National Park Service
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Natural Resource Program Center
Fort Collins, Colorado

Invasive Exotic Plant Monitoring at Homestead National Monument of America: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/020
NPS D-47

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 1 (2006)

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Executive Summary

During surveys in 2006, we documented 11 invasive exotic plant taxa at Homestead National Monument of America. Invasive exotic plants occurred in the restored prairies and the forest at the monument. Smooth brome, Osage orange, reed canarygrass, and white mulberry were widespread and abundant. We estimated that each of these plant species covered at least three acres on the monument. Five species occupied less than 0.1 acre. In general, several invasive exotic plants that are difficult to manage are a moderate problem at Homestead National Monument of America, but successful control is possible for a large group of species. The acreage estimates presented in the report may be used to plan management activities leading to control of exotic plants and the accomplishment of GPRA goal IA1b.

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Introduction

Author's note. In this report, we use the term invasive exotic plant to refer to plants that are not native to the park and that are presumed to pose environmental harm to native plant populations and/or communities based on a review of numerous state and regional invasive exotic plant lists. The great majority of the introductory text was taken from Welch and Geissler (2007) with slight modification.

Scope of invasive exotic plant problem for National Parks. Globalization of commerce, transportation, human migration, and recreation in recent history has introduced invasive exotic species to new areas at an unprecedented rate. Biogeographical barriers that once restricted the location and expansion of species have been circumvented, culminating in the homogenization of the Earth's biota. Although only 10% of introduced species become established and only 1% become problematic (Williamson 1993, Williamson and Fitter 1996) or invasive, nonnative species have profound impacts worldwide on the environment, economies, and human health. Invasive species have been directly linked to the replacement of dominant native species (Tilman 1999), the loss of rare species (King 1985), changes in ecosystem structure, alteration of nutrient cycles and soil chemistry (Ehrenfeld 2003), shifts in community productivity (Vitousek 1990), reduced agricultural productivity, and changes in water availability (D'Antonio and Mahall 1991). Often the damage caused by these species to natural resources is irreparable and our understanding of the consequences incomplete. Invasive species are second only to habitat destruction as a threat to wildland biodiversity (Wilcove et al. 1998). Consequently, the dynamic relationships among plants, animals, soil, and water established over many thousands of years are at risk of being destroyed in a relatively brief period.

For the National Park Service (NPS), the consequences of these invasions present a significant challenge to the management of the agency's natural resources "unimpaired for the enjoyment of future generations." National Parks, like other land management organizations, are deluged by new exotic species arriving through predictable (e.g., road, trail, and riparian corridors), sudden (e.g., long-distance dispersal through cargo containers and air freight), and unexpected anthropogenic pathways (e.g., weed seeds in restoration planting mixes). Nonnative plants claim an estimated 4,600 acres of public lands each year in the United States (Asher and Harmon 1995), significantly altering local flora. For example, exotic plants comprise an estimated 43% and 36% of the flora of the states of Hawaii and New York, respectively (Rejmanek and Randall 1994). Invasive plants infest an estimated 2.6 million acres of the 83 million acres managed by the NPS.

More NPS lands are infested daily despite diligent efforts to curtail the problem. Impacts from invasive species have been realized in most parks, resulting in an expressed need to control existing infestations and restore affected ecosystems. Additionally, there is a growing urgency to be proactive—to protect resources not yet impacted by current and future invasive species (Marler 1998). Invasive exotic species most certainly will continue to be a management priority for the National Parks well into the 21st Century. Invasive exotic plants have been consistently ranked as a top vital sign for long term monitoring as part of the NPS Inventory & Monitoring (I&M) Program. During the vital signs selection process in 2003, Heartland Network parks recognized the need for exotic plant monitoring (DeBacker et al. 2004). Nine parks (CUVA,

EFMO, GWCA, HEHO, HOCU, HOME, LIBO, OZAR, PERI) identified invasive exotic plants as their most important management issue, two parks (TAPR, WICR) identified invasive exotic plants as their second most important management issue, and PIPE identified invasive exotic plants as its third most important management issue. During this process, invasive exotic plant monitoring was recognized across all network parks as the most important shared monitoring need.

Prevention and early detection as keys to invasive exotic plant management. Prevention and early detection are the principal strategies for successful invasive exotic plant management. While there is a need for long-term suppression programs to address very high-impact species, eradication efforts are most successful for infestations less than one hectare in size (Rejmanek and Pitcairn 2002). Eradication of infestations larger than 100 hectares is largely unsuccessful, costly, and unsustainable (Rejmanek and Pitcairn 2002). Costs, or impacts, to ecosystem components and processes resulting from invasion also increase dramatically over time, making ecosystem restoration improbable in the later stages of invasion. Further, in their detailed review of the nonnative species problem in the United States, the US Congress, Office of Technology Assessment (1993) stated that the environmental and economic benefits of supporting prevention and early detection initiatives significantly outweigh any incurred costs, with the median benefit-to-cost ratio being 17:1 in favor of being proactive.

Although preventing the introduction of invasive exotic plants is the most successful and preferred strategy for resource managers, the realities of globalization, tight fiscal constraints, and limited staff time guarantee that invaders will get through park borders. Fortunately, invasive exotic plants quite often undergo a lag period between introduction and subsequent colonization of new areas. Managers, then, can take advantage of early detection monitoring to make certain invasive exotic species are found and successfully eradicated before populations become well established.

This strategy requires resource managers to: (1) detect invasive exotic species early (i.e., find a new species or an incipient population of an existing species while the infestation is small (less than 1 hectare), and (2) respond rapidly (i.e., implement appropriate management techniques to eliminate the invasive plant and all of its associated regenerative material).

Invasive exotic plant management at Homestead National Monument of America. While a complete history of park invasive exotic plant management issues is beyond the scope of this report, a few important highlights are given:

1. The prairies at Homestead National Monument of America support a few invasive exotic plants, including smooth brome (*Bromus inermis*) and bald brome (*Bromus racemosus*).

2. The forests at Homestead National Monument of America support a few invasive exotic plants, including Osage orange (*Maclura pomifera*), reed canarygrass (*Phalaris arundinacea*), and white mulberry (*Morus alba*).

3. Controlling invasive exotic plants at Homestead National Monument of America is needed to maintain the cultural landscape.

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 based on NPSpecies (the national NPS database for plant occurrence registration) constitute the early detection watch list. Invasive exotic plants known to occur on the park based on NPSpecies constitute the park-established watch list. Invasive exotic plants from the park-based watch list included 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 occasionally.

Field methods. Invasive exotic plant species on designated watch lists (Table 1) were sought in high priority areas on Homestead National Monument of America (Figure 1). Dan Tenaglia, the contract botanist for this project navigated through search units using a Thales GPS unit, identified invasive exotic plants in an approximately 6-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, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2). A total of 82 search units were surveyed at Homestead National Monument of America. The botanist had discretion to search a larger belt if feasible, to target locations likely to support exotic plants (e.g., field edges, roads), and to circumvent extremely difficult or hazardous terrain when needed. Cover was estimated for all plants observed while navigating in the search unit (i.e., not restricted to the 6-m belt).

Analytical methods. Data analysis involved simple displays, as well as calculation of plant frequency and cover. The invasive exotic plants encountered on Homestead National Monument of America were attributed to search units in a GIS (Figures 2 – 26). Note that entire search units were not fully searched. A park-wide cover range was estimated using the high and low values of the cover classes for each invasive exotic plant encountered, assuming that 20 % of the park was searched and that the areas searched were representative of the entire park. The park-wide frequency of invasive exotic plants was calculated as the percentage of occupied search units.

