National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Fort Collins, Colorado

Invasive Exotic Plant Monitoring at Arkansas Post National Memorial: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/016
NPS D-43

ON THE COVER
Mound at Osotouy unit, Arkansas Post National Memorial.

Invasive Exotic Plant Monitoring at Arkansas Post National Memorial: Year 1 (2006)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/016
NPS D-43

Craig C. Young, Jennifer L. Haack, J. Tyler Cribbs, and Holly J. Etheridge
National Park Service, Heartland I&M Network
Wilson's Creek National Battlefield, 6424 West Farm Road 182, Republic, MO 65738

March 2007

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The Natural Resource Publication series addresses natural resource topics that are of interest and applicability to a broad readership in the National Park Service and to others in the management of natural resources, including the scientific community, the public, and the NPS conservation and environmental constituencies. Manuscripts are peer-reviewed to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and is designed and published in a professional manner.

The Natural Resource Technical Report series is used to disseminate the peer-reviewed results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service's mission. The reports provide contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations. Current examples of such reports include the results of research that addresses natural resource management issues; natural resource inventory and monitoring activities; resource assessment reports; scientific literature reviews; and peer reviewed proceedings of technical workshops, conferences, or symposia.

Views and conclusions in this report are those of the authors and do not necessarily reflect policies of the National Park Service. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Printed copies of reports in these series may be produced in a limited quantity and they are only available as long as the supply lasts. This report is also available from the Heartland I&M Network website (http://www.nature.nps.gov/im/units/HTLN) on the internet, or by sending a request to the address on the back cover.

Please cite this publication as:

Young, C.C, J.L. Haack, J.T. Cribbs, and H.J. Etheridge. 2007. Invasive exotic plant monitoring at Arkansas Post National Memorial: Year 1 (2006). Natural Resource Technical Report NPS/HTLN/NRTR—2007/016. 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 20 invasive exotic plant taxa at Arkansas Post National Memorial. All of these taxa were known to occur on the park. Bluegrass, smooth brome, and reed canarygrass were widespread and abundant at Arkansas Post National Memorial. Each of these grasses was estimated to cover 12 or more acres on the monument. Out of the 19 invasive plants, 14 plants each occurred on less than two acres. In general, several invasive exotic plants are a major problem at Arkansas Post National Memorial, 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.

Table of Contents

Page

Introduction 1

Methods 3

Results and Discussion 4

Literature Cited 4

This page intentionally left blank.

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 Arkansas Post 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. Park-based invasive plant monitoring was conducted at Arkansas Post National Memorial in 2002.

2. A number of highly invasive exotics plants have established on Arkansas Post National Memorial. These plants include hardy orange (*Poncirus trifoliata*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and Canada thistle (*Cirsium arvense*).

3. Chinese privet at the memorial obscures the view through the forest understory in many sections of the park.

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 Arkansas Post National Memorial (Figures 1 and 2). 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 114 search units were surveyed at Arkansas Post 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 Arkansas Post National Memorial were attributed to search units in a GIS (Figures 3 – 21). 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 20 invasive exotic plant taxa were found during the survey at Arkansas Post National Memorial (Table 2). Eleven of these plant taxa were already known to occur at Arkansas Post National Memorial based on NPSpecies, the service-wide database for plant location data. Based on the survey results, Vasey's grass (*Paspalum urvillei*) was added to the park-based watch list. Eight plant taxa were not previously known to occur on the memorial according to NPSpecies.

The distribution and abundance of the invasive exotic plant species at Arkansas Post National Memorial varied widely. Two invasive exotic plants were widespread and abundant: hardy orange (*Poncirus trifoliata*) and Japanese honeysuckle (*Lonicera japonica*). Hardy orange covered at least 36 acres, while Japanese honeysuckle covered at least two acres. The three next most abundant invasive exotic plants with cover exceeding one acre included narrowleaf cattail (*Typha angustifolia*), common water hyacinth (*Eichhornia crassipes*), and Chinese privet (*Ligustrum sinense*). The remaining fifteen invasive exotic plant species covered less than 1 acre.

No invasive exotic plant species were noted as having unambiguously high ecological impact. (Table 2). Eight species were characterized as having at least a medium ecological impact. The remaining species had medium-low ecological impacts or less, including one species with low ecological impact. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, Chinese privet with a medium ecological impact was noted as having low management difficulty. Controlling this species will likely provide a high benefit for the management costs. On the other hand, the management of common water hyacinth, Japanese honeysuckle, Johnsongrass (*Sorghum halepense*), Bermudagrass (*Cynodon dactylon*), and Nepalese browntop (*Microstegium vimineum*) may prove to be more 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/.

Literature Cited

Asher, J. A., and D. W. Harmon. 1995. Invasive exotic plants are destroying the naturalness of U.S. Wilderness areas. International Journal of Wilderness 1:35-37.

D'Antonio, C. M., and B. E. Mahall. 1991. Root profiles and competition between the invasive, exotic perennial, *Carpobrotus edulis*, and two native shrub species in California coastal scrub. American Journal of Botany 78:885-894.

DeBacker, M.D., C.C. Young (editor), P. Adams, L. Morrison, D. Peitz, G.A. Rowell, M. Williams, and D. Bowles. 2005. Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program Vital Signs Monitoring Plan. National Park Service, Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield, Republic, Missouri, 104 pp. plus appendices.

Ehrenfeld, J.G. 2003. The effects of exotic plant invasions on soil nutrient cycling processes. Ecosystems 6:503-523.

King, W. B. 1985. Island birds: will the future repeat the past? Pages 3-15 *in* P. J. Moors, editor. Conservation of Island Birds. International Council for Bird Preservation. Cambridge University Press, Cambridge, UK.

Marler, M. 1998. Exotic plant invasions of federal Wilderness areas: current status and future directions. The Aldo Leopold Wilderness Research Institute. Rocky Mountain Research Station, Missoula, Montana, USA.

Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States. OTA-F-565. U.S. Congress, Government Printing Office, Washington, D.C., USA.

Rejmanek, M., and M. J. Pitcairn. 2002. When is eradication of exotic pest plants a realistic goal? Pages 249-253 in C. R. Veitch and M. N. Clout, editors. Turning the Tide: the Eradication of Invasive Species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Rejmanek, M., and J. M. Randall. 1994. Invasive alien plants in California: 1993 summary and comparison with other areas in North America. Madrono 41:161–177.

Tilman, D. 1999. The ecological consequences of changes in biodiversity: a search for general principles. Ecology 80:1455-1474.

Vitousek, P. M. 1990. Biological invasions and ecosystem processes: towards an integration of population biology and ecosystem studies. Oikos 57:7-13.

Welch, B.A. and P.H. Geissler. 2007. Early detection of invasive plants: a handbook. United States Geological Survey draft. http://www.pwrc.usgs.gov/brd/invasiveHandbook.cfm.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. Bioscience 48:607–615.

Williamson, M. 1993. Invaders, weeds and risk from genetically modified organisms. Experientia 49:219–224.

Williamson, M. and A. Fitter. 1996. The varying success of invaders. Ecology 77:1661–1666.

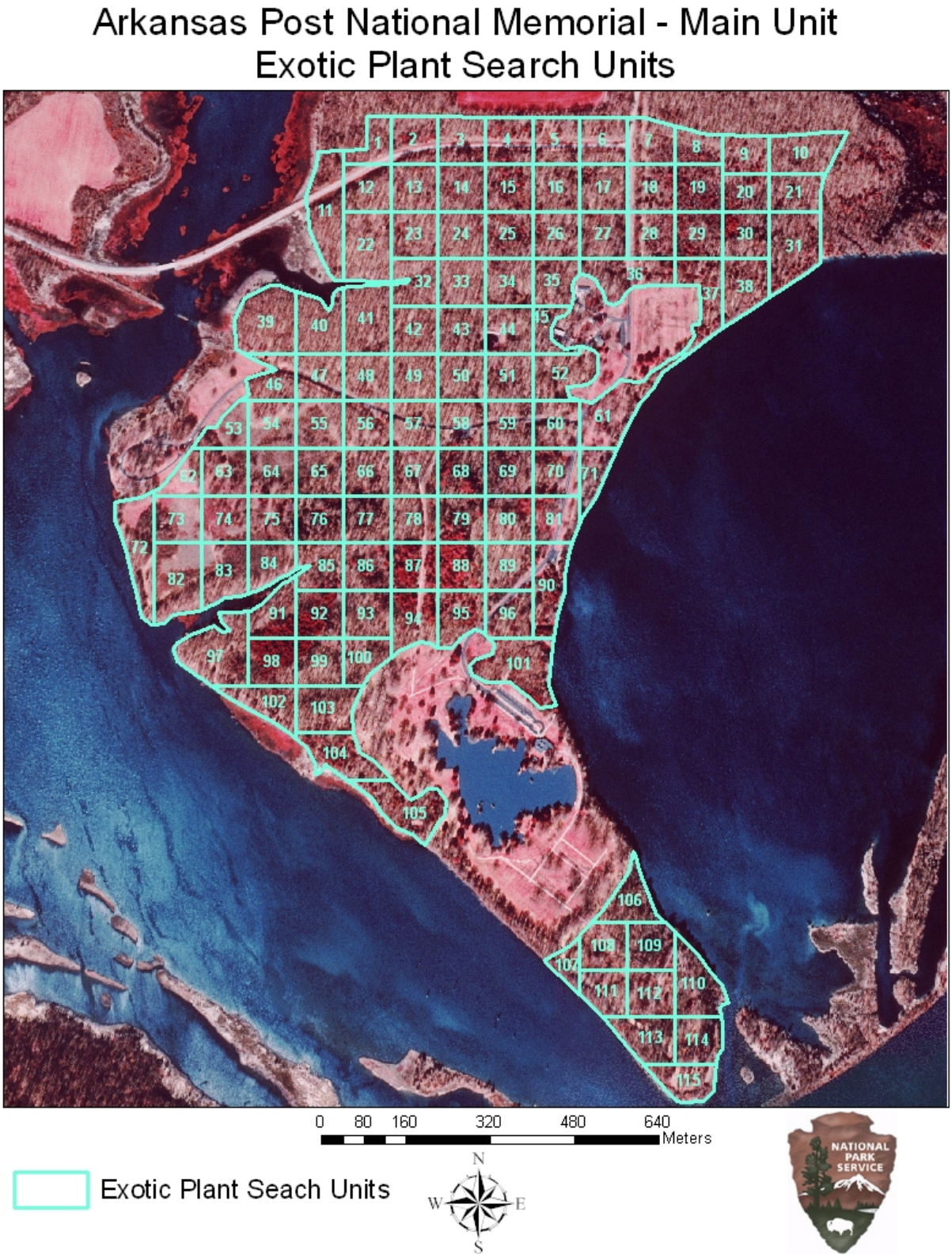

Figure 1. Invasive exotic plant search units at Arkansas Post National Memorial – Main Unit. The search units indicate the search locations for invasive exotic plants in 2006.

