



INVENTORY & MONITORING DIVISION

Northeast Temperate Network

JANUARY 2023

Forest Health Update for Marsh-Billings-Rockefeller NHP: 2006 - 2022

The Northeast Temperate Network (NETN) forest health monitoring crew has been visiting the 24 forest plots in Marsh-Billings-Rockefeller NHP (MABI) for 16 years. Data collected over this period indicate that the park's forests are a reflection of a long-period of human use and

influence. Compared to other parks in the region, the forests in MABI are relatively healthy. Canopy composition is diverse, and in some areas of the park, the regeneration layer is abundant and composed of native canopy-forming species.

The following is a further summary of the most recent findings, as well as a series of park maps that visually display forest health monitoring data. Please contact NETN staff with any questions about the park's forest health.

KEY FINDINGS

- Compared to other parks in the region, the forests in MABI are relatively healthy.
- The decades-long campaign to remove invasive plants in the park is clearly reflected in the data.
- Of concern are the areas in the park dominated by pest/disease, vulnerable tree species, and subcanopy species in the regeneration layer.
- Deer impacts are unsustainable throughout the park, and left unchecked will lead to compositional shifts away from deer-preferred species and loss of wildflowers.
- Promoting native canopy-forming species predicted to cope well with climate change will help ensure long-term viability of park forests.



Summary of MABI Forest Health

Tree Regeneration

An abundant regeneration layer containing tree seedlings and saplings of varying sizes and composed of species found in the canopy is an important component of a healthy, stable forest. When forests lack sufficient regeneration, or the species composition in

the regeneration layer does not match that of the canopy, we call this a "regeneration debt". In its most severe form, there is a complete lack of regeneration which, if allowed to persist, can ultimately lead to forest loss.

Compositional mismatch can be problematic if the species in the regeneration layer are



invasive, like Norway maple, or suboptimal, including pest/disease prone species such as many ash tree species.

MABI's forests are experiencing **moderate** regeneration debt. There are some positive trends in seedling density over time and a range of seedling size classes represented in the regeneration layer (Maps 1 & 2). Plots 6, 11, 17, 18, 19 (pictured above), and 23 are sufficiently stocked with canopy-forming native species (Maps 3 & 5). However, the rest of the park is lacking sufficient regeneration. In the 2022 survey, only 12 out of 24 plots met the minimum target for seedlings, and just 3 out of 24 plots met the saplings target.

Most concerning is the composition of the regeneration layer, which continues to be dominated by ash, American beech and subcanopy species, particularly hophornbeam (Map 3). Beech and ash species are vulnerable to exotic pests and pathogens that threaten their long-term viability in the

canopy. Subcanopy species are short-stature trees that are unable to form a tall, closed-canopy forest. As beech leaf disease (BLD), hemlock woolly adelgid (HWA) and emerald ash borer (EAB) continue to spread through the region, promoting regeneration of other native canopy-forming species is critical to maintaining forest cover in MABI. While NETN did not detect BLD in MABI in 2022 (Map 9), it was detected in nearby Saint-Gaudens National Historical Park, and it is only a matter of time that BLD is found in MABI (if not already present).

Native conifers, including eastern hemlock and white pine, are rare in the regeneration layer, indicating a likely compositional shift to hardwoods, primarily sugar maple if this pattern continues (Map 4). The latest Climate Change Tree Atlas (version 4)

predicts sugar maple to only experience modest declines in the most southern portion of its range and to have a very good capacity to cope with climate change even under the high emissions scenario (RCP 8.5). The rich soils in

MABI may also help buffer sugar maple from climate stress. Sugar maple is also shade tolerant and unlike oak species, does not require large canopy gaps to successfully recruit into the canopy. Sugar



Sugar maples are expected to do well in future climate change scenarios in Vermont.

maple is therefore a good species to promote in the regeneration layer. Minimizing new infestations of earthworms, particularly in the eastern part of the park (Map 9), is one way to promote sugar maple regeneration. Red maple and northern red oak are also good native species to encourage in the park.

Deer

Deer browse impacts are **medium or high** for all but 3 out of 24 forest plots in the 2022 survey (Map 6), which is unsustainable in the medium to long-term. Left unchecked, they will lead to compositional shifts away from deer-preferred species (hemlock and sugar maple), and loss of spring ephemeral wildflowers like trillium and bellworts. Reducing deer browse impacts through strategic fencing or culling would benefit the understory in MABI.

Invasive Species

Due in no small part to a long-running removal program, invasive plant species continue to be **relatively low** in MABI, with 10 out of 24 plots having no invasive plant detections in the most recent survey (Maps 7 and 8). Even where they were detected, invasive plant average percent cover was below 1%, suggesting the park's management efforts have paid off and invasive plants are largely at maintenance levels in MABI forests. The most common species detected were common buckthorn, exotic bush honeysuckle, and Japanese barberry, all of which are capable of dispersing and expanding rapidly. As long as the park continues their removal efforts, particularly in harvested areas or natural gaps, it is expected these patterns will hold up over time. NETN considers MABI an important example of successful invasive plant management in the northeast region.

In addition to invasive plants, NETN monitors invasive earthworms in forest health plots. Impacts from earthworms include reduced leaf-litter and altered soil nutrient cycling, which can negatively impact tree regeneration and understory



plants, and helping facilitate invasive species spread and persistence. The most commonly encountered species in the northeast are European nightcrawler worms, which were detected in 16 out of 24 plots in MABI. More recently, species from East Asia, known as "[crazy snake worms](#)", have started invading eastern forests. They can occupy soil at much higher densities and cycle nutrients faster than the European worms, and thus can cause more severe impacts to the understory. While



Crazy snake worm

all plots were examined for snake worms in the most recent cycle, none were detected. However, it is possible they were overlooked, as distinguishing between snake worms and European nightcrawlers is difficult in the spring.

Forest Structure & Composition

The park's canopy layer is a mix of sugar maple, hemlock, white ash, white pine, red pine, yellow birch, northern red oak, and a few other species. The

historic plantations also feature Scots pine, European larch, and Norway spruce. A diverse canopy such as this helps promote a high response variability to stressors like pests, diseases, and climate change.

Beech bark disease, which has been present in the region since the 1960s, was the only priority forest pest/pathogen detected in the 2022 monitoring visit. While these findings certainly bode well for the park's future forest, there are still concerning trends in tree mortality and recruitment. Expanding pests/pathogens will need to be observed and tracked closely as well.

