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You can stop invading species

Ontario

Workshop Manual: Aquatic Invasive Species

An Introduction to Identification, Collection and Reporting of Aquatic Invasive Species in Ontario Waters









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About this Workshop

The Ministry of Natural Resource's (MNR) Aquatic Invasive Species Program conducted a province-wide questionnaire of resource professionals in 2005 and a multi-agency and organization workshop in 2006. The aim was to find out about:

1. the regular activities (research, assessment, surveys, monitoring, etc.) occurring in aquatic ecosystems that detect (intentionally or accidentally) invasive species;

2. actions undertaken when invasive species are encountered; and

3. how to increase participation of these professionals in monitoring and reporting introductions and the spread of invasive species in Ontario.

The Field Guide to Aquatic Invasive Species (Field Guide; MNR, 2008), and this workshop were designed to address priorities identified through the original questionnaire and workshop. Specifically, they help address the identified needs for increased field capabilities and communications relevant to aquatic invasive species (AIS), and recommendations to provide related field training and tools. We hope that the training opportunities and tools created will enhance the capacity for early detection and monitoring of AIS in Ontario waters.

This workshop will provide resource professionals with an introduction to identifying AIS, collecting specimens to confirm identification, and reporting AIS detected in Ontario waters. We hope that biologists, researchers, resource managers, field technicians, enforcement staff, and others who work in aquatic ecosystems and may encounter AIS will benefit from the workshop and use the accompanying Field Guide. We ask for your assistance in reporting any occurrence of invasive species new to Ontario, or already present but in a new area, to the Invading Species Hotline (1-800-563-7711) or website (www.invadingspecies.com), as demonstrated in this workshop.

The Field Guide contains detailed identification information for more than 50 species of aquatic algae, plants, invertebrates and fish. It is printed on water-proof paper and bound with metal rings so that it can be opened for the addition of new species pages when they become available.

The workshop is designed as a four hour session, which includes lectures, demonstrations, lab activities, and discussions (see Table 1). Each topic pertains to specific learning outcomes as defined below:

Learning Outcomes

By the end of this workshop, the participant will be able to:

1. Understand the roles and responsibilities of various agencies and organizations involved in AIS prevention, risk management, control and outreach in Ontario.

2. Identify various aquatic invasive plants, invertebrates and fish found in Ontario or threatening to invade Ontario waters.

3. Prepare voucher specimens of AIS for viewing, storage and/or distribution.

4. Apply the Field Guide in the field and/or laboratory.

5. Know the appropriate reporting procedures and contacts for AIS in Ontario.

6. Know the best management practices for preventing the spread and introduction of AIS.

Table 1. Workshop Topics, Structure and Learning Outcomes

Length	Topic	Structure	Learning Outcomes
15 min	Overview – Introduction to AIS, Pathways and Management	Lecture	1 & 4
80 min	AIS Identification	Lecture and Demonstration	2 & 4
15 min	Recording Information and Reporting Sightings	Lecture	4 & 5
15 min	Prevention and Decontamination Measures	Lecture	1 & 5
85 min	Lab Activities – Collecting a Specimen	Lab Activity	3 & 4
10 min	Wrap Up	Discussion and fill out Evaluation	1 & 5

Overview

Introduction to Aquatic Invasive Species

The following terms provide some insight into the workshop context:

Alien species "(alien, exotic, foreign or non-indigenous species) - A species occurring in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities [… or] [a]ny species in an ecosystem that enters that ecosystem from outside the historic range of the species." (Canadian Council of Fisheries and Aquaculture Ministers [CCFAM] Aquatic Invasive Species Task Group [AISTG] , 2004)

Invasive Species (nuisance or pest species) – The introduction of a non-indigenous species into an ecosystem which may cause harm to the economy, environment, human health, recreation, or public welfare (CCFAM, 2004).

Aquatic invasive species (AIS) – Those invasive species that exist or occur in aquatic ecosystems

NOTE: As described in the above definitions, not all alien species are invasive (see Additional Resources; Glossary of Terms). In fact, a variety of alien species are important to the Ontario economy; they provide benefits in terms of food production, biological control, and recreation, with little or no environmental impact. Alien species are considered "invasive" when they cause harm to the environment, economy or society in their new ecosystem. In some cases, alien invasive species can overtake an ecosystem, causing radical and/or irreversible changes to its new environment. For example, the rusty crayfish, native to parts of the United States is now found in many southern Ontario watersheds, as well as northwestern Ontario in Lake of the Woods. This AIS out-competes endemic crayfish and was likely introduced unintentionally by improper disposal of bait brought to Ontario by American anglers (CCFAM, 2004).

AIS tend to share a combination of similar life history traits:

Figure 1 provides an overview of the common characteristics of AIS including; adaptability (e.g., non-selective diet, variety of environmental conditions), few natural predators or population controls, high reproductive capacity, the ability to thrive in disturbed ecosystems and superior capacity to compete for food and habitat (e.g., biotic and environmental factors).

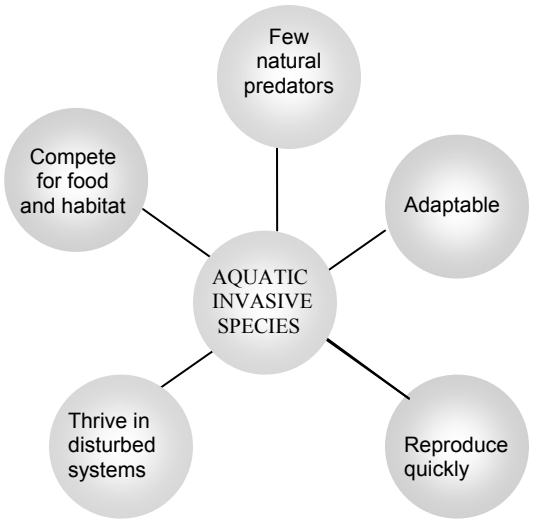


Figure 1. Common Characteristics of AIS.

Historical Perspective in Brief

Invasive species have been identified as second only to habitat destruction as a cause of the decline of global biodiversity. Ontario's aquatic species, habitats and ecosystems are particularly at risk with over 180 non-indigenous species established in the Great Lakes basin since European settlement to North America. Not all of these species have become "invasive" but certainly more than 10% have had significant ecological and economic impacts (Mills et. al. 1993). The best examples of which include the zebra mussel and the sea lamprey which have irrevocably altered the food web structure , function and ecological integrity of the Great Lakes.

These species invasions may continue to occur as an unfortunate consequence of Canada's trade and commerce increases with markets around the globe. Indeed, scientists have estimated that new introductions occur at the rate of 1 every 28 weeks to the Great Lakes basin (Ricciardi, 2006).

Pathways of Introduction and Spread

Movement of species occur naturally; through migration patterns, from climatic events, and other environmental factors. Natural movement of species outside of their natural range happens infrequently and occurs over many years. Humans however, can greatly contribute to the movement of species, in particular through economic and social activities. In recent years, technological advancements, accelerated participation in world trade, and recreational activities have accelerated the pace of intentional and unintentional movement of species; whereby, many species are introduced to new ecosystems sometimes with disastrous results (CCFAM, 2004).

The CCFAM (2004) noted that to manage the issue of AIS it is important to understand how AIS are introduced to Canada and how they are spread from lake to lake. There are seven key pathways for AIS introduction (from outside Canada) and spread (from within Canada): shipping, recreational and commercial boating, the movement of live bait, the aquarium and water garden industry, live food fish, unauthorized introductions, and canals and water diversion (see Table 2).

Table 2. Seven Pathways for the Introduction and Spread of AIS.

Pathways of Introduction and Spread	Description of Pathway	Species Examples
Shipping	Large ocean-going vessels with ballast capability (i.e., commercial vessels, naval and cruise ships) operating in the Great Lakes and St. Lawrence River basin. These vessels require ballast water to compensate for weight changes when cargo weight is insufficient for the vessel to maintain balance. Ballast water and sediment are taken onboard from a foreign port and released in a Great Lakes port containing a variety of organisms. AIS can be accidentally transported in the ballast waters or attached to the ships' hulls (CCFAM, 2004).	Zebra mussel, Spiny water flea,Round goby, and Ruffe, Purple loosestrife
Recreational and Commercial Boating	Includes all watercraft (e.g., powerboats, personal watercraft, yachts, canoes and float planes) and associated equipment (e.g., trailers and fishing equipment). It does not include large ocean-going ships, Organisms can become attached to watercraft and the associated equipment and be transported between waterbodies (CCFAM, 2004). For example, vegetation can be tangled in boat motors, mussels can be attached to boat hulls or live wells, and bilge water can contain plants, animals and micro-organisms like zebra mussel veligers, water fleas and mysids.	Zebra mussels and Eurasian water-milfoil
Movement of Live Bait	Use of live or dead organisms (minnows, worms, leeches, insect larvae) to catch fish. The organisms can be harvested by the angler or harvested by a licensed commercial bait harvester and sold by a licensed bait retailer as per the Ontario Fishery Regulations and the Fish and Wildlife Conservation Act(see Additional Information) Live baitfish or organisms unintentionally harvested (parasites, plant fragments, and other non-target organisms) that are released from bait buckets into a waterbody, which is illegal, in waters they did not originate fromcan lead to the introduction of new species. Even dead bait may carry other organisms.	Rusty crayfish, Round goby and Rock bass
Aquarium and Water Garden Trade	The intentional release or unintentional escape of organisms such as fish, plants, invertebrates, amphibians and reptiles that are used either indoors as aquarium pets or outdoors as elements of water gardens. Aquarium pets may be released by the public into waterways when they outgrow an aquarium or are no longer wanted. The contents of an aquarium emptied into a waterway, may also introduce aquarium animals as well as any plants or microorganisms it contained.	Koi, Goldfish, Fanwort, Purple loosestrife and Yellow Iris, Chinese mystersnail

Pathways of Introduction and Spread	Description of Pathway	Species Examples
	Water garden plants may be planted or animals placed in ponds near or along shorelines or floodplains where they may escape into the natural environment during flooding or extreme rain events. In addition, plants can spread into new areas if plant material is discarded at the end of the season into a waterway; plants can escape via dispersal of seeds, fruit, vegetative fragments or propagules. Organisms released into the wild, whether intentionally or unintentionally, may survive and reproduce (CCFAM, 2004).	
Live Food Fish	Live fish are sold for human consumption. The fish are either imported live or transported live within Canada. The fish themselves or other organisms found in the packing material may be accidentally released during shipping (CCFAM, 2004), or intentionally released by a consumer after purchasing the live fish.	Bighead carp, Black carp, Silver carp, and Rusty crayfish **NOTE**: these carp species are now illegal to possess alive and cannot be sold live.
Unauthorized Introductions	This pathway includes the intentional introduction of fish to a waterbody without proper authorization from the appropriate government agency. Individuals illegally (without a stocking license) introduce fish to lakes with the intention of enhancing or creating a fishery (CCFAM, 2004).	Rock bass, Small-mouth bass, Black crappie, Pike
Canals and Water Diversions	Artificial connections are built for transport and for water diversion between watersheds and within watersheds. This provides an unnatural pathway for organisms to travel between waterbodies (CCFAM, 2004).	Sea lamprey

Response to Aquatic Invasive Species

Numerous jurisdictions and organizations are involved in AIS prevention, detection, management, control and outreach activities in Ontario and Canada. Within the federal government, primary responsibility and authority rests with Fisheries and Oceans Canada and Environment Canada. Depending on the species and its pathway into Canadian waters, prevention actions can also involve Transport Canada, Industry Canada, the Canadian Food Inspection Agency (CFIA), the Canadian Border Services Agency (CBSA), Health Canada and others.

Provincial and territorial governments share the responsibility, as do bilateral organizations such as the International Joint Commission and the Great Lakes Fishery Commission. Industry, a variety of NGOs, First Nations and the general public are also involved in AIS outreach programs and the development of best management practices.

National Strategy and Action Plan

With the adoption of the UN Convention on Biodiversity in 1992, world leaders officially recognized the threat posed by invasive species. In 1995, Canada responded with the Canadian Biodiversity Strategy. In September 2001, federal, provincial and territorial ministers of forests, fisheries and aquaculture, endangered species and wildlife agreed to develop a Canadian plan to deal with the threat of invasive alien species which resulted in An Invasive Alien Species Strategy for Canada, 2004. The national strategy is an integral part of the prevention of new invasions, the detection of and response to new AIS and the management of established AIS (eradication, containment, and control).

In 2002, the Canadian Council of Fisheries and Aquaculture Ministers created the Aquatic Invasive Species Task Group (CCFAM) to develop an action plan to address the threat of AIS. This resulted in the development of A Canadian Action Plan to Address the Threat of Aquatic Invasive Species (CCFAM, 2004) which is one of three action plants developed as part of the national strategy for Canada.

The action plan states that “the ultimate [… management goal] is to minimize (and ideally eliminate) the introduction of harmful AIS, and remediate the impact of those already in Canada”. The plan’s underlying principles include incorporating environmental, economic, and social factors in decision making; working cooperatively with all stakeholders; and using science-based techniques to assess the risk of AIS (CCFAM, 2004).

Federally, Ballast Water Control and Management Regulations (2006) were implemented Canada-wide under the Canada Shipping Act (2001) (which relates to the Great Lakes in Ontario). Specifically the Regulations set requirements for sea-going vessel operators to develop and carry out a ballast water management plan, which ensures safe and effective management of the vessel's ballast water. The management plan must include at least one, or a combination of, four processes described below:

1. "the exchange of ballast water" – vessel must not exchange ballast water in restricted zones of waters under Canadian jurisdictions. Zones vary based on other management processes implemented for a vessel (Transport Canada, 2007.)

2. "the treatment of ballast water"– whichever treatment methods chosen must ensure that the ballast water reaches at least the minimum standards of concentration for viable organisms. Examples of treatment methods include filtration, the use of a chemical biocide, or UV treatment. NOTE: As of August 2008, no treatment technologies have been approved for use by Transport Canada (Transport Canada, 2007.)

3. "the discharge of ballast water to a reception facility"- the facility must be designed to hold ballast water and sediment, and be able to remove harmful substances including viable organisms (Transport Canada, 2007.)

4. "the retention of ballast water on board the ship" – if it is possible a management plan may stipulate that the ship's ballast water be retained on board rather than exchanged (Transport Canada, 2007.)

Since these regulations were implemented in 2006, this pathway to introduction and spread has been drastically diminished. Prior to these regulations, there were only voluntary guidelines in place that dealt with this pathway. The new regulations are much more applicable as they are Canada wide and apply to shipping vessels that do and do not have ballasts. Furthermore, there has been more compliance by the industry to abide by these new regulations as there are joint inspections in both Canada and the United States. In 2008, additional regulations were implemented for the St. Lawrence Seaway that further diminished the potential of this pathway.

Provincial Management Efforts

Based on the guidelines stipulated in the National strategy (Environment Canada, 2004) and the Canadian action plan (CCFAM, 2004), numerous AIS management efforts are being undertaken in Ontario.

Policy. In 2004 and 2005, the MNR and numerous partners including municipal, environmental, industry and First Nations developed Ontario's Biodiversity Strategy (OBS; MNR, 2005) which is a plan to help protect the province's biodiversity. The strategy recognizes AIS as a key threat to biodiversity.

Included in the OBS is an action item consistent with priorities in the national strategy and action plan and which directs implementation of the strategy and action plans in Ontario.

The Canada-Ontario Agreement (COA) is the federal-provincial agreement that supports the restoration and protection of the Great Lakes basin ecosystem. The COA outlines how the two governments will cooperate and coordinate their efforts to restore, protect, and conserve the Great Lakes basin ecosystems. It builds on the actions taken through previous agreements, and focuses on priorities for future actions. The COA also contributes to meeting Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement (Environment Canada, 2008). One of the specific goals of COA is to reduce the threat of aquatic invasive species to Great Lakes aquatic ecosystems and species and outlines specific action as to how the two governments can work towards this goal

Legislation. In Ontario, the main legislative and regulatory tools that are used to address the threat of AIS by MNR are the Fish and Wildlife Conservation Act (S.O. 1997, c. 41) and Ontario Fishery Regulations (under the federal Fisheries Act; S.O. 1985, c.F-14). In general, the regulations enable restrictions on the possession, purchase, sale, use and/or transport of certain species. To help prevent the spread of harmful organisms, species can be placed under a white list (allowable) or black list (not allowed). For example, a species white list for those used as bait, a species white list for those reared in aquaculture facilities, and a species black list for those that cannot be possessed. The regulations also allow for conditions to be placed on licenses issued by MNR for activities such as commercial harvest of fish, collection of fish for scientific purposes, and commercial aquaculture operations.

Risk Management. In recent years, Ontario has made great strides in AIS risk management, which includes analysis of risk of introduced species and pathways of concern, development of early detection protocols, and a rapid response plan for action for when new AIS are discovered.

