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Natural Resource Program Center
Fort Collins, Colorado

Invasive Exotic Plant Monitoring at Cuyahoga Valley National Park: Year 1 (2007)

Natural Resource Technical Report NPS/HTLN/NRTR—2007/063
NPS D-154

ON THE COVER. Garlic mustard (*Alliaria petiolata*) colonizing a sandbar in Cuyahoga Valley National Park. Photograph by Tom Vorac.

Invasive Exotic Plant Monitoring at Cuyahoga Valley National Park: Year 1 (2007)

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NPS D-158

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NPS D-154, November 2007

Executive Summary

During surveys in 2007, Davey Resource Group documented 47 invasive, exotic plant species on Cuyahoga Valley National Park. Three of these plant species were not previously documented as occurring on the park based on NPSpecies, the service-wide database for plant information. Multiflora rose, the most abundant invasive plant at Cuyahoga Valley National Park, covered between 20.4 and 436.5 acres. Of the 47 invasive plant species, 37 species occurred in less than 18 % of transects and 5 species occupied less than 1 acre. The relatively low cover of these species is encouraging and suggests that eradication or at least successful control may be a viable management option. In general, several exotic plants are a major problem at Cuyahoga Valley National Park, but successful control appears possible for some species. The acreage estimates presented in the report may be used to plan management activities leading to invasive plant control.

Acknowledgements

Davey Resource Group conducted all field work associated with this project. We thank project manager Dave Riddell and GIS supervisor Deborah Sheeler for management of this project. We thank Kristen Bates and Todd Crandall for covering over 160 miles of transects across some incredibly difficult terrain in the search of high priority invasive plants at Cuyahoga Valley National Park.

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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. Cuyahoga Valley National Park identified invasive exotic plants as the park's most important management issue (DeBacker et al. 2004). 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 Cuyahoga Valley National Park. 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. Cuyahoga Valley National Park encompasses lands subject to exotic plant invasion. The park has a long history of agricultural land-use and occurs within a rapidly suburbanizing portion of the greater Cleveland-Akron metropolitan area.

2. A recent survey documented 26 exotic plant species in 14 rare plant areas on the Cuyahoga Valley National Park (Vorac 2003). Extensive invasions of Japanese knotweed (*Polygonum cuspidatum*) were documented in riparian areas in the park (Dengg 2004).

3. The park completed three-year project focusing on managing exotic plants in 53 management zones. In 2005, management focused on high quality wetlands. Invasive plants targeted for control included common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canarygrass (*Phalaris arundinacea*).

4. Controlling invasive exotic plants at Cuyahoga Valley National Park stands as an ongoing challenge for park natural resource managers.

Methods

Watch lists. The invasive exotic plants on two 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. 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 Cuyahoga Valley National Park (Figure 1). Observers from Davey Resource Group, used a Trimble GPS unit to navigate along 400 m line transects, identified invasive exotic plants in an approximately 3 to 12-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, and 7=1,000-4,999.9 m^2). A total of 822 transects was surveyed at Cuyahoga Valley National Park. Of these, 456 transects were 400 m in length, while 376 were clipped by the park boundary. Cover was estimated for all plants observed while navigating along the transect.

Analytical methods. Data analysis involved simple displays, as well as calculation of plant frequency and cover. The invasive exotic plants encountered on Cuyahoga Valley National Park were attributed to line transects in a GIS. Polygons surrounding occupied line transects were highlighted on maps for each invasive exotic plant encountered (Figures 3 – 48). Note that entire polygons were not fully searched. The park-wide frequency of invasive exotic plants was calculated as the percentage of occupied transects. A park-wide cover range was calculated to estimate the abundance of each invasive exotic plant species identified using estimates of the park fraction observed:

$$\textit{fraction of park observed} = \frac{\textit{transect length} * \textit{number of transects} * \textit{belt width}}{\textit{reference frame area}}$$

Transect lengths were calculated for each park using the mean transect length. To calculate the minimum park-wide cover for each species, the lower endpoints of the cover class values assigned to a species along each transect search were summed and divided by the fraction of park observed assuming that a 12-m belt was surveyed. Maximum cover was calculated using the upper endpoints of the cover values in each search unit and assumed that a 3-m belt was surveyed.

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 2007, a total of 47 invasive exotic plant taxa were found during the survey at Cuyahoga Valley National Park (Table 2). Of these plants, 42 taxa were known to occur on the park based on the NPSpecies database. Glossy buckthorn (*Frangula alnus*) was not previously included on this watch list. Glossy buckthorn is not designated as a high priority for the entire network, but is wide-spread at CUVA and will be added to the park-based watch list. The species on the early detection list will be entered in NPSpecies and should subsequently be included on the park-established watch list.

The distribution and abundance of the invasive exotic plant species at Cuyahoga Valley National Park varied widely. Four species were very widespread, occurring in more then 40% of transects: multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*), European privet (*Ligustum vulgare*) and Japanese barberry (*Berberis thunbergii*). Common reed, Japanese knotweed, and black locust (*Robinia pseudoacacia*) were as abundant but were localized on the park. Eight species were moderately abundant, covering between 2 and 100 acres. The remaining 30 species covered less then 2 acres and occurred in less then 13% of the transects. The relatively low cover of these species is encouraging and suggests that eradication or at least successful control may be a viable management option.

Four species were noted as having unambiguously high ecological impact: reed canarygrass, autumn olive (*Elaeagnus umbellata*), purple loosestrife, and European alder (*Alnus glutinosa*). (Table 2). Eighteen species were characterized as having at high-medium or medium ecological impact. The remaining species had ambiguous medium-low ecological impacts or less, including seven species with low or insignificant impacts. Recognizing that the feasibility of control often strongly influences decisions regarding invasive exotic plant management, autumn olive with high ecological impacts was noted as having low management difficulty. Controlling this species will likely provide a high benefit for the management costs.

In summary, this report provides information on invasive exotic plant abundance and distribution as well as ecological impacts and management difficulty 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.

Denng, E. 2004. A Japanese Knotweed (*Polygonum cuspidatum)* Inventory of the Cuyahoga River and Selected Tributaries within Cuyahoga Valley National Park. National Park Service, Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield, Republic, Missouri.

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.

Vorac, T. and M. Schramm. 2003. An Invasive Exotic Plant Inventory of Rare Plant Areas of Cuyahoga Valley National Park. National Park Service, Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield, Republic, Missouri.

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.

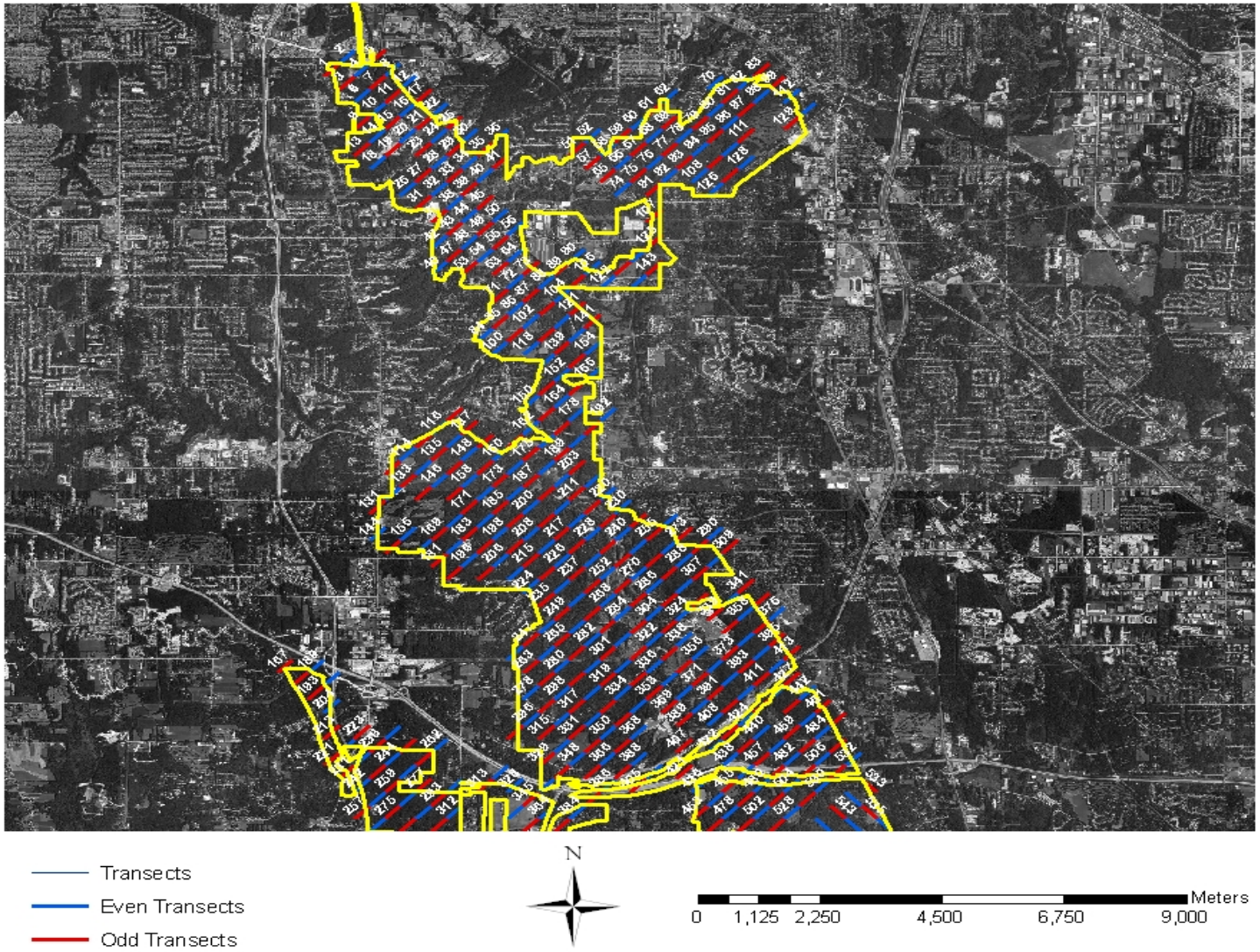
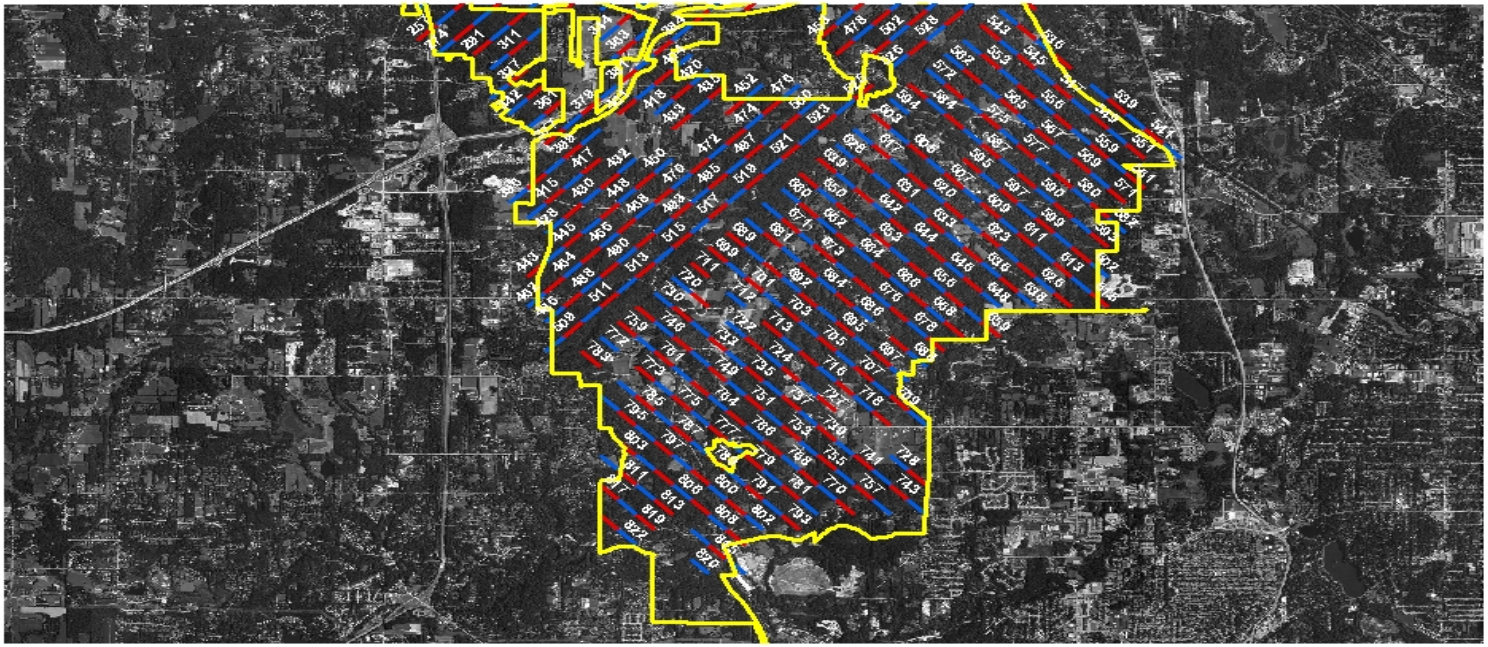


Figure 1A. Invasive exotic plant line transects at Cuyahoga Valley National Park (north section). The blue (even numbered) and red (odd numbered) transects indicate the search locations for invasive exotic plants in 2007.



Transects
Even Transects
Odd Transects

N

0 1,125 2,250 4,500 6,750 9,000 Meters

Figure 1.B Invasive exotic plant line transects at Cuyahoga Valley National Park (south section). The blue (even numbered) and red (odd numbered) transects indicate the search locations for invasive exotic plants in 2007.

Table 1. Watch list for Cuyahoga Valley National Park

Early Detection Watch List		Park-Established Watch List	
Acer ginnala	Amur maple	*Acer platanoides*	Norway maple
Aegopodium podagraria	Bishop's goutweed	*Ailanthus altissima*	Tree of heaven
Albizia julibrissin	Silktree	*Alliaria petiolata*	Garlic mustard
Ampelopsis brevipedunculata	Amur peppervine	*Alnus glutinosa*	European alder
Bromus sterilis	Poverty brome	*Arctium minus*	Lesser burdock
Bromus tectorum	Cheatgrass	*Berberis thunbergii*	Japanese barberry
Butomus umbellatus	Flowering rush	*Bromus inermis*	Smooth Brome
Carduus nutans	Nodding plumeless thistle	*Celastrus orbiculatus*	Oriental bittersweet
Centaurea biebersteinii	Spotted knapweed	*Cirsium arvense*	Canada thistle
Centaurea solstitialis	Yellow star-thistle	*Cirsium vulgare*	Bull thistle
Coronilla varia	Crownvetch	*Daucus carota*	Queen Anne's lace
Cynanchum louiseae	Louise's swallow-wort	*Dipsacus fullonum*	Fuller's teasel
Dioscorea oppositifolia	Chinese yam	*Elaeagnus umbellata*	Autumn olive
Dipsacus laciniatus	Cutleaf teasel	*Elymus repens*	Quackgrass
Egeria densa	Brazilian waterweed	*Euonymus fortunei*	Winter creeper
Elaeagnus angustifolia	Russian olive	*Glechoma hederacea*	Ground ivy
Euonymus alata	Burningbush	*Hedera helix*	English ivy
Euphorbia cyparissias	Cypress spurge	*Hemerocallis fulva*	Orange daylily
Euphorbia esula	Leafy spurge	*Hesperis matronalis*	Dames rocket
Frangula alnus	Glossy buckthorn	*Holcus lanatus*	Common velvetgrass
Lespedeza bicolor	Shrub lespedeza	*Humulus japonicus*	Japanese hop
Lespedeza cuneata	Sericea lespedeza	*Hypericum perforatum*	Common St. Johnswort
Lolium arundinaceum	Tall fescue	*Iris pseudacorus*	Paleyellow iris
Lolium pratense	Meadow fescue	*Leonurus cardiaca*	Common motherwort
Lolium spp	Ryegrass	*Ligustrum obtusifolium*	Border privet
Lotus tenuis	Narrow-leaf bird's-food trefoil	*Ligustrum vulgare*	European privet
Microstegium vimineum	Nepalese browntop	*Linaria vulgaris*	Butter and eggs
Miscanthus sinensis	Chinese silvergrass	*Lonicera japonica*	Japanese honeysuckle
Myriophyllum aquaticum	Parrot feather watermilfoil	*Lonicera maackii*	Amur honeysuckle
Onopordum acanthium	Scotch cottonthistle	*Lonicera morrowii*	Morrow's honeysuckle
Paulownia tomentosa	Princesstree	*Lonicera tatarica*	Tatarian honeysuckle
Polygonum perfoliatum	Asiatic tearthumb	*Lonicera X bella*	Showy fly honeysuckle
Polygonum sachalinense	Giant knotweed	*Lotus corniculatus*	Bird's-foot trefoil

Table 1 (cont.). Watch list for Cuyahoga Valley National Park			
Prunus mahaleb	Mahaleb cherry	*Lysimachia nummularia*	Creeping jenny
Pueraria montana var. lobata	Kudzu	*Lythrum salicaria*	Purple loosestrife
Pyrus calleryana	Callery pear	*Melilotus officinalis*	Yellow silvergrass
Rorippa nasturtium-aquaticum		*Morus alba*	White mulberry
Sorghum halepense	Johnsongrass	*Myosotis scorpioides*	True forget-me-not
Spiraea japonica	Japanese meadowsweet	*Myriophyllum spicatum*	Eurasian watermilfoil
Torilis arvensis	Spreading hedgeparsley	*Najas minor*	Brittle waternymph
Typha X glauca		*Pastinaca sativa*	Wild parsnip
Viburnum opulus	European Cranberrybush	*Phalaris arundinacea*	Reed canarygrass
Wisteria floribunda	Japanese wisteria	*Phragmites australis*	Common reed
		Poa compressa	Canada bluegrass
		Poa pratensis	Kentucky bluegrass
		Polygonum cuspidatum	Japanese knotweed
		Populus alba	White poplar
		Potamogeton crispus	Curly pondweed
		Potentilla recta	Sulphur cinquefoil
		Rhamnus cathartica	Common buckthorn
		Robinia pseudoacacia	Black locust
		Rosa multiflora	Multiflora rose
		Rumex acetosella	Common sheep sorrel
		Rumex crispus	Rumex crispus
		Saponaria officinalis	Bouncingbet
		Sonchus arvensis	Field sowthistle
		Tanacetum vulgare	Common tansy
		Torilis japonica	Erect hedgeparsley
		Typha angustifolia	Narrowleaf cattail
		Ulmus pumila	Siberian elm
		Verbascum thapsus	Common mullein
		Vinca minor	Common periwinkle

Table 2. Overview of invasive exotic plants found on Cuyahoga Valley National Park. 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), insignigicant (I), unknown (U), a range of ranks (indicated by /), or not available (--).

Scientific Name	Common Name	Watch List	Park-wide coverage (acres)	Frequency (percent)	Ecological impact	Management difficulty
Acer platanoides	Norway maple	Park-established	1.8 – 25.3	1.7	M	ML
Ailanthus altissima	Tree of heaven	Park-established	0.2 – 3.2	0.2	ML	ML
Alliaria petiolata	Garlic mustard	Park-established	17.9 – 345.1	57.1	ML	M
Alnus glutinosa	European alder	Park-established	0.1 – 1.6	0.1	H	U
Berberis thunbergii	Japanese barberry	Park-established	3.8 – 122.9	46.5	HM	I
Bromus inermis	Smooth brome	Park-established	0.1 – 5.8	4.3	M	ML
Celastrus orbiculatus	Oriental bittersweet	Park-established	0.03 – 1.3	0.5	ML	M
Cirsium arvense	Canada thistle	Park-established	1.0 – 31.6	12.8	ML	HM
Cirsium vulgare	Bull thistle	Park-established	0.05 – 1.8	1.7	ML	ML
Dipsacus fullonum	Fuller's teasel	Park-established	0.6 – 22.5	13.1	L	ML
Elaeagnus angustifolia	Russian olive	Early detection	1.5 – 27.0	4.0	HM	H
Eleagnus umbellata	Autumn olive	Park-established	4.2 – 81.6	11.2	H	L
Frangula alnus	Glossy buckthorn	Early-Detection	5.1 – 90.4	13.6	HL	M
Glechoma hederacea	Ground ivy	Park-established	1.1 – 29.0	8.2	MI	U
Hedera helix	English ivy	Park-established	0.1 – 2.6	0.7	M	ML
Hesperis matronalis	Dames rocket	Park-established	0.9 – 26.3	9.9	MI	HL
Iris pseudacorus	Paleyellow iris	Park-established	0.6 – 17.2	6.0	ML	HM
Ligustrum vulgare	European privet	Park-established	5.6 – 142.8	43.4	HL	HM
Lonicera japonica	Japanese honeysuckle	Park-established	2.7 – 69.1	16.2	M	HM
Lonicera maackii	Amur honeysuckle	Park-established	1.2 – 26.9	8.0	HM	M
Lonicera morrowii	Morrow's honeysuckle	Park-established	2.8 – 68.9	14.4	ML	M
Lonicera tatarica	Tatarian honeysuckle	Park-established	2.0 – 46.3	12.0	M	M
Lotus corniculatus	Bird's-foot trefoil	Park-established	0.6 – 18.3	6.9	ML	ML
Lysimachia nummularia	Creeping jenny	Park-established	2.6 – 67.5	18.5	L	L
Lythrum salicaria	Purple loosestrife	Park-established	1.7 – 32.1	5.4	H	H
Melilotus officinalis	Yellow silvergrass	Park-established	<0.4	0.6	M	M

Table 2 (cont.). Overview of invasive exotic plants found on Cuyahoga Valley National Park. 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), insignigicant (I), unknown (U), a range of ranks (indicated by /), or not available (--).

