



Problematic Plant Monitoring in Arkansas Post National Memorial

2006–2019

Natural Resource Report NPS/HTLN/NRR—2021/2270



ON THE COVER
Control of Chinese privet in Arkansas Post National Memorial
Photography by NPS

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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 28 potentially problematic plant taxa in Arkansas Post National Memorial. Of the 23 species found in 2019, we characterized 9 as very low frequency, 7 as low frequency, 5 as medium frequency, and 2 as high frequency. Cover of all species was low with a single species slightly exceeding a 1-acre threshold based on a midpoint estimate. Efforts to control the woody invasive black locust, Chinese privet, and hardy orange appear to have successfully reduced the cover of these plants across the Memorial Unit. Japanese stiltgrass may have been increasing as recently as 2015, but a combination of recent flooding and control efforts may have stemmed the spread of this invasive grass. Efforts to control localized patches of Chinaberry tree also appear to have reduced the cover of this species. Outside of the problematic species currently subject to control, the remaining species, in our opinion, do not require direct management action at this time.

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 Arkansas Post National Memorial in 2006, 2011, 2015, and 2019. The key metrics presented include plant cover and geographic distribution within the park.



Cypress swamps at Osotouy Unit, Arkansas Post National Memorial. 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 monitoring in the park constituted the early detection watch list (n = 93; Table 1). Prioritized problematic plants known to occur in the park based on previous monitoring constituted the park-established watch list (n = 28; 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 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 Arkansas Post National Memorial.

Scientific Name	Common Name
<i>Ailanthus altissima</i>	tree of heaven
<i>Alliaria petiolata</i>	garlic mustard
<i>Alternanthera sessilis</i>	sessile joyweed
<i>Ampelopsis brevipedunculata</i>	Amur peppervine
<i>Arthraxon hispidus</i>	small carpgrass
<i>Arctium minus</i> *	lesser burdock
<i>Bothriochloa bladhii</i>	Caucasian bluestem, Australian bluestem
<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>Carduus nutans</i>	nodding plumeless thistle
<i>Celastrus orbiculatus</i>	Oriental bittersweet
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium</i> sp.	thistle sp.
<i>Cirsium vulgare</i>	bull thistle
<i>Clematis terniflora</i>	sweet autumn virginsbower

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

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

Scientific Name	Common Name
<i>Dipsacus fullonum</i>	Fuller's teasel
<i>Discorea oppositifolia</i>	Chinese yarn
<i>Egeria densa</i> *	Brazilian waterweed
<i>Elaeagnus umbellata/angustifolia</i>	Russian/autumn olive complex
<i>Elaeagnus angustifolia</i> *	Russian olive
<i>Elaeagnus pungens</i>	thorny olive
<i>Elaeagnus umbellata</i>	autumn olive
<i>Elymus repens</i> *	quackgrass
<i>Eragrostis curvula</i>	weeping lovegrass
<i>Euonymus fortunei</i>	winter creeper
<i>Euphorbia cyparissias</i> *	cypress spurge
<i>Glechoma hederacea</i>	ground ivy
<i>Hemerocallis fulva</i> *	orange daylily
<i>Hedera helix</i>	English ivy
<i>Hesperis matronalis</i>	dames rocket
<i>Holcus lanatus</i>	common velvetgrass
<i>Humulus japonicus</i> *	Japanese hop
<i>Hydrilla verticillata</i> *	waterthyme
<i>Hypericum perforatum</i> *	common St. Johnswort
<i>Imperata cylindrica</i>	cogongrass
<i>Iris pseudacorus</i> *	paleyellow iris
<i>Lespedeza bicolor</i>	shrub lespedeza
<i>Leonurus cardiaca</i> *	common motherwort
<i>Ligustrum</i> spp.	privet sp.
<i>Ligustrum lucidum</i>	glossy privet
<i>Ligustrum vulgare</i>	European privet
<i>Linaria vulgaris</i> *	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>	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>Melilotus officinalis</i>	yellow sweetclover
<i>Morus alba</i>	white mulberry