In partnership with federal and industry stakeholders, risk management activities include the development of a national standardized methodology for individual species risk assessments and the risk assessments of key pathways for AIS introductions such as the shipping, baitfish, aquarium, recreational boating and water garden trades. These initiatives have increased Ontario's capacity to focus early detection efforts on priority pathways and species. Early detection tools such as the Invading Species Hotline (toll-free number for reporting sightings of invasive species) and website (www.invadingspecies.com) encourage agencies and citizens to learn about, and report invasive species (receiving over 1000 calls and over 50,000 visitors annually). In addition, monitoring and training workshops for biologists, technicians, and other field personnel help increase Ontario's capacity to identify new invasions of AIS.

Ontario's ability to respond to new introductions will be enhanced through the development of provincial rapid response frameworks for aquatic invasive plants and fish. The frameworks will provide guidance on agency contacts, options available as a response, tools and resources to consider, as well as regulatory requirements, permits and approvals involved with control activities such as eradication, suppression or containment. This project has been made possible by the generous funding provided by the Canada-Ontario Agreement for Respecting the Great Lakes.

Outreach and Education - OFAH and MNR Invading Species Awareness Program. The Invading Species Awareness Program was inaugurated in 1992 by the Ontario Federation of Anglers and Hunters (OFAH) in partnership with the MNR. This program was created to respond to the spread of zebra mussels through the pathway of recreational boating and has expanded since then to deliver awareness and education province-wide on other invading species and the pathways through which they are introduced and spread.

The Invading Species Awareness Program is recognized for its success throughout North America and has earned the support and participation of hundreds of partners from industry, NGOs, community groups, international organizations, and provincial and federal governments.

Figure 2. A variety of educational materials including tackle box stickers, and refrigerator magnets have been developed for the public through the Invasive Species Awareness Program. These materials remind cottagers, boaters and other user groups about their role in AIS prevention and management.

The program focuses on raising awareness and engaging support and participation from the public, industry and user groups to prevent the spread related to these pathways for invasive species introductions. Educating cottagers anglers, boaters and others possibly associated with the spread of AIS is done in a variety of ways. Examples include displays at trade shows, the website www.invadingspecies.com, public presentations to numerous audiences, school curriculum kits, and media such as brochures and stickers, television and radio public service announcements (see Figure 2 above).

Industry also partners with the MNR and OFAH to develop and deliver industry-specific best management practices and workshops. For example, Hazard Analysis and Critical Control Point (HACCP) workshops are delivered to bait harvesters to assess and reduce the risk that the bait they sell and the equipment and practices they use will be contaminated by AIS. Procedures to minimize spread are examined and incorporated on a case-by-case basis. All bait harvesters and dealers are required to complete an MNR approved plan to receive their license. In addition, work has commenced with the landscape industry to develop best management practices and to increase awareness of AIS issues.

Research. Research is an important component of understanding the threats AIS pose and options available for preventing spread and mitigating impacts. A range of research areas, from species biology and pathways of invasion to control measures help to improve management planning and decision making to address AIS.

The Canadian Aquatic Invasive Species Network (CAISN) is a national consortium of AIS specialists supported by the National Scientific and Engineering Research Council (NSERC) that funds AIS research across the country. There are three themes to CAISN research: Vectors and Pathways, Factors Affecting Establishment Success, and Risk Assessment Models (University of Windsor, 2008).

Ontario has a strong presence within CAISN. MNR is a funding partners and provides a member on the CAISN board of directors. Examples of research supported by MNR and/or COA include research on round goby biology and management tools, *Phragmites* experimental control, and fanwort pathway of invasion.

Early Detection and Monitoring. Monitoring aquatic ecosystems is critical to preventing, detecting, and reducing the spread and impact of AIS which threaten Ontario's biodiversity. MNR's AIS Program conducted a province-wide questionnaire (in 2005) for an initial assessment of existing activities that might contribute to detection and monitoring of AIS. The MNR subsequently conducted a workshop in 2006 with participants from numerous agencies and organizations that helped identify gaps, issues, opportunities and ideas to enhance cooperation, coordination, and integration of AIS monitoring.

Various governments and non-governmental organizations are involved in aquatic ecosystem monitoring. Most of these activities are not AIS focused but they may detect AIS incidentally. One of the many priorities identified from the 2006 workshop is the need for increased field capabilities to participate in early detection and monitoring for AIS through additional funding and staffing, the provision of training tools and opportunities, and guidance around procedures to follow upon encountering invasive species. The *Field Guide to Aquatic Invasive Species* and training workshops for professionals were created to help fulfill some of the needs identified in the workshop (MNR, 2006).

Control Efforts. Once established in its new environment, AIS are often difficult and very expensive to eradicate. Although control efforts may be ineffective and costly, they are sometimes necessary in order to minimize or eliminate the invasive species' impact on the environment, economy or society.

The Great Lakes Fishery Commission's Sea Lamprey Control program is an example of a successful control program. Upon its introduction into all the Great Lakes with the opening of the Welland Canal, the Sea Lamprey devastated many fisheries throughout the Great Lakes (especially Lake Trout). In response to this growing concern, the Sea Lamprey Control Program was initiated in 1955, and a variety of annual control initiatives have led to a 90% reduction in sea lamprey populations in the Great Lakes (CCFAM, 2004). Fisheries and Oceans Canada (DFO) along with US counterparts have led this effort with supporting contributions made by provincial (MNR) and state agencies.

The Invading Species Awareness Program contributes to a number of successful control programs and promotes their importance to the public, stakeholders, and governmental agencies. One of the most successful control programs in North America has been the Purple loosestrife biological control program for Ontario led by scientists at the University of Guelph in collaboration with provincial and federal agencies The program resulted in over 400 Galerucella beetle release sites since 1992 (Mackenzie, 2008), impacting loosestrife populations at over 80% of these localities (Corrigan, 2000).

Additional Information

To obtain more information on AIS, or to request copies of the Field Guide to Aquatic Invasive Species (either digitally or in print), please contact the Invading Species Hotline or visit their website (see box below). The hotline and website (see box below) can also be referred to for inquiries regarding the availability of new Field Guide pages as well as monitoring guidelines for volunteers, loaning of AIS displays, and information about AIS distribution.

Invading Species Hotline:

1-800-563-7711

Web Address:
http://www.invadingspecies.com

Email: invading_species@ofah.org

Table 3 provides a list of other agencies, organizations and strategies and regulatory documents related to AIS in Ontario.

Table 3. Contacts for Information on Aquatic Invasive Species

Type of Agency	Agency	Website
Federal Government	Environment Canada: An Invasive Alien Species Strategy for Canada and associated action plans	http://www.ec.gc.ca/eee-ias/Default.asp?lang=En&n=98DB3ACF-1
Regulations (Federal & Provincial)	Transport Canada: Canada Shipping Act (2001) - Ballast Water Control and Management Regulations	http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/400/csa448/csa448.html
	Fisheries and Oceans Canada: Fisheries Act	http://laws.justice.gc.ca/en/showtdm/cs/F-14///en
	Ontario Fishery Regulation (Under the Fisheries Act)	http://laws.justice.gc.ca/en/showtdm/cr/SOR-2007-237
Provincial Government	Ontario Ministry of Natural Resources: Biodiversity Strategy	http://www.mnr.gov.on.ca/en/Business/Biodiversity/Publication/MNR_E000066P.html
	Canada-Ontario Agreement Respecting The Great Lakes Basin Ecosystem	http://www.on.ec.gc.ca/coa
	OFAH & MNR Invading Species Awareness Program	Invading Species Hotline: 1-800-563-7711 www.invadingspecies.com (see Additional Resources section for available materials)
Industry	Bait Association of Ontario	73 Hunter Street East Peterborough, ON K9H 1G4 (705) 745-3398
	Shipping Federation of Canada	http://www.shipfed.ca

Type of Agency	Agency	Website
	Ontario Marina Operators' Association	http://www.marinasontario.com
	National Marine Manufacturers Association (Canada)	http://www.nmma.org
Environmental NGOs	Ontario Federation of Anglers and Hunters OFAH & MNR Invading Species Awareness Program	www.ofah.org Invading Species Hotline: 1-800-563-7711 www.invadingspecies.com
	Federation of Ontario Cottagers' Association	http://www.foca.on.ca
Research	Canadian AIS Network (CAISN)	http://www.uwindsor.ca/CAISN Hugh MacIsaac (Director of CAISN): http://web2.uwindsor.ca/courses/biology/macisaac/pages/index.htm
	Great Lakes Environmental Research Laboratory (GLERL – NOAA)	http://www.glerl.noaa.gov/
Binational Agencies	Great Lakes Fishery Commission	http://www.glfc.org
	International Joint Commission	http://www.ijc.org
	Great Lakes Commission	http://www.glc.org
	Great Lakes Panel on Aquatic Nuisance Species (under the Great Lakes Commission)	http://www.glc.org/ans/

Introduction to AIS – Demonstration

This section of the workshop highlights several AIS that occur in or threaten to invade Ontario waters. Ontario will be represented by two geographical areas: Ontario North – including the French River and Lake Nipissing, and Ontario South - not including the French River and Lake Nipissing (see Figure 3).

Figure 3. Map showing the two geographic regions (thick line south of Lake Nippissing and French River) applicable to this workshop: Ontario North and Ontario South (modified from Natural Resources Canada [NRC], 2000).

In this manual, and in the Field Guide, AIS are categorized into four groups (algae, plants, invertebrates and fish). Pathogens are only briefly mentioned here.

Pathogens - "Any agent that causes disease in plants or animals; typically referring to microbes such as bacteria, viruses, or protozoan parasites." (CCFAM, 2004)

Pathogens are extremely difficult to identify in fish, thus pathogens are not examined in detail for this workshop and not included in the Field Guide.

Example: Viral Hemorrhagic Septicemia (VHS)

Algae - "Any of various chiefly aquatic, eukaryotic, photosynthetic organisms, ranging in size from single-celled forms to the giant kelp: Algae were once considered to be plants but are now classified separately because they lack true roots, stems, leaves, and embryos" (Retrieved March 7, 2008 from http://www.thefreedictionary.com/algae).

Example: Didymo - *Didymosphenia geminate*

Plants Aquatic plants are found in and around water bodies. Plants can be free-floating or floating and rooted in sediment, rooted and submergent (under water) or emergent (both partly under water and partly above water surface).

Examples: Purple Loosestrife, Water Lettuce

Invertebrates - The bulk of AIS that are invertebrates and covered in this workshop consist of arthopods (crayfish), molluscs (snails, mussels and clams) and crustaceans (waterfleas and mysid).

Examples: Red Mysid, Rusty Crayfish

Fish includes any alien invasive fresh water fish.

Examples: Stickleback, Asian Carp

The Field Guide covers several important AIS present in or threatening to invade Ontario waters. These species include over 50 algae, plants invertebrates and fish.

The AIS Identification portion of the workshop is divided into two sections: Ontario North and Ontario South. Using the Field Guide the instructor will demonstrate how to identify select AIS. The instructor will lead you through the section that applies to your group.

Each section includes examples of the more than 50 AIS covered in the Field Guide. These sections will include an introduction to the morphology, similar species, habitats, range, pathway and impacts of some of the algae, plant, invertebrate and fish species occurring in or threatening to invade Ontario.

The species in this manual are labeled by scientific and common name as well as the nine letter code used in the Field Guide. The nine letter code was used as an alternative to page numbers and is described in section 1.1.1 of the Field Guide.

NOTE: In the field, you may encounter an unknown species that you are unable to identify using the Field Guide alone (e.g. native species).

Refer to the *Additional Resources* section of this manual for a list of useful references for the identification of plants, invertebrates and fish. These references include other field guides and keys.

Alternately, contact the Invading Species Hotline at 1-800-563-7711 or go to http://www.invadingspecies.com

AIS - Ontario North

Below is a list of invasive algae, plant, invertebrate, and fish species which will be covered in the workshop and that apply to Ontario North and (see Figures 3 and 4). For more species, please refer to the Field Guide. Some of the AIS covered in this section are also present in, or threaten to invade Ontario South (e.g., Didymo). The Field Guide describes the introduced range of each species.

Figure 4. Ontario North – Including the French River, Lake Nipissing (modified from NRC 2000).

ALGAE

- Didymo

PLANTS

- Flowering Rush
- Eurasian water-milfoil
- Yellow iris
- European common reed
- Curly-leaved pondweed

INVERTEBRATES

- Rusty crayfish
- Spiny waterflea
- Quagga mussel and Zebra mussel
- New Zealand mudsnail

FISH

- Fourspine and Threespine stickleback
- Round goby
- Rainbow smelt
- Eurasian ruffe

Didymo – Didymosphenia geminata

Cym-did-gem

Description:

- Freshwater diatom, which produces mucilage and polysaccharide stalks that attach to rocks, plants or other submerged surfaces
- Stalks are brownish yellow to white
- Colonies or mats may look like sewage sludge or wet tissue paper.
- Appears slimy (but feels like wet cotton)

Photo: Andrea Kirkwood (MNR, 2008)

Similar Species

- Other stalked diatoms such as *Gomphonema* spp. can produce similar growth characteristics, but never reach bloom levels like Didymo nor feel like wet wool

Introduced Range:

- Not known in Ontario
- Alberta, Quebec
- Possibily northern Europe, northern North America and parts of Asia

Native Range:

- Europe and Asia
- In Canada – British Columbia

Potential Impacts:

- Blooms cover benthic substrate in streams and rivers with up to 3 cm thick mats which can reach over 1 km in length. Large blooms may have a negative effect on community composition of benthic organisms
- Mats can clog water intake pipes as well as foul water crafts and equipment
- Mats appear as sewage sludge or toilet paper along shorelines, there are concerns over aesthetics and water use in terms of tourism and recreational water usage.
- Possible health concern- swimmer's eyes may become irritated from the diatom

Pathways of Introduction and Spread:

- Attaches well to neoprene and felt-soled waders; may attach to equipment such as fishing or diving gear.

Flowering Rush – *Butomus umbellatus*

But-but-umb

Description:

- Perennial aquatic plant
- Emergent with submergent forms
- Grows in water up to 2m deep (lakes, rivers, marshes, ponds and wet ditches)
- Leaves: erect, floating, or submersed; 5-10mm wide and up to 2.7m long (leaf tip tends to spiral); blade triangular in cross-section
- Flowers: emergent, perfect, pink, 2-2.5 cm wide, with three petals and three sepals; borne on an erect, leafless, flowering stalk as tall as leaves

Photo: Wasyl Bakowsky (MNR, 2008)

Introduced Range:

- In Ontario: Lakes Erie, St. Clair and Ontario, as well as in western St. Lawrence River, Severn River and the Winnipeg River system

Native Range:

- Eurasia

Potential Impacts:

- May displace native riparian vegetation, and hinder recreational water use

Pathways of Introduction and Spread:

- Water Garden Trade
- Recreational Boating

Eurasian Water Milfoil – *Myriophyllum spicatum*

Hal-myr-spi

Description:

- Submerged aquatic perennial.
- Grows in 0.5-10m deep water.
- Capable of forming dense canopy.
- Leaves: whorled, feather-like, pinnately divided with 12 or more leaf segments along each side, petiole absent or less than 2mm.
- Flowers: emergent, pink, in 3-10 whorls on terminal spike above water; present between late July and early August

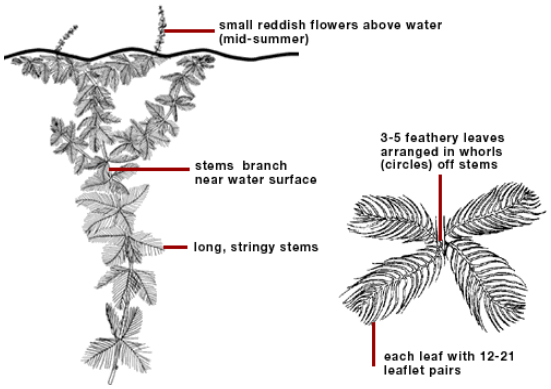


Illustration: University of Florida (MNR, 2008)

Similar Species:

- Native Northern water-milfoil (*M. sibiricum = exalbescens*) has leaves with 11 or fewer segments on each side of axis and forms turions. In addition, knob-like, shoot tips of crowded leaves are diagnostic of Northern water-milfoil but not always present
- Native coontails (*Ceratophyllum demersum, C. echinatum*) have leaves that are dichotomously divided rather than pinnately as in Native Northern water-milfoil (*M. sibiricum = exalbescens*); leaves with 11 or fewer segments on each side of axis and forms turions; knob-like, shoot tips of crowded leaves are diagnostic of Northern water-milfoil but not always present on Eurasian water-milfoil

Introduced Range:

- In Ontario present in the Great Lakes and southern Ontario, to coastal Georgian Bay and on the southern Canadian Shield

Native Range:

- Eurasia

Potential Impacts:

- Forms dense canopy over large areas, suppressing native vegetation and impeding water traffic and recreation, especially because of the entangled branches near the water surface
- May hybridize with native milfoil species possibly creating more vigorous or aggressive forms of the plant

Pathways of Introduction and Spread

- Recreational boating

Yellow Iris – *Iris pseudacorus*

Iri-iri-pse

Description:

- Emergent aquatic perennial.
- Leaves: erect, simple, linear sword-shaped, 40-100cm in length, 2-3cm wide, arising from rhizomes
- Flowers: bright yellow, 7-9cm wide, with three petals and three sepals; present between April and July

Photo: Wasyl Bakowsky (MNR, 2008)

Similar Species

- When no flowers present; Blue flag (*I. versicolor*) is often purplish in colour around the leaf base, and has shorter stems (20-60 cm) and typically smaller leaves (10-80 cm by 1-3 cm) than yellow iris

Introduced Range:

- Southern Ontario and parts of Southern Canada

Native Range:

- Eurasia

Potential Impacts:

- Forms dense stands; it may displace native vegetation and convert habitat from a wet to drier environment
- Can cause poisoning in animals if rhizomes are ingested or plant juices make skin contact (causes blistering of the skin in humans)

Pathways of Introduction and Spread:

- Recreational Boating
- Water Garden Trade

European Common Reed – *Phragmites australis* subsp. *australis*

Poa-phr-aus

Description:

- Extremely tall, emergent, perennial grass
- Grows in dense stands in shallow waters of brackish as well as freshwater wetlands, stream banks, lakeshores, wet fields and ditches
- Leaves: alternate, flat, elongate, gradual taper to a point, 15-40cm long, 2-4cm wide
- Stem: erect, hollow, 1-4m tall, from rhizome; internodes at stem base a pale yellow in summer to late fall
- Inflorescence: terminal, dense, many-branched with spikelets of 3-10 flowers; long soft white hairs give a feathery appearance to inflorescence; glumes (or bracts) smooth, lower glume of spikelet 2.6-4.2 mm long; flowers in late summer and early fall.

