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Fort Collins, Colorado

Invasive Exotic Plant Monitoring at Herbert Hoover National Historic Site: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/018
NPS D-56

ON THE COVER
Restored prairie at Herbert Hoover National Historic Site.

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Executive Summary

During surveys in 2006, we documented 25 invasive exotic plant taxa in the restored prairie at Herbert Hoover National Historic Site. Sweetclover and reed canarygrass were widespread and abundant at Herbert Hoover National Historic Site. Sweetclover was very prevalent in the western half of the prairie, is established on at least 44 acres, and was found in 84% of search units. Reed canarygrass covered at least 4 acres and occupied 50% of the search units. Out of the 25 invasive exotic plants, 20 plants each occurred on less than one acre. In general, several invasive exotic plants are a major problem at Herbert Hoover National Historic Site, but successful control is possible for a large group of species. We suggest the development of a plan to manage sweetclover in order to maintain the composition of a relatively diverse prairie. The acreage estimates presented in the report may also 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 Herbert Hoover National Historic Site. 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 restored prairie at Herbert Hoover National Historic Site is a significant cultural resource that is vulnerable to exotic plant invasions.

2. A number of highly invasive exotics plants have established on Herbert Hoover National Historic Site. These plants include crownvetch (*Securigera varia*), reed canarygrass (*Phalaris arundinacea*), smooth brome (*Bromus inermis*), and sweetclover (*Melilotus officinalis*).

3. Park use of prescribed fire may serve to control a number of invasive, exotic plant species, although mechanical and chemical methods control are likely needed as well.

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 Herbert Hoover National Historic Site (Figure 1). Network staff navigated through search units, 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 50 search units were surveyed at Herbert Hoover National Historic Site. The observers 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 Herbert Hoover National Historic Site 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 25 invasive exotic plant taxa were found during the survey at Herbert Hoover National Historic Site (Table 2). Three plants from the early detection list were identified during the survey. Nodding plumeless thistle (*Carduus nutans*) and crownvetch (*Securigera varia*) were included because they were not recognized as occurring in Iowa by the USDA Plants database. We believe, however, that the report for common buckthorn (*Rhamnus cathartica*) may be the first report for the site. We also documented six invasive exotic plants on the park-based list. The majority of the invasive exotic plant species identified during the survey were already known to occur at Herbert Hoover National Historic Site due to the park's strong botanical record.

The distribution and abundance of the invasive exotic plant species at Herbert Hoover National Historic Site varied widely. Sweetclover was the most aggressive invasive species on the park and has invaded at least 44 acres of the prairie. Two invasive grasses were widespread and abundant: reed canarygrass (*Phalaris arundinacea*) and smooth brome (*Bromus inermis*). The estimated cover of reed canarygrass exceeded 4 acres. Smooth brome covered at least 1.6 acres. The six next most abundant invasive exotic plants with cover exceeding 0.25 acres included bush honeysuckle (*Lonicera spp*), white mulberry (*Morus alba*), wild parsnip (*Pastinaca sativa*), bluegrass (*Poa spp*), Russian or autumn olive (*Elaeagnus* spp), and bird's-foot trefoil (*Lotus corniculatus*). Bluegrass, sweetclover, and smooth brome were widespread, occupying 90%, 84%, and 80% of the search units on the park, respectively.

Only two species were noted as having unambiguously high ecological impact: crownvetch and Russian / autumn olive (Table 2). Three species were characterized as having at least a medium ecological impact. The remaining species had ambiguous medium-low ecological impacts or less, including six species with low or insignificant impacts. The majority of the species on the park-based watch list are of little management concern. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, crownvetch and autumn olive with high ecological impacts were noted as having low management difficulty and occupy 2% and 36% of search units, respectively. Controlling these species will likely provide a high benefit for the management costs. Despite potentially significant management costs, in our opinion, park staff should develop a sweetclover management plan in order to prevent its dominance across the entire restored prairie.

In summary, this report provides information on invasive, exotic plant abundance and distribution, while characterizing 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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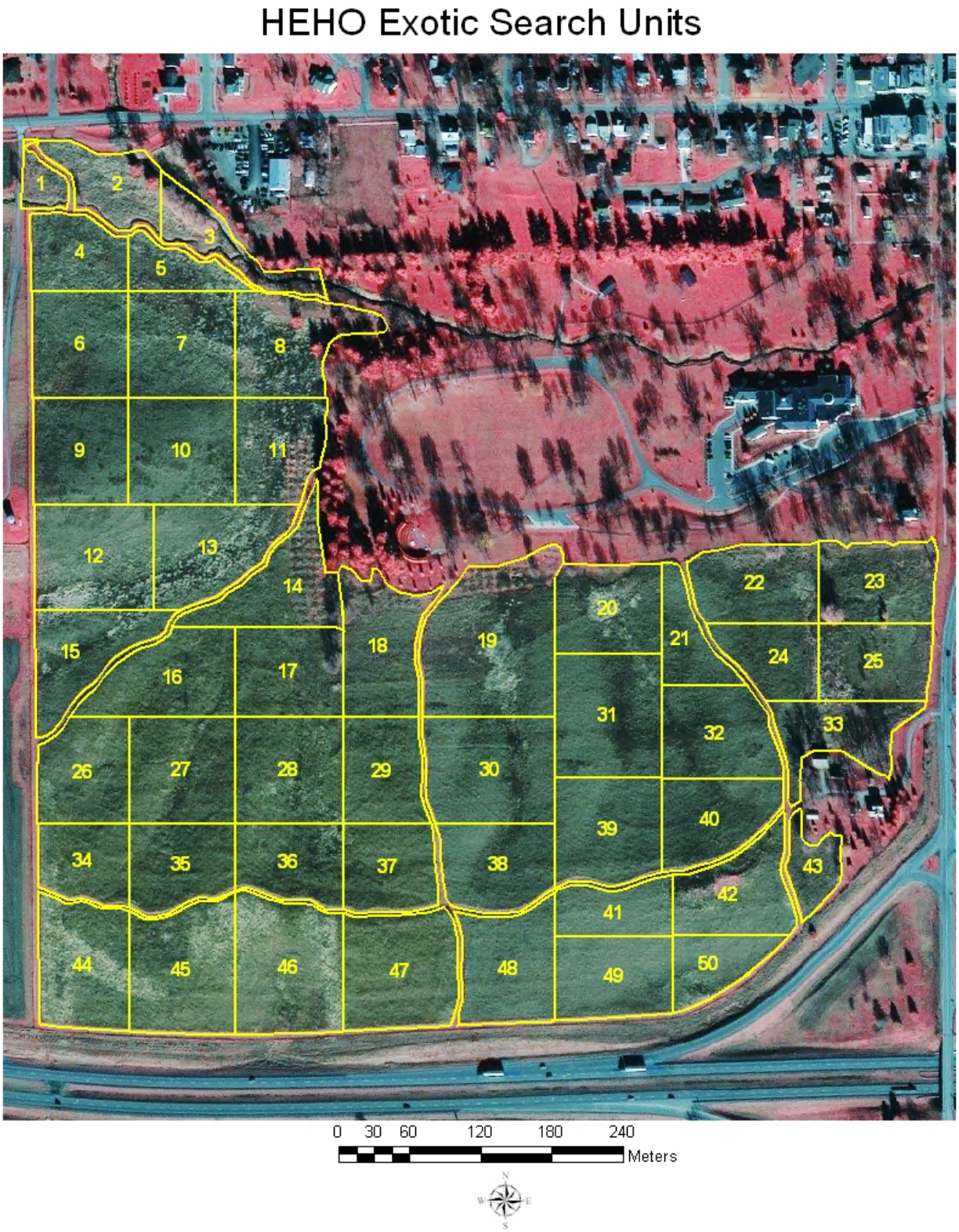

Figure 1. Invasive exotic plant search units at Herbert Hoover National Historic Site – Main Unit. The search units indicate the search locations for invasive exotic plants in 2006.

Table 1. Watch lists for Herbert Hoover National Historic Site

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Ailanthus altissima	Tree of heaven	*Arctium minus*	Lesser burdock	*Abutilon theophrastii*	Velvetleaf
Alliaria petiolata	Garlic mustard	*Bromus inermis*	Smooth brome	*Acer platanoides*	Norway maple
Alnus glutinosa	European alder	*Bromus tectorum*	Cheatgrass	*Calystegia sepium*	Hedge false bindweed
Azolla	Mosquitofern	*Cirsium arvense*	Canada thistle	*Chenopodium album*	Lambsquarters
Berberis thunbergii	Japanese barberry	*Cirsium vulgare*	Bull thistle	*Daucus carota*	Queen anne's lace
Carduus nutans	Nodding plumeless thistle	*Dactylis glomerata*	Orchardgrass	*Elymus repens*	Quackgrass
Celastrus orbiculatus	Oriental bittersweet	*Elaeagnus angustifolia*	Russian olive	*Euonymus atropurpureus*	Burningbush
Centaurea biebersteinii	Spotted knapweed	*Elaeagnus umbellata*	Autumn olive	*Polygonum spp*	Knotweed
Centaurea solstitialis	Yellow star-thistle	*Glechoma hederacea*	Ground ivy	*Sonchus arvensis*	Field sowthistle
Dipsacus fullonum	Fuller's teasel	*Hesperis matronalis*	Dames rocket	*Trifolium hybridum*	Alsike clover
Dipsacus laciniatus	Cutleaf teasel	*Lonicera morrowii*	Morrow's honeysuckle	*Trifolium pratense*	Red clover
Euonymus alata	Burning bush	*Lonicera tatarica*	Tatarian honeysuckle		
Euphorbia esula	Leafy spurge	*Lotus corniculatus*	Bird's-foot trefoil		
Frangula alnus	Glossy buckthorn	*Melilotus officinalis*	Sweetclover		
Holcus lanatus	Common velvetgrass	*Morus alba*	White mulberry		
Humulus japonicus	Japanese hop	*Pastinaca sativa*	Wild parsnip		
Hydrilla verticillata	Waterthyme	*Phalaris arundinacea*	Reed canarygrass		
Hyoscyamus niger	Black henbane	*Poa pratensis*	Kentucky bluegrass		
Lespedeza bicolor	Shrub lespedeza	*Potentilla recta*	Sulphur cinquefoil		
Lespedeza cuneata	Sericea lespedeza	*Robinia pseudoacacia*	Black locust		
Ligustrum vulgare	European privet	*Rosa multiflora*	Multiflora rose		
Schedonorus phoenix	Tall fescue	*Solanum dulcamara*	Climbing nightshade		
Schedonorus pratensis	Meadow fescue	*Ulmus pumila*	Siberian elm		
Lonicera maackii	Amur honeysuckle	*Verbascum thapsus*	Common mullein		
Lysimachia nummularia	Creeping jenny				
Lythrum salicaria	Purple loosestrife				
Myriophyllum spicatum	Eurasian watermilfoil				
Phragmites australis	Common reed				
Plantago lanceolata	Narrowleaf plantain				
Poa compressa	Canada bluegrass				
Polygonum cuspidatum	Japanese knotweed				
Populus alba	White poplar				
Potamogeton crispus	Curly pondweed				
Rhamnus cathartica	Common buckthorn				
Securigera varia	Crownvetch				
Sorghum halepense	Johnsongrass				
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 Herbert Hoover National Historic Site. 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
Melilotus officinalis	Sweetclover	Park-established	44.7 - 107.1	84	M	M
Phalaris arundinacea	Reed canarygrass	Park-established	4.1 - 16.8	50	----	----
Bromus inermis	Smooth Brome	Park-established	1.6 - 4.7	80	M	ML
Lonicera spp	Honeysuckle (bush)	Park-established	0.5 - 1.3	70	----	----
Morus alba	White mulberry	Park-established	0.25 - 1.1	68	ML	ML
Pastinaca sativa	Wild parsnip	Park-established	< 1.0	70	LI	L
Poa spp	Bluegrass	Park-established	< 0.75	90	----	----
Chenopodium album	Lambsquarters	Park-based	< 0.5	16	----	----
Elaeagnus spp	Russian olive/ Autumn olive	Park-established	< 0.5	36	HM / H	H / L
Lotus corniculatus	Bird's-foot trefoil	Park-established	< 0.5	10	ML	ML
Ulmus pumila	Siberian elm	Park-established	< 0.5	18	ML	ML
Calystegia sepium	Hedge false bindweed	Park-based	< 0.25	50	----	----
Cirsium arvense	Canada thistle	Park-established	< 0.25	18	ML	HM
Sonchus arvensis	Field sowthistle	Park-based	< 0.25	8	LI	HL
Cirsium vulgare	Bull thistle	Park-established	< 0.1	12	ML	ML
Elymus repens	Quackgrass	Park-based	< 0.1	20	ML	HM
Glechoma hederacea	Ground ivy	Park-established	< 0.1	12	MI	U
Rosa multiflora	Multiflora rose	Park-established	< 0.1	18	L	L
Verbascum thapsus	Common mullein	Park-established	< 0.1	14	ML	L
Carduus nutans	Nodding plumeless thistle	Early-detection	< 0.01	2	MI	HM
Dactylis glomerata	Orchardgrass	Park-established	< 0.01	12	LI	ML
Daucus carota	Queen anne's lace	Park-based	< 0.01	6	I	I
Securigera varia	Crownvetch	Early-detection	< 0.01	2	H	L
Rhamnus cathartica	Common buckthorn	Early-detection	< 0.001	2	M	M
Trifolium pratense	Red clover	Park-based	< 0.001	2	LI	I

