Natural and Cultural Resources Inventory: Bill Rivers Conservation Area, Leverett, MA

Margaret Engesser, Nathaniel Evers, Kyle Krigest, Jeffrey Mulligan, Lindsay Stevenson

May 2013

This project was prepared as part of the Natural Resources Inventory of Local Lands Course at the University of Massachusetts, Amherst, within the Department of Environmental Conservation.

White pine regrowth on the property. An image of a deer was captured by a wildlife camera.
Introduction

The Bill Rivers Conservation Area is located in the town of Leverett, MA, adjacent to the town's library and elementary school (see map 1). It is a 53-acre parcel owned by the Leverett Conservation Commission. The conservation area is named for Bill Rivers, a conservationist and long-time resident of Leverett who served for many years on the conservation commission.

The goal of this project was to inventory the natural and cultural resources of the property, and to present the findings of the inventory and recommendations to the Leverett Conservation Commission. The inventory includes data gathered on a variety of topics, including: forestry, wildlife, invasive species, soils, recreation, and archaeological sites. Recommendations are provided on each of these topics, with the goal of informing the future conservation decisions of this land.
Landowner Goals

After choosing from a handful of properties, the Town of Leverett’s Conservation Commission decided to have our group inventory the Bill Rivers parcel. The following are the Conservation Commission’s goals for the Bill Rivers Conservation Area:

1. General inventory of the area; wildlife present, forest cover, plants present, landscape description.
2. To use the area as an educational tool for the school and library, which are close to the property.
3. Continue to use the area and trail present for recreational purposes and after school activities.
4. Possibly use the already existing kiosk at the trail head as an information center, provide visitors with pamphlets.
5. Identify and record the possible historically significant stone structures located on the property. Protect and preserve them, but have them available for the public to see and benefit from.
6. Have a guide for a possible future management plan for the area so that active management can occur.

The Conservation Commission wants to continue to use this area of land as a conservation area, as well as an educational tool for the students that attend the school and the general public. There is one trail present on the property, and a handful of proposed trails that can hopefully be put into place in the future.

Context

Historical Context

The town of Leverett, located in Western Massachusetts, was founded in 1774 when it officially separated itself from the town of Sunderland. By the time railroads, electricity and cars were invented, and World War I had taken place, many people living in Leverett moved away in search of jobs in big cities and to serve in the military. Leverett became a town inhabited by older members of the population. However, when World War II ended, many returning soldiers moved back into the town, and many others decided to move there because of the University of Massachusetts. Despite the higher amount of people moving into Leverett over the years, the town has managed to remain one of the least developed towns in the state.
Landscape Context

The town of Leverett was founded in 1774 when it officially separated itself from the town of Sunderland. By the time railroads, electricity and cars were invented, and World War I took place, many people living in Leverett moved out to get jobs in big cities and to serve in the military. Leverett became a town inhabited by older members of the population. However, when World War II ended, many returning soldiers moved back into the town, and many others decided to move there because of the growing University of Massachusetts. Despite the higher amount of people moving in to Leverett over the years, they have still managed to be one of the least developed towns in the state. There remains a large amount of natural land. In fact, according to Mass Audubon’s Losing Ground statistics for Leverett, the percent of natural land is 90.5 as of 2005. That ranks 25th in the state out of 351. The remaining land is 4.5% developed (305 in the state) and 3.1% in agricultural land (193 in the state). In terms of acres, there is 14,693 total acres of land in Leverett and 666 are developed and 463 are agricultural. These stats are all very positive compared to the rest of the towns in Massachusetts. However, there is a possibility of this all changing. This is because Leverett has a very low amount of undeveloped land that is protected by the law (refer to the map below for further information). There are 950 total acres protected which is 277 out of all the other towns in the state. That comes out to 6.5% of the land, which is 315 in the state. these low numbers mean that at any point Leverett could be effected by urban sprawl because so little of the land is protected. Even though from 2000 to 2007 there was very little population growth (1,692 in 2000, 1,851 in 2010) there is still a possibility, especially since it is so close to one of the biggest colleges in the country.

Leverett is a rare town in terms of towns that are found in Massachusetts. Almost all of the land is forested, as stated before. The property of land we took inventory on is a reasonably large block of woods, which is also surrounded by large blocks of woods, something that is hard to come by. This is really important because such large areas of heavily wooded forests provide wider possibilities for species diversity, because some animals need bigger areas of woods to live and thrive in.

Overall, there are 23 square miles of land in Leverett. Only .1 percent of the area of the town is water. There are several brooks running through it, and the biggest body of water is the Leverett Pond. The brooks that run through all lead to the Connecticut River, which is a little bit west of the town. Basically the entire town is all hills, the tallest point being the abutting Brushy Mountain, standing at 1,260 feet. As far as transportation, there is only one route that runs through it, and that is Route 63, going through the western part of town. There are not interstates or highways going through it at all, and the closest one is interstate 91, to the west of Leverett. There are also no railways and only one bus route runs through, and even that has no regular stopping times. Leverett is a very quiet, cozy town.
Map 2. Land use map of areas near the Bill Rivers Conservation Area.
Native American History and Archaeological Resources

The Town of Leverett has a rich Native American history that is part of the town’s culture today. Leverett Pond was most likely an important area for Native Americans to hunt and fish, and it also influenced the areas in which colonists first settled in Leverett. The area surrounding Leverett Pond was also prime agricultural land. In addition to agriculture, early industry in Leverett consisted of factories and mills along Roaring Brook, located just south of the Bill Rivers property, which largely contributed to the growth and development of the town (DCR 2009).

Leverett Center was designated a historic district in 2008. This district is comprised of 4,670 acres, which includes 43 buildings and two structures. Its historical significance is architecturally-based. The town center includes Leverett’s primary town buildings, including Town hall, the library, the post office, the fire station, and the school (Register of Historic Places 2013).

Of significance specifically to the Bill Rivers property, aspects of the town’s Native American history are present on this property. The Native Americans who lived in this area were primarily of the Pocumtuc Tribe. They lived in the area of the Deerfield and Connecticut Rivers throughout Franklin County. They were an important tribe within the Connecticut Valley and ruled over other nearby tribes. During the infamous King Philip’s war of 1675, the Pocumtuc Tribe joined with other tribes to attack European settlements that threatened the Native American way of life (Gille 1999). The Pocumtucs lived in the area around Leverett at the same time as the early European colonists. They established alliances with other tribes, such as the Narragansetts. These tribes were largely located in Turners Falls, the town located just north of Leverett, which became a place for Indian refugees from the battles between the Native Americans and Europeans (Timreck 2010).

Archaeological Resources

The remnants of the early Native Americans can be seen throughout Leverett and on the Bill Rivers property. Within Leverett, there are hundreds of stone structures, or groupings, which are connected to the early Native Americans. One Native American site discovered in Turners Falls was the catalyst for the increased protection of these sites throughout the area, including Leverett.

Several years ago the Federal Aviation Administration wanted to expand the Turners Falls Airport runway, but it was discovered that Native American stone structures were located at the site. Members of the Narragansett Tribe were involved in identifying the structures as ceremonial stone structures used during traditional religious ceremonies. In order to stop the
airport from expanding and the destruction of these structures, the tribe appealed to the National Register of Historic Places to designate the site as a historic place. The stone structures at the Turners Falls Airport became the first ceremonial stone landscape in New England to be recognized as an historic site. With that, an 18 mile area around the site was designated a historic district, which includes Leverett. This experience has helped Turners Falls begin a new relationship with local tribes, and the town helps tribes preserve other sites. The Turners Falls case was controversial because it was the first historic site of its kind, and because archaeologists previously did not recognize New England as a place of early ceremonial Native American sites (Timreck 2010). From this, the United South and Eastern Tribes, Inc. (USET) established a resolution specifically pertaining to sacred ceremonial stone landscapes found in the Northeast. This resolution is important to the future historic designation of sacred stone landscapes in New England because it requests that federal agencies consult with Indian tribes regarding ceremonial stone landscapes. It also requires the federal government to provide more assistance for the protection of these sites (USET 2007).

It is unclear whether the stone structures located on the Bill Rivers property have historical significance and are related to a Native American tribe. Hopefully, through discussion with the individuals listed below, the significance of these sites will be determined through the course of this project. See the image below for one of the stone structures located on the Bill Rivers property.