Similar Species:

- Native subspecies *P. australis subsp. americanus* has red or purplish internodes at the base of the plant and a longer lower glume, 3.8-7 mm
- Native wild-rice (*Zizania spp*.) lacks the feathery-appearing inflorescence and has 1-flowered spikelets with no glumes compared to phragmites with feathery inflorescence, glumes present and many-flowered spikelets

Introduced Range:

- Southern Ontario, with scattered occurrences as far north as Georgian Bay and Lake Superior

Native Range:

- Eurasia

Potential Impacts:

- Forms large monocultural stands
- May displace native wetland vegetation, reduce plant species richness, and threaten habitat of rare species, species at risk and other wetland species

Pathways of Introduction and Spread:

- Water Garden Trade
- Recreational Boating

Curly-leaved Pondweed – *Potamogeton crispus*

Pot-pot-cri

Description:

- Submerged, perennial, rooted aquatic plant
- Found in freshwater lakes, rivers, streams, ponds, ditches, and canals, but also brackish waters; rooted in silt or clay, and sometimes gravel or sand
- Leaves: alternate, wavy, oblong, rounded at apex, green to red brown in colour, 3-8 cm long; margins finely and sharply toothed
- Flowers: emergent, small, red-brown in colour, borned on terminal spike; present May-June

Photo: Peter W. Bergstrom (MNR, 2008)

Introduced Range:

- Southern Ontario, southern Canadian Shield, and Georgian Bay-Severn River area

Native Range:

- Eurasia

Potential Impacts:

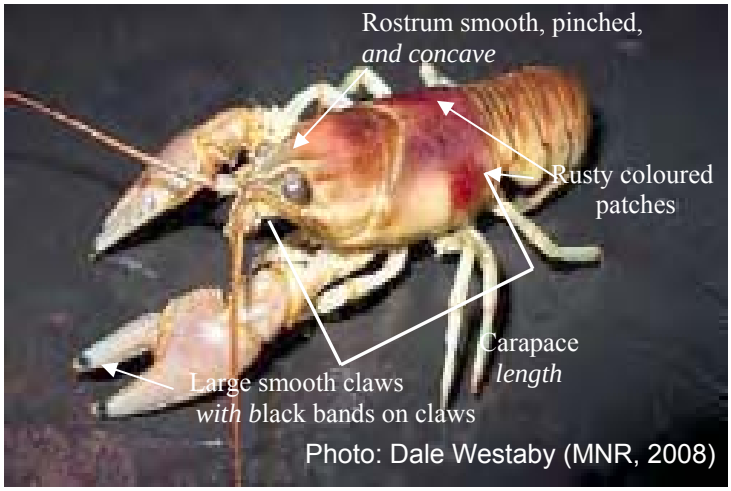
- Forms dense stands over large areas
- May crowd out other species, impede water flow, restrict recreational activities in the water, and alter oxygen levels with impacts on fish

Pathways of Introduction and Spread:

- Recreational Boating

Rusty Crayfish – *Orconectes rusticus*

Cam-orc-rus

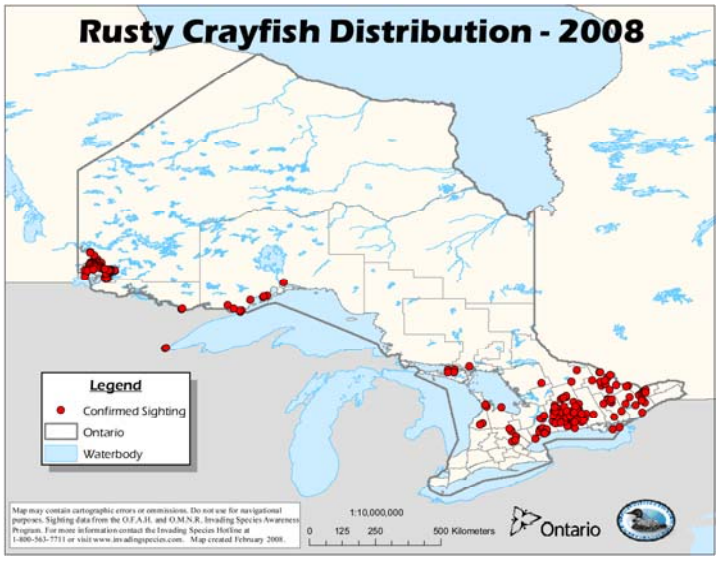


Description:

- Large crustacean
- Rostrum pinched and distinctly concave; upper surface smooth
- Rusty patches on both sides of carapace may be present
- Black bands on claw tips usually distinctive
- First copulatory stylet (of male) is straight to slightly curved; processes are fairly long (almost ½ total length of stylet) and uneven in length.

Similar Species:

- Native northern clearwater crayfish (*O. propinquus*) has a small yet distinctive ridge on the upper surface of a pinched rostrum, lacks rusty spots on the carapace and black bands on the claws, and the copulatory stylets are relatively short and stubby; however, this species can hybridize with rusty crayfish, obscuring some distinguishing characteristics.
- Native virile crayfish (O. virilis) has a mottled pattern on its back, lacks a pinched rostrum, and has very long stylets (processes ≥ ½ total length of stylet



Introduced Range:

- Introduced to Ontario and now present throughout Southeastern and southcentral Ontario, and parts of the Northwest (see distribution map)

Native Range:

- Native to Ohio River Basin running through Ohio, Kentucky, Tennessee, Indiana and Illinois in the Southern United States

Potential Impacts:

- Competes with native fish and crayfish for resources
- Hybridization can occur with native species

Pathways of Introduction and Spread:

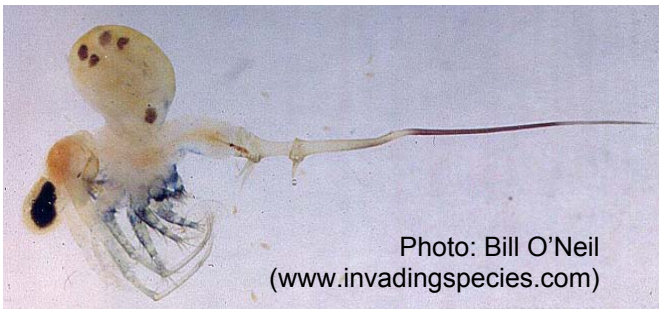
- Movement of Live Bait
- NOTE: Crayfish used as bait, must be from the waterbody where they were captured. Crayfish may not be sold as bait in Ontario. The limit on crayfish possession for use as bait is 36.
- Unauthorized Introduction (for commercial harvest)
- Aquarium Trade
- Biological Supply Houses

Rusty Crayfish Watch Card. See the website (www.invasdingspecies.com) and the additional resources section of this manual to order or obtain information about these and other AIS Resource Materials

Spiny Waterflea – *Bythotrephes longimanus*

Cer-byt-lon

Description:



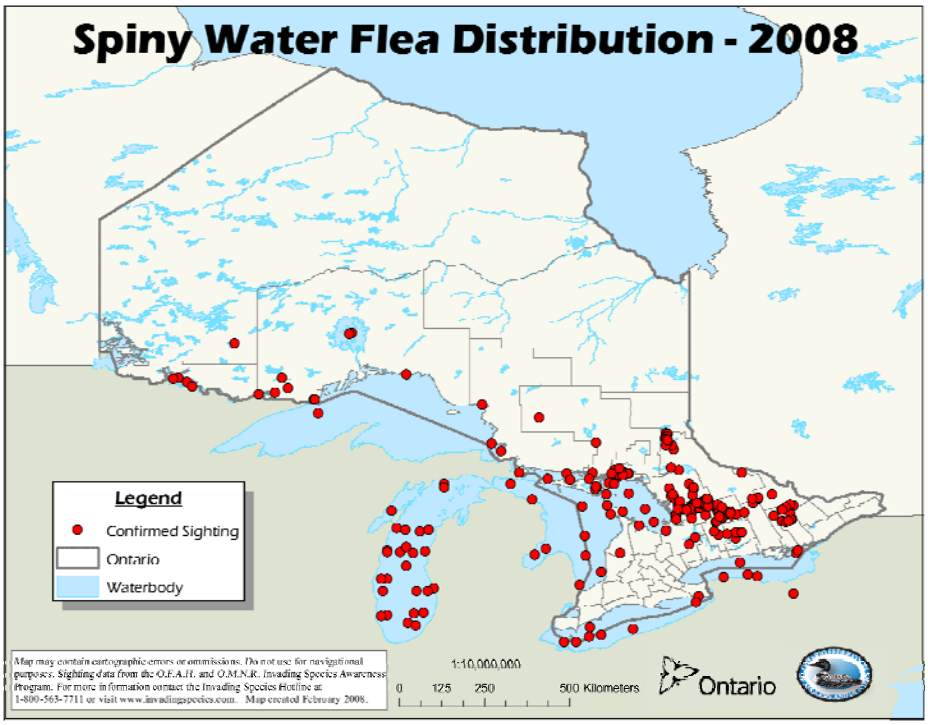
- Predatory cladoceran that collects in jelly-like masses on fishing lines, downrigger cables, or nets; masses may appear as clusters of tiny pins with blackdots
- 10 - 15 mm in length: tail spine is more than half of length
- Might have orange, blue and green colouring; red stripe runs half the length of tail
- Requires microscope to see features

Similar Species

- Invasive fishhook waterflea (*Cercopagis pengoi*) – also found in the Field Guide
- Native *Polyphemus pediculus* is much smaller with a short body and tail spine, and much bigger eye.
- Other native cladocerans (e.g., *Daphnia mendotae*) have only superficial similarity with much smaller tailspines (<25% of total length)

Introduced Range:

- Found in all the Great Lakes and over 100 inland lakes in Ontario
- Northern Ontario: Lake Nipigon, Rainy Lake, Lake of the Woods and a few Quetico Provincial Parks lakes
- Southern Ontario: Shield lakes (primarily around Parry Sound, Muskoka, Haliburton, Killarney and Temagami); a few lakes in Renfrew County (see distribution map on following page)



Native Range:

- Eurasia

Potential Impacts:

- Significant changes to lake zooplankton communities; including disappearances of species, and declines in species abundance and diversity
- Not a good food source for small fish, which have difficulty consuming the waterflea because of its spine, or larger fish that prey on the species but receive little nutritional value as the spines are indigestible and accumulate in stomachs

Pathways of Introduction and Spread:

- Shipping
- Recreational Boating
- Contaminated fishing equipment (e.g. downriggers, fishing lines)

Quagga Mussel – *Dreissena bugensis*

Dre-dre-bug

Zebra Mussel – Dreissena polymorpha

Dre-dre-pol

Description:

- Small freshwater mussels found in similar habitats; lakes, rivers, reservoirs, ponds, and quarries
- Adults settle on hard surfaces such as rocks, docks, cement, wood, and macrophytic plants

Side View
Photos: Michigan Sea Grant (MNR, 2008)

Ventral View
Photos: Myriah Richardson (MNR, 2008)

D. bugensis

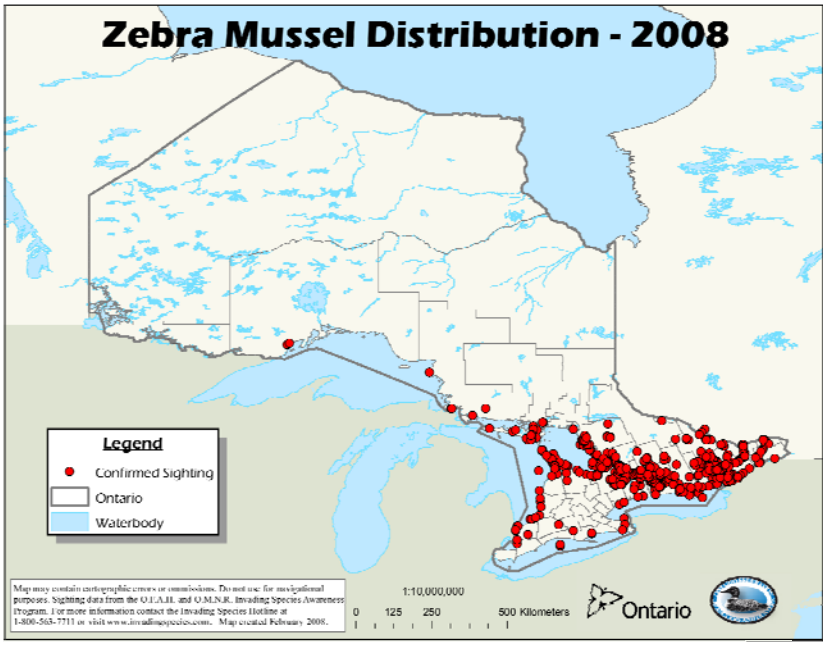
D. polymorpha

- Size: Up to 3cm long
- Shape: Ventral surface convex, left and right valves asymmetrical with curved midventral line
- Colour: variable, pale, may have coloured bands, bars or few to no zigzagged stripes
- Can colonize in sandy substrate
- Can reproduces in colder waters than zebra mussel (4-9º C)

- Size: Usually 2 to 2.5cm long, up to 4 cm long
- Shaped: Ventral surface flat to concave, shell D-shaped or triangular in cross section, left and right valves symmetrical with straight midventral line
- Colour: black or brown with variable white to yellow striped or zigzagged patterns
- Reproduces in warmer waters than quagga mussel (greater than 10ºC)

Introduced Range:

- Quagga mussel: occurs in Lakes Ontario, Huron, and Simcoe, the Rideau River, and several locations along the St. Lawrence River
- Zebra mussel: occurs in all the Great Lakes and the St. Lawrence River, and is spreading to inland lakes and rivers, including the Rideau Canal and Trent-Severn Waterway



Native Range:

- Both native to the Ponto-Caspian region of Eurasia

Potential Impacts:

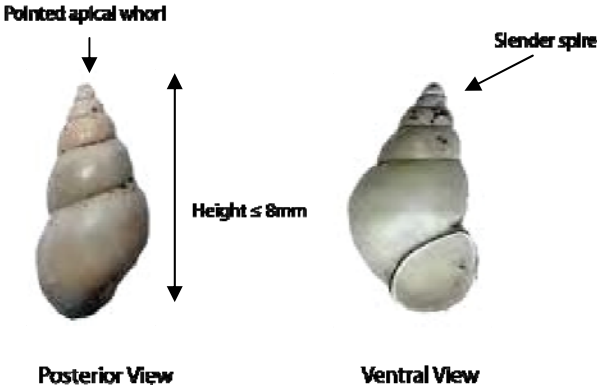
- Both species form dense colonies and filter feed large quantities of plankton, increasing the clarity of the water and affecting native species that prefer more turbid water (e.g., Walleye). Water clarity increases also promote aquatic macrophyte growth.
- Both species compete for food with native organisms (dense colonization in Ontario waterbodies have been followed by declines or complete losses in native mussels)
- Both species may facilitate the invasion of round goby into the Great Lakes as they are food sources in the round goby's native range
- Both species are serious biofoulers, , clogging water intake pipes and pollute swimming areas
- Bioaccumulates high levels of contaminants which are passed to species higher in the food chain; may be a contributing factor to botulism outbreaks in the Great Lakes
- Zebra mussels: form colonies on the shells of native mussels which threaten their ability to filter feed.

