Invasive Species Program 2009

by

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EXECUTIVE SUMMARY

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an organization exercising delegated authority from 11 federally recognized Ojibwe tribes in Minnesota, Wisconsin, and Michigan (Figure 1). These tribes retain hunting, fishing, and gathering rights in the territories ceded to the United States through various treaties. The degradation of native ecosystems by invasive species poses a serious threat to the continued exercise of these rights and the traditional lifeways they sustain.

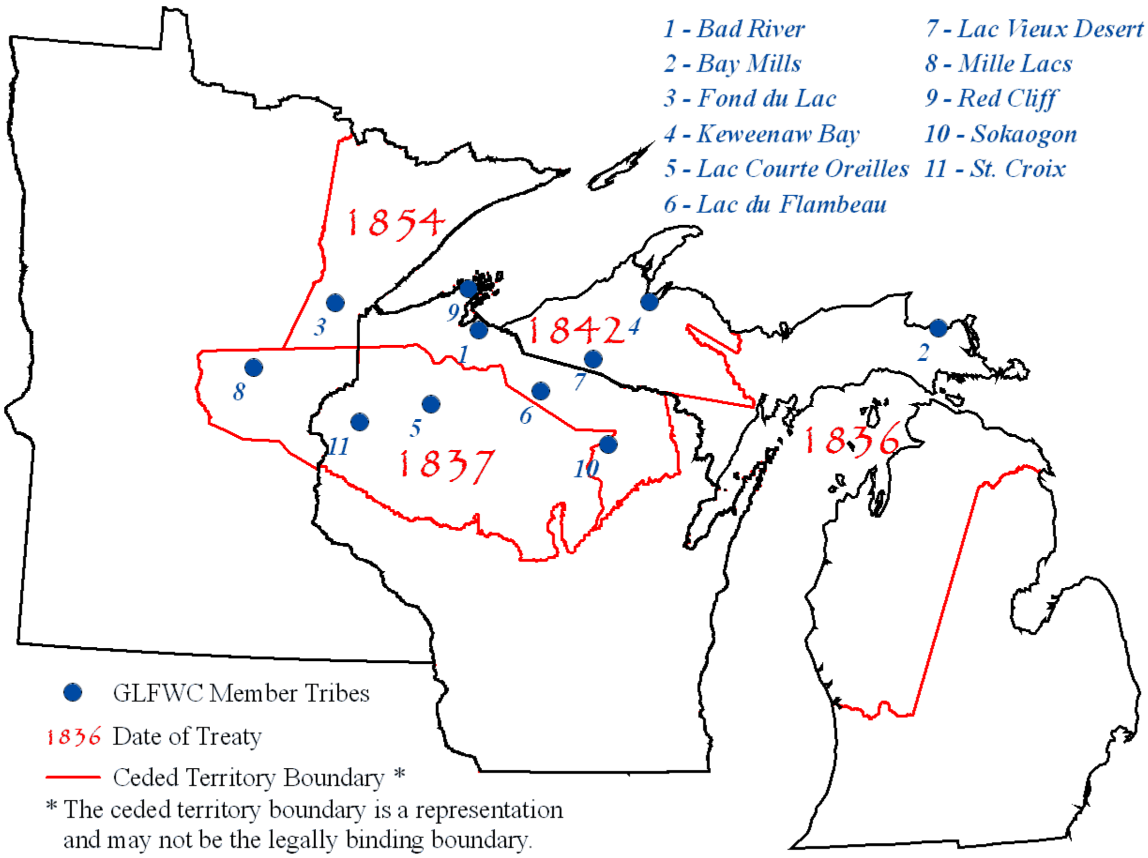

Figure 1. Location of GLIFWC member tribes and ceded territories.

Invasive species are considered by many biologists to be the second most important cause of biodiversity loss and species extinction worldwide, behind habitat destruction (OTA 1993, Wilcove *et al.* 1998, Enserink 1999). Wilcove *et al.* (1998) estimated that 57% of plants on the endangered species list are there at least in part because of invasive species. Besides physical displacement of native flora and fauna, invasive species can alter fire frequency, hydrologic properties, soil chemistry, and the physical and trophic structure of entire ecosystems (Walker and Smith 1997, Westbrooks 1998). This report summarizes the activities undertaken by GLIFWC staff during 2009 to address the spread of invasive species in the ceded territories. Taxonomic nomenclature cited in this report complies with the Integrated Taxonomic Information System (www.itis.gov).

GLIFWC's invasive species program consists of four comprehensive elements – education outreach, inventory and monitoring, control, and evaluation. Each of these elements is coordinated with local cooperators to maximize the efficient use of limited resources.

GLIFWC's noxious weed program started in 1988 with a pilot project to control purple loosestrife (*Lythrum salicaria*) in Fish Creek sloughs near Ashland, WI (Gilbert and Parisien 1989). This project has grown to include annual control efforts for purple loosestrife and leafy spurge (*Euphorbia esula*) populations throughout the Bad River - Chequamegon Bay watershed.

In 2001, GLIFWC initiated annual surveys for terrestrial invasive species (TIS) in an effort to assess the relative threat of the many non-native plants that have become established in the region and prioritize them for management (Falck and Garske 2002, Falck and Garske 2003). This effort continued in 2009 with a focus on the western portion of the 1842 ceded territory.

In 2004, GLIFWC initiated annual surveys for aquatic invasive species (AIS) as part of its invasive species program (Garske and Falck 2005). These surveys are coordinated with surveys conducted by various management partners and target waters with significant treaty resources and high visitation rates. The surveys look for invasive aquatic plants and animals, including zebra mussels (*Dreissena polymorpha*) spiny water fleas (*Bythotrephes cederstroemi*) and rusty crayfish (*Orconectes rusticus*).

GLIFWC's educational outreach efforts center around its web site (www.glifwc.org/invasives) which provides basic information on invasive species and provides access to a regional GIS database (www.maps.glifwc.org) of invasive species survey efforts, distribution records and control efforts. In addition, GLIFWC distributes and develops print material to raise awareness of invasive species issues.

Because non-native invasive plants disperse widely across the landscape and administrative boundaries, it is advantageous to work cooperatively with adjacent landowners towards common objectives. GLIFWC strives to coordinate its invasive species activities with local and regional cooperators by providing information on its website and participating in several forums to coordinate and guide invasive species management efforts.

ACKNOWLEDGMENTS

The Great Lakes Indian Fish and Wildlife Commission acknowledges the following government agencies for their financial support of GLIFWC's invasive species program. The BIA continues to provide the foundation for developing new partnerships and leveraging additional resources for invasive species management (Figure 2). The activities summarized in this report were funded by:

- Bureau of Indian Affairs (BIA)
  - GLIFWC's base funding
  - Noxious Weed Program
  - Invasive Species Initiative
  - Supplemental Funding

- Natural Resources Conservation Service (NRCS)
  - Wisconsin Tribal Advisory Council (WTCAC)

- U.S. Fish and Wildlife Service (USFWS)
  - Wisconsin AIS State Management Plan

- Wisconsin Department of Natural Resources (WDNR)
  - Aquatic Invasive Species Control Grants

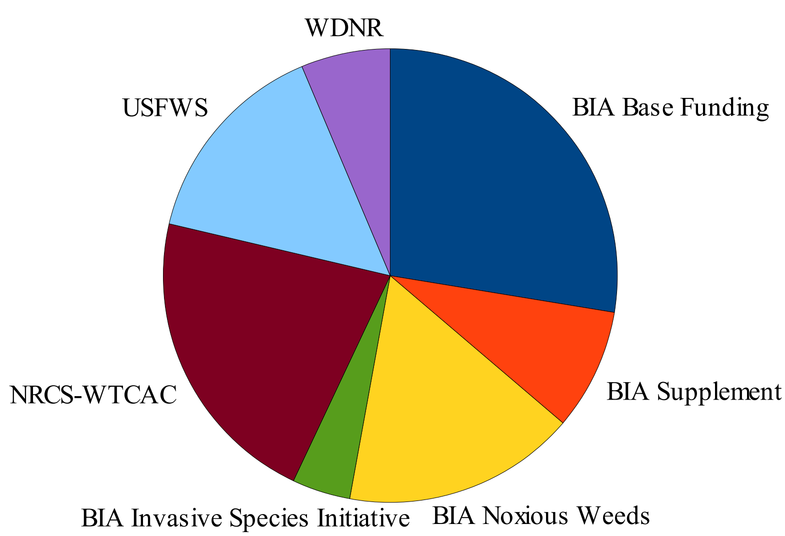

Figure 2. Funding sources for GLIFWC's Invasive Species Program in 2009.

TERRESTRIAL INVASIVE PLANT DISTRIBUTION MODELLING IN THE CEDED TERRITORIES

Non-native, invasive plants and animals have become major agents of environmental change. In Wisconsin alone, 29% of the 2189 vascular plant species listed in the state's official checklist are not native to the state. These plants vary greatly in their distribution, habitat requirements, ability to invade and adversely impact natural ecosystems, and feasibility of control. With limited resources available to manage invasive plants, managers need objective tools to help identify which species pose the greatest threats to local resources, and a process to prioritize and target invasive plant management efforts in a way that maximizes their cost-effectiveness.

In 1999, GLIFWC staff recognized the need to develop a database for invasive plants that could help guide future management efforts. Specifically, the database could be used to prioritize species for management, target educational outreach, and identify threats to treaty resources. To this end GLIFWC staff have compiled information on autecology, habitat requirements, ecological impacts and control options for more than 300 non-native plants established in temperate North America, from peer-reviewed literature and other sources.

GLIFWC has also taken an active role in inventorying invasive species across northern Wisconsin and western Upper Michigan. Since 2001 GLIFWC has conducted extensive surveys for aquatic and terrestrial plants (Falck and Garske 2002, Falck and Garske 2003, Garske and Falck 2005, Falck, Garske and Olson 2006, Falck, Olson and Garske 2007, Falck, Olson and Garske 2009). GLIFWC has also gathered data from other agencies, groups and individuals. A database of more than 37,000 invasive species sites has been compiled, including over 6,000 sites in the Lake Superior counties of Wisconsin (Iron, Ashland, Bayfield and Douglas). Interactive maps showing regional occurrence data for many invasive species are available online at http://maps.glifwc.org/ .

METHODS

Spatial data for environmental attributes likely to influence the distribution of terrestrial plants within the Northwoods Cooperative Weed Management Area were identified and acquired. These data were converted to raster grids with 30m cells and projected to the Wisconsin Transverse Mercator projection. Data sets included landcover, shade, minimum annual temperature, frost-free days, soil organic matter, soil pH, soil drainage class, soil water content, soil surface texture, distance from nearest road, and distance from nearest urban area. Gaps in occurrence data were identified within the project area and efforts were made to survey these previously unsurveyed areas (Figure 3).