Image 1. Stone structure located on the Bill Rivers property.
Site Characteristics

Soils

The western edge of the property, including Doolittle Brook is composed of Gloucester sandy loam, 25 to 45 percent slopes, very stony. This soil type is typically found in the uplands and on slopes and the surface area is usually covered with cobbles, stones, or boulders. Moving east, there is a large area of Canton fine sandy loam, 8 to 15 percent slopes, very stony. This area rises from the stream towards the uplands to the east. Typical of valley sides and hill slopes, this soil is also usually covered with cobbles, stones, and boulders. Continuing east is the Chatfield-Hollis complex, 8 to 15 percent slopes, rocky. This soil type covers about one third of the property and is similar to the other soils in terms of surface cover and characteristics such as an upland location. The eastern half, along the highest elevation of the property, is an area of many soil types mixed together. All these types are similar to the first three mentioned and the characteristics are very similar. These soils are well drained, generally around 20 inches to bedrock, and are typical of uplands in the northeast. As an overall note, all of these soil types are classified as ‘not prime farmland’ and the depth to the water table is greater than 80 inches. According to the survey, the pH of the soil ranges from 5.2 to 5.6, which is on the acidic side of the scale.

### Table 1. Natural Resource Conservation Service soil map legend and soil breakdown

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>108B</td>
<td>Chatfield-Hollis complex, 3 to 8 percent slopes, rocky</td>
<td>2.9</td>
<td>4.7%</td>
</tr>
<tr>
<td>109C</td>
<td>Chatfield-Hollis complex, 8 to 15 percent slopes, rocky</td>
<td>20.4</td>
<td>33.4%</td>
</tr>
<tr>
<td>109D</td>
<td>Chatfield-Hollis complex, 15 to 25 percent slopes, rocky</td>
<td>6.5</td>
<td>10.7%</td>
</tr>
<tr>
<td>114C</td>
<td>Hollis-Chatfield complex, 8 to 15 percent slopes, very rocky</td>
<td>2.4</td>
<td>4.0%</td>
</tr>
<tr>
<td>119F</td>
<td>Chatfield-Canton complex, 25 to 50 percent slopes, rocky</td>
<td>8.6</td>
<td>14.0%</td>
</tr>
<tr>
<td>260A</td>
<td>Sudbury sandy loam, 0 to 3 percent slopes</td>
<td>0.0</td>
<td>0.1%</td>
</tr>
<tr>
<td>421C</td>
<td>Canton fine sandy loam, 8 to 15 percent slopes, very stony</td>
<td>12.5</td>
<td>20.4%</td>
</tr>
<tr>
<td>421D</td>
<td>Canton fine sandy loam, 15 to 25 percent slopes, very stony</td>
<td>2.2</td>
<td>3.5%</td>
</tr>
<tr>
<td>440B</td>
<td>Gloucester sandy loam, 3 to 8 percent slopes</td>
<td>0.6</td>
<td>1.1%</td>
</tr>
<tr>
<td>441F</td>
<td>Gloucester sandy loam, 25 to 45 percent slopes, very stony</td>
<td>4.9</td>
<td>8.1%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>61.0</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
Suitability for log landings

The following map illustrates the suitability for log landings on the property. According to the NRCS description, log landing suitability is, “based on slope, rock fragments on the surface, plasticity index, content of sand, the unified classification of the soil, depth to a water table, ponding, flooding, and the hazard of soil slippage.” Yellow represents moderately suited areas, while red represents poorly suited area. In total, 63.7% of the property is moderately suited and 36.3% is poorly suited. The steep slopes and exposed bedrock outcrops greatly restrict the availability of suitable areas on the property.
Harvest equipment operability

The harvest equipment operability is based on the same factors as suitability for log landings and shows the suitability of the soil for harvesting equipment. 1.1% of the property is well suited (green), 76.8% is moderately suited (yellow), and 22.1% is poorly suited (red). The steep slopes of along Doolittle Brook and the eastern half of the property are the main limiting factors.

Map 6. Suitability of the property for harvesting equipment
Erosion hazard due to unpaved roads/trails

This map illustrates the erosion hazard and the risk of soil loss due to trails and roads. Slope is the main contributing factor to these ratings. 1.1% of the property is deemed slight risk, 4.7% is graded as moderate risk, and 94.2% of the land is at severe risk of erosion due to trails/roads.

Map 7. Erosion hazard risk due to unpaved roads/trails

*All of the above information on soils was generated from the US Department of Agriculture’s Natural Resource Conservation Service Web Soil Survey function. A complete and in depth 73 page report was generated and the highlights are included here.

Geology

The geology of the area, and Leverett as a whole, is very similar to the hill towns up and down the Connecticut River valley. The hills to the west and east of the river served as the boundaries of Glacial Lake Hitchcock some 15,000 years ago. This lake stretched from Connecticut into Vermont and held back the floodwaters of retreating glaciers. The sediments carried down the river and from streams in the uplands made the Connecticut River Valley the productive farmlands we see today. As a result of its higher elevation, Leverett was above the water level of the ancient lake and never received the influx of glacial deposits. The main geology of the Bill Rivers parcel is characterized by large areas of shallow bedrock and abundant
rock outcrops. These outcrops can be seen throughout the property and all the bedrock is predominantly granite. Along Doolittle Brook, there is a narrow swath of floodplain alluvium, which is made up of “unconsolidated sedimentary deposits”, which is subject to flooding. Further to the south and west of the property, there is more glacial till and deposits as the elevation drops toward the river.

Map 8. Geology of the parcel and surrounding area showing bedrock outcrops and glacial deposits
Map 9. Geological formations and type of bedrock found in the area

3. All GIS data obtained from MassGIS website
The elevation of the property ranges from 393 feet along Doolittle Brook to 718 feet along the ridge in the northeast corner of the parcel. The descent along the main trail from the western boundary down to the stream is very steep in some parts, with the soil survey categorizing the slope from 25 to 45 percent. From the brook, the terrain then steadily rises to the east, culminating in the outcrop that provides good views of Mt. Toby to the west. It is a fairly consistent rise in elevation, but becomes quite steep midway through the property. The main trail turns south right before the elevation really increases and the slopes in this area range anywhere from 15 percent to as much as 50 percent. Due to the steep slopes and exposed rock outcrops on the eastern half of the property, any proposed trails in this area must be carefully placed to avoid erosion of the already thin soil layer. This property showed prior disturbance to the forest landscape with a few old stumps and cut downed trees near the recreation trail. There was evidence of old stone walls and the composition of the forest resembled that of an abandoned field left to regenerate on its own. There is no evidence of recent forest activity as the property is full of forest litter and dead trees.

Map 10. US Geological Survey topographic map of the parcel and surrounding area
Wildlife Habitat

The 53 acre property contains multiple areas of water, including two perennial streams running through the top and bottom of the area. Two steel bridges exist to aid in crossing the first stream at the beginning of the trail, before the trail goes slightly uphill and bears either left or right. Uphill from the first stream is a slightly open, flat area which smaller seasonal creeks run through the undergrowth. At the time of the inventory there were large amounts of snow on the ground, and much of this standing water could be attributed to melt and runoff from the snow. In the northeast, or at the top of the property, there is a second stream. It sits behind the peak of the property, in a valley behind a steep elevation from the first stream.

There are several thick stands of hemlocks as well as areas of younger white pines. Red oak, white oak, sugar maple, red maple, white ash, hop-horn beam, muscle wood, and several birch species are the majority of the hardwood species present. In the northwest portion of the property, there is a large area of old dead trees, snags and cavity trees. Snags are older, dead trees that lack the top of them and many of the branches. They can be missing much or all of their bark depending on how long they have been dead. Cavity trees are trees that have holes or hollows in them that different species can live in such as pileated woodpeckers or porcupines (images 16 and 17). These are prime areas for wildlife habitat, particularly for species that depend on cavity trees or older forested areas.

A drawback to this parcel is that there are no areas of early successional growth forest, which will prevent certain species that specialize on this type of forest from living in this area. However, because this is an unfragmented area of forest that is in biomap 2, it is an area with high quality core habitat that would benefit from being kept intact.

