

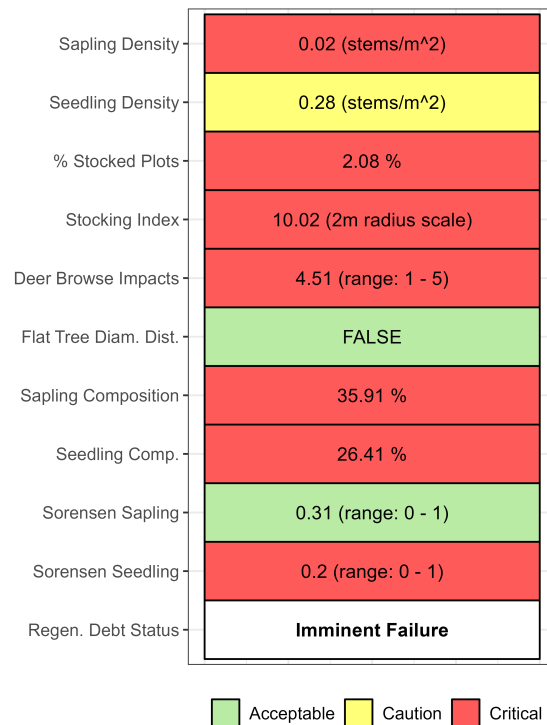


Figure 1. Regeneration Debt status for the most recent 4-year census (2022 – 2024) in Colonial National Historical Park (COLO). Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. Sapling/Seedling 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>).

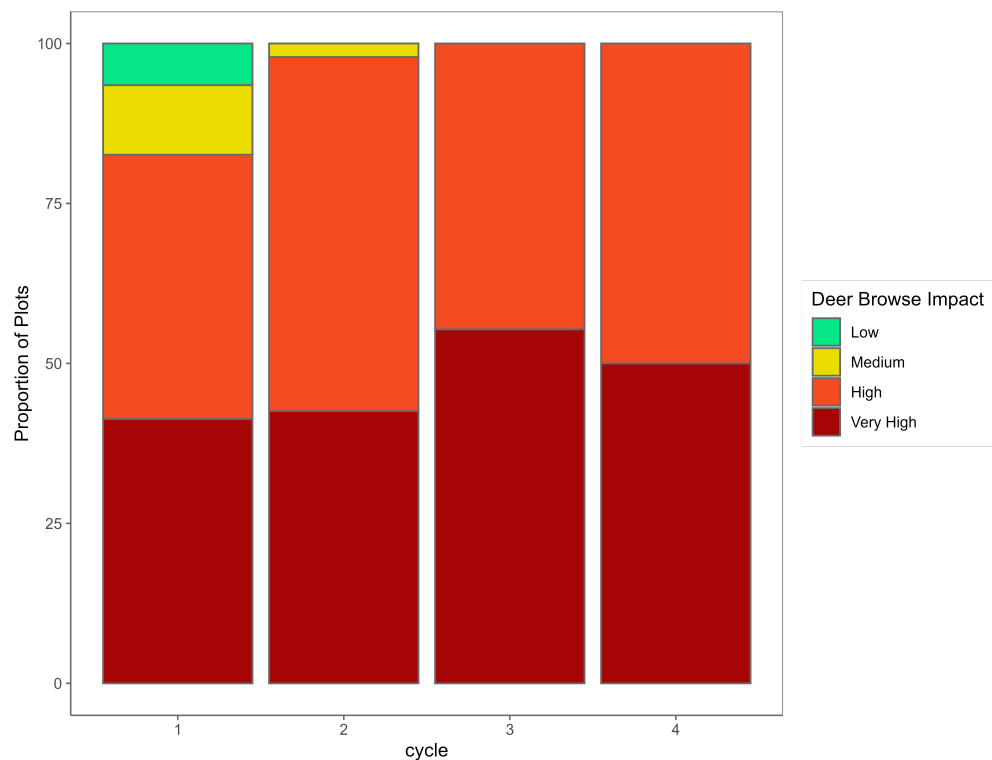


Figure 2. Deer browse impacts by cycle in Colonial National Historical Park (COLO). Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 2019 – 2023; Cycle 4: 2024. **Note that Cycle 4 only partially complete.**

