Documenting and Protecting New England's Old-Growth Forests

Jack Ruddat

Worcester Polytechnic Institute

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Documenting and Protecting New England’s Old-Growth Forests

Written By: Jack Ruddat
Documenting and Protecting New England’s Old-Growth Forests

An Interactive Qualifying Project
submitted to the Faculty of
Worcester Polytechnic Institute
in partial fulfillment of the requirements for the
degree of Bachelor of Science

by
Jack Ruddat

Date:
May 13, 2020

Report Submitted to:

Dr. Uma Kumar and Dr. Ingrid Shockey
Worcester Polytechnic Institute

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Abstract

Old-growth forests in New England have become exceedingly rare over the centuries but contribute greatly to biodiversity, ecological stability, and scientific knowledge. Many of these remaining forests are either unrecognized or lack protection from development. The goal of this project was to promote the preservation and appreciation for old-growth forests in New England. The state of Connecticut was chosen for mapping and documenting remaining standing old-growth forests, understanding stakeholders’ positions and preservation practices, and identifying suitability for public visitation.
Executive Summary

Old-growth forests in the United States can be identified as areas of land that have been continuously forested since before the early to mid-1800’s (Jönsson, Fraver, & Jonsson, 2009; Kershner & Leverett, 2004). They have become exceedingly rare over the centuries but contribute greatly to biodiversity and ecological stability (MacKinnon, 1998). Furthermore, they are laboratories for scientific knowledge regarding forest succession and development, plant relationships, and nutrient cycling (David et al., 1996). They harbor some of the most awe-inspiring, mysterious, and complex forms of beauty known to humanity, and yet are known by relatively few visitors. With over 350 years of logging history, Connecticut is hardly the place people would expect to find patches of 400+ year-old forest. It has been determined through this project that over 675 acres of old growth exist in plots ranging between one and 130 acres. Some of these ancient forests could be better appreciated and provide educational benefits if they were opened to the public. Doing this sustainably means careful consideration for balancing both access and protection. This project assessed the feasibility of developing access to several old-growth forests in Connecticut.

The goal of this project was therefore to promote the preservation and appreciation for old-growth forests in New England. More specifically, it sought to secure the preservation of Connecticut’s remaining unprotected old-growth forests and promote ecotourism in Western and Northwestern Connecticut by providing non-intrusive access to these unique areas where possible. To that end, I documented and mapped Connecticut’s remaining standing old-growth forests, recorded stakeholders’ positions about suitable preservation practices, and identified the suitability of these sites for public visitation.
Executive Summary

Although not as impressive as the redwoods and Douglas fir seen in the West, New England still supported some very old trees with their own unique characteristics and associated flora and fauna. Old-growth forests in the East are characterized as secondary or primary old growth; forests that are between 150 and 300 years old or those that have existed since before European settlement, respectively.

Approach

With the goal of promoting the preservation and appreciation for old-growth forests in New England, three objectives served to accomplish this goal:

1. Document and map Connecticut’s remaining standing old-growth forests
2. Understand stakeholders’ positions and perspectives on preservation practices
3. Identify suitability of sites for public visitation

The flowchart in Figure B below provides an organized visual for the relationship between the goal, objectives, and methods.
Connecticut harbors over 675 acres of standing old-growth forest in 25 sites across 13 towns (World Population Review, 2020). Most of the old growth was found in four forest habitats: hemlock-northern hardwoods (350 acres), boreal spruce-gum swamps (150 acres), eastern white pine stands (92 acres), and eastern red cedar glades (50 acres). There is likely more to be uncovered and additional documentation of these areas is a work in progress. While the focus of this project is on standing old-growth forests, additional areas of equivalent age exist as natural blowdowns such as that surrounding Cathedral Pines in Cornwall, CT. A map showing the locations, names, and sizes of known standing old growth (marked in green) in CT is shown in Figure C below.
The dominant canopy trees in these forests ranged in age from 150 to approximately 617 years old. The typical ages of canopy trees in these forests were as follows: hemlock-northern hardwoods (300-400), boreal spruce-gum swamps (130-617), eastern white pine stands (200-300), and eastern red cedar glades (300-600).

While several of the old-growth sites in Connecticut are known to forestry experts, they have varying but optimistic positions about the potential benefits of encouraging the public to visit old-growth forests. Perspectives from the stakeholders such as scientists, foresters, hikers, and conservationists tended to veer toward the side of caution to avoid risking damage to these irreplaceable natural resources. For example, Dr. Susan A. Masino, Ph.D., a professor of applied science at Trinity College, believes we should have a differentiated approach to how we treat our forests. She states that there need to be forests set aside for logging and recreation, but there also need to be areas of wilderness; places where the ecosystem is left intact and undisturbed by any human management such as seen in old growth (S. Masino, personal communication, April 5, 2020). Filmmaker and naturalist Ray Asselin views forest management as resource extraction that simplifies the structure of a forest by diminishing its biodiversity and genetic diversity. (R. Asselin, personal communication, April 10, 2020). According to Dr. Joan Maloof, ecologist and president of the Old-Growth Forest Network, without the support of the public, old-growth forests run the risk of succumbing to the will of foresters; most of whom see them solely as a means for economic profit. In forests with no public access, the public will not be able to experience the forest, and therefore will not likely be moved to protect it if threatened. In the case of very fragile ecosystems preserving the habitat is important, but off-limits forests should have strong protections already in place when they are closed to visitation. What good is closing
Executive Summary

a forest to preserve it from hikers, when it can then be destroyed by loggers? (J. Maloof, personal communication, April 13, 2020).

Recommendations

Based on the concerns that emerged from interviews with experts, I recommend that there be partnerships between the CT DEEP, land trusts near these areas, and the Old-Growth Forest Network.

I would recommend that of the sites lacking trails within them, Center Brook, Sandy Brook/Algonquin State Forest, Roberts Brook, and the Canaan Mountain Tract allow for trail construction. These areas would further benefit the public by having guidebooks written about their ecology, novelty, and features similar to what is given in Appendix M.

Finally, I recommend that some of these forests be given the opportunity to be used as centers for environmental education. The plot of woods next to the Park River in particular could be used as an educational resource for those that live in the city of Hartford, CT. Here, school field trips could focus on identifying local tree species, recognizing old trees, and the relationship between plants, animals, and fungi.

Without old-growth forests, many more species, including future medicines we extract from the natural world, could be lost to the axe. We live among the last remaining forested monarchs of southern New England, something which should be preserved for future generations to study and enjoy.
Acknowledgements

I would like to thank Dr. Uma Kumar and Dr. Ingrid Shockey for their invaluable assistance and guidance throughout this project. I would also like to thank all interviewees for sharing their expertise and points of view on protecting old-growth forests.
Authorship

This project was carried out and written by Jack Ruddat, a junior at Worcester Polytechnic Institute pursuing a Bachelor of Science in Electrical and Computer Engineering. His appreciation for ancient forests was funneled through the self-taught science of dendrochronology, the study of tree rings.

Figure D. Jack Ruddat and his dog Oliver (Photo credit: Helena Petroff, 2020)
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Chapter 1. Introduction

Old-growth forests in the United States can be identified as areas of land that have been continuously forested since before the early to mid-1800’s (Jönsson, Fraver, & Jonsson, 2009; Kershner & Leverett, 2004). They have become exceedingly rare over the centuries but contribute greatly to biodiversity and ecological stability (MacKinnon, 1998). Furthermore, they are laboratories for scientific knowledge regarding forest succession and development, plant relationships, and nutrient cycling (David et al., 1996). They harbor some of the most awe-inspiring, mysterious, and complex forms of beauty known to humanity, and yet are known by relatively few visitors. With over 350 years of logging history, Connecticut is hardly the place people would expect to find patches of 400+ year-old forest. It has been determined through this project that over 675 acres of old growth exist in plots ranging between one and 130 acres. Some of these ancient forests could be better appreciated and provide educational benefits if they were opened to the public. Doing this sustainably means careful consideration for balancing both access and protection. This project assessed the feasibility of developing access to several old-growth forests in Connecticut.

Most of the forests featured here are primary old-growth forests: those that have been continuously forested since before European settlement. The focus drew from the results of earlier research as well as new surveys and assessments of old-growth zones. These forest tracts are already areas of curiosity for nature enthusiasts, hikers, and ecologists, and so I also enlisted the Old-Growth Forest Network (OGFN), an organization whose mission entails “Creating a national network of protected old-growth forests” (Old-Growth Forest Network, 2020).

What we know is that most of these forests are not public knowledge nor are they preserved from logging or other forestry practices. Previous surveys cited only 200 acres of old growth in the state of Connecticut (Kershner & Leverett, 2004), however this information is incomplete. Based upon the results of my surveys conducted over the past three years, the total area of old growth has expanded to over 675 acres, most of which is in Litchfield county, equivalent to 0.0212% of CT’s forested land.

