



Invasive Exotic Plant Monitoring (Year 3) for Lincoln Boyhood National Memorial

Natural Resource Report NPS/HTLN/NRR—2016/1118



ON THE COVER

Invasive, exotic plants at Lincoln Boyhood National Memorial. Left to right: A) Japanese honeysuckle. B) Periwinkle near visitor's center. C) Periwinkle in forest. D) Chinese yam shading ground cover. E) Chinese yam growing into the canopy. F) Fruiting Chinese yam. G) Typical privet shrub. H) Park staff standing amidst periwinkle and privet. I) Multiflora rose seedbank.

Photograph by Michael H. Williams

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Craig C. Young, J. L. Haack-Gaynor, and Jordan C. Bell

National Park Service
Heartland Network
Republic, Missouri 65738

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Abstract

During the three surveys that occurred during 2006, 2011, and 2015, Heartland Network staff identified 44 plant species judged to be invasive. Treatment of selected species appears to be reducing the abundance of these species. The strongest evidence is found for declines in burning bush and silktree (also known as mimosa). Japanese honeysuckle accounts for the majority of invasive plant cover in the park. This species has not yet been treated, but may be included with efforts to control other evergreen vines such as Chinese wisteria, common periwinkle, English ivy, Oriental bittersweet, and winter creeper in the future.

Introduction

This study of invasive plants in Lincoln Boyhood National Monument completes the third round of monitoring for this vital sign. Beginning in 2010, the Heartland Exotic Plant Management Team began using these data to guide control of these problematic plants. This report explains the current status of invasive plants in the park and attempts to evaluate to the extent possible the effect of recent control efforts. These efforts, as more carefully outlined in the 2012 report (Young et al. 2012), serve to maintain and restore the park's cultural landscape.

Methods

Watch Lists

Invasive exotic plant species on three watch lists were sought during monitoring (Table 1). Plants designated as high priority invasive plant species (Young et al. 2007) and known to occur in Indiana, but not previously documented per NPSpecies (NPS 2012) constituted the "early detection watch list" (n=75). Designated invasive plants known to occur on the park per NPSpecies constituted the "park-established watch list" (n=25). Invasive exotic plants constituting the "park-based watch list" (n=5) included plants selected by park managers or network staff that were not designated as invasive in the protocol, but may not have been included due to incomplete information in NPSpecies (i.e., not documented) or inaccurate information in the USDA Plants database (i.e., state distribution information inaccurate) or simply due to differing opinions regarding Heartland Network's designation as a species to monitor. These plant species were also non-native with the exception of black locust, which is native to the United States, but not to south-central Indiana. While aquatic species are listed on the watch lists, terrestrial plants were the focus of this survey.

Field methods

Invasive plant species were sought in search units that covered the park except for developed areas (Figure 1). Dan Tenaglia conducted field work from August 8-11, 2006 using a MobileMapper GPS Unit. Dr. Steven Brewer with Copperhead Consulting and Ms. Kyla Hershey with Lawhon and Associates, Inc. used a Garmin 60CSx and Trimble Instruments model GeoXT handheld GPS units to conduct the second survey during August 8-14, 2011. Sarah Hinman, Karoloa Mlekush, and Craig Young conducted the third survey during July 21-23, 2015 using a combination of Trimble Juno XH, Juno XT, and Juno 5 GPS units. Surveys were conducted in search units, approximately 2 acres in size. Three equidistant transects through each search unit were surveyed; entire polygons were not fully searched. Observers surveyed invasive plants within a 3- to 12-m, using the widest observable belt within this range. Cover values were as follows: 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 231 transects within 77 search units were searched.

Analytical methods

A park-wide cover range was estimated for each invasive plant species encountered. First, calculations of the observed reference frame fraction were made by multiplying transect length, the number of transects, and the belt width. The belt width was either 3 m (the minimum possible width)

or 12 m (the maximum possible width). Transect length was calculated by summing the lengths of the 231 transects. The product was then divided by the reference frame area (Eq. 1).

$$\text{Eq.1. Fraction of area searched} = \frac{\text{transect length} * \text{number of transects} * \text{belt width}}{\text{reference frame area}}$$

The minimum fraction of area searched (belt width = 3 m) was 10%, and the maximum fraction of area searched (belt width = 12 m) was 40%.

