

Invasive Plant Species and Habitat Management Plan for Fort Necessity National Battlefield

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Executive Summary

This management plan:

- 1) summarizes the status of invasive plant species in Fort Necessity National Battlefield,
- 2) determines park-specific priorities for invasive species management, and
- 3) provides detailed recommendations for the implementation of invasive species management in the park.

Invasive Plant Species and Habitat Management Plan for

Fort Necessity National Battlefield

Invasive exotic plants threaten the natural resources of Fort Necessity National Battlefield (FONE). These nonnative species compete with native plant species, dramatically change plant communities, and degrade wildlife habitat. Since invasive plants are inherently difficult to control, the management of these species and their effects on park vegetation is challenging.

This management plan was created using the Invasive Plant Species and Habitat Management Planning Process developed by Art Gover at Penn State's Wildland Weed Management Unit (Gover 2016). This planning process is based on several important principles:

- Parks have finite resources that can only be directed to a small portion of potential natural resource needs.
- Use park-specific data to make informed strategic decisions with limited resources. Strategic management is effective by protecting natural resources without wasted effort.
- Protecting the best sites within a park maximizes the benefit to park natural resources per person-hour expended on invasive species management.
- Inaction is more harmful than action. The decision NOT to manage invasive plant species has continued and increasingly negative impacts on the park's natural resources.

Long-term forest health monitoring in FONE shows that at least one invasive species is present in 90.0% of the park's monitoring plots, and that invasive species are spreading within the park, covering an additional 3.5 hectares (8.6 acres) within the park each year (Miller et al. in press). Invasive shrubs such as multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), bush honeysuckle (*Lonicera* spp.), and winged burningbush (*Euonymus alatus*) are the most abundant and the fastest spreading invasive species. A summary of the invasive species information from forest health monitoring in FONE is shown in Figures 2 and 3, and Tables 1 and 2.

The Invasive Plant Species and Habitat Management Planning Process involves three steps: define habitat management zones, prioritization, and prescription.

Define Habitat Management Zones

To determine which areas of the park are more important to preserve, the park Natural Resource Manager, the Regional Invasive Plant Team Liaison, and two Plant Ecologists from the Eastern Rivers and Mountains Inventory and Monitoring Network met to delineate Habitat Management zones within FONE (Figure 1). Habitat management zones are discrete areas of the park that are ecologically or culturally valuable and where invasive species management is operationally feasible.

We considered vegetation types present in the park, the integrity (or lack of disturbance) of the plant communities, the resource value to the park in terms of natural and cultural stewardship, and the presence of rare or endangered species. Habitat management zones for FONE were determined based on the vegetation map (Perles et al. 2006) as well as data on the status of invasive plant species in the park. Invasive species data were collected from five sources: the vegetation classification and mapping project (Perles et al. 2006), the invasive species distribution and abundance report based on vegetation mapping data (Zimmerman and Yoder 2006), data collected at long-term forest health monitoring plots as part of the Eastern Rivers and Mountains Inventory and Monitoring Network (Perles et al. 2014, for current data see <https://www.nps.gov/im/ermn/vegetation-soils.htm>), the forest health assessment and biological evaluation conducted by the US Forest Service (Sykes and Hill 2017), and the Invasive Species Early Detection / Rapid Response Program coordinated by ERMN. Figures 2, 3, and 4 and Tables 1 and 2 show snapshots of the invasive species data used to define habitat management zones in FONE.

Prioritization

We then used a prioritization tool (Gover 2016) housed in an excel workbook to prioritize which habitat management zones and which invasive species should be managed in order to maximize the benefit to park natural resources. First, for each habitat management zone, we assigned a Stewardship Index based on the ecological value of the zone's vegetation, and an Outreach Index that captured the value of the zone to the park's interpretation goals. Using the workbook, we then evaluated the level of infestation of each known invasive plant species, the potential impacts of those invasive species on the habitats, the difficulty of managing those invasives, and the restoration effort required in each habitat. The resulting prioritization matrix (Table 3) provides strategic direction for managers to protect the best sites within a park.

Treating invasive shrubs and trees in the Great Meadow is the highest priority for invasive species management in FONE, followed by managing the herbaceous and vine invasive species in the Great Meadow. Removing the small infestations of princess tree (*Paulownia tomentosa*) in the Picnic Loop and Woodcock Fields will prevent this invasive from establishing widely in the park. Treating the invasive shrubs in the Woodcock Fields will protect crucial wildlife habitat, as well as eliminate invasive seed sources adjacent to the Great Meadow. Managing invasive shrubs in the Picnic Loop will protect the least invaded and most mature forests in the park. These priorities maximize the benefit to park natural resources per person-hour expended on invasive species management.

Prescription

Last, we described how strategic invasive species management will be implemented in the park. The prescription specifies: **who** will be doing the work, **how** the invasives will be managed, and **when** the management should be conducted for only the habitat management zones that were identified as priorities and for only those invasive species that were identified as priorities. See Table 4 for the invasive species management prescription for FONE.

Nearly all invasive management prescriptions in FONE require pesticide application. All pesticide applications must be made in accordance with Pennsylvania Department of Agriculture regulations as codified in PA Title 7 Section 128. A Pennsylvania Commercial or Public Certified Applicator can make or supervise the pesticide prescriptions proposed here. An non-licensed applicator, who may be an employee, a collaborator from another agency or organization, or a volunteer, must be under the direct supervision of a Certified Commercial or Public Applicator physically present at the work site. A Registered Technician can make applications without on-site supervision under the instruction of a certified applicator. When a Registered Technician is making applications, the responsible Certified Applicator must be available to be on site within 5 hours of receiving notification that physical presence is necessary. A Registered Technician may not independently supervise non-certified applicators.