The goal of this project was therefore to promote the preservation and appreciation for old-growth forests in New England. More specifically, it sought to secure the preservation of Connecticut’s remaining unprotected old-growth forests and promote ecotourism in Western and Northwestern Connecticut by providing awareness and non-intrusive access to these unique areas.
where possible. To that end, I documented and mapped Connecticut’s remaining old-growth forests, recorded stakeholders’ positions about suitable preservation practices, and identified the suitability of these sites for public visitation.
Chapter 2. Literature Review

This chapter presents archival research relevant to the goal of this project. I document perspectives on the pros and cons of visitation and how to capitalize or mitigate on positive and negative impacts. The literature review also investigates the psychological and physiological effect of ancient forests and features pertinent case studies.

2.1 Old-growth forests in southern New England

Ever since the start of European settlement primeval forests have been steadily declining in New England. There has been a radical shift in species distribution across the Northeastern United States compounded with the introduction of non-native and invasive species, some of which have brought individual tree species to near extinction (Thompson, Jonathan R., Carpenter, Cogbill, & Foster, 2013). In 1820, only 25% of Connecticut was forested. By 2010 the total rose to almost 60% with estimates of only 200 acres of old-growth forest or 0.0063% of its forested land (Kershner & Leverett, 2004; Wharton et al., 2004). Most of these forests were fragmented and small in area ranging anywhere from one to 130 acres. Although not as impressive as the redwoods and Douglas fir seen in the West, New England still supported some very old trees with their own unique characteristics and associated flora and fauna.

Some of the more well-known species of southern New England that attain great size or age in undisturbed environments are American sycamore, eastern hemlock, eastern red cedar, eastern white pine, sugar maple, sweet birch, tuliptree, white oak, and yellow birch.

Connecticut has been found to harbor hemlock-northern hardwood forests with canopy trees between 300 and 400 years old. Its eastern red cedar glades gave rise to trees approximately 600 years old and the boreal spruce-gum swamps have sustained trees in excess of 600 years old. In the summer, these areas are covered with every shade of green imaginable as they support a wide variety of ferns, mosses, lichens, and woody understory plants. These ancient forests were left alone due to inaccessibility, low profitability, disputes over property boundaries, the actions of private landowners, or as part of the preservation of adjacent natural landmarks such as waterfalls.

Few people recognize the presence of old growth in New England and their intrinsic value and scale as opposed to the second-growth forests we have become accustomed to. Not only do they provide a sense of identity and character to our land, but they can also provide
inspiration for the humanities in poetry, painting, and philosophy. A quintessential New England forest is exemplified in Figure 1 below.

![An old-growth hemlock-northern hardwood forest next to Wildcat Swamp in Norfolk, CT’s Great Mountain Forest](Photo credit: Jack Ruddat, 2020)

As we continue to uncover more of southern New England’s original forests, it is important to remain ever-vigilant to threats that seek to ruin the character they have patiently built up over the centuries. Not only is it my hope that they will add to the permanence of our land’s unique array of species and ecosystems, but also provide for the further enjoyment of future generations.

2.2 Advocate perspectives for old-growth forests and conservation best practices

Parties interested and concerned with New England’s ancient forests range from local nature enthusiasts to foresters who practice contemporary silviculture. From these groups there are two main perspectives for how to manage forests that can be placed on a spectrum from
complete conservation to partial development. For example, Dr. Susan A. Masino, Ph.D., a professor of applied science at Trinity College, believes we should have a differentiated approach to how we treat our forests. She states that there need to be forests set aside for logging and recreation, but there also need to be areas of wilderness: places where the ecosystem is left intact and undisturbed by any human management such as seen in old growth. According to her, the dominate narrative is that we need to manipulate forests to keep them healthy and assist in the storage of carbon. Therefore, the biggest threat to natural forests is the lack of conversation about the need for intact ecosystems free from management and the majority opinion that all forests require active management. As of 2015, only 31,575 acers or 1% of CT’s forestland is protected under law from timber salvaging and management, all of which is owned at the local level (Hochholzer, Stocker, Bentley, & Peracchio, 2015). Dr. Masino believes that public land should be prioritized because they exist across the state and in large enough tracts to protect core forest species and create a network for education, species migration, and conservation. In terms of the ever-changing “sustainable forestry” practices, we cannot deem them sustainable given that they have been in use for such a short time compared to the timescale of a forest or even individual trees. Blind logging on public land is most disturbing to our forests wherein areas are cut without surveying for old growth, vernal pools, endangered species, or special attributes significant to local communities. In short, Dr. Masino advocates for a conservative approach that ensures and cultivates a “strategic network of nature” (S. Masino, personal communication, April 5, 2020).

Professor Thomas Worthley teaches forest management and silviculture at the University of Connecticut. Although he is not opposed to applying practices such as an uneven-aged silvicultural selection system for achieving multi-aged ecosystems, he nonetheless acknowledges that most old-growth stands receive no management. The modern practices for forestry are broad depending on whether they are scientifically or economically based. A common example that he cites where forestry management is beneficial describes a young and densely wooded pine thicket. Say the town desires a park full of tall, majestic pine to walk through. In this case it would be best practice to cut all of the dying pine trees that lack sufficient sunlight and to keep the healthiest trees so that they can continue growing to maturity without competition. There is often a practical reason as to why an area has not been logged in the first place that contributes to its sequestration and resistance to invasive species, insect outbreaks, or blowdowns. Logging
practices are cash-driven, and so are not appropriate for silviculture. He recommends surveying old-growth stands to determine if any management is needed. Some of the most important principles to uphold are maintaining public access while creating the least amount of disturbance. It is also imperative that we pay very close attention to land ownership so that the owners of the land can be satisfied. Otherwise there is greater risk of depleting owners of benefit from the land and tempting deforestation in the pursuit of profit. Professor Worthley believes that these areas have the potential to be managed but could otherwise be left completely alone depending on the state of the forest and its ownership status (T. Worthley, personal communication, April 9, 2020).

The perspective of nature enthusiasts also provides keen insight as to how these areas should be treated. Filmmaker and naturalist Ray Asselin views forest management as resource extraction that simplifies the structure of a forest by diminishing its biodiversity and genetic diversity. He gives the example of the Muddy Brook Wildlife Management Area in Hardwick, MA, where hundreds of acres of 130-year-old forest were clear cut in order to restore that land to its alleged but unproven historical pitch pine habitat. There is a plan to possibly do the same to perhaps another 20,000 acres without first considering the ecological value of the existing forest. There is this concept of wildlands and woodlands published by Harvard Forest that Mr. Asselin supports. Its vision is to set aside at least 10% of forested land in New England as unmanaged wildlands and the rest as superbly managed woodlands used for local wood products. Ray Asselin very much appreciates the variety of lowlands, river bottoms, uplands, and the transition zone between southern oak-hickory and northern hardwood forests with a great mixture of species and habitats found in southern New England. It was his realization that old-growth forests still existed in Massachusetts that lead him to produce a recent film titled The Lost Forests of New England as a way to promote their protection and appreciation by the public (R. Asselin, personal communication, April 10, 2020).

Those interested in how we should be treating our few remaining old-growth forests see the existence of these tracts as vital to the integrity and character of New England’s landscape. It seems all too often their presence is overlooked and that our society has become too controlling over the natural course of nature that has served its purpose well beyond what we have come to understand in today’s world.
Conservation for old-growth forests is unique in that their survival depends very much upon their recognition and appreciation by the public. The typical narrative taught by foresters says that old growth is over-mature or, in a sense, “overgrown”. The notion is that late-successional forests contain too many wood debris and understory plants and can only be kept healthy and provide for more economically viable wood through human intervention (Nichols, 1913). The reality as noted earlier, is that old growth stores the largest amounts of carbon in living and dead wood, lowers the risk of forest fires, is more resistant to invasive plant species, and supports a greater diversity of species (Keeton, Whitman, McGee, & Goodale, 2011; Miller et al., 2018; Ritters et al., 2018; Thompson, J. R., Spies, & Ganio, 2007; Zlonis & Niemi, 2014). The notion that creating younger forests from older forests helps climate change mitigation is also false since “the mitigation value of forests lies not in their present net uptake of CO₂ but in the longevity of their accumulated carbon stocks” (Mackey et al., 2013).

