

Forest Health Data Summaries for **Allegheny Portage Railroad National Historic Site (2007 – 2024)**

Background

Forests are crucial resources in Allegheny Portage Railroad National Historic Site (ALPO), providing an important backdrop for interpreting the portage railroad, recreation opportunities for park visitors, habitat for countless animal and plant species, as well as protecting soil stability and stream health. The following forest health summaries are based on data collected in Eastern Rivers and Mountains Inventory and Monitoring Network (ERMN) long-term forest health monitoring plots between 2007 - 2024. There have been 24 ERMN forest health monitoring plots installed in ALPO, however, some plots have been retired due to trail construction through the plot or slopes that were too steep to implement monitoring without impacting the forest understory. Most plots in ALPO were sampled on a 4-year cycle and were visited four times during this reporting period.

Within each forest plot, tree and stand measurements, including an assessment of deer browse impact, are made within fixed-area, circular plots, 15-m in radius. Tree regeneration data are collected in four 2-m radius circular microplots embedded within each plot. Plots are permanently marked and measured at the same location every cycle. For a more detailed description of our methods, refer to the [ERMN forest monitoring protocol](#).

This document provides data summaries and interpretations of trends in tree regeneration, deer browse impacts, forest structure, tree canopy composition, and invasive plants to help inform National Park Service (NPS) staff of forest health condition and trends.

Tree Regeneration and Deer Impacts

An abundant regeneration layer that is composed of tree seedlings and saplings of varying sizes is an important component of a healthy forest. Regeneration debt occurs when forests lack sufficient regeneration, or the species composition in the regeneration layer does not match the canopy. ALPO has a forest regeneration status of Probable Failure, meaning that the park is experiencing regeneration failure due to insufficient and declining tree regeneration ([Miller et al. 2023](#)).

On average, seedling abundance is declining within ALPO, with declines observed across all height classes (Figure 1, Maps 1 and 2). The vast majority of the seedlings are in the smallest height class (5 - 15 cm in height), and we do not observe more seedlings maturing to taller height classes over time. The regeneration stocking index, which quantifies whether native seedling and sapling densities are sufficient to restock a forest canopy, indicates that 30% of plots in ALPO are severely understocked, 53% are moderately stocked, and 17% are sufficiently stocked with enough seedlings and sapling to replace the canopy (Map 5). The lack of regeneration can be attributed primarily to lack of sufficient light reaching the forest floor, since most of the forested plots have consistently high canopy cover (Map 7), dominated by maples which cast dense shade. Many

stands have abundant striped maple (*Acer pensylvanicum*) saplings (Figure 3) which further limit light availability in the understory.

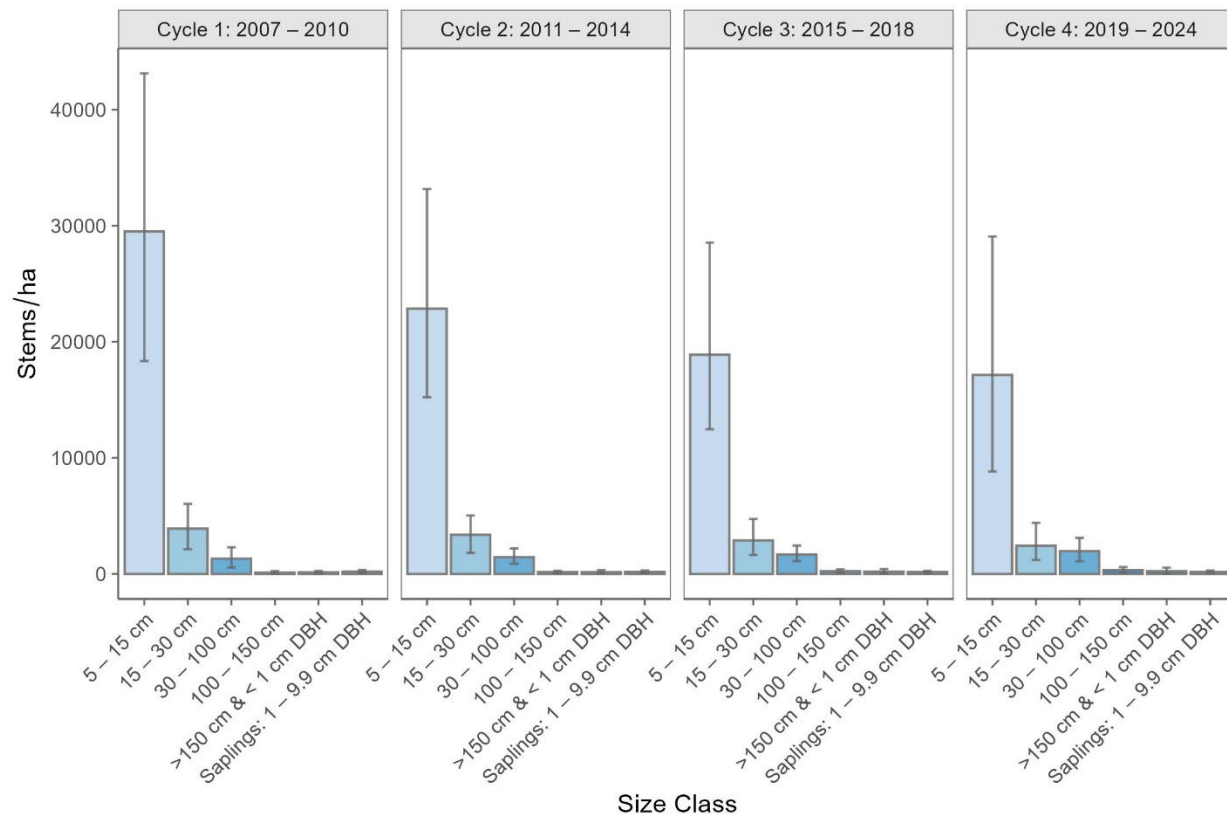


Figure 1. Trends in tree regeneration densities by height class in Allegheny Portage Railroad National Historic Site, 2007 – 2024. Error bars are 95% bootstrapped confidence intervals to account for non-normal error.

The abundance of striped maple saplings and tall seedlings is functioning like a bottleneck, preventing a wide diversity of tree species seedlings from maturing (Figures 2 and 3). In general, the seedling layer in ALPO is dominated by red maple (*Acer rubrum*) and black cherry (*Prunus serotina*), which is very similar to the dominant species in the forest canopy (compare Maps 3 and 4). Although oaks (*Quercus* spp.) are common canopy trees in some plots, they are conspicuously rare or absent in the seedling and sapling layers. Similarly, sugar maple (*Acer saccharum*) is underrepresented in the regeneration layers, compared to its presence in the forest canopy. Despite the diversity of species present as seedlings, the vast majority of saplings are striped maple, though striped maple sapling abundance reduced by half over the monitoring period likely due to competition. Notably, the abundance of ash saplings has increased in recent years, which is unusual given the devastation to canopy ash trees caused by the emerald ash borer (*Agrilus planipennis*).

Deer browse impacts are assessed on a scale of 1 – 5, with 1 representing unnaturally low impacts from deer exclusion and 5 representing severe impacts evidenced by a distinct browse line. Impacts of medium (3) or higher typically require management intervention to maintain adequate forest regeneration. In the most recent 4-year survey, most plots (56%) were rated as medium impact, with 22% of plots assigned low impacts and 22% of plots rated as high deer impacts (Map 6).

