



INVENTORY & MONITORING DIVISION

Northeast Temperate Network

JANUARY 2023

Forest Health Update for the Roosevelt-Vanderbilt NHS: 2007 - 2022

The Northeast Temperate Network (NETN) forest health monitoring crew has been visiting the 40 NETN forest plots in the Roosevelt-Vanderbilt NHS (ROVA) for 15 years on an alternating 4-year cycle. This brief is a summary of forest health analysis with focus on tree regeneration and recruitment, deer population

impacts, invasive plants and insects, tree species composition and condition, and tree mortality. Findings show that ROVA forests are regionally unique and complex, with ecological importance that extends well beyond park boundaries. But continued impacts from deer, invasive pests, and a lack of

enough tree regeneration pose significant concerns to their future.

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.

KEY FINDINGS

- As with several other parks in the Network, the forests in ROVA are in **peril of failure over time**.
- Park forests are regionally unique, with high diversity, older trees, and complex structure, whose ecological importance extends beyond park boundaries.
- Major concerns stem from widespread impacts of chronic deer overabundance, including reduced tree regeneration and loss in understory diversity.
- The combined impacts of pest-induced tree mortality and regeneration failure pose significant concerns to the future of ROVA's forests. These impacts are likely to be exacerbated by climate change.
- Without intervention, forests in ROVA will continue to degrade, resulting in loss of forest diversity, both in the canopy and in the understory, and eventual loss in forest cover.



Summary of ROVA Forest Health

Tree Regeneration and Deer

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 between the species in the regeneration layer and the



Low regeneration rates are being observed in many forest health plots (Plot 32 pictured) in the park.

canopy is another type of regeneration debt that can be problematic if the species in the regeneration layer are invasive, like Norway maple, or suboptimal, including pest/disease prone species such as ash.

Forests in ROVA are experiencing **significant regeneration debt**. While all but four plots have some native canopy-forming regeneration present across a range of size classes (Maps 1 & 2), the primary needs of regeneration abundance, namely seedling density, sapling density and stocking index, have all declined significantly over time. In the 2022 survey, only 16 out of 40 plots met the target of 0.25 seedlings/m² (~1,000 stems/acre), and no plots met the targets of 0.14 saplings/m² (550 saplings/acre) and a stocking index of 100 (Map 5). Note that these targets were established as part of a regional regeneration study. The species composition of the regeneration layer is

also concerning. Even though the native and robust [sugar maple](#) is the most abundant species in the regeneration layer and the canopy, the next most abundant species are problematic for numerous reasons. These species include Norway maple, [white ash](#), hophornbeam, and [American beech](#) (Map 3). Norway maple is an exotic invasive tree species. White ash is unlikely to recruit into the canopy because the emerald ash borer usually kills it before it can reach. It is now considered a subcanopy species, like hophornbeam, which are short-stature trees that rarely reach beyond the subcanopy layer of a forest. The recent invasion of beech leaf disease (BLD), which causes severe mortality of seedling and sapling-sized

beech and was first detected by NETN in VAMA in 2022, will likely cause declines in beech regeneration over time as the disease spreads. Outside of sugar maple, species dominant in the canopy, including [oak](#) and hemlock, are rare in the regeneration layer (Map 4). Impacts from overabundant

deer continue to be observed throughout ROVA, and are most severe in HOFR and sections of VAMA. All but one out of 40 plots **rated high or very high for deer browse impacts** in the most recent survey (Map 6).



White-tailed deer continue to have high impacts throughout the park.

The combined impacts of pest-induced tree mortality and regeneration failure pose significant threats to the future of ROVA's forests, and will only be exacerbated by increasing storm damage and resulting canopy loss due

to climate change. Lowering deer densities, either through culling or exclusion through fencing, is needed while there is still a chance for forests to recover. This is particularly important in areas of ROVA where tree mortality is highest, including areas near plots 4 (HOFR), 14 (VAMA), and 17 Roosevelt Farm and Forest (ROFF), where considerable ash mortality has recently happened and exceptionally low regeneration rates occur. These are significant issues that will require considerable effort and resources to implement. However, without intervention, forests in ROVA will continue to degrade, resulting in loss of forest diversity, both in the canopy and in the understory, and eventual loss in forest cover.

Invasive Plant Species

Invasive plant cover varies across park units in ROVA, with the highest and most diverse cover in VAMA and least cover in the ROFF unit (Maps 7 & 8). The most common invasive species across the park units are garlic mustard, Asian bittersweet, Japanese barberry, burning-bush, Norway maple, and multiflora rose (Map 8). Invasive woody species are of particular concern to forest health in ROVA, as these species can expand rapidly in response to canopy gaps, tend to persist once established, and can suppress native tree regeneration and understory diversity.

While Japanese stiltgrass percent cover and plot frequency have remained fairly stable over time, this species is capable of rapid expansion, particularly if deer impacts increase. Japanese stiltgrass is most abundant in plots in HOFR and VAMA and is only present at low levels in ROFF. We encourage park managers to keep Japanese stiltgrass from invading new areas and from expanding



Garlic mustard and Japanese stiltgrass abound in some plots (23 pictured).

in areas where abundance is currently low. In addition to treating with herbicide, installing boot scrapers at trail heads to keep hikers from transporting seeds, and cleaning off maintenance equipment between units may help reduce the spread of Japanese stiltgrass.

Forest Structure & Composition

The canopy in ROVA is diverse both within and among forest plots (Map 4), and stand-level tree diversity is demonstrably greater in ROVA than forests in the surrounding area.

Park forests also have considerably more complex older forest structure, such as large trees and snags and coarse woody debris, than surrounding unprotected forests. Tree

cores collected near forest plots in ROVA indicate that several stands, particularly in VAMA and ROFF units, are relatively old. Plots 7, 24, 36, and 40 have white oak trees that originated between 1818 and 1864. Plot 40 has several chestnut oaks that originated between 1833 and 1843. Taken together, the long history of protection in ROVA

has resulted in remarkably older and diverse forests that are [otherwise rare in the region](#), and their continued protection and management is important beyond the boundaries of the park. That said, a number of stressors, including exotic pests/pathogens and overabundant deer, threaten the unique nature and condition of the forests in ROVA.

Ash, in particular, experienced severe mortality in the most recent cycle due largely to emerald ash borer (Map 9).



Emerald ash borer

The red pine plantations also experienced severe mortality in the most recent cycle. Given that nearly all red pines that were alive in the first cycle have now died, this mortality is likely due to red pine scale rather than stem exclusion/

natural forest dynamics. While hemlock continues to persist in the canopy despite the presence of hemlock woolly adelgid and elongate hemlock scale, stem density and basal area have declined over time. Unfortunately, this pattern is expected to continue as winters become milder allowing HWA populations to build up higher



Complex forest structure, like snags and coarse woody debris, are ecologically important features found in the forests of the park. This tip-up mound (plot 22) could be used as a nesting site for Winter Wrens and provide refugia for some native plants and tree seedlings.

population densities and cause greater hemlock mortality.

The tree species that gained stem density over time were black birch, hickory, American beech, and some subcanopy species. Given the recent detection of beech leaf disease in ROVA (Map 9), recruitment of beech may be reduced over time. If these mortality and recruitment patterns continue, we expect the canopy in ROVA to become less diverse and more sugar maple and black birch dominated over time.

