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Invasive Exotic Plant Monitoring at Homestead National Monument of America

Year 2 (2009)

Natural Resource Technical Report NPS/HTLN/NRTR—2010/304

ON THE COVER
Prairie with woodland in the background at Homestead National Monument of America.

Invasive Exotic Plant Monitoring at Homestead National Monument of America

Year 2 (2009)

Natural Resource Technical Report NPS/HTLN/NRTR—2010/304

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Executive Summary

During surveys in 2006 and 2009, we documented 14 invasive exotic plant taxa in the restored prairies and the forest at Homestead National Monument of America. With the exception of climbing nightshade (*Solanum dulcamara*; identification tentative), all species were known to occur on the park. The most widespread and abundant species in 2009 included smooth brome (*Bromus inermis*), Osage orange (*Maclura pomifera*), reed canary grass (*Phalaris arundinacea*), and white mulberry (*Morus alba*). These species covered at least 4, 1, 0.6, and 0.6 acres, respectively. Overall, the majority of species (75%) showed decreasing trends in maximum abundance. Bluegrass (*Poa* spp.) was an exception to this trend and showed relatively high increases in frequency and abundance. Fire normally controls bluegrass and is the preferred treatment given that chemicals designed to reduce bluegrass will also kill native warm season grasses. With the exception of bluegrass, smooth brome, and reed canarygrass, which are notoriously difficult to control, many of the other invasive plant species are relatively easily controlled as needed. These species generally occur at such low abundance that on-going park efforts to control these species are likely to be very effective. The information presented in this report may be used to plan management activities leading to control of exotic plants and the accomplishment of GPRA goal IA1.

Introduction

An invasive exotic plant is a plant species that is not native to an area and is presumed to pose environmental harm to native plant populations or communities. In general, invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are second only to habitat loss as threats to global biodiversity (Scott and Wilcove 1998). Prevention and early detection are the principal strategies for successful invasive exotic plant management. Invasive exotic plants often undergo a lag period between introduction and subsequent colonization of new areas. Managers can take advantage of monitoring efforts to detect invasive exotic species early and initiate control actions before populations become well established (Welch and Geissler 2007).

The restored prairie and riparian forest at Homestead National Monument of America are significant cultural and natural resources that are vulnerable to exotic plant invasions. A number of highly invasive exotic plants have already become established in the prairie, including smooth brome (*Bromus inermis*) and bald brome (*Bromus racemosus*). The riparian forests at Homestead National Monument of America also support invasive exotic plants, including Osage orange (*Maclura pomifera*), reed canarygrass (*Phalaris arundinacea*), and white mulberry (*Morus alba*).

The monitoring objectives for invasive exotic plants at Homestead National Monument of America include:

1. Providing early detection monitoring for all invasive exotic plants included on the watch list.

2. Search at least 3% and up to 40% of the reference frame for invasive exotic plant occurrences on each park.

3. Estimate the abundance of invasive exotic plants in the park.

4. To the extent possible, identify temporal changes in the distribution of invasive exotic plants known to occur on network parks.

Methods

Watch lists

The invasive exotic plants on three watch lists were sought during monitoring (Table 1). Invasive exotic plants not known to occur on the park according to NPSpecies (the national NPS database for plant occurrence registration) constitute the "Early Detection Watch List". Invasive exotic plants known to occur on the park according to NPSpecies constitute the "Park-Established Watch List". The "Park-Based Watch List" included invasive exotic plants, selected by park managers or network staff, which may not have been included on the other lists due to incomplete information in NPSpecies (e.g., not documented) or USDA Plants (e.g., state distribution information inaccurate) databases, or due to differing opinions regarding network designation of a plant as a high priority. While aquatic species are listed on the watch lists, terrestrial plants were the focus of this survey. Aquatic plants were documented only occasionally.

Field methods

Surveys for invasive exotic plant species were conducted at Homestead National Monument of America during August 13-16, 2006 and July 6-8, 2009. Dan Tenaglia conducted the survey in 2006, while Craig Young, Josh Brinkman, and Seth Hendriks conducted the survey in 2009. Josh Brinkman and Seth Hendriks were associated with Pipestone National Monument as biological technicians. A total of 82 search units were surveyed (Figure 1). Observers navigated along three transects through each search unit, identified invasive exotic plants in a 3 m- to 12 m-belt, and attributed a coarse cover value to each species (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= 499.9-999.9 m^2, and 7 $\geq$ 1,000 m^2). Observers spaced themselves approximately equidistantly along the east or west border of a search unit prior to searching the unit in an easterly or westerly direction. Transects were not marked, however, such that the exact position of each transect may have varied between years. The widest belt possible given site conditions was used. Unit size ranged between 1.1 – 3.0 acres with a mean size of 2.0 acres. A total of 39% of search units ranged between 1.1 and 1.9 acres, while 61% of search units were between 2.0 and 3.0 acres in size.

For this report, *Solanum* plants surveyed have been documented as *Solanum dulcamara*. To facilitate ease of field identification between Kentucky and Canada bluegrass (*Poa pratensis* and *Poa compressa*, respectively), both species were categorized as bluegrass (*Poa* spp.) and were analyzed as a single taxon. In the 2013 survey, observers should confirm that the small shrubs in the Caprifoliacaeae are the native coralberry (*Symphoricarpos orbiculatus*) and not invasive bush honeysuckle.

Analytical methods

Data analysis involved simple displays, as well as calculation of plant cover and frequency. The invasive exotic plants encountered on Homestead National Monument of America were attributed to search units in a GIS (Figures 2 – 15). Note that entire search units were not fully searched. A park-wide cover range was estimated for each invasive exotic plant encountered.

We calculated the observed reference frame fraction 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). The product was then divided by the reference frame area (Eq. 1). We calculated transect lengths using the mean sample unit size and assuming square search units.

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

The minimum fraction of area searched (belt width = 3 m) was 0.100, and the maximum fraction of area searched (belt width = 12 m) was 0.401.

To calculate the minimum end of the estimated cover range for each species, we summed the lower endpoints associated with the assigned cover class values for that species and then divided by the reference frame fraction observed assuming the widest possible survey belt (i.e., maximum fraction observed) (12 m) (Eq. 2).

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

Maximum cover for each species was calculated similarly, using 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).

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

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.

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

Eq. 4. Frequency of an IEP species = $\frac{\Sigma \text{ units occupied by species}}{\Sigma \text{ units sampled}}$ X100

Invasiveness ranks

In order to provide additional information on the ecological impact and feasibility of control, the ecological impact and general management difficulty sub-ranks that constitute the invasiveness rank (I-rank), as determined by NatureServe (Morse et al. 2004), were listed when available. The ecological impact characterizes the effect of the plant on ecosystem processes, community composition and structure, native plant and animal populations, and the conservation significance of threatened biodiversity. General management difficulty ranks are assigned based on the resources and time generally required to control a plant, the non-target effects of control on native populations, and the accessibility of invaded sites. Sub-ranks are given as high (H), medium (M), low (L), insignificant (I), unknown (U), or a combination of ranks.

Results and Discussion

In 2006 and 2009, a total of 14 invasive exotic plant taxa were found during the survey at Homestead National Monument of America (Table 2). We found 11 species in 2006 and 11 species in 2009. With the exception of climbing nightshade, all invasive exotic plants found in 2009 were known to occur in the monument as a result of the park's strong botanical record. Because climbing nightshade has never been documented at Homestead National Monument of America or in Gage County, Nebraska, we need to further confirm the identity of this new species during the next survey in 2013.

The distribution and abundance of invasive exotic plant species at Homestead National Monument of America varied widely in 2009. Smooth brome, present in 53.7% of park search units, occupied the most area of the documented species, with a cover of at least four acres. With a frequency of 20.7% and occurring as a hedgerow on the southern border of the monument and in the woodland, Osage orange was the only other species with a cover of at least one acre. The

Osage orange hedgerow is an important cultural resource at Homestead National Monument of America and has not demonstrated invasive tendencies under existing conditions. White mulberry and reed canarygrass each covered at least 0.6 acres with frequencies of 34.1% and 29.3%, respectively. Only two other invasive exotic plant species displayed park-wide cover in excess of 0.1 acres: bluegrass and sweetclover (*Meliliotus officinalis*; based on data not explicitly shown in Table 2).

Comparisons of invasive plant abundance and frequency between 2006 and 2009 required careful consideration of the uncertainty associated with the measurements outlined in the monitoring protocol (Young et al 2007). We recognized two sources of uncertainty when analyzing occurrence (i.e., frequency) patterns within or between years. First, observers can make mistakes in their observations including overlooking or misidentifying plants within transects. The use of trained botanists and technicians is intended to minimize this source of uncertainty. Second, because transect locations and widths may vary between years, differences in plant detection may reflect natural spatial variability. This factor may strongly affect plant detection rates in any single search unit, but should vary randomly across all units. Such sampling error, which should be mitigated through the approximately similar location of transects between years, poses the greatest challenge to data interpretation in this protocol. While we observed a relatively high proportion of the reference frame compared to traditional sampling approaches (Young and Haack 2009), observers cannot observe all areas of the park. Additional observations from park staff or citizen scientists would increase detection of invasive plant species.