Pathways of Introduction and Spread:

- Shipping
- Recreational Boating
- Movement of Live Bait (transferred between lakes in bait buckets)
- Both species can survive for up to 22 days if the air is humid and the temperature is around 15°C

New Zealand Mud Snail – *Potamopyrgus antipodarum*

Hyd-pot-ant



Photos: Gerry Mackie (MNR, 2008)

Description:

- Small (5-8mm), slender, freshwater snail that can live in slightly brackish waters as well as freshwater; prefers silty sand and sediments in rivers, reservoirs, lakes and estuaries
- Shape: spire cone-shaped and slender with pointed apical whorl. Usually 5-6 whorls, up to 8. May have weak keel mid-whorl with coarse hairs.
- Colour: variable, normally horn-coloured but can range from light to dark brown; operculum: ear-shaped with off-centre nucleus

Similar Species:

- Native snails in Ontario: *Marstonia decepta* and *Pomatiopsis lapidaria* but both have a less pointed spire

Introduced Range:

- In Ontario, reported in Lake Superior at Thunder Bay, Lake Ontario near Niagara and Kingston, and in the St. Lawrence River
- United States: Several northeastern and western states and is also reported in Lake Erie
- Australia and Europe

Native Range:

- New Zealand

Potential Impacts:

- Competes for resources with native benthic macroinvertebrates
- Can be a dominant species; with up to 300,000 individuals/m^2 in some North American populations

Pathways of Introduction and Spread

- Shipping
- Movement of Live Bait (transported between lakes in the water from bait buckets)
- Recreational Boating
- Live Food Fish (transport of aquaculture products)

Fourspine Stickleback – *Apeltes quadracus*

Gas-ape-qua

Threespine Stickleback – *Gasterosteus aculeatus*

Gas-gas-acu

Description:

A. quadracu

Photo: Mark Gautreau (MNR, 2008)

G. aculeatus

Photo: John Lyons (MNR, 2008)

- Body: fusiform, compressed laterally; caudal peduncle very thin, without a lateral keel; ridge on both sides of the lower abdomen behind pectoral fins; total length 51-64 mm (up to 70 mm).
- Fins/spines: four dorsal spines, inclined alternately to left and right, of graduated size, with the first three close together followed by a wide gap between the third and the fourth
- Scales/plates: none.
- Colour: olive-green to brown on back, dark, mottled brown sides and silvery-white on belly; males may be all black; breeding male has red pelvic fins

- Body: fusiform, compressed laterally; narrow caudal peduncle usually with a lateral keel; ;total length 35-65 mm (up to 100 mm)
- Fins/spines: two to four (usually three) free dorsal spines, the first inserted over the pectoral base, the first two substantially larger than the third, or fourth, if present
- Scales/plates: lacks scales and may have up to 30 small bony plates on the sides; native Lake Ontario form partially plated
- Colour: green to brownish above with some darker markings, shading to silvery below; breeding males are bright red on lower sides and belly

Habitat:

- Shallow, brackish estuarial waters and, less frequently, fresh water streams and lakes

- Varied; common in shallow weedy areas of rivers, streams, lakes, and ponds; also in deep-water habitats and brackish water

Similar Species

- Brook stickleback (*Culaea inconstans*) has four to six (usually five) free dorsal spines of similar length, typically less than eye diameter and without lateral keels on the caudal peduncle.

Introduced Range:

- Fourspine stickleback: Lake Superior, from Thunder Bay east to the mouth of the Black River
- Threespine stickleback: Lakes Erie, Huron, Superior and connecting waterways

Native Range:

- Fourspine stickleback: coastal areas of eastern North America from the Gulf of St. Lawrence to Virginia
- Threespine stickleback: Niagara Falls, through Lake Ontario and the St. Lawrence and Ottawa Rivers, and the Hudson Bay Lowland; other parts of North America include along the west and east coasts south to Baja California and Virginia, respectively; also in Europe, Greenland and the Pacific coast of Asia

Potential Impacts:

- Both species may compete with native fish for invertebrate prey as well as prey upon the eggs and larvae of other fishes
- Populations of native sticklebacks declined following the establishment of these species in Lake Superior.

Pathways of Introduction and Spread:

- Shipping
- Movement of live bait (bait bucket transfers)

Round Goby – Neogobius melanostomus

Gob-neo-mel

Description:

- Small cylindrical fish with snout rounded to blunt; 60-250mm total length
- Mouth: wide, terminal to slightly subterminal; lips large, without barbels; nostril tubes do not reach upper lip
- Fins: first dorsal with 5-7 spines; second dorsal long with one spine and 11-14 soft rays; caudal fin rounded

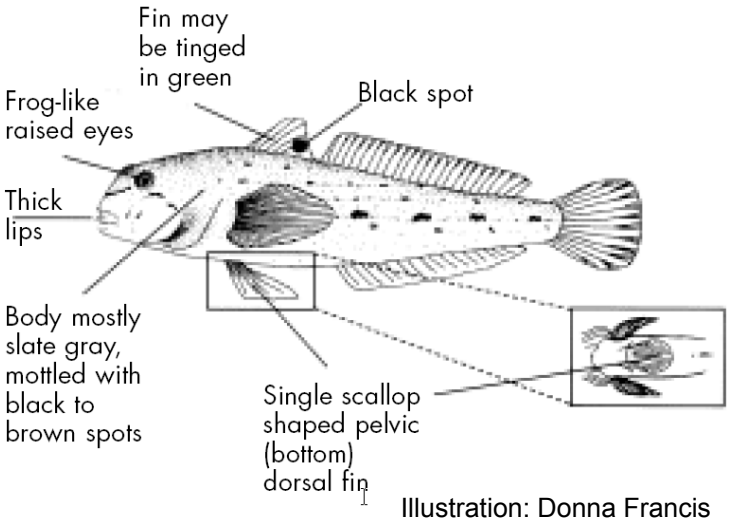


Illustration: Donna Francis (www.invadingspecies.com)

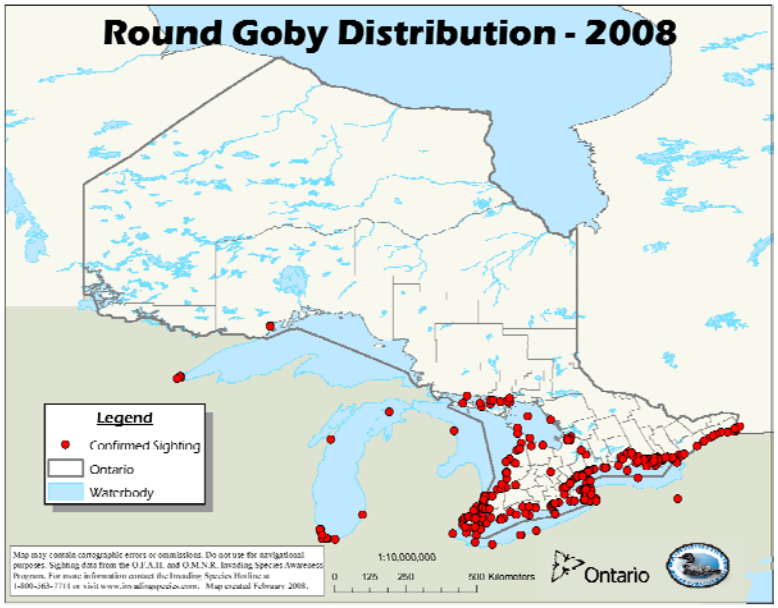
- Scales: small covering the top of the head, behind the eyes, and body, 45-57 along midline (without a lateral line). Pelvic fins fused to form suctorial disc (suction cup)
- Colour: back and sides mottled black, brown, or gray on a lighter brown, olive, or gray background, cream to white below; characteristic black spot, larger than the eye, on the rear of the first dorsal fin, although this feature is not apparent on some specimens. During spawning and nest guarding, males are black with yellow spots on the body.
- Found in cobble, gravel and sandy substrates, with or without vegetation, in near shore and deep waters, in lakes and the middle and lower reaches of rivers; can withstand low levels of dissolved oxygen

Similar Species:

- Native sculpins (*Cottus spp*. and *Myoxocephalus thompsonii*) are without scales and usually without a black spot on the first dorsal fin; pelvic fins are separate and do not form a suctorial disk
- Invasive Tubenose goby

Introduced Range:

- In Ontario, found in all Great Lakes, as well as the Trent River, Rice Lake, and Lake Simcoe in the Trent-Severn Waterway



Native Range:

- Black and Caspian Sea basins

Potential Impacts:

- Competes with native benthic fishes
- Eats fish eggs and larvae and so may pose a threat to sportfish populations
- May alter energy, contaminant, and nutrient pathways in the Great Lakes

Pathways of Introduction and Spread:

- Shipping
- Movement of Live Bait

Rainbow Smelt – *Osmerus mordax*

Osm-osm-mor

Description:

- Small fish found in clear lakes, rivers and coastal waters, often schooling in open water and spawning in streams1,2. (178-203mm [up to 350 mm)])
- Large terminal mouth with prominent teeth on the tongue and roof; protruding lower jaw
- Fins: without spines; single dorsal fin with 8-11 soft rays; caudal fin forked; anal fin with low profile and long base, 12-16 soft rays; adipose fin present
- Scales: thin and easily detached, 62-72 pored scales in an incomplete lateral line
- Colour: black to olive-tan back, silvery sides with iridescent blue, purple and pink hues, and whitish belly; head and posterior edge of tail darkly pigmented.

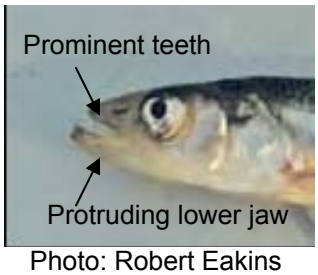


Photo: Robert Eakins (MNR, 2008)

Similar Species

- Superficially similar to some minnow speces which lack an adipose fin and prominent teeth
- Trout, salmon, lake herring and whitefish, the lateral line is complete and a pelvic axillary process is present

Introduced Range:

- In Ontario, found in all of the Great Lakes, the Trent-Severn Waterway from Lake Simcoe to Port Severn as well as Stony Lake, many Muskoka and Parry Sound area lakes, the Ottawa River and Lake Nipissing, the Lake Nipigon basin and in the Rainy and English-Wabigoon River systems including Lake of the Woods

Native Range:

- Atlantic coastal drainages from Labrador to New Jersey, as well as landlocked waters in Quebec, the Maritime Provinces and New England states. Also found in Pacific drainages of North America and Asia

Potential Impacts:

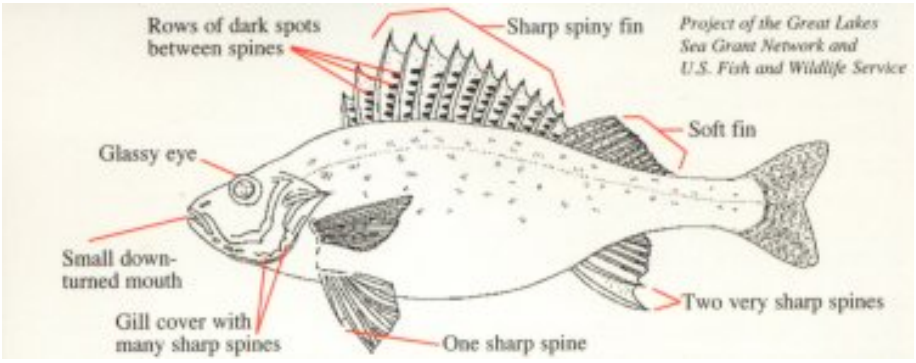
- May disrupt food webs and cause significant changes in zooplankton communities
- Negative effects to native fish, sometimes leading to their extirpation: e.g., yellow perch, walleye, lake herring, bloater, whitefish, lake trout, and slimy sculpin (competition and/or predation)

Pathways of Introduction and Spread:

- Intentional stocking in Michigan in early 1900's
- Shipping
- Improper disposal of fish remains

Eurasian Ruffe – *Gymnocephalus cernuus*

Per-gym-cer



Illustrations: www.invadingspecies.com

Description:

- Highly adaptable fish (exploits a wide range of depths and conditions in lakes and rivers); fusiform, fairly deep and compressed body; total length 110-150 m (up to 250 mm)
- Long anterior lobe of dorsal fin with 11-18 spines broadly attached by a membrane to a posterior soft lobe with one spine and 11-16 soft rays; black spots on dorsal and caudal fins
- Head is unscaled

Introduced Range:

- In Canada: Thunder Bay, Lake Superior
- In US: Lake Superior, Lake Huron, Lake Michigan

Native Range:

- Northern Europe and Asia

Potential Impacts:

- Due to their ability to reach very high population densities in a short time period, ruffe may have significant impacts by competing for zooplankton and benthic insects with native game and forage fishes, and predating on eggs and larvae of native sportfish.

Pathways of Introduction and Spread:

- Shipping
- Movement of Live Bait
    - Note: it is illegal to possess ruffe in Ontario.

AIS - Ontario South

Below is a list of invasive plant, invertebrate and fish species that are present in or threaten to invade Ontario South (see Figure 3 and Figure 5). For more species, please refer to the Field Guide. Some AIS covered in this section are also present in, or threaten to invade Ontario North (e.g., Rusty crayfish).

Figure 5. Ontario South – Not including the French River and Lake Nipissing (modified from NRC 2000).

PLANTS

- Fanwort
- Eurasian water-milfoil
- European frog-bit
- Yellow iris
- European Common reed
- European waterchestnut

INVERTEBRATES

- Rusty crayfish
- Spiny waterflea
- Quagga mussel and Zebra mussel
- Red mysid
- Banded mystery snail

FISHES

- Grass carp
- Rudd
- Round goby

Fanwort – Cabomba caroliniana

Cab-cab-car

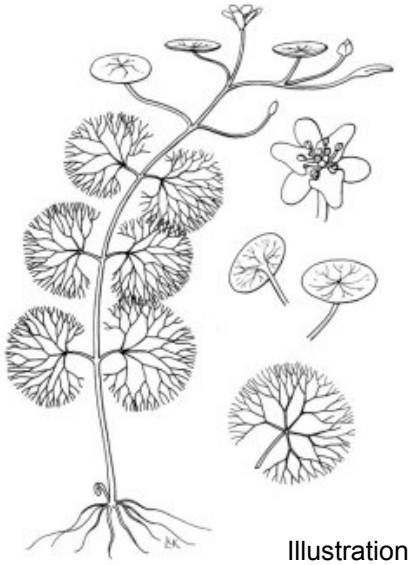


Illustration: University of Florida (MNR, 2008)

Description:

- Fanwort is a submerged, rooted, perennial, freshwater plant, typically under 2 m tall but can get much taller
- Submersed leaves: opposite (rarely whorled), with leaf blade palmately and finely dissected, fan-shaped, less than 6 cm broad
- Floating leaves: alternate, small with leaf blade linear or oblong to 30 mm in length
- Flowers: small, emergent (occasional submerged), with three petals and three sepals, white to pale yellow in colour and may include a pink or purplish tinge; present between late spring and early fall

Similar Species

- Bladderwort (*Utricularia vulgaris*),
- White water crowfoot (*Ranunculus aquatilis*),
- Northern water milfoil (*M. sibiricum = exalbescens*),
- Water marigold (*Megalodonta beckii*),
- Coontail (*Ceratophyllum demersum*):
- Only fanwort has the opposite, finely dissected,
- fan-shaped leaves on distinct petioles

Introduced Range:

- In Ontario, the Crowe River watershed north of Peterborough
- United States, India, Japan, Malaysia and Australia

Native Range:

- Subtropic and temperate regions of South America

Potential Impacts:

- Can form dense stands and -
- Displace native vegetation
- Clog drainage canals and streams
- Interfere with recreational uses
- Reduce water storage capacity, and
- Taint drinking water supplies

Pathways of Introduction and Spread:

- Aquarium Trade - It is a common aquarium plant, sold in pet stores across North America
- Water Garden trade
- Recreational Boating

Eurasian Water Milfoil – *Myriophyllum spicatum*

Hal-myr-spi

Description:

- Submerged aquatic perennial.
- Grows in 0.5-10m deep water.
- Capable of forming dense canopy.
- Leaves: whorled, feather-like, pinnately divided with 12 or more leaf segments along each side, petiole absent or less than 2mm.
- Flowers: emergent, pink, in 3-10 whorls on terminal spike above water; present between late July and early August

