



Northeast Temperate Network 2006-2008 Forest Health Monitoring Report

Natural Resource Report NPS/NETN/NRR—2009/104



ON THE COVER

Marsh-Billings-Rockefeller National Historic Park

Photograph by: Kate Miller

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Contents

	Page
Figures.....	iv
Tables.....	iv
Executive Summary.....	v
Acknowledgements.....	vii
Introduction.....	1
Plot Layout.....	5
Metrics and Results.....	7
Management Implications.....	17
Conclusions.....	19
Literature Cited.....	21
Appendix A. Permanent forest monitoring plot locations in NETN parks.....	25
Appendix B. Ecological Integrity Scorecard for NETN parks; selected metrics based on initial data.....	33
Appendix C. Key invasive exotic plant indicator species of forest, woodland and successional ecosystems in the northeastern U.S.that were used in the NETN Ecological Integrity Scorecard.....	35
Appendix D. List of non-native species detected in each park.....	36

Figures

	Page
Figure 1. Map of parks in the Northeast Temperate Network.	3
Figure 2. Plot layout showing square tree plot with 3 nested 2-m radius regeneration microplots, 8 1-m ² vegetation quadrats, and 3 15-m CWD transects. S _x is location of soil sample.	5

Tables

Table 1. Metrics and ratings for evaluating the ecological integrity of forest ecosystems.....	2
Table 2. Northeast Temperate Network forest monitoring panel design.....	6
Table 3. Northeast Temperate Network forest sampling plot allocation.	6
Table 4. Structural stage distribution of plots in NETN parks.	8
Table 5. Northeast Temperate Network park ratings for coarse woody debris and snag metrics. CWD Ratio is the ratio of CWD volume to live tree volume. Snag % is the percent of standing trees that are snags. M-L Snag refers to medium to large diameter (≥ 30 cm dbh) snags.....	9
Table 6. Percentage of plots in each tree regeneration rating by park. ACAD was not rated using this metric. See text for more details.....	10
Table 7. Percentage of plots in each tree condition rating by park.....	11
Table 8. Average number of indicator invasive plant species per forest plot, for each park.....	12
Table 10. Soil chemistry results for NETN parks.....	15

Executive Summary

The Northeast Temperate Network (NETN) Inventory and Monitoring Program has developed a long-term forest monitoring program to assess status and trends in forest composition, structure and function within NETN parks. In 2006, NETN began establishing and sampling permanent forest plots in ten National Park Units: Acadia National Park (ACAD), Eleanor Roosevelt National Historic Site (ELRO), Home of Franklin D. Roosevelt National Historic Site (HOFR), Marsh-Billings-Rockefeller National Historical Park (MABI), Minute Man National Historical Park (MIMA), Morristown National Historical Park (MORR), Saint-Gaudens National Historic Site (SAGA), Saratoga National Historical Park (SARA), Vanderbilt Mansion National Historic Site (VAMA), and Weir Farm National Historic Site (WEFA).

This report provides a preliminary assessment of forest condition from data collected between 2006 and 2008 for six metrics: structural stage distribution, coarse woody debris and snag abundance, tree regeneration, tree condition and forest pests, invasive plants, and soil chemistry. A more robust assessment will be completed after plot installation is complete in 2009, and trends will be assessed and reported after plot resampling begins in 2010.

In this preliminary assessment, most parks rated "Good" for structural stage distribution, indicating sufficient amounts of late-successional forest to provide wildlife habitat and maintain biodiversity. Alternatively, most parks fell short of providing coarse woody debris and dead, standing trees (snags) at levels providing necessary habitat for organisms relying on dead wood.

Tree regeneration was found to be limited at most parks. Many parks are under heavy browsing-pressure by white-tailed deer, which may need to be curtailed to provide adequate tree regeneration. We were not able to rate ACAD using this metric. However, NETN will continue to refine this metric for broader applicability across the network.

Condition of canopy trees rated "Good" or "Caution" for most parks. Beech bark disease is present at mild to moderate average severity in all parks. Hemlock woolly adelgid was detected in 4 parks within the current range of this pest, and should be a priority for early detection at parks beyond this range (i.e., in ACAD, MABI, SAGA and SARA).

Invasive exotic plant species were present in all parks. However, ACAD, MABI and SAGA rated "Good" for this metric, with few key invasive exotic species detected in monitoring plots. Across the network, the most common key invasive species detected were exotic honeysuckles (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), and Oriental bittersweet (*Celastrus orbiculata*).

Soil chemistry data indicates the potential impacts of atmospheric deposition. The carbon to nitrogen ratio (C:N) reflects the effect of nitrogen deposition, while the calcium to aluminum ratio (Ca:Al) documents the availability of toxic aluminum due to soil acidification. Acadia rated "Good" for C:N, SAGA and VAMA rated "Caution," and remaining parks rated "Significant Concern." For Ca:Al, MIMA rated "Significant Concern" while the other parks rated "Good" or "Caution."

These initial results suggest that most NETN parks have forest condition issues that may be improved through resource management actions such as increased retention of CWD and snags, early detection and eradication of key forest pests and invasive exotic plant species, control of existing invasive species populations, and reduction of white-tailed deer populations. However, significant management recommendations cannot be made until additional data are collected.

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Introduction

The Northeast Temperate Network (NETN) of the National Park Service (NPS) Inventory & Monitoring Program has developed a long-term monitoring program for forest resources within NETN parks. This program was developed in response to the identification of forest vegetation as a high-priority vital sign for the Network (Mitchell et al. 2006). This program also provides data for three additional high-priority vital signs: Acid Deposition and Stress, White-Tailed Deer Herbivory, and Landscape Context. The overall goal of the forest monitoring program is to assess status and trends in the composition, structure, and function of NETN forested ecosystems. Using the U.S. Forest Service's Forest Inventory and Analysis Program (FIA) as a starting point, NETN developed a protocol to monitor a representative suite of site and vegetation measures in an extensive network of randomly located permanent plots (Tierney et al. 2009b). Ten parks are monitored in this program: Acadia National Park (ACAD), Eleanor Roosevelt National Historic Site (ELRO), Home of Franklin D. Roosevelt National Historic Site (HOFR), Marsh-Billings-Rockefeller National Historical Park (MABI), Minute Man National Historical Park (MIMA), Morristown National Historical Park (MORR), Saint-Gaudens National Historic Site (SAGA), Saratoga National Historical Park (SARA), Vanderbilt Mansion National Historic Site (VAMA), and Weir Farm National Historic Site (WEFA) (Figure 1).

An important goal for this program is to interpret and report condition of forest systems in a way that effectively informs park managers and other stakeholders. To facilitate reporting, NETN developed an Ecological Integrity Scorecard to be used in addition to periodic and intensive statistical analyses and reporting. The scorecard uses the concept of "ecological integrity" to interpret the condition of forested ecosystems by assessing a suite of compositional, structural and functional metrics in relation to their natural or historical range of variation (Tierney et al., 2009a). For each metric, assessment points are defined that distinguish acceptable or expected conditions from undesired conditions based on current scientific understanding of their natural or historic range of variation (Bennetts et al. 2007). Integrity is interpreted for a broad audience using three categories: Good, Caution and Significant Concern. "Good" represents acceptable or expected conditions; "Caution" indicates a problem may exist; "Significant Concern" indicates undesired conditions that may need management action. For some metrics, NETN does not define conditions that merit "Significant Concern" because current knowledge is insufficient to justify this rating. Ecological integrity assessment points are summarized in Table 1. For a more detailed discussion of metric justification, calculation and confidence, refer to the Ecological Integrity Reporting SOP in Tierney et al. (2009a).

The NETN recognizes that "ecological integrity" may not be the primary goal of park natural resource management, particularly at historical parks and historic sites where cultural resource management may take precedence. Nevertheless, being able to compare the condition of park resources to ecological integrity benchmarks is valuable because it provides a deeper understanding of park condition, as well as a consistent baseline for assessment of management goals. The NETN is willing to work with parks to develop scorecards that track progress towards park management goals that differ from ecological integrity benchmarks, in addition to reporting ecological integrity.

Table 1. Metrics and ratings for evaluating the ecological integrity of forest ecosystems.

Metric type	Metric	Metric Ranking		
		Good	Caution	Significant Concern
Landscape structure	Forest patch size	> 50 ha	10-50 ha	< 10 ha
	Anthropogenic landuse	< 10%	10 - 40%	> 40%
Structure	Structural stage	≥ 70% (MABI, SAGA), 50% (ACAD), and 25% (MIMA, MORR, ROVA, SARA and WEFA) late-successional structure	< 70% (MABI, SAGA), 50% (ACAD), and 25% (MIMA, MORR, ROVA, SARA and WEFA) late-successional structure	< 70% (MABI, SAGA), 50% (ACAD), and 25% (MIMA, MORR, ROVA, SARA and WEFA) combined mature <i>and</i> late-successional structure
	Snag abundance	> = 10% standing trees are snags and > = 10% med-lg trees are snags ¹	< 10% standing trees are snags or < 10% med-lg trees are snags	< 5 med-lg snags/ha
	Coarse woody debris volume	> 15% live tree volume	5 - 15% live tree volume	< 5% live tree volume
Composition	Tree regeneration	Seedling ratio > = 0	Seedling ratio < 0	Stocking index outside acceptable range ²
	Tree condition	Foliage problem < 10% <i>and</i> no priority 1 or 2 pests ³ <i>and</i> BBD ≤ 2	Foliage problem 10 - 50% or priority 2 pest or BBD > 2	Foliage problem > 50% or priority 1 pest
	Biotic homogenization	No change	Increasing homogenization	
	Indicator species: invasive exotic plants	< 0.5 key species per plot	0.5 to < 3.5 key species per plot	3.5 or more key species per plot
	Indicator species: deer browse	No decrease in frequency of most browse-sensitive species	Decrease in frequency of most browsed species or increase in frequency of browse-avoided species	Decrease in frequency of most browsed species <i>and</i> increase in frequency of browse-avoided species
Function	Tree growth and mortality rates	Growth ≥ 60% mean <i>and</i> Mort ≤ 1.6%	Growth < 60% mean or Mort > 1.6%	
	Soil chemistry: acid stress	Soil Ca:Al ratio > 4	Soil Ca:Al ratio 1 - 4	Soil Ca:Al ratio < 1
	Soil chemistry: nitrogen saturation	Soil C:N ratio > 25	Soil C:N ratio 20 - 25	Soil C:N ratio < 20

¹Med-lg trees are ≥ 30 cm diameter-at-breast-height.