With these sources of error in mind, we interpreted the three possible scenarios that characterize changes in the frequency of invasive plant species between 2006 and 2009: In the first scenario, a species found within a search unit during the first and second sampling periods confirmed the longevity of the species in that location. In the second scenario, in which a species was not found in a search unit during either sampling period, we assumed that the species was absent or at least not highly abundant or widely distributed as these characteristics would increase detection probabilities. The third scenario–when a species was found in a search unit during one sampling period and not during the next–was the most problematic. This observation could reflect species turnover or a dramatic fluctuation in abundance that is typically associated with annual species. For this dataset, however, we assumed that in most cases the species was probably present during both sampling periods. We attributed the absence either to observer mistakes, which we expect are minimal, or to sampling error arising from the use of non-permanent transects and variable belt widths along transects.

The assumption made here for the third scenario will not always be appropriate. For example, a species that is not found or found at low frequency during an early sampling period and is then found in a relatively large number of search units during a later sampling period may be actively invading. Alternatively, for species subject to control actions, decreases in frequency between or among surveys could result from such management. Relatively dramatic changes in frequency, however, will only be expected for species with low abundance that respond readily to management techniques. In either case, such patterns will be best documented by increasing or decreasing trends from several years of survey data.

Six of the 14 invasive plant species increased in frequency between 2006 and 2009. The increase was small for reed canarygrass, which was all already common in 2006, occurring in 25.6% of the search units. Reed canarygrass was treated with glyphosate in selected areas between 2006 and 2009. We observed relatively large increases on a relative basis for two species that were uncommon in 2006 (occurring in < 10% of the search units): bluegrass and sweetclover. Bluegrass is managed with fire, while sweetclover has not been treated to date. Based on observations at Herbert Hoover National Historical Site, sweetclover can become very abundant in small prairies and is moderately difficult to manage. Climbing nightshade, nodding plumeless thistle (*Carduus nutans*), and Siberian elm (*Ulmus pumila*) were present in 2009, but not found in 2006. These three species, detected for the first time in 2009, are at low levels and are treated mechanically or chemically when found on the park.

Eight species decreased in frequency between 2006 and 2009. Of these, four were not specifically targeted with treatments. Decreases for smooth brome, Osage orange, and white mulberry, species that already occupied at least 25% of search units in 2006, were slight to moderate. Osage orange and white mulberry are currently only controlled within the prairie, while the majority of these species are located in cultural areas or in the riparian forest. The relative decreases were much greater for bald brome and common mullein (*Verbascum thapsus*). Bald brome was not treated, while common mullein is pulled by hand annually. Bull thistle (*Cirsium vulgare*), Japanese barberry (*Berberis thunbergii*), and Johnsongrass (*Sorghum halepense*) were identified in 2006, but not found in 2009. Thistles are pulled annually, while Japanese barberry and Johnsongrass were not treated.

We examined the entire suite of invasive exotic plant species to assess general changes in frequency between 2006 and 2009. Given that sampling error between years should be random (i.e., expected value for increasing and decreasing categories = 50%), we found that 57% of species decreased in frequency, while 43% increased. In this case, the combined effect of treatments, including fire, on invasive exotic plant frequencies does not appear to vary from those expected by chance alone. These treatments, however, may be important in maintaining current distributions for cool-season grasses such as smooth brome and bluegrass.

Interpreting changes in the abundance of invasive plant species between 2006 and 2009 required considerations of uncertainty in addition to those made for frequency. For example, in addition to observer detection mistakes, abundance estimates include error resulting from incorrect assignment of cover classes. As with detection, abundance estimation may vary between years due to variability in transect location, although the approximate similarity in location between years should mitigate this error. The uncertainty resulting from measurement error (i.e., the use of cover class ranges rather than point estimates) and the uncertainty resulting from variable belt widths are accounted for in the cover range provided for each invasive plant species (see *Analytical Methods*). For the purposes of comparing cover ranges for each species between 2009 and 2006, non-overlapping cover ranges represent the strongest evidence for a change in the abundance of a species between 2006 and 2009. Cover ranges may be very broad, however, and increase with abundance. Thus, relatively large differences in overlapping cover ranges could also be informative. For such overlapping cover ranges, the degree of overlap should be proportional to the strength of evidence for a true difference in abundance (i.e., a high degree of overlap in range represents a lower probability of a difference than a low degree of overlap).

Based on non-overlapping cover ranges, we identified one species as changing in abundance between 2006 and 2009: bluegrass increased in abundance. Bald brome and sweetclover apparently decreased between 2006 and 2009, even as the number of park search units containing bald brome decreased by more than 50% and those containing sweetclover increased by 50%. We interpreted the other overlapping ranges for all other species as reflecting general similarity in species' abundance between 2006 and 2009. Viewing the entire suite of invasive species with abundance greater than 0 during 2006 and 2009 as a whole (n=8), the maximum cover estimate increased for 25% of species and decreased for 75% of species. This pattern may suggest a general decreasing directional trend in invasive plant abundance, which may be associated with treatments, including prescribed fire.

Reed canarygrass ranks as the only invasive exotic plant at the monument in 2009 with a definitively high ecological impact (Table 2). This sod-forming, cool-season perennial grass is highly invasive and often associated with streams such as Cub Creek. The ecological impact for the other species ranged from medium to medium-insignificant. Reed canarygrass, bluegrass and nodding plumeless thistle were ranked as species generating high/medium management difficulty; however, the majority of the species are of little management concern with ratings of only medium to low-insignificant management difficulty. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, many invasive exotic species occur on less than one-tenth of an acre. Controlling as many species as possible now should provide a relatively high benefit for the cost. On the other hand, control of smooth brome and reed canarygrass may prove difficult as both grasses are abundant in Homestead National Monument of America.

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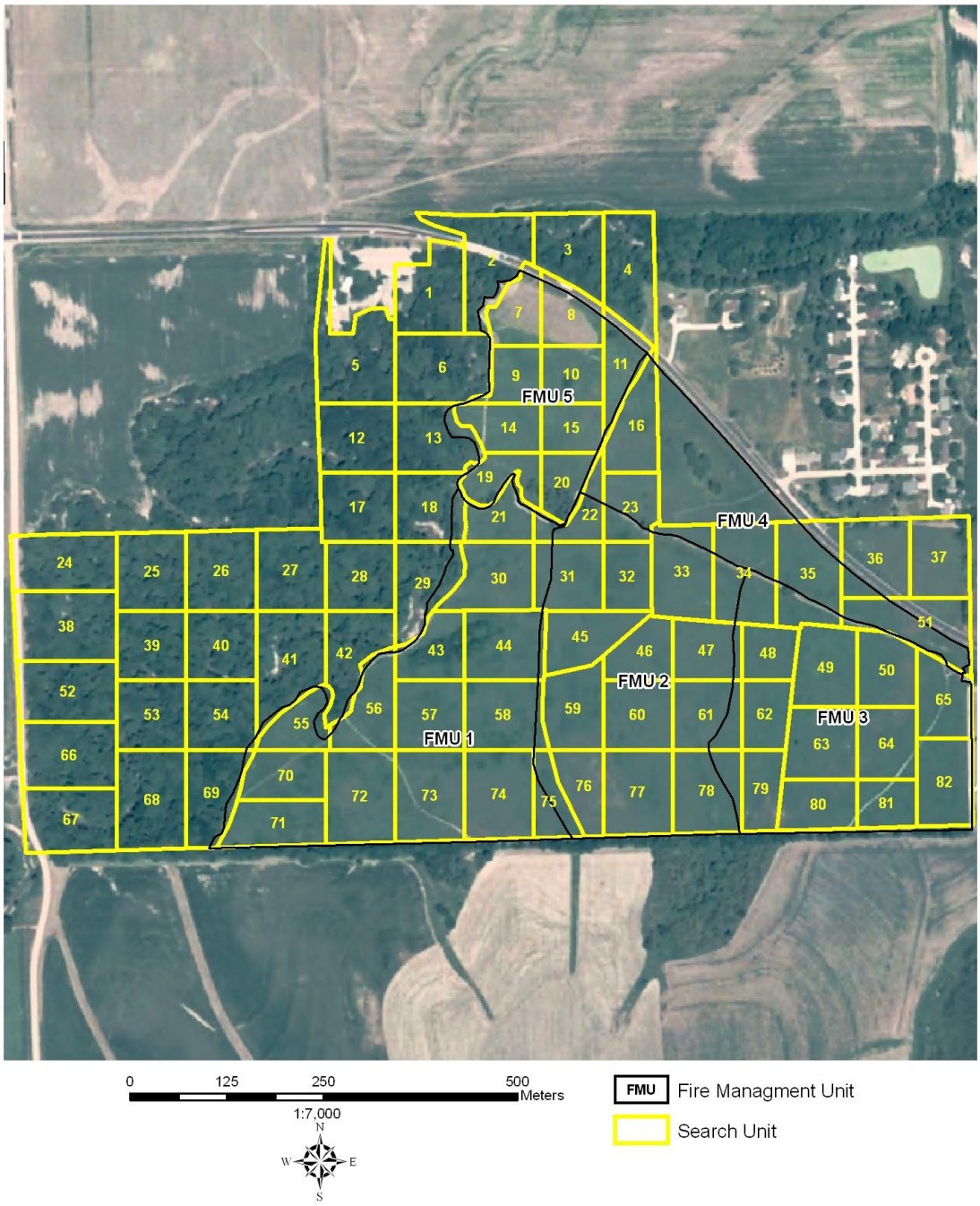

Figure 1. Invasive exotic plant search units at Homestead National Monument of America. The search units indicate the search locations for invasive exotic plants in 2006 and 2009.

