



Monitoring Maps Tell the Story of Park's Continuing Forest Woes

What Does the Future Hold for the Forest?



If you were to ask a Magic 8-Ball that question about Morristown NHP (MORR), as things stand now the answer at left would be a likely outcome. The Northeast Temperate

Network (NETN) has been monitoring forest health in MORR since 2007 across 29 plots. Too many deer, ever increasing invasive plant, animal, and insect species, and not enough tree regeneration continue to ail park forest health. But there are possible paths that could lead to different outcomes for the forest if steps are taken to redirect its current trajectory.



Talkin' Bout Regeneration

Many forest monitoring plots have had no, or very few, tree seedlings and/or saplings found in them since monitoring began about 12 years ago (Map 1, Table 1). A notable exception are the plots in the large enclosure

specifically built to keep hungry white-tailed deer out. Driving the point home is the fact that only two of the 29 total plots meet the park's Vegetation and White-tailed Deer Management Plan target of 500 saplings per acre, both of which are located in (wait for it...) the deer enclosure.

You don't need to have an 8-Ball or be Nostradamus to predict this future outcome: no seedlings/saplings today means no forest tomorrow. Currently, 22 of the park's plots don't have enough seedlings/sapling to replace the tree canopy (Map 5). Even where present, most seedlings are stunted in height (Map 2, Figure 1) - that is of course, except for those in the deer enclosure. Seedlings and saplings are mostly comprised of potentially problematic species like American beech, white ash, and low canopy species such as flowering dogwood and blackhaw (Map 4). While these are valuable native species on an individual level, from a forest/canopy tree perspective, they are less-than-ideal to be the dominant species in the regeneration layer. Beech is often limited in longevity as a canopy species by beech bark disease which has already caused significant damage in the northeast and continues to spread. White ash trees are not likely

Bottom Line:

While tree regeneration levels have increased in some areas, they remain too low to replace the current forest canopy if high deer pressure and abundant invasive shrubs persist.

to live long enough to become a canopy tree before succumbing to the emerald ash borer insect, the effects of which are beginning to show in MORR. Lastly, low canopy species are by their nature short-statured trees that rarely reach beyond the sub-canopy layer of a forest.

Doe. A Deer. A Ton of Deer in Fact

As much of the precluding evidence would suggest, the forests of the park are suffering from an overabundance of deer. All but three park plots rated high-to-very high for deer browse impacts in recent surveys (Map 6).

Across the park, only four plots have enough tree regeneration for areas with this amount of deer and, as I'm sure you could guess by this point, two of them are located in the large deer enclosure (Maps 14 & 25).



MORR Trees, Please

At the current time, the park's forest canopy is made up of a good mix of species. It consists of tulip poplar, oak species, beech, black birch, white ash, hickory species, maple species, and a smattering of others (Map 4). But

since there are few young trees growing in the sub-canopy and below to replace them in the coming decades, natural tree mortality means that diversity and cover can only decline unless something changes.

When a canopy gap is created in a typical forest (through a storm or a tree dying), it is a vital natural process that allows young trees to grow and fill them in.

For some other NETN parks, especially with mature even-age stands, this is important to help the forest become more diverse in age. However, for the forest of MORR, the story is quite different. Tree recruitment has failed for so many decades here that there aren't enough seedlings, saplings or sub-canopy trees waiting to fill in newly created gaps. Existing mature trees have been doing their best to fill in canopy gaps for decades, but are maxing out their physical ability to fill in much more. Additionally, the maturing stands in MORR are getting up there in age - some trees were already growing before Washington's army set up camp.



A typical forest scene in the park. A mix of maturing canopy trees, young beech trees, and a forest floor dominated by invasive shrubs (mostly Japanese barberry in this case) with little-to-no regeneration of seedlings or saplings sprouting in the understory. NPS photo.

As they are dying off, these stretched-out canopy trees are leaving even bigger gaps than in typical forests. These kinds of gaps, and the ones created by Hurricane Sandy, are too big for the existing trees to fill in, but invasive shrubs are perfectly poised to quickly leap in before there is any chance for native trees to do so.

The tree species seeing the highest rates of mortality are maples, birch, ash, oaks, and American elm (Figure 2). This trend may be accelerating too, as mortality was considerably greater - about 6x higher, than tree recruitment over the last 4-year cycle (Figure 2B).

If young trees are unable to grow and mature in a forest, it inexorably leads to a loss of forest cover. The numbers for MORR bear this out. When NETN began monitoring in 2007, all but two plots had over 50% canopy cover, and most had over 75% canopy cover (Map 7). Since then, several severe storms have created numerous canopy openings - a trend only expected to increase with climate change. Ash trees have also started dying off as the emerald ash borer infestation spreads.

Now, four plots have less than 50% canopy cover, and two plots that started at over 75% canopy cover have declined to the 50-75% level. This is unlikely to change in the near future as plots with the lowest canopy cover had little to no observed regeneration in the

most recent monitoring. They also have the highest invasive species cover (Map 8), particularly of invasive shrubs (Map 9).

Invasive and Pervasive

Invasive species continue to be a major problem in park forest plots. A motley line-up of several common and not-so-common invasive woody plants have been increasing in park plots over time. These include Japanese aralia, oriental bittersweet, autumn olive, burningbush, oriental photinia, and Siebold's arrowwood. While these are all of concern given their demonstrated invasion across eastern forests, the three most abundant shrubs - Japanese barberry, multiflora rose, and wine raspberry, are the most significant concerns to forest regeneration and understory diversity in the park, and should remain the highest priority for management.

The average cover of invasive species (36%) is actually more than double that of native species (13%). During the most recent monitoring, at least one invasive species was found in every plot, and 23 out of 29 plots had five or more invasive species (Table 2). The most abundant invasives are shrubs - particularly Japanese barberry, multiflora rose, and wine raspberry (Map 9 & Table 3). While invasive shrub cover was already prolific in MORR when monitoring began in '07, invasive shrubs have continued to increase

significantly in cover: by 6% over each 4-year cycle. Japanese barberry, the most abundant invasive species in the park and found in 86% of plots, has greatly increased - by 3% per cycle in cover. It is no coincidence that the plots with the greatest amount of invasive shrubs also tend to have low canopy cover and little to no tree regeneration. Invasive shrubs are well-known to suppress native plant growth.

Barberry, Birds, and *Borrelia burgdorferi*

Japanese barberry not only poses risks to forest health, but also to the humans and birds that may alight on or brush by one of these plants. Its prolific production of berries doesn't do birds any favors. They will readily



eat them, (and thus spread the seeds far and wide) but they don't pack quite the nutrient punch that native fruits do.

A study in Rochester, NY revealed the highest fat content and energy densities in fruits that migrant birds eat come

from native shrubs. NETN forest bird monitoring has also shown that bird numbers for species that rely on healthy and native forest structural integrity (eg. forest-ground nesters, interior forest reliant, shrub nesters, canopy nesters) are lower than would be expected in a properly functioning forest for the region.

Another element of barberry ecology has recently put it on the radar of public health officials. Turns out that it provides a fantastic haven for Lyme disease-carrying ticks. Research conducted by the University of Connecticut found that ticks with Lyme are much higher in areas with Japanese barberry. The numbers per acre are dramatic: ticks with Lyme presence varied from 10 infected ticks in an acre with no barberry, 40 where barberry was contained, 120 infected ticks per acre where barberry was not contained.

Why would this be the case? The umbrella-like, dense foliage of Japanese barberry sustains much higher humidity levels than most native shrub species. Ticks need this high humidity, or risk becoming desiccated if levels drop below 80 percent. When humidity levels drop too far in native shrubbery, ticks must shelter in the soil and can no longer "broadcast" their legs to try to attach to a passing warm-blooded mammal. Barberry also provides ideal nesting sites for white-footed mice and other rodents - primary sources for larval ticks' first blood meal and hosts for *Borrelia burgdorferi* - the bacteria that causes Lyme. Since the

majority of Lyme disease cases occur from nymphal tick bites, and nymphs are most active in the summer, risk is highest during these warm months when people are most likely to be hiking in the woods. A long-term study found that removing Japanese barberry from a wooded area lead to a significant reduction in the abundance of blacklegged ticks for as long as 6 years.

Worming Their Way Into the Woods

When they invade forests, earthworms reduce leaf-litter and alter soil nutrient cycling which can negatively impact tree regeneration and native understory plants, and all but unroll a Welcome mat for invasive species. The most commonly encountered earthworms in the northeast are European nightcrawlers, which have been detected in every park plot. More recently, "crazy snake worms" from Asia have started invading eastern forests.



