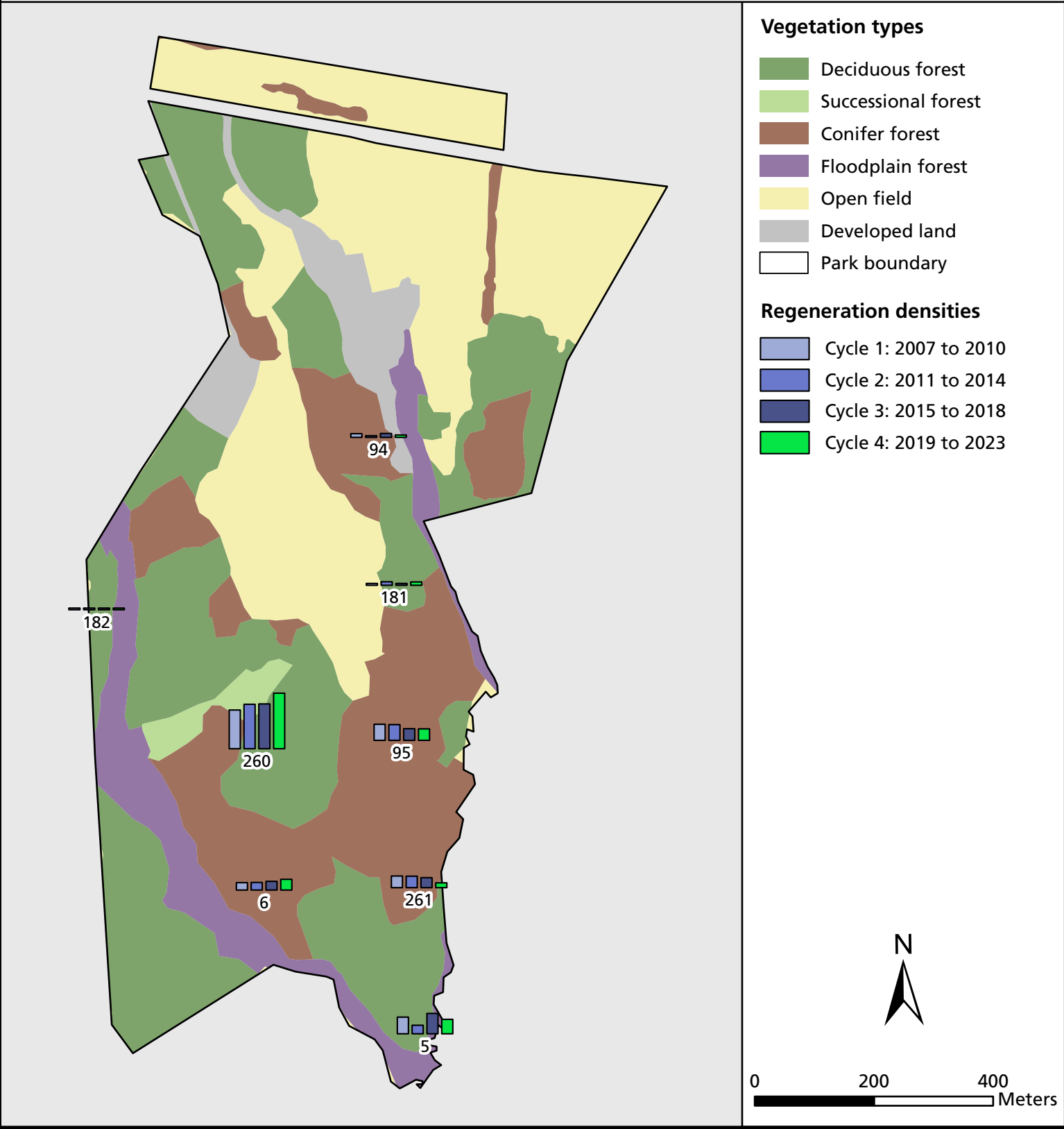




Map 1. Tree Regeneration by Cycle

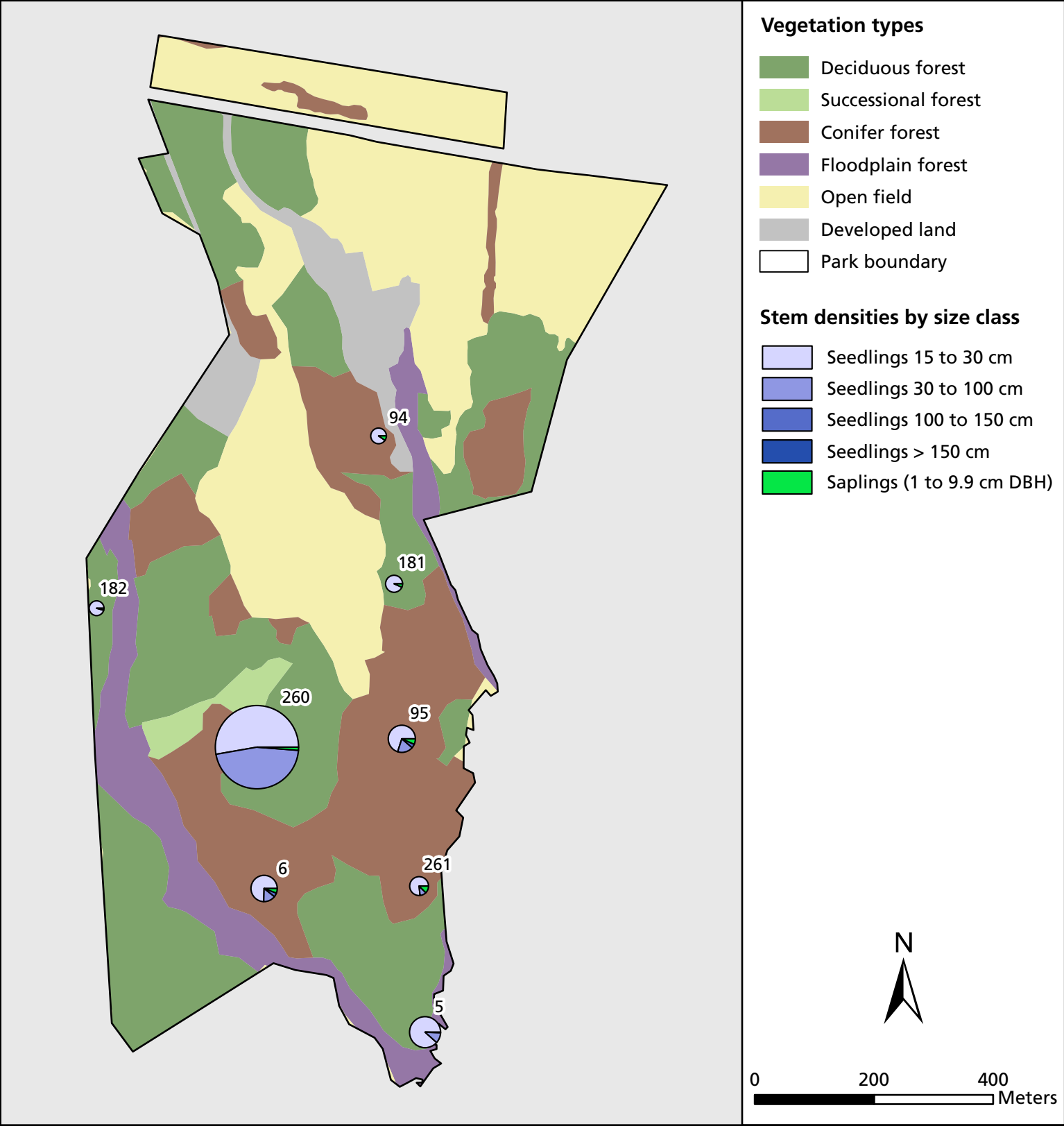
Trends in tree regeneration, including seedlings and saplings, observed in forest plots sampled from 2007-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Densities range from 0.3 to 8.7 stems/m², and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details. Reporting Date: 01/17/2024.





