



Problematic Plant Monitoring in Pea Ridge National Military Park

2006–2021

Natural Resource Report NPS/HTLN/NRR—2022/2397



ON THE COVER

Eastern redcedar (*Juniperus virginiana*) clearing in Pea Ridge National Military Park, Arkansas.

Photography by NPS

Problematic Plant Monitoring in Pea Ridge National Military Park

2006–2021

Natural Resource Report NPS/HTLN/NRR—2022/2397

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 2022

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 and technically accurate.

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. 2022. Problematic plant monitoring in Pea Ridge National Military Park: 2006–2021. Natural Resource Report NPS/HTLN/NRR—2022/2397. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2293656>.

Contents

	Page
Figures	iv
Tables	iv
Abstract	v
Introduction	1
Methods	2
Watch Lists	2
Field Methods	4
Analytical Methods	4
I-Ranks	5
Results and Discussion	6
Literature Cited	13

Figures

	Page
Figure 1. Transects used to monitor problematic plants in Pea Ridge National Military Park	5
Figure 2. Problematic plant frequency and abundance relationship in 2021 at Pea Ridge National Military Park	7

Tables

	Page
Table 1. Early detection problematic plant watch list used to guide surveys in Pea Ridge National Military Park.	2
Table 2. Park-established problematic plant watch list used to guide surveys in George Washington Carver National Monument.	3
Table 3. Cover and frequency of problematic plants found in Pea Ridge National Military Park	8

Abstract

Managers are challenged with the impact of problematic plants, including exotic, invasive, and pest plant species. Information on the cover and frequency of these plant species is essential for developing risk-based approaches to managing them. Based on surveys conducted in 2006, 2013, 2018, and 2021, Heartland Inventory and Monitoring Network staff and contractors identified a cumulative total of 38 potentially problematic plant species in Pea Ridge National Military Park. Of the 35 species found in 2021, we characterized 13 as very low frequency, 9 as low frequency, 9 as medium frequency, and 4 as high frequency. Of these 35 species, midpoint cover estimates of 4 medium frequency and all 4 high frequency species exceeded the 10-acre threshold. The 10-acre threshold represents a limit beyond which eradication of a problematic plant species is likely not possible. Clearing of eastern redcedar (*Juniperus virginiana*) continues to be evident in our observations, and sericea lespedeza (*Lespedeza cuneata*) appears to have increased as clearing progressed. The rapid increase in Japanese stiltgrass (*Microstegium vimineum*) appears to be parkwide. Because of the number, extent, and cover of problematic plants in the park, control efforts should focus on early detection treatments and strategic treatment of high priority, widespread species to protect features of the park's natural and cultural landscapes. High priority species may include plant species capable of rapid spread, species at low population levels, and species that can be effectively 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 as introduced by 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 the 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 Pea Ridge National Military Park (NMP) in 2006, 2013, 2018, and 2021. The key metrics presented include plant cover and geographic distribution within the park.



Early season Japanese stiltgrass (*Microstegium vimineum*) germination in woodland at Pea Ridge National Military Park, Arkansas.

Methods

All methods presented here are based on the Heartland Inventory and Monitoring Network invasive exotic plant monitoring protocol (Kull et al. 2022).

Watch Lists

We searched for potentially problematic plants on two lists. Prioritized problematic plants not previously found during monitoring in the park constituted the early detection watch list (n = 86; Table 1). Prioritized problematic plants known to occur in the park based on previous monitoring constituted the park-established watch list (n = 38; Table 2). In this report we included only plant species that we searched for in 2021. Of these, any species not sought during all previous survey periods were annotated in the table. While aquatic species were included on the watch lists, terrestrial plants were the focus of this survey. Aquatic plants were documented only occasionally.

Table 1. Early detection problematic plant watch list used to guide surveys in Pea Ridge National Military Park.

Scientific Name	Common Name
<i>Alliaria petiolata</i>	garlic mustard
<i>Alternanthera philoxeroides</i>	alligatorweed
<i>Alternanthera sessilis</i>	sessile joyweed
<i>Ampelopsis brevipedunculata</i>	Amur peppervine
<i>Arthraxon hispidus</i> ^b	small carpgrass
<i>Arundo donax</i>	giant reed
<i>Baccharis halimifolia</i>	eastern baccharis
<i>Bothriochloa bladhii</i>	Caucasian bluestem, Australian bluestem
<i>Bromus</i> sp. ^b	annual brome sp. (NOT <i>B. inermis</i>)
<i>Bromus tectorum</i>	cheatgrass
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium</i> sp. ^a	thistle sp.
<i>Clematis terniflora</i> ^b	sweet autumn virginsbower
<i>Conium maculatum</i> ^b	poison hemlock
<i>Datura stramonium</i> ^b	jimsonweed
<i>Dioscorea oppositifolia</i>	Chinese yam
<i>Dipsacus fullonum</i>	Fuller's teasel

^a searched for in 2013, 2018, and 2021 only

^b searched for in 2021 only

Table 1 (continued). Early detection problematic plant watch list used to guide surveys in Pea Ridge National Military Park.

