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Natural Resource Stewardship and Science

Invasive Exotic Plant Monitoring (Year 2) for Cuyahoga Valley National Park

Natural Resource Data Series NPS/HTLN/NRDS—2018/1177

ON THIS PAGE

Invasive, exotic plants at Cuyahoga Valley National Park. Left to right: (a) Japanese stilt grass growing beside Lock 29, (b) park staff member standing amidst hybrid cattail at the Beaver Marsh, (c) purple loosestrife growing along the banks of the canal near Rockside Station, (d) honeysuckle next to a grave from a 19th century farm, (e) Queen Anne's lace growing along the tracks of the park's Scenic Railway, (f) Amur honeysuckle next to the Boston Visitors Center, (g) Japanese knotweed invading the banks of the Cuyahoga River, (h) multiflora rose thicket by the Peninsula dam bypass i) Common reed invading Stumpy Basin, a rare plant area in the park.

Photographs by Brendan C. Morgan. (a, c-i) and Sonia N. Bingham (b)

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

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

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

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Abstract

Based on surveys conducted in 2007 and 2016, Heartland Inventory & Monitoring (I&M) Network staff and contractors identified 61 invasive exotic plant species at Cuyahoga Valley National Park. No taxa showed meaningful evidence for a decline. Multiflora rose and reed canarygrass accounted for the majority of invasive plant cover in the park, covering at least 294 and 257 acres, respectively. Multiflora rose and garlic mustard are the most widespread species in the park, occurring in 91% and 67% of the 822 transects surveyed in 2016. Japanese stilt grass is a standout among species surveyed; it was not observed in the 2007 survey, yet it now covers between 66 and 930 acres in the park. Of the 56 invasive exotic plants recorded in the 2016 survey, 44 species occurred in less than 20% of the 822 transects and six species occupied less than one acre. While the rapid spread of some species is concerning, the relatively low cover of many other species is encouraging and suggests that successful control may be a viable management option. The acreage estimates presented in the report may be used to plan invasive exotic plant control management activities.

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).

Previous surveys in Cuyahoga Valley National Park (NP) documented high levels of invasive exotic plants throughout the park (Vorac and Schramm 2003; Djuren and Young 2007). Invasive exotic plants present management challenges that may include changes in important habitats and alteration of ecosystem processes. This report provides a comprehensive, current view on the status of a large complement of invasive exotic plant species. The distribution and abundance information may be used to develop strategies for controlling invasive exotic plants in this urban ecosystem.

Garlic mustard (*Alliaria petiolata*) infestation on a sandbar in Cuyahoga Valley NP.

Methods

Watch Lists

We searched for invasive exotic plants from three watch lists. Invasive exotic plants not known to occur on the park based on NPSpecies (the national NPS database for plant occurrence registration) constituted the early detection watch list (n = 36; Table 1). Invasive exotic plants known to occur on the park based on NPSpecies constituted the park-established watch list (n = 62; Table 2). A third watch list, the park-based watch list, included one species of concern to park mangers (Table 3). The park-based watch list is used to capture species that may be of local concern to managers, but were not included as priority species on other watch lists. While aquatic species are listed on the watch lists, terrestrial plants were the focus of this survey. Aquatic plants were documented only occasionally.

Table 1. Early detection invasive exotic plant watch list for Cuyahoga Valley NP.

Scientific Name	Common Name
*Acer ginnala**	Amur maple
Albizia julibrissin	silktree
*Ampelopsis brevipedunculata**	Amur peppervine
Bromus sterilis	poverty brome
Bromus tectorum	cheatgrass
*Butomus umbellatus**	flowering rush
Carduus nutans	nodding plumeless thistle
*Cynanchum louiseae**	louise's swallow-wort
Dioscorea oppositifolia	Chinese yam
Dipsacus laciniatus	cutleaf teasel
Egeria densa	Brazilian waterweed
Elaeagnus angustifolia	Russian olive
*Euonymus alatus**	burningbush
*Euphorbia cyparissias**	cypress spurge
Euphorbia esula	leafy spurge
Frangula alnus	glossy buckthorn
Lespedeza bicolor	shrub lespedeza
Lespedeza cuneata	sericea lespedeza
*Lolium arundinaceum**	tall fescue
Microstegium vimineum	Nepalese browntop
Miscanthus sinensis	Chinese silvergrass
Myriophyllum aquaticum	parrot feather watermilfoil

* Taxa that were added to the watch list in 2016.