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, a total of 11 invasive exotic plant taxa were found during the survey at Homestead National Monument of America (Table 2). Two of these eight species were listed on the park based list. All invasive exotic taxa were already known to occur on the park due to the park's strong botanical record.

The distribution and abundance of the invasive exotic plant species at Homestead National Monument of America varied widely. Smooth brome (*Bromus inermis*), comprising at least nine acres, was widespread throughout the monument. Bald brome (*Bromus racemosus*) covered at least one acre in the prairie, while sweetclover (*Melilotus officinalis*) covered at least half an acre. The remaining invasive exotic plants in the prairie occupied less than one-tenth of an acre: bluegrass species (*Poa* spp), Johnsongrass (*Sorghum halepense*), Common mullein (*Verbascum thapsus*), and bull thistle (*Cirsium vulgare*). Osage orange (*Maclura pomifera*), occurring as a hedgerow on the southern border of the monument and in the woodland, occupied at least five acres. The Osage orange hedgerow is an important cultural resource at HOME. The trees have not demonstrated invasive tendencies under existing conditions. White mulberry (*Morus alba*) in the forests at Homestead National Monument of America was established on at least three acres. A small patch of Japanese barberry (*Berberis thunbergii*) was also found in the forest. Reed cannarygrass (*Phalaris arundinacea*), which is highly invasive and associated with streams such as Cub Creek, occupied at least roughly four acres.

No invasive exotic plant species were noted as having a definitively high ecological impact (Table 2). Only one species, Japanese barberry, had a high-medium ecological impact and was found in only one search unit. The other ten species were characterized as having medium or medium-low ecological impacts. 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. In the case of Japanese barberry, the management difficulty is noted as insignificant. Controlling as many species as possible now should provide a relatively low cost for a high benefit. On the other hand, control of smooth brome and reed canarygrass may prove to be difficult.

In summary, this report provides information on invasive, exotic plant abundance and distribution as well as the ecological impacts and management difficulty associated with these species. The information is designed to assist park natural resource managers in planning invasive exotic plant management. The following links may further assist managers: http://www.nature.nps.gov/im/units/htln/monitoring/projects/inp.htm and http://www.natureserve.org/explorer/.

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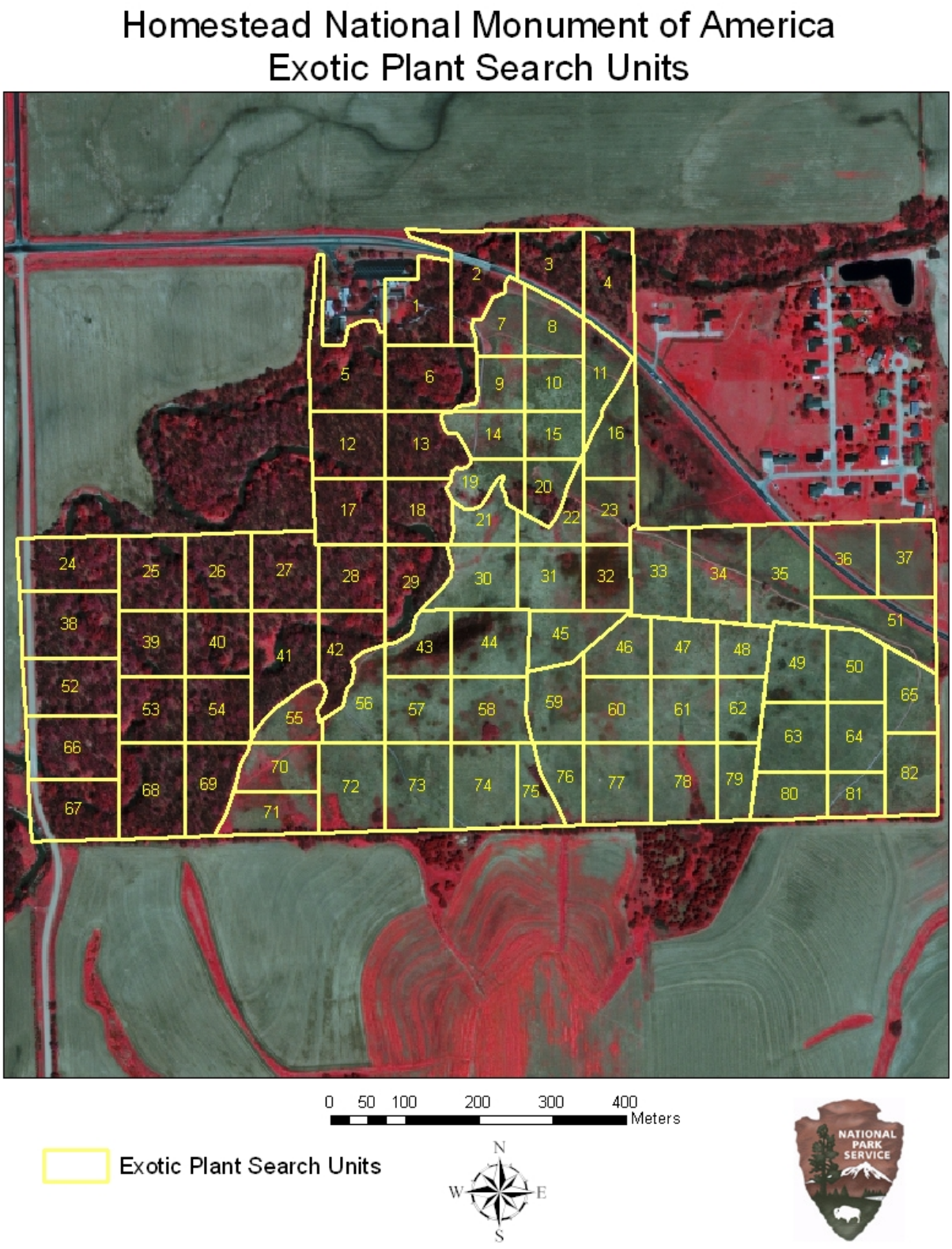

Figure 1. Invasive exotic plant search units at Homestead National Monument of America. The search units indicate the search locations for invasive exotic plants in 2006.

Table 1. Watch lists for Homestead National Monument of America

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

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. 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	Park-wide cover (acres)	Frequency (percent)	Ecological impact	Management difficulty
Bromus inermis	Smooth brome	Park-established	9.3 - 28.0	68.3%	M	ML
Maclura pomifera	Osage-orange	Park based	5.1 - 13.6	28.0%	ML	L
Phalaris arundinacea	Reed canary-grass	Park-established	3.8 - 11.8	25.6%	----	----
Morus alba	White mulberry	Park-established	3.3 - 9.9	39.0%	ML	ML
Bromus racemosus	Bald brome	Park based	1.0 - 2.8	12.2%	----	----
Melilotus officinalis	Sweet clover	Park-established	0.4 - 1.5	6.1%	M	M
Poa spp	Bluegrass	Park-established	< 0.1	2.4%	----	----
Sorghum halepense	Johnsongrass	Early-detection	< 0.1	4.9%	ML	HM
Verbascum thapsus	Common mullein	Park-established	< 0.01	3.7%	ML	L
Berberis thunbergii	Japanese barberry	Park-established	< 0.001	1.2%	HM	I
Cirsium vulgare	Bull thistle	Park-established	< 0.001	1.2%	ML	ML