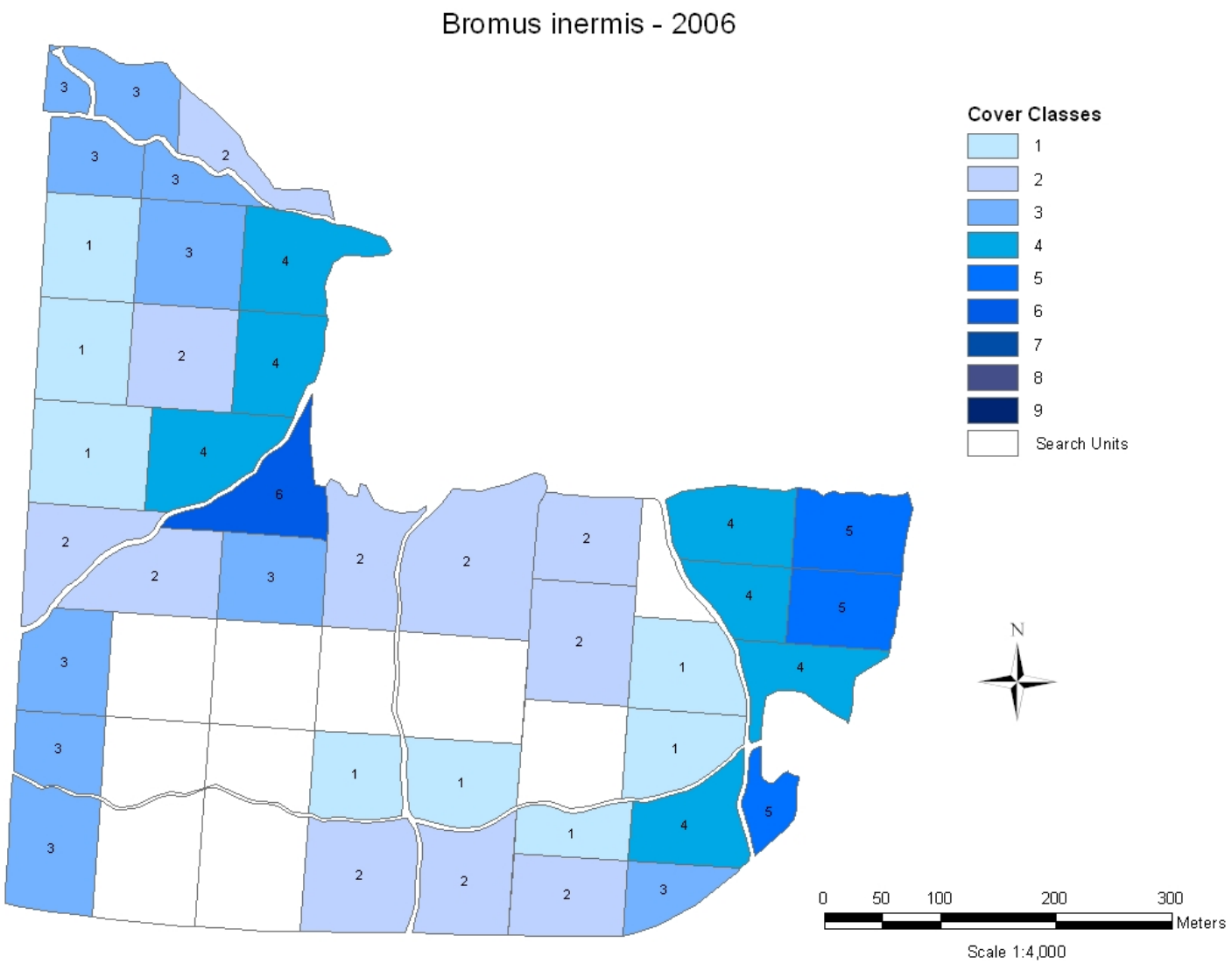

Figure 2. Abundance and distribution of *Bromus inermis* (smooth brome) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

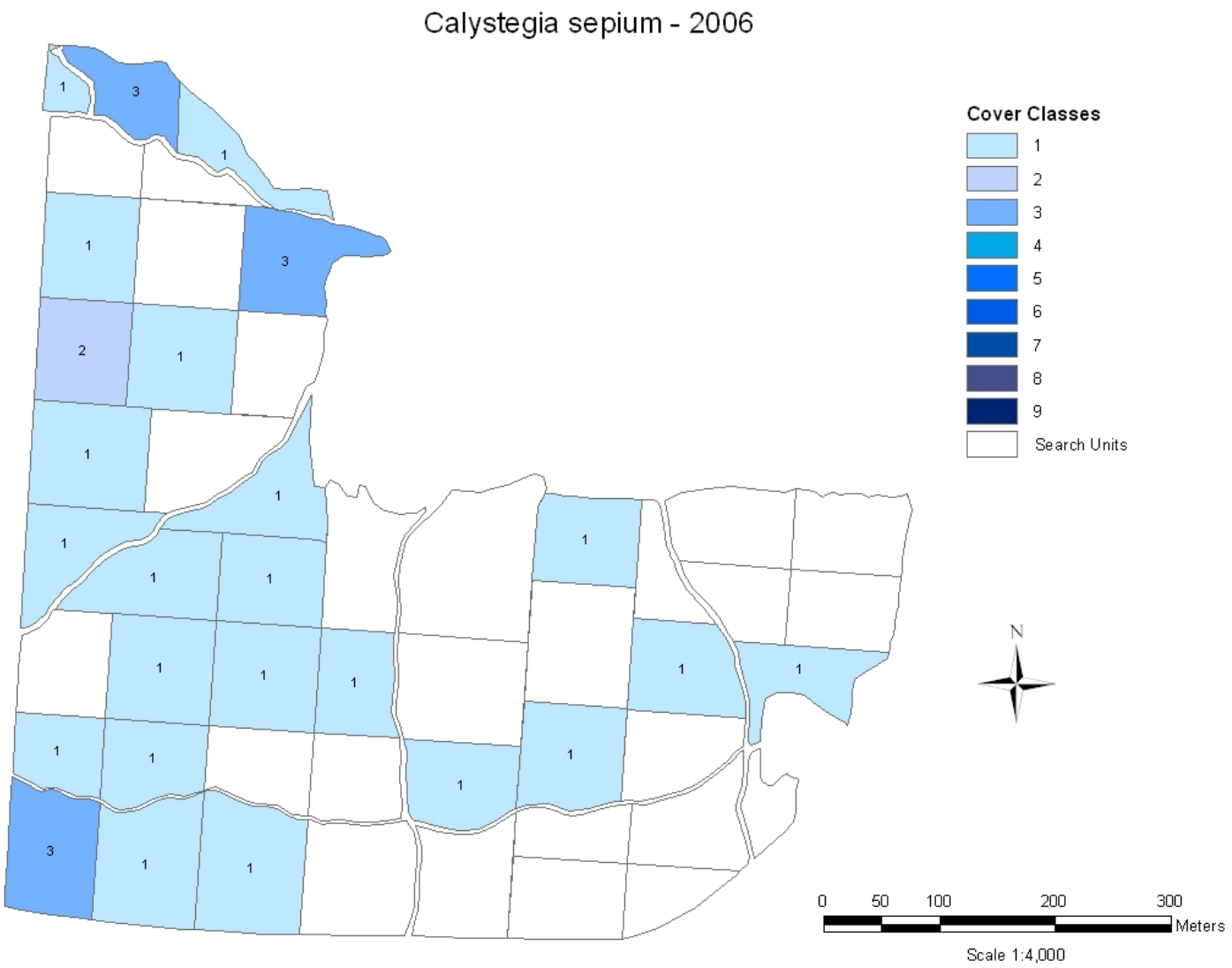

Figure 3. Abundance and distribution of *Calystegia sepium* (hedge false bindweed) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

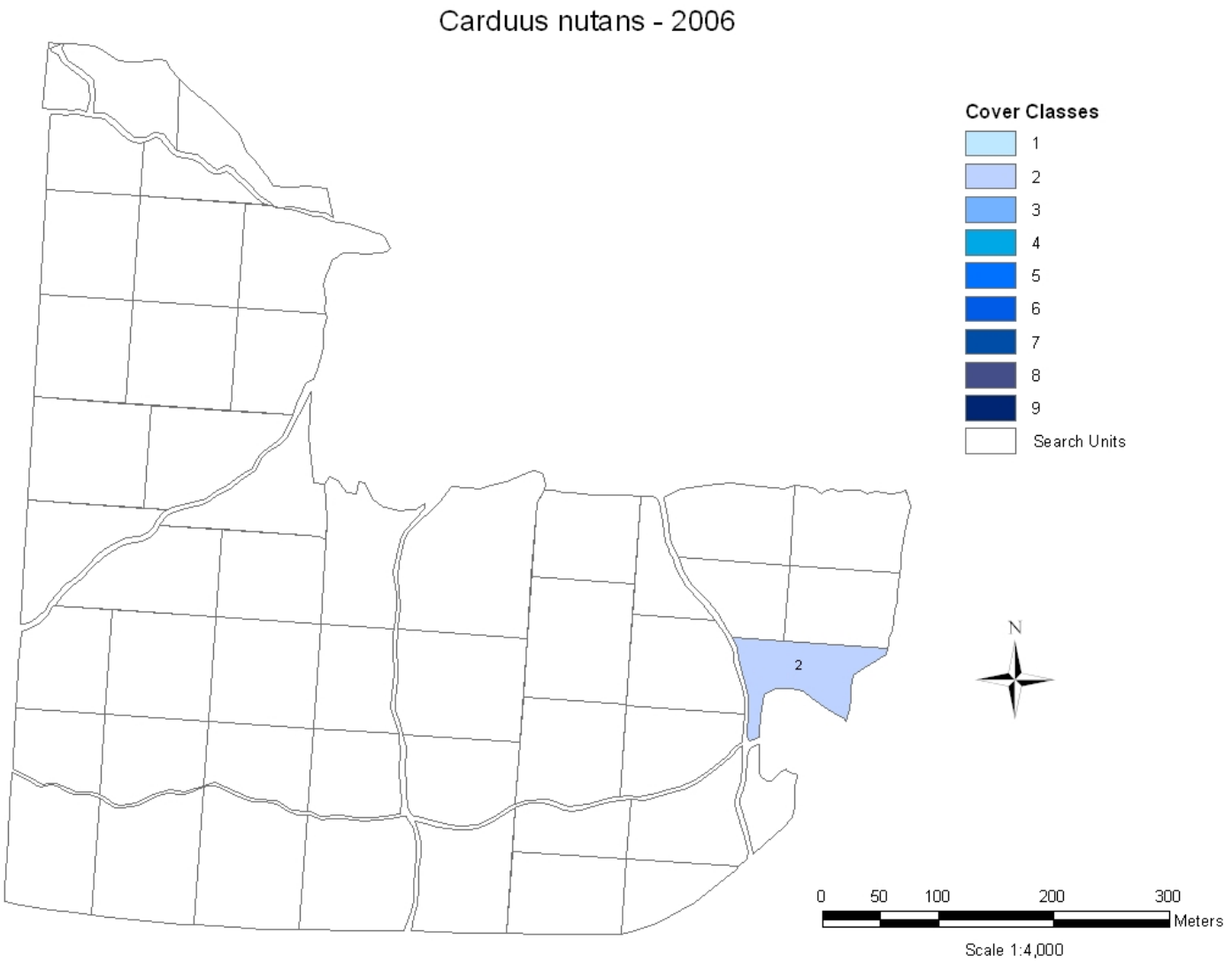

Figure 4. Abundance and distribution of *Carduus nutans* (nodding plumeless thistle) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

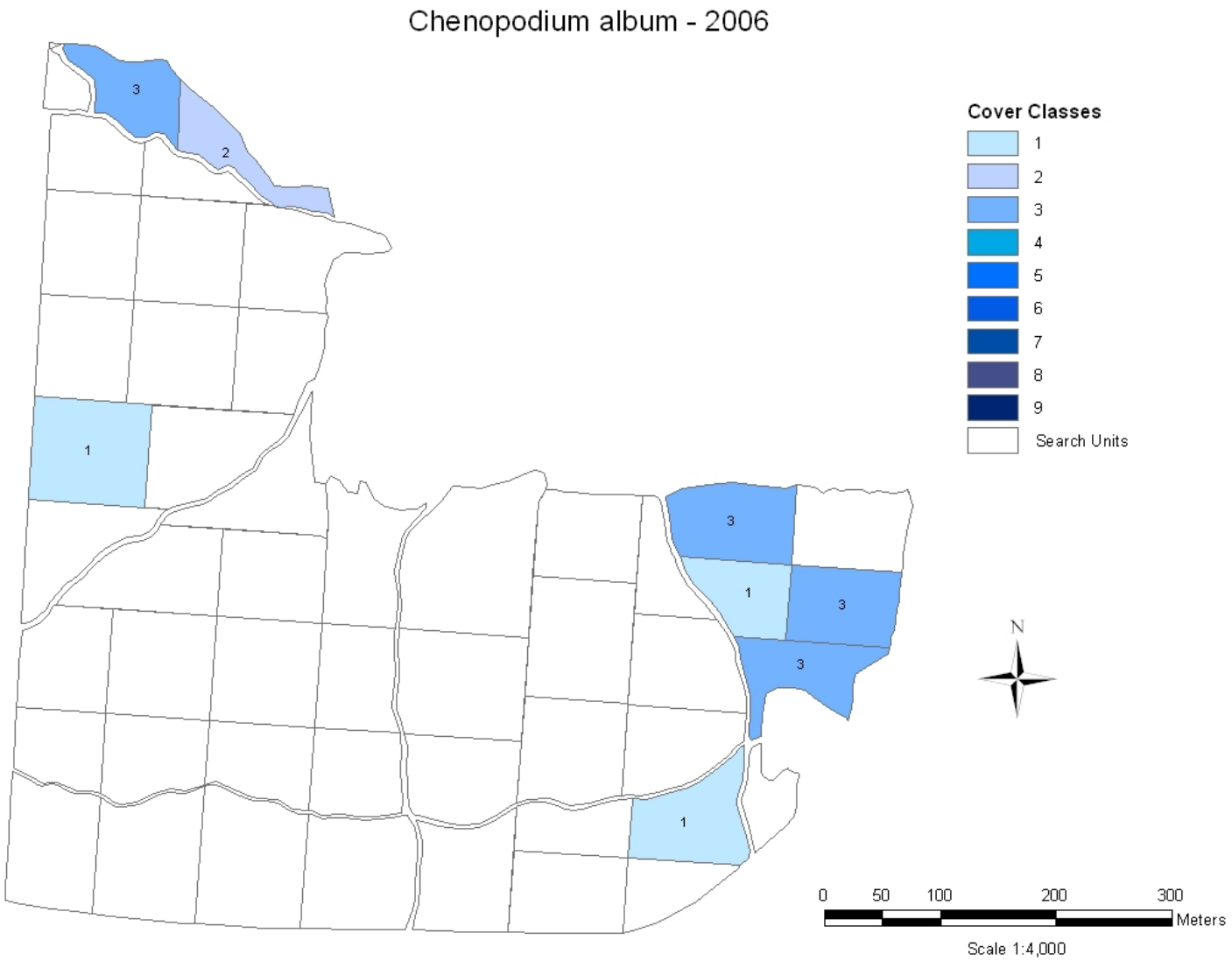

Figure 5. Abundance and distribution of *Chenopodium album* (lambsquarters) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

