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Ash Decline: An Opportunity for Young Forest Wildlife

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ASH DECLINE: AN OPPORTUNITY FOR YOUNG FOREST WILDLIFE

by

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Abstract

The overall decline of ash tree health presents an opportunity for landowners to salvage dying trees, thus contributing to state and federal efforts to create young forest habitat for a wide variety of wildlife species, in addition to benefitting from the financial and recreational opportunities that come following salvage operations. This case study examines the results of a decision made by the Metropolitan District Commission (MDC, Hartford, CT) to conduct a timber salvage operation on its public water supply watershed land to remove dying white ash (*Fraxinus americana)* trees and at the same time meet the goals of the State of Connecticut and the United States Fish and Wildlife Service (USFWS) for creating habitat for the New England cottontail (NEC; *Sylvilagus transitionalis)* and other wildlife dependent on young forests. Bird surveys conducted in the area by a wildlife biologist from 2009 to 2016, overlapping with the timber harvest, suggested that the young forest regenerated after the harvest may have been instrumental in attracting dozens of bird species that had not been recorded there in the past. The young forest created is expected to support New England cottontails, though they have not yet been observed there by the monitoring program.

Acknowledgements

This thesis could not have been completed without the incredible support from everyone at The Metropolitan District Commission's Water Supply Headquarters: Carol Youell, Andrew Hubbard, Scott Rogers, and everyone else who would do anything to make sure this thesis came to fruition. In my four years as an intern, I truly learned a great deal. I hope in return my enthusiasm for trivia returned the favor!

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Table of Contents

List of Figures

Introduction

Humans rely on healthy forest ecosystems for many resources including timber, recreation, wildlife viewing, harvesting, clean air, and clean water. However, what constitutes a "healthy" forest tends to differ depending upon whom you ask. One person might say that a healthy forest is one that has reached "old growth." Another may say a healthy forest is one that supports many species of wildlife. When a water utility was asked, their forester responded with, "A healthy forest is one that has a landscape mosaic of a variety of forest types, ages, and structures within which processes such as water filtration and retention occur without interruption. Such a mosaic assists the forest in being resilient against pests and abiotic natural disasters."[1] Regardless of how one defines a healthy forest, a critical part of maintaining a healthy forested landscape is maintenance of a landscape mosaic composed in part of young forests and other early successional habitat. Through active young forest management, foresters encourage new, diverse vegetative growth that provides the landscape with a buffer against pests and natural disasters that tend to affect more mature forests.

In addition, the involvement and education of all stakeholders including private landowners is extremely important. In the past, United States citizens watched as their government was unable to control forest epidemics caused by introduced and invasive species such as the gypsy moth (*Lymantria dispar*) and the chestnut blight fungus

[1] C Ronnie Drever et al., "Can Forest Management Based on Natural Disturbances Maintain Ecological Resilience?," Canadian Journal of Forest Research 36, no. 9 (September 1, 2006): 2285–99, doi:10.1139/x06-132.

(*Cryphonectria parasitica*).[2] When all stakeholders are kept up-to-date with current natural resources research, they are more likely to understand the consequences of forest epidemics and are thus able to make educated decisions and assist in tree and forest health programs. Tree health decline is clearly an issue that forest landowners are facing more frequently due to factors such as introduced, invasive species and climate change.

Currently, many foresters and forestland owners in the northeastern United States are concerned about the emerald ash borer (EAB, *Agrilus planipennis*). EAB is an invasive wood boring beetle native to Asia, introduced to Michigan in the early 1990s, but was not detected until 2002.[3] In Connecticut, the first positive identification was in New Haven county in 2012. [4] As of December 2016, over ninety towns have confirmed presence of EAB, having now been detected in every county in Connecticut.[3] EAB is highly destructive to ash because of its wood-boring behavior. It girdles the tree by boring serpentine larval galleries through the phloem and cambium.[3]

Description of the Case Study

This case study highlights land management practices implemented by a Connecticut public water utility, The Metropolitan District (MDC), to improve forest ecosystem health by salvaging dead and declining white ash (*Fraxinus americana)* trees

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[2] Fred Hain, "New Threats to Forest Health Require Quick and Comprehensive Research Response," *Journal of Forestry; Bethesda* 104, no. 4 (June 2006): 182–86.

[3] Daniel A. Herms and Deborah G. McCullough, "Emerald Ash Borer Invasion of North America: History, Biology, Ecology, Impacts, and Management," *Annual Review of Entomology* 59 (January 2014): 13–30, doi:10.1146/annurev-ento-011613-162051.

[4] "Emerald Ash Borer First Detected" (Connecticut Agricultural Experiment Station, 2017), http://www.ct.gov/deep/lib/deep/forestry/eab/eabmap.pdf.

and to create wildlife habitat for species of special concern. The MDC owns approximately 31,000 acres of land, of which approximately 25,000 acres are part of the active forest management program. The intention of this program is to invest in establishing and maintaining healthy forests surrounding its reservoirs, to ensure that the source water transported to its treatment facilities is as clean as possible.[5] Maintaining forest ecosystem health is an important factor in protecting public water supply reservoirs.[6] For public utilities that are involved with the treatment and distribution of water from surface sources, sustainable management of watershed forests is one of the most important ways to maintain healthy forests and protect the water at its source. According to a study conducted in 2005 by the United States Geological Survey, sixty-seven percent of the United States' public water supply relies on surface water sources such as reservoirs.[7] Immense planning effort preceded the construction of these reservoirs. Careful planning and maintenance is required to preserve the integrity of not only the physical structures themselves, but also the ecological integrity of their forested watersheds. Without sustainable management of watershed lands, many metropolitan areas would lose access to potable water, a strategic resource of paramount importance to public health.

As a regional non-profit municipal corporation, the mission of the MDC is "to

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[5] Carol Youell and Lisa Smith, "MDC 2007 Watershed Forest Management Plan" (Unpublished forest management plan, 2007).

[6] Sue Stolton and Nigel Dudley, "Managing Forests for Cleaner Water for Urban Populations | Forests and Water," *Corporate Document Repository | Food and Agriculture Organization of the United Nations*, accessed April 11, 2017, http://www.fao.org/docrep/010/a1598e/a1598e10.htm.

[7] United States Geological Survey Water Science School, "Public Supply Water Use," accessed April 11, 2017, https://water.usgs.gov/edu/wups.html.

provide its customers with safe, pure drinking water, environmentally protective wastewater collection and treatment, and other services that benefit the member towns."[8] Some of these other services include Geographic Information Systems (GIS) mapping and household hazardous waste collection for their eight member municipalities in the greater Hartford area. Given that the entire residential and working population of the greater Hartford region is dependent on clean water from MDC reservoirs, it is clear that they are also stakeholders, regardless of their level of understanding of forest ecosystems. In addition, there are many other Connecticut citizens who are private forestland owners and therefore they are also stakeholders of forest ecosystem health. Although stakeholder understanding and appreciation of forest ecosystem health may vary, with the right approach, all stakeholders can come to understand how active forest management can help keep their family forest and local watershed healthy and productive.

The MDC and Sustainable Forest Management

The Barkhamsted Reservoir is the largest drinking water supply source in the MDC's system and the largest reservoir in the State of Connecticut, having a total capacity of 30.3 billion gallons.[9] It is an important source of water for a population of 400,000 in the Greater Hartford region. [10] The reservoir is located in the Towns of Barkhamsted and Hartland, a rural part of northwestern Connecticut, and is protected by large tracts of forestland owned by the MDC. The watershed of the Barkhamsted

[8] "About Us | The Metropolitan District," accessed April 11, 2017, http://www.themdc.org/about-us.
[9] "History | The Metropolitan District," accessed April 11, 2017, https://themdc.org/about-us/history.
[10] "Water Quality | The Metropolitan District," accessed April 11, 2017, https://themdc.org/what-we-do/drinking-water/water-quality.

Reservoir encompasses over 53.8 square miles and extends into Massachusetts.

The quality and quantity of drinking water supplied by the MDC to Hartford and the other member municipalities are in part dependent upon decisions made by natural resource administrators and foresters located miles away from treatment facilities. Although the majority of the MDC's business operations occur at its headquarters in Hartford, the natural resources staff at the Water Supply Office in Barkhamsted actively manage over 25,000 acres of forestland surrounding its reservoirs. Approximately 12,600 of these acres protect the Barkhamsted Reservoir, the remainder surround the MDC's other reservoirs.[11] As such, the MDC manages and protects a wide variety of habitats for a myriad of flora and fauna species. Consequently, the MDC maintains the biological diversity and integrity of many natural resources for the towns in which it owns property.

The management of the MDC's forested watersheds is guided by ongoing research, the findings of published studies, and the MDC's Watershed Forest Management Plan. The goals of this plan are to protect and enhance water quality and quantity, maintain a healthy sustainable forest ecosystem, protect and enhance wildlife habitat and fisheries, and promote watershed research and education.[10] To fulfill these goals, the MDC often partners with state and federal agencies to conduct research. These partnerships have helped to further knowledge in the practices of silviculture, wildlife ecology, soil science, and hydrology.

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[11] Carol Youell and Lisa Smith, "MDC 2007 Watershed Forest Management Plan" (Unpublished forest management plan, 2007).

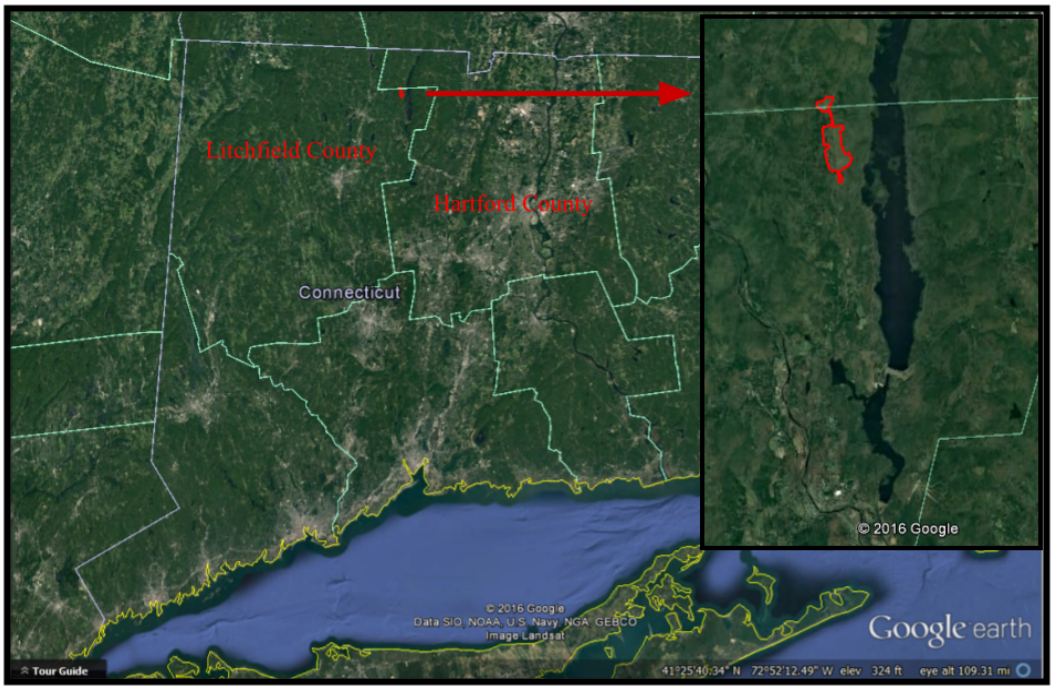


Figure 1. Location map of the Berry Lots harvest site, outlined in red.