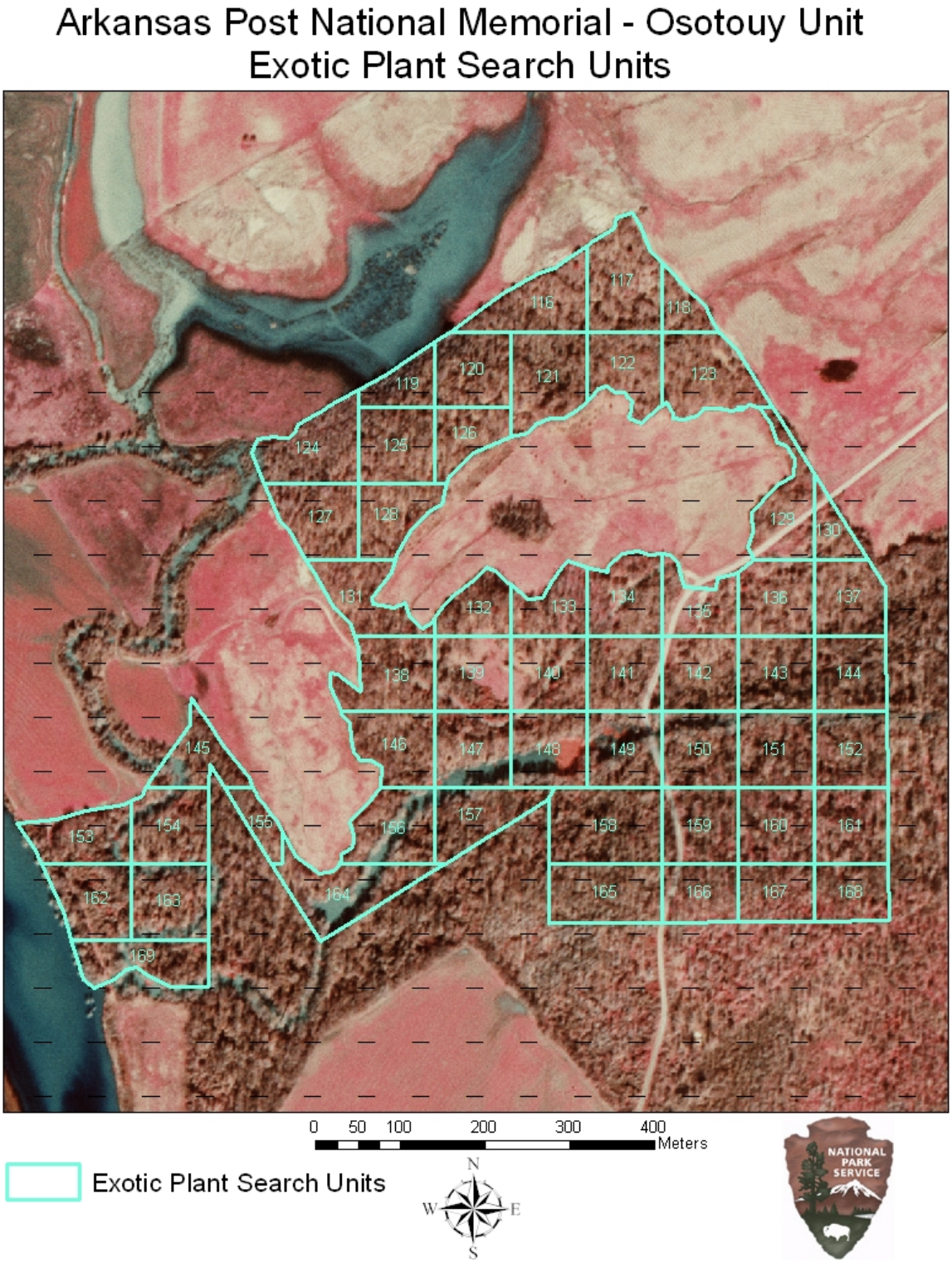

Figure 2. Invasive exotic plant search units at Arkansas Post National Memorial – Osotouy Unit. The search units indicate the search locations for invasive exotic plants in 2006.

Table 1. Watch lists for Arkansas Post National Memorial

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Ailanthus altissima	Tree of heaven	*Albizia julibrissin*	Silktree	*Paspalum urvillei*	Vasey's grass
Alliaria petiolata	Garlic mustard	*Alternanthera philoxeroides*	Alligatorweed		
Alternanthera sessilis	Sessile joyweed	*Baccharis halimifolia*	Eastern baccharis		
Ampelopsis brevipedunculata	Amur peppervine	*Cynodon dactylon*	Bermudagrass		
Arctium minus	Lesser burdock	*Echinochloa crus-galli*	Barnyardgrass		
Arundo donax	Giant reed	*Ligustrum sinense*	Chinese privet		
Azolla	Mosquitofern	*Ligustrum vulgare*	European privet		
Bothriochloa bladhii	Caucasian bluestem	*Lonicera japonica*	Japanese honeysuckle		
Bromus inermis	Smooth brome	*Poncirus trifoliata*	Hardy orange		
Bromus sterilis	Poverty brome	*Populus alba*	White poplar		
Bromus tectorum	Cheatgrass	*Robinia pseudoacacia*	Black locust		
Carduus nutans	Nodding plumeless thistle	*Sorghum halepense*	Johnsongrass		
Celastrus orbiculatus	Oriental bittersweet	*Torilis arvensis*	Spreading hedgeparsley		
Centaurea biebersteinii	Spotted knapweed	*Verbascum thapsus*	Common mullein		
Cirsium arvense	Canada thistle	*Vinca major*	Bigleaf periwinkle		
Cirsium vulgare	Bull thistle	*Wisteria sinensis*	Chinese wisteria		
Dactylis glomerata	Orchardgrass				
Dioscorea oppositifolia	Chinese yam				
Dipsacus fullonum	Fuller's teasel				
Egeria densa	Brazilian waterweed				
Eichhornia crassipes	Common water hyacinth				
Elaeagnus pungens	Thorny olive				
Elaeagnus umbellata	Autumn olive				
Eragrostis curvula	Weeping lovegrass				
Euonymus fortunei	Winter creeper				
Glechoma hederacea	Ground ivy				
Hedera helix	English ivy				
Hesperis matronalis	Dames rocket				
Holcus lanatus	Common velvetgrass				
Humulus japonicus	Japanese hop				
Hydrilla verticillata	Waterthyme				
Imperata cylindrica	Cogongrass				
Lespedeza bicolor	Shrub lespedeza				
Lespedeza cuneata	Sericea lespedeza				

Table 1 (cont.). Watch lists for Arkansas Post National Memorial

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Ligustrum lucidum	Glossy privet				
Lolium arundinaceum	Tall fescue				
Lolium pratense	Meadow fescue				
Lonicera maackii	Amur honeysuckle				
Lonicera morrowii	Morrow's honeysuckle				
Lotus corniculatus	Bird's-foot trefoil				
Lygodium japonicum	Japanese climbing fern				
Lysimachia nummularia	Creeping jenny				
Lythrum salicaria	Purple loosestrife				
Melia azedarach	Chinaberrytree				
Melilotus officinalis	Yellow sweetclover				
Microstegium vimineum	Nepalese browntop				
Morus alba	White mulberry				
Murdannia keisak	Wartremoving herb				
Myriophyllum aquaticum	Parrot feather watermilfoil				
Myriophyllum spicatum	Eurasian watermilfoil				
Nandina domestica	Sacred bamboo				
Pastinaca sativa	Wild parsnip				
Paulownia tomentosa	Princesstree				
Phalaris arundinacea	Reed canarygrass				
Photinia serratifolia	Taiwanese photinia				
Phragmites australis	Common reed				
Plantago lanceolata	Narrowleaf plantain				
Poa compressa	Canada bluegrass				
Poa pratensis	Kentucky bluegrass				
Polygonum cuspidatum	Japanese knotweed				
Potamogeton crispus	Curly pondweed				
Potentilla recta	Sulphur cinquefoil				
Pueraria montana var. lobata	Kudzu				
Pyrus calleryana	Callery pear				
Rhamnus cathartica	Common buckthorn				
Rosa multiflora	Multiflora rose				
Salvinia molesta	Kariba-weed				
Securigera varia	Crownvetch				

Table 1 (cont.). Watch lists for Arkansas Post National Memorial

Early Detection Watch List		Park-Established Watch List		Park-Based Watch List	
Solanum viarum	Tropical soda apple				
Sphenoclea zeylanica	Chickenspike				
Tamarix ramosissima	Saltcedar				
Torilis japonica	Erect hedgeparsley				
Triadica sebifera	Chinese tallow				
Typha angustifolia	Narrowleaf cattail				
Ulmus pumila	Siberian elm				
Vinca minor	Common periwinkle				
Wisteria floribunda	Japanese wisteria				

Table 2. Overview of invasive exotic plants found on Arkansas Post 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	Watch list	Park-wide cover (acres)	Frequency (percent)	Ecological impact	Management difficulty
Poncirus trifoliata	Park-established	36.1 – 72.2	39.6	----	----
Lonicera japonica	Park-established	2.2 – 9.4	58.6	M	HM
Typha angustifolia	Early detection	1.1 - 3.4	4.7	HM	M
Eichhornia crassipes	Early detection	1.0 - 2.8	4.7	HM	H
Ligustrum sinense	Park-established	1.0 - 3.9	38.5	M	L
Sorghum halepense	Park-established	<1.0	5.9	ML	HM
Vinca major	Park-established	<1.0	1.8	----	----
Baccharis halimifolia	Park-established	<0.75	9.2	----	----
Cynodon dactylon	Park-established	<0.5	0.6	ML	HM
Robinia pseudoacacia	Park-established	<0.5	6.5	HM	M
Alternanthera philoxeroides	Park-established	<0.25	7.8	HM	M
Lespedeza cuneata	Early detection	<0.25	1.2	ML	ML
Melia azedarach	Early detection	<0.25	1.8	ML	ML
Microstegium vimineum	Early detection	<0.25	3.0	M	HM
Murdannia keisak	Early detection	<0.25	3.0	M	U
Torilis japonica	Early detection	<0.25	1.2	----	----
Rosa multiflora	Early detection	<0.25	1.8	L	L
Albizia julibrissin	Park-established	<0.1	3.5	ML	ML
Paspalum urvillei	Add to park-based	<0.01	0.6	----	----
Verbascum thapsus	Park-established	<0.01	0.6	ML	L

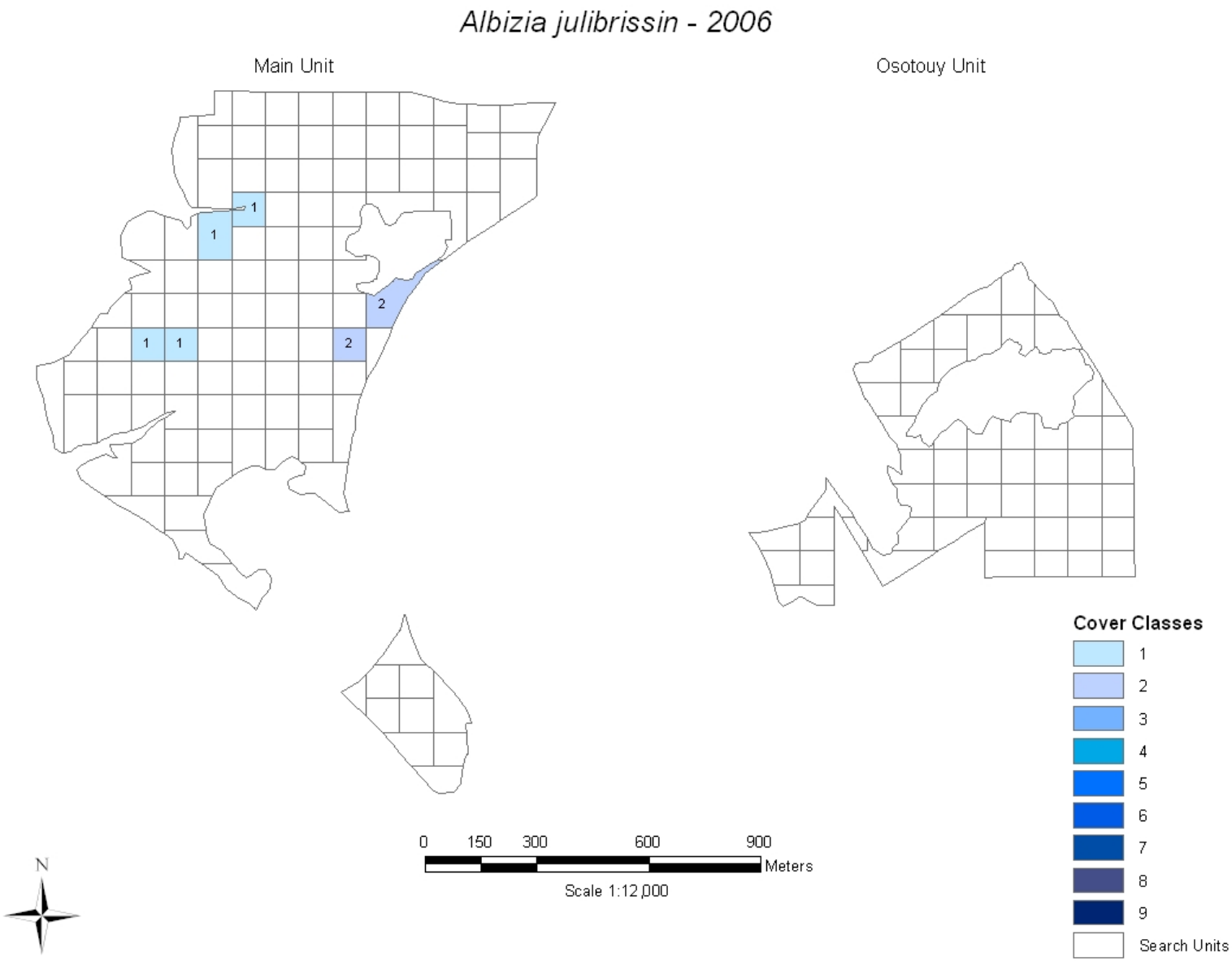

Figure 3. Abundance and distribution of *Ablizia julibrissin* (silktree) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