Scientific Name	Common Name	Watch List	Park-wide coverage (acres)	Frequency (percent)	Ecological impact	Management difficulty
Morus alba	White mulberry	Park-established	0.1 – 1.6	0.1	ML	ML
Pastinaca sativa	Wild parsnip	Park-established	<0.7	0.6	LI	L
Phalaris arundinacea	Reed canarygrass	Park-established	14.6 – 219.5	20.6	H	HM
Phragmites austrialis	Common reed	Park-established	5.8 – 108.2	9.6	--	--
Poa compressa	Canada bluegrass	Park-established	1.1 – 33.6	11.7	ML	HL
Poa pratensis	Kentucky bluegrass	Park-established	3.2 – 84.4	21.2	M	ML
Polygonum cuspidatum	Japanese knotweed	Park-established	9.2 – 147.2	6.7	HM	M
Populus alba	White poplar	Park-established	<0.6	0.24	ML	HL
Potentilla recta	Sulphur cinquefoil	Park-established	<0.1	0.6	HL	ML
Rhamnus cathartica	Common buckthorn	Park-established	0.04 – 1.6	0.6	M	M
Robinia pseudoacacia	Black locust	Park-established	12.1 – 187.6	12.0	HM	M
Rosa multiflora	Multifora rose	Park-established	20.4 – 436.5	83.9	L	L
Typha angustifolia	Narrowleaf cattail	Park-established	2.6 – 38.0	2.6	HM	M
Typha x glauca	Cattail	Early-Detection	0.03 – 1.3	0.5	--	--
Verbascum thapsus	Common mullein	Park-established	0.03 – 1.2	1.3	ML	L
Vinca minor	Common periwinkle	Park-established	0.5 – 15.1	6.3	I	U

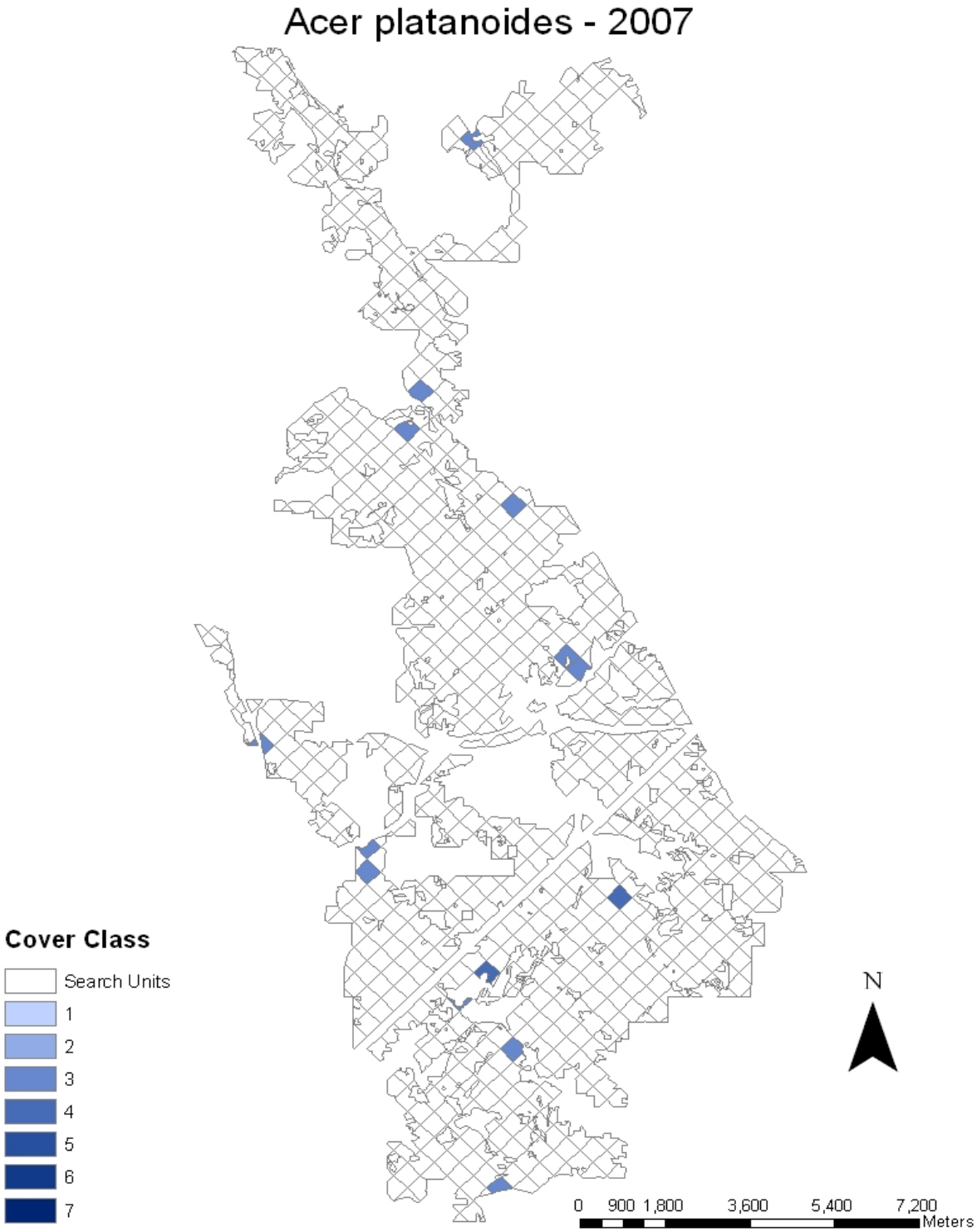


Figure 2. Abundance and distribution of *Acer platanoides* (Norway maple) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

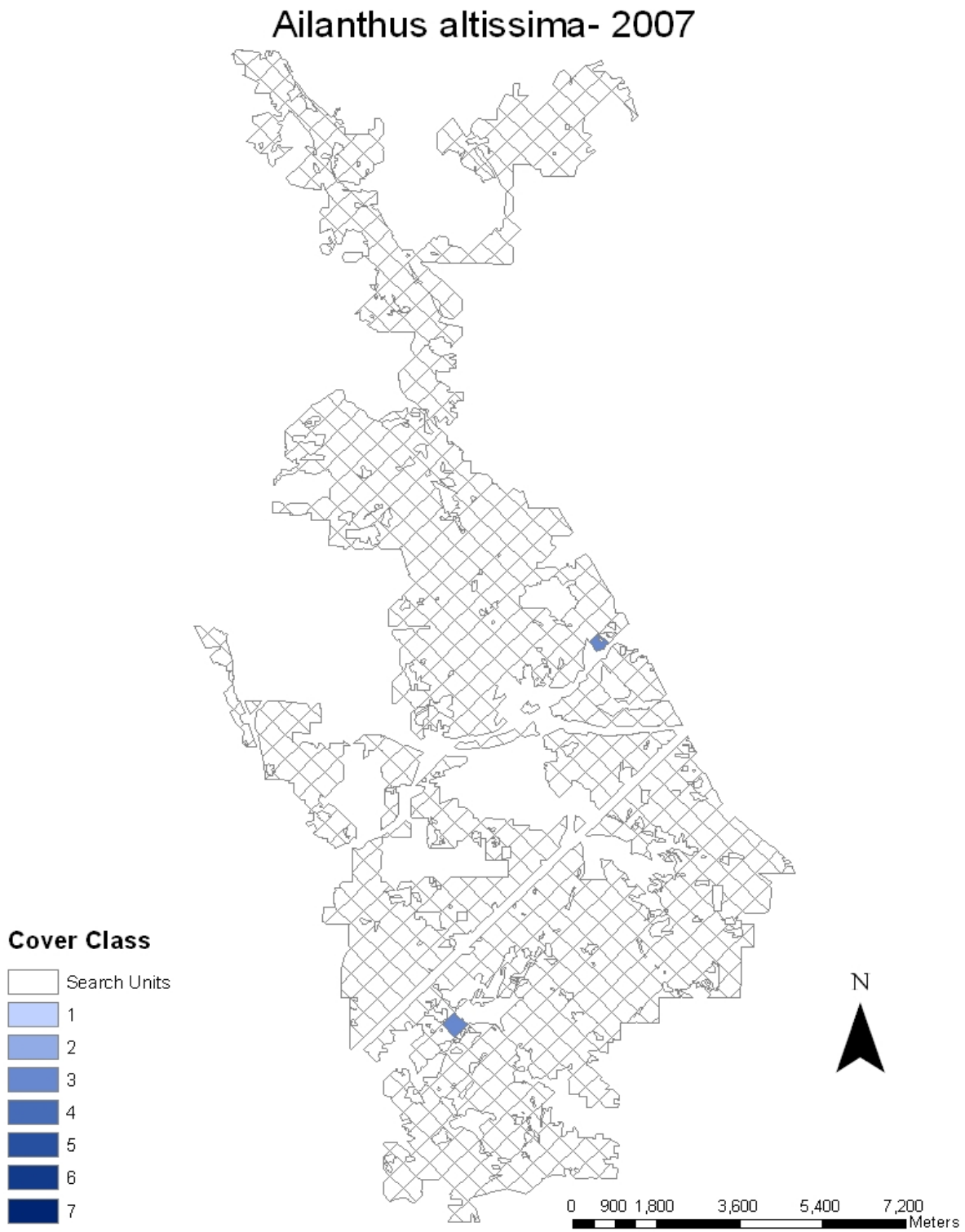


Figure 3. Abundance and distribution of *Ailanthus altissima* (tree of heaven) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

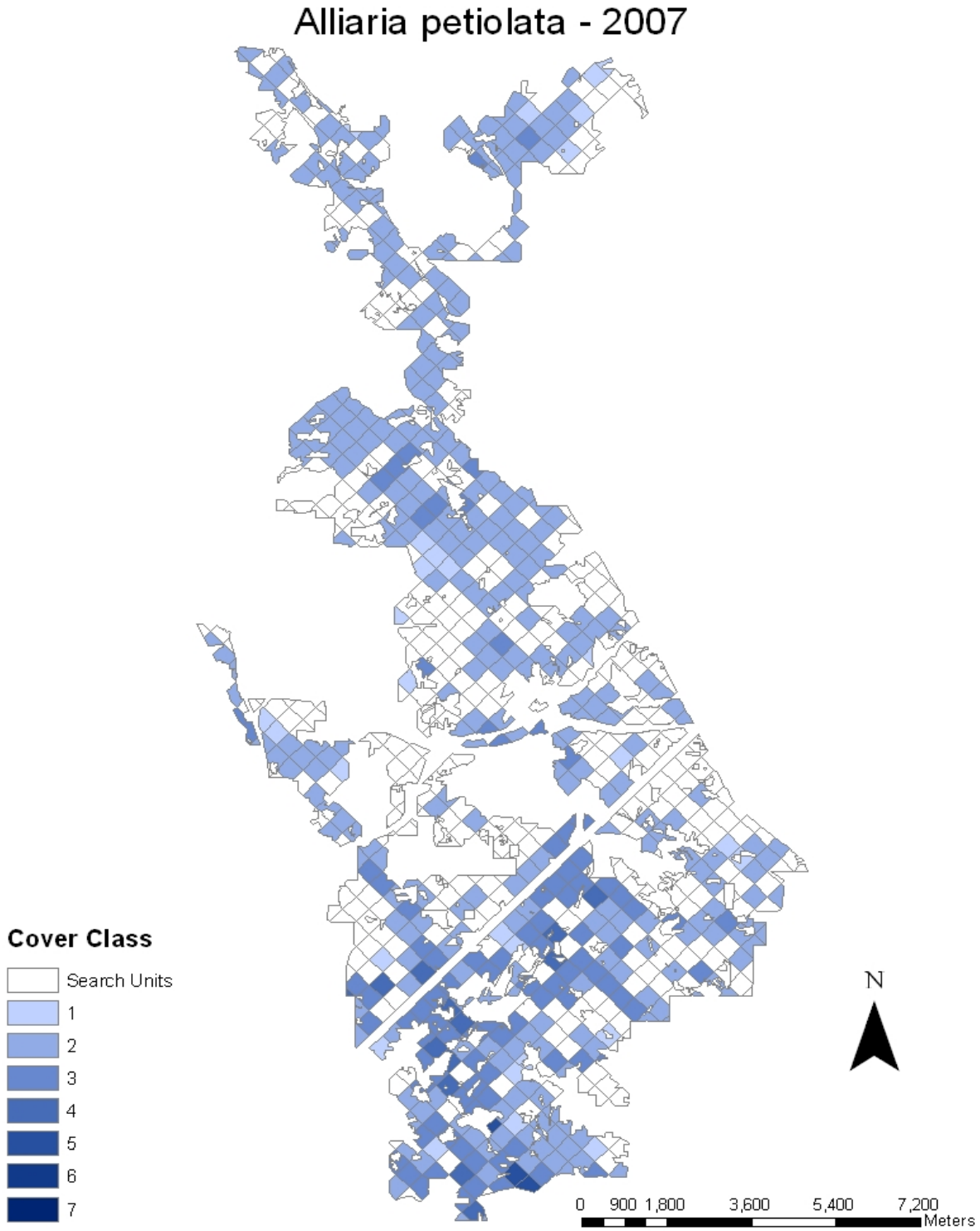


Figure 4. Abundance and distribution of *Alliaria petiolata* (garlic mustard) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

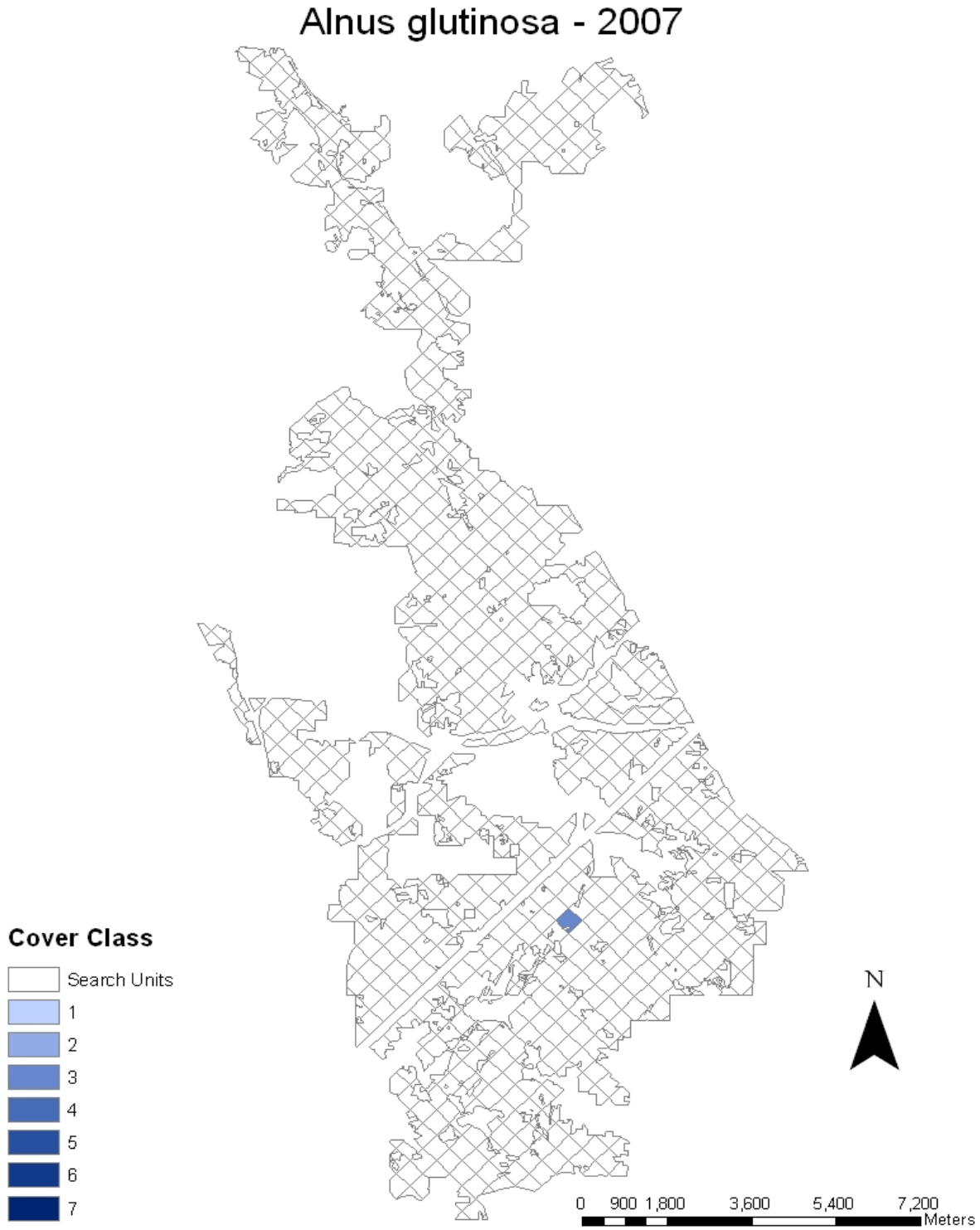


Figure 5. Abundance and distribution of *Alnus glutinosa* (European alder) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

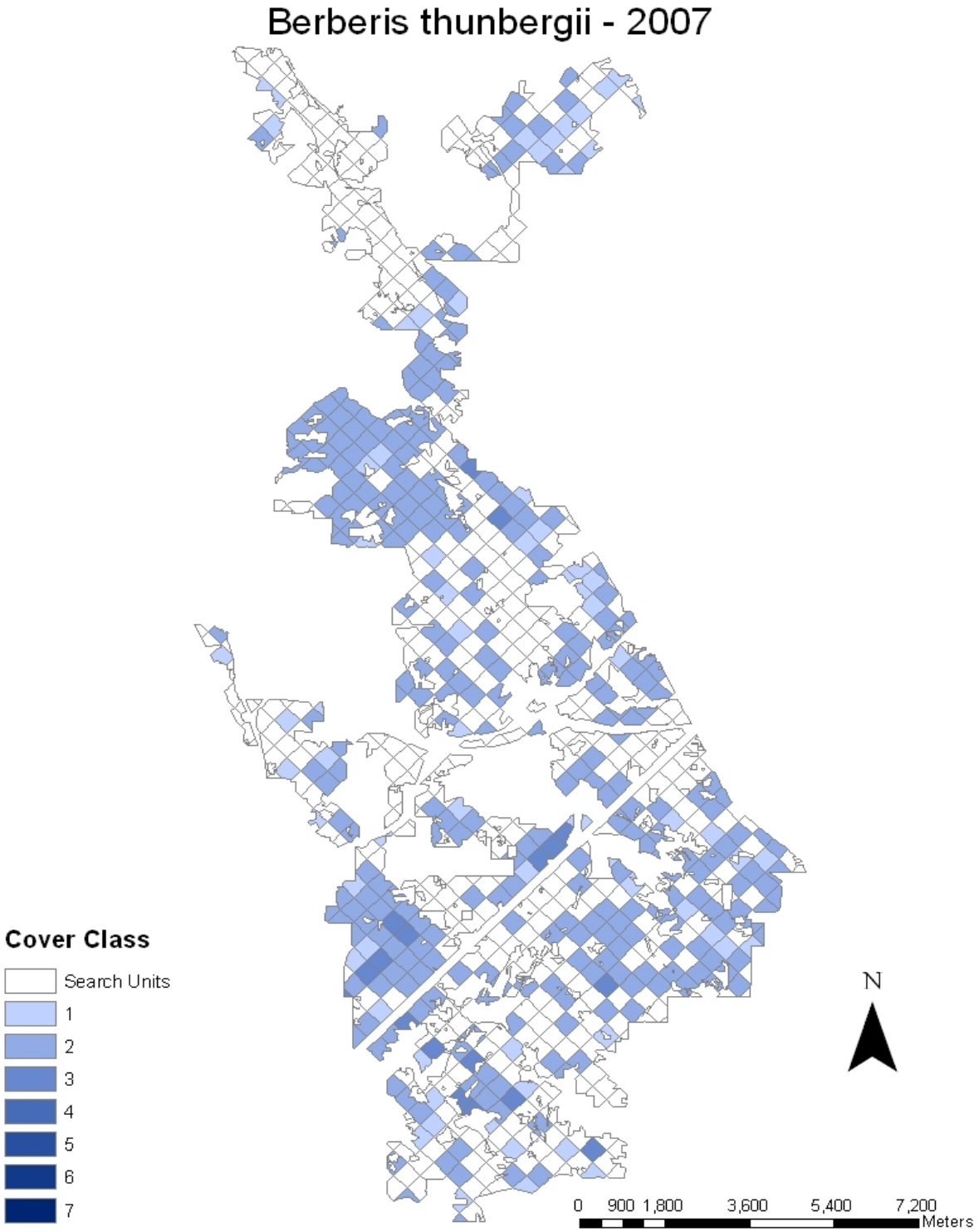


Figure 6. Abundance and distribution of *Berberis thunbergii* (Japanese barberry) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9m^2

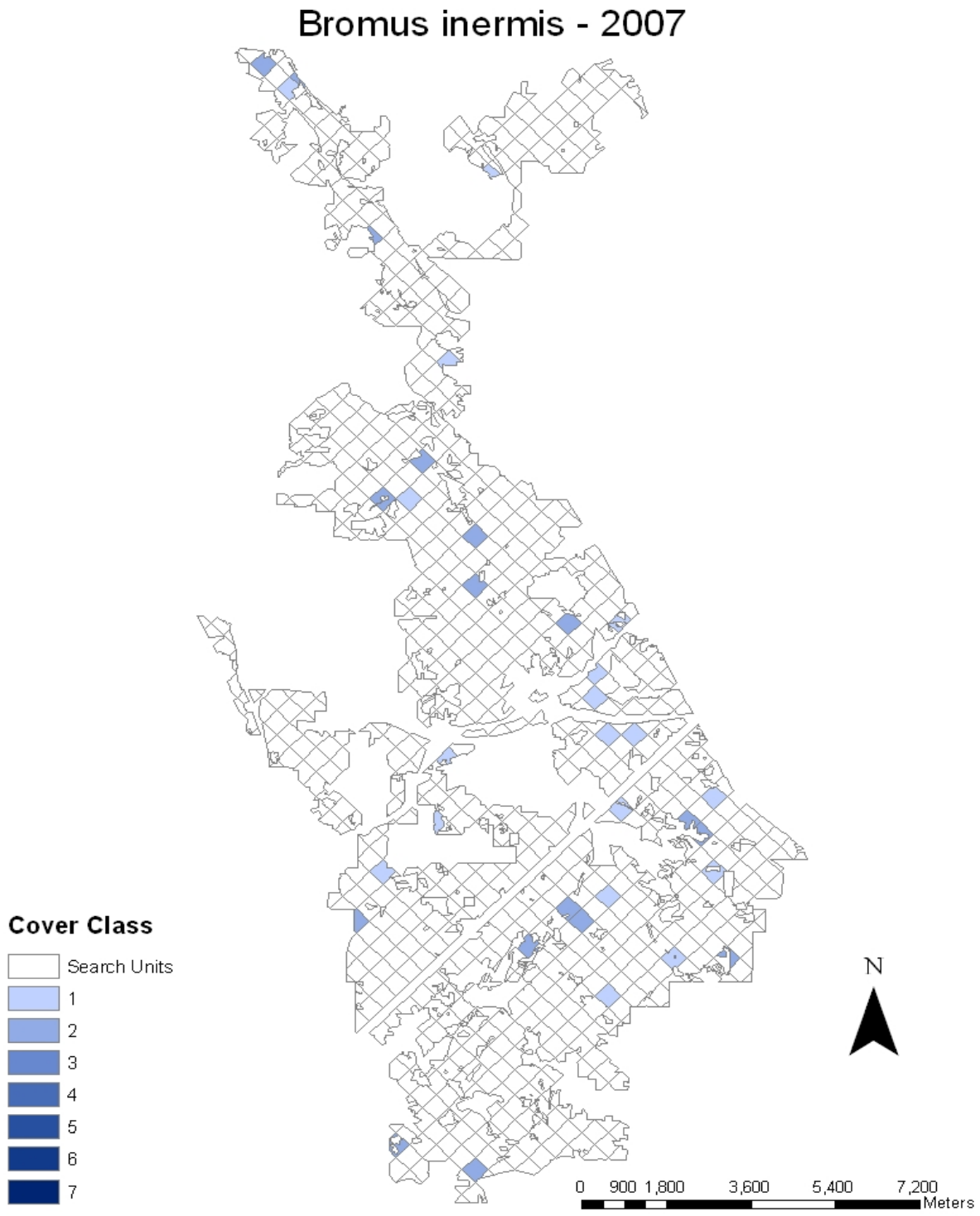


Figure 7. Abundance and distribution of *Bromus inermis* (smooth brome) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