The Case Study Area: "The Berry Lots"

The focus of this case study is a 166-acre site known as the "Berry Lots". It is located on the 53.8 mi^2 Barkhamsted Reservoir watershed on the border of the towns of Barkhamsted and Hartland, Connecticut (Figure 1). Longitudinally, the site falls between N41° 58' 27" and N41° 56' 59". Latitudinally, it falls between W72° 57' 11" and W72° 57' 30". Thirty percent of the site is comprised of Paxton and Montauk [12] soils: fine sandy loams, three to eight percent slopes, extremely stony. Another twenty-three percent of the site is Woodbridge [12] soils: fine sandy loam, three to fifteen percent slopes, extremely stony. These soils are deep and well-drained but have slow to moderate permeability, therefore water often pooled on site during heavy precipitation events.

[12] United States Department of Agriculture, Natural Resources Conservation Service et al., "Soil Survey of the State of Connecticut," 2003, https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/connecticut/CT600/0/connecticut.pdf.

(Figure 2, Figure 3)

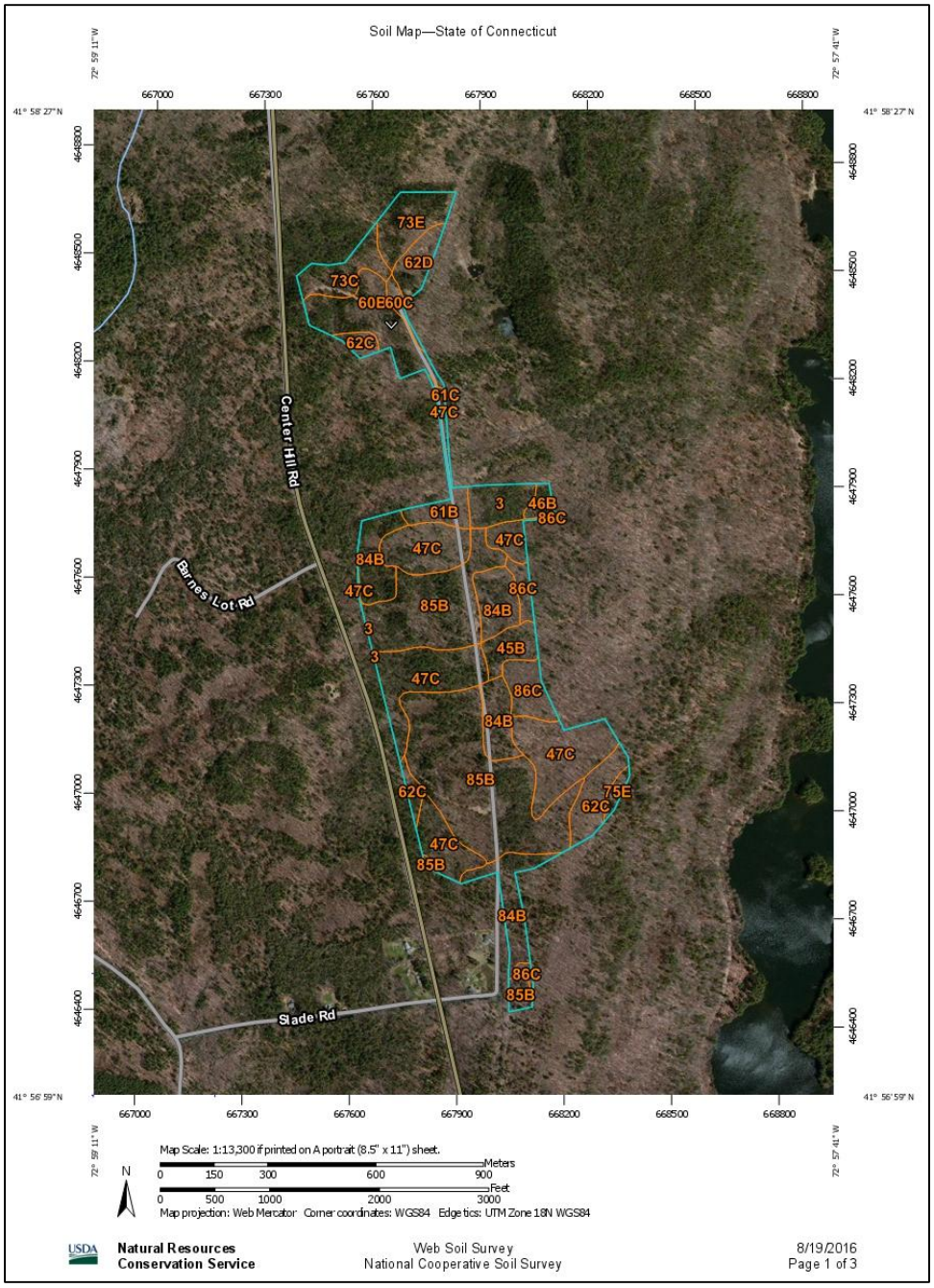
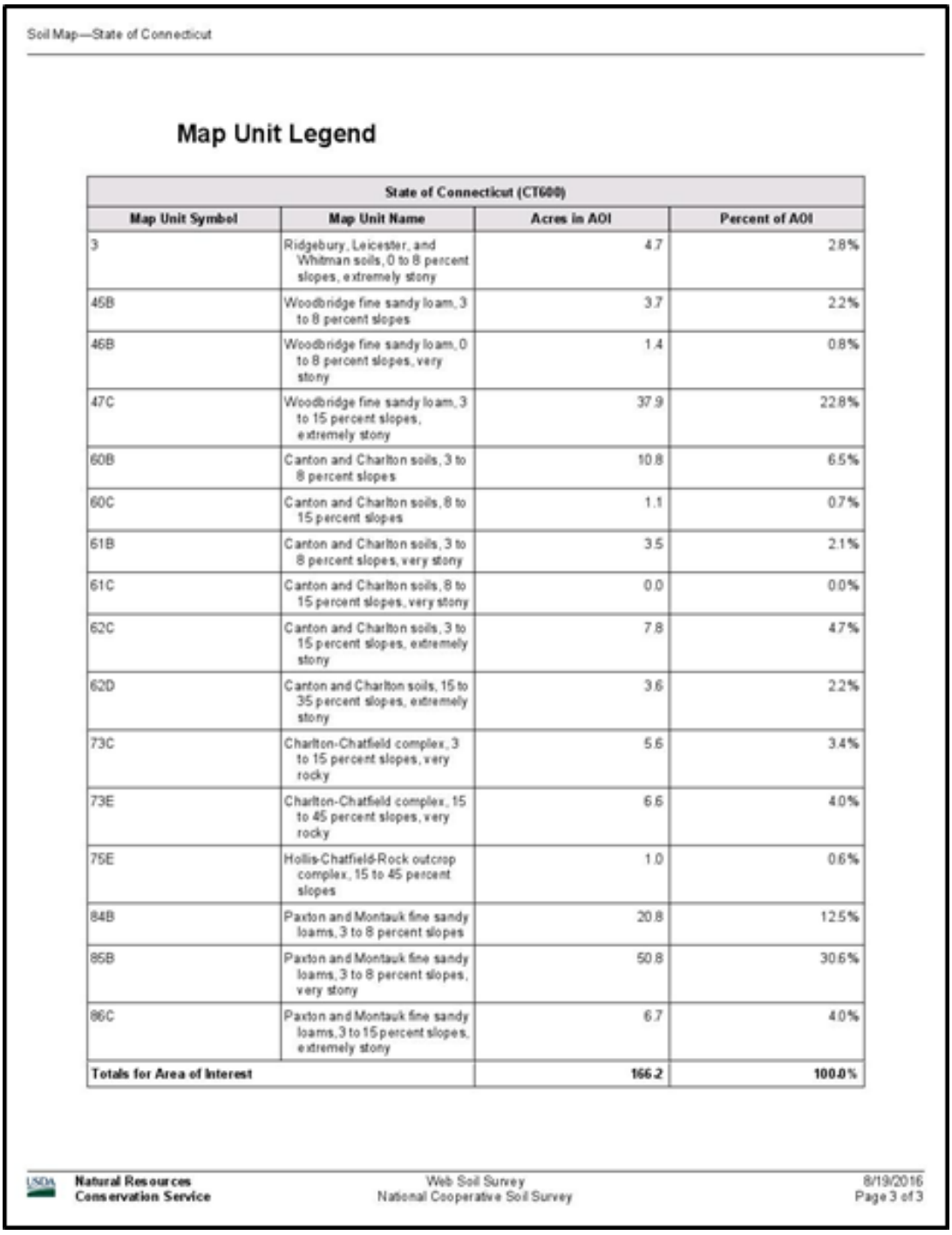


Figure 2. Soils map of the Berry Lots.



Soil Map—State of Connecticut

Map Unit Legend

State of Connecticut (CT600)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	4.7	2.8%
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	3.7	2.2%
46B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	1.4	0.8%
47C	Woodbridge fine sandy loam, 3 to 15 percent slopes, extremely stony	37.9	22.8%
60B	Canton and Charlton soils, 3 to 8 percent slopes	10.8	6.5%
60C	Canton and Charlton soils, 8 to 15 percent slopes	1.1	0.7%
61B	Canton and Charlton soils, 3 to 8 percent slopes, very stony	3.5	2.1%
61C	Canton and Charlton soils, 8 to 15 percent slopes, very stony	0.0	0.0%
62C	Canton and Charlton soils, 3 to 15 percent slopes, extremely stony	7.8	4.7%
62D	Canton and Charlton soils, 15 to 35 percent slopes, extremely stony	3.6	2.2%
73C	Charlton-Chatfield complex, 3 to 15 percent slopes, very rocky	5.6	3.4%
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	6.6	4.0%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	1.0	0.6%
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	20.8	12.5%
85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	50.8	30.6%
86C	Paxton and Montauk fine sandy loams, 3 to 15 percent slopes, extremely stony	6.7	4.0%
Totals for Area of Interest		**166.2**	**100.0%**

Natural Resources Conservation Service | Web Soil Survey, National Cooperative Soil Survey | 8/19/2016, Page 3 of 3

Figure 3. Key to the soils map of the Berry Lots.

