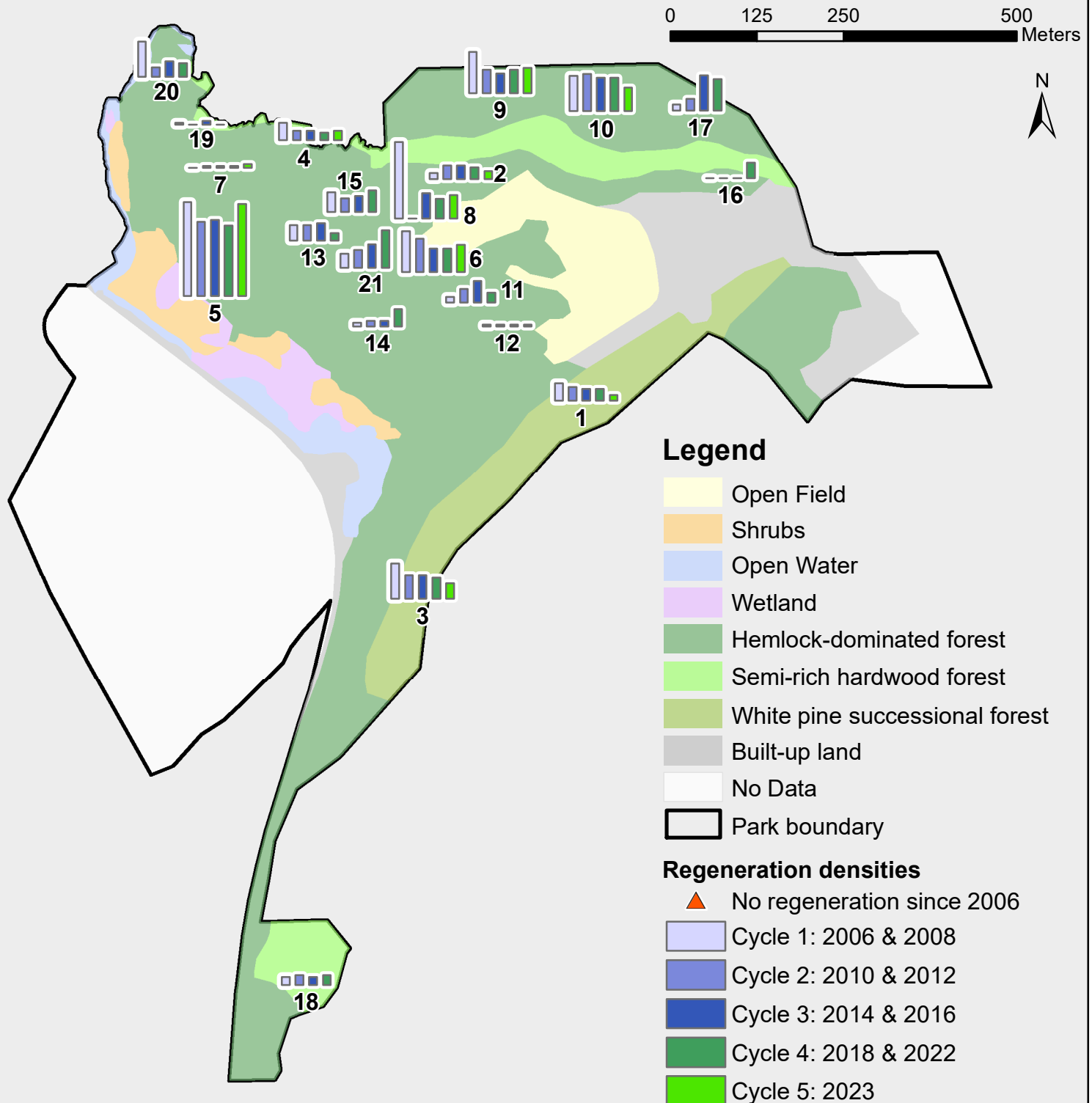




Map 1. Tree Regeneration by Cycle

Trends in tree regeneration, including seedlings and saplings, observed in forest plots sampled from 2006-2023. Plots are sampled in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, 2018, and 2023 and plots 11-21 sampled in 2008, 2012, 2016, and 2022. Densities range from 0 to 1.3 stems/m² and only include native canopy-forming species. Plot 8 data are missing in 2010. See Table 1 for more details. Date: 6/30/2023.





Map 2. Tree Regeneration by Size Class

Trends in tree regeneration by size class in forest plots from the most recent survey cycle (2022 and 2023). Plots are sampled in an alternating panel, with plots 1-10 sampled in 2023, and plots 11-21 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 1.3 stems/m² and only include native canopy-forming species. Date: 6/30/2023.

0 125 250 500
Meters

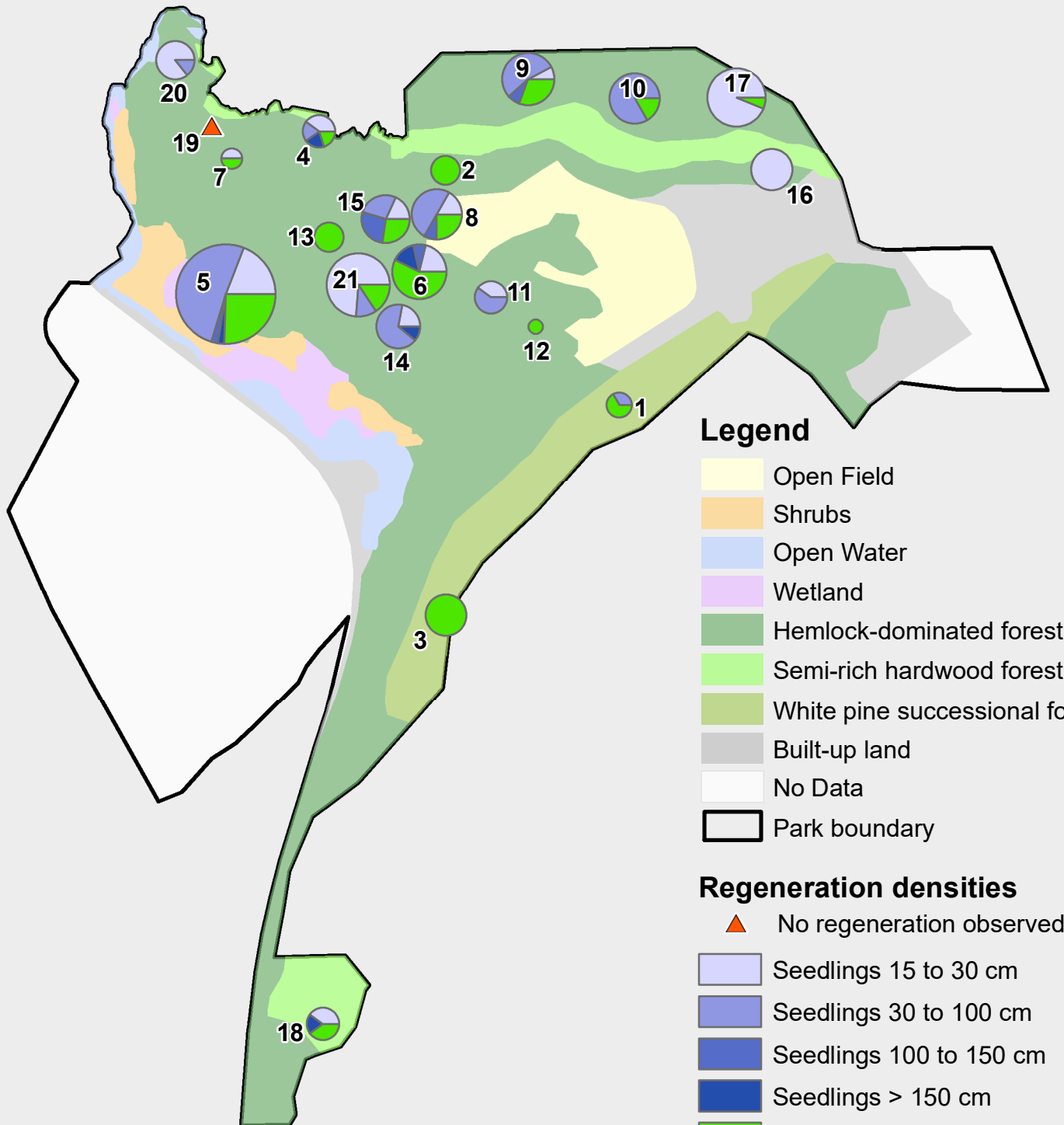


Legend

- Open Field
- Shrubs
- Open Water
- Wetland
- Hemlock-dominated forest
- Semi-rich hardwood forest
- White pine successional forest
- Built-up land
- No Data
- Park boundary

