Forest Management Plan for the Connecticut Forest and Park Association's Field Forest Property
153.43 mapped acres; 2026-2035
Bear Rock Road
Durham, CT – Middlesex County

Prepared for:

Connecticut Forest and Park Association
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2 IDENTIFICATION AND AGREEMENTS

Property

Address	Bear Rock Road
Town	Durham, CT
MBU(s)	50/01
Acreage	108.40 listed acres, 153.45 mapped acres
Forest Acreage	153.45

Landowner(s)

Name	Connecticut Forest and Park Association (CFPA)
Address	16 Meriden Road, Rockfall, CT 06481
Phone	860.346.8733
Email	info@ctwoodlands.org
Contact Person Name	Clare Cain
Contact Person Email	ccain@ctwoodlands.org

Foresters

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Plan Preparer

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3 MANAGEMENT RECOMMENDATION SCHEDULE[1]

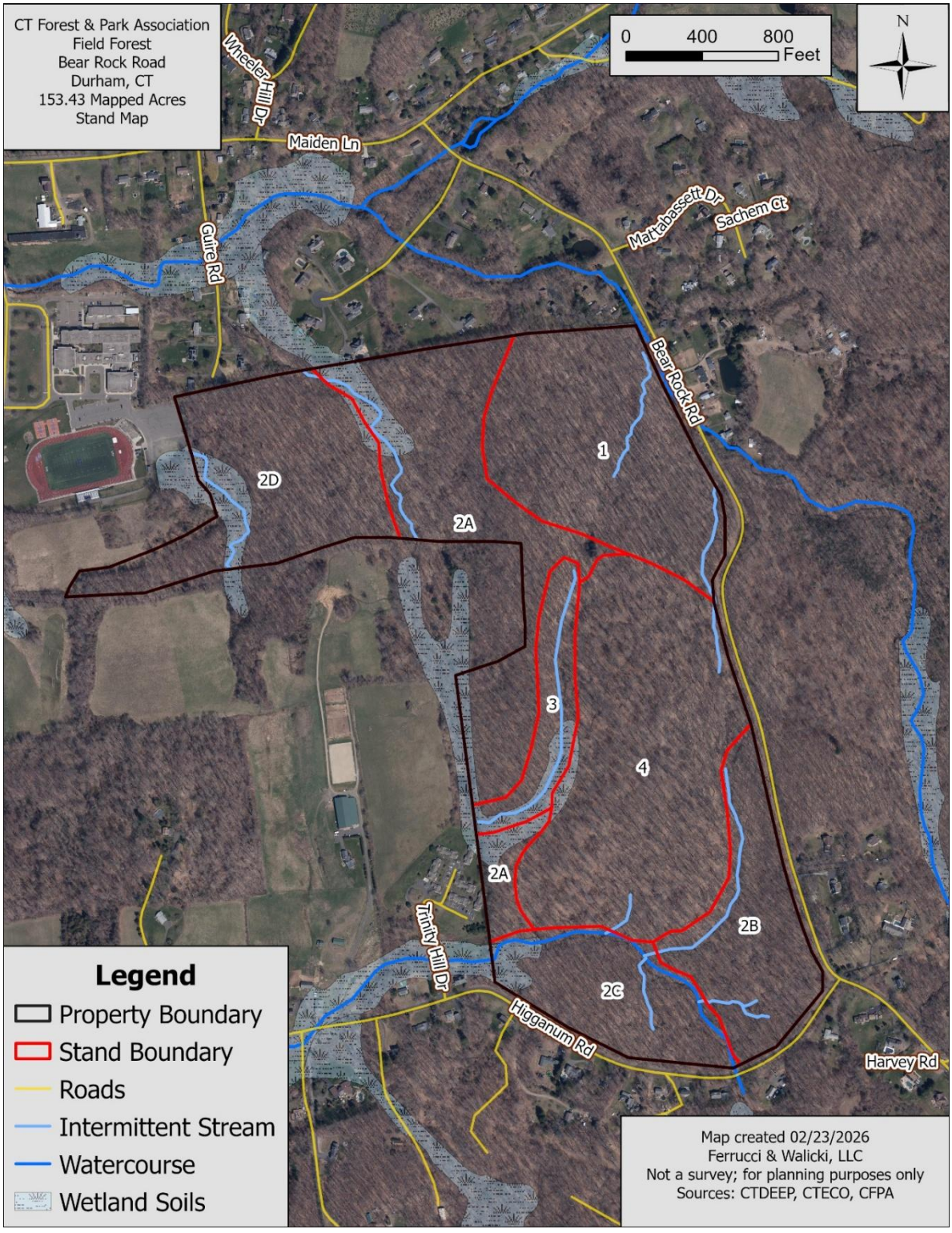
[1] See Section 9 for proposed management recommendation schedule.

4 MAPS

This map set is intended to highlight notable features observed on the property. The maps do not show every occurrence or the exact locations for features displayed and are intended to serve as a visual aid for additional context on topics discussed in the plan. The mapped acreage listed on the maps differs from the listed acreage on the town of Durham, CT, assessor's database by 45.03 acres, though the property boundary shapes are substantially the same. For the purposes of this plan, the mapped acreages are used to describe the stands and other features.

4.1 Property Overview Map

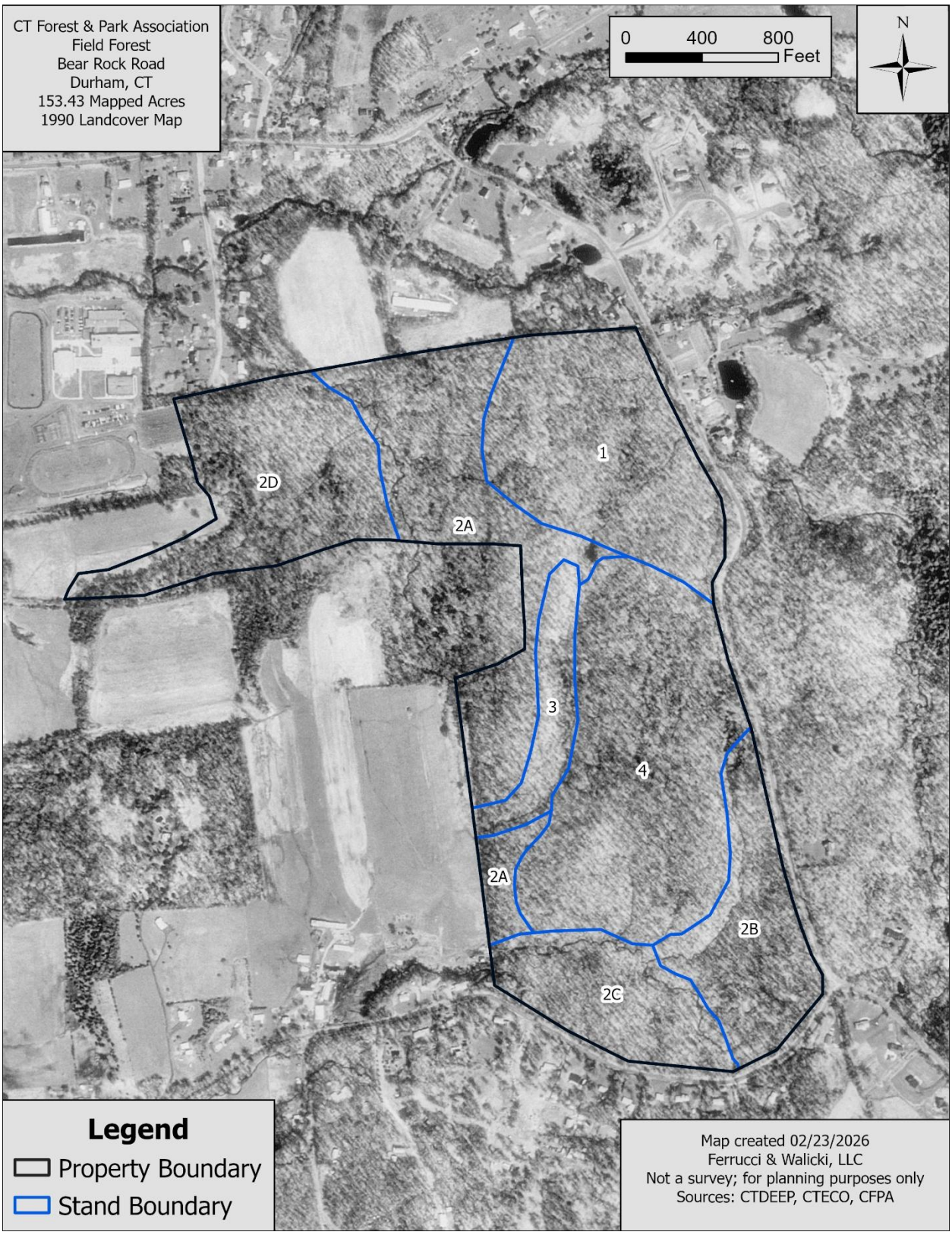
4.2 Stand Map


CT Forest & Park Association
Field Forest
Bear Rock Road
Durham, CT
153.43 Mapped Acres
Stand Map
0 400 800
Feet
N
Wheeler Hill Dr
Maiden Ln
Guire Rd
Mattabassett Dr
Sachem Ct
Bear Rock Rd
1
2D
2A
3
4
2A
2B
2C
Trinity Hill Dr
Higganum Rd
Harvey Rd
Legend
Property Boundary
Stand Boundary
Roads
Intermittent Stream
Watercourse
Wetland Soils
Map created 02/23/2026
Ferrucci & Walicki, LLC
Not a survey; for planning purposes only
Sources: CTDEEP, CTECO, CFPA

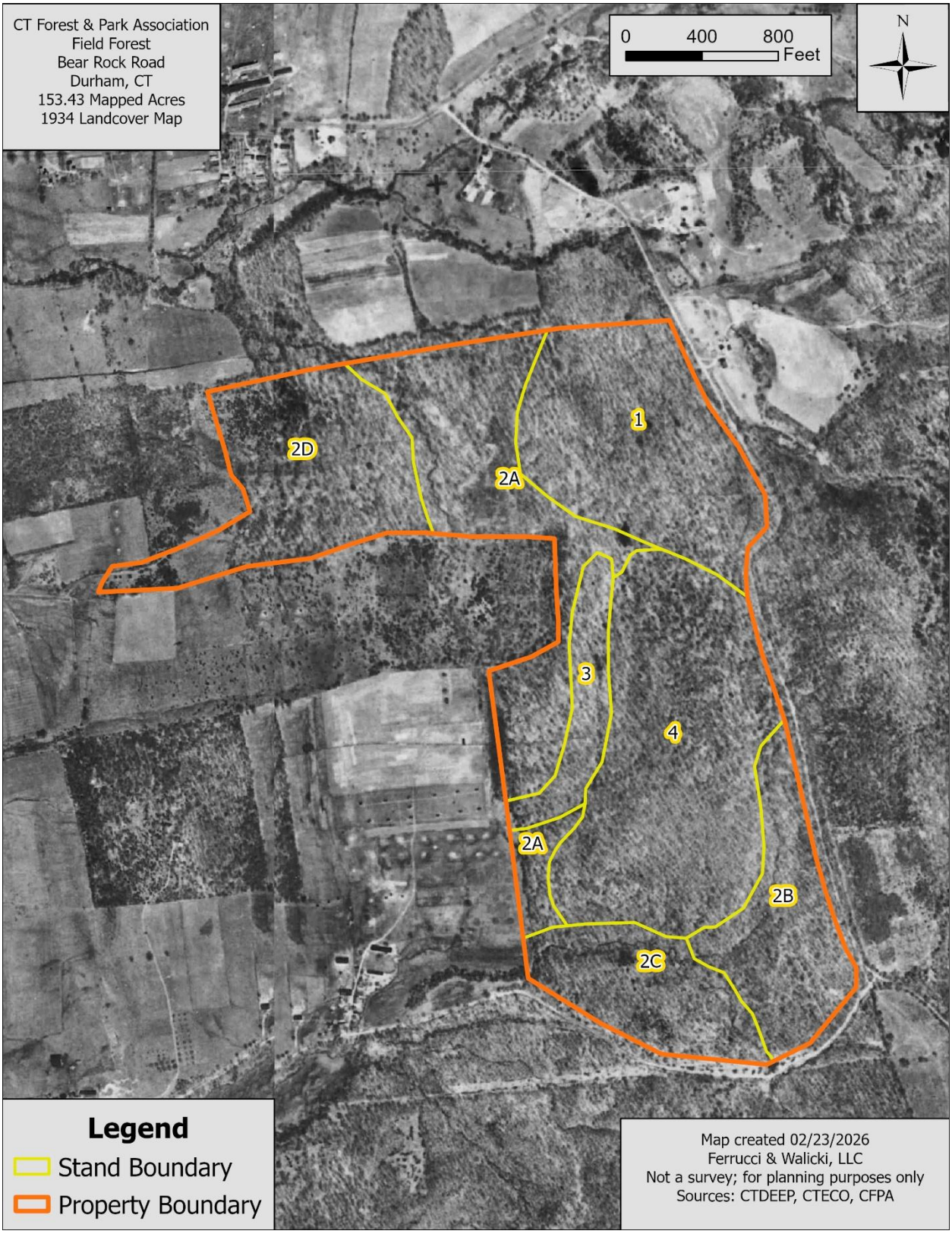
For the purposes of continuity, stand boundaries were kept uniform with the 2014 plan for the property prepared for CFPA and edited by Dan Donahue.

