

Background Materials

All About Invasives:

Ontario's aquatic habitats are world renowned for their beauty and abundance. Significant to our way of life, the plant and animal communities within these habitats are being harmed by invasive species.

What makes a species invasive?

Think about the last 5 birds you've seen. Was a house sparrow or starling among them? Both of these species were brought across the Atlantic Ocean and released in Central Park in New York City so North Americans could experience birds that were featured in Shakespeare's plays!

There are numerous species, not native to North America, living in the habitats around us. Humans have introduced many of these species. Problems arise when these new species take away habitat and food from native species, the original inhabitants. These species are referred to as invasive. Their introduction or spread threatens aspects of the environment, the economy, and society, including human health. Invasive species can originate from other continents, neighbouring countries, or from other ecosystems within Canada.

Aquatic invasive species are seriously impacting the lakes and rivers of Ontario, harming native fish, invertebrate and plant populations. Some of these creatures are voracious predators, capable of destroying aquatic habitats and out competing native fish or invertebrate species for food and shelter. Others are aggressive plants that can form dense mats of growth, displacing native species. When they die they remove dissolved oxygen from aquatic habitats impacting fish and other species and may foster the growth of bacteria.

Invasive species impact our native species and habitats because they:

- Have few natural enemies or predators!
- Out compete native species for food and habitat!
 - Reproduce quickly and often!
 - Can adapt to many conditions!
- Are able to migrate (and therefore spread) easily!
- Are generalists; they can eat a variety of foods and live in a variety of habitats!
- Often have a "special feature", for example they can defend themselves well or tolerate extreme conditions!
- Are aggressive predators or experience little competition from other species!

A Sampling of Invasive Species

EURASIAN RUFFE (*Gymnocephalus cernuus*)

Eurasian ruffe (rhymes with “tough”) are small fish, native to Europe. They were first brought to the Great Lakes in the ballast water of ships. Ruffe eat a variety of foods, including fish eggs. Their small size, hard spikes and the fact they spend their nights in shallow water feeding, and their days swimming safely in deep water, ensures that they can avoid predation better than native fish.

EUROPEAN FROG-BIT (*Hydrocharis morsus-ranae*)

European frog-bit looks like a miniature water lily with a small white flower. It is originally from Europe and Asia. This plant lives in calm waters. Frog-bit reproduces both sexually and asexually at rates faster than native species and grows quickly. It floats on the water’s surface, blocking sunlight and creating poor conditions for native plants growing beneath it.

FANWORT (*Cabomba caroliniana*)

Fanwort is a subtropical, submersed South American plant commonly sold for use in aquariums. Released into the wild, fanwort can establish itself in lakes, ponds and slow flowing water. It spreads when its broken stem fragments continue to grow, becoming a new plant. Fanwort can form dense mats, crowding out native plants, clogging drainage canals and areas where there is still water. It can make swimming and boating difficult and may impact fisheries.

GOLDFISH, KOI AND CARP SPECIES

(*Carassius spp.*, *Cyprinus spp.*)

Goldfish and koi are popular and beautiful aquarium fish. These and other carp species have the potential to become quite destructive to Ontario’s lakes and rivers. This is due to the fact that they can grow and reproduce quickly and in the process consume large quantities of aquatic vegetation that native species may depend on for food, shelter, laying eggs and protecting their young.

PURPLE LOOSTRIFE (*Lythrum salicaria*)

Purple loosestrife is a plant with a bright purple flower spike that contains many small purple flowers. It can grow to be over 1 m tall. Purple loosestrife reproduces prolifically. Its flowers produce millions of seeds each year that are blown in the wind and carried on water to new locations. The plant can also reproduce when its roots

are split apart and from plant fragments. Loosestrife takes over wetland habitats limiting biodiversity and sources of food and habitat for native species. This is a huge problem, as wetlands are the most biologically diverse productive components of our ecosystem.

ROUND GOBY (*Neogobius melanostomus*)

Originally from Europe, round gobies were brought to Ontario in the ballast water of ships. These 25 cm long fish are grey/brown and have a bottom fin in the shape of a suction cup – this allows them to sit on the bottom of streams and rivers. Round gobies are able to reproduce up to six times each year whereas native fish spawn only once. Round goby feed heavily on the eggs and fry of native fish including bass, lake trout and yellow perch.

RUSTY CRAYFISH (*Orconectes rusticus*)

Rusty crayfish are native to the Ohio-Tennessee River basin in the United States. These crayfish have larger, stronger claws and are more aggressive than other crayfish. This aggressive behaviour forces native crayfish from their hiding places thus making them more vulnerable to predation. The rusty crayfish also eats 2-3 times as much as our native crayfish. By eating large amounts of bottom-dwelling organisms, fish eggs and fry, they compete directly with young fish. They also eat aquatic plants in significant quantities, limiting nursery habitat and shelter for young and small fish. The main way rusty crayfish have spread is by accidental release into the wild – from anglers’ bait buckets and hobbyists’ aquariums.