Table 1. Watch lists for Homestead National Monument of America. The symbol ^ denotes aquatic plant species.

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Ailanthus altissima	Tree of heaven	*Berberis thunbergii*	Japanese barberry	*Bromus racemosus*	Bald brome
Alliaria petiolata	Garlic mustard	*Bromus inermis*	Smooth brome	*Echinochloa crusgalli*	Barnyardgrass
Arctium minus	Lesser burdock	*Carduus nutans*	Nodding plumeless thistle	*Maclura pomifera*	Osage orange
Azolla	Mosquitofern^	*Cirsium vulgare*	Bull thistle		
Bothriochloa bladhii	Caucasian bluestem	*Hesperis matronalis*	Dames rocket		
Bromus tectorum	Cheatgrass	*Melilotus officinalis*	Yellow sweetclover		
Butomus umbellatus	Flowering rush	*Morus alba*	White mulberry		
Cardaria draba	Whitetop	*Phalaris arundinacea*	Reed canarygrass		
Centaurea biebersteinii	Spotted knapweed	*Poa pratensis*	Kentucky bluegrass		
Centaurea solstitialis	Yellow star-thistle	*Rosa multiflora*	Multiflora rose		
Cirsium arvense	Canada thistle	*Ulmus pumila*	Siberian elm		
Cynanchum louiseae	Louise's swallow-wort	*Verbascum thapsus*	Common mullein		
Cynoglossum officinale	Gypsyflower				
Dactylis glomerata	Orchardgrass				
Dipsacus fullonum	Fuller's teasel				
Dipsacus laciniatus	Cutleaf teasel				
Egeria densa	Brazilian waterweed^				
Elaeagnus angustifolia	Russian olive				
Elaeagnus umbellata	Autumn olive				
Euphorbia esula	Leafy spurge				
Frangula alnus	Glossy buckthorn				
Glechoma hederacea	Ground ivy				
Humulus japonicus	Japanese hop				
Hyoscyamus niger	Black henbane				
Lespedeza cuneata	Sericea lespedeza				
Ligustrum vulgare	European privet				
Linaria dalmatica	Dalmatian toadflax				
Linaria vulgaris	Butter and eggs				
Schedonorus phoenix	Tall fescue				
Schedonorus pratensis	Meadow fescue				
Lonicera japonica	Japanese honeysuckle				
Lonicera maackii	Amur honeysuckle				
Lonicera tatarica	Tatarian honeysuckle				
Lotus corniculatus	Bird's-foot trefoil				
Lotus tenuis	Narrow-leaf bird's-foot trefoil				

Table 1 (cont.). Watch lists for Homestead National Monument of America.

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Lysimachia nummularia	Creeping jenny				
Lythrum salicaria	Purple loosestrife				
Myriophyllum spicatum	Eurasian watermilfoil^				
Onopordum acanthium	Scotch cottonthistle				
Pastinaca sativa	Wild parsnip				
Phragmites australis	Common reed				
Plantago lanceolata	Narrowleaf plantain				
Poa compressa	Canada bluegrass				
Polygonum cuspidatum	Japanese knotweed^				
Populus alba	White poplar				
Potamogeton crispus	Curly pondweed				
Potentilla recta	Sulphur cinquefoil				
Pueraria montana var. lobata	Kudzu				
Rhamnus cathartica	Common buckthorn				
Rhamnus davurica	Dahurian buckthorn				
Robinia pseudoacacia	Black locust				
Securigera varia	Crownvetch				
Solanum dulcamara	Climbing nightshade				
Sorghum halepense	Johnsongrass				
Tamarix ramosissima	Saltcedar				
Torilis arvensis	Spreading hedgeparsley				
Typha angustifolia	Narrowleaf cattail				
Viburnum opulus	European cranberrybush				
Vinca minor	Common periwinkle				

Table 2. Overview of invasive exotic plants found on Homestead National Monument of America in 2006 and 2009. Inequalities rather than cover ranges are shown for species with maximum cover value less than 1 acre. Ecological impact and general management difficulty based on NatureServe I-Rank subranks, Morse et al. 2004. Subranks are given as high (H), medium (M), low (L), insignificant (I), unknown (U), a range of ranks (indicated by /), or not available (--).

Species	Common Name	Watch list	2006 Park-wide cover (acres)	2009 Park-wide cover (acres)	2006 Frequency (percent)	2009 Frequency (percent) (Frequency difference 2006-2009)	Ecological impact	Management difficulty
Bromus inermis	Smooth brome	Park-established	4.6 - 54.6	4.1 - 62.0	65.9	53.7 (-12.2)	M	ML
Maclura pomifera	Osage-orange	Park-based	2.5 - 26.9	1.0 - 14.8	25.6	20.7 (-4.9)	ML	L
Phalaris arundinacea	Reed canary-grass	Park-established	1.9 - 23.5	0.6 - 10.6	25.6	29.3 (3.7)	H	HM
Morus alba	White mulberry	Park-established	1.6 - 19.8	0.6 - 10.6	37.8	34.1 (-3.7)	ML	ML
Bromus racemosus	Bald brome	Park-based	0.5 - 5.5	< 0.1	12.2	4.9 (-7.3)	----	----
Melilotus officinalis	Sweet clover	Park-established	0.2 - 3.0	< 0.5	6.1	12.2 (6.1)	M	M
Poa spp.	Kentucky / Canada Bluegrass	Park-established	< 0.1*	0.2 - 3.3	2.4	21.9 (19.5)	M / ML	ML / HM
Sorghum halepense	Johnsongrass	Early-detection	< 0.1	0	4.9	0 (-4.9)	ML	HM
Verbascum thapsus	Common mullein	Park-established	< 0.01	< 0.01	3.7	1.2 (-2.5)	ML	L
Berberis thunbergii	Japanese barberry	Park-established	< 0.01	0	1.2	0 (-1.2)	HM	I
Cirsium vulgare	Bull thistle	Park-established	< 0.01	0	1.2	0 (-1.2)	ML	ML
Carduus nutans	Nodding plumeless thistle	Park-established	0	< 0.01	0.0	1.2 (1.2)	MI	HM
Solanum dulcamara	Climbing nightshade	Early detection	0	< 0.01	0.0	1.2 (1.2)	L	LI
Ulmus pumila	Siberian elm	Park-established	0	< 0.01	0.0	1.2 (1.2)	ML	ML

*True difference in cover assumed based on non-overlapping cover ranges.