²Tree regeneration stocking index varies by park.

³Priority 1 pests are Asian longhorned beetle, emerald ash borer and sudden oak death. Priority 2 pests are hemlock woolly adelgid, balsam woolly adelgid, butternut canker, and beach bark disease (BBD).

This report summarizes results from the onset of monitoring in 2006 through the 2008 sampling year for 260 plots installed thus far. Methods have been consistent across years for all metrics except soil sampling and regeneration, both of which were modified for the 2007 sampling event. Herein we report preliminary status of the following metrics: structural stage distribution, coarse woody debris and snag abundance, tree regeneration (2007-8 only), tree condition, invasive plants, and soil chemistry. A more robust assessment of status will be completed after plot installation is completed in 2009, and trends will be assessed and reported after plot resampling begins in 2010.



Figure 1. Map of parks in the Northeast Temperate Network.

Plot Layout

Permanent forest plots are installed, and sampled on four-year intervals using a rotating panel design. One panel is sampled each year at ACAD (four sampling panels) and in alternate years at National Historical Parks and Historic Sites (two sampling panels) (Table 2). Plots were randomly located within each park using generalized random tessellation stratified sampling (GRTS; McDonald 2004). NETN has established 260 plots so far, and will complete plot installation in 2009 with a total of 350 forest plots (Table 3). Plot installation is complete at MABI, MIMA, SAGA and SARA, but will continue in 2009 at ACAD, MORR, ELRO, HOFR, VAMA and WEFA. Because ELRO and HOFR are adjacent, the sampling design treated them as a single unit. It is not possible to report on these parks individually because this design did not provide a sufficient sample size for ELRO as a standalone unit. Maps of forest plot locations are included in Appendix A.

The permanent plot design is illustrated in Figure 2. Tree and stand measurements are made within fixed-area, square plots ($15 \times 15 \text{ m}^2$ at ACAD; $20 \times 20 \text{ m}^2$ at the remaining parks). Tree regeneration is measured within three 2-m radius circular microplots embedded 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.

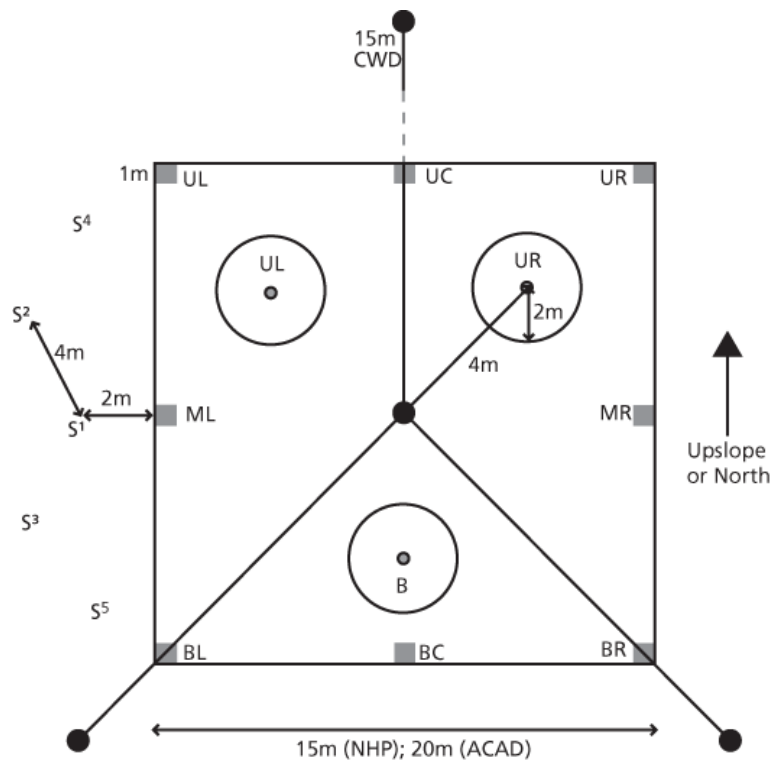


Figure 2. Plot layout showing square tree plot with 3 nested 2-m radius regeneration microplots, 8 1-m^2 vegetation quadrats, and 3 15-m CWD transects. S_x is location of soil sample.

Table 2. Northeast Temperate Network forest monitoring panel design

Panel	Year								
	1	2	3	4	5	6	7	8	9
1	X				X				X
2		X				X			
3			X				X		
4				X				X	

*ACAD sampled every year. SARA, MIMA, MABI, and SAGA sampled in panels 1 and 3. MORR, ROVA (HOFR, ELRO, VAMA), and WEFA sampled in panels 2 and 4.

Table 3. Northeast Temperate Network forest sampling plot allocation.

	Northeast Temperate Network Parks									
							ROVA			
	ACAD	SARA	MORR	MABI	MIMA	ELRO/ HOFR	VAMA	SAGA	WEFA	Total
Plots	176	32	28	24	20	24	16	20	10	350
Sampling Intensity (ha. forest/plot)	73	27	17	8	10	13	3	2	2	-

Metrics and Results

The results included in this report represent data collected from multiple years of sampling in different parks. Results reported for ACAD were collected in 2006, 2007, and 2008, and represents about 75% of all plots that will be established in ACAD. Results reported for MABI, MIMA, SAGA and SARA were collected in 2006 and 2008, and represent full plot installation. Results reported for MORR, ELRO/HOFR, VAMA and WEFA include data collected in 2007 and represent half of the plots that will be established in those parks. Exceptions are tree regeneration (data from 2006 was excluded) and soil metrics (2006 samples that were not consistent with later methods were excluded). All data were collected during the first sampling event for each plot, and therefore only status results are reported at this time. An Ecological Integrity Scorecard for a select group of metrics is included in Appendix B.

Structural Stage Distribution

Forested stands recovering from recent disturbance differ structurally from later successional stands. The distribution of structural stages is important for maintaining a full complement of native species, which vary in their dependence upon different successional stages. Human alteration and management have greatly changed the structural stage distributions of eastern forests, and these distributions will be further affected by altered disturbance regimes coincident with global climate change and outbreaks of exotic pests and pathogens (Dale et al. 2001). Comparison of existing distributions with those expected under natural disturbance regimes provides an indicator of altered disturbance regimes as well as habitat availability.

We calculated structural stage distribution from tree size and canopy position measurements, using a method similar to that of Frelich and Lorimer (1991), but substituting basal area for exposed crown area (Goodell and Faber-Langendoen 2007). We assigned ratings based on expected percentage of late-successional forest stages across the landscape as compiled by Frelich and Lorimer (1991) and Lorimer and White (2003). Expected structural stage distributions vary among forest ecosystem types, thus assessment points vary among parks, based on the matrix forest ecosystem dominant at each park. Assessment points were based on the following matrix forest ecosystems at each park: Acadian Low-Elevation Spruce-Fir-Hardwood Forest at ACAD; both Appalachian Hemlock-Northern Hardwood Forest and Laurentian-Acadian Northern Hardwoods Forest at MABI; Appalachian Hemlock-Northern Hardwood Forest at SAGA; both Appalachian Hemlock-Northern Hardwood Forest and Northeastern Interior Dry-Mesic Oak Forest at ROVA and SARA; and Northeastern Interior Dry-Mesic Oak Forest at MIMA, MORR, and WEFA. At parks with more than one matrix forest ecosystem type, assessment points were based conservatively on the type with lower late-successional structure.

This preliminary data indicates that structural stage distribution in NETN parks is reasonably good—all but three parks scored "Good" for this metric (Table 4). The three exceptions (ACAD, MABI, and SAGA) are dominated by matrix forest types with higher expected late-successional structure than the forest types at other parks, and were rated "Caution" based on a low percentage of late successional forest. ACAD's rating stems in part from early successional forests that originated after a notable fire in 1947 that swept across much of the eastern side of Mount Desert Island. Acadia's rating is likely to improve as recovery continues. Alternatively, MABI is a

Table 4. Structural stage distribution of plots in NETN parks.

Park	Plots Sampled	% Late-Successional	% Mature & Late-Successional	Rating
ACAD	106	16.0	50.9	Caution
ELRO/HOFR	12	41.7	83.3	Good
MABI	23	39.1	91.3	Caution
MIMA	19	31.6	73.7	Good
MORR	14	64.3	100.0	Good
SAGA	21	38.1	85.7	Caution
SARA	23	30.4	56.5	Good
VAMA	8	62.5	87.5	Good
WEFA	5	60.0	100.0	Good

working forest with both cultural and ecological management goals, and it may not be possible or desirable to increase late-successional forest to benchmark levels indicated by "ecological integrity" alone. It should be noted that this metric does not measure edge habitat, fragmentation, or pavement; NETN's landscape metrics (forest patch size and anthropogenic landuse) provide information on those features.