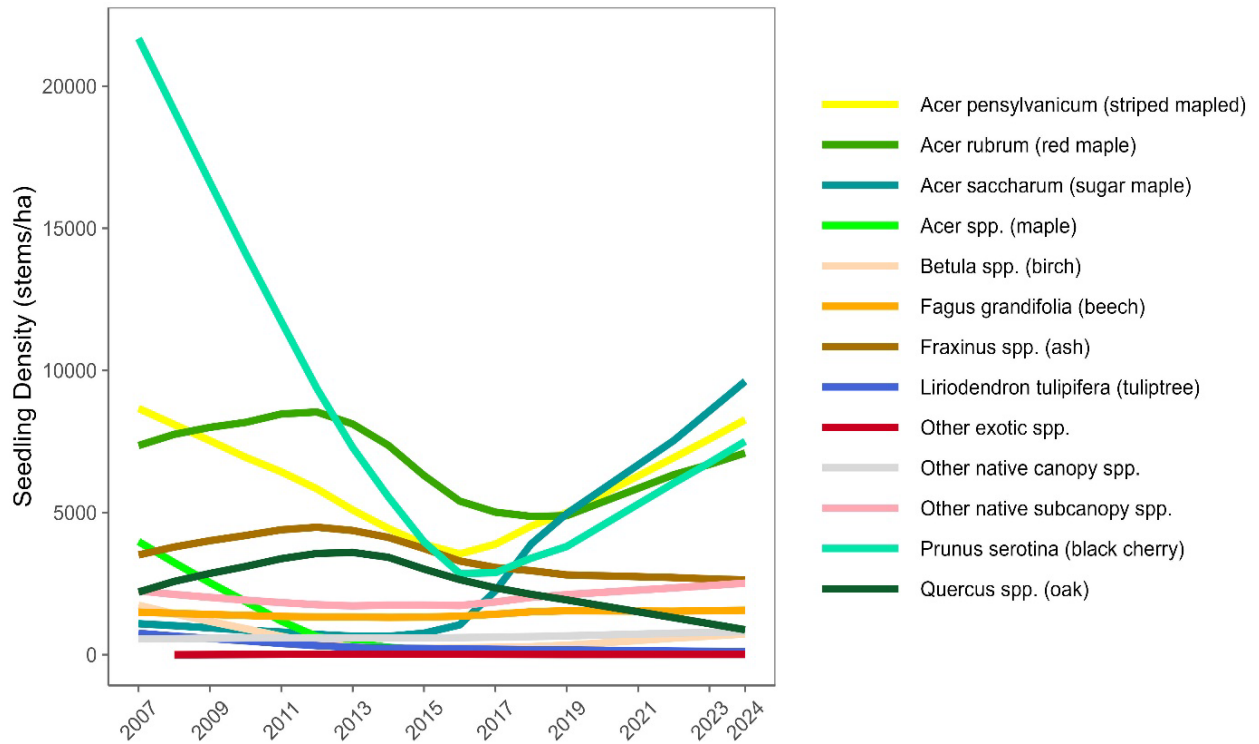


Figure 2. Trends in seedling density by species group and sample year in Allegheny Portage Railroad National Historic Site. Local regression smoothing approximated a linear trend between consecutive sample events per panel.

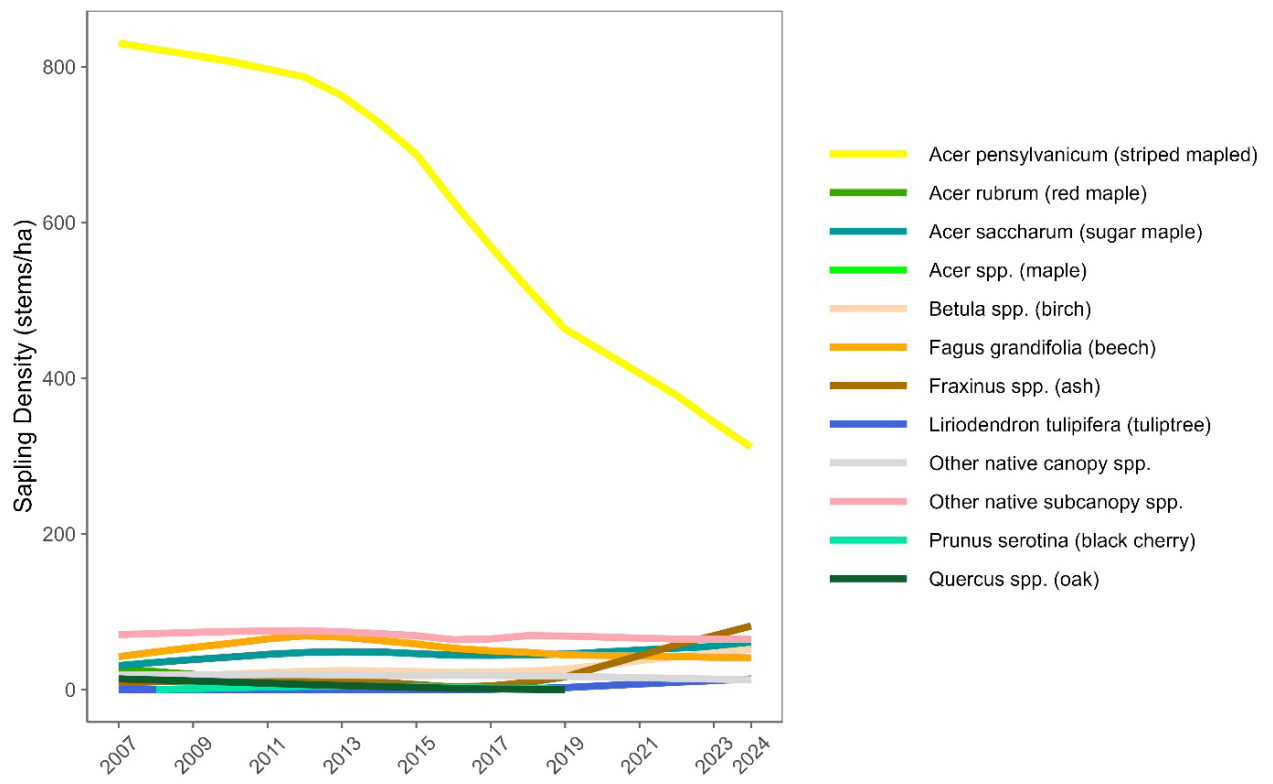


Figure 3. Trends in sapling density by species group and sample year in Allegheny Portage Railroad National Historic Site. Local regression smoothing approximated a linear trend between consecutive sample events per panel.

Forest Structure and Canopy Composition

Based on tree cores collected near our plots, trees in ALPO are primarily 80 to 100 years old, with the oldest cored trees, a red maple and a yellow birch (*Betula alleghaniensis*), originating nearly 150 years ago. Despite being young to middle-aged, the forests in ALPO have more complex older forest structure, such as large live trees and standing dead trees, than surrounding forests sampled by the US Forest Service ([Miller et al. 2016](#)). Therefore, the protection and management of park forests has importance beyond the boundaries of the park. Canopy cover within monitoring plots is consistently high and stable, as expected in middle-aged forests (Map 7). The abundance of downed coarse woody debris (Map 10) is another important component of forest structure that provides wildlife habitat and nutrient cycling.

Forest canopies in ALPO are dominated by red maple and black cherry, with oaks, American beech (*Fagus grandifolia*), and sugar maple as common associates (Figures 4 and 5, Map 4). As red maples decline in basal area and density, sugar maples appear to be making smaller gains. Oak, beech, black cherry, and most other canopy species have been somewhat stable over time. Notably, mature ash trees (*Fraxinus* spp.) have been nearly eliminated by emerald ash borer during this period.

Aside from emerald ash borer's impact on ash trees, several other pests threaten ALPO's forests. Hemlock wooly adelgid (*Adelges tsugae*) and elongate hemlock scale (*Fiorinia externa*) infest the park's hemlocks (*Tsuga canadensis*). Although the density of hemlocks is decreasing, hemlock basal area is stable, and mass mortality of hemlocks has not yet been observed in the park. American beech trees in ALPO have been exposed to beech bark disease (caused by the combination of a scale insect and a fungus) for around two decades. Beech, which is a prominent canopy tree in approximately one quarter of the park's monitoring plots, has shown slight declines in basal area and density over the monitoring period. However, the recently introduced beech leaf disease, caused by an invasive microscopic nematode (*Litylenchus crenatae* subsp. *mccannii*), poses a serious threat to the park's beech trees and saplings. Beech leaf disease causes mortality in beech saplings first, but forests in Ohio with a longer history of beech leaf disease are experiencing widespread mortality of canopy beech trees. Spongy moths (*Lymantria dispar*), also known to occur in ALPO, typically cause defoliation on oaks and other trees but have not yet caused widespread mortality in ALPO.