Perspectives on how these forests should be conserved range from those suggesting that these fragile environments be completely cut-off from human intervention and visitation, to those who support carefully identifying areas for ecotourism, passive recreation, and even forest management. Dr. Joan Maloof, ecologist and president of the Old-Growth Forest Network believes these tracts of land need to be visited and loved by the public in order to ensure long-lasting protection from logging and development. Without the support of the public, old-growth forests run the risk of succumbing to the will of foresters; most of whom see them solely as a means for economic profit. In forests with no public access, the public will not be able to experience the forest, and therefore will not likely be moved to protect it if threatened. In the case of very fragile ecosystems preserving the habitat is important, but off-limits forests should have strong protections already in place when they are closed to visitation. What good is closing a forest to preserve it from hikers, when it can then be destroyed by loggers? (J. Maloof, personal communication, April 13, 2020). Professor Thomas Worthley suggests that trails be constructed that avoid surrounding meadows or patches of forest that characterize a contrasting habitat. Trails that pass through these areas run the risk of introducing the seeds, eggs, or larvae of invasive species into an otherwise intact and unspoiled ecosystem. He also recommends that trails run along the perimeter with occasional spur trails that run in and out of the heart of the forest so that the older trees can be appreciated without the need for copious amounts of foot traffic and subsequent soil compaction (T. Worthley, personal communication, April 9, 2020).
2.3 Recognizing and valuing ancient forests

An essential part of this project was the ability to recognize old-growth forests. The literature abounds with scientific articles describing old-growth characteristics both at the individual tree and forest levels. Knowing the qualities of forests from different age classes is important for differentiating early successional forests from old-growth forests. Figure 2, below, shows the abundance of woody debris found in ancient forests.

![Figure 2. Downed woody debris in all stages of decay from a forest in North Canaan, CT (Photo credit: Jack Ruddat, 2020)](image)

Older forests are characterized as multi-aged ecosystems having larger average tree diameters, a greater volume of coarse woody debris, larger canopy gaps, more snags (standing dead trees), pit-and-mound topography, many shade-tolerant tree species (American beech, eastern hemlock, sugar maple, etc.), and an abundance of fungi, lichen, and moss covering trees and wood in all stages of decay (Henry, 2015; Kershner & Leverett, 2004; Ziegler, 2000). Individual trees, especially deciduous species, tend to have “balding” bark, stag-headed crowns,
tall, sinuous trunks that have a low degree of taper and are free of low-hanging branches, spiraling grain, and sparsely foliated crowns (Kershner & Leverett, 2004; Pederson, 2010). The more these characteristics are present, the older a given forest is likely to be. Old-growth forests in the East are subsequently characterized as secondary or primary old growth; forests that are between 150 and 300 years old or those that have existed since before European settlement, respectively. The concept of old growth can be visualized as a spoked wheel shown in Figures 3 and 4 below (Tyrrell et al., 1998). The closer a forest’s attributes are to the center of the wheel, the more it is said to conform to a late-seral, climax forest. Note that the age of an old-growth forest depends largely on its habitat and species composition.

Figure 3. A graphical representation of the old-growth concept (Tyrrell et al., 1998)
As per the example in Figure 4 above, northern hardwood forests reach their full expression of primary old-growth status at around 500 years and occur on upland sites at lower elevations with a very low amount of clearcutting and agricultural disturbance. The trees are well nourished and reach near the maximum size and age attainable per species. Natural catastrophes are infrequent, giving the ecosystem a high level of continuity and size. Not only is the forest naturally uneven-aged, but it has also reached near equilibrium in terms of successional development and addition to its above-ground biomass. The land is very dense with woody plants whose sizes are not only large by species, but also large in general compared to most other forest types. Furthermore, there are a fairly high number of snags, downed logs, and trees with internal and external cavities.
Ancient forests contribute enormously to biodiversity, the fight against extinction, and our emotional and cognitive health. With so few of these woodlands left in the Northeast it is important that their importance be amplified to conservationists, forestry agencies, and the general public. The cheapest way to reduce negative changes to the climate by carbon sequestration and reversing the extinction crisis is to allow for proforestation; old growth being the prime example. To that end, proforestation is the purposeful growing of intact forests to their full ecological potential. Approximately 2% of New England’s land area exists as forests free from all forms of logging, and only 1% exists in southern New England (Moomaw, Masino, & Faison, 2019). Furthermore, many species have been shown to be closely associated with old growth, some of them having become dependent across certain parts of their range. For example, the northern flying squirrel is closely associated with old-growth forests in the East, whereas the flammulated owl is very much dependent upon old-growth Douglas fir forests in British Columbia (Carey, 1989; Howie & Ritcey, 1987). Figure 5, below, shows a grouping of 300- to 350-year-old hemlock whose trunks are covered in lichen.
Simply visiting a forest, old growth or not, can improve emotional and cognitive health in terms of concentration, productivity, and one’s overall perspective on life. Physiological effects include the lowering one’s heart rate, blood pressure, and level of stress and anxiety (Shin, Yeoun, Yoo, & Shin, 2009). Research also suggests that immersion in a forest or “forest bathing” increases feelings of vigor, recovery, and vitality even more so than in urban settings (Takayama, Korpela, Lee, & Morikawa, 2014). Sages Ravine is one of CT’s most beautiful and unique forests; a worthy destination for forest bathing as shown in Figure 6 below.
The ability to recognize these ancient forests is imperative for their protection so that we can allow them to continue benefiting the world we live in. If foresters, ecologists, and state forest associations lack the knowledge necessary to recognize these vanishing ecosystems, then who will be there to protect them?

2.4 Case studies: Sequoia and Joshua Tree National Park

Case studies from Sequoia and Joshua Tree National Park provided insight into how and why nature can be set aside as protected parks. We can also learn from the greatest threats to these areas of novelty.

Case 1. Sequoia National Park

Sequoia National Park was the first national park instituted to protect a living organism: the giant sequoia tree. Access to these trees was originally limited to a small road, later to be
expanded for wagons in 1903 (National Park Service, 2017). Although logging of the area ceased due to the low commercial value of sequoia wood it was nevertheless protected from all forms of logging during the late 1800s through the U.S. military until 1916 with the formation of the National Park Service. Tourism to the site was not fully underway until the 1920s. Since then, the forest has suffered some setbacks. Climate change has unfortunately been a major factor in the decline of the giant sequoias, as have been invasive species. Both have put undue stress on species that have adapted to specific microhabitats by introducing climate-induced changes to the structure of the forest (Gamewarden, 2020). Many rare species exist within the forest whose populations have slowly dwindled due to hunting practices that were outlawed too late. Other conservation issues facing the park include a lack of breeding grounds outside the park and the poaching of butterfly eggs, an issue which is very difficult to control. From this we can conclude that resistance to invasive species and mitigating illegal poaching is necessary for the prolonging of a forest preserve. Preserving an area of land around the park may also be necessary for species’ habitat security, especially for forests of small acreage. Figure 7, below, shows a giant sequoia with a naturally occurring basal fire scar.
Case 2. Joshua Tree National Park

Joshua Tree National Park was protected as early as 1936, but not set aside as a national park until 1994. Its value lies not only in its ancient Joshua trees, but also its over 838 archeological sites, 160 historic buildings, and 5 cultural landscapes (National Park Service, 2019). The park now faces dangers from climate change and habitat destruction. Its trees are in danger of becoming endangered from rising temperatures and droughts, fires caused by non-native grasses, development for energy and off-road vehicles, and an increase in urbanization.
(Associated Press, 2019). It will likely be necessary to ban all forms of traffic other than walking, including mountain biking from the sites listed in this paper. Figure 8, below, shows the famous Joshua Trees in the National Park’s Queen Valley.

2.5 Summary

Many now fear that increased tourism is having a negative consequence on the beauty of natural areas as visitors commit arson and push the boundaries of sustainable tourism (Newell, 2020). Similarly, old-growth forests containing attractive features such as waterfalls, cliffs, or
caves may increase the likelihood of desecration to the area. It is therefore necessary to forgo mentioning specifics such as the location of CT’s second oldest known living tree (Figure 9) other than the park it resides in.

*Figure 9. Connecticut’s second oldest known living tree; an eastern red cedar approximately 600 years old (Photo credit: Jack Ruddat, 2016)*
The importance of conserving and appreciating New England’s few remaining old-growth forests is a topic of great importance in a world struggling with the ongoing threat of extinction, deforestation, and misuse of our forest resources. These forests represent the capacity of nature left alone and prove that nature’s built-in mechanisms far outperform modern-day forestry practices. It is humbling to reflect upon just how much of an understanding we lack about our native forests and how much is left to learn and appreciate for future generations.
Chapter 3. Methodology

This chapter serves as a reference for the methods used for collecting data, conducting archival research, and interviewing stakeholders. With the goal of promoting the preservation and appreciation for old-growth forests in New England, three objectives served to accomplish this goal:

1. Document and map Connecticut’s remaining standing old-growth forests
2. Understand stakeholders’ positions and perspectives on preservation practices
3. Identify suitability of sites for public visitation

The flowchart in Figure 10 below provides an organized visual for the relationship between the goal, objectives, and methods.