These worms can occur at much higher densities and cycle nutrients faster than the European worms, and thus cause more severe impacts to the understory. [See the species spotlight on snake worms](#) for more information. Snake worms have only been on NETN's radar for a few years, and 2019 was the first year the forest crew began looking for them in MORR. They definitively detected snake worms in three plots, but it's possible that they are present in more as distinguishing between snake worms and nightcrawlers is challenging in the spring.

Sowing the Seeds of Change

At it's current trajectory, the future of the park's forest looks grim. NETN's monitoring continues to indicate that MORR is losing forest cover of desirable species, while concurrently invasive shrub thickets expand into new ground. If possible, network scientists recommend major and sustained management practices that reduce deer populations and the densest invasive shrub thickets. In particular, invasive management efforts should focus on forest stands with significant numbers of ash in the canopy. If invasive shrubs are left to their own devices, they will only increase in cover as ash trees die from the emerald ash borer in the coming years. Reducing invasive shrubs to 10-20% cover and maintaining this lower cover for 5-10 years in these areas will hopefully give tree seedlings the opportunity to regenerate before invasive shrubs can expand and choke them out. With deer being a big issue as well, fencing or other deer management may also be necessary. NETN strongly encourages park managers and NPS staff to seek ways to course

correct the path that MORR's forests are currently on before more forest cover and native species are lost. Hopefully that would change the Magic 8-Ball's prediction to "Outlook Good."

Monitoring Maps, Table and Figures

A brief explanation of the following monitoring maps: the number next to the pie/bar charts on the maps is the NETN forest monitoring plot number.

Each plot is monitored once every 4 years. Pie chart size relates to the overall abundance of vegetation per plot. Bar chart length represents density over time per plot.

See [NETN's Forest Health Monitoring web page](https://www.nps.gov/im/netn) for access to the full monitoring summary. Also view or download other forest health related materials.



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MORRISTOWN NHP • ROOSEVELT-VANDERBILT NHS • SAINT-GAUDENS NHS • SAUGUS IRON WORKS NHS • SARATOGA NHP • WEIR FARM NHS



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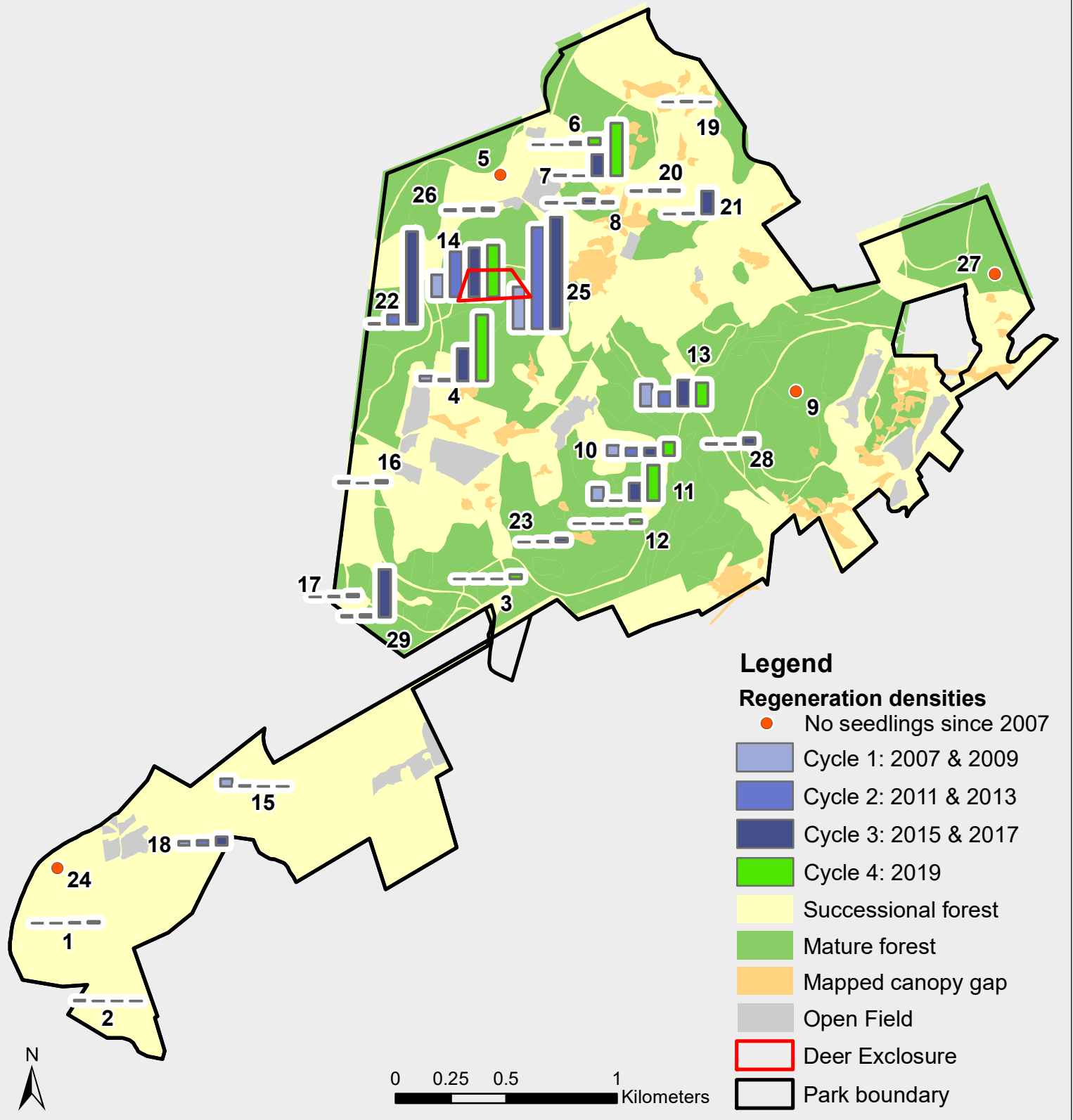
Table 1. Average plot-level seedling and sapling stem densities, converted to stems per acre, and stocking index by cycle. Only native, canopy-forming species are included. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017, Cycle 4= 2019. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year. The stocking index quantifies whether current regeneration densities are sufficient to restock a forest canopy. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. Bolded cells are plots that meet the minimum management target of 1,000 seedlings/acre and 550 saplings/acre, or have a stocking index >100 in the most recent cycle. Blue highlighted plots are in the deer enclosure.

Plot	Panel	Seedlings per acre				Saplings per acre				Stocking Index			
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
1	1	0	0	107.3	214.7	0	0	0	0	0	0	0.3	1.0
2	1	107.3	0	0	0	0	0	0	0	0.3	0	0	0
3	1	0	0	0	429.4	0	0	0	107.3	0	0	0	18.7
4	1	536.7	214.7	3649.8	7406.9	0	0	0	0	1.7	0.7	33.7	140.7
5	1	0	0	0	0	0	0	0	0	0	0	0	0
6	1	0	0	322.0	751.4	0	0	0	0	0	0	1	2.3
7	1	107.3	0	2361.6	5904	0	0	0	0	0.3	0	7.3	18.3
8	1	107.3	0	536.7	214.7	0	0	0	0	0.3	0	1.7	1.0
9	1	0	0	0	0	0	0	0	0	0	0	0	0
10	1	966.1	536.7	644.1	1288.2	214.7	322.0	214.7	214.7	37.3	52.0	36.0	64.7
11	1	1502.8	0	1932.2	3971.8	0	0	0	0	6	0	15.3	56.7
12	1	0	0	0	429.4	0	0	0	0	0	0	0	2
13	1	2254.3	1610.2	2683.7	2361.6	214.7	0	214.7	214.7	45.7	15.3	78.3	148.3
14	1	2469.0	5045.3	5367.3	5260.0	0	0	107.3	536.7	10.3	282.7	518.7	604
15	1	858.8	107.3	0	0	0	0	0	0	3	0.3	0	0
16	2	214.7	0	322	---	0	0	0	---	1.0	0	1.0	---
17	2	0	107.3	322	---	0	0	0	---	0	0.3	1.3	---
18	2	429.4	536.7	966.1	---	0	0	0	---	1.3	2.7	4.3	---
19	2	0	107.3	0	---	0	0	0	---	0	0.3	0	---
20	2	107.3	214.7	214.7	---	0	0	0	---	0.3	0.7	0.7	---
21	2	0	107.3	2576.3	---	0	0	0	---	0	0.3	15.0	---
22	2	107.3	1073.5	10412.6	---	0	0	0	---	0.3	3.7	38	---
23	2	0	107.3	429.4	---	0	0	0	---	0	0.3	1.3	---
24	2	0	0	0	---	0	0	0	---	0	0	0	---
25	2	4723.2	11378.7	10305.2	---	0	0	2254.3	---	27.7	634.3	911	---
26	2	107.3	214.7	322.0	---	0	0	0	---	0.7	7.3	1.7	---
27	2	0	0	0	---	0	0	0	---	0	0	0	---
28	2	107.3	107.3	751.4	---	0	0	0	---	0.3	0.3	2.3	---
29	2	214.7	322.0	5367.3	---	0	0	0	---	0.7	1.0	16.7	---



Map 1. Tree Regeneration by Cycle

Trends in tree regeneration stem densities, including seedlings and saplings, in forest plots sampled from 2007-2019. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2007, 2011, 2015, and 2019, and plots 16-29 sampled in 2009, 2013, and 2017. Densities range from 0 to 31,035 stems/ha, and only include native canopy-forming species (differs from 2017 summary, which included all native species). See Table 1 to view densities in stems/acre. Date: 6/7/2019.





