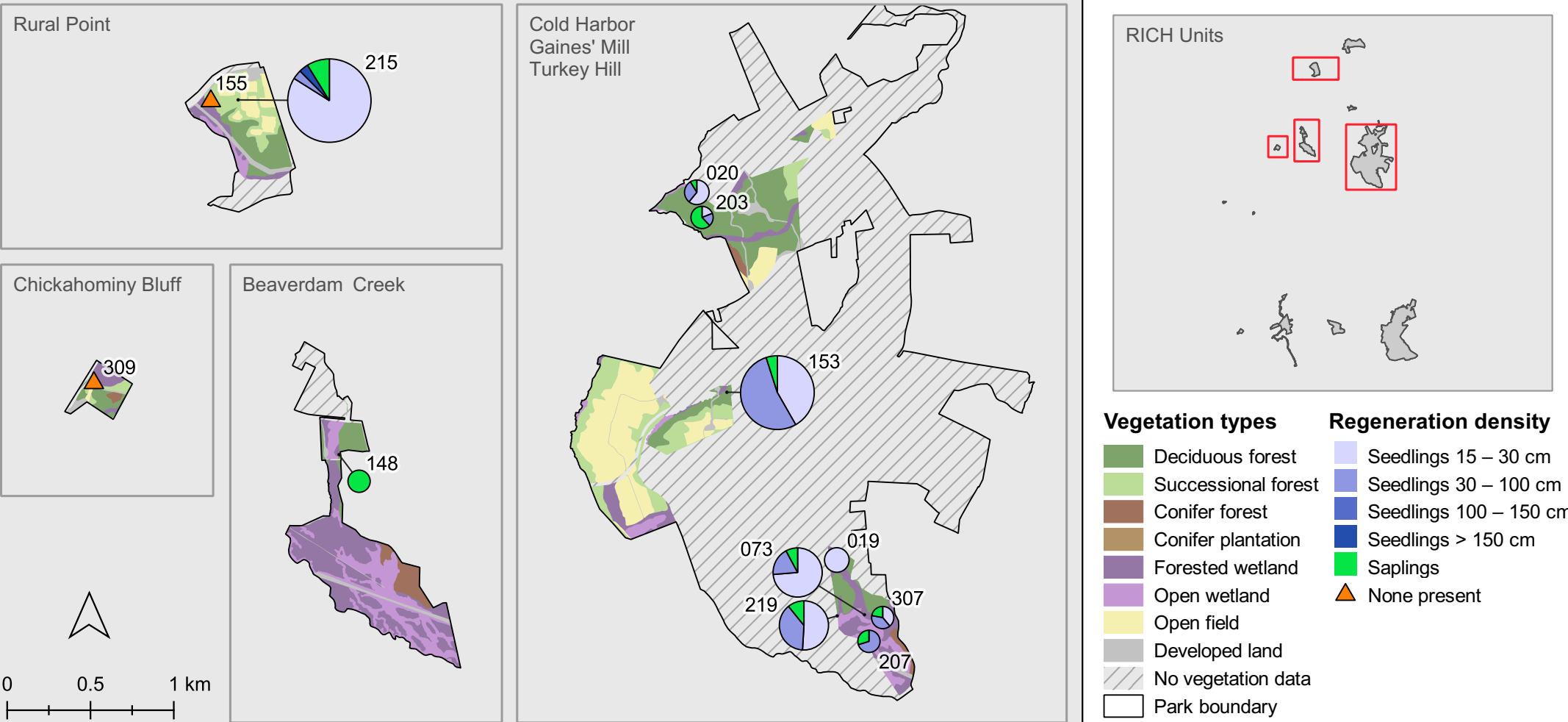




Map 1a. Tree Regeneration by Size Class

Tree regeneration stem densities by size class in forest plots from the most recent survey cycle (2016 – 2019). 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. Densities range from 0 to 1.9 stems/sq.m for an individual size class and only include native canopy-forming species. Seedlings are individuals ≥ 15 cm tall and < 1 cm diameter at breast height (DBH). Saplings are individuals ≥ 1 cm and < 10 cm DBH. Reporting Date: 08/20/2020.

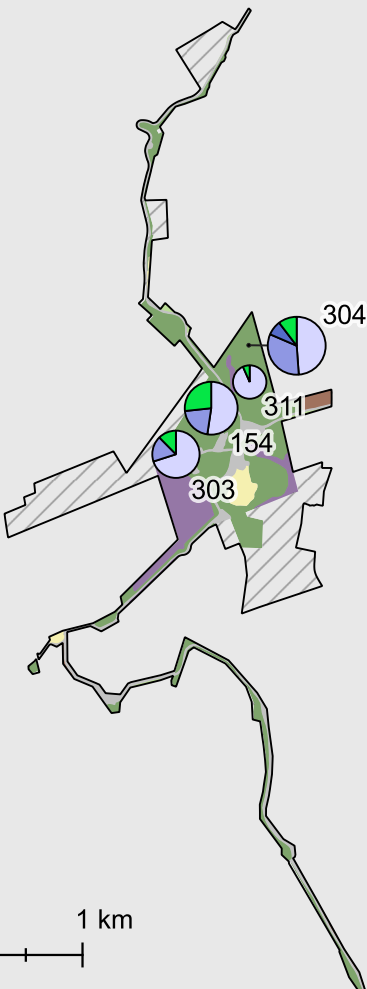




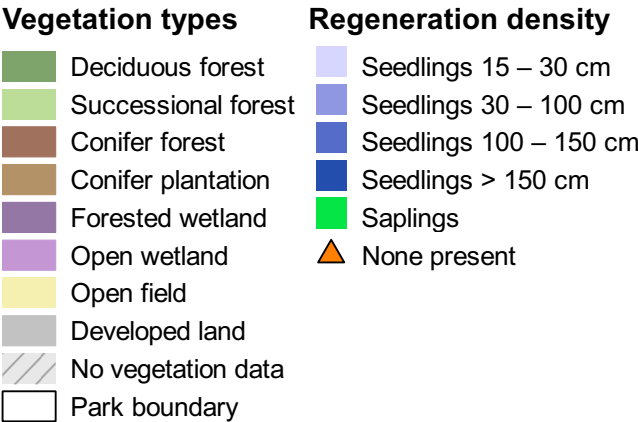
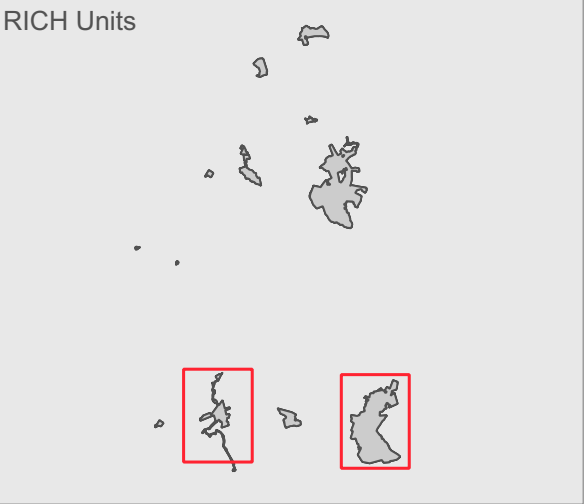
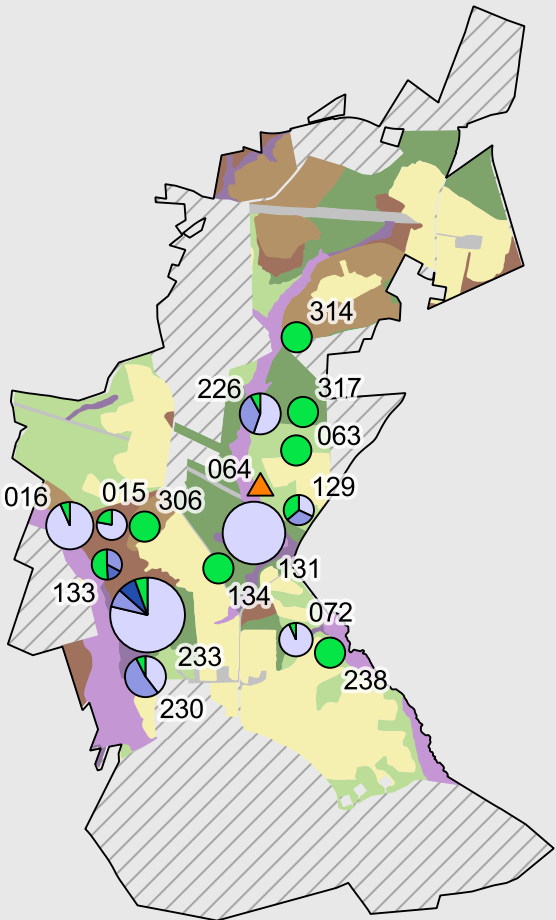
Map 1b. Tree Regeneration by Size Class

Tree regeneration stem densities by size class in forest plots from the most recent survey cycle (2016 – 2019). 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. Densities range from 0 to 1.9 stems/sq.m for an individual size class and only include native canopy-forming species. Seedlings are individuals ≥ 15 cm tall and < 1 cm diameter at breast height (DBH). Saplings are individuals ≥ 1 cm and < 10 cm DBH. Reporting Date: 08/20/2020.

