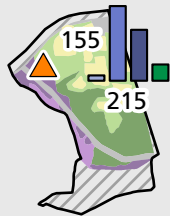




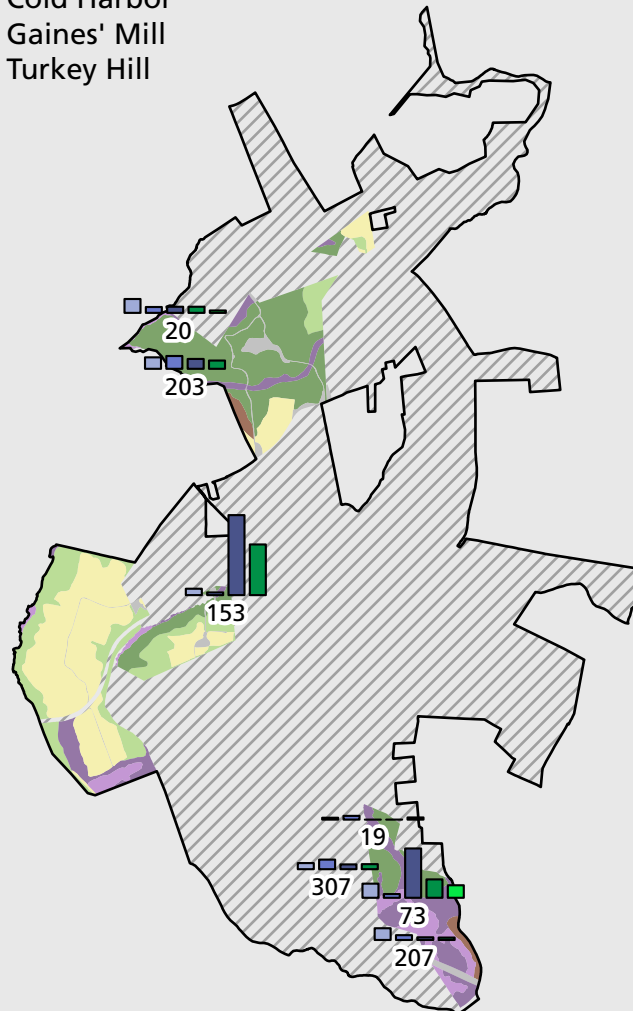
## Map 1a. Tree Regeneration by Cycle

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 to 3.6 stems/m<sup>2</sup> across all park units, and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



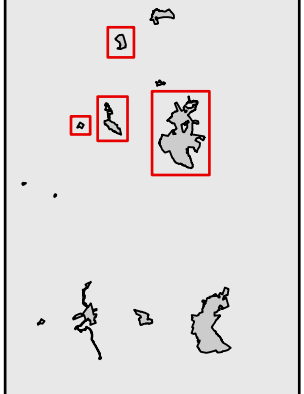
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types



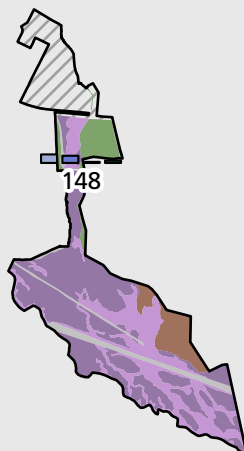
### RICH Units



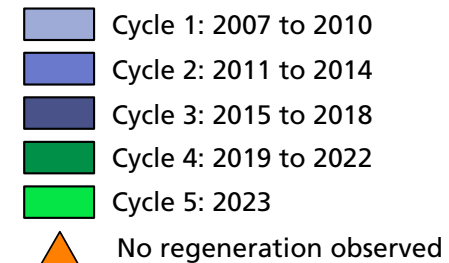
### Chickahominy Bluff



### Beaverdam Creek



### Regeneration densities



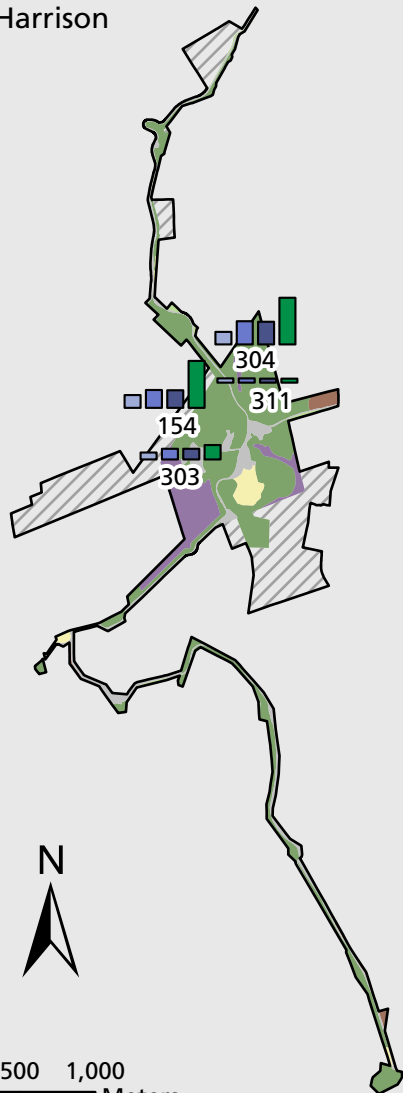
0 500 1,000  
Meters



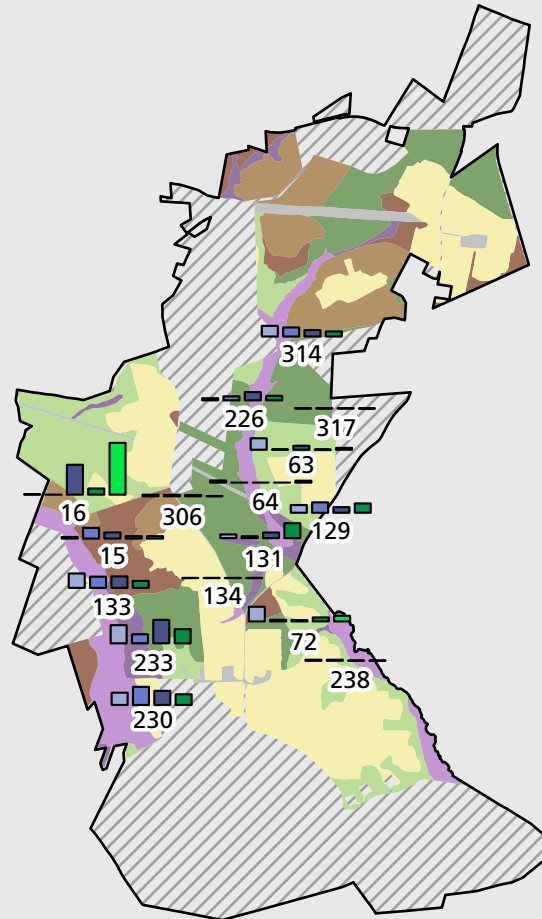
## Map 1b. Tree Regeneration by Cycle

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 to 3.6 stems/m<sup>2</sup> across all park units, and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



### Malvern Hill



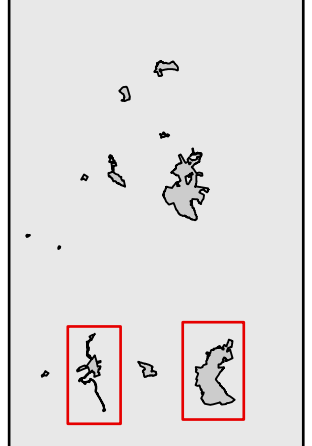
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Regeneration densities

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023
- No regeneration observed

### RICH Units

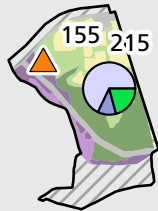




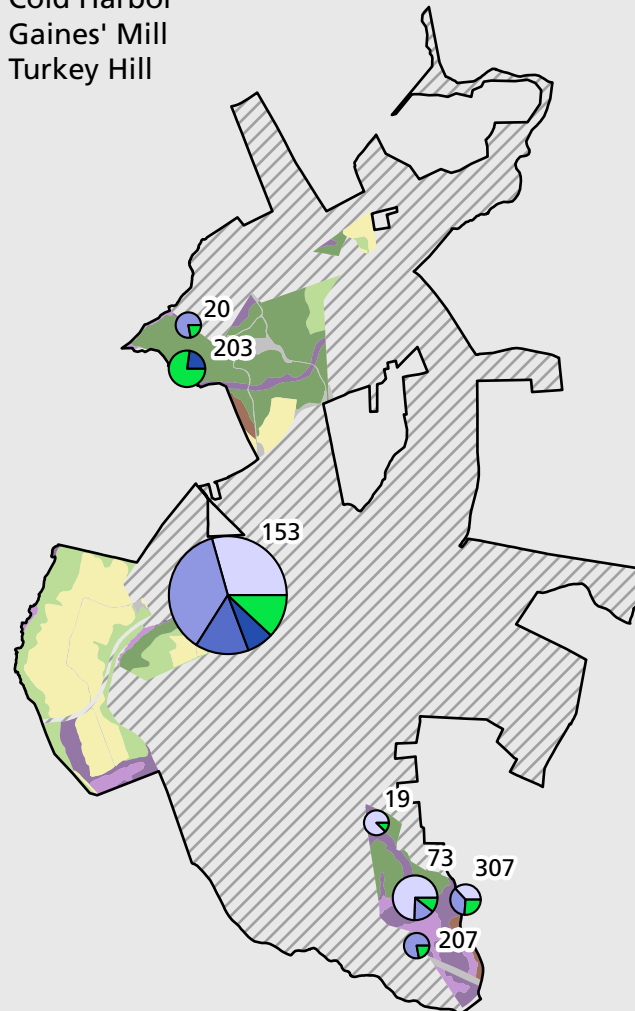
## Map 2a. Tree Regeneration by Size Class

Tree regeneration stem densities by size class in forest plots from the most recent census (2021-2023). 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 2.3 stems/m<sup>2</sup> across all park units, and only include native canopy-forming species. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



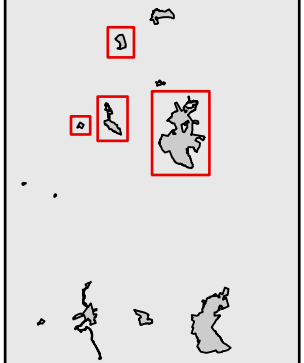
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

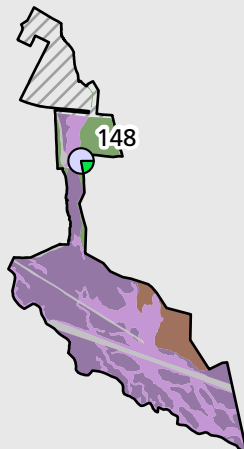
### RICH Units



### Chickahominy Bluff



### Beaverdam Creek



### Stem densities by size class

- Seedlings 15 to 30 cm
- Seedlings 30 to 100 cm
- Seedlings 100 to 150 cm
- Seedlings > 150 cm
- Saplings (1 to 9.9 cm DBH)
- No regeneration observed



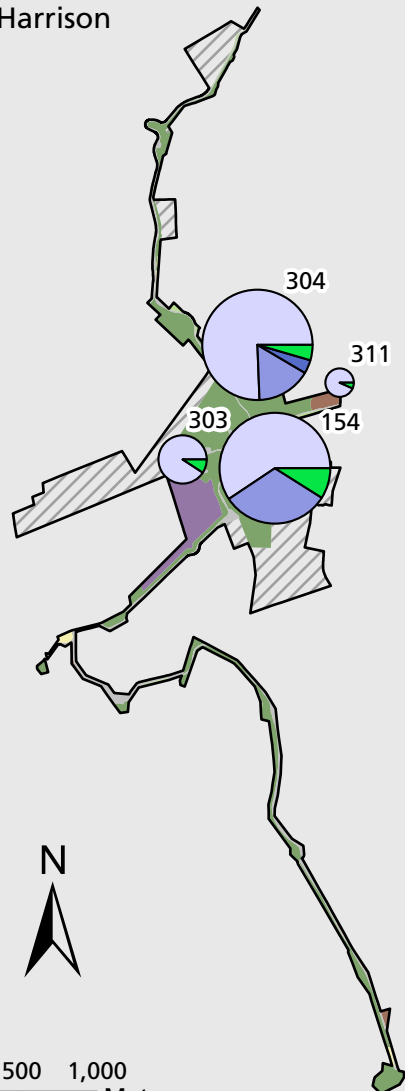
0 500 1,000  
Meters



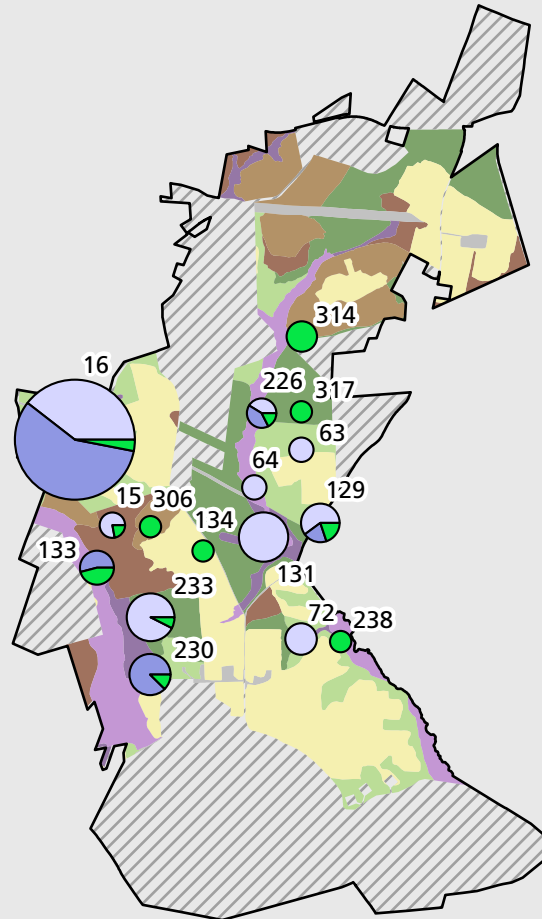
## Map 2b. Tree Regeneration by Size Class

Tree regeneration stem densities by size class in forest plots from the most recent census (2021-2023). 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 2.3 stems/m<sup>2</sup> across all park units, and only include native canopy-forming species. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



