Connecticut's Forest – A Legacy of Change in Today's Forest

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Abstract

Over the past four centuries, the forest of Connecticut has undergone significant changes. From the early 1600s, when Native American land-use practices included fire and agricultural clearing of the forest, on through the colonial period, and then the years of trade and industrial development, the forest has been heavily shaped by human society. Many of these practices, particularly those throughout the 19th century, were not beneficial to the forest. At the start of the 20th century, the new State forestry program sought to take on the challenges of restoring Connecticut's forests head-on through practices based on scientific management and productive use of the forest. Before it closed in 2005, Connecticut's State Forest Nursery had a main role in the recovery of the forest. While forest land acreage has more than doubled in size from its nadir in the first half of the 19th century, the challenges to forest management in Connecticut remain immense, as Connecticut's foresters rise to meet these challenges.

Introduction

Connecticut is a small State of 3.6 million ac (1.5 million ha), of which about 3.1 million ac (1.3 million ha) is land. Roughly rectangular, the State is 110 mi (177 km) long and 70 mi (112 km) wide, with its southern edge being the shore of Long Island Sound. Based on the 2010 census, Connecticut is the third smallest State, ranks 29th in population, and fourth in population density. The State has three major geologic regions—the eastern and western highlands, each composed of older, metamorphic rock, and a central valley, largely composed of basalt overlain by sandstone. The soils are largely glacially derived. The Connecticut River bisects the State, almost directly through the center.

Climatically, Connecticut has been described as northern continental grading into subtropical, as one travels from the higher elevations in the northern corners toward the shoreline. In Hartford, the average high/low temperatures are 84 ˚F and 63 ˚F (29 ˚C and 17 ˚C) in July and 35 ˚F and 16 ˚F (2 ˚C and -9 ˚C) in January. Average annual precipitation is 46 in (117 cm), distributed evenly throughout the year.

The present forest of Connecticut (figure 1) is described by the U.S. Department of Agriculture, Forest Service as oak-hickory, although it is converting more to a mixed hardwood forest increasingly dominated by maple (*Acer* sp.), beech (*Fagus* sp.), and birch (*Betula* sp.). The land area of the State is currently about 58 percent forested, down from a recent peak of 65 percent in the 1950s (Butler 2017), and 73 percent of the land is under tree canopy, including that of the individual trees in urban areas (Nowak and Greenfield 2012).

This article assumes that the majority of Connecticut's forests were established in or around the first decade of the 20th century. But before we can discuss the 20th century, the following sections give an overview of Connecticut's forests in the centuries before 1900.

The Native American and Colonial Periods

The first steady incursion of Dutch and English immigrants into the land that was to become Connecticut began in the early 17th century. Before that time, these lands were inhabited by several Native American Tribes. It is estimated that these lands were approximately 95 percent forested prior to European immigration. Living in the midst of this forest, the Native Americans were largely migratory and