Map 2. Tree Regeneration by Size Class

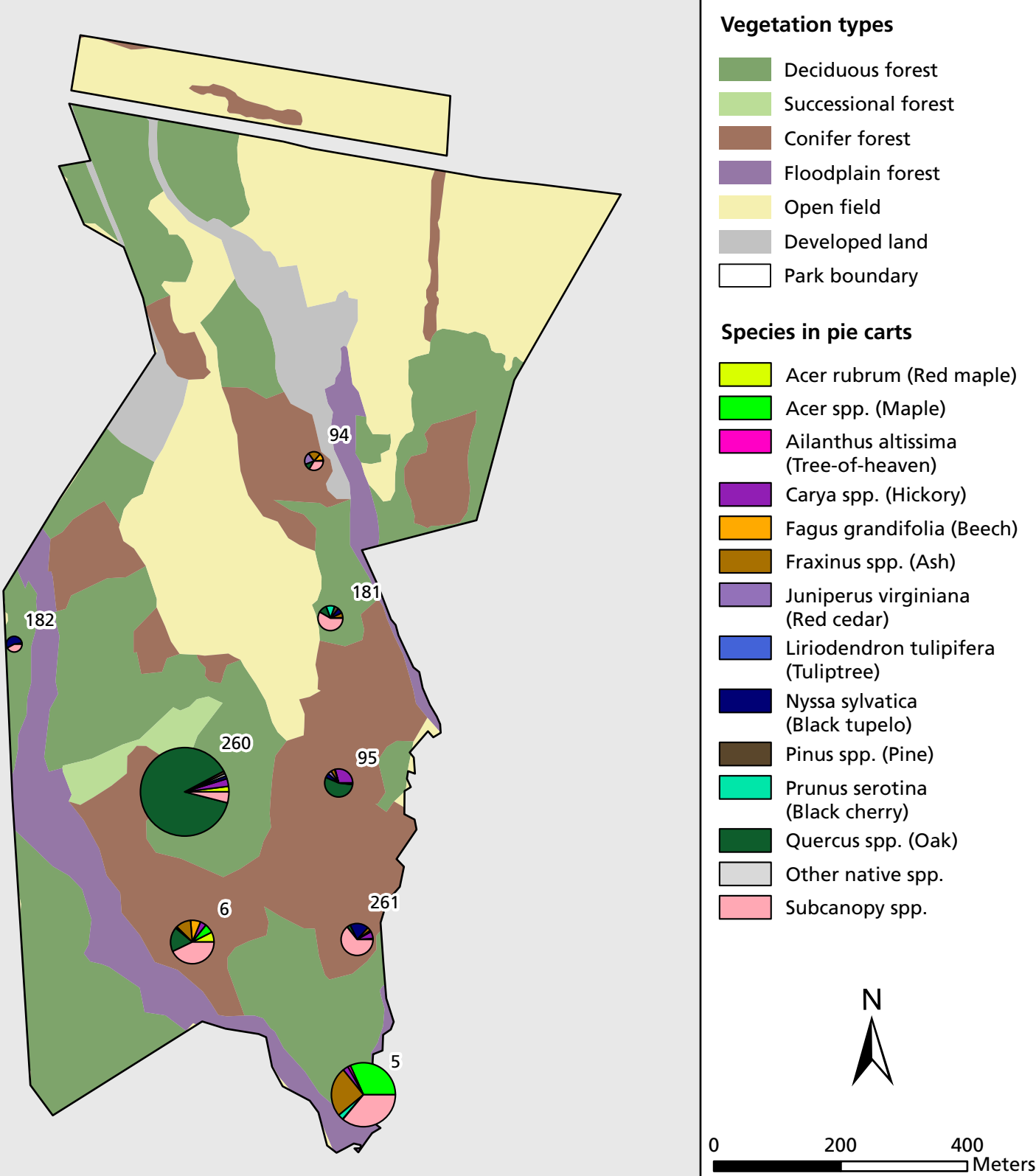
Tree regeneration stem densities by size class in forest plots from the most recent census (2019-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level regeneration density. Pies may be shifted to prevent overlap. Total densities range from 0.3 to 8.7 stem/m² and only include native canopy-forming species. Reporting Date: 01/17/2023.





Map 3. Tree Regeneration Composition

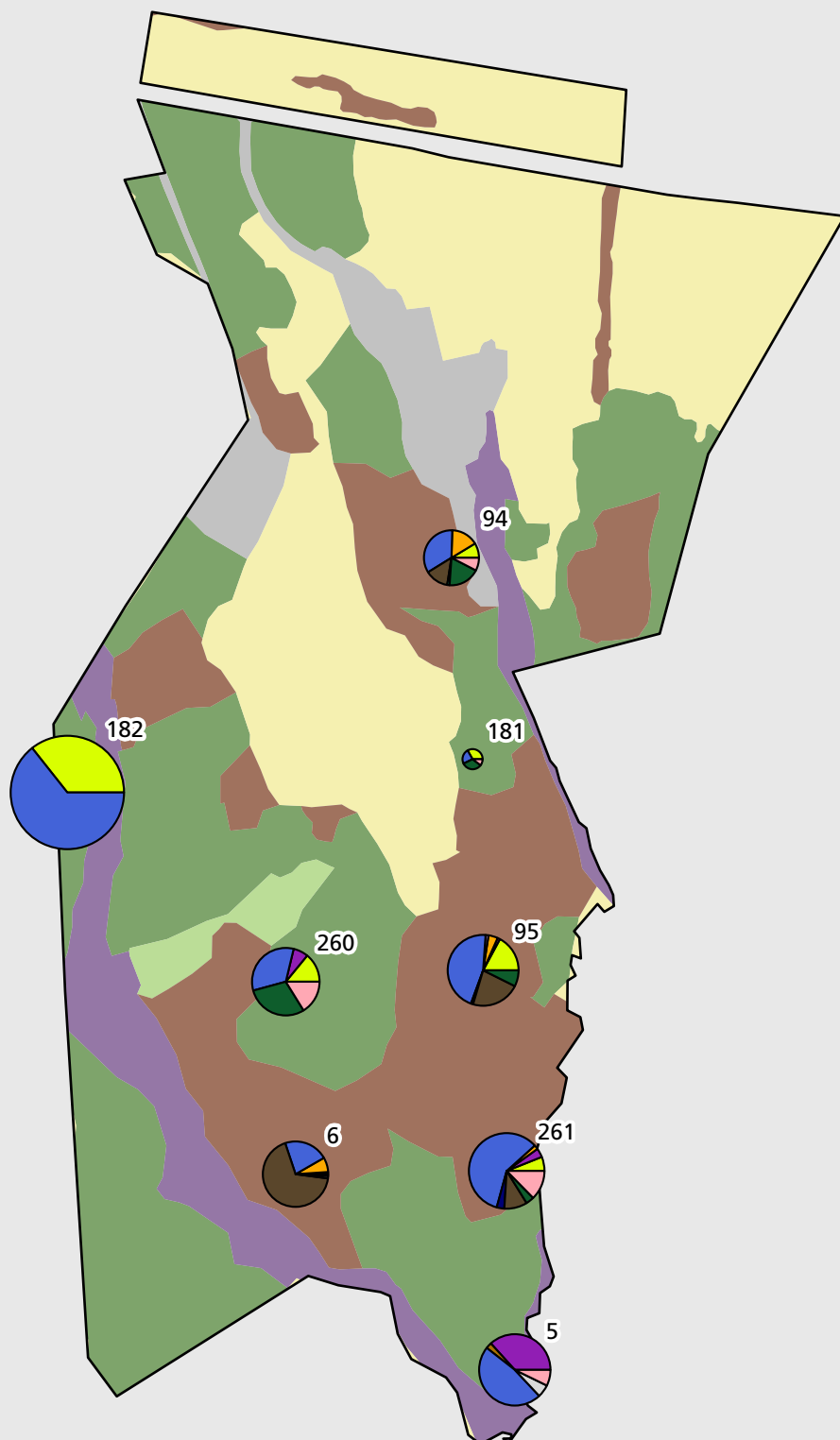
Tree regeneration, including seedlings and saplings, by species group observed in forest plots sampled in the most recent census (2019-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level regeneration density. Pies may be shifted to prevent overlap. Total densities ranges from 0.5 to 8.9 stems/m² and includes all species. Reporting Date: 01/17/2024.





Map 4. Tree Canopy Composition

Tree composition, by species group, observed in forest plots sampled in the most recent census (2019-2023). 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 plot-level basal areas. Pies may be shifted to prevent overlap. Total basal area ranges from 7.8 to 49.8 m²/ha. Reporting Date: 01/17/2024.



Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- Park boundary

Species in pie carts

- Acer rubrum* (Red maple)
- Carya* spp. (Hickory)
- Fagus grandifolia* (Beech)
- Fraxinus* spp. (Ash)
- Juniperus virginiana* (Red cedar)
- Liriodendron tulipifera* (Tuliptree)
- Nyssa sylvatica* (Black tupelo)
- Pinus* spp. (Pine)
- Prunus serotina* (Black cherry)
- Quercus* spp. (Oak)
- Other native spp.
- Subcanopy spp.

