Invasive Species Program 2017

by

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EXECUTIVE SUMMARY

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an agency 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.

This report summarizes the activities undertaken by GLIFWC staff during 2017 to address the spread of invasive species in the Ceded Territories. GLIFWC's invasive species program consists of 1) prevention, 2) early detection rapid response, 3) control and management, 4) research, and 5) coordination of these activities with cooperating tribes, government agencies and groups to maximize the efficient use of limited resources.

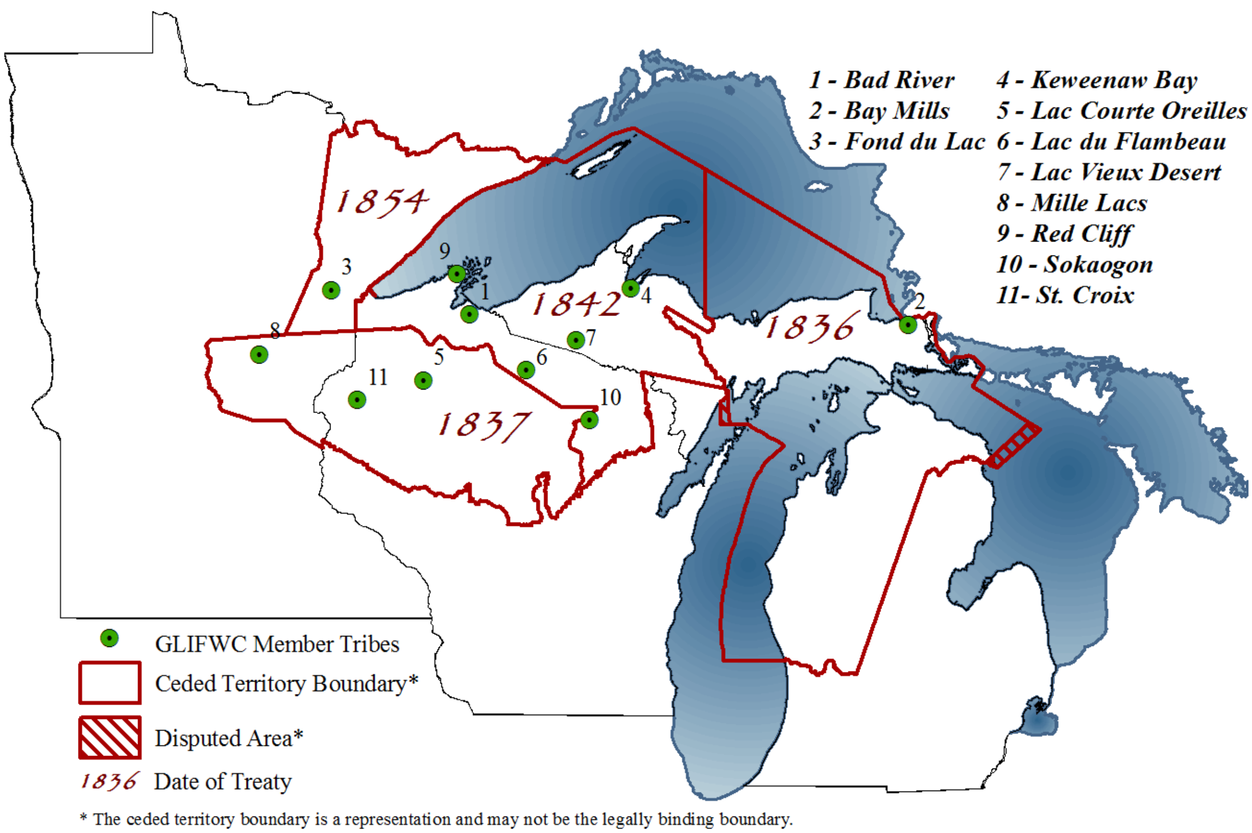

Figure 1. Location of GLIFWC member tribes and Ceded Territories.

ACKNOWLEDGMENTS

The Great Lakes Indian Fish and Wildlife Commission acknowledges the following 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 Program
  - Great Lakes Restoration Initiative (GLRI) Tribal AIS

- U.S. Environmental Protection Agency (EPA)
  - GLRI Coastal Wetlands Planning, Protection and Restoration

- U.S. Fish and Wildlife Service (USFWS)
  - Great Lakes Restoration Initiative (GLRI) Tribal AIS
  - Wisconsin State ANS Plan

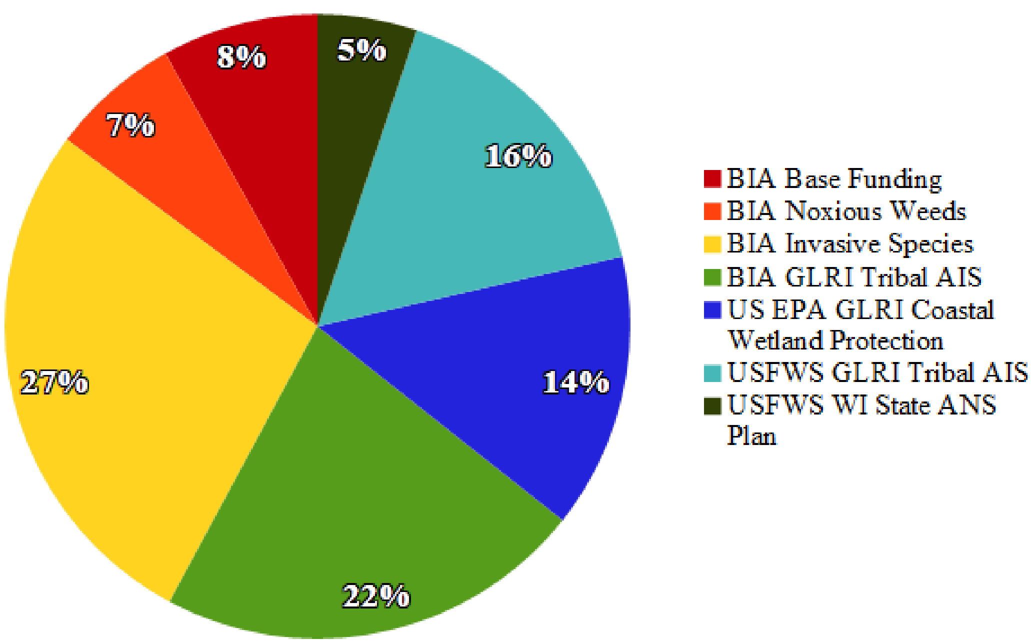

Figure 2: Funding sources for GLIFWC's Invasive Species Program in 2017.

PREVENTION

Introduction

The most effective approach to combat the spread of invasive species is to prevent their initial establishment. Because the vast majority of invasive species introductions can be attributed to human activities, effective prevention efforts depend on an informed public. A variety of education, outreach, and training materials are needed to alert a diverse public to the threats posed by invasive species and the actions required to prevent their spread.

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, stickers, 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 and quarterly newsletter - *Mazina'igan*.

Accomplishments

Mazina'igan Articles
GLIFWC's newsletter (circulation = 18,500) features articles on invasive species. Topics covered in 2017 included:

- "Chronicles of Mille Lacs: the walleye, the zebra mussel, & the waterflea" by GLIFWC Inland Fisheries Section. Summer 2017. http://www.glifwc.org/Mazinaigan/Summer2017/flipbook/index.html?page=1
- "A closer look at Lake Mille Lacs management" by GLIFWC Inland Fisheries Section. Summer 2017. http://www.glifwc.org/Mazinaigan/Summer2017/flipbook/index.html?page=4
- "Boardman River project aims to block lamprey, support fishery" by GLIFWC staff. Summer 2017. http://www.glifwc.org/Mazinaigan/Summer2017/flipbook/index.html?page=8
- "No news is good news" by Steven Garske. Short reminder that "Don't move firewood!" signs were still available. Summer 2017. http://www.glifwc.org/Mazinaigan/Summer2017/flipbook/index.html?page=8
- "Public engagement, education key to phragmites control" by Jennifer Ballinger. Summer 2017. http://www.glifwc.org/Mazinaigan/Summer2017/flipbook/index.html?page=8
- "Great Lakes, treaty resources enhanced under GLRI" by Jennifer Ballinger. Fall 2017. http://www.glifwc.org/Mazinaigan/Fall2017/index.html?page=8
- "Aquatic invasive species infestations multiply" by Steve Garske. Winter 2017/2018. http://www.glifwc.org/Mazinaigan/Winter%202017/index.html?page=6 .

Events, Presentations and Other Outreach Activities
Activities in 2017 included:

- Pocket size cards were distributed with permits during spring spearing and netting season to educate tribal harvesters on steps to prevent the spread of AIS, including how to clean equipment and specific tribal AIS regulations (Spring 2017).
- Fish measuring stickers with AIS prevention and tribal regulation information were distributed at tribal registration stations and GLIFWC events.
- GLIFWC's portable boat washer was used during tribal spring spearing and netting season:
    - Used by 84 tribal harvesters, who washed a total of 31 boats to remove potential AIS.
    - Stationed at landings of 8 different high priority tribal harvested waters (mostly in terms of walleye and northern pike harvest) with high priority AIS, particularly spiny water fleas (April-May 2017).
    - Having a boat washer available provided educational as well as preventive value.
- Purchased a portable boat washer, to be provided to tribal members for effective AIS prevention measures at boat landings (June 2017).
- Trained 5 staff in boat and equipment decontamination and prevention procedures for aquatic invasive species (June 2017).
- Assisted with invasive species education and garlic mustard (*Alliaria petiolata*) hand pulling event with Bad River Youth (15) along the Bad River in Mellen, WI (June 21, 2017).
- Helped plan, participated in, and presented at the Phragmites Open House and Panel Discussion in Duluth (April 20, 2017).
- GLIFWC's invasive species website 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.

EARLY DETECTION RAPID RESPONSE (EDRR)

Eradicating or containing invasive species is more feasible and cost effective when populations are at an early stage of infestation. GLIFWC staff have conducted annual invasive species surveys since 1995 and have documented over 10,000 occurrences for several hundred species of invasive organisms throughout the Ceded Territories. This information provides a baseline to determine if newly detected occurrences are nascent populations, and whether rapid response efforts are warranted. Early detections by GLIFWC staff have led to successful rapid response control efforts for curly-leaf pondweed (*Potamogeton crispus*), Eurasian water-milfoil (*Myriophyllum spicatum*), garlic mustard (*Alliaria petiolata*), knotweed (*Fallopia* spp.), non-native phragmites (*Phragmites australis* subsp. *australis)*, purple loosestrife (*Lythrum salicaria*), teasel (*Dipsacus* spp.), and yellow iris (*Iris pseudacorus*).

AQUATIC AND WETLAND INVASIVE SPECIES

Introduction

Since the early 1800s, at least 144 species of fish, plants, invertebrates, algae and pathogens have been introduced from other continents and become established in the riparian and aquatic habitats of the Great Lakes basin (GLANSIS 2017). Several dozen additional species native to North America but not the Great Lakes basin have been introduced to the basin as well. Many of these organisms have subsequently 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 (Pimentel et al. 2005).

GLIFWC staff continued to survey selected Ceded Territory waters in 2017 to 1) assess and document the scope of the problem, 2) detect small populations of the most ecologically disruptive invasive species before they become large, environmentally damaging populations, and 3) prioritize education and management efforts.

Methods

GLIFWC staff surveyed 21 lakes for aquatic invasive species (AIS) in northern Wisconsin and Michigan in 2017 (Figure 3, Table 1). Seventeen lakes were surveyed for a suite of invasive plants and animals. Lac Vieux Desert was visited twice – in June, primarily to delineate curly-leaved pondweed and Eurasian water milfoil, and in August, to delineate *manoomin* (wild rice) beds. The three Cisco Chain lakes (Cisco, Thousand Island, and Big Lake) were surveyed for waterfleas and veligers only. Lakes surveyed for AIS were chosen in coordination with tribal, state, county and other local management partners. Surveys mostly targeted lakes important for

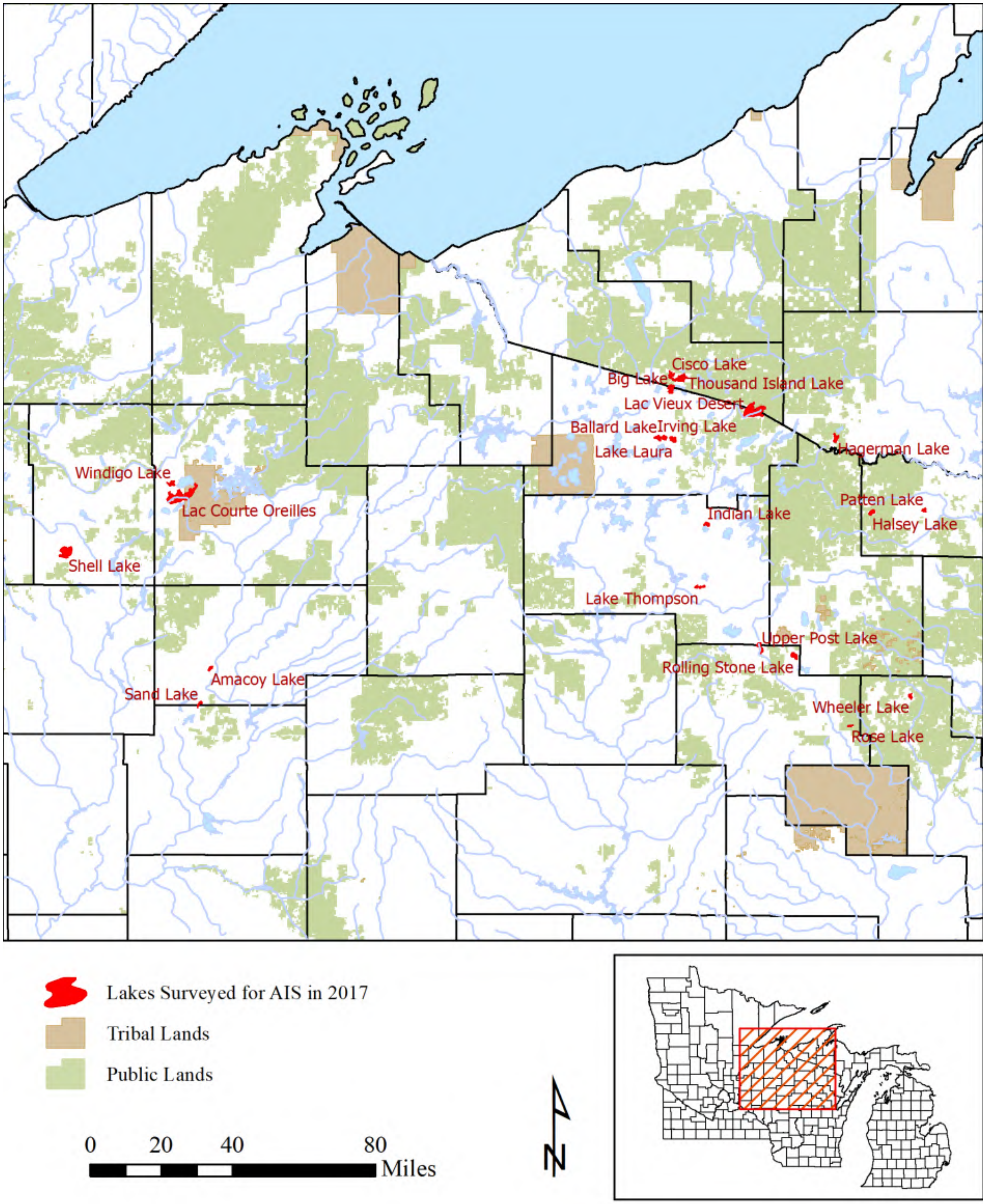

Figure 3: Lakes surveyed for aquatic invasive species in 2017.

