National Park Service
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Natural Resource Program Center
Fort Collins, Colorado

Invasive Exotic Plant Monitoring at George Washington Carver National Monument: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/017
NPS D-53

ON THE COVER
Prairie and woodland surrounding Moses Carver house at George Washington Carver National Monument.

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Executive Summary

During surveys in 2006, we documented 26 invasive exotic plant taxa at George Washington Carver National Monument. Invasive exotic plants occurred in the restored prairies and the forests at the monument. Japanese honeysuckle, bald brome, fescue, and Osage orange were widespread and abundant. We estimated that each of these plant species covered at least three acres on the monument. Thirteen species occupied less than an acre. In general, several invasive exotic plants are a moderate problem at George Washington Carver National Monument, 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 George Washington Carver National Monument. 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. Based on a survey in 2001, the woodlands and restored prairies at George Washington Carver National Monument support a number of invasive exotics plants. These plants include crownvetch (*Securigera varia*), bull thistle (*Cirsium vulgare*), tall fescue (*Schedonorus pratensis*), Japanese honeysuckle (*Lonicera japonica),* multiflora rose (*Rosa multiflora*), and Kentucky bluegrass (*Poa pratensis*).

2. In the past, the monument has taken steps to control invasive exotic plants, including the removal of Japanese honeysuckle (*Lonicera japonica*) from Carver Woods.

3. Controlling invasive exotic plants at George Washington Carver National Monument 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 George Washington Carver National Monument (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 97 search units were surveyed at George Washington Carver National Monument. 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 George Washington Carver National Monument 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 26 invasive exotic plant taxa were found during the survey at George Washington Carver National Monument (Table 2). Of these, 19 plant taxa were already known to occur at George Washington Carver National Monument based on NPSpecies, the service-wide database for plant location data. Based on the survey results, two plant taxa were added to the park-based watch list. European privet (*Ligustrum vulgare*) was added because the USDA Plants database does not recognize the plant as occurring in Missouri. Bald brome (*Bromus racemosus*) is not designated as a high priority, but was added because the plant was found to be wide-spread during the survey.

The distribution and abundance of the invasive exotic plant species at George Washington Carver National Monument varied widely. Japanese honeysuckle (*Lonicera japonica*) and Osage orange (*Maclura pomifera*) were widespread in the forests at the monument, covering at least 18 and three acres, respectively. The two dominant invasive exotic plants in the restored prairies, bald brome and fescue (*Lolium* spp.), covered at least seven and five acres, respectively. Eight species covered less than two acres, and 14 species occupied less than an acre.

Crownvetch (*Securigera varia)* was noted as having an unambiguously high ecological impact (Table 2). The majority of species were characterized with medium or medium-low ecological impact. The ecological impact of four species was low to insignificant. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, crownvetch with a high ecological impact was noted as having low management difficulty and amur honeysuckle (*Lonicera maackii*) with a high-medium impact was noted as having medium management difficulty. Controlling these species will likely provide a high benefit for the management costs. On the other hand, the management of Japanese honeysuckle, Johnsongrass (*Sorghum halepense*), and European privet (*Ligustrum vulgare*), 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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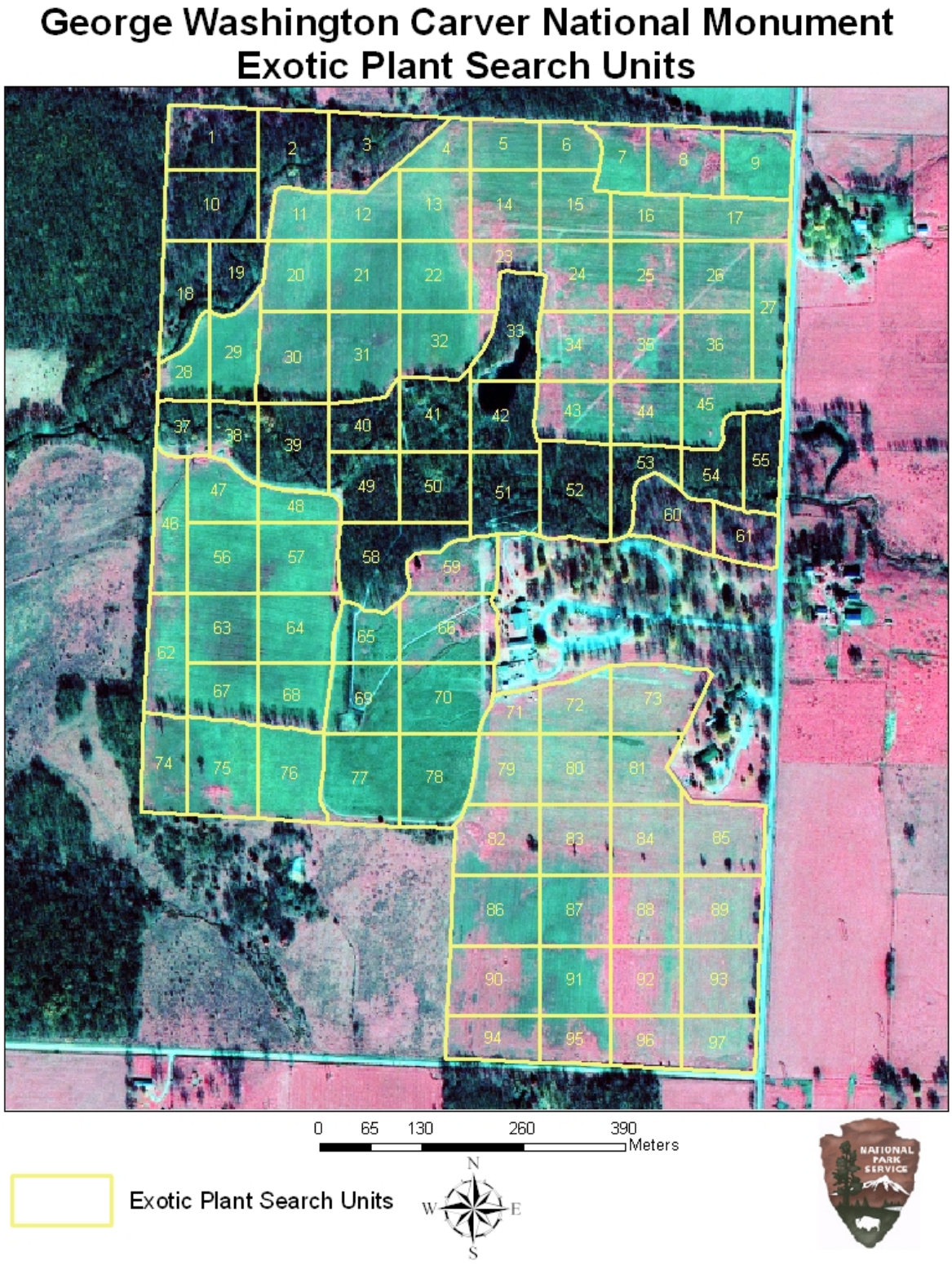

Figure 1. Invasive exotic plant search units at George Washington Carver National Monument. The search units indicate the search locations for invasive exotic plants in 2006.

Table 1. Watch lists for George Washing Carver National Monument

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Ailanthus altissima	Tree of heaven	*Acer ginnala*	Amur maple	*Bromus racemosus*	Bald brome
Albizia julibrissin	Silktree	*Arctium minus*	Lesser burdock	*Ligustrum vulgare*	European privet
Alliaria petiolata	Garlic mustard	*Bromus inermis*	Smooth brome	*Vicia villosa*	Winter vetch
Alnus glutinosa	European alder	*Bromus sterilis*	Poverty brome		
Arundo donax	Giant reed	*Bromus tectorum*	Cheatgrass		
Azolla	Mosquitofern	*Carduus nutans*	Nodding plumeless thistle		
Berberis thunbergii	Japanese barberry	*Cirsium arvense*	Canada thistle		
Bothriochloa bladhii	Caucasian bluestem	*Cirsium vulgare*	Bull thistle		
Celastrus orbiculatus	Oriental bittersweet	*Dactylis glomerata*	Orchardgrass		
Centaurea biebersteinii	Spotted knapweed	*Dipsacus fullonum*	Fuller's teasel		
Centaurea solstitialis	Yellow star-thistle	*Euonymus fortunei*	Winter creeper		
Cornus foemina	Stiff dogwood	*Glechoma hederacea*	Ground ivy		
Cynanchum louiseae	Louise's swallow-wort	*Hedera helix*	English ivy		
Cynanchum rossicum	European swallow-wort	*Lespedeza cuneata*	Sericea lespedeza		
Dioscorea oppositifolia	Chinese yam	*Lonicera japonica*	Japanese honeysuckle		
Dipsacus laciniatus	Cutleaf teasel	*Maclura pomifera*	Osage orange		
Egeria densa	Brazilian waterweed	*Melilotus officinalis*	Yellow sweetclover		
Eichhornia crassipes	Common water hyacinth	*Morus alba*	White mulberry		
Elaeagnus angustifolia	Russian olive	*Plantago lanceolata*	Narrowleaf plantain		
Elaeagnus umbellata	Autumn olive	*Poa compressa*	Canada bluegrass		
Euonymus alatus	Burning bush	*Poa pratensis*	Kentucky bluegrass		
Euphorbia esula	Leafy spurge	*Potamogeton crispus*	Curly pondweed		
Hesperis matronalis	Dames rocket	*Potentilla recta*	Sulphur cinquefoil		
Holcus lanatus	Common velvetgrass	*Rhus glabra*	Smooth sumac		
Humulus japonicus	Japanese hop	*Robinia pseudoacacia*	Black locust		
Lespedeza bicolor	Shrub lespedeza	*Rosa multiflora*	Multiflora rose		
Ligustrum sinense	Chinese privet	*Securigera varia*	Crownvetch		
Lonicera maackii	Amur honeysuckle	*Sorghum halepense*	Johnsongrass		
Lonicera morrowii	Morrow's honeysuckle	*Ulmus pumila*	Siberian elm		
Lotus corniculatus	Bird's-foot trefoil	*Verbascum thapsus*	Common mullein		
Lysimachia nummularia	Creeping jenny	*Vinca minor*	Common periwinkle		
Lythrum salicaria	Purple loosestrife				
Melia azedarach	Chinaberrytree				
Microstegium vimineum	Nepalese browntop				
Miscanthus sinensis	Chinese silvergrass				
Myriophyllum aquaticum	Parrot feather watermilfoil				
Myriophyllum spicatum	Eurasian watermilfoil				
Pastinaca sativa	Wild parsnip				
Paulownia tomentosa	Princesstree				

Table 1. Watch lists for George Washing Carver National Monument (cont.)

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Phalaris arundinacea	Reed canarygrass				
Phragmites australis	Common reed				
Polygonum cuspidatum	Japanese knotweed				
Populus alba	White poplar				
Populus tremuloides	Quaking aspen				
Pueraria montana var. lobata	Kudzu				
Rhamnus cathartica	Common buckthorn				
Schedonorus phoenix	Tall fescue				
Schedonorus pratensis	Meadow fescue				
Sesbania herbacea	Bigpod sesbania				
Solanum dulcamara	Climbing nightshade				
Spiraea japonica	Japanese meadowsweet				
Typha angustifolia	Siberian elm				
Viburnum opulus	Common periwinkle				
Wisteria sinensis	Chinese wisteria				

Table 2. Overview of invasive exotic plants found on George Washing Carver National Monument. 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 (--).

Scientific name	Common name	Watch list	Park-wide cover (acres)	Frequency (percent)	Ecological impact	Management difficulty
Lonicera japonica	Japanese honeysuckle	Park-established	18.9 - 47.2	27.8%	M	HM
Bromus racemosus	Bald brome	Add to park-based	7.3 - 27.5	33.0%	----	----
Lolium spp	Fescue species	Early-detection	5.0 - 15.0	20.6%	----	----
Maclura pomifera	Osage orange	Park-established	3.3 - 12.3	19.6%	ML	L
Poa spp	Bluegrass species	Park-established	1.6 - 7.7	7.2%	----	----
Rosa multiflora	Multiflora rose	Park-established	1.5 - 5.9	37.1%	L	L
Rhus glabra	Smooth sumac	Park-established	1.4 - 3.8	19.6%	----	----
Bromus inermis	Smooth brome	Park-established	1.3 -3.8	21.6%	M	ML
Sorghum halepense	Johnsongrass	Park-established	1.0 - 4.0	28.9%	ML	HM
Lespedeza cuneata	Sericea lespedeza	Park-established	0.7 - 2.8	35.1%	ML	ML
Securigera varia	Crownvetch	Park-established	0.6 - 1.2	1.0%	H	L
Torilis japonica	Erect hegeparsley	Park-established	0.6 - 1.2	1.0%	----	----
Bromus sterilis	Poverty brome	Park-established	<0.75	9.3%	ML	U
Euonymus fortunei	Winter creeper	Park-established	< 0.50	13.4%	M	LI
Ligustrum vulgare	Common privet	Add to park-based	< 0.5	14.4%	HL	HM
Dactylis glomerata	Orchardgrass	Park-established	< 0.25	13.4%	LI	ML
Melilotus officinalis	Sweetclover	Park-established	< 0.25	5.2%	M	M
Morus alba	White mulberry	Park-established	< 0.25	9.3%	ML	ML
Glechoma hederacea	Ground ivy	Park-established	< 0.1	2.1%	MI	U
Verbascum thapsus	Common mullein	Park-established	< 0.1	6.2%	ML	L
Celastrus orbiculatus	Oriental bittersweet	Early-detection	< 0.01	2.1%	ML	M
Lonicera maackii	Amur honeysuckle	Early-detection	< 0.01	1.0%	HM	M
Potentilla recta	Sulphur cinquefoil	Park-established	< 0.01	5.2%	HL	ML
Arctium minus	Lesser burdock	Park-established	< 0.001	1.0%	LI	MI
Euonymus alatus	Burning bush	Early-detection	< 0.001	1.0%	LI	L