There are also areas of bushes and undergrowth that provide ground cover for smaller species of birds and mammals, as well as some rocky uphill areas towards the back of the property. The entire parcel has a variety of different microhabitats, smaller specific habitats within a larger habitat or ecosystem, including many species of plants and trees as well as sources of water and rocky outcrops.
BioMap2 is a tool developed by the Massachusetts Natural Heritage Endangered Species Program that aims to identify habitat critical for rare species and ecosystem diversity. Core Habitat identifies areas critical for the long term persistence of rare species, as well as diverse ecosystems with high levels of biodiversity. The main species of conservation concern in this habitat are marbled salamanders, eastern box turtles, spotted turtles, and wood turtles. While these species may not be present on the property, the larger surrounding habitat is likely to contain at least some individuals. Critical Natural Landscapes identifies large landscape blocks that have been minimally impacted by development. These large areas help maintain connectivity between habitats and often contain wide ranging species that need significant amounts of undeveloped land. Forest Core is a component of core habitat that includes large, intact forests that are not largely impacted by roads or development while Landscape Blocks are a component of critical natural landscapes that identifies the largest, most intact areas of natural vegetation and wetlands. As seen in the maps below, much of the property falls into several or all of these categories. These designations of critical habitat and landscapes are due to the proximity to the Paul C. Jones Working Forest, which is one of the largest protected forests in the region and state.
Map 11. Maps displaying Massachusetts Natural Heritage and Endangered Species Program information. Top map shows core habitat and critical natural landscape while the lower map shows core forest area and critical natural landscape blocks.
Recreation

Leverett has many open space areas throughout town and residents enjoy an abundance of recreational opportunities. There is an extensive trail system throughout town, which includes the East Leverett Meadow Trail, Friendship Trail, Robert Frost Trail, Bill Rivers Trail, Rattlesnake Gutter Trails, and Teawaddle Hill Farm Trails. The Bill Rivers property has a loop trail that traverses the western part of the property (map 8).

The Leverett Trails Committee has instituted a Trail Stewards/Adopt-A-Trail program as a method for maintaining trails throughout Leverett. An individual or a group identifies a section of a trail they wish to be the stewards of, and informs the trails committee that they will be responsible for the regular maintenance and repair of this trail. The goal of this program is to instill stewardship and an environmental ethic among Leverett residents, and to maintain the town's trails for regular use. It was suggested at the town's annual trails committee meeting that the school, or a specific class, become the stewards of the Bill Rivers Trail, given the school’s proximity to the property and as a potential learning opportunity. There are also several proposed trails located on the Bill Rivers property, see map 9.

Map 12. Trails on the Bill Rivers Property.
Map 13. Proposed trails on the property.
Methodology

Forest Ecology

The 53 acre plot of land called the Bill Rivers Conservation area has a highly diverse forest with both deciduous and conifer stands. The 53 acres is delineated into 4 distinct forest stands that are shown in map 14. This inventory gathered data on the overstory, understory, regeneration, site index, and coarse woody debris of each forest stand. To get an accurate sample 5% of each stand was inventoried using variable prism plots with 10-factor prisms. The amount of plots per stand was calculated by finding 5% of the acreage of each stand and the amount of plots is shown in table 2 and the location of the plots are shown in map 15 To make these plots random the grid overlay feature in SOLO forest was used to create cruise lines going west-east of the property. These lines will be going west-east because the slopes of the property are going north-south and to get the most variable data on transects it is best to go the opposite of what the slopes are going.

At each plot species, tree height, diameter at breast height (DBH), crown classes, merchantable height and snags will be measured. The tree height and DBH determines the quantity of the trees. Height will be measured with a clinometer and DBH will be measured with a Biltmore stick and/or diameter tape. The crown class and snags will help to determine the forest structure. The crown class will be measured by categorizing the trees into dominant, co-dominant, intermediate and suppressed. Merchantable height is measured by using a Biltmore stick 66 feet away from the tree and measuring from the stump height up to a four inch top of the tree or until there is a large defect like a cavity or a large branch. Snags will be documented on every plot and only the DBH will be measured if it is dead.

The site index was also measured to determine the site’s overall ability to grow wood. This was measured by first finding the overall height of the tree by using the clinometer. Then a device called an increment borer is used to drill into the side of the most dominant tree and it extracts a tree core (image 3). This core shows the rings of the tree which is then counted to determine its age. Then the age and height is plotted on an existing graph that depicts the optimal growing curve of a particular species.

A regeneration study was also conducted to estimate the possible future of the forest stand. At each plot center a micro-plot of a fixed 10 foot radius was conducted and any stems 6 inches or smaller within the 10 feet was counted as regeneration.

A coarse woody debris survey was also conducted. Starting at plot center a 100 foot transect was created in the direction of the next plot and any coarse woody debris that was over 3 inches in diameter and 3 feet long that the 100 foot tape fell on was recorded as down woody debris. These transects can be seen in map 16. This data was then analyzed through a program that the US Forest Service provides called NED. Ned analyzed all the data and gave information on the overall forest structure, volume and diameter of each stand.
Map 14. Forest stands delineation.
<table>
<thead>
<tr>
<th>Stand</th>
<th>Acres</th>
<th>Type</th>
<th>Number of plots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand 1</td>
<td>18</td>
<td>Hemlock – Hardwood</td>
<td>8</td>
</tr>
<tr>
<td>Stand 2</td>
<td>27</td>
<td>Oak – Pine</td>
<td>10</td>
</tr>
<tr>
<td>Stand 3</td>
<td>13</td>
<td>White Pine – Hemlock</td>
<td>6</td>
</tr>
<tr>
<td>Stand 4</td>
<td>3</td>
<td>Mixed Hardwood - Hemlock</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. Stands broken down by acres, type and number of plots per stand.

Map 15. Measurement plots on the Bill Rivers property
Image 3. Above is a red oak tree core and below is a white pine tree core from the Bill Rivers Conservation property.
Invasive Species

We did not end up finding any invasive plant species. The method used to obtain this data was using transects on a GPS system. We walked 18 transects that were 100 feet each, and checked along each one for invasives, and never found any. This does not mean that there are not any invasive species, as our data obviously does not cover the entire property, but it is still a good sign.
Wildlife

Remote Cameras

Three remote cameras were placed at designated points along three transect lines. Cameras were left at each point for two weeks at a time before being moved to the next spot. The process of putting a camera out is simple; a tree is chosen in the area that will provide an appropriate base for the camera to be anchored on, as well as an unobstructed view of the target area. A strap is attached around the tree, holding the camera as flush as possible to the trunk, and the camera settings are programmed to choose how often pictures should be taken when the motion sensor is triggered as well as how many photos should be taken in one interval. Cameras should generally be placed overlooking an opening in the forest, preferably along a game trail or other area that shows signs of activity. They should be placed to the north or east, to avoid interference from the sun. Another important reminder is to make sure branches (especially pines) and understory growth are not too close to the camera. The motion of these objects in the wind can trigger the camera and leave you with hundreds of blank photos to sort through. Attractants are often used to lure animals in and although food bait is often frowned upon, scent lures can be purchased and used. For many of the cameras in this inventory, a scent lure consisting of ground up roadkill was used to draw in curious and hungry animals.

The cameras were first set out in mid-February. One was placed along the eastern bank of Doolittle Brook while the other two were placed just off the main hiking trail. Tracks in the snow in these areas indicated the presence of deer, fox, and possibly a bobcat, which made this a prime location for placing cameras. Placing cameras near water is usually a safe bet for recording images of many different species. Two week later, the cameras were all moved east along the designated transect lines, placing them midway through the property, along the steep slopes. In general, each point along the camera transect line is 1,000 feet apart. Several weeks later, the cameras were moved for a final time, with two placed on the far eastern edge of the property near Black Brook and the third placed back along Doolittle Brook.
Track Boxes

Another method used to survey wildlife on the property was track boxes. These corrugated plastic boxes are three feet along with wire mesh on one end and a one foot by one foot opening on the other end. A piece of sheet metal on the bottom of the box allows the track plate to slide in and out. A piece of adhesive contact paper is placed on the sheet metal and bait, in this case raw chicken, is placed near the enclosed end. The entrance of the box is sprinkled with coco powder and any animal that walks into the box will leave footprints behind.

Image5. Track box along Doolittle Brook

In general, track boxes should be placed along areas of obvious animal movement and stream banks are excellent locations. The boxes should be flush with ground so even the smallest animals can enter and the entrance to the box should face downhill to avoid running water when it rains. We placed the two boxes out for two weeks at a time and replaced the paper, bait, and coco powder each time out. Initially the boxes were placed along the western bank of Doolittle Brook with one to the north of the bridge and one south of the bridge. When the boxes were moved, we placed them in similar areas on the eastern bank of the brook.

Bird Survey

The bird survey count was conducted on April 20, 2013. Due to the seasonally cool spring weather, many migrant species have yet to return and the majority of birds seen during this inventory were year round species. To conduct the survey three transect lines were chosen. These lines span west to east across the property, which covers a wide gradient of elevation and environmental conditions. Five survey points, each 500 feet apart were placed along the transect
lines for a total of 15 points. The survey is conducted by standing the point for ten minutes and identifying any bird heard or seen within a 50 meter radius. This process is repeated for each point and provides a general idea of species present on the property and the type of habitat that is preferred.