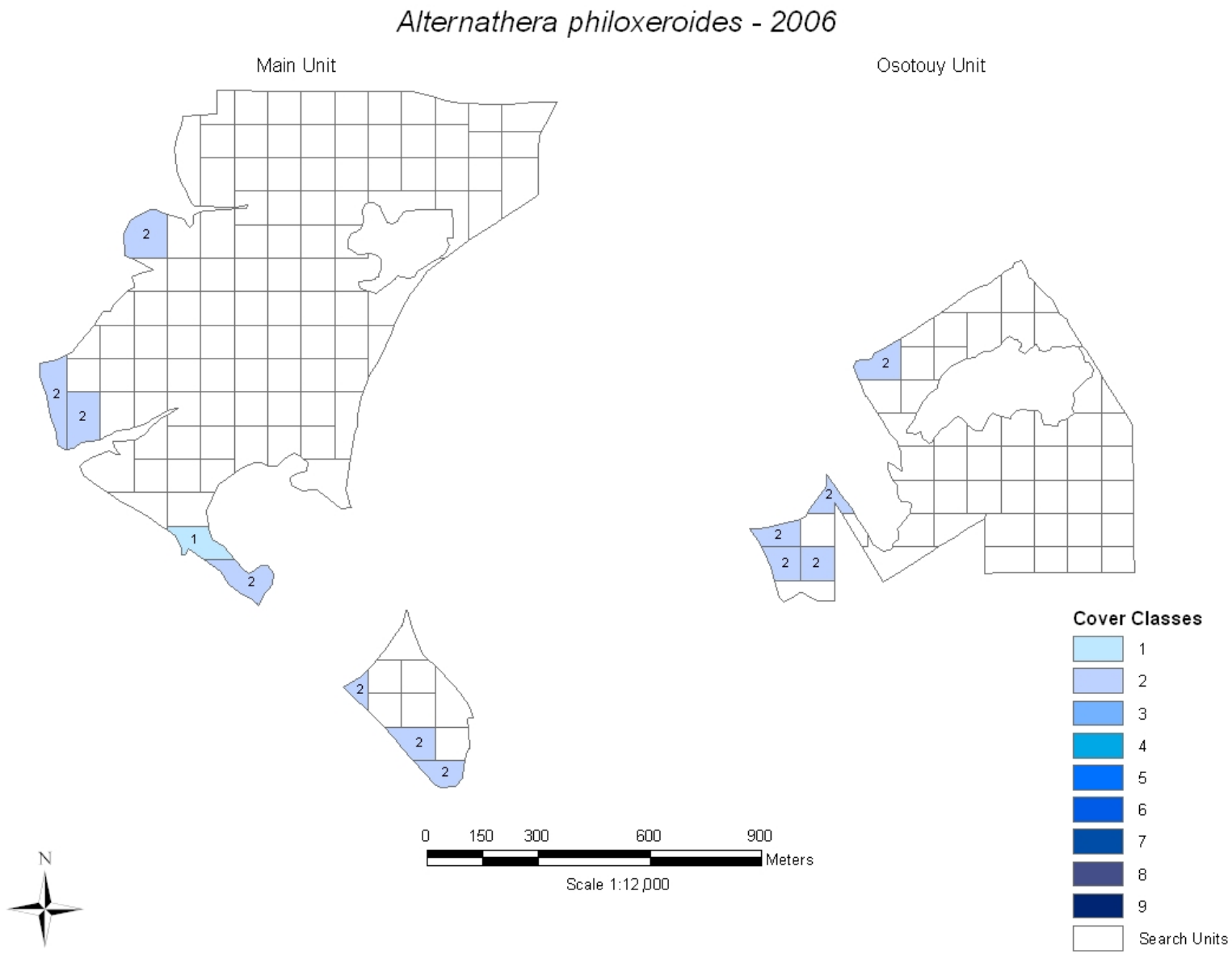

Figure 4. Abundance and distribution of *Alternathera philoxeroides* (alligatorweed) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

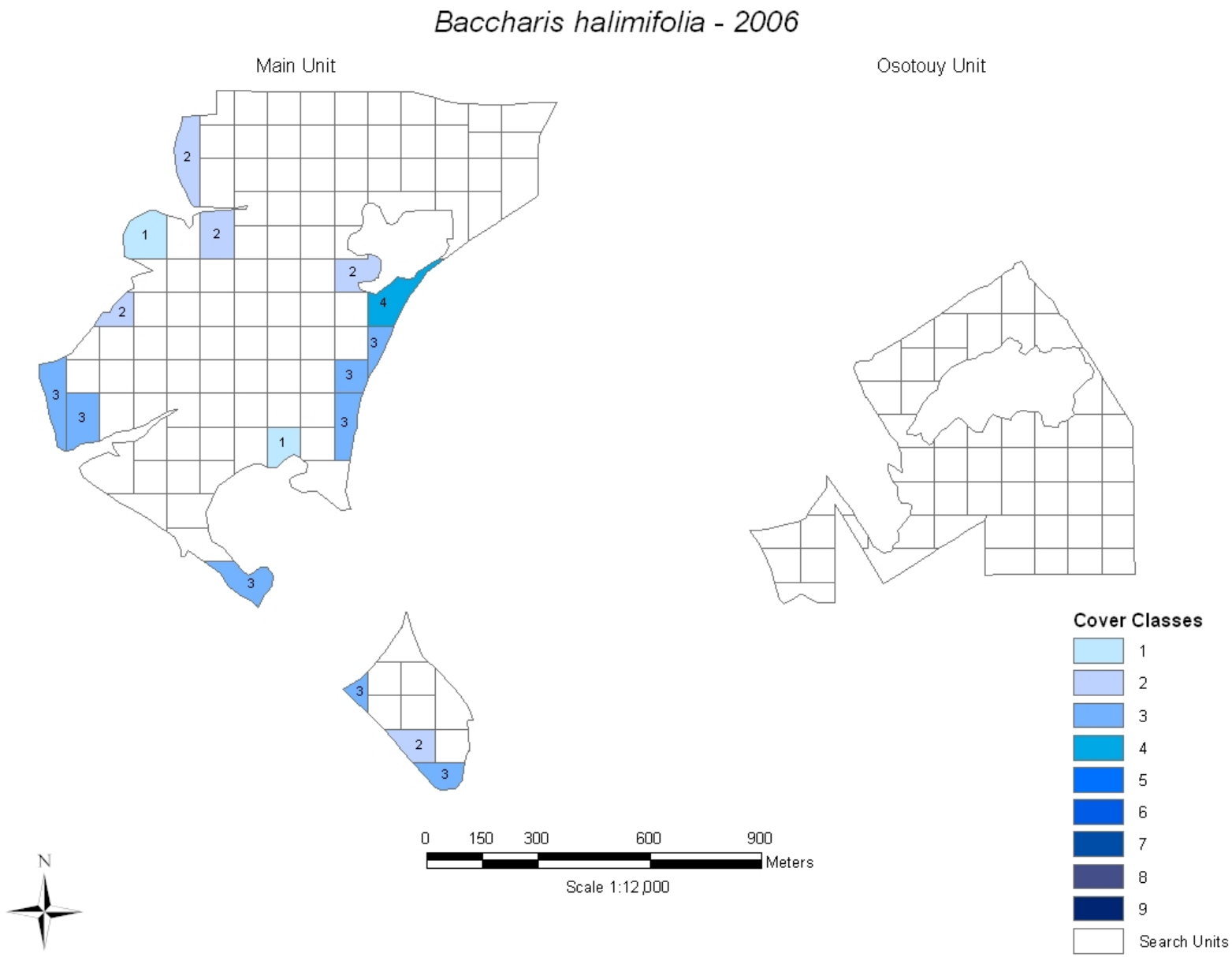

Figure 5. Abundance and distribution of *Baccharis halimifolia* (Eastern baccharis) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

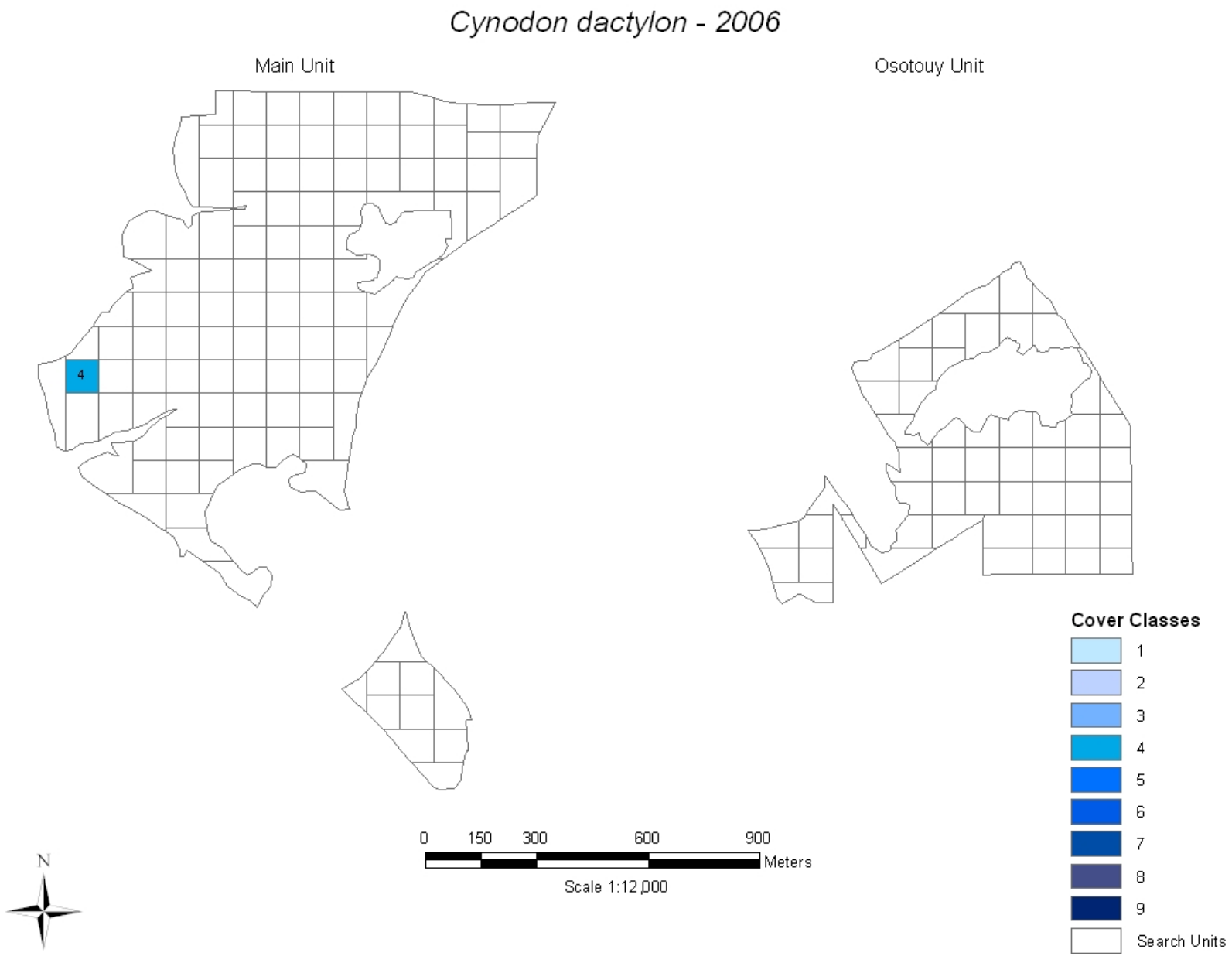

Figure 6. Abundance and distribution of *Cynodon dactylon* (Bermudagrass) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 77=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

