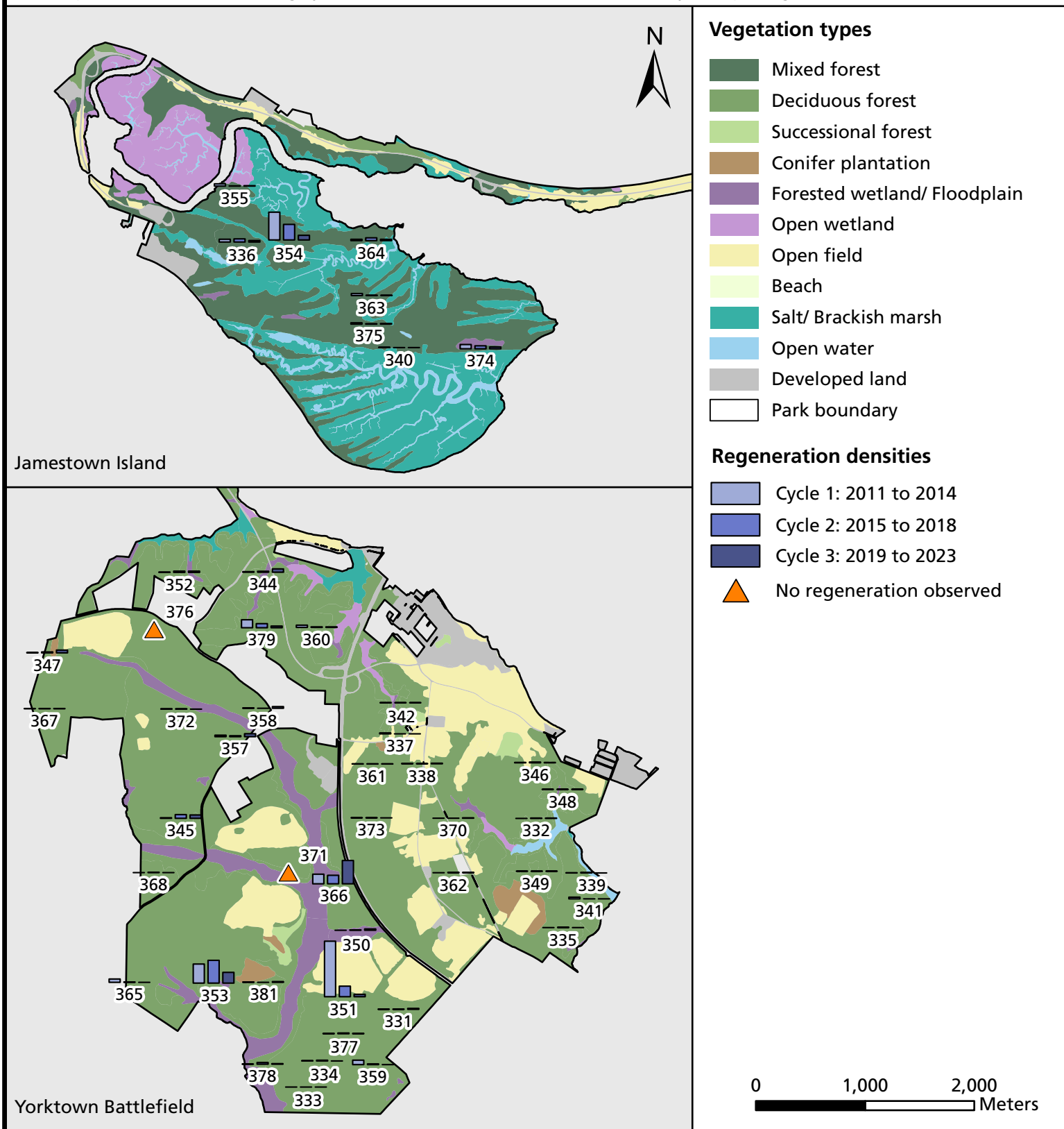




Map 1. Tree Regeneration by Cycle

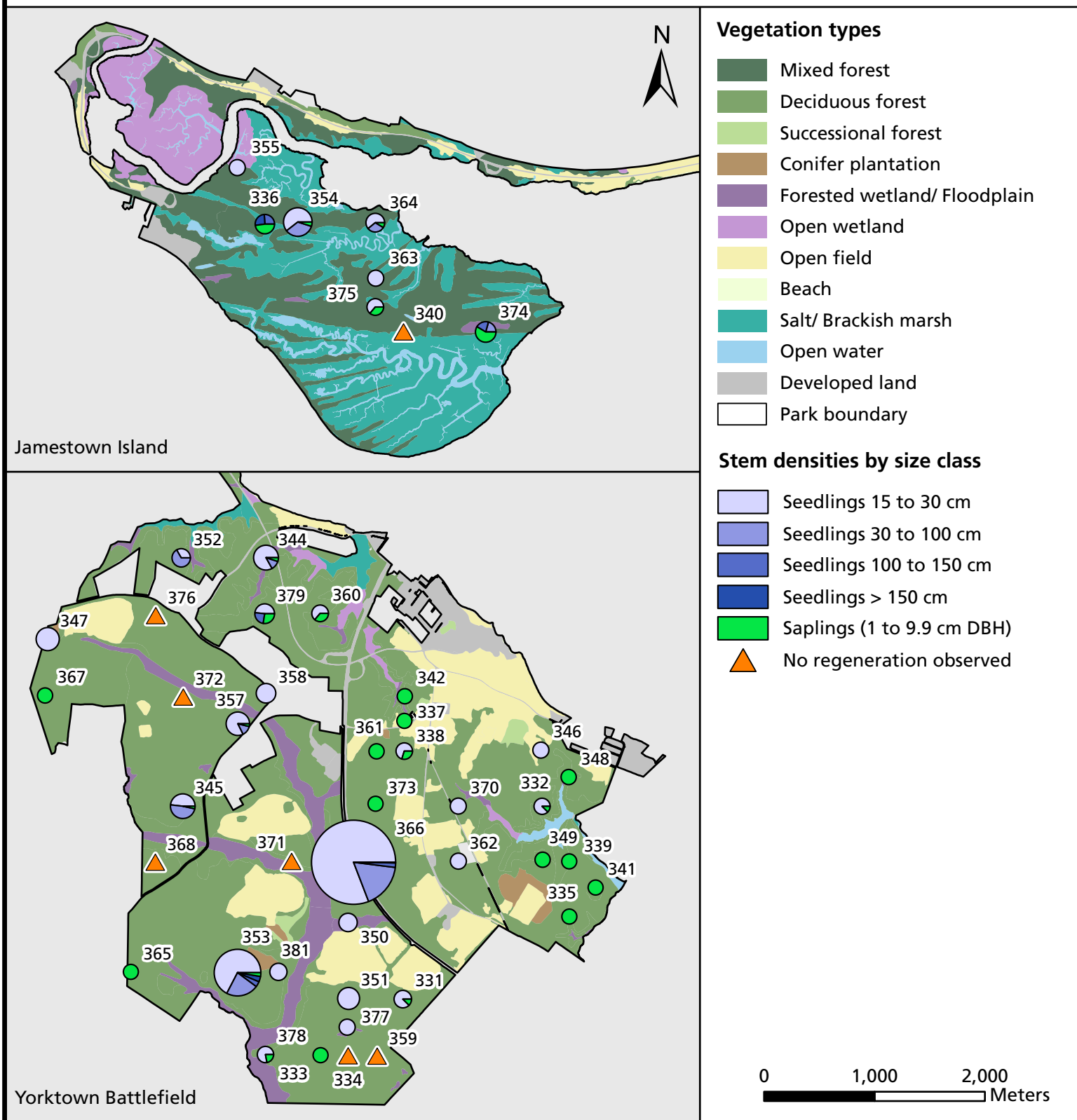
Trends in tree regeneration, including seedlings and saplings, observed in forest plots sampled from 2011-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Densities range from 0 to 11.5 stems/m², and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 2. Tree Regeneration by Size Class