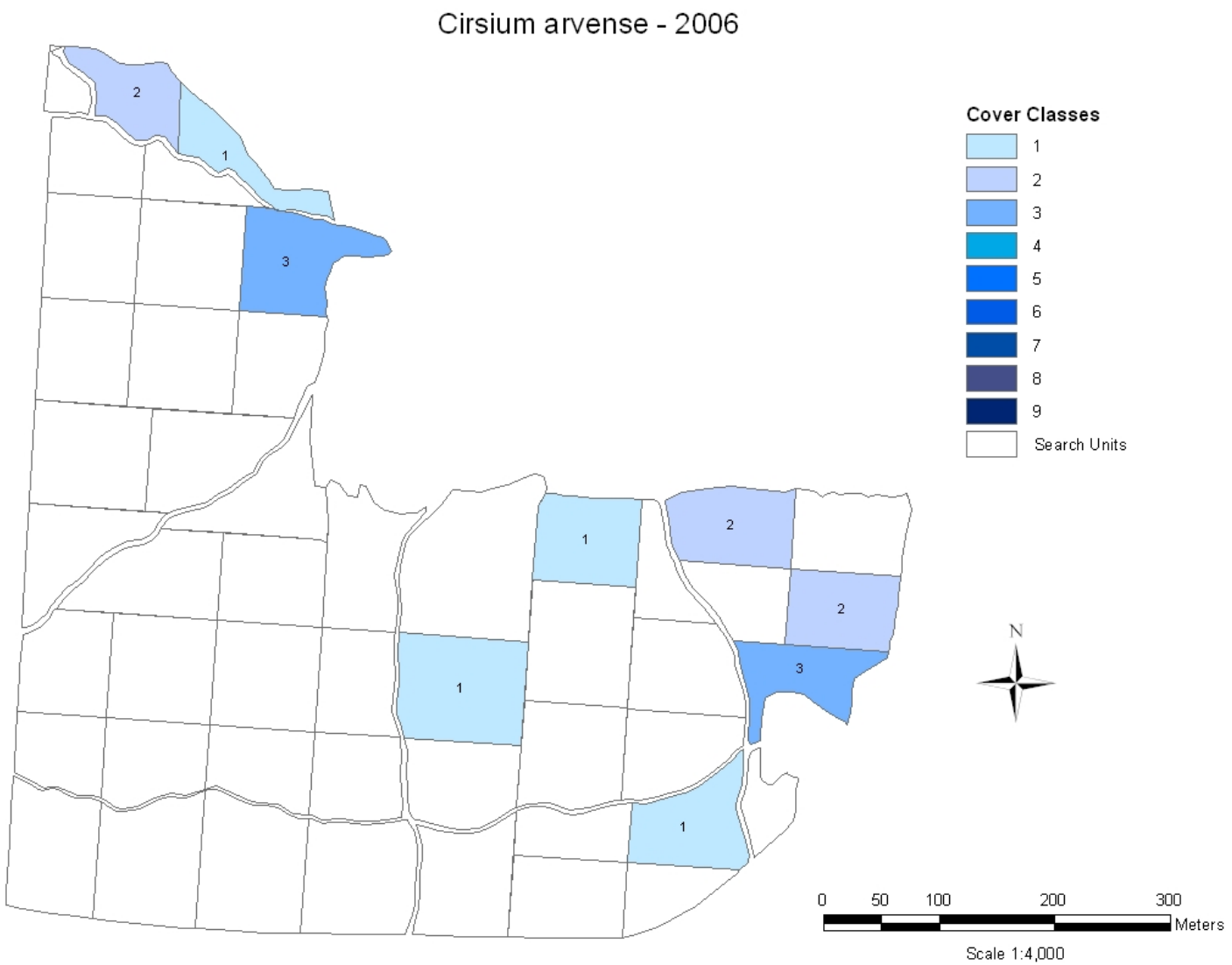

Figure 6. Abundance and distribution of *Cirsium arvense* (canada thistle) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

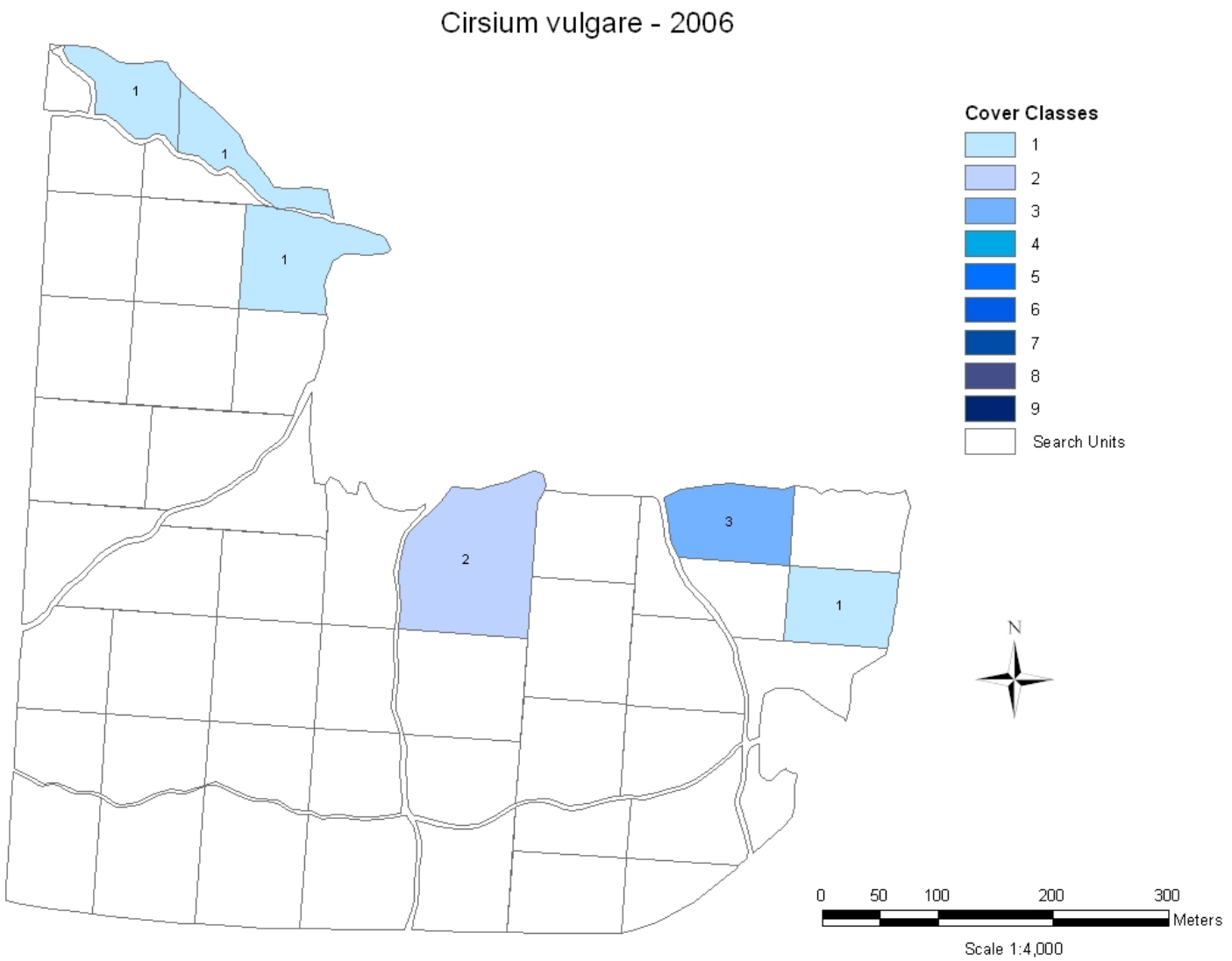

Figure 7. Abundance and distribution of *Cirsium vulgare* (bull thistle) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

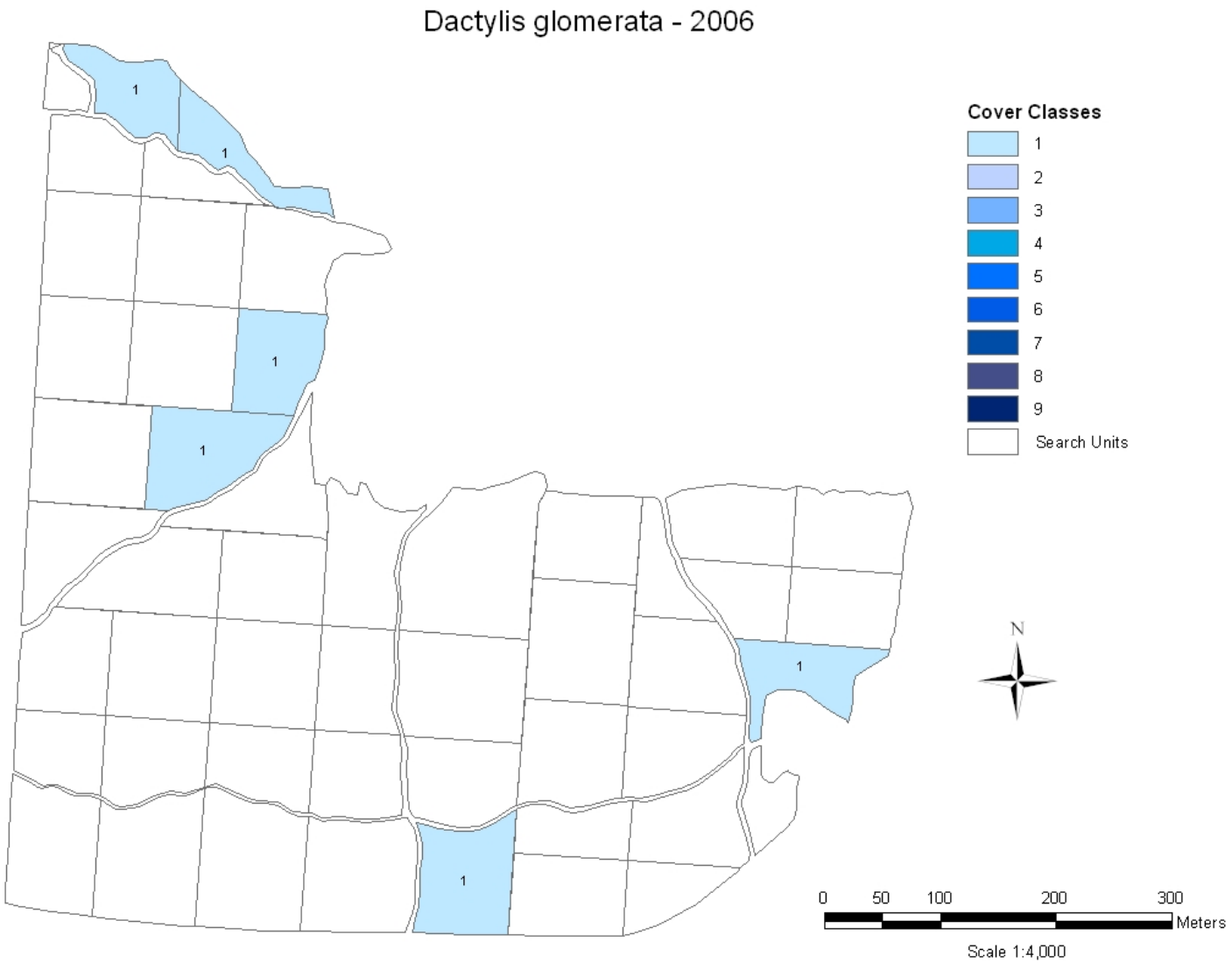

Figure 8. Abundance and distribution of *Dactylis glomerata* (orchardgrass) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