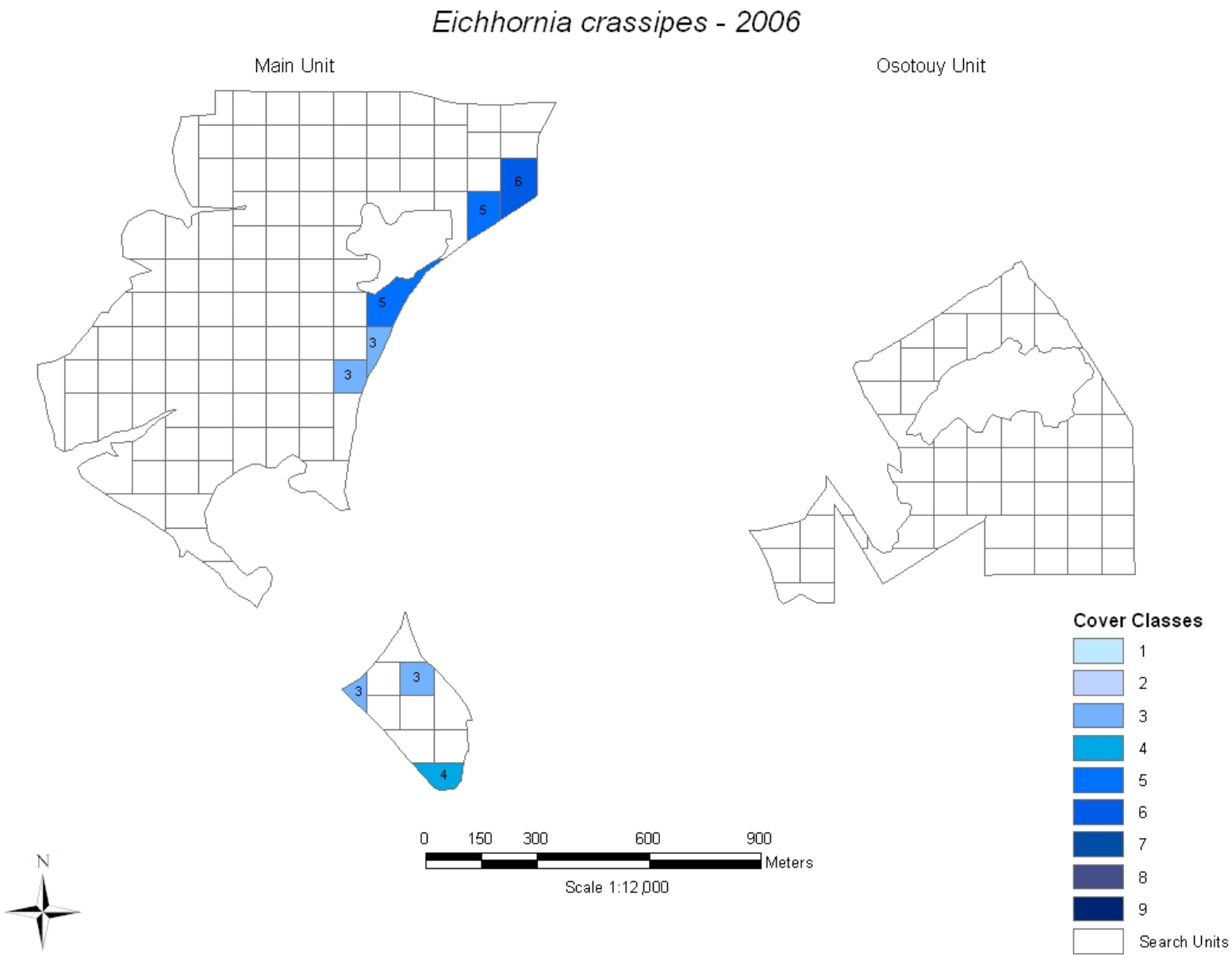

Figure 7. Abundance and distribution of *Eichhornia crassipes* (common water hyacinth) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

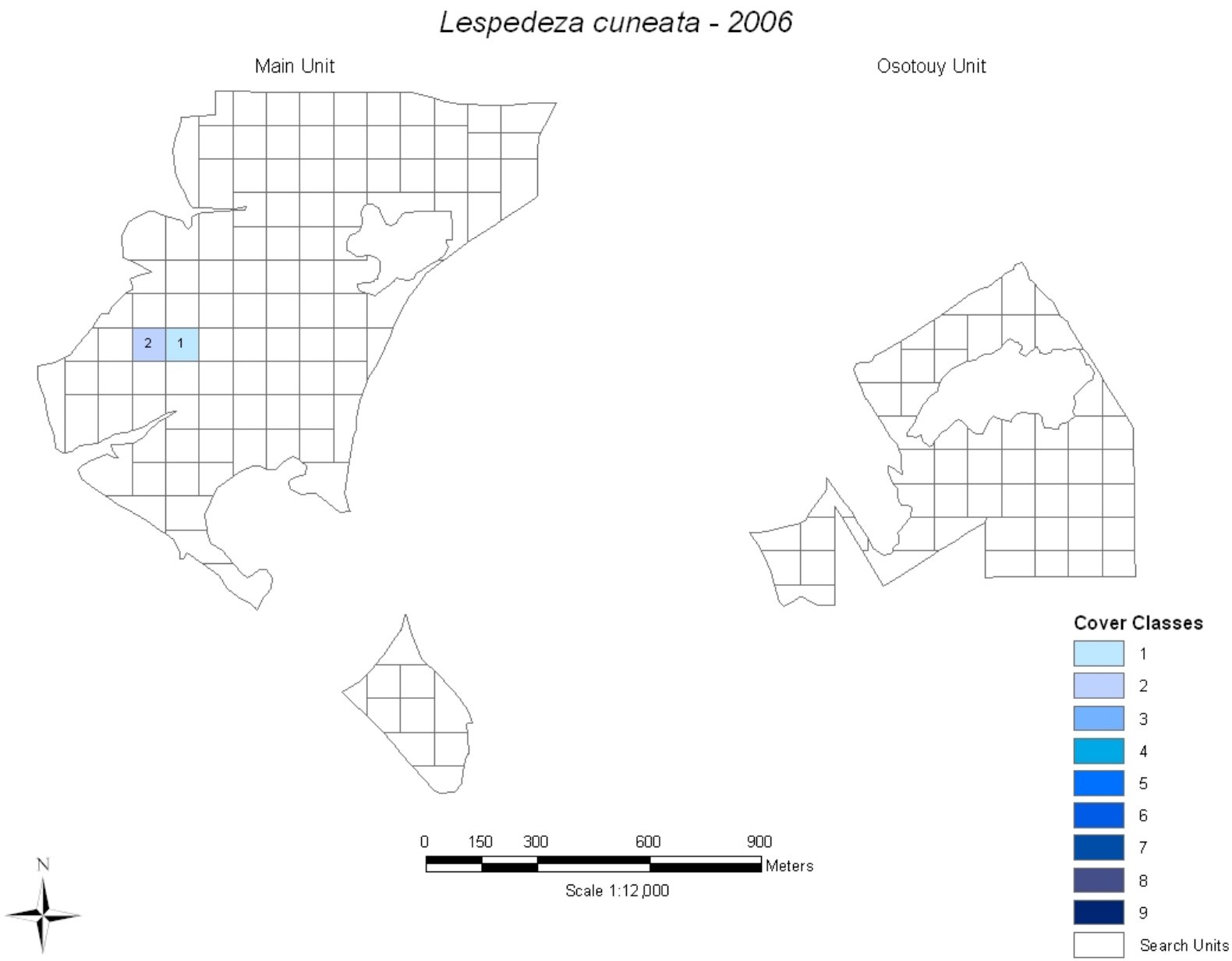

Figure 8. Abundance and distribution of *Lespedeza cuneata* (sericea lespedeza) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

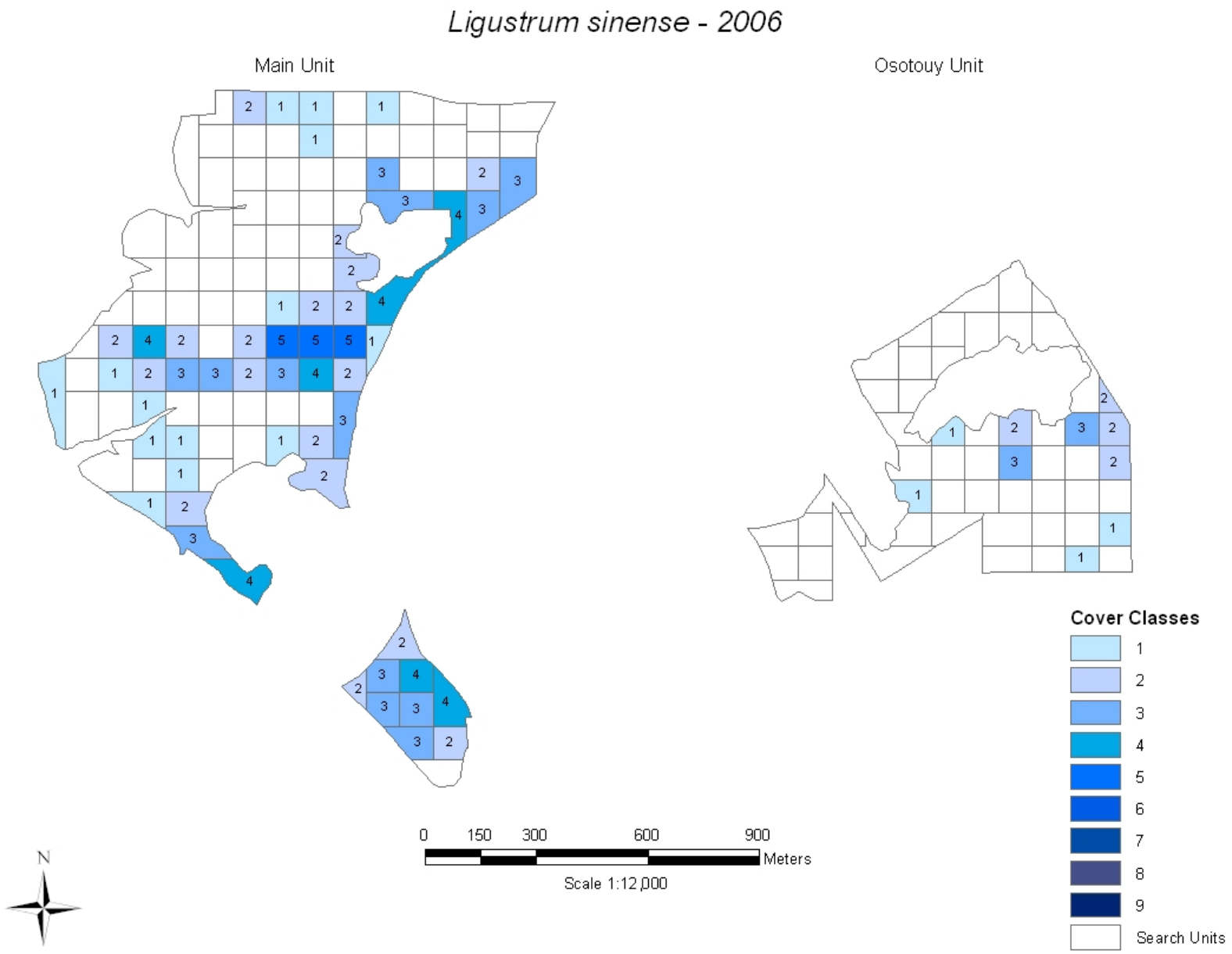

Figure 9. Abundance and distribution of *Ligustrum sinense* (Chinese privet) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