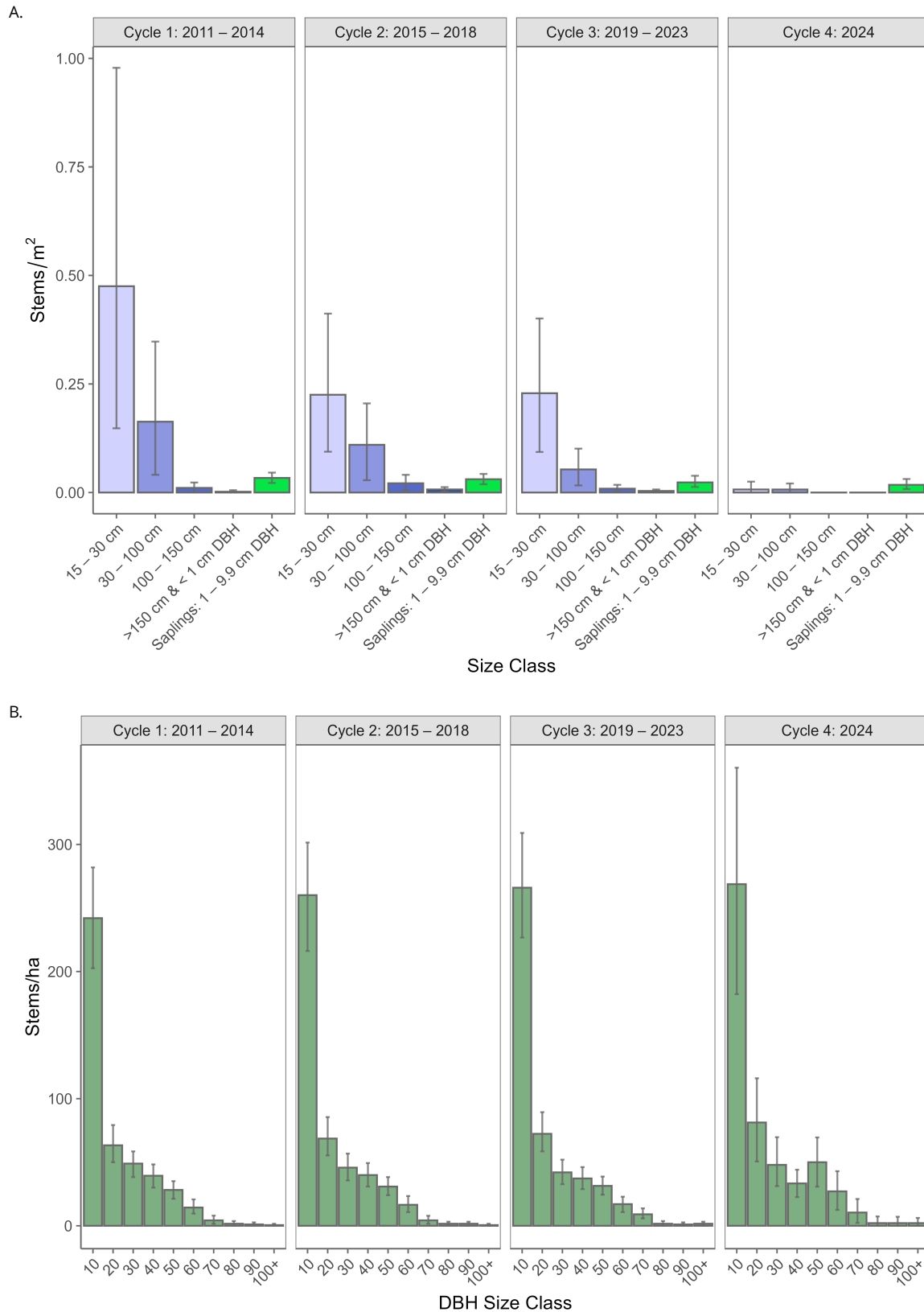


Figure 3. Stem density distributions by cycle in Colonial National Historical Park (COLO). Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 2019 – 2023; Cycle 4: 2024. **Note that Cycle 4 is only partially complete.** Figure A shows regeneration densities by size class. Figure B shows tree density 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.