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

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

Scientific Name	Common Name
<i>Myosotis scorpioides</i> *	true forget-me-not
<i>Myriophyllum spicatum</i> *	Eurasian watermilfoil
<i>Nandina domestica</i>	sacred bamboo
<i>Najas minor</i> *	brittle waternymph
<i>Nasturtium officinale</i> *	watercress
<i>Pastinaca sativa</i>	wild parsnip
<i>Paulownia tomentosa</i>	princesstree
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Phragmites australis</i>	common reed
<i>Photinia serratifolia</i>	Taiwanese photinia
<i>Phyllostachys</i> spp. *	bamboo
<i>Poa compressa/pratensis</i>	Canada/Kentucky bluegrass complex
<i>Populus alba</i>	white poplar
<i>Poa compressa</i>	Canada bluegrass
<i>Potamogeton crispus</i> *	curly pondweed
<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Prunus mahaleb</i> *	Mahaleb cherry
<i>Pueraria montana</i>	kudzu
<i>Pyrus calleryana</i>	Callery pear
<i>Rhamnus cathartica</i>	common buckthorn
<i>Rumex acetosella</i> *	common sheep sorrel
<i>Salvinia molesta</i>	kariba-weed
<i>Saponaria officinalis</i> *	bouncingbet
<i>Schedonorus arundinaceus</i>	tall fescue
<i>Schedonorus pratensis</i>	meadow fescue
<i>Securigera varia</i>	crownvetch
<i>Solanum viarum</i>	tropical soda apple
<i>Spiraea</i> sp.	spirea sp.
<i>Sphenoclea zeylanica</i>	chickenspike
<i>Tamarix ramosissima</i>	saltcedar
<i>Tanacetum vulgare</i> *	common tansy
<i>Torilis arvensis</i> *	spreading hedgeparsley
<i>Triadica sebifera</i>	Chinese tallow
<i>Typha xglauca</i> *	hybrid cattail
<i>Typha</i> sp.	cattail sp.
<i>Ulmus pumila</i>	Siberian elm
<i>Vinca minor</i>	common periwinkle
<i>Wisteria floribunda</i>	Japanese wisteria

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

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

Scientific Name	Common Name
<i>Albizia julibrissin</i>	silktree
<i>Alternanthera philoxeroides</i>	alligatorweed
<i>Arundo donax</i>	giant reed
<i>Baccharis halimifolia</i>	eastern baccharis
<i>Bromus racemosus</i> ^a	bald brome, spiked brome
<i>Cynodon dactylon</i>	Bermudagrass
<i>Daucus carota</i> ^a	Queen Anne's lace
<i>Echinochloa crus-galli</i>	barnyardgrass
<i>Eichhornia crassipes</i>	common water hyacinth
<i>Lespedeza cuneata</i>	sericea lespedeza
<i>Ligustrum sinense</i>	Chinese privet
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Melia azedarach</i>	Chinaberrytree
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass
<i>Murdannia keisak</i>	wartremoving herb
<i>Myriophyllum aquaticum</i>	parrot feather watermilfoil
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Poncirus trifoliata</i>	hardy orange, trifoliolate orange
<i>Rosa multiflora</i>	multiflora rose
<i>Robinia pseudoacacia</i>	black locust
<i>Rumex crispus</i> ^a	curly dock
<i>Sorghum halepense</i>	Johnsongrass
<i>Torilis japonica</i> ^b	erect hedgeparsley
<i>Torilis</i> spp.	hedgeparsley
<i>Typha angustifolia</i>	narrowleaf cattail
<i>Verbascum thapsus</i>	common mullein
<i>Vinca major</i>	bigleaf periwinkle
<i>Wisteria sinensis</i>	Chinese wisteria

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

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

Field Methods

We searched for problematic plant species on designated watch lists (Tables 1 and 2) across Arkansas Post National Memorial (Figure 1). Contracted staff conducted the monitoring from August 30–September 7, 2006, and August 8–14, 2011. NPS staff used Trimble GPS units to conduct monitoring during July 7–9, 2015, June 24–26, 2019, and October 1, 2019.

