Invasive Species Awareness Program (2019)

Executive Summary

The Invading Species Watch program entered a transitional year in 2019 with the Ontario Federation of Anglers and Hunters passing on the torch to other like-minded groups to continue the citizen-science program. A special thanks to Barbara Szita-Knight, Farquhar Lake, Kawartha Conservation, the Coalition of Haliburton Property Owners Associations, and numerous Lake Stewards from central and eastern Ontario for picking up the torch. Also, a special thanks to Renata Claudi and Bob Prescott of RNT Consulting for their technical advice and support. Finally, thank you to the Minden Animal Hospital for providing a safe sample drop off location and the 53 lakes who made this program a continued success!

The ISW program focussed on determining the presence or absence of zebra and/or quagga mussels veligers (Appendix B) and the spiny water flea (Appendix C). See Appendix A for general invasive species information.

Ten monitoring kits containing all the necessary equipment and instructions were circulated to program volunteers. During the fall and winter of 2019, RNT Consulting performed the analysis of water samples from the 53 lakes that were monitored during the summer. Of the 53 waterbodies sampled, zebra mussel veligers were found in 5 lakes whereas spiny waterflea was discovered in 5 lakes.

The results of the 2019 Invading Species Watch program will be entered into the EDDMapS Ontario invasive species database (www.EDDMapS.org/Ontario). EDDMapS was adapted for Ontario by the Invading Species Awareness Program in 2014 as a tool to document, track and map invasive species throughout the province. This database currently tracks 197 different invasive species within Ontario and is linked to other EDDMapS databases throughout Canada and the United States.

Methodology

Following the protocol in the program manual, participants monitored their lakes between mid-June and early September. The volunteers collecting lake samples used plankton haul nets (63 microns) at 3-5 locations on the lake. In total, 141 samples were collected from 53 lakes. The participants were responsible for disinfecting the equipment before and after they monitored their lakes as per the program protocol included in the kit. The samples were returned to Kawartha Conservation, and then delivered to RNT Consulting for analysis.

RNT Consulting provided analysis of the plankton samples, following the Schaner protocol using a sugar solution to separate zebra mussel veligers from the sample (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.

[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.

Results

Zebra & Quagga mussel veligers were only present 5 lakes with only 2 new observations and 3 previous positive observations.

For distribution mapping please visit: https://www.eddmaps.org/ontario/distribution/viewmap.cfm?sub=10567

*It is important to note that although veligers are detected the survival of adult mussels is dependent on various factors such as water chemistry. For more information please see Appendix B:
Will Zebra Mussels Survive In My Lake?

Spiny Water flea were found present in 5 lakes with 1 new observation and 4 previous positive observations.

For distribution mapping please visit:

https://www.eddmaps.org/ontario/distribution/viewmap.cfm?sub=59823

Next steps

1. Results will be uploaded and plotted on the (www.EDDMapS.org/Ontario) through the Ontario Federation of Anglers and Hunters.
2. 2020 programming to be determined.
3. Make invasive species awareness a priority on your lake. Contact Brook Schryer brook_schryer@ofah.org at the OFAH for education materials including signage.
4. Promote CLEAN, DRAIN, DRY on your lakes.
5. Consider monitoring other invasive species.

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APPENDIX A: GENERAL INVASIVE SPECIES INFORMATION

INVADING SPECIES: REASONS FOR CONCERN

Invasive species create serious ecological and economic problems in Ontario, Canada, and the rest of the world. The introduction of new invasive species occurs on a regular basis through various pathways. Currently, 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 and are listed as 'invasive.'

Although the details of these impacts are not fully known, there is an agreement among the scientific community that invading species threaten Ontario's biodiversity. The Committee on the Status of Endangered Wildlife estimates 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 five times faster than terrestrial organisms and three times faster than coastal species (Ricciardi & Rasmussen, 1999).

INVADING SPECIES: PATHWAYS OF INTRODUCTION

Invasive 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 invasive 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, drained, and dried before leaving a waterbody. For more information regarding this procedure, please contact the Invading Species Hotline at 1-800-563-7711 or visit http://www.invadingspecies.com/boating/.

INVADING SPECIES: WHY DO THEY SUCCEED SO WELL?

Typically, invasive 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 as they would in their native range. Furthermore, these species typically reproduce quickly either through multiple reproductive cycles in a single year or by having high fecundity. Additionally, invasive 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, reproduce, and spread when introduced to new environments.

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

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 OFAH

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 with more than 100 byssal threads that are secreted from a gland at the base of its foot."[1] 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

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

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 larger individuals.

Will Zebra Mussels Survive In My Lake?

	No Survival		**Poor Growth**		**Mod. Growth**		**Good Growth**		**Best Growth**
Criteria	**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	>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, pH [2] 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.

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.

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

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.[3] 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.

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 farther 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

[3] 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.

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 scaups' 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 and many had between 1,000 and 2,000 zebra mussels attached to them. 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, and 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. This abundance of shells produce an unpleasant odour and 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 25 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 has contributed 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.

APPENDIX C: SPINY WATER FLEA INFORMATION

THE SPINY WATERFLEA: BIOLOGY OF INVASION

It is likely that the spiny waterflea (*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 waterflea 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. They can also be spread through infested angling or boating equipment such as fishing lines, downrigger cables, and anchor ropes.

THE SPINY WATERFLEA: BIOLOGY

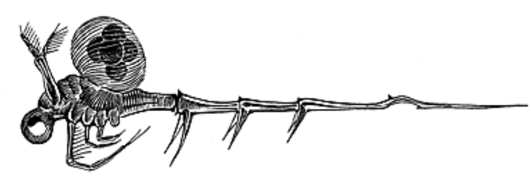

Figure 4: The Spiny Water Flea

The spiny waterflea 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 of the spiny waterflea 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 waterflea 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 waterflea 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

Spiny waterflea consumes up to three times as much as native species of zooplankton. Spiny waterfleas consume smaller species of native zooplankton such as *Daphnia,* which is an important food source for juvenile fish species. As a result, the spiny waterflea 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 waterflea; however, studies have indicated that juvenile fish smaller than 10 cm in length are unable to use the spiny waterflea 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 waterflea because of the long tail spine, which prevents that fish from swallowing it.

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