Map 17. Bird survey transects.
Archaeological and Cultural Resources

Interviews

Interviews were conducted with an employee at the elementary school and with a Leverett resident, Eva Gibavic, who does research on the Native American stone structures. A ceremonial landscapes preservationist with the Narragansett Indian Tribal Historic Preservation Office was also contacted and provided information, although a formal interview was not conducted. Interview questions with the school teacher included the following:

➢ Do you think a pamphlet or informational sign located at the trailhead kiosk, that would include information on these archaeological sites, would be beneficial to people who visit the property? If so, what specific information would you want to be included and people to know about?
➢ Does the school teach about these stone structures and Leverett's Native American history?

Interview questions with Eva Gibavic included:

➢ What is the significance of the stone structures on the Bill Rivers Conservation Area property?
  ▪ Has anyone from a tribe or other agency officially examined and documented these sites?
  ▪ What is the history behind these structures and when were they discovered on the property?
  ▪ How do these structures tie into the larger historical context of Leverett?
  ▪ Do visitors and/or residents come to this property specifically to see the stone structures?
➢ How have these Native American stone structures in general influenced the culture in Leverett?

Recreation

Trail Sign-In Sheet

A sign-in sheet was placed at the trailhead kiosk on March 13th as a tool to gauge the number of people using the trail on a daily basis. The sign explained what our class is doing on this property and that having an idea of how many people use the trail daily helps inform the recommendations made in the final report. Unfortunately, the sign in sheet was torn down and the information lost. The sign is included at the end of this report.

Trails Committee Meeting

The Leverett Trails Committee held its annual meeting on March 3, 2013 at the Leverett library. The committee was started about 2 1/2 years ago and is focused on trails throughout Leverett, including the trails at the Bill Rivers property. One of the goals of the committee is to identify what residents are looking for in their trails and any new projects that would potentially create new trails. Maps of Leverett's trails are currently disseminated at the Leverett Library; however, the committee plans to distribute maps at several other locations throughout town to
raise awareness of the trails. The trails committee faces several challenges with the maintenance of Leverett’s trails. As new trails are built, the town must figure out a way to balance the maintenance of old and new trails. Determining how much and what kind of signage along trails is an important goal for the trails committee, and they must balance the wilderness of the trails with providing information for the public. Signage is also important for differentiating town-owned land and private property, as many trails, including the Bill Rivers Trail, abut private property.

The trails on the Bill Rivers property were established by the trails committee during two workdays. The trails committee is also planning to place poetry boxes at several trailheads throughout town, including the Bill Rivers kiosk. These boxes will include poems, photographs, maps, and other information regarding the town or that trail that anyone can place in the box. For the Bill Rivers property, the poetry box has the potential to include information produced from this class, in addition to the kiosk.

Interviews

An interview was conducted with an employee at the school. Since the school is adjacent to the property, it was assumed that school employees might have an understanding of the recreational use of the property. The following questions were asked to an employee from the school:

- How would you characterize the use of the trail and other recreational activities that occur on the Bill Rivers Conservation Area property? What are the intentions of people using the trail? (ie. Dog walking, exercise, wildlife observation etc.)
- Are there proposed trails on the property?
- How does this property compare to other conservation areas in Leverett that provide recreational opportunities? (eg. Do more people use this property during a certain time of the year compared to another property, which area of town receives the most recreational users?)
- Please describe any school events or library programs that occur on this property throughout the year.
- Do you think a pamphlet or informational sign placed at the trailhead kiosk would be beneficial to residents and/or visitors using this property? If so, what types of information would you want included in the pamphlet or sign?
Results and Recommendations

Forest Ecology

Stand Description

Hemlock – Hardwood

This 18 acre hemlock hardwood stand is located on the west side of the property and is dominated in the overstory by mostly eastern hemlock and eastern white pine as they make up 69% of the basal area in this stand. The other minor species present was red maple, sweet birch, yellow birch and red oak. The regeneration was mostly eastern hemlock and red maple as they were found in one third of the stand. Doolittle brook runs through this stand which brings in a lot of water and nutrients which helps out the species that like rich sites like red maple and hemlock. Elevation in this area is also low as the slope gradually gets higher the further east into the property.

Hemlock wholly adelgid was found in this stand and it has a major impact on the future forest landscape and management goals. This will be discussed in the forest health section.

<table>
<thead>
<tr>
<th></th>
<th>Mean Diameter (in.)</th>
<th>Density (Trees/Acre)</th>
<th>Basal Area (Ft²/Acre)</th>
<th>Cordwood Vol. (Cords/Acre)</th>
<th>Sawtimber Vol. (BF/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Hemlock</td>
<td>9.1</td>
<td>160</td>
<td>43.7</td>
<td>9</td>
<td>2,339</td>
</tr>
<tr>
<td>Eastern White Pine</td>
<td>13.5</td>
<td>38.9</td>
<td>38.8</td>
<td>10</td>
<td>3,533</td>
</tr>
<tr>
<td>Red Maple</td>
<td>8</td>
<td>110.1</td>
<td>34.3</td>
<td>7</td>
<td>1,012</td>
</tr>
<tr>
<td>Sweet Birch</td>
<td>7.5</td>
<td>16.4</td>
<td>5</td>
<td>1</td>
<td>77</td>
</tr>
<tr>
<td>Yellow Birch</td>
<td>7.3</td>
<td>8.7</td>
<td>2.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Red Oak</td>
<td>16</td>
<td>0.9</td>
<td>1.3</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>335</td>
<td>125.6</td>
<td>27</td>
<td>27</td>
<td>7,061</td>
</tr>
</tbody>
</table>

Oak – Pine

This 27 acre oak pine stand is located just east of the hemlock hardwood stand and is dominated by eastern white pine with 34% of basal area and northern red oak with 31% of basal area in the stand. The other minor species in this stand are sweet birch and red maple. A couple paper birches and White oaks were counted but not a large sample was found. This stand is dominated with large sections of white pine regeneration as 70% of the stand was found to have
some white pine regeneration and NED calculated over 1,000 stems per acre. Sweet birch is the next prevalent regeneration species as it appeared on half of the stand and red maple was next appearing in 40% of the stand. The west side of this stand is relatively level with minor slopes. The eastern side of the stand has major slopes and elevation change.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Diameter (in.)</th>
<th>Density (Trees/Acre)</th>
<th>Basal Area (Ft²/Acre)</th>
<th>Cordwood Vol. (Cords/Acre)</th>
<th>Sawtimber Vol. (BF/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern White Pine</td>
<td>10.2</td>
<td>1,695.7</td>
<td>37.1</td>
<td>9</td>
<td>3,189</td>
</tr>
<tr>
<td>Red Oak</td>
<td>9.7</td>
<td>65.9</td>
<td>34.1</td>
<td>8</td>
<td>1,454</td>
</tr>
<tr>
<td>Red Maple</td>
<td>6.9</td>
<td>75.7</td>
<td>16.9</td>
<td>3</td>
<td>758</td>
</tr>
<tr>
<td>Sweet Birch</td>
<td>4.3</td>
<td>175.2</td>
<td>11.6</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>Eastern Hemlock</td>
<td>10.8</td>
<td>19.5</td>
<td>6</td>
<td>1</td>
<td>269</td>
</tr>
<tr>
<td>Paper Birch</td>
<td>9.2</td>
<td>6.5</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>White Oak</td>
<td>12</td>
<td>2.6</td>
<td>2</td>
<td>0</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2,041.1</td>
<td>110.7</td>
<td>24</td>
<td>5,809</td>
</tr>
</tbody>
</table>