Figure 2. Abundance and distribution of *Berberis thunbergii* (Japanese barberry) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 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= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

Figure 3. Abundance and distribution of *Bromus inermis* (smooth brome) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 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= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

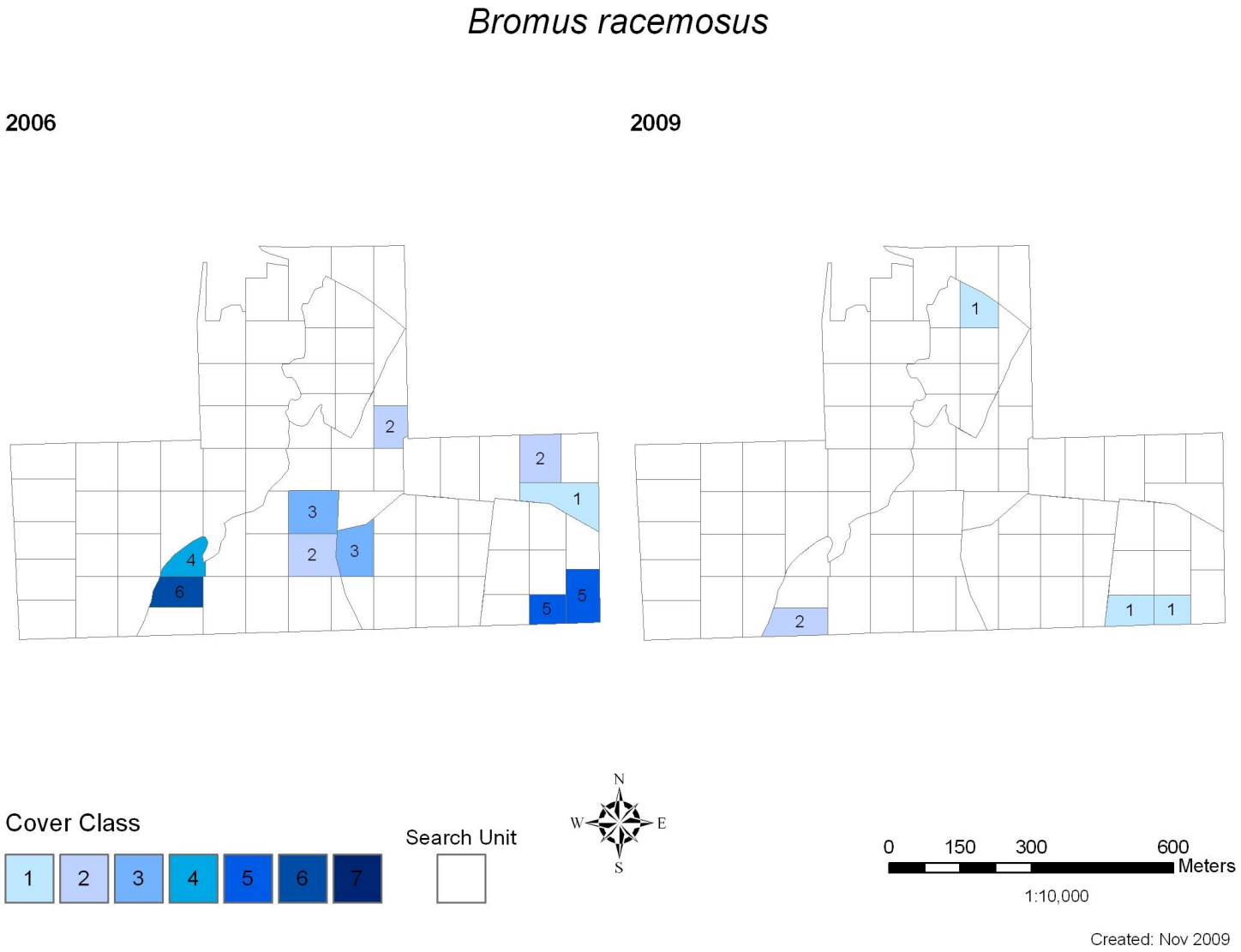

Figure 4. Abundance and distribution of *Bromus racemosus* (bald brome) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

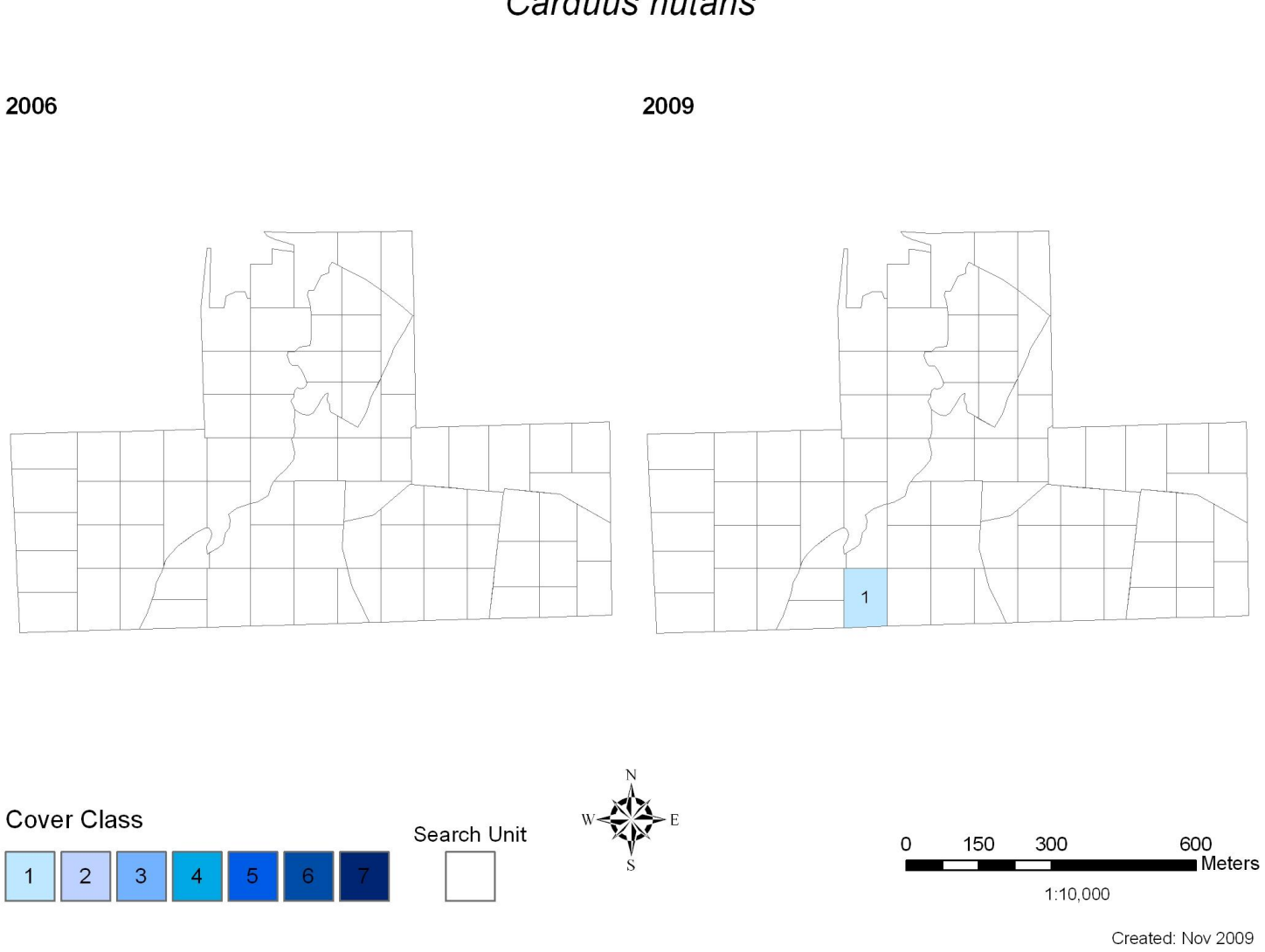

Figure 5. Abundance and distribution of *Carduus nutans* (nodding plumeless thistle) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