4.3 Historic Landcover (2012) Map

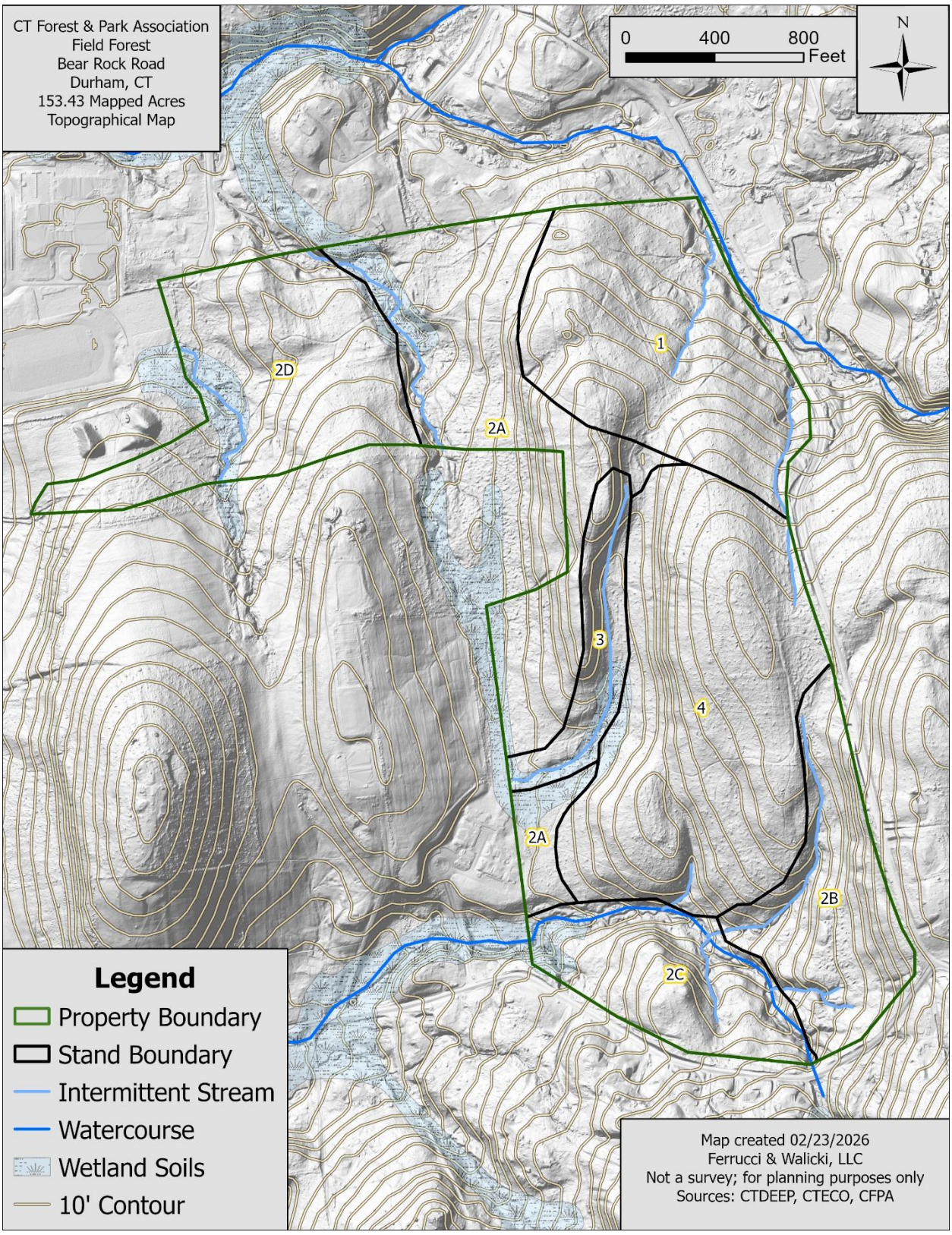
4.4 Historic Landcover (1990) Map



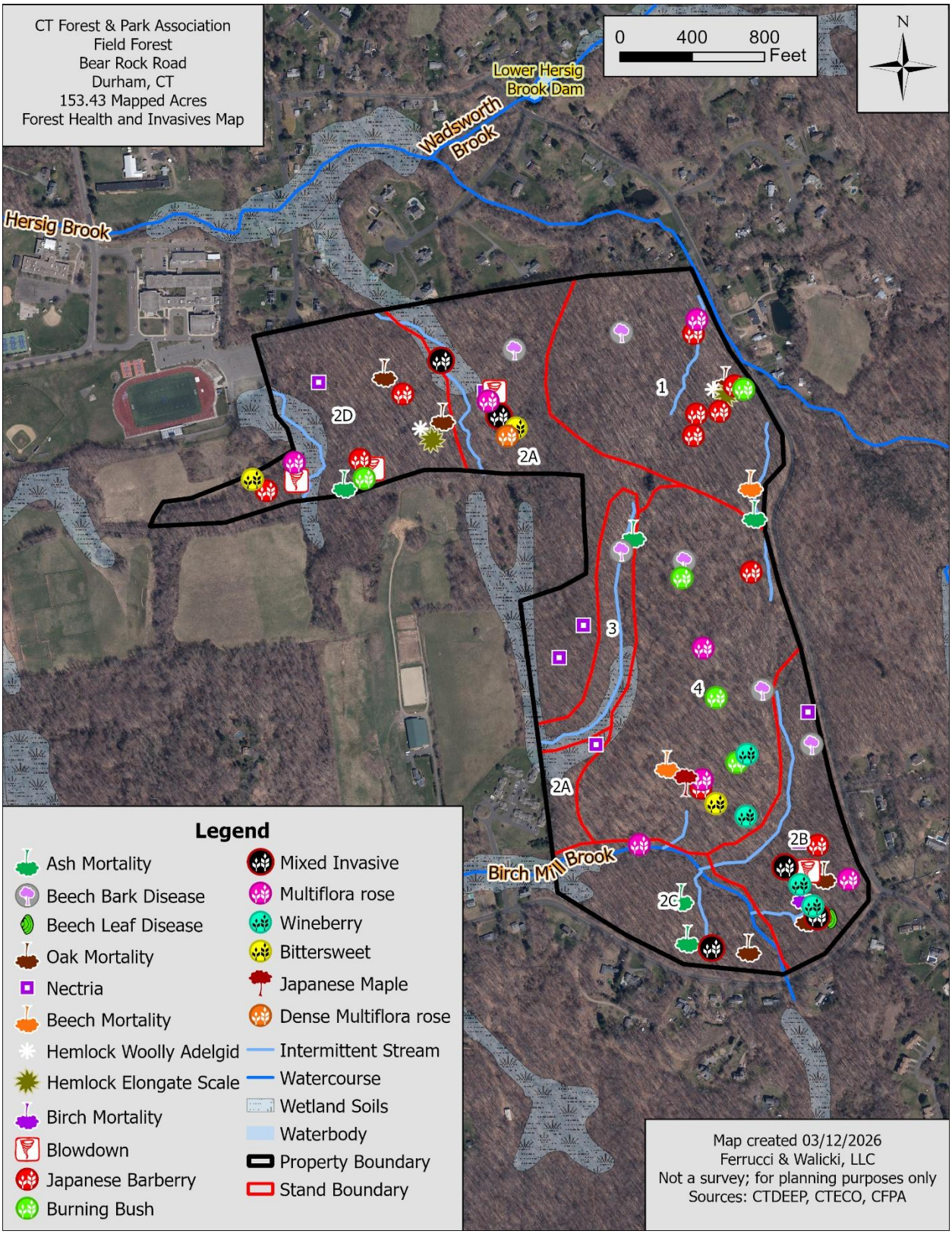
4.5 Historic Landcover (1934) Map



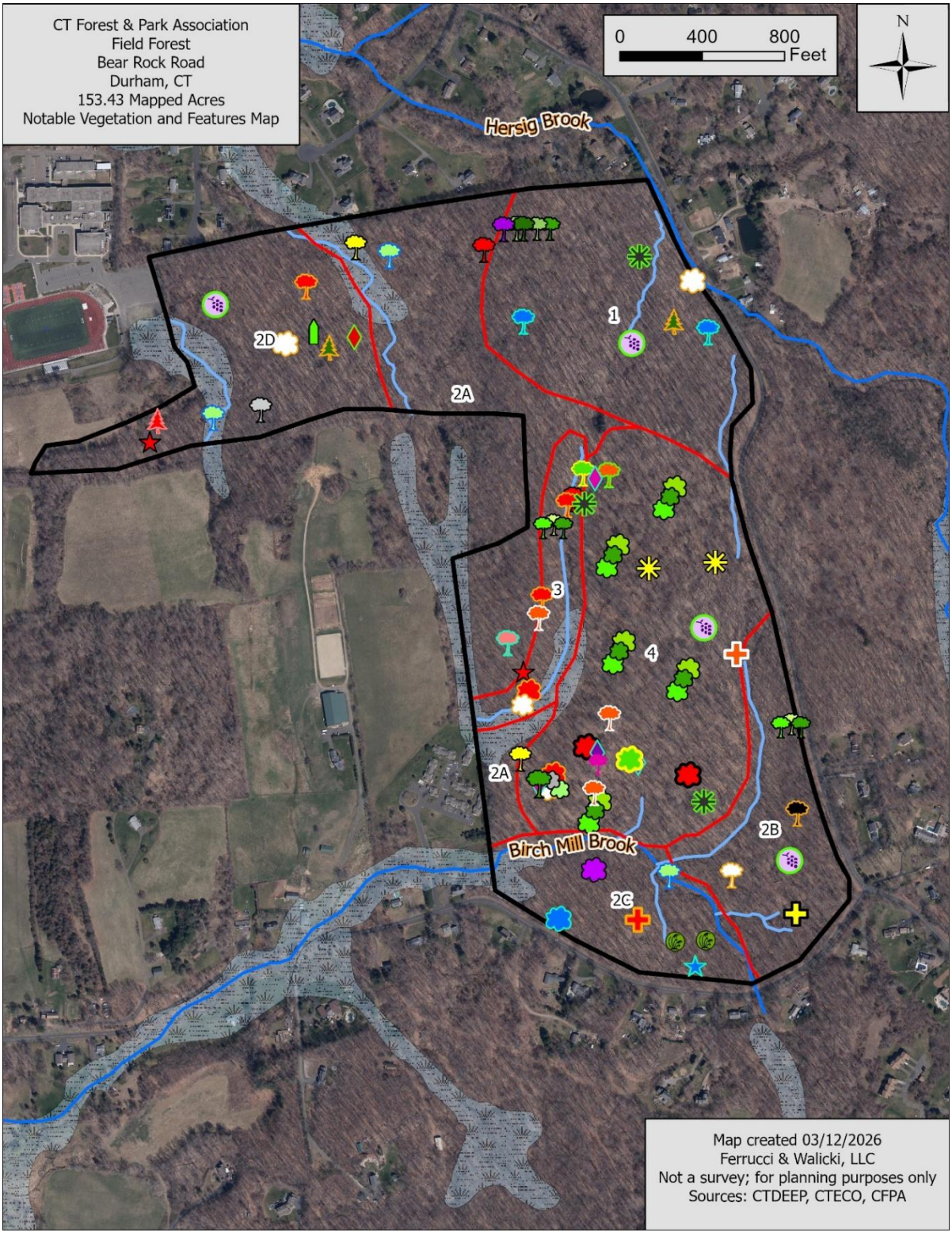
4.6 Topography Map



4.7 Forest Health and Invasives Map

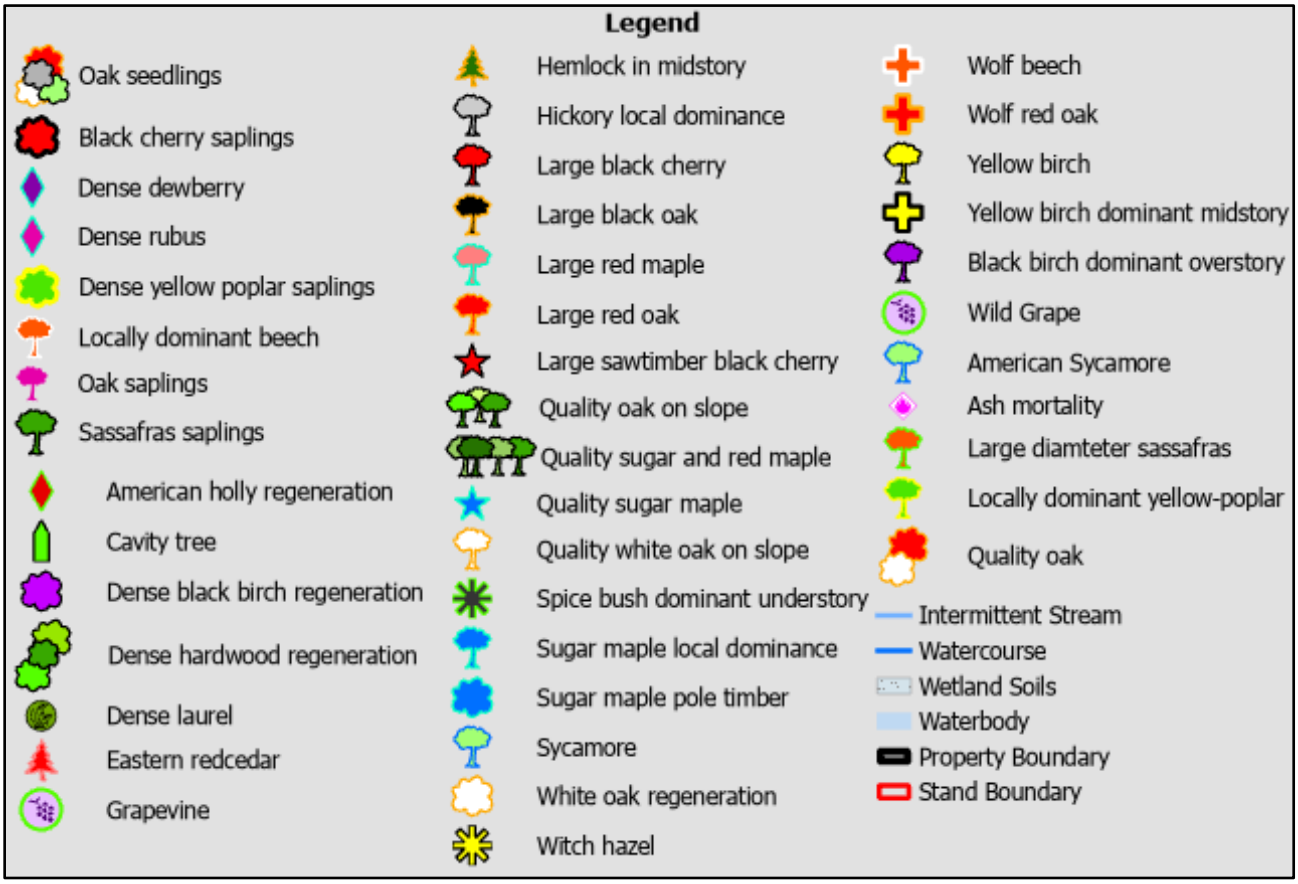


4.8 Notable Vegetation and Features Map

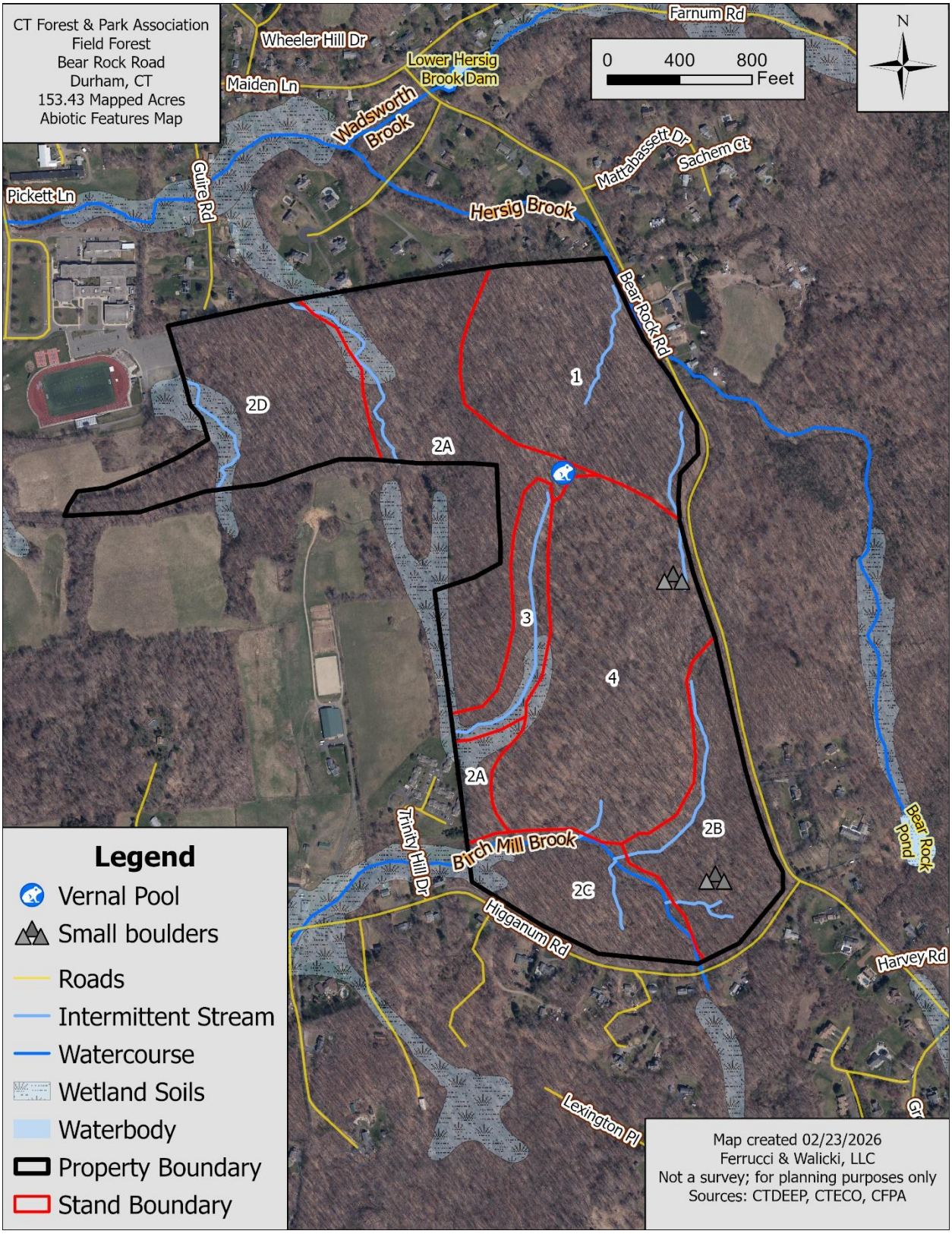


*Legend on next page

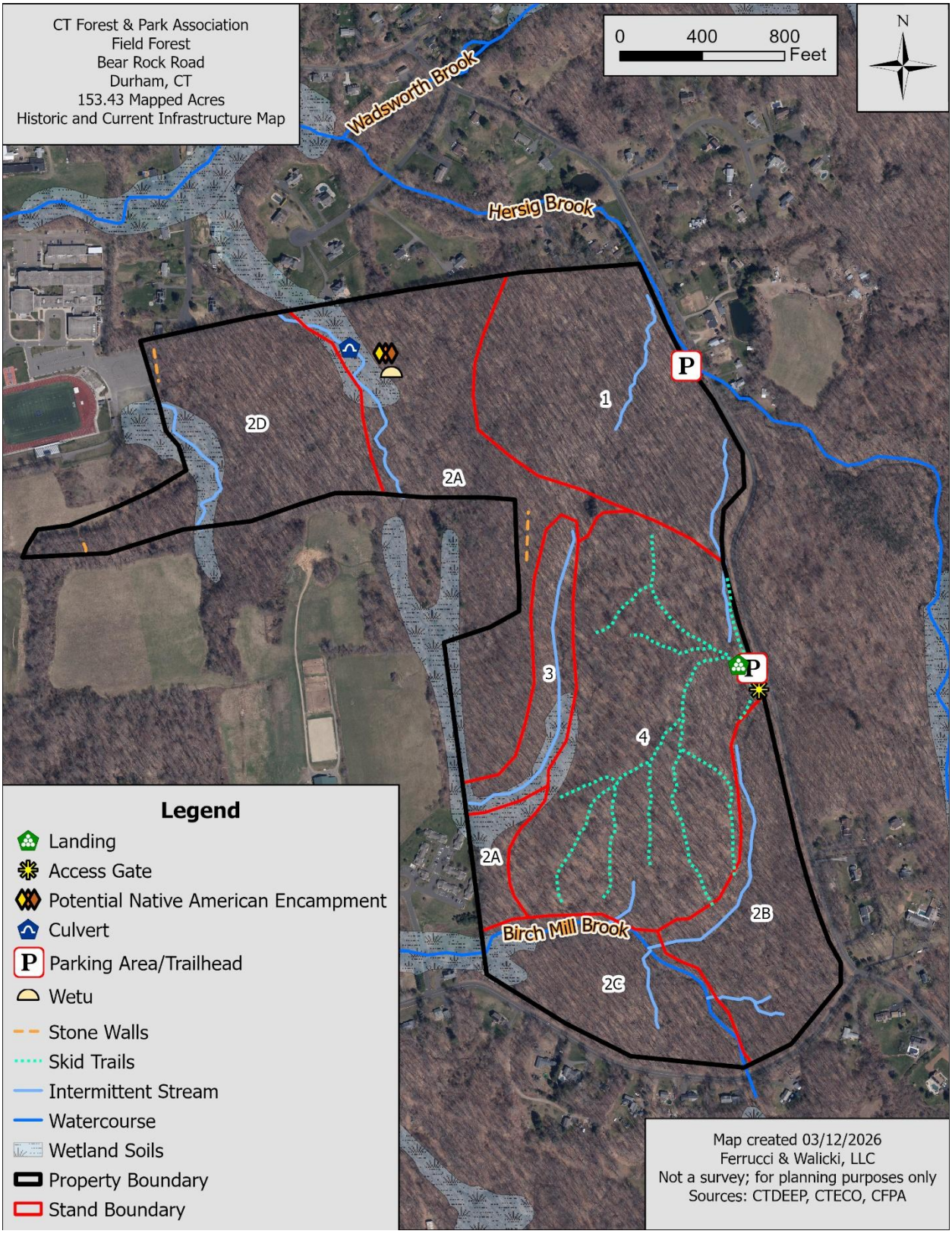
4.9 Notable Vegetation Map Legend



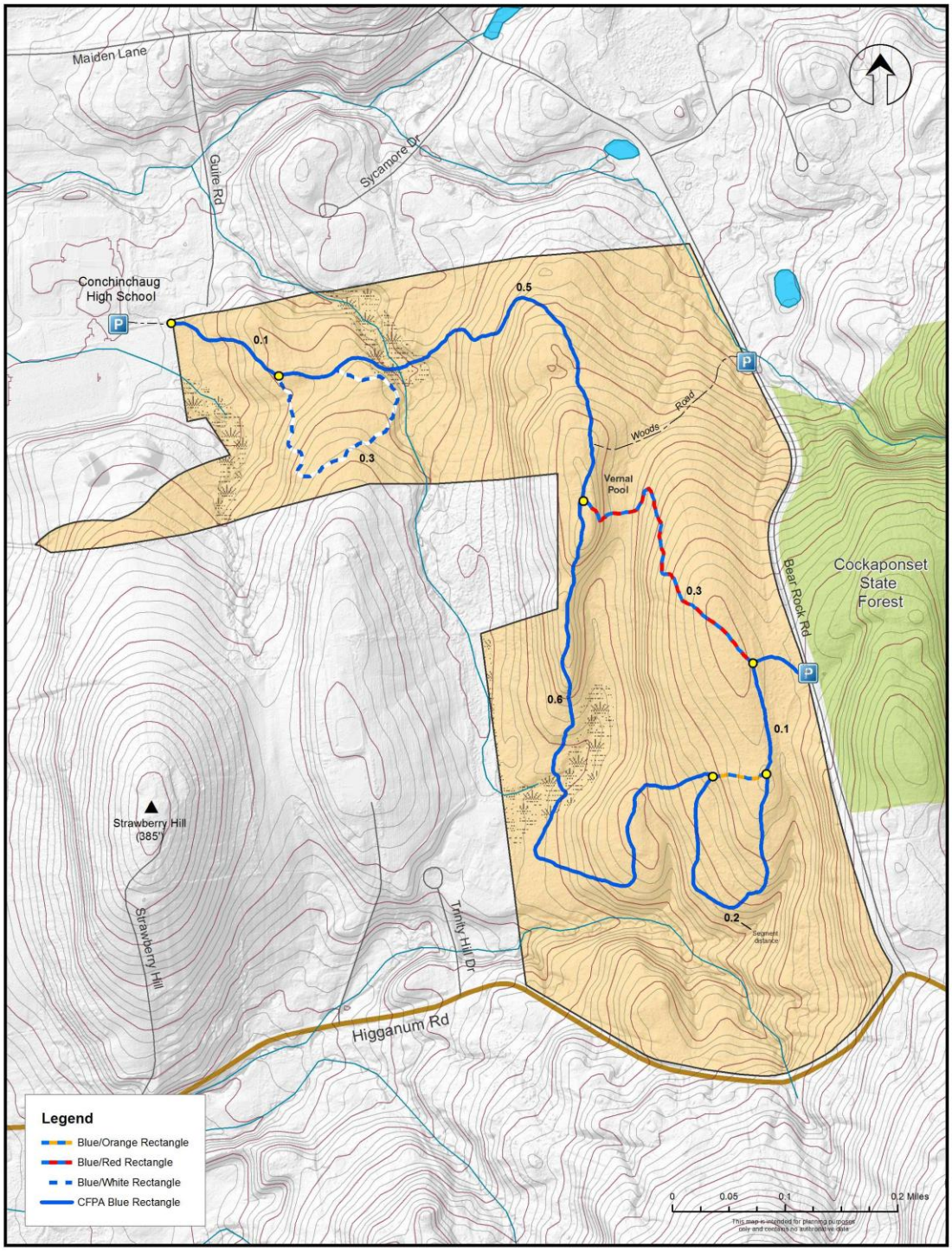
4.10 Abiotic (Hydrologic & Geologic) Features Map



4.11 Historic and Current Infrastructure Map

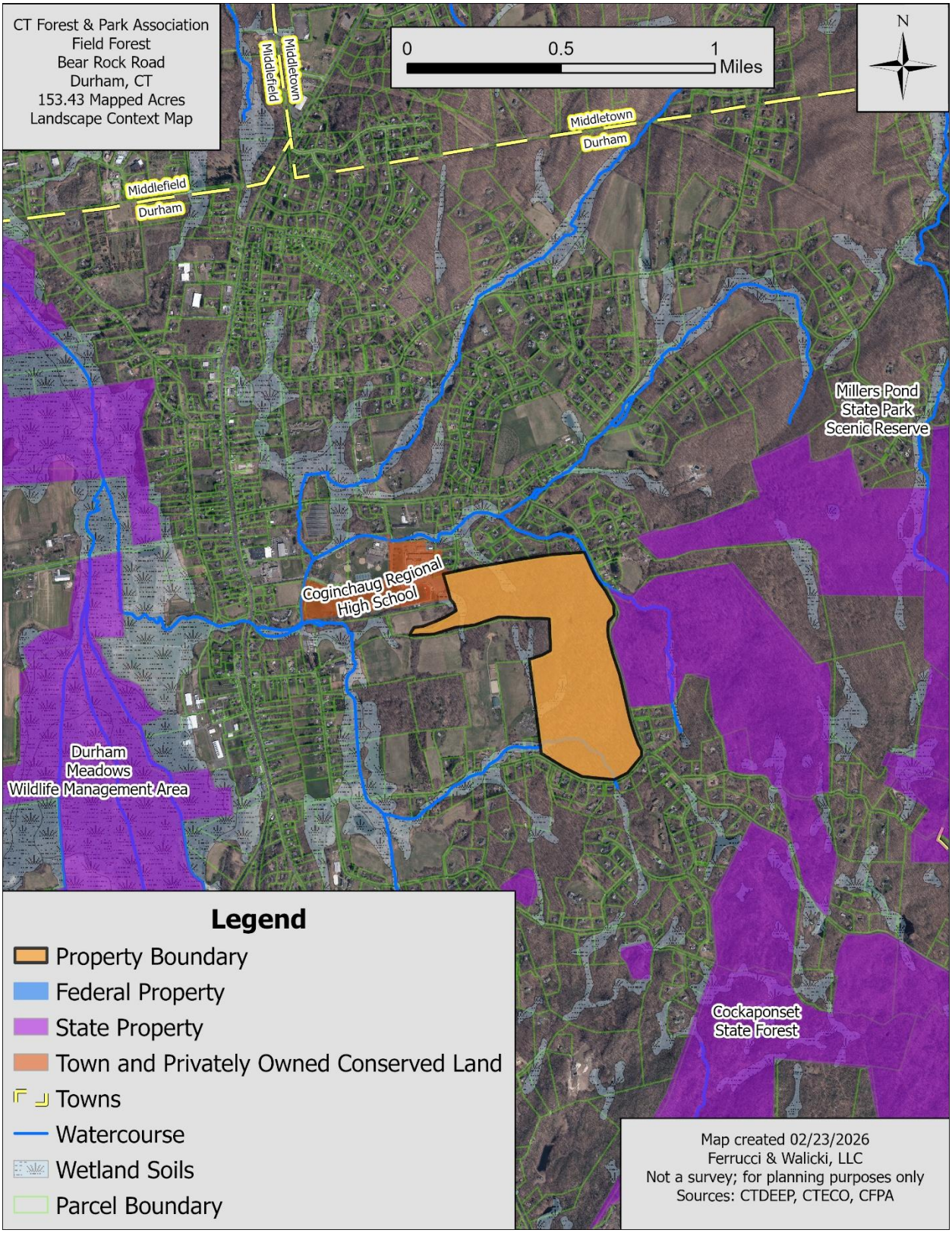


4.12 Current Infrastructure (Trails) Map

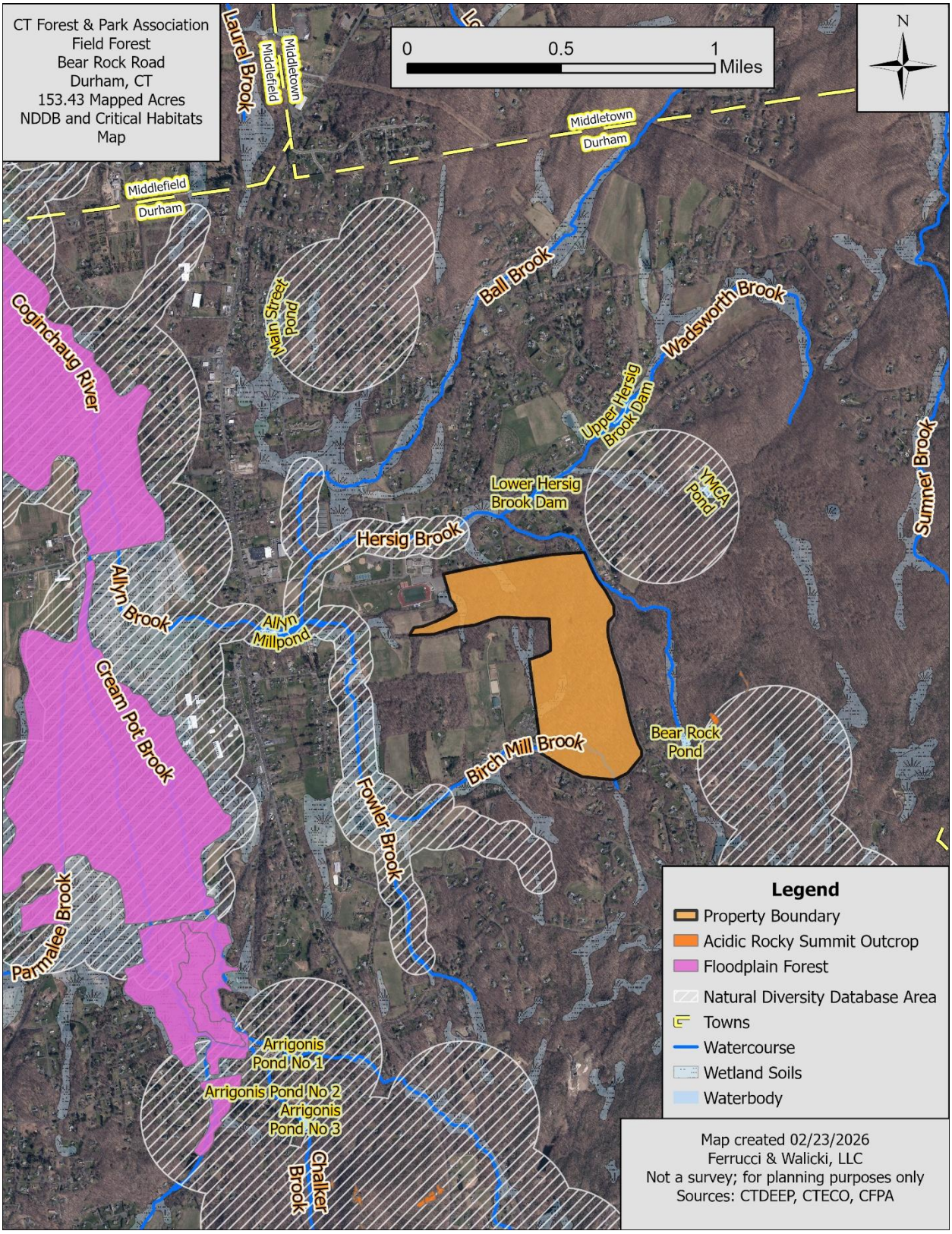


Map courtesy of CFPA

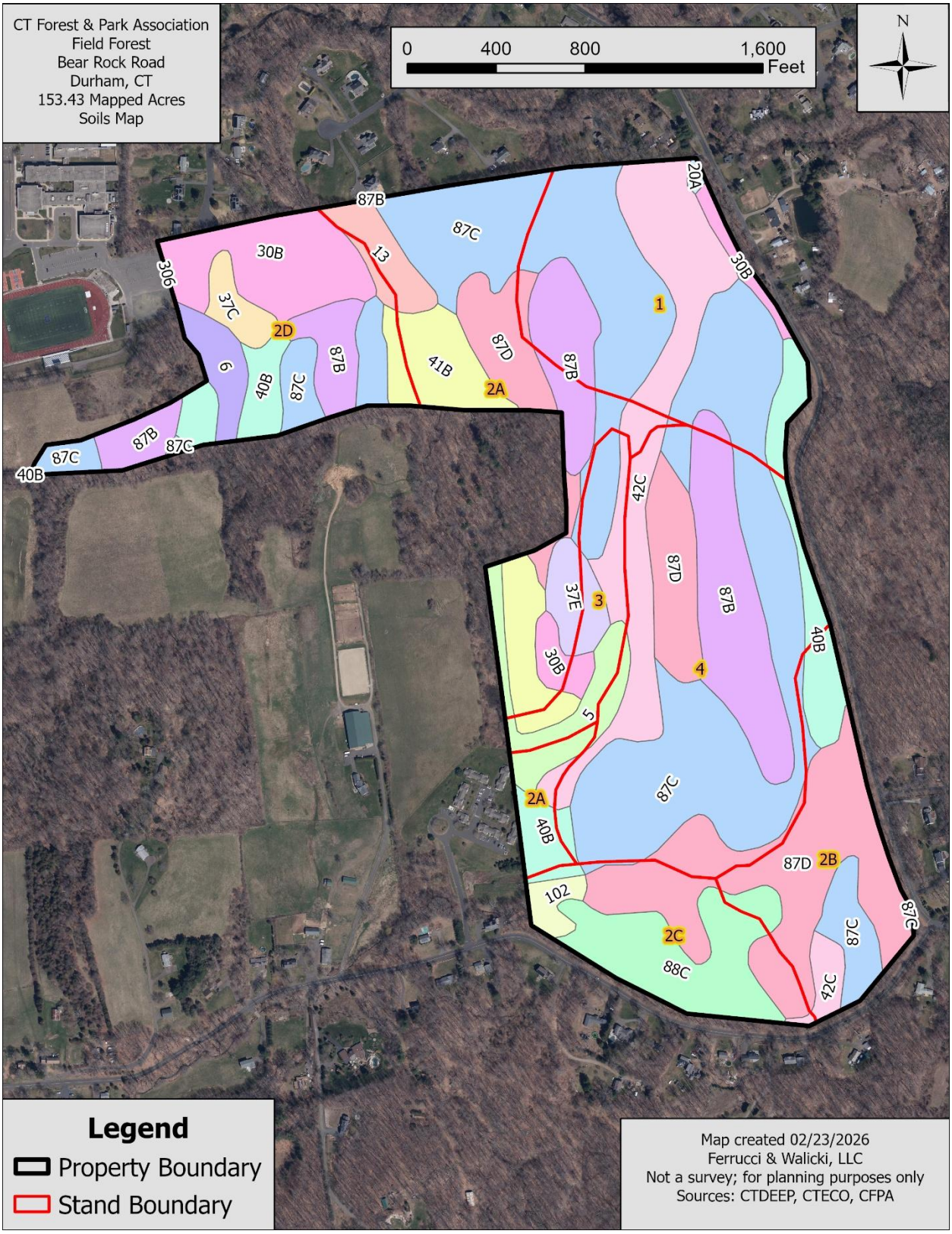
4.13 Landscape Context Map



4.14 Natural Diversity Database and Critical Habitats Map



4.15 Soils Map



4.16 Soils Map Legend

Soil Type	Soil Key	Acres
Walpole sandy loam, 0 to 3 percent slopes	13	2.48
Wethersfield loam, 8 to 15 percent slopes, very stony	88C	8.26
Ellington silt loam, 0 to 5 percent slopes	20A	0.19
Udorthents-Urban land complex	306	>0.005
Manchester gravelly sandy loam, 15 to 45 percent slopes	37E	2.43
Ludlow silt loam, 2 to 8 percent slopes, very stony	41B	7.58
Ludlow silt loam, 2 to 15 percent slopes, extremely stony	42C	1.29
Branford silt loam, 3 to 8 percent slopes	30B	0.68
Branford silt loam, 3 to 8 percent slopes	30B	6.9
Branford silt loam, 3 to 8 percent slopes	30B	1.35
Pootatuck fine sandy loam	102	1.16
Wilbraham and Menlo soils, 0 to 8 percent slopes, extremely stony	6	2.22
Wethersfield loam, 8 to 15 percent slopes	87C	16.94
Wethersfield loam, 3 to 8 percent slopes	87B	8.88
Wethersfield loam, 3 to 8 percent slopes	87B	1.68
Wethersfield loam, 3 to 8 percent slopes	87B	2.53
Wethersfield loam, 3 to 8 percent slopes	87B	4.57
Wethersfield loam, 8 to 15 percent slopes	87C	2.44
Wethersfield loam, 8 to 15 percent slopes	87C	0.16
Wethersfield loam, 8 to 15 percent slopes	87C	0.08
Wethersfield loam, 8 to 15 percent slopes	87C	0.9
Wethersfield loam, 8 to 15 percent slopes	87C	2.93
Wethersfield loam, 8 to 15 percent slopes	87C	23.38
Ludlow silt loam, 2 to 15 percent slopes, extremely stony	42C	13.63
Ludlow silt loam, 3 to 8 percent slopes	40B	>0.005
Ludlow silt loam, 3 to 8 percent slopes	40B	2.01
Ludlow silt loam, 3 to 8 percent slopes	40B	2.77
Ludlow silt loam, 3 to 8 percent slopes	40B	4.21
Manchester gravelly sandy loam, 3 to 15 percent slopes	37C	1.58
Wilbraham silt loam, 0 to 3 percent slopes	5	4.27
Wethersfield loam, 15 to 25 percent slopes	87D	15.39
Wethersfield loam, 15 to 25 percent slopes	87D	>0.005
Wethersfield loam, 15 to 25 percent slopes	87D	4.32
Wethersfield loam, 15 to 25 percent slopes	87D	4.51
Total Acreage		153.43

5 PROPERTY OVERVIEW

The Howard B. Field Forest (herein referred to as Field Forest or "the property") is composed of a mixture of upland hardwood forest, forested wetlands, riparian areas surrounding drainages, and one vernal pool. Large sawtimber yellow-poplar, sugar maple, American beech, hickories, and oaks (white, red, and black) dominate the overstory in most places within the property. The forested stands within Field Forest are a mixture of age classes and are classified as even-aged and two-aged.

- 153.43 mapped acres of forest land
- Central-east portion of Durham, CT
    - Bear Rock Road abuts the entire eastern property boundary. Two trailheads/small parking areas are present on this road and these are the easiest ways to access the property on foot.
    - Additional parking areas are found in the northwestern corner of the property on the nearby Coginchaug Regional High School property and at the cul-de-sac at the south end of Guire Road where there is another trailhead.
    - Additional road frontage is shared in the south with Higganum Road.
    - Surrounding areas are highly developed or in agriculture to north west and south. To east is large block of forest including a block of Cockaponset State Forest
- Most roadside boundaries are marked with Connecticut Forest and Park Association placards, but are not marked with boundary paint.

5.1 Property History

Like most current forestland in Connecticut the property was cleared and used for agriculture for some period following European settlement in New England and appears to have been abandoned from agricutlural uses in the late 19th or early 20th century. This assertion is based on the current condition of forested areas, the bulk of which is ecologically young second-growth. The land here was still actively being farmed in the early 1900s until it came into the past landowners' possession (the Field Family) in 1928 (Howard B. Field FSP 2014).

In 2014 CFPA created a guidance document to help better understand the property and to guide stewardship activities that would occur in subsequent years. The *Howard B. Field Forest Stewardship Plan* (Howard B. Field FSP 2014) was prepared by and included contributions from local CT Certified Foresters and CFPA board members and staff. The plan included descriptions of each mapped stand and recommendations to be implemented duirng the 10-year period following the plan's completion. The stands shown in this plan are uniform with the stands from the last plan to retain continuity for being able to track stand changes over time both qualitatively and quantitatively.

Field Forest was gifted to the Connecticut Forest and Park Association (CFPA) in October 2001 by Howard Brigham Field Jr., deeding it to CFPA in his will. According to the will of Mr. Field, his heirs are allowed to hunt on the property, while the public can make use of it through passive recreation (hike, and observe nature) on the designated trails.

A forest management project was done in a portion of Stand 4 in 2016-2017 to demonstrate sustainable forest stewardship, habitat enhancement, the production and utilization of local wood products, and to serve as a dynamic educational opportunity for the public to experience before and after the treatment. Prior to any tree cutting, CFPA staff successfully treated invasive plants within the project area and some

invasives were also treated along Bear Rock Road. Before and after the treatment was complete, CFPA organized tours for the public to be able to explain what was being done and why. After the operation was complete, signs were installed in some locations along trails to inform visitors to the property of what occurred during the harvest, the goals and intended outcomes of the treatments, and how they were done.

During the initial 2016-2017 operation, additional trees were marked for removal after the operation had begun. The reason for this is the rapid mortality of ash trees due to an infestation by the emerald ash borer, a non-native invasive insect pest. In 2018 a follow up salvage harvest was conducted after spongy moth[2] (another non-native invasive insect) swept through the area, resulting in extensive oak mortality. In both cases, the additional trees that were marked for removal were primarily those that were closest to trails. Many of the dead trees further from trails were left standing to provide habitat for insects, birds, and other wildlife as they decompose. Prior to these operations, the last known timber harvest occurred in 1958 (Howard B. Field FSP 2014).

After these harvests occurred in the central portion of the property (Stand 4), a diverse mix of young native trees, shrubs, grasses/forbes, and wildflowers have begun regenerating below the retained trees.