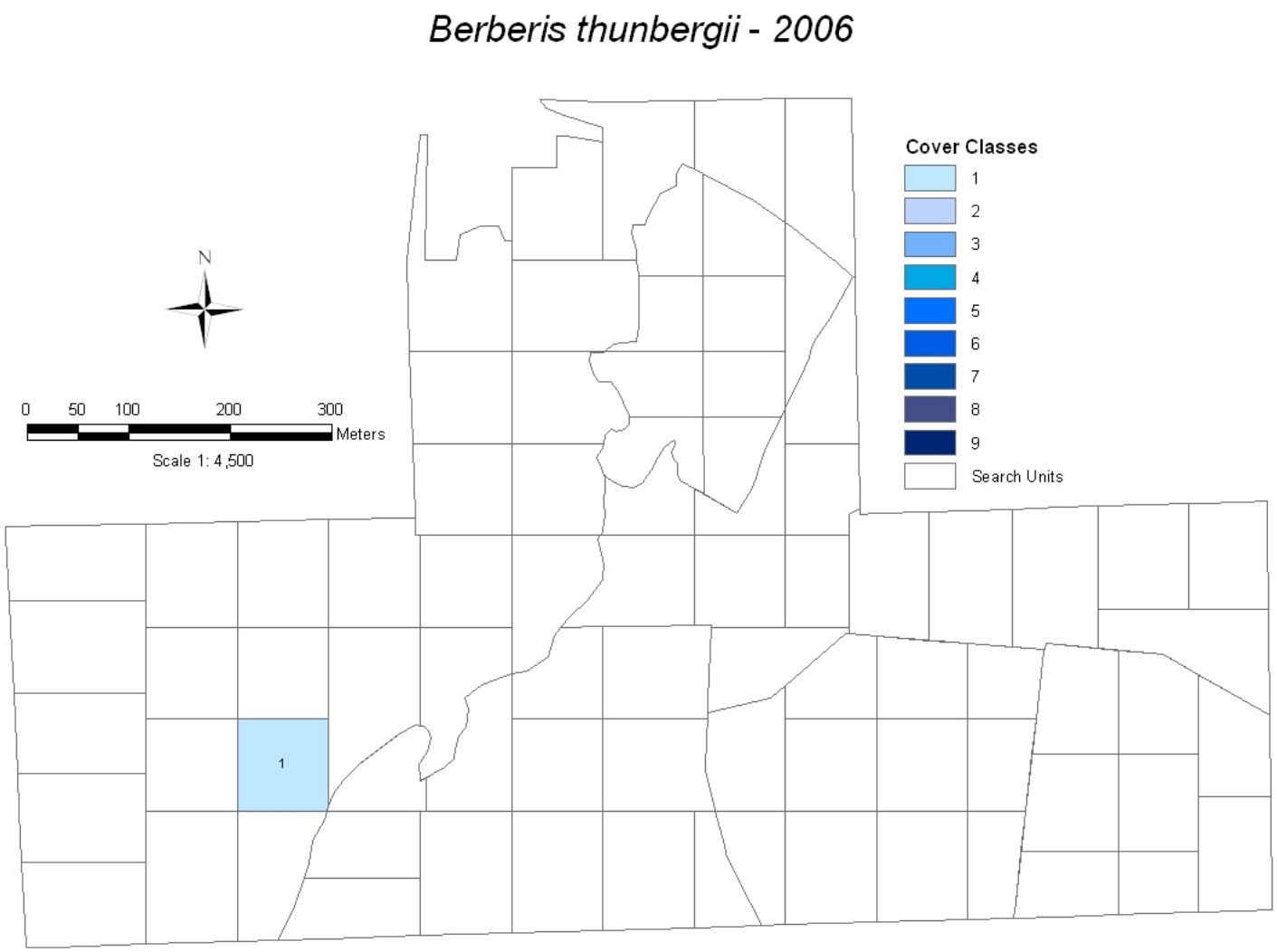

Figure 2. Abundance and distribution of *Berberis thunbergii* (Japanese barberry) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

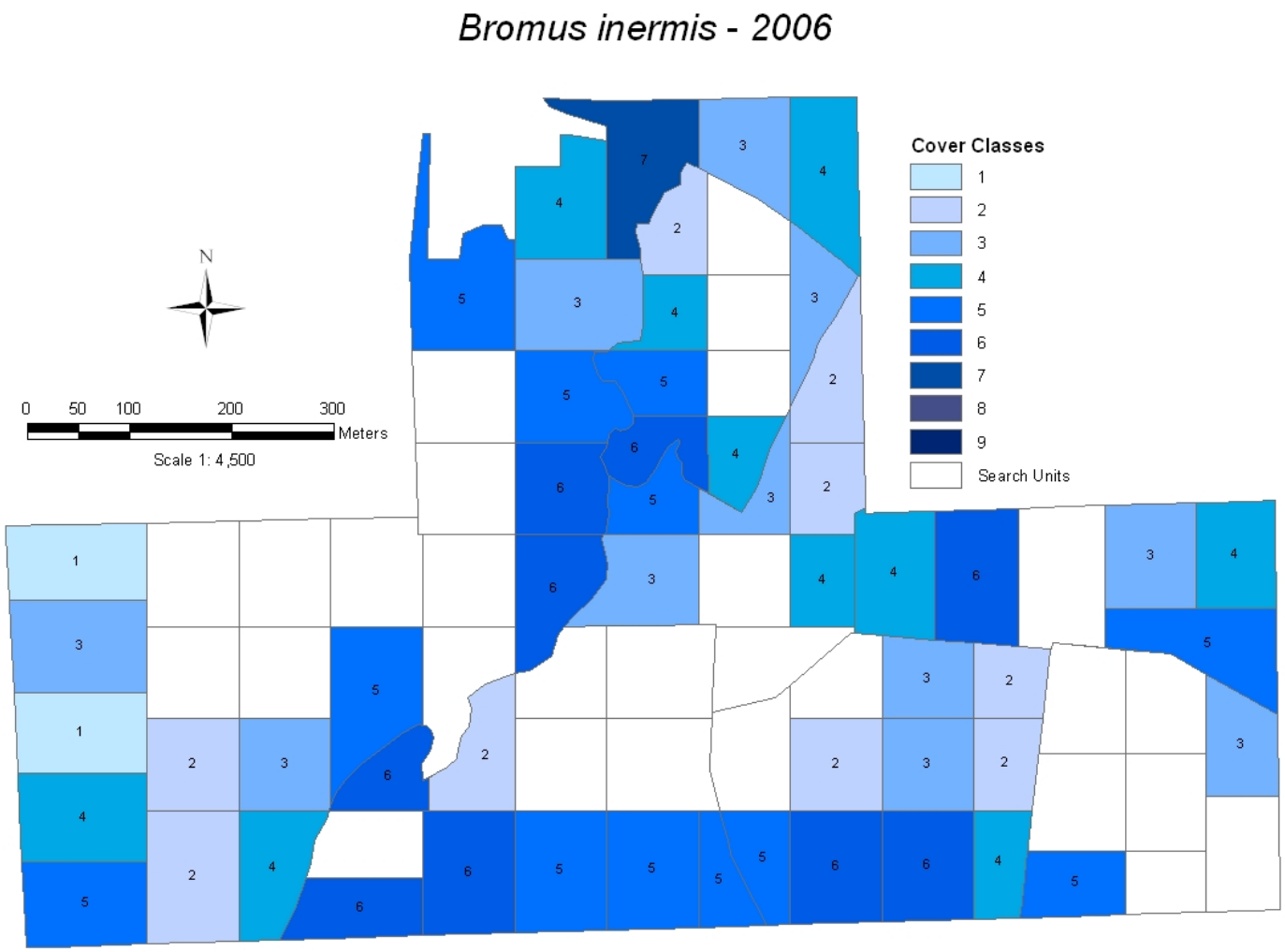

Figure 3. Abundance and distribution of *Bromus inermis* (smooth brome) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