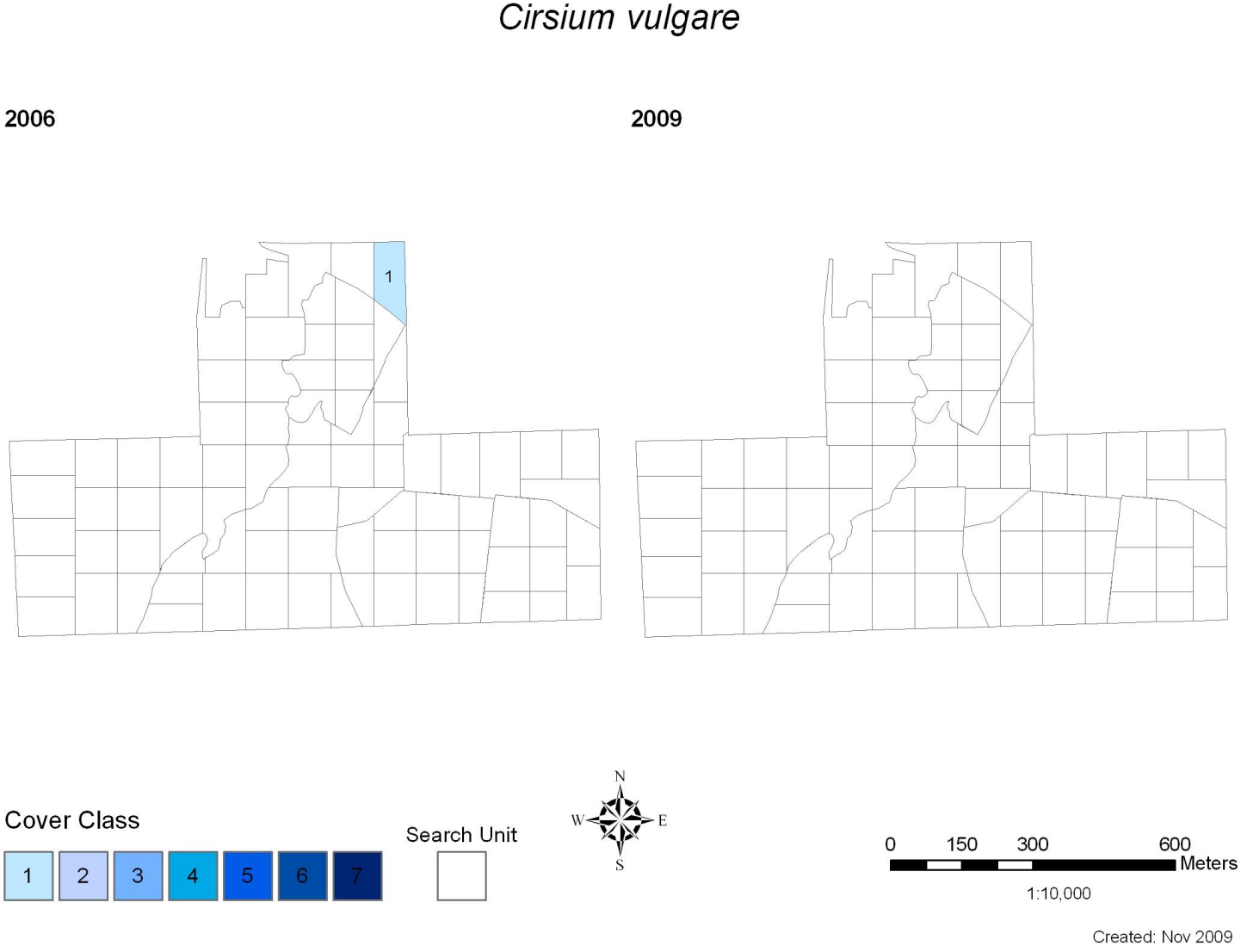

Figure 6. Abundance and distribution of *Cirsium vulgare* (bull thistle) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

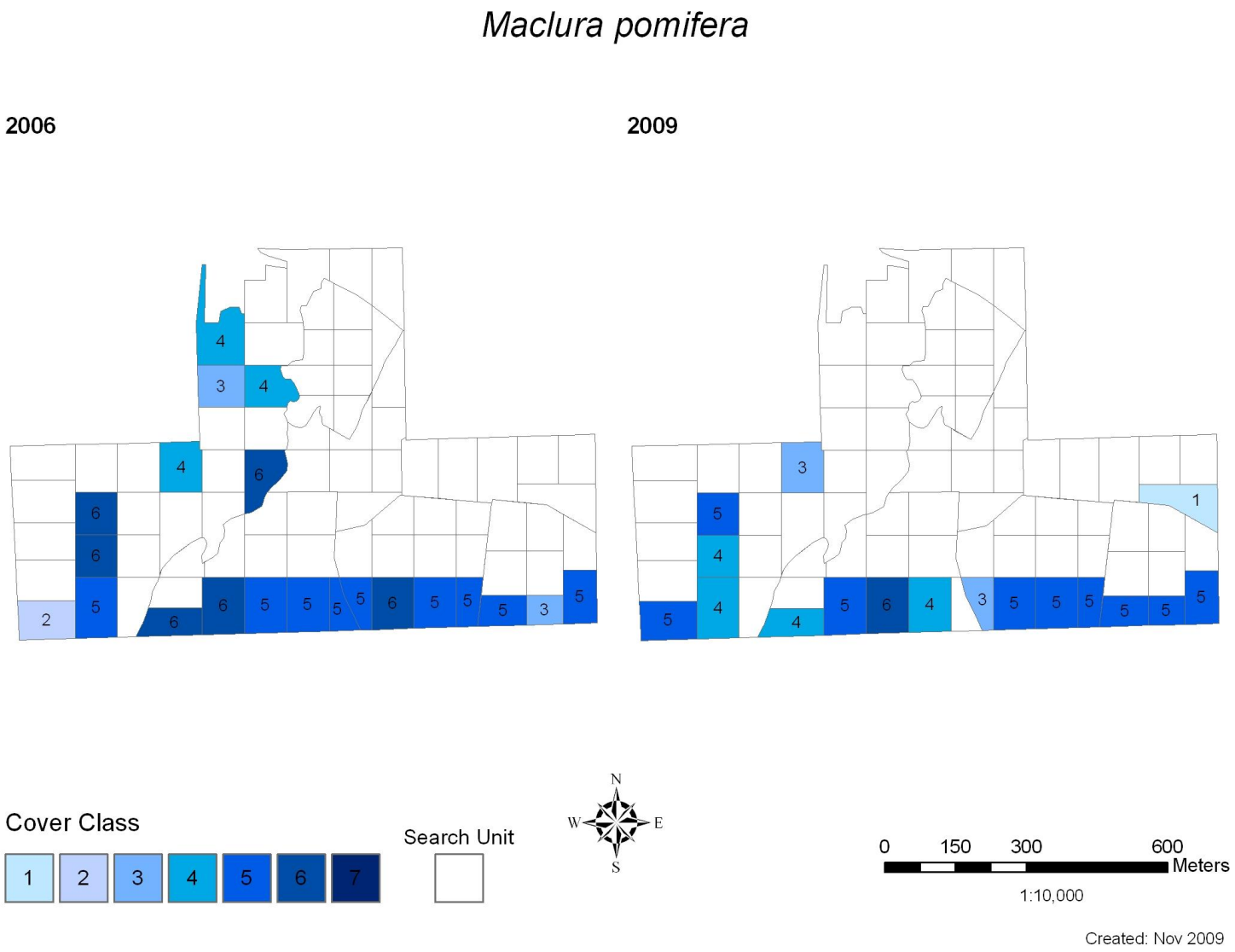

Figure 7. Abundance and distribution of *Maclura pomifera* (Osage-orange) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

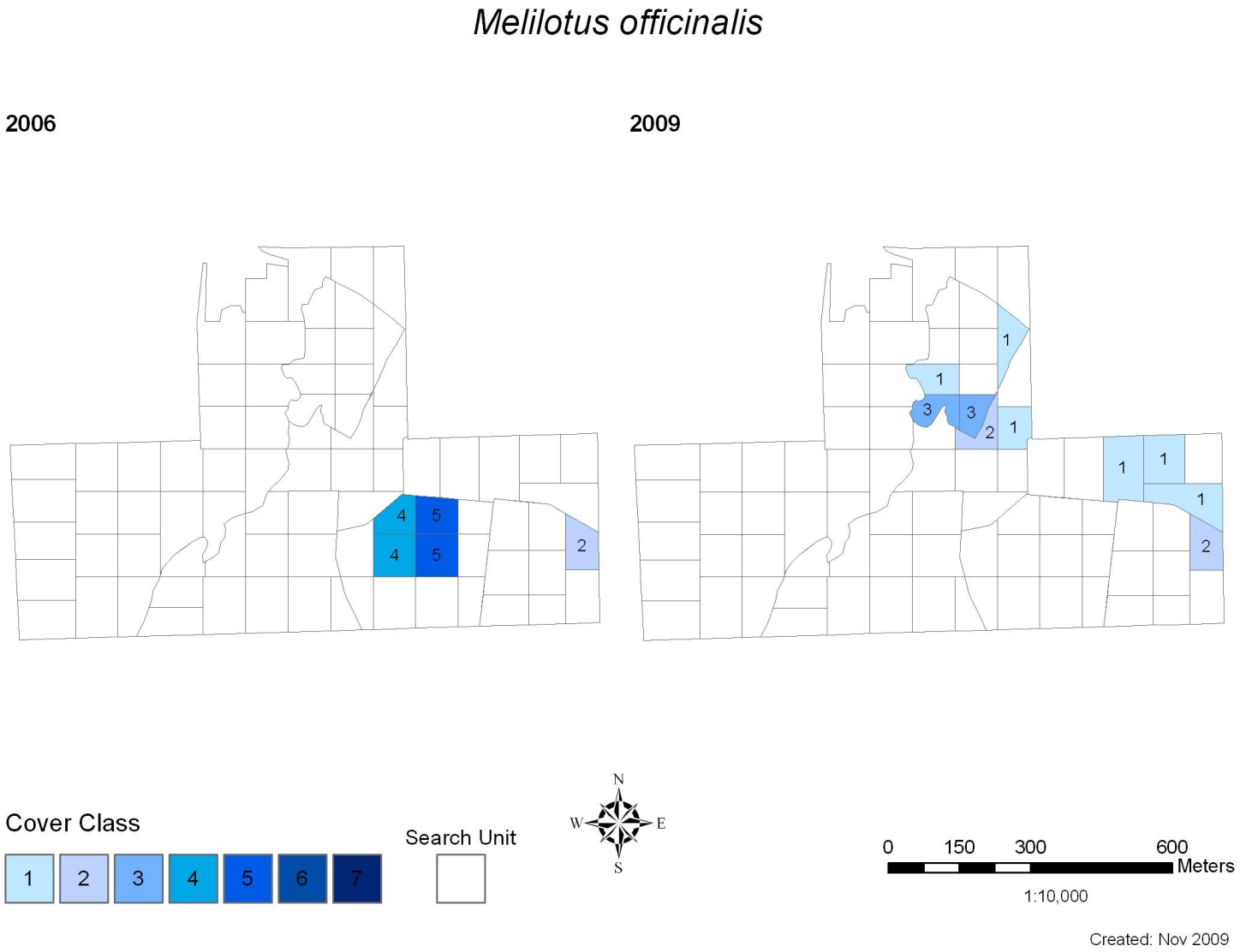

Figure 8. Abundance and distribution of *Melilotus officinalis* (yellow sweetclover) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