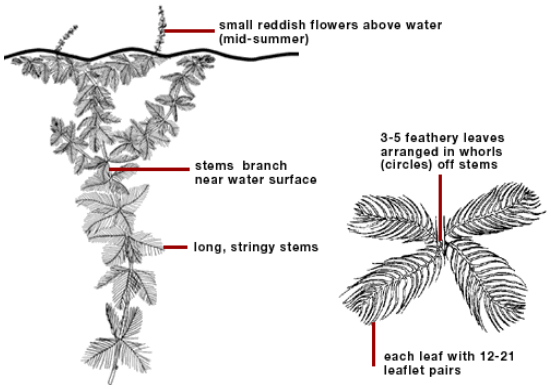


Illustration: University of Florida (MNR, 2008)

Similar Species:

- Native Northern water-milfoil (*M. sibiricum = exalbescens*) has leaves with 11 or fewer segments on each side of axis and forms turions. In addition, knob-like, shoot tips of crowded leaves are diagnostic of Northern water-milfoil but not always present
- Native coontails (*Ceratophyllum demersum, C. echinatum*) have leaves that are dichotomously divided rather than pinnately as in Native Northern water-milfoil (*M. sibiricum = exalbescens*); leaves with 11 or fewer segments on each side of axis and forms turions; knob-like, shoot tips of crowded leaves are diagnostic of Northern water-milfoil but not always present on Eurasian water-milfoil

Introduced Range:

- In Ontario present in the Great Lakes and southern Ontario, to coastal Georgian Bay and on the southern Canadian Shield

Native Range:

- Eurasia

Potential Impacts:

- Forms dense canopy over large areas, suppressing native vegetation and impeding water traffic and recreation, especially because of the entangled branches near the water surface
- May hybridize with native milfoil species possibly creating more vigorous or aggressive forms of the plant

Pathways of Introduction and Spread

- Recreational boating

European Frog-Bit – Hydrocharis morsus-ranae

Hyd-hyd-mor

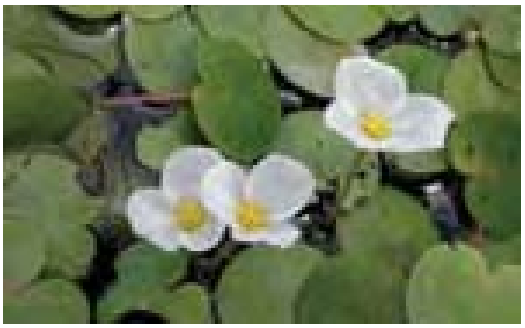


Photo: Wasyl Bakowski (MNR, 2008)

Description:

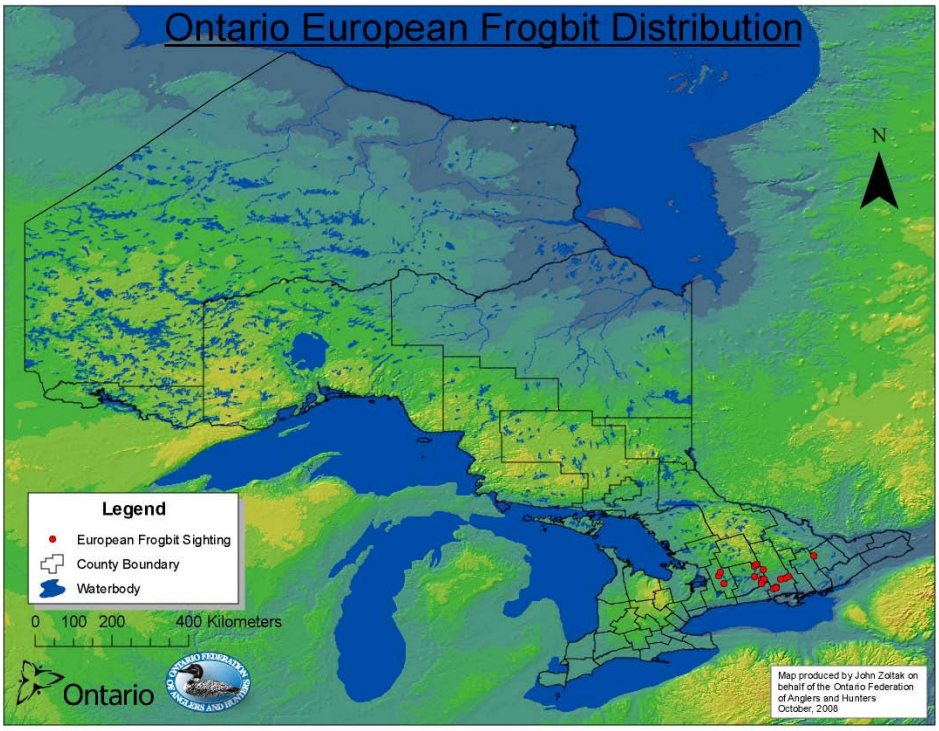
- A free-floating (or rooted when on mud) perennial aquatic plant
- Rounded or heart-shaped leaves (6cm wide) with aerenchyma on underside of leaf in midvein region
- Flowers emergent, 3 green sepals, 3 white petals up to about 2cm and 2-3 times the length of the sepals; present from spring to fall
- Stolons form below water surface or soft mud and produce terminal buds which develop a single root and give rise to new rosettes
- Turions, or modified stolon buds, about 1 cm long, detach and overwinter on lake floor, then surfaces in spring to form new plant

Similar Species:

- Native Water shield

Introduced Range:

- St. Lawrence River to Lake Ontario, through the Kawartha Lakes, the Rideau and Ottawa River systems, and some other inland waterbodies, with occurrences along Lakes Erie and St. Clair
- Southern margin of the Canadian Shield, southwestern Quebec and the St. Lawrence River
- New York and Vermont



Native Range:

- Eurasia

Potential Impacts:

- Forms large dense floating mats which can reduce submerged plant cover by diminishing light and competing for gases and nutrients
- Dense mats also impede water flow, boat traffic, and recreational activities

Pathways of Introduction and Spread:

- Accidental, initial release likely from a water garden at Central Experimental Farm in Ottawa
- Recreational Boating

Yellow Iris – *Iris pseudacorus*

Iri-iri-pse

Description:

- Emergent aquatic perennial.
- Leaves: erect, simple, linear sword-shaped, 40-100cm in length, 2-3cm wide, arising from rhizomes
- Flowers: bright yellow, 7-9cm wide, with three petals and three sepals; present between April and July

Photo: Wasyl Bakowsky (MNR, 2008)

Similar Species

- When no flowers present; Blue flag (*I. versicolor*) is often purplish in colour around the leaf base, and has shorter stems (20-60 cm) and typically smaller leaves (10-80 cm by 1-3 cm) than yellow iris

Introduced Range:

- Southern Ontario and parts of Southern Canada

Native Range:

- Eurasia

Potential Impacts:

- Forms dense stands; it may displace native vegetation and convert habitat from a wet to drier environment
- Can cause poisoning in animals if rhizomes are ingested or plant juices make skin contact (causes blistering of the skin in humans)

Pathways of Introduction and Spread:

- Recreational Boating
- Water Garden Trade

European Common Reed – *Phragmites australis* subsp. *australis*

Poa-phr-aus

Description:

- Extremely tall, emergent, perennial grass
- Grows in dense stands in shallow waters of brackish as well as freshwater wetlands, stream banks, lakeshores, wet fields and ditches
- Leaves: alternate, flat, elongate, gradual taper to a point, 15-40cm long, 2-4cm wide
- Stem: erect, hollow, 1-4m tall, from rhizome; internodes at stem base a pale yellow in summer to late fall
- Inflorescence: terminal, dense, many-branched with spikelets of 3-10 flowers; long soft white hairs give a feathery appearance to inflorescence; glumes (or bracts) smooth, lower glume of spikelet 2.6-4.2 mm long; flowers in late summer and early fall.

Similar Species:

- Native subspecies *P. australis subsp. americanus* has red or purplish internodes at the base of the plant and a longer lower glume, 3.8-7 mm
- Native wild-rice (*Zizania spp*.) lacks the feathery-appearing inflorescence and has 1-flowered spikelets with no glumes compared to phragmites with feathery inflorescence, glumes present and many-flowered spikelets

Introduced Range:

- Southern Ontario, with scattered occurrences as far north as Georgian Bay and Lake Superior

Native Range:

- Eurasia

Potential Impacts:

- Forms large monocultural stands
- May displace native wetland vegetation, reduce plant species richness, and threaten habitat of rare species, species at risk and other wetland species

Pathways of Introduction and Spread:

- Water Garden Trade
- Recreational Boating

European Water Chestnut – *Trapa natans*

Tra-tra-nat

Description:

- Floating, annual aquatic plant; may be free-floating or rooted in substrate
- Floating alternate leaves: form densely crowded rosette up to 30 cm in diameter; blade rhomboid, 2-5 cm wide, margins sharply toothed
- Submersed leaves: opposite, finely dissected, feather-like
- Flowers: emergent, 4 white petals, 8 mm long; present in the summer, up to first frosts
- Produces conspicuous "woody" nut, 3-4 cm wide with 4 sharp barbed spines

Photo: Michael D. Naylor (MNR, 2008)

Introduced Range:

- Recently established in Ontario, in a bay connected to the Ottawa River in Voyageur Provincial Park
- Southwestern Quebec
- Northeastern US (close to the south shore of L. Ontario)

Native Range:

- Eurasia, Africa

Potential Impacts:

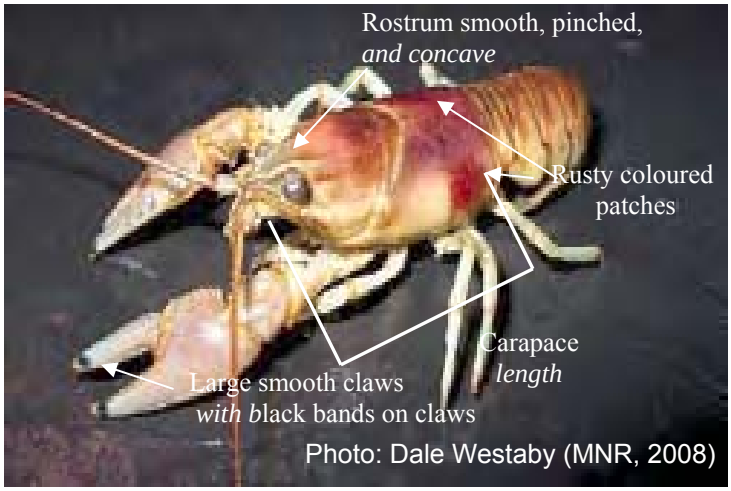
- Forms dense, large floating mats and may:
  - Shade-out submerged plants and other organisms
  - Interfere with recreational activities such as boating, fishing and swimming; the hard nut with barbed spines with barbed spines, which accumulate on shore can cause injury when stepped on

Pathways of Introduction and Spread:

- Water Garden Trade
- Desired for medicinal values (intentionally cultured)

Rusty Crayfish – *Orconectes rusticus*

Cam-orc-rus

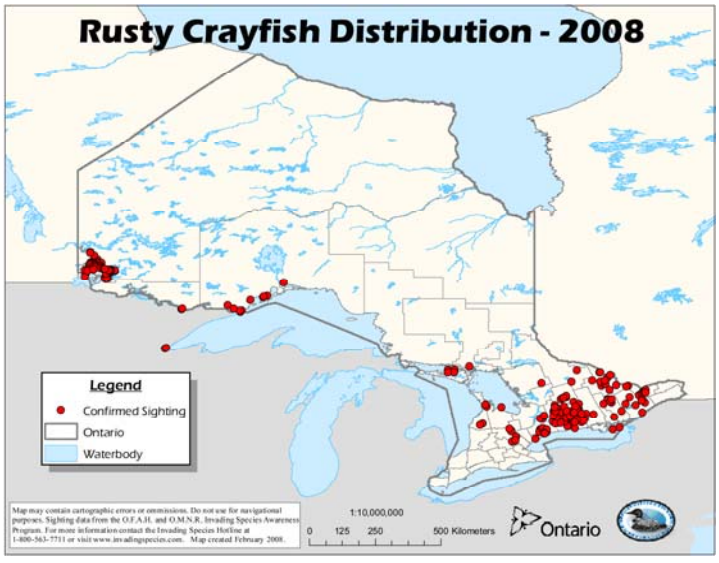


Description:

- Large crustacean
- Rostrum pinched and distinctly concave; upper surface smooth
- Rusty patches on both sides of carapace may be present
- Black bands on claw tips usually distinctive
- First copulatory stylet (of male) is straight to slightly curved; processes are fairly long (almost ½ total length of stylet) and uneven in length.

Similar Species:

- Native northern clearwater crayfish (*O. propinquus*) has a small yet distinctive ridge on the upper surface of a pinched rostrum, lacks rusty spots on the carapace and black bands on the claws, and the copulatory stylets are relatively short and stubby; however, this species can hybridize with rusty crayfish, obscuring some distinguishing characteristics.
- Native virile crayfish (O. virilis) has a mottled pattern on its back, lacks a pinched rostrum, and has very long stylets (processes ≥ ½ total length of stylet



Introduced Range:

- Introduced to Ontario and now present throughout Southeastern and southcentral Ontario, and parts of the Northwest (see distribution map)

Native Range:

- Native to Ohio River Basin running through Ohio, Kentucky, Tennessee, Indiana and Illinois in the Southern United States

Potential Impacts:

- Competes with native fish and crayfish for resources
- Hybridization can occur with native species
- Feeds on aquatic plant beds, can destroy nursery and spawning habitats.

Pathways of Introduction and Spread:

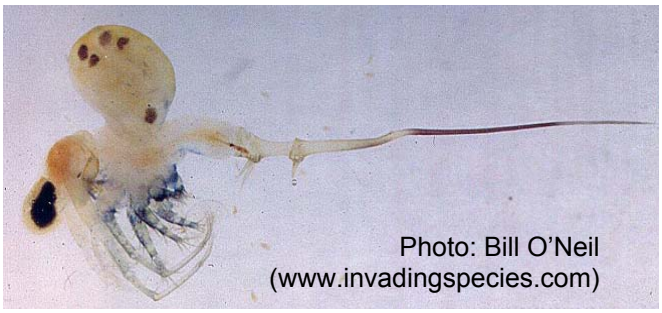
- Movement of Live Bait
- NOTE: Crayfish used as bait, must be from the waterbody where they were captured. Crayfish may not be sold as bait in Ontario. The limit on crayfish possession for use as bait is 36.
- Unauthorized Introduction (for commercial harvest)
- Aquarium Trade
- Biological Supply Houses

Rusty Crayfish Watch Card. See the website (www.invasdingspecies.com) and the additional resources section of this manual to order or obtain information about these and other AIS Resource Materials

Spiny Waterflea – *Bythotrephes longimanus*

Cer-byt-lon

Description:



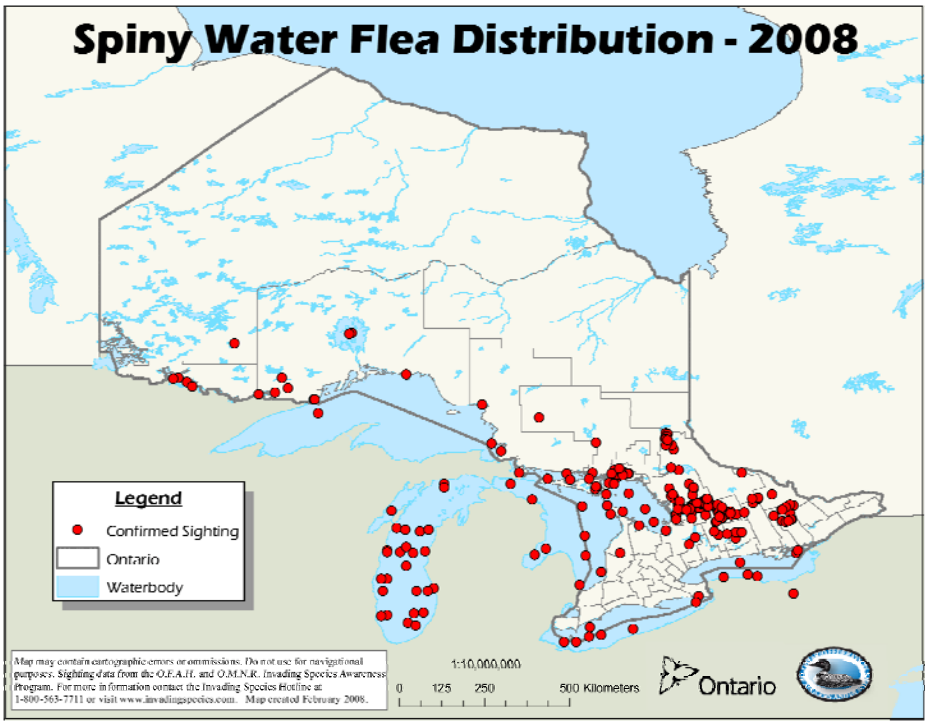
- Predatory cladoceran that collects in jelly-like masses on fishing lines, downrigger cables, or nets; masses may appear as clusters of tiny pins with blackdots
- 10 - 15 mm in length; tail spine is more than half of length
- Might have orange, blue and green colouring; red stripe runs half the length of tail
- Requires microscope to see features