Map 2. Tree Regeneration by Size Class

Trends in tree regeneration stem densities by size class in forest plots from the most recent survey cycle (2017 & 2019). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2019, and plots 16-29 sampled in 2017. Pie size is proportional to plot-level regeneration, and location may be shifted to prevent overlap. Densities range from 0 to 21,220 stems/ha for an individual size class and only include native canopy-forming species (differs from 2017 summary, which included all native species). See Table 1 to view densities in stems/acre. Date: 6/7/2019.

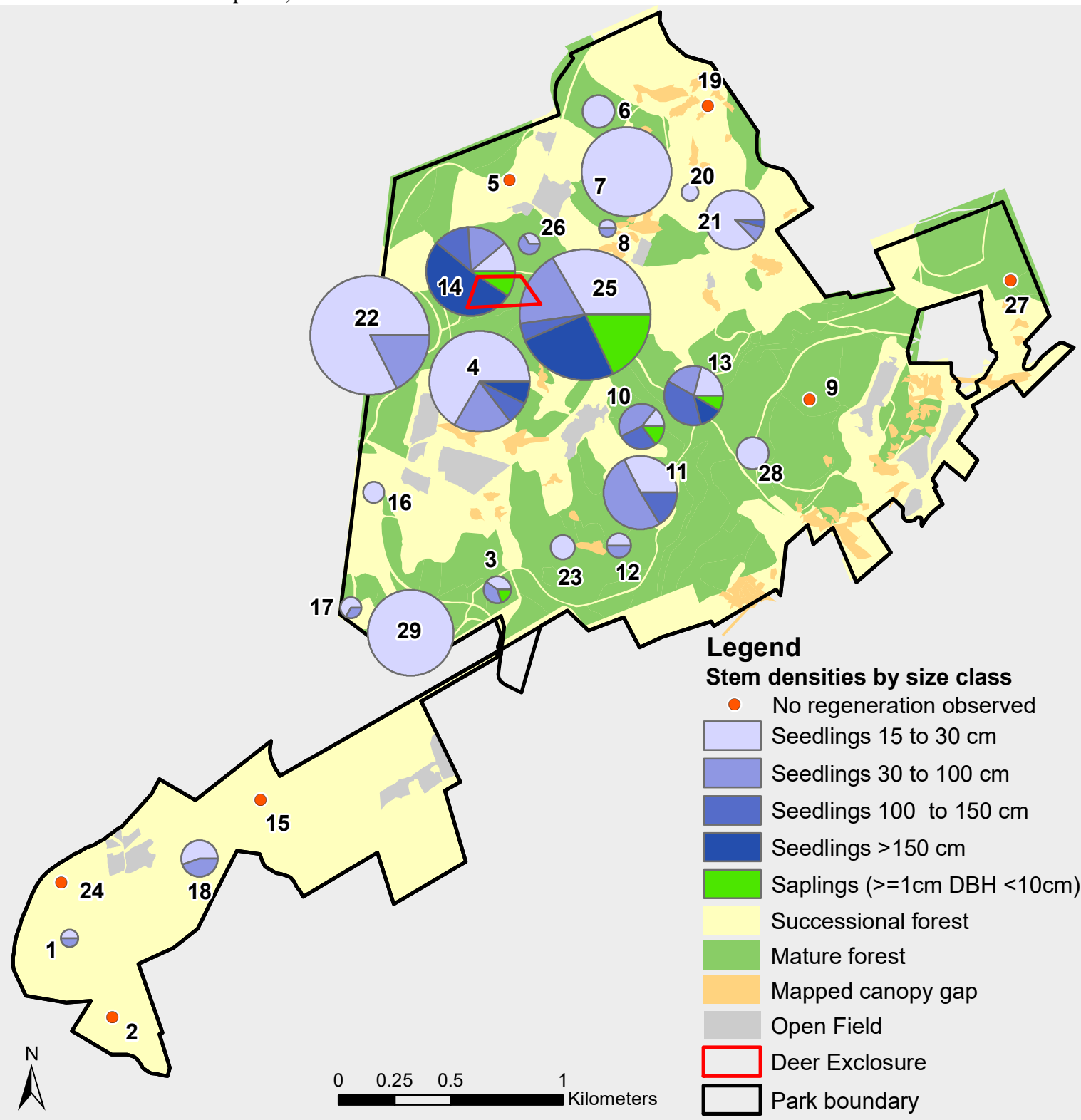


Table 1. Average plot-level seedling and sapling stem densities, converted to stems per acre, and stocking index by cycle. Only native, canopy-forming species are included. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017, Cycle 4= 2019. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year. The stocking index quantifies whether current regeneration densities are sufficient to restock a forest canopy. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. Bolded cells are plots that meet the minimum management target of 1,000 seedlings/acre and 550 saplings/acre, or have a stocking index >100 in the most recent cycle. Blue highlighted plots are in the deer enclosure.

Plot	Panel	Seedlings per acre				Saplings per acre				Stocking Index			
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
1	1	0	0	107.3	214.7	0	0	0	0	0	0	0.3	1.0
2	1	107.3	0	0	0	0	0	0	0	0.3	0	0	0
3	1	0	0	0	429.4	0	0	0	107.3	0	0	0	18.7
4	1	536.7	214.7	3649.8	7406.9	0	0	0	0	1.7	0.7	33.7	140.7
5	1	0	0	0	0	0	0	0	0	0	0	0	0
6	1	0	0	322.0	751.4	0	0	0	0	0	0	1	2.3
7	1	107.3	0	2361.6	5904	0	0	0	0	0.3	0	7.3	18.3
8	1	107.3	0	536.7	214.7	0	0	0	0	0.3	0	1.7	1.0
9	1	0	0	0	0	0	0	0	0	0	0	0	0
10	1	966.1	536.7	644.1	1288.2	214.7	322.0	214.7	214.7	37.3	52.0	36.0	64.7
11	1	1502.8	0	1932.2	3971.8	0	0	0	0	6	0	15.3	56.7
12	1	0	0	0	429.4	0	0	0	0	0	0	0	2
13	1	2254.3	1610.2	2683.7	2361.6	214.7	0	214.7	214.7	45.7	15.3	78.3	148.3
14	1	2469.0	5045.3	5367.3	5260.0	0	0	107.3	536.7	10.3	282.7	518.7	604
15	1	858.8	107.3	0	0	0	0	0	0	3	0.3	0	0
16	2	214.7	0	322	---	0	0	0	---	1.0	0	1.0	---
17	2	0	107.3	322	---	0	0	0	---	0	0.3	1.3	---
18	2	429.4	536.7	966.1	---	0	0	0	---	1.3	2.7	4.3	---
19	2	0	107.3	0	---	0	0	0	---	0	0.3	0	---
20	2	107.3	214.7	214.7	---	0	0	0	---	0.3	0.7	0.7	---
21	2	0	107.3	2576.3	---	0	0	0	---	0	0.3	15.0	---
22	2	107.3	1073.5	10412.6	---	0	0	0	---	0.3	3.7	38	---
23	2	0	107.3	429.4	---	0	0	0	---	0	0.3	1.3	---
24	2	0	0	0	---	0	0	0	---	0	0	0	---
25	2	4723.2	11378.7	10305.2	---	0	0	2254.3	---	27.7	634.3	911	---
26	2	107.3	214.7	322.0	---	0	0	0	---	0.7	7.3	1.7	---
27	2	0	0	0	---	0	0	0	---	0	0	0	---
28	2	107.3	107.3	751.4	---	0	0	0	---	0.3	0.3	2.3	---
29	2	214.7	322.0	5367.3	---	0	0	0	---	0.7	1.0	16.7	---

