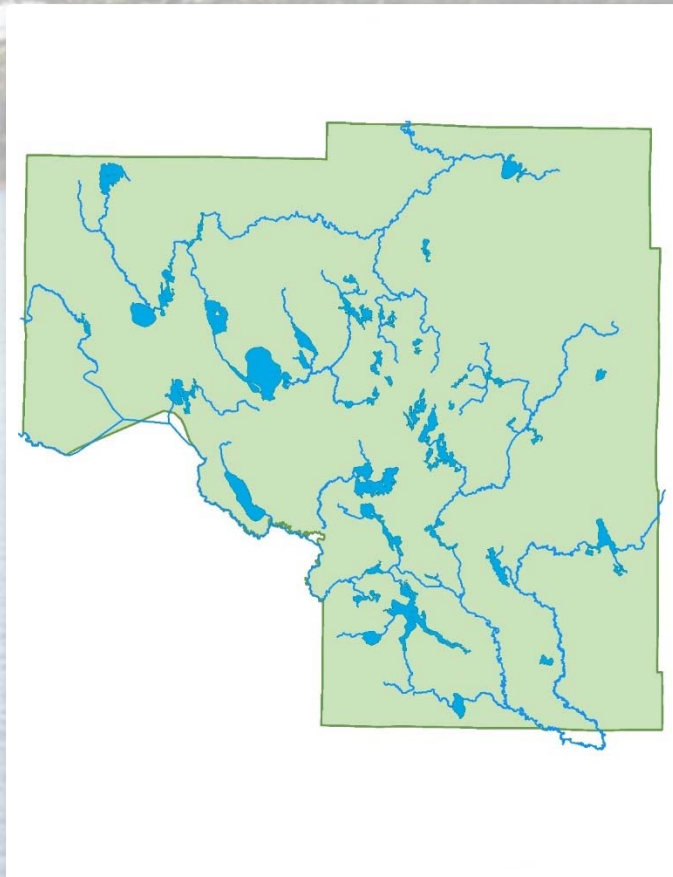
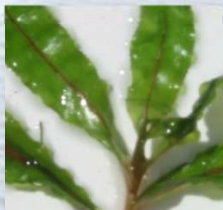


Itasca County

AIS Prioritization

A planning tool developed for AIS risk management and prevention

2016



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Itasca County Soil and Water Conservation District
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Introduction

Background

Aquatic Invasive Species (AIS) are aquatic plants and animals that are not native to Minnesota, and cause environmental changes to our waters, have negative economic consequences to our communities, or are harmful to human health. Minnesota's natural resources are threatened by a number of Aquatic Invasive Species such as Zebra mussels, Starry stonewort, Flowering rush, Eurasian watermilfoil and Asian carp.

Because invasive species are usually spread by humans, the risk pathways are similar for many AIS.

Zebra mussels are particularly harmful because they spread so rapidly and there are currently no effective treatment options. They attach to hard surfaces such as boats, docks, boat lifts, aquatic plants, and water intake pipes, and can clog pipes, cut feet, and damage boats. Zebra mussels have a large economic impact to water treatment facilities, lakeshore owners, lake recreators, and the tourism industry.



Figure 1. Minnesota Lakes infested by Zebra mussels, 2016. Zebra mussel infested lakes are indicated in red.

Zebra mussels also affect the aquatic ecosystem by filtering out microscopic plankton from the water, and therefore removing the food source for other aquatic organisms. This has implications up the food chain, such as affecting fish populations.

As of the end of 2016 Zebra mussels have been found in approximately 120 lakes in Minnesota, and the DNR has included an additional 9 water bodies on their infested waters list because they are connected to a lake infested with Zebra mussels (MNDNR 2017)(Figure 1). The infestations are clustered around areas with high traffic lakes such as Brainerd, Alexandria, Detroit Lakes and Minneapolis. This pattern of spread is consistent with what has been seen in Michigan, another state with Zebra mussel infested lakes (Johnson *et al.* 2006).

In order to slow or stop the spread of AIS in Minnesota, a concentrated effort is required. Ideally, unlimited resources would be available to protect all lakes, but in reality, budgets are always limited. Therefore, prioritizing lakes due to their risk of infestation is helpful in creating and implementing an AIS management plan.

Project Goals

Highest risk time of year
+
Highest risk lakes
=
When/where to focus AIS prevention

The goals of this project were to assess the risk of AIS infestation in Itasca County in order to prioritize funding and efforts to prevent the further spread of AIS. Fifty lakes were selected by Itasca County for this prioritization document. Lakes were chosen based on size, public accesses and use.

Vectors of spread were evaluated for each lake such as connectivity to other water bodies and public use. In addition, the suitability of each water body to Zebra mussel establishment was evaluated considering water chemistry, substrate, dissolved oxygen and temperature. There has been a lot of research done on Zebra mussel suitability in lakes, and there has not been as much research done the suitability for other AIS. A report card was developed for each water body showing the available data and assigned AIS risk category. The public use and overall infestation risk ratings apply to all aquatic invasive species, while the suitability rating applies to just Zebra mussels.

These risk ratings can be used in AIS management plans to prioritize lakes for specific prevention measures. A summary table using the assessments to form management recommendations is provided (Table 13). This table can be used to guide the most efficient use of AIS funds in the most effective way possible.

Setting

Watersheds

A basin is the area of land drained by a river or lake and its tributaries. There are ten major drainage basins in Minnesota (Figure 2). Each drainage basin is made up of smaller units called watersheds, which correspond to the drainage of individual streams.

Watersheds are categorized as major or minor. A minor watershed is the smallest category of watershed. A group of minor watersheds that eventually flows into a common stream, such as the Rum River, forms a major watershed. A group of major watersheds that flow into a common river, such as the Mississippi River, form a basin. A group of basins that flow into a common river form a divide.



Figure 2. Minnesota showing all major drainage basins and Itasca County.

There are two different basins in Itasca County, the Upper Mississippi River and the Rainy River. The water in the Mississippi River Basin drains south and the water in the Rainy River drains north.

The Upper Mississippi River Basin covers approximately 20,100 square miles. It starts at the headwaters in Itasca State Park and runs a general north easterly course to Bemidji, then over to Grand Rapids before turning south and running through Brainerd, Little Falls, St. Cloud and the Twin Cities Metro area before it combines with the St. Croix River at Lock and Dam 2 near Hastings. As the river runs its course, it drains a mixture of forests, prairie, agriculture and urban land areas (MPCA 2000).

The Rainy River Basin is home to some of Minnesota's finest forest and water resources. Voyageurs National Park and the Boundary Waters Canoe Area Wilderness (BWCA) are located within the basin.

Itasca County

Itasca County contains six major watersheds: Upper/Lower Red Lake River Watershed, Big Fork River Watershed, Little Fork River Watershed, St. Louis River Watershed, Mississippi R. Headwaters Watershed, and Mississippi R. Grand Rapids Watershed (Figure 3). Watersheds are important to consider in aquatic invasive species (AIS) planning because AIS can spread downstream. An infestation in a large chain of lakes, such as along the Mississippi River, can have implications for spread throughout the rest of the Mississippi River Basin.



Figure 3. Itasca County with its lakes and rivers.

History of AIS in Itasca County

Plants

Curly-leaf pondweed is a common invasive plant in Minnesota (Figure 3). It is unknown when it was first established; however, it was most likely introduced to the state by accident in the early 1900s when common carp were intentionally brought to Minnesota. Curly-leaf pondweed has been in Minnesota so long that many people do not realize that it is a non-native species (DNR). It is widespread in many lakes (Figure 11). Thousands of dollars annually are spent controlling this invasive plant in Itasca County.



Figure 4. Curly-leaf pondweed.

Eurasian watermilfoil is an invasive plant that is more prevalent in the Twin Cities Metro Area than in northern Minnesota (Figure 4). In Itasca County, Coon-Sandwich, Hale, Ice, McKinney, North Twin and South Twin lakes are infested with Eurasian watermilfoil (Figure 6). Eurasian watermilfoil is able to be managed with aquatic herbicides, but it can be expensive.



Figure 5. Eurasian watermilfoil, MN DNR.



Figure 6. Starry stonewort.

Starry stonewort is fairly new to Minnesota, and first showed up in Lake Koronis in 2015. Since then, it has spread to some lakes in Beltrami County, and Lake Winnibigoshish on the border of Itasca and Cass Counties. Starry stonewort is a nuisance alga that becomes very dense. Researchers and the DNR are still working on the best way to treat this invasive alga. The Starry stonewort in Lake Winnibigoshish is a major concern for Itasca County. Many boats come and go from Lake Winnibigoshish and the risk for spread is very high.

Flowering rush is an invasive emergent plant that can grow very thick along shorelines. It is present in North Twin, South Twin, Spider, Trout, Holman and Hart lakes in Itasca County. Flowering rush is able to be managed with aquatic herbicides, but it can be expensive.



Figure 8. Flowering rush.



Figure 7. Purple loosestrife flowers with weevils eating it.

Purple loosestrife is a wetland plant from Europe and Asia. It was introduced into the east coast of North America in the 1800s. First spreading along roads, canals, and drainage ditches, then later distributed as an ornamental, this exotic plant is in 40 states and all Canadian border provinces. There is a method of biocontrol established for purple loosestrife – the release of weevil beetles that eat the plant. Thousands of dollars are spent controlling this plant in Itasca County.

Animals

Zebra mussel veligers were first documented in Lake Winnibigoshish in 2012 (Figure 7). Since 2013, Zebra mussels have spread to other lakes around Lake Winnibigoshish including Cut Foot Sioux and Sand Lakes. So far, Zebra mussel infestations in Itasca County have stayed right around Lake Winnibigoshish.

Faucet snails are established in Bowstring, Blackwater, Cut Foot Sioux, Winnibigoshish and some other small lakes in Itasca County (Figure 6). The snail is an intermediate host for three parasites that kill ducks and coots. The parasite has contributed to the deaths of about 9,000 scaup and coots in 2007 and 2008 on Lake Winnibigoshish. Faucet snails also compete with native snails, and may clog water intake pipes and other submerged equipment. There is no evidence that other wildlife besides waterfowl, including any fish species, is adversely affected by the parasites present in Faucet snails. Anglers can eat fish from Faucet snail infested waters without worry of the parasite.



Figure 10. Zebra mussels (USFWS).



Figure 9. Faucet snails.

Itasca County Aquatic Invasive Species

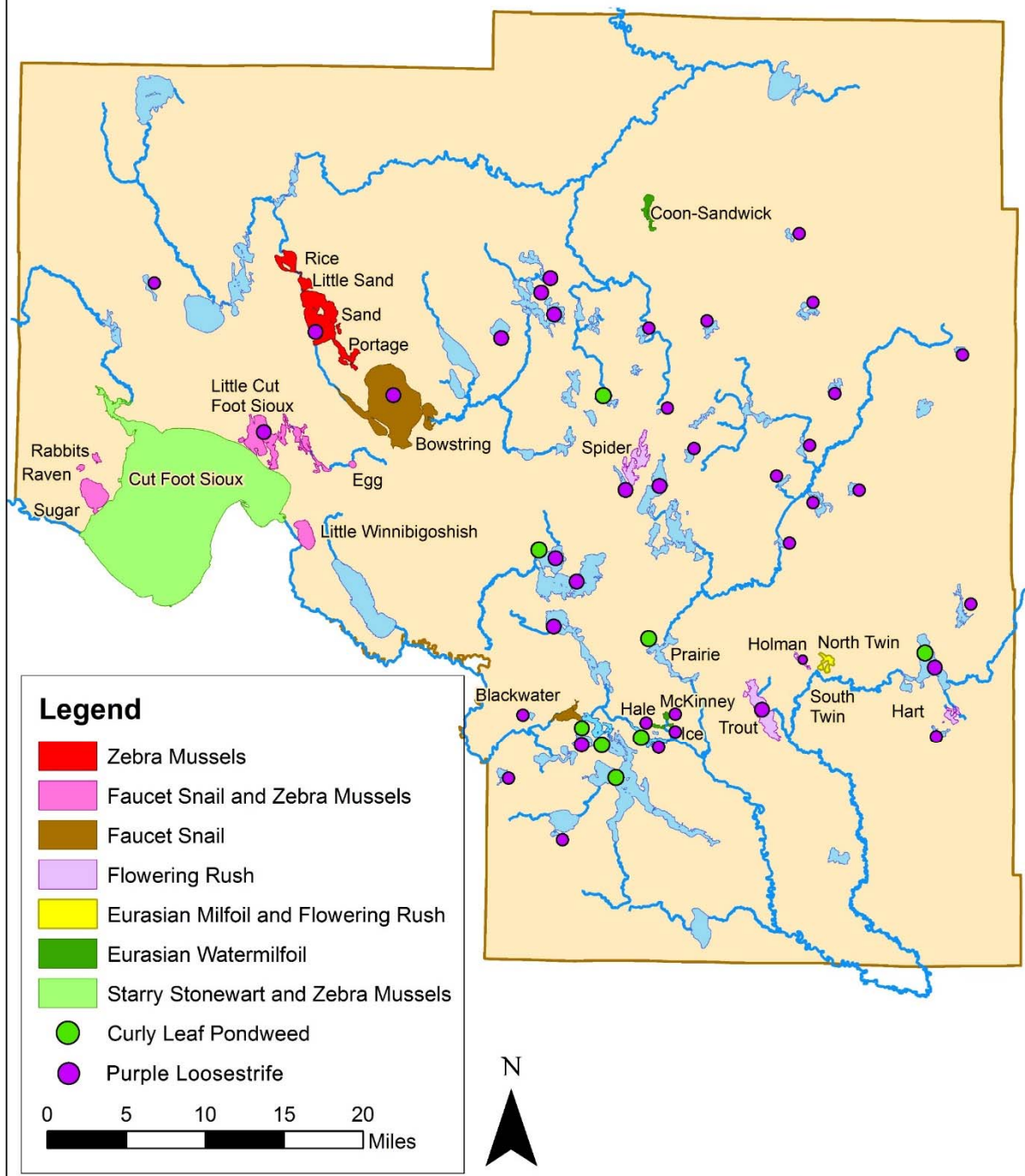


Figure 11. Aquatic species infestations in Itasca County.