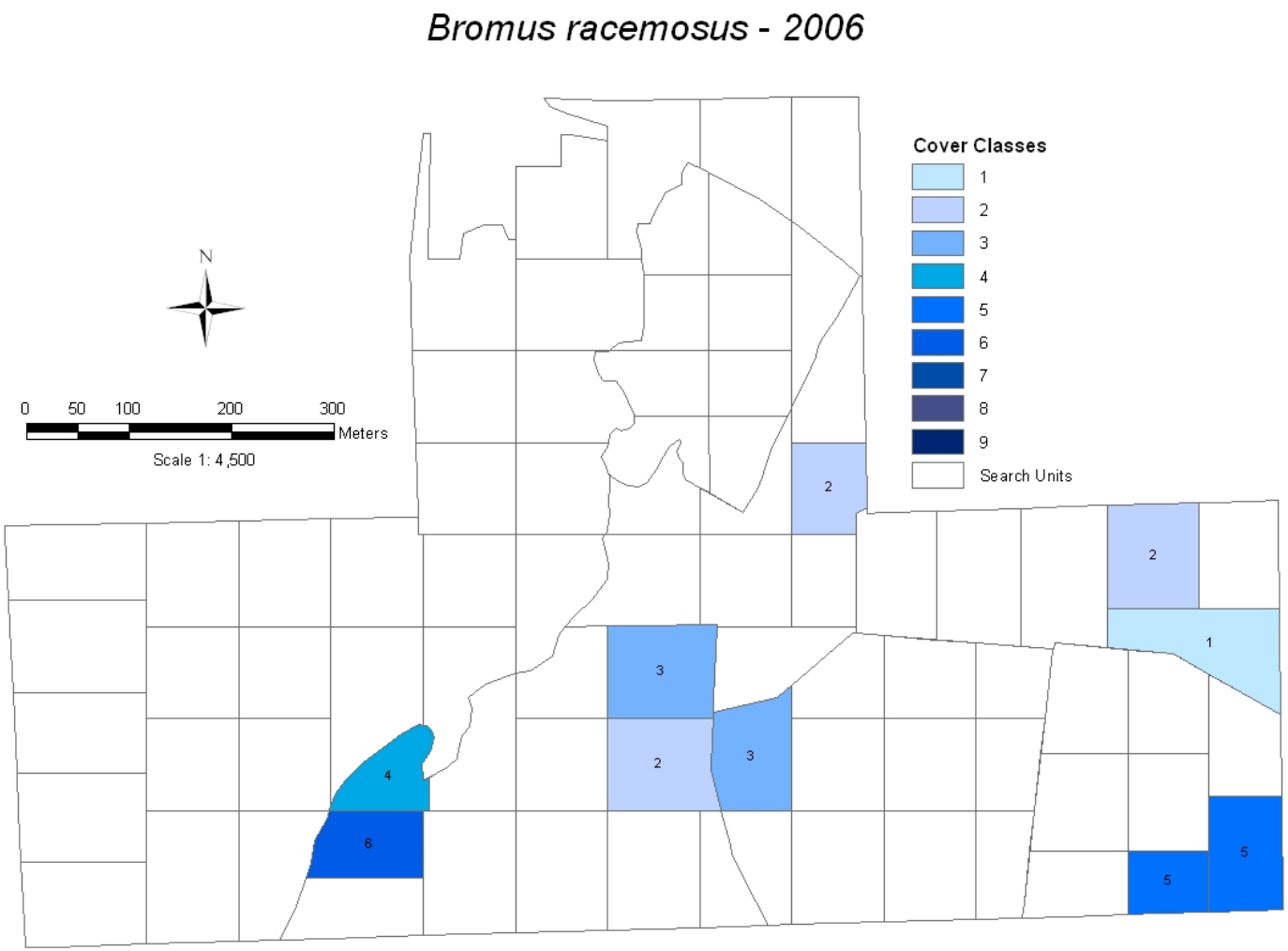

Figure 4. Abundance and distribution of *Bromus racemosus* (bald brome) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