While mortality has occurred across a range of tree species, beech, white ash and subcanopy species are the only ones that have gained in stem density since monitoring began in 2006. As emerald ash borer (EAB), beech leaf disease (BLD), red pine scale (RPS), and hemlock woolly adelgid (HWA) move into the park in the coming years, maintaining a diverse canopy and regeneration layer will be critical to ensure continual forest cover in the park.



Coarse woody debris coverage is improving in the park over time.

While not exotic, brambles (*Rubus* spp.) have increased in several plots over time in response to harvesting (Map 11, Table 4), particularly plots 2, 6, 12, and 24. Dense brambles may be slowing regeneration in these areas, particularly plots 2 and 24, where canopy cover and regeneration densities are both very low and bramble shrub cover is high.

Coarse woody debris has increased in volume throughout the park (Map 12), with 17 out of 24 plots now meeting or exceeding the minimum threshold of 20 – 50 m³/ha

of dead wood proposed by Müller and Bütler (2010) as needed to support the range of taxa dependent on dead wood habitat (Map 13). This includes seven out of eleven plots that have been harvested since monitoring began in 2006 and that have sufficient dead wood volume (plots 2, 6, 8, 9, 12, 15, and 16). This suggests that in most cases, silvicultural treatments are retaining sufficient dead wood.

For more information

The [NETN website](#) is chock full of information related to park forest health as well as all the

other long-term monitoring programs. Like all of NETN's parks, MABI has its own [web page](#) providing a convenient one-stop shopping place for all things MABI related.

The recently launched [Resilient Forests Initiative](#) contains many useful resources and insights about the current and future efforts to help regional national parks manage forest health challenges by raising awareness of threats and fostering collaboration.

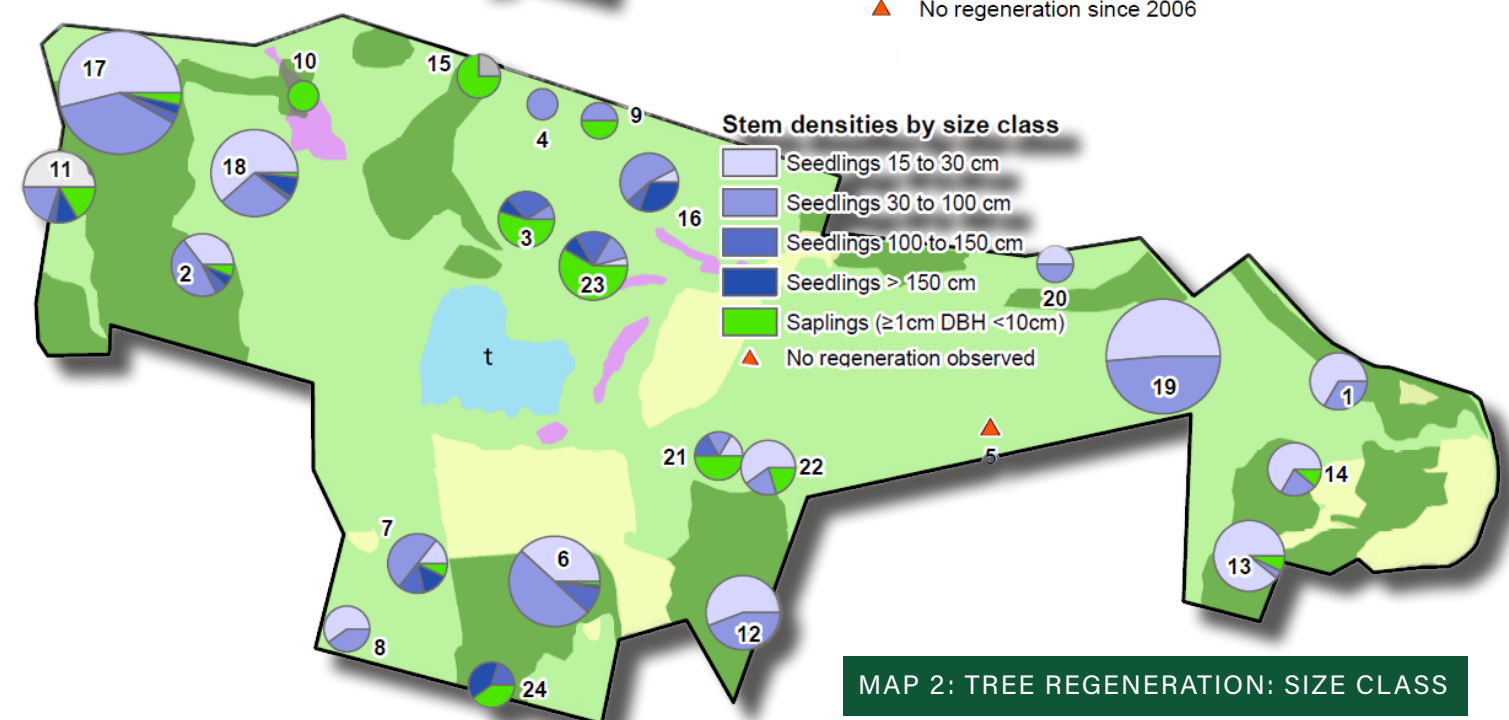
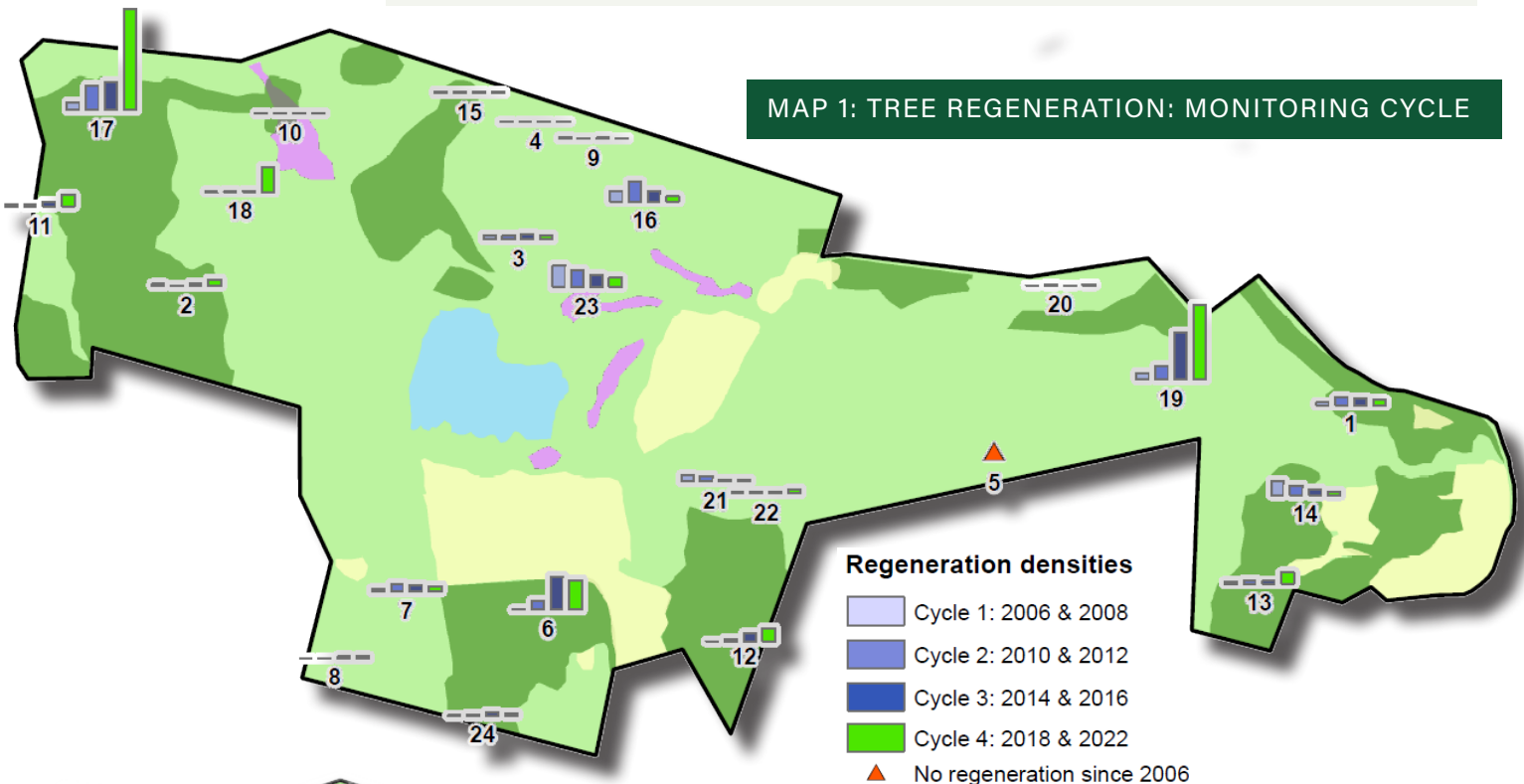
PARK MONITORING MAPS