Methods

AIS Risk Assessment and Prioritization

The lakes in Itasca County have water chemistry, temperature, and dissolved oxygen data available (Table 1). These data were collected by Itasca County, Lake Associations, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources and were used in the AIS risk assessment for lakes.

Table 1. Selected lakes in Itasca County.

Lake Name	Lake ID	Lake Name	Lake ID
Ball Club	31-0812-00	Johnson (Marcell)	31-0687-00
Balsam	31-0259-00	Little Bowstring	31-0758-00
Bass	31-0576-00	Little Jessie	31-0784-00
Bello	31-0726-00	Little Long	31-0613-00
Blackwater	31-0561-00	Little Wabana	31-0399-00
Bluewater	31-0395-00	Moose	31-0722-00
Bowstring	31-0813-00	Natures	31-0877-00
Buck	31-0069-00	North Star	31-0653-00
Burrows	31-0413-00	Pickereel	31-0339-00
Caribou	31-0620-00	Pokegama	31-0532-00
Coon-Sandwich	31-0524-00	Prairie	31-0384-00
Crooked	31-0193-00	Rice	31-0717-00
Crooked	31-0543-00	Round	31-0896-00
Cut Foot Sioux	31-0857-00	Sand (Grand Rapids)	31-0438-00
Deer	31-0334-00	Sand (Squaw Lake)	31-0826-00
Deer	31-0719-00	Shallow	31-0084-00
Dixon	31-0921-00	Siseebakwet	31-0554-00
Dora	31-0882-00	Snaptail	31-0255-00
Grave	31-0624-00	Spider	31-0538-00
Hale	31-0373-00	Splithand	31-0353-00
Hart	31-0020-00	Swan	31-0067-00
Island	31-0913-00	Trout (Coleraine)	31-0216-00
Jack the Horse	31-0657-00	Trout (Marcell)	31-0410-00
Jessie	31-0786-00	Turtle	31-0725-00
		Wabana	31-0392-00

Water Connectivity

One of the highest risks to a water body becoming infested with AIS is if a nearby upstream lake is infested (Horvath 1996). Infested lakes can serve as a source of Zebra mussel veligers and invasive plant fragments for downstream water bodies and adjacent lakes; however, the inter-lake distance must be fairly close for the spread to be possible. Various studies have suggested a downstream veliger dispersal of 1-18 km (0.6-11 miles) in small streams (Lucy *et al.* 2005; Horvath *et al.* 1996). In this assessment, lakes that have an infested lake already identified less than 20 km (12 mi) upstream are at a high risk of infestation since the Zebra mussels could spread downstream (Table 2). Lakes that are in a chain have a moderate risk because if any upstream lakes get infested with Zebra mussels or invasive plants (<20 km), they could spread downstream. Headwaters lakes have a very low risk of infestation through water connectivity.

In addition to stream connections, adjacent water bodies have the potential to infest each other via boats going from one lake to another, regardless if the lakes are connected or not.

Table 2. Water connectivity and the related risk of AIS infestation.

Water Connectivity Category	Risk of infestation
Headwaters lake	Low risk
Small chain of lakes	Moderate risk
Large chain of lakes or upstream infested lake	High risk

Public Use

Boats and water related equipment have been shown to be one of the largest vectors in the spread of AIS (Johnson *et al.* 2001). While directly measuring boat transfer is difficult, the spread by boat can be estimated with some surrogate information, which we derived as follows and called "Total Boat Units" First, the number of public accesses and related parking spots are known on each lake. The more public accesses on the lake, the more potential boats can use the lake. Second, the number of resorts and hotels on the lake can be quantified. The hotels and resorts on the lake attract local and regional visitors, increasing the risk of infestation. Third, the number of fishing tournaments and special events on lakes can be quantified through a permitting process. Fishing tournaments and special events draw visitors to the lakes. Finally, the homeowners on the lake own an average of one dock/boat lift/boat per property. The purchase of an infested boat lift or other water related equipment has been the source of several documented new infestations in Minnesota. This use relationship coupled with transport of boats and water equipment from lake to lake increases the probability of infestation. "Destination lakes" for popular fish species like walleyes and muskies, along with popular recreation waters for boating and swimming, are at increased risk for infestation.

Public access inspections data were reviewed for each lake but difficulty in standardizing these across lakes challenged their reliability to be used as part of public use data for the final risk assessment. In the end, we calculated total boat units (TBU) as parking spaces + resort units + lake parcels + special events (Tables 3-4). For parcels, an average of one boat per parcel was used in the calculation. For fishing tournaments, the total boats participating in the tournament was used.

For access parking and resort units, the numbers were multiplied by 15 weeks of summer between Memorial Day and Labor Day for an estimated total summer use. The assumption for resort units is that each unit will have one watercraft a week for 15 weeks. This number is likely underestimated, but the ratings still come out the same either way, showing that the calculations are very robust (Tables 3-4). In weighting the resorts and accesses by the 15 weeks of summer, they are weighted appropriately compared to the resident parcels.

Table 3. Public use rating calculations. **All numbers are the total number of boats for the 15 weeks of summer.*

Lake	DOW	Private Parcels*	Access Parking*	Resort Units*	Special Events	Total*	Risk
Pokegama	31-0532-00	1,160	750	165	400	2,475	High
Cut Foot Sioux	31-0857-00	1	705	555	250	1,511	High
Bowstring	31-0813-00	197	570	585	140	1,492	High
Sand	31-0826-00	271	105	960	0	1,336	High
Bass	31-0576-00	220	75	765	40	1,100	Moderate
Turtle	31-0725-00	285	45	615	100	1,045	Moderate
Deer	31-0719-00	471	180	225	130	1,006	Moderate
Wabana	31-0392-00	176	225	375	130	906	Moderate
Island	31-0913-00	184	150	570	0	904	Moderate

Table 3 continued on the next page...

Table 3 continued. Public rating use calculations. **All numbers are total number of boats for 15 weeks of summer.*

Lake	DOW	Private Parcels*	Access Parking*	Resort Units*	Special Events	Total*	Risk
Swan	31-0067-00	456	105	210	120	891	Moderate
Jessie	31-0786-00	128	90	255	400	873	Moderate
North Star	31-0653-00	110	90	585	0	785	Moderate
Trout	31-0216-00	197	255	0	300	752	Moderate
Splithand	31-0353-00	80	450	0	120	650	Moderate
Moose	31-0216-00	104	75	420	40	639	Moderate
Ball Club	31-0812-00	73	90	405	40	608	Moderate
Round	31-0896-00	76	120	390	0	586	Moderate
Balsam	31-0259-00	109	90	195	20	414	Low
Prairie	31-0384-00	248	90	75	0	413	Low
Siseebakwet	31-0554-00	147	75	120	30	372	Low
Dora	31-0882-00	32	270	0	0	302	Low
Rice	31-0717-00	88	120	0	60	268	Low
Dixon	31-0921-00	64	15	180	0	259	Low
Shallow	31-0084-00	121	60	0	40	221	Low
Spider	31-0538-00	53	120	0	40	213	Low
Buck	31-0069-00	121	45	0	40	206	Low
Little Jessie	31-0784-00	78	120	0	0	198	Low
Deer	31-0334-00	122	60	0	0	182	Low
Coon-Sandwich	31-0524-00	0	180	0	0	180	Low
Blackwater	31-0561-00	20	150	0	0	170	Low
Caribou	31-0620-00	20	45	105	0	170	Low
Jack the Horse	31-0657-00	39	0	105	0	144	Low
Little Bowstring	31-0758-00	48	30	60	0	138	Low
Little Wabana	31-0399-00	32	0	105	0	137	Low
Crooked	31-0193-00	91	30	0	0	121	Low
Little Long	31-0613-00	30	90	0	0	120	Low
Sand	31-0438-00	58	60	0	0	118	Low
Grave	31-0624-00	66	45	0	0	111	Low
Burrows	31-0413-00	65	30	15	0	110	Low
Pickerel	31-0339-00	47	60	0	0	107	Low
Natures	31-0877-00	37	60	0	0	97	Low
Hart	31-0020-00	65	30	0	0	95	Low
Hale	31-0373-00	29	60	0	0	89	Low
Bello	31-0726-00	31	45	0	0	76	Low
Snaptail	31-0255-00	52	15	0	0	67	Low
Bluewater	31-0395-00	59	0	0	0	59	Low
Johnson	31-0687-00	49	0	0	0	49	Low
Trout	31-0410-00	33	0	0	0	33	Low
Crooked	31-0543-00	2	30	0	0	32	Low

Table 4. Use ratings and assigned risk for AIS mussel infestation.

	Low Risk	Moderate Risk	High Risk
Total Boat Units (the sum of public access parking spaces, resort units, lake parcels and special events)	0-500	501-1,200	1,201+

Zebra Mussel Suitability

There is a wealth of research published on Zebra mussel suitability in lakes, but not as much research on other AIS. Therefore, for this report, suitability ratings were focused on just Zebra mussels.

Water Chemistry

Available water quality data was compiled and analyzed for each major lake in Itasca County. The average was calculated for each available parameter. The values were then compared to the ranges in Table 5 to determine the potential for Zebra mussels to establish and reproduce in the water body. Calcium was considered first, based on its importance in shell formation (Mackie & Schloesser 1996); however calcium data were not available for all water bodies. Next, alkalinity, hardness and pH were considered (Mackie & Claudi 2010; Hincks & Mackie 1997). Lastly, Secchi depth, chlorophyll a and total phosphorus were considered, although they are not sufficient parameters alone to assess risk (Mackie & Claudi 2010).

Total phosphorus and chlorophyll a are useful in determining the lake's trophic state, which does affect suitability for Zebra mussels. Zebra mussels thrive best in mesotrophic lakes (Karatayev et al. 1998, Nelepa 1992). Eutrophic lakes have a lower suitability due to too much phosphorus and chlorophyll a, and usually softer substrates.

Table 5. Water column Zebra mussel suitability criteria (Mackie and Claudi 2010).

Parameter	Risk		
	Low Little Potential for Larval Development	Moderate (survivable, but will not flourish)	High (favorable for optimal growth)
Calcium (mg/l)	8-15	15-30	>30
pH	7.0-7.8 or 9.0-9.5	7.8-8.2 or 8.8-9.0	8.2-8.8
Hardness (mg/L)	30-35	55-100	100-280
Alkalinity (mg/L)	30-55	55-100	100-280
Specific Conductance (umhos)	30-60	60-110	>110
Secchi depth (m)	1-2 or 6-8	4-6	2-4
Chlorophyll a (ug/L)	2.0-2.5 or 20-25	8-20	2.5-8
Total Phosphorus	5-10 or 35-50	10-25	25-35

Substrate Suitability

One of the reasons Zebra mussels are such a nuisance is that they attach to hard substrates via their byssal threads. Zebra mussels prefer a hard substrate for attachment although they will attach to plants as well (Karatayev et al. 1998). In lakes, they have been documented to colonize on rocks, docks, boatlifts and water intake pipes. Lakes with mainly soft substrate and not many man-made structures may not be as supportive to Zebra mussel colonization. Plants have just moderate suitability because in Minnesota they die off at the end of each summer, meaning the Zebra mussels that are attached to them must crawl to other substrates or die off during winter (Karatayev et al. 1998). Comments are made for each water body, its dominant substrate, and its likelihood to support Zebra mussels. The substrate types were determined by the MNDNR (Table 6).

Table 6. Substrate descriptions and their suitability to Zebra mussel survival.

Substrate (MNDNR)	Description	Suitability to Zebra mussels
Muck	Decomposed organic material	Low
Marl	Calcareous material	Low
Silt	Fine material with little grittiness	Low
Sand	Diameter less than 1/8 inch	Moderate
Submerged macrophytes	Underwater rooted plants	Moderate
Gravel	Diameter 1/8 to 3 inches	High
Rubble	Diameter 3 to 10 inches	High
Boulder	Diameter over 10 inches	High

Temperature

Zebra mussels begin reproduction when water temperature is above 12 C, but ideal reproduction temperature occurs above 17-18C (McMahon 1996). The upper thermal limit for North American Zebra mussels occurs somewhere around 30 C (McMahon 1996). The optimal temperature range for zebra mussel spawning in North America is estimated to be between 18-26 C.

In Minnesota, lakes are usually ice-covered on average from November to March. During the ice-covered season, it is assumed that the water temperature is too cold for Zebra mussel spawning. However, the Zebra mussels do over-winter at the bottom of the lake (Mackie *et al.* 1989).

In summer, Minnesota lakes rarely exceed 30 C (86 F); therefore, it is likely that the Zebra mussels reproduce all summer once the water temperature reaches 17-18 C. This occurrence has been documented in Pelican Lake, where Zebra mussel veligers were first found at 18 C in 2012 and 19 C in 2013 (Rufer 2015).

The maximum temperature was reported for each lake and the risk was assigned based on if the lake exceeded 32 C in mid-summer or not (Table 7). The lake's mixing regime and period of hypolimnetic anoxia were also noted as research has found that few Zebra mussel veligers occur below the thermocline in temperate lakes (Mackie *et al.* 1989).

Table 7. Temperature values and their impact on Zebra mussel survival.

Survival Potential	Temperature Range	Risk Rating
Prevent zebra mussel establishment	> 32 C	Low
Little impact on mussel survival	8 – 31 C	High

Overall Ratings

AIS infestation risk rating

The two main vectors of spread for AIS are lake connectivity and public use. The risks from these two categories were combined for an overall risk of infestation rating for each lake. A scoring system was used to weight each of these two categories, which resulted in three overall risk categories (Table 8).

Table 8. Combined AIS infestation risk rating using public use and connectivity.

	Public Use Total Boat Units	Connectivity	Combined Risk Rating
Low Risk	0-500	0 = Headwaters Lake	0-750
Moderate Risk	501-2,000	500 = Chain of Lakes	751-1,699
High Risk	2,000+	1,000 = Infested or Infested lake upstream	1,700+

Zebra mussel Suitability Rating

The two main factors for zebra mussels thriving in a lake are suitable water chemistry and suitable substrate. The risks from these two categories were combined for an overall suitability rating for each lake. This suitability rating can be interpreted as the probability that Zebra mussels will thrive in the lake. A scoring system was used to weight each of these two categories, which resulted in three overall risk categories (Table 9).