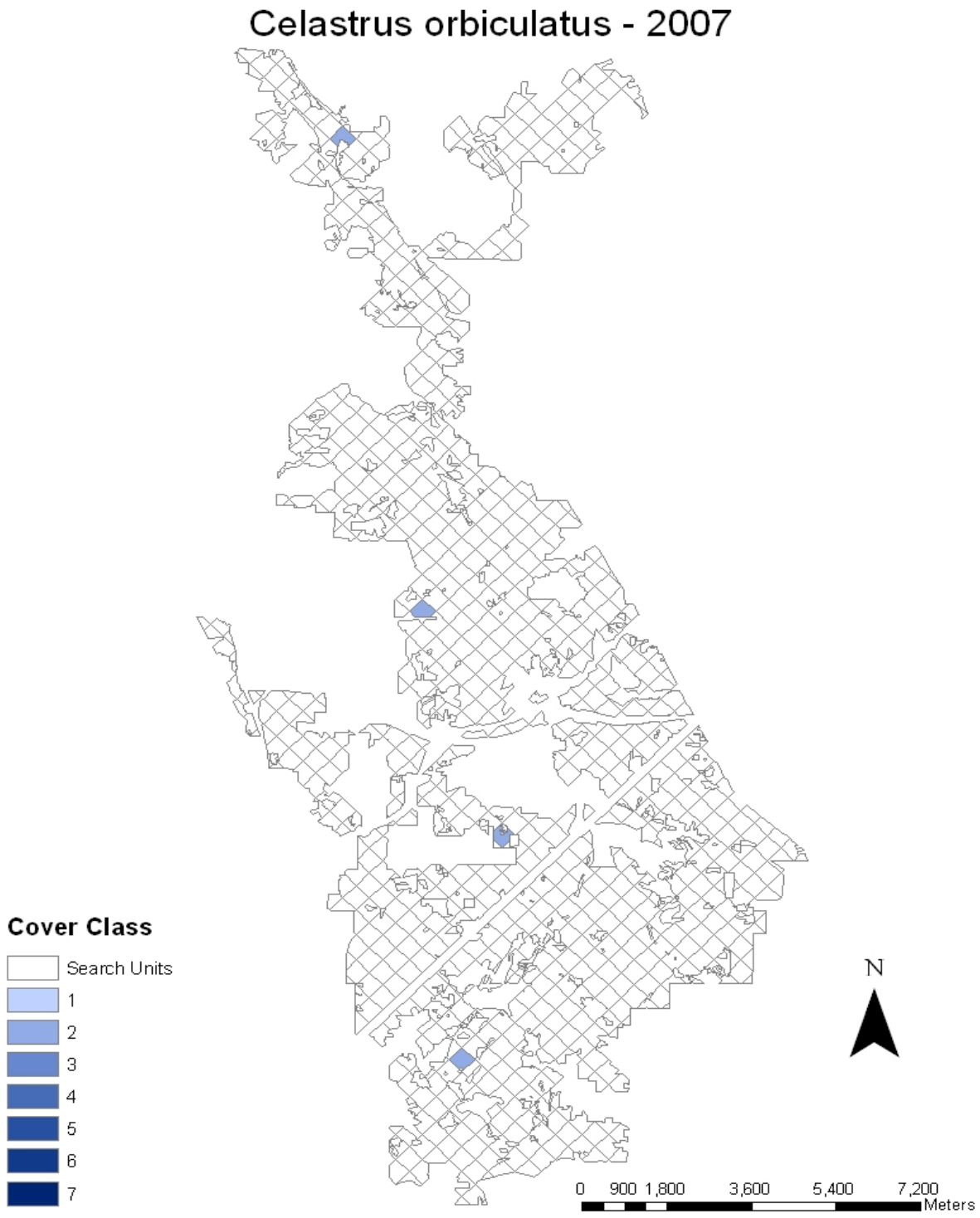


Figure 8. Abundance and distribution of *Celastrus orbiculatus* (Oriental bittersweet) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

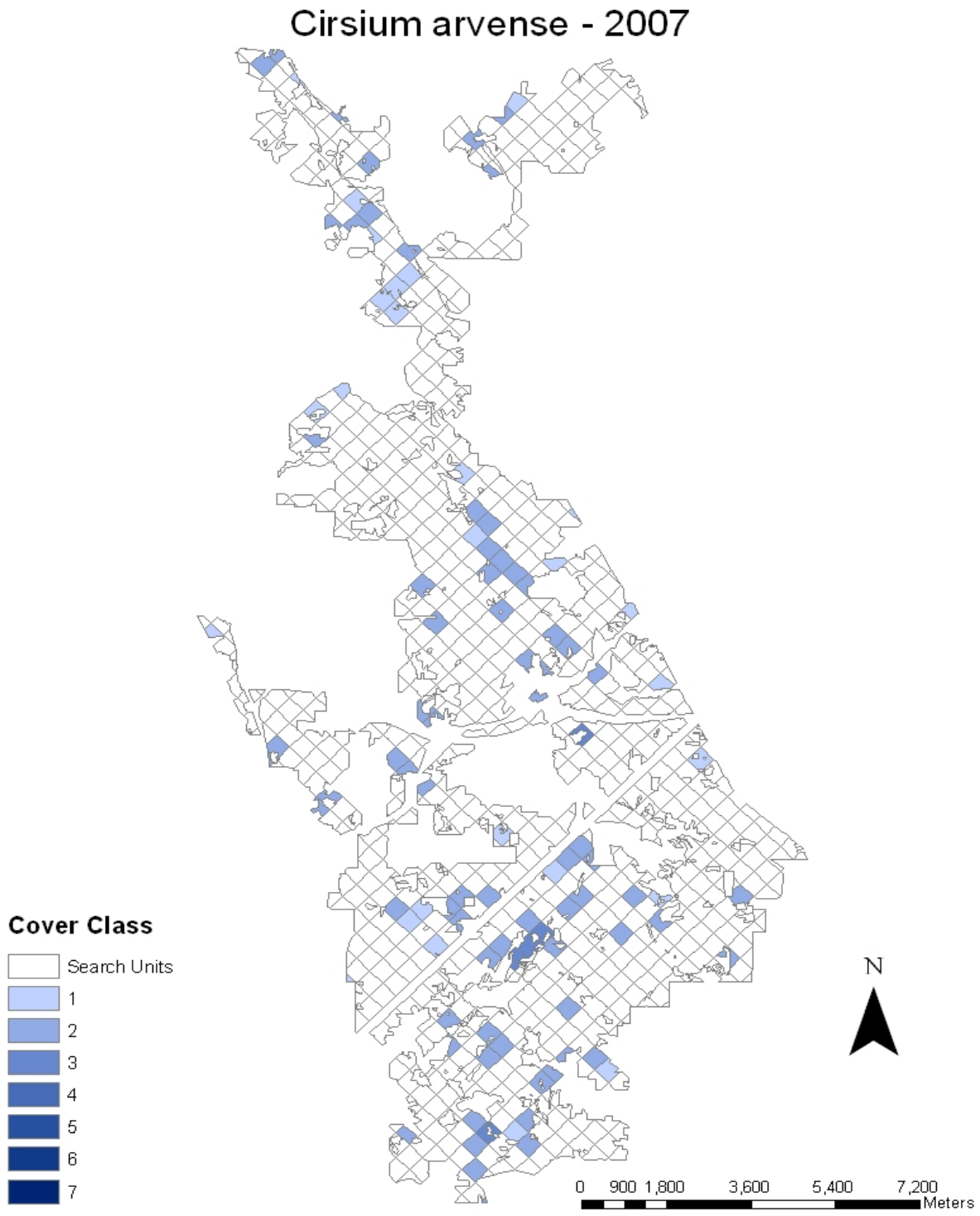


Figure 9. Abundance and distribution of *Cirsium arvense* (Canada thistle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

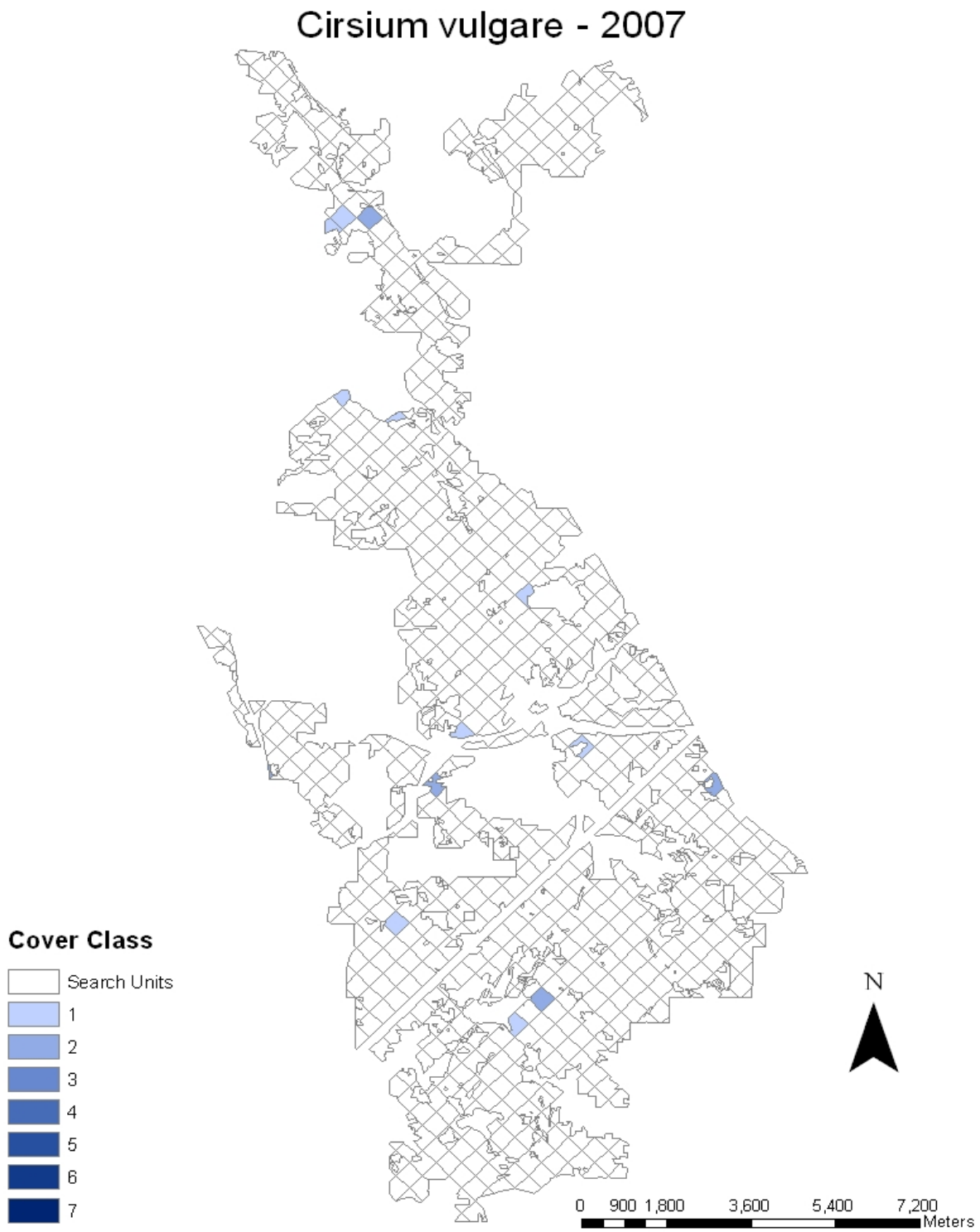


Figure 10. Abundance and distribution of *Cirsium vulgare* (Bull thistle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

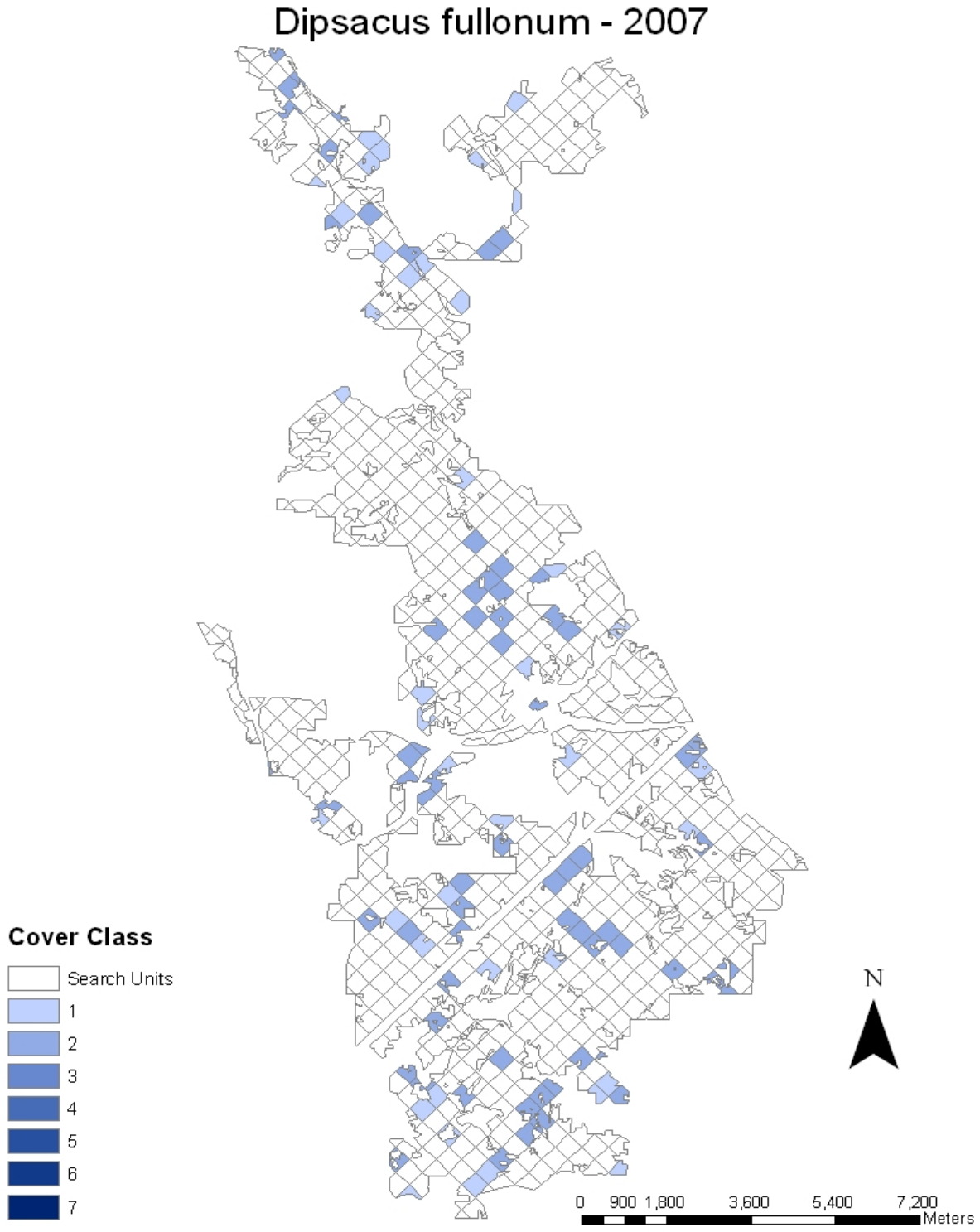


Figure 11. Abundance and distribution of *Dipsacus fullonum* (Fuller's teasel) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

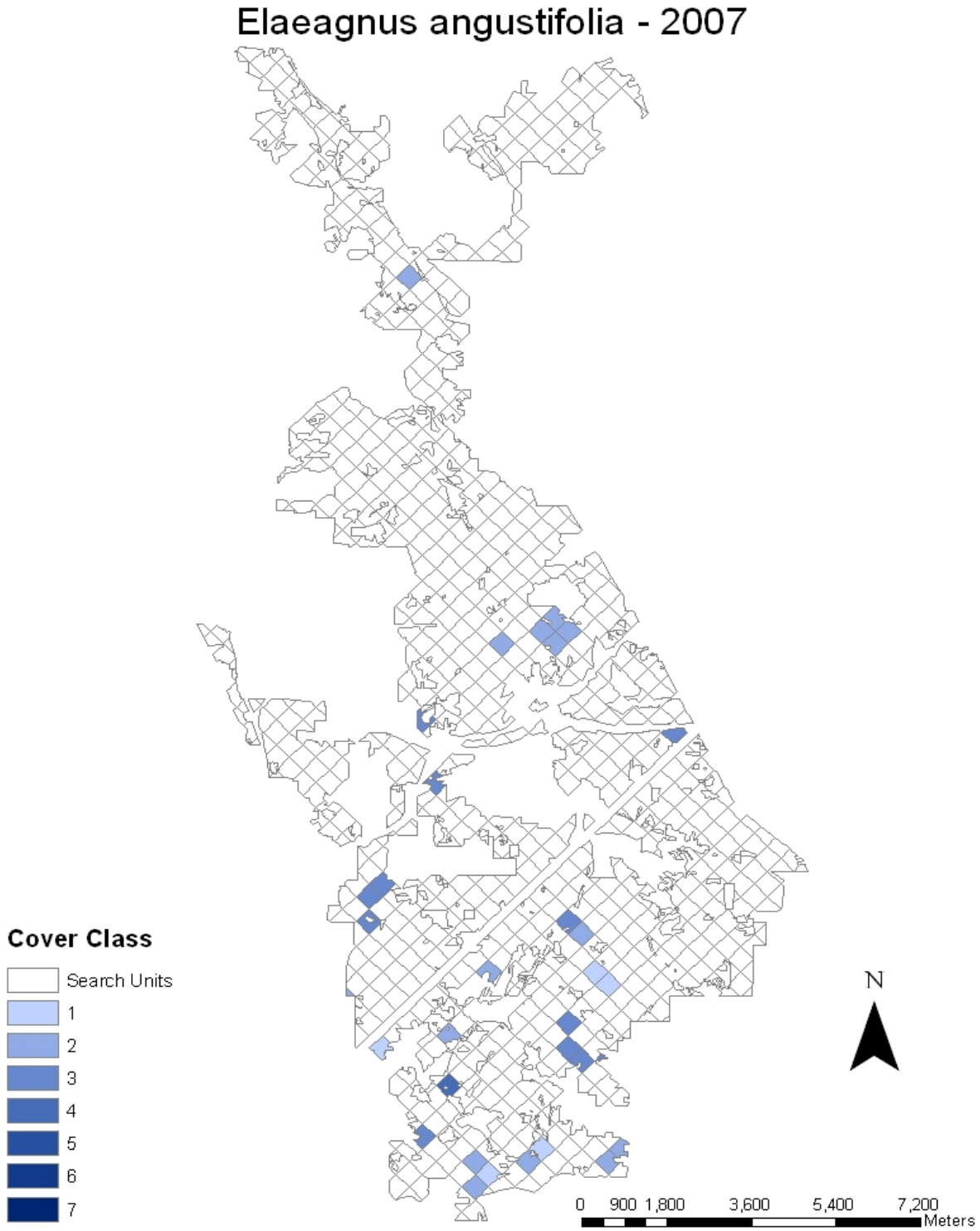


Figure 12. Abundance and distribution of *Elaeagnus angustifolia* (Russian olive) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

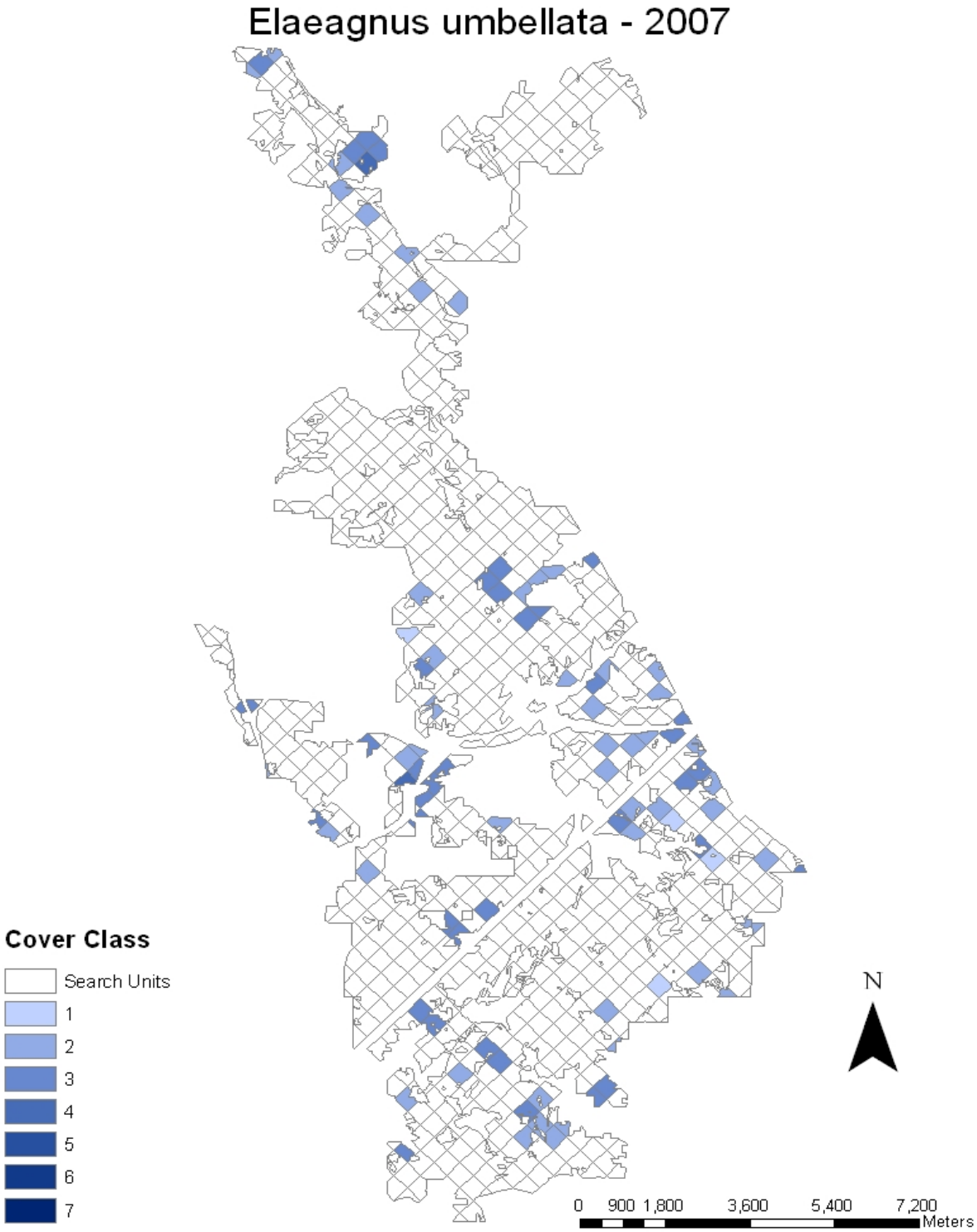


Figure 13. Abundance and distribution of *Elaeagnus umbellata* (Autumn olive) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