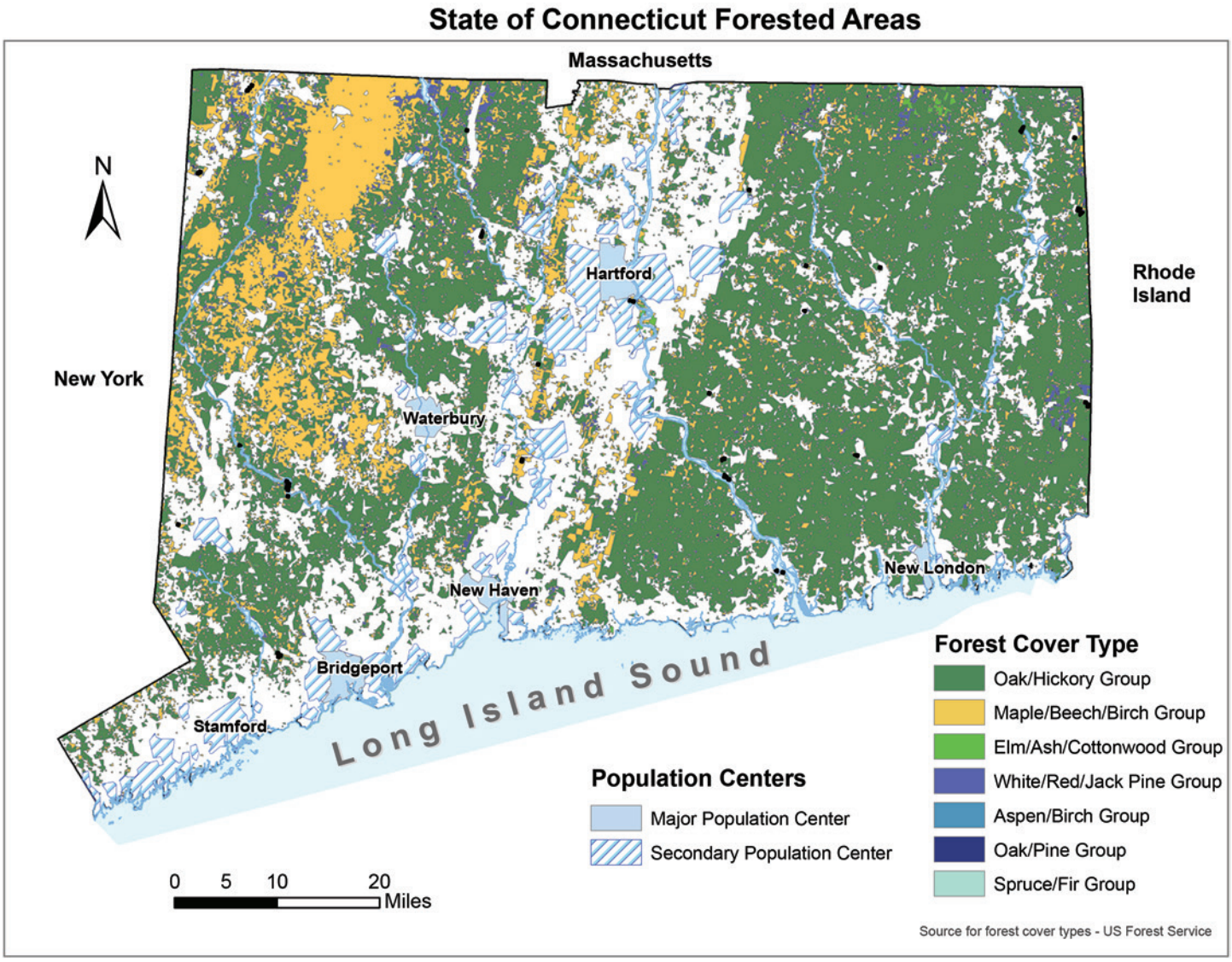

Figure 1. Overview of Connecticut's forests. Map created by Chris Donnelly using USDA Forest Service Forest Inventory and Analysis and Forest Health data for the Northeastern United States, available through Databasin.org.

territorial in their way of life. They practiced rotating agriculture and used fire for land clearing. Fire was also used to clear underbrush for forestscaping, with the planned regrowth fostering an increase in game animals such as turkey and deer. Early Europeans frequently commented on the open, park-like condition of Southern New England forests that resulted from these well-established Native American forest management practices. The Native Americans' seasonal cycle of land use was reflected in the mosaic quality it gave to the natural forested ecosystem.

Once they arrived, the European settlers who came to New England were not migratory. For the most part, they sought to build a way of life centered on individual property ownership, with the maintenance of livestock a key feature. Despite major differences, however, in important ways these early European settlers and the Native Americans were fundamentally similar. The settlers also lived a life highly connected to the land, dependent on the seasons and what the local landscapes had to offer. In New England, the focus of the settlers tended to be less on the individual accumulation of wealth and more on the establishment of a community, one that would carry over across generations. Forests were critical for providing wood for building, fuel, and household items such as bowls, furniture, and farm implements. The forests also provided materials for fences that, perhaps as much as anything, signified the major landscape changes.

These settlers did not clear all forests to get to the soil below. Township records for colonial Southern New England suggest that tilled land for corn, and

Figure 2. Cathedral Pines in Cornwall, CT; one of Connecticut's few remnant old-growth forests. (Photo by Chris Donnelly 2018)

later potatoes, was usually no more than about 10 percent of a typical farm. In addition, there was land for pasturage, meadows for growing hay, orchards, and woodlands. Perhaps 30 to 50 percent of early farms were left in forest to provide for household needs.

While these settlers lived in close association with the land, they were also prepared to make large changes to facilitate their way of life. They were willing to eliminate ecosystem features for which they saw no particular need. Wetlands were regularly cleared and drained and tilled fields were fertilized with manure to improve their fertility. Old-growth forests (figure 2), along with populations of wolves, beavers, and deer, diminished.

Fortunately, records exist that allow a glimpse back into early forests of this region. As New England was settled and property boundaries marked out, witness trees were established to define these boundaries. These early records of landownership survive in extensive numbers, serving as a de facto survey of forest composition at the time when the boundaries of the first colonial properties were set. In a comprehensive review of these witness trees within New England, Cogbill et al. (2002) found that both oaks (*Quercus* sp.) and hickories (*Carya* sp.) were about twice as common as they are today (table 1).

Due to changing land-use practices, shifts in species composition would be expected to occur in the early years after European settlement. For example, the use of European tools such as the axe would have had an influence. Pollen records suggest that oaks declined following European settlement, perhaps due to preferential harvesting, while the amount of chestnut increased, likely benefiting from steady seed production along with its being a prolific stump sprouter (Brugam 1978, Foster 1995).

Trade and Transportation – Connecticut Forests in the Nineteenth Century

After the colonial period, major changes in land use continued. Developments in trade, transportation,

Table 1. Witness tree genera as compared to recent FIA tree populations.

Genus	Genus proportions (%) of colonial witness trees	Current forest composition (%) based on FIA data*
Oak (*Quercus* sp.)	60	28
Hickory (*Carya* sp.)	10	5
Chestnut (*Castanea* sp.)	9	0
Maple (*Acer* sp.)	4	29
Beech (*Fagus* sp.)	3	3
Pine (*Pinus* sp.)	3	5
Ash (*Fraxinus* sp.)	3	3
Hemlock (*Tsuga* sp.)	3	7
Witness trees were typically recorded by current common name and not recorded as to species. For instance, 'oak' would have been recorded and not necessarily 'red oak' or 'white oak'.	From Cogbill et al. (2002). These percentages are based on the combined Connecticut and Rhode Island records.	*Only trees 7" dbh and over are included in this table, based on the assumption that smaller diameter trees would not have been used as witness trees. Data source: Butler et al. 2012 – Table_CT-10

FIA = Forest Inventory and Analysis

industry, and energy all had their influence. It is estimated that the forest cover in Connecticut reached its lowest point sometime between 1825 and 1850, driven partly by the craze in raising Merino sheep, but also due to population increases (Foster 2017, Harper 1918). By 1825, canals and then railroads led to new trading patterns. This opening of the States and territories further west released some of the growing population pressure in rural areas.

It was the industrial revolution, however, that was the main story. By 1850, industry and manufacturing had replaced farming as the economic mainstay in Connecticut, though farms were still necessary to provide such goods as fresh vegetables and milk. The new economic center shifted from the higher-elevation rural settlements to the factory centers along the many fast-flowing rivers and streams as well as the coastal and central cities and towns from which goods were sent and received.

The return of farmland to woodland largely happened on its own as farmers planted fewer crops and gradually abandoned all but the best pastures in favor of imported feed for their livestock (Foster et al. 2008). With the rise of the new industrial centers, these re-growing forests became an important source of fuel for factories. Initially, firewood was used, but it was heavy and costly to transport. Charcoal, produced by burning hardwoods in oxygen-starved conditions, became a prime forest product and a key companion of industrial growth (figure 3). Charcoaling remained a main provider of energy for manufacturing until the early 1900s, by which time charcoal had been largely replaced by coal.

