Forest Data Summaries for Minute Man National Historical Park: 2006-2018

Background

Summaries are based on data collected in Northeast Temperate Network (NETN) long-term forest monitoring plots. There are 20 NETN forest plots in MIMA. Each plot is sampled on an alternating 4-year cycle, with plots 1-10 sampled in 2006, 2010, 2014, and 2018, and plots 11-20 sampled in 2008, 2012, and 2016. Within each forest plot, tree and stand measurements, including an assessment of deer browse impact, are made within 20 x 20 m square plots. Tree regeneration is tallied by size class within three 2-m radius circular microplots within each square plot. Coarse woody debris (CWD) is assessed using line intersect sampling along three 15-m transects originating at plot center. Understory diversity is monitored within eight 1-m^2 quadrats, and soil samples are obtained from a location adjacent to the plot. Plots are permanently marked and measured at the same location every cycle. For a more detailed description of the forest monitoring protocol, including background information, field methods, and sample design, refer to the NETN forest monitoring protocol.

This document provides summaries and interpretations of forest health to help inform park staff of any potential issues detected by NETN forest monitoring. This report has been updated to include results from the 6/18-6/21/2018 survey, which is the first of two panels in Cycle 4. Note that summaries are considered preliminary until after the 2018 data are thoroughly checked and certified at the end of the field season.

Summary

The forests in MIMA reflect a long history of human land use, including a diverse flora composed of many non-native and old field species. Regeneration rates are moderate to low across MIMA (See Maps 1 & 4). This may be due in part to deer impacts (See Map 3), which are potentially increasing. Competition from invasive shrubs, particularly glossy buckthorn (*Rhamnus frangula*), is also likely suppressing regeneration and impacting native diversity (See Map 8). In addition, invasive trees, including Norway maple (*Acer platanoides*) and black locust (*Robinia pseudoacacia*), are well established in the forest canopy (See Map 6). Efforts to limit their spread into the less invaded areas of the park, such as removing mature plants that can disperse seeds, will help ensure continual native forest canopy in MIMA. On a positive note, overall coarse woody debris (CWD) volume has increased over time (See Map 10), which is at least partially the result of changes to the park's approach to managing CWD.

Interpretation of Maps

Map 1. Regeneration by Cycle

Trends in tree regeneration density over time are variable across the park. Regeneration density has increased in several plots (e.g., Plots 3, 11, 12, and 16), decreased in others (e.g., plots 1 and 14), and other remained relatively stable. Without a clear pattern, management implications are difficult to determine from this metric alone.

Map 2. Regeneration by Size Class

Healthy forests typically have tree seedlings and saplings of varying sizes, whereas forests with impacts from deer browse tend to be dominated by seedlings less than 30 cm (~1 ft) tall. In MIMA, 8 out of 20 plots (40%) are dominated by seedlings less than 30 cm tall, although saplings are also present in half of these plots.

Map 3. Index of Deer Browse Impacts: 2016 & 2018

The index of deer browse impacts (DBI) is a 1 to 5 scale that qualitatively assesses deer impacts to a plot. A DBI value of 1 describes a forest in the complete absence of deer and a value of 5 corresponds to an understory experiencing very high deer impacts (i.e. no regeneration or herbaceous species preferred by deer present and visible browse on non-preferred species). Mean DBI scores above 3.5 indicate that forest plots have sustained such heavy browse that the understory composition has shifted from browse-

preferred woody and herbaceous species (e.g., sugar maple and liliaceous herbs) to browse-resistant or non-preferred species (e.g., beech, ferns and invasive species). The average DBI in cycle 3 (2014 & 2016) was 3.2, medium impact. This value is up from the cycle 2 (2010 & 2012) average of 2.6, low impact, suggesting that deer impacts are potentially increasing. In addition, the 10 plots sampled in Cycle 4 (2018) averaged 3.4 for DBH, whereas the same group of plots in Cycle 3 (2014) averaged a DBI of 3.1. Plots with the highest DBI scores tend to be on the eastern side of the park.

Map 4. Regeneration Stocking Index: 2016 & 2018

The regeneration stocking index quantifies whether current seedling and sapling densities are sufficient to restock a forest canopy, and only includes canopy-forming tree species. The index is a weighted sum of native seedling and sapling densities where larger size classes are weighted higher in the calculation. Areas with high deer impacts require a stocking index of 100 to be sufficiently stocked to replace the forest canopy. Based on the most recent survey cycle (2016 & 2018), only three out of 20 plots (15%) are sufficiently stocked for areas with high deer impacts. Fourteen out of 20 plots (70%) are severely understocked and do not have enough regeneration to replace the forest canopy (Table 1). The stocking index also has a slight downward trend across the cycles, with the mean stocking index for Cycle 1 at 49.1, Cycle 2 at 44.0, and Cycle 3 at 42.0. In addition, the mean stocking index for plots sampled in 2018 was 30.3, which is down from 35.7 for the same group of plots sampled in Cycle 3 (2014). These values are all in the category: moderately to sufficiently stocked for areas with low deer impacts.

Map 5. Regeneration Composition

White ash (*Fraxinus americana*) is the most abundant species in the regeneration layer in MIMA plots, followed by black cherry (*Prunus serotina*) and white pine (*Pinus strobus*). White ash is particularly prevalent on plots 11 and 17. The dominance of white ash is a concern, as the spread of emerald ash borer (EAB), which was detected nearby in Waltham, MA in 2017, threatens its long-term status in the forest canopy. The abundance of black cherry regeneration is interesting, considering it is currently only a small component of the canopy. There is also a predominance of exotic tree species regeneration. Norway maple is the seventh most abundant tree seedling overall. Exotic hawthorn (*Crataegus spp.*) and white mulberry (*Morus alba*) were also present. Encouraging native tree regeneration, particularly species that grow to canopy height, and removing seed-bearing individuals of exotic trees will help ensure continual native forest cover in MIMA.

Map 6. Canopy Tree Composition by Basal Area

Basal area, which is a common metric to assess tree abundance, is the cross-sectional area occupied by each species (based on the diameter at breast height) on a plot, converted to m^2/ha. Plots with a high basal area have larger and/or more trees than plots with a low basal area. In MIMA, total basal area varies between plots and between species. Red maple (*Acer rubrum*), white pine, and black oak (*Quercus velutina*) are the three most abundant tree species. All three species are fairly well represented in the regeneration layer, suggesting that they will remain an important part of the canopy in the future. Black cherry may become more abundant if its dominance in the regeneration layer continues.

Exotic tree species have also become an important part of the canopy. The fifth most common tree species, based on basal area, is black locust. Black locust is an efficient nitrogen fixer that can both outcompete native species and facilitate invasion of exotic species through changing the surrounding soil chemistry. Therefore, while black locust is native to the southeastern United States, it is considered an aggressive invader in the Northeastern US. One good sign is that black locust is nearly absent in the regeneration layer. On the other hand, Norway maple is abundant in both the canopy and regeneration layer. Norway maples can suppress native plant growth because of their dense, shallow root systems and the deep shade produced by their canopies.