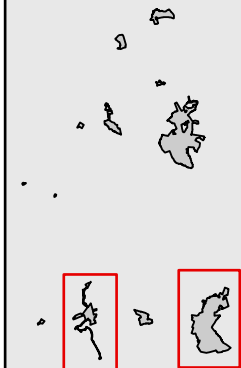
### Malvern Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### RICH Units



### Stem densities by size class

- Seedlings 15 to 30 cm
- Seedlings 30 to 100 cm
- Seedlings 100 to 150 cm
- Seedlings > 150 cm
- Saplings (1 to 9.9 cm DBH)
- No regeneration observed



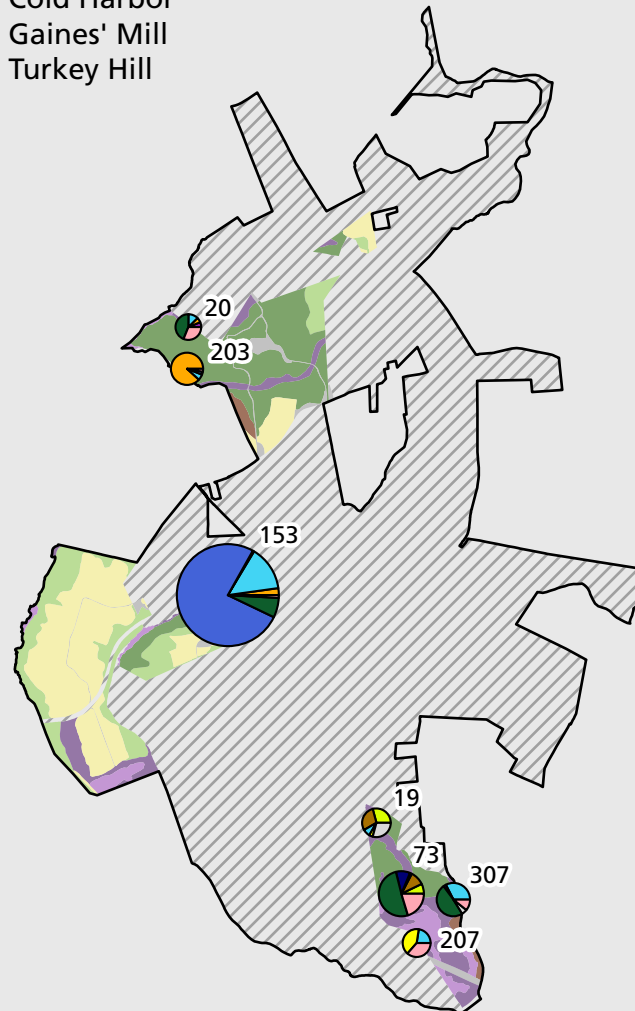
## Map 3a. Tree Regeneration Composition

Tree regeneration, including seedlings and saplings, by species group observed in forest plots sampled in the most recent census (2021-2023). 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 3.3 stems/m<sup>2</sup> across all park units, and includes all species. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



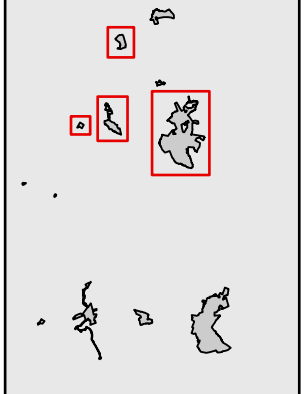
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types



### RICH Units



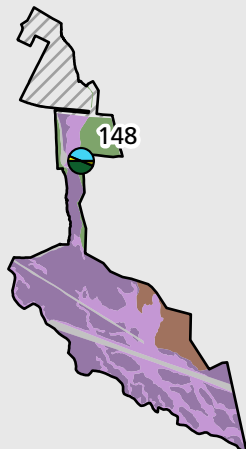
### Species in pie charts



### Chickahominy Bluff



### Beaverdam Creek



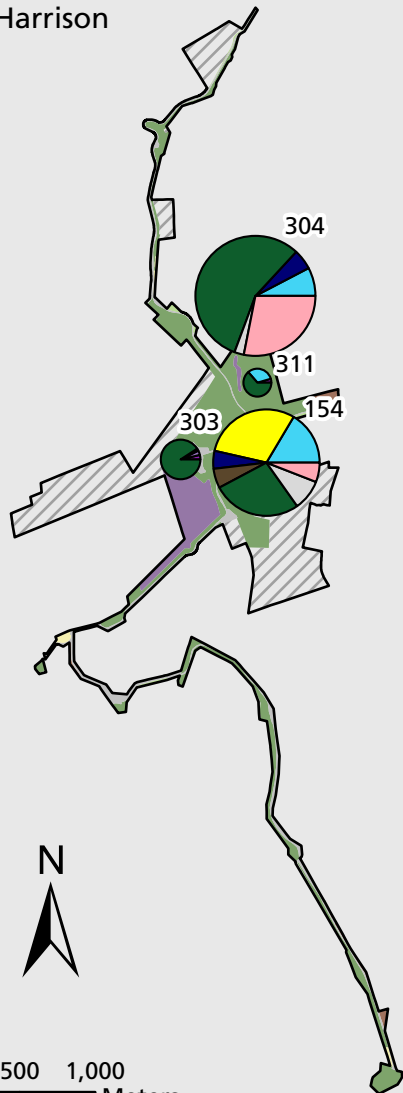
0 500 1,000  
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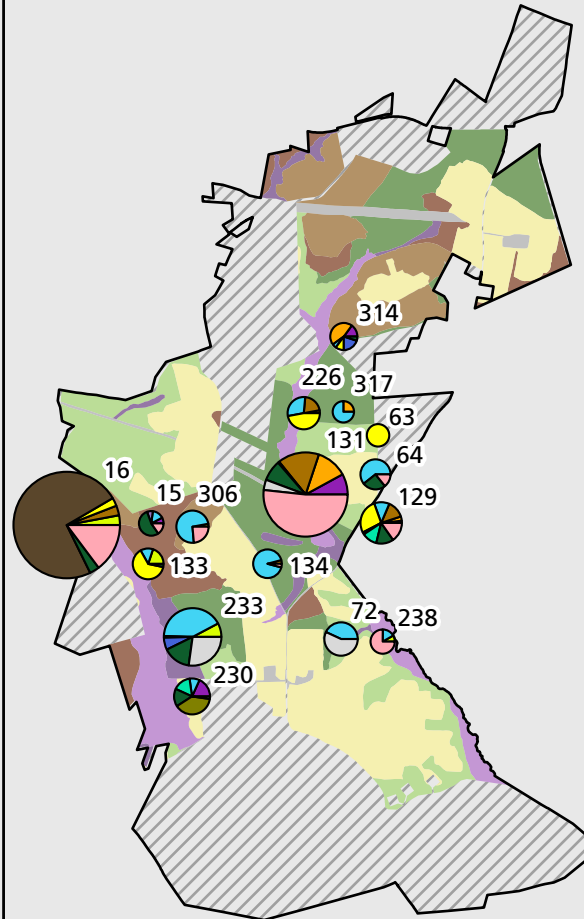
## Map 3b. Tree Regeneration Composition

Tree regeneration, including seedlings and saplings, by species group observed in forest plots sampled in the most recent census (2021-2023). 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 3.3 stems/m<sup>2</sup> across all park units, and includes all species. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



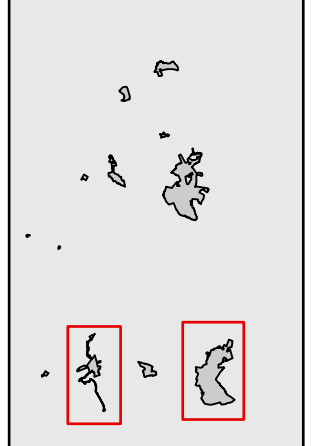
### Malvern Hill



### Vegetation types



### RICH Units



### Species in pie charts

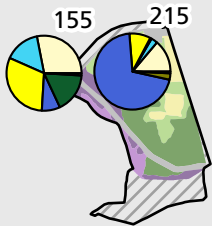




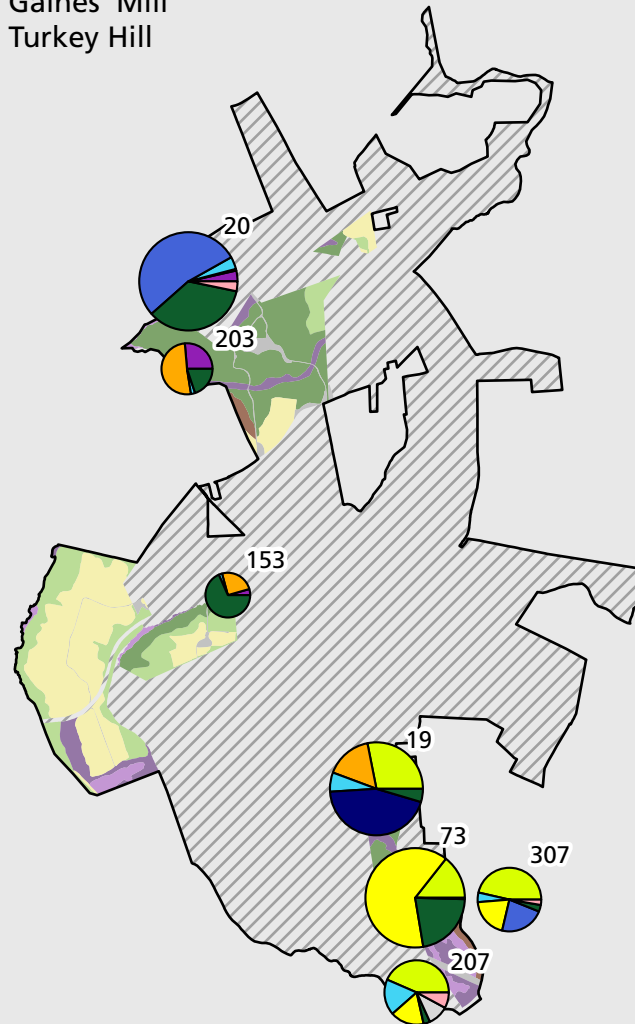
## Map 4a. Tree Canopy Composition

Tree composition, by species group, observed in forest plots sampled in the most recent census (2021-2023). 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 9.5 to 58.2 m<sup>2</sup>/ha across all park units. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



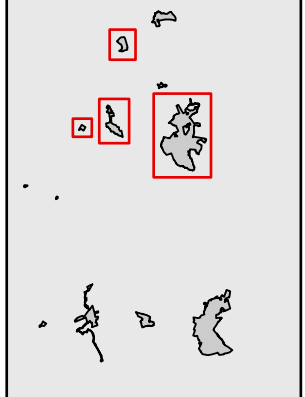
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### RICH Units



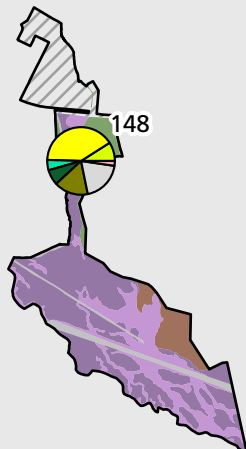
### Species in pie charts

- Acer rubrum (Red maple)
- Betula spp. (Birch)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Ilex opaca (American holly)
- Juniperus virginiana (Red cedar)
- Liquidambar styraciflua (Sweetgum)
- Liriodendron tulipifera (Tuliptree)
- Nyssa sylvatica (Black tupelo)
- Pinus spp. (Pine)
- Prunus serotina (Black cherry)
- Quercus spp. (Oak)
- Ulmus spp. (Elm)
- Other native spp.
- Subcanopy spp.

### Chickahominy Bluff



### Beaverdam Creek



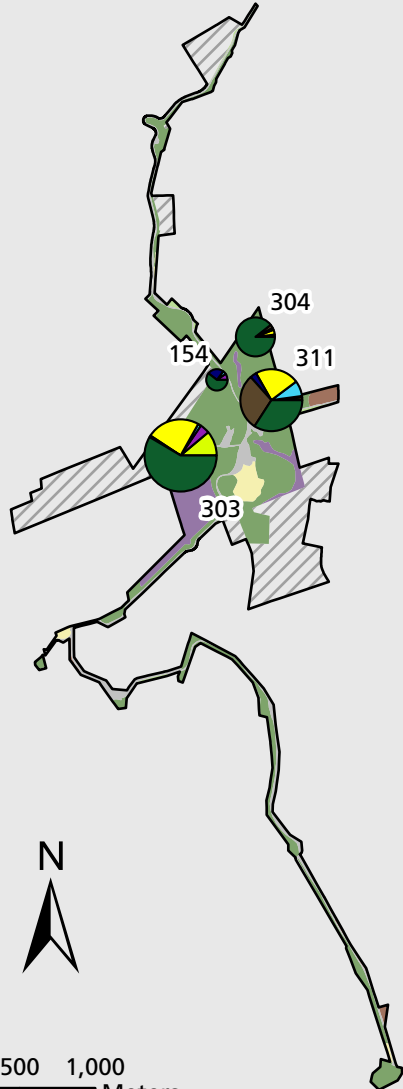
0 500 1,000  
Meters



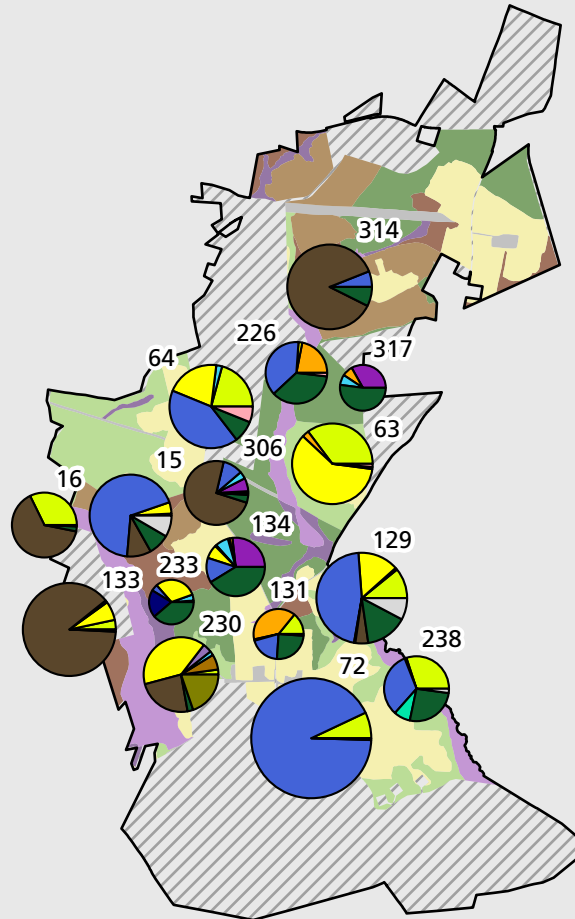
## Map 4b. Tree Canopy Composition

Tree composition, by species group, observed in forest plots sampled in the most recent census (2021-2023). 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 9.5 to 58.2 m<sup>2</sup>/ha across all park units. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



### Malvern Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Species in pie charts

- Acer rubrum* (Red maple)
- Betula* spp. (Birch)
- Carya* spp. (Hickory)
- Fagus grandifolia* (Beech)
- Fraxinus* spp. (Ash)
- Ilex opaca* (American holly)
- Juniperus virginiana* (Red cedar)
- Liquidambar styraciflua* (Sweetgum)
- Liriodendron tulipifera* (Tuliptree)
- Nyssa sylvatica* (Black tupelo)
- Pinus* spp. (Pine)
- Prunus serotina* (Black cherry)
- Quercus* spp. (Oak)
- Ulmus* spp. (Elm)
- Other native spp.
- Subcanopy spp.

