

Invasive Species Management Plan for the Boardman River (Brown Bridge Pond to Union Street Dam)

Prepared for:
Grand Traverse Band of the Ottawa and Chippewa Indians



Funding for this project provided by:
Bureau of Indian Affairs, Great Lakes Restoration Initiative Grant

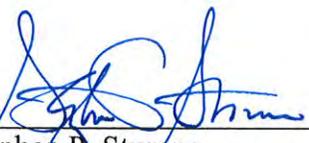


Prepared by:
AMEC Environment & Infrastructure, Inc.



December 14, 2011

Project No. 3310110003.0002


Stephen P. Stumne
Principal Scientist
12/14/2011
Date

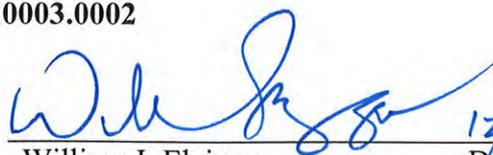

William J. Elzinga
Senior Principal
12/14/2011
Date

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
1.1	Project Description and Purpose	1
1.2	Invasive Species Definition	1
1.3	Management Goals	3
2.0	AQUATIC INVASIVE SPECIES.....	4
3.0	TERRESTRIAL INVASIVE SPECIES.....	6
4.0	MANAGEMENT OBJECTIVES	8
4.1	Aquatic Invasive Species	8
4.2	Terrestrial Invasive Species	9
5.0	CONTROL PLANS FOR INVASIVE PLANT SPECIES	11
6.0	REFERENCES.....	17

TABLES

Table 3-1	Regional Invasive Plant Species	7
Table 5-1	Herbicide Control of Invasive Vegetative Species	16

FIGURES

Figure 1-1	Boardman River Overview	2
------------	-------------------------------	---

APPENDICIES

Appendix A	Invasive Species Profiles.....	19
Appendix B	Compliance Log	40

List of Abbreviations and Acronyms

AOSTA	Association of Seed Technologists and Analysts
MDNR	Michigan Department of Natural Resources
GTB	Grand Traverse Band of the Ottawa and Chippewa Indians
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1.0 INTRODUCTION

1.1 Project Description and Purpose

AMEC Environment & Infrastructure, Inc. (AMEC) has prepared this Invasive Species Management Plan for the Grand Traverse Band of the Ottawa and Chippewa Indians (GTB) in conjunction with their Boardman River Dams Removal Project. Dam removal will create opportunities for invasive species to become established. In particular, dam removal will create large expanses of previously inundated and un-vegetated soils that may be colonized by invasive plant species which may out-compete desirable native plant species. Furthermore, the change in aquatic habitat type from reservoir to free-flowing river may also provide opportunities for aquatic invasive species to become established or spread. This plan identifies and prioritizes species to be controlled and provides the methods and procedures for control of invasive species during dam removal and subsequent river/floodplain restoration.

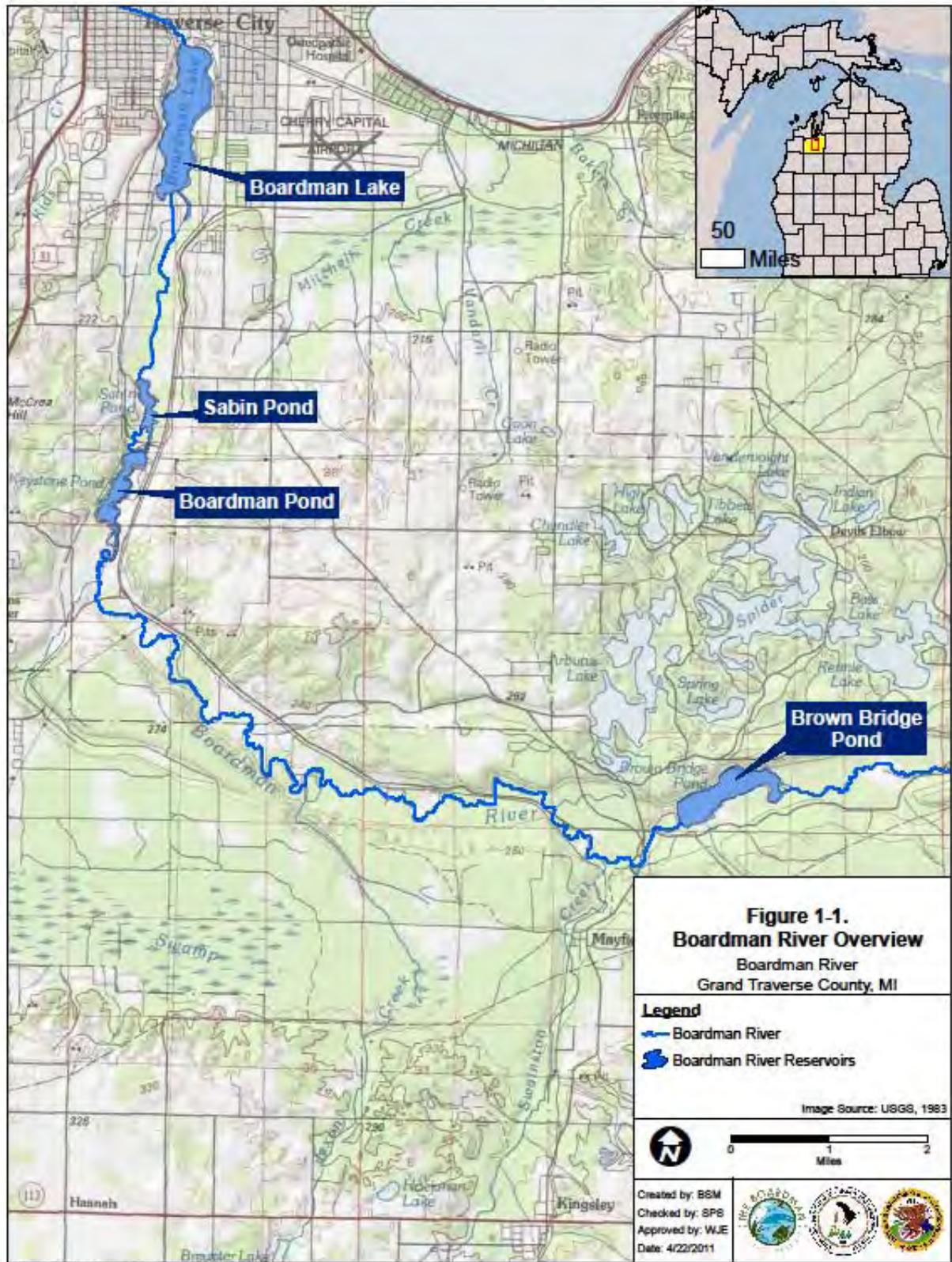
The Boardman River is located in Grand Traverse and Kalkaska counties in the northwestern portion of Michigan's Lower Peninsula. Its headwaters are formed in the Mahan swamp in north central Kalkaska County and flows in a southwesterly direction for approximately 40 miles. Turning north for nine miles, it empties into Grand Traverse Bay at Traverse City [Michigan Department of Natural Resources (MDNR), 2002].

The Boardman River watershed drains a surface area of approximately 291 square miles and includes 179 lineal stream miles and 12 natural lakes [U.S. Army Corps of Engineers (USACE), 2006]. The project area is an approximate 20-mile section of the Boardman River's main stem in Grand Traverse County from the upper reaches of Brown Bridge Pond to Union Street Dam. Four reservoirs are located on the Boardman River within the study area as depicted in Figure 1-1. Brown Bridge Pond, Boardman Pond (aka Keystone Pond), Sabin Pond, and Boardman Lake are located approximately 18.5, 6.1, 5.3, and 1.5 river miles, respectively, upstream from the river's mouth in Grand Traverse Bay.

The study area is characterized by glaciated topography and sandy soils. Areas immediately adjacent to the river contain tag alder, willows and dogwood with varying mixtures of cedar, balsam, hemlock, tamarack, aspen and white birch. Upland areas adjacent to the river contain red oak, red maple, aspen and jack pine with large white pines and red pine scattered throughout both the upland and lowland areas (MDNR, 2002).