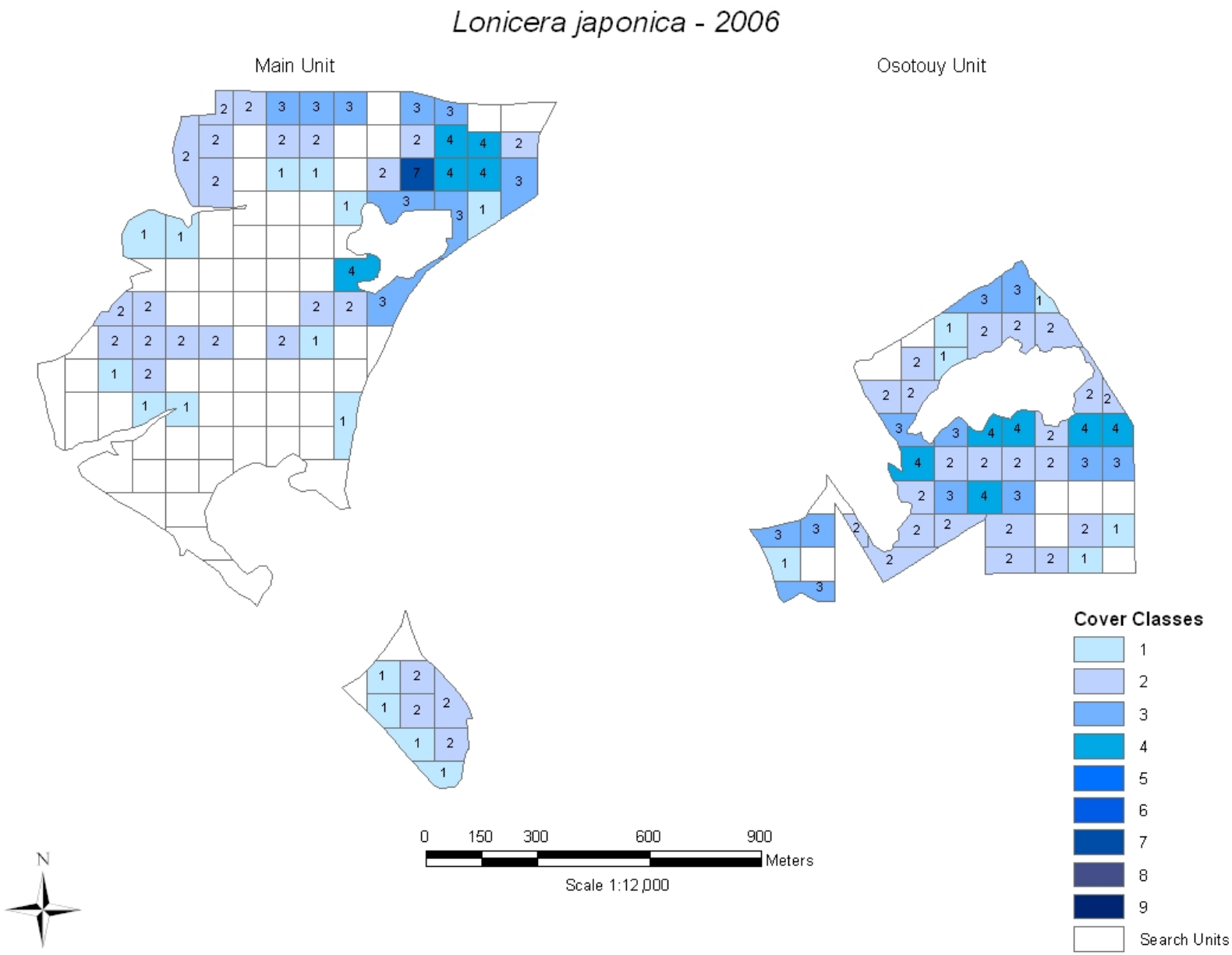

Figure 10. Abundance and distribution of *Lonicera japonica* (Japanese honeysuckle) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

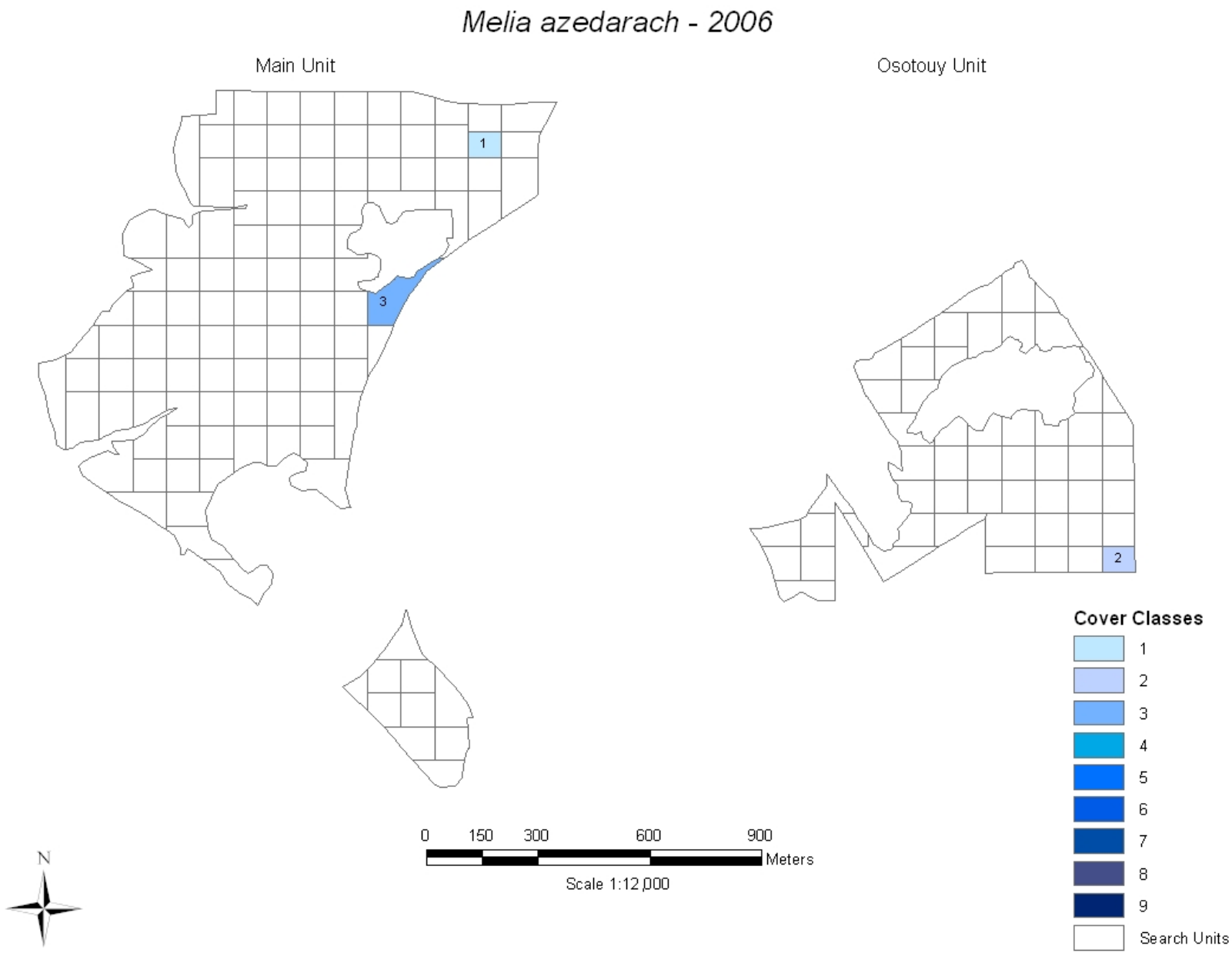

Figure 11. Abundance and distribution of *Melia azedarach* (Chinaberrytree) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

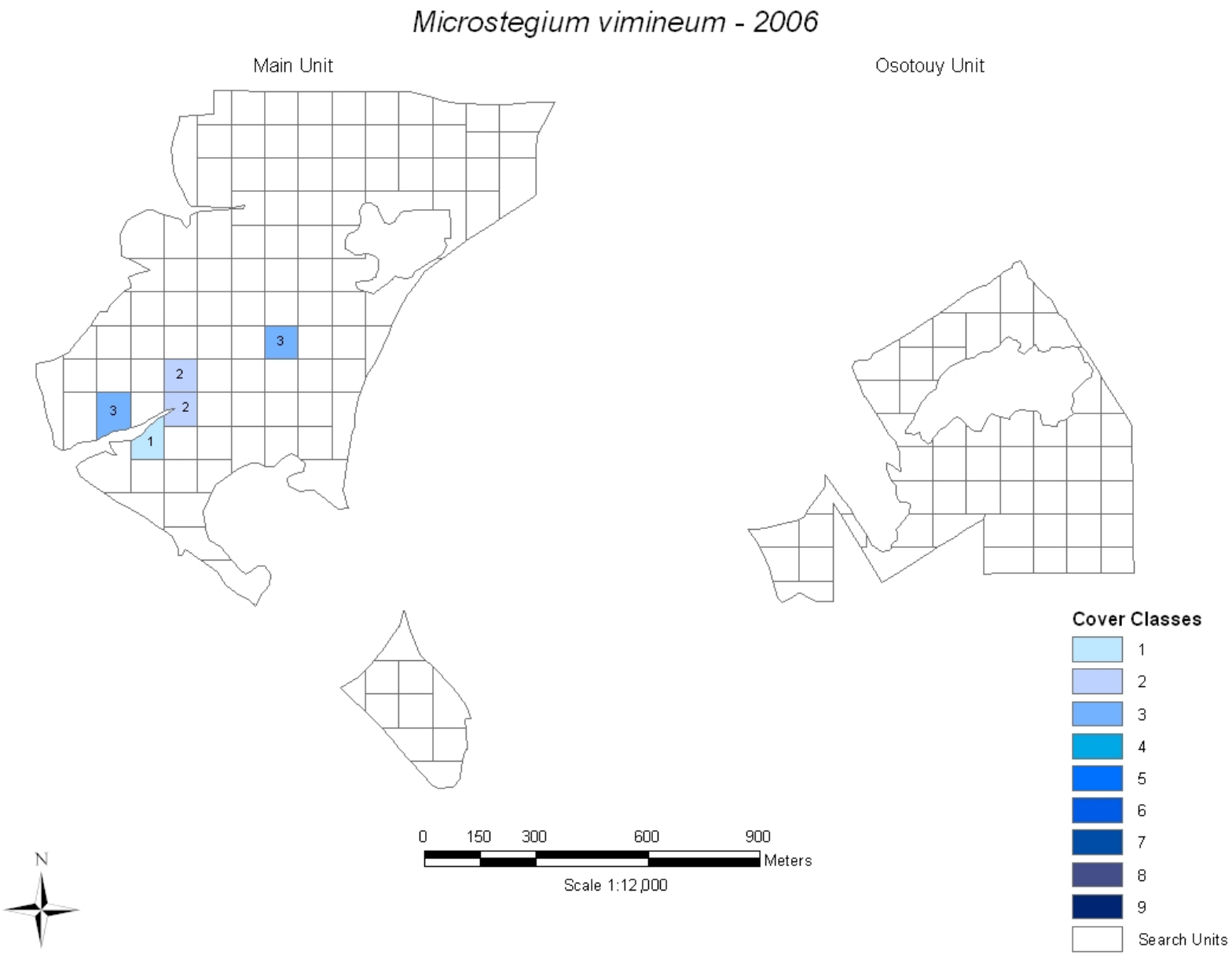

Figure 12. Abundance and distribution of *Microstegium vimineum* (Nepalese browntop) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