By the end of the 19th century, stone walls, wells, cellar holes, and remnants of charcoal mounds were scattered throughout the fields and woods of Connecticut. Beaver, wolves, and turkey had been eliminated, and black bear and white-tailed deer were nearly gone. The passenger pigeon had become totally extinct. It has been suggested that the loss of this bird had a major impact on the forest. As the massive flocks moved through the forests during the spring, they ate huge quantities of beechnuts, chestnuts, and acorns. Because white oak (*Quercus alba* L.) germinates in the fall, its acorns were not available during these migrations. Without the passenger pigeon, white oak lost this advantage, further affecting forest composition (Faison 2014).

Figure 3. Charcoal production was an important fuel source until the early 1900s. (a) In the early stages of charcoal production, several cords of wood are piled around a central pole. (b) The wood is then covered with dirt to restrict air flow as the wood is slowly burned in oxygen-deprived conditions. (Photo a courtesy of Yale University archives and photo b courtesy of the State of Connecticut Library archives)

The First Half of the Twentieth Century

Connecticut's forests were in poor condition at the start of the 20th century (figure 4). Austin Hawes, Connecticut's third State Forester, described the condition of the State's forested land in those years as follows:

> For a generation the portable sawmills had been eating further and further up the hillsides removing timber which had been inaccessible for the old water powered mills. The demand for railroad ties, poles and posts resulted in practically uniform clear cutting, and the slash from these

Figure 4. A view within Meshomasic State Forest— Connecticut's first State Forest— in 1906 shows the unhealthy condition of forestland at that time. (Photo courtesy of the State of Connecticut Library archives)

> operations made tinder, which resulted in great forest conflagrations. Almost every slope was covered with unsightly scars where gaunt fire-killed trees stood out against the horizon. The evergreen trees, pine and hemlock particularly, had suffered from repeated fires and natural reproduction of these species had been almost eliminated so that the woods were becoming more and more patches of hardwood brush (Hawes 1957, p. 22).

Hawes served as State Forester from 1904 until 1909 and again from 1921 until his retirement in 1944. Early on, Hawes set his sights on two major goals: reestablishing the forests as a healthy and productive use of the land and instilling in the public an appreciation of forestry and forest management as essential to maintaining this productive and useful landscape. For the latter, Hawes and his colleagues needed to appeal to farmers. In 1900, the majority of Connecticut's forestland was owned by farmers. As described by Henry S. Graves, director of the Yale Forest School (as it was known at the time), in a 1907 address to the Connecticut Forestry Association:

> General talk about forestry is not needed so much as information on how to practice it. Farmers and other owners do not want to hear about the protective influence of forests on stream flows, but how to plant trees and how to increase their rate of growth. Experience has shown me in my own work that I can accomplish more with an owner in the educational line by a few hours walk in the woods, than by writing a half dozen books. The Connecticut farmer must be his own forester (Graves 1907, p. 37).

One of Hawes's early research efforts was a tally of existing plantations and how they came into being. Several plantations, primarily for white pine (*Pinus strobus* L.), existed prior to the State's forestry program, most notably the Shaker Plantation, established in Enfield in 1876. In 1905, Hawes oversaw the establishment of the Rainbow Plantation, located very near to where the Bradley International Airport is today. This plantation was used until 1943 for research purposes and as a source of seedlings for private- and State-owned lands. In 1903, Connecticut established its first State Forest in Portland, followed by its second, 2 years later, in Union.

From 1901 to 1921, the Station Forester of the Connecticut Agricultural Experiment Station (CAES) also served as the Connecticut State Forester. Thus, the Rainbow Plantation was a CAES-owned operation. In 1921, the General Assembly of Connecticut voted to establish the State Forester as a separate position, distinct from that of the CAES Station Forester. As a result, the State Forester reported to the State Park and Forest Commission, while the Station Forester continued to provide outreach advice to landowners and distribute seedlings from the Rainbow Plantation. In 1924, the United States Congress passed the Clarke-McNary Act, partly for the purpose of helping States provide assistance to private forest landowners. This Act led to the appointment, in 1926, of Connecticut's first Extension Forester. This position was affiliated with the University of Connecticut, the State's land-grant university. After that, the focus of the Station Forester was more centered on research. The Station, however, continued to provide seedlings to private landowners until its nursery was closed. As for the State Forester, that office continued to have a role in outreach through the previously established service forestry program. The State Forester was also given full responsibility for the growing State Forest system.

Establishment of the Connecticut State Nursery

In 1905, there were just two State Forests, totaling 1,400 ac (565 ha). In 1921, there were five, totaling 4,452 ac (1,800 ha). Then, within a year, the total number of acres had increased to 7,260 ac (2,935 ha), and to 11,500 ac (4,650 ha) by 1925. As a consequence, the General Assembly voted in 1925 for $5,000 to establish a nursery on State lands. In explaining this vote, Hawes wrote, "Besides the desirability of increasing the percentage of softwoods in the state, there was always more interest in planting than in any other aspects of forestry" (Hawes 1957, p. 86). The State Nursery opened in 1928 in People's Forest in Barkhamsted to produce seedlings for planting on State lands (figure 5). It was not until 1945, following CAES's closure of the Rainbow Plantation Nursery, that this State Nursery began to provide seedlings to qualifying private landowners.

In August 1955, the State Nursery at People's State Forest flooded. In December, the legislature voted to

Figure 5. The first Connecticut State Nursery, located in Barkhamsted, within the People's State Forest was established in 1928. (Photo courtesy of the State of Connecticut Library archives circa 1950)

allocate $36,000 to re-establish the nursery in Pachaug State Forest in Voluntown. In approving this funding, the legislature anticipated that the nursery would be able to produce up to 2 million seedlings annually for meeting both public and private forest planting needs throughout the State. The new nursery was also expected to provide seedlings to environmental and conservation organizations, and to towns and schools for Arbor Day events.