MDC forestation and cutting history maps through the 1960s [14] show that the site was composed of the following stand types: eastern hemlock (*Tsuga canadensis)*/ hardwood, Norway spruce (*Picea abies*), red maple (*Acer rubrum*)/swamp hardwoods, red pine (*Pinus rubra*), gray birch (*Betula populifolia)*/red maple, white pine (*Pinus strobus*), white pine/hardwoods, mixed hardwoods, and aspen (*Populus tremuloides*)/ willow (*Salix* spp). The northernmost eastern hemlock/hardwood stand and a large area of red maple and mixed hardwoods were harvested in 1974.[13] It was followed by a harvest in 1992 (Figure 4) which removed the residual red pine on site, as well as a

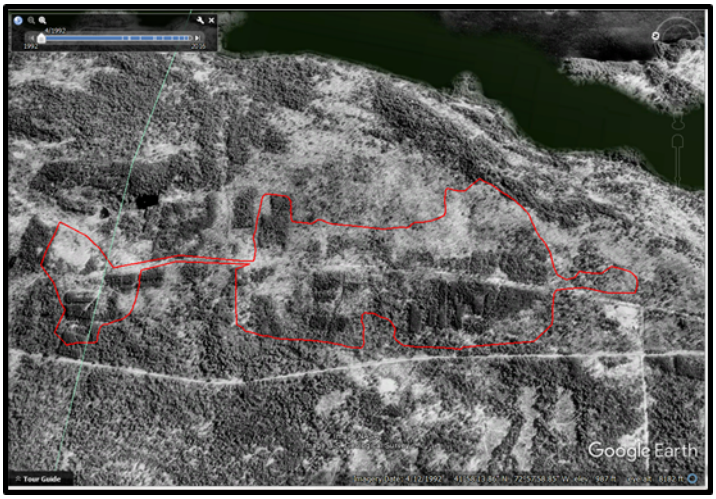


Figure 4. Aerial view of the Berry Lots harvest site, April 1992.
Credit: Google Earth.

couple of stands of Norway spruce.

The remaining acreage was mainly red maple/swamp hardwoods. A pre-harvest inventory of the initial acreage revealed that the site was composed of 66% white ash, 22% red maple, 4% black cherry (*Prunus serotina),* and 1% northern red oak (*Quercus*

[13] The methodology of the 1974 harvest is unknown.

rubra), by basal area. The remaining 7% was a variety of other species.[14] Although the original acreage of aspen/willow was only 8 acres, it appears that large patches of the clearcut areas are now dominated by aspen.[15] A inventory has not been completed to determine the species composition post-harvest.

Culturally speaking, the area was densely settled and used for agricultural and light industrial activity during the early 1800s. The remnants of this activity include mature sugar maple (*Acer saccharum)* trees once tapped for their sap, the access road running through the site, which was originally a carriage road and was later improved, and numerous stone walls which delineate old boundaries. After the MDC bought the land in the mid-1930s, they allowed public access to harvest wild berries at the Berry Lots up until the 1970s.[16]

In the early 2010s, the ash trees on the Berry Lots site were showing symptoms of poor health and decline, and many were dying, which prompted the attention of MDC foresters. (Appendix A) The ash trees were also under imminent threat of widespread mortality due to the fast spreading Emerald Ash Borer. The exact cause of the decline in the ash trees at the Berry Lots was never explored. However, there were several potential factors including site conditions such as: being at a relatively high elevation on the landscape, variance in precipitation events and subsequent soil moisture.[17] A biotic factor

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[14] Andrew Hubbard, "Berry Lots Pre-Harvest Inventory" (The Metropolitan District, 2013).
[15] "MDC Forest Stand Types 1932-1990," Unpublished hand-drawn maps (The Metropolitan District, 1990 1932).
[16] "MDC Annual Report 1960-1970" (The Metropolitan District, 1970).
[17] H. Woodcock, W. A. Patterson, and K. M. Davies, "The Relationship between Site Factors and White Ash (Fraxinus Americana L.) Decline in Massachusetts," *Forest Ecology and Management* 60, no. 3 (September 1, 1993): 271–90, doi:10.1016/0378-1127(93)90084-Z.

of ash decline is ash yellows, caused by a phytoplasma (*Candidatus phytoplasma fraxini*) and which mainly affects white ash (*Fraxinus americana)*.[18] The ash could also have been stressed from exposure to air pollutants. It is known that ash, in general, (*Fraxinus* spp*.)* are especially sensitive to pollutants such as those emitted by the combustion of coal.[19] [20] Based on Connecticut's location relative to the coal belt, in addition to the high density of vehicular traffic that passes through the Tri-State area, it is often called "the tailpipe of America." [21] Furthermore, in 2016 Connecticut remained in nonattainment for ozone per the Environmental Protection Agency's National Ambient Air Quality Standards.[22] Given these air quality conditions, it is plausible that the ash could have been further stressed due to an overabundance of ozone, sulfur oxides, and nitrogen oxides in the air.[19] This likely exacerbated the growing situation of EAB in the state and may have caused the otherwise healthy ash on the Berry Lots to become targets for nearby EAB. According to a staff member at the Connecticut Agricultural Experiment Station, the first positive identification of EAB in the town within which the Berry Lots is located, was less than a mile away, in 2016.[23]

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[18] Alejandro A. Royo and Kathleen S. Knight, "White Ash (Fraxinus Americana) Decline and Mortality: The Role of Site Nutrition and Stress History," *Forest Ecology and Management* 286 (December 15, 2012): 8–15, doi:10.1016/j.foreco.2012.08.049.

[19] Craig R. Hibben, "Ash Dieback in the Northeast: Report on Severity and Causes," in *Proceedings of the First Conference of the Metropolitan Tree Improvement Alliance*, vol. 1 (Lanham, Maryland, 1976), 87–96, https://www.ces.ncsu.edu/fletcher/programs/nursery/metria/metria01/m112.pdf.

[20] Bonnie Appleton et al., "Air Pollution" (Virginia Cooperative Extension), accessed May 5, 2017, https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/430/430-022/430-022_pdf.pdf.

[21] "Connecticut Files Two Petitions with EPA Seeking Action to Improve Air Quality and Public Health," *State of Connecticut | Department of Energy & Environmental Protection*, June 6, 2016, http://www.ct.gov/deep/cwp/view.asp?Q=581418.

[22] "Attainment of the National Ambient Air Quality Standards," *State of Connecticut | Department of Energy & Environmental Protection*, May 26, 2016, http://www.ct.gov/deep/cwp/view.asp?a=2684&q=321762&depNav_GID=1744.

[23] Connecticut Agricultural Experiment Station, Inquiry to CAES pertaining to EAB in Barkhamsted, Telephone, August 2016.

Knowing that EAB was an approaching risk, there was increased potential for the implementation of a *Fraxinus* spp. quarantine by the State of Connecticut. Given this potential, MDC foresters chose to harvest the declining trees as soon as possible to capture their current value[24] and to promote the growth of a new and healthy forest.

To evaluate their options, MDC foresters drafted the following site management alternatives:

A. Leave the ash to decline and die on site. This would cause natural forest openings as the ash declined over time. It would also increase the amount of coarse woody material on site which would decay over time and contribute to invertebrate, amphibian, and small mammal habitat. However, in doing so, the MDC would lose harvest revenue from the dying and declining trees. Additionally, they would miss an opportunity to expedite the establishment of young forest for the New England cottontail and other young forest-dependent wildlife.
B. Remove only the ash from the site. This would address ash decline. However, MDC foresters determined that a majority of what would be the residual trees were considered unacceptable growing stock (i.e., poor form, quality, susceptible to windthrow, etc.) and would not contribute to regenerating a healthy, dynamic forest.
C. Conduct a traditional silvicultural clearcut. MDC foresters stated that this option would be an opportunity to completely restart the site. It was predicted that conducting a clearcut would provide an opportunity to create habitat for many of Connecticut's Species of Greatest Conservation Need, including the New England cottontail.[25] Drawbacks of this approach would include having large areas of land exposed in the short-term, leaving birds and NEC with fewer opportunities to seek cover from predators. Another disadvantage of this approach is that it might

[24] Andrew Hubbard, "Berry Lots - Mill Tally System" (The Metropolitan District, 2013).
[25] "Connecticut's Young Forest and Shrubland Initiative," *Department of Energy & Environmental Protection*, April 4, 2017, http://www.ct.gov/deep/cwp/view.asp?a=2723&q=514596&deepNav_GID=1655.

increase the potential for the colonization and spread of invasive plant species in the forest openings.

D. Conduct a clearcut with reserves. The United States Forest Service (USFS) defines a clearcut with reserves as:

> *A clearcutting regeneration method in which varying numbers of reserve trees are retained to achieve goals other than regeneration. This method produces a two-aged stand in which varying numbers of reserve trees are not harvested….*[26]

This prescription would retain reserve trees on-site to provide food, cover and nesting opportunities for wildlife, as the remainder of the area undergoes transition to early successional vegetation. Species to be retained would include sugar maple, northern red oak, white pine, and eastern hemlock. The site's mature sugar maples would be left as reserve trees to provide multiple benefits to various species of wildlife. Reserve trees would provide hard and soft mast, with some having the potential to become large diameter snags. Benefits to wildlife would include song perches, cavities for roosting and nesting, a variety food resources, and overall enhanced vegetative structure.

Factors Involved in the Final Management Decision

From 2006 until the harvest in 2013, MDC foresters were aware of the conservation efforts surrounding the need to create habitat for the New England cottontail. The United States Fish and Wildlife Service (USFWS) had received Notices of Intent from non-profit organizations that threatened to sue the USFWS unless actions were taken regarding the conservation of the New England cottontail under the provisions of the Endangered Species Act (ESA).[27] Since the USFWS could not make an immediate

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[26] United States Department of Agriculture United States Forest Service, "Reforestation Glossary," accessed April 11, 2017, https://www.fs.fed.us/restoration/reforestation/glossary.shtml.