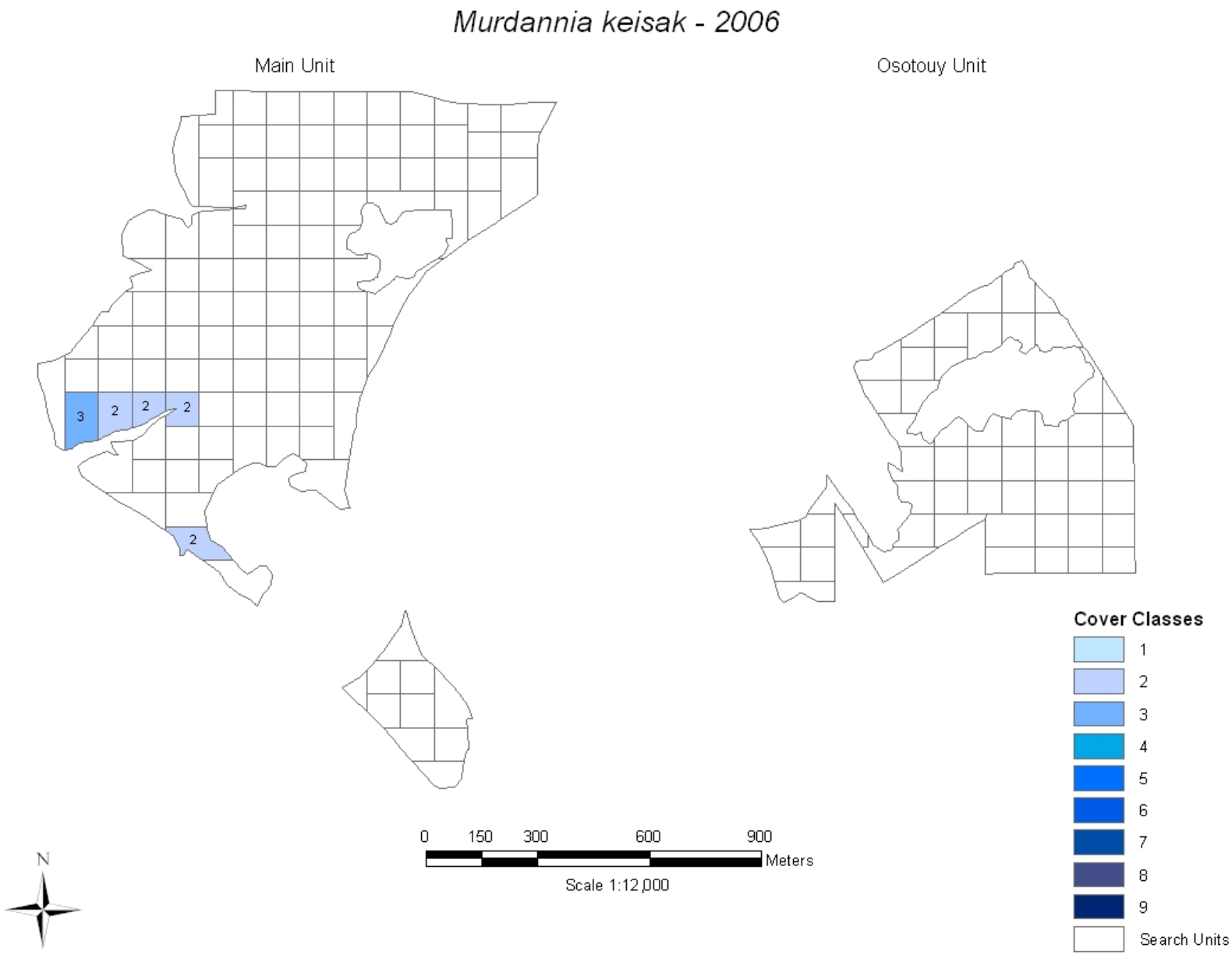

Figure 13. Abundance and distribution of *Murdannia keisak* (wartremoving herb) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

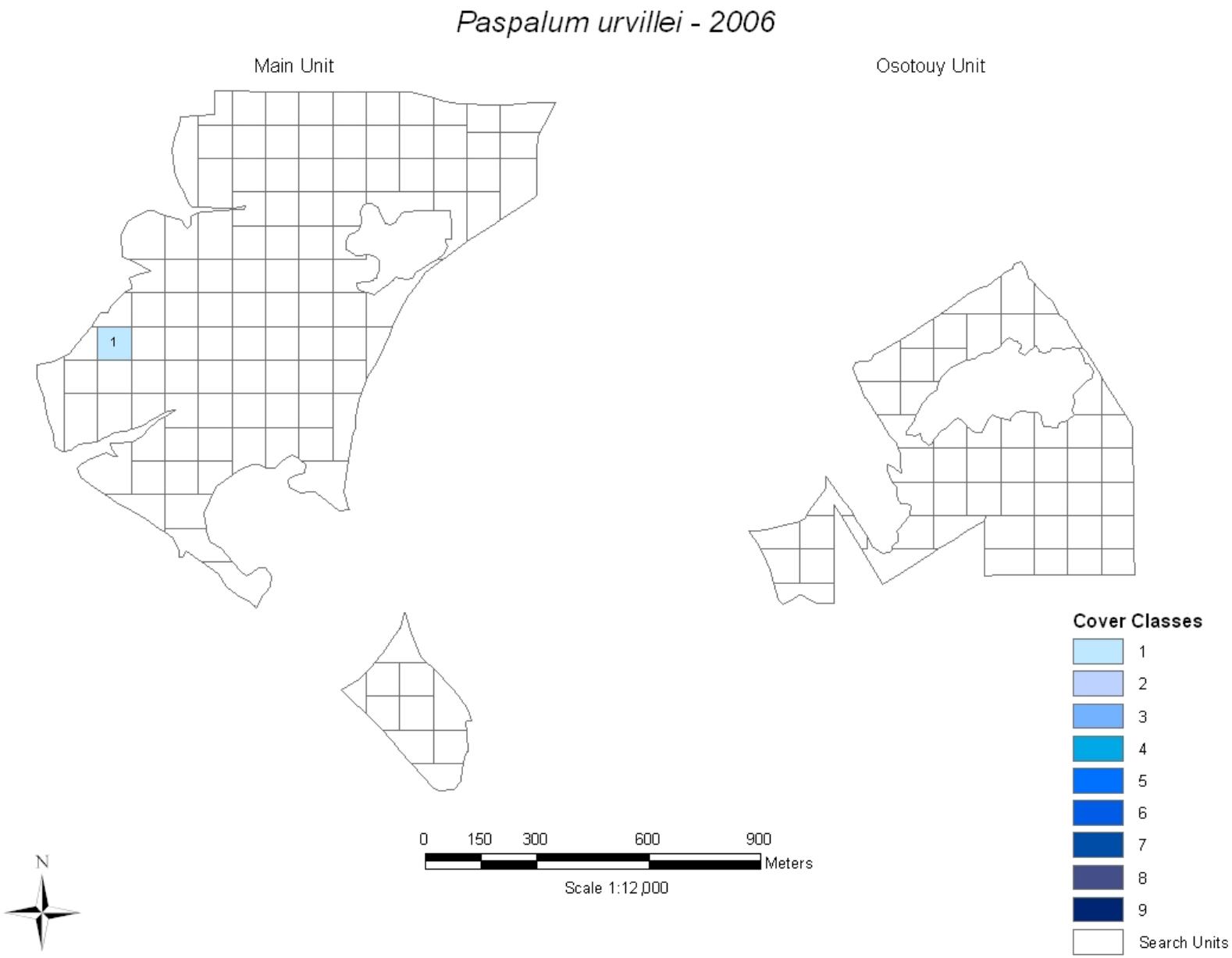

Figure 14. Abundance and distribution of *Paspalum urvillei* (Vasey's grass) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

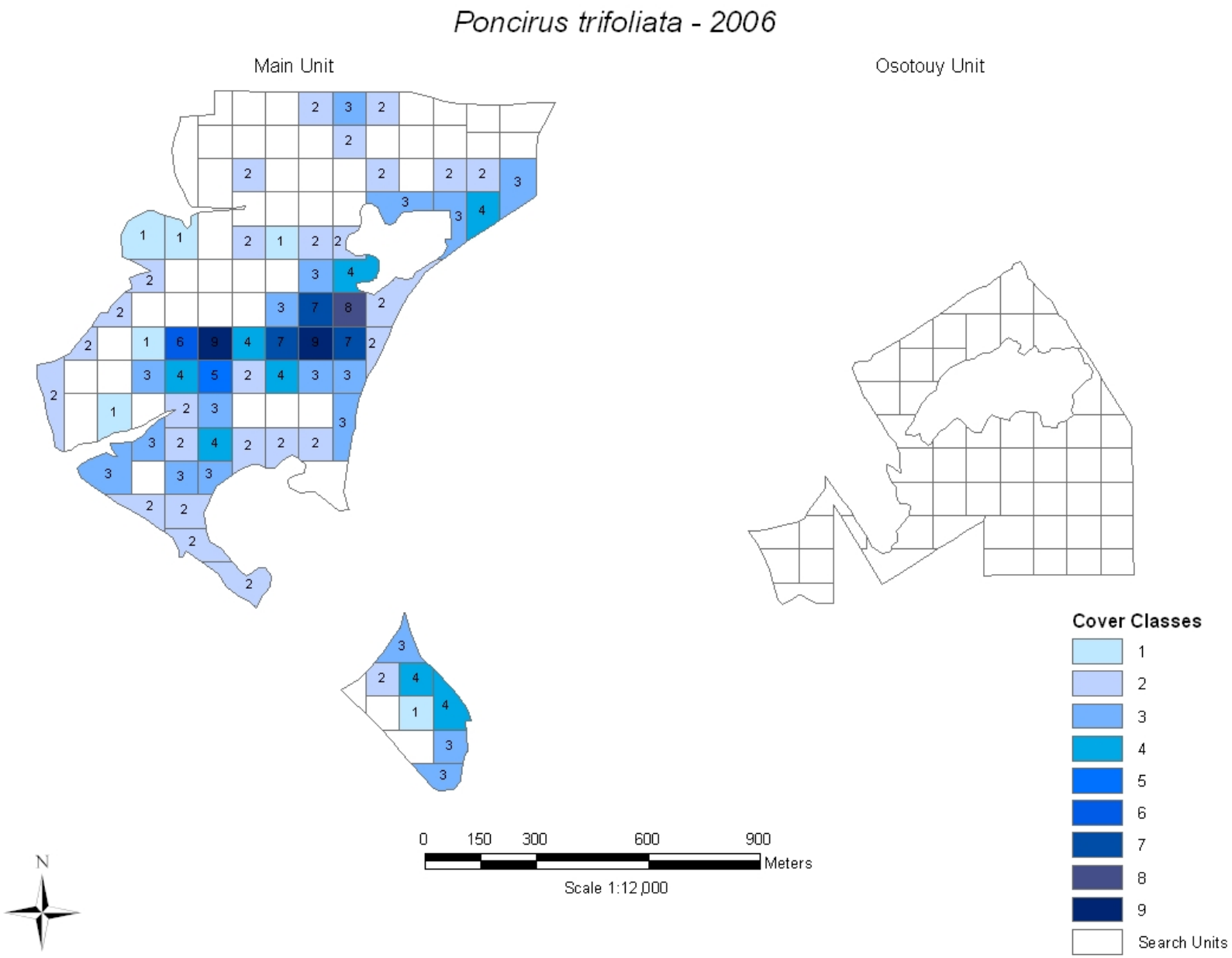

Figure 15. Abundance and distribution of *Poncirus trifoliata* (hardy orange) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

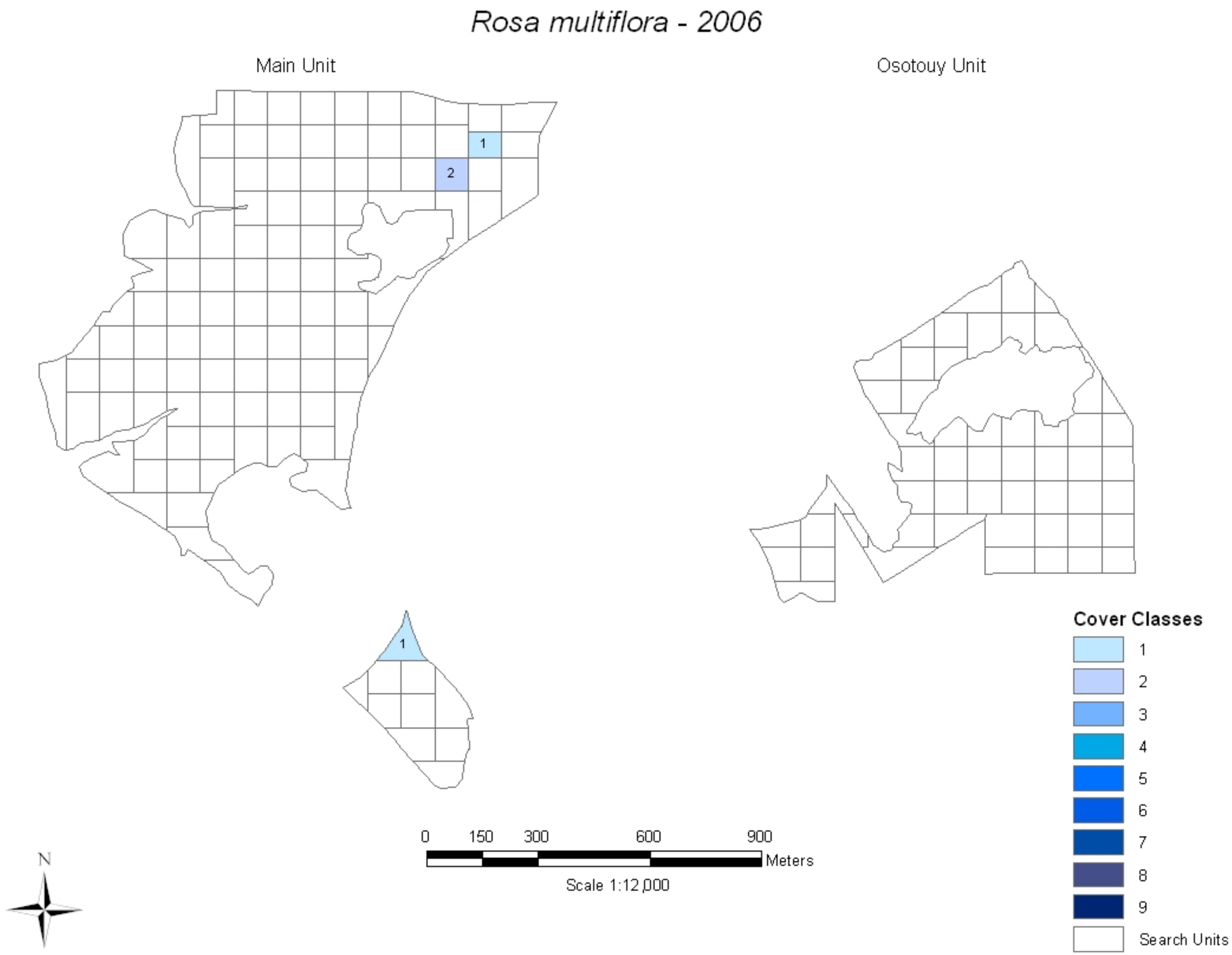

Figure 16. Abundance and distribution of *Rosa multiflora* (multiflora rose) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