### RICH Units

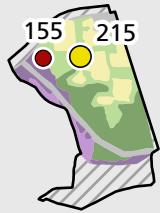




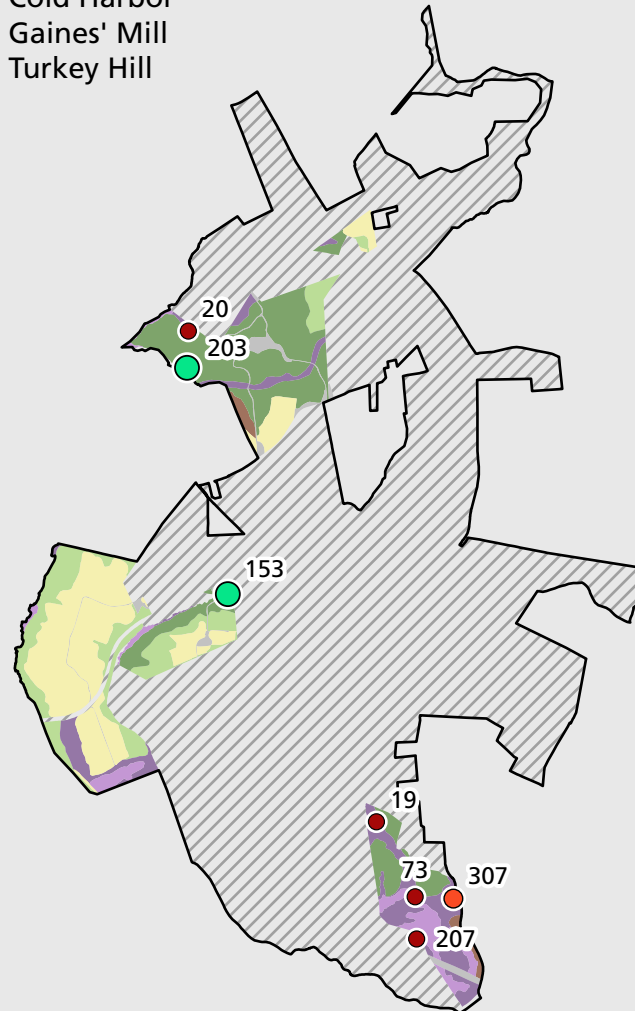
## Map 5a. Tree Regeneration Stocking Index

Regeneration stocking index for the most recent census (2021-2023). 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 0-306.7 across all park units). Only native canopy-forming species included. See Table 1 for stocking index values. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



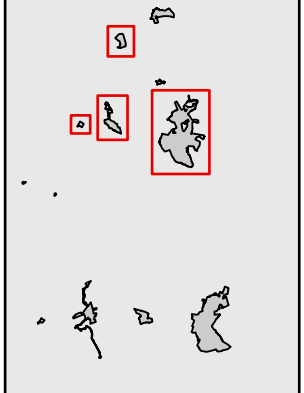
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### RICH Units



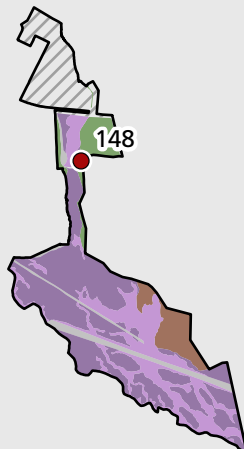
### Stocking index ranges

- <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.

### Chickahominy Bluff



### Beaverdam Creek



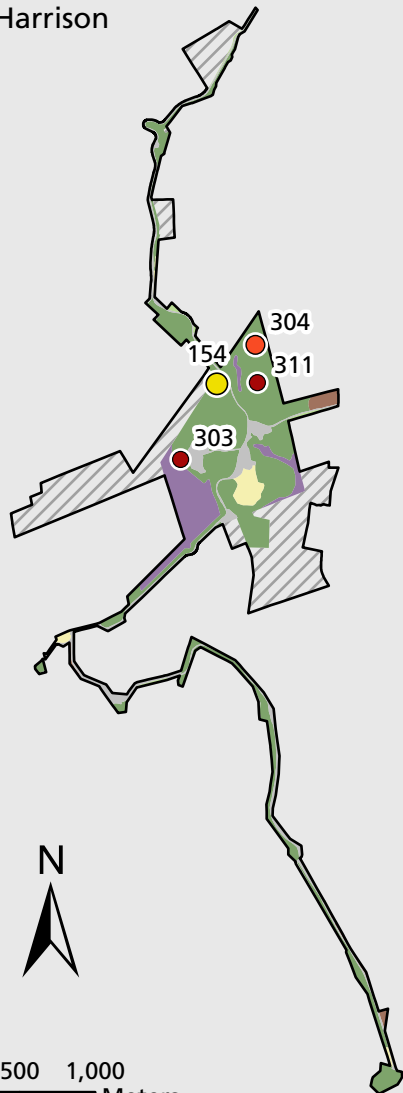
0 500 1,000  
Meters



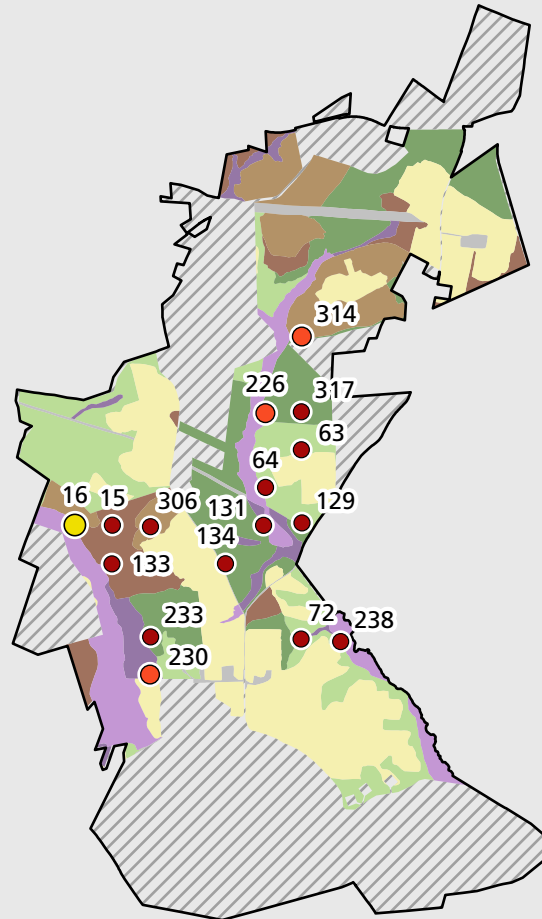
## Map 5b. Tree Regeneration Stocking Index

Regeneration stocking index for the most recent census (2021-2023). 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 0-306.7 across all park units). Only native canopy-forming species included. See Table 1 for stocking index values. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



### Malvern Hill



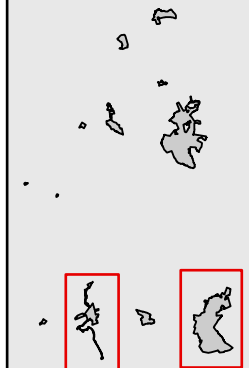
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation 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.

### RICH Units

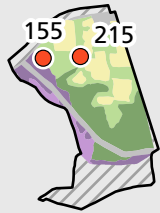




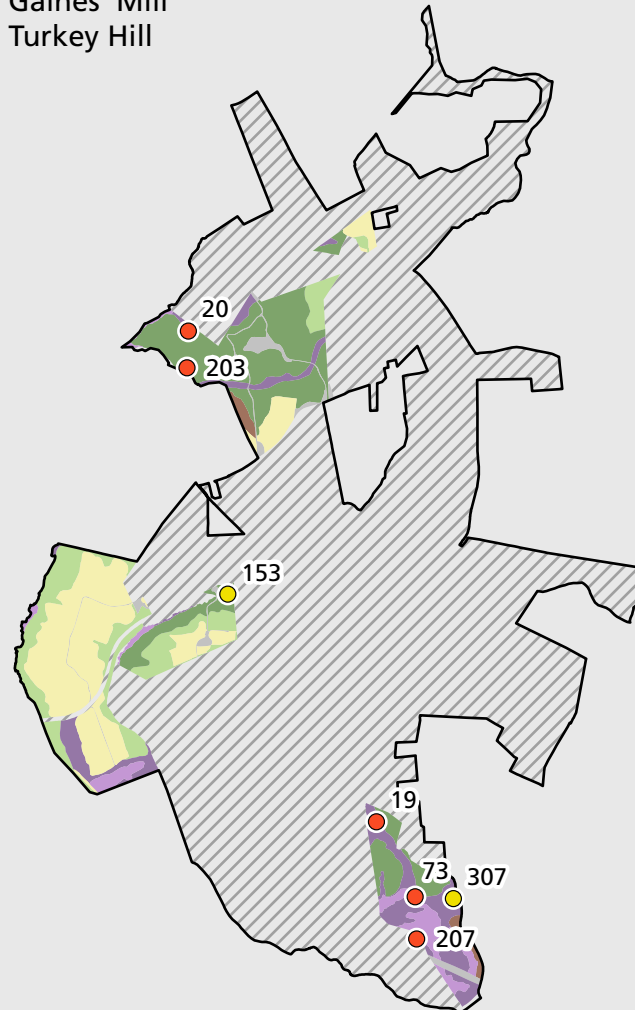
## Map 6a. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent census (2021-2023). 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 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



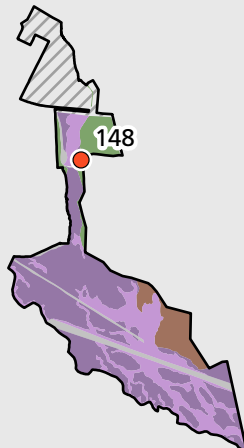
### Cold Harbor Gaines' Mill Turkey Hill



### Chickahominy Bluff



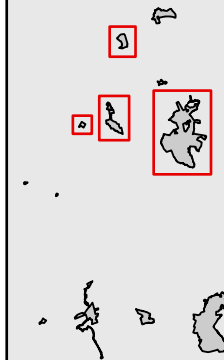
### Beaverdam Creek



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### RICH Units



### Deer browse index

- 1) No impact: found only in well-maintained deer enclosures.
- 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.



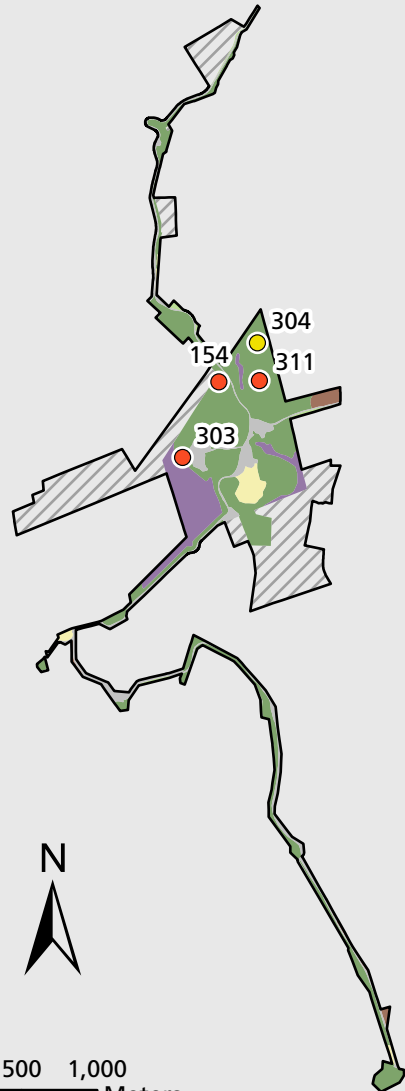
0 500 1,000  
Meters



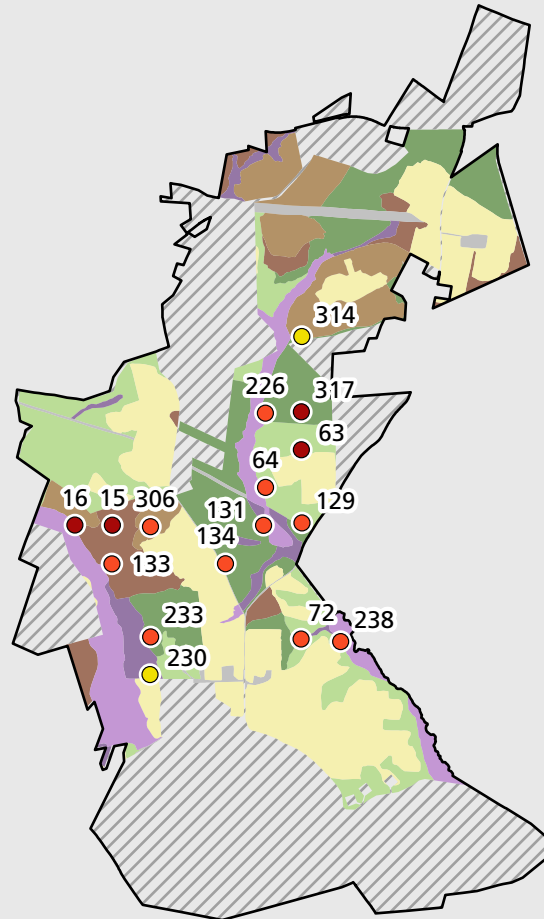
## Map 6b. Index of Deer Browse Impacts

Index of deer browse impacts observed in forest plots in the most recent census (2021-2023). 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 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



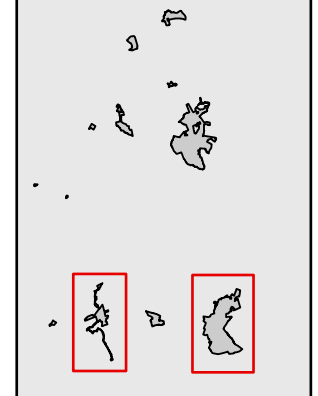
### Malvern Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### RICH Units



### Deer browse index

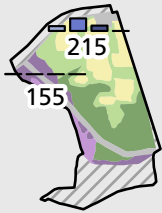
- 1) No impact: found only in well-maintained deer enclosures.
- 2) Low impact: deer-preferred (DP) species abundant and of varying heights.
- 3) Medium impact: DP species present, but mostly under 30 cm tall. DP herbs present but stunted and flowering is uncommon.
- 4) High impact: DP species are rare 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.



