National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Fort Collins, Colorado

Invasive Exotic Plant Monitoring at Lincoln Boyhood National Memorial: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/021
NPS D-43

ON THE COVER

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

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March 2007

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Please cite this publication as:

Cribbs, J.T., C.C. Young, J.L. Haack, and H.J. Etheridge. 2007. Invasive exotic plant monitoring at Lincoln Boyhood National Memorial: Year 1 (2006). Natural Resource Technical Report NPS/HTLN/NRTR—2007/021. National Park Service, Fort Collins, Colorado.

NPS D-43, March 2007

Acknowledgements

Dan Tenaglia conducted all field work associated with this report in 2006. Dan died on February 13, 2007 following a collision two days earlier while riding his bike near his home in Opelika, Alabama. We are grateful for his work. Dan's botanical photography can be found at his Missouri Plants website: http://www.missouriplants.com/.

Executive Summary

During surveys in 2006, we documented 31 invasive exotic plant taxa at Lincoln Boyhood National Memorial. Japanese honeysuckle was widespread and abundant at Lincoln Boyhood National Memorial. Japanese honeysuckle was established on at least 3.2 acres and occurred in 94.8% of search units. Common periwinkle was the second most abundant species with a cover of 1.3 acres and occurred in 24.7% of search units. A total of 27 invasive exotic plant species each covered one acre or less of the memorial. In general, several invasive exotic plants are a moderate problem at Lincoln Boyhood National Memorial, but successful control appears 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 Lincoln Boyhood National Memorial. 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 forest at Lincoln Boyhood National Memorial is a significant cultural resource that is vulnerable to exotic plant invasions.

2. Based on a 2003 survey, the following invasive, exotic plants were found at Lincoln Boyhood National Memorial: multiflora rose (*Rosa multiflora*), privet species (*Ligustrum* spp.), common periwinkle (*Vinca minor*), sericea lespedeza (*Lespedeza cuneata*), and Chinese yam (*Dioscorea oppositifolia*).

3. Park use of mechanical and chemical methods of control will be needed to control a number of invasive, exotic plant species.

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.

Field methods. Invasive exotic plant species on designated watch lists (Table 1) were sought in high priority areas on Lincoln Boyhood National Memorial (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 77 search units were surveyed at Lincoln Boyhood National Memorial. 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 Lincoln Boyhood National Memorial were attributed to search units in a GIS (Figures 2 – 32). 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 31 invasive exotic plant taxa were found during the survey at Lincoln Boyhood National Memorial (Table 2). Of these, 17 species were listed in NPSpecies as occurring at the memorial. Eleven species and three species were identified from the early detection watch list and park based watch lists, respectively.

The distribution and abundance of the invasive exotic plant species at Lincoln Boyhood National Memorial varied widely. Japanese honeysuckle (*Lonicera japonica*) was the most abundant and widespread invasive exotic plant species on the park. Japanese honeysuckle was found in 94.8 % of search units and was estimated to cover between three and ten acres. The next three most abundant species included common periwinkle (*Vinca minor*), European privet (*Ligustrum vulgare*), and multiflora rose (*Rosa multiflora*), covering at least 1.3, 0.7, and 0.6 acres, respectively. The remaining 27 invasive exotic plant species each covered less than one acre of the park.

Only two species were noted as having definitively high ecological impacts: autumn olive (*Elaeagnus umbellata*) and crownvetch (*Securigera varia*) (Table 2). Nine species were characterized as having at least a medium ecological impact. The remaining species had medium-low ecological impacts or less, including six species with low or insignificant impacts. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, autumn olive, crownvetch, and Japanese barberry (*Berberis thunbergii*) with potentially high ecological impacts were noted as having low or insignificant management difficulty. Controlling these species will likely provide a high benefit for the management costs. Furthermore, management of the numerous small invasive exotic populations on Lincoln Boyhood National Memorial may well limit the financial and ecological costs associated with the spread of these species.

In summary, this report provides information on invasive, exotic plant abundance and distribution. The report also characterizes 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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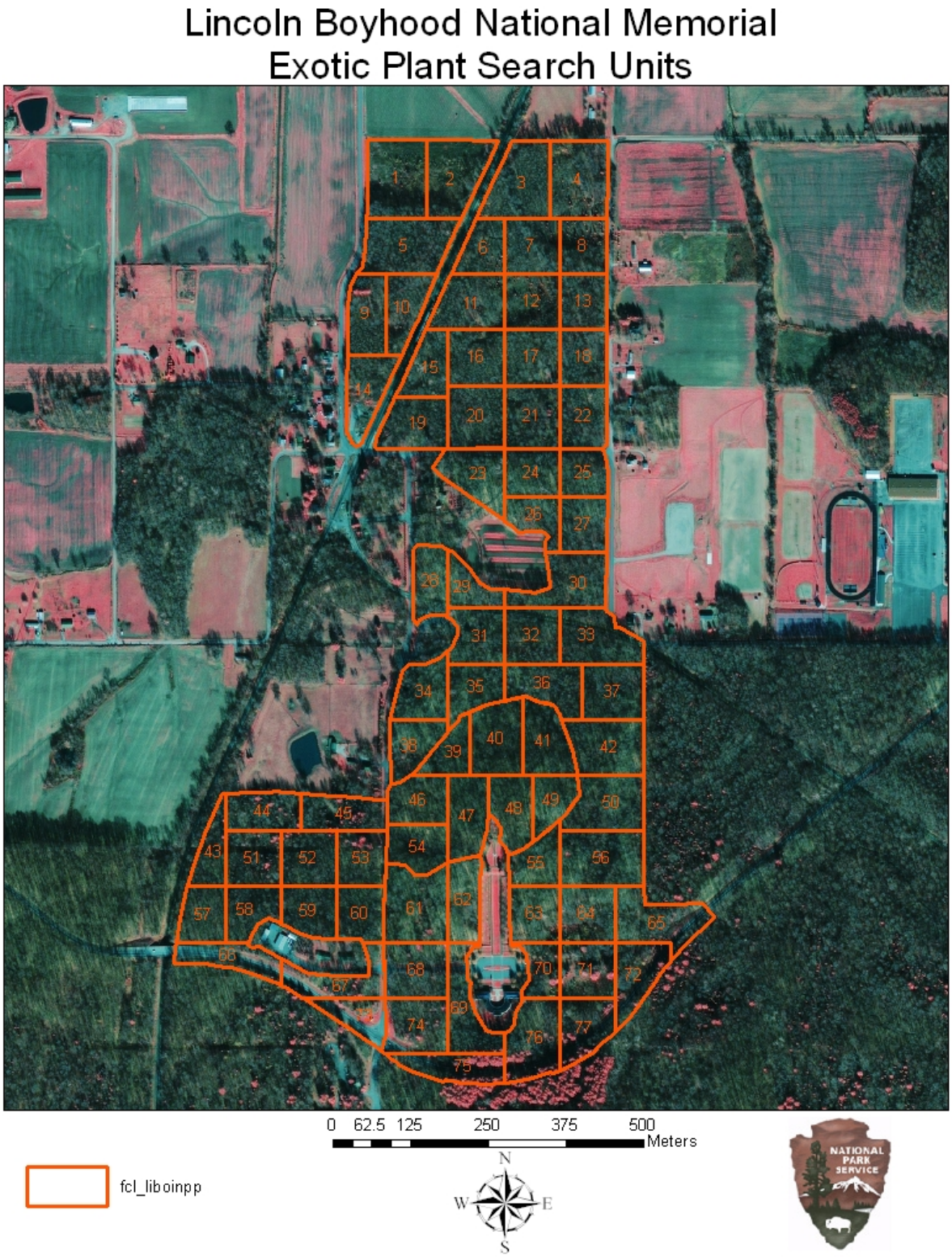

Figure 1. Invasive exotic plant search units at Lincoln Boyhood National Memorial. The search units indicate the search locations for invasive exotic plants in 2006.

Table 1. Watch lists for Lincoln Boyhood National Memorial

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Acer platanoides	Norway maple	*Albizia julibrissin*	Silktree	*Ligustrum obtusifolium*	Border privet
Ailanthus altissima	Tree of heaven	*Berberis thunbergii*	Japanese barberry	*Wisteria sinensis*	Chinese wisteria
Alliaria petiolata	Garlic mustard	*Dactylis glomerata*	Orchardgrass	*Ligustrum sinense*	Chinese privet
Alnus glutinosa	European alder	*Dioscorea oppositifolia*	Chinese yam		
Arctium minus	Lesser burdock	*Euonymus alatus*	Burningbush		
Azolla	Mosquitofern	*Euonymus fortunei*	Winter creeper		
Bromus inermis	Smooth brome	*Glechoma hederacea*	Ground ivy		
Bromus sterilis	Poverty brome	*Hedera helix*	English ivy		
Bromus tectorum	Cheatgrass	*Lespedeza cuneata*	Sericea lespedeza		
Butomus umbellatus	Flowering rush	*Ligustrum vulgare*	European privet		
Carduus nutans	Nodding plumeless thistle	*Lolium pratense*	Meadow fescue		
Celastrus orbiculatus	Oriental bittersweet	*Lonicera japonica*	Japanese honeysuckle		
Centaurea biebersteinii	Spotted knapweed	*Lonicera morrowii*	Morrow's honeysuckle		
Centaurea solstitialis	Yellow star-thistle	*Melilotus officinalis*	Yellow sweetclover		
Cirsium arvense	Canada thistle	*Morus alba*	White mulberry		
Cirsium vulgare	Bull thistle	*Plantago lanceolata*	Narrowleaf plantain		
Cynanchum louiseae	Louise's swallow-wort	*Poa compressa*	Canada bluegrass		
Cynanchum rossicum	European swallow-wort	*Poa pratensis*	Kentucky bluegrass		
Dipsacus fullonum	Fuller's teasel	*Polygonum cuspidatum*	Japanese knotweed		
Dipsacus laciniatus	Cutleaf teasel	*Robinia pseudoacacia*	Black locust		
Egeria densa	Brazilian waterweed	*Rosa multiflora*	Multiflora rose		
Elaeagnus umbellata	Autumn olive	*Verbascum thapsus*	Common mullein		
Euphorbia esula	Leafy spurge	*Vinca minor*	Common periwinkle		
Frangula alnus	Glossy buckthorn				
Hesperis matronalis	Dames rocket				
Holcus lanatus	Common velvetgrass				
Humulus japonicus	Japanese hop				
Hyoscyamus niger	Black henbane				
Lespedeza bicolor	Shrub lespedeza				
Lolium arundinaceum	Tall fescue				
Lonicera maackii	Amur honeysuckle				
Lonicera tatarica	Tatarian honeysuckle				
Lonicera X bella	Showy fly honeysuckle				
Lotus corniculatus	Bird's-foot trefoil				
Lysimachia nummularia	Creeping jenny				
Lythrum salicaria	Purple loosestrife				

Table 1. Watch lists for Lincoln Boyhood National Memorial (cont.)

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Microstegium vimineum	Nepalese browntop				
Miscanthus sinensis	Chinese silvergrass				
Myriophyllum spicatum	Eurasian watermilfoil				
Ornithogalum umbellatum	Sleepydick				
Pastinaca sativa	Wild parsnip				
Paulownia tomentosa	Princesstree				
Phalaris arundinacea	Reed canarygrass				
Phragmites australis	Common reed				
Populus alba	White poplar				
Potamogeton crispus	Curly pondweed				
Potentilla recta	Sulphur cinquefoil				
Pueraria montana var. lobata	Kudzu				
Rhamnus cathartica	Common buckthorn				
Securigera varia	Crownvetch				
Solanum dulcamara	Climbing nightshade				
Sorghum halepense	Johnsongrass				
Spiraea japonica	Japanese meadowsweet				
Torilis arvensis	Spreading hedgeparsley				
Torillis japonica	Erect hedgeparsley				
Typha angustifolia	Narrowleaf cattail				
Ulmus pumila	Siberian elm				
Viburnum opulus	European cranberrybush				

Table 2. Overview of invasive exotic plants found on Lincoln Boyhood National Memorial. 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
Lonicera japonica	Japanese honeysuckle	Park-established	3.2 - 9.8	94.8%	M	HM
Vinca minor	Common periwinkle	Park-established	1.3 - 5.4	24.7%	I	U
Ligustrum vulgare	European privet	Park-established	0.7 - 2.7	68.8%	HL	HM
Rosa multiflora	Multiflora rose	Park-established	0.6 - 2.5	72.7%	L	L
Robinia pseudoacacia	Black locust	Park-established	< 1.0	32.5%	HM	M
Ailanthus altissima	Tree of heaven	Early detection	< 0.5	16.9%	ML	ML
Elaeagnus umbellata	Autumn olive	Early detection	< 0.5	28.6%	H	L
Euonymus fortunei	Winter creeper	Park-established	< 0.5	32.5%	M	LI
Microstegium vimineum	Nepalese browntop	Early detection	< 0.5	26.0%	M	HM
Spiraea spp	Meadowsweet	Early detection	< 0.5	5.2%	ML	HM
Albizia julibrissin	Silktree	Park-established	< 0.25	6.5%	ML	ML
Celastrus orbiculatus	Oriental bittersweet	Early detection	< 0.25	36.4%	ML	M
Dioscorea oppositifolia	Chinese yam	Park-established	< 0.25	9.1%	ML	MI
Euonymus alatus	Burningbush	Park-established	< 0.25	10.4%	LI	L
Hedera helix	English ivy	Park-established	< 0.25	6.5%	M	ML
Lespedeza cuneata	Sericea lespedeza	Park-established	< 0.25	14.3%	ML	ML
Sorghum halepense	Johnsongrass	Early detection	< 0.25	1.3%	ML	HM
Dactylis glomerata	Orchardgrass	Park-established	< 0.1	2.6%	LI	ML
Ligustrum obtusifolium	Border privet	Park-based	< 0.1	1.3%	LI	L
Lonicera maackii	Amur honeysuckle	Early detection	< 0.1	3.9%	HM	M
Lonicera morrowii	Morrow's honeysuckle	Park-established	< 0.1	3.9%	ML	M
Lotus corniculatus	Bird's-foot trefoil	Early detection	< 0.1	1.3%	ML	ML
Lysimachia nummularia	Creeping jenny	Early detection	< 0.1	9.1%	L	L
Polygonum cuspidatum	Japanese knotweed	Park-established	< 0.1	6.5%	HM	M
Securigera varia	Crownvetch	Early detection	< 0.1	2.6%	H	L
Wisteria sinensis	Chinese wisteria	Park-based	< 0.1	3.9%	ML	L
Berberis thunbergii	Japanese barberry	Park-established	< 0.01	9.1%	HM	I
Cirsium vulgare	Bull thistle	Early detection	< 0.01	9.1%	ML	ML
Ligustrum sinense	Chinese privet	Park-based	< 0.01	2.6%	M	L
Poa compressa	Canada bluegrass	Park-established	< 0.01	2.6%	ML	HL
Verbascum thapsus	Common mullein	Park-established	< 0.001	1.3%	ML	L

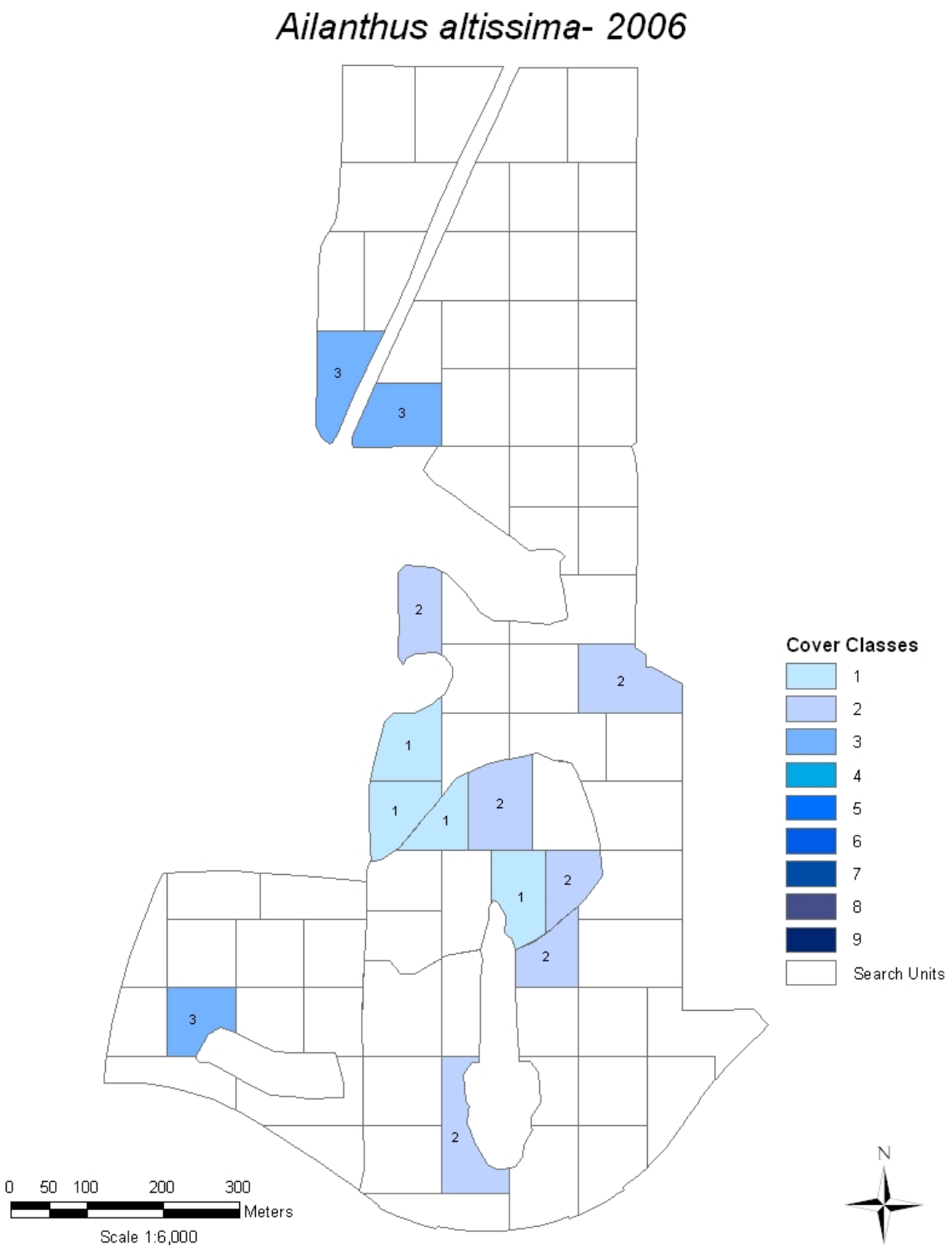

Figure 2. Abundance and distribution of *Ailanthus altissima* (tree of heaven) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1000-4999.9 m^2, 8=5000-9999.9 m^2, and 9=10,000-14999.9.