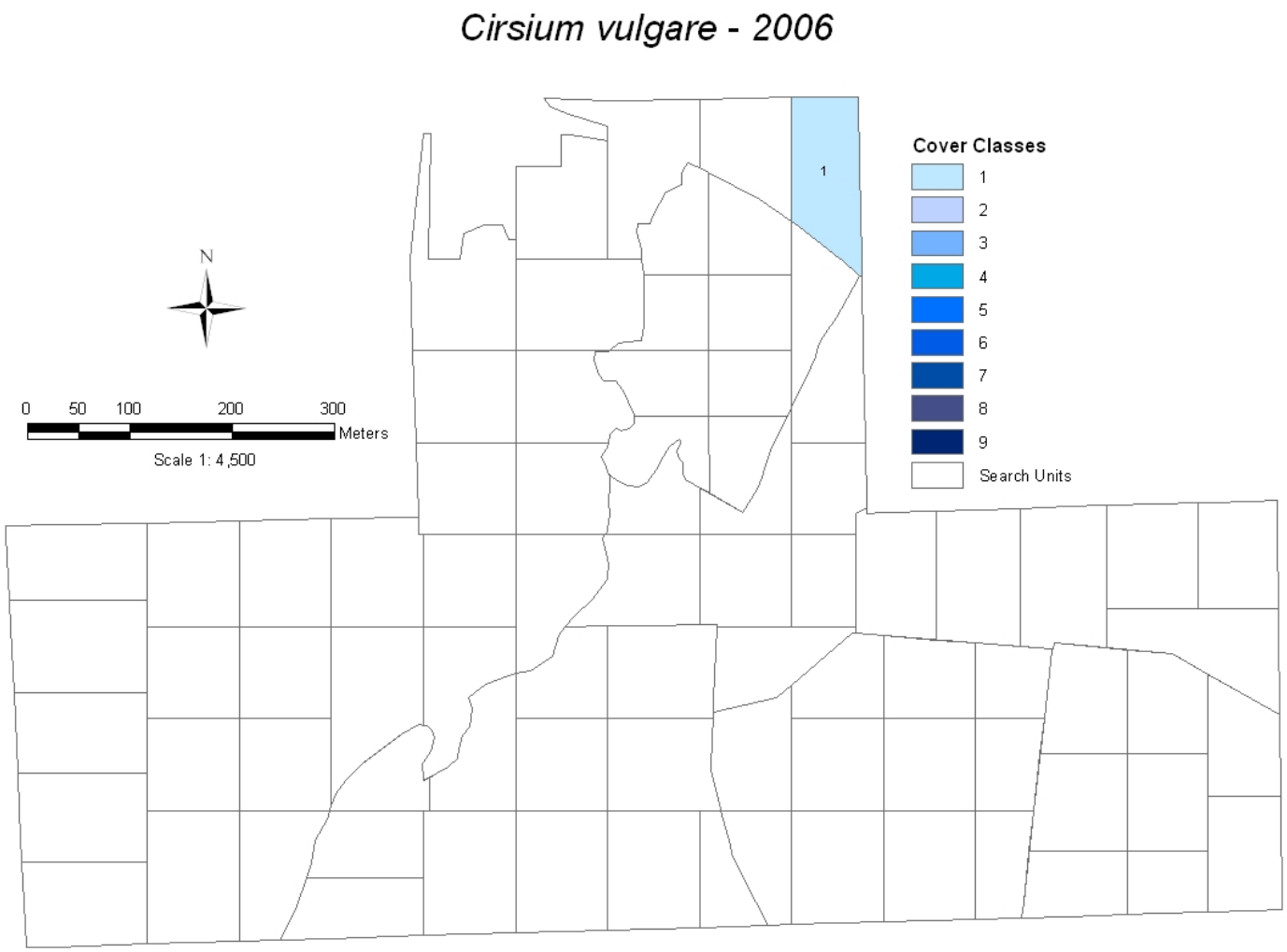

Figure 5. Abundance and distribution of *Cirsium vulgare* (bull thistle) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

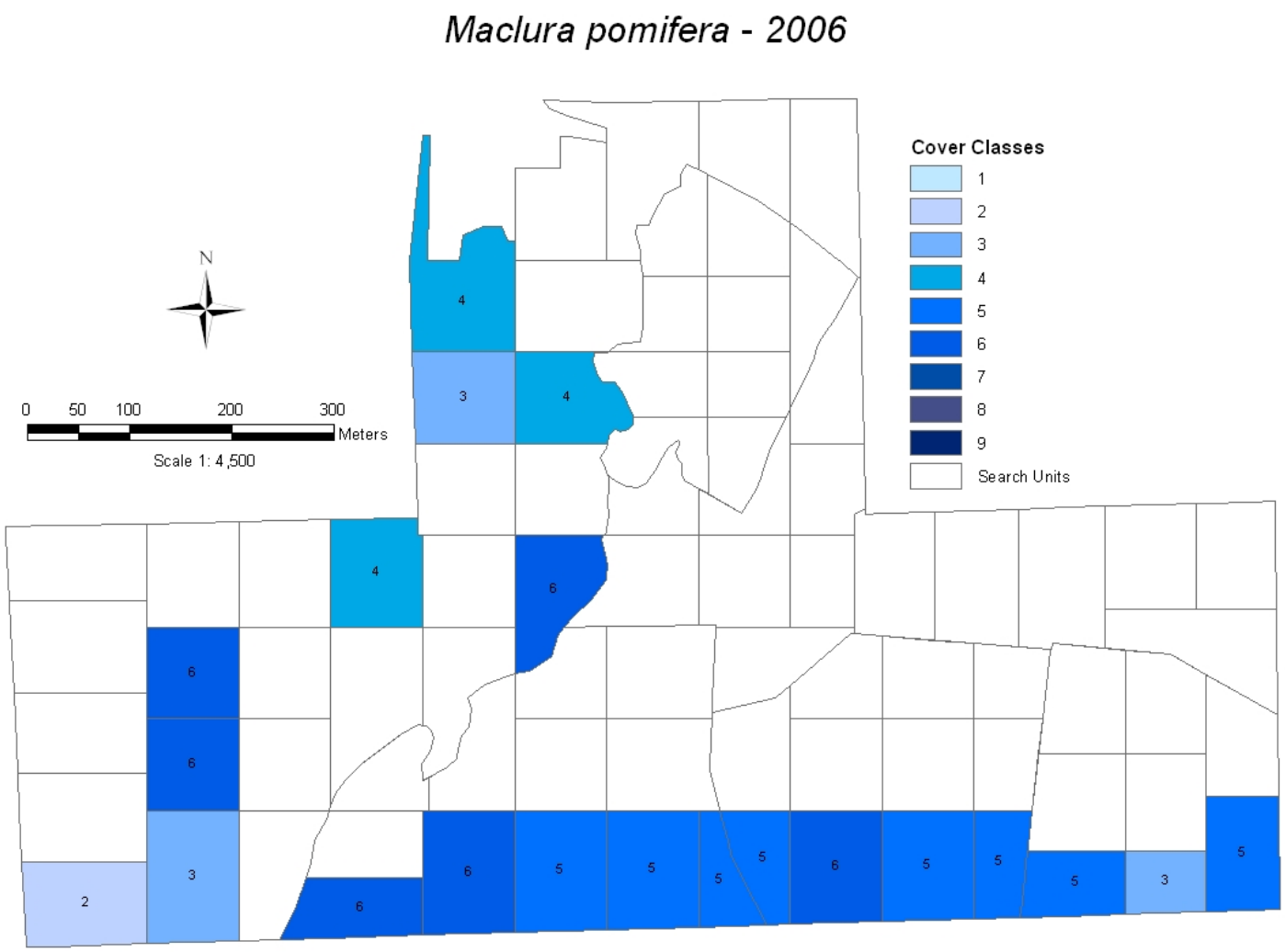

Figure 6. Abundance and distribution of *Maclura pomifera* (Osage orange) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