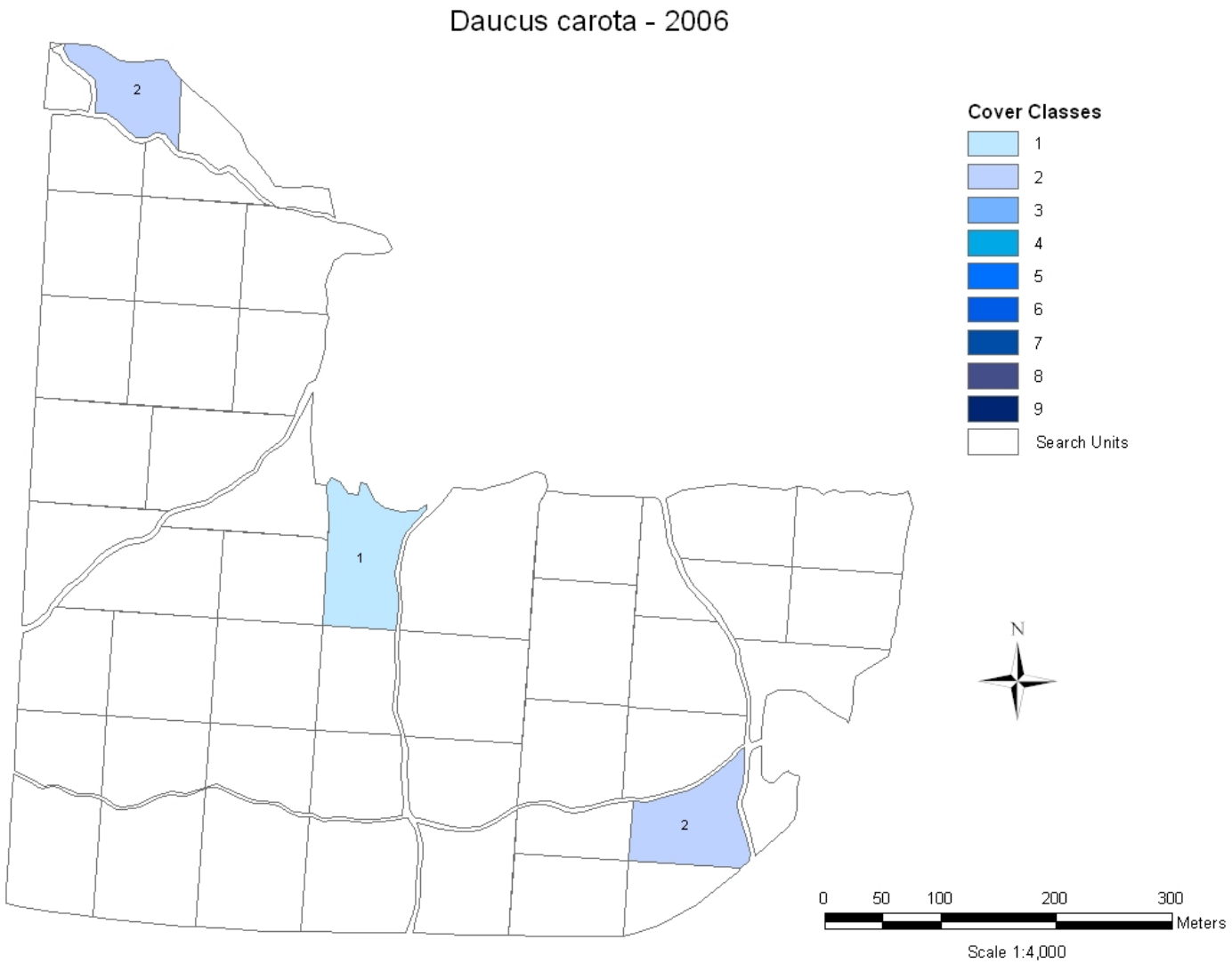

Figure 9. Abundance and distribution of *Daucus carota* (queen anne's lace) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

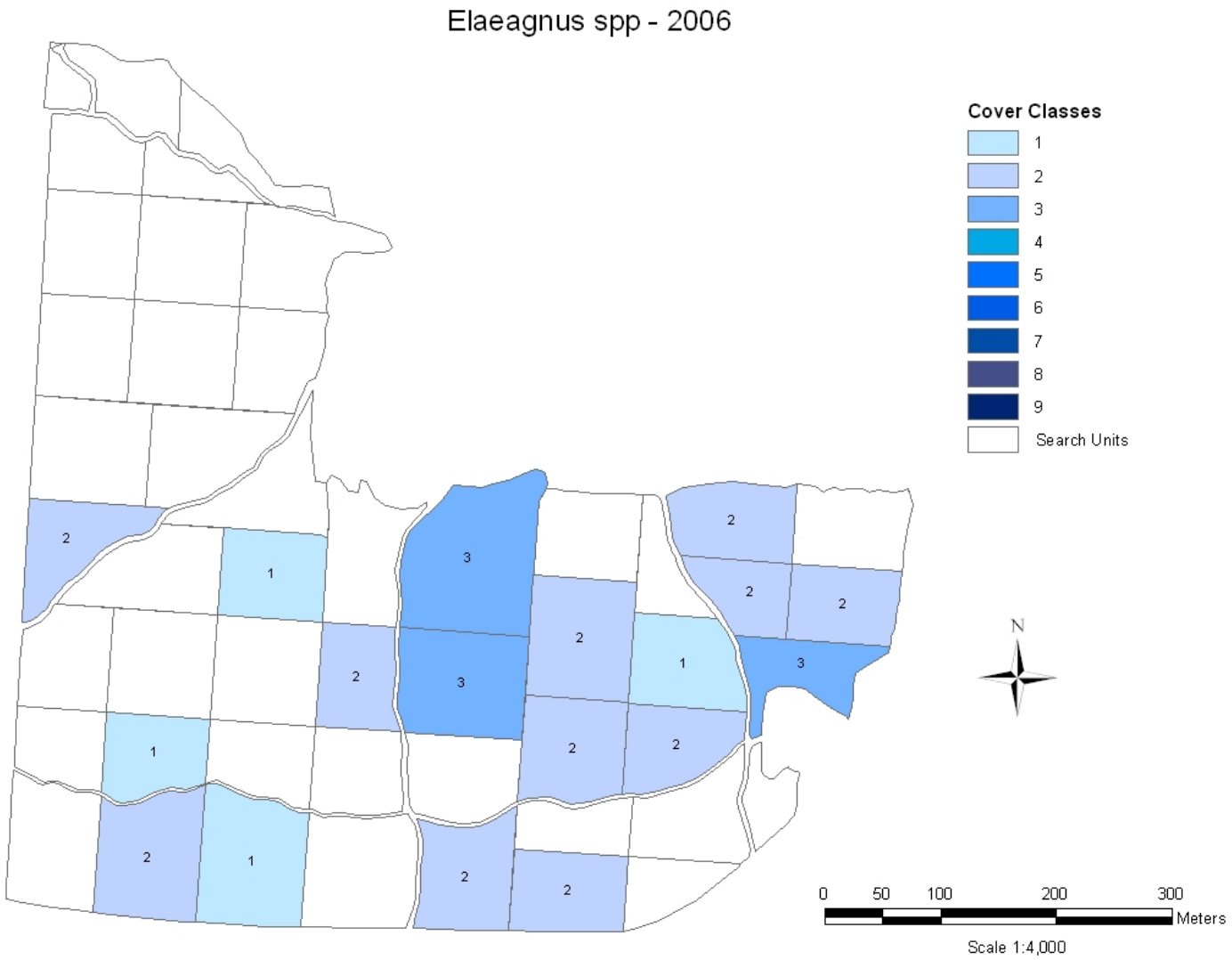

Figure 10. Abundance and distribution of *Elaeagnus spp* (olive) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

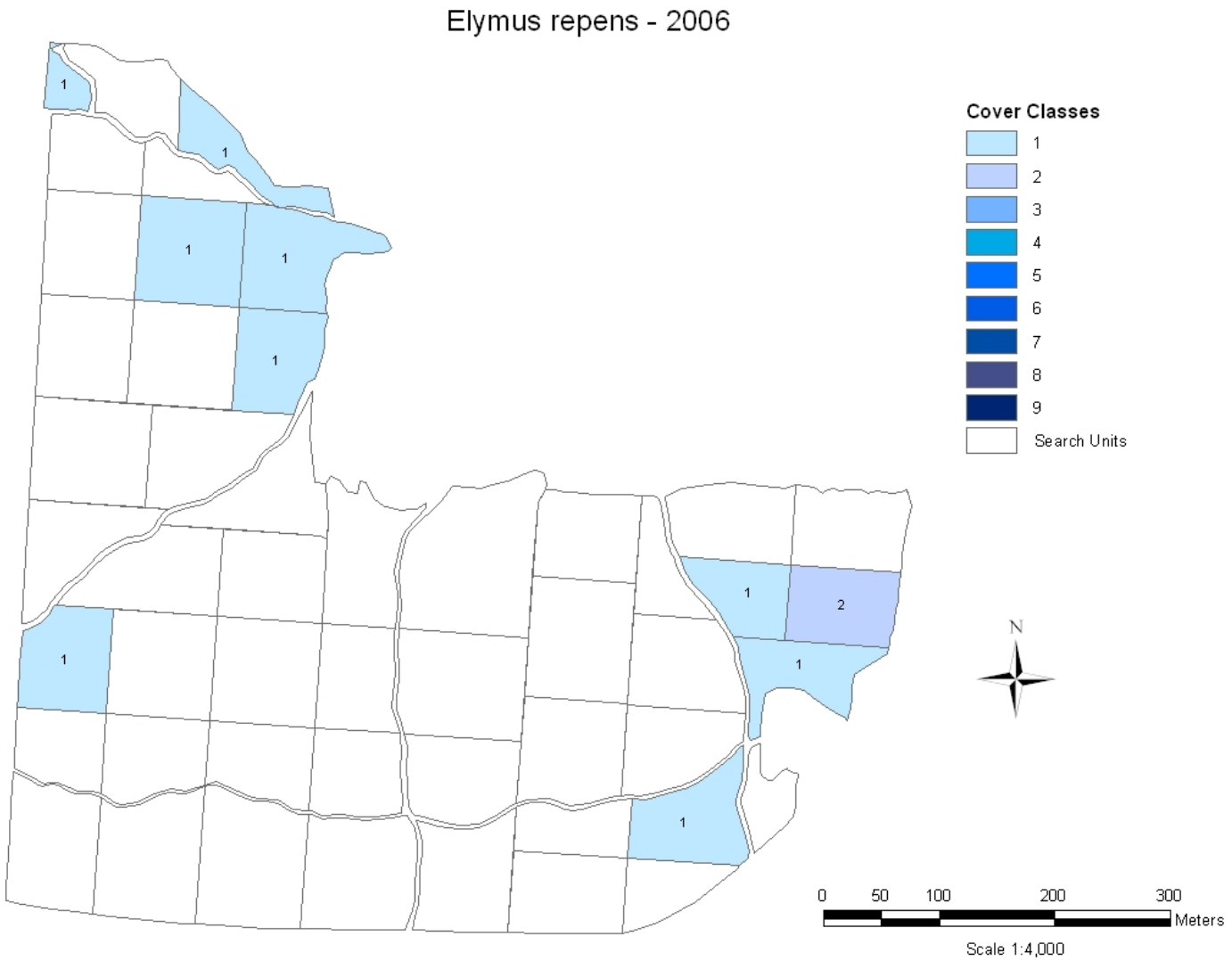

Figure 11. Abundance and distribution of *Elymus repens* (quackgrass) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

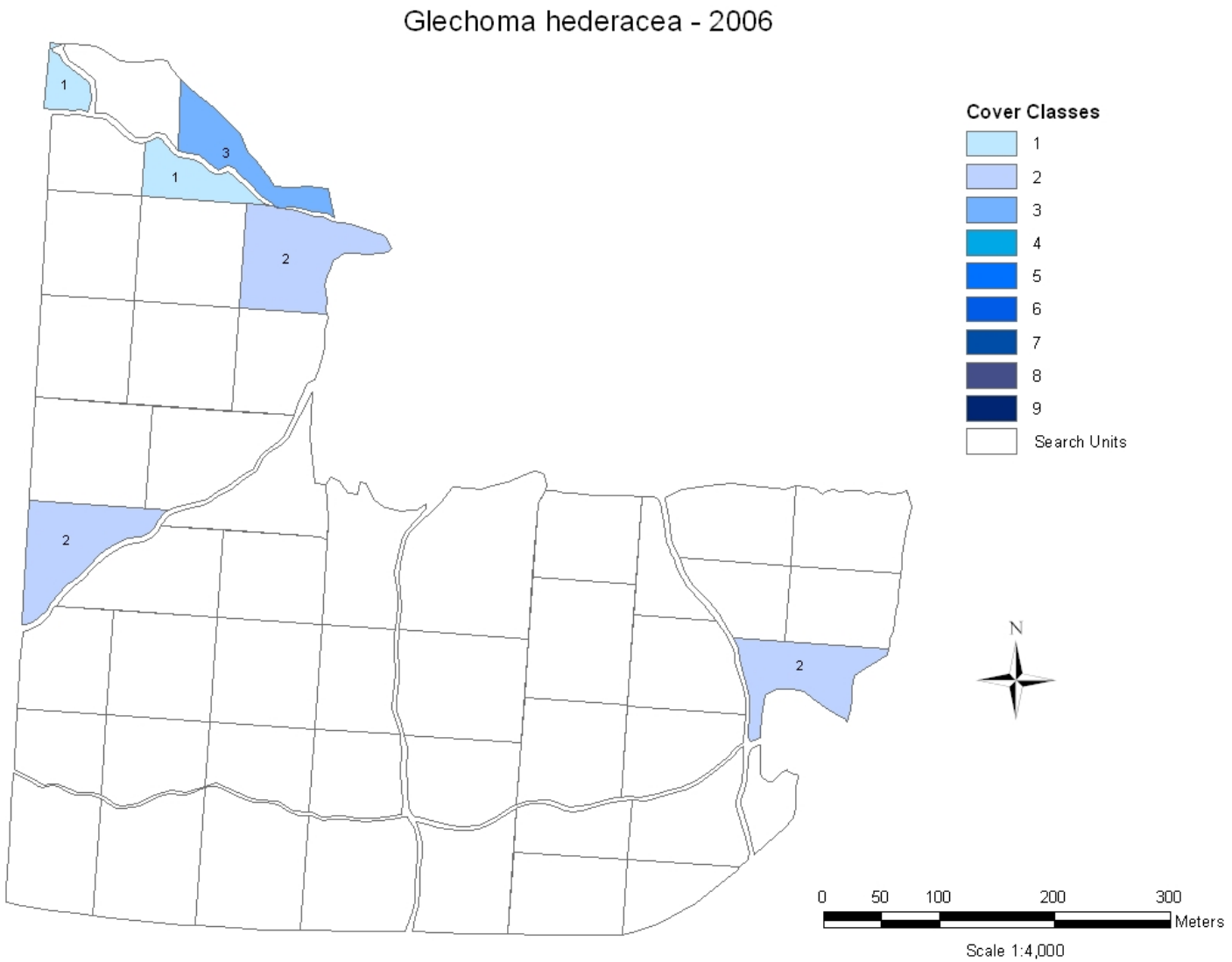

Figure 12. Abundance and distribution of *Glechoma hederacea* (ground ivy) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