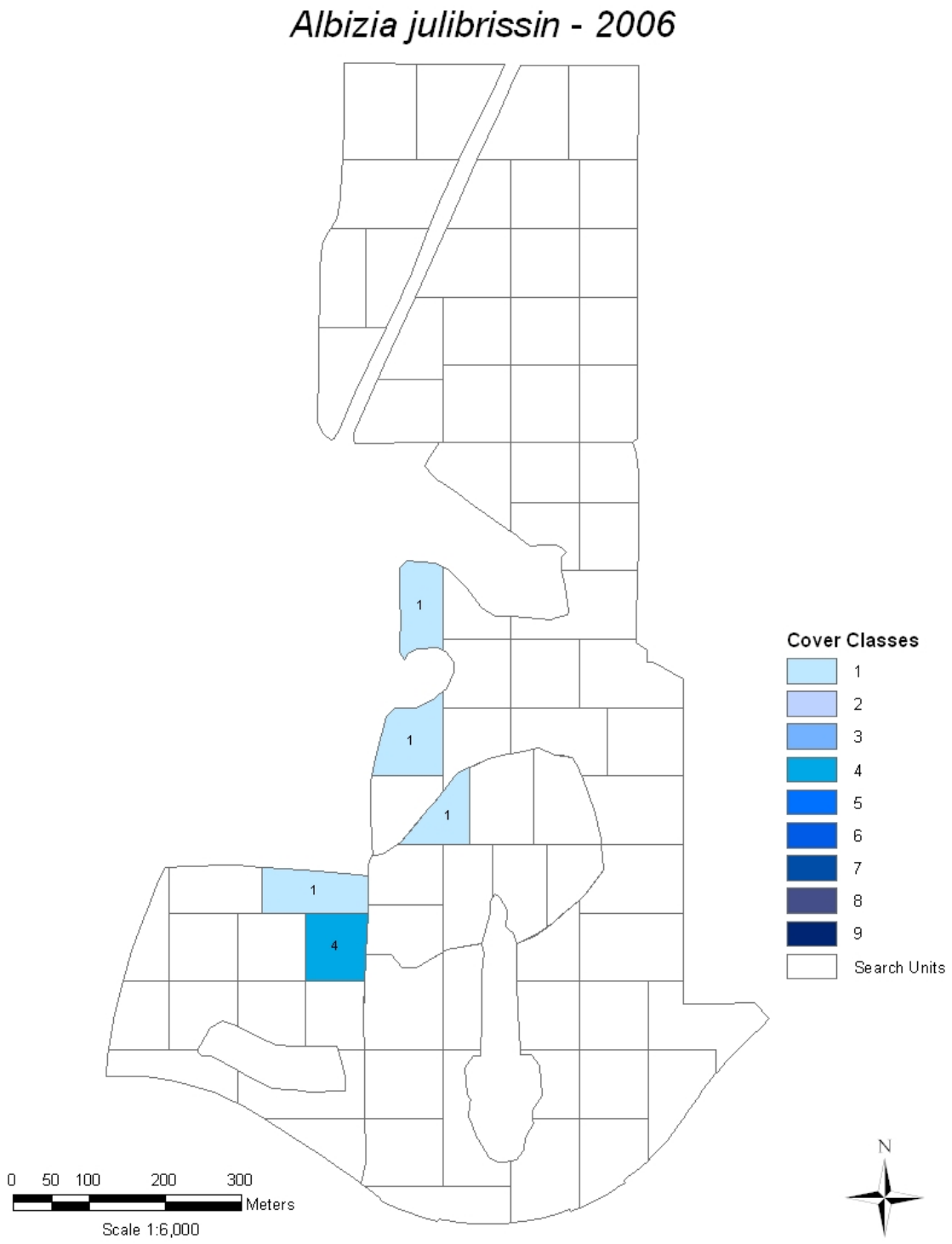

Figure 3. Abundance and distribution of *Albizia julibrissin* (silktree) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

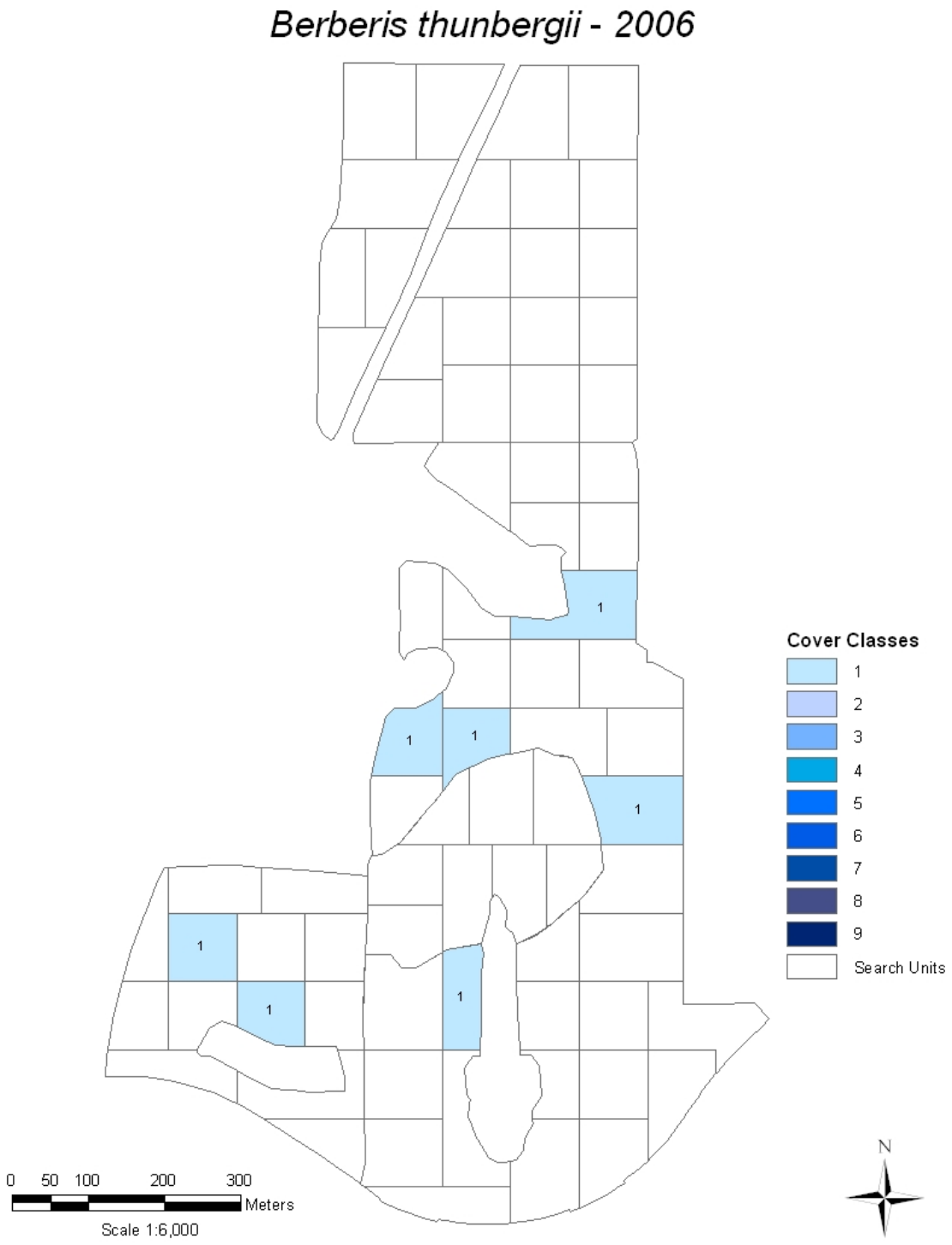

Figure 4. Abundance and distribution of *Berberis thunbergii* (Japanese barberry) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

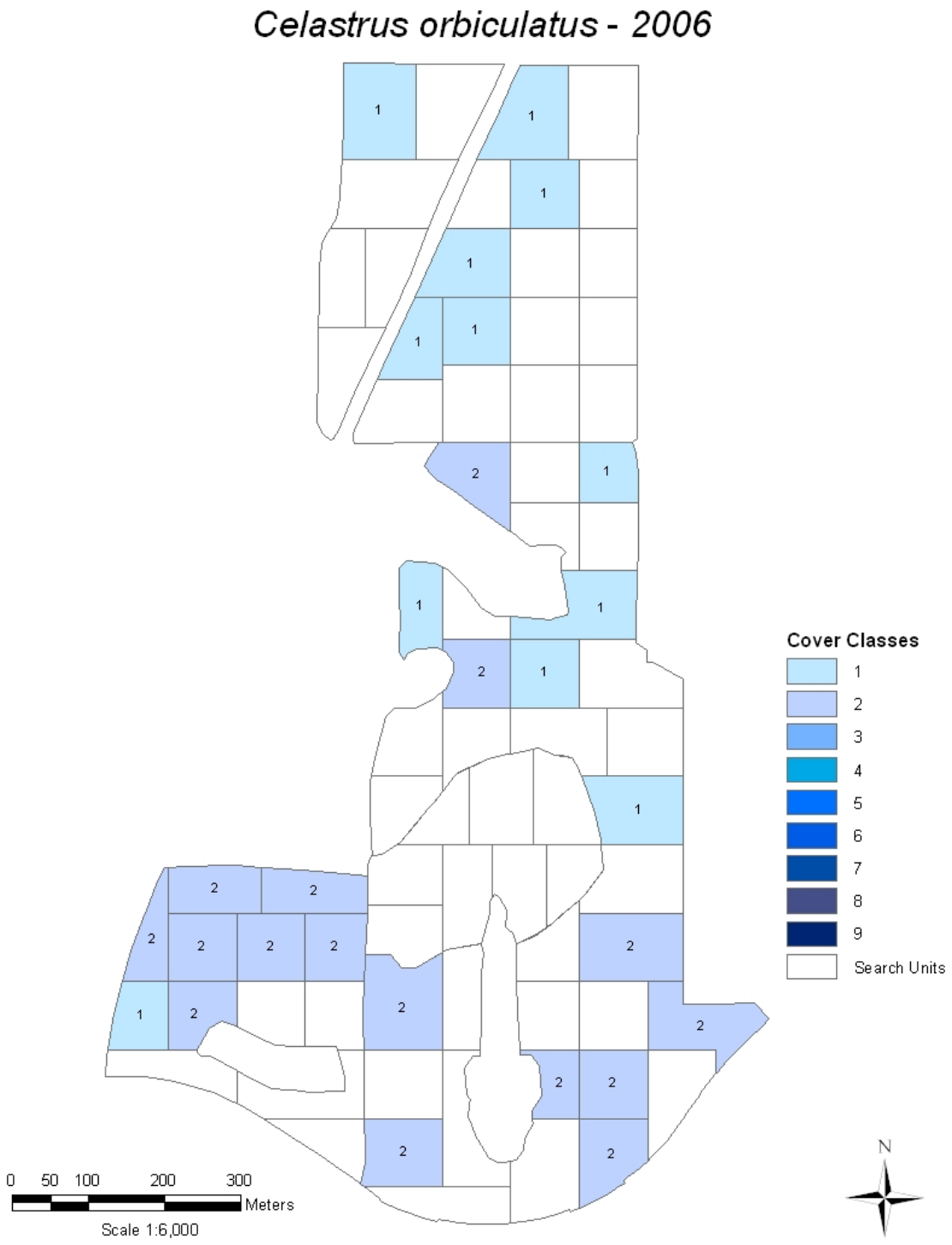

Figure 5. Abundance and distribution of *Celastrus orbiculatus* (oriental bittersweet) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

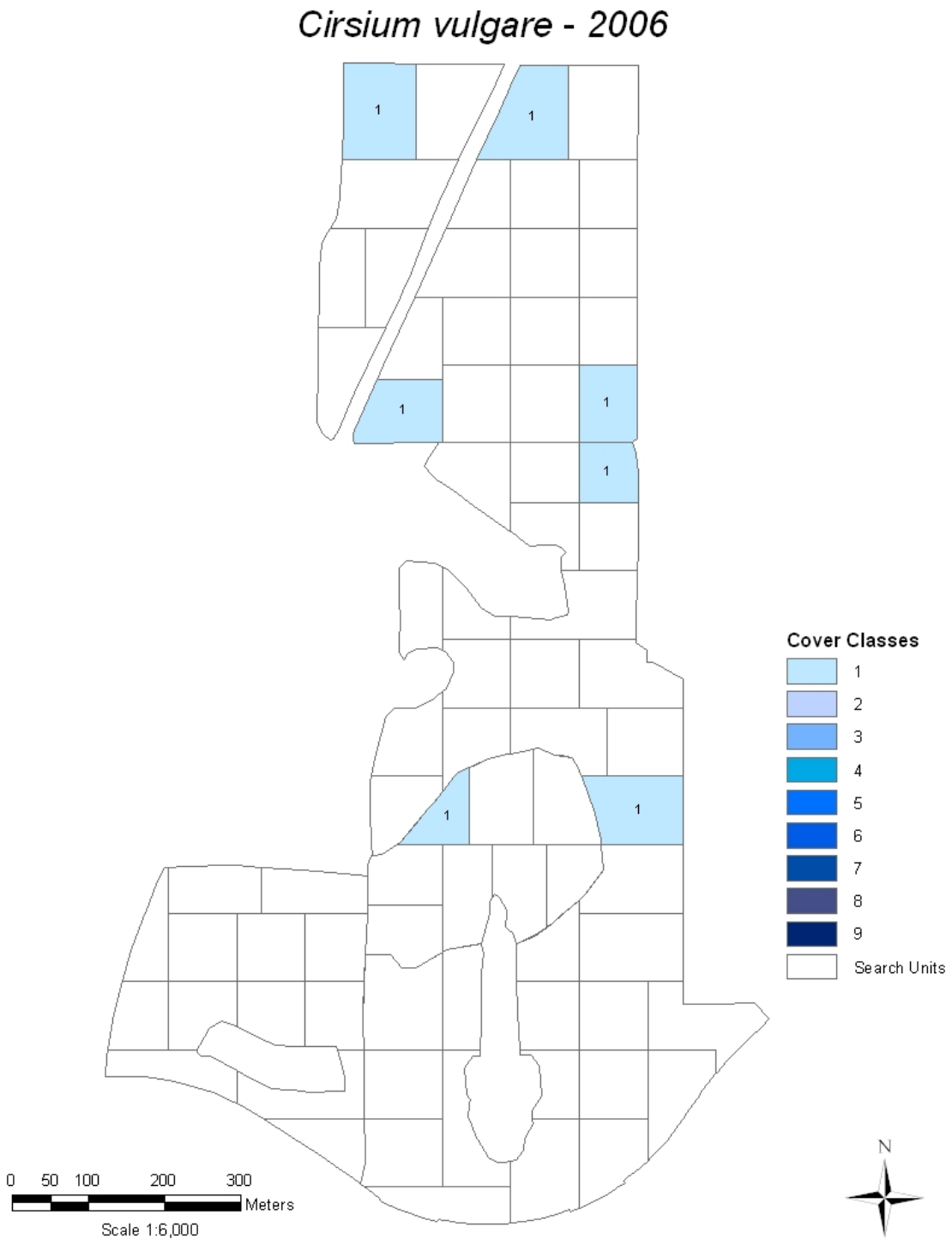

Figure 6. Abundance and distribution of *Cirsium vulgare* (bull thistle) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