Regeneration densities

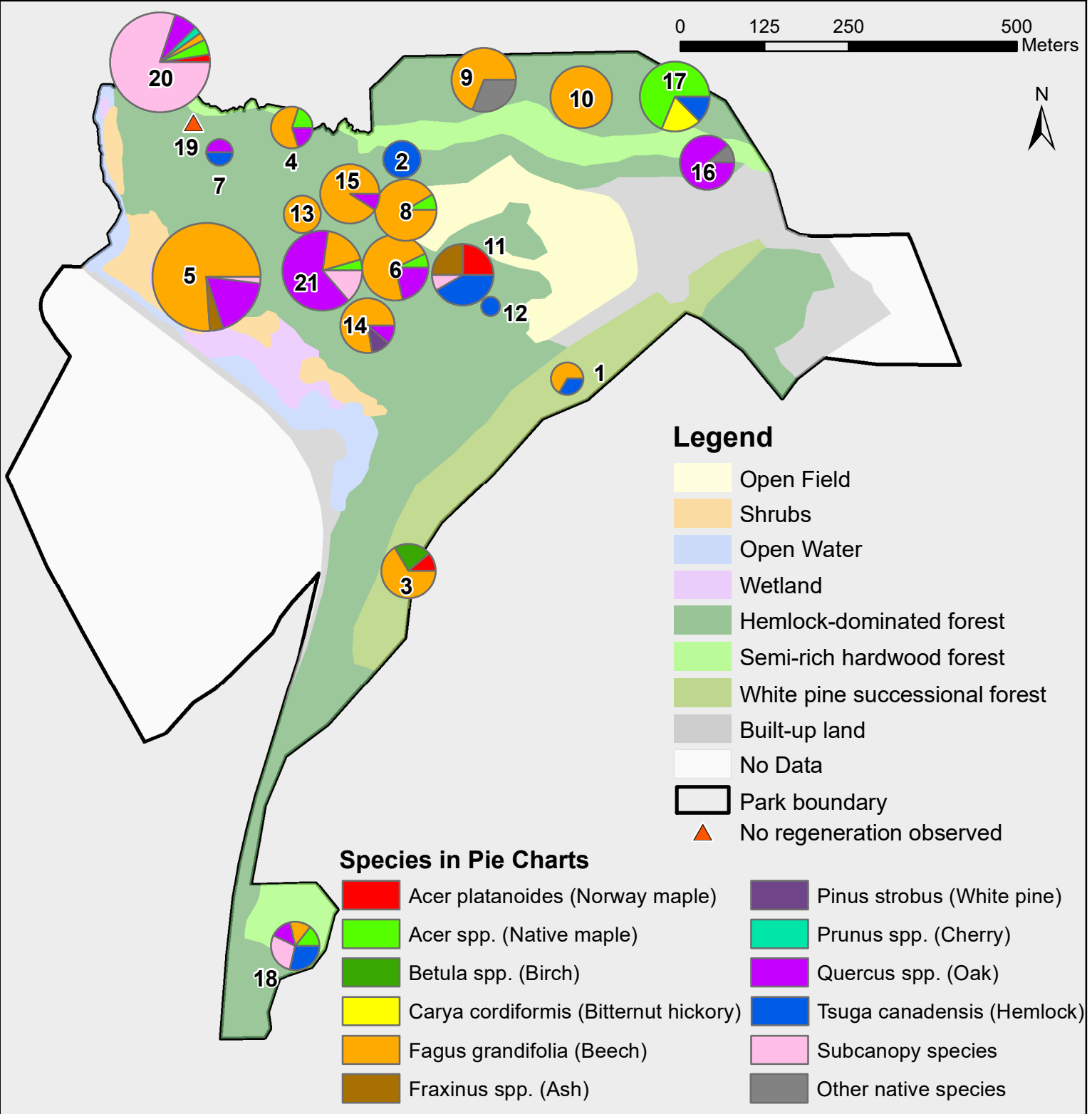
- No regeneration observed
- Seedlings 15 to 30 cm
- Seedlings 30 to 100 cm
- Seedlings 100 to 150 cm
- Seedlings > 150 cm
- Saplings (≥ 1 cm DBH < 10cm)





Map 3. Tree Regeneration Composition

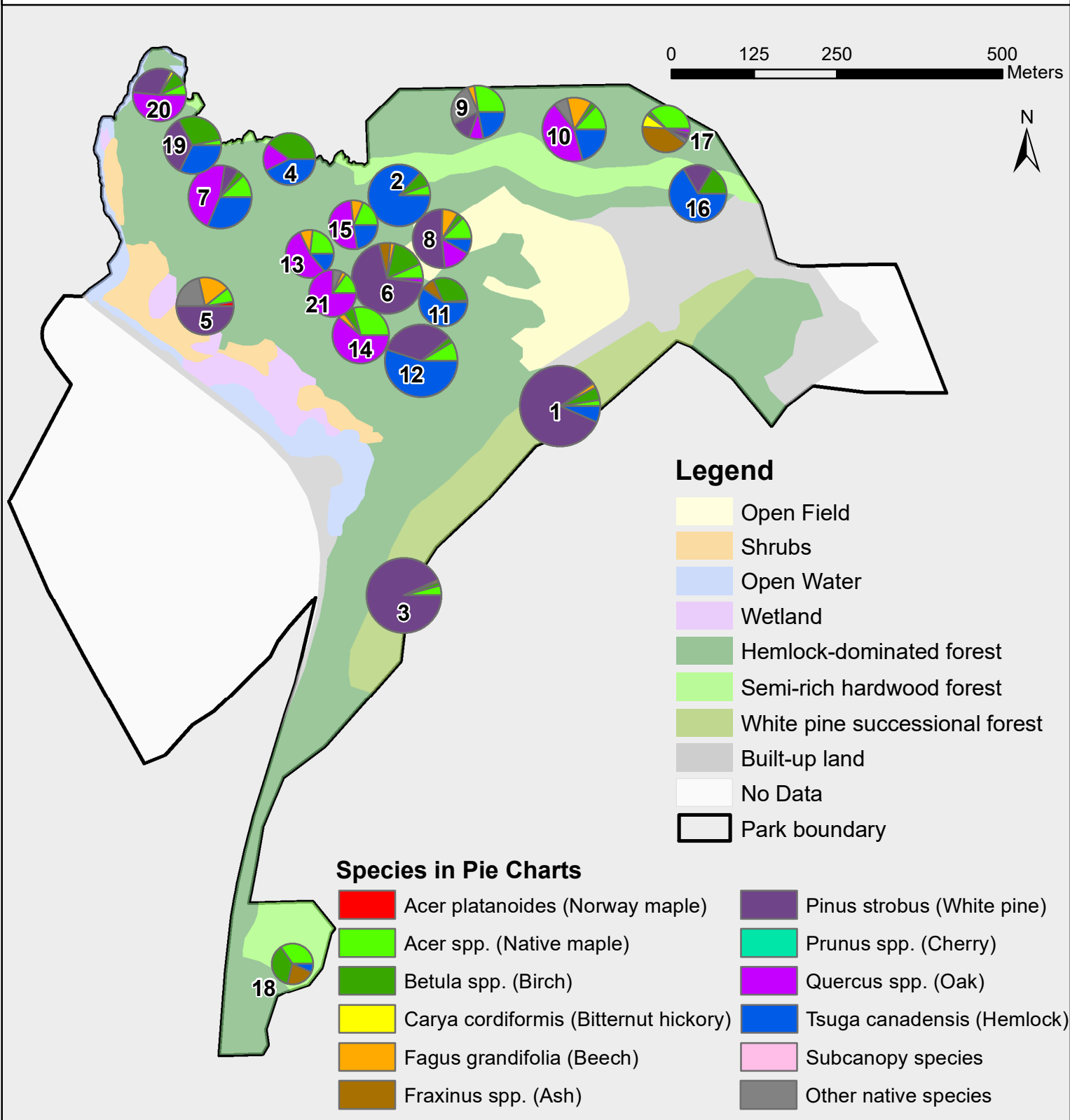
Trends in tree regeneration, including seedlings and saplings, by species group observed in forest plots in the most recent 4-year census (2022 and 2023). Plots are sampled in an alternating panel, with plots 1-10 sampled in 2023, and plots 11-21 sampled in 2022. Pie size is proportional to the total plot-level regeneration (plot-level density range: 0 to 1.3 stems/m²). Pies may be shifted from actual plot location to prevent overlap. Note that striped maple (*A. pensylvanicum*) is included in the subcanopy group. Date: 7/5/2023.





Map 4. Tree Canopy Composition

Trends in tree composition, by species group, observed in forest plots in the most recent 4-year census (2022 and 2033). Plots are sampled in an alternating panel, with plots 1-10 sampled in 2023, and plots 11-21 sampled in 2022. Pie size is proportional to the total plot-level basal area (range: 22.0 to 84.1 m²/hectare). Pies may be shifted from actual plot location to prevent overlap.
Date: 7/5/2023.





Map 5. Tree Regeneration Stocking Index

Trends the regeneration stocking index for the most recent 4-year census (2022 and 2023). This index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights and quantifies whether current regen. densities are sufficient to restock a forest canopy. The stocking index is averaged over three 2-m radius microplots per forest plot and only includes native canopy-forming species (range 0-125.7). See Table 1 for stocking index values. Date: 7/5/2023.