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 survey belt (i.e., maximum fraction observed) (Eq. 2).

$$\text{Eq.2. Minimum cover estimate} = \frac{\sum \text{low end of cover value range for species}}{\text{fraction of area searched assuming 12-m belt width}}$$

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) (Eq. 3).

$$\text{Eq. 3. Maximum cover estimate} = \frac{\sum \text{high end of cover value range for species}}{\text{fraction of area searched assuming 3-m belt width}}$$

The park-wide frequency of invasive exotic plants was then calculated as the percentage of occupied search units (Eq. 4).

$$\text{Eq. 4. Frequency of an invasive plant species} = \frac{\sum \text{search units occupied by species}}{\sum \text{search units sampled}} \times 100$$

Taken together, the minimum and maximum cover estimates provide 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, maps were created for each target invasive plant species (see attached GeoPdf). The maps indicated which search unit was occupied and the estimated cover class value for that search unit during each survey period.

Lincoln Boyhood National Memorial Exotic Plant Search Units

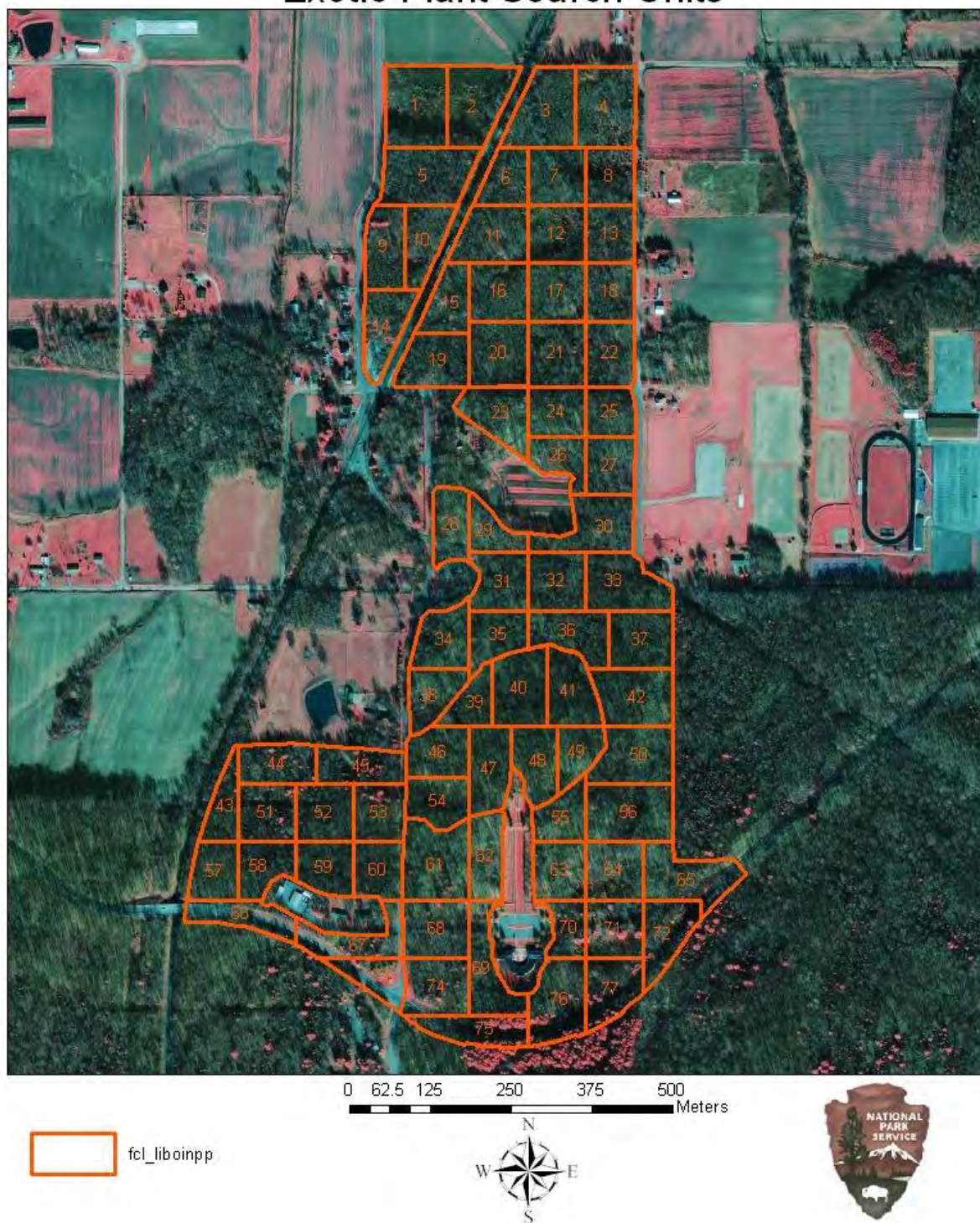


Figure 1. Invasive exotic plant search units at Lincoln Boyhood National Memorial. The search units indicate the search locations for invasive exotic plants in 2006, 2011, and 2015.