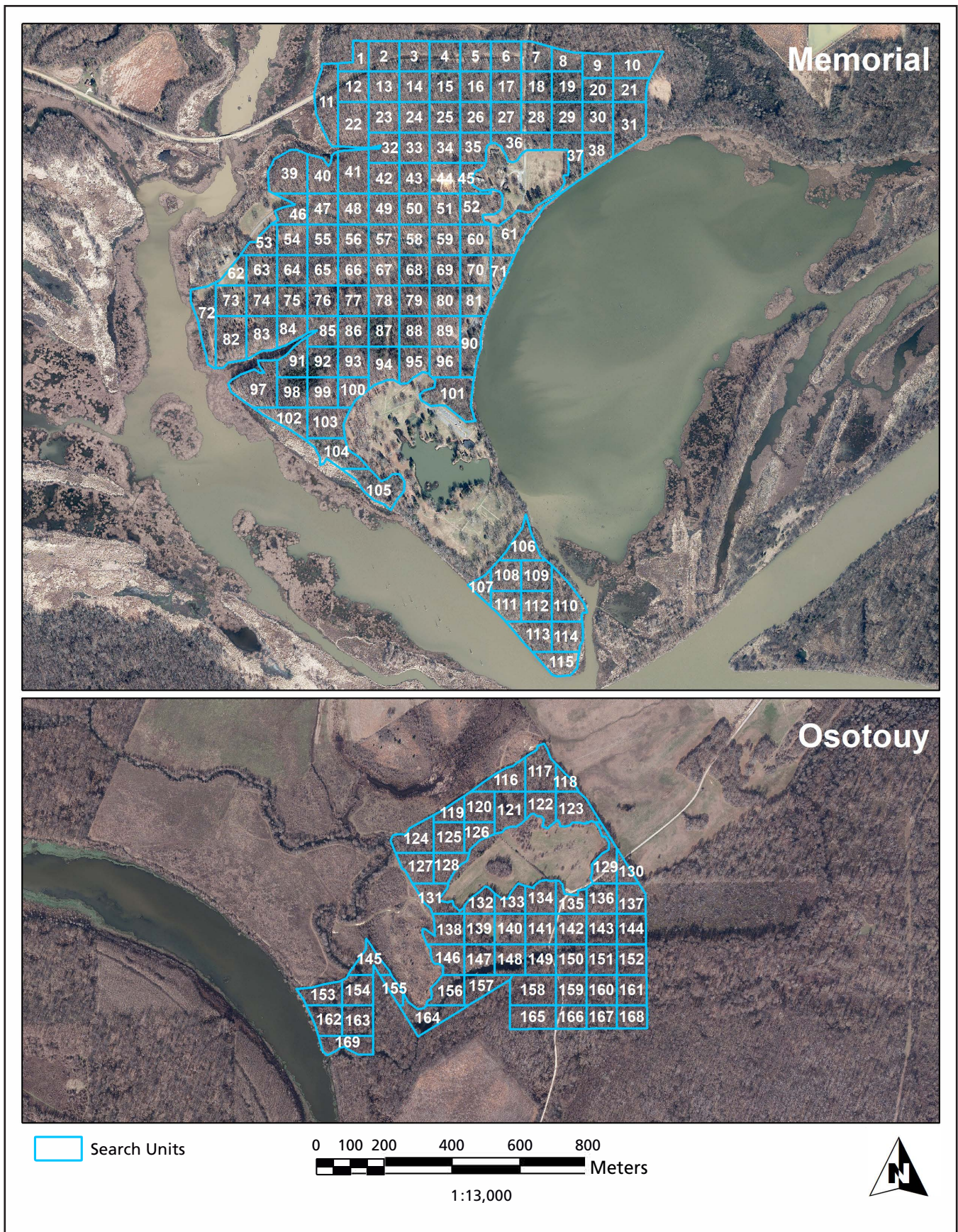


Figure 1. Location of search units used to monitor problematic plants in Arkansas Post National Memorial. The park consists of two units: Memorial Unit and Osotouy Unit. Search unit size averaged 2.0 acres.

The shift from later to early summer should not affect our ability to identify the species found over the course of monitoring. The second trip in 2019 was to search areas that were flooded during the June trip.

Observers made three roughly equidistant passes through each search unit, normally in the east to 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. The same 169 search units were surveyed each time (Figure 1).

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. To do this we used an average search unit size of 2.0 acres (8,124.5 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. In this study, we evaluated if the cover data collected in 2019 differed from any previous years based on non-overlapping cover ranges.