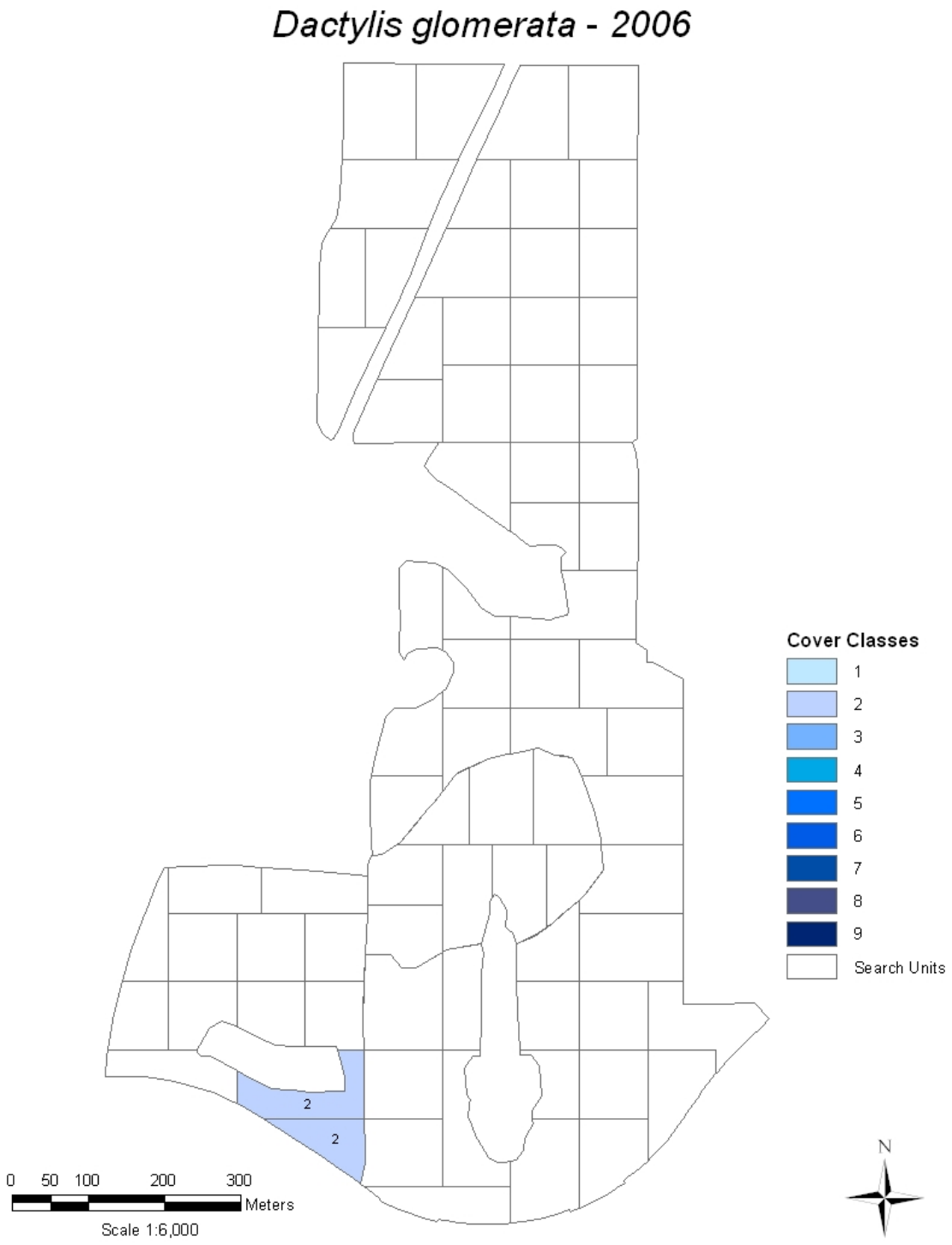

Figure 7. Abundance and distribution of *Dactylis glomerata* (orchardgrass) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

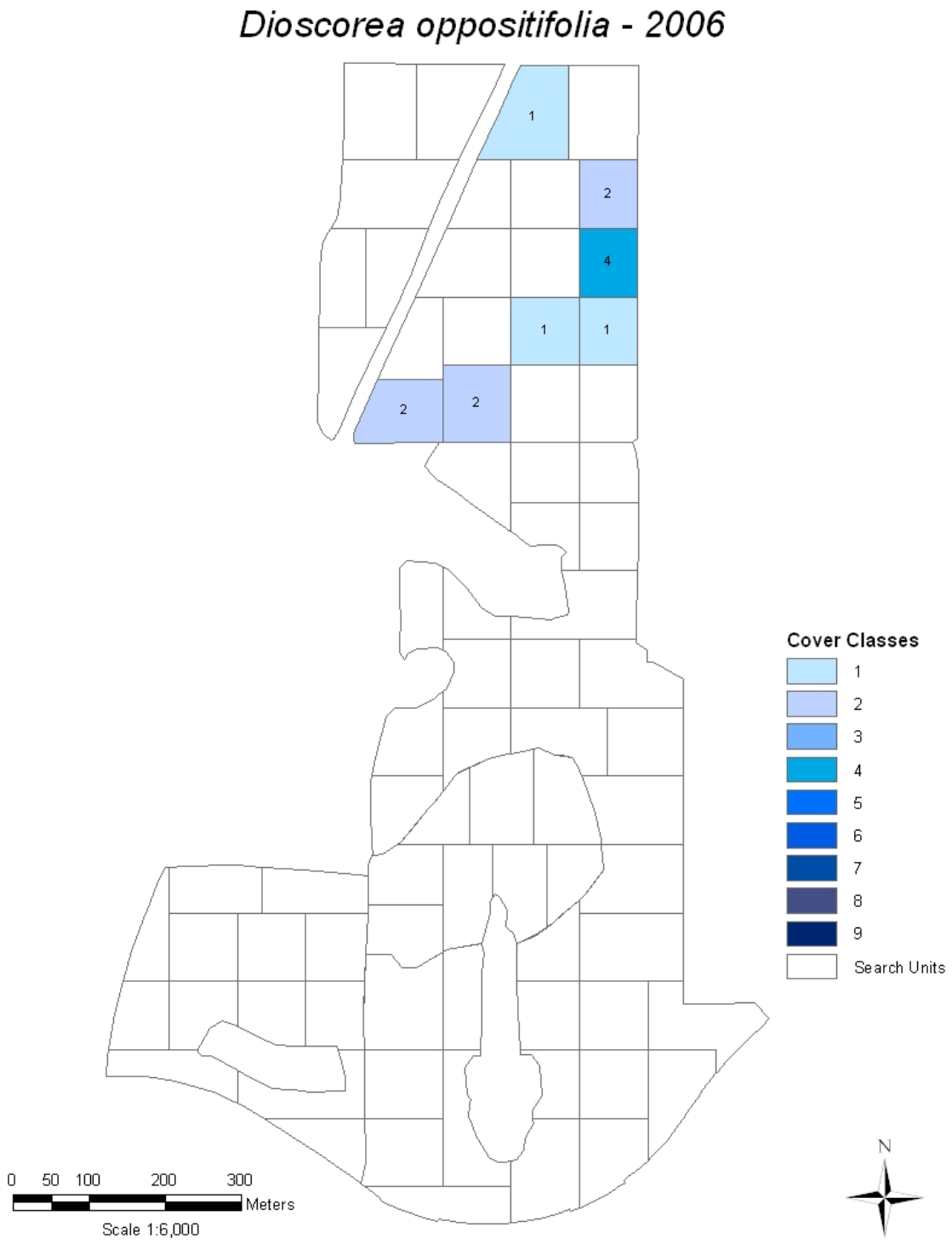

Figure 8. Abundance and distribution of *Dioscorea oppositifolia* (chinese yam) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

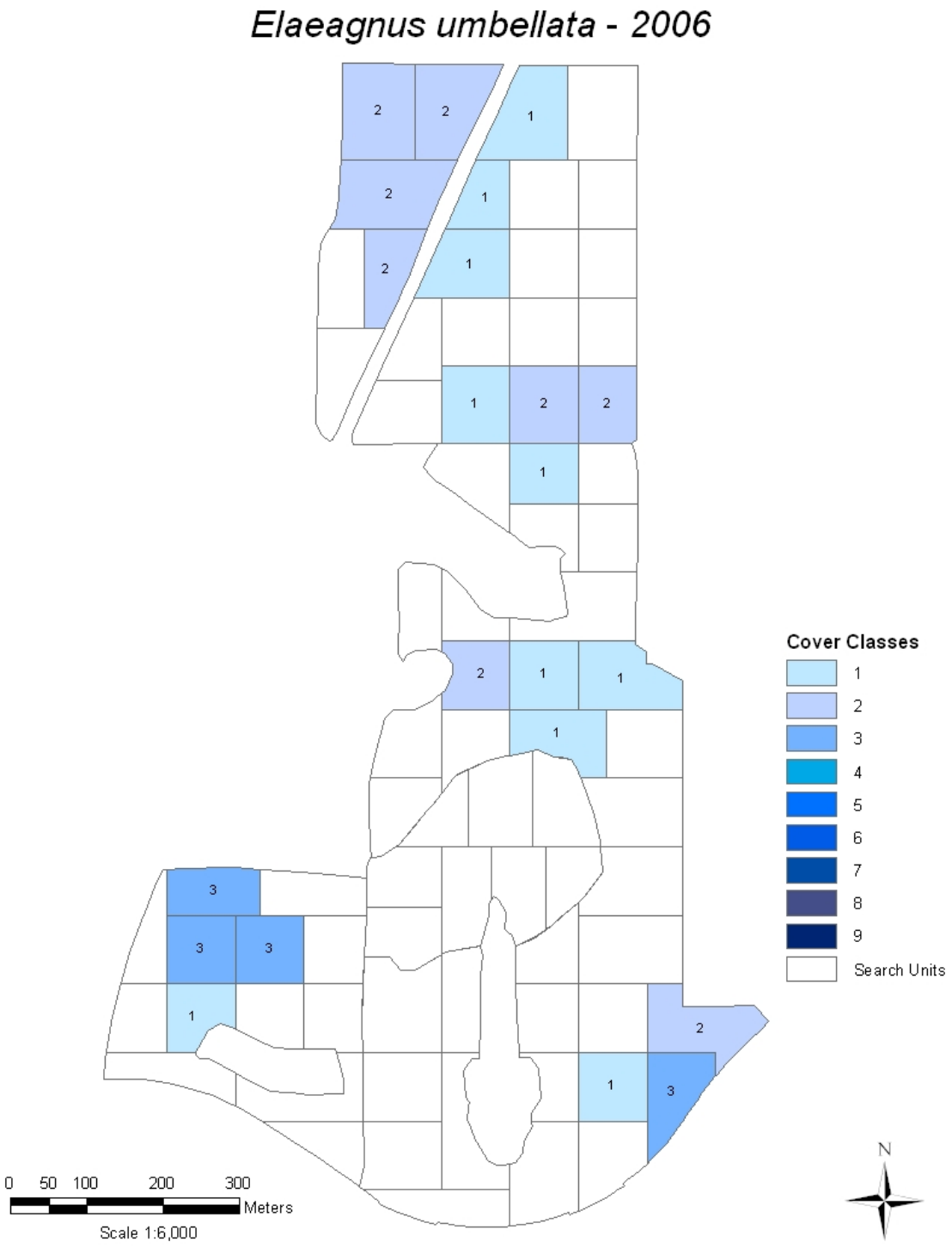

Figure 9. Abundance and distribution of *Elaeagnus umbellata* (autumn olive) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

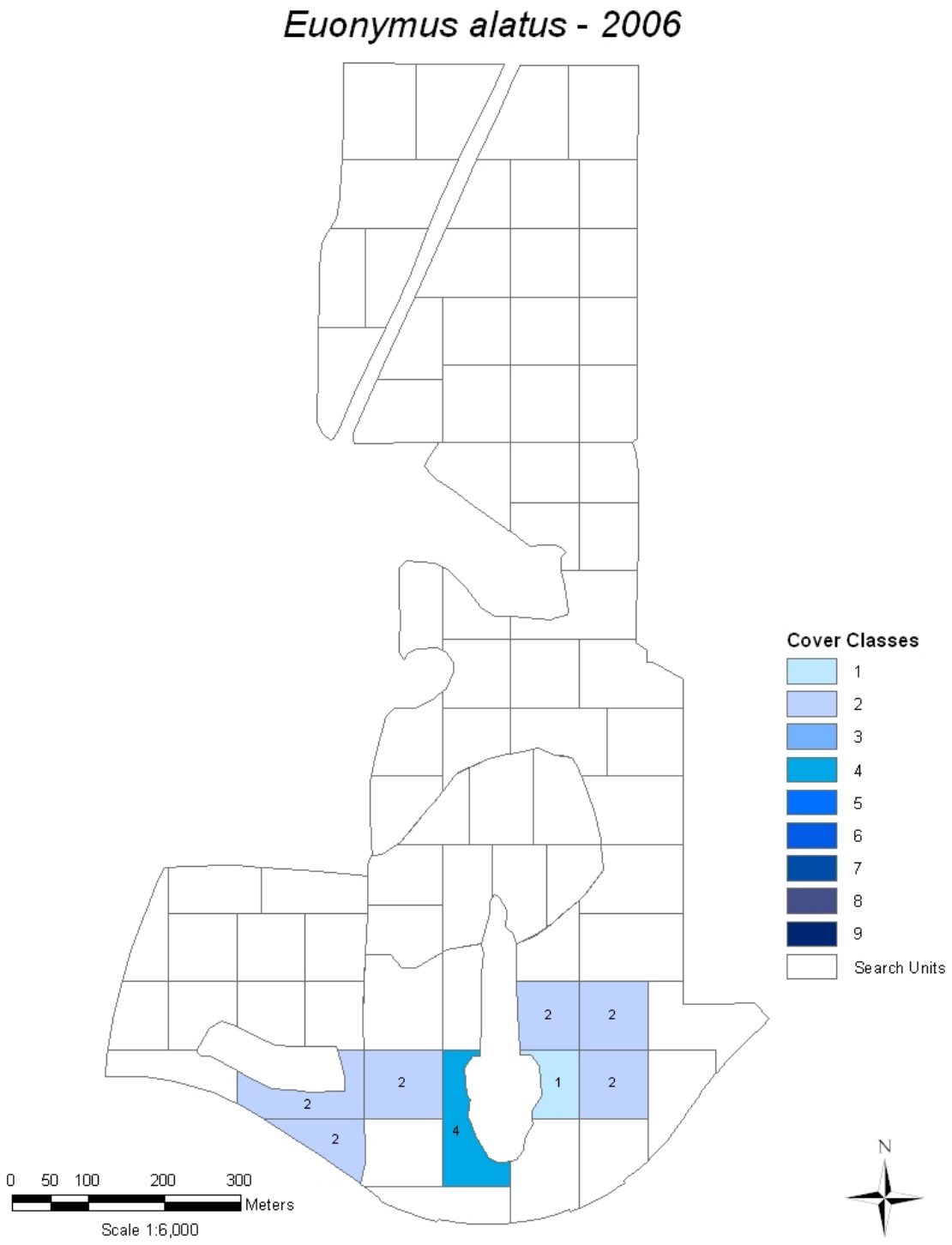

Figure 10. Abundance and distribution of *Euonymus alatus* (burningbush) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