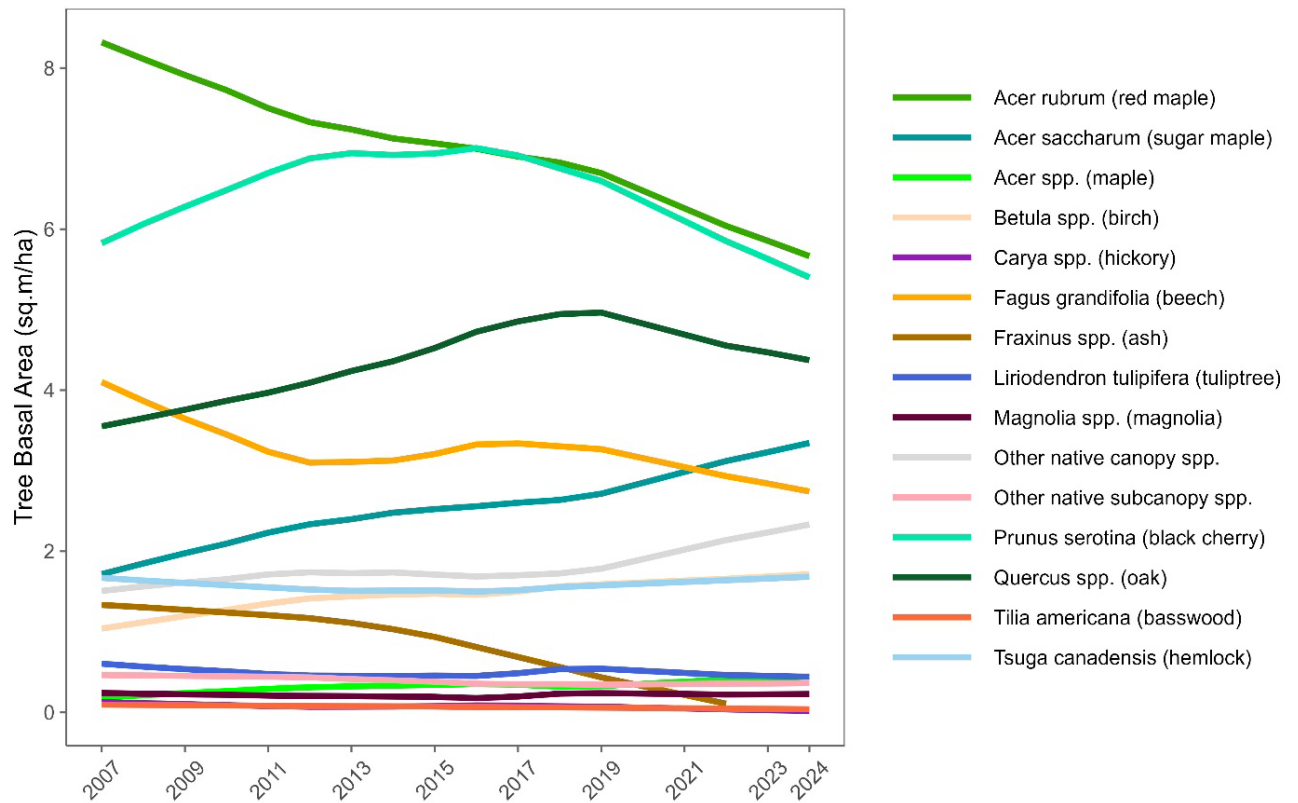


Figure 4. Trends in tree basal area by species group and sample year in Allegheny Portage Railroad National Historic Site. Local regression smoothing approximated a linear trend between consecutive sample events per panel.

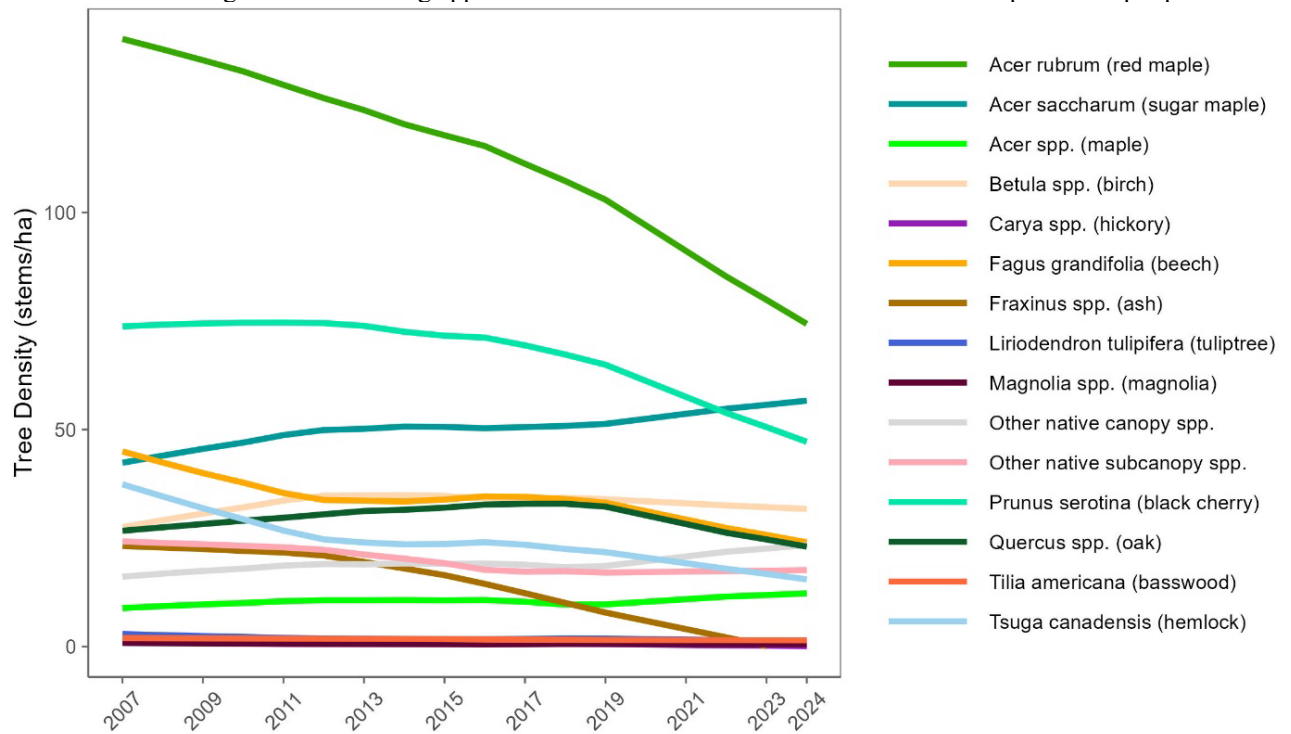


Figure 5. Trends in tree density by species group and sample year in Allegheny Portage Railroad National Historic Site. Local regression smoothing approximated a linear trend between consecutive sample events per panel.

Invasive Species

Invasive plants can have dramatic impacts on forest health by altering forest structure and diversity, suppressing tree regeneration, altering nutrient cycling and disturbance regimes, and reducing native species diversity. In ALPO, invasive plants are not uniformly distributed throughout the park (Maps 8 and 9). Very few to no invasive plants were detected in forest plots on the Summit near the Picnic Area and Visitor's Center, as well as along Inclines 7 and 8. By contrast, Foot of Ten forests are heavily invaded with exotic shrubs such as multiflora rose (*Rosa multiflora*), honeysuckles (*Lonicera* spp.), and privet (*Ligustrum* spp.), along with Japanese stiltgrass (*Microstegium vimineum*). Many areas in the Staple Bend unit are infested with Japanese and Giant knotweeds (*Reynoutria* spp.).

The increasing abundance of invasives in ALPO ([Miller et al. 2021](#)) highlights the importance of implementing strategic invasive plant management, especially to protect the high quality forests at the Summit. Asian bittersweet (*Celastrus orbiculatus*) and invasive shrubs are important targets for control since these species impede forest resilience.