[27] United States Department of the Interior: Fish and Wildlife Service, Proposed Rules. "Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the New England Cottontail as an

determination due to a lack of information, they directed state agencies [28] to invest in research, breeding programs, and young forest management in an effort to protect the species until they had enough information to make a proper decision. During this process, and in response to this directive, the New England Cottontail Conservation Initiative [29] was formed. This partnership of federal and state agencies, non-profit organizations, universities, and other entities worked on researching the species and creating, restoring, protecting, and managing its natural habitat and populations. State and federal biologists were enlisted to offer advice to landowners that showed an interest in reestablishing young forests for the New England cottontail. MDC foresters were aware of the federal and state habitat goals for the New England cottontail. To understand how "young forest" was defined in Connecticut, MDC foresters referenced the Connecticut Wildlife Action Plan written by the Connecticut Department of Energy and Environmental Protection (CT DEEP).[24] The Connecticut Wildlife Action Plan defines young forest as:

> *...characterized by seedling sapling trees smaller than 4.9 inches diameter at breast height (DBH), usually composed of late seral stage species (oak, hickory, maple, beech, ash) but may include "pioneer" type species including cherry, aspen and birch. Young forests may be either coniferous, deciduous, or both, having trees less* [*sic*] *0- 20 years in age. These forests are characterized by high stem density (hardwood species typically), often interspersed with patches of herbaceous plants and briars growing up shortly after disturbance...*[30]

Endangered or Threatened Species, 50 CFR, Part 17" *Federal Register* 80, no. 178 (September 15, 2015): 55286, https://www.gpo.gov/fdsys/pkg/FR-2015-09-15/pdf/2015-22885.pdf.

[28] "New England Cottontail Conservation | New England Cottontail Saved from Extinction," *Northeast Region, U.S. Fish and Wildlife Service*, July 5, 2016, https://www.fws.gov/northeast/newenglandcottontail/.

[29] "New England Cottontail | New England Cottontail Management," *Working Together for the New England Cottontail*, accessed April 11, 2017, https://newenglandcottontail.org/.

[30] Terwilliger Consulting Inc., "Connecticut Wildlife Action Plan | Chapter 4 | Conservation Actions for Connecticut's Key Habitats and Species of Greatest Conservation Need" (Wildlife Action Plan, February 29, 2016), http://www.ct.gov/deep/lib/deep/wildlife/pdf_files/nongame/ctwap/CTWAP-Chapter4.pdf.

MDC foresters recognized that their forestlands lacked sufficient young forest. The clear majority of their resources were older, mature forests. According to the MDC, dynamic forests or "green infrastructure" [31] is the ideal land cover type to protect drinking water. It provides natural filtration, buffers surface reservoirs from pollutants, intercepts runoff, moderates stream flows, and stabilizes soils.[32] In turn, these functions ultimately reduce the costs of and the amount of water treatment needed to meet (or exceed) state and federal health standards. As a part of a dynamic forest landscape, young forests increase forest landscape diversity which in turn promotes the resiliency of forested landscapes against catastrophes such as hurricanes, insect infestations, fungal outbreaks, and other disturbances. It was therefore in the MDC's best interest to increase its acreage of young forest habitat to enhance the temporal, spatial, and structural complexity of its forestland.

After consulting with state biologists, the Berry Lots site was identified to be within the Connecticut New England cottontail "Northern Border" Focus Area, and within ten miles of three known New England cottontail locations.[33] The MDC proceeded to work with CT DEEP and USFWS biologists to create a NEC habitat management plan in the hopes that the planned harvest activity would have a positive impact on NEC populations in the "Northern Border" Focus Area. The opportunity to create NEC habitat added importance to the management decision made at the Berry Lots site due to the fact

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[31] United States Environmental Protection Agency, "Green Infrastructure," March 15, 2017, https://www.epa.gov/green-infrastructure.
[32] Ian Calder et al., "Towards a New Understanding of Forests and Water.," accessed April 14, 2017, http://www.fao.org/docrep/010/a1598e/a1598e02.htm.
[33] "Connecticut | Making Habitat and Helping Cottontails," Working Together for the New England Cottontail, accessed April 14, 2017, https://newenglandcottontail.org/demo/connecticut.

that it contributed to state and federal goals for both young forest habitat and NEC recovery.

After conferring with state and federal wildlife biologists, MDC foresters determined that the aforementioned "Option D," a clearcut with reserves, would be the best approach to address the goals of the federal and state initiatives, as well as the MDC's Watershed Forest Management Plan. The timber would be sold on a mill tally basis and part of the contract would stipulate that trees would be painted to indicate those that could not be taken. (Appendix B) Trees marked with an orange ring were to be left as reserves, "W" marked trees would be left standing for cavity nesting wildlife, "G" marked trees were to be girdled to accelerate snag creation, and "X" marked trees were to be felled to serve as the foundations for a minimum of five, 20'x20'x4' brush piles for wildlife, specifically, the New England cottontail.[34]

J&K Logging of Hartland, Connecticut won the contract to conduct the harvest operation. Originally, the harvest was planned to encompass 40 acres. It was later expanded to include an additional 126 acres to address other areas of ash decline. Due to many months of inoperable conditions, the logging operation spanned from the winter of 2013 through the winter of 2015.

Bird Surveys at the Berry Lots

Ever since the Spotted Owl controversy, many Americans have had a heightened awareness of the need to save "old-growth" forest for those species that depend on it. Due

[34] For more information about the harvest specifications, see Appendix B: *Terms and Conditions of Berry Lots Ash Salvage, M-047, March 2013*.

to this drive to save mature forest, timber harvesting was vilified. However, over the last fifty years, ornithologists have observed an alarming trend with young forest dependent species.[35] Since natural and anthropogenic disturbances had been restricted, many young forest dependent birds were losing nesting habitat, resulting in declining populations. With the launch of the Young Forest Project in 2011 [36], more people became aware and educated about the plight of young forest species and thus the need to manage for young forests. The Young Forest Project aims to diversify forested landscapes through creation of young forests. They identify anthropogenic factors as reasons why young forest is not being created rapidly enough, naturally. As a solution, they offer ways to get involved with federal, state, and non-profit partners to create and enhance young forest habitat.

The MDC was already aware of the necessity of young forests for the New England cottontail. After identifying the New England cottontail crisis, they were introduced to "Foresters for the Birds," [37] a program spread by Audubon Vermont to train foresters as to how and why forest type, age, and vertical structure can affect the species of birds that utilize forests. Since their newly created young forest should have attracted young forest dependent birds, an informal research project began. MDC foresters wanted to know which species of birds could be observed on site and how species abundance changed from pre-harvest years to post-harvest years.

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[35] Scott Schlossberg and David I. King, "Ecology and Management of Scrubshrub Birds in New England: A Comprehensive Review," *Natural Resources Conservation Service, Beltsville, Maryland, USA*, August 30, 2007, https://wmc.ar.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013252.pdf.

[36] "The Young Forest Project: Growing Wildlife Habitat Together," accessed April 11, 2017, www.youngforest.org/sites/default/files/research_documents/The%20Young%20Forest%20Project_v3_Script.pdf

[37] "Foresters for the Birds," *Audubon Vermont*, January 21, 2016, http://vt.audubon.org/conservation/foresters-birds.

A graduate of UConn [38], Mr. David Rosgen's passion and knowledge of ornithology has been an asset to various ornithological research projects in Connecticut for many years, including observations of birds on MDC property. His bird surveys at the Berry Lots began in 2009 and apart from 2010 and 2011, continued through 2016 with all observations posted to eBird.[39] Mr. Rosgen's observations suggest that the Berry Lots harvest has provided staging and nesting habitat for young forest dependent bird species.

Methodology of Bird Surveys at the Berry Lots

Mr. Rosgen's methodology followed the travelling count protocol of eBird.[40] The Berry Lots site has a service road that aligns parallel with Connecticut State Rt. 181 (CT Rt. 181). Although the physical and temporal length of the travelled route varied depending on a variety of factors throughout the years, Mr. Rosgen was consistent with beginning each survey between 3:00 PM and 5:00 PM. This period, although unusual for bird surveys, was the only time he was available to do surveys. Often, just the service road was walked or driven, but on days where the weather was appropriate, he would

[38] Formerly, the University of Connecticut. Rebranding in 2013 changed its official wordmark to UConn.
[39] "A real-time, online checklist program...to maximize the utility and accessibility of the vast numbers of bird observations made each year by recreational and professional bird watchers. It is amassing one of the largest and fastest growing biodiversity data resources in existence." http://ebird.org/content/ebird/about/
[40] "How to Make Your Checklists More Valuable: Ways to Count," *eBird*, accessed April 11, 2017, http://help.ebird.org/customer/portal/articles/974012-how-to-make-your-checklists-more-valuable.

return to his starting point by walking on CT Rt. 181. (Figure 5)

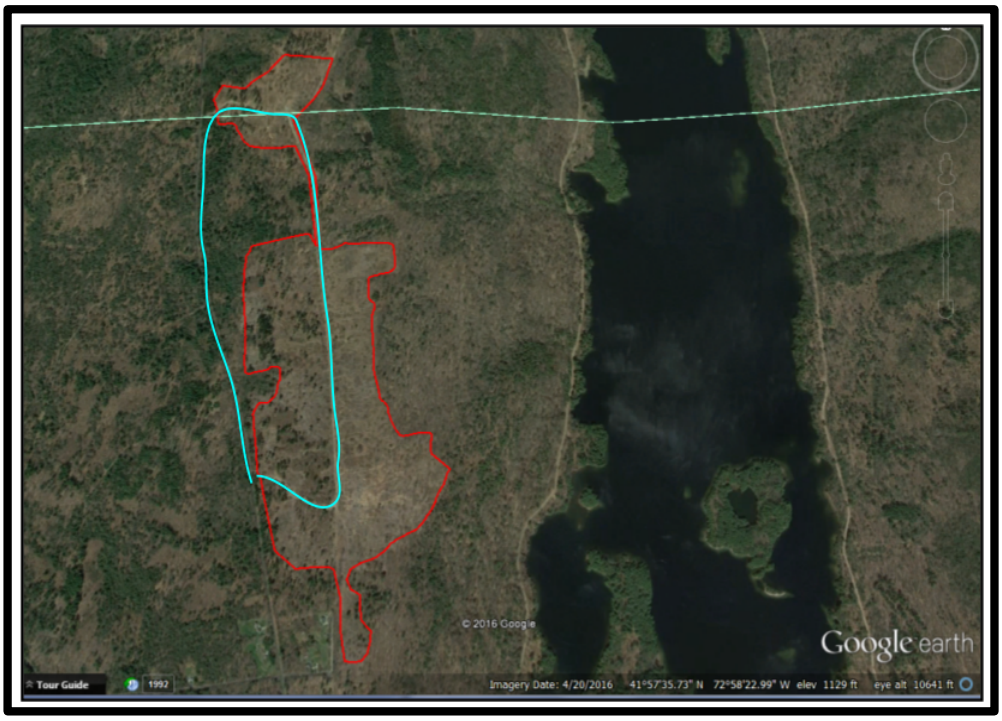

Figure 5. Aerial view of the Berry Lots harvest site, April 2016. The harvest area is delineated in red, with Mr. Rosgen's bird survey route in blue. The eastern side of the bird survey route follows Connecticut Route 181.

This allowed him to detect species that preferred shrubs such as mountain laurel (*Kalmia latifolia*), and large diameter snag trees within a mature forest-type setting. These snags and shrubs were retained as an aesthetic buffer strip between the harvest and CT Rt. 181.