Strategic Management Protects Park Resources

Invasive species management is crucial to ensuring the success of the Great Meadow Restoration, as well as protecting the park's forests, which provide the backdrop and context for interpretation of the historic Fort, habitat for hundreds of native plants and animals, and recreational opportunities for park visitors. Inaction will result in declines in the park's native flora, degraded wildlife habitat, and ultimately, the loss of native forests within the park. The strategic prescriptions presented in this report direct scarce resources to the areas of the park where invasive species management will most benefit the park's cultural and natural resources.

This plan will be updated every 4 years, after all the park's forest health monitoring plots have been revisited. The latest monitoring data and new observations from the Invasive Species Early Detection / Rapid Response Program will be incorporated into the updated plan. However, the excel workbook prioritization tool can be updated at any time (e.g., new invasive species found, land parcel newly acquired by the park, etc), in order to evaluate evolving management priorities.

Literature Cited

- Gover, A. 2016. Introduction to the Habitat and Invasive Species Mangement Planning Process. Pennsylvania State University Wildland Weed Management. (<https://plantscience.psu.edu/research/projects/wildland-weed-management>).
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Figure 1.
Invasive species habitat
management zones in
Fort Necessity National Battlefield.

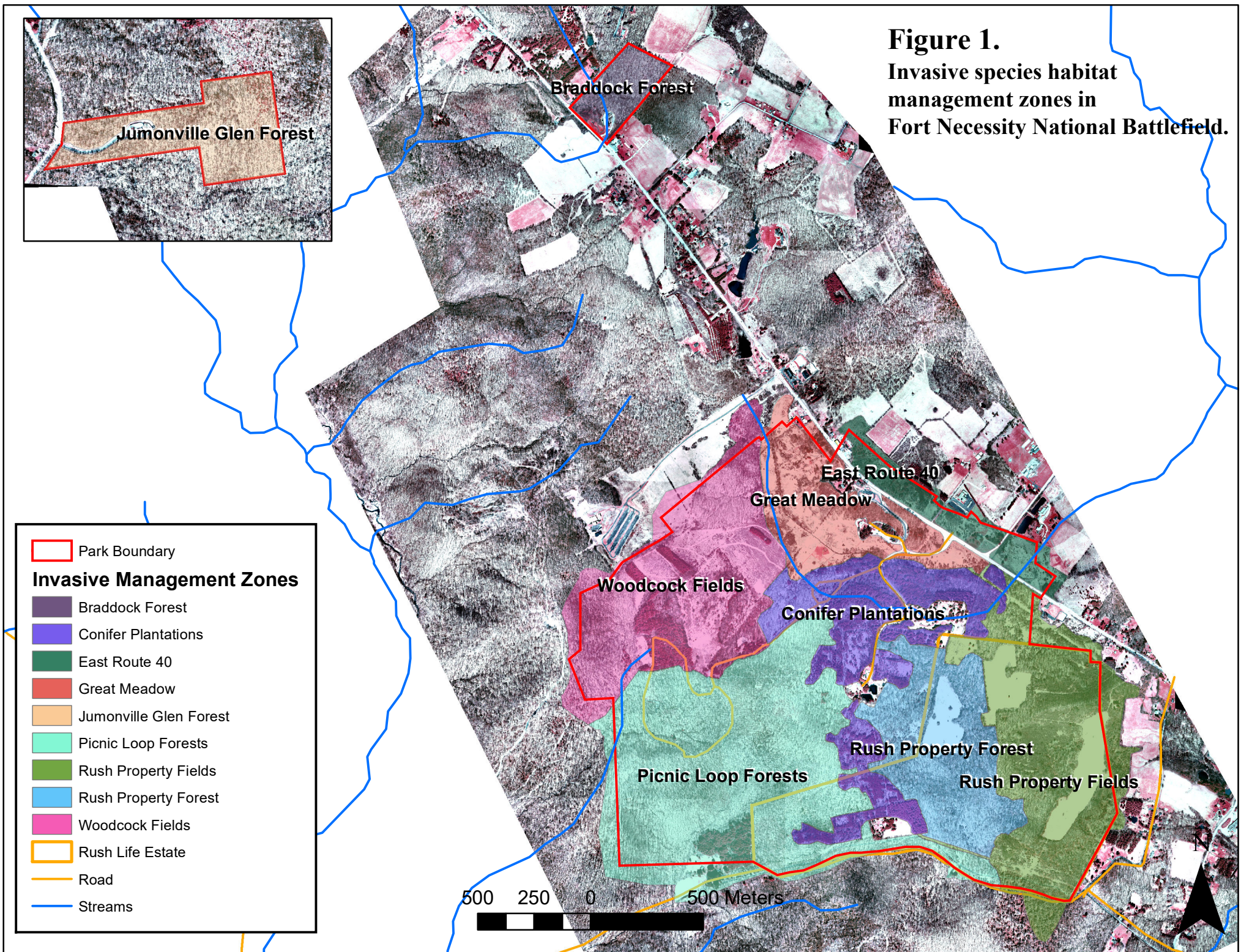


Figure 2. Average Invasive Species Percent Cover by Cycle

Trends in percent cover of invasive species observed in quadrats in forest health monitoring plots sampled from 2007-2018. Each plot is sampled on a 4-year cycle. Average invasive cover among quadrats within each plot ranges from 0 to 70%. See Table 1 for percent cover values.