Coarse Woody Debris and Snag Abundance

Dead wood, in the form of standing dead trees (snags) and fallen coarse woody debris (CWD), is an important structural feature of forests that provides habitat for many taxa. Silviculture, land management and hazard tree removal can reduce the quantity or quality of these features; however, thoughtful land management can maintain or enhance snags and CWD (Keeton 2006).

Density of snags and volume of CWD in mature and late-successional stands varies substantially across ecosystems and with site conditions (Tyrrell et al. 1998). However, positive relationships between live and dead tree density and volume can be used to indicate expected snag and CWD levels (Tierney et al. 2009b). This metric assesses the density of snags and volume of CWD in relationship to live tree density and volume. Since NETN plots are not large enough to accurately estimate rare features such as snags, snag abundance is evaluated at the scale of the park only.

Pieces of CWD (≥ 10 cm diameter and ≥ 1 m long) were tallied along three 15m line intercept transects per plot. Snags were measured within each tree plot, and will be tracked through time until they are no longer standing.

Table 5. Northeast Temperate Network park ratings for coarse woody debris and snag metrics. CWD Ratio is the ratio of CWD volume to live tree volume. Snag % is the percent of standing trees that are snags. M-L Snag refers to medium to large diameter (≥ 30 cm dbh) snags.

Park	CWD Ratio	CWD Rating	Snag %	M-L Snag %	M-L Snags/ha	Snag Rating
ACAD	0.14	Caution	17.9	9.8	7.8	Caution
ELRO/HOFR	0.38	Good	10.1	9.5	12.5	Caution
MABI	0.07	Caution	8.2	1.8	3.1	Sig. Concern
MIMA	0.03	Sig. Concern	9.5	3.2	3.8	Sig. Concern
MORR	0.08	Caution	10.9	4.1	5.4	Caution
SAGA	0.08	Caution	13.7	5.3	10.7	Caution
SARA	0.14	Caution	17.5	3.3	3.1	Sig. Concern
VAMA	0.28	Good	14.7	13.9	15.6	Good
WEFA	0.04	Sig. Concern	5.8	0.0	0.0	Sig. Concern

Most NETN parks fell short of desired levels of snags and coarse woody debris (Table 5). VAMA was an exception, rating "Good" for both. ELRO/HOFR also rated well, earning "Good" for CWD, and very narrowly missing "Good" for snags because the level of medium- to large-sized snags was slightly low. ACAD narrowly missed "Good" ratings for both metrics, and SARA fell just short of the CWD "Good" rating. MORR and SAGA both rated "Caution" for snags due to low medium- to large-sized snag levels. The remainder of the parks fell well below desired levels of CWD (i.e., MABI, MIMA, MORR, SAGA and WEFA) or medium- to large-sized snags (i.e., MABI, MIMA, SARA, WEFA). However, our ability to detect uncommon landscape features such as medium- to large-sized snags in this preliminary analysis is limited.

Forested systems in most NETN parks are relatively young, and may fall short of desired levels of late-successional CWD and snags for some time without management intervention.

Tree Regeneration

This metric assesses the quantity and composition of advance tree regeneration in the forest understory, which will impact future canopy structure and composition. Regeneration can be affected by a variety of stressors, including invasive species and climate change. Most notably, sustained, selective browsing by a historically high population of white-tailed deer is currently impacting seedling establishment, growth and composition in parts of the midwest and northeast US (Cote et al. 2004). Significant impacts on forest tree regeneration are associated with deer densities ≥ 8.5 per km², well above presettlement estimates of 3-4 deer per km² in the northeastern US (Russell et al. 2001; Augustine and deCalesta 2003).

Beginning in 2007, tree regeneration has been monitored in three 2-m radius microplots located in each forest plot. Established tree seedlings (>15 cm tall) and sapling (up to 10cm dbh) are quantified by species and height class. To assess deer impacts, we use two approaches. Deer preferentially browse particular seedling species and size classes (30-75cm tall; Cornett et al.

2000). Sweetapple and Nugent (2004) developed a simple ratio of seedling species richness in browsed versus unbrowsed size classes of preferred species. We use this ratio to distinguish “Good” from “Caution”. A complementary approach by McWilliams et al. (2005) quantifies whether current seedling quantities are sufficient to restock a mid-Atlantic hardwood forest stand. We use this approach to assess minimum canopy tree stocking, which varies by park and dominant forest type. The stocking index defined in McWilliams et al. (2005) is only applicable to forest types in MORR, ELRO/HOFR, VAMA and WEFA, and NETN has not yet defined stocking assessment points for ACAD, MABI, MIMA, SAGA and SARA.

Limited tree regeneration due to heavy deer-browse pressure is a potential concern at many NETN parks (ELRO/HOFR, MIMA, MORR, SARA, WEFA; Table 6). An abundance of invasive exotic species also may be a contributing factor. ACAD was not rated using this metric because it is inappropriate for the spruce-fir forest at that park, which is dominated by species with low palatability to deer. Likewise, a rating of "significant concern" has not yet been defined for the hemlock-hardwood forests dominant at MABI and SAGA. The NETN will continue to refine this metric to be more broadly applicable across the network.

Tree Condition

Qualitative observation of specific tree health problems and canopy foliage condition can provide an early warning indicator of problems or decline in canopy trees of a particular species or region. As the season progresses, most trees develop minor foliage problems. However, more extensive damage to canopy foliage may be indicative of tree health problems within a species or across a region, and could be related to soil chemistry, climate stress, pathogens, or other stressors. In particular, exotic pests and pathogens have the potential to severely impact forest tree composition as well as structure and function. A number of pest species pose serious threats to northeastern forests if they advance into the region, including Asian longhorned beetle, emerald ash borer and sudden oak death.

Table 6. Percentage of plots in each tree regeneration rating by park. ACAD was not rated using this metric. See text for more details.

Park	Plots	% Good	% Caution	% Sig. Concern
ELRO/HOFR	12	25	33	42
MABI	12	17	83	N/A
MIMA	10	20	40	40
MORR	14	7	14	79
SAGA	11	18	82	N/A
SARA	16	19	25	56
VAMA	8	63	38	0
WEFA	5	20	40	40

For this metric, NETN crews look for canopy foliage problems (e.g., chlorosis, necrosis, herbivory, etc.) and obvious evidence of specific forest pests of concern in the region. In addition, the severity of beech bark disease (BBD) is estimated using a four point scale of increasing severity. To assess this metric, ratings are assigned based on average percent canopy foliage showing visible damage combined with pest detection and BBD severity (see Table 1).

Tree condition was mostly "Good" in ACAD, SAGA and WEFA, and a mixture of "Good" and "Caution" in the remaining parks (Table 7). However, more than 10% of the plots in MABI, MIMA and SARA rated "Significant Concern" for this metric. At MABI and SARA, this "Significant Concern" rating was assigned due to high levels of defoliation in 2006. Populations of forest tent caterpillar (*Malacosoma disstria*) were particularly high in New York and Vermont in 2006 (Wood et al. 2009), and may have contributed to the high level of defoliation in those parks. In MIMA, two of the plots rated "Significant Concern" due to an outbreak of tar spot (*Rhytisma* spp.) on Norway maple (*Acer platanoides*). Tar spot is a common leaf disease of broadleaf trees, but tree health is generally not impacted because the disease occurs late in the growing season.

Beech bark disease is present throughout the region, and was found in all parks where beech trees occurred in plots (i.e., all but ELRO, VAMA, and WEFA). Average severity ranged from mild to moderate, and was highest in ACAD.

Hemlock woolly adelgid (HWA) was detected in ELRO, HOFR, VAMA and WEFA, all of which lie within areas infested by HWA for at least 10 years. MORR also lies in an infested area, but Eastern hemlock did not occur in forest plots established there. The NETN will continue to track HWA, and watch for new detections outside of the current known distribution (i.e., in ACAD, MABI, SAGA and SARA).

Table 7. Percentage of plots in each tree condition rating by park.

Park	Plots Monitored	% Good	% Caution	% Sig. Concern
ACAD	126	60	37	3
ELRO/HOFR	12	42	58	0
MABI	24	38	50	13
MIMA	20	15	70	15
MORR	14	29	71	0
SAGA	21	57	43	0
SARA	32	47	38	16
VAMA	8	50	50	0
WEFA	5	60	40	0

Obvious visual cues for additional forest pests or pathogens of concern were not seen in NETN forest plots. However, it should be noted that NETN crews do not have the time or expertise to make an exhaustive search.

Invasive Plant Indicator Species

Invasive exotic species have the potential to impact structure, composition and function of forested ecosystems, and are one of the leading threats to biodiversity and ecological integrity of ecosystems worldwide (Mooney et al. 2005). Early Detection of Invasive/Exotic Plants is an important NETN vital sign that has been incorporated into several long term monitoring protocols. Status and trends of invasive species are monitored currently by this protocol, and the Eastern Rivers and Mountains Network (ERMN) and NETN are developing a separate protocol for early detection of invasive species and forest pests.

The frequency and abundance of invasive plant species were measured in eight 1-m² quadrats nested within each forest plot. Additional invasive plant species not detected in quadrat sampling but present in the plot were recorded.

To better understand the threat posed by invasive exotic plants, we developed a list of key non-native plant species that are highly invasive in northeastern forest, woodland, and successional habitats (Appendix C). Included species are those that may dominate and/or persist under shaded conditions (i.e., in forest or woodland), or that may disrupt succession to forest or woodland. Several non-native species such as knapweeds (*Centaurea* spp.) and celandine (*Chelidonium majus*) were not used as indicator species, despite being present in several parks, because they do not meet the indicator guidelines. Therefore, total abundance of non-native species is higher than reported here for indicator invasives. Herein, we summarize presence/absence data for these key species. A complete list of all non-native species detected in each park unit is shown in Appendix D.