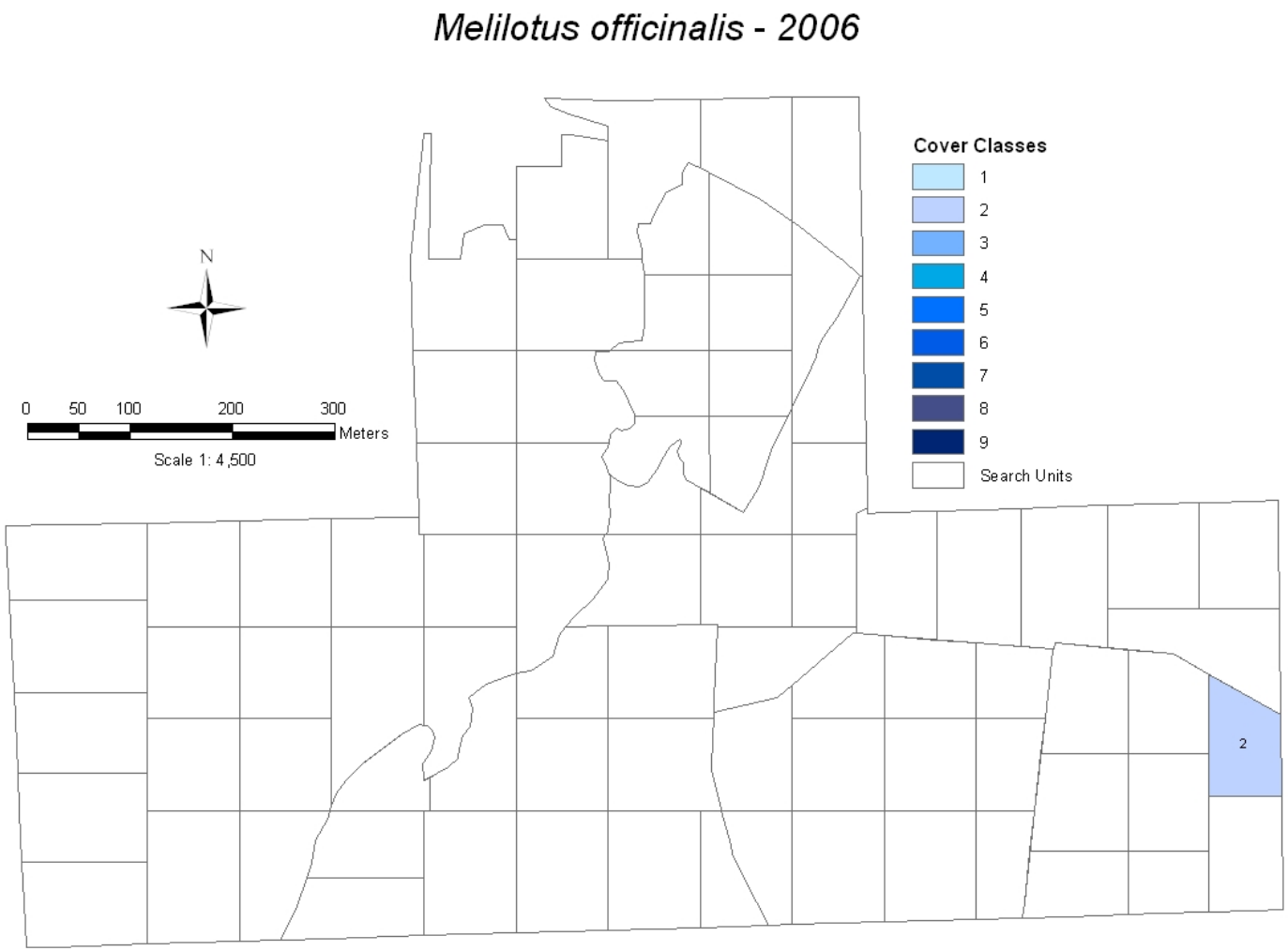

Figure 7. Abundance and distribution of *Melilotus officinalis* (sweetclover) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

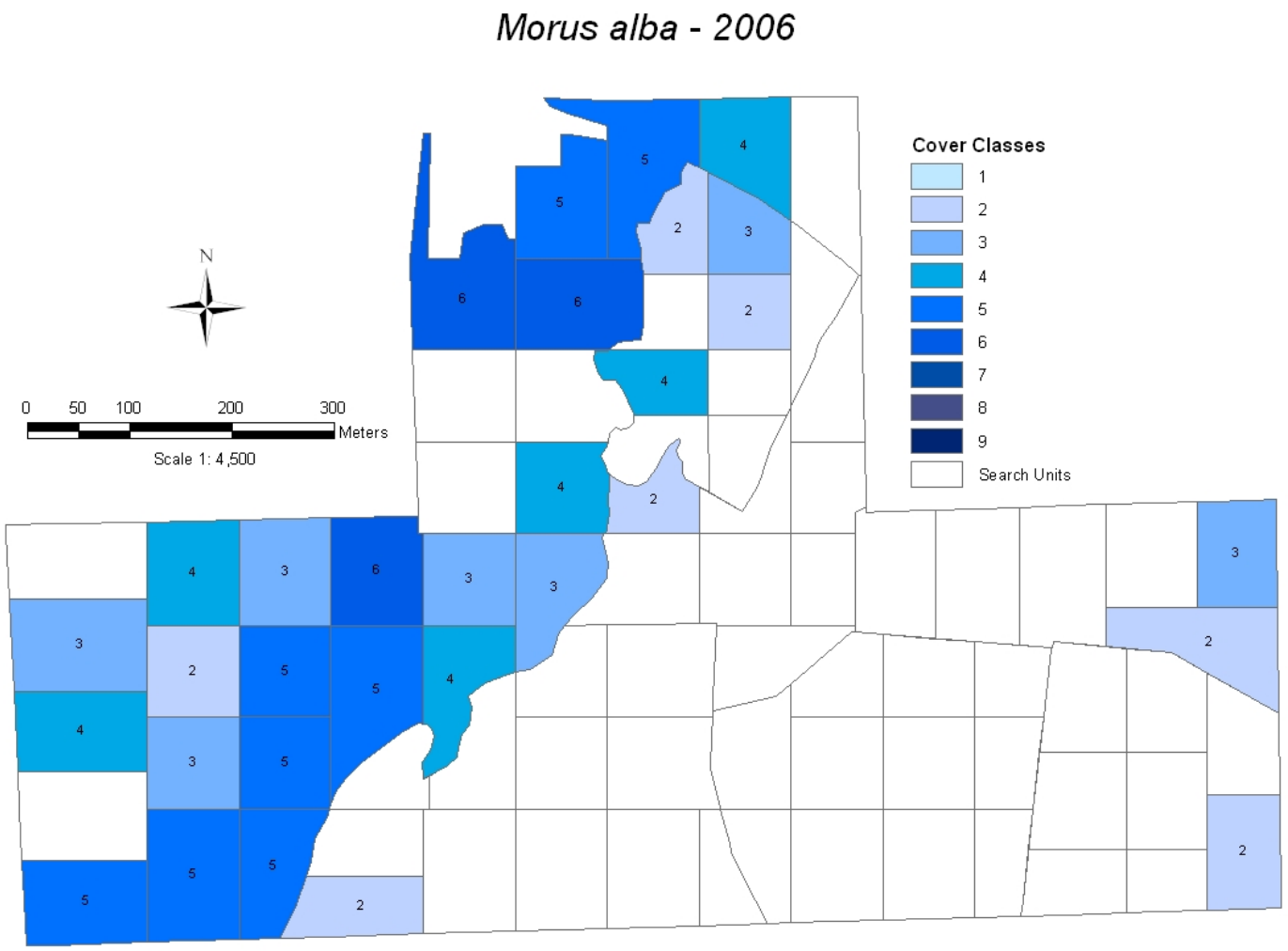

Figure 8. Abundance and distribution of *Morus alba* (white mulberry) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

