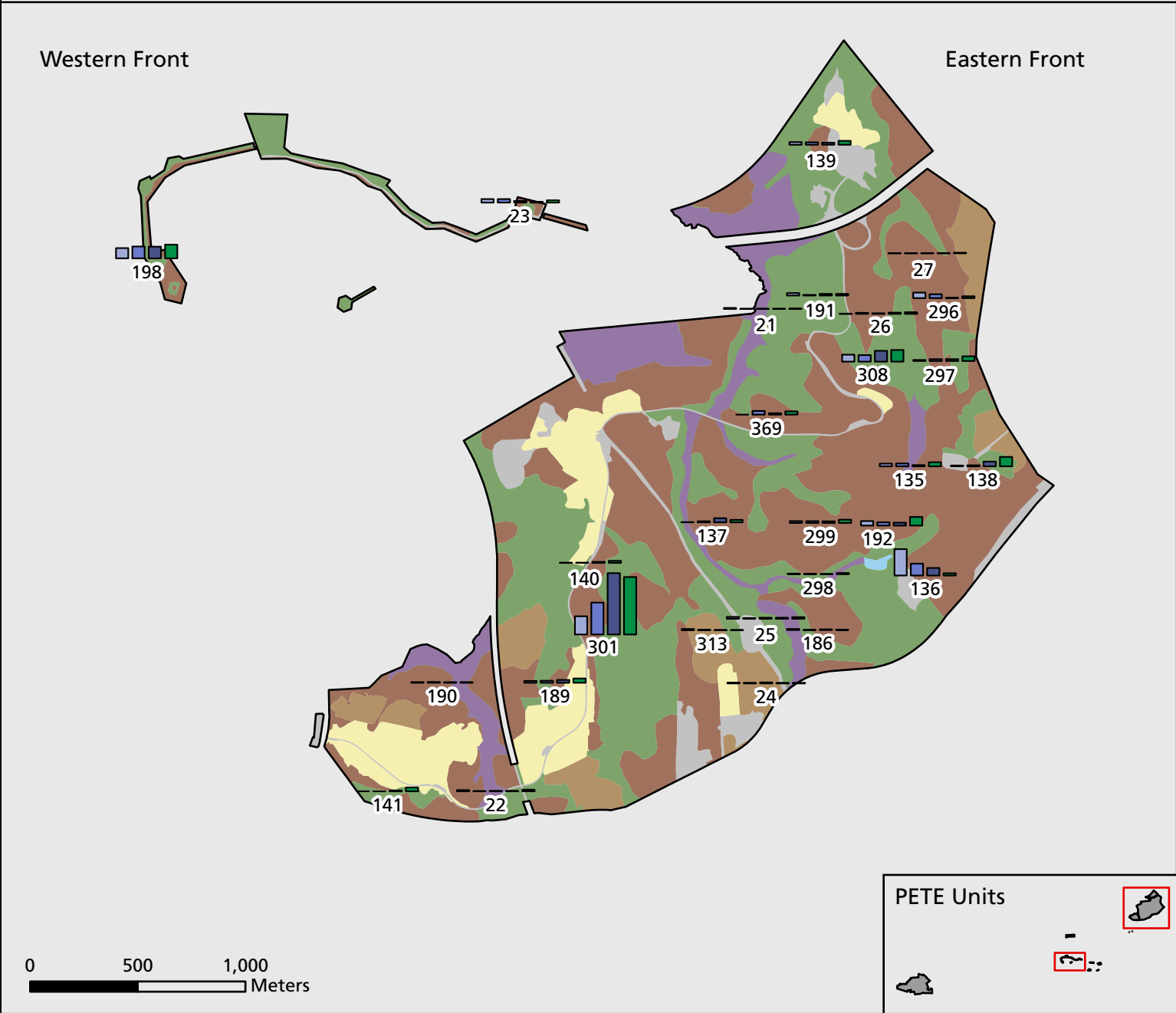




Map 1a. Tree Regeneration by Cycle

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 13.4 stems/m² across all park units, and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details.
Reporting Date: 12/20/2023.



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



Vegetation types

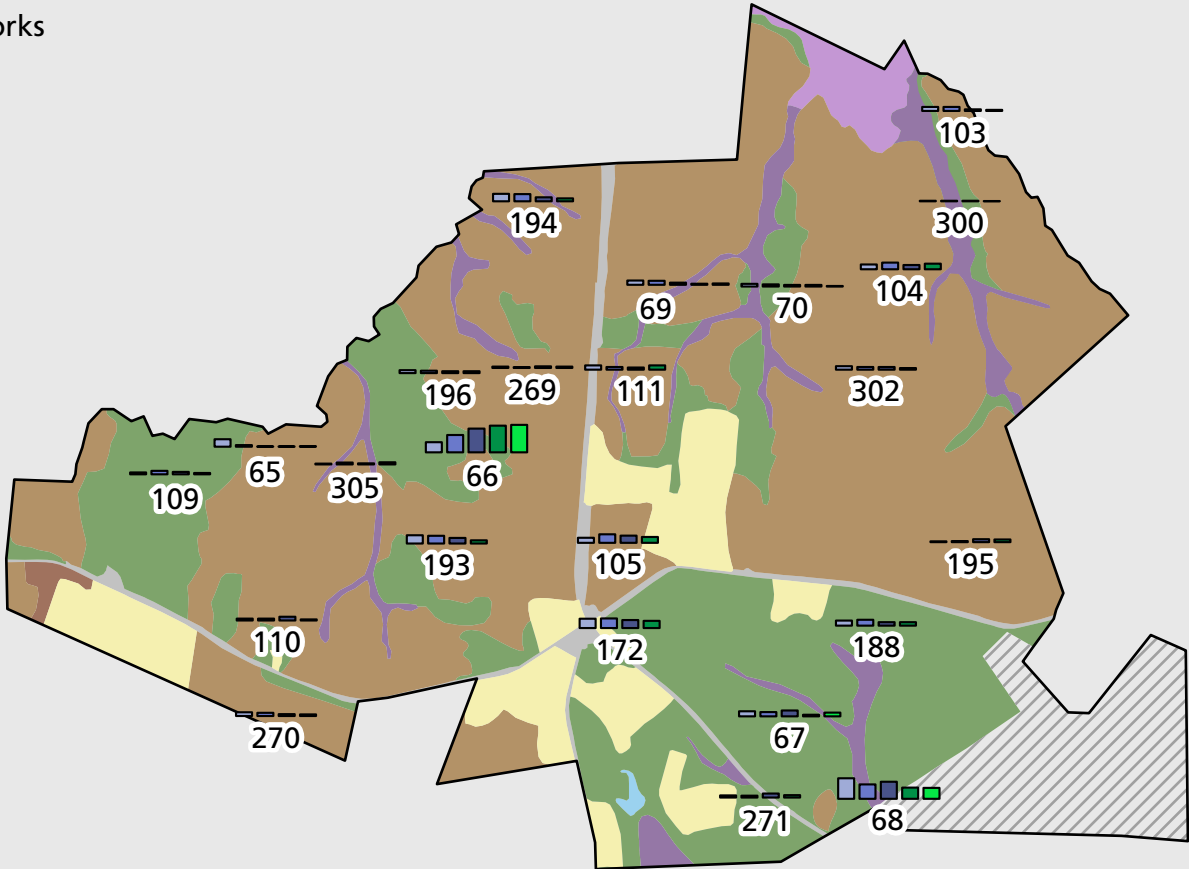
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary



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 13.4 stems/m² across all park units, and only include native canopy-forming species. Charts may be shifted to prevent overlap. See Table 1 for more details.
Reporting Date: 12/20/2023.

Five Forks



0 500 1,000
Meters

PETE Units



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



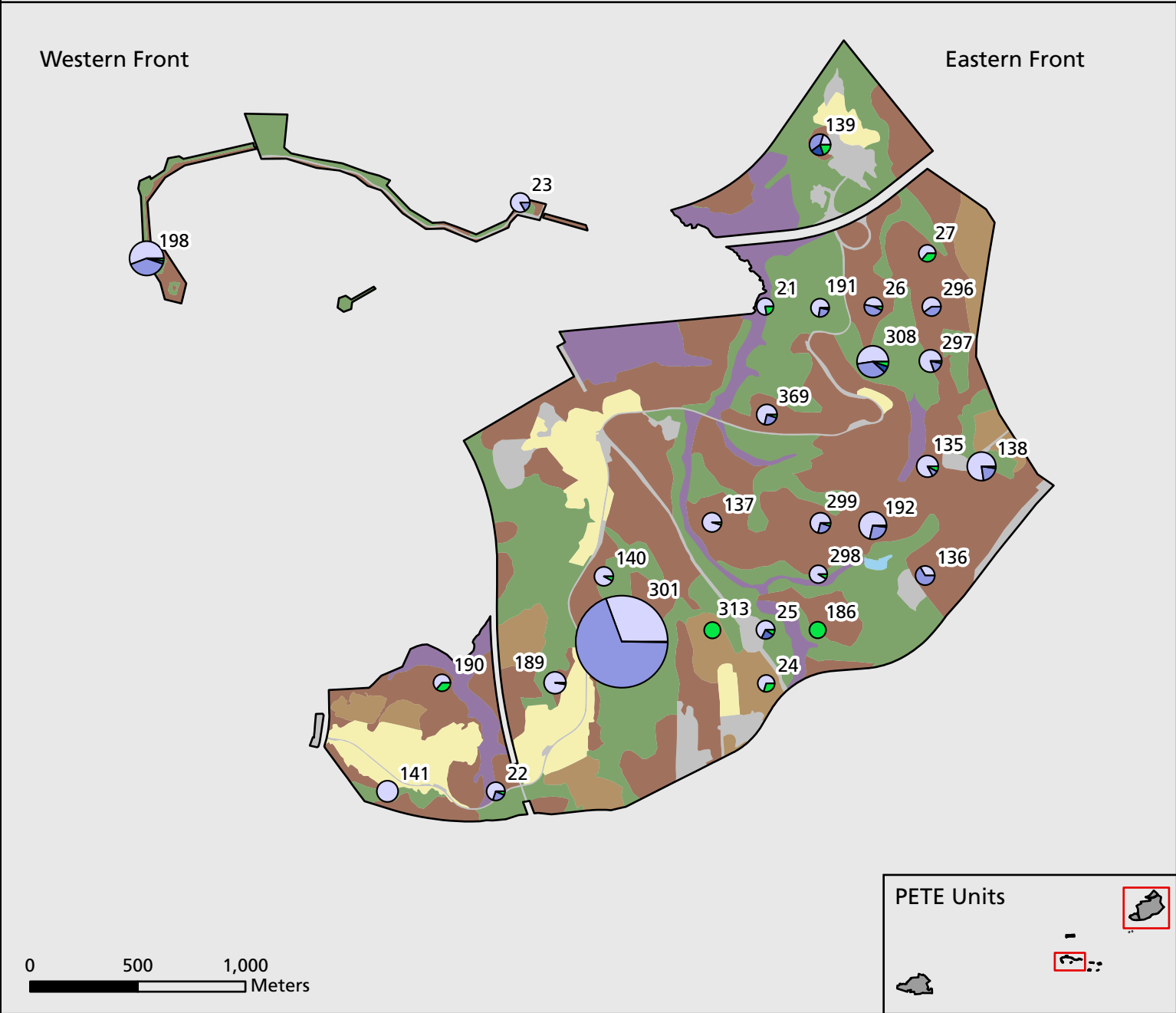
Vegetation types

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



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 12.5 stems/m² across all park units, and only include native canopy-forming species. Reporting Date: 12/20/2023.



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)



Vegetation types

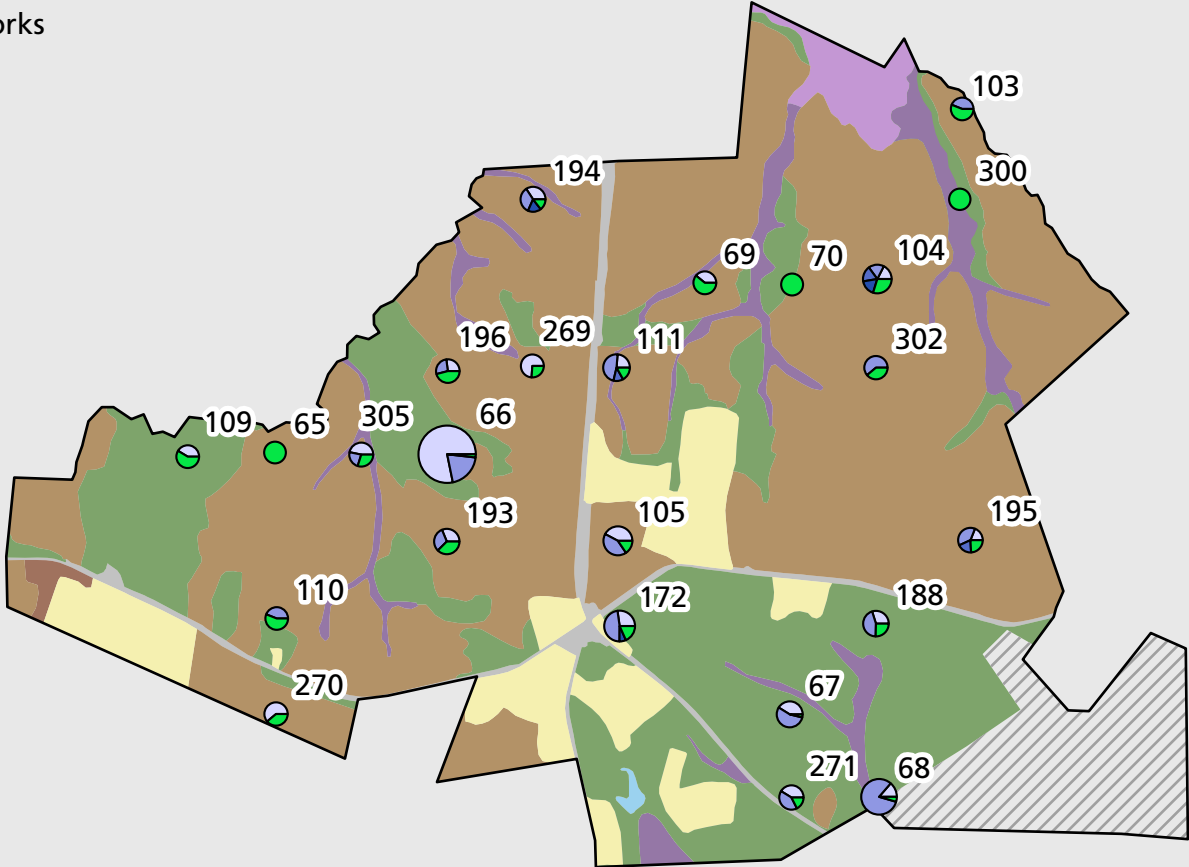
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary



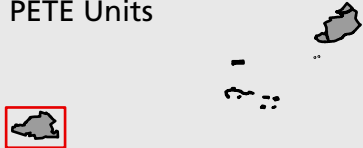
Map 2b. Tree Regeneration by Size Class

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 12.5 stems/m² across all park units, and only include native canopy-forming species. Reporting Date: 12/20/2023.