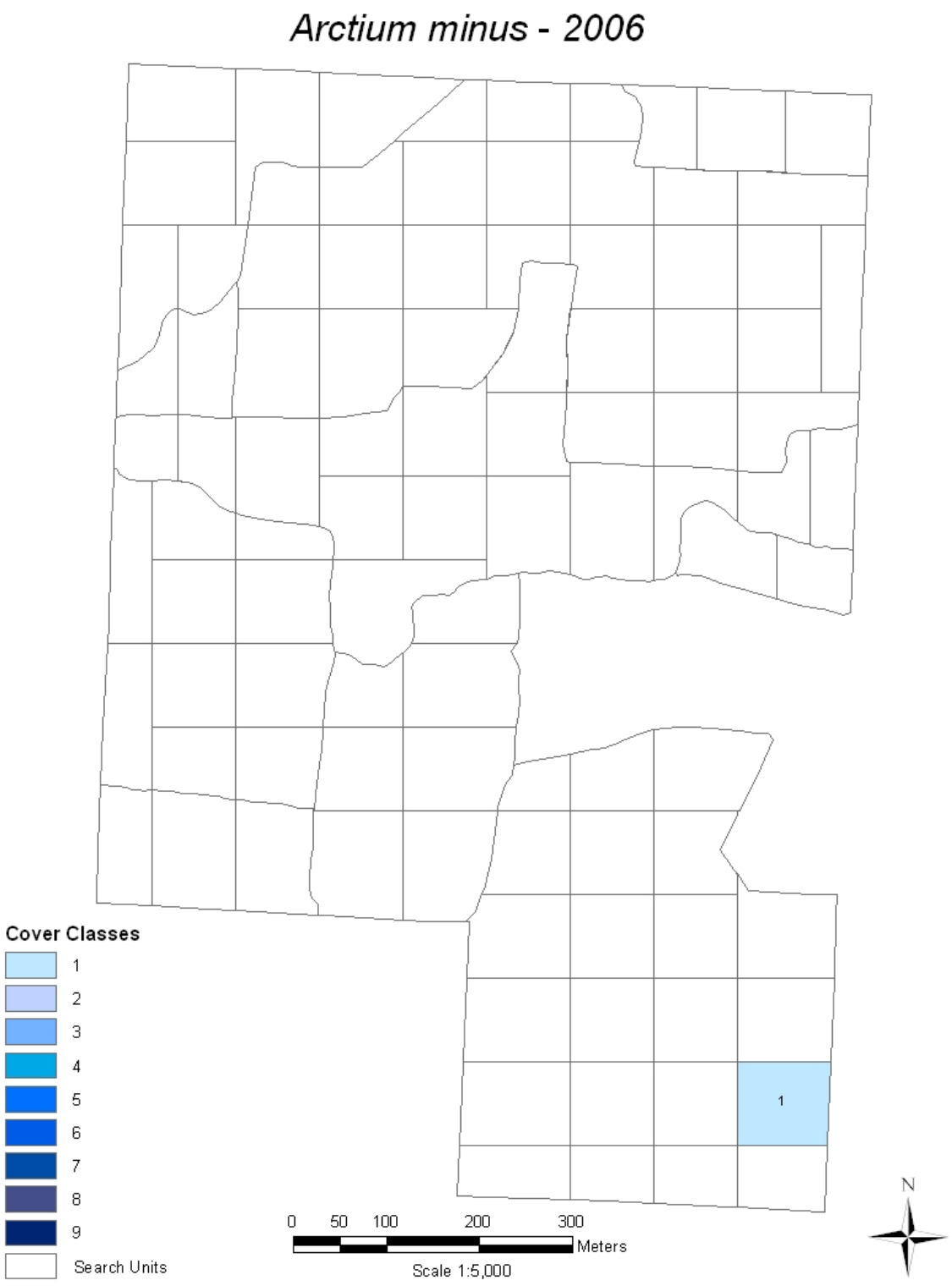

Figure 2. Abundance and distribution of *Arctium minus* (lesser burdock) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

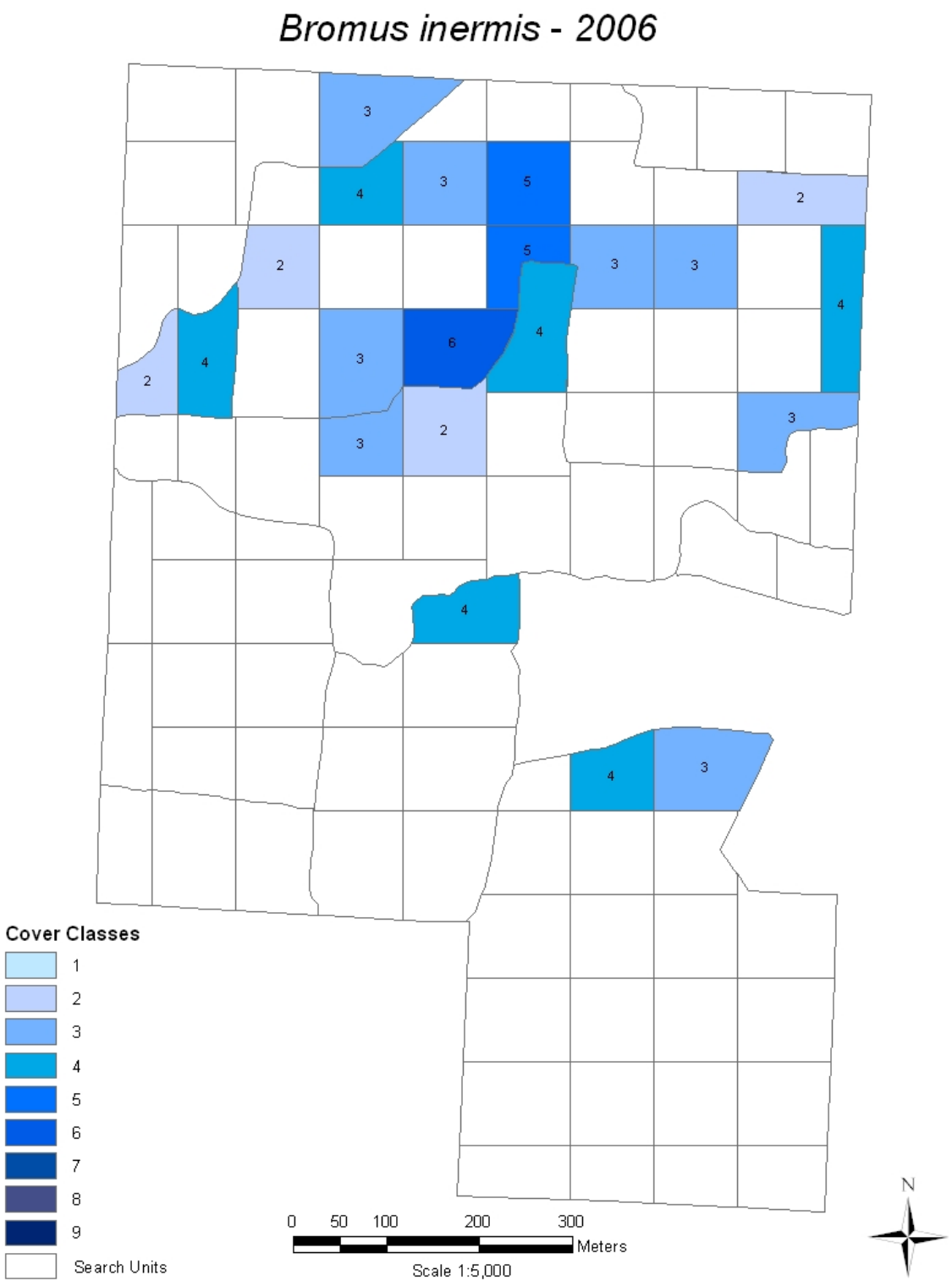

Figure 3. Abundance and distribution of *Bromus inermis* (smooth brome) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

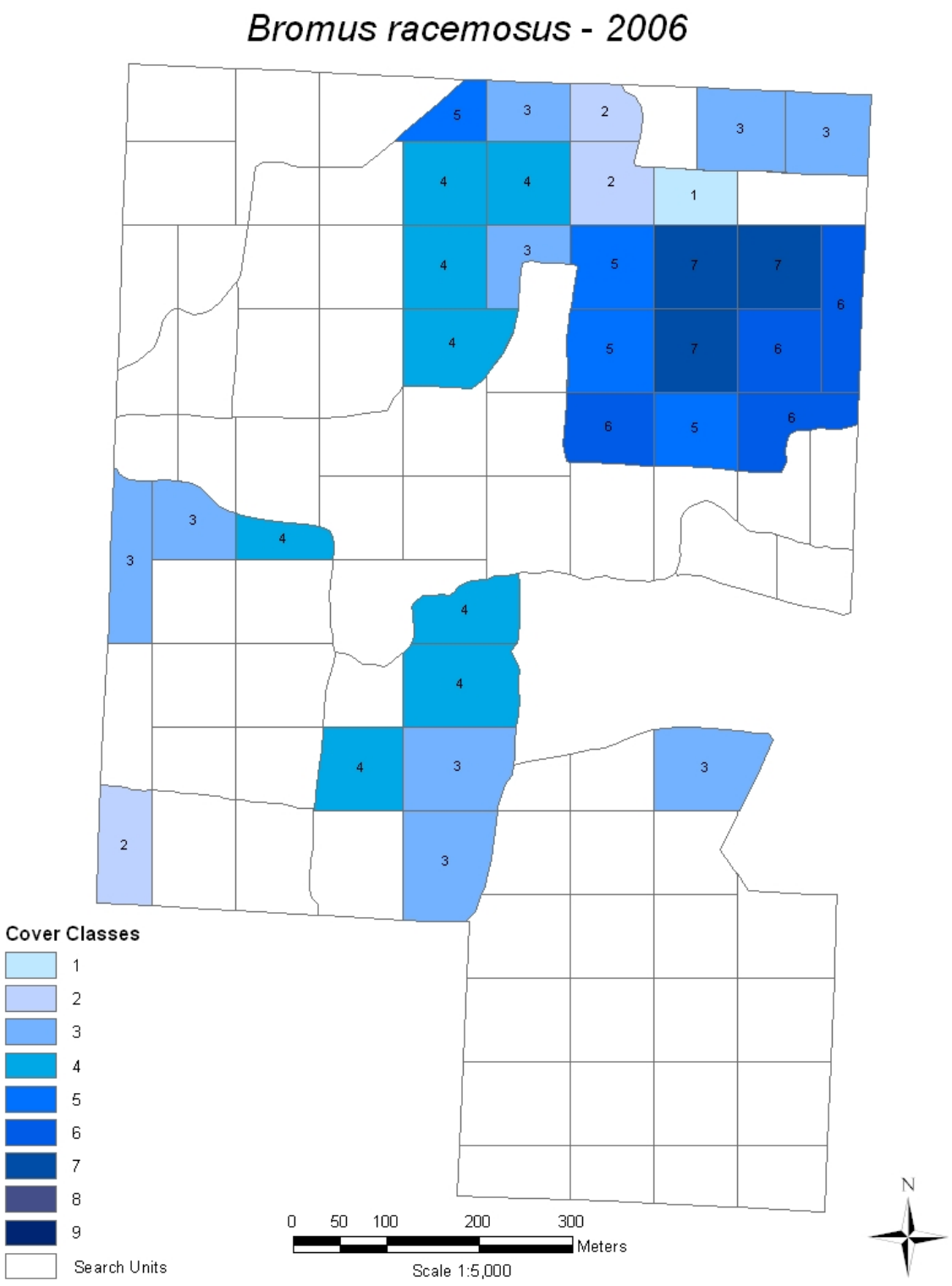

Figure 4. Abundance and distribution of *Bromus racemosus* (bald brome) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

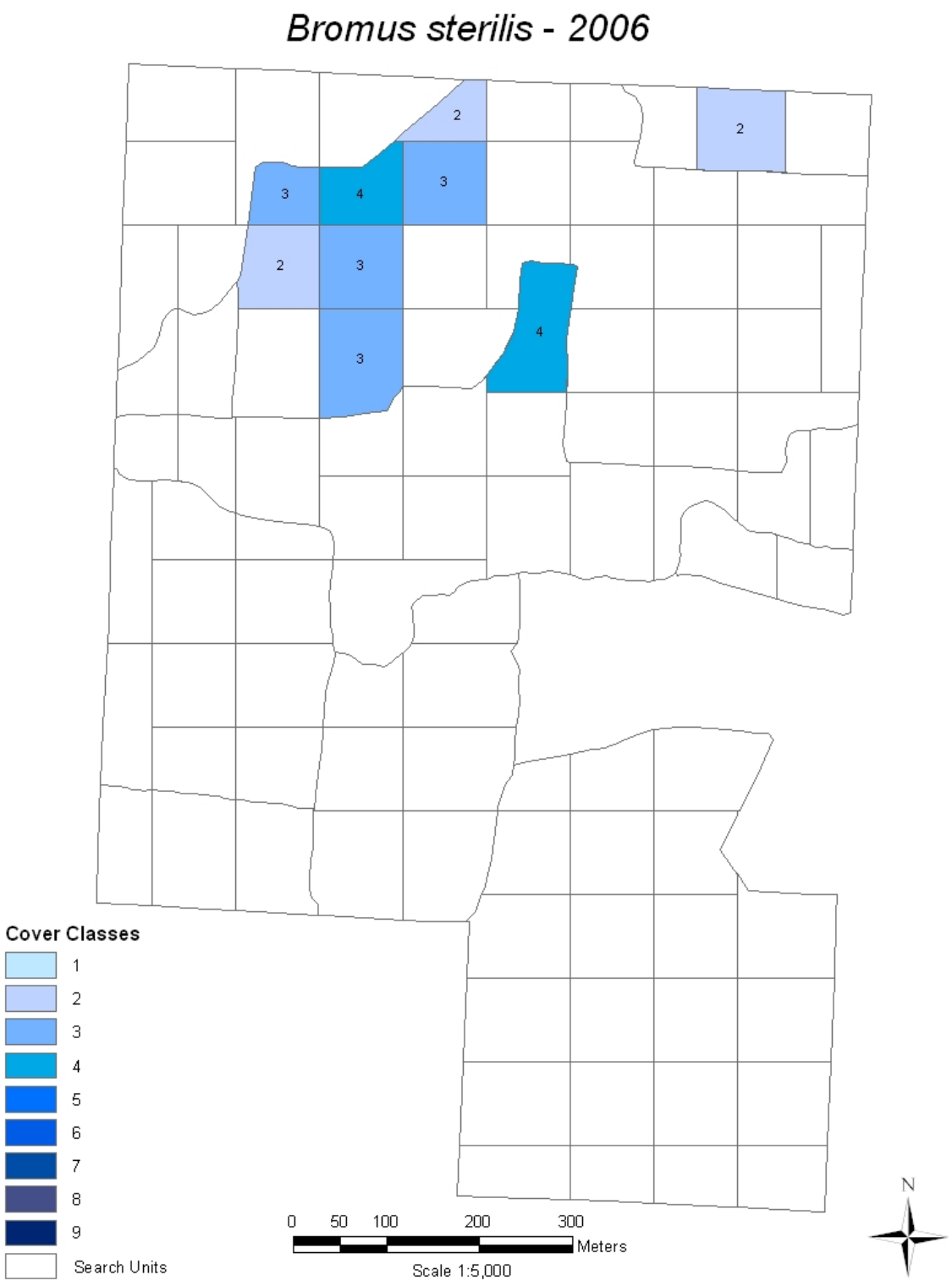

Figure 5. Abundance and distribution of *Bromus sterilis* (poverty brome) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