White Pine – Hemlock

This 13 acre white pine hemlock stand is located to the west of the oak pine stand and is dominated by eastern hemlock with having 47.5% of the basal area in the stand. The next major species present was red oak at 26.6% and white pine at 11.7% of the stand. Other minor species found were red maple, white oak and sweet birch. Eastern hemlock is the most prevalent species for regeneration as it was found in two thirds of the stand. Red maple is also a dominant regeneration species as it was found in half of the stand. Sweet birch, white pine and red oak had some regeneration but were only found in less than 20% of the stand. This stand has heavy slopes and has the highest elevation of all other stands.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Diameter (in.)</th>
<th>Density (Trees/Acre)</th>
<th>Basal Area (Ft²/Acre)</th>
<th>Cordwood Vol. (Cords/Acre)</th>
<th>Sawtimber Vol. (BF/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Hemlock</td>
<td>7.2</td>
<td>232.9</td>
<td>61.1</td>
<td>8</td>
<td>1,453</td>
</tr>
<tr>
<td>Red Oak</td>
<td>4.2</td>
<td>367.1</td>
<td>34.3</td>
<td>8</td>
<td>1,852</td>
</tr>
<tr>
<td>Eastern White Pine</td>
<td>10.6</td>
<td>57.8</td>
<td>15</td>
<td>3</td>
<td>1,124</td>
</tr>
<tr>
<td>White Oak</td>
<td>12.9</td>
<td>7.4</td>
<td>6.7</td>
<td>2</td>
<td>247</td>
</tr>
<tr>
<td>Red Maple</td>
<td>4.2</td>
<td>11.8</td>
<td>7.9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sweet Birch</td>
<td>4.1</td>
<td>58.2</td>
<td>3.7</td>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>735.2</td>
<td>128.7</td>
<td>23</td>
<td>4,796</td>
</tr>
</tbody>
</table>
Mixed Hardwood – Hemlock

This 3 acre mixed hardwood hemlock stand is located on the east side of the property and is dominated by eastern hemlock with 30% of the basal area in the stand. Silver maple (19%), American beech (17.3%), red maple (15.3%), and white pine (9.5%) all are minor species in the stand. Red maple, eastern hemlock and American beech were the only species present in regeneration being found on half of the stand. This stand has a stream on the eastern border so it creates a rich site that is important for species like silver maple.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Diameter</th>
<th>Density (Trees/Acre)</th>
<th>Basal Area (Ft²/Acre)</th>
<th>Cordwood Vol. (Cords/Acre)</th>
<th>Sawtimber Vol. (BF/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Hemlock</td>
<td>9.3</td>
<td>65.6</td>
<td>30.9</td>
<td>8</td>
<td>3,039</td>
</tr>
<tr>
<td>Silver Maple</td>
<td>15.1</td>
<td>16.2</td>
<td>20</td>
<td>6</td>
<td>1,729</td>
</tr>
<tr>
<td>Red Maple</td>
<td>6.9</td>
<td>62.2</td>
<td>16.1</td>
<td>4</td>
<td>1,152</td>
</tr>
<tr>
<td>Eastern White Pin</td>
<td>21</td>
<td>4.2</td>
<td>10</td>
<td>3</td>
<td>1,146</td>
</tr>
<tr>
<td>American Beech</td>
<td>7.6</td>
<td>57.8</td>
<td>18.2</td>
<td>2</td>
<td>874</td>
</tr>
<tr>
<td>Red Oak</td>
<td>24</td>
<td>1.6</td>
<td>5</td>
<td>1</td>
<td>584</td>
</tr>
<tr>
<td>Sweet Birch</td>
<td>12.5</td>
<td>5.9</td>
<td>5</td>
<td>1</td>
<td>323</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>213.5</strong></td>
<td><strong>105.2</strong></td>
<td><strong>25</strong></td>
<td><strong>8,847</strong></td>
<td></td>
</tr>
</tbody>
</table>

The story of this forest resembles the story of a large chunk of Massachusetts forests. It might be hard to fathom but just over 150 years ago forests in New England were almost completely cut. 60 to 80 percent of all Massachusetts forests were cut for agriculture with Leverett directly affected. Once the farms died and started locating out of Massachusetts and more out west, the forest started to regenerate and by around 1910 a lot of these old fields have become second growth white pine stands. At this time white pine was a valuable tree species as it was used extensively with the shipping box business so these white pine stands eventually got cut. Today what we are seeing in this forest is the hardwood regeneration from this last pine cut back in the early 1900’s (image 6). This section borrowed heavily from the Harvard Forest dioramas and if you are interested in learning more about the history of the New England forests you can go here: http://harvardforest.fas.harvard.edu/dioramas

To find the quality of the wood growing in a stand the best measurement would be to use a site index. A site index is a relative measure of a specific species of tree that depicts the productivity of the site. A site index is a graph that has tree height on the Y-axis and tree age on the X-axis. There are then multiple site index curves that have been measured and calculated from previous forest sites. When the tree is put on the graph whichever curve it lands on determines if the sites productivity as above average, average, or below average. Two dominant trees were chosen on the Bill Rivers Conservation property to determine site index, one white pine and one red oak. The white pine was 85 feet and had a tree age of 75, when put on the graph it had a site index of 60 which is average. The red oak was 80 feet tall and had an age of 75, when put on the graph it had a site index of 65 which is actually above average for a normal red oak (image 7). What this means is that the white pine on the stand is growing at an average rate yet the site productivity is better than average for red oak. If the property was managed for forestry red oak would be the favored species to try and grow.

Doolittle Brook runs through the west side of the property in the hemlock hardwood stand (image 8). This brook is important for two reasons, it is a part of the Connecticut River watershed and this brook has been classified as a Coldwater Fisheries Resource (CFR). A CFR stream means that it is a high quality body of water for cold water fish reproduction like trout. (http://www.mass.gov/dfwele/dfw/fisheries/conservation/cfr/cfr_home.htm) The hemlock hardwood stand helps support the quality of the stream by keeping erosion of the banks to a minimum and to provide shade to the water. Trout need the water to be cool because respiration rates in aquatic animals can increase by 10% or more for every 1°C increase in water temperature. Animals respiring at higher rates require more oxygen, but dissolved oxygen decreases as water temperature rises. Just a change of 5°C can kill a trout so keeping the water temperature down is crucial. The mature hemlocks, white pines, and red maples are keeping the water cool year round.

Going east away from the brook and up slope the forest transitions from a hemlock hardwood stand to an oak pine stand. This is the biggest stand on the property with 27 of the 53
acres located in this stand. Besides being the biggest it would also be the most valuable stand in terms of timber production. Northern red oak is a valuable timber species in New England as it is averaged at $200 per thousand board feet. Our inventory found that for just the red oaks alone an estimate of $218 per acre or $5,886 for the stand could be obtained. Although this stand has a lot of monetary value this area is likely to be more valuable to wildlife and recreation. Being a mixed oak and pine stand creates diversity for wildlife species. The white pine gives cover and forage to large mammals like deer while oak helps out small mammals like squirrels with acorn forage. Oaks also creates nesting locations for birds and their dead snags helps woodpeckers with their foraging. With the nice diversity of trees and the low slopes this area is really valuable to recreation. There is already a lot of use in this stand as the main walking trail goes through it (map 19). With the easy incline and nice diversity of trees and wildlife this area maintains a high recreational value.

Further east from the oak pine stand the forest transitions back to a more conifer dominant overstory as about half of this stand is covered with eastern hemlock. This stand does not offer much value in terms of timber production as it is dominated by low quality hemlock and the stand has steep slopes as much as 50%. This stands only real value would be wildlife habitat or recreation for hikers. This also goes for the last stand which is a mixed hardwood hemlock stand but as it is only 3 acres and with another stream abutting it on the east there is no other option then to leave it.

Image 6. Hardwood regeneration from old white pine stands.
Image 7. Site index curves for eastern white pine and northern red oak.

Image 8. Doolittle brook running through the west side of the property.
Understory

With the heavy winter and cold spring there was not a lot of understory species present at the time of collecting data for the inventory. The species identified with minor occurrences was tree clubmoss (Lycopodium obscurum) and partridgeberry (Mitchella repens). One understory shrub that was found in a few locations was mountain laurel (Kalmia latifolia). This species was abundant in patches throughout the forest (image 9). With the growing season in full force a second separate inventory could be done on just the understory.

**Regeneration**

Eastern hemlock and white pine were the two most abundant species found to be regenerating throughout the stand. Eastern hemlock regeneration was found in all of the stands and at a pretty abundant rate of at least a frequency of over 30% with the exception of the oak pine stand. White pine was most abundant in the oak pine stand and there were sections of this stand with extremely high sapling count as one plot had as much as 70 saplings in one 10 foot diameter (image 10). There was very little hardwood regeneration especially with the oaks as red oak was found in only two out of the four stands and with low frequency. This could be because
of the high deer population on the property. Deer like to forage hardwood regeneration so when there is little sign of regeneration of hardwoods it is usually caused by deer destruction.