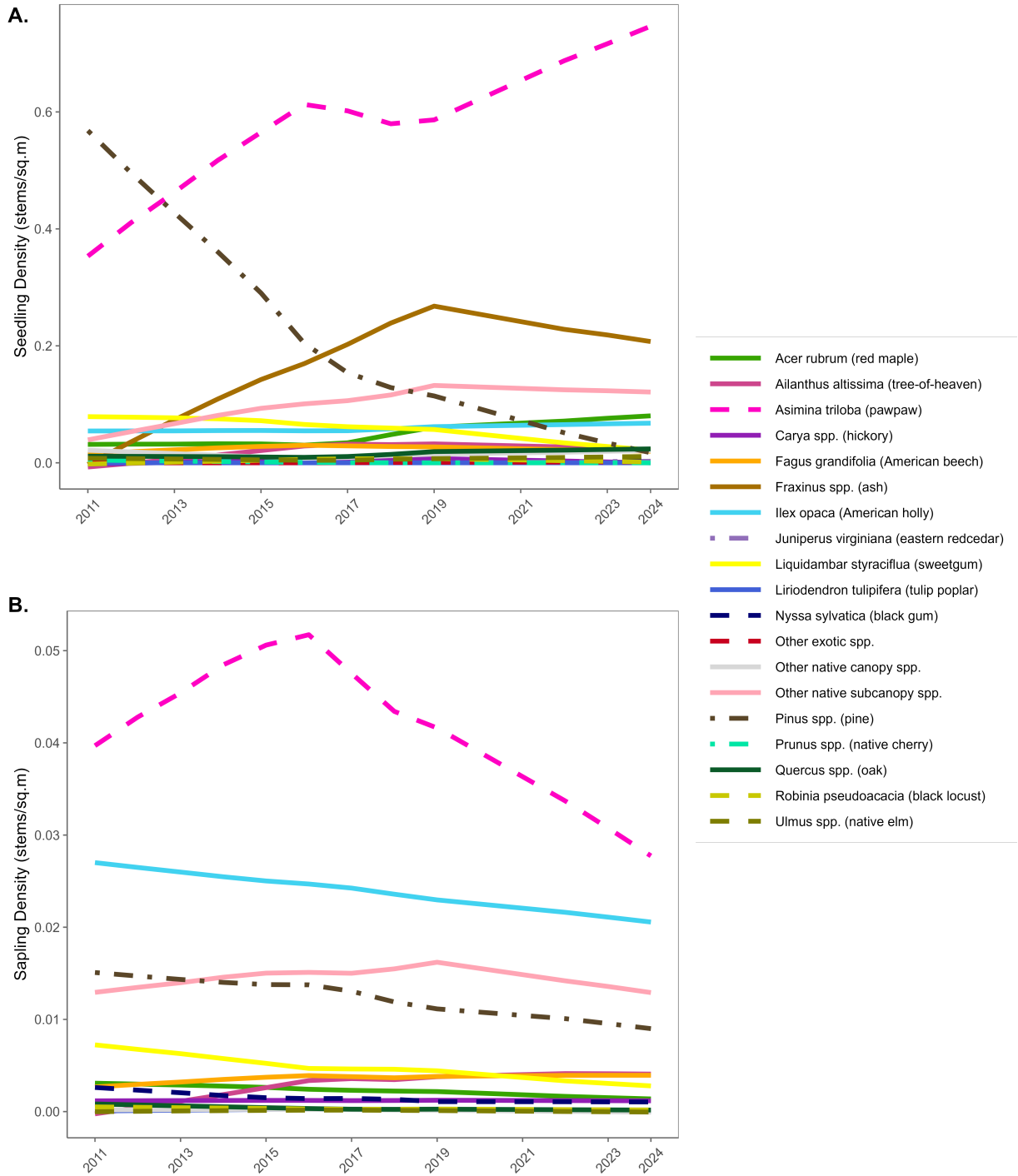


Figure 4. Loess smoothed changes in stem density for seedlings (A) and saplings (B) by species group and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