Table 9. Combined Zebra mussel suitability rating using water chemistry and substrate.

	Water Quality	Substrate	Combined Risk Rating
Low Risk	0 = The majority of averages in green category.	0 = Clay, Silt, Muck	0 - Low
Moderate Risk	500 = The majority of averages in yellow category.	500=Sand, Submerged macrophytes	1000 - Moderate
High Risk	1,000 = The majority of averages in red category.	1,000 = Rocks, Gravel, Rubble	2000 - High

Lake Risk Assessment Summary: Ball Club Lake (31-0812-00)

AIS infestation risk rating: Moderate

1. Connectivity: Low Risk
2. Public Use: Moderate Risk

ZM Suitability Risk Rating: High

1. Water Chemistry: High Risk
2. Substrate: Moderate Risk

Characteristics

Major Watershed: Miss. R. Headwaters
 Location: 7 miles west of Deer River in Ball Club
 Surface Area: 3,844 acres
 Percent Littoral: 28%
 Max Depth: 80 feet
 Inlets: stream from Little Ball Club, 3 headwater streams, fisherman's brook



Summary

Ball Club Lake has three upstream lakes and moderate public use, resulting in a low AIS infestation risk rating. Water chemistry shows that it is a hard water lake with ample calcium for zebra mussel shell development; therefore, the suitability rating is high.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	3 upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (73)	608	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (535)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Marl, Silt	95%, 88%, 30%	Moderate

Water Chemistry Risk

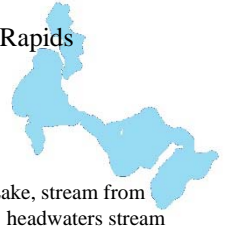
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	39.9	1	>30
pH*		8.4	1	8.2-8.8
Alkalinity*	mg/L	140	1	100-280
Specific Conductance *	uS/cm	264	1	>110
Secchi Depth	ft	11.0	1	6.56-13.12
Chlorophyll a	ug/L	3.0	3	2.5-8
Total Phosphorus	ug/L	20.0	4	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	15.1 (1)	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Balsam Lake (31-0259-00)

AIS infestation risk rating: Moderate 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 13 southeast of Marcell Surface Area: 714 acres Percent Littoral: 42% Max Depth: 42 feet Inlets: Balsam Creek, stream from King Lake, stream from Scrapper Lake, stream from Hunter Lake, 1 headwaters stream
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Balsam Lake has low public use, but the 22 upstream lakes results in an overall moderate AIS infestation risk rating. Water chemistry and substrate data show that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	22 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (109)	414	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (305)		
Substrate Suitability (frequency of occurrence, DNR)		Detritus, Sand, Gravel	100%, 93%, 47%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	28.3	1	>30
pH*		8.1	6	8.2-8.8
Alkalinity*	mg/L	99	10	100-280
Specific Conductance *	uS/cm	159	3	>110
Secchi Depth	ft	10.8	161	6.56-13.12
Chlorophyll a	ug/L	4	22	2.5-8
Total Phosphorus	ug/L	17	30	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Bass (31-0576-00)

AIS infestation risk rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 3 miles north of Cohasset Surface Area: 2714 acres Percent Littoral: 46% Max Depth: 76 feet Inlets: Stream from Little Bass Lake, 1 headwater stream, Pohl Creek, stream from Bullhead Lake, Stevens Brook
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Bass Lake has 7 upstream lakes and moderate public use, resulting in a high AIS infestation risk rating. Water chemistry and substrate data show that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	7 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (220)	1,100	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (880)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rubble	68%, 63%, 23%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	35.8	1	>30
pH*		8.2	23	8.2-8.8
Alkalinity*	mg/L	120	13	100-280
Specific Conductance *	uS/cm	186	23	>110
Secchi Depth	ft	13.6	760	6.56-13.12
Chlorophyll a	ug/L	5	75	2.5-8
Total Phosphorus	ug/L	19	80	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.3 (27)	>32 C	High
Dissolved oxygen	9.5 (11)	<7 mg/L	High

Lake Risk Assessment Summary: Bello Lake (31-0726-00)

AIS infestation risk rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 5 ½ miles north of Marcell Surface Area: 527 acres Percent Littoral: 60% Max Depth: 58 feet Inlet: stream from Mike Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Bello Lake has two upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Upstream lakes	2 upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (31)	76	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (45)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rock	55%, 40%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	21.2	1	>30
pH*		8.0	7	8.2-8.8
Alkalinity*	mg/L	73	9	100-280
Specific Conductance *	uS/cm	130	1	>110
Secchi Depth	ft	10.5	165	6.56-13.12
Chlorophyll a	ug/L	2	8	2.5-8
Total Phosphorus	ug/L	10	8	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	6.7 (1)	>32 C	High
Dissolved oxygen	10.2 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Blackwater Lake (31-0561-00)

AIS infestation risk rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 2 miles west of Cohasset Surface Area: NA Percent Littoral: NA Max Depth: NA Inlets: Mississippi River, Blackwater Creek
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Blackwater Lake has 359 upstream lakes, and 19 of them are infested with zebra mussels. Even though there is low public use, the presence of infested lakes upstream gives Blackwater Lake a high AIS infestation risk rating. Water chemistry data show there is enough calcium for zebra mussel shell formation. There are no other water chemistry or substrate data for evaluation.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Long chain of lakes	359 upstream lakes; 19 infested	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (20)	170	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (150)		
Substrate Suitability (frequency of occurrence, DNR)		NA	NA	NA

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	34.9	1	>30
pH*		NA	0	8.2-8.8
Alkalinity*	mg/L	NA	0	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	2	1	6.56-13.12
Chlorophyll a	ug/L	NA	0	2.5-8
Total Phosphorus	ug/L	NA	0	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Bluewater Lake (31-0395-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 12 miles north of Grand Rapids Surface Area: 359 acres Percent Littoral: 21% Max Depth: 120 feet Inlet: None
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Bluewater Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (59)	59	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (0)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Gravel	55%, 15%, 15%	High

Water Chemistry Risk

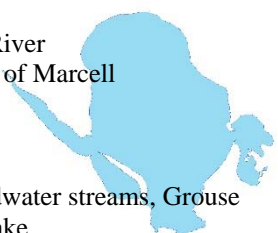
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	93	1	>30
pH*		8.5	40	8.2-8.8
Alkalinity*	mg/L	130	8	100-280
Specific Conductance *	uS/cm	242	38	>110
Secchi Depth	ft	18.6	722	6.56-13.12
Chlorophyll a	ug/L	1	19	2.5-8
Total Phosphorus	ug/L	8	19	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.5 (8)	>32 C	High
Dissolved oxygen	9 (9)	<7 mg/L	High

Lake Risk Assessment Summary: Bowstring Lake (31-0813-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : High Risk	Characteristics Major Watershed: Big Fork River Location: 10 miles southwest of Marcell Surface Area: 9,526 acres Percent Littoral: 51% Max Depth: 32 feet Inlets: Big Fork River, 5 headwater streams, Grouse Creek, stream from Taylor Lake 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Bowstring Lake has 70 upstream lakes and high public use, resulting in a high AIS infestation risk rating. Water chemistry and substrate data show that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	70 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (197)	1,492	High
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (1,295)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rubble	70%, 15%, 10%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	26.4	1	>30
pH*		8.3	26	8.2-8.8
Alkalinity*	mg/L	99	6	100-280
Specific Conductance *	uS/cm	184	25	>110
Secchi Depth	ft	9.2	17	6.56-13.12
Chlorophyll a	ug/L	23	15	2.5-8
Total Phosphorus	ug/L	38	17	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.4 (10)	>32 C	High
Dissolved oxygen	9.5 (10)	<7 mg/L	High

Lake Risk Assessment Summary: Buck Lake (31-0069-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 11 miles north of Nashwauk Surface Area: 495.1 acres Percent Littoral: 42% Max Depth: 31 feet Inlets: None
ZM Suitability Risk Rating: Low 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : High Risk	

Summary

Buck Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data, especially calcium, show the lake may not be suitable for zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	206	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Boulder	80%, 15%, 5%	High

Water Chemistry Risk

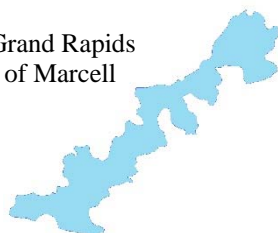
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	10.4	1	>30
pH*		7.6	60	8.2-8.8
Alkalinity*	mg/L	42.3	11	100-280
Specific Conductance *	uS/cm	125.0	55	>110
Secchi Depth	ft	9.9	205	6.56-13.12
Chlorophyll a	ug/L	8.8	6	2.5-8
Total Phosphorus	ug/L	26.8	6	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	22.7 (9)	>32 C	High
Dissolved oxygen	8.4 (9)	<7 mg/L	High

Lake Risk Assessment Summary: Burrows Lake (31-0413-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 10 miles southeast of Marcell Surface Area: 291 acres Percent Littoral: 78% Max Depth: 36 feet Inlet: None
ZM Suitability Risk Rating: Low 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Burrows Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that it is a soft water lake and substrates are soft, which could be unsuitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (65)	110	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (45)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Detritus, Marl	95%, 80%, 25%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	8.6	1	>30
pH*		7.1	3	8.2-8.8
Alkalinity*	mg/L	12	7	100-280
Specific Conductance *	uS/cm	28	1	>110
Secchi Depth	ft	12.3	87	6.56-13.12
Chlorophyll a	ug/L	6	9	2.5-8
Total Phosphorus	ug/L	15	9	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	21 (1)	>32 C	High
Dissolved oxygen	7.6 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Caribou Lake (31-0620-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 5 miles south of Marcell Surface Area: 247 acres Percent Littoral: 20% Max Depth: 152 feet Inlet: None
ZM Suitability Risk Rating: Low 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : High Risk	

Summary

Caribou Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that it is an oligotrophic soft water lake, which could be unsuitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (20)	170	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (150)		
Substrate Suitability (frequency of occurrence, DNR)		Clay/Sand, Boulder, Gravel/Rubble	85%, 15%,	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	NA	0	>30
pH*		8.0	30	8.2-8.8
Alkalinity*	mg/L	27	5	100-280
Specific Conductance *	uS/cm	53	27	>110
Secchi Depth	ft	30.7	223	6.56-13.12
Chlorophyll a	ug/L	1	16	2.5-8
Total Phosphorus	ug/L	10	17	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	23.6 (4)	>32 C	High
Dissolved oxygen	8.9 (4)	<7 mg/L	High

Lake Risk Assessment Summary: Coon-Sandwich Lake (31-0524-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 4 miles southeast of Bigfork Surface Area: 593 acres Percent Littoral: 28% Max Depth: 380 feet Inlet: None
ZM Suitability Risk Rating: Low 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : High Risk	

Summary

Coon-Sandwich Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that it is a soft water lake with low calcium, which could be unsuitable to Zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	180	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Rock	50%, 45%, 5%	High

Water Chemistry Risk

Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	12.1	1	>30
pH*		8.3	31	8.2-8.8
Alkalinity*	mg/L	49	11	100-280
Specific Conductance *	uS/cm	87	30	>110
Secchi Depth	ft	11.5	10	6.56-13.12
Chlorophyll a	ug/L	5	11	2.5-8
Total Phosphorus	ug/L	16	11	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.3 (11)	>32 C	High
Dissolved oxygen	9 (11)	<7 mg/L	High

Lake Risk Assessment Summary: Crooked Lake (31-0193-00)

AIS Infestation Risk Rating: Moderate

1. Connectivity: High Risk
2. Public Use: Low Risk

ZM Suitability Risk Rating: Moderate

1. Water Chemistry: Moderate Risk
2. Substrate: High Risk

Characteristics

Major Watershed: Miss. R. Grand Rapids
 Location: 8 ½ miles northwest of Nashwauk
 Surface Area: 463 acres
 Percent Littoral: 46%
 Max Depth: 60 feet
 Inlets: stream from Bass Lake, stream from Fourth Sucker Lake, stream from Moose Lake, stream from Bray Lake



Summary

Crooked Lake has low public use, but the 84 upstream lakes results in a moderate AIS infestation risk rating. Water chemistry data show that the lake has a moderate suitability to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large lake chain	84 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (91)	121	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (30)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rubble	85%, 10%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	18	3	>30
pH*		7.8	11	8.2-8.8
Alkalinity*	mg/L	78	14	100-280
Specific Conductance *	uS/cm	138	4	>110
Secchi Depth	ft	6.6	124	6.56-13.12
Chlorophyll a	ug/L	6	12	2.5-8
Total Phosphorus	ug/L	20	12	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	20 (2)	>32 C	High
Dissolved oxygen	7 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Crooked Lake (31-0543-00)

AIS Infestation Risk Rating Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 10 miles northwest of Nashwauk Surface Area: 134.5 acres Percent Littoral: 78.4% Max Depth: 46 feet Inlets: None
ZM Suitability Risk Rating: Moderate 1. <u>Water Chemistry</u> : Moderate Risk 2. <u>Substrate</u> : High Risk	

Summary

Crooked Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that the lake has a moderate suitability to Zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	32	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Rubble	75%, 20%, 5%	High

Water Chemistry Risk

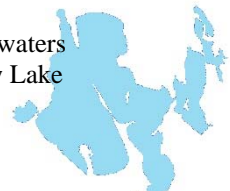
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	19.9	1	>30
pH*		7.4	10	8.2-8.8
Alkalinity*	mg/L	14	9	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	9.7	26	6.56-13.12
Chlorophyll a	ug/L	4.5	21	2.5-8
Total Phosphorus	ug/L	10.0	21	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	NA
Dissolved oxygen	NA	<7 mg/L	NA

