



Problematic Plant Monitoring in Wilson's Creek National Battlefield

2006–2020

Natural Resource Report NPS/HTLN/NRR—2022/2398



ON THE COVER

Invasive plant treatments on Bloody Hill Glade, Wilson's Creek National Battlefield, Republic, Missouri.
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 and frequency of these plant species is essential for developing risk-based approaches to managing them. Based on surveys conducted in 2006, 2013, 2016, and 2020, Heartland Inventory and Monitoring Network staff and contractors identified a cumulative total of 53 potentially problematic plant species in Wilson's Creek National Battlefield. Of the 40 species found in 2020, we characterized 9 as very low frequency, 13 as low frequency, 9 as medium frequency, and 9 as high frequency. Of these 40, midpoint cover estimates of 1 low-frequency, 4 medium-frequency, and 8 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. Because of the number, 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 that can be effectively controlled.

Introduction

The National Park Service 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 Wilson’s Creek National Battlefield (NB) in 2006, 2013, 2016, and 2020. The key metrics presented include plant cover and geographic distribution within the park.



Common mullein (*Verbascum thapsus*), a common potentially problematic plant, found on Walnut Glade, Wilson’s Creek National Battlefield, Republic, Missouri. NPS

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 = 70; Table 1). Prioritized problematic plants known to occur in the park based on previous monitoring constituted the park-established watch list (n = 53; Table 2). In this report we included only plant species that we searched for in 2020. 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 Wilson's Creek National Battlefield.

Scientific Name	Common Name
<i>Acer ginnala</i>	Amur maple
<i>Alnus glutinosa</i>	European alder
<i>Arthraxon hispidus</i> ^d	small carpgrass
<i>Arundo donax</i>	giant reed
<i>Berberis thunbergii</i>	Japanese barberry
<i>Bothriochloa bladhii</i>	Caucasian bluestem, Australian bluestem
<i>Bromus</i> sp.	annual brome sp. (NOT <i>B. inermis</i>)
<i>Centaurea solstitialis</i>	yellow star-thistle
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed
<i>Cirsium</i> sp.	thistle sp.
<i>Cirsium arvense</i>	Canada thistle
<i>Clematis terniflora</i> ^d	sweet autumn virginsbower
<i>Cornus foemina</i>	stiff dogwood
<i>Cynanchum louiseae</i> ^a	Louise's swallow-wort
<i>Cynanchum rossicum</i> ^a	European swallow-wort

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

^c Searched for in 2006, 2013, and 2020 only

^d Searched for in 2020 only

Table 1 (continued). Early detection problematic plant watch list used to guide surveys in Wilson's Creek National Battlefield.

Scientific Name	Common Name
<i>Egeria densa</i> ^a	Brazilian waterweed
<i>Eichhornia crassipes</i> ^a	common water hyacinth
<i>Elaeagnus angustifolia</i>	Russian olive
<i>Elaeagnus umbellata/angustifolia</i> ^d	Russian/autumn olive complex
<i>Elymus repens</i> ^a	quackgrass
<i>Euphorbia cyparissias</i> ^a	cypress spurge
<i>Euphorbia esula</i>	leafy spurge
<i>Glechoma hederacea</i>	ground ivy
<i>Hedera helix</i>	English ivy
<i>Hemerocallis fulva</i> ^a	orange daylily
<i>Holcus lanatus</i>	common velvetgrass
<i>Iris pseudacorus</i> ^a	paleyellow iris
<i>Leonurus cardiaca</i> ^a	common motherwort
<i>Lepidium latifolium</i> ^a	broadleaved pepperweed
<i>Lespedeza bicolor</i>	shrub lespedeza
<i>Ligustrum obtusifolium</i> ^a	border privet
<i>Linaria vulgaris</i> ^a	butter and eggs
<i>Lolium perenne</i>	perennial ryegrass
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Lonicera shrub (maackii/morrowii/tatarica)</i> ^a	bush honeysuckle sp. (Amur-Morrow's-Tatarian complex)
<i>Lotus corniculatus</i> ^a	bird's-foot trefoil
<i>Lotus tenuis</i> ^c	narrow-leaf bird's-foot trefoil
<i>Lysimachia nummularia</i> ^b	creeping jenny
<i>Lythrum salicaria</i> ^b	purple loosestrife
<i>Melia azedarach</i> ^b	Chinaberrytree
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass
<i>Myosotis scorpioides</i> ^a	true forget-me-not
<i>Myriophyllum aquaticum</i> ^a	parrot feather watermilfoil
<i>Myriophyllum spicatum</i> ^a	Eurasian watermilfoil
<i>Najas minor</i> ^a	brittle waternymph
<i>Onopordum acanthium</i> ^a	Scotch cottonthistle
<i>Pastinaca sativa</i>	wild parsnip

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

^c Searched for in 2006, 2013, and 2020 only

^d Searched for in 2020 only

Table 1 (continued). Early detection problematic plant watch list used to guide surveys in Wilson's Creek National Battlefield.