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

We have retained *Ligustrum sinense* as the identify of privet found in Arkansas Post National Memorial based on reported distribution (EddMaps 2020).

Results and Discussion

Plant cover and frequency estimates for the problematic plants encountered at Arkansas Post 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 = 9), (2) low frequency (>2–10%, n = 7), (3) medium frequency (>10–40%, n = 5), and (4) high frequency (>40%, n = 2). 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. The midpoints of cover estimates for all problematic plants found at Arkansas Post National Memorial fell well below this threshold.

Arkansas Post National Memorial supports 28 problematic plants. The long-term data suggest several changes in the cover of problematic plants as a result of park management efforts. In the Memorial Unit, the Heartland Invasive Plant Management Team has focused on four problematic plants: black locust (*Robinia pseudoacacia*), Chinese privet (*Ligustrum sinense*), hardy orange (*Poncirus trifoliata*), and Japanese stiltgrass (*Microstegium vimineum*). The cover of Chinese privet and hardy orange has declined since 2006. Chinese privet declined from a maximum cover

of 7.8 acres in 2006 to 0.3 acres in 2019, although the frequency of Chinese privet remained high in 2019 at 45%. Hardy orange decreased from a maximum cover of 82.7 acres in 2006 to 1.0 acres in 2019; frequency in 2019 was 30.8%. The maximum cover of black locust at 0.3 acres in 2019 was also lower than all previous years, although cover ranges did not indicate actual differences. Frequency was relatively low at 6.5% in 2019. Despite control efforts, Japanese stiltgrass cover did not differ among years based on cover ranges. The 2019 maximum cover value of 0.8 acres was less than the 6.4 acres observed in 2015, but more than the 0.3 acres and 0.5 acres observed in 2006 and 2011, respectively. More recent declines may be associated with flooding in 2019. Given the ability of this annual grass to spread, we recommend continuing to focus on its control.

We also controlled Chinaberry tree (*Melia azedarach*) less systematically during treatment of the other species. Plant cover declined from a maximum cover value of 0.6 acres in 2015 to 0.03 acres in 2019; frequency in 2019 was 2.4%. 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.

Table 3. Cover and distribution of potentially problematic plants found in Arkansas Post 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 either increased or decreased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	Mgmt
<i>Albizia julibrissin</i>	silk tree	2006	0.0015	0.0578	3.6	ML	ML
<i>Albizia julibrissin</i>	silk tree	2011	0.0062	0.1233	0.6	ML	ML
<i>Albizia julibrissin</i>	silk tree	2015	0.0062	0.1255	1.2	ML	ML
<i>Albizia julibrissin</i>	silk tree	2019	0.0070	0.1567	3.6	ML	ML
<i>Alternanthera philoxeroides</i>	alligatorweed	2006	0.0075	0.2958	7.7	HM	M
<i>Alternanthera philoxeroides</i>	alligatorweed	2011	0.1223	2.1711	8.3	HM	M
<i>Alternanthera philoxeroides</i>	alligatorweed	2015	0.1956	2.8758	13.0	HM	M
<i>Alternanthera philoxeroides</i>	alligatorweed	2019	0.0090	0.3536	11.2	HM	M
<i>Arundo donax</i>	giant reed	2011	0.0062	0.1233	0.6	H	L
<i>Baccharis halimifolia</i>	eastern baccharis	2006	0.0835	1.3601	9.5	n/a	n/a
<i>Baccharis halimifolia</i>	eastern baccharis	2011	0.1124	2.2706	6.5	n/a	n/a
<i>Baccharis halimifolia</i>	eastern baccharis	2015	0.0620	0.9914	10.7	n/a	n/a
<i>Baccharis halimifolia</i>	eastern baccharis	2019	0.0233	0.5567	10.1	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2006	0.0007	0.0267	1.2	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2015	0.0006	0.0245	0.6	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2019	0.0146	0.3356	7.1	n/a	n/a
<i>Cynodon dactylon</i>	Bermudagrass	2006	0.0309	0.2469	0.6	ML	HM
<i>Cynodon dactylon</i>	Bermudagrass	2011	0.8760	11.3085	21.3	ML	HM
<i>Cynodon dactylon</i>	Bermudagrass	2015	0.0087	0.2212	8.9	ML	HM
<i>Cynodon dactylon</i>	Bermudagrass	2019	0.1122	2.0112	18.3	ML	HM
<i>Daucus carota</i>	Queen Anne's lace	2019	0.0062	0.1233	0.6	I	I
<i>Echinochloa crus-galli</i>	barnyardgrass	2011	0.0006	0.0245	0.6	LI	U
<i>Eichhornia crassipes</i>	common water hyacinth	2006	0.4880	5.6814	4.7	HM	H
<i>Eichhornia crassipes</i>	common water hyacinth	2011	0.9341	10.9183	8.9	HM	H
<i>Eichhornia crassipes</i>	common water hyacinth	2015	0.0088	0.2256	4.1	HM	H
<i>Eichhornia crassipes</i>	common water hyacinth	2019	0.0508	1.1611	12.4	HM	H