Conclusions

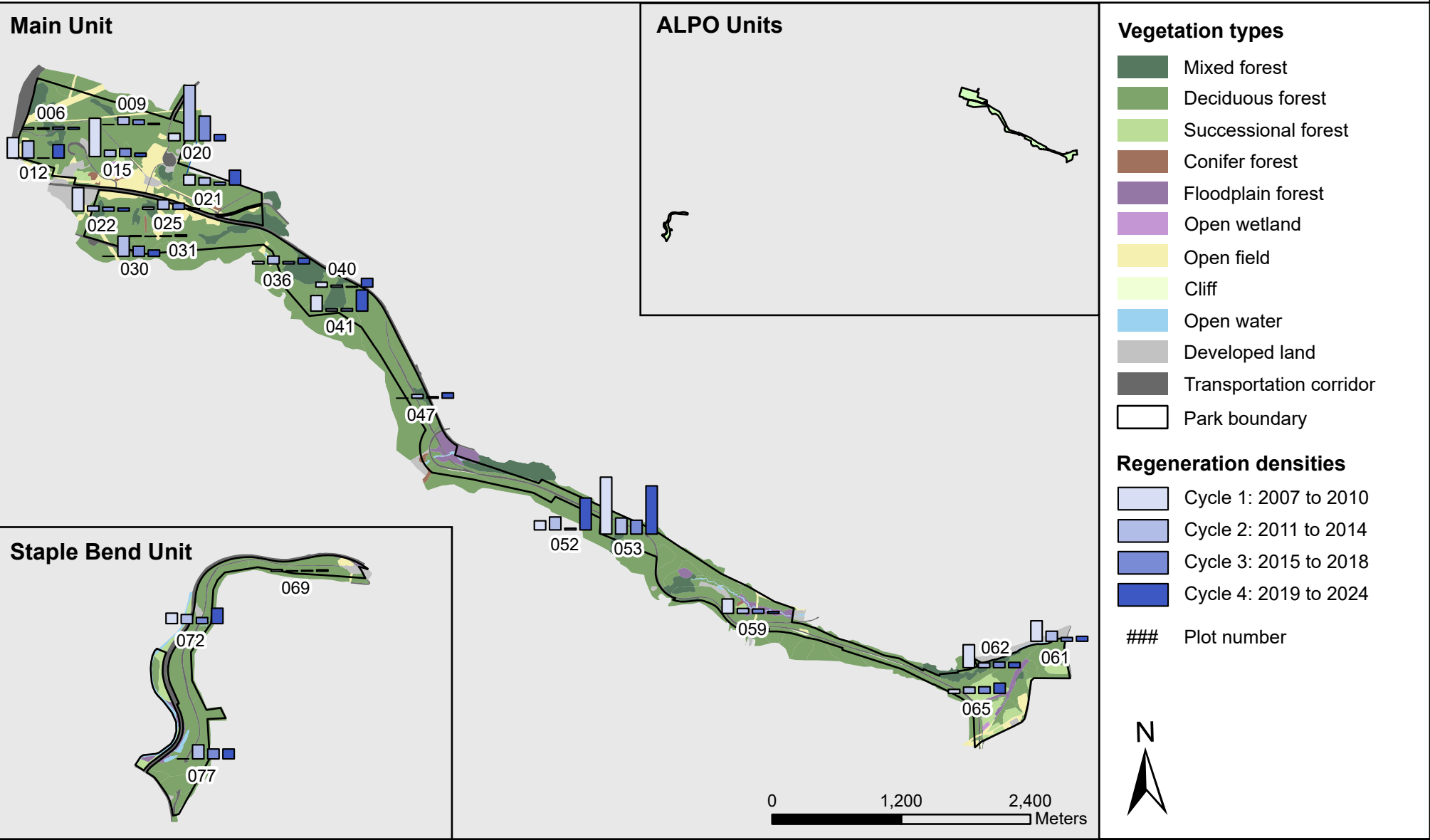
Forests are an important ecological and cultural resource in ALPO that provide under-represented and regionally significant forest habitat. However, forest pests and pathogens, along with invasive plants, threaten the ability of park forests to regenerate. The park should continue to assess forest stands at risk or already impacted by pests and pathogens, and prioritize invasive plant management in stands where canopy gaps have increased or may soon increase light to the forest floor. Continued investment in invasive plant management through early detection and rapid response, release of approved biological controls, and strategic invasive plant management in high priority habitats will also bolster forest resilience.

Author Contributions

This summary document, completed in December 2025, was written by Stephanie Perles, ERMN Plant Ecologist. Maps and figures were created by Sara Thiessen (ERMN Forest Crew Member) and Stephanie Perles. This document was adapted from materials developed by staff from the NPS Northeast Temperate and Mid-Atlantic Inventory and Monitoring Networks, including Kate Miller (NETN/MIDN Quantitative Ecologist), Camilla Seirup (former NETN/MIDN Forest Crew Leader), and Jamie Attanasio (NETN/MIDN Forest Crew Member).

Map 1. Native Canopy-Forming Tree Regeneration by Cycle

Trends in tree regeneration, including seedlings and saplings of native canopy-forming species, observed in forest plots during four monitoring cycles spanning 2007 - 2024. Plot-level regeneration stem densities range from 199 to 160,945 per hectare. Reporting Date: 12/15/2025.

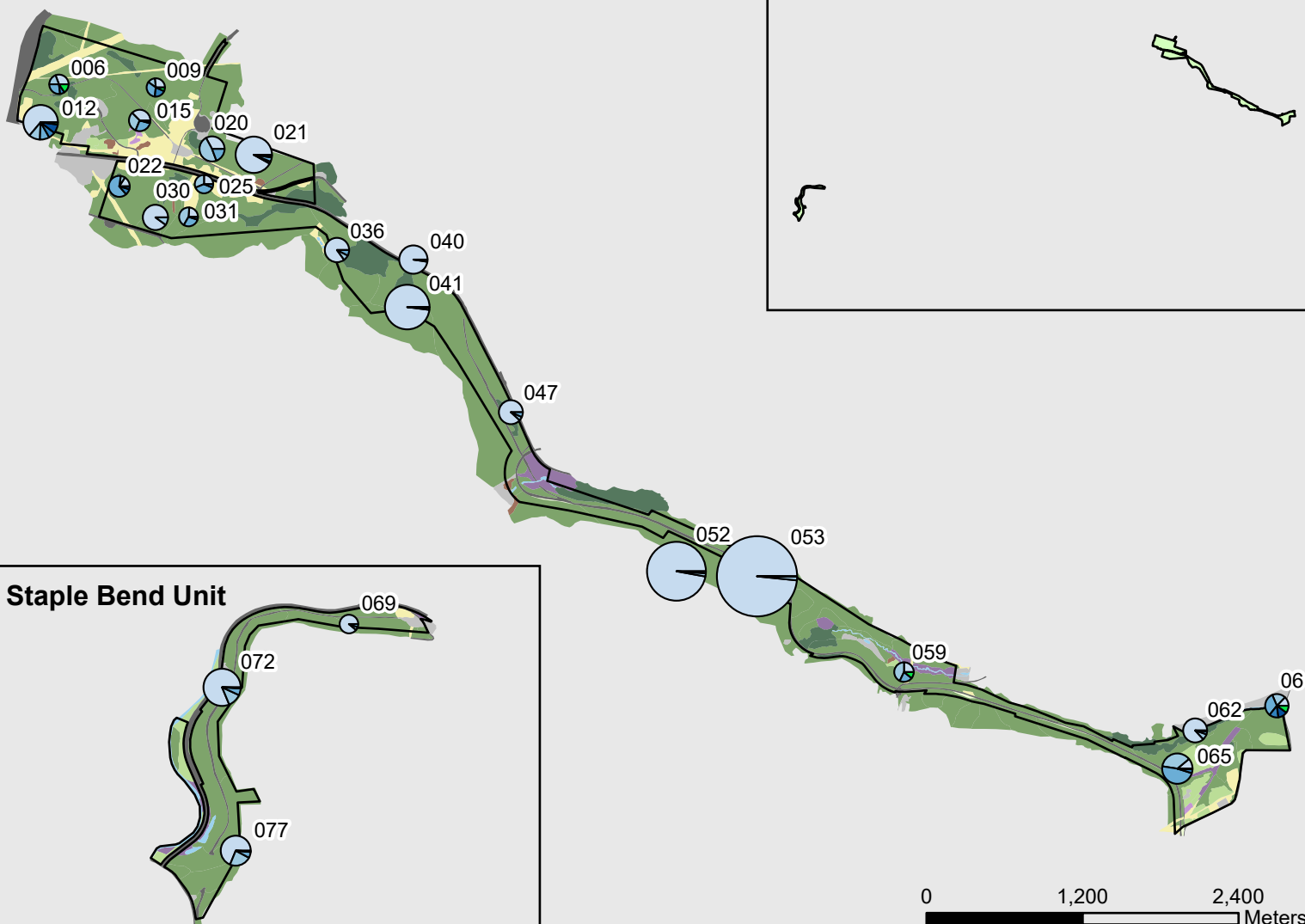




Map 2. Native Canopy-Forming Tree Regeneration by Size Class

Tree regeneration, including seedlings and saplings of native canopy-forming species, by size class observed in forest plots during the last census (2019 - 2024). Pie size is proportional to plot-level regeneration density. Plot-level regeneration stem densities range from 2,984 to 136,077 per hectare. Reporting Date: 12/15/2025.