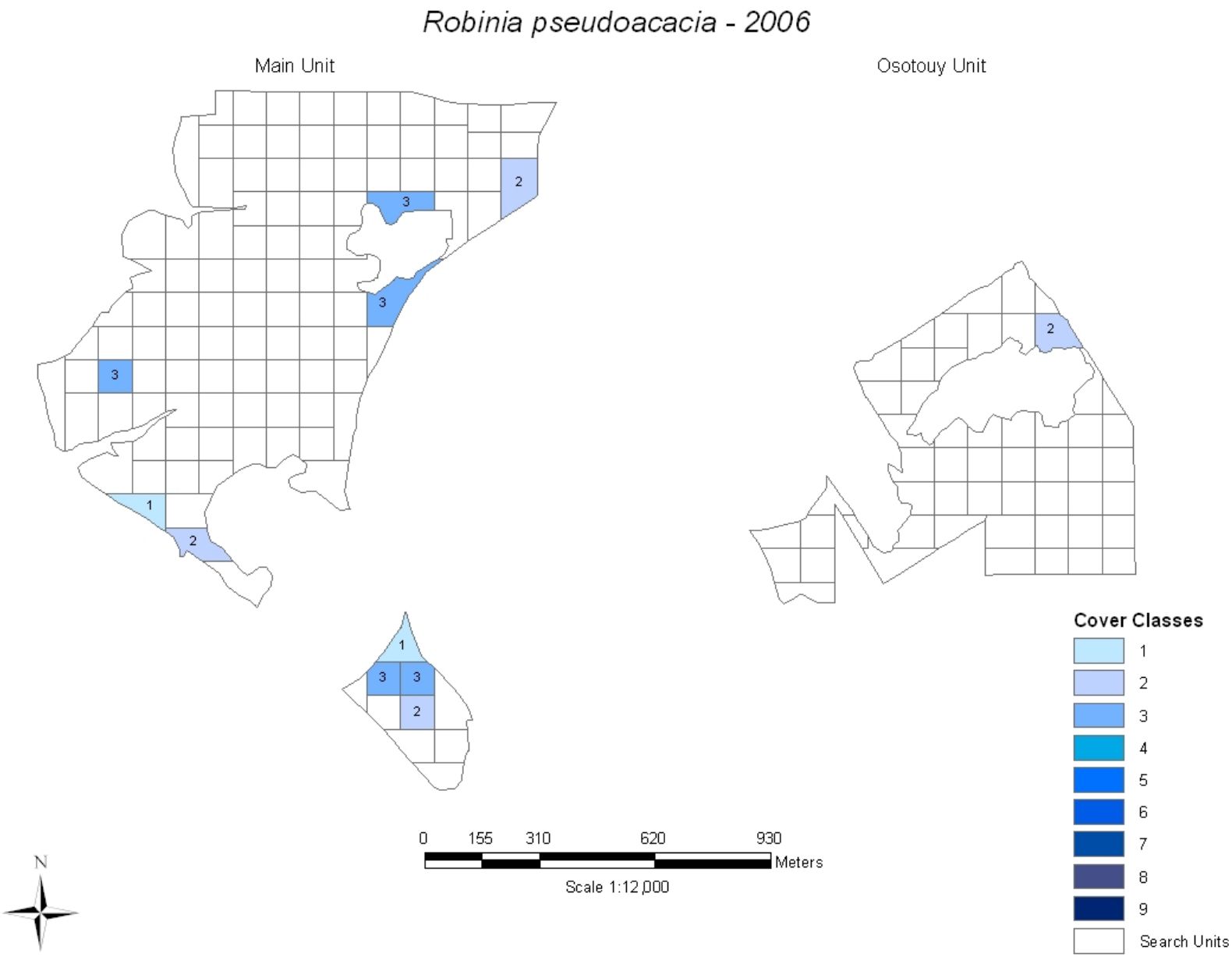

Figure 17. Abundance and distribution of *Robinia pseudoacacia* (black locust) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

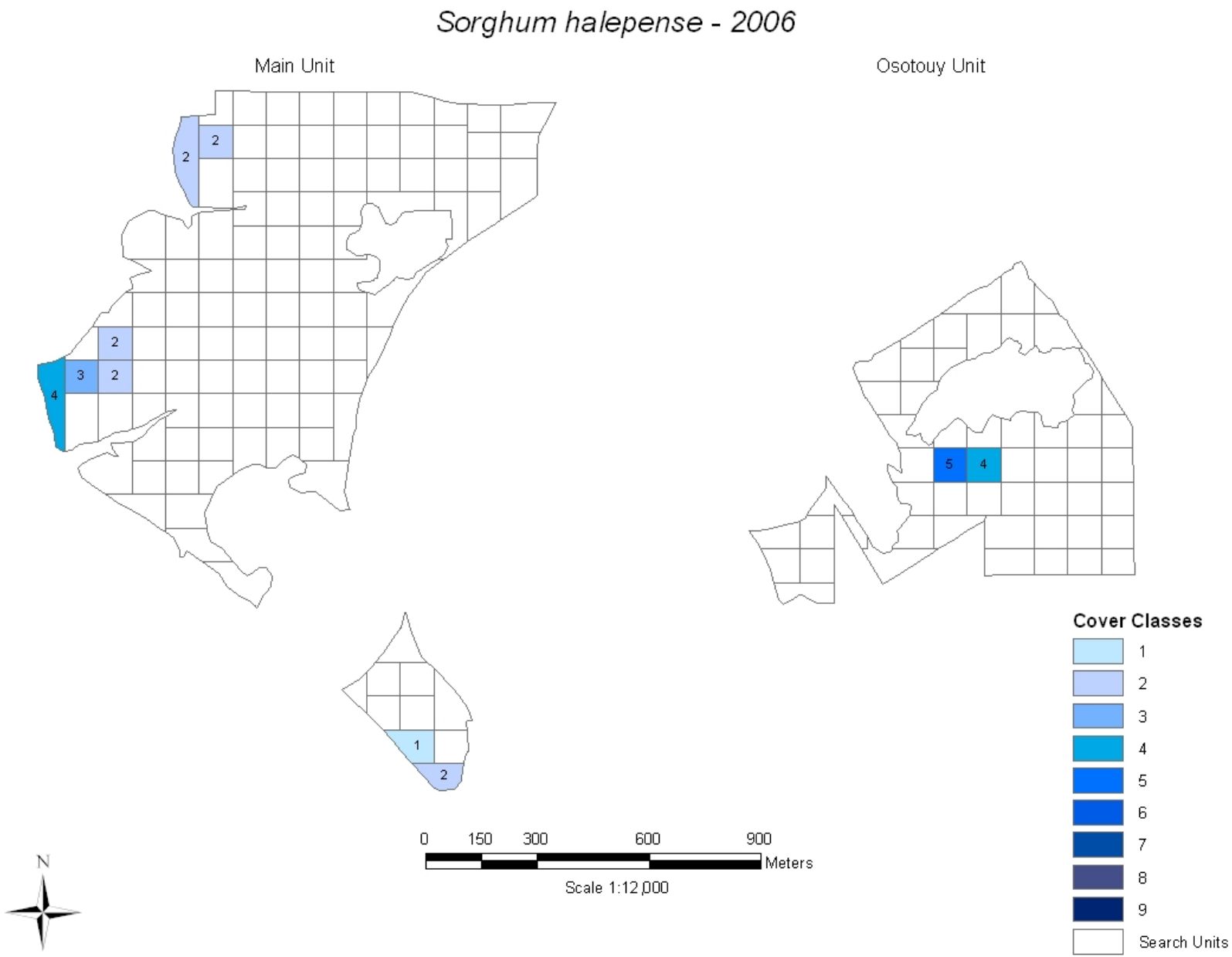

Figure 18. Abundance and distribution of *Sorghum halepense* (Johnsongrass) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9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

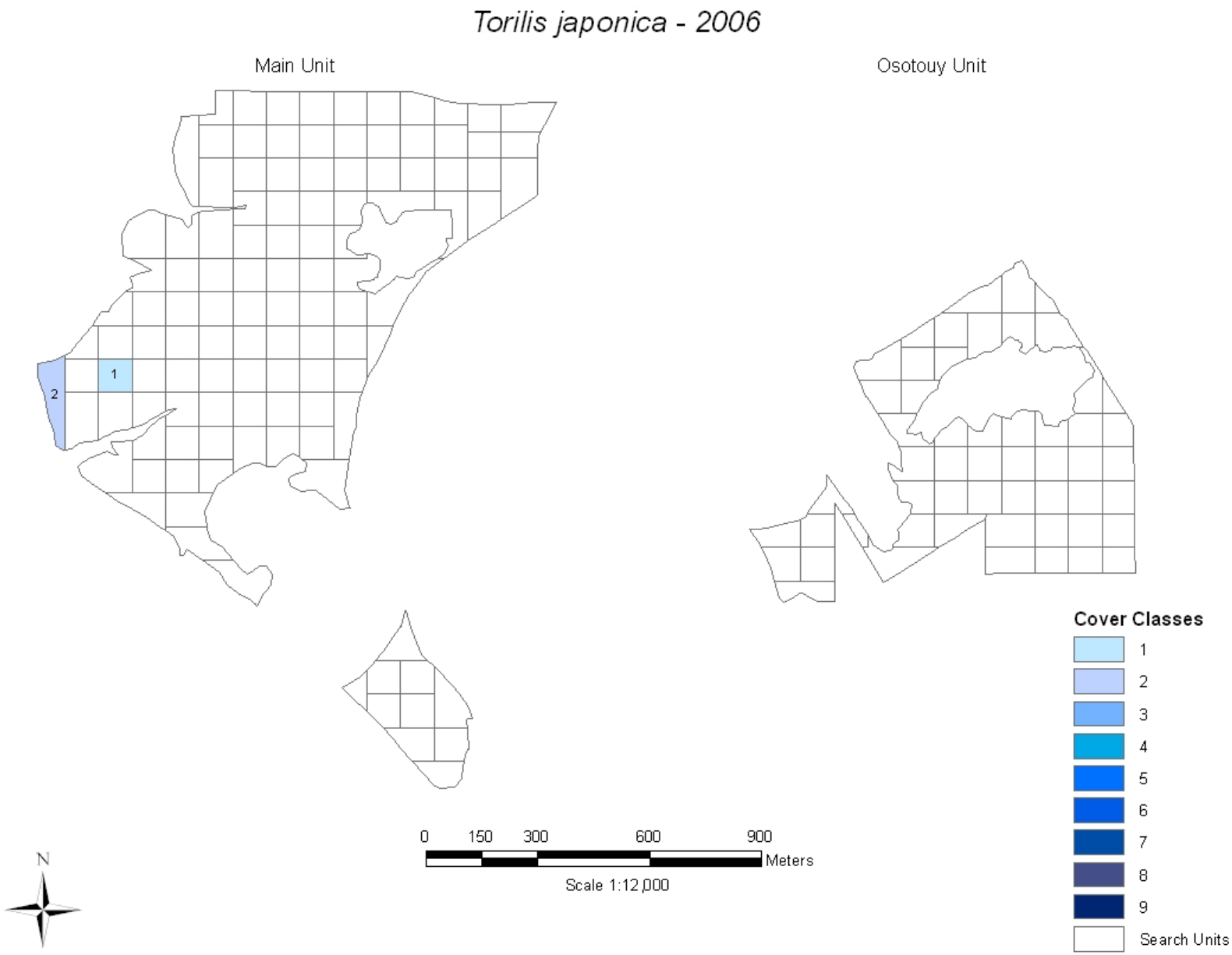

Figure 19. Abundance and distribution of *Torilis japonica* (erect hedgeparsley) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