0 125 250 500
Meters

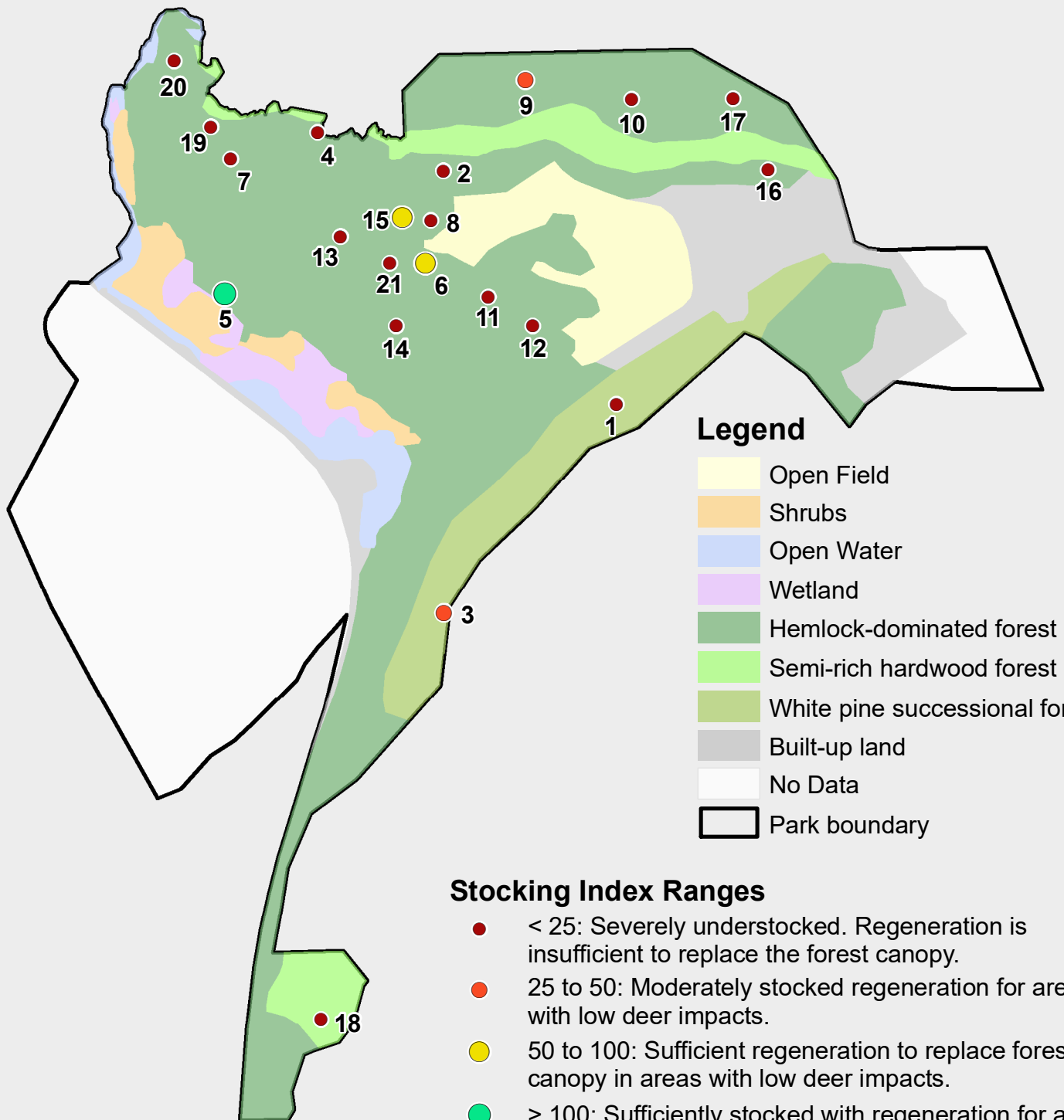


Legend

- Open Field
- Shrubs
- Open Water
- Wetland
- Hemlock-dominated forest
- Semi-rich hardwood forest
- White pine successional forest
- Built-up land
- No Data
- Park boundary

Stocking Index Ranges

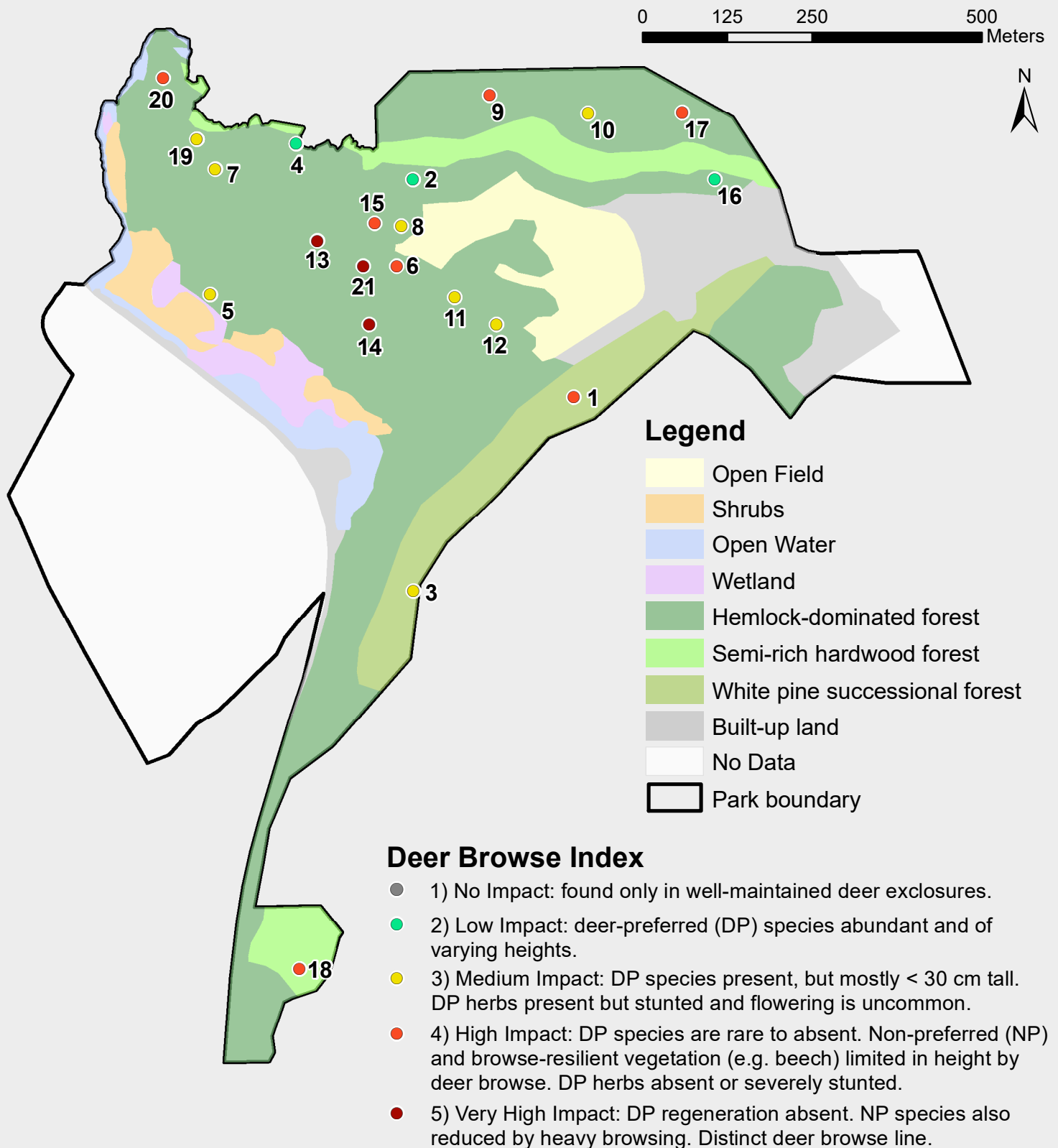
- < 25: Severely understocked. Regeneration is insufficient to replace the forest canopy.
- 25 to 50: Moderately stocked regeneration for areas with low deer impacts.
- 50 to 100: Sufficient regeneration to replace forest canopy in areas with low deer impacts.
- > 100: Sufficiently stocked with regeneration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





Map 6. Index of Deer Browse Impacts

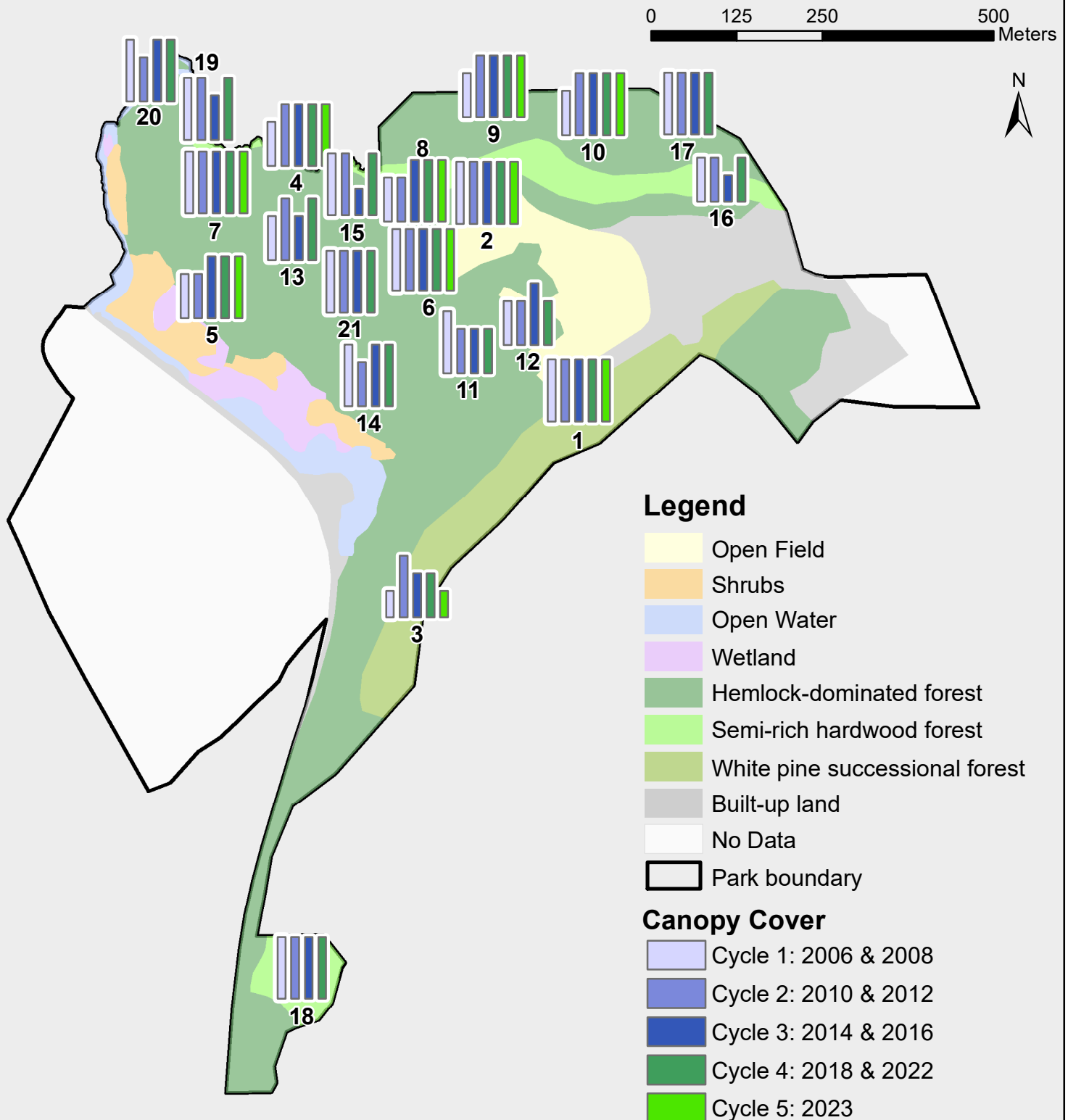
Index of deer browse impacts observed in forest plots in the most recent 4-year census (2022 & 2023). Plots are sampled in an alternating panel, with plots 1-10 sampled in 2023 and plots 11-21 sampled in 2022. Deer browse impacts are assessed on a scale of 1-5, with 1 representing no impact and 5 representing severe impacts. Date: 7/5/2023.