Fort Harrison



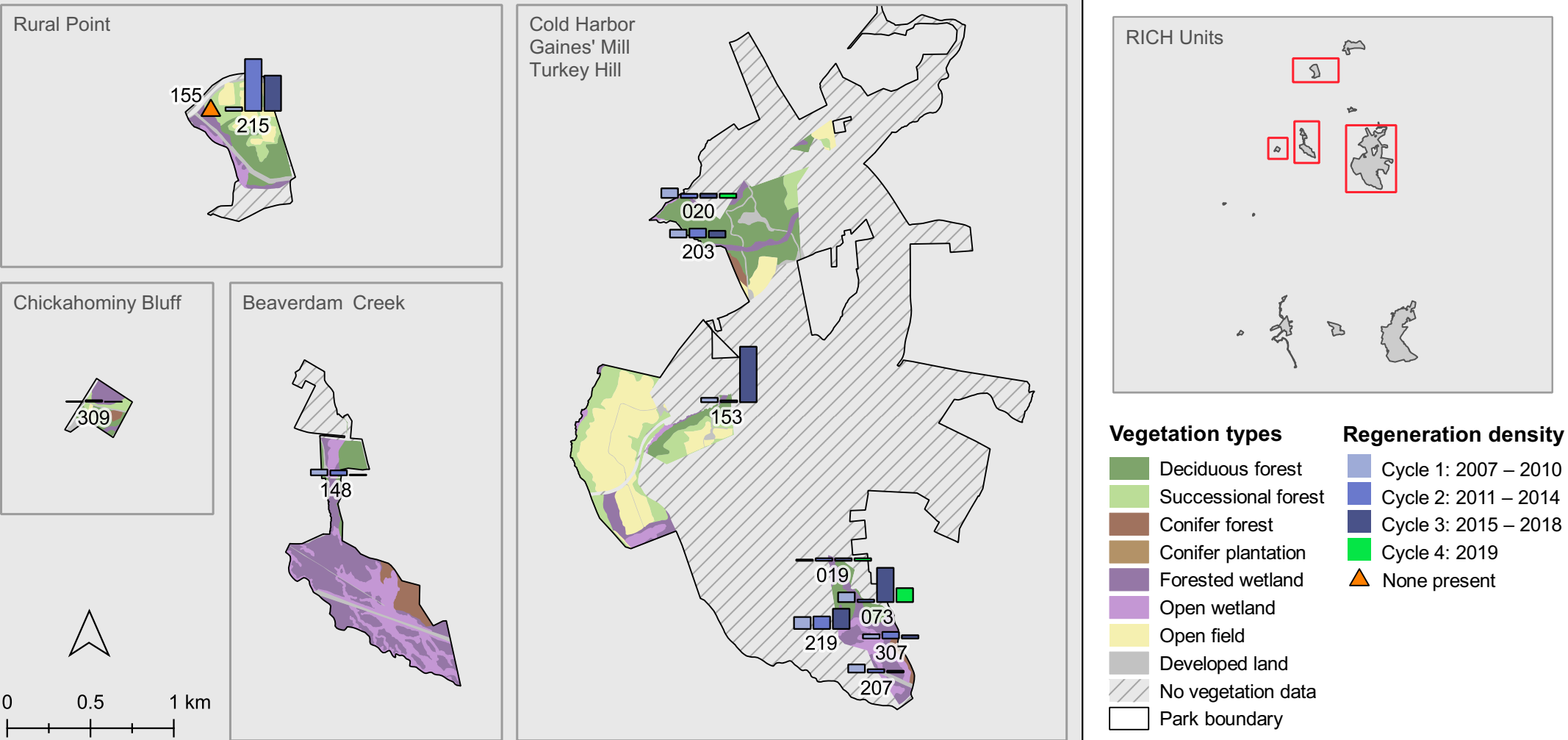
Malvern Hill





Map 2a. Tree Regeneration by Cycle

Tree regeneration stem densities, including seedlings and saplings, in forest plots sampled from 2007 – 2019. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The number of bars per plot corresponds to the number of times the plot has been sampled. Densities range from 0 to 3.6 stems/sq.m, and only include native canopy-forming species. Charts may be shifted to prevent overlap. Reporting Date: 08/20/2020.





Map 2b. Tree Regeneration by Cycle

Tree regeneration stem densities, including seedlings and saplings, in forest plots sampled from 2007 – 2019. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The number of bars per plot corresponds to the number of times the plot has been sampled. Densities range from 0 to 3.6 stems/sq.m, and only include native canopy-forming species. Charts may be shifted to prevent overlap. Reporting Date: 08/20/2020.

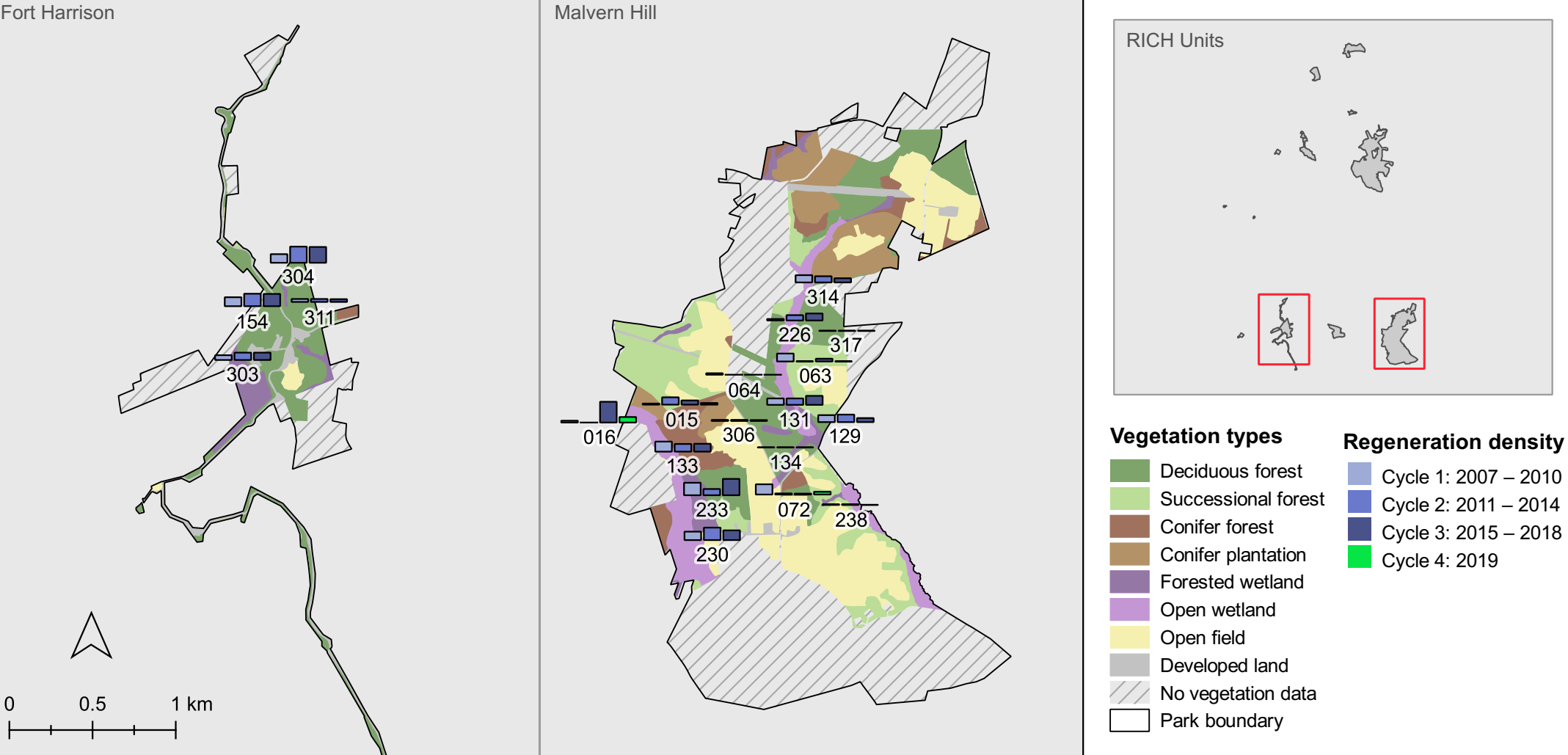
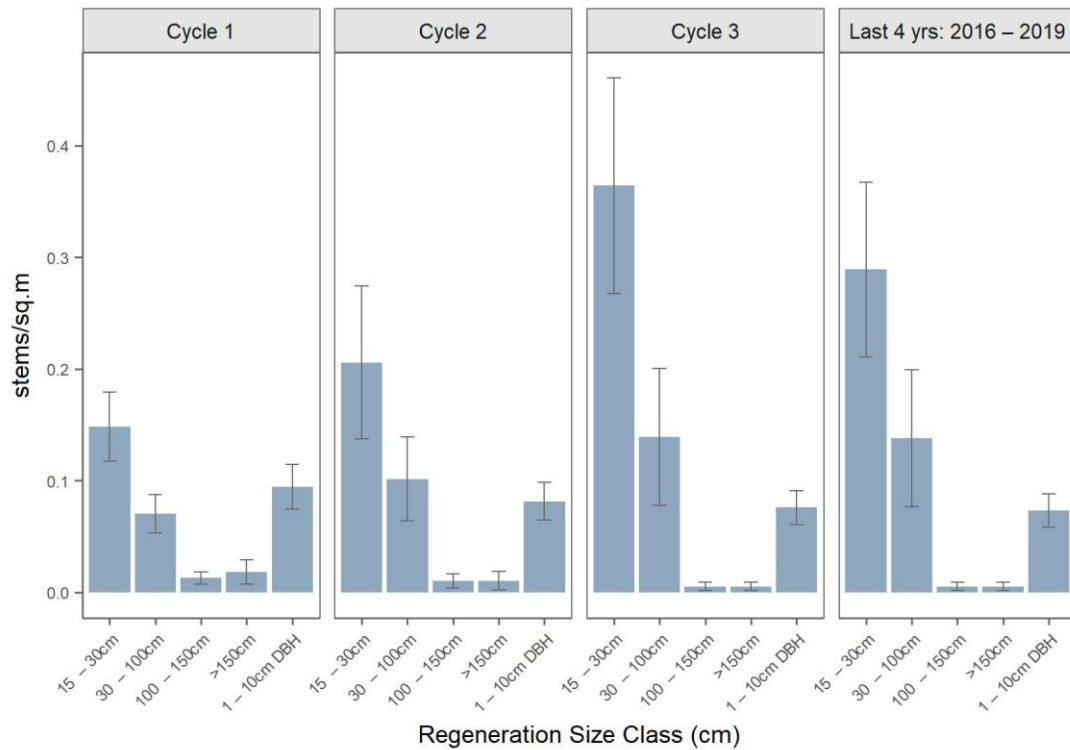


Table 1. Average plot-level seedling and sapling stem densities (stems/sq.m), and stocking index by cycle in Richmond National Battlefield Park. Only native canopy-forming species are included. Cycle 1 is 2007 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018. Note that only 1/4 of the plots have been sampled for Cycle 4 in 2019. 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. Stocking index values below 2 indicate severely understocked regeneration. Forests in areas with high deer densities need a stocking index value of at least 8 to be sufficiently stocked. Plots that meet this threshold are green.