Five Forks



PETE 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)



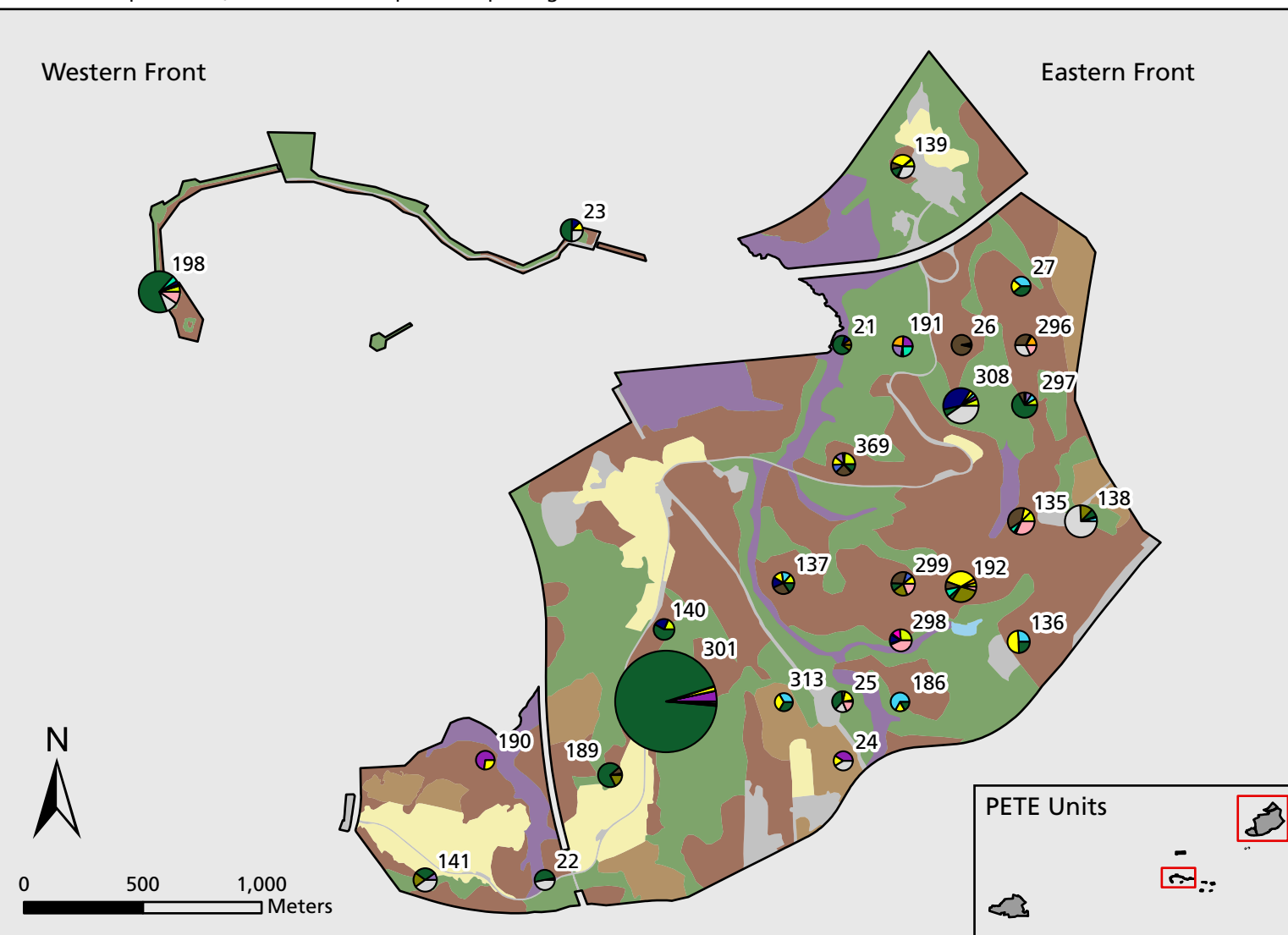
Vegetation types

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



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 0.04 to 12.5 stems/m² across all park units, and includes all species. Reporting Date: 12/20/2023.



Species in pie charts

- Acer rubrum* (Red maple)
- Ailanthus altissima* (Tree-of-heaven)
- Betula lenta* (Sweet 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.

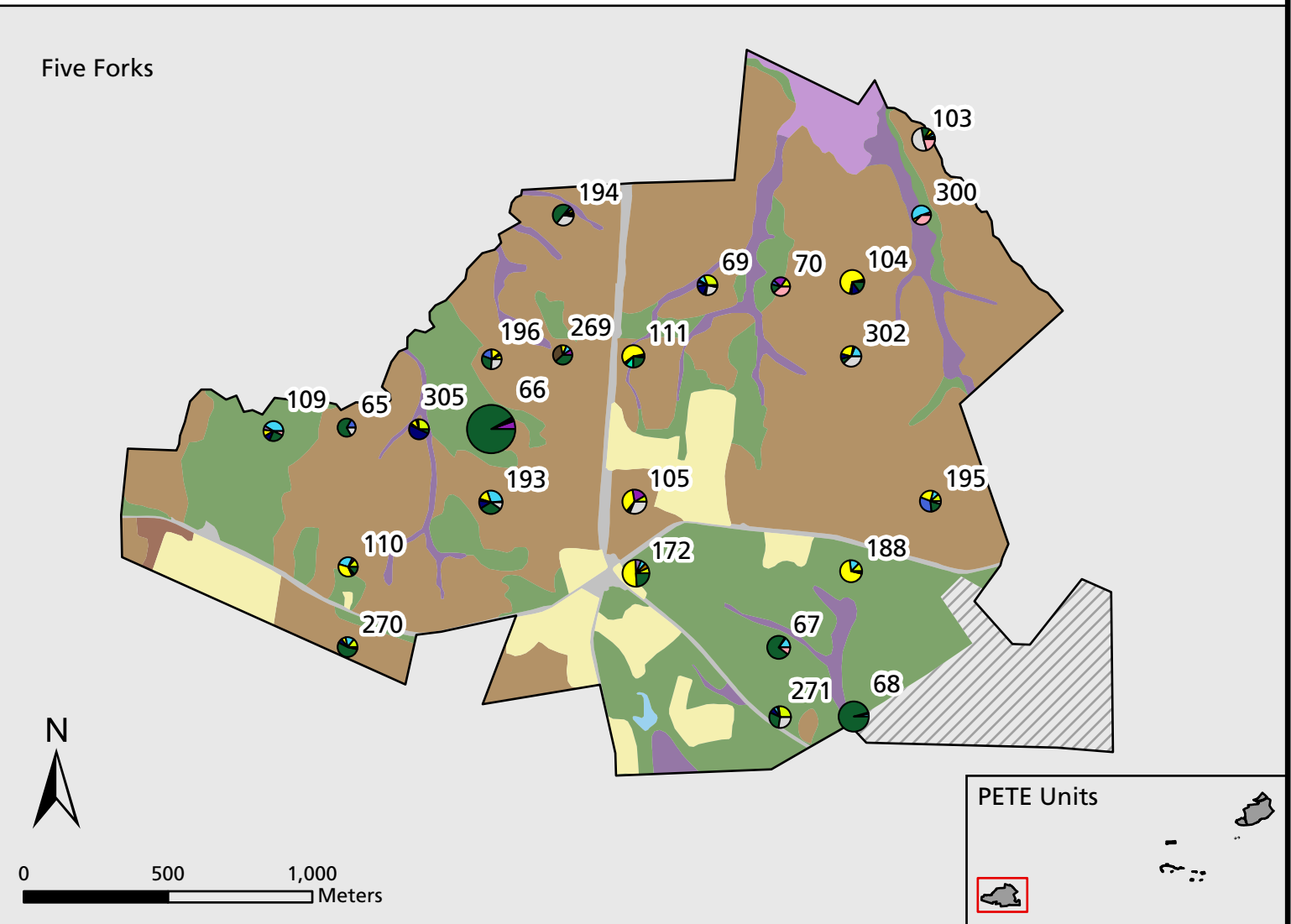
Vegetation types

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



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 0.04 to 12.5 stems/m² across all park units, and includes all species. Reporting Date: 12/20/2023.



Species in pie charts

-  *Acer rubrum* (Red maple)
-  *Ailanthus altissima* (Tree-of-heaven)
-  *Betula lenta* (Sweet 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.

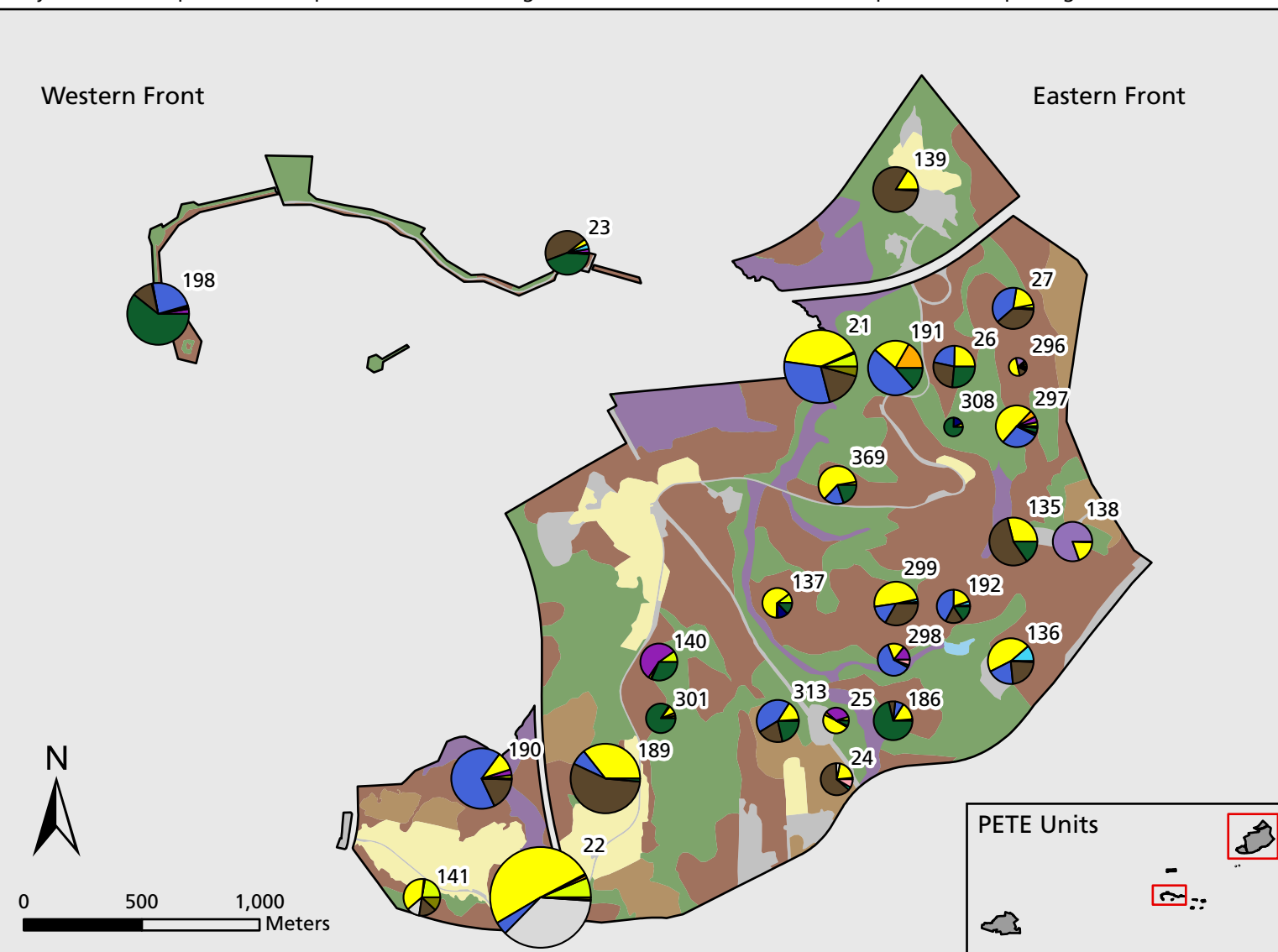
Vegetation types

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



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 16.3 to 73.6 m²/ha across all park units. Reporting Date: 12/20/2023.



Species in pie charts

- Acer rubrum* (Red maple)
- 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.