SEA LAMPREY (*Petromyzon marinus*)

The sea lamprey is a long, jawless, fish without scales that resembles an eel. They have horn-shaped teeth set in a disk-shaped mouth which they use to attach themselves to the sides of fish. They then eat away the fishes’ skin and scales to feed on its blood and body fluids. This either kills the fish or leaves them with serious wounds that are susceptible to parasites and disease. Originating in the Atlantic ocean, sea lamprey were prevented from entering the Great Lakes by physical barriers such as waterfalls. Shipping canals built at the turn of the century

allowed sea lamprey to expand their range into all of the Great Lakes.

SPINY WATER FLEA (*Bythotrephes longimanus*)

Spiny water fleas are tiny crustaceans (the size of your baby fingernail) with a large black eye. They are voracious predators feeding on other crustaceans, often eating two to three times more food than native species. By eating this much, they limit food for native zooplankton and fish. The spiny water flea, as its name suggests, has a long tail spine with barbs on it. The barbs make it difficult for young fish and fry to swallow – they literally cough them up – further limiting feeding opportunities for local fish. The spiny water flea can hitchhike to other waters on boats, boat trailers and other equipment such as fishing gear and snorkelling/scuba gear. They were originally brought to the Great Lakes in the ballast water of foreign ships. The **FISHHOOK WATER FLEA** (*Cercopagis pengoi*), is similar to the spiny water flea but is smaller with a loop or hook at the end of its tail. Their impact is similar.

ZEBRA MUSSEL (*Dreissena polymorpha*)

Zebra mussels and the related QUAGGA MUSSEL

(*Dreissena bugensis*) are small crustaceans with a yellow, brown and cream-striped shell. Female zebra mussels produce over one million eggs each season, which spread throughout water systems by floating on currents and being inadvertently transferred by people and their boats. Zebra mussels prefer warmer, shallower waters while quagga mussels can also live in colder, deeper waters, therefore inhabiting all areas of a waterbody. Both mussels eat by filtering phytoplankton (tiny plants) out of the water. Zooplankton (the primary food of young fish) also eats these plants. This competition with the mussels for food can have impacts throughout the food chain. Removal of large volumes of phytoplankton causes lake water to become clearer. This changes the lake habitat by enabling sunlight to penetrate further down and encourage weed growth and force fish like walleye to deeper and darker water. They also attach themselves to hard surfaces such as clamshells, crayfish, boat hulls, docks, buoys, etc. and can clog water pipes. They can hurt swimmers feet and infect predators with the contaminants they can carry. They were introduced to the Great Lakes by foreign ships dumping their ballast water.

There are over 180 different exotic species in the Great Lakes Basin!

Sea lamprey has long been considered a delicacy in Europe.

It is said that King Henry I of England, in a fit of royal gluttony, died from a “surfeit of lamprey”!

The round goby has a well-developed sensory system that helpsthem detect water movement.

This allows them to feed in complete darkness, giving them an advantage over other fish!

The Eurasian ruffe’s ability to “see” its prey is not through its eyesight but rather through a sophisticated system of bone canals that contain sensory organs called “neuromatsts”. The Neuromasts can detect vibrations from both prey and predators. This ability allows the ruffe to seek darker waters, thus avoiding predators.

There are some lakes where the rusty crayfish is so prolific that they cover the bottom of the beach.

Being very aggressive, they will hold their claws up in such a menacing way that swimmers are afraid to swim for fear of stepping on them and getting pinched!

It’s costing millions of dollars a year to try to control invasive species and repair the damage they have caused to Ontario habitats!

**Big Stats
and Interesting
Facts!**

How Do They Get Here?

Aquatic invasive species can spread readily... we're the one's who inadvertently help them! Below are the main ways these wily critters currently make their way into the aquatic habitats of Ontario:

1. AQUARIUMS AND WATER GARDENS

We love the tranquil beauty of our aquariums and water gardens. Unfortunately, many of the aquatic plants and animals that are promoted and for sale in many pet stores, garden centres and nurseries are not native to our area and some have the potential to become seriously invasive aquatic weeds, invertebrates and fish. Aquarium owners may feel they are doing the right thing for their pets by releasing them back to nature and water gardeners may not realize that their contained gardens are not so contained. If invasive species get into the wild, they can do severe damage to habitats, our economy and maybe even our health.

2. GONE FISHING

Fishing is a popular pastime that allows many kids and families to enjoy Ontario's sparkling lakes and rivers. It is a common and accepted practice for anglers to use live bait like minnows and crayfish when they are fishing. Unfortunately, many people don't realize that releasing this bait when they are finished fishing to a new waterbody is illegal and a way of introducing new and potentially harmful species to those habitats. Invasive species in the bait bucket can wreak havoc on our lakes and rivers. These new species may: compete with native species for food and space; feed on the eggs and young of native fish; and, occasionally, carry and spread disease. Not only does this affect habitats but it can also harm local livelihoods and recreation. Examples of invasives

potentially in bait that are harmful if released alive are: rusty crayfish, European ruffe, rudd and round goby. Invertebrate species such as zebra mussel veligers and the spiny and fishhook water flea or their eggs may be in bait bucket water and could also spread if released from one water body to another.