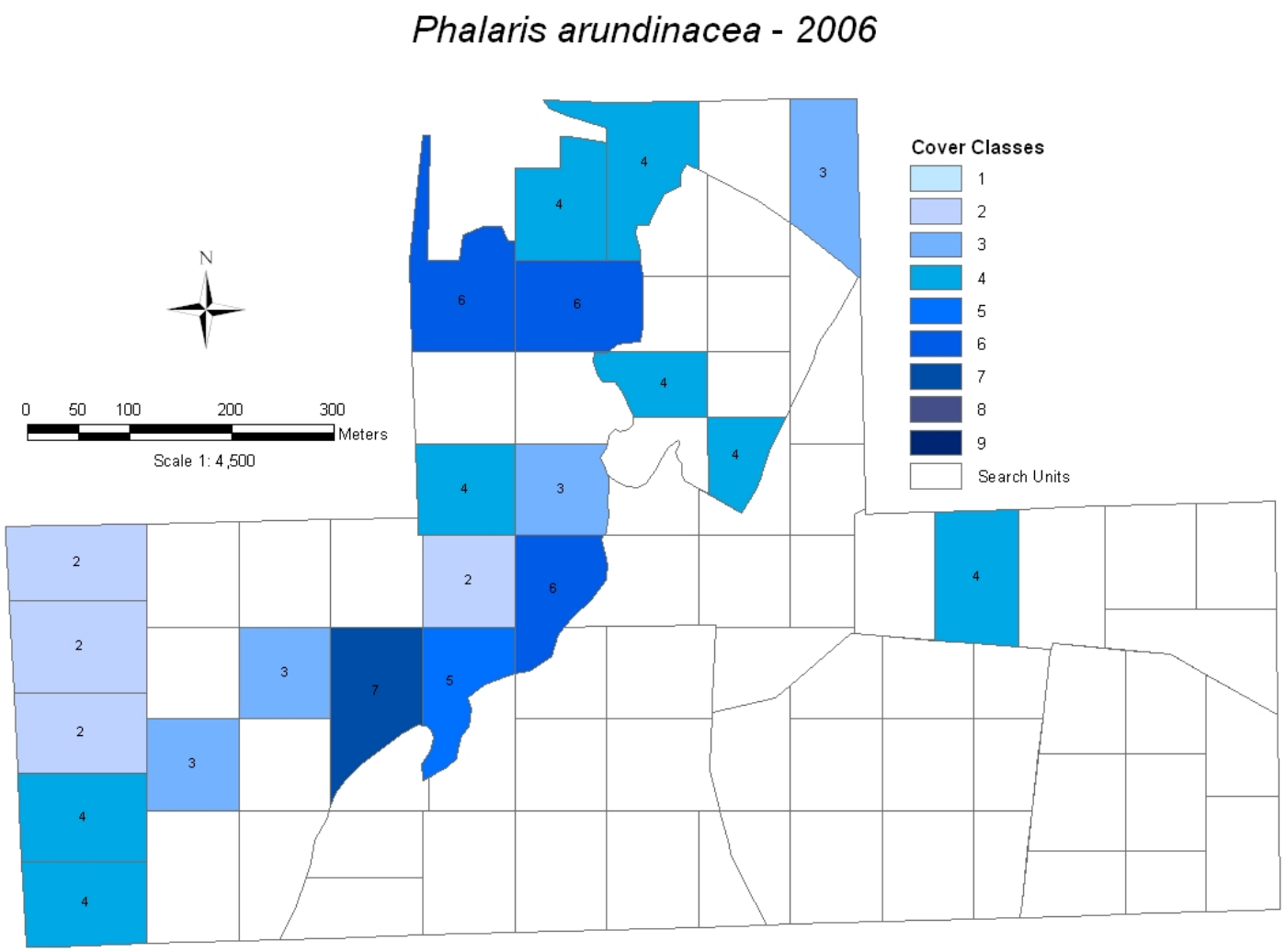

Figure 9. Abundance and distribution of *Phalaris arundinacea* (reed canarygrass) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

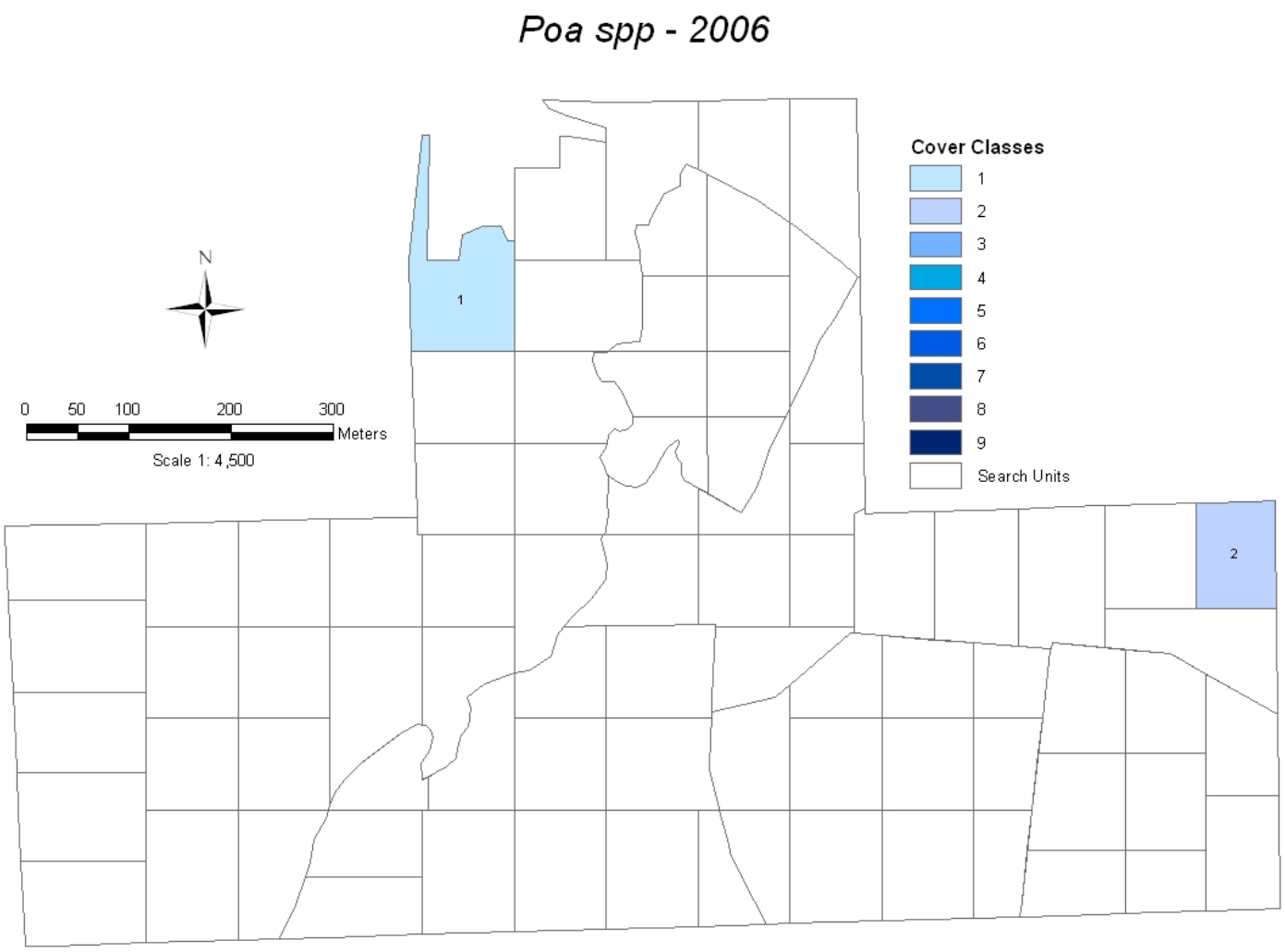

Figure 10. Abundance and distribution of *Poa spp* (bluegrass) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