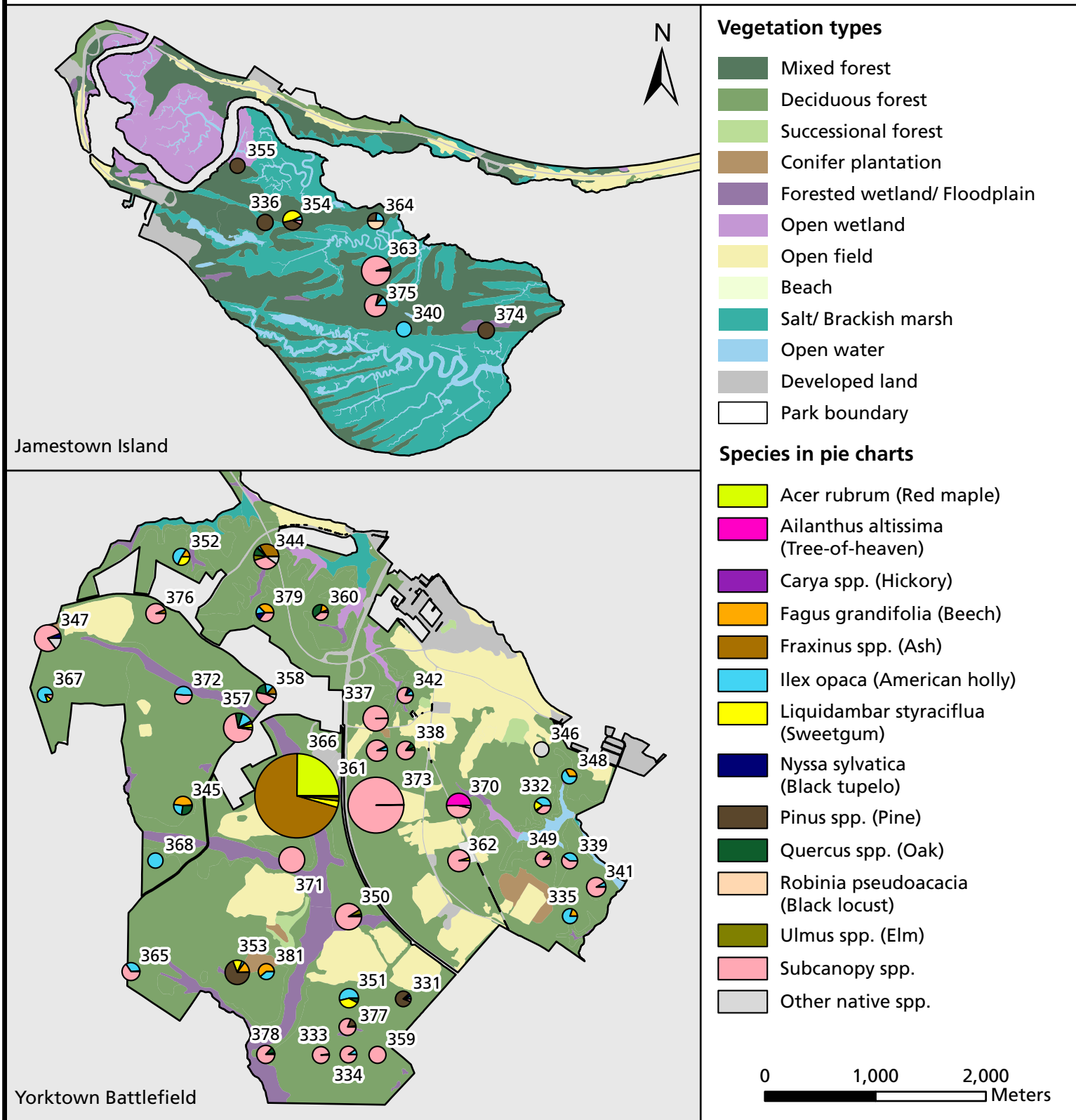
Tree regeneration stem densities by size class in forest plots from the most recent census (2019-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level regeneration density. Pies may be shifted to prevent overlap. Total densities range from 0 to 4.8 stems/m² and only include native canopy-forming species. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 3. Tree Regeneration Composition

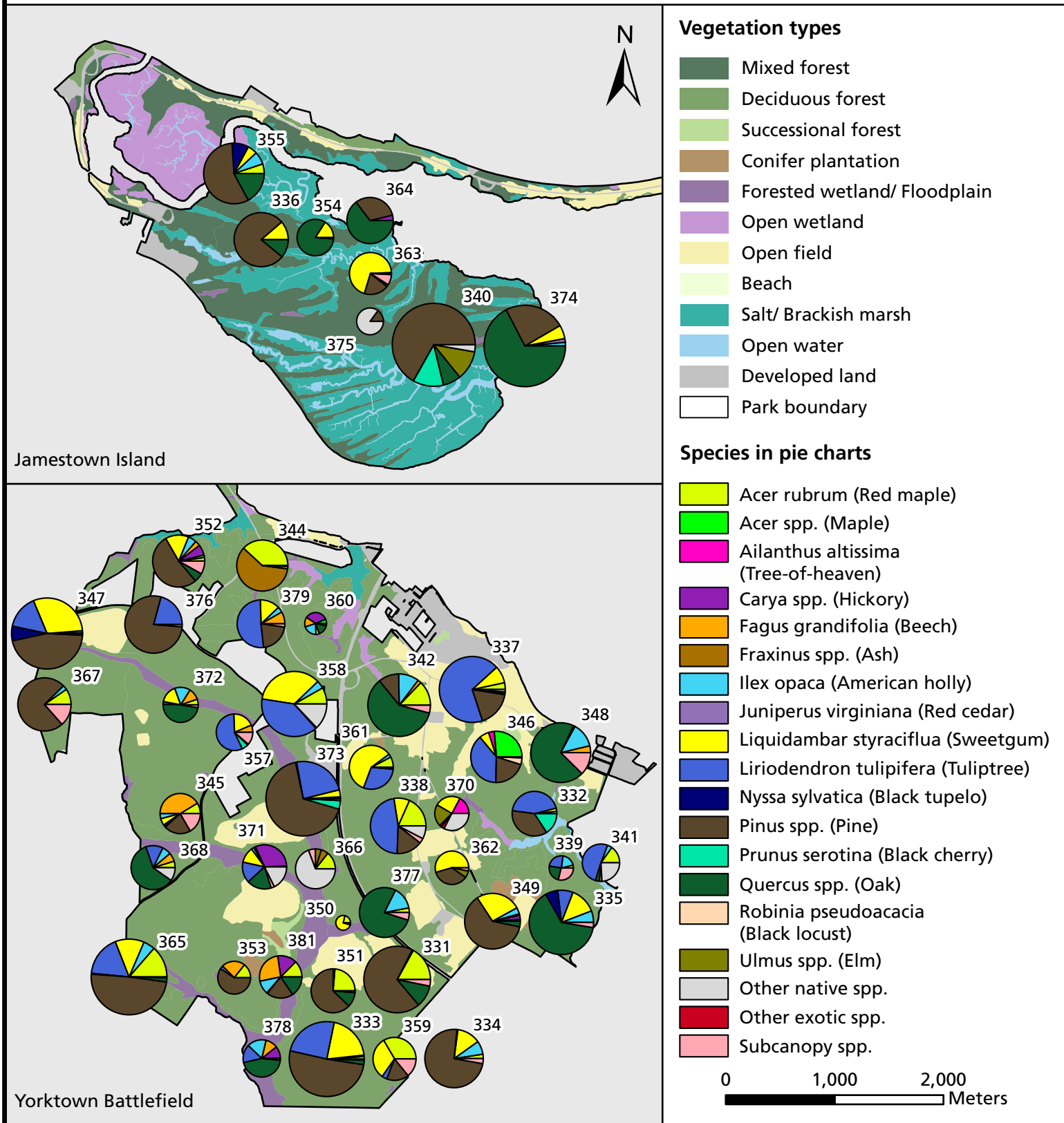
Tree regeneration, including seedlings and saplings, by species group observed in forest plots sampled in the most recent census (2019-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level regeneration density. Pies may be shifted to prevent overlap. Total densities range from 0.06 to 4.8 stems/m² and includes all species. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 4. Tree Canopy Composition