Scientific Name	Common Name
<i>Echinochloa crus-galli</i>	barnyardgrass
<i>Egeria densa</i> ^a	Brazilian waterweed
<i>Eichhornia crassipes</i> ^a	common water hyacinth
<i>Elaeagnus angustifolia</i> ^a	Russian olive
<i>Elaeagnus pungens</i>	thorny olive
<i>Elaeagnus umbellata</i>	autumn olive
<i>Elaeagnus umbellata/angustifolia</i> ^b	Russian/autumn olive complex
<i>Elymus repens</i> ^a	quackgrass
<i>Eragrostis curvula</i>	weeping lovegrass
<i>Euphorbia cyparissias</i> ^a	cypress spurge
<i>Hedera helix</i>	English ivy
<i>Hemerocallis fulva</i> ^a	orange daylily
<i>Hesperis matronalis</i>	dames rocket
<i>Holcus lanatus</i>	common velvetgrass
<i>Humulus japonicus</i> ^a	Japanese hop
<i>Hydrilla verticillata</i> ^a	waterthyme
<i>Imperata cylindrica</i>	cogongrass
<i>Leonurus cardiaca</i> ^a	common motherwort
<i>Lespedeza bicolor</i>	shrub lespedeza
<i>Ligustrum lucidum</i>	glossy privet
<i>Ligustrum sinense</i>	Chinese privet
<i>Ligustrum vulgare</i>	European privet
<i>Linaria vulgaris</i> ^a	butter and eggs
<i>Lotus corniculatus</i>	bird's-foot trefoil
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Lonicera shrub (maackii/morrowii/tatarica)</i> ^a	bush honeysuckle sp. (Amur-Morrow's-Tatarian complex)
<i>Lygodium japonicum</i>	Japanese climbing fern
<i>Lysimachia nummularia</i>	creeping jenny
<i>Lythrum salicaria</i>	purple loosestrife
<i>Melia azedarach</i>	Chinaberrytree
<i>Murdannia keisak</i>	wartremoving herb
<i>Myosotis scorpioides</i> ^a	true forget-me-not
<i>Myriophyllum aquaticum</i> ^a	parrot feather watermilfoil
<i>Myriophyllum spicatum</i> ^a	Eurasian watermilfoil

^a searched for in 2013, 2018, and 2021 only

^b searched for in 2021 only

Table 1 (continued). Early detection problematic plant watch list used to guide surveys in George Washington Carver National Monument.

Scientific Name	Common Name
<i>Najas minor</i> ^a	brittle waternymph
<i>Nandina domestica</i>	sacred bamboo
<i>Nasturtium officinale</i> ^a	watercress
<i>Pastinaca sativa</i>	wild parsnip
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Photinia serratifolia</i>	Taiwanese photinia
<i>Phragmites australis</i>	common reed
<i>Phyllostachys</i> ^a	bamboo
<i>Poa compressa/pratensis</i> ^b	Canada/Kentucky bluegrass complex
<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Poncirus trifoliata</i>	hardy orange, trifoliolate orange
<i>Populus alba</i>	white poplar
<i>Potamogeton crispus</i> ^a	curly pondweed
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Prunus mahaleb</i> ^a	Mahaleb cherry
<i>Pueraria montana</i>	kudzu
<i>Rhamnus cathartica</i>	common buckthorn
<i>Rumex acetosella</i> ^a	common sheep sorrel
<i>Salvinia molesta</i>	kariba-weed
<i>Saponaria officinalis</i> ^a	bouncingbet
<i>Schedonorus pratensis</i>	meadow fescue
<i>Solanum viarum</i>	tropical soda apple
<i>Sphenoclea zeylanica</i>	chickenspike
<i>Spiraea sp.</i> ^b	spirea sp.
<i>Tamarix ramosissima</i>	saltcedar
<i>Tanacetum vulgare</i> ^a	common tansy
<i>Triadica sebifera</i>	Chinese tallow
<i>Typha angustifolia</i>	narrowleaf cattail
<i>Typha x glauca</i> ^a	hybrid cattail
<i>Typha sp.</i> ^a	cattail sp.
<i>Ulmus pumila</i>	Siberian elm
<i>Vinca minor</i>	common periwinkle
<i>Wisteria floribunda</i>	Japanese wisteria
<i>Wisteria sinensis</i>	Chinese wisteria

^a searched for in 2013, 2018, and 2021 only

^b searched for in 2021 only

Table 2. Park-established problematic plant watch list used to guide surveys in George Washington Carver National Monument.