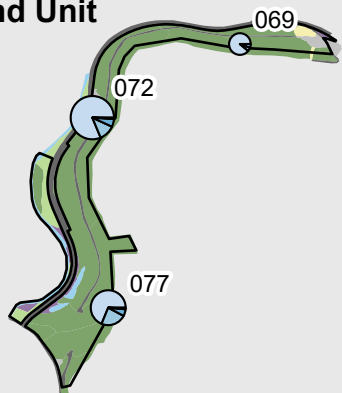
Main Unit



ALPO Units



Staple Bend Unit



Vegetation types

- Mixed forest
- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open wetland
- Open field
- Cliff
- Open water
- Developed land
- Transportation corridor
- Park boundary

Regeneration densities

- Seedlings 5 to 15 cm
- Seedlings 15 to 30 cm
- Seedlings 30 to 100 cm
- Seedlings 100 to 150 cm
- Seedlings > 150 cm
- Saplings
- ### Plot number



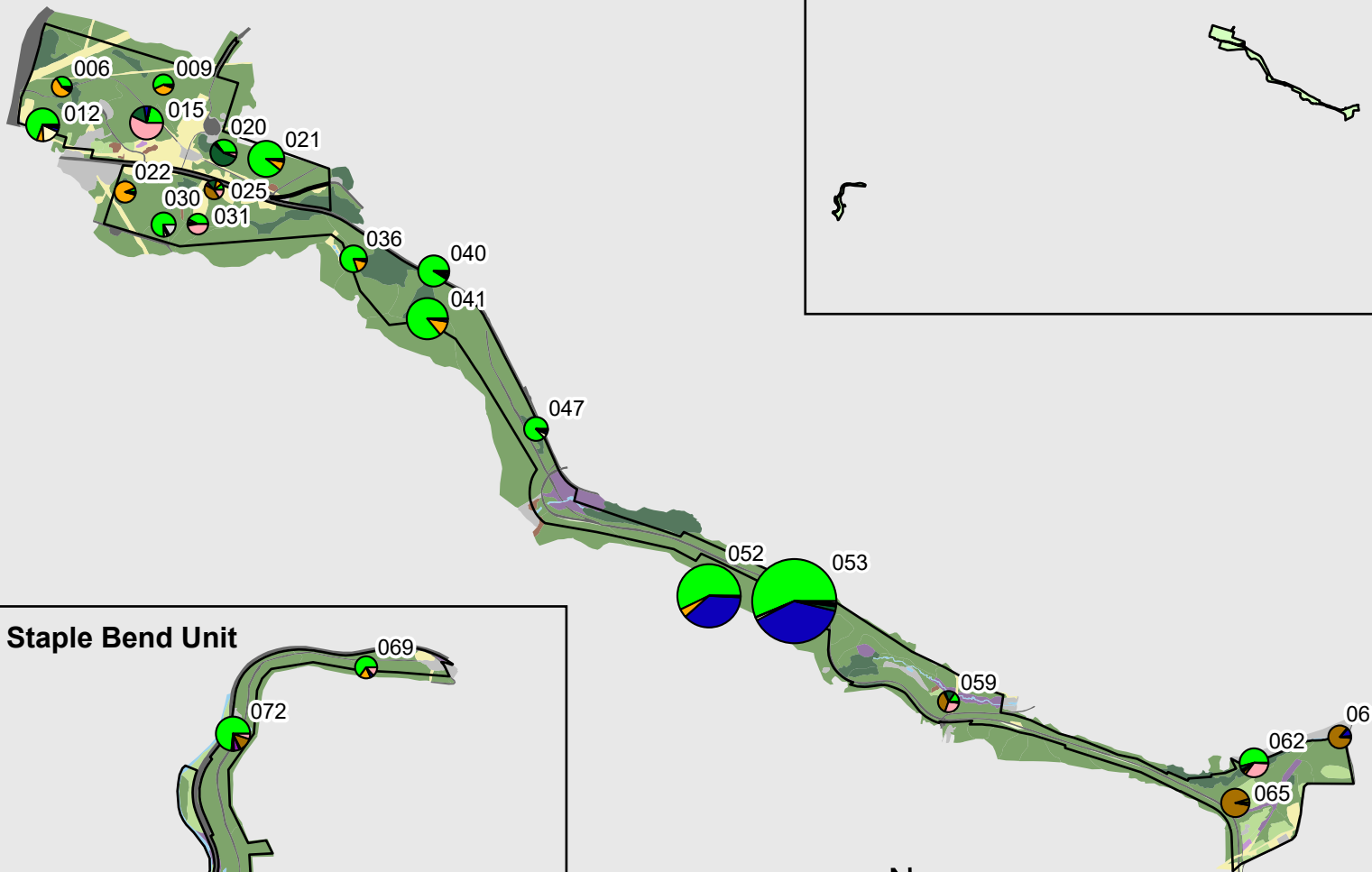
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Map 3. Tree Regeneration Composition

Tree regeneration, including seedlings and saplings, by species group observed in forest plots during the last census (2019 - 2024). Pie size is proportional to plot-level regeneration density. Plot-level regeneration stem densities range from 3,780 to 189,195 per hectare. Reporting Date: 12/15/2025.

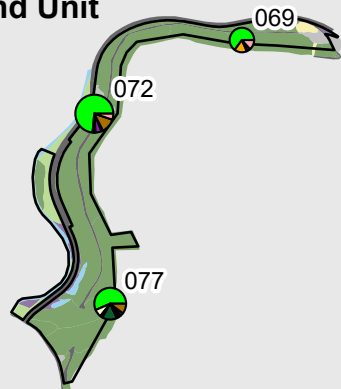
Main Unit



ALPO Units



Staple Bend Unit



Vegetation types

- Mixed forest
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Tree regeneration composition

- Acer spp. (Maple)
- Betula spp. (Birch)
- Carya spp. (Hickory)
- Fagus grandifolia (American Beech)
- Fraxinus spp. (Ash)
- Liriodendron tulipifera (Tulip Poplar)
- Magnolia spp. (Magnolia)
- Prunus spp. (Cherry)
- Quercus spp. (Oak)
- Tilia americana (Basswood)
- Tsuga canadensis (Eastern Hemlock)
- Ulmus spp. (Elm)
- Other native canopy spp.
- Other native subcanopy spp.
- Exotic spp.

Plot number



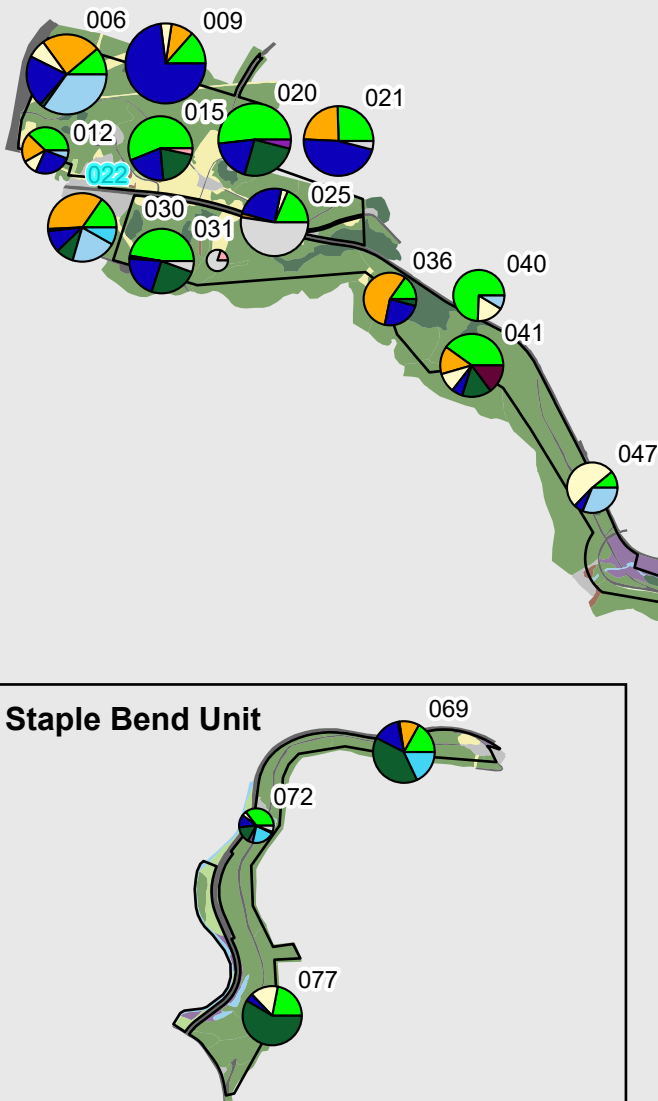
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Map 4. Tree Canopy Composition

Tree composition, by species group, observed in forest plots sampled in the most recent census (2019-2024). Pie size is proportional to plot-level tree basal area. Total basal area ranges from 5.6 to 48.5 m²/ha. Reporting Date: 12/15/2025.