Species Selection for Tree Planting in Connecticut

At the Rainbow Plantation, 17 hardwood and 16 conifer species were planted as trials to determine which species grew well in Connecticut and could be recommended for planting. These trials indicated the potential value of certain non-native species such as red pine (*Pinus resinosa* Aiton). From the start, however, the two mainstay species for planting in Connecticut were expected to be eastern white pine and American chestnut (*Castanea dentata* [Marshall] Borkh.). In fact, the first two sites chosen as State Forests, Portland in 1903 and Union in 1905, were selected primarily due to their perceived ability to grow chestnut and white pine, respectively.

Interest in chestnut was particularly high. This species is a fast-growing tree of good form with high decay resistance and strong, versatile wood that can be readily sawn into good-quality lumber. Its nuts are also valuable mast for wildlife. In many parts of its range, chestnut meal was a major component of the local diet for people as well as wildlife. Because it sprouted readily and grew rapidly on cleared sites, 25 to 50 percent of the stems in Connecticut's re-growing forest were reported to be chestnut by the early 1900s (figure 6).

The plans for chestnut as the centerpiece of Connecticut forestry took a huge hit, however, when chestnut blight was discovered in 1905 on the grounds of the Brooklyn Botanical Gardens in New York. In 1907, the blight was found in Connecticut. By 1911, it was clear that the future forests in the State would have to go forward without chestnut as a major component (figure 7).

About that time, things looked almost as bad for eastern white pine. In 1900, an exotic fungus, the white pine blister rust, had been imported from Europe. Fortunately, efforts to control this disease throughout the century proved effective and the species was saved. The main control tool used was the near-eradication in the wild of all gooseberry (*Ribes* sp.), the alternate host to the rust.

Despite the obstacles, seedling production and tree planting contributed significantly to reforestation in Connecticut. Estimated forest cover increased from 38 percent in 1900, to 46 percent in 1920, and to 65 percent by 1952. According to Hawes, "A summary made in 1929 of all forest plantings which had been done in the state over the past approximately twenty years was 16,600 acres, of which 1,690 acres were in state forests and 4,725 acres belonging to Water and Power Companies. The balance was on private

Figure 6. Chestnut, a species that readily sprouts after fire, was an important component of Connecticut forest land in the early 20th century. The initials refer to Walter L. Mulford, the first Connecticut State Forester. (Photo courtesy of the Connecticut Agricultural Experiment Station archives)

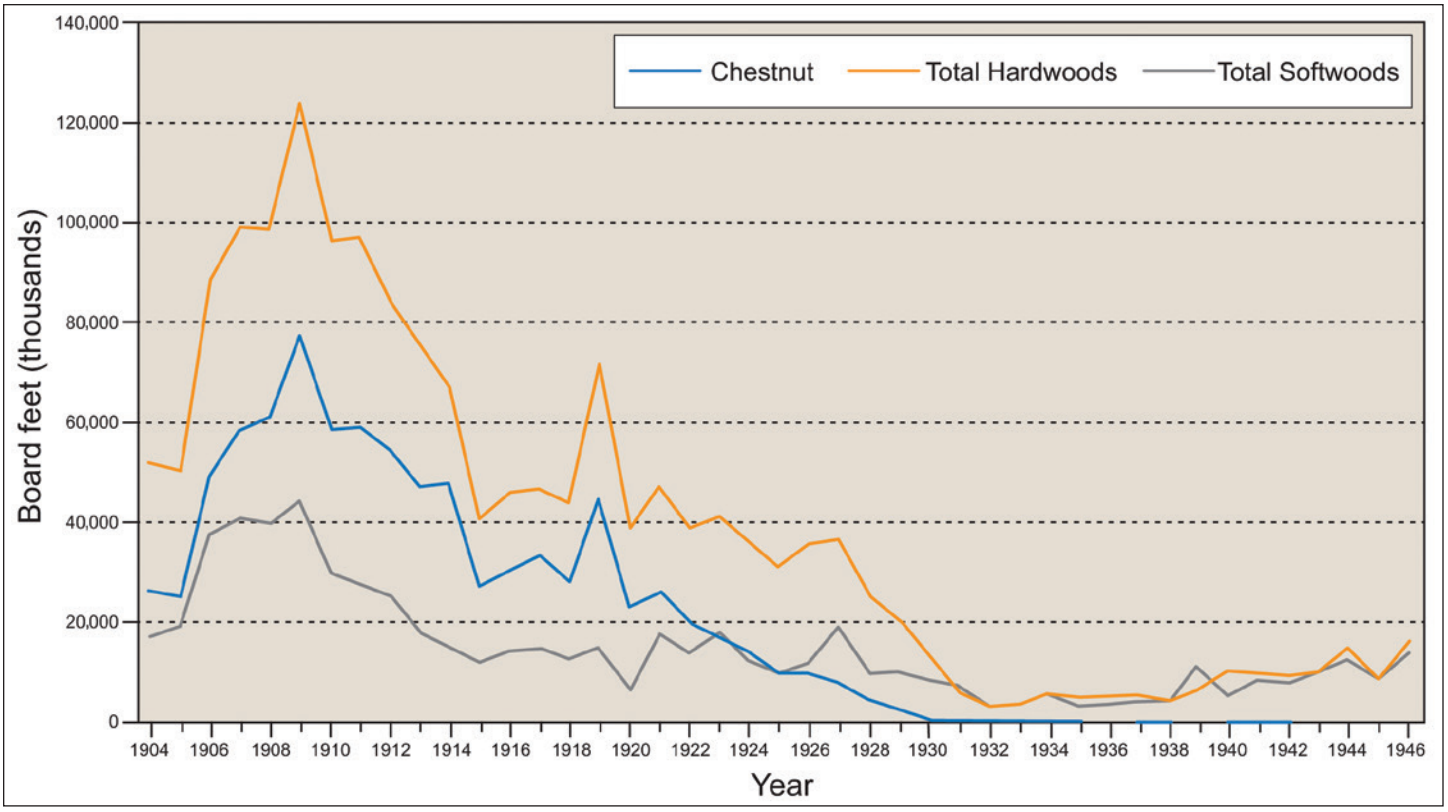

Figure 7. Lumber production in Connecticut, 1904–1940. (Source: Steer 1948)

holdings" (Hawes 1957, p. 86). Using the 1925 State Forest acreage as a guide, these comments by Hawes suggest that 10 to 15 percent of State Forest lands had been hand-planted using nursery stock. Hawes also noted that 1,117,000 seedlings, mostly conifers, had been planted on the State Forests between 1922 and 1928. Reviewing these forest plantings as a whole, he commented, somewhat ruefully, that "some of these areas had been destroyed due to fire or been suppressed by lack of care" (Hawes 1957, p. 86).