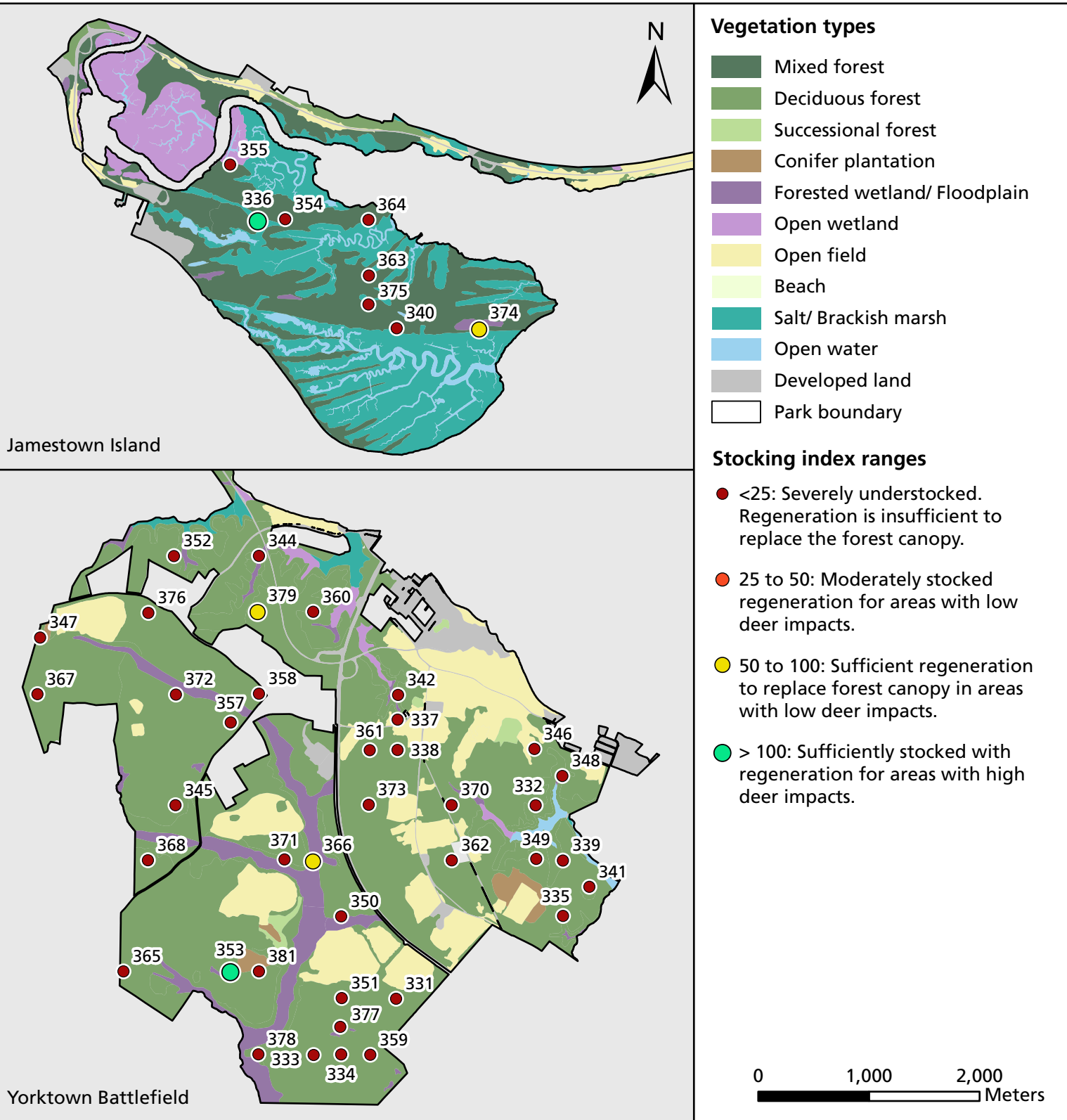
Tree composition, by species group, observed in forest plots sampled in the most recent census (2019-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level basal areas. Pies may be shifted to prevent overlap. Total basal area ranges from 4.5 to 67.6 m²/ha. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/11/2023.





Map 5. Tree Regeneration Stocking Index

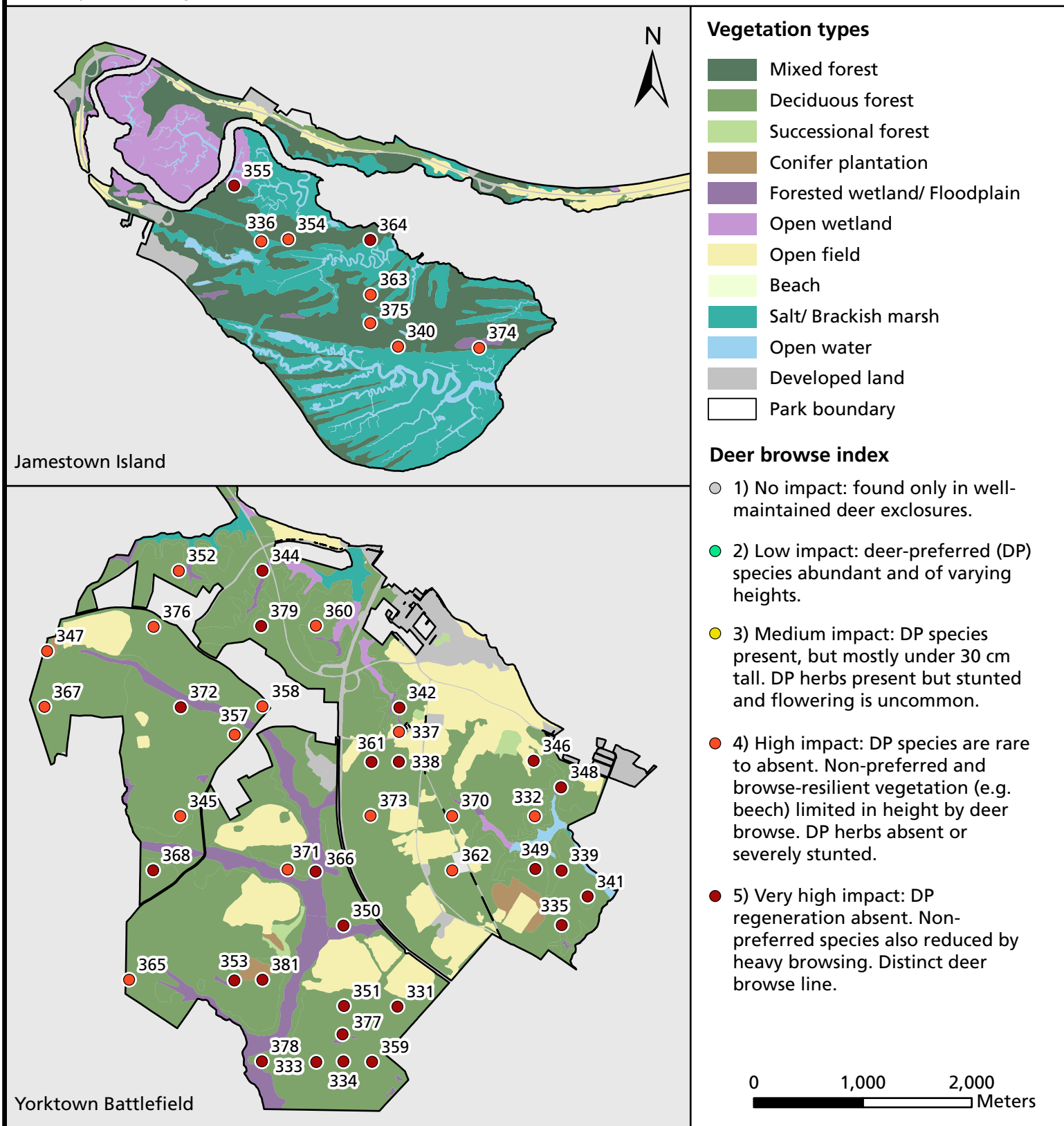
Regeneration stocking index for the most recent census (2019-2023). This index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights and quantifies whether current regeneration densities are sufficient to restock a forest canopy. Stocking index is reported at a 2-m scale to maintain consistency with other regional publications (range 0-112.1). Only native canopy-forming species included. See Table 1 for stocking index values. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 6. Index of Deer Browse Impacts

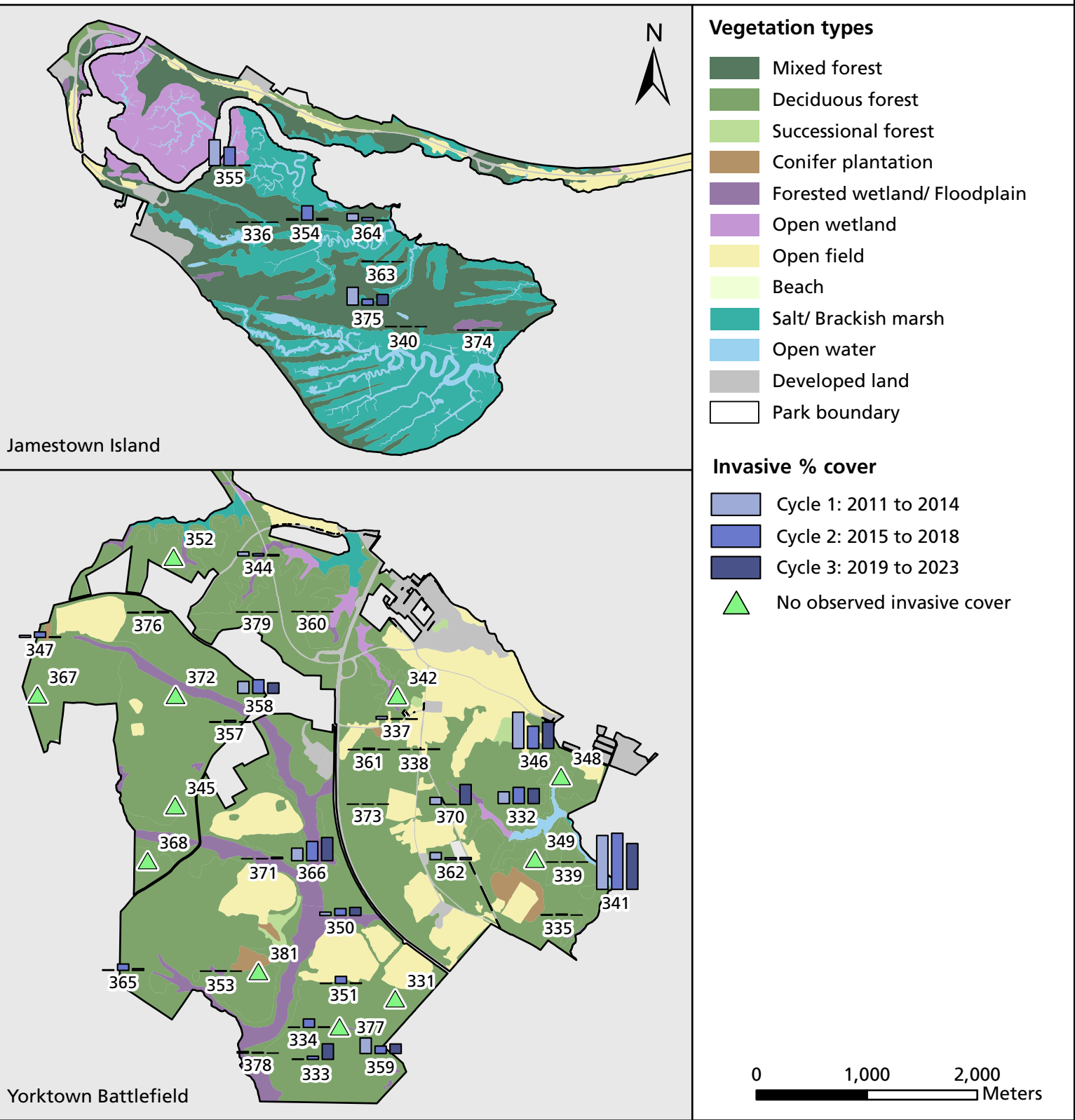
Index of deer browse impacts observed in forest plots in the most recent census (2019-2023). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Deer browse impacts are assessed on a scale of 1-5, with 1 representing no impact and 5 representing severe impacts. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/11/2023.





Map 7. Invasive % Cover by Cycle

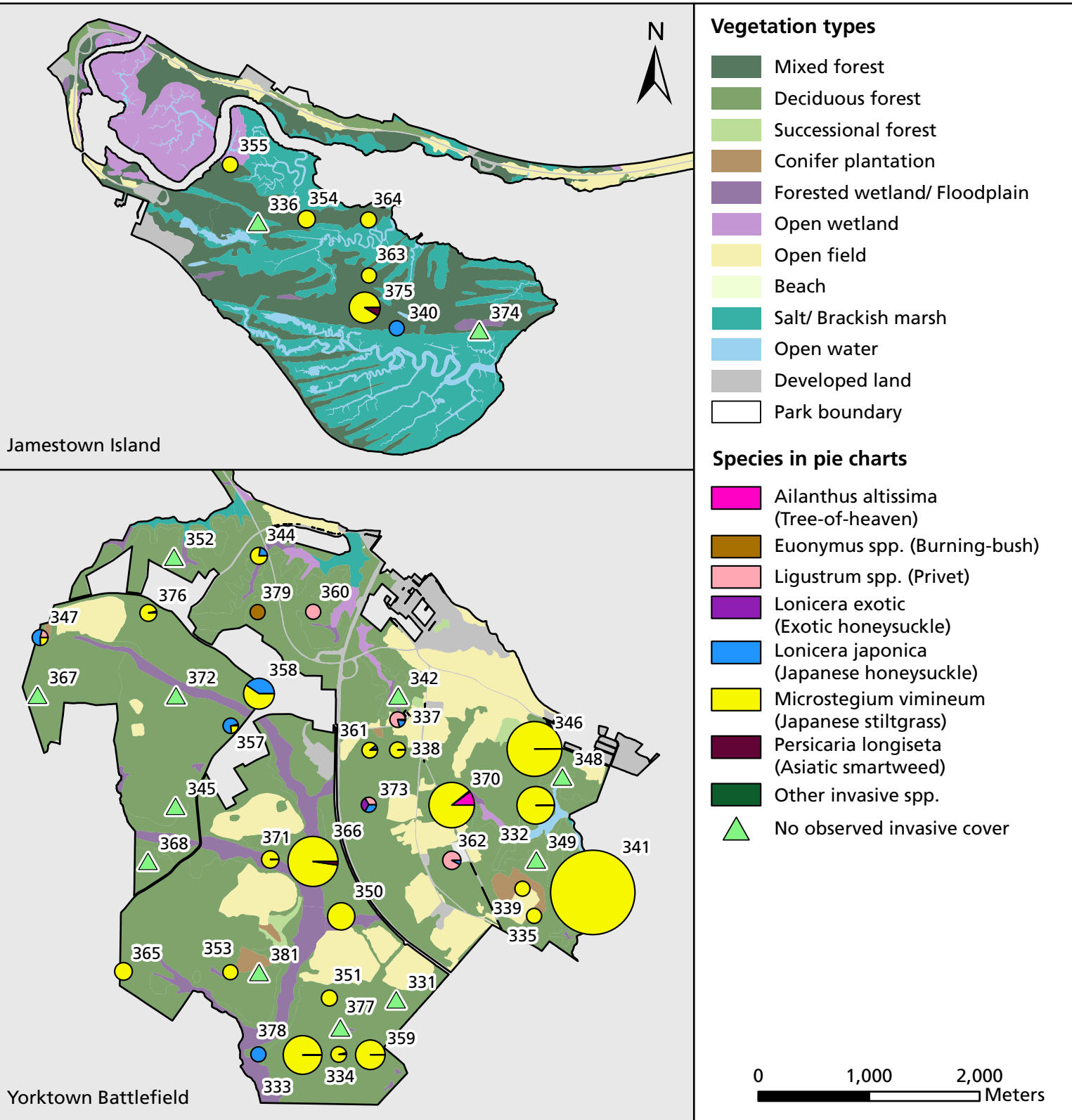
Trends in percent cover of invasive species observed in quadrats in forest plots sampled from 2011-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Average invasive cover per plot ranges from 0 to 56.7%. See Table 2 for % cover values. 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. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 8. Invasive % Cover by Species