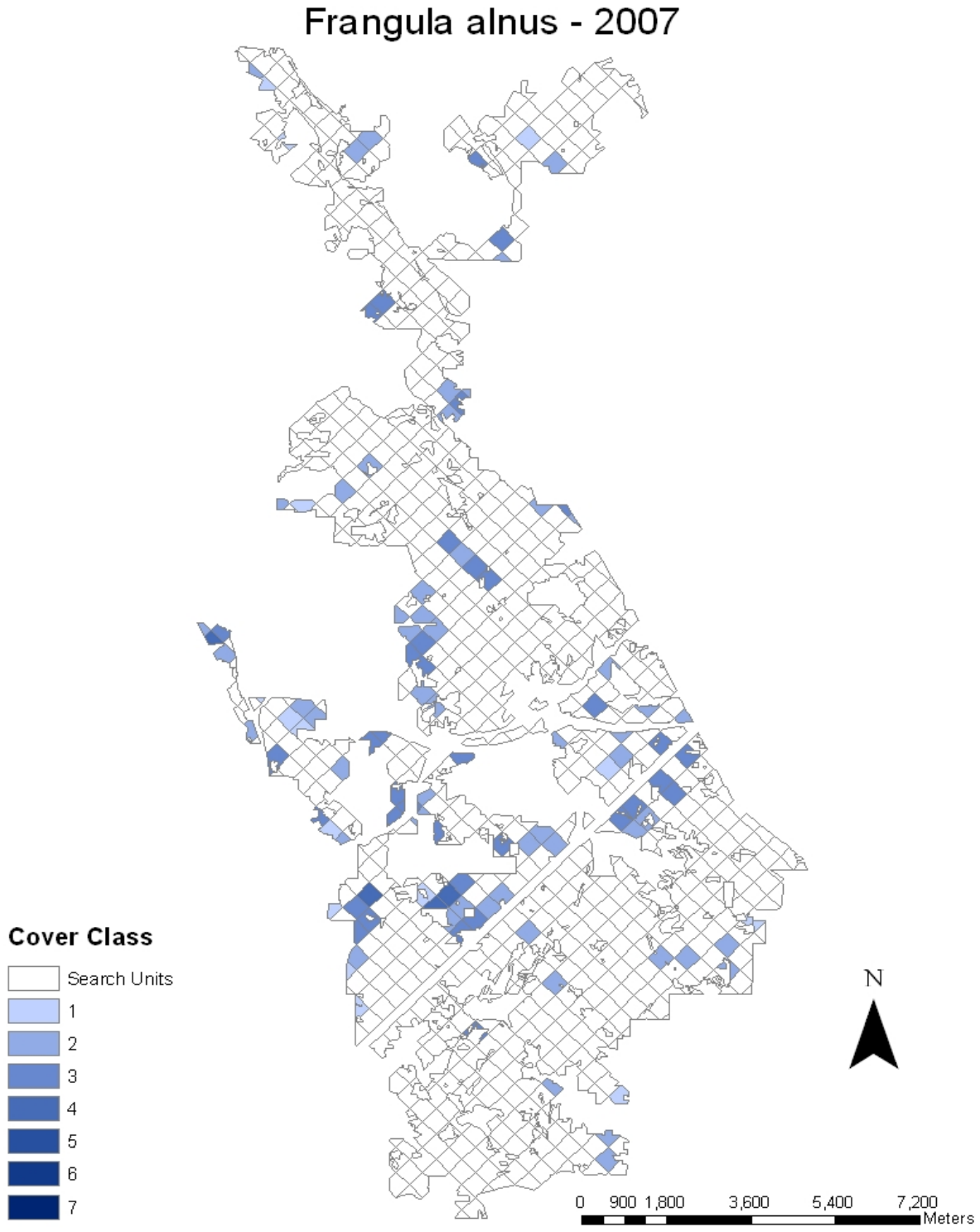


Figure 14. Abundance and distribution of *Frangula anlus* (glossy buckthorn) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

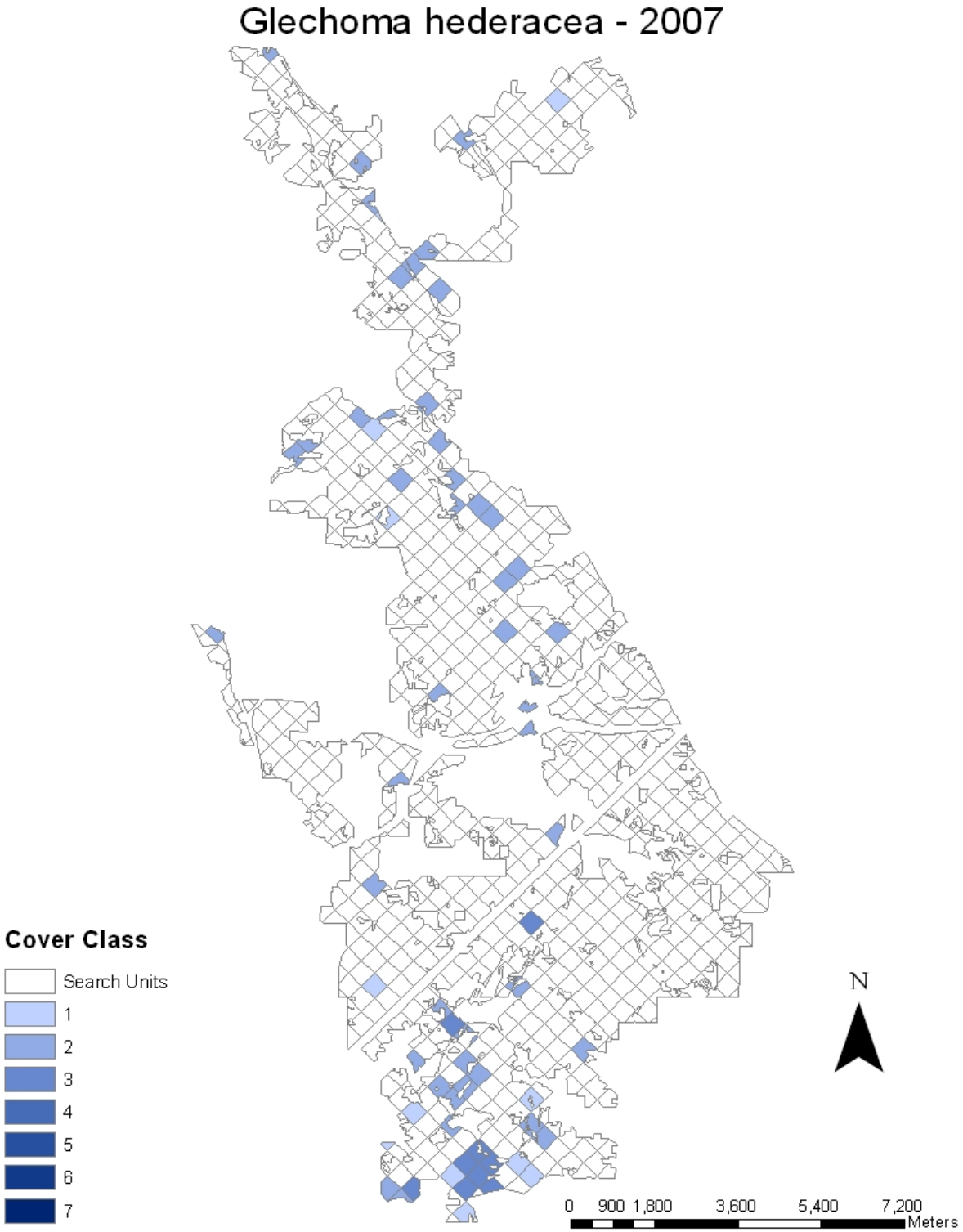


Figure 15. Abundance and distribution of *Glechoma hederacea* (ground ivy) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

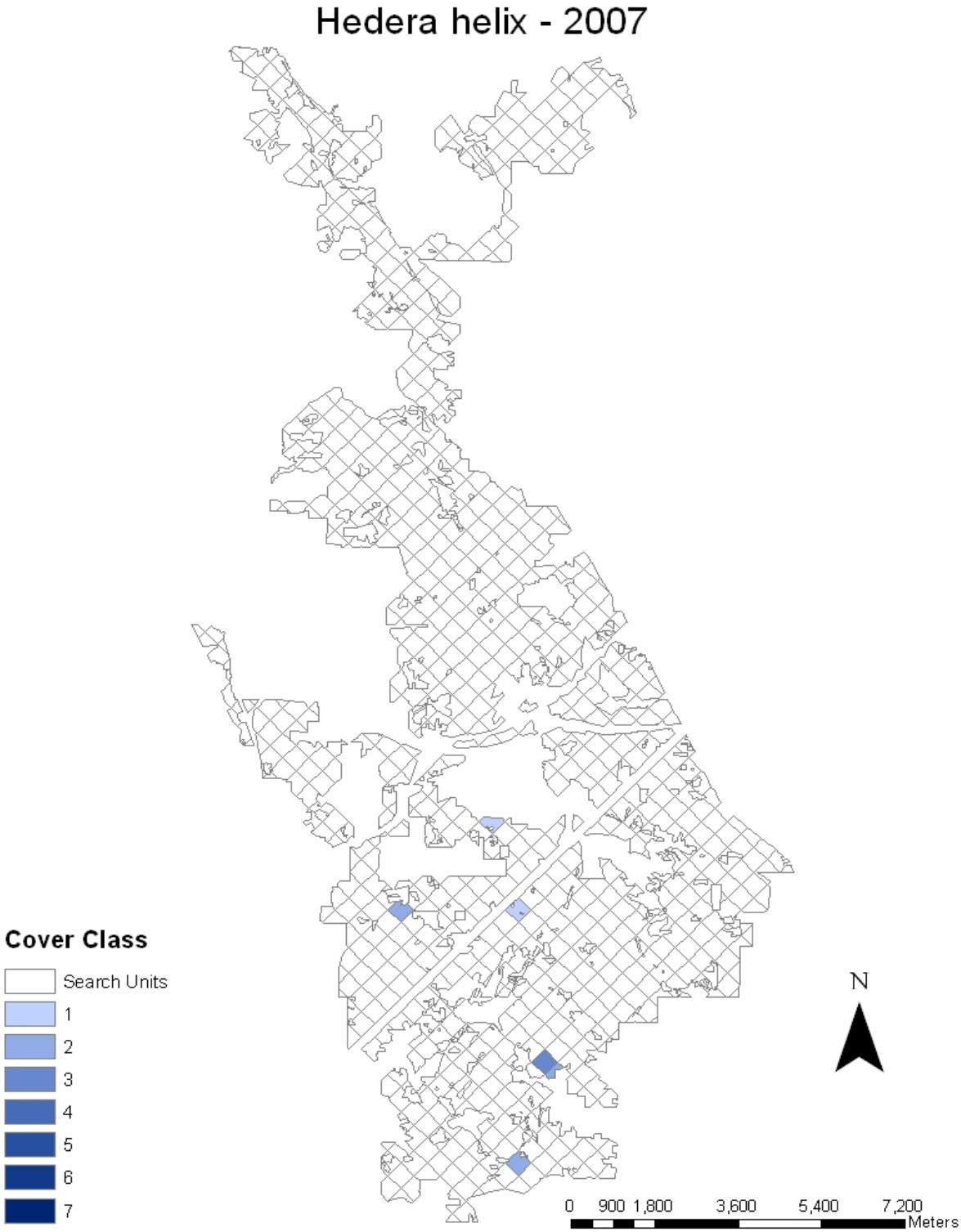


Figure 16. Abundance and distribution of *Hedera helix* (English ivy) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

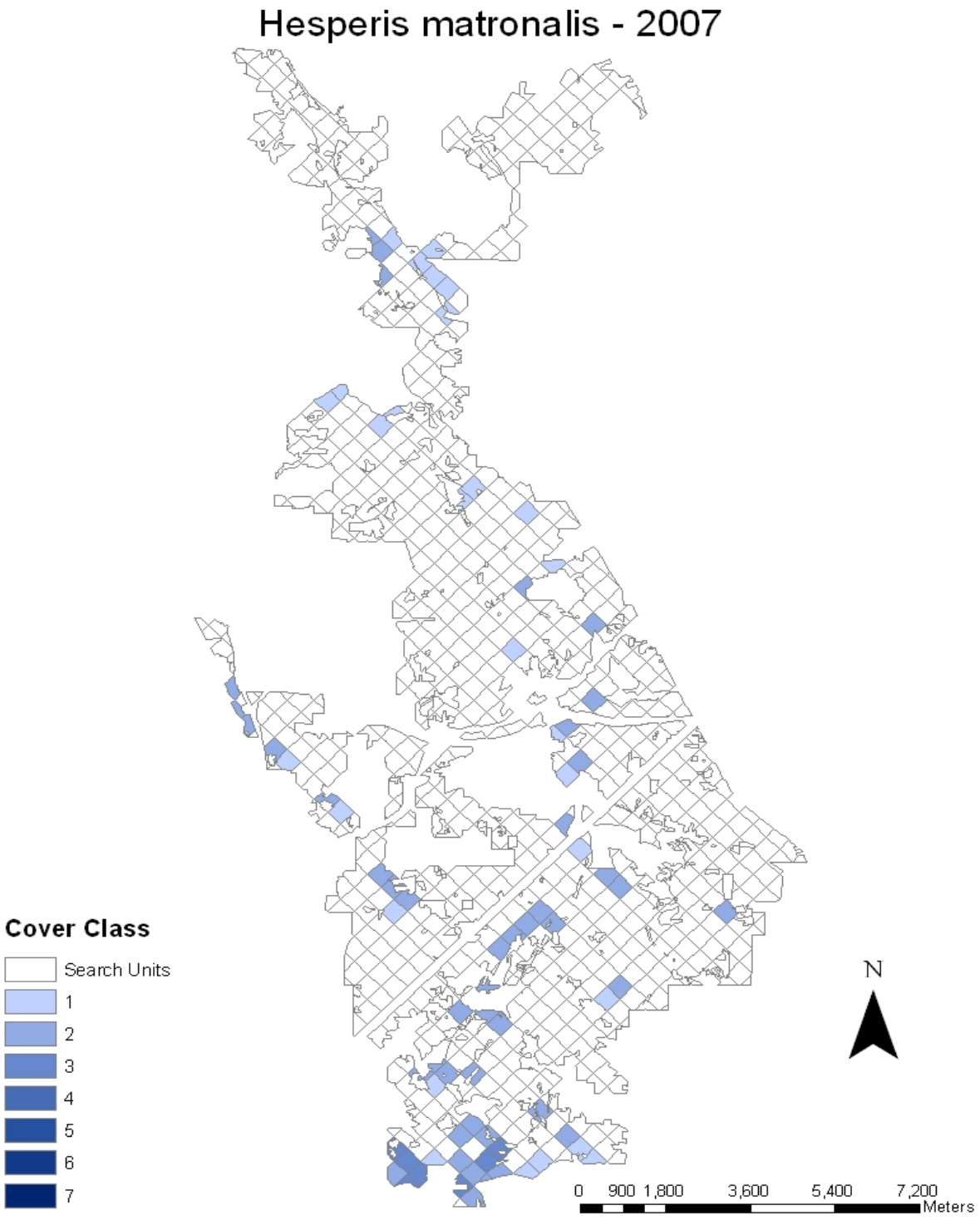


Figure 17. Abundance and distribution of *Hesperis matronalis* (Dames rocket) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

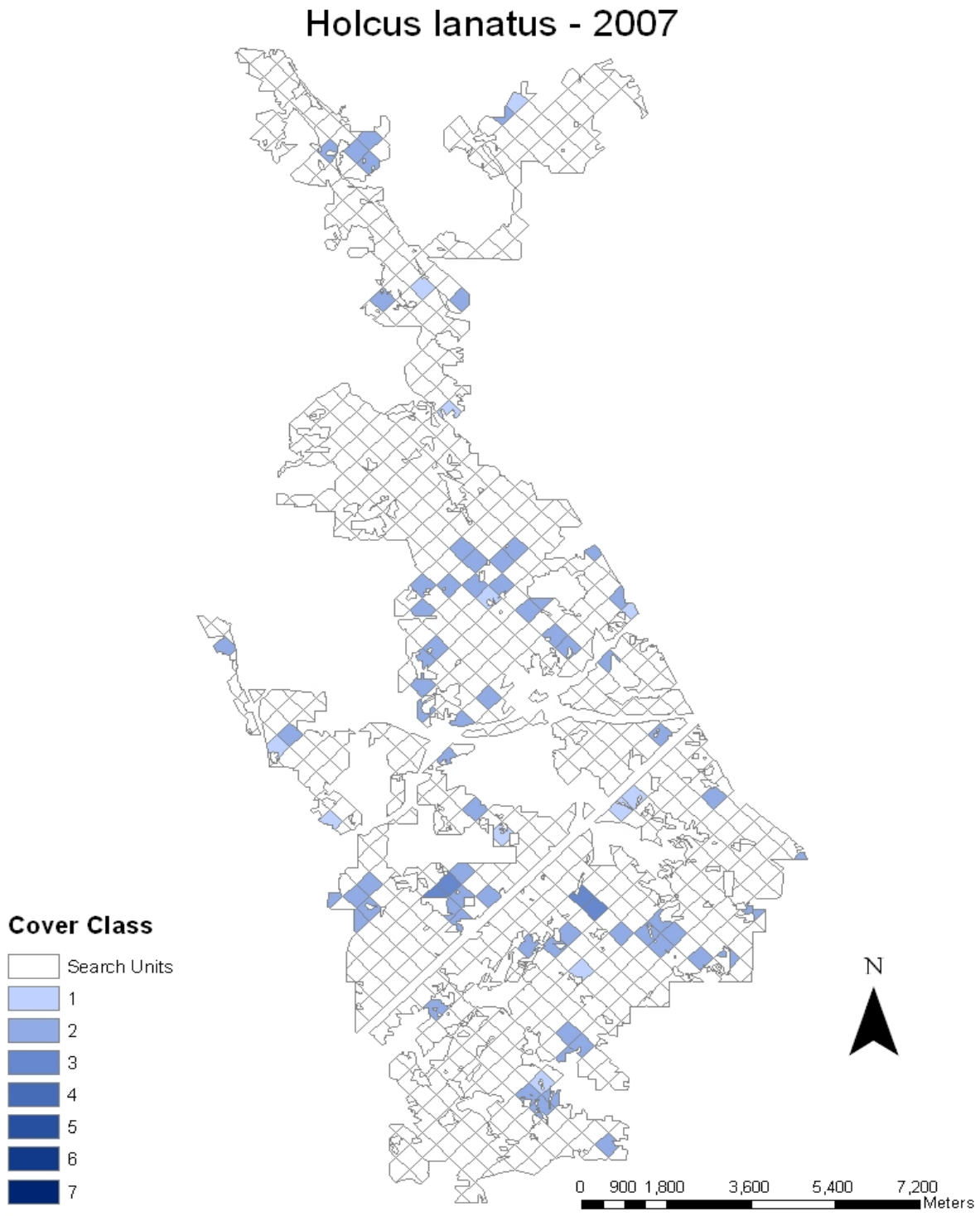


Figure 18. Abundance and distribution of *Holcus lanatus* (common velvetgrass) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

Figure 19. Abundance and distribution of *Iris pseudacorus* (paleyellow iris) at Cuyahoga Valley National Park, 2007. 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, and 7=1,000-4,999.9 m^2.

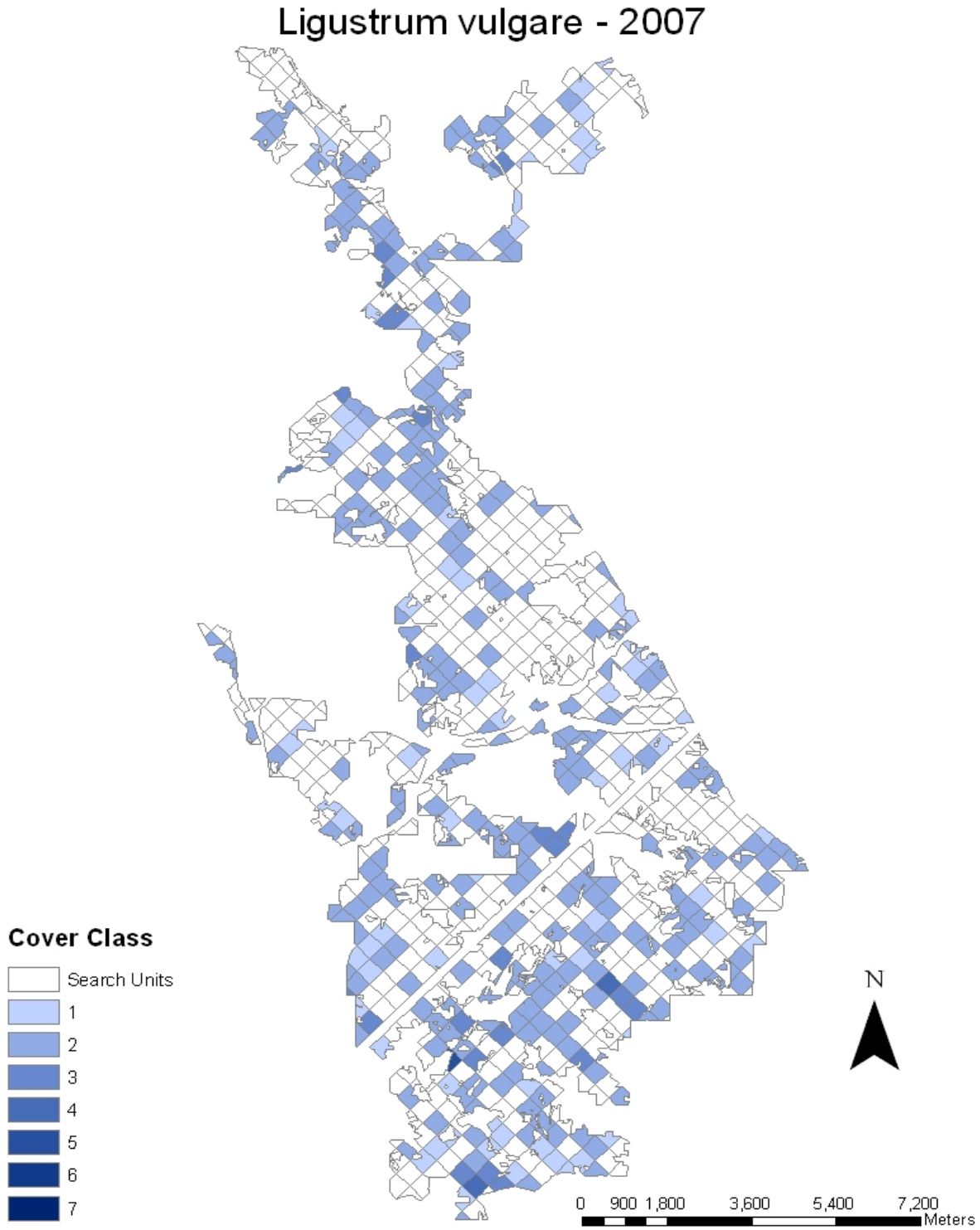


Figure 20. Abundance and distribution of *Ligustrum vulgare* (European privet) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