Table 8. Average number of indicator invasive plant species per forest plot, for each park.

Park	Average # species found	Rating
ACAD	<0.1	Good
ELRO/HOFR	2.9	Caution
MABI	<0.5	Good
MIMA	4	Sig. Concern
MORR	5.4	Sig. Concern
SAGA	<0.5	Good
SARA	2.8	Caution
VAMA	2.6	Caution
WEFA	2.4	Caution

ACAD, MABI and SAGA all rated "Good" for this metric; few plots there had any key invasive plants (Table 8). In contrast, MORR and MIMA both averaged more than four key invasive species per plot, and so rated "Significant Concern" for this metric. All other parks received a "Caution" rating.

The most frequent indicator invasives detected were exotic honeysuckles (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), and oriental bittersweet (*Celastrus orbiculata*) (Table 9). Early detection and control of these four species should be a high priority for NETN parks.

Soil Chemistry

The NETN monitors soil chemistry to understand the effects of acidic deposition on the health of forest vegetation. Acidic deposition from rain or fog is a special concern for forests in the Northeast and on thin soils where soil buffering capacity is generally low. Acid deposition alters forest soil chemistry by depleting soil nutrients such as calcium (Ca), magnesium (Mg) and potassium (K) through leaching, and can result in increased availability of toxic aluminum (Al). Moreover, atmospheric deposition has dramatically increased inputs of nitrogen (N) in this region. Concern has arisen that excess N may "saturate" forested ecosystems, causing excess nitrification and N leaching, which in turn could exacerbate the effects of acidification (Aber et al. 1998). All these changes can reduce plant growth and increase susceptibility of trees to other stresses (Bullen and Bailey 2005).

The NETN collects a composite of up to three soil samples from each O and A horizon. If no soil horizons are apparent, NETN collects a composite of the upper soil containing fine roots to a maximum depth of 10 cm. The upper soil layers (O and A) are where the bulk of fine roots are located and plant uptake occurs. We rate soil chemistry based on the ratio of exchangeable Ca:Al, a widely-used indicator of acid stress on forest soils (Cronan and Grigal 1995), and the ratio of total C to total N in soil samples, a primary indicator of N status (Aber et al. 2003; MacDonald et al. 2002). Soil metrics are rated on median values for all park samples, rather than means, due to the high variation typical in soil chemistry sampling.

Soil chemistry results differ between our two indicators (Table 10). The median Ca:Al ratio indicates a soil acidification problem at MIMA (rated "Significant Concern") and possibly also at ACAD, SAGA and WEFA (rated "Caution"). Looking at individual plots, at least a quarter of all plots in ACAD, MIMA, MORR, SAGA, VAMA, and WEFA received a "Significant Concern" rating for the Ca:Al ratio.

Alternatively the C:N ratio indicates excess N may be present at all parks except ACAD, with SAGA and VAMA rating "Caution" and all others parks rating "Significant Concern." These results correspond somewhat to estimated annual nitrogen deposition rates, which show a decrease along a SW-NE gradient from southwestern New York to Maine (Ollinger et al. 1993).

Combining the two indicators, only MIMA rates "Significant Concern" for both metrics. Five parks rated "Good" for Ca:Al but "Significant Concern" for N; apparently high N levels in these parks have not yet translated into significant changes in Ca:Al.

Table 9. Three most frequent key invasive species found in forest plots at NETN parks. “# Plot Occur.” is the number of plots in which each species was found. Fewer than three key invasive species were found at SAGA.

Park	Plots Sampled	Latin Name	Common Name	# Plot Occurrence	Frequency
ACAD	125	<i>Berberis thunbergii</i>	Japanese barberry	1	0.8
		<i>Frangula alnus</i>	Glossy buckthorn	1	0.8
		<i>Lonicera</i> spp. (Exotic)	Exotic honeysuckles	1	0.8
		<i>Rosa multiflora</i>	Multiflora rose	1	0.8
ELRO/ HOFR	12	<i>Ailanthus altissima</i>	Tree-of-heaven	8	66.7
		<i>Alliaria petiolata</i>	Garlic mustard	6	50.0
		<i>Rosa multiflora</i>	Multiflora rose	5	41.7
MABI	24	<i>Lonicera</i> spp. (Exotic)	Exotic honeysuckles	5	20.8
		<i>Berberis vulgaris</i>	European barberry	4	16.7
		<i>Rhamnus cathartica</i>	Common buckthorn	2	8.3
MIMA	20	<i>Frangula alnus</i>	Glossy buckthorn	19	95.0
		<i>Rosa multiflora</i>	Multiflora rose	15	75.0
		<i>Acer platanoides</i>	Norway maple	10	50.0
		<i>Celastrus orbiculata</i>	Oriental bittersweet	10	50.0
MORR	14	<i>Berberis thunbergii</i>	Japanese barberry	12	85.7
		<i>Lonicera</i> spp. (Exotic)	Exotic honeysuckles	12	85.7
		<i>Microstegium vimineum</i>	Japanese stiltgrass	9	64.3
SAGA	21	<i>Lonicera</i> spp. (Exotic)	Exotic honeysuckles	7	35.0
		<i>Berberis thunbergii</i>	Japanese barberry	4	20.0
SARA	32	<i>Lonicera</i> spp. (Exotic)	Exotic honeysuckles	30	93.7
		<i>Rhamnus cathartica</i>	Common buckthorn	30	93.7
		<i>Rosa multiflora</i>	Multiflora rose	19	59.4
VAMA	8	<i>Alliaria petiolata</i>	Garlic mustard	7	87.5
		<i>Celastrus orbiculata</i>	Oriental bittersweet	6	75.0
		<i>Berberis thunbergii</i>	Japanese barberry	3	37.5
WEFA	5	<i>Berberis thunbergii</i>	Japanese barberry	4	80.0
		<i>Celastrus orbiculata</i>	Oriental bittersweet	4	80.0
		<i>Euonymus alata</i>	Winged burning bush	2	40.0
		<i>Rosa multiflora</i>	Multiflora rose	2	40.0

Table 10. Soil chemistry results for NETN parks.

Park	Ca:Al			C:N		
	Median	% Plots SC	Rating	Median	% Plots SC	Rating
ACAD	1.4	46.0	Caution	32.3	5.6	Good
ELRO/ HOFR	10.0	8.3	Good	16.7	75.0	Sig. Concern
MABI	19.8	19.0	Good	15.4	85.7	Sig. Concern
MIMA	0.7	61.5	Sig. Concern	14.5	84.6	Sig. Concern
MORR	25.0	28.6	Good	14.7	78.6	Sig. Concern
SAGA	1.2	38.1	Caution	20.6	42.9	Caution
SARA	22.7	15.8	Good	13.7	89.5	Sig. Concern
VAMA	17.1	25.0	Good	20.9	25.0	Caution
WEFA	3.6	40.0	Caution	15.2	100.0	Sig. Concern

Management Implications

The NETN is in the early stages of monitoring forest health. The NETN should complete two full rounds of data collection before significant management recommendations can be made. The following description of management implications are intended to provide preliminary suggestions for maintaining or improving forest health in NETN parks based on initial data. Please note that this monitoring program was designed to monitor forest health across park units, and it is important that management activities related to forest health be conducted park-wide rather than focused around specific forest plots.

Structural Stage Distribution

Structural stage distribution of forests in NETN parks were mostly rated “Good”. In parks without active forest management, such as ACAD, it will be important to track this metric over time, as forests age and as stressors such as climate change and introduced pests or pathogens alter disturbance regimes. In parks with active or planned forest management, such as MABI, it may be useful to consider appropriate benchmarks based jointly on cultural and ecological goals, and also to consider the use of novel management strategies that enhance late-successional features (Keeton 2006)

Coarse Woody Debris and Snag Abundance

At parks which fell well short of desired levels of CWD (i.e., MABI, MIMA, MORR, SAGA and WEFA) or medium- to large-sized snags (i.e., MABI, MIMA, SARA, WEFA, resource managers may consider using new active or planned timber harvesting techniques designed to accelerate development of CWD and snags (Keeton 2006). These methods include felling and leaving trees or pulling over and leaving trees to increase CWD densities, and girdling selected medium to large sized, low vigor trees to increase snag densities.

Tree Regeneration

The NETN will continue to refine the tree regeneration metric for broader applicability across the network. Tree regeneration is an important concern in parks with intense deer-browse pressure and an abundance of invasive species, such as at MORR, MIMA and SARA. Efforts to reduce white-tailed deer populations and curtail populations of invasive exotic species may both be necessary to improve tree regeneration success at these parks.

Tree Condition

Long-term trend data are necessary to determine the best course of management action, and NETN currently only has status data. The two forest problems detected in NETN parks (beech bark disease and hemlock woolly adelgid) were found in regions known to be infested for a decade or more. Early detection and control of HWA in new areas (ACAD, MABI and SAGA) should be a high priority for park managers, due to the importance of Eastern hemlock (*Tsuga canadensis*) and the high mortality caused by HWA. Likewise, park managers should give high priority to early detection of additional highly-destructive forest pests that may spread to NETN forest (i.e., Asian long-horned beetle, emerald ash borer, and sudden oak death).

Invasive Plant Indicator Species

Invasive species are a critical threat to forest health in all NETN parks. In parks where multiple invasive plant species are already well-established throughout the park (i.e., MIMA and MORR), targeted control of invasives in special habitats (e.g., riparian areas) or rare communities may be the best approach. Parks that do not currently have a serious invasive species problem (i.e., ACAD, MABI and SAGA) should be vigilant to new invasions, and make efforts to eradicate known occurrences before they spread.

