



Invasive Plant Monitoring in George Washington Carver National Monument

2006–2016

Natural Resource Data Series NPS/HTLN/NRDS—2018/1171





ON THIS PAGE

Heartland Exotic Plant Management Team treating Japanese honeysuckle (*Lonicera japonica*), George Washington Carver National Monument.

Photography by NPS

ON THE COVER

Japanese honeysuckle (*Lonicera japonica*) in the vicinity of Carver Creek, George Washington Carver National Monument.

Photography by NPS

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

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Abstract

Managers are challenged with the impact of problematic plants, including exotic, non-native, and pest plant species. Information on the abundance, distribution, and location of these plants is essential for developing risk-based approaches to managing these species. Based on surveys conducted in 2006, 2013, and 2016, Heartland Network staff and contractors identified 46 invasive plant species in George Washington Carver National Monument. Of these species, we characterized 21 as low frequency/low abundance, eight as medium frequency/low to medium abundance, and three as high frequency/medium to high abundance. This pattern showed that most species were neither widespread nor highly abundant, suggesting that actions taken now may be highly effective in maintaining or reducing these invasive plant populations in the park.

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 13112, 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 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 study presents invasive plant monitoring at George Washington Carver National Monument (NM) over three periods between 2006 and 2016. Results will help improve decision-making with respect to problematic plants in the park. The key metrics presented include plant abundance and geographic distribution within the park.



Conservation Corps Iowa crew members are an essential National Park Service Partner in the effort to control invasive plants, such as Japanese honeysuckle (*Lonicera japonica*) and sericea (*Lespedeza cunneata*) at George Washington Carver NM.

Methods

Watch Lists

We searched for invasive exotic plants that were on three watch lists. The prioritization for developing the lists is flexible and described in detail in Young et al. (2007). Because our prioritization, NPSpecies, and botanical nomenclature are subject to periodic updating, we only include species that we searched for during 2013 and 2016 in this report. Any plants sought only in 2006 are not included. In general, prioritized invasive exotic plants not known to occur in the park based on NPSpecies (the national NPS database for plant occurrence registration) constituted the early detection watch list (n=67; Table 1).

Table 1. Early detection invasive plant watch list used to guide surveys in George Washington Carver NM.

Scientific Name	Common Name
<i>Ailanthus altissima</i>	tree of heaven
<i>Albizia julibrissin</i>	silk tree
<i>Alliaria petiolata</i>	garlic mustard
<i>Alnus glutinosa</i>	European alder
<i>Arundo donax</i>	giant reed
<i>Berberis thunbergii</i>	Japanese barberry
<i>Bothriochloa bladhii</i>	Caucasian bluestem
<i>Celastrus orbiculatus</i>	Oriental bittersweet
<i>Centaurea solstitialis</i>	yellow star-thistle
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed
<i>Cornus foemina</i>	stiff dogwood
<i>Cynanchum louiseae</i> *	Louise's swallow-wort
<i>Cynanchum rossicum</i> *	European swallow-wort
<i>Dioscorea oppositifolia</i>	Chinese yam
<i>Dipsacus laciniatus</i>	cutleaf teasel
<i>Egeria densa</i> *	Brazilian waterweed
<i>Eichhornia crassipes</i> *	common water hyacinth
<i>Elaeagnus angustifolia</i>	Russian olive
<i>Elaeagnus umbellata</i>	autumn olive
<i>Euonymus alatus</i>	burning bush
<i>Euphorbia cyparissias</i> *	cypress spurge
<i>Euphorbia esula</i>	leafy spurge
<i>Hesperis matronalis</i>	dames rocket
<i>Holcus lanatus</i>	common velvetgrass
<i>Humulus japonicus</i> *	Japanese hop
<i>Iris pseudacorus</i> *	pale yellow iris
<i>Leonurus cardiaca</i>	common motherwort

* taxa that were sought in 2013 and 2016 only.

Table 1 (continued). Early detection invasive plant watch list used to guide surveys in George Washington Carver NM.