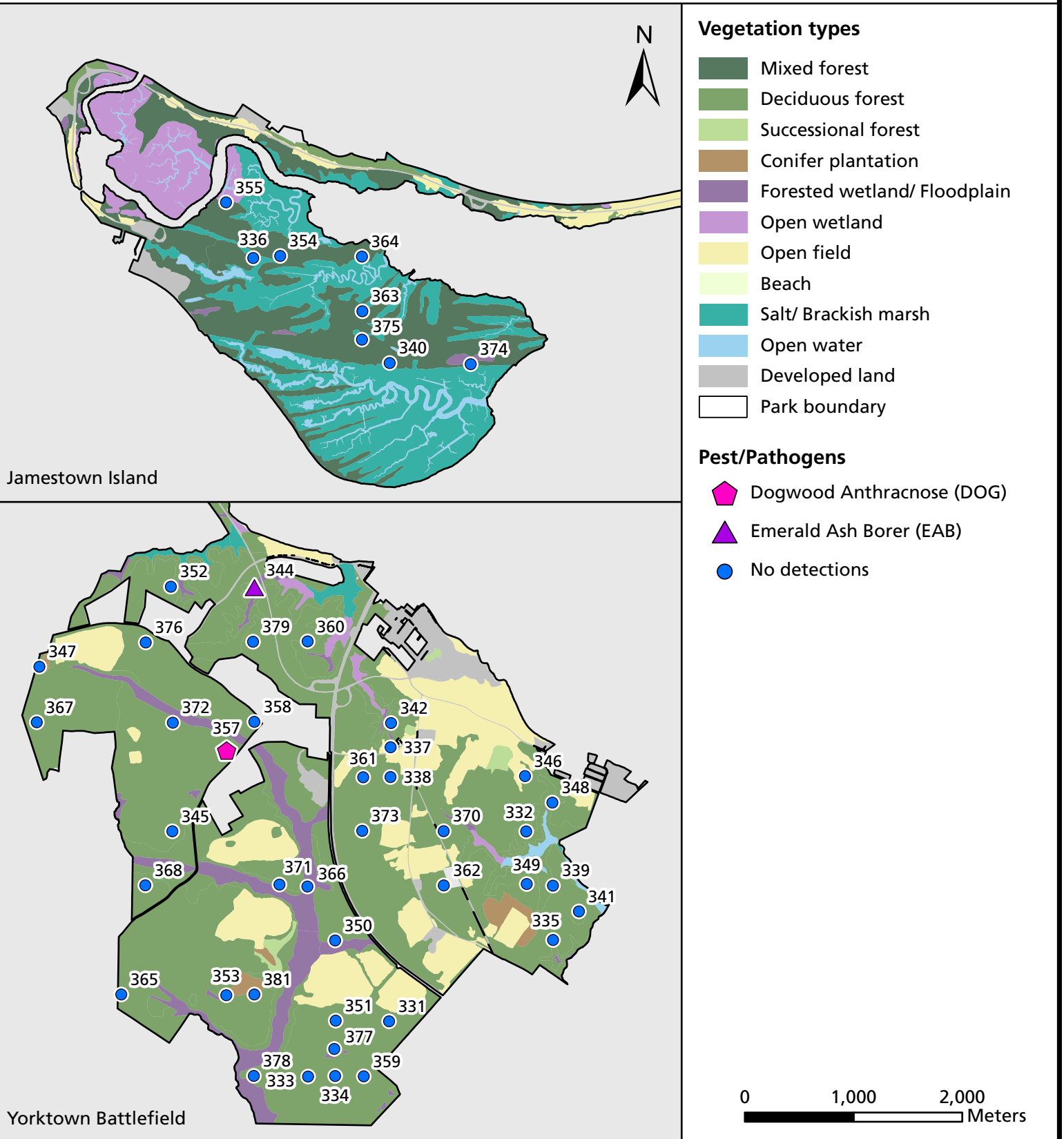
Percent invasive cover by species observed in quadrats in forest plots sampled in the most recent census (2019-2023). The top 10 species or genera by % cover are displayed individually, less common species are grouped as 'Other invasive spp.'. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pies may be shifted to prevent overlap. Average invasive cover ranges from 0 to 46.2% for total invasive cover. See Table 3 for more information. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 9. Forest Pest/Pathogen Detections

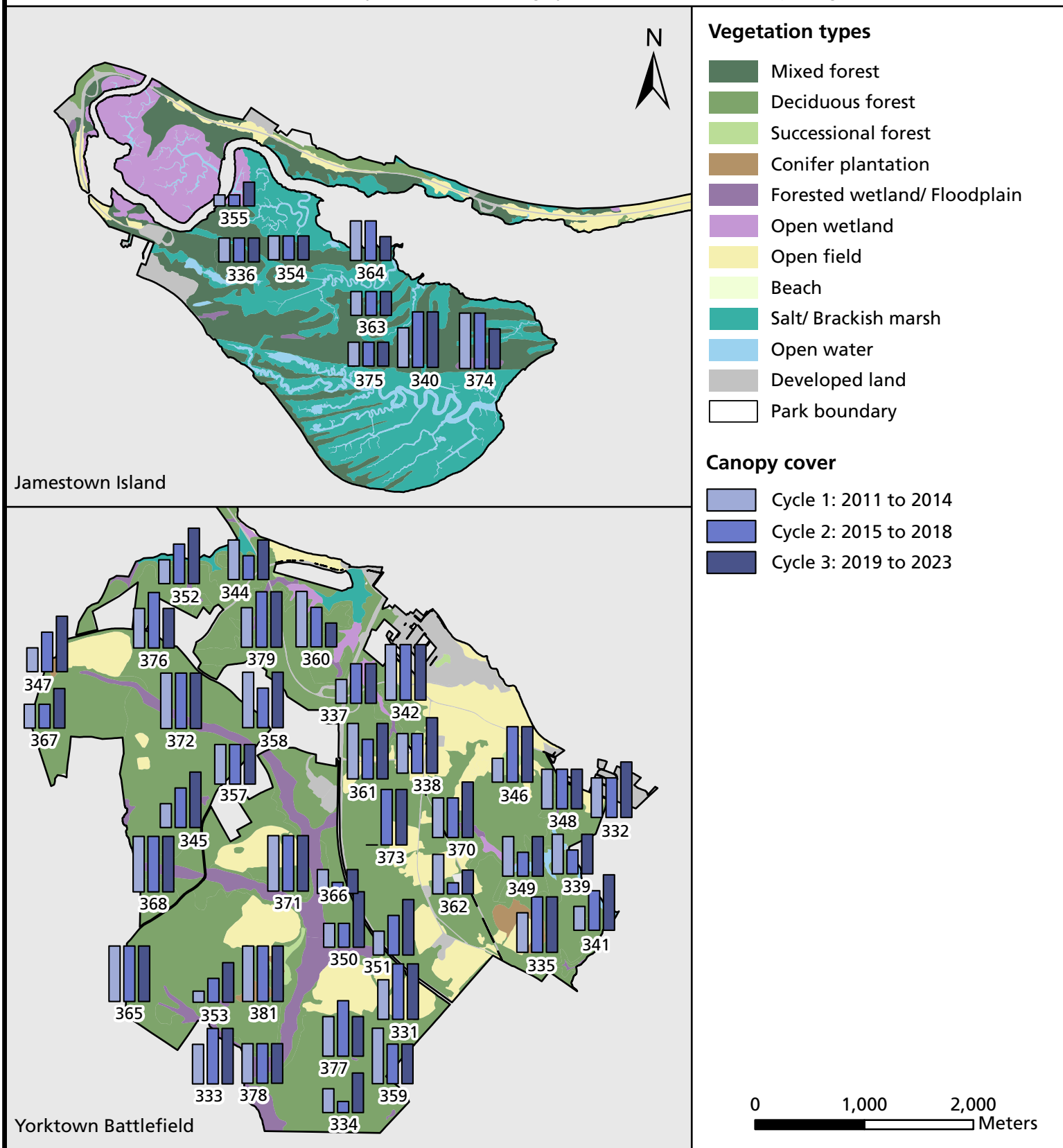
Detection of priority forest pests in forest plots sampled during the most recent census (2019-2023). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.





Map 10. Canopy Cover by Cycle

Trends in tree canopy in forest plots from 2011-2023. 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 10 - 25% to >75%. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Plot 373 is missing Cycle 1 crown closure data. Reporting Date: 12/15/2023.





Map 11. Ash Tree Density by Cycle

Trends in live ash tree density in forest plots sampled from 2011-2023. 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 15 stems/400m² and only include individuals >10 cm DBH. Note that plot 380 was last sampled in 2014 due to flooding by beaver dam and was not included in this analysis. Reporting Date: 12/15/2023.