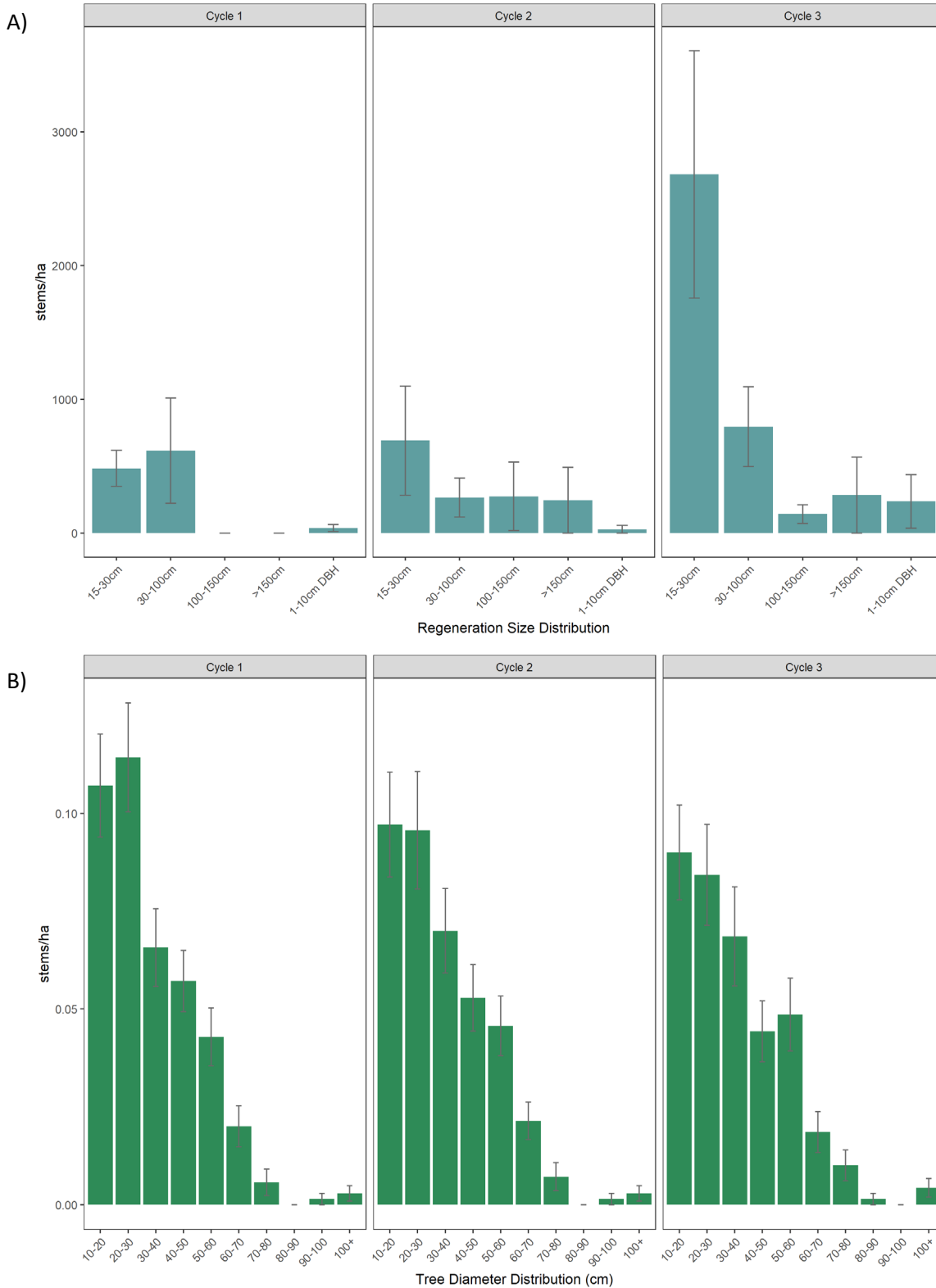


Figure 1. Stem density distributions for the three complete survey cycles in Morristown National Historical Park. Cycle 1 is 2006-2009; Cycle 2 is 2010-2013; Cycle 3 is 2014-2017. Figure A shows seedling and sapling densities by size class. Figure B shows tree density by diameter at breast height increments. Error bars are ± 1 SE.

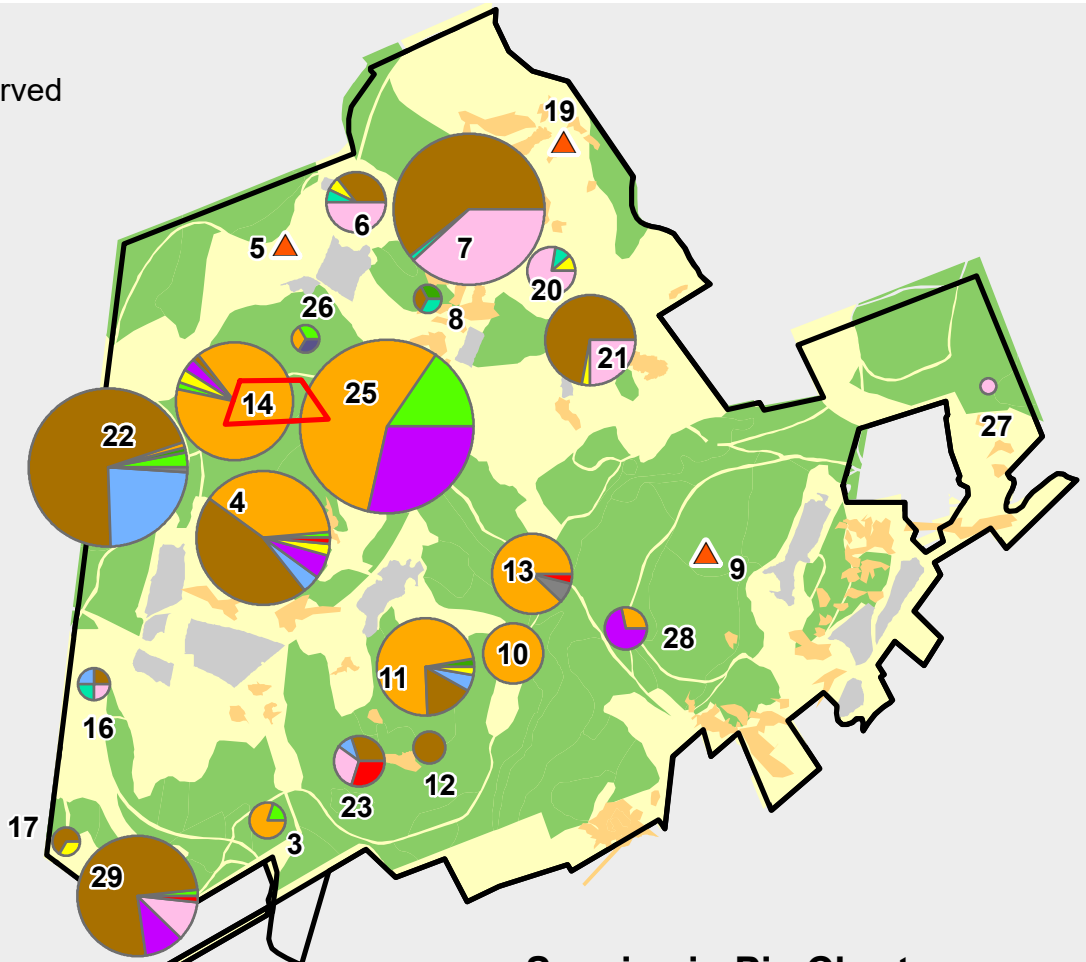


Map 3. Tree Regeneration Composition

Trends in tree regeneration, including seedlings and saplings, by species group observed in forest plots in the most recent survey cycle (2017 & 2019). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2019, and plots 16-29 sampled in 2017. Pie size is proportional to the total plot-level regeneration density range: 0 to 18,302 stems/ha). Pies may be shifted from actual location to prevent overlap. Date: 6/7/2019.