During his surveys, he would pause every few feet to tally birds that he observed by audio and/or visual cues on a data sheet. He stayed on the service road except to check six bluebird boxes which were within twenty feet of the road. During each survey, observations of herbaceous and woody plant regeneration were recorded (Appendix C) along with observations of other species of fauna.

To statistically analyze the observations, summarizations of each month's observations from eBird from June of 2009 until August of 2016 were downloaded. The data were then organized into Excel spreadsheets. Information on effort was acquired by sifting through every eBird entry for the Berry Lots and summing the total time submitted by month. Beginning in 2012, there was an increasing trend of total species observed. In May of 2016, ninety different species were observed to be present, a record for the site (Figure 6). Although number of species observed per hour effort rose slightly from 2009 to 2016, the increase was not significant, as most of the change fell within one standard deviation of the mean (Figure 7).[41]

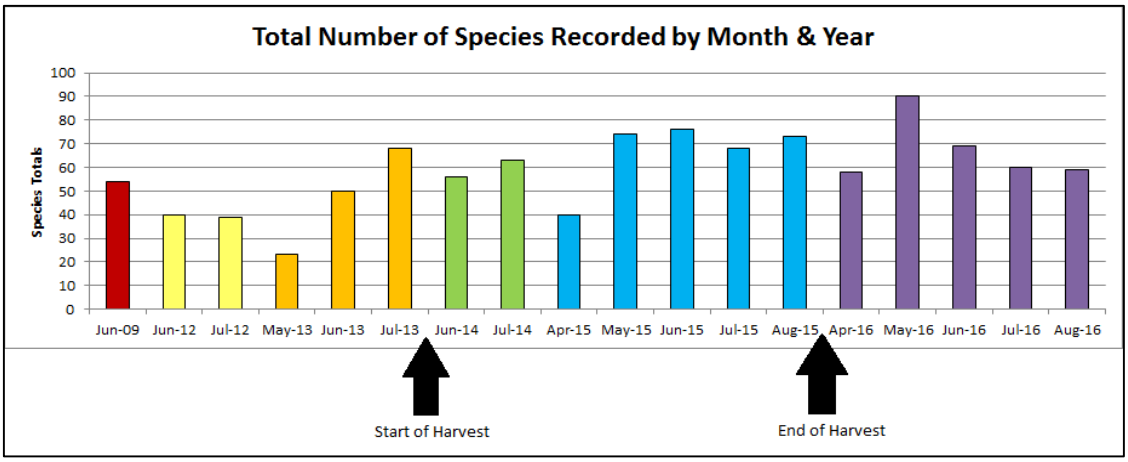

Figure 6. Monthly total number of species observed. 2009 and 2012 are pre-harvest, 2013 and 2014 are during harvest and 2015 and 2016 are post-harvest.

[41] Standard deviation represents a data set's average variance from the mean. Two to three standard deviations from the mean would have signified a more statistically significant increase.

After data pertaining to effort was acquired, Figure 7 was created by determining species observed per hour and then calculating standard error. The mean species observed per hour for the pre-harvest period was 15.06, during the harvest it was 19.6, and post-harvest it was 17.2. Given a standard error of 1.09, the pre-harvest mean is still significantly lower than either the during harvest or post-harvest mean. Although a causation cannot be attributed to the management activity, there is a correlation between period of harvest and mean species observed per hour effort.

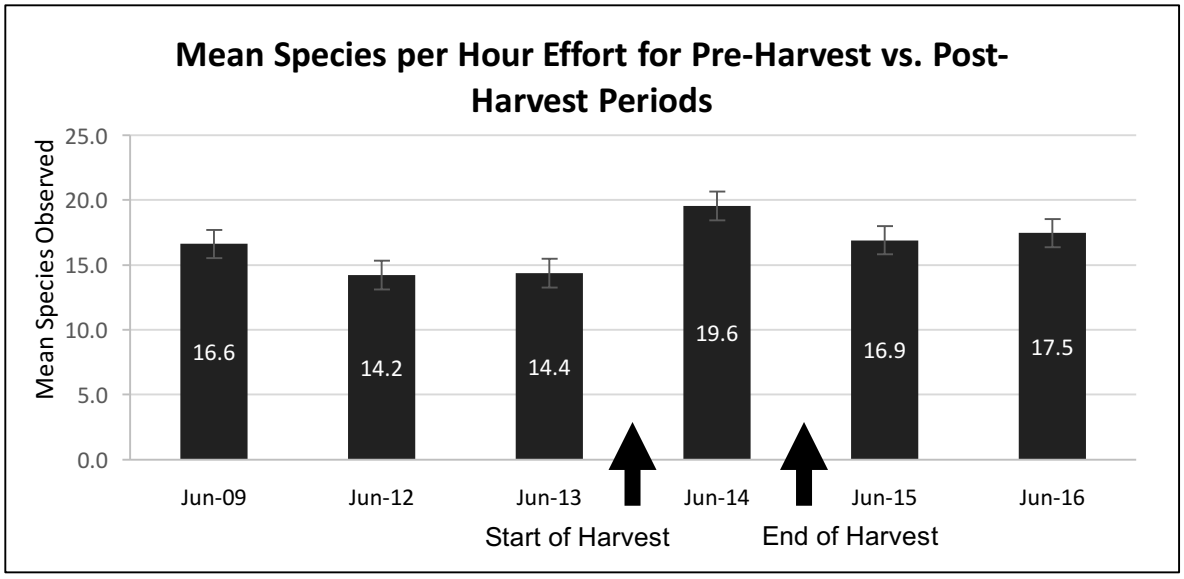

Figure 7. Mean species observed per hour effort for the months of June. 2009 and 2012 are pre-harvest, 2013 and 2014 are during harvest, and 2015 and 2016 are post-harvest. The standard error was calculated to be 1.09

Summary of Bird Observations

Since 2009, 108 species of birds have been observed at the Berry Lots (Appendix D). Five percent of the observed birds are on the Audubon Connecticut Priority Birds list

[42] [43] including: Bald Eagle, American Woodcock, Wood Thrush, Black-throated Blue Warbler, Prairie Warbler, and Bobolink. Altogether, thirty-one species, or 28.7% of Appendix D, have been identified as conservation priority species by at least one of the following: The International Union for the Conservation of Nature (IUCN), the 2015 Connecticut Wildlife Action Plan, or Audubon Connecticut.

The region surrounding the Berry Lots is located has been recently designated as the "Barkhamsted Block" Audubon Important Bird Area (Figure 8). This designation indicates that there are resources in this area that Audubon considers important for the

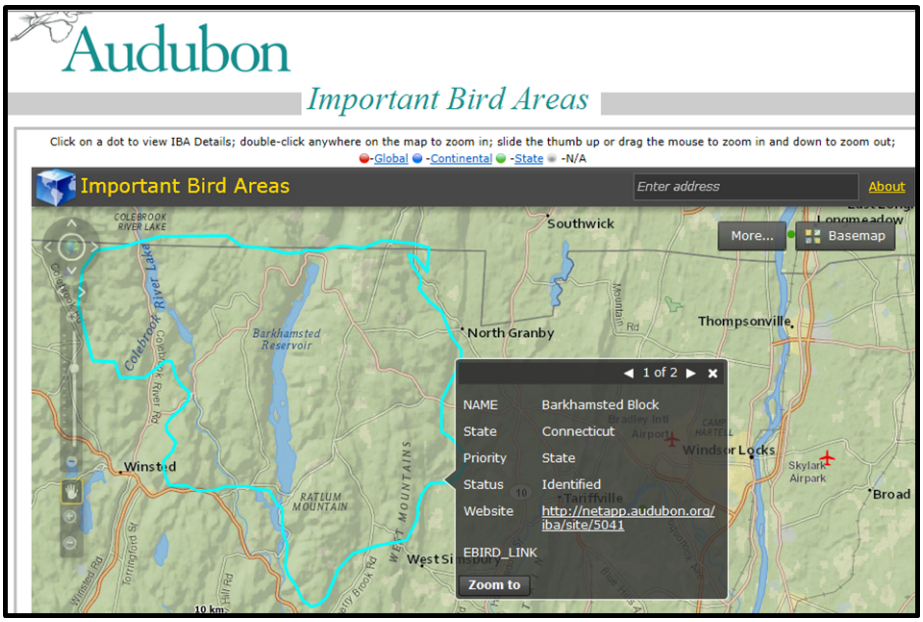

Figure 8. "Barkhamsted Block" Audubon Important Bird Area as found in an earlier version of: http://www.audubon.org/important-bird-areas.

conservation of multiple species of birds. Observations of breeding bird richness suggest that this designation was appropriate.

Based on recorded observations, average breeding bird species richness, corrected

[42] Audubon CT Priority Bird Species definition: "birds of significant conservation need, for which our actions, over time, can lead to measurable improvements in status."
[43] "Priority Bird Species," *Audubon Connecticut*, August 7, 2015, http://ct.audubon.org/conservation/priority-bird-species.

for effort, increased from 2011 to 2016 (Figure 7). May 2013 (not shown) was an anomaly with a mean of 31.5 species observed per hour, but it is likely that this increase can be explained by the likely presence of flyover/stopover migrants. These species have not been observed breeding in Connecticut and thus are not likely to have bred on site.

Given the focus on creating habitat for young forest dependent wildlife, many of the black cherry (*Prunus serotina)* trees were retained for soft mast. It was observed that their retention fed flocks of Cedar Waxwings (*Bombycilla cedrorum)* and Baltimore Orioles (*Icterus galbula)*. In 2015, an American Kestrel (*Falco sparverius*) was observed using a single white pine in the largest clearing as a perch. However, the most notable species observed was the breeding pair of Blue-winged Warblers [44] (*Vermivora cyanoptera*) in 2016. Although Blue-winged Warblers had been observed on site in previous years, it was not until 2016 that nesting and young-feeding activity was observed. Due to climate change, Blue-winged Warbler habitat has been overlapping with Golden-winged Warbler [45] (*Vermivora chrysoptera*) habitat. In these shared zones, hybridization is being observed between these two species. As such, wildlife biologists are concerned about creating and restoring habitat for each species so that the likelihood of hybridization decreases. The decision to interfere with Blue-winged Warbler and Golden-winged Warbler hybridization is a complicated, philosophical question of ethics. Although hybridization can occur naturally, when it happens as a result of anthropogenic forces, research suggests that it may cause decreases in biodiversity and the genetic

[44] "Blue-Winged Warbler," *The Cornell Lab of Ornithology | All About Birds*, 2015, https://www.allaboutbirds.org/guide/Blue-winged_Warbler/id.
[45] "Golden-Winged Warbler," *The Cornell Lab of Ornithology | All About Birds*, 2015, https://www.allaboutbirds.org/guide/Golden-winged_Warbler/lifehistory.

integrity of a species.[46] For this reason, it makes financial and logistical sense to invest in habitat management activities that may assist in preventing species from becoming potential candidates for ESA listing. The process of listing can be drawn out and complicated. Proactivity in forest management activities for at-risk wildlife such as that which was undertaken for the NEC helps to avoid unnecessary listing and thus prioritizing species that truly need the attention and resources.