Species distribution modelling programs overlay environmental layers on occurrence data for each species being analyzed, creating maps showing the estimated probability of the species

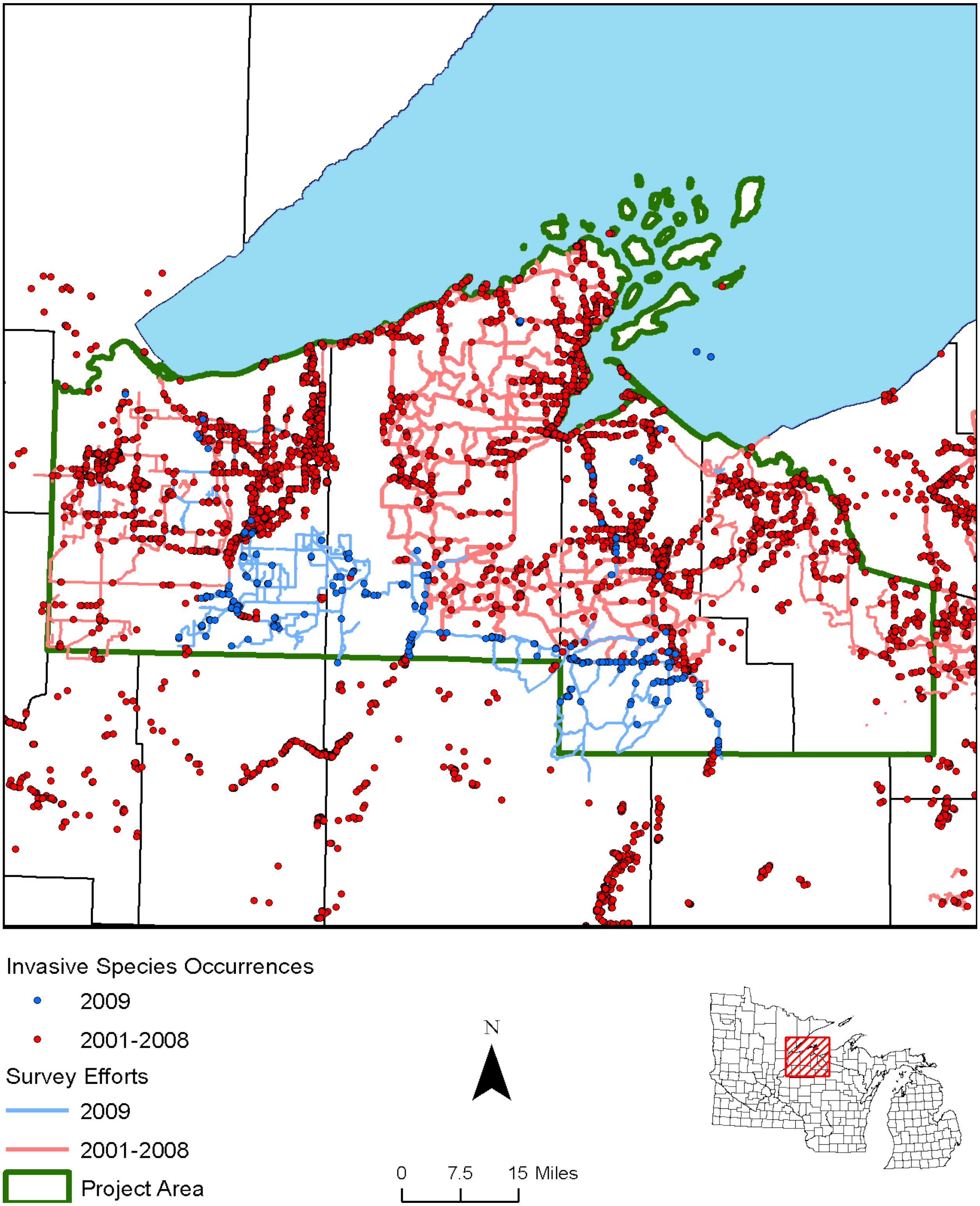

Figure 3. Invasive species occurrence records collected and compiled by GLIFWC within the Northwoods Cooperative Weed Management Area, 2001-2009.

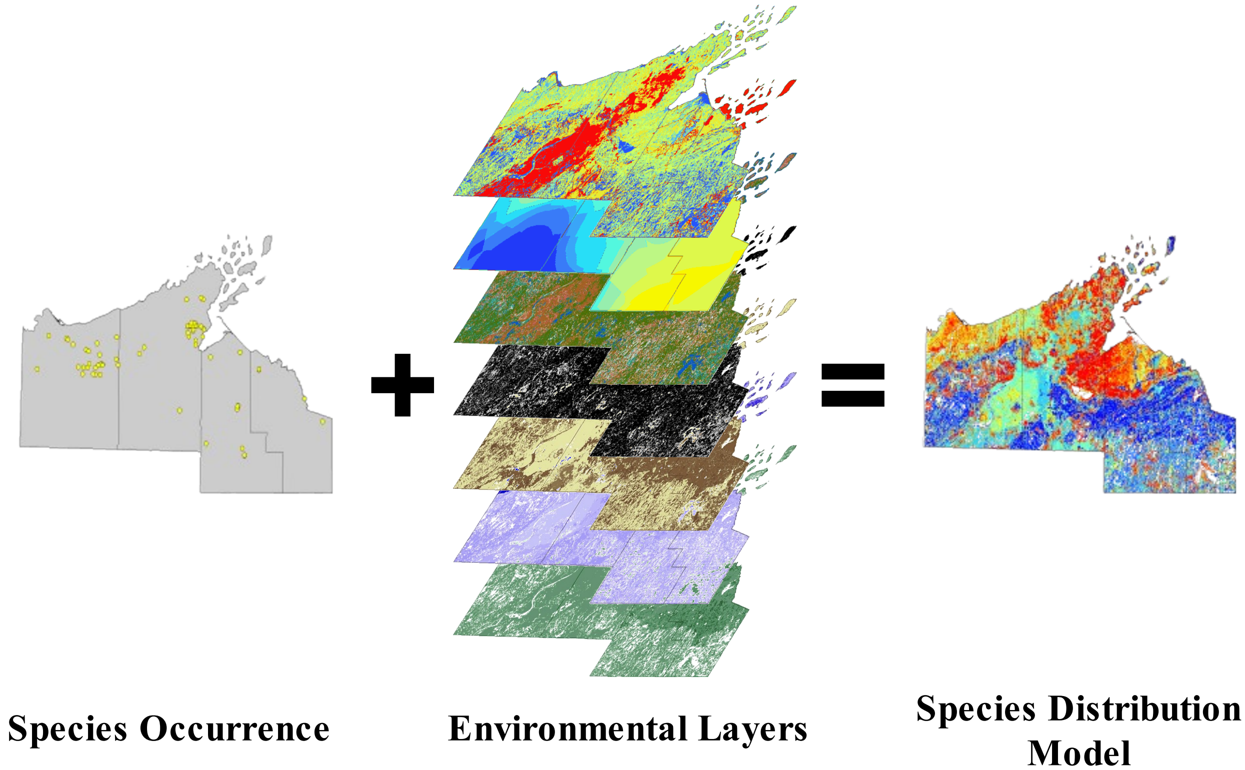

Figure 4. Conceptual diagram of invasive species distribution modelling.

occurring across the landscape, and predicting its potential distribution (Figure 4.). These methods have advanced significantly in recent years, with simple habitat-matching programs such as BIOCLIM (Busby 1991) and DOMAIN (Carpenter et al. 1993) being joined by "second-generation" modelling programs that can fit more complex non-linear relationships, including Ecological Niche Factor Analysis (Biomapper, Hirzel and Arlettaz 2003), Genetic Algorithm for Rules Production (GARP, Stockwell and Peters 1999), and the maximum entropy method (Maxent, Phillips et al. 2006).

Two open source software packages were used to develop species distribution models for invasive plants in the project area. OpenModeller (http://openmodeller.sourceforge.net/) implements multiple niche modelling algorithms including Desktop GARP, and Maxent (http://www.cs.princeton.edu/~schapire/maxent/) implements the maximum entropy algorithm. Both software packages use the occurrence data and environmental layers as input and generate GIS grid coverages as outputs.

RESULTS

Maxent has become the primary tool for producing models. Maxent was chosen for a number of reasons, including 1) like several other second-generation modelling programs, Maxent is designed to use presence-only data, 2) Unlike most other modelling programs, Maxent is capable of using categorical as well as continuous data (e.g., WISCLAND land cover data), 3) Maxent is capable of using a target-group background layer, to reduce or cancel out locational bias in the data, 4) The developers of the Maxent method have produced reliable and relatively easy-to-use software to run the models, and 5) Maxent is consistently ranked near or at the top in model performance tests (Elith et al. 2006, Elith and Graham 2009).

The Maxent species distribution model output includes a GIS grid coverage. Each grid is comprised of 30 m^2 cells ranging in value from 0 and 1, representing the probability of an invasive plant species being present at that location. Using the model output with relevant GIS overlays provides insights into where management activities can be most cost-effective. For example, isolated occurrences in large areas of high potential should be prioritized for treatment. Conversely, treatment can be deferred for sites within, or adjacent to, areas of low potential. Additional priorities could be derived by overlaying GIS coverages for other resources potentially threatened by invasive plants such as sensitive habitats or cultural resources.

Draft niche models have been developed for several species within the Northwoods Cooperative Weed Management Area including leafy spurge (Figure 5), purple loosestrife (Figure 6), Eurasian honeysuckles, and garlic mustard. The results for these relatively common and familiar species suggests that these methods will be useful for modelling the less common and less familiar species that are just becoming established in the ceded territories.