Map 7. Canopy Cover by Cycle

Trends in tree canopy cover in forest plots sampled from 2006-2023. Plots are sampled in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, 2018, and 2023, and plots 11-21 sampled in 2008, 2012, 2016, and 2022. Canopy cover ranges from 25 - 50% to >75%. Date 7/7/2023.

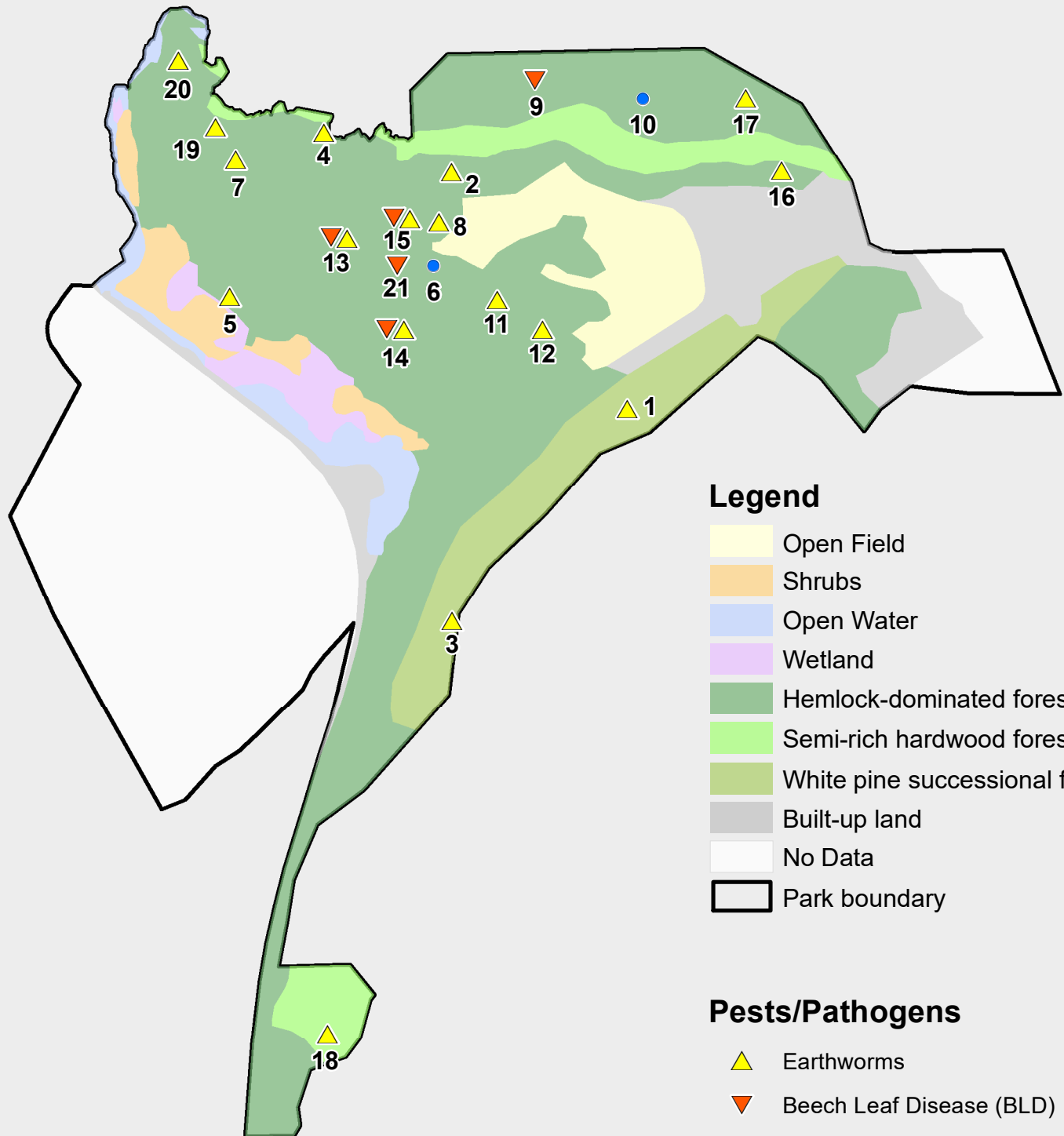




Map 8. Forest Pest/Pathogen Detections

Priorirty pest and pathogen detections in forest plots sampled from 2022-2023. Plots are sampled in an alternating panel with plots 1-10 sampled in 2023 and plots 11-21 sampled in 2022. Plots 13, 14, and 15 have both BLD and earthworms. Note that BLD may be more widespread than map indicates. The late frost in 2023 made distinguishing frost from BLD damage difficult. Beech Bark Disease is also widespread in the park but not noted here. Date: 7/5/2023.

0 125 250 500 Meters



Legend

- Open Field
- Shrubs
- Open Water
- Wetland
- Hemlock-dominated forest
- Semi-rich hardwood forest
- White pine successional forest
- Built-up land
- No Data
- Park boundary