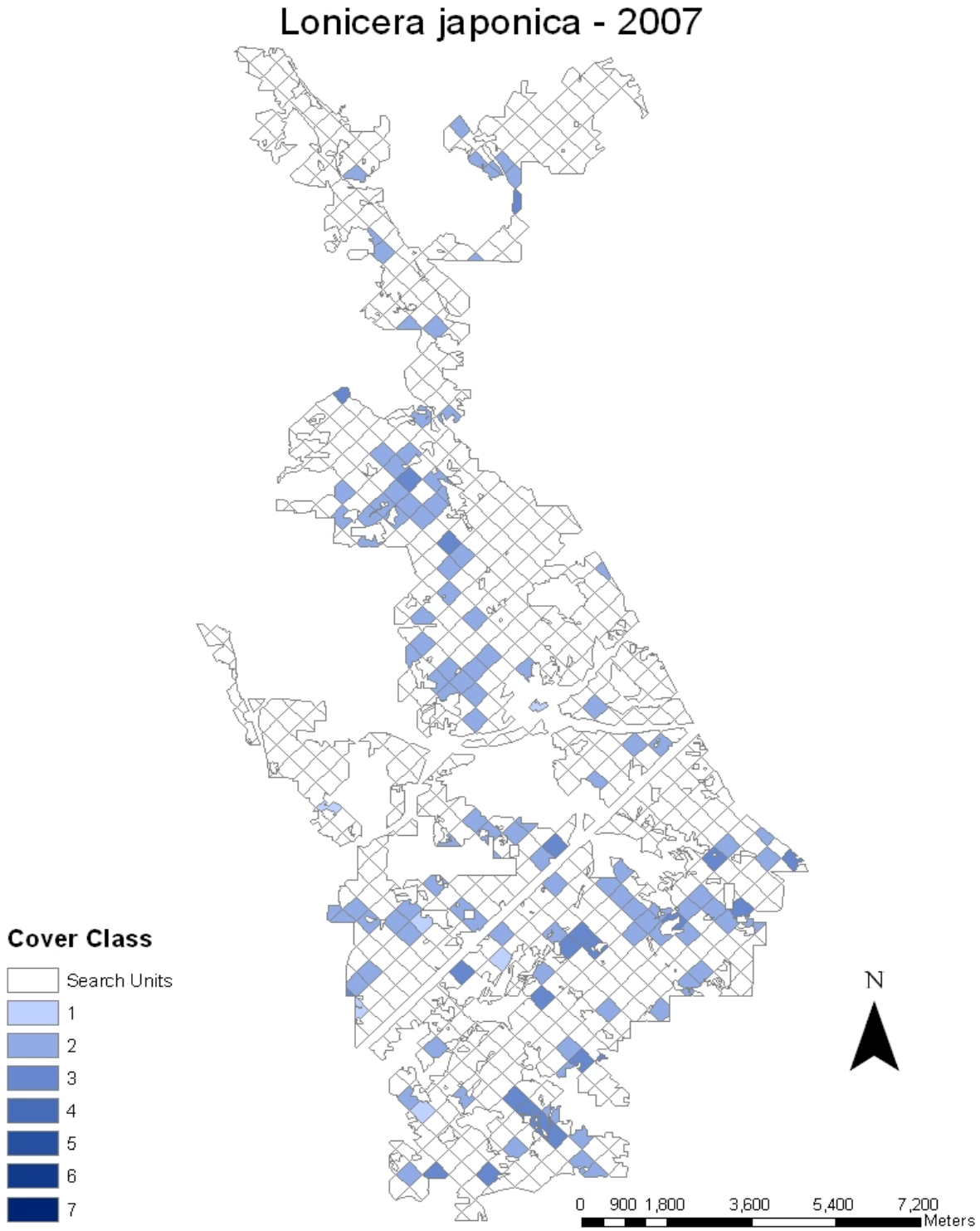


Figure 21. Abundance and distribution of *Lonicera japonica* (Japanese honeysuckle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

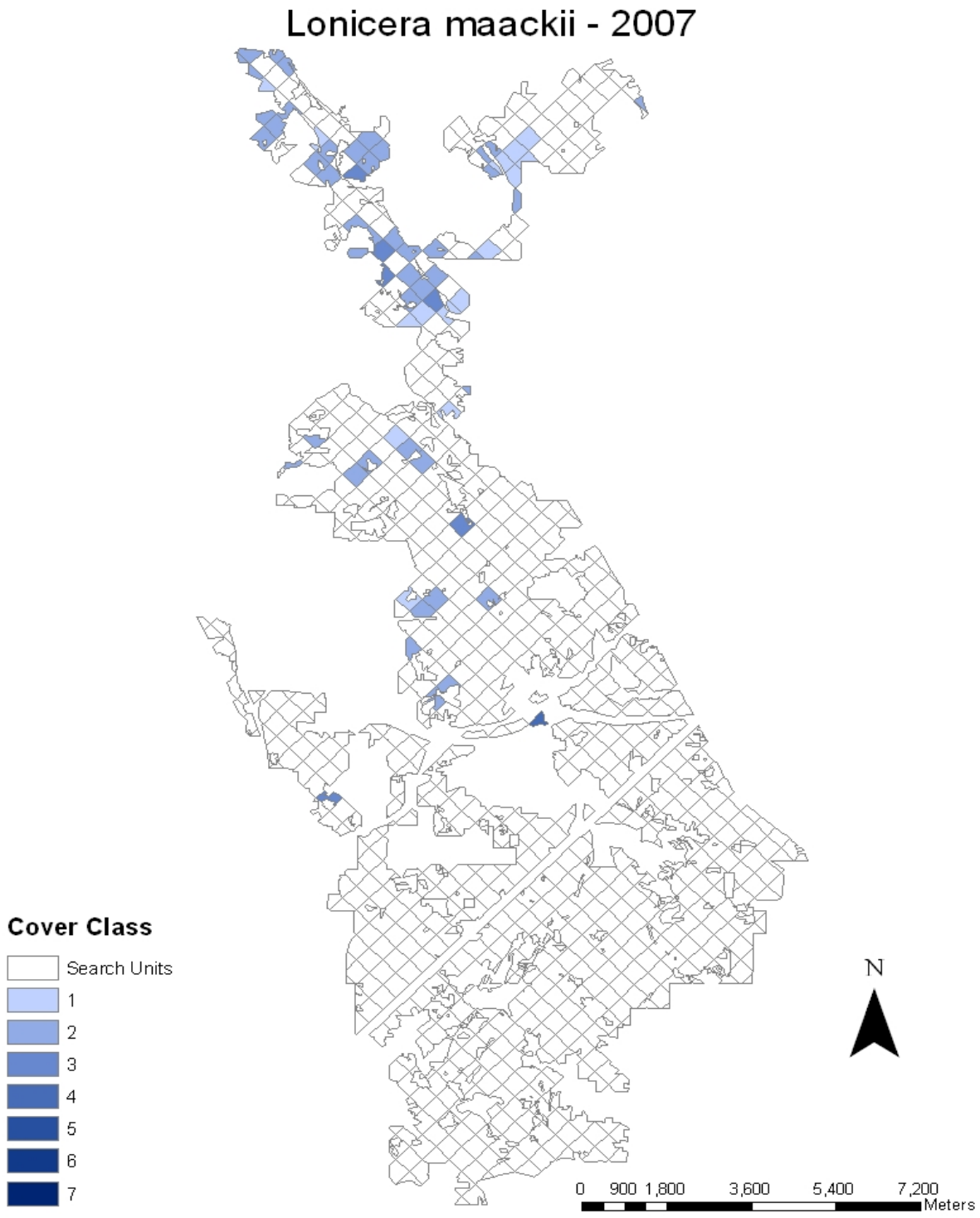


Figure 22. Abundance and distribution of *Lonicera maackii* (Amur honeysuckle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

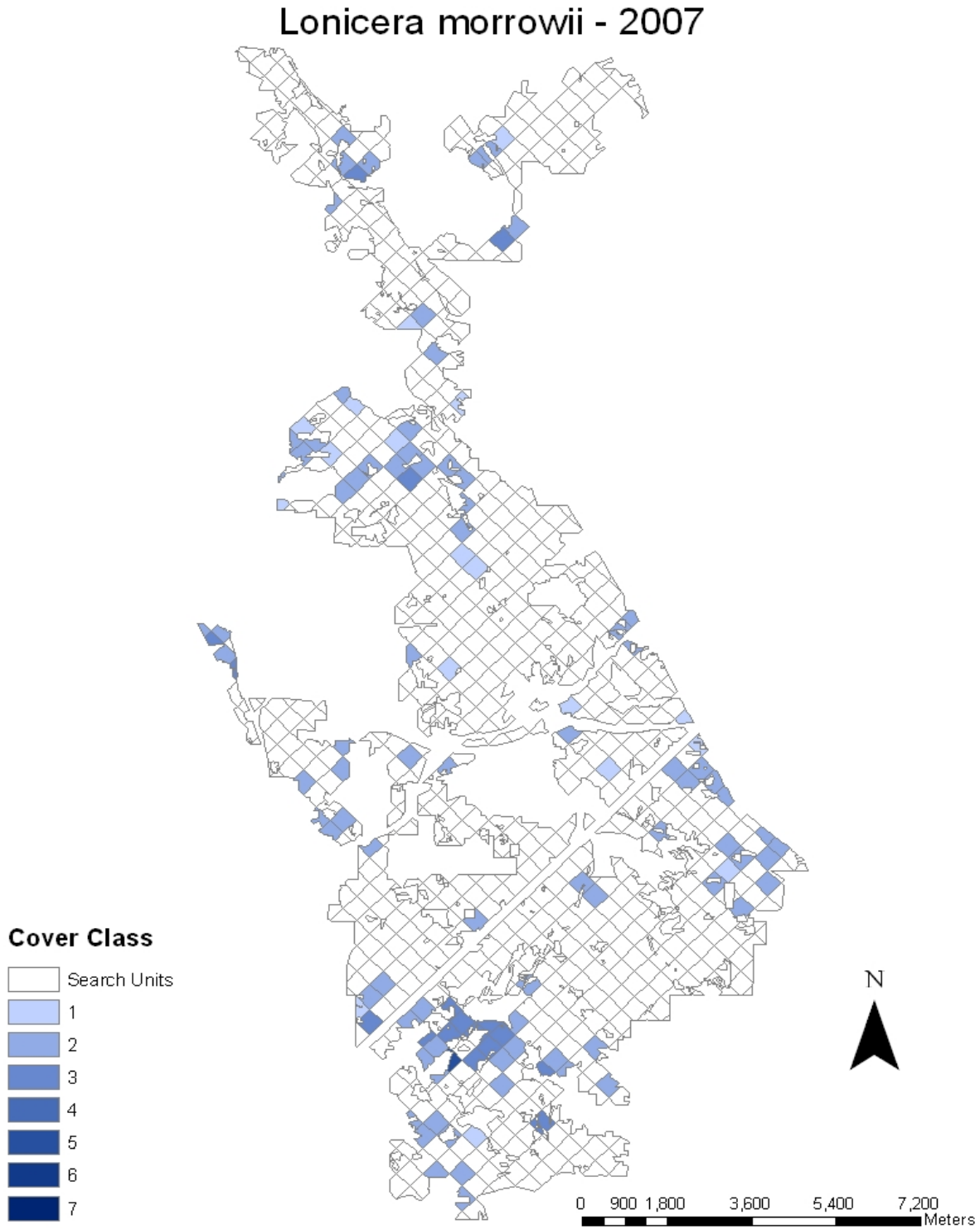


Figure 23. Abundance and distribution of *Lonicera morrowii* (Morrow's honeysuckle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

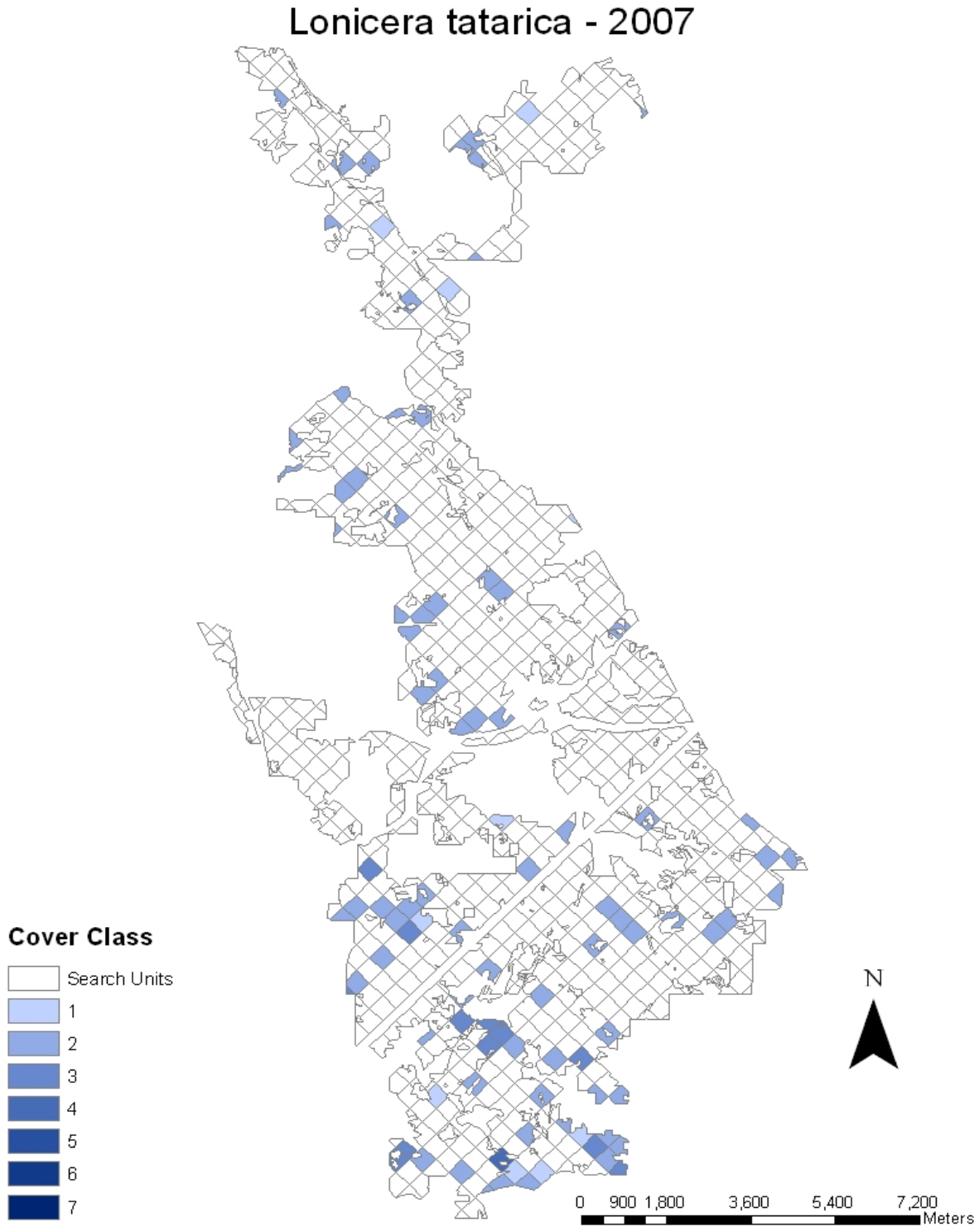


Figure 24. Abundance and distribution of *Lonicera tatarica* (Tatarian honeysuckle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

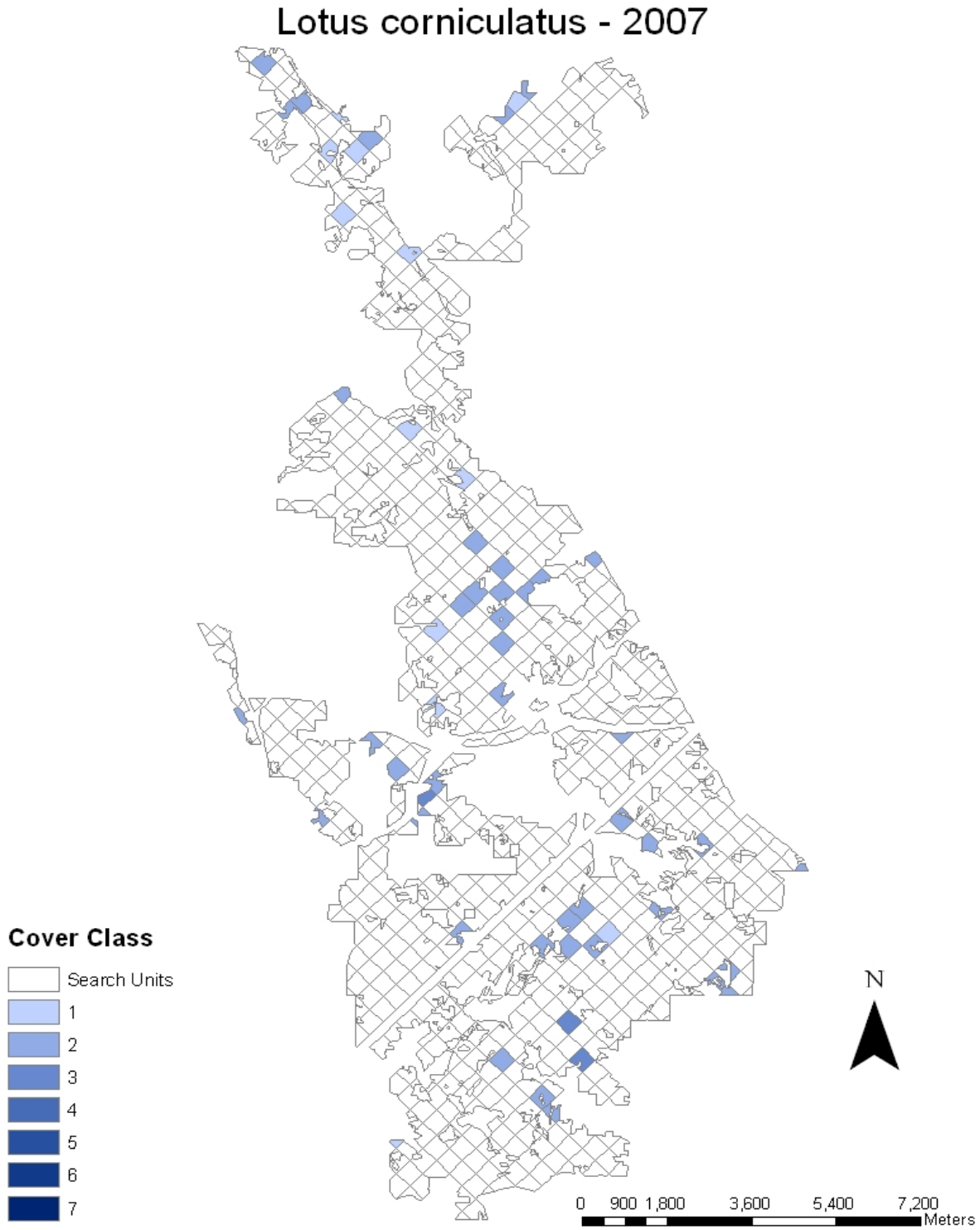


Figure 25. Abundance and distribution of *Lotus corniculatus* (bird's-foot trefoil) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

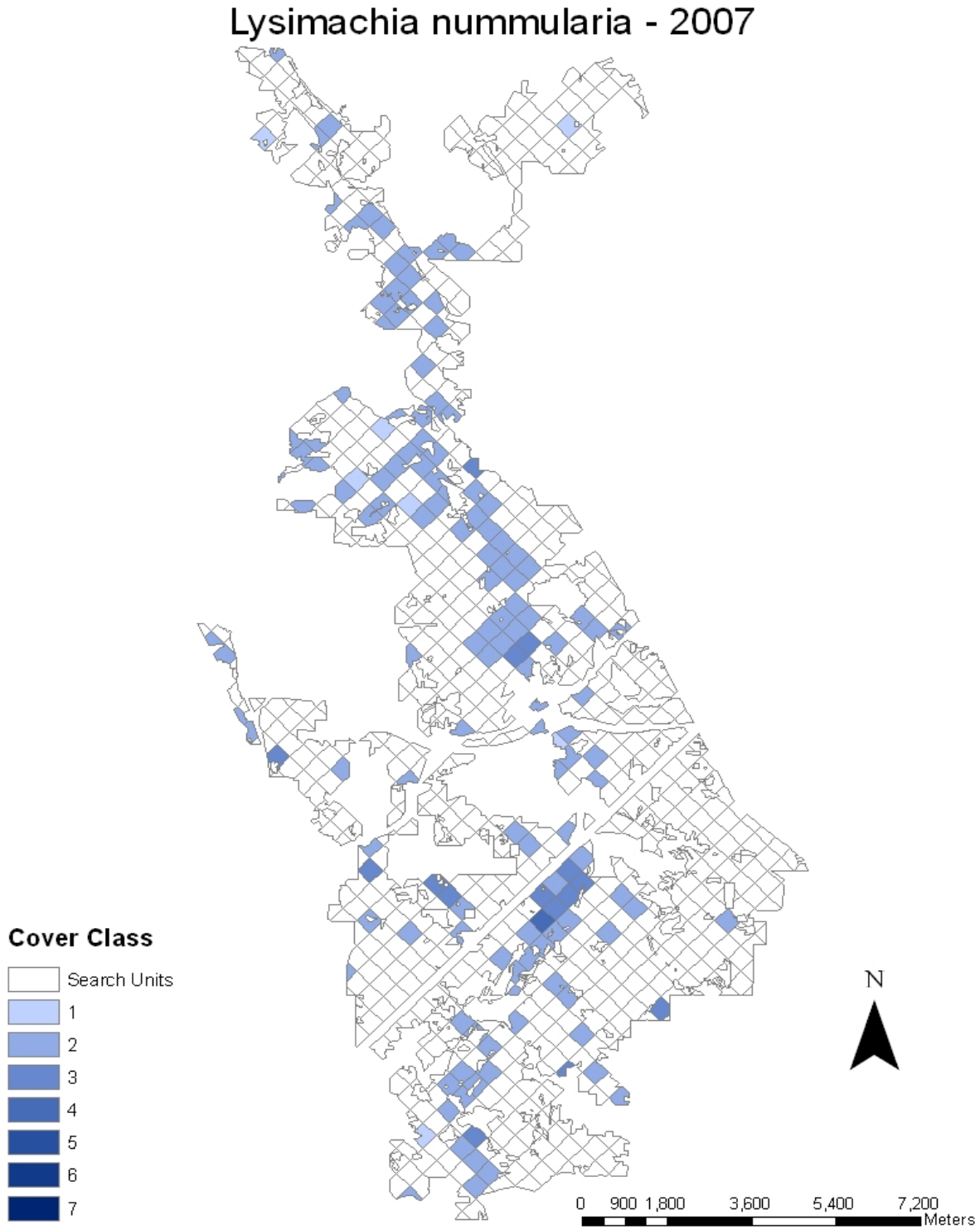


Figure 26. Abundance and distribution of *Lysimachia nummularia* (creeping jenny) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