Scientific Name	Common Name
<i>Paulownia tomentosa</i>	princesstree
<i>Phragmites australis</i>	common reed
<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Populus alba</i>	white poplar
<i>Populus tremuloides</i>	quaking aspen
<i>Potamogeton crispus</i> ^a	curly pondweed
<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>Saponaria officinalis</i> ^a	bouncingbet
<i>Schedonorus pratensis</i>	meadow fescue
<i>Sesbania herbacea</i>	bigpod sesbania
<i>Spiraea</i> sp.	spirea sp.
<i>Spiraea japonica</i>	Japanese meadowsweet, Japanese spirea
<i>Tamarix ramosissima</i> ^b	saltcedar
<i>Tanacetum vulgare</i> ^a	common tansy
<i>Typha</i> sp.	cattail sp.
<i>Typha angustifolia</i>	narrowleaf cattail
<i>Typha x glauca</i> ^a	hybrid cattail
<i>Viburnum opulus</i> ^a	European cranberrybush
<i>Vicia villosa</i> ^c	winter vetch
<i>Wisteria sinensis</i>	Chinese wisteria

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

^c Searched for in 2006, 2013, and 2020 only

^d Searched for in 2020 only

Table 2. Park-established problematic plant watch list used to guide surveys in Wilson's Creek National Battlefield.

Scientific Name	Common Name
<i>Ailanthus altissima</i>	tree-of-heaven
<i>Albizia julibrissin</i>	silktree
<i>Alliaria petiolata</i>	garlic mustard
<i>Arctium minus</i>	lesser burdock
<i>Bromus arvensis</i> ^b	field brome
<i>Bromus inermis</i>	smooth brome
<i>Bromus racemosus</i>	bald brome, spiked brome
<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>Cirsium vulgare</i>	bull thistle
<i>Daucus carota</i> ^a	Queen Anne's lace
<i>Dioscorea oppositifolia</i>	Chinese yam
<i>Dipsacus fullonum</i>	Fuller's teasel
<i>Dipsacus laciniatus</i>	cutleaf teasel
<i>Elaeagnus umbellata</i>	autumn olive
<i>Euonymus alatus</i>	burningbush, winged euonymus
<i>Euonymus fortunei</i>	winter creeper
<i>Hesperis matronalis</i>	dames rocket
<i>Humulus japonicus</i>	Japanese hop
<i>Hypericum perforatum</i> ^a	common St. Johnswort
<i>Juniperus virginiana</i> ^a	eastern redcedar
<i>Lespedeza cuneata</i>	sericea lespedeza
<i>Ligustrum</i> sp.	privet sp.
<i>Ligustrum sinense</i>	Chinese privet
<i>Ligustrum vulgare</i>	European privet
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Maclura pomifera</i>	Osage orange
<i>Melilotus officinalis</i>	yellow sweetclover
<i>Miscanthus sinensis</i>	Chinese silvergrass
<i>Morus alba</i>	white mulberry
<i>Nasturtium officinale</i> ^a	watercress
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Poa compressa</i>	Canada bluegrass
<i>Poa compressa/pratensis</i>	Canada/Kentucky bluegrass complex

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

Table 2 (continued). Park-established problematic plant watch list used to guide surveys in Wilson's Creek National Battlefield.

Scientific Name	Common Name
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Rhus copallinum</i> ^a	winged sumac
<i>Rhus glabra</i>	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>Sonchus arvensis</i> ^a	field sowthistle
<i>Sorghum halepense</i>	Johnsongrass
<i>Torilis arvensis</i> ^a	spreading hedgeparsley
<i>Torilis japonica</i>	erect hedgeparsley
<i>Ulmus pumila</i>	Siberian elm
<i>Verbascum thapsus</i>	common mullein
<i>Vinca minor</i>	common periwinkle

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

Field Methods

We searched for problematic plant species on designated watch lists (Table 1) across Wilson's Creek NB (Figure 1). Contracted staff conducted the monitoring August 22–27, 2006, and June 17–23, 2013. NPS staff used Trimble GPS units to conduct monitoring July 20–27, 2016, and July 14–21, 2020. 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), which may have inflated detection rates and abundance estimates. Cover was summarized for each plant taxon within each line 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 157 search units were surveyed during each survey in 2006, 2013, and 2016. Slight modifications were made in 2020 (Figure 1), including eliminating line search units less than 45 m in length and reconnecting any

line search units that had previously had a section clipped out based on habitat.

Analytical Methods

A park-wide cover range was estimated for each problematic plant species encountered each year. First, we calculated the minimum and maximum fraction of the park observed. The configuration of line search units shifted slightly in 2020, causing an increase in area covered from 27,008.2 to 27,593.3 m². The fraction of the park observed assuming a 3-m belt was calculated as 1.48% in 2006, 2013, and 2016 and 1.52% in 2020. The fraction of the park observed assuming a 12-m belt was calculated as 5.93% in 2006, 2013, and 2016 and 6.02% in 2020.