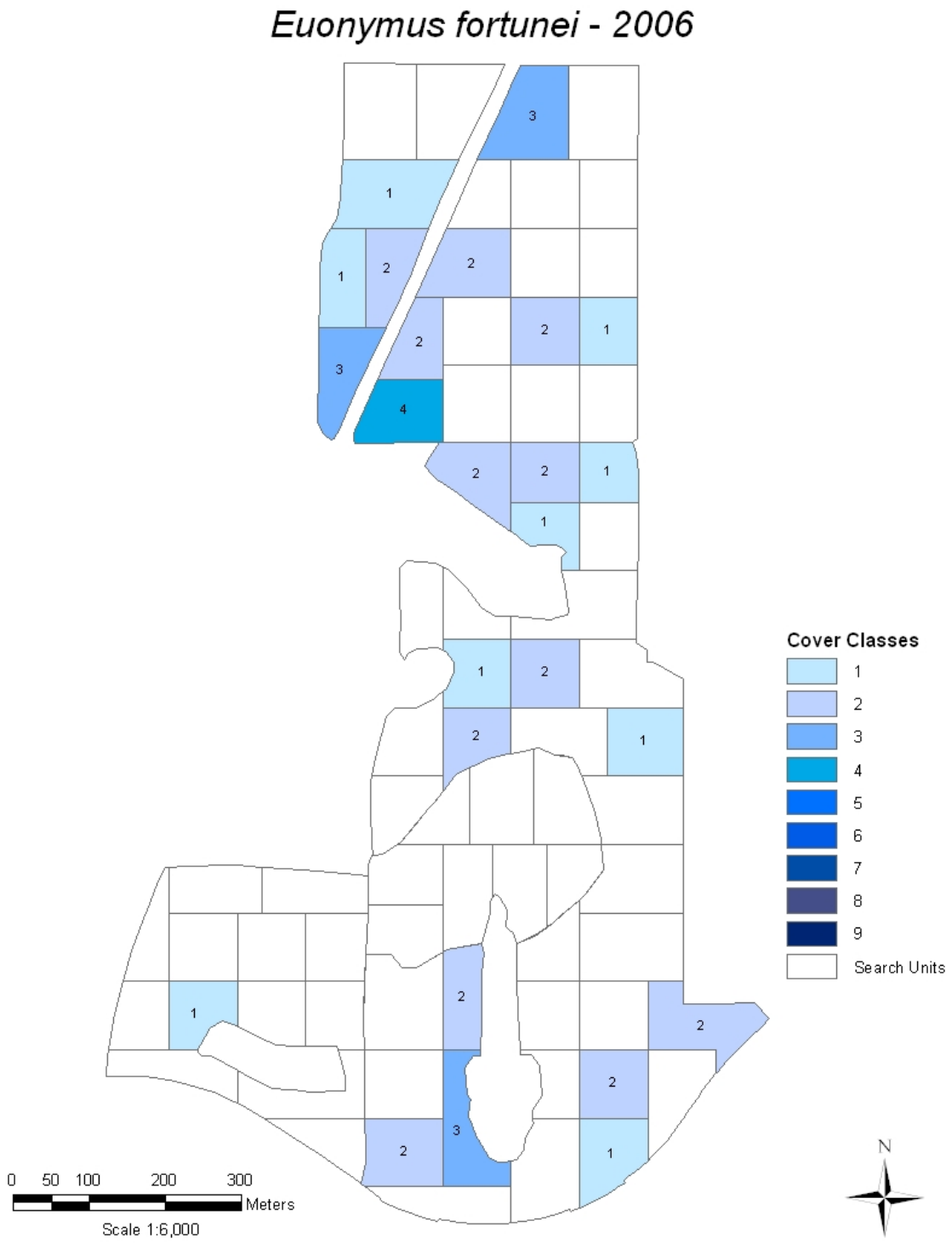

Figure 11. Abundance and distribution of *Euonymus fortunei* (winter creeper) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

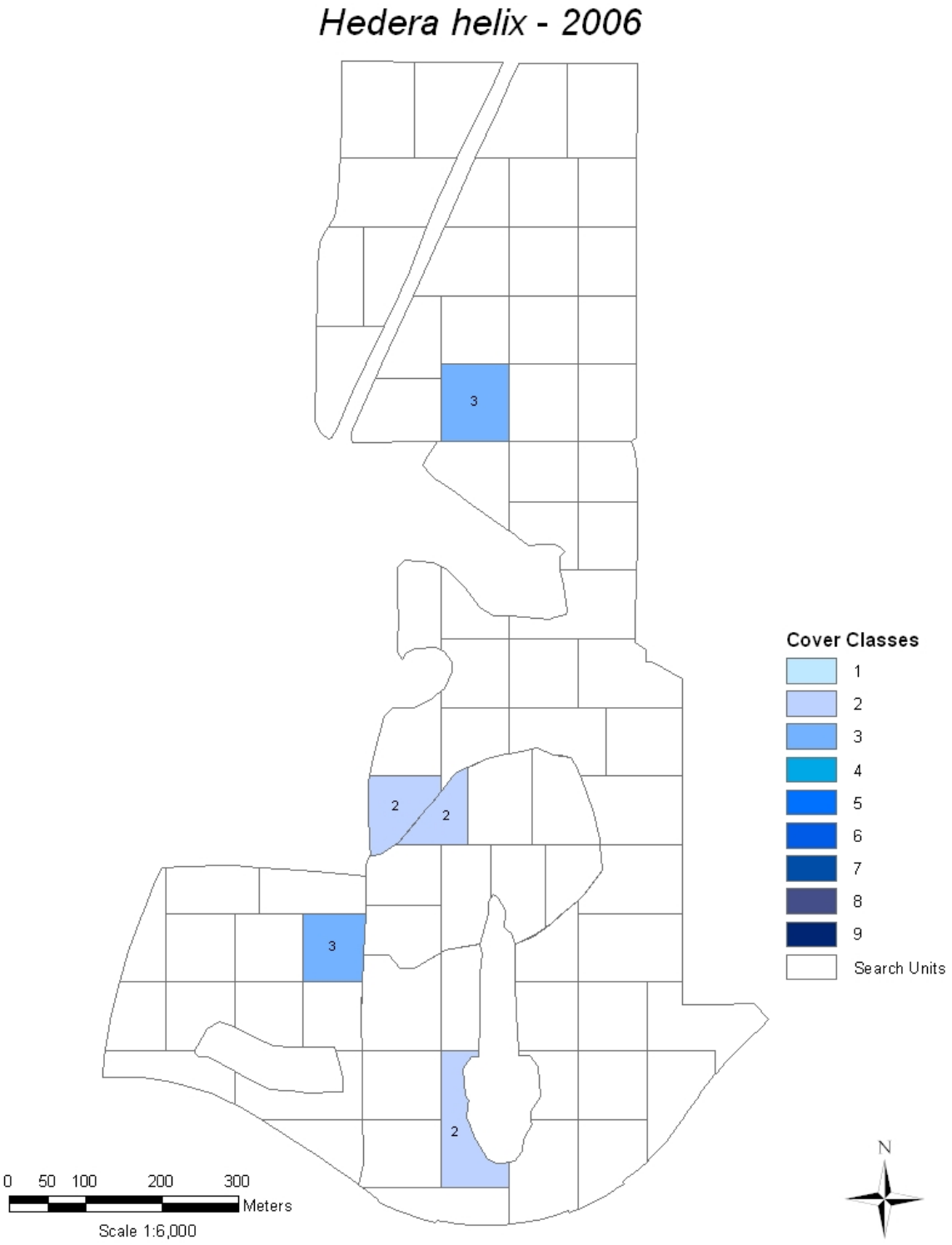

Figure 12. Abundance and distribution of *Hedera helix* (English ivy) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

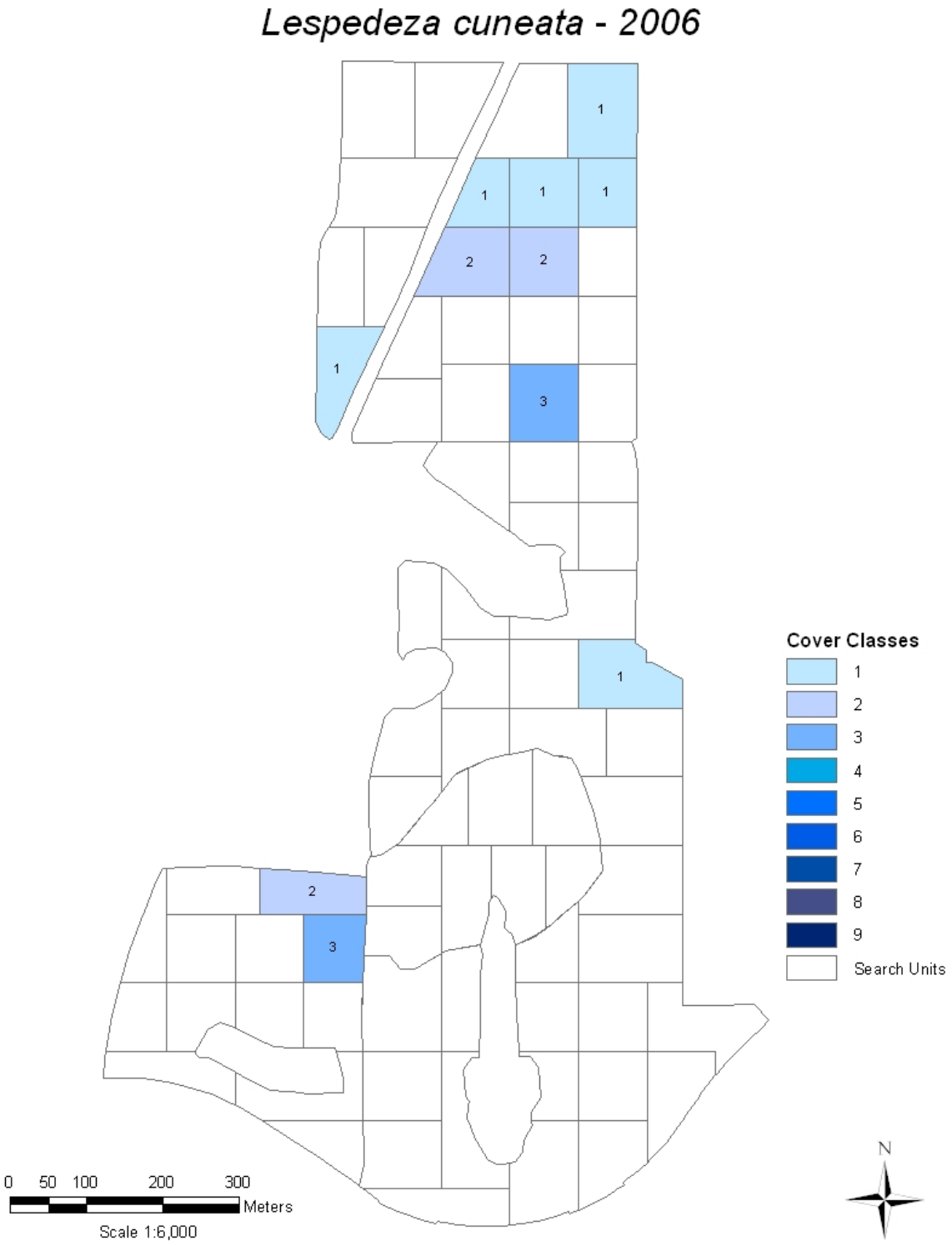

Figure 13. Abundance and distribution of *Lespedeza cuneata* (sericea lespedeza) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

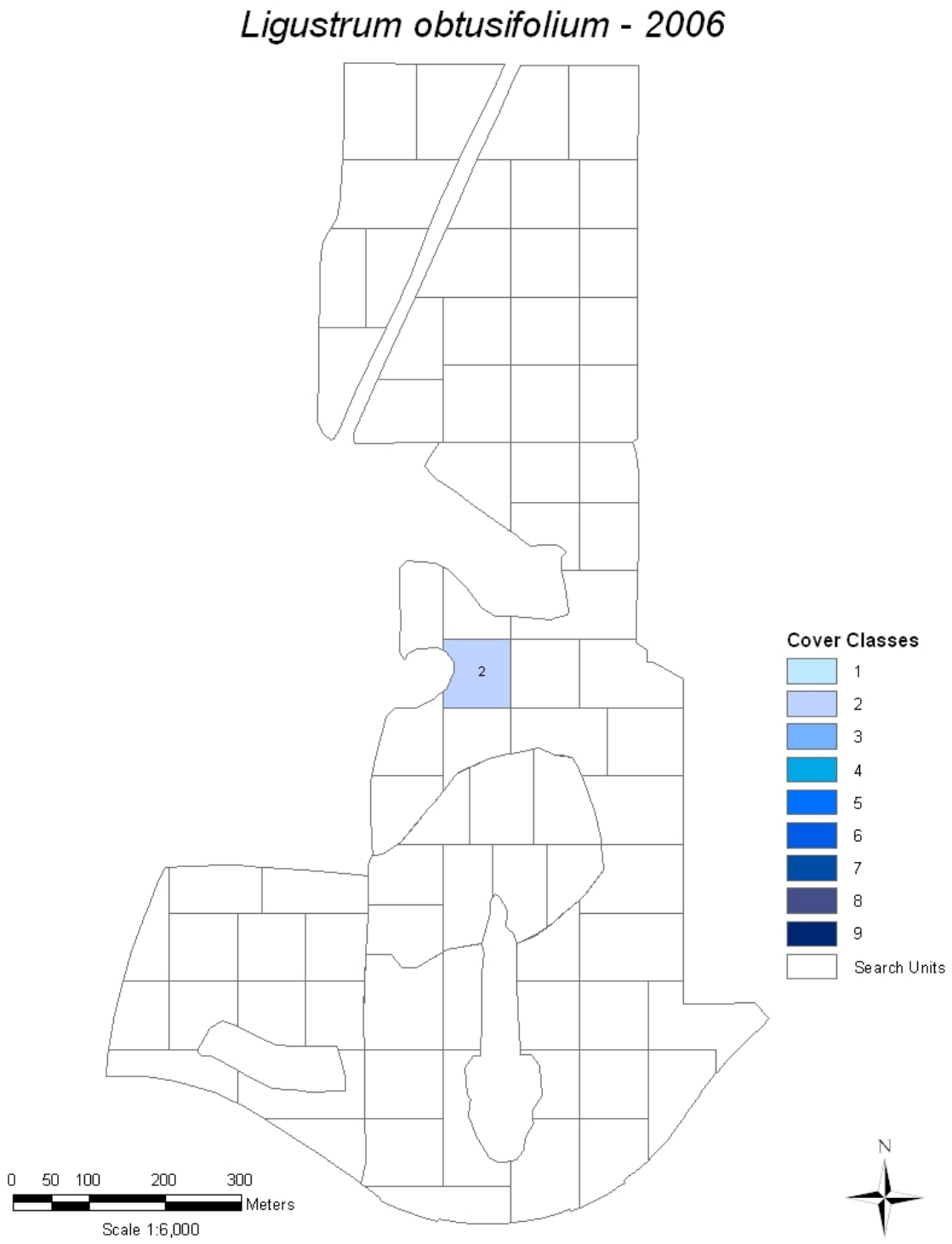

Figure 14. Abundance and distribution of *Ligustrum obtusifolium* (border privet) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

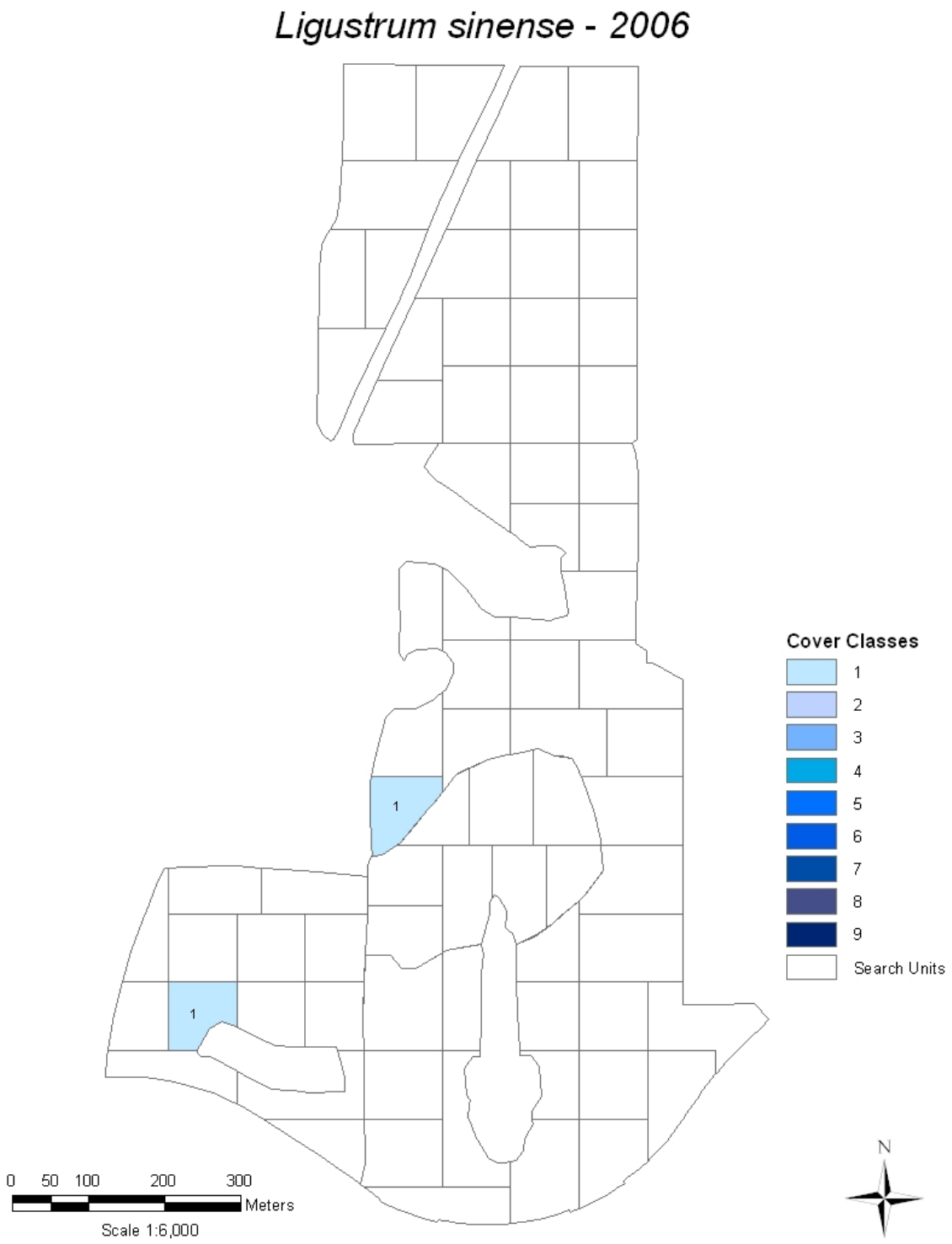

Figure 15. Abundance and distribution of *Ligustrum sinense* (chinese privet) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