1.2 Invasive Species Definition

Non-native species are those species that arrived in and colonized an area only with direct or indirect human assistance, even if they are native elsewhere in the state. Non-native species may also be called "non-indigenous", "alien", "exotic", "adventive" or "naturalized" species. Invasive species, as defined by Executive Order 13112, includes alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. According to Executive Order 13112, each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, prevent the introduction of invasive species; detect and control populations of such species; monitor invasive species populations; and provide for the restoration of native species in ecosystems that have been invaded.



1.3 Management Goals

Because reservoir drawdown, dam removal, and subsequent ecosystem restoration will result in large areas of newly exposed soil, this Invasive Species Management Plan will focus on these bottomland areas. Upland areas above the existing reservoirs will be considered in the context of invasive species seed sources. Goals of this plan include:

- Prioritize invasive species based on site characteristics, species characteristics, and likelihood of successful control.
- Prevent new infestations and target existing high priority infestations to minimize invasive species' seed source for disturbed and newly exposed soils.
- Restore a natural river system while eliminating or minimizing colonization or spread of invasive species. Species targeted for control include those determined in Table 3-1 to be high priority species (those most disruptive and likely to affect the most valued areas).
- Restore native wetland and floodplain plant communities suitable for native wildlife and human recreation while eliminating or minimizing establishment of invasive plant species. Prioritization should be given to native species from the region to preserve local genotypes. Species targeted for control include those that may threaten the establishment and dominance of native matrix plant species.
- Establish erosion control and soil conservation measures by providing appropriate native vegetative cover in areas previously inundated by the reservoirs.
- Maintain high quality habitat for listed species of conservation concern focusing on the many known natural features in the study area such as those outlined in the 2002 Brown Bridge Quiet Area Management Plan and the 2009 Natural Education Reserve Management Plan (encompasses Sabin and Boardman Ponds).
- Identify and maintain high quality habitat restored after drawdown and dam removal through both active and passive restoration methods that incorporate particular focus on plants and communities that are of traditional cultural significance to the Grand Traverse Band of the Ottawa and Chippewa Indians and other Tribal people in the Region.

2.0 AQUATIC INVASIVE SPECIES

Several aquatic invasive species are known to exist within Grand Traverse Bay including the sea lamprey (*Petromyzon marinus*), fishhook water flea (*Cercopagis pengoi*), rusty crayfish (*Orconectes rusticus*), spiny water flea (*Bythotrephes cederstroemi*), Eurasian ruffe (*Gymnocephalus cernuus*), alewife (*Alosa pseudoharengus*), and Eurasian water milfoil (*Myriophyllum spicatum*). The USACE has expressed concern regarding the potential removal of Union Street Dam and subsequent migration of aquatic invasive species from Grand Traverse Bay into the Boardman River system (USACE, 2006).

For the purpose of this plan we are assuming that Union Street Dam will not be removed. As such, this plan does not address the aquatic invasive species listed above, with the exception of the sea lamprey. Sea lamprey have already been discovered upstream of Union Street Dam, thus they are included in the discussion below. Should Union Street Dam be modified or removed, appropriate invasive species control measures will be identified and implemented.

Union Street Dam historically served as a lamprey barrier but several year classes of larval sea lamprey were discovered in the Boardman River between Union Street Dam and Sabin Dam in the fall of 2010. Investigation to identify how sea lamprey traversed this historical barrier is ongoing (Adair, 2010).

The sea lamprey (*Petromyzon marinus*) is an anadromous fish species that was inadvertently introduced into the Great Lakes through shipping canals in the early 1900s (GLFC, 2011). Its normal life cycle is for adults to migrate from the ocean into fresh water to spawn, dying soon afterward (USFWS, 2011). In the Great Lakes, spawning runs take place from April to July (Carlander, 1969). Eggs hatch about two weeks after spawning, and the larvae drift downstream and burrow into depositional areas (UMN, 2011). Larvae feed on detritus and algae for up to 10 years (average three to six years) until they transform into the parasitic adult (GLFC, 2011). These individuals attach to a host fish and extract blood and other body fluids. In the normal life cycle, the parasitic phase is in the ocean and lasts for approximately one to two years (UMN, 2011). In the Great Lakes, however, their voracious feeding behavior has been destructive to the native fish populations. They were considered the major cause of the collapse of the lake trout, whitefish, and chub fisheries in the Great Lakes during the 1940s and 1950s (USGS, 2011). A profile of the sea lamprey is provided in Appendix A.

Zebra mussels (*Dreissena polymorpha*) are known to exist in Boardman Lake and Brown Bridge Pond (ECT, 2009). Because of their ability to disrupt ecosystem food webs, to form monocultures on hard substrates, to replace native aquatic organisms, and their presence in the Boardman River system, zebra mussels are addressed herein.

Zebra mussels are native to the Black and Caspian Sea but spread throughout Western Europe in the 19th century and subsequently arrived in the U.S. in the ballast of a transatlantic ship. They were first identified in 1988 in Lake St. Claire in Michigan, which connects Lake Huron and Lake Erie. By 1990 zebra mussels were found in all five Great Lakes and within a few short years had spread to the Illinois, Mississippi, Tennessee, Cumberland, Arkansas, Hudson, and Ohio River basins (Benson and Raikow, 2011).

Adult zebra mussels grow to 2 inches in length and form dense colonies of as many as 700,000 individuals per square meter. Colonies form on any hard surface, whether living or inanimate. The U.S. Fish and Wildlife Service (USFWS) estimated \$5 billion in economic impact over a ten-year period.

Costs are associated with activities such as cleaning and maintenance of water intake pipes, removal of shell buildup on recreational beaches, and general control efforts (Benson and Raikow, 2011).

Zebra mussels can have profound effects on the ecosystems they invade. They primarily consume phytoplankton, but other suspended material is filtered from the water column including bacteria, protozoans, other micro-zooplankton, and silt. Reductions in zooplankton biomass may cause increased competition, decreased survival and decreased biomass of larval fish and adult planktivorous fish. Other effects include the extirpation of native unionid clams through epizootic colonization (Schloesser et al. 1996, Baker and Hornbach 1997). A profile of the zebra mussel is provided in Appendix A.

3.0 TERRESTRIAL INVASIVE SPECIES

The Grand Traverse Conservation District has plans to inventory and map populations of invasive plant species within the study area during the summer of 2011. Results of this study may be useful in the development of revised and more specific control strategies for high priority invasive plant species.

The Grand Traverse Regional Invasive Species Network (GTRISN) has provided a list of invasive plant species across a five county region including the counties of Benzie, Leelanau, Grand Traverse, Antrim, and Charlevoix (Table 3-1). Although GTRISN did not identify spotted knapweed (*Centaurea stoebe*) in their list, it was added to Table 3-1 as recommended by the Grand Traverse Conservation District (GTCD).

Based on input from the GTCD, the species in Table 3-1 were assigned a priority level – low, medium or high – wherein “high” represents the species most likely to invade and become problematic in the bottomland areas following drawdown and dam removal. Invasive species are considered “high” priority based on characteristics that render them problematic – such as high seed production or capability to spread readily from rhizomes – and based on known populations in the vicinity of the Boardman River Dams Removal Project. In contrast, “low” priority species are those that are not expected to become problematic due to lack of suitable habitat or lack of known seed sources or parent material near the project area.

Species profiles are provided in Appendix A. Management of these species is addressed Section 4.0 based on assigned priority level.