Plot	Seedlings per sq. meter				Saplings per sq. meter				Stocking Index			
	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
015	0	0.4	0.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	3.5	3.4	1.4	1.3
016	< 0.1	0	1.3	0.3	< 0.1	0	< 0.1	< 0.1	1.9	0	2.0	1.5
019	< 0.1	0.2	0.2	0.2	0	0	0	0	0.2	0.2	0.2	0.2
020	0.6	0.3	0.3	0.3	< 0.1	< 0.1	< 0.1	< 0.1	2.4	0.8	1.4	1.5
063	0.5	0	0.2	0	< 0.1	< 0.1	< 0.1	< 0.1	1.4	0.6	0.8	0.6
064	< 0.1	0	0	0	< 0.1	0	0	0	0.7	0	0	0
072	0.3	0	0	0.2	0.3	< 0.1	< 0.1	< 0.1	30.7	3.5	2.9	0.8
073	0.4	0	2.1	0.8	0.2	0.2	0.1	< 0.1	11.0	8.3	8.2	4.5
129	0.3	0.3	0.2	-	0.1	0.2	< 0.1	-	6.4	8.2	5.0	-
131	0.4	0.4	0.6	-	0	0	0	-	0.5	0.4	0.6	-
133	0.3	0.3	0.3	-	0.3	0.2	0.3	-	16.5	14.4	15.0	-
134	0	0	0	-	< 0.1	< 0.1	< 0.1	-	0.6	0.6	0.6	-
148	0.3	0.3	0	-	0.1	< 0.1	< 0.1	-	10.9	3.8	2.4	-
153	0.3	< 0.1	3.4	-	< 0.1	< 0.1	0.2	-	3.6	1.9	14.2	-
154	0.3	0.6	0.6	-	0.2	0.2	0.2	-	12.8	11.9	11.4	-
155	0	0	0	-	0	0	0	-	0	0	0	-
203	0.3	0.3	0.2	-	0.2	0.2	0.3	-	21.4	25.0	13.8	-
207	0.5	0.2	< 0.1	-	< 0.1	< 0.1	< 0.1	-	1.8	2.5	1.9	-
215	< 0.1	3.2	2.1	-	0.2	0.2	0.2	-	7.8	13.6	16.3	-
219	0.7	0.7	1.2	-	0.1	0.1	0.1	-	7.6	8.2	8.7	-
226	< 0.1	0.3	0.4	-	< 0.1	< 0.1	< 0.1	-	0.7	1.1	2.4	-
230	0.5	0.8	0.6	-	< 0.1	< 0.1	< 0.1	-	4.7	5.8	3.3	-
233	0.8	0.3	1.0	-	< 0.1	< 0.1	< 0.1	-	5.4	8.0	8.1	-
238	0	0	0	-	< 0.1	< 0.1	< 0.1	-	2.4	2.4	0.6	-
303	0.3	0.4	0.4	-	< 0.1	< 0.1	< 0.1	-	3.2	3.4	3.4	-
304	0.4	0.9	0.9	-	0.1	0.1	0.1	-	7.7	10.9	8.1	-
306	0	0	0	-	< 0.1	< 0.1	< 0.1	-	3.5	3.5	2.9	-
307	0.3	0.4	0.2	-	< 0.1	< 0.1	< 0.1	-	1.6	1.1	2.6	-
309	0	< 0.1	0	-	< 0.1	< 0.1	0	-	1.2	0.8	0	-
311	0.2	0.2	0.2	-	< 0.1	< 0.1	< 0.1	-	1.3	1.3	0.8	-
314	0	0	0	-	0.5	0.4	0.3	-	23.6	20.0	13.6	-
317	0	0	0	-	< 0.1	< 0.1	< 0.1	-	1.2	1.2	1.2	-

A)



B)

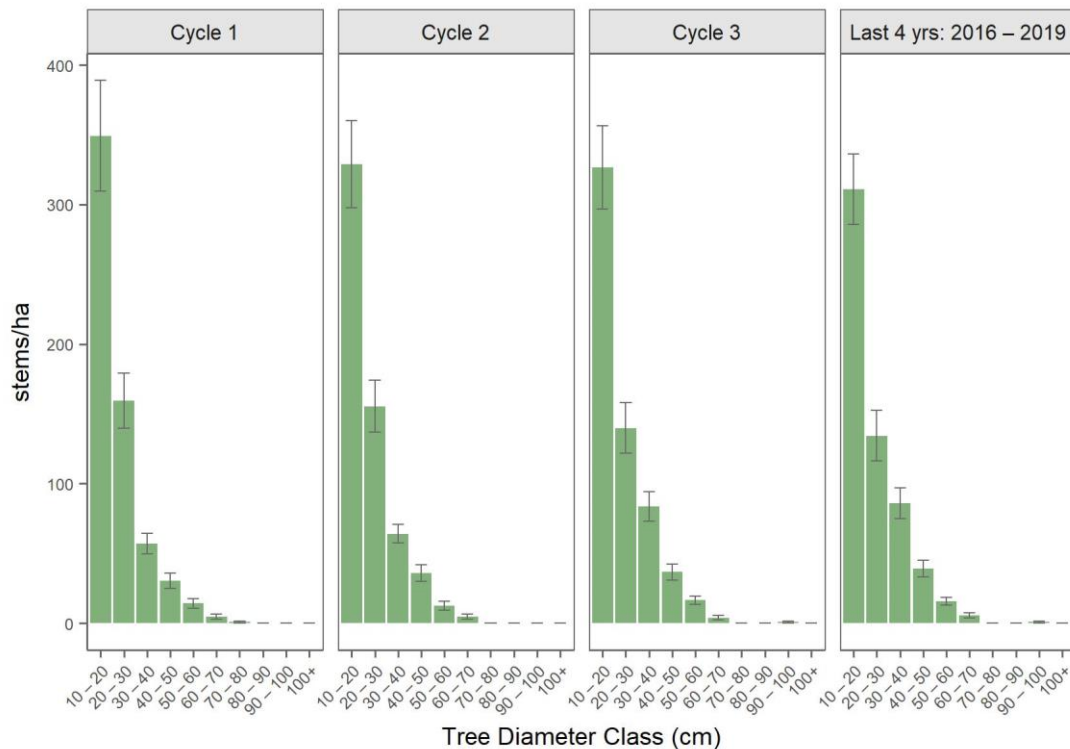
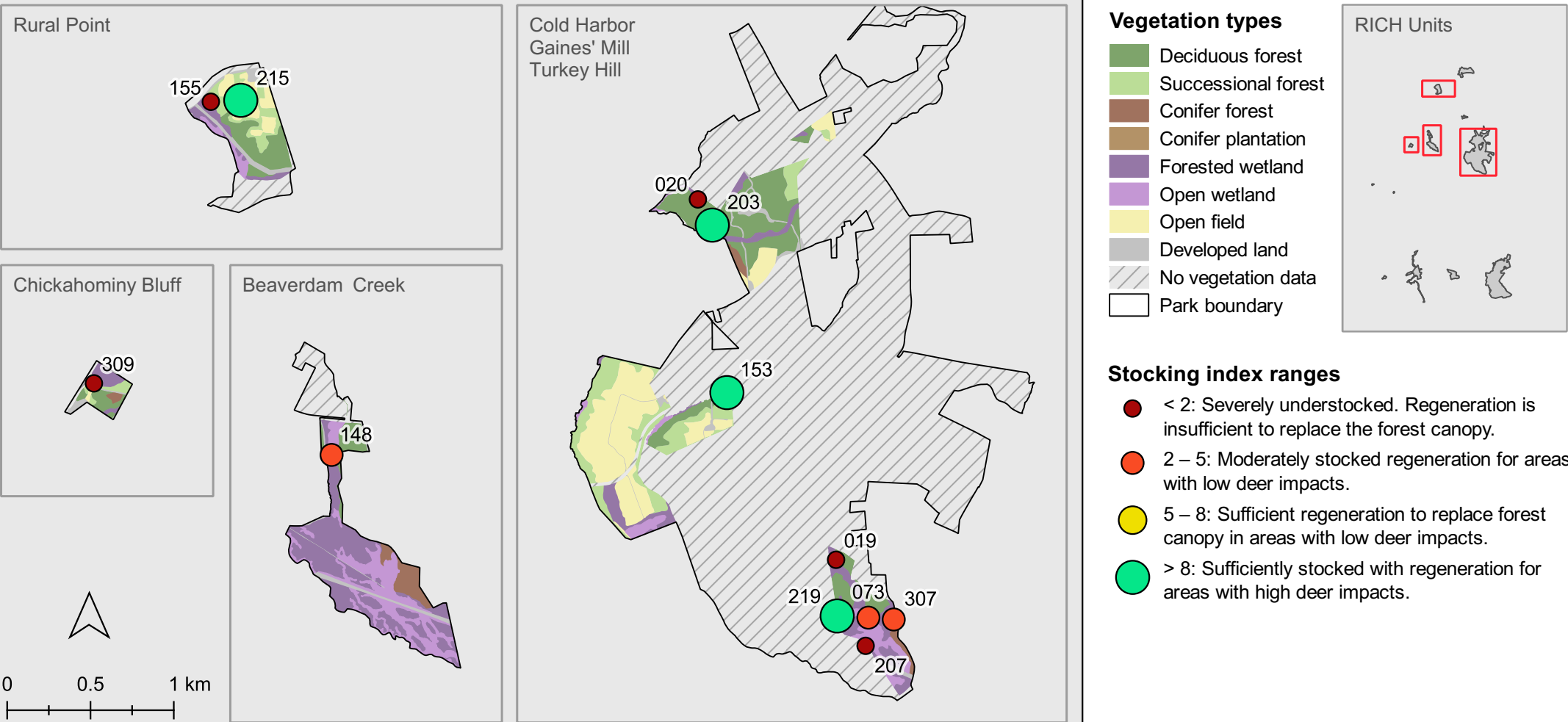


Figure 1. Stem density distributions for Richmond National Battlefield Park. Figure A shows seedling and sapling densities by size class. Figure B shows tree density by diameter at breast height at 10 cm increments. Cycle 1 is 2007 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018. The last 4 years is the most recent survey of every plot. Error bars are ± 1 SE.