Forest Data Summaries for Minute Man National Historical Park: 2006-2018

Map 7 + 8. Invasive Shrub Species % Cover by Cycle and Composition

The most common invasive species in MIMA are shrubs and woody vines (Table 3). Average cover of invasive shrubs and vines increased from 10.6% in Cycle 1 to 14.7% in Cycle 3 (Map 7, Table 2). The most abundant invasive shrub in MIMA is glossy buckthorn, which was found in 19 out of 20 plots by Cycle 3 (Map 8, Table 3). Oriental bittersweet (*Celastrus orbiculatus*) and multiflora rose (*Rosa multiflora*) were also commonly found in plots, but had lower percent cover. Oriental bittersweet was documented in 9 plots in Cycle 1, but was found in 18 plots in Cycle 3. Frequency of other invasive species that are common in MIMA, such as garlic mustard (*Alliaria petiolata*) and purple loosestrife (*Lythrum salicaria*), has remained relatively stable over time (Table 3).

Map 9. Earthworms: Presence or Absence

Earthworms are not native to New England and have been linked, along with overabundant deer and invasive plant species, to losses in native plant diversity. Earthworms were detected in 13 out of 20 plots (65%) in MIMA. The plots without earthworms are often found in or adjacent to wetlands. While it is possible that earthworms have not yet reached these plots, it is more likely that the soil may be too wet to support earthworms in these areas or that earthworms occur at such low levels that they are not easily detected. Snake worms (*Amynthas agrestic*), which were recently detected by park staff in MIMA, were not detected in the forest plots sampled in 2018. However, the timing of sampling in MIMA is not ideal for distinguishing snake worms from the more common European earthworms (family: Lumbricidae), and the snake worm may have gone undetected.

Map 10 + 11. Coarse Woody Debris Levels and by Cycle

Coarse woody debris (CWD) volume has increased from 8.8 m^3/ha in Cycle 1 to 11.8 m^3/ha in Cycle 3. Mean CWD volume is even higher for the first 10 plots sampled in Cycle 4 (2018), averaging 18.3 m^3/ha. A recent review of temperate and boreal forest organisms that are dependent on dead wood found a threshold of 20-50 m^3/ha of CWD volume was required to support a broad suite of these species (Müller and Bütler 2010). Using these thresholds, only 4 out of 20 plots in MIMA meet this minimum requirement. These results suggest that MIMA's recent efforts to retain and/or enhance CWD have effectively increased CWD volume in the park. However, CWD development is a naturally slow process, and it will take time for the majority of MIMA's forest plots to meet the CWD thresholds. As long as MIMA management continues to retain dead wood as trees die, we expect this metric to continue to improve.

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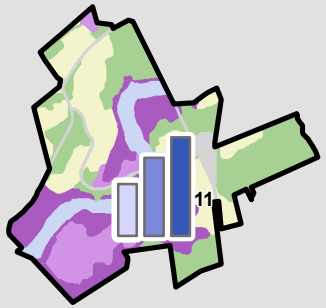
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Map 1. Regeneration by Cycle

Trends in tree regeneration stem densities, including seedlings and saplings, observed in forest plots sampled from 2006-2018. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, and 2018, and plots 11-20 sampled in 2008, 2012, and 2016. Densities range from 0 to 11,671 stems/ha. Date: 6/26/2018.

North Bridge



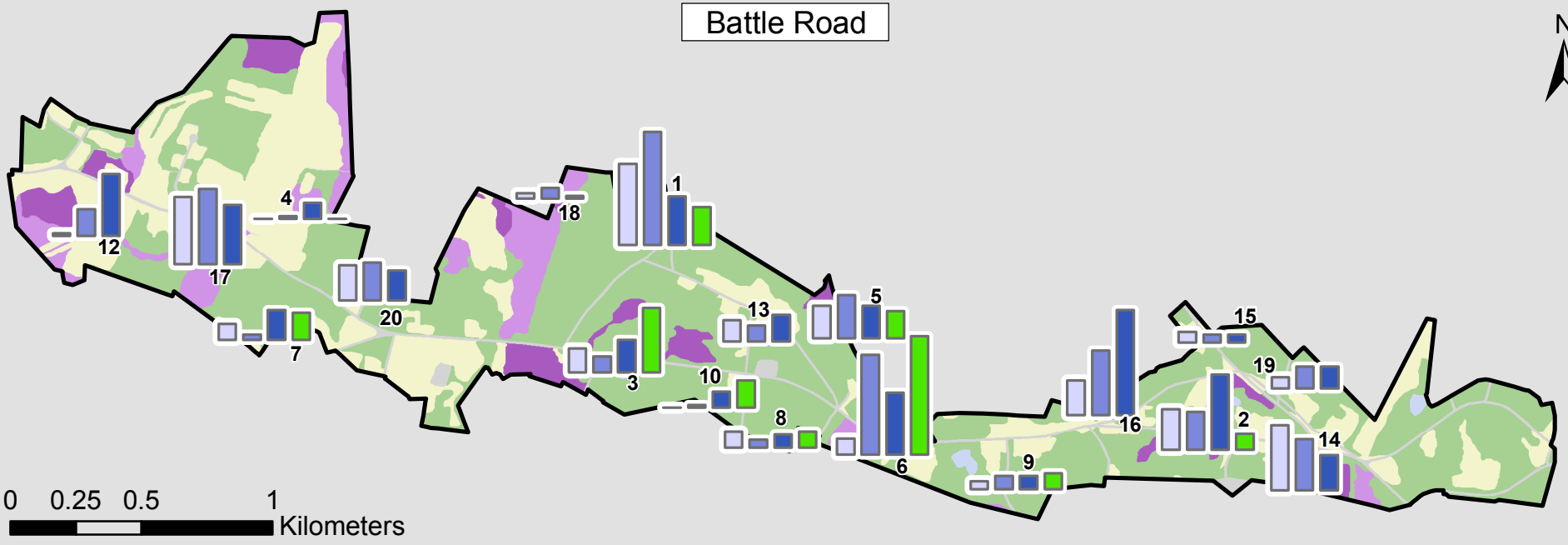
Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary

Regeneration densities

- Cycle 1: 2006 & 2008
- Cycle 2: 2010 & 2012
- Cycle 3: 2014 & 2016
- Cycle 4: 2018

Battle Road



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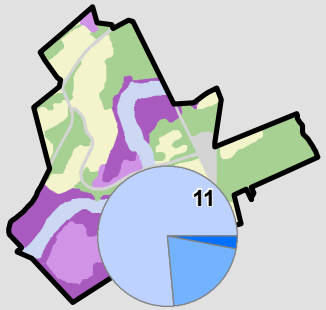
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Map 2. Regeneration by Size Class

Trends in tree regeneration stem densities by size class observed in forest plots in the most recent survey cycle (2016 & 2018). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018, and plots 11-20 sampled in 2016. Pie size is proportional to the total plot-level regeneration (plot-level density range: 0 to 6,897 stems/hectare for an individual size class). Pies may be shifted from actual plot location to prevent overlap. Date: 6/26/2018.