- Park Boundary
- Plantation
- Natural Forest
- Open Field/Garden
- Forested Wetland
- Open Water

The maps below display trends in tree regeneration by monitoring cycle (map 1: 2006-2022) and size class (map 2: 2018-2022), including seedlings and saplings, observed in forest plots. Densities range from 0 to 6.8 stems/m², and only include native canopy forming species. Densities are lower than the 2018 report because ash trees are no longer considered canopy-forming due to their susceptibility to emerald ash borer mortality.

Trends in tree regeneration by size class in forest plots are from the most recent survey cycle 2. Pie size is proportional to plot-level regeneration and location may be shifted to prevent pie overlap. Total densities range from 0 to 6.8 stems/m² and only include native canopy-forming species.

MAP 1: TREE REGENERATION: MONITORING CYCLE

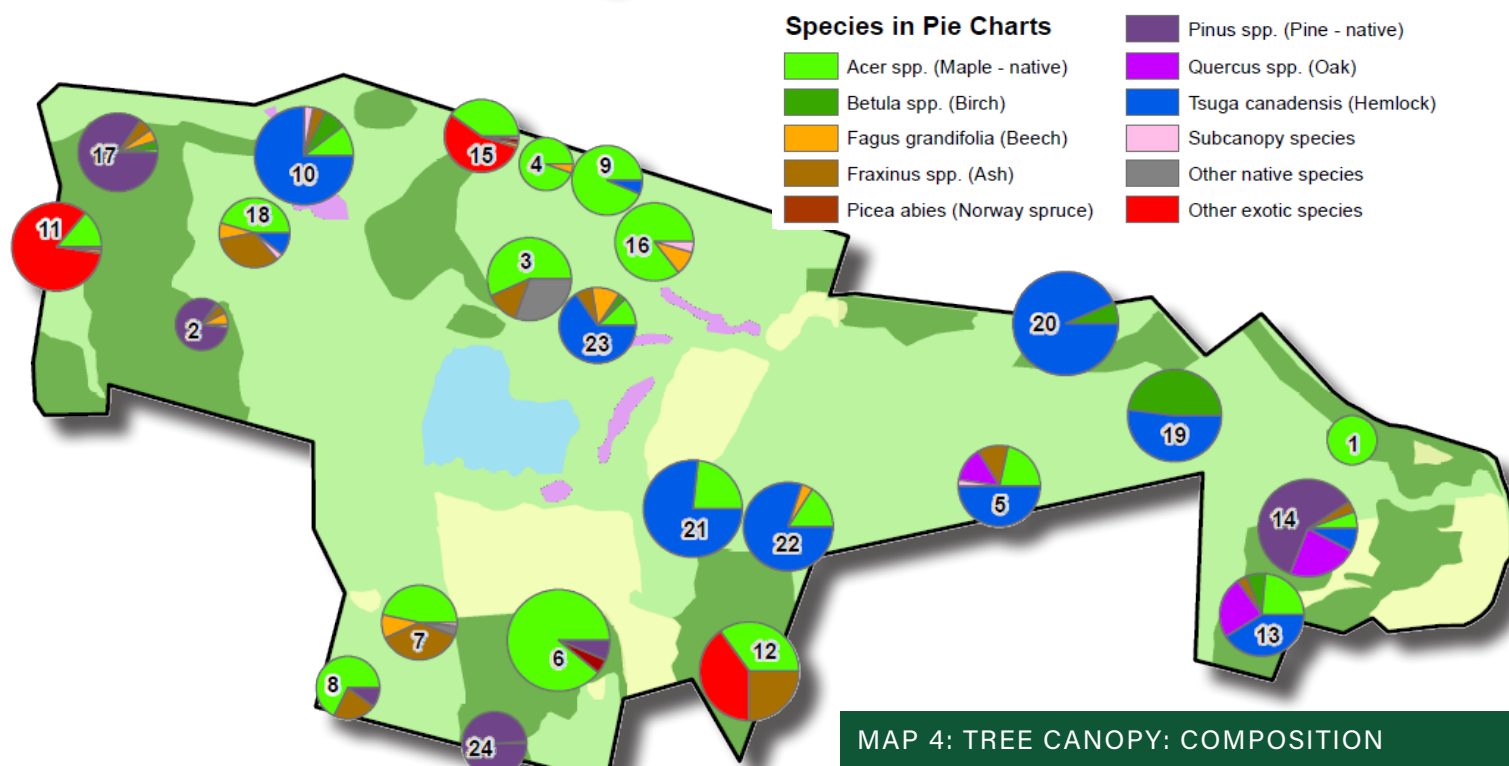
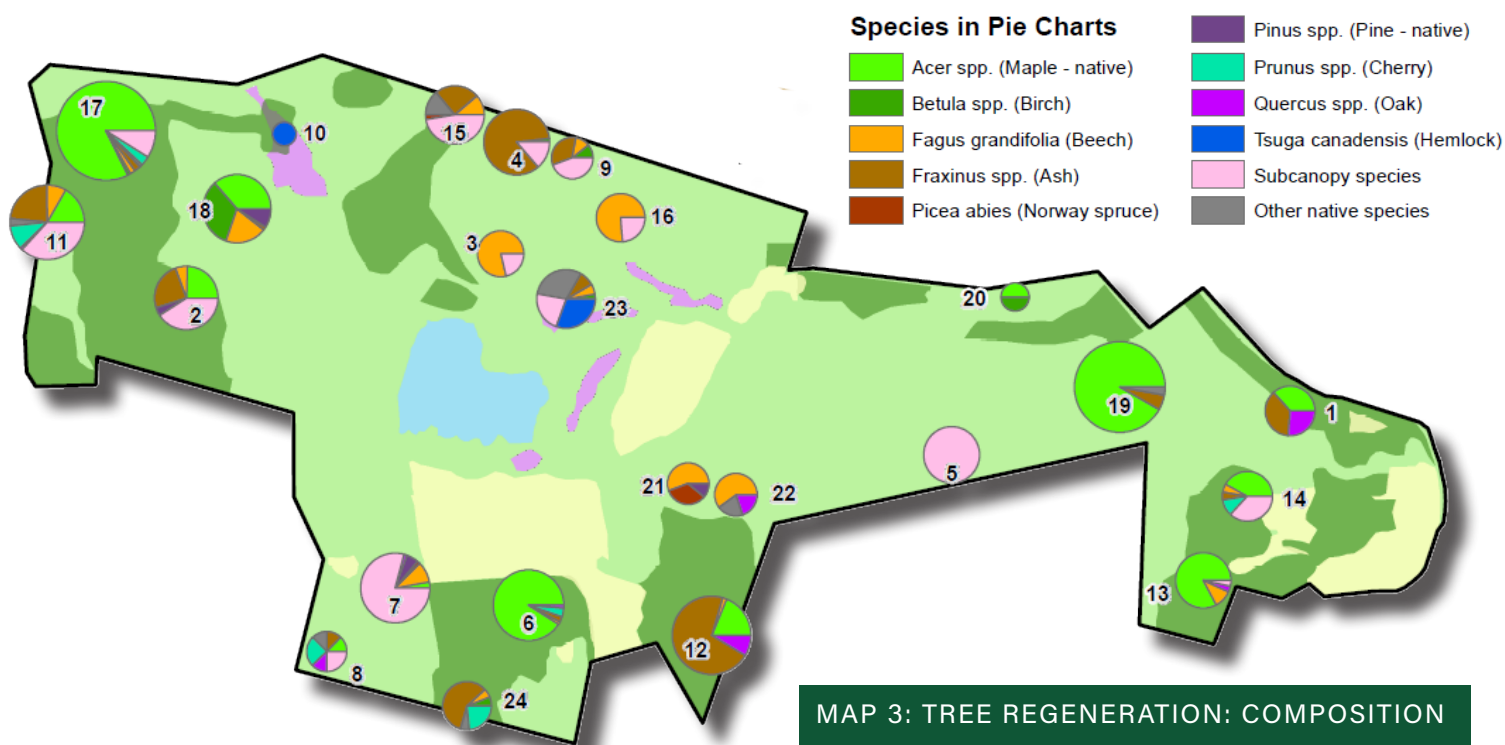


MAP 2: TREE REGENERATION: SIZE CLASS

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The maps below display trends in tree regeneration (map 3), including seedlings and saplings, and tree canopy composition (map 4) observed in forest plots in the most recent survey cycle (2018 and 2022). Pie size is proportional to the total plot-level regeneration (map 3: range: 0.03 to 7.8 stems/m²) and total plot-level basal area (map 4: range: 11.7 to 52.8 m²/hectare). Pies may be shifted from actual plot location to prevent overlap. Note that striped maple and mountain maple are included in the subcanopy species, not the maple group.