Table 1 (continued). Early detection invasive exotic plant watch list for Cuyahoga Valley NP.

Scientific Name	Common Name
*Onopordum acanthium**	Scotch cottonthistle
Paulownia tomentosa	princesstree
*Polygonum perfoliatum**	Asiatic tearthumb
Polygonum sachalinense	giant knotweed
*Prunus mahaleb**	Mahaleb cherry
*Pueraria montana var. lobata**	kudzu
*Pyrus calleryana**	callery pear
Securigera varia	crownvetch
Sorghum halepense	Johnsongrass
Spiraea japonica	Japanese meadowsweet
*Torilis arvensis**	spreading hedgeparsley
Typha x glauca	hybrid cattail
Viburnum opulus	European cranberrybush
Wisteria floribunda	Japanese wisteria

* Taxa that were added to the watch list in 2016.

Table 2. Park-established invasive exotic plant watch list for Cuyahoga Valley NP.

Scientific Name	Common Name
Acer platanoides	Norway maple
Ailanthus altissima	tree of heaven
Alliaria petiolata	garlic mustard
Alnus glutinosa	european alder
*Arctium minus**	lesser burdock
Berberis thunbergii	Japanese barberry
Bromus inermis	smooth brome
Celastrus orbiculatus	Oriental bittersweet
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
*Daucus carota**	Queen Anne's lace
Dipsacus fullonum	Fuller's teasel
Elaeagnus umbellata	autumn olive
*Elymus repens**	quackgrass
Euonymus fortunei	winter creeper
Glechoma hederacea	ground ivy
Hedera helix	English ivy
*Hemerocallis fulva**	orange daylily
Hesperis matronalis	dames rocket

* Taxa that were added to the watch list in 2016.

Table 2 (continued). Park-established invasive exotic plant watch list for Cuyahoga Valley NP.

Scientific Name	Common Name
Holcus lanatus	common velvetgrass
*Humulus japonicus**	Japanese hop
*Hypericum perforatum**	common St. Johnswort
Iris pseudacorus	paleyellow iris
*Leonurus cardiaca**	common motherwort
*Ligustrum obtusifolium**	border privet
Ligustrum vulgare	European privet
*Linaria vulgaris**	butter and eggs
Lonicera japonica	Japanese honeysuckle
Lonicera maackii	Amur honeysuckle
Lonicera morrowii	Morrow's honeysuckle
Lonicera tatarica	Tatarian honeysuckle
Lonicera x bella	showy fly honeysuckle
Lotus corniculatus	bird's-foot trefoil
Lysimachia nummularia	creeping jenny
Lythrum salicaria	purple loosestrife
Melilotus officinalis	yellow silvergrass
Morus alba	white mulberry
*Myosotis scorpioides**	true forget-me-not
Myriophyllum spicatum	Eurasian watermilfoil
Najas minor	brittle waternymph
Pastinaca sativa	wild parsnip
Phalaris arundinacea	reed canarygrass
Phragmites australis	common reed
Poa compressa	Canada bluegrass
Poa pratensis	Kentucky bluegrass
Polygonum cuspidatum	Japanese knotweed
Populus alba	white poplar
Potamogeton crispus	curly pondweed
Potentilla recta	sulphur cinquefoil
Rhamnus cathartica	common buckthorn
Robinia pseudoacacia	black locust
Rosa multiflora	multiflora rose
*Rumex acetosella**	common sheep sorrel
*Rumex crispus**	curly doc
*Saponaria officinalis**	bouncingbet
*Sonchus arvensis**	field sowthistle
*Tanacetum vulgare**	common tansy
*Torilis japonica**	erect hedgeparsley
Typha angustifolia	narrowleaf cattail
Ulmus pumila	Siberian elm
Verbascum thapsus	common mullein
Vinca minor	common periwinkle

* Taxa that were added to the watch list in 2016.