3. BOATING FOR FUN

Invasive species are cunning hitchhikers, finding their way into Ontario waters by clinging to commercial and recreational boats or by hiding out in the water contained in watercraft. Boaters then, must be very wary, cleaning and inspecting their boats before moving them from water body to water body. Boats have been a major mode of transportation for: zebra mussels, the spiny and fishhook water flea, and plants such as European frog bit and Eurasian water milfoil. As well as boats, invasive species can attach themselves to propellers, trailers and other boating gear and equipment or be contained in the water in live wells, the bilge or the motor.

4. THE MARKETPLACE

We love our food and as a result, there is a growing culinary interest in buying live fish from the market. This is great but we need to exercise caution! Some exotic food species are aggressively invasive and if released into Ontario's aquatic habitats, they can take over food and space from other species and generally have few natural enemies.

Invasive species were brought to Ontario through human activity. We now need human activity to help solve this harmful problem. It's a big task that requires us all to pitch in!

Make waves!
Everyone can help keep our aquatic habitats healthy!

Actions to Stop Species Invasion!

Invasive species pose enormous threats to our aquatic ecosystems. Fortunately, the actions we can take to prevent these invaders are simple:

AQUARIUM CARE-IUM

Responsible aquarium owners and habitat stewards will:

- Never release or flush aquatic plants or fish into a lake, river, pond, stream, drainage ditch or sewer.
- Return or donate unwanted aquarium animals and plants to local pet stores, school groups, or community centres.
- Find out about the Fish Rescue Programs that can help you find a home for your unwanted pet by contacting the Invading Species Hotline toll-free at 1-800-563-7711 or visit www.invadingspecies.com

Aquarium owner's motto: Aquarium in! Nothing out!

GARDENERS OF THE DEEP

Responsible owners of water gardens and habitat stewards will:

- Dispose of unwanted and invasive plants by drying them completely and discarding them in household garbage. Don't compost them because some seeds can withstand drying and freezing.
- Consider using native aquatic plants and animals in your garden found at your local nursery. Ask to be sure that their native range includes your region. Never collect native plants from the wild.
- Select a site for your water garden as far away as possible from natural waterways and any areas subject to flooding.
- Remove potential "hitchhikers" from your purchases by rinsing in a light coloured bucket until free of soil.

Water gardener's motto: Grow Native! Not Invasive!

FISHING CREDO

Responsible anglers and habitat stewards will:

- Never empty bait buckets into the water. It is illegal to release live fish from one body of water into another.
- Always put unwanted bait in the garbage or on dry land.
- Keep unused bait for future use by freezing or salting it.
- Never use round goby (See Cottage County's Most Wanted Blackline Master – The Bait Bandit) as bait! It's illegal!

Angler's motto: Live bait doesn't get a break to escape!

AHOY THERE, BOATER!

Responsible boaters and habitat stewards will:

- Inspect their boats, trailer and equipment before leaving any body of water, removing any plants, mud and animals that they see.
- Drain water from their boat including the live well, bilge, and motor while still at the lake or river they have just enjoyed.
- Wash their boat and gear with hot water or high-pressure water (like a garden hose spray) or dry it out in the sun for at least 5 days before moving it to another body of water.

Boating enthusiasts motto: A loved boat is a scrubbed boat.

AT THE MARKET

Responsible chefs and habitat stewards will:

- Refuse to buy or sell specific species of live carp (grass, big head, silver or black) or snakeheads (a vicious type of fish!) since this is illegal!
- Never release fish or other animals bought at the market into the wild.

Food lover's motto: Just say no to live carp and snakeheads!

It's as
simple as
1, 2, 3!

1. Learn how to stop invasive species and help habitats stay healthy!
2. Help out more by teaching others!
3. Enjoy and protect our beautiful Ontario waters!

Invasive Species Teaching Resources

CURRICULA

Community Stewardship Projects on Exotic Aquatic Species

Booklet of activities and community stewardship projects developed by students as part of Sea Grant's "Exotic Aquatics on the Move" education project. To download the booklet, please visit... <http://www.iisgcp.org/edu/cr/index.html>.

Produced by the Illinois-Indiana Sea Grant Program. 2001.

Contact: Valerie Eichman, IL-IN Sea Grant [eichman@uiuc.edu] [217/333-8055] or Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: Single hard copies available free of charge.

EATM: Exotic Aquatics on the Move

CD: "Building a Web of Awareness for Geography Educators and Students." Twenty-seven lessons on aquatic invasive species available as printable PDF files and in alignment with the National Geography Education Standards. Visit... <http://www.iisgcp.org/EXOTICSP/>.

Produced by six Sea Grant Programs (IL-IN, LA, MN, NY, OH, and WA) and six Geographic Education Alliances (IL, IN, LA, MI, NY, and WA). 2001.

Contact: Robin Goettel, IL-IN Sea Grant [goettel@uiuc.edu] [217/333-4780] or Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$2.50

ESCAPE: Exotic Species Compendium of Activities to Protect the Ecosystem

An extensive collection on AIS for K-12 students! The compendium includes 36 hands-on, multidisciplinary activities, as well as game boards, zebra mussel shells, posters, music, an educational video, and more. To view lesson plans, please visit... <http://www.iisgcp.org/edu/escape/index.html>.

