

2012

Invading Species Watch Program Annual Report



ONTARIO'S
**INVADING
SPECIES**
AWARENESS PROGRAM

Ontario Federation of Anglers and Hunters

2012

ACKNOWLEDGEMENTS

The *Invading Species Watch* program is an initiative of the *Invading Species Awareness Program*, a partnership of the Ontario Federation of Anglers and Hunters (OFAH) and the Ontario Ministry of Natural Resources (OMNR).

We would like to take this opportunity to introduce and thank some of the program's partners. These new and longstanding partnerships allowed for program expansion into new areas and improved delivery in existing areas in 2012:

- Algonquin Provincial Park
- Bruce Trail Conservancy
- Central Lake Ontario Conservation Authority (CLOCA)
- Credit Valley Conservation Authority (CVC)
- Eastern Georgian Bay Stewardship Council
- Human Resources and Skills Department Canada's Summer Jobs Program
- Kids For Turtles Environmental Education (KFT)
- Killbear Provincial Park
- Kirkland Lake District MNR Office
- Lake of the Woods District Property Owners Association (LOWDPOA)
- Lower Trent Conservation Authority
- Manitoulin and Area Stewardship Council
- Ministry of Natural Resources: Kirkland Lake and Sault Ste Marie
- Mississippi Valley Conservation (MVC)
- Nottawasaga Valley Conservation Authority (NVCA)
- Ontario Streams
- Plenty Canada
- Ontario Streams
- Rideau Valley Conservation Authority (RVCA)
- Sault Ste. Marie District MNR Office
- South Nation Conservation Authority
- University of Windsor
- Voyageur Provincial Park
- Wasaga Beach Provincial Park

We would also like to extend our gratitude to Terry Rees (Federation of Ontario Cottagers' Associations), Bob Bowles and Jacquie Kent (Kids for Turtles Environmental Education), Susan McLeod (Lake of the Woods District Property Owners Association), Anne Anderson (Lower Trent Conservation), Seija Deschenes and Mary Ellen Shain (Manitoulin Area Stewardship Council), Lisa Keable (Sault Ste. Marie District MNR), Susan Lee (Mississippi Valley Conservation), David Featherstone (Nottawasaga Valley Conservation Authority), Larry McDermott (Plenty Canada), Dayna Laxton (Ontario Streams), Michael Yee and Sarah McLeod (Rideau Valley Conservation Authority), Terry Crawford (Eastern Georgian Bay Stewardship Council), Michelle Scheerder (South Nation Conservation), Patricia Lowe, Diana Shermet (Central Lake Ontario Conservation Authority), Lauren McDonald and Leah Marinigh (Kirkland Lake District MNR), Donna Wales (Biodiversity Section MNR), and Renata Claudi of RNT Consulting for their technical advice and support.

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We would also like to take this opportunity to thank many of the OFAH staff for their assistance and support, including Sophie Monfette, Terry Quinney, Matt Smith, Alison Kirkpatrick, Karen Shier and Philip Shaw.

We extend special thanks to the volunteers participating in the *Invading Species Watch* program. Volunteer involvement in monitoring and raising awareness is fundamental to the success of invasive species prevention efforts.

Finally, thanks are also extended to all individuals and lake and cottage associations who financially assisted the *Invading Species Awareness Program* through monetary donations. The support of these organizations has been essential to the success of this program and is appreciated. Thank you. If you wish to contribute to the *Invading Species Awareness Program*, donations can be made to the:

Ontario Federation of Anglers and Hunters
Invading Species Awareness Program
Box 2800, 4601 Guthrie Drive
Peterborough, Ontario, K9J 8L5

EXECUTIVE SUMMARY

The spring of 2012 marked the beginning of another extremely busy and successful year for the *Invading Species Watch* program. The program is in its fourteenth year of operation and is coordinated by the Ontario Federation of Anglers and Hunters (OFAH) in partnership with the Ontario Ministry of Natural Resources (OMNR). In 2012, the program monitored 129 lakes and waterways for the presence of spiny water flea (*Bythotrephes longimanus*) and zebra mussel veligers (*Dreissena polymorpha*).

The program was delivered through the participation of lake associations and conservation clubs across the province. The Rideau Valley Conservation Authority (RVCA), Mississippi Valley Conservation (MVC), South Nation Conservation (SNC), Lower Trent Conservation, Nottawasaga Valley Conservation Authority (NVCA), Central Lake Ontario Conservation Authority (CLOCA), Credit Valley Conservation (CVC), Manitoulin and Area Stewardship Council, Thunder Bay Stewardship Council, Plenty Canada, Lake of the Woods District Property Owners Association, Kids For Turtles Environmental Education, Ontario Streams and the Kirkland Lake and Sault Ste. Marie District MNR offices, enabled the program's delivery by hosting summer students. These summer students were responsible for the recruitment of volunteers and assisting volunteer monitoring efforts in their respective regions. The Federation of Ontario Cottagers' Associations (FOCA) also assisted by promoting the program to their members.

The response to these new partnerships and continued dedication of existing partners was outstanding, enabling the program to achieve the following objectives:

1. Establish a provincial volunteer network to track the spread of Zebra Mussels (*Dreissena polymorpha*), and spiny water flea (*Bythotrephes longimanus*) in Ontario waters.
2. Update Ontario distribution information and an international database that tracks the spread of aquatic invasive species in North America;
3. Increase the local awareness of aquatic invasive species and encouraged greater public involvement in preventing the spread to inland lakes;
4. Provide participants with early identification of the presence of aquatic invasive species, thus providing an opportunity to initiate protection systems to minimize impacts.

Fourteen monitoring kits containing all the necessary equipment and instructions were circulated to program volunteers. In the fall and winter of 2012, RNT Consulting performed the analysis of water samples from the 129 lakes that were monitored during the summer. **Spiny water fleas were discovered in 14 lakes, nine of which were new occurrences. Zebra mussel veligers were found in 18 lakes, with three new occurrences.**

The results of the *Invading Species Watch* program were entered into a database of existing *Invading Species Watch* records, which allows users to link with existing OMNR databases and information systems, and provides access to the complete lake history. This database also enables the generation of updated GIS based distribution maps of both the spiny water flea and the zebra mussel, which is critical to the development of awareness initiatives and prevention strategies, to prevent the spread of invasive species into new areas.

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THE ONTARIO FEDERATION OF ANGLERS AND HUNTERS

SECTION 1:

1.0 THE ONTARIO FEDERATION OF ANGLERS AND HUNTERS: WHO WE ARE

The Ontario Federation of Anglers and Hunters (OFAH) is Ontario's largest, non-profit conservation-based organization, representing 100,000 members, subscribers and supporters, and 670 member clubs. The OFAH's dedication to conservation can be seen through our numerous youth and adult conservation programs, fisheries and wildlife research and restoration initiatives, and the partnerships we have formed with government and conservation organizations across the province.

1.1 THE INVADING SPECIES AWARENESS PROGRAM

In 1992, in response to growing concern over the threat of aquatic invasive species to Ontario's lakes and waterways, the OFAH formed a partnership with the Ontario Ministry of Natural Resources (OMNR) to implement the *Invading Species Awareness Program*. The primary objective of the program is to prevent the spread of aquatic invasive species through accessible, educational hands-on programs and initiatives. Some of the program's successful initiatives include:

- **Invading Species Hotline (1-800-563-7711)** – a toll-free Ontario wide number for the public to report sightings or to obtain information on aquatic invasive species.
- **EDDMapS** – a web-based mapping system used to depict the distribution of invasive species throughout North America. It is easy to use, open to the public to use and contribute to and no knowledge of GIS is required. Currently an Ontario-specific EDDMapS database is being developed to aid in Ontario invasive species monitoring and management.
- **Purple Loosestrife Biological Control** – an initiative to control purple loosestrife through the introduction of leaf-eating beetles (*Galerucella spp*) in co-operation with a variety of partners including O.M.N.R, the Ontario Wetland Habitat Fund, Ontario Beetles, the University of Guelph and concerned citizens. Purple loosestrife bio-control has resulted in reductions of purple loosestrife of more than 80% in many areas across the province.
- **Invaders in Our Waters DVD** - An interactive DVD with downloads of educational material in both English and French. The DVD also includes short informative video breaks describing the impacts, pathways of introductions and prevention of invasive species. The DVD is available to schools, libraries, public interest groups and cottage associations for presentations.
- **Making Waves! Protecting Aquatic Habitats From Invasive Species** - Curriculum and lesson plans designed to assist grade 4 and grade 6 teachers to introduce students to the concept of healthy habitats and our role in protecting them from invasive species.
- **Invasive Species Workshops** – The invading species workshops are designed to provide training on the proper methods of invasive species collection and identification.