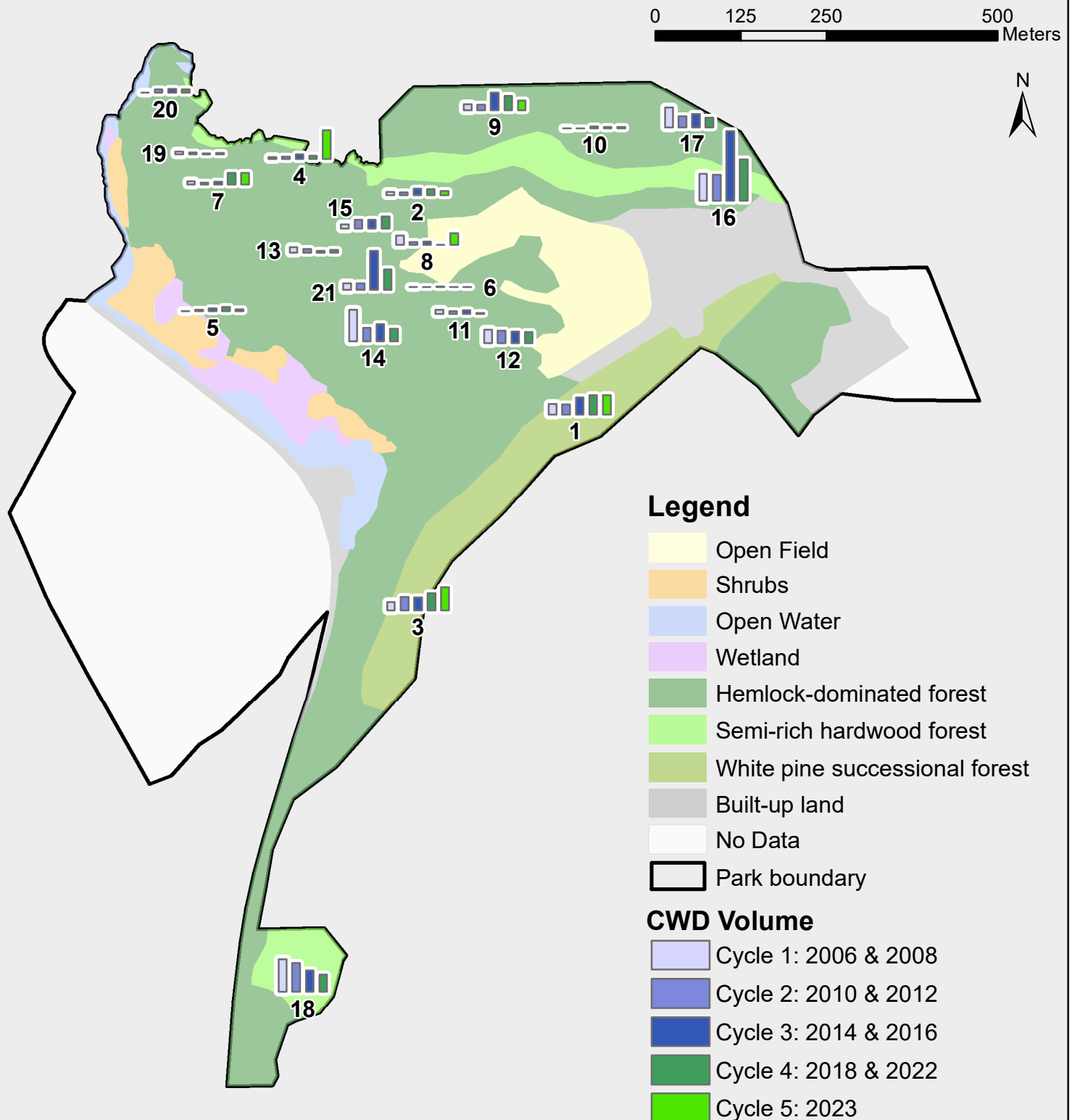
Pests/Pathogens

- Earthworms
- Beech Leaf Disease (BLD)
- No pests/pathogen detected



Map 9. Coarse Woody Debris by Cycle

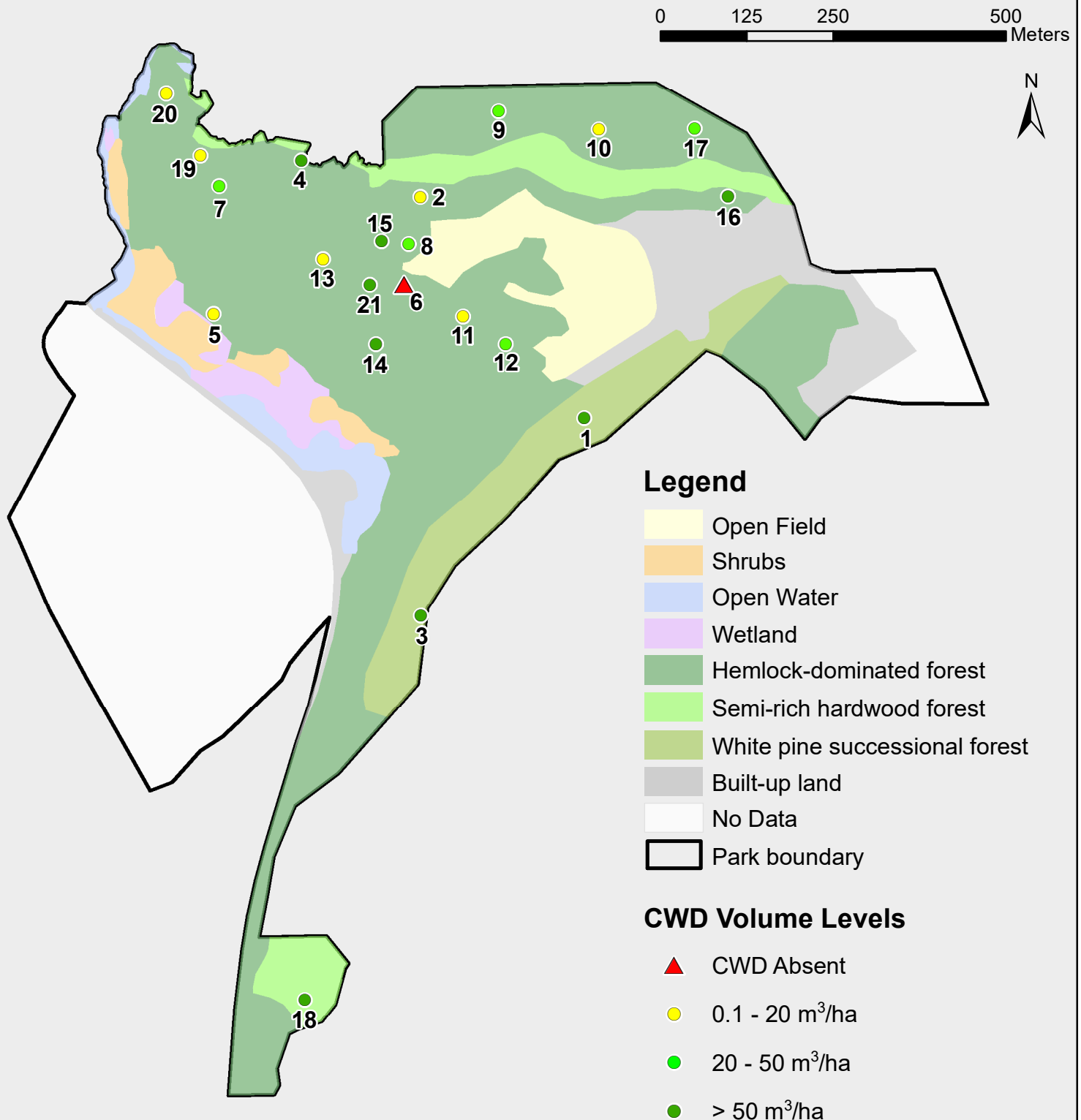
Trends in Coarse Woody Debris (CWD) volume observed in plots sampled from 2006-2023. Plots are sampled in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, 2018, and 2023, and plots 11-21 sampled in 2008, 2012, 2016, and 2022. CWD volume ranges from 0 to 288.7 m³/ha (4,126.6 ft³/ac). Date: 7/7/2023.





Map 10. Coarse Woody Debris Ratings

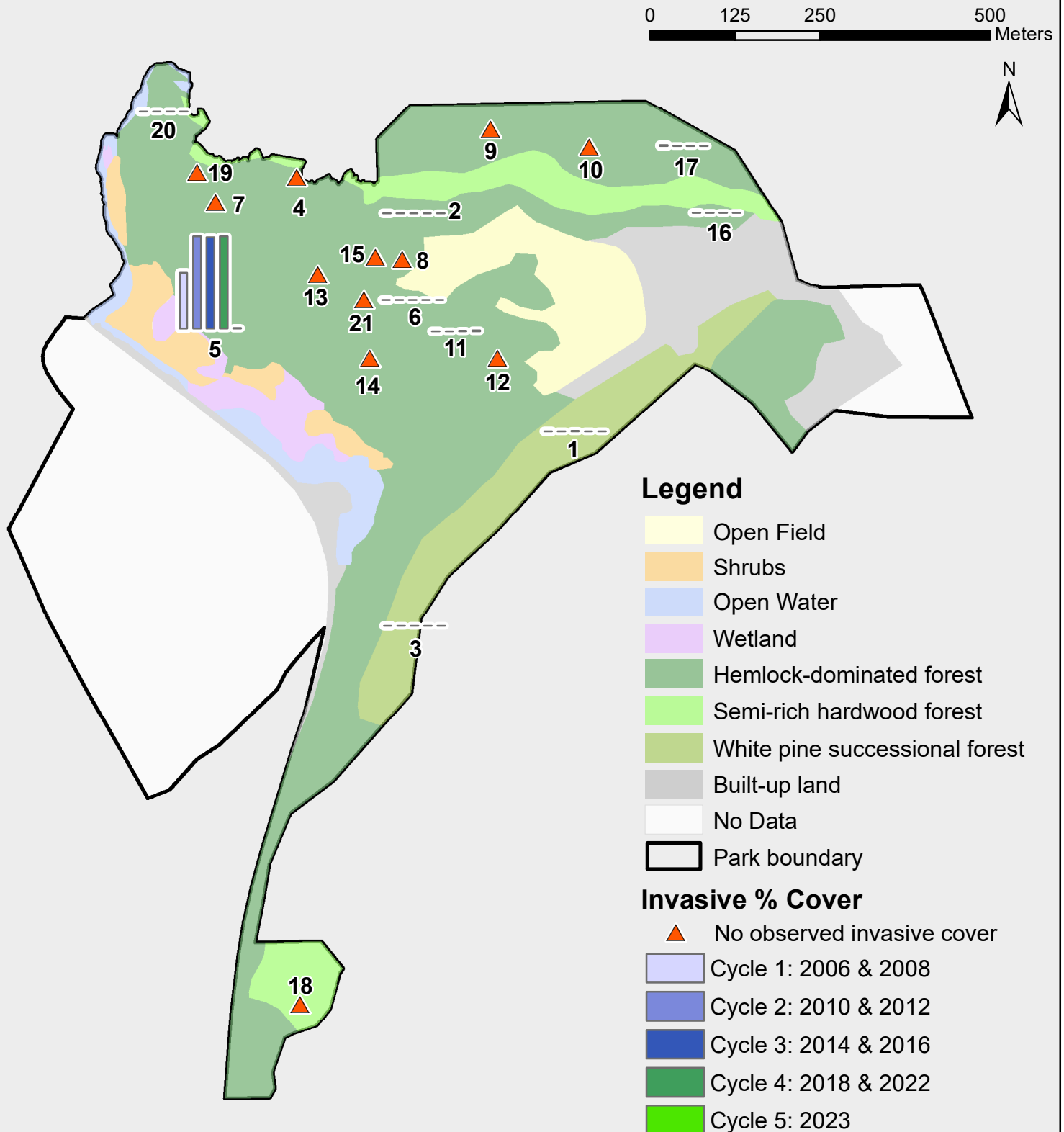
Coarse woody debris volume (m^3/ha) for the most recent 4-year census (2022 and 2023). Plots 1-10 were sampled in 2023 and plots 11-21 were sampled in 2022. Volumes range from 0 to $289 \text{ m}^3/\text{hectare}$ ($4,127 \text{ ft}^3/\text{ac}$). Plots are color coded by volume to indicate whether they meet the $20\text{-}50 \text{ m}^3/\text{ha}$ ($285.8\text{-}714.6 \text{ ft}^3/\text{ac}$) threshold in Müller and Bütler (2010). Date: 7/7/2023.