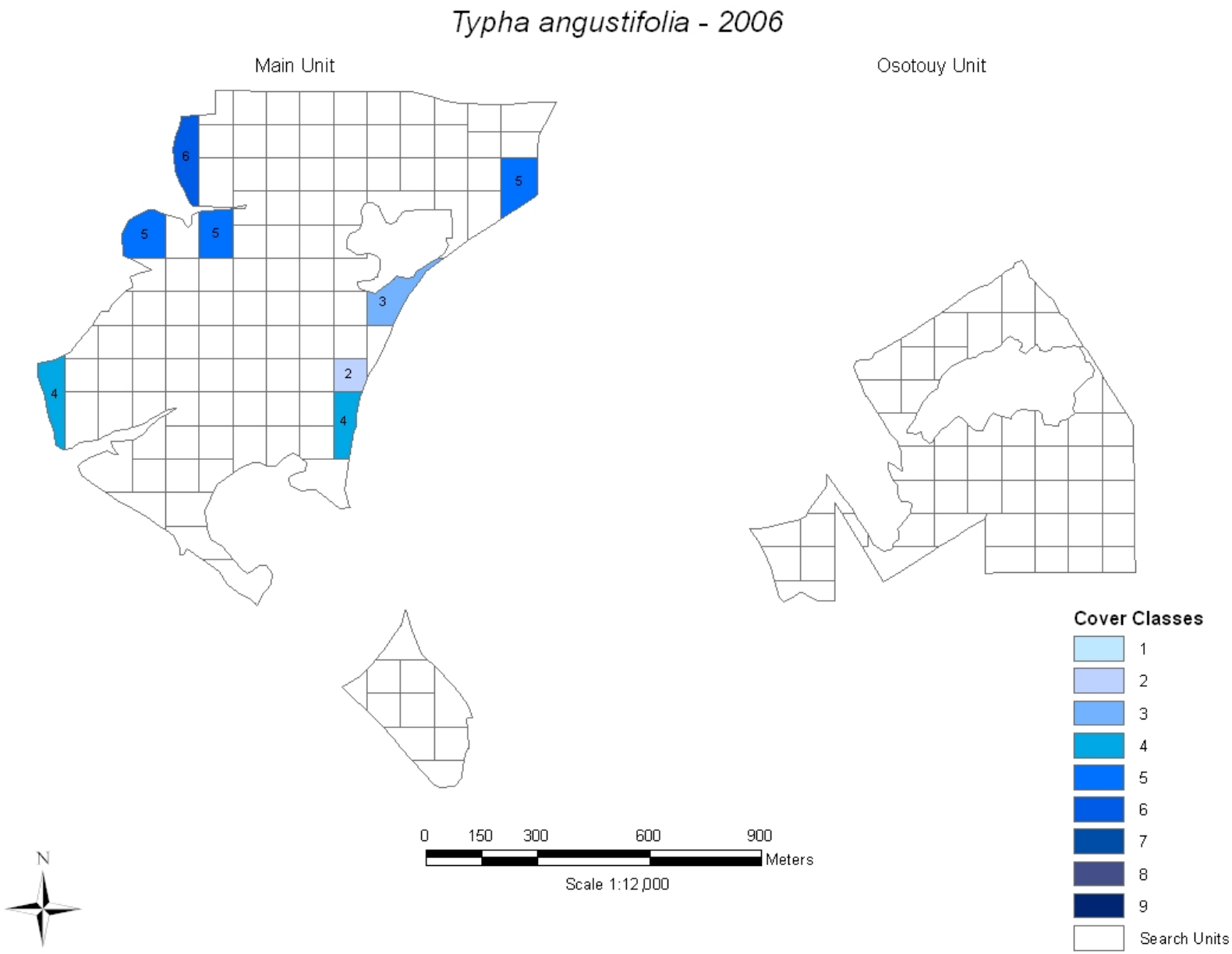

Figure 20. Abundance and distribution of *Typha angustifolia* (narrowleaf cattail) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

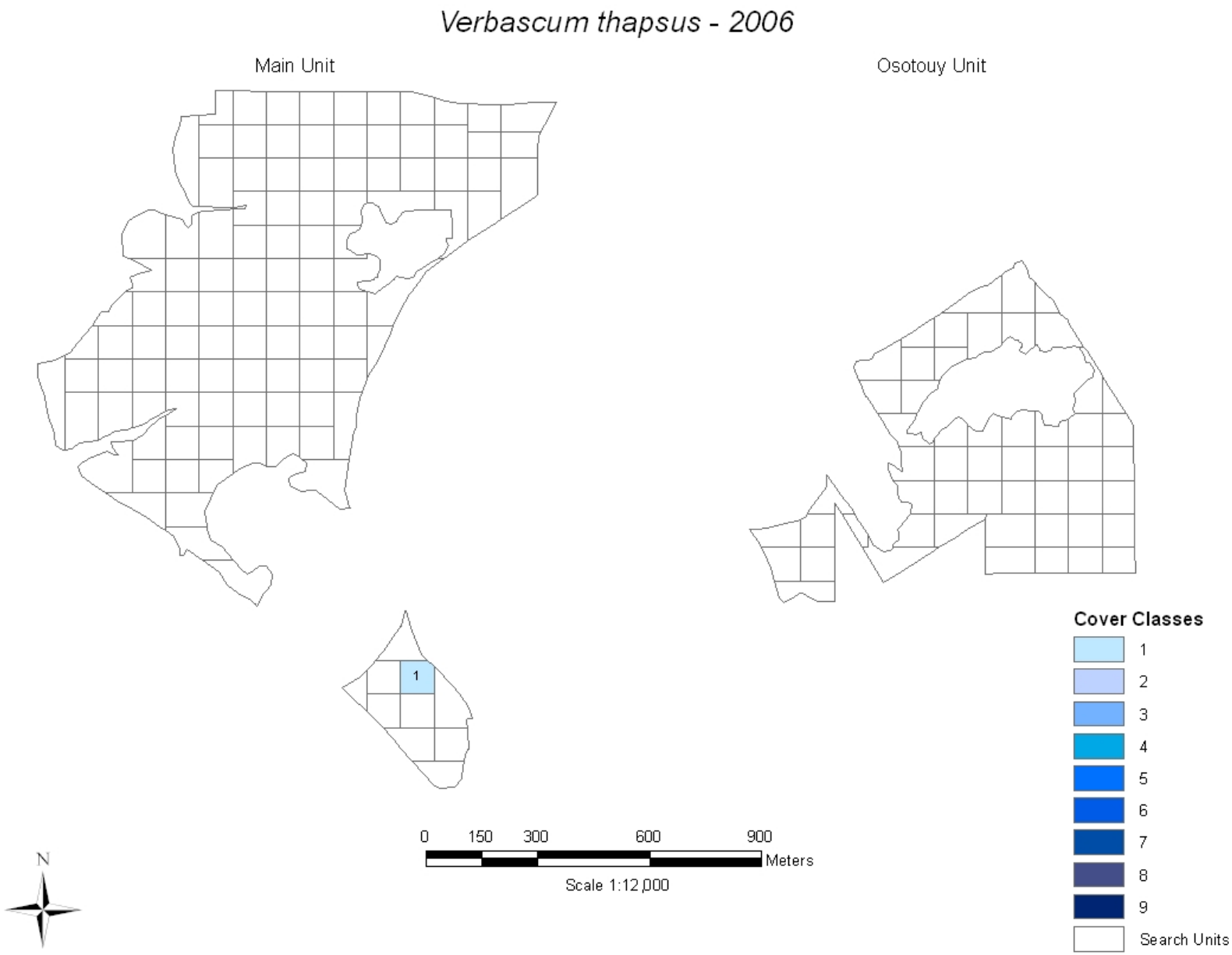

Figure 21. Abundance and distribution of *Verbascum thapsus* (common mullein) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 m^2.

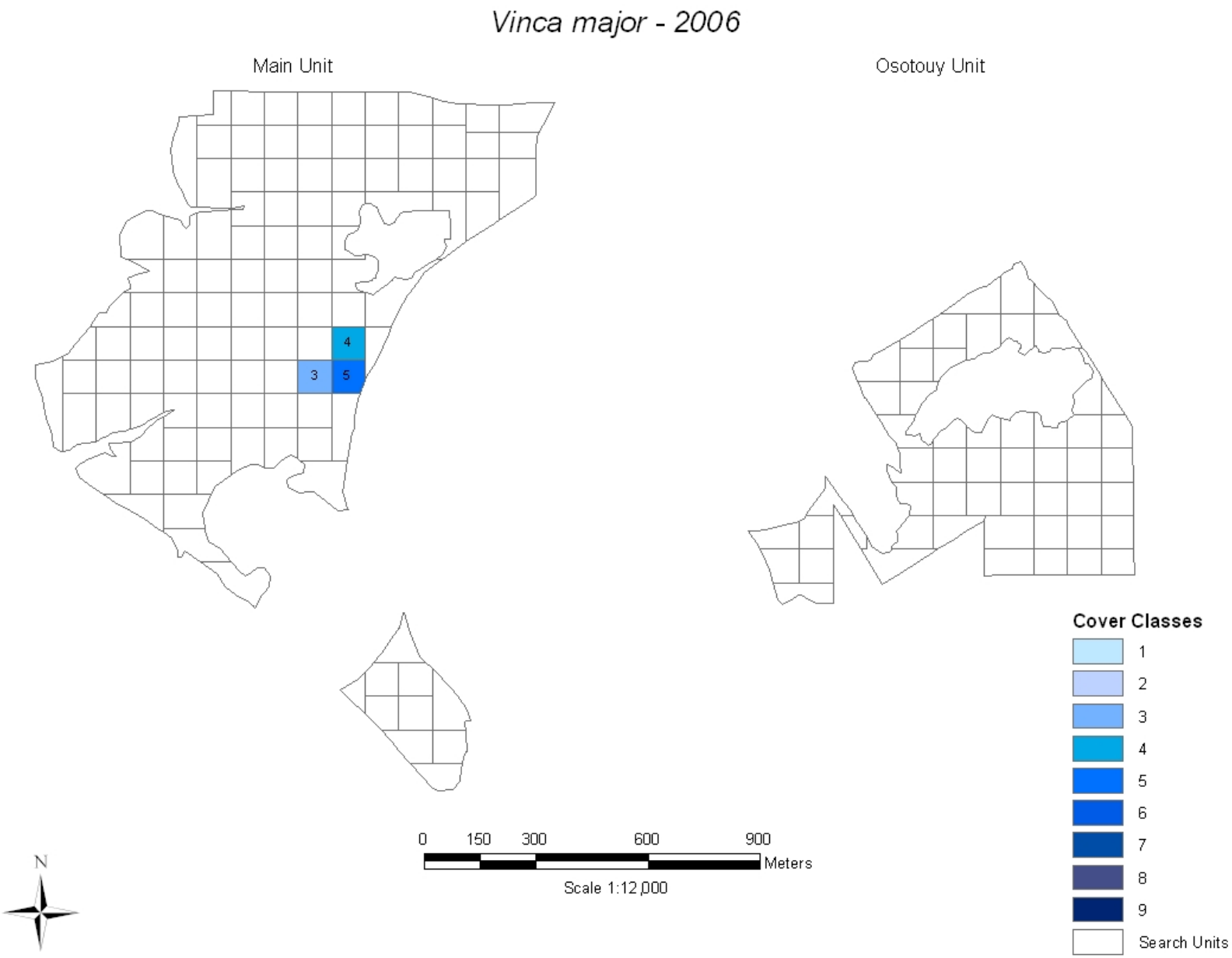

Figure 22. Abundance and distribution of *Vinca major* (bigleaf periwinkle) at Arkansas Post National Memorial, 2006. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, 7=1,000-4,999.9 m^2, 8=5,000-9,999.9 m^2, and 9=10,000-14,999.9 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-43, March 2007

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nps.gov

EXPERIENCE YOUR AMERICA T