In addition to species of conservation interest by various agencies and organizations, many non-focal species were also observed on site. Large mammals such as black bear (*Ursus americanus),* moose (*Alces alces)*, and eastern coyotes (*Canis latrans x Canis lycaon)* or their sign, were consistently found on site. Black bear were observed feeding on the berries and apples along the road, and moose were seen foraging on the aspen and herbaceous plants along the edges of the clearings. Smaller biota were also observed utilizing the site for feeding and reproduction including amphibians, reptiles, invertebrates, and small mammals found along stone walls and within the sediment settling pools along the sides of the service road. Since these settling pools held water throughout the summer, they could support breeding populations of a variety of amphibians including wood frogs (*Rana sylvatica),* green frogs (*Rana clamitans melanota),* bullfrogs (*Rana catesbeiana),* and salamanders.

The variety of wildlife observed at the Berry Lots suggests that with similar management techniques, other forestland owners could aim to attract a similar variety.

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[46] Joanna Malukiewicz et al., "Natural and Anthropogenic Hybridization in Two Species of Eastern Brazilian Marmosets (Callithrix Jacchus and C. Penicillata)," *PLOS ONE* 10, no. 6 (June 10, 2015): e0127268, doi:10.1371/journal.pone.0127268.

However, potential species depends heavily on region, quality of habitat features, established communities, and habitat connectivity.

Post-Harvest Vegetative Structure

During harvest, much of the acreage to be clearcut had little to no apparent growing vegetation (Appendix E). Post-harvest observations of vegetation were limited to being roadside and along skid trails. The density of vegetation made it difficult to complete a vegetative survey of the site (Figure 9).

Figure 9. Post-harvest photos taken of the Berry Lots during the summer of 2015. Note the density of forbs, graminoids, and brambles.

However, quaking aspen (*Populus tremuloides)* and highbush blueberry (*Vaccinium corymbosum)* appeared to be the two most dominant species of woody vegetation. (Figure 10) In addition, a wide variety of forbes and graminoids quickly spread across the site, filling in the open spaces.

Figure 10. Post-harvest photos taken during the summer of 2016. In the second photo, the PVC pipe was measured to be six feet from the bottom to the orange ring of flagging.

Forest Management for Wildlife: An Evolving Field

The rate at which New England forests regenerated after being cleared peaked in the 1960s.[47] With the end of the era of farm abandonment, the rate of creation of young forest declined and wildlife biologists realized that populations of associated species had been in decline since the 1960s.[48] [49] People became concerned with losing young forest species that were unique to New England. Given this newfound concern, young forest creation across New England quickly gained a mascot: The New England cottontail.

For a while, studies suggested that group selection and patch cuts, which imitated the naturally occurring gap dynamics of a mature forest, were enough to attract these species.[50] A study published in 2003 recommended that group selection and patch cuts be at least 1.98 acres and regenerated every 10-15 years if management goals are focused on young forest or shrubland birds in the northeastern United States.[51] Perhaps it was believed that the aesthetics of a clearcut would not attract enough support from landowners, and therefore more effort was put into promoting other silvicultural practices. Regardless, it was soon realized that these gaps only attracted species that were

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[47] The Nature Conservancy, "A Policy Agenda for Conserving New England's Forests," 2012, https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/maine/forest-policy-agenda.pdf?redirect=https-301.

[48] Schlossberg and King, "Ecology and Management of Scrub-shrub Birds in New England."

[49] David R. Foster et al., "Wildlife Dynamics in the Changing New England Landscape," *Journal of Biogeography* 29, no. 10–11 (October 1, 2002): 1337–57, doi:10.1046/j.1365-2699.2002.00759.x.

[50] Robert A. Askins, Benjamin Zuckerberg, and Leah Novak, "Do the Size and Landscape Context of Forest Openings Influence the Abundance and Breeding Success of Shrubland Songbirds in Southern New England?," *Forest Ecology and Management* 250, no. 3 (October 20, 2007): 137–47, doi:10.1016/j.foreco.2007.05.009.

[51] Richard M DeGraaf and Mariko Yamasaki, "Options for Managing Early-Successional Forest and Shrubland Bird Habitats in the Northeastern United States," *Forest Ecology and Management*, Early-Successional Forests and Shrubland Habitats in the Northeastern United States :Critical Habitats dependent on Disturbance, 185, no. 1–2 (November 3, 2003): 179–91, doi:10.1016/S0378-1127(03)00254-8.

more tolerant of edges and not dependent on large, open, disturbed areas.

Recent research supports the claim that young forests are important and necessary parts of a healthy forest landscape.[52] Furthermore, studies are showing that diversification of vegetative composition and vertical structure can contribute to increasing species diversity of forest bird communities.[53] Diversification at the landscape-scale of vegetative composition and vertical structure may be attained through implementation of a wide variety of silvicultural practices including: clearcuts, shelterwood treatments, and single-tree selection.[54] [55] [56] These larger, more intensive harvests not only support breeding populations of young forest dependent species, but also support post-fledging habitat for species that nest in mature and intact forests.[57] In support of this finding, Wood Thrushes which are associated with mature or intact forests, were consistently observed from the main access road of the Berry Lots.

In 2016, a shelterwood study conducted in eastern Connecticut established that there are certain species of forest birds that can be used as indicator species for certain stages of stand development or vertical structures of forests.[55] For example, Indigo

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[52] Jae R. Pasari et al., "Several Scales of Biodiversity Affect Ecosystem Multifunctionality," Proceedings of the National Academy of Sciences 110, no. 25 (June 18, 2013): 10219–22, doi:10.1073/pnas.1220333110.

[53] Marlyse C. Duguid et al., "Changes in Breeding Bird Abundance and Species Composition over a 20 Year Chronosequence Following Shelterwood Harvests in Oak-Hardwood Forests," *Forest Ecology and Management* 376 (September 15, 2016): 221–30, doi:10.1016/j.foreco.2016.06.010.

[54] Amber Roth, Thesis information advising session., February 2017.

[55] Eben Goodale et al., "The Relationship between Shelterwood Cuts and Crown Thinnings and the Abundance and Distribution of Birds in a Southern New England Forest," *Forest Ecology and Management* 258, no. 3 (June 30, 2009): 314–22, doi:10.1016/j.foreco.2009.04.020.

[56] Mariko Yamasaki, Christine A. Costello, and William B. Leak, "Effects of Clearcutting, Patch Cutting, and Low-Density Shelterwoods on Breeding Birds and Tree Regeneration in New Hampshire Northern Hardwoods," August 2014, https://www.fs.fed.us/nrs/pubs/rp/rp_nrs26.pdf.

[57] Scott H. Stoleson, "Condition Varies with Habitat Choice in Postbreeding Forest Birds," *The Auk* 130, no. 3 (July 1, 2013): 417–28, doi:10.1525/auk.2013.12214.

Buntings (*Passerina cyanea*) and Prairie Warblers indicate early stand initiation (0-7 years).[58] Observations at the Berry Lots were consistent with this study since both Indigo Buntings and Prairie Warblers were repeatedly present on site post-harvest.

For some bird species, clearcutting may not be the best decision nor a sound financial decision for the landowner. If forestland owners do not feel comfortable planning clearcuts, timber stand improvement activity may help landowners manage their forests to meet financial and wildlife goals. The practice of removing low quality trees around the highest quality trees through thinning helps the released trees gain volume faster and thus increase in value faster. Populations of interior forest species can be maintained until the crop trees have reached financial maturity. At this point, removal of the overstory will give rise to the regeneration of young forest species and the subsequent use of the site by associated fauna.[59]

Of course, there will never be one single silvicultural practice that can provide everything for every species in a given area. Whenever possible, snag and/or cavity trees should always be retained as they provide nesting and shelter habitat that takes many years to develop in young stands.[60] Other microhabitat features may not be as apparent to us, but they can be extremely important to a species' habitat selection process.[61] As such,

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[58] Duguid et al., "Changes in Breeding Bird Abundance and Species Composition over a 20 Year Chronosequence Following Shelterwood Harvests in Oak-Hardwood Forests."

[59] David T. Rankin and Noah G. Perlut, "The Effects of Forest Stand Improvement Practices on Occupancy and Abundance of Breeding Songbirds," *Forest Ecology and Management* 335 (January 1, 2015): 99–107, doi:10.1016/j.foreco.2014.09.031.

[60] Scott Haulton, "Effects of Silvicultural Practices on Bird Communities in Deciduous Forests of Eastern and Central North America," October 2008, http://208.40.244.65/dnr/forestry/files/fo-ManagedForestBirdReview.pdf.

[61] S.W. MacFaden and David E. Capen, "Avian Habitat Relationships at Multiple Scales in a New England Forest," *Forest Science* 48, no. 2 (May 2002): 243–53.

it is important to conduct a variety of silvicultural practices across the landscape that will ensure a diverse mosaic of forests.

Overcoming Sociocultural Barriers to Act on Opportunities to Salvage Ash

Not every community will be equally affected by the loss of ash. Although forest products generate the second highest amount of agricultural and forest product income for the state of Connecticut, the most significant industry (greenhouses, nurseries, floriculture, and sod) makes nearly two and a half times more.[62] Conversely, if black ash (*Fraxinus nigra*) were to disappear due to the EAB, the Wabanaki of Maine would lose a keystone material for basketweaving: a critical piece of their culture and a tradition that has sustained families throughout generations.[63] This disproportionality in valuation and impact between communities is important for landowners to understand across the native range of *Fraxinus* spp. In addition to potential income and the potential to create habitat for young forest species, landowners can potentially delay the spread of the rapidly spreading EAB to more sensitive, ash-dependent communities such as the five nations that make up the Wabanaki Confederacy: Abenaki, Maliseet, Mi'kmaq, Passamaquoddy, and Penobscot.[64]

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[62] Linda Piotrowicz, "Grow Connecticut Farms: Developing, Diversifying, and Promoting Agriculture | First Annual Report," December 2012, http://www.ct.gov/doag/lib/doag/boards_commissions_councils/gcf/grow_ct_farms_3_6_2013_low.pdf.
[63] Joe Rankin, "Rising From the Ashes," *Center for Northern Woodlands Education*, December 5, 2014, http://northernwoodlands.org/articles/article/maine-basketmakers.
[64] "Beyond the Mandate: Continuing the Conversation" (Hermon, Maine, June 14, 2015), https://d3n8a8pro7vhmx.cloudfront.net/mainewabanakireach/pages/17/attachments/original/1468974047/TRC-Report-Expanded_July2015.pdf?1468974047.