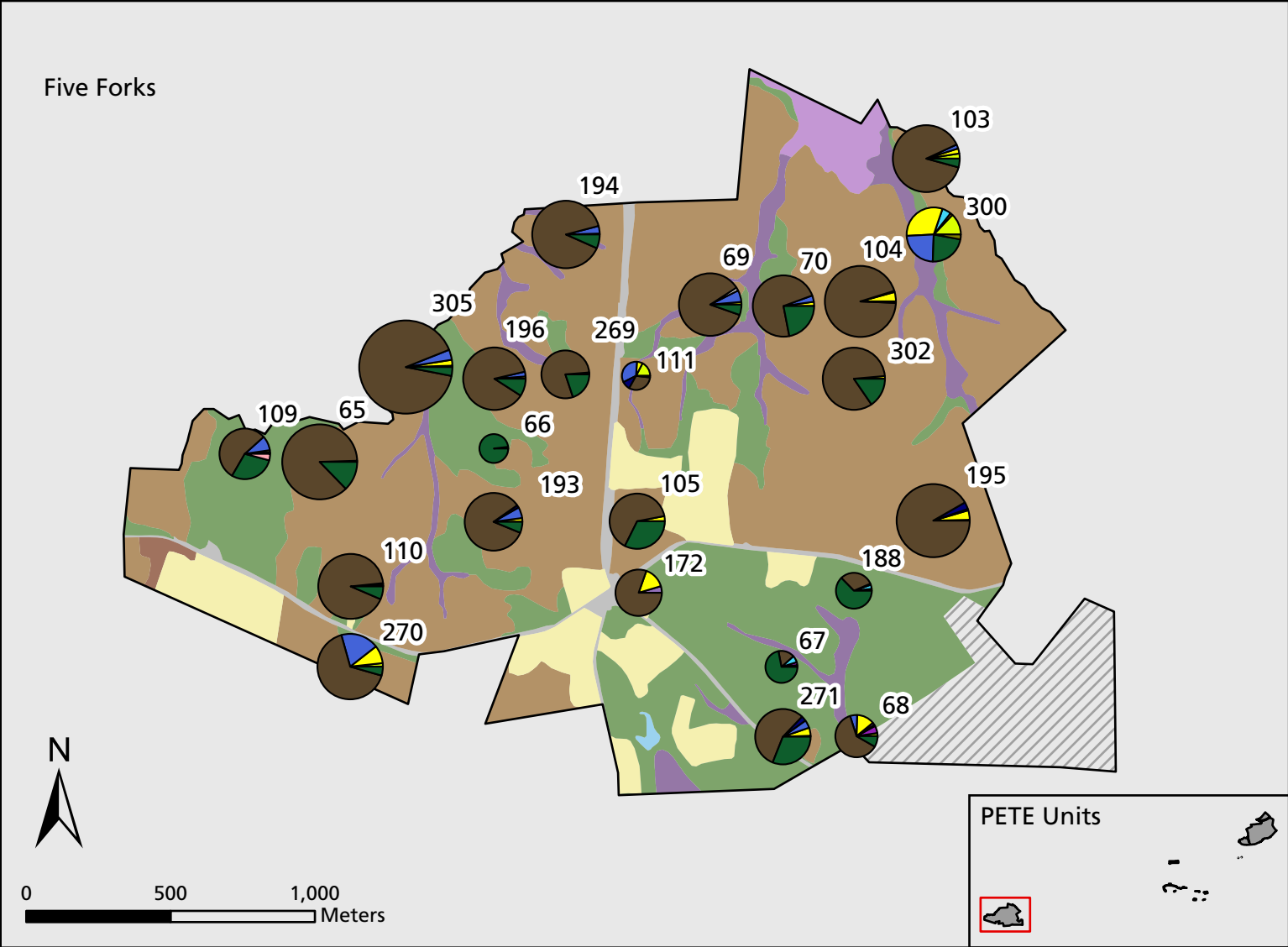
Vegetation types

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



Map 4b. Tree Canopy Composition

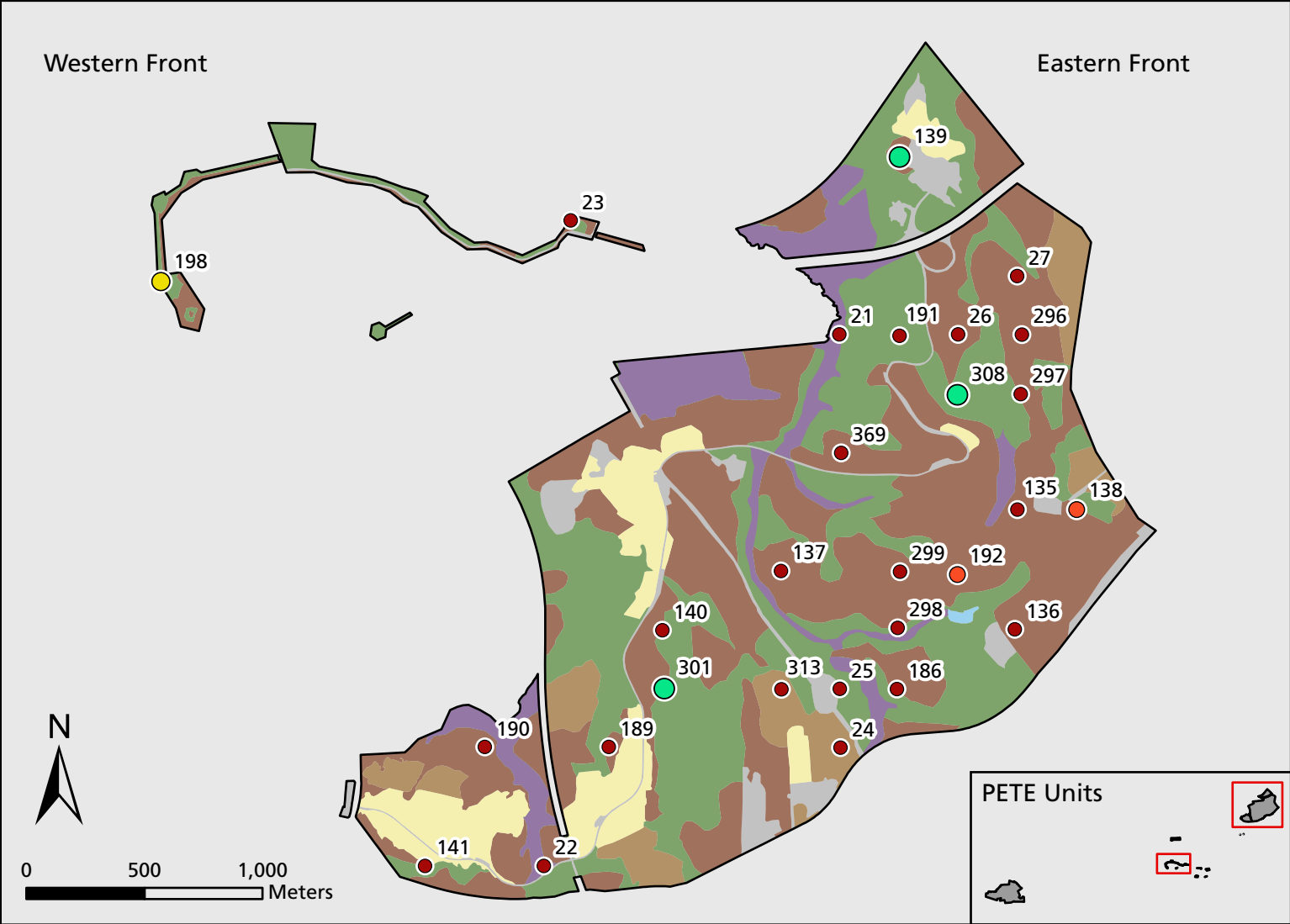
Tree composition, by species group, observed in forest plots sampled in the most recent census (2021-2023). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level basal areas. Pies may be shifted to prevent overlap. Total basal area ranges from 16.3 to 73.6 m²/ha across all park units. Reporting Date: 12/20/2023.





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 0-319.7 across all park units). Only native canopy-forming species included. See Table 1 for stocking index values. Reporting Date: 12/20/2023.

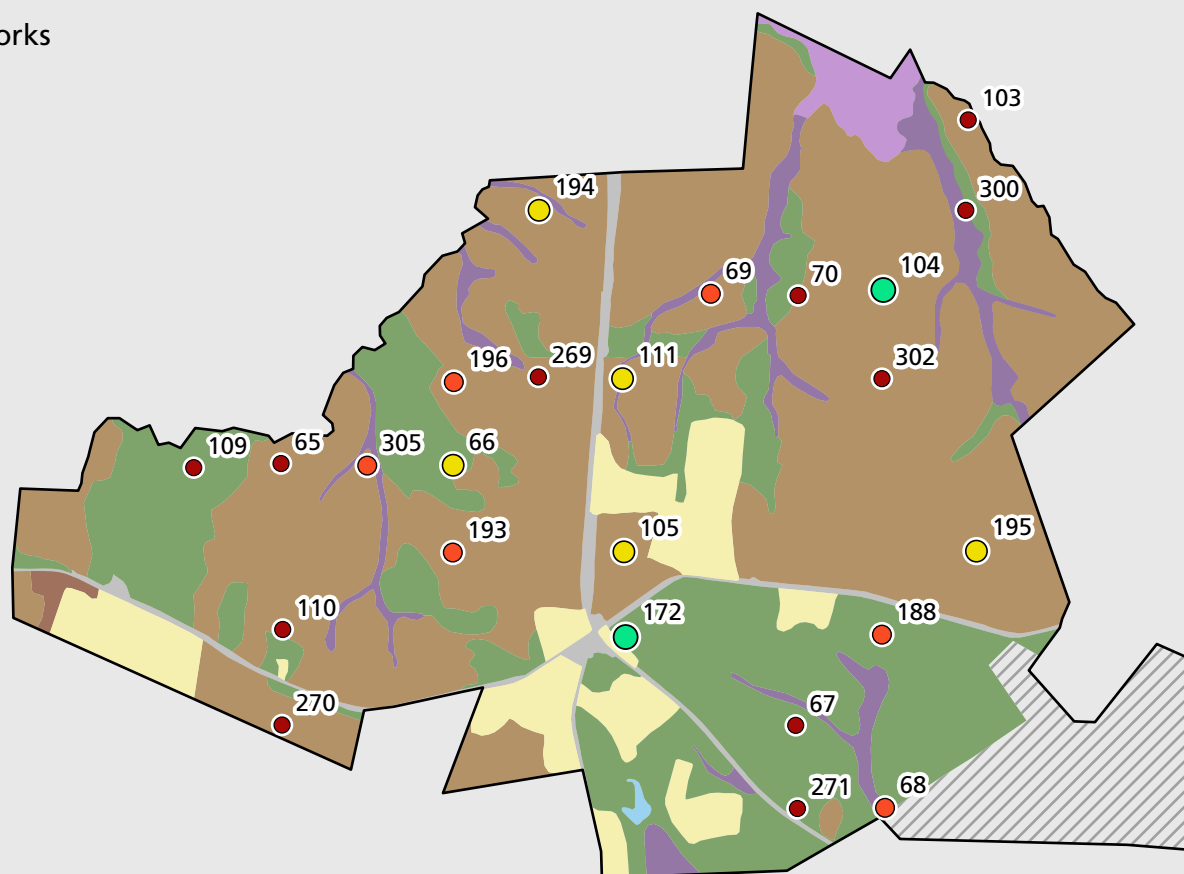




Map 5b. Tree Regeneration Stocking Index

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 0-319.7 across all park units). Only native canopy-forming species included. See Table 1 for stocking index values. Reporting Date: 12/20/2023.

Five Forks



PETE 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.

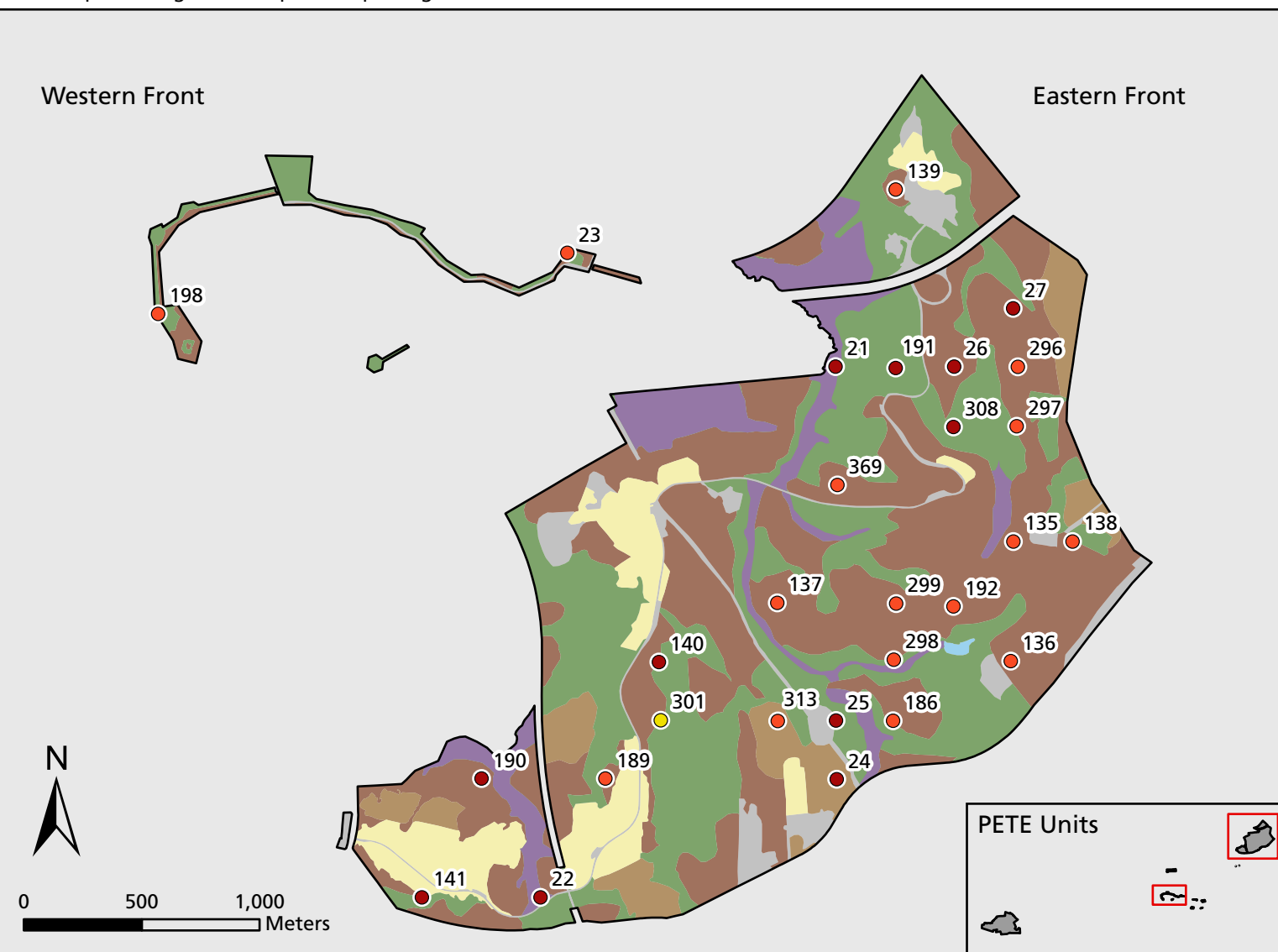
Vegetation types

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



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. Reporting Date: 12/20/2023.