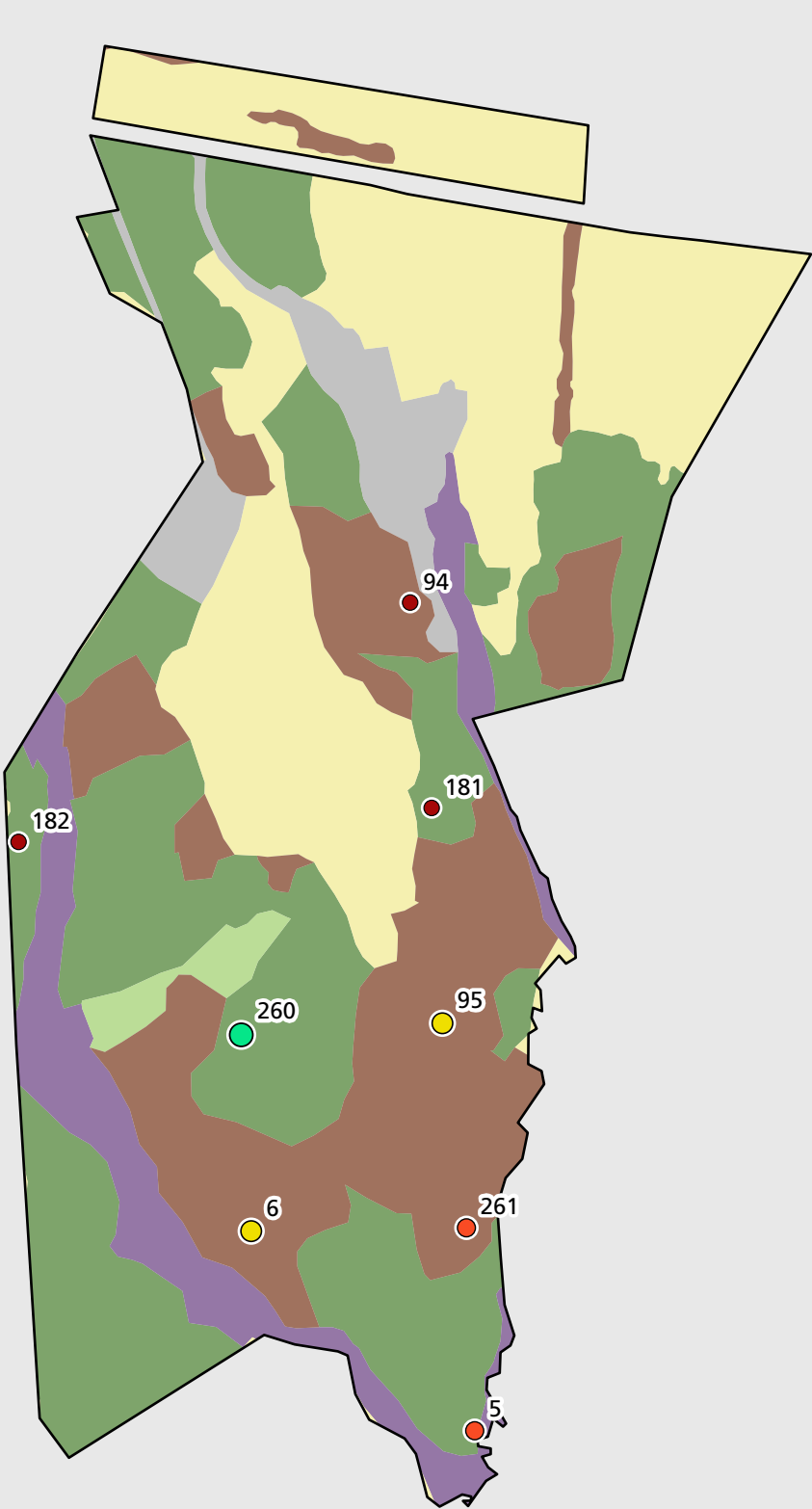


0 200 400
Meters



Map 5. Tree Regeneration Stocking Index

Regeneration stocking index for the most recent census (2019-2023). 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. Stocking index is reported at a 2-m scale to maintain consistency with other regional publications (range 4.2-172.9). Only native canopy-forming species included. See Table 1 for stocking index values. Reporting Date: 01/17/2024.



Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- 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.

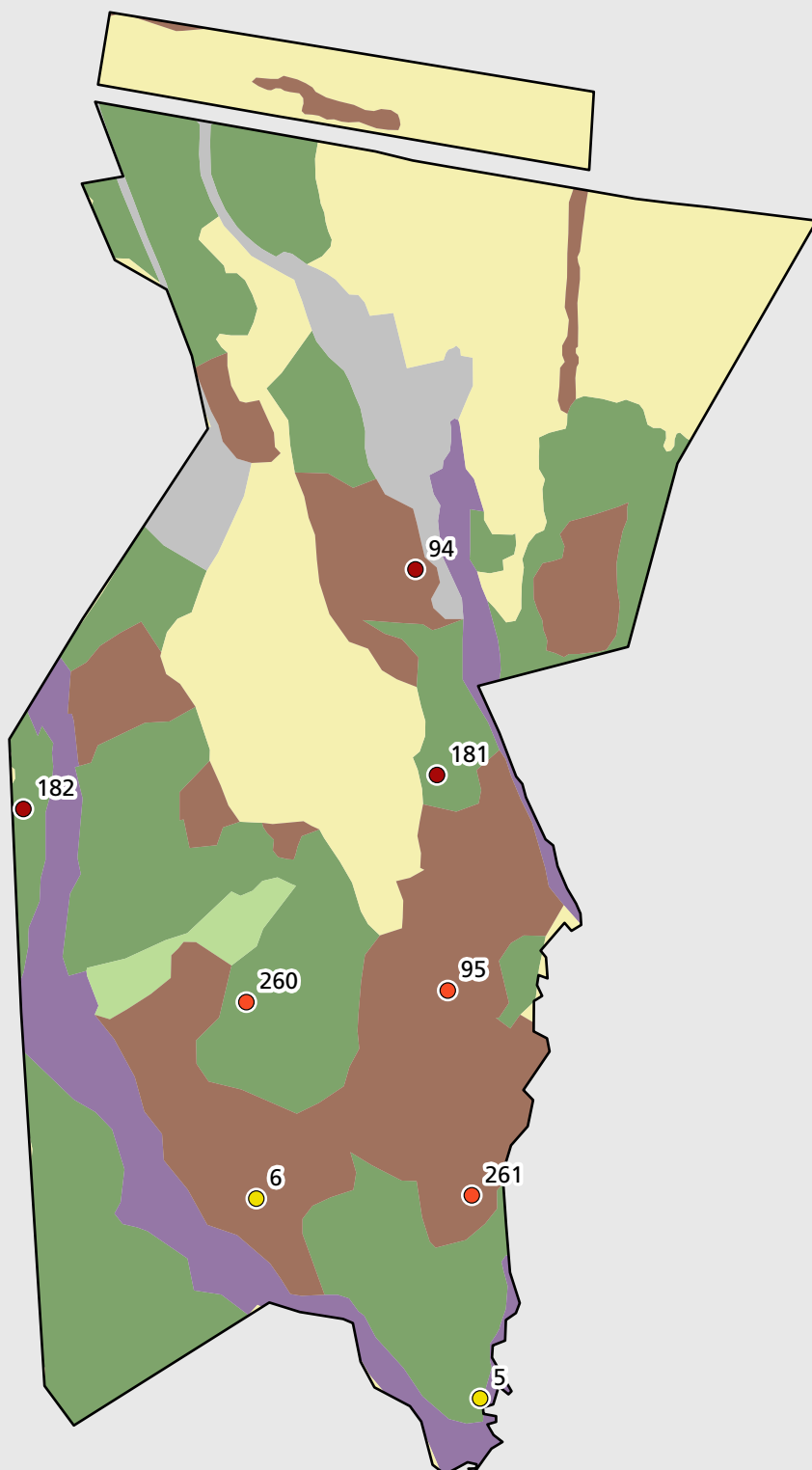


0 200 400 Meters



Map 6. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent census (2019-2023). 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: 01/17/2024.



Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- 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.