Table 3-1 Regional Invasive Plant Species

Botanical Name	Common Name	Priority Level¹
<i>Berberis thunbergii</i>	Japanese barberry	H
<i>Centaurea stoebe</i>	Spotted knapweed	H
<i>Cirsium arvense</i>	Canada thistle	H
<i>Cirsium palustre</i>	European swamp thistle	H
<i>Cirsium vulgare</i>	Bull thistle	H
<i>Elaeagnus umbellata</i>	Autumn olive	H
<i>Euphorbia esula</i>	Leafy spurge	H
<i>Frangula alnus</i>	Glossy buckthorn	H
<i>Lonicera spp.</i>	Honeysuckles	H
<i>Lythrum salicaria</i>	Purple loosestrife	H
<i>Pastinaca sativa</i>	Wild parsnip	H
<i>Phalaris arundinacea</i>	Reed canary grass	H
<i>Phragmites australis</i>	Phragmites (non-native)	H
<i>Polygonum cuspidatum</i>	Japanese knotweed	H
<i>Polygonum sachalinense</i>	Giant knotweed	H
<i>Rhamnus cathartica</i>	Common buckthorn	H
<i>Typha angustifolia</i>	Narrow-leaved cattail	H
<i>Alliaria petiolata</i>	Garlic mustard	M
<i>Celastrus orbiculatus</i>	Oriental bittersweet	M
<i>Elaeagnus angustifolia</i>	Russian olive	L
<i>Gypsophila paniculata</i>	Baby's breath	L
<i>Hesperis matronalis</i>	Dame's rocket	L
<i>Leymus arenarius</i>	Lyme grass	L
<i>Rosa multiflora</i>	Multiflora rose	L

List Source: Grand Traverse Regional Invasive Species Network and Grand Traverse Conservation District

¹ Priority Levels are based on species characteristics and presence/absence in project vicinity; Priority Levels are tentative and subject to change based on inventory/survey results

4.0 MANAGEMENT OBJECTIVES

4.1 Aquatic Invasive Species

Sea Lamprey

Control of the sea lamprey was one of the reasons for forming the Great Lakes Fishery Commission, and the efforts of numerous agencies have resulted in a significant reduction of its populations in many areas (GLFC, 2011). Integrated control efforts have consisted of several elements: field assessment, chemical lampricide application, construction of barriers or traps, and release of sterile males into the population (NYSDEC, 2011).

Specific management objectives for sea lampreys include modification of the existing fish ladder at Union Street Dam to provide a more reliable lamprey barrier, and treatment with lampricide as necessary based on periodic monitoring results. Plans for modification of the fish ladder at Union Street Dam are an integral part of the Boardman River Dams Removal Project. Modifications would include elements that allow only strong jumping species to pass thereby preventing sea lamprey passage. In addition, the Boardman River between Sabin Dam and Boardman Lake was surveyed and treated with lampricide in the fall of 2010 – the first treatment in the upper Boardman River since 1987 – and is scheduled for retreatment in 2011 (Adair, 2011). The combination of barrier modification at Union Street Dam, lampricide application, and follow up monitoring are considered the most practical and effective management options for sea lamprey in the Boardman River.

Zebra Mussel

According to the USACE (2006), damming the Boardman River has allowed the exotic zebra mussel to inhabit Boardman Lake and Brown Bridge Pond. Removal of Brown Bridge, Boardman, and Sabin dams may limit zebra mussel colonization to Boardman Lake (providing Union Street Dam remains intact) since the Boardman River mainstem may not provide optimal habitat (USACE, 2006).

Based on this assumption, and because total eradication of zebra mussels is nearly impossible without damage to native species, specific management objectives for zebra mussels include monitoring the existing zebra mussel population in the Boardman River immediately downstream of Brown Bridge Pond prior to and following dam removal to evaluate their continued existence and potential need for specific management in the free-flowing river. Because the lentic conditions in Brown Bridge Pond are likely increasing the particulate food supply in the free flowing river immediately downstream of the dam, dam removal may result in a population decline or complete removal of zebra mussels in this reach of the river following restoration. Monitoring activities should delineate (using GPS) the downstream edge of the colony in the baseline condition (prior to dam removal) and monitoring should continue for five consecutive years following dam removal to document colony status in the river.

Dam removal itself will occur in a manner that will limit dispersal of organisms. As the colonized concrete slabs are removed using traditional construction equipment, the concrete will be immediately removed to upland locations for interim storage or to truck beds for disposal in appropriate upland demolition disposal facilities. Dam debris containing zebra mussels will not be stockpiled, temporarily stored, or otherwise returned to aquatic ecosystems. Construction equipment including tracks, buckets and tires of track hoes, dozers, high lifts, and haul trucks, will be thoroughly cleaned (high-pressure spray with hot water) before entering work zones and upon exiting to limit dispersal of zebra mussels to other

inland waters. An example compliance log is provided in Appendix B and is intended for use during project implementation.

Zebra mussels normally require a threshold temperature of 12°C or 54°F to initiate spawning, although in the Great Lakes spawning has been observed in water temperatures of 10°C or 50°F (Bartell et al. 2007). Brown Bridge Dam is tentatively scheduled for demolition and removal in 2012. As such, in order to prevent the existing colony within the dam from spawning in the dam's final year of existence, dam removal would need to be completed no later than early spring of 2012. However, if zebra mussels don't survive the free flowing river conditions without the artificial increase in particulate food supply from the pond, seasonal timing of dam removal becomes irrelevant.

Any boats that may be used in research, monitoring, demolition of dam facilities or general work on the reservoirs shall have bilge water and live wells drained/cleaned and the hulls and trailers shall be thoroughly cleaned prior to entering and leaving the site.

4.2 Terrestrial Invasive Species

Priority levels for invasive plant species are tentative and subject to change based on the results of the inventory/survey for invasive plant species scheduled for summer 2011. Regardless of priority level, prevention is to be stressed over treatment. All off-road construction equipment – including track hoes, dozers, high lifts, skid steers, haul trucks, water trucks, mowers, and pick-up trucks if taken off road – is to be thoroughly inspected prior to commencement of work. Any signs of plant material, mud or other debris that could contain seed or viable plant material from another job site will be reason for rejection of equipment. Equipment will then be power washed clean at an off-site facility prior to entry into work zones. An example compliance log is provided in Appendix B and is intended for use during project implementation.

Access routes and construction laydown areas should not be sited within areas known to contain invasive species. Inputs to this process will include the results of the inventory/survey for invasive plant species scheduled for summer 2011.

In order to prevent infestations of invasive plant species on bare soils it will be imperative to quickly establish native vegetative cover following drawdown and dam removal activities. This will be hastened by active restoration of the site when planting native grasses and/or temporary annual cover. To avoid weed seed contamination, a certified seed laboratory should test each seed lot against the State noxious weed list using Association of Seed Technologists and Analysts (AOSTA) standards, and provide documentation of the seed inspection test. Passively managed restoration areas that completely rely on natural succession are considered higher risk areas for infestations of invasive plant species.

Application of topsoil and natural soil amendments, such as compost, are common practices used to hasten restoration success in otherwise infertile soils. Topsoil should not be used unless the source location and site vegetation are known. Specific discussion has focused on the possibility of using municipal leaf compost to amend sandy soils during restoration following dam removal along the Boardman River. Such compost is known to contain weed seed of species such as black locust (*Robinia pseudoacacia*) and leafy spurge (*Euphorbia esula*). Areas where compost is utilized should be tracked and routinely inspected for the presence of invasive species. Management practices described herein should be implemented to minimize and/or eliminate the presence of invasive plant species on restoration sites following dam removal.

In the case of aggressive invasive species, it may be necessary to eradicate the species to the extent possible. Other invasive species should be monitored carefully to identify any increase in abundance or cover at the expense of desirable native species. As such, the management approach may change for a given invasive species over time.

High Priority Terrestrial Invasive Species

High priority herbaceous invasive plant species include spotted knapweed (*Centaurea stoebe*), Canada thistle (*Cirsium arvense*), European swamp thistle (*C. palustre*), bull thistle (*C. vulgare*), leafy spurge (*Euphorbia esula*), purple loosestrife (*Lythrum salicaria*), wild parsnip (*Pastinaca sativa*), reed canary grass (*Phalaris arundinacea*), Phragmites (*Phragmites australis*), Japanese knotweed (*Polygonum cuspidatum*), Giant knotweed (*P. sachalinense*), and narrow-leaved cattail (*Typha angustifolia*). As such, there are 11 high priority herbaceous invasive plant species documented herein. In addition, five high priority woody invasive plant species are identified including Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), honeysuckles (*Lonicera spp.*), common buckthorn (*Rhamnus cathartica*), and glossy buckthorn (*Frangula alnus*).