Archaeologic, Cultural, and Historic Sites

- *Wetu constructed by Wesleyan University Students in collaboration with the CFPA (created in 2025);*
- *Historical foundation;*
- *Native American encampment site in the northern portion of the property* (Howard B. Field FSP 2014);
- *Stone walls;*
- *Old cedar fence posts.*

5.2 Summary of Goals

Each land steward has a unique outlook for the future of the property they tend to. In producing a plan for future management of any property it is valuable to clearly outline goals to help inform stewardship recommendations and desired future conditions. These goals, as well as best management and silvicultural practices firmly based in science, inform landowners, foresters, contractors, and other stewards in how to achieve desirable long-term outcomes. CFPA has identified these primary goals for management of the property:

- Ensure that the property can be utilized as an educational hub and outdoor classroom for students, educators, and the public to learn about proper land stewardship and active forest management activities;
- Climate resilience;
- Maintained ecological values and characteristics;
- Reduce invasive plant populations;
- Continued high quality experiences for recreational users of the property;
- Engage the community in conservation efforts, encouraging active participation and volunteerism towards local natural resources.

[2] Formerly called gypsy moth.

6 LANDSCAPE CONTEXT[3]

Durham, Connecticut is well-developed with an intermixed forest-development arrangement including residential properties of various sizes mixed with small-scale agricultural operations scattered across the landscape. Conserved forest blocks like Field Forest provide habitat for species sensitive to human related disturbances. Forest refugia in developed areas can help bridge populations between larger blocks and improve genetic material exchange among both plants and animals, improving population resilience to stressors like changing climate regimes. Some species in the spotlight of conservation efforts in Connecticut, like ruffed grouse, are limited by short annual migration ranges.

The hardwood dominated forests and some forested wetlands that make up this property is beneficial from an ecological perspective. Hardwood local dominance is one strength of the property, along with the influx of young vegetation now regenerating following the 2016-2018 treatments. The dense understory cover the regeneration provides is useful on the landscape scale for habitat and structural complexity. This two aged forest condition compliments well, the even-aged regeneration treatment that was conducted at the Cockaponset State Forest property just east of Bear Rock Road prior to 2016. Besides these two areas with regenerating young forest components, there is a general lack of young forest on the landscape level.

Adjacent Ownerships and Nearby Conserved Land

There is additional conserved land to the east – Cockaponset State Forest and the Millers Pond State Park Scenic Reserve – both owned and managed by Connecticut Department of Energy and Environmental Protection (DEEP). DEEP state lands foresters are currently in the process of updating the plans for this block of Cockaponset. Also in the far west there is the Durham Meadows Wildlife Management Area, also owned by the State of CT. These properties combine to represent the largest blocks of conserved land near Field Forest.

Coginchaug Regional High School lies to the northwest of the property. The close proximity to the high school represents an opportunity for educators and students to learn about sustainable forest management, plant and wildlife species identification within our forests, water function, and the importance of responsible stewardship of the land.

Special Sites and Considerations

There are portions of this property with characteristics that have special value to or are otherwise important to the surrounding landscape.

- Vernal pool in the northcentral portion of the property.
- Forested wetlands in the southern and northern parts of the property.
- Diverse mixed hardwood upland forests found throughout the rest of the forested parts of the property.
- Watercourses, steep ravines, and riparian areas

[3] For visual context, and additional information on nearby conserved areas see map in Section 4.13

6.1 Water and Soil Protection

Field Forest is a mix of upland forest and forested wetlands. There are multiple watercourses scattered across the property including several intermittent drainages that contain running water for a portion of the year and during storm events. One significant hydrological feature to continue to protect is the vernal pool in the northern portion of the property. Hersig Brook to the north of the property drains into Bear Rock Pond to the southeast. Some of the intermittent drainages in the northern portion of the property drain into Hersig Brook. The most significant watercourse within the forest is Birch Mill Brook which cuts through the southern portion of the property. Stands 2c and 2b are largely inaccessible with equipment because of the steep conditions found here and the close proximity to Birch Mill Brook and forested wetlands downslope of these stands. The other wetland areas visible in mapping (see Section 4.10) are accessible on foot and would be more accessible if stewardship activities were to be implemented near them. Following best management practices to ensure water quality during and following forest stewardship activities will protect sensitive portions of these stands.

6.2 Geology

Notable geologic features found within Field Forest:

- A drumlin[4] in the central portion of Stand 4
- Scattered boulders in places
- Steep valleys with watercourses/and or streams flowing through
- Rolling hills

The soils of Field Forest are highly productive and consist of either Prime Farmland Soils or Statewide Important Farmland Soils. Certain tree species on the property – yellow-poplar, sugar maple, hickory, ash, and, to a certain extent, black cherry – indicate that the soil here is fertile and effective at retaining moisture. Oak, hickory, and beech occur more frequently on slopes and higher elevations of land where soil is not as moist. Tall tree heights in places throughout the property bear out the productivity of the soils here. The soils on the property include[5]:

- Walpole sandy loam
- Wethersfield loam;
- Ellington silt loam;
- Manchester gravelly sandy loam;
- Ludlow silt loam;
- Branford silt loam;
- Pootatuck fine sandy loam;
- Wilbraham and Menlo soils;
- And Wilbraham silt loams.

6.3 NDDB and Critical Habitat

Connecticut's Natural Diversity Database (NDDB) and mapping indicates that no rare, threatened, endangered, or special concern species occur on this property. There are multiple instances of known NDDB bubbles to the east and northeast in the Cockaponset State Forest. Some Critical Habitats are also

[4] Drumlins are "spoon-shaped" rounded hills with a north-south orientation. These are the result of historical glaciers retreating from the landscape. They are typically indicative of productive and fertile soils.

[5] Soils information comes from USDA. This information is based on long-running soil surveys conducted on public and private lands across the nation. For more information see https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

nearby, such as acidic rocky summit outcrop in the east and south and floodplain forest in the west but none are mapped as present on the property.

7 ECOLOGICAL CONDITIONS

The property hosts several ecological communities commonly found in Connecticut such as oak-hickory forest, mixed hardwood upland forest, forested wetlands, bands of riparian forest, and the vernal pool. Though some important communities are absent (notably the presence of large amounts of softwood, young forest, and old forest conditions), the existing moderate diversity of ecological communities on the property provides a good foundation to build on in achieving the goals of the landowner.

7.1 Forest Health

In general, forest health throughout this property is good. The most important health issues noted on the property include populations of invasive plant species scattered throughout the understory, and the presence of various diseases and non-native insect pests. Minimal amounts of erosion on trails is also occurring though no impacts to watercourses appear to have occurred. Some tip-ups/blowdowns of trees have also occurred from wind events. Though this phenomenon is a natural (and important) part of the development of forests, in places it has allowed the development of invasive plants and has had an impact on the longevity of the blown down trees. Tree health and vigor throughout the property is relatively uniform with most trees expressing large crowns, growing to tall heights, and occupying ample space in the canopy (i.e., low rates of competition and crown closure among most individuals). There are some areas (i.e., northern and southern portion of 2a and parts of 2d) where rates of crown competition amongst certain trees are higher, mainly due to a higher proportion of black birch in the canopy. Additionally, areas outside of Stand 4 have less diverse rates of regeneration due to closed canopy conditions and instead are mainly composed of mesic species, black birch and red maple, that will eventually make up the future forest here. Over time this can reduce the ecological value these areas can provide to wildlife in the area.

Insect and Disease

Information in this section is provided as a list with detailed commentary in the “notes” column. More information regarding the life cycle and history of populations in the United States of specific pest agents is provided in the “Insect and Disease” section of the appendix. Additionally, more specific information regarding infestations on the property is provided in the “Forest Health” section of each stand description in Section 9.

It is important to note that the forest management plan inventory process provides a snapshot of forest conditions but does not provide a full phenological picture of the property. That said, some forest pests will be either undetectable or in life stages which make detecting the true scale of abundance on the property difficult depending on when forest inventory visits occurred. Vigilant information gathering and regular monitoring of a forest stand is the best approach to early detection of forest stressors, which in turn is the best chance of mitigating the stressors’ impact.

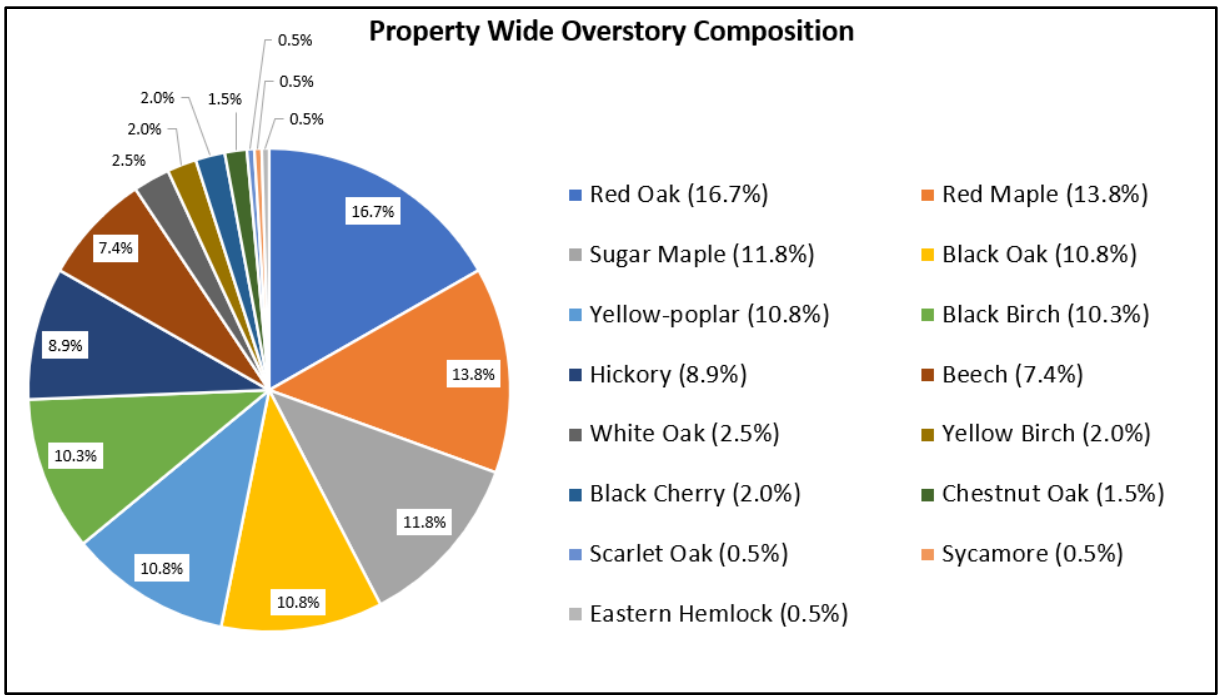
Insect Pest	Status	Notes
Elongate Hemlock Scale (EHS)	Present in all hemlock.	Observed on all hemlock within the property.
Emerald Ash Borer (EAB)	Historically[6] was present on the property, current population unknown.	No standing live ash were noted. Multiple (dead) standing and downed individuals scattered throughout the property. Widescale mortality occurred from 2017-2020.
Hemlock Woolly Adelgid (HWA)	Present in all hemlock.	Observed on all hemlock within the property.
Spongy moth	Historically[7] was present on the property, current population unknown.	Many standing snags and downed individuals (mostly oak) scattered throughout the property. Widescale mortality occurred from 2017-2018.

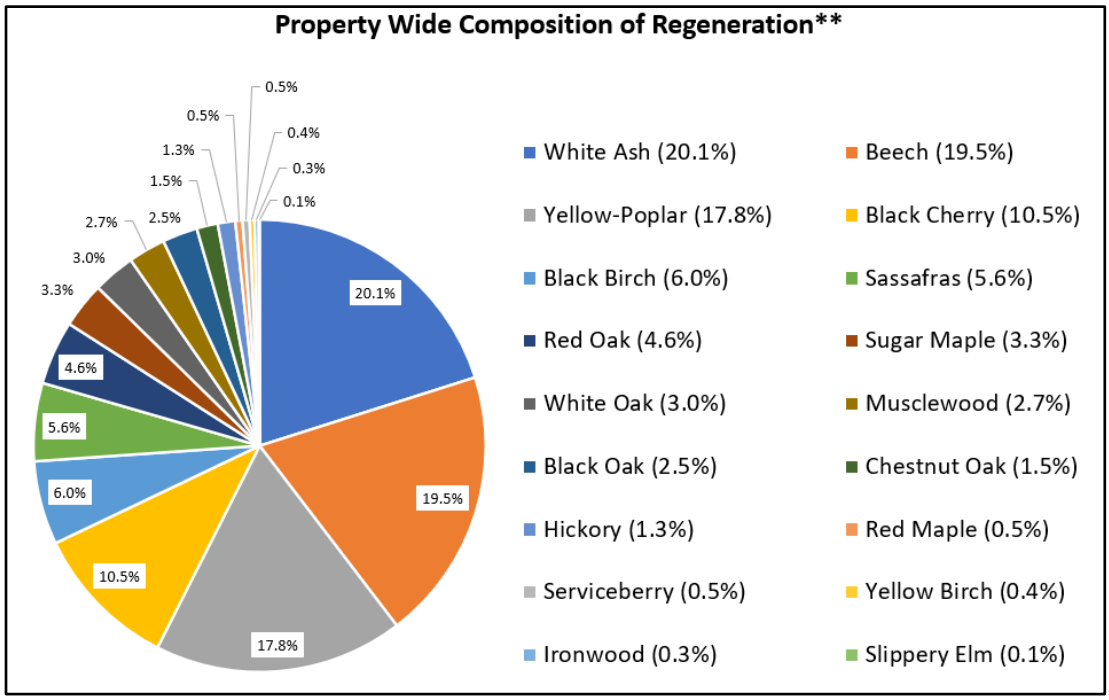
Disease Species	Status	Notes
Beech Bark Disease (BBD)	Low – Moderate Level infestation	BBD is widespread throughout the property on most but not all dominant and co-dominant beech, some beech mortality as a likely result of BBD was noted.
Beech Leaf Disease (BLD)	Severe impacts	Hindering photosynthetic response of beech in all strata. Adding additional stressors which is concerning for the future of beech across the landscape and on a regional scale.
Nectria Canker	Moderately severe impacts	Noted in black and yellow birch. Likely caused mortality of both species in some areas. Many black birch still persisting despite infection. Common amongst areas where black birch is dominant in the overstory.

[6] First detected in 2017 during the initial stages of log removal during the forest management project in Stand 4

[7] Significant damage and mortality of populations of oak trees occurred in 2017-2018 following the completion of initial phase of the forest management project in Stand 4. Individuals and groups of red, white, and black oaks were killed in Stand 4 and elsewhere on the property following an infestation of spongy moth combined with drought conditions in 2017. This led CFPA to complete a second entry removing some of the spongy-moth killed oak.

Regeneration and Resource Allocation





Property wide composition of regeneration is made up of both seedlings ***and* saplings from quantitative data.

Property Wide Overstory	
Species	% Composition
Red Oak	16.7%
Red Maple	13.8%
Sugar Maple	11.8%
Black Oak	10.8%
Yellow-poplar	10.8%
Black Birch	10.3%
Hickory	8.9%
Beech	7.4%
White Oak	2.5%
Yellow Birch	2.0%
Black Cherry	2.0%
Chestnut Oak	1.5%
Scarlet Oak	0.5%
Sycamore	0.5%
Eastern Hemlock	0.5%

Property Wide Regeneration	
Species	% Composition
White Ash	20.1%
Beech	19.5%
Yellow-Poplar	17.8%
Black Cherry	10.5%
Black Birch	6.0%
Sassafras	5.6%
Red Oak	4.6%
Sugar Maple	3.3%
White Oak	3.0%
Musclewood	2.7%
Black Oak	2.5%
Chestnut Oak	1.5%
Hickory	1.3%
Red Maple	0.5%
Serviceberry	0.5%
Yellow Birch	0.4%
Ironwood	0.3%
Slippery Elm	0.1%

Overall, forest regeneration appears relatively diverse in large part due to the treatments that occurred in Stand 4. Regeneration outside of the treatment area is much less diverse and contains more mesic shade tolerant species like red maple, beech, and black birch. Most oak regeneration is found in places where small gaps in the overstory (typically a result of treatments in Stand 4, and oak, beech, or ash mortality) have allowed enough light to reach the forest floor for regeneration to become established. The exception to this is within Stand 4 where the last timber harvest occurred which is where the most dense regeneration of yellow-poplar, ash, black cherry, hickory and some oak exists. However, in these areas there are some species with less palatability to deer such as black birch that have made it past deer browse height and are now overtopping more desirable species below (i.e., oak, black cherry, and hickory) in the sapling and seedling size class.

Treatments to release desirable regeneration should occur where it makes sense to do so based on other forest characteristics including the species composition and condition of surrounding overstory trees. Treatments to encourage the establishment of desirable regeneration should also be performed in some areas that currently lack regeneration to enhance the resilience and structural complexity of those areas. Careful tending and “weeding” around desirable species in the understory and midstory of Stand 4 would be effective in enhancing growing conditions for these individuals. More detail on stand management recommendations can be found in ‘*Stand Level Details and Recommendations*’ (Section 9).

Beech makes up a large percentage of regeneration (19.5%) and is well distributed property-wide. This is due to its high levels of shade tolerance and the fact that deer typically don’t browse it. Another factor that could lead to high rates of beech regeneration is the impacts of BBD which may be creating the dense resprouting conditions from the stressed beech in the overstory and midstory. In general, rates of regeneration and relative diversity of regeneration are low outside of Stand 4 due to the closed canopy conditions found in the other forested portions of the property.

Despite the fair amounts of regeneration present on the property, there are no large patches of young forest (i.e., areas between 0-15 years old). In addition, though oak regeneration is present in places, it is

not present in sufficient numbers (11.6% of observed regeneration) to replace existing oaks present in the overstory (currently occupying approximately 32% of the overstory trees) as they die over time. In the absence of natural or anthropogenic disturbance, oak is likely to remain stagnant where it is established and will continue to decline in terms of its presence on the property over time. In most of the stands on the property targeted treatments to increase understory tree density and species diversity are appropriate. Young forest conditions are still present in Cockaponset State Forest just east of the property but will soon age out of utility for species that require this stage of forest development for their habitat.

One red oak was cored was cored in the eastern portion of Stand 1 and is estimated to be 110 years old +/- 5 years. An additional black oak was cored in the southern-central portion of Stand 2 and it is estimated that this tree is 100 years old +/- 5 years. Based on cut oak (exact species unknown) stumps observed in Stand 4 the stump is estimated to be 80-90 years old when it was cut eight years ago.

Deer browse is significantly impacting the structure of the young age class of trees establishing across the property. Deer sign is present in nearly all portions of the property and browse on seedlings and other vegetation is ubiquitous with signs of deer occupancy. During the inventory in the winter of 2026, multiple deer tracks, scat, and visual signs of browse on select seedlings were observed throughout the forest. Deer browse could also be a contributing factor to oak regeneration being stagnant in the understory in some places.

Invasive Plants

Populations of invasive plants in forested areas are low to moderate and are irregularly distributed across the property. The areas with the most significant populations of invasive species typically are those where gaps in the canopy have naturally occurred over time (i.e., blowdowns from high wind events, mortality from diseases like *Nectria* canker or BBD, spongy moth, and EAB) and in wet areas and along the drainages/watercourses as well as along Bear Rock Road.

In some areas with blowdowns, or other disturbances (such as those listed above) that have created canopy gaps, there are significant populations of invasive species that are apparently increasing in size over time. These conditions are present in the northern block of Stand 2a in the northern portion of the property, and in the southwestern corner of the property in Stand 2b. Invasive plants, specifically wineberry and multiflora rose, are growing densely in the understory in these areas of the property and preventing native vegetation, including tree regeneration, from establishing. Without intervention these portions of the property are at risk of expanding and creating invasive dominated conditions which provide minimal ecological utility, very low resilience, and no potential for carbon accumulation compared to any native ecosystem which would alternatively occupy the growing space.

Japanese barberry and stiltgrass, burning bush, multiflora rose, garlic mustard, Japanese maple (tree), wineberry, Asiatic bittersweet, Japanese knotweed, and potentially more[8] were all noted on the property.

Wildfire Risk and Prescribed Fire

[8] The majority of the forest inventory occurred during the winter of 2026 when 6-8 inches of snow were on the ground, hindering observation of more herbaceous invasives such as garlic mustard and stiltgrass, which is why they are not on the map in section 4.7.

The impacts of wildfire played a minimal role in the development of the forested stands on the property. This assertion is based on overall tree species composition (abundant – maple, birch, and yellow-poplar – dominant overstory conditions) and a lack of an oak dominant canopy across the property[9]. Prescribed fire would likely be effective in regenerating fire-adapted species like oak and hickory. Small scale ground fire would likely alter the dynamics of the understory in some places on the property, which is currently made up of exclusively spicebush in certain areas and the thin barked, fire-susceptible black birch and beech in other, more upland areas. Small-scale prescribed fire could aid in scarifying the soil and would likely result in encouraging oak and other fire-adapted tree species to regenerate, as well as a potential increase in wildflowers and other herbaceous native plant species.

7.2 Fish, Wildlife, and Biodiversity

Structure and Composition

The current forest conditions on this property accommodate a variety of wildlife species but are limited for species that require a few conditions: young forest, open upland areas, softwood dominated forest, and old-growth structure (multi-aged forest with abundant standing snags and downed woody material) are some of the habitat conditions that are generally absent or in limited supply on the property. That said, the mix of forest cover types and water features on the property all combine to provide a great starting point for habitat diversity.

Sawtimber-sized trees, from small to large[10], make up most of the basal area of this property with large numbers of poletimber-sized[11] trees and some saplings growing between and beneath them. There are some areas in which seedlings and saplings[12] grow densely (Stand 4 post-harvest). With the exception of the regenerating forest at Cockaponset, based on aerial photo interpretation, much of the forest cover adjacent to and surrounding this property generally contains similar size classes and mixes of species or is non-forest (farmland and/or pasture to the east and private residential dwellings to the south). There appears to be a greater concentration of softwoods to the east about ¼ to ½ mile from the property within the Cockaponset State Forest (see "Landscape Context" map in Section 4.13). The softwood cover on the east side of Bear Rock Road is disproportionately beneficial for its size compared to the hardwood stands surrounding it because some species of wildlife prefer or require forests with some softwood component which allows them to meet certain habitat requirements. Small softwood inclusions can facilitate such species like Eastern Screech Owl, pine warbler, brown creeper, porcupine and others, to occupy the site when they otherwise would not.

Snags, Cavities, and Down Woody Material

[9] Oak is fire-adapted and responds well to burning. Some oak and hickory forest types regenerated from small scale fires in certain areas of the state following agricultural abandonment of the land by early European settlers and demise of the American Chestnut tree.

[10] For the purposes of this plan, small sawtimber-sized trees range from 12-16 inches dbh. Medium diameter is 16-20 inches and large is 20 inches plus.

[11] Poletimber sized trees range from 5-11 inches dbh

[12] Seedlings are trees less than 4.5 ft. tall. Saplings are trees that are over 4.5 ft. tall but are 5 inches dbh or smaller. For the quantitative data represented in this plan, seedlings were only counted if they are greater than 6 inches tall, though qualitative observations were made for all the regeneration irrespective of height.

Current volumes of standing and downed woody material is not adequate for providing the range of benefits mentioned above. Standing and downed woody material is much more abundant in areas where ash was established, and many areas of the property have very limited coarse woody material (CWM) and fine woody material (FWM)[13] on the forest floor. Where CWM and snags are present, they are locally similar in size and stage of decay because of the events (windthrow or mortality from EAB or spongy moth) that killed them. More diverse pools of standing snags and downed woody material provide greater benefits to wildlife. Very well decayed CWM that could act as a substrate for establishment of some tree species (eastern white pine, hemlock, black and yellow birch, red maple, etc.) are infrequent. To improve this condition recommendations regarding the retention and recruitment of woody material are found in Section 9. General guidelines which are considered for these recommendations are below:

General management guidelines for coarse woody material (CWM)

1. Larger pieces of CWM are more valuable than smaller pieces.
2. CWM scattered across a site is more valuable than if it is concentrated (with some piles).
3. It is important to maintain a full range of CWM decay classes (from hard to crumbling).
4. Coniferous CWM is generally longer lasting than wood from deciduous trees.
5. For long-term management, consider the distribution and quantity of future CWM sources, including retention of snags and cavity trees where safety is not an immediate concern.

Forage Dynamics

Currently, valuable hard mast producing trees (especially oak and hickory) play a major role in many stands on this property. Hickory is locally dominant in certain places in Field Forest. One other source of hard mast is American beech, although it tends to be less productive in nut production in southern New England compared to the production value associated with this species in northern New England.

Soft mast producing species including sassafras, wild grape, blackberry, mapleleaf viburnum, raspberry, spicebush, and some invasive plants are present in various places throughout the property. In tree form there is also large diameter black cherry present on the property. Spicebush is present on the property in abundance within the understory and into the midstory in some places. This includes (but is by no means limited to) the northern portion of Stand 4 within which many of the spicebush were cut during the 2016-2018 management activities to facilitate access. Those individuals sprouted vigorously and now grow as densely or more than prior to 2016. This shrub is also a host plant for the spicebush swallowtail butterfly. Some soft mast invasive species are present as well, such as Japanese barberry and wineberry though the value of their flowers and fruits are limited compared to native species.

There is a moderate number of pollinator friendly plants such as mapleleaf viburnum, raspberry, blackberry, spicebush, white wood aster, heath, swamp dewberry, skunk cabbage, jack-in-the-pulpit, trout lily, wood anemone, violets, white rattlesnake root, dwarf ginseng, red trillium, azure bluet, Solomon's seal (smooth and false), among others, present in the understory throughout the property. Beneficial pollinator trees present include yellow-poplar, maples (sugar and red), black cherry, oaks, and

[13] For the purposes of this plan, coarse woody material are those pieces of downed wood that are greater than 4 inches in diameter; fine woody material is composed of the twigs, branches, and other tree top sections that are less than 4 inches in diameter.

sassafras. For more information about managing forests with pollinators and other insects in mind, see this document created by Xerces Society.

7.3 Carbon Cycle Dynamics

This property has not historically been managed explicitly for carbon sequestration or storage. The recommendations within this plan are likely to increase long-term carbon sequestration and storage, both on the property and within the durable forest products that will ideally be generated through forest management activities. This will be accomplished by maintaining much of the carbon stored currently on the property (in trees and soils) and by increasing carbon sequestration rates through the removal of invasive plants and establishment and/or release of native tree regeneration and retained mature trees that will sequester carbon more effectively and store it for longer. Limiting unnecessary soil disturbance can help retain the carbon stored in soils.

Though not as prolific as the storage in trees and soils it is important to recognize that long-lived forest products store carbon as well as serving human needs. Durable, long-lasting wood products continue to store carbon in their fibers while live trees retained in the forest can increase their rates of carbon uptake and storage due to increased resource availability, primarily sunlight.

Storage

Carbon is being stored in tree species like oaks, yellow-poplar, hickory, sugar maple, beech, and more. Some of the most dominant trees in certain places can also be the longest-lived species (i.e., oaks, hickory, and sugar maple) given ideal growing conditions. These species have the ability to live for centuries, allowing them to store carbon for long periods of time. Outside of Stand 4 (post-harvest) there is a limited amount of downed woody material of various size and decay classes across the property. Areas where ash, oak, beech, or birch mortality has historically occurred typically have more standing woody material which is still storing carbon before they fall to the ground and begin to decompose. Even after falling much of the stored carbon is retained on site as it returns to the soil as the wood decomposes, though some of it is released back into the atmosphere.

Sequestration

Sequestration rates are likely higher in Stand 4 due to the recent forest management activities that occurred there which has increased the growing space around retained trees. The dense influx of tree regeneration growing beneath the retained trees is also sequestering carbon quickly. Rates of sequestration would likely be lower in other parts of the property due to dense overstory conditions and lower rates of regeneration in the understory and midstory. Invasives present in certain areas on the property are currently occupying growing space that native vegetation and trees could be utilizing, reducing overall sequestration rates and current long-term storage potential. Overstory trees in parts of the property that have had trees blowdown nearby or are near instances of overstory mortality events likely have increased sequestration rates due to a slight increase in growing space within the canopy.

8 FOREST MANAGEMENT

Field Forest is fully stocked[14] throughout all of the forested stands described in this plan. Active management in the central portion of the property (Stand 4) has resulted in a diverse mixture of shade tolerant and shade mid-tolerant species regenerating below retained trees. Other stands (specifically Stands 1 and 2) that historically have experienced limited or no active management mainly have shade tolerant tree species regenerating in the understory and midstory. Moving forward, in accessible portions of the property where active management is appropriate, both even and uneven-aged forest management techniques should be practiced. This mix of approaches is representative of how natural agents of disturbance impact the landscape.