Table 3. Park-based invasive exotic plant watch list for Cuyahoga Valley NP.

Scientific Name	Common Name
Dactylis glomerata	orchard grass

Field Methods

To search for invasive exotic plant species across Cuyahoga Valley NP, we used 400-m transects unless clipped by the park boundary (Figure 1). Observers from Davey Resource Group used a Trimble GPS unit to survey transects in 2007. Brendan Morgan surveyed these transects again in 2016 using a Trimble Geo 7x for navigation. In 2007, surveyors included observations that extended to the end of their line of sight from a transect and had discretion to leave the transect to find additional observations. In 2016, observers surveyed invasive plants along 400-m transects and restricted observations to within a 3- to 12-meter belt (i.e., 1.5 m or 6 m on each side, left and right, of the transect, respectively), using the widest observable distance within that range. Cover was estimated for all plants observed while navigating along the transect using the following cover values: 0 = 0, 1 = 0.1–0.9 m^2, 2 = 1–9.9 m^2, 3 = 10–49.9 m^2, 4 = 50–99.9 m^2, 5 = 100–499.9 m^2, 6 = 500–999.9 m^2, 7 = 1000–4,999.9 m^2. A total of 822 transects were surveyed at Cuyahoga Valley NP. Of these, 385 transects were 400 m in length, while 437 were clipped by the park boundary.

In 2016, at least every other week and even more frequently at the start of the survey, Heartland I&M Network staff visited the field in teams of two to review and discuss cover estimates and plant taxonomic issues in order to limit inter-observer cover estimate errors. Additionally, 1-m^2 and 10-m^2 squares were flagged in the field station yard to allow staff to recalibrate their visual cover estimates every morning.

Analytical Methods

We note two assumptions here with respect to the analytical methods. We treated the 2007 and 2016 data similarly, which required the assumption that observations during 2007 were also made within a 3- to 12-m wide belt. This assumption is reasonable, but introduces additional uncertainty when comparing cover values between years. All such comparisons must be made cautiously. Secondly, we treated all

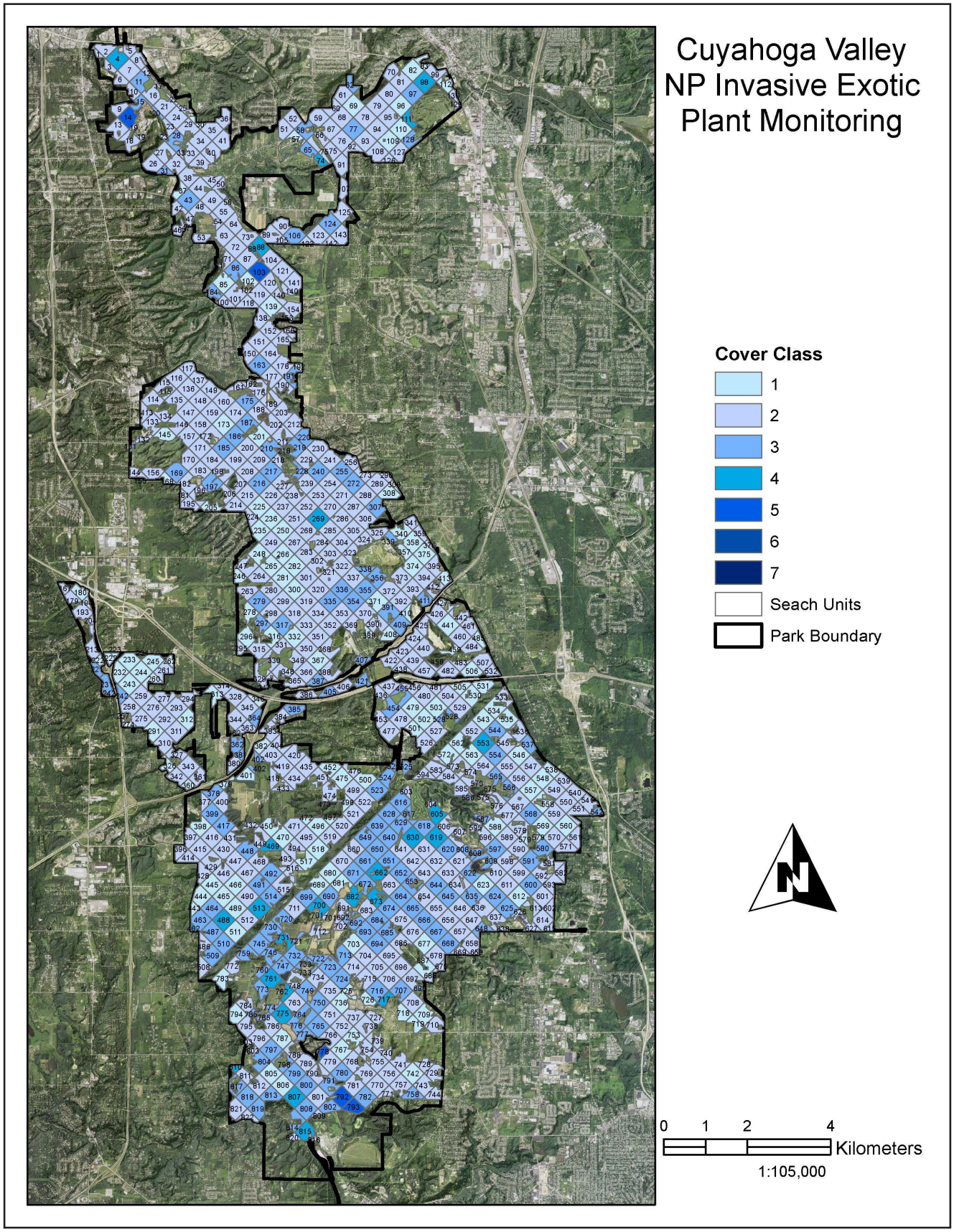

Figure 1. Location of survey units used to display exotic plant locations in Cuyahoga Valley NP. Search transects (not shown) bisect survey units in a southwest-northeast direction.

transects as complete transects regardless of actual length for the purposes of frequency calculations.

Cover class values were standardized across the various Heartland I&M Network survey protocols whereby cover class 7 is between 1000 and 4,999.9 m^2. However, in this survey a maximum 12-m belt surveyed along a 400-m transect would lead to a maximum cover calculation of 4,800 m^2. Therefore, we made all calculations involving cover class 7 using this maximum cover value.

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 by dividing the minimum (3 m) and maximum (12 m) belt width by the distance between transects (400 m). As a result, the minimum fraction of area searched (belt width = 3 m) was 0.75%, and the maximum fraction of area searched (belt width = 12 m) was 3%.

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 on each transect 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.

Equation 3:

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

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 represented 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 class value for each search unit during each survey period.

Taxonomic Notes

We acknowledge that identification mistakes may have occurred during monitoring in 2016 (taxonomic notes were not recorded in 2007) for the following plants: *Elaeagnus* sp. (olive), *Lonicera macckii*, *L. morrowii*, *L. tatarica* & *L. x bella* (bush honeysuckles), and *Poa* sp. (bluegrass). While we searched for Russian olive (*Elaeagnus angustifolia*) , it is morphologically similar to autumn olive (*Elaeagnus umbellata*) making it difficult and time consuming to examine every individual plant. There are likely more Russian olive in the park than we reported in this study. The bush honeysuckles present a similar problem, particularly in large dense populations. Tatarian honeysuckle (*L. tatarica*) was misidentified as Amur honeysuckle (*L. maackii*) in the 2016 survey. Bluegrass species can be difficult to identify in the field; Canada bluegrass (*P. compressa*) and Kentucky bluegrass (*P. pratensis*) were likely misidentified at times. All senesced bluegrass that was too difficult to identify was recorded as *Poa* sp. All mowed areas that intersected transects were recorded as *Poa* sp. due to the common inclusion of Kentucky bluegrass in lawn grass seed mixes.

Additionally, *Iris* sp., *Myosotis* sp., and *Typha* sp. were all recorded only to genus in 2016 in cases when flowers were not available. The survey staff had a

high level of confidence that the taxa reported here were the exotic species *Iris pseudacorus*, *Myosotis scorpioides* and *Typha x glauca*. Due to these identification issues, the cover estimates associated with these taxa may be best interpreted at the genus—rather than the species—level. Additionally, the five taxa that were recorded as genus only—*Iris* sp., *Myosotis* sp., *Poa* sp., *Typha* sp. and *Viburnum* sp.—were not counted in discussions of number of total species unless noted.

Methodological Notes

Invasive exotic plant monitoring at Cuyahoga Valley NP is one of the Heartland I&M Network's most ambitious projects. The survey encompasses close to 200 miles of transects that are often interrupted by geographic obstacles such as the Cuyahoga River, the canal, steep valley walls, and two highways. To better keep track of cover estimates of several species at once in the rugged terrain, the surveyor developed a system in 2016 where cover of each plant was tallied in 10-m^2 increments across the 400-m transects. In this way, the surveyor could complete one section of a transect and then travel to the other section of that same transect (e.g., around the river, canal etc.) while not losing track of previous observations.

Occasionally vegetation was so dense that navigating along the transect was physically impossible. In these cases the surveyor would stay as close as possible to the transect and estimate plant cover from an "off transect" vantage point. Fortunately, the dense vegetation usually consisted of a monoculture (e.g., multiflora rose [*Rosa multiflora*]) making cover fairly simple to estimate.

Even with the Trimble Geo 7x, we still commonly encountered issues with location accuracy. When operating under dense canopy, on cloudy/rainy days, under power lines, or in steep-sided valleys such as Tinkers Creek, the surveyor's location on the GPS appeared to "bounce" away from the transect location also shown on the GPS unit. This was very common when climbing long steep slopes and likely resulted from improved or decreased positional accuracy as the GPS unit gained or lost satellites. Anecdotally, these steep slopes were often barren of any target plant species, mitigating the effect of this navigation error on cover estimates.

Results and Discussion

Invasive exotic plant surveys at Cuyahoga Valley NP found 44 species in 2007 and 55 species in 2016 (Table 4) for a total of 61 unique species in the combined survey effort. Of the five species observed in 2007, but not in 2016, three occurred in less than 1% of transects in 2007: European alder (*Alnus glutinosa*), sulphur cinquefoil (*Potentilla recta*), and wild parsnip (*Pastinaca sativa*). These three species are likely still present in the park, but were overlooked due to methodological differences, inter-observer error, or measurement error due to deviations from the transects caused by difficult terrain or inaccuracies from the GPS unit (see Methods section). Smooth brome (*Bromus inermis*), observed in 4.3% of the transects in 2007, was searched for in 2016 and many members of the brome genus were collected and identified in the lab, but smooth brome was never observed. We presume that the 2007 observation was a misidentification. Tatarian honeysuckle was observed in 99 transects in 2007, but was not recorded in 2016. Tatarian honeysuckle was likely misidentified as Amur honeysuckle by the 2016 survey staff and was still prevalent in the park.

Of the 18 species observed in 2016, but not in 2007, 12 were added to the 2016 lists and were not searched for in 2007. Of the remaining six, common velvetgrass (*Holcus lanatus*), cutleaf teasel (*Dipsacus lacinatus*), European cranberrybush (*Viburnum opulus*), and showy fly honeysuckle (*Lonicera x bella*), occurred in 5% or less of transects surveyed and could have been missed in the original 2007 survey. Crownvetch (*Securigera varia*) and Nepalese browntop (*Microstegium vimineum*) were not observed in 2007, but were now covering 66–931 acres and 17–246 acres of the park, respectively. We suggest that this increase in these two species is likely a result of additional spread over the 9-year period.

Of the 60 taxa (including genus-only observations) documented in the 2016 survey, five taxa were widespread in the park, occurring in more than 40% of transects with relatively high park-wide cover: Amur honeysuckle, European privet (*Ligustrum vulgare*), garlic mustard (*Alliaria periolata*), Japanese barberry (*Berberis thunbergii*), and multiflora rose. Ten taxa—autumn olive, bluegrass (all three *Poa* spp.), creeping jenny (*Lysimachia nummularia*), dame's rocket

Japanese honeysuckle (*Lonicera japonica*) infestation in Cuyahoga Valley NP.

Table 4. Abundance and distribution of invasive exotic plants found in Cuyahoga Valley NP. Ecological impact (EI) and general management difficulty (Mgmt) based on NatureServe I-Rank subranks (Morse et al. 2004). Subranks are given as high (H), medium (M), low (L), insignificant (I), unknown (U), or not available (n/a).

Scientific Name	Common name	2007 Low Cover Estimate (ac)	2007 High Cover Estimate (ac)	2007 Frequency	2016 Low Cover Estimate (ac)	2016 High Cover Estimate (ac)	2016 Frequency	E.I.	Mgmt.
Acer platanoides	Norway maple	1.8	26.3	1.7%	0.4	3.3	0.1%	M	ML
Ailanthus altissima	tree of heaven	0.2	3.3	0.2%	0.4	3.6	0.2%	ML	ML
Alliaria petiolata	garlic mustard	18.5	358.9	57.1%	121.4	1,682.8	66.8%	ML	M
Alnus glutinosa	European alder	0.1	1.6	0.1%	–	–	–	H	U
*Arctium minus**	lesser burdock	–	–	–	0.5	10.7	3.5%	LI	MI
Berberis thunbergii	Japanese barberry	4.0	127.9	46.5%	60.7	919.6	57.9%	HM	I
Bromus inermis	smooth brome	0.2	6.1	4.3%	–	–	–	M	ML
Celastrus orbiculatus	Oriental bittersweet	0.0	1.3	0.5%	21.7	346.8	11.1%	ML	M
Cirsium arvense	Canada thistle	1.0	32.8	12.8%	9.7	155.9	18.9%	ML	HM
Cirsium vulgare	bull thistle	0.0	1.9	1.7%	1.2	24.7	4.4%	ML	ML
Dactylis glomerata	orchardgrass	1.1	42.0	18.1%	5.2	91.1	13.1%	LI	ML
*Daucus carota**	Queen Anne's lace	–	–	–	1.3	31.2	16.9%	I	I
Dipsacus fullonum	Fuller's teasel	0.6	23.4	13.1%	1.7	33.8	11.6%	L	ML
Dipsacus laciniatus	cutleaf teasel	–	–	–	0.0	0.7	0.4%	L	ML
Elaeagnus angustifolia	Russian olive	1.5	28.1	4.0%	0.0	0.3	0.1%	HM	HM
Elaeagnus umbellata	autumn olive	4.4	84.8	11.2%	59.0	883.3	33.2%	H	L
*Elymus repens**	quackgrass	–	–	–	31.2	541.2	2.8%	ML	HM
*Euonymus alatus**	burningbush	–	–	–	1.6	28.8	8.4%	L	LI
Frangula alnus	glossy buckthorn	5.2	94.0	13.6%	100.9	1,694.8	33.3%	HL	M
Glechoma hederacea	ground ivy	1.1	30.2	8.2%	16.0	231.0	14.4%	MI	U
Hedera helix	English ivy	0.1	2.7	0.7%	0.7	9.9	1.2%	M	ML
*Hemerocallis fulva**	orange daylily	–	–	–	0.3	5.3	0.5%	MI	L
Hesperis matronalis	dames rocket	1.0	27.3	9.9%	9.2	148.9	20.0%	MI	HL
Holcus lanatus	common velvetgrass	–	–	–	3.6	63.7	5.1%	HM	HL
*Humulus japonicus**	Japanese hop	–	–	–	1.2	14.8	1.0%	ML	ML
*Hypericum perforatum**	common St. Johnswort	–	–	–	0.0	0.2	1.0%	ML	M
Iris sp.	–	–	–	–	0.3	6.7	5.7%	n/a	n/a
Iris pseudacorus	paleyellow iris	0.6	17.9	6.0%	0.4	3.5	0.9%	ML	HM
Ligustrum vulgare	European privet	5.8	148.5	43.4%	77.1	1,107.0	60.0%	HL	HM

* Taxa that were added to the watch list in 2016 and not searched for in 2007.

Table 4 (continued). Abundance and distribution of invasive exotic plants found in Cuyahoga Valley NP. Ecological impact (EI) and general management difficulty (Mgmt) based on NatureServe I-Rank subranks (Morse et al. 2004). Subranks are given as high (H), medium (M), low (L), insignificant (I), unknown (U), or not available (n/a).

Scientific Name	Common name	2007 Low Cover Estimate (ac)	2007 High Cover Estimate (ac)	2007 Frequency	2016 Low Cover Estimate (ac)	2016 High Cover Estimate (ac)	2016 Frequency	E.I.	Mgmt.
*Linaria vulgaris**	butter and eggs	–	–	–	0.0	0.1	0.2%	ML	HM
Lonicera x bella	showy fly honeysuckle	–	–	–	3.0	60.3	1.5%	n/a	n/a
Lonicera japonica	Japanese honeysuckle	2.8	71.9	16.2%	36.0	535.0	24.8%	M	HM
Lonicera maackii	Amur honeysuckle	1.3	28.0	8.0%	113.5	1,556.6	45.5%	HM	M
Lonicera morrowii	Morrow's honeysuckle	2.9	71.7	14.4%	35.8	496.5	32.2%	ML	M
Lonicera tatarica	Tatarian honeysuckle	2.0	48.1	12.0%	–	–	–	M	M
Lotus corniculatus	bird's-foot trefoil	0.6	19.0	6.9%	4.1	83.3	9.0%	ML	ML
Lysimachia nummularia	creeping jenny	2.7	70.2	18.5%	49.9	640.9	28.8%	L	L
Lythrum salicaria	purple loosestrife	1.7	33.4	5.4%	1.1	23.8	4.4%	H	H
Melilotus officinalis	sweetclover	0.0	0.4	0.6%	0.4	4.0	0.6%	M	M
Microstegium vimineum	Nepalese browntop	–	–	–	66.2	930.9	10.2%	M	HM
Morus alba	white mulberry	0.1	1.6	0.1%	0.2	4.9	0.4%	ML	M
Myosotis sp.	–	–	–	–	10.1	89.7	2.9%	n/a	n/a
*Myosotis scorpioides**	true forget-me-not	–	–	–	4.5	83.2	7.1%	n/a	n/a
Pastinaca sativa	wild parsnip	0.0	0.7	0.6%	–	–	–	LI	L
Phalaris arundinacea	reed canarygrass	15.1	228.3	20.6%	257.4	3,639.9	25.1%	H	HM
Phragmites australis	common reed	6.0	112.5	9.6%	78.0	1,287.8	9.6%	H	HM
Poa sp.	bluegrass	–	–	–	147.5	2,200.5	21.4%	n/a	n/a
Poa compressa	Canada bluegrass	1.1	34.9	11.7%	20.0	273.3	8.4%	ML	HL
Poa pratensis	Kentucky bluegrass	3.3	87.8	21.2%	11.2	165.0	4.9%	M	ML
Polygonum cuspidatum	Japanese knotweed	9.5	153.1	6.7%	119.5	1,563.2	8.6%	HM	M
Populus alba	white poplar	0.0	0.7	0.2%	0.0	0.3	0.1%	ML	HL
Potentilla recta	sulphur cinquefoil	0.0	0.1	0.6%	–	–	–	HL	ML
Rhamnus cathartica	common buckthorn	0.0	1.6	0.6%	0.2	3.4	0.6%	M	M
Robinia pseudoacacia	black locust	12.5	195.1	12.0%	14.3	186.8	4.1%	HM	M
Rosa multiflora	multiflora rose	21.1	453.9	83.9%	294.7	3,788.3	91.4%	L	L
*Rumex crispus**	curly dock	–	–	–	0.1	2.9	1.8%	LI	ML
Securigera varia	crownvetch	–	–	–	17.5	246.0	10.1%	H	L

* Taxa that were added to the watch list in 2016 and not searched for in 2007.

Table 4 (continued). Abundance and distribution of invasive exotic plants found in Cuyahoga Valley NP. Ecological impact (EI) and general management difficulty (Mgmt) based on NatureServe I-Rank subranks (Morse et al. 2004). Subranks are given as high (H), medium (M), low (L), insignificant (I), unknown (U), or not available (n/a).

Scientific Name	Common name	2007 Low Cover Estimate (ac)	2007 High Cover Estimate (ac)	2007 Frequency	2016 Low Cover Estimate (ac)	2016 High Cover Estimate (ac)	2016 Frequency	E.I.	Mgmt.
*Sonchus arvensis**	field sowthistle	–	–	–	0.0	0.1	0.5%	LI	HL
*Torillis japonica**	spreading hedgeparsley	–	–	–	1.2	27.8	15.5%	n/a	n/a
Typha sp.	cattail	–	–	–	0.0	0.1	0.2%	n/a	n/a
Typha angustifolia	narrowleaf cattail	2.6	39.5	2.6%	9.9	191.4	0.5%	HM	M
Typha x glauca	hybrid cattail	0.0	1.3	0.5%	51.9	748.3	6.0%	HM	M
Verbascum thapsus	common mullein	0.0	1.2	1.3%	0.4	4.4	2.1%	ML	L
Viburnum sp.	–	0.0	0.7	0.4%	–	–	–	n/a	n/a
Viburnum opulus	European cranberrybush	–	–	–	0.1	3.4	4.7%	n/a	n/a
Vinca minor	common periwinkle	0.5	15.7	6.3%	26.3	369.2	6.6%	I	U

* Taxa that were added to the watch list in 2016 and not searched for in 2007.

(*Hesperis matronalis*), glossy buckthorn (*Frangula alnus*), Japanese honeysuckle (*Lonicera japonica*), Morrow's honeysuckle (*Lonicera morrowii*), and reed canarygrass (*Phalaris arundinacea*) —were moderately widespread, occurring in 20% to 33% of transects with moderate coverage.

Common reed (*Phragmites australis*), hybrid cattail (*Typha x glauca*), Japanese knotweed (*Polygonum cuspidatum*), Nepalese browntop, and quackgrass (*Elymus repens*) were localized and had moderate coverage. All of these species except quackgrass, which was mostly found in utility corridors, occurred in dense monocultures in aquatic habitats, but were limited to less than 10% of transects. Lesser burdock (*Arctium minus*), Canada thistle (*Cirsium arvense*), erect hedgeparsley (*Torilis japonica*), Fuller's teasel (*Dipsacus fullonum*), orchard grass (*Dactylis glomerata*), and Queen Anne's lace (*Daucus carota*) were found throughout the park (11-20% of transects), but did not occur in dense monocultures and mostly invaded forest edges and fields.

Finally, crownvetch, ground ivy (*Glechoma hederacea*), Oriental bittersweet (*Celastrus orbiculatus*), and true forget-me-not (all *Myosotis* spp.) all invaded in small, very dense monocultures, but were not widespread and had low overall abundance (83–347 acres at most). However, *C. orbiculatus* abundance may have increased dramatically since the 2007 survey and has a high potential to spread. Additionally, because *C. orbiculatus* is a vine and grows up tree trunks, the birds-eye-view method of estimating coverage does not account for all the foliage along the trunk. The remaining 29 taxa found in 2016 all occurred in 9% or less of transects with low cover.

In conclusion, we did not detect any meaningful decline in invasive exotic plant abundance between the 2007 and 2016 surveys. In spite of the differences in methodology between 2007 and 2016, we believe that the data suggest increases in the spread of Nepalese browntop, Oriental bittersweet, and crownvetch as well as increases in the abundance of multiflora rose and Amur honeysuckle. Control efforts at Cuyahoga Valley NP primarily focus on project areas, such as the efforts at Terra Vista, rather than individual species, so park-wide decreases would not necessarily be expected. The results of this study will hopefully continue to guide park natural resource managers in their efforts to develop approaches to invasive exotic plant management.

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