Because high priority invasive plant species have the potential to directly interfere with the management goals identified herein, specific objectives have been established. Measurable objectives for high priority invasive plant species include:

- Provide at least annual surveillance to identify new populations, expanding populations, and to determine the effectiveness of prior treatment and management.
- Annually treat all populations of high priority invasive species on the bottomlands and seed sources in surrounding parklands with appropriate herbicide using the prescribed rates at the prescribed times. If treatment of all populations is not feasible due to time and financial restraints, species should be managed based on survey data from the GTCD and Invasive Species Network Coordinator. Priority should be given the 'winnable battles', factoring in regional population densities, threat, and risk to native populations.

Medium Priority Terrestrial Invasive Species

The two medium priority invasive plant species as listed in Table 3-1 include garlic mustard (*Alliaria petiolata*) and Oriental bittersweet (*Celastrus orbiculatus*).

Measurable objectives for medium priority invasive species include:

- Provide at least annual surveillance to identify new or expanding populations and to determine the effectiveness of prior treatment and management.
- Treat select populations in sensitive or problematic areas with appropriate herbicide using the prescribed rates at the prescribed times.

Low Priority Terrestrial Invasive Species

The five low priority invasive plant species as listed in Table 3-1 include Russian olive (*Elaeagnus angustifolia*), baby's breath (*Gypsophila paniculata*), dame's rocket (*Hesperis matronalis*), lyme grass (*Leymus arenarius*), and multiflora rose (*Rosa multiflora*).

Measurable objectives for low priority invasive species include:

- Provide at least annual surveillance to identify new or expanding populations and to determine if the priority level should be adjusted to medium or high priority.

5.0 CONTROL PLANS FOR INVASIVE PLANT SPECIES

General control strategies that may be employed against invasive plant species include pulling, cutting, mowing, girdling, prescribed fire, biological control, flooding, and herbicide application. Some of these methods, such as pulling and girdling, are labor intensive and are more appropriate for small infestations or localized sites.

Biological controls involve the introduction of non-native agents to control populations of invasive species and generally involve authorizations from and coordination with multiple agencies and stake holders. As such, biological controls are not discussed in this plan.

A natural and low-cost method to control woody invasive species is through fire management. Prescribed fire should be utilized as an enhancement and management tool where sufficient fuel (typically grass species) has been restored through either active or passive restoration techniques. Use of prescribed fire requires a burn permit and authorization from state and/or local governments.

Controlled flooding is another management tool that requires the use of a water control device for implementation. This method would only be practical in select wetland locations after dam removal if water control structures are installed during restoration.

Many times successful control of invasive plant species requires the combination or sequential use of several control strategies such as cutting woody stems prior to herbicide application or prescribed burning with follow up herbicide application.

Herbicides should only be applied by trained and licensed herbicide applicators. All herbicides should be applied in accordance with the label requirements and at the rates specified on the label for the target species. Methods are described below and are summarized in Table 5-1.

Woody Species: Buckthorns, Honeysuckles, Autumn Olive, Japanese Barberry, and Oriental Bittersweet

Buckthorns, honeysuckles, Japanese barberry, and autumn olive are all considered high priority invasive species because they are known to exist in the study area and have a high potential for invading the study area after drawdown and dam removal. Oriental bittersweet (a vine) is considered medium priority species that will be monitored carefully and managed as necessary. All of these woody species can be chemically treated, as needed, in a similar fashion.

Larger specimens should be cut at or near ground level followed by an application of triclopyr (Garlon or equivalent) to the cut stumps preferably in the fall from September 1 through November. Stump/stems should be treated immediately following cutting. If the stems are growing in water or within 500' of water, substitute a glyphosate-based herbicide labeled for use in aquatic ecosystems such as Rodeo or equivalent. For best results, use herbicide in combination with commercially available basal oil with a penetrant.

For small stems less than one inch (1") in diameter (including resprouts), shrubs may be wick or sponge treated with triclopyr (Garlon or equivalent) to the basal bark from the ground up to at least six inches (6") around the root collar instead of cutting and stump treatment. This method should be applied in the summer or fall.

Avoid cut/treat and basal bark treatments in the spring when sap is flowing up from the roots to the stems. Herbicide will not be effectively absorbed during this time period.

Spotted Knapweed (High Priority)

Spotted knapweed is a biennial or short-lived perennial that reproduces solely from seed. It has a deep taproot and typically forms a basal rosette of leaves in its first year and flowers in subsequent years. Plants typically bloom from June to August. Spotted knapweed infests a variety of disturbed and natural habitats including dry prairie sites, oak and pine barrens, and on lake dunes and sandy ridges. It out-competes native plant species, reduces native plant and animal biodiversity, and decreases forage production for wildlife (Wisconsin DNR, 2010).

The most effective control is early detection and removal of pioneering plants. Small populations can be removed by digging or pulling – the entire root should be removed. Aminopyralid (Milestone SH or equivalent), a selective herbicide that is not lethal to grasses, provides post emergence control of spotted knapweed when applications are made during the spring. Herbicide applications implemented during the bolt stage should be made with clopyralid (Curtail or equivalent), a more selective herbicide affecting only legumes and composites, and should be applied at 0.25 pound acid equivalent per acre (PCA, 2009 and Wisconsin DNR, 2010).

Reed Canary Grass (High Priority)

Reed canary grass is a major threat to marshes and natural wetlands in the upper Midwest because of its hardiness, aggressive nature, and rapid growth. Native wetland and wet prairie species are typically replaced after several years of reed canary grass presence. It is of particular concern because of the difficulty of selective control (INPC, 2011).

For large monocultures of reed canary grass, the aboveground stems and/or dead litter should be removed preferably by burning in spring. New growth following the burn should be allowed to reach a height of 8-12 inches and then should be sprayed with glyphosate (RoundUp or Rodeo if growing in or near water, or equivalent) in accordance with the label instructions (INPC, 2011). If mowing, the clippings should be removed prior to herbicide application. Herbicide application should take place in June before it goes dormant. Repeat applications may be necessary for multiple years.

Purple Loosestrife (High Priority)

Purple loosestrife may become problematic in bottomland areas following drawdown and dam removal. It adapts readily to natural and disturbed wetlands and forms dense, homogeneous stands that restrict native wetland plant species, including some federal and state species of conservation concern. Mature plants may have as many as thirty flowering stems and are capable of producing an estimated two to three million, minute seeds each year (PCA, 2009).

Small infestations of young purple loosestrife plants may be pulled by hand, preferably before seed set. For older plants, spot treating with a glyphosate (Rodeo or equivalent) per label requirements is recommended. Herbicide application may be most effective when applied late in the season when plants are preparing for dormancy. In order to limit seed production, however, both mid-summer and fall applications are recommended (PCA, 2009). Biological control agents were release several years ago near Sabin Pond and at this time appear to be keeping the species under control. Careful monitoring following dam removal will determine the need for additional treatment in the restoration and post-restoration phase of the project.

Narrow-leaved Cattails (High Priority)

Common cattail (*Typha latifolia*) is a natural component of pre-settlement wetland communities and should not be eliminated unnecessarily. Narrow-leaved cattail (*T. angustifolia*), however, is not native to Michigan and is capable of rapid growth in disturbed areas where it quickly forms large monocultures that lack the habitat and food value of a more diverse plant community. Annual monitoring should provide careful investigation to distinguish between the native common cattail and invasions of narrow-leaved cattail.

Treatment of cattails should occur in June or July using a glyphosate-based herbicide labeled for use over water (Rodeo, or equivalent) as described above for purple loosestrife. For large monocultures, remove dead (sprayed) stems by burning. Cattails do not need to be completely eliminated from the site but rather their stem density should be reduced to allow for the establishment of other matrix native species through site plantings and natural succession.

Common Reed – *Phragmites* (High Priority)

Phragmites is a high priority invasive species that may become problematic in bottomland areas following drawdown and dam removal. Although native *Phragmites* exists, the alien strain is a serious invader. Once it invades a site it can spread quickly, crowding out native wetland species, changing marsh hydrology, altering wildlife habitat, and increasing a site's fire potential. Its high biomass blocks light to other plants and occupies all the growing space belowground such that plant communities can turn into *Phragmites* monocultures very quickly. *Phragmites* can spread both by seed dispersal and vegetatively via fragments of rhizomes that break off and are transported elsewhere. New populations of the introduced type may appear sparse for the first few years of growth but will typically form a pure stand that chokes out desirable native species very quickly (PCA, 2009).