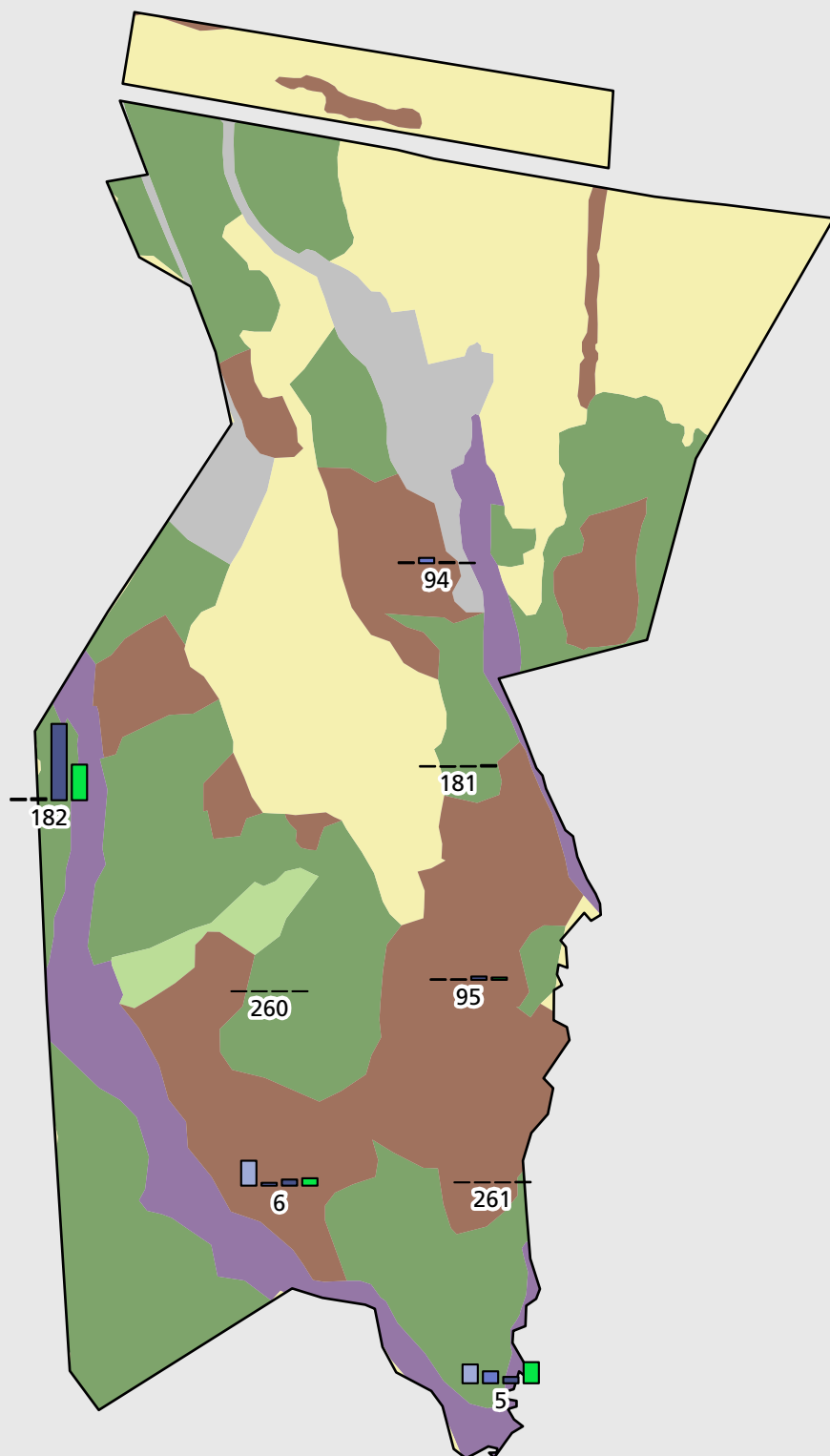


0 200 400
Meters



Map 7. Invasive % Cover by Cycle

Trends in percent cover of invasive species observed in quadrats in forest plots sampled from 2007-2023. 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 to 11.7%. See Table 2 for % cover values. Average cover may be increasing over time in part due to protocol change. See the Table 2 caption and the MIDN Summary of Major Protocol Changes (<https://irma.nps.gov/DataStore/Reference/Profile/2297098>) for details. Reporting Date: 01/17/2024.



Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- Park boundary

Invasive % cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2023

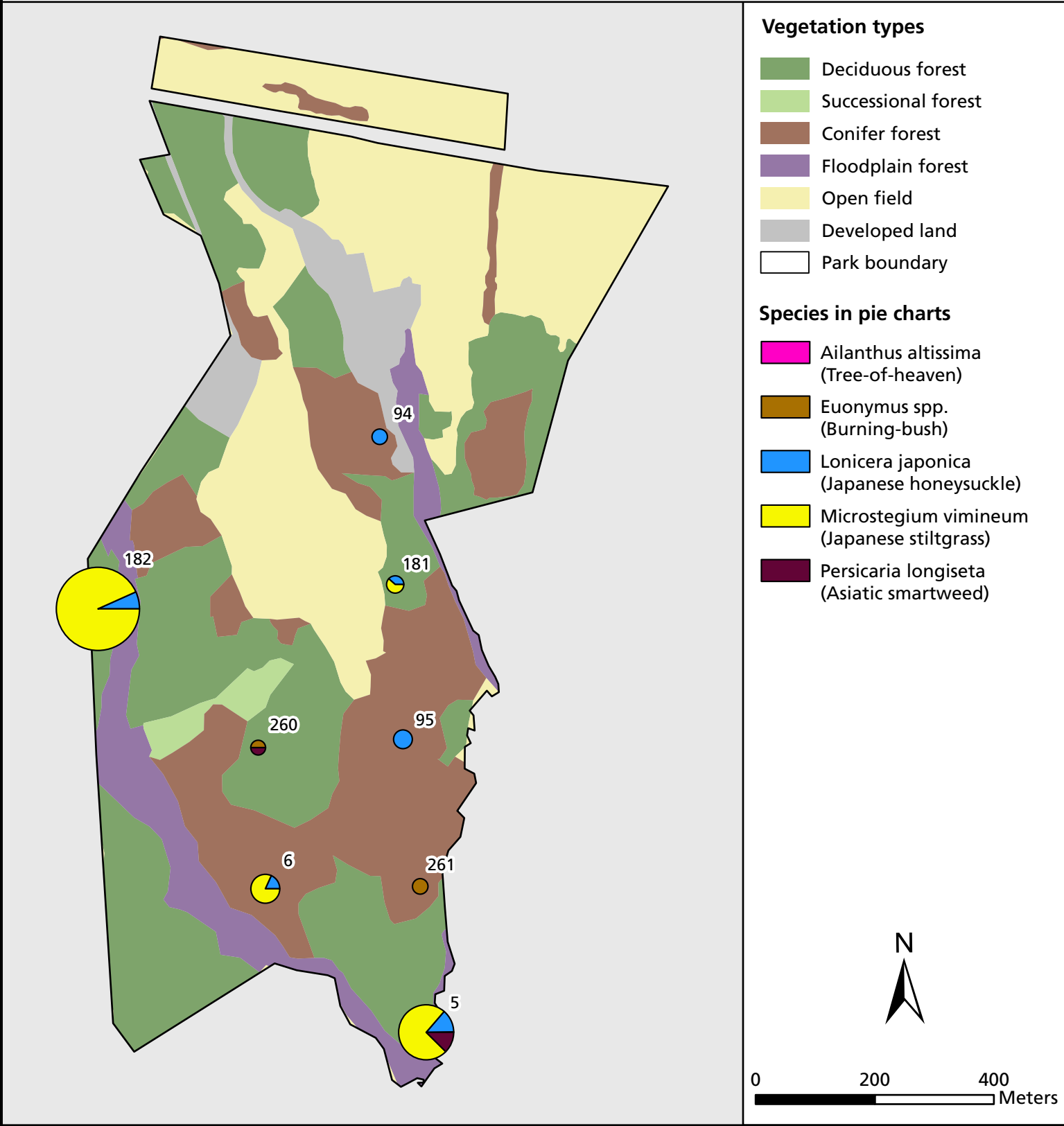


0 200 400 Meters



Map 8. Invasive % Cover by Species

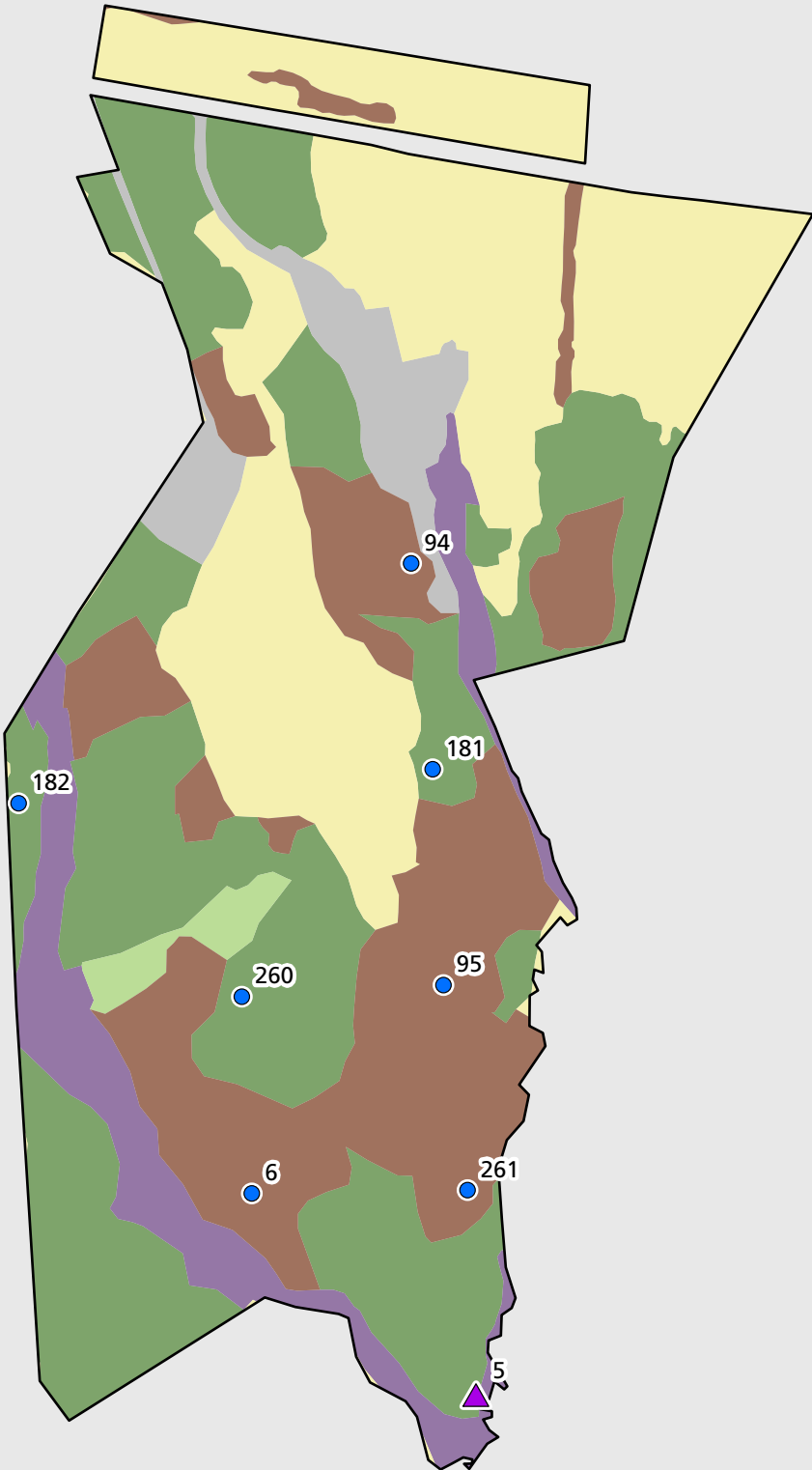
Percent invasive cover by species observed in quadrats in forest plots sampled in the most recent census (2019-2023). The top 10 species or genera are displayed individually; less common species are grouped as 'Other invasive spp.'. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to total invasive cover (range: 0 to 5.5%), and location may be shifted to prevent overlap. See Table 3 for more information. Reporting Date: 01/17/2024.





Map 9. Forest Pest/Pathogen Detections

Detection of priority forest pests in forest plots sampled during the most recent census (2019-2023). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Reporting Date: 01/17/2024.

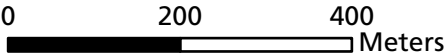


Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- Park boundary

Pests/Pathogens

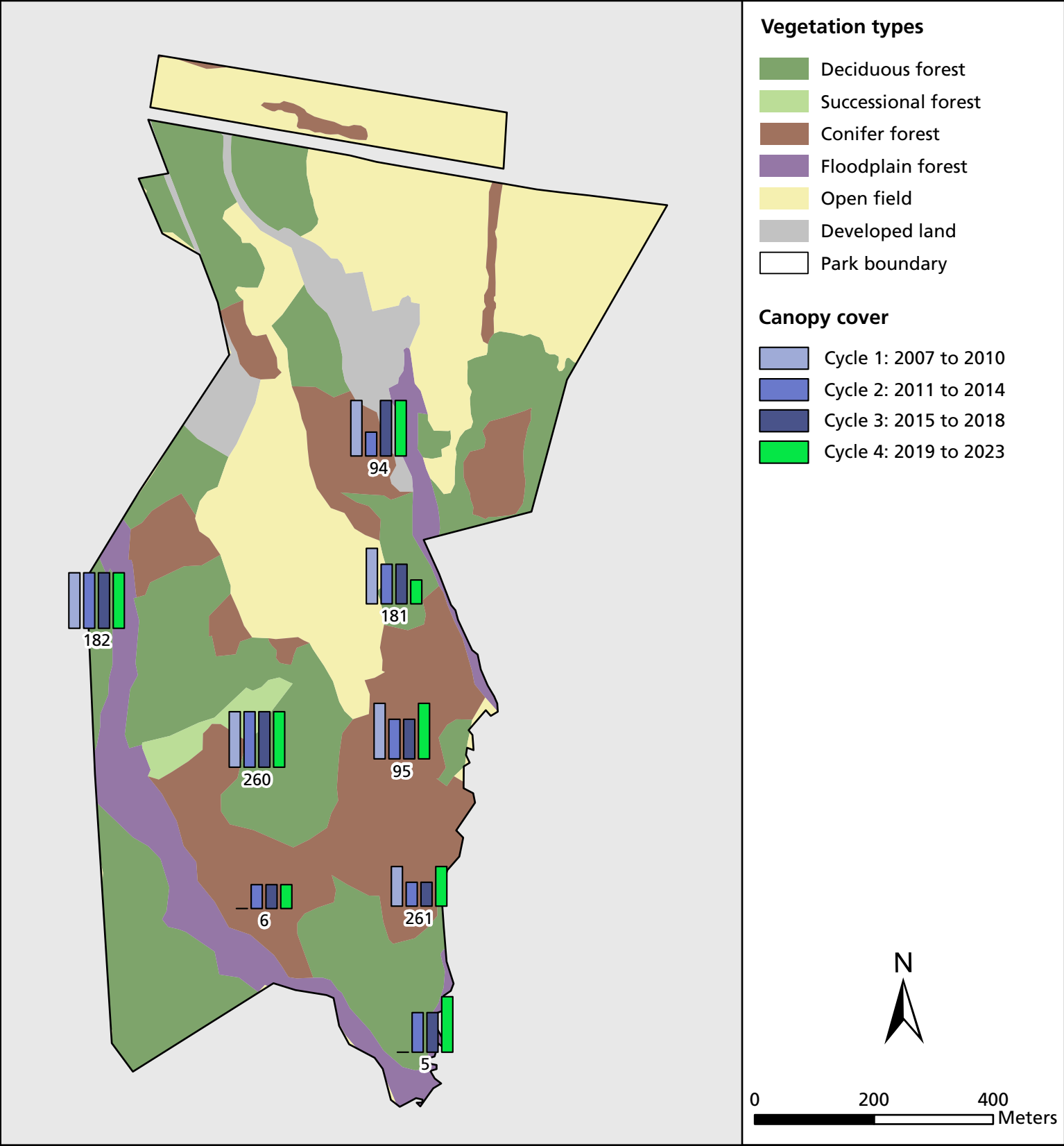
- Emerald Ash Borer (EAB)
- No detections