Table 1. Invasive plant watch lists used to guide surveys in Lincoln Boyhood National Memorial during 2006, 2011, and 2015. These watch lists include an early detection watch list, a park-established watch list, and a park-based watch list.

Early Detection Watch List	
Scientific name	Common name
<i>Acer platanoides</i>	Norway maple
<i>Alliaria petiolata</i>	Garlic mustard
<i>Alnus glutinosa</i>	European alder
<i>Arctium minus</i>	Lesser burdock
<i>Bromus inermis</i>	Smooth brome
<i>Bromus sterilis</i>	Poverty brome
<i>Bromus tectorum</i>	Cheatgrass
<i>Butomus umbellatus</i>	Flowering rush
<i>Carduus nutans</i>	Nodding plumeless thistle
<i>Celastrus orbiculatus</i>	Oriental bittersweet
<i>Centaurea solstitialis</i>	Yellow star-thistle
<i>Centaurea stoebe ssp. micranthos</i>	Spotted knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium vulgare</i>	Bull thistle
<i>Cynanchum louiseae</i>	Louise's swallow-wort
<i>Cynanchum rossicum</i>	European swallow-wort
<i>Dipsacus fullonum</i>	Fuller's teasel
<i>Dipsacus laciniatus</i>	Cutleaf teasel
<i>Egeria densa</i>	Brazilian waterweed
<i>Elaeagnus umbellata</i>	Autumn olive
<i>Elymus repens</i>	Quackgrass
<i>Euonymus alata</i>	Burningbush
<i>Euphorbia cyparissias</i>	Cypress spurge
<i>Euphorbia esula</i>	Leafy Spurge
<i>Frangula alnus</i>	Glossy buckthorn
<i>Hesperis matronalis</i>	Dames rocket
<i>Holcus lanatus</i>	Common velvetgrass
<i>Humulus japonicus</i>	Japanese hop
<i>Hypericum perforatum</i>	Common St. Johnswort
<i>Iris pseudacorus</i>	Paleyellow iris
<i>Leonurus cardiaca</i>	Common motherwort
<i>Lepidium latifolium</i>	Broadleaved pepperweed
<i>Lespedeza bicolor</i>	Shrub lespedza
<i>Linaria vulgaris</i>	Butter and eggs
<i>Lolium arundinaceum</i>	Tall fescue
<i>Lolium pratense</i>	Meadow fescue
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera tatarica</i>	Tatarian honeysuckle
<i>Lonicera X bella</i>	Bell's honeysuckle (hybrid)

Table 1 (cont.). Invasive plant watch lists used to guide surveys in Lincoln Boyhood National Memorial during 2006, 2011, and 2015. These watch lists include an early detection watch list, a park-established watch list, and a park-based watch list.

Scientific name	Common name
Early Detection Watch List (continued)	
<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 spicatum</i>	Eurasian watermilfoil
<i>Najas minor</i>	Brittle waternymph
<i>Onopordum acanthium</i>	Scotch cottonthistle
<i>Ornithogalum umbellatum</i>	Sleepydicke
<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>Populus alba</i>	White poplar
<i>Potamogeton crispus</i>	Curly pondweed
<i>Potentilla recta</i>	Sulphur cinquefoil
<i>Prunus mahaleb</i>	Mahaleb's cherry
<i>Pueraria montana var. lobata</i>	Kudzu
<i>Pyrus calleryana</i>	Callery pear
<i>Rhamnus cathartica</i>	Common buckthorn
<i>Rorippa nasturtium-aquaticum</i>	Watercress
<i>Rumex crispus</i>	Curly dock
<i>Saponaria officinalis</i>	Bouncingbet
<i>Sonchus arvensis</i>	Field sowthistle
<i>Securigera varia</i>	Crownvetch
<i>Sorghum halepense</i>	Johnsongrass
<i>Spiraea japonica</i>	Japanese meadowsweet
<i>Tanacetum vulgare</i>	Common tansy
<i>Torilis arvensis</i>	Spreading hedgeparsley
<i>Torilis japonica</i>	Ercet hedgeparsley
<i>Typha angustifolia</i>	Narrowleaf cattail
<i>Typha X glauca</i>	Hybrid cattail
<i>Ulmus pumila</i>	Siberian elm
<i>Viburnum opulus</i>	European cranberrybush

Table 1 (cont.). Invasive plant watch lists used to guide surveys in Lincoln Boyhood National Memorial during 2006, 2011, and 2015. These watch lists include an early detection watch list, a park-established watch list, and a park-based watch list.