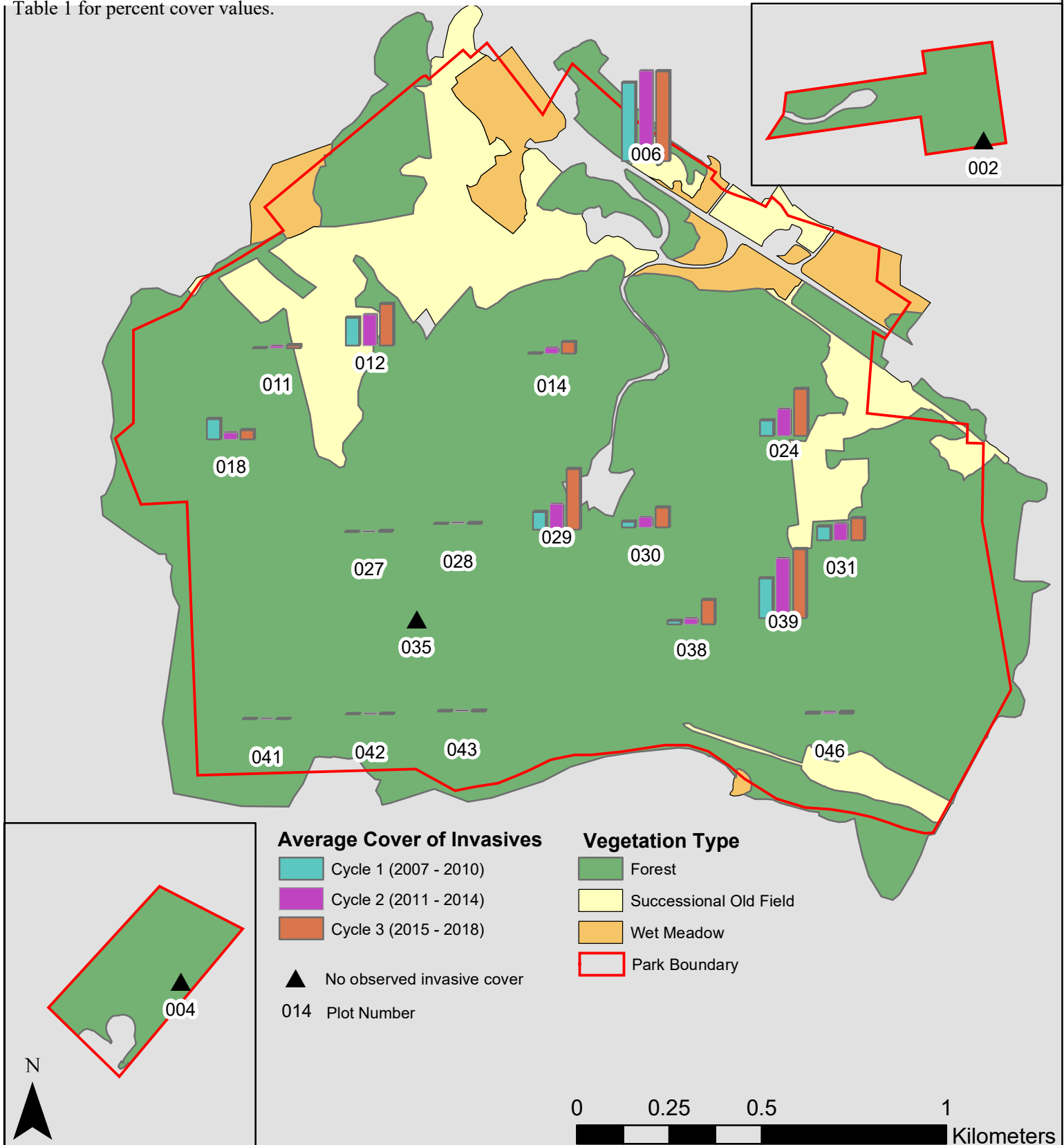


Figure 3. Percent Cover by Invasive Species

Percent cover by invasive species observed in quadrats in forest health monitoring plots during the most recent completed survey (cycle 3; 2014-2018). Larger circles represent higher cover of invasives.