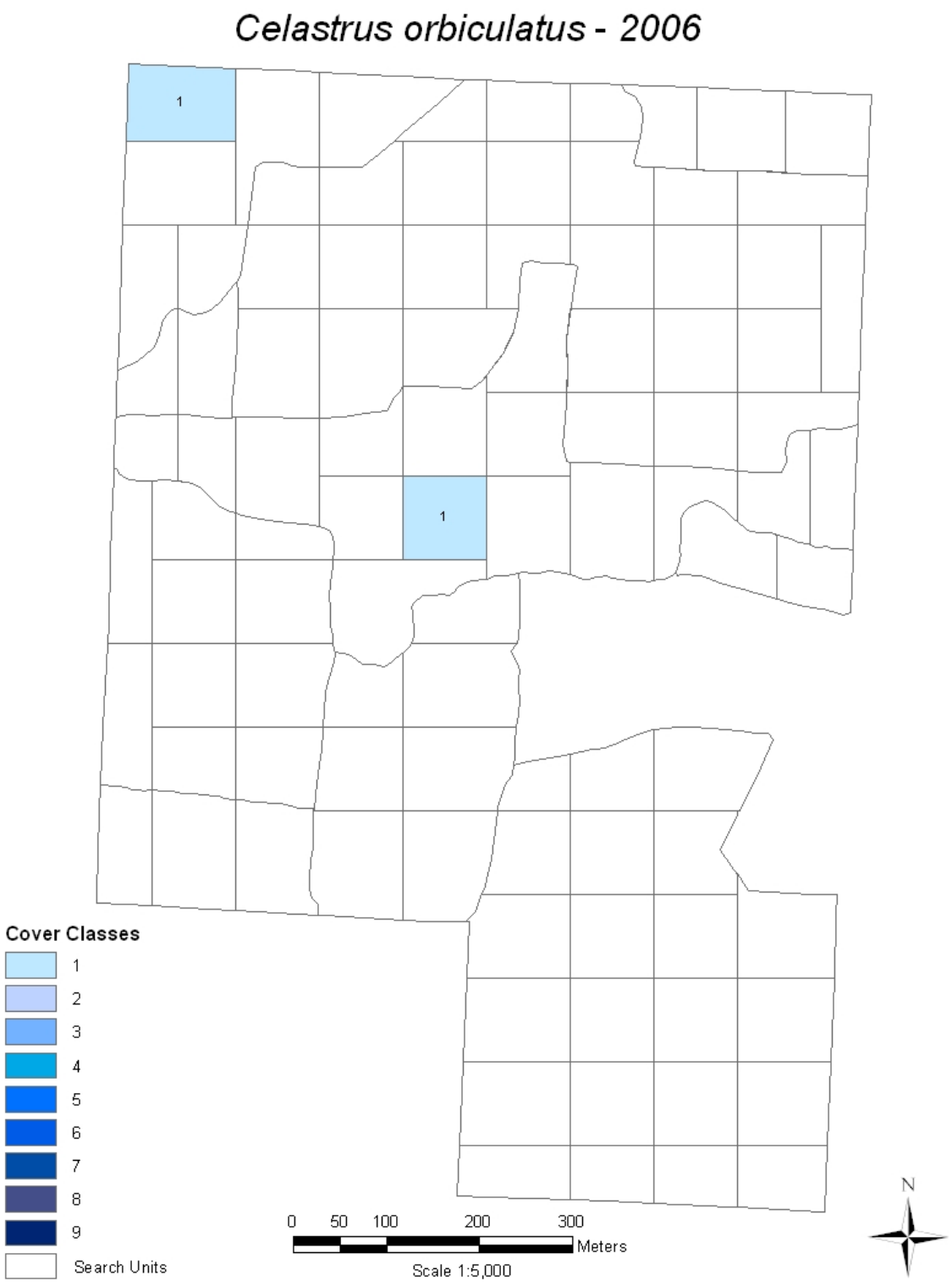

Figure 6. Abundance and distribution of *Celastrus orbiculatus* (oriental bittersweet) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9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

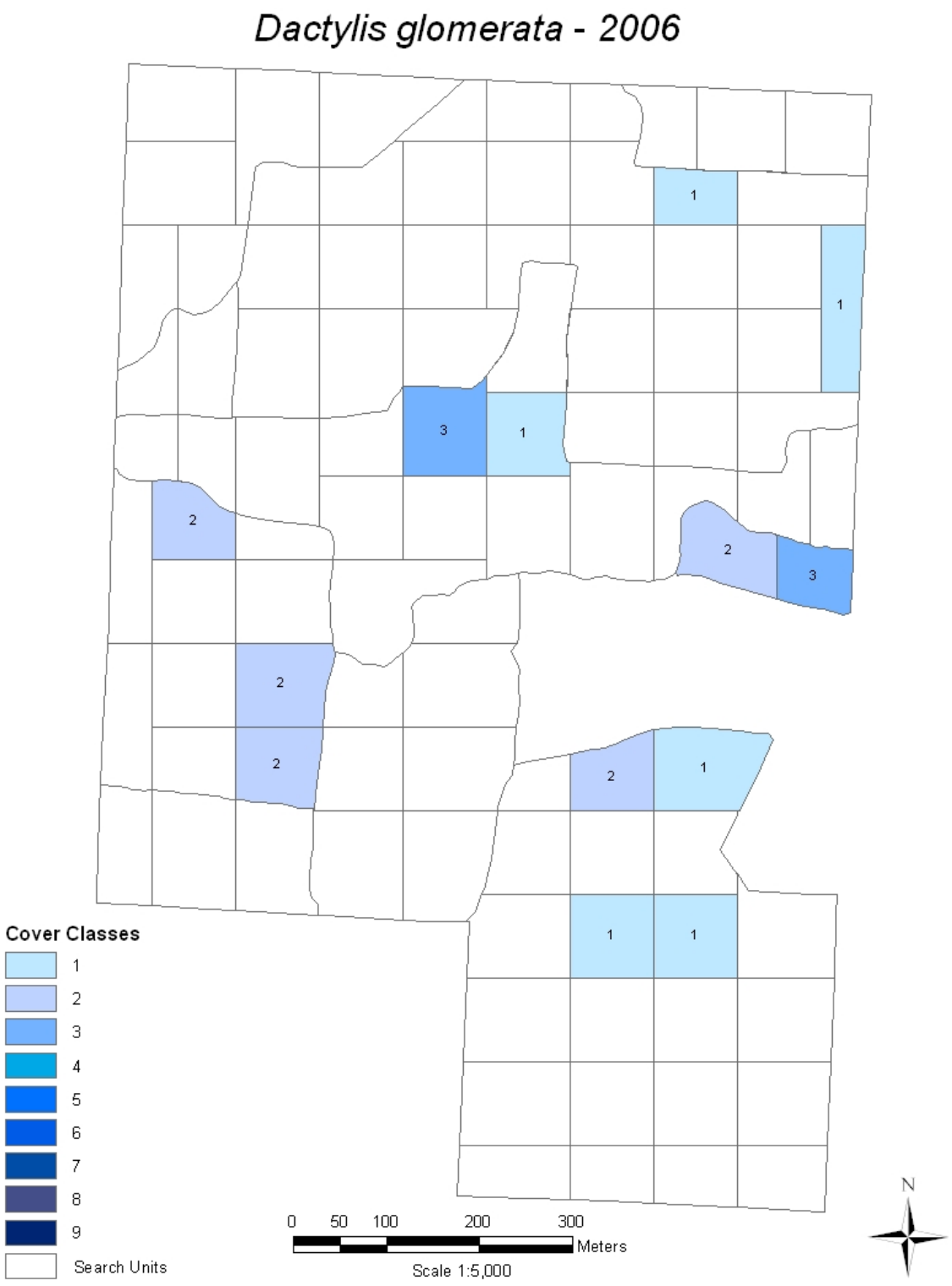

Figure 7. Abundance and distribution of *Dactylis glomerata* (orchardgrass) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and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

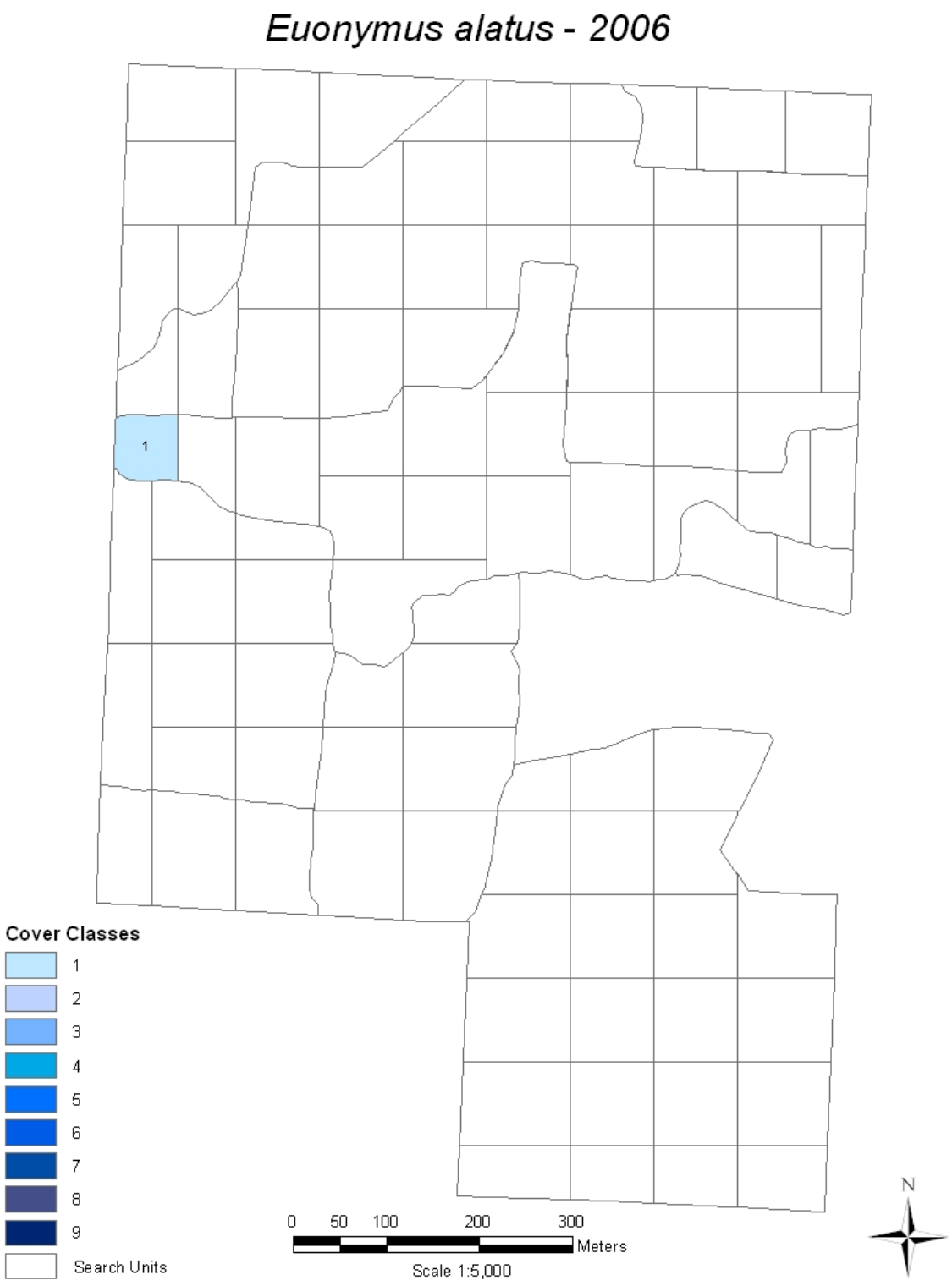

Figure 8. Abundance and distribution of *Euonymus alatus* (burningbush) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