Table 1. Lakes surveyed for aquatic invasive species in 2017. Trophic status of lakes located partly or entirely within Wisconsin was obtained from WI DNR 2017. Trophic status of Michigan lakes was based on our observations. Conductivity was measured at a depth of 1 meter, at approximately the deepest point in the lake.

State	Waterbody	WBIC	Watershed	Acres	Date(s)	Survey Type	Trophic Status	Cond. (µS/cm)	# Vel Samples	# Wflea Samples
MI	Cisco Lake*	27-275	Lake Superior	567	08/28	Veligers, waterfleas	Mesotrophic	78	1	1
MI	Thousand Island Lk*	27-265	Lake Superior	1009	08/28	Veligers, waterfleas	Mesotrophic	84	1	1
MI, WI	Big Lake*	2963800	Lake Superior	780	08/28	Veligers, waterfleas	Eutrophic	76	0	1
MI, WI	Lac Vieux Desert**	1631900	Mississippi River	4403	6/19-22, 8/21	EWM, CLP	Mesotrophic	---	0	0
MI	Hagerman Lake	36-190	Lake Michigan	565	08/31	All AIS taxa	Oligotrophic	107	3	1
WI	Halsey Lake	679300	Lake Michigan	506	8/29	All AIS taxa	Mesotrophic	163	1	1
WI	Patten Lake	653700	Lake Michigan	254	8/30	All AIS taxa	Mesotrophic	132	1	1
WI	Rolling Stone Lake	389300	Lake Michigan	682	07/10-11	All AIS taxa	Eutrophic	129	1	1
WI	Rose Lake	494200	Lake Michigan	115	07/18	All AIS taxa	Oligotrophic	207	1	1
WI	Upper Post Lake	399200	Lake Michigan	765	07/19	All AIS taxa	Eutrophic	98	1	1
WI	Wheeler Lake	439800	Lake Michigan	281	07/12	All AIS taxa	Oligotrophic	163	1	1
WI	Indian Lake	1598900	Mississippi River	354	07/17	All AIS taxa	Mesotrophic	64	0	1
WI	Lake Thompson	1569900	Mississippi River	401	07/20	All AIS taxa	Eutrophic	65	0	1
WI	Amacoy Lake	2359700	Mississippi River	283	07/03	All AIS taxa	Eutrophic	84	0	1
WI	Sand Lake	2353600	Mississippi River	272	06/28	All AIS taxa	Oligotrophic	112	3	1
WI	Lac Courte Oreilles	2390800	Mississippi River	5140	07/06	All AIS taxa	Oligotrophic	102	4	1
WI	Windigo Lake	2046600	Mississippi River	503	07/05	All AIS taxa	Mesotrophic	17	0	1
WI	Ballard Lake	2340700	Mississippi River	503	08/14-15	All AIS taxa	Mesotrophic	51	1	1
WI	Irving Lake	2340900	Mississippi River	419	08/15	All AIS taxa	Eutrophic	62	0	0
WI	Lake Laura	995200	Mississippi River	628	08/16	All AIS taxa	Oligotrophic	48	0	1
WI	Shell Lake	2496300	Mississippi River	2513	06/26-27	All AIS taxa	Mesotrophic	36	0	1

*Zebra mussel and/or spiny waterflea sampling only.
**Spring Eurasian water milfoil and curly-leaved pondweed survey only.

tribal *ogaa* (walleye) and *manoomin* harvest. Most lakes chosen had high visitation rates or were in close proximity to infested waters.

For the 17 comprehensively surveyed lakes, qualitative surveys for invasive species were conducted by observing the littoral zone from the water's surface. The boat was driven roughly parallel to shore, in a meandering pattern between shallow water and the outer edge of the littoral zone. Surveys focused on submergent, emergent and shoreline plants. These areas were also inspected for invasive animals or evidence of their presence. Surveys attempted to cover as much of the shoreline (including island shorelines) as possible, with shorelines of all but two lakes (Lac Courte Oreilles and Shell Lake) completely surveyed.

Boat landings were treated as high priority areas. All public and some private boat landings were surveyed. Shorelines, shallow water areas, pier supports, floating fragments, rocks and beach debris in the vicinity of the landings were inspected for invasive plants and animals. Rake tosses and D-net pulls were conducted at the main boat landing for five minutes. The material retrieved by each rake throw was placed in a bin and inspected for invasive plants and animals. Rake throws were omitted when inspecting landings of several oligotrophic lakes with rocky or sandy bottoms and little vegetation.

Ecologically disruptive aquatic invasive species with limited abundance and distribution in the Ceded Territories were classified as “priority species” (Table 2). Aquatic invasive species that could not be easily quantified such as invertebrates or crustaceans, species that were abundant and widespread within the waterbody, and terrestrial invasive plants were classified as “present” and only their initial occurrence within a waterbody was documented.

If a “priority” invasive plant species was found on a lake where it was previously undocumented, a specimen was collected, along with notes on location and habitat. Collections were sent to the Neil A. Harriman Herbarium at the University of Wisconsin – Oshkosh (OSH) or the Wisconsin State Herbarium at UW Madison (WIS), with any duplicates mounted and accessioned into the GLIFWC herbarium cabinet. *Manoomin* or wild rice (*Zizania palustris*) and native phragmites (*Phragmites australis* subsp. *americanus*) populations were also documented. Location and other data for native phragmites populations were added to GLIFWC's database and shared with management partners.

Locations were mapped with mobile data collection. KoBo Toolbox, a free open-source data collection tool, was used to create custom data entry forms. Attribute data for each site was recorded using a mobile phone with sliding screens, drop-down menus and built-in constraints in a GIS file-capable format. Data was automatically synced, or uploaded from the mobile phone once network service or a wireless network became available.

Plankton nets (50-cm diameter, 64-micron mesh) were used to sample for zebra and quagga

Table 2: "Priority" species for the 2017 aquatic and shoreline invasive species surveys.

Scientific Name	Common Name	Scientific Name	Common Name
Invertebrates			
Bithynia tentaculata	Faucet snail	*Dreissena bugensis*	Quagga mussel
Bythotrephes longimanus	Spiny water flea	*Dreissena polymorpha*	Zebra mussel
Cercopagis pengoi	Fishhook water flea	*Potamopyrgus antipodarum*	New Zealand mudsnail
Corbicula fluminea	Asian clam	*Procambarus clarkii*	Red swamp crayfish
Plants			
Butomus umbellatus	Flowering rush	*Microstegium vimineum*	Japanese stilt grass
Cabomba caroliniana	Fanwort	*Myriophyllum aquaticum*	Parrot feather
Callitriche stagnalis	Pond water-starwort	*Myriophyllum spicatum*	Eurasian water-milfoil
Crassula helmsii	Australian swamp stonecrop	*Najas minor*	Slender-leaved naiad
Egeria densa	Brazillian waterweed	*Nymphoides pelata*	Yellow floating heart
Eichhornia crassipes	Water hyacinth	*Phragmites australis* subsp. *australis*	Non-native phragmites
Glyceria maxima	Tall manna grass	*Pistia stratiotes*	Water lettuce
Heracleum mantegazzianum	Giant hogweed	*Fallopia japonica*	Japanese knotweed
Humulus japonicus	Japanese hop	*Fallopia sachalinensis*	Giant knotweed
Hydrilla verticillata	Hydrilla	*Fallopia* x *bohemica*	Bohemian knotweed
Hydrocharis morsus-ranae	European frog-bit	*Potamogeton crispus*	Curly pondweed
Lysimachia nummularia	Moneywort	*Trapa natans*	Water chestnut

mussel veligers. Vertical plankton tows were used to sample for veligers, following Wisconsin Department of Natural Resources (WI DNR) protocol (WI DNR 2010). With several exceptions, veliger tows were only conducted on lakes that had high enough dissolved calcium levels (based on specific conductance readings) to sustain a zebra or quagga mussel population (see Papeş et al. 2011). Specific conductance was measured in the deepest basin of each lake at a depth of one meter, using a YSI Model 30 meter to determine the current suitability of each lake. Lakes with a specific conductance reading of equal to or greater than 99 µS/cm were considered suitable and were sampled.

On small or shallow lakes, only one veliger sample was collected. At least three veliger samples were collected from three larger lakes including Hagerman Lake, where zebra mussels were found on the supports of a dock in 2009. (No evidence of zebra mussels has been found at Hagerman Lake since then.) The remaining samples were collected from other bays or basins. Immediately after collection, samples were condensed, transferred to sample bottles, and labeled and preserved with 190 proof ethyl alcohol, at a ratio of four parts alcohol to one part plankton sample.

An Ekman dredge was used to sample for spiny and fishhook water fleas following the protocol of Walsh and Vander Zanden (2016). Sediment samples were collected at the deepest location of each lake. At the sampling point, the dredge was lowered to within one meter of the lake bottom. It was then dropped the remaining distance and the “messenger” (a cylindrical metal weight) was sent down the rope to set the dredge. The sample was then condensed, transferred to a plastic bag, labeled and kept cool until it could be frozen.

Veliger samples were sent to the WI DNR Science Operations Center in Madison, Wisconsin for analysis. Water flea samples were examined by GLIFWC staff, by analyzing them under a dissecting microscope to look for spine fragments that would indicate the presence of water fleas.

After finishing each lake, the boat, trailer and equipment were thoroughly disinfected. Plant fragments and other debris were removed by hand or with a brush at the landing, and the drain plug was removed in an area where the water would not run into the lake. A washing location was chosen to ensure that the disinfection solution and rinse water would not run into storm water drains or other areas that might contaminate surface waters. The boat, trailer and all equipment that came into contact with the water (including plankton nets and cups, Ekman dredge, collection nets, ropes, weights, anchor and paddles) were sprayed with a 500 ppm bleach solution. After the appropriate contact time (10 minutes), the boat, trailer and all equipment were rinsed thoroughly. The boat motor was flushed with tap water by using a flushing attachment (flush muffs) for at least two minutes. Veliger sampling equipment was disinfected with the bleach solution, then rinsed and soaked in vinegar for 20 minutes. The vinegar was used to dissolve any veliger remains, ensuring there would be no false positives in subsequent samples. Lakes with known infestations of easily spread invasives (such as water fleas or zebra mussels) were surveyed at the end of each week, to minimize the risk of spreading them to the next waterbody.

Results

A total of 31 new aquatic and wetland invasive species occurrences comprising 9 taxa were found in 2017 (Table 3). Previously unrecorded populations of *Iris pseudacorus* were found on four lakes. New narrow-leaved and hybrid cattail populations were found on 6 and 5 lakes, respectively, and Eurasian marsh thistle was recorded on 4 new lakes. A large, mature Oriental bittersweet (*Celastrus orbiculatus*) plant was found climbing a paper birch tree at the edge of a lawn next the shore of Sand Lake. New banded mysterysnail (*Viviparus georgianus*) populations were recorded from 3 lakes.

Two new “priority” species occurrences were found on survey lakes in 2017. The first was a fragment of Eurasian water milfoil, found in Anchor Bay of Lac Courte Orielles Lake in Sawyer County. The second was a well-established population of non-native phragmites on Lake Laura in Vilas County.

Two occurrences of an Asian willow called “ *qi liu*” (*Salix integra* Thunberg in Murray cv. 'Hakuro-Nishiki') were also recorded: a large shrub near the shore of Indian Lake, and a row of several large shrubs on the shore of Wheeler Lake, next to the boat landing. Both populations appear to have been planted. This plant was also a component of several yard and garden plantings, but these were not recorded. Apparently this species is widely available in the horticultural trade (see MBG 2017 for example) but has not been recorded outside cultivation in North America (Chao and Gong 1999). Whether it will spread on its own is unknown.

A total of 67 curly pondweed and 181 Eurasian water-milfoil locations were mapped during the spring survey of Lac Vieux Desert.

Nineteen zebra mussel veliger and 19 water flea plankton samples were collected during 2017. No zebra or quagga mussel veligers, or spiny or fishhook water fleas were detected in any of the samples.

Small populations of *manoomin* were found in 3 survey lakes. Two of these lakes (Rolling Stone and Halsey) had had anecdotal reports of *manoomin* (Peter David, pers. comm. by email, October 3, 2017). The third (Ballard) is connected to Irving Lake, which supports a well-known population of *manoomin*.

A specimen of bittersweet was sent to WIS, with a duplicate preserved in the GLIFWC herbarium. A specimen of qi liu from Wheeler Lake were sent to OSH, with a duplicate kept in the GLIFWC herbarium. A specimen of non-native phragmites from the Lake Laura population and another from the North Shore Road population were sent to WIS, with a duplicate of each kept at GLIFWC.

Discussion

Early detection of invasive species before they become large, environmentally damaging populations makes eradication more likely and reduces the amount of effort required for effective control. The behavior of relatively new introductions such as *Salix integra* should be monitored to see whether they begin to reproduce and spread on their own.

Table 3: Aquatic and wetland invasive species found during the GLIFWC lake survey. Cisco Chain Lakes (Big, Cisco, and Thousand Island) were surveyed for waterfleas and veligers only. Lac Vieux Desert was surveyed for curly-leaf pondweed and Eurasian water milfoil only.