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SECTION 2:

2.0 INVADING SPECIES WATCH

2.1 PROJECT GOALS AND OBJECTIVES

In 1998, in response to the need for information on the spread and distribution of invasive species in Ontario waterways, the OFAH created the *Invading Species Watch* program. Since this time, over 600 lakes have been monitored for the presence of zebra mussel and spiny water flea through this volunteer based program. Each year a growing number of cottage associations, conservation organizations, and concerned citizens participate in this important initiative.

The objectives of the program are the following:

1. Establish a volunteer network to track the spread of zebra mussel (*Dreissena polymorpha*) and spiny water flea (*Bythotrephes longimanus*) in Ontario waters;
2. Increase local awareness of the threat of aquatic invasive species and encourage greater public involvement in preventing the spread to Ontario's inland waters;
3. Update Ontario distribution maps and contribute to an international database that tracks the spread of aquatic invasive species in North America;
4. Provide participants with early identification of the presence of aquatic invasive species, thus providing an opportunity to initiate prevention measures to minimize impacts and spread;
5. Expand the monitoring program into regions of the province that have not been monitored extensively, such as northern Ontario.

The program is operated on a partnership basis with a variety of government agencies, non-government organizations, academic institutions and community groups including:

- Eastern Georgian Bay Stewardship Council
- Lake of the Woods District Property Owners Association (LOWDPOA)
- Ministry of Natural Resources: Kirkland Lake and Sault Ste Marie Districts
- Mississippi Valley Conservation (MVC)
- Rideau Valley Conservation Authority (RVCA)
- South Nation Conservation Authority

Would your group or organization like a presentation on invading species?

Staff members of the Invading Species Awareness Program are available to give formal presentations at your lake association meetings or community events. Please contact the Invading Species Hotline at **1-800-563-7711** for more information.

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SECTION 3:

3.0 METHODS

3.1 VOLUNTEER RECRUITMENT

In 2012, the program was promoted extensively to recruit new volunteers from across the province. Program promotion occurred at 175 events including a variety of major trade shows as well as lake association and stewardship council meetings and local community events including the Toronto Boat Show, the Toronto Sportsmen Show, and the Spring Cottage Life Show.

3.2 MEDIA PROMOTION:

The *Invading Species Awareness Program* was also promoted through a variety of media across the province, including 44 newspaper, radio, and magazine articles.

3.3 PROGRAM PARTNER PROMOTION:

ISAP program staff promoted the program through the *Invading Species Hotline*, as well as through their attendance at trade shows and conferences. RVCA, SNC, MVC, Manitoulin Area Stewardship Council and LOWDPA also promoted the *Invading Species Watch* program through their community programs and initiatives such as the Watershed Watch program.

3.4 PROGRAM IMPLEMENTATION

The OFAH coordinates the participation of lake associations and volunteers. Volunteers receive an introductory package in the early spring (prior to their sampling date), which includes the sample bottles, forwarding instructions, courier labels and scheduled date to receive the monitoring equipment during the summer.

Twenty-two students participated as part of the Invading Species Hit Squad. In partnership with the Rideau Valley, South Nation, and Mississippi Valley Conservation Authorities, Kirkland Lake, and Sault Ste. Marie OMNR District Offices, OFAH, and Lake of the Woods District Property Owners Association, and the Georgian Bay Stewardship Council some students coordinated and facilitated volunteers, as well as lake associations and conservation clubs in their respective areas. All students managed volunteers in their areas, arranged sampling dates and assisted volunteers with actual sampling. In addition, they increased public awareness of invasive species by attending over 130 events throughout the summer.

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Figure 2: Summer students (Dean Nolan, left and David Ryrrie) with the Invading Species Awareness Program 2012

3.5 PROGRAM MONITORING

Following the protocol in the program manual, participants monitored their lakes once between mid-June and early September; collecting lake samples using plankton haul nets (63 microns) at 3-5 locations on the lake. In total, 338 Samples were collected from 129 lakes averaging 2.6 samples per lake. The participants were responsible for disinfecting the equipment before and after they monitored their lakes. The samples were returned to the OFAH, and then shipped to RNT Consulting for analysis. In total 14 monitoring kits were circulated in the summer of 2012 to volunteers throughout Ontario, sampling 129 lakes.

3.6 PROGRAM ANALYSIS: METHODS

RNT Consulting provided analysis of the plankton samples, following the Schaner protocol using a sugar solution to separate zebra mussel veligers from the sample¹ (Schaner, 1990). The refined sample was then observed under a cross-polarized light, as described by Johnson (Johnson, 1995) to cause the zebra mussel veligers to appear as small glowing 'D' shaped objects with dark crosses.² Volunteers were contacted at the end of the program and provided with the results.

¹ Schaner, Ted, 1990. Detection of Zebra Mussel Veligers in Plankton Samples Using Sugar Solution. Ontario Ministry of Natural Resources, Lake Ontario Fisheries Unit 1990 Annual Report, LOA 91.1 (Chapter 6).

² Johnson, L.E., 1995. Enhanced Early Detection and Enumeration Of Zebra Mussel (*Dreissena* spp.) Veligers Using Cross-Polarized Light Microscopy, Williams College-Mystic Seaport.

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3.7 RESULTS

Of the 129 lakes or waterways sampled in 2012, spiny waterflea were discovered in 14 lakes with nine being new occurrences. Zebra mussel veligers were found in 18 lakes with three first occurrences.

Zebra mussel veligers were discovered in the following lakes:

Bold indicates a first occurrence

Zebra Mussel (<i>Dreissena polymorpha</i>)		
Waterbody	County	Township
Balsam Lake	Kawartha Lakes Division	Bexley
Bass Lake	Leeds and Grenville United Counties	Lansdowne
Big Rideau Lake	Lanark County	Burgess
Black Lake	Lanark County	Burgess
Burridge Lake	Frontenac County	Bedford
Christie Lake	Lanark County	South Sherbrooke
Clayton Lake	Lanark County	Lanark
Fanshawe Lake	Middlesex County	London
Kashwakamak Lake	Frontenac County	Barrie
Lower Rideau Lake	Lanark County	Elmsley
Mississippi Lake	Lanark County	Beckwith
Red Horse Lake	Leeds and Grenville United Counties	Lansdowne
Singleton Lake	Leeds and Grenville United Counties	Lansdowne
Six Mile Lake	Muskoka District Municipality	Baxter
South Nation River	Prescott and Russell United Counties	Plantagenet
Upper Rideau Lake	Leeds and Grenville United Counties	North Crosby
Westport Sand Lake	Leeds and Grenville United Counties	North Crosby
Wolfe Lake	Leeds and Grenville United Counties	North Crosby

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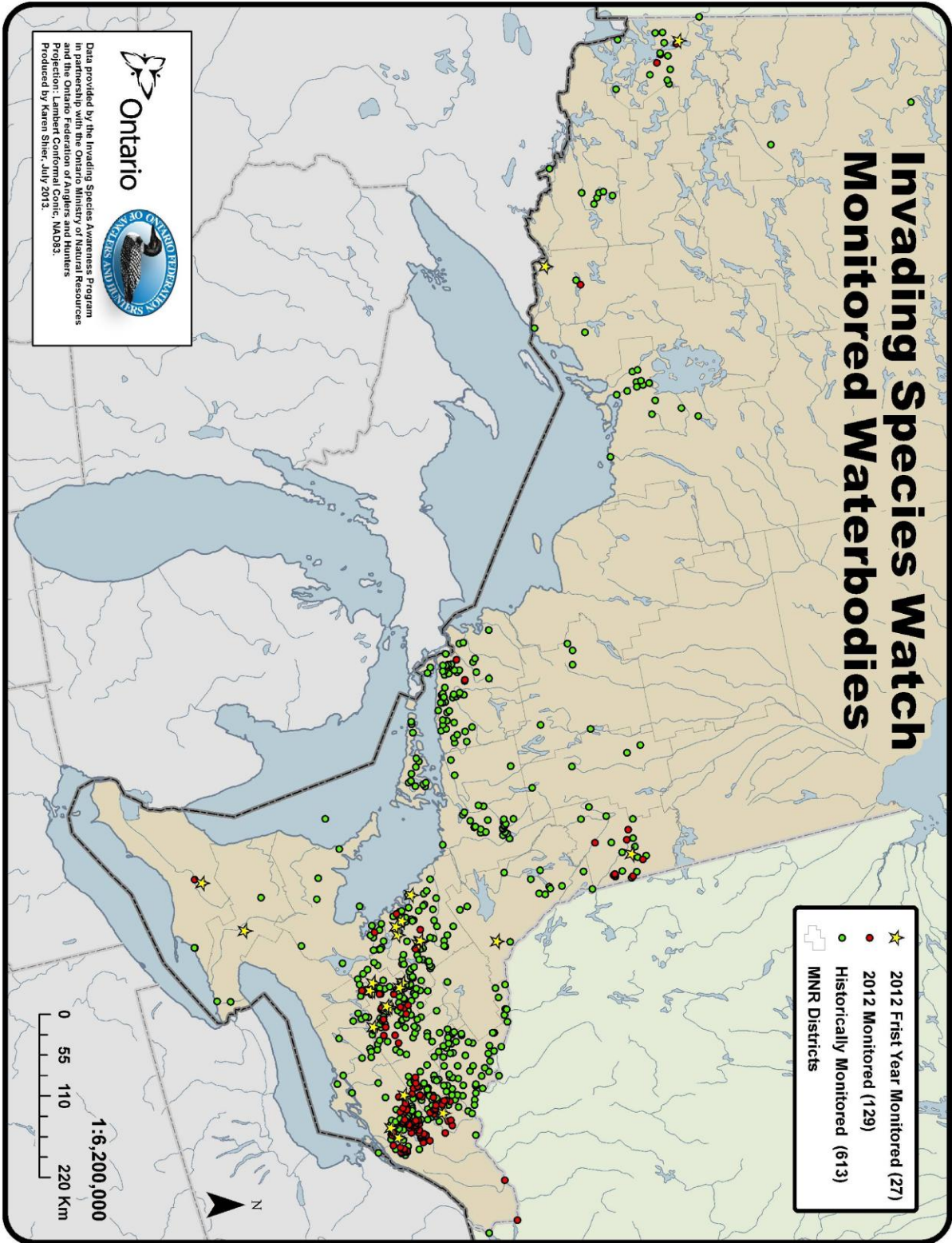
Spiny water flea were discovered in the following lakes:

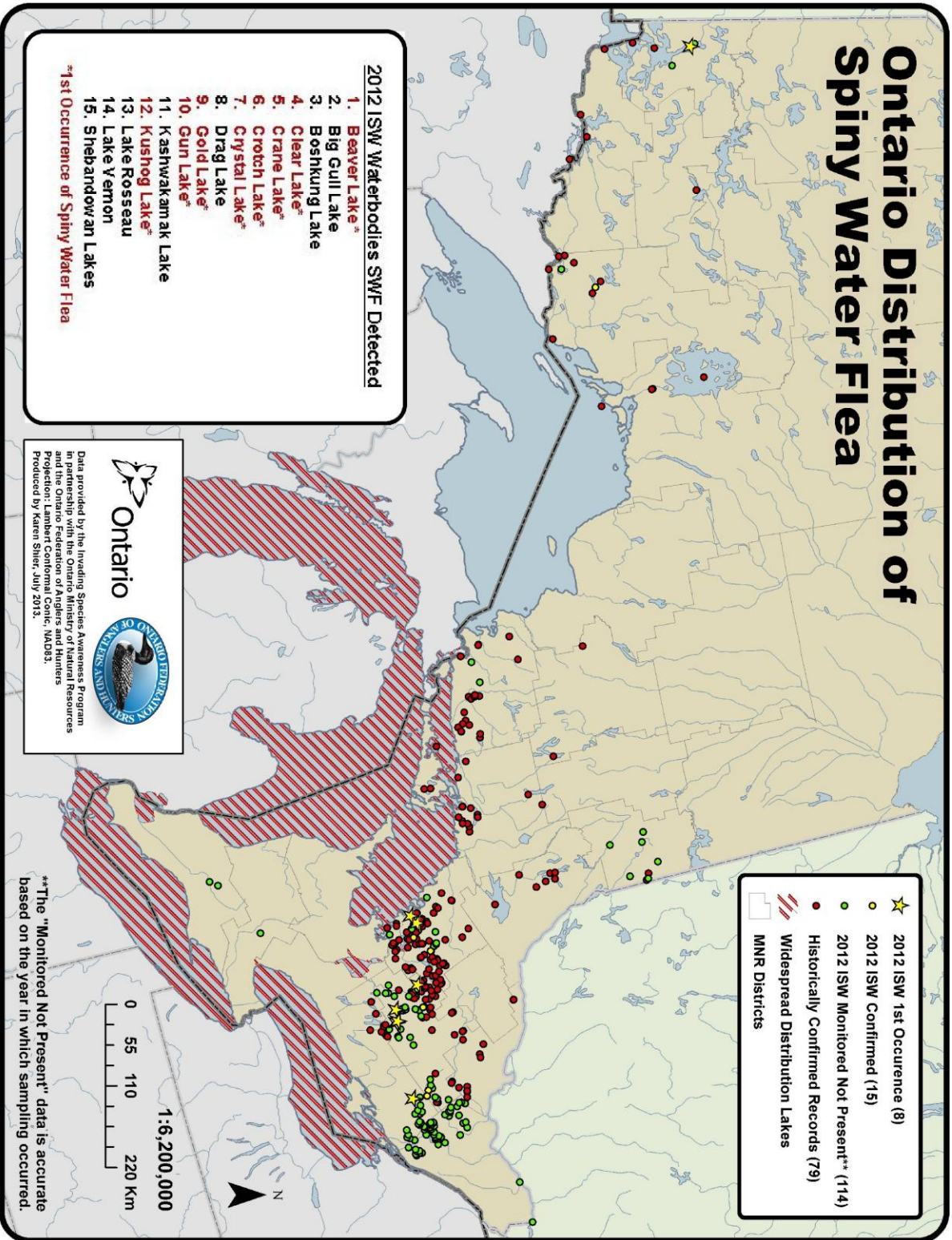
Bold indicates a first occurrence

Spiny Waterflea (<i>Bythotrephes longimanus</i>)		
Waterbody	County	Township
Beaver Lake	Peterborough County	Cavendish
Big Gull Lake	Frontenac County	Clarendon
Boshkung Lake	Haliburton County	Stanhope
Clear Lake	Parry Sound District	Humphrey
Crane Lake	Parry Sound District	Conger
Crotch Lake	Frontenac County	Kennebec
Crystal Lake	Peterborough County	Galway
Drag Lake	Haliburton County	Dudley
Gold Lake	Peterborough County	Cavendish
Gun Lake	Kenora District	
Kashwakamak Lake	Frontenac County	Barrie
Kushog Lake	Haliburton County	Stanhope
Lake Rosseau	Muskoka District Municipality	Medora
Lake Vernon	Muskoka District Municipality	Stisted

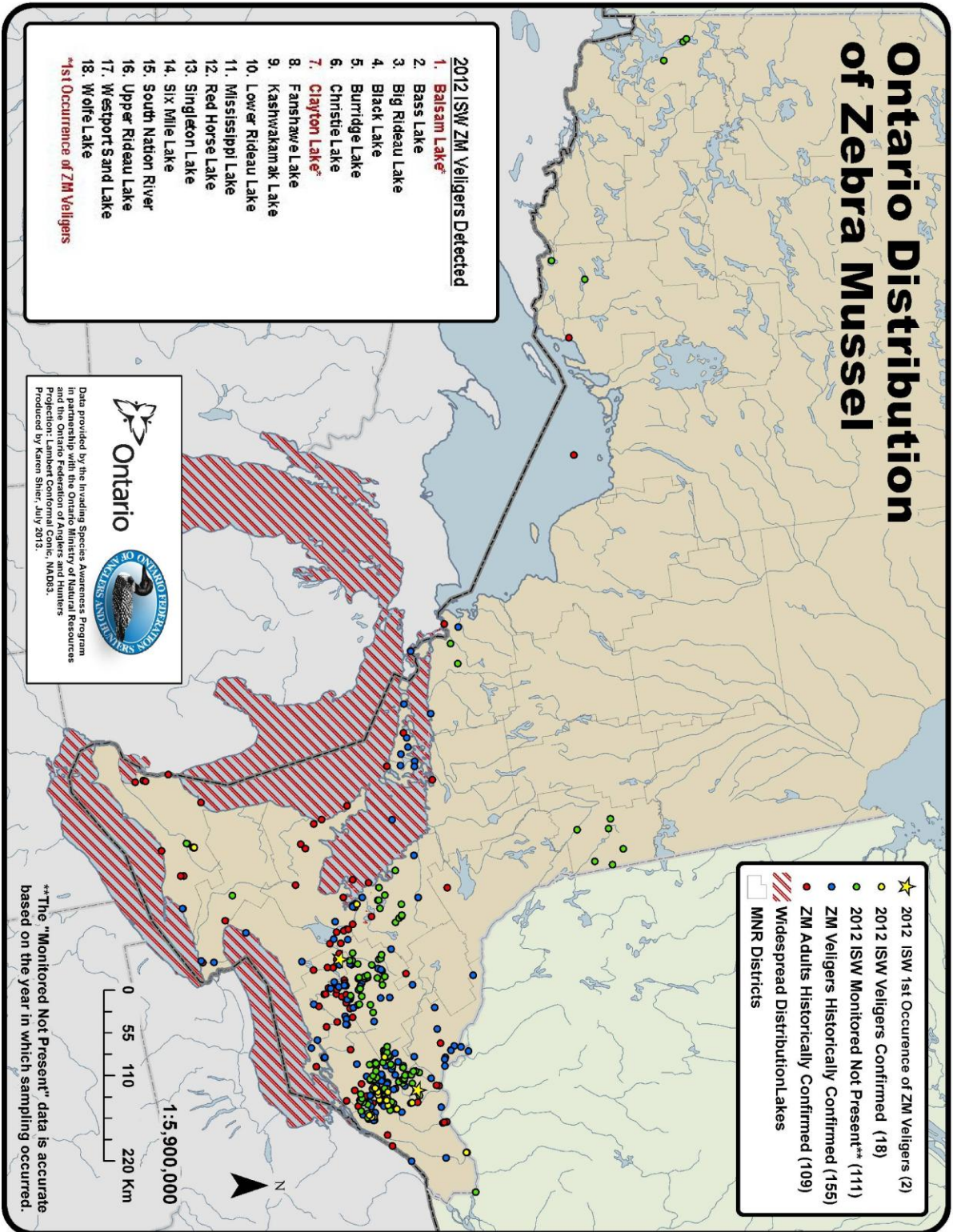
**bolded names are first occurrences of reports within the Invading Species Watch database*