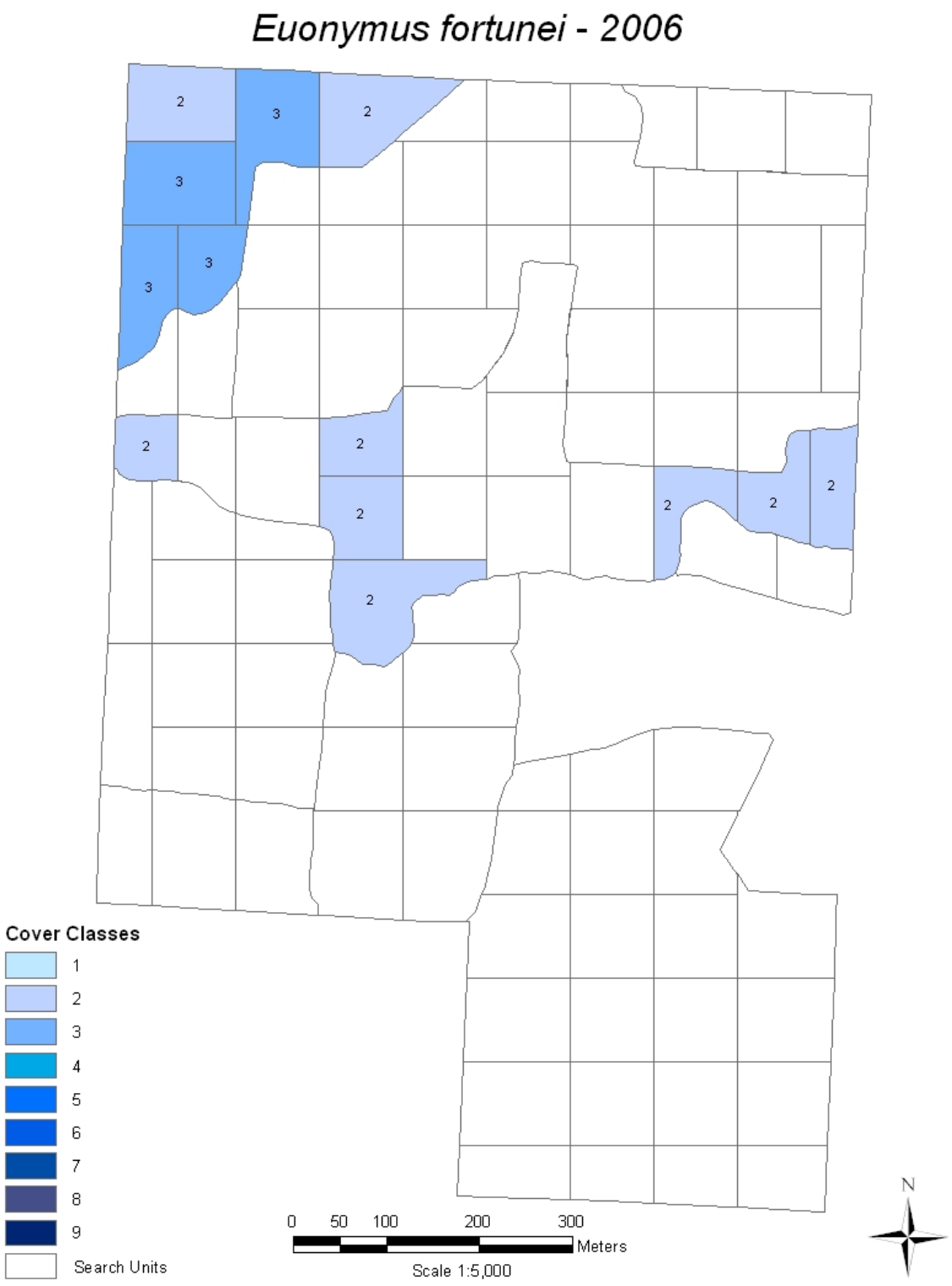

Figure 9. Abundance and distribution of *Euonymus fortunei* (winter creeper) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and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

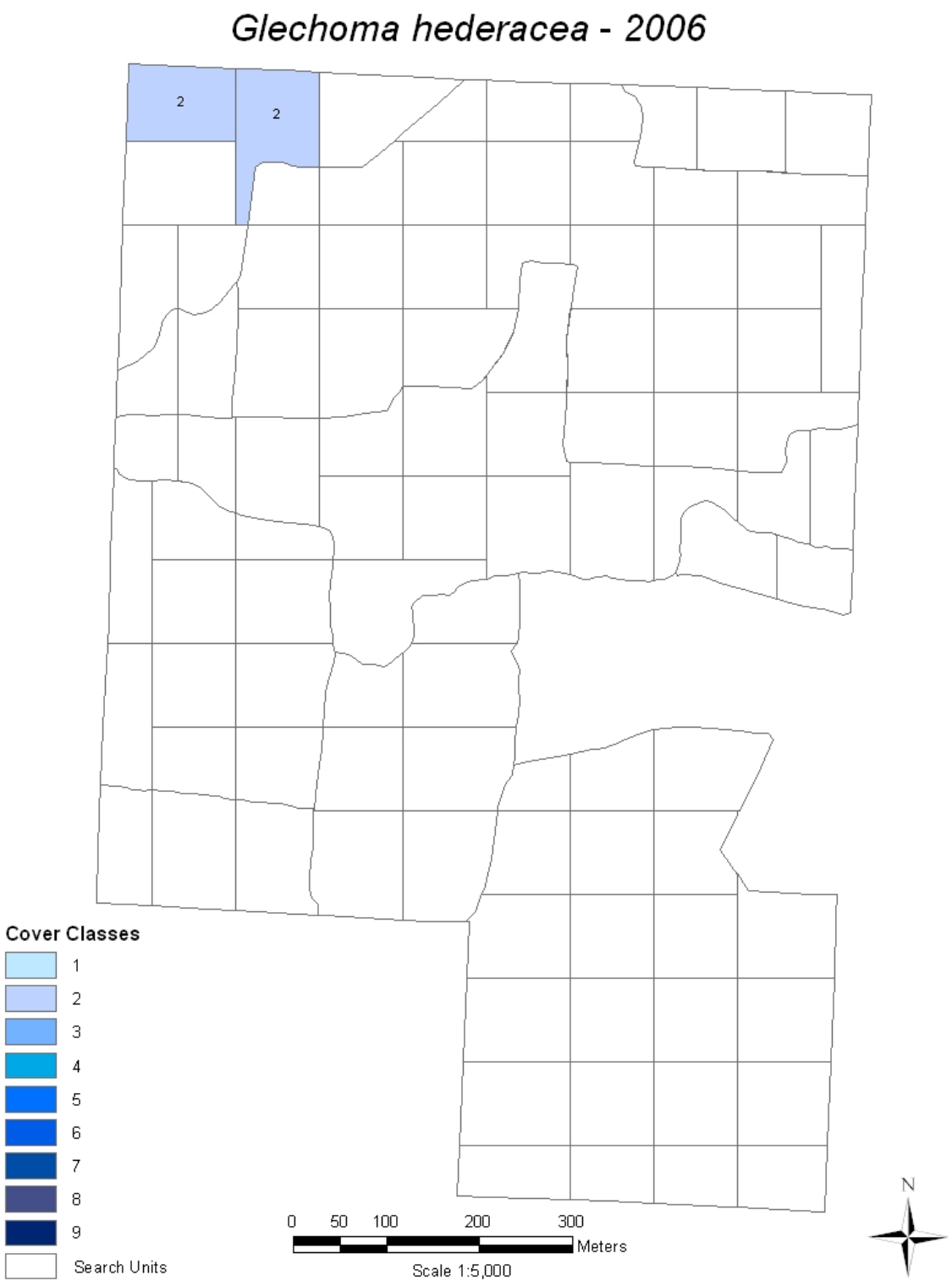

Figure 10. Abundance and distribution of *Glechoma hederacea* (ground ivy) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

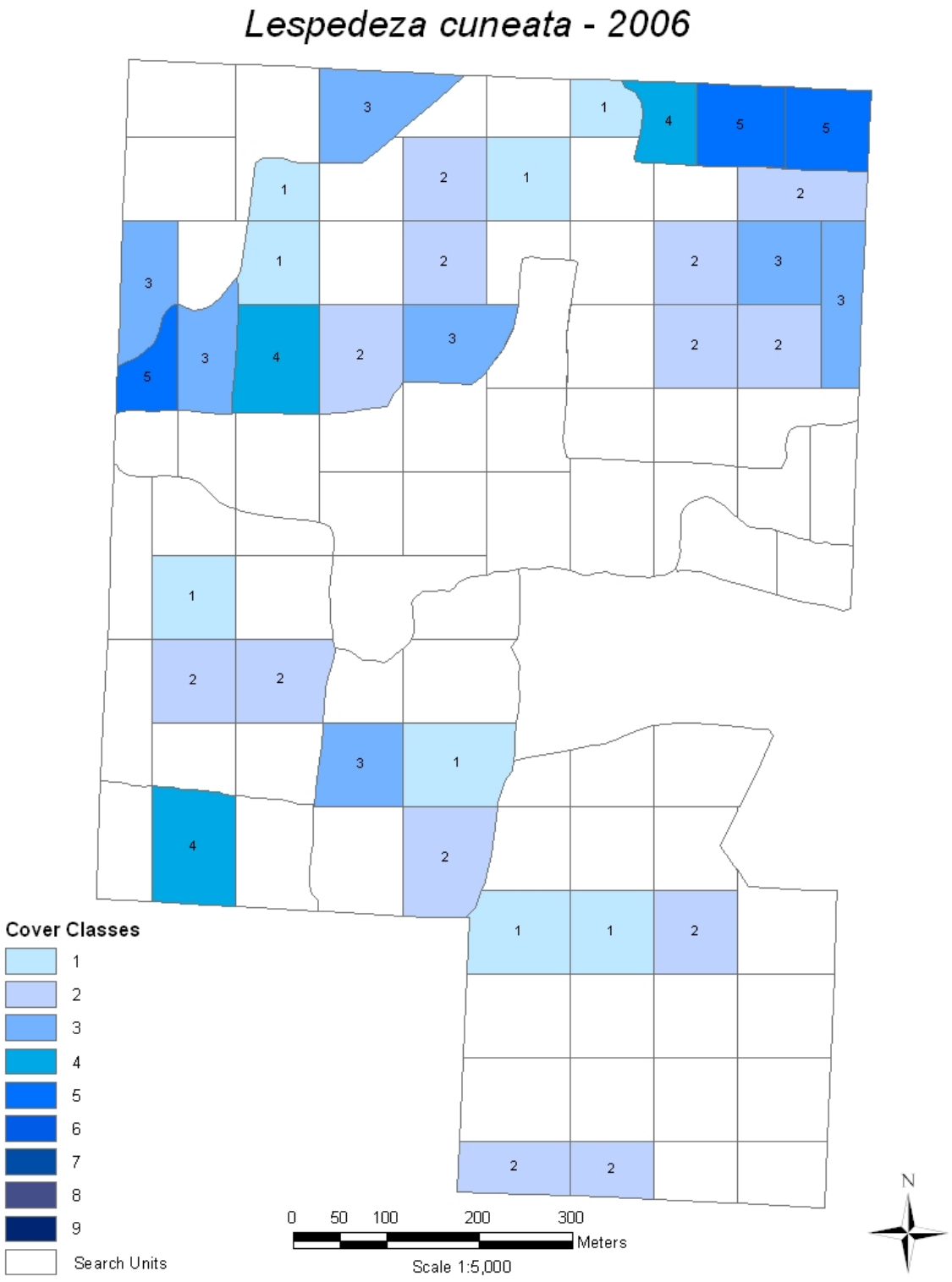

Figure 11. Abundance and distribution of *Lespedeza cuneata* (chinese lespedeza) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

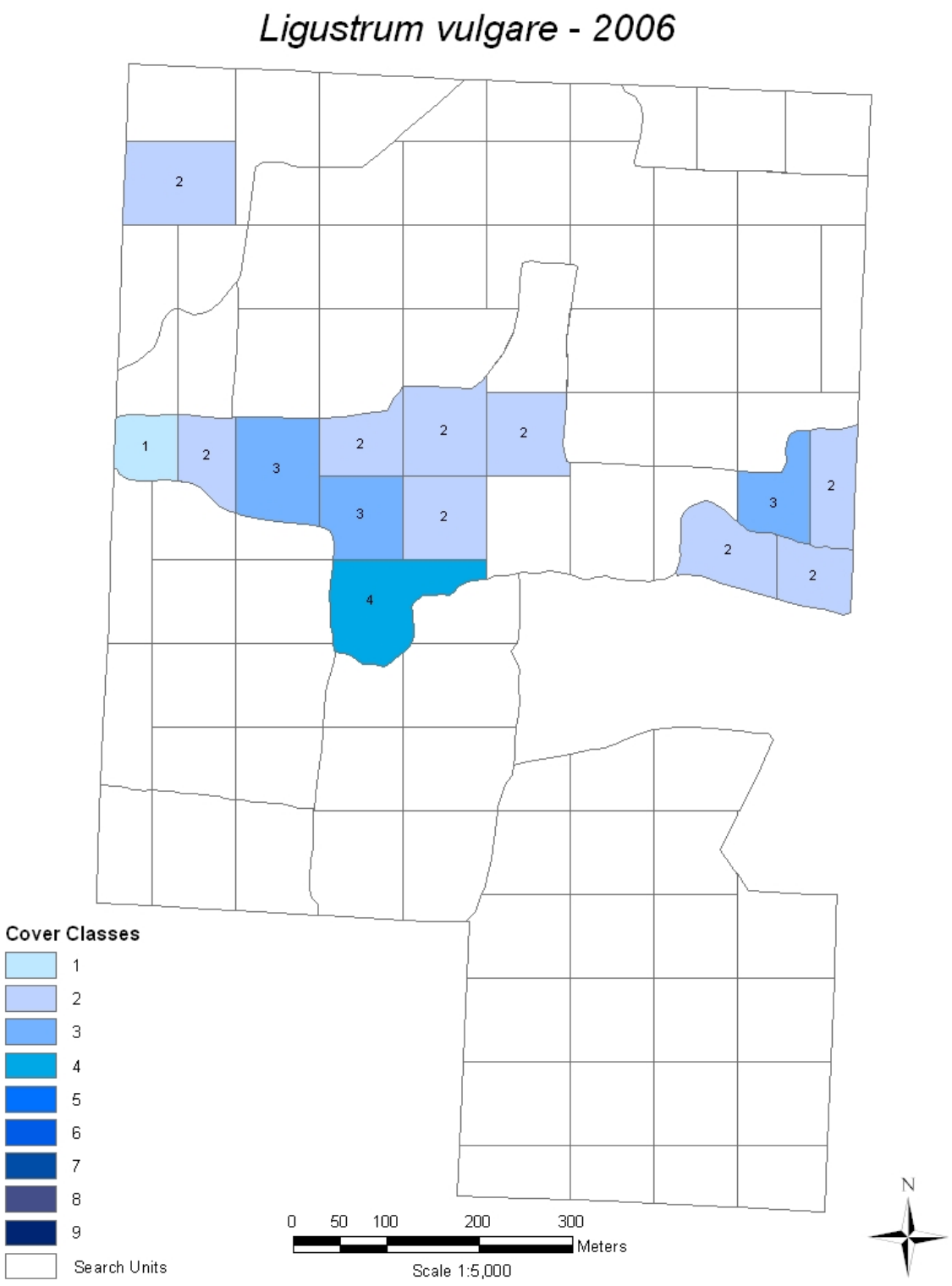

Figure 12. Abundance and distribution of *Ligustrum vulgare* (european privet) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