Control should include a combination of herbicide treatment and prescribed fire. Apply glyphosate (RoundUp or Rodeo if growing in or near water, or equivalent) in late summer after the plants have flowered, either as a cut stump treatment or foliar spray (PCA, 2009). Burn the treated patch in the fall after it turns brown and then apply herbicide again. Multiple applications may be necessary for several years. If a population can be controlled soon after it has invaded chances of success are much higher because the below-ground rhizome network will not be as extensive. As such, annual monitoring and prompt management are important.

Canada Thistle (High Priority)

Canada thistle is a perennial alien species capable of crowding out and replacing native grasses and forbs. Introduction to new areas occurs mostly by windborn seed or sometimes by stormwater run-off but once established it can spread rapidly by rhizomes or root segments. It is detrimental to natural areas, particularly open vegetative communities, and can change the natural structure and species composition. Prairies, barrens, savannas, and glades are susceptible, particularly those sites that have been disturbed and are reverting naturally to native species (passive restoration), as well as those undergoing manipulative active restoration management. Intentionally planted groundcover, especially a native grassland planting, greatly aids control efforts by combining competition with control techniques (Gover, et al, 2007).

A foliar application of a 1-2% solution of glyphosate (Roundup or equivalent) applied in spring when plants are 6-10 inches (15.2 -25.4 cm) tall is an effective herbicide treatment (INPC, 2011). Individual plants should be spot-treated with a wick applicator. Large clusters can be spray treated but glyphosate is

nonselective and precautions should be taken to avoid contact with desirable native vegetation. Consecutive treatment for multiple years may be required.

Bull Thistle and European Swamp Thistle (High Priority)

Bull and European swamp thistle are biennial alien plant species that reproduce only by seed thus mechanical control, mowing and pulling, to eliminate seed is marginally effective in reducing numbers if persistently maintained for several years. If cut during or after flowering, the flower heads must be collected and removed from the site to prevent seed dispersal.

Chemical control is most effective when plants are in the rosette stage and least effective when flowering. Spot spray or wick glyphosate (RoundUp, Rodeo if near water, or similar) or trichopyr (Garlon) per label directions to first-year basal rosettes spring or fall and to second-year basal rosettes just before bolting in spring (Minnesota DNR, 2011).

Japanese and Giant Knotweed (High Priority)

Japanese knotweed is an upright, shrublike, herbaceous perennial that can grow to over 10 feet in height. Giant knotweed is a closely related but larger species with similar characteristics. Japanese knotweed spreads quickly to form dense thickets that exclude native vegetation and greatly alter natural ecosystems. It poses a significant threat to riparian areas, where it can survive severe floods and is able to rapidly colonize scoured shores and islands. Once established, populations are extremely persistent (PCA, 2009).

Apply glyphosate (Roundup, Rodeo if applying in or near water or equivalent) or triclopyr (Garlon or equivalent) per the label instructions during the growing season. Do not apply so heavily that herbicide drips off leaves. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65 °F (PCA, 2009).

Where plants are established within or around desirable natives, cut the stem and immediately apply a 25% solution of glyphosate (Roundup, Rodeo if applying in or near water, or equivalent) or triclopyr (Garlon or equivalent).

Wild Parsnip (High Priority)

Wild parsnip is an alien monocarpic perennial spending one or more years as a basal rosette. When conditions are favorable, it flowers, produces seed, and dies. Wild parsnip slowly invades an area in waves following initial infestation. Once the population builds, it spreads rapidly. This species is an aggressive, Eurasian weed that frequently invades and modifies a variety of open habitats. Care should be taken to avoid skin contact with the juices of this plant which can cause phytophotodermatitic effects. If the plant juices come in contact with skin in the presence of sunlight, a rash and/or blistering can occur, as well as skin discoloration that may last several months (Wisconsin DNR, 2010).

For small infestations, an effective control method is to cut the entire root just below ground level with a sharp shovel or spade. Cutting below ground level prevents resprouting. In wet soils the plants can be pulled out of the ground by hand. All seeds must be removed from the site and disposed of in a landfill or by burning.

The best method for large infestations is to burn the site, then follow with spot applications of herbicide. Immediately after a burn, wild parsnip is one of the first plants to green. A 1 to 3 percent glyphosate (RoundUp or equivalent) solution can be spot applied per label instructions to the basal rosette of the

parsnip. Alternatively, adult plants can be spot treated during the time of bolting until flowering (mid-May to mid-June) and again in the fall targeting plants still in the rosette stage.

Leafy Spurge (High Priority)

Leafy spurge is a perennial herb that displaces native vegetation in prairie habitats and fields through shading and by usurping available water and nutrients and through plant toxins that prevent the growth of other plants underneath it. Leafy spurge is an aggressive invader and can completely overtake large areas of open land. Because of its persistent nature and ability to regenerate from small pieces of root, leafy spurge is extremely difficult to eradicate (PCA, 2009) and should be monitored for carefully on an annual basis.

If leafy spurge is identified during annual monitoring, immediate action should commence to eradicate it from the site. Imazapic (Plateau or equivalent) is a selective herbicide that has been most effective on leafy spurge. Plateau is only available to government agencies and should be used as labeled for leafy spurge. The best method for control is to attack the plant two times in its growing season. In late spring or early summer (before seeding), remove blooms by cutting or mowing, leaving as many leaves as possible. In the fall apply Impazapic before the first killing frost, when the milky sap is still present. Cut plants should be marked with flagging in the spring for easy identification in the fall. This herbicide may harm cool season grasses but should not harm warm-season prairie grasses (Wisconsin DNR, 2010).

Fire in conjunction with herbicides may be more effective than either method alone. Burning stimulates vegetative growth, making the plant more vulnerable to herbicides (MDC, 2011). Follow the fall herbicide application with a prescribed burn the following spring. The process may have to be repeated many times. Prescribed burning will not be likely to provide adequate control if used alone because its effect would be only on top growth and seeds. Established plants would quickly resprout (MDC, 2011).

Garlic Mustard (Medium Priority)

Garlic mustard is an alien cool-season biennial herb that is rapidly spreading in woodland ecosystems. It dominates the forest floor and can displace most native herbaceous species within ten years. Unlike other plants that invade disturbed habitats, garlic mustard readily spreads into high quality forests (Wisconsin DNR, 2010). This is a medium priority invasive species but has the potential to become more problematic over time.

Minor infestations can be eradicated by hand pulling at or before the onset of flowering.

Should herbicide treatment become necessary, infestations can be controlled by applying a 1-2% solution of glyphosate (RoundUp or equivalent) to the foliage of individual plants and dense patches during late fall or early spring. At these times, most native plants are dormant, but garlic mustard is green and vulnerable (garlic mustard will grow as long as there is no snow cover and the temperature is above 35 °F). Because glyphosate is a nonselective herbicide that will kill desirable native plants, managers should exercise caution during application. Wicking can be implemented in lieu of spraying if necessary. An early spring application of 1% tricolopyr has been used, resulting in a 92% rosette mortality rate (Wisconsin DNR, 2010).