Map 3a. Tree Regeneration Stocking Index

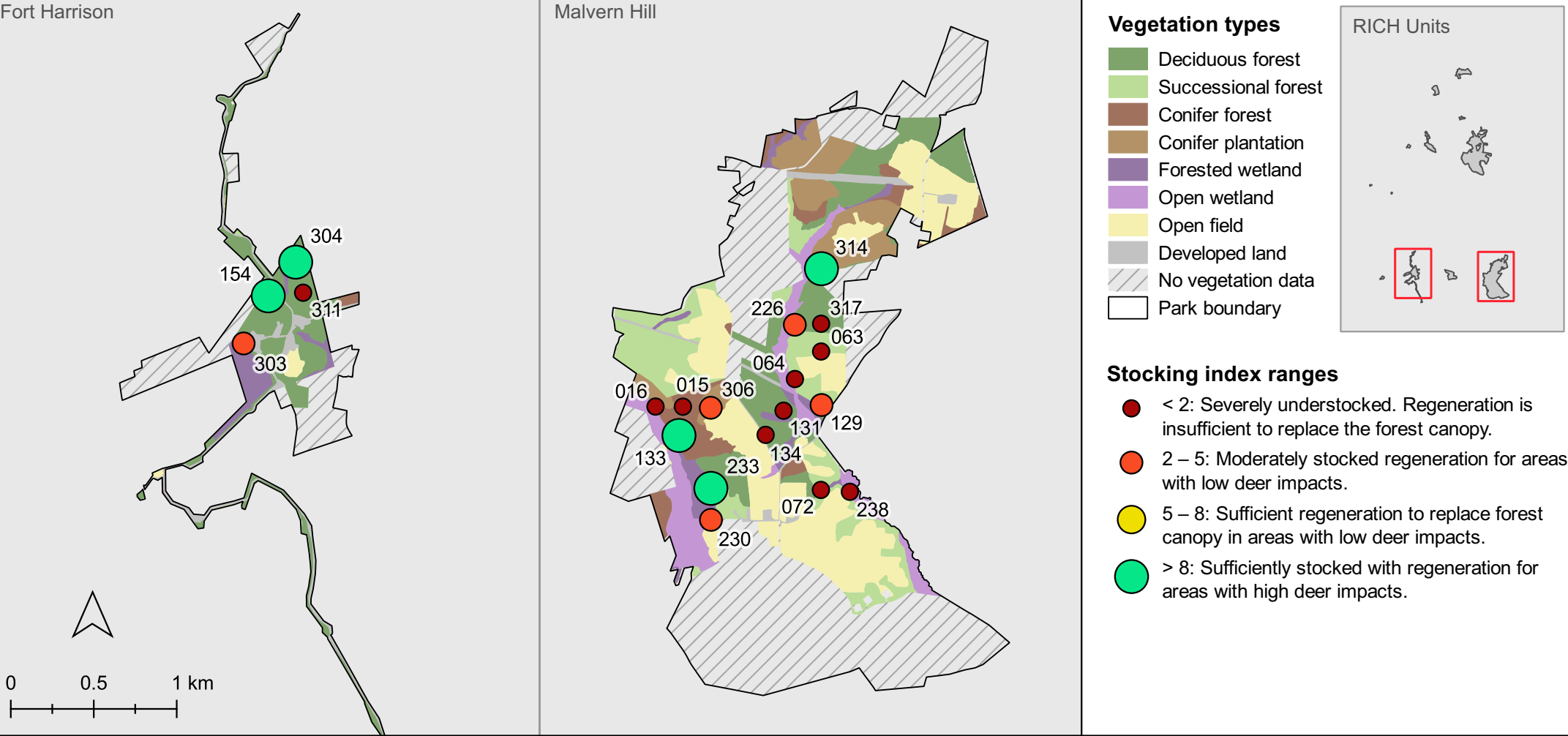
Regeneration stocking index for the most recent survey cycle (2016 – 2019). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The stocking index quantifies whether current regeneration densities are sufficient to restock a forest canopy. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. The stocking index only includes native canopy-forming species (range: 0 – 16.3). Values below 2 are severely understocked. Values above 8 are sufficiently stocked for areas with high deer abundance. See Table 1 for plot-level stocking values. Reporting Date: 08/20/2020.





Map 3b. Tree Regeneration Stocking Index

Regeneration stocking index for the most recent survey cycle (2016 – 2019). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The stocking index quantifies whether current regeneration densities are sufficient to restock a forest canopy. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. The stocking index only includes native canopy-forming species (range: 0 – 16.3). Values below 2 are severely understocked. Values above 8 are sufficiently stocked for areas with high deer abundance. See Table 1 for plot-level stocking values. Reporting Date: 08/20/2020.



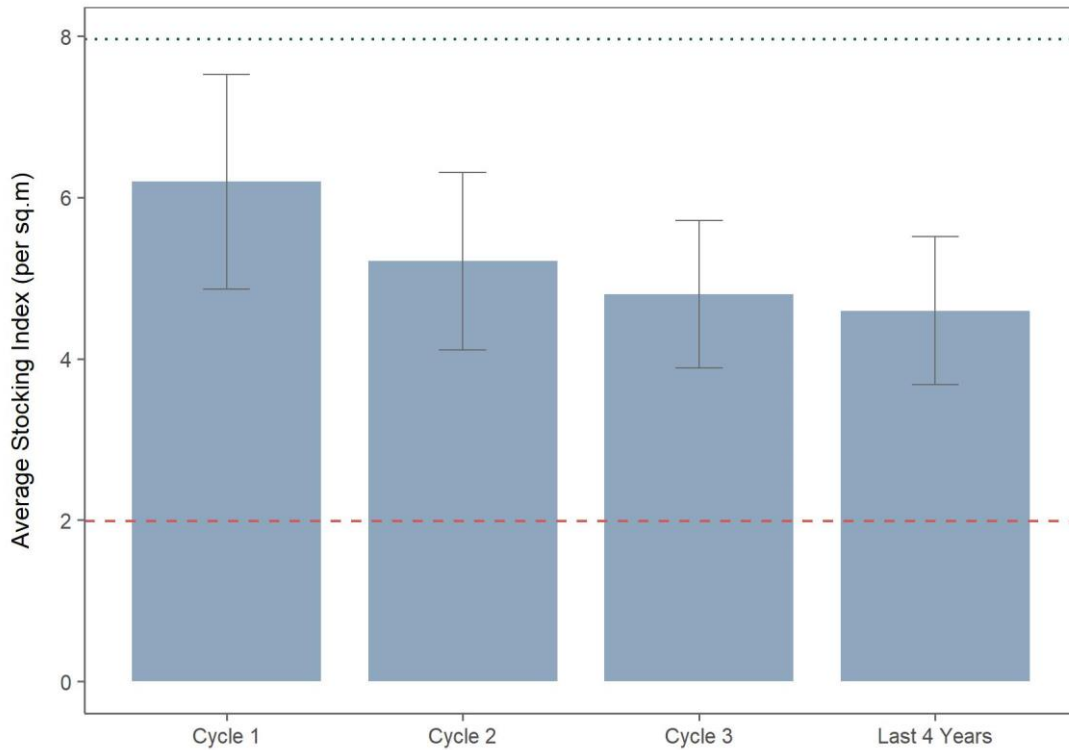


Figure 2. Regeneration stocking index averaged by cycle in Richmond National Battlefield Park. The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. The stocking index only includes native canopy-forming species (range: 0 – 30.7). Values below 2 (red dashed line) are severely understocked. Values above 8 (green dotted line) are sufficiently stocked for areas with high deer abundance. Cycle 1 is 2007 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018, Last 4 Years is 2016 – 2019. Error bars are ± 1 SE.