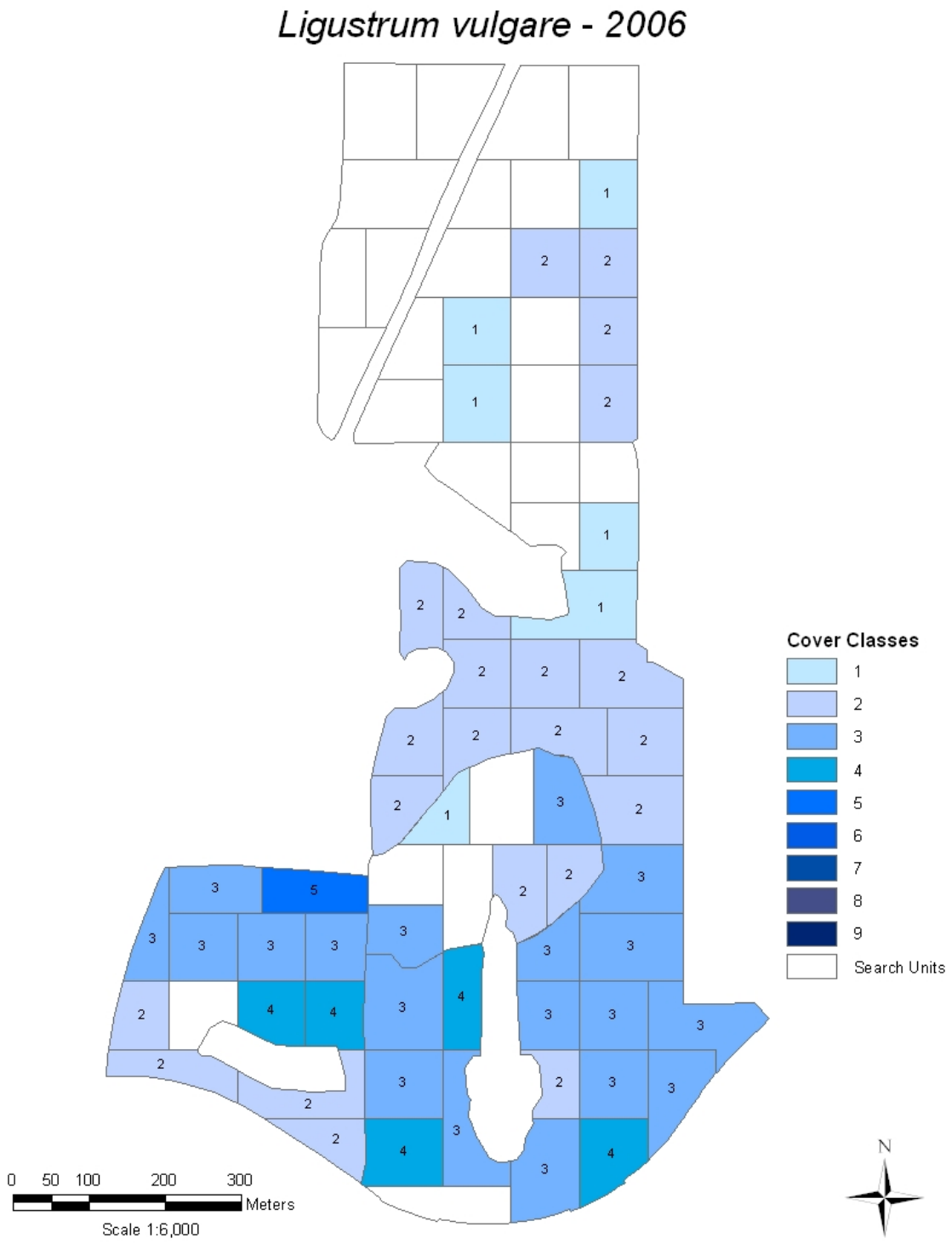

Figure 16. Abundance and distribution of *Ligustrum vulgare* (european privet) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

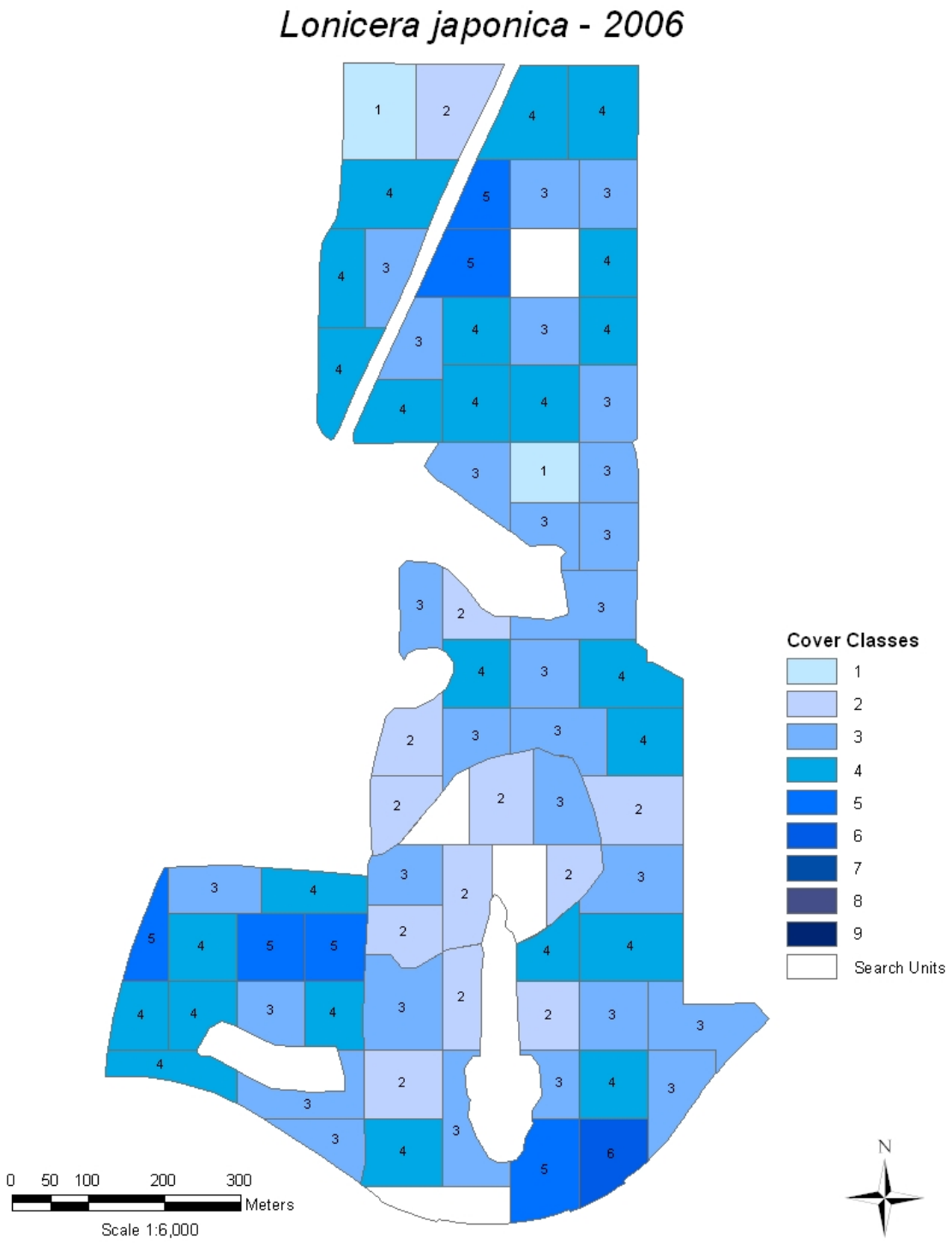

Figure 17. Abundance and distribution of *Lonicera japonica* (Japanese honeysuckle) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

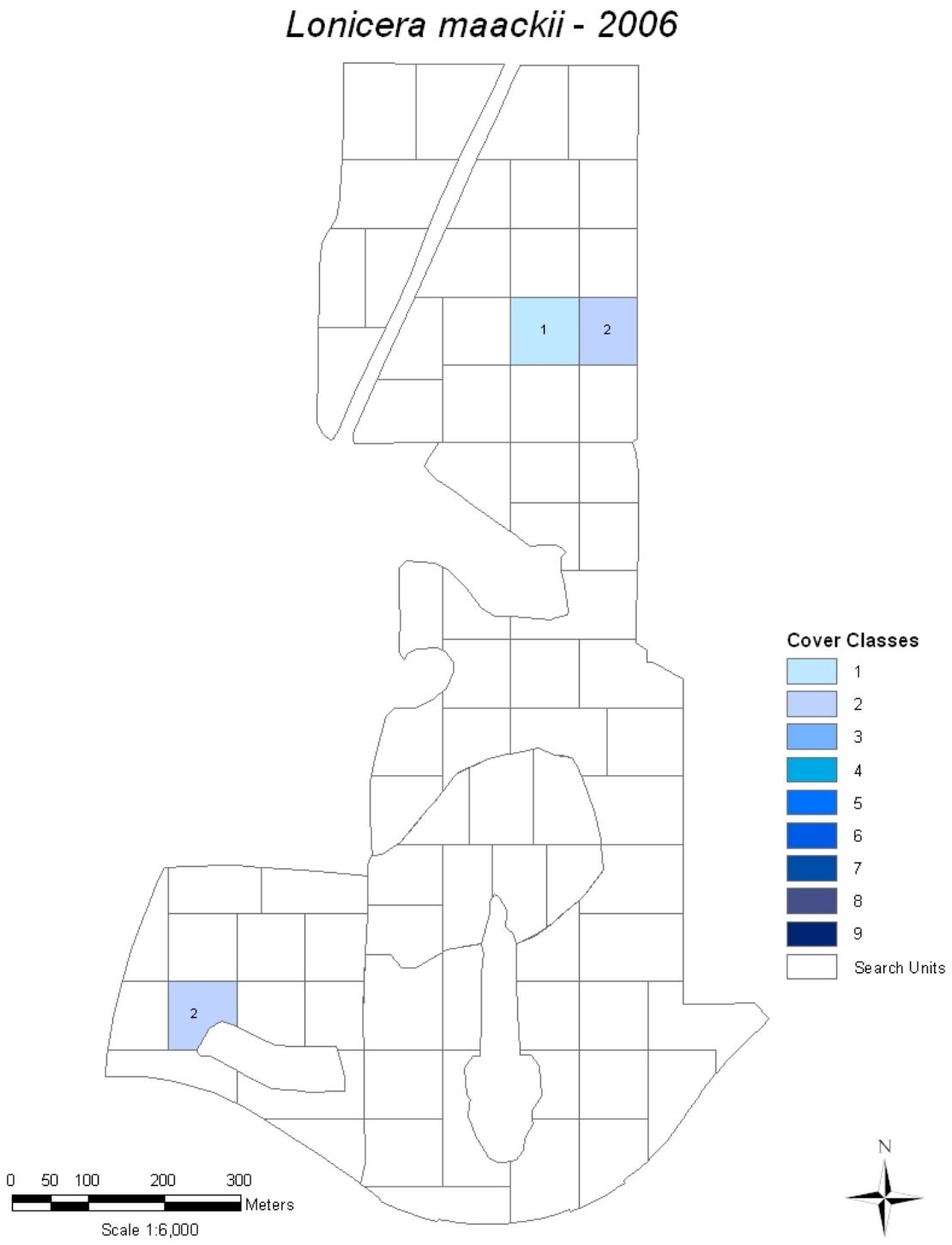

Figure 18. Abundance and distribution of *Lonicera maackii* (amur honeysuckle) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

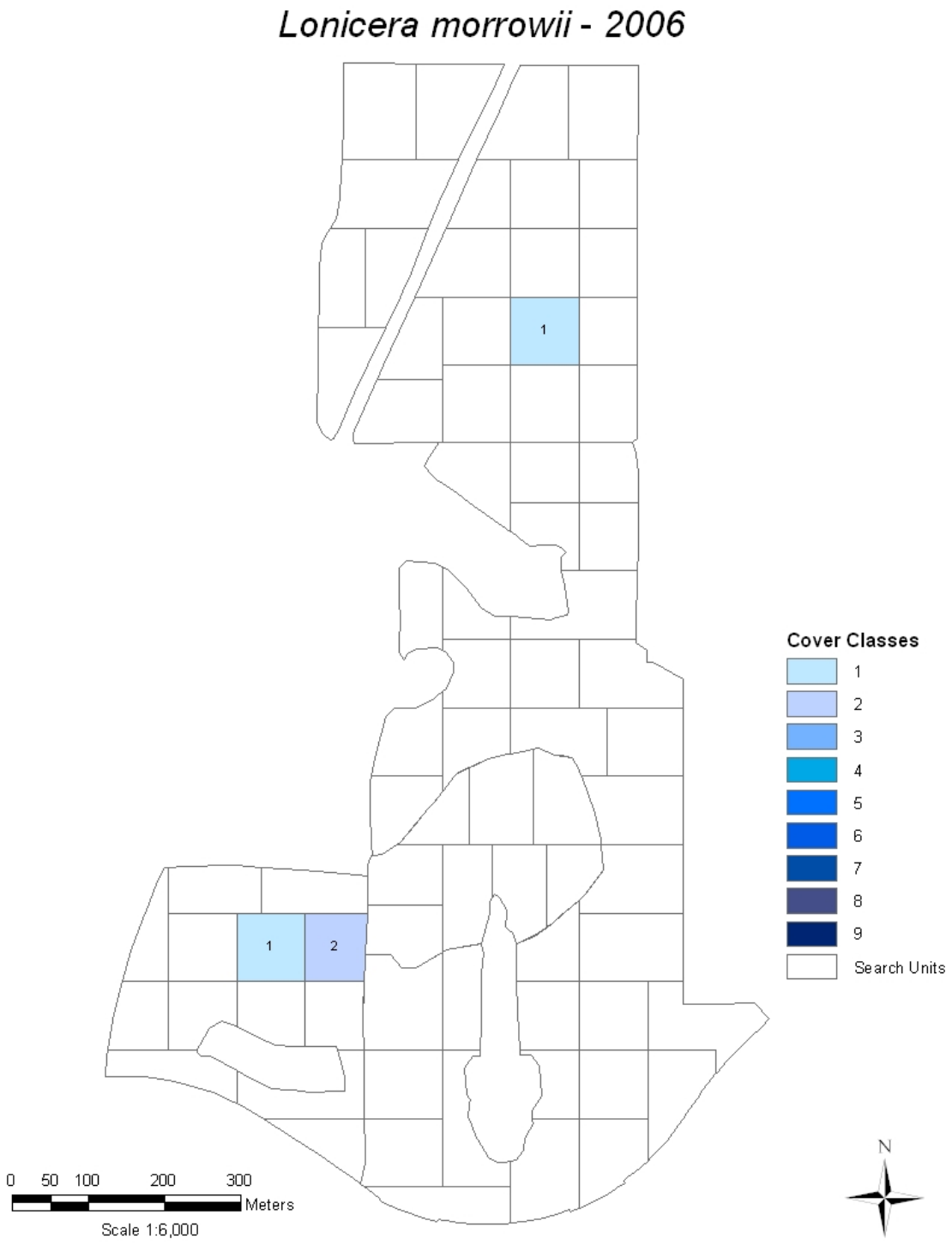

Figure 19. Abundance and distribution of *Lonicera morrowii* (morrow's honeysuckle) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