Table 5-1 Herbicide Control of Invasive Vegetative Species

Botanical Name	Common Name	Priority Level	Potential Control Techniques
Woody species ¹	See below ¹	Refer to Table 3-1	Cut and apply Garlon to stumps of larger specimens in fall. For saplings or resprouts, apply Garlon to basal bark in fall. If growing in water, use Rodeo instead of Garlon.
<i>Centaurea stoebe</i>	Spotted knapweed	H	Milestone SH applied as a post emergent control in the spring. Herbicide applications made during the bolt stage should be made with Curtail.
<i>Cirsium arvense</i>	Canada thistle	H	Apply RoundUp in spring when plants are 6-10" tall.
<i>Cirsium palustre</i>	European swamp thistle	H	Apply RoundUp or Garlon to 1 st year basal rosettes in spring or fall and to 2 nd year basal rosettes in spring just before bolting.
<i>Cirsium vulgare</i>	Bull thistle	H	Apply RoundUp or Garlon to 1 st year basal rosettes in spring or fall and to 2 nd year basal rosettes in spring just before bolting.
<i>Euphorbia esula</i>	Leafy spurge	H	Remove blooms in late spring or early summer by cutting or mowing. Apply Plateau in fall while milky sap is still present.
<i>Lythrum salicaria</i>	Purple loosestrife	H	Apply Rodeo in mid summer and fall per label requirements.
<i>Pastinaca sativa</i>	Wild parsnip	H	Burn, then apply RoundUp or Rodeo after it greens up again. Also spot treat from bolting until flowering (mid-May to mid-June) and target basal rosettes in fall.
<i>Phalaris arundinacea</i>	Reed canary grass	H	Burn (or mow and remove clippings), allow growth to 8-12", spray with RoundUp or Rodeo per label requirements.
<i>Phragmites australis</i>	Phragmites (non-native)	H	Late summer herbicide (RoundUp or Rodeo) treatment after flowering, burn in mid to late fall, and reapply herbicide again to the green resprouts.
<i>Polygonum cuspidatum</i>	Japanese knotweed	H	Apply RoundUp or Garlon during the growing season per label requirements. Use Rodeo if growing in water.
<i>Polygonum sachalinense</i>	Giant knotweed	H	Apply RoundUp or Garlon during the growing season per label requirements. Use Rodeo if growing in water.
<i>Typha angustifolia</i>	Narrow-leaved cattail	H	Spray with Rodeo in June or July and burn to remove dead stems. Retreat as necessary.
<i>Alliaria petiolata</i>	Garlic mustard	M	Apply RoundUp or Garlon in early spring or late fall.

¹ Control techniques are the same for buckthorns, honeysuckles, autumn olive, Russian olive, Japanese barberry, Oriental bittersweet, and multiflora rose.

6.0 REFERENCES

- Adair, Robert. 2011. Integrated Management of Sea Lampreys in Lake Michigan 2010 (Report to the Lake Michigan Committee Annual Meeting, March 22-23, 2011). U.S. Fish and Wildlife Service.
- Baker, S. M., and D. J. Hornbach, 1997, Acute physiological effects of zebra mussel (*Dreissena polymorpha*) infestation on two unionid mussels, *Actinonaias ligmentina* and *Amblema plicata*, Canadian Journal of Fisheries and Aquatic Sciences 54:512-519.
- Bartell, S.M., Wu, Y., Nair, S.K., Orr, J., and Ragland J. 2007. Risk Assessment and Decision Analysis Support for Invasive Mussel Management for the St. Croix Basin and Adjacent Upper Mississippi River. Final Report. Submitted to the U.S. Army Corps of Engineers, St. Paul District in partial fulfillment of contract # W912ES-05-D-0002 Task Order 07. September 2007. Available on-line at:
http://www.mvp.usace.army.mil/docs/projs/651_Risk_Assessment_and_Decision_Analysis_musselreport.pdf. Accessed on April 21, 2011.
- Benson, A. J. and D. Raikow. 2011. *Dreissena polymorpha*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Available at
<http://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=5>. Accessed February 21, 2011.
- Carlander, Kenneth D. 1969. Handbook of Freshwater Fishery Biology. Volume One. Iowa State University Press. Available on-line at:
http://books.google.com/books?hl=en&lr=&id=0E8TOXsjWHkC&oi=fnd&pg=PR5&ots=SlIENkkq5S&sig=Tsug_xGCwb1wNQa2pgWISkbSFIs#v=onepage&q&f=false. Accessed April 21, 2011.
- ECT Environmental Consulting and Technology, Inc. 2009. Boardman River Feasibility Study, A Summary of Terrestrial Habitats in the Boardman River Watershed. January 2009.
- Gover, A., Johnson, J., and Sellmer, J. 2007. Managing Canada Thistle. Penn State University Department of Horticulture. Available on-line at
http://vm.cas.psu.edu/Publications/CREP_WS_1_CIRAR.pdf. Accessed March 31, 2011.
- Great Lakes Fishery Commission. Available on-line at <http://www.glfsc.org/lampcon.php>. Accessed March 31, 2011.
- Illinois Nature Preserves Commission (INPC), 2011. Vegetation Management Guide. Available on-line at <http://www.inhs.uiuc.edu/research/VMG/>. Accessed March 31, 2011.
- Michigan Department of Natural Resources (MDNR), 2002. *Boardman River Natural River Plan*, Grand Traverse and Kalkaska Counties, Revised March 12, 2002.
- Minnesota Department of Natural Resources, 2011. Invasive Terrestrial Plants. Available on-line at <http://www.dnr.state.mn.us/invasives/terrestrialplants/index.html>. Accessed March 31, 2011.
-

- Missouri Department of Conservation (MDC), 2011. Invasive Plant Management. Available on-line at <http://mdc.mo.gov/landwater-care/plant-management/invasive-plant-management>. Accessed March 31, 2011.
- New York State Department of Environmental Conservation. Available on-line at <http://www.dec.ny.gov/animals/6998.html>. Accessed March 31, 2011.
- Northwest Michigan Cooperative Weed Management Area (CWMA), 2011. Available on-line at <http://www.garlic-mustard.org/target-species/blue-lyme-grass/>. Accessed April 6, 2011.
- Plant Conservation Alliance (PCA), 2009. Least Wanted: Alien Plant Invaders of Natural Areas. Available on-line at <http://www.nps.gov/plants/alien/fact.htm>. Accessed March 31, 2011.
- Schloesser, D. W., T. F. Nalepa, and G. L. Mackie, 1996. Zebra mussel infestation of unionid bivalves (Unionidae) in North America. *American zoologist* 36:300-310.
- University of Minnesota, Minnesota Sea Grant. Available on-line at http://www.seagrant.umn.edu/ais/sealamprey_battle. Accessed March 31, 2011.
- URS Corporation, 2010. Project Management Plan for the Boardman River Feasibility Study, Detailed Project Report and Environmental Impact Statement (95% Draft). Revised July 16, 2010.
- U.S. Army Corps of Engineers (USACE), 2006. *Preliminary Restoration Plan for the Boardman River Mainstem Grand Traverse County, Michigan Section 506 Great Lakes Fishery and Ecosystem Restoration*. July 2006.
- U.S. Fish and Wildlife Service, Connecticut River Coordinator's Office. Available on-line at http://www.fws.gov/r5csrc/fish/zi_pema.html. Accessed March 31, 2011.
- U.S. Geological Survey, Upper Midwest Environmental Sciences Center. Available on-line at http://www.umesc.usgs.gov/invasive_species/sea_lamprey.html. Accessed March 31, 2011.
- Wisconsin Department of Natural Resources, 2010. Invasive Species: Plants. Available on-line at <http://dnr.wi.gov/invasives/plants.asp>. Accessed March 31, 2011.

APPENDIX A

INVASIVE SPECIES PROFILES

	<p>Scientific Name: <i>Petromyzon marinus</i>^{1,2}</p> <p>Common Name: Sea Lamprey</p> <p>Description: A parasitic aquatic vertebrate native to the Atlantic Ocean, visibly similar to eels. A cartilaginous fish without jaws that uses a round, sucking-disk mouth with rings of teeth to attach to fish. It is able to live in fresh or salt water. An anadromous fish, adults swim up rivers and streams to spawn and die. In the Great Lakes, spawning runs take place from April-July. Larvae live on the bottom of streams and rivers for 3 to 6 years before migration as an adult to feed on fish.</p> <p>Habitat: Atlantic Ocean, the Great Lakes, rivers and streams that flow in and out of the Great Lakes. No natural predators within the Great Lakes; devastating to many of the Great Lakes' fisheries.</p>
	<p>Scientific Name: <i>Dreissena polymorpha</i>^{3,4}</p> <p>Common Name: Zebra mussel</p> <p>Description: A freshwater bivalve native to eastern Europe. Its name is from the striped pattern on the shell, though color variations can be light or dark colored with no stripes. Visibly similar to <i>Dreissena bugensis</i>, but Zebra mussels have a flattened underside. They are prolific breeders, and a single adult female can produce up to 1 million eggs annually. Spawning in the Great Lakes can occur in temperatures near 10°C or 50°F, unusually in late spring or early summer. Larvae use water currents for dispersal and will settle on any hard surface.</p> <p>Habitat: Any freshwater habitat, including lakes, rivers, streams, and ponds. In all the Great Lakes, and spread across the mid-western states.</p>



Scientific Name: *Centaurea stoebe*^{5,6}

Common Name: Spotted Knapweed

Priority Level: High

Description: Spotted knapweed is a biennial or short-lived perennial that reproduces solely from seed. It has a deep taproot and typically forms a basal rosette of leaves in its first year and flowers in subsequent years. Plants typically bloom from June to August and look similar to the thistles.