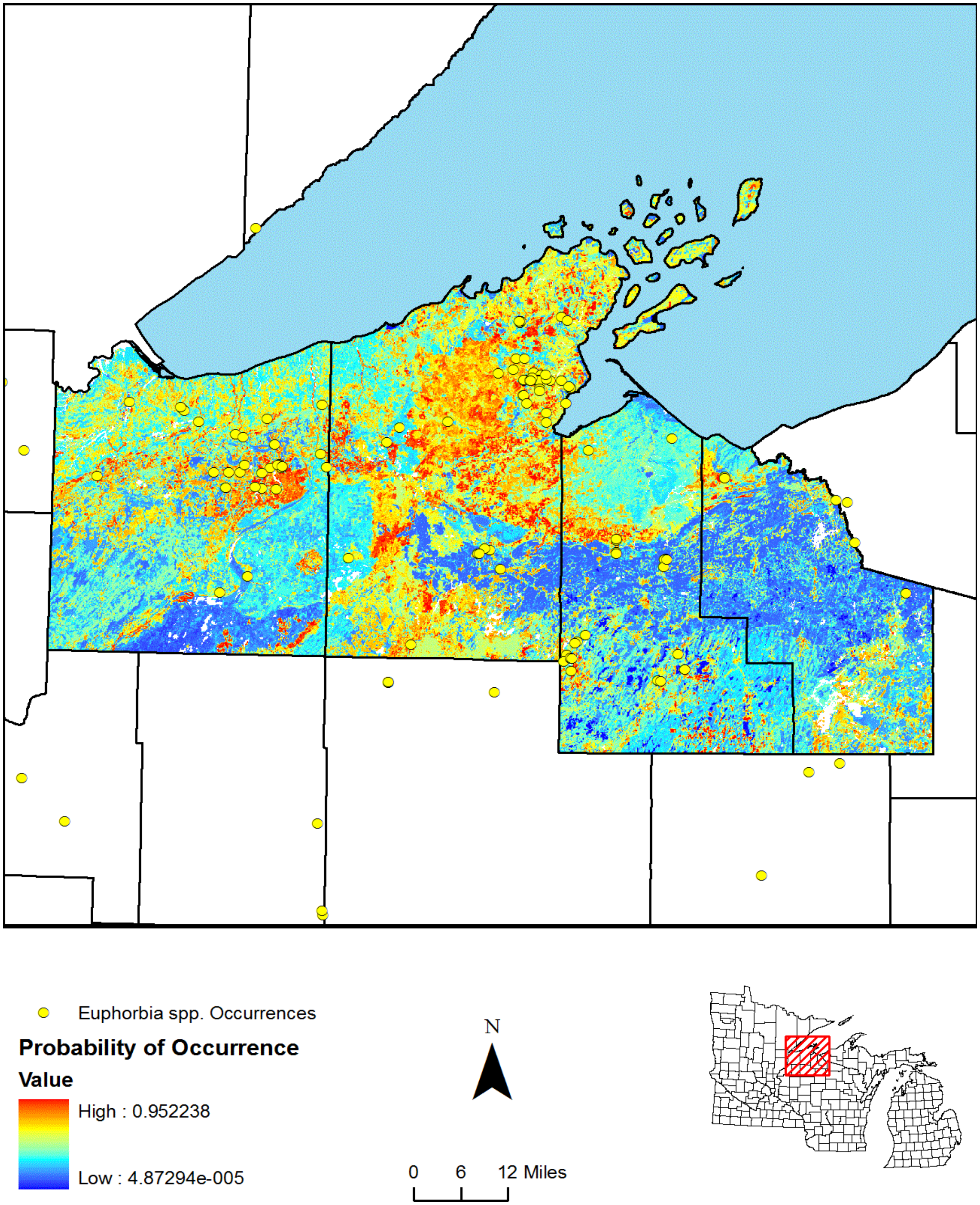

Figure 5. Distribution model for *Euphorbia* spp.

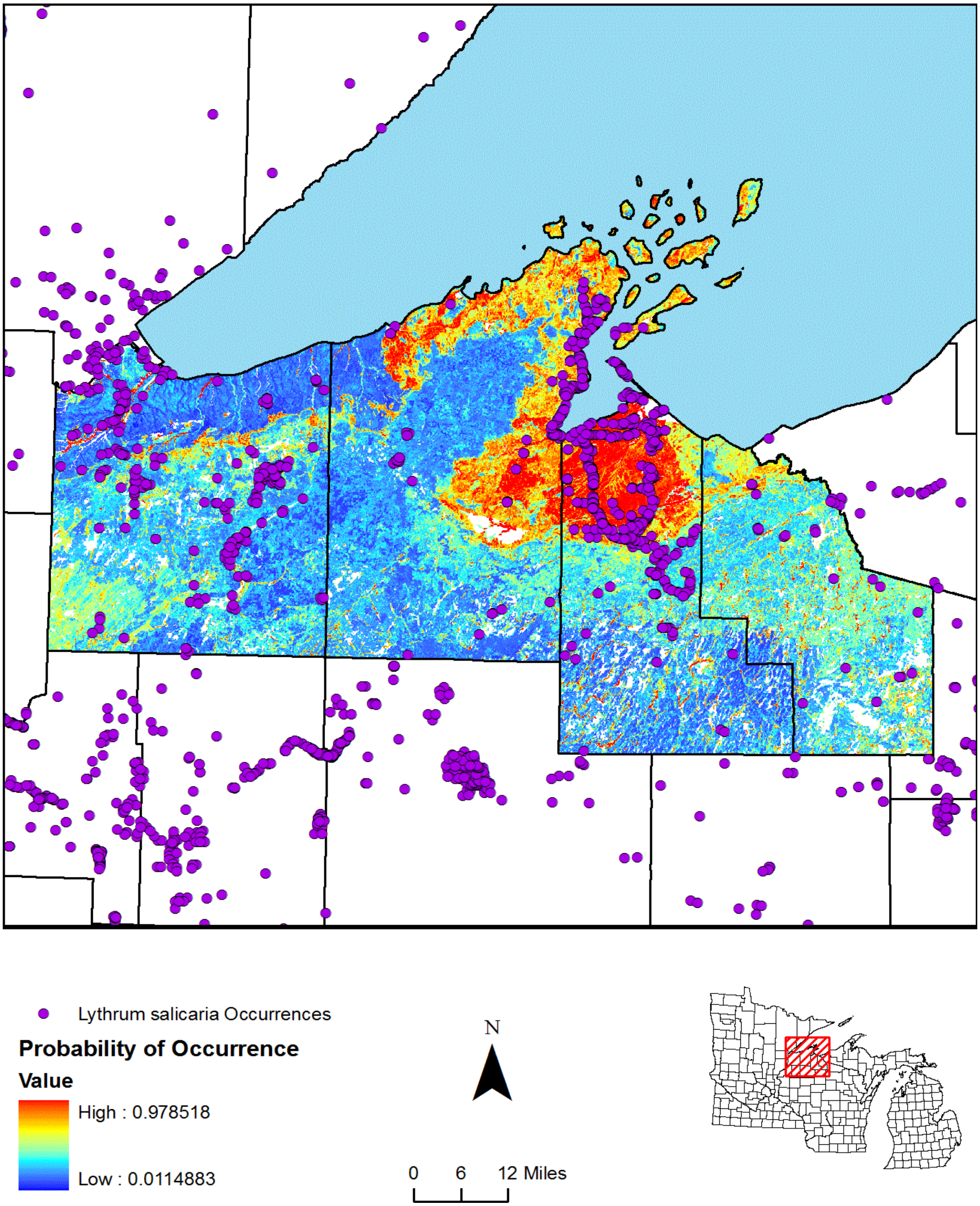

Figure 6. Distribution model for *Lythrum salicaria*.

AQUATIC INVASIVE SPECIES INVENTORIES IN THE CEDED TERRITORIES

Since the early 1800s, at least 183 species of fish, plants, invertebrates, algae, and pathogens have been introduced into the riparian and aquatic habitats of the Great Lakes (GLERL 2006). Many of these organisms have since invaded inland lakes and rivers in the ceded territory, and others are poised to do so. The most destructive of these invasives have caused major environmental and economic impacts - the economic cost of zebra mussels alone has been estimated at $1 billion since its introduction (Pimentel *et al.* 2005).

GLIFWC staff surveyed select ceded territory waters in 2009 to 1) assess and document the scope of the problem, 2) detect small populations of the worst invasives before they become large, environmentally damaging populations, and 3) prioritize education and management efforts.

METHODS

In 2009, 30 lakes were chosen for survey in coordination with the Wisconsin Department of Natural Resources (WDNR), UW-Madison Center for Limnology and County AIS coordinators. Surveys targeted lakes important to the tribes for *ogaa* (walleye) and *manoomin* (wild rice) harvest, as well as lakes with high visitation rates (Table 1, Figure 7). An effort was made to visit each lake twice during the summer to increase the chances of detecting zebra mussel (*Dreissena polymorpha*) veligers and plants with varying phenology.

Surveys targeted the most likely areas for introductions. Boat landings were a high priority. All public and some private boat landings on each lake were surveyed. Shorelines, shallow water areas, pier supports, rocks, floating fragments and beach debris in the vicinity of the landings were inspected for invasive plants and animals. The presence of aquatic invasive species informational signs at the landings was also recorded. This information will be compiled with data collected by GLIFWC's inland fishery assessment crews and the WDNR to identify landings lacking signs.

Surveys also focused on inlets, outlets, shallow or protected bays, wetland areas, disturbed areas, developed shorelines and shorelines in close proximity to roads. Shorelines were typically surveyed from the outer edge of the littoral zone from a slow moving boat. Dense beds of vegetation, and patches of unfamiliar vegetation were inspected intensively. The area was also surveyed for invasive animals or evidence of their presence. As much of the shoreline as possible was surveyed.

The most ecologically destructive aquatic invasive species threatening ceded territory waters were categorized as "priority" species (Table 2) and were recorded at each site they were detected. Other aquatic invasive species considered less invasive, or so common as to be

Table 1. Lakes surveyed for aquatic invasive species in 2009.

State	County	Lake Name	WBIC	Acres	Dates Surveyed
MI	Gogebic	Cisco	27-275	567.4	7/23, 9/3
		Dinner	27-117	107.6	7/20, 9/2
		Thousand Island	27-265	1008.7	7/23, 9/3
	Iron	Indian	36-138	196.7	7/21, 9/1
		Winslow	36-1760	259.5	7/21, 9/2
MI/WI	Gogebic/Vilas	Tenderfoot	2962400	453.1	6/25, 8/5
WI	Chippewa	Lake Wissota	2152800	345.1	7/15, 8/26
		Long	2351400	935.7	6/16, 7/28
	Chippewa/Rusk	Chain	2350500	454.1	6/17, 7/29
	Florence	Fay	677100	272.5	7/2, 8/10
	Forest	Butternut	692400	1246.4	6/30, 8/12
		Franklin	692900	839.4	7/1, 8/11
		Lily	376900	216.6	7/6, 8/19
		Lucerne	396500	1038.7	7/7, 9/1
		Mole	390600	77.1	7/9
		Roberts	378400	435.1	7/9, 8/19
	Oconto	Archibald	417400	392.1	7/8, 8/18
		Bass	417900	145	7/8, 8/19
		Maiden	487500	278.2	7/8, 8/17
	Oneida/Forest	Sevenmile	1605800	518.2	6/29, 8/13
	Rusk	Island	2350200	542.7	6/17-18, 7/29-30
		Potato	2355300	540.3	7/14, 8/24
		Pulaski	1875900	125.4	6/15, 7/27
	Sawyer	Moose	2420600	1559	7/16, 8/25
		Tiger Cat Flowage	2435000	180.1	8/27
	Vilas	Black Oak	1630100	563.8	7/22, 9/2
		Boulder	2338300	515.6	8/6
		Palmer	2962900	644.1	8/5
		Papoose	2328700	422.4	8/4
		White Sand	2339100	746.4	6/23, 8/3