Lake Risk Assessment Summary: Cut Foot Sioux Lake (31-0857-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : High Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 8 miles south of Squaw Lake Surface Area: 2771 acres Percent Littoral: 68% Max Depth: 77 feet Inlets: stream from Deer Lake, 1 headwater stream, stream from Dry Creek Lake, Simpson Creek, stream from Little Cut Foot Sioux Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Cut Foot Sioux Lake has 9 upstream lakes and high public use, resulting in a high AIS infestation risk rating. Cut Foot Sioux Lake is listed as **infested** with zebra mussels. Water chemistry and substrate data show that the lake is suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Classified INFESTED	9 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (1)	1,511	High
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (1,510)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rock	50%, 45%, 5%	High

Water Chemistry Risk

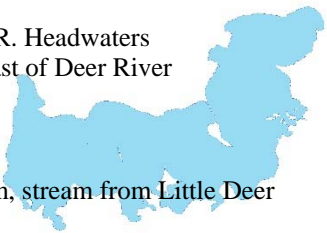
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	24.6	1	>30
pH*		8.1	14	8.2-8.8
Alkalinity*	mg/L	155	12	100-280
Specific Conductance *	uS/cm	234	4	>110
Secchi Depth	ft	9.6	158	6.56-13.12
Chlorophyll a	ug/L	7	21	2.5-8
Total Phosphorus	ug/L	21	25	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	22 (7)	>32 C	High
Dissolved oxygen	9 (7)	<7 mg/L	High

Lake Risk Assessment Summary: Deer Lake (31-0719-00)

AIS Infestation Risk Rating: Moderate <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Low Risk 2. <u>Public Use</u>: Moderate Risk 	Characteristics Major Watershed: Miss. R. Headwaters Location: 7 miles northeast of Deer River Surface Area: 4094 acres Percent Littoral: 22% Max Depth: 101 feet Inlets: 1 headwater stream, stream from Little Deer Lake 
ZM Suitability Risk Rating: High <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: High Risk 	

Summary

Deer Lake has one upstream lake and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show that it is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters lake	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (471)	1,006	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (535)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Rubble, Marl	88%, 63%, 48%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	31.2	1	>30
pH*		8.2	161	8.2-8.8
Alkalinity*	mg/L	120	137	100-280
Specific Conductance *	uS/cm	214	48	>110
Secchi Depth	ft	16.5	157	6.56-13.12
Chlorophyll a	ug/L	2	32	2.5-8
Total Phosphorus	ug/L	10	35	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	23.7 (39)	>32 C	High
Dissolved oxygen	9.8 (29)	<7 mg/L	High

Lake Risk Assessment Summary: Deer Lake (31-0334-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 12 miles east of Effie Surface Area: 1854 acres Percent Littoral: 73% Max Depth: 50 feet Inlets: 3 headwater streams, stream from Shoal Lake, stream from Arbo Lake, Hay Creek, Prairie River 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Deer Lake has low public use, but having 15 upstream lakes results in a moderate AIS infestation risk rating. Water chemistry data show that it is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large lake chain	15 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (122)	182	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (60)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Marl	97%, 43%, 43%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	29.5	1	>30
pH*		8.1	33	8.2-8.8
Alkalinity*	mg/L	115	18	100-280
Specific Conductance *	uS/cm	171	12	>110
Secchi Depth	ft	9.9	202	6.56-13.12
Chlorophyll a	ug/L	4	11	2.5-8
Total Phosphorus	ug/L	12	11	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.4 (12)	>32 C	High
Dissolved oxygen	9.3 (12)	<7 mg/L	High

Lake Risk Assessment Summary: Dixon Lake (31-0921-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 7 miles west of Squaw Lake Surface Area: 622 acres Percent Littoral: 63% Max Depth: 29 feet Inlets: 6 headwater streams, stream from Taylor Lake, Bowstring River
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Dixon Lake has low public use, but having 12 upstream lakes results in a moderate AIS infestation risk rating. Water chemistry data shows that the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large lake chain	12 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (64)	259	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (195)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Silt	57%, 43%, 20%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	47.9	1	>30
pH*		8.4	19	8.2-8.8
Alkalinity*	mg/L	126	7	100-280
Specific Conductance *	uS/cm	245	18	>110
Secchi Depth	ft	5.8	164	6.56-13.12
Chlorophyll a	ug/L	16	23	2.5-8
Total Phosphorus	ug/L	39	28	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	27.2 (12)	>32 C	High
Dissolved oxygen	9.6 (6)	<7 mg/L	High

Lake Risk Assessment Summary: Dora Lake (31-0882-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 4 miles west of Wirt Surface Area: 430 acres Percent Littoral: 100% Max Depth: 15 feet Inlets: Big Fork River, stream from Coddington Lake 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Dora Lake has 71 upstream lakes and 5 of those lakes are infested with zebra mussels. Even though the lake has low public use, the infested lakes upstream result in a high AIS infestation risk rating. Water chemistry data show that the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large watershed	71 upstream lakes; 5 infested	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (32)	302	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (270)		
Substrate Suitability (frequency of occurrence, DNR)		Muck, Sand	85%, 15%	Moderate

Water Chemistry Risk

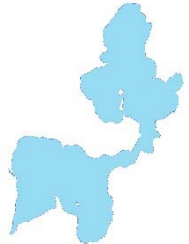
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	27	1	>30
pH*		8.1	24	8.2-8.8
Alkalinity*	mg/L	112	15	100-280
Specific Conductance *	uS/cm	218	22	>110
Secchi Depth	ft	9.5	275	6.56-13.12
Chlorophyll a	ug/L	10	35	2.5-8
Total Phosphorus	ug/L	40	34	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.7 (10)	>32 C	High
Dissolved oxygen	7.6 (4)	<7 mg/L	High

Lake Risk Assessment Summary: Grave Lake (31-0624-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 6 ½ miles south of Marcell Surface Area: 525 acres Percent Littoral: 84% Max Depth: 39 feet Inlet: Big Fork River	
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk		

Summary

Grave Lake has one upstream lake and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show that it is likely suitable to Zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	111	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Muck, Marl, Boulder	100%, 30%, 30%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	37.7	1	>30
pH*		8.1	11	8.2-8.8
Alkalinity*	mg/L	143	12	100-280
Specific Conductance *	uS/cm	244	3	>110
Secchi Depth	ft	13.1	281	6.56-13.12
Chlorophyll a	ug/L	4	20	2.5-8
Total Phosphorus	ug/L	13	20	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	22 (1)	>32 C	High
Dissolved oxygen	8.2 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Hale Lake (31-0373-00)

AIS Infestation Risk Rating: Low <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Low Risk 2. <u>Public Use</u>: Low Risk 	Characteristics Major Watershed: Miss. R. Grand Rapids Location: In Grand Rapids Surface Area: 130 acres Percent Littoral: 27% Max Depth: 57 feet Inlet: stream from Crystal Lake 
ZM Suitability Risk Rating: High <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: Moderate Risk 	

Summary

Hale Lake has two upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that Hale Lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Small lake chain	2 upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (29)	89	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (60)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Clay	50%, 40%, 10%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	82	1	>30
pH*		8.4	16	8.2-8.8
Alkalinity*	mg/L	113	6	100-280
Specific Conductance *	uS/cm	239	21	>110
Secchi Depth	ft	15.7	267	6.56-13.12
Chlorophyll a	ug/L	2	6	2.5-8
Total Phosphorus	ug/L	9	6	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.8 (5)	>32 C	High
Dissolved oxygen	8.8 (5)	<7 mg/L	High

Lake Risk Assessment Summary: Hart Lake (31-0020-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 6 miles south of Pengilly Surface Area: 325 acres Percent Littoral: NA Max Depth: 55 feet Inlets: 1 headwater stream, stream from unnamed lake 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Hart Lake has one upstream lake and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show that Hart Lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (65)	95	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (30)		
Substrate Suitability (frequency of occurrence, DNR)		Detritus, Sand, Muck	79%, 79%, 53%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	58	1	>30
pH*		8.1	11	8.2-8.8
Alkalinity*	mg/L	100	14	100-280
Specific Conductance *	uS/cm	170	1	>110
Secchi Depth	ft	10.2	87	6.56-13.12
Chlorophyll a	ug/L	3	13	2.5-8
Total Phosphorus	ug/L	13	13	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	20 (1)	>32 C	High
Dissolved oxygen	8 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Island Lake (31-0913-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Big Fork River Location: 4 miles south of Northome Surface Area: 3108 acres Percent Littoral: 39% Max Depth: 35 feet Inlets: stream from Williams Lake, 3 headwater streams 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Island Lake has two upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to Zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Small lake chain	2 upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (184)	904	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (720)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Rubble, Detritus	79%, 55%, 33%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	31.1	1	>30
pH*		8.6	3	8.2-8.8
Alkalinity*	mg/L	110	4	100-280
Specific Conductance *	uS/cm	205	4	>110
Secchi Depth	ft	8.8	256	6.56-13.12
Chlorophyll a	ug/L	15	52	2.5-8
Total Phosphorus	ug/L	33	52	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.8 (37)	>32 C	High
Dissolved oxygen	9.8 (6)	<7 mg/L	High

Lake Risk Assessment Summary: Jack the Horse Lake (31-0657-00)

AIS Infestation Risk Rating Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 3 miles northeast of Marcell Surface Area: 363 acres Percent Littoral: 61% Max Depth: 45 feet Inlet: stream from Little Dick Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Jack the Horse Lake has one upstream lake and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	144	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Detritus, Muck	60%, 55%, 40%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	39.3	1	>30
pH*		8.2	5	8.2-8.8
Alkalinity*	mg/L	144	6	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	13	164	6.56-13.12
Chlorophyll a	ug/L	3	8	2.5-8
Total Phosphorus	ug/L	10	8	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Jessie Lake (31-0786-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Big Fork River Location: 6 miles west of Marcell Surface Area: 1740 acres Percent Littoral: 25% Max Depth: 40 feet Inlets: 3 headwater streams, Spring Lake Creek
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Jessie Lake has six upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Lake chain	6 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	873	Moderate
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Gravel	80%, 15%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	37.5	1	>30
pH*		7.9	5	8.2-8.8
Alkalinity*	mg/L	140	1	100-280
Specific Conductance *	uS/cm	233	3	>110
Secchi Depth	ft	8.7	432	6.56-13.12
Chlorophyll a	ug/L	10	10	2.5-8
Total Phosphorus	ug/L	33	22	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	20 (6)	>32 C	High
Dissolved oxygen	9.8 (6)	<7 mg/L	High

Lake Risk Assessment Summary: Johnson Lake (31-0687-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 3 miles northeast of Marcell Surface Area: 304 acres Percent Littoral: 37% Max Depth: 51 feet Inlet: Johnson Creek	
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk		

Summary

Johnson Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	no upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	49	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Clay, Gravel	100%, 50%, 45%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32.6	1	>30
pH*		8.3	6	8.2-8.8
Alkalinity*	mg/L	108	10	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	10.9	108	6.56-13.12
Chlorophyll a	ug/L	2	10	2.5-8
Total Phosphorus	ug/L	9	10	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Little Bowstring Lake (31-0758-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 7 miles south of Marcell Surface Area: 327 acres Percent Littoral: 36% Max Depth: 33 feet Inlets: Big Fork River, stream from Pike Lake, stream from Maki Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Little Bowstring Lake has four upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Small lake chain	4 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	138	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Clay	95%, 50%, 50%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	NA	0	>30
pH*		8.6	8	8.2-8.8
Alkalinity*	mg/L	143	8	100-280
Specific Conductance *	uS/cm	269	8	>110
Secchi Depth	ft	8	221	6.56-13.12
Chlorophyll a	ug/L	10	15	2.5-8
Total Phosphorus	ug/L	29	15	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.5 (14)	>32 C	High
Dissolved oxygen	9.1 (8)	<7 mg/L	High

Lake Risk Assessment Summary: Little Jessie Lake (31-0784-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 7 miles southwest of Marcell Surface Area: 628 acres Percent Littoral: 31% Max Depth: 55 feet Inlets: 2 headwater streams 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Little Jessie Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (78)	198	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (120)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Gravel	75%, 10%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32.7	1	>30
pH*		8.5	10	8.2-8.8
Alkalinity*	mg/L	147	10	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	15.4	126	6.56-13.12
Chlorophyll a	ug/L	3	10	2.5-8
Total Phosphorus	ug/L	10	10	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Little Long Lake (31-0613-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 9 miles southeast of Marcell Surface Area: 253 acres Percent Littoral: 61% Max Depth: 61 feet Inlet: stream from Wolf Lake 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Little Long Lake has nine upstream lakes and low public use, resulting in a moderate AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	9 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (30)	120	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (90)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck	80%, 20%	Moderate

Water Chemistry Risk

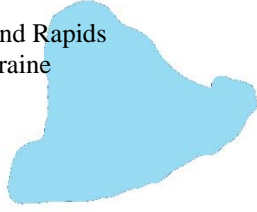
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32.1	1	>30
pH*		NA	0	8.2-8.8
Alkalinity*	mg/L	113	5	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	16.1	146	6.56-13.12
Chlorophyll a	ug/L	1	1	2.5-8
Total Phosphorus	ug/L	16	8	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Little Wabana Lake (31-0399-00)

<p>AIS Infestation Risk Rating: Low</p> <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Low Risk 2. <u>Public Use</u>: Low Risk <p>ZM Suitability Risk Rating: High</p> <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: High Risk 	<p>Characteristics</p> <p>Major Watershed: Miss. R. Grand Rapids Location: 8 miles north of Coleraine Surface Area: 116 acres Percent Littoral: 32% Max Depth: 57 feet Inlet: None</p> 
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Summary

Little Wabana Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (32)	137	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (105)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Marl, Rubble	70%, 20%, 5%	High

Water Chemistry Risk

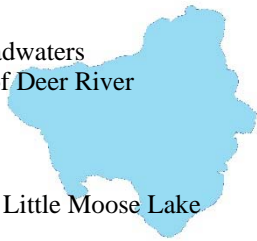
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	48	4	>30
pH*		8.3	10	8.2-8.8
Alkalinity*	mg/L	NA	0	100-280
Specific Conductance *	uS/cm	136	10	>110
Secchi Depth	ft	19.2	458	6.56-13.12
Chlorophyll a	ug/L	4	16	2.5-8
Total Phosphorus	ug/L	12	16	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	23.6 (5)	>32 C	High
Dissolved oxygen	10 (5)	<7 mg/L	High