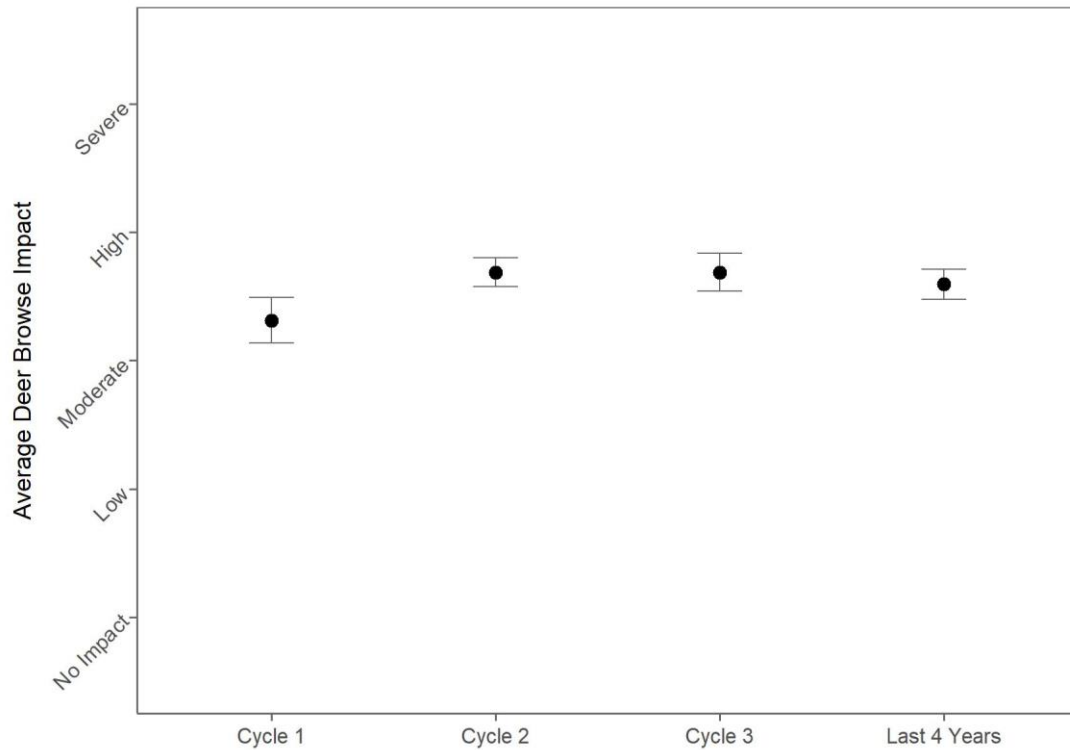
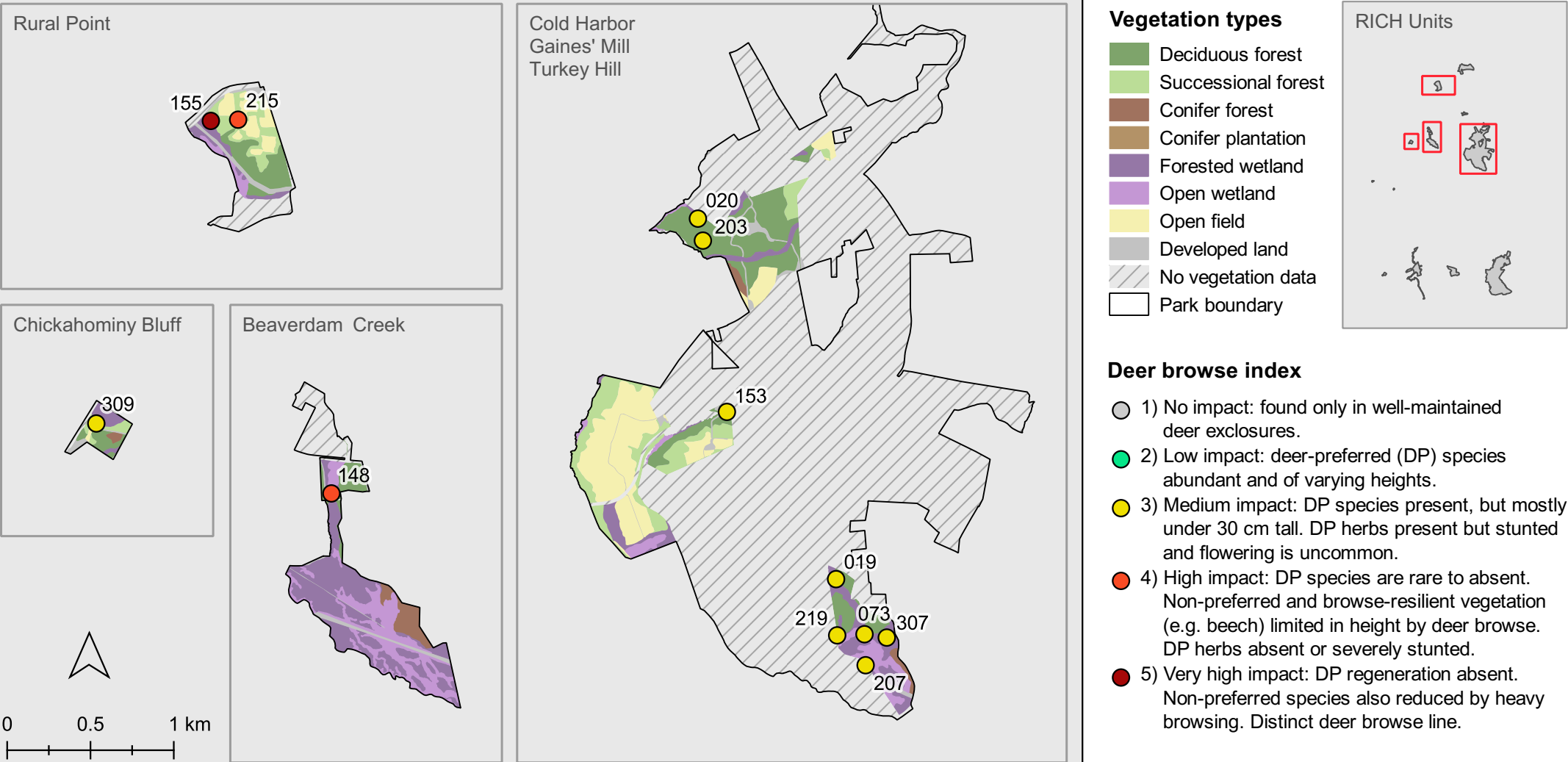


Figure 3. Average deer browse impact by cycle in Richmond National Battlefield Park. Deer browse impacts are assessed on a scale of 1 – 5, with 1 representing no impact and 5 representing severe impacts. Cycle 1 is 2009 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018, Last 4 Years is 2016 – 2019. DBI was not collected until 2009. Error bars are ± 1 SE.



Map 4a. Index of Deer Browse Impacts

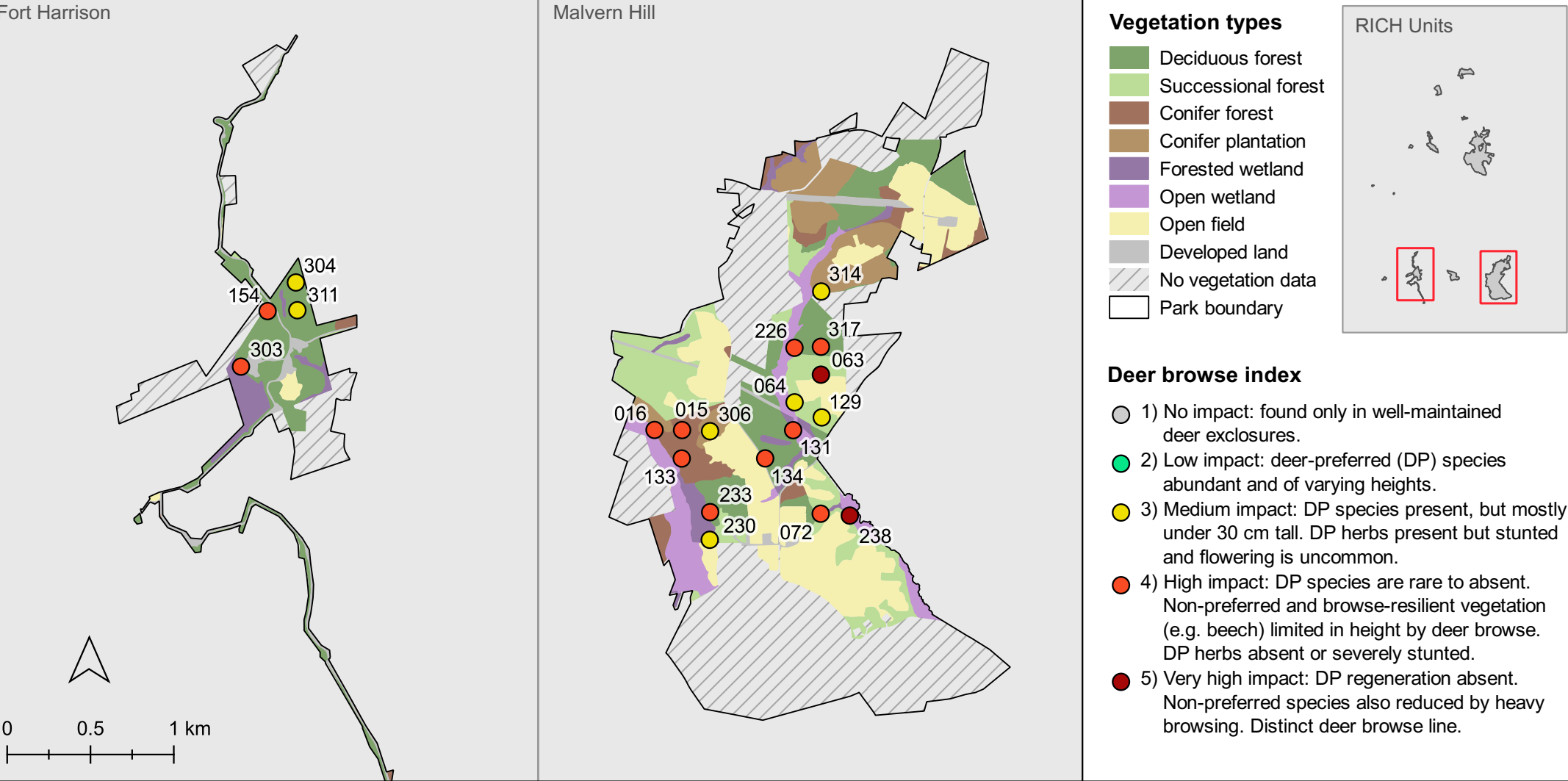
Index of deer browse impacts observed in forest plots in the most recent survey cycle (2016 – 2019). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Deer browse impacts are assessed on a scale of 1 – 5, with 1 representing no impact and 5 representing severe impacts. Reporting Date: 08/20/2020.





Map 4b. Index of Deer Browse Impacts

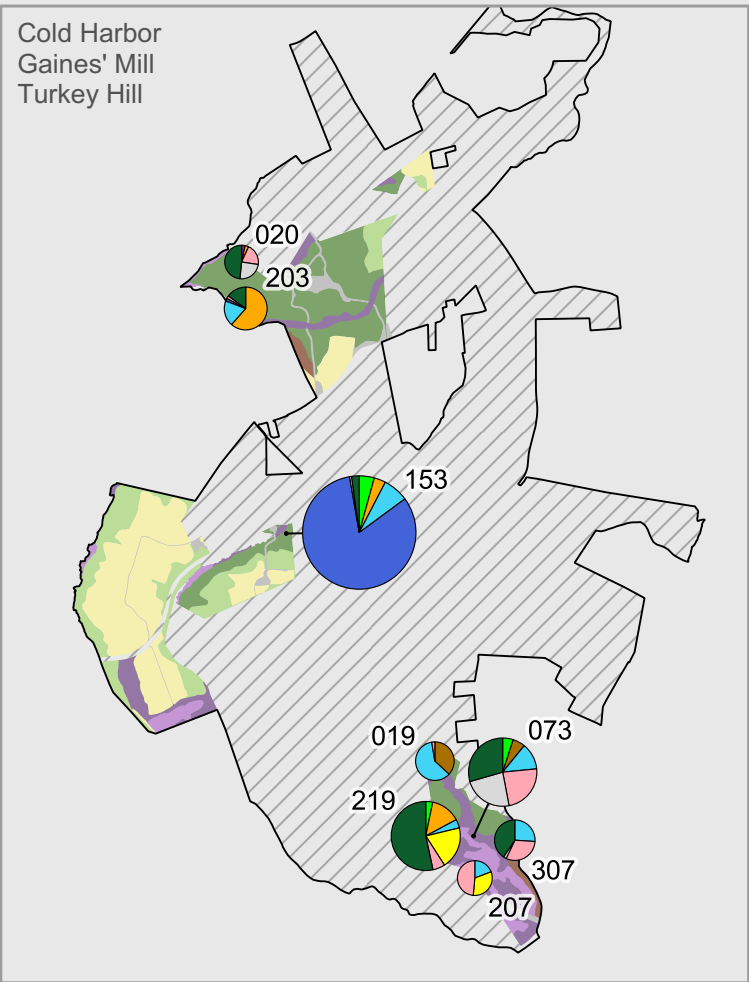
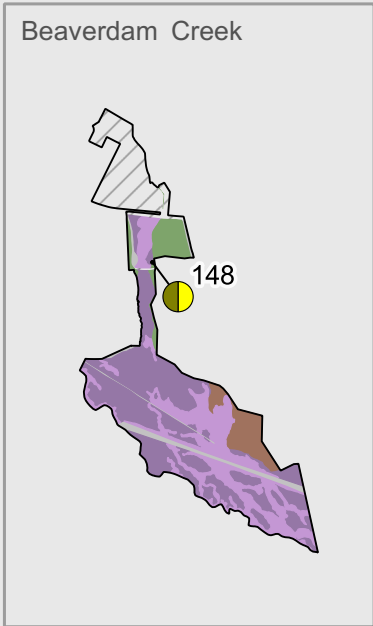
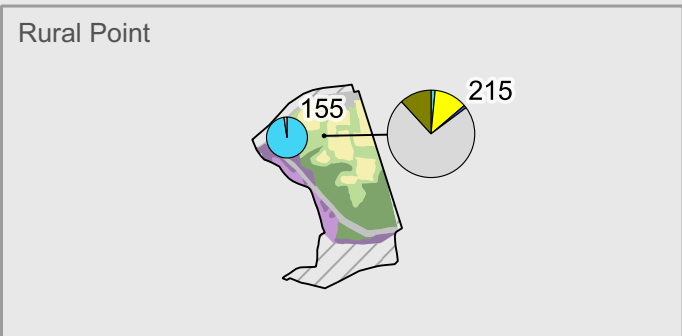
Index of deer browse impacts observed in forest plots in the most recent survey cycle (2016 – 2019). Each plot is sampled on a 4-year cycle, with one quarter of the plots sampled every year. Deer browse impacts are assessed on a scale of 1 – 5, with 1 representing no impact and 5 representing severe impacts. Reporting Date: 08/20/2020.