All participants, regardless of their individual lake results were encouraged to use the extensive resources of the *Invading Species Awareness Program* to raise public awareness of invasive species and to encourage their involvement in prevention measures. A list of available resources and an order form is available on the OFAH website at www.invadingspecies.com.





Ontario Distribution of Zebra Mussel



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SECTION 4:

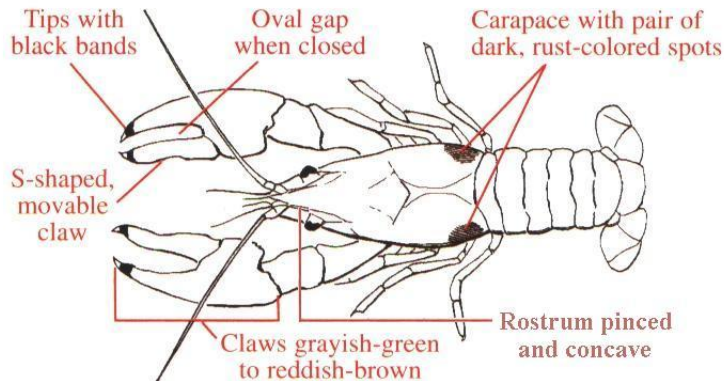
4.0 INVADING SPECIES WATCH

4.1 NEW SPECIES

The Invading Species Watch Program has primarily investigated the distribution of the spiny water flea and zebra mussel. However, there are many other invasive species that are also of concern. With that in mind, the OFAH, in cooperation with the OMNR and Dr. Premek Hamr, has developed a new rusty crayfish monitoring protocol. If you would like to assist us by monitoring for rusty crayfish, please contact the Invading Species Hotline at 1-800-563-7711.

Rusty crayfish are native to the United States. They degrade aquatic habitats by feeding heavily on aquatic vegetation and cause harm to native fish populations by feeding on their eggs and fry. Rusty crayfish are very aggressive and often outcompete native crayfish species for food and habitat. In areas of rusty crayfish invasion, native crayfish species have been known to decline or disappear.

General Characteristics of rusty crayfish are the rusty red patches on their body, black tips on their claws and their rostrum (the area between the eyes) appears pinched and concave. Use the following illustration as a guide to identify rusty crayfish; please note that some characteristics may be absent in live specimens. If you see a rusty crayfish, keep a sample and report the sighting to the Invading Species Hotline.



In addition to monitoring for rusty crayfish, the *Invading Species Watch* Program will continue to expand the number of lakes it monitors and to make even more presentations to spread awareness of the threat of invasive species. There are many other species such as Eurasian water milfoil, round goby, and European frogbit that pose a threat to Ontario's native species. If you would like to monitor for these or any other invasive species, you can contact the Invading Species for details or feedback.

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APPENDIX A: GENERAL INVASIVE SPECIES INFORMATION

INVADING SPECIES: REASONS FOR CONCERN

Invading species create serious ecological and economic problems in Ontario, Canada and the world. The introduction of new invading species occurs on a regular basis through various pathways. There are over 185 non-indigenous species found in the Great Lakes basin alone. Although most species may be benign, or have not been studied, approximately 10% of these species have had significant ecological and/or economic impacts.

Although the details of these impacts are not fully known, there is an agreement among the scientific community that invading species threaten biodiversity. The Committee on the Status of Endangered Wildlife estimated that 25% of Canada's endangered species, 31% of Canada's threatened species and 16% of Canada's vulnerable species are in some way at risk from non-native species (Lee, 2002). Other researchers predict that aquatic invasive species will contribute to extinction rates of 4% per decade, suggesting that fresh water organisms will go extinct 5 times faster than terrestrial organisms and 3 times faster than coastal species (Ricciardi & Rasmussen, 1999).

INVADING SPECIES: PATHWAYS OF INTRODUCTION

Invading species can enter new geographical areas by various means; both natural and human-made. Natural means of introduction include wind, water current, and animal assisted dispersal. Man-made pathways of introduction include shipping and ballast water, canals, the aquarium and horticultural trades, bait buckets and illegal fish transfers.

INVADING SPECIES: PATHWAYS OF SPREAD

Once these non-indigenous species are in Ontario waters, they can spread from waterbody to waterbody by both natural and human made pathways. Animals or water currents can carry and disperse invading species; however, the major pathway of spread involves human activities. Recreational boating and angling can inadvertently spread these invaders to new waterbodies. It is of critical importance to ensure that boats, trailers, motors etc. are properly cleaned and disinfected before leaving a waterbody. For more information regarding this procedure, please contact the Invading Species Hotline at 1-800-563-7711 or visit www.invadingspecies.com.



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INVADING SPECIES: WHY DO THEY FLOURISH IN THEIR NEW HOMES?

Typically, invading species flourish in new waterbodies for a number of reasons. Most have few or no predators and/or diseases in their new habitats to keep their populations in balance. Furthermore these species reproduce quickly and in some cases more often than native species. Invading species often have an ability to adapt to various ecosystems and environmental conditions. These characteristics, combined with numerous mechanisms for spread, enable invasive species to rapidly become established when introduced to new locations.

Unfortunately, once an invading species becomes established there is often little that can be done to eradicate them from a waterbody. This reaffirms the importance of prevention efforts.

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APPENDIX B: ZEBRA MUSSEL INFORMATION

THE ZEBRA MUSSEL: BIOLOGY OF INVASION

The zebra mussel was originally native to the Caspian Sea and Ural River in Asia. In the nineteenth century, it spread west and now occurs in most of Europe, the western portion of the Commonwealth of Independent States (formally the Soviet Union) and Turkey. In the mid 1980's, a Eurasian vessel released ballast water into the Great Lakes region that contained either adult or larval forms of the zebra mussel (*Dreissena polymorpha*). Zebra mussels were first discovered in water intake pipes in industrial and municipal water plants in Lake St. Clair near Detroit in 1988. Today, zebra mussels have successfully invaded all of the Great Lakes, the Rideau and Trent Severn waterways and a number of inland waterbodies in Ontario.

The most notable traits attributing to the rapid spread of the zebra mussel are its prolific reproductive capabilities and methods of dispersal by natural or human induced means. The microscopic zebra mussel larva (veligers) are free swimming and rely on water currents and wave action to transport them to new locations downstream. Due to their microscopic size, veligers can be transferred to new waterbodies via the bilge water and bait buckets of unsuspecting boaters or anglers. Additionally, adult zebra mussels can attach to any hard surface and can be easily transferred to new waters via boat hulls as well as attached to aquatic plants on boat trailers. Recreational boating is generally recognized as being the main facilitator in the dispersal of zebra mussels to new locations within connected lakes or waterways (upstream systems) and inland lakes.

THE ZEBRA MUSSEL: BIOLOGY



The zebra mussel (*Dreissena polymorpha*) is a freshwater clam (mollusc) that can be distinguished from native clams by its brown and cream to yellow stripes and flat to concave shell bottom. The free-swimming microscopic planktonic veliger, also distinguish zebra mussels from the two families of native clams, *Unioniidea* and *Sphaeriidae*, which do not produce free-swimming larval forms.

Figure 2: Zebra Mussel
Source: The O.F.A.H.

Male and female zebra mussels participate in either one or two spawning events per year typically between May to September and possibly as late as October. Zebra mussels normally begin to reproduce when water temperatures reach 12° Celsius (Table 1). One female zebra mussel can produce between 40,000 and 1 million eggs per season. Microscopic eggs hatch and release veligers. Over a period of 3 weeks veligers grow a thin “D” shaped transparent shell and slowly settle to the bottom of the lake or waterway. They then attach to any firm surface using byssal (sticky) threads. “An individual zebra mussel can attach to an object

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with more than 100 byssal threads that are secreted from a gland at the base of its foot.”³ These byssal threads also distinguish the zebra mussel from native North American fresh water clams that only have a single thread that is present only in the juvenile stage. Development from the egg stage to the settling stage is highly variable and is largely influenced by temperature, the warmer the water the faster the development.