Lake Risk Assessment Summary: Moose Lake (31-0722-00)

AIS Infestation Risk Rating: Moderate <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Moderate Risk 2. <u>Public Use</u>: Moderate Risk 	Characteristics Major Watershed: Miss. R. Headwaters Location: 6 ½ miles northeast of Deer River Surface Area: 1274 acres Percent Littoral: 28% Max Depth: 61 feet Inlets: Deer River, stream from Little Moose Lake 
ZM Suitability Risk Rating: High <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: High Risk 	

Summary

Moose Lake has ten upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	10 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (104)	639	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (535)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Rock, Clay	75%, 15%, 10%	High

Water Chemistry Risk

Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	9.4**	1	>30
pH*		8.3	4	8.2-8.8
Alkalinity*	mg/L	113	3	100-280
Specific Conductance *	uS/cm	244	5	>110
Secchi Depth	ft	14.5	200	6.56-13.12
Chlorophyll a	ug/L	4	14	2.5-8
Total Phosphorus	ug/L	14	16	25-35


*primary parameters for zebra mussel Suitability

**This data point was collected at a 17m depth, so is not surface calcium.

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26 (14)	>32 C	High
Dissolved oxygen	10.2 (8)	<7 mg/L	High

Lake Risk Assessment Summary: Natures Lake (31-0877-00)

AIS Infestation Risk Rating: Moderate <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Moderate Risk 2. <u>Public Use</u>: Low Risk 	Characteristics Major Watershed: Big Fork River Location: 1 mile east of Squaw Lake Surface Area: 2250 acres Percent Littoral: 100% Max Depth: 4 feet Inlets: 2 headwater streams, Wagner Creek, stream from Round Lake 
ZM Suitability Risk Rating: High <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: NA Risk 	

Summary

Natures Lake has low public use, but having 16 upstream lakes results in a moderate AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	16 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (37)	97	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (60)		
Substrate Suitability (frequency of occurrence, DNR)		NA	NA	NA

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32.8	1	>30
pH*		8.8	1	8.2-8.8
Alkalinity*	mg/L	110	1	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	5.1	165	6.56-13.12
Chlorophyll a	ug/L	4	5	2.5-8
Total Phosphorus	ug/L	34	7	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	21 (1)	>32 C	High
Dissolved oxygen	10.2 (1)	<7 mg/L	High

Lake Risk Assessment Summary: North Star Lake (31-0653-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Big Fork River Location: 2 miles south of Marcell Surface Area: 821 acres Percent Littoral: 31% Max Depth: 88 feet Inlet: Potato Creek 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

North Star Lake has one upstream lake and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry data show the lake is likely suitable for zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (110)	785	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (675)		
Substrate Suitability (frequency of occurrence, DNR)		Marl, Detritus, Sand	83%, 68%, 63%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	34.5	1	>30
pH*		8.4	9	8.2-8.8
Alkalinity*	mg/L	127	13	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	13.7	209	6.56-13.12
Chlorophyll a	ug/L	2	27	2.5-8
Total Phosphorus	ug/L	13	38	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	21.5 (1)	>32 C	High
Dissolved oxygen	8.6 (1)	<7 mg/L	High

Lake Risk Assessment Summary: Pickerel Lake (31-0339-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Big Fork River Location: 13 miles east of Effie Surface Area: 241 acres Percent Littoral: 29% Max Depth: 40 feet Inlet: None
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Pickerel Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	107	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Detritus, Muck	75%, 55%, 50%	Moderate

Water Chemistry Risk

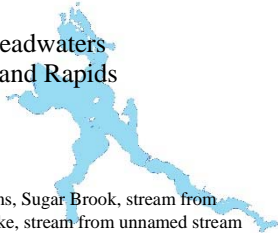
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	31.3	1	>30
pH*		8.1	11	8.2-8.8
Alkalinity*	mg/L	109	16	100-280
Specific Conductance *	uS/cm	186	4	>110
Secchi Depth	ft	9.6	209	6.56-13.12
Chlorophyll a	ug/L	5	16	2.5-8
Total Phosphorus	ug/L	16	16	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.3 (5)	>32 C	High
Dissolved oxygen	8.6 (5)	<7 mg/L	High

Lake Risk Assessment Summary: Lake Pokegama (31-0532-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : High Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 3 miles south of Grand Rapids Surface Area: 6703 acres Percent Littoral: 32% Max Depth: 110 feet Inlets: Smith Creek, 5 headwater streams, Sugar Brook, stream from Cavanaugh Lake, stream from Munzer Lake, stream from unnamed stream
Suitability Risk Rating: High 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : Low Risk	

Summary

Lake Pokegama has 13 upstream lakes and high public use, resulting in a high AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large lake chain	13 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (1,160)	2,475	High
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (1,315)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Rock, Rubble	73%, 10%, 10%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	31.7	1	>30
pH*		8.3	96	8.2-8.8
Alkalinity*	mg/L	134	90	100-280
Specific Conductance *	uS/cm	262	96	>110
Secchi Depth	ft	14.9	1,558	6.56-13.12
Chlorophyll a	ug/L	4	95	2.5-8
Total Phosphorus	ug/L	14	105	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.3 (29)	>32 C	High
Dissolved oxygen	9.7 (29)	<7 mg/L	High

Lake Risk Assessment Summary: Prairie Lake (31-0384-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 5 miles north of Grand Rapids Surface Area: 1129 acres Percent Littoral: 80% Max Depth: 31 feet Inlets: stream from Shoal Lake, stream from unnamed lake, 3 headwater streams
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : Low Risk 2. <u>Substrate</u> : Low Risk	

Summary

Prairie Lake has two upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Lake chain	2 upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	413	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Boulder	50%, 40%, 10%	High

Water Chemistry Risk

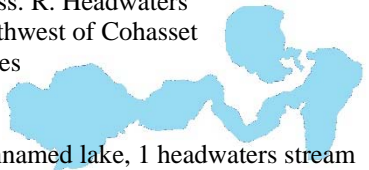
Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	24.1	1	>30
pH*		NA	0	8.2-8.8
Alkalinity*	mg/L	76	7	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	5.4	258	6.56-13.12
Chlorophyll a	ug/L	6	14	2.5-8
Total Phosphorus	ug/L	27	6	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	27.1 (12)	>32 C	High
Dissolved oxygen	8.7 (11)	<7 mg/L	High

Lake Risk Assessment Summary: Rice Lake (31-0717-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 4 miles southwest of Cohasset Surface Area: 863 acres Percent Littoral: 30% Max Depth: 68 feet Inlets: stream from unnamed lake, 1 headwaters stream
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Rice Lake has one upstream lake and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	268	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Marl (55%), Sand (40%), Rubble (5%)	55%, 40%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32	1	>30
pH*		8.2	6	8.2-8.8
Alkalinity*	mg/L	159	10	100-280
Specific Conductance *	uS/cm	NA	0	>110
Secchi Depth	ft	13.3	88	6.56-13.12
Chlorophyll a	ug/L	2	10	2.5-8
Total Phosphorus	ug/L	9	10	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	NA	>32 C	High
Dissolved oxygen	NA	<7 mg/L	High

Lake Risk Assessment Summary: Round Lake (31-0896-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Big Fork River Location: 1 mile west of Squaw Lake Surface Area: 2860 acres Percent Littoral: 68% Max Depth: 24 feet Inlets: 4 headwater streams, Popple River, Dunbar River, stream from Alice Lake
ZM Suitability Risk Rating: Moderate 1. <u>Water Chemistry</u> : Moderate Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Round Lake has 13 upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show a moderate suitability to zebra mussels. It could be that the lake is too eutrophic to support a thriving zebra mussel population.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Large lake chain	13 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (76)	586	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (510)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Detritus, Muck	95%, 87%, 15%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	29.1	1	>30
pH*		8.2	5	8.2-8.8
Alkalinity*	mg/L	119	5	100-280
Specific Conductance *	uS/cm	223	5	>110
Secchi Depth	ft	6.8	105	6.56-13.12
Chlorophyll a	ug/L	21	23	2.5-8
Total Phosphorus	ug/L	56	27	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.9 (7)	>32 C	High
Dissolved oxygen	9 (6)	<7 mg/L	High

Lake Risk Assessment Summary: Sand Lake (31-0826-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : High Risk	Characteristics Major Watershed: Big Fork River Location: 6 miles east of Squaw Lake Surface Area: 4225 acres Percent Littoral: 46% Max Depth: 70 feet Inlets: stream from Cedar Lake, stream from Birdseye Lake, stream from Mushgee Lake, Dinner Creek, Bowstring River
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Sand Lake has 42 upstream lakes and high public use, resulting in a high AIS infestation risk rating. Sand Lake is **infested** with zebra mussels. Water chemistry and substrate data show that the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Classified INFESTED	42 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (271)	1,336	High
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (1,065)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Muck, Rock	70%, 20%, 10%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	22.2	1	>30
pH*		8.2	18	8.2-8.8
Alkalinity*	mg/L	117	20	100-280
Specific Conductance *	uS/cm	204	12	>110
Secchi Depth	ft	9.7	425	6.56-13.12
Chlorophyll a	ug/L	8	41	2.5-8
Total Phosphorus	ug/L	22	45	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.2 (10)	>32 C	High
Dissolved oxygen	9.1 (5)	<7 mg/L	High

Lake Risk Assessment Summary: Sand Lake (31-0438-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 11 miles southeast of Marcell Surface Area: NA Percent Littoral: NA Max Depth: 50 feet Inlet: None 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Sand Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (58)	118	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (60)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Rock, Muck	40%, 35%, 15%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	22.9	1	>30
pH*		8.2	17	8.2-8.8
Alkalinity*	mg/L	80	9	100-280
Specific Conductance *	uS/cm	140	13	>110
Secchi Depth	ft	17.8	425	6.56-13.12
Chlorophyll a	ug/L	3	19	2.5-8
Total Phosphorus	ug/L	13	15	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.5 (13)	>32 C	High
Dissolved oxygen	9 (13)	<7 mg/L	High

Lake Risk Assessment Summary: Shallow Lake (31-0084-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 1 ½ miles west of Warba Surface Area: 539 acres Percent Littoral: 52% Max Depth: 85 feet Inlet: None
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Shallow Lake has no upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters Lake	No upstream lakes	Low
Public Use	Resident Watercraft/Boat Lift Impact	221	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Gravel, Detritus	60%, 30%, 10%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	23.5	1	>30
pH*		7.6	5	8.2-8.8
Alkalinity*	mg/L	NA	0	100-280
Specific Conductance *	uS/cm	156	7	>110
Secchi Depth	ft	15.6	336	6.56-13.12
Chlorophyll a	ug/L	4	43	2.5-8
Total Phosphorus	ug/L	10	46	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.5 (36)	>32 C	High
Dissolved oxygen	10.1 (6)	<7 mg/L	High

Lake Risk Assessment Summary: Siseebakwet (Sugar) (31-0554-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Headwaters Location: 8 miles southwest of Grand Rapids Surface Area: 1210 acres Percent Littoral: 22% Max Depth: 105 feet Inlets: stream from South Sugar, Sugar Brook
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Siseebakwet Lake has four upstream lakes and low public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Lake chain	4 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	372	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Rock	90%, 5%, 5%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	82	6	>30
pH*		8.4	12	8.2-8.8
Alkalinity*	mg/L	135	17	100-280
Specific Conductance *	uS/cm	259	13	>110
Secchi Depth	ft	14.6	970	6.56-13.12
Chlorophyll a	ug/L	2	24	2.5-8
Total Phosphorus	ug/L	8	21	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.6 (16)	>32 C	High
Dissolved oxygen	9.7 (16)	<7 mg/L	High

Lake Risk Assessment Summary: Snaptail Lake (31-0255-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 11 miles northwest of Nashwauk Surface Area: 177 acres Percent Littoral: 43% Max Depth: 68 feet Inlet: 1 headwaters stream
ZM Suitability Risk Rating: Moderate 1. <u>Water Chemistry</u> : Moderate Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Snaptail Lake has one upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry data, specifically calcium, show the lake is likely moderately suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	67	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Silt, Muck	80%, 10%, 10%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	15.3	1	>30
pH*		7.9	3	8.2-8.8
Alkalinity*	mg/L	51	3	100-280
Specific Conductance *	uS/cm	109	3	>110
Secchi Depth	ft	11.5	316	6.56-13.12
Chlorophyll a	ug/L	4	30	2.5-8
Total Phosphorus	ug/L	14	37	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	27.6 (20)	>32 C	High
Dissolved oxygen	8.4 (3)	<7 mg/L	High

Lake Risk Assessment Summary: Spider Lake (31-0538-00)

AIS Infestation Risk Rating: Low 1. <u>Connectivity</u> : Low Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 11 miles east of Suomi Surface Area: 1,392.5 acres Percent Littoral: 55.1% Max Depth: 35 feet Inlet: 1 headwaters stream
ZM Suitability Risk Rating: Moderate 1. <u>Water Chemistry</u> : Moderate Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Spider Lake has one upstream lakes and low public use, resulting in a low AIS infestation risk rating. Water chemistry datashow the lake is likely moderately suitable to zebra mussels.