Main Unit



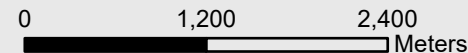
ALPO Units



Vegetation types



Tree canopy composition

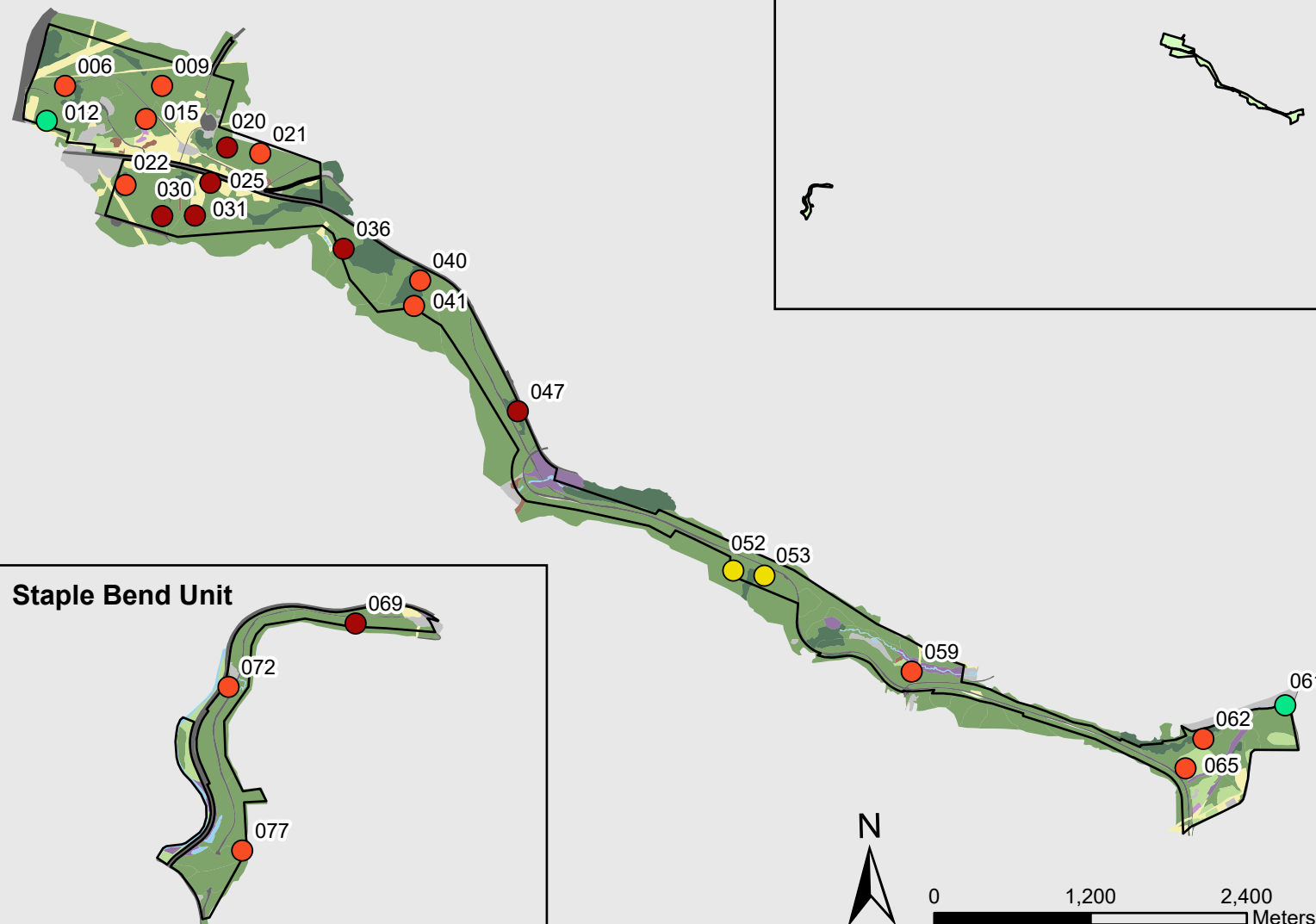




Map 5. Tree Regeneration Stocking Index

Regeneration stocking index for the most recent census (2019-2024) quantifies whether regeneration is sufficient to restock a forest canopy given deer browse impacts. This index is a weighted sum of native canopy-forming tree seedling and sapling and is reported as a plot-wide average from four microplots. Index values range from 4.75 to 354.
Reporting Date: 12/15/2025.

Main Unit



ALPO Units

Vegetation types

- Mixed forest
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- Developed land
- Transportation corridor
- Park boundary

Stocking index

- < 30: Severely understocked, regeneration is insufficient to replace the forest canopy.
- 30 - 100: Moderately stocked regeneration, sufficient for areas with low deer impacts.
- 100 - 200: Sufficient regeneration to replace forest canopy in areas with moderate (or fewer) deer impacts.
- > 200: Sufficient regeneration to replace forest canopy in areas with high (or fewer) deer impacts.

Plot number



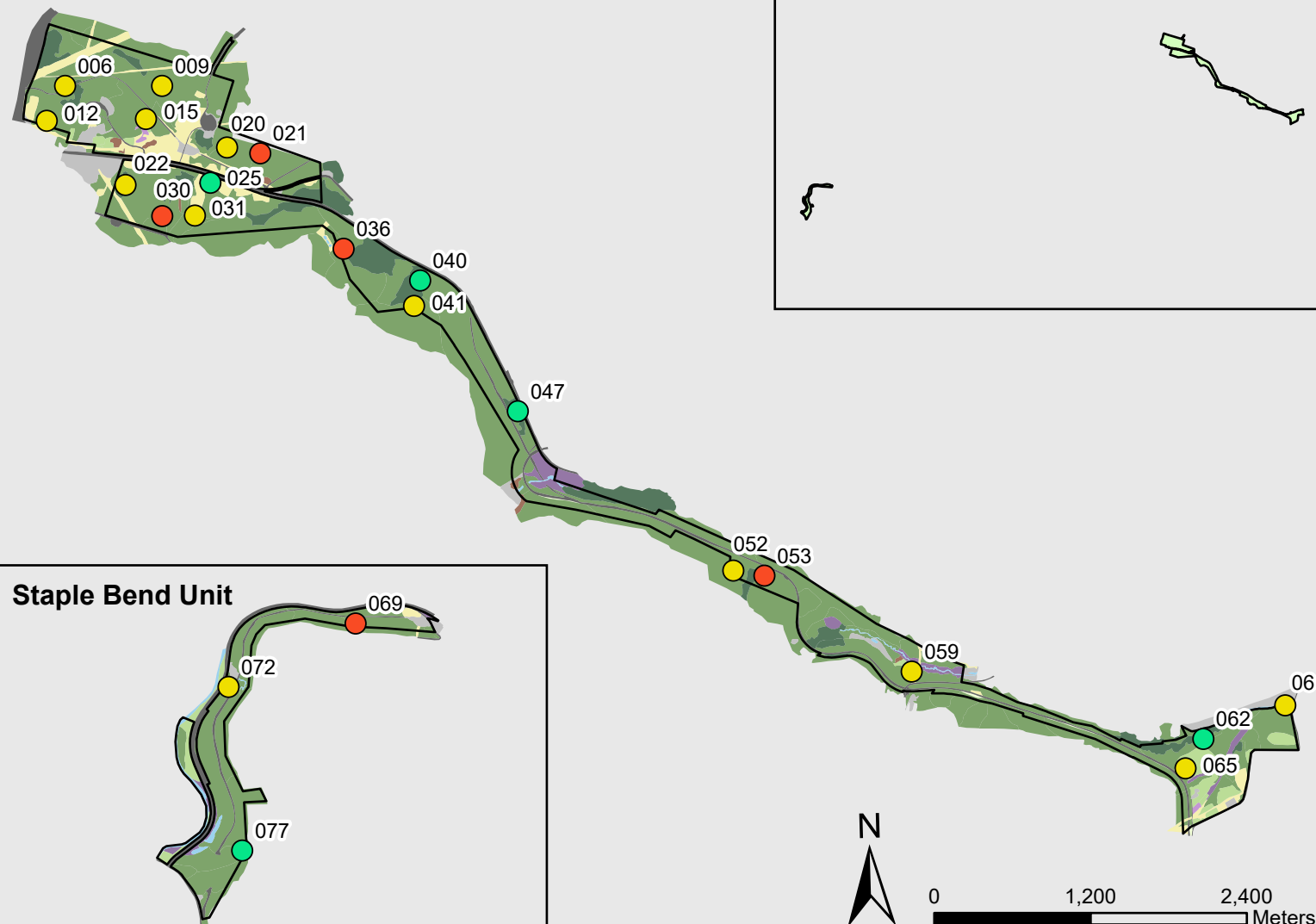
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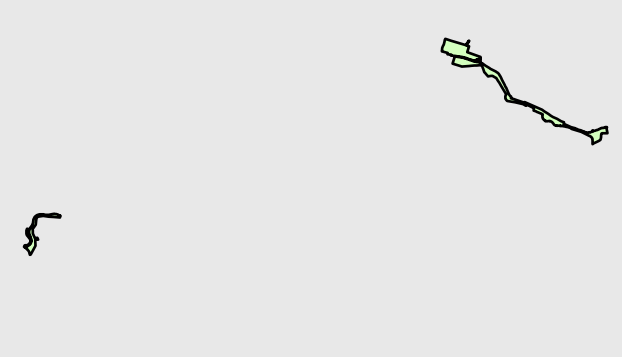
Map 6. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent census (2019-2024). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Deer browse impacts are assessed on a scale of 1-5, with 1 representing no impact and 5 representing severe impacts. Reporting Date: 12/15/2025.