Table 3 (continued). Cover and distribution of potentially problematic plants found in Arkansas Post 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 either increased or decreased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	Mgmt
<i>Lespedeza cuneata</i>	sericea lespedeza	2006	0.0007	0.0267	1.2	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2015	0.0001	0.0022	0.6	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2019	0.0001	0.0022	0.6	ML	ML
<i>Ligustrum sinense</i> (decrease in 2019)	Chinese privet	2006	0.5089	7.8616	38.5	M	L
<i>Ligustrum sinense</i>	Chinese privet	2011	0.1248	3.0003	34.3	M	L
<i>Ligustrum sinense</i>	Chinese privet	2015	0.0135	0.5204	43.8	M	L
<i>Ligustrum sinense</i>	Chinese privet	2019	0.0091	0.3469	45.0	M	L
<i>Lonicera japonica</i>	Japanese honeysuckle	2006	1.1102	18.6841	58.0	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2011	0.3201	6.4830	43.8	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2015	0.0329	0.9237	54.4	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2019	0.0507	1.2691	43.8	M	HM
<i>Melia azedarach</i>	Chinaberrytree	2006	0.0069	0.1500	1.8	ML	ML
<i>Melia azedarach</i>	Chinaberrytree	2011	0.0006	0.0245	0.6	ML	ML
<i>Melia azedarach</i> (decrease in 2019)	Chinaberrytree	2015	0.0646	0.6027	6.5	ML	ML
<i>Melia azedarach</i>	Chinaberrytree	2019	0.0008	0.0311	2.4	ML	ML
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2006	0.0137	0.2978	3.0	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2011	0.0253	0.5177	3.0	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2015	0.3543	6.3825	12.4	M	HM
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	2019	0.0593	0.8869	6.5	M	HM
<i>Murdannia keisak</i> (decrease in 2019)	wartremoving herb	2006	0.0086	0.2212	3.0	M	U
<i>Murdannia keisak</i>	wartremoving herb	2015	0.0001	0.0022	0.6	M	U