Map 5a. Tree Regeneration by Composition

Tree regeneration stem densities, including seedlings and saplings, by species group observed in forest plots sampled in the most recent survey cycle (2016 – 2019). 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. Densities range from 0 to 3.2 stems/sq.m for an individual species group. See <https://npsforveg.shinyapps.io/midn/> for more specific plot level information. Reporting Date: 08/20/2020.



Vegetation types

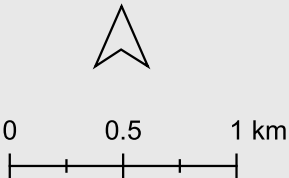
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Forested wetland
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

RICH Units



Species in pie charts

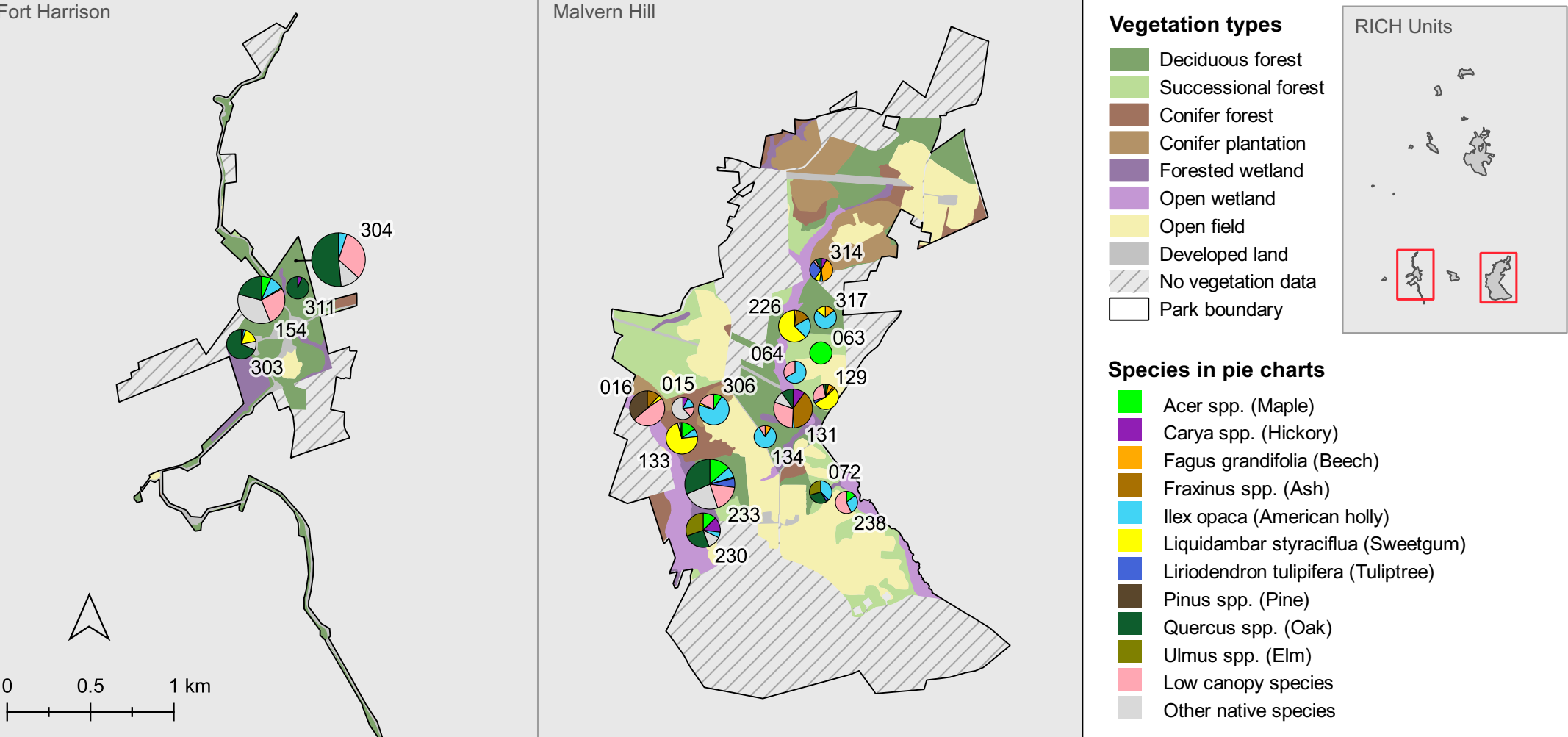
- Acer spp. (Maple)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Ilex opaca (American holly)
- Liquidambar styraciflua (Sweetgum)
- Liriodendron tulipifera (Tuliptree)
- Pinus spp. (Pine)
- Quercus spp. (Oak)
- Ulmus spp. (Elm)
- Low canopy species
- Other native species





Map 5b. Tree Regeneration by Composition

Tree regeneration stem densities, including seedlings and saplings, by species group observed in forest plots sampled in the most recent survey cycle (2016 – 2019). 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. Densities range from 0 to 3.2 stems/sq.m for an individual species group. See <https://npsforveg.shinyapps.io/midn/> for more specific plot level information. Reporting Date: 08/20/2020.

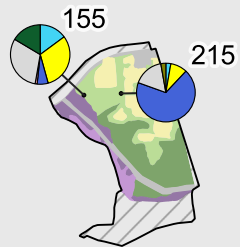




Map 6a. Tree Canopy Composition

Live basal area by species group observed in forest plots sampled in the most recent survey cycle (2016 – 2019). 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 area. Pies may be shifted to prevent overlap. Basal areas range from 0 to 48.4 sq.m/ha for an individual species group. See <https://npsforveg.shinyapps.io/midn/> for more specific plot level information. Reporting Date: 08/20/2020.

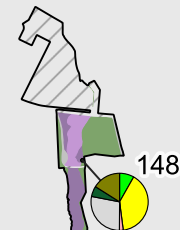
Rural Point



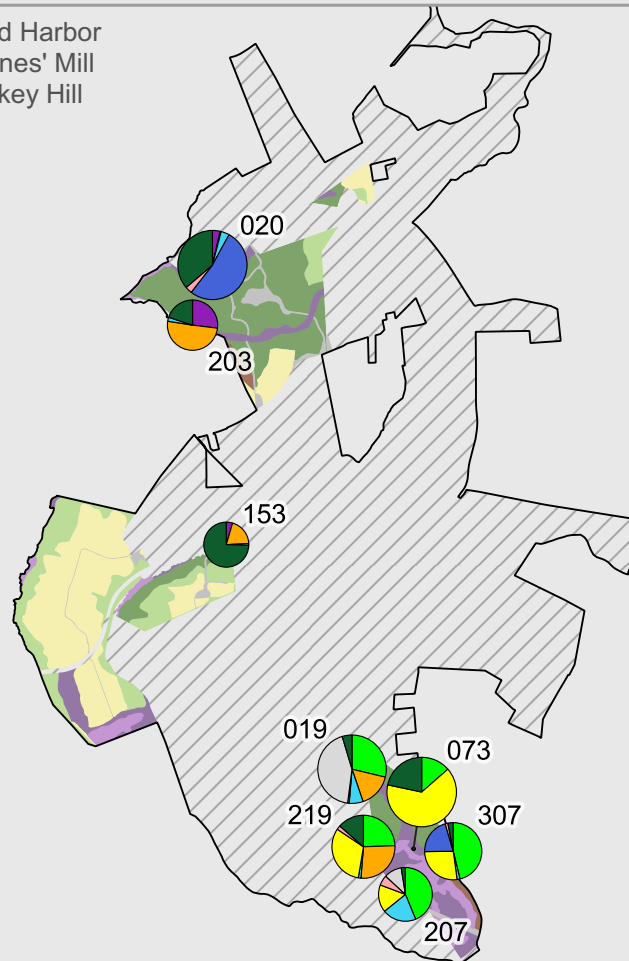
Chickahominy Bluff



Beaverdam Creek



Cold Harbor
Gaines' Mill
Turkey Hill



Vegetation types

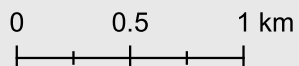
- Deciduous forest
- Successional forest
- Conifer forest
- Conifer plantation
- Forested wetland
- Open wetland
- Open field
- Developed land
- No vegetation data
- Park boundary

