4 Invasive Species

4.1 What is an Invasive Species?

Invasive alien species (IAS) are defined as plants, animals or micro-organisms that have been introduced by human action outside their natural past or present distribution, and whose introduction or spread threatens the environment, the economy, or society, including human health. Invasive species may originate from other countries, or from other ecosystems within Canada. They are not native to the ecosystems they threaten, and are often introduced to new ecosystems without the predators or pathogens of their native range. They typically exhibit rapid growth, reproduction and dispersal, making them highly destructive, competitive and difficult to control (MNR, 2012b).

Many IAS have become naturalized species in parts of Ontario; examples include zebra mussels, quagga mussels, and round goby. Naturalized invasive species are introduced species with self-sustaining populations unlikely to be eradicated that continue to pose a threat to our environment, economy or society. Managing naturalized invasive species involves measures to prevent their spread beyond existing ranges, developing techniques to adapt to their presence, and finding ways to reduce their impacts (MNR, 2012b).

4.2 What is the problem?

The invasive alien species problem is the result of a complex combination of economic, social, geographic, and environmental factors.

4.2.1 Aquatic Invasive Species

Since Canada is home to 20% of the world's fresh water and has one of the world's longest coastlines, the economic and environmental consequences of inaction are extreme. Few people are sufficiently aware of the nature and magnitude of the threat and, as a result, there is a widespread lack of compliance with voluntary practices and regulations designed to limit the spread of IAS resulting from human activity. Although applicable legislation and regulations exist in many cases, they have not always been adequately brought to bear on the problem. The consequences of invasive species becoming established include damage to sensitive ecosystems, as well as negative impacts on fishing, tourism, and other industries that form the backbone of local economies (DFO, 2004).

In addition to the primary effects, which can be seen shortly after a species becomes established, the alteration of such things as food webs and water quality can cause secondary impacts that take much longer to manifest. This further complicates the ability of agencies to manage invasive species. For example, the filter feeding activity of zebra mussels rapidly increased water clarity in the lower Great Lakes (as discussed in Section 2.1.3). Over a much longer period, the increased light penetration (due to clearer water) produced significant growth and spread of aquatic vegetation and increased the frequency and severity of toxic algal blooms (DFO, 2004).

Nearly twice as many aquatic invasions occurred during the second half of the 20th century (as compared to the first half) and recent data suggests that the pace is still accelerating. The increase in both the volume and speed of global trade, especially in the case of goods or vessels from countries with similar climates to Canada, has led to ever-higher risks of alien invasive species entering Canada – risks that are further exacerbated by insufficient surveillance and enforcement (DFO, 2004).

The largest single source of new alien aquatic species, estimated at about 75% in the Great Lakes region, is ballast water in ships. Water taken on in foreign ports, complete with local organisms, is discharged in Canadian waters, along with undesirable hitchhikers. Ballast tanks have been known to house up to several hundred different species. Globalization and internet-based commerce have also increased the intentional and unintentional importation of alien species for various purposes, some of which pose a threat if released into the wild. Not all invasive species come from overseas, some are native to North America but became harmful invasives because they were introduced beyond their natural range (DFO, 2004).

4.2.2 Invasive Plants and Plant Pests

Many of the important issues of recent decades have involved introductions of invasive plants or invasive plant pests, necessitating costly measures to control or eradicate unwanted species, restore habitats or crops damaged by the incursion, and recover markets for Canada's agriculture or forest products lost as a result of the weed or pest's presence. Billions of dollars are spent each year in North America on remedial actions to mitigate the impacts of invasive alien species. Expenses include costs of preventing introductions, controlling or eradicating pest populations, and restoring habitats after control measures have been implemented. Costs attributable to invasive alien species include loss of marketability, reduction in yield of harvestable crops, and increased costs of production due to pest effects, as well as losses in property value, increased fire-fighting costs and others (TPPWG, 2004).

Canada's annual timber losses due to invasive alien species are estimated at 61 million m^3, which is equivalent to $720 million in financial losses to stumpage, royalties and rent revenues (Kremar-Nozic et al., 2000). The present-day cost of the damage caused by invasive alien species affecting forestry and agriculture has been estimated to be $7.5 billion annually (Dawson, 2002).

Invasive alien plants and plant pests can also cause major environmental damage. According to the World Conservation Union invasive alien species are second only to habitat loss as a threat to biodiversity (IUCN, 2000). They alter ecosystem functions such as hydrology and natural succession, displace and reduce populations of native species, modify habitats and hybridize with native species. Their impact on native ecosystems and species is often severe and irreversible. It has been estimated that approximately 24% of the Species at Risk in Canada may be threatened with extinction by invasive alien species (Stronen, 2002).

4.2.3 Climate Change

Climate change is likely to increase the rate of new invasions into Ontario and promote the spread of already-established species (Rahel and Olden, 2008). A warming climate will increase environmental stresses, and may result in less resilient ecosystems that are unable to combat invasive species. MNR's (2012) Strategic Plan presents specific actions that can help Ontario manage and control invasive species in the context of a changing climate. For example, monitoring, eradication and control efforts must consider not only current conditions, but also how the future climate of a region could affect the spread and management of invasive species. Similarly, risk assessments may need to include analyses of our changing climate.