Scientific name	Common name
Park-Established Watch List	
<i>Ailanthus altissima</i>	Tree of heaven
<i>Albizia julibrissin</i>	Silktree
<i>Berberis thunbergii</i>	Japanese barberry
<i>Bromus racemosus</i>	Bald brome
<i>Daucus carota</i>	Queen Anne's lace
<i>Dioscorea oppositifolia</i>	Chinese yam
<i>Euonymus fortune</i>	Winter creeper
<i>Glechoma hederacea</i>	Ground ivy
<i>Hedera helix</i>	English ivy
<i>Hemerocallis fulva</i>	Orange daylily
<i>Lespedeza cuneata</i>	Sericea lespedeza
<i>Ligustrum obtusifolium</i>	Border privet
<i>Ligustrum vulgare</i>	European privet
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Melilotus officinalis</i>	Sweetclover
<i>Morus alba</i>	White mulberry
<i>Poa compressa</i>	Canada bluegrass
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Robinia pseudoacacia</i>	Black locust
<i>Rosa multiflora</i>	Multiflora rose
<i>Rumex acetosella</i>	Common sheep sorrel
<i>Verbascum thapsus</i>	Common mullein
<i>Vinca minor</i>	Common periwinkle
Park-Based Watch List	
<i>Dactylis glomerata</i>	Bermudagrass
<i>Forsythia suspensa</i>	Weeping forsythia
<i>Lolium perenne</i>	Perennial ryegrass
<i>Ligustrum sinense</i>	Chinese privet
<i>Wisteria sinensis</i>	Chinese wisteria

Results and Discussion

We identified a cumulative total of 44 out of 105 (42%) invasive plant species sought during the three surveys (Table 2). Of these, 29 (66%) were identified during the most recent survey; 22 (50%) were identified during all three surveys; and 11(25%) were identified during a single survey.

Melilotus officinalis (sweetclover) and *Potentilla recta* (sulphur cinquefoil) were the single new finds in 2015. The former plant was already known to occur in the park, while the latter is a new detection. We are hopeful that the absence of *Lespedeza cuneata* (Chinese lespedeza), *Phalaris arundinacea* (reed canarygrass), *Pyrus calleryana* (Callery pear), *Securigera varia* (crownvetch), *Sorghum halepense* (Johnsongrass), and *Verbascum thapsus* (common mullein) in 2015 reflect successful control of these species.

Of the 22 species that were present during 2006 and 2015, 14 were treated as part of control efforts. Of these, *Albizia julibrissin* (silktree) and *Euonymus alatus* (burning bush) clearly declined in abundance in 2015 relative to 2006. Of the treated species, nine (64%) declined in frequency compared to two of five (40%) untreated species. The doubling in frequency of *Microstegium vimineum* (Japanese stiltgrass) frequency suggests that this species is increasing its footprint within the park.

At this time, *Lonicera japonica* (Japanese honeysuckle) remains the most abundant species that is currently not treated. Given the difficulty in treating this species, we recommend continued planning to address this species and the other evergreen vines including *Euonymus fortunei* (wintercreeper), *Hedera helix* (English ivy), and *Vinca minor* (common periwinkle). In the meantime, we recommend beginning efforts to control the vines *Celastrus orbiculatus* (Oriental bittersweet) and *Wisteria sinensis* (Chinese wisteria), while continuing to control plants already under treatment.

We acknowledge that identification mistakes during monitoring may beset the *Ligustrum* sp. (privet), *Lonicera macckii* and *L. morrowii* (bush honeysuckles), and *Poa* spp. (bluegrass) observations. The numbers associated with these species may be best interpreted at the genus- rather than the species-level.

In conclusion, invasive plants continue to occupy significant area within Lincoln Boyhood National Memorial. These data provide evidence, however, that control efforts appear to be reducing the abundance of and perhaps even eliminating several problematic plants within the park.

Table 2. Cover estimates and frequency of invasive plants found in Lincoln Boyhood National Memorial during 2006, 2001, and 2015 surveys. ^ Indicates plant species to which control measures have been applied in the park. * Non-overlapping cover ranges are identified using letters (a, b, etc.).

Scientific Name	Common Name	Year	Low Cover Estimate (ac)	High Cover Estimate (ac)	Frequency (%)
<i>Ailanthus altissima</i> [^]	tree of heaven	2006	0.0225	0.5256	16.9
		2011	0.0766	0.8382	10.4
		2015	0.0020	0.0778	6.5
<i>Albizia julibrissin</i> [^]	silk tree	2006 a	0.0311	0.2558	6.5
		2011 a	0.0698	1.4320	6.5
		2015 b	0.0001	0.0044	2.6
<i>Alliaria petiolata</i>	garlic mustard	2006	0.0074	0.1722	3.9
		2011	0.0002	0.0089	5.2
		2015	0.0006	0.0245	1.3
<i>Berberis thunbergii</i> [^]	Japanese barberry	2006 a	0.0004	0.0156	9.1
		2011 b	0.0272	0.5911	10.4
		2015 a	0.0001	0.0044	2.6
<i>Bromus racemosus</i>	bald brome	2011	0.0025	0.0979	5.2
		2015	0.0006	0.0245	1.3
<i>Celastrus orbiculatus</i>	Oriental bittersweet	2006	0.0106	0.4181	36.4
		2011	0.0099	0.2701	9.1
		2015	0.0083	0.3247	33.8
<i>Cirsium vulgare</i>	bull thistle	2006	0.0004	0.0156	9.1
		2011	0.0019	0.0734	3.9
<i>Dactylis glomerata</i>	orchardgrass	2006	0.0012	0.0489	2.6
		2015	0.0006	0.0245	1.3
<i>Daucus carota</i>	Queen Anne's lace	2006	0.0006	0.0245	1.3
		2011	0.0012	0.0489	2.6
		2015	0.0016	0.0623	10.4
<i>Dioscorea oppositifolia</i> [^]	Chinese yam	2006	0.0329	0.3269	9.1
		2011	0.1995	4.0258	10.4
		2015	0.0458	0.5958	11.7
<i>Echinochloa crus-galli</i>	barnyardgrass	2011	0.0124	0.2466	2.6
<i>Elaeagnus umbellata</i> [^]	autumn olive	2006	0.0303	0.7112	28.6
		2011	0.1878	3.4296	27.3
		2015	0.0090	0.2323	13.0
<i>Euonymus alatus</i> [^]	burningbush	2006 a	0.0347	0.3959	10.4
		2011 a	0.0297	0.6889	15.6
		2015 b	0.0007	0.0267	15.6
<i>Euonymus fortunei</i>	winter creeper	2006	0.0574	0.9304	32.5

Table 2 (cont.). Cover estimates and frequency of invasive plants found in Lincoln Boyhood National Memorial during 2006, 2011, and 2015 surveys. ^ Indicates plant species to which control measures have been applied in the park. * Non-overlapping cover ranges are identified using letters (a, b, etc.).

Scientific Name	Common Name	Year	Low Cover Estimate (ac)	High Cover Estimate (ac)	Frequency (%)
<i>Euonymus fortunei</i>	winter creeper	2011	0.9181	17.8114	39.0
		2015	0.2061	3.5400	44.2
<i>Forsythia suspensa</i> [^]	weeping forsythia	2006 a,b	0.0285	0.6445	15.6
		2011 a	0.1921	3.1120	7.8
		2015 b	0.0075	0.1745	5.2
<i>Hedera helix</i>	English ivy	2006 a,b	0.0142	0.3200	6.5
		2011 a	0.1606	2.8407	5.2
		2015 b	0.0025	0.0979	5.2
<i>Hemerocallis fulva</i>	orange daylily	2011	0.0142	0.3200	6.5
		2015	0.0077	0.1811	9.1
<i>Lespedeza cuneata</i>	sericea lespedeza	2006	0.0146	0.3333	14.3
		2011	0.0019	0.0734	3.9
<i>Ligustrum obtusifolium</i> [^]	border privet	2006 a	0.0006	0.0245	1.3
		2011 b	0.0019	0.0734	3.9
<i>Ligustrum sinense</i> [^]	Chinese privet	2006	0.0001	0.0044	2.6
<i>Ligustrum vulgare</i> [^]	European privet	2006	0.3476	5.3639	68.8
		2011	0.9878	16.5165	77.9
		2015	0.1211	2.2368	75.3
<i>Lolium perenne</i>	perennial ryegrass	2011	0.0006	0.0245	1.3
<i>Lonicera japonica</i>	Japanese honeysuckle	2006	1.6014	19.5576	94.8
		2011	8.4516	146.0450	100.0
		2015	3.1704	51.9228	98.7
<i>Lonicera maackii</i> [^]	Amur honeysuckle	2006	0.0013	0.0512	3.9
		2011	0.0377	0.7643	9.1
<i>Lonicera morrowii</i> [^]	Morrow's honeysuckle	2006	0.0007	0.0289	3.9
		2015	0.0001	0.0022	1.3
<i>Lotus corniculatus</i>	bird's-foot trefoil	2006	0.0006	0.0245	1.3
<i>Lysimachia nummularia</i>	creeping jenny	2006	0.0038	0.1490	9.1
		2011	0.0253	0.5177	6.5
		2015	0.0093	0.2478	9.1
<i>Melilotus officinalis</i>	sweetclover	2015	0.0002	0.0089	5.2
<i>Microstegium vimineum</i> [^]	Nepalese browntop	2006	0.0599	0.9069	26.0