PARK MONITORING MAPS

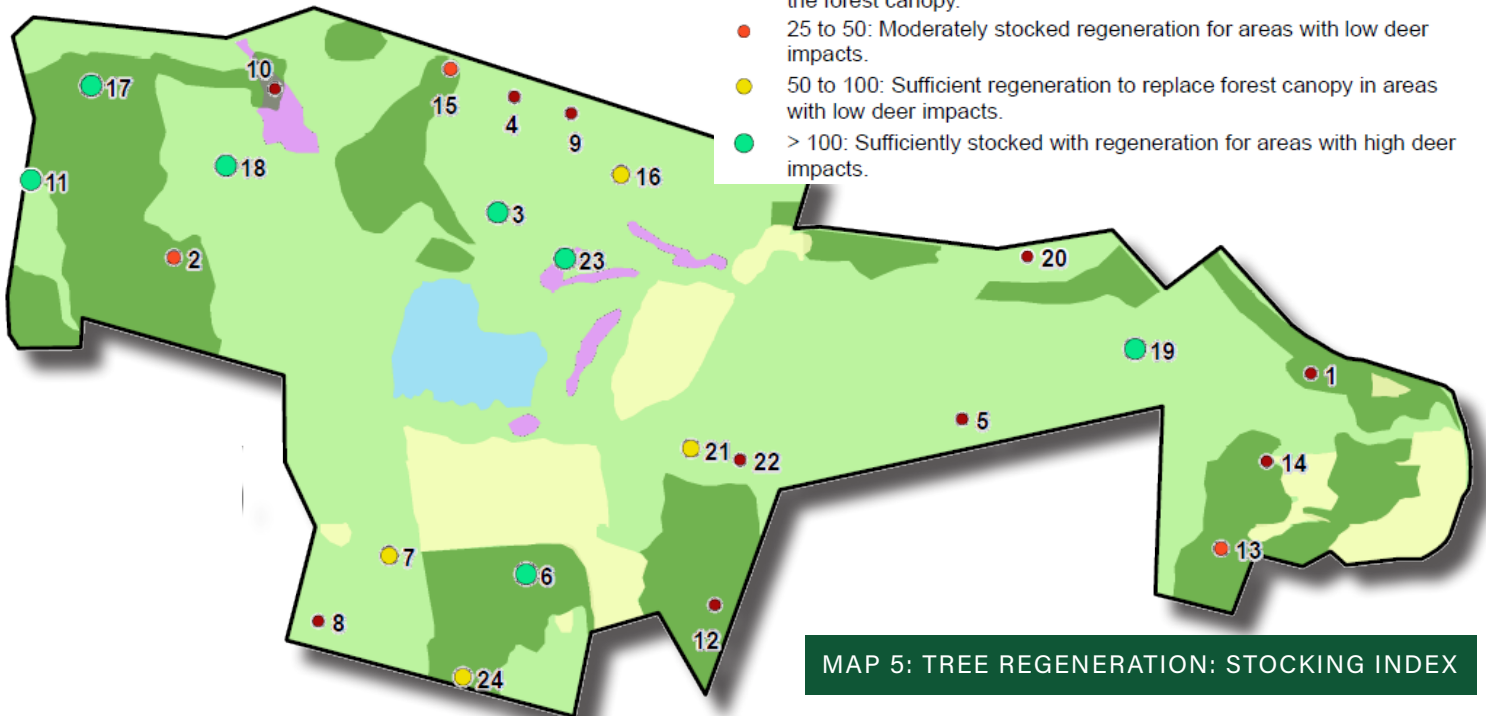
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The maps below display trends in the regeneration stocking index (map 5) and deer browse impacts (map 6) for the most recent survey cycle (2018 and 2022). The stocking index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights and quantifies whether current regeneration densities are sufficient to restock a forest canopy. It is averaged over three 2-m radius micro plots per forest plot and only includes native canopy-forming species (range 0-334).

The index of deer browse impacts are assessed on a scale from 1-5, with 1 representing no impact and 5 representing severe impacts.

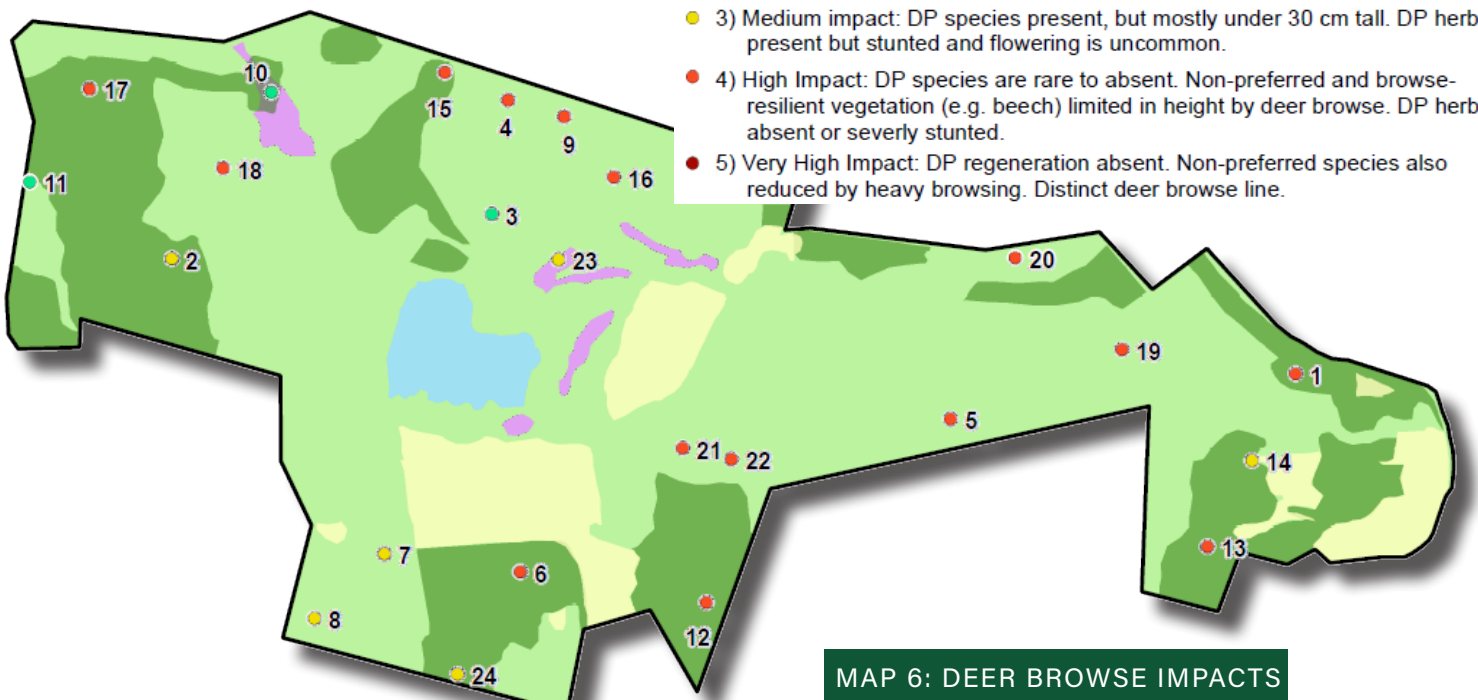
Stocking Index Ranges

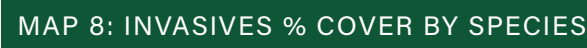
-  < 25: Severely understocked. Regeneration is insufficient to replace the forest canopy.
-  25 to 50: Moderately stocked regeneration for areas with low deer impacts.
-  50 to 100: Sufficient regeneration to replace forest canopy in areas with low deer impacts.
-  > 100: Sufficiently stocked with regeneration for areas with high deer impacts.



Deer Browse Index

-  1) No Impact: found only in well-maintained deer exclosures.
-  2) Low Impact: deer preferred (DP) species abundant and of varying heights.
-  3) Medium impact: DP species present, but mostly under 30 cm tall. DP herbs present but stunted and flowering is uncommon.
-  4) High Impact: DP species are rare to absent. Non-preferred and browse-resilient vegetation (e.g. beech) limited in height by deer browse. DP herbs absent or severely stunted.
-  5) Very High Impact: DP regeneration absent. Non-preferred species also reduced by heavy browsing. Distinct deer browse line.