3.1 Document and map Connecticut’s remaining standing old-growth forests

The documenting and mapping of CT’s old-growth forests is a process which involved extensive onsite observations. The most important of these was recognition of old growth using a
combination of ecological visual indicators and tree-ring samples. Areas conducive to old growth were identified by seeking out land that had been continuously forested since 1934 and occurred on steep, rugged, or swampy terrain. Plots were identified and marked with ArcGIS Earth using USGS topographic maps and an imported web mapping service from the University of Connecticut containing aerial photographs of CT from 1934. When available, photos were referenced from online that would show any old-growth characteristics of the area in question. Once a site had been identified, onsite assessments were conducted for old-growth indicators in individual trees and the forest as a whole.

Dendrochronologist Neil Pederson, Ph.D. (2010) described six external characteristics of old-growth deciduous trees in the Eastern United States. These characteristics were documented using an iPhone 6S camera and trees were preferentially sampled based on these indicators. Further observations were noted regarding old-growth characteristics pertaining to the forest as a whole (Henry, 2015; Kershner & Leverett, 2004).

Trees were sampled using a three-thread, 16” long, 0.20” diameter, Hagløf-style increment borer. An increment borer is a long metal pipe with a handle on one end and tapered cutting threads on the other used to screw into and retrieve core samples from trees as shown in Figure 11 below.
The following procedure is based on Phipps’ (1985) manual for collecting and preparing tree-ring samples. Before sampling the tree, the increment borer was placed perpendicular to the trunk and aimed towards the center or pith of the tree. For trees that grew on sloped terrain, deciduous species were cored on the downhill side and coniferous on the uphill side when possible due to differences in the way deciduous and coniferous trees correct for leaning trunks (Grissino-Mayer, 2003). Over 150 cores samples from 22 different tree species were reviewed from work done specifically for this project and in the past three years. A tree-ring count was made for each sample and marked on the core mount along with the species name, ID number, and location taken. The circumference (tape measure), GPS location (iPhone 6S), and species name for each tree sampled was documented in an iPhone app called Pocket Earth to be later uploaded to ArcGIS Earth as KML files.

The acreage of these tracts was measured using ArcGIS Earth’s measuring tools while referencing old-growth tree markers and GPS waypoints collected onsite. These forest boundaries were edited by comparing with aerial photographs taken during the fall of 1934.
showing what areas of land were forested and whether or not their compositions were mostly deciduous, coniferous, or mixed. A comparison of aerial photographs from 1934 and estimated old-growth boundaries is shown below in Figure 12.

Figure 12. A comparison of 1934 aerial imagery with estimated old-growth boundaries in Colebrook, CT (note that the 1934 overlay was slightly shifted up and to the right with respect to real-time imagery [University of Connecticut Library Map and Geographic Information Center, MAGIC, 2018])

3.2 Understand stakeholders’ positions and perspectives on preservation practices

Understanding the concerns and values of stakeholders was invaluable for determining how best to treat these forests and preserve them for future generations. Archival research was carried out on preservation practices from case studies and successful initiatives. This research focused particularly on land conservation organizations such as the Old-Growth Forests Network (OGFN) and the Connecticut Forest & Park Association (CFPA). The five steps in saving a forest according to the OGFN are (Goold & Abdo, 2018):

1. “Learn: Who owns the forest?
2. Connect: Find stakeholders who care about the forest
3. Persuade: Campaign to save the forest
4. **Enact**: Execute the forest protection measure
5. **Monitor**: Celebrate, monitor, and manage the forest”

These steps and their specifics were used as guidelines in protecting the old-growth forests presented in this report. Case studies were also evaluated from Joshua Tree and Sequoia National Park through the National Park Service website. Ecologist and founder of the Old-Growth Forest Network Dr. Joan Maloof, Dr. Susan A. Masino (a neuroscientist who studies how forests improve brain health), and old-growth forest enthusiast, filmmaker, and naturalist Ray Asselin were interviewed on the above objective. Interview questions for each interviewee can be found under Appendices A, B, and C, respectively.

One of the Governor's Council on Climate Change (GC3) forestry meetings was also attended through Zoom on April 7, 2020 in order to gain a better perspective on making recommendations for actions and policies concerned with climate change.

### 3.3 Identify suitability of sites for public visitation

The suitability of an old-growth forest for public visitation depended upon factors including whether or not it was accessible and how many visitors it could handle on a yearly basis. The topography, fragility, and accessibility of each site was qualitatively measured by referencing a checklist of desired or needed prerequisites found under Appendix D. This checklist was based upon factors that limit the use of forestland for recreational activities including availability of open spaces, awareness of available resources, road access and parking, the lack of trails, illegal ATV/ORV use, and the lack of an umbrella organization for CT’s outdoor recreational users (Hochholzer et al., 2015).
Old-growth forest expert Robert T. Leverett, forester and dendrologist Thomas Worthley, and Executive Director of the Connecticut Forest & Parks Association Eric Hammerling were interviewed in depth on the above objective. Interview questions for each interviewee can be found under Appendices E, F, and G, respectively.

Additional information was secured from an interview with Paul Elconin, the director of land conservation for CT’s largest land trust, Weantinoge Heritage Land Trust (see Appendix H).

I also sent out a survey to recreational users of local forests and hiking trails to determine interest, awareness, and regard for old-growth forest reserves. This survey was sent out to two clubs from Worcester Polytechnic Institute, my neighborhood, and my IQP class. Survey questions can be found in Appendix I or at the following link:  
Chapter 4. Results and Discussion

This chapter presents collected data and discusses its implications. All data was collected around the three objectives: documenting and mapping Connecticut’s remaining standing old-growth forests, understanding stakeholders’ positions and perspectives on preservation practices, and identifying suitability of sites for public visitation.

4.1 Documenting and mapping Connecticut’s remaining standing old-growth forests

Although only 5,543 mi$^2$ with 736 people per square mile, Connecticut harbors over 675 acres of old-growth forest in 25 sites across 13 towns (World Population Review, 2020). Most of the old growth was found in four forest habitats: hemlock-northern hardwoods (350 acres), boreal spruce-gum swamps (150 acres), eastern white pine stands (92 acres), and eastern red cedar glades (50 acres). There is likely more to be uncovered and additional documentation of these areas is a work in progress. While the focus of this project is on standing old-growth forests, additional areas of equivalent age exist as natural blowdowns such as that surrounding Cathedral Pines in Cornwall, CT. A map showing the locations, names, and sizes of known standing old growth (marked in green) in CT is shown in Figures 14 and 15 below.
Figure 14. Map of Connecticut’s old-growth forests (Esri, HERE, & NPS, 2019)

Figure 15. Map of Connecticut’s old-growth forests—Litchfield and Hartford Counties (Esri, HERE, & NPS, 2019)
The dominant canopy trees in these forests ranged in age from 150 to over 600 years old. The typical ages of canopy trees in these forests were as follows: hemlock-northern hardwoods (300-400), boreal spruce-gum swamps (130-617), eastern white pine stands (200-300), and eastern red cedar glades (300-600). Tree ages are presented from the five most represented and sampled species from youngest to oldest with their respective diameters in Table 1 below. Tree, shrub, and other plant species identified during this project can be found in Appendix J.

Table 1. Old-growth age-diameter comparison

The results of this survey revealed ~125% more old-growth forest than what had been previously documented. These forests were identified by surveying for old-growth characteristics and taking tree-ring samples when necessary (see Figure 16).
Figure 16. Two very large eastern hemlocks ~9.4′ in circumference exhibiting very low stem taper and tall crowns in North Canaan, CT (Photo credit: Jack Ruddat, 2020)

Forest ecosystems were typified as Appalachian (hemlock)-northern hardwoods, boreal spruce-gum swamps, eastern white pine, eastern red cedar-oak-hickory glades, pitch pine outcrops, and tulip-beech-maple forest (Anderson et al., 2013). Surveys documenting the location and character of previously known old growth can be found in three different sources: The Sierra Club Guide to the Ancient Forests of the Northeast, Old Growth in the East: A Survey, and A Fieldbook: Great Mountain Forest (Davis, 2003; Gaige & Glogower, 2016; Kershner & Leverett, 2004).

4.2 Understand stakeholders’ positions and perspectives on preservation practices

While several of the old-growth sites in Connecticut are known to forestry experts, they have varying but optimistic positions about the potential benefits of encouraging the public to visit old-growth forests. Perspectives from the stakeholders such as expert ecologists, foresters,
hikers, conservationists, and landowners tended to veer toward the side of caution to avoid risking damage to these irreplaceable natural resources.

President and founder of the Old-Growth Forest Network Joan Maloof, for example, believes there should be a national register of historic places specifically for forests. I asked her how we can increase awareness and appreciation for these forests. She stressed that people need to have the chance to see and interpret them. She explained further saying that without public visitation there can be no relationship with the forest, and no actional powerful enough to combat industries that seek to make a profit off these lands. It was her opinion that visitation of these forests rarely results in vandalism due to the sensitive nature-loving people who generally seek them out, relative difficulty to access, and rarity. Areas that are conducive to large-crowd recreation such as lakes, waterfalls, or rock-climbing walls are at the most risk for irreversible damage (J. Maloof, personal communication, April 13, 2020).