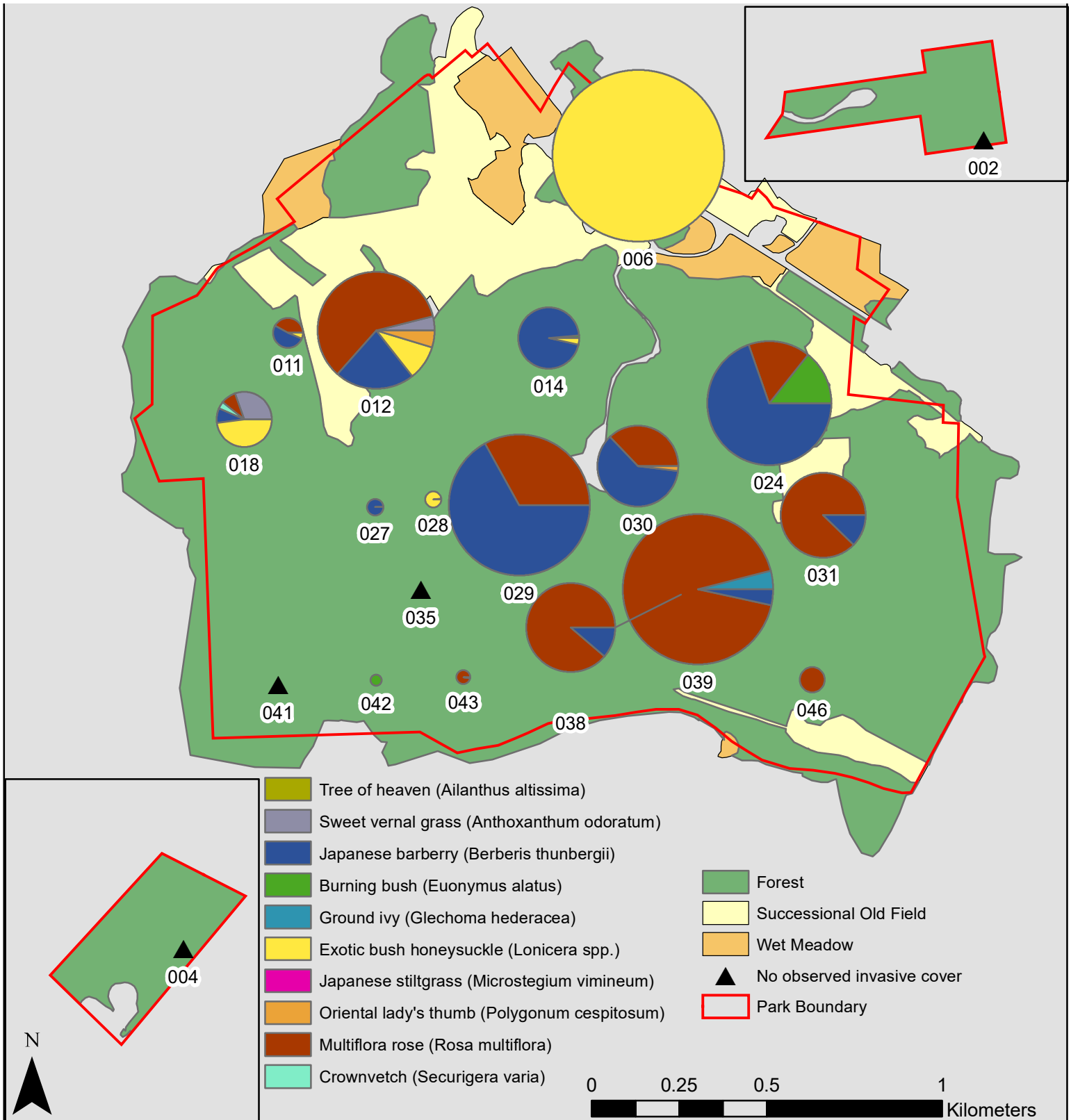


Table 1. Number of invasive species detected in each forest health monitoring plot and average percent cover of all invasive species observed in quadrats by plot and cycle. Cycle 1 spans 2007 - 2010; Cycle 2 spans 2011 - 2014; and Cycle 3 spans 2015 - 2018. Cycle 4 includes only plots sampled in 2019 and has not yet been completed.

Plot	Average Percent Cover of Invasive Species				Number of Invasive Species			
	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
2	0	0	0	0	0	0	0	0
4	0	0	0	--	0	0	0	--
6	60.65	69.80	69.47	--	4	3	3	--
11	0	1.60	2.08	7.67	1	3	4	5
12	21.36	23.98	32.14	--	5	5	5	--
14	0	4.60	8.78	6.71	1	2	5	6
18	15.77	4.90	7.16	--	6	9	6	--
24	11.90	20.89	36.31	--	5	6	5	--
27	0.02	0.13	0.63	--	3	3	4	--
28	0	0.54	0.62	0.98	0	3	4	6
29	13.80	19.75	47.01	--	5	4	4	--
30	4.60	7.77	15.51	--	2	3	5	--
31	10.83	13.08	17.08	--	5	5	3	--
35	0	0	0	--	2	1	1	--
38	2.47	4.48	18.71	--	5	5	4	--
39	30.88	46.27	53.30	--	4	4	5	--
41	0	0.02	0	0.00	0	1	2	4
42	0	0	0.29	--	0	3	1	--
43	0.13	0.26	0.45	--	3	3	3	--
46	0.64	1.47	1.48	--	2	3	4	--

Table 2. Percent of forest health monitoring plots containing specific invasive species by cycle.

Latin Name	Common Name	Cycle 1 (2007 - 2010)	Cycle 2 (2011 - 2014)	Cycle3 (2015 - 2018)
<i>Ailanthus altissima</i>	tree of heaven	0%	0%	5%
<i>Ailanthus altissima</i>	tree of heaven	0%	0%	5%
<i>Anthoxanthum odoratum</i>	sweet vernalgrass	25%	15%	15%
<i>Arctium minus</i>	lesser burdock	5%	0%	0%
<i>Berberis thunbergii</i>	Japanese barberry	60%	70%	75%
<i>Berberis vulgaris</i>	common barberry	0%	5%	0%
<i>Celastrus orbiculatus</i>	Oriental bittersweet	0%	0%	5%
<i>Cirsium arvense</i>	Canada thistle	5%	0%	0%
<i>Cirsium vulgare</i>	bull thistle	5%	0%	0%
<i>Euonymus alatus</i>	burningbush	10%	20%	35%
<i>Glechoma hederacea</i>	ground ivy	10%	15%	10%
<i>Ligustrum</i> sp.	privet	0%	0%	5%
<i>Lonicera morrowii</i>	Morrow's honeysuckle	45%	60%	50%
<i>Lonicera</i> sp. Exotic	honeysuckle	0%	15%	10%
<i>Lysimachia nummularia</i>	creeping jenny	0%	5%	0%
<i>Microstegium vimineum</i>	Japanese stiltgrass	0%	5%	5%
<i>Polygonum caespitosum</i>	Oriental ladythumb	30%	25%	35%
<i>Polygonum persicaria</i>	spotted ladythumb	0%	5%	0%
<i>Rosa multiflora</i>	multiflora rose	65%	85%	85%
<i>Securigera varia</i>	crownvetch	5%	5%	5%