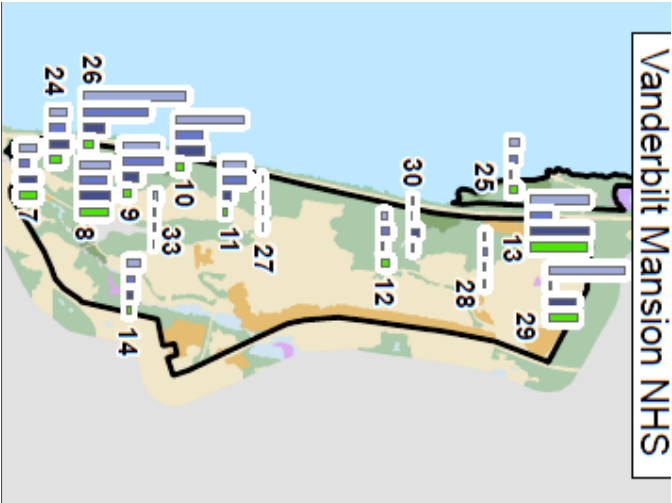
forest health as well as all the other long-term monitoring programs. Like all of NETN's parks, ROVA has its own [web page](#) providing a convenient one-stop shopping place for all things ROVA-related.

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.

For more information

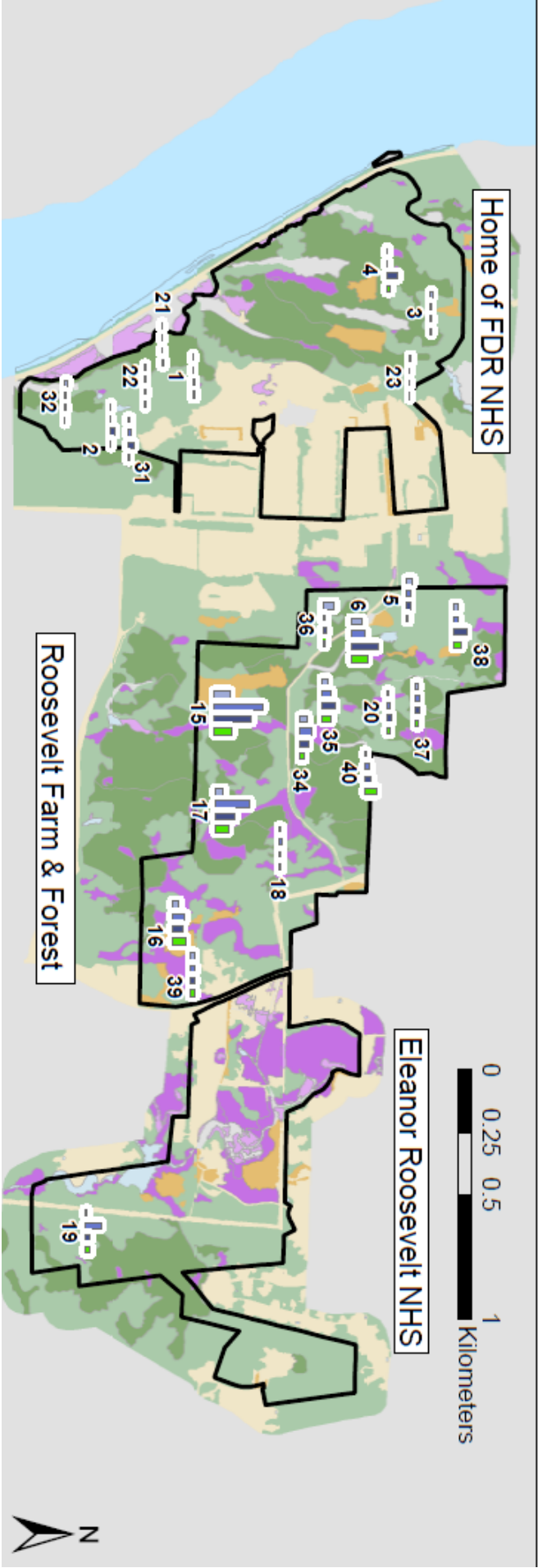
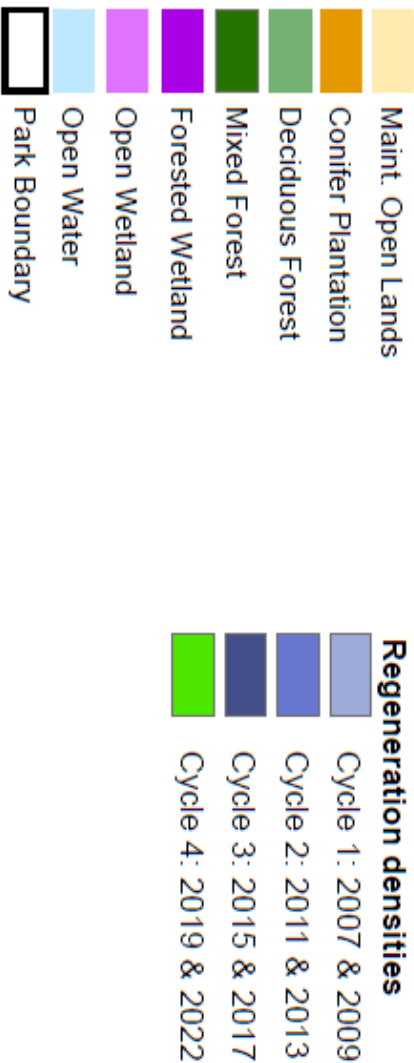
The [NETN website](#) is chock full of information related to park

PARK MONITORING MAPS

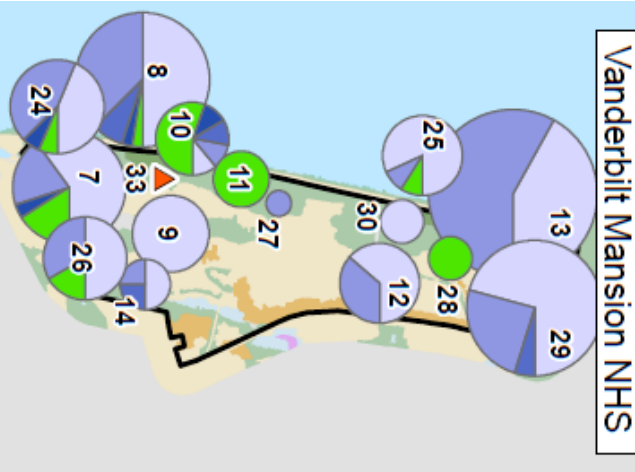


Trends in tree regeneration, including seedlings and saplings, in forest plots sampled from 2007-2022. Plots are sampled in an alternating panel, with plots 1-20 sampled in 2007, 2011, 2015, and 2019, and plots 21-40 sampled in 2009, 2013, 2017, and 2022. Densities range from 0 to 2.4 stems/m² and only include native canopy-forming species.