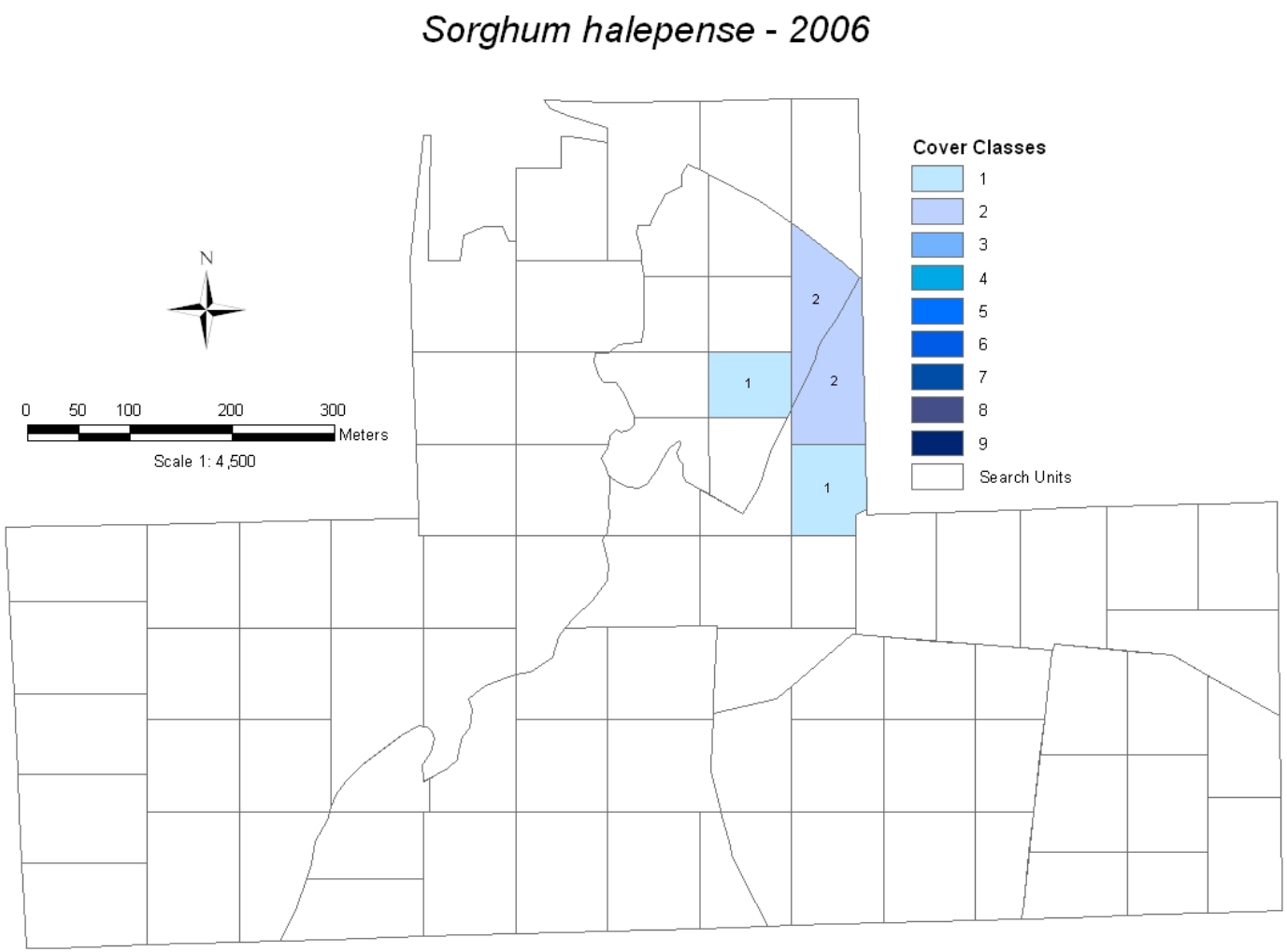

Figure 11. Abundance and distribution of *Sorghum halepense* (Johnsongrass) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

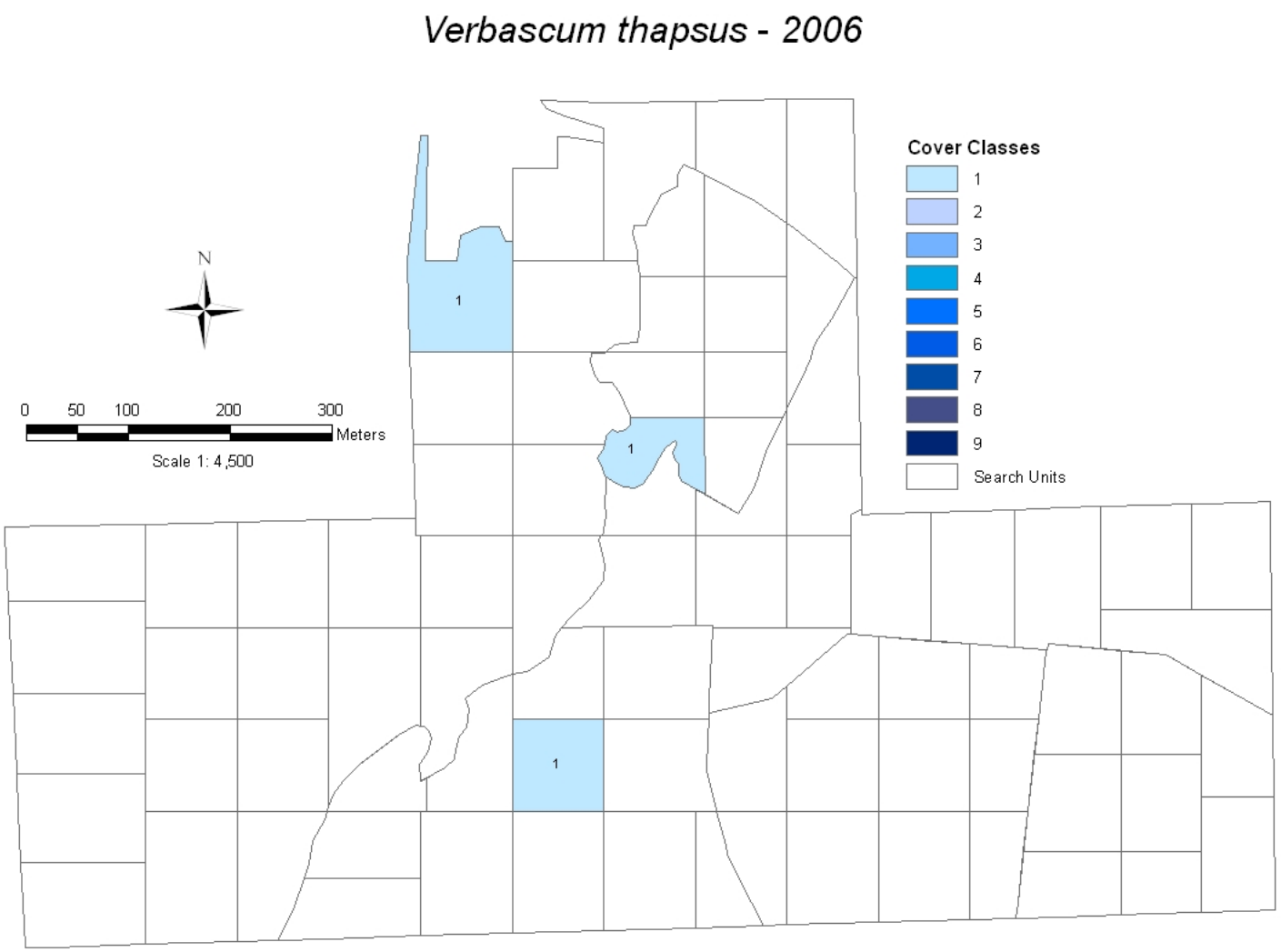

Figure 12. Abundance and distribution of *Verbascum thapsus* (common mullein) at Homestead National Monument of America, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 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 U.S. Department of the Interior (DOI) is the nation's principal conservation agency, charged with the mission "*to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities."* More specifically, Interior protects America’s treasures for future generations, provides access to our nation’s natural and cultural heritage, offers recreation opportunities, honors its trust responsibilities to American Indians and Alaska Natives and its responsibilities to island communities, conducts scientific research, provides wise stewardship of energy and mineral resources, fosters sound use of land and water resources, and conserves and protects fish and wildlife. The work that we do affects the lives of millions of people; from the family taking a vacation in one of our national parks to the children studying in one of our Indian schools.

NPS D-47, March 2007

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