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.

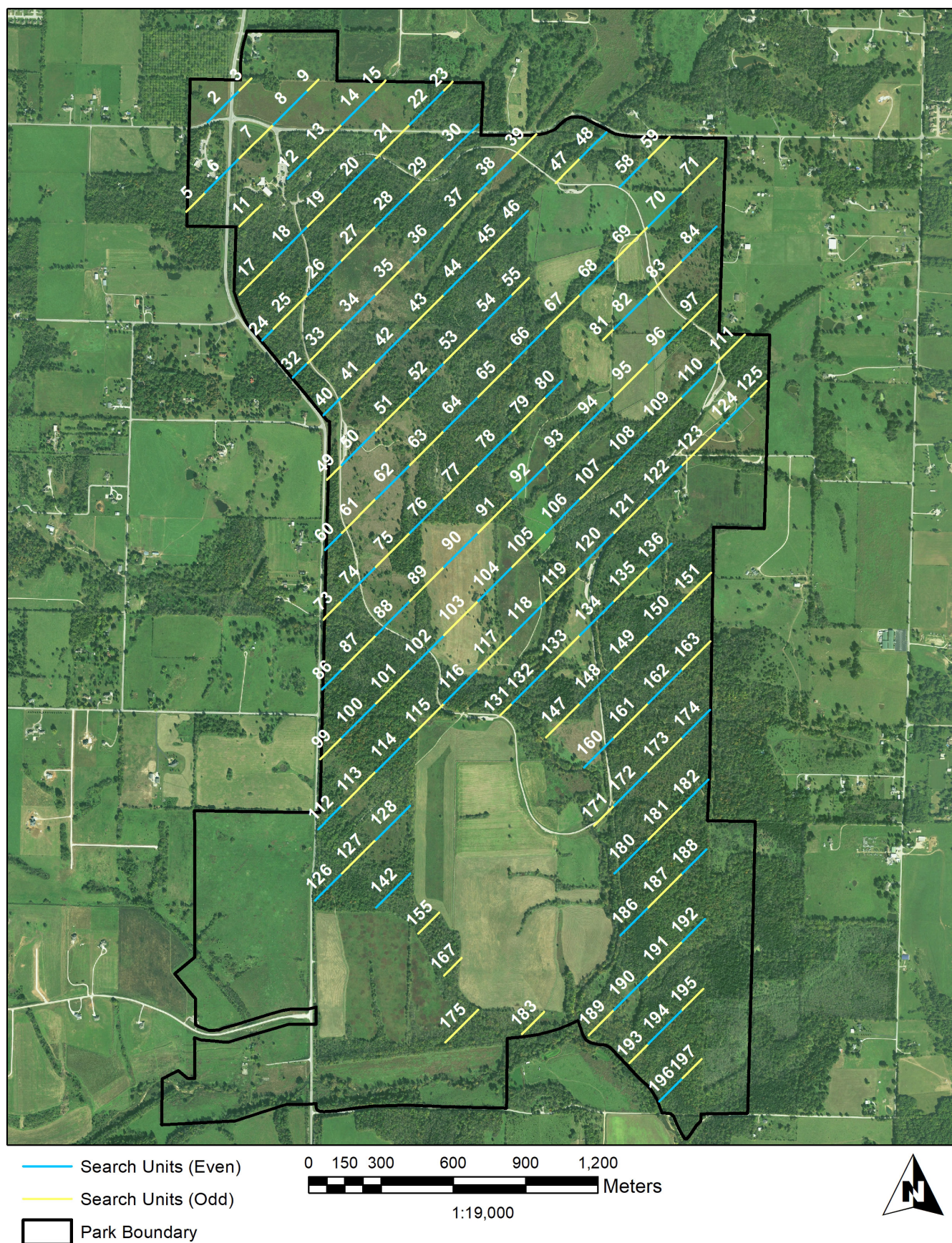


Figure 1. Location of search units used to monitor problematic plants in Wilson's Creek National Battlefield.

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 between monitoring events represent the strongest evidence for change in cover. In this study, we evaluated if the

cover data for each species collected in 2020 differed from any previous years based on non-overlapping cover ranges.

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. We also included the ecological impact and management difficulty sub-ranks (Table 3) because of their more direct implications for park management (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 Wilson's Creek NB are presented in Table 3 and the 2020 data are depicted graphically using frequency and the midpoint of the cover range (Figure 2). In the figure, we grouped plants in four categories: (1) very low frequency ($\leq 2\%$, $n = 9$), (2) low frequency ($> 2\text{--}10\%$, $n = 13$), (3) medium frequency ($> 10\text{--}40\%$, $n = 9$), and (4) high frequency ($> 40\%$, $n = 9$). While many factors affect our ability to control problematic plants, we use 10 acres as a guideline to identify lower and higher probabilities for successful control. Based on this threshold, the cover midpoints suggest a low probability of control for one low-frequency species (smooth brome [*Bromus inermis*]), four medium-frequency species (smooth sumac [*Rhus glabra*], Kentucky bluegrass [*Poa pratensis*], wintercreeper [*Euonymus fortunei*], and winged sumac [*Rhus copallinum*]), and eight high-frequency species (tall fescue [*Schedonorus arundinaceus*], Queen Anne's lace [*Daucus carota*], Osage orange [*Maclura pomifera*], sericea lespedeza [*Lespedeza cuneata*], Japanese honeysuckle [*Lonicera japonica*], bald brome [*Bromus racemosus*], eastern redcedar [*Juniperus virginiana*], and multiflora rose [*Rosa multiflora*]).