MAP 1: TREE REGENERATION: MONITORING CYCLE

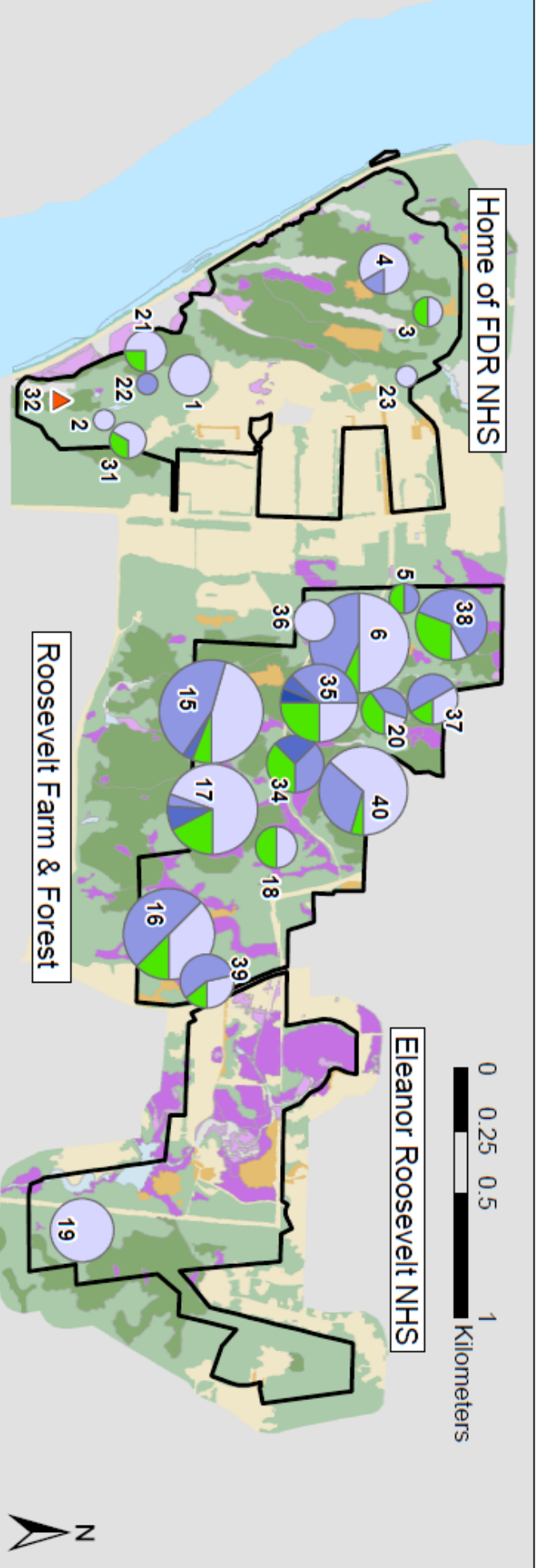


PARK MONITORING MAPS

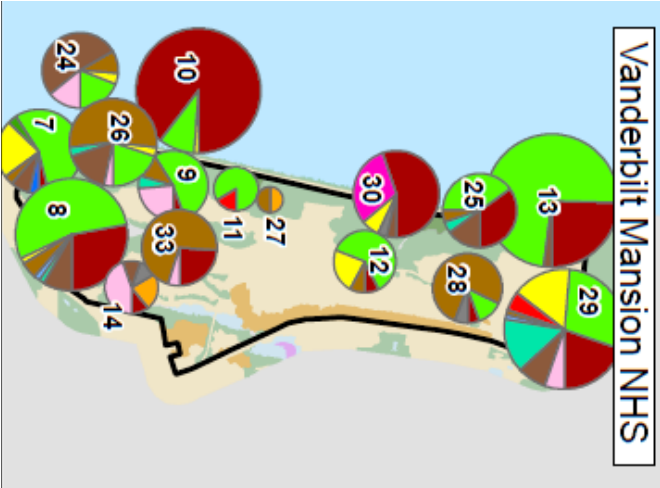


Trends in tree regeneration stem densities by size class in forest plots from the most recent survey cycle (2019 and 2022). Plots are sampled in an alternating panel, with plots 1-20 sampled in 2019, and plots 21-40 sampled in 2022. Pie size is proportional to plot-level regeneration, and location may be shifted to prevent overlap. Total densities range from 0 to 2.1 stems/m² and only include native canopy-forming species

MAP 2: TREE REGENERATION: SIZE CLASS

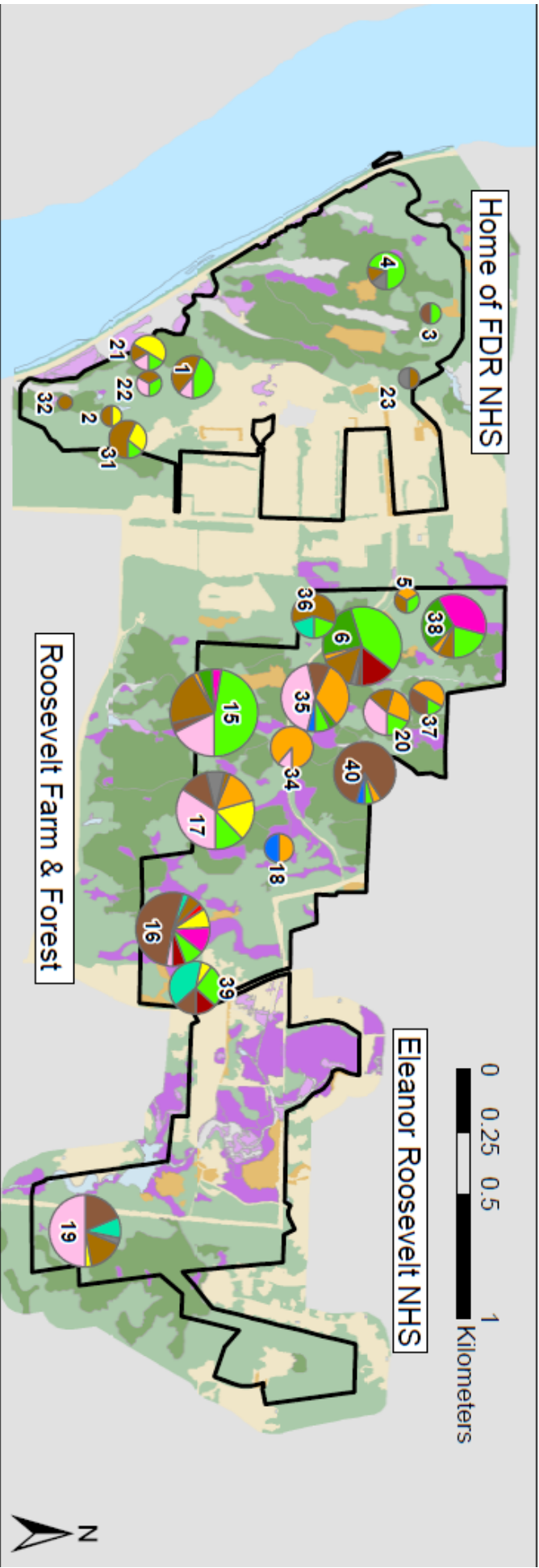
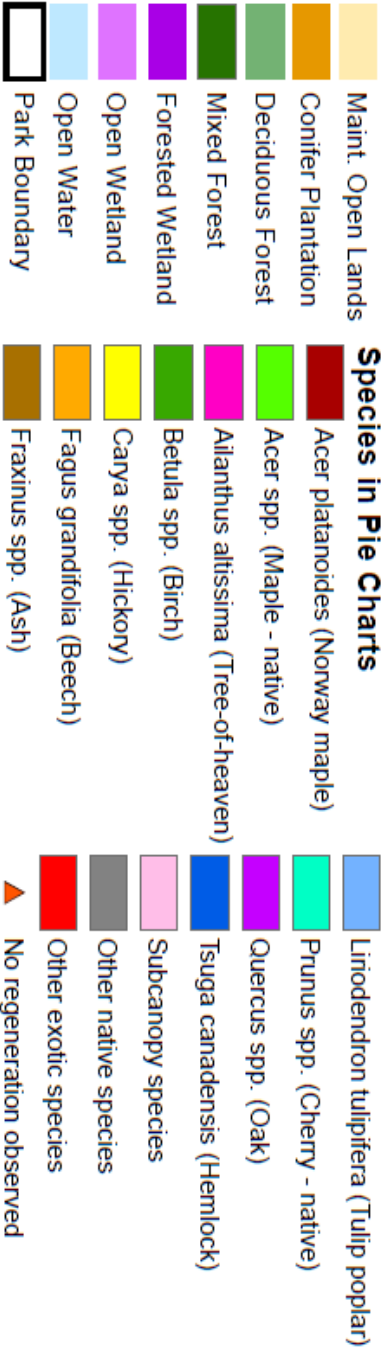