After an immature mussel settles it can remain attached to a hard substrate for life. However, if conditions become unsuitable, from physical disturbance, poor water quality or water temperature changes, zebra mussels can release from their byssal threads. Individuals can then be carried passively, with the assistance of water currents and attach to new surfaces by secreting new byssal threads. Additionally, zebra mussels can crawl by extending a foot-like structure, anchoring it to substrate with mucus and then contracting the muscles to pull the body forward. Small individuals are more mobile than large mussels.

Will Zebra Mussels Survive In My Lake?

Criteria	No Survival		Poor Growth		Mod. Growth		Good Growth		Best Growth
	From	To	From	To	From	To	From	To	
Alkalinity (mg CaCO _{3/l})	0	17	18	35	36	87	88	122	>122
Calcium (mg/l)	5	6	10	11	25	26	35	>35	
Total Hardness (mg CaCO _{3/l})	0	22	23	41	43	90	91	125	>125
Conductivity (μ Siemens)	0	21	22	36	37	82	83	110	>110
PH	0	6.8	6.9	7.4	7.5	7.8	7.9	8.0	>8.0
Temperature (°C) ^a	<-2	>40	0-8	28-30	9-12	25-27	13-17	21-24	18-20

Table 1: Approximate Growth Performance of Zebra Mussels in Relation to Alkalinity, Calcium, Total Hardness, Conductivity, pH⁴ and temperature.

Note: Temperature should be interpreted with caution here because it affects mussels at both high and low values. For example there is no survival at temperatures below -2 or above 40°C but there is survival between these temperatures; there is poor growth both between 0-8°C and 28-30°C but moderate to best growth between these extremes.

³ US Army Corps of Engineers: Zebra Mussels: Biology, Ecology and Recommended Control Strategies. Technical Note ZMR-1-01

⁴ Claudi, Renata and Mackie Gerald, L. 1994. Practical Manual for Zebra Mussel Monitoring and Control. Lewis Publishers: Boca Raton, Florida USA.

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Zebra Mussels Under The Microscope!

One of the simplest and most efficient methods for analyzing the *Invading Species Watch* Program water samples involves the use of cross-polarized light. Zebra mussel larvae are one of the few reflective objects found in the samples. Larvae are reflected due to the calcium structure of the larval shell and they glow as bright spots under polarized light. Because of the arrangement of the calcium particles, portions of the shell do not reflect the light and thus the veligers appear with small glowing “Maltese” crosses. Under the polarized light zebra mussels can be confused with ostracods and are distinguished based on size, shape, or other features. However cross-polarized light provides a simple way to narrow the range of possibilities from hundreds of aquatic species captured in a plankton haul.

THE ZEBRA MUSSEL: IMPACTS OF THE INVASION IN ONTARIO

ECOLOGICAL IMPACTS

Aquatic ecosystems that have established zebra mussel populations can experience significant alterations from their natural state including food, habitat and biodiversity-related alterations.

Food Related Alterations

Zebra mussels are filter feeders, removing microscopic plant and animal matter from water as a source of food. Each mussel can filter about one litre of lake water per day. However, not all of what they consume is digested. What they don't eat is combined with mucus as “pseudo-feces” and is discharged onto the lake bottom where it accumulates.

A consequence of their filtering capabilities includes the reduction of phytoplankton (algae) diversity and numbers from the water column. Zebra mussels also remove, through filtering, small animals (i.e. rotifers, immature copepods). As phytoplankton and zooplankton are a source of food for larval fish and young fish, they may compete with zebra mussels for this important food source.

The zebra mussel has also been linked to the decline of diporeia, a tiny shrimp-like amphipod, in the Great Lakes, which is an important food source for many fish species. Since the early 1990's, populations of diporeia have either disappeared or dramatically declined in many areas of the Great Lakes. For example, in the Kingston basin of Lake Ontario, diporeia abundance has fallen to near zero, from a previous level of 14,000 per square meter.⁵ Diporeia is an organism that formerly represented up to 70% of the Great Lakes biomass of bottom-dwelling invertebrates. Diporeia's decline has caused a major food chain disruption, affecting fish species such as whitefish.

⁵ Lozano, S.J., Scharold, J.V., and Nalepa, T.F. 2001. Recent declines in benthic macroinvertebrate densities in Lake Ontario. *Can. J. Fish. Aquat. Sci.* **58**: 518-529.

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Habitat Related Alterations

When zebra mussels filter water organisms, matter is removed from the water and as a result water clarity increases. Sunlight can then penetrate further into the water column, causing an increase in plant growth. This increase in sunlight is detrimental to light sensitive fish such as walleye and could force these fish to re-locate to darker and deeper areas of the lake or waterway. However, this increased light penetration can have positive effects for certain species including bass and pike, which flourish in high light environments.

Fish spawning habitats may also be altered by the colonization of zebra mussels on rocks. Many fish species depend on rocky or cobble surfaces and the crevices between them for suitable spawning habitat. Once the zebra mussel colonizes an area, these crevices disappear. In a typical zebra mussel infestation, adult zebra mussels can reach densities in the thousands per square metre. These high densities negatively impact both fish spawning habitats and smaller native aquatic organisms, which, feed on fine particles from the water, and have to compete with the zebra mussel for food. Additionally the sedimentation that results from the excretion of pseudo-feces and feces fills the preferred spawning areas and crevices between them that fish depend upon.

Contaminant Bioaccumulation

Recent studies in North America have demonstrated high levels of contaminant bioaccumulation in zebra mussels (Bioaccumulation is described as the accumulation of contaminants by aquatic organisms from sources such as water, food and in the case of zebra mussels, suspended sediment particles in the water column). These toxins may become available to zebra mussel predators higher in the food chain. Contaminants found in zebra mussel populations include hexachlorobenzene and pentachlorophenol. In the Netherlands, analysis of zebra mussels indicated that they had accumulated cadmium, mercury, lead, PCB's, pesticides, and petroleum hydrocarbons (Reeders and Bij de Vaate 1992). Not only does the zebra mussel absorb these deadly contaminants in their body tissues, but they can also release them into the sediment through their pseudo-feces.

Since zebra mussels have invaded the Great lakes, scientists have noted a decline in greater and lesser scaup duck populations. These waterfowl feed on zebra mussels and scientists are concerned that they may accumulate selenium in their tissue, possibly affecting lesser scaup reproductive ability. (Petrie, 2002)

Biodiversity Alterations

Zebra mussels have also severely affected native clam populations in the Great Lakes by interfering with their ability to feed, grow, move, and reproduce. Nine species of clams have disappeared or declined in Lake Erie since the introduction of zebra mussels. Data from Lake St. Clair indicated that in 1990, 100% of the clams were encrusted with zebra mussels with an average of 638 zebra mussels per clam. Many clams had between 1,000 and 2,000 zebra

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mussels. In 1991 the density of living clams was only one eightieth of 1990 levels and the number of living clam species had decreased from 11 to 4. (Gillis and Mackie 1992)

ECONOMIC IMPACTS

The most visible and dramatic effects of zebra mussels occur in industrial and municipal facilities. Intake pipes and screens of facilities i.e. power plants, factories, municipal drinking water facilities become clogged with large colonies of zebra mussels. The economic impacts of zebra mussels in Ontario are staggering. While exact figures are difficult to generate, the following figures are known:



Figure 2. A pipe clogged by zebra mussels (provided by Peter Yates)

- Ontario Power Generation spends approximately \$20 million per year for zebra mussel control; and
- Canada spends an estimated \$500 million annually on alien species control efforts in the Great Lakes (Commissioner of the Environment and Sustainable Development 2001).

In the Great Lakes region, industrial plants and public utilities have been shut down periodically to deal with damage caused by zebra mussels. This costs

millions of dollars in repair costs and lost production.

Socio-economic impacts can occur on public and private beaches, which become littered with thousands of zebra mussels, which produce an unpleasant odour and zebra mussel shells are sharp which render beaches painful to walk on. The habitat changes caused by zebra mussels such as the promotion of aquatic weed growth can also restrict recreational boating and swimming activities.

Due to the ecological and economic impacts of the zebra mussel, it is recognized as one of the world's worst invaders. The zebra mussel has spread throughout the Great Lakes and numerous inland lakes in southern Ontario within a mere 15 years. This is an astounding fact considering this range spans across 3 different eco-zones, each with markedly different climates, geography and lake or waterways. There continues to be many unanswered questions about zebra mussels regarding their impacts and potential distribution in Ontario. The *Invading Species Watch* program is contributing to answering these critical questions by documenting the distribution of zebra mussels and providing resource managers with critical information about the dispersal and lake conditions necessary for invasion.