Deer browse index

- 1) No impact: found only in well-maintained deer exclosures.
- 2) Low impact: deer-preferred (DP) species abundant and of varying heights.
- 3) Medium impact: DP species present, but mostly under 30 cm tall. DP herbs present but stunted and flowering is uncommon.
- 4) High impact: DP species are rare to absent. Non-preferred and browse-resilient vegetation (e.g. beech) limited in height by deer browse. DP herbs absent or severely stunted.
- 5) Very high impact: DP regeneration absent. Non-preferred species also reduced by heavy browsing. Distinct deer browse line.

Vegetation types

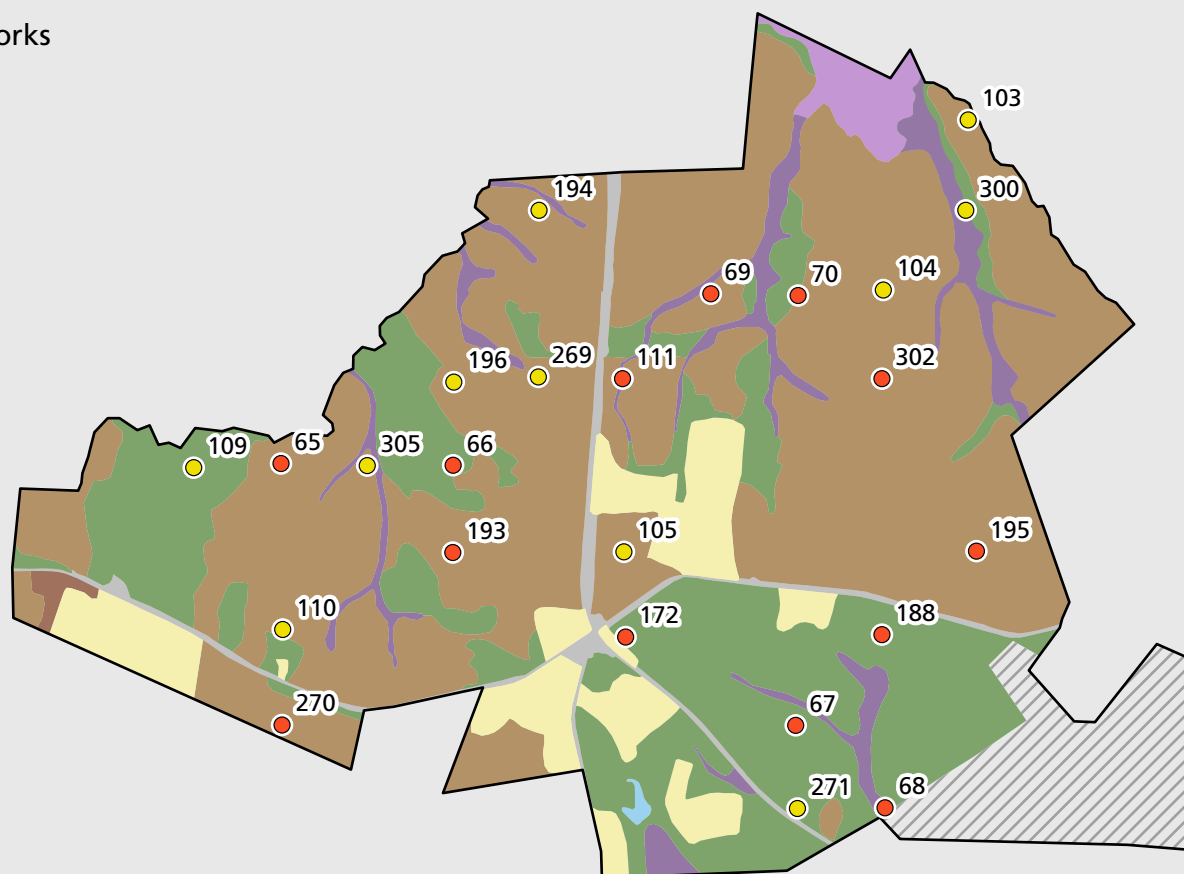
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary



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. Reporting Date: 12/20/2023.

Five Forks



PETE Units



Deer browse index

- 1) No impact: found only in well-maintained deer exclosures.
- 2) Low impact: deer-preferred (DP) species abundant and of varying heights.
- 3) Medium impact: DP species present, but mostly under 30 cm tall. DP herbs present but stunted and flowering is uncommon.
- 4) High impact: DP species are rare to absent. Non-preferred and browse-resilient vegetation (e.g. beech) limited in height by deer browse. DP herbs absent or severely stunted.
- 5) Very high impact: DP regeneration absent. Non-preferred species also reduced by heavy browsing. Distinct deer browse line.

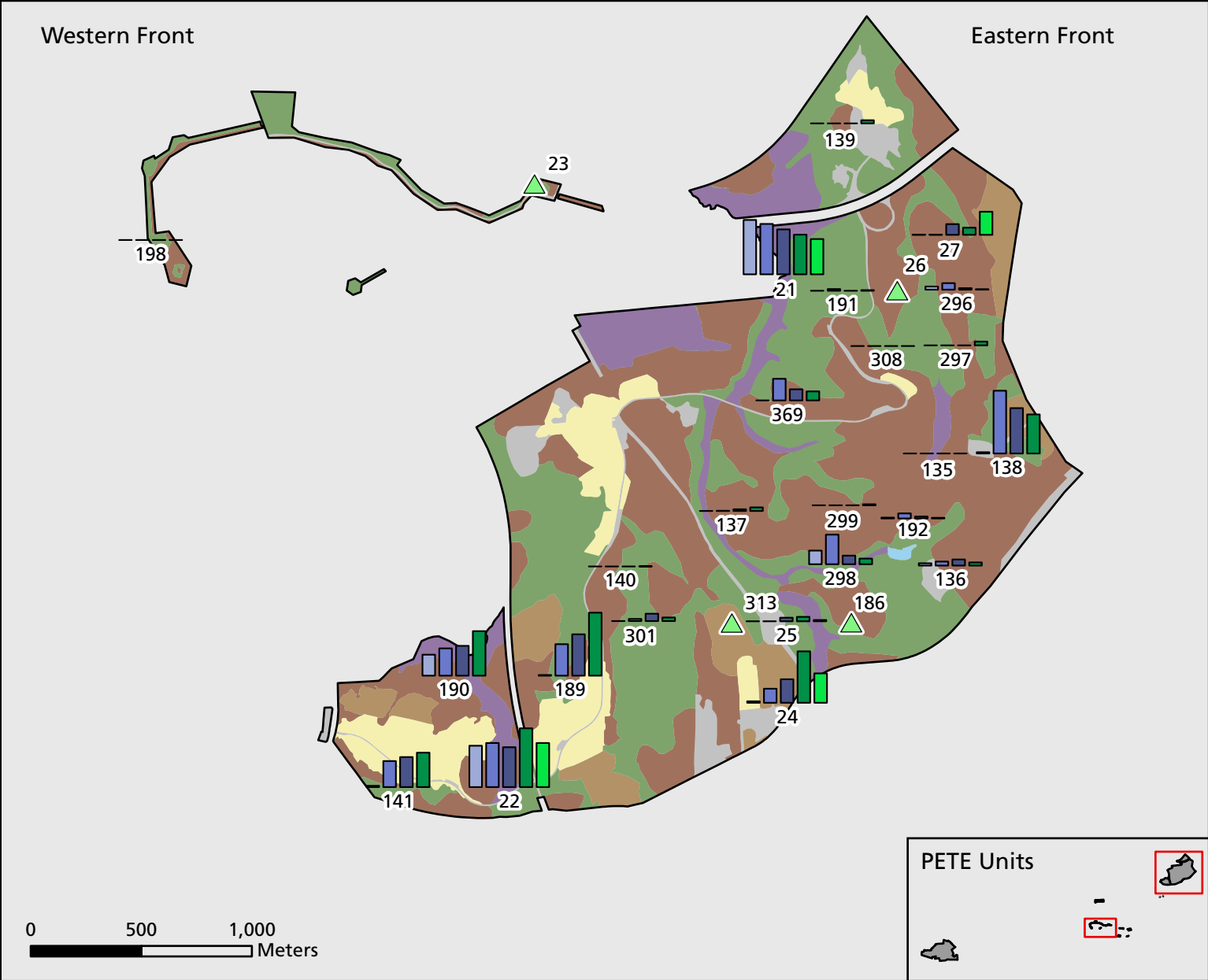
Vegetation types

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



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 66.9% 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. Reporting Date: 12/20/2023.



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

Vegetation types

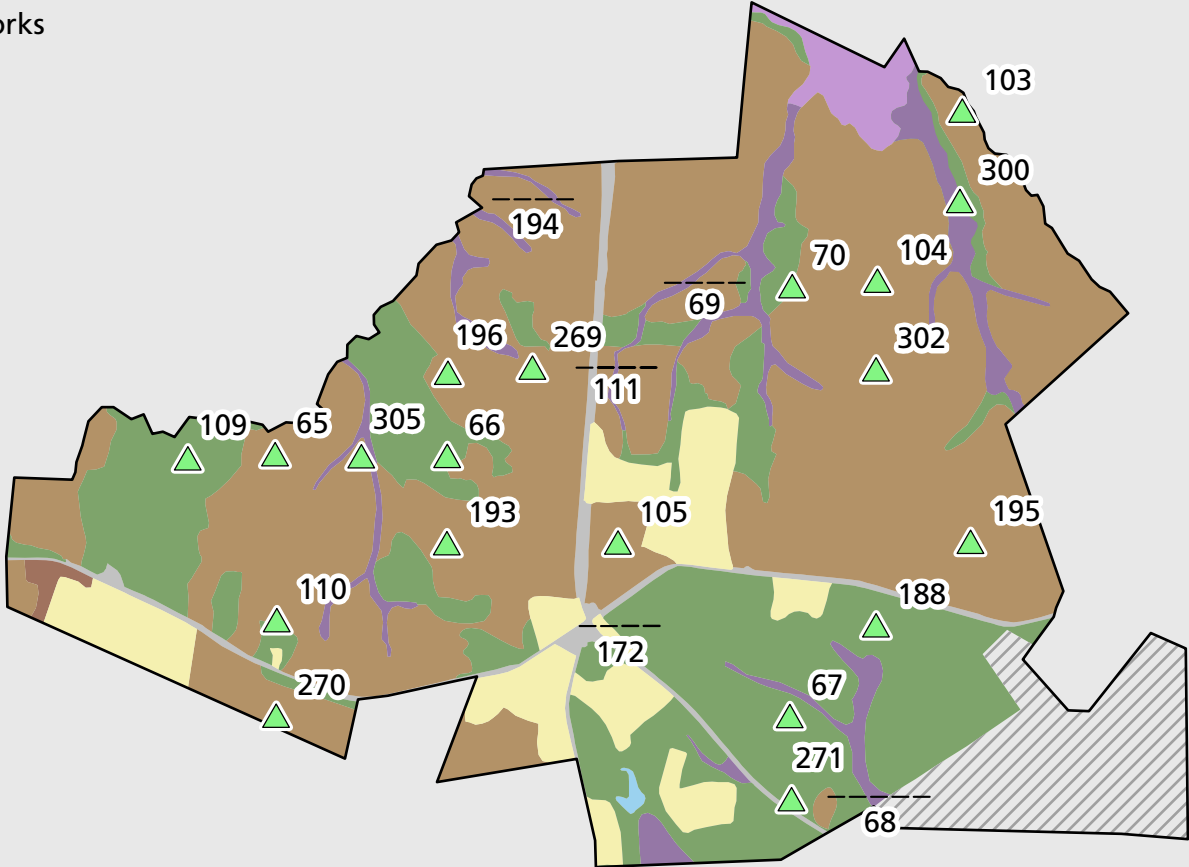
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary



Map 7b. Invasive % Cover by Cycle

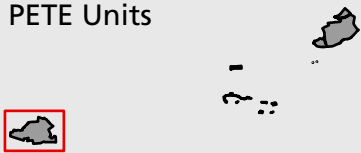
Trends in percent cover of invasive species observed in quadrats in forest plots sampled from 2007-2023. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Average invasive cover per plot ranges from 0 to 66.9% across all park units. See Table 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. Reporting Date: 12/20/2023.

Five Forks



0 500 1,000
Meters

PETE Units



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



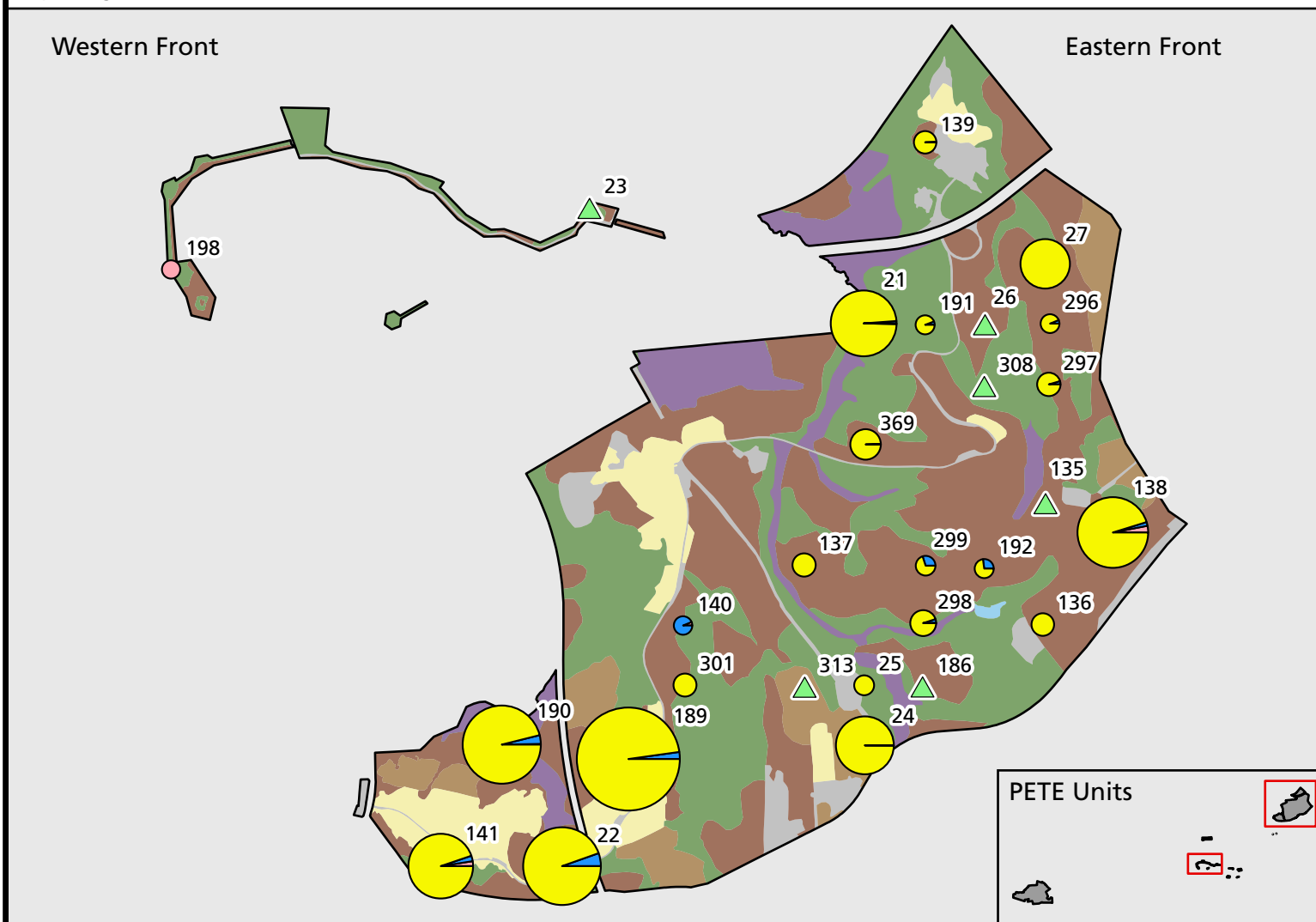
Vegetation types

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



Map 8a. Invasive % Cover by Species

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 66.9% 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. Reporting Date: 12/20/2023.