Map 10. Canopy Cover by Cycle

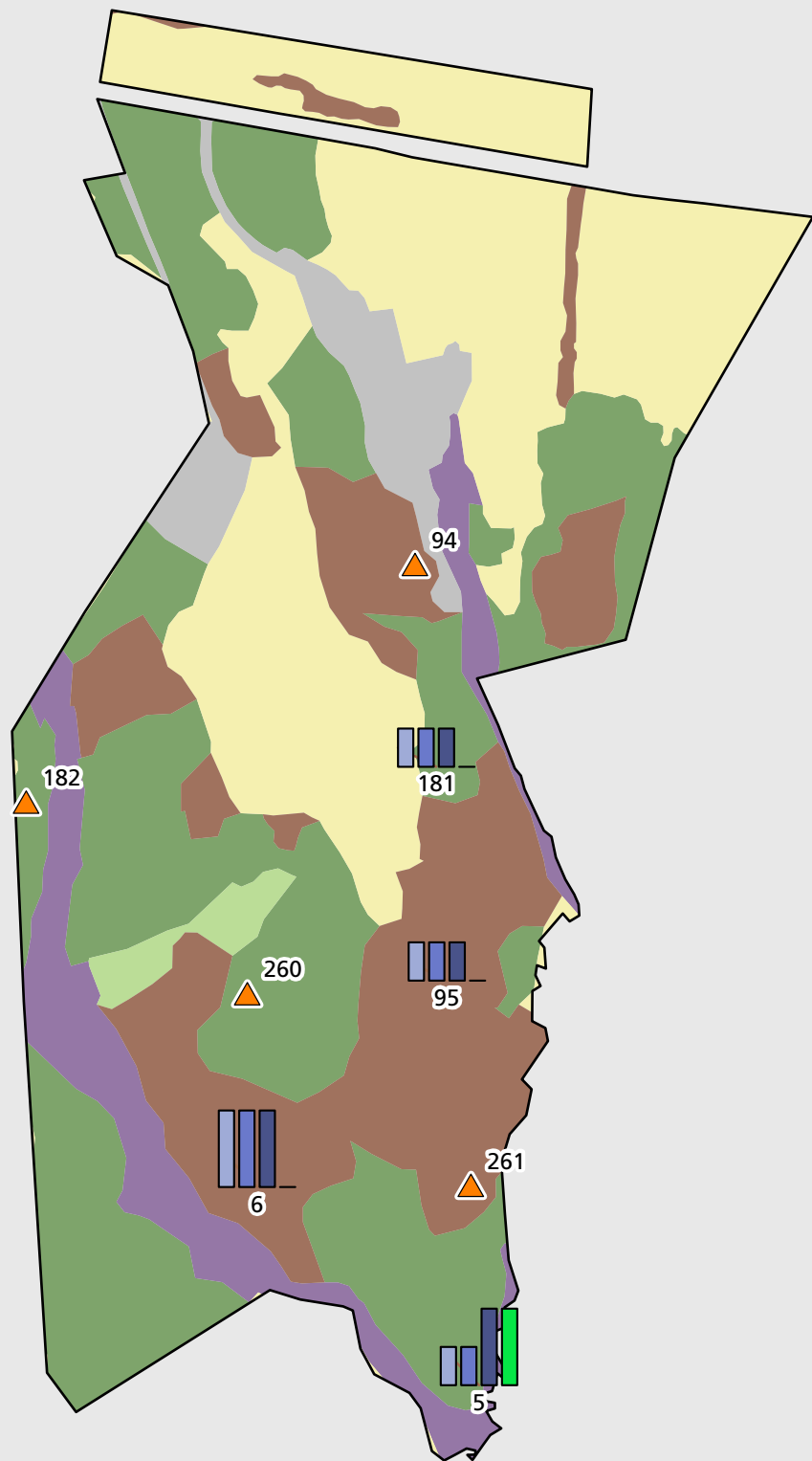
Trends in tree canopy in forest plots from 2007-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Canopy cover ranges from 25 - 50% to >75%. Canopy cover was not measured in 2007. Reporting Date: 01/17/2024.





Map 11. Ash Tree Density by Cycle

Trends in live ash tree density in forest plots sampled from 2007-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Densities range from 0 to 2 stems/400m² and only include individuals >10 cm DBH. Reporting Date: 01/17/2024.



Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Floodplain forest
- Open field
- Developed land
- Park boundary

Ash tree densities

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2023
- No ash trees present

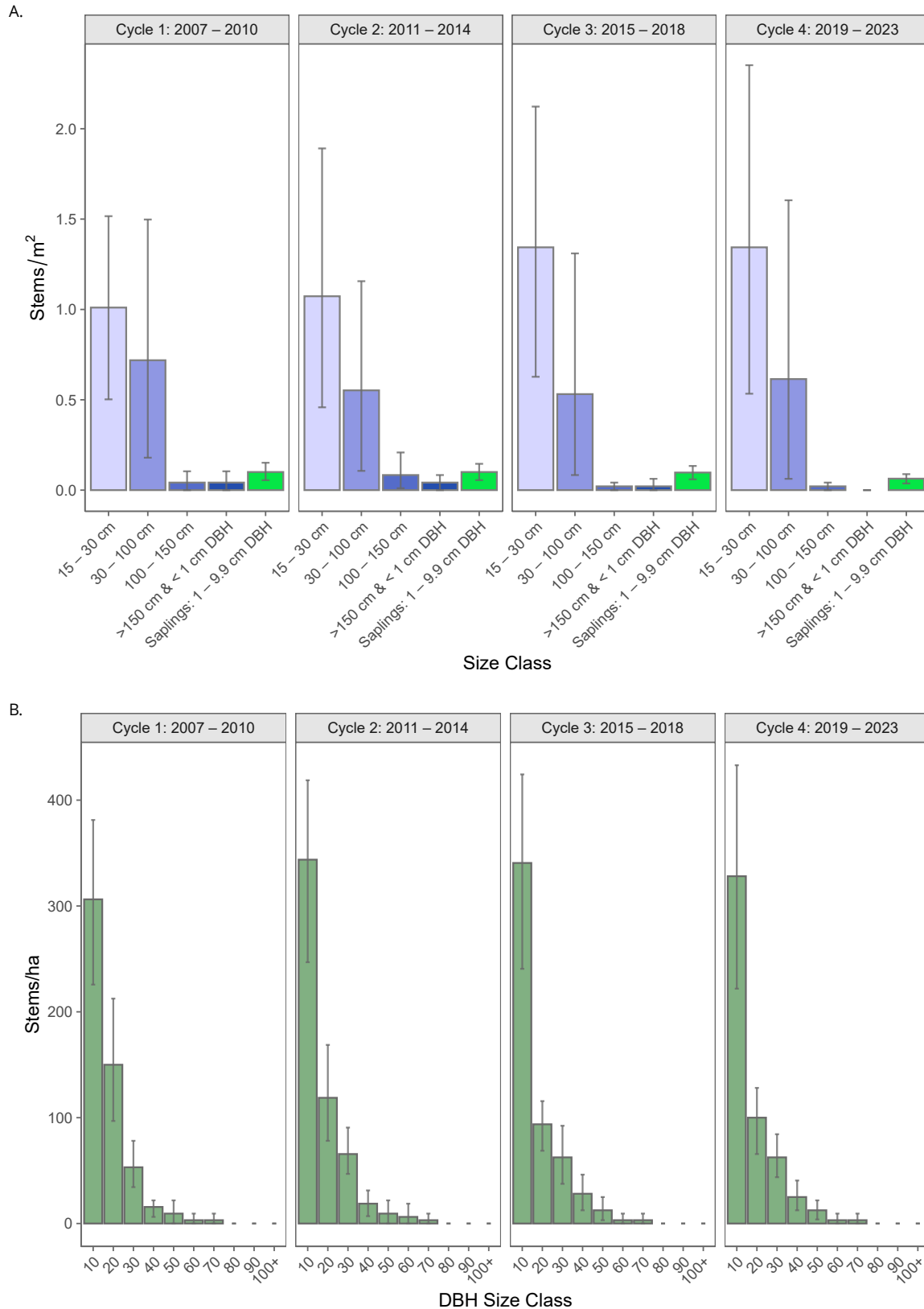


Figure 1. Stem density distributions by cycle in Booker T Washington National Monument (BOWA). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2023. Figure A shows regeneration densities by size class. Figure B shows tree density by diameter at breast height (DBH) increments. Error bars are 95% bootstrapped confidence intervals to account for non-normal error. An asterisk denotes a linear DBH distribution that is indicative of long-term recruitment failure.

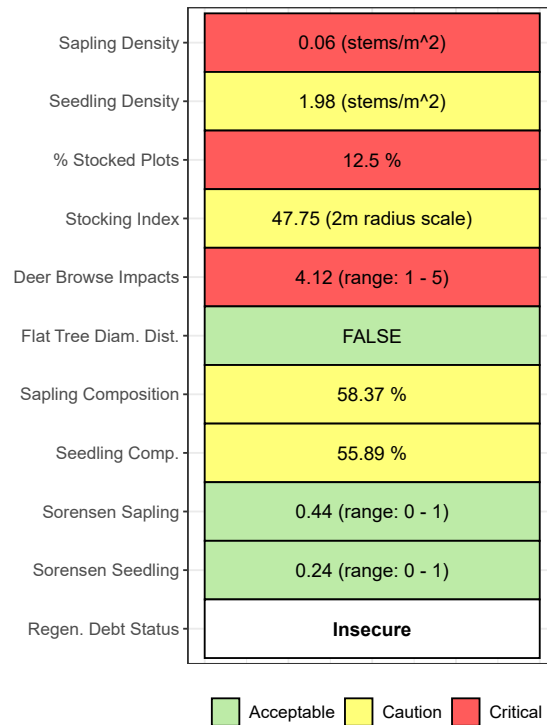


Figure 2. Regeneration Debt status for the most recent 4-year census (2019 – 2023) in Booker T Washington National Monument (BOWA). Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. Sapling/Seedling Composition is the % of total stems composed of native canopy-forming species. Sorensen is a measure of how closely the regen. layer matches canopy composition. For more details on metric calculations, thresholds and assessment of status, see Miller et al. 2023 (<https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.2837>).