Based on non-overlapping cover ranges, we observed several changes in species cover in 2020 compared to at least one previous year. This included reduced cover in poverty brome (*Bromus sterilis*), Japanese hedgeparsley (*Torilis japonica*), and common periwinkle (*Vinca minor*). European privet (*Ligustrum vulgare*) increased.

Across the monitoring record, Wilson's Creek NB was found to support 53 problematic plant species. Several of these species are well-established throughout much of the park. We found Osage orange, sericea lespedeza, Japanese honeysuckle, bald brome, eastern redcedar, and multiflora rose in over half of the park search units. Of these frequently observed species, sericea lespedeza and bald brome were commonly found in open grasslands, while the other species were found primarily in woodlands. Sericea lespedeza and eastern redcedar have been highly targeted at the park for control in prairies and glades, respectively.

Silk tree (*Albizia julibrissin*), white mulberry (*Morus alba*), and tree-of-heaven (*Ailanthus altissima*) were all found in woodlands and were at low frequency levels that may allow local eradication. The climbing vine Chinese yam (*Dioscorea oppositifolia*) is another plant that is at low enough levels to potentially remove it from the park. The noxious weed Johnsongrass (*Sorghum halepense*) appears to have increased in frequency over the study period, while there is no clear pattern in distribution changes in the noxious nodding plumeless thistle (*Carduus nutans*).

Given the large number, extent, and cover of problematic plants in Wilson's Creek NB, managers must strategically prioritize any control projects. These monitoring data continue to provide a generalized understanding of problematic plant cover and distribution to support management decisions.