Figure 4.
Presence of Invasive
Species in Fort Necessity
National Battlefield

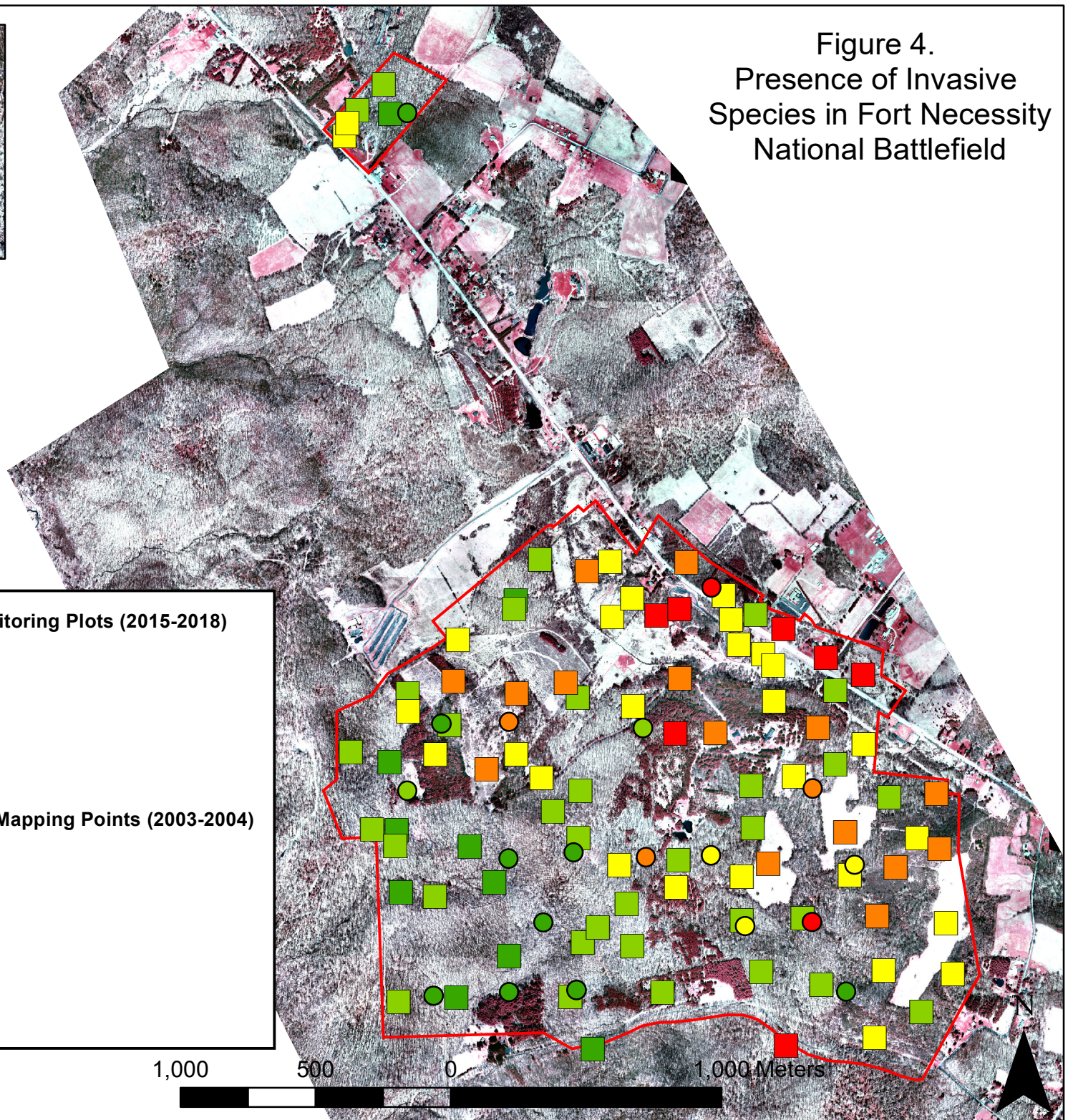
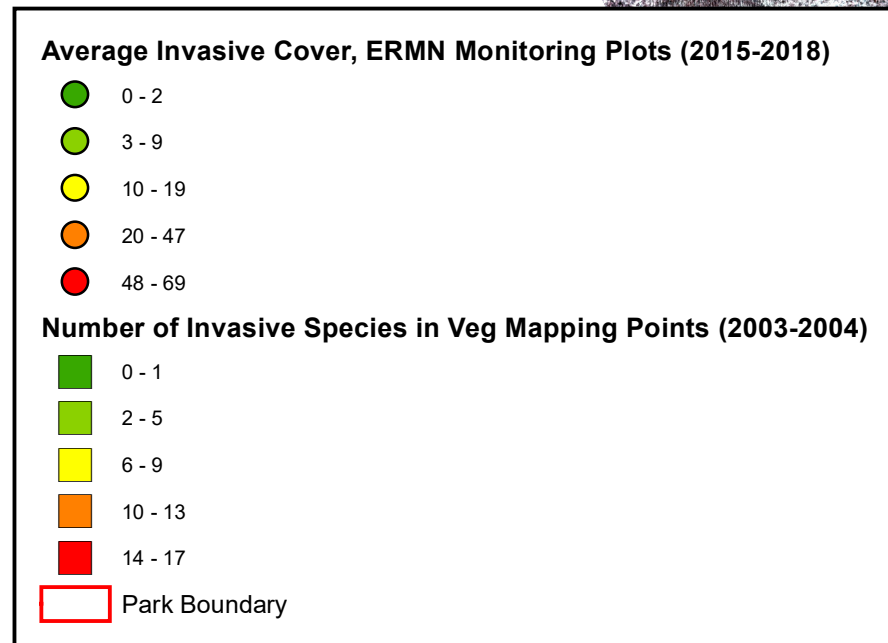
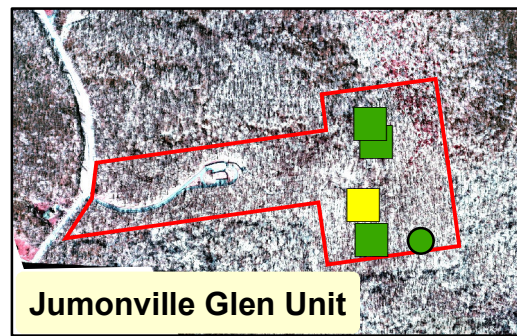


Table 3. Prioritization matrix for invasive species management in Fort Necessity National Battlefield. Higher numbers indicate higher priority species and habitat zones for invasive species management.