**Coarse Wood Debris**

Coarse woody debris (CWD) is often overlooked in forestry but it is a very important part to the forest composition. CWD is exceptional to have in the forest for two reasons; one because snags and down woody debris are essential habitat conditions for wildlife. Secondly CWD recycles the nutrients back into the forest and is a host for many fungi and insects. The Bill Rivers Conservation area has a good amount of coarse woody debris (image 11). Out of the 26 plots, 23 of them were found to have at least one dead tree and some had multiple. 16 100-foot transects were recorded randomly throughout the whole property to find how much downed woody debris is on the property. We measured the amount of CWD in a measure called cords. A cord is the volume of wood that is stacked 4 feet wide, 8 feet long, and 4 feet high. The total amount of CWD sampled on the property came out to be 12.28 cords which is a good level for old growth characteristics which will be discussed more in the recommendations section. Snags
that are 12 – 18” in diameter are the most ideal for wildlife and the average of snags of that size came out to 2.75 per acre. The average of snags over 18” was 0.375. Both of these numbers show that there are good quality snags for wildlife already on the propert
Recommendations

Forest management is crucial to maintaining a healthy and sustainable forest. The recommendations on forest management is based on the landowner goals that was discussed earlier in this report. The most important values to manage is wildlife and recreation with little interest in timber production. Managing for wildlife can be very difficult as some species like certain types of forest structure as their habitat. There is a large amount of diversity already on the site as described in the wildlife section of the report. The forest structure works well for the diversity of wildlife however the forest is pretty uniform with even aged stands and not much diversity of the forest structure only with species diversity. There are two different types of habitats missing in the forest, they are early successional habitat and forests with “old growth” characteristics. Recommendations will be made for creating those two types of habitats, managing for water quality, and a do nothing management approach.

Managing for early successional habitat

Early successional habitat is either grasslands, shrublands or young forests. These habitats are usually created by large disturbances such as wildfire or clearcutting. Some species that were captured with the wildlife cameras like the wild turkey thrive in early successional habitats. Lots of song birds also thrive in this habitat so creating the habitat could bring in more species of birds that would enhance the recreational value.

Early successional habitats only work on large undeveloped land like the 53 acres of the Bill Rivers property because these habitats only thrive if there are large continuous tracts of forest surrounding it. The best way to artificially create early successional habitat is to create little ¼ to 2 acre patch openings. These openings can also enhance recreational value by creating an educational experience describing what these small openings are.

More information on early successional habitat for forest openings can be found here: http://www.wildlife.state.nh.us/Wildlife/Northeast_Mgt_Guide/Ch06_Managing_Forest_Openings.pdf
Managing for “old growth” characteristics

Old growth forests are the rarest type of habitats in New England as there is only one tenth of one percent of the forests as old growth. It would take hundreds of years to grow true old growth forest but there is a way to manage for old growth characteristics. Bird species such as the pileated woodpecker and the wood thrush are some species that succeed in old growth forests. The characteristics of old growth are forests that have a large diversity of tree ages and sizes, gaps in the forest canopy, large cavity trees, and large downed trees.

To speed up the process of old growth those four characteristics need to increase significantly than what is currently in the forest. From the coarse woody debris sampling there actually is already a large amount of downed trees where it came out to 12.28 cords of wood per acre. A normal old growth forest has 15 cords of wood per acre so the 12.28 is very close to old growth standards. For snags old growth forests usually have 2-3 times more snags per acre then the second growth forests. The amount of snags per acre found in this property was 2.75 for trees 12-18” in diameter and 0.375 for snags about 18” in diameter. The minimum targets for old growth characteristics are 4 per acre for trees 12-18” and 1 per acre for trees above 18”. The best way to meet these targets would be to girdle selected trees that are at least double the tree height away from any recreational walking trails. Finally to increase the diversity of tree ages and sizes the best way would be to fell some trees to create openings in the canopy and leaving the trees on the floor. This will create a multi aged stand and also increase the number of downed trees in the area.
More information on managing for old growth characteristics can be found at: http://masswoods.net/information-on/restoring-old-growth-characteristics

Image 13. Old growth forest before American settlement. Taken from the Harvard Forest dioramas.

**Managing for water quality**

As stated in the results section the Doolittle brook runs through the west end of the property and that is a very crucial body of water for trout production and that it is part of the Connecticut River watershed. The best way to maintain healthy water is to have a healthy forest because they are a natural filter to clean water. Having a robust overstory also keeps the sun off of the water which keeps the temperature down. The best way to manage water quality is to not cut anything along the water. If it was decided to have a timber harvest make sure to create a buffer of at least 50-100 feet from the water as a no cut zone.
Do nothing approach

Forests do not need to be managed to change the forest composition as they will over time with natural disturbances such as wind, ice and lightning. The approach to do nothing will allow the forest to grow naturally and maintain the already high recreation and wildlife value. There are few large tracts of forest in Massachusetts and the value to keep this forest intact may be more important than any management opportunity. This forest also abuts the Paul C. Jones working forest which is an actively managed forest of 3,486 acres. To keep the Bill Rivers Conservation area intact and continuous next to this large heavily managed forest is important to the biodiversity in the area.
In order to keep out any invasive plants that might be in the block of forest surrounding the property, precautionary actions are necessary. The best way to keep invasive plants out of an uncontaminated area is to make sure no one accidentally carries any hitchhiking invasive seedlings onto the property. This can be prevented by making sure any people who like to hike
different trails make sure they clean off any equipment they have taken onto another property, to ensure there are no seeds belonging to an invasive species. Basically the only way to implement this plan is to educate people, possibly by having something about the prevention of invasive plant species in the information kiosk. People need to be told that they have to check anything they have brought into other areas of forest to make sure no hitchhiking seedlings are present.

Keeping invasive species out of an area is so important because these non-native plants can easily take control of large parts of understory area. They move in and dominate understories and push out native plants due to their ability to out compete everything that is already there. This happens because when an invasive is introduced to an area, there are no natural consumers of the plant to keep it controlled, which leads to the invasive spreading to any open space it can find. They typically are also able to grow and spread faster than the native plant species. Checking the site for any invasives on a fairly regular basis would be recommended, because once the invasive intrudes on an area, the outcome could be detrimental. One recommendation for this would be to set up a time that volunteers can come and do this with someone supervising them. I worked for Habitat in Belmont for a summer, which is a branch of Mass Audubon, and they have a weekly volunteer program called pulling partners. Everywhere, a good number of people would show up and their job would be to remove any invasive plant species we could find by hand removing them. It was interesting because the volunteers really seemed to enjoy being part of helping the property of forest land, especially the children, which brings me to the next point. Even if you were having trouble bringing volunteers in, I think having groups of children from the school do this activity would be a great idea. The children I worked with really liked the idea of being able to accomplish something, especially after explaining to them the dangers of what invasive plant species can do to a forest. Here is a link to their website explaining what they do:

http://www.massaudubon.org/Nature_Connection/Sanctuaries/Habitat/get_involved.php

Even though we did not find any invasive plant species, we did come across an invasive insect. We found a hemlock covered with hemlock woolly adelgid next to the first stream on the property. We later returned to the tree and set up 4 transects going 100 feet north, south, east and west away from the original tree (map 21). Unfortunately, we found in our small sample size that there were several hemlocks that had been infected with the pesky woolly adelgid. We found 3 infected hemlocks each going west, south and east, while for some reason north did not have any infected trees. The absence of HWA is important information, because some hemlocks are immune to the attack of this insect. Really the most important thing people can do is report hemlocks that have NOT been affected, rather than reporting ones that have been. Swift and aggressive action needs to be taken as the HWA spread reasonably quickly if nothing is done, and can kill all the hemlocks within an area within a decade. Already 50% of the hemlocks on the east coast have been attacked by the tiny insect, and it is just a matter of time before even more fall victim to the pest, unless something is done about it.
Map 21. Transects for hemlock woolly adelgid detection.