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APPENDIX C: SPINY WATER FLEA INFORMATION

THE SPINY WATER FLEA: BIOLOGY OF INVASION

It is likely that the spiny water flea (*Bythotrephes longimanus*), like the zebra mussel, was introduced to the Great Lakes from the discharge of ship ballast water. The first recorded occurrence of the spiny water flea in North America was in Lake Ontario in 1982, and by 1987 it was present in all of the Great Lakes. Now you can also find spiny water flea in many inland lakes and waterways throughout Ontario.

Due to their small size, eggs and adults are easily transferred to new lakes or waterways as stowaways in the bilge, and transom wells of boats and other personal watercraft, or spread through infested angling or boating equipment such as fishing lines, downrigger cables and anchor ropes.

THE SPINY WATER FLEA: BIOLOGY



Figure 4: The Spiny Water Flea

Source: Bell Museum, University of Minnesota

The spiny water flea belongs to the class Crustacea, a group of animals such as crabs and shrimps that possess a hard exoskeleton (outer shell). This Eurasian animal is approximately 1 cm in length, and as its name suggests, has a long barbed tail spine that accounts for 80% of its length. The spine contains from one to four pairs of barbs, which can be used to determine the age of the animal (US Sea Grant, 2005).

Like all other Crustacea, its exoskeleton moults in order to grow. The spiny water flea is unique because it sheds only the exoskeleton that covers its body, retaining the exoskeleton that covers the tail spine. The animal is never without its long, stout spine, which suggests that the tail serves a vital protective function. (US Sea Grant, 2005)

The head has a large black eye and a pair of swimming antennae. Also present are a pair of jaws which are used to pierce and shred its prey. This animal has four pairs of legs; the first, longer pair is used for catching prey, whereas the other pairs of limbs are designed for grasping prey while they are being consumed. Spiny water flea is a voracious predator and can eat up to 20 organisms of zooplankton daily.

SPINY WATER FLEA: IMPACTS OF THE INVASION IN ONTARIO

ECOLOGICAL IMPACTS

Like the zebra mussel, the spiny water flea can have significant and rapid impacts on lake ecosystems, many of which still remain unknown. However recent research initiatives have identified several impacts including native zooplankton species reduction, food chain disruptions, and water clarity reductions

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Spiny water flea consumes up to three times as much as native species of zooplankton. Spiny water flea consumes smaller species of native zooplankton such as *Daphnia*, which is an important food source for juvenile fish species. As a result the spiny water flea competes directly with these juvenile fish for food. When populations of this invader are high, consumption is significant, and the amount of food available to native species of predatory zooplankton, smaller forage fish, and juvenile fish is largely reduced.

Planktivorous fish such as whitefish and lake herring feed on spiny water flea. However, studies have indicated that juvenile fish smaller than 10 cm in length are unable to use the spiny water flea as a source of food due to the long tail spine, which prevents them from swallowing it. Research by Rae Barnhisel of Michigan Technological University found that young yellow perch cough up the spiny water flea because of the long tail spine, which prevents that fish from swallowing it.

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APPENDIX D: 2012 INVADING SPECIES WATCH RESULTS

Results from the *Invading Species Watch* in 2012

Waterbody	County	Township	Spiny Water Flea	Zebra Mussel
Adams Lake	Lanark County	Burgess	N	N
Adams Lake	Lanark County	Burgess	N	N
Adams Lake	Lanark County	Burgess	N	N
Ardoch Lake	Frontenac County	Clarendon	N	N
Bagot Long Lake	Renfrew County	Bagot	N	N
Bagot Long Lake	Renfrew County	Bagot	N	N
Bagot Long Lake	Renfrew County	Bagot	N	N
Balsam Lake	Kawartha Lakes Division	Bexley	N	Y
Balsam Lake	Kawartha Lakes Division	Bexley	N	Y
Balsam Lake	Kawartha Lakes Division	Bexley	N	Y
Bass Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Bear Lake	Parry Sound District	Monteith	N	N
Bear Lake	Parry Sound District	Monteith	N	N
Bear Lake	Parry Sound District	Monteith	N	N
Beaver Lake	Peterborough County	Cavendish	Y	N
Beaver Lake	Peterborough County	Cavendish	Y	N
Beaver Lake	Peterborough County	Cavendish	Y	N
Big Gull Lake	Frontenac County	Clarendon	Y	N
Big Gull Lake	Frontenac County	Clarendon	Y	N
Big Gull Lake	Frontenac County	Clarendon	N	N
Big Gull Lake	Frontenac County	Clarendon	Y	N
Big Gull Lake	Frontenac County	Clarendon	N	N
Big Gull Lake	Frontenac County	Clarendon	Y	N
Big Rideau Lake	Lanark County	Burgess	N	Y
Big Rideau Lake	Lanark County	Burgess	N	Y
Big Rideau Lake	Lanark County	Burgess	N	Y
Big Rideau Lake	Lanark County	Burgess	N	Y
Black Lake	Lanark County	Burgess	N	Y
Black Lake	Lanark County	Burgess	N	N
Bobs Lake	Frontenac County	South Canonto	N	N
Boshkung Lake	Haliburton County	Stanhope	Y	N
Boshkung Lake	Haliburton County	Stanhope	N	N
Bowley Lake	Lanark County	Ramsay	N	N
Bowley Lake	Lanark County	Ramsay	N	N

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Bowley Lake	Lanark County	Ramsay	N	N
Buck Lake	Parry Sound District	Mcmurrich	N	N
Buck Lake	Parry Sound District	Mcmurrich	N	N
Burridge Lake	Frontenac County	Bedford	N	Y
Burridge Lake	Frontenac County	Bedford	N	N
Butterill Lake	Frontenac County	Bedford	N	N
Canning Lake	Haliburton County	Minden	N	N
Canning Lake	Haliburton County	Minden	N	N
Canning Lake	Haliburton County	Minden	N	N
Canonto Lake	Frontenac County	South Canonto	N	N
Canonto Lake	Frontenac County	South Canonto	N	N
Canonto Lake	Frontenac County	South Canonto	N	N
Carnahan Lake	Frontenac County	Olden	N	N
Carpenter Lake	Algoma District	Morin	N	N
Carpenter Lake	Algoma District	Morin	N	N
Carpenter Lake	Algoma District	Morin	N	N
Chandos Lake	Peterborough County	Chandos	N	N
Chandos Lake	Peterborough County	Chandos	N	N
Chandos Lake	Peterborough County	Chandos	N	N
Chandos Lake	Peterborough County	Chandos	N	N
Christie Lake	Lanark County	South Sherbrooke	N	Y
Christie Lake	Lanark County	South Sherbrooke	N	N
Christie Lake	Lanark County	South Sherbrooke	N	Y
Clayton Lake	Lanark County	Lanark	N	Y
Clayton Lake	Lanark County	Lanark	N	N
Clear Lake	Parry Sound District	Humphrey	Y	N
Clear Lake	Parry Sound District	Humphrey	Y	N
Clear Lake	Parry Sound District	Humphrey	Y	N
Clyde Lake	Renfrew County	Blithfield	N	N
Clyde Lake	Renfrew County	Blithfield	N	N
Coon Lake	Peterborough County	Burleigh	N	N
Coon Lake	Peterborough County	Burleigh	N	N
Coon Lake	Peterborough County	Burleigh	N	N
Crane Lake	Parry Sound District	Conger	Y	N
Crane Lake	Parry Sound District	Conger	N	N
Crane Lake	Parry Sound District	Conger	Y	N
Crego Lake	Kawartha Lakes Division	Somerville	N	N
Crego Lake	Kawartha Lakes	Somerville	N	N

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Division				
	Kawartha Lakes			
Crego Lake	Division	Somerville	N	N
	Leeds and Grenville			
Crosby Lake	United Counties	North Crosby	N	N
	Leeds and Grenville			
Crosby Lake	United Counties	North Crosby	N	N
	Leeds and Grenville			
Crosby Lake	United Counties	North Crosby	N	N
Crotch Lake	Frontenac County	Kennebec	Y	N
Crotch Lake	Frontenac County	Kennebec	Y	N
	Leeds and Grenville			
Crow Lake	United Counties	South Crosby	N	N
	Leeds and Grenville			
Crow Lake	United Counties	South Crosby	N	N
	Leeds and Grenville			
Crow Lake	United Counties	South Crosby	N	N
Crystal Lake	Peterborough County	Galway	Y	N
Crystal Lake	Peterborough County	Galway	Y	N
Crystal Lake	Peterborough County	Galway	Y	N
Dalhousie Lake	Lanark County	Dalhousie	N	N
Dalhousie Lake	Lanark County	Dalhousie	N	N
Davern Lake	Lanark County	Dalhousie	N	N
		South		
Davern Lake	Lanark County	Sherbrooke	N	N
		South		
Davern Lake	Lanark County	Sherbrooke	N	N
Drag Lake	Haliburton County	Dudley	Y	N
Drag Lake	Haliburton County	Dudley	N	N
Eagle Lake	Frontenac County	Hinchinbrooke	N	N
Eagle Lake	Frontenac County	Hinchinbrooke	N	N
Eagle Lake	Frontenac County	Hinchinbrooke	N	N
East Cove Pond	Middlesex County	London	N	N
East Cove Pond	Middlesex County	London	N	N
East Cove Pond	Middlesex County	London	N	N
Echo Lake	Algoma District	Kehoe	N	N
Echo Lake	Algoma District	Kehoe	N	N
Echo Lake	Algoma District	Kehoe	N	N
Elbow Lake	Frontenac County	Hinchinbrooke	N	N
Elbow Lake	Frontenac County	Hinchinbrooke	N	N
Elbow Lake	Frontenac County	Hinchinbrooke	N	N
Elbow Lake	Frontenac County	Pittsburgh	N	N