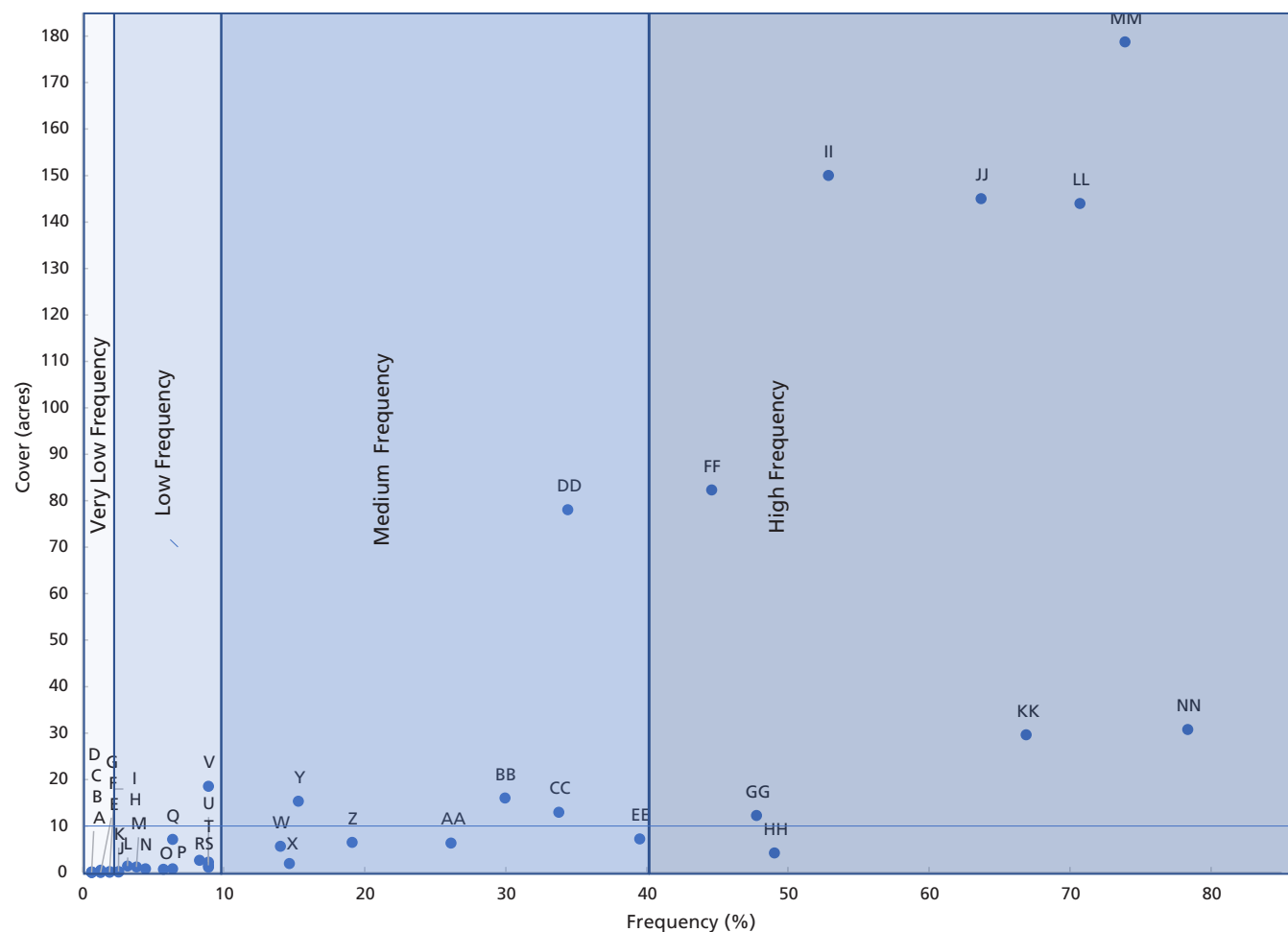


Figure 2. 2020 problematic plant cover and frequency relationship at Wilson's Creek National Battlefield. The cover measure used is based on the midpoint of the cover range. Plants are placed into four categories: very low frequency ($\leq 2\%$), low frequency ($> 2\text{--}10\%$), medium frequency ($> 10\text{--}40\%$), and high frequency ($> 40\%$). The 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) *Dioscorea oppositifolia*, B) *Robinia pseudoacacia*, C) *Albizia julibrissin*, D) *Vinca minor*, E) *Potentilla recta*, F) *Bromus arvensis*, G) *Humulus japonicus*, H) *Rumex crispus*, I) *Dipsacus fullonum*, J) *Hypericum perforatum*, K) *Torilis japonica*, L) *Bromus tectorum*, M) *Morus alba*, N) *Ailanthus altissima*, O) *Ligustrum* spp., P) *Melilotus officinalis*, Q) *Securigera varia*, R) *Carduus nutans*, S) *Ligustrum vulgare*, T) *Euonymus alatus*, U) *Celastrus orbiculatus*, V) *Bromus inermis*, W) *Elaeagnus umbellata*, X) *Verbascum thapsus*, Y) *Rhus glabra*, Z) *Bromus sterilis*, AA) *Sorghum halepense*, BB) *Poa pratensis*, CC) *Euonymus fortunei*, DD) *Rhus copallinum*, EE) *Lonicera maackii*, FF) *Schedonorus arundinaceus*, GG) *Daucus carota*, HH) *Torilis arvensis*, II) *Maclura pomifera*, JJ) *Lespedeza cuneata*, KK) *Lonicera japonica*, LL) *Bromus racemosus*, MM) *Juniperus virginiana*, and NN) *Rosa multiflora*.

Table 3. Cover and frequency of potentially problematic plants found in Wilson's Creek National Battlefield. 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, or not available (n/a). The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicates 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	2006	0.05	1.18	2.55	ML	ML
<i>Ailanthus altissima</i>	tree-of-heaven	2013	0.04	0.83	0.64	ML	ML
<i>Ailanthus altissima</i>	tree-of-heaven	2016	0.06	1.40	5.73	ML	ML
<i>Ailanthus altissima</i>	tree-of-heaven	2020	0.06	1.48	4.46	ML	ML
<i>Albizia julibrissin</i>	silk tree	2020	0.00	0.16	0.64	ML	ML
<i>Alliaria petiolata</i>	garlic mustard	2013	0.00	0.17	0.64	ML	M
<i>Alliaria petiolata</i>	garlic mustard	2016	0.00	0.05	1.91	ML	M
<i>Arctium minus</i>	lesser burdock	2006	0.00	0.02	0.64	LI	MI
<i>Arctium minus</i>	lesser burdock	2013	0.00	0.02	0.64	LI	MI
<i>Arctium minus</i>	lesser burdock	2016	0.00	0.02	0.64	LI	MI
<i>Bromus arvensis</i> ^b	field brome	2016	0.00	0.17	0.64	n/a	n/a
<i>Bromus arvensis</i>	field brome	2020	0.01	0.32	1.27	n/a	n/a
<i>Bromus inermis</i>	smooth brome	2006	8.97	172.31	5.10	M	ML
<i>Bromus inermis</i>	smooth brome	2013	15.88	286.51	17.20	M	ML
<i>Bromus inermis</i> (decrease from 2013)	smooth brome	2016	0.94	9.18	7.64	M	ML
<i>Bromus inermis</i>	smooth brome	2020	3.27	33.81	8.92	M	ML
<i>Bromus racemosus</i>	bald brome, spiked brome	2006	38.73	757.63	42.68	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2013	49.05	648.62	76.43	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2016	12.06	164.17	60.51	n/a	n/a
<i>Bromus racemosus</i>	bald brome, spiked brome	2020	22.62	265.31	70.70	n/a	n/a
<i>Bromus sterilis</i>	poverty brome	2006	0.14	3.91	13.38	ML	U
<i>Bromus sterilis</i> (increase from 2006)	poverty brome	2013	23.25	394.75	46.50	ML	U
<i>Bromus sterilis</i>	poverty brome	2016	1.82	27.95	33.12	ML	U
<i>Bromus sterilis</i> (decrease from 2013)	poverty brome	2020	0.58	12.40	19.11	ML	U

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson's Creek National Battlefield. 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, or not available (n/a). The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicates 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>Bromus tectorum</i>	cheatgrass	2006	0.00	0.18	1.27	H	HM
<i>Bromus tectorum</i> (increase from 2006)	cheatgrass	2013	0.82	14.34	7.64	H	HM
<i>Bromus tectorum</i>	cheatgrass	2016	0.46	9.24	3.82	H	HM
<i>Bromus tectorum</i>	cheatgrass	2020	0.13	2.61	3.18	H	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2006	0.21	1.71	2.55	MI	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2013	0.70	16.32	34.39	MI	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2016	0.03	1.19	12.10	MI	HM
<i>Carduus nutans</i>	nodding plumeless thistle	2020	0.47	4.79	8.28	MI	HM
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2006	0.02	0.66	2.55	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2013	0.35	4.84	5.73	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2016	0.34	4.59	7.64	ML	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2020	0.31	4.14	8.92	ML	M
<i>Cirsium vulgare</i>	bull thistle	2006	0.01	0.50	1.91	ML	ML
<i>Cirsium vulgare</i>	bull thistle	2016	0.00	0.17	0.64	ML	ML
<i>Daucus carota</i> ^a	Queen Anne's lace	2013	2.86	30.91	21.66	I	I
<i>Daucus carota</i>	Queen Anne's lace	2016	0.83	18.85	43.95	I	I
<i>Daucus carota</i>	Queen Anne's lace	2020	1.06	23.52	47.77	I	I
<i>Dioscorea oppositifolia</i>	Chinese yam	2006	0.00	0.02	0.64	ML	MI
<i>Dioscorea oppositifolia</i>	Chinese yam	2020	0.00	0.01	0.64	ML	MI
<i>Dipsacus fullonum</i>	Fuller's teasel	2006	0.00	0.18	1.27	L	ML
<i>Dipsacus fullonum</i>	Fuller's teasel	2016	0.01	0.20	1.91	L	ML
<i>Dipsacus fullonum</i>	Fuller's teasel	2020	0.01	0.34	1.91	L	ML
<i>Dipsacus laciniatus</i>	cutleaf teasel	2013	0.01	0.20	1.91	L	ML

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson’s Creek National Battlefield. 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, or not available (n/a). The assignment of “decrease from” a particular year or “increase from” a particular year next to a species indicates 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>Elaeagnus umbellata</i>	autumn olive	2006	0.10	2.49	4.46	H	L
<i>Elaeagnus umbellata</i>	autumn olive	2013	0.10	2.34	4.46	H	L
<i>Elaeagnus umbellata</i>	autumn olive	2016	0.07	1.93	8.92	H	L
<i>Elaeagnus umbellata</i>	autumn olive	2020	0.85	10.45	14.01	H	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2006	0.02	0.71	4.46	LI	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2016	0.03	1.14	10.19	LI	L
<i>Euonymus alatus</i>	burningbush, winged euonymus	2020	0.12	2.97	8.92	LI	L
<i>Euonymus fortunei</i>	winter creeper (increase in 2020)	2006	0.01	0.48	7.64	M	LI
<i>Euonymus fortunei</i>	winter creeper	2013	0.08	2.37	8.28	M	LI
<i>Euonymus fortunei</i>	winter creeper	2016	0.06	2.15	33.76	M	LI
<i>Euonymus fortunei</i> (increase from 2006)	winter creeper	2020	1.19	24.69	33.76	M	LI
<i>Hesperis matronalis</i>	dames rocket	2013	0.00	0.17	0.64	MI	HL
<i>Hesperis matronalis</i>	dames rocket	2016	0.00	0.02	0.64	MI	HL
<i>Humulus japonicus</i>	Japanese hop	2006	0.01	0.35	1.91	ML	ML
<i>Humulus japonicus</i>	Japanese hop	2013	0.05	1.16	1.91	ML	ML
<i>Humulus japonicus</i>	Japanese hop	2016	0.02	0.86	4.46	ML	ML
<i>Humulus japonicus</i>	Japanese hop	2020	0.04	0.97	1.27	ML	ML
<i>Hypericum perforatum</i> ^a	common St. Johnswort	2013	0.00	0.02	0.64	ML	M
<i>Hypericum perforatum</i>	common St. Johnswort	2016	0.01	0.29	5.73	ML	M
<i>Hypericum perforatum</i>	common St. Johnswort	2020	0.01	0.20	2.55	ML	M
<i>Juniperus virginiana</i> ^a	eastern redcedar	2013	34.88	550.26	57.96	n/a	n/a
<i>Juniperus virginiana</i>	eastern redcedar	2016	38.85	543.03	76.43	n/a	n/a
<i>Juniperus virginiana</i>	eastern redcedar	2020	23.01	334.52	73.89	n/a	n/a