Scientific Name	Common Name
<i>Lepidium latifolium</i> *	broadleaved pepperweed
<i>Lespedeza bicolor</i>	shrub lespedeza
<i>Ligustrum obtusifolium</i> *	border privet
<i>Ligustrum sinense</i>	Chinese privet
<i>Linaria vulgaris</i> *	butter and eggs
<i>Lonicera</i> spp	honeysuckle
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Lotus corniculatus</i>	bird's-foot trefoil
<i>Lysimachia nummularia</i>	creeping jenny
<i>Lythrum salicaria</i>	purple loosestrife
<i>Microstegium vimineum</i>	Nepalese browntop
<i>Miscanthus sinensis</i>	Chinese silvergrass
<i>Myosotis scorpioides</i> *	true forget-me-not
<i>Myriophyllum aquaticum</i>	parrot feather watermilfoil
<i>Myriophyllum spicatum</i> *	Eurasian watermilfoil
<i>Najas minor</i> *	brittle water nymph
<i>Rorippa nasturtium-aquaticum</i>	waterscress
<i>Onopordum acanthium</i> *	Scotch cottonthistle
<i>Pastinaca sativa</i>	wild parsnip
<i>Paulownia tomentosa</i>	princess tree
<i>Phalaris arundinacea</i>	reed canarygrass
<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>Prunus mahaleb</i> *	Mahaleb cherry
<i>Pueraria montana</i>	kudzu
<i>Rhamnus cathartica</i>	common buckthorn
<i>Schedonorus arundinaceus</i>	tall fescue
<i>Schedonorus pratensis</i>	meadow fescue
<i>Sesbania herbacea</i>	bigpod sesbania
<i>Sonchus arvensis</i> *	field sowthistle
<i>Spiraea japonica</i>	Japanese meadowsweet
<i>Tanacetum vulgare</i> *	common tansy
<i>Typha</i> spp	cattail
<i>Typha angustifolia</i>	narrowleaf cattail
<i>Typha x glauca</i> *	hybrid cattail
<i>Viburnum opulus</i> *	European cranberry bush
<i>Wisteria sinensis</i>	Chinese wisteria

* taxa that were sought in 2013 and 2016 only

Prioritized invasive exotic plants known to occur in the park based on NPSpecies constituted the park-established watch list (n=40; Table 2).

Table 2. Park-established invasive plant watch list used to guide surveys in George Washington Carver NM.

Scientific Name	Common Name
<i>Carduus nutans</i>	nodding plumeless thistle
<i>Acer ginnala</i>	Amur maple
<i>Arctium minus</i>	lesser burdock
<i>Bromus inermis</i>	smooth brome
<i>Bromus racemosus</i>	bald brome
<i>Bromus sterilis</i>	poverty brome
<i>Bromus tectorum</i>	cheatgrass
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium vulgare</i>	bull thistle
<i>Daucus carota</i>	Queen Anne's lace
<i>Dipsacus fullonum</i>	Fuller's teasel
<i>Elymus repens</i> *	quackgrass
<i>Euonymus fortunei</i>	winter creeper
<i>Glechoma hederacea</i>	ground ivy
<i>Hedera helix</i>	English ivy
<i>Heimerocallis fulva</i> *	orange daylily
<i>Hypericum perforatum</i> *	common St. Johnswort
<i>Lespedeza cuneata</i>	sericea lespedeza
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Maclura pomifera</i>	osage orange
<i>Melilotus officinalis</i>	yellow sweetclover
<i>Morus alba</i>	white mulberry
<i>Poa compressa</i>	Canada bluegrass
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Potamogeton crispus</i>	curly dock
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Rhus glabra</i>	smooth sumac
<i>Rhus glabra</i>	smooth sumac
<i>Robinia pseudoacacia</i>	black locust
<i>Rosa multiflora</i>	multiflora rose
<i>Rumex acetosella</i>	common sheep sorrel
<i>Rumex crispus</i> *	curly dock
<i>Saponaria officinalis</i>	bouncingbet
<i>Securigera varia</i>	crownvetch
<i>Sorghum halepense</i>	Johnsongrass
<i>Torilis arvensis</i> *	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

*taxa that were sought in 2013 and 2016 only.