Produced by the Illinois-Indiana Sea Grant Program in partnership with the Michigan, Minnesota, New York, and Ohio Sea Grant Programs. 2001.

Contact: Valerie Eichman, IL-IN Sea Grant [eichman@uiuc.edu] [217/244-8809] or Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$58 (plus shipping)

Exploring Science Writing: An Environmental Focus

Eighteen exercises engage high school students in writing clearly about ecosystem issues and in understanding

science-based stories. Enhances science, language arts, and interdisciplinary curricula. For further explanation, please visit... <http://www.seagrant.umn.edu/seiche/apr.99/art11.html>.

Produced by the Michigan Sea Grant Program in collaboration with the University of Rhode Island Journalism Department. 1998.

Contact: Mike Klepinger, MI Sea Grant [klep@msu.edu] [517/353-5508] or Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$6

Native Species, Nature's Choice

A 24-page curriculum unit informs young Canadians about the nature of invasive species, how they are introduced and spread, their impacts on native species and spaces, and how to protect our natural riches in the face of this threat. This unit uses inquiry-based lesson plans focusing on alien species for Grades 4-12 available in both French and English. To download this free unit, please visit... www.wildeducation.org/programs/nww2003/nww2003booklet_e.pdf.

Also available is Battle with the Alien Space Invaders, an on-line game that introduces the threats of invasive species and how to solve the problem through the restoration cycle. Please visit... www.wildeducation.org/maze_invasives/battle_mazec.htm.

Produced by the Canadian Wildlife Federation (CWF)

Contact: Canadian Wildlife Federation [info@cwf-fcf.org]

Cost: Free

Nonindigenous Species Activities for Youth

Activities and lesson plans focusing on aquatic and terrestrial nonindigenous species may be downloaded at no cost. Please visit... <http://msucares.com/pubs/publications/p2286.pdf>.

Produced by the Mississippi Sea Grant Advisory Service, Mississippi State University, and the Mississippi Cooperative Extension Service. 1997.

Contact: MS-AL Sea Grant [228/818-8836]

Cost: Free

Purple Loosestrife Project

Learning activities focus on wetland stewardship, habitat protection, and biological control. Curricula are divided into ten sections and may be downloaded at no cost. Please visit... <http://www.miseagrant.umich.edu/pp/activities.html>. To find out more about the project and ways to get involved, visit the "purple pages" at... <http://www.miseagrant.umich.edu/pp/activities.html>.

www.miseagrant.umich.edu/pp/index.html.

Produced by Michigan State University in collaboration with the Michigan Sea Grant Program. 1997.

Contact: Mike Klepinger, MI Sea Grant [klep@msu.edu] [517/353-5508]

Cost: Free

SEE CELLA CHOW! A Purple Loosestrife Biological Control Manual for Teachers

Fifteen activities focus on wetland ecology and invasive species. Lessons emphasize biocontrol efforts, including the development, rearing, and release of beetles to combat purple loosestrife. The activity set provides teachers with background information, links to state standards, and activity instructions. For updates on cost and to view related Web pages, please visit... <http://www.wiscwetlands.org/cella.htm> or to download please visit... http://www.dnr.state.wi.us/org/es/science/publications/ss981_2003.htm#document

Produced by the Wisconsin Department of Natural Resources, the Wisconsin Wetland Association and Wisconsin Teachers. 2003.

Contact: Derek Strohl, WI Wetland Assoc. [derek@wiscwetlands.org] [608/250-9771] or Brock Woods, WI DNR [Brock.Woods@dnr.state.wi.us] [608/221-6349]

Cost: Determined at publication time

Traveling Trunk Adventure: Exotic Aquatics

Get up close and personal with exotic plants and animals! Trunk includes interdisciplinary lesson plans, preserved specimens, stories, identification guides, lesson plans, and a video that uses the 'Bill Nye the Science Guy' approach to learning. Designed for audiences ages 9-adult. Trunk assists educators in providing intensified studies of exotic species. To learn more, visit... <http://www.seagrant.umn.edu/education/ttindex.html>.

Developed by the Minnesota Sea Grant Program in collaboration with the Illinois-Indiana Sea Grant Program. 1996.

Contact: Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$35 / 10-day rental (costs vary depending on shipping)

Traveling Trunk Adventure: Zebra Mussel Mania

Tune into zebra mussels and other exotic species with this award-winning science kit and curriculum. The trunk, geared towards learners ages 9-14, includes ten lesson plans which incorporate experiments, games, stories,

and other hands-on activities. Lessons meet the science education standards. To learn more, visit... <http://www.invadingspecies.com/Library.cfm> in Canada and visit... <http://www.seagrant.umn.edu/education/ttindex.html> in the U.S.

Developed by the Illinois-Indiana Sea Grant Program in collaboration with the Minnesota Sea Grant Program. 1994.

Contact: Invading Species Awareness Program [invading_species@ofah.org] [1-800-563-7711] in Canada and Robin Goettel, IL-IN Sea Grant [goettel@uiuc.edu] [217/333-4780] in the U.S.