Table 2 (cont.). Cover estimates and frequency of invasive plants found in Lincoln Boyhood National Memorial during 2006, 2011, and 2015 surveys. ^ Indicates plant species to which control measures have been applied in the park. * Non-overlapping cover ranges are identified using letters (a, b, etc.).

Scientific Name	Common Name	Year	Low Cover Estimate (ac)	High Cover Estimate (ac)	Frequency (%)
<i>Microstegium vimineum</i> ^	Nepalese browntop	2011	0.2904	5.1862	28.6
		2015	0.0232	0.6714	42.9
<i>Morus alba</i>	white mulberry	2011 a	0.0371	0.3702	2.6
		2015 b	0.0002	0.0089	5.2
<i>Phalaris arundinacea</i> ^	reed canarygrass	2011	0.0618	1.2353	1.3
<i>Poa compressa</i>	Canada bluegrass	2006	0.0001	0.0044	2.6
<i>Poa (compressa?)</i>	bluegrass	2011	0.0074	0.1722	3.9
<i>Polygonum cuspidatum</i> ^	Japanese knotweed	2006 a	0.0075	0.1767	6.5
		2011 b	0.6610	12.8485	5.2
		2015 a	0.0019	0.0734	3.9
<i>Potentilla recta</i>	sulphur cinquefoil	2015	0.0001	0.0022	1.3
<i>Pyrus calleryana</i> ^	Callery pear	2011	0.0062	0.1233	1.3
<i>Robinia pseudoacacia</i> ^	black locust	2006	0.1531	1.6719	31.2
		2011	0.1594	3.2806	31.2
		2015	0.0395	0.8332	23.4
<i>Rosa multiflora</i> ^	multiflora rose	2006	0.2855	4.9826	72.7
		2011	2.0584	33.0237	88.3
		2015	0.2466	4.5369	77.9
<i>Schedonorus phoenix</i>	tall fescue	2011 a	0.8420	16.1325	18.2
		2015 b	0.0377	0.3946	3.9
<i>Securigera varia</i> ^	crownvetch	2006	0.0012	0.0489	2.6
<i>Sorghum halepense</i> ^	Johnsongrass	2006	0.0309	0.2469	1.3
<i>Spiraea sp.</i> ^	spirea	2006	0.0933	0.7650	5.2
		2011	0.0371	0.3702	2.6
		2015	0.0130	0.2711	3.9
<i>Verbascum thapsus</i>	common mullein	2006	0.0001	0.0022	1.3
<i>Vinca minor</i>	common periwinkle	2006	0.6493	10.7691	24.7
		2011	4.3626	72.0752	28.6
		2015	0.8582	12.0810	39.0
<i>Wisteria sinensis</i>	Chinese wisteria	2006	0.0069	0.1500	3.9
		2011	0.0692	1.4075	5.2
		2015	0.0630	1.2842	3.9