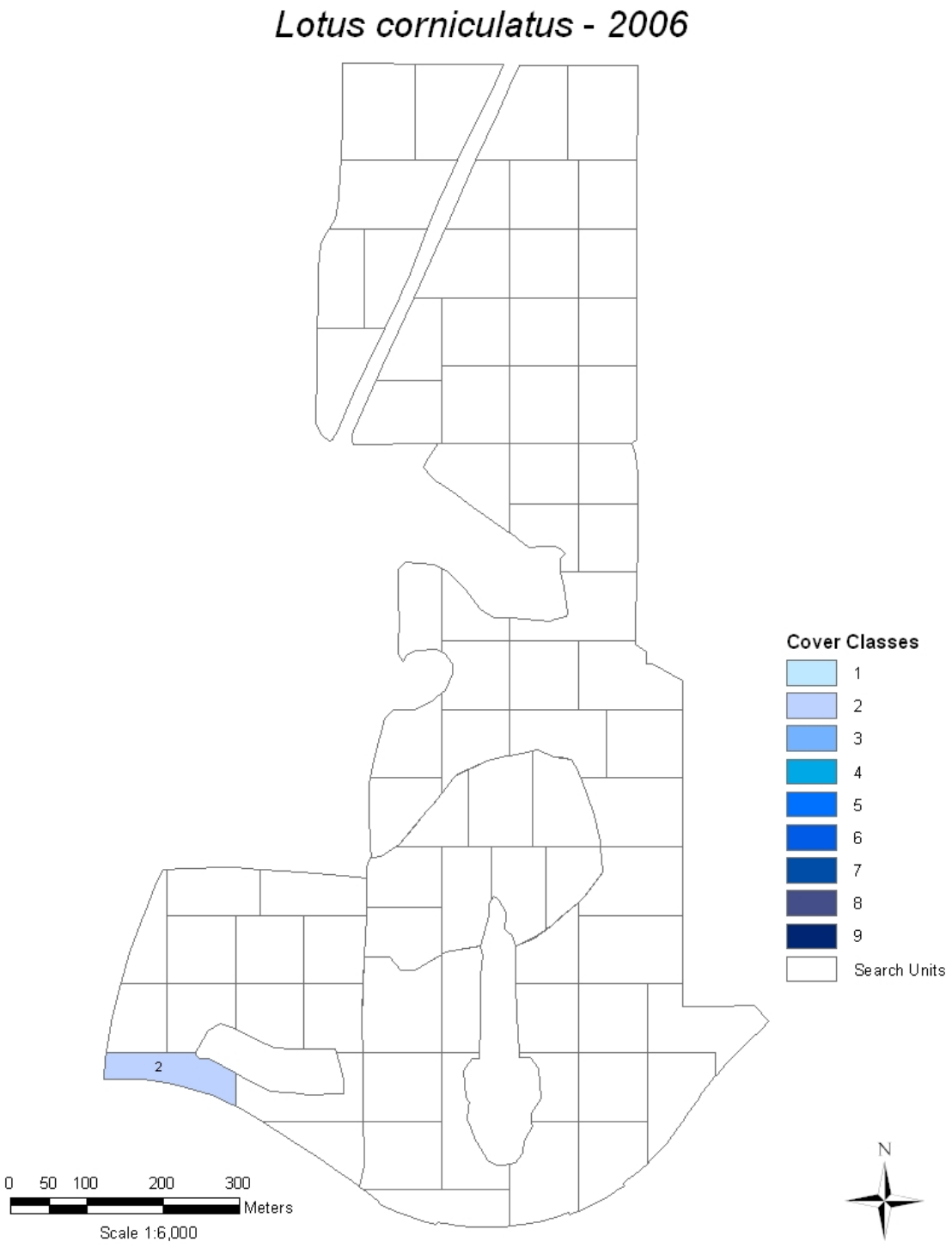

Figure 20. Abundance and distribution of *Lotus corniculatus* (bird's-foot trefoil) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

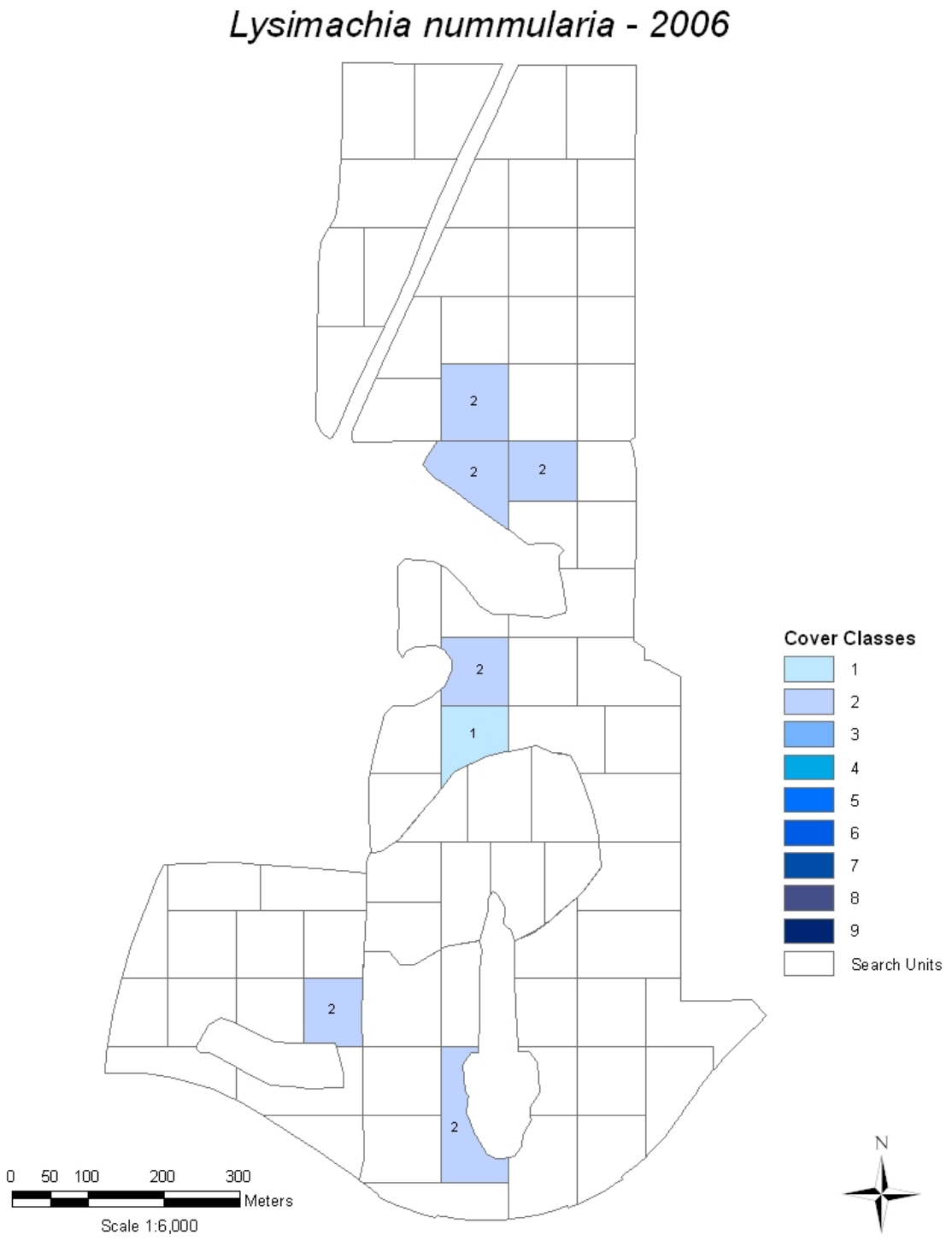

Figure 21. Abundance and distribution of *Lysimachia nummularia* (creeping jenny) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

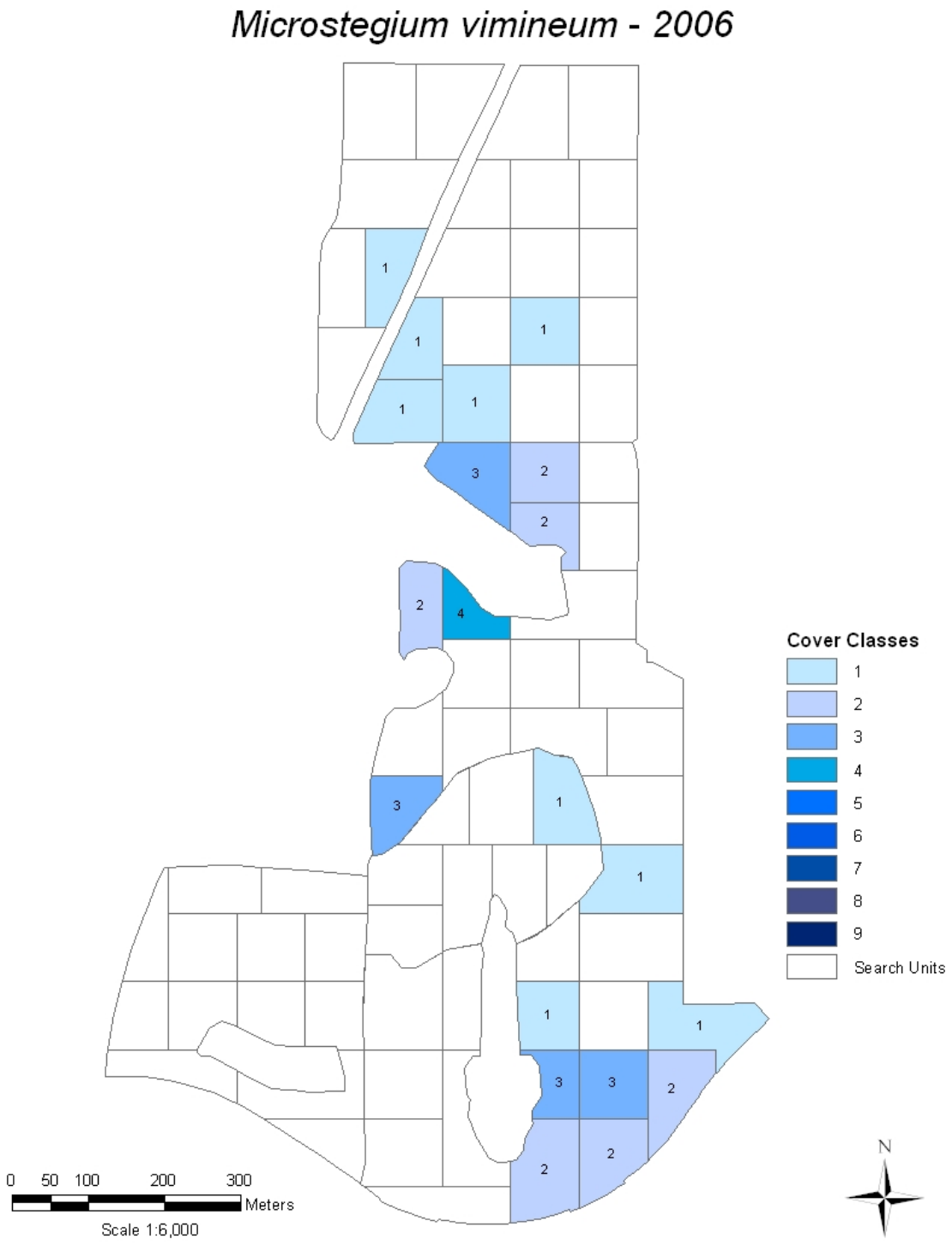

Figure 22. Abundance and distribution of *Microstegium vimineum* (nepalese browntop) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

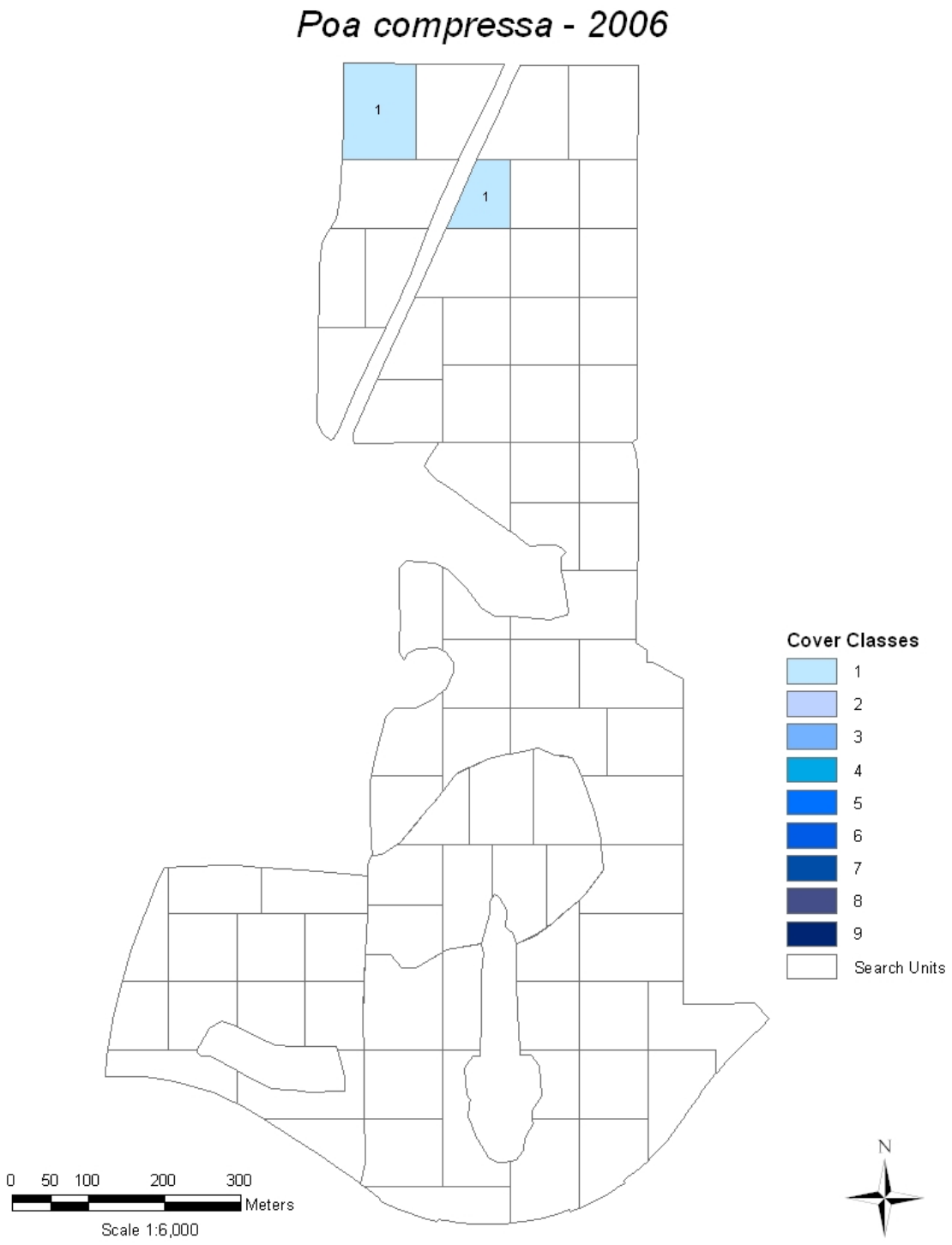

Figure 23. Abundance and distribution of *Poa compressa* (Canada bluegrass) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