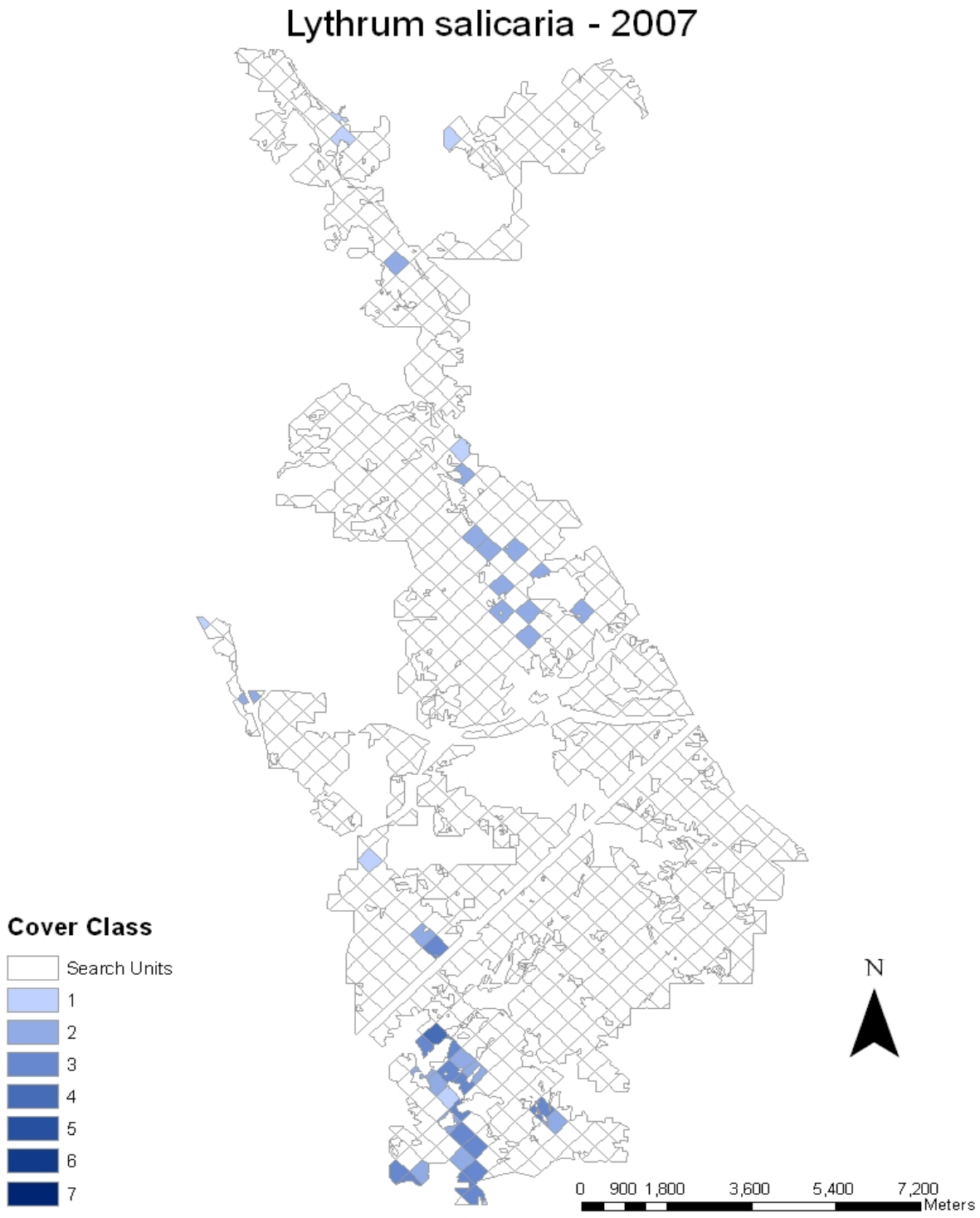


Figure 27. Abundance and distribution of *Lythrum salicaria* (purple loosestrife) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

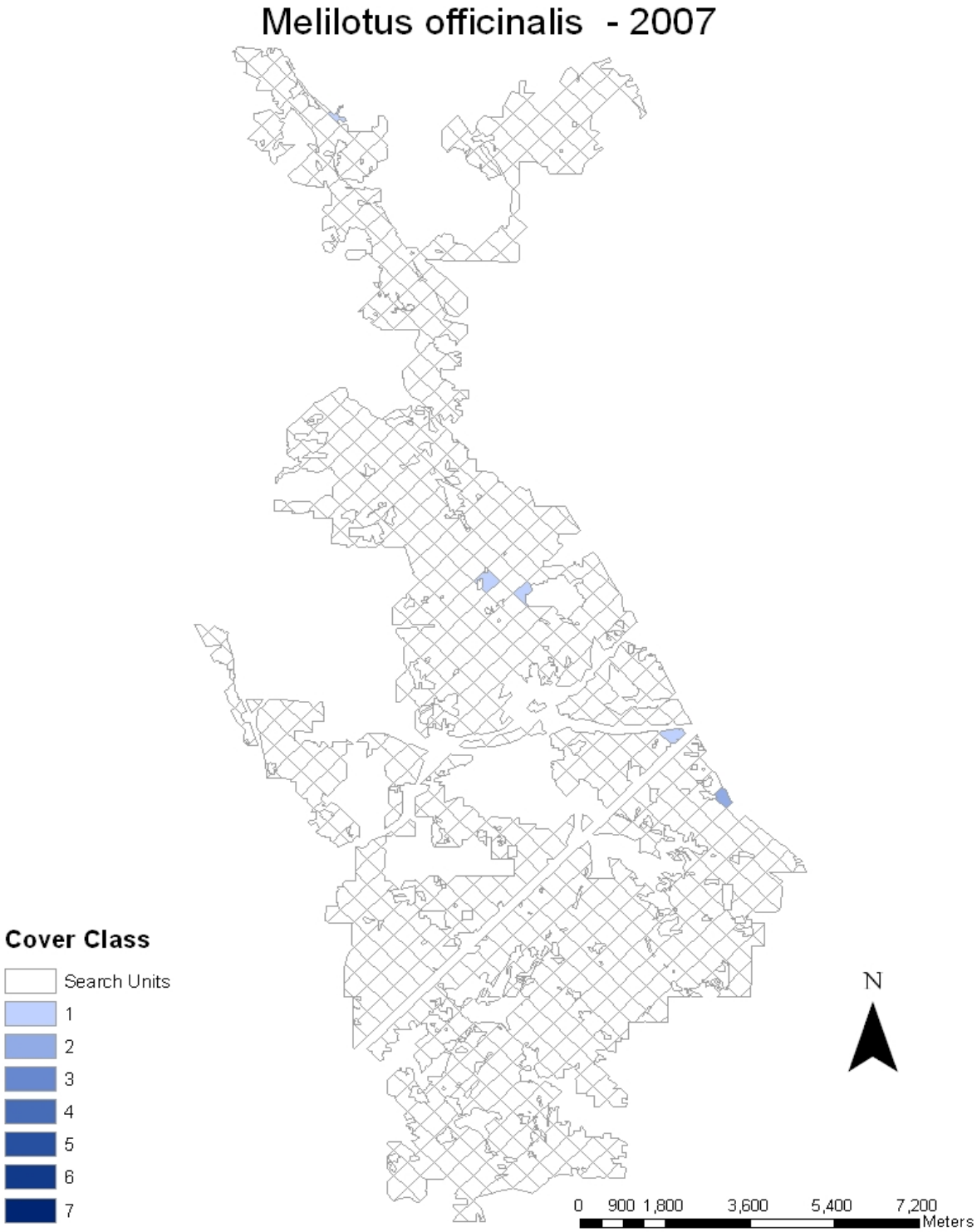


Figure 28. Abundance and distribution of *Melilotus officinalis* (yellow sweetclover) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

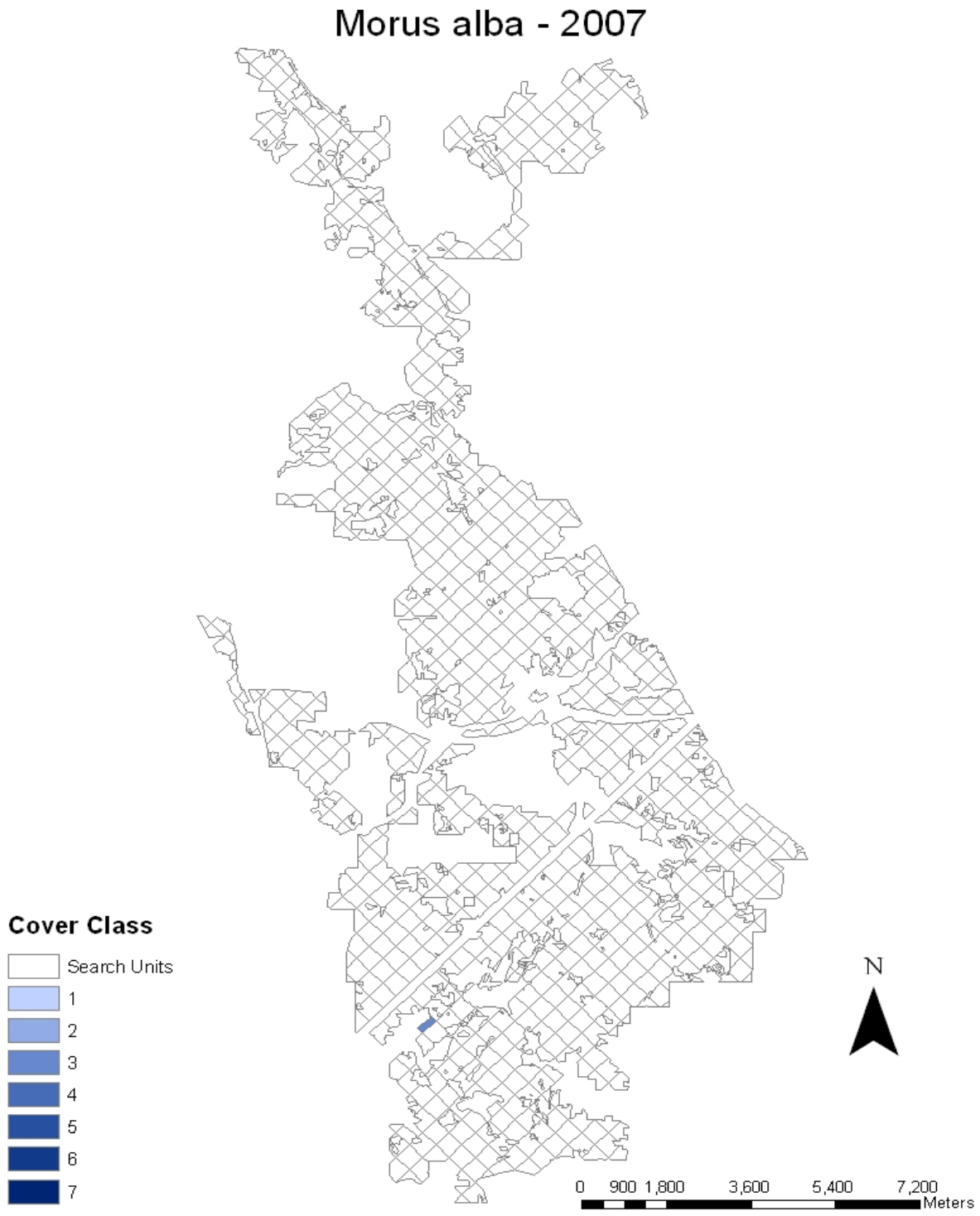


Figure 29. Abundance and distribution of *Morus alba* (white mulberry) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

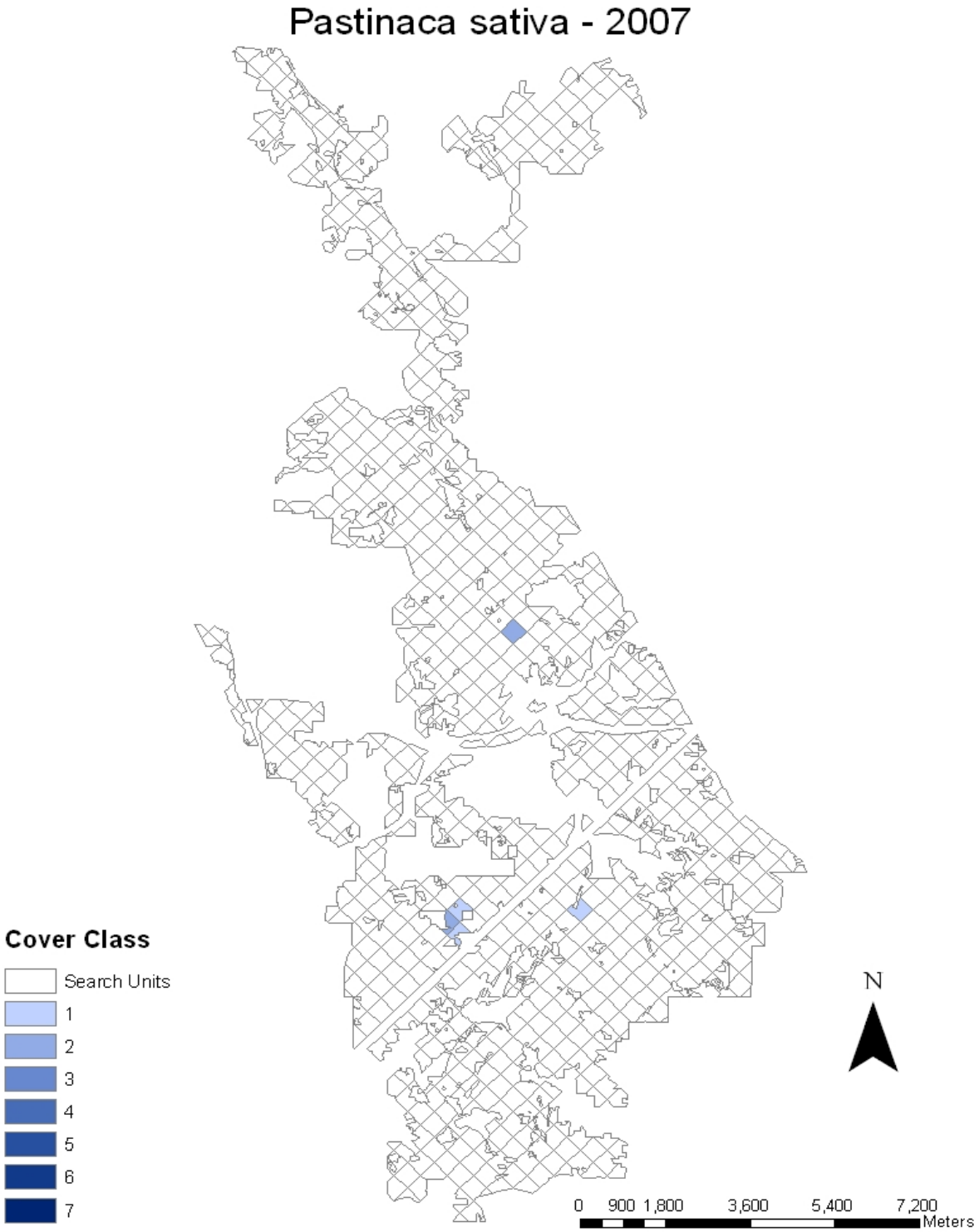


Figure 30. Abundance and distribution of *Pastinaca sativa* (wild parsnip) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

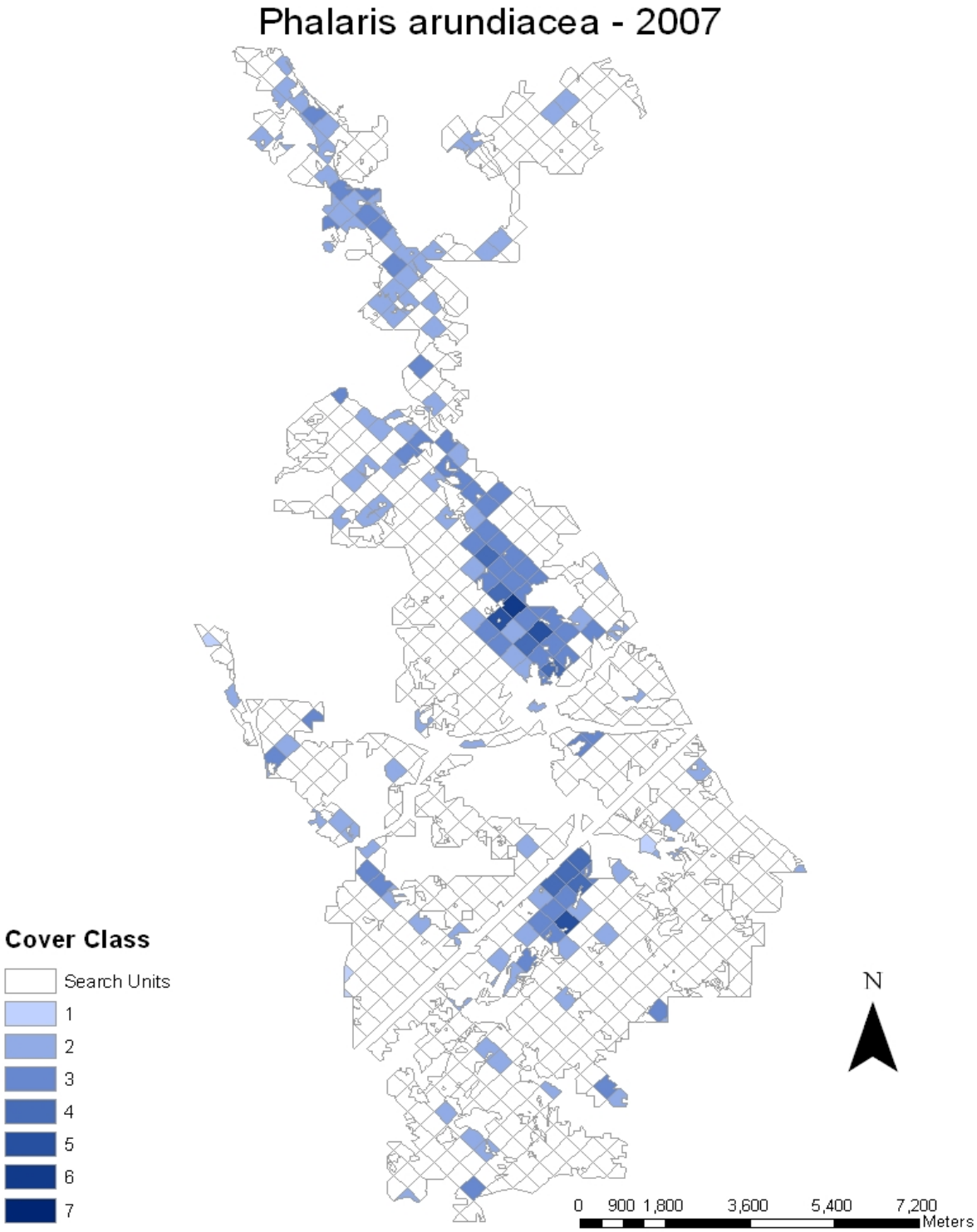


Figure 31. Abundance and distribution of *Phalaris arundinacea* (reed canarygrass) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

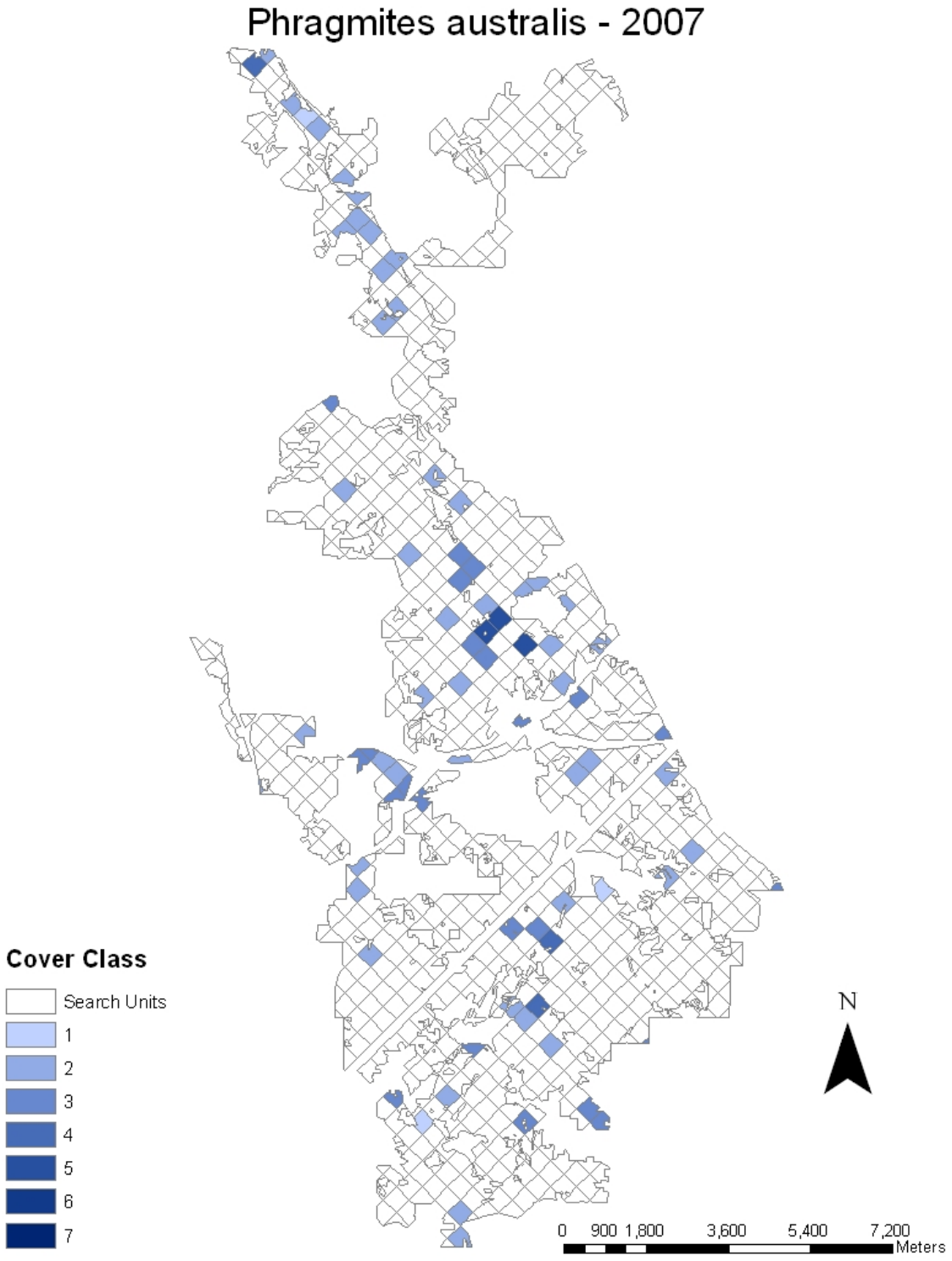


Figure 32. Abundance and distribution of *Phragmites australis* (common reed) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

Figure 33. Abundance and distribution of *Poa compressa* (Canada bluegrass) at Cuyahoga Valley National Park, 2007. 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, and 7=1,000-4,999.9 m^2.