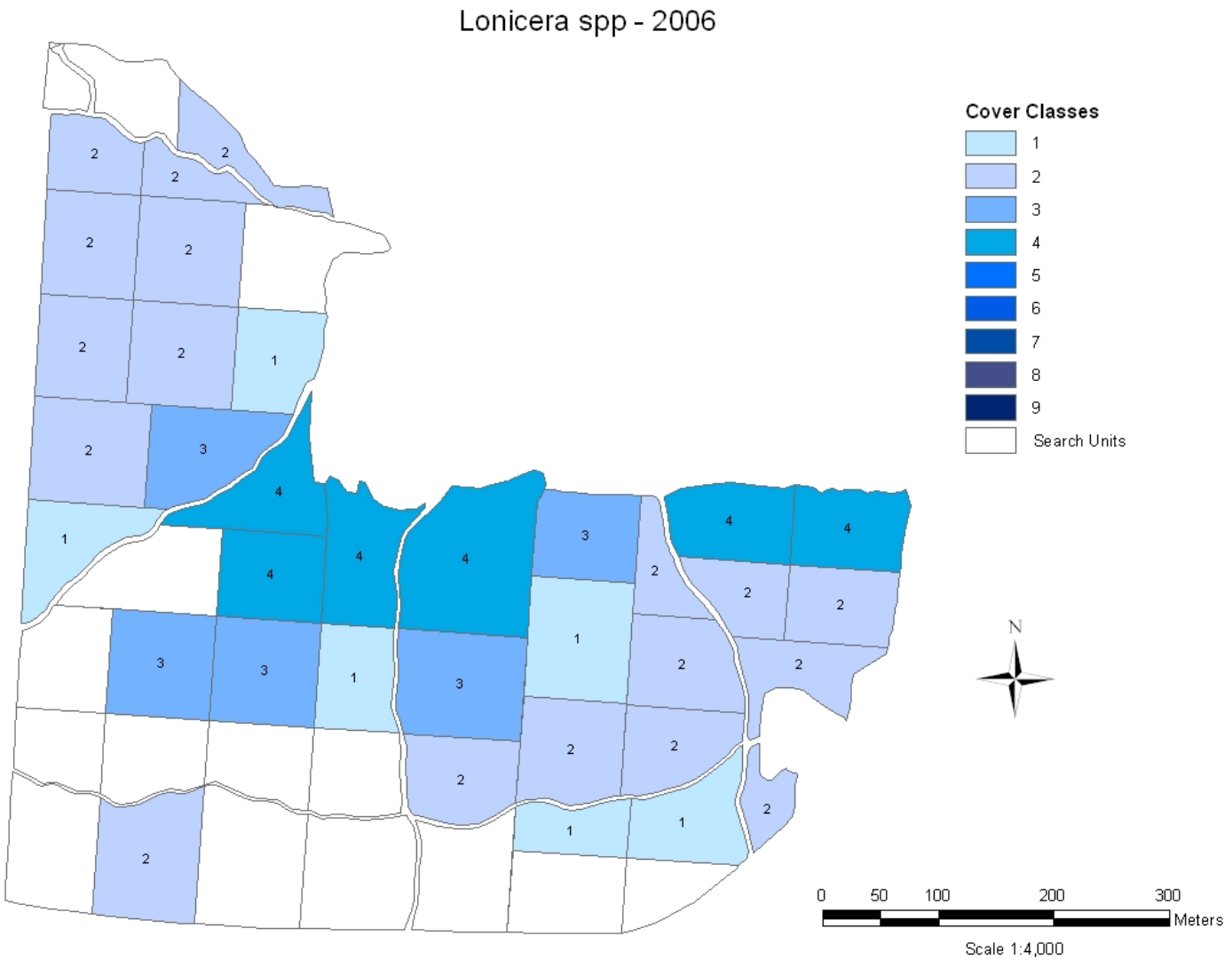

Figure 13. Abundance and distribution of *Lonicera spp* (honeysuckle) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

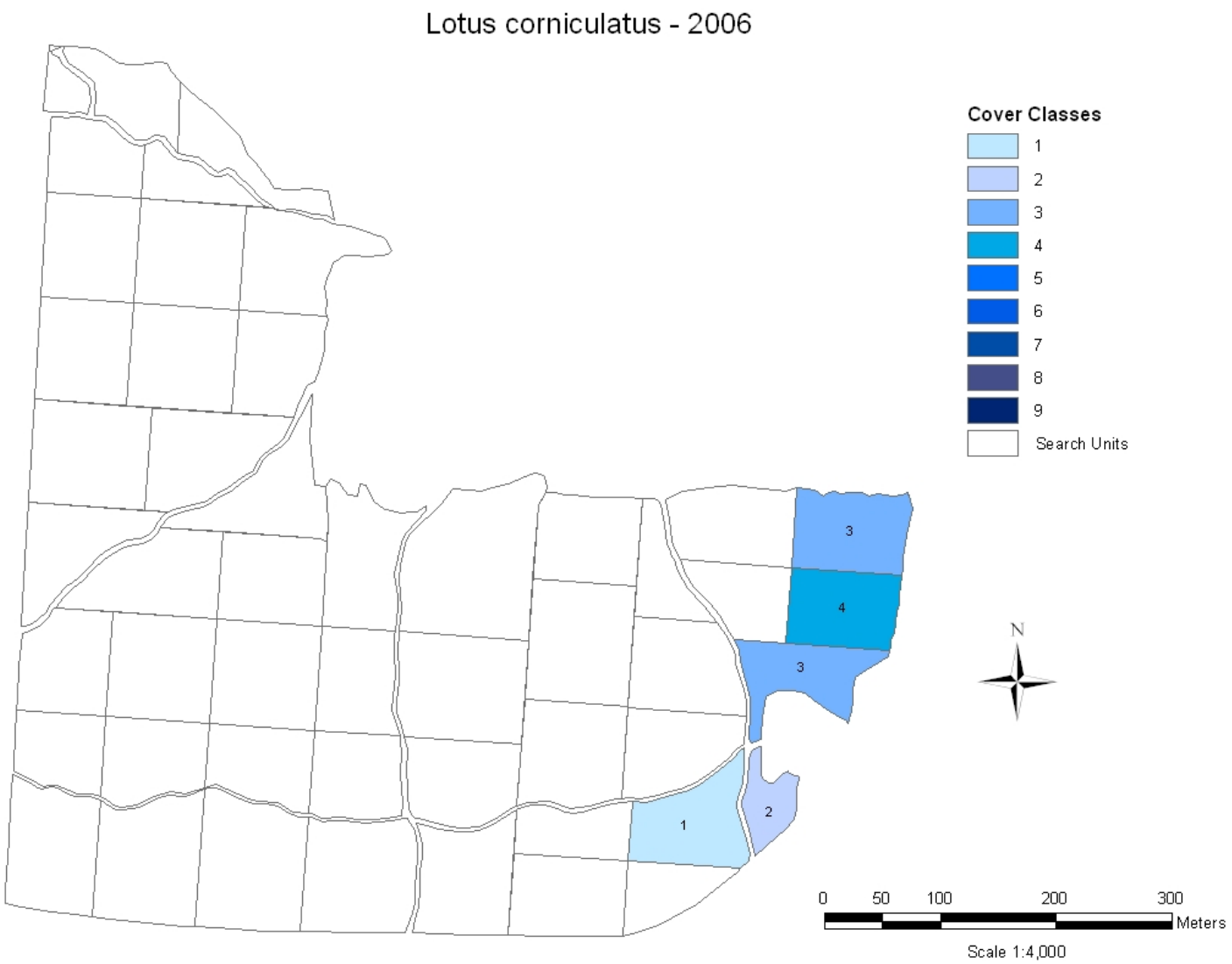

Figure 14. Abundance and distribution of *Lotus corniculatus* (bird's-foot trefoil) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

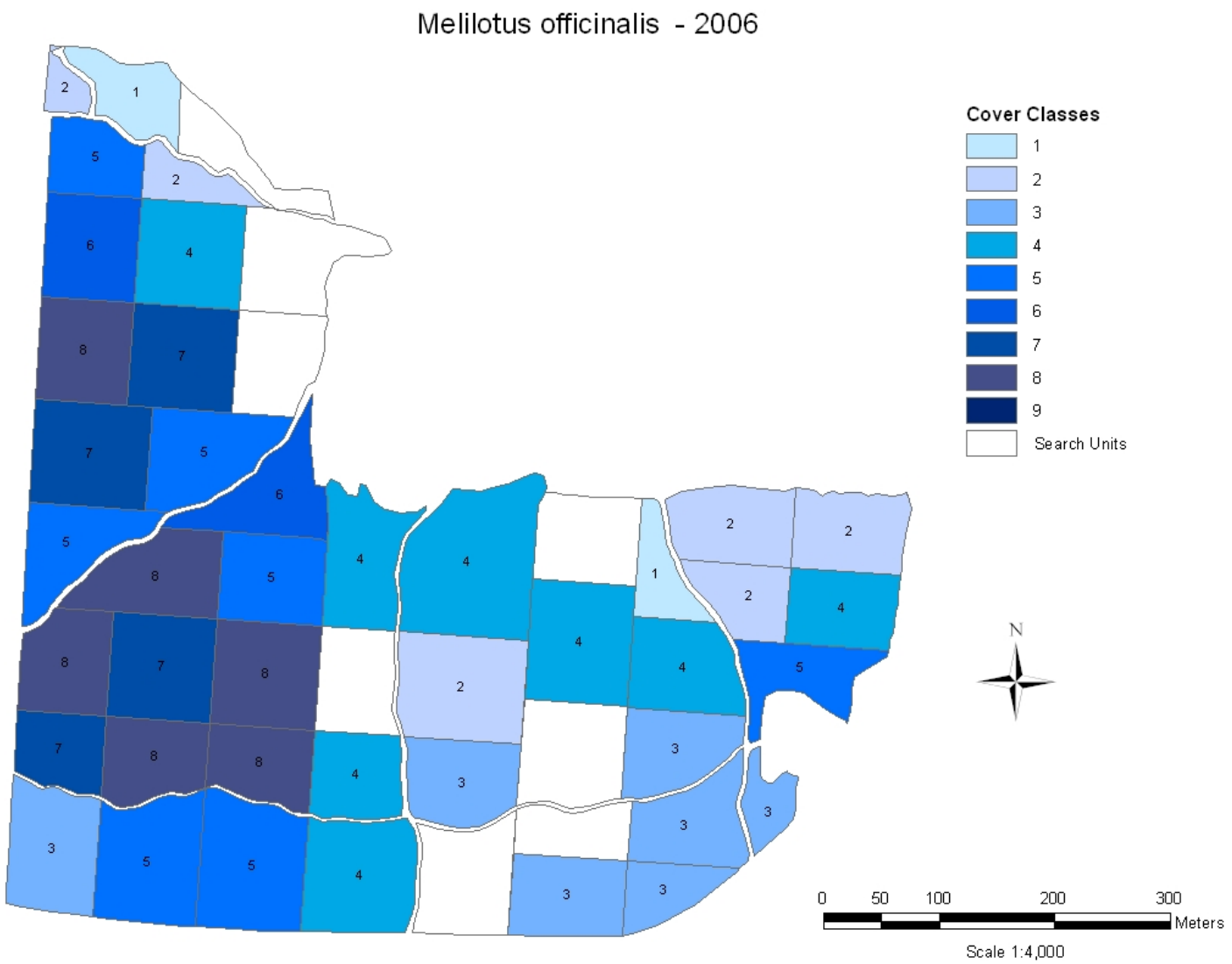

Figure 15. Abundance and distribution of *Melilotus officinalis* (sweetclover) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