Scientific Name	Common Name
<i>Ailanthus altissima</i>	tree-of-heaven
<i>Albizia julibrissin</i>	silk tree
<i>Arctium minus</i> ^a	lesser burdock
<i>Bromus inermis</i>	smooth brome
<i>Bromus racemosus</i>	bald brome, spiked brome
<i>Bromus sterilis</i>	poverty brome
<i>Carduus nutans</i>	nodding plumeless thistle
<i>Celastrus orbiculatus</i>	Oriental bittersweet
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed
<i>Cirsium vulgare</i>	bull thistle
<i>Cynodon dactylon</i>	Bermudagrass
<i>Daucus carota</i> ^a	Queen Anne's lace
<i>Euonymus fortunei</i>	winter creeper
<i>Glechoma hederacea</i>	ground ivy
<i>Hypericum perforatum</i> ^a	common St. Johnswort
<i>Iris pseudacorus</i> ^a	pale yellow iris
<i>Juniperus virginiana</i>	eastern redcedar
<i>Lespedeza cuneata</i>	sericea lespedeza
<i>Ligustrum sp.</i>	privet sp.
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Melilotus officinalis</i>	yellow sweetclover
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass
<i>Morus alba</i>	white mulberry
<i>Paulownia tomentosa</i>	princess tree
<i>Poa compressa</i>	Canada bluegrass
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Pyrus calleryana</i>	Callery pear
<i>Rhus copallinum</i> ^a	winged sumac
<i>Rhus glabra</i> ^a	smooth sumac
<i>Robinia pseudoacacia</i>	black locust
<i>Rosa multiflora</i>	multiflora rose
<i>Rumex crispus</i> ^a	curly dock
<i>Schedonorus arundinaceus</i>	tall fescue
<i>Securigera varia</i>	crown vetch
<i>Sorghum halepense</i>	Johnsongrass
<i>Torilis arvensis</i> ^a	spreading hedgeparsley
<i>Verbascum thapsus</i>	common mullein
<i>Vinca major</i>	bigleaf periwinkle

^a Searched for in 2013, 2018, and 2021 only

Field Methods

We searched for problematic plant species on designated watch lists (Table 1 and 2) across Pea Ridge NMP (Figure 1). Contracted staff conducted the monitoring September 13–16, 2006, and August 19–24, 2013. NPS staff used Trimble GPS units to conduct monitoring August 6–8, 2018, and August 16–18, 2021. Observers estimated plant cover in a 3- to 12-m belt along line search units (i.e., transects), using the widest belt in which the observers were able to view plants. However, in 2006 only, the observer had the discretion to leave the search belt to find additional observations and target locations likely to support exotic plants (e.g., field edges, roads, etc.), which may have inflated detection rates and abundance estimates.

Cover was summarized for each plant taxon within each search unit using these cover classes: 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. In 2006, 97 permanent line search units were included, but this number increased to 101 units in subsequent surveys. While the intended length of each transect was 400 m, some transects (n = 46) were clipped at the park boundary. Average transect length in this study was 315.0 m. The same search units were surveyed during each survey year (Figure 1).

Analytical Methods

A park-wide cover range and frequency was estimated for each problematic plant species encountered during each year (Table 3). First, we calculated the minimum and maximum fraction of the park observed. The configuration of line search units shifted slightly after 2006, causing an increase in area covered from 31,657.4 to 31,812.3 m². The fraction of the park observed assuming a 3-m belt was calculated as 0.75% (2006–2021). The fraction of the park observed assuming a 12-m belt was calculated as 3.00% in 2006 and 3.02% in 2013, 2018, and 2021.

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:

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

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. In this study, we evaluated if the cover data differed between years based on non-overlapping cover ranges.