Habitat Management Zone	Braddock Forest	Conifer Plantations	Route 40 East	Great Meadow	Jumonville Glen Forest	Picnic Loop Forests	Rush Property Fields	Rush Property Forests	Woodcock Fields
Habitat Type	MF	MF	YF	WL	MF	MF	YF	MF	YF
Stewardship Index	1	0	0	2	2	2	0	1	1
Outreach Index	0	0	0	2	0	1	0	0	0
Species									
Japanese stiltgrass	0	0	0	0	5	6	2	3	5
bull thistle	0	4	2	6	0	7	4	5	7
common teasel	0	0	2	0	0	0	0	0	0
garlic mustard	5	4	2	0	0	7	0	0	0
wild parsnip	0	0	0	8	0	0	0	0	0
Canada thistle	0	4	2	7	0	0	0	5	5
crownvetch	0	4	2	7	0	0	4	0	5
exotic shrubs	0	3	3	8	0	6	3	4	6
autumn olive	0	3	3	0	7	0	3	0	6
empress tree	0	5	0	0	0	0	0	0	0
Japanese barberry	4	3	0	8	7	6	3	4	6
multiflora rose	4	3	3	8	0	6	3	4	6
privet	0	3	3	8	0	6	3	0	6
shrub honeysuckle	4	3	3	8	0	6	3	4	6
winged euonymus	0	3	3	8	0	8	3	4	6
tree-of-heaven	0	5	0	0	0	8	0	0	0
Japanese honeysuckle	0	0	2	0	0	0	0	0	0
Oriental bittersweet	0	0	0	0	0	0	0	3	0
creeping jeeny	0	0	0	0	0	0	0	0	8
Creeping charlie	0	3	3	0	7	8	3	4	6
Oriental Ladysthumb	0	0	3	0	0	8	3	4	6
spotted ladysthumb	0	5	5	0	7	8	5	6	8
Japanese knotweed	0	0	0	9	6	0	0	0	0

Highest Priority
High Priority
Medium Priority
Lower Priority

Habitat Type: MF = Mature Forest, YF = Young Forest, WL = Wetland.

Stewardship Index: 0 indicates disturbed site significantly impacted by invasive species; 1 indicates intermediate level of ecological disturbance; 2 HMZ has high ecological value, resembles intact ecosystem, includes critical water-quality areas regardless of the level of invasive impact.

Outreach Index: 0 indicates management efforts will go unnoticed outside of park staff; 1 indicates work done in zone visibly promotes the Park's mission; 2 indicates outside groups or agencies are interested in supporting work in this zone due to high outreach value.

Table 4. Prescription and calendar for invasive species management for priority invasive species in priority habitat zones in Fort Necessity National Battlefield.

Priority Rank	Habitat Management Zone	Species	Lead Worker	Method	Comments	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
9	Great Meadow	Japanese knotweed	Registered Tech	Cut	cut in mid to late June. Spray with Glyphosate / Imazapyr or mix of two in late August/early												
8	Great Meadow	wild parsnip	Registered Tech	Foliar-Broadleaf	Milestone												
8	Great Meadow	exotic shrubs	Staff	Cut	then treat re-growth with												
8	Great Meadow	exotic shrubs	Registered Tech	Foliar-AirStrike													
8	Great Meadow	Japanese barberry	Staff	Cut	then treat re-growth with												
8	Great Meadow	Japanese barberry	Registered Tech	Foliar-AirStrike													
8	Great Meadow	multiflora rose	Staff	Cut	then treat re-growth with												
8	Great Meadow	multiflora rose	Registered Tech	Foliar-AirStrike													
8	Great Meadow	privet	Staff	Cut	then treat re-growth with												
8	Great Meadow	privet	Registered Tech	Foliar-AirStrike													
8	Great Meadow	shrub honeysuckle	Staff	Cut	then treat re-growth with												
8	Great Meadow	shrub honeysuckle	Registered Tech	Foliar-AirStrike													
8	Great Meadow	winged euonymus	Staff	Cut	then treat re-growth with												
8	Great Meadow	winged euonymus	Registered Tech	Foliar-AirStrike													
7	Great Meadow	Canada thistle	Registered Tech	Foliar-Specialized	Aminopyralid												
7	Great Meadow	crownvetch	Registered Tech	Foliar-Broadleaf	Triclopyr alone												
6	Great Meadow	bull thistle	Registered Tech	Foliar-Broadleaf													
8	Picnic Loop Forests	winged euonymus	Staff	Cut	then treat re-growth with												
8	Picnic Loop Forests	winged euonymus	Registered Tech	Foliar-AirStrike													
8	Picnic Loop Forests	tree-of-heaven	Registered Tech	Foliar-AirStrike	For trees <5" diameter												
8	Picnic Loop Forests	tree-of-heaven	Registered Tech	Stem-basal	For trees >5" diameter												
8	Picnic Loop Forests	Creeping charlie	Registered Tech	Foliar-AirStrike													
8	Picnic Loop Forests	Oriental Ladythumb	Volunteer	Pull	OR												
8	Picnic Loop Forests	Oriental Ladythumb	Registered Tech	Foliar-AirStrike													
8	Picnic Loop Forests	spotted ladythumb	Volunteer	Pull	OR												
8	Picnic Loop Forests	spotted ladythumb	Registered Tech	Foliar-AirStrike													
7	Picnic Loop Forests	bull thistle	Registered Tech	Foliar-Broadleaf													
7	Picnic Loop Forests	garlic mustard	Volunteer	Pull													
6	Picnic Loop Forests	Japanese stiltgrass	Registered Tech	PRE	Fall w/ indaziflam or spring w/ prodiamine or pendimethalin												
6	Picnic Loop Forests	Japanese stiltgrass	Registered Tech	Foliar-Specialized	Mid to late summer with grass killer: quizalifop or fluazifop												
6	Picnic Loop Forests	exotic shrubs	Staff	Cut	then treat re-growth with												
6	Picnic Loop Forests	exotic shrubs	Registered Tech	Foliar-AirStrike													
6	Picnic Loop Forests	Japanese barberry	Staff	Cut	then treat re-growth with												
6	Picnic Loop Forests	Japanese barberry	Registered Tech	Foliar-AirStrike													
6	Picnic Loop Forests	multiflora rose	Staff	Cut	then treat re-growth with												
6	Picnic Loop Forests	multiflora rose	Registered Tech	Foliar-AirStrike													
6	Picnic Loop Forests	privet	Staff	Cut	then treat re-growth with												
6	Picnic Loop Forests	privet	Registered Tech	Foliar-AirStrike													
6	Picnic Loop Forests	shrub honeysuckle	Staff	Cut	then treat re-growth with												
6	Picnic Loop Forests	shrub honeysuckle	Registered Tech	Foliar-AirStrike													
8	Woodcock Fields	creeping jenny	Registered Tech	Foliar-AirStrike													
8	Woodcock Fields	spotted ladythumb	Volunteer	Pull	OR												
8	Woodcock Fields	spotted ladythumb	Registered Tech	Foliar-AirStrike													
7	Woodcock Fields	bull thistle	Registered Tech	Foliar-Broadleaf													
6	Woodcock Fields	exotic shrubs	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	exotic shrubs	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	autumn olive	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	autumn olive	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	Japanese barberry	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	Japanese barberry	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	multiflora rose	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	multiflora rose	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	privet	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	privet	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	shrub honeysuckle	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	shrub honeysuckle	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	winged euonymus	Staff	Cut	then treat re-growth with												
6	Woodcock Fields	winged euonymus	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	Creeping charlie	Registered Tech	Foliar-AirStrike													
6	Woodcock Fields	Oriental Ladythumb	Volunteer	Pull	OR												
6	Woodcock Fields	Oriental Ladythumb	Registered Tech	Foliar-AirStrike													
7	Jumonville Glen Fores	autumn olive	Staff	Cut	then treat re-growth with												
7	Jumonville Glen Fores	autumn olive	Registered Tech	Foliar-AirStrike													
7	Jumonville Glen Fores	Japanese barberry	Staff	Cut	then treat re-growth with												
7	Jumonville Glen Fores	Japanese barberry	Registered Tech	Foliar-AirStrike													
7	Jumonville Glen Fores	Creeping charlie	Registered Tech	Foliar-AirStrike													
7	Jumonville Glen Fores	spotted ladythumb	Volunteer	Pull	OR												
7	Jumonville Glen Fores	spotted ladythumb	Registered Tech	Foliar-AirStrike													
6	Jumonville Glen Fores	Japanese knotweed	Registered Tech	Cut	cut in mid to late June. Spray with Glyphosate / Imazapyr or mix of two in late August/early												