Cost: \$30 for a three week rental plus shipping in Canada and \$25 rental in the U.S. (costs vary depending on shipping)

POSTERS and PRINT MATERIALS

A Sampling of Invasive Species

The Invading Species Awareness Program, a partnership program between the Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources provides free outreach materials that include posters, stickers, magnets, watch cards, factsheets and brochures explaining the aquatic invasive species of concern in Ontario and the Great Lakes, pathways of introduction and impacts. Please visit... <http://www.invadingspecies.com/Library.cfm> to view and order on-line.

Produced by the Invading Species Awareness Program, a partnership of the Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources.

Contact: The Invading Species Hotline [1-800-563-7711] [invading_species@ofah.org]

Cost: Free

Aliens Among Us

Ohio Department of Natural Resource's colorful poster visually explores aquatic and wetland invasive plants and animals. Graphics include fish, mollusks, and plants, as well as ways to prevent their spread.

Produced by Ohio DNR's Division of Wildlife in collaboration with the Division of Natural Areas & Preserves and the U.S. Fish & Wildlife Service. 2002.

Contact: Jennifer Windus, ODNR [Jennifer.Windus@dnr.state.oh.us] [614/265-6468]

Cost: Single copies available free of charge

America's Least Wanted: Alien Species Invasions of U.S. Ecosystems

Booklet includes a "Dirty Dozen" gallery of twelve of our nation's most damaging invasive species. Publication focuses on the harm they bring to "Hard-Hit Ecosystems."

Produced by The Nature Conservancy. 1996.

Contact: The Nature Conservancy [invasivespecies@tnc.org] [703/841-5300]

Cost: Available at <http://www.conserveonline.org/2001/06/s/amleast>

America's Most Unwanted

Poster features educational graphics regarding the U.S.'s "most unwanted" invasive species. Information on the bottom of the poster can be copied for classroom use. For information and to access additional materials, visit NOAA at... <http://www.education.noaa.gov/>.

Produced by the National Oceanic and Atmospheric Administration National Sea Grant Program Office in collaboration with Minnesota Sea Grant. 2001.

Contact: Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$5

AIS Watch Cards

Wallet-sized cards popular amongst boaters. Eurasian watermilfoil, ruffe, round goby, rusty crayfish, spiny waterflea, fishhook waterflea, European frogbit, zebra mussel, and purple loosestrife cards identify species' characteristics, problems posed, means of spread, and "what you can do" to prevent and slow their spread. To view and order watch cards, please visit... <http://www.invadingspecies.com/Library.cfm> in Canada or <http://www.seagrant.umn.edu/exotics/zmid.html> in the U.S.

Produced by the Great Lakes Sea Grant Network and U.S. Fish and Wildlife Service. 1998.

Contact: Ontario Federation of Anglers and Hunters at 1-800-563-7711 or MN Sea Grant [218/726-6191] or another Great Lakes Sea Grant Network Office.

Cost: Copies available free of charge

Biological Invasions

This fold-out booklet examines how aquatic invasive species enter North American waters, resulting harm, and what can be done to help solve the problems. Booklet includes pictures, graphs, distribution maps, and informative text. Provides an excellent overview of problems associated with aquatic invasive species nationwide.

Produced by the Great Lakes Panel on Aquatic Invasive Species. 1998.

Contact: Great Lakes Commission [734/971-9135] or Minnesota Sea Grant [218/726-6191].

Cost: Single copies available free of charge

Bio-Invasions: Breaching Natural Barriers

Booklet (20 pp.) explains in simple, clear terms the threat of non-native aquatic species and potential impacts on the economy and on the environment. Booklet is specific to west coast invasions. Booklet is available at... <http://www.wsg.washington.edu/pubs/bioinvasions/bioinvasionsindex.html>.

Produced by the University of Washington Sea Grant Program. 1998.

Contact: Andrea Copping, WA Sea Grant [acopping@u.washington.edu] [206/685-8209]

Cost: Free

A Field Guide to Aquatic Exotic Plants and Animals

Learn how to identify species in the Great Lakes region by way of this popular, informative brochure filled with colorful pictures and illustrations. Brochure shares the history behind species' invasions, species' biology, and species' likely means of spread. Guide dedicates panel pages to round goby, sea lamprey, rusty crayfish, white perch, flowering rush, and curly-leaf pondweed. Visit... <http://www.seagrant.umn.edu/exotics/fieldguide.html>.

Produced by the Minnesota Department of Natural Resources. 1995.

Contact: MN Sea Grant [218/726-6191]

Cost: Single copies available free of charge

Hitchhikers: Guide to Exotic Species

Waterproof guide to 14 introduced marine species, as well as information on a few native species found along the New England coast. For further explanation and other resources, visit... <http://massbay.mit.edu/exoticspecies/hitchhikers/index.html>.

Produced by the MIT Sea Grant Program. 2002.

Contact: MIT Sea Grant [617/253-7041]

Cost: Single copies available free of charge

Marine Education: A Bibliography of Educational Materials

Resource materials include educational materials on a variety of aquatic topics. The bibliography includes

books, reports, videos, and brochures available from the Nation's Sea Grant College Programs. Please visit...

<http://nsgd.gso.uri.edu/edu.html> to view the full list.

Produced by the Texas A&M Sea Grant Program. 1997.