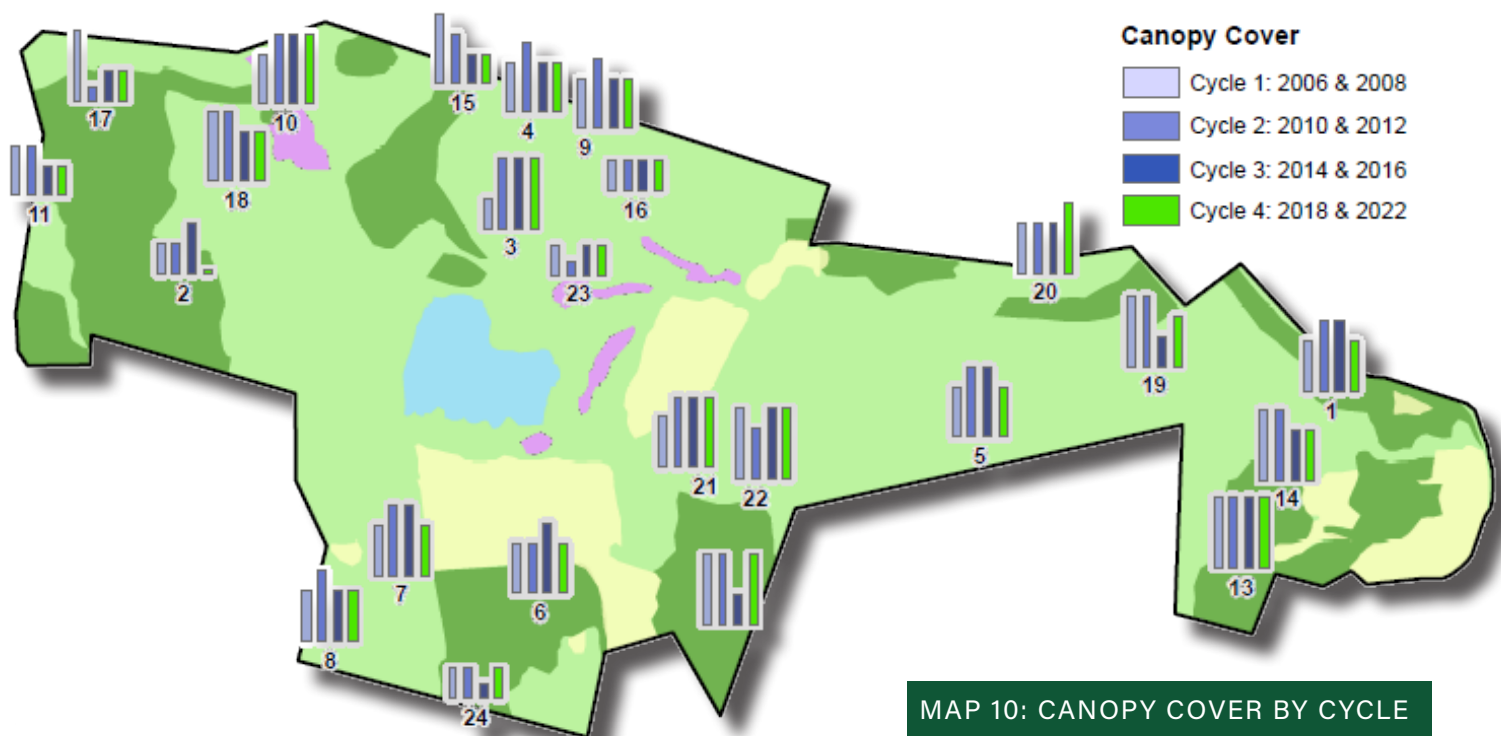
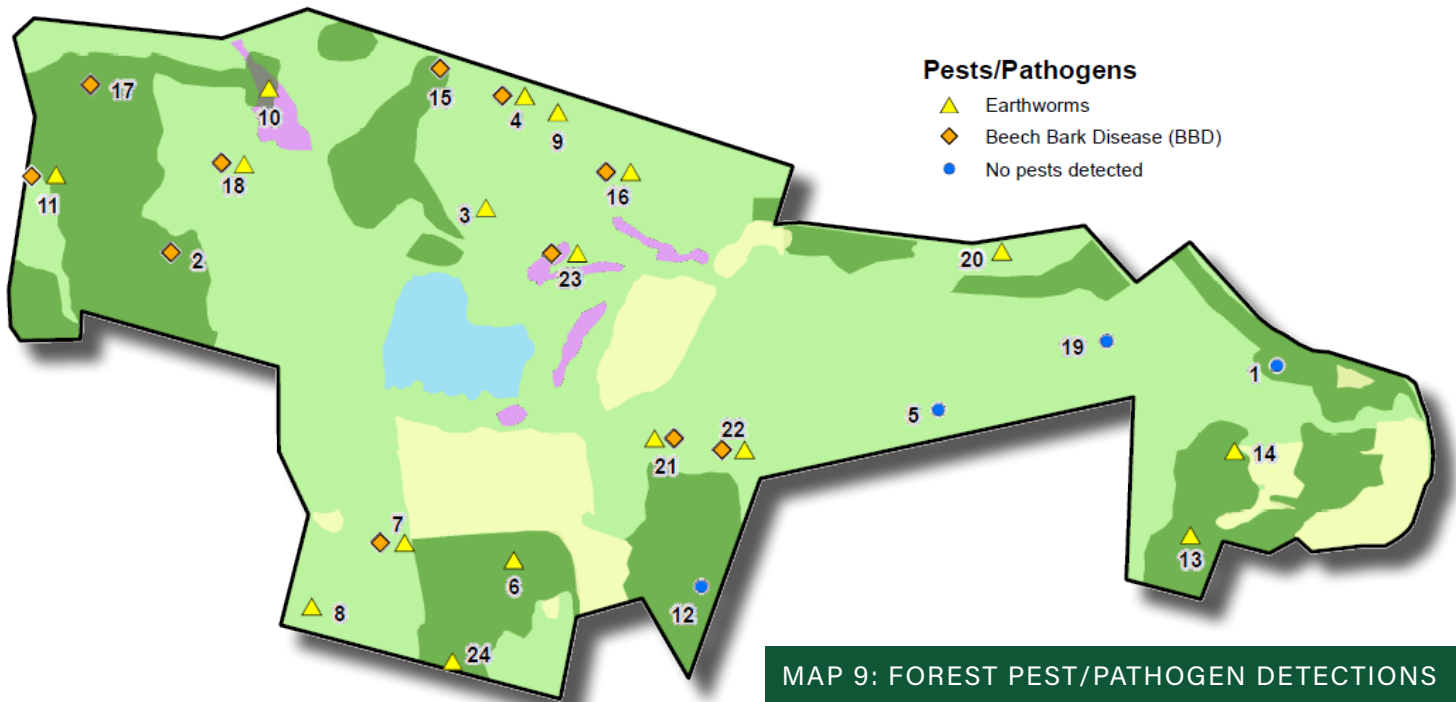