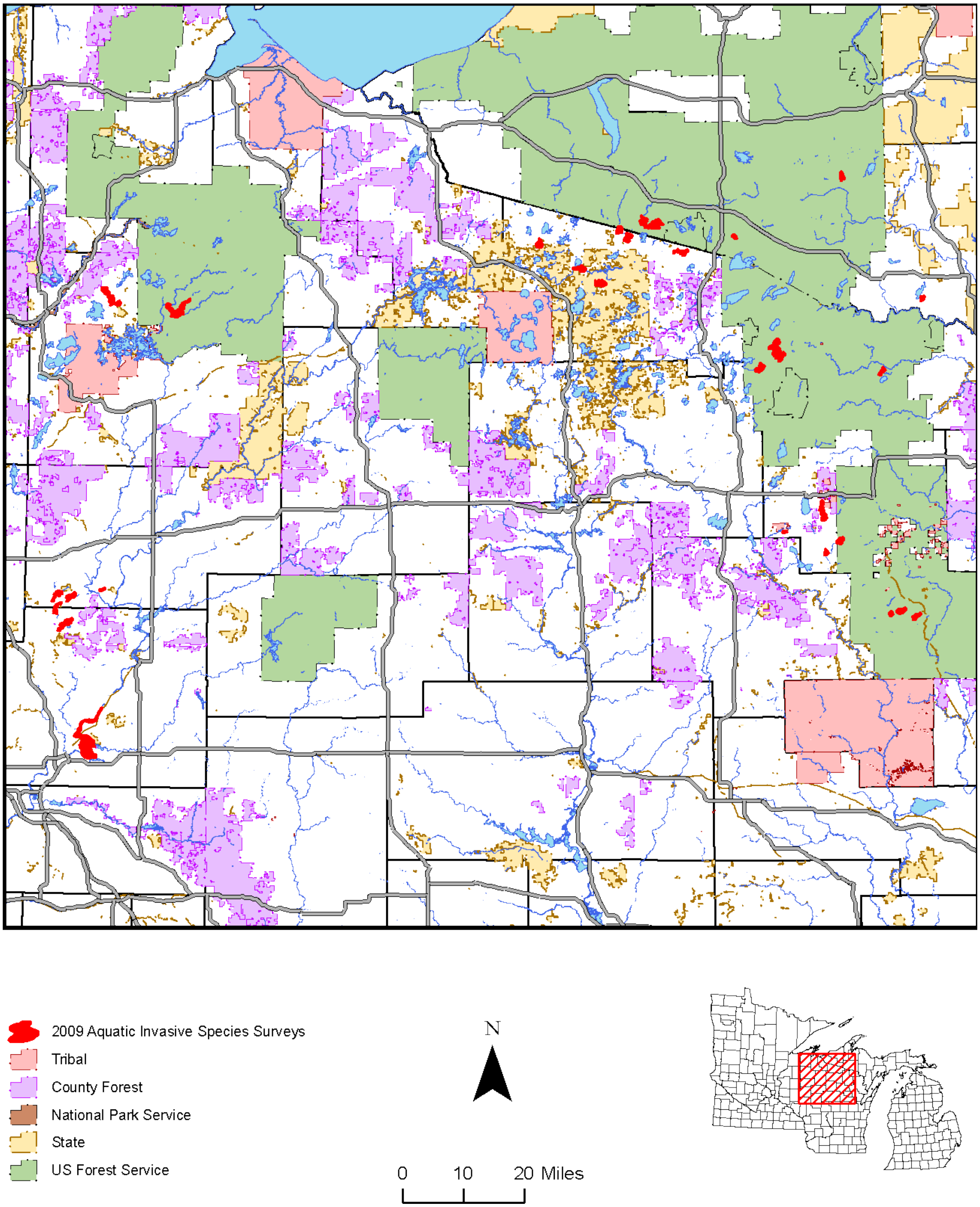

Figure 7. Lakes surveyed for aquatic invasive species in 2009.

Table 2. "Priority" species surveyed for in 2009.

Scientific Name	Common Name	Detected
Animals		
Bythotrephes longimanus	spiny waterflea	No
Cercopagis pengoi	fishhook waterflea	No
Dreissena bugensis	quagga mussel	No
Dreissena polymorpha	zebra mussel	No
Plants		
Butomus umbellatus	flowering rush	Yes
Eichhornia crassipes	water hyacinth	No
Hydrilla verticillata	hydrilla	No
Hydrocharis morsus-ranae	European frog-bit	No
Iris pseudacorus	yellow iris	Yes
Lythrum salicaria	purple loosestrife	Yes
Myriophyllum spicatum	Eurasian water-milfoil	Yes
Najas minor	brittle naiad	No
Nymphoides peltata	yellow floating-heart	No
Phragmites australis ssp. *australis*	common reed (Eurasian)	No
Pistia stratiotes	water lettuce	No
Potamogeton crispus	curly pondweed	Yes
Trapa natans	water chestnut	No

impractical to delineate, along with some terrestrial invasive species were recorded as "present" or "absent" on each lake (Table 3). Wherever purple loosestrife was encountered, the presence or absence of biological control beetles (*Galerucella* spp.) was also recorded. Voucher specimens were prepared for new invasive plant infestations and new county records. These specimens were sent to the Robert W. Freckmann Herbarium at the University of Wisconsin – Stevens Point. Observations of *manoomin* and the native type of common reed were also documented.

Locations were mapped using a TDS® Recon 400 hand-held computer with a Holux® GM-270 compact flash GPS card. Site locations and attribute data for each site were entered directly into a GIS database using ESRI's® ArcPad software. ArcPad provided an integrated environment to display the current GPS location overlain on GIS layers including lakes, local roads and pre-existing invasive species data. Custom data entry forms were developed using ESRI® ArcPad Application Builder. The forms speeded data entry in the field and reduced the potential for error by providing drop-down menus with standardized nomenclature and required fields.

Plankton nets were used to sample for zebra mussel veligers, spiny water fleas and fishhook water fleas. Vertical plankton tows were used to sample for zebra mussel veligers following WDNR-UWEX (2006). Oblique plankton tows were used to sample for spiny and

Table 3. "Lower priority" aquatic and terrestrial invasive species detected in 2009.

Scientific Name	Common Name
Animals	
Cipangopaludina chinensis	Chinese mysterysnail
Orconectes rusticus	rusty crayfish
Viviparus georgianus	banded mysterysnail
Plants	
Berberis thunbergii	Japanese Barberry
Cirsium palustre	Eurasian marsh thistle
Euphorbia cyparissias	cypress spurge
Lonicera tatarica, *L. morrowii*, *L.* X *bella*	Eurasian bush honeysuckles
Mentha piperita, *M.spicata*, *M.* X *gentilis*	Eurasian mints
Myosotis scorpioides	water forget-me-not
Phalaris arundinacea	reed canary grass
Polygonum cuspidatum	Japanese knotweed
Rhamnus cathartica	common buckthorn
Robinia psuedocacia	black locust
Salix fragilis, S. alba, *S.* X *rubens*	white, crack and hybrid willow
Sedum spp.	stonecrop
Solanum dulcamara	bittersweet nightshade
Typha angustifolia, T. X *glauca*	narrow-leaf and hybrid cattail

fishhook water fleas following Johnson (2004). When sampling for water fleas, a suitably deep portion of the lake was chosen and the net was towed through the water for approximately 100 meters. This distance was estimated by towing the plankton net for 120 seconds at approximately 3 km per hour. The water column was surveyed by allowing the net to sink as close to the bottom as possible and then slowly pulling the net back up.

The number of veliger and water flea samples taken on each lake was based on lake size and available time. Three samples were taken on larger lakes or lakes with multiple bays. Typically at least one sample was taken near a busy boat landing and one or two additional samples in other bays or basins. On smaller or shallow lakes, only one or two samples were taken. Both veliger and water flea samples were condensed, transferred to sample bottles, labeled and preserved with 190 proof ethyl alcohol, at a ratio of four parts alcohol to one part plankton sample. Zebra mussel veliger samples were sent to the WDNR Service Center in Plymouth, Wisconsin for analysis. Water flea plankton samples were examined at the GLIFWC lab.

After leaving each lake, the boat and all equipment were thoroughly disinfected. Plant fragments and other debris were removed at the landing by hand. The drain plug was pulled away from the landing to ensure water would not run into the lake. Lakes with known infestations were surveyed at the end of each week. The boat, trailer and all equipment that came into contact with the water (plankton nets, ropes, weights, anchor, paddles, bilge, bilge pump and D-net) were sprayed with a 2200 ppm bleach solution for a 5 minute contact time. This procedure has been shown to kill *Heterosporis* spp., viral hemorrhagic septicemia virus (VHSv), spring viremia of carp virus (SVCv), largemouth bass virus (LMBv), lymphosarcoma and zebra mussel zooplankton (Marcquenski and AveLallemant 2007). After the appropriate contact time, the boat, trailer and all equipment were thoroughly rinsed. The boat motor was flushed using a 1:100 Virkon-S disinfectant solution, allowed to sit for 20 minutes and then flushed with water. The washing location was chosen to ensure that the water used to disinfect would not run into storm water drains or other areas that might contaminate water.

RESULTS

A total of 271 invasive species sites comprising 24 taxa were mapped in 2009. “Priority” species accounted for 109 of the sites, Table 6 provides a summary of invasive species detected by lake. Forty-nine boat landings also were surveyed for aquatic and terrestrial invasive species, and AIS signage was documented at each landing. A total of 133 zebra mussel veliger and 51 water flea plankton samples were collected during 2009. No water fleas or zebra mussel veligers were detected in any of the samples.

Table 4. Summary of invasive species detected in 2009.