PARK MONITORING MAPS



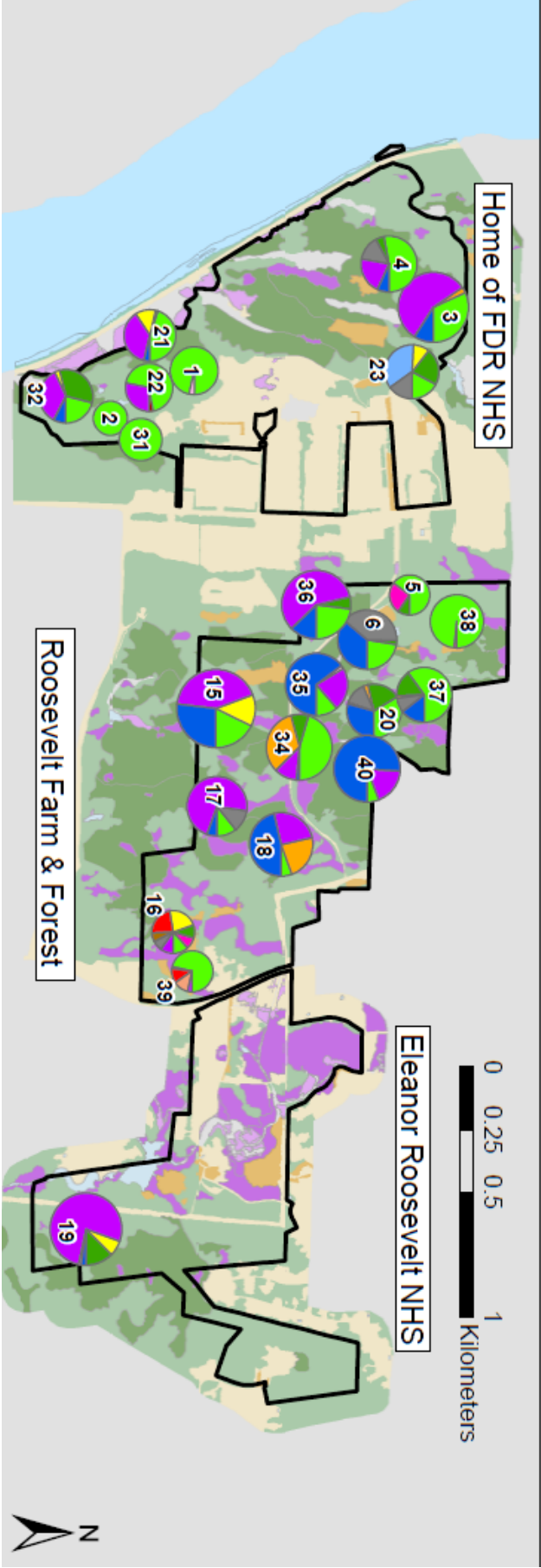
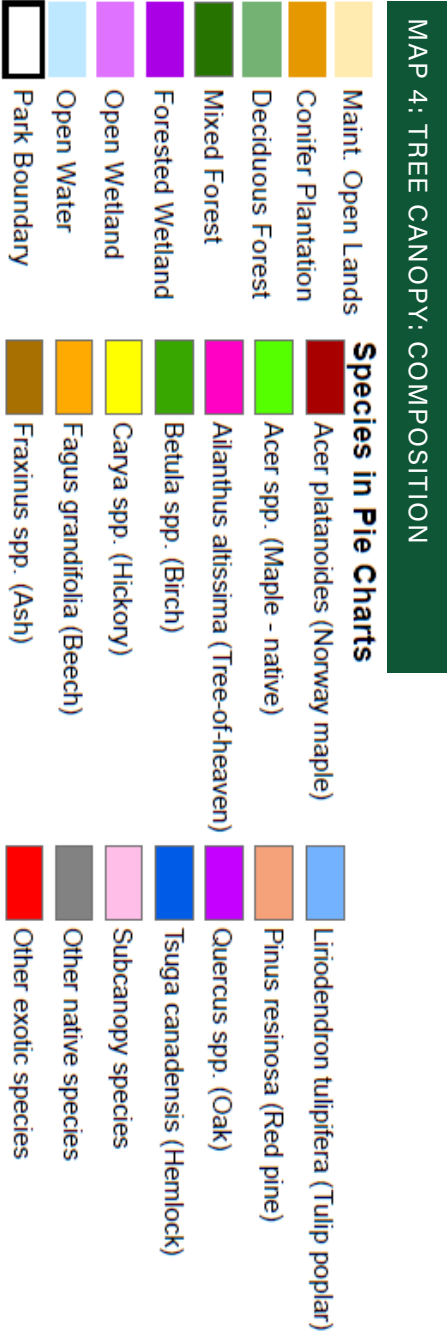
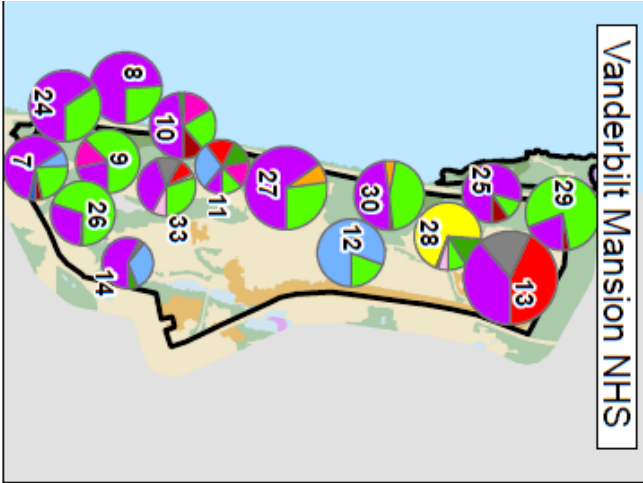
Trends in tree regeneration, including seedlings and saplings, by species group observed in forest plots in the most recent survey cycle (2019 and 2022). Plots are sampled in an alternating panel, with plots 1-20 sampled in 2019 and plots 21-40 sampled in 2022. Pie size is proportional to the total plot-level regeneration (plot-level density range: 0.02 to 2.9 stems/m²). Pies may be shifted from actual location to prevent overlap.