Attribute	Description	Number	Infestation Risk
Water Connectivity	Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	213	Low
	Non-resident Watercraft Impact		
Substrate Suitability (frequency of occurrence, DNR)	Sand, Muck, Gravel	65%, 15%, 10%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	24.3	1	>30
pH*		7.9	137	8.2-8.8
Alkalinity*	mg/L	89.7	15	100-280
Specific Conductance *	uS/cm	177.4	137	>110
Secchi Depth	ft	12.4	113	6.56-13.12
Chlorophyll a	ug/L	5.2	15	2.5-8
Total Phosphorus	ug/L	9.2	12	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.6 (30)	>32 C	High
Dissolved oxygen	8.6 (30)	<7 mg/L	High

Lake Risk Assessment Summary: Splithand Lake (31-0353-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 7 miles northeast of Hill City Surface Area: 1369 acres Percent Littoral: 41% Max Depth: 30 feet Inlets: stream from Mud Lake, Splithand Creek
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Splithand Lake has seven upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity			7 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (80)	650	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (345)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Detritus, Muck	95%, 68%, 20%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	23.9	1	>30
pH*		8.4	16	8.2-8.8
Alkalinity*	mg/L	93	3	100-280
Specific Conductance *	uS/cm	173	16	>110
Secchi Depth	ft	5.6	268	6.56-13.12
Chlorophyll a	ug/L	15	21	2.5-8
Total Phosphorus	ug/L	28	5	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	26.6 (9)	>32 C	High
Dissolved oxygen	9.6 (7)	<7 mg/L	High

Lake Risk Assessment Summary: Swan Lake (31-0067-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 5 miles south of Nashwauk Surface Area: 2467 acres Percent Littoral: 55% Max Depth: 65 feet Inlets: Swan River, stream from Hart Lake, 1 headwater stream, O'Brien Creek, Oxhide Creek, Pickeret Creek
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : Moderate Risk	

Summary

Swan Lake has 20 upstream lakes and moderate public use, resulting in a high AIS infestation risk rating. Water chemistry data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	20 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (456)	891	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (435)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Detritus, Muck	70%, 50%, 35%	Moderate

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	31.5	1	>30
pH*		8.2	59	8.2-8.8
Alkalinity*	mg/L	116	40	100-280
Specific Conductance *	uS/cm	271	38	>110
Secchi Depth	ft	13.8	1026	6.56-13.12
Chlorophyll a	ug/L	9	53	2.5-8
Total Phosphorus	ug/L	23	68	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.5 (25)	>32 C	High
Dissolved oxygen	9.1 (19)	<7 mg/L	High

Lake Risk Assessment Summary: Trout Lake (31-0216-00)

AIS Infestation Risk Rating: Moderate <ol style="list-style-type: none"> 1. <u>Connectivity</u>: Low Risk 2. <u>Public Use</u>: Moderate Risk 	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 1 mile south of Coleraine Surface Area: 1862 acres Percent Littoral: 30% Max Depth: 138 feet Inlets: Trout Creek, 2 headwater streams 
ZM Suitability Risk Rating: High <ol style="list-style-type: none"> 1. <u>Water Chemistry</u>: High Risk 2. <u>Substrate</u>: High Risk 	

Summary

Trout Lake has one upstream lake and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Headwaters	1 upstream lake	Low
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (197)	752	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (555)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Marl, Rubble	95%, 60%, 48%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	36.8	1	>30
pH*		8.5	93	8.2-8.8
Alkalinity*	mg/L	128	75	100-280
Specific Conductance *	uS/cm	323	63	>110
Secchi Depth	ft	15.7	1251	6.56-13.12
Chlorophyll a	ug/L	6	128	2.5-8
Total Phosphorus	ug/L	35	157	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	25.8 (45)	>32 C	High
Dissolved oxygen	9.6 (44)	<7 mg/L	High

Lake Risk Assessment Summary: Trout Lake (31-0410-00)

AIS Infestation Risk Rating: Moderate 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Low Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 12 miles south of Marcell Surface Area: 1736 acres Percent Littoral: 43% Max Depth: 157 feet Inlets: stream from Lower Spring Lake, stream from Moore Lake, stream from Day Lake, Clearwater Creek 
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Trout Lake has low public use, but having 17 upstream lakes results in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	17 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (33)	33	Low
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (0)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Gravel, Rubble	50%, 25%, 15%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	92	1	>30
pH*		8.4	20	8.2-8.8
Alkalinity*	mg/L	122	8	100-280
Specific Conductance *	uS/cm	220	18	>110
Secchi Depth	ft	16.5	823	6.56-13.12
Chlorophyll a	ug/L	2	23	2.5-8
Total Phosphorus	ug/L	6	19	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.1 (7)	>32 C	High
Dissolved oxygen	9.2 (8)	<7 mg/L	High

Lake Risk Assessment Summary: Turtle Lake (31-0725-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : Moderate Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Big Fork River Location: 2 miles north of Marcell Surface Area: 2126 acres Percent Littoral: 29% Max Depth: 135 feet Inlets: 1 headwaters lake, stream from Hatch Lake, stream from Maple Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Turtle Lake has 8 upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels.

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	8 upstream lakes	Moderate
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (285)	1,045	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (760)		
Substrate Suitability (frequency of occurrence, DNR)		Sand/Silt, Boulder	70%, 30%	High

Water Chemistry Risk


Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	32.7	1	>30
pH*		8.6	19	8.2-8.8
Alkalinity*	mg/L	140	5	100-280
Specific Conductance *	uS/cm	242	22	>110
Secchi Depth	ft	15.7	930	6.56-13.12
Chlorophyll a	ug/L	2	40	2.5-8
Total Phosphorus	ug/L	9	45	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	22.3 (15)	>32 C	High
Dissolved oxygen	9.1 (15)	<7 mg/L	High

Lake Risk Assessment Summary: Wabana Lake (31-0392-00)

AIS Infestation Risk Rating: High 1. <u>Connectivity</u> : High Risk 2. <u>Public Use</u> : Moderate Risk	Characteristics Major Watershed: Miss. R. Grand Rapids Location: 10 miles north of Coleraine Surface Area: 2221 acres Percent Littoral: 46% Max Depth: 115 feet Inlets: stream from Bluewater Lake, Clearwater Creek, stream from Twin Lake
ZM Suitability Risk Rating: High 1. <u>Water Chemistry</u> : High Risk 2. <u>Substrate</u> : High Risk	

Summary

Wabana Lake has 21 upstream lakes and moderate public use, resulting in a moderate AIS infestation risk rating. Water chemistry and substrate data show the lake is likely suitable to zebra mussels

Attribute		Description	Number	Infestation Risk
Water Connectivity		Lake chain	21 upstream lakes	High
Public Use	Resident Watercraft/Boat Lift Impact	Number of privately owned parcels (176)	906	Moderate
	Non-resident Watercraft Impact	Total number of resort units, public access parking spots and special events for summer (730)		
Substrate Suitability (frequency of occurrence, DNR)		Sand, Gravel, Rubble	45%, 40%, 10%	High

Water Chemistry Risk

Parameter	Unit	Average	Sample Size	Suitable Range
Calcium*	Mg/L	69	4	>30
pH*		8.3	30	8.2-8.8
Alkalinity*	mg/L	115	16	100-280
Specific Conductance *	uS/cm	215	110	>110
Secchi Depth	ft	19	247	6.56-13.12
Chlorophyll a	ug/L	2	30	2.5-8
Total Phosphorus	ug/L	11	22	25-35

*primary parameters for zebra mussel Suitability

Seasonal Temperature and Dissolved Oxygen Risk

	Description, value (N)	Lethal Limit	Suitability Rating
Summer maximum temperature	24.5 (14)	>32 C	High
Dissolved oxygen	8.8 (14)	<7 mg/L	High

Results and Discussion

Results

The public use and overall AIS infestation risk ratings apply to all aquatic invasive species, while the suitability rating applies to just Zebra mussels. The lakes in Itasca County resulted in differing AIS infestation and Zebra mussel suitability risk ratings (Table 10). In general terms, the headwaters lakes with very little development came out with the lowest AIS infestation risk ratings because they have no water bodies upstream and not much traffic. Of the selected lakes assessed in this report, the headwaters lakes that also had low public use include Shallow, Buck, Little Jessie, Coon-Sandwich, Caribou, Little Wabana, Sand (0438), Burrows, Pickerel, Bluewater, Johnson, and Crooked (0543). Lakes that had moderate AIS infestation risk ratings had the combination of moderate public use and being in the middle of a chain of lakes (Table 10, Figure 13).

Lakes with high AIS infestation risk ratings include Pokegama, Sisseebakwet, Bowstring, Cut Foot Sioux, Sand (0826), Bass, Turtle, Wabana, Swan, Dora, and Blackwater (Figure 13). Dora and Blackwater have low public use, but they have infested lakes upstream from them, which resulted in a high infestation rating. The rest of the high-risk lakes have a very high public use, especially Pokegama and Sisseebakwet (Figure 12). Lake Pokegama has the highest total of public accesses and property owners of any lake in the county (Table 3). Public use risks come from both lake visitors via boats and lake property owners via boats, boat lifts, docks and other water-related equipment.

Most of the lakes in Itasca County resulted in a high Zebra mussel suitability rating (Figure 14). The lakes in northwest and north central Minnesota are considered hardwater lakes from glacial deposits of calcium carbonate (limestone) (Wetzel 2001). Water chemistry data show that four of the lakes evaluated in this report are soft water lakes, which are likely unsuitable to Zebra mussels: Buck, Burrows, Caribou, and Coon-Sandwich. In the lakes with moderate suitability, there wasn't always enough data to determine if the lake was soft or hard water, or the lake could be too eutrophic for zebra mussels to thrive: Spider, Snaptail, and Crooked (0543), Crooked (0193), and Round. Testing calcium in these lakes would help further determine the suitability of the lake to Zebra mussels.

Substrates can also be a limiting factor for Zebra mussel survival. Zebra mussels are not able to attach silt, muck, and sand directly. In areas with these substrates, the Zebra mussels will attach to plants, native mussels, and pieces of wood or stones (Karatayev et al. 1998). They will also attach to each other in clumps. Therefore, lakes that have predominantly silt, muck and clay have a low substrate suitability rating. In addition, in lakes that tend to be more eutrophic, Zebra mussels have a low suitability. Zebra mussels do not thrive in eutrophic lakes like they do in mesotrophic lakes (Karatayev et al. 1998, Nelepa 1992).

Of the other AIS in Itasca County, Starry stonewort is a major concern. Lake Winnibigoshish has Starry stonewort and high public use. Starry stonewort can spread by small fragments stuck to boats, docks, lifts and other water-related equipment. Boat inspections and education can help prevent the spread of Starry stonewort.

Curly-leaf pondweed, Flowering rush and Eurasian watermilfoil are present in Itasca County (Figure 11). They are able to be treated and controlled with herbicides, but treatment is very expensive. Preventing their establishment in additional lakes is important for future lake enjoyment and cost control.

Table 10. Summary of risk ratings and prioritized recommendations taking into account the risk.

Lake Name	Lake ID	Public Use Risk	Infestation Risk	Suitability Risk	AIS Program Prioritized Recommendations
Ball Club	31-0812-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Balsam	31-0259-00	Low	Moderate	High	1. Education
Bass	31-0576-00	Moderate	High	High	1. Public Access Inspections 2. Education
Bello	31-0726-00	Low	Low	High	1. Education
Blackwater	31-0561-00	Low	High	High	1. Education 2. Public Access Inspections
Bluewater	31-0395-00	Low	Low	High	1. Education
Bowstring	31-0813-00	High	High	High	1. Public Access Inspections 2. Education 3. Early Detection Monitoring
Buck	31-0069-00	Low	Low	Low	1. Education
Burrows	31-0413-00	Low	Low	Low	1. Education
Caribou	31-0620-00	Low	Low	Low	1. Education
Coon-Sandwich	31-0524-00	Low	Low	Low	1. Education
Crooked	31-0193-00	Low	Moderate	Moderate	1. Education
Crooked	31-0543-00	Low	Low	Moderate	1. Education
Cut Foot Sioux	31-0857-00	High	High	High	1. Public Access Inspections 2. Education 3. Early Detection Monitoring
Deer	31-0334-00	Low	Moderate	High	1. Education
Deer	31-0719-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Dixon	31-0921-00	Low	Moderate	High	1. Education
Dora	31-0882-00	Low	High	High	1. Education 2. Early detection
Grave	31-0624-00	Low	Low	High	1. Education
Hale	31-0373-00	Low	Low	High	1. Education

Table 10 continued on the next page...

Table 10 continued. Summary of risk ratings and prioritized recommendations taking into account the risk.

Lake Name	Lake ID	Public Use Risk	Infestation Risk	Suitability Risk	AIS Program Prioritized Recommendations
Hart	31-0020-00	Low	Low	High	1. Education
Island	31-0913-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Jack the Horse	31-0657-00	Low	Low	High	1. Education
Jessie	31-0786-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Johnson	31-0687-00	Low	Low	High	1. Education
Little Bowstring	31-0758-00	Low	Low	High	1. Education
Little Jessie	31-0784-00	Low	Low	High	1. Education
Little Long	31-0613-00	Low	Moderate	High	1. Education
Little Wabana	31-0399-00	Low	Low	High	1. Education
Moose	31-0722-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Natures	31-0877-00	Low	Moderate	High	1. Education
North Star	31-0653-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Pickereel	31-0339-00	Low	Low	High	1. Education
Pokegama	31-0532-00	High	High	High	1. Public Access Inspections 2. Education 3. Early Detection Monitoring
Prairie	31-0384-00	Low	Low	High	1. Education
Rice	31-0717-00	Low	Low	High	1. Education
Round	31-0896-00	Moderate	Moderate	Moderate	1. Public Access Inspections 2. Education
Sand	31-0438-00	High	High	High	1. Public Access Inspections 2. Education 3. Early Detection Monitoring
Sand	31-0826-00	Low	Low	High	1. Education
Shallow	31-0084-00	Low	Low	High	1. Education

Table 10 continued on the next page...

Table 10 continued. Summary of risk ratings and prioritized recommendations taking into account the risk.