		High Priority					Lower Priority																	
County	**Lake Name**	*Butomus umbellatus*	*Iris pseudacorus*	*Lythrum salicaria*	*Myriophyllum spicatum*	*Potamogeton crispus*	*Berberis thunbergii*	*Cipangopaludina chinensis*	*Cirsium palustre*	*Euphorbia cyparissias*	*Lonicera tatarica, L. morrowii, L. X bella*	*Mentha piperita, M.spicata, M. X gentilis*	*Myosotis scorpioides*	*Orconectes rusticus*	*Phalaris arundinacea*	*Polygonum cuspidatum*	*Rhamnus cathartica*	*Robinia psuedocacia*	*Salix fragilis, S. alba, S. X rubens*	*Sedum* spp.	*Solanum dulcamara*	*Typha angustifolia, T. X glauca*	*Viviparus georgianus*	Total
Gogebic	Cisco					✓	✓	✓					✓											4
	Dinner							✓	✓			✓			✓									4
	Thousand Island																							0
Iron	Indian								✓		✓				✓				✓					4
	Winslow								✓															1
Gogebic/Vilas	Tenderfoot			✓									✓		✓							✓		4
Chippewa	Lake Wissota			✓				✓			✓	✓			✓	✓	✓	✓	✓		✓	✓		11
	Long		✓							✓	✓	✓		✓	✓			✓	✓			✓		9
Chippewa/Rusk	Chain			✓		✓	✓				✓		✓		✓	✓	✓	✓	✓	✓	✓	✓		13
Florence	Fay																							0
Forest	Butternut		✓						✓			✓	✓		✓				✓		✓	✓		8
	Franklin							✓	✓			✓			✓						✓		✓	6
	Lily														✓				✓					2
	Lucerne								✓	✓		✓	✓		✓				✓		✓			7
	Mole							✓	✓			✓			✓				✓					5
	Roberts								✓			✓	✓		✓				✓		✓		✓	7
Oconto	Archibald	✓			✓			✓	✓						✓				✓		✓	✓	✓	9
	Bass							✓	✓			✓			✓	✓			✓				✓	7
	Maiden		✓								✓	✓	✓		✓				✓		✓			7
Oneida/Forest	Sevenmile											✓			✓				✓					3
Rusk	Island			✓								✓			✓				✓		✓	✓		6
	Potato					✓					✓	✓			✓				✓		✓			6
	Pulaski							✓							✓				✓			✓		4
Sawyer	Moose														✓				✓			✓		3
	Tiger Cat Flowage														✓				✓			✓	✓	4
Vilas	Black Oak								✓	✓			✓		✓						✓			5
	Boulder			✓			✓	✓				✓	✓	✓	✓				✓					8
	Palmer										✓	✓	✓		✓						✓	✓		6
	Papoose			✓						✓		✓	✓		✓				✓		✓			7
	White Sand											✓	✓		✓				✓				✓	5
	Total	1	3	6	1	3	3	9	11	4	7	17	12	2	26	3	2	3	21	1	13	11	6	

PURPLE LOOSESTRIFE CONTROL ACTIVITIES IN THE BAD RIVER - CHEQUAMEGON BAY WATERSHED

INTRODUCTION

Purple loosestrife is a perennial, herbaceous wetland plant native to Europe. It arrived in eastern North America in the early 1800's via plants brought by settlers, seeds carried within livestock, and in ballast soil carried by ships (Thompson *et al*. 1987). After its introduction, purple loosestrife quickly spread westward displacing native wetland plant communities. Its current distribution includes much of the U.S. and southern Canada.

Purple loosestrife can germinate in moist, exposed soils and tolerates a wide range of pH, nutrient, and light levels. Once established, seedlings can survive shallow flooding. The plant develops a large rootcrown and dense shoots that out-compete adjacent plant life. The stalks are square and commonly attain heights up to 2m on mature plants. The leaves are opposite each other and alternate at 90 degree angles along the stem. The distinctive flowering spike of purple loosestrife blooms from mid July through early September in the upper Great Lakes region.

Purple loosestrife degrades wetland habitats by out-competing native vegetation. On exposed substrates, purple loosestrife seeds germinate at such a high density that they out-compete native vegetation. The herbivores and pathogens that keep loosestrife from dominating European wetlands are absent in North America. This lack of natural enemies combined with prolific seed production gives purple loosestrife a substantial advantage over native vegetation. Diverse wetland plant communities can quickly be displaced by monotypic stands of purple loosestrife. Reductions in native plant diversity result in a loss of food and shelter for the numerous insect, amphibian, mammal, and bird species that depend on healthy wetlands for their survival.

METHODS

GLIFWC's integrated control efforts continued to focus on purple loosestrife within the Bad River/Chequamegon Bay watershed. Treated sites were mapped using a TDS® Recon 400 hand-held computer with a Holux® GM-270 compact flash GPS card. Site locations and attribute data for each site were entered directly into a GIS database using ESRI's® ArcPad software. Custom data entry forms were created using ESRI's® ArcPad Application Builder to increase accuracy and efficiency of data entry. Attribute data for each site were also collected including an estimate of the number of plants, acreage class, type of herbicide used, and an estimate of the amount of herbicide applied. These data were used to prioritize effort and select control methods based on the areal extent of the site, number of plants, and the site's location within the watershed.

Small sites (< 0.5 acres) in upper reaches of the watershed were prioritized for chemical control. Depending on the hydrology of the site, control crews using back-pack sprayers applied either Glyphosate (Glypro®) or Triclopyr (Garlon 3A®) to purple loosestrife plants. Glyphosate was used on sites with standing water, while Triclopyr was used where standing water was absent. Triclopyr has the advantage of being dicot-specific, allowing grasses and sedges to persist and re-colonize the site in a shorter time period. Chemical control efforts focused primarily on road rights-of-way between Mellen and Bayfield. Private properties were also treated after consent forms were signed by the landowner.

Large sites (> 1 acre) in lower reaches of the watershed, sites with poor access, and sites where landowners have expressed a preference for biological control were given high priority for biological control. The release of *Galerucella* beetles (native to Europe) in the United States for biological control of purple loosestrife was approved by USDA - APHIS in 1992. In 2008, beetles were collected from locally established populations in late May or early June and transferred directly to new release sites. Release sites from prior years were visited in early June and again in late summer to ascertain overwinter survival, assess suitability of sites for collection of adults, and to take site photos documenting the effects of beetle herbivory.

RESULTS

In 2009, GLIFWC staff treated 198 sites with herbicide. Figure 8 illustrates the distribution of chemical control efforts for purple loosestrife in 2009. Biological control efforts since 2000 have established over 60 viable *Galerucella* populations throughout the Bad River – Chequamegon Bay watershed and site visits continue to document their impacts (Figures 9 and 10). Because all of the largest sites within Bad River-Chequamegon Bay watershed already have established populations of *Galerucella* beetles (Figure 11), no beetles were released within the watershed in 2009. However, three days of field collections for *Galerucella* beetles were sponsored by GLIFWC and the Northwoods Cooperative Weed Management Area (NCWMA). Participants were led by GLIFWC staff to previously established biocontrol sites to collect beetles for loosestrife control efforts throughout northern Wisconsin. Participants included staff from the U.S. Forest Service, Wisconsin DNR and several private landowners.

DISCUSSION

The use of biological controls has allowed GLIFWC's control crew to place greater emphasis on treating small satellite populations with herbicide before they become significant source populations (Figure 12). This strategy also reduces the amount of herbicide applied at any one site (Figure 13). The establishment of local *Galerucella* populations has eliminated the need for mass rearing, allowing beetles to be collected *en masse* from established sites and released on the same or following day at new sites. The field collection day sponsored by GLIFWC and NCWMA has also extended this benefit to cooperators outside of GLIFWC's focus watershed; three more collection days are planned for 2010.

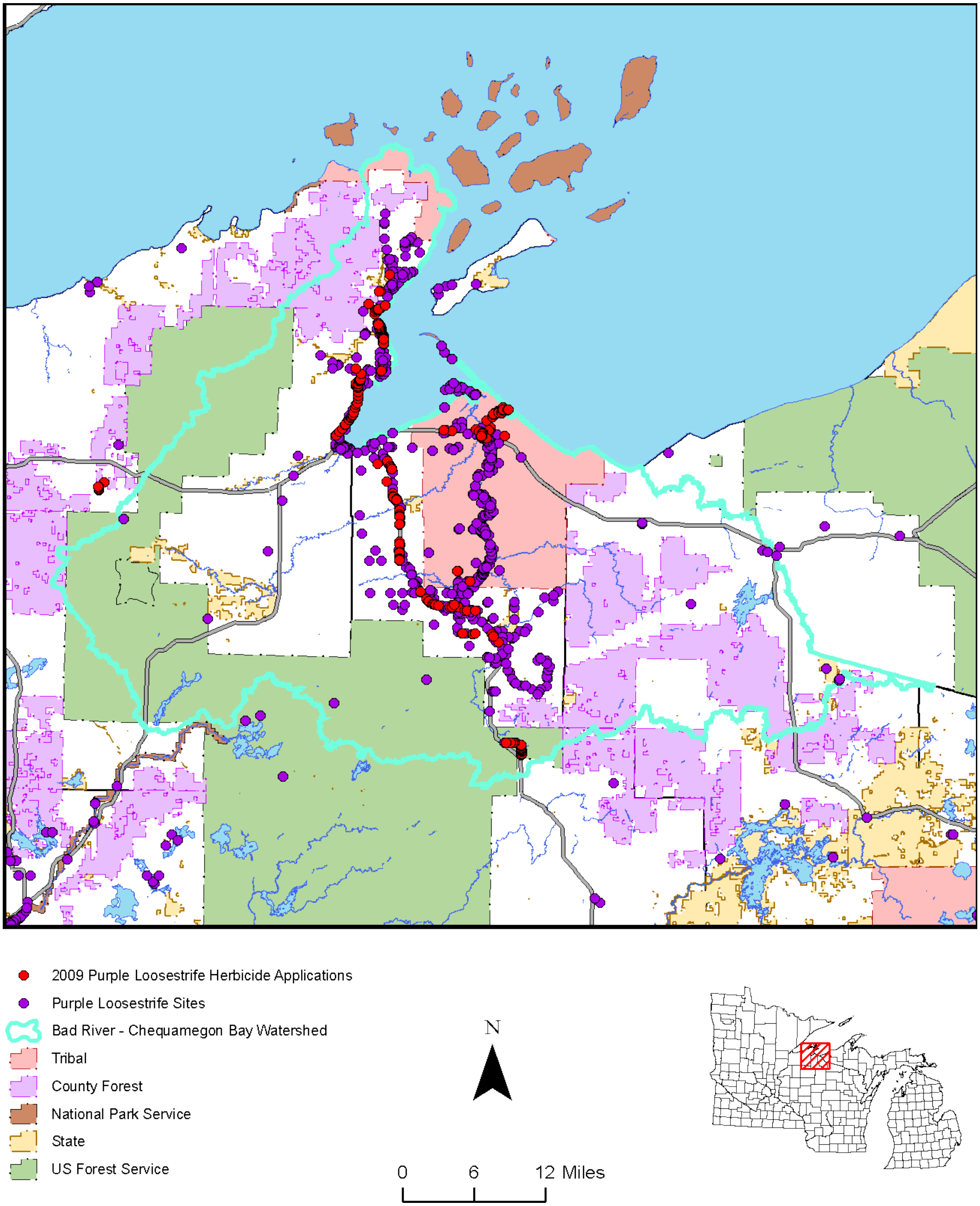

Figure 8. Purple loosestrife herbicide applications in 2009.