Wildlife

In total, 26 species were observed on the property, in addition to small, unidentified fish seen in Doolittle Brook. After completing field work and analyzing pictures and data, the following species were observed on the property:

<table>
<thead>
<tr>
<th><strong>Taxonomic Group:</strong></th>
<th><strong>Common Name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibian</td>
<td>Red Back Salamander</td>
</tr>
<tr>
<td>Amphibian</td>
<td>Dusky Salamander</td>
</tr>
<tr>
<td>Amphibian</td>
<td>Spotted Salamander (Egg Mass)</td>
</tr>
<tr>
<td>Taxonomic Group:</td>
<td>Common Name</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Bird</td>
<td>Wild Turkey</td>
</tr>
<tr>
<td>Bird</td>
<td>Chipping Sparrow</td>
</tr>
<tr>
<td>Bird</td>
<td>Tufted Titmouse</td>
</tr>
<tr>
<td>Bird</td>
<td>Pine Siskin</td>
</tr>
<tr>
<td>Bird</td>
<td>White-Breasted Nuthatch</td>
</tr>
<tr>
<td>Bird</td>
<td>Black-Capped Chickadee</td>
</tr>
<tr>
<td>Bird</td>
<td>Winter Wren</td>
</tr>
<tr>
<td>Bird</td>
<td>Eastern Phoebe</td>
</tr>
<tr>
<td>Bird</td>
<td>American Crow</td>
</tr>
<tr>
<td>Bird</td>
<td>Hermit Thrush</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Bird</td>
<td>Downy Woodpecker</td>
</tr>
<tr>
<td>Bird</td>
<td>Brown Creeper</td>
</tr>
<tr>
<td>Bird</td>
<td>Pileated Woodpecker</td>
</tr>
<tr>
<td>Bird</td>
<td>Turkey Vulture</td>
</tr>
<tr>
<td>Bird</td>
<td>Red-Tailed Hawk</td>
</tr>
</tbody>
</table>

Image 17. Wild Turkey on remote camera

<table>
<thead>
<tr>
<th>Taxonomic Group:</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammal</td>
<td>Bobcat</td>
</tr>
<tr>
<td>Mammal</td>
<td>Coyote</td>
</tr>
<tr>
<td>Mammal</td>
<td>White-tailed Deer</td>
</tr>
<tr>
<td>Mammal</td>
<td>Fisher</td>
</tr>
<tr>
<td>Mammal</td>
<td>Gray Fox</td>
</tr>
<tr>
<td>Mammal</td>
<td>Virginia Opossum</td>
</tr>
<tr>
<td>Mammal</td>
<td>Raccoon</td>
</tr>
<tr>
<td>Mammal</td>
<td>Eastern Gray Squirrel</td>
</tr>
</tbody>
</table>

Image 19. A bobcat caught on camera along Doolittle Brook

Image 20. A coyote caught on camera near the southern property line
Image 21. White-tailed deer along Black Brook on the eastern edge of the property.

Image 22. A raccoon investigates the track box along Doolittle Brook.

Image 23. A fisher walks past the track box to the north of the bridge along Doolittle Brook.
Overall, there is a significant presence of wildlife on the property across a wide array of taxa. Several species observed including bobcat, fisher, and hermit thrush require large tracts of intact forest and their presence on the property is likely due to the nearby Paul C. Jones Working Forest. This large block of forest likely holds many species not found on smaller or developed properties. Many of the other species recorded use both forestland and edge habitat such as that found along the western boundary of the property. By entering vegetation and habitat characteristics into NE Wild, a computer program created by the US Forest Service, we estimate there are 221 species of amphibians(17), reptiles(20), birds(134), and mammals(50) that use habitat similar to that found in the Bill Rivers Conservation Area either seasonally or year round. It is most likely that there are many more species present on the property than we observed, but much less than the NE Wild report would suggest.

While the track boxes were somewhat inconclusive, the remote cameras provided an in depth look into the abundance of species in the area. Deer and raccoon were the most photographed species and wild turkeys were captured on multiple cameras as well. Deer scat is very prevalent on the property and all signs point to a large, healthy population in the area. While the bird survey observed 14 species, this number will increase remarkably as the breeding season nears. The diversity of habitat available, as well as the size and number of cavity trees all point towards a healthy population of resident and breeding species. The highest concentration of wildlife, both observed during the bird survey and on camera, is around the two streams crossing the property. In addition to animals relying the on stream for food and water, many species live in or along the river. The spotted salamander egg masses were seen in a small pool next to Doolittle Brook and both species of lungless salamander were found under logs near the brook. Small fish, possibly blacknose dace were observed in Doolittle Brook and areas of the stream seem deep enough to support additional species and possibly brook trout. There are significant signs of beaver activity along Doolittle Brook, although none recent. Beavers and other large aquatic species may use the stream as a travel corridor between larger bodies of water.
Wildlife Management Recommendations

This area has great potential to be used as a learning opportunity by the school as well as the library, and there are many local species present on this parcel. The dead trees, snags, and cavity trees are crucial to the species that depend on them, such as pileated woodpeckers, northern flickers, porcupines and other smaller songbirds that nest in holes in the trunks of these trees. According to the forest inventory, there were 23 snags in the 26 plots inventoried. There were 2.75 snags that were 12-18” DBH per acre, and 0.375 snags that were over 18” DBH per acre. This is a significant amount for the size of the property, and leaving them on the property will increase the habitat for species that specialize on them. Although they tend to make a forest look unsightly and unhealthy, they should not be completely removed from the property and some should be kept to provide habitat for certain species.
As mentioned previously, the parcel contains no real areas of early successional growth. One management recommendation could be to clear cut some small areas of the property to create these areas in the upcoming years, which would in turn diversify the landscape and provide more habitats for species that depend on this kind of forest growth. However, because over half of this property is considered to be in a biomap 2 core habitat area, small clear cuts to the property may detract from the integrity of the area. The habitat quality is important on this property especially for some of the core species that were sighted such as fisher and bobcat. There are always many options when dealing with a piece of property, and clear cutting will help to grow early successional forest. In this scenario however we would recommend that the core habitat present be kept intact.

According to the NE Wild species list, many other species that depend on the biomap 2 core habitat are present on this property. In addition to fishers and bobcats, animals such as red-shouldered hawks, broad-winged hawks, ruffed grouse, barn owls, great horned owls, porcupines, mink, river otter, black bear and moose are predicted to be present on the property, and managing for the core habitat that is currently present will increase the viability of these species on the property.

As for species management, it is evident through trail camera pictures as well as tracks seen on the property that there is a large number of white tailed deer on the property. The population present does not seem to be a nuisance at the moment, but it is something to keep in mind when thinking about managing the tree species present. If the deer population increases too
much, deer over browsing will decrease the health of the forested areas on the property. The abundance of young white pine and hemlock stands provide a safe area for deer to shelter during the winter, which increases their chances of surviving until the next year. A threat to these evergreen shelter trees is Wooly Adelgid, as mentioned earlier. It is important to monitor its presence because it would have detrimental effects on young white tailed deer surviving the winter to reproduce in the spring season. Many small paths were seen throughout the property, presumably used by larger groups of deer throughout the winter. Presently, this does not seem to be a problem but is something to keep in mind.

Image 28. A large stand of white pine regrowth

If this area is to be used as an educational tool for the school or library, signs or plaques along the trail would be a beneficial way to teach children about the importance of different areas and species on the property. Near the river, in the area where there are many snags and cavity trees, and in an area with young white pine trees would be areas of opportunity to places signs. There is also a bulletin board at the trail head for this property, which could be used to hang posters with information about the species that can be seen on the property and their importance to the local ecosystem. It is easy for people to be interested in the animals present in an area, but it is also important for them to understand the importance of habitat they depend on.
Archaeological Resources

The Bill Rivers property has a number of stone groupings that are thought to have derived from the early Native Americans. In order to gain more information on the specific stone structures on the property, informal interviews were done with two individuals. Eva Gibavic is a resident of Leverett and a regional specialist in Native American ceremonial stone structures, and Doug Harris who is a Preservationist for Ceremonial Landscapes with the Narragansett Indian Tribal Historic Preservation Office. Both Eva and Doug are experts on this topic, and would be good resources for the town to contact in the future regarding the stone structures.

Eva provided more general information on the stone structures in Leverett and some next steps that the town could take to identify the structures on the Bill Rivers property. Eva has discovered more than 10 general areas on nearby Brushy Mountain that have stone structures, with the number of stone features ranging from 1 to 60 at each location. It is possible that there are more on Brushy Mountain and on other properties throughout Leverett. For the Bill Rivers property specifically, Eva noted that it is difficult to determine the significance of the stone structures when pieces are still missing. Therefore, if the town desires to dig deeper into the stone structures on the property, it is recommended that the tribes be directly contacted. The town could also provide a tribe with pictures of the stone structures as a preliminary verification that they are Native American in origin.

Representatives from the Tribal Historic Preservation Office of the Narragansett and Wampanoag (Gay Head/Aquinnah) have visited other sites in Leverett to verify the stone structures; however, they have not been to the Bill Rivers property yet. According to Eva, she does not see the need to show the sites such as those on the Bill Rivers property, because they are not threatened as many other sites are.
The stone structures on the Bill Rivers property are not a main reason why residents visit the property, and generally in Leverett they are not considered a big selling point. This is good because, according to Eva, the stone structures are not monitored and there is no real protection of them. Generally, they have not been publicized; however, they do appear on some maps.