MAP 3: TREE REGENERATION: COMPOSITION



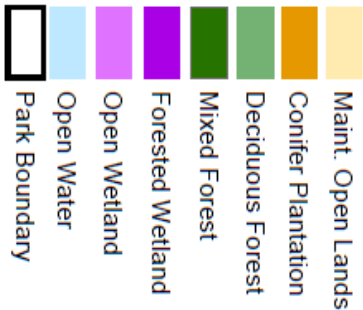
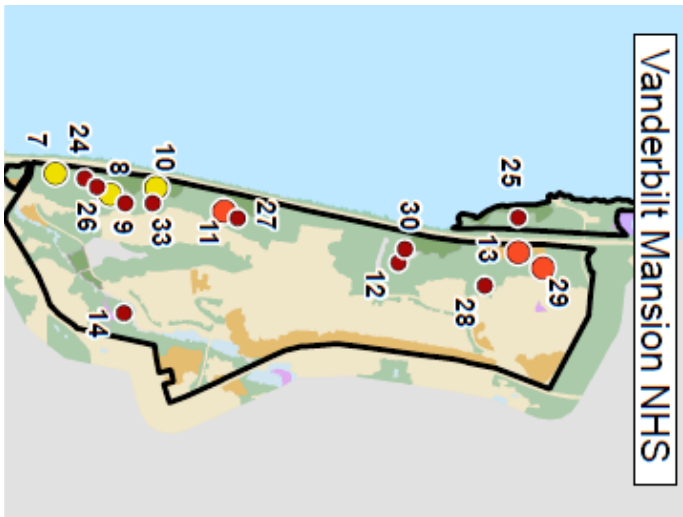
PARK MONITORING MAPS

Trends in live tree basal area by species group for plots in the most recent survey cycle (2019 and 2022). Plots are sampled in an alternating panel, with plots 1-20 sampled in 2019 and plots 21-40 sampled in 2022. Pie size is proportional to the total plot-level basal area (range 10.4 to 55.8 m2/ha for a species). Pies may be shifted from actual location to prevent overlap.



PARK MONITORING MAPS

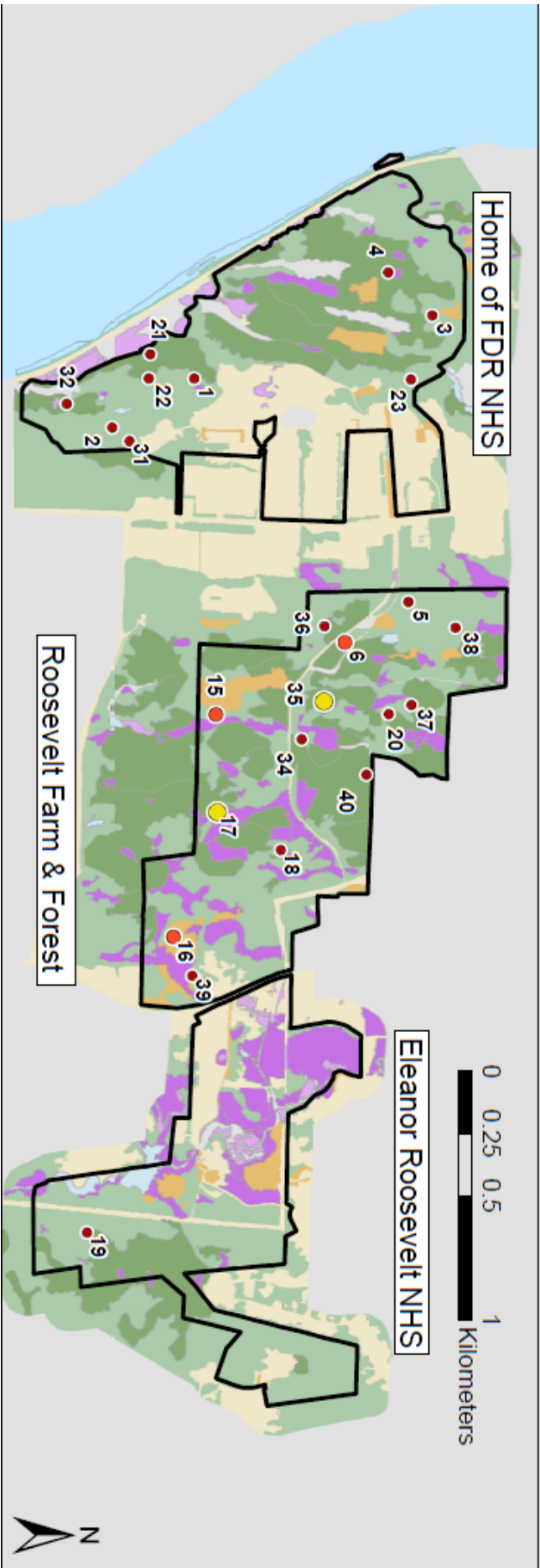
Trends in the regeneration stocking index for the most recent survey cycle (2019 & 2022). This index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights and quantifies whether current regeneration densities are sufficient to restock a forest canopy. The stocking index only includes native canopy-forming species (range: 0-91).



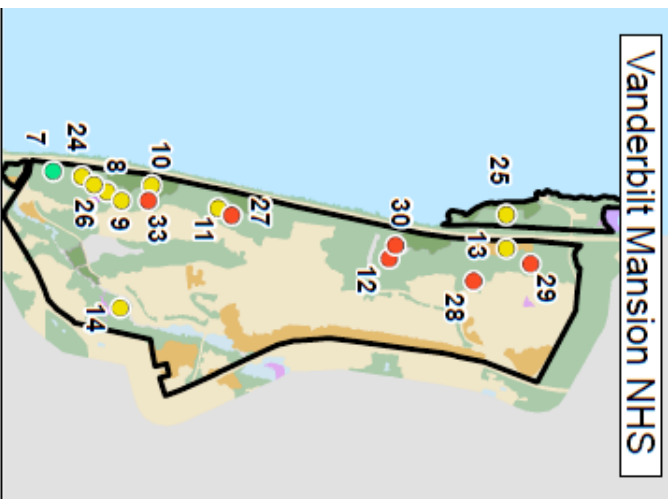
MAP 5: TREE REGENERATION: STOCKING INDEX

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.