Literature Cited

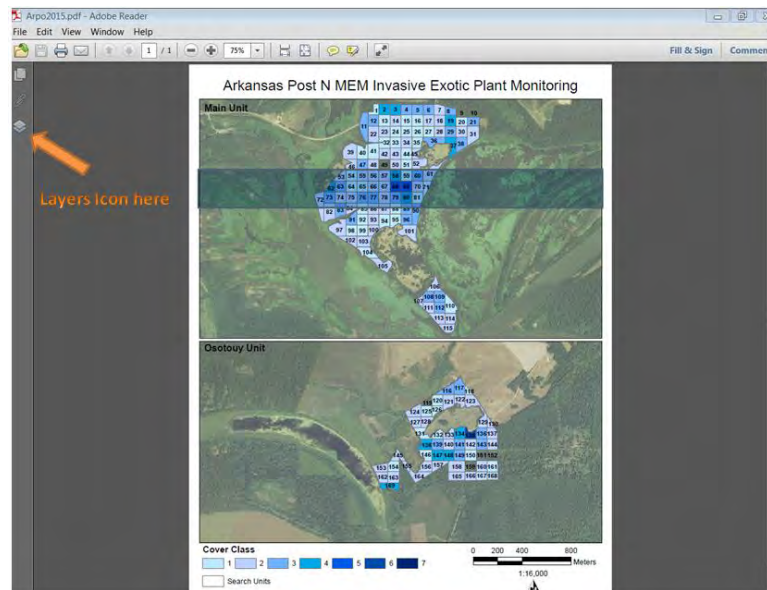
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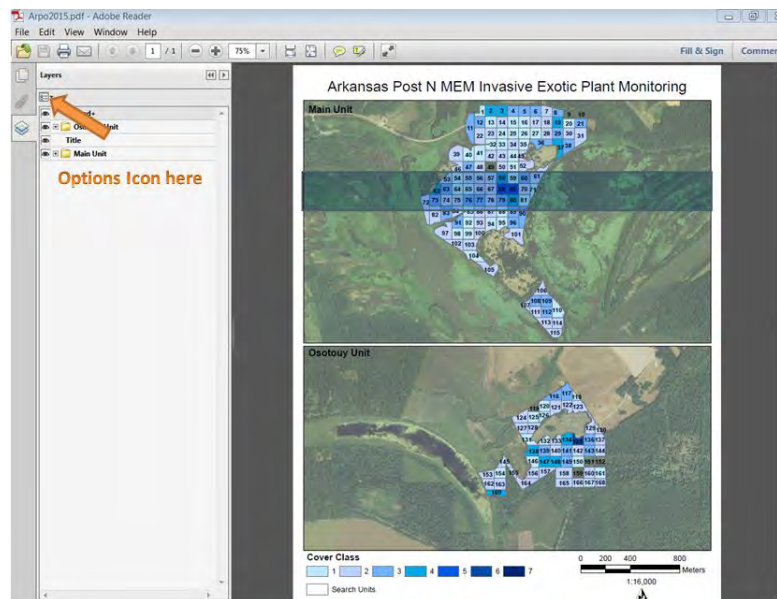
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Appendix A. Viewing GeoPdfs

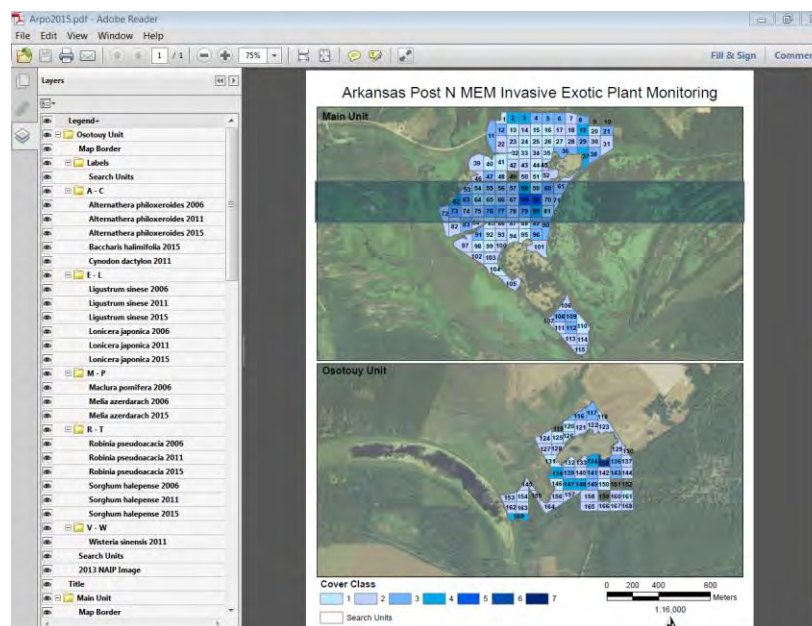
Open a report in Adobe Reader 9.0 or other Adobe software product. When the report first opens, a map will appear highlighting the search units. To interpret the map, first click the layers icon (double overlapping diamonds).