Highest Priority
High Priority
Medium Priority

Volunteers and non-certified staff do methods in blue
Pesticide Applicators conduct methods in gray

Control Method should occur in months colored in green

Lead Worker	Description of Worker
Volunteer	As a <i>lead</i> worker, volunteers are limited to manual methods, and whatever equipment they are qualified/permited to use. Volunteers may not apply pesticides unless a Certified Applicator is present.
Staff	This is a park employee, but one without pesticide applicator credentials.
Registered Technician	This is a park employee who has completed the required annual training sanctioned by the PA Department of Agriculture (PDA). A Registered Technician can apply pesticides autonomously, in operations in which they have been trained, but they may not supervise non-credentialed applicators.
Certified Applicator	This is a park employee who has passed the Core and Category 23 Pesticide Applicator exams, and is <i>licensed</i> . A Certified Applicator may apply autonomously, and may also supervise other non-credentialed applicators as long they are on-site.
Contractor	A blanket term describing any individual or company paid to execute work.

Method	Description of Control Methods
Cut then spray	Remove top growth using hand-held or motorized tools. Typically directed towards woody plants, including vines. Any woody shrubs can be cut to a stump and then immediately treated with stump oil, or cut and then treated with Foliar AirStrike after the plant leafs out again, at least 6 weeks later.
Foliar-AirStrike	An herbicide application to target plant foliage. 'AirStrike' is a label for <i>glyphosate</i> plus <i>triclopyr</i> , a non-selective mixture used for most spot treatments and for sites with multiple species of exotic shrubs.
Foliar-Broadleaf	An herbicide application to target plant foliage. 'Broadleaf' is a label for <i>triclopyr</i> plus <i>2,4-D</i> is a selective mixture to control broadleaved weeds without injuring grasses.
Foliar-Specialized	An herbicide application to target plant foliage. 'Specialized' refers to any herbicide or mixture that is not 'AirStrike' or 'Broadleaf', and is used for a specific target species. Examples include <i>quizalofop-P</i> to treat Japanese stiltgrass, or <i>aminopyralid</i> or <i>aminocyclopyrachlor</i> to treat Canada thistle.
Pre-emergent	A preemergent herbicide can be applied to prevent annual species, such as Japanese stiltgrass or mile-a-minute, from germinating.
Pull	Remove plant from soil by pulling or digging it from the soil using manual equipment.
Other Methods Not Currently Specified in this Plan	
Stem-basal	Woody species can be stem-treated. Basal bark is an oil-based mixture applied to the lower portion of intact stems.
Stump-oil	Non-suckering woody plants can be cut and stump-treated to prevent regrowth. Oil-based mixtures can also be applied to previously cut stumps by treating the remaining bark as well.
Monitor	Systematic review of site to detect target species, whether new infestation or remnants from previous operation.
Bare-root Planting	Installing individual plants that have been dug from the soil, exposing their roots. A common technique with woody plants, where a 1-year old plant is dug in the late winter while dormant, and planted as soon as possible.
Container Planting	Plants are grown in containers ('pots'), rather than in the field. In this method the roots are intact, and planting can occur at any time.
Live Stake Planting	Live stakes are cuttings from certain woody species that will root and grow when simply stuck in moist soil in the early spring.
Warm-season Seeding	Warm- vs. Cool-season is a common reference to grasses. It is an issue because the "season" of the grass determines its seeding time. Warm-season grasses are seeded in the spring or dormant season, while cool-season grasses can also be fall-seeded.
Cool-season Seeding	Warm- vs. Cool-season is a common reference to grasses. It is an issue because the "season" of the grass determines its seeding time. Cool-season grasses are seeding in the spring, fall, or dormant season, while warm-season are not fall-seeded.
Prescribed Fire	Use of planned fire to remove existing aboveground plant material. Converts existing biomass to ash, providing elements such as potassium and phosphorus; and removes accumulated plant litter at ground level, improving habitat structure for ground nesting birds and small mammals.
Masticate	Refers to the use of forestry mower (e.g. FECON) to remove woody vegetation. Specifically, this refers to devices with a horizontal axle, and armored, fixed-teeth that shred woody stems, and can also reduce stump tissue.
Brush Hog	This refers to a mower used for infrequent cutting of little-managed vegetation, or "field mowing", distinct from the "finish" mowing of turfgrass. "Brush Hog" is not proprietary ("Bush Hog" is), and is also a definition in the <i>Wikipedia</i> .
Targeted Removal	Removal of specific woody stems, to modify edge habitat or create residual trees. Semantically, this is distinct from "thinning", which is a silvicultural practice to improve desirable tree growth, and it is also distinct from "selective cut" which is a commonly used as euphemism for the silvicultural malpractice known as "high-grading".
Tillage	Soil disruption, typically with a tractor-drawn implement. Useful to thin dense monotypic stands of warm-season grasses or goldenrods to release or introduce other species. With the availability of no-till seed drills, tillage is rarely needed for seedbed preparation.
Biological Control	Classical biological control is the release of an organism that impacts one specific host. This is most commonly accomplished with insects. In Pennsylvania, the purple loosestrife beetle and mile-a-minute weevil have been released to specifically suppress those weeds.
Foliar-Specialized	An herbicide application to target plant foliage. 'Specialized' refers to any herbicide or mixture that is not 'AirStrike' or 'Broadleaf', and is used for a specific target species. Examples include <i>quizalofop-P</i> to treat Japanese stiltgrass, or <i>aminopyralid</i> or <i>aminocyclopyrachlor</i> to treat Canada thistle.
Stem-hack	Woody species can be stem-treated. Hack and squirt is a concentrated mixture applied to fresh, spaced cuts made in the bark.
Stump-aqueous	Non-suckering woody plants can be cut and stump-treated to prevent regrowth. Water-based mixtures can be applied to freshly-cut stumps.