Contact: State Sea Grant Program

Cost: \$2

Photo-Mural: Invasive Non-Native Plants

Large, laminated photo-mural of 37 invasive non-native plants found in the U.S. Plants are depicted in attractive color photographs. To view, visit... <http://aquat1.ifas.ufl.edu/>.

Produced by the Center for Aquatic and Invasive Plants, University of Florida, Bureau of Invasive Plant Management, the Florida Department of Environmental Protection, Sea Grant, and Cerexagri. 2001.

Contact: APIRS Photo-Mural, Center for Aquatic and Invasive Plants, 7922 NW 71 St, Gainesville, FL 32653

Cost: Free (requests in writing – limited copies available)

Stop Aquatic Hitchhikers!

Sticker lists four easy steps boaters and anglers can take before and after using their watercraft. To view, visit...

<http://www.protectyourwaters.net>.

Produced by the ANS Task Forces' Communication, Outreach and Prevention Committee's National ANS Outreach Campaign. 002.

Contact: MN Sea Grant [218/726-6191]

Cost: Single copies available free of charge

Wild Cards

Wisconsin Department of Natural Resources has developed a series of identification cards for a variety of native and non-native plants and animals found in Wisconsin, including nine aquatic invaders. Designed for children, the cards include photos and descriptions, as well as how invaders pose problems and why native species are beneficial.

Produced by the Wisconsin Department of Natural Resources. 2002.

Contact: Ron Martin, WI DNR [martir@dnr.state.wi.us] [608/266-9270]

Cost: Single cards available free of charge

VIDEOS and DVDs

Invaders in Our Waters

A comprehensive DVD package that includes: a 7 minute overview of the impacts of aquatic invasive species in

Ontario with a focus on the pathways of how they can be introduced; six-two minute and four-30 second PSA messages focusing on each pathway of concern; and a list of resource materials available free from the Invading Species Awareness Program.

Produced by the Invading Species Awareness Program, a joint partnership of the Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources in conjunction with the Ontario Ministry of Agriculture, Food and Rural Affairs.

Contact: Invading Species Hotline [1-800-563-7711] [invading_species@ofah.org]

Cost: Free

Alien Ocean

Zebra mussels from the Black Sea. Green crabs from the Baltic Sea. How did they get here and what impacts do they have on our waters? Alien Ocean tells the dramatic story of scallop fishermen, cargo ship captains, pilots and the scientists who are pioneering a new field called "invasion ecology."

Produced by the Maryland Sea Grant Program. 1998.

Contact: MD Sea Grant [mdsg@mdsg.umd.edu] [301/403-4220]

Cost: \$24.95

Aquatic Invaders

"Cutting Edge Technology Report" shares the threats and challenges aquatic invaders have on our nation's ecosystems. Provides an overview of the problem, including highlighted segments on Chinese mitten crabs, European green crabs, zebra mussels, and sea lampreys.

Produced by the Information Television Network. 2000.

Contact: Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$5

Aquatic Exotics

Video takes a 'Bill Nye the Science Guy' approach to aquatic invasive species. This 22-minute video, designed for elementary and middle school students, is in the Exotic Aquatics Traveling Trunk. To view video clip, visit... <http://www.sgnis.org/av/video/aquatic.htm>.

Produced by the Minnesota Department of Natural Resources. 1995.

Contact: MN DNR: Publications Dept. [ecoservices@dnr.state.mn.us] [651/296-2835]

Cost: Free to school libraries; \$10 for additional copies.

STOP EXOTICS: Clean Your Boat

Eleven-minute video featuring John Ratzenberger (“Cliff” from TV show, Cheers). The video explores steps boaters, sailors and personal watercraft users can take in order to prevent the spread of exotic plants and animals. For more information, please visit... <http://www.seagrant.umn.edu/exotics/stop.html>.

Produced by the Minnesota Sea Grant Program. 2000.

Contact: Doug Jensen, MN Sea Grant [djensen1@d.umn.edu] [218/726-8712]

Cost: \$10

You Ought To Tell Somebody! Dealing with Aquatic Invasive Species

Twenty-three minute video provides an overview on aquatic invasive species, as well as the identification and natural history behind one significant new threat, the Chinese mitten crab. Visit... <http://seagrant.oregonstate.edu/sgps/multimedia.html>.

Produced by the Oregon Sea Grant Program. 2001.

Contact: Paul Heimowitz, OR Sea Grant [paul.heimowitz@orst.edu] [503/722-6718]

Cost: \$18.95 + 3.95 (postage)

Zebra Mussels: Lessons Learned in the Great Lakes Region

Control, Biology, Spread and Impact, and Outreach Tools Set of four videos may be purchased together or individually. Control takes a look at the comprehensive monitoring and control techniques for industrial and municipal facilities. Biology provides an overview of the basic biology, including physical characteristics, life cycle, and reproductive behavior. Spread and Impact explores the zebra mussel’s spread and distribution, as well as the resulting ecological and social impacts in the Great Lakes. Outreach Tools explores educational resource materials developed by Sea Grant, suitable for the classroom. To view video clips, visit... <http://www.iisgcp.org/EXOTICSP/NMEA/zmlesson.htm>.

Produced by the Illinois-Indiana Sea Grant Program in collaboration with the Purdue University Ag Comm Service. 1998.