Early detection of new invasive species should be a high priority for all parks. To assist parks with early detection, NETN and ERMN are developing a protocol for detecting and reporting invasive species. This protocol will be pilot-tested in several NETN parks during the 2009 field season.

Soil Chemistry

There are few management possibilities that can address acid deposition in soils at the park level. For the most part, atmospheric deposition is a regional problem that must be addressed at the regional or national level. Over time these data may help justify stricter air quality standards. Continued monitoring of soil chemistry in concert with forest composition, structure and function will help us better understand the impacts of acid deposition on forest health.

Conclusions

Preliminary results indicate that some forest health problems may exist in NETN parks. In particular, levels of CWD and snags and tree regeneration fall below expected levels based on ecological integrity, and may benefit from management action. Soil chemistry results indicate potential atmospheric deposition impacts at all parks. Early detection and eradication of key forest pests and invasive exotic plant species should be a priority at all NETN parks. In addition, control of existing invasive species populations, increased retention of CWD and snags, and reduction of white-tailed deer populations may be advisable at several parks. As the impacts of climate change and other regional stressors increasingly challenge long-term management of park resources, it becomes even more important to limit the impacts of more local stressors, and to respond with all management options available.

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Appendix A. Permanent forest monitoring plot locations in NETN parks.

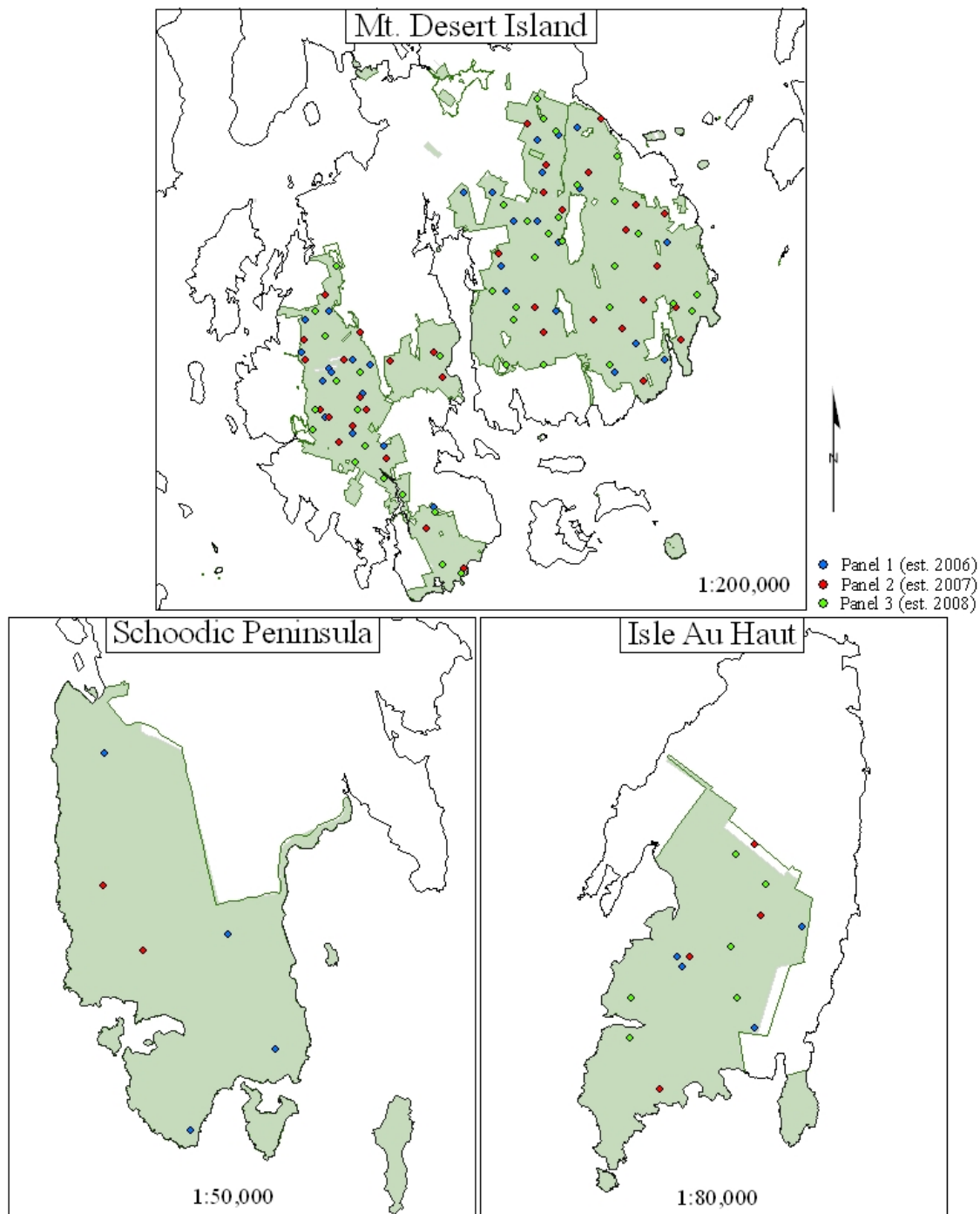


Figure A-1. Forest plot locations in Acadia National Park representing 3 years of plot establishment.

Figure A-2. Forest plot locations in Marsh-Billings-Rockefeller National Historic Park.

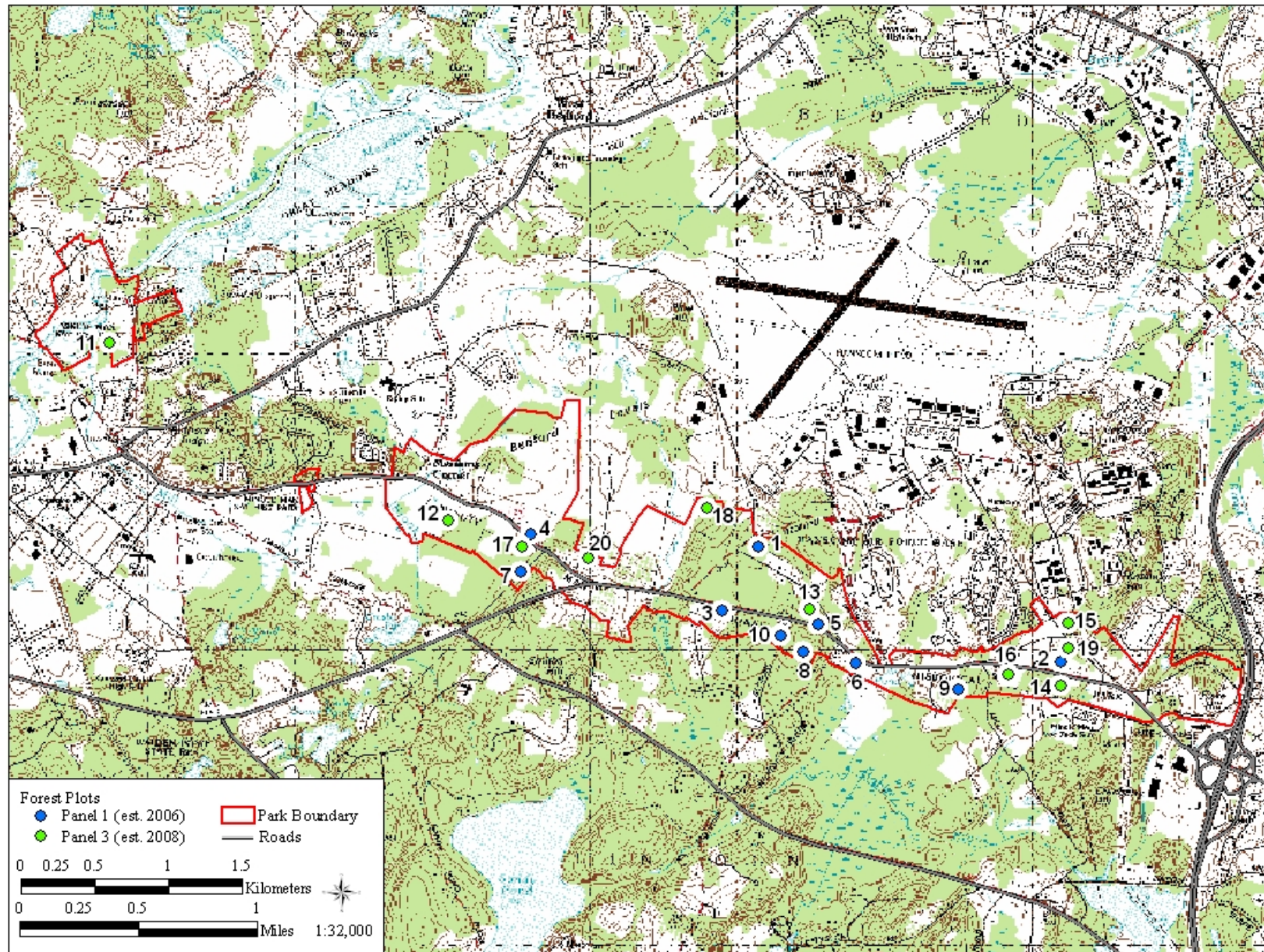


Figure A-3. Forest plot locations in Minute Man National Historic Park.