4.3 What is being done?

The ultimate goal of any invasive species plan must be to minimize (and ideally eliminate) both the introduction of new alien invasive species and the spread and impact of those already present in Canada. This includes prevention of unwanted introductions, early detection of potential invaders, rapid response to prevent establishment, and management to contain alien invasive species that have already become established. The basis for a Canadian plan requires a long-term approach that recognizes the relationship between a healthy environment and a sustainable economy (DFO, 2004).

By far the most effective way of controlling invasive species is to prevent their entry into Canada in the first place. This proactive approach will avoid increasing the existing burden of controlling species that have already established themselves, the cost of which is already many millions of dollars. Prevention efforts should address imports, exports and the movement of species within Canada. Specific activities include border control, inspection, enforcement, education and communication, risk analysis, and information management (DFO, 2004).

For species that have already been introduced, the focus turns to eradication, controlling their spread, or adaptive management. While early detection is possible for some species, the lag time between introduction and establishment is often measured in years or even decades. Regardless of when a new species is discovered, the Canadian plan must be able to respond quickly. A rapid response plan assesses all aspects of the introduction, including the potential for successful eradication or control (DFO, 2004).

Once a species becomes established, the task becomes much more challenging. Damage to local ecosystems may already have occurred such that complete eradication may no longer be feasible. Any control measures must be subject to comprehensive analyses in terms of their potential harmful effects on other species or the ecosystem as a whole (DFO, 2004).

The level of intervention should correspond proportionally to the level of threat. Control measures are currently hampered by inadequate resources, lack of coordination, and the absence of suitable control tools or the authority to use them (DFO, 2004).

Any management activities intended to eliminate invasive species must include a restoration component. A damaged ecosystem will not always be able to regenerate itself to its previous state and is more susceptible to subsequent invasion. This may involve taking an active approach in terms of encouraging native species to thrive. The healthier an ecosystem is, the more capable it is of resisting invasions (DFO, 2004).

In 2011, the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada, the Canadian Forest Service and the Ministry of Natural Resources formally agreed to coordinate their efforts to deal with invasive species. A key mechanism for this coordination is the Invasive Species Centre (ISC), a not-for-profit entity established in Sault Ste. Marie by Canada and Ontario. The Invasive Species Centre is a regional centre focusing on Ontario and the Great Lakes, with linkages to adjacent provinces and Great Lakes states. Federal, provincial and local governments currently spend billions of dollars responding to invasive species outbreaks. The role of the ISC is to facilitate and improve coordination, collaboration and decision-making on invasive species issues, so available resources can be used in the most effective and efficient manner (ISC, 2013).

4.3.1 Federal and Provincial Strategic Plans

World leaders have recognized the threat posed by invasive alien species since 1992, when they agreed on the UN Convention on Biodiversity. In response, Canada developed the 1995 Canadian Biodiversity Strategy, which recognized the need to conserve biodiversity and promote the sustainable use of biological resources through increased understanding, legislation, incentives and other means. In it, the federal, provincial and territorial governments expressed a commitment to take all necessary steps to prevent the introduction of harmful alien species and eliminate or reduce their effects on ecosystems (DFO, 2004).

In September 2001, federal, provincial and territorial ministers of forests, fisheries and aquaculture, endangered species and wildlife identified invasive alien species as a priority, calling for the development of a Canadian plan to deal with the threat. Later that year, a national workshop brought together numerous stakeholders to determine the basic approach and underlying principles for the Canadian plan (DFO, 2004).

In 2004, a national strategy called the Invasive Alien Species Strategy for Canada was released. The strategy identified key goals and implementation strategies for addressing the problem. Three thematic working groups undertook the task of producing corresponding action plans in three areas: 1) Aquatic Organisms; 2) Terrestrial Plants and Plant Pests; and 3) Terrestrial Animals and Animal Diseases (MNR, 2012b).

The federal strategy provides a framework under which provincial plans can be developed. The government of Ontario has prepared a provincial level strategic plan that provides details on how Ontario will meet the goals set out in the national strategy and national action plans. It also helps to inform priorities in provincial strategies aimed at control of particular species. Other provincial documents also address invasive species such as, the proposed Ontario Government Plan to

Conserve Biodiversity 2012 and Ontario's Draft Great Lakes Strategy 2012. In addition to these, the renewed Ontario's Biodiversity Strategy, 2011 acknowledges that invasive species are a leading cause of biodiversity loss (MNR, 2012b).

4.3.2 Great Lakes

Inter-jurisdictional discussions on Great Lakes issues, including invasive species, occur in a number of ways. The International Joint Commission (IJC) provides a forum for Canada, the United States and their respective Great Lakes provinces and states to discuss concerns about water quality and quantity in the "boundary waters" – the lakes and rivers shared by Canada and the United States. The IJC has established a number of Advisory Working Groups. One of those groups has produced a report entitled "Binational Aquatic Invasive Species Rapid-response Policy Framework" (MNR, 2012b).

The Great Lakes Water Quality Agreement (GLWQA), first signed in 1972, commits Canada and the United States to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin ecosystem. It includes a number of objectives.

The Great Lakes Protection Act is proposed legislation that, if passed, aims to restore and protect the Great Lakes so they stay drinkable, swimmable, fishable, for present and future generations. Ontario's Draft Great Lakes Strategy is intended to describe how Ontario will focus a variety of tools to take action to achieve Great Lakes goals – through existing laws and programs, the Great Lakes Protection Act, 2012 (if passed), the Canada-Ontario agreement respecting the Great Lakes Basin Ecosystem (COA), and other partnerships and collaboration with many partners across Ontario and across the Great Lakes (MNR, 2012b).

The Canada-Ontario agreement respecting the Great Lakes Basin ecosystem (COA) is an agreement between the governments of Canada and Ontario to restore and protect the Great Lakes Basin ecosystem. COA is the primary mechanism through which Canada meets its obligations and commitments under the GLWQA. Reducing the threat of aquatic invasive species to the Great Lakes is a goal of the current COA (MNR, 2012b).

The Great Lakes Fishery Commission provides a binational forum for fisheries management in the lakes. Its five lake committees contribute to the development of management plans for their respective lakes. Some of these have aquatic invasive species on their agenda; some have aquatic invasive species forums (MNR, 2012b).

A variety of other committees support discussions on Great Lakes issues, including invasive species. These include the Great Lakes Fish Health Committee, the Council of Lake Committees, the Council of Great Lakes Fisheries Agencies, and the Law Enforcement Committee. The U.S. Fish and Wildlife Service, through the Great Lakes Commission (GLC), supports a Great Lakes panel on aquatic nuisance species, a forum to discuss activities (legislation, education, outreach, etc.) regarding aquatic nuisance species by Great Lakes states. Canada, Ontario and Quebec participate on this panel (MNR, 2012b).

Finally, Ontario also works with the federal government through forums such as the Canada-Ontario Fisheries Advisory Board and national bodies such as the Canadian Council of Fisheries and Aquaculture Ministers to address aquatic invasive species issues (MNR, 2012b).

4.3.3 Education to Change Public Attitudes and Behaviours

Since 1992, MNR has partnered with the OFAH to deliver the province-wide Invading Species Awareness Program, focusing on education and outreach, and programs designed to monitor the occurrence and distribution of invasive species. One of the program's key activities is to communicate to anglers the importance of not dumping bait into lakes and rivers. MNR and OFAH have conducted angler surveys every five years since the program was initiated, to determine whether it is having the desired impact. The results of the 2009 survey demonstrated a decline in the number of anglers that dump their bait and an increase in the number of boaters that clean their boat and equipment (MNR, 2012b).

4.3.4 Aquatic Invasive Species

The process of minimizing the effects of invasive species begins with understanding how they get into Canadian waters in the first place and how they spread once they are introduced. DFO's (2004) report on aquatic invasive species identifies and describes the main pathways: shipping, recreational and commercial boating, the use of live bait, the aquarium/water garden trade, live food fish, unauthorized introductions and transfers, and canals and water diversions. Developing a clear picture of the seven key pathways for introduction or spread provides the necessary information for taking effective action. While the seven pathways have been identified as primary sources for the introduction and spread of aquatic invasive species, the report notes that new pathways could be identified in the future, as a result of changing trade patterns or public interest. Readers are referred to DFO's report (listed in Section 4.6) for further information about each pathway.

Ballast water has long been known to be one of the main sources for the introduction and spread of aquatic invasive species in the Great Lakes and St. Lawrence River. In response, Canada and the United States have put in place stringent regulations governing ocean-going vessels and their ballast water. The 2006 regulations enacted by Transport Canada, and the 2008 regulations enacted by the St. Lawrence Seaway Development corporation, require ocean-going vessels to flush their tanks with salt water before entering the St. Lawrence Seaway and the Great Lakes. All vessels entering the seaway are checked through a joint U.S./Canadian inspection program and compliance rates in 2009 were recorded at 97.9% (Great Lakes Ballast Water Working Group, 2010). Any non-compliant vessels are dealt with on a case-by-case basis to ensure that unmanaged foreign ballast water is not released in the Great Lakes. Collectively, the Canadian and U.S. St. Lawrence Seaway regulations, along with monitoring, have significantly reduced the risk of aquatic invasive species entering via ship ballast tanks. If these regulations had been enacted earlier, they might have prevented many aquatic invasive species from entering the Great Lakes basin (MNR, 2012b).

4.3.5 Invasive Plants and Plant Pests

Pathways analysis is the first step in preventing the introduction of invasive alien species, and involves identifying the main pathways that facilitate their movement and dispersal. Studies in the United States and Australia, for example, have shown that most of their invasive plants were originally introduced intentionally, for ornamental or agricultural purposes. Literature on invasive plants introduced in Canada confirms the intentional introduction of plants for agricultural, ornamental or medicinal uses as one source of invasive alien species (Claudi et al., 2002). By contrast, plant pests are seldom intentionally introduced, but instead arrive as contaminants in commodity shipments or hitchhikers on vehicles and shipping containers. Weeds may also be introduced unintentionally, for example as contaminants of seed imported for planting. Pathways analysis is the tool used to identify and assess the different means by which species may be introduced to new areas and the relative likelihood of successful establishment occurring as a result. This allows subsequent pest risk assessments, research, and policy development to focus on priority high-risk pathways (TPPWG, 2004).

A comprehensive pathways analysis has not yet been conducted for invasive alien plants and plant pests in Canada. A preliminary pathways analysis conducted by the CFIA provides a broad overview of the main pathways of entry for plants and plant pests. The most significant pathway categories identified are: 1) live plants and plant parts; 2) viable seed; and 3) wood and forest products. These are primary pathways through which invasive plants or plant pests may be intentionally (though inadvertently) introduced and through which other plant pests may be accidentally introduced as contaminants. Other pathways by which invasive alien species may be introduced include tissue culture propagules such as potato micro-propagated plantlets and minitubers, and pathogen cultures imported for research, teaching or industrial purposes. Readers are referred to TPPWG's (2004) report for further information about each pathway.

4.4 Invasive Species in Ontario

Ontario has a higher risk of new invasive species entering and becoming established, compared to other regions in Canada. Historical data shows that Ontario has had more non-native species establish within its borders than other provinces and territories. Compared to other provinces, Ontario has the highest number of invasive plant species, with 441. This can be compared to Quebec, with 395; and British Columbia, with 368. The lowest numbers are in Nunavut, with 16 species (CFIA, 2008). Ontario also has the most non-native freshwater fish, with 26 known species. This is approximately twice as many as in each of the Maritimes, Québec, Alberta and Manitoba, and one and a half times as many as in British Columbia (Mills et al., 2000).

Ontario has been and will continue to be susceptible to invasive species arriving and surviving due to the favourable environmental conditions and nature of our society (industrialized, urbanized, locally and globally mobile, and high population density), our economy (large quantities of imports, significant goods-producing industry sector), our geographic location (proximity to a major international shipping channel, the Great Lakes St. Lawrence Seaway, and multiple land and water

entry points on Ontario's borders), and the degraded habitat and ecosystems in many of Ontario's ecological regions. Ontario imports more goods, from more places in the world, than any other province or territory, and ships many goods onward to other parts of Canada. This economic activity brings both benefits and risks. More trade increases the chances of invasive species arriving inadvertently, for example in packaging, in containers on ships, or in ballast water. In fact, approximately 64% of the overseas containers that arrive in Canada are opened in the Ontario portion of the Great Lakes basin (MNR, 2012b).

There are a number of invasive alien species that are of concern to Ontario. This list includes species that are present in the province, as well as those that are at risk of being introduced. These invasive species pose a threat to Ontario's environment, economy and/or society. For more information about invasive alien species, please visit the following links:

- Terrestrial Invasive Species: www.mnr.gov.on.ca/en/Business/Biodiversity/2ColumnSubPage/STDPROD_068690.html
- Aquatic Invasive Species: www.mnr.gov.on.ca/en/Business/Biodiversity/2ColumnSubPage/STDPROD_068689.html

A selection of invasive alien species of concern to Georgian Bay is summarized below. To determine what invasive species are present in your region look at the distribution maps, prepared by the Ontario Invading Species Awareness Program, online:

- www.invadingspecies.com/resources/distribution-maps/

4.4.1 Zebra and Quagga Mussels

Since first being discovered in Lake St. Clair in the mid-1980s, the zebra mussel has become one of the most notorious invaders of Canadian waters. Originally from the Black and Caspian Sea area, it has spread throughout the Great Lakes and beyond. Zebra and quagga mussels both arrived in the ballast of ocean-going ships (DFO, 2004).

Significant changes to aquatic ecosystems have been documented as a result of the introduction of zebra and quagga mussels (as discussed in Section 2.1.3). These mussels filter out large amounts of phytoplankton. This filtering causes the water to become clearer allowing more sunlight to penetrate the water column. Changes in weed growth patterns occur and force some fish, such as walleye that are light sensitive, to find new habitat. In addition, when these mussels die and decompose, they add nutrients to the nearshore areas and this can cause nuisance algae blooms. These ecosystem alterations have caused problems for those who live in the coastal communities as well as industries and businesses that depend on these ecosystems (MNR, 2012b).

Zebra and quagga mussels also directly threaten native mussels by colonizing their shells and smothering them. The impacts are particularly pronounced in the lower Great Lakes. Zebra and quagga mussels have virtually eliminated native mussels from Lake Erie, Lake St. Clair, and the Detroit River, leaving only small populations in a few refuges (MNR, 2012b).

In addition to habitat changes and threats to native species, these invaders cause significant damage to human infrastructure by fouling water intake pipes or attaching themselves to other structures. Although there are ongoing efforts to find a mechanism to control zebra mussels, it is unlikely that this species will be completely eradicated from Ontario's waters due to its wide distribution. The zebra mussel invasion has had serious economic consequences:

- The total impact of Zebra Mussels in Ontario is estimated to be between $75–91 million per year (Marbek, 2010).
- The city of Windsor has spent between $400,000 to $450,000 per year for activated charcoal treatment to eliminate taste and odour problems from municipal water supplies after Zebra Mussels invaded lake St. Clair, upstream of the city's water intake line (Colautti et al., 2006).
- Zebra Mussels have cost Ontario power producers $6.4 million per year in increased control/operating costs and about $1 million per year in research costs (Colautti et al., 2006).

4.4.2 Sea Lamprey

Sea lamprey are considered a significant factor in the collapse of the lake trout and whitefish fisheries in the mid-1940s and 50s (as discussed in Section 2.2.6). Prior to sea lamprey entering the Great Lakes, Canada and the US harvested close to 6.8 million kgs (15 million lbs) of lake trout in Lakes Huron and Superior each year. By the early 1960s the annual catch was about 136,077 kgs (300,000 lbs), a significant 98% decrease. The sea lamprey control program, implemented in 1955, has successfully resulted in reducing sea lamprey populations by 90%. The combined average annual investment by Canada and the US in the sea lamprey control program is $22 million. Although this program has led to increased employment and growth in commercial fish stocks, the ongoing expense underscores the fact that the cost of prevention is far less than the cost of control and mitigation. If sea lamprey had been prevented from entering Canadian waters in the early 20th century, these annual, continuing costs would never have materialised. The combined economic value (in Canada and the US) of recreational and commercial fishing on the Great Lakes is currently estimated at about $4.5 billion (DFO, 2004).

4.4.3 Round Goby

The round goby is a small, bottom-dwelling invasive fish. Native to the Black and Caspian seas in eastern Europe, it was first found in North America in 1990 in the St. Clair River north of Windsor, Ontario. Researchers believe the fish was brought to North America in the ballast water of ships from Europe. In less than a decade the round goby has successfully spread through all five Great Lakes and has begun to invade inland waters. In some areas the fish has reached densities of more than 100 fish per square metre (MNR, 2012d).

Impacts of Round Goby (MNR, 2012d):

- The fish compete with and prey on native bottom-dwelling fish such as mottled sculpin (*Cottus bairdii*) and logperch (*Percina caprodes*). Round goby also threaten several species at

risk in the Great Lakes Basin, including the northern madtom (*Noturus stigmosus*), the eastern sand darter (*Ammocrypta pellucida*), and several species of freshwater mussels.

- Round goby have reduced populations of sport fish by eating their eggs and young, and competing for food sources.
- Researchers believe the round goby is linked to outbreaks of botulism type E in Great Lakes fish and fish-eating birds. The disease is caused by a toxin that may be passed from zebra mussels, to goby, to birds, resulting in large die-offs of fish and birds.

4.4.4 Asian Carps

Asian carps were brought from Asia to North America in the 1960s and 70s. Since then they have migrated north through U.S. waterways towards the Great Lakes. Preventing Asian carps from spreading into the Great Lakes is the best way to prevent harm to Ontario's native fish species (MNR, 2011).

Asian carps prefer cool to moderate water temperatures, like those found near the shores of the Great Lakes. The Department of Fisheries and Oceans in collaboration with U.S. authorities, has recently completed a risk assessment affirming that all five Great Lakes are hospitable to Asian carp and that, if established, they will likely disrupt the native fishery, alter the ecosystem and create another food web. If Asian carps become established in Ontario waters, they would likely eat the food supply that our native fish depend on and crowd them out of their habitat. The decline of native fish species could damage sport and commercial fishing in Ontario, which brings millions of dollars a year into the province's economy (MNR, 2011).

The term "Asian carps" includes four species: Bighead, Silver, Grass and Black carp. Bighead carp and Silver carp are the species that have spread the most aggressively and can be considered one of the greatest threats to the Great Lakes. Silver carp are a hazard for boaters. The vibration of boat propellers can make Silver carp jump up to three metres out of the water. Boaters and water-skiers in areas of the Mississippi and Illinois rivers have been seriously injured by jumping fish (MNR, 2011).

In 2012, DNA from Asian carp species was found in the waters of Lake Erie. Environmental DNA extracted from water samples can be used to determine if a target species has been in the vicinity. The discovery was made by researchers with Notre Dame University's Environmental Change Initiative in Indiana. Genetic material was discovered at two locations: at the mouth of Maumee Bay in Michigan, and in Sandusky Bay in Ohio. The source of the DNA is unknown; it could have come from a live or dead fish, from the digestive system of a bird, or a rotting fish. Following this discovery (of the DNA), MNR conducted sampling on the Canadian side of the lake and the results were negative (no DNA of Asian carp was found) (Raveena, 2013).

In May 2013, an angler caught a grass carp (weighing 18.5 kg) close to the mouth of the Grand River, near Lake Erie. Lab tests revealed that the fish was sterile. According to Fisheries and Oceans Canada, several U.S. states allow the stocking of grass carp in order to control aquatic plants. The

states also require the fish to be sterilized in order to prevent them from reproducing (CBC News, 2013).

Asian carps (Silver carp, Bighead carp, Grass carp, and Black carp) (MNR, 2011):

- Are successful invaders that have replaced native species in areas of the Mississippi River and its tributaries
- Make up more than 50 per cent of the fish by weight in some parts of the Illinois River
- Can grow more than 25 centimetres in their first year
- Typically weigh two to four kilograms, but can weigh up to 40 kilograms and reach more than a metre in length
- Can eat up to 20 per cent of their body weight in plankton each day
- Reproduce rapidly.

In May 2012, the federal government announced that it would allocate $17.5 million over the next five years to address prevention, early warning, rapid response, and management and control of this invasive species. In August 2012, MRN and the federal government announced they are joining the U.S. Asian Carp Regional Coordinating Committee, which brings together U.S. federal, state and local agencies to coordinate short-term action to stop Asian carp from migrating into the Great Lakes. Despite this progress, several organizations and agencies are concerned about the possibility of Asian carp entering the Great Lakes via the Chicago sanitary and ship canal. The Great Lakes Commission and Great Lakes-St. Lawrence Cities Initiative issued recommendations last January regarding the permanent separation of the Mississippi and Great Lakes basins. The propose creating this separation by upgrading the sewage, flood control and waterborne transportation infrastructure in the Chicago area. The estimated cost for this separation solution is between $3.2 and $9.5 billion. The proposal notes that the long-term benefits outweigh these initial costs; by preventing the migration of invasive species, there will be significant long-term savings in improved water quality, strengthened flood protection, and modernized shipping facilities. For example, approximately $500 million is spent annually to address zebra mussels (GBF, 2012).

4.4.5 Spiny and Fishhook Waterfleas

Spiny and fishhook waterfleas are small aquatic predators native to Eurasia. The first reports of spiny and fishhook waterfleas in North America were both in Lake Ontario – spiny waterflea in 1982 and fishhook waterflea in 1998. Both species were introduced to the Great Lakes in ballast water from ocean-going ships (MNR, 2012e).

Both waterfleas are species of zooplankton – small animals that rely on water currents and wind to move long distances. Spiny and fishhook Waterfleas prefer large, deep, clear lakes, but can also be found in shallower waters. Spiny waterfleas move to deeper, cooler waters during the day and swim towards the water surface at night to feed, while fishhook waterfleas stay near the surface (MNR, 2012e).

Impacts of spiny and fishhook waterfleas (MNR, 2012e):

- Researchers believe that spiny waterfleas are the greatest threat to the biodiversity and structure of native zooplankton communities on the Canadian Shield since acid rain.
- Because their main diet is zooplankton, they reduce food supplies for small fish and the young of sport fish such as bass, walleye and yellow perch.
- A few animals can quickly multiply into a large population.
- They are easily spread between waterbodies on angling equipment and bait buckets, and in live wells and bilge waters.
- Spiny waterflea introductions result in an average 30 to 40 per cent decline in native populations of zooplankton.
- Spiny and fishhook Waterfleas can affect recreational angling and commercial fishing. Their tail spines catch on fishing equipment, making it difficult to reel in lines, and clogging commercial nets and trawl lines.

4.4.6 Giant Hogweed

A large perennial native to the Caucasus Mountains in southwest Asia, giant hogweed has been widely introduced in Europe and North America as a garden curiosity. Present in Canada since at least the 1940's but currently expanding its range, it has spread widely and become a problematic weed in Ontario and B.C., and has recently been reported in Quebec, New Brunswick, Nova Scotia and Newfoundland. A serious weed that can out-compete native plant species, giant hogweed is difficult to control; in part because it produces a sap increases the sensitivity of the skin to sunlight. Contact with the sap can cause severe burns that blister and scar and sensitivity to sunlight may continue for years (MNR, Date unknown b).

4.4.7 Eurasian Water Milfoil

Eurasian water-milfoil is an invasive aquatic plant native to Europe, Asia and northern Africa. Introduced to North America in the 19th century, it is now one of the most widely distributed invasive aquatic plants on the continent. It may have been introduced through the aquarium trade or the ballast water of ships (MNR, Date unknown a).

Eurasian water-milfoil prefers shallow water one to three metres deep, but can root in up to 10 metres of water. A fast-growing perennial, it forms dense underwater mats that shade other aquatic plants. When large stands begin to die off in the fall, the decaying plants can reduce oxygen levels in the water (MNR, Date unknown a).

Impacts of Eurasian water milfoil (MNR, 2012b):

- The plant reduces biodiversity by competing aggressively with native plants.
- Reduced oxygen levels in the water caused by decomposing plants can kill fish.
- Thick mats of Eurasian water-milfoil can hinder recreational activities such as swimming, boating, and fishing.

- Dense stands can create stagnant water, which is ideal habitat for mosquitoes.
- Invasive species can also have an economic impact on individual landowners. A recent study shows that property values were depressed by as much as 16.4% for shoreline residences in Vermont affected with Eurasian water milfoil.

4.4.8 Phragmites

Invasive phragmites is an aggressive plant that spreads quickly and out-competes native species for water and nutrients. It releases toxins from its roots into the soil to hinder the growth of and kill surrounding plants. While it prefers areas of standing water, its roots can grow to extreme lengths, allowing it to survive in relatively dry areas (MNR, Date unknown c). Invasive Phragmites (MNR, Date unknown c):

- Crowds out native vegetation, thus resulting in decreased plant biodiversity.
- Generally provides poor habitat and food supplies for wildlife, including several Species at Risk.
- Grows very quickly thereby causing lower water levels as water is transpired faster than it would be with native vegetation.
- Increases fire hazards as stands are composed of a high percentage of dead stalks.
- Can affect agriculture, cause road safety hazard and impact recreational activities such as swimming, boating and angling.

Invasive phragmites has resulted in significant habitat losses for several species of wetland-dependent wildlife. Without effective control programs, declines are expected to continue to occur at an exponential rate (Bolton and Brooks, 2010).

MNR has been involved in invasive phragmites control pilot projects since 2007. This work focuses on the investigation of effective and efficient control options within sensitive coastal habitats such as wetlands and dunes. Projects are ongoing and some progress has been made within small, targeted, dry sites. Work to date demonstrates that control costs range between $865 and $1,112 per hectare (Gilbert et al., 2009a, Gilbert et al., 2009b).

4.4.9 Japanese Knotweed

Japanese Knotweed is an aggressive semi-woody perennial plant that is native to eastern Asia. In the 1800's it was introduced to North America as an ornamental species and also planted for erosion control. It has since spread throughout the United States and Canada (Ontario's Invading Species Awareness Program, Date unknown).

Japanese Knotweed is often mistaken for bamboo; however it is easily distinguished by its broad leaves and its ability to survive Ontario winters. Japanese Knotweed is especially persistent due to its vigorous root system, which can spread nearly 10 metres from the parent stem and grow through concrete and asphalt. This invader is very persistent and once it becomes established, is incredibly difficult to control (Ontario's Invading Species Awareness Program, Date unknown).