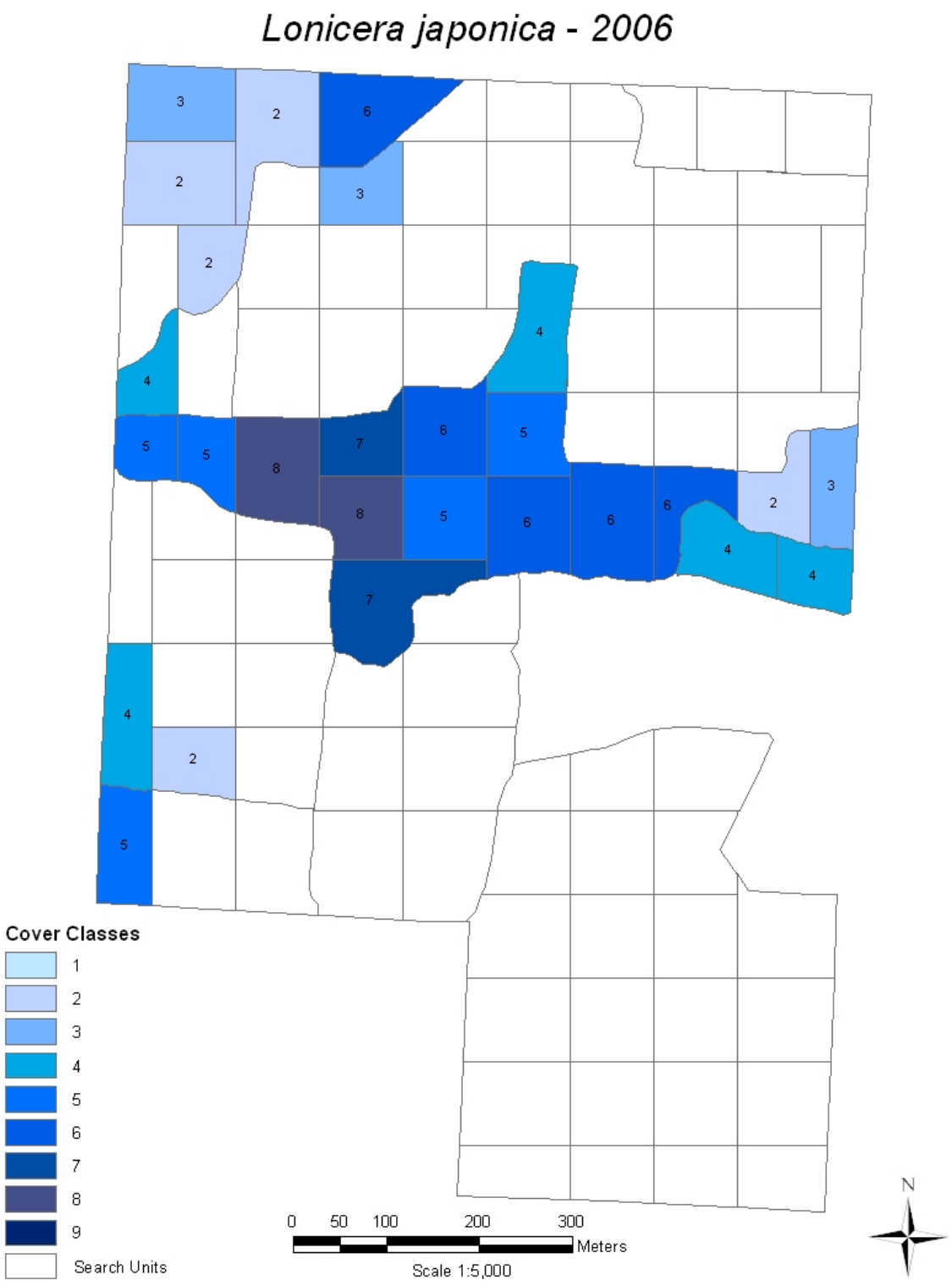

Figure 13. Abundance and distribution of *Lonicera japonica* (Japanese honeysuckle) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2,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

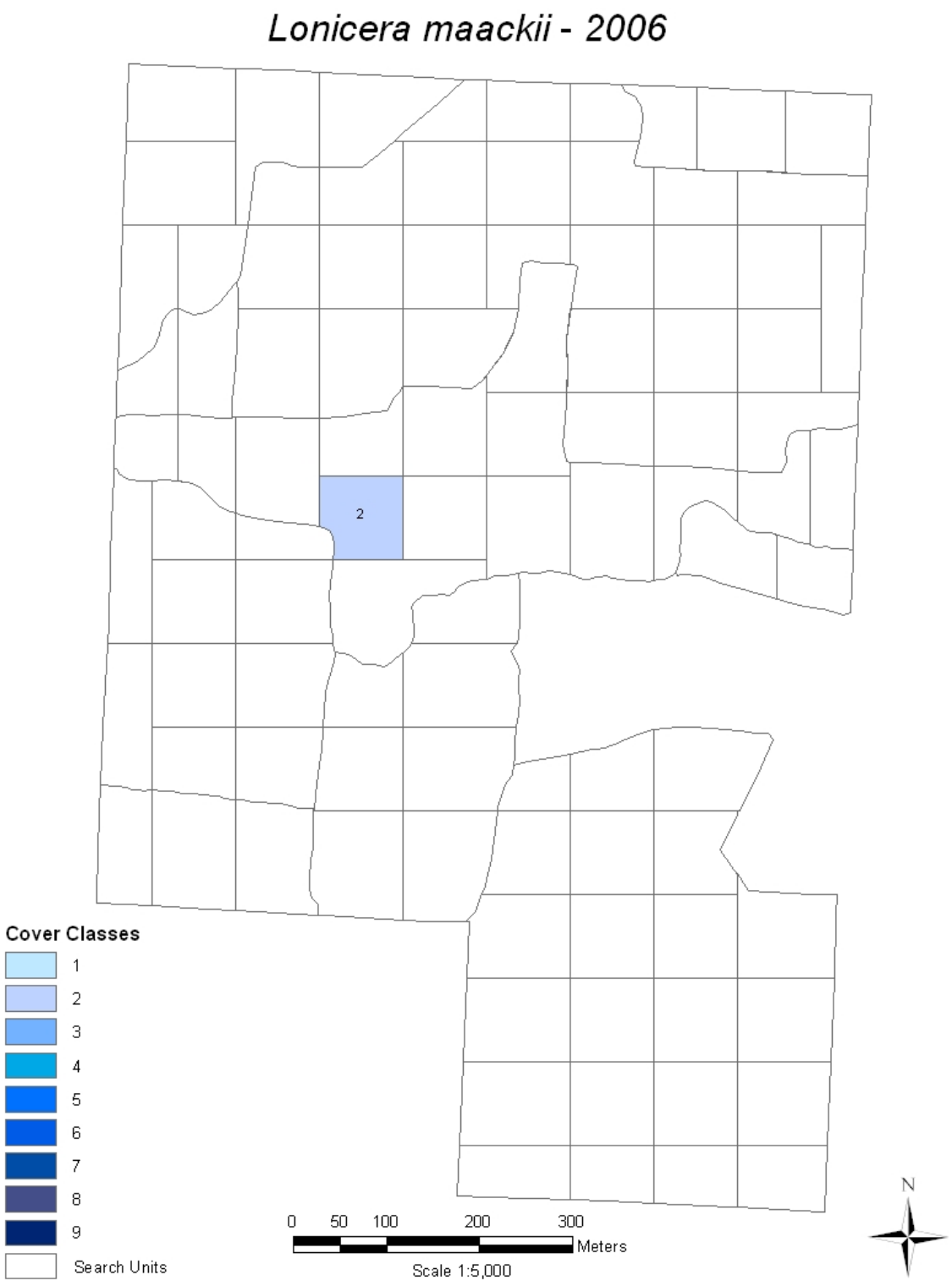

Figure 14. Abundance and distribution of *Lonicera maackii* (amur honeysuckle) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and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

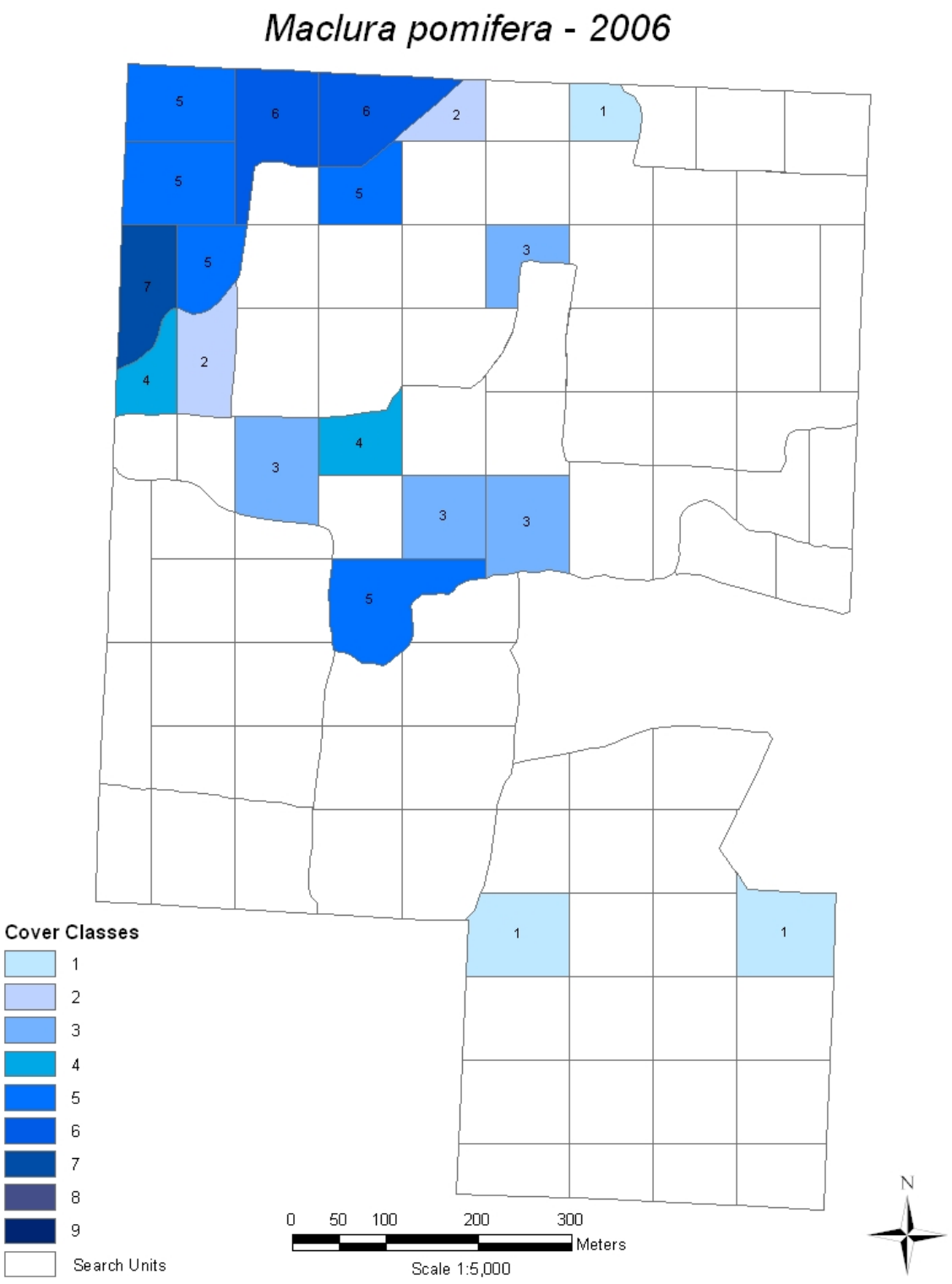

Figure 15. Abundance and distribution of *Maclura pomifera* (Osage-orange) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