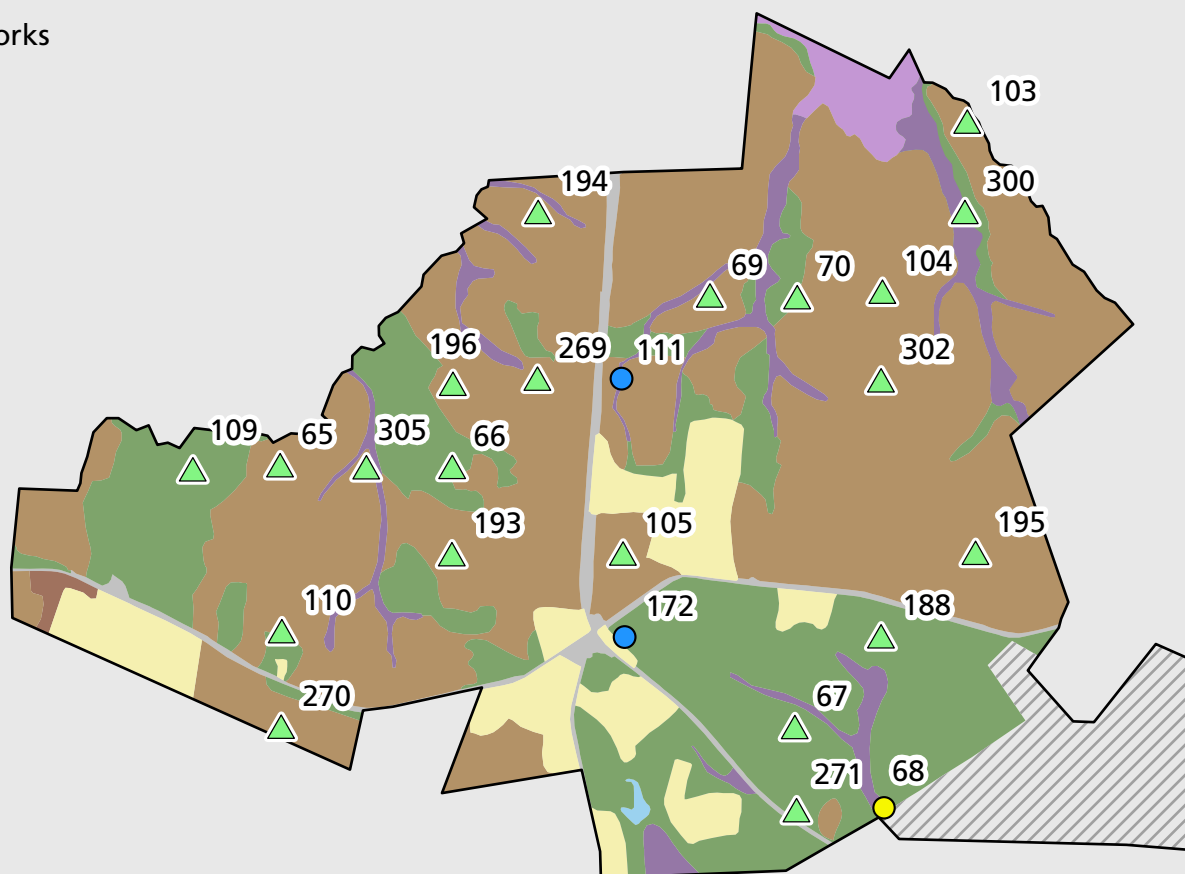




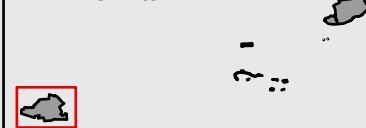
Map 8b. Invasive % Cover by Species

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 66.9% 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. Reporting Date: 12/20/2023.

Five Forks



PETE Units



Species in pie charts

- Ailanthus altissima* (Tree-of-heaven)
- Ligustrum* spp. (Privet)
- Lonicera japonica* (Japanese honeysuckle)
- Microstegium vimineum* (Japanese stiltgrass)
- Persicaria longiseta* (Asiatic smartweed)
- Other invasive spp.
- No observed invasive cover

Vegetation types

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

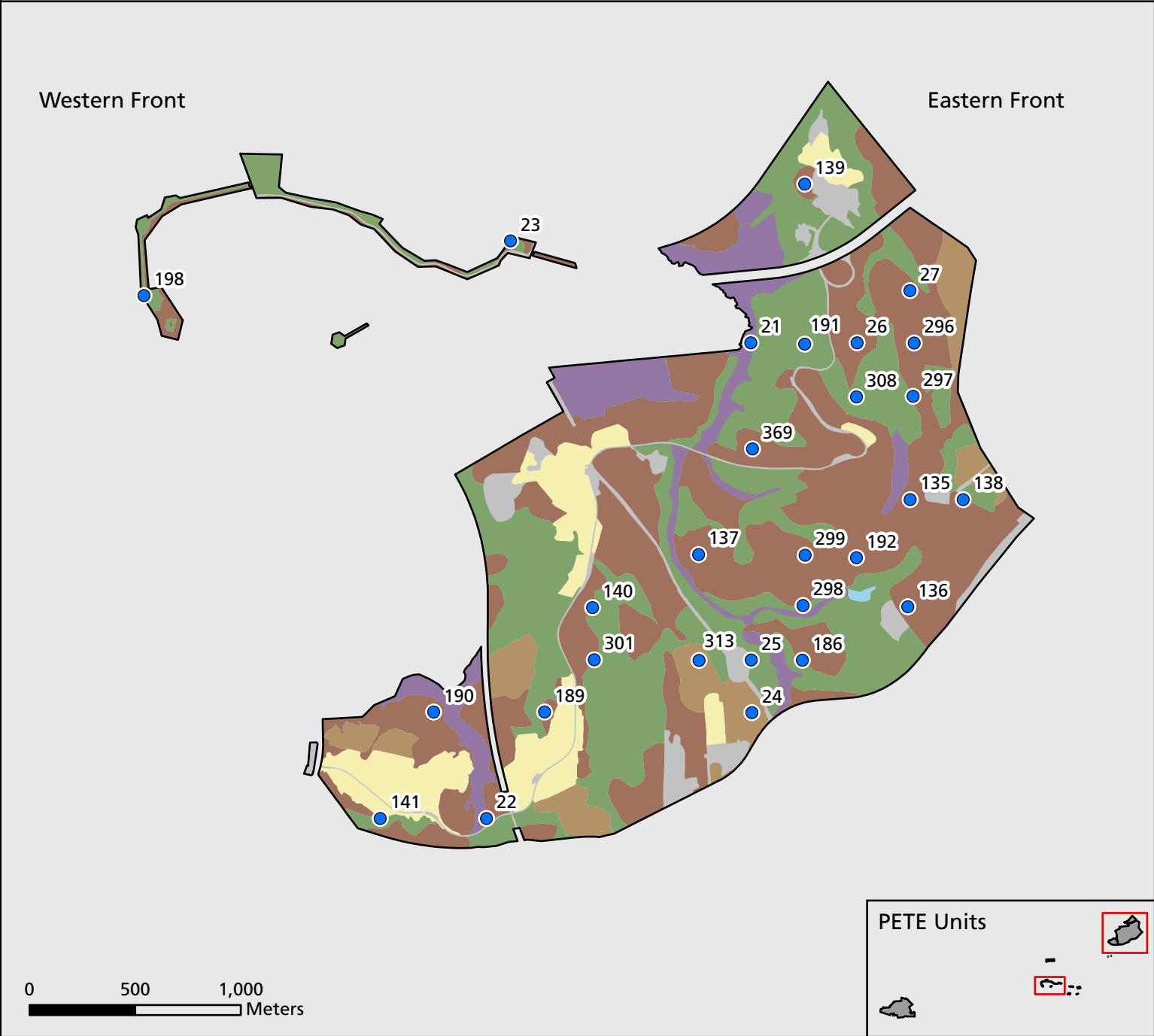
0 500 1,000
Meters





Map 9a. 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. Reporting Date: 12/20/2023.



Pests/Pathogens

- No detections

Vegetation types

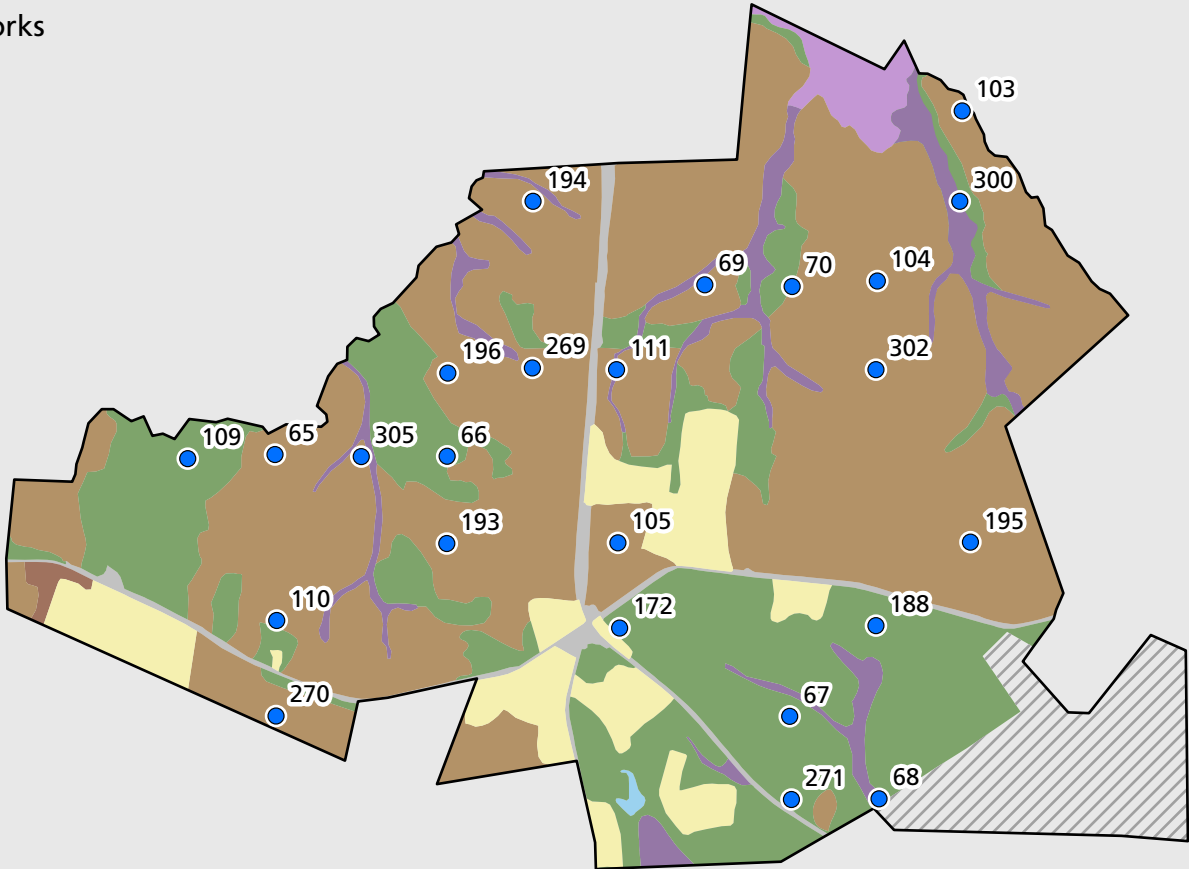
Deciduous forest	Open wetland
Successional forest	Open field
Conifer forest	Developed land
Conifer plantation	No vegetation data
Floodplain forest	Park boundary



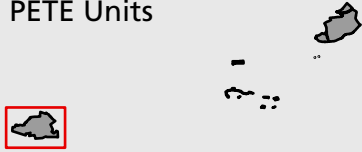
Map 9b. Forest Pest/Pathogen Detections

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. Reporting Date: 12/20/2023.

Five Forks



PETE Units



Pests/Pathogens

● No detections



Vegetation types

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



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. Reporting Date: 12/20/2023.