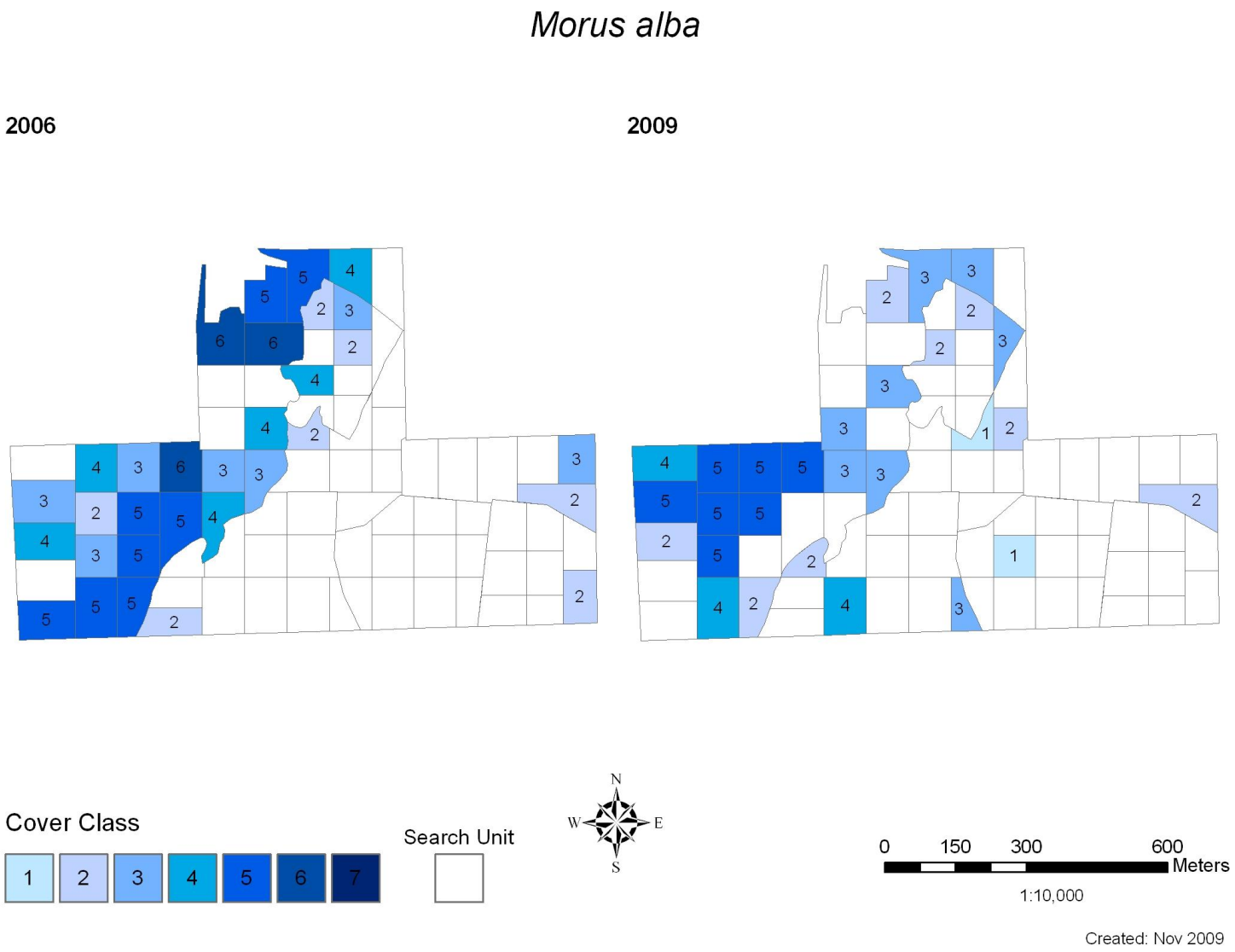

Figure 9. Abundance and distribution of *Morus alba* (white mulberry) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

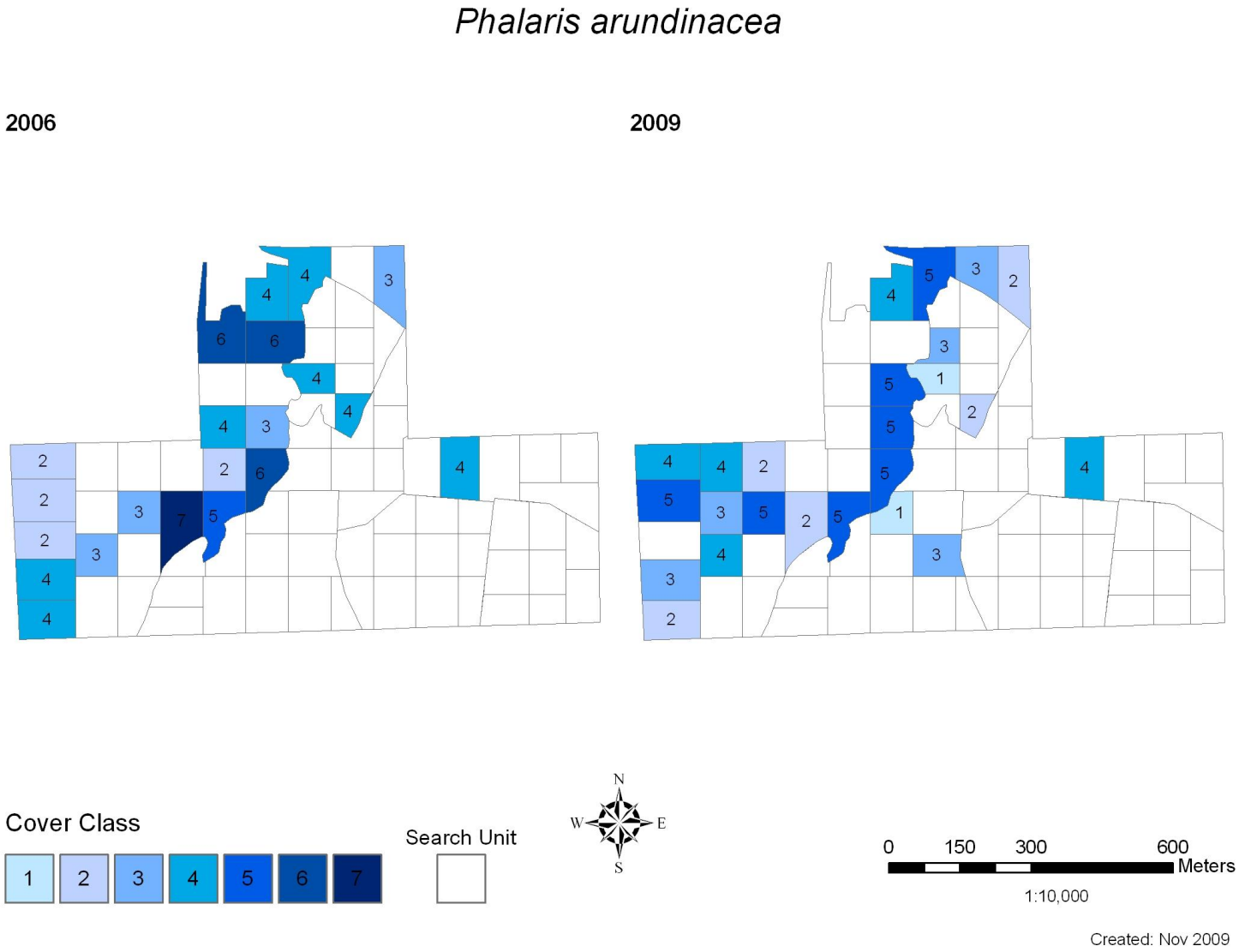

Figure 10. Abundance and distribution of *Phalaris arundinacea* (reed canarygrass) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