Similar Species

- Invasive fishhook waterflea (*Cercopagis pengoi*) – also found in the Field Guide
- Native *Polyphemus pediculus* is much smaller with a short body and tail spine, and much bigger eye.
- Other native cladocerans (e.g., *Daphnia mendotae*) have only superficial similarity with much smaller tailspines (<25% of total length)

Introduced Range:

- Found in all the Great Lakes and over 100 inland lakes in Ontario
- Northern Ontario: Lake Nipigon, Rainy Lake, Lake of the Woods and a few Quetico Provincial Parks lakes
- Southern Ontario: Shield lakes (primarily around Parry Sound, Muskoka, Haliburton, Killarney and Temagami); a few lakes in Renfrew County (see distribution map on following page)



Native Range:

- Eurasia

Potential Impacts:

- Significant changes to lake zooplankton communities; including disappearances of species, and declines in species abundance and diversity
- Not a good food source for small fish, which have difficulty consuming the waterflea because of its spine, or larger fish that prey on the species but receive little nutritional value as the spines are indigestible and accumulate in stomachs

Pathways of Introduction and Spread:

- Shipping
- Recreational Boating
- Contaminated fishing equipment (e.g. downriggers, fishing lines)

Quagga Mussel – *Dreissena bugensis*

Dre-dre-bug

Zebra Mussel – Dreissena polymorpha

Dre-dre-pol

Description:

- Small freshwater mussels found in similar habitats; lakes, rivers, reservoirs, ponds, and quarries
- Adults settle on hard surfaces such as rocks, docks, cement, wood, and macrophytic plants

Side View
Photos: Michigan Sea Grant (MNR, 2008)

Ventral View
Photos: Myriah Richardson (MNR, 2008)

D. bugensis

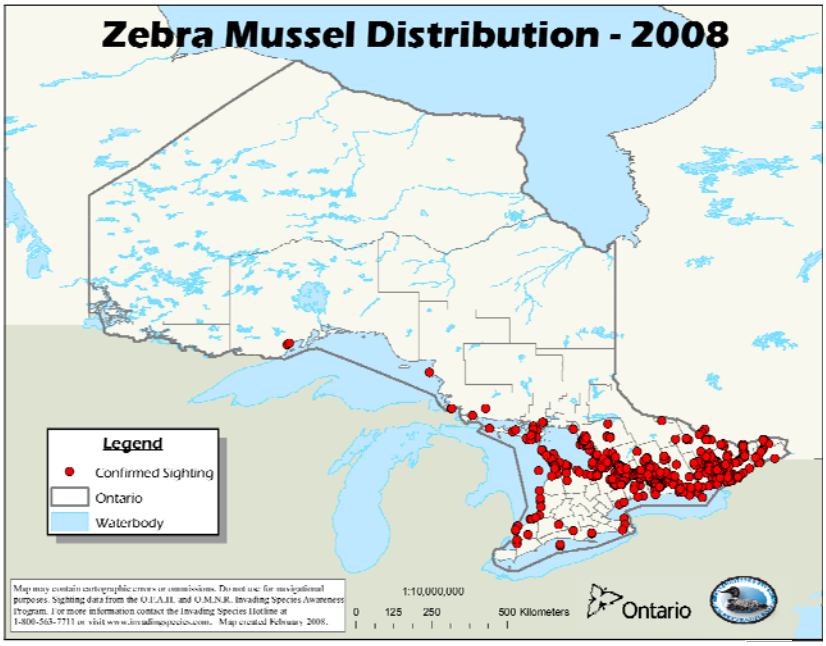
D. polymorpha

- Size: Up to 3cm long
- Shape: Ventral surface convex, left and right valves asymmetrical with curved midventral line
- Colour: variable, pale, may have coloured bands, bars or few to no zigzagged stripes
- Can colonize in sandy substrate
- Can reproduces in colder waters than zebra mussel (4-9º C)

- Size: Usually 2 to 2.5cm long, up to 4 cm long
- Shaped: Ventral surface flat to concave, shell D-shaped or triangular in cross section, left and right valves symmetrical with straight midventral line
- Colour: black or brown with variable white to yellow striped or zigzagged patterns
- Reproduces in warmer waters than quagga mussel (greater than 10ºC)

Introduced Range:

- Quagga mussel: occurs in Lakes Ontario, Huron, and Simcoe, the Rideau River, and several locations along the St. Lawrence River
- Zebra mussel: occurs in all the Great Lakes and the St. Lawrence River, and is spreading to inland lakes and rivers, including the Rideau Canal and Trent-Severn Waterway



Native Range:

- Both native to the Ponto-Caspian region of Eurasia

Potential Impacts:

- Both species form dense colonies and filter feed large quantities of plankton, increasing the clarity of the water and affecting native species that prefer more turbid water (e.g., Walleye). Water clarity increases also promote aquatic macrophyte growth.
- Both species compete for food with native organisms (dense colonization in a Ontario waterbodies have been followed by declines or complete losses in native mussels)
- Both species may facilitate the invasion of round goby into the Great Lakes as they are food sources in the round goby's native range
- Both species are serious biofoulers, , clogging water intake pipes and pollute swimming areas
- Bioaccumulates high levels of contaminants which are passed to species higher in the food chain; may be a contributing factor to botulism outbreaks in the Great Lakes Zebra mussels: form colonies on the shells of native mussels which threaten their ability to filter feed.

Pathways of Introduction and Spread:

- Shipping
- Recreational Boating
- Movement of Live Bait (transferred between lakes in bait buckets)
- Both species can survive for up to 22 days if the air is humid and the temperature is around 15°C

Red Mysid – Hemimysis anomala

Mys-hem-ano

Photo: NOAA Great Lakes Environmental Research (www.invadingspecies.com)

Description:

- A small macroinvertebrate (crustacean); not a true shrimp
- Found in slow moving fresh or brackish water
- Body 6.5-11 mm in length, with large, black, stalked eyes 6.5-11 mm.
- Telson (observed under low magnification) is truncated (uncleft) with two terminal, prominent spines and short spines along the outer margins
- Can be seen forming red swarms in shadows of docks and piers avoiding direct sunlight during the day

Similar Species:

- Native opossum shrimp (*Mysis relicta*) which recently may be referred to as *Mysis diluviana* in some literature, looks very similar but its telson is forked and lacks long terminal spines compared to red mysid

Introduced Range:

- Ontario: first found in Lake Ontario at Pickering in 2006; it has now been reported from several other locations on Lake Ontario and Lake Erie.
- United States (Lakes Ontario and Erie in New York, and Lake Michigan)
- Europe

Native Range:

- Ponto-Caspian region of Eurasia

Potential Impacts:

- Forms dense swarms of individual organisms (500 individuals/m3) and eats phytoplankton and zooplankton
- May alter the plankton community through predation on or resource competition with native zooplankton or planktivorous fish

Pathways of Introduction and Spread:

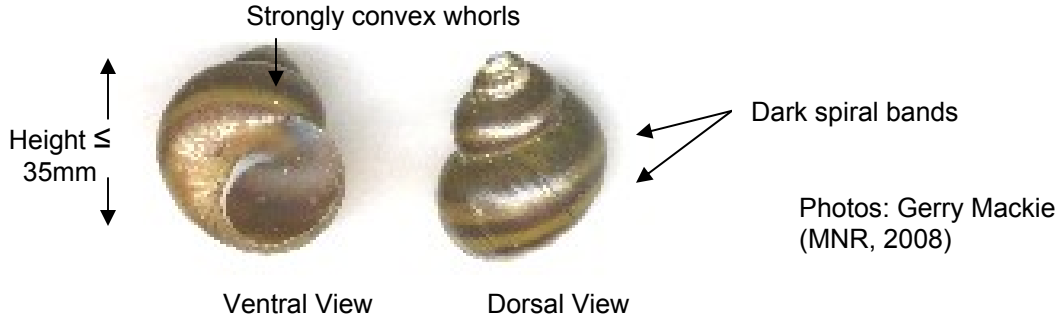
- Shipping
- Recreational Boating
- Movement of Live Bait

Banded Mystery Snail – *Viviparus georgianus*

Viv-viv-geo

Description:

- A large, banded, freshwater snail found in lakes and slow-moving streams with a muddy substrate and vegetation
- Shell height up to 3.5 cm, spherical, inflated, 4-5 strongly convex whorls separated by deep sutures
- Operculum ear-shaped with concentric growth lines
- Yellow to greenish brown with prominent dark-reddish spiral



Similar Species:

- Native brown mystery snail (*Campeloma decisum*) - similar in size but has a more oblong spire, a blunt or corroded terminal whorl, while lower whorls are less inflated or convex and lack spiral bands
- Invasive Chinese and Japanese mystery snail (*Cipangopaludina chinensis*, and *C.japonicus*)

Introduced Range:

- Ontario: Lakes Erie and Ontario, the Kawartha Lakes, the lower Trent-Severn, Crowe and Moira River watersheds, the lower Rideau Lakes and Ottawa River system, and the Grand River
- Quebec and Northeastern United States

Native Range:

- In the United States in the Mississippi River system, north to Indiana and southward including many southeastern states

Potential Impacts:

- Possible predation on largemouth bass embryos
- May compete with native snails for food and habitat

Pathways of Introduction and Spread:

- Aquarium Trade
- Recreational Boating
- Movement of Live Bait

Grass Carp – *Ctenopharyngodon idella*

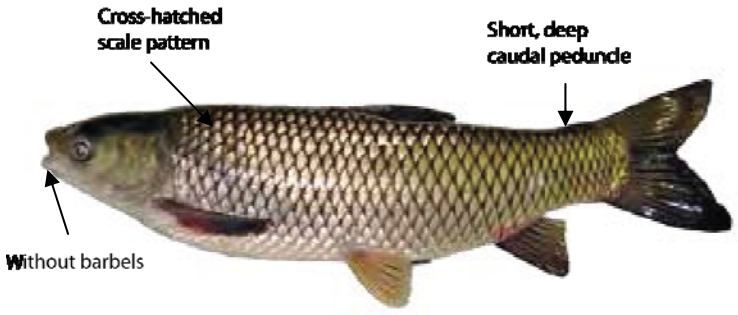
Cyp-cte-ide

Description:

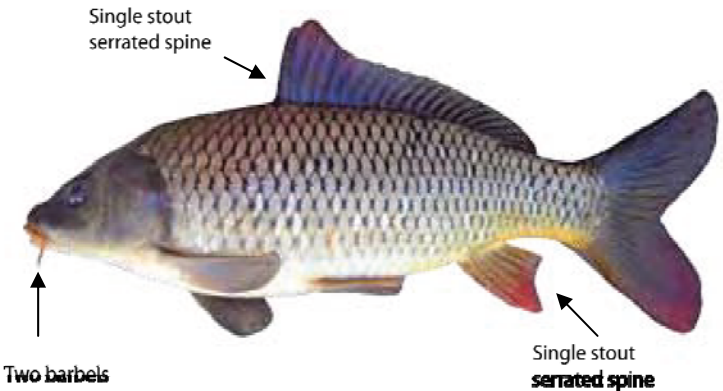
- Body: fusiform and moderately compressed; head broad and scaleless; caudal peduncle short and relatively deep; total length from 50-90 cm (up to 125 cm).
- Mouth: terminal to subterminal, of moderate size, without barbels.
- Pharyngeal teeth: a double row of four pointed, finely grooved or serrated teeth on each side, visible on dissection.
- Fins: spines absent; anal fin set far back; dorsal fin short with 7–9 rays.
- Scales: large with dark margins creating cross-hatched pattern, 34-47 scales in lateral line.
- Colour: olive-brown above blending to white below; juveniles are silvery
- Found in vegetated lakes, ponds and backwaters of rivers and tolerates dissolved oxygen levels and broad range of temperatures

Similar Species:

- Common carp looks similar but has barbels. See pictures showing key identification features that help differentiate between Common and Grass carps (right)



Grass Carp



Common Carp

Photos: Grass carp – John Derkson; Common carp – Douglas Watkinson (MNR, 2008)

Introduced Range:

- Fewer than 10 records in Ontario from Lakes Huron, Erie, and Ontario (including the Don River); no indication of establishment
- United States; Mississippi watershed
- Europe, Africa, Australia, Indian subcontinent, Central, and South America

Native Range:

- Eastern Asia (southern Russia to northern Vietnam)

Potential Impacts:

- Vegetation removal by this species may reduce or eliminate food and habitat (breeding shelter etc.) for native species
- Feeding activities may cause algal blooms, increase turbidity and alkalinity, while lowering dissolved oxygen levels

Pathways of Introduction and Spread:

- Before the possession of live grass carp was prohibited in 2005, its availability in the live food fish industry and water garden trade posed a considerable risk of accidental or unlawful release
- Stocking for vegetation management in US and Western Canada - note: does not feed preferentially on Eurasian water-milfoil

Rudd – *Scardinus erythropthalmus*

Cyp-sca-ery

Description:

- Member of the minnow family; robust, laterally compressed fish, 100-250mm long (up to 360mm),
- Mouth: terminal and oblique; Eyes: iris yellow to orange, often with red spot over pupil
- Scales: Anterior radii on scales; lateral line scales 38-42
- Colour: brown-green above with brassy yellow to rosy sides and bright orange or red fins
- Most often found in still or sluggish, often vegetated water, can inhabit a variety of freshwater habitats; commonly occurs in upper portion of water column, may thrive in degraded habitats unsuitable for native species

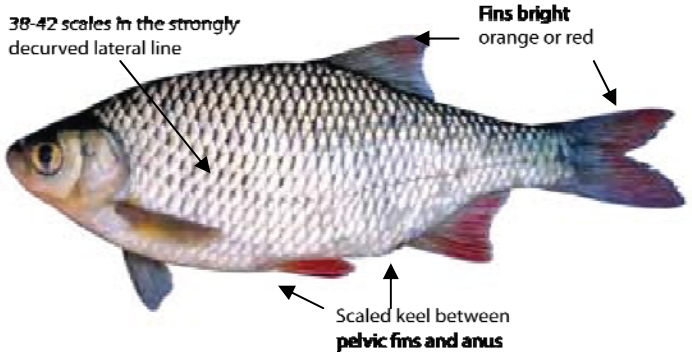


Photo: John Lyons (MNR, 2008)

Similar Species:

- Closely resembles the Golden shiner (Notemigonus crysoleucas) which has clear to pale orange (usually yellow) fins, not bright orange or red, 44-54 lateral line scales; no anterior radii on scales; does not have red spot on pupil

Introduced Range:

- In Ontario, scattered occurrences in the lower Great Lakes
- One inland occurrence: Lake Wilcox (in the Humber River watershed; north of Toronto)

Native Range:

- Western Europe to Caspian and Aral Sea basins

Potential Impacts:

- May compete with native fish species for invertebrate food sources
- Feeds heavily on aquatic macrophytes
- It has been suggested that genetic compatibility between the rudd and the golden shiner poses a threat to the genetic integrity of the latter species

Pathways of Introduction and Spread:

- Movement of Live Bait – note it is not a legal baitfish

Round Goby – *Neogobius melanostomus*

Gob-neo-mel

Description:

- Small cylindrical fish with snout rounded to blunt; 60-250mm total length
- Mouth: wide, terminal to slightly subterminal; lips large, without barbels; nostril tubes do not reach upper lip
- Fins: first dorsal with 5-7 spines; second dorsal long with one spine and 11-14 soft rays; caudal fin rounded

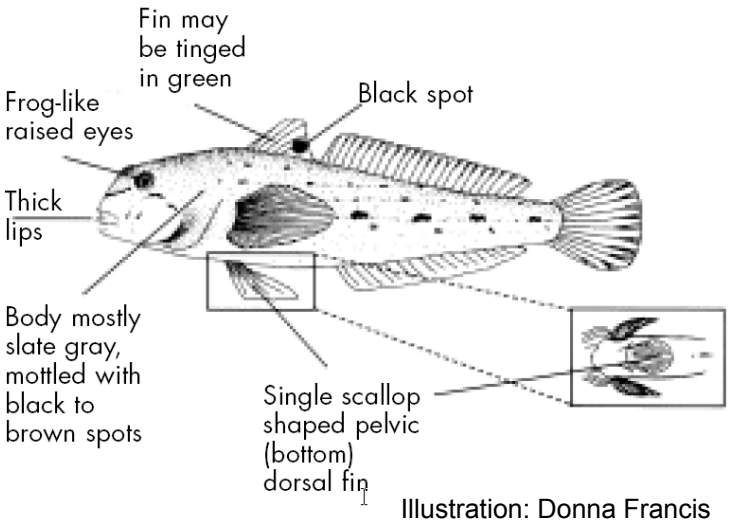


Illustration: Donna Francis (www.invadingspecies.com)

