, the total conservation lands include: over 1,000 acres of conservation land owned by the Town, another 1,000 acres owned by the state as an operational dairy farm and park (Great Brook Farm State Park a.k.a. GBFSP), 321 acres owned by the U.S government as a National Wildlife Refuge, and more than 224 acres owned by the Carlisle Conservation Foundation. A large portion of all of this land is accessible to the public and includes trails. Of this total, the Town Forest/Heidke Land, Greenough, National Wildlife Refuge and a portion of GBFSP are part of the *BioMap2* core habitat 2378, which has 5 core components: Forest Core, Wetland Core, Aquatic Core, Species of Conservation Concern, and Priority & Exemplary Natural Communities. Some of the other conservation parcels in Carlisle, or sections of them, are part of the *BioMap2* Core Habitat areas for the one core component, Species of Conservation Concern. In other words, Town Forest/Heidke Land is part of the only *BioMap2* core habitat in Carlisle that has multiple core habitat components.

Looking at the bigger picture helps to clarify how important the Town Forest/Heidke Land, Greenough, and National Wildlife Refuge habitat is. This habitat assessment of the Town

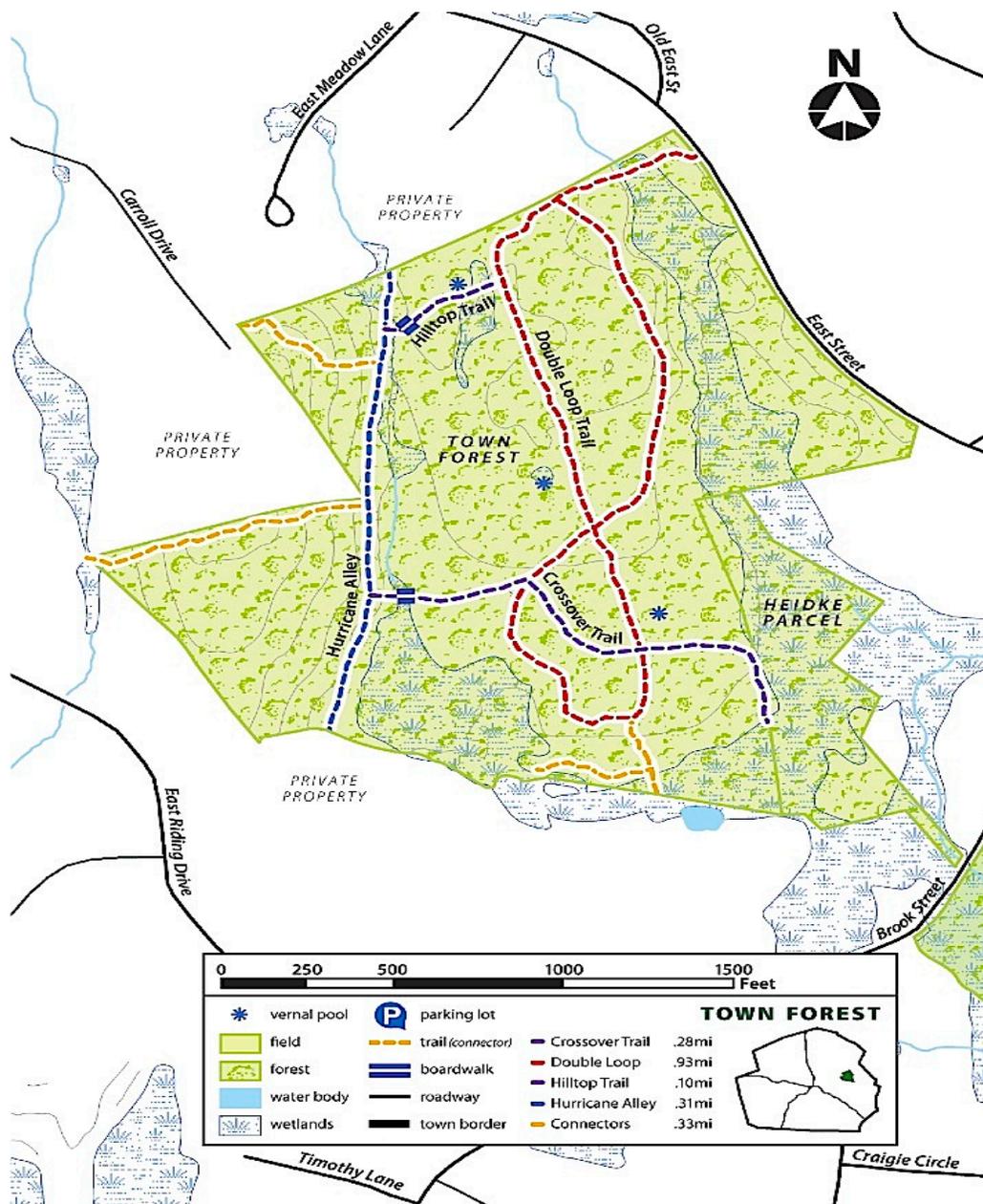
Forest/Heidke Land can only be done to a certain point but it is still important to carefully consider the complexity and interrelatedness of these ecosystems and their susceptibility to impact when making management decisions and policy. The limitation of not being able to discern the exact impact of certain perturbations suggests that a conservative approach is warranted when balancing any impact, especially in the form of human access and activity, with that of habitat quality preservation. Any environmental changes or increases in activity or access should be carefully weighed against their impact to both immediate and long-term habitat quality.

This assessment began as a result of a request to place a trail transecting the southwest corner of the Town Forest from the western end of an access trail along the northern edge of that area to the southern end of the Hurricane Alley Trail, making a loop instead of the Hurricane Alley Trail ending at the property line. Looking at the map in Figure 10-1 below, this seems like a logical step to improve the public's enjoyment of the Hurricane Alley Trail. The observations made about this particular area during this assessment of the entire Town Forest/Heidke Land were:

1. The southern end of the Hurricane Alley Trail currently serves as access for the relevant abutting private property. The abutting private property is presently totally blocked by numerous, large windthrown white pines.
2. The southwest corner is the only part of the Town Forest that is not visited by the public except for the access trail along the northern edge, which is seldom used.
3. The NRCS soil mapping indicates that soils well suited for wildlife habitat are in this general area.
4. There are more hardwood species in this area than the rest of the Town Forest.
5. This was the only area where evidence was found of Pileated Woodpecker activity in the form of rectangular holes in tree snags.
6. Deer regularly travel through this area as well as congregate here throughout the year although there was no evidence that they slept here during the last winter season.
7. Deer deliberately scent the area with their feces (pellets) in concentrated patches. "... pellet densities are a more sensitive measure of deer activity and habitat utilization because they indicate areas where deer are able to pause, rest, and bed down - areas where deer are not disturbed, but relaxed."⁵⁷
8. Coyotes regularly travel through this area along approximately the same pathways as the deer. Some coyote scat was found in addition to their tracks.
9. Many tracks of small mammals (mice, squirrels and chipmunks) and one unidentified animal were found among the rock piles in the center and near the rock wall along the southwest and northern borders of this area.
10. This section of the Town Forest is a wildlife corridor in addition to habitat based on the wildlife tracks and scat.

⁵⁷ Lenth B, Brennan M, Knight RL, *The Effects of Dogs on Wildlife Communities* (2006), 19

Figure 10-1. Town Forest Trails Committee Map



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