A third watch list, the park-based watch list, included additional species of concern that have not been prioritized for searches (n=4; Table 3). While aquatic species were included on the watch lists, terrestrial plants were the focus of this survey. Aquatic plants were documented only occasionally.

Table 3. Park-based invasive plant watch list used to guide surveys in George Washington Carver NM.

Scientific Name	Common Name
<i>Juniperus virginiana</i> *	eastern redcedar
<i>Ligustrum vulgare</i>	European privet
<i>Lolium perenne</i> *	perennial ryegrass
<i>Rhus copallinum</i> *	winged sumac

* taxa that were sought in 2013 and 2016 only.

Field Methods

We searched for invasive exotic plant species on designated watch lists (Table 1) across George Washington Carver NM (Figure 1). In 2006, Dan Tenaglia, the contract botanist for this project, navigated along three non-fixed, roughly equidistantly spaced transects through search units using a Thales GPS unit and identified invasive plants in an approximately 6-m belt. The observer, however, 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.). In 2013, staff with ESS and sub-contractor George Yatskievych from the Missouri Botanical Garden navigated using a Trimble GeoXT GPS unit to conduct the survey. Jordan Bell, Sherry Leis, and Craig Young with the NPS Heartland I&M Network conducted the survey in 2016. In 2013 and 2016, observers restricted observations to within a 3- to 12-meter belt along transects within search units, using the widest observable distance within that range. 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 = 1000–4,999.9 m². A total of 97 search units were surveyed in the park in 2006 and 114 units were surveyed in 2013 and 2016.

Analytical Methods

It is important to note that we treated all data similarly, which required the assumption that observations during 2006 were also made within a 3- to