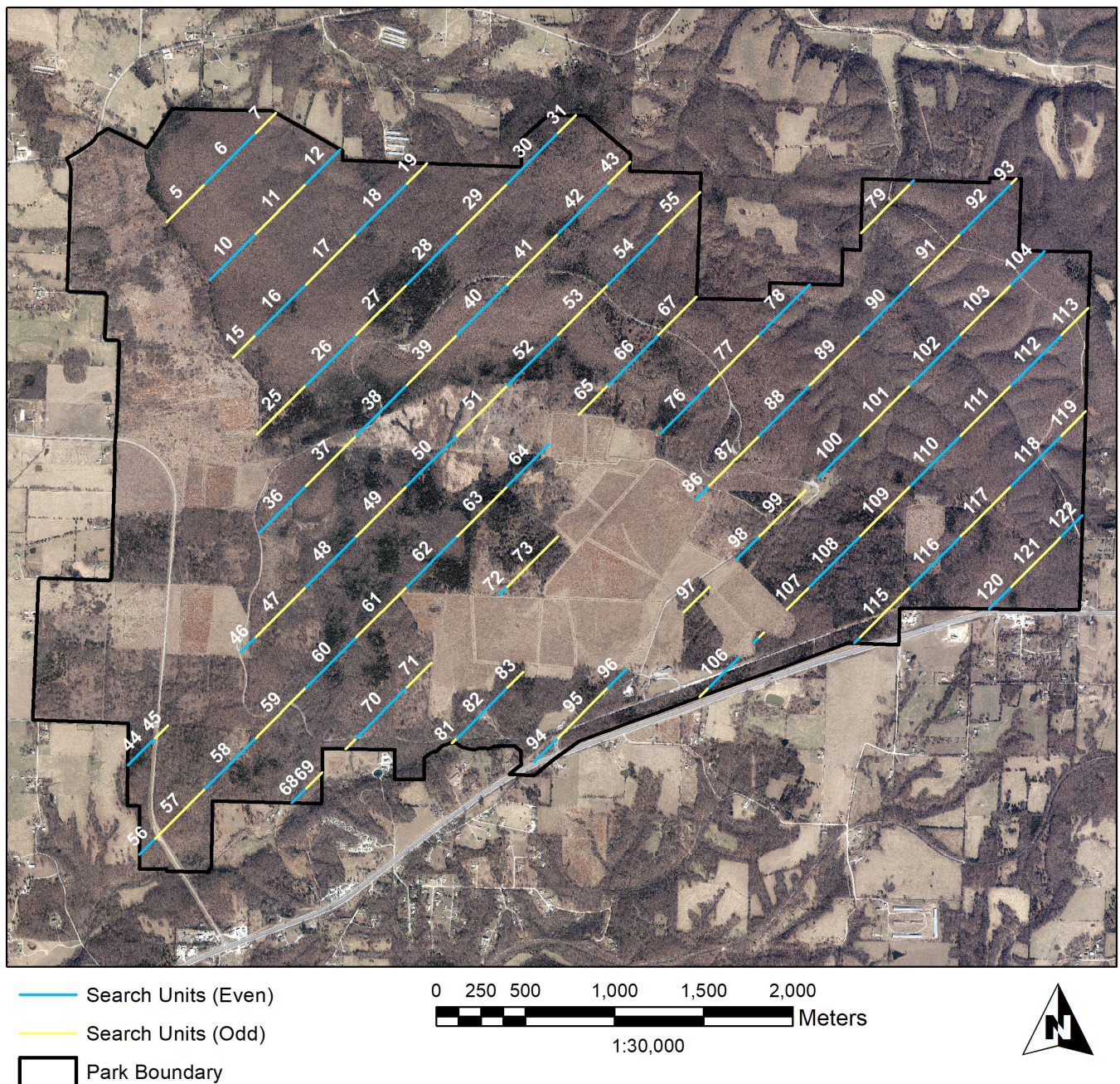


Figure 1. Transects used to monitor problematic plants in Pea Ridge National Military Park. Unclipped transects measured 400 m in length.

I-Ranks

We report the I-ranks or invasive ranks from *NatureServe Explorer* (NatureServe 2018) that are calculated using a standard protocol to assess the impacts of these plants (see Morse et al. 2004 for calculation details). The I-ranks consist of four sub-ranks: ecological impact, current distribution/

cover, 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 Table 3 of the Results section (NatureServe 2018). Some plants could not be assigned an I-rank due to missing source data.

Results and Discussion

Plant cover and frequency estimates for the problematic plants encountered at Pea Ridge NMP are presented in Table 3 and the 2021 data are depicted graphically using frequency and the mid-point of the cover range (Figure 2). In the figure, we grouped plants in four categories: (1) very low frequency ($\leq 2\%$, $n = 13$), (2) low frequency ($> 2\text{--}10\%$, $n = 9$), (3) medium frequency ($> 10\text{--}40\%$, $n = 9$), and (4) high frequency ($> 40\%$, $n = 4$).

While many factors impact our ability to control problematic plants, we use 10 acres as a guideline to identify lower and higher probabilities for successful control. The cover midpoints of four of the medium frequency (winged sumac [*Rhus copallinum*], black locust [*Robinia pseudoacacia*], Japanese honeysuckle [*Lonicera japonica*] and tall fescue [*Schedonorus umbellata*]) and all four of the high frequency species (sericea lespedeza [*Lespedeza cuneata*], multiflora rose [*Rosa multiflora*], Japanese stiltgrass [*Microstegium vimineum*], and eastern redcedar [*Juniperus virginiana*]) exceeded this threshold.

Based on non-overlapping cover ranges, we observed several changes in species cover in 2021 compared to at least one previous year. This included increased cover of bigleaf periwinkle (*Vinca major*), crown vetch (*Securigera varia*), and Kentucky bluegrass (*Poa pratensis*). Japanese stiltgrass also increased in 2021 compared to levels observed in 2006 and 2013.