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



Vegetation types

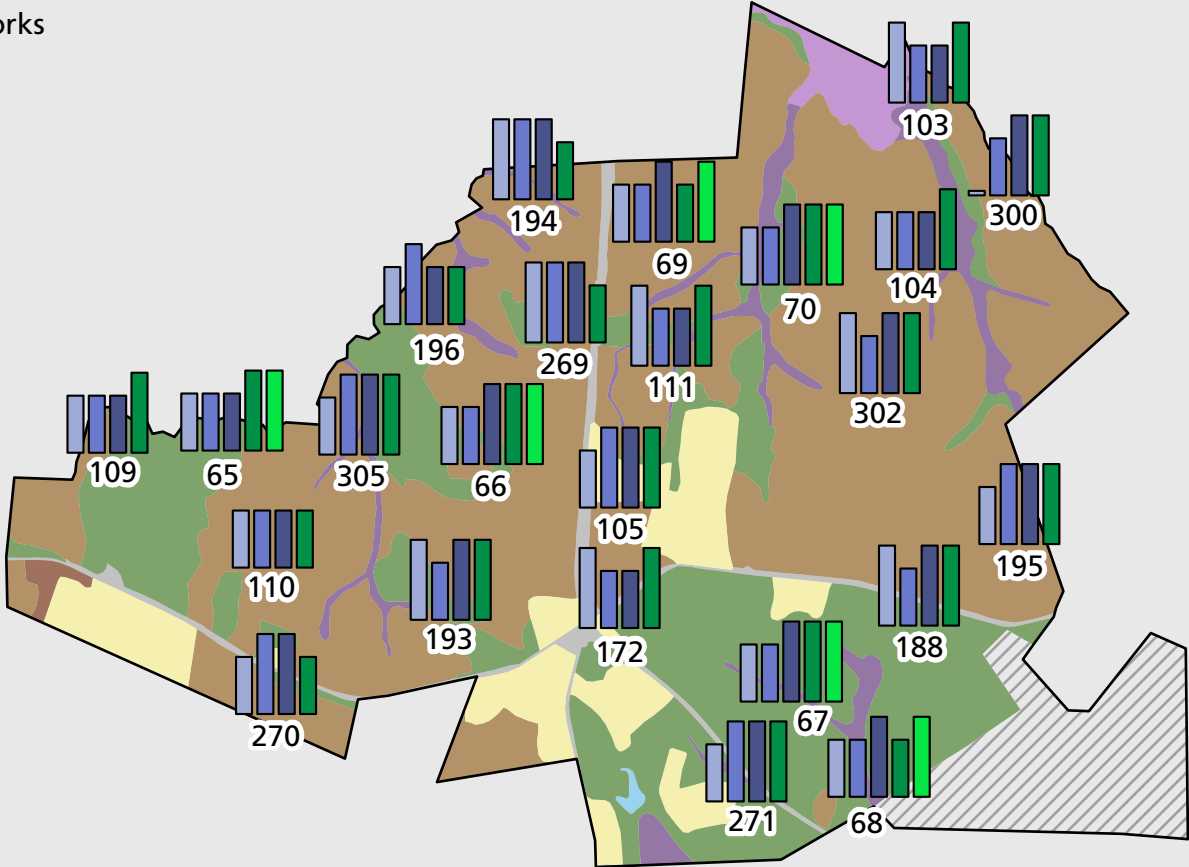
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Floodplain forest
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary



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. Reporting Date: 12/20/2023.

Five Forks



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

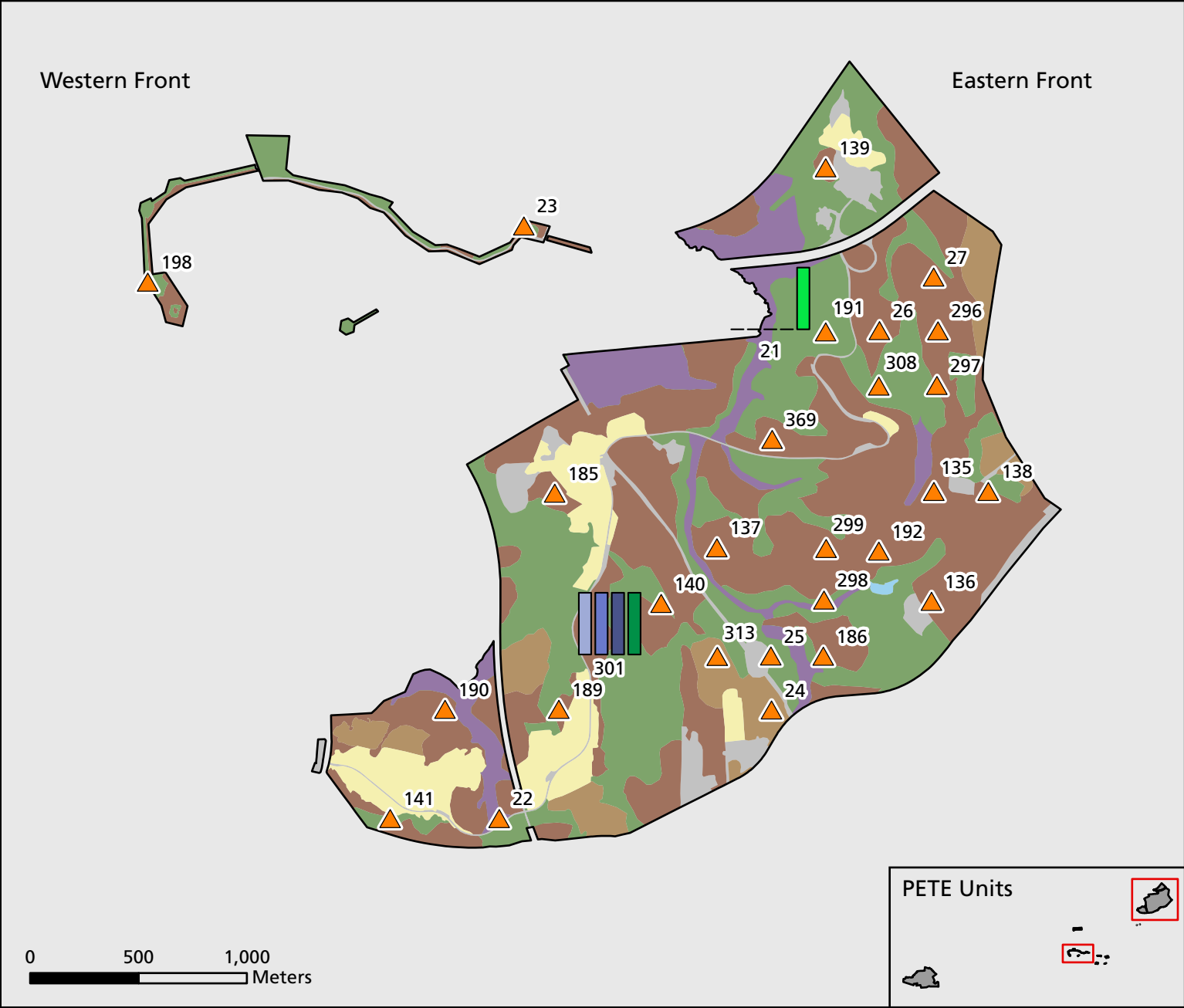
Vegetation types

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



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 1 stems/400m² across all park units, and only include individuals >10 cm DBH. Reporting Date: 12/20/2023.



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

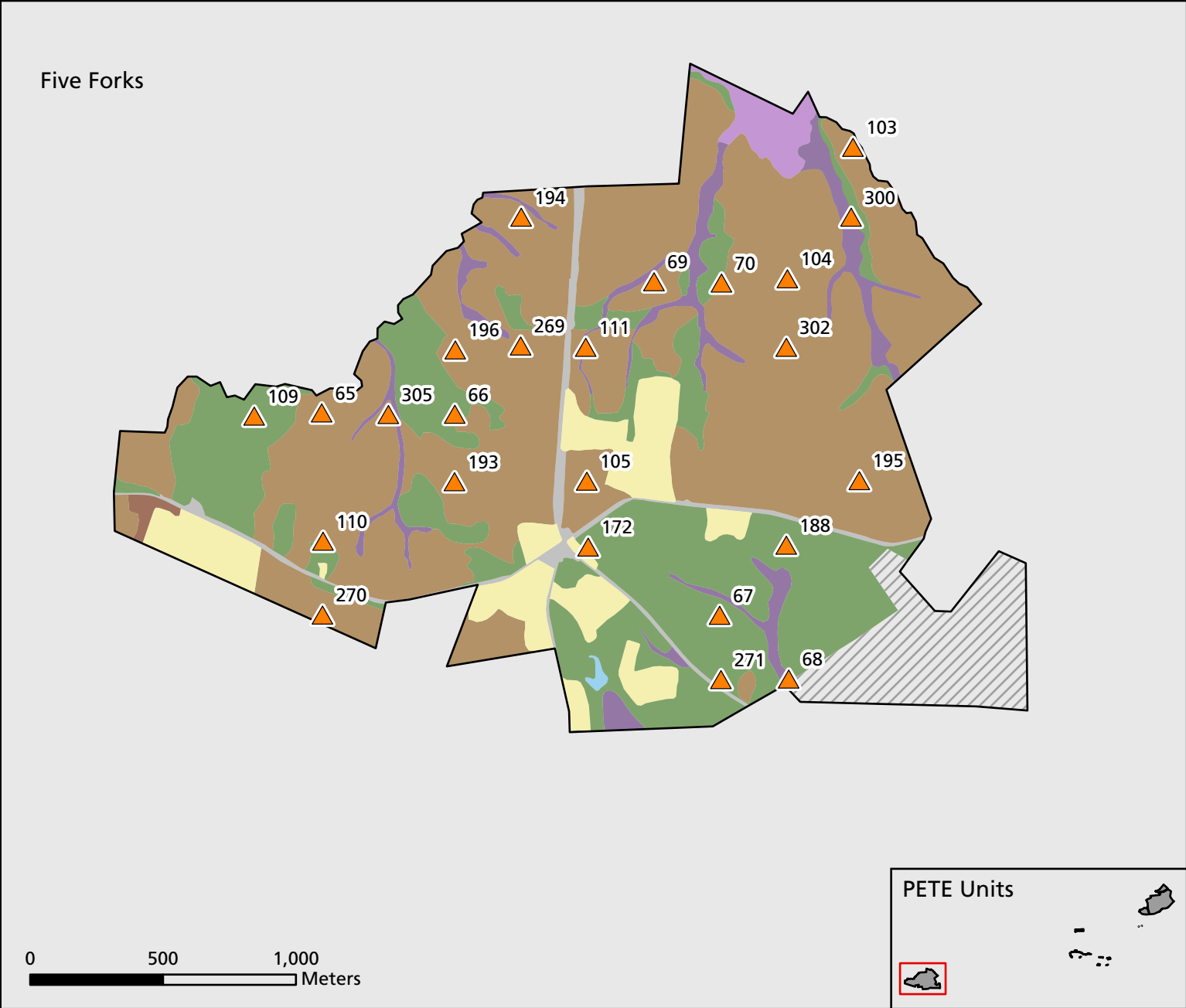
Vegetation types

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



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 1 stems/400m² across all park units, and only include individuals >10 cm DBH. Reporting Date: 12/20/2023.



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

Vegetation types

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

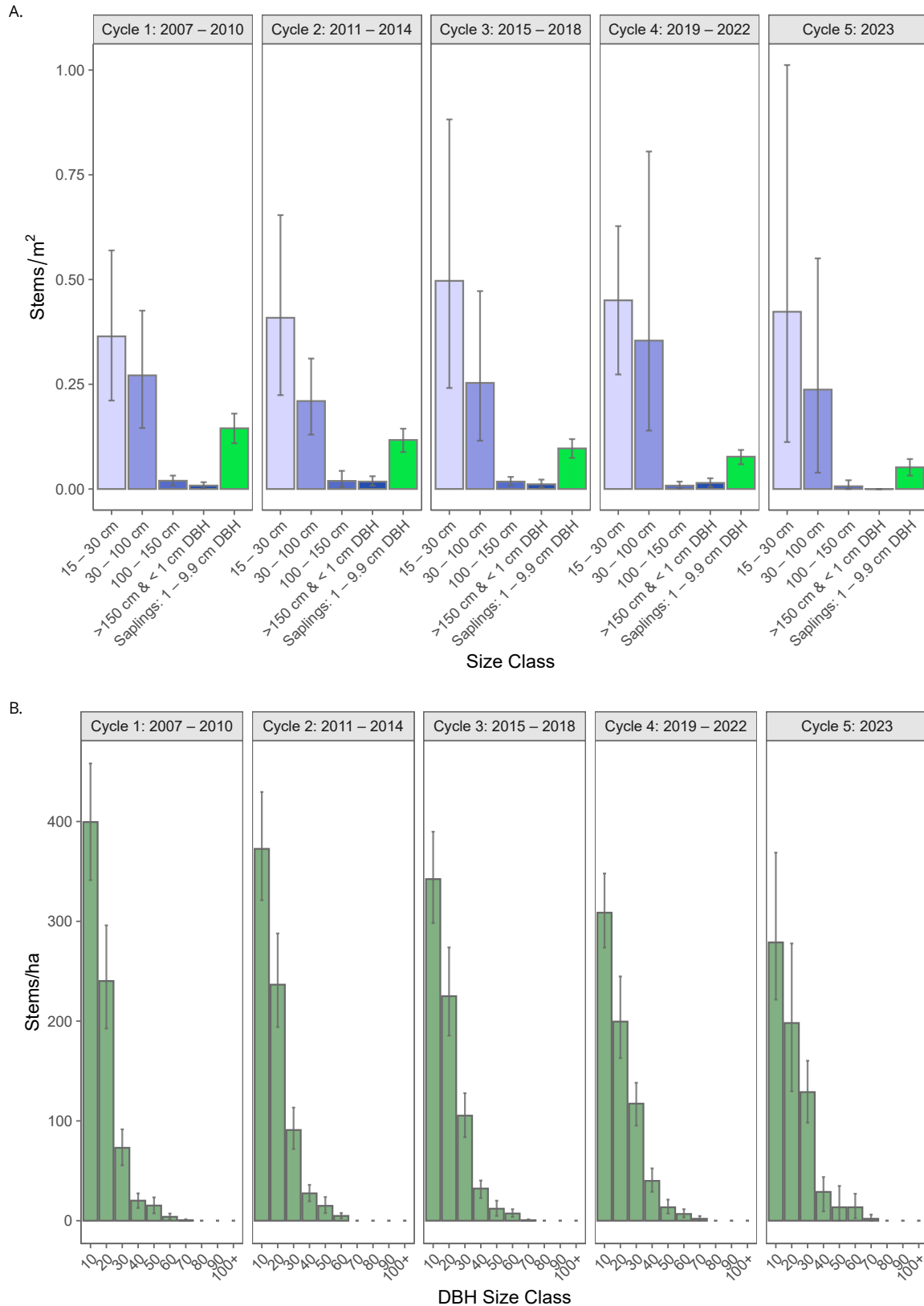


Figure 1. Stem density distributions by cycle in Petersburg National Battlefield (PETE). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2022; Cycle 5: 2023. Note that cycle 5 is only partially complete. Figure A shows regeneration densities by size class. Figure B shows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