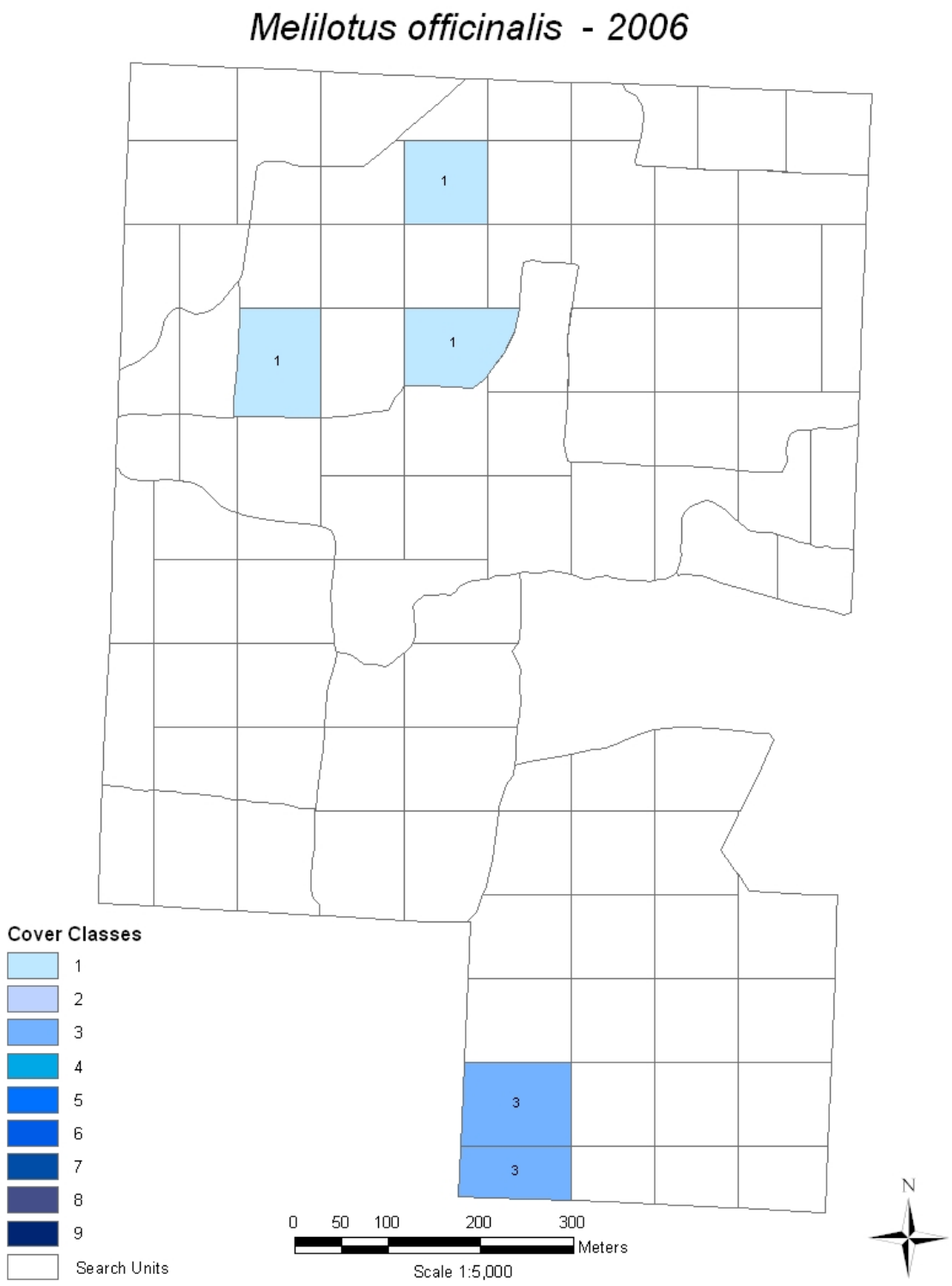

Figure 16. Abundance and distribution of *Melilotus officinalis* (sweetclover) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

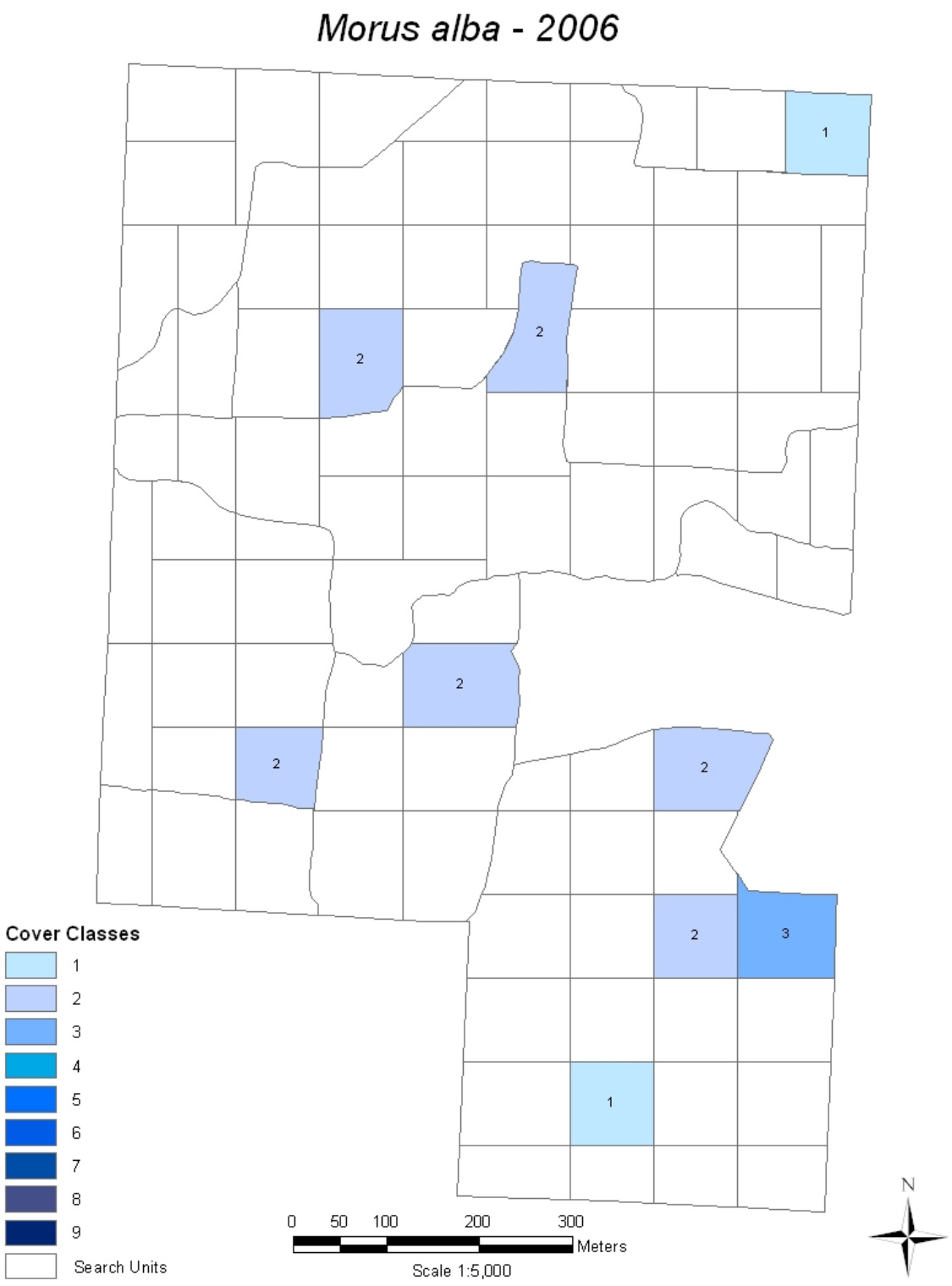

Figure 17. Abundance and distribution of *Morus alba* (white mulberry) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

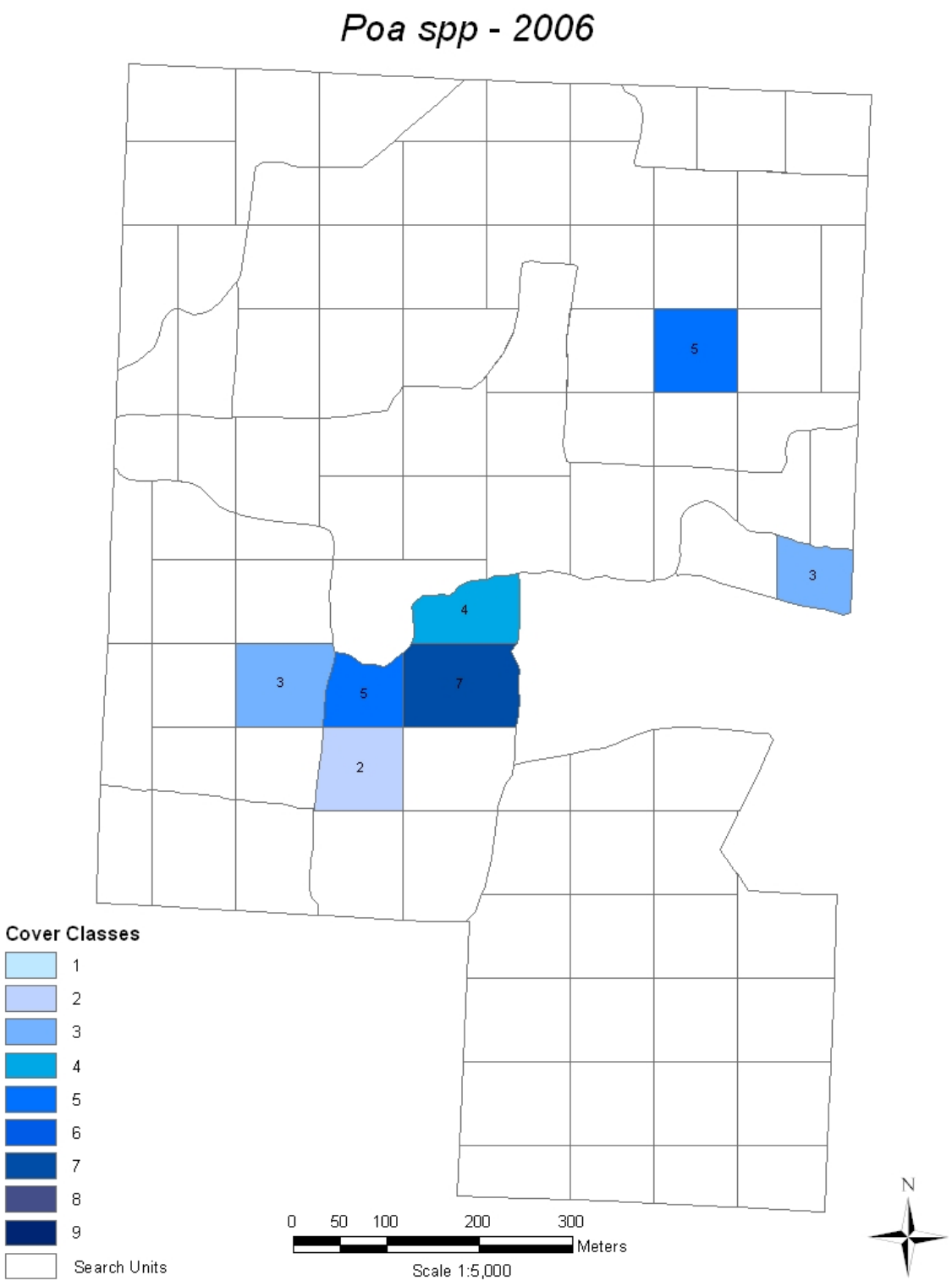

Figure 18. Abundance and distribution of *Poa spp.* (bluegrass) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

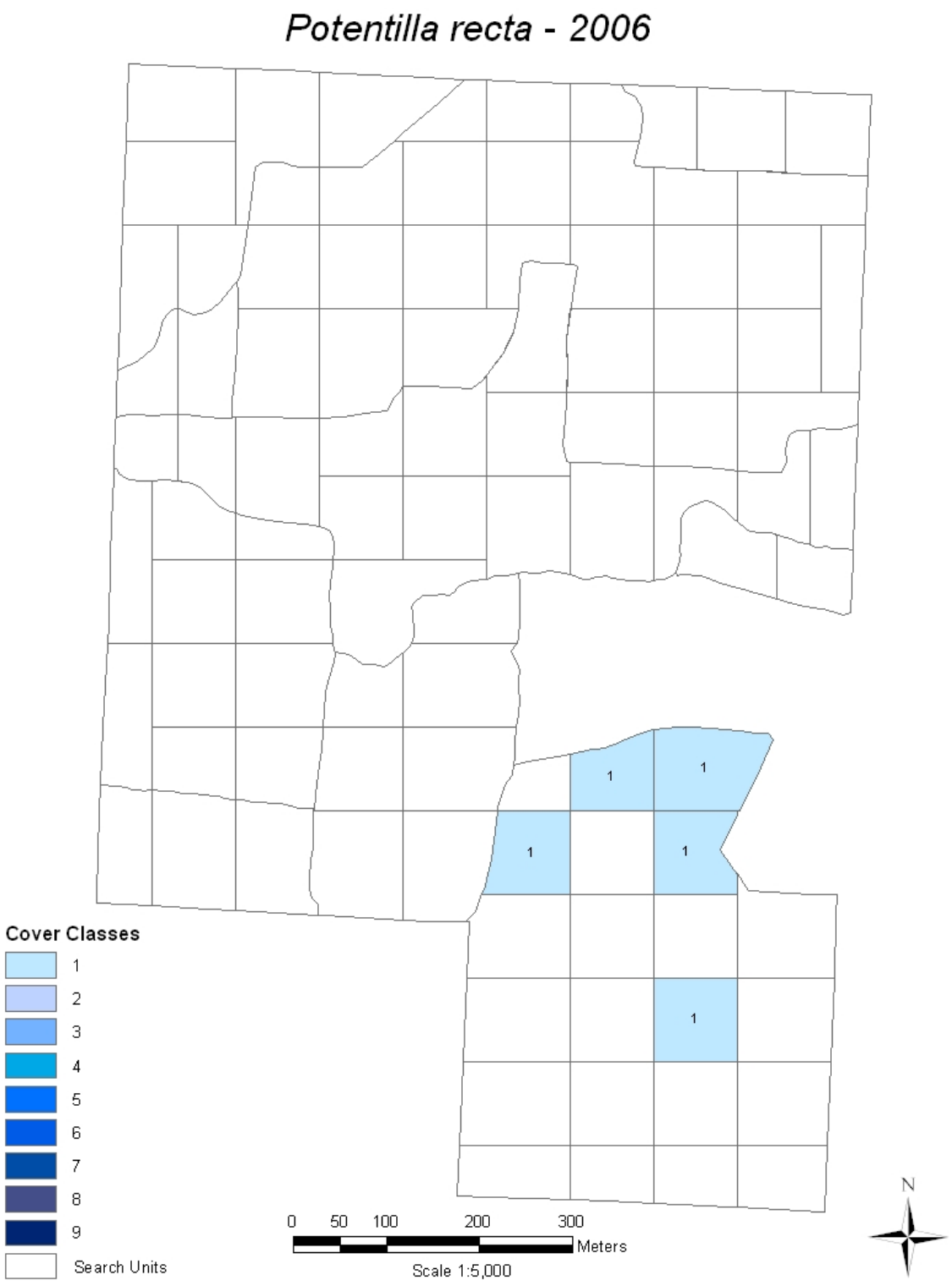

Figure 19. Abundance and distribution of *Potentilla recta* (sulphur five-fingers) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