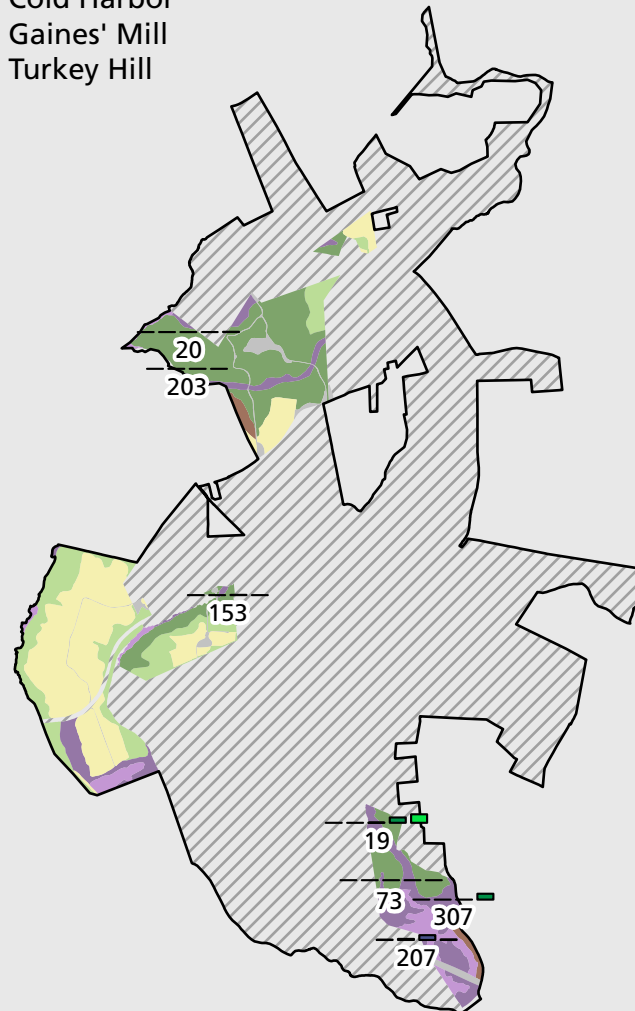
## Map 7a. Invasive % Cover by Cycle

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 65.0% across all park units. 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 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Rural Point



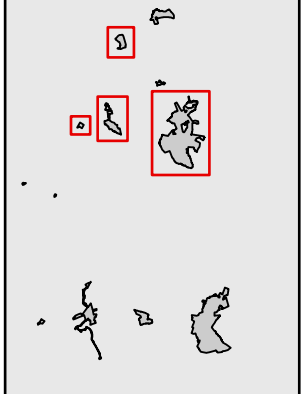
### Cold Harbor Gaines' Mill Turkey Hill



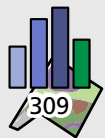
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

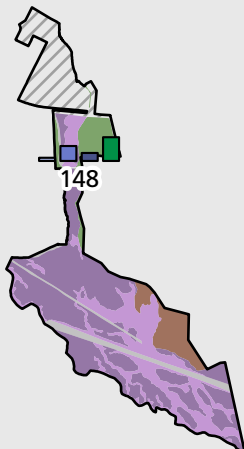
### RICH Units



### Chickahominy Bluff



### Beaverdam Creek



### Invasive % cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023
- No observed invasive cover



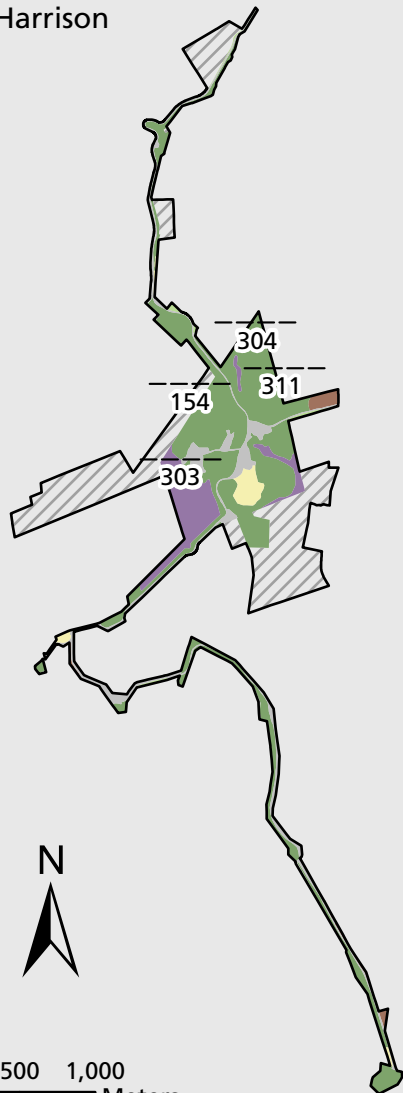
0 500 1,000  
Meters



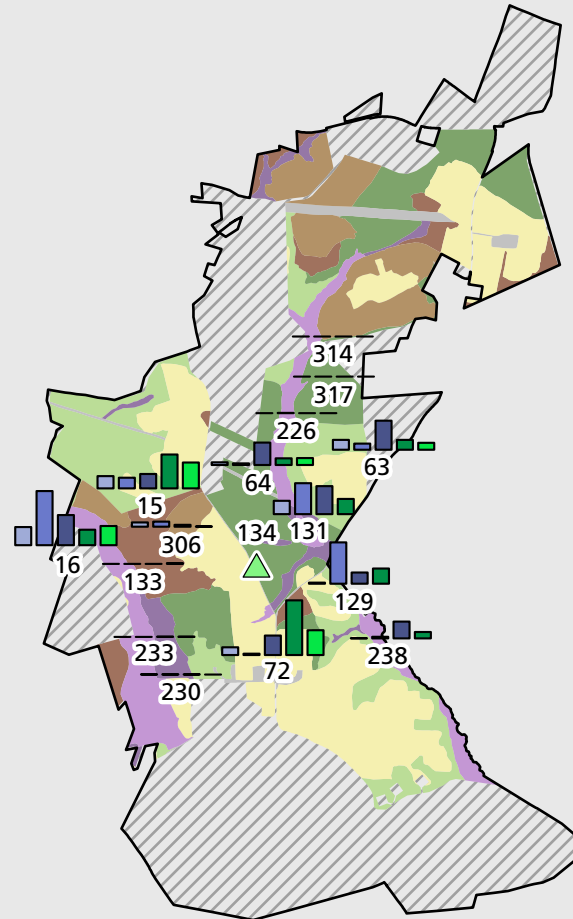
## Map 7b. Invasive % Cover by Cycle

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 65.0% across all park units. 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 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/21/2023.

### Fort Harrison



### Malvern Hill



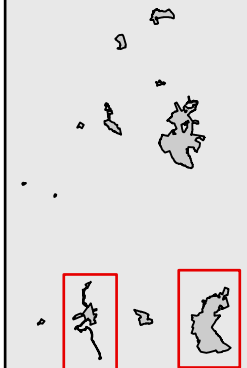
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Invasive % cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023
- No observed invasive cover

### RICH Units

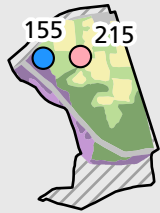




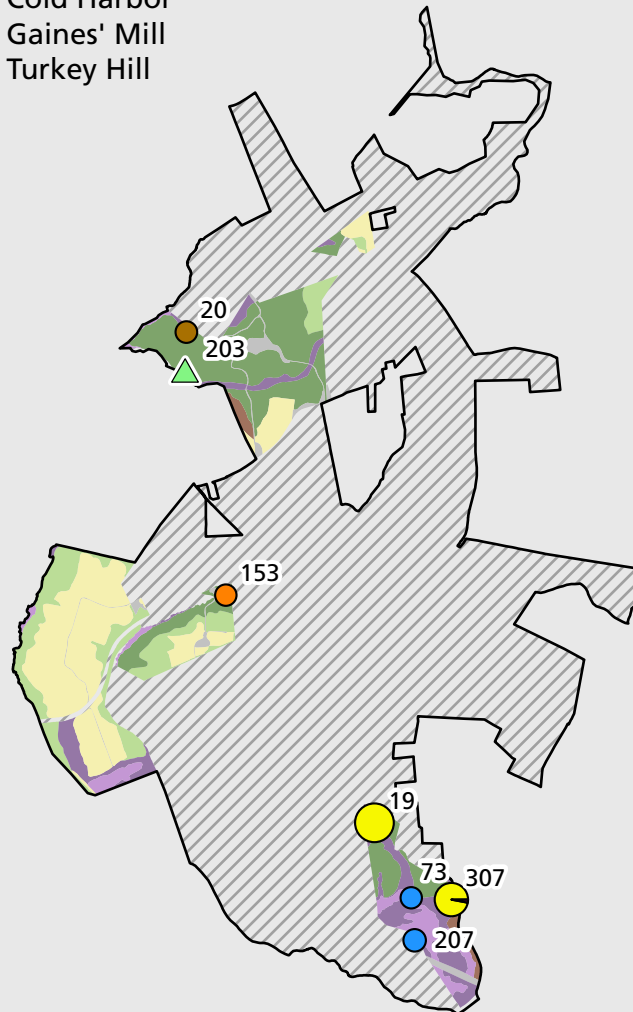
## Map 8a. Invasive % Cover by Species

Percent invasive cover by species observed in quadrats in forest plots sampled in the most recent census (2021-2023). 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 65.0% across all park units), and location may be shifted to prevent overlap. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. See Table 3 for more information. Reporting Date: 12/21/2023.

### Rural Point



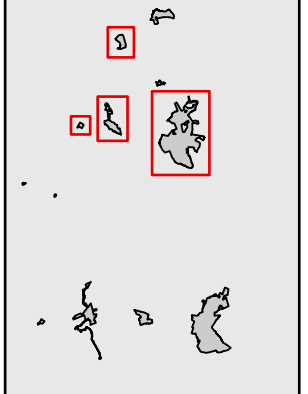
### Cold Harbor Gaines' Mill Turkey Hill