Impacts of Japanese Knotweed (Ontario's Invading Species Awareness Program, Date unknown):

- Spreads quickly, creating dense thickets that degrade wildlife habitats.
- Reduces plant biodiversity by competing with other native vegetation. Thick layers of decomposing stems and leaves on the ground make it difficult for native plant species to establish.
- Aggressive plant with a strong root system that has been known to break through asphalt and concrete.
- Plant populations are extremely persistent. Plants are able to survive severe floods and re-colonize areas.
- It can establish along riverbanks, where pieces of roots can break off and float downstream to start new populations.

4.4.10 Purple Loosestrife

Purple loosestrife arrived in Canada in the early 19th century. It is considered invasive as it forms dense monocultural stands over very large areas, threatening wetland habitat and communities. In 1992 the Canadian and U.S. governments approved the release of leaf-feeding beetles, galerucella calmariensis and g. pusilla, to control this invasive plant. Although purple loosestrife will never be eradicated, these insects have been effective in reducing loosestrife populations and enabling native vegetation to become re-established. Despite this successful control program, purple loosestrife is still considered invasive (MNR, 2012c).

4.4.11 Asian Long-horned Beetle

The Asian long-horned beetle is a forest pest native to several Asian countries that attacks and kills a wide range of hardwood trees. This invasive insect was found in an industrial park bordering Toronto and the city of Vaughan in 2003. Upon discovery of the beetle, the CFIA immediately initiated efforts to eradicate the insect, in partnership with several other agencies (MNR, 2010a).

- The majority of Canadian broadleaf trees are at risk from the Asian long-horned beetle, including all species of maple.
- They do not attack conifers.
- Canada 's temperate climate is well suited for the establishment of the insect as the larva spends winters deep within the wood protected from harsh winter conditions.
- The beetle has no known natural enemies within Canada's forests.
- Insecticides do not protect infested trees and only kill some beetles when applied to uninfested trees before attack.
- The only way to combat the beetle is to identify, cut down, and burn or chip the infested tree.
- Infested trees are also prone to secondary attack from other insects and diseases.
- The estimated potential economic impact to Canada is $9 billion in wood products and $100M in maple syrup products annually.

The CFIA lists certain areas as 'regulated' in order to slow the spread of the emerald ash borer. As of May 2013, there are two regulated areas in Ontario; Bruce County and Frontenac County. The movement of all ash tree materials and all firewood out of the regulated areas will be restricted. Updates to regulated areas are provided at this website:

- http://www.inspection.gc.ca/plants/plant-protection/insects/emerald-ash-borer/latest-information/eng/1337287614593/1337287715022?utm_source=FOCA+Elert+May+2013&utm_campaign=FOCA+Elert+16May2013&utm_medium=email

4.4.12 Emerald Ash Borer

Emerald Ash Borer is a highly destructive insect pest of ash trees Native to Asia, it was accidentally introduced to North America on imported wood packaging or crating material. Little information was known about the beetle at the time. Despite substantial research and control efforts, the beetle has continued to spread to new areas. Some of this spread has been natural dispersal, but the long distance spread has been helped by people, especially through the movement of nursery stock or infested firewood from infested areas (MNR, 2010b).

- The emerald ash borer is able to attack and kill healthy trees.
- All native ash species are at risk.
- Ash trees of all sizes are susceptible to attack, from 5 cm DBH (diameter at breast height) to 90 cm DBH or greater. Larvae have been found in branches as small as 1.1 cm in diameter.
- Ash trees are widespread in Canada and the United States, both in natural and urban settings, and green ash is one of the most commonly planted species in the urban forest.

It poses a major economic and environmental threat to urban and forested areas of Canada and the U.S containing ash trees. During the short time that it has been in North America, the emerald ash borer has killed over one million trees in southwestern Ontario. The City of Toronto estimates it will cost $37 million over five years to cut and replace the city-owned trees that are killed by the emerald ash Borer (MNR, 2012b). The Canadian Food inspection Agency has spent over $30 million and cut over 130,000 trees to slow the spread of the beetle (MNR, 2012c).

4.4.13 Pine Shoot Beetle

The pine shoot beetle is native to Europe, North Africa and Asia. It was first found in Ohio in 1992. Subsequent surveys since then have found the insect in 26 counties in southern Ontario, several locations in Quebec and over 180 counties across 8 states in the northeastern United States. Although the pine shoot beetle was first found in Ontario in 1992, it has probably been present for 10 or more years (MNR, 2010d).

Originally the pine shoot beetle was thought to be mostly a benign pest, causing limited damage to pines, primarily Scots pine. In 1998 the situation changed in Ontario; the pine shoot beetle was found to be attacking Scots pine and native pines in high numbers, resulting in tree mortality in several stands. Like many other introduced organisms it is thought to have arrived in North America

through imports shipped using wooden crates, wooden pallets, or with logs used to brace loads (MNR, 2010d).

- This pest attacks both healthy and stressed trees.
- All native pines in Ontario are at risk, as well as Austrian, Scots and Mugo pines.
- Some current harvesting practices provide an excellent environment for this pest to reproduce.
- No practical insecticide treatment exists.
- The beetle attacks trees in 2 ways:
    - Adults attack 1-3 year old healthy shoots by tunneling in the pith towards the tip, resulting in shoot death.
    - Adults bore under the bark of the main stem of the tree, construct a brood chamber, mate and lay eggs. Developing larvae then feed on the cambium resulting in tree death by girdling.