- Scales: small covering the top of the head, behind the eyes, and body, 45-57 along midline (without a lateral line). Pelvic fins fused to form suctorial disc (suction cup)
- Colour: back and sides mottled black, brown, or gray on a lighter brown, olive, or gray background, cream to white below; characteristic black spot, larger than the eye, on the rear of the first dorsal fin, although this feature is not apparent on some specimens. During spawning and nest guarding, males are black with yellow spots on the body.
- Found in cobble, gravel and sandy substrates, with or without vegetation, in near shore and deep waters, in lakes and the middle and lower reaches of rivers; can withstand low levels of dissolved oxygen

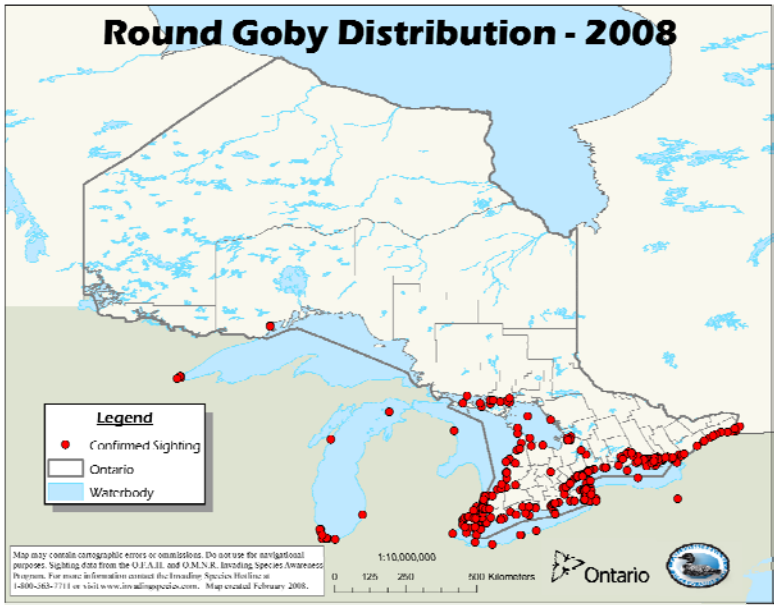
Similar Species:

- Native sculpins (*Cottus spp*. and *Myoxocephalus thompsonii*) are without scales and usually without a black spot on the first dorsal fin; pelvic fins are separate and do not form a suctorial disk
- Invasive Tubenose goby

Introduced Range:

- In Ontario, found in all Great Lakes, as well as the Trent River, Rice Lake, and Lake Simcoe in the Trent-Severn Waterway

Native Range:



s

pian Sea basins

Potential Impacts:

- Competes with native benthic fishes
- Eats fish eggs and larvae and so may pose a threat to sportfish populations
- May alter energy, contaminant, and nutrient pathways in the Great Lakes

Pathways of Introduction and Spread:

- Shipping
- Movement of Live Bait

Reporting Procedure

If you encounter a species new to Ontario or AIS already present but in a new area, whether they are included in the field guide or not, it is important that your finding is reported so that appropriate actions may be taken. The reporting procedure that is recommended is provided in Section 3.0 in the Field Guide. It involves **collecting a specimen, recording information, and reporting the sighting**.

Because a specimen is needed for verification by experts and sometimes as a voucher in a collection, the Field Guide describes materials and methods for collecting a specimen of algae, plants, invertebrates, or fishes. Some of these methods will be covered in the laboratory section of this workshop (i.e., storage in Lugol's solution, pressing plants, freezing, and digital photography.) Regardless of your choice of preparation method, it is recommended that that you take digital photographs as well, as they can be useful to show key identification features of the specimen or to show the extent of the infestation.

Along with your collection, it is important to document pertinent information about your finding for reporting purposes. This documentation includes taking digital photos which can be useful to show key identification features of the specimen or to show the extent of an infestation. The following information sheet (Figure 6.) from the Field Guide - 3.2 Recording Information, lists what information to record and submit.

Submit your report to
The *Invading Species Hotline*:

1-800-563-7711

Web Address:
http://www.invadingspecies.com

Email: invading_species@ofah.org

Contact name*	**Affiliation***
Phone number*	**Email***
Date of observation* yyyy/mm/dd	**Species scientific name*, common name**
Waterbody name*	**County***
Township*	**Datum*** Record the Datum being used with your GPS (NAD 83 preferred)
DDLatitude*, DDLongitude* In decimal degrees (DD); include at least 5 decimal places. E.g., 44.10016, -78.29386.	
Or - **UTM*** Although latitude/longitude are preferred, if providing UTM coordinates, include UTM Zone, Easting and Northing. E.g., Zone 17, 716599 E, 4886588 N.	
Source of coordinates* E.g., paper map, GPS, electronic or online maps and software, other (explain).	
Directions* Use stable landmarks or reference points (intersections, nearest town, etc.) which will remain long after the observation. E.g., East of the town of Bewdley, on South shore of Rice Lake, 250 metres East from Bamsey Dr. and Oak Hills Rd. intersection.	
Description of occurrence* Describe the habitat, number of individuals or size of occurrence, etc. E.g., in 20 x 50 metre shallow marsh, with approximately 10 flowering individuals.	
Other noteworthy information	

Figure 6. Information to record upon encountering an AIS. The fields marked with an asterisks (*) are the most important to fill, if not all information can be recorded (MNR, 2008).

Prevention and Decontamination Measures

Best Management Practices

Field work has the potential to contribute to the spread of aquatic invasive species (AIS) when equipment is moved between waterbodies. Movement of equipment including nets, bins, boats, trailers, anchors, buckets, boots, waders and all lines and ropes associated with equipment, between waterbodies has the potential to transfer AIS. Many AIS are not visible to the naked eye so staff cannot rely on visible signs alone.

It is imperative that staff working in aquatic ecosystems take precautions to ensure that their activities do not result in the unintentional spread of AIS including aquatic plants, invertebrates, fish and pathogens.

Field equipment such as gill nets, anchors and ropes are extremely susceptible to contamination from AIS. Fragments of aquatic plants such as Eurasian water milfoil and curly leaved pond-weed can become entangled on gear. Microscopic invaders such as zebra mussel larva and spiny water flea can adhere to the net mesh and ropes, or dormant resting eggs may be contained in the mud on anchors or in boot treads. Even personal gear such as chest and hip-waders has been identified as a possible vector in the spread of AIS. Vehicles such as tow vehicles, boats, the trailers they are transported on and float planes also pose a risk and must be decontaminated between use on different waterbodies.

Note that each treatment identified below effectively decontaminates equipment however implementing more than one can improve efficacy and save time and effort (eg. inspection, removal and drying are an effective integrated approach to treat for zebra mussels. While zebra mussel larva (less than 1 mm) may survive out of water for only a few hours, juveniles (1-7 mm long) may survive a couple of days and adults (up to 44 mm) up to 21 days under ideal (damp, cool) conditions. Using the inspection and removal process, eliminates the most stubborn and resilient stages of juveniles and adults. Combining inspection and removal with drying will kill remaining larvae effectively eliminating the risk of spread.

These Best Management Practices are based on the following important principles:

1. Assume every waterbody is infested

2. Boats and equipment should always be considered contaminated.

3. Treat equipment after each use if it is being moved to another waterbody.

4. Keep boats and equipment clean between trips and let dry for as long as possible.

Gear is grouped into 3 categories with decontamination procedures described for each:

1. Sampling and personal gear;

2. boat, motor, and trailer

3. float planes.

Where possible, different options are described to allow flexibility in choosing a decontamination procedure that is as practical as possible given different field scenarios.

Generally the first step is always to visually inspect equipment, followed by removing any obvious contaminants, then draining any standing water, and finally a treatment to remove or kill anything not visible. The treatments are based on the most current information available to address waterflea and zebra mussel contamination.

Table 4. Best Management Practices for the Decontamination of Sampling and Personal Gear

1. Decontamination of Sampling Gear & Personal Gear – methods and materials	
A. Use different gear for each waterbody visited	
• Requires multiple gears to allow for clean gear to be used on each lake	1. Preferred practice but may not always be possible. 2. Recommended in fly-in situations or when multiple lakes may be visited in the same day.
B. Clean equipment between uses	
• High pressure water (>250 psi) • 50° C water or steam • 5 min. exposure time for hot water • ½ hr. expose time for steam • Net drying rack	1. Visually inspect sampling and personal gear, and remove all debris (plants, sticks, mud etc.). 2. Roll out nets and other equipment and rinse with high pressure water OR 3. Spray or submerge in hot water for at least 5 minutes OR 4. Steam equipment in a steam box 5. Allow equipment to dry completely and then remain dry for at least 12 hours prior to use.
Tips: • Use rubber waders, boots and gloves because neoprene waders and gloves, and felt soled boots entrap AIS more readily and are harder to decontaminate than rubber. • Use a tagging system to identify decontaminated equipment from dirty equipment. For example, green tags to indicate clean equipment, red for equipment that has not been decontaminated yet. • Don't forget to decontaminate your personal angling gear if you go fishing • A steam box can be made from an unused refrigerator or other suitable insulated container. Drill a small hole in the side of the fridge to fit the nozzle of a commercial steam cleaner. Gear can be stacked on the shelves of the fridge. A zip tie or rope can be used to hold the trigger open on the steam cleaner. This method uses significantly less hot water than the hot water wash method. Purchase a commercial steam cleaner similar to the model found at http://www.tecnovap.it/prodotti/linea%20industriale/?id=44.	

Table 5. Best Management Practices for the Decontamination of Transportation Equipment (excluding float planes)

2. Decontamination of Truck, Boat, Motor and Trailer – methods and materials	
A. Use different boat, motor and trailer for each waterbody visited	
• Requires multiple vessels to allow for clean boat to be used on each lake	1. Preferred practice but recognized as not very practical.
B. Clean boat between uses	
• High pressure water (>250 psi) • 50° C water • Engine motor flusher (muffs)	(1) Visually inspect and remove aquatic plants, animals and mud from inside and outside of boat (keel, trim tab, transducer, lower unit, propeller) and trailer (rollers, lights, axle, fenders, etc.). (2) Drain water from motor, live well, tanks and sampling equipment before leaving water access area. (3) Flush engine cooling system with water > 50° C (4) If boat has been in water less than 24 hrs, towel dry hull of boat and motor. (5) If boat has been in water more than 24 hours: a) Pressure wash boat >250 psi; OR b) Wash with hot water >50° C; OR c) Leave in the sun to dry for at least 5 days.
Tips: • Pay particular attention to cracks and crevices that may hide unwanted organisms, plants and mud. • Don't forget to inspect and clean anchor line, anchor and any other boating equipment that may have come in contact with lake water. • Drain all water from motor starting with motor in operating position then manually tip or hydraulically trim motor up, and tip motor from side to side. If removing motor from boat, stand it upright to allow water to drain prior to transporting. • Engine motor flushers (muffs) are readily available at stores selling boating equipment and can be hooked to a garden hose to flush engine cooling system.	

Table 6. Best Managment Practices for the Decontamination of Float Planes

3. Decontamination of Float Planes – materials and methods	
A. Before entering the aircraft	
• High pressure water (>250 psi) • 50° C water • 5 min. exposure time for hot water	1. Inspect and remove aquatic plants from the floats, wires or cables, and water rudders. 2. Pump floats out (they may contain infested water). If moored in waters for more than 24 hours, check the transom, chine, bottom, wheel wells, and the step area of floats. The surface will feel gritty or rough if mussels are attached. If mussels are present on the floats see section C. Mooring and Removal of Aircraft for Storage.
B. Pre and post takeoff checks	
	1. Avoid taxing through heavy surface growths of plants before takeoff. 2. Raise and lower water rudders several times to clear off plants before takeoff. 3. Raise and lower water rudders several times to clear off plants after takeoff. 4. If aquatic plants are visible on any part of the aircraft after takeoff, return to lake that you took off from and remove plant fragments
C. Mooring and Removal of Aircraft for Storage	
• Requires removal of aircraft from water • High pressure water (>250 psi) • 50° C water • Stiff bristled brush	(1) Remove aircraft from the water and: a) Pressure wash >250 psi; OR b) Wash with hot water >50° C; OR c) Leave in the sun to dry for at least 5 days. (2) Aircraft moored for extended periods in mussel infested waters may have mussels attached to the floats and should be cleaned regularly. In remote locations where mussels are present, but where there are no provisions for drying, spraying, or treating the floats with hot water, hand-cleaning the submerged portions of floats with a stiff bristled scrub brush and physically removing adult mussels is the best option available for preventing the spread of zebra and quagga mussels.
Tips: • During hot, dry summer temperatures, a few days in the sun will kill adult zebra mussels • Longer drying times of up to 10 days are required to kill adult mussels during cool, damp weather. • Ensure that contracted pilots and MNR pilots are aware of these precautions.	

Options for Chemical Disinfection

Chemical disinfectants such as salt, chlorine and vinegar are not reported to be successful against spiny water flea. Hatching success in spiny water flea eggs was still observed after being subjected to pH ranges between 3 and 11 for a period of 4 months (Branstrator pers. comm.). If concern for AIS spread is directed specifically at only zebra mussels, one of the following disinfectants may be used on personal gear and equipment to kill all life stages of zebra mussels if properly applied (AIS HACCP training manual):

1. 100% vinegar dip for 20 minutes
2. 200-250mg/L chlorine bleach for 60 minutes
3. 500mg/L hydrogen peroxide for 60 minutes
4. 4mg/L potassium permanganate for 60 minutes
5. 1% table salt (based on 312g/cup sodium chloride - see table 7 for acceptable salt water concentrations) for 24 hours.

Table 7. Volumes of water of salt required to prepare a saltwater solution effective for the decontamination of zebra mussel.

Volume of Water Litres (US Gallons)	Volume of Salt Cups
18.93L (5 US Gal)	2/3
37.82L (10 US Gal)	1
94.63L (25 US Gal)	3
189.27L (50 US Gal)	6
378.54L (100 US Gal)	12 (2/3)

Following chemical treatment, equipment should be thoroughly rinsed free of disinfectant with water to ensure no negative impacts to the aquatic ecosystem from any chemical residue. Care also should be taken to properly dispose of chemical disinfectants. If in the field for an extended period of time it may not be possible to use and properly dispose of some of these treatments.

Note: Salt treatment is not effective to kill the VHS virus or pathogens; the effect of vinegar and potassium permanganate are unknown.

Laboratory Activities

The remainder of this workshop will be comprised of activities designed to practice some of the principals covered today. They will help you become equipped to properly react to encountering AIS in the field.

Activity 1. Proper decontamination of boats, trailers and other sampling equipment is the best way to prevent AIS introductions and/or spread. As shown on the previous pages, there are several ways that you can decontaminate your gear in order to prevent introductions. This group activity will review these decontamination methods in a variety of unique case studies.

Activity 2-4. Part of the reporting procedure includes collecting a voucher specimen. Even if you are completely confident that you have correctly identified a species that you have encountered, the Invading Species Hotline may request a voucher specimen. The Field Guide outlines the recommended processes for collecting specimens of each group. Following the steps provided for Activities 2-4 will help you better understand these processes.

Activity 5 and 6. These activities will test your recently acquired identification skills for plants, inverts, and fish.

Activity Number	Description	Format
1	Decontamination and Prevention Case Studies	Case Study - Class Activity – 12.5min
2	Preparing Algae Samples – Preparation in Lugol's Solution & Viewing Invasive Zooplankton	Lab – In lab groups – 12.5 min
3	Preparing Plant Samples – Pressing	Lab – In lab group – 12.5 min
4	Preparing Fish Samples – Digital Photography	Lab – In lab group – 12.5 min
5	Encountering & Identification of an Invasive Plant and/or Invertebrate in the Field	Case Study – In lab group – 12.5 min
6	Encountering & Identification of an Invasive Fish	Case Study – In lab group – 12.5 min

Table 8. Laboratory Activities

Activity 1: Decontamination and Prevention of AIS (Case Studies)

By properly decontaminating your boat, trailer and any other sampling gear, you can become apart of the solution to prevent the spread and introduction of AIS. This activity will be done in both your lab groups and as an entire class.

First, break up into lab groups of 3-4 depending on the class size. Each group will then be given a case study and you will have 5 minutes as a lab group to discuss the case study and come up with the most suitable decontamination method. Each lab group will then chose an administrator who will speak on behalf of the lab group.

The lab technician will then read each case study and will ask the lab group administrators to share their group's conclusions on the appropriate decontamination method. Following the discussion of each case study, the class will then have a chance to add their comments or suggestions in order to compliment the lab group's effort.