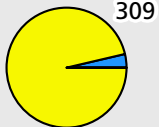
### Vegetation types



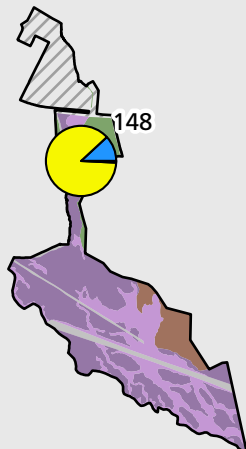
### RICH Units



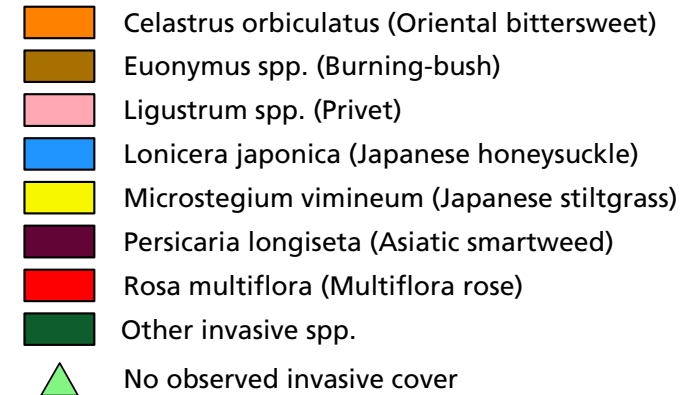
### Chickahominy Bluff



### Beaverdam Creek



### Species in pie charts



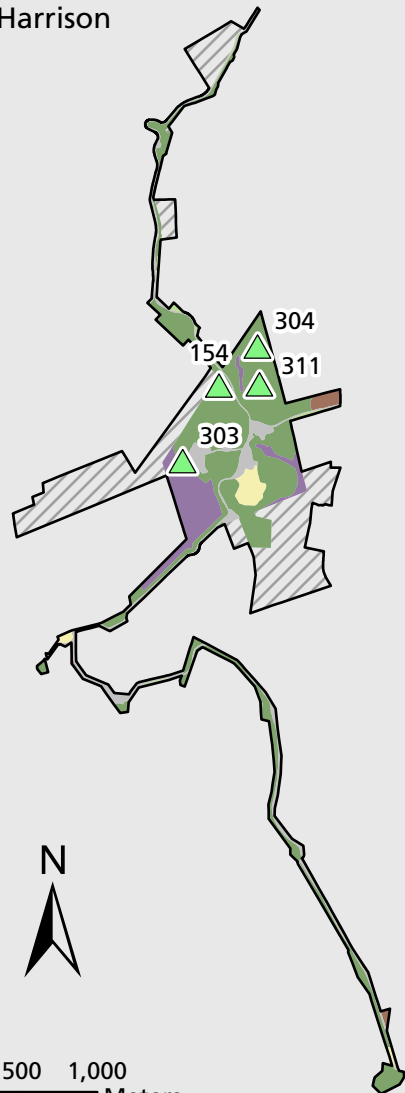
0 500 1,000  
Meters



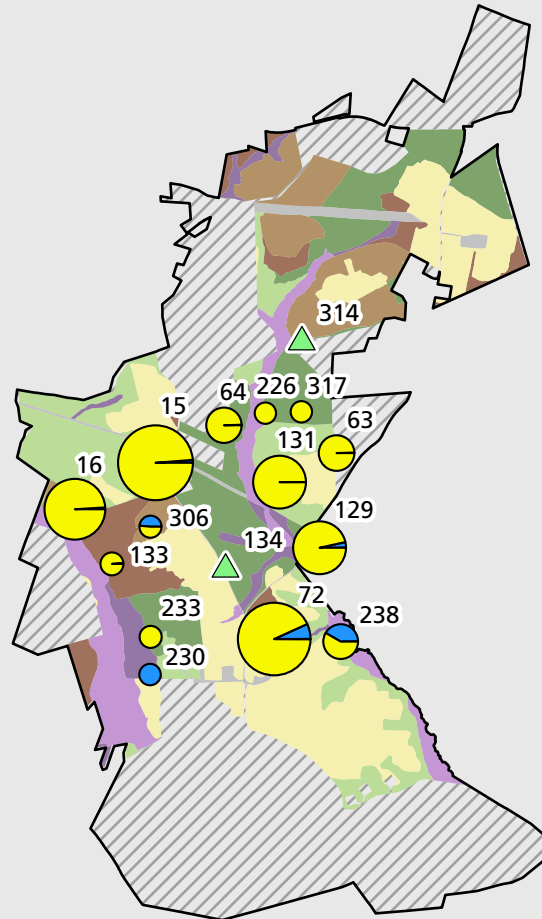
## Map 8b. Invasive % Cover by Species

Percent invasive cover by species observed in quadrats in forest plots sampled in the most recent census (2021-2023). 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 65.0% across all park units), and location may be shifted to prevent overlap. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. See Table 3 for more information. Reporting Date: 12/21/2023.

### Fort Harrison



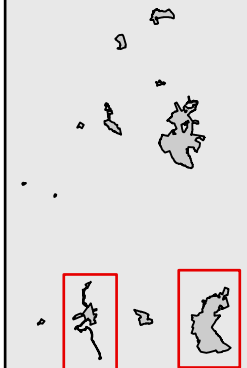
### Malvern Hill



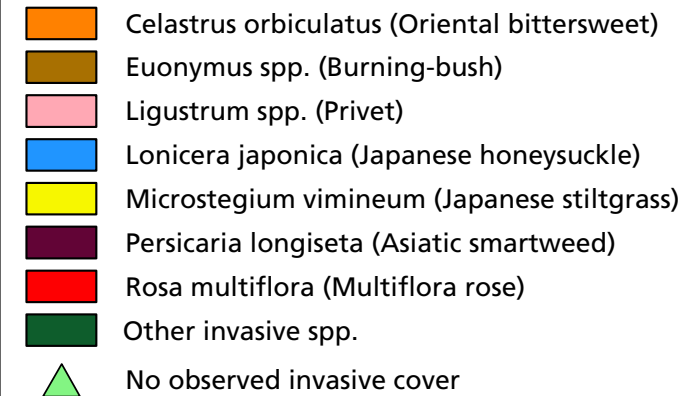
### Vegetation types



### RICH Units



### Species in pie charts

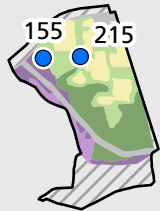




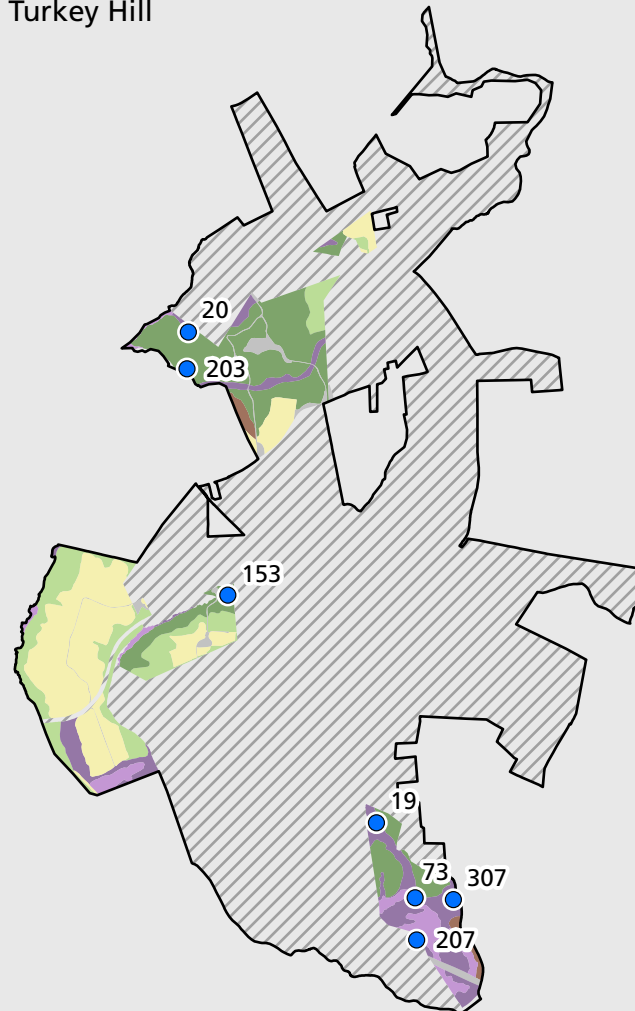
## Map 9a. Forest Pest/Pathogen Detections

Detection of priority forest pests in forest plots sampled during the most recent census (2021-2023). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/15/2023.

### Rural Point



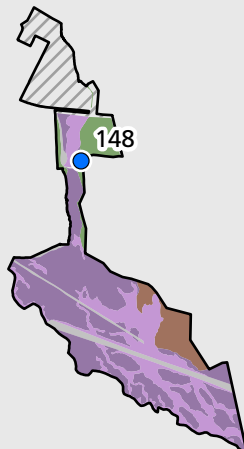
### Cold Harbor Gaines' Mill Turkey Hill



### Chickahominy Bluff



### Beaverdam Creek



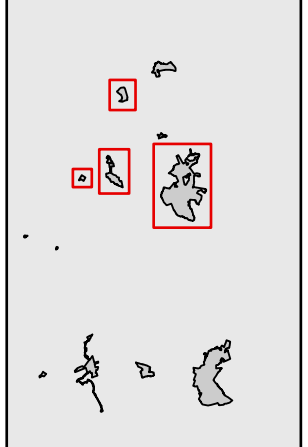
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Pests/Pathogens

- Dogwood Anthracnose (DOG)
- No detections

### RICH Units



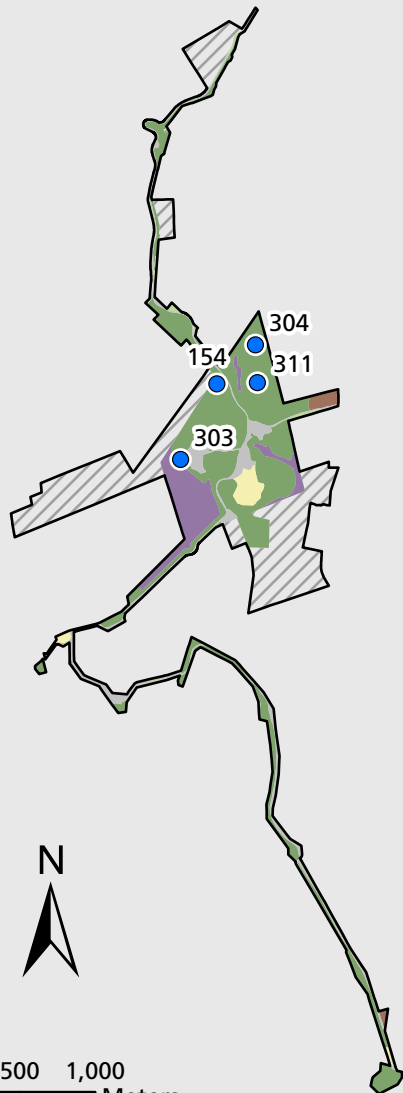
0 500 1,000  
Meters



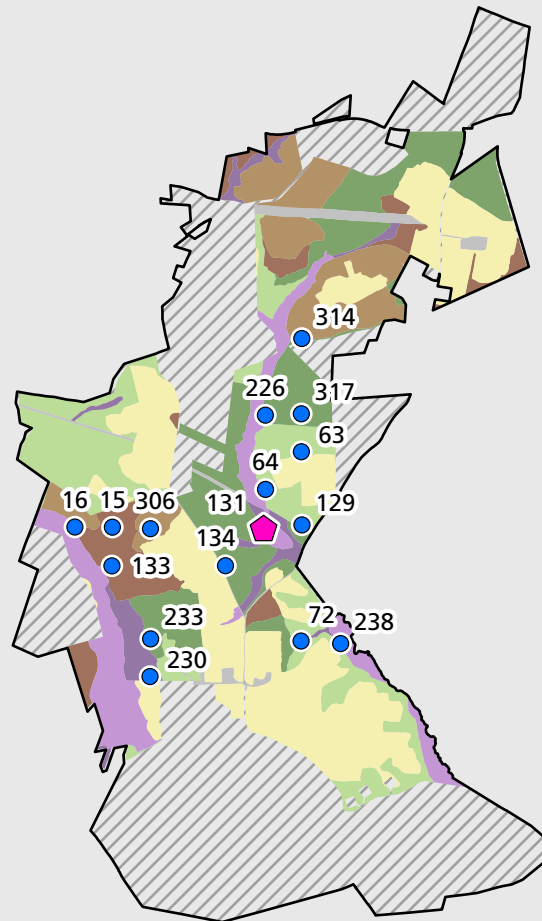
## Map 9b. Forest Pest/Pathogen Detections

Detection of priority forest pests in forest plots sampled during the most recent census (2021-2023). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/15/2023.

### Fort Harrison



### Malvern Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Pests/Pathogens

- Dogwood Anthracnose (DOG)
- No detections

### RICH Units

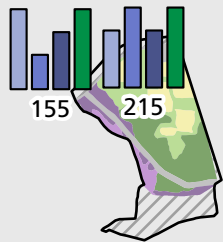




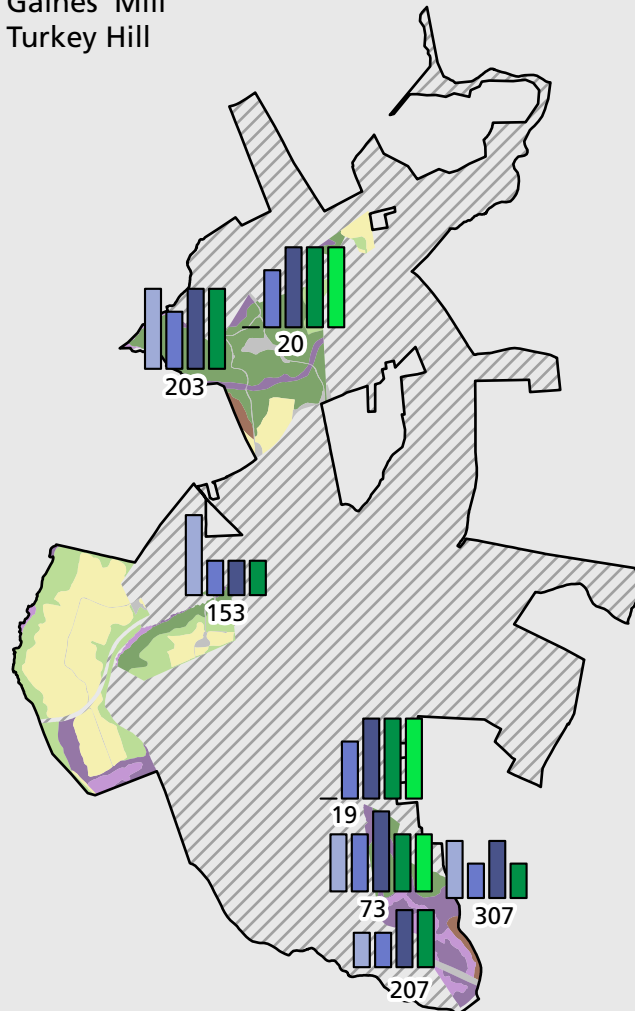
## Map 10a. Canopy Cover by Cycle

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 10 - 25% to >75% across all park units. Canopy cover was not measured in 2007. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/15/2023.