LOCATION			PLANTS									MOLLUSKS			CRUSTA-CEANS		OTHER	
STATE	COUNTY	LAKE	Curly-leaf pondweed	Eurasian marsh thistle	Yellow iris	Purple loosestrife	Water forget-me-not	Eurasian water milfoil	Narrow-leaf cattail	Hybrid cattail	Eurasian phragmites	Zebra mussel	Chinese mystery snail	Banded mystery snail	Spiny waterflea	Rusty crayfish	Fresh water jellyfish	Heterosporis sutherlandae
MI	Gogebic	Cisco	X_W										X_G			X_W		
MI	Gogebic	Thousand Island	X_W					Xw					X_G			Xw		
MI, WI	Gogebic/Vilas	Big						X					X	X		X		
MI, WI	Gogebic/Vilas	Lac Vieux Desert	X, G					X, G					X	X, G		X	X	X_{GLFC}
MI	Iron	Hagerman		G			G		X_G			?						
WI	Florence	Halsey																
WI	Florence	Patten					G		G	G						X, G		
WI	Langlade	Rolling Stone	X, G	G	G								X, G	X, G		X		
WI	Langlade	Rose												X, G		X		
WI	Langlade/Oneida	Upper Post	X, G		G	X, G	G						X, G	X		X		
WI	Oconto	Wheeler	X*		G		G	X, G		G			X, G	X, G				
WI	Oneida	Indian							G				X, G				X	
WI	Oneida	Thompson		G		X*	G		G				X, G	X*		X		
WI	Rusk	Amacoy	X, G							G			X, G					
WI	Rusk/Chippewa	Sand	X, G				X, G		G	G								
WI	Sawyer	Lac Courte Oreilles	X, G				G	G					X, G	G		X		
WI	Sawyer	Windigo																
WI	Vilas	Ballard				X*X_G, G	X, G							X, G				
WI	Vilas	Irving												G				
WI	Vilas	Laura		G					G		G			X, G				
WI	Washburn	Shell	X			X*G			G							X_G		

X = Previously verified by WI DNR (WI DNR 2017).
X* = Previously reported but not verified (WI DNR 2017).
X_w = Invasive Species Control Coalition of Watersmeet (ISCCW 2016).
X_{GLFC} = Great Lakes Fisheries Commission fact sheet (GLFC 2017).
X_G = GLIFWC database (not included by other sources).
G = observed during GLIFWC 2017 AIS survey.
? = ZM shells found in 2009, but not found since then.

Oriental bittersweet is a highly invasive species, and follow-up and control of the small Sand Lake population is recommended.

Data for the non-native phragmites site at Lake Laura was shared with the WI DNR, along with the other newly discovered populations of this plant (see below). Follow up treatment will be scheduled for 2018.

PHRAGMITES

Introduction

Phragmites australis is a clonal wetland grass found in marsh ecosystems worldwide. Native (subsp. *americanus*) and non-native (subsp. *australis*) phragmites are both widely distributed in North America. A third subspecies of uncertain origin (subsp. *berlandieri* Saltonstall & Hauber) occurs along the Gulf Coast of the southeastern US and eastern Mexico (Swearingen and Saltonstall 2010).

Local spread of phragmites is primarily vegetative, by underground rhizomes and overland runners. The runners can grow up to 16 feet per year. Long distance dispersal occurs primarily via floating root fragments, and seeds carried by wind or water. Even dislodged shoot sections can re-root from the nodes and grow.

Non-native phragmites is extremely invasive, growing in moist habitats, even colonizing floating vegetation mats in deeper water. It is more tolerant of flooding and salt water than the native subspecies (Meyerson et al. 2009). It can grow to 20 feet tall, and reach densities of over 160 stems per square yard. It can quickly establish dense clonal stands that almost completely exclude all other wetland plants. Large stands of phragmites alter hydrology, by increasing evaporation from wetlands and trapping sediments. They can also potentially increase fire frequency and intensity, by producing large amounts of durable, flammable stalks which remain standing through the winter, eventually ending up as a thick carpet of thatch.

Non-native phragmites poses a serious environmental risk to the freshwater estuaries of Lake Superior and inland *manoomin* waters. Although it is now common along the Lake Michigan shoreline, it is still uncommon in the Lake Superior watershed. Because of its limited distribution and abundance in the Lake Superior watershed, and the serious threat it poses to coastal estuaries and nearshore open waters, non-native phragmites is a high priority for control efforts.

Several small populations of non-native phragmites were detected and treated in 2013 along the western shoreline of Chequamegon Bay, near the Red Cliff, Bayfield, and Washburn wastewater treatment plants (WWTPs). Until recently, the use of non-native phragmites in WWTPs to dewater sewage sludge (reed bed technology) was permitted by WI DNR, with the EPA permitting its use for tribal applications.

Until fairly recently it was thought that phragmites spread primarily by floating roots and rhizomes, and that the seeds had low viability. However, recent studies suggest that seed viability and production is directly related to soil nutrients (Saltonstall and Stevenson 2007, Kettenring 2013). Continued surveillance and follow-up treatments will be required until these seed-producing populations are removed. GLIFWC is actively engaged with all three communities and the permitting agencies to replace non-native phragmites with native phragmites in their treatment facilities, and to remove these non-native phragmites populations from the landscape. Removal of non-native populations from the WWTP will begin in 2018. GLIFWC is planning on continuing close monitoring of the areas around the WWTPs, as well as the travel route from the WWTPs to the landfill that the non-native phragmites debris and sludge is being transported to.

Surveys conducted in 2014 detected 70 occurrences of non-native phragmites within the St. Louis River Estuary, which forms the border between Minnesota and Wisconsin. Response planning was initiated in the fall of 2014, with treatment initiated on the Wisconsin side in 2015. Additional surveillance was conducted in 2016 and 2017, to continue assessment of the current distribution and abundance of phragmites in the estuary, assess treatment effectiveness, and verify previous reports that lacked identification to the subspecies level.

Methods

Surveys: As with the AIS survey, attribute data for each phragmites site was recorded using the mobile phone application. Data collected for each site included location, estimated number of plants (shoots), acreage class, and whether control had been done. All newly discovered native and non-native phragmites locations were recorded wherever they were encountered. *Manoomin* was also recorded during these surveys, as were several high priority (in terms of location and/or distribution on the landscape) invasive plants.

In 2017 GLIFWC staff monitored 10 sites that had previously been reported to the WI DNR. Some of these sites had been previously treated with herbicide by the DNR or other partners.

Three Lake Superior coastal wetland complexes were surveyed for native and non-native phragmites in 2017 (Figure 4). Over 623 miles were covered in surveying these wetlands. Areas near roadsides and trails were surveyed by biking, walking, or slowly driving, watching both sides of the road and adjacent wetlands. Areas away from roads and trails were surveyed by motorboat or canoe. Additional road corridors were surveyed in northern Wisconsin and northeastern Minnesota.

Over 998 miles of roadsides, trails, beaches and shorelines were surveyed for phragmites in 2017

(Figure 4). More than 38 miles were surveyed by biking or walking, 10 miles by canoeing, 41 miles by motorboat, and 909 miles by motor vehicle.

Control: Sites along Chequamegon Bay and the Wisconsin side of the St. Louis River estuary were treated as necessary. GLIFWC crews applied imazapyr (Polaris®) herbicide with backpack sprayers or by hand swiping the shoots.

Control data for each site was recorded using a mobile phone application to document the locations of phragmites sites and control efforts. Data collected for each site included location, estimated number of plants, acreage class, type of herbicide used, and the approximate amount of herbicide applied.

Results

A total of forty-two treated non-native phragmites sites were monitored in Chequamegon Bay and the Wisconsin side of the St. Louis River estuary (Figures 4 and 5).

Of the 10 phragmites sites forwarded to us by the WI DNR for verification, four still had small numbers of live shoots (up to about 50). No live shoots were found at two treated sites, though one of these sites (Wabeno) had a small number of live Japanese knotweed shoots. At the Little Long Lake site, a patch of bare ground was evident on a steep, shaded slope between a summer cottage and the lake, but no evidence of phragmites was found there or along the nearby shoreline. No evidence of phragmites (live or dead) or herbicide treatment was found at three remaining sites, including two near Winchester. A final site (Dodge Lake near Polar, Wisconsin) was not visited due to logistical problems.

Of the 28 known non-native phragmites sites on the Wisconsin side of the St Louis River, 14 still had one or more live shoots (Figure 5). Most of the remaining sites appeared to have been completely eradicated. The water level of Lake Superior was near or at record levels during this year's survey (GLERL 2017), and the St. Louis River was high as well, partly inundating several sandbars and the long barrier island just west of Chase's Point. Several of the phragmites sites were inundated or eroded away by the high water. Three new non-native phragmites sites were also detected and treated. The GLIFWC control crew treated 19 non-native phragmites sites on the Wisconsin side of the St. Louis River with imazapyr (Polaris®) herbicide, using back-pack sprayers or by hand swiping the shoots. (The discrepancy in the number of extant versus treated sites was due to variation in how several sites were delineated during the two visits.)

Nine additional sites were monitored. Two sites west of Duluth, Minnesota were apparently not treated. The previously treated site on the south side of County BB in northwestern Douglas County, Wisconsin was treated by hand swiping the shoots, as requested by the landowners. There was a small patch of bare ground on the north side of BB where the other patch had been,

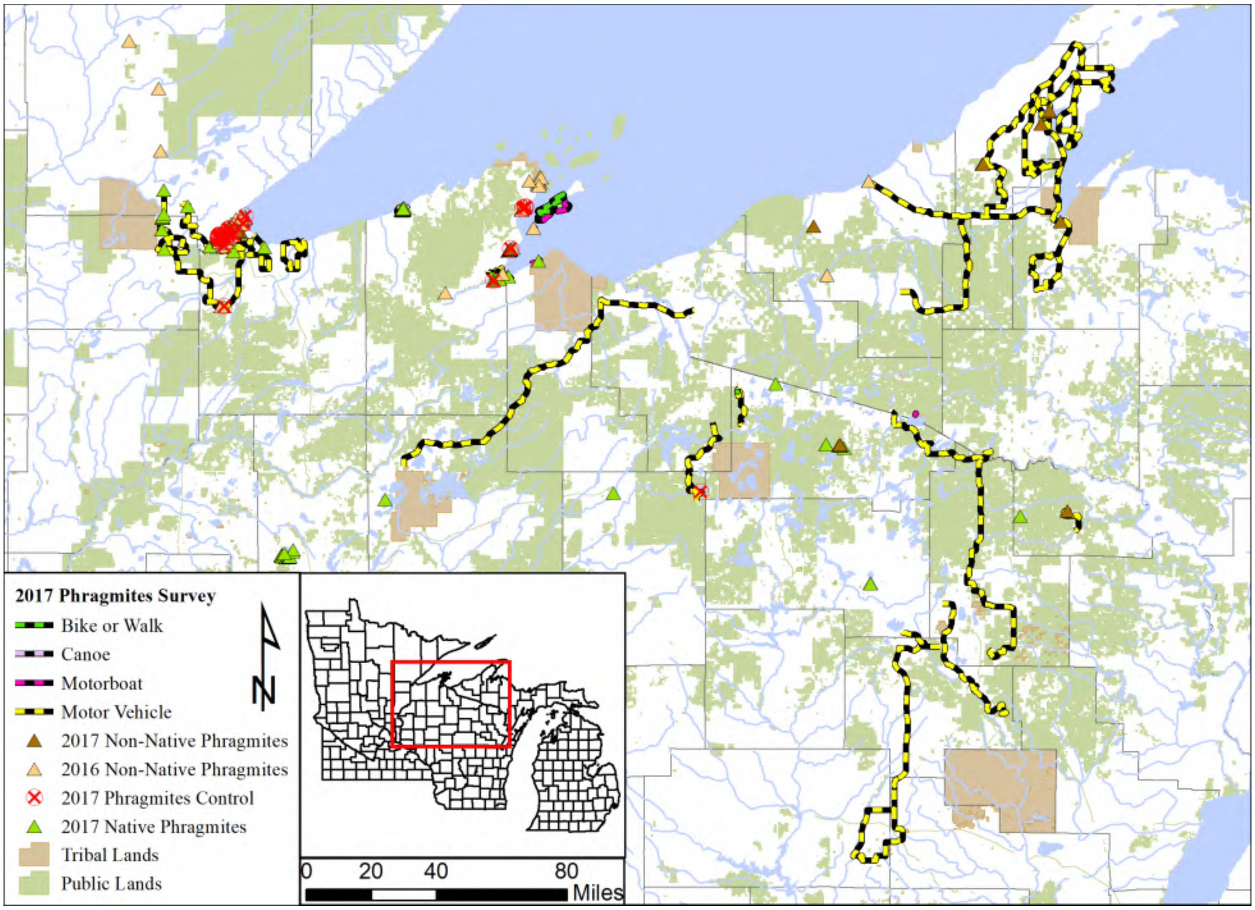

Figure 4: Overview of phragmites 2017 survey routes, occurrences and treatment sites. Native phragmites occurrences are new records, while non-native occurrences are for populations still extant after treatment in 2016.

but no live phragmites was evident. There were also no live phragmites shoots at the site of the variegated patch in Price County that was previously treated.

Five new non-native phragmites populations were found by GLIFWC during the 2017 survey. These included two well-established populations on the west side of the City of Superior, a small population along US Highway 2 about three miles west southwest of Ashland, and a small population on the shoulder of a gravel road near Patten Lake in Florence County. The last two populations had both been mowed earlier in the season and were relatively short and inconspicuous. GLIFWC staff treated the Highway 2 population soon after it was found.