Oaks are extremely ecologically valuable and currently play a major role in many parts of the forest on this property. The long-term presence of oak in our forests is critical for many reasons (some of which are discussed in the Wildlife Habitat and Biodiversity Section of this plan), but overall oak is declining both on the property and regionally. Where feasible, successfully regenerating oak over time in parts of this property can help to ensure the long-term sustainability and productivity of the forest. As Tom Worthley (Associate Extension Professor in Forestry from the University of Connecticut) would say, "If we want people 100 years from now to be able to experience 100-year-old oak trees, we have to start today with a seedling." Details regarding silvicultural recommendations can be found in Section 9.

The long-term presence of softwood, especially eastern hemlock, is another factor in considering management of this property. Hemlock are important for cover and forage, especially for birds and deer. Encouraging hemlock regeneration addresses the relatively low amounts of softwood cover currently growing in the region. Promoting multiple age classes of hemlock, including regenerating young hemlock, improves the likelihood of retaining beneficial softwood cover for following generations of humans and wildlife.

It is not the intent of this management plan to create a scenario in which all of the acreage in this plan receives some treatment. The entire property should be cared for and monitored, but not everywhere is appropriate for active management. Specifically, portions of Stands 2 could be set aside as permanent reserves. This will be addressed further in the stand description and recommendation for this and other stands.

8.1 Recreation and Aesthetics

There are about 2.2 total miles of trails within the Field Forest property. Per the CFPA the trails within the property are open to hiking only[15]. Hunting is also allowed on the property but by special permit only. Field Forest has an extensive aesthetic benefit to the surrounding landscape, with towering hardwoods,

[14] Stocking refers to the relative density of how much of the available growing space in an area is occupied by trees. In this case, fully stocked means that all the available growing space is currently occupied which results in mostly closed canopy conditions. In essence this means there are trees growing densely in the upper canopy in close proximity to each other with limited growing space amongst their crowns frequently resulting in high amounts of intertree competition for space and light, and a lack of available sunlight in the understory.

[15] https://ctwoodlands.org/trails/field-forest-trails/

forested wetlands, multiple intermittent streams, and one vernal pool for visitors of the property to view and appreciate.

8.2 Forest Products

The sale of sustainably produced forest products is not a goal of the CFPA at this time, but it can be a useful byproduct of treatments prescribed in certain areas and as an opportunity to stimulate the local economy. That said revenue may be generated as a result of implementation of some recommendations in Section 9. Specifically, recommendations in Stands 1 and 2 have potential to generate income. Revenue from the sale of timber as a result of implementing stewardship activities can be used to fund non-commercial treatments on the property, improvements to trail infrastructure, and for potential educational opportunities that may interest the association (i.e., new signage in certain places).

8.3 Access

Field Forest can be accessed by the two trailheads/small parking areas that are located on Bear Rock Road in the east. From here the trails are easily accessible on foot. Visitors to the forest can access the various forested areas by utilizing the blue, blue-yellow, blue-white, and blue-red trails. Another parking area is present in the northwestern corner of the property near Coginchaug Regional High School, which provides direct access to the blue and blue-white trail. Access with equipment to the northern portion of the property is feasible due to the existing woods roads and skid trails from past management activities. The far southern portion of the property is harder to access with equipment due to the steep terrain found there.

8.4 Reforestation Opportunities

The entirety of the property is currently forested. No additional opportunities for reforestation are recommended at this time.

8.5 Summary of Silvicultural Objectives

- Reduction in seed-bearing black birch property-wide due to it's susceptibility to *Nectria* canker and its tendency to outcompete more ecologically and economically valuable native species.
- Create free-to-grow conditions for desirable regeneration in parts of the understory.
- Enhanced growing conditions for softwoods on the property to help combat invasive pests (HWA and elongate scale).
- Increased rates of regeneration for climate adapted species (oak and hickory).
- Create variably sized canopy gaps in certain stands to diversify tree species, age and size class, enhance spatial conditions, and increase structural complexity in all strata.

8.6 Management Design and Mitigation

- Retain at least 50% canopy closure adjacent to wetlands, streams, and vernal pools unless doing so will both advance another important goal and will not permanently/significantly impact site hydrology.
- Retain existing snags and downed woody material on site unless removal or transport is necessary to facilitate access
- Minimize skid trail distances and avoid water crossings except as absolutely necessary.
- Leave tops and slash on site for both nutrient cycling and wildlife habitat. Use some tops and slash to create brush piles.
- Leave all snags, where not a safety concern, for wildlife habitat.

- Avoid disturbance to stonewalls and other historic features as much as possible.
- Require any harvest equipment to be pressure washed and thoroughly dried before being brought onto the property to reduce the risk of additional invasive seeds being transported into the forest.
- Any seed mix used to stabilize soils or skid trails must be certified invasive-free and should be composed of native (or at least non-invasive) plants. Where mulching is necessary use invasive-free straw as opposed to hay mulch to cover seed until successful germination can occur.
- Follow all Connecticut Best Management Practices not covered above to maintain water quality and soil stability. Published BMPs should be viewed as a minimum requirement and actual measures taken to protect water and soil resources will likely exceed legal requirements.

8.7 Resource Concerns

Degraded Plant Condition

- Lack of size class diversity in some places caused by complete canopy closure.
- Lack of shade intolerant and mid-tolerant regeneration caused by near complete canopy closure throughout most of the forested areas.
- Lack of shade mid-tolerant free-to-grow seedling regeneration in some places.
- Dense invasive plants inhibiting growth of tree regeneration and native understory and wetland vegetation in places.

Plant Pest Pressure

- Emerald ash borer (historical mortality)
- Spongy moth (historical mortality)
- Beech leaf disease and BBD impacting beech.
- HWA and elongate scale impacting hemlock.

Terrestrial Habitat for Wildlife and Invertebrates

- Lack of early successional habitat.
- Suspected low productivity (lack of flowers and fruit) of existing shrubs due to shade from complete canopy closure.

Aquatic Habitat for Fish and Other Organisms

- Some invasive cover along riparian buffers provides monogenous, simple cover for both terrestrial species and aquatic species which use shaded cover and structure on the margins.

9 STAND LEVEL DETAILS AND RECOMMENDATIONS

Field Forest Stands

Stand	Description	Acreage
1	Even-age mixed hardwood sawtimber	26.4
2	Even-age oak and yellow-poplar sawtimber	81.9
3	Forested Wetland	6.4
4	Two-aged oak and yellow-poplar sawtimber	38.6
	Total Acreage	**153.3**

Stand 1

Acreage – 26.4

Forest Type – Even-age mixed hardwood sawtimber

Estimated Age – 90-100 years

Estimated Canopy Height – 70-80 feet

Site Index – 55

Index Species – sugar maple

Stocking – fully stocked (NE-195)

Soils – Wethersfield loam, Ludlow silt loam, and Branford silt loams.

Dominant and Codominant Trees – Sugar maple, yellow-poplar, oak (red and white), beech, red maple, black birch, sycamore

Current Stand Dynamics –

	BA/acre**	BA/acre AGS**	Trees/acre**	Trees/acre AGS**	Volume/acre (MBF)	Volume/acre AGS (MBF)	CD/Acre	CD/Acre AGS
Seedlings			750					
Saplings			50					
Sawtimber trees	87	57	60	32	1.1	1.0	3.8	1.6
Poletimber trees	10	0	24	0			0.8	0.0
Snags	20		11					
Total	97	57	84	32			4.7	1.6
MSD*	14.5							

*Quadratic Mean Stand Diameter

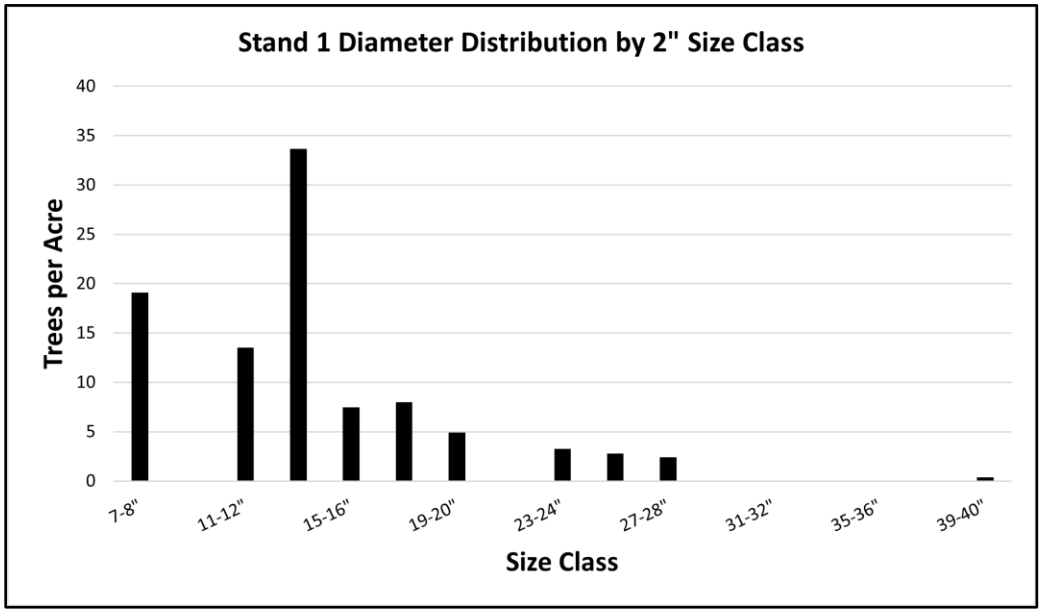
** Total per acre BA and trees values include live sawtimber and poletimber-sized trees only

MBF= Thousand board feet; CD=Cord (firewood)

BA= Basal area and is given in square ft./acre

Species	SqFt./acre	% Composition
Red Maple	23	24.1%
Sugar Maple	23	24.1%
Yellow-Poplar	20	20.7%
Beech	17	17.2%
Black Birch	7	6.9%
Red Oak	3	3.4%
Sycamore	3	3.4%
Total	**97**	

Species	Trees Per Acre	% Composition
Sugar Maple	28	33.6%
Red Maple	27	32.4%
Beech	13	15.5%
Black Birch	7	8.0%
Yellow-Poplar	5	5.5%
Red Oak	3	3.7%
Sycamore	1	1.3%
Total	**84**	



Forest Health – Healthwise, Stand 1 is in good condition. Individual tree health varies but most trees are healthy throughout the stand, with full crowns and relatively clean main stems. Oak, beech, and ash mortality has occurred in various parts of this stand. Oak mortality likely occurred as a result of historical spongy moth infestations in 2018. Beech most likely perished in this stand from BBD infection which can cause the trunk of the beech tree to weaken and eventually snap from ice or wind storms. Ash mortality has occurred in this stand as a direct result of historical EAB infestation in the recent past.

Invasive plants are established in various places within the understory. They are not established in any one spot at a high density but instead occur as lone individuals throughout Stand 1. Without preparatory treatments the invasives established here have the potential to spread further throughout the stand if natural disturbances create more gaps in the canopy over time.

There is a lone individual hemlock in the midstory in the eastern portion of the stand. Similar to other hemlock found in the area it is infested with HWA and the elongate scale. Cold winters like the winter of 2025-2026 can reduce populations of HWA over time due to the decline they can experience during these cold snaps (i.e., extended periods of time with temperatures below freezing). The hemlock here was persisting in fair health even with the current infestation rates.

Rates of deer browse are apparently moderate in Stand 1 due to stagnation of oak seedlings in the understory in some places and visual browse impacts on said regeneration. Deer tracks and scat are also evident throughout the stand and were easily seen in the snow.

Beech is being impacted in all strata by BLD. BBD was mainly seen on larger diameter individuals.

Primary Concerns

- Potential future impacts of invasive plant or insect/disease stressors.
- Lack of free-to-grow seedlings.

Other Concerns

- Native understory diversity is lacking and is made up mainly of spicebush.
- Single even-age class throughout.
- Lack of multiple age classes.

Strengths

- Overstory diversity, presence of large diameter individuals (producers).
- Moist fertile soils evidenced by high populations of sugar maple and some understory vegetation.
- Presence of sycamore (aesthetics) and hemlock in midstory in a hardwood dominant stand.
- Some established oak regeneration (mainly white oak seedlings).

Tree Growth Potential – Stand 1 has high potential for growing high quality well-formed individuals. This is evident based on visual observations of trees in the area. Multiple maples (red and sugar) and other hardwoods with clean trunks and straight form are growing tall and vigorously throughout the stand.

Regeneration – Rates and diversity of regeneration are relatively low throughout Stand 1. This is mainly due to the closed canopy conditions found within this stand and the moderately dense spicebush in the understory present here. Although white oak represents 55.6% of observed seedling regeneration within this stand, it is not uniformly distributed throughout the understory of the stand and instead occurs in dense patches underneath historical oak and/or ash mortality. These small openings in the canopy have allowed enough sunlight to reach the forest floor and establish said oak regeneration. Regeneration like this is likely to be lost over time without external disturbance or tending from interested peoples.

Sugar maple and black cherry are the other two most common species regenerating in the seedling size class (both are 22.2% of regeneration) behind white oak. It was not evidently apparent but both of these species are likely being browsed by deer to some extent as well. Beech makes up 40% of observed sapling regeneration but it is also not uniformly distributed throughout the stand and it typically occurs near larger beech dominant in the overstory. Sugar maple saplings are present in multiple places throughout Stand 1 in the midstory, and they are currently poised well to regenerate into the overstory if conditions allow for this to occur.

Species	Seedlings Per Acre	% Composition
White Oak	417	55.6%
Sugar Maple	167	22.2%
Black Cherry	167	22.2%
Total	**750**	

Species	Saplings Per Acre	% Composition
Beech	20	40.0%
Sugar Maple	20	40.0%
Black Birch	5	10.0%
Red Maple	5	10.0%
Total	**50**	

Understory Vegetation[16] **–** Species noted in the understory of Stand 1 include spicebush, mapleleaf viburnum, wild grape, brambles (raspberry, blackberry), among others.

Species listed from the 2014 Field Forest FSP include Christmas fern and trout lily, which both are further indicators of site enrichment.

Topography – Stand 1 slopes towards the north-northeast. The highest points of elevation in this stand are present in the southeastern portion of the stand. Geological features are limited throughout and topographically this stand is relatively simple.

Wildlife Habitat Opportunities – Stand 1 provides quality wildlife habitat for generalist species that depend on closed canopy hardwood forests. Where hemlock occurs in some places within the midstory it is apparent that the cover and thermoregulation provided by this softwood is being used by deer and potentially other species for bedding and/or resting. The variation in structure this softwood component provides to an otherwise hardwood dominant stand is beneficial for a suite of birds and other wildlife. Throughout much of the stand there is relatively dense understory and midstory coverage from spicebush. This shrub is the host plant of the spicebush swallowtail butterfly. It is an abundant source of soft mast, nectar, and pollen as well.

A diverse range of snags are present in Stand 1 from historical mortality events. This includes but is not limited to oak, beech, ash, and birch snags. Live excavations were noted in many snags and they are irregularly distributed throughout the stand. Sugar maples are abundant in Stand 1. The sap from these trees is an essential source of carbohydrates for bird species such as the yellow-bellied sapsucker and historically for humans as maple syrup. As the sapsucker creates holes in the sugar maples, sap will quickly ooze out creating an ideal sap food source for squirrels, porcupines, hummingbirds, and a suite of insects. Hard mast is in relative abundance throughout from dominant and co-dominant overstory red oak and beech, although beech is not as productive/important of a hard mast source in southern NE as it is in Northern NE. Red oak acorns are a vital source of hard mast as well but are preferentially consumed after more ideal sources of hard mast (i.e., white oak acorns) are gone.

Spicebush is the main source of soft mast in Stand 1. The small red drupes[17] are consumed by a suite of bird species. These fruits are high in fat and typically are consumed quickly. Wild grape is an additional source of soft mast in this stand and it is an essential source of quick energy for bird species embarking

[16] Understory vegetation information regarding herbaceous species is relatively limited for all stands from the recent inventory due to the majority of it taking place during the winter of 2026 (6-8 inches of snow on the ground).

[17] A type of fruit in which an outer fleshy part (exocarp, or skin, and mesocarp, or flesh) surrounds a single shell.

on fall migrations since the fruit is typically ripe at that time. Trout lily is beneficial to pollinators in the area when this spring ephemeral wildflower is in bloom. Intermittent streams in Stand 1 provide a source of fresh drinking water for wildlife although they are not consistently filled with water throughout the year.

Invasive Plants – Invasive plants are established in this stand at a low density. Lone individual Japanese barberry, burning bush, and multiflora rose are present in the eastern portion of the stand. Without treatment these plants may one day expand their population further into the forested regions of this stand if there is an increase in natural disturbance in the canopy.

Hydrologic Features – Two intermittent drainages are present in the eastern portion of Stand 1.

Management History – According to aerial imagery from 1934, this stand was mostly forested at that time. Stand 1 likely reforested following agricultural abandonment of some form in the early 1900s. Active agriculture was prevalent at that point in some parts of the property and much of the surrounding land. Farmland in the east from 1934 imagery has now been turned into residential properties. As of the writing of the last management plan in 2014, a local maple syrup producer had been tapping a 6-acre portion of the land here. XXX

Landowner Objectives –

- Reduced invasive plant populations.
- Maintained ecological characteristics and values.
- Enhanced growing conditions for established desirable regeneration.
- Long term presence and enhanced growing conditions of softwood population.
- Increased growing space around the most vigorous hard mast producing trees and underrepresented species within the stand (i.e., oak and hickory).
- Diverse native understory vegetation, shrubs, and tree regeneration (additional age class).
- Increased population of pollinator producing plants.

Desired Future Conditions – A diverse range of native hardwood tree species in the overstory with a younger age class regenerating below them. Varied shrub layer and herbaceous layer with an increase in both fruiting and pollinator plant species. Established regeneration of the most beneficial hard mast tree species (oak and hickory) past deer browse height, allowing them to grow into the midstory and beyond over time.

Recommendations

2027-2029 – Treat invasives throughout the stand.

2030 [light thinning] – Reduce overall stand BA to 60-70 ft./acre by focusing removal on species with highest abundance throughout the stand. This includes black birch, sugar maple, yellow-poplar, and red maples that exhibit poor form or small crown size. Retain the most vigorous and structurally diverse (i.e., large crowns, cavities, clean main trunk, or unique bark characteristics) trees that are beneficial to a suite of wildlife such as oaks, hickories, yellow birch, and black cherry. Focus retention on some of the largest well-formed trees that visitors to the forest can enjoy and appreciate such as sugar maple for its showy colorful fall leaves, sycamore for its unique camouflage bark, and yellow-poplar for its towering dominant

nature and size. This treatment can also increase residual growth rates for the retained trees and allow them to sequester increased rates of carbon over time.

Cut trees around hemlock wherever it occurs in the midstory to increase its photosynthetic response. Enhanced growing conditions and space around the hemlock can help to maintain this species in the midstory and aid in its defense against infestation from both the HWA and HES.

[gap expansion] – Utilize historical mortality of oak, beech, birch or ash as anchor points to expand on canopy gaps. This would likely release established oak regeneration in the understory since most of it in Stand 1 currently occurs below said mortality. Trees with little to no commercial value (i.e., excessive rot, *Nectria*, or poor form) can be cut and retained on site to increase amounts of CWM and/or FWM throughout the stand. Tops of felled trees should be strategically placed over established regeneration if feasible to reduce the likelihood of deer browse.

Retain some standing snags of oak and ash. These are quality wildlife habitat features and are important for a suite of wildlife such as birds, insects, and mammals. Great care must be taken in retention of these individuals to ensure that they will not be hazardous to hikers and other visitors to the forest over time. Maintain adequate buffers from the vernal pool that extends into the southern portion of the stand.

Due to volumes to be removed, this treatment is likely to be non-commercial. However, if the work is done in conjunction with treatments prescribed for Stand 2, it has the potential to be marginally commercially viable.

Ongoing [deer exclosure] – There is a dense pocket of mainly white oak seedling regeneration near the eastern roadside boundary along Bear Rock road just north of the trailhead/parking area. Fence in this regeneration in attempts to prevent future deer browse and allow the established regeneration to grow up past deer browse height (typically 6-7 feet). Over time monitor the fencing to ensure no tree branches or trees fall onto it and allow deer or other wildlife to enter the area. Erect signage to explain the purpose of the exclosure and to help inform visitors to the forest of the importance of protecting species such as oak from deer browse. A similar approach can be taken to prevent deer browse throughout the stand if excessive deer browse is noted on other established and dense desirable regeneration over time.

Cut back some spice bush along the blue-red trail to increase visibility of the trail. This would likely increase the diversity of the herbaceous layer along the trail as well, and potentially enhance diversity of flowering native plants, and sedges/grasses.

Replace the rotting roof structure on top of the kiosk at the northern trailhead/parking area. Monitor for new populations of invasive species post treatment, re-treating as needed.

No-Action Alternative – Invasive species may increase in population size if not treated in a timely manner. In addition, if more gaps are created in the canopy from natural disturbance invasives will spread further throughout the stand, limiting regeneration of native trees and understory vegetation. Desirable regeneration present in this stand such as oak is likely to remain stagnant in the understory without careful tending and external disturbance (natural or anthropogenic).

Stand 2

Acreage – 81.9 (5 blocks)[18]

Forest Type – Even-age oak and yellow-poplar sawtimber

Estimated Age – 90-100 years

Estimated Canopy Height – 80-90 feet

Site Index – 60

Index Species – red oak

Stocking – fully stocked (NE-195)

Soils – Ludlow silt loam, Wethersfield loam, Wilbraham and Menlo soils, Manchester gravelly sandy loam, Udorthents-Urban land complex, Branford silt loam, Walpole sandy loam, and Pootatuck fine sandy loam.

Dominant and Codominant Trees – oak (red, white, and black), yellow-poplar, hickory, black birch, beech, red maple, sugar maple, yellow birch, black cherry

Current Stand Dynamics –

	BA/acre**	BA/acre AGS**	Trees/acre**	Trees/acre AGS**	Volume/acre (MBF)	Volume/acre AGS (MBF)	CD/Acre	CD/Acre AGS
Seedlings			1200					
Saplings			740					
Sawtimber trees	101	62	53	29	1.5	1.2	4.9	2.7
Poletimber trees	14	4	39	15			1.0	0.2
Snags	12		8					
Total	115	66	92	44			6.0	2.9
MSD*	15.1							

*Quadratic Mean Stand Diameter

** Total per acre BA and trees values include live sawtimber and poletimber-sized trees only

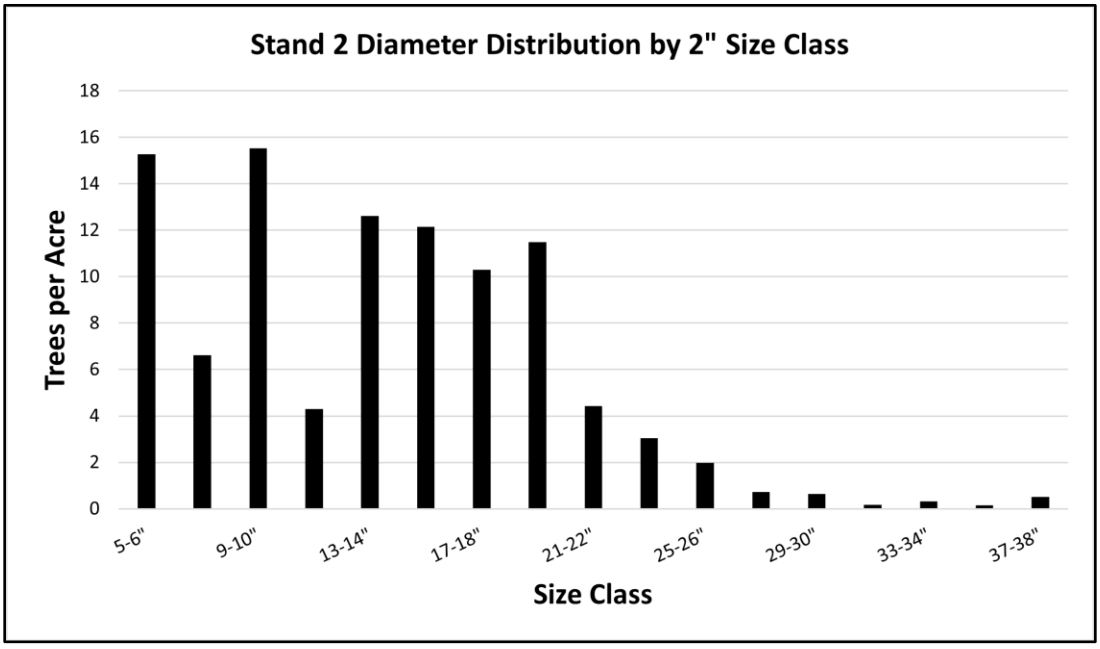
MBF= Thousand board feet; CD=Cord (firewood)

BA= Basal area and is given in square ft./acre

[18] Stand 2 is broken up into five distinct blocks for the purposes of the plan. The different blocks are based on differences in topography, hydrological features, and relative location.

Species	SqFt./acre	% Composition
Red Oak	20	17.4%
Black Birch	18	15.7%
Black Oak	17	14.8%
Red Maple	13	11.3%
Beech	9	7.8%
Sugar Maple	8	7.0%
Hickory	7	6.1%
Yellow-Poplar	7	6.1%
Yellow Birch	4	3.5%
Black Cherry	4	3.5%
Chestnut Oak	3	2.6%
White Oak	3	2.6%
Eastern Hemlock	1	0.9%
Scarlet Oak	1	0.9%
Total	**115**	

Species	Trees Per Acre	% Composition
Beech	18	19.8%
Black Birch	15	16.6%
Sugar Maple	12	13.1%
Red Maple	11	11.7%
Black Oak	7	7.7%
Red Oak	7	7.1%
Hickory	5	5.2%
Yellow Birch	4	3.9%
White Oak	3	3.7%
Black Cherry	3	3.5%
Eastern Hemlock	3	3.1%
Yellow-Poplar	2	2.3%
Chestnut Oak	2	1.9%
Scarlet Oak	0.4	0.5%
Total	**92**	



Forest Health – Stand 2 has multiple health issues. Blowdowns in this stand from shallow soil and high wind events have created areas in the understory where invasive plants have become established. Although a disturbance like a blowdown is a natural process in a forested ecosystem it can also lead to altered vegetation composition if invasive plant species are established in the area prior to the disturbance. Ash mortality has occurred in this stand as a result of historical EAB infestation. Oak mortality present in some places is a likely result of spongy moth infestation from years past. In general this stand has some of the most dense populations of invasives property-wide. Where they are found these plants are reducing the wildlife habitat quality (lower quality source of soft mast native wildlife is not adapted to) and prohibiting regeneration of native tree species and other understory vegetation.

Nectria canker is present in many yellow and black birch throughout the stand. Some birch mortality has occurred as a likely cause of *Nectria* infection as well. HWA and HES are impacting hemlock in the midstory of Stand 2 similarly to the hemlock in Stand 1.

Primary Concerns

- *Nectria* canker infected black birch occupying growing space in the canopy.
- Future blowdown events that may allow for the spread of invasive species currently established in the understory.
- Dominant dense black birch overstory in some places (increased susceptibility to *Nectria* canker and seed-bearing individuals)

Other Concerns

- Increased crown closure rates in canopy due to dense stocking conditions.
- Lack of free-to-grow seedlings and saplings of shade mid-tolerant species.

Strengths

- Large well-formed producers (black cherry, red oak, hickory).
- Locally dominant hickory in some parts of the overstory.
- Yellow birch saplings present in the midstory in some places.
- Favorable growing conditions in some areas.

Tree Growth Potential – The potential for growing large diameter and tall individuals is high for Stand 2 based on visual observations of dominant trees growing throughout this stand. Multiple tall oaks, maples, hickories, and black cherry are present with clean main stems and large crowns. On some slopes, like the western facing slopes in Stand 2b, red and white oak grow particularly well in the soil conditions found here. Hickory is locally dominant in the northwestern block Stand 2d and it also appears to grow well there.

Regeneration – Beech is dominant (47.9% of observed seedling regeneration and 47.3% of sapling regeneration) throughout the midstory and understory in Stand 2. Higher numbers of dominant and co-dominant beech and the mostly closed canopy conditions (beech is shade tolerant) found within Stand 2 are two likely explanations for the prolific regeneration of beech here. Black cherry is found commonly in the seedling size class after beech (20.8%), along with sassafras (12.5% of seedling regeneration). Having both of these desirable species present in the understory is beneficial for any future disturbance that may occur here as they would be able to regenerate into the future forest. Overall rates of oak regeneration are relatively low for Stand 2, but as mentioned before the closed canopy in places is not allowing enough sunlight to reach the forest floor to successfully regenerate oak.