Activity 2a: Preparing Algae Sample – Preparation in Lugol's solution

To practice preparing an algae sample, follow the steps below (Method B in the Field Guide), and use the supplies provided. Each person in the group may complete this activity

1. Using the forceps provided, collect a small clump of the algae Place the clump inside the container or whirl pack. If they are attached to substrate, scrape the algae from surface into the container.

2. Place about 5-10 ml of water in container

3. Add enough drops of Lugol's solution to turn the water a strong tea colour

4. Seal lid, or close whirl pack to prevent spillage

5. Label your specimen using a sticky label and the marker provided (date, location, species, contact)

6. You may keep your voucher specimen for later reference. Be sure to keep it in a cool dark place.

Activity 2b: Viewing Invasive Zooplankton Using a Dissecting Scope

You will most likely finish Activity 2a before it is time to rotate to the next activity station. Use this extra time to view some of the invasive zooplankton samples with the dissecting microscopes that are provided. While doing this activity, you should consider the following;

1. Compare and sketch the differences between fishhook waterflea (*Cercopagis pengoi*) and the spiny waterflea (*Bythotrephes longimanus*).

2. Compare and sketch the differences between the red mysid (*Hemimysis anomala*) and the native deepwater mysid (*Mysis relicta*).

3. View and sketch the gammarid (*Echinogammarus ischnus*) if time permits.

Activity 3: Preparing Plant Samples – Pressing

Follow the steps below (Method C in Field Guide) and use the supplies provided to practice preparing a plant sample.

1) Choose a specimen and identify using Field Guide
2) Gently dry wet plant with paper towel
3) On top of corrugated cardboard, place a layer of folded newspaper
4) Lay plant on folded newspaper
    a) Spread plant parts so there is minimum overlap between parts
    b) The stem can be folded zig-zag-like to fit
    c) Display the underside of at least one leaf
    d) Press open flowers to display the inside
    e) Place any loose seed and fruit into a small paper packet/envelope
5) Cover plant with a layer of newspaper, then another piece of cardboard
6) Tie ribbon or straps around layers of cardboard and newspaper to fasten pieces together so contents stay in place
7) A weight of some form (e.g., book) may also be placed on top to help flatten and secure contents
8) Label your specimen on by attaching a sticky label to the outside of your press. (date, location, species, contact)
9) When completed Steps 1-8, refer to section 3.1.2 of Field Guide and review the other methods suggested. Discuss with your group reasons for using different methods of plant preparation (the last two steps are to be completed after this workshop)

STEPS TO TAKE LATER

10) Store in a well ventilated, dry and warm area
11) If newspaper is damp after first 24 hours, replace it with dry newspaper and store as described in (10)..

Activity 4: Preparing Fish Samples – Digital Photography

To practice preparing a fish sample using digital photography, follow the steps below and use the supplies provided.

1) In pairs, lay the fish on a flat, surface provided
2) Extend the gills and fins, so that they appear natural (as if the fish is swimming – see Figure 7, below)

Figure 7: Natural looking Common Carp (New York State Department of Environmental Conservation, May 2007)

3) Supply ample light to reduce shade spots
4) Photograph whole fish alongside a ruler or other object like a pen or coin so that the relative size of the fish is evident. (you can use anything that you have with you in the field – for instance your Field Guide!)
5) Using the close-up setting of the camera, photograph the external features listed below. Use the Fish Anatomy page which is found at the end of the **blue pages** in you Field Guide.

External Features to Photograph:

a) pelvic fin
b) eyes
c) anal fin
d) caudal fin
e) operculum

1) Download your pictures onto the laptop for viewing

2) Ask yourself the questions:

Do you think they would be valuable as part of an AIS report?

3) If you answered NO to the question above, what improvements are required?

Activity 5: Encountering an Invasive Plant or Invertebrate in the Field

This activity simulates encountering an aquatic invasive plant or invertebrate while working in the field. It will reinforce the various steps that should be taken to help manage invading species in Ontario waters.

1) Each person in the group should select one case study package. The package should include a scenario and a preserved or live voucher specimen (either a plant or invertebrate).

2) Individually, use your the Field Guide or any other identification key to identify the species. (The photo index in the Field Guide is a good starting point for this exercise) What AIS are you dealing with?

AIS Common Name: _____

AIS Scientific Name: _____

3) Examine the species' introduced range in your Field Guide and determine whether or not it is a reportable species.

   Will you report this sighting? (explain)

   _____
   _____
   _____

   What method of preservation will you employ for this sample? (explain)

   _____
   _____
   _____

4) Record all the reporting information requested in your field guide (refer to Section 3.2 of the Field Guide). Use the form provided on the next page in order to fill out all the appropriate information.

5) After each member of the lab group has completed filling out their reporting form and identifying their AIS, open up the answer key envelope and determine if you are correct or not.

Note: If you have additional time, use this to ID more voucher specimens

Contact name*	Affiliation*
Phone number*	Email*
Date of observation* yyyy/mm/dd	Species scientific name*, common name
Waterbody name*	County*
Township*	Datum* Record the Datum being used with your GPS (NAD 83 preferred)
DDLatitude*, DDLongitude* In decimal degrees (DD); include at least 5 decimal places. E.g., 44.10016, -78.29386.	
Or - UTM* Although latitude/longitude are preferred, if providing UTM coordinates, include UTM Zone, Easting and Northing. E.g., Zone 17, 716599 E, 4886588 N.	
Source of coordinates* E.g., paper map, GPS, electronic or online maps and software, other (explain).	
Directions* Use stable landmarks or reference points (intersections, nearest town, etc.) which will remain long after the observation. E.g., East of the town of Bewdley, on South shore of Rice Lake, 250 metres East from Bamsey Dr. and Oak Hills Rd. intersection.	
Description of occurrence* Describe the habitat, number of individuals or size of occurrence, etc. E.g., in 20 x 50 metre shallow marsh, with approximately 10 flowering individuals.	
Other noteworthy information	

Activity 6: Encountering an Invasive Fish in the Field

This activity simulates encountering an aquatic invasive plant fish while working in the field. It will reinforce the various steps that should be taken to help manage invading species in Ontario waters.

1) Each person in the group should select one case study package. The package should include a scenario and a preserved or live voucher specimen (either a plant or invertebrate).

2) Individually, use your the Field Guide or any other identification key to identify the species. (The photo index in the Field Guide is a good starting point for this exercise). What AIS are you dealing with?

AIS Common Name: _____

AIS Scientific Name: _____

3) Examine the species' introduced range in your Field Guide and determine whether or not it is a reportable species.

   Will you report this sighting? (explain)

   _____

   _____

   _____

   What method of preservation will you employ for this sample? (explain)

   _____

   _____

   _____

4) Record all the reporting information requested in your field guide (refer to Section 3.2 of the Field Guide). Use the form provided on the next page in order to fill out all the appropriate information.

5) After each member of the lab group has completed filling out their reporting form and identifying their AIS, open up the answer key envelope and determine if you are correct or not.

Note: If you have additional time, use this to ID more voucher specimens

Contact name*	**Affiliation***
Phone number*	**Email***
Date of observation* yyyy/mm/dd	**Species scientific name*, common name**
Waterbody name*	**County***
Township*	**Datum*** Record the Datum being used with your GPS (NAD 83 preferred)
DDLatitude*, DDLongitude* In decimal degrees (DD); include at least 5 decimal places. E.g., 44.10016, -78.29386.	
Or - **UTM*** Although latitude/longitude are preferred, if providing UTM coordinates, include UTM Zone, Easting and Northing. E.g., Zone 17, 716599 E, 4886588 N.	
Source of coordinates* E.g., paper map, GPS, electronic or online maps and software, other (explain).	
Directions* Use stable landmarks or reference points (intersections, nearest town, etc.) which will remain long after the observation. E.g., East of the town of Bewdley, on South shore of Rice Lake, 250 metres East from Bamsey Dr. and Oak Hills Rd. Intersection.	
Description of occurrence* Describe the habitat, number of individuals or size of occurrence, etc. E.g., in 20 x 50 metre shallow marsh, with approximately 10 flowering individuals.	
Other noteworthy information	

Glossary of Terms

Plants:

Aerenchyma – type of plant tissue with thin-walled cells containing large intercellular spaces

Annual – a plant that completes its life cycle in one year – germinating from seed, flowering, setting seed, and dying in one growing season

Apex – a tip

Axillary – in an axil, e.g., the angle between leaf and stem

Axis – central line along which lateral parts of the plant are arranged

Beak – a comparatively short and stout terminal appendage on a thickened organ like a seed or fruit

Biennial – requiring two years to complete its life cycle, usually involving vegetative growth in the first year and reproduction (flowering, fruiting) and senescence (death) in the second year

Bract – a specialized, reduced leaf associated with a flower or flower cluster

Bulbil – a small, bulb-like structure (vegetative propagule) produced by some plants in the axils of leaves, inflorescences or rhizomes

Culm – a plant stem

Dichotomous(ly) – forking in pairs

Dissected – divided into many small segments

Elongate – considerably longer than wide

Emergent – partly submersed in water, partly above water surface

Entire – a continuous edge without teeth or lobes

Ephemeral – not permanent; existing for a short time

Glume – one of a pair of bracts, found at the base of a grass spikelet, which do not subtend flowers

Inflorescence – a flower cluster; the arrangement of flowers on the axis

Internode – the part of a stem between two nodes

Ligule – collar-like appendage at the upper edge of a leaf sheath

Linear – very long and narrow, with parallel edges

Midvein – the central vein of a leaf

Nectary – a gland that secretes nectar

Node – the place where a leaf or branch is attached to a stem

Oblong – shaped like a geometrical rectangle (other than a square)

Palmate(ly) – lobes or leaf segments radiating from a common point

Pedicel – the stalk of a single flower in an inflorescence

Perennial – a plant that lives for more than two years

Perfect – describes a single flower that has both male (stamen) and female (pistil) reproductive organs

Petiole – a leaf stalk

Pinnate(ly) – leaflets (or segments) arranged on two sides of an axis

Plicate – having folds, usually lengthwise

Prickle – a sharp outgrowth

Regular – describes a flower that is symmetrical when divided in half or into equal parts through the middle

Rhizome – an underground stem, usually elongate

Riparian – adjacent to a river or stream, including shores and floodplains

Rosette – a cluster of leaves or other organs radiating from a centre point

Simple – not divided or branched into parts

Spike – an elongate inflorescence with stalkless flowers

Spikelet – the smallest unit of an inflorescence

Stipule – an appendage at the base of a leaf stalk, usually leaf-like

Stolon – an elongate, creeping stem spreading horizontally on the surface of the ground, usually rooting at nodes or tips

Submerged (Submersed) – under water

Tepal – a sepal or petal; the term is applied when these structures are not easily distinguished from one another

Terminal – at the end, or tip of

Turion – a winter bud; sometimes a scaly, bulb-like growth from a bud on a rhizome or other vegetative organ

Whorl – a ring of 3 or more similar structures (e.g., leaves) radiating from a node or common point

Invertebrates:

Amphipod – any of numerous small, flat-bodied crustaceans of the group Amphipoda

Aperture – opening of a snail shell from which foot and body protrude

Apex –tip

Apical whorl – top or apex of the spire; the first formed part of snail shell

Appendage – external body part

Barb – point or pointed part projecting backward from a main point as of a fishhook

Beak – apex or umbo of a bivalve shell; the first formed part

Carapace – the dorsal section of the exoskeleton; the hard outer covering or case of certain organisms

Caudal – at, or near the tail or the posterior end of the body

Concentric – describes the growth lines of a snail operculum that lie entirely within each other; not forming a spiral

Crustacean – any chiefly aquatic arthropod of the class Crustacea, typically having the body covered with a hard shell or crust

Distal – farthest; situated away from the point of origin or attachment

Gonopod –male sexual organ; first pair of pleopods specialized for fertilization in male crayfish (copulatory stylets)

Hinge teeth – part of the thickened part of a bivalve shell where the two halves join

Lip – structure surrounding the aperture of a snail shell

Lobe – roundish projection or division

Malleations – flattened areas, as if hammered

Nucleus – center point of growth rings in a snail operculum

Operculum – thin plate-like structure attached to the foot of a prosobranch snail that covers the aperture when the foot is withdrawn

Parthenogenic – asexual reproduction; cloning

Periostracum – hard chitinous covering on the outer shell of many molluscs

Pleopods – first of five pairs of abdominal legs or swimmerets; may be modified into male gonopod or copulatory stylets

Prosobranch – gill-breathing snail

Proximal – nearest; situated toward the point of origin or attachment

Rostrum – anterior part of carapace between eyes [ref to crayfish]

Spire – cone-shaped surface of a snail shell that tapers to a point; the whorl containing the snail body usually not considered to be part of the spire

Stylets – [copulatory stylets] pair of pleopods specialized for fertilization in male crayfish

Suture –groove marking the junction of adjacent whorls

Telson –last segment or division of the body of a crustacean; helps form the tail fan of crustaceans

Umbo – beak or apex [tip] of a bivalve mussel

Unionid – native freshwater clams of the order Unionoida, with a‘prearly’ appearance on shell surface

Uropod – 3 form the tail fan of a crustacean

Veliger – zooplanktonic, larval form of some molluscs, including introduced Dreissena mussels

Viviparous – a type of reproduction in which the young are internally maintained in uterus up until a 4-whorl stage before birth (e.g., livebearing snail)

Whorl – a single spiral turn of a snail shell

Fish:

Ammocoete – a larval form of a lamprey lacking eyes and teeth

Scale radius – line radiating from the focus of the scale

Bicuspid – two-pointed

Caudal peduncle – posterior fleshy portion of the body between the anal and tail fins

Barbel – a fleshy sensory appendage extending from the mouth, chin or nose

Branchial – pertaining to the gills

Buccal funnel – the circular, jawless mouth of a lamprey

Fusiform – spindle shaped, tapering at both ends

Isthmus – fleshy narrowing between gill openings on the underside of the head

Lateral line – series of pore-like openings along both sides of the body

Molariform – teeth with flattened, molar-like grinding surfaces

Myomere – a section of repeated muscle units

Keel – a raised edge running lengthwise along the ventral midline or on the sides of the caudal peduncle

Oblique (**mouth**) – the line of the closed mouth forms an angle of 45°or more

Origin (fin) – the most anterior point where the fin meets the body

Pelvic axillary process – a lance-shaped projection at the base of each pelvic fin

Peritoneum – the lining of the abdominal wall, the colour of which distinguishes some species

Pharyngeal teeth – toothlike projections from the fifth gill arch, visible through dissection

Scalati on – the extent of the skin covered with scales

Subterminal (mouth) – snout overhangs the mouth opening

Supraterminal (mouth) – lower jaw extends forward beyond the upward opening of the mouth

Suctorial disk – a round structure formed by the fusion of the pelvic fins on the underside of a goby

Terminal (mouth) – tips of both jaws form the most anterior portion of the head

Unicuspid – single pointed

Useful Resources for Species Identification

Plants

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Information and Educational Products Available from the Invading Species Awareness Program

Product	Title	French/Engl
Fact Sheets	Rudd	F/E
	Grass Carp	F/E
	Round Goby	F/E
	Rusty Crayfish	F/E
	Spiny Water Flea	F/E
	Fishhook Water Flea	F/E
	Zebra Mussel	E
	Fanwort	F/E
	Yellow Floating Heart	F/E
	European Frog-Bit	F/E
	VHS	E
	Sea Lamprey: The Battle Continues (Brochure)	E
	Invaders in Our Waters Making Waves Curriculum	E
Watch Cards	Eurasian Water Milfoil	F/E
	Purple Loosestrife	F/E
	Round Goby	F/E
	Spiny and Fishhook Water Flea	F/E
	Ruffe	E
	Rusty Crayfish	F/E
	Bighead and Silver Carp	E
	European Frog-Bit	E
Aquarium and Water Gardens	Aquatic Invasive Species: A Guide for Water Gardeners and Aquarium Owners (Brochure)	F/E
	Purple Loosestrife: What You Should Know, What You Can Do (brochure)	E
	Fanwort: What You Need to Know about this Aquatic Invasive Species (Brochure)	E
	Never Release Aquarium Water, Pets or Plants-	F/E
	Never Release Aquarium Water ,Pets or Plants-	F/E
	Water Garden Invaders - Poster	F/E
	Water Garden Invaders – Magnet	F/E
	Blue Vervain Seed Packet	F/E
Recreational Boating	Boater's Checklist Sticker (Waterproof)	F/E
	Information for Boaters: Help Stop the Spread of Aquatic Invasive Species (Brochure)	F/E
	STOP the spread – Aluminum Boat Launch Sign	E
Live Bait	Don't Dump Your Bait Bucket! Poster	F/E
	Wait! Don't Dump Your Bait! Sticker	F/E
	Protect Ontario Waters – VHS Sticker	F/E
	Round Goby Watch Sign (Corrugated plastic	F/E
	Stop it's Illegal, Don't Use Round Goby as Bait!	F/E

**For pricing information and to order these products visit www.invadingspecies.com

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