As mentioned previously, a well-established population of phragmites was found on Lake Laura in Vilas County. The lake level appeared to be at least two feet higher than average this year, based on inundated shoreline vegetation, stranded docks, and unsuccessful attempts to

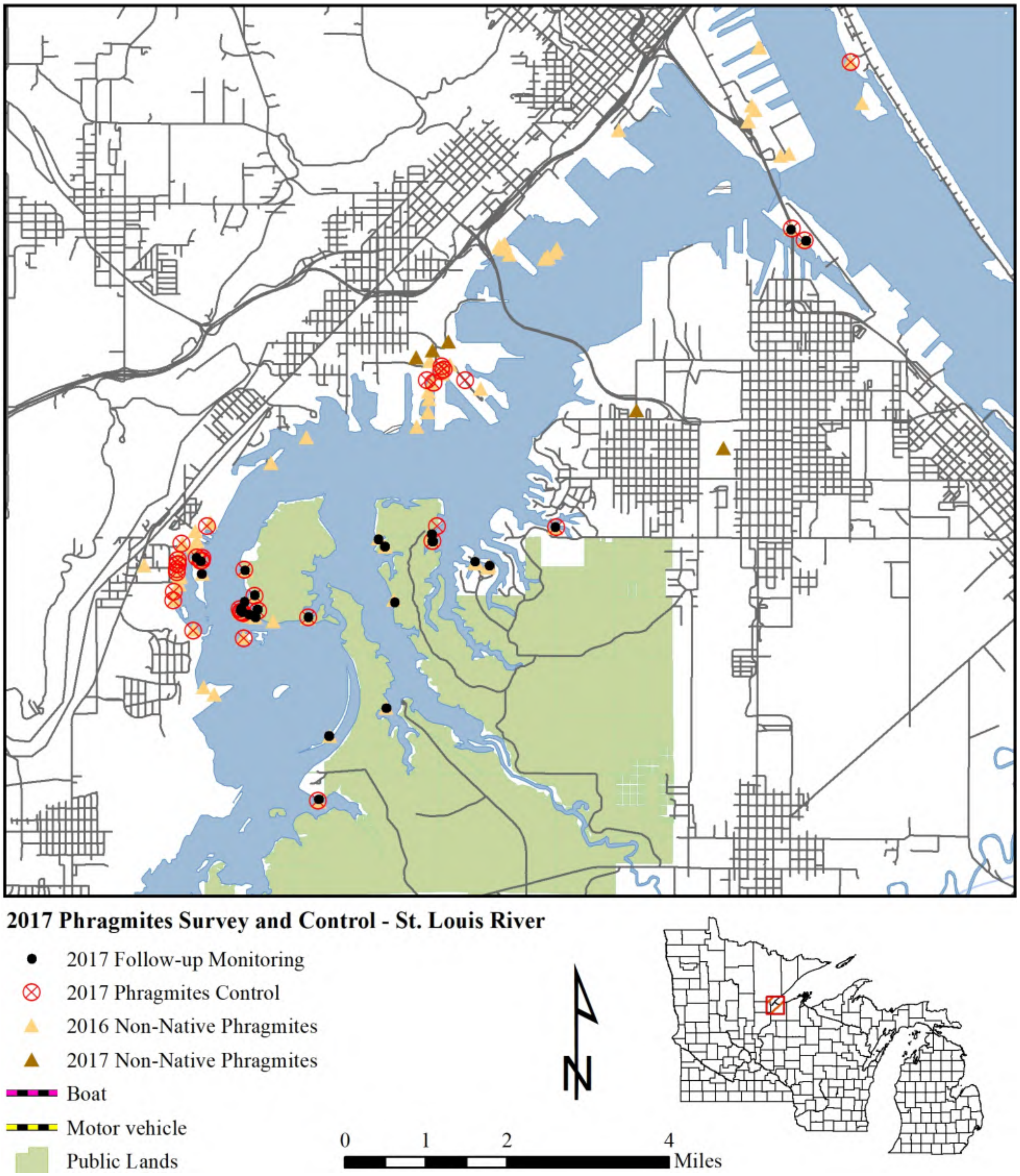

Figure 5: Phragmites 2017 survey routes, occurrences and treatment sites. No live phragmites was found at untreated follow-up sites. Minnesota sites were treated by CAD, while Wisconsin sites were treated by GLIFWC.

get the boat into the lake in previous years, due to low water at the landings. The largest area of non-native phragmites was in water from a few inches to around 4 feet deep. A moderately-sized population of native phragmites was also recorded on the shoreline of Lake Laura.

Surveys of the Flag River/Bibon Lake wetlands, Madeline Island and Fish Creek sloughs found no non-native phragmites. A population found by GLIFWC near the tip of Long Island in August 2016, and sprayed by GLIFWC later that month, had no live shoots.

Approximately 2.4 acres of non-native phragmites were chemically treated by GLIFWC (assuming sites recorded as < 0.25 acre averaged 0.125 acres). The relative abundance of non-native phragmites shoots at treatment sites in 2017 was the highest of any year since treatment began in 2012 (Figure 5). As in previous years, most sites required less than 1 gallon of herbicide mix (Figure 6).

After permitting issues precluded treatment on the Minnesota side of the St. Louis River Estuary in 2016, treatment began in 2017. In spring of 2017 GLIFWC entered into a subcontract with Community Action Duluth (CAD) to control phragmites populations on the Minnesota side of the estuary. CAD's Stream Corp Program staff detected five new sites on the Minnesota side. They also conducted initial chemical treatment on 19 sites on the Minnesota side of the estuary.

GLIFWC staff continued to work cooperatively to manage non-native phragmites along the St. Louis River Estuary. Staff helped initiate and facilitate WI DNR control efforts on the Wisconsin side of the St. Louis River in 2015. GLIFWC staff continues to work in partnership with the Minnesota DNR, 1854 Treaty Authority, Fond du Lac Band, and the St. Louis River Alliance to plan and conduct phragmites control efforts on the Minnesota side of the St. Louis River Estuary. GLIFWC staff are members of the technical advisory team overseeing the planning and management activities.

GLIFWC staff detected a total of 71 native phragmites occurrences in 2017 (Figure 4). Native phragmites occurrences were documented from roadsides, wetlands and lakeshores during the survey. This includes one or more occurrences on Shell, Lac Courte Oreilles, Ballard, Irving, Laura, Halsey and Thompson Lakes, as well as Fish Creek slough, and Flag River slough/Bibon Lake. (The wetlands around Bibon Lake support an extensive population of native phragmites.) No phragmites populations (native or non-native) were found during our survey of western Madeline Island.

Staff collected samples from one native and one questionably native (based on appearance) phragmites population within the Lake Superior watershed, for genetic analysis by Professor Nic Tippery of UW-Whitewater. Tippery tested approximately 60 samples from across Wisconsin. Results indicated that about half of these represented native genotypes and the other half non-native genotypes. Most of the alleles detected in the questionably native population (from

Douglas County, WI) were those typical of native genotypes. However, one marker (HEX_09) included a "native" allele (allele 212) not found in any of the other populations. This population was also one of only two native populations with (non-native) allele 147 at marker HEX_11, which nearly all the non-native populations had. Tippery called it an "an interesting population of native phragmites", but cautioned that "there remains some uncertainty about our results".

All phragmites occurrences that have been verified as either native or non-native were published online to coordinate appropriate responses among management partners. Sites treated in 2017 were also uploaded.

A large population of queen-of-the-meadow (*Filipendula ulmaria*) was documented in the shrub swamps and open wetlands on the lower reaches of the Flag River, and a smaller population was found near the marina in LaPointe, on Madeline Island. While not delineated, the Flag River population undoubtedly consists of hundreds if not thousands of plants, inhabiting multiple acres of wetland and shoreline. This plant has been collected several times in northern Bayfield County, including the Flag River slough. A specimen of queen-of-the-meadow was collected and sent to OSH.

Manoomin populations were recorded in the Flag River/Bibon Lake and Fish Creek Slough. This plant had previously been reported (at least anecdotally) on the Flag River and the Fish Creek Slough, but not on Bibon Lake (Peter David, pers. comm. by email, October 3, 2017). The populations were all relatively small, ranging from less that 10 to several hundred plants. The Fish Creek slough had been seeded with *manoomin* some years ago by GLIFWC staff (Peter David, pers. comm.), and this may have initiated the two small populations observed in 2017.

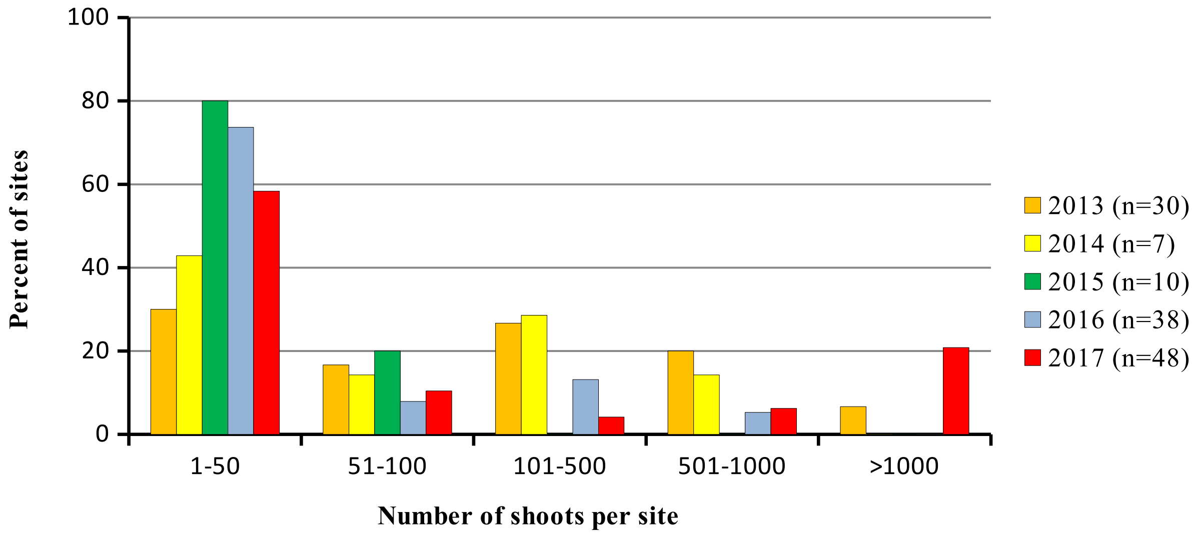

Figure 6. Abundance of non-native phragmites shoots, at sites treated from 2013 through 2017. (One 2016 site lacking abundance data was omitted.)

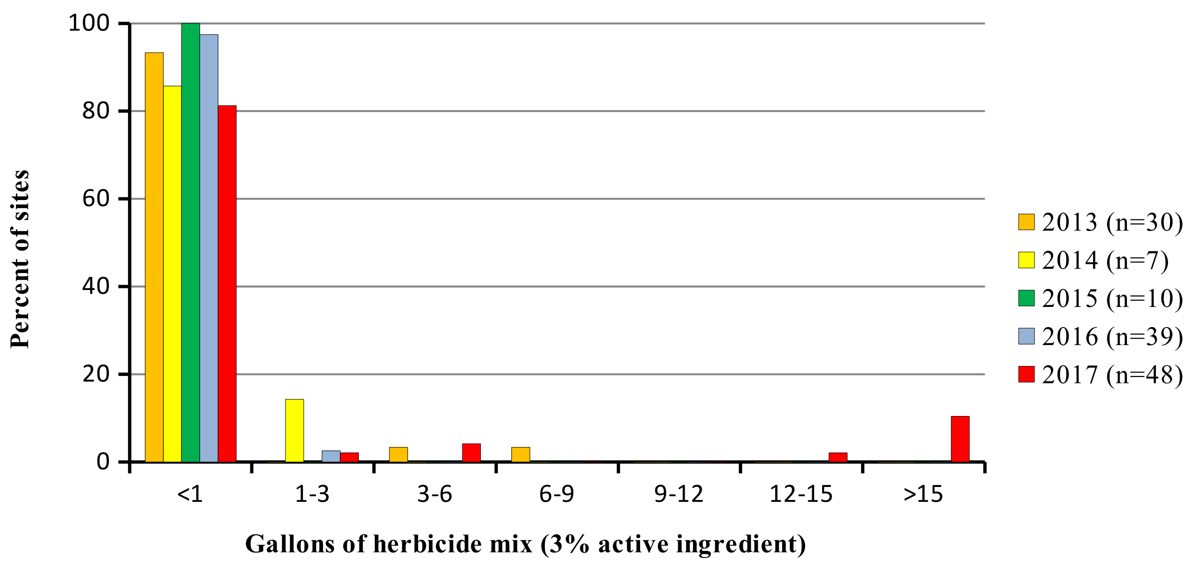

Figure 7. Amount of herbicide mix applied to non-native phragmites, at sites treated from 2013 through 2017.

TEASEL

Introduction

Common and cut-leaved teasel (*Dipsacus laciniatus* and *D. fullonum*) are closely related species, introduced to North America and the Ceded Territory. Common teasel is native to Europe, temperate Asia, and northern Africa, while cut-leaved teasel is native to Europe and temperate Asia (Gucker 2009). Common teasel was introduced to North America as early as the 1700s, while cut-leaved teasel was established in the eastern US before 1900. Common teasel is now widely established across the continental United States. Cut-leaved teasel is primarily established in the northeastern and Midwestern U.S. (sources in Gucker 2009). Although both species are only sparingly established in the Ceded Territory, they are locally common in southern Wisconsin and southern lower Michigan (Wisflora 2017, Voss and Reznicek 2017).

Both common and cut-leaved teasel are herbaceous biennials. Immature teasel plants spend their first year as rosettes. After developing a deep taproot and surviving the winter, they bolt, flower, produce seed, and die. Flowering plants are very spiny and may reach more than 7 ft tall (sources in Gucker 2009). Each plant may produce over 3,000 seeds. The seeds float and are readily spread by water. Teasels produce a fairly short-lived seed bank, with very few seeds surviving beyond 5 years in the soil. Teasel often spreads rapidly along roadsides, presumably aided by mowing equipment and snow plows (Stolp and Cochran 2006, Gucker 2009).

Dry teasel stalks and seedheads persist well into the winter. The seedheads are frequently used in dry-flower arrangements and other decorations. Dispersal from dry seedheads has likely initiated the establishment of numerous new populations (sources in Gucker 2009). Teasel tends to be common in and around cemeteries, presumably originating from floral arrangements left there.

Both teasel species readily invade sunny, disturbed habitats including roadsides, dumps, seeps, ditches, fencelines, power corridors and fields. Both tolerate dry to fairly wet soils. Prairie, savanna and sedge meadows are the natural communities most at risk from teasel invasion (Annen 2007). Prairie and savanna communities are some of the most endangered habitats in North America.

Common and cut-leaved teasel are listed as "prohibited" under Minnesota's Noxious Weed Law (MN Statutes 18.75-18.91, see http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/nwlawrevisor.aspx). It is illegal to transport or sell teasel without a permit in Minnesota, and landowners must make a good-faith attempt to control or eradicate it on their property. Both species are also listed as "restricted" invasive species under Wisconsin's invasive species rule (Wis. Adm. Code chapter NR 40, http://docs.legis.wisconsin.gov/code/admin_code/nr/001/40.pdf). This means they can be possessed and cultivated in Wisconsin, but cannot be knowingly transported, transferred to another party, or introduced to a new site without a permit.

Methods

Surveys: Locations of reported teasel sites were acquired from GLIFWC staff and Northwoods Cooperative Weed Management Area (NCWMA) cooperators.

Control: GLIFWC crews controlled populations by manual or chemical treatment, depending on site size and landowner's preference. Manual treatment was conducted by cutting the taproot below the soil surface using a sharp spade. Metsulfuron methyl (Escort®) herbicide was used for chemically treating sites.