Contact: IL-IN Sea Grant, Administration [217/333-6444] or Outreach [765/494-3573]

Cost: \$20 for video set or \$7.50 each

BOOKS and CDs

Alien Invaders: The Continuing Threat of Exotic Species

Book for youth, grades 6-12. Specific cases, plentiful photos, and boxed insets highlight particularly interesting stories involving non-indigenous species’ introductions. The book was selected a “Best Book for the Teen Age” by the New York Public Library. Visit... <http://www.author-illustr-source.com/sneebcollard.htm#Published%20Books>.

Published by Franklin Watts. 1996.

Contact: Sneed B. Collard, III, Author [collard@bigsky.net]

Cost: \$15

Exotics To Go! Presentations and Publications to Prevent the Spread of Aquatic Invasive Species

Compact disc includes seven “conveniently wrapped” PowerPoint presentations on aquatic invasive species, loaded with images of problem species, fact sheets, brochures, and pamphlets. Presentations and documents designed to give general audience a greater understanding of the impacts of AIS. To order, visit... <http://www.seagrant.umn.edu/exotics/exoticstogo.html>.

Produced by the Minnesota and Illinois-Indiana Sea Grant Programs. 2001.

Contact: MN Sea Grant [218/726-6191]

Cost: \$2.50

Oh No! Hannah’s Swamp is Changing

An illustrated children’s book for grades K-4 identifying what nonindigenous species are, the effects they have on ecosystems, and what can be done to stem the tide. Written by LA Sea Grant’s Marilyn Barrett-O’Leary and illustrated by Catherine Kiffe, a local artist and teacher, the book also includes a poster and several activities for young students.

Produced by the Louisiana Sea Grant Program. 2002.

Contact: Marilyn Barrett-O’Leary, LA Sea Grant [moleary@lsu.edu] [225/578-6349]

SGNIS (Sea Grant Nonindigenous Species)

Compact disc contains a collection of educational materials and peer-reviewed research publications produced by the National Sea Grant College Programs. To view contents, visit SGNIS’s home-page at... <http://>

www.sgnis.org.

Produced by Minnesota Sea Grant on behalf of the Great Lakes Sea Grant Network. 2001.

Contact: MN Sea Grant [218/726-6191]

Cost: \$8

Think About the Planet

A musical CD by Remy Rodden that includes a song about invasive species titled "The Invadin' Alien Blues".

Please visit... **www.thinkabout.ca/**

Produced by Think About...Productions.

Contact: Remy Rodden [1-867-668-7953] or Canadian Wildlife Federation [1-800-563-9453]

Cost: \$20 CD and \$17 cassette, S&H and taxes included

Visualizing the Great Lakes

Compact disc contains 500 high-quality images gathered from 30 Great Lakes' agencies. A great tool to assist in the development of publications and PowerPoint presentations. Visit... **http://www.seagrant.umn.edu/pubs.vgl/index.html.**

Produced by the Minnesota Sea Grant Program and the U.S. Environmental Protection Agency's Great Lakes National Program Office. 1998.

Contact: MN Sea Grant [218/726-6191]

Cost: \$12

WEB SITES

The following Web sites include general information on aquatic invasive species, AIS. Sites offer photos, descriptions, and maps; as well as information on the impacts invasive species have on food webs and ecosystems.

www.invadingspecies.com

Invading Species Awareness Program: This site, representing a partnership program of the Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources, has detailed information of aquatic invasive species found in Ontario. In addition, it provides many activities that enable citizens to participate in the prevention of invasive species spread and to assist in control efforts.

www.mnr.gov.on.ca/MNR/fishing/threat.html

Ontario Ministry of Natural Resources: This site contains brief summaries of the invasive species found in Ontario,

including their characteristics, where they have been spotted and what to do to prevent their spread.

http://www.cwf-fcf.org/

Canadian Wildlife Federation: A bilingual site that includes a section on invasive species and houses "The Invasive Species in Canada database" which describes the species that are considered invasive in Canada, where they're from, where they're found, how they're introduced and their ecological impacts. Includes several educational programs and resources for educators and students.

http://www.protectyourwaters.net

Protect Your Waters is designed for anyone who enjoys spending time on the water. The Web site, based on a national media campaign, includes procedures and tips for boaters and personal watercraft users to assist in preventing the spread of aquatic exotic species. The frequently updated site includes ways to "Become Informed and Take Action."

http://www.sgnis.org/

Sea Grant Nonindigenous Species: An educator's information/resource guide. Information center contains collection of resources produced by Sea Grant and other institutions. Includes informative Kid's Page displaying 3-D images of prominent aquatic invasive species.

http://nas.er.usgs.gov

US Geological Survey: Nonindigenous aquatic species. Information resource pages include updated distribution maps identifying locations and spread of aquatic invasive species by region, as well as species' facts, images, biology and updated status reports.

http://www.seagrant.umn.edu

University of Minnesota Sea Grant College Program. Invasive species pages include updated information on zebra mussels, round goby, ruffe and other aquatic invasive species affecting the Great Lakes region. Contains links to many prominent AIS Web sites.

http://www.greatlakesseagrant.org/

Great Lakes Sea Grant Network. A network of Sea Grant programs working in partnership with government and private sectors. Site includes general information on aquatic invasive species, as well as links to additional, helpful sites.