Pea Ridge NMP supports a relatively large number of potentially problematic plants. This includes several plant species that may be candidates for eradication from the park because they have relatively low abundances: tree-of-heaven (*Ailanthus altissima*), silktree (*Albizia julibrissin*), princess tree (*Paulownia tomentosa*), Callery pear (*Pyrus calleryana*), crown vetch, white mulberry (*Morus alba*) and spotted knapweed (*Centaurea stoebe* var *micranthos*). The efforts to reduce eastern redcedar to promote open oak-hickory woodlands appears to have led to the expected decrease in this species' abundance, although increases in sericea lespedeza (*Lespedeza cuneata*) may be an unexpected result of such canopy thinning. Substantial increases in Japanese stiltgrass appear to have occurred across many areas in the park; frequency increased from 14.4% to 72.8% between 2006 and 2021, and cover increased from a minimum of <1 acre to at least 104.8 acres over the 15-year period. The relationships between these increases and land management practices should be further investigated with more rigorous and specific analyses. The number, abundance, and extent of these problematic plants observed in the most recent survey require that managers strategically prioritize projects.

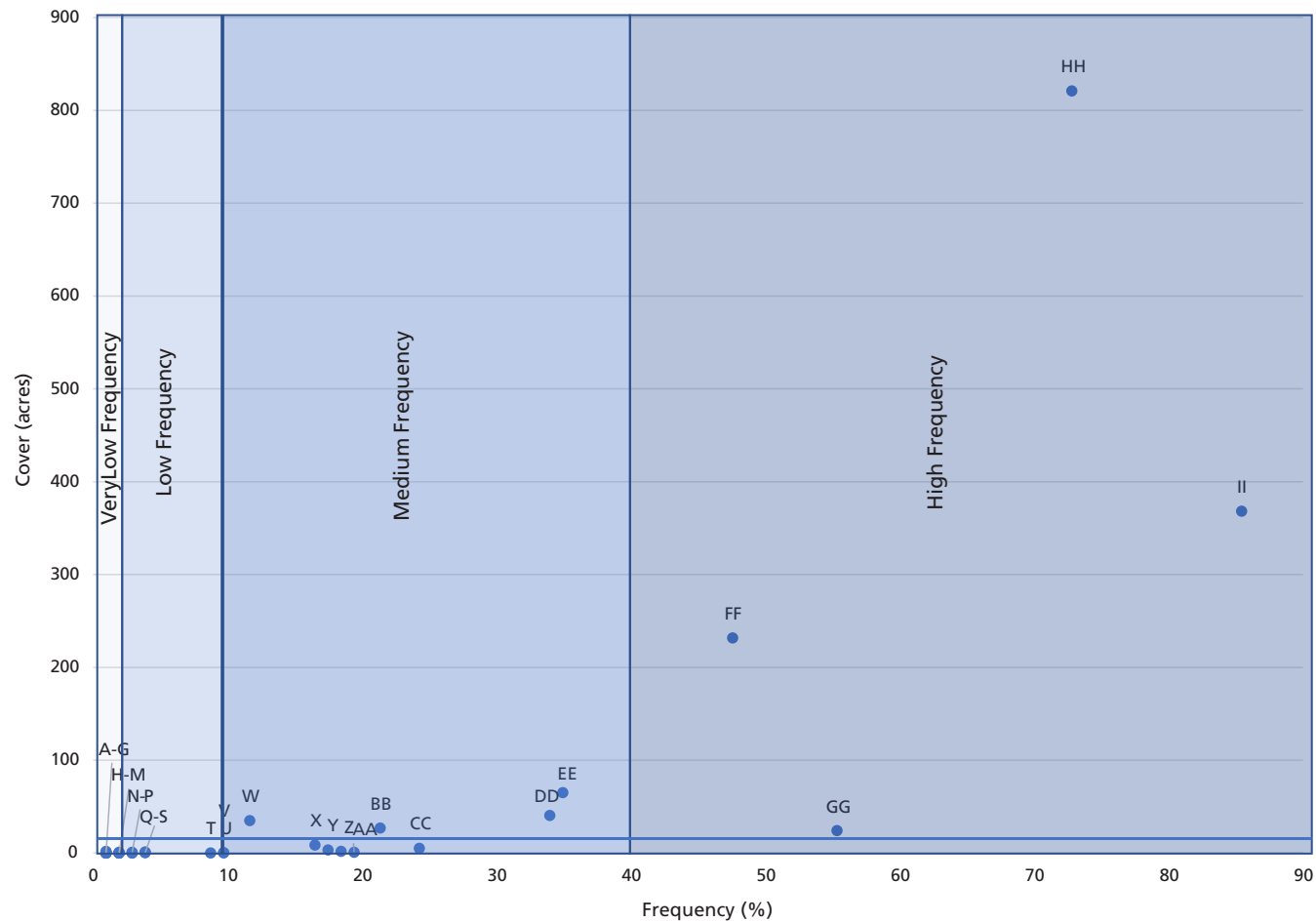


Figure 2. Problematic plant frequency and abundance relationship in 2021 at Pea Ridge National Military Park. The abundance measure used is based on the midpoint of the abundance range. Plants are placed into four categories: very low frequency ($\leq 2\%$), low frequency ($> 2\text{--}10\%$), medium frequency ($> 10\text{--}40\%$) and high frequency ($> 40\%$). The vertical line marks the 10-acre threshold at which successful control of a plant becomes less likely. Species in ascending order of frequency include A) *Poa compressa*, B) *Morus alba*, C) *Paulownia tomentosa*, D) *Albizia julibrissin*, E) *Iris pseudacorus*, F) *Vinca major*, G) *Glechoma hederacea*, H) *Pyrus calleryana*, I) *Carduus nutans*, J) *Bromus inermis*, K) *Rumex crispus*, L) *Melilotus officinalis*, M) *Securigera varia*, N) *Cirsium vulgare*, O) *Celastrus orbiculatus*, P) *Ailanthus altissima*, Q) *Bromus sterilis*, R) *Centaurea stoebe* ssp. *micranthos*, S) *Cynodon dactylon*, T) *Torilis arvensis*, U) *Euonymus fortunei*, V) *Verbascum thapsus*, W) *Rhus copallinum*, X) *Sorghum halepense*, Y) *Poa pratensis*, Z) *Ligustrum* spp., AA) *Daucus carota*, BB) *Robinia pseudoacacia*, CC) *Bromus racemosus*, DD) *Lonicera japonica*, EE) *Schedonorus phoenix*, FF) *Lespedeza cuneata*, GG) *Rosa multiflora*, HH) *Microstegium vimineum*, and II) *Juniperus virginiana*.