Attribute data for each site was recorded using the mobile phone application to document the locations of teasel sites and control efforts. Data collected for each site included location, an estimate of the number of plants, acreage class, type of control used (chemical or manual), and an estimate of the amount of herbicide applied.

Results

In 2017, five common or cut-leaf teasel sites were relocated and treated. (The two Washburn sites were in close proximity to each other, and were considered to be one site for treatment in 2017.) Two small sites were manually treated, while three larger sites were treated with herbicide. All were estimated at under 100 plants. Figure 8 illustrates the distribution of detected occurrences and control efforts. Figure 9 shows the abundance of teasel at each treatment site.

Discussion

With only five known locations still extant in northern Wisconsin, teasel is a high priority for eradication before it becomes more widespread and ecologically damaging. Common and cut-leaved teasel are priority species for the NCWMA as well.

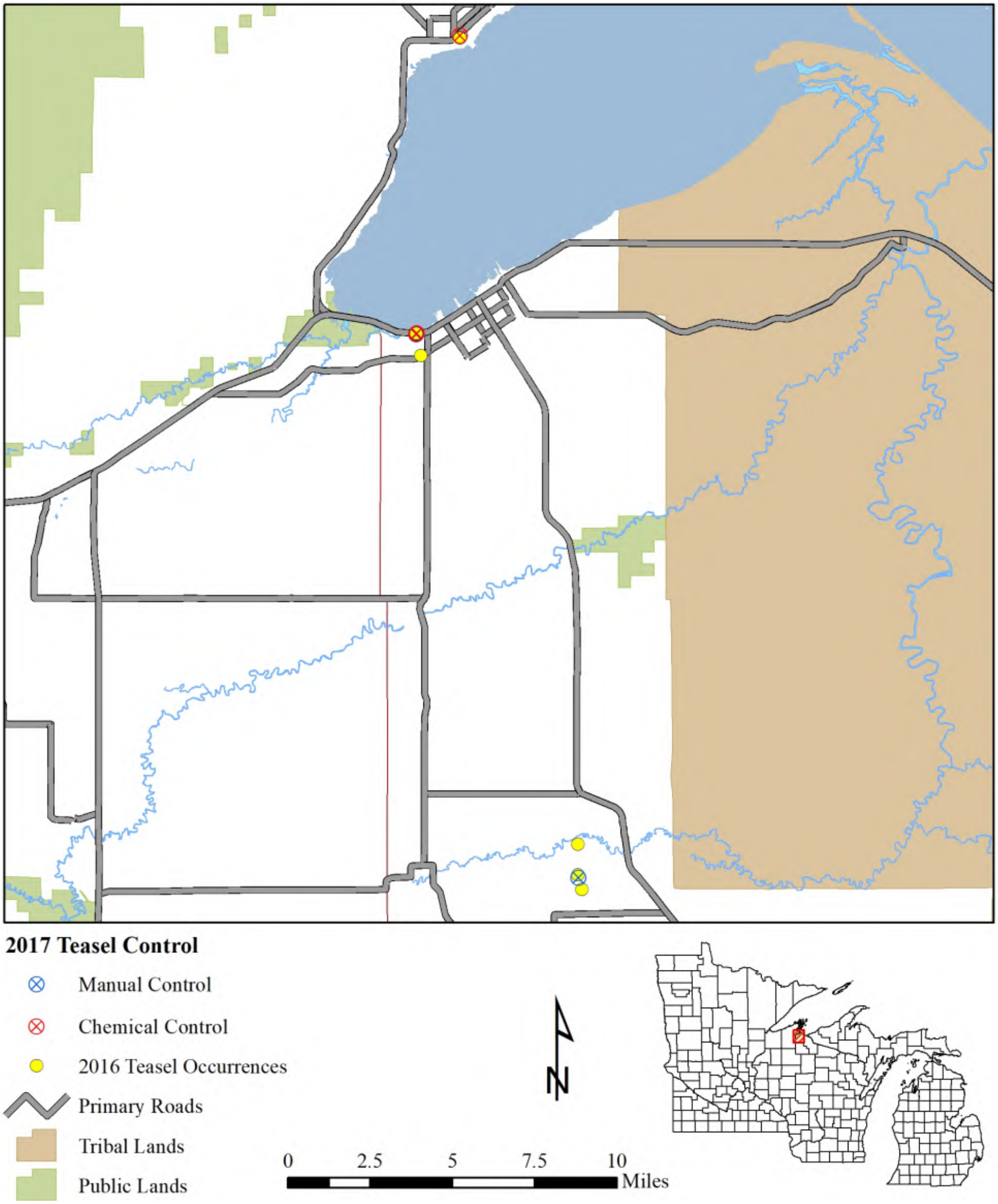

Figure 8: 2017 GLIFWC teasel control efforts. No plants were found at untreated occurrences.

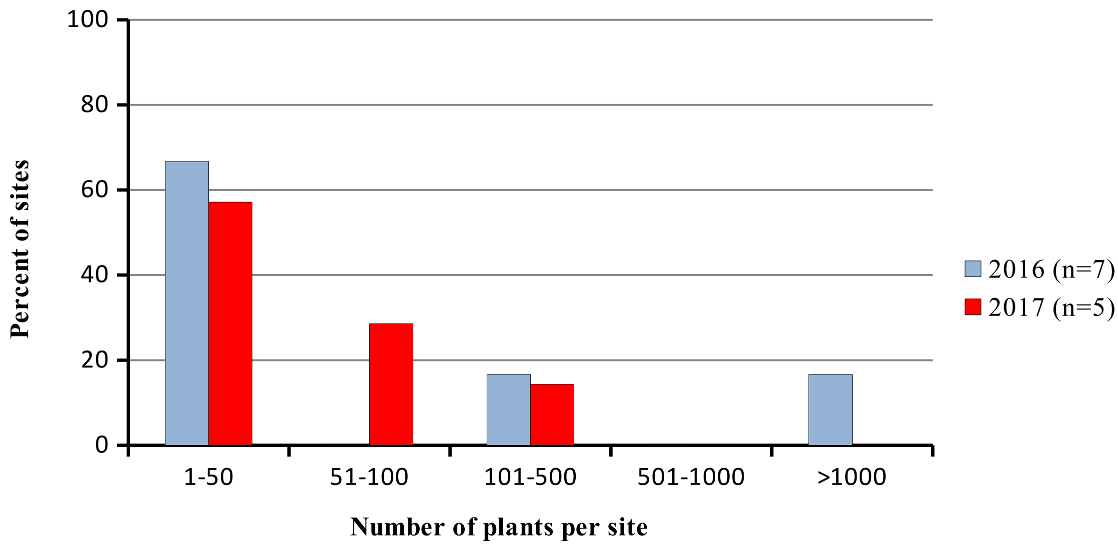

Figure 9. Abundance of common and cut-leaf teasel at sites treated in 2016 and 2017.

WILD PARSNIP

Introduction

Wild parsnip (*Pastinaca sativa* L.) is native to Eurasia. It is the wild ancestor of the cultivated garden parsnip, and wild and cultivated forms can freely cross. It was introduced into North America at Jamestown, Virginia in 1609 (Berenbaum et al. 1984). It has probably been established in eastern North America for more than two centuries, reaching Michigan by 1838 (Voss and Reznicek 2017) and Wisconsin by 1894 (Wisflora 2017). Wild parsnip is now found across the US and adjacent Canada, except for the extreme southeastern US. It is locally common across the upper Great Lakes region, and appears to be increasing in abundance and extent.

Wild parsnip is a taprooted biennial or monocarpic perennial, growing for two or more years before it bolts, flowers, and dies (Hendrix and Trapp 1992). Immature plants form a rosette. Flowering plants are typically around 3 ft tall, though may reach 5 ft tall. Like other members of the parsley family, wild parsnip produces flat-topped flower clusters called umbels. The golden-yellow flower clusters may reach 4-8 inches across. Plants typically bolt in June and flower in July. The seeds are about 1/4 inch long, flat, elliptic, and slightly winged. Unless dislodged, the seeds tend to remain attached to the dead stalk well into autumn.

Wild parsnip does well along moist to dry roadsides, old fields, clearings, power line corridors, and other sunny, disturbed areas. It also invades open streambanks and cut-over woods. Mowing and snow-plowing undoubtedly facilitate its spread along roadsides.

Like some other members of the parsley family, wild parsnip produces chemicals that cause photodermatitis, characterized by blistering and discoloration of the skin when exposed to sunlight (Berenbaum et al. 1984). Photodermatitis can be severe, especially in susceptible individuals. On the other hand, wild parsnip is reputed by some to be edible, and at least as tasty as cultivated forms (Thayer 2006). Several related plants, including water hemlock (*Cicuta maculata*), are extremely poisonous.

Wild parsnip is abundant at a number of sites in northern Wisconsin and the western Upper Peninsula (S. Garske, pers. obs.). It has been a high priority for control for GLIFWC and the NCWMA and partners.

Methods

<u>Surveys:</u> In 2016 GLIFWC staff surveyed roadsides, utility corridors and areas near prior wild parsnip reports. Locations of previously reported sites were acquired from prior GLIFWC surveys, along with the Bad River Natural Resources Department, City of Ashland, Iron County Land and Water Conservation Department (LWCD), and other cooperating agencies. Rights-of-way were surveyed by walking or slowly driving along roadsides or paths, surveying both sides of the corridor. Individual sites were flagged with a site number to assist with management efforts. If populations extended for some distance along a road or trail, the two end points were flagged.

After monitoring was completed, occurrence data and site maps were shared with partners including Bad River Natural Resources Department, Ashland, Bayfield, and Iron County Land and Water Conservation Departments and the City of Ashland to coordinate follow-up management efforts.

<u>*Control:*</u> GLIFWC crews applied metsulfuron methyl (Escort®) herbicide to wild parsnip rosettes at most sites in late spring and early summer, with a minority of sites sprayed in September. Spring treatments targeted all age classes of plants, while fall treatments focused on rosettes that did not bolt earlier in the season.

Attribute data for each site was entered in the field using a mobile phone application to document the locations of wild parsnip sites and control efforts. Data collected for each site included location, an estimate of the number of plants, acreage class, type of control used (chemical or manual), and the approximate amount of herbicide applied.

Results

Thirteen additional wild parsnip occurrences were detected in 2017 (Figure 10). Sites ranged from one to more than 1000 plants, and ranged from < 0.25 to nearly 1 acre. Eight sites were within the current control area (Vilas, Ashland and Bayfield Counties), with the other 5 sites in eastern Marathon and western Shawano counties. Sixty-nine sites were treated with herbicide, including 5 of the "new" sites. Figure 10 illustrates the distribution of detected occurrences and control efforts in 2017. Figures 11 and 12 show the abundance of wild parsnip at each treated site, and the amount of herbicide used at each site in 2016 and 2017.

Discussion

While GLIFWC lead the survey efforts for wild parsnip in 2017, follow-up treatment was conducted in cooperation with multiple partners. Ashland County LWCD treated some sites in the City of Ashland (with herbicide provided by GLIFWC). GLIFWC control staff assisted Iron County LWCD in treating a 2 mile long stretch of wild parsnip along State Highway 77 just east of Upson. Of the 69 sites that GLIFWC treated, 24 were treated in cooperation with Bad River Natural Resources staff on the Bad River reservation. GLIFWC crews treated 23 sites in Ashland County near the town of Marengo. Patches treated in 2017 were smaller on average than those treated in 2016 (Figure 11). Wild parsnip was not systematically surveyed for in 2017, but staff recorded 8 new sites in Ashland and eastern Bayfield counties, and 5 new sites in western Marathon and eastern Shawano Counties. Reports of new patches from cooperators seemed to be more frequent than in previous years though, and it seems likely that the extensive flooding across northern Wisconsin in 2016 facilitated the spread of this plant.

The populations documented in Marathon and Shawano Counties appeared to be only a small subset of the populations occurring in this part of the southern Ceded Territory. While control efforts in the established control area are likely to continue in 2018, it is unlikely that these new sites can be included in treatment efforts at this time.

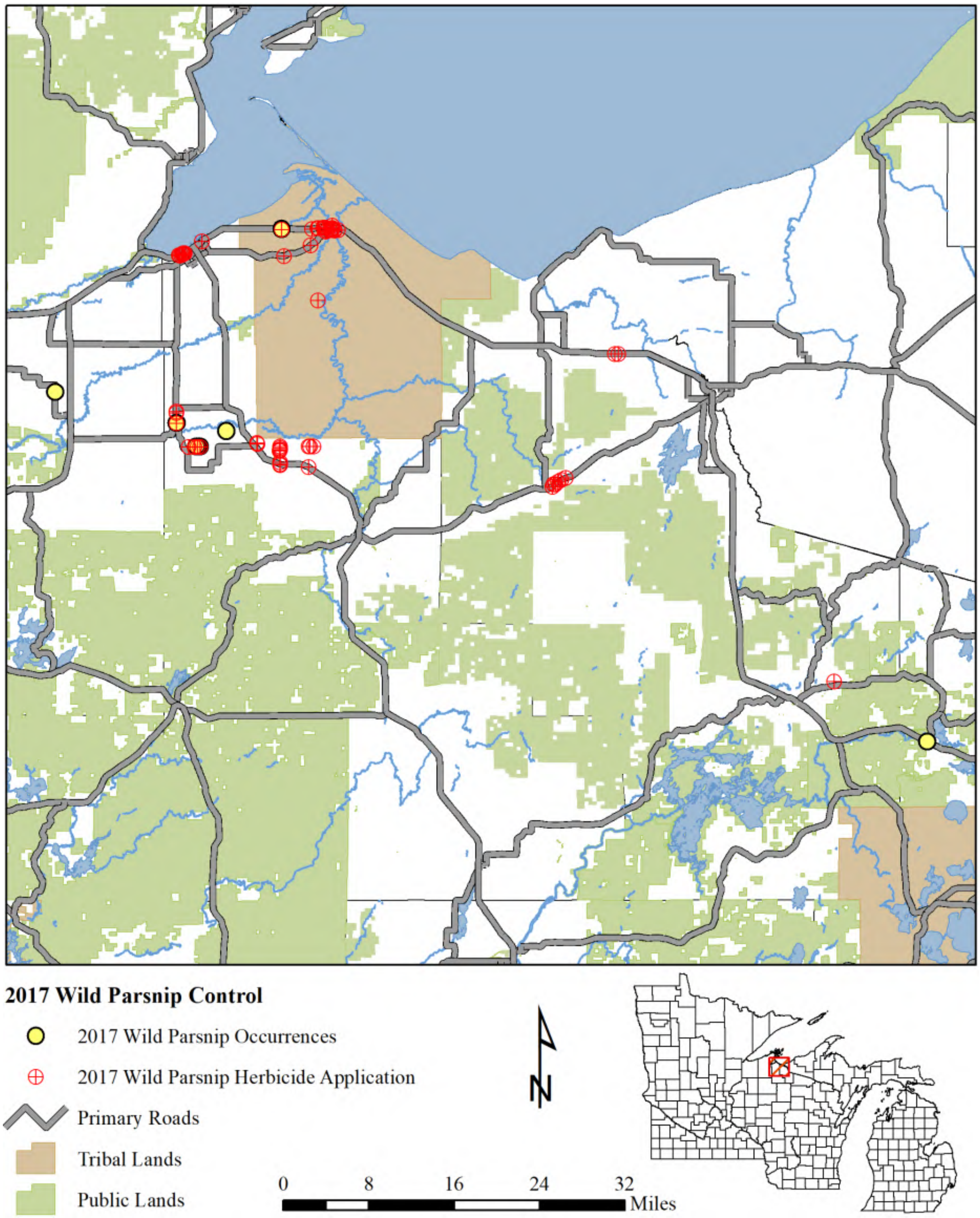

Figure 10: Wild parsnip occurrences and GLIFWC control sites in 2017.