Other Challenges

In 1938, a major hurricane caused enormous damage in Connecticut (figure 8). Hawes estimated that 20 percent of the State's timber volume and 100,000 street trees were lost in this storm, a number that easily would have been higher if most of the forest had not been in young stands. Hawes reported, "While the forests of Connecticut have been in a deplorable condition ever since the death of the chestnut in the early years of the present century, the timber loss through the hurricane was undoubtedly less than it would have been except for this fact" (Hawes 1939, p. 16).

Despite the Great Depression, Hawes described the 1930s as the "Golden Age of Forestry in Connecticut" (Hawes 1957) due to the activities of the Civilian Conservation Corps (CCC) (figure 9). Since road building using CCC funding was proscribed by Federal law, the CCC workers established extensive "truck trails." The goal was a mile of 'trail' for each 500 ac (202 ha) of forest. These workers were also active in implementing

Figure 8. The Keney Park in Hartford, CT, designed for public recreation by Frederick Law Olmstead, was one of many heavily damaged by the 1938 hurricane. Log salvage was one approach to removing the downed trees. (Photo courtesy of Keney Park Sustainability Project 1938).

Figure 9. This footbridge was constructed by the Civilian Conservation Corps workers in the American Legion State Forest. (Photo courtesy of the State of Connecticut Library archives circa 1935)

timber stand improvement measures throughout the State forests, including efforts to minimize gypsy moth impacts, another pest problem that had found its way into Connecticut.

The Second Half of the Twentieth Century Through 2020

In the second half of the 20th century, the focus of forestry in Connecticut shifted towards management of hardwood forests and an increased reliance on natural regeneration. For the most part, hardwoods with some conifers intermixed are the native vegetation in Connecticut. Hardwood forests tend to occur whether or not the landowner invests in their establishment. Planting extensive stands of conifers means upfront costs and long-term risk. Red pine, for example, growing south of its natural range, proved susceptible to the red pine scale, virtually eliminating it as a timber crop and taking the investment of many landowners with it. Forestland ownership also changed with farmers owning less and less of the land and new landowners bringing new values. Many of these new landowners did not see the forest as something needing investment until the trees had grown to a certain size.

Forest Management

In a study of Connecticut's forest program, MacDonald (1969) described four phases of forest policy from 1900 to 1968. The early phase was an appeal to farmers, with reforestation and forest plantings as key features. The second phase focused on the establishment of a forest products industry in the State. The third phase moved recreational aspects of forests into the forefront (figure 10), with hunting, fishing, camping, hiking, and management of parks guiding both State forestland acquisition and overall forest policy (see also Chapman 1935). Finally, by the 1960s, the forest gained recognition as an important component of the State's environment (figure 11). This culminated in 1971 when the State forestry program was included within Connecticut's newly established Department of Environmental Protection.

Figure 10. By the 1930s, recreational opportunities became increasingly important factors in State forest policy. Development of the automobile is credited for encouraging more visitors to the forest seeking recreation, a trend that continues to this day. (Photo by Chris Donnelly 2008)

In 1962, Public Act 490 passed the legislature, reducing the tax burden on farmlands and forestlands of at least 25 ac (10 ha) in size. However, the Act did not place any management or harvesting requirements on forestland owners. This continues to present a challenge to foresters throughout the State, as this statute provides no incentive for forest management beyond keeping the land as forest for the tax break. This factor may limit forest landowners from seeking additional advice from forest professionals.

At the same time, there were several factors working in favor of sound forest management. For one, New Haven, CT, happens to be the home of the Yale School of Forestry (renamed, in 1972 the Yale School of Forestry and Environmental Studies). This school produces a regular crop of graduate students, many of whom take advantage of Connecticut's forests to explore basic aspects of hardwood silviculture and stand development (e.g., Oliver 1978). Secondly, Connecticut forests proved capable of producing high-quality timber, especially oak, which continues to attract great interest from Europe and China. Thirdly, many individuals, families, and corporations that own the forests are often highly motivated towards conservation and maintaining the forests as forests, to be intrinsically valued for what they are.

An extensive study of Connecticut's early 21st century woodland owners provides a clear contrast between the prototypical farmer of Hawes's early years and current forest landowners (Tyrell 2015). For example, by the early 2000s, the typical woodland owner has more formal education than the average Connecticut resident. In addition, Connecticut woodland owners show a strong conservation ethic and place a high value on a woodland-owning lifestyle, which means protecting privacy, nature, wildlife habitat, beauty, scenery, and biological diversity. The study also shows, however, that the number of woodland owners who receive management advice from forestry professionals is relatively low.