Professor of Applied Science at Trinity College, Susan Masino, takes a similar approach to Joan Maloof, only with more focus on biodiversity and the well-being of our natural resources. When asked about the biggest threats to today’s forests, she expressed her concerns about the false narrative that forests need to be managed in order to remain healthy. During our interview I learned more about the value of old growth. She cited the benefits of old-growth forests including biodiversity, resilience to invasive species, warding off the extinction crisis, and mitigating climate fluctuations. In her mind the practices conducted by foresters induce more harm than good and should only be done on lands that are set aside for growing and harvesting lumber. A differentiated approach among production forests, research forests, and natural areas allows for a certain percentage of forestland to be kept as intact wilderness, free from human disturbances (S. Masino, personal communication, April 5, 2020).
Thomas Worthley, who teaches forestry management and silviculture at the University of Connecticut, did not have as much knowledge or passion for old-growth forests in particular, but nonetheless advocates for responsible decision-making when it comes to preserving these natural areas. I asked him if modern-day forestry practices should be applied to old growth and he supposed that old-growth stands could receive an uneven aged silvicultural selection system designed to achieve multi-aged systems, although most are left alone to his knowledge. He goes on to cite an example of when forestry management is of use. If a town desired to have a park full of tall pine trees and the current area was overcrowded by many small, dying stems competing for sunlight, then it would be wise to selectively cut the dead and dying trees so that the healthier trees could continue growing without undue stress. Worthley explains that old-growth plots need to be surveyed to determine if any management is needed before opening it to the public (T. Worthley, personal communication, April 9, 2020).

Old-Growth Forest expert Robert T. Leverett provided insight as to why these areas should be protected and how they should be treated. He stated that old-growth forests in general are more resilient to disturbances, but that those found in southern New England are more susceptible due to edge effects as they are small in acreage. Therefore, although it is important for people to know about these forests, those that are small in acreage should be visited cautiously and perhaps serve more as teaching sites rather than recreational areas. I asked him what features might make an old-growth forests unable to be visited by the public to see how his expertise might contribute to the topic of protection. Mr. Leverett said that their understories are vulnerable to trampling by visitors and that certain novelties could become a target of vandalism such as New England’s tallest tree. Oftentimes individuals desire protections for these forests, but land managers do not. Back in the early 1990’s, Dr. Mary Byrd Davis began collecting information on remaining old growth in the Eastern United States. What she found is that some of these places were known by only a few
people. Robert Leverett relays this information as a tribute to how far we have come but also stresses that awareness for these forests is still something that needs to be worked on (R. Leverett, personal communication, April 12, 2020).

In addition to expert positions, I reached out to town officials from Colebrook, Cornwall, and Salisbury, CT, as well as the trail stewardship director for the CFPA to get a sense for how the community viewed access to these public lands. Due to time constraints and unavailability, these interviews were not possible.

Ownership for each of these forests can be found in Appendix K. I learned, however that sites owned by the state are typically free from management unless legitimate reason is brought to the attention of the CT DEEP and approved (E. Hammerling, personal communication, April 13, 2020). Privately owned sites are typically at low risk due to the rugged nature and difficulty of access to these sites, but nonetheless depends on the wishes of their respective owners, a process that can take considerable negotiation. These perspectives presented a range of concerns that would require careful planning and cooperation at many levels of local and state management. Nevertheless, the vast majority of these sites are not officially protected.

4.3 Identify suitability of sites for public visitation

After running each site through the checklist site assessment (see Appendix D), it was determined that 14 out of 18 surveyed sites met the criteria for critical services including parking, cell service, areas to rest, and a water source nearby (Enders Falls, Center Brook, Sandy Brook-Algonquin State Forest, Falls Brook, Hurricane Brook, Roberts Brook, Canaan Mountain Tract, Mohawk Mountain Black Spruce Bog, Cathles Trail). A sample feature that was measured in this checklist can be seen below in Figure 21 illustrating adequate roadside parking.
In addition, 11 of the sites had either emergency access, wheelchair and stroller access, picnic areas, or was suitable for mountain biking (Enders Falls, Falls Brook, Hurricane Brook, Mohawk Mountain Black Spruce Bog, Wildcat Swamp, Talcott Mountain, Cathles Trail, Western Barndoor Hill, Belden Forest, Stonecrest Tract, Park River). However, some areas lacked access via trail (Center Brook, Sandy Brook-Algonquin State Forest, Colebrook River Lake Tract, unnamed spruce swamp, Wildcat Swamp, Stonecrest Tract, Park River). Nine sites contained endangered or vulnerable species (Center Brook, Sandy Brook-Algonquin State Forest, Colebrook River Lake Tract, unnamed spruce swamp, Wildcat Swamp, Mohawk Mountain Black Spruce Bog, Talcott Mountain, Cathles Trail, Western Barndoor Hill). These considerations enabled me to create a suitability rubric for each location as shown in Table 2 below.
<table>
<thead>
<tr>
<th>Sites</th>
<th>Access</th>
<th>Safety</th>
<th>Rare Species</th>
<th>Risks to Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enders Falls</strong></td>
<td>Ample parking Trail access: need to cross river to access most of the old growth</td>
<td>Rocky terrain, sometimes with steep slopes</td>
<td>✓ ✓ ✓</td>
<td>None known Logging allowed in Enders State Forest, but restricted to trail maintenance around falls Contains beech bark disease (BBD), elongate hemlock scale (EHS), and hemlock woolly adelgid (HWA)</td>
</tr>
<tr>
<td><strong>Center Brook</strong></td>
<td>Minimal parking across brook No trails</td>
<td>Rocky terrain, sometimes with steep slopes</td>
<td>✓ X ✓</td>
<td>Many (White, 2017) Adjacent to large area of private property labeled as a wildlife refuge Contains BBD, EHS, and HWA</td>
</tr>
<tr>
<td><strong>Sandy Brook-Algonquin State Forest</strong></td>
<td>Minimal parking across brook No trails</td>
<td>Rocky terrain, sometimes with steep slopes</td>
<td>✓ X ✓</td>
<td>Many (White, 2017) Adjacent to large area of private property labeled as a wildlife refuge Contains BBD, EHS, and HWA</td>
</tr>
<tr>
<td><strong>Colebrook River Lake Tract</strong></td>
<td>No parking; requires 1/2-mile trek along main road No trails Very steep slope across main road to access</td>
<td>Rocky terrain, often with steep slopes</td>
<td>✓ X ✓</td>
<td>Many (White, 2017) Contains EHS</td>
</tr>
<tr>
<td><strong>Falls Brook</strong></td>
<td>Ample parking</td>
<td>Rocky terrain,</td>
<td>✓ ✓ ✓</td>
<td>None known Frequented trail near riverbed;</td>
</tr>
<tr>
<td>Location</td>
<td>Trail access</td>
<td>Rocky terrain, sometimes with steep slopes</td>
<td>Lacks emergency access within site</td>
<td>MDC property farther down river</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------</td>
<td>-------------------------------------------</td>
<td>-----------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Hurricane Brook</td>
<td>Ample parking Trail access</td>
<td>√</td>
<td>√</td>
<td>None known</td>
</tr>
<tr>
<td>Roberts Brook</td>
<td>Ample parking Partial trail access</td>
<td>Rocky terrain, sometimes with steep slopes</td>
<td>√</td>
<td>None known</td>
</tr>
<tr>
<td>Canaan Mountain Tract</td>
<td>Ample parking Trail access</td>
<td>Rocky terrain, often with steep slopes</td>
<td>√</td>
<td>None known</td>
</tr>
<tr>
<td>Sages Ravine</td>
<td>Ample parking Trail access; partly present within old growth</td>
<td>Rocky terrain, often with very steep slopes</td>
<td>√</td>
<td>None known</td>
</tr>
<tr>
<td>Unnamed Spruce Swamp</td>
<td>No parking; requires a 2-mile trek by service road Trail passes by; difficult to access</td>
<td>Wet and muddy Flat terrain</td>
<td>×</td>
<td>Red spruce, creeping snowberry, and several others (Mickelson, 2000; National Resources Conservation Science, 2002)</td>
</tr>
<tr>
<td>Mohawk Mountain Black Spruce Bog</td>
<td>Ample parking Trail access</td>
<td>Flat, swampy terrain with boardwalks</td>
<td>√</td>
<td>Southern bog lemming, species of horse fly,</td>
</tr>
<tr>
<td>Location</td>
<td>Parking Access</td>
<td>Trail Access</td>
<td>Terrain Features</td>
<td>Vegetation and Conservation Status</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------</td>
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<td>------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Wildcat Swamp</td>
<td>No parking; requires a 0.2-mile bushwhack to swamp</td>
<td>No trails</td>
<td>Wet and muddy Some slopes around swamp</td>
<td>Red spruce (National Resources Conservation Science, 2002)</td>
</tr>
<tr>
<td>Talcott Mountain</td>
<td>Ample parking Trail access</td>
<td>Steep cliff edges, rocky terrain with a few steep, semi-marked trails</td>
<td>✓ ✓ ✗</td>
<td>Many (Gruner et al., 2006)</td>
</tr>
<tr>
<td>Cathles Trail</td>
<td>Ample parking Trail access</td>
<td>Steep cliff edges</td>
<td>✓</td>
<td>Emergency access is difficult ✗</td>
</tr>
<tr>
<td>Western Barndoor Hill</td>
<td>Ample parking Trail access</td>
<td>Steep cliff edges</td>
<td>✓</td>
<td>Emergency access is difficult ✗</td>
</tr>
<tr>
<td>Belden Forest</td>
<td>Ample parking Trail access</td>
<td>Gently rolling terrain</td>
<td>✓ ✓ ✗</td>
<td>None known</td>
</tr>
<tr>
<td>Stonecrest Tract</td>
<td>No public parking No trails</td>
<td>Rocky terrain, often with steep slopes</td>
<td>✓ ✓ ✓</td>
<td>None known</td>
</tr>
<tr>
<td>Park River</td>
<td>Minimal parking</td>
<td>Surrounded by river,</td>
<td>✓ ✗ ✓</td>
<td>None known</td>
</tr>
</tbody>
</table>
To identify suitability with users, I surveyed (see Appendix I) a total of 60 hikers and outdoor enthusiasts, as well as ordinary residents to assess interest in visiting sites such as these. When asked whether or not they believed old-growth forests still existed in southern New England, almost 60% of respondents said yes while ~40% said no. The most popular state for hiking appeared to be New Hampshire with 34 of the respondents making mention of it, followed by Massachusetts (33), Connecticut (30), Maine (29), Vermont (25), New York (16), California (15), and 17 others (12 or less). Only three of the respondents said that they do not enjoy hiking in any state. A mix of responses came about when asking what people enjoy or do not enjoy about hiking. Most of the positives mention immersion in the beauty of nature, exercise, feelings of peace, being far away from civilization, exploration, outlooks, large and unique trees, waterfalls, and the various smells and sounds associated with nature. The most common negatives included bugs (mosquitoes and ticks), poor weather conditions, lack of medical help in some areas, crowded areas, and seeing litter or habitats destroyed. I also asked if respondents had ever heard of old-growth forests and if they were aware of any in the Northeast. Thirty-nine respondents were not aware of the term while 22 were, with 13 of those 22 having knowledge of their existence in the Northeast.
In terms of distance, most were willing to travel fairly far, the most common being between 45 minutes and 2 hours. Only two were not interested in visiting, with three being unsure. Around 72% of respondents said that a guidebook would increase the likelihood of them visiting an old-growth forest. More than half (53%) could identify between just 0 and 5 tree species, whereas ~32% knew between 5 and 10 species, and only 15% knew over 10 tree species. Approximately 71% of respondents believe the forests they hike in are between 50 and 100 years old. The number of people who cited their forests as being between 100- and 150-years-old or greater than 150 years old were equivalent (~12% each). Only four people said they were not currently concerned about our forests with 19 of those concerned involved in a nature conservation organization. Specific details on location, species, and size of surveyed areas can be found in Appendix L.
Discussion