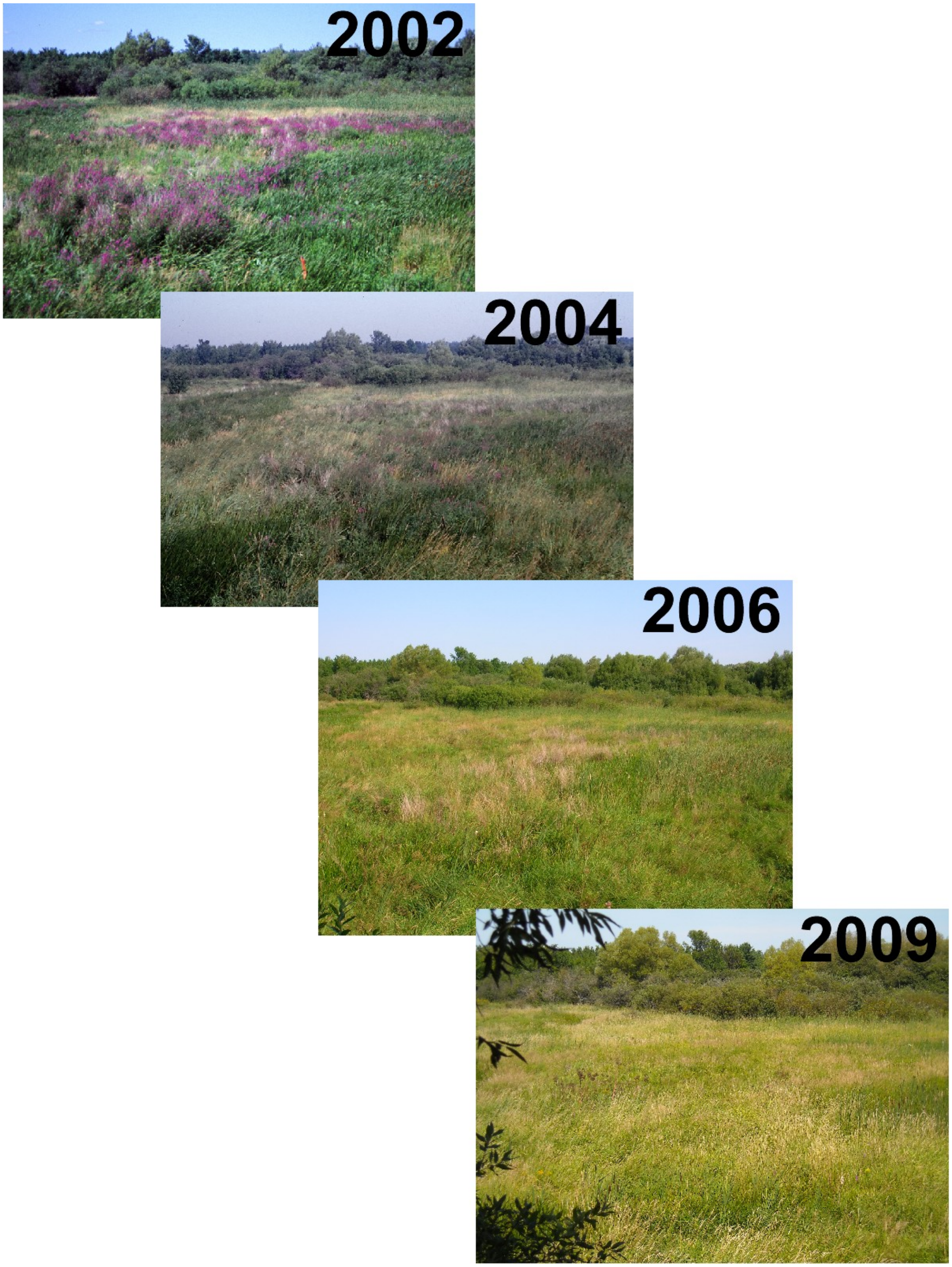

Figure 9. *Galerucella* release site near the mouth of Whittlesey Creek, Ashland, WI. *Galerucella* were released in 2002 and purple loosestrife abundance has steadily decreased.

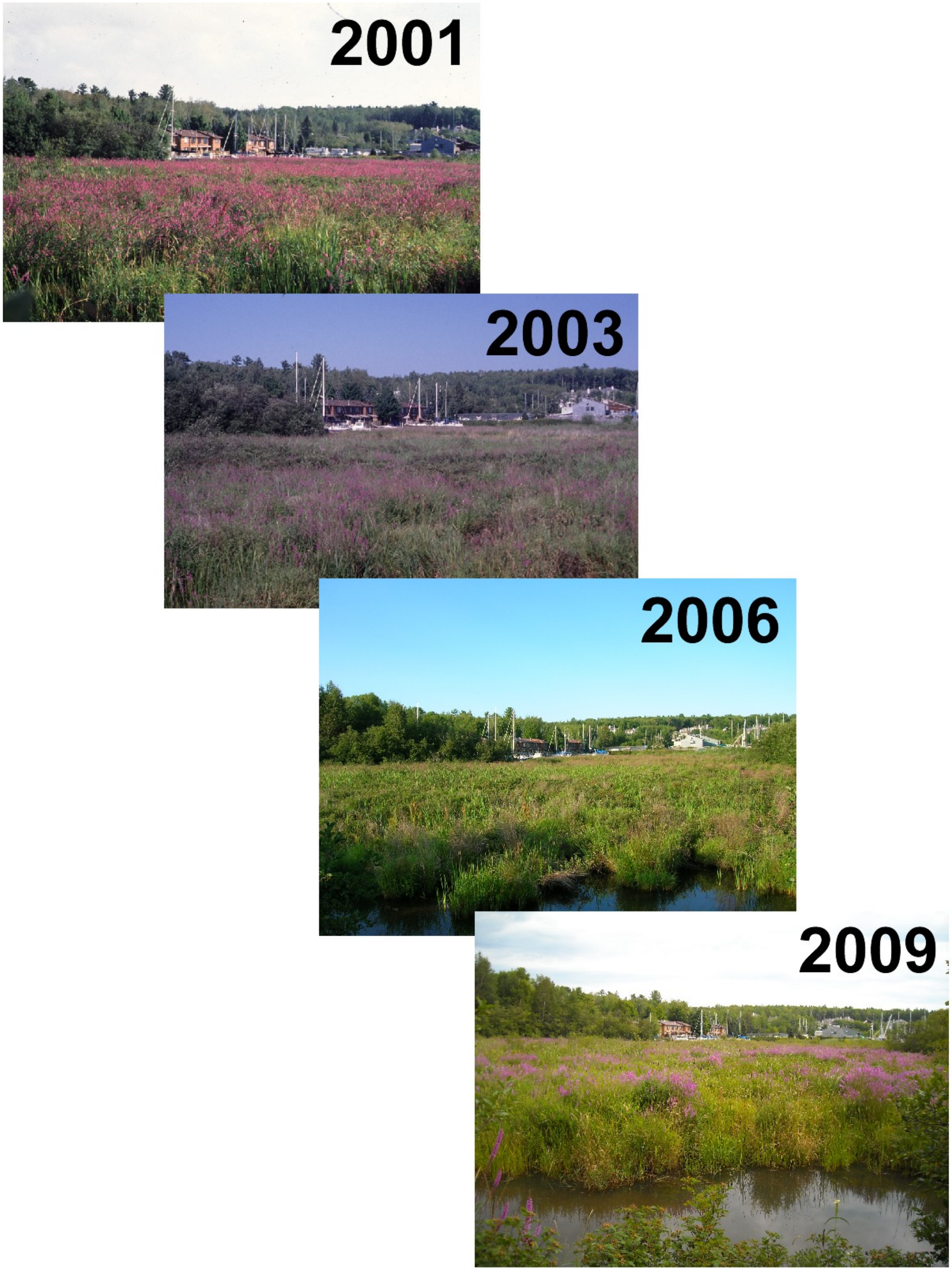

Figure 10. *Galerucella* release site near Washburn, WI. *Galerucella* were released in 2002 with peak impacts occurring in 2006. Purple loosestrife abundance has rebounded in 2008 and 2009.

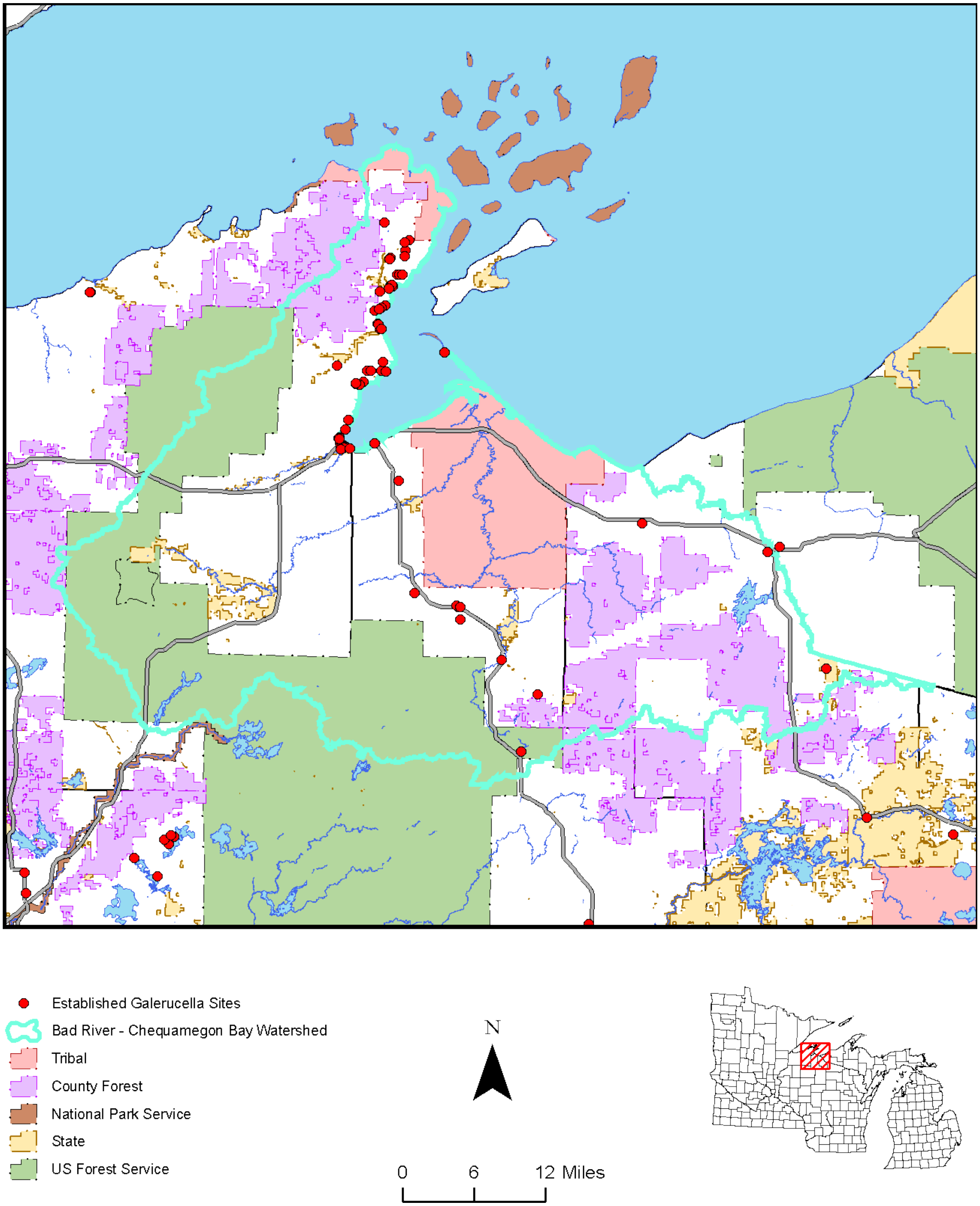

Figure 11. *Galerucella* release sites within the Bad River – Chequamegon Bay watershed.