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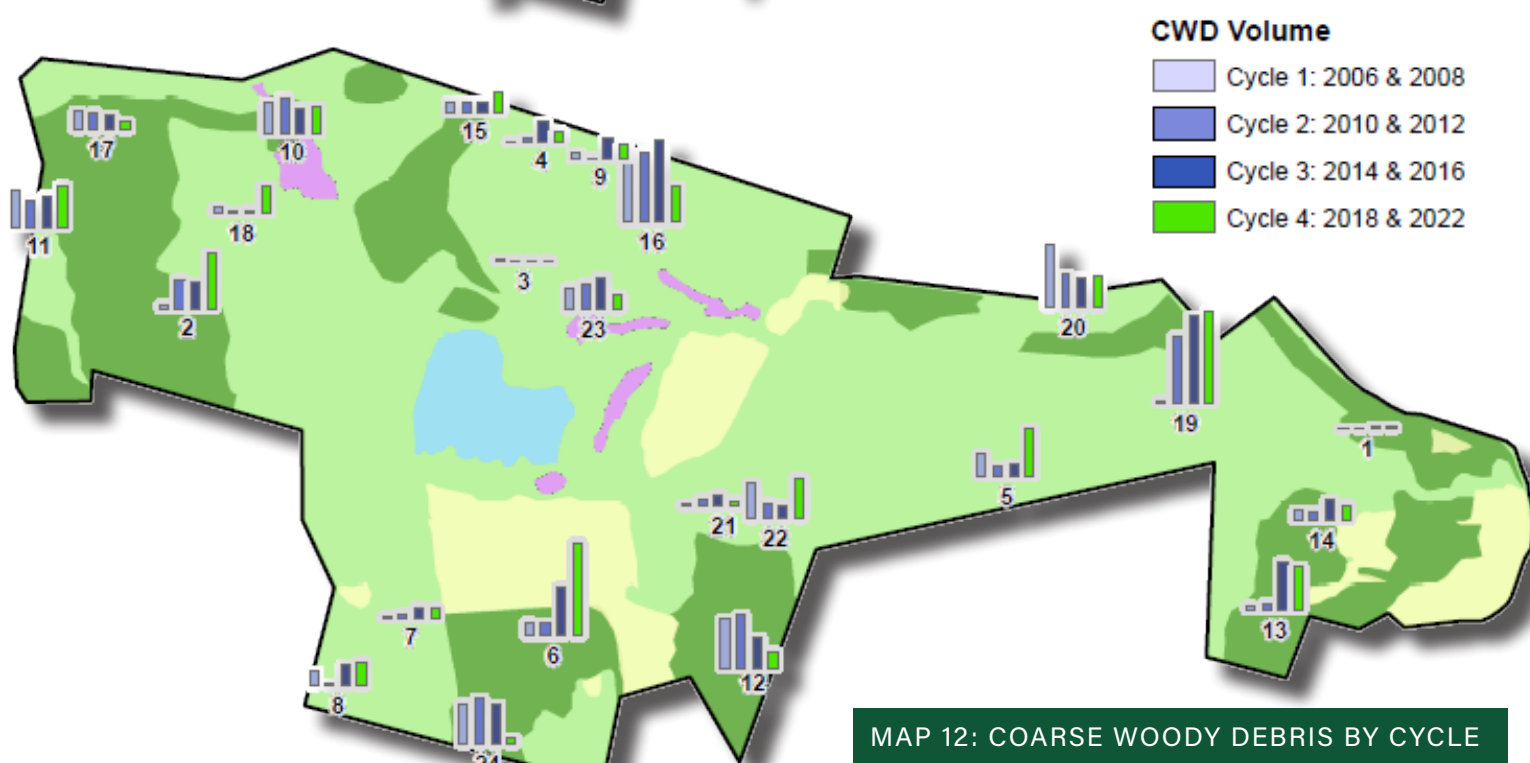
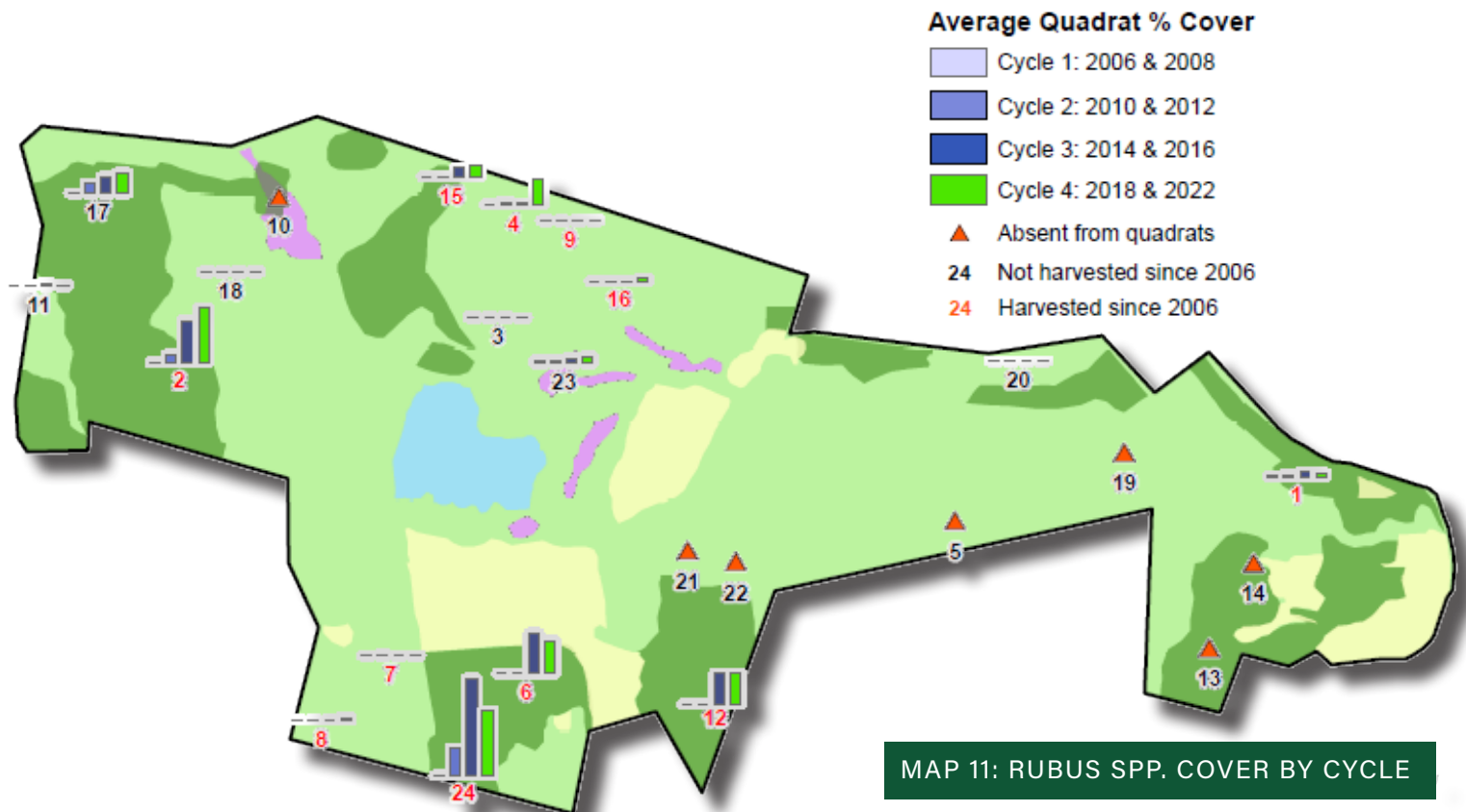
The maps below display trends in tree priority pest and pathogen detections (map 9: 2018-2022) and tree canopy cover (map 10: 2006-2022) in forest plots. Plots with multiple pests present (e.g., 3, 4, 7, etc.) have multiple symbols. Canopy cover ranges from 10 - 25% to >75%.