Map 11. Invasive % Cover by Cycle

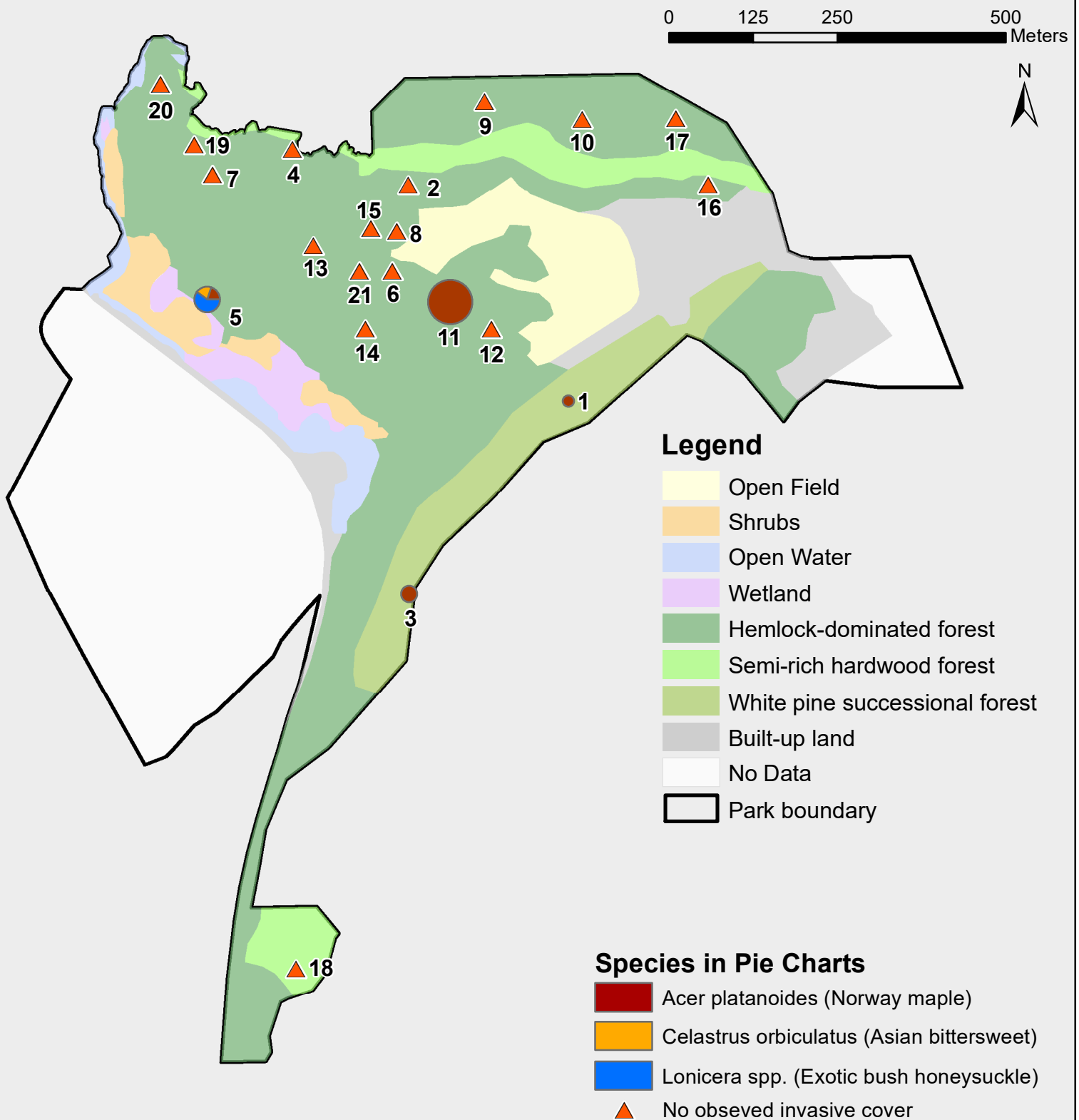
Trends in percent cover of invasive species observed in plots sampled from 2006-2023. Plots are sampled in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, 2018, and 2023, and plots 11-21 sampled in 2008, 2012, 2016, and 2022. Average invasive cover ranges from 0 to 22.2%. See Table 2 for % cover values. Date: 7/5/2023.





Map 12. Invasive % Cover by Species

Trends in % invasive cover by species observed in quadrats for plots in the most recent 4-year census (2022 & 2023). Plots are sampled in an alternating panel, with plots 1-10 sampled in 2023 and plots 11-21 sampled in 2022. Pie size is proportional to total invasive cover (range: 0 to 0.2%), and location may be shifted to prevent overlap. See Table 2 for more information.
Date: 7/5/2023.



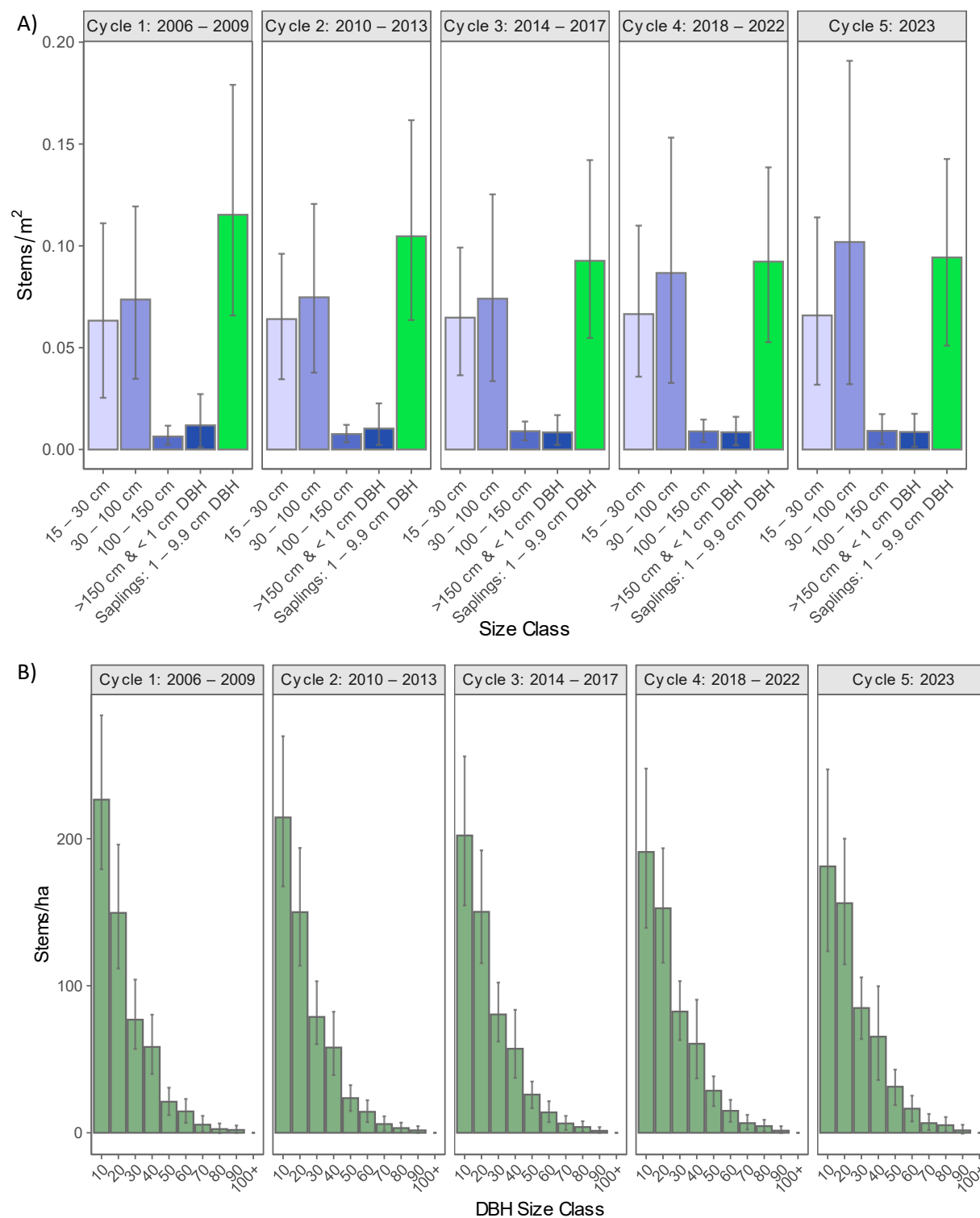


Figure 1. Stem density distributions in 10 cm increments by survey cycle in Saint-Gaudens National Historical Park. Cycle 1 is 2006-2009; Cycle 2 is 2010-2013; Cycle 3 is 2014-2017; Cycle 4 is 2018-2022; Cycle 5 is 2023. Note that Cycle 5 only includes the first panel of 10 plots. Figure A shows regeneration densities by size class. Figure B shows tree density by diameter at breast height (DBH) increments. Error bars are 95% bootstrapped confidence intervals. An asterisk denotes a linear DBH distribution that is indicative of long-term recruitment failure.

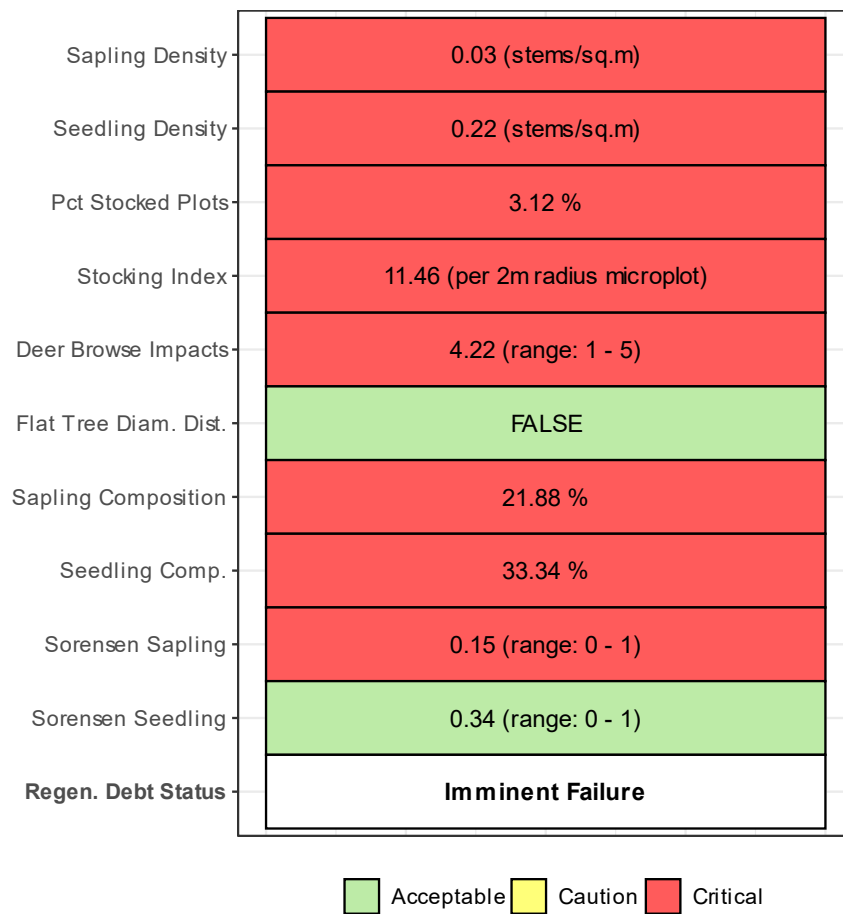


Figure 2. Regeneration Debt metrics and status for the most recent 4-year census (2022 and 2023) in Saint-Gaudens National Historical Park. Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. See [Miller et al. 2023](#) for more details on metric calculations, thresholds, and assessment of status.

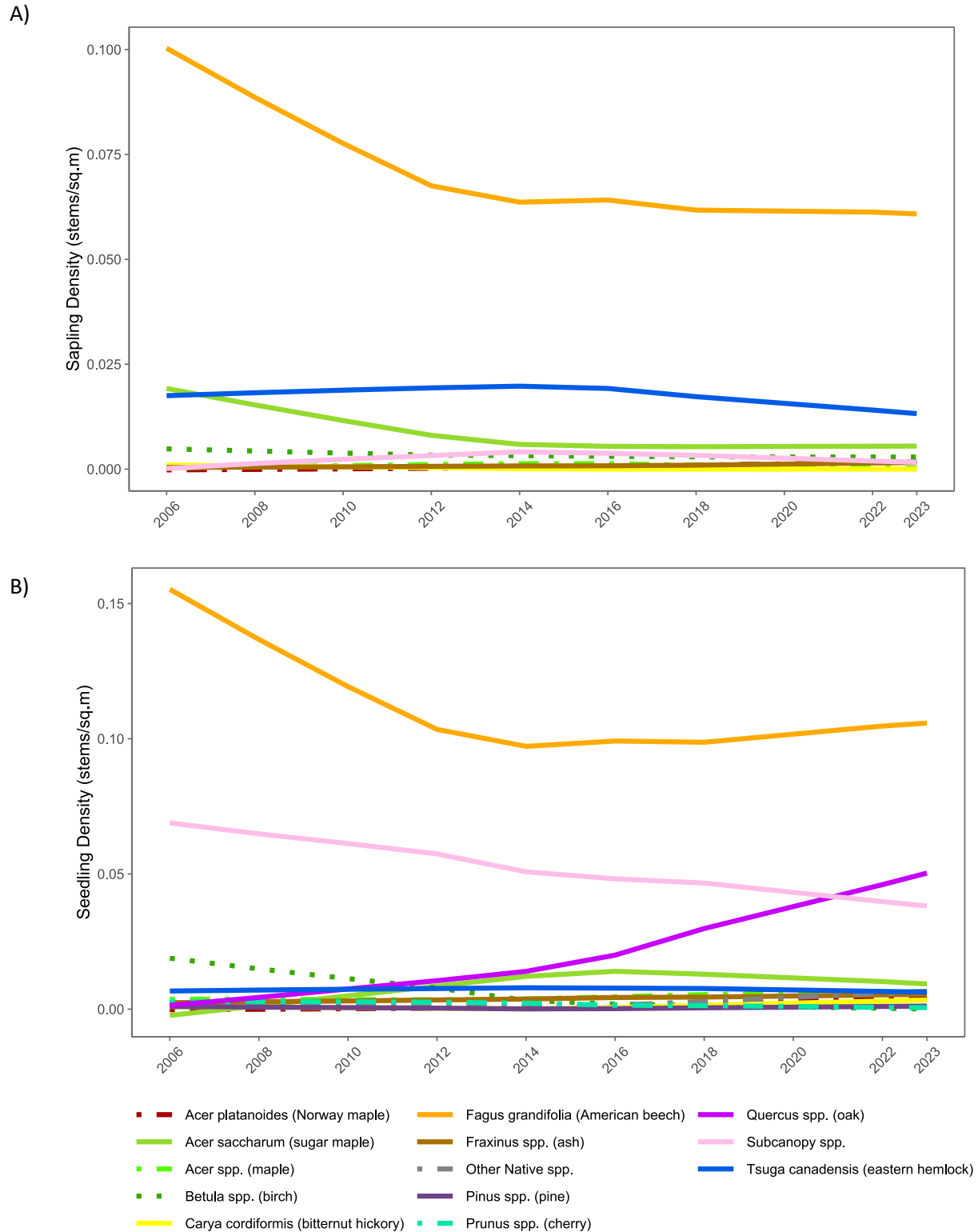


Figure 3. Loess smoothed changes in stem density for saplings (A) and seedlings (B) by species group and sample year in Saint-Gaudens National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

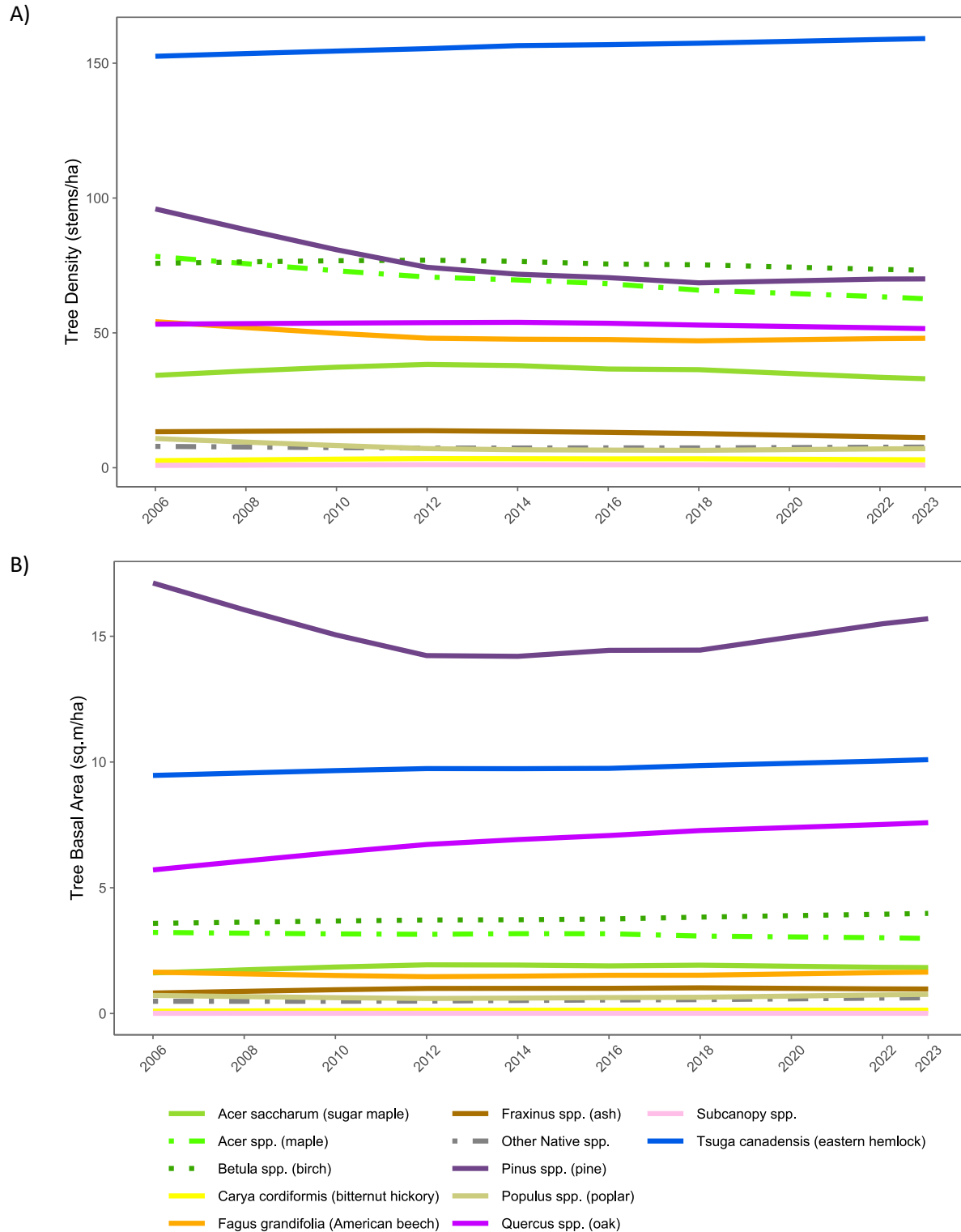


Figure 4. Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Saint-Gaudens National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

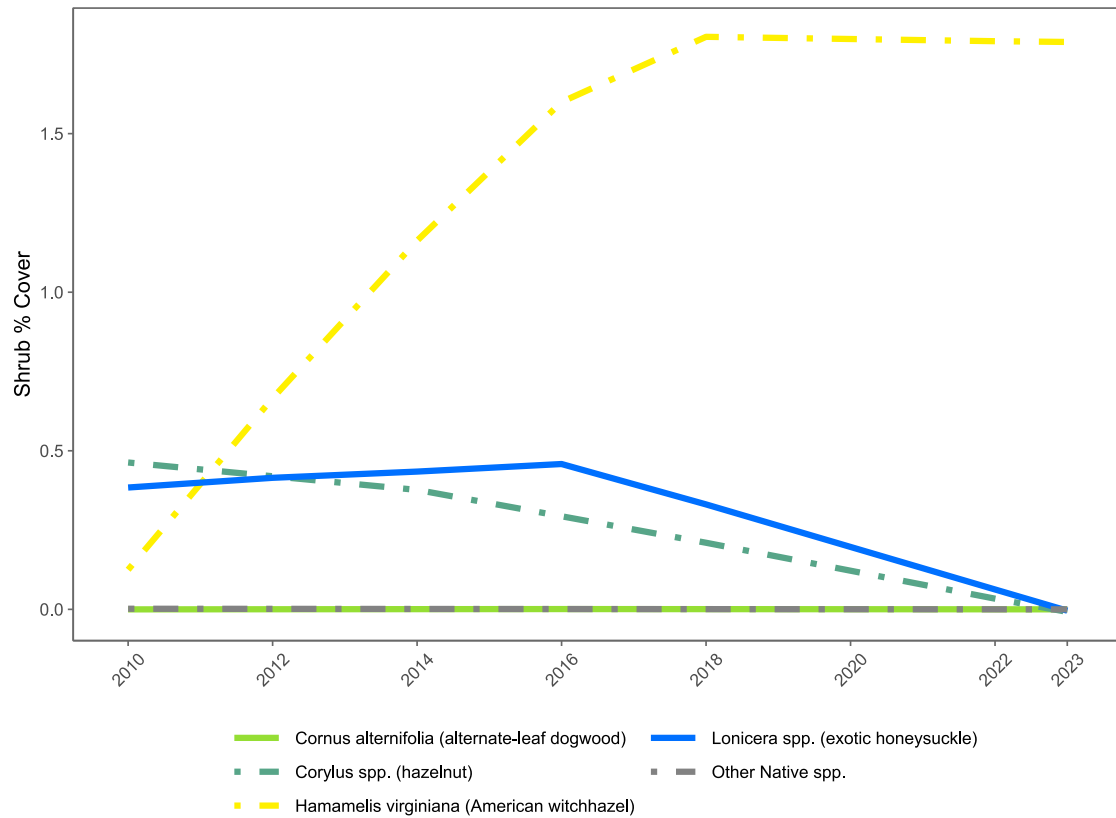


Figure 5. Loess smoothed changes in shrub % cover collected in 2-m radius microplots by species group and sample year in Saint-Gaudens National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel. Note that this metric differs from quadrat % cover in that data collection started in 2010, and there's no height limit for shrub cover (vs. quadrats only including cover up to 1.5m).

Table 1. Average plot-level seedling and sapling stem densities, converted to stems per m², and stocking index by cycle. Only native, canopy-forming species are included. Note that Fraxinus spp. (ash species) are no longer considered canopy-forming species. Cycle 1 = 2006 & 2008; Cycle 2 = 2010 & 2012; Cycle 3 = 2014 & 2016; Cycle 4 = 2018 & 2022; Cycle 5 = 2023. 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. 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. Note that plot 8 was not sampled in cycle 2. Plots 11-21 have not yet been sampled in Cycle 5.

Plot	Panel	Seedlings per m ²					Saplings per m ²					Stocking Index				
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
1	1	0.00	0.11	0.08	0.08	0.03	0.24	0.08	0.08	0.08	0.05	50.00	8.00	8.00	8.00	0.67
2	1	0.08	0.05	0.00	0.00	0	0.00	0.13	0.19	0.16	0.11	2.00	63.33	50.00	16.67	0
3	1	0.16	0.05	0.03	0.05	0	0.32	0.27	0.29	0.24	0.21	154.00	101.00	67.33	51.00	33.33
4	1	0.08	0.08	0.11	0.08	0.11	0.16	0.05	0.03	0.03	0.03	100.00	13.67	40.33	17.33	18
5	1	0.64	0.61	0.66	0.58	0.93	0.64	0.40	0.37	0.37	0.32	408.00	200.67	154.33	145.33	125.67
6	1	0.32	0.21	0.13	0.11	0.16	0.24	0.24	0.19	0.21	0.21	158.00	139.33	134.67	85.33	74.33
7	1	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.03	0.00	0.33	0.00	0.00	0.33
8	1	0.72	---	0.24	0.19	0.24	0.32	---	0.11	0.08	0.08	63.00	---	22.00	4.67	11.33
9	1	0.32	0.19	0.13	0.19	0.24	0.24	0.13	0.13	0.13	0.11	7.00	43.33	36.33	50.00	45
10	1	0.48	0.45	0.40	0.40	0.27	0.00	0.05	0.05	0.05	0.05	11.00	59.00	42.33	25.33	23.33
11	2	0.05	0.13	0.29	0.13	---	0.03	0.05	0.00	0.00	---	0.67	2.33	4.67	2.67	---
12	2	0.00	0.00	0.00	0.00	---	0.03	0.03	0.03	0.03	---	0.00	0.00	0.00	0.00	---
13	2	0.00	0.00	0.05	0.00	---	0.21	0.21	0.19	0.11	---	66.67	50.00	34.00	16.67	---
14	2	0.05	0.08	0.08	0.24	---	0.00	0.00	0.00	0.00	---	1.00	1.33	1.67	21.33	---
15	2	0.19	0.11	0.13	0.21	---	0.08	0.08	0.08	0.08	---	75.67	52.67	59.00	56.00	---
16	2	0.00	0.00	0.00	0.21	---	0.00	0.00	0.00	0.00	---	0.00	0.00	0.00	2.67	---
17	2	0.03	0.13	0.45	0.40	---	0.05	0.03	0.03	0.03	---	0.33	1.67	5.67	5.00	---
18	2	0.03	0.05	0.05	0.08	---	0.08	0.08	0.05	0.05	---	6.67	7.00	7.00	17.33	---
19	2	0.03	0.00	0.05	0.00	---	0.00	0.00	0.00	0.00	---	0.33	0.00	0.67	0.00	---
20	2	0.48	0.13	0.21	0.19	---	0.00	0.00	0.00	0.00	---	6.67	2.33	9.33	2.67	---
21	2	0.13	0.16	0.24	0.42	---	0.05	0.08	0.08	0.08	---	35.00	19.67	19.67	22.67	---

Table 2. Average % cover and number of invasive species detected in each plot by cycle. Cycle 1= 2006 & 2008; Cycle 2= 2010 & 2012; Cycle 3= 2014 & 2016; Cycle 4= 2018 & 2022; Cycle 5 = 2023. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year. Note that plots 11-21 have not yet been sampled in Cycle 5. Yellow highlighted cells indicate major changes in cover between cycles.

Plot	Panel	Average % Cover					Number of Species per Plot				
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
1	1	0.00	0.00	0.04	0.00	0.01	0	1	2	2	3
2	1	0.00	0.00	0.00	0.01	0.00	0	0	0	1	0
3	1	0.00	0.00	0.00	0.00	0.03	1	1	2	2	2
4	1	0.00	0.00	0.00	0.00	0.00	0	1	0	0	1
5	1	13.45	22.20	21.91	22.16	0.06	3	4	4	6	4
6	1	0.00	0.00	0.01	0.00	0.00	0	0	1	0	0
7	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
8	1	0.00	0.00	0.00	0.00	0.00	0	2	0	0	0
9	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
10	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
11	2	0.00	0.00	0.04	0.19	---	1	0	2	2	---
12	2	0.00	0.00	0.00	0.00	---	0	0	0	0	---
13	2	0.00	0.00	0.00	0.00	---	0	0	0	0	---
14	2	0.00	0.00	0.00	0.00	---	1	1	0	2	---
15	2	0.00	0.00	0.00	0.00	---	0	0	0	0	---
16	2	0.00	0.00	0.03	0.00	---	1	0	2	1	---
17	2	0.20	0.01	0.00	0.00	---	1	1	3	5	---
18	2	0.00	0.00	0.00	0.00	---	0	1	0	1	---
19	2	0.00	0.00	0.00	0.00	---	0	0	0	0	---
20	2	0.03	0.03	0.01	0.00	---	3	4	1	3	---
21	2	0.00	0.00	0.00	0.00	---	0	0	0	0	---

Table 3. Number of plots out of 21 where priority invasive species were detected by cycle. Cycle 1 = 2006 & 2008; Cycle 2 = 2010 & 2012; Cycle 3 = 2014 & 2016; Cycle 4 = 2018 & 2022; Cycle 5 = 2023. Species on the list include all exotic vascular plant species that are capable of dominating Northeastern US forest habitats, and does not include all exotic species detected in SAGA forest plots. Note only 10 plots have been sampled in cycle 5.

Latin Name	Common Name	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
<i>Acer platanoides</i>	Norway maple	1	1	5	6	3
<i>Berberis thunbergii</i>	Japanese barberry	4	2	2	2	1
<i>Celastrus orbiculatus</i>	Asian bittersweet	0	2	1	3	1
<i>Euonymus alatus</i>	burningbush	0	1	1	3	0
<i>Ligustrum</i> spp.	privet	0	1	0	0	0
<i>Lonicera</i> spp.	exotic bush honeysuckle	5	6	5	7	3
<i>Rhamnus cathartica</i>	common buckthorn	0	1	1	2	1
<i>Rhamnus frangula</i>	glossy buckthorn	0	0	1	0	1
<i>Rosa multiflora</i>	multiflora rose	0	0	1	2	0

Table 4. Priority forest pest and invasive plant detections by plot in the most recent 4-year census (2022 & 2023) in Saint-Gaudens National Historical Park. Coordinates are in NAD83 UTM Zone 18N. Average quadrat % cover provided where data exist to indicate abundance. Cover of 0 indicates the species was present on the plot, but did not occur in quadrats.

Plot	X	Y	Latin Name	Common Name	Avg. % Cover	Type
SAGA-001	712527	4819562	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-001	712527	4819562	Rhamnus frangula	glossy buckthorn	0	shrub
SAGA-004	712118	4819935	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-005	711991	4819713	Lonicera - Exotic	honeysuckle - exotic	0.0375	shrub
SAGA-009	712403	4820006		beech leaf disease	NA	pest
SAGA-011	712352	4819709	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-013	712149	4819792		beech leaf disease	NA	pest
SAGA-014	712226	4819669		beech leaf disease	NA	pest
SAGA-014	712226	4819669	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-015	712234	4819818		beech leaf disease	NA	pest
SAGA-016	712735	4819883	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-017	712687	4819981	Euonymus alatus	burningbush	0	shrub
SAGA-017	712687	4819981	Lonicera - Exotic	honeysuckle - exotic	0	shrub
SAGA-020	711922	4820032	Euonymus alatus	burningbush	0	shrub
SAGA-021	712217	4819755		beech leaf disease	NA	pest