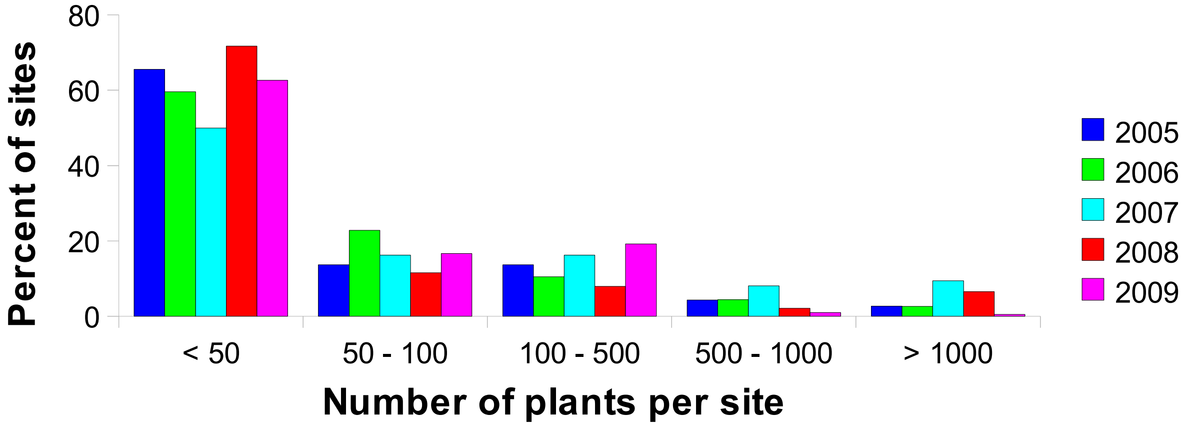

Figure 12. Abundance of purple loosestrife at sites treated in 2005-2009.

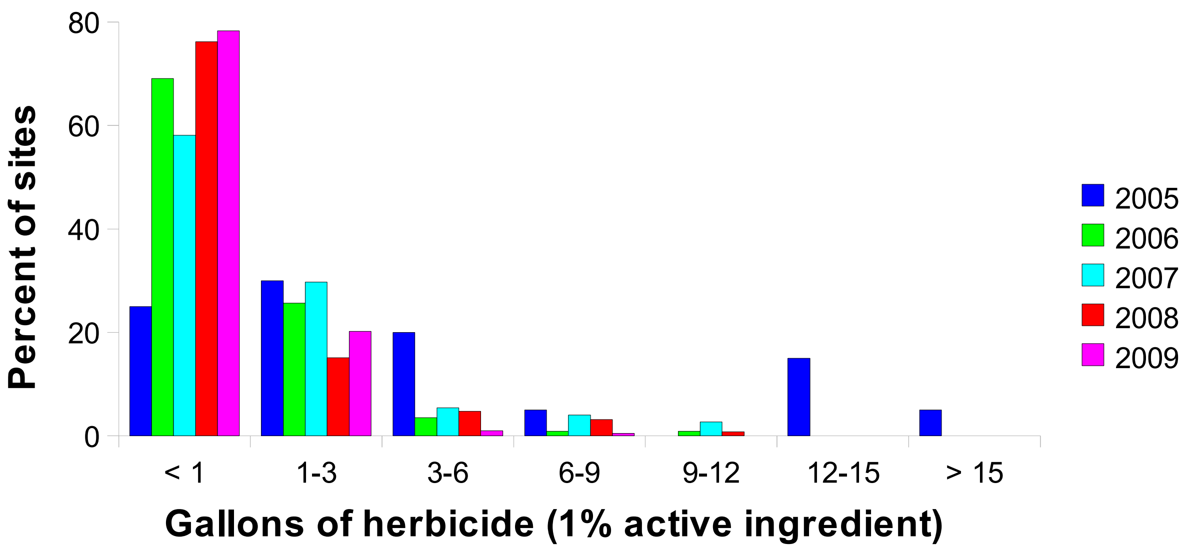

Figure 13. Amount of herbicide applied to purple loosestrife infestations in 2005-2009.

LEAFY SPURGE CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

INTRODUCTION

Leafy spurge is a perennial herb native to Eurasia. It was first recorded in North America from Massachusetts in 1827. It is thought to have arrived in contaminated seed. By the early 1900's, leafy spurge had spread as far west as North Dakota.

Leafy spurge thrives in open, sunny habitats. The plant reaches heights of up to 1 meter, though they are often shorter on poor sites. The plants bloom in late May and early June, producing clusters of inconspicuous flowers subtended by yellow bracts. The seed capsules of leafy spurge open explosively, dispersing seeds up to 15 feet. The seeds are often carried further by water, wildlife, and heavy equipment. Leafy spurge also spreads vegetatively, allowing the plant to dominate a site. The extensive root system of leafy spurge can penetrate as far as 15 feet underground.

Leafy spurge displaces native vegetation in open habitats including prairies, pine barrens, pastures, abandoned fields, and roadsides. It is especially dominant on dry or nutrient poor sites where its extensive root system and lack of natural enemies give it a substantial advantage over native vegetation. Because leafy spurge is unpalatable to cattle and deer, it can cause significant economic and ecological impacts.

Pine barrens habitats in northwestern Wisconsin are unique habitats that are especially vulnerable to the threats posed by leafy spurge. These areas provide habitat for a wide range of wildlife, as well as gathering and hunting opportunities for tribal members.

METHODS

GLIFWC staff evaluated the ecological threats and feasibility of control for over 300 non-native plants within Ashland and Bayfield counties in 2001 (Falck and Garske 2002, Falck and Garske 2003). Baseline distribution and abundance data were collected from the field and compiled with information on ecological impacts and control options from peer-reviewed literature and other sources. The resulting database was used to rank species into four management categories according to each plant's relative abundance, ecological impact, and feasibility for control. The results indicated that leafy spurge posed the greatest threat to local habitats, while its relatively low abundance and wide range of control options made it feasible to contain and control.

GLIFWC initiated chemical control for leafy spurge in the fall of 2003 using imazapic (Plateau®) herbicide applied with backpack sprayers. Herbicide was applied in the fall when plants were senescing and drawing energy reserves back into their roots for the winter. Herbicide was applied until a hard freeze damaged or killed the shoots, preventing uptake by the plants. Shoot damage was monitored by checking for the presence of milky sap in broken stems.

Treated sites were mapped using a TDS® Recon 400 hand-held computer with a Holux® GM-270 compact flash GPS card. Site locations and attribute data for each site were entered directly into a GIS database using ESRI's® ArcPad software. Custom data entry forms were created using ESRI's® ArcPad Application Builder to increase accuracy and efficiency of data entry. Attribute data for each site were also collected including an estimate of the number of plants, acreage class, type of herbicide used, and an estimate of the amount of herbicide applied.

RESULTS

In 2009, GLIFWC staff treated 28 sites with herbicide. Figure 14 illustrates the distribution of chemical control efforts for leafy spurge in 2009.

Road rights-of-way on the eastern edge of the Moquah Barrens near Washburn, WI comprised the core area of local leafy spurge populations and provided a massive seed source for dispersal via road maintenance activities such as mowing and grading. Private properties were also treated after consent forms were signed by the landowner. GLIFWC staff also participated in one workday sponsored by the Northwoods Cooperative Weed Management Area to treat several large infestations on private lands, providing herbicide, backpack sprayers, and assistance with herbicide application. Participants also included private landowners, the National Park Service Exotic Plant Management Team, US Forest Service, and Wisconsin DNR.

DISCUSSION

Much progress has been made on leafy spurge control efforts. Unlike previous years, the vast majority of sites treated in 2009 consisted of less than 500 plants (Figure 15). Consequently, much less herbicide was applied at each site in 2009 (Figure 16). Integrated measures employing both herbicide and biological controls have shown great success on private lands west of Washburn, Wisconsin. GLIFWC staff attempted to collect *Aphthona* beetles from these sites in 2009 to release at new sites, but their populations had already crashed due to the drastic reductions in leafy spurge at these sites. GLIFWC subsequently obtained several thousand *Aphthona* beetles from WDNR and released them at two sites in northern Bayfield County (Figure 17). GLIFWC staff will continue to monitor these sites in the future to track their progress.