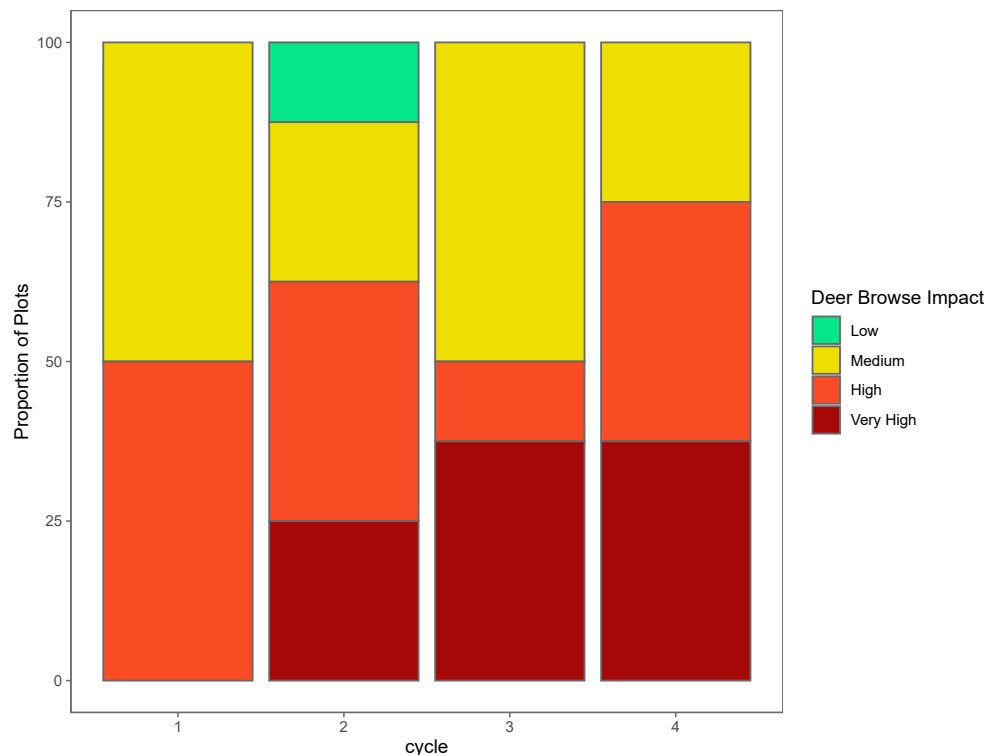


Figure 3. Deer browse impacts by cycle in Booker T Washington National Monument (BOWA). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2023.

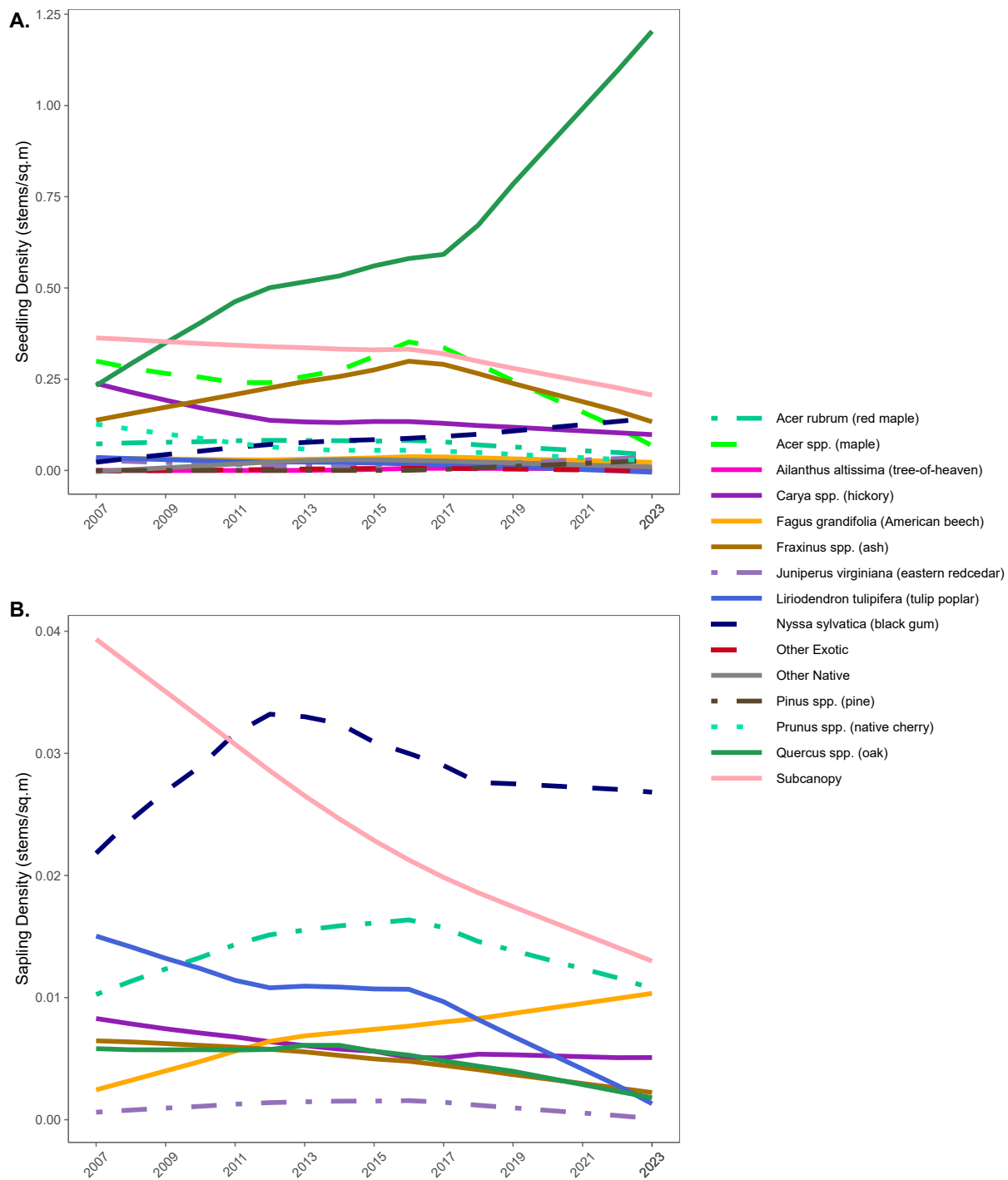


Figure 4. Loess smoothed changes in stem density for seedlings (A) and saplings (B) by species group and sample year in Booker T Washington National Monument. Specified loess span approximated a linear trend between consecutive sample events per panel.