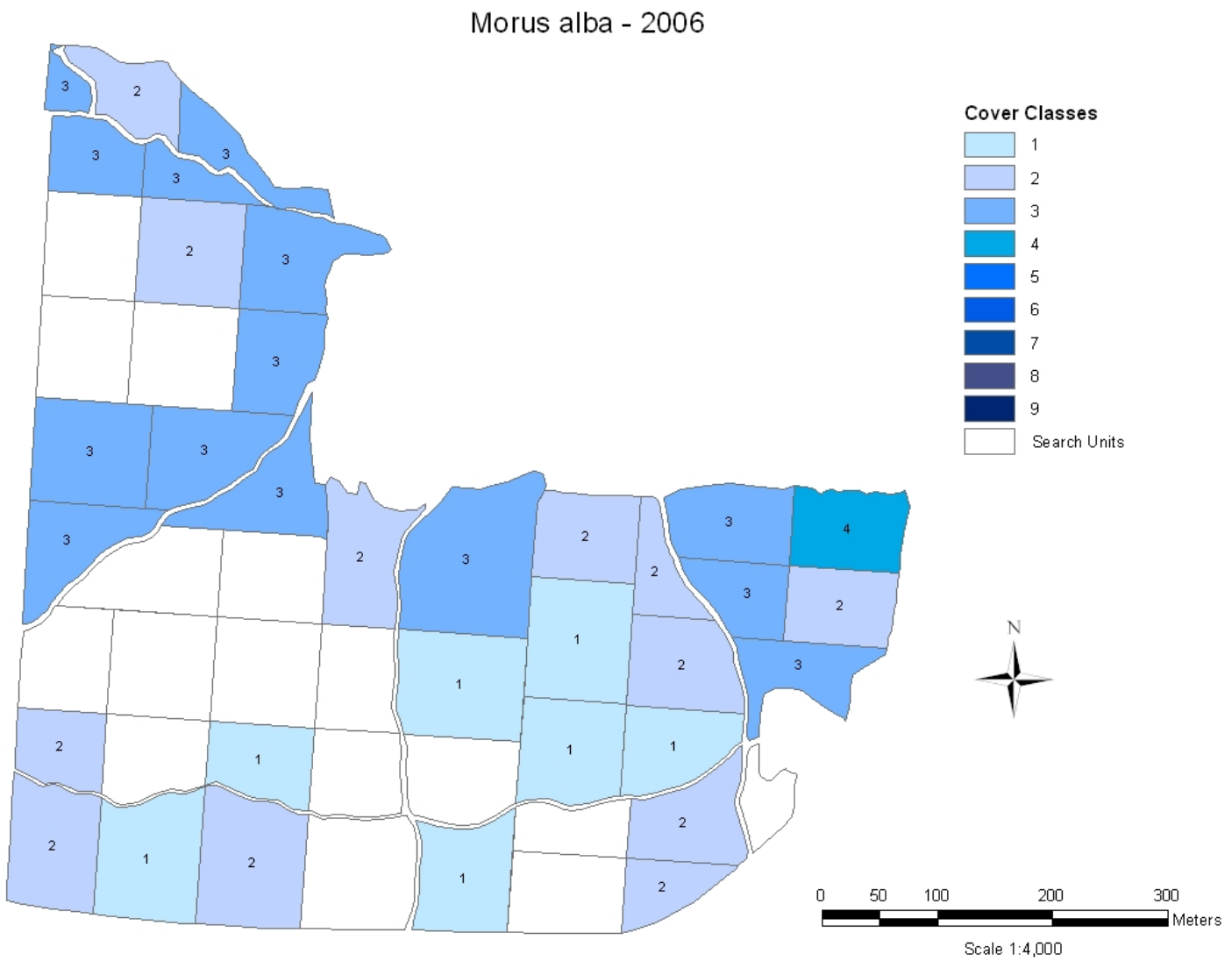

Figure 16. Abundance and distribution of *Morus alba* (white mulberry) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

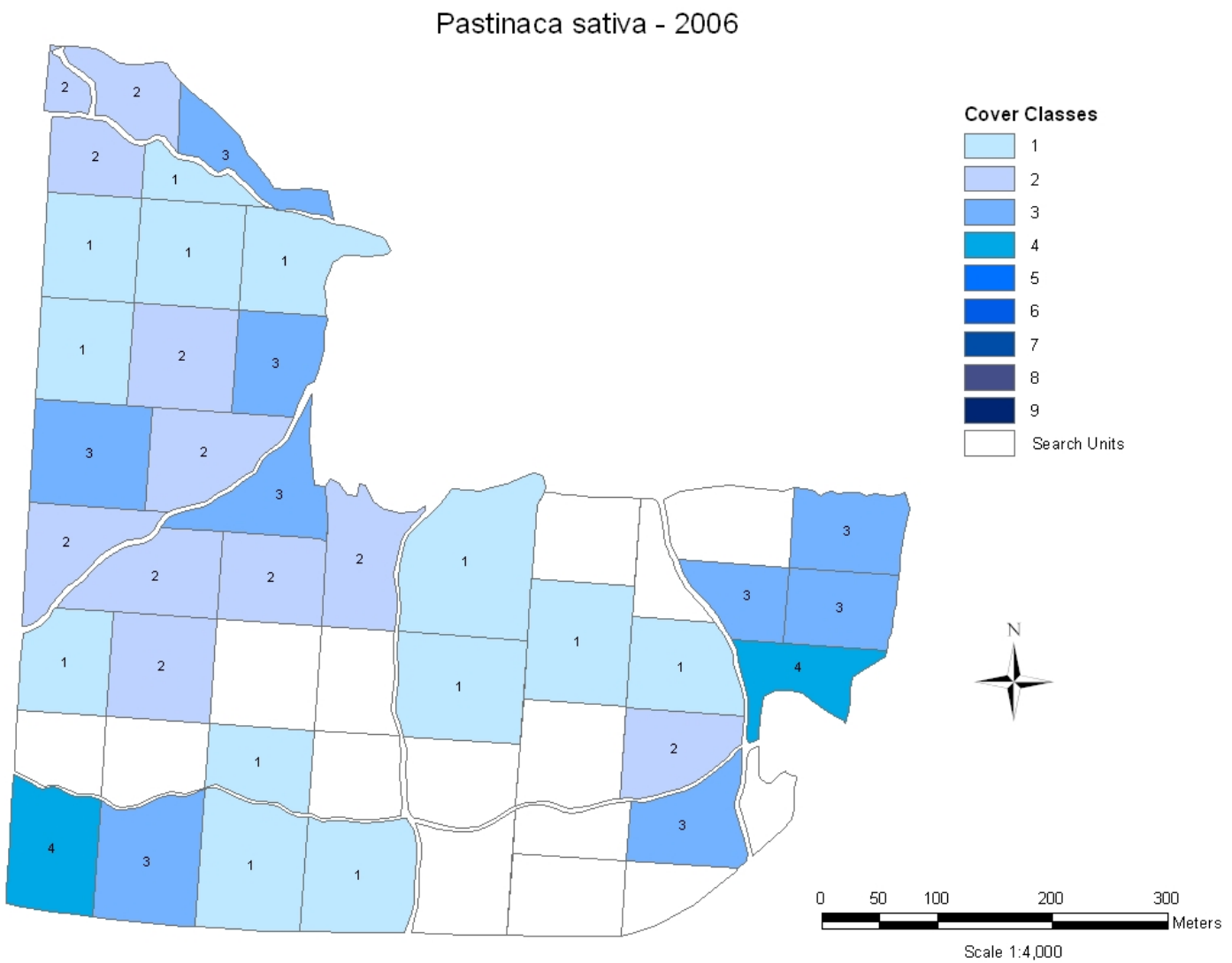

Figure 17. Abundance and distribution of *Pastinaca sativa* (wild parsnip) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

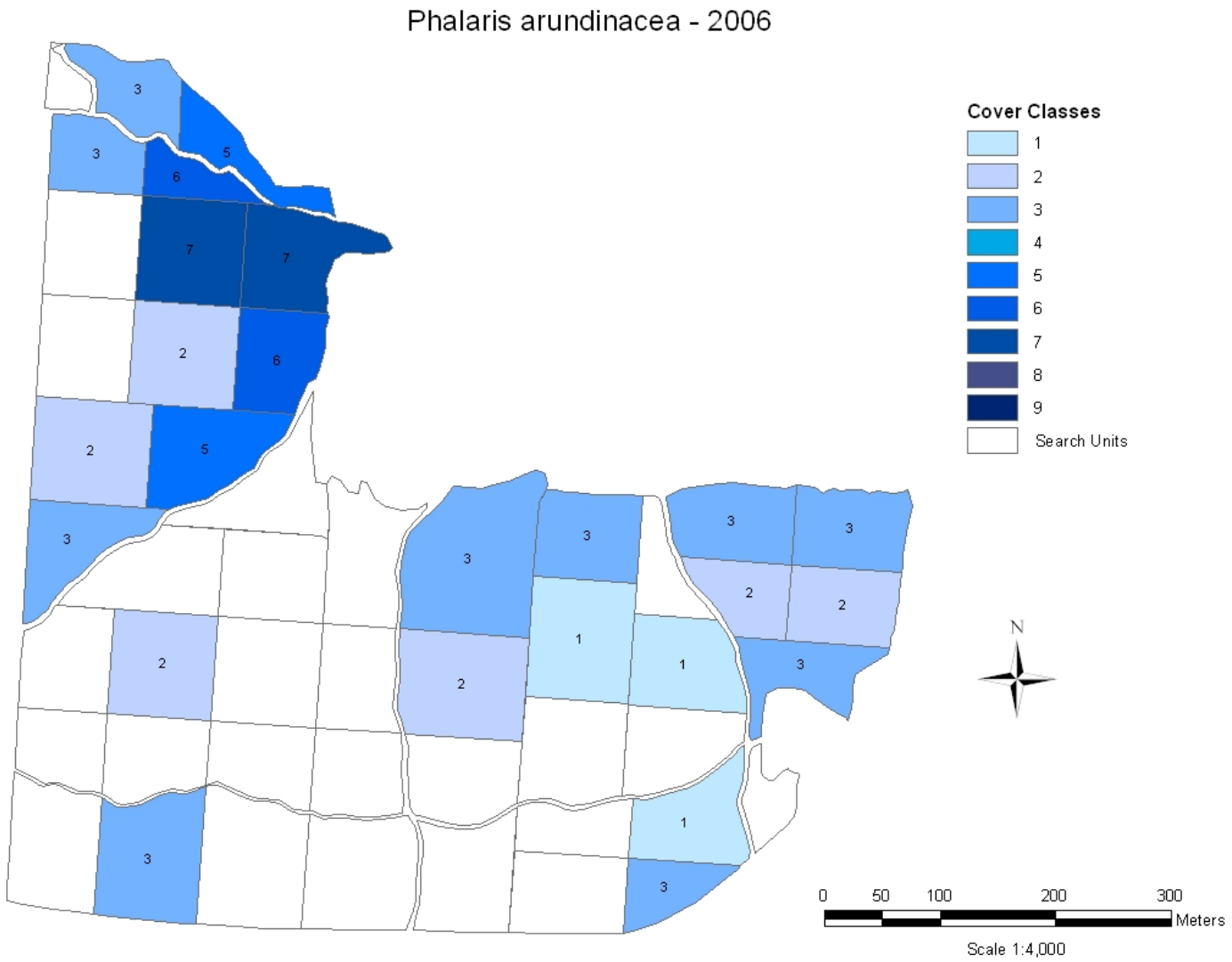

Figure 18. Abundance and distribution of *Phalaris arundinacea* (reed canarygrass) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

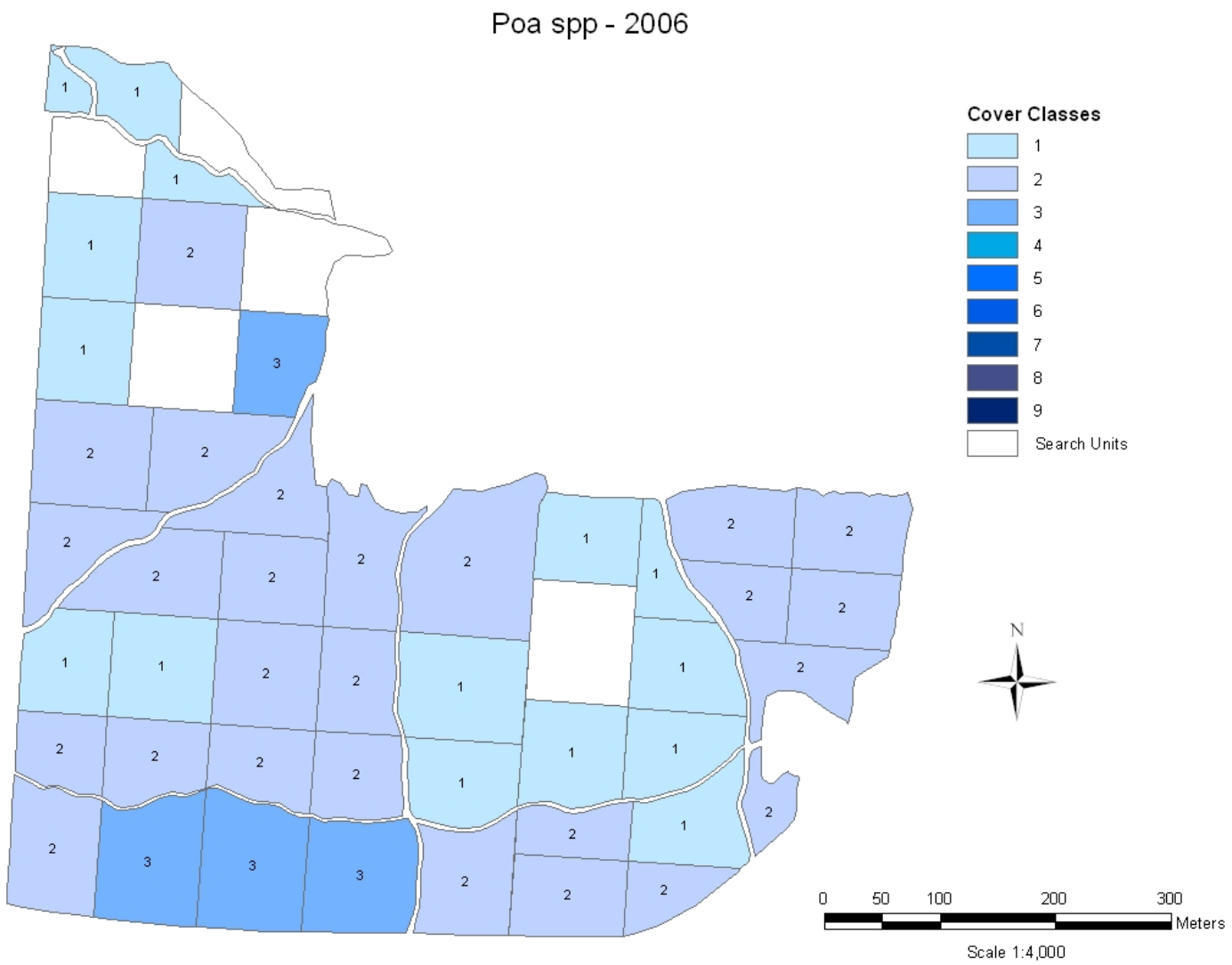

Figure 19. Abundance and distribution of Poa spp (bluegrass) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