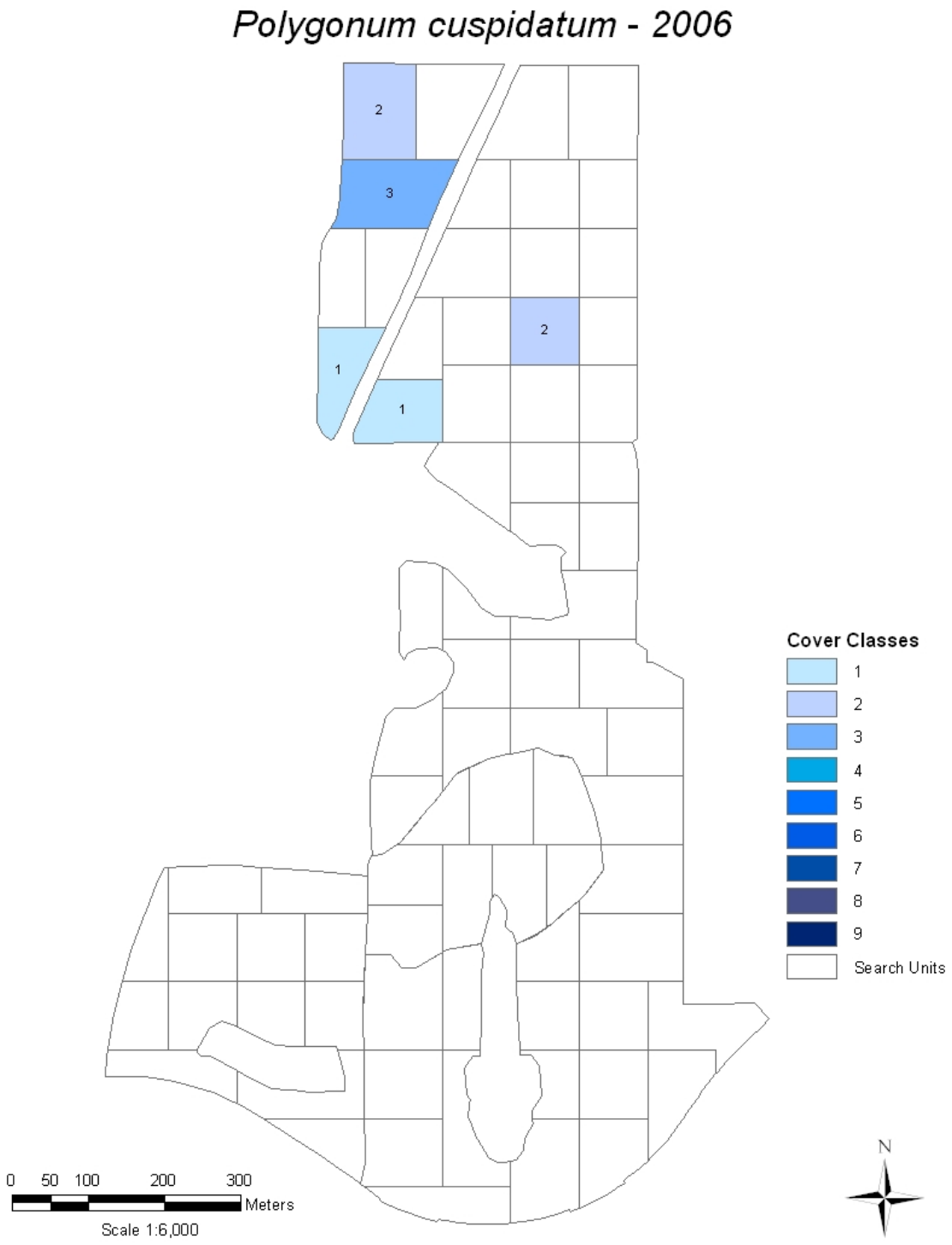

Figure 24. Abundance and distribution of *Polygonum cuspidatum* (japanese knotweed) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

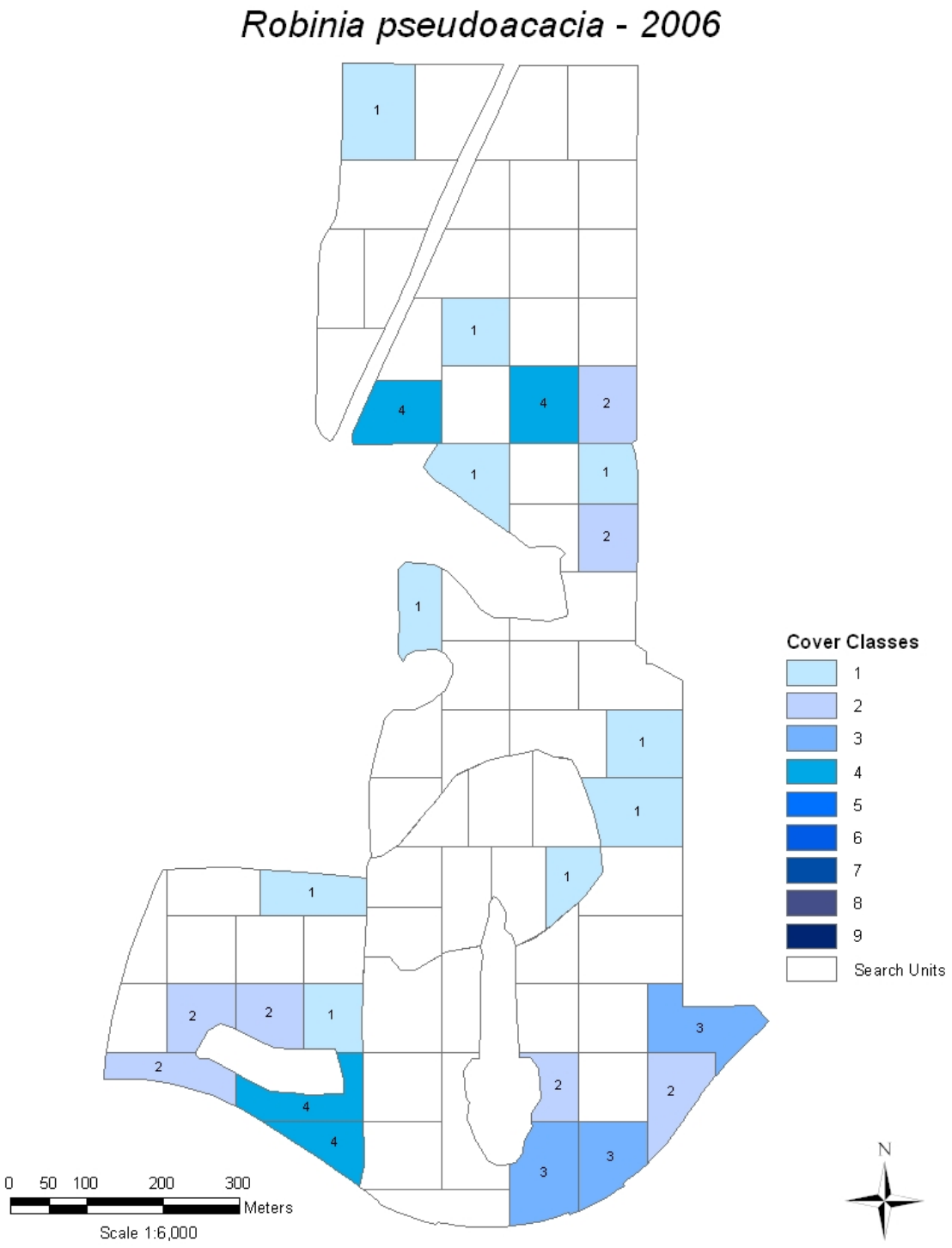

Figure 25. Abundance and distribution of *Robinia pseudoacacia* (black locust) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

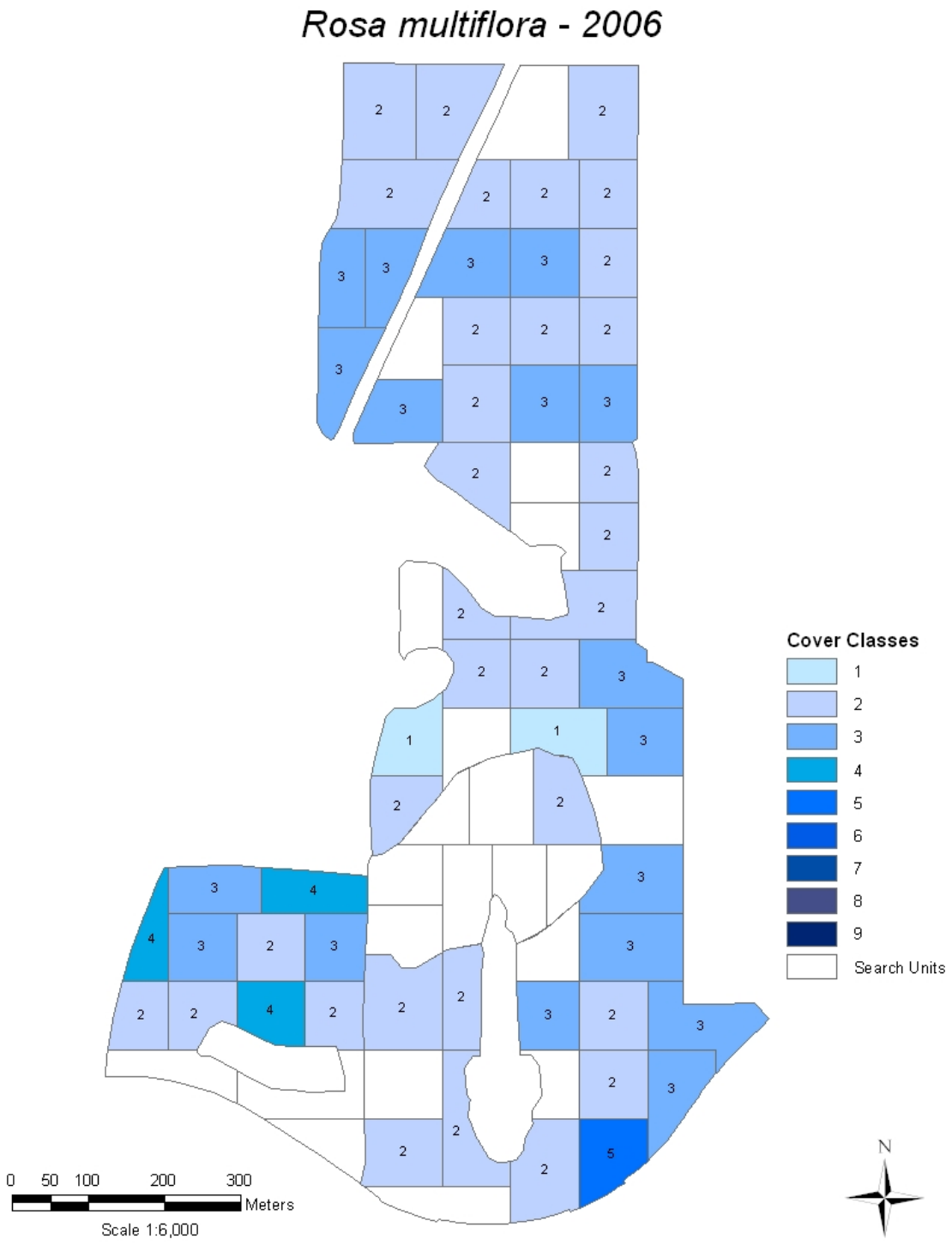

Figure 26. Abundance and distribution of *Rosa multiflora* (multiflora rose) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

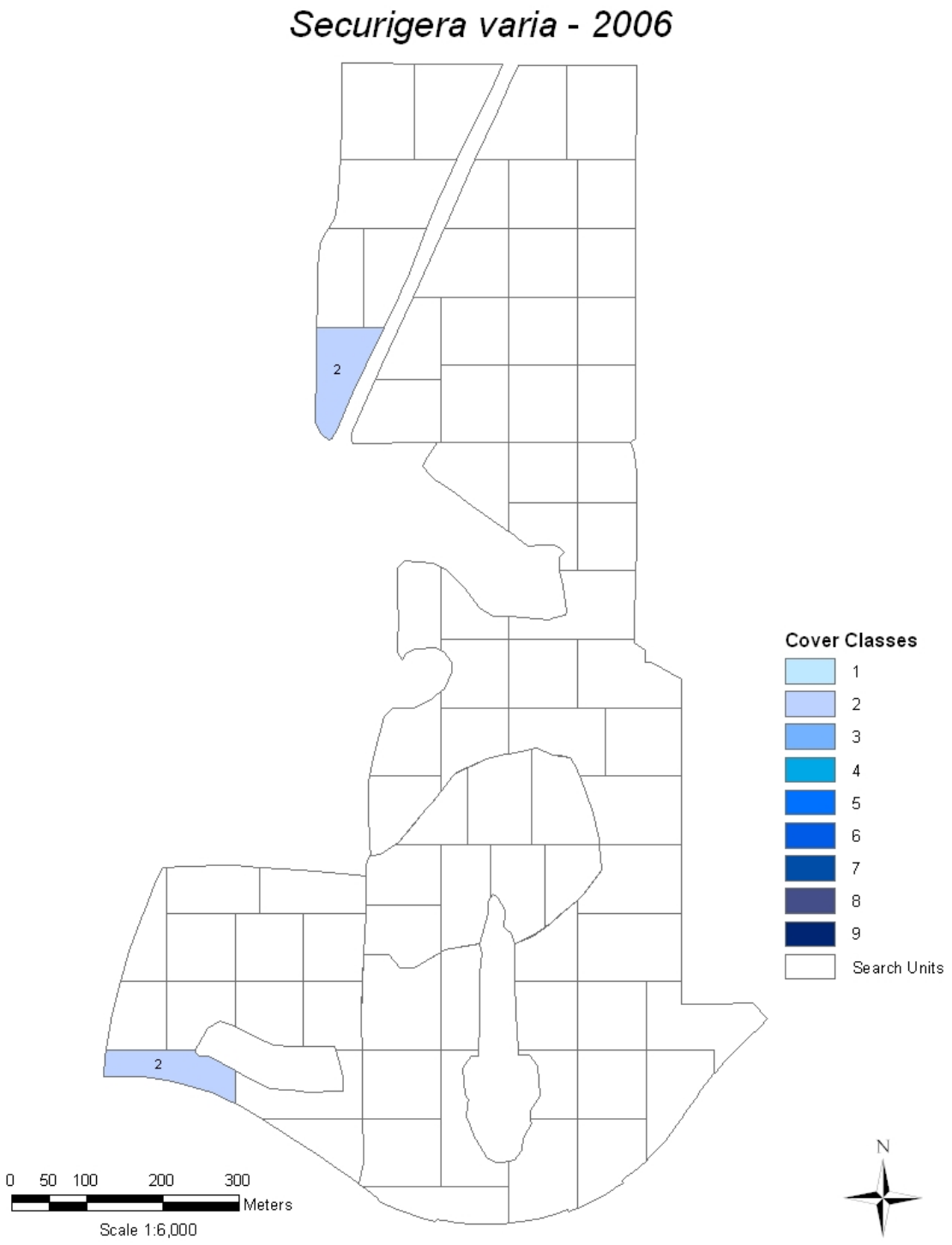

Figure 27. Abundance and distribution of *Securigera varia* (crownvetch) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

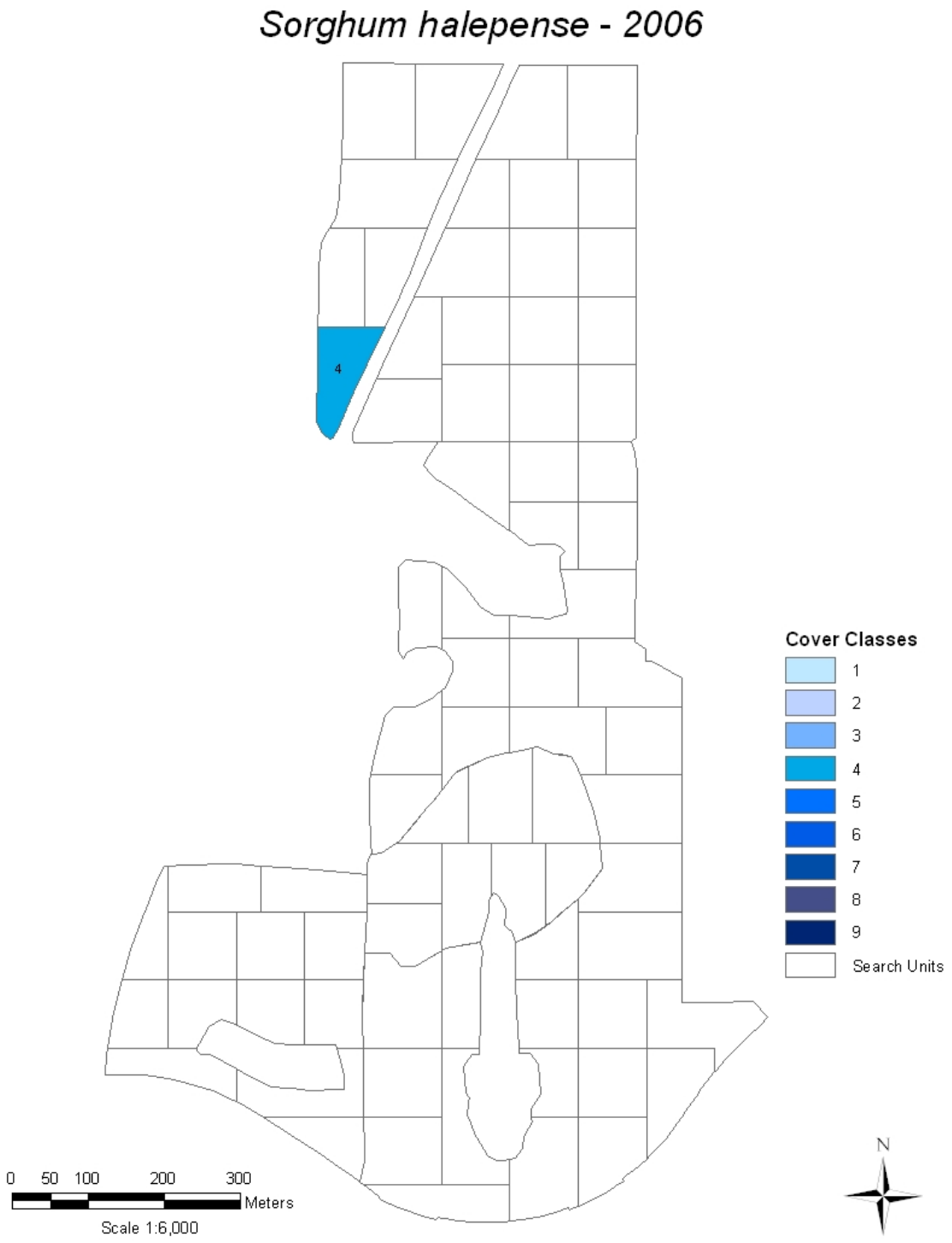

Figure 28. Abundance and distribution of *Sorghum halepense* (Johnsongrass) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