### Rural Point



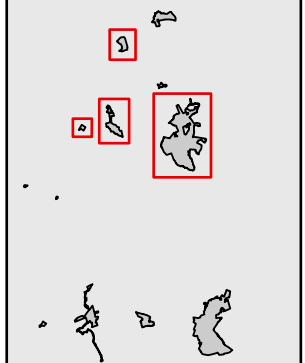
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

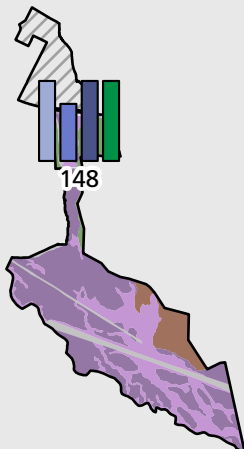
### RICH Units



### Chickahominy Bluff



### Beaverdam Creek



### Canopy cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023



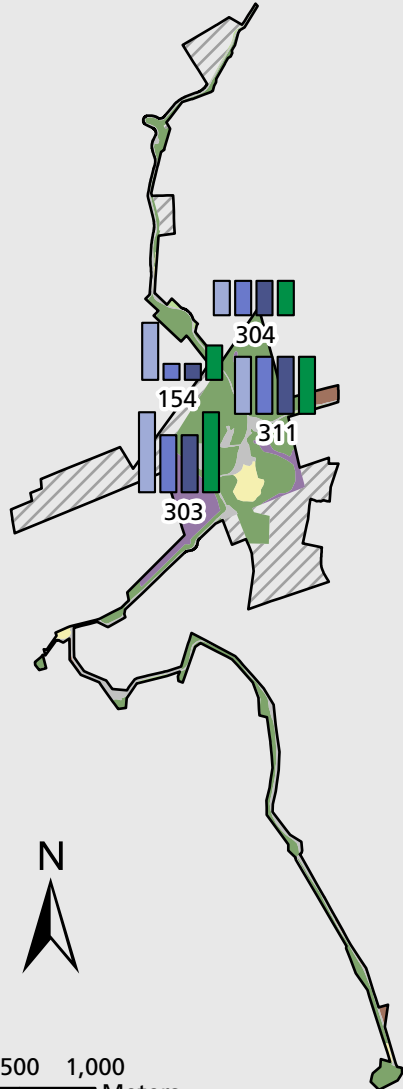
0 500 1,000  
Meters



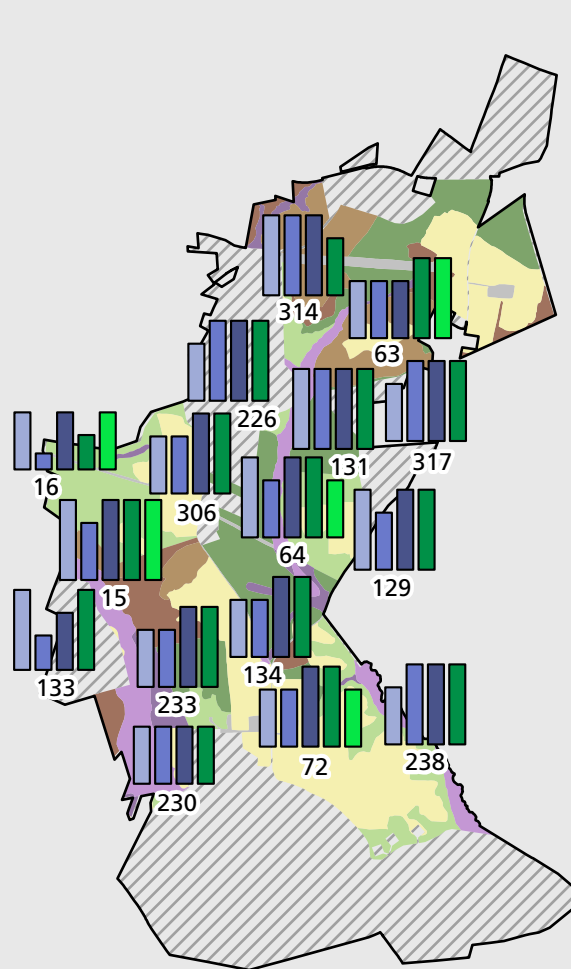
## Map 10b. Canopy Cover by Cycle

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 10 - 25% to >75% across all park units. Canopy cover was not measured in 2007. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 12/15/2023.

### Fort Harrison



### Malvern Hill



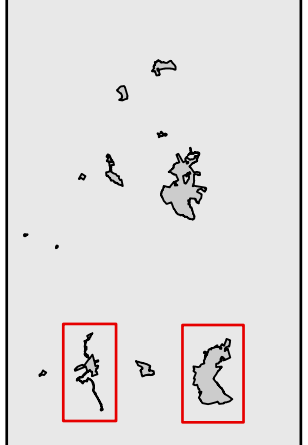
### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Canopy cover

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023

### RICH Units

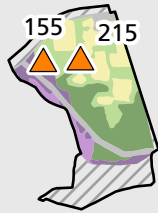




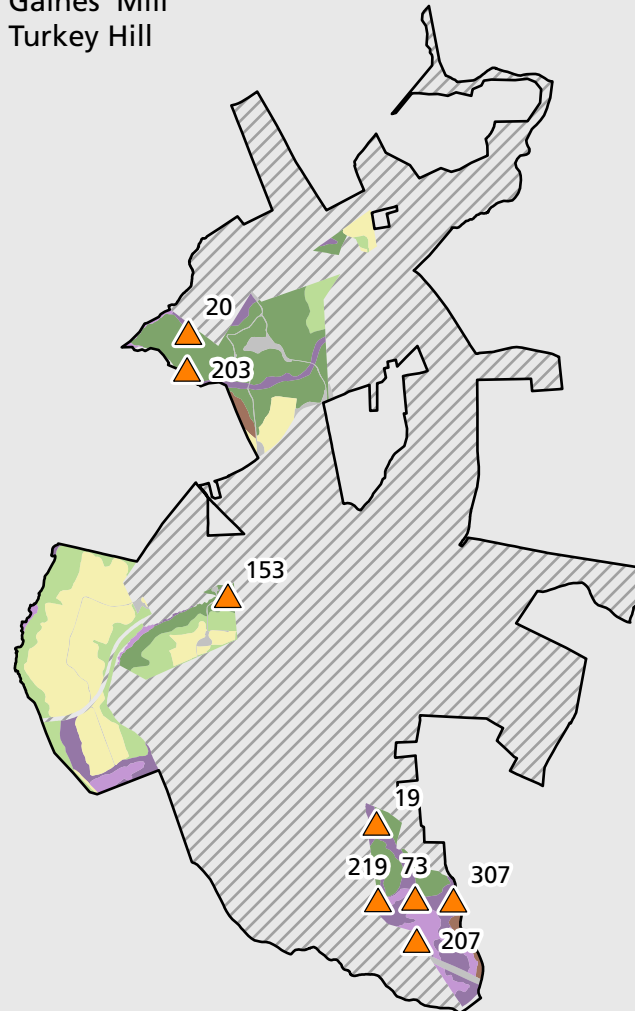
## Map 11a. Ash Tree Density by Cycle

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 8 stems/400m<sup>2</sup> across all park units, and only include individuals >10 cm DBH. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 01/17/2024.

### Rural Point



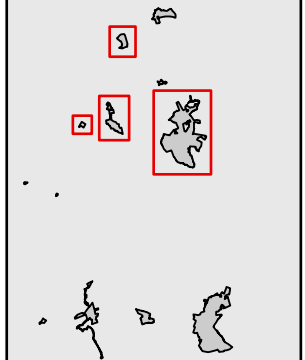
### Cold Harbor Gaines' Mill Turkey Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

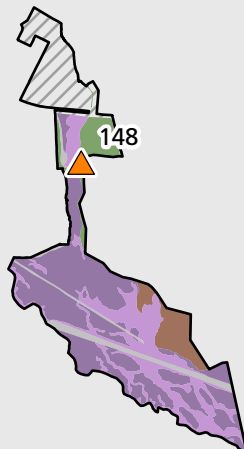
### RICH Units



### Chickahominy Bluff



### Beaverdam Creek



### Ash tree densities

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023
- No ash trees present



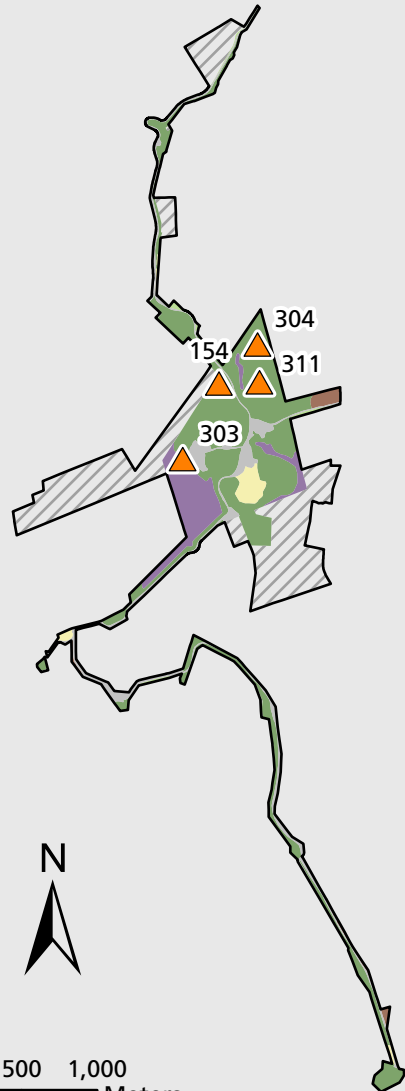
0 500 1,000  
Meters



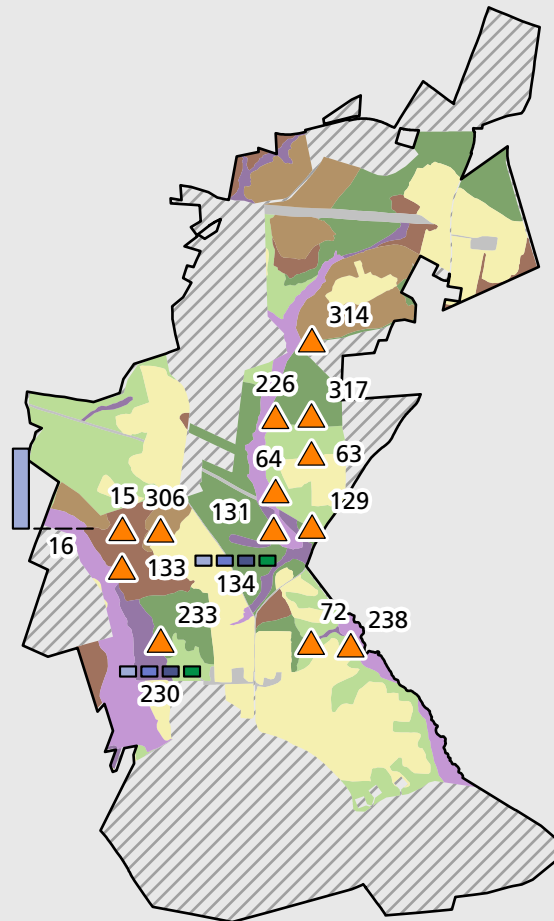
## Map 11b. Ash Tree Density by Cycle

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 8 stems/400m<sup>2</sup> across all park units, and only include individuals >10 cm DBH. Note that plot 219 was not sampled in 2021 due to safety concerns and was not included in this analysis. Reporting Date: 01/17/2024.

### Fort Harrison



### Malvern Hill



### Vegetation types

- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

### Ash tree densities

- Cycle 1: 2007 to 2010
- Cycle 2: 2011 to 2014
- Cycle 3: 2015 to 2018
- Cycle 4: 2019 to 2022
- Cycle 5: 2023
- No ash trees present

### RICH Units



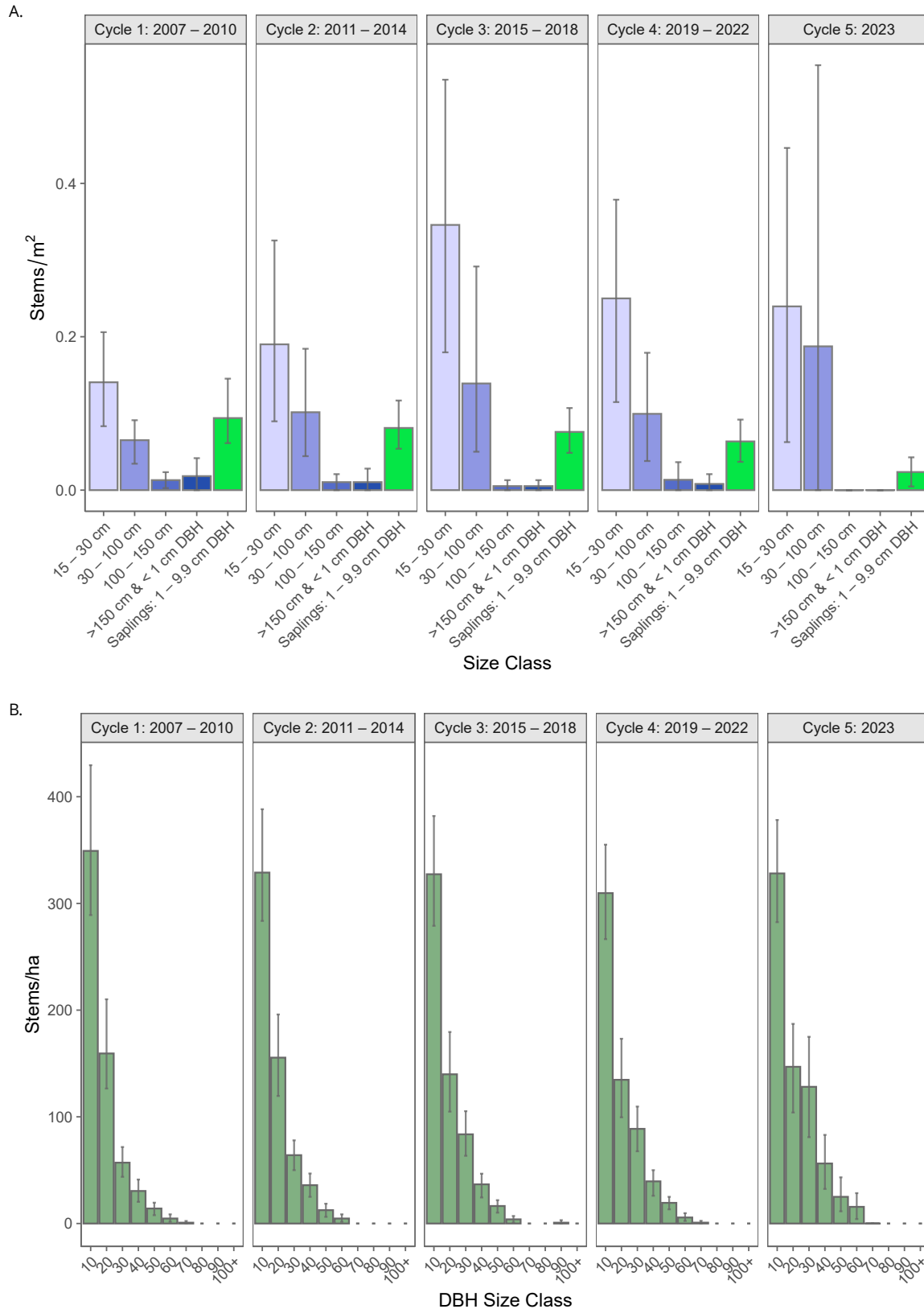


**Figure 1.** Stem density distributions by cycle in Richmond National Battlefield Park (RICH). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2022; Cycle 5: 2023. Note that cycle 5 is only partially complete. Figure A shows regeneration densities by size class. Figure 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.