Next, click on the options icon to “Expand All”.



Click on the “eye” icons to turn the associated information on and off on the map.



In most cases, the viewer will turn off all layers except for a single species-year combination. In order to visualize changes in abundance and distribution of a species among years, the layers of interest can be turned on and off in sequence. Multiple versions of the report and geopdf map may be opened at once if simultaneous, side-by-side comparisons are needed.

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.

NPS 422/131190, January 2016

National Park Service
U.S. Department of the Interior

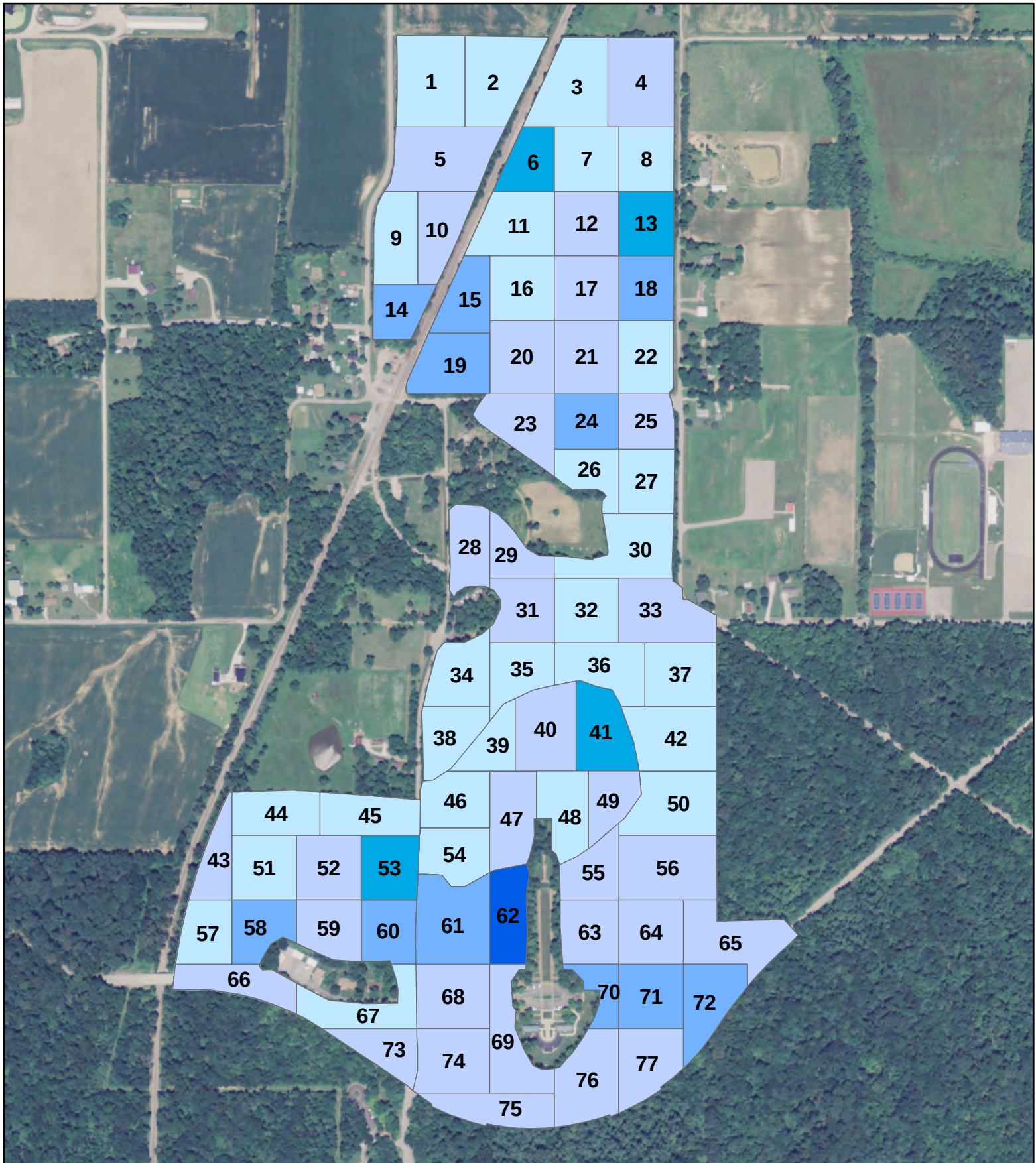


Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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Cover Class



Search Units