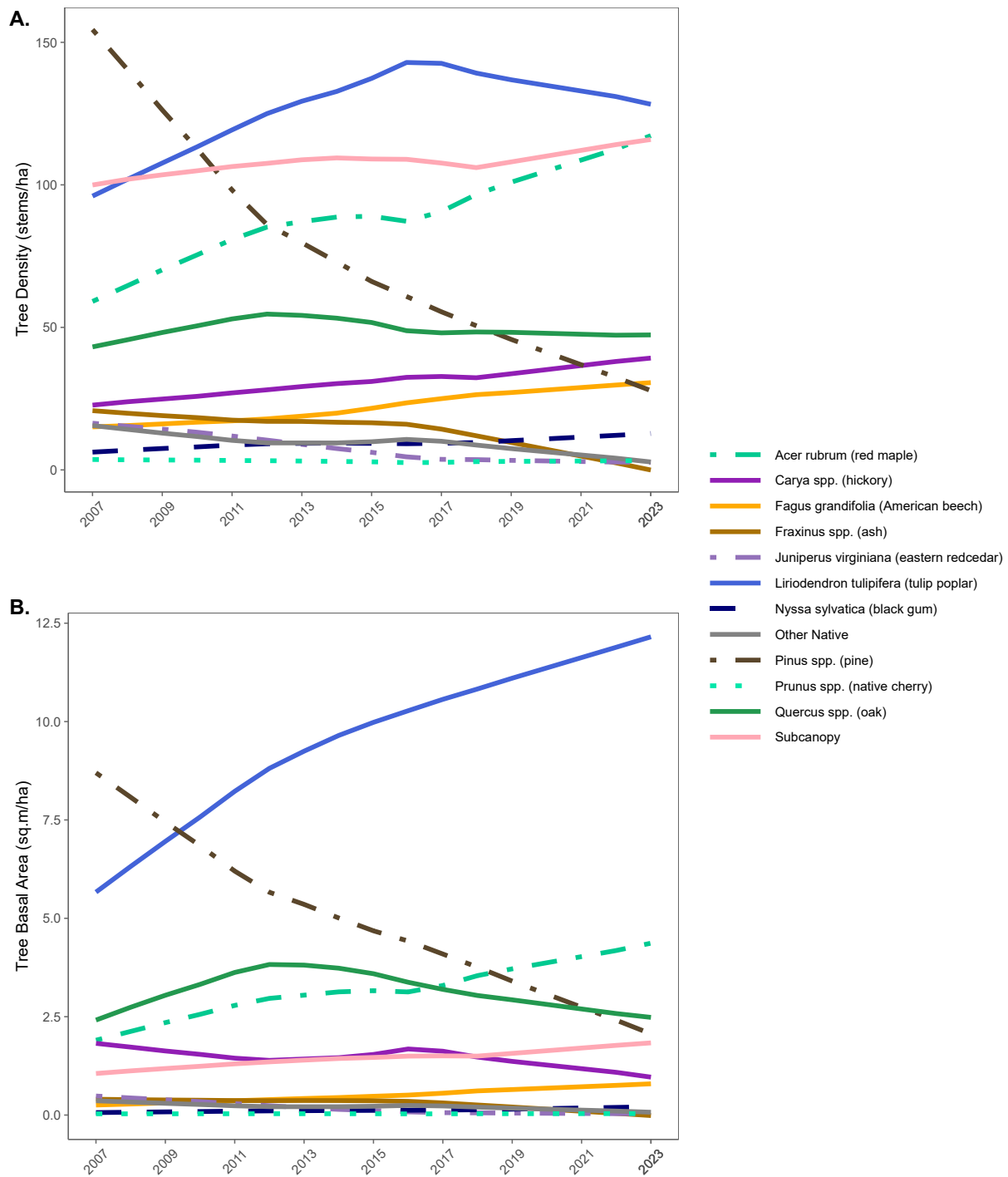


Figure 5. Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Booker T Washington National Monument. Specified loess span approximated a linear trend between consecutive sample events per panel.

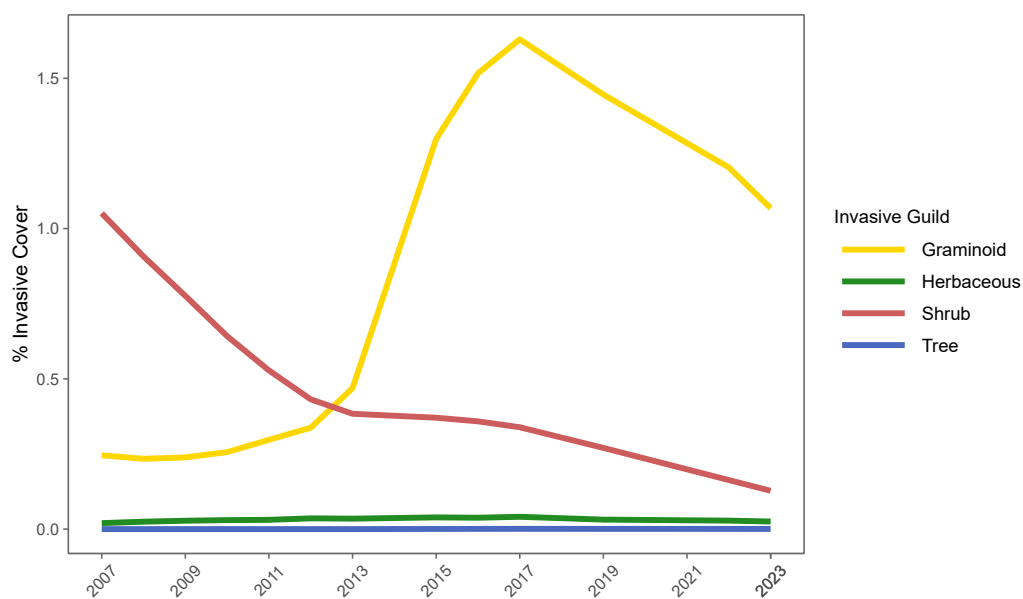


Figure 6. Loess smoothed changes in invasive plant percent cover by guild and sample year in Booker T Washington National Monument. Specified loess span approximated a linear trend between consecutive sample events per panel.



Table 1. Average plot-level seedling and sapling stem densities (stems per m²) and stocking index (at the 2m radius scale) by cycle. Only native, canopy-forming species are included. Note that *Fraxinus* spp. (ash species) are no longer considered canopy-forming species. Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2023. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). 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. Cells highlighted in green are plots that meet the minimum management target of 0.25 seedlings/m² and 0.14 saplings/m² or have a stocking index >100. These are the same thresholds used in Figure 2 and are described in Miller et al. 2023.

Plot	Panel	Seedlings per sq.m				Saplings per sq.m				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
5	1	2.58	1.33	3.17	2.25	0.01	0.01	0.01	0.01	37.70	16.71	40.84	31.42
6	1	1.08	1.08	1.25	1.58	0.07	0.09	0.12	0.09	16.71	100.66	33.68	50.39
94	2	0.50	0.17	0.50	0.33	0.08	0.08	0.12	0.04	30.66	10.56	15.83	4.15
95	2	2.33	2.25	1.67	1.67	0.20	0.21	0.17	0.12	163.87	104.18	91.61	74.64
181	3	0.25	0.50	0.25	0.50	0.05	0.05	0.05	0.04	10.56	15.83	10.56	6.28
182	3	0.25	0.25	0.25	0.25	0.01	0.01	0.01	0.01	4.15	4.15	3.14	3.14
260	4	5.83	6.75	6.83	8.58	0.22	0.20	0.17	0.11	394.46	390.06	277.84	172.91
261	4	1.67	1.67	1.42	0.67	0.15	0.14	0.14	0.09	58.94	109.20	55.92	39.08



Table 2. Average % cover and number of invasive species detected in each plot by cycle. Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2023. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). Plots with at least 10% average cover or 4 or more invasive species present are in yellow. Average cover and species counts may be increasing over time due to protocol changes, including additions to the indicator species list over time, a plot search for indicator species starting in 2009 and all woody species being sampled in quadrats starting in 2019. More details can be found in the MIDN Summary of Major Protocol Changes (<https://irma.nps.gov/DataStore/Reference/Profile/2297098>)

PlotCode	PanelCode	Average % Cover				Number of Species per Plot			
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
5	1	2.88	1.82	0.96	3.22	2	3	3	5
6	1	3.81	0.42	0.92	1.14	2	2	2	3
94	2	0.18	0.83	0.19	0.07	1	1	1	2
95	2	0.09	0.09	0.49	0.33	1	1	1	1
181	3	0.09	0.06	0.07	0.22	3	3	3	3
182	3	0.22	0.32	11.70	5.47	3	2	3	3
260	4	0.00	0.00	0.00	0.02	0	0	0	2
261	4	0.01	0.00	0.00	0.07	1	1	1	2



Table 3. Number of plots out of 8 where priority invasive species were detected. Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2023. Species on the list include all exotic vascular plant species that are capable of dominating Eastern US forest habitats, and does not include all exotic species detected in MIDN forest plots. Average cover and species counts may be increasing over time due to additions to the protocols, including a plot search for additional indicator species starting in 2009 and all woody species being sampled in quadrats starting in 2019. Species have also been added to the indicator list over time. More details can be found in the MIDN Summary of Major Protocol Changes (<https://irma.nps.gov/DataStore/Reference/Profile/2297098>)

Latin Name	Common Name	Cycle 1	Cycle 2	Cycle 3	Cycle 4
<i>Ailanthus altissima</i>	Tree of heaven	0	0	0	4
<i>Euonymus</i>	burningbush	0	0	0	2
<i>Lonicera - Exotic</i>	honeysuckle - exotic	2	1	0	0
<i>Lonicera japonica</i>	Japanese honeysuckle	7	6	7	7
<i>Microstegium vimineum</i>	Japanese stiltgrass	3	4	4	4
<i>Persicaria longiseta</i>	Oriental lady's thumb	0	1	2	2
<i>Rosa multiflora</i>	multiflora rose	1	1	1	2



Table 4. Invasive plant and pest/pathogen early detections in Booker T Washington National Monument observed in the most recent census of each plot. Coordinates are in UTM NAD83 Zone 17N.

Plot	Year	X	Y	Latin Name	Common Name	Type
BOWA-006	2019	612567	4107811	<i>Elaeagnus umbellata</i>	autumn olive	shrub
BOWA-005	2019	612837	4107570	<i>Agrilus planipennis</i>	emerald ash borer	pest