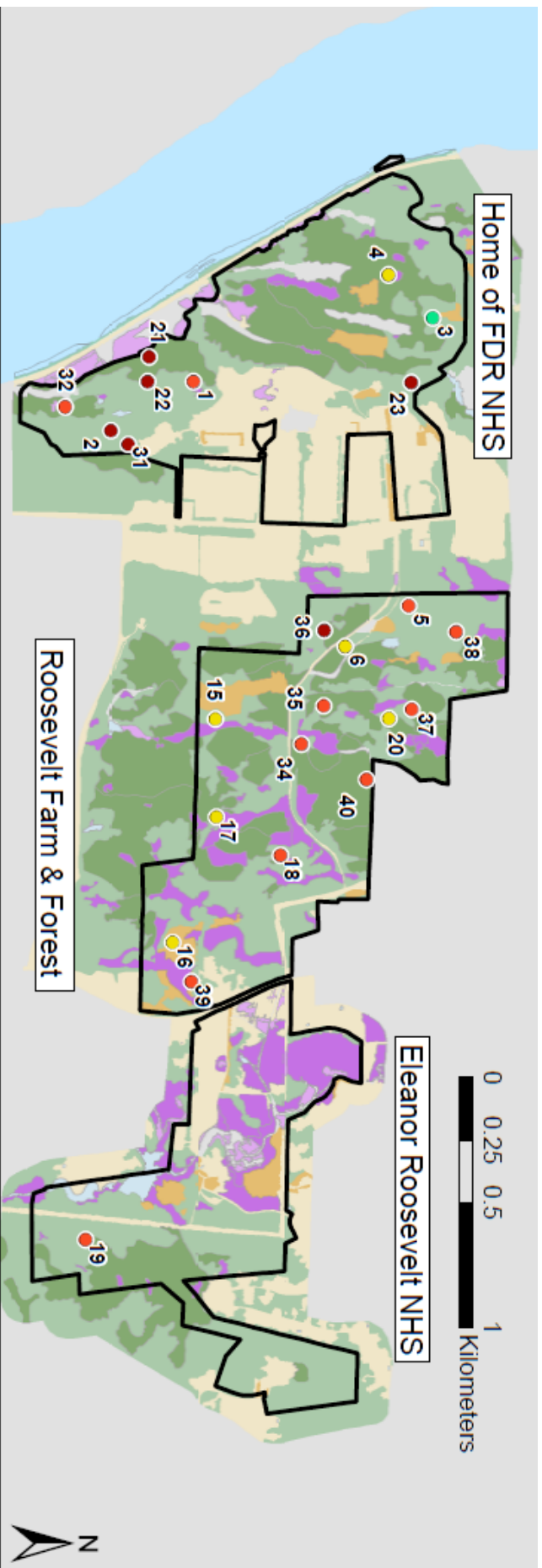
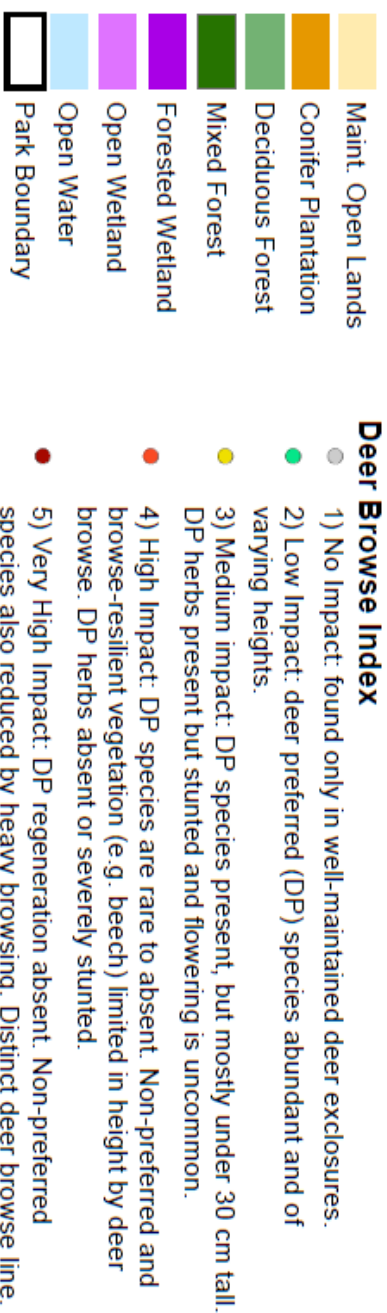


PARK MONITORING MAPS



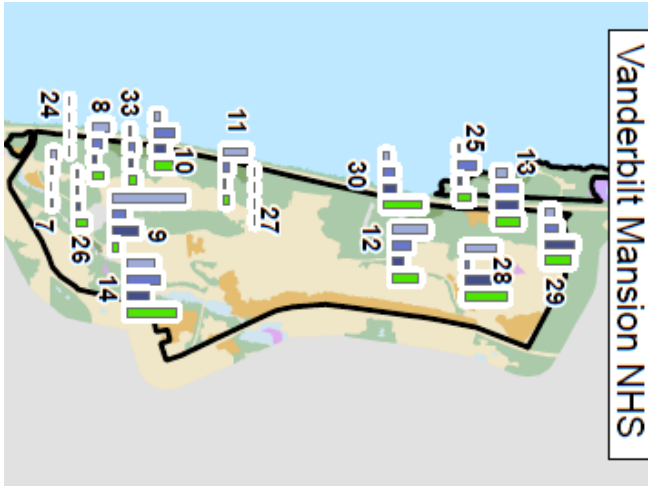
Trends in tree regeneration, including seedlings and saplings, in forest plots sampled from 2007-2022. Plots are sampled in an alternating panel, with plots 1-20 sampled in 2007, 2011, 2015, and 2019, and plots 21-40 sampled in 2009, 2013, 2017, and 2022. Densities range from 0 to 2.4 stems/m² and only include native canopy-forming species.

MAP 6: DEER BROWSE IMPACTS

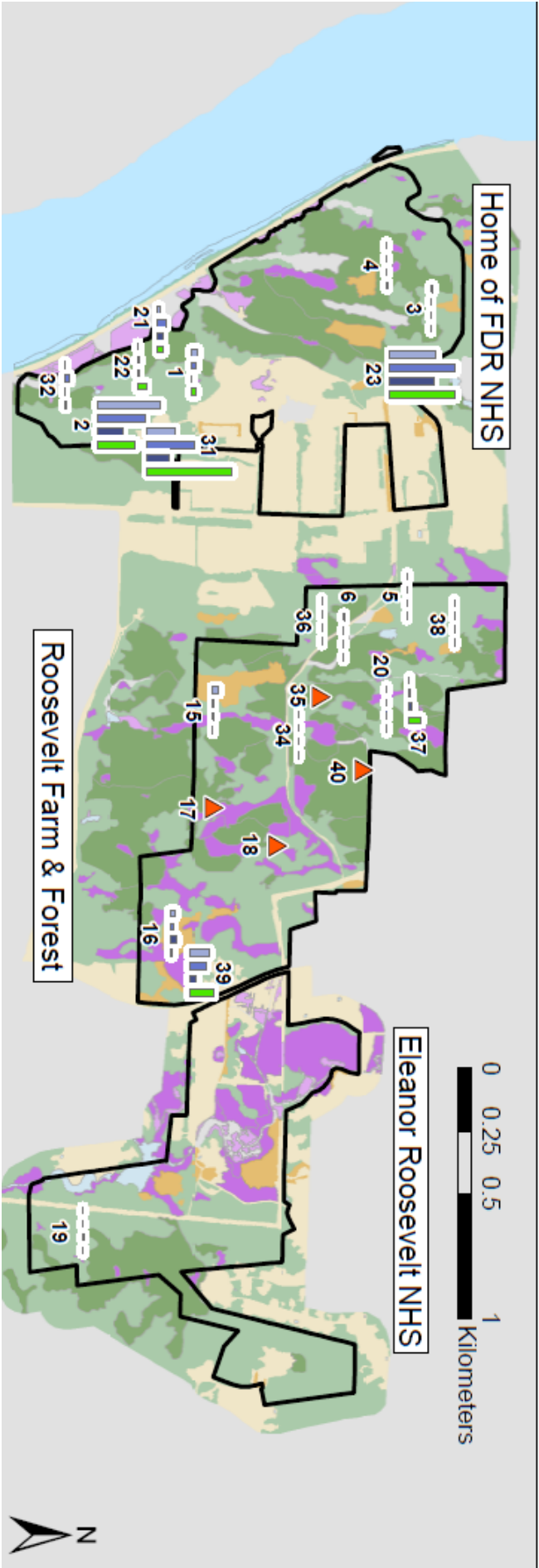
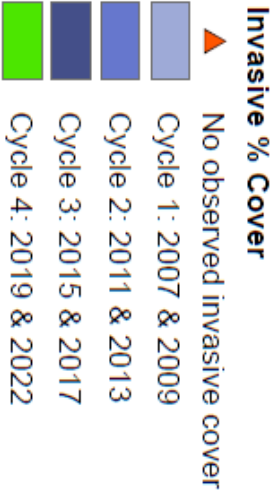
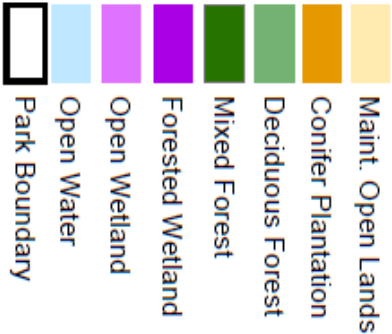