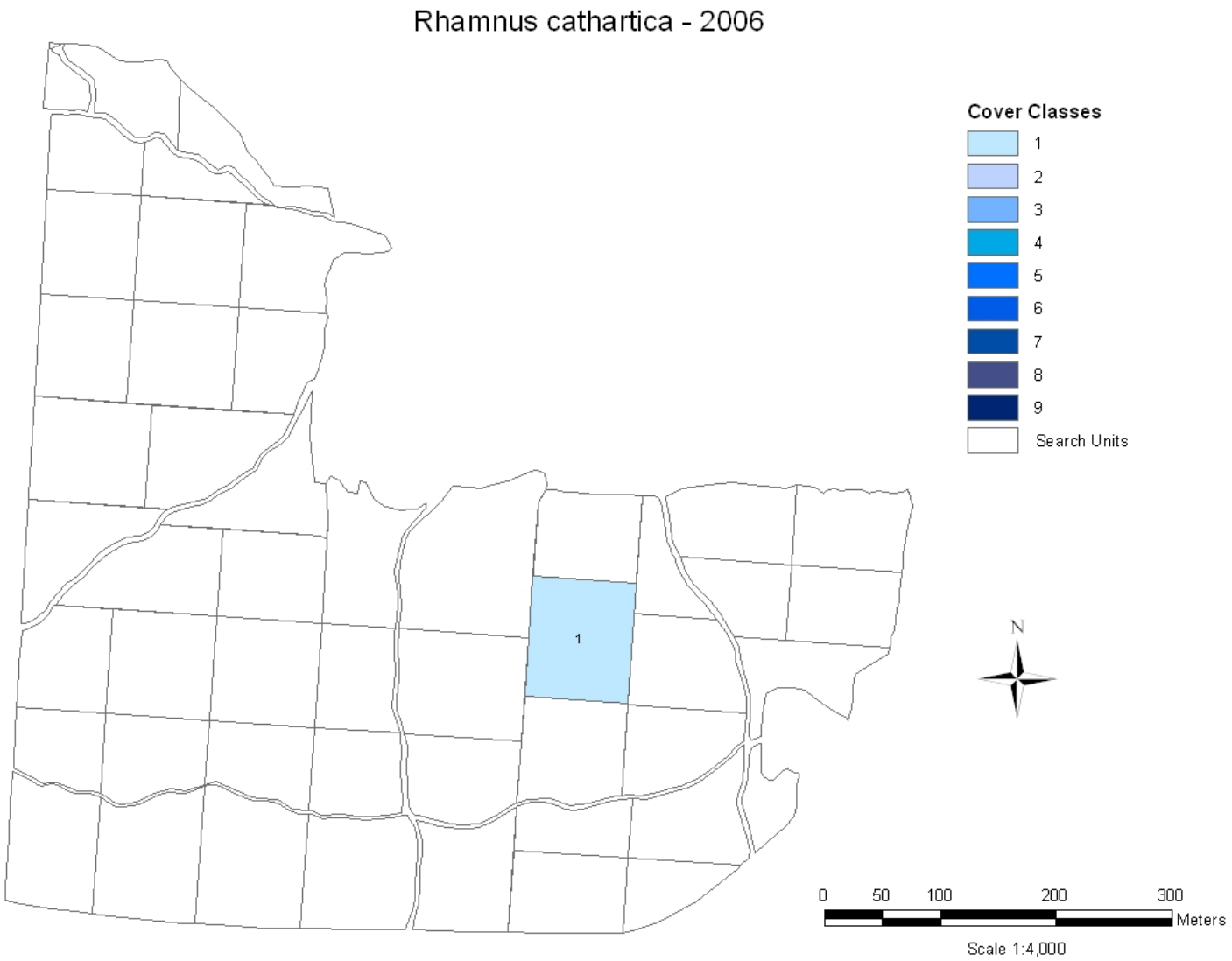

Figure 20. Abundance and distribution of *Rhamnus cathartica* (common buckthorn) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

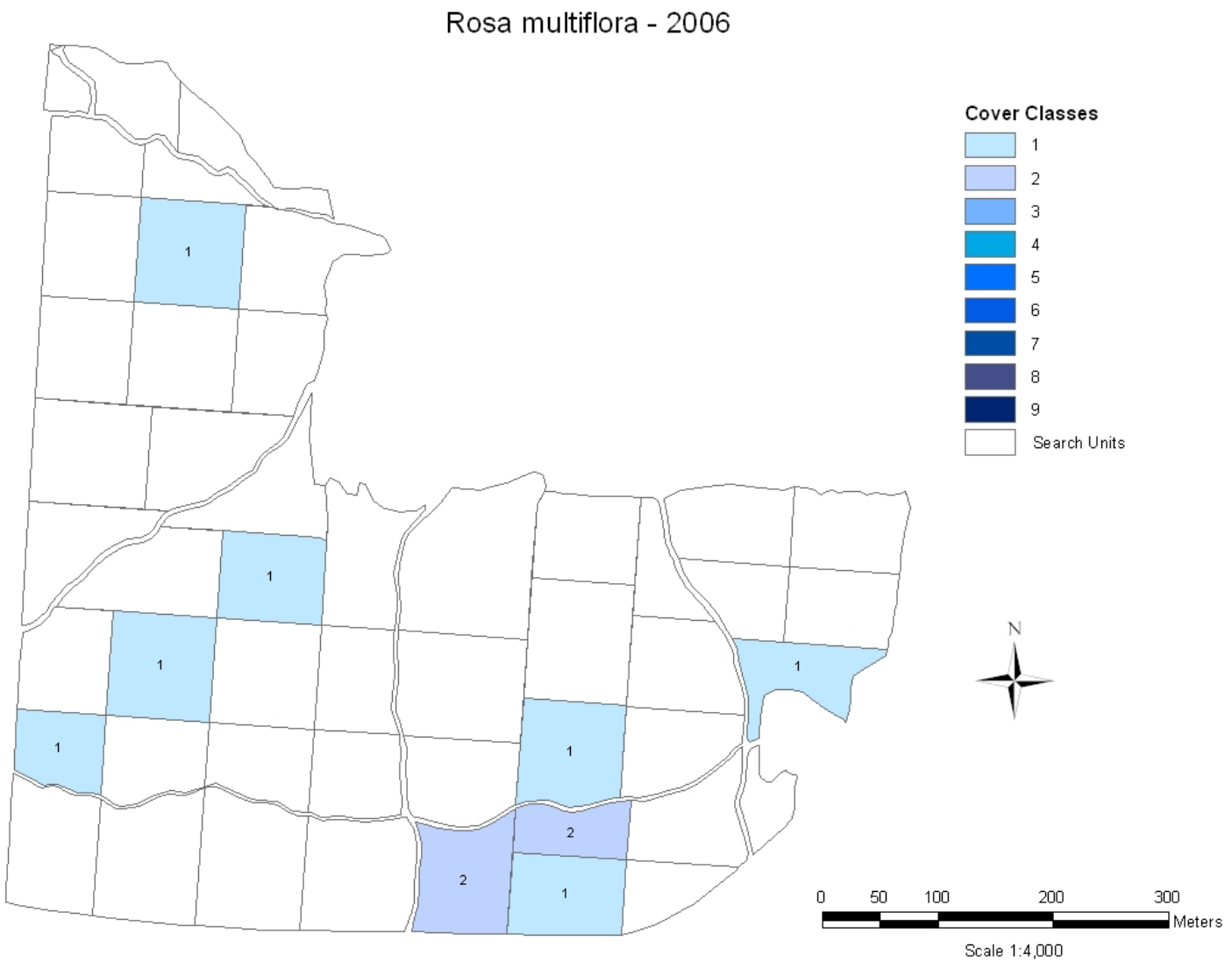

Figure 21. Abundance and distribution of *Rosa multiflora* (multiflora rose) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

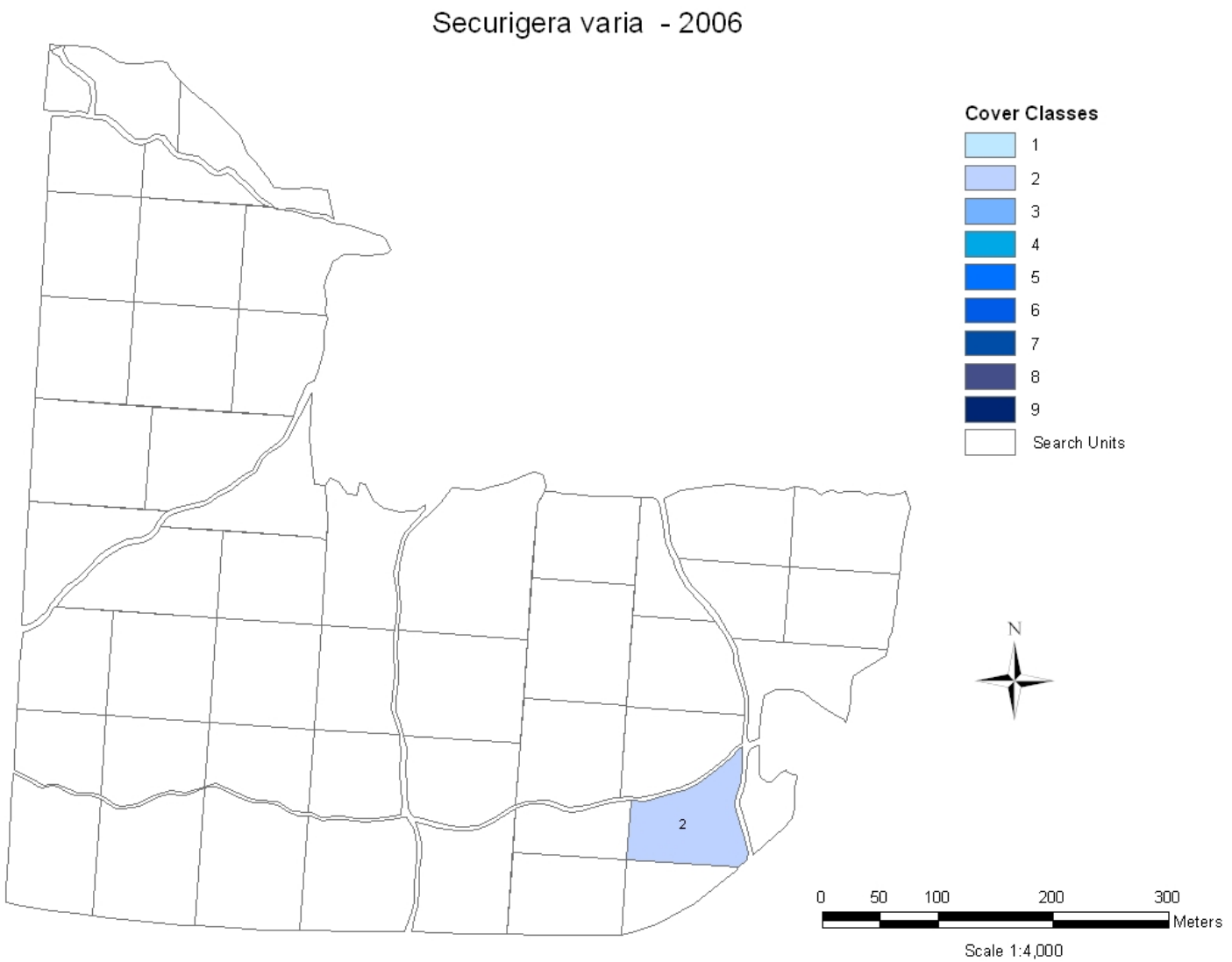

Figure 22. Abundance and distribution of *Securigera varia* (crownvetch) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