North Bridge



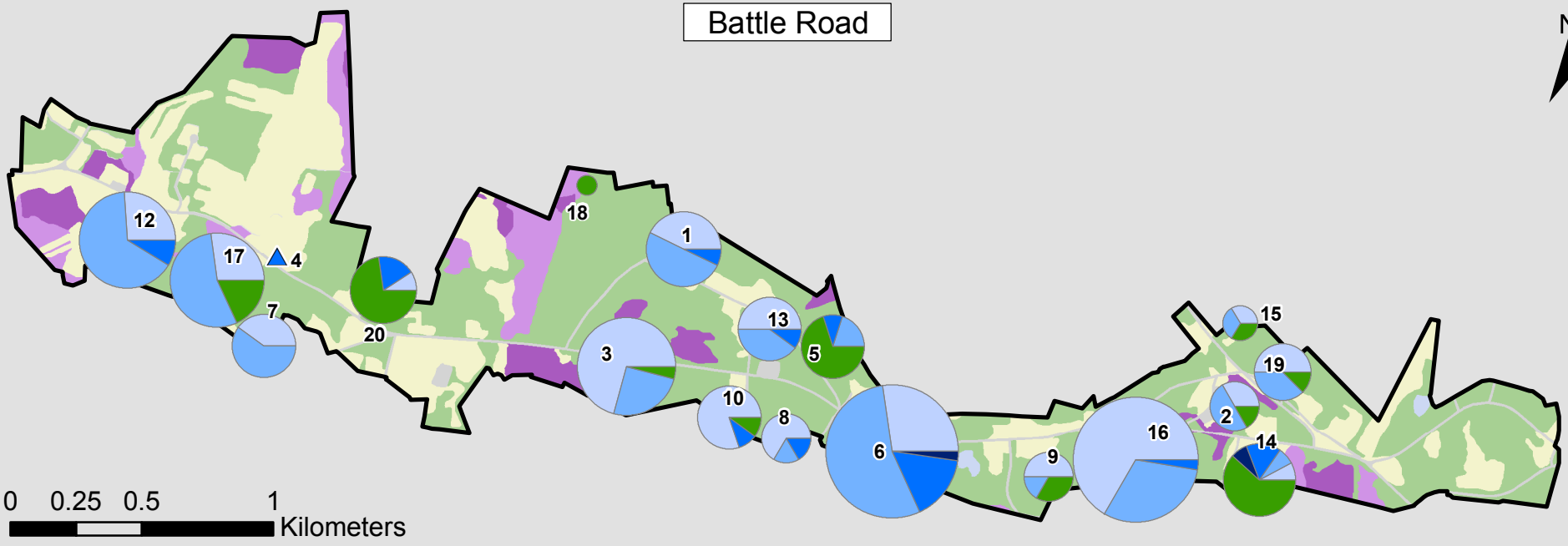
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- Park Boundary

Regeneration densities

- No regeneration observed
- Seedlings 15 to 30 cm
- Seedlings 30 to 100 cm
- Seedlings 100 to 150 cm
- Seedlings >150 cm
- Saplings (≥1 cm & <10 cm DBH)

Battle Road



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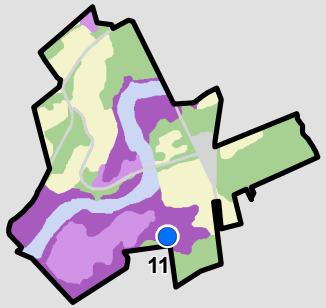
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Map 3. Index of Deer Browse Impacts: 2016 & 2018

Index of deer browse impacts observed in forest plots in the most recent four years of sampling (2016 & 2018). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018 and plots 11-20 sampled in 2016. Deer browse impacts are assessed on a scale of 1-5, with 1 representing no impact and 5 representing severe impacts.
Date: 6/27/2018.

North Bridge



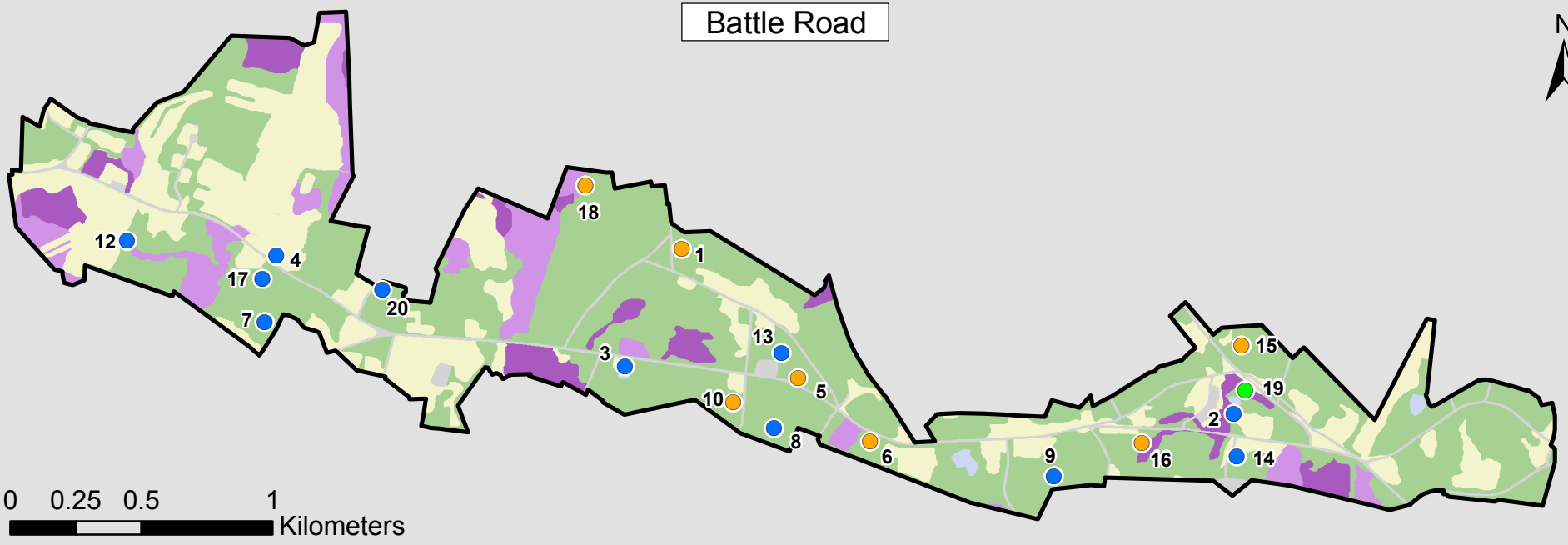
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Deer Browse Index

- 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 < 30 cm tall. DP herbs present but stunted and flowering is uncommon.
- 4) High Impact: DP species are rare to absent. Non-preferred (NP) 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. NP species also reduced by heavy browsing. Distinct deer browse line.