Habitat: Spotted knapweed infests a variety of disturbed and natural habitats including dry prairie sites, oak and pine barrens, and on lake dunes and sandy ridges.



	<p>Scientific Name: <i>Cirsium arvense</i>⁵</p> <p>Common Name: Canada thistle</p> <p>Priority Level: High</p> <p>Description: A perennial herbaceous plant with branched, ridged, slightly hairy stems; flowering from June to October in either rose-purple, lavender, or white flower heads; produces small, dry, single-seeded achenes (fruits) that are dispersed by wind.</p> <p>Habitat: Meadows, fields, pastures, prairies, and disturbed areas. Most successful in disturbed upland areas but will invade wet areas with fluctuating water levels such as stream banks and wet prairies.</p>
	<p>Scientific Name: <i>Elaeagnus umbellata</i>⁶</p> <p>Common Name: Autumn olive</p> <p>Priority Level: High</p> <p>Description: A deciduous shrub or tree growing up to 20 feet tall. Leaves are alternate with smooth margins, oval to lanceolate in shape, and dark green in color but have silver-white scales on the undersides. Flowers are small and yellow with reddish to pink fruits. Seed dispersal is due primarily to various bird species.</p> <p>Habitat: Thrives in various soils, including poor nutrient soils, and full sun, but can tolerate shade. Will invade grasslands and sparse woodlands, but rarely wet areas or heavily forested areas. Prefers areas of disturbance, including roadsides, pastures, and open fields.</p>



Scientific Name: *Cirsium palustre*⁶

Common Name: European swamp thistle

Priority Level: High

Description: A biennial herb that grows 4 to 5 feet in height. First-year plants develop as leaves in rosettes close to the ground. The following year a flowering stem will form with longer leaves (6-8 inches) at the base and shorter leaves higher on the stem. Flowering occurs in June and July with clusters of purple flower heads. Feathery seeds are primarily dispersed by wind.

Habitat: Prefers primarily moist habitats such as wetlands and alongside rivers, streams, and lake and pond shores, but will also invade forests, open fields, and roadsides.



Scientific Name: *Cirsium vulgare*⁶

Common Name: Bull thistle

Priority Level: High

Description: An herbaceous biennial with coarse leaves that are spiny above and have woolly white hairs below; a prickly, winged stem; a spiny green ovoid flower head produces purple flowers from June through August. Feathery seeds dispersed primarily by wind.

Habitat: Highly successful in areas of disturbance, including pastures, old fields, prairies, roadsides, and waste areas. Can invade native and restored grasslands.



Scientific Name: *Euphorbia esula*⁵

Common Name: Leafy spurge

Priority Level: High

Description: A perennial herbaceous plant with smooth stems, occurring in clusters from a vertical root, and showy yellow flower bracts flowering from late May to June. Seed capsules open explosively, allowing seeds with a high germination rate to disperse up to 15 feet. Seeds may also be dispersed by wildlife and water.

Habitat: Tolerates moist to dry soil conditions, while most successful invading during dry conditions and in areas of disturbance.



Scientific Name: *Lonicera spp.*⁵

Common Name: Honeysuckles

Priority Level: High

Description: Perennial vines or deciduous shrubs with opposite leaves along the stem with fragrant, tubular flowers less than 1 inch. Flower colors range from white to pink, eventually turning yellow. Highly prolific fruit is spread mainly by numerous bird species.

Habitat: All types of disturbed areas, including fields, pastures, roadsides, forests, wetlands, bogs, lakeshores, and river shorelines.



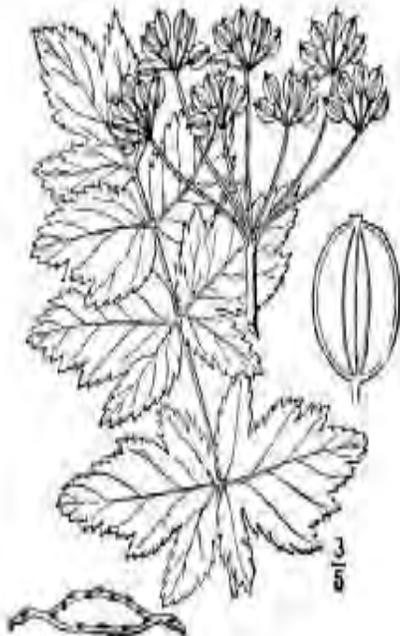
Scientific Name: *Lythrum salicaria*⁵

Common Name: Purple loosestrife

Priority Level: High

Description: An herbaceous perennial with either opposite or whorled leaves, and a square, somewhat woody stem. Can grow between 4 and 6 feet tall and produces large magenta-colored flower spikes, blooming from June to September. Each mature plant can produce over 2 million seeds per year. Reproduction also occurs through underground stems.

Habitat: Invades numerous wetland areas, including river and stream banks, pond edges, reservoirs, wet meadows, tidal and non-tidal marshes, and is highly successful in disturbed wetlands.



Scientific Name: *Pastinaca sativa*⁶

Common Name: Wild parsnip

Priority Level: High

Description: A monocarpic perennial herb, it develops as a leafy rosette close to the ground for one or more years before producing a single flowering stem in favorable conditions that can grow up to 4 feet tall. Leaves are alternate, pinnately compound, branched, and have saw-toothed margins. Flowering occurs from June to July with numerous yellow umbellate flowers. Large numbers of seeds are produced allowing for rapid reproduction.

Habitat: Aggressively invades open fields, pastures, and grasslands. Prefers sunny conditions, and can tolerate a variety of habitats and soils, including both dry and wet areas.



Scientific Name: *Phalaris arundinacea*⁶

Common Name: Reed canary grass

Priority Level: High

Description: A large perennial wetland grass that can grow between 2 to 9 feet tall with a vertical, smooth stem that gradually tapers into leaf blades up to 10 inches long. Leaf blades are flat and both sides are rough textured. The panicles are compact and can be either erect or slightly spreading. Dense green to purple flower clusters occur from May to June, then change to light brown. Reproduction occurs from both seeds and rhizomes.

Habitat: Successful in a variety of habitats, from upland fields and partially forested areas to most wetland environments, including stream and river banks, marshes, wet prairies, and fens. Highly successful in disturbed areas.





Scientific Name: *Phragmites australis*⁵

Common Name: Common reed/Phragmites
(non-native)

Priority Level: High

Description: A perennial grass producing thick, dense stands and can grow up to 15 feet high; elongate leaves; produces purple or golden bushy panicles that flower from late July to August. Reproduction occurs both through rhizomes grown horizontally along the surface or subsurface, and through seeds carried by wind and water.

Habitat: River and stream edges, tidal and non-tidal brackish and freshwater marshes, roadsides, lakes and ponds. Highly successful in disturbed areas.