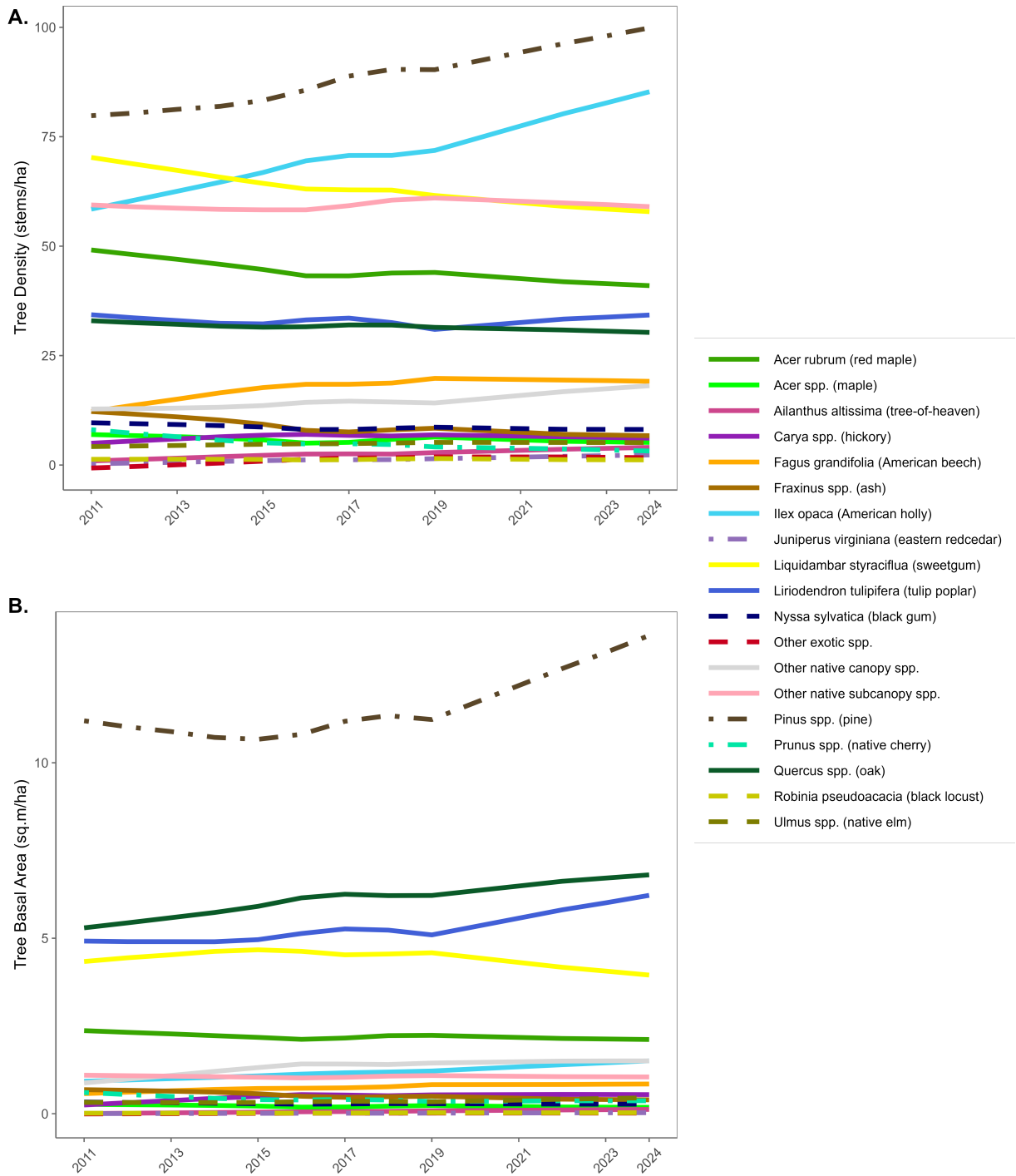


Figure 5. Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

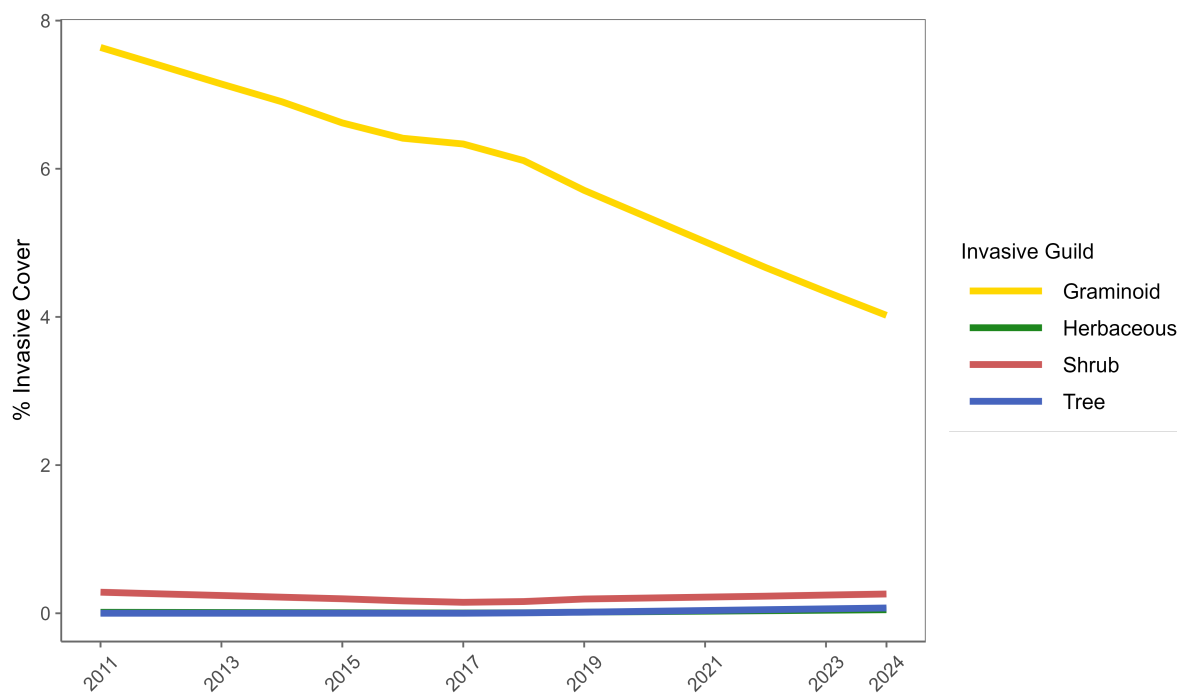


Figure 6. Loess smoothed changes in invasive plant percent cover by guild and sample year in Colonial National Historical Park. Specified loess span approximated a linear trend between consecutive sample events per panel.



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; Cycle 4: 2024. 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. **Note that Cycle 4 is only partially complete.**

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
331	1	0.00	0.00	0.17	0.00	0.05	0.05	0.02	0.01	0.00	0.00	2.14	0.00
332	1	0.00	0.08	0.08	0.00	0.01	0.01	0.01	0.01	7.41	8.42	8.42	7.41
333	1	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
334	1	0.08	0.17	0.00	0.00	0.00	0.00	0.00	0.00	2.14	2.14	0.00	0.00
335	1	0.00	0.08	0.00	0.00	0.01	0.01	0.01	0.01	0.00	1.01	0.00	0.00
336	1	0.33	0.42	0.17	0.08	0.24	0.22	0.15	0.08	120.13	165.12	102.92	24.38
337	1	0.17	0.00	0.00	0.00	0.02	0.01	0.01	0.01	2.14	0.00	0.00	0.00
338	1	0.00	0.00	0.08	0.00	0.06	0.05	0.04	0.02	7.41	0.00	1.01	0.00
339	1	0.00	0.08	0.00	0.00	0.02	0.02	0.01	0.01	7.41	8.42	0.00	0.00
340	1	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.00	0.00
341	1	0.33	0.00	0.00	0.08	0.01	0.01	0.01	0.01	4.15	0.00	0.00	1.01
342	1	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.00	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	0.17	0.17	0.58	-	0.01	0.01	0.00	-	3.14	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; Cycle 4: 2024. 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. **Note that Cycle 4 is only partially complete.**

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
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; Cycle 4: 2024. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). **Note that Cycle 4 is only partially complete.** Plots with at least 10% average cover or 4 or more invasive species present are in yellow. Protocol evolution over time has impacted invasive species % cover and counts. The estimated change in invasive species % cover and count in Colonial National Historical Park (COLO) that can be attributed to protocol change is 0.05% and 0.26 species per plot for the most recent census. More details can be found in the MIDN Summary of Major Protocol Changes. (<https://irma.nps.gov/DataStore/Reference/Profile/2189101>)

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
331	1	0.00	0.00	0.00	0.00	0	0	0	0
332	1	11.92	16.50	15.03	8.87	3	4	3	4
333	1	0.43	3.25	15.77	3.44	2	2	2	2
334	1	0.17	8.50	0.45	0.02	2	2	3	2
335	1	0.32	0.90	0.02	0.03	2	2	3	5
336	1	0.00	0.01	0.01	0.00	1	1	3	2
337	1	2.80	0.63	0.39	0.97	4	4	4	4
338	1	0.02	0.01	0.64	0.35	3	2	4	4
339	1	0.00	0.01	0.02	0.00	1	1	2	2
340	1	0.00	0.01	0.01	0.01	0	2	3	3
341	1	54.39	56.68	46.22	32.65	2	3	4	5
342	1	0.01	0.00	0.00	0.03	1	2	3	3
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	22.52	26.53	-	3	4	4	-
347	2	2.01	5.45	0.60	-	3	3	4	-
348	2	0.00	0.00	0.02	-	0	1	1	-
349	2	0.00	0.00	0.00	-	2	3	2	-
350	2	3.44	7.03	8.14	-	2	2	3	-
351	2	0.29	7.09	0.62	-	1	2	1	-
352	2	0.00	0.00	0.00	-	0	1	1	-
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	0.16	1.77	0.25	-	5	3	3	-
358	3	12.10	13.83	10.81	-	5	3	6	-
359	3	15.74	7.63	9.68	-	2	2	2	-
360	3	0.14	0.03	0.04	-	1	1	3	-
361	3	0.16	1.51	0.48	-	3	3	4	-
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; Cycle 4: 2024. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). **Note that Cycle 4 is only partially complete.** Plots with at least 10% average cover or 4 or more invasive species present are in yellow. Protocol evolution over time has impacted invasive species % cover and counts. The estimated change in invasive species % cover and count in Colonial National Historical Park (COLO) that can be attributed to protocol change is 0.05% and 0.26 species per plot for the most recent census. More details can be found in the MIDN Summary of Major Protocol Changes. (<https://irma.nps.gov/DataStore/Reference/Profile/2189101>)