Battle Road



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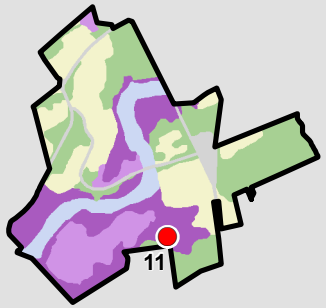
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Map 4. Regeneration Stocking Index: 2016 & 2018

Trends in the regeneration stocking index for the most recent 4 years of sampling (2016 & 2018). The index is a weighted sum of seedling and sapling densities where larger seedling size classes get higher weights. The stocking index is averaged over three 2-m radius microplots per forest plot (range 0-147). See Table 1 for plot-level stocking index values. Date: 6/27/2018.

North Bridge



Legend

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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.

Battle Road

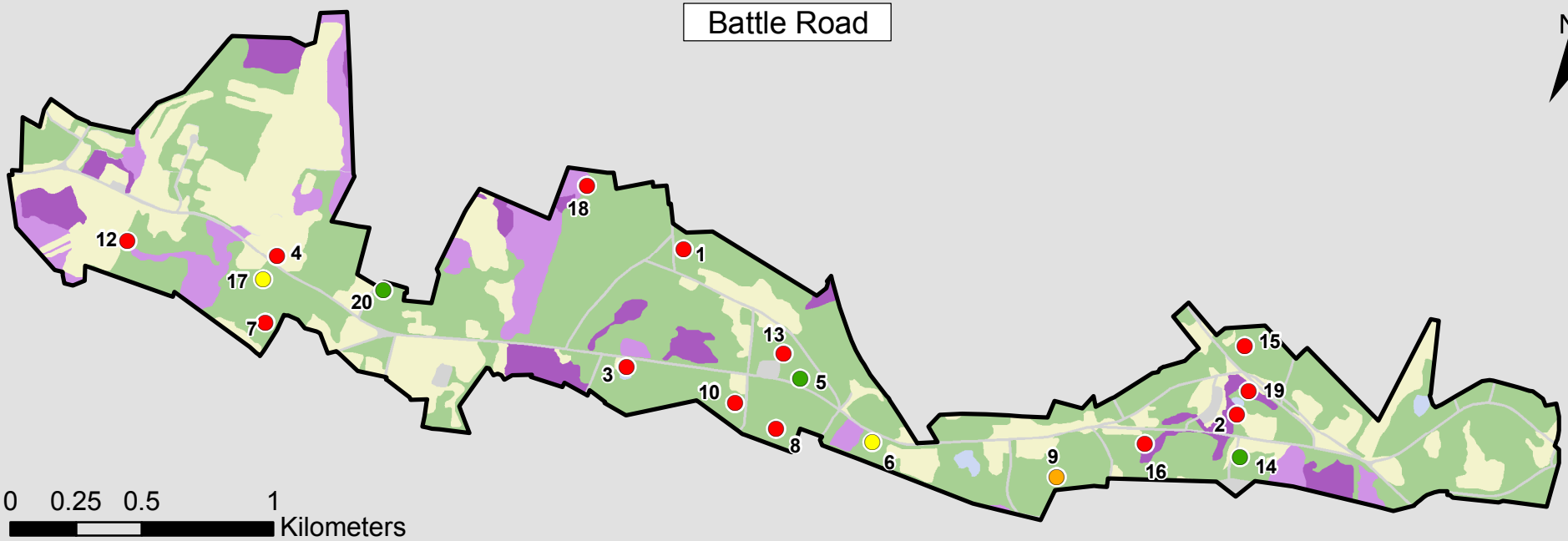


Table 1. Average plot-level seedling and sapling stem densities per hectare and stocking index by cycle. Cycle 1 = 2006 & 2008; Cycle 2 = 2010 & 2012; Cycle 3 = 2014 & 2016; Cycle 4 = 2018 only. Plots are sampled in alternating years, with Panel 1 sampled the first year, and Panel 2 sampled the second year. The stocking index qualifies whether current regeneration densities are sufficient to restock a forest canopy, and only includes native canopy-forming tree species. The index is a weighted sum of seedling and sapling densities where larger seedling classes get higher weights. Green fields are plots that have a stocking index >100, sufficient to replace a forest canopy in areas of high deer impacts. Color coding matches the Regeneration Stocking Index map.

Plot	Panel	Seedlings per hectare				Saplings per hectare				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
1	1	7957.7	11140.8	4774.6	3713.6	0.0	0.0	0.0	0.0	**10.0**	44.7	27.3	**12.0**
2	1	795.8	2387.3	7162.0	1326.3	3183.1	1326.3	265.3	265.3	201.0	**2.0**	77.0	**19.0**
3	1	2387.3	1591.5	3183.1	6100.9	0.0	0.0	0.0	265.3	**3.0**	**1.7**	**6.0**	**6.3**
4	1	0.0	265.3	1591.5	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.7**	**1.3**	**0.0**
5	1	1591.5	1856.8	1326.3	795.8	1591.5	2387.3	1856.8	1856.8	102.0	136.7	125.3	124.0
6	1	1591.5	9814.6	6100.9	11671.4	0.0	0.0	0.0	0.0	**3.0**	40.7	27.7	83.3
7	1	1591.5	530.5	2387.3	2652.6	0.0	0.0	530.5	0.0	**3.0**	**0.7**	38.3	**5.3**
8	1	1591.5	795.8	1326.3	1591.5	0.0	0.0	0.0	0.0	**3.0**	**1.3**	**2.0**	**8.7**
9	1	0.0	530.5	530.5	1061.0	795.8	795.8	795.8	530.5	50.0	50.7	50.7	35.0
10	1	0.0	0.0	1326.3	2387.3	0.0	265.3	265.3	265.3	**0.0**	**0.0**	**1.7**	**9.3**
11	2	4509.4	6896.7	9018.8		265.3	265.3	0.0		37.7	74.0	20.0	
12	2	265.3	2652.6	6100.9		0.0	0.0	0.0		**0.7**	**3.7**	**16.7**	
13	2	1856.8	1326.3	2652.6		265.3	265.3	0.0		**18.0**	**24.0**	**9.3**	
14	2	4244.1	2387.3	1326.3		2122.1	2652.6	2122.1		159.0	148.7	140.7	
15	2	265.3	530.5	530.5		795.8	265.3	265.3		56.7	**16.7**	**17.7**	
16	2	3183.1	6100.9	10345.1		265.3	265.3	0.0		**21.3**	36.0	**19.3**	
17	2	5835.7	6631.5	4774.6		795.8	795.8	1061.0		66.7	78.0	76.7	
18	2	530.5	1061.0	0.0		0.0	0.0	265.3		**0.7**	**2.3**	**16.7**	
19	2	530.5	1856.8	1856.8		530.5	265.3	265.3		40.3	25.7	**19.3**	
20	2	530.5	1061.0	795.8		2917.8	2652.6	2122.1		206.7	191.0	146.7	

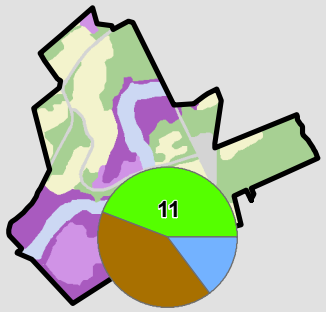
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Map 5. Regeneration Composition

Trends in tree regeneration, including seedlings and saplings, by species group observed in forest plots in the most recent survey cycle (2016 & 2018). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018, and plots 11-20 sampled in 2016. Pie size is proportional to the total plot-level regeneration (plot-level density range: 0 to 11,671 stems/ha). Pies may be shifted from actual plot location to prevent overlap. Date: 6/27/2018.