State Nursery Closure

In the mid-1960s, the State Nursery was still going strong, producing about 1.8 million seedlings in a typical year. About two-thirds of seedlings went to private landowners, one-sixth went to the State of Rhode

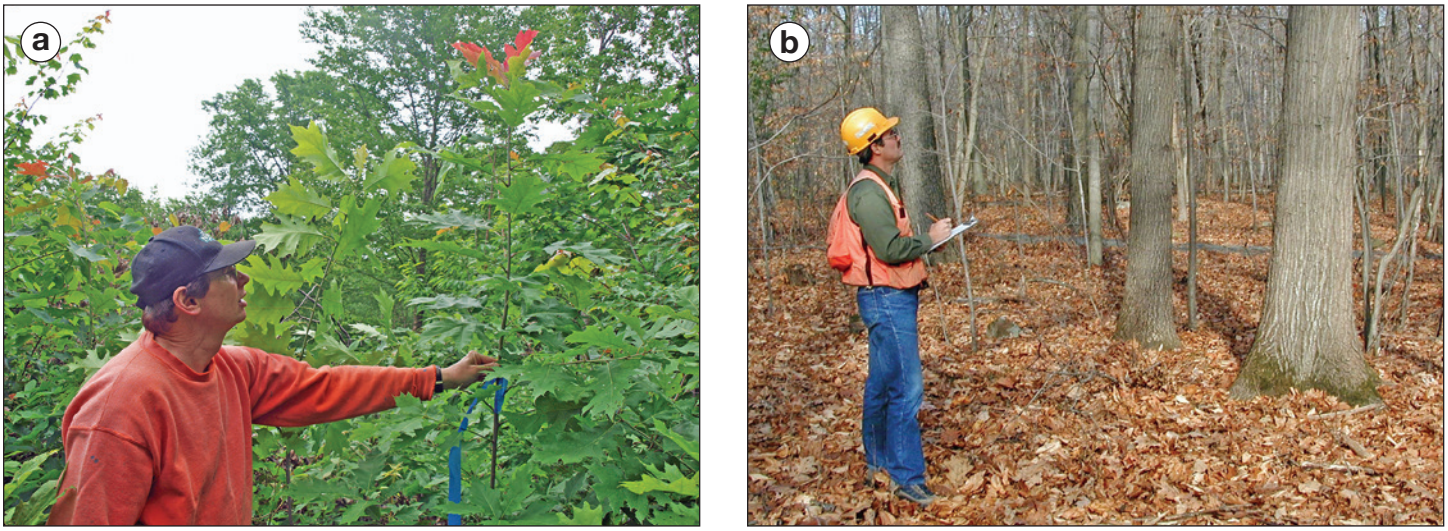

Figure 11. Forests in Connecticut are recognized as environmentally important. (a) State Lands Forester Ed McGuire inspects young red oak growing on State forest property. (b) Service Forester Rob Rocks inspects a thrifty red oak tree growing on private land. (Photos by Chris Donnelly 2012, 2014)

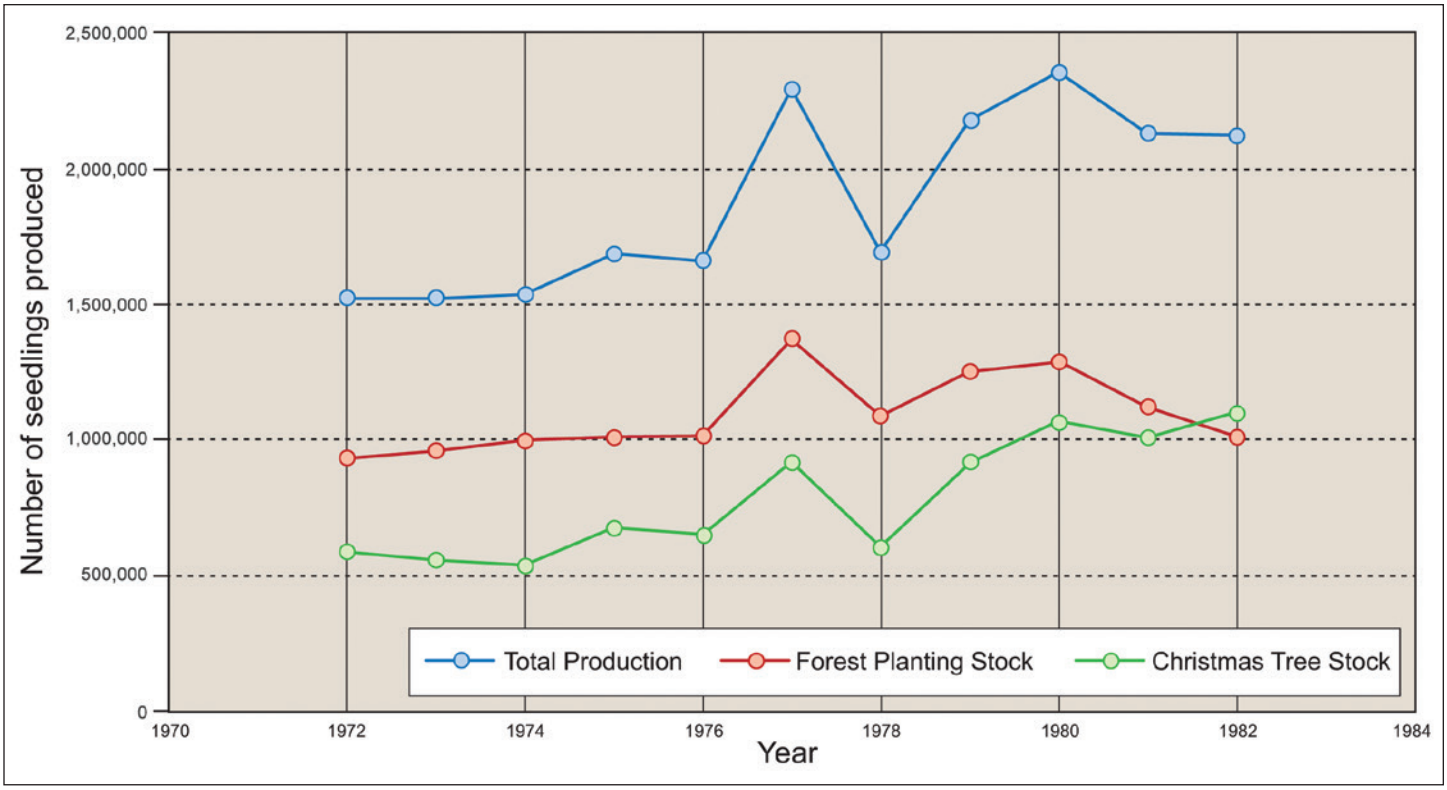

Figure 12. Seedling production at the Connecticut State Nursery changed over time until more than half of production was for Christmas trees. (Source: Cubanski 1988)