Lake Name	Lake ID	Public Use Risk	Infestation Risk	Suitability Risk	AIS Program Prioritized Recommendations
Siseebakwet	31-0554-00	Low	Moderate	High	1. Education
Snaptail	31-0255-00	Low	Low	Moderate	1. Education
Spider	31-0538-00	Low	Low	Moderate	2. Education
Splithand	31-0353-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Swan	31-0067-00	Moderate	High	High	1. Public Access Inspections 2. Education
Trout	31-0216-00	Low	Moderate	High	1. Education
Trout	31-0410-00	Moderate	Moderate	High	1. Public Access Inspections 2. Education
Turtle	31-0725-00	Moderate	High	High	1. Public Access Inspections 2. Education
Wabana	31-0392-00	Moderate	High	High	1. Public Access Inspections 2. Education

Itasca County Public Use Risk

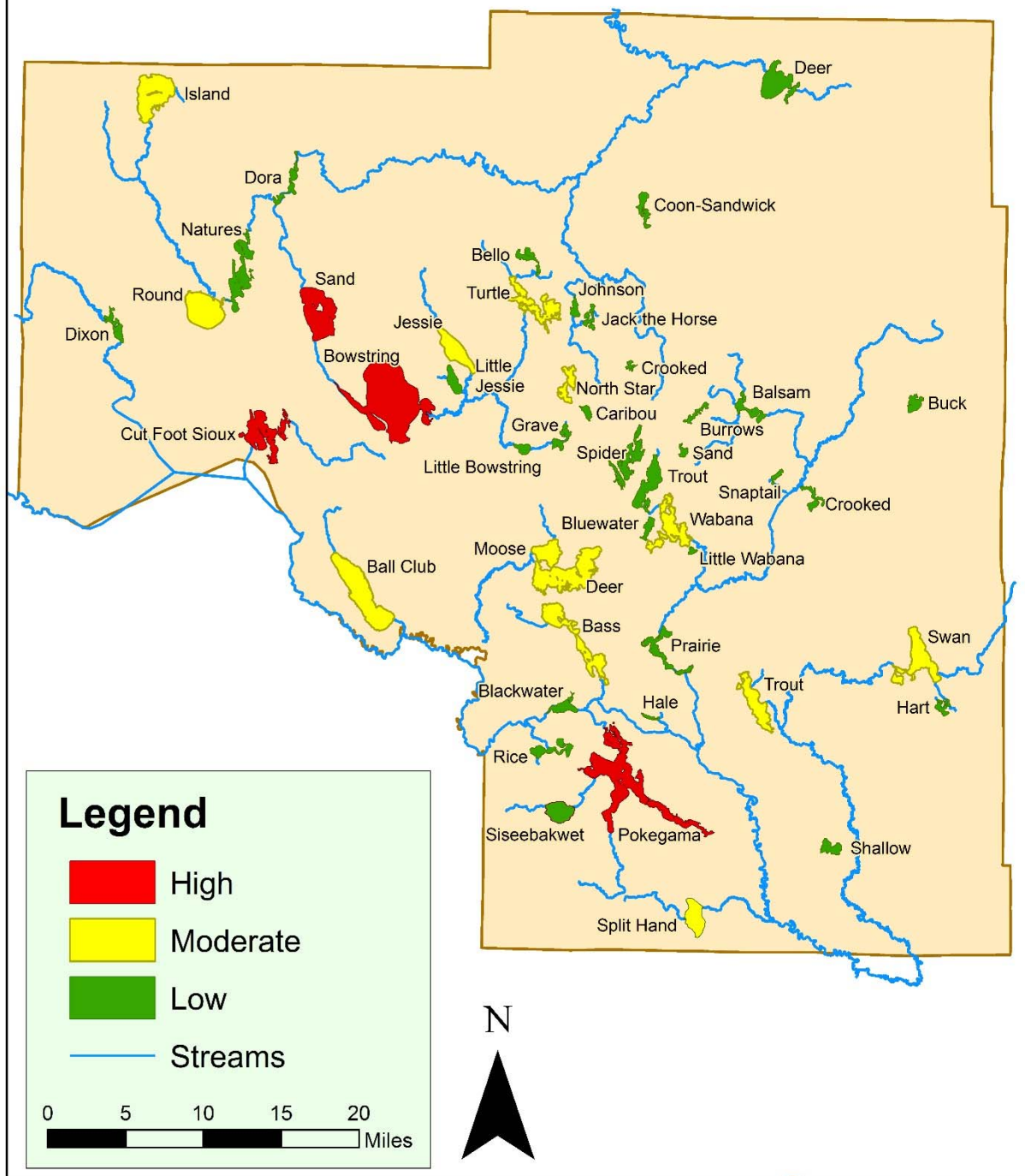


Figure 12. Public use risk rating for lakes in Itasca County.

Itasca County Zebra Mussel Infestation Risk

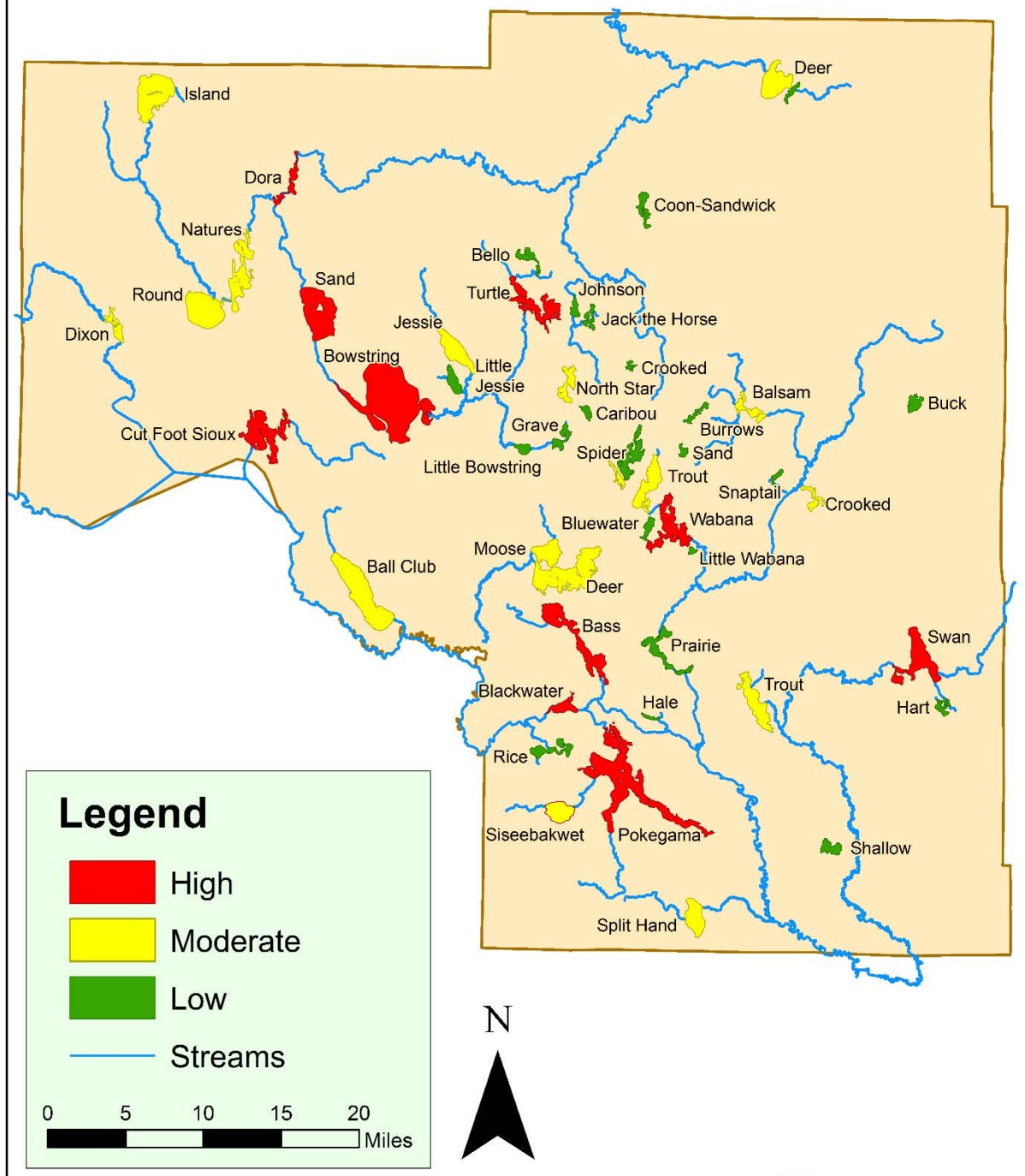


Figure 13. Overall Zebra mussel AIS infestation risk rating in Itasca County.

Itasca County

Zebra Mussel Suitability Risk

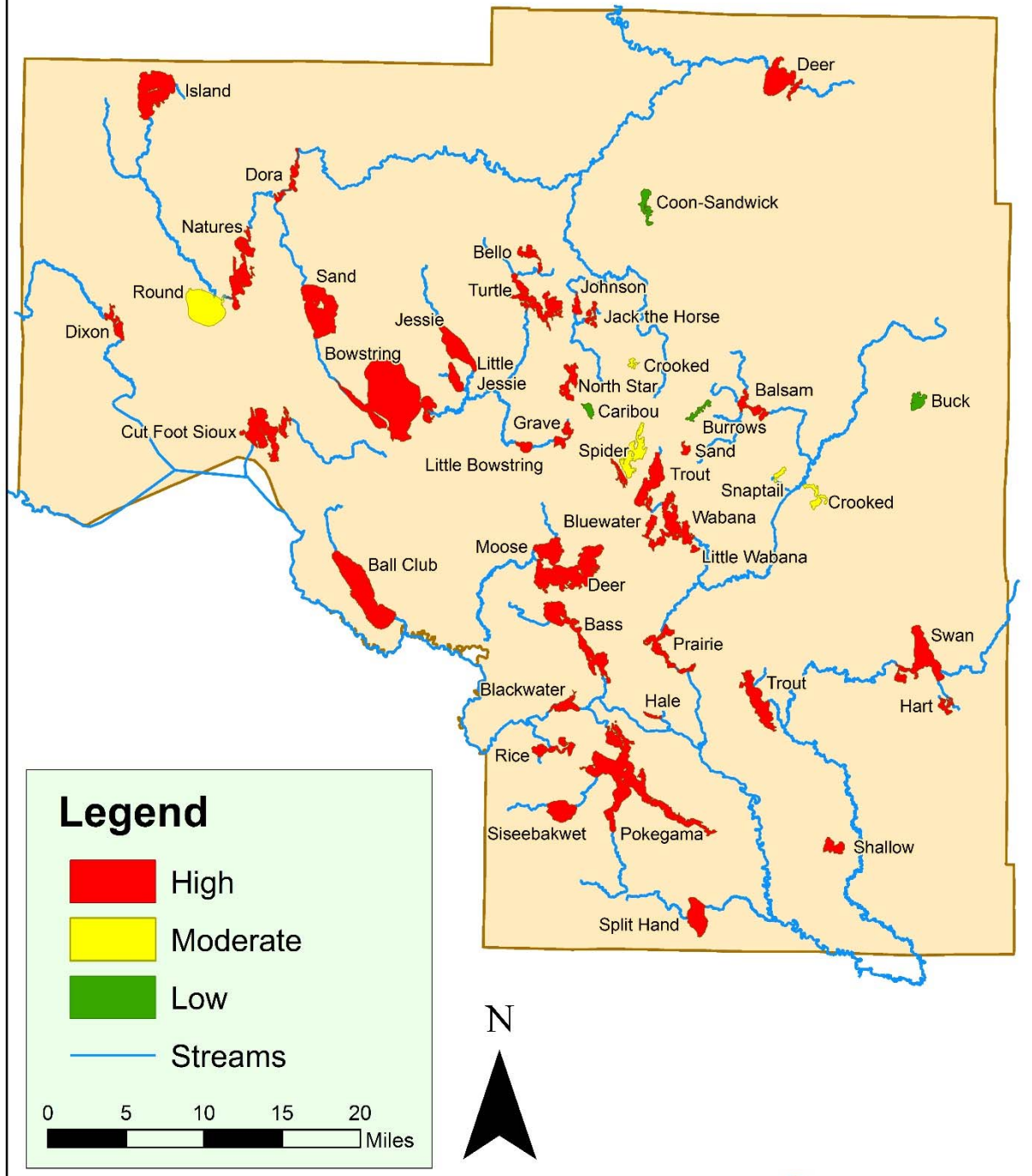


Figure 14. Overall Zebra mussel suitability risk rating in Itasca County.

Data Gaps

This study identified some data gaps in Itasca County. Calcium is the most important water chemistry parameter when evaluating Zebra mussel habitat suitability. Many lakes did not have any historical calcium data. It is recommended that this data be collected to assist with overall verification of water chemistry. The data gaps are indicated on the lake report cards. See the table below for a summary of parameters needed for each lake (Table 11).

Table 11. Summary of data gaps for water bodies in Itasca County.

Lake Name	Lake ID	Parameters Needed
Ball Club	31-0812-00	Secchi, Chlorophyll-a, Total Phosphorous, Dissolved Oxygen
Balsam	31-0259-00	Temperature, Dissolved Oxygen
Blackwater	31-0561-00	pH, Alkalinity, Specific Conductance, Chlorophyll-a, Total Phosphorous, Temperature, Dissolved Oxygen
Caribou	31-0620-00	Calcium
Crooked	31-0543-00	Specific Conductance, Temperature, Dissolved Oxygen
Gunn	31-0452-00	pH, Specific Conductance
Jack the Horse	31-0657-00	Specific Conductance, Temperature, Dissolved Oxygen
Johnson	31-0687-00	Specific Conductance, Temperature, Dissolved Oxygen
Little Bowstring	31-0758-00	Calcium
Little Jessie	31-0784-00	Specific Conductance, Temperature, Dissolved Oxygen
Little Long	31-0613-00	pH, Specific Conductance, Temperature, Dissolved Oxygen
Little Wabana	31-0399-00	Alkalinity
Natures	31-0877-00	Specific Conductance
North Star	31-0653-00	Specific Conductance
Prairie	31-0384-00	pH, Specific Conductance
Rice	31-0717-00	Specific Conductance, Temperature, Dissolved Oxygen
Shallow	31-0084-00	Alkalinity

Vectors of Spread – Infestation Routes

In order to have a watershed strategy for AIS program management, the vectors of spread for each lake needs to be determined. This risk assessment process also identifies the vectors of spread for the lakes in the watershed. For headwaters lakes there is no risk of infestation from upstream, so any new infestation would come from lake users (boats, boat lifts, docks, etc). For lakes in a river chain, both lake users and upstream lakes need to be considered as potential vectors of spread.