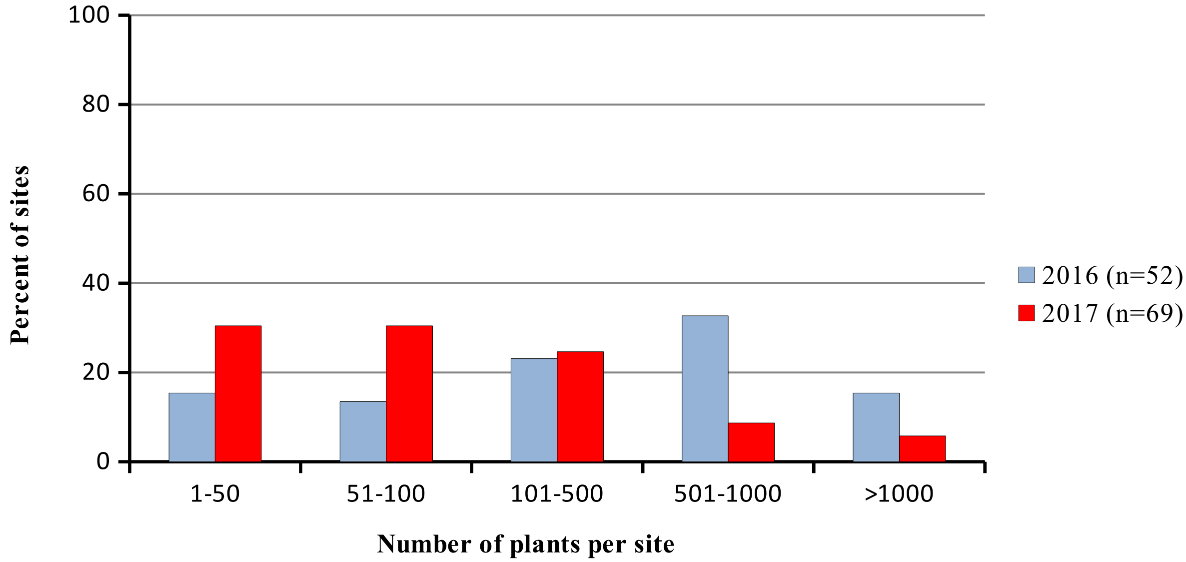

Figure 11. Abundance of wild parsnip at sites treated in 2016 and 2017.

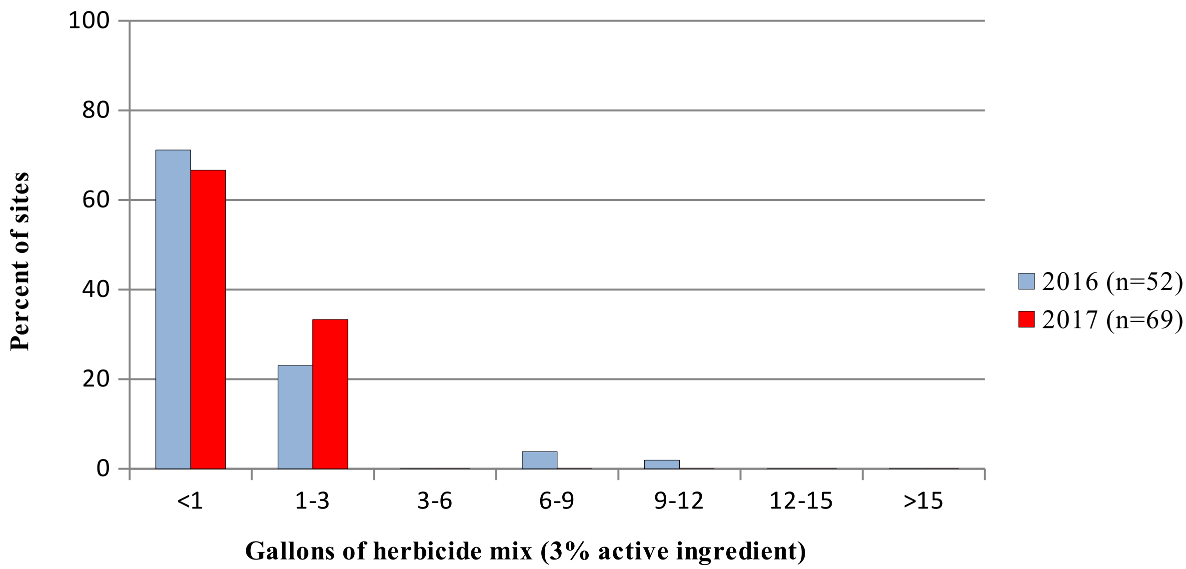

Figure 12. Amount of herbicide mix applied to wild parsnip sites treated by GLIFWC in 2016 and 2017.

YELLOW IRIS

Introduction

Yellow iris (*Iris pseudacorus* L.) is native to Europe (except Iceland), western Asia and North Africa, where it is typical of lowlands and coastal sites (Sutherland 1990). It arrived in North America by 1771, when it was recorded as being cultivated at Thomas Jefferson's home of Monticello in Virginia (Wells and Brown 2000). It is now widely introduced in North America, especially in the northeastern U.S. and the Pacific Northwest. In the upper Great Lakes region it is sporadically established, but often common where found.

Yellow iris is a rhizomatous perennial. Plants flower in May and June, typically producing 5-6 seed pods. Pods examined in two different unpublished studies averaged 32 and 46 seeds per pod (Sutherland 1990). In one experiment, seedlings grown from seeds collected the previous fall produced their first flowers three summers later (Dymes 1920). Seed viability is apparently high - viability of seeds from 20 Pacific Northwest populations averaged 99.1% (Gaskin et al. 2016).

While yellow iris colonies spread locally through rhizome expansion, long-distance dispersal appears to be almost entirely by seed (Gaskin et al. 2016). The seeds are capable of floating for more than 1000 hours (Coops and Van Der Velde 1995), providing ample opportunity for dispersal by wind and flowing water. Seeds can potentially be carried long distances by diving birds, which may pick them up on their backs when resurfacing (Dymes 1920). The primary method of introduction to new waterbodies is by gardeners "naturalizing" yellow iris plants on lakeshores and wetland edges.

In Europe, yellow iris is a dominant member of the *Iris pseudacorus* - *Filipendula ulmaria* mire community, which frequently includes purple loosestrife as well (Sutherland 1990). It often grows in saturated soils or in shallow water, and sometimes forms extensive vegetation mats over deeper water. While it is considered an obligate wetland plant, established plants are quite drought-tolerant, and are able to grow in dry sand (Dykes 1974, in Sutherland 1990). Yellow iris is highly tolerant of acidic soils, occurring at pH of 3.6-7.7 (Unit of Comparative Ecology, unpublished data, in Sutherland 1990). Yellow iris requires a fair amount of nitrogen (Ellenberg 1979, in Sutherland 1990), which may preclude it from invading fens and bogs. Typical habits include wet meadows, marshes, swamps, stream and riverbanks, lakeshores, and floodplain forests.

In England yellow iris readily colonizes areas sprayed for phragmites, forming exensive colonies (Sutherland 1990). Because it spreads well by seed, development of mature seed should be prevented as much as possible (Gaskin et al. 2016).

Yellow iris is established but not yet widespread in the Fish Creek slough of Chequamegon Bay of Lake Superior. It is listed as “restricted” under Wisconsin's NR 40 rule.

Methods

Locations of yellow iris sites were obtained from GLIFWC data and NCWMA cooperators. Yellow iris control in Chequamegon Bay began in 2014, when one site was treated. Ten sites were treated in the bay in 2016. Populations were controlled with herbicides. Isopropylamine salt of imazapyr (Polaris®) was used for chemically treating sites in 2017.

Attribute data for each site was entered in the field using the mobile phone application to document yellow iris patches and control efforts. Data collected for each site included location, an estimate of the number of plants, acreage class, type of control used (chemical or manual), and an estimate of the amount of herbicide applied.

Results

A total of 45 yellow iris sites were recorded in 2017 (Figure 13). One was within the Fish Creek slough and another was in a marsh bordering Chequamegon Bay. A third occupied a shallow roadside ditch on Madeline Island. The rest were distributed among three inland lakes (Table 3). A total of 29 sites were treated in 2017, with one of these sites treated manually. As in 2016, most “plants” consisted of clumps with an estimated 50 leaves/shoots or less, with a minority having 50-100 shoots (Figure 14). Less than one gallon of herbicide was used at each site.

Discussion

Because the number of yellow iris patches in the Fish Creek sloughs and Chequamegon Bay is still fairly limited, and patch size is still relatively small, yellow iris in the Bay will continue to be a priority for eradication. Populations on most inland lakes are also still relatively small and could be controlled. The greatest obstacle might be obtaining landowner permission to treat colonies on private lands, some of which are obviously being cultivated.

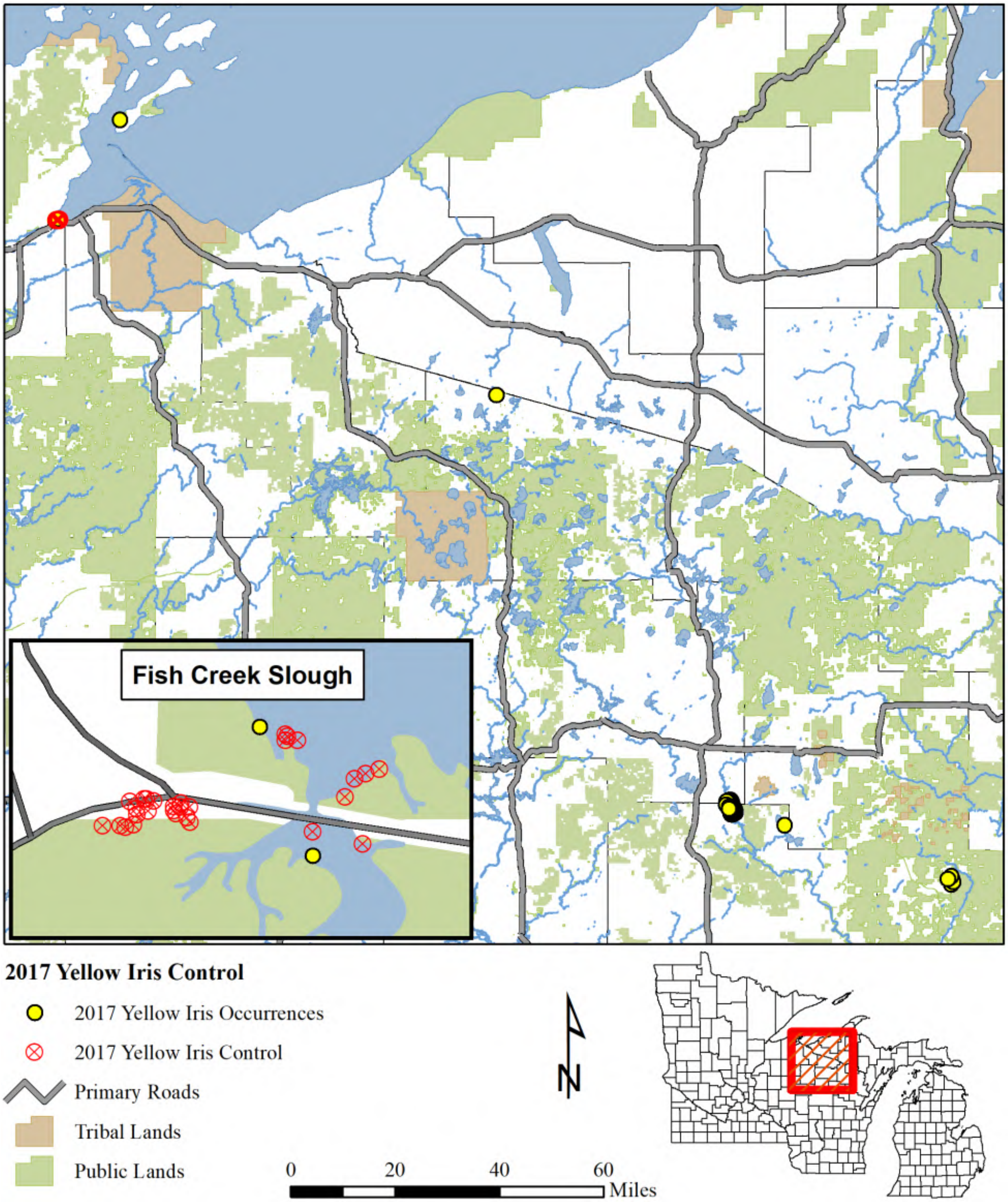

Figure 13: Yellow iris occurrences and GLIFWC control sites in 2017. The 2017 sites were found in late summer, after treatment efforts had been completed for the season.