Table 3. Cover and frequency of problematic plants found in Pea Ridge National Military Park. 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 high (H), medium (M), low (L), insignificant (I), a range of the above ranks, not available (n/a), or native. The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicated that the cover in that year for that species changed relative to the noted year based on non-overlapping cover intervals.

Scientific Name	Common Name	Year	Minimum Cover Estimate (acres)	Maximum Cover Estimate (acres)	Frequency (%)	EI	Mgmt
<i>Ailanthus altissima</i>	tree-of-heaven	2018	0.08	1.64	0.97	ML	ML
<i>Ailanthus altissima</i>	tree-of-heaven	2021	0.08	1.70	2.91	ML	ML
<i>Albizia julibrissin</i>	silk tree	2013	0.02	0.65	1.94	ML	ML
<i>Albizia julibrissin</i>	silk tree	2018	0.08	1.64	0.97	ML	ML
<i>Albizia julibrissin</i> (decrease from 2018)	silk tree	2021	0.00	0.03	0.97	ML	ML
<i>Arctium minus</i> ^a	lesser burdock	2013	0.01	0.36	1.94	LI	MI
<i>Bromus inermis</i>	smooth brome	2006	0.00	0.03	1.03	M	ML
<i>Bromus inermis</i>	smooth brome	2013	0.01	0.33	0.97	M	ML
<i>Bromus inermis</i>	smooth brome	2021	0.00	0.06	1.94	M	ML
<i>Bromus racemosus</i> ^a	bald brome, spiked brome	2006	0.00	0.03	1.03	n/a	n/a
<i>Bromus racemosus</i> (increase from 2006)	bald brome, spiked brome	2013	1.00	22.00	22.33	n/a	n/a
<i>Bromus racemosus</i> (increase from 2006)	bald brome, spiked brome	2018	0.13	3.66	18.45	n/a	n/a
<i>Bromus racemosus</i> (increase from 2006)	bald brome, spiked brome	2021	0.45	10.00	24.27	n/a	n/a
<i>Bromus sterilis</i>	poverty brome	2013	0.20	4.92	6.80	ML	U
<i>Bromus sterilis</i> (decrease from 2006)	poverty brome	2018	0.00	0.15	4.85	ML	U
<i>Bromus sterilis</i>	poverty brome	2021	0.02	0.71	3.88	ML	U
<i>Carduus nutans</i>	nodding plumeless thistle	2013	0.00	0.03	0.97	MI	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2018	0.00	0.03	0.97	MI	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2021	0.00	0.06	1.94	MI	HM
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2021	0.01	0.39	2.91	ML	M
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	2006	0.12	2.95	5.15	M	HL
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	2013	0.02	0.68	2.91	M	HL
<i>Centaurea stoebe</i> ssp. <i>micranthos</i> (decrease from 2006)	spotted knapweed	2018	0.00	0.09	2.91	M	HL
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	2021	0.08	1.73	3.88	M	HL
<i>Cirsium vulgare</i>	bull thistle	2018	0.00	0.06	1.94	ML	ML
<i>Cirsium vulgare</i>	bull thistle	2021	0.00	0.09	2.91	ML	ML

^a Searched for in 2013, 2018, and 2021 only

Table 3 (continued). Cover and frequency of problematic plants found in Pea Ridge National Military Park. 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 high (H), medium (M), low (L), insignificant (I), a range of the above ranks, not available (n/a), or native. The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicated that the cover in that year for that species changed relative to the noted year based on non-overlapping cover intervals.

Scientific Name	Common Name	Year	Minimum Cover Estimate (acres)	Maximum Cover Estimate (acres)	Frequency (%)	EI	Mgmt
<i>Cynodon dactylon</i>	Bermudagrass	2018	0.18	3.94	3.88	ML	HM
<i>Cynodon dactylon</i>	Bermudagrass	2021	0.10	2.33	3.88	ML	HM
<i>Daucus carota</i> ^a	Queen Anne's lace	2013	0.11	2.89	12.62	I	I
<i>Daucus carota</i>	Queen Anne's lace	2018	0.02	0.95	11.65	I	I
<i>Daucus carota</i>	Queen Anne's lace	2021	0.05	1.78	19.42	I	I
<i>Euonymus fortunei</i>	winter creeper	2013	4.76	41.88	8.74	M	LI
<i>Euonymus fortunei</i>	winter creeper	2018	0.66	8.25	4.85	M	LI
<i>Euonymus fortunei</i>	winter creeper	2021	0.02	0.59	9.71	M	LI
<i>Glechoma hederacea</i>	ground ivy	2013	0.00	0.03	0.97	MI	U
<i>Glechoma hederacea</i>	ground ivy	2018	0.01	0.33	0.97	MI	U
<i>Glechoma hederacea</i>	ground ivy	2021	0.41	3.29	0.97	MI	U
<i>Hypericum perforatum</i> ^a	common St. Johnswort	2013	0.00	0.03	0.97	ML	M
<i>Iris pseudacorus</i> ^a	paleyellow iris	2018	0.00	0.06	1.94	ML	HM
<i>Iris pseudacorus</i>	paleyellow iris	2021	0.01	0.33	0.97	ML	HM
<i>Juniperus virginiana</i>	eastern redcedar	2006	128.19	2,135.63	76.29	n/a	n/a
<i>Juniperus virginiana</i>	eastern redcedar	2013	73.72	893.96	86.41	n/a	n/a
<i>Juniperus virginiana</i>	eastern redcedar	2018	67.85	924.47	88.35	n/a	n/a
<i>Juniperus virginiana</i>	eastern redcedar	2021	46.39	689.96	85.44	n/a	n/a
<i>Lespedeza cuneata</i>	sericea lespedeza	2006	6.81	79.66	34.02	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2013	15.91	169.31	39.81	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2018	2.36	40.49	48.54	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2021	29.60	434.12	47.57	ML	ML
<i>Ligustrum</i> sp.	privet sp.	2006	0.00	0.09	3.09	M	HL
<i>Ligustrum</i> sp.	privet sp.	2018	0.06	2.40	20.39	M	HL
<i>Ligustrum</i> sp. (increase from 2006)	privet sp.	2021	0.13	3.66	18.45	M	HL

^a Searched for in 2013, 2018, and 2021 only

Table 3 (continued). Cover and frequency of problematic plants found in Pea Ridge National Military Park. 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 high (H), medium (M), low (L), insignificant (I), a range of the above ranks, not available (n/a), or native. The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicated that the cover in that year for that species changed relative to the noted year based on non-overlapping cover intervals.

Scientific Name	Common Name	Year	Minimum Cover Estimate (acres)	Maximum Cover Estimate (acres)	Frequency (%)	EI	Mgmt
<i>Lonicera japonica</i>	Japanese honeysuckle	2006	2.92	55.77	32.99	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2013	18.61	167.64	17.48	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2018	2.09	23.31	23.30	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2021	6.80	74.44	33.98	M	HM
<i>Melilotus officinalis</i>	yellow sweetclover	2013	0.02	0.68	2.91	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2018	0.00	0.06	1.94	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2021	0.01	0.36	1.94	M	M
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2006	0.34	8.52	14.43	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2013	1.15	19.79	21.36	M	HM
<i>Microstegium vimineum</i> (increase from 2006)	Nepalese browntop, Japanese stiltgrass	2018	17.29	276.01	56.31	M	HM
<i>Microstegium vimineum</i> (increase from 2006, 2013)	Nepalese browntop, Japanese stiltgrass	2021	104.78	1,537.08	72.82	M	HM
<i>Morus alba</i>	white mulberry	2021	0.00	0.03	0.97	ML	ML
<i>Paulownia tomentosa</i>	princesstree	2018	0.01	0.33	0.97	ML	L
<i>Paulownia tomentosa</i>	princesstree	2021	0.00	0.03	0.97	ML	L
<i>Poa compressa</i>	Canada bluegrass	2006	0.00	0.03	1.03	ML	HL
<i>Poa compressa</i>	Canada bluegrass	2021	0.00	0.03	0.97	ML	HL
<i>Poa pratensis</i>	Kentucky bluegrass	2013	0.49	11.48	14.56	M	ML
<i>Poa pratensis</i> (decrease from 2013)	Kentucky bluegrass	2018	0.00	0.15	4.85	M	ML
<i>Poa pratensis</i> (increase from 2018)	Kentucky bluegrass	2021	0.29	6.56	17.48	M	ML
<i>Pyrus calleryana</i>	Callery pear	2021	0.00	0.06	1.94	LI	ML
<i>Rhus copallinum</i> ^a	winged sumac	2013	2.34	38.16	16.50	n/a	n/a
<i>Rhus copallinum</i>	winged sumac	2018	1.36	13.53	11.65	n/a	n/a
<i>Rhus copallinum</i>	winged sumac	2021	4.02	66.22	11.65	n/a	n/a
<i>Rhus glabra</i> ^a	smooth sumac	2013	0.03	1.33	4.85	n/a	n/a
<i>Rhus glabra</i>	smooth sumac	2018	0.01	0.36	1.94	n/a	n/a

^a Searched for in 2013, 2018, and 2021 only

Table 3 (continued). Cover and frequency of problematic plants found in Pea Ridge National Military Park. 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 high (H), medium (M), low (L), insignificant (I), a range of the above ranks, not available (n/a), or native. The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicated that the cover in that year for that species changed relative to the noted year based on non-overlapping cover intervals.

Scientific Name	Common Name	Year	Minimum Cover Estimate (acres)	Maximum Cover Estimate (acres)	Frequency (%)	EI	Mgmt
<i>Robinia pseudoacacia</i>	black locust	2006	0.28	6.36	11.34	HM	M
<i>Robinia pseudoacacia</i> (increase from 2006)	black locust	2013	7.23	82.06	14.56	HM	M
<i>Robinia pseudoacacia</i> (increase from 2006)	black locust	2018	6.99	82.11	17.48	HM	M
<i>Robinia pseudoacacia</i>	black locust	2021	2.98	50.93	21.36	HM	M
<i>Rosa multiflora</i>	multiflora rose	2006	2.24	36.59	34.02	L	L
<i>Rosa multiflora</i>	multiflora rose	2013	6.60	66.48	31.07	L	L
<i>Rosa multiflora</i>	multiflora rose	2018	0.38	10.33	43.69	L	L
<i>Rosa multiflora</i>	multiflora rose	2021	3.29	44.92	55.34	L	L
<i>Rumex crispus</i>	curly dock	2013	0.00	0.06	1.94	LI	ML
<i>Rumex crispus</i>	curly dock	2021	0.00	0.06	1.94	LI	ML
<i>Schedonorus arundinaceus</i>	tall fescue	2013	10.64	202.50	35.92	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2018	1.76	23.05	33.98	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2021	9.82	120.37	34.95	M	HM
<i>Securigera varia</i>	crown vetch	2018	0.00	0.03	0.97	H	L
<i>Securigera varia</i> (increase from 2018)	crown vetch	2021	0.08	1.67	1.94	H	L
<i>Sorghum halepense</i>	Johnsongrass	2006	0.20	4.59	6.19	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2013	0.56	7.63	12.62	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2018	0.63	13.64	18.45	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2021	1.02	16.25	16.50	ML	HM
<i>Torilis arvensis</i> ^a	spreading hedgeparsley	2018	0.01	0.21	6.80	n/a	n/a
<i>Torilis arvensis</i>	spreading hedgeparsley	2021	0.01	0.27	8.74	n/a	n/a
<i>Verbascum thapsus</i>	common mullein	2006	0.01	0.42	4.12	ML	L
<i>Verbascum thapsus</i>	common mullein	2013	0.02	0.77	5.83	ML	L
<i>Verbascum thapsus</i>	common mullein	2018	0.19	4.44	10.68	ML	L
<i>Verbascum thapsus</i>	common mullein	2021	0.02	0.59	9.71	ML	L

^a Searched for in 2013, 2018, and 2021 only

Table 3 (continued). Cover and frequency of problematic plants found in Pea Ridge National Military Park. 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, not available (n/a), or native. The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicated that the cover in that year for that species changed relative to the noted year based on non-overlapping cover intervals.

Scientific Name	Common Name	Year	Minimum Cover Estimate (acres)	Maximum Cover Estimate (acres)	Frequency (%)	EI	Mgmt
<i>Vinca major</i>	bigleaf periwinkle	2013	0.08	1.64	0.97	ML	M
<i>Vinca major</i> (decrease from 2013)	bigleaf periwinkle	2018	0.00	0.03	0.97	ML	M
<i>Vinca major</i> (increase from 2018)	bigleaf periwinkle	2021	0.08	1.64	0.97	ML	M

^a Searched for in 2013, 2018, and 2021 only

Literature Cited

- Kull, K. A., C. C. Young, J. L. Haack-Gaynor, L. W. Morrison, and M. D. DeBacker. 2022. Problematic plant monitoring protocol for the Heartland Inventory and Monitoring Network: Narrative, version 2.0. Natural Resource Report NPS/HTLN/NRR—2022/2376. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2293355>.
- 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).

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