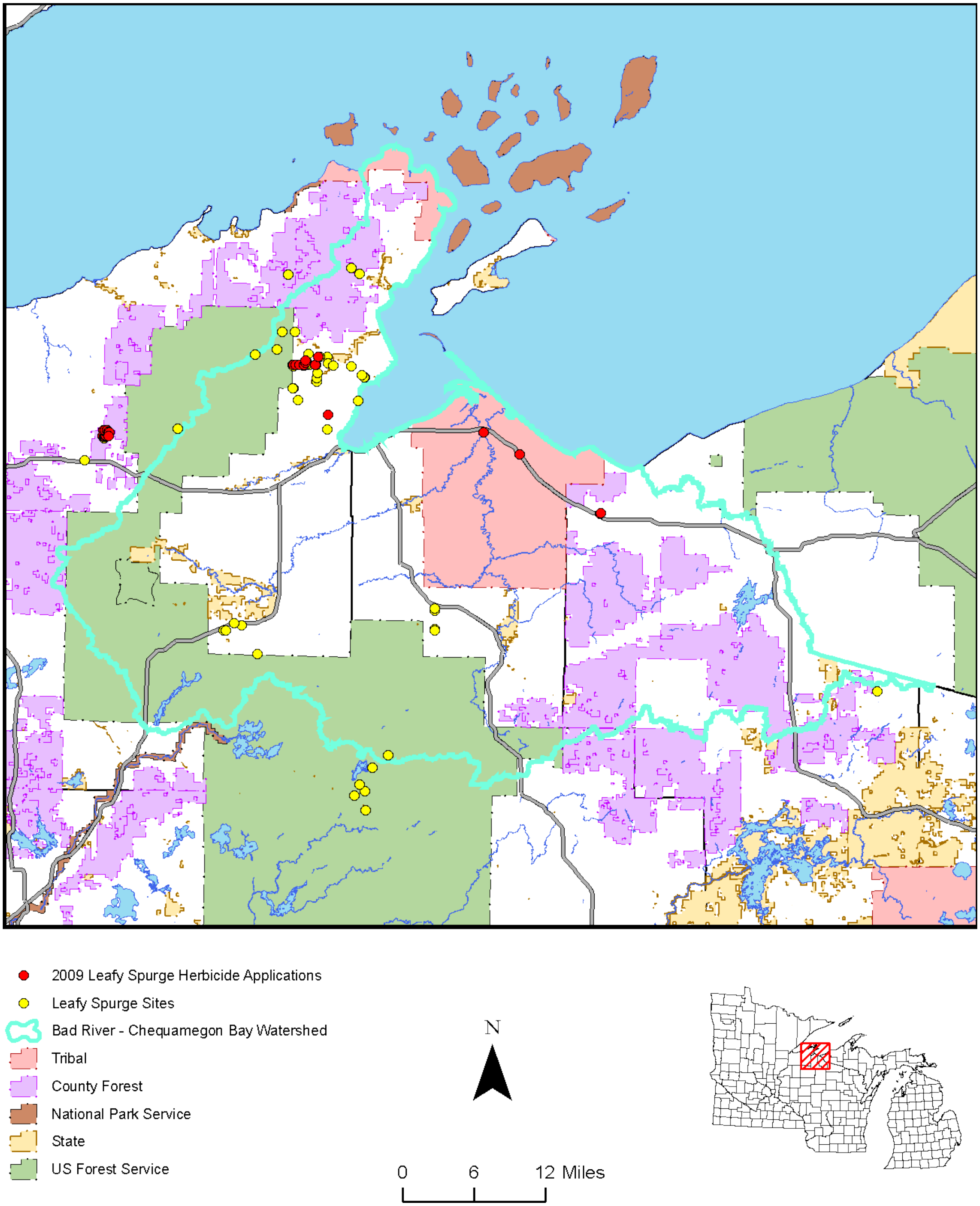

Figure 14. Leafy spurge herbicide applications in 2009.

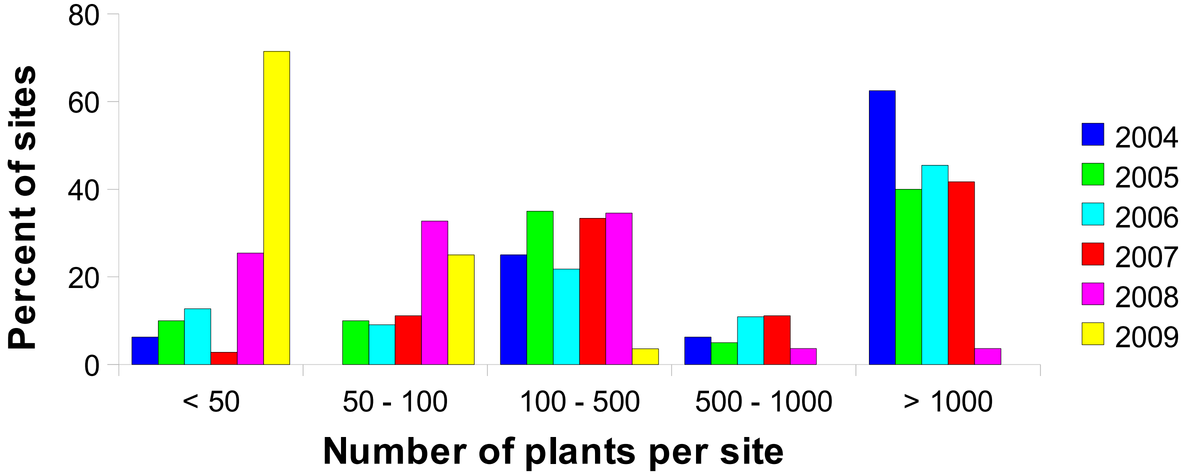

Figure 15. Abundance of leafy spurge at sites treated in 2004-2009.

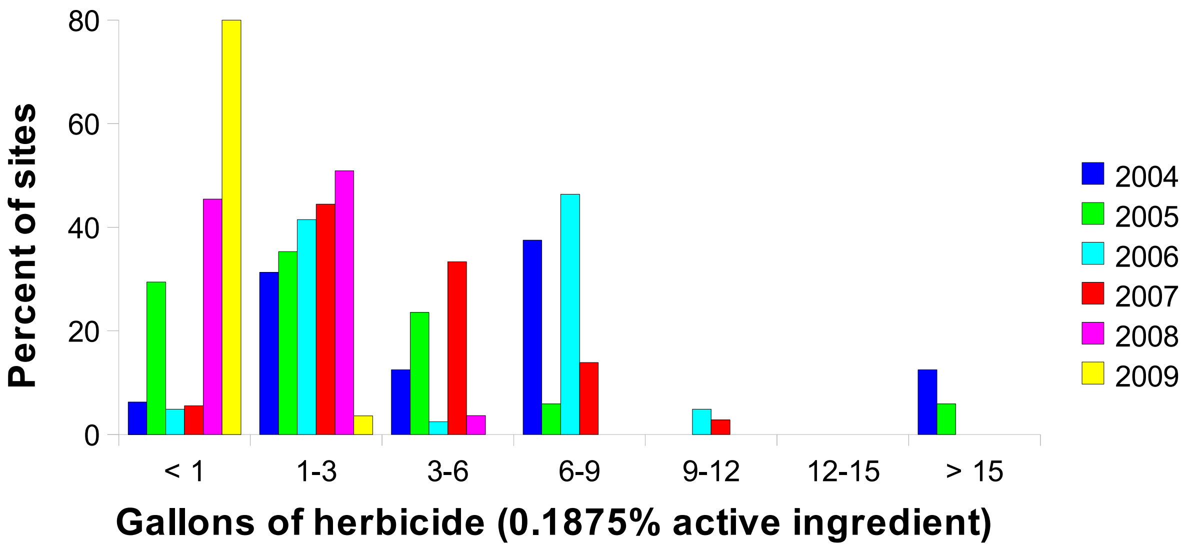

Figure 16. Amount of herbicide applied to leafy spurge infestations in 2004-2009.

Figure 17. *Aphthona* release site in northern Bayfield County, 2009.

EDUCATION OUTREACH ACTIVITIES

INTRODUCTION

Because the vast majority of invasive species introductions can be attributed to human activities, effective prevention and control efforts depend on an informed public. Unfortunately, awareness of the ecological and economic impacts of invasive species among the general public is generally low (Colton and Alpert 1998). To help address this situation, GLIFWC initiated an educational outreach program in 1998 to raise public awareness of this important issue.

PROGRAM OVERVIEW

A suite of educational materials have been compiled and/or developed to reach a broad range of audiences. These materials include ID cards, brochures, slide and poster presentations, and videos. GLIFWC distributes educational material with the help of cooperating state and federal agencies throughout the ceded territories. Additional outreach is provided via GLIFWC's invasive species web site (www.glifwc.org/invasives) and quarterly newsletter - *Mazina'igan*.

ACCOMPLISHMENTS

Mazina'igan Feature Articles

Starting in 2004, each issue of GLIFWC's quarterly newsletter has featured an article on at least one invasive species issue. Topics covered in 2009 included the NCWMA garlic mustard workday and GLIFWC staff participation, invasive plant modelling efforts, and new and emerging invasive plant threats to the north woods.

www.glifwc.org/invasives

GLIFWC's invasive species web site features species abstracts for many of the regions' invasive plants, photos that can be downloaded for educational purposes, GLIFWC reports, and links to interactive maps and other Internet resources on invasive species. No work was conducted on this site in 2009 and the site is in need of updates and maintenance.

COORDINATION AND COOPERATION

INTRODUCTION

Because non-native invasive plants disperse widely across the landscape and administrative boundaries, it is advantageous to work cooperatively towards management and control objectives. In addition, the introduction and spread of new invasive species in the region continues to out-pace control activities, and is too much for any one agency to manage alone. GLIFWC strives to coordinate its invasive species activities with cooperating agencies, universities, non-governmental organizations, and the general public to maximize the efficient use of limited resources.

ACCOMPLISHMENTS

GLIFWC staff are actively engaged in several long-term initiatives that seek to enhance interagency cooperation and coordination of invasive species management and planning:

Northwoods Cooperative Weed Management Area (NCWMA): Formally established in 2006, NCWMA provides a forum to share information, collaborate on planning and cooperate on management activities in northern Wisconsin. GLIFWC staff were instrumental in obtaining funding for and developing a website (www.northwoodscwma.org) and brochure for the NCWMA. GLIFWC staff also worked with the NCWMA on annual leafy spurge control activities (providing labor, herbicide and other equipment) and purple loosestrife biological control activities (leading field trips to collect *Galerucella* beetles from previous release sites).

St. Croix National Scenic Riverway Comprehensive Interstate Management Plan for the Prevention and Control of Aquatic Nuisance Species: Completed in March of 1998 in cooperation with the Lower St. Croix Management Commission, Minnesota Department of Natural Resources, Minnesota-Wisconsin Boundary Area Commission, National Park Service, Wisconsin Department of Natural Resources, U.S. Fish and Wildlife Service, and the Upper St. Croix Management Commission. This plan makes GLIFWC eligible for funding from the U.S. Fish and Wildlife Service to implement tasks identified in the plan and helps facilitate cooperation on AIS issues within the St. Croix watershed.

Wisconsin's Comprehensive Management Plan To Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species: Completed in cooperation with the Wisconsin Department of Natural Resources and UW-Extension in September of 2003, this plan makes GLIFWC eligible for funding from the U.S. Fish and Wildlife Service to implement tasks identified in the plan and helps facilitate cooperation with the WDNR on AIS issues.

www.maps.glifwc.org: The goal of this project is to facilitate much of the collaborative work discussed above by providing a common communications infrastructure. GLIFWC compiles and shares information on invasive species distribution and management efforts throughout Minnesota, Wisconsin, and Michigan at www.maps.glifwc.org.

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