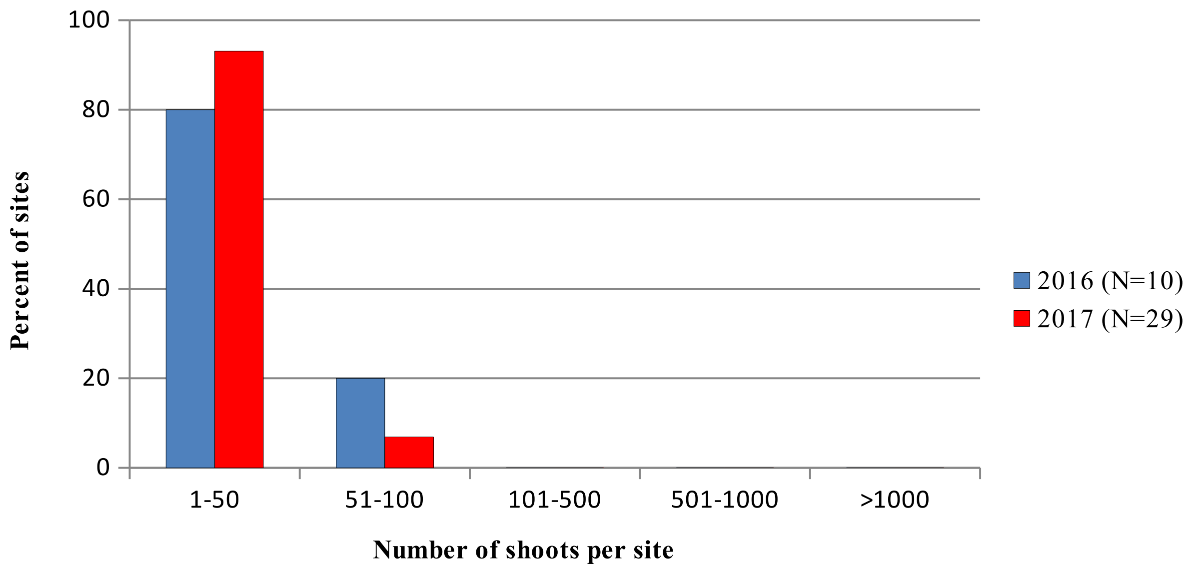

Figure 14. Abundance of yellow iris at sites treated in 2016 and 2017.

CONTROL AND MANAGEMENT

Once invasive species become widely established, the most effective action is to prevent their spread or minimize their impacts through control measures. Integrated pest management (IPM) uses the most effective method or combination of methods available, while attempting to minimize the cumulative environmental impacts of treatment. Methods may include manual, chemical and biological control. GLIFWC has included two plants in this category: garlic mustard and purple loosestrife.

Two staff members completed the Wisconsin State Pesticide Applicator Training and Certification (PAT) in “Aquatic and Mosquito”, and one staff member also completed PAT Training and Certification in ”Right-of-Way & Natural Areas.” One staff member also attended the NCWMA herbicide workshop in Ashland on April 11, 2017.

GARLIC MUSTARD

Introduction

Garlic mustard [*Alliaria petiolata* (Bieb.) Cavara & Grande] is a shade-tolerant, highly invasive forest herb native to Europe. All parts of the plant smell like garlic. It was likely introduced to North America by early European colonists as a medicinal and salad plant. First recorded outside cultivation on Long Island, New York in 1868 (Nuzzo 1993), it is now widely established and locally abundant in the eastern and midwestern US and in adjacent Canada, and occurs in scattered locations in western North America as well (USDA-FHTET 2014).

Garlic mustard is a strict biennial. In cold temperate climates including the Ceded Territory, most seeds lay dormant for about 20 months, germinating in early spring of the second year (Cavers et al. 1979). A small percentage of seeds may remain dormant for up to 5 years and possibly longer.

Garlic mustard plants spend their first year as rosettes, with each plant developing a slim white taproot that often forms a shallow "S" shape just below the base of the shoot. Rosettes bolt and flower in the spring of their second year, producing stalks up to 3 ft or more tall. Clusters of small, white, 4-petaled flowers are produced from mid-May through June, with seed pods ripening in June and early July. It is not unusual to see plants only two inches tall flowering and producing seed (S. Garske, pers. obs.).

Although tolerant of sunny habitats, garlic mustard grows best in light to moderate shade, and is quite capable of growing and reproducing in deep shade. It prefers moist, well-drained soil, but tolerates a wide variety of soil conditions from wet clay to well-drained sandy soil (Cavers et al. 1979). Like most mustard family (Brassicaceae) members it is intolerant of very acid soils, though (Grime et al. 1988). It does well on seasonally inundated habitats such as floodplains. Common habitats include moist to wet riverbanks, floodplains, woodland edges, and interior woods. In favorable habitats garlic mustard is a transformative species, forming nearly monotypic carpets that largely displace the native plant community, eliminating the food and habitat for native insects and other invertebrates, and altering the habitat for birds and mammals that depend on native ecosystems for survival (Nuzzo 1993).

Garlic mustard plants are green all their lives. The rosettes resume growth within days after snow melt, when most native forest plants are still dormant. Thus the two-week period just after snow melt is an excellent time to look for new patches, and to treat existing patches with herbicide.

Scattered small to moderate-sized populations of garlic mustard probably grow undetected across much of the Ceded Territory. GLIFWC invasive plant surveys in northern Wisconsin in the mid- to late 2000s revealed at least two dozen small patches growing in flowerbeds, in yards and adjacent woods, in campsites (usually at the back of the site, where people unload their equipment), and along back roads. Dozens of small sites have also been found in the Ottawa National Forest (ONF) and western Upper Michigan (Ian Shackleford, ONF botanist, pers. comm., S. Garske, pers. obs.). Eradication is possible at many of these sites, given landowner cooperation and a sustained effort over a period of years.

Large garlic mustard populations are apparently still rare in northern Wisconsin and Upper Michigan. Known infestations include one around the former WI DNR fish hatchery ponds on the northwest side of Presque Isle in Vilas County, Wisconsin, and another along the Montreal River, which forms the border of Wisconsin and Upper Michigan. A third occurs along the Bad River floodplain from upstream of Mellen to just downstream of Mellen, near the southern border of Copper Falls State Park. The Presque Isle population was treated by volunteers for a number of years, until the town began contracting with a professional weed control specialist. Garlic mustard numbers there have been reduced to a small fraction of what they once were, but the population has not been completely eradicated. The Montreal River population is being controlled by a coalition led by the Ottawa National Forest and the Iron County (WI) Land & Water Conservation Department, with GLIFWC, the WI DNR and volunteers assisting as well.

The Bad River population is the most extensive population known in northern Wisconsin. Since its discovery in 2007, a broad spectrum of groups and individuals including the WI DNR, GLIFWC, the NCWMA, Bad River Head Start students, school groups from Ashland and Mellen, and local volunteers have participated in controlling this infestation. The infestation has been controlled with manual pulling of second-year plants in spring, followed by spring herbicide treatment of particularly densely infested sites, and fall herbicide treatment of first-year rosettes. This effort has reduced the number of plants in the treatment area to a small fraction of what it was originally, and turned dense carpets of garlic mustard into scattered plants amid a diversity of mostly native vegetation. Unfortunately, despite the reduction in the number of plants, the total area infested by garlic mustard appears to be roughly the same (S. Garske, pers. obs.). Even more disappointing, a systematic survey for garlic mustard by GLIFWC in 2016 revealed extensive, previously undetected infestations for nearly three miles upstream of the treatment area.

Research into possible biological control organisms has resulted in the identification of four weevil species (Coleoptera: Circulionidae) that are host-specific and show promise of being effective in controlling garlic mustard (USDA-FHTET 2014). One of these, a root crown miner (*Ceutorhynchus scrobicollis*) was recommended for release by the USDA-APHIS Technical Advisory Group for Biological Control Agents of Weeds (TAG) in early 2017, but has not yet been approved for release in the United States (Van Riper et al 2017). Approval of this insect is likely in 1-2 years (Laura Van Riper, pers. comm. by email, December 11, 2017).

Methods

Surveys: GLIFWC staff resurveyed the approximately 70-acre main control area along the Bad River floodplain in the City of Mellen, in preparation for 2017 management efforts. Each site was flagged with two strips of flagging having the same site number. A mobile phone application was used to record the locations of garlic mustard sites, the estimated number of plants, and acreage class. GLIFWC shared distribution data with management partners and cooperators for coordinated management.

Control: Sites were manually controlled in spring by hand pulling second year plants, in order to reduce seed production at the site. Follow-up fall treatment was conducted by applying tryclopyr triethylamine salt (Renovate 3®) or sulfometuron methyl (Oust®) herbicide with backpack sprayers, targeting first-year rosettes after the native plants were dormant.

After manual control at each site, one site flag was (usually) removed. The second flag was removed after chemical control. The flagging was returned to the office, and the site numbers were documented in order to verify control of each site. (Participants occasionally removed both flags during manual control, which made follow-up treatment a bit more difficult.)

Results

A total of 82 garlic mustard sites were recorded on the Bad River floodplain. Manual control was conducted on 44 sites and chemical on 39 sites. (Some sites received both treatments.) Figure 15 illustrates the distribution of detected occurrences and control efforts in 2017.

Discussion

Until 2016 garlic mustard was considered an early detection rapid response species by GLIFWC. Due to the large area of infestation found upstream of the known infested area that year, eradication no longer seems feasible. This species poses huge potential impacts to treaty resources, so it will continue to be a high priority for management efforts including containment and eradication where possible.

While GLIFWC took the lead for survey and management efforts along the Bad River in Mellen and in the City of Ashland, NCWMA cooperators lead management efforts on multiple additional sites. GLIFWC staff assisted with spring manual control along the Montreal River in Iron County, Wisconsin and early fall treatment in Washburn near the Lake Superior shoreline.

Additional populations were documented in 2016. Sites were found at the City of Bayfield's composting facility, on the Red Cliff Reservation and near Lake Namekagon in Bayfield County. NCWMA cooperators are taking the lead monitoring and treating these sites.

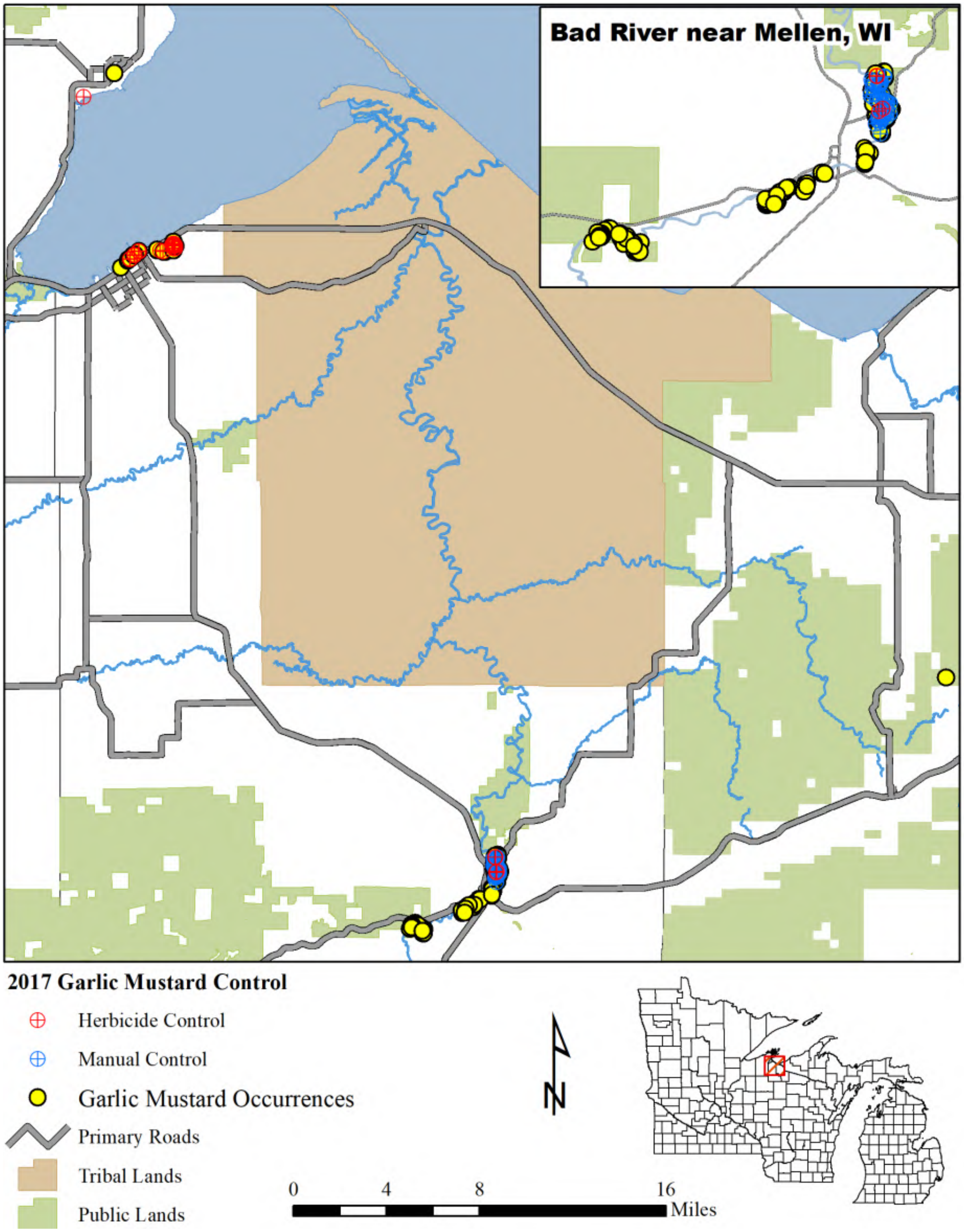

Figure 15: Garlic mustard occurrences and 2017 integrated management efforts.

PURPLE LOOSESTRIFE

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). It is currently distributed across much of the U.S. and southern Canada.

Purple loosestrife can germinate in moist, exposed soils. It tolerates a wide range of pH, nutrient, and light levels. Once established, seedlings can survive temporary flooding. The plant develops a large root crown and dense shoots that are square in cross-section, and can reach 2 m tall. The distinctive pink-purple spikes of 6-petaled flowers appear 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 high densities that they crowd out native vegetation. Except for two closely related species of *Galerucella* beetles (Coleoptera: Chrysomelidae), which have been widely released as biocontrols, 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 numerous insect, amphibian, mammal, and bird species that depend on healthy wetlands for their survival.

Methods

GLIFWC's integrated control efforts continue to focus on purple loosestrife within the Bad River/Chequamegon Bay watershed in northern Wisconsin (Figure 16). Small sites (< 0.5 acres) in upper reaches of the watershed were prioritized for chemical control. Control crews applied triclopyr (Garlon 3A® or Renovate®) to purple loosestrife plants. Renovate® is approved for over-water use and was used on sites with standing water, while Garlon 3A® was used where standing water was absent. Triclopyr is dicot-specific, allowing grasses and sedges to persist and re-colonize sites in a shorter time period. Chemical control efforts focused primarily on road rights-of-way between Mellen and Bayfield, Wisconsin. Private properties were also treated after consent forms were signed by the landowner.