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
363	3	0.59	0.00	0.02	-	2	0	3	-
364	3	7.09	3.14	0.65	-	2	3	2	-
365	3	0.56	6.46	1.72	-	2	2	2	-
366	3	12.63	19.52	23.35	-	3	3	4	-
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	20.34	-	4	4	5	-
371	4	0.03	0.02	1.59	-	2	2	4	-
372	4	0.00	0.00	0.00	-	0	0	2	-
373	4	0.03	0.02	0.03	-	2	2	2	-
374	4	0.02	0.00	0.03	-	2	2	2	-
375	4	17.91	5.97	10.70	-	4	4	4	-
376	4	0.18	1.21	1.29	-	3	3	3	-
377	4	0.00	0.00	0.00	-	1	0	0	-
378	4	1.49	0.67	0.02	-	3	2	4	-
379	4	0.00	0.00	0.01	-	0	1	3	-
381	4	0.00	0.00	0.00	-	1	0	0	-



Table 3. Number of plots out of 47 where exotic species were detected. Cycle 1: 2011 – 2014; Cycle 2: 2015 – 2018; Cycle 3: 2019 – 2023; Cycle 4: 2024. Priority invasive species capable of dominating Eastern US forest habitats are highlighted in yellow. **Note that Cycle 4 is only partially complete.** Protocol evolution has impacted the number of invasive species monitored through time. Species were not consistently monitored before the year specified in the Year Added column. More details can be found in the MIDN Summary of Major Protocol Changes. (<https://irma.nps.gov/DataStore/Reference/Profile/2189101>)

Latin Name	Common Name	Invasive	Year Added	Cycle 1	Cycle 2	Cycle 3	Cycle 4
<i>Ailanthus altissima</i>	tree-of-heaven	Yes	2019	2	2	4	2
<i>Berberis bealei</i>	Beale's barberry	No	2019	0	0	1	1
<i>Duchesnea indica</i>	mock strawberry	No	2007	1	3	4	1
<i>Elaeagnus</i>	exotic olive	Yes	2019	0	0	2	3
<i>Elaeagnus pungens</i>	thorny olive	Yes	2019	0	0	1	3
<i>Euonymus</i>	burningbush	Yes	2019	0	0	2	0
<i>Hedera helix</i>	English ivy	Yes	2007	8	6	23	7
<i>Ilex aquifolium</i>	English holly	No	2019	0	0	1	0
<i>Ilex crenata</i>	Japanese holly	No	2019	0	0	1	0
<i>Lespedeza cuneata</i>	Chinese lespedeza	Yes	2007	0	0	2	0
<i>Ligustrum</i>	privet	Yes	2009	16	17	21	6
<i>Lonicera - Exotic</i>	honeysuckle - exotic	Yes	2007	0	1	0	0
<i>Lonicera japonica</i>	Japanese honeysuckle	Yes	2007	26	27	31	9
<i>Microstegium vimineum</i>	Japanese stiltgrass	Yes	2007	34	35	34	9
<i>Morus alba</i>	white mulberry	No	2019	0	0	1	0
<i>Persicaria longiseta</i>	Asiatic lady's thumb	Yes	2009	3	2	4	0
<i>Rosa multiflora</i>	multiflora rose	Yes	2007	1	3	2	0



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-344	2022	364854	4122302	<i>Agrilus planipennis</i>	emerald ash borer	pest
COLO-357	2022	364599	4120797	<i>Discula destructiva</i>	dogwood anthracnose	pest



Table 5. List of tree species included in Maps 3 and 4 and how each was displayed.