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Elbow Lake	Frontenac County	Pittsburgh	N	N
Elbow Lake	Frontenac County	Pittsburgh	N	N
Elk Lake	Timiskaming District	James	N	N
Elk Lake	Timiskaming District	James	N	N
Esson Lake	Haliburton County	Monmouth	N	N
Esson Lake	Haliburton County	Monmouth	N	N
Esson Lake	Haliburton County	Monmouth	N	N
Fanshawe Lake	Middlesex County	London	N	Y
Fanshawe Lake	Middlesex County	London	N	Y
Fanshawe Lake	Middlesex County	London	N	Y
Farren Lake	Lanark County	South Sherbrooke	N	N
Farren Lake	Lanark County	South Sherbrooke	N	N
Fawn Lake	Parry Sound District	Mcmurrich	N	N
Fermoy Lake	Frontenac County	Bedford	N	N
Flower Round Lake	Lanark County	Lavant	N	N
Flower Round Lake	Lanark County	Lavant	N	N
Fortescue Lake	Haliburton County	Cavendish	N	N
Fortescue Lake	Haliburton County	Cavendish	N	N
Fortescue Lake	Haliburton County	Cavendish	N	N
Fox Lake	Muskoka District Municipality	Stisted	N	N
Fox Lake	Muskoka District Municipality	Stisted	N	N
Fox Lake	Muskoka District Municipality	Stisted	N	N
Gold Lake	Peterborough County	Cavendish	Y	N
Gold Lake	Peterborough County	Cavendish	Y	N
Gold Lake	Peterborough County	Cavendish	Y	N
Goodfellow Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Goodfellow Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Goodfellow Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Green Lake	Frontenac County	Barrie	N	N
Grippen Lake	Leeds and Grenville United Counties	Leeds	N	N

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Grippen Lake	Leeds and Grenville United Counties	Leeds	N	N
Grippen Lake	Leeds and Grenville United Counties	Leeds	N	N
Guerley Lake	Frontenac County	Pittsburgh	N	N
Guerley Lake	Frontenac County	Pittsburgh	N	N
Guerley Lake	Frontenac County	Pittsburgh	N	N
Gun Lake	Kenora District	null	Y	N
Gun Lake	Kenora District	null	Y	N
Gun Lake	Kenora District	null	N	N
Head Lake	Kawartha Lakes Division	Laxton	N	N
Head Lake	Kawartha Lakes Division	Laxton	N	N
Head Lake	Kawartha Lakes Division	Laxton	N	N
Hoggs Bay	Lanark County	Burgess	N	N
Hoggs Bay	Lanark County	Burgess	N	N
Horne Lake	Lanark County	Dalhousie	N	N
Howard Lake	Timiskaming District	Arnold	N	N
Howard Lake	Timiskaming District	Arnold	N	N
Jack Lake	Peterborough County	Methuen	N	N
Jack Lake	Peterborough County	Methuen	N	N
Jack Lake	Peterborough County	Methuen	N	N
Jack Lake	Peterborough County	Methuen	N	N
Jack Lake	Peterborough County	Methuen	N	N
Joes Lake	Lanark County	Lavant	N	N
Joes Lake	Lanark County	Lavant	N	N
Joes Lake	Lanark County	Lavant	N	N
Kashwakamak Lake	Frontenac County	Barrie	Y	Y
Kashwakamak Lake	Frontenac County	Barrie	N	Y
Kennebec Lake	Frontenac County	Kennebec	N	N
Kennebec Lake	Frontenac County	Kennebec	N	N
Kennebec Lake	Frontenac County	Kennebec	N	N
Kenogami Lake	Timiskaming District	Grenfell	N	N
Kenogami Lake	Timiskaming District	Grenfell	N	N
Killenbeck Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Killenbeck Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Killenbeck Lake	Leeds and Grenville United Counties	Lansdowne	N	N

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Kushog Lake	Haliburton County	Stanhope	N	N
Kushog Lake	Haliburton County	Stanhope	N	N
Kushog Lake	Haliburton County	Stanhope	Y	N
Lake Joseph	Muskoka District Municipality	Medora	N	N
Lake Joseph	Muskoka District Municipality	Medora	N	N
Lake Joseph	Muskoka District Municipality	Medora	N	N
Lake Rosseau	Muskoka District Municipality	Medora	Y	N
Lake Rosseau	Muskoka District Municipality	Medora	Y	N
Lake Rosseau	Muskoka District Municipality	Medora	Y	N
Lake Vernon	Muskoka District Municipality	Stisted	Y	N
Lake Vernon	Muskoka District Municipality	Stisted	Y	N
Lake Vernon	Muskoka District Municipality	Stisted	Y	N
Leggat Lake	Frontenac County	Olden	N	N
Leggat Lake	Frontenac County	Olden	N	N
Leggat Lake	Frontenac County	Olden	N	N
Little Boshkung Lake	Haliburton County	Minden	N	N
Little Crosby Lake	Leeds and Grenville United Counties	North Crosby South	N	N
Little Silver Lake	Lanark County	Sherbrooke South	N	N
Little Silver Lake	Lanark County	Sherbrooke	N	N
Long Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Long Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Long Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Long Lake	Lanark County	Burgess	N	N
Long Lake	Lanark County	Burgess	N	N
Long Lake	Lanark County	Burgess	N	N
Long Lake	Frontenac County	Hinchinbrooke	N	N
Long Lake	Frontenac County	Hinchinbrooke	N	N

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Long Lake	Frontenac County	Hinchinbrooke	N	N
Long Lake	Timiskaming District	Lebel	N	N
Long Lake	Timiskaming District	Lebel	N	N
Long Pond Lake	Frontenac County	Bedford	N	N
Long Pond Lake	Frontenac County	Bedford	N	N
Longbow Lake	Kenora District	Kirkup	N	N
Longbow Lake	Kenora District	Kirkup	N	N
Longbow Lake	Kenora District	Kirkup	N	N
Loon Call Lake	Peterborough County	Anstruther	N	N
Loon Call Lake	Peterborough County	Anstruther	N	N
Loon Call Lake	Peterborough County	Anstruther	N	N
Loon Lake	Haliburton County	Dudley	N	N
Loon Lake	Haliburton County	Dudley	N	N
Loon Lake	Haliburton County	Dudley	N	N
Loon Lake	Haliburton County	Dudley	N	N
Loon Lake	Lanark County	Burgess	N	N
Lower Rideau Lake	Lanark County	Elmsley	N	N
Lower Rideau Lake	Lanark County	Elmsley	N	Y
Lower Rideau Lake	Lanark County	Elmsley	N	N
Lyndhurst Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Lyndhurst Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Lyndhurst Lake	Leeds and Grenville United Counties	Lansdowne	N	N
Malcolm Lake	Frontenac County	Clarendon	N	N
Maple Lake	Haliburton County	Glamorgan	N	N
Maple Lake	Haliburton County	Glamorgan	N	N
Maple Lake	Haliburton County	Glamorgan	N	N
McLaren Lake	Lanark County	Burgess	N	N
Mississippi Lake	Lanark County	Beckwith	N	Y
Mississippi Lake	Lanark County	Beckwith	N	Y
Northern Light Lake	Thunder Bay District	null	N	N
Northern Light Lake	Thunder Bay District	null	N	N
Northern Light Lake	Thunder Bay District	null	N	N
Northern Light Lake	Thunder Bay District	null	N	N
Northern Light Lake	Thunder Bay District	null	N	N
OBrien Lake	Lanark County	South Sherbrooke	N	N
OBrien Lake	Lanark County	South Sherbrooke	N	N