Looking at the findings from this project, I see that there are good reasons to showcase old-growth forests, as well as some cautions that need careful oversight. A concern that came up frequently had to do with the question of maintenance and oversight for these areas. In many cases natural areas of note are managed by the CT DEEP or by private organizations such as Simsbury Land Trust or Weantinoge Heritage Land Trust in CT. In this case, it may mean a collaboration between the CT DEEP, CFPA, and local land trusts to ensure the permanent safeguarding of CT’s old-growth forests. Given the lack of knowledge regarding these areas among officials and even forestry professionals, there may also be the need for an organization such as the OGFN to make recommendations, conduct further surveys, and create incentives or pathways for permanent protection.

Other concerns that emerged from the data were focused on disturbing delicate habitats such as swamps and mountain sides or trespassing on private property. Fortunately, these instances are unlikely to develop into anything beyond minor nuances since the areas in question are difficult to access and therefore greatly discourage violation of any restrictions. For instance, accessing the delicate unnamed spruce swamp in Norfolk’s Great Mountain Forest is possible only by hiking through a dense and disorienting thicket of mountain laurel and younger trees where mosquitoes and ticks are plentiful. The area of private property bordering Center Brook and the Sandy Brook-Algonquin State Forest area lies on top of a steep hill where trespassing signs are distinct and numerous. Furthermore, there are no trails in either of these forests and those that contain trails provide very little opportunity for trespassing or irreversibly damaging their habitats. It is possible that the dry, windy basalt ridge lines existing throughout the eastern red cedar glades may suffer from human-caused forest fires and loosening of the thin soils through rock climbing where many of the rarest plants grow. Illegal campfires are a common area of concern for these communities and their control depends largely upon the land’s ownership (Sharp, Lewis, Wagner, & Lee, 2013). Fortunately, the eastern red cedar glades covered in this paper are contained within state parks and their oldest trees are largely inaccessible to the average or even experienced hiker.
Based on the results of my survey, it seems that the average outdoor enthusiast is largely unaware of the existence of old growth, particularly in the Northeast. There is also a dichotomy between peoples’ interest in ancient forests and their natural literacy given how few trees the majority of respondents could identify. Given this data and the fact that most were concerned for the health and well-being of our forests, especially forests that incite the most interest such as old growth, the distribution of this information will likely prove useful to accelerating the appreciation for old-growth forests in New England. Already many respondents from the survey have expressed interest in learning more about these forests and sharing this data with others. I chose to use Center Brook as the prime example for CT’s old growth given its relatively large acreage, proximity to other old-growth sites, varying topography, large species size and advanced age, and its abundance of easily recognizable old-growth features across several tree species. With such evidence of appreciation and enthusiasm, I am hopeful for the protection, appreciation, and sustained and responsible visitation, for CT’s remaining primeval forests.
Chapter 5. Recommendations and Conclusion

Recommendations

Form advocacy partnerships

In response to the concerns that emerged from expert interviews, I recommend that there be partnerships between the CT DEEP, land trusts near these areas, and the Old-Growth Forest Network. It would then be advised that a group formed by the CT Appalachian Mountain Club and CFPA survey and determine the layout of trails in forests deemed feasible.

Partnerships can also include maintenance and site-work agreements. I would recommend that of the sites lacking trails within them, Center Brook, Sandy Brook/Algonquin State Forest, Roberts Brook, and the Canaan Mountain Tract be considered for trail construction. The construction of these trails should be made around the perimeter of the area in question with several “spur trails” used to access particularly unique features such as a grove of old trees, waterfall, or vista.

Develop visitor guidebooks

Some areas already allow for public access, so prioritizing these areas for public education and awareness should be a top priority. These areas would further benefit the public by having guidebooks written about their ecology, novelty, and features similar to what has been designed in Appendix M and seen here in Figure 24:
To inform these guides, further research and a more complete inventory should be conducted in these forests to determine precisely which species occupy the space, especially to determine if they are threatened or endangered. The use of an online database such as CT DEEP or Harvard Forest could greatly aid in the recognition and upkeep of these woodlands by citing up-to-date information on species, age, size, location, acreage, disturbances, and other field observations.

**Develop forest-centered environmental education**

I also highly recommend that some of these forests be given the opportunity to be used as centers for environmental education. The plot of woods next to the Park River in particular could be highlighted as an educational resource for those that live in the city of Hartford, CT. Another would be Belden Forest in Simsbury, CT which is easily accessible and provides perspectives into the historical stature of eastern white pine. I would envision school field trips that focus on
identifying local tree species, recognizing old trees and how past events have shaped their growth, and the relationship between plants, animals, and fungi.