Table 3 (continued). Cover and distribution of potentially problematic plants found in Arkansas Post 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 either increased or decreased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	Mgmt
<i>Myriophyllum aquaticum</i>	parrot feather watermilfoil	2015	0.0001	0.0022	0.6	M	U
<i>Poa pratensis</i>	Kentucky bluegrass	2019	0.0006	0.0245	0.6	M	ML
<i>Poncirus trifoliata</i> (decrease in 2019)	hardy orange, trifoliolate orange	2006	4.4526	82.7043	39.6	n/a	n/a
<i>Poncirus trifoliata</i>	hardy orange, trifoliolate orange	2011	0.1934	3.5205	31.4	n/a	n/a
<i>Poncirus trifoliata</i>	hardy orange, trifoliolate orange	2015	0.1167	2.0554	42.6	n/a	n/a
<i>Poncirus trifoliata</i>	hardy orange, trifoliolate orange	2019	0.0377	1.0003	30.8	n/a	n/a
<i>Robinia pseudoacacia</i>	black locust	2006	0.0335	0.7188	6.5	HM	M
<i>Robinia pseudoacacia</i>	black locust	2011	0.0735	0.8372	7.1	HM	M
<i>Robinia pseudoacacia</i>	black locust	2015	0.0860	1.0860	14.8	HM	M
<i>Robinia pseudoacacia</i>	black locust	2019	0.0140	0.3111	6.5	HM	M
<i>Rosa multiflora</i>	multiflora rose	2006	0.0007	0.0289	1.8	L	L
<i>Rosa multiflora</i>	multiflora rose	2015	0.0006	0.0245	0.6	L	L
<i>Rosa multiflora</i>	multiflora rose	2019	0.0001	0.0022	0.6	L	L
<i>Rumex crispus</i> ^a	curly dock	2019	0.0001	0.0022	0.6	LI	ML
<i>Sorghum halepense</i>	Johnsongrass	2006	0.1329	1.9768	5.9	ML	HM
<i>Sorghum halepense</i> (decrease in 2019)	Johnsongrass	2011	0.7055	14.1324	4.7	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2015	0.0454	0.5780	6.5	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2019	0.0035	0.1379	7.1	ML	HM
<i>Torilis japonica</i> ^b	erect hedgeparsley	2006	0.0007	0.0267	1.2	n/a	n/a
<i>Torilis japonica</i>	erect hedgeparsley	2019	0.0002	0.0067	1.8	n/a	n/a
<i>Torilis</i> spp.	hedgeparsley	2019	0.0001	0.0022	0.6	n/a	n/a

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

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

Table 3 (continued). Cover and distribution of potentially problematic plants found in Arkansas Post 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 either increased or decreased relative to the noted year based on non-overlapping cover intervals.

ScientificName	CommonName	PeriodID	Low Cover Estimate (acres)	High Cover Estimate (acres)	Frequency	EI	Mgmt
<i>Typha angustifolia</i> (decrease in 2019)	narrowleaf cattail	2006	0.5628	6.8181	4.7	HM	M
<i>Typha angustifolia</i>	narrowleaf cattail	2011	0.1501	3.0372	5.3	HM	M
<i>Typha angustifolia</i> (decrease in 2019)	narrowleaf cattail	2015	0.2669	3.1353	7.1	HM	M
<i>Typha angustifolia</i>	narrowleaf cattail	2019	0.0058	0.2291	7.7	HM	M
<i>Verbascum thapsus</i>	common mullein	2006	0.0001	0.0022	0.6	ML	L
<i>Verbascum thapsus</i>	common mullein	2011	0.0006	0.0245	0.6	ML	L
<i>Verbascum thapsus</i>	common mullein	2015	0.0001	0.0022	0.6	ML	L
<i>Vinca major</i>	bigleaf periwinkle	2006	0.0988	1.6054	1.8	ML	M
<i>Vinca major</i>	bigleaf periwinkle	2011	0.3521	2.9643	2.4	ML	M
<i>Vinca major</i>	bigleaf periwinkle	2015	0.0124	0.2488	1.8	ML	M
<i>Vinca major</i>	bigleaf periwinkle	2019	0.0432	0.4935	1.8	ML	M
<i>Wisteria sinensis</i>	Chinese wisteria	2011	0.0130	0.2711	1.8	ML	L
<i>Wisteria sinensis</i>	Chinese wisteria	2015	0.0062	0.1255	1.2	ML	L
<i>Wisteria sinensis</i>	Chinese wisteria	2019	0.0069	0.1500	1.8	ML	L