RICH Units



Species in pie charts

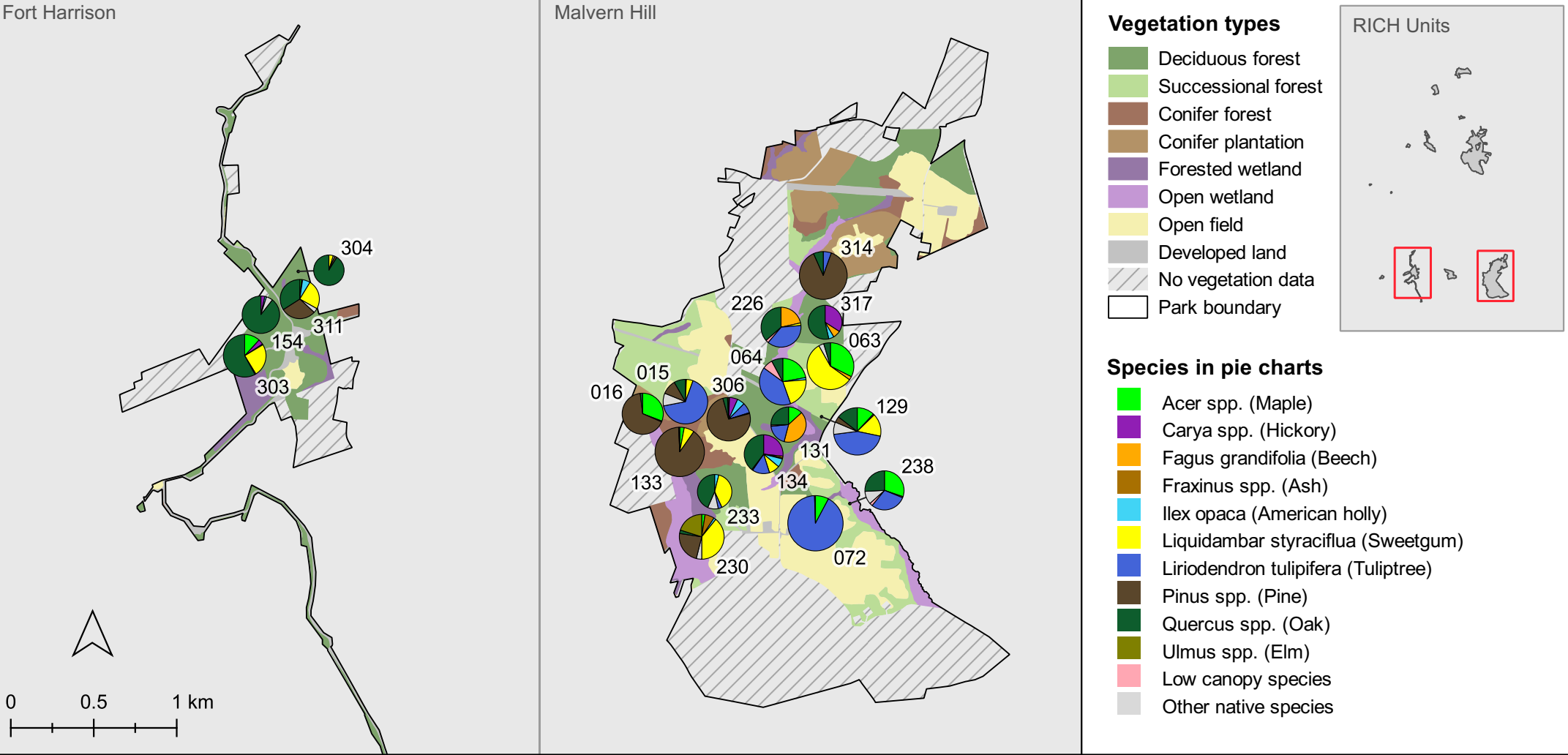
- Acer spp. (Maple)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Ilex opaca (American holly)
- Liquidambar styraciflua (Sweetgum)
- Liriodendron tulipifera (Tuliptree)
- Pinus spp. (Pine)
- Quercus spp. (Oak)
- Ulmus spp. (Elm)
- Low canopy species
- Other native species





Map 6b. Tree Canopy Composition

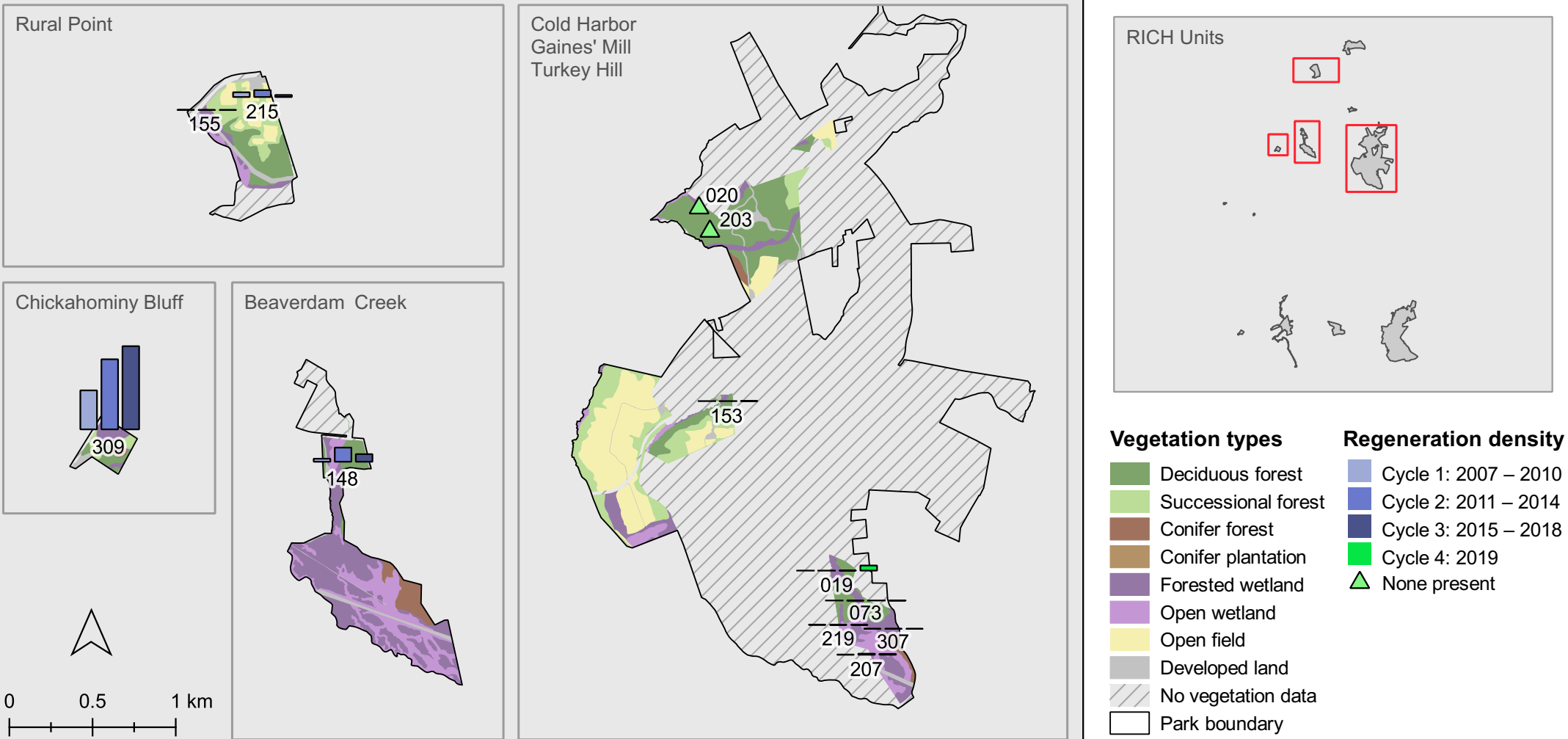
Live basal area by species group observed in forest plots sampled in the most recent survey cycle (2016 – 2019). Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. Pie size is proportional to plot-level basal area. Pies may be shifted to prevent overlap. Basal areas range from 0 to 48.4 sq.m/ha for an individual species group. See <https://npsforveg.shinyapps.io/midn/> for more specific plot level information. Reporting Date: 08/20/2020.





Map 7a. Invasive % Cover by Cycle

Average percent cover of invasive species observed in quadrats in forest plots sampled from 2007 – 2019. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The number of bars per plot corresponds to the number of times the plot has been sampled. Average invasive cover per plot ranges from 0 to 71.4%. See Table 2 for % cover values. See Table 3 for a species list; only species monitored since 2007 were included in this metric. Reporting Date: 08/20/2020.





Map 7b. Invasive % Cover by Cycle

Average percent cover of invasive species observed in quadrats in forest plots sampled from 2007 – 2019. Each plot is sampled on a 4-year cycle in a rotating panel, with one quarter of the plots sampled every year. The number of bars per plot corresponds to the number of times the plot has been sampled. Average invasive cover per plot ranges from 0 to 71.4%. See Table 2 for % cover values. See Table 3 for a species list; only species monitored since 2007 were included in this metric. Reporting Date: 08/20/2020.

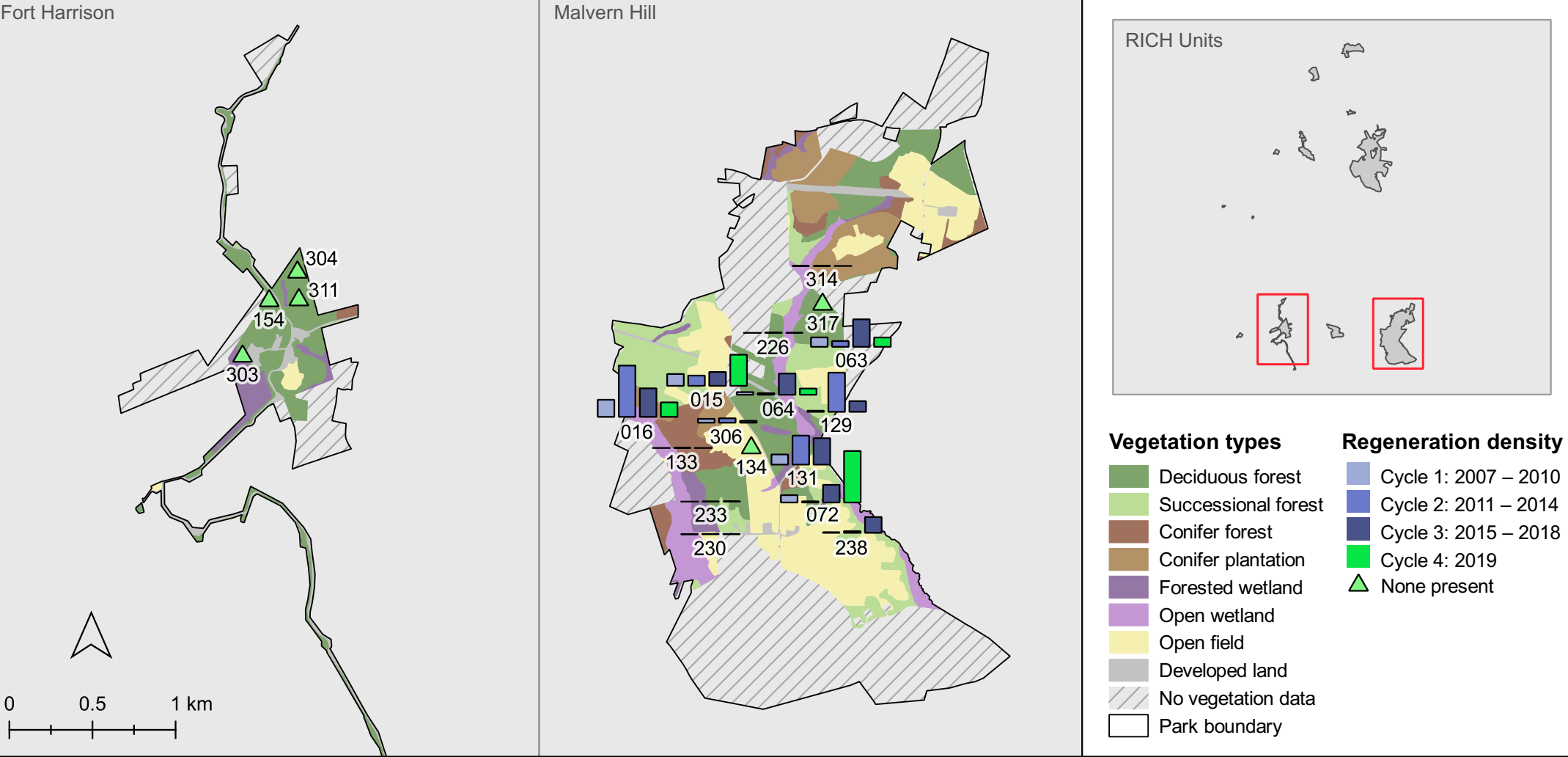


Table 2. Average % cover of invasive species detected in each plot by cycle in Richmond National Battlefield Park. Cycle 1 is 2007 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018. Note that only 1/4 of the plots have been sampled for Cycle 4 in 2019. See Table 3 for a species list; only species monitored since 2007 were included in this metric.

Plot	Average % cover			
	Cycle 1	Cycle 2	Cycle 3	Cycle 4
015	10.1	8.8	11.9	26.7
016	14.7	44.1	24.5	12.5
019	0	0	0.2	4.4
020	0	0	0	0
063	8.1	5.0	23.6	8.0
064	2.3	1.3	18.2	5.3
072	6.3	1.0	15.2	44.2
073	0	< 0.1	0	< 0.1
129	1.0	33.7	9.2	-
131	8.7	24.9	22.7	-
133	0	< 0.1	0	-
134	0	0	0	-
148	2.6	12.1	6.5	-
153	0	0	0.2	-
154	0	0	0	-
155	0.2	< 0.1	< 0.1	-
203	0	0	0	-
207	0.2	0.9	0.7	-
215	4.1	5.9	1.7	-
219	0.1	< 0.1	< 0.1	-
226	0	0.3	< 0.1	-
230	0.2	0.3	0.3	-
233	0	< 0.1	0.1	-
238	0.5	1.4	13.6	-
303	0	0	0	-
304	0	0	0	-
306	3.3	3.7	1.6	-
307	< 0.1	< 0.1	< 0.1	-
309	33.5	60.2	71.4	-
311	0	0	0	-
314	< 0.1	< 0.1	0	-
317	0	0	0	-

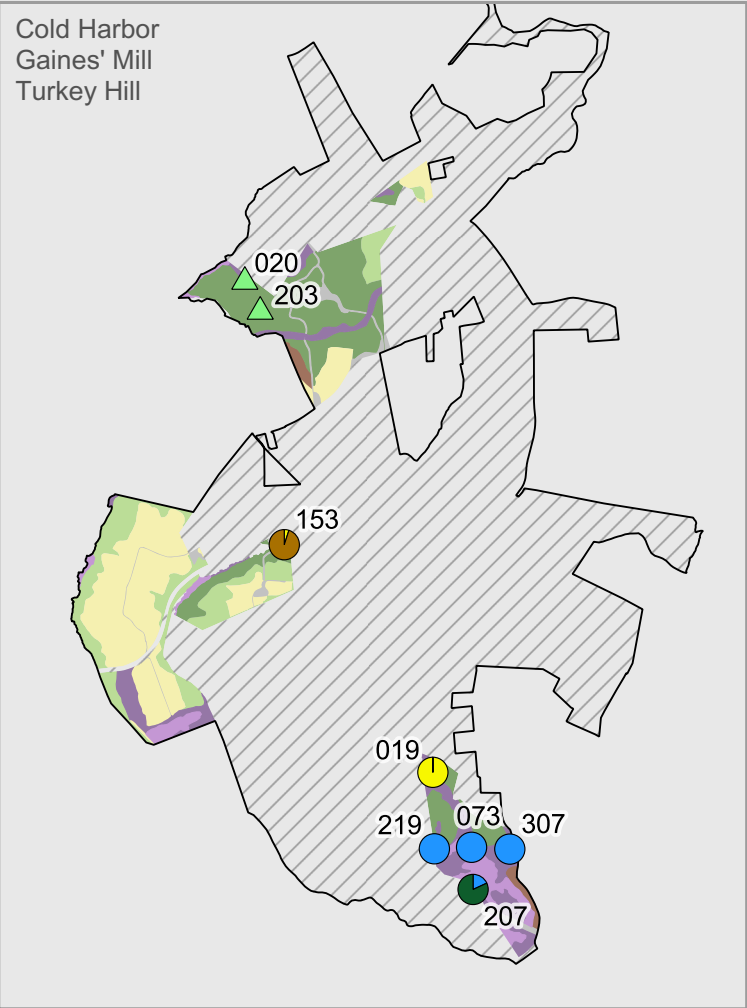
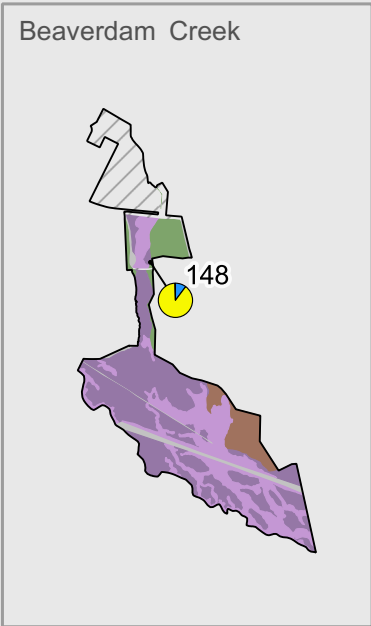
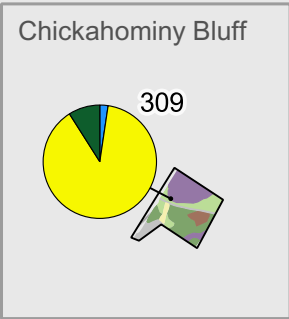
Table 3. Number of plots where invasive species were detected by cycle in Richmond National Battlefield Park. Cycle 1 is 2007 – 2010, Cycle 2 is 2011 – 2014, Cycle 3 is 2015 – 2018. Note that only 1/4 of the plots have been sampled for Cycle 4 in 2019. Note that not all species have been monitored for the same amount of time, as indicated by the Year added column. Species that are exotic to the mid-Atlantic region, but not considered invasive are indicated by *.

Latin name	Common name	Year added	Number of plots with species present			
			Cycle 1	Cycle 2	Cycle 3	Cycle 4
<i>Ailanthus altissima</i>	Tree-of-heaven	2007	4	1	1	0
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2007	1	1	1	1
<i>Dioscorea oppositifolia</i>	Chinese yam	2013	0	0	2	0
<i>Duchesnea indica</i> *	Mock strawberry	2007	3	1	1	1
<i>Glechoma hederacea</i> *	Ground ivy	2007	0	1	1	0
<i>Hedera helix</i>	English ivy	2007	1	1	2	0
<i>Ligustrum</i> spp.	Privet	2009	1	4	7	4
<i>Lonicera</i> spp. - Exotic	Exotic bush honeysuckle	2007	3	1	0	0
<i>Lonicera japonica</i>	Japanese honeysuckle	2007	17	21	20	7
<i>Lonicera maackii</i>	Amur honeysuckle	2007	1	0	0	0
<i>Microstegium vimineum</i>	Japanese stiltgrass	2007	13	19	21	6
<i>Paulownia tomentosa</i>	Princess tree	2007	1	0	0	0
<i>Persicaria longiseta</i> *	Oriental lady's thumb	2009	6	8	9	5
<i>Persicaria perfoliata</i>	Mile-a-minute	2007	0	1	1	0
<i>Rosa multiflora</i>	Multiflora rose	2007	3	2	3	0
<i>Vinca minor</i> *	Lesser periwinkle	2007	1	0	0	0
Number of plots	-	-	32	32	32	8



Map 8a. Invasive % Cover by Species

Average percent invasive cover by species observed in quadrats in forest plots sampled in the most recent survey cycle (2016 – 2019). 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 invasive cover. Pies may be shifted to prevent overlap. Average invasive cover ranges from 0 to 63.3% for an individual species. See Table 3 for more information. Reporting Date: 08/20/2020.



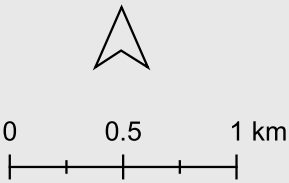
Vegetation types

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

RICH Units

Species in pie charts

- Ligustrum spp. (Privet)
- Lonicera japonica (Japanese honeysuckle)
- Microstegium vimineum (Japanese stiltgrass)
- Other exotic herbs
- Other invasive woody species
- None present





Map 8b. Invasive % Cover by Species

Average percent invasive cover by species observed in quadrats in forest plots sampled in the most recent survey cycle (2016 – 2019). 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 invasive cover. Pies may be shifted to prevent overlap. Average invasive cover ranges from 0 to 63.3% for an individual species. See Table 3 for more information. Reporting Date: 08/20/2020.