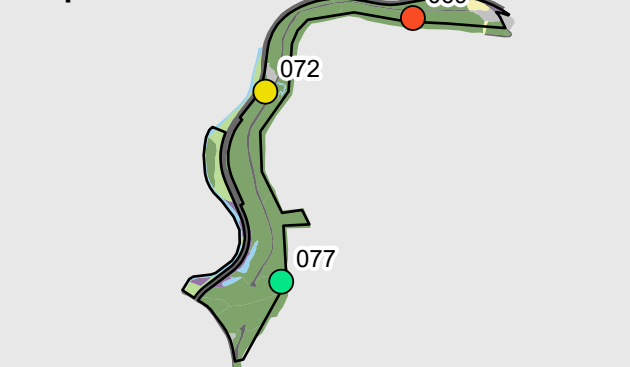
Main Unit



ALPO Units



Staple Bend Unit



Vegetation types

- Mixed forest
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Deer browse impact index

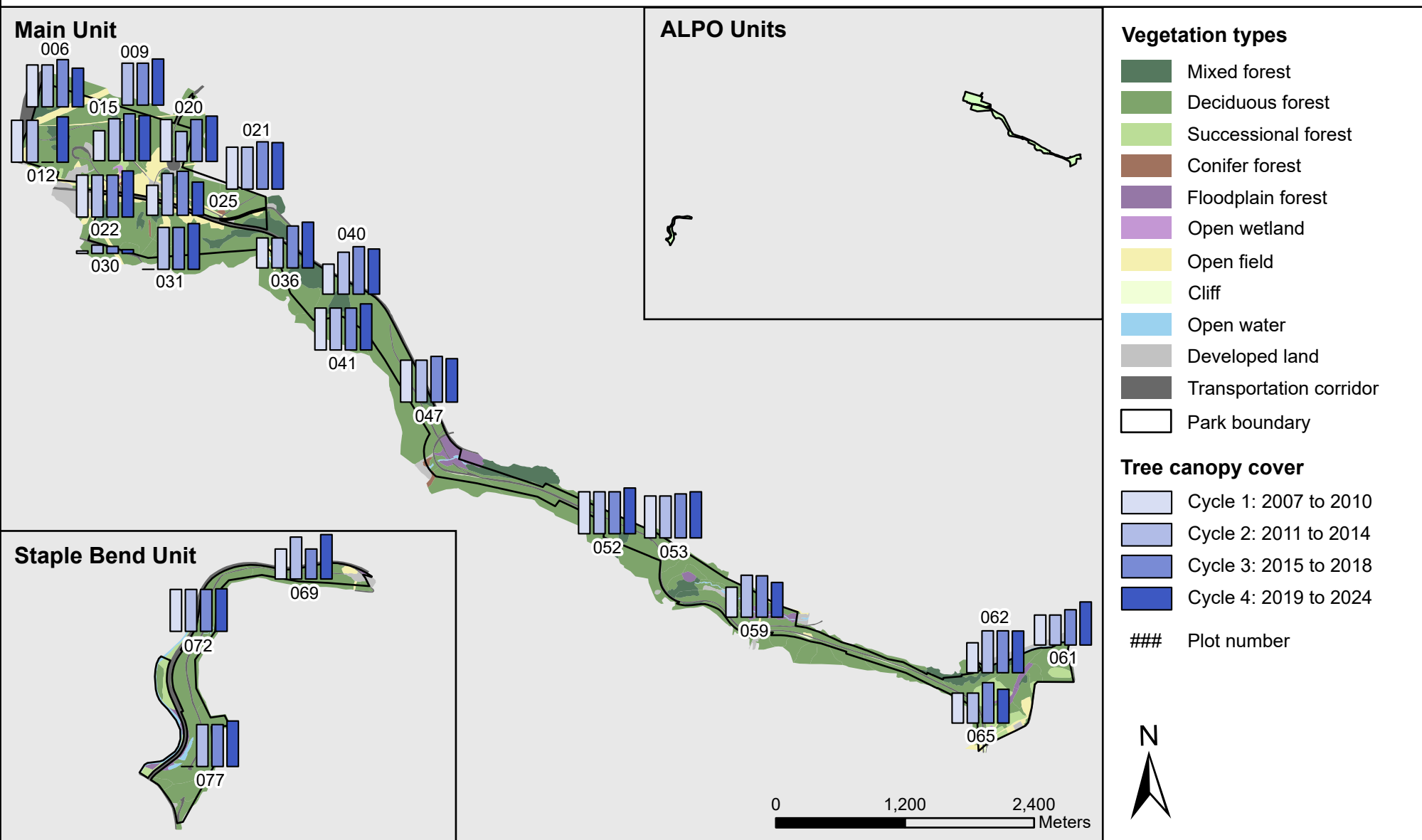
- 2) Low impact: Deer-preferred (DP) species abundant and of varying heights.
- 3) Medium impact: DP species present, but mostly under 30 cm tall. DP herbs present but stunted and flowering is uncommon.
- 4) High impact: DP species are rare to absent. Non-preferred and browse-resilient vegetation (e.g. beech) limited in height by deer browse. DP herbs absent or severely stunted.

Plot number



Map 7. % Canopy Cover by Cycle

Trends in tree canopy cover in forest plots from 2007-2024. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Canopy cover ranges from 0% to 98.8%. Reporting Date: 12/15/2025.