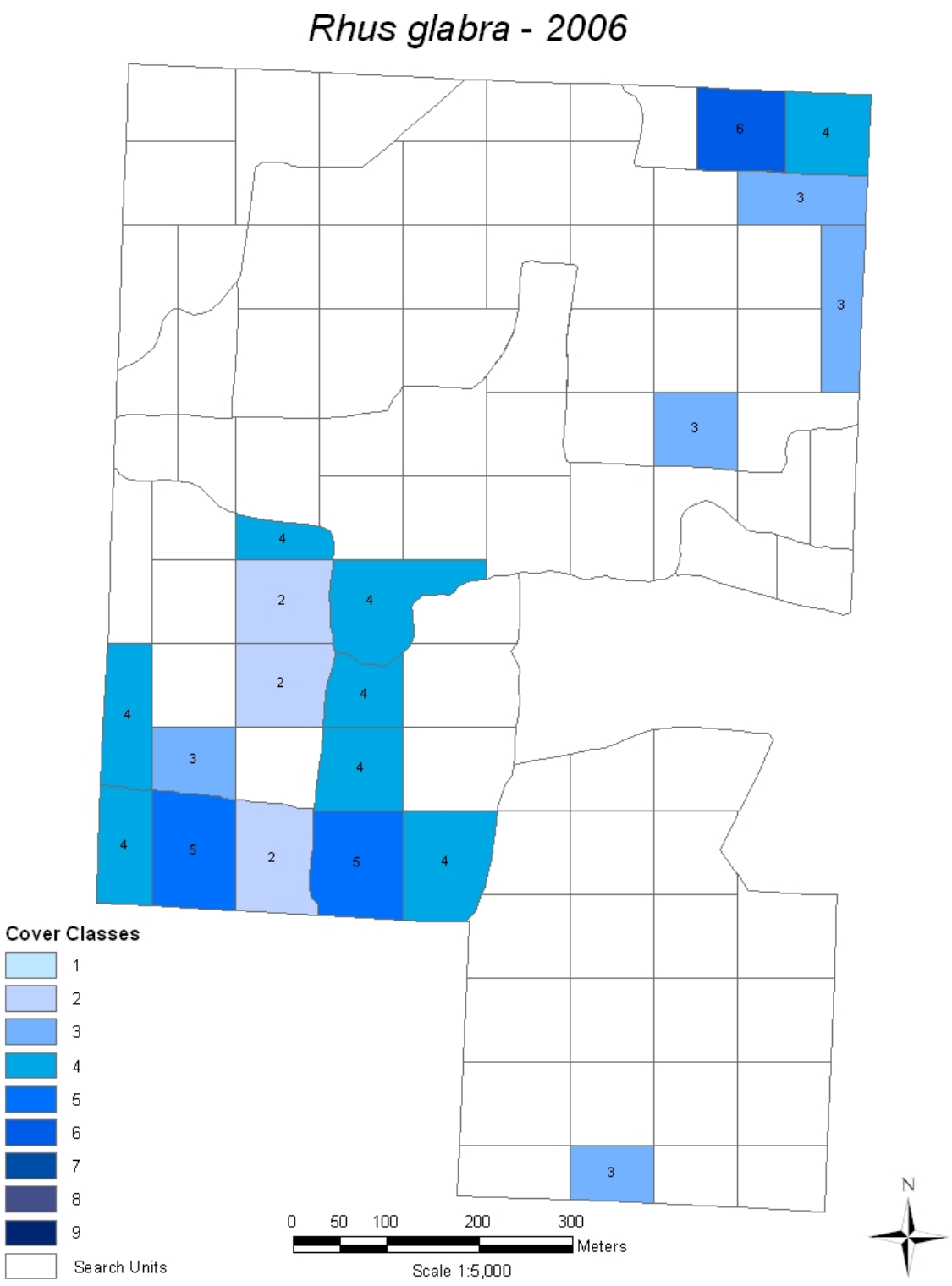

Figure 20. Abundance and distribution of *Rhus glabra* (smooth sumac) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

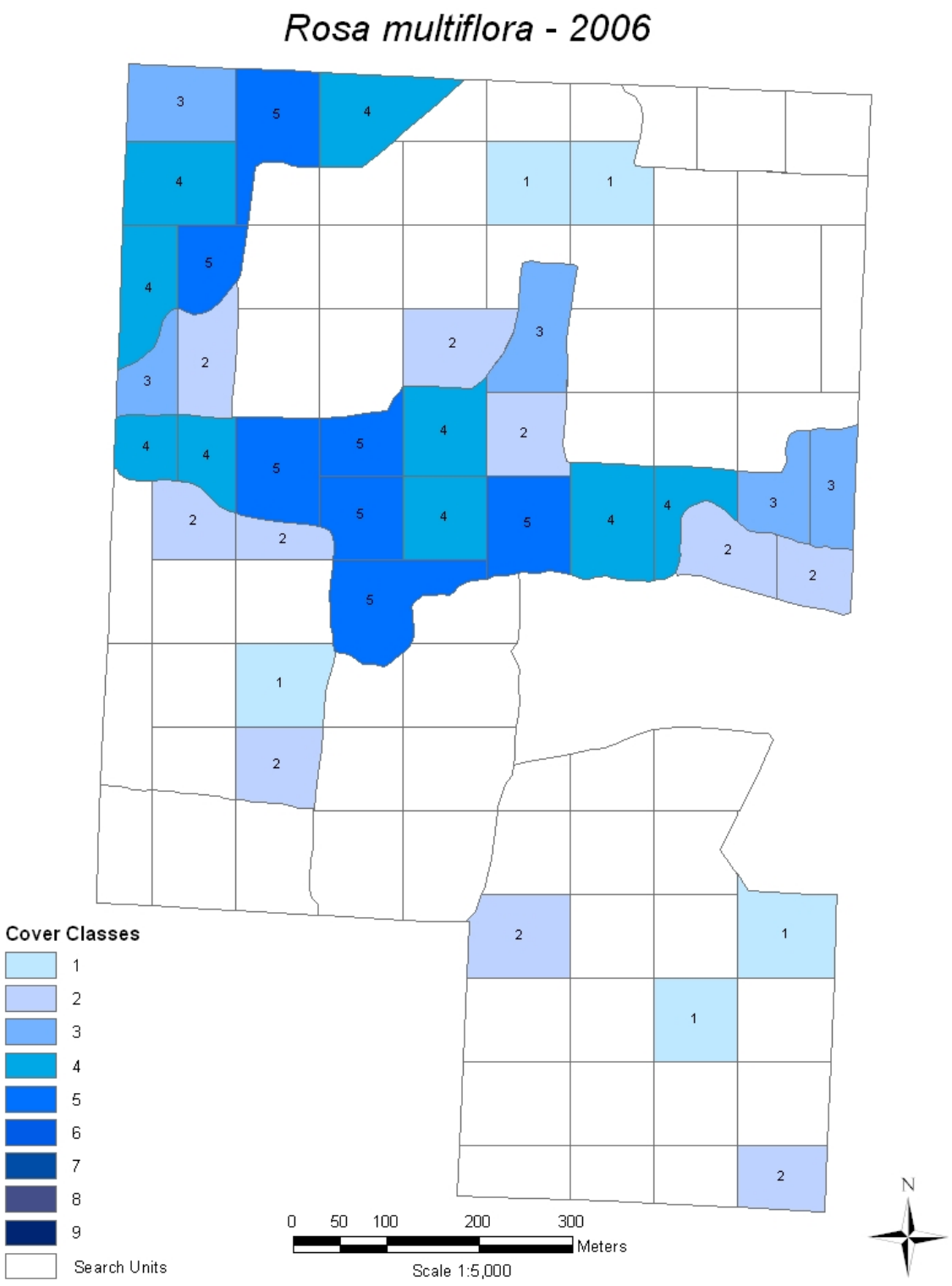

Figure 21. Abundance and distribution of *Rosa multiflora* (multiflora rose) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and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

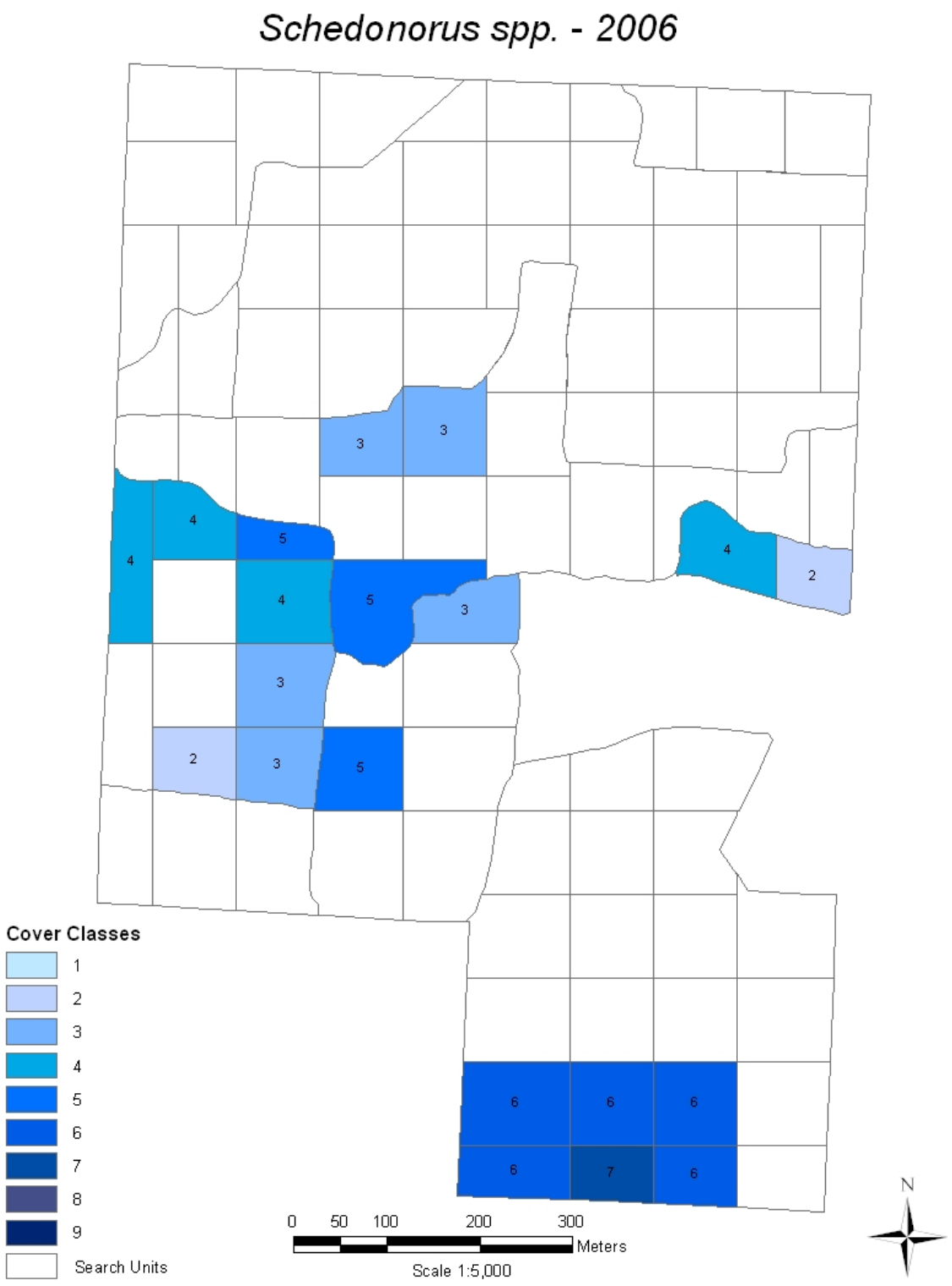

Figure 22. Abundance and distribution of *Schedonorus spp.* (fescue) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