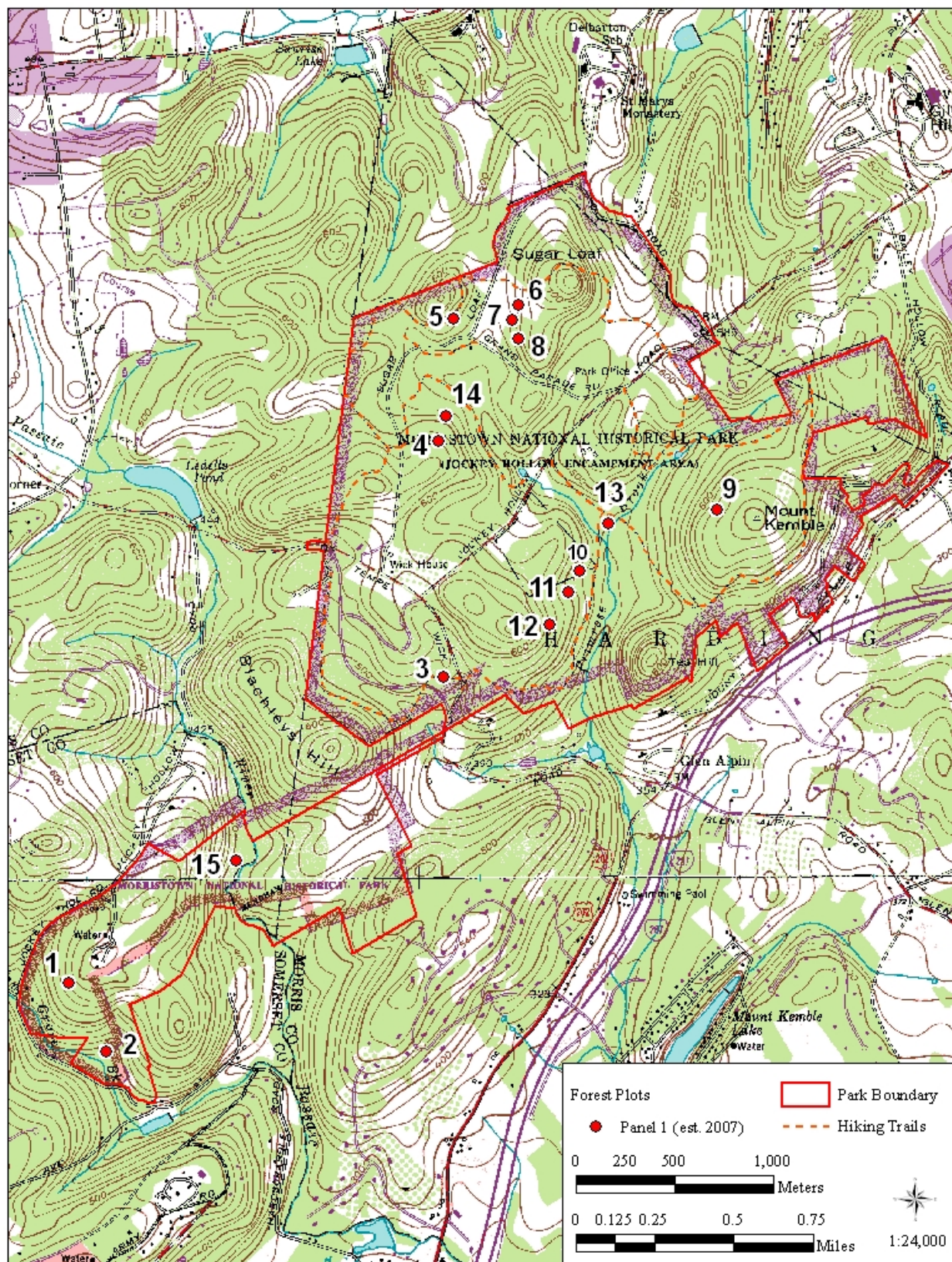


Figure A-4. Forest plot locations in Morristown National Historic Park.

Figure A-5. Forest plot locations in Roosevelt-Vanderbilt National Historic Sites.

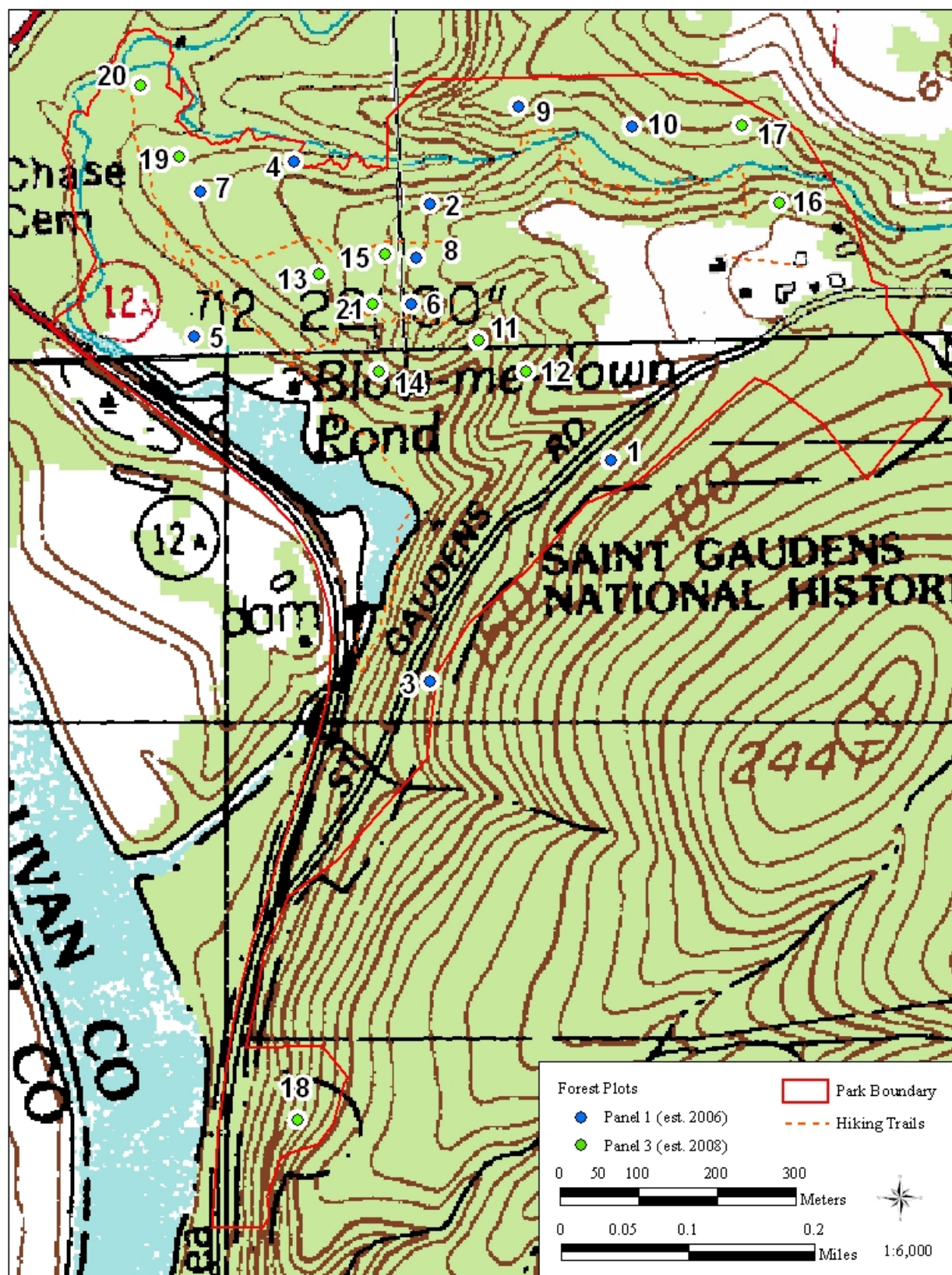


Figure A-6. Forest plot locations in Saint-Gaudens National Historic Site.