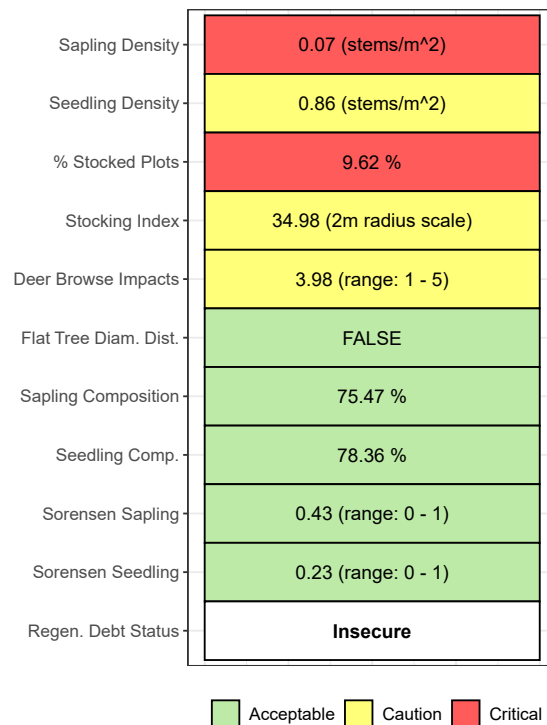


Figure 2. Regeneration Debt status for the most recent 4-year census (2021 – 2023) in Petersburg National Battlefield (PETE). Flat Tree Diam. Dist. stands for Flat Tree Diameter Distribution. If TRUE, the density of small trees is lower than expected due to chronic regeneration failure. Sapling/Seedling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

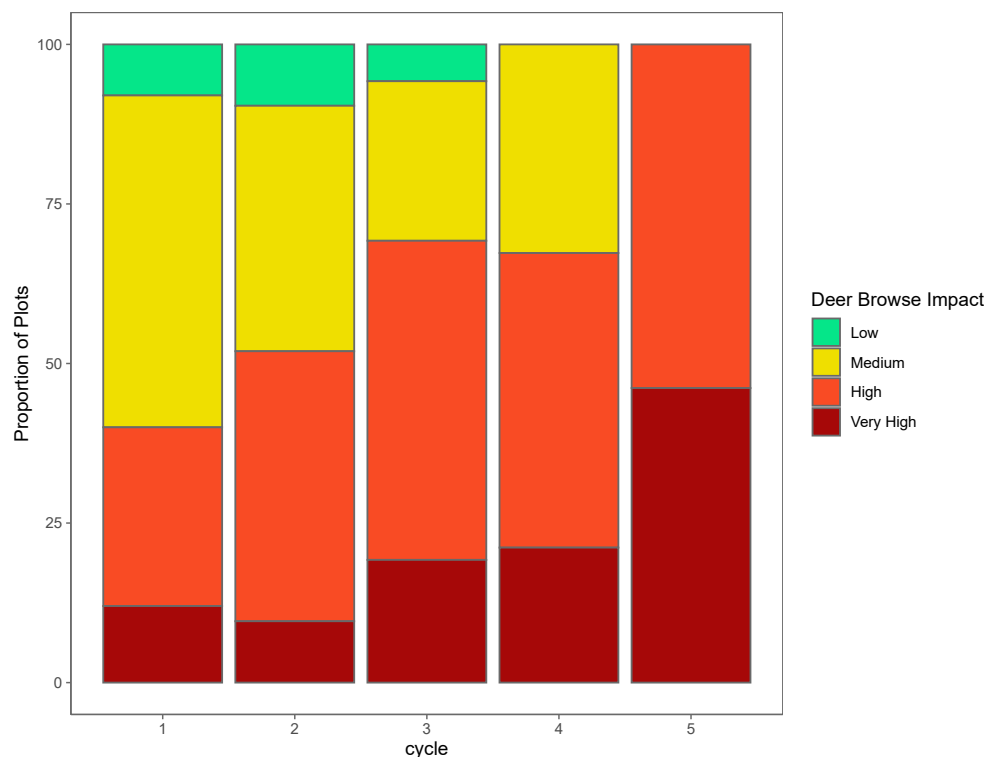


Figure 3. Deer browse impacts by cycle in Petersburg National Battlefield (PETE). Cycle 1: 2007 – 2010; Cycle 2: 2011 – 2014; Cycle 3: 2015 – 2018; Cycle 4: 2019 – 2022; Cycle 5: 2023. Note that cycle 5 is only partially complete.

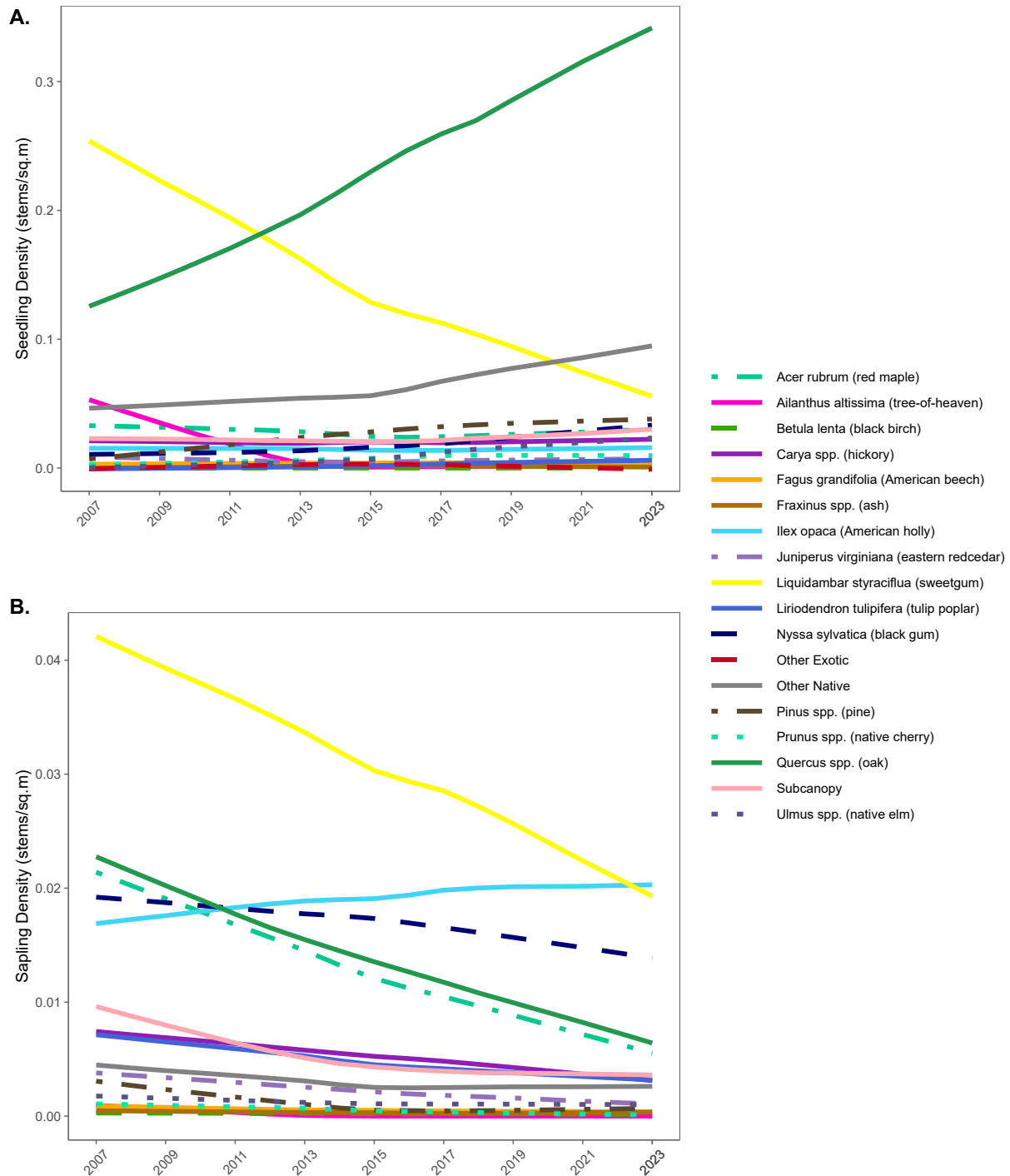


Figure 4. Loess smoothed changes in stem density for seedlings (A) and saplings (B) by species group and sample year in Petersburg National Battlefield. Specified loess span approximated a linear trend between consecutive sample events per panel.

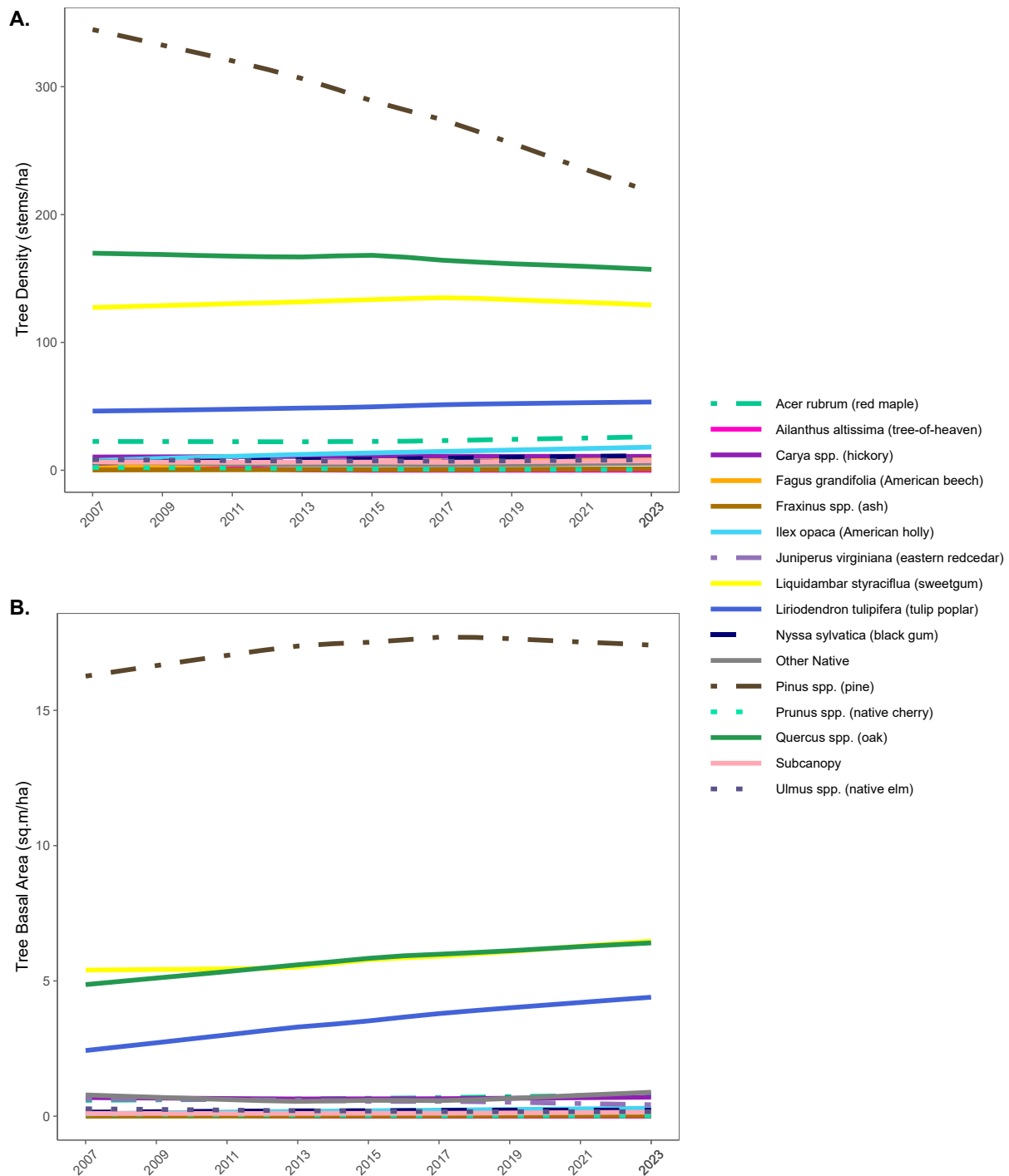


Figure 5. Loess smoothed changes in tree stem density (A) and basal area (B) by species group and sample year in Petersburg National Battlefield. Specified loess span approximated a linear trend between consecutive sample events per panel.

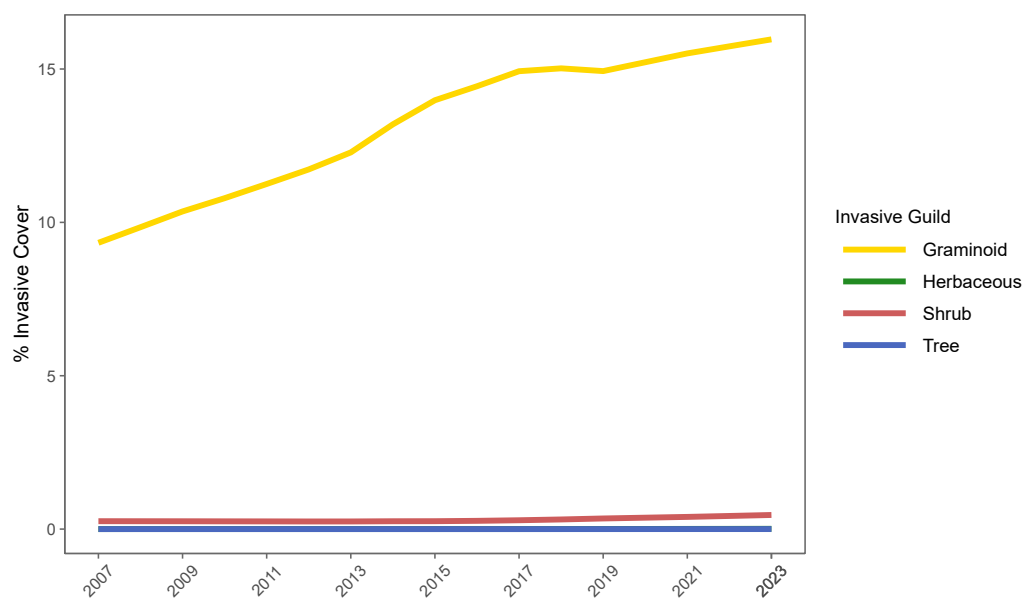


Figure 6. Loess smoothed changes in invasive plant percent cover by guild and sample year in Petersburg National Battlefield. Specified loess span approximated a linear trend between consecutive sample events per panel.