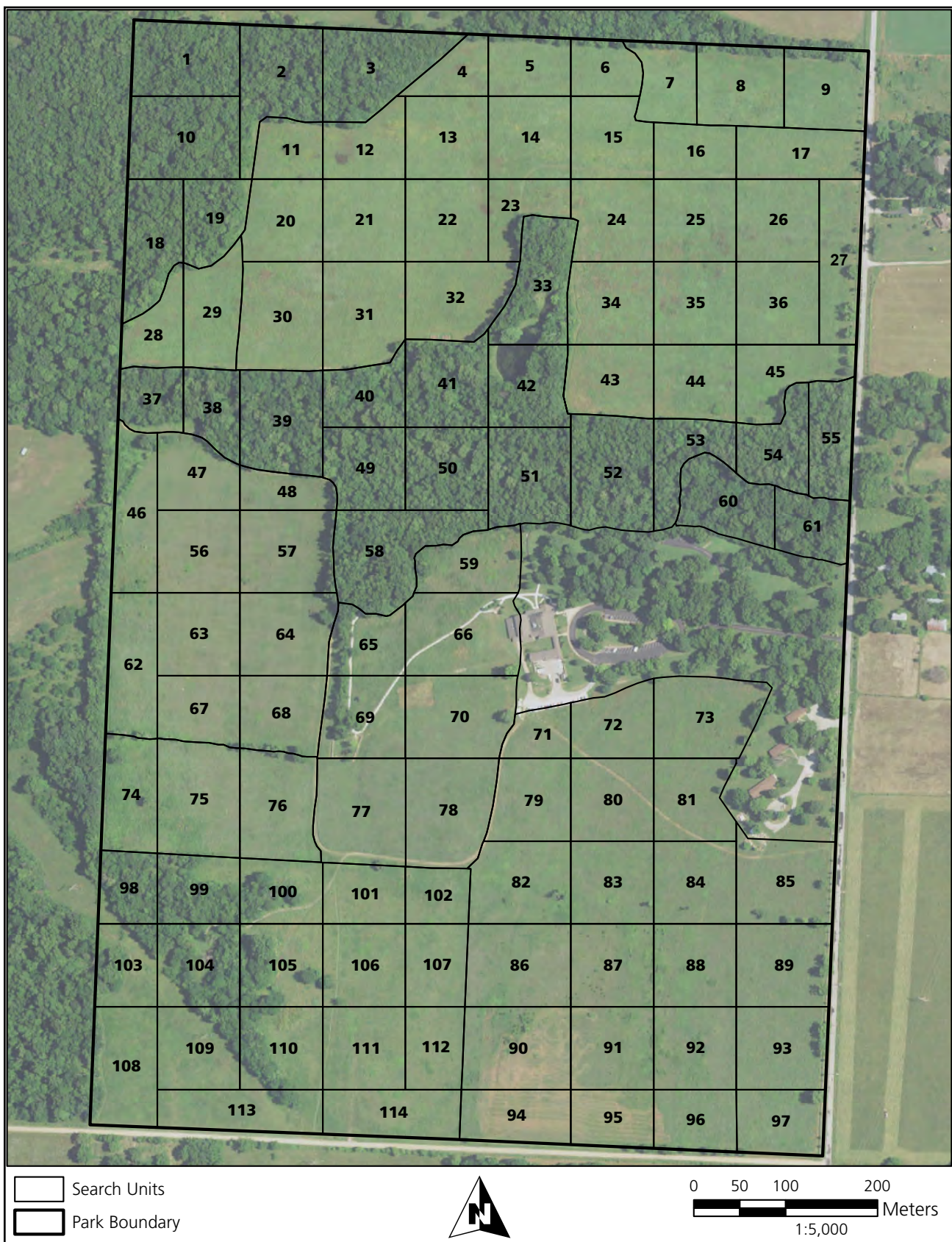


Figure 1. Location of search units used to monitor invasive plants in George Washington Carver NM. Search unit size averages 1.9 acres. Transects 1–97 were included in the 2006 survey, while all 114 units were included in subsequent surveys.

12-m wide belt. Further complicating comparisons between 2006 and subsequent years, the number of search units increased from 97 to 114 after the park acquired additional land. Finally, we treated all search units as equivalent for the purposes of frequency calculations. These changes should be considered when comparing metrics between years.

A park-wide cover range was estimated for each invasive 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 1.9 acres (7,689 m²). When calculated as a square, a unit of this size has length and width of 87.7 m. The fraction of the park observed assuming a 3-m belt (3 transects × 87.7m length × 3-m width) was calculated as 10.2%. The fraction of the park observed assuming a 12-m belt (3 transects × 87.7m length × 12-m width) was calculated as 41.1%.

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:

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

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 invasive exotic plants was calculated as the percentage of occupied search units. A total of 97 search units were surveyed in the park in 2006 and 114 units were surveyed in 2013 and 2016.

Equation 3:

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

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 abundance.

Finally, we created maps for each target invasive plant species (not included in this report). The maps show occupied search units and the estimated cover value for each search unit during each survey period.

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 abundance/distribution, trend in distribution/abundance, and management difficulty. The ecological impact and management difficulty sub-ranks, when available, were presented in Table 2 of the Results section (NatureServe 2018).

Taxonomic Notes

Certain species groups have likely resulted in missed identifications over the course of the study. The annual brome species *Bromus racemosus*, *Bromus sterilis*, and *Bromus tectorum* and the bluegrass species *Poa* spp, *Poa compressa*, and *Poa pratensis* are difficult to identify in the late summer and may best be considered at the level of genus. This also appears to be the case for *Torilis* species which were identified consistently as *Torilis arvensis* in 2006, but likely as *Torilis japonica* in 2013 and 2016. Finally, a *Lolium* species identified in 2006 may have been *Schedonorus arundinaceus* (formerly *Lolium arundinaceum*), but because we are uncertain this species is not shown in this report.

Results

Plant abundance and frequency estimates are presented in Table 4 and the 2016 data are depicted graphically in Figure 2. In the figure, we categorized plants in three categories: (1) low frequency/low abundance, (2) medium frequency/low to medium abundance, and (3) high frequency/medium to high abundance. Plant locations with abundance are contained available for park use. These data are

highly effective for early detection of invasive plants in the park. The extensive nature of this sampling design, however, may include high levels of unspecified observer error. The data provide a generalized understanding of invasive plant abundance and distribution to effectively support invasive plant management decisions.