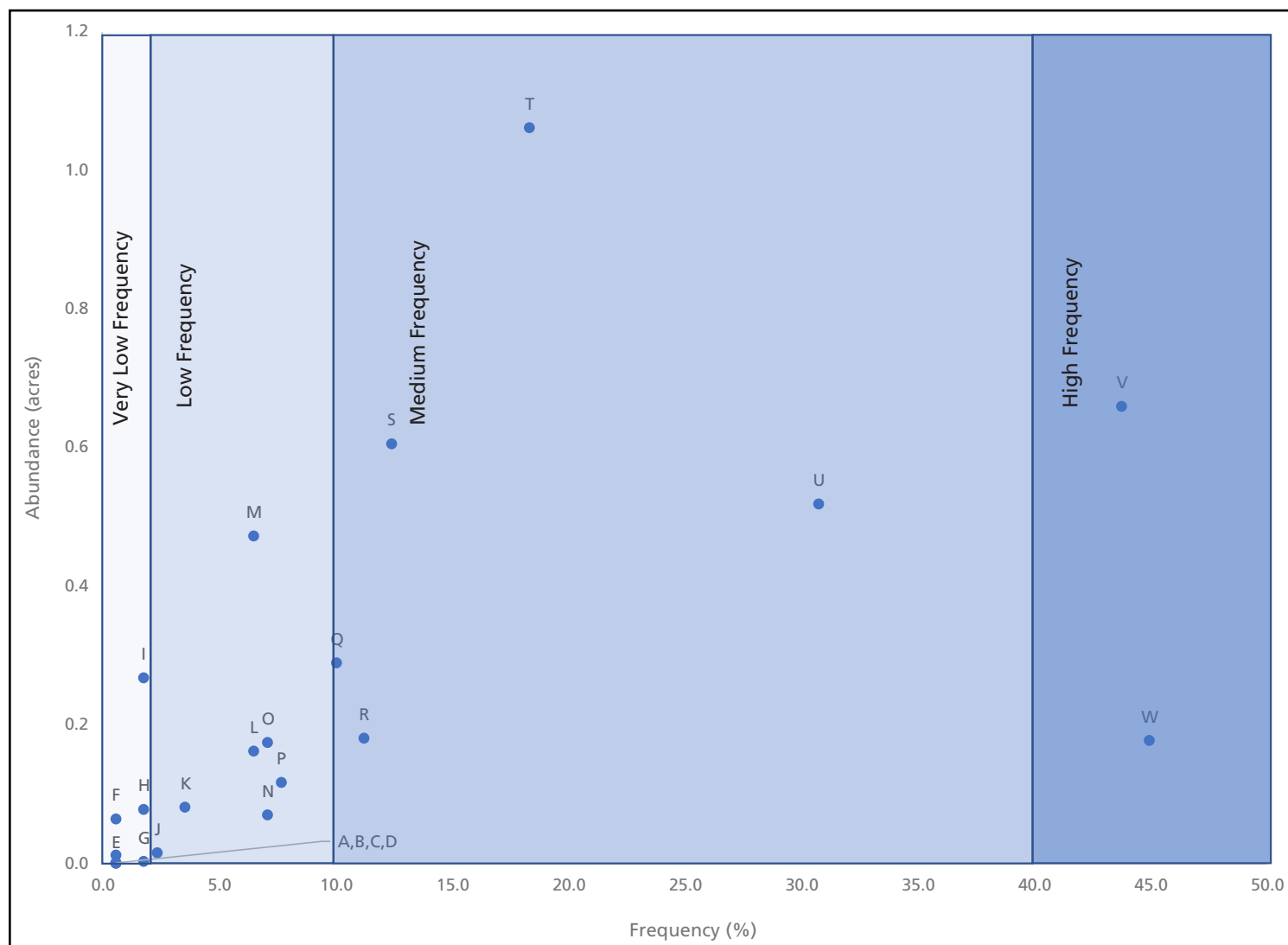


Figure 2. Problematic plant cover and frequency relationship in 2019 at Arkansas Post National Memorial. The cover measure used is based on the midpoint of the cover range. Plants are categorized into four categories: very low frequency (<2%), low frequency (>2–10%), medium frequency (>10–40%) and high frequency (>40%). Species in ascending order of frequency include A) *Lespedeza cuneata*, B) *Rosa multiflora*, C) *Rumex crispus*, D) *Torilis* spp., E) *Poa pratensis*, F) *Daucus carota*, G) *Torilis japonica*, H) *Wisteria sinensis*, I) *Vinca major*, J) *Melia azedarach*, K) *Albizia julibrissin*, L) *Robinia pseudoacacia*, M) *Microstegium vimineum*, N) *Sorghum halepense*, O) *Bromus racemosus*, P) *Typha angustifolia*, Q) *Baccharis halimifolia*, R) *Alternanthera philoxeroides*, S) *Eichornia crassipes*, T) *Cynodon dactylon*, U) *Poncirus trifoliata*, V) *Ligustrum sinense*, and W) *Lonicera japonica*.

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