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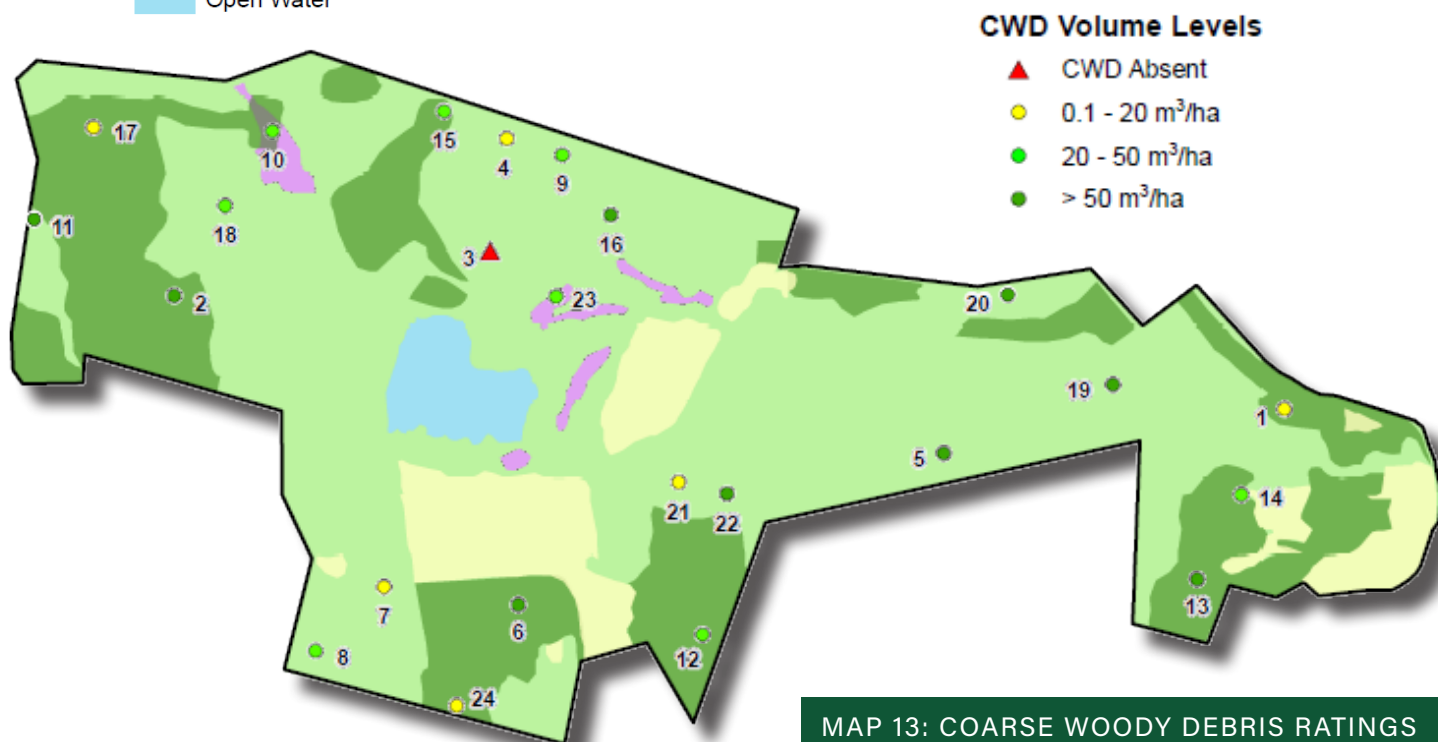
The maps below display trends in *Rubus* spp. (map 11: blackberries and raspberries) and Coarse Woody Debris (map 12: CWD) volume observed in forest plots sampled from 2006-2022. Percent *rubus* cover ranges from 0 to 91%. Plot numbers labeled red have been harvested since monitoring began in 2006. CWD volume ranges from 0 to 165.7 m³/ha (2,368.1 ft³/ac).



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The map below displays trends in coarse woody debris volume (m³/ha) for the most recent survey cycle (2018 and 2022). Volumes range from 0 to 165.7 m³/hectare (2,368.1 ft³/ac). Plots are color coded by volume to indicate whether they meet the 20-50 m³/ha (285.8-714.6 ft³/ac) threshold in Müller and Bütler (2010).



NETN FOREST HEALTH MONITORING STAFF

The NETN forest health monitoring crew is made up of a dedicated group of seasonal technicians (with support from the [Schoodic Institute](#)). It is lead by NETN biological technician Camilla Seirup. Protocol lead is NETN plant ecologist Kate Miller, who also analyzed the data and created the maps in this brief.

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