Large sites (> 1 acre) and sites with poor access were a 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. GLIFWC has been rearing and releasing *Galerucella* beetles and collecting and redistributing them within the watershed since 2000. Release sites from prior years were visited in late summer to ascertain overwinter survival and to take site photos documenting the effects of beetle herbivory.

Treated sites were mapped using a mobile phone application to document the locations of purple loosestrife sites and control efforts. Attribute data collected for each site included an estimate of the number of plants, acreage class, type of control used (chemical or biological), and an estimate of the amount of herbicide applied.

Results

In 2017, GLIFWC staff treated 139 purple loosestrife sites with herbicide and one site manually. Figure 17 shows the decrease in patch size from 2012 through 2017. Figure 18 shows the decrease in amount of herbicide mix being applied per patch of purple loosestrife from 2012 through 2017. Biological control efforts since 2000 have established over 60 *Galerucella* populations throughout the Bad River - Chequamegon Bay watershed, and site visits continue to document their impacts. Time series photos (Figures 19-21) illustrate the effectiveness of *Galerucella* beetles in substantially reducing the abundance of loosestrife at three northern Wisconsin sites.

Discussion

The use of biological controls has allowed GLIFWC's control crew to place greater emphasis on treating small populations with herbicide before they become significant source populations (Figure 18). This strategy also reduces the amount of herbicide applied at each site (Figure 18). Biological control has been effective at most sites throughout the watershed, although results vary with loosestrife population size, disturbance, native seed bed quality, weather, and wetness of the site. While *Galerucella* beetles will not eliminate loosestrife from the landscape, they can greatly reduce its density and abundance, and its impacts on natural ecosystems and native species.

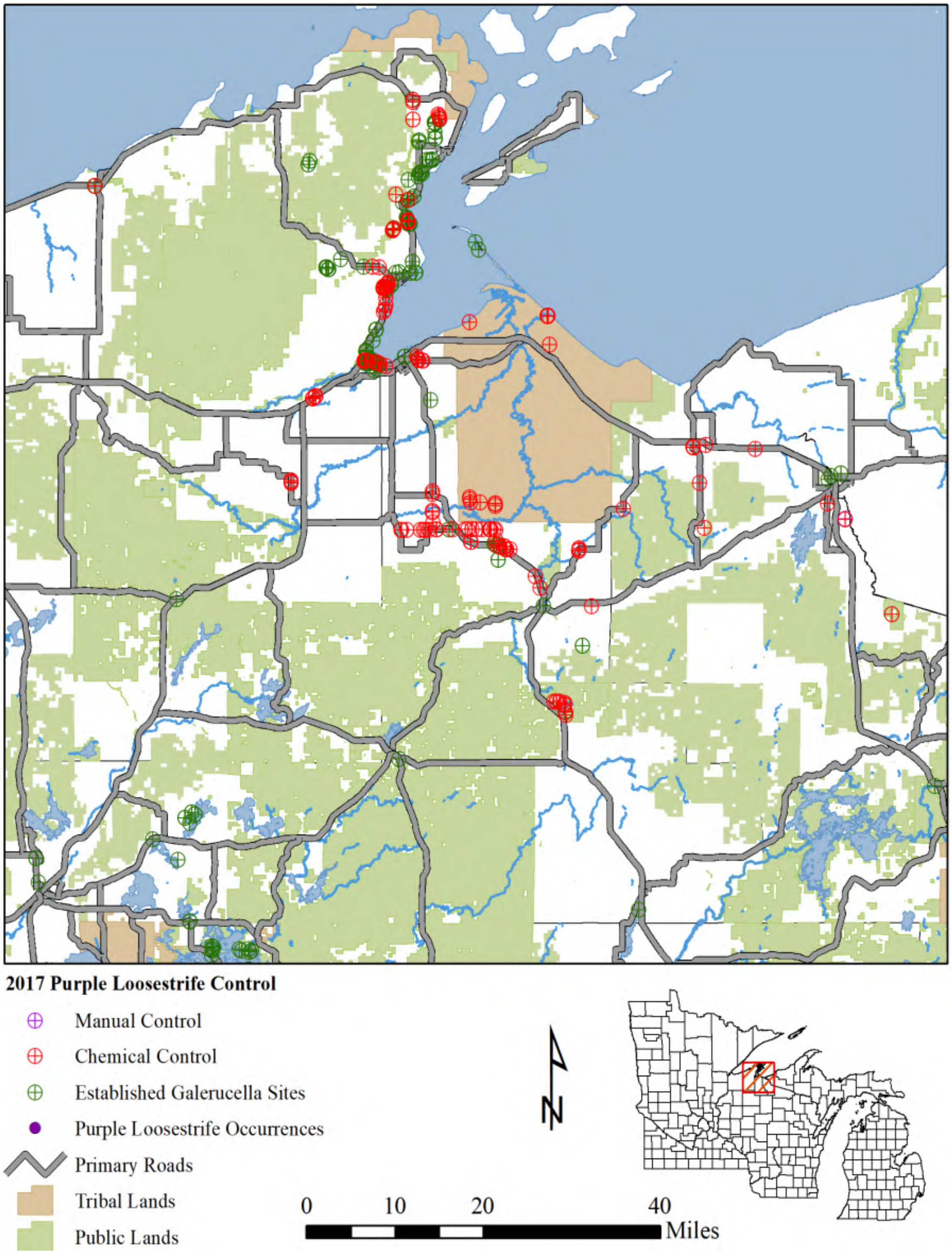

Figure 16. Purple loosestrife distribution and GLIFWC control efforts in 2017.

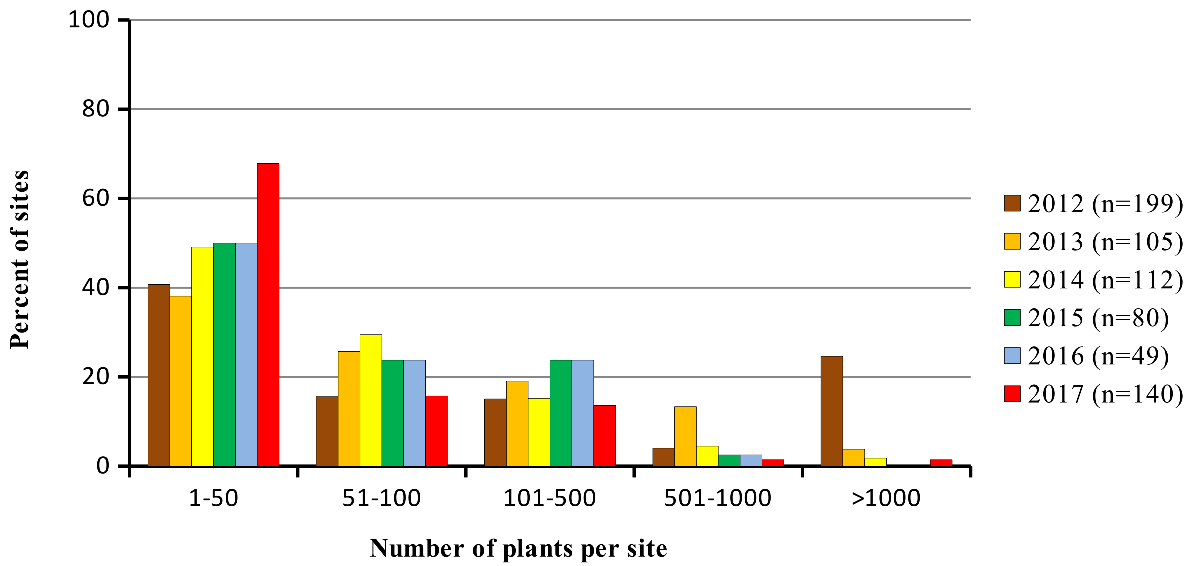

Figure 17. Purple loosestrife abundance at sites treated in 2012-2017.

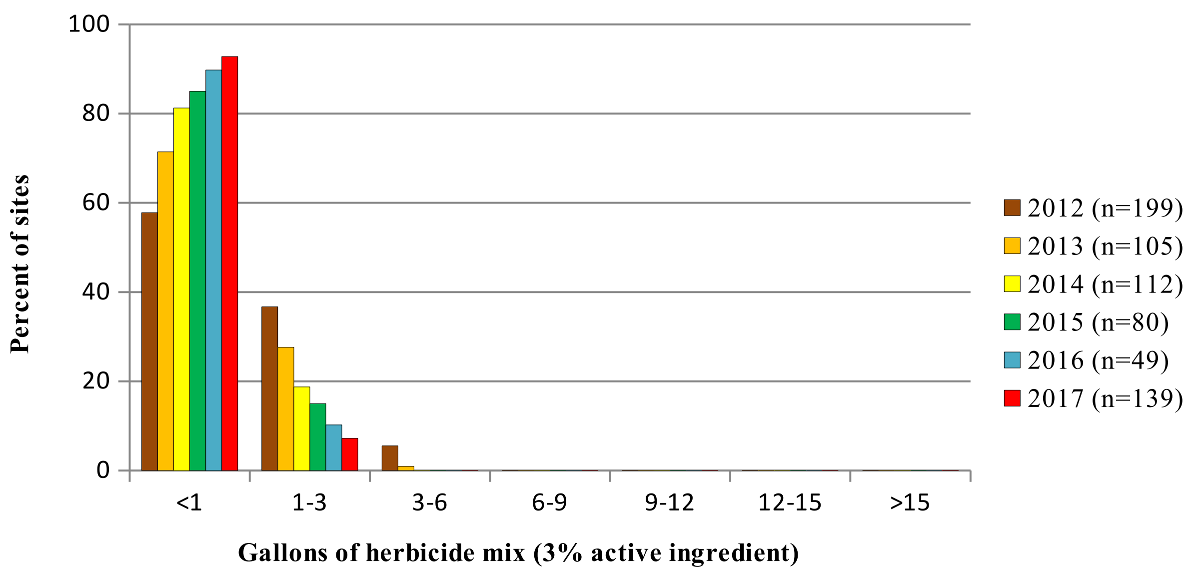

Figure 18. Amount of herbicide mix applied to purple loosestrife sites, 2012-2017. (One 2017 site that was treated manually was omitted.)

Figure 19: *Galerucella* release site west of Bayfield, Wisconsin.

Figure 20: *Galerucella* release site. Port Superior, south of Bayfield, Wisconsin.

Figure 21: *Galerucella* release site. County Highway J near Bayfield, Wisconsin.

RESEARCH AND TRAINING

Introduction

New invasive species continue to be introduced to the Ceded Territory, and new management techniques continue to be developed to reduce their spread. Research is required to address gaps in knowledge as they become evident, especially with respect to understanding potential impacts of invasive species and identifying or informing selection of cost-effective management actions.

Accomplishments

Activities in 2017 included:

- Staff attended several conferences and workshops to stay informed of new invasive species making their way to the Ceded Territories, new prevention and monitoring measures, and research and management techniques. Events attended included:
  - Emerald Ash Borer Information Workshop, sponsored by the WI DNR. January 25, 2017, Hayward, WI.
  - Herbicide Use Training and Invasive Plant ID Workshop. April 11, 2017, Ashland WI.
  - Phragmites Open House. April 20, 2017, Duluth, MN.
  - 2017 Wisconsin AIS Partnership Meeting, sponsored by the WI DNR. November 1-2, Stevens Point, WI.

- Staff obtained and reviewed various reports, management plans, and peer-reviewed scientific literature on invasive plant biology, ecology, distribution and control. These publications were primarily obtained from online sources, and accessioned into a literature database using ProCite 5.0 software.

COOPERATION AND COORDINATION

Introduction

Because invasive species disperse widely across the landscape and administrative boundaries, it is necessary to work cooperatively to achieve success. 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 activities with invasive species management partners to maximize the efficient use of limited resources. Management partners include Tribes, U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, state agencies, county governments, municipalities, universities, and non-government organizations.

Accomplishments

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

Northwoods Cooperative Weed Management Area (NCWMA): Formally established in 2006, the NCWMA provides a forum to share information, collaborate on planning and cooperate on management activities in Douglas, Bayfield, Ashland, and Iron Counties in northern Wisconsin. In 2017, GLIFWC staff worked with NCWMA partners to organize the spring garlic mustard control week in Ashland County and helped with garlic mustard control activities in Iron County, Wisconsin. Staff shared herbicide with partners for wild parsnip control activities. Staff also helped monitor and control giant hogweed sites and participated in wild parsnip control efforts in Iron County. GLIFWC staff assisted in choosing the location for the garlic mustard boot brush station, at the boardwalk trailhead across the street from the Secondary School in Mellen, to prevent the spread of garlic mustard. (This trail runs through a scenic and biologically diverse floodplain swamp to the Bad River.)

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 WI DNR on AIS issues. Staff is working with partners to update this plan, with an anticipated completion date in mid-2018.

Wisconsin Headwaters Invasives Partnership (WHIP): Formally established in 2010, WHIP provides a forum to share information, collaborate on planning, and cooperate on management activities in Vilas and Oneida Counties in northern Wisconsin. GLIFWC has a history of surveying inland waters in Vilas and Oneida Counties for AIS and sharing the findings with WHIP partners.

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.

Phragmites Management and Cooperation in the Lower St. Louis River Estuary: In 2014, GLIFWC staff facilitated a multi-agency meeting to share survey results and coordinate follow-up monitoring and control efforts for non-native phragmites along the Lower St. Louis River. In 2016, GLIFWC staff continued to work cooperatively to manage non-native phragmites along the St. Louis River Estuary. GLIFWC staff were instrumental in the creation of a new partnership with the Minnesota DNR, 1854 Treaty Authority, Fond du Lac Band, and St. Louis River Alliance to plan and conduct phragmites control efforts on the Minnesota side of the St. Louis River Estuary. In 2017, staff conducted follow-up monitoring and treatment of sites on the Wisconsin side of the Estuary. GLIFWC staff are members of the technical advisory team overseeing the planning and management activities on the Minnesota side. GLIFWC staff also created a database application to better manage and share information with technical team partners. Data includes non-native phragmites site information, monitoring, management efforts, contacts and landowner permissions.

Lake Namekagon aquatic plant management meeting: GLIFWC staff attended the first Lake Namekagon aquatic plant management meeting, held by the WI DNR in 2017. In late 2017, one staff member accepted an invitation to serve on the Lake Namekagon Lake Association's Aquatic Plant Management Planning Committee.

maps.glifwc.org: The goal of this project is to facilitate collaboration by providing a common communications infrastructure. maps.glifwc.org provides a portal for viewing invasive species distribution and management in the context of the Ceded Territories and other GIS layers relevant to GLIFWC's member tribes such as *manoomin* and *ogaa* waters.

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