PARK MONITORING MAPS

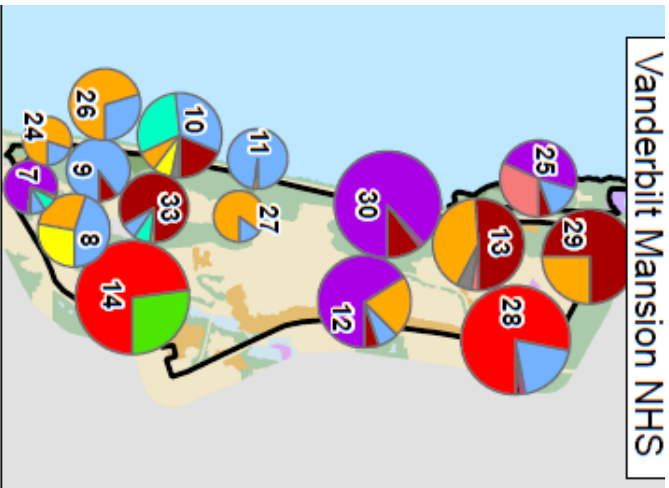
Trends in percent cover of invasive species observed in plots sampled from 2007-2022. Plots are sampled in an alternating panel, with plots 1-20 sampled in 2007, 2011, 2015, and 2019 and plots 21-40 sampled in 2009, 2013, 2017, and 2022. Average invasive cover ranges from 0 to 35.4%.



MAP 7: INVASIVES % COVER BY CYCLE

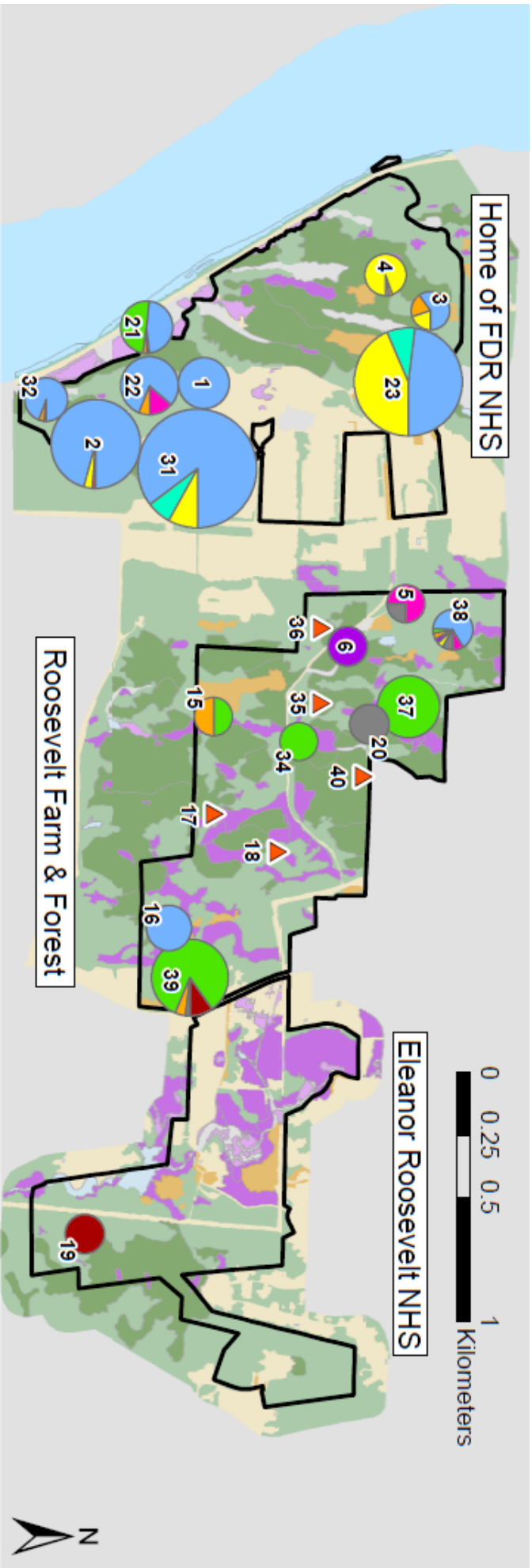


PARK MONITORING MAPS

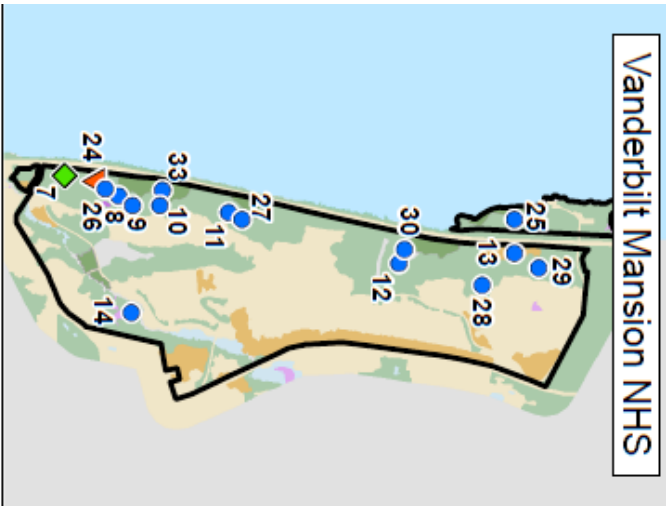


Trends in percent invasive cover by species observed in quadrats for plots in the most recent survey cycle (2019 & 2022). Plots are sampled in an alternating panel, with plots 1-20 sampled in 2019, and plots 21-40 sampled in 2022. Pie size is proportional to total invasive cover (range: 0 to 35.4%), and location may be shifted to prevent overlap.