Legend

- No regeneration observed
- Successional forest
- Mature forest
- Mapped canopy gap
- Open Field
- Deer Exclosure
- Park boundary



Species in Pie Charts

- Acer spp. (Maple)
- Betula lenta (Black birch)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus americana (White ash)
- Liriodendron tulipifera (Tulip poplar)
- Prunus spp. (Cherry)
- Quercus spp. (Oak)
- Ulmus spp. (Elm)
- Low canopy species
- Other native species
- Exotic species



0 0.25 0.5 1 Kilometers

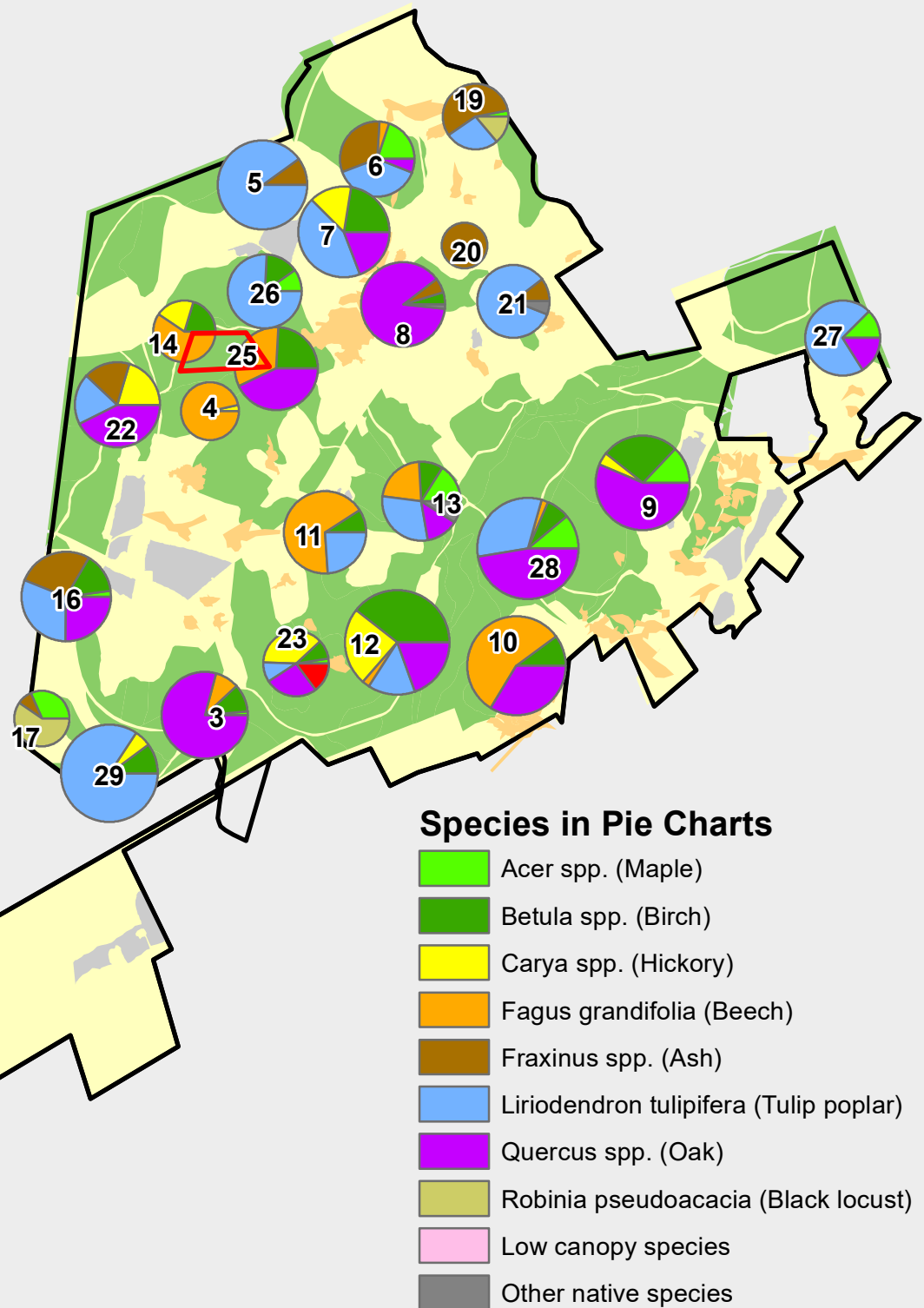


Map 4. Tree Canopy Composition

Trends in live tree basal area by species group for plots in the most recent survey cycle (2017 & 2019). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2019, and plots 16-29 sampled in 2017. Pie size is proportional to plot-level basal area (range: 8.0 to 50.4 sq.m/ha). Pies may be shifted from actual location to prevent overlap. Date: 6/7/2019.

Legend

- Successional forest
- Mature forest
- Mapped canopy gap
- Open Field
- Deer Exclosure
- Park boundary



Species in Pie Charts

- Acer spp. (Maple)
- Betula spp. (Birch)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Liriodendron tulipifera (Tulip poplar)
- Quercus spp. (Oak)
- Robinia pseudoacacia (Black locust)
- Low canopy species
- Other native species
- Other Exotic species



0 0.25 0.5 1
Kilometers

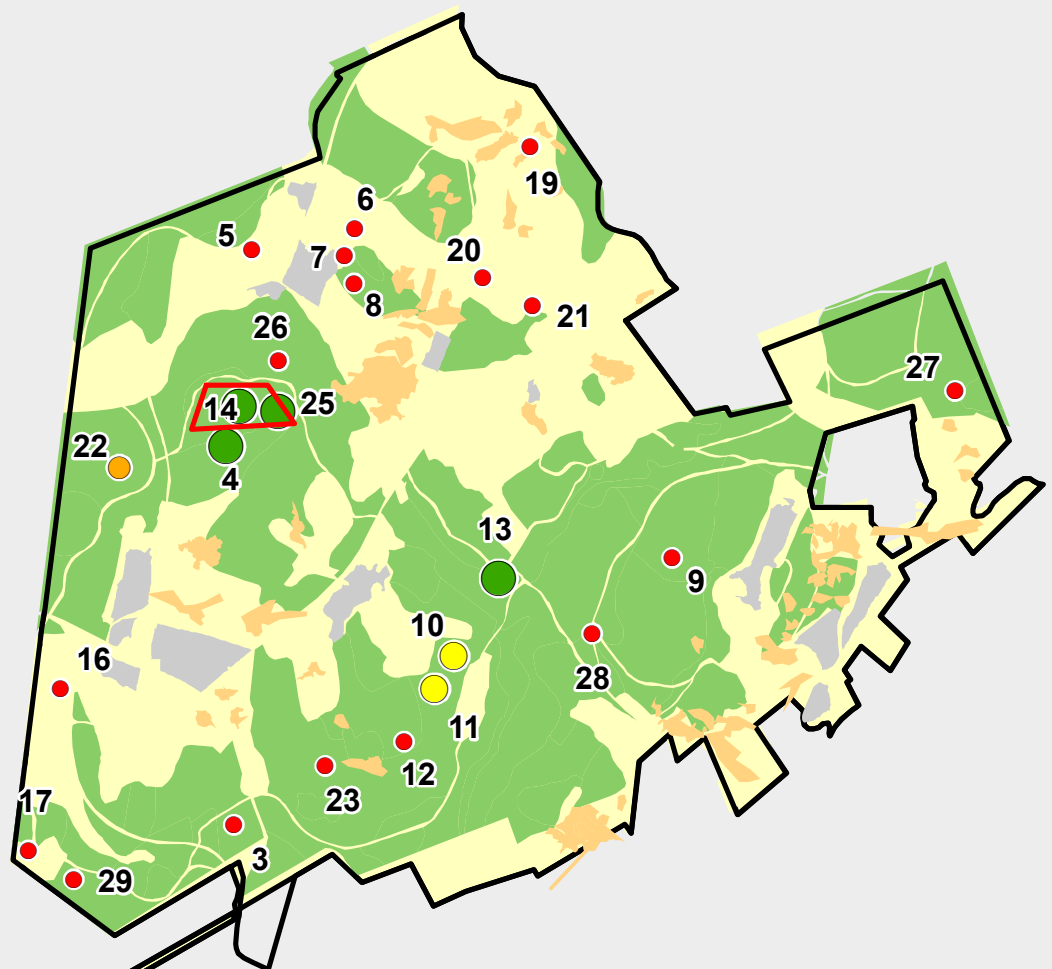


Map 5. Tree Regeneration Stocking Index

Trends in the regeneration stocking index for the most recent survey cycle (2017 & 2019). This index quantifies whether current regeneration densities are sufficient to restock a forest canopy. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. The stocking index is averaged over three 2-m radius microplots per plot and only includes native canopy-forming species (range: 0-911). See Table 1 for plot-level stocking values. Date: 6/9/2019.