Zebra mussels can be transferred from infested waters through several different pathways. These pathways are highly dependent upon the time of year and the stage in the Zebra mussel life cycle. The risk pathway ratings for time of year are shown in Table 12.

1. Connectivity via a river or stream.
An upstream infested lake is almost certain to infest downstream lakes if the stream distance between lakes is short enough.
2. Transfer of equipment from lake to lake.
The transfer of a large breeding adult Zebra mussel population from one lake to another on an infested boat lift, dock, swim raft or other water-related equipment has a very high probability of infesting a lake.
3. Transfer of mussels hitchhiking on vegetation or mud on boat and trailers.
The risk of hitchhiking mussels depends somewhat on the time of year. When vegetation dies off in the fall, the Zebra mussels fall off into the sediments. Therefore, Zebra mussels are only attached to plants from approximately June to September. Zebra mussels can't be transferred alone in mud because they do not thrive in soft substrates; they need to be attached to a hard surface.
4. Transfer of veligers or mussels from live wells, bilges, and any area of the boat that holds water.
The risk of veliger transfer depends greatly on the time of year. In infested lakes in northwest Minnesota, it has been documented that Zebra mussel veligers are at peak concentrations in early July (Rufer 2015). Therefore, July is the month of the year where veliger transfer from lake to lake has the highest risk for infestation. Research has shown that veligers are non-existent during the ice-covered season, so there is essentially no risk of veliger transfer in the winter (Rufer 2015).
5. Transfer of juvenile mussels on boats not thoroughly cleaned after being tied up on infested waters for an extended period of time.
The risk of mussel transfer on boats is highest in July through September, because that is when the mussels are reproducing and settling on new hard surfaces.
6. Transfer of veligers and juvenile mussels on swimwear, SCUBA equipment, waders or other gear used in water.
The risk of veliger transfer on gear depends somewhat on the time of year. July and August would be the times of highest risk throughout the year. Overall, this pathway is considered to be very low risk potential because the amount of water transferred is so small.

Risk – Time of Year

The risk of Zebra mussel infestation varies by the time of year. Data sources show that in Minnesota, the time of year that has the highest concentration of Zebra mussel veligers matches up with the highest use time for the public (Figures 23-24, Pesch & Bussiere 2014, Rufer 2015). The implications of these data indicate that additional prevention measures should be implemented during July to prevent Zebra mussel spread.

In Pesch and Busierre's (2014) survey of 2nd Homeowners in Central and West Central Minnesota, the highest use time of year was July, at an average of 16 days during that month (Figure 23, Pesch & Bussiere 2014). Rufer's monitoring of Zebra mussel veligers in Pelican Lake, a Zebra mussel infested lake in Otter Tail County, shows the peak density for Zebra mussels is in July (Figure 24, Rufer 2015).

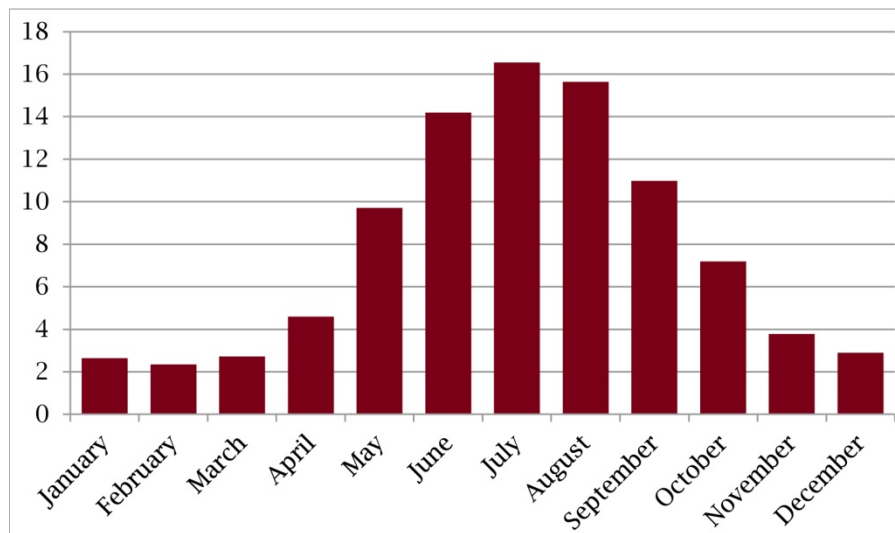


Figure 15. Average number of days occupied per month (n=552) from Pesch & Bussiere 2014.

The full report can be downloaded from this link:

<http://www.extension.umn.edu/community/research/reports/docs/2014-2nd-Homeowners.pdf>

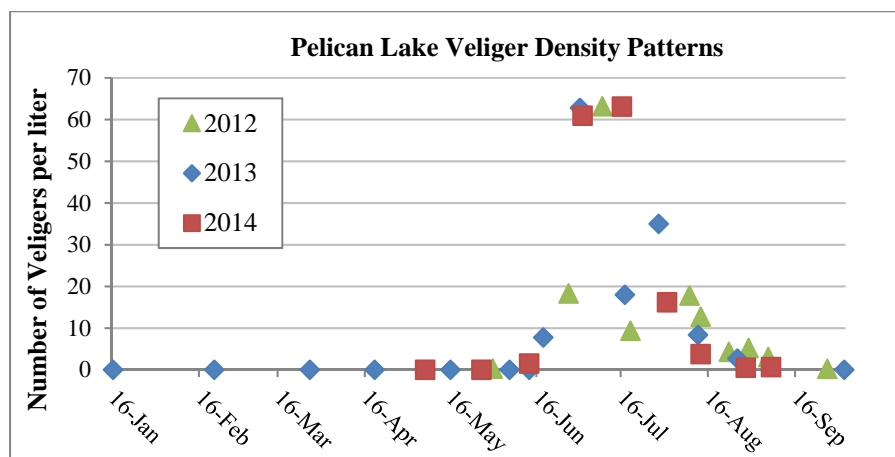


Figure 16. Veliger densities in Pelican Lake, 2012-2014 from Rufer 2015.

The full report can be downloaded from this link:

<http://pgolid.org/wp-content/uploads/2014/01/PGOLID-Veliger-Report-2012-2014.pdf>

Table 12. Summary of risk pathways depending on the time of year. The Zebra mussel life stage for the pathway is indicated in *italics*.

Risk Pathway	Typical Minnesota Open Water Season							Typical Minnesota Ice-covered season				
	April	May	June	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March
1. Connectivity via a river or stream.	insignificant	insignificant	Moderate <i>Veligers</i>	High <i>Veligers</i>	Moderate <i>Veligers</i>	Low <i>Veligers</i>	insignificant	insignificant	insignificant	insignificant	insignificant	insignificant
2. Transfer of equipment from lake to lake.	insignificant	insignificant	Moderate <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	Low <i>Adults & juveniles</i>	insignificant	insignificant	insignificant	insignificant	insignificant
3. Transfer of mussels hitchhiking on vegetation or mud on boats, trailers and gear.	Low <i>Adults & juveniles</i>	Low <i>Adults & juveniles</i>	Moderate <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	Moderate <i>Adults & juveniles</i>	Low <i>Adults & juveniles</i>	insignificant	insignificant	insignificant	insignificant	insignificant
4. Transfer of veligers via water in boats (live wells, bilges, etc) and float planes.	insignificant	insignificant	Moderate <i>Veligers</i>	High <i>Veligers</i>	Moderate <i>Veligers</i>	Low <i>Veligers</i>	insignificant	insignificant	insignificant	insignificant	insignificant	insignificant
5. Transfer of juvenile mussels on boats not thoroughly cleaned after being tied up on infested waters for an extended period of time.	insignificant	insignificant	Moderate <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	High <i>Adults & juveniles</i>	Moderate <i>Adults & juveniles</i>	Low <i>Adults & juveniles</i>	insignificant	insignificant	insignificant	insignificant	insignificant
6. Transfer of veligers and juvenile mussels on swimwear, SCUBA equipment, waders or other gear used in water.	insignificant	insignificant	Low <i>Veligers</i>	High <i>Veligers</i>	Moderate <i>Veligers</i>	Low <i>Veligers</i>	insignificant	insignificant	insignificant	insignificant	insignificant	insignificant

Sources: Zebra mussel veliger time-of-year risk was taken from Rufer 2015.

Zebra mussel adult and juvenile time-of-year risk was taken from Mackie &Claudi 201, Mackie 1996, McMahon 1996.

AIS Program Management Recommendations

In an ideal world, all Aquatic Invasive Species (AIS) prevention programs would be applied to all lakes. In reality, budgets are always limited, so prioritization of programs due to risk ratings is necessary. Due to the differing risk ratings, programs can be individualized to fit each lake's risk category (Table 13). Lakes with high public use ratings should be at the highest priority for boat inspections at public accesses. Lakes that are already infested should have boat-washing stations nearby for decontamination. All lakes should be targeted with a watershed-wide education program. Because the highest risk time of the summer and one of the highest tourism times of the summer intersect on 4th of July week, focus *additional* targeted education and outreach during this time of year. For monitoring, ideally all lakes would be monitored for adult Zebra mussels because if trained volunteers are used there is no monetary cost, but there is a large benefit.

The assessments in this report result combine the report cards with the risk of time of year (Table 12) in the following specific Aquatic Invasive Species Program Management Recommendations (Table 13). This portion of the report can be inserted directly into the county's AIS Plan, and guide the use of the county's AIS funds in the most efficient and effective way possible.

Table. 13. Framework for the watershed's AIS plan.

Activity	Target Lakes	Target Time of Year	Who	Cost	Narrative
<i>Watercraft Inspections</i>	<u>Priority 1:</u> <ul style="list-style-type: none"> • Pokegama • Cut Foot Sioux • Sand • Bowstring <u>Priority 2:</u> <ul style="list-style-type: none"> • Wabana • Swan • Turtle • Bass • Moose • Round • Jessie • Island • Deer (0719) • North Star • Ball Club • Trout (0216) • Splithand 	<u>Priority 1:</u> July <u>Priority 2:</u> August <u>Priority 3:</u> June	County	TBD	This activity depends on available funding. If limited funding is available, focus inspections on the high risk public use lakes (Pokegama, Cut Foot Sioux, Sand, Bowstring) in July. If more funding is available, add in moderate public use risk lakes (Priority 2 list) in July. Next, add in August inspections and then June.

Table 13 continued on the next page...

Table. 13 continued. Framework for the watershed's AIS plan.

Activity	Target Lakes	Target Time of Year	Who	Cost	Narrative
Early Detection Monitoring: <i>Zebra mussel veligers</i>	<ul style="list-style-type: none"> • Pokegama • Bowstring • Wabana • Swan • Turtle • Bass • Dora • Blackwater 	July	County or Lake Associations	\$630	Collect plankton tow samples in high infestation risk lakes in early and late July for veliger analysis. Early detection allows for possible treatment.
Early Detection Monitoring: <i>Adult Zebra mussels</i>	<p><u>Priority 1:</u></p> <ul style="list-style-type: none"> • Pokegama • Bowstring • Wabana • Swan • Turtle • Bass <p><u>Priority 2:</u></p> <ul style="list-style-type: none"> • Moose • Round • Jessie • Balsam • Dixon • Deer (0334) • Split Hand • Crooked • Island • Deer (0719) • Natures • Trout (0410) • Little Long • North Star • Ball Club • Trout (0216) • Sissebakwet 	<p><u>Priority 1:</u> September</p> <p><u>Priority 2:</u> Every other week from late June to mid-September</p>	Volunteers, Lake Associations	\$0	<p>a. In September, conduct a lake-wide inspection of docks and boat lifts as they are removed from the lake.</p> <p>b. Place a cinder block in 5-8 feet of water near the public access and any other heavily used areas of the lake, and have the volunteers check the block (pull it up or snorkel) every other week from late June to mid-September. Record results on the MN DNR's website: http://www.dnr.state.mn.us/volunteering/zebramussel_monitoring/report.html</p>

Table 13 continued on the next page...

Activity	Target Lakes	Target Time of Year	Who	Cost	Narrative
<i>Monitoring: Invasive Plants</i>	<u>Priority 1:</u> <ul style="list-style-type: none"> • Pokegama • Cut Foot Sioux • Sand • Bowstring • Wabana • Swan • Turtle • Bass <u>Priority 2:</u> <ul style="list-style-type: none"> • Moose • Round • Jessie • Balsam • Dixon • Deer (0334) • Split Hand • Crooked (0193) • Island • Deer (0719) • Natures • Trout (0410) • Little Long • North Star • Ball Club • Trout (0216) • Sissebakwet 	Mid to late June	County, Lake Associations, or private contractor	TBD	Conduct plant surveys to look for aquatic invasive plants. Mid to late June will catch Curly-leaf pondweed, Flowering rush, Starry stonewort, and Eurasian watermilfoil. The first priority lakes are those with a high AIS infestation risk rating. The second priority lakes are those with a moderate AIS infestation risk rating.
<i>Water Quality Monitoring</i>	See Table 11 for data gaps.	May – September	Lake Associations	TBD	Monitor lakes for missing parameters shown in Table 11. Priority parameters for each lake would be Calcium, Alkalinity, pH and Specific Conductance as they have the most effect on Zebra mussel suitability.
<i>Decontamination</i>	All infested lakes (See Figure 6)	<u>Priority 1:</u> 4 th of July week <u>Priority 2:</u> Memorial Day to Labor Day	DNR and/or County	TBD	Provide decontamination opportunities for boats leaving infested lakes. Inform boaters on where the decontamination station is located.

Table 13 continued on the next page...

Table. 13 continued. Framework for the watershed's AIS plan.

Activity	Target Lakes	Target Time of Year	Who	Cost	Narrative
<i>Education and Outreach</i>	All	<u>Priority 1</u> : 4 th of July week <u>Priority 2</u> : Memorial day to labor day <u>Priority 3</u> : Year round	County and watershed	TBD	Conduct a consistent watershed-wide education program to schools and the general public. In high tourism areas, such as Grand Rapids, focus <i>additional</i> education around 4 th of July since that is the highest risk time of the year for spread.

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