Sugar maple and yellow birch are also relatively abundant in the sapling size class in some places (23.6% and 4.7% of noted regeneration). Where yellow birch is most abundant it is typically near wetter soils, along intermittent drainages and wetlands, or near the watercourse in Stand 2c, Birch Mill Brook.

Species	Seedlings Per Acre	% Composition
Beech	575	47.9%
Black Cherry	250	20.8%
Sassafras	150	12.5%
Chestnut Oak	75	6.3%
Black Birch	50	4.2%
Black Oak	25	2.1%
Hickory	25	2.1%
White Ash	25	2.1%
White Oak	25	2.1%
Total	**1200**	

Species	Saplings Per Acre	% Composition
Beech	350	47.3%
Sugar Maple	175	23.6%
Black Birch	50	6.8%
Musclewood	40	5.4%
Yellow Birch	35	4.7%
Red Maple	30	4.1%
Ironwood	20	2.7%
Hickory	15	2.0%
Sassafras	10	1.4%
Black Cherry	5	0.7%
Slippery Elm	5	0.7%
Yellow-Poplar	5	0.7%
Total	**740**	

Understory Vegetation – Some species noted in the understory of Stand 2 include but are not limited to, dense pockets of mountain laurel, mapleleaf viburnum, striped pipsissewa, spice bush, some American holly regeneration, wild grape, and various hardwood seedlings.

Topography – Stand 2 is topographically diverse with deep valleys, steep slopes, and some forested wetlands. As mentioned before, Stand 2b has mostly western facing slopes that slope downward to nearby Birch Mill Brook. A height of land exists in the far eastern portion of 2b near Bear Rock road. Similarly, in Stand 2c there is a height of land off of Higganum road, which then also slopes downwards to the north towards Birch Mill Brook. The terrain of block 2a is not nearly as steep as the two blocks in the south, making this area much more accessible for management purposes. Topography in block 2d is gentle and much flatter than other blocks.

Wildlife Habitat Opportunities – Stand 2 provides quality wildlife habitat for some generalist and specialist species that rely on forested wetlands, watercourses with extensive tree canopy cover, vernal pools, and closed canopy hardwood forests. Some canopy gaps from historical tree morality have allowed for the establishment of dense clusters of invasive plants such as wineberry, which does provide some soft mast value to wildlife in the area. Similarly to Stand 1, hemlock is present in the midstory in some places here as well, adding an additional source of vertical structure to Stand 2. Snags and live excavations within them were noted in all blocks of Stand 2, creating ideal nesting and cover for a suite of birds. Larger variations of CWM are present as blowdowns, which can create micro-habitats that are ephemeral in nature similar to vernal pools.

One large vernal pool is present in the central portion of Stand 2a. This hydrological feature is important habitat for a wide variety of amphibians, reptiles, and insects. Amphibians such as Jefferson salamander, marbled salamander, spring peeper, wood frog, and bullfrog utilize this habitat feature for all or part of their life cycle due to the absence of fish within the pool. Birch Mill Brook in the southern blocks of Stand 2 is an important source of drinking water and habitat for wildlife. The brook is quality habitat for freshwater fish and aquatic macroinvertebrates that fish may feed on.

Hard mast is relatively common throughout Stand 2 and includes dominant and co-dominant hardwood species such as oak, hickory, and beech. Large diameter producers (red and white oaks, hickories) supply an essential food source for wildlife such as acorns and nuts that are high in fat. Soft mast is present in larger diameter black cherries, eastern redcedar, wild grape, brambles (*rubus* spp.), and spicebush. Flowering species like black cherry, spicebush, striped pipsissewa, and brambles all provide quality sources of nectar and pollen which benefit different suites of species of insects and pollinators.

Invasive Plants – Invasive plants are established in various parts of Stand 2. The most dense occurrence of invasive plants is typically nearby blowdown disturbances. Here there are some dense populations of wineberry and multiflora rose in some places. Outside of these dense clumps they exist as lone individuals scattered throughout the various blocks of Stand 2. Invasive species noted here include but are not limited to, Japanese barberry, multiflora rose, Asiatic bittersweet, and burning bush. Dense populations of wineberry represent a source of soft mast that can spread prolifically throughout the forested regions of property given ideal conditions.

Hydrologic Features – As previously mentioned the most significant hydrological features within Stand 2 is the vernal pool, intermittent streams, Birch Mill brook, and some portions of forested wetlands/wetter soils.

Management History – According to aerial imagery from 1934, most blocks and portions of Stand 2 were forested at that time. A portion of the western finger of Stand 2d was cleared for agricultural purposes based on 1934 imagery and by 1990 that area had reverted to forest. The other blocks of Stand 2 likely reverted to forest following agricultural abandonment of the land in the late 19th century.

In collaboration with the CFPA, students from nearby Wesleyan University in a class titled "*WOOD: Building with the Forest*"[19] constructed a wetu[20] using beech saplings from the forest for parts of the structure. The wetu was constructed in the northern portion of Stand 2a.

Landowner Objectives –

- Reduced invasive plant populations.
- Diverse native understory vegetation.
- Maintained ecological characteristics and values.
- Protection of culturally significant sensitive areas (both past and present).
- Maintained canopy cover around water features to prevent accelerated warming.
- Enhanced adaptive capacity and resiliency.

Desired Future Conditions – Large native overstory trees (soft and hard mast) most beneficial to wildlife with ample growing space and full crowns. Diverse understory native vegetation with a suite of native tree seedlings free-to-grow into the midstory and beyond. Increased rates of CWM throughout the stand, with some intentionally placed around/near vernal pool.

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[19] https://ctwoodlands.org/news/building-on-tradition/

[20] A seasonal home traditionally used by local Indigenous people in southern New England.

Recommendations

2027-2029 – Treat invasives throughout the stand.

2030 [thinning] – Thin the northern portion of stand 2a to 70-80 ft./acre to increase growing space around the crowns of retained trees. Focus removal on *Nectria* infected black birch, poorly formed red maple and other species that occur frequently throughout the stand (such as black oak for example that exhibits relatively poor form and generally has a shorter lifespan than red and white oak). Retain trees beneficial to wildlife (white and red oak, sugar maple, black cherry, and sassafras) and those that exhibit complex habitat features (i.e., cavities, rotting limbs, and unique bark characteristics). Retain hemlock wherever it occurs within the midstory, cutting trees nearby that may be limiting its photosynthetic response, allowing them to better defend against the HWA and HES.

[group selection] – If reasonable access can be gained to Stand 2d further in the west (the largest barrier to entry is the drainage that separates this stand from Stand 2a), consider a group selection within the workable areas of this stand. Focus retention on locally dominant hickories and oaks (red, white, or well-formed black) in order to retain and regenerate the native oak-hickory forest type. Other species to retain include yellow birch near the wetter soils, and structurally diverse (i.e., multi-stem, cavities, or large crowns) black cherry, and yellow-poplar. Employ a targeted removal on groups of black birch and red maple in attempt to reduce the seed-bearing potential of these species across the landscape. Avoid working directly in the nearby wetland soils. Cutting groups of trees and creating canopy gaps roughly ¼ - ½ an acre in size may be sufficient in releasing shade-mid tolerant seedlings and saplings currently established in the understory.

Non-merchantable trees can be retained on site to increase amounts of CWM and to benefit wildlife that may utilize this feature for cover, reproduction, or as a source of forage. Tops of trees from both treatments can be lopped and left scattered throughout the stand to serve as protection against deer browse on palatable tree species, and to provide an added layer of vertical structure for wildlife. Install signage during and after this work to ensure visitors to this portion of the forest can understand the how, the what, and the why behind the treatment.

Due to volumes to be removed, these treatment are likely to be non-commercial. However, if the work is done in conjunction with treatments prescribed for Stand 1, it has the potential to be marginally commercially viable.

Maintain appropriate operating distance and buffer from the wetu to ensure it does not get damaged during the treatment. Employ a similar buffer and operating distance from the vernal pool in the center of Stand 2a.

Ongoing – Monitor for new populations of invasive species, re-treating as needed. Remove the incorrectly placed private property sign in the central portion of Stand 2d. Install signage describing the significance of the wetu for visitors to the site. Monitor desirable regeneration that may establish following treatments for significant deer browse. If deer browse remains a problem over time, install deer exclosures in some places to lessen future browse impacts, or erect fencing around individual young tree seedlings/and or saplings (i.e., white oak, hickory, or black cherry).

Some trees with excessive lean are overhanging the vernal pool in Stand 2a. Hinge cut these trees so they fall directly above the pool to create additional basking habitat for a suite of reptiles that may utilize this unique habitat feature.

[promote old forest characteristics] – Due to the relatively steep conditions in the southern blocks of Stand 2, close proximity to watercourses and/or streams, and lack of reliable access, allow these areas (specifically the southern portion of 2a and the area to the west of Stand 3, 2b, and 2c) to develop over time with limited management (i.e., mainly invasive species treatments). Although these areas are not true "old growth" forest they do exhibit similar conditions such as large diameter dominant trees in the canopy, standing snags and some downed CWM, and occasional small canopy gaps. Hand-felling of some *Nectria* infected black birch wherever it occurs can be useful in creating micro-gaps in the canopy and increasing growing space around trees growing amongst the black birch. This can also aid in reducing the seed source of black birch across the landscape. Felled trees can be retained on the ground to increase rates of CWM throughout the stand as well.

No-Action Alternative – Invasive plant species are likely to continue to spread throughout the interior of the forested regions of this stand. *Nectria* infected black birch will continue to decline over time. Regeneration present in this stand in the form of shade mid-tolerant species is likely to remain stagnant over time. The oak-hickory forest type will eventually be replaced by more mesic species (red/sugar maple and black birch) as overstory trees succumb to old age.

Stand 3

Acreage – 6.4

Forest Type – forested wetland

Estimated Age – 90-100 years

Estimated Canopy Height – 80-90 feet

Soils – Wethersfield loam, Manchester gravelly sandy loam, Ludlow silt loam, Wilbraham silt loam, and Branford silt loams.

Dominant and Codominant Trees – yellow-poplar, black cherry, oak (red, white, and black), black birch, red maple, hickory, and beech

Forest Health – Stand 3 is in relatively good condition. There are limited populations of invasive plants throughout the stand and the majority of overstory trees have full crowns, clean main stems, and limited rates of dieback and/or decline. Some historical ash mortality has occurred in this stand but the understory below these individuals is largely composed of native vegetation. Blowdowns have occurred in various places within Stand 3 but similar to areas below ash mortality the vegetation has remained native in nature. Beech in this stand are being impacted by BBD and BLD.

<u>Primary Concerns</u>

- Future health of beech as a result of BBD and BLD infection.

<u>Strengths</u>

- Dominant well-formed overstory hardwoods.

- Quality canopy closure over drainage.
- Dense midstory composed of native vegetation.
- Low rates of invasive plant species.

Tree Growth Potential – Based on visual observations of dominant and co-dominant trees in this stand, it is apparent that various hardwood species can grow well here. Some key visual indicators of quality growth include clean main trunks relatively free of defects, large full crowns, and multiple tall individuals. This may be in part due to the close proximity of the drainage that runs through the center of the stand and the steep conditions found in the western portion of Stand 3. Organic material likely washes down from the height of land to the toe of slope near the drainage where it collects in the soil. Some of the largest and tallest individual trees are growing in this area. Saturated rich soils near the drainage aid in growing high quality trees as well.

Regeneration – Rates of regeneration were not quantitatively measured but based on qualitative observations, there are limited amounts of seedling regeneration throughout Stand 3 due to the mostly closed canopy conditions found here and the dense spicebush midstory. Some black birch, red maple, and beech saplings are growing in the midstory at higher elevations.

Understory Vegetation – Some species noted in Stand 3 include but are not limited to; spicebush, which is relatively dense and in abundance, green briar, and dense patches of brambles are established in places with increased exposure to sunlight (typically near canopy gaps created by ash mortality).

Topography – The majority of Stand 3 is relatively flat with a rise in elevation towards the height of land found in the west within Stand 2.

Wildlife Habitat Opportunities – Stand 3 provides good habitat conditions for wildlife species that depend on mostly closed canopy forested wetlands. The drainage that runs through the center of this stand provides a steady source of fresh water for wildlife in the area. Large overstory yellow-poplars are an important source of nectar and pollen that honeybees and other pollinators depend on. Wetland conditions found here create ideal breeding grounds for a variety of insects that will in turn be a source of forage for bats and birds. Blowdowns and the associated pit-like depression left in the soil from the root ball of the blown down individual create ephemeral microhabitats that can fill with water after extended periods of rain or snow melt. Large diameter oaks and black cherry represent a balanced source of both hard and soft mast. Soft mast is also present from the dense spicebush and occasional green briar. Both of these plants provide beneficial cover on the forest floor as well.

Invasive Plants – Relatively low establishment across the stand. None were explicitly observed during field visits to Stand 3 but there are likely some lone individuals irregularly dispersed throughout the stand.

Hydrologic Features – The majority of the stand consists of wetland soils. A drainage runs through the central portion of Stand 3 as well.

Management History – Based on 1934 aerial imagery its evident that this area was reforested by then or in the process of reforestation. Historical management of this area would likely have been limited in the past due to the wet swampy conditions and poorly drained soils found here. The CFPA has constructed a

bridge in this stand that allows for easy crossing over the drainage towards the trail that is present in Stand 3.

Landowner Objectives –

- Reduced invasive plant populations.
- Maintained ecological characteristics and values.
- Maintained canopy closure over drainage.
- Retain area as wetland to allow for proficient pollutant and water filtration source.

Desired Future Conditions – Forested wetland with large overstory trees with healthy full crowns and dense native vegetation growing below.

Recommendations

2026-2028 – Identify, treat, and/or remove any invasive species. Due to low populations these likely can be hand pulled over time.

Ongoing [ecological reserve] – Due to the saturated soils found here, semi-steep conditions in the west, and the close proximity to the drainage, allow this stand to develop free from any form of management (with the exception of invasive species removal/treatment). Monitor for new populations of invasive species over time, re-treating or hand pulling new sprouts as necessary.

Stand 4

Acreage – 38.6

Forest Type – two-aged oak and yellow-poplar sawtimber

Estimated Age – 90-100 years

Estimated Canopy Height – 80-90 feet

Site Index – 58

Index Species – hickory

Stocking – fully stocked (NE-195)

Soils – Wethersfield loam and Ludlow silt loam.

Dominant and Codominant Trees – red oak, hickory, sugar maple, yellow-poplar, red maple, black and white oak, beech, black birch

Current Stand Dynamics –

	BA/acre**	BA/acre AGS**	Trees/acre**	Trees/acre AGS**	Volume/acre (MBF)	Volume/acre AGS (MBF)	CD/Acre	CD/Acre AGS
Seedlings			4192					
Saplings			1392					
Sawtimber trees	101	62	53	29	1.5	1.2	4.9	2.7
Poletimber trees	23	7	65	15			1.0	0.2
Snags	12		8					
Total	124	69	118	44			6.0	2.9
MSD*	13.9							

*Quadratic Mean Stand Diameter

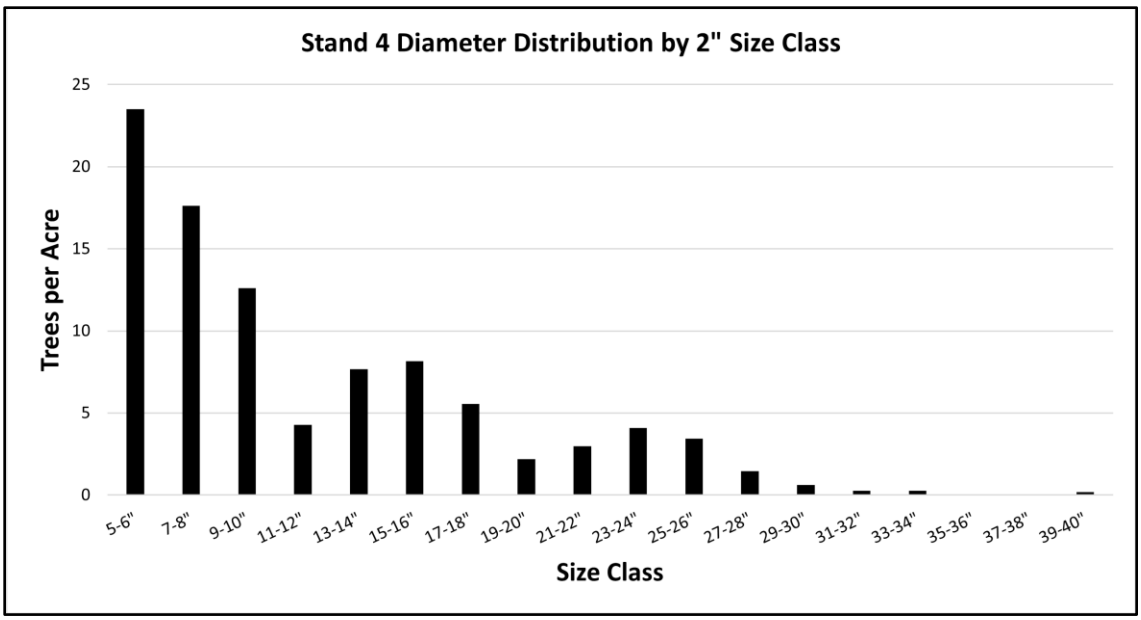
** Total per acre BA and trees values include live sawtimber and poletimber-sized trees only

MBF= Thousand board feet; CD=Cord (firewood)

BA= Basal area and is given in square ft./acre

Species	SqFt./acre	% Composition
Red Oak	20	22.0%
Hickory	17	18.6%
Sugar Maple	14	15.3%
Yellow-Poplar	14	15.3%
Red Maple	12	13.6%
Black Oak	8	8.5%
White Oak	3	3.4%
Beech	2	1.7%
Black Birch	2	1.7%
Total	**91**	

Species	Trees Per Acre	% Composition
Sugar Maple	39	43.0%
Hickory	18	19.7%
Red Maple	13	14.2%
Yellow-Poplar	8	8.8%
Red Oak	5	5.9%
Black Oak	4	4.0%
White Oak	2	1.8%
Beech	1	1.4%
Black Birch	1	1.2%
Total	**91**	



Forest Health – Stand 4 is in good condition. Some health concerns and risks include but are not limited to invasive plants established in the understory in certain areas and BBD impacting dominant and co-dominant beech. Although it was not directly observed in Stand 4 due to the time of year the inventory occurred, beech is likely being impacted by BLD in this stand within all strata.

Primary Concerns

- Desirable species regenerating in the sapling size class currently being overtopped by more dominant and aggressive native species.
- The potential for invasive species established in the understory to spread throughout the stand.

Other Concerns

- Potential deer browse impacts on desirable species within the seedling size class.

Strengths

- Diverse suite of hardwood trees with large well-formed crowns, clean main trunks, and tall dominant nature in the overstory.
- Dense and diverse sapling and seedling regeneration with some desirable species in the mix.
- Increased population of flowering and fruiting species in the understory.

Tree Growth Potential – Stand 4 has high potential for growing quality hardwood tree species. The presence of multiple well-formed tall individuals (oaks, hickories, yellow-poplar and sugar maple) are evidence of this. The majority of Stand 4 is situated atop a height of land called a “drumlin”. Drumlins typically are indicators of fertile and productive soils. Dense young tree regeneration (most of which are growing vigorously) is further indication of the productive conditions found within Stand 4.

Regeneration – Due to the previous timber harvest that occurred in Stand 4, rates of regeneration are dense throughout the stand and contain a diverse range of species, both desirable and undesirable. Yellow-poplar is abundant in the seedling and sapling size class throughout the stand (26.6% and 35.4% of observed regeneration, respectively). White ash is one of the most common species in the seedling size class as well. Red oak and black cherry seedlings are relatively abundant in some places, but are not uniformly distributed throughout the stand. Black birch is consistently overtopping some of the aforementioned seedlings since it is very common in the midstory and sapling size class (26.5% of regeneration). Careful tending to improve the growing conditions for shade mid-tolerant species like oak and black cherry would likely aid in promoting these species into the midstory and beyond.

Species	Seedlings Per Acre	% Composition
White Ash	1500	35.8%
Yellow-Poplar	1115	26.6%
Red Oak	346	8.3%
Black Cherry	308	7.3%
Beech	269	6.4%
Black Birch	154	3.7%
Musclewood	154	3.7%
Black Oak	154	3.7%
Sassafras	115	2.8%
Serviceberry	38	0.9%
Hickory	38	0.9%
Total	**4192**	

Species	Saplings Per Acre	% Composition
Yellow-Poplar	492	35.4%
Black Birch	369	26.5%
Sassafras	146	10.5%
Beech	108	7.7%
White Ash	77	5.5%
Black Cherry	54	3.9%
Sugar Maple	46	3.3%
Musclewood	38	2.8%
Red Maple	23	1.7%
Hickory	15	1.1%
Ironwood	15	1.1%
Red Oak	8	0.6%
Total	**1392**	

Understory Vegetation – Some of the vegetation noted in this stand includes brambles, spicebush, witch hazel, white wood aster, and wild grape.

Topography – Stand 4 is topographically diverse with the north-south oriented drumlin in the eastern portion of the stand and one other smaller height of land in the southwestern portion. Terrain is steeper heading down towards the forested wetland (Stand 3) in the western portion of the stand.

Wildlife Habitat Opportunities – Stand 4 provides a diverse range of habitat values for generalist species and others that may use the dense understory and midstory tree regeneration below the retained hardwood trees. Some dense patches of brambles have expanded in places due to enhanced growing conditions, allowing them to increase their fruiting and flowering capabilities. Large diameter producers that were retained from the past timber harvest (oaks and hickories) represent important sources of hard mast that benefit a suite of wildlife in the area. Witch hazel is present in the midstory in some places and it is an important source of late season nectar and pollen in the region which benefits various pollinators. Some large diameter sassafras were noted in Stand 4 (not necessarily reflected in inventory data), these trees are high quality sources of soft mast and potential cavities. White wood aster is relatively common throughout the understory of Stand 4 as well and is another quality source of native pollen and nectar. Soft mast such as wild grape and spicebush is also present in some places within the understory of Stand 4.

Coarse woody material of varying size classes is relatively abundant in some places within Stand 4 due to the last timber harvest. This downed material represents important habitat for insects, reptiles, pollinators, and more for foraging, breeding, and general cover. The semi-open canopy conditions found here create ideal conditions for bats to forage for insects due to the absence of a dense overstory which can interfere with their echolocation when hunting for food. Shagbark hickory in this stand is an important source of cover and potential roosting habitat for tree bats in the area since they may utilize the flaky strips of bark. Red maples with exfoliating bark characteristics are important sources of cover that benefit a wide array of insects which can provide birds in the area with an additional source of forage.

Invasive Plants – Invasive plants are scattered irregularly throughout Stand 4. Instead of occurring as large dense clumps they typically are present as lone individuals. Some species noted in Stand 4 include but are not limited to wineberry, Asiatic bittersweet, Japanese maple, multiflora rose, Japanese barberry, and stiltgrass that typically occurs near or in trails.

Hydrologic Features – Some intermittent streams are present in Stand 4. One branches off from Birch Mill Brook in nearby Stand 2c and another one is present in the northeastern corner of the stand. There is a portion of wetland soils in the western extent of Stand 4 as well.

Management History – According to 1934 aerial imagery, this stand was forested at that time. It's likely that this stand reforested following agricultural abandonment in the late 19th century. The fertile soils found here would have been beneficial for growing crops or pasture following European settlement of the area. As previously stated, a timber harvest occurred in this stand in 2016-2017. Invasive plant species were also treated in this area and along the roadside boundary prior to the harvest. A follow up salvage harvest occurred in 2018 after spongy moth and EAB moved through the forest here.

Landowner Objectives –

- Reduced invasive plant populations.
- Maintained ecological characteristics and values.
- Free-to-grow shade mid-tolerant seedlings and saplings (oak, hickory, and black cherry).

Desired Future Conditions – Maintained large overstory dominant and co-dominant variety of hardwood tree species. Desirable young trees regenerating below with ample growing space and protection from deer browse if necessary. Diverse herbaceous layer containing native pollinator plants.

Recommendations

2027-2029 – Treat invasives throughout the stand.

2027 [Pre-commercial release, a.k.a. weeding] – Oak, hickory, sassafras, and black cherry are regenerating irregularly throughout Stand 4 but where they occur these species are typically being overtopped and crowded out mainly by black birch saplings. Cut surrounding vegetation around established desirable saplings to enhance growing conditions over time. Target mainly black birch and potentially some yellow-poplar since they are both abundant throughout the midstory. This can be done in conjunction with volunteers from the public, members of the CFPA, and/or students from the nearby

Coginchaug High School. Work like this can create a vested interest in our ecological systems and allows for increased exposure to the concept of sound land stewardship.

[deer exclosure] – Consider fencing areas around established oak seedling regeneration and cutting undesirable and/or poorly formed trees and saplings around said regeneration. The exclosure can help to promote the oaks into the midstory and past deer browse height (around 6-7 feet). Cutting trees around the fencing would likely aid in maintaining it to ensure that tree limbs or trees themselves do not fall onto and damage the fencing while also increasing rates of sunlight for the established regeneration.

Ongoing – Attempt to address drainage issues impacting the trail system in this stand. There are some areas where there is excessive seepage and water running directly through the blue trail creating difficult access on foot for visitors to the forest during wetter times of year. Monitor for new populations of invasive species, re-treating and/or removing new sprouts as needed.

No-Action Alternative – Oaks and other desirable species regenerating in the midstory will continue to be shaded out and overtopped by other species surrounding them such as black birch due to the birches aggressive regenerative nature.

10 GENERAL PROPERTY RECOMMENDATIONS

- Locate, mark, and maintain all boundary lines.

- With any activity undertaken on the property, attempt to:
  1. Improve forest health, adaptive capacity, and species diversity.
  2. Improve vertical and horizontal structural diversity and complexity, including retaining and recruiting snags and cavity trees where doing so is not counter-productive to the goal of the activity.
  3. Ensure water quality and soil stability.
     - Follow Connecticut's Field Guide for Best Management Practices for Water Quality while Harvesting Forest Products during any forest management operations.

- Attempt to limit populations of invasive plant species. Keep abreast of information regarding invasive insects. Amend plan to salvage imminently infested stems if necessary. **Vigilance and re-treatment of invasives will be critical.**

- Attempt to maintain and enhance healthy populations of softwood tree species on the property.

- Whenever possible, avoid forest management activities that involve tree cutting during the songbird breeding and migration seasons (i.e. mid-April to mid-August) if it makes sense given operational concerns and goals of the treatment. If it is determined that bat habitat may be impacted, the window of recommended inactivity or limited activity could be extended until November 1 to accommodate bat active seasons.

- Recruit some very large diameter trees (>30" DBH) scattered throughout the property, even if these trees are not "wolf trees" to increase structural diversity. These large trees could become "legacy trees" and be allowed to mature and die naturally.

- If deer exclosures are constructed, monitor these areas yearly to ensure that the fencing does not incur excessive damage over time from falling limbs etc., and allow for deer or other wildlife to enter.

- Maintain roads and trails to maintain access and limit erosion throughout the property. Conduct regular inspections of all trails and respond accordingly as erosion occurs. Implement best management practices by creating water bars on sloped trails and ensuring sections of trail through wet soils are stilted with bridges and/or boardwalks.

- Update trail map on the CFPA website for the property to reflect the one used within this plan (see map in section 4.12 for reference).

- Where and when appropriate work with adjacent landowners to "manage across boundaries". In this particular case the most likely cooperating landowner will be the State of Connecticut due to the adjacency of the Cockaponset State Forest.

- Monitor the health and condition of both beech and hemlock over time as they are impacted by BBD/BLD, HWA, and HES.

11 SUMMARY OF RECOMMENDATIONS BY YEAR

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13 GLOSSARY

acceptable growing stock (AGS)
Trees that are vigorous and now or in the future are capable of producing a sawlog that is at least 8 feet long

aspect
The general direction in which land slopes

basal area
A commonly used measure of forest density or stocking. It is measured as the cross sectional area of a tree in square feet at 4.5 feet above ground.

B-level
The stocking level considered optimal for sawtimber growth.

board foot
A measurement unit for lumber volume. One board foot is a piece of wood 1 foot long by 1 foot wide by 1 inch thick (Abbreviated b.f.)

breast height
Measurement at which diameter is generally measured for inventory and timber tally purposes. Breast height is measured at 4.5 feet above the ground. Where there is any slope, breast height is always measured from the highest part of the slope where the ground intersects the tree.

clearcut
An even-age silvicultural technique in which all the trees in an area are severed and – typically – removed. Silvicultural clearcuts generally remove all trees above 2 inches dbh. Commercial clearcuts or "high-grades" remove all the trees of value leaving poorer quality trees of a variety of diameters.

clearcut with reserves
A modified clearcut in which the majority of the trees in an area are cut, but some minimal trees are left standing. Typically reserve trees will allow to mature and will not be cut. This differs from a shelterwood or seed tree harvest in that residual trees following the initial regeneration cut are intended for removal.

clear log
A length of tree stem or cut log that has no horizontal (i.e. side) branches.

coppice
A sprout from roots or stumps. Or a practice of cutting a tree or group of trees to cause them to resprout from the stump or roots.

continuous forest inventory (CFI)
An inventory of this type is based on a mechanically laid out network of permanent one-fifth acre plots which are to be measured and re-measured periodically on our state forests. Due to the periodic

measurement of all trees above sapling size on these plots, a very accurate record is made of growth, drain and mortality of the forest area from time to time.

cord
A measurement unit for firewood. One cord of stacked wood measures 4 feet by 4 feet by 8 feet. 1 cord contains 85 cubic feet of solid wood. (Abbreviated cd)

course woody material
Coarse woody material are those pieces of downed wood that are greater than 4 inches in diameter

crown
The top of the tree, including the live branches and the leaves.

cruise
An inventory of standing trees during which information about species, size and other characteristics is gathered.

cull
A tree of such poor quality that it is not suitable for sawtimber. Culls are sometimes sold for firewood.

dbh
Diameter of a tree outside the bark measured at breast height

den tree
A tree with a hollow or cavity large enough to potentially be used by wildlife (a.k.a. cavity tree)

desirable
From the silvicultural perspective desirable trees are typically healthy/vigorous individuals of species which have potential to benefit landowner goals (economic, ecological, or otherwise) for the planning cycle. These may be high value timber trees or large diameter declining cavity trees or individuals of species which are not highly represented on the property/landscape. This term is not inherently economic and is completely dependent on goals and objectives.

even-age management
Managing trees in such a way that it creates a single or two age classes in a stand.

free-to-grow
A condition in which seedlings, saplings, or other smaller, younger vegetation has sufficient sunlight to allow them to continue to develop. This is achieved when there is little to no competing vegetation overtopping the smaller vegetation.

fine woody material
Fine woody material is composed of the twigs, branches, and other tree top sections that are less than 4 inches in diameter.

functional habitat

areas which provide required components for a given species and are in close enough proximity to other quality habitat sites to allow for the exchange of genetics over the broader landscape; important metric for species with minimal yearly migration potential or which have specific and uncommon habitat requirements.

glacial erratics
often simply called erratics, or erratic boulders, are rocks that have been transported by ice and deposited elsewhere. The type of rock (lithology) that the glacial erratic is made from is different to the lithology of the bedrock where the erratic is deposited.

girdle
To attempt to kill a tree by cutting through the outer bark and cambium around its entire circumference.

hardwood
A deciduous, broadleaf tree. Angiosperm.

high-grade
A logging practice in which only the best trees are removed leaving poorer quality and/or damaged trees.

International ¼ Rule
A type of log (measuring) rule. The International Rule is the legal standard for measuring sawtimber in Connecticut.

legacy tree
A tree that is intentionally and permanently retained, including through the processes of decay.

live crown ratio
The ratio of live crown length to total tree height.

mast
Seeds and nuts produced by trees and shrubs. Mast is often discussed in terms of hard and soft and is crucial to providing food for wildlife.

mbf
One thousand board feet (of sawtimber) or "a thousand".

midstory
Level of strata of the forest layer from between 6-30 feet in height. Dense foliage in this stratum is important for nesting and cover for many forest breeding birds and other wildlife.

mixedwood
A forested area that contains both hardwood and softwood tree species in the main canopy. Typically a mixedwood stand contains between 25-75% softwood.

old forest

A second-growth forest that exhibits a critical mass of old-growth characteristics. Old-growth characteristics may be achieved through both passive and active management (Connecticut DEEP Forestry Division).

Old-growth forest
Forests that were never directly affected by intensive human land use, such as the uses implemented by Europeans (Connecticut DEEP Forestry Division).

overstory
The portion of trees in a stand which form the upper canopy.

overstory removal
An even age silvicultural treatment type in which most or all of the overstory trees are removed in order to release established regeneration.

poletimber
Trees from 5 to 11 inches diameter at breast height (4.5 feet above ground). Also pole or pole tree.

regeneration
New trees, generally seedlings, saplings and sprouts. Regenerating a forest involves replacing existing trees with new ones.

release
To free a desirable tree from competition by cutting or otherwise killing one or more adjacent competing trees or shrubs.

root grub
Large anchoring root of oak seedling which stores energy during early establishment period. Following disturbance oaks put out a prolific sprouting response using the significant store of energy to gain competitive advantage over other regenerating species/individuals.

sapling
A tree from 1 to 5 inches diameter.

sawlog
A log that is straight, large and sound enough to be sawn into boards. Sawlogs are usually at least 8 feet long and ten inches or larger in diameter.

sawtimber tree
A tree large enough to contain at least one sawlog. (Saw)timber trees are usually twelve inches or larger in diameter outside the bark at breast height.

Second-Growth Forest
Forests that are not old growth; these are forests that established and grew following intensive human land use. Second-growth forests are not age specific (Connecticut DEEP Forestry Division).

seedling
A tree from newly germinated up to 1 inch diameter.

Selection System
A silvicultural system involving the removal of individual trees or groups of trees at regular intervals. This system tends to promote the development of uneven aged forests.

Shelterwood System
A silvicultural system whereby new trees are regenerated under the partial shelter of other trees. This system is one of the options available to regenerate a stand or part of a stand to create an even aged or two-aged forest. (The latter occurs when the overstory trees are not removed following the successful regeneration of trees in the understory).

silvicultural system
A planned program of silvicultural treatments during the entire life of a stand. The main focus is on the methods used to obtain desirable regeneration.

silviculture
The science and the art of growing and tending trees for a variety of purposes.

slash
The debris left after logging, pruning or thinning. Slash can include tree tops and unused or unusable portions of the main stems of trees.

softwood
A coniferous, frequently "evergreen" tree. A gymnosperm. Common examples include pine, hemlock, spruce, fir, cedar, and larch (though the latter is not evergreen).

stand type
A group or community of trees sufficiently uniform with respect to size, species composition, spatial arrangement, age or condition to be distinguished from other groups of trees.

stocking
An indication of the amount or density of trees in a stand.

strata
The different heights of vegetation in the forest. Typically divided into understory, midstory, overstory or superstory. The latter exists when a few trees are at least twice as tall as most trees in the stand.

stumpage
Standing trees, usually associated with volume information and intended for sale.

thinning
A cutting done in immature stands in order to maintain tree health and vigor, stimulate the growth of the trees that remain and increase the total yield of useful material from the stand.

tolerance
The relative ability of a tree species to survive and/or grow in shade.

timber stand improvement (TSI)
Improving a stand of trees, usually by pruning, cull-tree removal or pre-commercial thinning.

Umbrella species
An organism (typically an invertebrate) which has a specific set of known habitat requirements which are also preferential for some or all life functions of a broad suite of other organisms. These species are usually charismatic (humans have a warm attitude toward them). Managing for multiple umbrella species which have unique requirements is a proven approach to restore diversity to the landscape.

unacceptable growing stock (UGS)
Trees which are either incapable of producing at least an 8 foot long sawlog now or in the future due to defect, rot, branches, etc. or are in poor health, have significant decline/dieback, or are likely to succumb to insect or disease mortality in the near future.

understory
Vegetation in the lower levels or strata of the forest. Frequently is composed of tree seedlings and saplings, shrubs, herbaceous species and/or invasive plants. Dense low-growing vegetation and foliage is important for many species of wildlife which use this stratum of the forest for cover, nesting, and forage opportunities. Can be considered between ground level to 5 feet in height.

uneven-age management
Managing trees in such a way that it creates three or more age classes in a stand. The selection system is most often used to develop uneven-age stands.

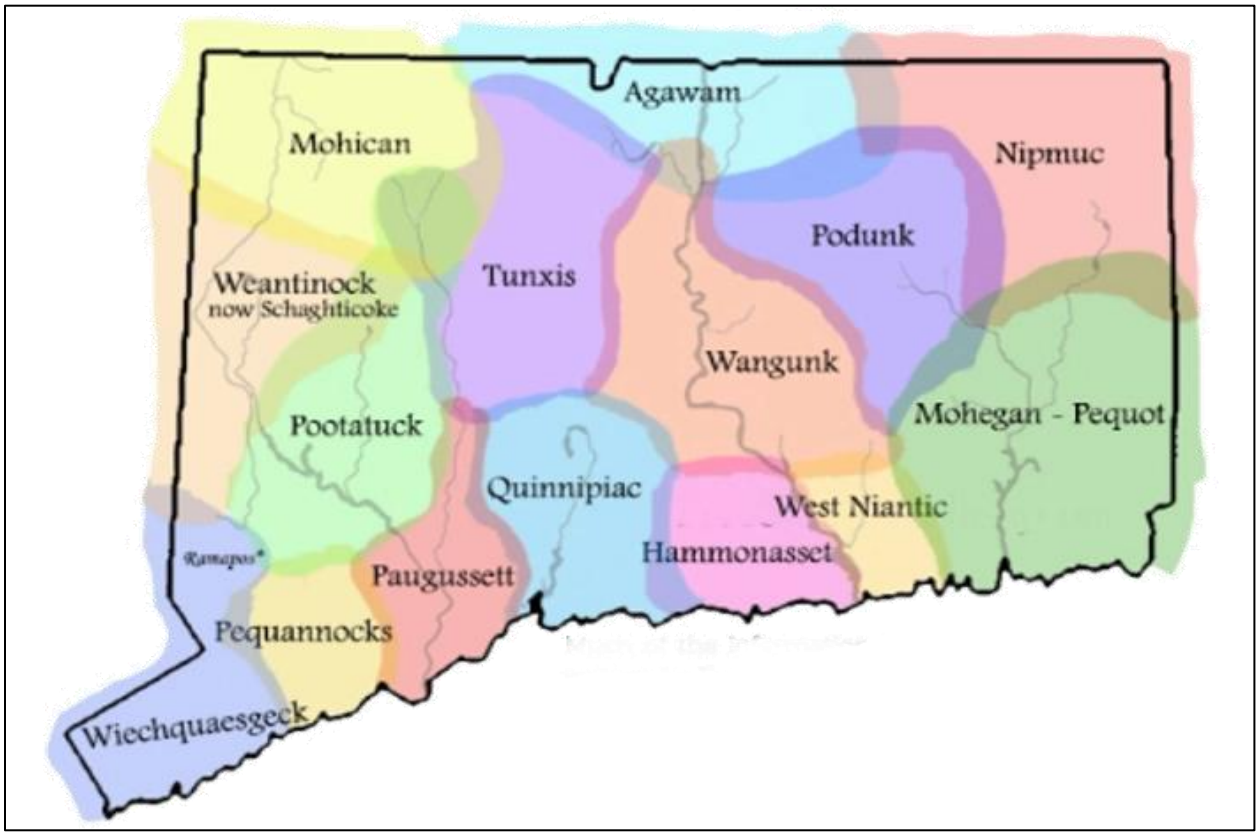
wolf tree
A large, open-grown tree that was present in an area before it reverted to forest

APPENDIX

A.1 Land Use History

Most current forestland in Connecticut was cleared and used for agriculture for some period following European settlement in New England. Similarly, most current forestland in Connecticut was abandoned from agricutlural uses in the late 19th or early 20th century as modern technologies reshaped the food system and regional economies. Stone walls scattered across the landscape are typically evidence that livestock grazing was at least a component of the agricultural use during this period. In southern New England both sheep and cow grazing was historically common. Prior to European arrival in the region algonquin tribes resided across the Connecticut landscape.

Tribal land usage was generally less sedentary and the impacts caused by indigenous agricultural and forage practices (understory burning, intentional tree felling, use of downed wood, etc.) were more ephemeral on the landscape than the intensively maintained permenant settlements that the European lifeway required. That said, there are places in Connecticut where the effects of tribal land stewardship is still evident (ridges with natural communities shaped by historic fire regimes, stone piles used to indicate travel corridors, burial locations, and meeting places, etc.).



Estimated tribal territories, circa 1600. This map was informed by multiple sources, all of whom were European settlers of the region. Miscommunication at that time may have misinformed the names and territories we now attribute to certain tribes. Smaller tribes and nuances of tribal lifeways that European settlers did not understand may also oversimplify the way this information in contemporarily understood. The CT State Native American and Indigenous Council (NIC) recognizes the historic presence of the Agawam, Hammonasset, Mohegan-Pequot, Mohican, Nipmuc, Paugussett, Pequannocks, Podunk, Pootatuck,, Quinnipiac, Ramapos , Tunxis, Wangunk, Weantinock (now Schaghticoke), West Niantic, Wiechquaesgeck. ***CREDIT: NIC.***

The period of landscape-scale clearing, which began in the early 18th century, was ripe with human impacts on native ecosystems, but also directly to wildlife populations. Large predators (wolves and catamounts), fur bearers (fisher, beaver), and a number of avian species (passenger pigeon) were extirpated from Connecticut between 1700 and the early 1800s. White-tailed deer populations declined to near extirpation by 1800 due to hunting for human subsistence and early trade markets (buck skins were one of the first American exports to Europe and were also used as currency for trading more locally – a "buck" was worth a dollar). Local white-tailed deer extinction was common in most of Connecticut in the early

19th century (The North American population is estimated as low as 300,000 individuals at one time, a 98-99% mortality rate based on estimated pre-colonial populations of 30 million[21]).

Impacts to wildlife populations came both directly from killing/taking and also was driven by rapid and mass-scale shifts in available habitat. While some impacts to wildlife caused during this period are permenant (wolves will not return to southern New England unless human populations and land use significantly change) others were relatively temporary. The shift in land use trends which led to broad reforestation across the state between 1900 and 1930, combined with the formation of the modern North American conservation model[22], resulted in rapid recovery of many game and associated non-game species[23]. Deer populations were still so low at this point that forests developed during this period with nearly no browse pressure. Shade intolerant and mid-tolerant trees (oaks, hickories, yellow-poplar, aspen, cedar, and white pine) were regenerated at a landscape scale due to a combination of low deer browse pressure and growing conditions available in abandoned agricultural lands.

The scientific practice of forestry was brought to North America from western Europe around the turn of the 20th century. Interest in managing for sustained timber yields on newly reforested land drove the advancement of forestry at that time. Most woodlots in Connecticut during that period experienced frequent low intensity firewood removals, and some experienced infrequent commercial logging operation. Despite advancements in scientific understanding, land was commonly mismanaged at that time by individuals looking to liquidate the valueable portions of a forest, which led to the process we call high-grading[24]. By the 1970s, forestry had advanced to improve our understanding of natural processes in forests. At that point, common contemporary forestry practices in New England shifted from focusing on uniformity and sustained maximization of timber yields to attempting to mimic the results of natural disturbances to reach a more holistic set of goals with a focus on ecological function more than maximized yield. This holistic approach has continued to develop and now includes conisderations of many more parts of the system than were known about fifty years ago. Many, but not nearly all, forests which have regenerated in the past 150 years have experienced some level of tree cutting and removals.

Active forest management is relatively uncommon in Connecticut today. This is, in part, driven by a commonly held misunderstanding that the currently established forests are “wild” (untouched by man at any point in history) and the idea that any management that involves the taking of a tree is inherently degradative. Contemporary regional research and modern pressures including deer overabundance, invasive plant, and novel disturbances (EAB, beech leaf disease, shifting growing seasons and precipitation regimes) combine to show the need for active forest management to reach important goals set by government and non-government agencies, and private ownerships of all kinds for biodiversity, wildlife population restoration/protection, and resilience/adaptability to uncertain future climate regimes.

[21] Weitzel, E. M. (2025). Commodification of white-tailed deer (Odocoileus virginianus) in 17th century southern New England.

[22] Hallmarks of the NA Conservation Model are using funds generated by the sale of permits for regulated hunting seasons to fund research and land conservation that aims to provide the highest quality habitat possible. The Pittman-Robertson Act (1937) is a federal law that directs all funds generated from a standard excise tax on weapons and munitions sales to be distributed to states for use in the conservation of natural space, education of hunters, and management of habitat for game and non-game wildlife species.

[23] Hammerson, G. A. (2004). Connecticut Wildlife: Biodiversity, natural history, and conservation. University Press of New England.

[24] High-grading is the result of “selective” cutting that removes the highest quality trees and leaves poor quality trees to continue growing. High grading commonly results in a loss of stand-level diversity and productivity as well as more frequent and severe impacts from stressors like disease.

A.2 Landscape Level Considerations

Forests provide essential ecosystem services (water and air filtration, temperature regulation at landscape and site-specific scales, mitigation of flood and other natural disturbance effects, habitat , and many other important outcomes) which humans and other organisms living in New England rely on. Forests are also home to the majority of the region's terrestrial biodiversity. Non-forested systems (watercourses, fields and meadows, shorelines, wetlands other water features, and some other characteristics like exposed ledge and other geological features, among others) are also invaluable to the biodiversity in our region. Development is the major driver of forest fragmentation and most parts of Connecticut are subject to high development pressure. While there is need for homes and other human infrastructure, developing already fragmented areas that are not parts of large forest blocks is an approach that can help limit the impact of human development on native species and ecosystems.

Large, contiguous forest blocks provide better habitat for wildlife, and specifically for species sensitive to human related disturbance like fisher, bobcat, and some forest interior bird species like scarlet tanager and wood thrush. Larger areas of unfragmented habitat also facilitate genetic material exchange among both plants and animals, improving population resilience to stressors like changing climate regimes. The proliferation of some species in the spotlight of conservation efforts in Connecticut, like ruffed grouse, are limited by short annual migration ranges.

That said smaller forested blocks can also provide many of the ecosystem services mentioned above and provide important islands of refuge from human disturbance in more developed areas. Smaller forest blocks on a fragmented landscape can bridge populations from one large block to another and can also benefit certain prey species by lowering the likelihood of occupancy by predators which prefer to hunt within a core of habitat (relatively uncommon). The creation and stewardship of very small scale forests (sometimes referred to as a Miyawaki Forest) has started with some important projects in Connecticut increasing the awareness of the importance of even small patches of forests for plants, pollinators, birds, and humans alike.

Forest Succession at the Landscape Scale

Historically, forests were considerably more connected than they are on the contemporary landscape. Old-growth forest, with a patchy arrangement of areas in different successional phases and irregularly distributed biological legacy structures (large expanses of uprooted trees, long-lived bogs and swamps which experienced very infrequent severe disturbances), was a dominant landscape condition in southern New England[25] prior to European settlement[26]. The level of fragmentation on the landscape today has created a lack of continuity not just of forest cover, but of the effects of the natural disturbances which historically shaped this landscape. Forest succession can be discussed as four stages for ease of communication. Forest succession can be viewed from all scales and zooming out to the landscape level when considering the implications of decisions made on any one property can create outsized effects from that property on the dynamics of the surrounding land. The four stages are forest initiation, stem

[25] D'Amato, A.W., & Catanzaro, P. (2022). *Restoring Old-Growth Characteristics to New England's and New York's Forests*.

[26] This generalization is not intended to minimize the real impact that indigenous tribes had on the landscape which included frequent intentional burning in places, clearing and maintenance of agricultural fields, and constructing semi-permanent settlements.

exclusion, understory reinitiation, and complex/old forest conditions. All stages of development are dynamic and the forest is constantly changing though the change is not always visible to us.

Forest initiation occurs directly following a high-severity disturbance (reset of conditions) or an abandonment of high intensity land use that allows a forest to (re)grow and is characterized by rapidly growing pioneer species of all classes (trees, shrubs, herbs) occupying the available growing space. Forest initiation ends as the vegetative structure shifts from a mix of annuals and perennials to a much heavier composition of perennials, and when all available physical growing space is occupied. *Stem exclusion*[27] begins when tree saplings have become dense enough that competition stress begins to shape the dominance structure of that class of trees. When the stem exclusion stage has ended and single trees and small groups of dominant and codominant trees fall from the canopy, creating spots of direct light and an overall increase in ambient light in lower strata, understory plants and trees on the more tolerant end of the light requirement spectrum begin to establish. This is known as *understory reinitiation*. A mature forest will persist in the understory reinitiation stage for some time. If a higher intensity disturbance affects that forest during understory reinitiation the impacted portions of the forest will revert to an earlier stage. If the forest remains mostly undisturbed for 200-300 years (in southern New England) *complex structure* begins to accumulate and the forest can be characterized as having "*old-growth*" functions[28]. What this indicates is that the area is very mature compared to other regional forests and has an abundance of complex structure and biological legacies.

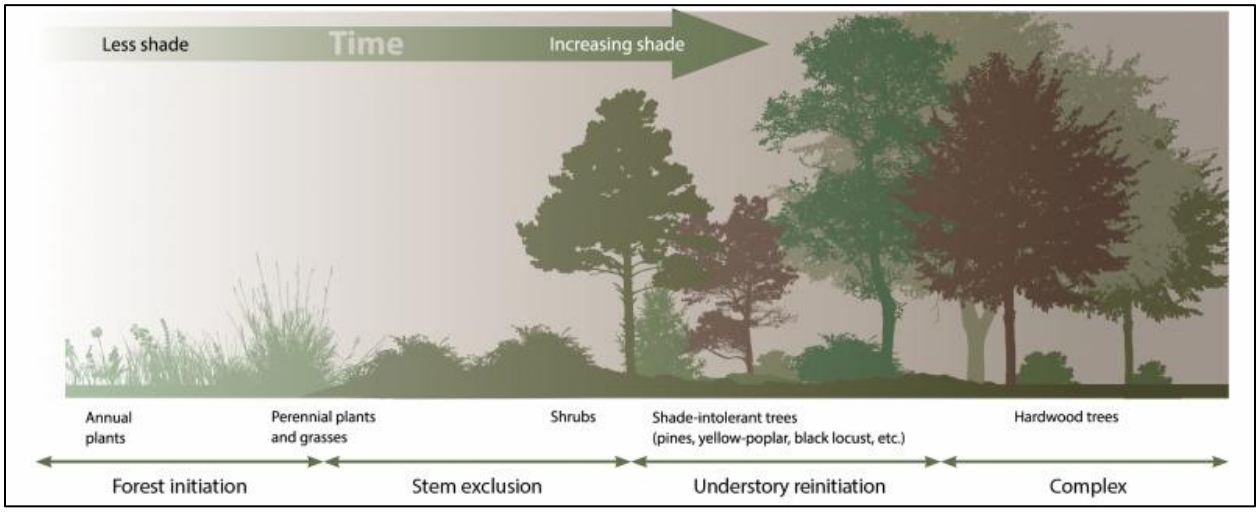


Illustration by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Tech.

A.3 Water and Soil Resources

Protection of the invaluable functions of aquatic and soil ecosystems is a primary ecosystem service forests provide. To ensure water and soil resources are maintained well, Best Management Practices (BMPs) based on scientific research are employed when forest management activities are conducted, especially but not limited to in and around sensitive areas such as vernal pools, drainages, wetland or

[27] Self-thinning is another phrase for the stem exclusion stage and accurately describes the process the forest experiences. Trees with less competitive characteristics are shaded out and better fit individuals effectively "thin" less fit trees from the cohort.

[28] This assumes that the forest has developed some of the conditions that are considered a part of the old-growth functions including some very large trees (though not always present and is site and species dependent), abundance standing dead and downed trees all in various stages of decay, multiple size and age classes of trees, limited soil disturbance, etc.

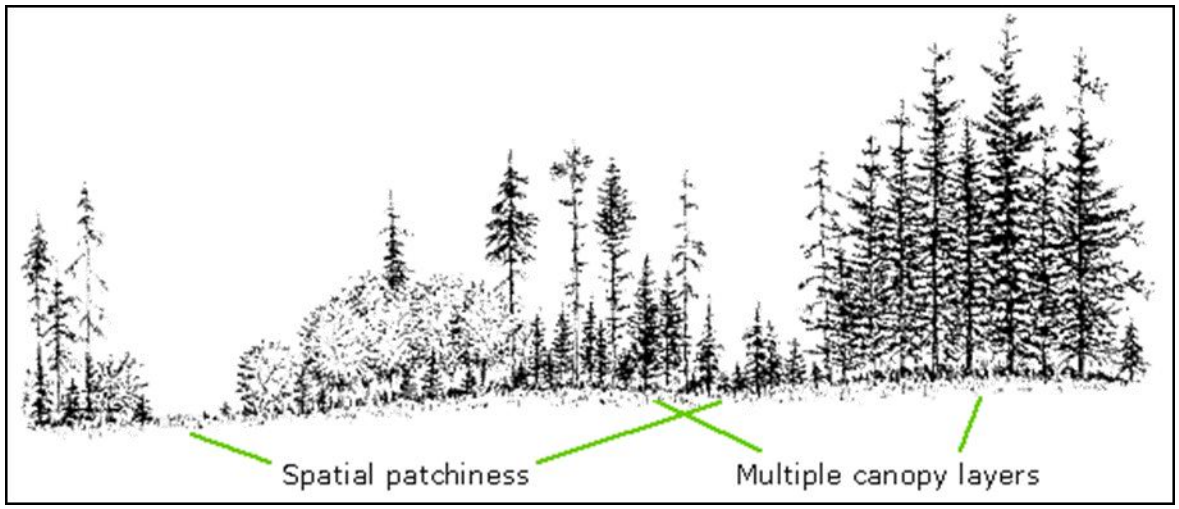
other sensitive soils, and slopes. These guidelines are intended to maintain functions of sensitive ecosystems (flood mitigation, amphibian breeding habitat, water filtration, etc.) while recognizing that intentional human stewardship of forests can have beneficial impacts.

A.4 Geology

Geology and topography are highly influential over the vegetation that grows on a site. Generally, soils at higher elevation, especially those with sandy compositions, are drier and less nutrient rich than those in lowlands, typically with clay comprising more of the soil profile. Trees and other vegetation have evolved over millennia to establish on sites across the spectrum of soil composition, depth, moisture, and nutrient availability. The groups of species which typically inhabit sites of a certain soil/geologic character are known as "natural communities." Natural communities are regionally variable (different species mixes occur on similar sites in different regions) because of the role climate/disturbance regimes played in evolution of these communities. Soils are not the only factor driving the formation of natural communities, but they are perhaps the most influential factor[29].

A.5 Forest Health

Commonly in Connecticut, species diversity found in the overstory is high, but few tree species are abundant in the understory and those present (unless they are shade tolerant like beech, hemlock, sugar maple, yellow birch, black birch to a certain extent, etc.) are unlikely to persist or thrive without a disturbance (human caused or natural) that provides them additional light and growing space. This trend of a shift toward a less diverse mix of species in the future forest represents a common condition in Connecticut's forests. The reduction in vegetative diversity results in reduced biodiversity of the associated fauna (insect and wildlife) as well as reduced adaptive capacity related to insect and disease infestations and changing climatic conditions.



The figure above shows the multiple canopy layers in one spot representing vertical structure and the spatial patchiness of horizontal structure over a wider area, both described in greater detail below. Diagram courtesy of the British Columbian Ministry of Forests.

[29] Historic land use and climate/disturbance regimes are also influential on natural communities.

Structure

Forest structural diversity is described both vertically and horizontally. Both pertain to the relative uniformity of successional conditions in any given land unit (stand, property, watershed, town, etc.). Vertical diversity is the presence of vegetation of various heights (also called strata) in a relatively small observable area. Horizontal diversity is the variation of vegetation types and heights on a larger landscape scale. Having a mix of successional and structural conditions on a property improves resilience. For example, if there are multiple age classes and size classes of trees in an area impacted by a wind event, the larger trees are likely to be impacted the most, but having younger, smaller trees in place can allow the forest to respond quickly to the disturbance and continue growing with a site-appropriate mix of trees.

Complex structure like large, unearthed root masses and abundant dead woody material improves niche abundance by creating more cover and shelter opportunities. Increasing the amount of large diameter trees while promoting pockets of densely growing young trees, including some larger patches of young forest, improves complexity and increases niche availability for wildlife.

The Importance of Oak

Oaks are important to retain as a major part of this forest now and into the future because:

- They support a wide variety of insects and wildlife, the likes of which no other native genera (i.e., genus or group of species) does
- They have very specific associations with some species of birds that nest in our area including (but not limited to) scarlet tanager, cerulean warbler, black-throated blue warbler
- They are well-adapted to current climatic conditions and projected climate changes
- They grow well on this site
- They are historically significant on the property
- They are aesthetically pleasing and long-lived
- Besides *Lymantria dispar* (a.k.a. spongy moth, formerly known as gypsy moth), there is currently a lack of oak-specific insects and diseases that tend to have large scale negative health implications which makes them an important piece of the puzzle for resilience and forest health and diversity moving forward
- The wood from oak is very valuable and can be used for a variety of purposes from firewood to flooring.

The Importance of Softwoods

General benefits on a hardwood dominated landscape:

- The diversity they add in terms of cover, forage (including nectar for pollinators), and structural elements
- The wildlife associations they provide including specific songbird habitat for nesting and foraging
- Both native pines are well adapted to projected future climate conditions

Hemlock are important for a variety of reasons including:

- Their function as a temperature regulating element along cold-water streams
- Their ability to act as shelter during storms and adverse winter conditions
- Their ability to tolerate shade adding structural complexity to closed canopy understories and midstories
- Their effective capture of rainwater reducing potential for erosion, and their efficient use of subsurface water allowing more available water for other plants and trees (Harvard Forest, 2017)

Proactively encouraging the development of multiple size and age classes of trees as well as increasing diversity of native vegetation in the regenerating cohorts can help buffer the property's risk of catastrophic impacts in any major storm event. As described above, this is part of the philosophy of not putting all the forest's eggs in one basket (e.g., a single age class or condition).

Wind and Precipitation

Wind is the primary agent of forest disturbance in southern New England. Wind can be described, similarly to other abiotic disturbances like fire, in terms of intensity (measure of wind speed and persistence relative to typical wind patterns) and severity (measure of on the ground impacts of an event). High intensity winds typically cause moderate to high severity impacts (depending on duration of the event and other compounding conditions like accompanying precipitation, season, etc.). High intensity wind events are uncommon compared to lower intensity winds which cause low severity (single tree and small patch disturbances) impacts.

High intensity winds are often associated with heavy precipitation events, especially during hurricane season (August-October). Tornadoes are another high intensity wind event that occurs regionally, but they are typically much shorter lived and much less frequently occurring than the tornadoes in the plains of the Midwest. Recently, southern New England has experienced more irregular, but generally heavier, precipitation events. These heavy precipitation events, especially when paired with extended periods of drought that create hydrophobic soil conditions prior to rains, have created more frequent flooding and soil erosion than was considered "normal" in the 20th Century. This dynamic is a concern for the health of trees across the spectrum of soil moisture tolerances because drought adapted species may be fine during a two month period with no rain but struggle to maintain healthy roots when flooding occurs or persists; the inverse is true for species evolved to growing in flood plains.

Historically, high intensity wind events caused severe impacts on a broad scale (hundreds of contiguous acres) on an irregular and infrequent basis. Low intensity wind events often act to sever damaged branches or fell whole trees which are already impacted by other stresses, like ice accumulation on fine branches. Low intensity wind disturbance occurs frequently in a forest stand and could be quantified as an amount of cubic volume lost per year from the above ground live growing stock. Historically, the combination of frequent low severity impacts to unhealthy/weakened trees and more indiscriminate high severity events were the primary actors that shaped ecologically complex (old-growth) ecosystems[30]. Since 1900, which is a good reference because of the amount of reforestation occurring across the state at this time was high and this provides a wide enough window (~125 years) to compare to scientifically backed estimates of historic disturbance return intervals, there have been relatively few high severity wind events that caused landscape scale disturbance. The hurricanes of 1938 and 1954, and more recently an early snowstorm in October of 2011, Hurricanes Irene and Sandy of 2011 and 2012 respectively are some of the most significant disturbances from this period. There have been a number of lower intensity wind events (hurricanes in 1985 and 1991 and various tornadoes which caused impacts to portions of towns) and hyper-localized flooding events which have regional significance to the more local landscape across the state as well.

[30] Beaver activity, which was significantly more prevalent on the landscape, and top down vegetative control asserted by the feeding behavior of prey species that feel predation pressure from wolves and catamounts were also significantly impactful in shaping the vegetative arrangement in southern New England prior to extirpation of all three species. Beavers have returned to the landscape but the outsized landscape impacts of beaver damming is minimized by human land use.

Insect and Disease[31]

The spongy moth (formerly known as gypsy moth) is an early- to mid-season defoliator of a variety of species of trees, but it focuses primarily on oak and aspen. Cool, moist spring weather helps build populations of fungus which help control the moth populations when they are in the larval (i.e., caterpillar) stages. There is also a virus which can help control populations when they reach a critical mass. More information regarding biological control methods: VA DOF Spongy Moth Control Methods

One method of reducing the negative impacts of spongy moth on forests is to keep individual trees healthy and vigorous through periodic thinning and to manage for species diversity, including trees that the insect finds less palatable. For more information on spongy moth and its control see this website: DEEP: Spongy-Moth-Information-for-Tree-and-Woodland-Owners .

Emerald ash borer is an invasive insect from Asia discovered in Canton, Michigan in 2002. Since then, it has spread wherever there are sufficient populations of ash trees, including Connecticut as of 2012 most often colonizing new areas as a result of humans transporting infested logs or firewood. All Connecticut counties have populations of EAB. Currently, there are no forest management techniques known to ensure the survival of ash trees once infected, so ash are often cut to salvage economic value or maintain safety where these are landowner goals. Since EAB will only fly as far as they need to find a new host tree, it's important that not all ash trees in any given area are cut because doing so will hasten their spread.

Signs of EAB infestation include the telltale serpentine galleries beneath the bark in the sapwood and the small D-shaped exit holes formed when the larvae exit the tree. Symptoms of infestation include crown dieback, epicormic branching, blonding[32], and/or tree mortality. There are several ways to dispose of an ash infested with EAB once the tree is felled including chipping it into mulch, turning it into lumber, hiring a professional tree service to take it away, or burning it. Ash makes excellent firewood even when freshly cut. Since the larvae reside inside the bark, infected trees should never be transported long distances to avoid spreading the borer faster than it would naturally disperse.

Beech leaf disease (BLD), which is new to Connecticut (first discovered in 2019 in Fairfield County), has begun to impact large swaths of beech trees in some parts of the state and was noted throughout this property. This disease is not yet well understood in terms of the dynamics of Connecticut's forests and beech's response here, but it has been established in different parts of the U.S. and Canada for over a decade. The disease is caused by a nematode (small roundworm-like insect) and its presence results in leaf discoloration, leaf curl, and early leaf drop, all of which can impact tree health. The Connecticut

[31] This section includes information on common forest stressors agents in play on the contemporary landscape. This is not intended to be an exhaustive list of all potential insects and diseases which may impacts the native trees of Connecticut. This list does also includes information on pest species which impact trees that may not currently exist on the property. Given the broad goal of increasing biodiversity these stressors are included to provide as full a breadth of knowledge as possible, in case new species with specific stressors become established on the property.

New pests are typically introduced through global trade systems and novel stressors may establish in the region over this ten-year planning cycle. Vigilance and monitoring are the most appropriate first line of defense against invasive pests, especially when that particular stress agent has not yet impacted a your property. Primary sources for this information include forestpests.org (USFS) and the Connecticut Agricultural Experiment Station (CEAS) which both provide fact sheets on the suite of non-native forest pests impacting the region today.

[32] "Blonding" is the term used for the removal of outer bark by woodpeckers to access the beetles beneath the bark of the tree. The inner bark that is exposed by the woodpeckers' removal of the outer bark is significantly lighter in color than the outer bark, giving the tree a blonde appearance from a distance.

Agricultural Experiment Station is currently working on experimental solutions to help treat infested beech trees and have had some promising successes, but not for a forest-wide setting. For more information see: https://portal.ct.gov/-/media/DEEP/forestry/BLD/Beech-Leaf-Disease---Updates-2021.pdf

Beech bark disease is a complex introduced into the tree when an insect called the beech scale feeds on sap just under the bark by attaching itself to the outside of the tree and drilling into the tree through the bark. A fungus called Nectria then finds its way into the vascular system of the tree. The physical manifestation of this on beech trees is black pock marks on the normally smooth light grey bark of the beech. The result of infestation is a loss of vigor, introduction of rot, and frequently structural failure and mortality can occur. Since many beech regenerate from root suckers, large areas of beech can be genetically identical. Beech bark disease is impacting a portion of beech established on the preserve and some mortality has occurred to trees infested by the disease complex.

Hemlock woolly adelgid is an invasive insect from Japan that feeds on the stored nutrients in the twigs of hemlock, thus weakening the tree and causing a sometimes-rapid decline. Hemlock woolly adelgid was first found in Connecticut and 1985 and had become ubiquitous by 1997. Although many hemlock have died since then, many have also hung on in varying levels of health. While there is no single treatment or management activity that is both effective and feasible for protecting hemlock in the forest from HWA, light thinnings to increase the vigor of surviving hemlock can make individual trees more able to survive HWA infestation.

Elongate hemlock scale (*Fiorinia externa*) is a non-native and invasive insect which latches itself onto the underside of hemlock needles, injecting its mouthparts into the primary nutrient pathway of the needle and sucking out the nutrients. If enough scale is present on an individual tree, the foliage of that tree will begin to appear greyish-green and can eventually die.

Nectria is a genus of fungi in the Ascomycete family which forms cankers on living trees. One of the most common species of *Nectria* is *N. galligena*, which forms cankers on the stems of black and yellow birch. Although the cankers do not usually kill the tree, they do impact its form and can significantly reduce its timber value if the canker is located within an otherwise valuable log. Additionally, the canker structurally weakens the tree, making it more likely to break during wind events. In extreme cases where there are many cankers on the stem of a single tree, the cankers can effectively cut off nutrient flow up and down the stem if they fully encircle the stem. Some birch on this property are impacted by *Nectria*, but it is not particularly widespread or a serious forest health issue at this point. Managing to minimize the impacts of *Nectria* primarily entails cutting trees that appear to be susceptible and retaining trees which appear to be resistant. *Nectria* is present on the property and is infesting more trees where birches are locally dominant and growing relatively densely.

Asian jumping worm is an earth worm species endemic to Asia. These rapidly reproducing worms regularly inhabit former agricultural fields and areas adjacent to agricultural lands. Asian jumping worms process leaf litter quickly and can impact regeneration due to a lack of duff to germinate within for species which prefer or require a humus medium. The soil binding effect of their feeding habit reduces the water holding capacity of impacted areas. Asian jumping worm feeding behavior can also disturb the root system of established plants. This can all result in reduced forest productivity, decreased biodiversity, and increased susceptibility to erosion and issues related to excessive precipitation.

The white pine weevil (*Pissodes strobe*) is a native insect that kills the terminal leader[33] of species of softwood trees. Common hosts for this insect include white pine, Norway spruce, and blue spruce. White pine is the only one of these species that is native to this area. The white pine weevil female lays her eggs in the terminal leader of suitable white pine trees. When the larvae hatch they burrow into the terminal leader. Their feeding can deform and kill the terminal leader which causes the horizontal branches to subsequently compete for dominance. This results in poor form, and while it is not fatal to the tree, can create structural instability depending on how the horizontal branches form to take the killed leader's place, and significantly reduces or eliminates any potential economic value of the tree.

American chestnut was once a dominant tree on upland sites in Connecticut, and across the entire northeast region. Chestnut blight was first identified in the United States in the 1930s. The fungus infiltrates chestnuts when openings are formed in the bark, either from a wound or as the bark separates while the tree grows, then rapidly regenerates and expands until water and nutrient passageways are blocked inside the host tree and the tree dies. This pathogen does not affect the root systems of chestnuts, however, which is why chestnut trees that died 80-90 years ago are still able to send up shoots even after repeated infections and die-offs from the fungus.

Dutch Elm Disease is a systematic vascular disease which causes wilt and early senescence by disrupting the flow nutrients across the trees cambium (inner bark). Dutch elm disease can infect both native elm species (American and slippery). The disease was first discovered in the region in the 1930s. Since, elms, which were historically abundant in floodplains and other lowland natural communities, have become a much lesser component of the diverse lowland communities which occur across the state. That said, occasional mature elms appear to exhibit some level of resistance and these individuals regularly reproduce. Apparently resistant individuals are typically poorly formed and show signs of stress including dieback and cankers.

Oak Wilt (*Bretziella fagacearum*) is a fungal disease which infects the xylem (water transporting cells) of the infected tree. Oak wilt was first identified in the United States in the 1940s in Wisconsin and spread to Connecticut by the 2010s. The disease is spread both by touching root systems and by insect vectors (bark and sap beetle species). Oak wilt can cause significant photosynthetic disruption and early leaf drop. Infection can cause mortality relatively quickly, especially in red oak species which are more susceptible to infection and impacts. Signs of oak wilt include early browning of leaves, typically occurs on individual branches as the disease moves through the tree (flagging).

Thousand Cankers Disease of Walnut (TCD) results from the combined activity of a fungus (*Geosmithia morbida*) and the walnut twig beetle (*Pityophthorus juglandis*). TCD causes bubbly, wart-like cankers on the bole and larger branches of infected walnut trees. TCD infects both white (butternut) and black walnut across the state. While lumber-quality walnut were not widespread in Connecticut prior to the introduction of TCD the impact to the tree causes disruption to fruit production, which has potentially significant impacts to forage load of areas where walnut is abundant. TCD is occasionally deadly, but typically acts as the primary stressor to walnut trees which are later stressed to senescence by secondary factors.

[33] The terminal leader is the top vertical extension of a tree.

White Pine Blister Rust is the result of infection by a non-native fungus *(Cronartium ribicola)* that causes the disease white pine blister rust. All of the North American white pines are susceptible to the rust. The rust, native to Asia, was introduced to North America around the turn of the twentieth century. White pine blister rust is carried by plants in the *Ribes* genus (currants). The infection causes blisters which burst and further spread the disease in sap flowing down the tree. Ultimately, blister rust disrupts tree function to the point that not enough resources are available to maintain foliage. Pines that die of blister rust essentially run out of energy to both fight infection and maintain photosynthetic capacity.

Asian Longhorned Beetle, ALB, (*Anoplophora glabripennis*) is a large, wood-boring beetle endemic to central and eastern Asia. The beetle typically uses maples, but other hardwoods are also susceptible to hosting the species. Similar to emerald ash borer, the main impact of ALB is caused by adult beetles entering the tree to lay their eggs, which consume cambium of the host tree as they develop from egg to adult and eventually emerge. Signs of ALB include large round exit holes left by adult beetles when they emerge from the host and frass at the base of trees which indicated juveniles feeding below the bark. ALB outbreaks are becoming more frequent in the mid-Atlantic region and this trend may continue into southern New England as shifts occur in climate regimes.

European Pine Sawfly, EPS, (*Neodiprion sertifer*) is an species endemic to mainland Europe and the British Isles. This accidentally introduced pest was first found in North America in 1925 in New Jersey. It has since spread throughout the eastern United States. EPS impacts planted pine species (Scots pine, mungo pine, red pine) in Connecticut and is not known to feed on eastern white pine regularly. The primary impact of EPS is caterpillars defoliating the needle of whole branches, and whole trees at outbreak levels. EPS caterpillars are born from eggs laid on pine needles the previous fall and they feed from tip to base on the needle bundles where they are born.

Forest Tent Caterpillar (*Malacosoma disstria*), a.k.a. army worm, is a moth species, which in its juvenile form practices communal feeding. Unlike eastern tent caterpillar, which typically feeds on species in the *Rosaceae* genus (cherries, crab apples) and does not cause major health impacts, forest tent caterpillars are less discriminate feeders which can cause decline in oaks, tulip poplar, willows, and other hardwoods (especially as saplings). Forest tent caterpillars go through natural boom and bust population cycles and impacts are typically only a concern when populations rise to or near the maximum.

Hemlock Borer (*Melanophila fulvoguttata*) is a native insect and secondary pest of eastern hemlock. Hemlock impacted by borers often loose bark on the main stem and show signs of stress via blonding (reddish discoloration on severely impacted stems). Presence of hemlock borer is an indication of significant stress, and whole stands of hemlock which are impacted by borer may be at risk of severe disturbance.

Southern Pine Beetle (*Dendroctonus frontalis*) is a bark beetle endemic to the southeastern United States. The southern pine beetle evolved outside of the natural range of pitch pine, the primary host in southern New England, and eastern white pine, only occasionally impacted. That said, pitch pine is not well adapted to responding to infestation by southern pine beetle and can be driven to mortality. Similar to other wood boring beetles, the impacts of SPB are caused by the activities of juveniles which hatch inside the tree and feed on live material within the tree as they develop into adults that exit the host tree in search of mates. White pine is infrequently impacted but is similarly maladapted to defending the impacts caused by pine beetle larvae.

Regeneration and Resource Allocation

During the forest inventory, regeneration was observed in two ways. The first was a nested 1/100th-acre plot at each inventory point that tallied saplings and a 1/1000th-acre plot in which seedlings were tallied. Seedlings were only tallied in this quantitative assessment if they were taller than 6 inches in height. Both nested plots were taken from the plot center at each inventory point. The second was visual observations made at each inventory point that recorded whether a species was present or not regardless of the sapling or seedling's height and regardless of whether the sapling or seedling fell within the nested plots.

Tree growth rates are frequently proportional to tree vigor and associated health for many of the species of interest, primarily oak. Tree growth rates are impact by several factors including:

- Site conditions (overall site and microsite)
- Genetics
- Slope position and aspect (i.e. direction the slope faces)
- Competition (primarily for sunlight)
- Species

Shade tolerant trees such as hemlock and some hardwoods (including beech) can be perfectly healthy but growing very slowly. For other species which require more sunlight, individual tree vigor and growth can be increased by active management techniques, such as thinning or crop tree release, that allow each individual more sunlight and room to grow.

In addition to using active forest management to attempt to increase vigor for the sake of healthier trees, a more vigorously growing forest can be more resilient when attacked by insects and/or infested with diseases. Forest management that increases structural diversity and complexity can also help a forest to be better prepared to respond to storm events and the threats posed by climate change.

Although it is important to attempt to ensure tree health and vigor through active management, not all trees that appear to be poorer quality should be removed. Having some trees (standing and on the ground) that show signs of rot etc. helps provide an element of ecological diversity that is important for a variety of species of insects, fungi, bacteria, and wildlife.

Deer are the primary large ungulate in southern New England. Deer feed on leaves throughout the growing season and can play a significant role in what vegetation persists on a site. Because of high deer populations and a relatively low amount of regenerating forest less palatable species are becoming more abundant than they have been for the past 250+ years. A lack of predation pressure on deer has allowed relatively unimpeded foraging and removed the element of "top down" control which wolves and catamounts had on the landscape before they were extirpated from the area. The impact of browse pressure has simplified the structure and diversity of the forest understory and midstory. Many parts of the state, and the region, suffer from an overabundance of deer. In forests, deer impact the abundance and diversity of understory vegetation, including tree regeneration, by preferentially browsing some species and ignoring others. Some preferred browse species are oaks, sugar maple, yellow birch, hickory, hemlock, and pines, while they tend to ignore invasive plants, beech, black birch, and to some degree, red maple. Accordingly, an excess of deer in a given area will make it extremely difficult to successfully regenerate desired tree species.

Invasive Plants

Without preparatory treatments of invasive populations, the other actions recommended in this plan, which are aimed at improving forest health by diversifying structure, may have reduced positive impacts and could result in an unintentional increase in invasive plants which in turn would have negative impacts on long-term biodiversity, productivity, habitat values, and resilience.

Not all non-native species are considered invasive. In fact, some non-native plants such as apple trees and some clovers have become naturalized in our region and are considered beneficial for a variety of reasons, including their values for pollinators, wildlife, and aesthetics. As opposed to native and beneficial naturalized species like those described above, invasive plant species have qualities that make them detrimental to the overall ecological health of an area. These qualities can give invasive plants a competitive advantage over native species and can lead to the development of monocultures of invasives, reducing species diversity. Such features include:

- Vigorous sprouting when above ground portions of the plant are cut;
- Prolific seed production;
- Rapid growth rates;
- Ability to colonize disturbed areas;
- Long periods of seed bank viability;
- Extended growing seasons due to early leaf out and ability to photosynthesize later in the season;
- A lack of wildlife species that browse on buds.

The reduction in species diversity noted above is important because a diverse ecosystem is more resilient to climate change and other environmental stressors and helps to provide habitat options for wildlife and insect populations, including pollinators. Wildlife and insect species have adapted to be able to utilize the pollen, seeds etc. produced by native species in an area. In general, fewer insect species utilize the nectar of invasive plants. Because significant populations of invasive plant species can have a negative effect on ecosystem health, it is best to treat known infestations while they are small and manageable. For more information on how to identify and control invasive plant species in Connecticut visit: https://cipwg.uconn.edu/control-information/#.

Invasive species control generally includes one or more of the following:

Chemical control – using herbicides/pesticides

Mechanical control – physical removal of the invading species

Biological control – introduction of natural enemies or predators

Ecological control – manipulation of environmental factors to favor species

Wildfire and Prescribed Burn Opportunities

Forest fire is described in terms of severity and intensity. Fire severity is the extent to which damage occurs, in other words the long-term effect fire has on a site. High severity fire is synonymous with a stand

replacing event where most or all vegetation is killed, essentially resetting succession. Intensity describes the characteristics of the fire while it is occurring (flame length and rate of spread). Low intensity fires are those which burn the forest floor at slow to moderate rates of spread. Low intensity fires with a mix of low and moderate severity impacts are the goal of most prescribed burns.

Fire is an agent of natural disturbance in all forests globally. Some forest types are adapted to persist or thrive with regimes of frequent low severity fires while others experience fire very infrequently and at stand replacing severity. Determining where each property and forest stand falls within this spectrum informs management, including controlled burning of appropriate sites and allows land stewards to prepare for wildfires.

The original stewards[34] who co-evolved with and managed North American ecosystems extensively used fire as a tool in landscape augmentation. Advances in scientific research have pointed to the utility of prescribed burning in achieving management goals. These advances have created a unique opportunity to build relationships between land stewards interested in prescribed burning and the indigenous people who originally practiced this management in the region.

Suppression[35] of fires in New England since the early 20th century has built up fuels[36] on sites which formerly experienced semi regular burning. In some forest types, suppression has created the potential for catastrophic landscape scale wildfire. This potential is notably less likely to occur in a given year than fires in the western and southeastern United States. While prescribed fire is a management option, it is not appropriate for some sites. On sites which may have historically experienced frequent fire but are not candidates for burning today there are mechanical means of reducing fuel loads and managing for the historical cover type.

A.6 Wildlife, and Biodiversity

Structure and Composition

Many wildlife species use multiple habitat types and conditions to complete their life cycles. Providing diverse habitats can help ensure successful survival and reproduction of a variety of species. Lack of specific habitat features is often the limiting factor that determines whether or not a species can survive or thrive in a given area. Common habitat requirements include cover from predators, access to water, shelter from weather, suitable breeding areas, and places where wildlife can successfully forage or hunt for food.

As a forest develops, vegetation size and species mixes can and frequently do change. Concurrently, its usefulness for satisfying the requirements of any given species also changes. Because of this, a mosaic of different habitat types is often beneficial and even necessary for most species of wildlife to be successful. For example, wild turkeys use mature forest with down woody material or shrubby areas for nesting habitat or breeding habitat. After the young have hatched they use open fields where they feed on soft-

[34] Indigenous communities globally traditionally used fire as a tool for landscape manipulation.

[35] Fire suppression describes the practice of preventing and eliminating fires without consideration for the role fire plays in ecosystem function. This doctrine has been adapted in recent years by state and federal agencies to include the implementation of prescribed burning as a method for reducing wildfire ignition and spread to potentially hazardous or costly areas.

[36] The term fuels describes any flammable material which will or could burn and spread fire. In fire prone areas reduction of fuels (leaf litter; fine woody debris; dense areas of complex vertical structure) mitigates the likelihood of wildfire ignition from natural or accidentally human caused sources.

bodied insects. As the young turkeys develop they are able to use the mature forest for feeding on hard mast[37] from oak and beech trees[38].

Early successional habitat dominated by dense growth of tree seedlings and saplings is severely underrepresented in this region. There is a paucity of areas with large, contiguous patches of 0-15 year old tree seedlings, saplings and shrubs as the featured[39] vegetation. Some of the recommendations in this plan are intended to create areas in which seedlings, saplings, and understory vegetation grow densely to diversify the forest's structure, regenerate target species, and for that condition's utility to wildlife.

On the other side of the spectrum, there are not many places in Connecticut and throughout the region that have old forests. Old forests frequently contain many of the features that managing for structural diversity and complexity creates. These include lots of coarse and some fine woody material, small canopy gaps, trees of various sizes and age classes, and large diameter live and dead trees. Old forests provide unique habitat conditions utilized by certain species of fungi that generally aren't otherwise present. Though there are no obligate old forest wildlife species in this area (pine marten and goshawk populations are nearby and both are near old forest obligates which require complex structure for their hunting strategy), many of the species that utilize diverse, well-managed forests will also use the structural attributes old forests provide. All treatments recommended in this plan will create some of these attributes. Recommendations of passive management[40] indicate that the stand is on a trajectory toward diverse old-forest condition with no need for intervention. Passively managed areas develop complexity slower than areas actively managed to provide similar structural compositions.

Recent studies at the University of Vermont have helped increase our understanding of how people can manage forests to increase carbon storage, maintain tree vigor, and emulate old forest conditions. These treatments include light thinnings, retaining many of the larger diameter trees, creating small canopy gaps to encourage regeneration, allowing much of the woody material to remain on site, and in some cases purposefully toppling trees using machines with cables to pull trees over with root ball intact to simulate windthrown trees[41].

Snags, Cavities, and Down Woody Material

As a forest develops and trees become stressed by competition, drought, disease, insects, or severe weather, some trees begin to decline and die. In our changing climate, more extreme storms are likely to occur more frequently. As processes of decline happens regardless of cause, columns of rot can develop in affected trees. Following the development of rot, insects often find their way into the tree, which in turn attracts predators including woodpeckers. The woodpeckers create larger openings in the trees, and are then used by them and other wildlife as shelter cavities.

[37] Mast is fruit or nuts produced by woody shrubs or trees. Examples include acorns (hard mast) and cherries (soft mast).

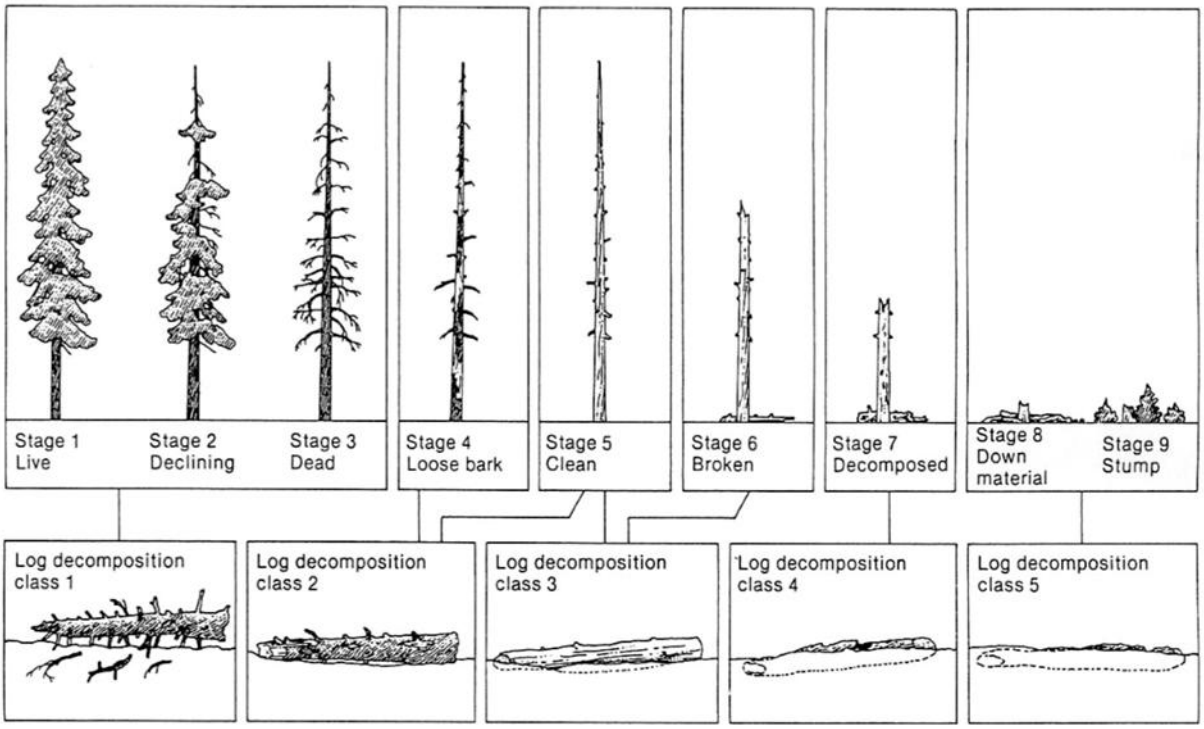
[38] DeGraff, R. M. and M. Yamasaki, New England Wildlife Habitat, Natural History and Distribution, University Press of New England, Hanover, NH, 2009, 126.

[39] Featured indicates that this is the primary (i.e., top) layer of growth in the stand or area.

[40] Passive management does not include treatment of non-native invasive plants and/or pests. Controlling non-native species is essential in promoting healthy ecosystems.

[41] Mimicking Mother Nature, UVM Scientists 'Nudge' Forests Toward Old Growth Conditions. Masterson. 2017.

As trees die[42], some remain standing and continue to rot, becoming what are known as standing dead snags. Snags provide habitat for insects that birds and small mammals will eat. As these trees, or pieces of them fall, down woody material is created. Larger pieces (greater than 4" inches in diameter) are considered to be coarse woody material or CWM. Smaller pieces of down woody material are referred to as fine woody material or FWM. Coarse and fine woody material are both important as habitat features and for the purposes of habitat, nutrient cycling, hydrologic cycles, and other reasons on the site.



Standing dead decay classes (1-9) and downed CWM decay classes (1-5) (Harmon et. al., 2011). Trees act as habitat structure throughout the full lifespan of the woody material produced by the live tree. Material from softwood species are generally longer lasting after tree death because of the resinous characteristics of most softwoods.

CWM can provide habitat for salamanders and other wildlife that use it for cover. Also, as downed logs enter late stages of decomposition they retain significant moisture, acting as germination sites for seedlings. Yellow birch, hemlock, and white pine specifically do well germinating from "nurse logs". During the process of decomposition, carbon in coarse woody material is slowly released back into the atmosphere and reabsorbed into the soil. Fine woody material when aggregated (intentionally – in the form of slash piles – or otherwise) can act as nesting and foraging areas as well as cover for many species. The amount, size, and arrangement of woody material on the forest floor also impacts the variety and abundance of insects, fungi, and herbaceous plants, hydrologic regimes, and fuels characteristics of a forest (Mount 2002).

As a forest matures, large trees die and fall to the ground, increasing CWM. While some forms of active forest management result in a net increase in woody material, the increase is generally in fine woody material that has less long-term value than large diameter material and is much more ephemeral as it

[42] Harmon et. al., 2011.

decomposes relatively rapidly, returning the vast majority of growth limiting soil nutrients held in live trees if tree tops are retained). Retaining large snags and live potential cavity trees during management activities adds to the supply of coarse and fine woody material. In addition, the purposeful retention of some large CWM can help recruit additional features which will be more long-lasting and have greater ecological impact.

The Role of Primary Producers in the Forest Food Web

Forage from trees, shrubs, and all other forest vegetation are the foundation of the forest food web. Leaves, buds, flowers, nectar, pollen, berries, and nuts are consumed by herbivores, including many species of insects, which are preyed upon by mammalian, reptilian, and avian predators or by omnivores which may predate and/or be preyed upon. In this way the primary producers of a forest have a "bottom up" effect on the fauna that can persist in an ecosystem. This means that a forest with more abundant and diverse palatable forage will support a broader suite of species than one with a simpler and less palatable composition. Properties with higher biodiversity of lower forage classes (i.e., understory vegetation) are also more attractive to long-ranging predators, like bobcat, bear, and red-shouldered hawk, and will likely become core habitat for these species (DeGraaf and Yamasaki 2009). Productivity is increased when vegetative structure is composed of mostly or exclusively native vegetation.

Mast production is an important consideration for determining and improving habitat quality. Mast comes in two main forms: hard and soft. Hard mast includes nuts and other physically hard seeds produced by species such as oak, hickory, beech, and hazelnut among others. Soft mast is present in the form of berries and other soft fruits including black cherry, sassafras, dogwood, and tupelo in tree form, but also blueberry, huckleberry, and many viburnums in shrub form. Forests with a mix of hard and soft mast from a diversity of trees and shrubs provide a fuller suite of food sources for foraging insects and wildlife.

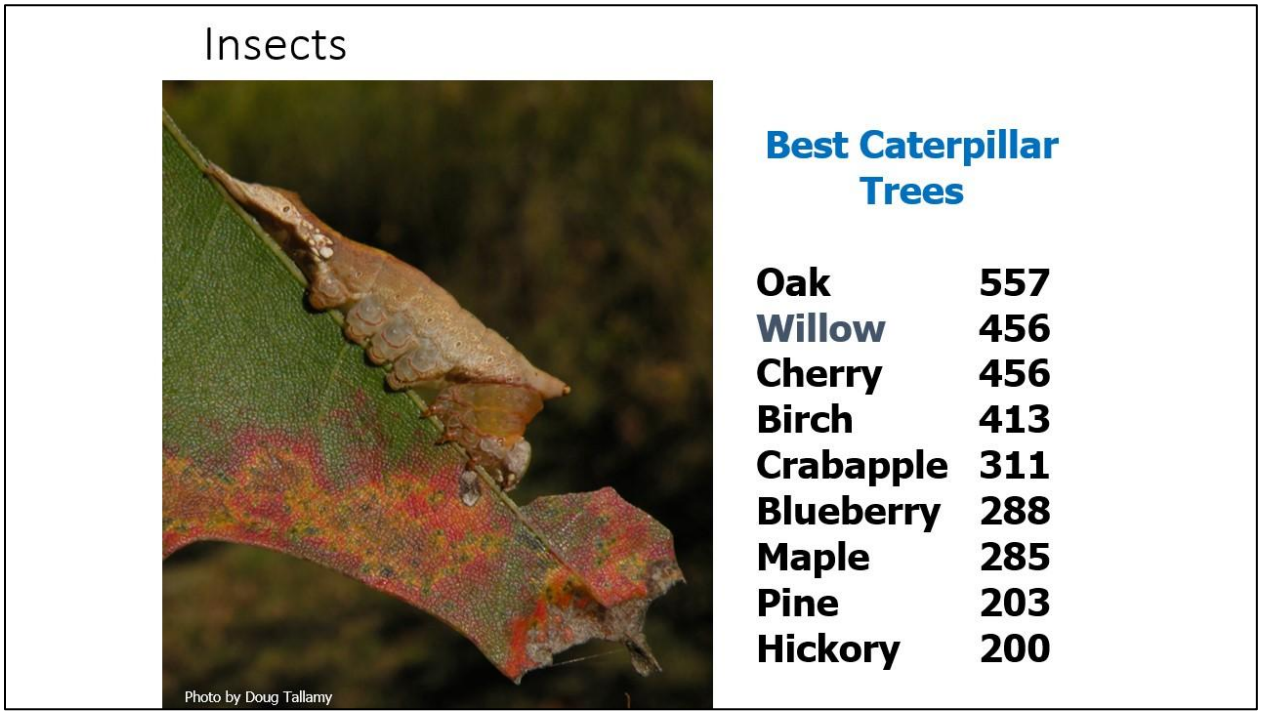
Currently, valuable hard mast producing trees (especially oak) play a major role in many forests across the state. Wildlife species that depend on mast generated by this cover type include ruffed grouse, wild turkey, redheaded and red-bellied woodpeckers, blue jay, squirrels, chipmunks, mice, gray fox, red fox, black bear, striped skunk, and white-tailed deer. "Wood duck, American black duck and mallard can also benefit from hard mast where... [hard mast producing trees] occur adjacent to shallow water bodies, streams and other wetlands" (DeGraaf et al. 2009). Among hard masting species, specifically oaks, large diameter individuals produce disproportionately high volumes of nuts compared to smaller trees. Genetics also play a role in mast production so identifying and retaining heavy producers can improve mast production in the local genetic stock (Patterson et. al. 2023).

Soft mast producing species including tupelo, sassafras, wild grape, blackberry, maple leaf viburnum, raspberry, spicebush, blueberry, huckleberry, and some invasive plants range in abundance but are generally less common than hard mast producers in mature forest stands. It is beneficial for many species of wildlife to have a combination of hard and soft mast in their diet as each mast source provides different dietary elements. Hard mast often has more protein and fats, whereas soft mast tends to be higher in sugars.

Leaves are fed upon by insects and some mammals. Each tree species hosts its own suite of insect herbivores, with oaks (especially white oak) being one of the most preferred genus for herbivores. These insects are essential links in the forest food web. Secondary, and to a lesser extent tertiary, consumers including bats rely on these insect herbivores as a food source. Many of the migratory birds, and all

migratory bats in our region breed in New England because of the diverse and abundant insect populations which are available in forests, fields, and aquatic ecosystems.

Buds contain densely packed nutrient stores and provide a winter food source for many resident species. Buds are relied upon by grouse, rabbits, deer, and other year-long residents to survive the long dormant species. Some insects (e.g., oak leaftier) have evolved their life cycle to feed as larva on buds as they begin to expand/open in spring. Others use buds as overwintering shelter.



Oak trees provide forage for more caterpillars than any of our other native species of trees (Tallamy, 2007). Slide courtesy of National Audubon Society and Audubon Connecticut.

Trees and other forest vegetation, including early spring ephemerals, are food sources for bees, moths, flies, and butterflies among others. Maintaining diverse sources of nectar from native vegetation that provide sources of flowers for nectar and pollen throughout the growing season is vital for sustaining healthy pollinator populations. Without adequate populations of nectar feeding species (especially insects), plants that can self-pollinate would have a competitive advantage which would simplify the species composition in an ecosystem, perpetuating a loss in biodiversity and productivity. Additionally, a loss of nectar-feeding insects would result in a net loss of consumers going to the top of the food chain. The diversity found on the property is beneficial to pollinators. Increasing the abundance of some less common species which are often outcompeted by more common species would improve the habitat quality on the property for species which have coevolved relationships with these less common species.

A.7 Carbon Cycle Dynamics

Carbon offset markets are a relatively new path to revenue generation for forestland owners. Carbon markets aim to quantify and monetize the atmospheric carbon captured and stored in a forest. Carbon is sequestered as a tree photosynthesizes and is stored in wood as growth occurs. Young, open-grown trees sequester carbon much more rapidly than trees growing in closed canopy forests. Well-functioning forests comprised mostly of healthy and vigorously growing trees sequester carbon more efficiently, due to

elevated growth rates compared to overly dense stands, and store carbon longer due to lower annual mortality rates (some carbon is released to the atmosphere by decomposing trees – freshly decaying wood releases more carbon than in later stages of decay).

The recommendations within this plan are likely to increase long-term carbon sequestration and storage, both on the property and within the durable forest products that will ideally be generated through forest management activities. This will be accomplished by maintaining much of the carbon stored currently on the property (in trees and soils) and by increasing carbon sequestration rates through the removal of invasive plants and release of native tree regeneration and retained mature trees that will sequester carbon more effectively and store it for longer. Limiting unnecessary soil disturbance can help retain the carbon stored in soils.

Though not as prolific as the storage in trees and soils it is important to recognize that long-lived forest products store carbon as well as serving human needs. Durable, long-lasting wood products continue to store carbon in their fibers while live trees retained in the forest can increase their rates of carbon uptake and storage due to increased resource availability, primarily sunlight.

A.8 Inventory Methodology

To conduct the inventory presented in this plan, a series of plots were laid out in the proposed treatment area. At each plot, a 20 Basal Area Factor angle gauge was used to determine basal area. Individual tree measurements were recorded with a diameter tape and/or a Biltmore stick while tree health was determined by visual inspection. Abundance and diversity of tree regeneration is assessed quantitatively by a pair of nested regeneration plots (1/100th-acre for saplings and 1/1000th-acre for seedlings) taken near each overstory plot. Understory native and non-native/invasive plant dynamics are assessed qualitatively property wide while collecting quantitative tree related data. Resource concerns were identified using a combination of quantitative data from inventory plots and qualitative visual observations both at inventory plots and throughout the property as a whole. For the quantitative data represented in this plan, seedlings were only counted if they are greater than 6 inches tall, though qualitative observations were made for all the regeneration irrespective of height.

A.9 Forest Management

Silviculture

The practice of managing forest ecosystems to grow trees is known as silviculture. Often foresters refer to silviculture as “an art and a science” this description is based in the variability of natural systems, which creates challenges in terms of predictability while also allowing for practitioners to be highly creative in addressing the goals of a project. Silviculture is a relatively new science, first introduced in America at Yale around the turn of the 20th Century. Early silvicultural research and education was driven by goals of sustained timber generation. The contemporary impetus of silviculture is much more subjective and dependent on the goals of the interested party. Generally, goals which aim to improve ecological conditions (Ecological Forestry), especially habitat for wildlife and increasingly carbon cycling, are more commonly the driving force of management decision making in the region today. Often, models based on historic pollen records[43] and wildlife surveys inform the landscape level landcover targets for ecological

[43] Sediment cores from ponds, lakes, and bogs can be analyzed to determine the relative abundance of different plants at different points historically. Pollen records inform our understanding of historic landcover by applying our understanding of the

forestry practitioners while landowner goals are more informative to stand level decision making. Ecological forestry practitioners have adopted and modified the original sustained yield silvicultural techniques developed in the 1900s to create a more holistic toolbox for land stewards to employ in achieving their goals.

Recommended actions in this plan are intended to achieve stated goals with care and balance for as many features and factors as possible. Dates and recommendations should be flexible based on changing conditions and goals. Ensure equipment is suitable to achieving the goals of the operation without concerns of negative equipment-related degradation.
Using concepts from New England Forestry Foundation (NEFF) guidelines for "Exemplary Forestry[44]" can help ensure the management activities undertaken can maintain and enhance resilience and productivity.

a. Continuously improving forest stands in terms of both quality and quantity.
b. Providing conditions which are well-suited to the umbrella wildlife species known to be representative of the habitat needs of the great majority of native species
c. Maintaining connectivity between habitats.
d. Achieving a diverse size class distribution of 5-15% of stands in seedlings, 30-40% in saplings and poles, 40-50% in sawtimber and including up to 10% of the landscape in large diameter multi-storied stands.
e. Growing tree species well-suited to each site (e.g., matched to soil and physiographic conditions as well as expected changes in climatic conditions).
f. Stocking that fully occupies the sites; this is an average of "B" line stocking for stands not currently being regenerated.
g. Growing and harvesting quality timber at an average of 0.5 cords/acre/year.
h. Addressing climate change

Active Forest Management Techniques

Tree cutting and other direct manipulations of the vegetation growing in a stand can have impacts across a range of intensity. Foresters generally aim to accomplish one or some combination of the following goals when conducting active management operation: Regenerate a mix of species of a certain shade tolerance based on the retained overstory's canopy closure; Improve growing conditions for established overstory trees to improve vigor and/or growth rates; Restore historic natural conditions to areas which have been "benignly neglected" compared to historic management regimes that shaped certain natural communities (i.e., fire adapted communities); Produce a variety of forest products from firewood to sawtimber and beyond. Various forest management techniques (described below) can be employed to accomplish these broad goals for the purpose of achieving specific landowner objectives on a property.

At Ferrucci & Walicki we take our ethical duty to leave the lands we interact with in a better condition than when we came in contact with them very seriously. We do not participate in management operations driven by revenue generation if that means that the future ecological functionality of the area will be at risk (a.k.a., high-grading).

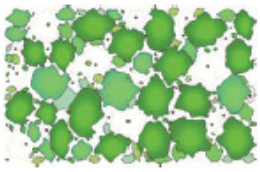
arrangements different suites of plants are typically found in an area to the abundance of pollen of different species at different levels (ages) within a sediment core sample.

[44] Exemplary Forestry is a concept developed and promoted by the New England Forestry Foundation. It is intended to help increase the awareness of important and potentially measurable forest management outcomes with a wide breadth of goals driven in large part by regionally appropriate presence of wildlife species and site specific potential for production of wood.

That said, revenue generation is a valid and sometimes necessary goal for forestland owners. Well-planned operations can both generate revenue and improve the ecological conditions of the area of work. Being able to sustainably produce a variety of forest products as part of the management of the forest also provides an additional benefit to local, regional and global economies. Ecological forestry techniques, which are based in extensive regional scientific research and a deep understanding of how different forest types react to different treatments, are a way that we as foresters help landowners to accomplish the highly variable goals they have for their land.

In 2013 Jeff Ward, Tom Worthley, Peter Smallidge, and Karen Bennett updated the Northeast Forest Regeneration Handbook (see sources cited for full reference) to communicate with forest landowners and forestry professionals about the range of ecological silviculture treatments available to address the silvicultural goals of a stand or property. The handbook included a number of useful graphics that help landowners understand the implications of different silvicultural recommendations they may see in this plan or elsewhere. That section of the handbook is provided below[45]; descriptions are in order of least to most intense in terms of tree removal.

[45] There is no description of thinning or crop tree release in the source handbook. Thinnings are variable in terms of retention/removals based on the level of stocking of the initial stand. Crop tree release is a relatively simple technique to envision because the only trees cut during a crop tree release are those directly competing with crop trees. The intensity of removals in a CTR is based on the amount and spacing of crop trees.



Single-tree selection

SINGLE-TREE SELECTION

Single-tree selection (or, simply, the selection method) is used to create or maintain multiple-aged or uneven-aged conditions in a forest stand. Some trees from all size classes are harvested from the stand during each harvest entry or treatment. Selection systems result in the least dramatic changes in the forest compared with other techniques. A selection system is the most technically difficult to implement, but offers some unique advantages. This regeneration method most closely mimics the processes found in unmanaged forests, albeit at an accelerated pace, where trees gradually decline and die. Removals are done on a periodic basis so that trees of a variety of age classes are established and growing in the stand. The openings created for regeneration provide conditions most favorable to slower growing shade-tolerant species.

With this system it is difficult, if not impossible, to regenerate certain species in areas having high deer densities. Because the forest remains relatively open, deer can access the small patches of regeneration. In these patches, deer will preferentially browse some species (sugar maple, hemlock) and leave others. The end result is a silvicultural system that, by nature, restricts species diversity and simultaneously limits the abundance of palatable species. Few successes of the selection system exist in low-elevation northern hardwood stands. Low site quality further reduces species diversity by favoring typically less-desired species, including beech and striped maple.

Landowners who consciously practice uneven-aged management by the selection method are generally most interested in maintaining a continuous forest cover with trees of differing ages. The most desired growing stock can be identified and its growth enhanced through the gradual removal of poorer quality competing trees. Fast-growing trees and high-income yields are generally a lower priority for these landowners. This method is commonly applied in settings where multiple objectives, such as habitat, esthetics, recreation, and income, all must interact. **This method should not be confused with the commonly used and abused phrase "selective cutting," which has no basis in scientific forestry practice or terminology**. See "Diameter-Limit Cutting and High Grading" on page 40.

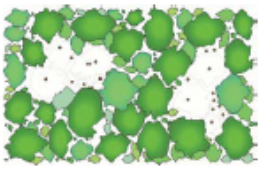
Advantages

Maintains continuous forest cover with low visual impact; periodic income for forest owner; favors shade-tolerant species; ability to remove declining trees; harvest schedules can be adjusted for market conditions; can maintain cavity and den trees.

Disadvantages

High skill required for successful implementation; higher costs for inventory, marking, and harvesting; may result in lower fiber productivity and lower yield in subsequent harvests; will lead to long-term loss of diversity; increased potential of damage to residual trees; may require several decades to transition an existing even-aged stand into an uneven-aged stand.

Group Selection or Patch Cutting



Group selection or patch cutting

A variant of the traditional selection system is the group selection system, which removes small groups of trees rather than individual trees. The larger openings encourage regeneration by a greater diversity of species. Group selection compares with small-scale and localized high-intensity disturbance, such as multiple tree fall gaps associated with a microburst wind event, an ice storm, or, perhaps, pockets of insect or disease mortality. It is a hybrid method incorporating some of the features of both the single-tree selection and silvicultural clearcutting methods.

This approach does not select individual trees or distribute the intensity of the harvest evenly throughout the stand, but rather removes groups of trees. This method is suitable for certain habitat enhancement and can also be used to create a multiple-aged condition. Poorly formed and less valuable trees are cut and removed along with the commercially marketable ones.

A greater diversity of regenerating species can result if the patches created are large enough to permit full sunlight to reach the forest floor in part of the patch, creating conditions in which shade-intolerant species can compete. A good rule of thumb for shade-intolerant species is to make the minimum opening twice as wide as the surrounding trees are tall, resulting in openings that are at least a half-acre in size. Smaller openings (¼ acre) may be sufficient for midtolerant species or to release saplings (e.g., white pine, sugar maple, red oak) established during previous harvests. During each harvest designed to create new groups, some tending or thinning of previously established groups should occur.

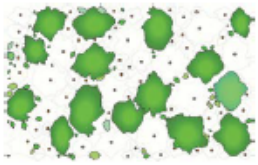
A forest managed using the group selection method will soon resemble a quilt of multiaged and multisized trees. Crucial to the long-term success of group selection is careful placement of the skid trails and roads. A well-designed road system not only lowers harvesting costs, but also provides the landowner with a trail system for recreational use.

Advantages

Allows regeneration of shade-intolerant species without clearcutting if patches are large; provides the landowner with periodic income; provides a variety of habitats, from early to late successional; harvest schedules can be adjusted for market conditions.

Disadvantages

Resulting patchwork forest increases management costs; patches may be too small for midtolerant or intolerant species that require abundant sunlight; deer may concentrate feeding in recent patches; residual trees near patch edges may be susceptible to damage.



Shelterwood system

Shelterwood System

As its name implies, this method regenerates a new forest under the temporary shelter of older trees. The shelterwood system is similar to disturbances in which only a scattering of overstory trees remains alive. Examples of these disturbances include overgrazing by cattle, a moderate wildfire, or species-specific insect or disease mortality.

Residual trees should be selected from those that had been the most dominant stems in the preharvest forest in order to provide a seed source and moderate the climate for the new stand, which becomes established over a number of years and will become the next even-aged forest. Simultaneously, the residual overstory benefits from extra growth and increases in value until it, too, is removed. The landowner derives relatively substantial income from each of the harvests. A period with no timber income will follow the final overstory removal (see Silvicultural Clearcutting on page 38), however, until the new forest is old enough for commercial thinning.

The shelterwood regeneration method can be applied over two or three harvest stages, depending on physical, biological, and economic factors. This method dovetails well with recreational and habitat objectives. The initial harvests create an increasingly park-like tableau of majestic trees canopied over a carpet of new regeneration and wildflowers.

Landowners and foresters should pay attention to the presence of an established understory during the initial harvest. Forests that were thinned late in development may have an existing layer of unplanned-for small trees of less desired species and interfering vegetation in the understory. If present, these trees will begin to grow faster in response to the increase in light and soil moisture and will become the next forest. If the smaller trees are predominantly desired species, no understory treatment is needed. If the smaller trees are mostly undesirable species, some application of low disturbance is paramount. Low disturbance treatments might include fire, controlled grazing, or herbicides.

The overstory is harvested in two or three clearly defined stages scheduled several years apart. The number of overstory removal stages, and the interval between them, are scheduled according to the desired regeneration species mix. If, for example, a three-stage shelterwood system is applied in a stand at 10-year intervals, the overstory trees will be harvested over a 20-year timeframe and the new forest will be almost 20 years old by the time the final cut is made.

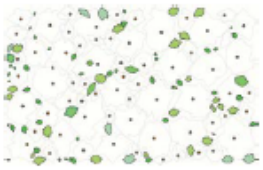
The goal of a shelterwood is to develop advanced regeneration of desired species. Advanced regeneration is older seedlings with large, well-established root systems that allow the seedlings to be competitive with other vegetation when the overstory is removed in the final harvest. New seedlings of many species, especially oaks, have poor height growth even in full sunlight until they have become advanced regeneration (Brose and others 2008).

Advantages

Can increase midtolerant (e.g., oak) regeneration; increased volume growth of residual trees can maintain stand volume growth; least dramatic even-aged silvicultural system; possible genetic improvement in regeneration; damage to residual sawtimber usually minimal; increased vertical structure; regular periodic income to the landowner during harvest stages; some residual trees can be retained beyond the final harvest to maintain large and mature trees in the stand.

Disadvantages

High skill required for successful implementation; requires market for smaller trees; stands on thin or poorly drained soils may have significant loss of residual trees to windthrow; residual trees may lose quality due to epicormic branches (water sprouts); delay in implementing successive stages (harvests) can lead to loss of midtolerant species and damage to new regeneration.



Silvicultural clearcutting

Silvicultural Clearcutting

It comes as a surprise to some that clearcutting, when properly planned and executed, is an indispensable and legitimate regeneration method. There are certain species of trees that fully develop only under the full sunlight conditions found after clearing all competing vegetation, including yellow-poplar, aspen, paper birch, many oaks, eastern redcedar, and butternut. Without clearcutting or final overstory removal following a shelterwood, these species will gradually decline and become rare.

There are other situations in which clearcutting is appropriate. Sometimes a forest stand is in such poor condition as a result of insect damage or past abuse that it does not fit with the long-range objectives of the landowner. Faced with this situation, a landowner may be better off to remove the existing stand and start over. There may also be times when a landowner wishes to convert an area from one type of species to another (e.g., diversify habitat by converting a stand of red maple to eastern white pine).

A clearcut mimics the conditions found following a catastrophic windstorm or fire, returning the forest to its earliest successional stage. It provides the best competitive advantage to the species that require full sunlight to survive. Regeneration must come from seedlings established prior to overstory removal, from a nearby seed source, or from root or stump sprouts. As with the other regeneration techniques, failure to ensure a source of seedlings will result in regeneration failure.

It is important to understand that for shade-intolerant regeneration to be successful, **complete removal of all competing vegetation is required**. Removing only the trees that are most valuable or larger than a certain size and leaving the others behind does not constitute a silviculturally correct clearcut system; it is a commercial clearcut with all of its potentially negative impacts. See "Diameter-Limit Cutting and High Grading" on page 40.

Advantages

Easiest method to mark and harvest; necessary to regenerate shade-intolerant species; high diversity of grasses and herbs until crown closure; provides early-succession habitat; potentially substantial one-time income for landowner.

Disadvantages

Esthetically less desirable for the general public; unacceptable for many small forest owners; residual poles and large saplings must be removed; no commercial timber income from forest for at least 30 to 40 years, more likely 60 to 75 years, depending on the species that is regenerated.

Reserve Tree

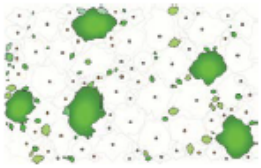
The reserve-tree method, a hybrid between a clearcut and a shelterwood system, is more esthetically pleasing in that not all of the overstory vegetation is removed. Borrowing an idea from the shelterwood system, a few trees are left scattered in the stand to provide vertical structure and a potential source of seed. The residual trees should be chosen from the healthiest trees in the stand, those likely to survive for another hundred years. The main difference between the reserve-tree method and a shelterwood system is that this method is a very high-intensity, but one-time (low frequency) disturbance event. All of the remaining vegetation is removed at once, and the new forest will be even aged. The reserve trees are kept to maintain some of the esthetic quality, provide some vertical structure heterogeneity, and potentially provide some seed. The reserve trees are generally kept until the next stand matures and is ready for its first commercial harvest. The new forest will be a mixture of species similar to that found in a silvicultural clearcut. Some habitat enhancement value from retaining these large scattered trees can be realized as well.

Advantages

Esthetically more pleasing than a clearcut; provides regeneration conditions similar to a clearcut (i.e., beneficial for midtolerants and intolerants); reserve trees will be very large at end of next rotation; provides roost trees for raptors and other birds; reserve trees serve as a supplemental seed source, especially for pine and yellow-poplar.

Disadvantages

Reserve trees are susceptible to windthrow and lightning damage (and lost volume); crown breakage of reserve trees can damage smaller regeneration; large crowns of reserve trees may damage other trees during next harvest operation; no income for 30 to 40 years.



Reserve tree

Passive Forest Management

Tree cutting is not always the most appropriate approach in achieving the goals set by a land steward. Passive forest management is the **intentional** decision to forgo tree cutting or manipulation of other **native** vegetation. Similar to active management this is done with a particular desired outcome and/or set of goals in mind the achievement of which can conceivably be attained passively. As opposed to active management which attempts to mimic natural disturbances in specific areas with specific treatment types, passive management relies on a much longer time frame and the caprice of nature within the area being managed passively.

Passive management is not benign neglect, in that electing to passively manage an area is an inherently involved decision. In an ideal situation, passive management is accompanied by a regular and clear monitoring protocol to ensure the area remains healthy and that the goals for the passively managed area are being achieved. If forest pests including non-native insects, disease, and plants migrate to passively managed stands a response may be necessary to mitigate potential negative previously unforeseen impacts, but depending on the response, the area may no longer be considered as passively managed.

Passive management is often recommended for areas that would be difficult to access for contemporary forest management equipment, for areas with special characteristics (i.e., the incredibly rare patch of true old-growth forest in southern New England) or sensitive sites, or a number of other reasons or conditions. Passive management is an important forestry technique and part of the toolbox in these situations within

which a site could be degraded instead of improved by active management techniques or the goals for an area would not be able to be met with active management techniques.