According to a report written by the Sustaining Family Forests Initiative (SFFI),[65] sixty percent of Connecticut is forested, of which seventy-three percent is privately owned. Given this, and the immediate threat of EAB across the state, private landowners have great influence over the future characteristics of Connecticut's forests. One of the greatest barriers to conserving Connecticut forests, is the lack of trusted service and extension foresters within the state:

"[the CT DEEP, Forestry Division is] charged with providing assistance to forest landowners throughout Connecticut. However, the resources of the Division are small, with only two service foresters assigned to work with private landowners." [65]

In general, forestland owners need access to trustworthy natural resource professionals in order to take full advantage of all ecological, recreational, and financial benefits their privately-owned forests offer. There are natural resources professionals from nonprofit organizations, consulting firms, and other state departments, that can be just as helpful as those state service foresters. However, as one individual stated in the SFFI study, it appears as though there is more information on non-forestland property maintenance such as gardening.[66] Adding to the problem is the institutionalized barrier between landowners and current scientific research. Even though current research may exist, it may not be easily accessible to landowners. For this reason, many landowners prefer to get their information from university or government sources [66] which are often

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[65] Mary L. Tyrell, "Understanding Connecticut Woodland Owners | A Report on the Attitudes, Values, and Challenges of Connecticut's Family Woodland Owners" (Yale School of Forestry and Environmental Studies, March 2015), http://www.ct.gov/deep/lib/deep/forestry/ct_woodland_owners_report.pdf.
[66] Tyrell, "Understanding Connecticut Woodland Owners | A Report on the Attitudes, Values, and Challenges of Connecticut's Family Woodland Owners."

easier to access and provide information on current issues and research on solutions, thus appearing to be more transparent. In doing research, it should be easy for landowners to find material pertinent to factors contributing to ash decline. However, there appears to be a lack of material for the general public. Many studies have been done pertaining to ash decline factors, however proper guides and educational material should be written and posted to these sites that forestland owners prefer to reference. In doing so, forestland owners will be able to more clearly address their forest health issues.

In addition to accessing educational material on forest management, some states offer financial incentives to maintain forestland. However, of those families that own forestland in Connecticut, not all are currently eligible for "Connecticut's Land Use Value Assessment Law for Farm Land, Forest Land, and Open Space Land", more commonly known as "PA-490." Of those that are enrolled, ninety-six percent stated that it is important in helping them keep their land undeveloped. For those that did not qualify due to prior definitions of "forest", newly proposed changes to PA-490 may make it easier for the once ineligible forestland owners to enroll in 2017-2018. Changes to the legal definition of seedlings and including young forest maintenance as an exception to § 12-107d-3 "Standards for forest land classification" would also encourage and allow landowners to manage for *young* forest.[67] In addition, government agencies such as the US Department of Agriculture's Natural Resources Conservation Service offer cost-share

[67] Christopher Martin, "Concerning Classification of Forestland, §12-107d-1 through 12-107d-5 "Policies and Standards for Evaluating Land Proposed for Classification as Forest Land | Tracking # PR2016-026," Notice of Intent (State of Connecticut | Department of Energy and Environmental Protection), accessed April 11, 2017, https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid={508E8C58-0000-C9E5-8D20-9AA434597A24}.

programs that allow landowners to split the cost of wildlife habitat management activities. By conducting a harvest, landowners may be able to recover a part of or their entire half of the cost.

However, even though land can be enrolled in a forestland tax incentive program, there may not be a clause requiring the landowner to have a management plan or engage in active management. For this reason, it is important to address the need to educate forestland owners on basic sustainable forest management activities that are not financially stressful. Not every forestland owner may be willing to engage in timber management practices. It is suggested that instead of trying to get landowners to take a leap of faith from no management to intensive management, that foresters and other natural resource professionals attempt to bridge that gap with "light management activities" such as cutting firewood, building trails, and treatment or removal of invasive plants.[68] These management activities could pique interest in more intensive management activities such as those involved with managing for young forest dependent bird species or stand regeneration.

Conclusion

Many species at risk of or already experiencing population decline depend upon forest disturbances at some point in their lifecycles. It is for this reason that it is critical for forest landowners to understand the importance of monitoring and managing their forests. There are many issues facing northern forests today including introduced,

[68] Tyrell, "Understanding Connecticut Woodland Owners | A Report on the Attitudes, Values, and Challenges of Connecticut's Family Woodland Owners."

invasive plants and insects as well as native and natural stresses. To address these stresses, landowners must first acknowledge their existence. It is therefore imperative that forestland owners are able to easily access identification and management tools or professional assistance through state agencies or private consultants. Through active management, forestland owners can help to mitigate these problems as they arise before they result in extensive tree mortality and loss of desired wildlife species. As the case study with the Berry Lots has suggested, a salvage operation can turn into an opportunity to provide young forest habitat for species in need.

While forest management plans are often not required for private forests, they are highly beneficial in identifying long term landowner goals and establishing attainable objectives to meet those goals. Natural resources professionals can engage the private forestland owner community by asking:

1. Have you ever had a licensed forester conduct a forest inventory of your forestland?
2. Are you aware of the health of your forest?
3. Has a certified wildlife biologist conducted a wildlife habitat assessment of your forestland?

These types of questions can begin the conversation about engaging in forest management activities that could contribute to regional or national conservation efforts. The Berry Lots case study is an excellent example of a quasi-private forestland owner that could contribute to the New England cottontail regional effort to prevent it from being listed under the Endangered Species Act. Since the completion of the Berry Lots

harvest in 2015, the MDC has conducted wildlife habitat assessments in other management units to expand their potentially positive impacts on young forest dependent wildlife.

The observations of birds at the Berry Lots suggest that creation of young forest can provide nesting and staging habitat for many bird species. When accounting for survey effort and focusing on the month of June when migratory species are nesting, mean species richness increased, although not significantly by statistical standards. In addition, high total species counts from May 2016, although appearing to be significant, can be explained by the presence of migrant species that would likely never breed on site.

As such, it may be that the silvicultural actions taken by the MDC have made a positive impact on the site's overall allure to various bird species. However, without having conducted a study following standardized protocol, conclusions about trends and actual impact on the bird community should not be conjectured, thus avoiding conclusions drawn under the influence of confirmation bias.

Long-term surveys to track changes in bird diversity or abundance should be implemented using a standardized protocol such as randomly generated point counts or travelling count transects that would allow for more specific statistical analyses. Additionally, replicating surveys across several sites would contribute to the likelihood that the data will be able to contribute to a scientifically publishable article.

People have and will continue to manage forests for numerous and diverse reasons. Although we have introduced species that threaten the existence of other, native, species, we still have the potential to mitigate the damage done by these invasive species.

The fate of ash and young forest species depends on how we manage our forests now. Through effective communication with wildlife biologists and silviculturists, forestland owners can be a part of the solution instead of hosting the problem.

"If you choose not to decide, you still have made a choice."

"Freewill" - Rush

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Appendix A: Pre-harvest photos of the Berry Lots. Season and direction listed top to bottom: summer/north, fall/west, fall/south.

Appendix B: "*Terms and Conditions of Berry Lots Ash Salvage M-047, March 2013"*

- All unmarked trees 4" in diameter and up shall be cut within the flagged salvage area with the following exceptions:
    a. White pine and hemlock trees shall not be cut in the flagged area unless marked
    b. Reserve trees with orange rings around them shall not be damaged
    c. Trees marked with an orange "G" shall be double ring girdled
    d. Cavity trees marked with an orange "W" shall be left standing for wildlife
    e. Trees marked with an orange "X" will be dropped and form the foundation of 20'x20'x4' brush piles. A minimum of 5 brush piles shall be built - locations to be determined by MDC Forester.
- A log forwarder must be used to transport material from the flagged salvage area to the landing(s) and a mechanical harvester must be used for tree cutting, excepting trees too large for its capacity, which may be hand felled.
- Haul routes and landing locations to be determined in consultation with MDC Forester at start of operation.
- All marked vines shall be cut as designated without damaging any residual trees.
- No stumping required. Stumps not to exceed 12" in height.
- Within the roadside tree removal area all timber and firewood marked with blue slashes are to be removed and roads and ditches to remain open.
- Tops are included in the sale down to a 4" tip. The slash must be left on site.
- Skidding with tops and or roots attached is not allowed.
- No whole tree harvesting or processing of forest products on site.

Appendix C. A collection of positively identified vegetation at the Berry Lots site.

Scientific Name	**Common Name**	**Notes**
Trees		
Populus tremuloides	Quaking aspen	Vigorous regeneration
Acer rubrum	Red maple	
Acer saccharum	Sugar maple	Left as residuals
Acer pensylvanicum	Striped maple	
Acer spicatum	Mountain maple	
Quercus rubra	Northern red oak	
Quercus alba	White oak	
Fraxinus americana	White ash	Almost completely salvaged
Prunus serotina	Black cherry	Many left for wildlife
Picea abies	Norway spruce	Old plantation, left for wildlife
Pseudotsuga menziesii	Douglas-fir	Old plantation
Malus spp.	Apple	Orchard residuals, left for wildlife
Shrubs		
Cornus amomum	Silky Dogwood	
Cornus sericea	Redosier Dogwood	
Cornus racemosa	Gray Dogwood	
Viburnum lantanoides	Hobblebush	Good source of nectar
Ilex verticilata	Winterberry holly	
Alnus incana	Speckled alder	
Alnus rubra	Red alder	
Vaccinium corymbosum	Highbush blueberry	Vigorous growth in open area
Kalmia latifolia	Mountain laurel	
Clethra alnifolia	Sweet pepperbush	Good source of nectar
Prunus virginiana	Chokecherry	

Scientific Name	**Common Name**	**Notes**
Salix spp.	Willow spp.	
Rosa multiflora	Multiflora rose	Invasive, to be treated
Berberis thunbergii	Japanese barberry	Invasive, to be treated
Forbs		
Viburnum dentatum	Arrowwood viburnum	
Viburnum lentago	Nannyberry	
Cyperaceae spp.	Sedge spp.	Forage for wildlife
Trifolium arvense	Rabbit's foot clover	Forage for wildlife
Juncus spp.	Sedge spp.	Forage for wildlife
Rudbeckia hirta	Black-eyed susan	Forage for wildlife
Asteraceae spp.	Aster spp.	
Impatiens capensis	Orange Jewelweed	
Lobelia cardinalis	cardinal flower	Good source of nectar
Helianthus sp.	fall sunflower	Forage for wildlife
Lotus corniculatus	Bird's foot trefoil	
Vicia spp.	Vetch spp.	Good source of nectar
Cirsium vulgare	Common thistle	Forage for wildlife
Urtica dioica	Stinging nettle	
Solidago spp.	Goldenrod spp.	Forage for wildlife
Trifolium pratense	Red clover	Forage for wildlife
Trifolium repens	White clover	Forage for wildlife
Rubus spp.	Brambleberries	Soft mast for wildlife
Artemisia vulgaris	Mugwort	Invasive, treated 2016
Toxicodendron radicans	Poison ivy	
Ambrosia spp.	Ragweed	Forage for wildlife
Celastrus orbiculatus	Asiatic bittersweet	Invasive, to be treated

Scientific Name	Common Name	Notes
Parthenocissus quinquefolia	Virginia creeper	
Vitis spp.	Grapevine spp.	Soft mast for wildlife

Appendix D: List of birds seen at the Berry Lots, their migratory status [69] and conservation importance based on various conservation organizations.