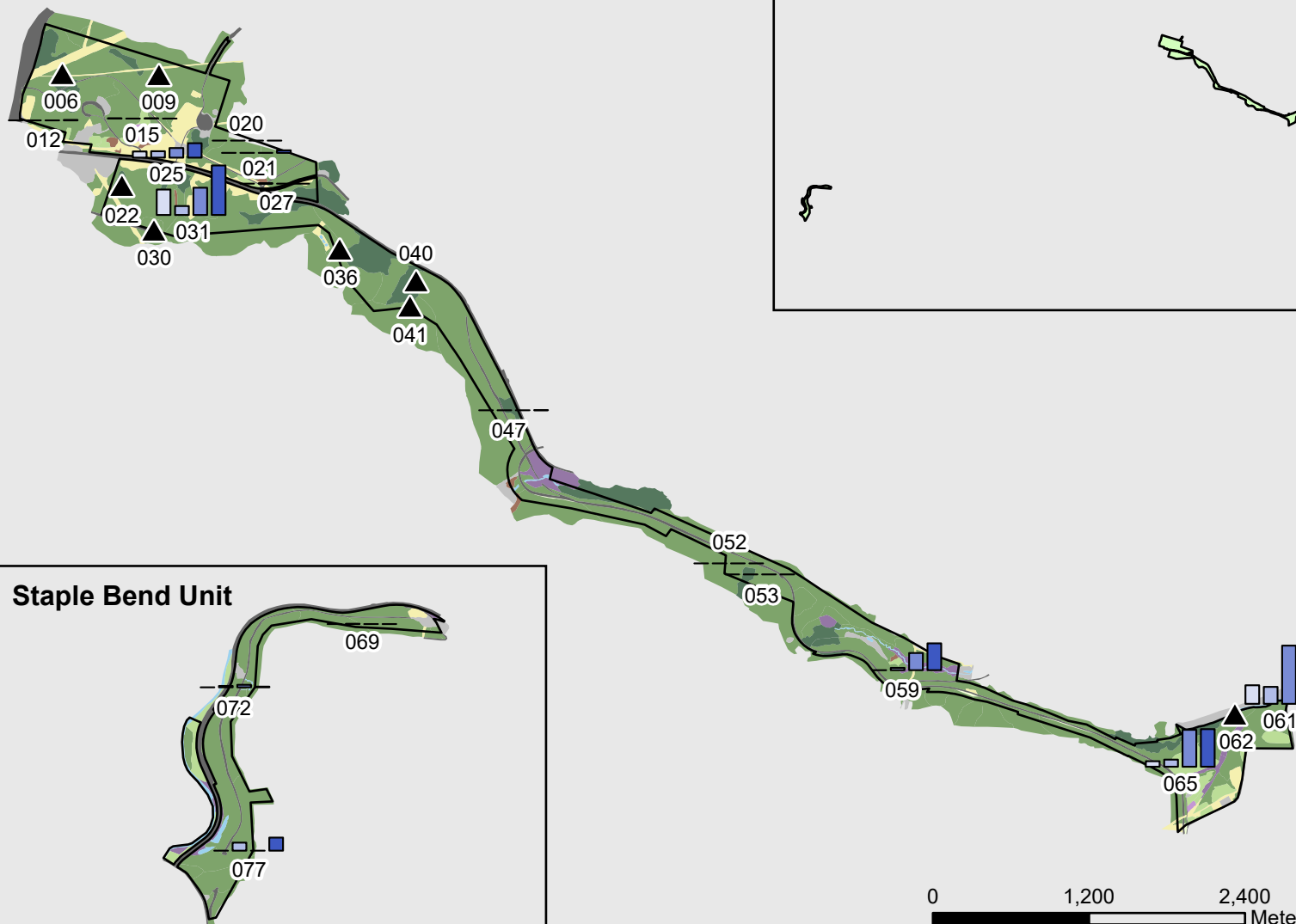




Map 8. Invasive % Cover by Cycle

Trends in percent cover of invasive species observed in quadrats in forest plots sampled from 2019-2024. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Average invasive cover per plot ranges from 0.01 to 128.3%. Cover exceeding 100% indicates multiple invasive species were overlapping within the quadrats. Reporting Date: 12/15/2025.

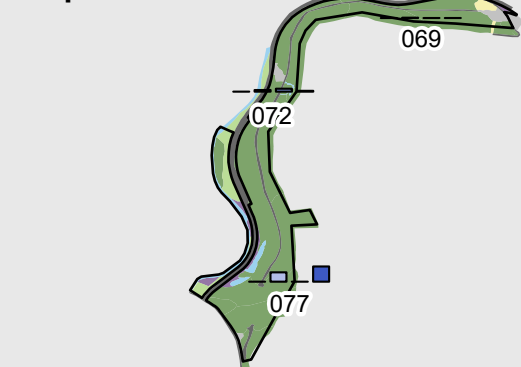
Main Unit



ALPO Units



Staple Bend Unit



Vegetation types

- Mixed forest
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- Park boundary

Invasive cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2024
- No invasive plants present
- Plot number

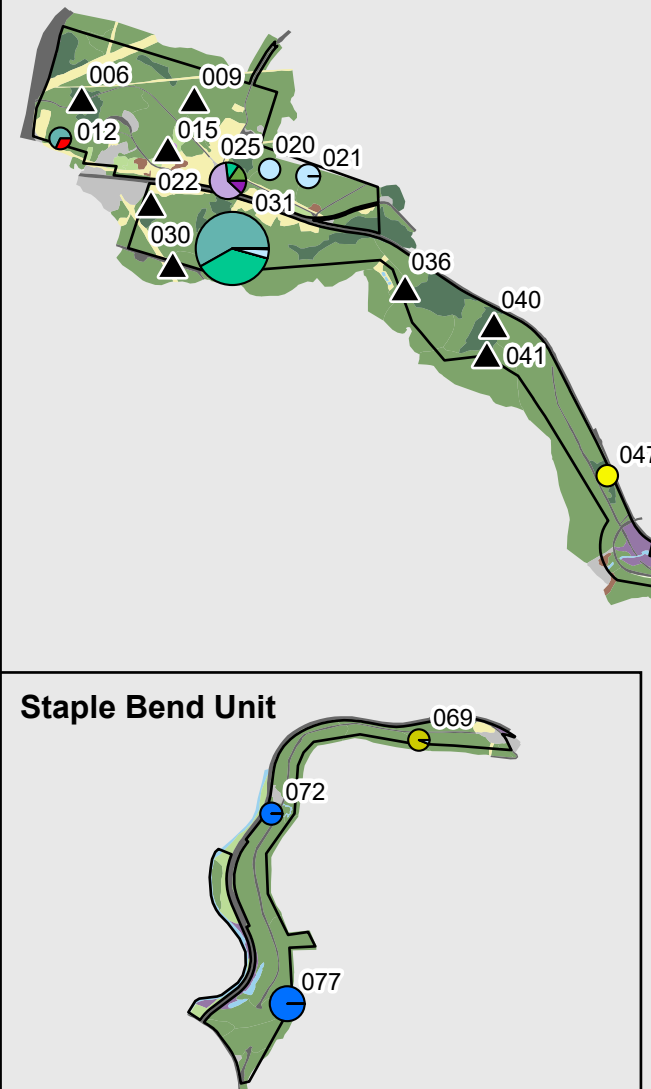




Map 9. Invasive % Cover by Species

Percent cover of invasive plant species observed in quadrats in forest plots sampled in the most recent census (2019-2024). The top 10 species or genera are displayed individually; less common species are grouped as 'Other invasive spp.'. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to total invasive cover (range: 0.02 to 128.3%). Reporting Date: 12/15/2025.

Main Unit



ALPO Units



Vegetation types

- Mixed forest
- Deciduous forest
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Invasive species

- Alliaria petiolata (Garlic Mustard)
- Anthoxanthum odoratum (Sweet Vernal Grass)
- Berberis thunbergii (Japanese Barberry)
- Celastrus orbiculatus (Asiatic Bittersweet)
- Elaeagnus umbellata (Autumn Olive)
- Hesperis matronalis (Dame's Rocket)
- Lonicera exotica (Exotic Honeysuckle)
- Ligustrum spp. (Privet)
- Microstegium vimineum (Japanese Stiltgrass)
- Persicaria spp. (Smartweeds)
- Reynoutria spp. (Knotweeds)
- Rosa multiflora (Multiflora Rose)
- Other invasive spp.
- ▲ No invasive plants present
- ### Plot number



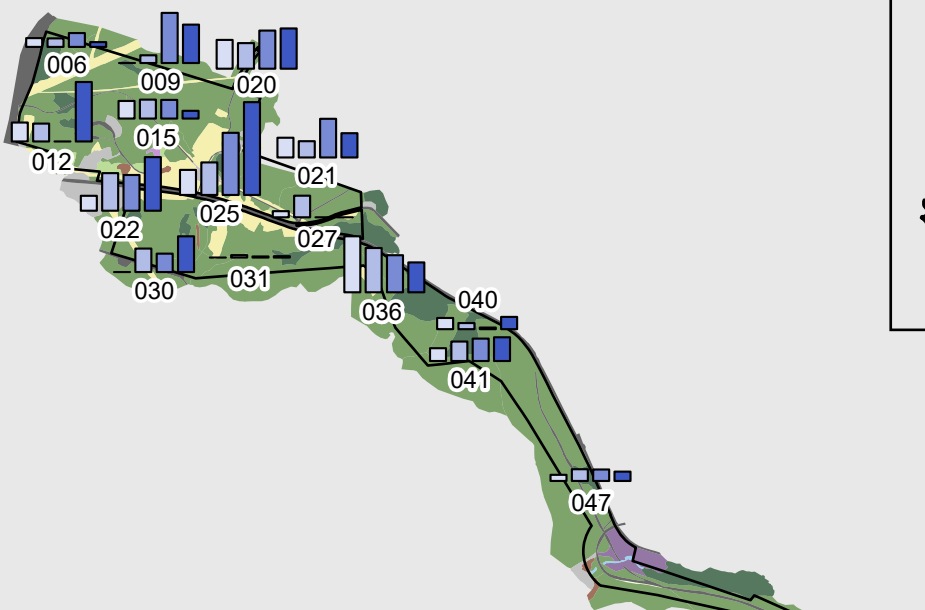
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Map 10. Coarse Woody Debris by Cycle

Trends in coarse woody debris (CWD) volume observed in plots sampled from 2007-2024. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. CWD volume ranges from 0.9 to 137.5 m³/ha. Reporting Date: 12/15/2025.

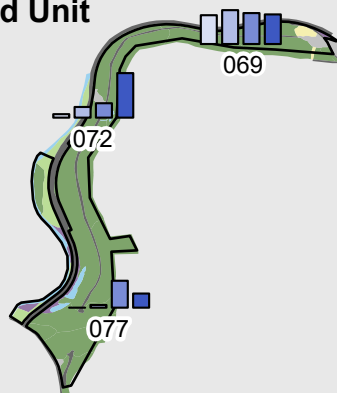
Main Unit



ALPO Units



Staple Bend Unit



Vegetation types

- Mixed forest
- Deciduous forest
- Successional forest
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- Park boundary

Coarse woody debris volume

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2024

Plot number

0 1,200 2,400 Meters