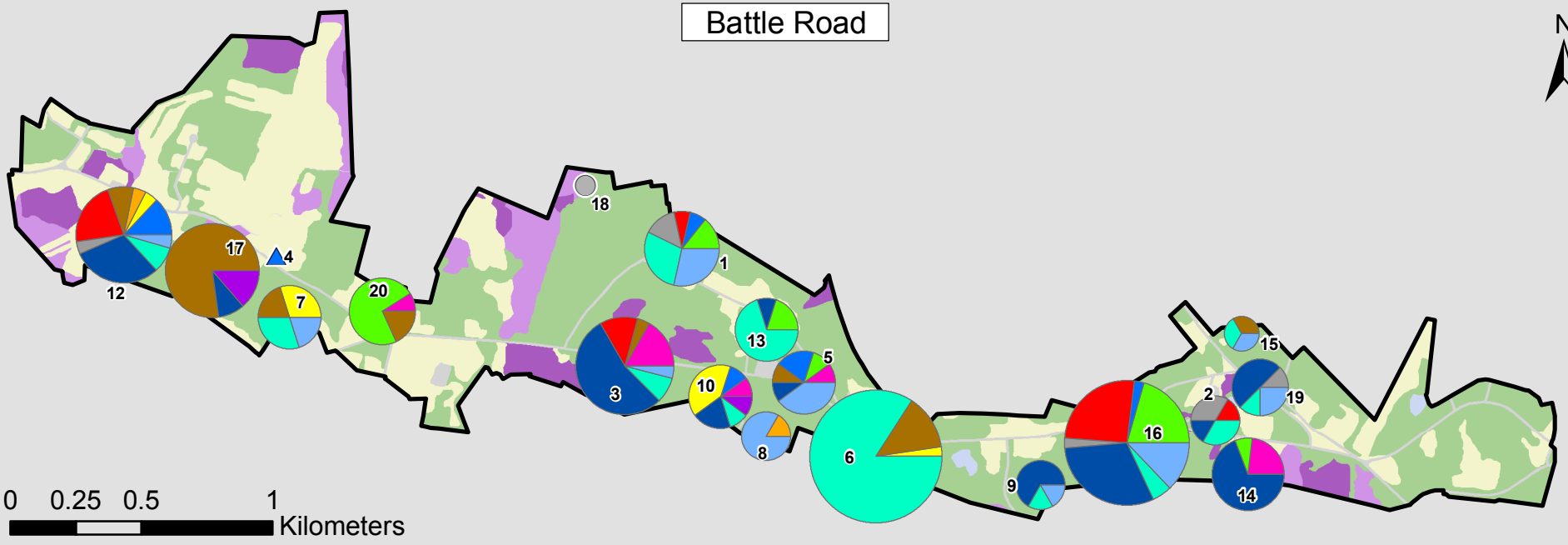


Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary
- No regeneration observed

Species in Pie Charts

- Acer platanoides (Norway maple)
- Acer spp. (Maple - Native)
- Betula spp. (Birch)
- Carya spp. (Hickory)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Other exotic species
- Other native species
- Pinus strobus (White pine)
- Prunus spp. (Cherry)
- Quercus spp. (Oak)
- Ulmus spp. (Elm)



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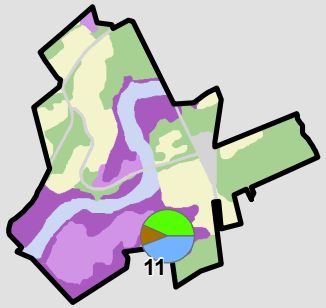
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Map 6. Canopy Tree Composition by Basal Area

Trends in tree composition, by species group, observed in forest plots in the most recent survey cycle (2016 & 2018). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018, and plots 11-20 sampled in 2016. Pie size is proportional to the total plot-level basal area (plot-level basal area range: 19.0 to 78.0 m^2/hectare). Pies may be shifted from actual plot location to prevent overlap. Date: 6/27/2018.

North Bridge



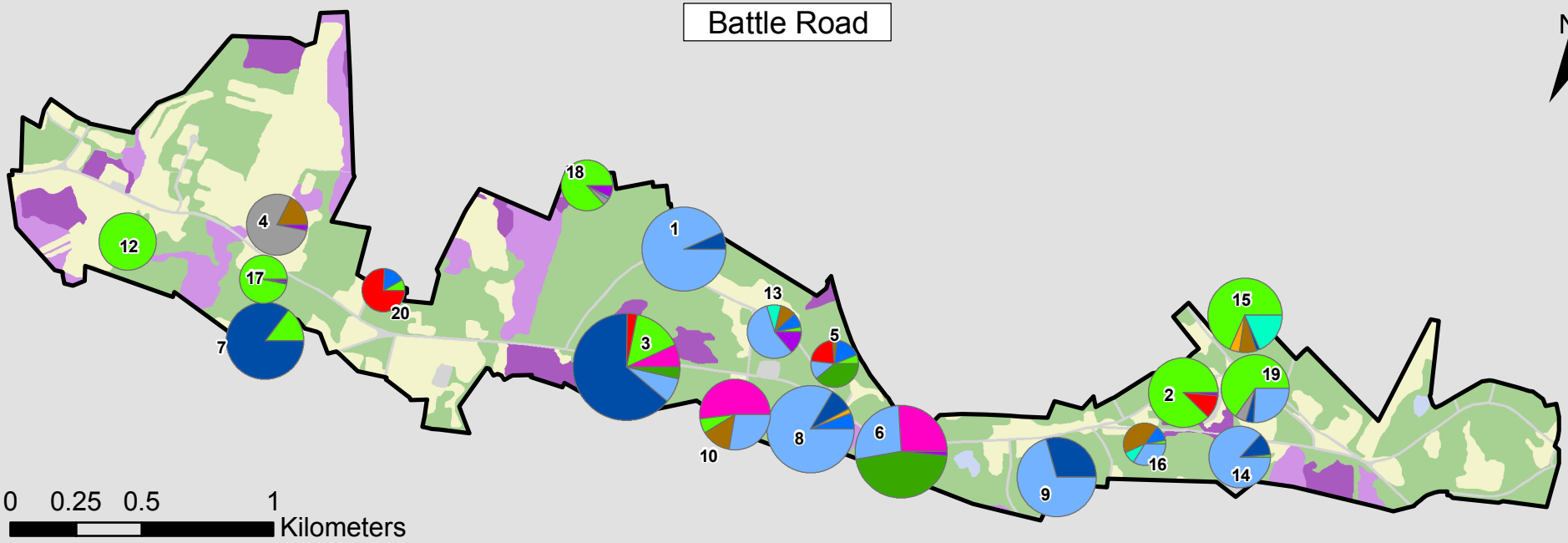
Legend

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Species in Pie Charts

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- Acer spp. (Maple - Native)
- Betula spp. (Birch)
- Fagus grandifolia (Beech)
- Fraxinus spp. (Ash)
- Other exotic species
- Other native species
- Pinus strobus (White pine)
- Prunus spp. (Cherry)
- Quercus spp. (Oak)
- Robinia pseudoacacia (Black locust)
- Ulmus spp. (Elm)