Island as the nursery took on a regional role, and one-sixth went to the State forests. By the mid-1980s, demand for seedling stock from the nursery exceeded production. Much of this increase in demand, however, came from Christmas tree growers as demand for forest planting stock was declining (figure 12). In part, this was due to white-tailed deer. Deer thrived in Connecticut's rebounding forests and, by the 1970s, had become a scourge for those who sought to underplant nursery stock. Deer, it appears, preferentially feed on nursery seedlings. The changing demands and other factors made running the State Nursery complicated and, in some ways, controversial. As a result, the State Nursery was closed in 2005. Many foresters view this closure as the loss of an important tool, especially as there are limited replacement sources for seedling stock within the State.

Current Challenges and Strategies for Forest Management in Connecticut

In the last few decades, the risks faced by specialized ecosystems have received greater consideration. One such ecosystem is the pitch pine-scrub oak barrens that occur on dry, sandy soils in association with fire (figure 13). Since these barrens are often considered to be poor for agricultural use but good for development, approximately 95 percent of these barrens within Connecticut have been lost (Gluck 2015). A long history of wildland fire suppression is also a factor. State Land foresters have led efforts to increase the amount of pitch pine (*Pinus rigida* Mill.) in the State's forests, through controlled burns, seedling planting (when they were still available from the State Nursery), and direct sowing of seeds harvested from existing trees.

Figure 13. Pitch pine regeneration in the pitch pine scrub oak barrens within Wharton Brook State Park in Wallingford, CT. These seedlings were first released by an overstory harvest in 2015. A controlled burn planned for that year was cancelled after an outbreak of southern pine beetle in the park, also in 2015. A major windstorm in 2018 further opened the canopy. (Photo by Chris Donnelly 2019)

Another concern is the balance of age classes within the State's forests. Because much of the forest initiated from large-scale, contemporaneous events, such as heavy logging in the early 1900s, the demise of the chestnut, and the 1938 hurricane, the forests are largely even-aged and many stands are of the same age. As stated in Wharton et al. (2004, p. 32):

> In Connecticut forests today, a beneficial mix of stand size classes may not exist. A disproportionate area – 69 percent of the timberland area – is in mature stands. In addition, there is an unusually small amount of regenerating stands, which comprise only 6 percent of timberland. The overall nature of tree growth, a decline in the abandonment of farmland, and reduced timber harvesting activities, have contributed to produce a forest comprised predominantly of mature stands and with a deficit of regenerating stands.

The extent of this problem became apparent when a major gypsy moth outbreak, combined with drought, occurred in eastern Connecticut from 2015 to 2017 (figure 14). The drought interfered with the activation of the maimaiga fungus that normally keeps the gypsy moth in check. In 2017, the combination of extensive repeated defoliation and drought stress led to large-scale tree mortality, especially for oaks in this part of the State (figure 15).

In response to the sudden loss of so much mature forest canopy, Connecticut's State Land foresters are considering four aspects of these oak-dominated stands (Evans 2019):

1. Encouraging and maintaining natural regeneration. Advanced regeneration of a mix of oak seedlings is somewhat hit or miss in these stands. The seedbank, however, is very good, with hick-