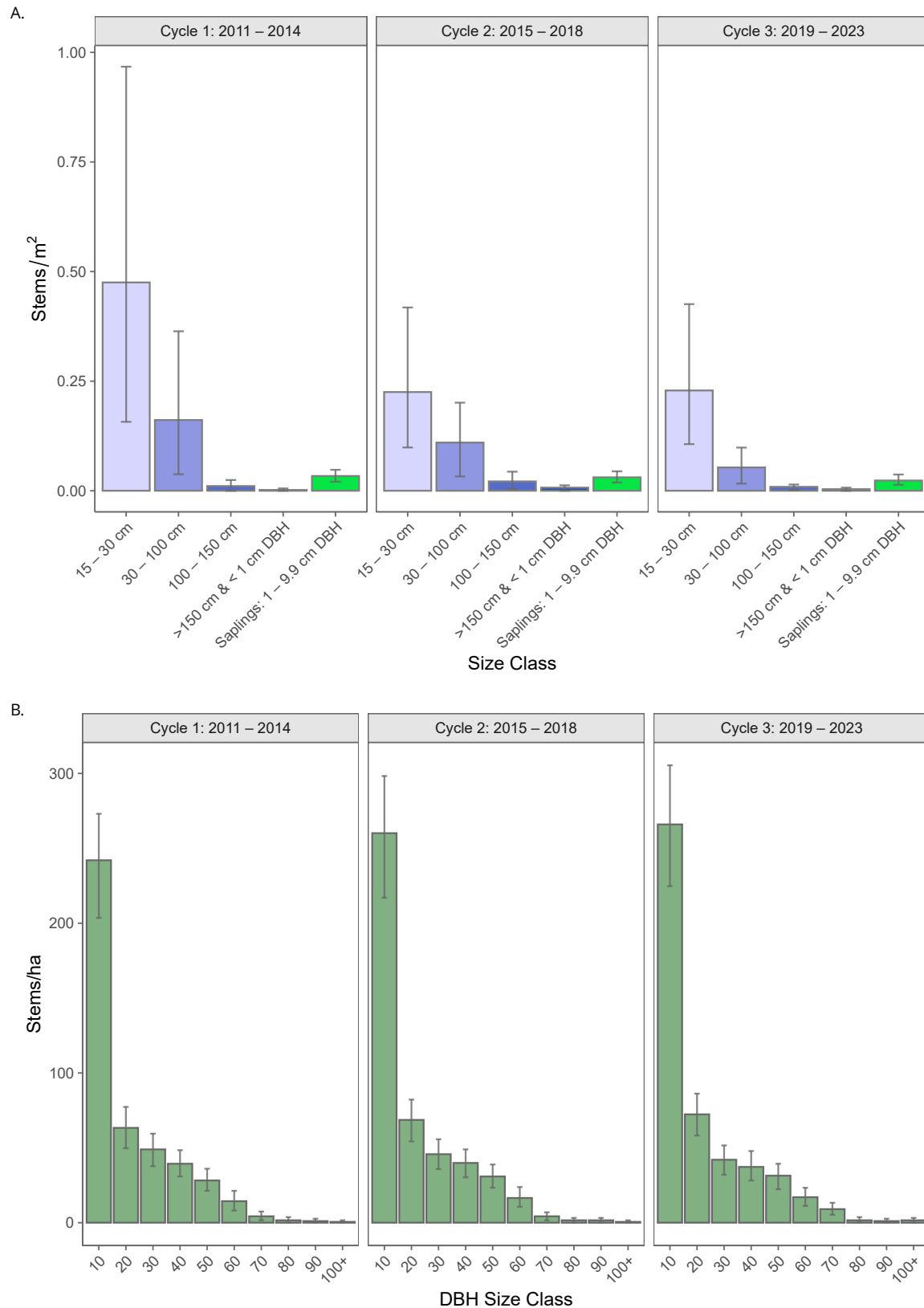


Figure 1. Stem density distributions by cycle in Colonial National Historical Park (COLO). Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 2019 – 2023. Figure A shows regeneration densities by size class. Figure B shows tree density by diameter at breast height (DBH) increments. Error bars are 95%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

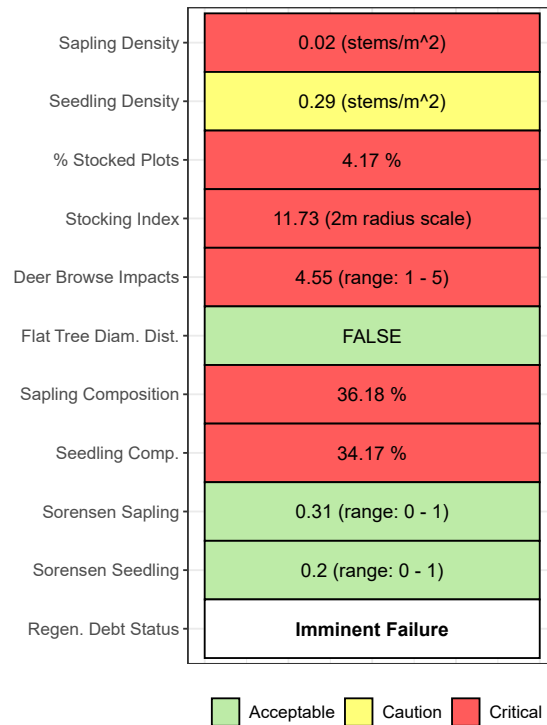


Figure 2. Regeneration Debt status for the most recent 4-year census (2019 – 2023) in Colonial National Historical Park (COLO). Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. Sapling/Seedling 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>).

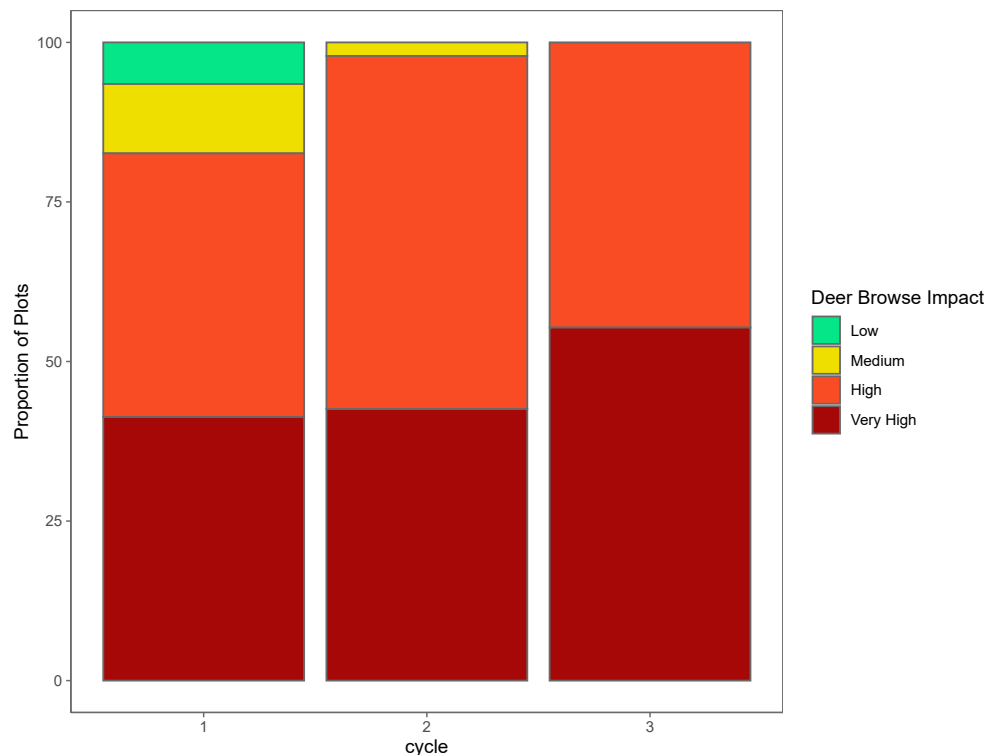


Figure 3. Deer browse impacts by cycle in Colonial National Historical Park (COLO). Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 2019 – 2023.