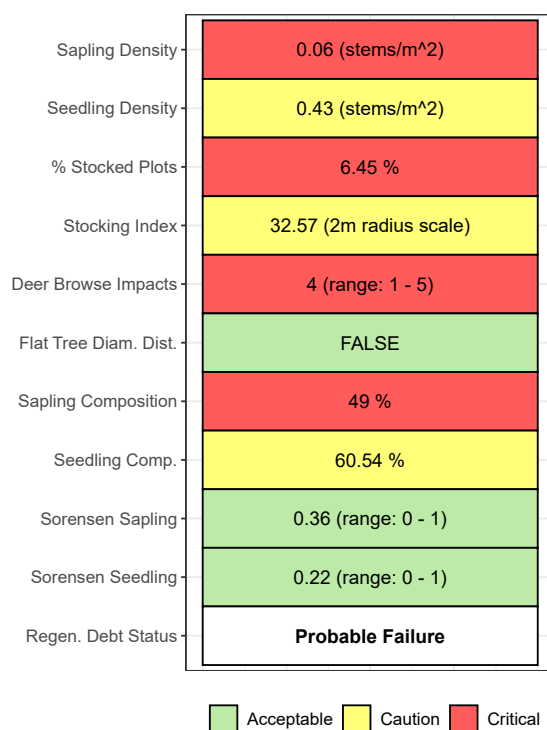


**Figure 2.** Regeneration Debt status for the most recent 4-year census (2021 – 2023) in Richmond National Battlefield Park (RICH). Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. Sapling/Seedling 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>).

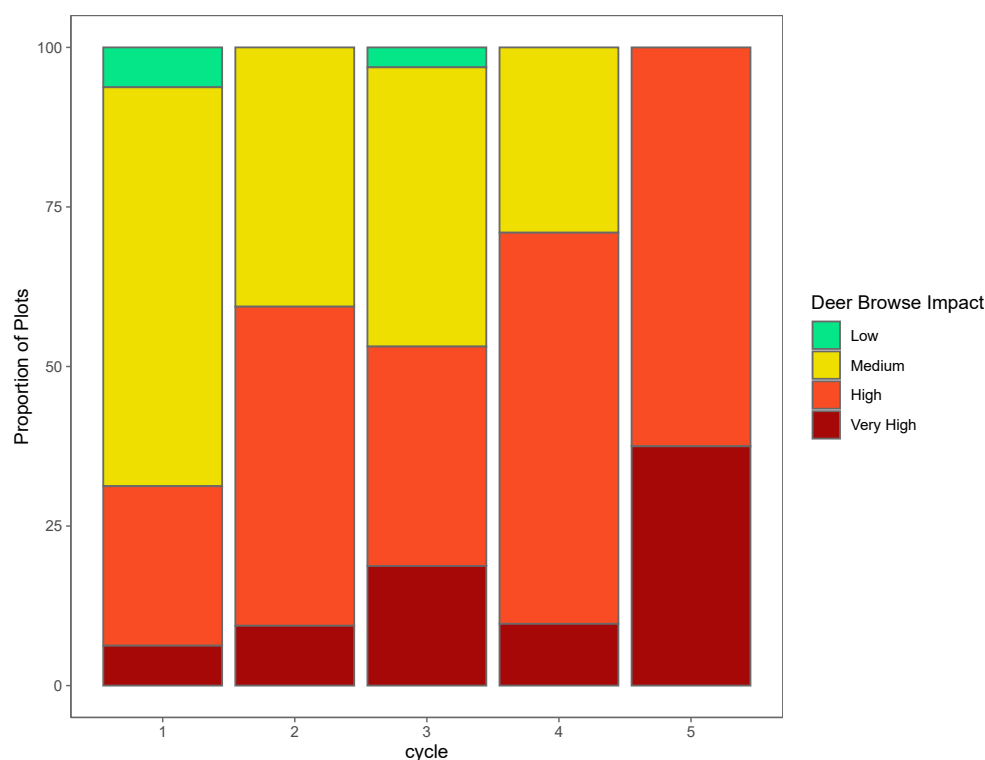


**Figure 3.** Deer browse impacts by cycle in Richmond National Battlefield Park (RICH). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2022; Cycle 5: 2023. Note that cycle 5 is only partially complete.

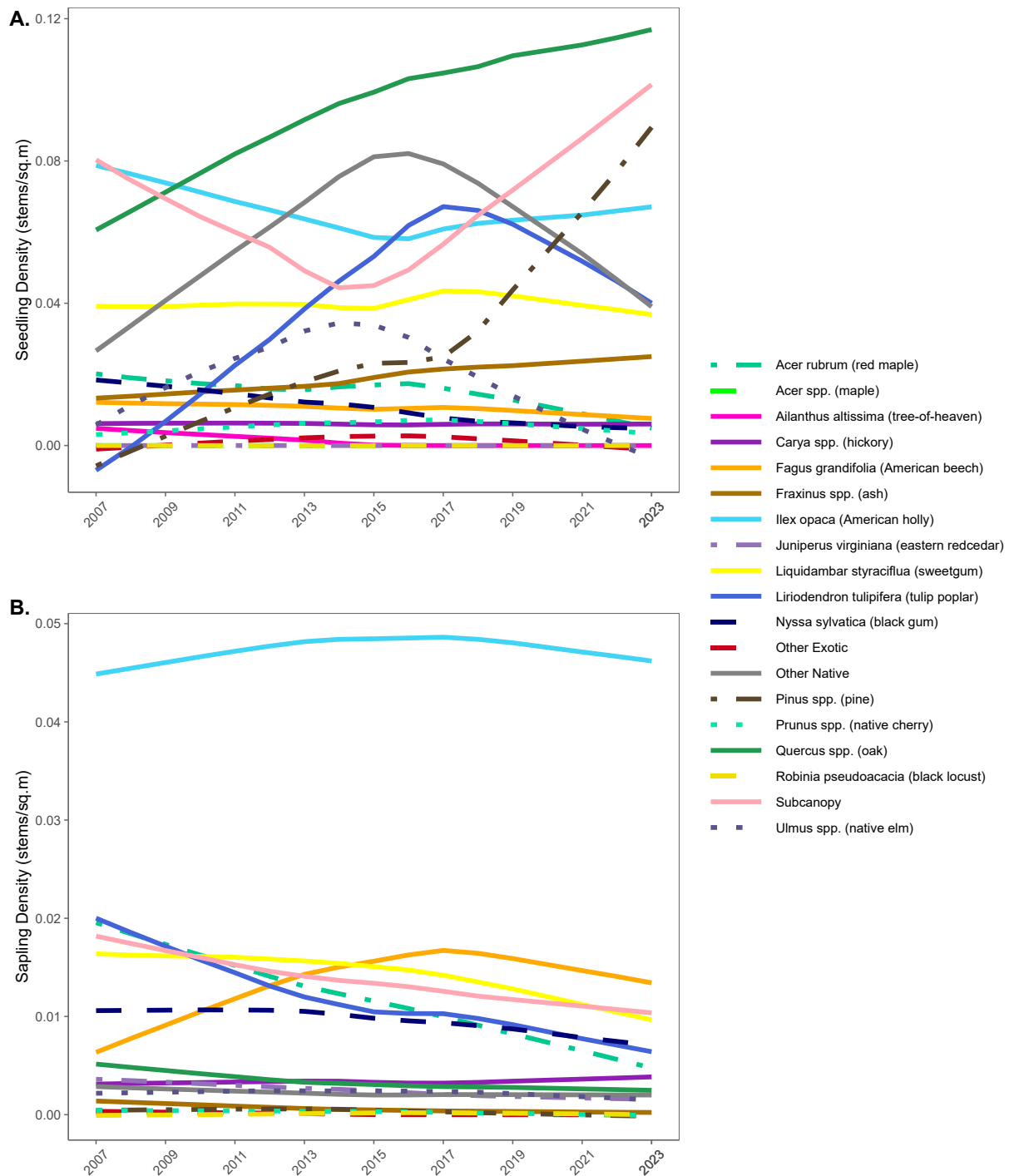


**Figure 4.** Loess smoothed changes in stem density for seedlings (A) and saplings (B) by species group and sample year in Richmond National Battlefield Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

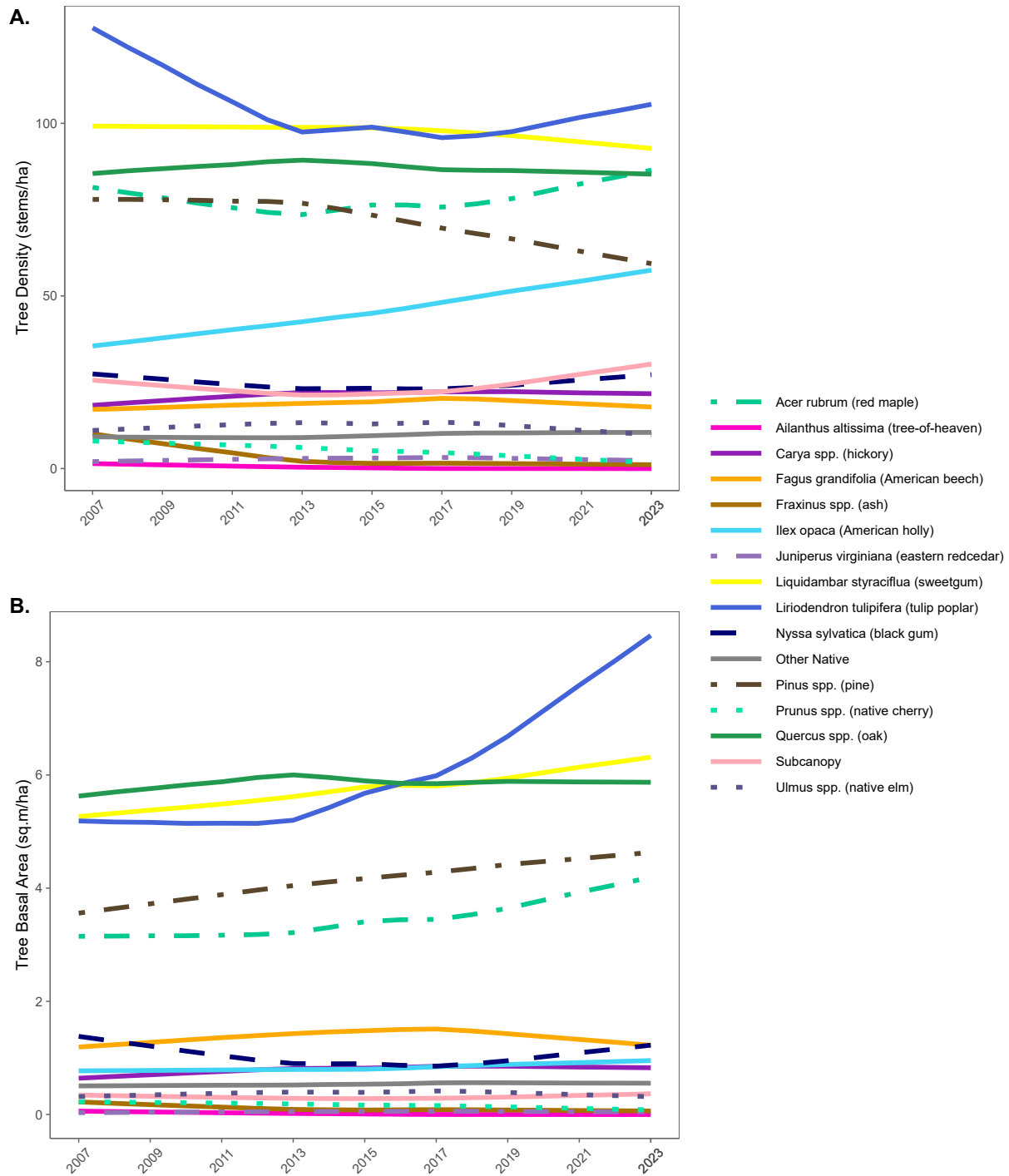


**Figure 5.** Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Richmond National Battlefield Park. Specified loess span approximated a linear trend between consecutive sample events per panel.

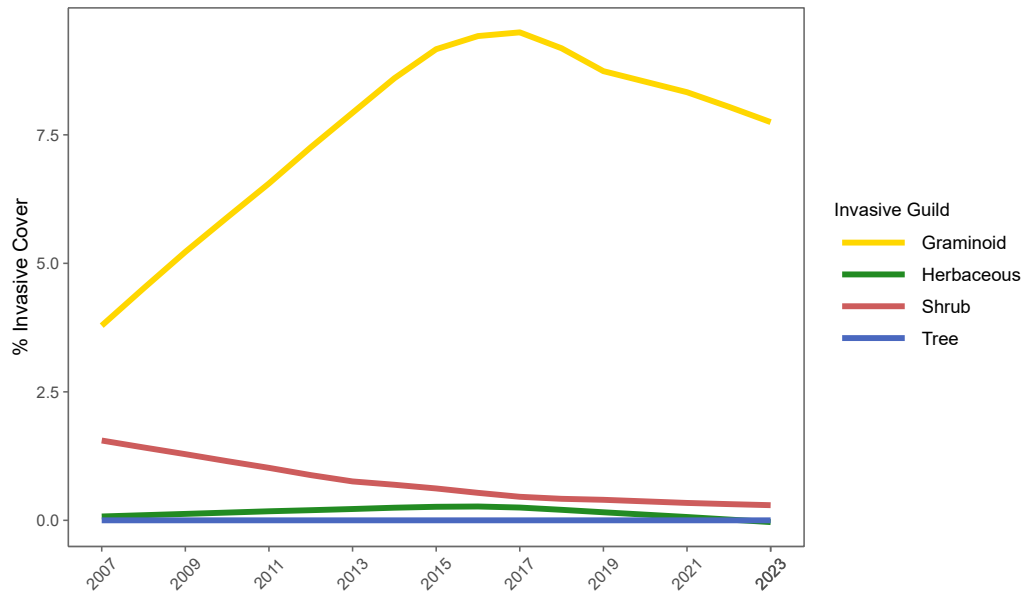


**Figure 6.** Loess smoothed changes in invasive plant percent cover by guild and sample year in Richmond National Battlefield Park. Specified loess span approximated a linear trend between consecutive sample events per panel.