It is still not very clear what the exact connection is between the stone structures and the history of Leverett. Eva suggested this might need to occur at the property level by determining past ownership of a property to see how the land was used in the past and who owned it. Generally, the town's historical and archaeological community needs to recognize and understand these sites more. Because many of these sites were only discovered the past several years, it will take time for people to gain a better understanding and appreciation for the stone structures and work towards better protecting them.

Finally, Doug Harris from the Narragansett Indian Tribal Historic Preservation Office was contacted regarding the stone structures on the Bill Rivers property. He and Eva have worked together in the past to identify structures in other parts of Leverett and nearby towns. According to Doug, his native ancestors used the stone structures and their landscapes to communicate with Mother Earth as a way to maintain balance and harmony with all earthly creatures. He noted that once the structures have all been mapped, it is easier to determine their significance and relationship to one another. Therefore, the significance of the structures on the Bill Rivers property will need to be determined in conjunction with structures at different locations.

Recommendations

If the Town of Leverett decides to pursue the verification of the stone structures on the Bill Rivers property, it is recommended that Eva and Doug be contacted. Their contact information is below.

Eva Gibavic  
Email: evadeva22@gmail.com

Doug Harris, Preservationist for Ceremonial Landscapes  
Narragansett Indian Tribal Historic Preservation Office (NITHPO)  
(1-413-325-7691)

Both Doug and Eva mentioned the protection of the stone structures. While Leverett is included in the historic district originating from the structures found at the Turners Falls Airport, there is no other source of protection for these stone structures. According to Doug, the approach to protecting these sites so far has relied upon stewardship by local residents who keep an eye on
the sites. There have been no formal regulations put in place to protect these ceremonial stone structures.

For the stone structures located on the Bill Rivers property, possible actions could include placing a sign at each structure denoting the historical significance of the site and that visitors do not touch the structure. The conservation commission could also consider implementing a buffer zone surrounding the sites for added protection. Because many people do visit the property for recreation, and the school frequently uses the property, it is suggested that some form of protection be applied to these historic sites.

Recreation

One of the main goals for the recreational aspect of this inventory was to determine usage of the trail through a visitors sign in sheet that was placed at the trailhead (Appendix A). However, the sign in sheet was removed in early April by someone not associated with our class. Therefore, we were unable to gather any data on how many people use the trail. The sign is included in this report and could be used as a model if the conservation commission would want to gauge public use in the future.

Several town residents and people who work in town were contacted, including teachers at the elementary school, about the Bill Rivers property and how often people visit the property. One resident said she and her husband frequently use the trail for hiking with their dog, and that the bridges have made the trail much more accessible. This person also used to teach at the school and had always wanted to have an outdoor classroom on the property. Instead, she had to take her classes to Northfield Mountain to teach them activities such as orienteering and tracking. Another resident stated that she has taken her homeschool group recently to the property to use the hiking trail. Finally, one of the elementary school teachers stated that the property is generally used heavily by school groups and recreational hikers. In comparison to other town conservation lands, the Bill Rivers property is not as wet, so most likely has more users at certain times of the year than other properties do. The Bill Rivers property also provides good access to Brushy Mountain for bikers and hikers.

The school has an afterschool program that often uses the Bill Rivers property, and teachers sometimes take their classes onto the property. The fifth-graders at the school have also done plant and animal surveys on the property in the past. There are also preschool and elementary school groups that are led by a town resident onto the property. This resident shows the children plants and animal tracks, and leads greenhouse work using nearby local fields and the neighboring woods for plant related activities.

One of the teachers responded to all of the questions listed above under the methods section. In summary, he thinks that having a pamphlet or other form of information located at the trailhead kiosk is a good idea, as many people in the town have a lot of pride in Leverett and are interested in local history. Specifically for the information at the kiosk, he thinks that information
on plant and animal species, and the archaeological sites, would be of greatest interest to
residents using the trail. He also suggested including information on the history of the property,
including past ownership.

Finally, when asked if the school teaches about the stone structures and Leverett's Native
American history, he stated that the school brings fifth and sixth graders to Brushy Mountain on
occasion. These trips are usually accompanied by members of the Rattlesnake Gutter Trust, who
teach the children about Leverett history during and after the trip. Additionally, the kindergarden
class has done some units on Native American culture and history, including the Native
Americans who lived locally.

Recommendations

In order to encourage more use of the property by the school, it is recommended that the
school work with the conservation commission to designate a location for an outdoor classroom.
Having a designated spot would help decrease disturbance by schoolchildren throughout the
property. The outdoor classroom should also be located away from any stone structures in order
to minimize any further disturbance to them.

It is also recommended that information about the property be posted at the trailhead
kiosk. The brochure provided by this class would be good to place at the kiosk, so people using
the trail will have more understanding of the property. It might also be beneficial to post a trail
map at the kiosk, especially for people who are unfamiliar with the property.
Conclusion

The goal of this inventory is to provide the Leverett Conservation Commission with useful information regarding the Bill Rivers Conservation Area. The inventory revealed a dynamic environment which is home to an abundance of plant and wildlife species. The archaeological resources of the property make it unique, and it is a conservation area that is frequently used by residents and visitors. The recommendations are based on the findings of the inventory and are merely suggestions. We hope that the information provided in this report will be useful for the current and future management of the Bill Rivers Conservation Area.

Bibliography


Timreck, Ted. 2010. Great Falls: Discovery, Destruction and Preservation in a Massachusetts Town (Film). Hidden Landscapes LLC, Wellesley, MA.

Appendices

Appendix A: Trail Sign-In Sheet

Attention Trail User

Dear Bill Rivers Conservation Area Trail User,

A class at the University of Massachusetts is conducting an inventory of this property, which includes wildlife counts, forest measurements, stone structures, and recreational use. In order to gauge how many people use this trail on a daily basis, we ask that you write your name or place an “X” on the date (s) for which you are using the trail. Having idea of how many people use this trail will help inform our final recommendations to the Leverett Conservation Commission. Thank you for your participation in this project.

For more information about this project, please contact Paul Catanzaro at 413-545-4839.

Sincerely,
UMASS Students

March 2013

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B. Forest Inventory Terminology

TERMINOLOGY (http://www.dnr.state.md.us/forests/gloss.html)

10-factor Prism – An angled prism that is used in variable plots to determine if a tree is “in” or “out.” Each tree that is in represents 10 square feet of basal area in the stand.

Basal Area – the cross-sectional area of the trunk 4 1/2 feet above the ground; (per acre) the sum of the basal areas of the trees on an acre; used as a measure of forest density (image 25)

Biltmore stick - a tool calibrated to measure the diameter of a tree at breast height.

Clinometer – an instrument used to determine the height of a tree.

Coarse Woody Debris – Downed trees on the forest floor that is characterized as soft wood or hard wood and if there is bark present or not.

Diameter of Breast Height (DBH) – standard measurement of a tree's diameter, usually taken at 4 1/2 feet above the ground.

Crown Class – The classification of the trees amount of canopy cover.
**Dominant** - trees that extend above surrounding individuals and capture sunlight from above and around the crown.

**Co-Dominant** - a tree that extends its crown into the canopy and receives direct sunlight from above but limited sunlight from the sides. One or more sides of a codominant tree are crowded by the crowns of dominant trees.

**Intermediate** - trees with crowns that extend into the canopy with dominant and codominant trees. These trees receive little direct sunlight from above and none from the sides. Crowns generally are small and crowded on all sides.

**Suppressed** – Crowns entirely below the canopy level.

**Merchantable Height** – the point on a tree stem to which the stem is salable. Limits are: the point at which a sawlog tree is less than 8 inches in diameter, measured inside the bark (dib); the point at which a pulpwood tree is less than 4 inches dib; or the point on any tree where a defect is found that cannot be processed out.

**Overstory** – the level of forest canopy that includes the crowns of dominant, codominant, and intermediate trees.

**Regeneration** – Any tree less than 6” in DBH.

**Site Index** – a measure of the quality of a site based on the height of dominate trees at a specified age (usually 50 years), depending on the species (Image 26).

**Snag** – a dead tree that is still standing. Snags provide important food and cover for a wide variety of wildlife species.

**SOLO Forest** – Mapping program used on the GPS

**Understory** – the level of forest vegetation beneath the canopy.

**Variable Plot** – Plots that do not have a constant, defined area and is defined by using an angled prism to determine if a tree is “in” or “out” of a plot. The larger the tree the greater the chance that it is “in.”
BASAL AREA:

square feet of tree stem area per acre of land

example: 150 ft²/acre

Figure 4. Basal area is the sum of the cross-sectional area of tree stems measured at DBH, or 4.5 feet above ground.

Image 25. Image of what basal area is.