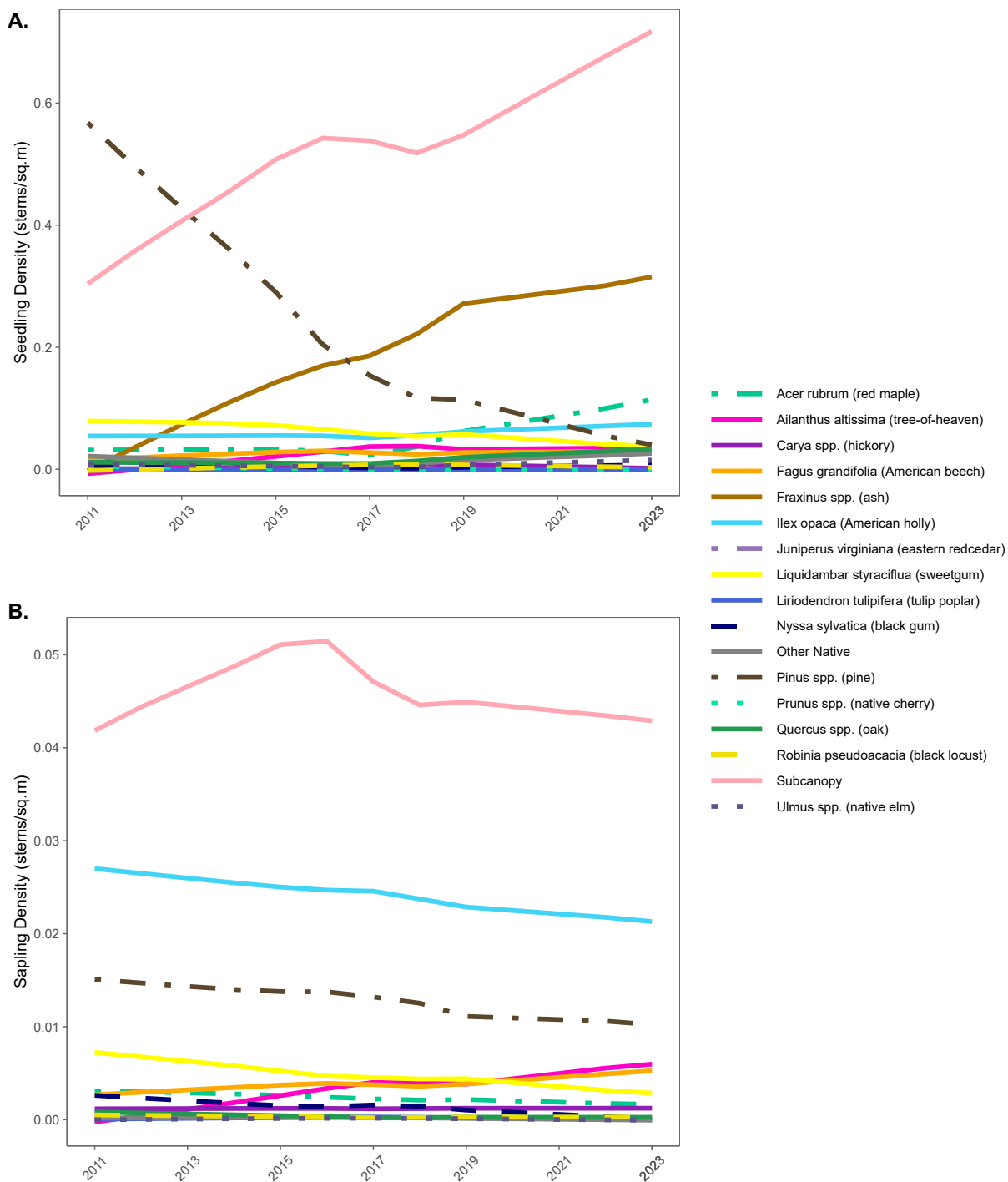


Figure 4. Loess smoothed changes in stem density for seedlings (A) and saplings (B) by species group and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

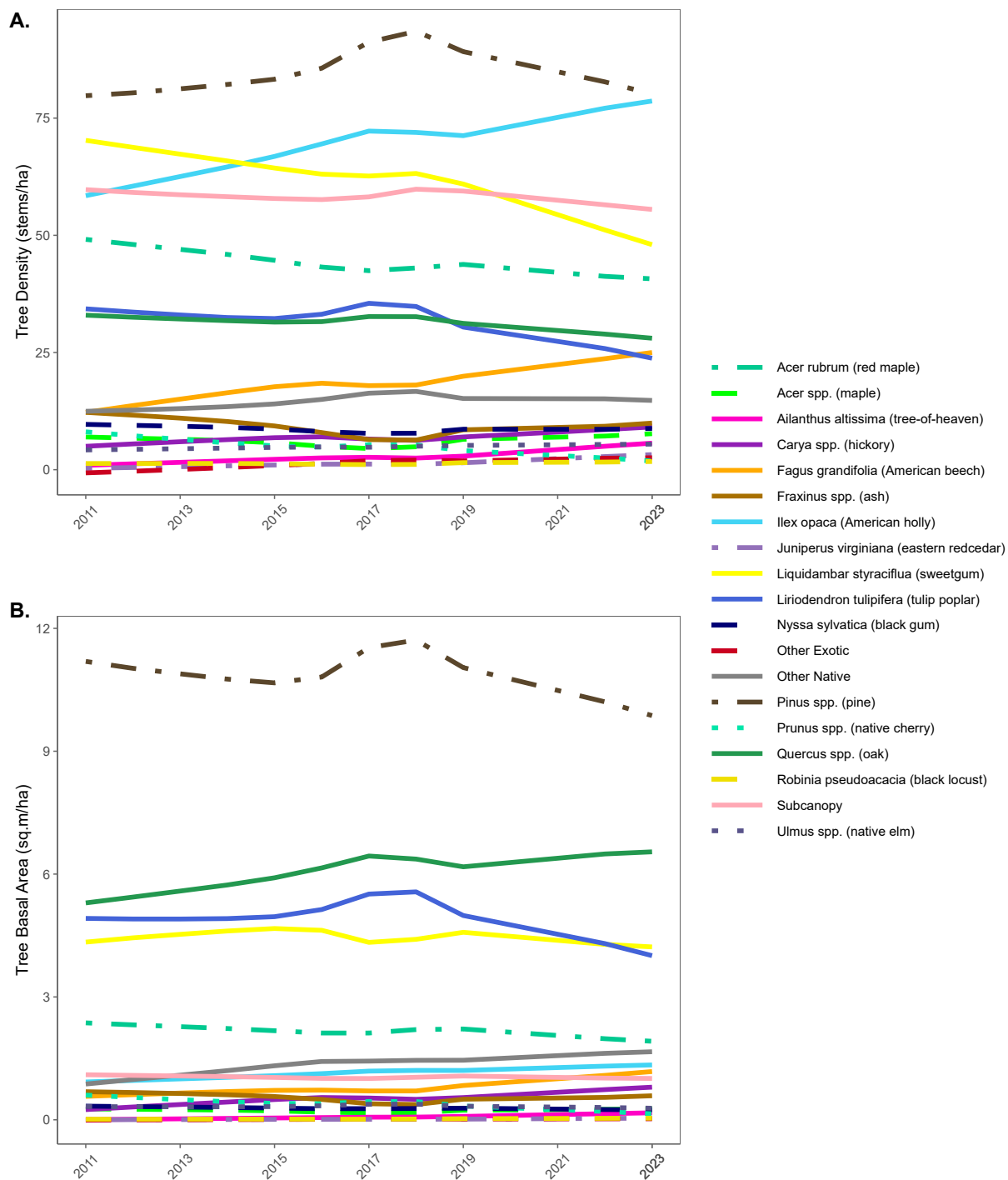


Figure 5. Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

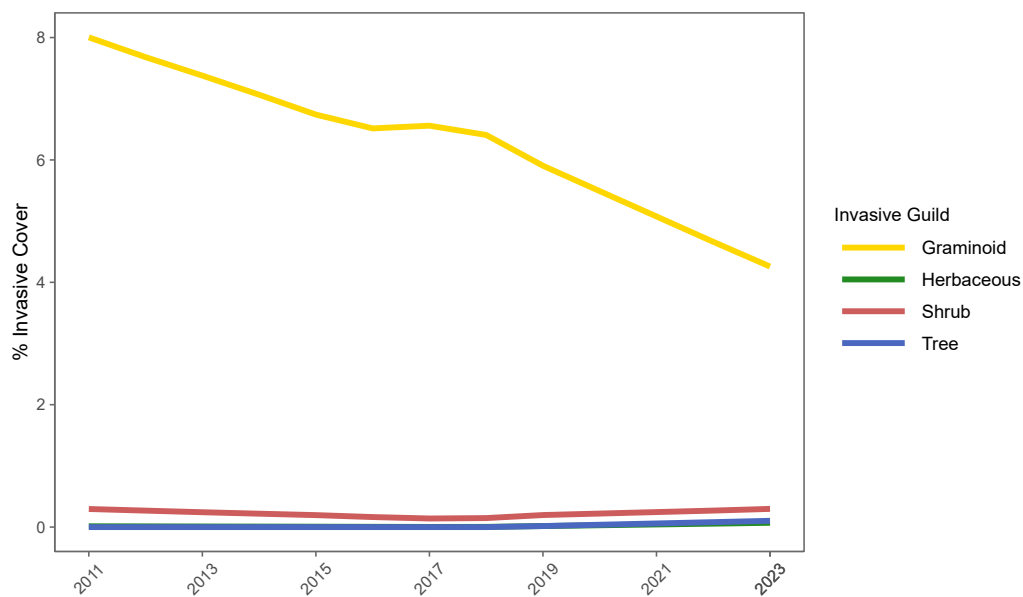


Figure 6. Loess smoothed changes in invasive plant percent cover by guild and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.