Conclusion

The care of these forests is essential to the well-being of not only our water supply, biodiversity, and certain rare and endangered species, but also for our mental health as it relates to the opportunity to experience the beauty of creation, exercise in enjoyable settings, and learn about the fascinating natural world around us. The loss of old-growth forests has been the cause of extinction for several animals, including the passenger pigeon (Haney & Schaadt, 1996). Without old-growth forests, many more species, including future medicines we extract from the natural world could be lost to the axe. We live among the last remaining forest monarchs of southern New England, something which should be preserved for future generations to study and enjoy.
Figure 25. Connecticut’s oldest known living tree; a black gum approximately 617 years old (Photo credit: Jack Ruddat, 2020)
References


Appendices

Appendix A: Interview Questions for Joan Maloof

1. Tell me about your passion for old-growth forests.
2. What contributions do you see provided in old-growth forests, especially in the Northeast with regards to the environment, local towns, and preservation?
3. Have you ever found the cost and effort needed to protect a forest to be beyond what is feasible?
4. What are the costs and what kind of effort is needed to protect an old-growth grove?
5. What do you find most important, and most difficult in protecting old-growth forests?
6. Is there such thing as a forest not worth protecting due to factors such as size, lumbering operations, conflicts with abutters, or low quality?
7. What do you think some of the biggest threats to forests are in today’s world?
8. How can we increase awareness and appreciation for old-growth forests in the Northeast?

Appendix B: Interview Questions for Susan A. Masino

1. Tell me about your passion for old-growth forests.
2. What about forests do you find personally most valuable, particularly in older growth?
3. How do forests promote brain health and do older forests have a more significant impact than secondary growth?
4. Have you ever been a participant of a land conservation effort and if so, what was your experience?
5. What do you think some of the biggest threats to forests are in today’s world?
6. How can we increase awareness and appreciation for old-growth forests in the Northeast?

Appendix C: Interview Questions for Ray Asselin

1. Where is your favorite place to hike and why?
2. What do you value most about forests in the Northeast?
3. Have you ever been a participant of a land conservation effort and if so, what was your experience like?
4. What do you think some of the biggest threats to forests are in today’s world?
5. How can we increase awareness and appreciation for old-growth forests in the Northeast?
6. How long have you been involved in the promotion of old-growth forests and what was your initial motivation?

Appendix D: Checklist for Suitability of Public Visitation

- Parking
- Walking suitability
  - rocky terrain,
  - steep slopes,
  - wet or muddy
  - Description:
- Cell service
- Emergency access
- Wheelchair and stroller access
- Mountain bike suitability
- Areas to rest
- Water nearby?
- Picnic area?
- At risk for forest fires?
- Endangered or vulnerable species
- Private property?

Appendix E: Interview Questions for Robert T. Leverett

1. Tell me about your passion for old-growth forests.
2. Are old-growth forests more fragile than secondary growth. If so, why?
3. Are you aware of any New England old-growth forests that have suffered significantly from unregulated public visitation?
4. Why is it important for people to visit these sites?
5. Do you think that some sites should be out of the public view?
6. What sorts of features might make an old-growth forest unable to be visited by the public?
7. Are old-growth forests widely known in the Northeast, or are many sites still relatively secret?
8. If a guidebook were to be made for these forests, what information would be most important to include?

Appendix F: Interview Questions for Thomas Worthley
1. What makes an old-growth forest so unique other than its age?
2. What sorts of features might make an old-growth forest unable to be visited by the public?
3. Would you view modern-day forestry practices as a sustainable form of forest management? If so, should these forest practices be applied to old growth as well?
4. In your experience with forest management, what would you say are some of the most important principles to uphold, especially in terms of public visitation?
5. If a guidebook were to be made for these forests, what information would be most important to include?
6. Would you say that damage to a particular forest or area of vegetation after knowledge is made public of its novelty could be a cause for concern in the Northeast, especially in Connecticut?

Appendix G: Interview Questions for Eric Hammerling
1. What sorts of features might make a forest unable to be visited by the public?
2. How does the CFPA go about evaluating and area to determine if it is fit for public visitation whether it be hiking, fishing, rock climbing, camping, etc.?
3. Are most hiking areas in CT secured from logging or types of forestry management such as selective logging and thinning?
4. If a guidebook were to be made for these forests, what information would be most important to include?
5. Have there been any issues as far as you know with rock climbing in the Metacomet range where habitats are often delicate?
6. Which counties experience the most foot traffic in forests?
7. What sorts of regulations might you foresee needing to be put in place in something as novel as an old-growth forest?

Appendix H: Interview Questions for Paul Elconin

1. What sorts of features might make a forest unable to be visited by the public?
2. How does the Weantinoge Land Trust go about evaluating an area to determine if it is fit for public visitation whether it be hiking, fishing, rock climbing, camping, etc.?
3. Are most hiking areas in CT secured from logging or types of forestry management such as selective logging and thinning?
4. If a guidebook were to be made for these forests, what information would be most important to include?
5. What sorts of regulations might you foresee needing to be put in place in something as novel as an old-growth forest?

Appendix I: Hiking in Old-Growth Forests Survey

Feel free to be as brief or descriptive as you want in your answers.

* Required

1. Would it surprise you to hear that there are still forests containing trees over 300, even 400 years old in southern New England? *
   - Yes
   - No
2. Which states do you enjoy hiking in, if any? *
3. Please describe what you do or do not enjoy about hiking *
4. How often do you hike and where are your favorite places to hike? Please explain.
5. Have you ever heard of an old-growth forest (those with canopy trees >150 years old), and if so, are you aware of any in the Northeast? *
6. If trails were made that allowed access to some of Connecticut’s last remaining stands of original forest, would you or people you know of be interested in visiting (please explain)? How far would you be willing to travel? *
7. Would a guidebook increase the likelihood of you visiting an old-growth forest? *
   o Yes
   o No
8. How many tree species can you identify? *
   o 0-5
   o 5-10
   o 10-20
   o >20
9. If you had to guess, how old do you think the average tree is in the areas you hike?
   o 10-50
   o 50-100
   o 100-150
   o >150
10. Are you concerned for the future well-being of our forests? Are you a part of any conservation organizations and if so, which ones?
11. Do you have any additional comments about your interests or disinterests of old-growth forests or hiking in general?

Appendix J: Observed Plant Species

glabra), pitch pine (*Pinus rigida*), red maple (*Acer rubrum*), red spruce (*Picea rubens*), sassafras (*Sassafras albidum*), shagbark hickory (*Carya ovata*), sheep laurel (*Kalmia angustifolia*), striped maple (*Acer pensylvanicum*), sugar maple (*Acer saccharum*), sweet birch (*Betula lenta*), tuliptree (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), white oak (*Quercus alba*), winterberry holly (*Ilex verticillata*), and yellow birch (*Betula alleghaniensis*).

**Plants:** American wintergreen (*Gaultheria procumbens*), Christmas fern (*Polystichum acrostichoides*), clubmoss (*Dendrolycopodium* sp.), common fern moss (*Thuidium delicatulum*), black raspberry (*Rubus occidentalis*), Indian pipe (*Monotropa uniflora*), northern maidenhair fern (*Adiantum pedatum*), polypody (*Polypodium* sp.), partridge berry (*Mitchella repens*), rose twisted stalk (*Treptopus lanceolatus*), shining clubmoss (*Huperzia lucidula*), wild sarsaparilla (*Aralia nudicaulis*), and wood ferns (*Dryopteris* spp.).

**Appendix K: Ownership**

Enders State Forest: State of Connecticut

Center Brook: Private

Sandy Brook-Algonquin State Forest: State of Connecticut

Colebrook River Lack Tract: State of Connecticut; Metropolitan District

Falls Brook: State of Connecticut; Metropolitan District

Hurricane Brook: State of Connecticut

Roberts Brook: State of Connecticut; Metropolitan District

Canaan Mountain Tract: State of Connecticut

Sages Ravine: USA; Woodland Sanctuary Ltd.

Unnamed Spruce Swamp: Great Mountain Forest Cooperation

Wildcat Swamp: State of Connecticut, Great Mountain Forest Cooperation, Goshen Land Trust, two private landowners