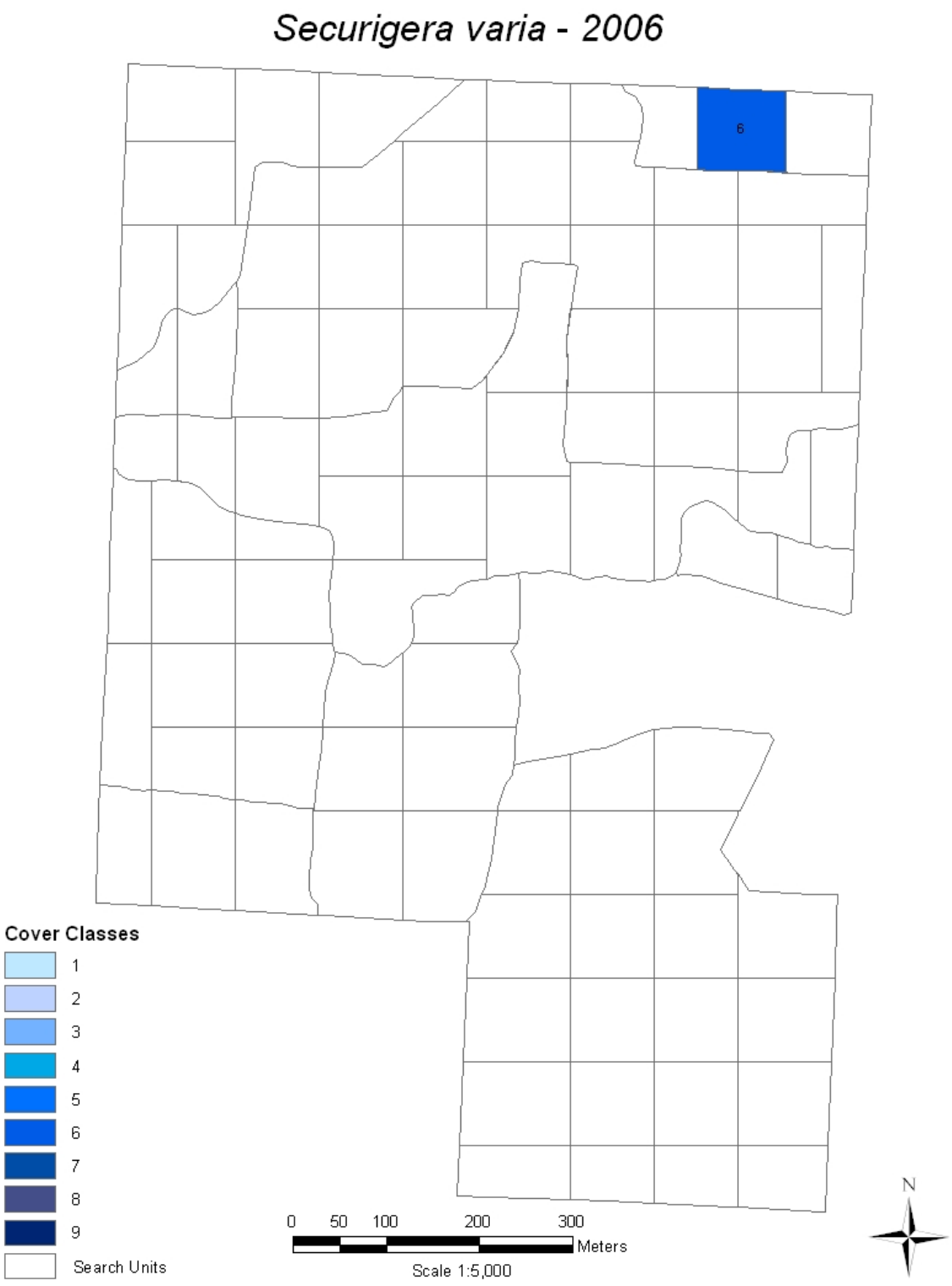

Figure 23. Abundance and distribution of *Securigera varia* (crownvetch) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

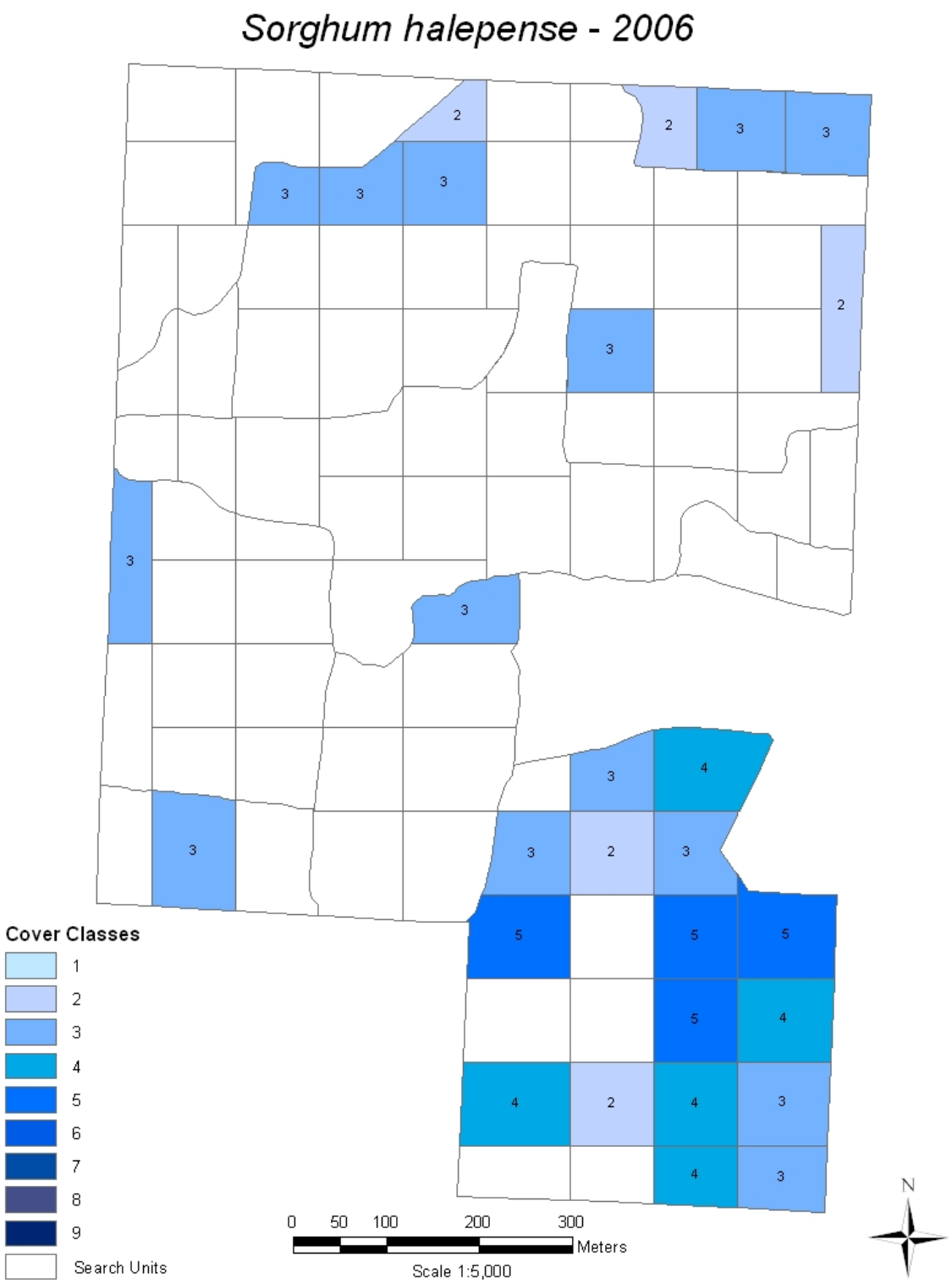

Figure 24. Abundance and distribution of *Sorghum halepense* (Johnsongrass) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

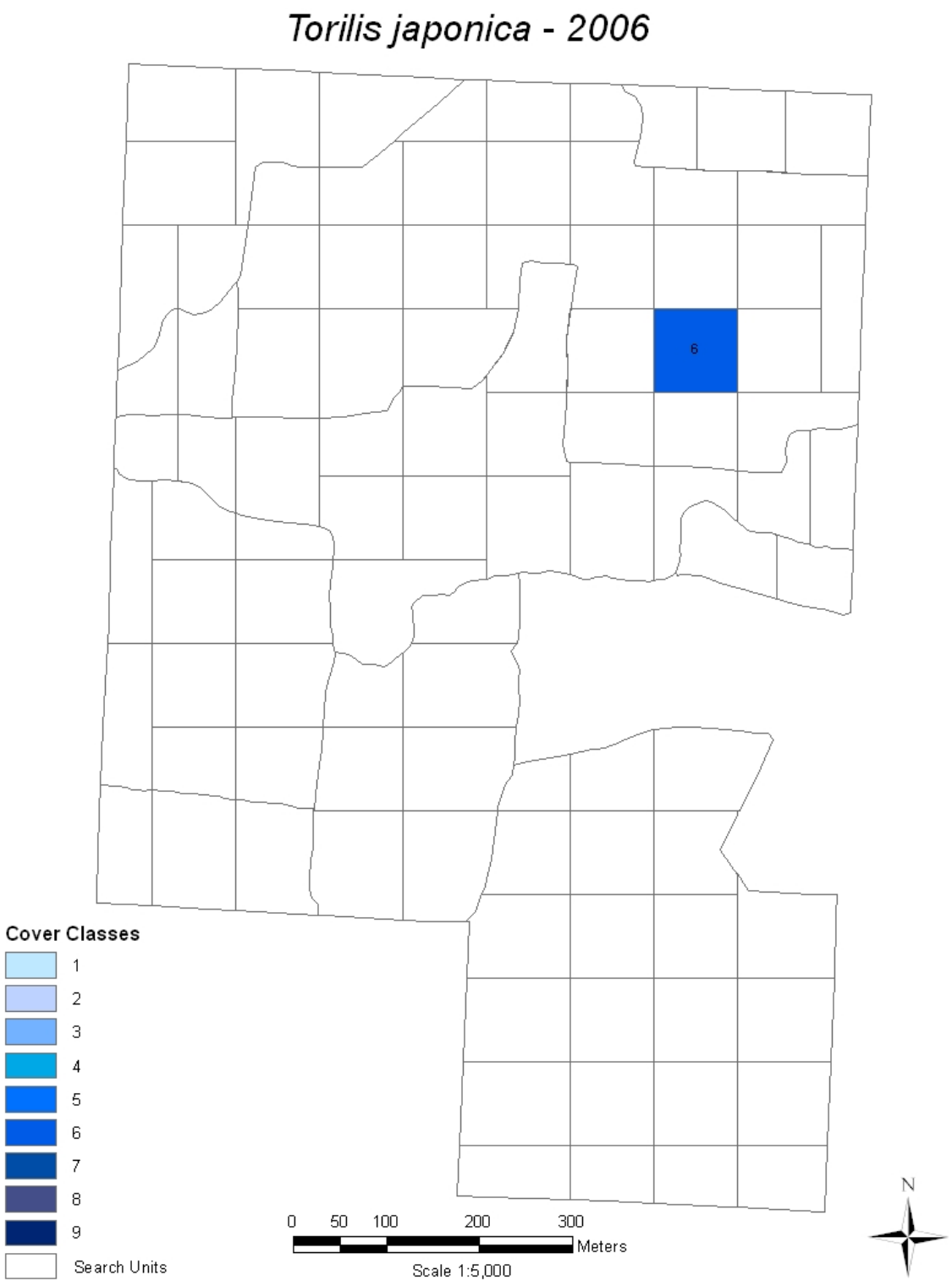

Figure 25. Abundance and distribution of *Torilis japonica* (erect hedge-parsley) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

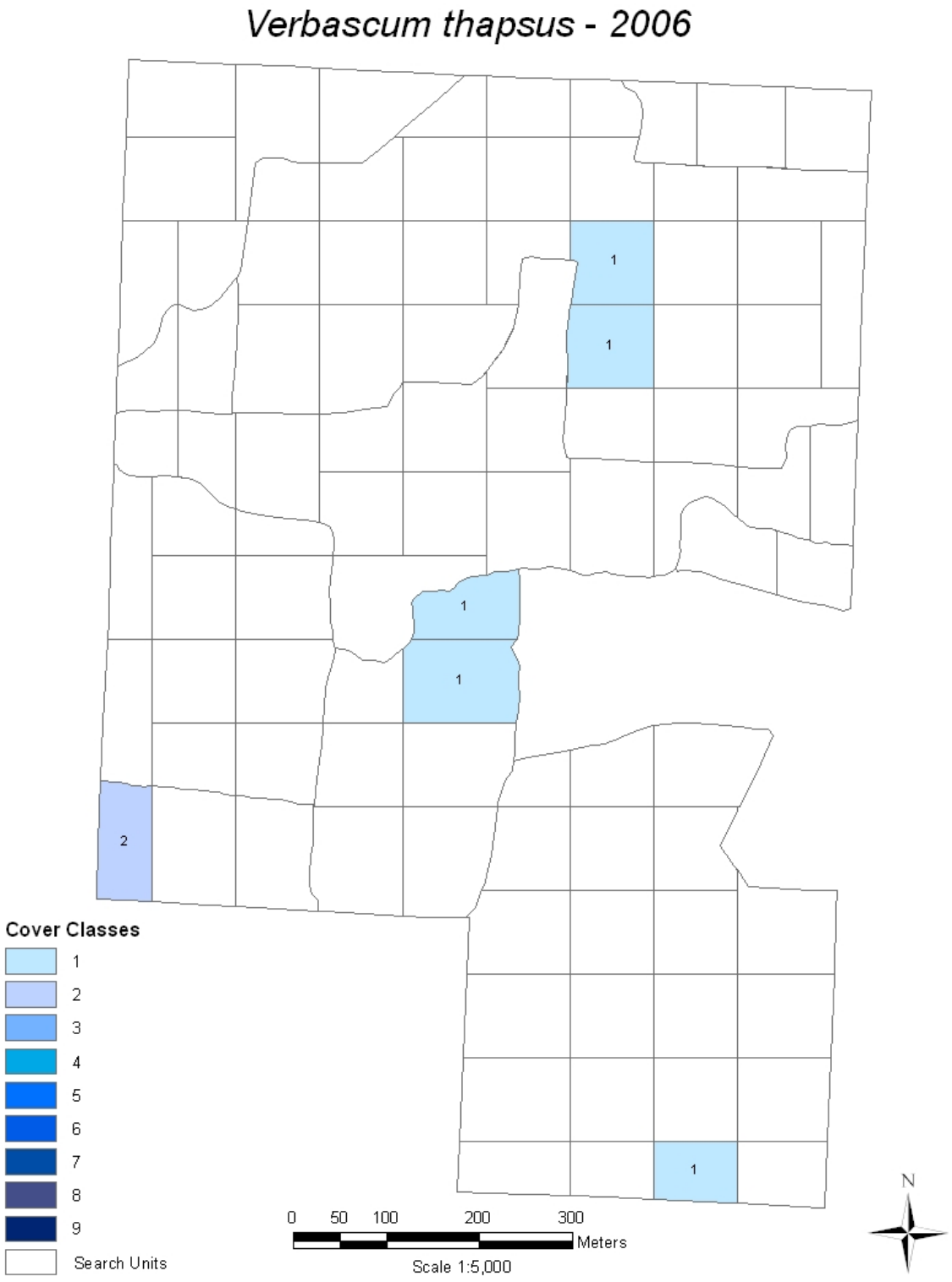

Figure 26. Abundance and distribution of *Verbascum thapsus* (common mullein) at George Washington Carver National Monument, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 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 sscientists, 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-53, March 2007

Natural Resource Program Center
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Fort Collins, CO 80525

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