4.4.14 Beech Bark Disease

Beech bark disease is currently spreading along eastern Georgian Bay, with recent outbreaks occurring in Killbear Provincial Park and Wasausking. The disease results from the combined action of the beech scale insect and a pathogenic fungus, Nectria coccinea. Most affected beech end up succumbing to the disease, either directly or as a result of being attacked by other pathogens. The beech scale insect is part of the scale family. In mid-summer, the female deposits her eggs (asexual reproduction) in the bark fissures. The larva hatches and stays in the same place or migrates to other cracks. In fall, the nymph becomes stationary again and secretes a woolly envelope. This woolly envelope makes the tree look like it is covered with snow. The scale insect over winters in the bark of the tree. The fungal spores are disseminated by rain splash or by the wind and penetrate into the tree through wounds created by the scale insect. The fungus first causes a depression in the bark of the affected region and cankerous blisters of various sizes also form. On severely affected trees, there are so many cankers that they end up merging. Tree mortality is often caused by other pathogens, such as Hypoxylon fungi, for example, or other insects (Forest Invasive Alien Species, 2011).

4.4.15 White Nose Syndrome

The condition has been dubbed "white nose syndrome" because some affected bats have visible rings of white fungus around their faces. The cause of the syndrome is believed to be *Geomyces destructans*, a fungus that grows in the skin of the bat, producing a white, fuzzy appearance on the muzzle, wings and ears. Infected bats emerge from torpor (the state of low physical activity characteristic of hibernating animals) more frequently than normal during winter hibernation, exhausting their energy reserves before food becomes available in the spring (MNR, 2012f).

White nose syndrome has killed more than five million bats in the northeastern U.S. It was first identified in a cave near Albany, New York, in 2006. Cases have also been found in more than a

dozen American states as well as Quebec, New Brunswick and Nova Scotia. In March 2010, white nose syndrome was confirmed for the first time in Ontario (MNR, 2012f).

The ministry is concerned about the potential impact of white nose syndrome on Ontario's bat populations. Although the condition is not well understood, it is believed that human activity in caves is contributing to its spread. Therefore, the public is urged to refrain from entering non-commercial caves and abandoned mines where bats may be present. The public is also urged to refrain from entering any caves or abandoned mines in the United States or Canada where white nose syndrome has been identified (MNR, 2012f).

4.5 What can I do to help?

4.5.1 Aquatic invasive species

Here are a few ways you can help stop the spread of invasive species in Ontario:

- Inspect your boat, trailer and equipment after each use. Remove all plants, animals and mud before moving to a new waterbody.
- Drain water from your motor, live well, bilge and transom wells while on land.
- Rinse all recreational equipment with high pressure (>250 psi) or hot (50°C / 122°F) water OR let it dry in the sun for at least five days.
- Don't release any live fish into Ontario lakes, rivers or streams.
- Don't import live fish into Ontario.
- Learn how to identify invasive aquatic species and how to prevent the spread of these unwanted species. If you've seen an Asian carp or other invasive species in the wild please contact the toll free Invading Species Hotline at 1-800-563-7711.
- Never buy or use round goby as bait. It is against the law to use round goby as bait or to have a live round goby in your possession.
- If you catch a fish with a sea lamprey attached, do not return the sea lamprey to the water. Kill it and put it in the garbage.
- Don't help sea lampreys pass over dams and culverts that block their spawning migration.
- Have a fish pet that is no longer wanted? Don't release it into the wild and don't flush dead fish down the toilet. Put them in the garbage or compost.

4.5.2 Invasive plants and plant pests

- Gardeners should use only native plants and are encouraged to ask garden centres for plants that are not invasive. For helpful suggestions see:
  - www.invadingspecies.com/download/publications/brochures/Northern%20Grow%20me%20Instead%20ENG.pdf
  - www.evergreen.ca
- Learn how to properly identify invasive plants, such as Japanese knotweed, and how to effectively manage invasive plants on your property.

  - www.invadingspecies.com/download/publications/Guides/Landowners%20Guide%20to%20Controlling%20Invasive%20Woodland%20Plants.pdf
  - www.invadingspecies.com/download/publications/Guides/Quick%20Reference%20guide%20to%20Invasive%20plant%20species.pdf
- Already have an invasive species on your property? To learn about what to do if you find an invasive species on your property, read the species fact sheets available online:
  - www.ontario.ca/invasivespecies
- Do not dispose of invasive plants in the compost pile – discard them in the regular garbage or check with your municipality for disposal information.
- When hiking, prevent the spread of invasive plants and seeds by staying on trails and keeping pets on a leash.
- Going camping? Don't transport firewood. Buy it locally; leave what you don't use there.
- Learn how to identify Phragmites or common reed grass, and if found, follow the Best Management Practices to remove it:
  - www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@biodiversity/documents/document/stdprod_089643.pdf

4.6 Resources and Further Reading

1. Ontario's Invading Species Program
   - www.invadingspecies.com
2. Ontario Invasive Plant Council
   - www.ontarioinvasiveplants.ca
   - www.youtube.com/user/Oninvasives
3. Invasive Species Centre
   - www.invasivespeciescentre.ca
4. Government of Ontario
   - www.ontario.ca/invasivespecies
5. DFO's (2004) report on Aquatic Invasive Species
   - www.dfo-mpo.gc.ca/science/enviro/ais-eae/plan/plan-eng.htm