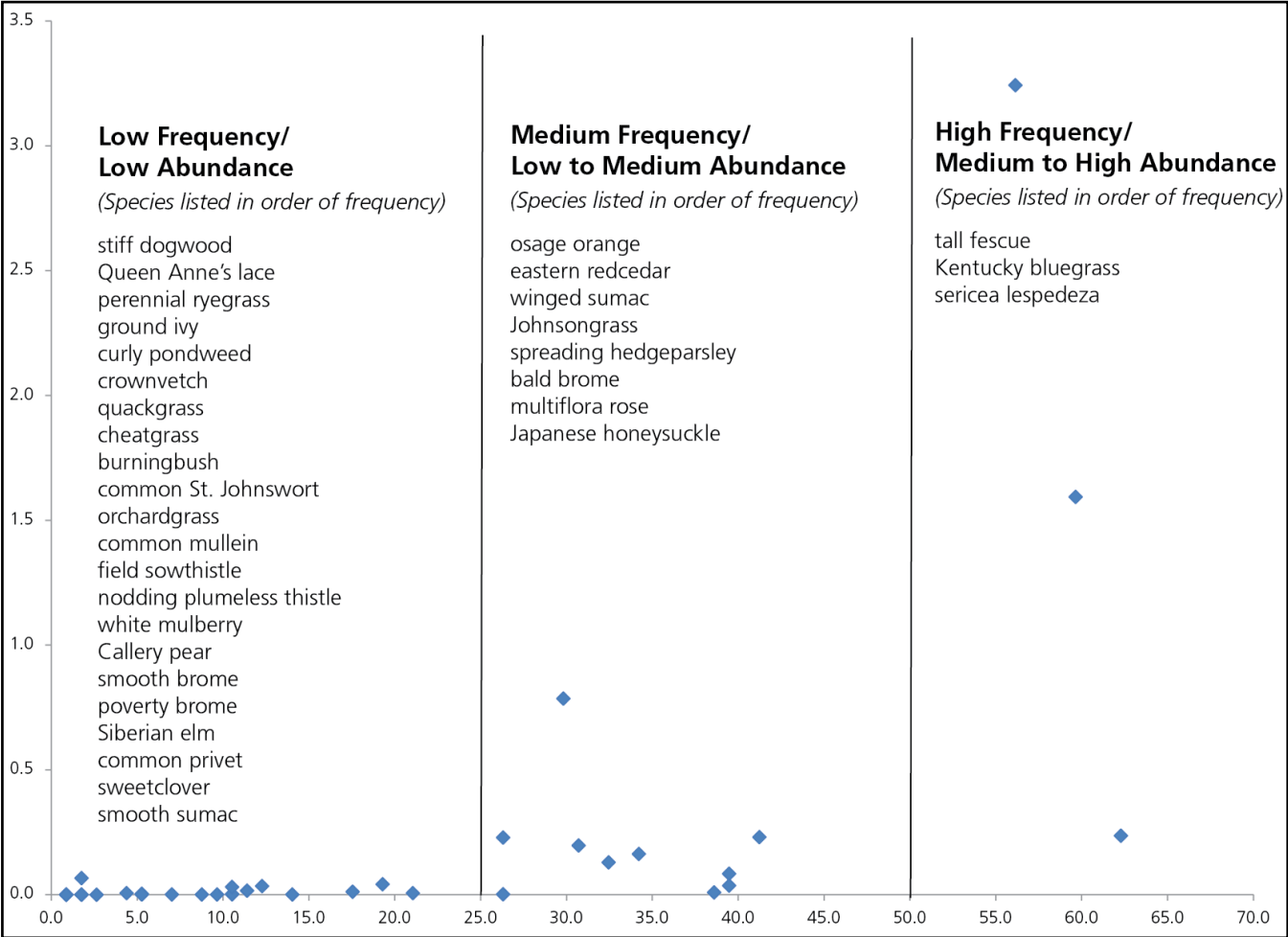


Figure 2. 2016 invasive plant abundance and frequency estimates at George Washington Carver NM. The abundance measure used is based on the low-end of the abundance range. Plants are categorized into three categories: low frequency/low abundance, medium frequency/low to medium abundance, and high frequency/medium to high abundance.