Battle Road



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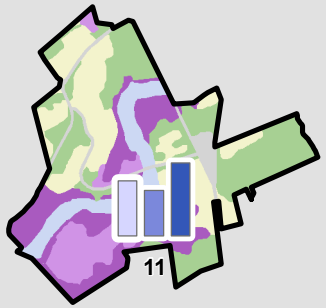
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Map 7. Invasive Shrub % Cover by Cycle

Trends in percent cover of invasive shrub and vine species observed in plots sampled from 2006-2018. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, and 2018, and plots 11-20 sampled in 2008, 2012, and 2016. Average invasive shrub cover ranges from 0 to 53%. See Table 2 for % cover values. Date: 6/27/2018.

North Bridge



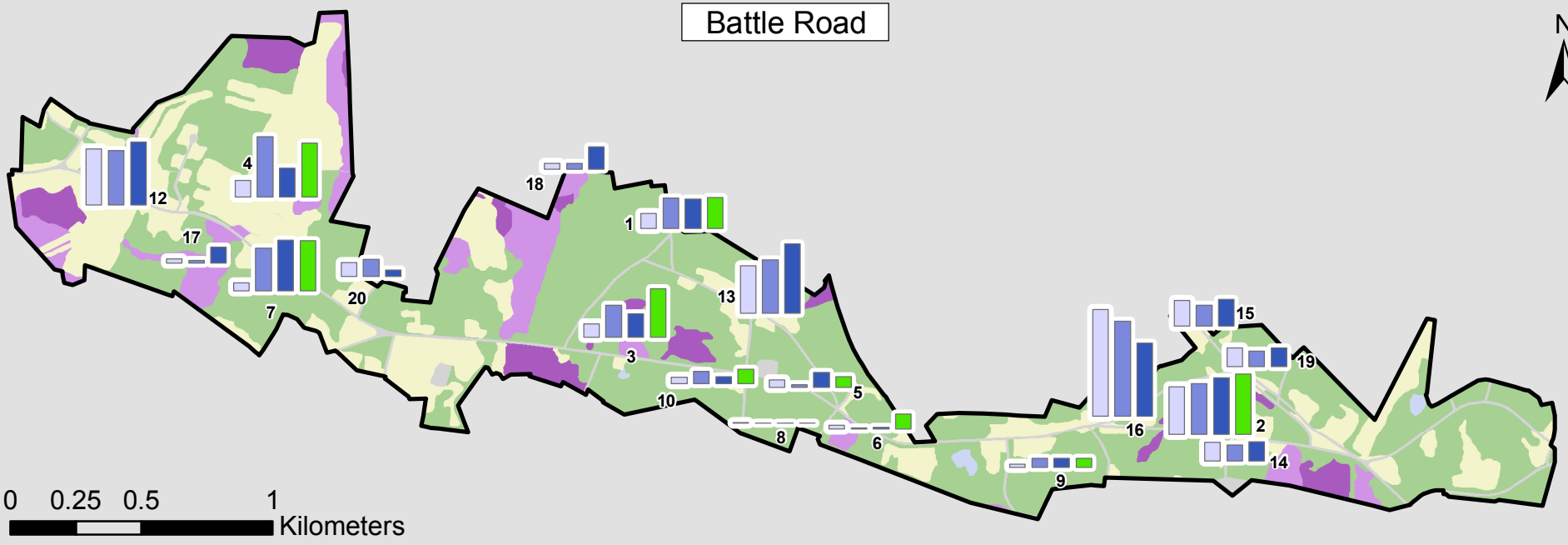
Legend

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- Park Boundary

Average Quadrat % Cover

- Cycle 1: 2006 & 2008
- Cycle 2: 2010 & 2012
- Cycle 3: 2014 & 2016
- Cycle 4: 2018

Battle Road



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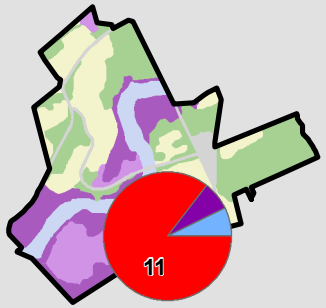
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Map 8. Invasive Shrub Composition: 2016 & 2018

Invasive shrub and vine species composition observed in forest plots in the most recent 4 years of sampling (2016 & 2018). Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018, and plots 11-20 sampled in 2016. Pie size is proportional to the average cover found in quadrats (cover range: 0 to 36.5%). Pies may be shifted from actual plot location to prevent overlap. Date: 6/27/2018.

North Bridge



Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary

Species in Pie Charts

- Berberis thunbergii (Japanese barberry)
- Celastrus orbiculatus (Oriental bittersweet)
- Euonymus spp. (Burningbush)
- Ligustrum spp. (Privet)
- Lonicera japonica (Japanese honeysuckle)
- Lonicera spp. (Exotic bush honeysuckle)
- Rhamnus cathartica (Common buckthorn)
- Rhamnus frangula (Glossy buckthorn)
- Rosa multiflora (Multiflora rose)