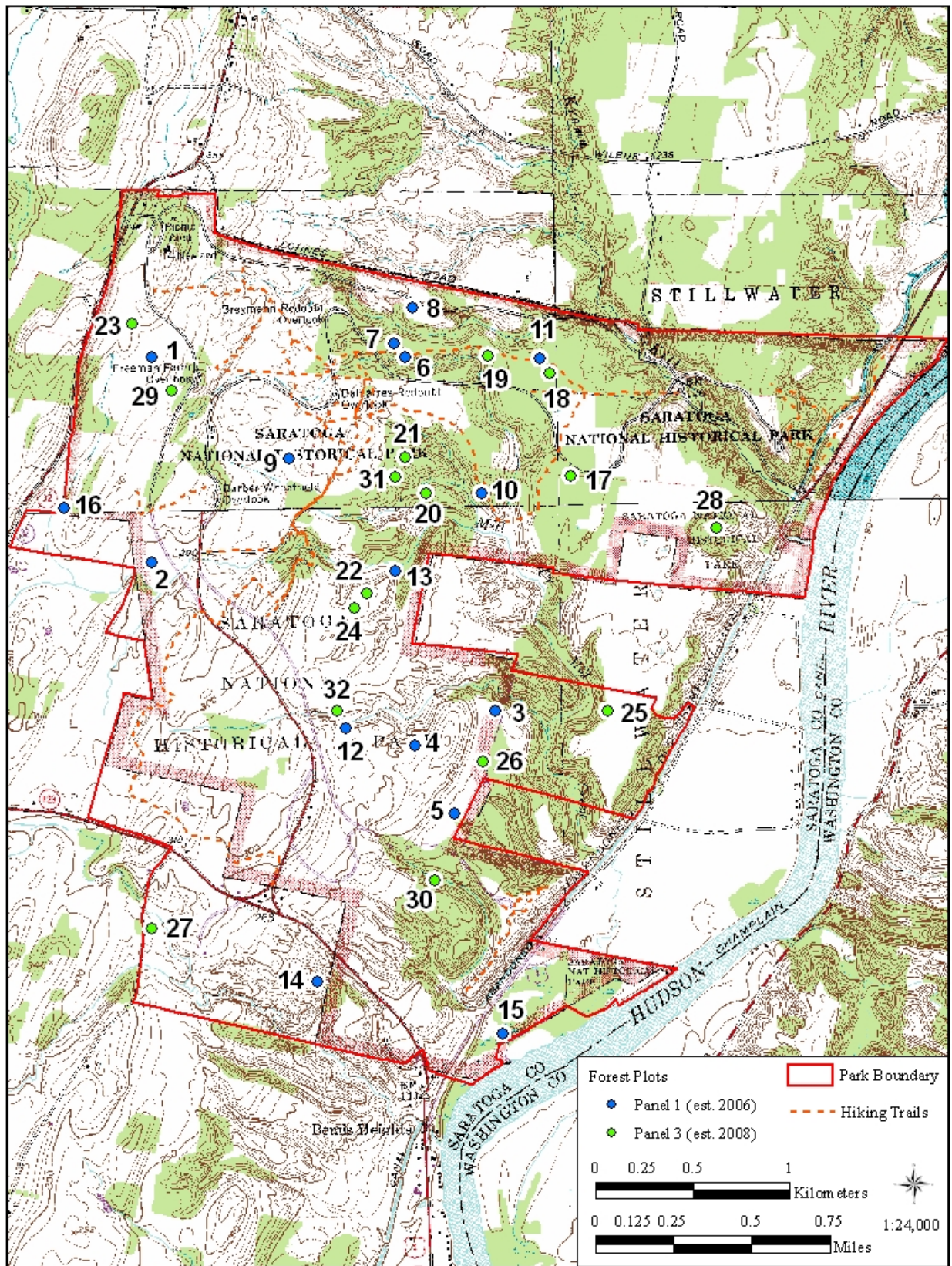


Figure A-7. Forest plot locations in Saratoga National Historic Park.

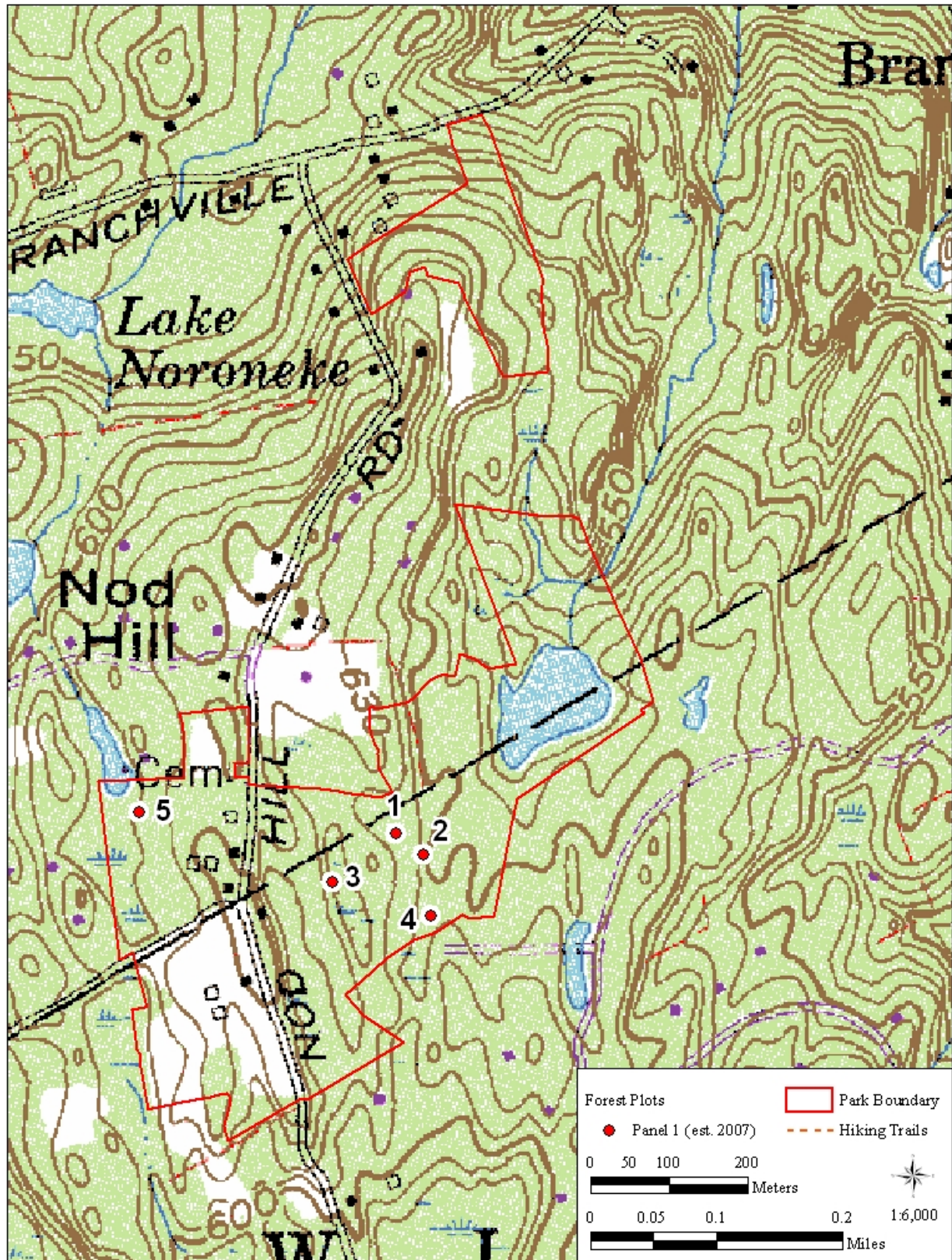


Figure A-8. Forest plot locations in Weir Farm National Historic Site.

Appendix B. Ecological Integrity Scorecard for NETN parks; selected metrics based on initial data.

	Structural Stage Distribution	CWD	Snag Abundance	Invasive Plant Indicator Species	Soil Chemistry- Ca:Al	Soil Chemistry- C:N
ACAD	Caution	Caution	Caution	Good	Caution	Good
ELRO/HOFR	Good	Good	Caution	Caution	Good	Sig. Concern
MABI	Caution	Caution	Sig. Concern	Good	Good	Sig. Concern
MIMA	Good	Sig. Concern	Sig. Concern	Sig. Concern	Sig. Concern	Sig. Concern
MORR	Good	Caution	Caution	Sig. Concern	Good	Sig. Concern
SAGA	Caution	Caution	Caution	Good	Caution	Caution
SARA	Good	Caution	Sig. Concern	Caution	Good	Sig. Concern
VAMA	Good	Good	Good	Caution	Good	Caution
WEFA	Good	Sig. Concern	Sig. Concern	Caution	Caution	Sig. Concern

Appendix C. Key invasive exotic plant indicator species of forest, woodland and successional ecosystems in the northeastern U.S. that were used in the NETN Ecological Integrity Scorecard.

Latin name	Common name	Habitat
<i>Acer platanoides</i>	Norway maple	Open & forest habitats
<i>Ailanthus altissima</i>	Tree-of-heaven	Edges & successional habitats
<i>Alliaria petiolata</i>	Garlic mustard	Open & forest habitats
<i>Berberis thunbergii</i>	Japanese barberry	Open & forest habitats
<i>Berberis vulgaris</i>	European barberry	Open & wooded habitats
<i>Cardamine impatiens</i>	Narrowleaf bittercress	Open & wooded habitats
<i>Celastrus orbiculata</i>	Oriental bittersweet	Edges & successional habitats
<i>Cynanchum louiseae</i>	Black swallow-wort	Open, successional & wooded habitats
<i>Cynanchum rossicum</i>	European swallow-wort	Open, successional & wooded habitats
<i>Euonymus alata</i>	Winged burning bush	Open, successional & wooded habitats
<i>Frangula alnus</i>	Glossy buckthorn	Wetland & successional habitats
<i>Ligustrum spp. (obtusifolium, vulgare)</i>	Privet	Successional & forest habitats
<i>Lonicera japonica</i>	Japanese honeysuckle	Edges & successional habitats
<i>Lonicera spp. (morrowii, tatarica, x bella)</i>	Exotic honeysuckles	Open & successional habitats
<i>Luzula luzuloides</i>	Forest woodrush	Open & wooded habitats
<i>Microstegium vimineum</i>	Japanese stiltgrass	Open & forest habitats
<i>Polygonum caespitosum</i>	Oriental ladythumb	Open & successional habitats
<i>Polygonum cuspidatum</i>	Japanese knotweed	Riparian, open & successional habitats
<i>Rhamnus cathartica</i>	Common buckthorn	Riparian, open & successional habitats
<i>Rhodotypos scandens</i>	jetbead	Open, successional & wooded habitats
<i>Rosa multiflora</i>	Multiflora rose	Open & successional habitats
<i>Rubus phoenicolasius</i>	Wineberry	Open, successional & wooded habitats

Appendix D. List of non-native species detected in each park.

“Count” refers to number of plots the species occurred in, and “% Freq.” is the percentage of plots the species occurred in. Non-native status follows Natureserve exotic species designations.