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: 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/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 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
21	1	0.17	0.00	0.00	0.00	0.08	0.07	0.04	0.02	0.02	0.02	9.55	7.41	0.00	0.00	1.01
22	1	0.25	0.00	0.08	0.08	0.33	0.02	0.02	0.02	0.02	0.02	5.28	0.00	1.01	2.14	5.28
23	1	0.75	0.75	0.33	0.17	0.50	0.02	0.01	0.01	0.00	0.00	32.42	12.57	5.28	3.14	7.29
24	1	0.08	0.08	0.17	0.08	0.08	0.11	0.06	0.04	0.04	0.04	8.42	1.01	9.55	8.42	15.83
25	1	0.33	0.08	0.17	0.17	0.33	0.08	0.07	0.06	0.05	0.04	34.81	16.96	4.15	4.15	24.13
26	1	0.00	0.17	0.08	0.25	0.33	0.06	0.04	0.04	0.02	0.02	14.83	2.14	2.14	3.14	6.28
27	1	0.00	0.00	0.00	0.00	0.08	0.06	0.06	0.05	0.05	0.05	0.00	0.00	0.00	0.00	1.01
65	1	1.17	0.17	0.00	0.00	0.00	0.08	0.08	0.06	0.06	0.07	24.13	3.14	0.00	0.00	7.41
66	1	1.50	2.75	3.83	4.33	4.50	0.18	0.15	0.14	0.12	0.08	80.17	84.19	68.24	88.22	75.52
67	1	0.75	0.58	0.92	0.25	0.58	0.12	0.12	0.08	0.02	0.02	50.64	55.92	44.23	17.97	18.98
68	1	3.08	2.17	2.67	1.75	1.75	0.33	0.24	0.20	0.13	0.08	86.21	158.34	148.79	86.96	40.84
69	1	0.25	0.25	0.08	0.00	0.08	0.48	0.42	0.29	0.19	0.13	115.36	101.54	60.32	44.48	30.66
70	1	0.08	0.00	0.00	0.08	0.00	0.37	0.35	0.25	0.17	0.09	38.08	37.07	29.66	23.25	7.41
103	2	0.25	0.42	0.08	0.08	-	0.40	0.25	0.19	0.11	-	34.81	91.23	8.42	2.14	-
104	2	0.33	0.75	0.42	0.67	-	0.46	0.37	0.32	0.28	-	123.78	170.40	181.71	189.88	-
105	2	0.50	1.17	1.00	0.83	-	0.37	0.25	0.21	0.15	-	166.63	86.58	88.47	52.78	-
109	2	0.17	0.42	0.25	0.08	-	0.15	0.14	0.13	0.12	-	60.07	35.94	27.52	15.83	-
110	2	0.17	0.17	0.50	0.08	-	0.14	0.15	0.14	0.11	-	37.82	18.98	25.26	2.14	-
111	2	0.58	0.33	0.25	0.58	-	0.14	0.11	0.12	0.12	-	69.74	42.22	34.81	68.49	-
135	2	0.42	0.50	0.17	0.83	-	0.15	0.14	0.11	0.07	-	29.53	22.12	17.97	11.56	-
136	2	5.75	2.58	1.67	0.50	-	0.00	0.00	0.00	0.00	-	116.24	48.13	51.27	10.43	-
137	2	0.00	0.17	0.83	0.50	-	0.06	0.06	0.05	0.02	-	0.00	3.14	10.43	6.28	-
138	2	0.08	0.17	1.00	2.00	-	0.08	0.06	0.05	0.05	-	1.01	2.14	14.70	30.41	-
139	2	0.33	0.33	0.25	0.67	-	0.22	0.21	0.21	0.17	-	84.45	110.46	88.47	144.76	-
140	2	0.00	0.00	0.17	0.42	-	0.05	0.05	0.04	0.04	-	0.00	0.00	2.14	5.28	-
141	2	0.00	0.00	0.17	0.83	-	0.00	0.00	0.00	0.00	-	0.00	0.00	2.14	10.43	-
172	3	1.25	1.33	1.08	1.00	-	0.33	0.26	0.26	0.22	-	159.97	186.99	151.42	115.61	-
186	3	0.17	0.00	0.08	0.00	-	0.07	0.06	0.06	0.05	-	2.14	0.00	1.01	0.00	-
188	3	0.67	0.83	0.42	0.42	-	0.19	0.17	0.15	0.14	-	76.91	96.64	81.93	30.66	-
189	3	0.33	0.42	0.58	0.92	-	0.08	0.05	0.02	0.02	-	12.69	12.69	7.29	11.56	-



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: 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/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 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
190	3	0.08	0.08	0.08	0.08	-	0.07	0.08	0.06	0.05	-	2.14	1.01	1.01	1.01	-
191	3	0.50	0.08	0.33	0.33	-	0.05	0.05	0.02	0.01	-	89.35	23.25	5.28	5.28	-
192	3	0.92	0.67	0.58	1.83	-	0.05	0.04	0.04	0.04	-	33.68	17.84	7.29	29.28	-
193	3	1.08	1.00	0.75	0.33	-	0.29	0.31	0.20	0.20	-	97.01	87.71	49.64	35.94	-
194	3	1.08	1.08	0.58	0.42	-	0.18	0.13	0.09	0.07	-	57.93	62.08	45.24	66.10	-
195	3	0.00	0.08	0.42	0.33	-	0.12	0.09	0.09	0.11	-	22.24	43.23	55.79	63.21	-
196	3	0.25	0.25	0.17	0.17	-	0.26	0.17	0.15	0.14	-	34.81	31.54	44.23	40.21	-
198	3	2.08	2.50	2.42	2.92	-	0.17	0.11	0.11	0.07	-	81.93	96.38	42.98	71.25	-
269	4	0.08	0.00	0.17	0.17	-	0.15	0.12	0.09	0.06	-	31.67	22.24	17.97	9.55	-
270	4	0.42	0.33	0.17	0.17	-	0.22	0.19	0.14	0.11	-	111.59	41.22	17.97	2.14	-
271	4	0.25	0.25	0.58	0.33	-	0.09	0.08	0.07	0.07	-	18.98	12.69	67.10	13.70	-
296	4	1.17	0.83	0.08	0.42	-	0.02	0.01	0.00	0.00	-	90.10	66.98	1.01	7.29	-
297	4	0.17	0.33	0.33	1.00	-	0.06	0.05	0.05	0.04	-	16.96	12.69	11.56	14.70	-
298	4	0.08	0.08	0.00	0.25	-	0.04	0.02	0.02	0.02	-	8.42	1.01	0.00	3.14	-
299	4	0.33	0.33	0.33	0.67	-	0.05	0.05	0.04	0.04	-	83.82	107.82	5.28	10.43	-
300	4	0.08	0.08	0.08	0.00	-	0.02	0.02	0.02	0.02	-	8.42	2.14	2.14	0.00	-
301	4	3.92	6.92	13.33	12.50	-	0.04	0.04	0.04	0.02	-	49.26	104.68	226.19	266.03	-
302	4	0.25	0.25	0.25	0.17	-	0.33	0.21	0.18	0.11	-	64.47	28.53	12.69	4.15	-
305	4	0.00	0.17	0.08	0.25	-	0.15	0.15	0.11	0.11	-	44.48	55.04	31.67	33.80	-
308	4	1.42	1.33	2.25	2.42	-	0.12	0.11	0.12	0.13	-	59.82	114.35	115.48	181.58	-
313	4	0.25	0.08	0.00	0.00	-	0.04	0.02	0.02	0.02	-	4.15	1.01	0.00	0.00	-
369	3	-	0.75	0.25	0.67	-	-	0.07	0.06	0.04	-	-	19.98	5.28	10.43	-



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
21	1	57.79	53.48	47.61	42.12	37.52	2	3	3	4	4
22	1	44.00	46.93	42.38	62.38	46.92	2	3	4	5	4
23	1	0.00	0.00	0.00	0.00	0.00	0	1	0	0	0
24	1	1.46	15.01	24.93	54.59	31.27	2	2	1	2	2
25	1	0.00	0.01	3.75	4.61	1.26	0	1	1	2	1
26	1	0.00	0.00	0.00	0.00	0.00	0	0	0	1	2
27	1	0.14	0.31	11.47	7.58	24.59	2	2	2	2	2
65	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
66	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
67	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
68	1	0.00	0.00	0.00	0.00	0.01	0	0	0	0	1
69	1	0.00	0.01	0.00	0.00	0.00	0	1	0	0	0
70	1	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
103	2	0.00	0.00	0.00	0.00	-	0	0	0	0	-
104	2	0.00	0.00	0.00	0.00	-	0	0	0	0	-
105	2	0.00	0.00	0.00	0.00	-	0	0	0	0	-
109	2	0.00	0.00	0.00	0.00	-	0	0	0	0	-
110	2	0.00	0.00	0.00	0.00	-	0	0	0	0	-
111	2	0.02	0.13	0.30	0.30	-	1	1	1	1	-
135	2	0.00	0.01	0.00	0.00	-	0	1	1	1	-
136	2	2.50	4.18	6.47	3.36	-	1	2	2	2	-
137	2	0.02	0.13	1.76	3.88	-	1	1	1	1	-
138	2	1.38	66.74	48.13	41.38	-	2	3	3	3	-
139	2	0.02	0.05	0.03	3.28	-	1	2	3	5	-
140	2	0.00	0.01	0.01	0.13	-	0	1	3	3	-
141	2	1.41	27.64	31.89	36.62	-	2	3	4	4	-
172	3	0.00	0.01	0.26	0.27	-	2	2	1	1	-
186	3	0.00	0.00	0.00	0.00	-	0	0	1	1	-
188	3	0.00	0.00	0.00	0.00	-	0	0	0	0	-
189	3	0.62	33.49	43.82	66.89	-	2	4	3	4	-



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
190	3	22.33	29.02	31.63	47.27	-	2	3	3	3	-
191	3	0.05	1.78	0.06	0.58	-	2	2	2	2	-
192	3	0.95	5.38	1.92	0.58	-	2	2	2	2	-
193	3	0.00	0.00	0.00	0.00	-	0	0	1	0	-
194	3	0.01	0.01	0.00	0.00	-	1	1	0	0	-
195	3	0.00	0.00	0.00	0.00	-	0	1	1	0	-
196	3	0.00	0.00	0.00	0.00	-	0	0	0	0	-
198	3	0.00	0.00	0.00	0.01	-	0	1	1	3	-
269	4	0.00	0.00	0.00	0.00	-	0	0	0	0	-
270	4	0.00	0.00	0.00	0.00	-	0	0	0	0	-
271	4	0.00	0.00	0.00	0.00	-	0	0	0	0	-
296	4	3.25	6.82	1.63	0.40	-	2	2	3	2	-
297	4	0.03	0.02	0.03	4.03	-	2	2	2	3	-
298	4	14.39	31.42	9.18	5.98	-	2	2	3	5	-
299	4	0.01	0.03	0.03	1.08	-	2	2	2	2	-
300	4	0.00	0.00	0.00	0.00	-	0	0	0	1	-
301	4	0.00	2.16	7.80	3.68	-	0	2	1	2	-
302	4	0.00	0.00	0.00	0.00	-	1	1	1	1	-
305	4	0.00	0.00	0.00	0.00	-	0	0	0	0	-
308	4	0.00	0.02	0.01	0.00	-	1	1	1	2	-
313	4	0.00	0.00	0.00	0.00	-	0	1	0	0	-
369	3	-	22.88	11.91	9.62	-	-	2	2	3	-



Table 3. Number of plots out of 52 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	1	0	1	3	0
<i>Berberis thunbergii</i>	Japanese barberry	0	1	1	1	0
<i>Celastrus orbiculatus</i>	oriental bittersweet	0	0	0	2	0
<i>Euonymus fortunei</i>	climbing euonymus	1	0	0	0	0
<i>Ligustrum</i>	privet	0	5	8	10	2
<i>Lonicera - Exotic</i>	honeysuckle - exotic	4	0	0	0	0
<i>Lonicera japonica</i>	Japanese honeysuckle	14	22	22	22	4
<i>Microstegium vimineum</i>	Japanese stiltgrass	17	23	24	25	7
<i>Persicaria longiseta</i>	Oriental lady's thumb	0	4	1	4	2
<i>Rosa multiflora</i>	multiflora rose	0	3	1	4	1
<i>Rubus phoenicolasius</i>	wine raspberry	0	0	1	2	0



Table 4. Invasive plant and pest/pathogen early detections in Petersburg National Battlefield 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
PETE-137	2021	290350	4122799	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-298	2022	290844	4122558	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-135	2021	291351	4123059	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-308	2022	291097	4123545	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-141	2021	288843	4121550	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-068	2023	267857	4113056	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-190	2021	289096	4122054	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-025	2023	290599	4122300	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-026	2023	291100	4123801	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-136	2021	291340	4122552	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-198	2021	281607	4116550	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-301	2022	289856	4122301	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-138	2021	291602	4123059	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-297	2022	291365	4123548	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-139	2021	290852	4124552	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-191	2021	290852	4123795	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-024	2023	290602	4122051	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-027	2023	291350	4124048	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-192	2021	291097	4122784	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-021	2023	290597	4123801	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-369	2021	290605	4123299	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-140	2021	289848	4122548	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-022	2023	289346	4121550	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-299	2022	290854	4122796	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-189	2021	289621	4122054	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-296	2022	291370	4123800	<i>Microstegium vimineum</i>	Japanese stiltgrass	graminoid
PETE-298	2022	290844	4122558	<i>Celastrus orbiculatus</i>	oriental bittersweet	shrub
PETE-369	2021	290605	4123299	<i>Celastrus orbiculatus</i>	oriental bittersweet	shrub
PETE-186	2021	290841	4122299	<i>Rubus phoenicolasius</i>	wine raspberry	shrub
PETE-139	2021	290852	4124552	<i>Rubus phoenicolasius</i>	wine raspberry	shrub