Battle Road

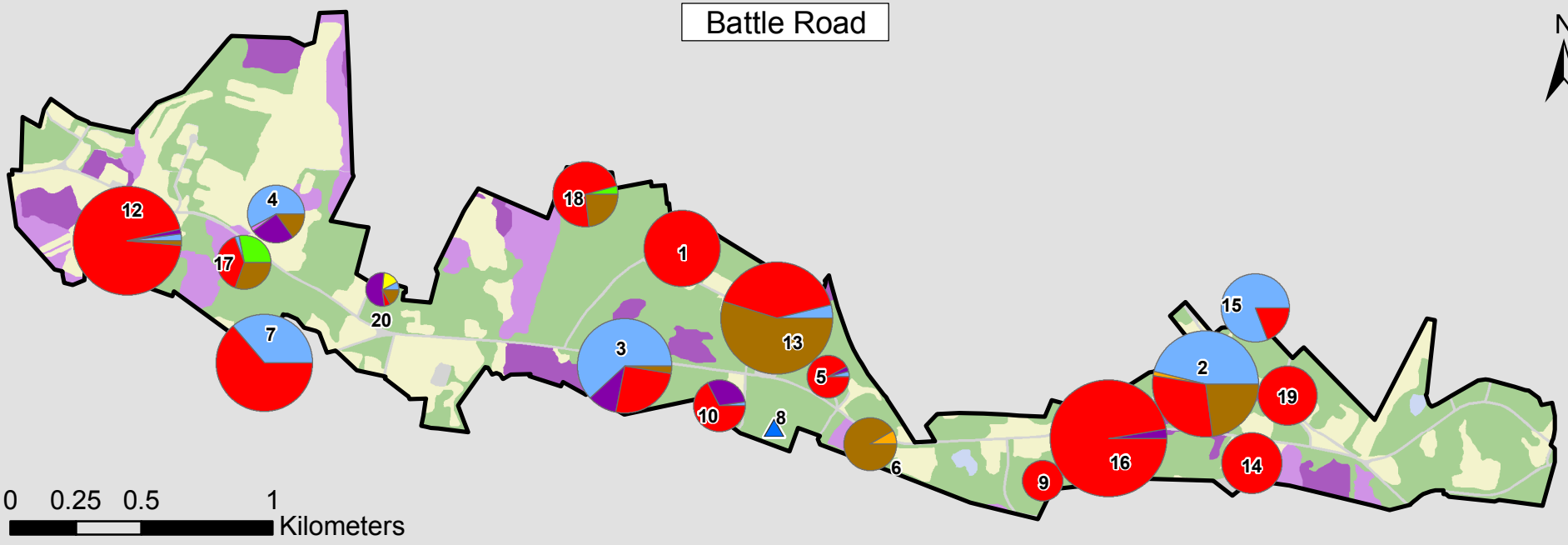


Table 2. Average invasive shrub cover per plot by cycle. Cycle 1 = 2006 & 2008; Cycle 2 = 2010 & 2012; Cycle 3 = 2014 & 2016; Cycle 4 = 2018. Plots are sampled in alternating years with Panel 1 sampled the first year, and Panel 2 sampled the second year.

Plot	Panel	Cycle 1	Cycle 2	Cycle 3	Cycle 4
1	1	7.6	14.4	14.9	15.5
2	1	23.6	25.4	28.3	30.2
3	1	5.2	16.0	11.6	23.9
4	1	7.5	19.6	9.1	8.8
5	1	0.9	1.3	7.2	4.8
6	1	0.0	0.0	0.7	7.5
7	1	4.1	21.3	25.4	25.1
8	1	0.4	0.0	0.0	0.0
9	1	1.4	4.4	4.4	4.4
10	1	2.4	5.6	3.6	7.3
11	2	23.0	19.0	30.6	
12	2	27.9	27.2	31.6	
13	2	24.0	26.3	33.6	
14	2	9.3	8.2	9.8	
15	2	1.0	5.1	12.4	
16	2	53.5	47.5	36.6	
17	2	1.9	1.2	7.8	
18	2	2.9	2.9	11.4	
19	2	9.4	7.7	9.4	
20	2	6.9	8.4	3.0	

Table 3. Number of plots where priority invasive species were detected by cycle. Cycle 1 = 2006 & 2008; Cycle 2 =2010 & 2012; Cycle 3 = 2014 & 2016; Cycle 4 = 2018. Species list includes all exotic vascular plant species that are capable of dominating Northeastern US forest or wetland habitats, and does not include all exotic species detected in SAGA forest plots. Note that only one half of plots have been sampled in Cycle 4, with a maximum plot count of 10 instead of 20.

Latin Name	Common Name	Cycle 1	Cycle 2	Cycle 3	Cycle 4
Acer palmatum	Japanese maple	1	1	1	0
Acer platanoides	Norway maple	10	9	9	5
Alliaria petiolata	garlic mustard	7	6	7	4
Berberis thunbergii	Japanese barberry	4	5	5	2
Cardamine impatiens	narrowleaf bittercress	0	0	1	0
Celastrus orbiculatus	oriental bittersweet	9	16	18	7
Cirsium vulgare	bull thistle	0	0	1	1
Eleagnus spp.	autumn olive, silverberry	0	0	1	1
Euonymus spp.	burningbush	2	2	7	4
Fallopia japonica	Japanese knotweed	2	0	0	0
Ligustrum spp.	privet	0	4	3	2
Lonicera japonica	Japanese honeysuckle	0	1	1	1
Lonicera spp.	exotic bush honeysuckle	10	10	11	4
Lysimachia nummularia	creeping jenny	1	1	1	0
Lythrum salicaria	purple loosestrife	3	5	4	0
Morus alba	white mulberry	0	3	1	0
Phalaris arundinacea	reed canarygrass	3	1	2	0
Phragmites australis	common reed	1	0	0	0
Prunus avium	sweet cherry	0	0	1	1
Rhamnus cathartica	common buckthorn	4	7	5	4
Rhamnus frangula	glossy buckthorn	19	18	19	9
Robinia hispida	bristly locust	0	0	1	0
Robinia pseudoacacia	black locust	4	4	4	4
Rosa multiflora	multiflora rose	14	17	15	7
Solanum dulcamara	climbing nightshade	3	1	3	1
Viburnum lantana	wayfaringtree	0	0	1	0

Northeast Temperate Network
Forest Health Monitoring Program

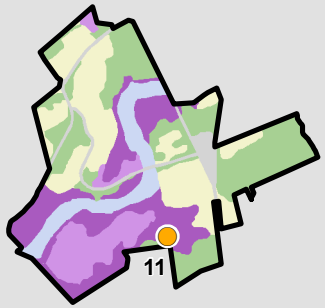
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Map 9. Earthworms: Presence or Absence

Presence or absence of earthworms detected on forest plots. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2018 and plots 11-20 sampled in 2016. For this analysis, earthworm presence on a plot was considered permanent once detected. For instance, if earthworms were observed on a plot in Cycle 2, but not in Cycle 3, earthworms are still considered 'Present'. Date: 6/27/2018.

North Bridge



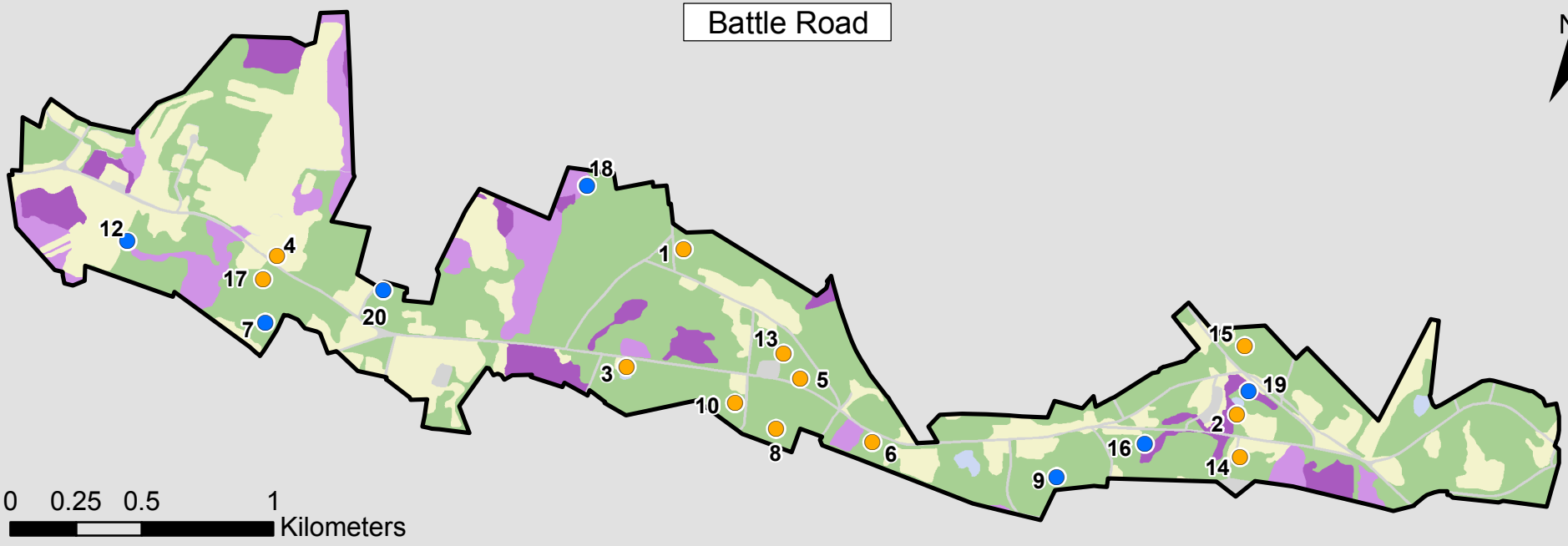
Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary

Earthworms

- Absent: Earthworms not detected
- Present: Earthworms detected

Battle Road



Northeast Temperate Network
Forest Health Monitoring Program

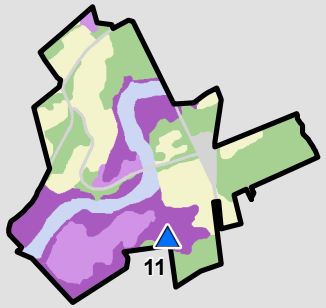
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Map 10. Coarse Woody Debris by Cycle

Trends in Coarse Woody Debris (CWD) volume observed in plots sampled from 2006-2018. Each plot is sampled on a 4-year cycle in an alternating panel, with plots 1-10 sampled in 2006, 2010, 2014, and 2018, and plots 11-20 sampled in 2008, 2012, and 2016. CWD volume ranges from 0 to 89.3 m^3/ha. Date: 6/27/2018.

North Bridge



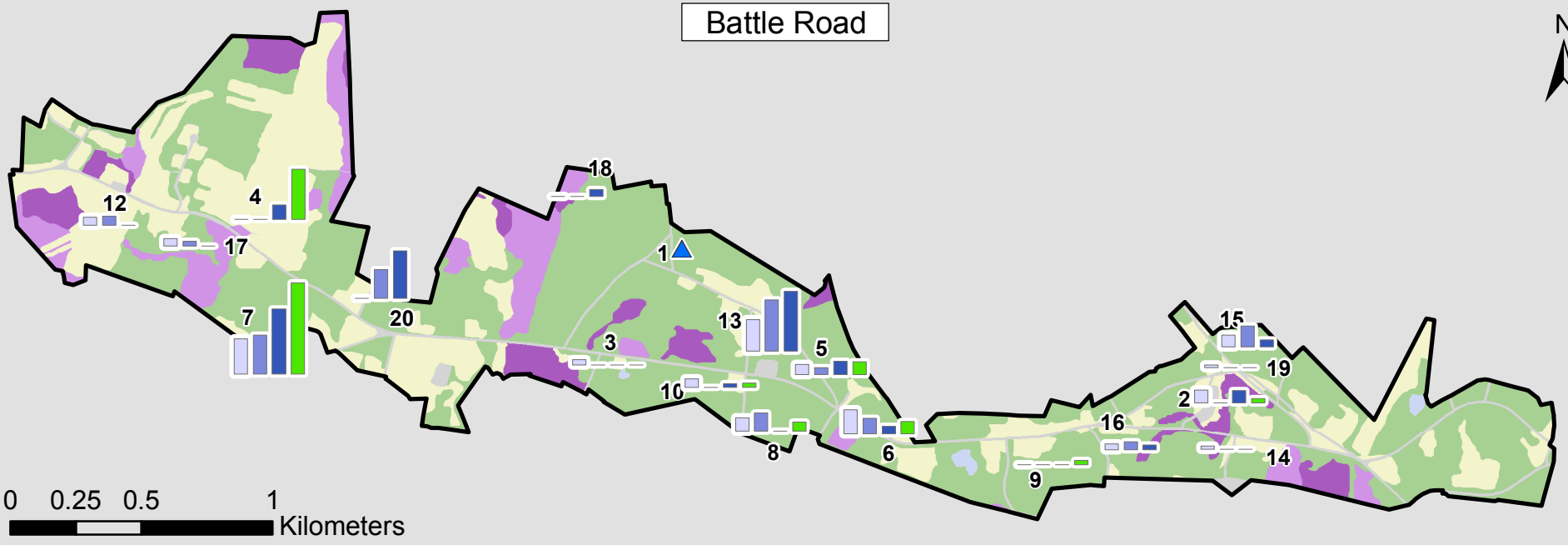
Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary

CWD Volume

- Cycle 1: 2006 & 2008
- Cycle 2: 2010 & 2012
- Cycle 3: 2014 & 2016
- Cycle 4: 2018
- No CWD Present

Battle Road



Northeast Temperate Network
Forest Health Monitoring Program

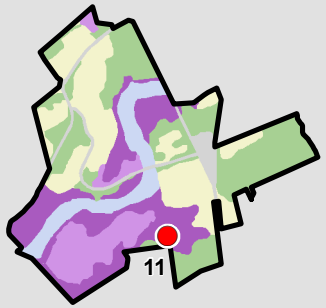
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Map 11. Coarse Woody Debris Levels

Coarse woody debris volume (m3/ha) for the most recent 4 year survey cycle (2016 & 2018). Plots 1-10 were sampled in 2018, and plots 11-20 were sampled in 2016. Volumes range from 0 to 89.3 m^3/hectare. Plots are color coded by volume to indicate whether they meet the 20-50 m^3/ha threshold in Müller & Bütler (2010). Date: 6/27/2018.

North Bridge



Legend

- Open Field
- Forested Land
- Open Wetland
- Forested Swamp
- Open Water
- Paved/ Developed Land
- Park Boundary

CWD Volume Levels

- CWD Absent
- 0.1 - 20 m^3/ha
- 20 - 50 m^3/ha
- > 50 m^3/ha

Battle Road