Table 4. Abundance and distribution of invasive plants found in George Washington Carver NM (n = 97 for 2006, n = 114 for 2013 and 2016). 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), unknown (U), a range of the above ranks, or not available (n/a). NATIVE represents species that are native to the U.S., but are known to behave invasively in some settings.

Scientific Name	Common Name	2006 low cover estimate (acres)	2006 high cover estimate (acres)	2006 frequency	2013 low cover estimate (acres)	2013 high cover estimate (acres)	2013 frequency	2016 low cover estimate (acres)	2016 high cover estimate (acres)	2016 frequency	EI	Mgmt
<i>Arctium minus</i>	–	0.00006	0.002	0.9	0.0009	0.03	6.2	–	–	–	LI	MI
<i>Bromus inermis</i>	smooth brome	0.7	7.0	21.6	0.04	0.5	11.4	0.02	0.4	11.4	M	ML
<i>Bromus racemosus</i>	bald brome	4.0	54.0	33.0	0.4	7.0	71.1	0.08	2.0	39.5	n/a	n/a
<i>Bromus sterilis</i>	poverty brome	0.09	1.0	9.3	1.0	17.0	37.7	0.03	0.4	12.3	ML	U
<i>Bromus tectorum</i>	cheatgrass	–	–	–	0.6	9.0	56.1	0.006	0.1	4.4	H	HM
<i>Carduus nutans</i>	nodding plumeless thistle	–	–	–	0.01	0.4	44.7	0.001	0.05	10.5	MI	HM
<i>Celastrus orbiculatus</i>	Oriental bittersweet	0.0001	0.004	2.1	–	–	–	–	–	–	ML	M
<i>Cornus foemina</i>	stiff dogwood	–	–	–	0.0006	0.02	0.9	0.0006	0.02	0.9	n/a	n/a
<i>Dactylis glomerata</i>	orchardgrass	0.02	0.4	13.4	–	–	–	0.001	0.04	7.0	LI	ML
<i>Daucus carota</i>	Queen Anne's lace	–	–	–	–	–	–	0.00006	0.002	0.9	I	I
<i>Elymus repens</i> *	quackgrass	–	–	–	–	–	–	0.0002	0.007	2.6	ML	HM
<i>Euonymus alatus</i>	burningbush	0.00006	0.002	1.0	–	–	–	0.003	0.1	5.3	LI	L
<i>Euonymus fortunei</i>	winter creeper	0.03	0.7	13.4	0.4	5.0	14.0	0.2	4.0	26.3	M	LI
<i>Glechoma hederacea</i>	ground ivy	0.001	0.05	2.1	0.006	0.1	0.9	0.07	1.0	1.8	MI	U
<i>Hedera helix</i>	English ivy	–	–	–	0.00006	0.002	0.9	–	–	–	M	ML
<i>Hemerocallis fulva</i> *	orange daylily	–	–	–	0.0006	0.02	0.9	–	–	–	MI	L
<i>Hypericum perforatum</i> *	common St. Johnswort	–	–	–	0.01	0.3	16.7	0.0003	0.01	5.3	ML	M
<i>Juniperus virginiana</i> *	eastern redcedar	–	–	–	0.04	1.0	29.8	0.2	3.0	30.7	Native	Native
<i>Lespedeza cuneata</i>	sericea lespedeza	0.3	6.0	35.1	0.01	0.6	36.0	0.2	5.0	62.3	ML	ML
<i>Ligustrum sinense</i>	Chinese privet	–	–	–	0.03	0.6	8.8	–	–	–	M	L
<i>Ligustrum vulgare</i>	commonpage i privet	0.05	0.8	14.4	–	–	–	0.01	0.3	17.5	HL	HM
<i>Lolium perenne</i> *	perennial ryegrass	–	–	–	0.01	0.3	7.9	0.00006	0.002	0.9	M	MI
<i>Lonicera japonica</i>	Japanese honeysuckle	4.0	68.0	27.8	0.3	4.0	36.8	0.2	5.0	41.2	M	HM
<i>Lonicera maackii</i>	Amur honeysuckle	0.0006	0.02	1.0	0.0006	0.02	0.9	–	–	–	HM	M
<i>Maclura pomifera</i>	osage orange	2.0	24.0	19.6	0.3	4.0	31.6	0.8	10.0	29.8	ML	L
<i>Melilotus officinalis</i>	sweetclover	0.01	0.2	5.2	0.01	0.3	13.2	0.04	0.6	19.3	M	M

* taxa that were sought in 2013 and 2016 only.