Legend

- Successional forest
- Mature forest
- Mapped canopy gap
- Open Field
- Deer Exclusion
- Park boundary



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..

0 0.25 0.5 1 Kilometers



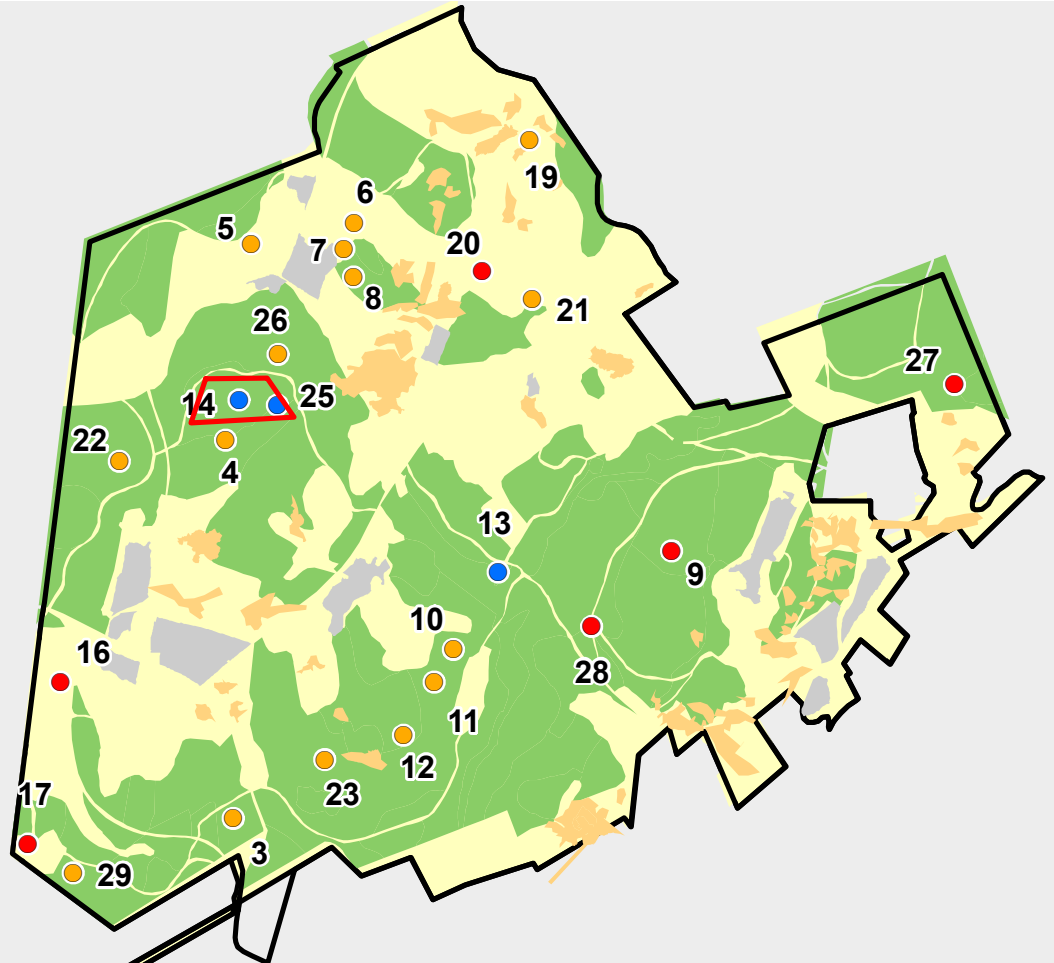


Map 6. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent survey cycle (2017 & 2019). Each plot is sampled on a 4-year cycle, with plots 1-15 sampled in 2019 and plots 16-29 sampled in 2017. Deer browse impacts are assessed on a scale of 1-5, with 1 representing no impact and 5 representing severe impacts. Date: 6/9/2019.

Legend

- Successional forest
- Mature forest
- Mapped canopy gap
- Open Field
- Deer Exclosure
- Park boundary



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.



0 0.25 0.5 1
Kilometers

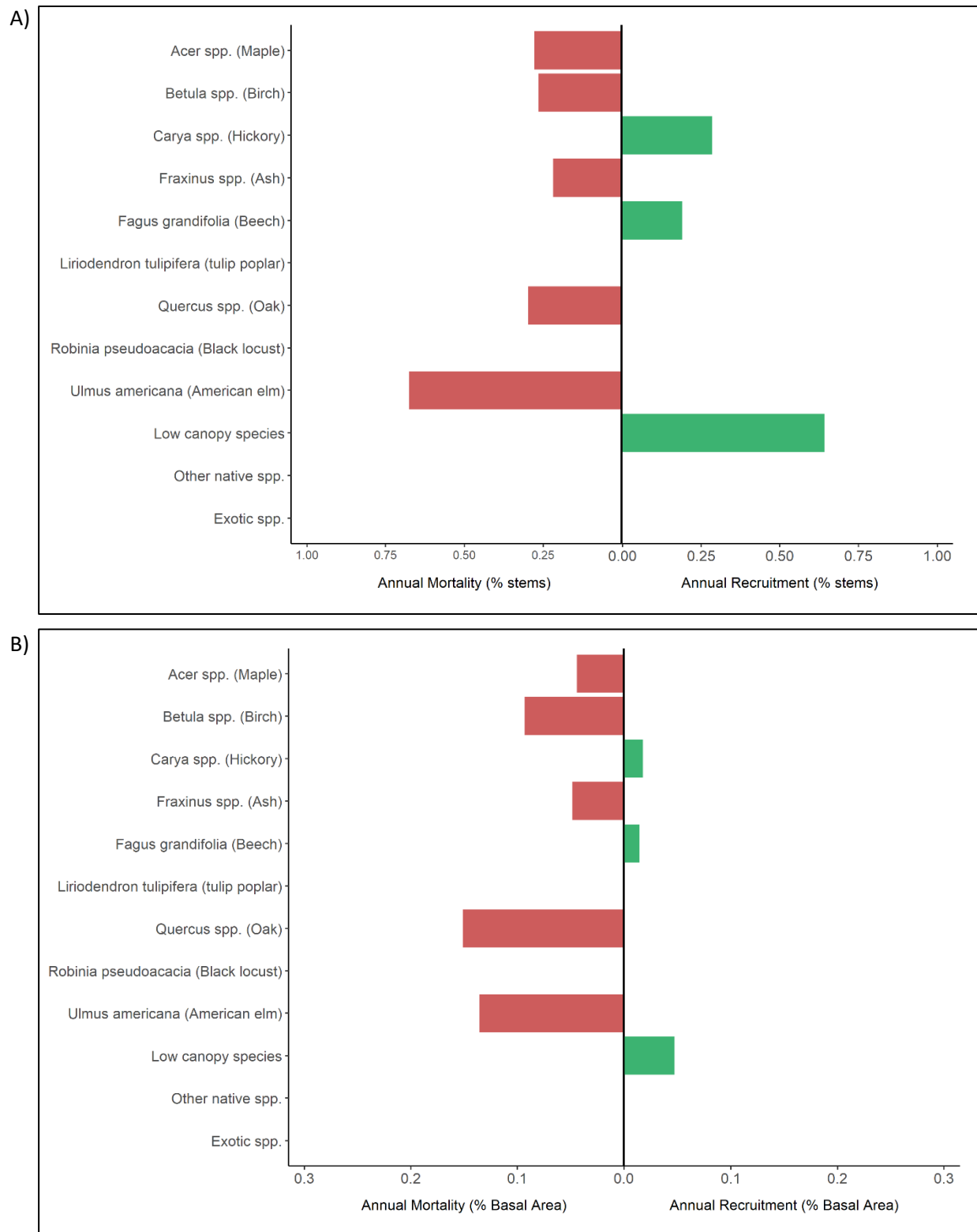
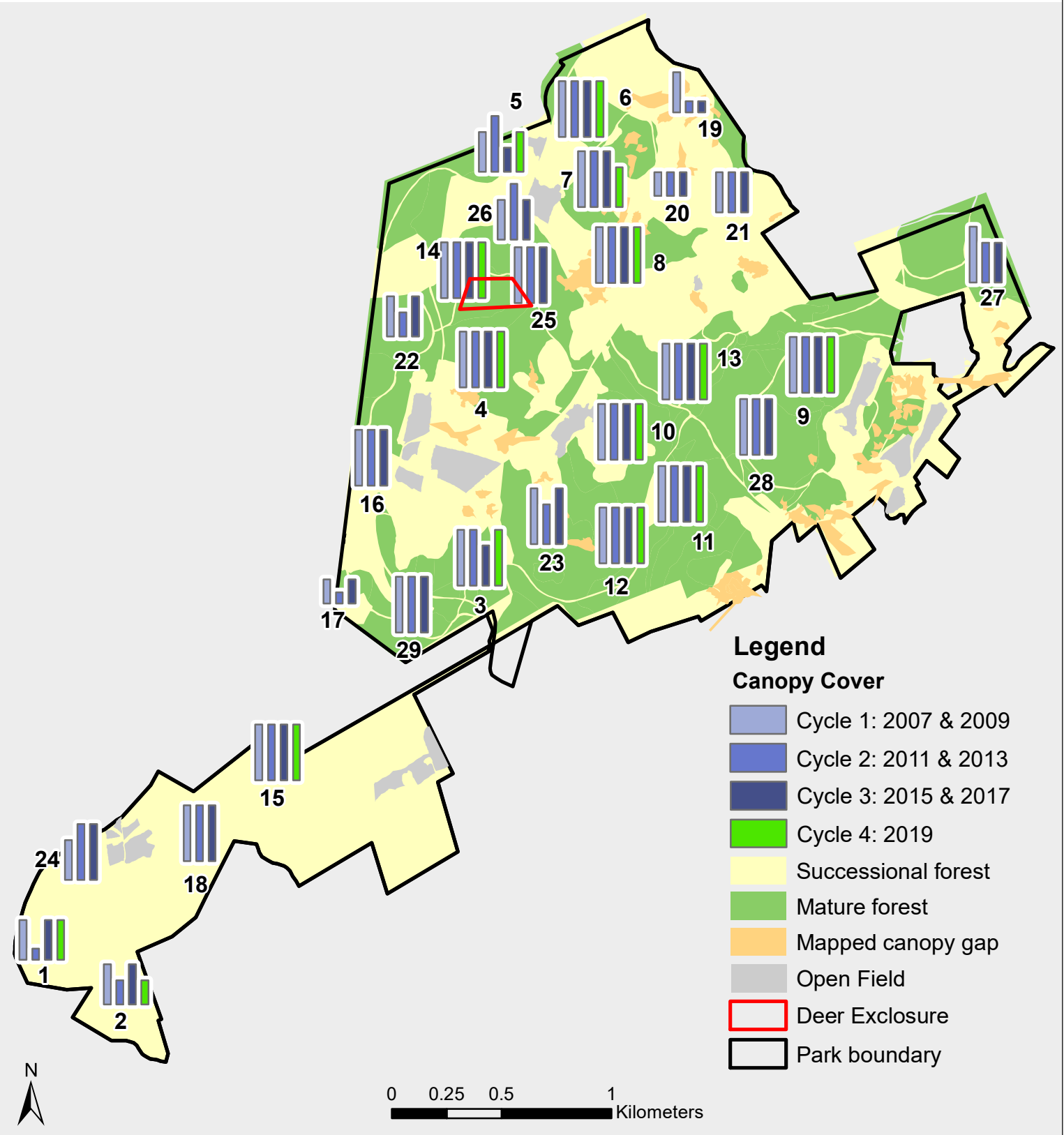