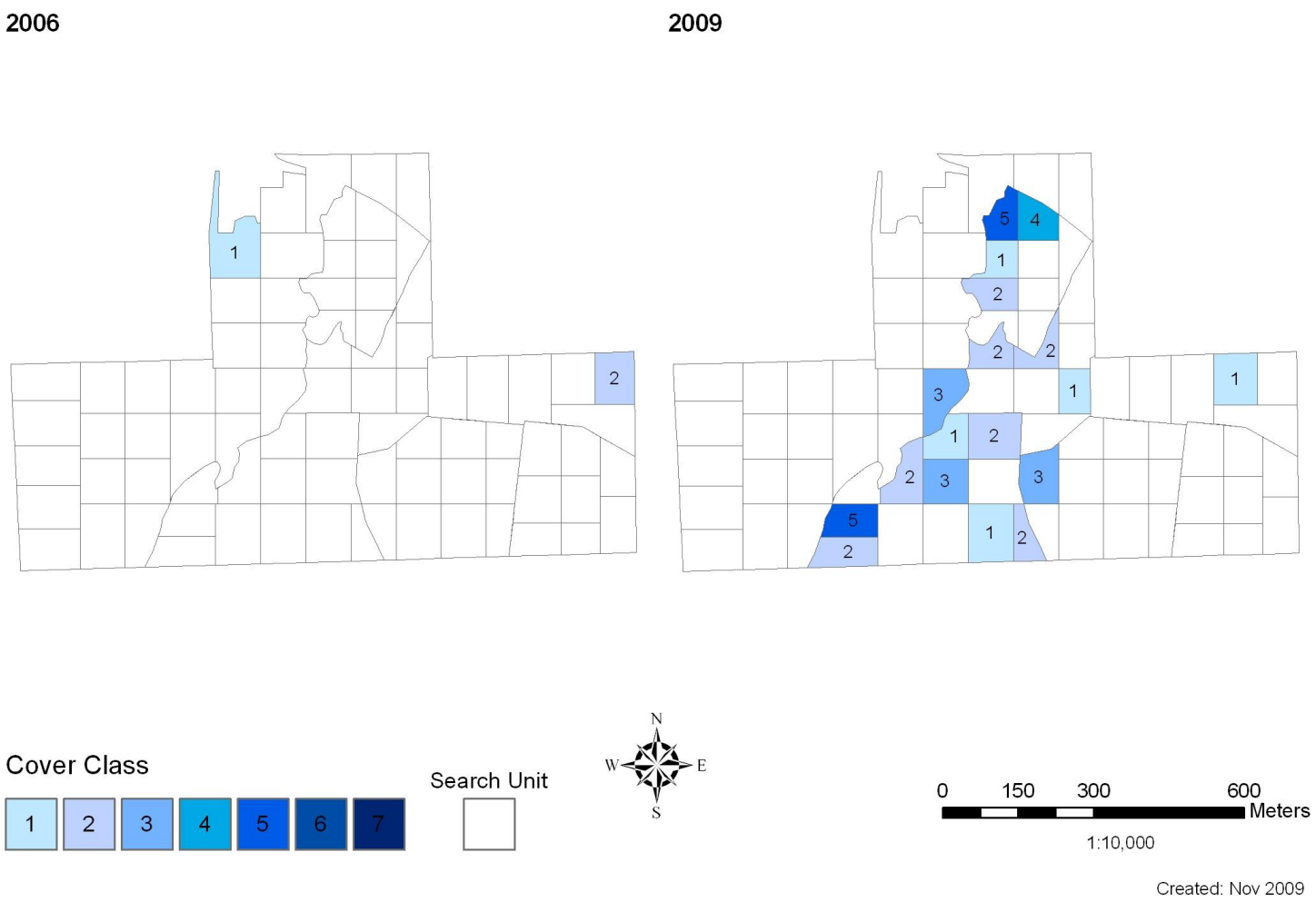

Figure 11. Abundance and distribution of *Poa* spp. (bluegrass) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

Solanum dulcamara

Figure 12. Abundance and distribution of *Solanum dulcamara* (climbing nightshade) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 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= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

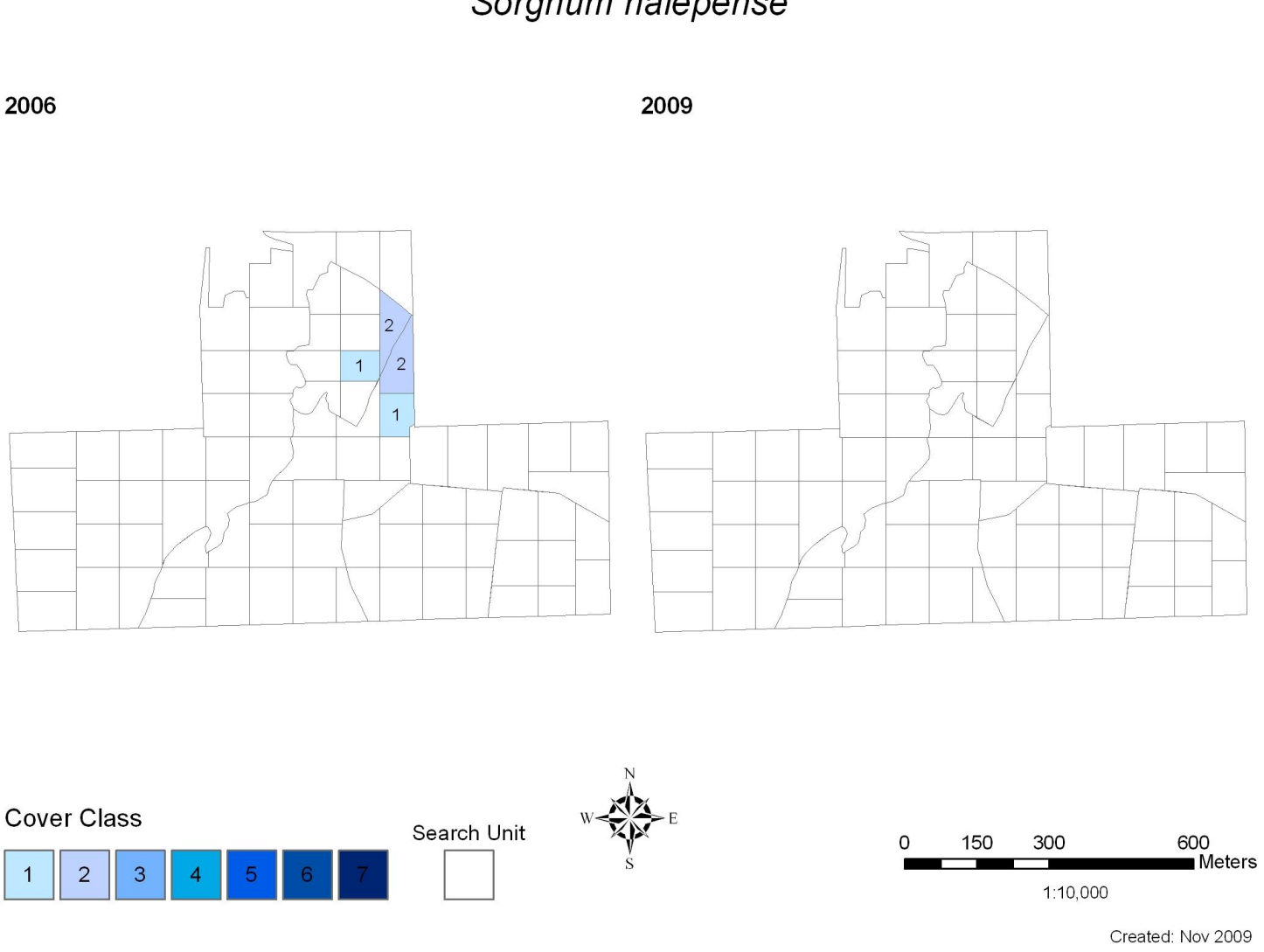

Figure 13. Abundance and distribution of *Sorghum halepense* (Johnsongrass) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