Table 4 (continued). Abundance and distribution of invasive plants found in George Washington Carver NM (n = 97 for 2006, n = 114 for 2013 and 2016). 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), unknown (U), a range of the above ranks, or not available (n/a). NATIVE represents species that are native to the U.S., but are known to behave invasively in some settings.

Scientific Name	Common Name	2006 low cover estimate (acres)	2006 high cover estimate (acres)	2006 frequency	2013 low cover estimate (acres)	2013 high cover estimate (acres)	2013 frequency	2016 low cover estimate (acres)	2016 high cover estimate (acres)	2016 frequency	EI	Mgmt
<i>Morus alba</i>	white mulberry	0.01	0.3	9.3	–	–	–	0.002	0.09	10.5	ML	ML
<i>Phalaris arundinacea</i>	reed canarygrass	–	–	–	0.00006	0.002	0.9	–	–	–	H	HM
<i>Poa</i> spp	bluegrass	0.8	15.0	7.2	–	–	–	–	–	–	n/a	n/a
<i>Poa compressa</i>	Canada bluegrass	–	–	–	0.0008	0.03	3.5	–	–	–	ML	HL
<i>Poa pratensis</i>	Kentucky bluegrass	–	–	–	0.3	5.0	64.9	2.0	21.0	59.6	M	ML
<i>Potamogeton crispus</i> *	curly pondweed	–	–	–	0.0007	0.03	1.8	0.0001	0.004	1.8	M	ML
<i>Potentilla recta</i>	sulphur cinquefoil	0.0003	0.01	5.2	–	–	–	–	–	–	HL	ML
<i>Pyrus calleryana</i>	Callery pear	–	–	–	–	–	–	0.03	0.3	10.5	LI	ML
<i>Rhus copallinum</i> *	winged sumac	–	–	–	0.1	2.0	42.1	0.1	2.0	32.5	Native	Native
<i>Rhus glabra</i>	smooth sumac	0.7	7.0	19.6	0.01	0.5	19.3	0.006	0.2	21.1	Native	Native
<i>Rorippa nasturtium-aquaticum</i>	watercress	–	–	–	0.001	0.05	2.6	–	–	–	ML	MI
<i>Rosa multiflora</i>	multiflora rose	0.7	12.0	37.1	0.08	2.0	35.1	0.04	1.0	39.5	L	L
<i>Rumex acetosella</i>	common sheep sorrel	–	–	–	0.006	0.2	10.5	–	–	–	LI	H
<i>Rumex crispus</i> *	curly dock	–	–	–	0.03	1.0	61.4	0.002	0.07	26.3	LI	ML
<i>Schedonorus phoenix</i>	tall fescue	–	–	–	0.9	11.0	79.8	3.0	31.0	56.1	M	HM
<i>Securigera varia</i>	crownvetch	0.3	2.0	1.0	0.03	0.3	2.6	0.0007	0.03	1.8	H	L
<i>Sonchus arvensis</i>	field sowthistle	–	–	–	0.00006	0.002	0.9	0.0007	0.02	9.6	LI	HL
<i>Sorghum halepense</i>	Johnsongrass	0.5	8.0	28.9	0.02	0.7	28.9	0.2	2.0	34.2	ML	HM
<i>Torilis arvensis</i> *	spreading hedgeparsley	–	–	–	0.05	1.0	54.4	0.009	0.4	38.6	n/a	n/a
<i>Torilis japonica</i>	erect hedgeparsley	0.3	2.0	1.0	–	–	–	–	–	–	n/a	n/a
<i>Ulmus pumila</i>	Siberian elm	–	–	–	0.0007	0.03	1.8	0.001	0.03	14.0	ML	ML
<i>Verbascum thapsus</i>	common mullein	0.0009	0.03	6.2	0.002	0.07	11.4	0.0006	0.02	8.8	ML	L

* taxa that were sought in 2013 and 2016 only.

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