Figure 2. Annual tree mortality and recruitment rates for the most recent survey cycle (2016-2019) in Morristown National Historical Park. Figure A represents % of stems that died (mortality) and the % of stems gained (recruitment) from the previous survey cycle (2011-2015). Figure B is the % of basal area (m^2/ha) that died or was gained from the previous survey cycle.



Map 7. Canopy Cover by Cycle

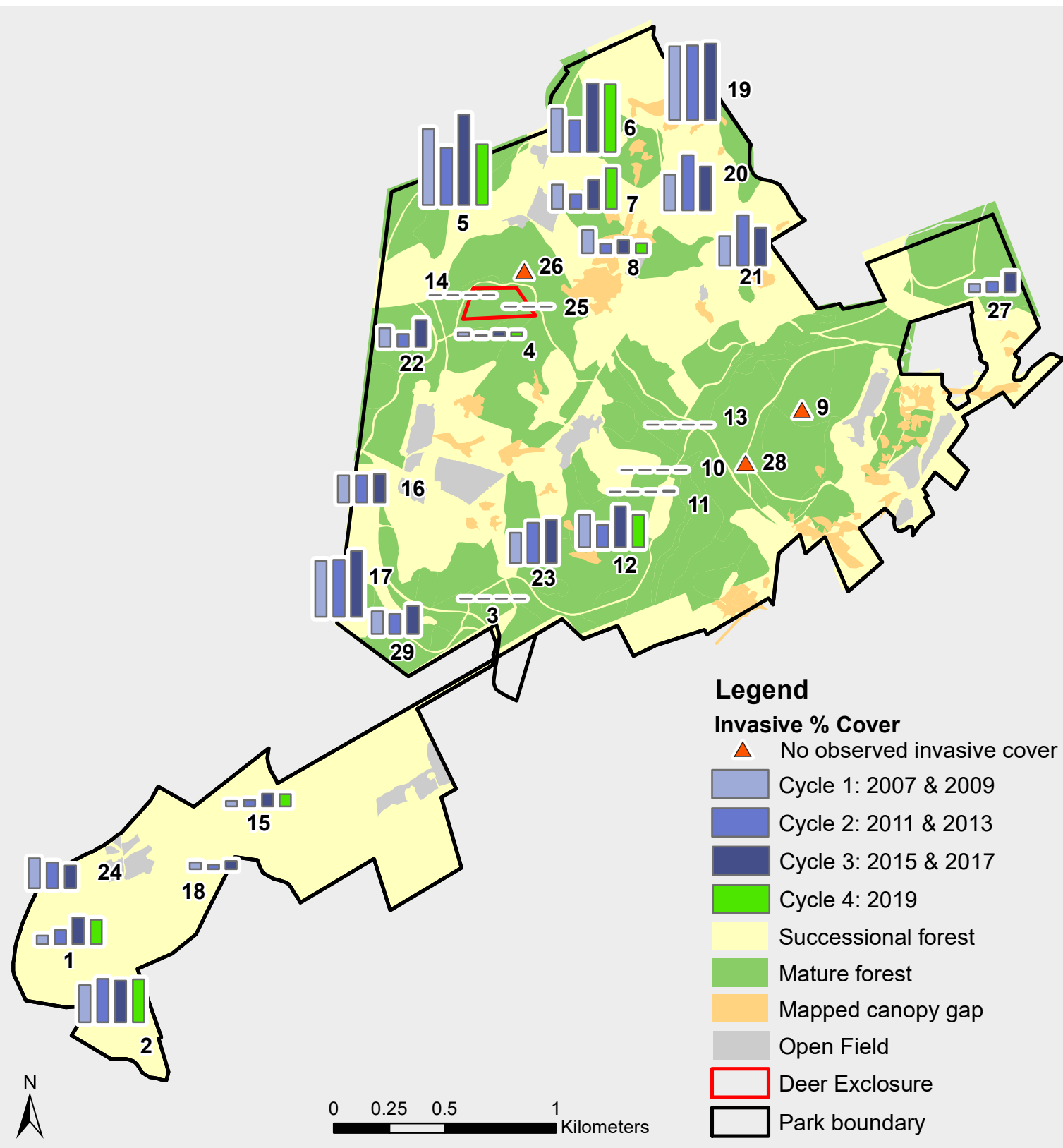
Trends in tree canopy cover in forest plots sampled from 2007-2019. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2007, 2011, 2015, and 2019, and plots 16-29 sampled in 2009, 2013, and 2017. Canopy cover ranges from 10 - 25% to >75%. Date: 6/7/2019.





Map 8. Invasive % Cover by Cycle

Trends in percent cover of invasive species observed in quadrats for plots sampled from 2007-2019. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2007, 2011, 2015, and 2019 and plots 16-29 sampled in 2009, 2013, and 2017. Average invasive cover ranges from 0 to >100%. See Table 2 for % cover values. Date: 6/7/2019.





Map 9. Invasive % Cover by Species

Trends in percent invasive cover by species observed in quadrats for plots in the most recent survey cycle (2017 & 2019). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-15 sampled in 2019 and plots 16-29 sampled in 2017. Average total invasive cover ranges from 0 to >100%. See Table 3 for more information. Date: 6/7/2019.