Invasive Plant Trend Analysis

Summary of Invasive Species Status and Trends for Fort Necessity National Battlefield

from

Miller, K.M., McGill, B.J., Weed, A. S., Seirup, C.E., Comiskey, J.A., Matthews, E.R., Perles, S.J., and J. P. Schmit. 2020. Long-term trends indicate that invasive plants are pervasive and increasing in eastern national parks. In press.

Status

In the most recent cycle in Fort Necessity National Battlefield (FONE; 2015-2018), at least one invasive species was detected in 90.0% of plots, and on average, 47.5% of quadrats had at least one invasive species and average total invasive cover was 15.4% (Table 1). The shrub guild was the most abundant guild in FONE, found in 90.0% of plots, and averaging 43.8% quadrat frequency, and 15.1% quadrat cover (Figure 1). The most abundant invasive species in FONE was multiflora rose (*Rosa multiflora*), occurring in 85.0% of plots, and averaging 6.5% cover. Japanese barberry (*Berberis thunbergii*) was the second most abundant invasive species, occurring in 75.0% of plots, and averaging 4.5 % cover. The next three most abundant invasive species in FONE were exotic bush honeysuckle (*Lonicera*), winged burningbush (*Euonymus alatus*), and oriental lady's thumb (*Persicaria longiseta*).

Trends

There were a total of 7 significant trends in invasive abundance in FONE. Quadrat frequency of total invasives increased significantly by 5.4% per cycle. Average cover of total invasives increased significantly by 4.3% per cycle. Shrub quadrat frequency increased significantly by 4.5% per cycle. Herbaceous average cover increased significantly by 0.7% per cycle. Shrub average cover increased significantly by 3.2% per cycle. Japanese barberry (*Berberis thunbergii*) average cover increased significantly by 1.3% per cycle. Multiflora rose (*Rosa multiflora*) average cover increased significantly by 1.9% per cycle.

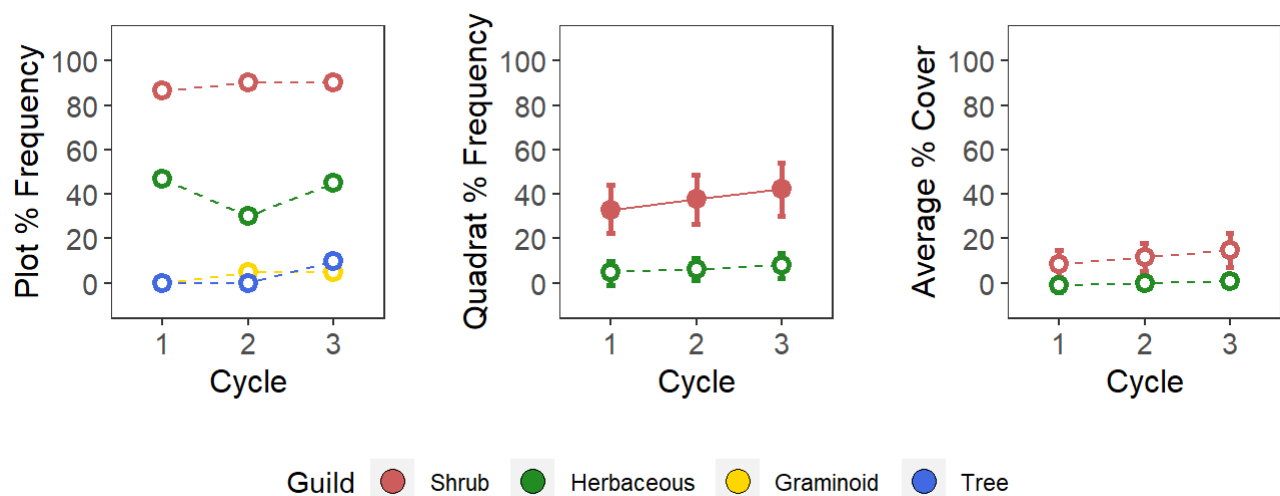


Figure 1. Trends by guild and cycle in FONE. Solid symbols and lines indicate significant trends. Error bars are 95% confidence intervals.