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Oomen Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Oomen Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Oomen Property (unnamed lake)	South Frontenac County	Frontenac	N	N
Ottawa River	Prescott and Russell United Counties	East Hawkesbury	N	N
Otter Lake	Leeds and Grenville United Counties	Elmsley	N	N
Otter Lake	Leeds and Grenville United Counties	Elmsley	N	N
Otter Lake	Leeds and Grenville United Counties	Elmsley	N	N
Otty Lake	Lanark County	Burgess	N	N
Otty Lake	Lanark County	Burgess	N	N
Otty Lake	Lanark County	Burgess	N	N
Paddys Lake	Lanark County	Dalhousie	N	N
Patterson Lake	Lanark County	Dalhousie	N	N
Patterson Lake	Lanark County	Dalhousie	N	N
Pike Lake	Lanark County	Burgess	N	N
Pike Lake	Lanark County	Burgess	N	N
Pike Lake	Lanark County	Burgess	N	N
Pistol Lake	Kenora District	null	N	N
Pistol Lake	Kenora District	null	N	N
Pistol Lake	Kenora District	null	N	N
Puslinch Lake	Wellington County	Puslinch	N	N
Puslinch Lake	Wellington County	Puslinch	N	N
Puslinch Lake	Wellington County	Puslinch	N	N
Rainbow Lake	Lanark County	South Sherbrooke	N	N
Red Horse Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Red Horse Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Red Horse Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Rib Lake	Timiskaming District	Dunmore	N	N
Rib Lake	Timiskaming District	Dunmore	N	N
Rib Lake	Timiskaming District	Dunmore	N	N
Robertson Lake	Lanark County	Lavant	N	N
Robertson Lake	Lanark County	Lavant	N	N

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Robertson Lake	Lanark County	Lavant	N	N
Rock Lake	Lanark County	Burgess	N	N
Round Lake	Lanark County	Burgess	N	N
Round Lake	Lanark County	Burgess	N	N
Salerno Lake	Haliburton County	Glamorgan	N	N
Salerno Lake	Haliburton County	Glamorgan	N	N
Salerno Lake	Haliburton County	Glamorgan	N	N
Salmon Lake	Peterborough County	Cavendish	N	N
Salmon Lake	Peterborough County	Cavendish	N	N
Salmon Lake	Peterborough County	Cavendish	N	N
Shadow Lake	Kawartha Lakes Division	Laxton	N	N
Shadow Lake	Kawartha Lakes Division	Laxton	N	N
Shadow Lake	Kawartha Lakes Division	Laxton	N	N
Shawenegog Lake	Frontenac County	Barrie	N	N
Shawenegog Lake	Frontenac County	Barrie	N	N
Shebandowan Lakes	Thunder Bay District	Haines	N	N
Shebandowan Lakes	Thunder Bay District	Haines	N	N
Shebandowan Lakes	Thunder Bay District	Haines	N	N
Shebandowan Lakes	Thunder Bay District	Haines	N	N
Shebandowan Lakes	Thunder Bay District	Haines	N	N
Shebeshekong Lake	Parry Sound District	Carling	N	N
Shebeshekong Lake	Parry Sound District	Carling	N	N
Shebeshekong Lake	Parry Sound District	Carling	N	N
Silver Lake	Kawartha Lakes Division	Bexley	N	N
Silver Lake	Kawartha Lakes Division	Bexley	N	N
Silver Lake	Kawartha Lakes Division	Bexley	N	N
Singleton Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Singleton Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Singleton Lake	Leeds and Grenville United Counties	Lansdowne	N	Y
Six Mile Lake	Muskoka District Municipality	Baxter	N	Y
Six Mile Lake	Muskoka District Municipality	Baxter	N	Y

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Six Mile Lake	Muskoka District Municipality	Baxter	N	Y
South Lake	Leeds and Grenville United Counties	Leeds	N	N
South Lake	Leeds and Grenville United Counties	Leeds	N	N
South Lake	Leeds and Grenville United Counties	Leeds	N	N
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	Y
South Nation River	Prescott and Russell United Counties	Plantagenet	N	N
South Nation River	Prescott and Russell United Counties	Plantagenet	N	N
Spectacle Lake	Frontenac County	Loughborough	N	N
Spectacle Lake	Frontenac County	Loughborough	N	N
Spectacle Lake	Frontenac County	Loughborough	N	N
Spectacle Lake	Leeds and Grenville United Counties	North Crosby	N	N
Stormy Lake	Haliburton County	Glamorgan	N	N
Stormy Lake	Haliburton County	Glamorgan	N	N
Stormy Lake	Haliburton County	Glamorgan	N	N
Taylor Lake	Lanark County	Lanark	N	N
Tommy Lake	Leeds and Grenville United Counties	North Crosby	N	N
Upper Mazinaw Lake	Frontenac County	Barrie	N	N
Upper Mazinaw	Frontenac County	Barrie	N	N

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Lake				
Upper Park Lake	Lanark County	Dalhousie	N	N
Upper Park Lake	Lanark County	Dalhousie	N	N
Upper Rideau Lake	Leeds and Grenville United Counties	North Crosby	N	Y
Upper Rideau Lake	Leeds and Grenville United Counties	North Crosby	N	N
Upper Rideau Lake	Leeds and Grenville United Counties	North Crosby	N	N
Upper Rideau Lake	Leeds and Grenville United Counties	North Crosby	N	Y
Wendigo Lake	Timiskaming District	Bayly	N	N
Wendigo Lake	Timiskaming District	Bayly	N	N
Westport Sand Lake	Leeds and Grenville United Counties	North Crosby	N	N
Westport Sand Lake	Leeds and Grenville United Counties	North Crosby	N	Y
Westport Sand Lake	Leeds and Grenville United Counties	North Crosby	N	Y
White Lake	Peterborough County	Galway	N	N
White Lake	Peterborough County	Galway	N	N
White Lake	Peterborough County	Galway	N	N
Widows Rapids	Lanark County	Lanark	N	N
Wolfe Lake	Leeds and Grenville United Counties	North Crosby	N	Y
Wolfe Lake	Leeds and Grenville United Counties	North Crosby	N	N
Wolfe Lake	Leeds and Grenville United Counties	North Crosby	N	Y
Wollaston Lake	Hastings County	Wollaston	N	N
Wollaston Lake	Hastings County	Wollaston	N	N
Wollaston Lake	Hastings County	Wollaston	N	N

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Literature Cited:

- Claudi, Renata and Mackie Gerald, L. 1994. Practical Manual for Zebra Mussel Monitoring and Control. Lewis Publishers: Boca Raton, Florida USA.
- Commissioner of the Environment and Sustainable Development, 2001. A legacy worth protecting: charting a Sustainable course in the Great Lakes and St. Lawrence River Basin. Available: www.oag-bvg.gc.ca/domino/reports.nsf/html/c101sec6e.html [August 2005].
- Johnson, L.E., 1995. Enhanced Early Detection and Enumeration Of Zebra Mussel (*Dreissena* spp.) Veligers Using Cross-Polarized Light Microscopy, Williams College-Mystic Seaport.
- Lee, G.2002. Alien Invasive Species: threat to Canada's biodiversity. Natural Resources Canada, Canadian Forest Service, Ottawa, On.
- Mackie, G.L., D.Pathy, P.Gillis, E.Dobson, 1992. Biology and impacts of zebra mussels in Lake St.Clair and Lake Erie. A final report submitted to Ontario. Ministry of Environment for project 4436.81pp.
- Ontario Hansard. 1999. Jerry Ouellette, MPP Oshawa, Hansard, #L022, Thurs, Dec 2 1999.
- Petrie, S. A. and M. L. Schummer. 2002. Waterfowl response to zebra mussels on the lower Great Lakes. *Birding*. August: 346-351.
- Ricciardi, A., and J.B. Rasmussen. 1999. Extinction rates of North American freshwater fauna. *Conservation Biology* 13: 1220-1222
- Reeders and Bijde Vaate, 1992. Zebra Mussels: Biology, impacts and control. Chapter 3: colonization, Ecology, and positive Aspects of Zebra Mussels (*Dreissena polymorpha*) in the Netherlands. p.55. Lewis Publishing.
- Schaner, Ted, 1990. Detection of Zebra Mussel Veligers in Plankton Samples Using Sugar Solution. Ontario Ministry of Natural Resources, Lake Ontario Fisheries Unit 1990 Annual Report, LOA 91.1 (Chapter 6).
- Science Daily, 2005. Science Daily [Online]. Internet Viruses Help Ecologists Control Invasive Species. Available: www.sciencedaily.com/releases/2005/03/050309111303.htm. [August 2005].
- Sea Grant , 2005. MNSG: Outreach [Online]. Spiny tailed *bythotrephes*; Its life history and effects on the Great Lakes. Available: www.seagrant.umn.edu/exotics/spiny.html [August, 2005].

THE ONTARIO FEDERATION OF ANGLERS AND HUNTERS

Sea Grant, 1992. The Spiny water flea, *Bythotrephes cederstroemi*; Another unwelcome newcomer to the Great Lakes. Ohio State University. FS-049

US Army Corps of Engineers: Zebra Mussels: Biology, Ecology and Recommended Control Strategies. Technical Note ZMR-1-01