



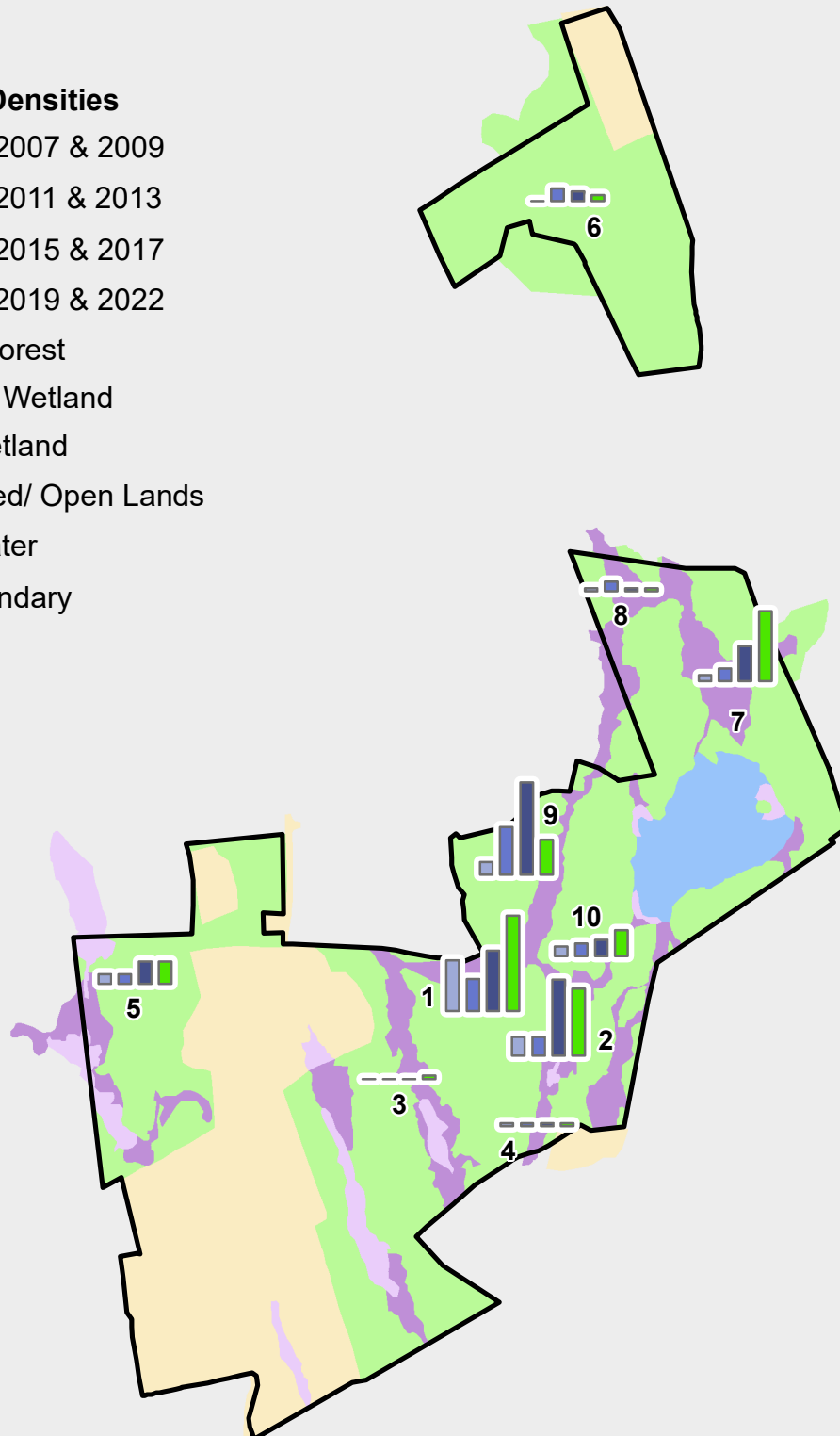
Map 1. Tree Regeneration by Cycle

Trends in tree regeneration, including seedlings and saplings, in forest plots sampled from 2007- 2022. Plots are sampled in an alternating panel, with plots 1-5 sampled in 2007, 2011, 2015, and 2019, and plots 6-10 sampled in 2009, 2013, 2017, and 2022. Densities range from 0 to 0.8 stems/m², and only include native canopy-forming species. Note the unit change from the 2019 report to match manuscript in review. See Table 1 for more details. Date: 8/23/2022.

Legend

Regeneration Densities

-  Cycle 1: 2007 & 2009
-  Cycle 2: 2011 & 2013
-  Cycle 3: 2015 & 2017
-  Cycle 4: 2019 & 2022
-  Upland Forest
-  Forested Wetland
-  Open Wetland
-  Maintained/ Open Lands
-  Open Water
-  Park boundary





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 (2019 and 2022). Plots are sampled in an alternating panel, with plots 1-5 sampled in 2019, and plots 6-10 sampled in 2022. Pie size is proportional to plot-level regeneration, and location may be shifted to prevent overlap. Total densities range from 0.02 to 0.8 stems/m² and only include native canopy-forming species. Note the unit change from the 2019 report to match manuscript in review.

Date: 8/23/2022.

Legend

Stem densities by size class

-  Seedlings 15 to 30 cm
-  Seedlings 30 to 100 cm
-  Seedlings 100 to 150 cm
-  Seedlings >150 cm
-  Saplings (>=1cm DBH <10cm)
-  Upland Forest
-  Forested Wetland
-  Open Wetland
-  Maintained/ Open Lands
-  Open Water
-  Park boundary

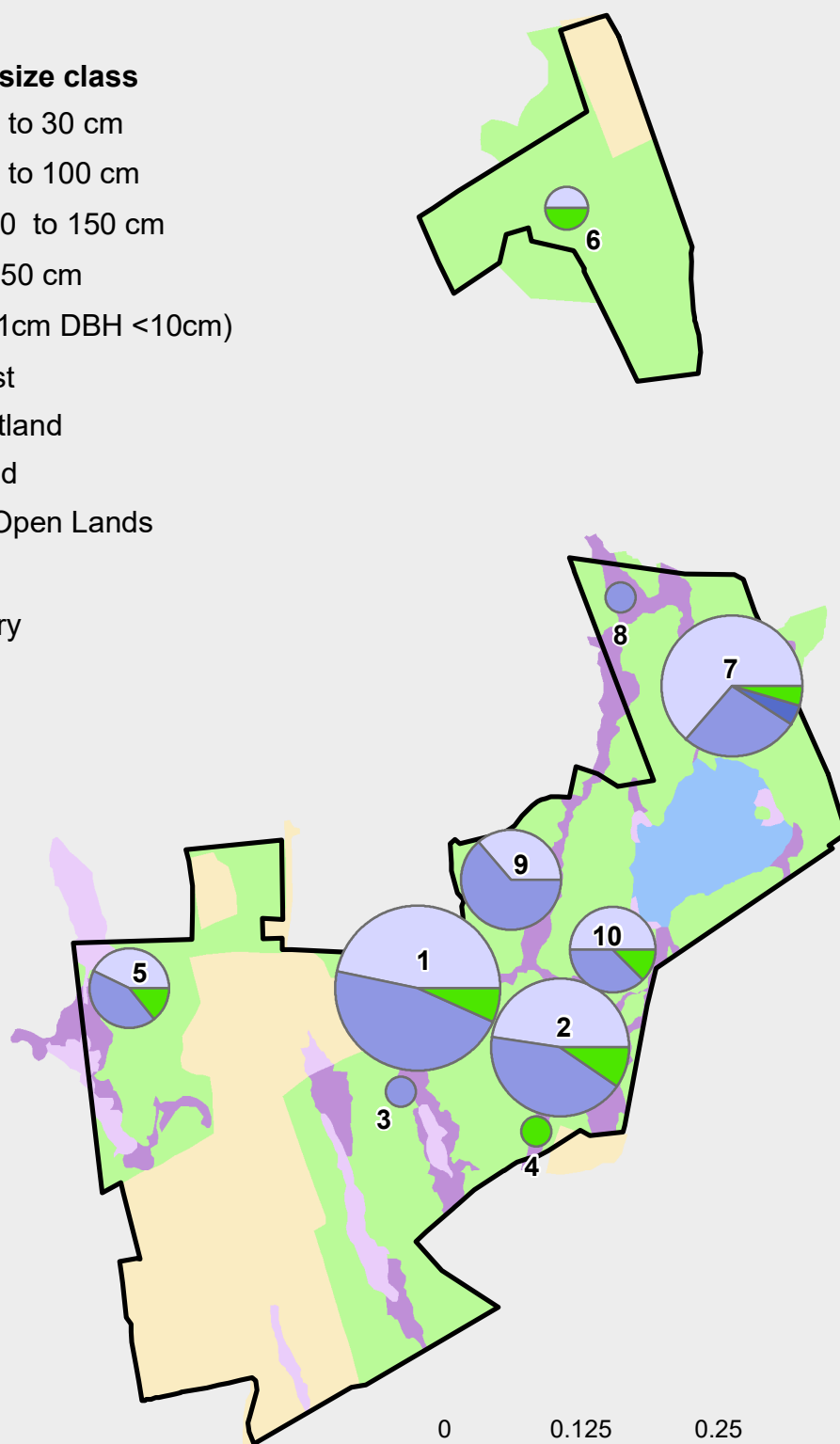


Table 1. Average plot-level seedling and sapling stem densities, converted to stems per m², and stocking index by cycle. Only native, canopy-forming species are included. Note that *Fraxinus* spp. (ash species) are no longer considered canopy-forming species, which differs from the 2019 summary. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017, Cycle 4= 2019 & 2022. 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.

Plot	Panel	Seedlings per m ²				Saplings per m ²				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	0.29	0.16	0.42	0.74	0.13	0.11	0.08	0.05	22	36.33	29.33	14
2	1	0.08	0.08	0.56	0.5	0.08	0.08	0.08	0.05	1.33	1.33	10.33	9.33
3	1	0	0	0	0.03	0	0	0	0	0	0	0	0.67
4	1	0	0	0	0	0.03	0.03	0.03	0.03	0	0	0	0
5	1	0	0	0.16	0.16	0.08	0.08	0.03	0.03	16.67	16.67	18.67	19.67
6	2	0	0.08	0.08	0.03	0	0.03	0	0.03	0	1	1	0.33
7	2	0.03	0.08	0.27	0.56	0.03	0.03	0.03	0.03	0.33	1.33	4.67	15.33
8	2	0	0.05	0.03	0.03	0.03	0.03	0	0	0	0.67	0.67	0.67
9	2	0.05	0.32	0.74	0.29	0.05	0.08	0.03	0	23.67	43.33	10.67	6
10	2	0.08	0.11	0.13	0.19	0	0	0	0.03	1	1.67	8.33	20

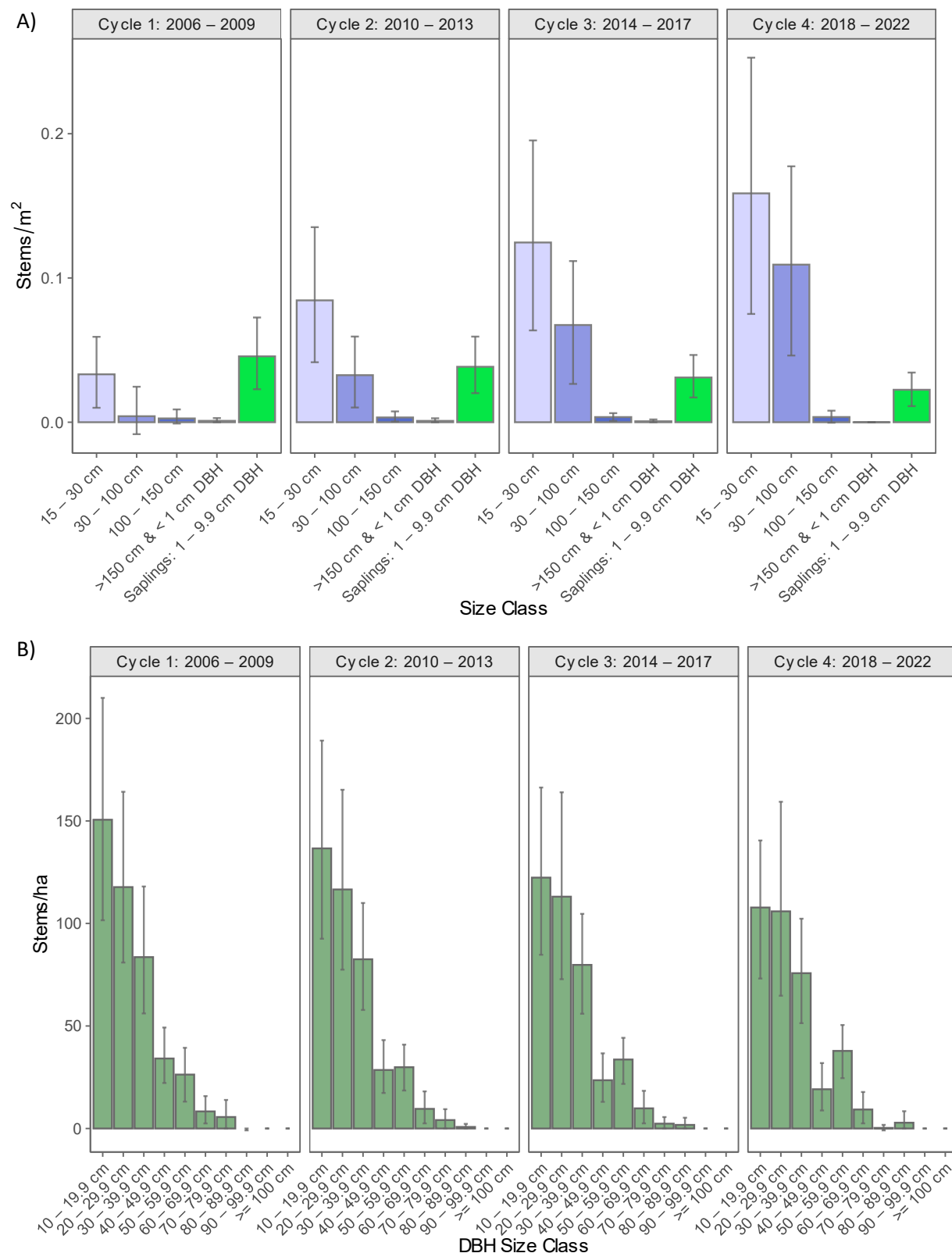


Figure 1. Stem density distributions by survey cycle in Weir Farm National Historical Park. Cycle 1 is 2006-2009; Cycle 2 is 2010-2013; Cycle 3 is 2014-2017; Cycle 4 is 2018-2022. Figure A shows regeneration densities by size class. Figure B shows tree density by diameter at breast height (DBH) increments.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

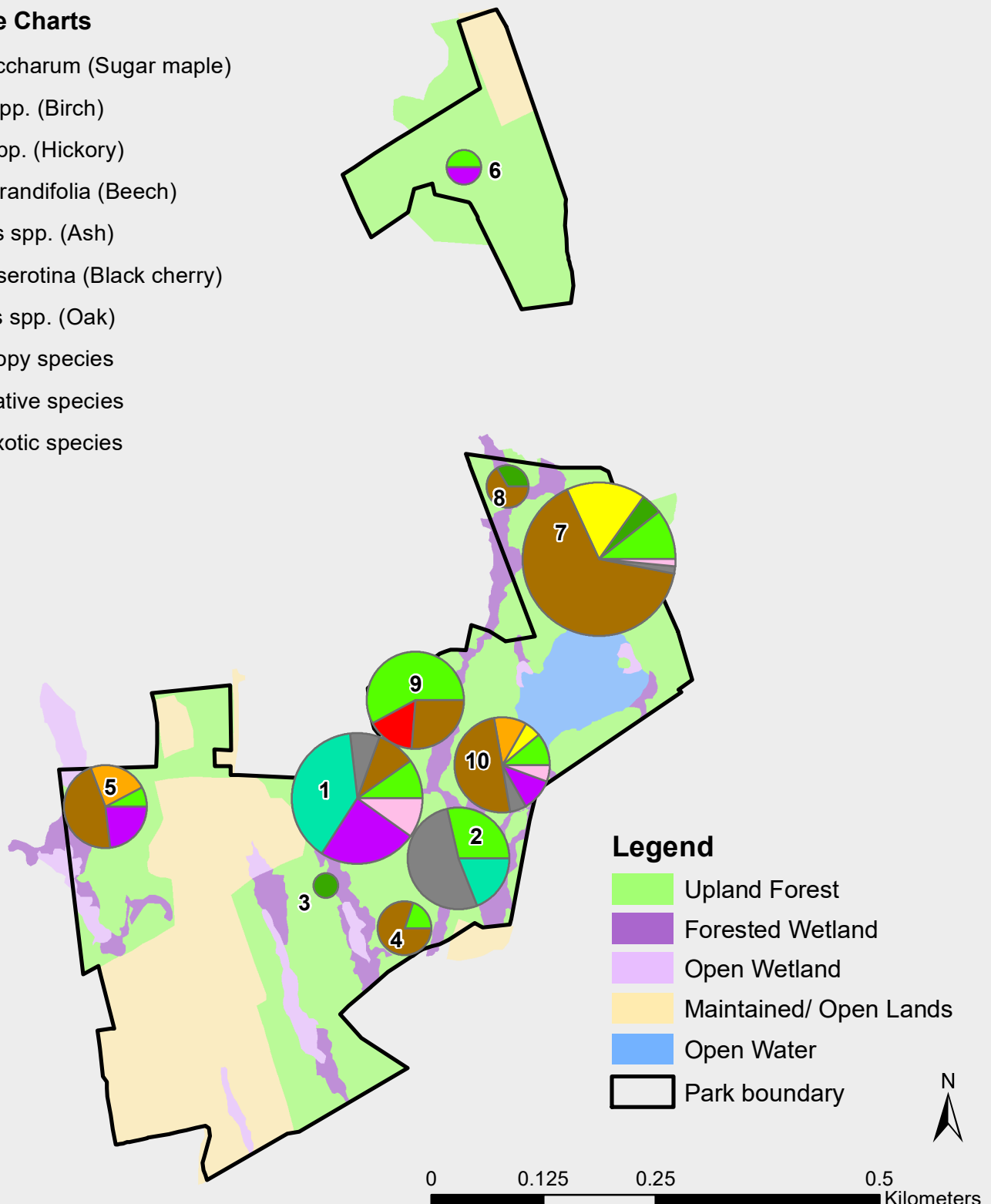


Map 3. Tree Regeneration Composition

Trends in tree regeneration, including seedlings and saplings, by species group observed in forest plots in the most recent survey cycle (2019 and 2022). Plots are sampled in an alternating panel, with plots 1-5 sampled in 2019 and plots 6-10 sampled in 2022. Each pie is proportional to the total plot-level regeneration (plot-level regeneration range: 0.02 to 1.7 stems/m²). Pies may be shifted from actual location to prevent overlap. Date: 8/23/2022.

Species in Pie Charts

- Acer saccharum* (Sugar maple)
- Betula* spp. (Birch)
- Carya* spp. (Hickory)
- Fagus grandifolia* (Beech)
- Fraxinus* spp. (Ash)
- Prunus serotina* (Black cherry)
- Quercus* spp. (Oak)
- Subcanopy species
- Other native species
- Other exotic species



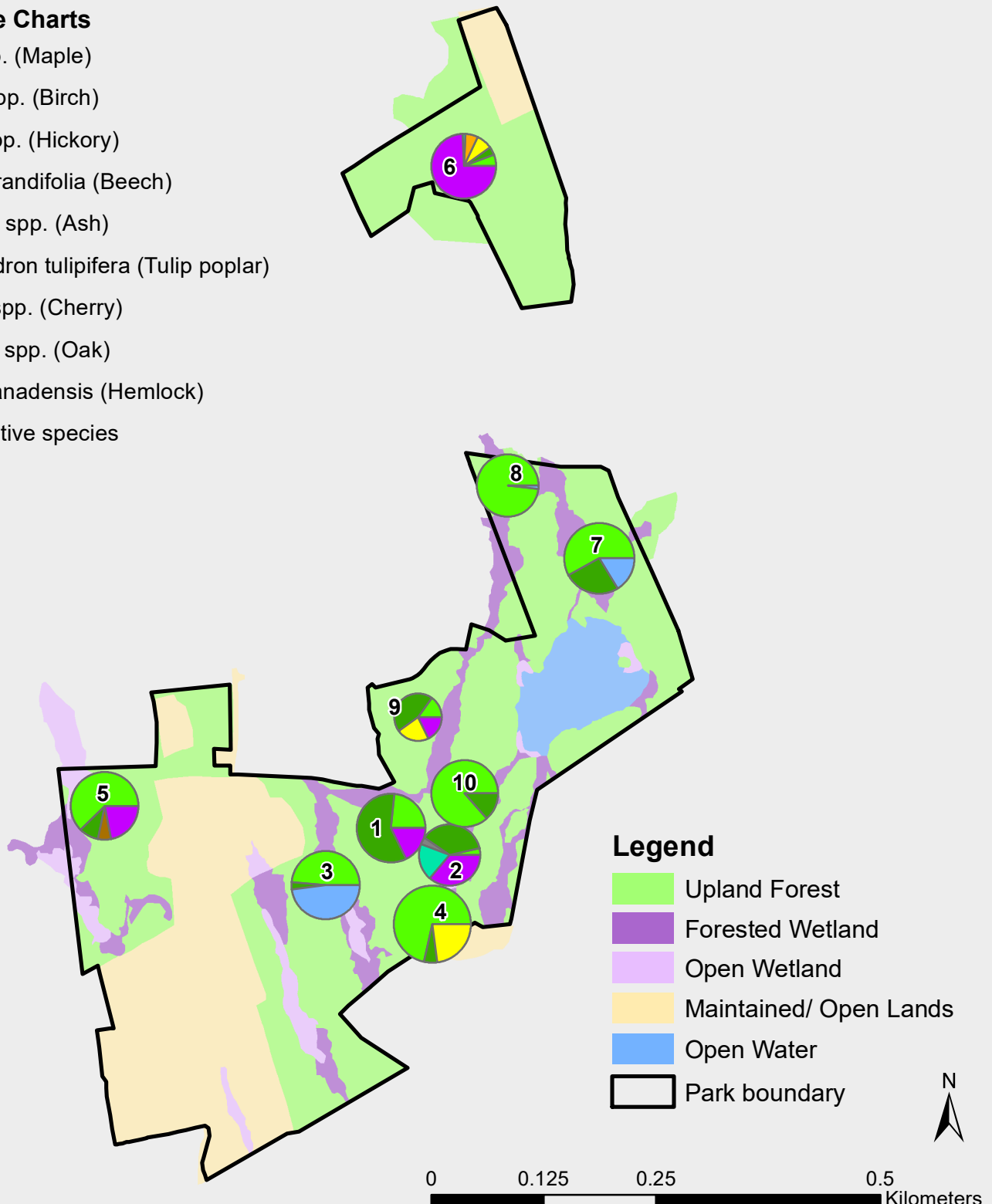


Map 4. Tree Canopy Composition

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 1-5 sampled in 2019 and plots 6-10 sampled in 2022. Pie size is proportional to the total plot-level basal area (range: 15.2 to 40.3 m²/ha). Pies may be shifted to prevent overlap. Date: 8/23/2022.

Species in Pie Charts

- Acer spp. (Maple)
- Betula spp. (Birch)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Liriodendron tulipifera (Tulip poplar)
- Prunus spp. (Cherry)
- Quercus spp. (Oak)
- Tsuga canadensis (Hemlock)
- Other native species



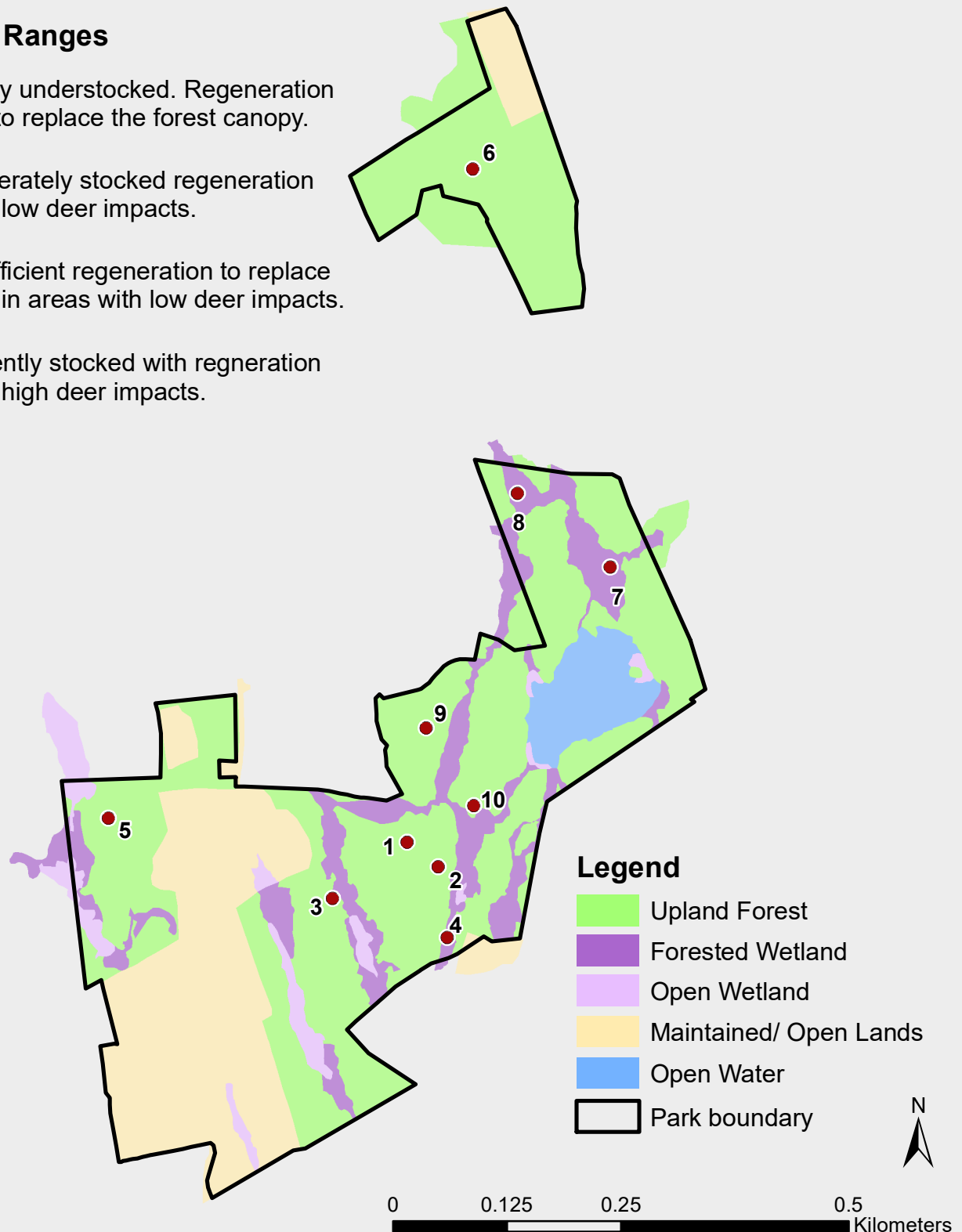


Map 5. Tree Regeneration Stocking Index

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: 0-19.7). See Table 1 for plot-level stocking values. Date: 8/23/2022.

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.



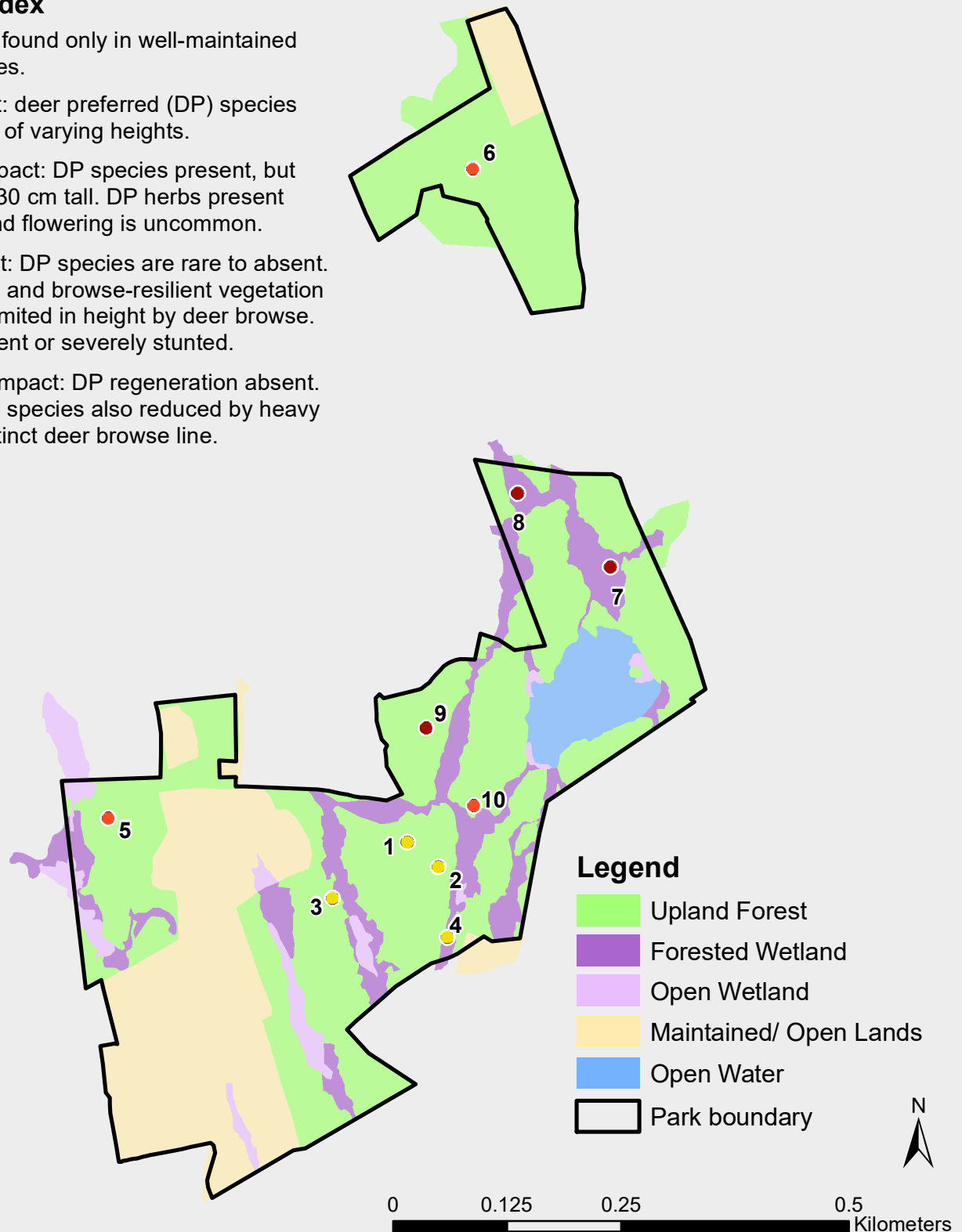


Map 6. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent survey cycle (2019 & 2022). Plots are sampled in an alternating panel, with plots 1-5 sampled in 2019 and plots 6-10 sampled in 2022. Date: 8/23/2022.

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.





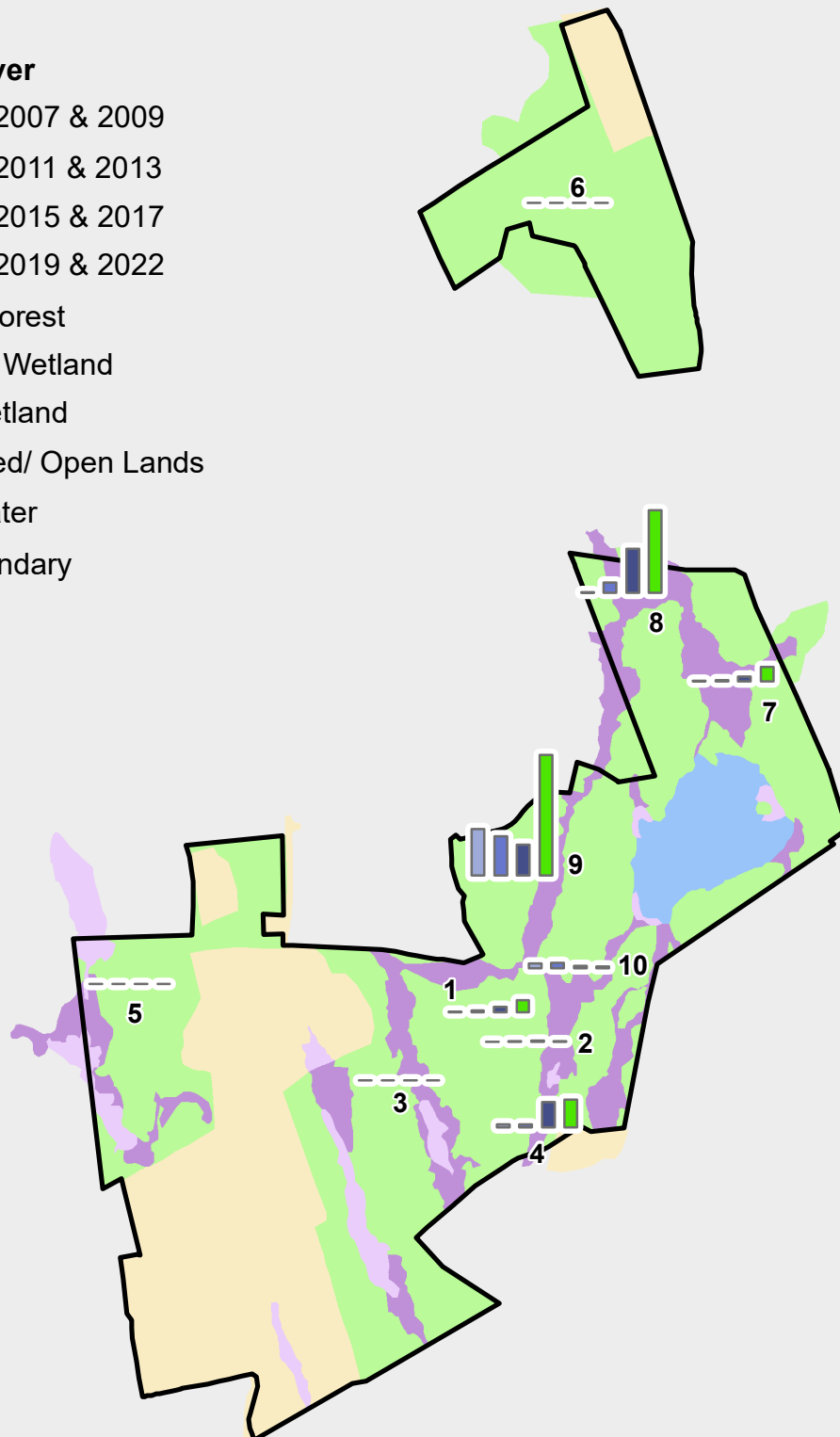
Map 7. Invasive % Cover by Cycle

Trends in percent cover of invasive species observed in quadrats for plots samples from 2007-2022. Plots are sampled in an alternating panel, with plots 1-5 sampled in 2007, 2011, 2015, and 2019 and plots 6-10 sampled in 2009, 2013, 2017, and 2022. Average invasive cover ranges from 0 to 55.7%. See Table 2 for plot-level % cover values. Date: 8/23/2022.

Legend

Invasive % Cover

-  Cycle 1: 2007 & 2009
-  Cycle 2: 2011 & 2013
-  Cycle 3: 2015 & 2017
-  Cycle 4: 2019 & 2022
-  Upland Forest
-  Forested Wetland
-  Open Wetland
-  Maintained/ Open Lands
-  Open Water
-  Park boundary



0 0.125 0.25 0.5 Kilometers



Map 8. Invasive % Cover by Species

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 1-5 sampled in 2019, and plots 6-10 sampled in 2022. Pie size is proportional to total invasive cover (range: 0 to 55.7%), and location may be shifted to prevent overlap. Date: 8/23/2022.

Species in Pie Charts

-  No observed invasive cover
-  *Alliaria petiolata* (Garlic mustard)
-  *Berberis thunbergii* (Japanese barberry)
-  *Cardamine impatiens* (Narrowleaf bittercress)
-  *Celastrus orbiculatus* (Asian bittersweet)
-  *Euonymus* spp. (Burningbush)
-  *Euonymus fortunei* (Wintercreeper)
-  *Lonicera japonica* (Japanese honeysuckle)
-  *Microstegium vimineum* (Japanese stiltgrass)
-  *Rosa multiflora* (Multiflora rose)
-  *Rubus phoenicolasius* (Wine raspberry)
-  *Vincetoxicum* spp. (Swallow-wort)

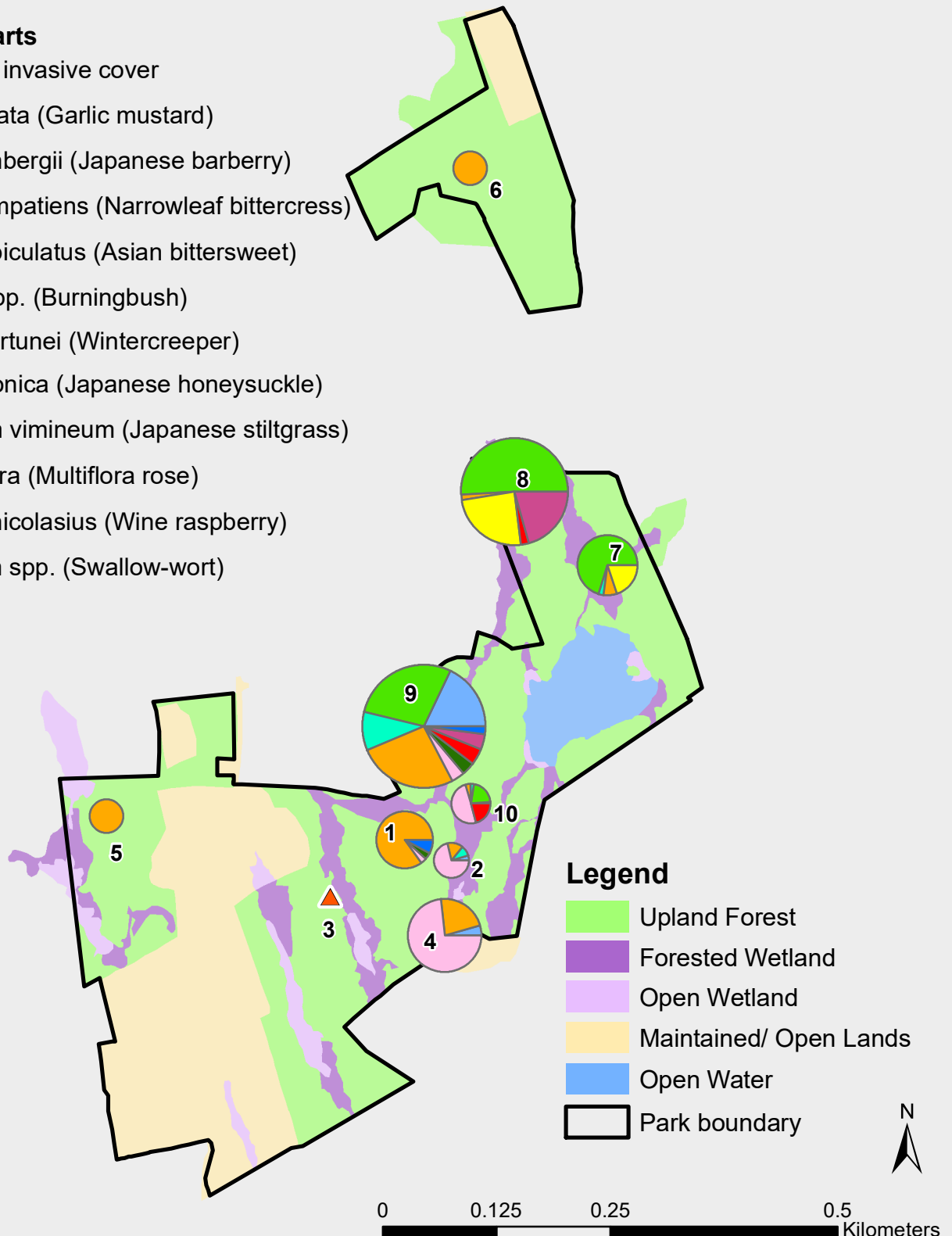


Table 2. Average % cover and number of invasive species detected in each plot by cycle. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017, Cycle 4= 2019 & 2022. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year.

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	0.24	0.86	2.43	5.54	3	6	6	6
2	1	0.04	0.24	0.64	0.26	4	4	5	10
3	1	0.00	0.00	0.01	0.00	1	1	1	2
4	1	1.35	1.33	11.74	12.79	3	7	8	10
5	1	0.00	0.01	0.04	0.05	1	5	6	7
6	2	0.00	0.00	0.00	0.00	1	0	0	2
7	2	0.44	0.65	2.41	6.71	3	5	8	9
8	2	0.23	4.70	20.50	38.25	4	5	9	10
9	2	21.43	18.18	14.18	55.75	9	12	13	12
10	2	2.39	2.60	1.16	0.89	4	5	5	6

Table 3. Number of plots out of 10 where priority invasive species were detected by cycle. Cycle 1= 2007 & 2009; Cycle 2= 2011 & 2013; Cycle 3= 2015 & 2017; Cycle 4= 2019 & 2022. 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 WEFA forest plots.

Latin Name	Common Name	Cycle 1	Cycle 2	Cycle 3	Cycle 4
<i>Acer platanoides</i>	Norway maple	0	3	1	3
<i>Alliaria petiolata</i>	garlic mustard	1	5	6	6
<i>Berberis thunbergii</i>	Japanese barberry	8	9	9	9
<i>Berberis vulgaris</i>	common barberry	0	0	0	1
<i>Cardamine impatiens</i>	narrowleaf bittercress	1	1	4	7
<i>Celastrus orbiculatus</i>	Asian bittersweet	8	7	8	8
<i>Elaeagnus angustifolia</i>	Russian olive	0	0	1	0
<i>Euonymus alatus</i>	burningbush	6	6	8	8
<i>Euonymus fortunei</i>	wintercreeper	1	1	3	5
<i>Ligustrum</i> spp.	privet	0	1	2	2
<i>Lonicera</i> spp.	exotic bush honeysuckle	0	0	0	3
<i>Lonicera japonica</i>	Japanese honeysuckle	1	4	4	4
<i>Microstegium vimineum</i>	Japanese stiltgrass	1	2	5	5
<i>Rosa multiflora</i>	multiflora rose	5	6	5	6
<i>Rubus phoenicolasius</i>	wine raspberry	0	2	2	4
<i>Viburnum sieboldii</i>	Siebold's arrowwood	0	0	0	1
<i>Vincetoxicum nigrum</i>	black swallow-wort	1	2	2	2

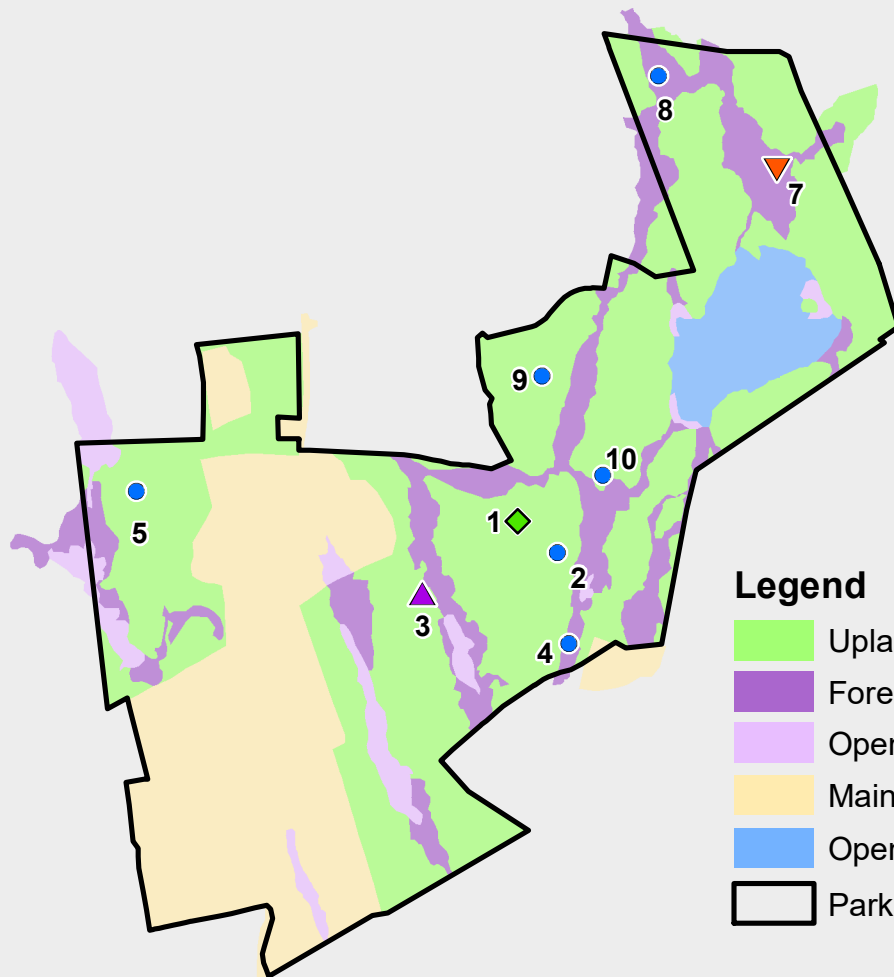
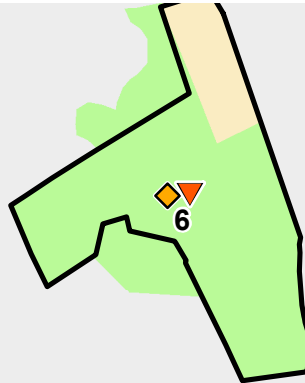


Map 9. Forest Pest/Pathogen Detections

Detections of priority forest pests in forest plots sampled during the most recent survey cycle (2019 & 2022). Plots are sampled in an alternating panel with plots 1-5 sampled in 2019 and plots 6-10 sampled in 2022. Plots with multiple pests present (e.g. 6) have multiple symbols. Note that BLD may be more widespread than map indicates, as plots 1-5 were sampled prior to the detection in 2022. Date: 8/23/2022.

Legend

- ▼ Beech Leaf Disease (BLD)
- ◆ Beech Bark Disease (BBD)
- ▲ Emerald Ash Borer (EAB)
- ◆ Hemlock Woolly Adelgid (HWA)
- No Detections



Legend

- Upland Forest
- Forested Wetland
- Open Wetland
- Maintained/ Open Lands
- Open Water
- Park boundary

0 0.125 0.25 0.5 Kilometers



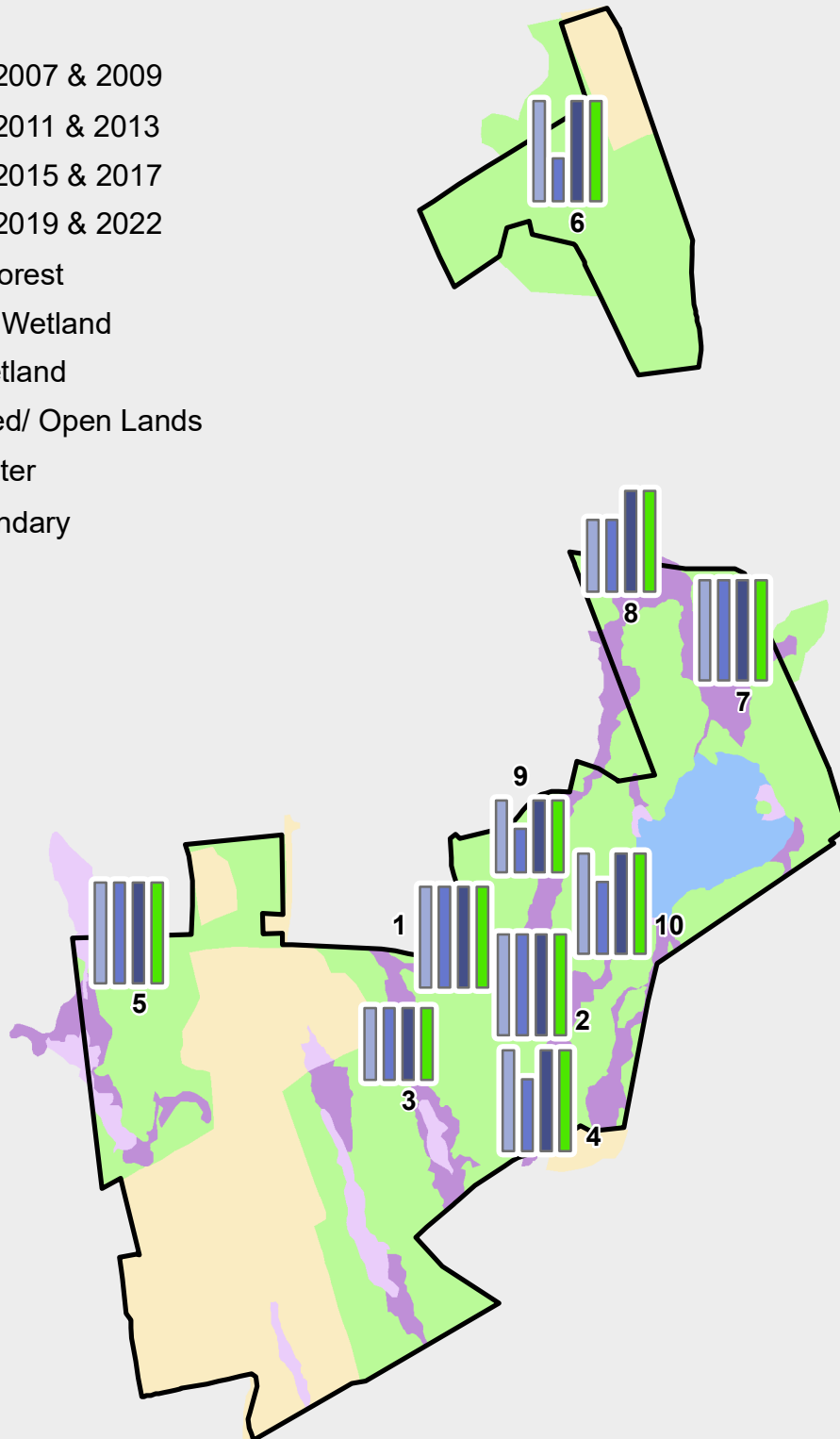


Map 10. Canopy Cover by Cycle

Trends in tree canopy cover in forest plots sampled from 2007-2022. Plots are sampled in an alternating panel, with plots 1-5 sampled in 2007, 2011, 2015, and 2019, and plots 6-10 sampled in 2009, 2013, 2017, and 2022. Canopy cover ranges from 25 - 50% to >75%. Date: 8/23/2022.

Legend

-  Cycle 1: 2007 & 2009
-  Cycle 2: 2011 & 2013
-  Cycle 3: 2015 & 2017
-  Cycle 4: 2019 & 2022
-  Upland Forest
-  Forested Wetland
-  Open Wetland
-  Maintained/ Open Lands
-  Open Water
-  Park boundary



0 0.125 0.25 0.5 Kilometers



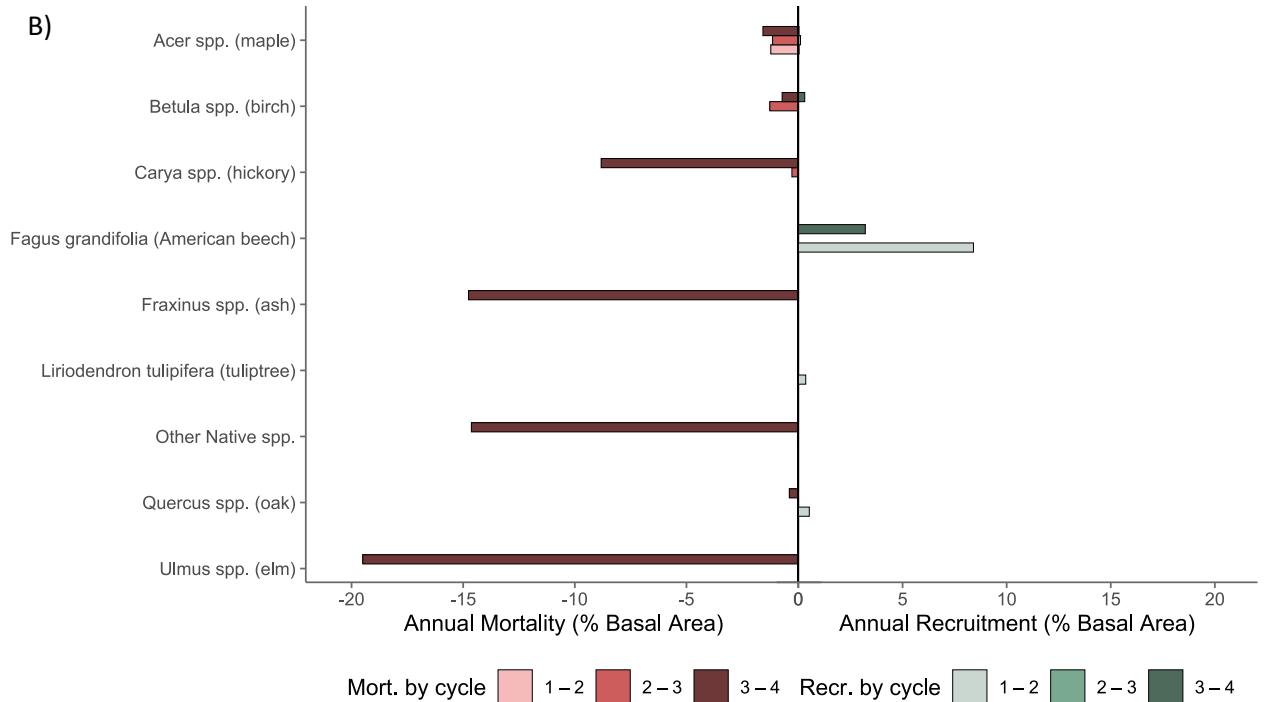
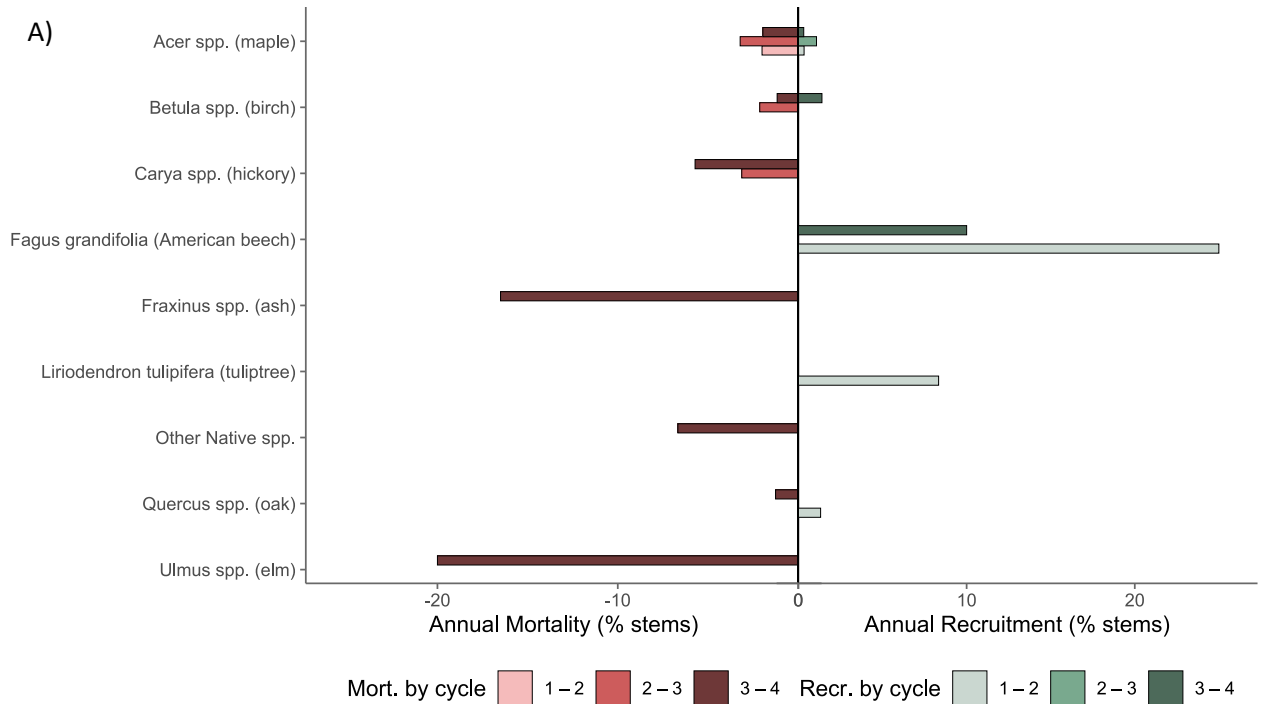


Figure 2. Annual tree mortality and recruitment rates by cycle in Weir Farm National Historical Park. Figure A represents % of stems that died (mortality) and the % of stems gained (recruitment) per year from the previous cycle. Figure B is the % of basal area per year that died or was gained from the previous cycle.

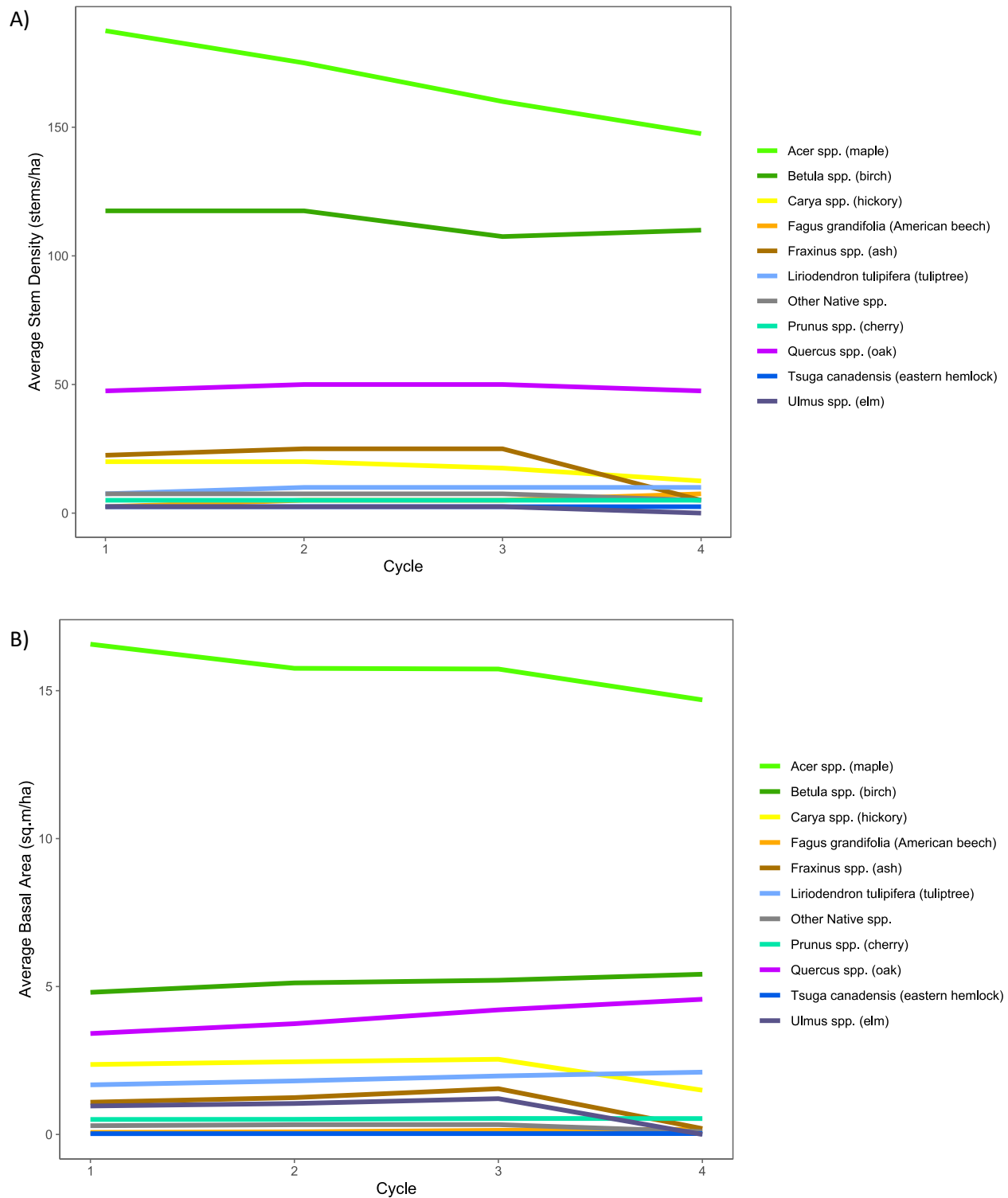


Figure 3. Change in stem density (A) and basal area (B) by species and cycle in Weir Farm National Historical Park. Cycle 1 = 2006 – 2009; Cycle 2 = 2010 – 2013; Cycle 3 = 2014 – 2017; Cycle 4 = 2018 – 2022.