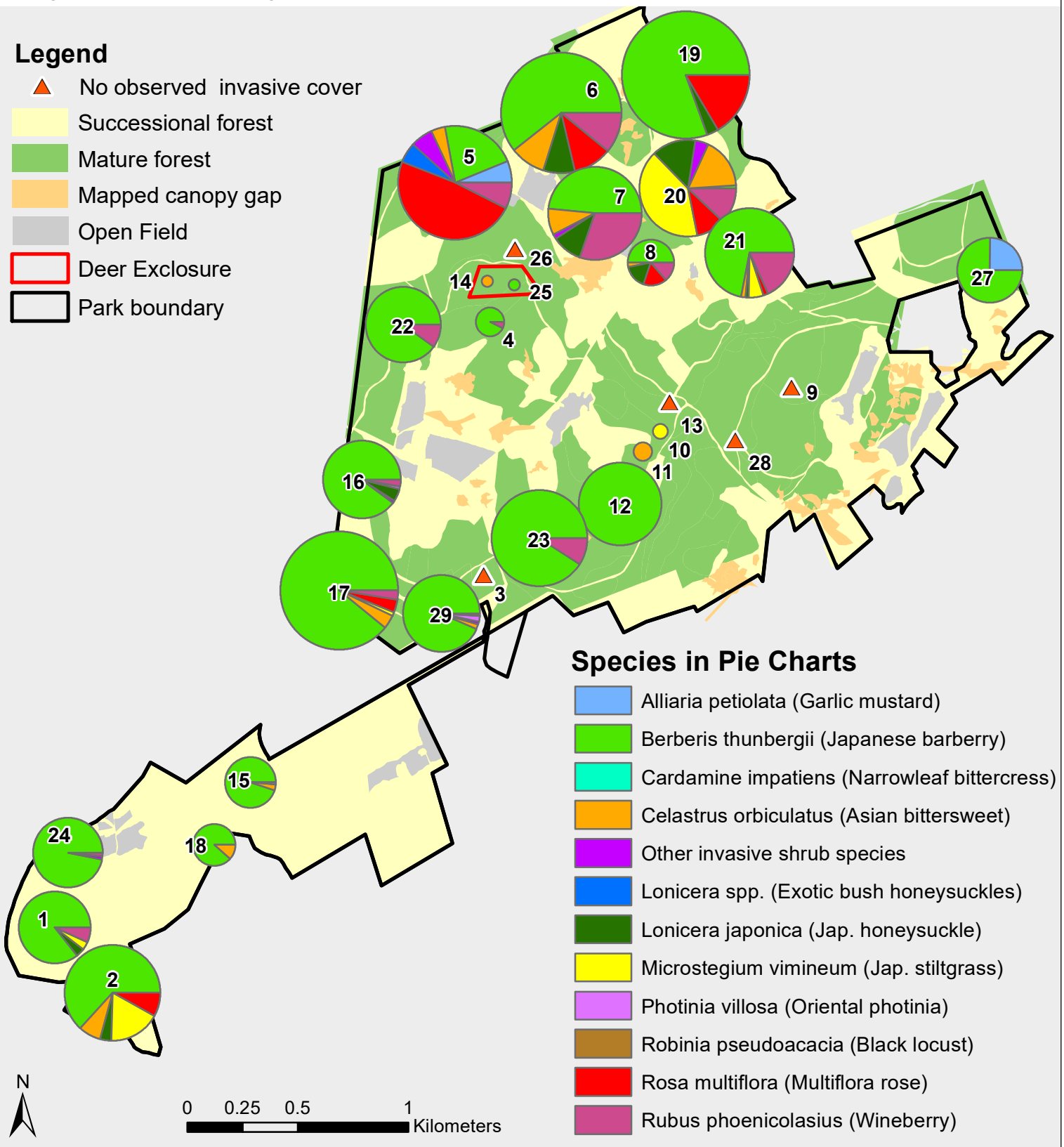


Table 2. Average % cover and number of invasive species detected in each plot by cycle. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017, Cycle 4= 2019. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year. Blue highlighted plots are in the deer enclosure.

Plot	Panel	Average % Cover				Number of Species per Plot			
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
1	1	11.2	18.5	35.8	32.7	9	8	12	11
2	1	49.6	58.3	55.7	58.0	12	8	10	10
3	1	0	0	0.1	0	2	3	4	7
4	1	5.1	1.9	6	5.3	4	8	7	5
5	1	102.6	77	122.0	81.9	11	10	14	12
6	1	58.7	42.5	92.7	91.8	9	11	11	11
7	1	33.1	19.8	39.0	55.1	10	10	11	11
8	1	31.0	12.6	17.6	13.4	7	7	8	10
9	1	0	0	0	0	1	0	1	1
10	1	0	0	0	1	1	1	3	4
11	1	0	0	0.2	2.2	2	3	2	4
12	1	44.0	30.0	55.1	43.5	3	3	7	10
13	1	0	0	0.2	0	2	4	6	5
14	1	0.2	0.2	0.4	0.2	5	4	5	5
15	1	7.6	8.8	17.1	16.6	3	4	8	9
16	2	36.5	36.6	38.5	---	9	10	11	---
17	2	75.3	76.4	88.4	---	7	11	12	---
18	2	9.2	6.1	11.2	---	8	8	8	---
19	2	99.3	100.7	102.9	---	11	11	11	---
20	2	48.2	74.6	59.1	---	10	9	11	---
21	2	39.8	68.2	50.7	---	7	9	12	---
22	2	24.7	17.1	36.0	---	7	9	10	---
23	2	40.5	54.0	58.4	---	4	8	8	---
24	2	40.7	35.0	30.6	---	7	9	11	---
25	2	0	0.2	0.2	---	2	3	3	---
26	2	0	0	0	---	5	5	4	---
27	2	11.3	14.0	26.6	---	7	6	7	---
28	2	0	0	0	---	0	1	1	---
29	2	30.3	26.8	37.6	---	7	11	10	---

Table 3. Number of plots out of 29 where priority invasive species were detected by cycle. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017; Cycle 4= 2019. This list includes all exotic vascular plant species that are capable of dominating Northeastern US forest habitats, but does not include all exotic species detected in MORR forest plots. *Note that only half of the plots have been sampled in Cycle 4, with 15 as the maximum number of plots.

Latin Name	Common Name	Cycle 1	Cycle 2	Cycle 3	Cycle 4*
<i>Acer platanoides</i>	Norway maple	1	3	3	1
<i>Actinidia</i> spp.	Kiwi vine	0	0	2	0
<i>Ailanthus altissima</i>	Tree-of-heaven	0	0	1	1
<i>Alliaria petiolata</i>	Garlic mustard	13	11	11	6
<i>Ampelopsis brevipedunculata</i>	Porcelainberry	1	1	1	0
<i>Aralia elata</i>	Japanese aralia	0	1	3	2
<i>Berberis thunbergii</i>	Japanese barberry	25	25	25	13
<i>Cardamine impatiens</i>	Narrowleaf bittercress	19	20	20	9
<i>Celastrus orbiculatus</i>	Asian bittersweet	20	24	27	15
<i>Elaeagnus umbellata</i>	Autumn olive	1	0	2	0
<i>Euonymus alatus</i>	Burningbush	8	14	17	11
<i>Fallopia japonica</i>	Japanese knotweed	1	0	0	0
<i>Ligustrum</i> spp.	Privet	7	14	14	6
<i>Lonicera</i> - Exotic	exotic bush honeysuckle	4	0	0	1
<i>Lonicera japonica</i>	Japanese honeysuckle	11	13	12	6
<i>Lysimachia nummularia</i>	Creeping jenny	1	0	1	0
<i>Microstegium vimineum</i>	Japanese stiltgrass	21	20	19	10
<i>Photinia villosa</i>	Oriental photinia	0	4	13	5
<i>Ranunculus ficaria</i>	Fig buttercup	1	1	1	0
<i>Rhamnus cathartica</i>	Common buckthorn	3	0	0	0
<i>Rhodotypos scandens</i>	Jetbead	1	2	2	1
<i>Robinia pseudoacacia</i>	Black locust	4	4	6	2
<i>Rosa multiflora</i>	Multiflora rose	12	15	18	9
<i>Rubus phoenicolasius</i>	Wine raspberry	16	19	22	13
<i>Viburnum dilatatum</i>	Linden arrowwood	1	2	3	2
<i>Viburnum sieboldii</i>	Siebold's arrowwood	1	1	5	2