**Table 1.** Average plot-level seedling and sapling stem densities (stems per m<sup>2</sup>) 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 – 2022; Cycle 5: 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/m<sup>2</sup> and 0.14 saplings/m<sup>2</sup> 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 5 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 5 | Cycle 1           | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 | Cycle 1        | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 |
| 15   | 1     | 0.00               | 0.42    | 0.25    | 0.08    | 0.08    | 0.07              | 0.06    | 0.02    | 0.02    | 0.02    | 14.83          | 21.11   | 10.56   | 8.42    | 8.42    |
| 16   | 1     | 0.00               | 0.00    | 1.33    | 0.25    | 2.25    | 0.02              | 0.00    | 0.01    | 0.02    | 0.07    | 0.00           | 0.00    | 17.84   | 10.56   | 67.23   |
| 19   | 1     | 0.08               | 0.17    | 0.00    | 0.00    | 0.08    | 0.00              | 0.00    | 0.00    | 0.00    | 0.01    | 2.14           | 2.14    | 0.00    | 0.00    | 8.42    |
| 20   | 1     | 0.58               | 0.25    | 0.25    | 0.25    | 0.08    | 0.04              | 0.01    | 0.02    | 0.02    | 0.02    | 22.12          | 3.14    | 10.56   | 11.56   | 9.55    |
| 63   | 1     | 0.50               | 0.00    | 0.17    | 0.00    | 0.08    | 0.01              | 0.01    | 0.01    | 0.01    | 0.00    | 10.43          | 0.00    | 2.14    | 0.00    | 1.01    |
| 64   | 1     | 0.08               | 0.00    | 0.00    | 0.00    | 0.08    | 0.01              | 0.00    | 0.00    | 0.00    | 0.00    | 1.01           | 0.00    | 0.00    | 0.00    | 1.01    |
| 72   | 1     | 0.33               | 0.00    | 0.00    | 0.17    | 0.25    | 0.33              | 0.07    | 0.06    | 0.01    | 0.00    | 192.89         | 7.41    | 7.41    | 2.14    | 3.14    |
| 73   | 1     | 0.42               | 0.00    | 2.10    | 0.75    | 0.50    | 0.21              | 0.17    | 0.12    | 0.07    | 0.06    | 27.52          | 29.66   | 36.32   | 11.56   | 7.29    |
| 129  | 2     | 0.25               | 0.33    | 0.17    | 0.33    | -       | 0.09              | 0.13    | 0.08    | 0.08    | -       | 34.81          | 35.94   | 17.97   | 20.11   | -       |
| 131  | 2     | 0.17               | 0.08    | 0.25    | 0.67    | -       | 0.00              | 0.00    | 0.00    | 0.00    | -       | 2.14           | 1.01    | 3.14    | 8.42    | -       |
| 133  | 2     | 0.33               | 0.25    | 0.25    | 0.17    | -       | 0.32              | 0.25    | 0.26    | 0.14    | -       | 81.43          | 69.62   | 62.20   | 11.56   | -       |
| 134  | 2     | 0.00               | 0.00    | 0.00    | 0.00    | -       | 0.01              | 0.01    | 0.01    | 0.01    | -       | 0.00           | 0.00    | 7.41    | 0.00    | -       |
| 148  | 2     | 0.25               | 0.25    | 0.00    | 0.08    | -       | 0.13              | 0.07    | 0.05    | 0.02    | -       | 85.07          | 17.97   | 7.41    | 1.01    | -       |
| 153  | 2     | 0.25               | 0.08    | 3.42    | 2.00    | -       | 0.04              | 0.04    | 0.18    | 0.27    | -       | 23.00          | 8.42    | 148.53  | 306.75  | -       |
| 154  | 2     | 0.33               | 0.58    | 0.58    | 1.92    | -       | 0.25              | 0.22    | 0.21    | 0.19    | -       | 86.71          | 76.15   | 61.32   | 76.91   | -       |
| 155  | 2     | 0.00               | 0.00    | 0.00    | 0.00    | -       | 0.00              | 0.00    | 0.00    | 0.00    | -       | 0.00           | 0.00    | 0.00    | 0.00    | -       |
| 203  | 3     | 0.33               | 0.33    | 0.17    | 0.08    | -       | 0.18              | 0.25    | 0.27    | 0.28    | -       | 254.47         | 298.83  | 143.88  | 193.15  | -       |
| 207  | 3     | 0.50               | 0.17    | 0.08    | 0.08    | -       | 0.02              | 0.05    | 0.04    | 0.02    | -       | 8.42           | 16.96   | 9.55    | 9.55    | -       |
| 215  | 3     | 0.08               | 3.17    | 2.08    | 0.58    | -       | 0.15              | 0.19    | 0.20    | 0.15    | -       | 24.38          | 96.76   | 145.27  | 60.19   | -       |
| 219  | 3     | 0.67               | 0.67    | 1.17    | -       | -       | 0.11              | 0.14    | 0.14    | -       | -       | 57.93          | 51.65   | 43.23   | -       | -       |
| 226  | 3     | 0.08               | 0.17    | 0.33    | 0.17    | -       | 0.01              | 0.01    | 0.04    | 0.04    | -       | 8.42           | 11.56   | 28.53   | 25.38   | -       |
| 230  | 3     | 0.50               | 0.75    | 0.58    | 0.42    | -       | 0.05              | 0.06    | 0.05    | 0.06    | -       | 29.28          | 42.98   | 18.98   | 25.26   | -       |
| 233  | 3     | 0.75               | 0.33    | 1.00    | 0.58    | -       | 0.06              | 0.07    | 0.06    | 0.05    | -       | 46.24          | 77.79   | 79.80   | 22.12   | -       |
| 238  | 3     | 0.00               | 0.00    | 0.00    | 0.00    | -       | 0.05              | 0.05    | 0.01    | 0.01    | -       | 22.24          | 22.24   | 0.00    | 0.00    | -       |
| 303  | 4     | 0.25               | 0.42    | 0.42    | 0.58    | -       | 0.06              | 0.06    | 0.06    | 0.06    | -       | 17.97          | 20.11   | 13.70   | 14.70   | -       |
| 304  | 4     | 0.42               | 0.92    | 0.92    | 2.00    | -       | 0.14              | 0.13    | 0.11    | 0.09    | -       | 15.83          | 55.54   | 35.56   | 49.26   | -       |
| 306  | 4     | 0.00               | 0.00    | 0.00    | 0.00    | -       | 0.07              | 0.07    | 0.06    | 0.01    | -       | 14.83          | 7.41    | 7.41    | 0.00    | -       |
| 307  | 4     | 0.25               | 0.42    | 0.17    | 0.17    | -       | 0.02              | 0.01    | 0.05    | 0.06    | -       | 5.28           | 6.28    | 25.38   | 32.80   | -       |
| 309  | 4     | 0.00               | 0.08    | 0.00    | 0.00    | -       | 0.02              | 0.01    | 0.00    | 0.00    | -       | 14.83          | 2.14    | 0.00    | 0.00    | -       |
| 311  | 4     | 0.17               | 0.17    | 0.17    | 0.17    | -       | 0.02              | 0.02    | 0.01    | 0.01    | -       | 2.14           | 2.14    | 2.14    | 2.14    | -       |



**Table 1 (cont.).** Average plot-level seedling and sapling stem densities (stems per m<sup>2</sup>) 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 – 2022; Cycle 5: 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/m<sup>2</sup> and 0.14 saplings/m<sup>2</sup> 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 5 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 5 | Cycle 1           | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 | Cycle 1        | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 |
| 314  | 4     | 0                  | 0       | 0       | 0       | -       | 0.48              | 0.41    | 0.28    | 0.22    | -       | 111.09         | 81.43   | 51.9    | 44.48   | -       |
| 317  | 4     | 0                  | 0       | 0       | 0       | -       | 0.02              | 0.02    | 0.02    | 0.01    | -       | 0.00           | 0.00    | 0.0     | 0.00    | -       |



**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 – 2022; Cycle 5: 2023. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). Note that cycle 5 is only partially complete. 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 5 | Cycle 1                    | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 |
| 15       | 1         | 9.96            | 8.77    | 11.79   | 27.46   | 21.13   | 2                          | 3       | 3       | 3       | 2       |
| 16       | 1         | 14.72           | 44.09   | 24.53   | 12.47   | 15.57   | 2                          | 3       | 2       | 2       | 2       |
| 19       | 1         | 0.00            | 0.00    | 0.16    | 4.40    | 6.88    | 0                          | 1       | 3       | 4       | 3       |
| 20       | 1         | 0.00            | 0.00    | 0.00    | 0.00    | 0.13    | 0                          | 0       | 1       | 1       | 1       |
| 63       | 1         | 8.08            | 4.95    | 23.62   | 8.02    | 5.63    | 2                          | 2       | 2       | 4       | 4       |
| 64       | 1         | 2.25            | 1.34    | 18.18   | 5.35    | 5.54    | 2                          | 2       | 2       | 4       | 4       |
| 72       | 1         | 6.29            | 0.99    | 15.72   | 44.37   | 20.24   | 3                          | 4       | 4       | 4       | 4       |
| 73       | 1         | 0.00            | 0.01    | 0.00    | 0.02    | 0.01    | 0                          | 1       | 0       | 1       | 1       |
| 129      | 2         | 0.97            | 33.67   | 9.19    | 12.44   | -       | 2                          | 2       | 3       | 4       | -       |
| 131      | 2         | 10.76           | 25.21   | 22.73   | 12.43   | -       | 3                          | 3       | 3       | 3       | -       |
| 133      | 2         | 0.00            | 0.01    | 0.00    | 0.63    | -       | 0                          | 1       | 1       | 3       | -       |
| 134      | 2         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 1       | 0       | 0       | -       |
| 148      | 2         | 2.58            | 12.14   | 6.52    | 19.33   | -       | 4                          | 4       | 5       | 4       | -       |
| 153      | 2         | 0.00            | 0.00    | 0.17    | 0.03    | -       | 0                          | 1       | 2       | 1       | -       |
| 154      | 2         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 0       | 1       | 0       | -       |
| 155      | 2         | 0.19            | 0.04    | 0.05    | 0.01    | -       | 2                          | 4       | 3       | 2       | -       |
| 203      | 3         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 0       | 0       | 0       | -       |
| 207      | 3         | 0.15            | 0.90    | 3.82    | 0.46    | -       | 1                          | 2       | 2       | 1       | -       |
| 215      | 3         | 3.81            | 10.11   | 4.42    | 0.03    | -       | 6                          | 5       | 5       | 2       | -       |
| 219      | 3         | 0.14            | 0.02    | 0.02    | -       | -       | 2                          | 1       | 1       | -       | -       |
| 226      | 3         | 0.00            | 0.31    | 0.01    | 0.01    | -       | 0                          | 1       | 1       | 1       | -       |
| 230      | 3         | 0.16            | 0.32    | 0.27    | 0.04    | -       | 2                          | 2       | 2       | 2       | -       |
| 233      | 3         | 0.00            | 0.02    | 0.12    | 0.29    | -       | 1                          | 1       | 1       | 2       | -       |
| 238      | 3         | 0.30            | 1.40    | 13.58   | 5.30    | -       | 5                          | 3       | 4       | 3       | -       |
| 303      | 4         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 0       | 0       | 0       | -       |
| 304      | 4         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 0       | 0       | 0       | -       |
| 306      | 4         | 3.41            | 4.03    | 1.62    | 0.29    | -       | 3                          | 4       | 4       | 2       | -       |
| 307      | 4         | 0.03            | 0.04    | 0.01    | 4.75    | -       | 1                          | 2       | 2       | 4       | -       |
| 309      | 4         | 33.48           | 55.72   | 65.03   | 38.95   | -       | 4                          | 3       | 3       | 6       | -       |
| 311      | 4         | 0.00            | 0.00    | 0.00    | 0.00    | -       | 0                          | 0       | 0       | 0       | -       |



**Table 2 (cont.).** 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 – 2022; Cycle 5: 2023. Plots are sampled in 4-year rotations, with a quarter of the plots sampled each year (i.e. a panel). Note that cycle 5 is only partially complete. 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 5 | Cycle 1                    | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 |
| 314      | 4         | 0.01            | 0.02    | 0       | 0.00    | -       | 1                          | 1       | 1       | 1       | -       |
| 317      | 4         | 0.00            | 0.00    | 0       | 0.01    | -       | 0                          | 1       | 1       | 1       | -       |



**Table 3.** Number of plots out of 31 where priority invasive species were detected. Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2022; Cycle 5: 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. Note that cycle 5 is only partially complete. 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 | Cycle 5 |
|------------------------------|-----------------------|---------|---------|---------|---------|---------|
| <i>Ailanthus altissima</i>   | Tree of heaven        | 3       | 1       | 0       | 2       | 0       |
| <i>Celastrus orbiculatus</i> | oriental bittersweet  | 1       | 1       | 1       | 3       | 0       |
| <i>Euonymus</i>              | burningbush           | 0       | 0       | 0       | 0       | 1       |
| <i>Ligustrum</i>             | privet                | 1       | 4       | 7       | 13      | 4       |
| <i>Lonicera - Exotic</i>     | honeysuckle - exotic  | 3       | 1       | 0       | 0       | 0       |
| <i>Lonicera japonica</i>     | Japanese honeysuckle  | 17      | 21      | 20      | 20      | 6       |
| <i>Microstegium vimineum</i> | Japanese stiltgrass   | 13      | 19      | 21      | 18      | 6       |
| <i>Persicaria longiseta</i>  | Oriental lady's thumb | 6       | 8       | 9       | 7       | 4       |
| <i>Persicaria perfoliata</i> | Asiatic tearthumb     | 0       | 1       | 1       | 0       | 0       |
| <i>Rosa multiflora</i>       | multiflora rose       | 3       | 2       | 3       | 2       | 0       |



**Table 4.** Invasive plant and pest/pathogen early detections in Richmond National Battlefield 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 |
|----------|------|--------|---------|---------------------------------------------------------|--------------------|------|
| RICH-020 | 2023 | 297600 | 4163048 | <i>Litylenchus crenatae</i> ssp. <i>Mcannii</i> complex | beech leaf disease | pest |