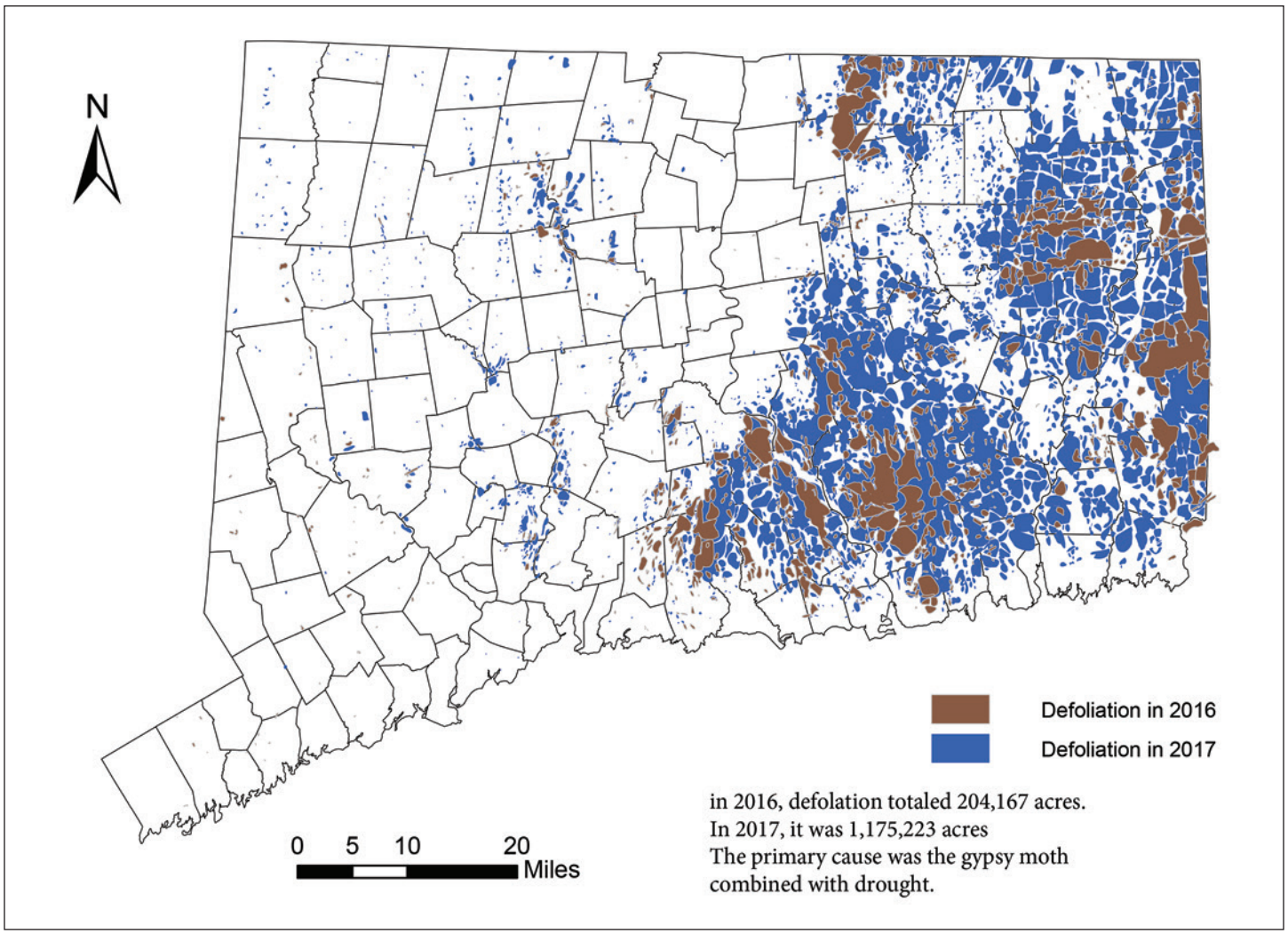

Figure 14. Overview of defoliation in Connecticut in 2016 and 2017. Map created by Chris Donnelly using data provided by the Connecticut Agricultural Experiment Station.

Figure 15. Oak forest defoliation occurred due to the combination of gypsy moth and drought. Photo was taken in August 2017, when re-foliation of oaks should have occurred. (Photo by Chris Donnelly)

ory, tulip poplar (*Liriodendron tulipifera* L.), black cherry (*Prunus serotina* Ehrh.), and other hardwoods all present, even in places where oak regeneration is limited. The fall of 2018 proved to be a good seed-crop year for white pine, adding an additional desirable seed source to the mix (figure 16).

2. Limiting opportunities for invasive plant species. Heavy regrowth is important for minimizing the incursion of invasive plant species. Invasive plants are a serious problem, hindering regeneration and causing additional forest-use problems, such as increased exposure to Lyme disease due to the relationship between Japanese barberry (*Berberis thunbergii* DC.) and the blacklegged deer tick (Williams et al. 2009). Experience indicates that shade from the regrowth can work to restrict or exclude invasive plants. In these stands, the number of invasive plants is relatively low in their interior, likely due to shading. Judicious herbicide treatments of plants such as Japanese stiltgrass (*Microstegium vimineum* [Trin.] A. Camus) also help.

Figure 16. White pine seedlings released through the removal of a low-quality, hardwood overstory. While not from a stand affected by gypsy moth, this is a good example of a "catch" of pine seedlings. (Photo by Chris Donnelly 2007)

3. Increased potential for larger fires. These areas have been subject to significant wildfires in the past, when the forest stands were younger and conditions were similar to what they are now. It will be important to make needed preparations should such fires occur, such as mowing areas of heavy shrub growth along roads to improve access for fire crews.

4. Harvesting in areas where damage is heaviest. In unmanaged areas, mid-story trees in the stratified, even-aged forest are often suppressed American beech (*Fagus grandifolia* Ehrh.), black birch (*Betula lenta* L.), and red maple (*Acer rubrum* L.). Releasing these species can yield a result similar to what happens following a high-grade operation, in which trees of low value and poor form come to dominate the stand. For this reason, even though the moth- and drought-killed oaks are of only modest value, due to their condition, their harvest may be justified by the simultaneous removal of this new, low-value overstory, in order to trigger germination of the diverse seedbank mentioned earlier.

Reflecting Back and Looking Forward

Are the forests of Connecticut better off in the 21st century than they were at the start of the 20th? For many people, this is a glass half full or half empty question. Certainly, there are many facts on the glass half full side. Among these are:

- 58 percent of the State is forested (Butler 2017).
- A profitable lumber industry is established within the State.
- More than 150 foresters and 300 other forestry professionals are currently certified through a rigorous examination process by the State's Department of Energy and Environmental Protection.
- The State has 32 State forests, covering more than 169,000 ac (68,400 ha; about 5.5 percent of the State land area).

With regard to the "glass half empty" outlook, factors include:

- Loss or diminished status of key forest trees such as chestnut and ash
- Extensive forest regeneration problems caused by invasive plants and deer
- Frequent outbreaks of exotic insect and disease problems (figure 17)
- The current unmanaged condition of many public and private forests
- The continued conversion of forestlands to subdivisions.

Indeed, the challenges to management of Connecticut's forests remain immense. Even with these concerns, however, Connecticut's forests are a long way from the "unsightly scars" and "gaunt fire-killed trees" referenced by Austin Hawes. The progress Connecticut has made is testimony to the solid vision and hard work of many people (figure 18), including the early State foresters, the many State Forestry staff over the years who dedicated their careers to bringing back the forests, the forest workers such as those associated with the CCC who helped shape the forest acre by acre, and the forest landowners and public policy makers, who helped to define a structure that has allowed a remarkable ecological turnaround to occur.

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Figure 17. Current challenges to forests in Connecticut include concerns about new insect and disease pests. State Lands Forester Jerry Milne and Connecticut Agricultural Experiment Station Entomologist Claire Rutledge explore an unusual outbreak of southern pine bark beetle in a mixed pine stand in Connecticut. (Photo by Chris Donnelly 2015)

Figure 18. A volunteer helps plant disease-tolerant American elms in the Connecticut River floodplain in an effort to improve the genetic resources of that species. This project is being led by the Nature Conservancy with support from such agencies as Connecticut DEEP and the USDA Forest Service. (Photo by Chris Donnelly 2012)

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