Latin Name	Group: Map 3. Regeneration	Group: Map 4. Tree Canopy
<i>Acer floridanum</i>	-	Acer spp. (maple)
<i>Acer rubrum</i>	Acer rubrum (red maple)	Acer rubrum (red maple)
<i>Ailanthus altissima</i>	Ailanthus altissima (tree-of-heaven)	Ailanthus altissima (tree-of-heaven)
<i>Asimina triloba</i>	Asimina triloba	Other native subcanopy spp.
<i>Carpinus caroliniana</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Carya</i>	Carya spp. (hickory)	-
<i>Carya cordiformis</i>	Carya spp. (hickory)	Carya spp. (hickory)
<i>Carya glabra</i>	-	Carya spp. (hickory)
<i>Carya tomentosa</i>	Carya spp. (hickory)	Carya spp. (hickory)
<i>Celtis occidentalis</i>	Other native canopy spp.	Other native canopy spp.
<i>Cornus florida</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Diospyros virginiana</i>	Other native canopy spp.	Other native canopy spp.
<i>Fagus grandifolia</i>	Fagus grandifolia (American beech)	Fagus grandifolia (American beech)
<i>Fraxinus</i>	Fraxinus spp. (ash)	-
<i>Fraxinus americana</i>	Fraxinus spp. (ash)	Fraxinus spp. (ash)
<i>Fraxinus pennsylvanica</i>	Fraxinus spp. (ash)	Fraxinus spp. (ash)
<i>Ilex aquifolium</i>	Other exotic spp.	-
<i>Ilex opaca</i>	Ilex opaca (American holly)	Ilex opaca (American holly)
<i>Juglans nigra</i>	-	Other native canopy spp.
<i>Juniperus virginiana</i>	Juniperus virginiana (eastern redcedar)	Juniperus virginiana (eastern redcedar)
<i>Ligustrum</i>	-	Other exotic spp.
<i>Liquidambar styraciflua</i>	Liquidambar styraciflua (sweetgum)	Liquidambar styraciflua (sweetgum)
<i>Liriodendron tulipifera</i>	-	Liriodendron tulipifera (tulip poplar)
<i>Magnolia grandiflora</i>	Other native canopy spp.	Other native canopy spp.
<i>Morella cerifera</i>	-	Other native subcanopy spp.
<i>Nyssa biflora</i>	-	Other native canopy spp.
<i>Nyssa sylvatica</i>	Nyssa sylvatica (black gum)	Nyssa sylvatica (black gum)
<i>Ostrya virginiana</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Oxydendrum arboreum</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Persea palustris</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Pinus</i>	Pinus spp. (pine)	-
<i>Pinus taeda</i>	Pinus spp. (pine)	Pinus spp. (pine)
<i>Pinus virginiana</i>	-	Pinus spp. (pine)
<i>Platanus occidentalis</i>	-	Other native canopy spp.
<i>Prunus serotina</i>	-	Prunus spp. (native cherry)
<i>Quercus (Red group)</i>	Quercus spp. (oak)	-
<i>Quercus alba</i>	-	Quercus spp. (oak)
<i>Quercus coccinea</i>	-	Quercus spp. (oak)
<i>Quercus falcata</i>	Quercus spp. (oak)	Quercus spp. (oak)
<i>Quercus michauxii</i>	-	Quercus spp. (oak)
<i>Quercus montana</i>	-	Quercus spp. (oak)
<i>Quercus muehlenbergii</i>	-	Quercus spp. (oak)
<i>Quercus nigra</i>	Quercus spp. (oak)	-
<i>Quercus phellos</i>	Quercus spp. (oak)	Quercus spp. (oak)
<i>Quercus rubra</i>	-	Quercus spp. (oak)
<i>Quercus stellata</i>	-	Quercus spp. (oak)
<i>Quercus velutina</i>	-	Quercus spp. (oak)
<i>Robinia pseudoacacia</i>	Robinia pseudoacacia (black locust)	Robinia pseudoacacia (black locust)
<i>Sassafras albidum</i>	Other native subcanopy spp.	Other native subcanopy spp.
<i>Ulmus</i>	Ulmus spp. (native elm)	-
<i>Ulmus americana</i>	Ulmus spp. (native elm)	Ulmus spp. (native elm)
<i>Ulmus rubra</i>	Ulmus spp. (native elm)	Ulmus spp. (native elm)
<i>Viburnum prunifolium</i>	Other native subcanopy spp.	-