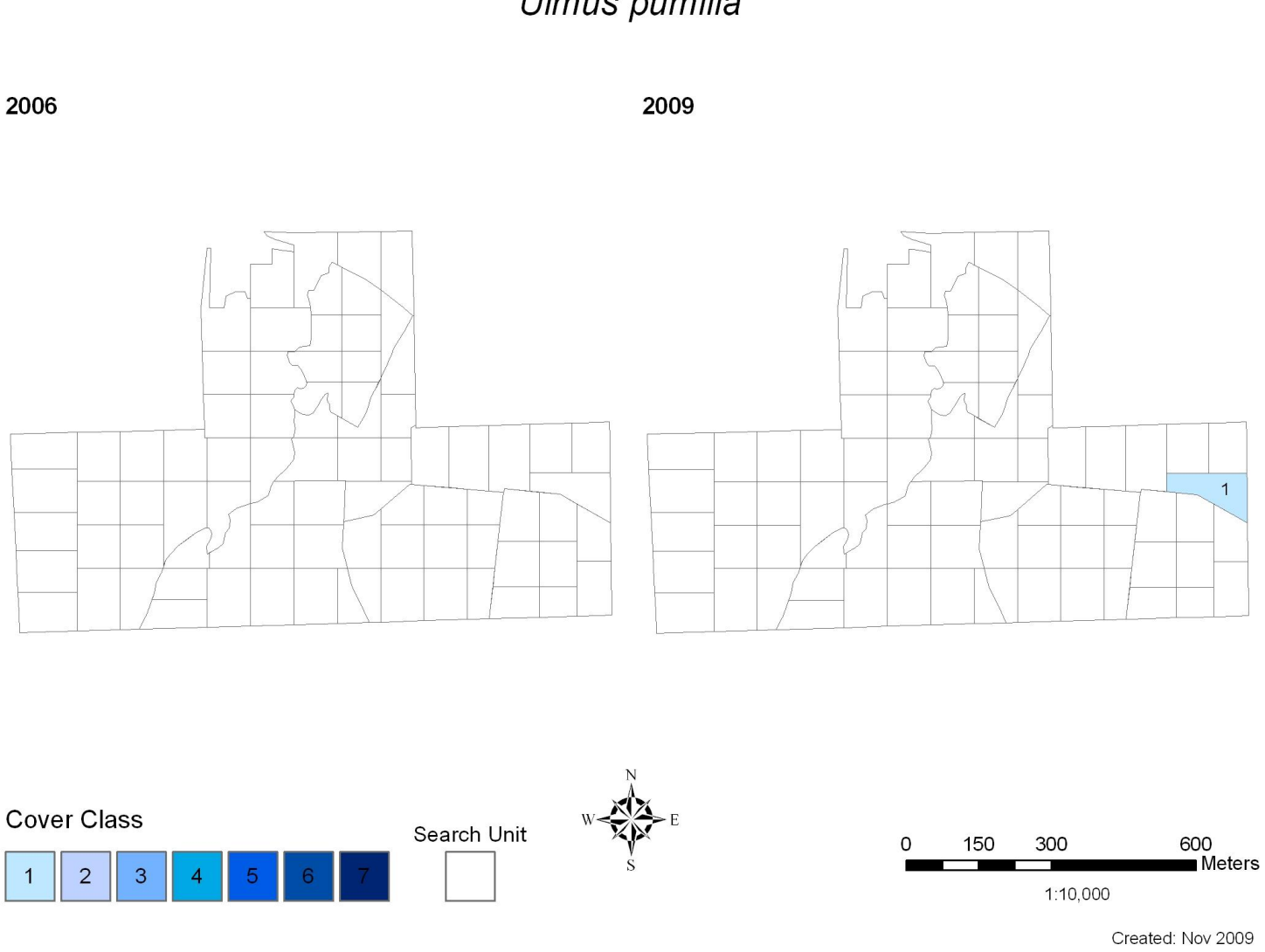

Figure 14. Abundance and distribution of *Ulmus pumilla* (Siberian elm) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

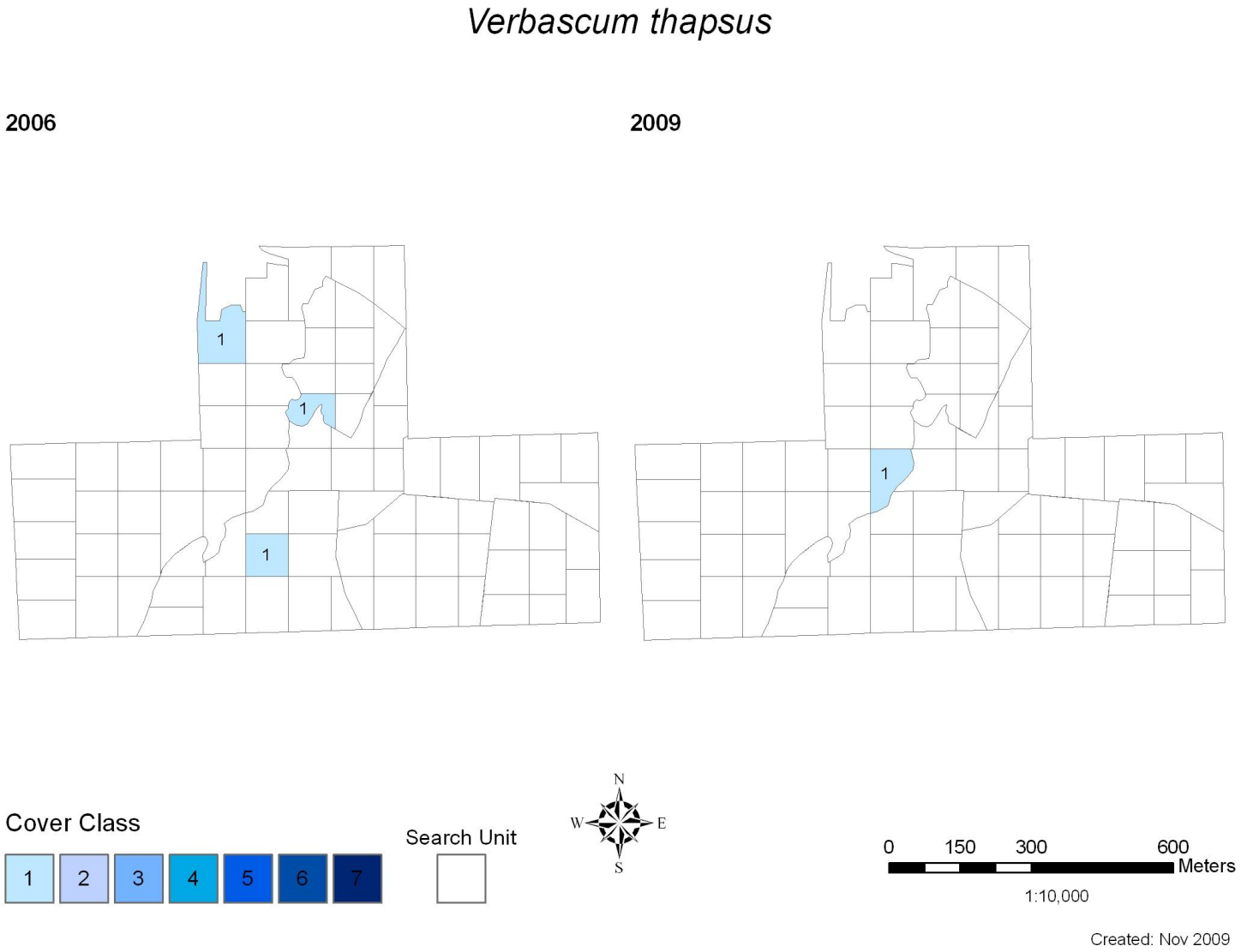

Figure 15. Abundance and distribution of *Verbascum thapsus* (common mullein) at Homestead National Monument of America, 2006 and 2009. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7 ≥ 1,000 m^2.

The NPS has organized its parks with significant natural resources into 32 networks linked by geography and shared natural resource characteristics. HTLN is composed of 15 National Park Service (NPS) units in eight Midwestern states. These parks contain a wide variety of natural and cultural resources including sites focused on commemorating civil war battlefields, Native American heritage, westward expansion, and our U.S. Presidents. The Network is charged with creating inventories of its species and natural features as well as monitoring trends and issues in order to make sound management decisions. Critical inventories help park managers understand the natural resources in their care while monitoring programs help them understand meaningful change in natural systems and to respond accordingly. The Heartland Network helps to link natural and cultural resources by protecting the habitat of our history.

The I&M program bridges the gap between science and management with a third of its efforts aimed at making information accessible. Each network of parks, such as Heartland, has its own multi-disciplinary team of scientists, support personnel, and seasonal field technicians whose system of online databases and reports make information and research results available to all. Greater efficiency is achieved through shared staff and funding as these core groups of professionals augment work done by individual park staff. Through this type of integration and partnership, network parks are able to accomplish more than a single park could on its own.

The mission of the Heartland Network is to collaboratively develop and conduct scientifically credible inventories and long-term monitoring of park "vital signs" and to distribute this information for use by park staff, partners, and the public, thus enhancing understanding which leads to sound decision making in the preservation of natural resources and cultural history held in trust by the National Park Service.

www.nature.nps.gov/im/units/htln/

Heartland Network
Natural Resource Monitoring

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 368/101722, April 2010

National Park Service
U.S. Department of the Interior

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