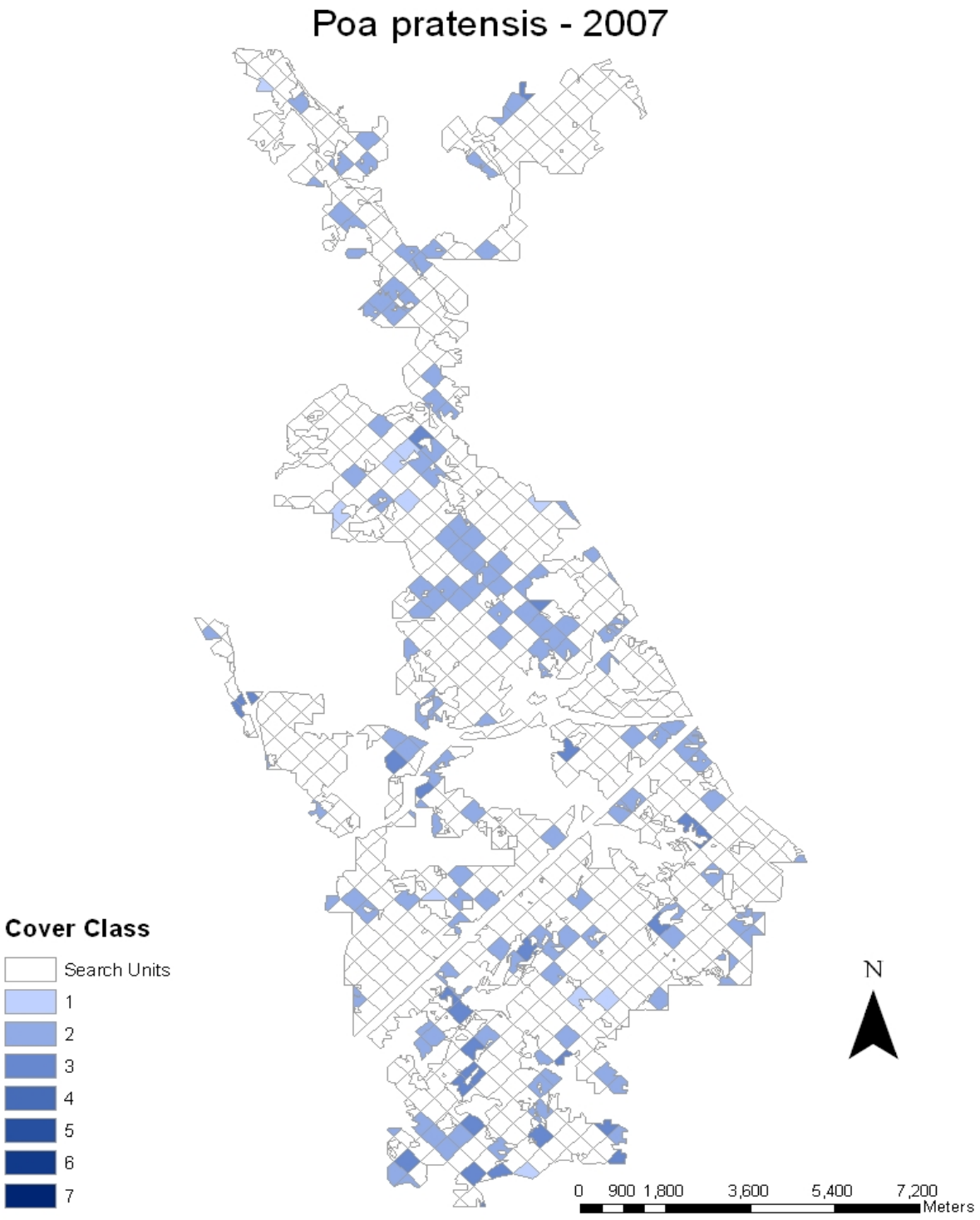


Figure 34. Abundance and distribution of *Poa pratensis* (Kentucky bluegrass) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

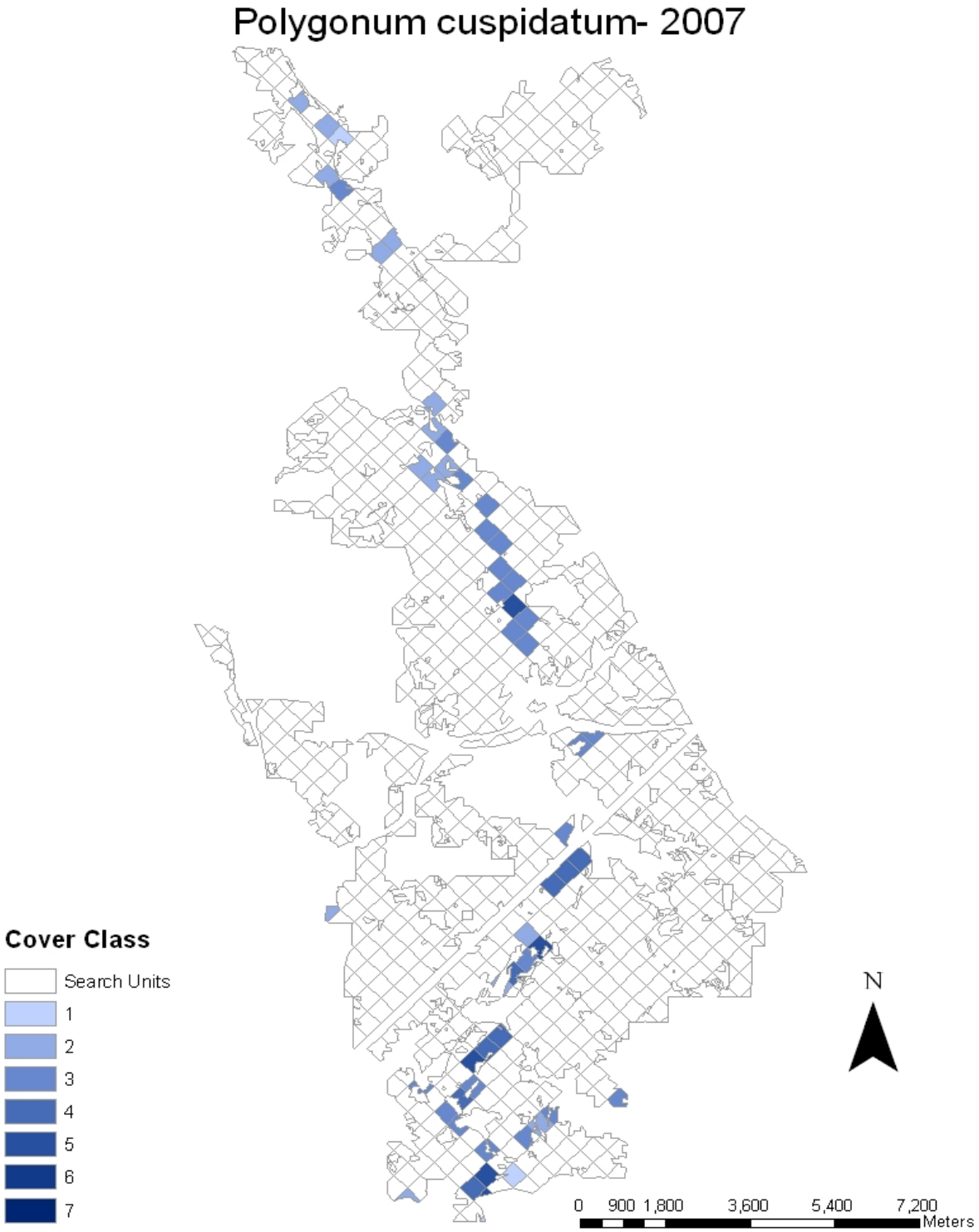


Figure 35. Abundance and distribution of *Polygonum cuspidatum* (Japanese knotweed) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

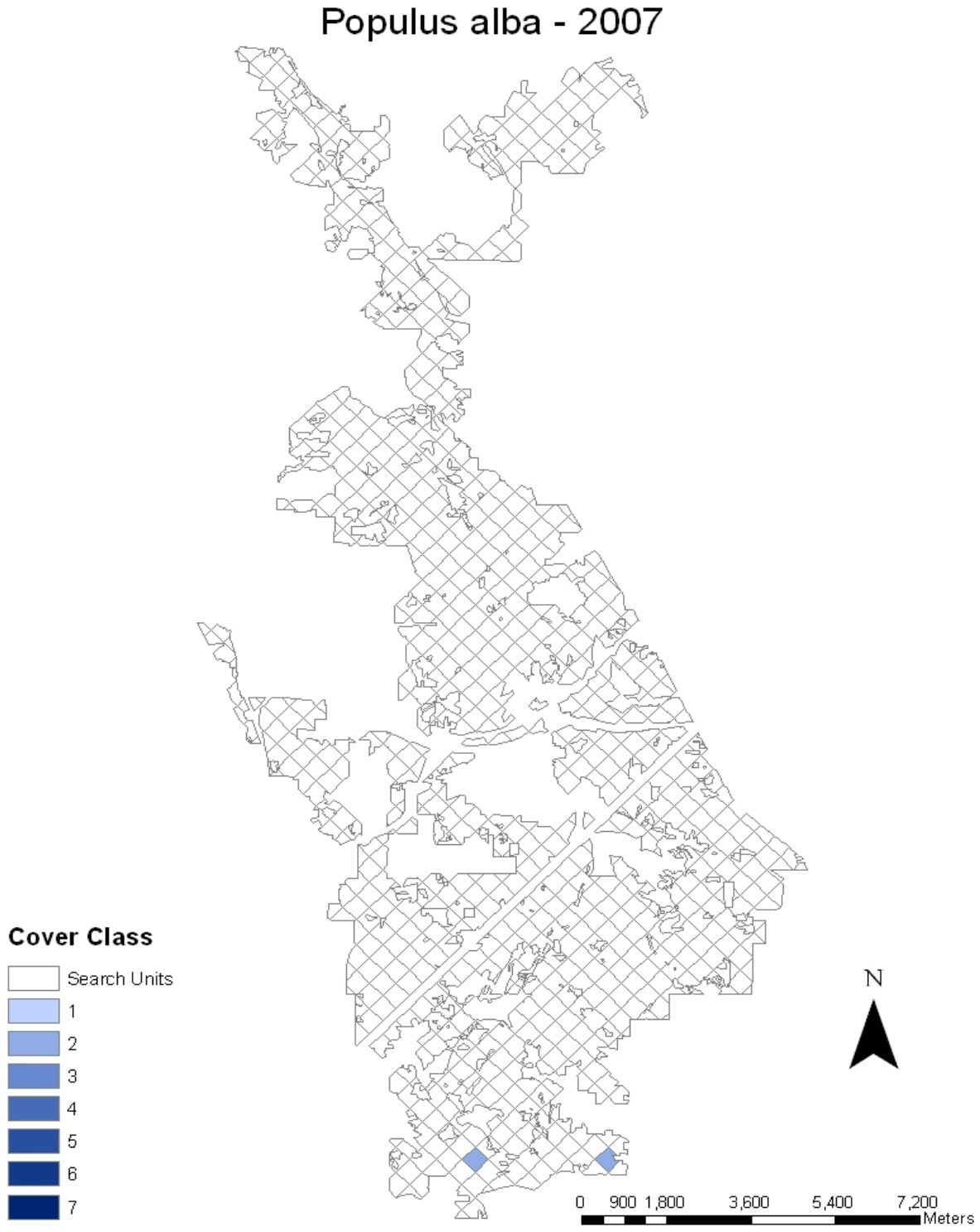


Figure 36. Abundance and distribution of *Populus alba* (white poplar) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

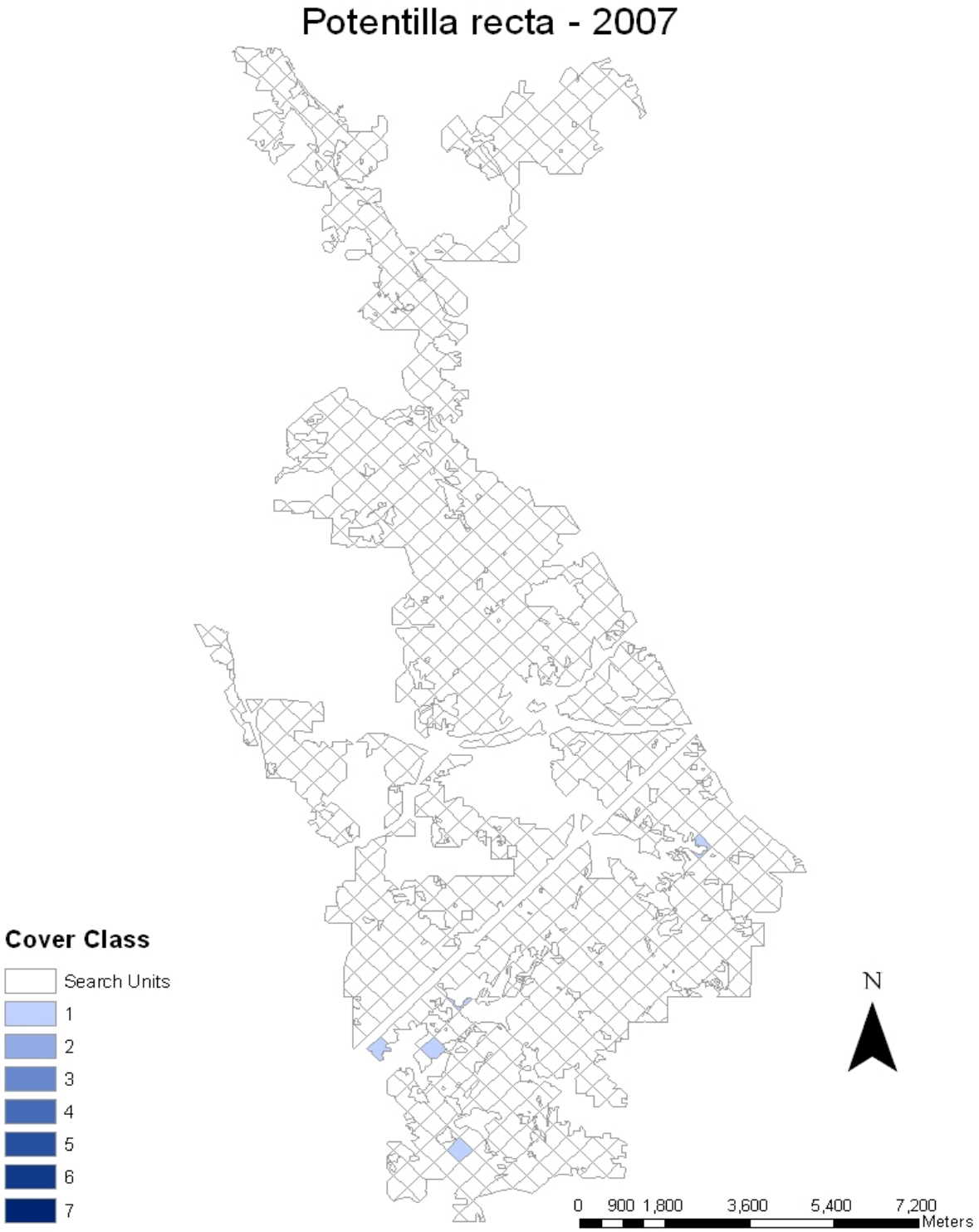


Figure 37. Abundance and distribution of *Potentilla recta* (sulphur cinquefoil) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

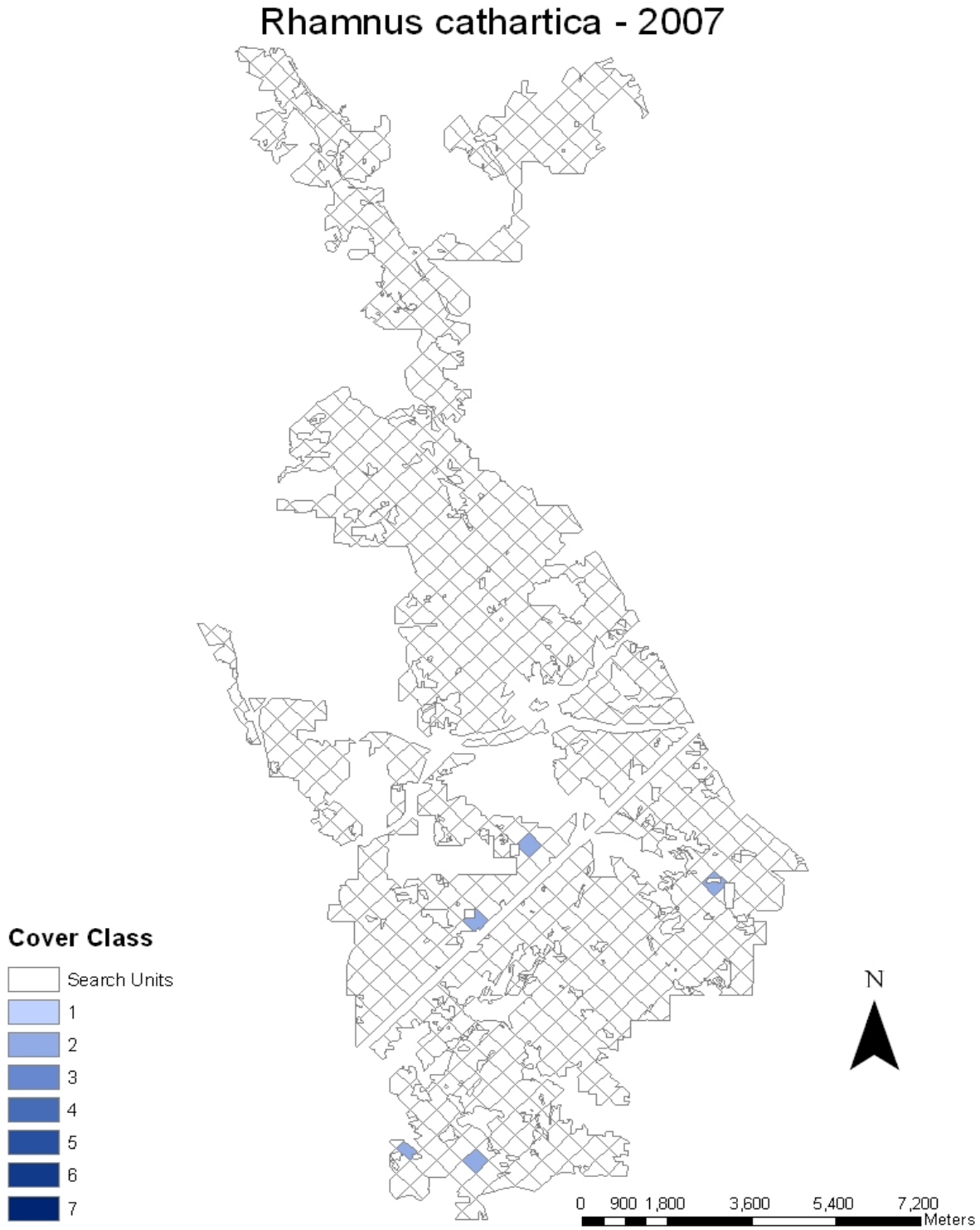


Figure 38. Abundance and distribution of *Rhamnus cathartica* (common buckthorn) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

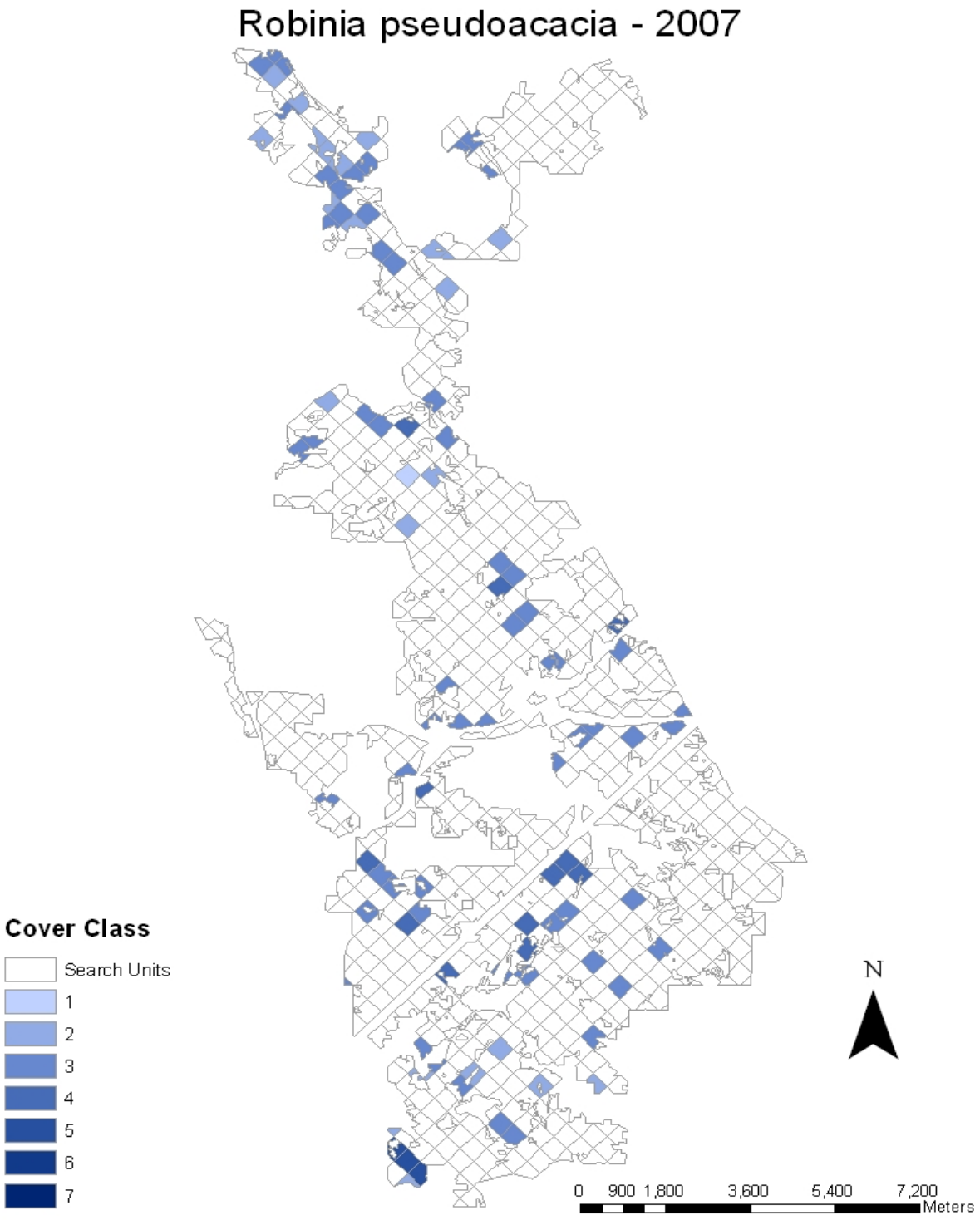


Figure 39. Abundance and distribution of *Robinia pseudoacacia* (black locust) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