MAP 8: INVASIVES % COVER BY SPECIES

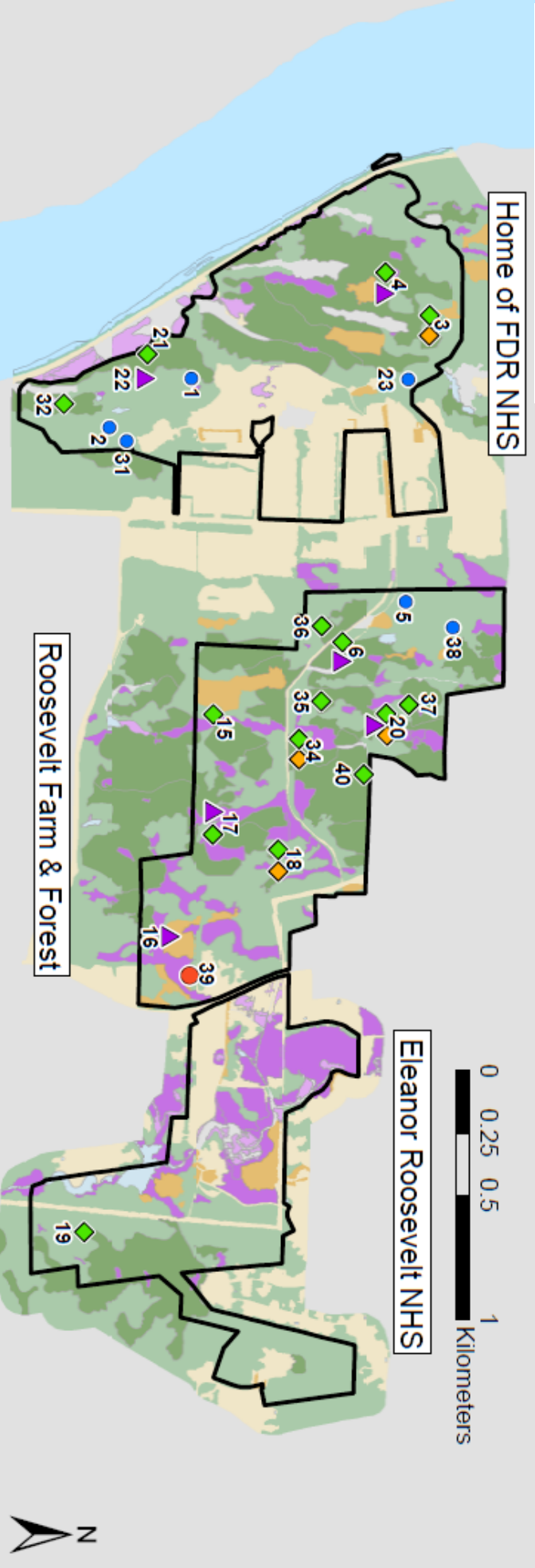


PARK MONITORING MAPS



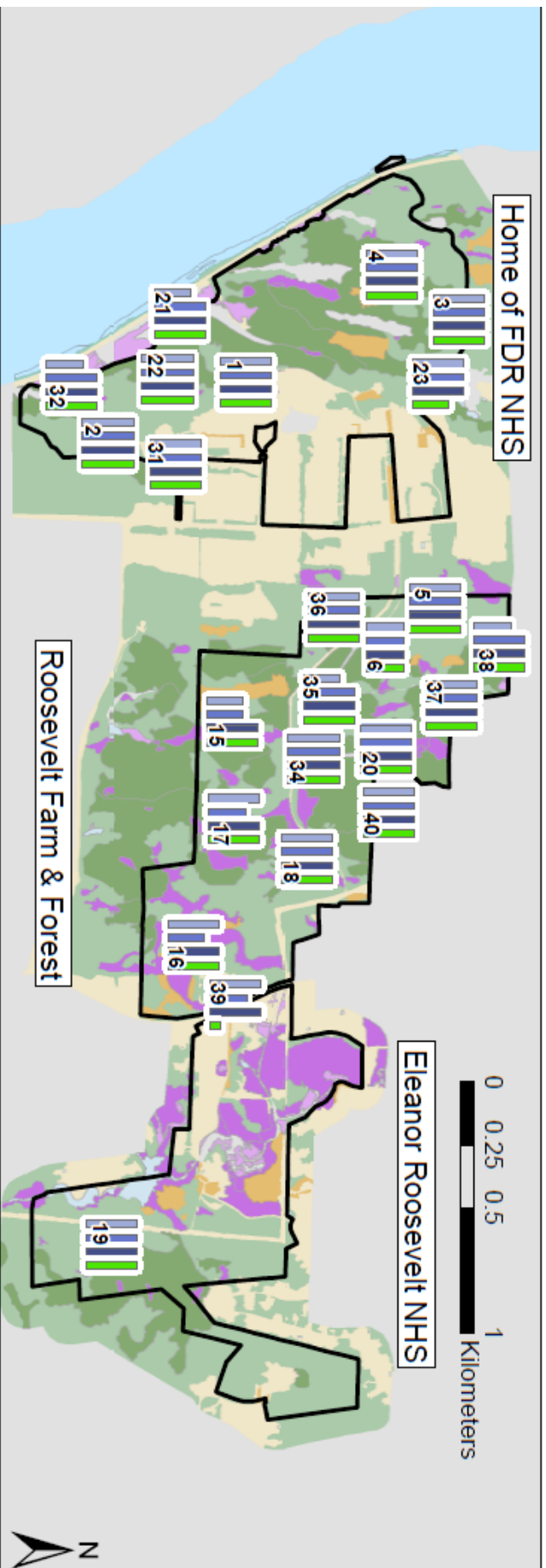
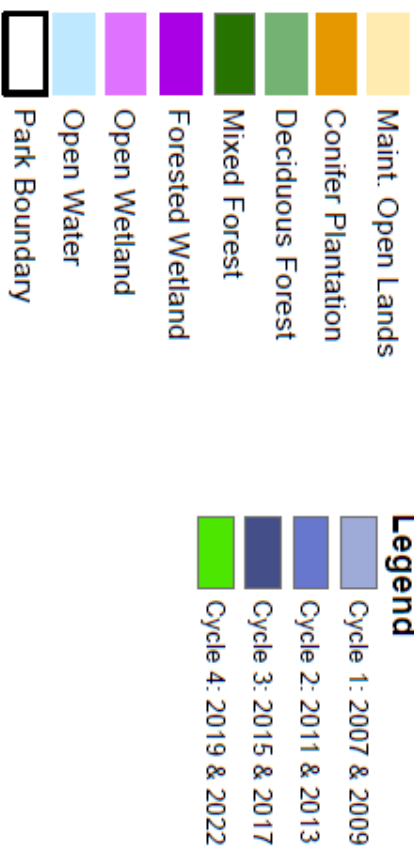
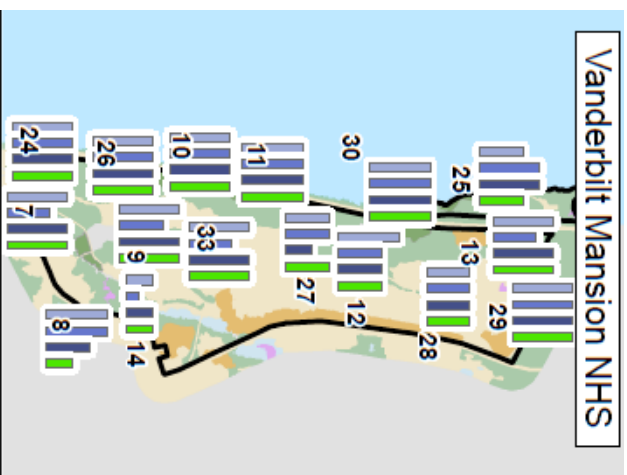
Priority pest and pathogen detections in forest plots sampled from 2019-2022. Plots are sampled in an alternating panel with plots 1-20 sampled in 2019 and plots 21-40 sampled in 2022. Plots with multiple pests present (e.g. 3, 4, 6, etc.) have multiple symbols. Note that BLD may be more widespread than map indicates, as plots 1-20 were sampled prior to the first detection in 2022.

MAP 9: FOREST PEST/PATHOGEN DETECTIONS



PARK MONITORING MAPS

Trends in tree canopy cover in forest plots sampled from 2007-2022. Plots are sampled in an alternating panel, with plots 1-20 sampled in 2007, 2011, 2015, and 2019, and plots 21-40 sampled in 2009, 2013, 2017, and 2022. Canopy cover ranges from 10 - 25% to > 75%



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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