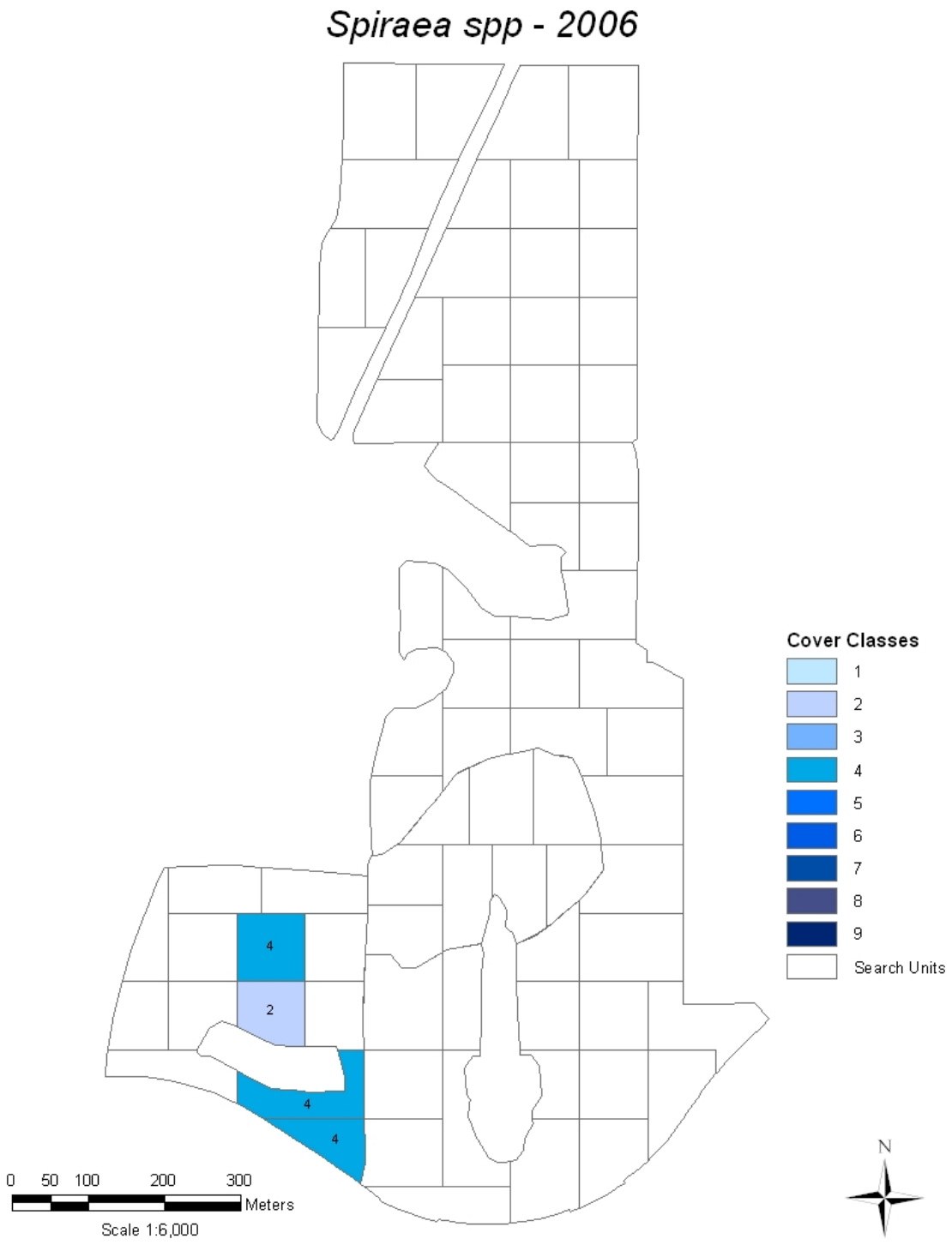

Figure 29. Abundance and distribution of *Spiraea spp* (meadowsweet) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

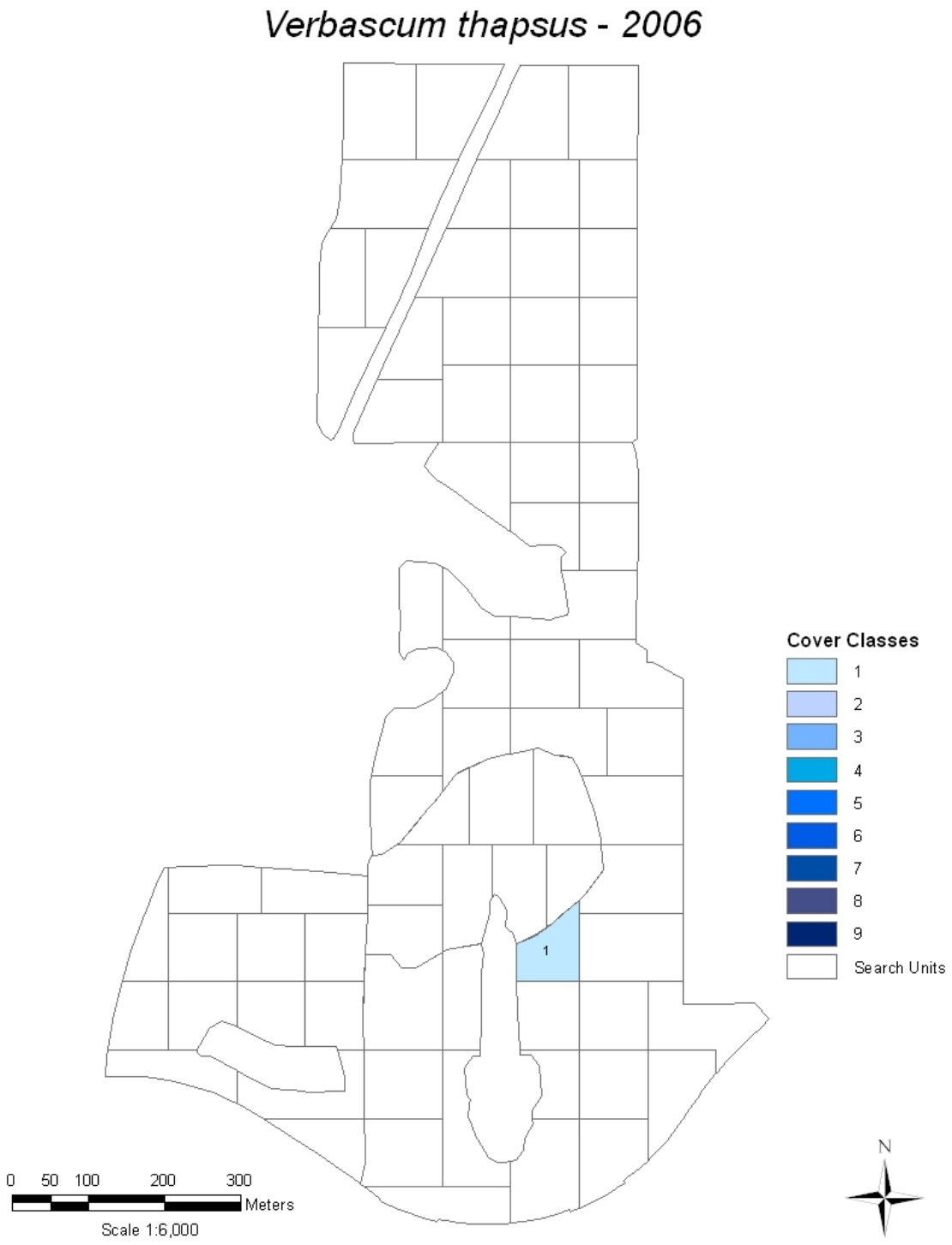

Figure 30. Abundance and distribution of *Verbascum thapsus* (common mullein) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

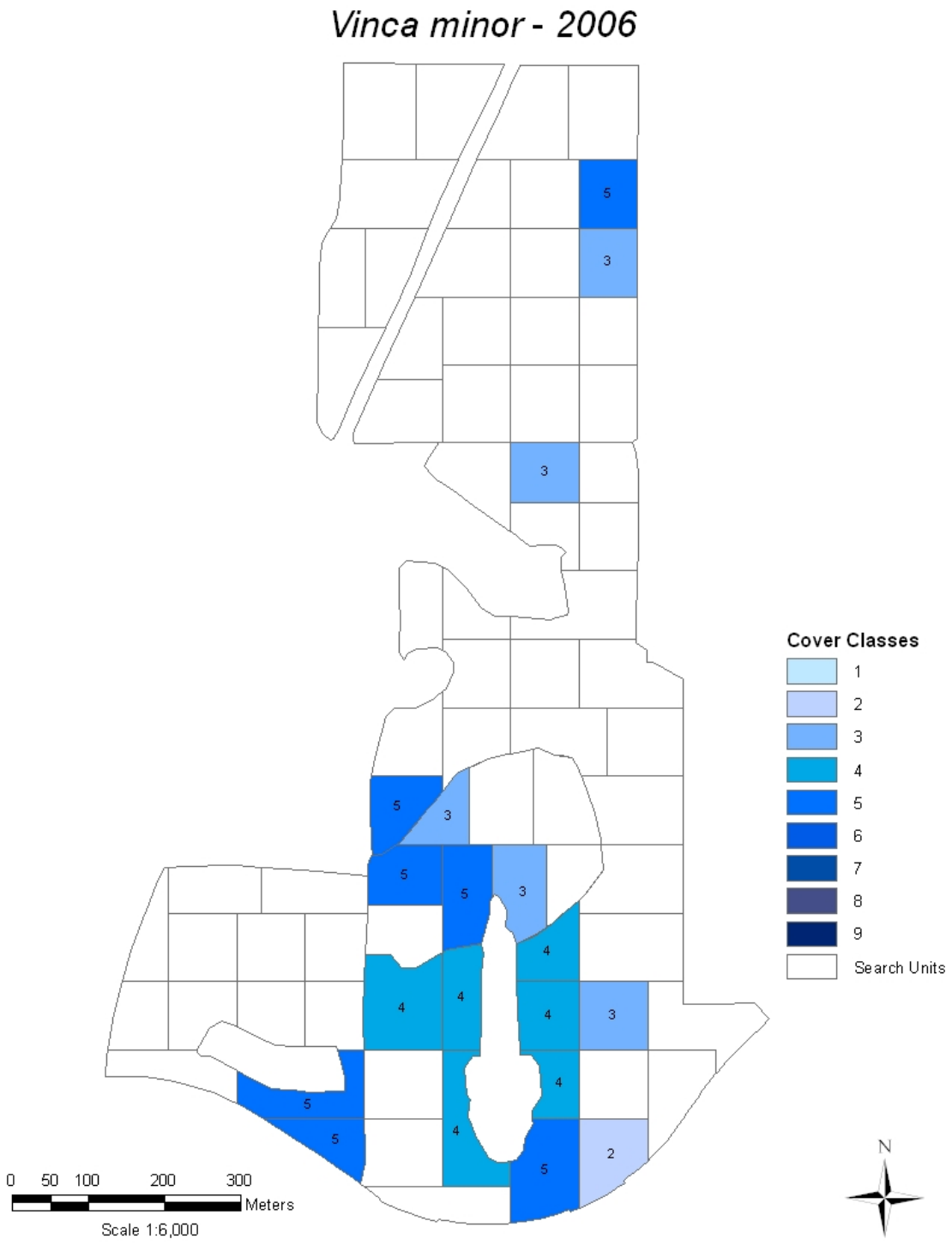

Figure 31. Abundance and distribution of *Vinca minor* (common periwinkle) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

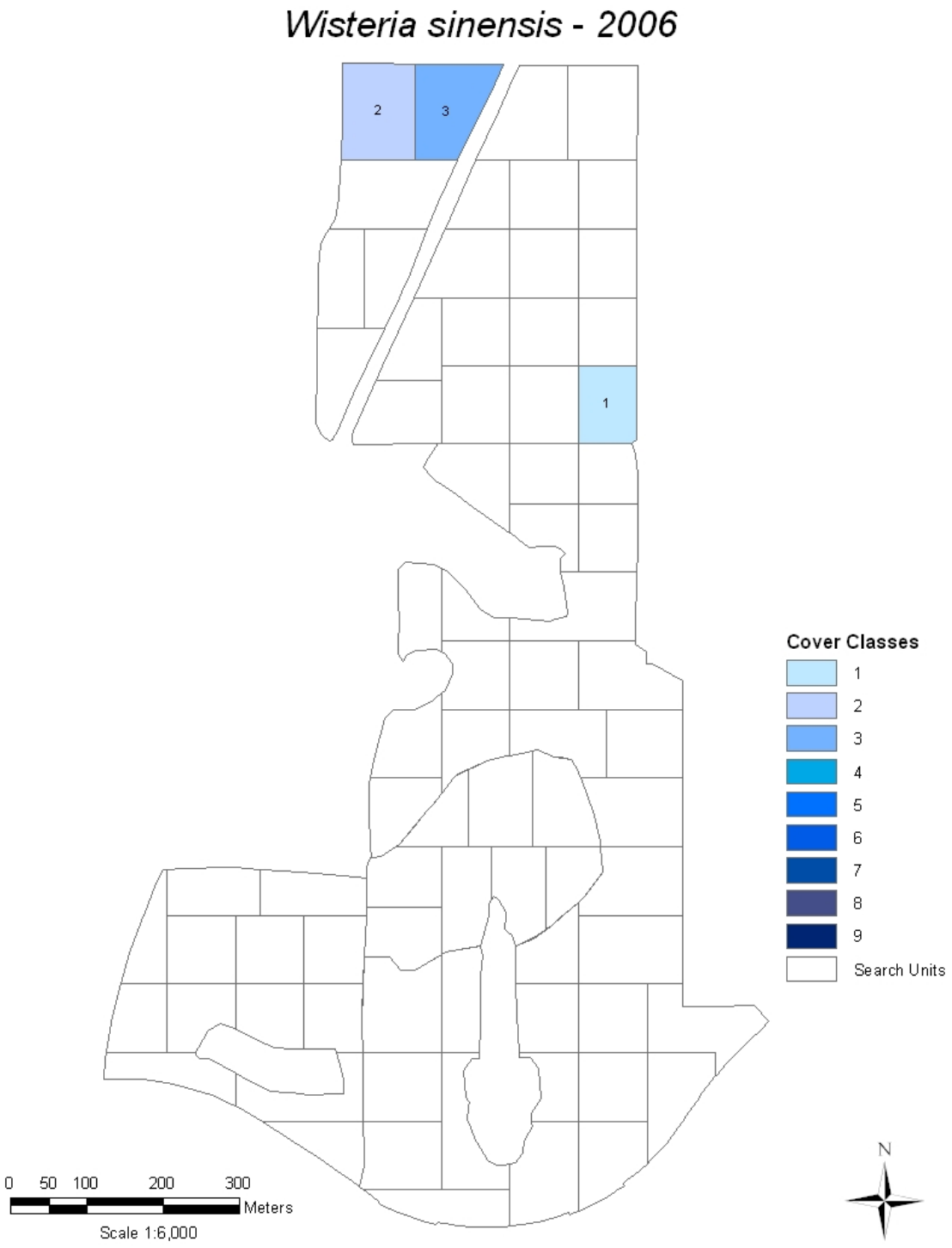

Figure 32. Abundance and distribution of *Wisteria sinensis* (chinese wisteria) at Lincoln Boyhood National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9.

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-43, March 2007

National Park Service
U.S. Department of the Interior

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