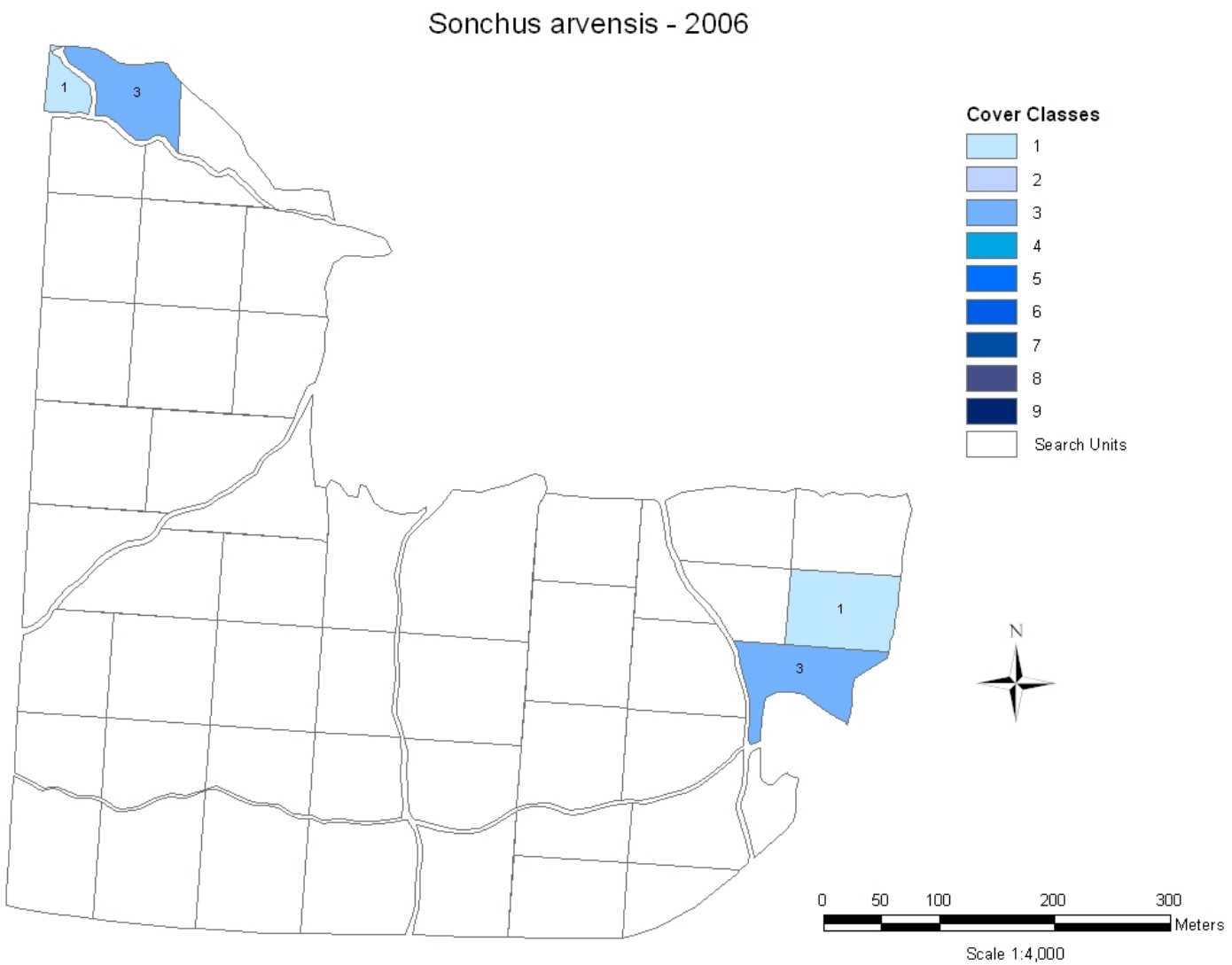

Figure 23. Abundance and distribution of *Sonchus arvensis* (field sowthistle) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

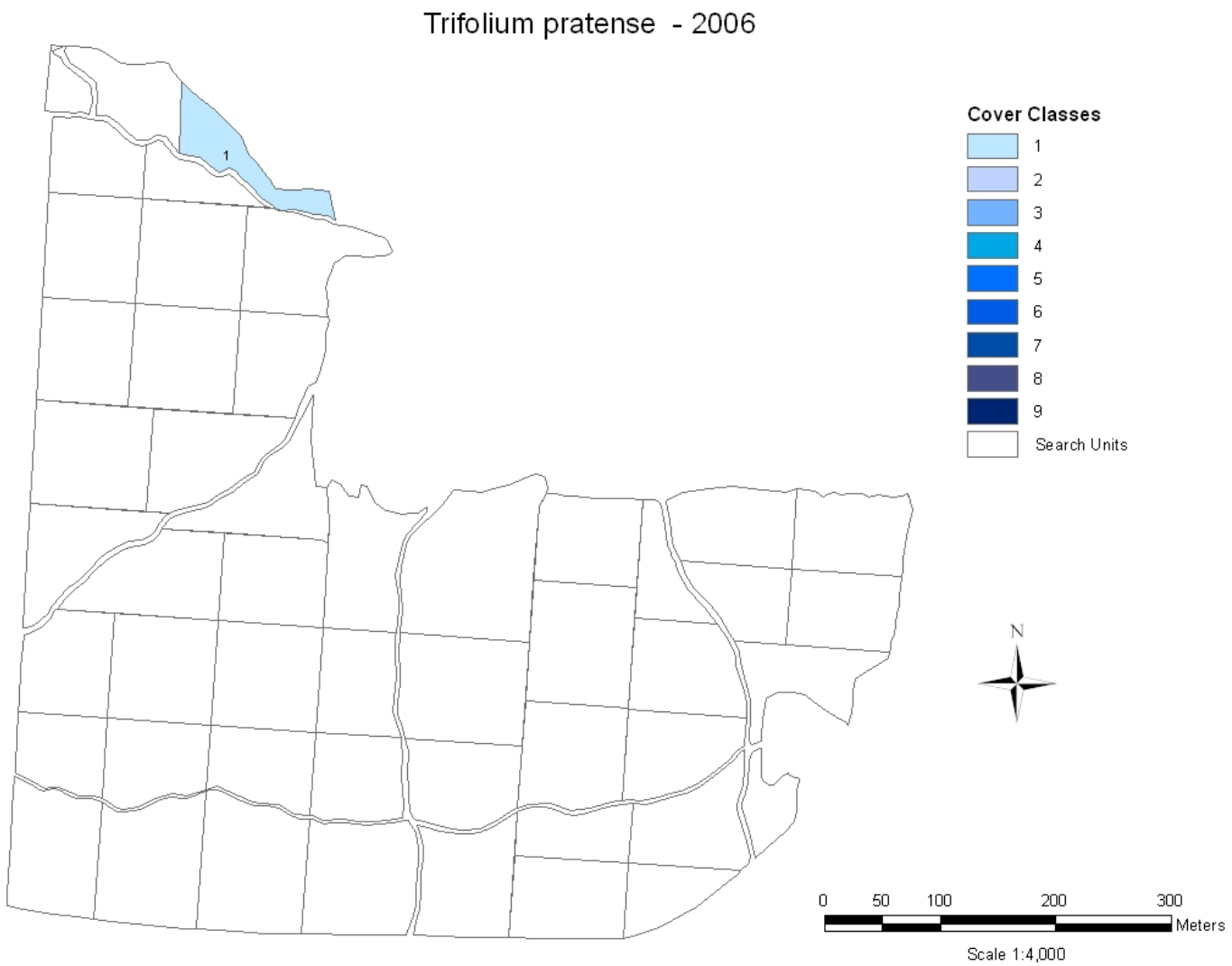

Figure 24. Abundance and distribution of *Trifolium pratense* (red clover) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

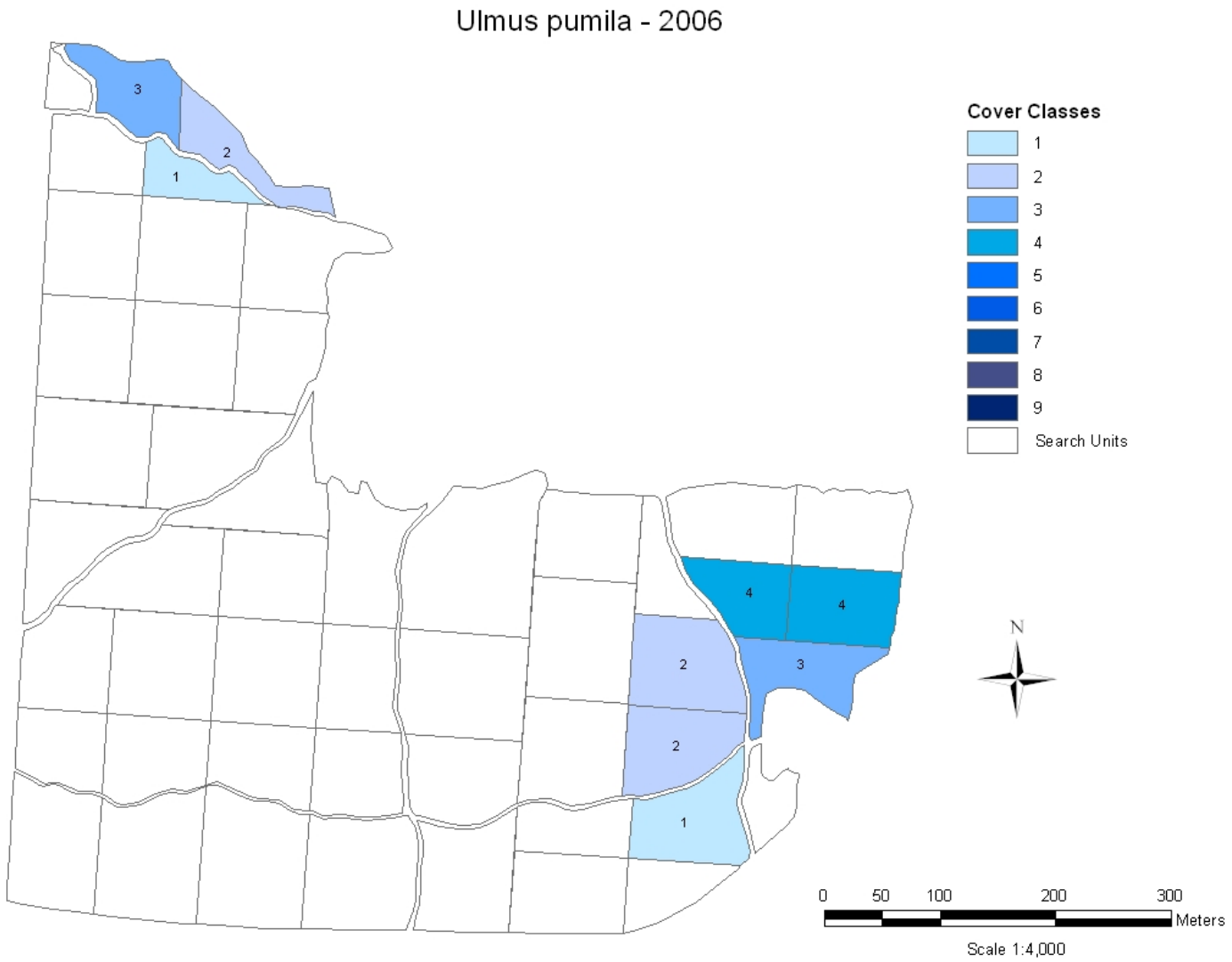

Figure 25. Abundance and distribution of *Ulmus pumila* (siberian elm) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

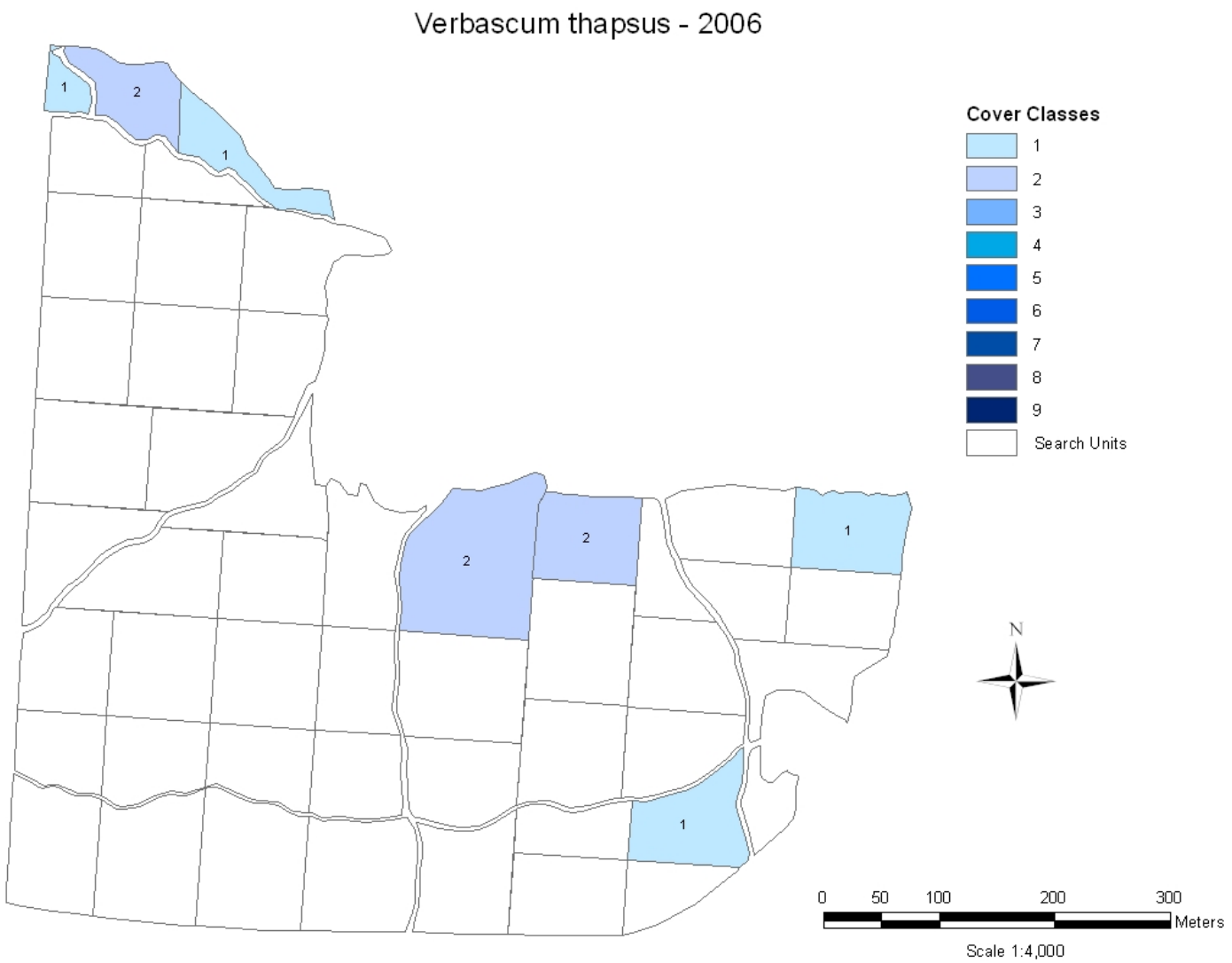

Figure 26. Abundance and distribution of *Verbascum thapsus* (common mullein) at Herbert Hoover National Historic Site, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 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-56, March 2007

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
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Fort Collins, CO 80525

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