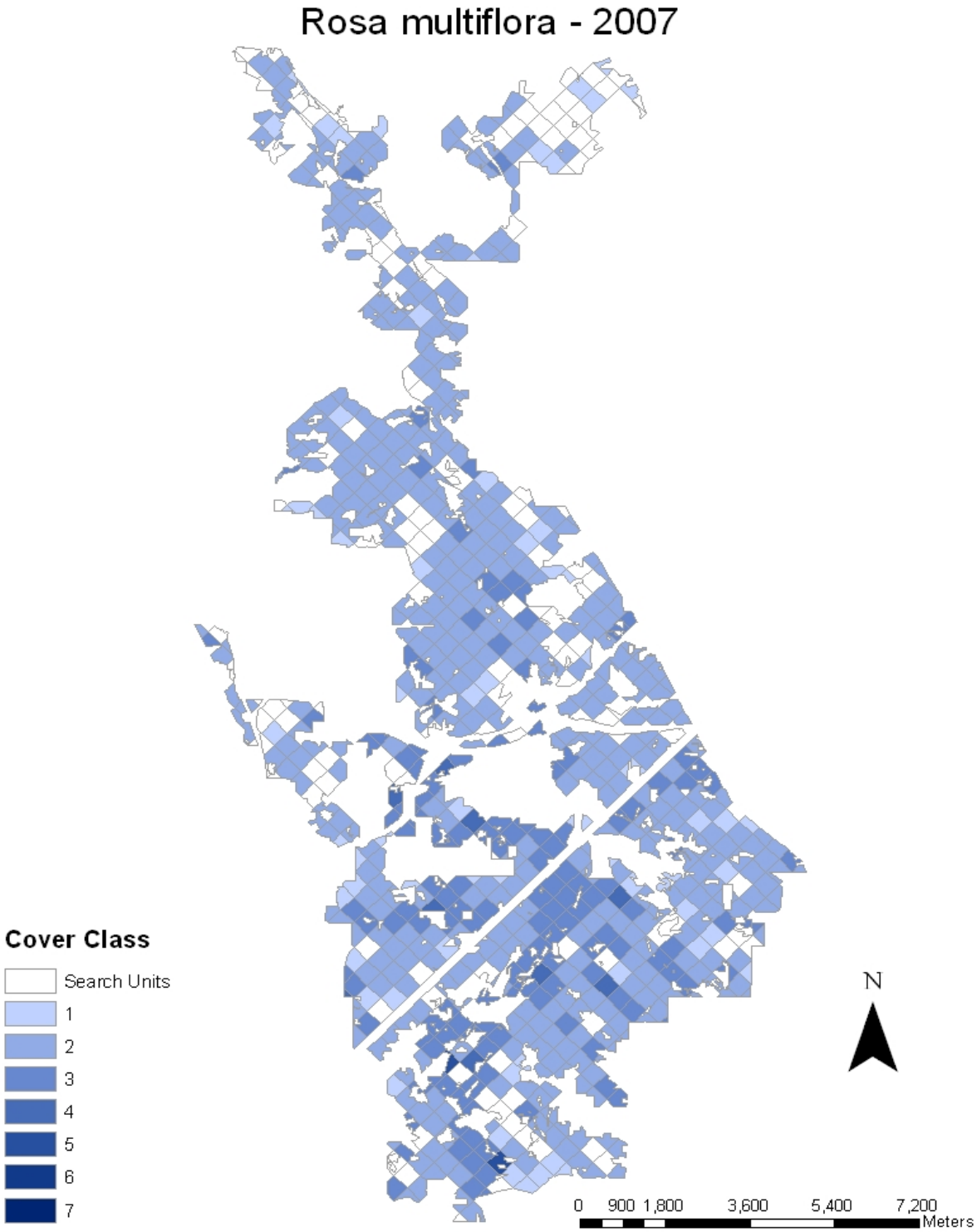


Figure 40. Abundance and distribution of *Rosa multiflora* (multiflora rose) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

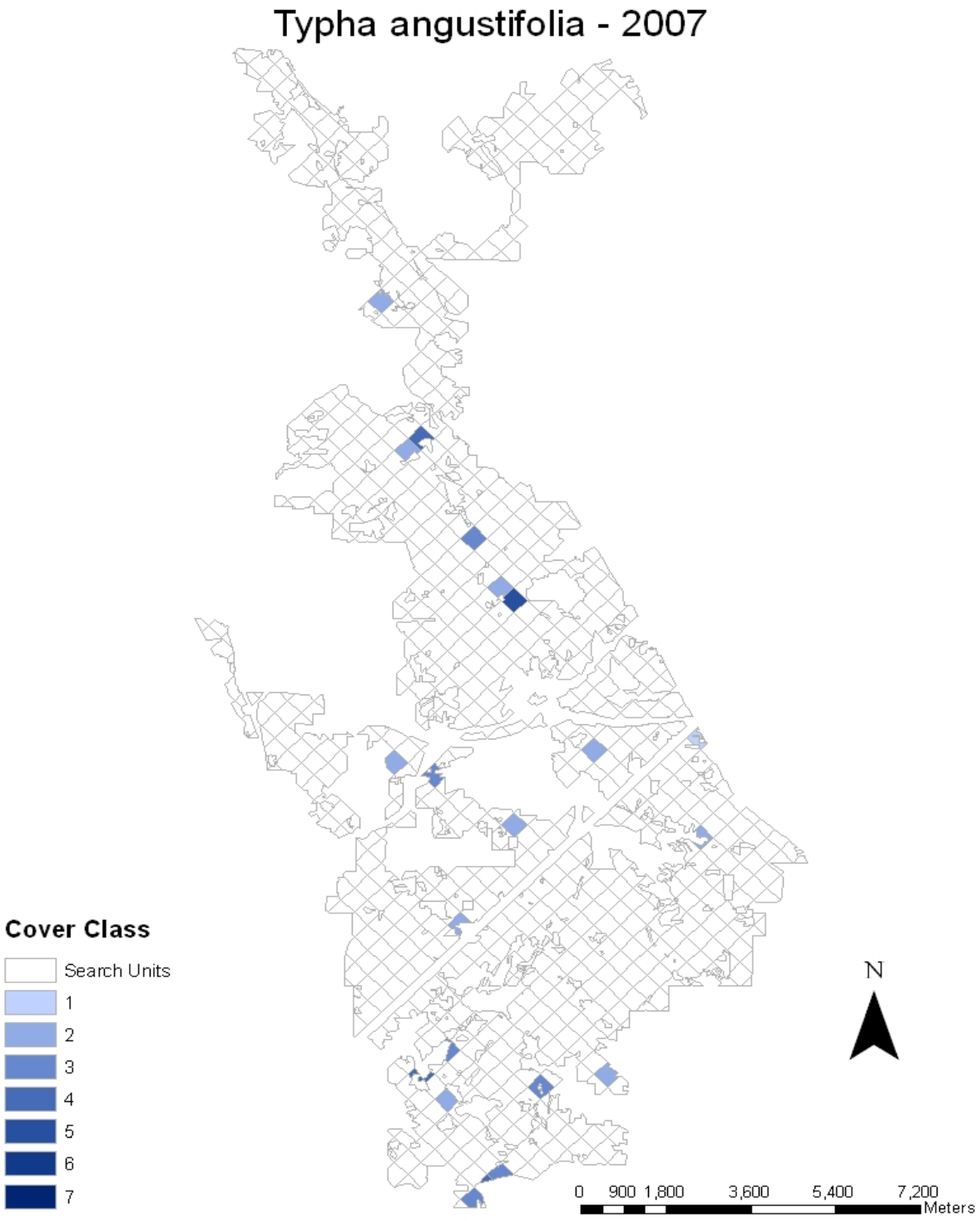


Figure 41. Abundance and distribution of *Typha angustifolia* (narrowleaf cattail) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

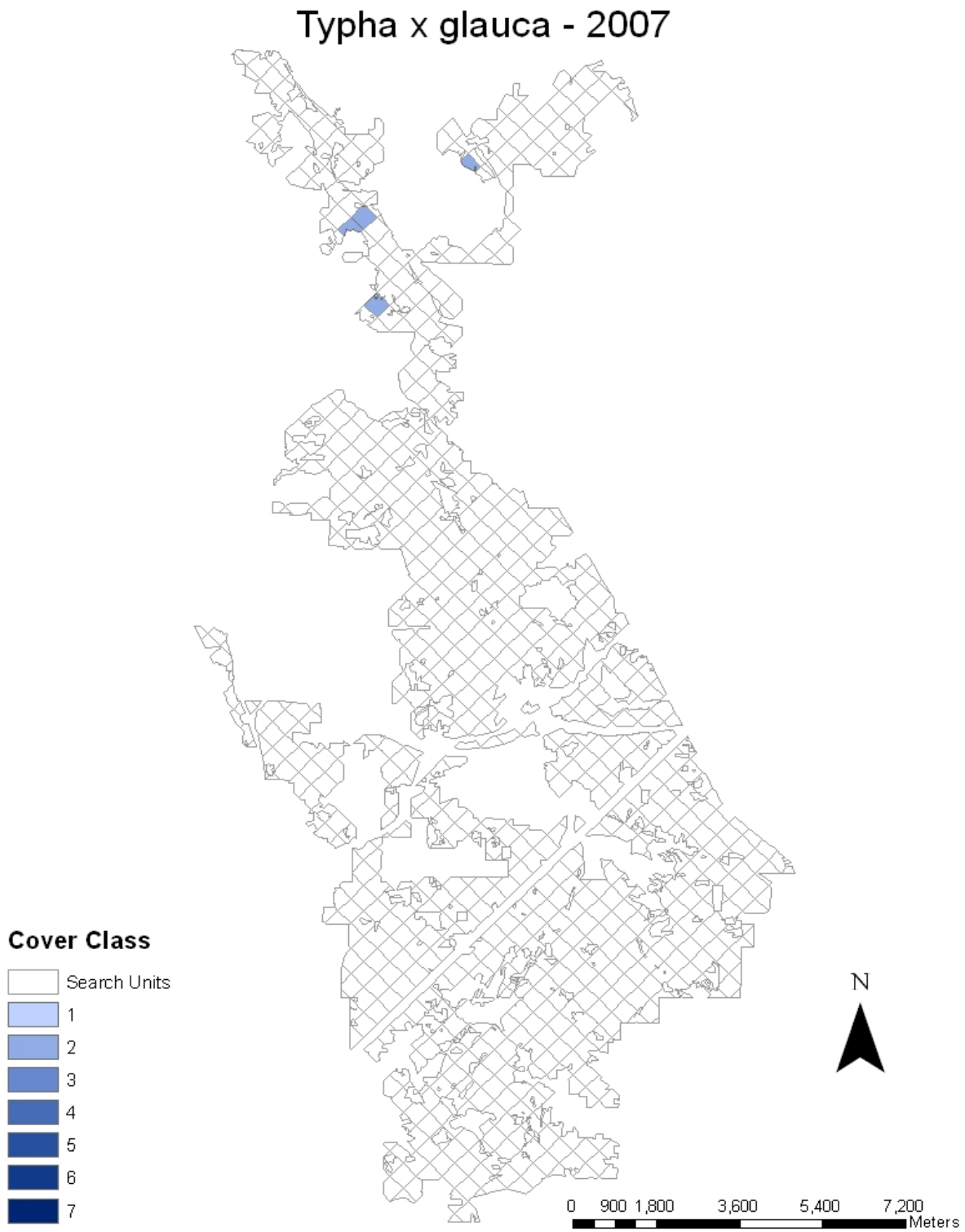


Figure 42. Abundance and distribution of *Typha x glauca* (cattail) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

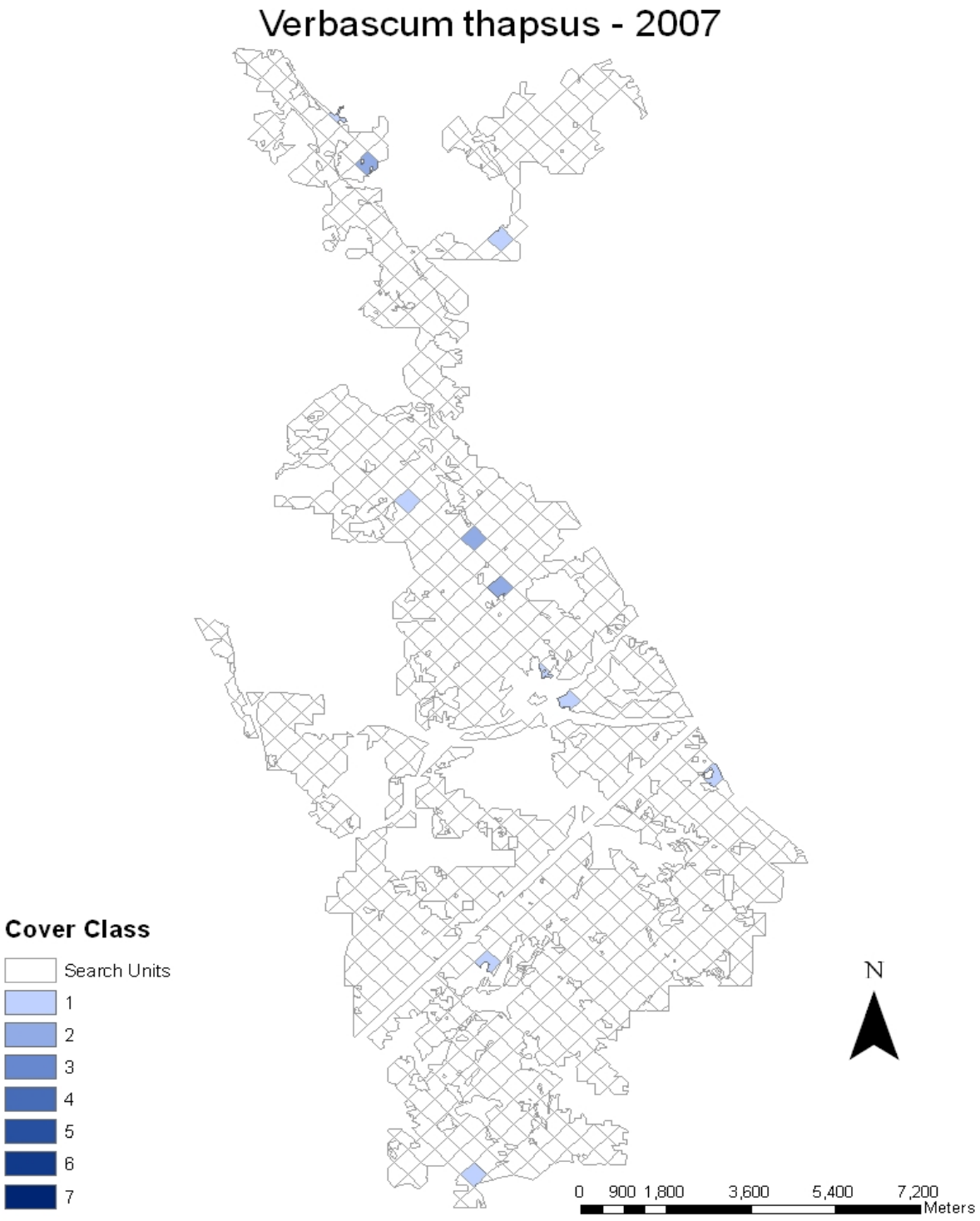


Figure 43. Abundance and distribution of *Verbascum thapsus* (common mullein) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

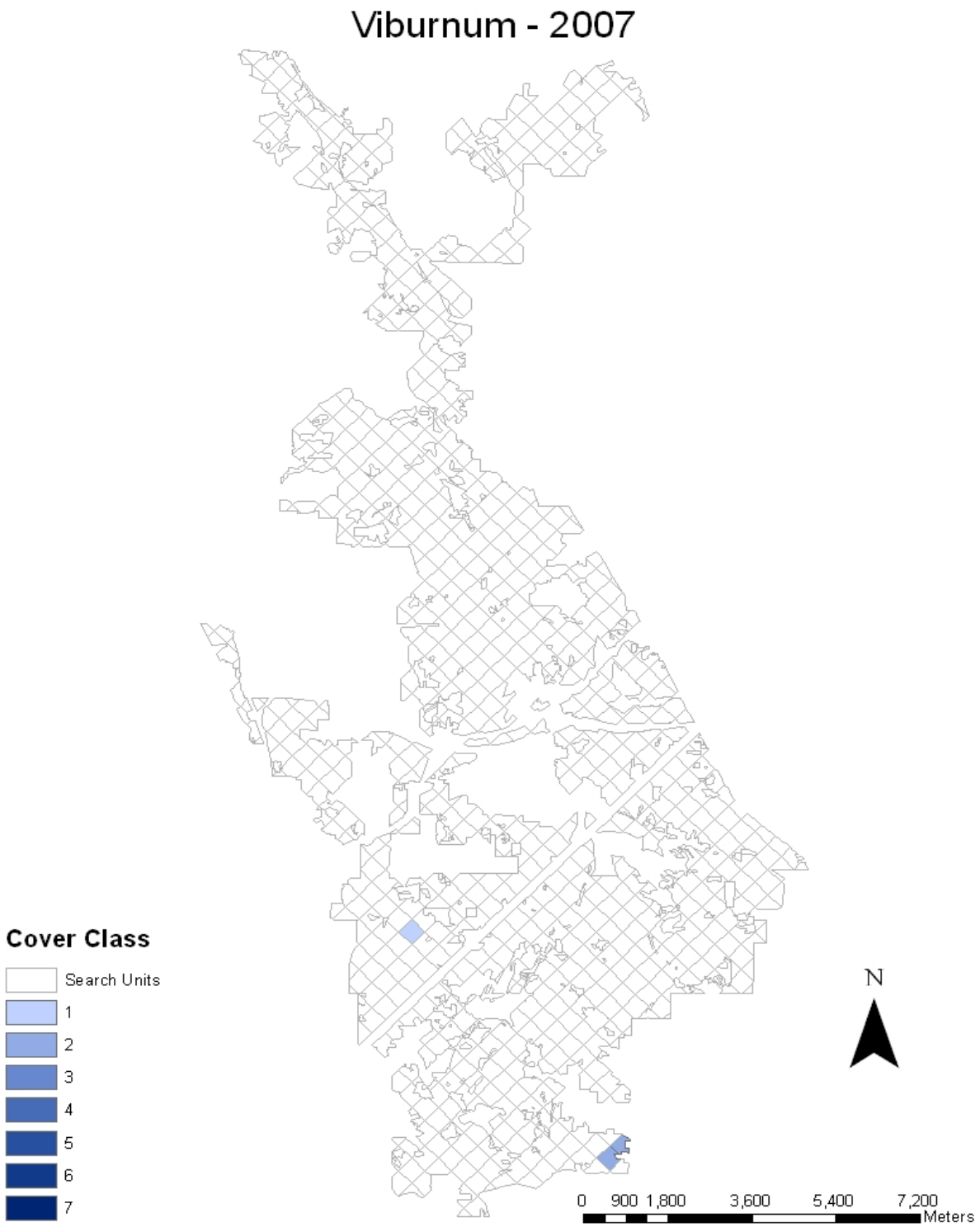


Figure 44. Abundance and distribution of *Viburnum spp.* (viburnum) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

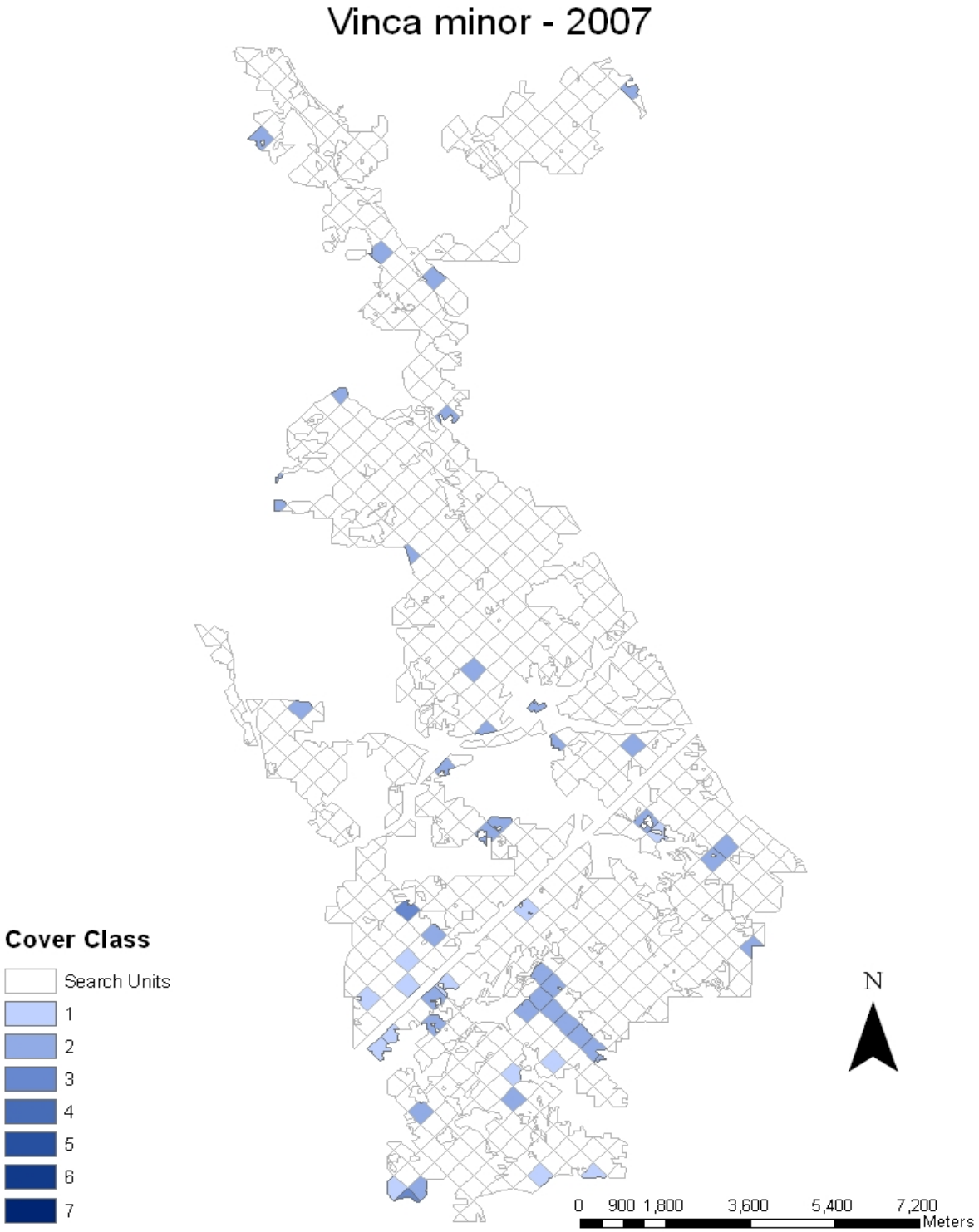


Figure 45. Abundance and distribution of *Vinca minor* (common periwinkle) at Cuyahoga Valley National Park, 2007. Cover classes are as follows: 1=0.1-0.9 m^2, 2=1-9.9 m^2, 3=10-49.9 m^2, 4= 50-99.9 m^2, 5=100-499.9 m^2, 6= 499.9-999.9 m^2, and 7=1,000-4,999.9 m^2.

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 Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS D-154, November 2007

National Park Service
U.S. Department of the Interior

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