Common Name	**Scientific Name**	**Migratory Status**	**IUCN Red List**	**CT WAP 2015**	**Audubon CT Priority Birds**
Wood Duck	*Aix sponsa*	YRR	LC		
Ruffed Grouse	*Bonasa umbellus*	YRR	LC	VI	
Wild Turkey	*Meleagris gallopavo*	YRR	LC		
Great Blue Heron	*Ardea herodias*	YRR	LC		
Turkey Vulture	*Cathartes aura*	BSR	LC		
Osprey	*Pandion haliaetus*	Potential YRR	LC		
Sharp-shinned Hawk	*Accipiter striatus*	YRR	LC	MI	
Cooper's Hawk	*Accipiter cooperii*	YRR	LC		
Bald Eagle	*Haliaeetus leucocephalus*	YRR	LC	I	X
Red-shouldered Hawk	*Buteo lineatus*	YRR	LC		
Broad-winged Hawk	*Buteo platypterus*	BSR	LC	VI	
Red-tailed Hawk	*Buteo jamaicensis*	YRR	LC		
American Woodcock	*Scolopax minor*	BSR	LC	MI	X
Rock Dove	*Columba livia*	Introduced YRR	LC		
Mourning Dove	*Zenaida macroura*	YRR	LC		
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BSR	LC	VI	
Yellow-billed Cuckoo	*Coccyzus americanus*	BSR	LC	VI	

[69] YRR: Year Round Resident
BSR: Breeding Season Resident
Migrant: only passing through
Introduced: non-native to the region
Potential: BSR/YRR/Migrant ranges overlap/intersect over northwest Connecticut.
MI: Most Important
VI: Very Important
I: Important
X: Signifies that it is an Audubon CT Priority Bird.

Barred Owl	*Strix varia*	YRR	LC		
Northern Saw-whet Owl	*Aegolius acadicus*	YRR	LC	I	
Common Name	**Scientific Name**	**Migratory Status**	**IUCN Red List**	**CT WAP 2015**	**Audubon CT Priority Birds**
Common Nighthawk	*Chordeiles minor*	BSR	LC		
Chimney Swift	*Chaetura pelagica*	BSR	NT	VI	
Ruby-throated Hummingbird	*Archilochus colubris*	BSR	LC		
Red-bellied Woodpecker	*Melanerpes carolinus*	YRR	LC		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Potential YRR	LC		
Downy Woodpecker	*Dryobates pubescens*	YRR	LC		
Hairy Woodpecker	*Leuconotopicus villosus*	YRR	LC		
Northern Flicker	*Colaptes auratus*	YRR	LC	VI	
Pileated Woodpecker	*Dryocopus pileatus*	YRR	LC		
American Kestrel	*Falco sparverius*	YRR	LC	MI	
Olive-sided Flycatcher	*Contopus cooperi*	BSR	NT		
Eastern Wood-Pewee	*Contopus virens*	BSR	LC	I	
Alder Flycatcher	*Empidonax alnorum*	BSR	LC		
Willow Flycatcher	*Empidonax traillii*	BSR	LC		
Least Flycatcher	*Empidonax minimus*	BSR	LC	VI	
Eastern Phoebe	*Sayornis phoebe*	BSR	LC		
Great Crested Flycatcher	*Myiarchus crinitus*	BSR	LC		
Eastern Kingbird	*Tyrannus tyrannus*	BSR	LC		
Yellow-throated Vireo	*Vireo flavifrons*	BSR	LC		
Blue-headed Vireo	*Vireo solitarius*	BSR	LC		
Philadelphia Vireo	*Vireo philadelphicus*	Migrant	LC		

Red-eyed Vireo	*Vireo olivaceus*	BSR	LC		
Blue Jay	*Cyanocitta cristata*	BSR	LC		
Common Name	**Scientific Name**	**Migratory Status**	**IUCN Red List**	**CT WAP 2015**	**Audubon CT Priority Birds**
American Crow	*Corvus brachyrhynchos*	BSR	LC		
Common Raven	*Corvus corax*	BSR	LC		
Tree Swallow	*Tachycineta bicolor*	BSR	LC		
Barn Swallow	*Hirundo rustica*	BSR	LC		
Black-capped Chickadee	*Poecile atricapillus*	YRR	LC		
Tufted Titmouse	*Baeolophus bicolor*	YRR	LC		
Red-breasted Nuthatch	*Sitta canadensis*	YRR	LC		
White-breasted Nuthatch	*Sitta carolinensis*	YRR	LC		
Brown Creeper	*Certhia americana*	YRR	LC	I	
House Wren	*Troglodytes aedon*	BSR	LC		
Winter Wren	*Troglodytes hiemalis*	WR	LC		
Blue-grey Gnatcatcher	*Polioptila caerulea*	BSR	LC		
Golden-crowned Kinglet	*Regulus satrapa*	YRR	LC		
Ruby-crowned Kinglet	*Regulus calendula*	BSR	LC		
Eastern Bluebird	*Sialia sialis*	Potential YRR	LC		
Veery	*Catharus fuscescens*	BSR	LC	I	
Hermit Thrush	*Catharus guttatus*	BSR	LC		
Wood Thrush	*Hylocichla mustelina*	BSR	NT	MI	X
American Robin	*Turdus migratorius*	BSR	LC		
Grey Catbird	*Dumetella carolinensis*	YRR	LC		
European Starling	*Sturnus vulgaris*	IntroducedYRR	LC		
Cedar Waxing	*Bombycilla cedrorum*	YRR	LC		

Ovenbird	*Seiurus aurocapilla*	BSR	LC	I	
Worm-eating Warbler	*Helmitheros vermivorum*	BSR	LC	VI	
Common Name	**Scientific Name**	**Migratory Status**	**IUCN Red List**	**CT WAP 2015**	**Audubon CT Priority Birds**
Louisiana Waterthrush	*Parkesia motacilla*	BSR	LC	VI	
Blue-winged Warbler	*Vermivora cyanoptera*	BSR	LC		
Black-and-white Warbler	*Mniotilta varia*	BSR	LC	I	
Tennessee Warbler	*Oreothlypis peregrina*	Migrant	LC		
Nashville Warbler	*Oreothlypis ruficapilla*	BSR	LC		
Mourning Warbler	*Geothlypis philadelphia*	Migrant	LC		
Common Yellowthroat	*Geothlypis trichas*	BSR	LC		
American Redstart	*Setophaga ruticilla*	BSR	LC		
Cape May Warbler	*Setophaga tigrina*	Migrant	LC		
Northern Parula	*Setophaga americana*	Migrant	LC	I	
Magnolia Warbler	*Setophaga magnolia*	BSR	LC		
Bay-breasted Warbler	*Setophaga castanea*	Migrant	LC		
Blackburnian Warbler	*Setophaga fusca*	BSR	LC	I	
Chestnut-sided Warbler	*Setophaga pensylvanica*	BSR	LC	VI	
Blackpoll Warbler	*Setophaga striata*	Migrant	LC		
Black-throated Blue Warbler	*Setophaga caerulescens*	BSR	LC	VI	X
Pine Warbler	*Setophaga pinus*	BSR	LC		
Yellow-rumped Warbler	*Setophaga coronata*	BSR	LC		
Prairie Warbler	*Setophaga discolor*	BSR	LC	MI	X
Black-throated Green Warbler	*Setophaga virens*	BSR	LC		
Chipping Sparrow	*Spizella passerina*	BSR	LC		

Field Sparrow	*Spizella pusilla*	BSR	LC		
Dark-eyed Junco	*Junco hyemalis*	YRR	LC		
Common Name	**Scientific Name**	**Migratory Status**	**IUCN Red List**	**CT WAP 2015**	**Audubon CT Priority Birds**
White-crowned Sparrow	*Zonotrichia leucophrys*	Migrant	LC		
White-throated Sparrow	*Zonotrichia albicollis*	YRR	LC		
Song Sparrow	*Melospiza melodia*	YRR	LC		
Swamp Sparrow	*Melospiza georgiana*	YRR	LC		
Eastern Towhee	*Pipilo erythrophthalmus*	BSR	LC	VI	
Scarlet Tanager	*Piranga olivacea*	BSR	LC	VI	
Northern Cardinal	*Cardinalis cardinalis*	YRR	LC		
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	BSR	LC	I	
Indigo Bunting	*Passerina cyanea*	BSR	LC		
Bobolink	*Dolichonyx oryzivorus*	BSR	LC		X
Red-winged Blackbird	*Agelaius phoeniceus*	YRR	LC		
Common Grackle	*Quiscalus quiscula*	YRR	LC		
Brown-headed Cowbird	*Molothrus ater*	YRR	LC		
Orchard Oriole	*Icterus spurius*	BSR	LC		
Baltimore Oriole	*Icterus galbula*	BSR	LC	I	
House Finch	*Haemorhous mexicanus*	YRR	LC		
Purple Finch	*Haemorhous purpureus*	BSR	LC		
Pine Siskin	*Spinus pinus*	BSR	LC		
American Goldfinch	*Spinus tristis*	BSR	LC		

Appendix E. Photos taken during the first winter of the Berry Lots harvest (2013).

Author's Biography

Bianca M. Beland, was born on October 11, 1994 in Barkhamsted, CT. She graduated from Northwest Regional #7 High School in 2012. Enrolled as a double major in Forestry and Wildlife Ecology, she also accepted an invitation to the Honors College. In the spring of 2015, she was initiated into the Gamma Chapter of Xi Sigma Pi: Forestry Honors Society. In 2015-2016 she served as the Vice President and in 2016-2017, as the President. In April of 2017, she became a founding sister of the reinstalled Alpha Kappa chapter of Delta Delta Delta.

After graduation, Bianca intends to finish an article being written for the public pertaining to her Honors Thesis. She aims to have it published in the Connecticut DEEP's bimonthly magazine: *Connecticut Wildlife*. She also plans to take the Connecticut Forester's License exam, look for experience working with environmental policy in Connecticut, and volunteer with the Greater Hartford alumnae chapter of Delta Delta Delta.