Mohawk Mountain Black Spruce Bog: State of Connecticut

Talcott Mountain: State of Connecticut; Metacon Gun Club

Cathles Trail: Town of Simsbury; Simsbury Land Trust

Western Barndoor Hill: Granby Land Trust; private

Belden Forest: Town of Simsbury

Stonecrest Tract: Town of Ridgefield
## Appendix L: Location, Species, and Size

<table>
<thead>
<tr>
<th>Site</th>
<th>Address</th>
<th>Coordinates</th>
<th>Species (max age)</th>
<th>Size (acres)</th>
</tr>
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<tbody>
<tr>
<td><strong>Enders Falls</strong></td>
<td>173-117 Barkhamsted Rd, West Granby, CT</td>
<td>(41°57′14.8″N; 72°52′42.6″W)</td>
<td>American beech (177), American hornbeam, American witch-hazel, chestnut oak (280), eastern hemlock (430), green ash (200), hobblebush, mountain laurel, northern red oak (161), paper birch, red maple (260), sassafras, striped maple, sugar maple (210), sweet birch (280), tuliptree (175), yellow birch</td>
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<tr>
<td><strong>Center Brook &amp; the Sandy Brook Tract</strong></td>
<td>Pisgah Mountain Rd, Colebrook, CT</td>
<td>(41°59′34.9″N; 73°05′20.8″W), (41°59′56.7″N; 73°04′41.9″W), (41°59′21.3″N; 73°04′22″W), (41°58′58.4″N; 73°03′42.9″W)</td>
<td>American beech (267), American witch-hazel, black cherry (152), eastern hemlock (~400), hobblebush, mountain laurel, mountain maple, northern red oak (scarce), paper birch (scarce), red maple (~220), striped maple, sugar maple (365), sweet birch (~250), ash (185), yellow birch (309+)</td>
<td>~123.5</td>
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<tr>
<td><strong>Colebrook River Lake Tract</strong></td>
<td>Colebrook River Rd, Winsted, CT</td>
<td>(42°00′51.9″N; 73°03′2.8″W)</td>
<td>American beech, American witch-hazel, ash, eastern hemlock, hobblebush, mountain laurel, northern red oak, shagbark hickory, sugar maple, sweet birch, yellow birch</td>
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<tr>
<td><strong>Falls Brook</strong></td>
<td>Morrison Hill Rd, West Hartland, CT</td>
<td>(42°01′4.6″N; 72°57′21.1″W)</td>
<td>American basswood (scarce), American beech (195+), ash, eastern hemlock (~174+), northern red oak, paper birch, red maple, sugar maple, sweet birch, yellow birch (213+)</td>
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<td><strong>Hurricane Brook</strong></td>
<td>Hurricane Brook Rd,</td>
<td>(42°01′9.4″N; 72°54′51.1″W,</td>
<td>American beech, ash, eastern hemlock (294), hobblebush,</td>
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<td>Description</td>
<td>Plants</td>
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<tr>
<td>East Hartland, CT</td>
<td>Roberts Brook, East Hartland, CT</td>
<td>mountain laurel, northern red oak (215+), red maple, sugar maple, sweet birch (290+ [330?]), white oak (scarce), yellow birch</td>
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<td>Sunset Rd, East Hartland, CT</td>
<td>(41°58′54.7″N; 72°56′25.3″W)</td>
<td>American beech, ash, black cherry (scarce—189+), eastern hemlock (~288), eastern hophornbeam, hobblebush, mountain laurel, northern red oak, paper birch, red maple, American hornbeam (scarce), striped or mountain maple, sugar maple, sweet birch, tuliptree (scarce), eastern white pine, yellow birch</td>
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<td>140 Lower Rd, East Canaan, CT</td>
<td>Canaan Mountain Tract</td>
<td>American beech, eastern hemlock (331), eastern white pine (171+), mountain laurel, northern red oak, paper birch, red maple (172+), striped maple, sugar maple, sweet birch, yellow birch</td>
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<tr>
<td>554 Under Mountain Rd, Salisbury, CT</td>
<td>Sages Ravine</td>
<td>American beech, Canadian yew, chestnut oak, eastern hemlock (400), hobblebush, mountain laurel, paper birch, pitch pine (scarce), striped maple, sweet birch, eastern white pine, yellow birch</td>
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<tr>
<td>North Goshen Rd, Goshen, CT</td>
<td>Unnamed Spruce Swamp</td>
<td>Black gum (334+), eastern hemlock (194), mountain holly, mountain laurel, red maple, red spruce, winterberry holly, yellow birch</td>
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<tr>
<td>North Goshen Rd, Goshen, CT</td>
<td>Wildcat Swamp</td>
<td>Black gum (617), eastern hemlock, eastern white pine, mountain laurel, northern red oak, paper birch, pink azalea, red maple, red spruce (301), yellow birch</td>
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<td>Mohawk Mountain Rd,</td>
<td>Mohawk Mountain</td>
<td>American larch, black gum (250), black spruce (130), yellow birch</td>
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<td>Mohawk Mountain Rd,</td>
<td>(41°49′58.59″N; 73°18′6.97″W)</td>
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<td>Location</td>
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<td>Coordinates</td>
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<tr>
<td>Black Spruce Bog</td>
<td>West Cornwall, CT</td>
<td></td>
<td>eastern hemlock (322), eastern white pine, highbush blueberry, leatherleaf, mountain holly, northern red oak, red maple, sheep laurel</td>
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<tr>
<td>Talcott Mountain State Park</td>
<td>Summit Ridge Dr, Simsbury, CT</td>
<td>(41°50′19.9″N; 72°47′48.3″W)</td>
<td>American basswood, American beech, American witch-hazel, bear oak, black cherry, chestnut oak (263+), eastern hemlock (200), eastern hophornbeam, eastern red cedar (~600), eastern white pine (278), ash, mockernut hickory (326), northern red oak (238), paper birch, pitch pine, shagbark hickory, sugar maple (~270), sweet birch, white oak</td>
<td></td>
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<tr>
<td>Cathles Trail</td>
<td>North Saddle Ridge Drive, West Simsbury, CT</td>
<td>(41°54′9.7″N; 72°51′32.9″W)</td>
<td>Ash, chestnut oak (~285), eastern hemlock, eastern hophornbeam, eastern red cedar (256+), eastern white pine, northern red oak (~240), pignut hickory (297), shagbark hickory (260+), striped maple</td>
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<tr>
<td>Western Barndoor Hill</td>
<td>198 Barndoor Hills Rd, Granby, CT</td>
<td>(41°55′46″N; 72°49′25.9″W)</td>
<td>Bear oak, eastern red cedar (300), northern red oak, pignut hickory (237), eastern white pine</td>
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<tr>
<td>Belden Forest</td>
<td>14 Beldenwood Rd, Simsbury, CT</td>
<td>(41°52′27.61″N; 72°48′32.69″W)</td>
<td>American beech, black oak, chestnut oak, eastern hemlock, eastern white pine (189+), northern red oak, pignut hickory, red maple, striped maple, sweet birch, white oak, yellow birch</td>
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<tr>
<td>Stonecrest Tract</td>
<td>96 Stonecrest Rd, Ridgefield, CT</td>
<td>(41°18′32.4″N; 73°29′46″W)</td>
<td>American basswood (scarce), American beech, American witch-hazel, ash, black oak, eastern hemlock (scarce), eastern red cedar (snags), mockernut hickory, northern red oak (151+), Norway maple (invasive),</td>
<td></td>
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<tr>
<td>Park River</td>
<td>Scarborough St, Hartford, CT</td>
<td>(41°46'47.94&quot;N; 72°42'22.95&quot;W)</td>
<td>sugar maple (254+), sweet birch (265), tuliptree (150), white oak, American beech (136), American sycamore, eastern hop hornbeam, northern red oak, red maple, shagbark hickory (217+), sweet birch, white oak (~272), 11</td>
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</tr>
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</table>
**Center Brook Forest**

Center Brook, located in Colebrook, CT, is an old-growth forest containing canopy trees between 200 and 400 years old. Before Litchfield County was established in 1751 much of the landscape was covered in hemlock-northern hardwood forests like the one pictured below. Here you will find trees over 2.5' in diameter soaring over 100 feet into the sky. Due to the slow taper of older trunks, most of the forest appears like the columns of a woody cathedral.

**Identifying Old Growth**

The distinctive bark pattern of eastern hemlock trees over 350 years old.

The secluded Beulah Falls descends the steepest part of the ravine where yellow birch and Canadian yew become more common.

Below is a scattering of Canadian yew. This under-story plant thrives in cool, deeply shaded environments and propagates primarily through cloning.

The oldest trees display certain characteristics revealing of their age. These include low stem taper, thick, deeply furrowed plates of bark, largely branch-free trunks, sinuosity, balding/thinning bark, and stag-headed crowns. Do not, however, be misguided by their size. One tree was found to be 11.73' in diameter, and yet almost 350 years old, similar in age to some of the largest trees in this forest.

Above is a yellow birch well over 310 years old. Notice the balding bark and stag-headed crown.
**Welcome to Colebrook, CT’s Center Brook Forest!**

Walk among forest giants up to 400 years old, fern-covered glacial erratics, raging waterfalls, and the beauty of God’s natural world. Please treat the area with respect and stick to the main trail.

**Species to look for**

Red-spotted newt in its terrestrial juvenile stage.

To the right are the needles of a hemlock, the most common tree in this forest.

(Marlow, 2003)

To the left is the characteristically smooth, gray bark of an American beech. These species can be found at Center Brook in higher elevations, often retaining their golden-dead leaves as saplings during the winter.

(Bradley, 2015)

On the right are the leaves of a red maple, Center Brook’s second most common tree species. Older red maps display shaggy bark patterns.

(Ware & Ware, 2013)

**Hazards to be aware of**

Be careful not to venture too close to the ravine near the falls, especially during the winter months, icy conditions, or floods. The steep, rocky slopes and cold, fast moving waters could easily lead to serious injury.

The steepest part of the ravine just after Beulah Falls is riddled with large rocks.

The fast-moving rapids of Beulah Falls flows past large boulders both below and above the water.