	<p>Scientific Name: <i>Polygonum cuspidatum</i>⁶</p> <p>Common Name: Japanese knotweed</p> <p>Priority Level: High</p> <p>Description: A large herbaceous perennial that grows up to 10 feet in height in areas reaching several acres in size. The stems are hollow, reddish-brown, and arching, with spade-shaped mature leaves and heart-shaped young leaves. Flowering occurs in late summer with long clusters of small greenish-white flowers. Reproduction is primarily through underground rhizomes, with some seed propagation.</p> <p>Habitat: Successful in many variable habitats, environments, soil types, and moisture conditions. Invades wetland areas, including the banks of streams and rivers. Highly successful in disturbance areas.</p>
	<p>Scientific Name: <i>Polygonum sachalinense</i>⁶</p> <p>Common Name: Giant knotweed</p> <p>Priority Level: High</p> <p>Description: A woody perennial herb that can reach 12 feet in height with hollow stems and alternate, petioled, and ovate leaves that are 6 to 14 inches long. Flowering occurs from August to October with greenish-white flowers and a three-sided achene fruit. Reproduction is mainly through rhizomes, but seeds and broken pieces of stems can also be dispersed by water or wind and take root.</p> <p>Habitat: Successfully invades many habitats, but prefers moist conditions and areas of disturbance, including river and stream banks, wet fields, roadsides, and railroad right-of-ways.</p>



Scientific Name: *Rhamnus cathartica*⁵

Common Name: Common buckthorn

Priority Level: High

Description: A shrub or tree capable of growing 22 feet high with a 10 inch diameter trunk. The outer bark is gray to brown with a rough surface. The tip of twigs will often have a spine. Oval leaves with jagged, toothed margins and no hairs on either side of the leaves. Produces dense flower clusters in spring, with male and female flowers on separate plants, but only female trees producing fruit. Seed dispersal occurs through wildlife.

Habitat: Can be found both in forested areas and open prairies, fields, and pastures. Successful in disturbed sites and tolerates numerous soil types, both wet and dry.



Scientific Name: *Frangula alnus*⁵

Common Name: Glossy buckthorn

Priority Level: High

Description: Very similar to *Rhamnus cathartica* but the leaves have smooth margins and are hairy on the undersides. The tips of the twigs do not have spines.

Habitat: See *Rhamnus cathartica*.



Scientific Name: *Alliaria petiolata*⁵

Common Name: Garlic mustard

Priority Level: Medium

Description: A biennial herb with heart-shaped or triangular, coarsely toothed leaves. In the first year plants develop leaf bunches close to the ground that remains green throughout the winter and flower in the spring of the second year. When flowering, plants can reach 3.5 feet and have clusters of small, white flowers. When the leaves are crushed, they produce a smell of garlic. Seeds are spread around near the plant or dispersed by wildlife and/or humans.

Habitat: Highly successful in disturbed areas, Garlic mustard will invade the edges of rivers and streams, forests, roadsides, and trail edges.



Scientific Name: *Berberis thunbergii*⁵

Common Name: Japanese barberry

Priority Level: Medium

Description: A deciduous shrub ranging from 2 to 8 feet in height. The leaves are small and either green, bluish-green, or dark reddish purple. Branches are deeply grooved and have a sharp spine at each node. It produces pale yellow flowers from April to May and fruits in late summer and fall. Seeds are dispersed by wildlife and branches that touch the ground can root and sprout new plants.

Habitat: Able to adapt to numerous environments and habitats, including wetlands, forests, and open fields. Resistant to drought and highly successful in areas of disturbance.



Scientific Name: *Celastrus orbiculatus*⁵

Common Name: Oriental bittersweet

Priority Level: Medium

Description: A deciduous, woody, perennial vine or shrub having leaves that are alternate and glossy with finely toothed margins. Male plants are non-fruiting, while female plants have greenish flower clusters and yellow, three-valved fruits which, when mature, will open to three red-orange arils containing the seeds. Reproduction occurs through seed dispersal by numerous species of birds.

Habitat: Invades many disturbed habitats, including forests, open fields, and marshes. Prefers sunny and open areas, but is tolerant of shade.



Scientific Name: *Elaeagnus angustifolia*⁵

Common Name: Russian olive

Priority Level: Low

Description: A small shrub or tree that can grow up to 30 feet high with lance-shaped, smooth margined and alternate leaves. Silvery to rusty scales heavily cover the stems, leaves, and buds. In June and July it produces cream-yellow flowers, which are then later replaced by clusters of silvery fruits. Seeds are dispersed by various bird species.

Habitat: Can tolerate shade, but prefers open areas in fields and along streams and rivers. Successful in wet and dry areas with various soil conditions.



Scientific Name: *Gypsophila paniculata*⁶

Common Name: Baby's breath

Priority Level: Low

Description: An herbaceous perennial up to 3 feet in height. The opposite leaves are 1 to 4 inches long with a prominent mid-vein. Flowering occurs by the third year with small white or pink flowers on branched clusters. Seeds are dispersed by wind or water.

Habitat: Successful in areas of disturbance, including pastures, open fields, farmland, and roadsides. Invaded the Great Lakes sand dunes.



Scientific Name: *Hesperis matronalis*⁶

Common Name: Dame's rocket

Priority Level: Low

Description: A perennial herb with fragrant white, pink, or purple flowers. Alternate leaves are oblong and have sharply toothed margins. Flowering occurs from May to August. Aggressive reproduction is due to a high quantity of seeds being produced throughout the flowering season.

Habitat: Successfully inhabits both moist forested areas and open areas, including roadsides and open fields.

	<p>Scientific Name: <i>Leymus arenarius</i>^{6,7}</p> <p>Common Name: Lyme grass</p> <p>Priority Level: Low</p> <p>Description: A perennial grass, 2 to 4 feet in height, with 12 inch long blue-green leaves. Flowering occurs in early summer with dense blue-green spikes that later turn light brown in color. Reproduction primarily through rhizomes but also by seed.</p> <p>Habitat: Successful in most habitats and is resistant to drought and extreme temperatures. Highly invasive in well-drained sandy soils and has invaded the Great Lakes sand dunes.</p>
	<p>Scientific Name: <i>Rosa multiflora</i>⁵</p> <p>Common Name: Multiflora rose</p> <p>Priority Level: Low</p> <p>Description: A perennial shrub; leaves are divided into 5 to 11 leaflets with sharply toothed margins along arched stems. A pair of fringed bracts is at the base of each leaf stalk. Flowering occurs in May and June with clusters of white to pink flowers, which are replaced in the summer by small red fruits. The fruits remain throughout the winter. Each plant can produce millions of seeds annually, which are dispersed primarily by various bird species.</p> <p>Habitat: Successful in many habitats and environments; stream banks and river edges, forests, pastures, open fields, roadsides, and areas of disturbance.</p>



© Thomas G. Barnes

Scientific Name: *Typha angustifolia*⁶

Common Name: Narrow-leaved cattail

Priority Level: High

Description: A perennial herb with long lanceolate leaves that originate at the base of the stem. The flower head is a brown spike at the end of a 3 to 9 foot stem and is divided into pistillate and staminate flowers. Reproduction occurs both by seed dispersed by wind and through rhizomes.

Habitat: Require either wet soil or shallow water; will invade roadside ditches, freshwater marshes, shallow ponds, and the edges of lakes.

Sources-See Section 6.0 References:

¹ Great Lakes Fishery Commission

² Handbook of Freshwater Fishery Biology

³ USGS Nonindigenous Aquatic Species Database

⁴ Risk Assessment and Decision Analysis Support for Invasive Mussel Management for the St. Croix Basin and Adjacent Upper Mississippi River

⁵ Plant Conservation Alliance

⁶ Wisconsin DNR Invasive Species: Plants

⁷ Northwest Michigan CWMA - Lyme Grass

APPENDIX B

COMPLIANCE LOG

Boardman River Dams Removal Project Invasive Species Management Compliance Log

Site Location:	Date:
Contractor Name:	Personnel:

Equipment Name/ID #:			
Equipment Incoming: <input type="checkbox"/>	Equipment Outgoing: <input type="checkbox"/>		
Location of Equipment's Last Use:			
Equipment Type:			
Scraper <input type="checkbox"/>		*Pick Up Truck <input type="checkbox"/>	
Track Hoe <input type="checkbox"/>		Boat <input type="checkbox"/>	
Back Hoe <input type="checkbox"/>		Tractor <input type="checkbox"/>	
Skid Steer <input type="checkbox"/>		Seed Drill <input type="checkbox"/>	
Dozer <input type="checkbox"/>		Mower <input type="checkbox"/>	
Haul Truck <input type="checkbox"/>		ATV/Utility Vehicle <input type="checkbox"/>	
Other <input type="checkbox"/>	Specify: _____		
*Required if taken off-road			

Equipment Decon Method:	
Power Wash with Cold Water: <input type="checkbox"/>	Power Wash with Hot Water: <input type="checkbox"/>

Comments: