



Problematic Plant Monitoring in Lincoln Boyhood National Memorial

2006–2019

Natural Resource Report NPS/HTLN/NRR—2021/2272



ON THE COVER

Conservation Corps Iowa controlling invasive plants in Lincoln Boyhood National Memorial, Lincoln City, Indiana
Photography by NPS

Problematic Plant Monitoring in Lincoln Boyhood National Memorial

2006–2019

Natural Resource Report NPS/HTLN/NRR—2021/2272

Craig C. Young

National Park Service
Heartland Inventory and Monitoring Network
Republic, Missouri

Editing and Design by
Tani Hubbard

National Park Service &
Northern Rockies Conservation Cooperative
12661 E. Broadway Blvd.
Tucson, AZ 85748

June 2021

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the [Heartland Inventory and Monitoring Network website](#) and the [Natural Resource Publications Management website](#). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Young, C. C. 2021. Problematic plant monitoring in Lincoln Boyhood National Memorial: 2006–2019. Natural Resource Report NPS/HTLN/NRR—2021/2272. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2286660>.

Contents

	Page
Figures	iv
Tables	iv
Abstract	v
Introduction	1
Methods	2
Watch Lists	2
Field Methods	2
Analytical Methods	5
I-Ranks	5
Taxonomic Notes	5
Results and Discussion	6
Literature Cited	14

Figures

	Page
Figure 1. Location of search units used to monitor problematic plants in Lincoln Boyhood National Memorial	4
Figure 2. 2019 problematic plant cover and frequency relationship at Lincoln Boyhood National Memorial	13

Tables

	Page
Table 1. Early detection problematic plant watch list used to guide surveys in Lincoln Boyhood National Memorial.	2
Table 2. Park-established problematic plant watch list used to guide 2019 surveys in Lincoln Boyhood National Memorial.	3
Table 3. Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial	7

Abstract

Managers are challenged with the impact of problematic plants, including exotic, invasive, and pest plant species. Information on the cover, distribution, and location of these plants is essential for developing risk-based approaches to managing these species. Based on surveys conducted in 2006, 2011, 2015, and 2019, Heartland Network staff and contractors identified a cumulative total of 45 potentially problematic plant taxa in Lincoln Boyhood National Memorial. Of the 34 species found in 2019, we characterized 4 as very low frequency, 14 as low frequency, 9 as medium frequency, and 7 as high frequency. A single species exceeded a 10-acre threshold based on a mid-point estimate. Because of the number of problematic plant taxa, as well as the extent and cover of problematic plants in the park and the small park size, control efforts should focus on treating high priority species across the entire park. High priority species may include plant species capable of rapid spread, species at low population levels, and species which can effectively be controlled.

Introduction

The National Park Service’s management policies distinguish between native and exotic (i.e., non-native) plant species (NPS 2006). Exotic plant species are typically characterized by their introduction due to human actions, whether intentional or not. Invasive plants, following the definition used in Executive Order 13751, are those plants that are exotic and cause ecological or economic harm. Finally, pest plants are defined less by their biology and more by their context in the same way that the term *weed* is defined (NPS 2006). Pest plants, which include native species, interfere with a specific management objective, including an objective of protecting human health. We suggest thinking of this collection of exotic, invasive, and pest plants as *potentially problematic* species.

Park managers, however, are only required to control any problematic plants that lead to *resource impairment*. For plant populations causing effects that fall

short of the impairment threshold, park managers wield a high level of discretion in judging whether the population should be controlled or not. The standard for making this decision rests on five criteria: the origin of the species, prudence, feasibility, the harm (i.e., impact) that the plant causes to park resources, and the harm that removal causes (NPS 2006). As with impairment determinations, these decisions are based on professional judgment, environmental assessment, consultation with regulating agencies, evidence-based scholarship, subject matter expertise, and civic engagement with the public (NPS 2006).

This report presents the results of problematic plant monitoring conducted at Lincoln Boyhood National Memorial in 2006, 2011, 2015 and 2019. The key metrics presented include plant cover and geographic distribution within the park.



Japanese stiltgrass, a problematic grass found in Lincoln Boyhood National Memorial, Lincoln City, Indiana. NPS

Methods

All methods presented here are based on the Heartland Inventory and Monitoring Network invasive exotic plant monitoring protocol (Young et al. 2007).

Watch Lists

We searched for potentially problematic plants on two lists. Prioritized problematic plants not previously found during park monitoring constituted the early detection watch list (n = 65; Table 1). Prioritized problematic plants known to occur in the park based on previous monitoring constituted the park-established watch list (n = 45; Table 2). In this report we included only plant species that we searched for in 2019. Of these, any species not sought during all previous surveys were annotated in the tables. While aquatic species were included on the watch lists, terrestrial plants were the focus of this survey. Aquatic plants were documented only occasionally.

Field Methods

We searched for problematic plant species on designated watch lists (Tables 1 and 2) across Lincoln Boyhood National Memorial. Contracted staff conducted the monitoring during August 8–11, 2008, and July 18–22, 2011. NPS staff used Trimble GPS units to conduct monitoring during July 21–23, 2015, and July 17–19, 2019. The reference frame included 77 search units, although one search unit was excluded in error in 2006 (Figure 1). Observers made three roughly equi-distant passes through each search unit, normally in the east-west direction. On each pass through the search units, observers estimated plant cover in a 3 to 12-m belt using the widest belt in which the observers were able to view plants and pooled those estimates for the entire unit. Cover was summarized for each plant species within each search unit using these cover values: 0 = 0, 1 = 0.1–0.9 m², 2 = 1–9.9 m², 3 = 10–49.9 m², 4 = 50–99.9 m², 5 = 100–499.9 m², 6 = 500–999.9 m², 7 = 1,000–4,999.9 m².

Table 1. Early detection problematic plant watch list used to guide surveys in Lincoln Boyhood National Memorial.

ScientificName	CommonName
<i>Acer platanoides</i>	Norway maple
<i>Alnus glutinosa</i>	European alder
<i>Arthraxon hispidus</i>	small carpgrass
<i>Bromus inermis</i>	smooth brome
<i>Bromus</i> sp.	annual brome sp. (NOT <i>B. inermis</i>)
<i>Bromus sterilis</i>	poverty brome
<i>Bromus tectorum</i>	cheatgrass
<i>Butomus umbellatus</i>	flowering rush
<i>Carduus nutans</i>	nodding plumeless thistle
<i>Centaurea solstitialis</i>	yellow star-thistle
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium</i> sp.	thistle sp.
<i>Cynanchum louiseae</i>	Louise's swallow-wort
<i>Cynanchum rossicum</i>	European swallow-wort
<i>Dipsacus fullonum</i>	Fuller's teasel
<i>Dipsacus laciniatus</i>	cutleaf teasel
<i>Egeria densa</i> *	Brazilian waterweed
<i>Elymus repens</i> *	quackgrass
<i>Euphorbia cyparissias</i> *	cypress spurge
<i>Euphorbia esula</i>	leafy spurge
<i>Frangula alnus</i>	glossy buckthorn
<i>Glechoma hederacea</i>	ground ivy
<i>Hesperis matronalis</i>	dames rocket
<i>Holcus lanatus</i>	common velvetgrass
<i>Humulus japonicus</i>	Japanese hop
<i>Iris pseudacorus</i> *	paleyellow iris
<i>Lespedeza bicolor</i>	shrub lespedeza
<i>Leonurus cardiaca</i> *	common motherwort
<i>Lepidium latifolium</i>	broadleaved pepperweed
<i>Ligustrum</i> spp.	privet sp.
<i>Linaria vulgaris</i> *	butter and eggs
<i>Lonicera xbella</i>	showy fly honeysuckle
<i>Lonicera</i> shrub (<i>maackii</i> / <i>tatarica</i>)	bush honeysuckle sp. (Amur-Morrow's-Tatarian complex)
<i>Lonicera tatarica</i>	Tatarian honeysuckle
<i>Lythrum salicaria</i>	purple loosestrife
<i>Miscanthus sinensis</i>	Chinese silvergrass

*Searched for 2011, 2015, and 2019 but not in 2006.

Table 1 (continued). Early detection problematic plant watch list used to guide surveys in Lincoln Boyhood National Memorial.

ScientificName	CommonName
<i>Myosotis scorpioides</i> *	true forget-me-not
<i>Myriophyllum spicatum</i> *	Eurasian watermilfoil
<i>Najas minor</i> *	brittle waternymph
<i>Nasturtium officinale</i> *	watercress
<i>Onopordum acanthium</i>	Scotch cottonthistle
<i>Ornithogalum umbellatum</i>	sleepydicke
<i>Pastinaca sativa</i>	wild parsnip
<i>Paulownia tomentosa</i>	princesstree
<i>Phragmites australis</i>	common reed
<i>Populus alba</i>	white poplar
<i>Potamogeton crispus</i> *	curly pondweed
<i>Prunus mahaleb</i>	Mahaleb cherry
<i>Pueraria montana</i>	kudzu
<i>Rhamnus cathartica</i>	common buckthorn
<i>Rumex acetosella</i> *	common sheep sorrel
<i>Rumex crispus</i> *	curly dock
<i>Saponaria officinalis</i> *	bouncingbet
<i>Schedonorus pratensis</i>	meadow fescue
<i>Sonchus arvensis</i>	field sowthistle
<i>Spiraea japonica</i>	Japanese meadowsweet, Japanese spirea
<i>Tanacetum vulgare</i> *	common tansy
<i>Torilis arvensis</i> *	spreading hedgeparsley
<i>Torilis japonica</i> *	erect hedgeparsley
<i>Typha angustifolia</i>	narrowleaf cattail
<i>Typha x glauca</i> *	hybrid cattail
<i>Typha</i> sp.	cattail sp.
<i>Ulmus pumila</i>	Siberian elm
<i>Viburnum opulus</i>	European cranberrybush

*Searched for 2011, 2015, and 2019 but not in 2006.

Table 2. Park-established problematic plant watch list used to guide surveys in Lincoln Boyhood National Memorial.

ScientificName	CommonName
<i>Ailanthus altissima</i>	tree of heaven
<i>Albizia julibrissin</i>	silk tree
<i>Alliaria petiolata</i>	garlic mustard
<i>Arctium minus</i> *	lesser burdock
<i>Berberis thunbergii</i>	Japanese barberry
<i>Bromus racemosus</i> *	bald brome, spiked brome

*Searched for in 2011, 2015, and 2019 but not in 2006.

Table 2 (continued). Park-established problematic plant watch list used to guide surveys in Lincoln Boyhood National Memorial.

ScientificName	CommonName
<i>Celastrus orbiculatus</i>	Oriental bittersweet
<i>Cirsium vulgare</i>	bull thistle
<i>Clematis terniflora</i>	sweet autumn virginsbower
<i>Daucus carota</i> *	Queen Anne's lace
<i>Dioscorea oppositifolia</i>	Chinese yam
<i>Elaeagnus umbellata</i>	autumn olive
<i>Euonymus alatus</i>	burningbush, winged euonymus
<i>Euonymus fortunei</i>	winter creeper
<i>Hemerocallis fulva</i> *	orange daylily
<i>Hedera helix</i>	English ivy
<i>Hypericum perforatum</i> *	common St. Johnswort
<i>Lespedeza cuneata</i>	sericea lespedeza
<i>Ligustrum obtusifolium</i>	border privet
<i>Ligustrum sinense</i>	Chinese privet
<i>Ligustrum vulgare</i>	European privet
<i>Lotus corniculatus</i>	bird's-foot trefoil
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Lysimachia nummularia</i>	creeping jenny
<i>Melilotus officinalis</i>	yellow sweetclover
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass
<i>Morus alba</i>	white mulberry
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Poa compressa/pratensis</i>	Canada/Kentucky bluegrass complex
<i>Poa compressa</i>	Canada bluegrass
<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Pyrus calleryana</i> *	Callery pear
<i>Rosa multiflora</i>	multiflora rose
<i>Robinia pseudoacacia</i>	black locust
<i>Schedonorus arundinaceus</i>	tall fescue
<i>Securigera varia</i>	crownvetch
<i>Sorghum halepense</i>	Johnsongrass
<i>Spiraea</i> sp.	spirea sp.
<i>Verbascum thapsus</i>	common mullein
<i>Vinca minor</i>	common periwinkle
<i>Wisteria sinensis</i>	Chinese wisteria

*Searched for in 2011, 2015, and 2019 but not in 2006.

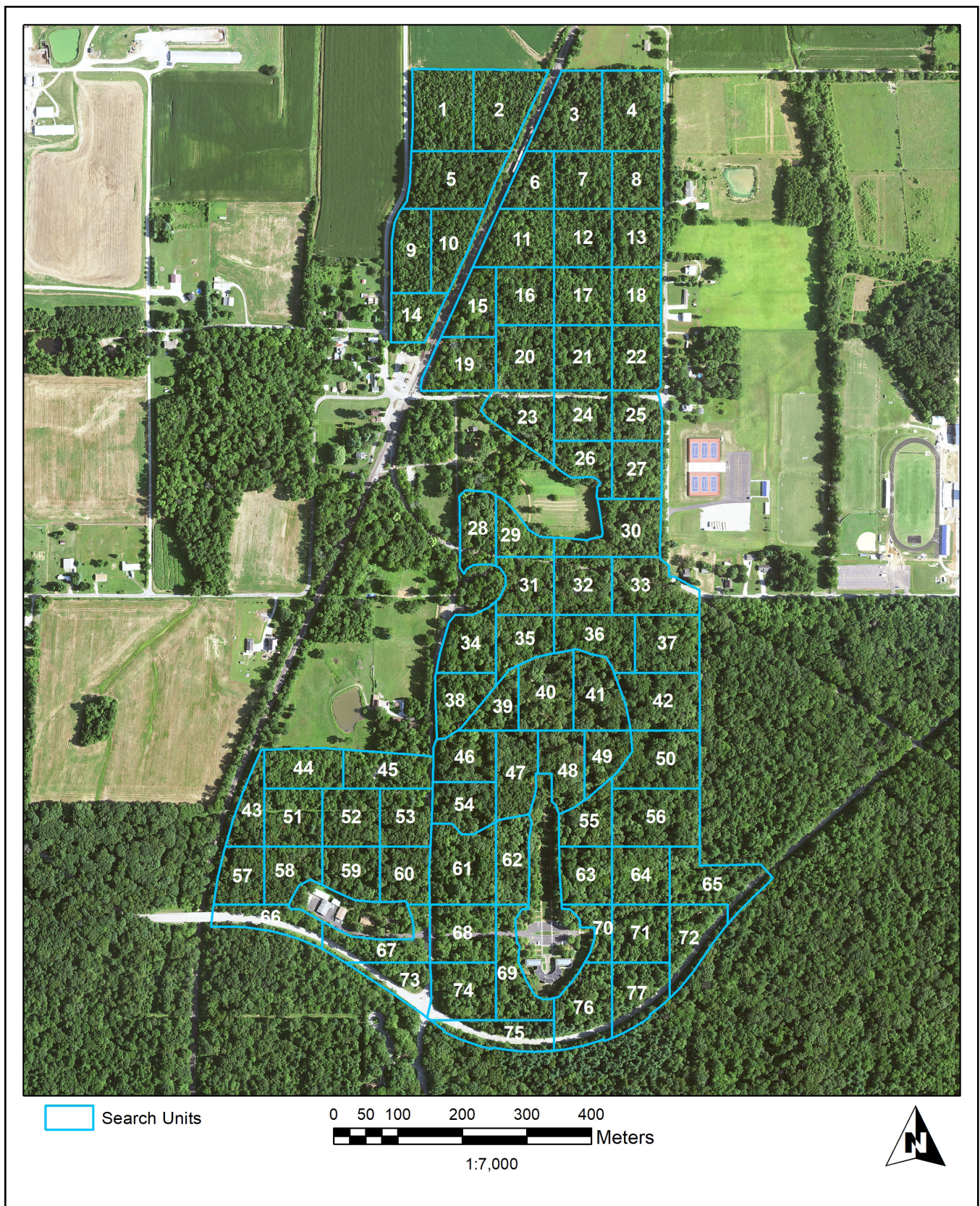


Figure 1. Location of search units used to monitor problematic plants in Lincoln Boyhood National Memorial. Search unit size averaged 2.0 acres.

Analytical Methods

A park-wide cover range was estimated for each problematic plant species encountered during each year. First, we calculated the minimum and maximum fraction of the park observed based on 2011, 2015, and 2019. To do this we used an average search unit size of 2.0 acres (8,015.6 m²). The fraction of the park observed assuming a 3-m belt was calculated as 10.0%. The fraction of the park observed assuming a 12-m belt was calculated as 40.0%.

To calculate the minimum of the estimated cover range for each species, the lower endpoints associated with the assigned cover class values for that species were summed and then divided by the reference frame fraction observed assuming the widest possible (12 m) survey belt (i.e., maximum fraction observed; Equation 1).

Equation 1:

$$\text{Minimum cover estimate} = \frac{\sum \text{low end of cover value range for species}}{\text{fraction of park observed assuming 12-m (max) belt width}}$$

Maximum cover for each species was calculated similarly, summing the upper endpoints of the cover values in each occupied search unit and assuming that a 3-m belt was surveyed (i.e., minimum fraction of area observed; Equation 2).

Equation 2:

$$\text{Maximum cover estimate} = \frac{\sum \text{high end of cover value range for species}}{\text{fraction of park observed assuming 3-m (min) belt width}}$$

Cover values were then converted from square meters to acres by multiplying each value by 0.000247105.

The park-wide frequency of problematic plants was calculated as the percentage of occupied search units (Equation 3). We treated all search units as equivalent for the purposes of frequency calculations.

Equation 3:

$$\text{Frequency of a problematic plant species} = \frac{\sum \text{search units occupied by species}}{\sum \text{search units surveyed}} \times 100$$

Taken together, the minimum and maximum cover estimates provided an estimated range of cover that accounts for the uncertainty arising from the sampling method. Non-overlapping ranges represent the strongest evidence for differences in cover.

I-Ranks

The I-rank or invasive ranks are calculated using a standard protocol to assess the impacts of these plants (Morse et al. 2004). The I-ranks consist of four sub-ranks: ecological impact, current cover/distribution, trend in distribution/cover, and management difficulty. Because of their more direct implications for park management, the ecological impact and management difficulty sub-ranks, when available, were presented in the Results section (NatureServe 2018).

Taxonomic Notes

Over the course of the study in Lincoln Boyhood National Memorial, three privet (*Ligustrum* spp.) species were identified. Chinese privet (*L. sinense*) was identified in 2006 and border privet (*L. obtusifolium*) was identified in 2006 and 2011. In both cases, field observers identified only a few occurrences, with European privet (*Ligustrum vulgare*) accounting for the majority of observations in these years and all of the observations in 2015 and 2019. Patterns for these species are best interpreted at the genus-level. The Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), and blue grass complex are also best interpreted at the genus-level.

Results and Discussion

Plant cover and frequency estimates for the problematic plants encountered at Lincoln Boyhood National Memorial are presented in Table 3 and the 2019 data are depicted graphically using frequency and the midpoint of the cover range (Figure 2). In Figure 2 we grouped plants in four categories: (1) very low frequency (<2%, n = 2), (2) low frequency (>2–10%, n = 14), (3) medium frequency (>10–40%, n = 9), and (4) high frequency (>40%, n = 7). While many factors impact our ability to control problematic plants, we use 10 acres as a guideline to identify lower and higher probability chances for successful control. Only a single medium frequency species, common periwinkle (*Vinca minor*), exceeded this threshold.

Across the monitoring record, Lincoln Boyhood National Memorial supported a high number (n = 45) of problematic plant taxa. These taxa range from

potential candidates for eradication such as crown-vetch (*Securigera varia*) and garlic mustard (*Alliaria petiolata*) to high frequency species such as European privet (*Ligustrum vulgare*) and Japanese stiltgrass (*Microstegium vimineum*). The increase in frequency of Japanese stiltgrass from 26.3% in 2006 to 88.2% in 2019 despite recent control efforts suggests the need to continue these efforts. The high number of these problematic plant species requires that managers strategically prioritize projects. These data continue to serve as early-detection monitoring and provide a generalized understanding of problematic plant cover and distribution to support problematic plant management decisions in Lincoln Boyhood National Memorial.

Table 3. Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of “decrease in 2019” or “increase in 2019” next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Ailanthus altissima</i>	tree of heaven	2006	0.0225	0.5309	17.1	ML	ML
<i>Ailanthus altissima</i>	tree of heaven	2011	0.0766	0.8466	10.5	ML	ML
<i>Ailanthus altissima</i>	tree of heaven	2015	0.0020	0.0786	6.6	ML	ML
<i>Ailanthus altissima</i>	tree of heaven	2019	0.0089	0.2324	11.8	ML	ML
<i>Albizia julibrissin</i>	silk tree	2006	0.0311	0.2583	6.6	ML	ML
<i>Albizia julibrissin</i> (decrease in 2019)	silk tree	2011	0.0698	1.4464	6.6	ML	ML
<i>Albizia julibrissin</i>	silk tree	2015	0.0001	0.0045	2.6	ML	ML
<i>Albizia julibrissin</i>	silk tree	2019	0.0014	0.0539	5.3	ML	ML
<i>Alliaria petiolata</i>	garlic mustard	2011	0.0074	0.1740	3.9	ML	M
<i>Alliaria petiolata</i>	garlic mustard	2015	0.0002	0.0090	5.3	ML	M
<i>Alliaria petiolata</i>	garlic mustard	2019	0.0009	0.0359	7.9	ML	M
<i>Arctium minus</i> *	lesser burdock	2011	0.0006	0.0247	1.3	LI	MI
<i>Berberis thunbergii</i>	Japanese barberry	2006	0.0004	0.0157	9.2	HM	I
<i>Berberis thunbergii</i> (decrease in 2019)	Japanese barberry	2011	0.0272	0.5970	10.5	HM	I
<i>Berberis thunbergii</i>	Japanese barberry	2015	0.0001	0.0045	2.6	HM	I
<i>Berberis thunbergii</i>	Japanese barberry	2019	0.0007	0.0270	15.8	HM	I
<i>Bromus racemosus</i> *	bald brome, spiked brome	2011	0.0025	0.0988	5.3	n/a	n/a
<i>Bromus racemosus</i> *	bald brome, spiked brome	2015	0.0006	0.0247	1.3	n/a	n/a
<i>Bromus racemosus</i> *	bald brome, spiked brome	2019	0.0009	0.0337	6.6	n/a	n/a
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2006	0.0106	0.4223	36.8	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2011	0.0099	0.2728	9.2	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2015	0.0083	0.3280	34.2	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2019	0.2288	3.8626	85.5	ML	M

*Searched for in 2011, 2015, and 2019 but not 2006.

Table 3 (continued). Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of “decrease in 2019” or “increase in 2019” next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Cirsium vulgare</i>	bull thistle	2006	0.0004	0.0157	9.2	ML	ML
<i>Cirsium vulgare</i>	bull thistle	2011	0.0019	0.0741	3.9	ML	ML
<i>Cirsium vulgare</i>	bull thistle	2019	0.0001	0.0022	1.3	ML	ML
<i>Clematis terniflora</i>	sweet autumn virginsbower	2006	0.0006	0.0247	1.3	n/a	n/a
<i>Daucus carota</i> *	Queen Anne's lace	2006	0.0006	0.0247	1.3	I	I
<i>Daucus carota</i> *	Queen Anne's lace	2011	0.0012	0.0494	2.6	I	I
<i>Daucus carota</i> *	Queen Anne's lace	2015	0.0016	0.0629	10.5	I	I
<i>Daucus carota</i> *	Queen Anne's lace	2019	0.0007	0.0292	3.9	I	I
<i>Dioscorea oppositifolia</i>	Chinese yam	2006	0.0329	0.3302	9.2	ML	MI
<i>Dioscorea oppositifolia</i>	Chinese yam	2011	0.1995	4.0665	10.5	ML	MI
<i>Dioscorea oppositifolia</i>	Chinese yam	2015	0.0458	0.6018	11.8	ML	MI
<i>Dioscorea oppositifolia</i>	Chinese yam	2019	0.0760	1.5710	7.9	ML	MI
<i>Elaeagnus umbellata</i>	autumn olive	2006	0.0303	0.7184	28.9	H	L
<i>Elaeagnus umbellata</i> (decrease in 2019)	autumn olive	2011	0.1878	3.4642	27.6	H	L
<i>Elaeagnus umbellata</i>	autumn olive	2015	0.0090	0.2346	13.2	H	L
<i>Elaeagnus umbellata</i>	autumn olive	2019	0.0036	0.1438	18.4	H	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2006	0.0347	0.3999	10.5	LI	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2011	0.0297	0.6959	15.8	LI	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2015	0.0007	0.0270	15.8	LI	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2019	0.0147	0.4593	52.6	LI	L
<i>Euonymus fortunei</i>	winter creeper	2006	0.0574	0.9397	32.9	M	LI
<i>Euonymus fortunei</i>	winter creeper	2011	0.9181	17.9912	39.5	M	LI
<i>Euonymus fortunei</i>	winter creeper	2015	0.2061	3.5758	44.7	M	LI
<i>Euonymus fortunei</i>	winter creeper	2019	0.6456	9.2235	75.0	M	LI

*Searched for in 2011, 2015, and 2019 but not in 2006.

Table 3 (continued). Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of “decrease in 2019” or “increase in 2019” next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Hedera helix</i>	English ivy	2006	0.0142	0.3232	6.6	M	ML
<i>Hedera helix</i>	English ivy	2011	0.1606	2.8694	5.3	M	ML
<i>Hedera helix</i>	English ivy	2015	0.0025	0.0988	5.3	M	ML
<i>Hedera helix</i>	English ivy	2019	0.0328	0.3257	6.6	M	ML
<i>Hemerocallis fulva</i> *	orange daylily	2011	0.0142	0.3232	6.6	MI	L
<i>Hemerocallis fulva</i> *	orange daylily	2015	0.0077	0.1830	9.2	MI	L
<i>Hemerocallis fulva</i> *	orange daylily	2019	0.0075	0.1785	6.6	MI	L
<i>Hypericum perforatum</i> *	common St. Johnswort	2019	0.0177	0.4603	34.2	ML	M
<i>Lespedeza cuneata</i> (decrease in 2019)	sericea lespedeza	2006	0.0146	0.3367	14.5	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2011	0.0019	0.0741	3.9	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2019	0.0001	0.0045	2.6	ML	ML
<i>Ligustrum obtusifolium</i>	border privet	2006	0.0006	0.0247	1.3	LI	L
<i>Ligustrum obtusifolium</i>	border privet	2011	0.0019	0.0741	3.9	LI	L
<i>Ligustrum sinense</i>	Chinese privet	2006	0.0001	0.0045	2.6	M	L
<i>Ligustrum vulgare</i>	European privet	2006	0.3476	5.4181	69.7	HL	HM
<i>Ligustrum vulgare</i>	European privet	2011	0.9878	16.6833	78.9	HL	HM
<i>Ligustrum vulgare</i>	European privet	2015	0.1211	2.2594	76.3	HL	HM
<i>Ligustrum vulgare</i>	European privet	2019	0.1079	2.5951	82.9	HL	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2006	1.6014	19.7552	96.1	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2011	8.4516	147.5199	100.0	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2015	3.1704	52.4472	100.0	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2019	0.8471	12.7434	98.7	M	HM
<i>Lonicera maackii</i>	Amur honeysuckle	2006	0.0013	0.0517	3.9	HM	M
<i>Lonicera maackii</i>	Amur honeysuckle	2011	0.0377	0.7720	9.2	HM	M
<i>Lonicera maackii</i>	Amur honeysuckle	2019	0.0028	0.1101	11.8	HM	M

*Searched for in 2011, 2015, and 2019 but not 2006.

Table 3 (continued). Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of “decrease in 2019” or “increase in 2019” next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Lonicera morrowii</i>	Morrow's honeysuckle	2006	0.0007	0.0292	3.9	ML	M
<i>Lonicera morrowii</i>	Morrow's honeysuckle	2015	0.0001	0.0022	1.3	ML	M
<i>Lotus corniculatus</i>	bird's-foot trefoil	2006	0.0006	0.0247	1.3	ML	ML
<i>Lysimachia nummularia</i>	creeping jenny	2006	0.0038	0.1505	9.2	L	L
<i>Lysimachia nummularia</i>	creeping jenny	2011	0.0253	0.5229	6.6	L	L
<i>Lysimachia nummularia</i>	creeping jenny	2015	0.0093	0.2503	9.2	L	L
<i>Lysimachia nummularia</i>	creeping jenny	2019	0.0045	0.1797	13.2	L	L
<i>Melilotus officinalis</i>	yellow sweetclover	2015	0.0002	0.0090	5.3	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2019	0.0001	0.0022	1.3	M	M
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2006	0.0599	0.9160	26.3	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2011	0.2904	5.2386	28.9	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2015	0.0232	0.6782	43.4	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2019	0.6102	9.1611	88.2	M	HM
<i>Morus alba</i> (decrease in 2019)	white mulberry	2011	0.0371	0.3739	2.6	ML	ML
<i>Morus alba</i>	white mulberry	2015	0.0002	0.0090	5.3	ML	ML
<i>Morus alba</i>	white mulberry	2019	0.0001	0.0045	2.6	ML	ML
<i>Phalaris arundinacea</i>	reed canarygrass	2011	0.0618	1.2478	1.3	H	HM
<i>Poa compressa</i>	Canada bluegrass	2006	0.0001	0.0045	2.6	ML	HL
<i>Poa compressa/pratensis</i>	Canada/Kentucky bluegrass complex	2011	0.0074	0.1740	3.9	M	M
<i>Poa pratensis</i>	Kentucky bluegrass	2019	0.0001	0.0045	2.6	M	ML
<i>Polygonum cuspidatum</i>	Japanese knotweed	2006	0.0075	0.1785	6.6	HM	M
<i>Polygonum cuspidatum</i> (decrease in 2019)	Japanese knotweed	2011	0.6610	12.9783	5.3	HM	M
<i>Polygonum cuspidatum</i>	Japanese knotweed	2015	0.0019	0.0741	3.9	HM	M
<i>Polygonum cuspidatum</i>	Japanese knotweed	2019	0.0007	0.0270	2.6	HM	M
<i>Potentilla recta</i>	sulphur cinquefoil	2015	0.0001	0.0022	1.3	HL	ML

*Searched for in 2011, 2015, and 2019 but not 2006.

Table 3 (continued). Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of “decrease in 2019” or “increase in 2019” next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Pyrus calleryana</i> *	Callery pear	2011	0.0062	0.1246	1.3	LI	ML
<i>Pyrus calleryana</i> *	Callery pear	2019	0.0009	0.0337	19.7	LI	ML
<i>Robinia pseudoacacia</i> (decrease in 2019)	black locust	2006	0.1531	1.6888	31.6	HM	M
<i>Robinia pseudoacacia</i> (decrease in 2019)	black locust	2011	0.1594	3.3137	31.6	HM	M
<i>Robinia pseudoacacia</i>	black locust	2015	0.0395	0.8417	23.7	HM	M
<i>Robinia pseudoacacia</i>	black locust	2019	0.0025	0.0988	18.4	HM	M
<i>Rosa multiflora</i>	multiflora rose	2006	0.2855	5.0330	73.7	L	L
<i>Rosa multiflora</i>	multiflora rose	2011	2.0584	33.3572	89.5	L	L
<i>Rosa multiflora</i>	multiflora rose	2015	0.2466	4.5827	78.9	L	L
<i>Rosa multiflora</i>	multiflora rose	2019	0.9267	14.8360	93.4	L	L
<i>Schedonorus arundinaceus</i> (decrease in 2019)	tall fescue	2011	0.8420	16.2955	18.4	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2015	0.0377	0.3986	3.9	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2019	0.0125	0.2536	5.3	M	HM
<i>Securigera varia</i>	crownvetch	2006	0.0012	0.0494	2.6	H	L
<i>Securigera varia</i>	crownvetch	2019	0.0001	0.0022	1.3	H	L
<i>Sorghum halepense</i> (decrease in 2019)	Johnsongrass	2006	0.0309	0.2494	1.3	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2019	0.0003	0.0112	6.6	ML	HM
<i>Spiraea</i>	spirea sp.	2006	0.0933	0.7728	5.3	ML	HM
<i>Spiraea</i>	spirea sp.	2011	0.0371	0.3739	2.6	ML	HM
<i>Spiraea</i>	spirea sp.	2015	0.0130	0.2738	3.9	ML	HM
<i>Spiraea</i>	spirea sp.	2019	0.0068	0.1493	2.6	ML	HM
<i>Verbascum thapsus</i>	common mullein	2006	0.0001	0.0022	1.3	ML	L

*Searched for in 2011, 2015, and 2019 but not 2006.

Table 3 (continued). Cover and frequency of potentially problematic plants found in Lincoln Boyhood National Memorial. Ecological impact (EI) and general management difficulty (Mgmt) are based on NatureServe I-Rank sub-ranks (Morse et al. 2004; NatureServe 2018). Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), a range of the above ranks, or not available (n/a). The assignment of "decrease in 2019" or "increase in 2019" next to a species indicates that the cover in 2019 for that species had decreased or increased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	I-Rank_Mgmt
<i>Vinca minor</i>	common periwinkle	2006	0.6493	10.8779	25.0	I	U
<i>Vinca minor</i>	common periwinkle	2011	4.3626	72.8031	28.9	I	U
<i>Vinca minor</i>	common periwinkle	2015	0.8582	12.2030	39.5	I	U
<i>Vinca minor</i>	common periwinkle	2019	1.9485	22.9341	35.5	I	U
<i>Wisteria sinensis</i>	Chinese wisteria	2006	0.0069	0.1515	3.9	ML	L
<i>Wisteria sinensis</i>	Chinese wisteria	2011	0.0692	1.4217	5.3	ML	L
<i>Wisteria sinensis</i>	Chinese wisteria	2015	0.0630	1.2972	3.9	ML	L
<i>Wisteria sinensis</i>	Chinese wisteria	2019	0.0062	0.1246	1.3	ML	L

*Searched for in 2011, 2015, and 2019 but not 2006.

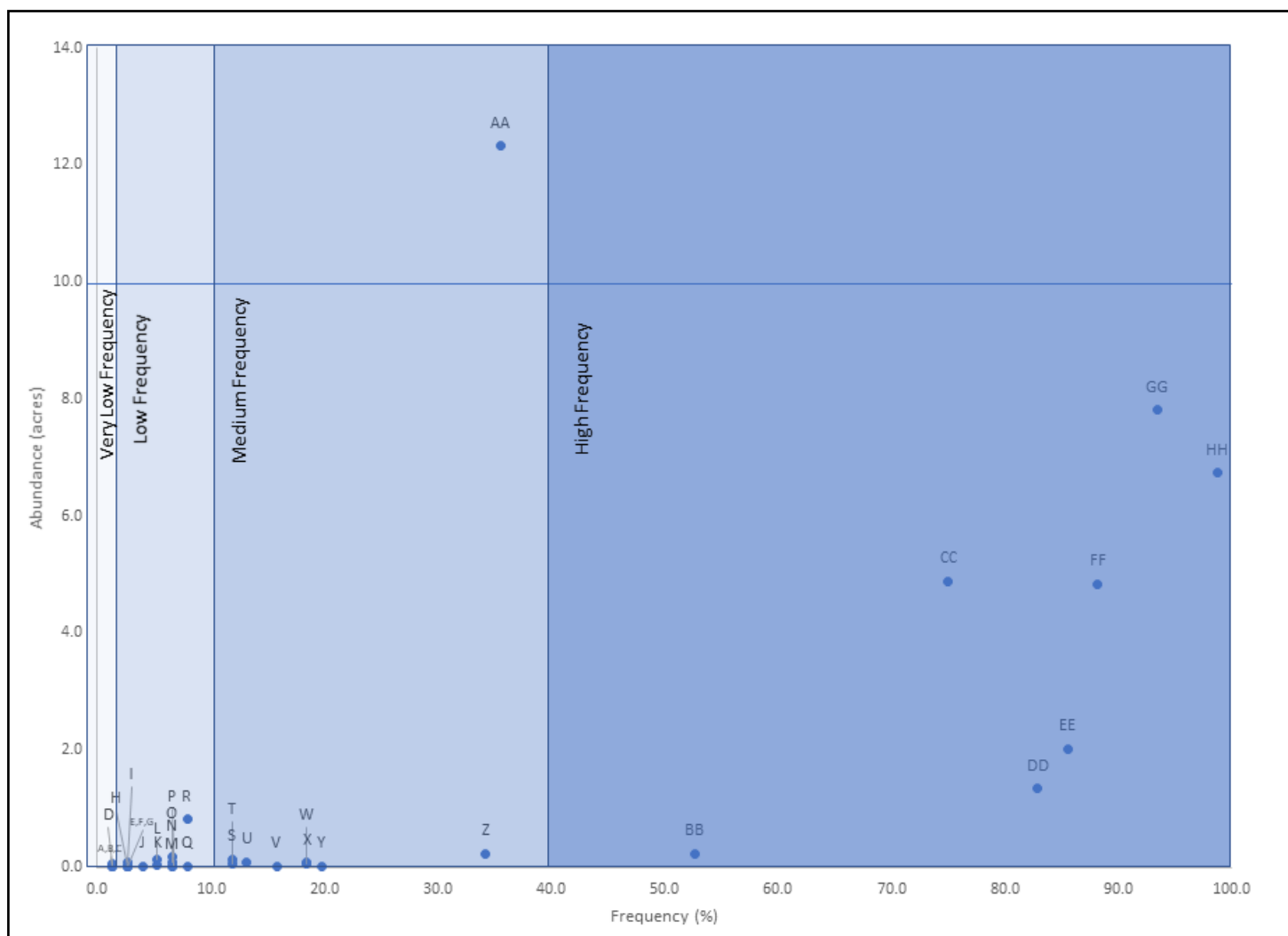


Figure 2. Problematic plant cover and frequency relationship in 2019 at Lincoln Boyhood National Memorial. The cover measure used is based on the midpoint of the cover range. Plants are categorized into four categories: very low frequency (<2%), low frequency (>2–10%), medium frequency (>10–40%) and high frequency (>40%). The horizontal line marks the 10-acre threshold at which successful control of a plant becomes less likely. Species in ascending order of frequency include A) *Cirsium vulgare*, B) *Securigera varia*, C) *Melilotus officinalis*, D) *Wisteria sinensis*, E) *Poa pratensis*, F) *Lespedeza cuneata*, G) *Morus alba*, H) *Polygonum cuspidatum*, I) *Spiraea* sp., J) *Daucus carota*, K) *Albizia julibrissin*, L) *Schedonorus arundinaceus*, M) *Sorghum halepense*, N) *Bromus racemosus*, O) *Hemerocallis fulva*, P) *Hedera helix*, Q) *Alliaria petiolata*, R) *Dioscorea oppositifolia*, S) *Lonicera maackii*, T) *Ailanthus altissima*, U) *Lysimachia nummularia*, V) *Berberis thunbergii*, W) *Robinia pseudoacacia*, X) *Elaeagnus umbellata*, Y) *Pyrus calleryana*, Z) *Hypericum perforatum*, AA) *Vinca minor*, BB) *Euonymus alatus*, CC) *Euonymus fortune*, DD) *Ligustrum vulgare*, EE) *Celastrus orbiculatus*, FF) *Microstegium vimineum*, GG) *Rosa multiflora*, and HH) *Lonicera japonica*.

Literature Cited

Morse, L. E., J. M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive species assessment protocol: Evaluating non-native plants for their impact on biodiversity. Version 1. NatureServe, Arlington, Virginia.

National Park Service (NPS). 2006. Management policies 2006. Available at https://www.nps.gov/policy/MP_2006.pdf (accessed 5/9/2019).

NatureServe. 2018. NatureServe Explorer. Available at <http://explorer.natureserve.org/> (accessed 28 March 2018).

Young, C. C., J. L. Haack, L. W. Morrison, and M. D. DeBacker. 2007. Invasive exotic plant monitoring protocol for the Heartland Network Inventory and Monitoring Program. Natural Resource Report NPS/HTLN/NRR-2007/018. National Park Service, Fort Collins, Colorado.

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.

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525