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: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 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 1	Cycle 2	Cycle 3	Cycle 1	Cycle 2	Cycle 3
331	1	0.00	0.00	0.17	0.05	0.05	0.02	0.00	0.00	2.14
332	1	0.00	0.08	0.08	0.01	0.01	0.01	7.41	8.42	8.42
333	1	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
334	1	0.08	0.17	0.00	0.00	0.00	0.00	2.14	2.14	0.00
335	1	0.00	0.08	0.00	0.01	0.01	0.01	0.00	1.01	0.00
336	1	0.33	0.42	0.17	0.24	0.22	0.15	120.13	165.12	102.92
337	1	0.17	0.00	0.00	0.02	0.01	0.01	2.14	0.00	0.00
338	1	0.00	0.00	0.08	0.06	0.05	0.04	7.41	0.00	1.01
339	1	0.00	0.08	0.00	0.02	0.02	0.01	7.41	8.42	0.00
340	1	0.08	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.00
341	1	0.33	0.00	0.00	0.01	0.01	0.01	4.15	0.00	0.00
342	1	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00
344	2	0.08	0.17	0.67	0.02	0.04	0.04	8.42	9.55	9.42
345	2	0.08	0.75	0.67	0.04	0.04	0.02	8.42	17.84	12.57
346	2	0.08	0.17	0.08	0.01	0.00	0.00	1.01	2.14	1.01
347	2	0.08	0.17	0.58	0.01	0.01	0.00	1.01	2.14	7.29
348	2	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00
349	2	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00
350	2	0.00	0.08	0.25	0.00	0.00	0.00	0.00	1.01	3.14
351	2	11.50	2.17	0.50	0.00	0.00	0.00	178.07	60.70	6.28
352	2	0.08	0.25	0.25	0.00	0.00	0.00	1.01	3.14	5.28
353	2	3.92	4.67	2.17	0.05	0.06	0.06	50.27	98.52	112.09
354	2	5.67	3.08	0.92	0.09	0.12	0.05	208.85	221.55	23.12
355	2	0.33	0.00	0.08	0.13	0.04	0.00	21.11	0.00	1.01
357	3	0.25	0.17	0.58	0.05	0.04	0.02	10.56	9.55	15.83
358	3	0.08	0.00	0.33	0.00	0.00	0.00	1.01	0.00	4.15
359	3	0.92	0.17	0.00	0.00	0.00	0.00	16.71	4.15	0.00
360	3	0.42	0.08	0.08	0.06	0.05	0.05	20.11	8.42	8.42
361	3	0.00	0.00	0.00	0.04	0.04	0.02	0.00	0.00	0.00
362	3	0.00	0.08	0.08	0.00	0.00	0.00	0.00	2.14	1.01



Table 1 (cont.). 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: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 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 1	Cycle 2	Cycle 3	Cycle 1	Cycle 2	Cycle 3
363	3	0.42	0.08	0.08	0.00	0.00	0.00	7.29	2.14	1.01
364	3	0.17	0.50	0.25	0.12	0.07	0.02	69.24	69.24	4.15
365	3	0.67	0.08	0.00	0.01	0.01	0.01	9.42	1.01	0.00
366	3	2.00	1.75	4.83	0.01	0.01	0.01	27.27	25.13	91.11
367	3	0.00	0.00	0.00	0.04	0.04	0.02	0.00	0.00	0.00
368	3	0.00	0.08	0.00	0.00	0.00	0.00	0.00	1.01	0.00
370	4	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	1.01
371	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
372	4	0.08	0.08	0.00	0.01	0.01	0.00	8.42	8.42	0.00
373	4	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00
374	4	0.75	0.42	0.17	0.14	0.19	0.24	35.81	91.61	74.90
375	4	0.17	0.00	0.08	0.12	0.09	0.05	53.91	7.41	1.01
376	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
377	4	0.08	0.17	0.08	0.00	0.00	0.00	2.14	2.14	1.01
378	4	0.00	0.33	0.08	0.02	0.02	0.02	0.00	5.28	1.01
379	4	1.58	0.75	0.25	0.08	0.08	0.09	82.06	151.05	60.07
381	4	0.08	0.00	0.17	0.00	0.00	0.00	1.01	0.00	2.14



Table 2. Average % cover and number of invasive species detected in each plot by cycle. Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 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 1	Cycle 2	Cycle 3
331	1	0.00	0.00	0.00	0	0	0
332	1	11.92	16.50	15.03	3	4	3
333	1	0.43	3.25	15.77	2	2	2
334	1	0.17	8.50	0.45	2	2	2
335	1	0.32	0.90	0.02	2	2	3
336	1	0.00	0.01	0.00	1	1	2
337	1	2.77	0.48	0.36	3	3	3
338	1	0.02	0.01	0.63	3	2	3
339	1	0.00	0.01	0.02	1	1	1
340	1	0.00	0.01	0.01	0	2	3
341	1	54.39	56.68	46.21	2	3	3
342	1	0.00	0.00	0.00	0	1	2
344	2	3.94	2.17	1.32	3	4	4
345	2	0.00	0.00	0.00	0	0	0
346	2	36.70	22.50	26.51	3	3	3
347	2	2.01	5.45	0.59	3	3	3
348	2	0.00	0.00	0.00	0	0	0
349	2	0.00	0.00	0.00	1	3	1
350	2	3.44	7.03	8.14	2	2	2
351	2	0.29	7.09	0.62	1	2	1
352	2	0.00	0.00	0.00	0	1	0
353	2	0.01	0.31	0.01	1	1	2
354	2	1.38	14.40	1.58	2	2	3
355	2	26.17	18.77	0.45	2	2	5
357	3	0.15	1.77	0.25	4	3	3
358	3	12.10	13.83	10.51	4	3	4
359	3	15.74	7.63	9.68	2	2	2
360	3	0.14	0.03	0.01	1	1	2
361	3	0.16	1.51	0.47	3	3	3
362	3	7.14	1.82	2.15	3	3	3



Table 2 (cont.). Average % cover and number of invasive species detected in each plot by cycle. Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 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 1	Cycle 2	Cycle 3
363	3	0.59	0.00	0.01	2	0	2
364	3	7.09	3.14	0.65	1	2	1
365	3	0.56	6.46	1.72	2	2	2
366	3	12.63	19.52	23.35	3	3	3
367	3	0.00	0.00	0.00	0	0	0
368	3	0.00	0.00	0.00	0	0	0
370	4	7.13	0.14	20.27	4	4	5
371	4	0.03	0.02	1.59	2	2	3
372	4	0.00	0.00	0.00	0	0	1
373	4	0.03	0.02	0.03	2	2	3
374	4	0.02	0.00	0.00	1	1	1
375	4	17.90	5.97	10.70	3	4	5
376	4	0.18	1.21	1.29	3	3	2
377	4	0.00	0.00	0.00	1	0	0
378	4	1.49	0.67	0.01	3	2	3
379	4	0.00	0.00	0.01	0	1	2
381	4	0.00	0.00	0.00	1	0	0



Table 3. Number of plots out of 48 where priority invasive species were detected. Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 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
<i>Ailanthus altissima</i>	Tree of heaven	2	2	4
<i>Euonymus</i>	burningbush	0	0	2
<i>Ligustrum</i>	privet	16	17	21
<i>Lonicera - Exotic</i>	honeysuckle - exotic	0	1	3
<i>Lonicera japonica</i>	Japanese honeysuckle	26	27	31
<i>Microstegium vimineum</i>	Japanese stiltgrass	34	35	34
<i>Persicaria longiseta</i>	Oriental lady's thumb	3	2	4
<i>Rosa multiflora</i>	multiflora rose	1	3	2



Table 4. Invasive plant and pest/pathogen early detections in Colonial National Historical Park observed in the most recent census of each plot. Coordinates are in UTM NAD83 Zone 18N.

Plot	Year	X	Y	Latin Name	Common Name	Type
COLO-373	2023	365846	4120054	<i>Lonicera - Exotic</i>	honeysuckle - exotic	shrub
COLO-375	2023	344349	4118785	<i>Lonicera - Exotic</i>	honeysuckle - exotic	shrub
COLO-370	2023	366595	4120051	<i>Lonicera - Exotic</i>	honeysuckle - exotic	shrub
COLO-344	2022	364854	4122302	<i>Agrilus planipennis</i>	emerald ash borer	pest