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^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson's Creek National Battlefield. 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, or not available (n/a). The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicates 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>Lespedeza cuneata</i>	sericea lespedeza	2006	93.94	1,673.61	53.50	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2013	10.50	166.74	47.77	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2016	37.64	545.52	61.15	ML	ML
<i>Lespedeza cuneata</i>	sericea lespedeza	2020	24.11	265.93	63.69	ML	ML
<i>Ligustrum</i> sp.	privet sp.	2016	0.10	2.48	10.19	M	HL
<i>Ligustrum</i> sp.	privet sp.	2020	0.06	1.37	5.73	M	HL
<i>Ligustrum sinense</i>	Chinese privet	2013	0.05	1.16	1.91	M	L
<i>Ligustrum vulgare</i>	European privet	2006	0.01	0.35	1.91	HL	HM
<i>Ligustrum vulgare</i>	European privet	2016	0.00	0.03	1.27	HL	HM
<i>Ligustrum vulgare</i> (increase from 2016)	European privet	2020	0.08	2.17	8.92	HL	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2006	10.60	152.25	45.86	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2013	9.06	134.11	62.42	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2016	1.15	21.68	66.88	M	HM
<i>Lonicera japonica</i>	Japanese honeysuckle	2020	3.62	55.67	66.88	M	HM
<i>Lonicera maackii</i>	Amur honeysuckle	2006	4.17	83.65	1.27	HM	M
<i>Lonicera maackii</i> (decrease from 2006)	Amur honeysuckle	2013	0.09	2.04	4.46	HM	M
<i>Lonicera maackii</i>	Amur honeysuckle	2016	0.58	7.22	17.20	HM	M
<i>Lonicera maackii</i>	Amur honeysuckle	2020	0.71	13.70	39.49	HM	M
<i>Maclura pomifera</i>	Osage orange	2006	33.45	586.44	39.49	ML	L
<i>Maclura pomifera</i>	Osage orange	2013	14.84	208.64	38.85	ML	L
<i>Maclura pomifera</i>	Osage orange	2016	27.61	384.06	58.60	ML	L
<i>Maclura pomifera</i>	Osage orange	2020	18.13	281.92	52.87	ML	L

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^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson’s Creek National Battlefield. 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, or not available (n/a). The assignment of “decrease from” a particular year or “increase from” a particular year next to a species indicates 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>Melilotus officinalis</i>	yellow sweetclover	2006	0.04	1.61	10.83	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2013	0.05	1.22	4.46	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2016	0.18	3.96	10.19	M	M
<i>Melilotus officinalis</i>	yellow sweetclover	2020	0.06	1.53	6.37	M	M
<i>Miscanthus sinensis</i>	Chinese silvergrass	2006	0.00	0.02	0.64	ML	HL
<i>Morus alba</i>	white mulberry	2006	0.06	1.55	5.73	ML	ML
<i>Morus alba</i>	white mulberry	2016	0.56	11.54	6.37	ML	ML
<i>Morus alba</i>	white mulberry	2020	0.10	2.27	3.82	ML	ML
<i>Nasturtium officinale</i> ^a	watercress	2016	0.00	0.05	1.91	ML	MI
<i>Phalaris arundinacea</i>	reed canarygrass	2013	0.00	0.18	1.27	H	HM
<i>Poa compressa</i>	Canada bluegrass	2006	0.01	0.33	1.27	ML	HL
<i>Poa compressa</i>	Canada bluegrass	2016	0.00	0.06	2.55	ML	HL
<i>Poa compressa/pratensis</i>	Canada/Kentucky bluegrass complex	2006	0.14	3.18	5.10	M	M
<i>Poa pratensis</i>	Kentucky bluegrass	2013	10.68	174.74	26.11	M	ML
<i>Poa pratensis</i>	Kentucky bluegrass	2016	2.01	28.61	22.93	M	ML
<i>Poa pratensis</i>	Kentucky bluegrass	2020	2.16	29.85	29.94	M	ML
<i>Potentilla recta</i>	sulphur cinquefoil	2006	0.00	0.02	0.64	HL	ML
<i>Potentilla recta</i>	sulphur cinquefoil	2016	0.00	0.02	0.64	HL	ML
<i>Potentilla recta</i>	sulphur cinquefoil	2020	0.00	0.03	1.27	HL	ML
<i>Rhus copallinum</i> ^a	winged sumac	2013	15.46	201.26	38.85	n/a	n/a
<i>Rhus copallinum</i>	winged sumac	2016	10.75	159.13	46.50	n/a	n/a
<i>Rhus copallinum</i>	winged sumac	2020	13.11	143.05	34.39	n/a	n/a