<http://www.glifwc.org/epicenter/>

Great Lakes Indian Fish and Wildlife Commission. Emphases on invasive plants and ecological impacts on the Great Lakes... interactive maps, slide library, educational materials and more.

<http://nature.org/initiatives/invasivespecies/>

The Nature Conservancy identifies invasive species as one of the most critical conservation issues today. Web site includes photos, graphs, and downloadable documents relating to invasive species, ecosystems, and habitat loss.

The following Web sites offer in-depth, detailed information on aquatic invasive species. Sites include technical reports, newspaper and journal articles, and access to photo, video, and slide libraries.

http://www.cce.cornell.edu/aquaticinvaders/nan_ld.cfm

National Aquatic Nuisance Species Clearinghouse. Searchable Web site houses a library of research, public policy, and outreach education publications pertaining to invasive marine and freshwater aquatic invasive species. Technical publications deal with the impacts, biology, spread and control of AIS.

<http://www.anstaskforce.gov/>

Aquatic Nuisance Species Task Force. An intergovernmental organization dedicated to the prevention and control of AIS. Established through U.S. Congress's Nonindigenous Aquatic Nuisance Control and Prevention Act of 1990.

<http://www.nsgd.gso.uri.edu/>

A Marine, Coastal, and Great Lakes information resource site and lending library for Sea Grant funded, developed, and published documents.

<http://www.great-lakes.net>

Great Lakes Information Network (GLIN). Current information from newspaper and journal articles, scientific papers, conferences, press releases and education curricula. Includes an education and curriculum page for students and teachers.

The following Web sites include lessons and games on invasive species, as well as access to educational water-related Web sites. Sites may prove useful for educators integrating aquatic invasive species education into broader curricular units.

www.wildeducation.org/programs/wld_prog.asp

Fishways / Project Wild / Focus on Forests / Below Zero: Interactive games, activities and lesson plans educating children on the importance of healthy habitats and ecosystems from the Canadian Wildlife Federation. Fishways contains lesson plans that teach about fish and Ontario's aquatic habitats. This website also provides access to the curricular programs: Project Wild, Focus on Forests and Below Zero.

http://www.nps.gov/piro/wl_lesns.htm

The National Park Service. A compilation of games and activities set up to assist educators teaching about plant and wildlife management. Includes "The Deadly Plant Invaders Game" – an active lesson engaging students in learning about the effects of invasive species.

<http://www.vims.edu/bridge/>

The Bridge: Ocean sciences education teacher resource site. Includes links to interactive activities for all ages as well as updated information on water studies. A unique clearinghouse to some of the best K-12 science education sites available online.

<http://www.iisgcp.org/EXOTICSP/index.html>

Exotic Aquatics on the Move: Developed by National Sea Grant and Geographic Education Alliance. Site offers general invasive species information, as well as case studies on a wide array of species. Also features links and access to instructional materials.

www.ducks.ca

Ducks Unlimited: Project Webfoot teaches the value of wetland ecosystems and helping them take positive actions to conserve wetlands in their own communities. Download curriculum-linked resources for grades 4-12.

www.campsite24.ca

Ontario Parks—Campsite 24. This website is for both students and teachers, and brings Ontario's parks and protected areas to your home, classroom or library. Download curriculum-linked resources for grades 2-6.

GLOSSARY

Adaptations	The traits and characteristics that help plant and animal species live in a particular habitat and community.
Carnivores	Animals that get their food energy from feeding on other animals only.
Community	A group of plants and animals living and interacting together in a habitat.
Competition	When two or more species need the same, limited resource (ex. light energy, food energy, living space, etc).
Consumer	A species that must consume or eat other living things to get its energy.
Ecosystem	The community of living things and non-living things around it (air, water, soil and rock, for example).
Exotic Species	A species that is not originally from a particular habitat.
Food Chain	The plant and animal species that make up a continuous transfer of energy. Each consumers a lower member of the food chain and in turn is preyed upon by a higher member of the food chain.
Habitat	A place that is home to a plant, animal or community of plants and animals.
Herbivores	Animals that get their food energy from feeding on plants only.
Invasive Species	Species that did not originate in the particular habitat it is now residing in. These species have special adaptations that make them very successful in their new habitat and community at the expense of other, native, plants and animals or our economy or society.
Native Species	An animal or plant species that is originally from a particular habitat.
Omnivores	Animals that get their food energy from feeding on both plants and other animals.
Parasite	A species that grows, feeds, and is sheltered on or in a different species while not helping it to survive.
Photosynthesis	The process in which green plants create food energy (sugar) from air (carbon dioxide) and water using the energy from light.
Predator	Animals that hunt other animals for food.
Prey	Animals that are hunted by predators for food.
Producers	Species that produce their own food through photosynthesis; plants are producers.
Species	Types of plants and animals.
Stewardship	Taking care of our habitats; making responsible choices and taking action to ensure they remain healthy for the species that live within them.
Wetlands	A wet, lowland habitat, such as a marsh or swamp.