Park	Species	Count	% Freq
ACAD	<i>Berberis thunbergii</i>	1	0.8
	<i>Festuca filiformis</i>	10	7.9
	<i>Frangula alnus</i>	1	0.8
	<i>Lonicera</i> spp. (Exotic)	1	0.8
	<i>Phleum pratense</i>	1	0.8
	<i>Poa nemoralis</i>	1	0.8
	<i>Ranunculus acris</i>	2	1.6
	<i>Rosa multiflora</i>	1	0.8
	<i>Stellaria graminea</i>	1	0.8
ELRO/ HOFR	<i>Acer platanoides</i>	1	8.3
	<i>Ailanthus altissima</i>	8	66.7
	<i>Alliaria petiolata</i>	6	50.0
	<i>Berberis thunbergii</i>	1	8.3
	<i>Celastrus orbiculata</i>	1	8.3
	<i>Chelidonium majus</i>	2	16.7
	<i>Conium maculatum</i>	1	8.3
	<i>Duchesnea indica</i>	1	8.3
	<i>Epipactis helleborine</i>	1	8.3
	<i>Euonymus alata</i>	1	8.3
	<i>Glechoma hederacea</i>	2	16.7
	<i>Hesperis matronalis</i>	1	8.3
	<i>Lonicera</i> spp. (Exotic)	4	33.3
	<i>Lysimachia nummularia</i>	1	8.3
	<i>Microstegium vimineum</i>	3	25.0
	<i>Picea abies</i>	1	8.3
	<i>Polygonum caespitosum</i>	3	25.0
	<i>Robinia pseudoacacia</i>	1	8.3
	<i>Rosa multiflora</i>	5	41.7
	<i>Solanum dulcamara</i>	1	8.3
MABI	<i>Berberis thunbergii</i>	1	4.2
	<i>Berberis vulgaris</i>	4	16.7
	<i>Daphne mezereum</i>	1	4.2
	<i>Epipactis helleborine</i>	17	70.8
	<i>Euonymus atropurpurea</i>	1	4.2
	<i>Hesperis matronalis</i>	2	8.3

Park	Species	Count	% Freq
MIMA	<i>Hieracium aurantiacum</i>	2	8.3
	<i>Lapsana communis</i>	1	4.2
	<i>Larix decidua</i>	1	4.2
	<i>Leucanthemum vulgare</i>	1	4.2
	<i>Lonicera</i> spp. (Exotic)	4	16.7
	<i>Picea abies</i>	7	29.2
	<i>Pinus sylvestris</i>	1	4.2
	<i>Plantago major</i>	1	4.2
	<i>Ranunculus acris</i>	1	4.2
	<i>Rhamnus cathartica</i>	3	12.5
	<i>Solanum dulcamara</i>	2	8.3
	<i>Taraxacum officinale</i>	11	45.8
	<i>Trifolium repens</i>	1	4.2
	<i>Verbascum thapsus</i>	3	12.5
	<i>Acer palmatum</i>	1	5.0
	<i>Acer platanoides</i>	10	50.0
	<i>Aegopodium podagraria</i>	1	5.0
	<i>Agrostis capillaris</i>	2	10.0
	<i>Alliaria petiolata</i>	7	35.0
	<i>Allium sativum</i>	1	5.0
	<i>Anthoxanthum odoratum</i>	3	15.0
	<i>Barbarea vulgaris</i>	1	5.0
	<i>Berberis thunbergii</i>	4	20.0
	<i>Catalpa speciosa</i>	1	5.0
	<i>Celastrus orbiculata</i>	10	50.0
	<i>Chelidonium majus</i>	4	20.0
	<i>Convallaria majalis</i>	4	20.0
	<i>Dactylis glomerata</i>	1	5.0
	<i>Daucus carota</i>	1	5.0
	<i>Euonymus alata</i>	2	10.0
	<i>Frangula alnus</i>	19	95.0
	<i>Hemerocallis fulva</i>	1	5.0
	<i>Holcus lanatus</i>	1	5.0
	<i>Hosta ventricosa</i>	1	5.0
	<i>Hypericum perforatum</i>	2	10.0
	<i>Lonicera</i> spp. (Exotic)	9	45.0
	<i>Lysimachia nummularia</i>	1	5.0
	<i>Lythrum salicaria</i>	3	15.0
	<i>Malus</i> spp.	4	20.0

Park	Species	Count	% Freq
MORR	<i>Paulownia tomentosa</i>	1	5.0
	<i>Phalaris arundinacea</i>	3	15.0
	<i>Phragmites australis</i>	1	5.0
	<i>Pinus nigra</i>	1	5.0
	<i>Pinus sylvestris</i>	1	5.0
	<i>Poa compressa</i>	1	5.0
	<i>Poa trivialis</i>	4	20.0
	<i>Polygonum cuspidatum</i>	2	10.0
	<i>Ranunculus acris</i>	2	10.0
	<i>Rhamnus cathartica</i>	4	20.0
	<i>Robinia pseudoacacia</i>	3	15.0
	<i>Rosa multiflora</i>	14	70.0
	<i>Saponaria officinalis</i>	1	5.0
	<i>Solanum dulcamara</i>	3	15.0
	<i>Sonchus</i> sp.	1	5.0
	<i>Symphytum officinale</i>	1	5.0
	<i>Taxus cuspidata</i>	1	5.0
	<i>Trifolium repens</i>	2	10.0
	<i>Acer platanoides</i>	1	6.7
	<i>Alliaria petiolata</i>	6	40.0
	<i>Allium vineale</i>	2	13.3
	<i>Anthoxanthum odoratum</i>	2	13.3
	<i>Berberis thunbergii</i>	12	80.0
	<i>Cardamine impatiens</i>	8	53.3
	<i>Celastrus orbiculata</i>	8	53.3
	<i>Epipactis helleborine</i>	1	6.7
	<i>Euonymus alata</i>	2	13.3
	<i>Frangula alnus</i>	1	6.7
	<i>Ligustrum vulgare</i>	3	20.0
	<i>Lonicera</i> spp. (Exotic)	6	40.0
	<i>Microstegium vimineum</i>	9	60.0
	<i>Polygonum caespitosum</i>	2	13.3
	<i>Rhamnus cathartica</i>	3	20.0
	<i>Rhodotypos scandens</i>	1	6.7
	<i>Robinia pseudoacacia</i>	2	13.3
	<i>Rosa multiflora</i>	5	33.3
	<i>Rubus phoenicolasius</i>	5	33.3
	<i>Viburnum sieboldii</i>	1	6.7

Park	Species	Count	% Freq
SAGA	<i>Berberis thunbergii</i>	4	19.0
	<i>Epipactis helleborine</i>	7	33.3
	<i>Hypericum perforatum</i>	1	4.8
	<i>Lapsana communis</i>	2	9.5
	<i>Lonicera</i> spp. (Exotic)	7	33.3
	<i>Solanum dulcamara</i>	2	9.5
	<i>Taraxacum officinale</i>	1	4.8
	<i>Verbascum thapsus</i>	1	4.8
SARA	<i>Agrostis capillaris</i>	1	3.1
	<i>Agrostis gigantea</i>	1	3.1
	<i>Alliaria petiolata</i>	8	25.0
	<i>Allium vineale</i>	1	3.1
	<i>Anthoxanthum odoratum</i>	2	6.3
	<i>Arctium</i> spp.	4	12.5
	<i>Barbarea vulgaris</i>	3	9.4
	<i>Berberis thunbergii</i>	3	9.4
	<i>Centaurea biebersteinii</i>	1	3.1
	<i>Centaurea jacea</i>	4	12.5
	<i>Cerastium fontanum</i>	1	3.1
	<i>Dactylis glomerata</i>	1	3.1
	<i>Daucus carota</i>	6	18.8
	<i>Dianthus</i> sp.	1	3.1
	<i>Euonymus atropurpurea</i>	1	3.1
	<i>Galium mollugo</i>	6	18.8
	<i>Glechoma hederacea</i>	4	12.5
	<i>Hypericum perforatum</i>	2	6.3
	<i>Leucanthemum vulgare</i>	2	6.3
	<i>Lonicera</i> spp. (Exotic)	30	93.8
	<i>Lotus corniculatus</i>	2	6.3
	<i>Lysimachia nummularia</i>	4	12.5
	<i>Malus pumila</i>	4	12.5
	<i>Melilotus officinalis</i>	2	6.3
	<i>Phalaris arundinacea</i>	3	9.4
	<i>Phleum pratense</i>	5	15.6
	<i>Plantago major</i>	16	50.0
	<i>Poa compressa</i>	7	21.9
	<i>Poa trivialis</i>	2	6.3
	<i>Prunus cerasus</i>	1	3.1
	<i>Pyrus</i> spp.	1	3.1

Park	Species	Count	% Freq
VAMA	<i>Ranunculus acris</i>	18	56.3
	<i>Rhamnus cathartica</i>	30	93.8
	<i>Rorippa nasturtium-aquaticum</i>	1	3.1
	<i>Rosa multiflora</i>	19	59.4
	<i>Rumex alpinus</i>	4	12.5
	<i>Sonchus</i> spp.	2	6.3
	<i>Taraxacum officinale</i>	16	50.0
	<i>Thymus</i> spp.	5	15.6
	<i>Trifolium repens</i>	3	9.4
	<i>Vicia cracca</i>	5	15.6
	<i>Alliaria petiolata</i>	7	87.5
	<i>Berberis thunbergii</i>	3	37.5
	<i>Cardamine impatiens</i>	1	12.5
	<i>Celastrus orbiculata</i>	6	75.0
	<i>Chelidonium majus</i>	1	12.5
	<i>Conium maculatum</i>	4	50.0
	<i>Euonymus alata</i>	2	25.0
	<i>Hemerocallis fulva</i>	2	25.0
	<i>Lysimachia nummularia</i>	1	12.5
	<i>Microstegium vimineum</i>	1	12.5
WEFA	<i>Myosotis scorpioides</i>	1	12.5
	<i>Phragmites australis</i>	1	12.5
	<i>Plantago major</i>	1	12.5
	<i>Ranunculus acris</i>	1	12.5
	<i>Rosa multiflora</i>	1	12.5
	<i>Vinca minor</i>	2	25.0
	<i>Berberis thunbergii</i>	4	80.0
	<i>Celastrus orbiculata</i>	4	80.0
	<i>Euonymus alata</i>	2	40.0
	<i>Rosa multiflora</i>	2	40.0

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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