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson's Creek National Battlefield. 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, or not available (n/a). The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicates 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>Rhus glabra</i>	smooth sumac	2006	1.61	23.59	28.03	n/a	n/a
<i>Rhus glabra</i>	smooth sumac	2013	5.59	52.74	20.38	n/a	n/a
<i>Rhus glabra</i>	smooth sumac	2016	5.57	80.49	24.84	n/a	n/a
<i>Rhus glabra</i>	smooth sumac	2020	2.03	28.69	15.29	n/a	n/a
<i>Robinia pseudoacacia</i>	black locust	2020	0.00	0.01	0.64	HM	M
<i>Rosa multiflora</i>	multiflora rose	2006	5.39	66.56	59.87	L	L
<i>Rosa multiflora</i>	multiflora rose	2013	25.65	414.06	67.52	L	L
<i>Rosa multiflora</i>	multiflora rose	2016	3.21	53.98	76.43	L	L
<i>Rosa multiflora</i>	multiflora rose	2020	3.78	57.79	78.34	L	L
<i>Rumex crispus</i> ^a	curly dock	2016	0.01	0.44	5.73	LI	ML
<i>Rumex crispus</i>	curly dock	2020	0.00	0.04	1.91	LI	ML
<i>Schedonorus arundinaceus</i>	tall fescue	2013	40.28	711.51	52.23	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2016	12.60	149.15	48.41	M	HM
<i>Schedonorus arundinaceus</i>	tall fescue	2020	12.92	151.76	44.59	M	HM
<i>Securigera varia</i>	crownvetch	2006	0.05	1.33	2.55	H	L
<i>Securigera varia</i> (increase from 2006)	crownvetch	2013	4.40	88.49	7.64	H	L
<i>Securigera varia</i> (decrease from 2013)	crownvetch	2016	0.14	3.22	7.01	H	L
<i>Securigera varia</i>	crownvetch	2020	0.91	13.36	6.37	H	L
<i>Sonchus arvensis</i> ^a	field sowthistle	2013	0.01	0.38	3.18	LI	HL
<i>Sonchus arvensis</i>	field sowthistle	2016	0.01	0.23	3.18	LI	HL
<i>Sorghum halepense</i>	Johnsongrass	2006	0.15	3.36	6.37	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2013	0.55	11.88	10.83	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2016	1.59	22.59	17.83	ML	HM
<i>Sorghum halepense</i>	Johnsongrass	2020	0.89	11.75	26.11	ML	HM

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^b Searched for in 2006 and 2020 only

Table 3 (continued). Cover and frequency of potentially problematic plants found in Wilson's Creek National Battlefield. 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, or not available (n/a). The assignment of "decrease from" a particular year or "increase from" a particular year next to a species indicates 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>Torilis arvensis</i> ^a	spreading hedgeparsley	2013	6.22	118.13	54.78	n/a	n/a
<i>Torilis arvensis</i> (decrease from 2013)	spreading hedgeparsley	2016	0.05	1.82	32.48	n/a	n/a
<i>Torilis arvensis</i>	spreading hedgeparsley	2020	0.29	8.12	49.04	n/a	n/a
<i>Torilis japonica</i>	erect hedgeparsley	2006	0.60	9.03	26.75	n/a	n/a
<i>Torilis japonica</i> (decrease from 2006)	erect hedgeparsley	2013	0.00	0.17	0.64	n/a	n/a
<i>Torilis japonica</i> (decrease from 2006)	erect hedgeparsley	2020	0.01	0.35	2.55	n/a	n/a
<i>Ulmus pumila</i>	Siberian elm	2013	0.05	1.33	2.55	ML	ML
<i>Ulmus pumila</i>	Siberian elm	2016	0.00	0.18	1.27	ML	ML
<i>Verbascum thapsus</i>	common mullein	2006	0.07	2.72	19.75	ML	L
<i>Verbascum thapsus</i>	common mullein	2013	0.21	5.93	26.11	ML	L
<i>Verbascum thapsus</i>	common mullein	2016	0.02	0.57	11.46	ML	L
<i>Verbascum thapsus</i>	common mullein	2020	0.28	3.62	14.65	ML	L
<i>Vinca minor</i>	common periwinkle	2006	0.01	0.33	1.27	I	U
<i>Vinca minor</i>	common periwinkle	2013	0.21	1.67	0.64	I	U
<i>Vinca minor</i>	common periwinkle	2016	0.01	0.33	1.27	I	U
<i>Vinca minor</i> (decrease from 2013)	common periwinkle	2020	0.00	0.16	0.64	I	U

^a Searched for in 2013, 2016, and 2020 only

^b Searched for in 2006 and 2020 only

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

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Natural Resource Stewardship and Science

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