Laurentian Great Lakes and their invasive species

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Largest Group of Freshwater Lakes in the World

• Contain 21% of the world’s surface freshwater
Variety of Habitat Types

- Deep cold oligotrophic lakes
- Shallow warm eutrophic lake and bays
- Coldwater rivers
- Large warmwater rivers
- Small tributaries
- Wetlands
GLANSIS

182 Non-Native Species

• 55 rooted plants
• 27 species of algae
• 49 invertebrates
  – 18 mollusks
  – 20 crustaceans
• 23 pathogens
• 28 species of fish
Non-Native Fish

Of the 28 fish, 9 were intentionally stocked

- Common carp
- Pink salmon
- Rainbow smelt
- Brown trout
- Rainbow trout
- Coho salmon
- Chinook salmon
- Kokanee/sockeye salmon (still listed in GLANSIS)
- Western mosquitofish
Non-Native Fish

Of the 28 fish, 19 were unintentionally introduced

- Alewives
- Round goby
- Tubenosed goby
- Eurasian ruffe
- Threespine sticklebacks
- Fourspine sticklebacks
- White perch
- Goldfish
- Rudd
- Blueback herring
- Suckermouth minnow
- Bluespotted sunfish
- Chain pickerel
- Shortnosed gar
- Orangespotted sunfish
- Redear sunfish
- Oriental weatherfish
- Ghost shiner
- Margined madtom
Two Pathways for Entry of the Most Disruptive Invasive Species

• Canals

• Ballast
Canals and locks created which connected the lakes together to allow maritime transportation.
Niagara Falls: Prevented many species from entering the upper Great Lakes?
Welland Canal
Opened access to upper lakes
Connected to the Atlantic Ocean via the St. Lawrence Seaway

16th largest U.S. port in cargo volume, 1100 vessels annually
Connected to the Mississippi River and Gulf of Mexico via diversion out of Lake Michigan.
Connected to James Bay/Hudson Bay via diversion into Lake Superior

![Map of Ogoki/Long Lac/Niagra region](image)
Connected to the Hudson River Drainage via the Erie Canal
Ballast Water
A significant pathway for non-native entry into the Great Lakes and subsequent spread throughout the Great Lakes.
Ballast Water

• Introduced 4 fish, 3 snails, 7 mussel/clams and 17 other invertebrates
• Mandatory ballast water exchange since 1993
• NOBOBs must conduct a saltwater exchange since 2008
Ballast Water

- According to U.S. and Canadian officials, as of 2009 there is no unmanaged ballast water entering the Great Lakes.
Worst Great Lakes Non-Native Fish

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<td>9. Asiatic Clams</td>
<td>Asia</td>
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SEA LAMPREY

- Most devastating invader of the Great Lakes
- Nearly eradicated lake trout in all Great Lakes
- Heavily impacted whitefish, burbot, walleye, catfish, salmon, rainbow trout, and brown trout
Sea Lamprey

- Native to Atlantic coast and possibly Lake Ontario
- Entered other Great Lakes when Welland Canal deepened in 1919
- Adult sea lamprey can kill 40 lbs of fish

Suck blood and body fluids from fish
Sea Lamprey

- Successfully controlled with chemicals, low-head barriers, traps, sterilized male releases
- Controls have resulted in a 90% reduction
- Annual control costs are approximately $15 million
Zebra / Quagga Mussels

- Attach to any hard surface
- Approach densities of 1 million per square meter
- Have caused extermination of native mussels
- Because of their numbers, zebra mussels filter a tremendous volume of water each day.
- Make the water more clear.
- Disrupt food webs.
Decline of Freshwater Shrimp -- Diporeia

10,000/m² to 0/m²

- Gone from Lake Erie
- Significant declines in Lakes Michigan, Huron, and Ontario
- No decline in Lake Superior
Diporeia Decline in Lake Michigan

Diporeia Populations

1994-1995

2000

2005

Density (per m² x 10³)

Density (per m² x 10³)

Density (per m² x 10³)
Impacts of Zebra Mussels

- As water clarity increase, aquatic plants begin to grow to nuisance levels and choke some marinas and harbors in the Great Lakes
Impacts of Zebra Mussels

- Can increase bioaccumulation of contaminants like PCBs, PAHs, and metals in fish and waterfowl
- Can cause type E botulism in gobies feeding on zebra mussels which has resulted in sportfish and bird kills when infected gobies are eaten.
Zebra / Quagga Mussels

Fouled Boats

Clogged Pipes
Impacts of Zebra/Quagga Mussels on Great Lakes Water Users

Estimated annual cost for monitoring and controlling zebra/quagga mussels in the Great Lakes is $30 to $400 million
Rainbow Smelt

- Small coastal Atlantic Ocean fish
- Stocked many times in the Great Lakes
- Has had negative impacts on native species
First occurrences of smelt in the Great Lakes
Smelt contributed to declines in native fish populations such as cisco (lake herring) and lake whitefish.
Smelt

Unlike other exotics, smelt also provided a commercial fishery.
It also created a party every spring in the “good old days”

Smelt Wrestling
Smelt

• For a short period smelt provided:
  – a large near-shore forage base for trout and salmon
  – a strong commercial fishery
  – a big spring party and sport fishery

• Smelt have also been responsible for:
  – declines in cisco (lake herring), whitefish, walleye, yellow perch through predation and competition
Alewives
• Introduced from Atlantic Coast through Erie Canal
• Alewife populations exploded in Great Lakes
• They became commercially valuable
  – In 1957, 222,000 lbs harvested
  – In 1967, 42 M lbs harvested
  – More pounds harvested than all others species combined

Alewives
• Outgrew their resources and suffered major die-offs
• In Lake Michigan, they caused yellow perch, bloater chubs, emerald shiners, and lake herring to decline

Alewives
Alewives Impact

Salmon were stocked and fishing flourished resulting in a significant economic impact across the Great Lakes.
Alewives Impact

• Alewives altered the Great Lakes ecosystem and **changed the Great Lakes from a commercial fishery to a sport fishery**

• High levels of thiaminase cause low thiamine levels and Early Mortality Syndrome in lake trout

• Alewives have been implicated in the declines of Great Lakes ciscoes, yellow perch, emerald shiners, and deepwater sculpins – primarily through predation on fry and eggs.
Summary

- The Laurentian Great Lakes are the largest group of lakes in the world.
- They have been linked by canals where historically they were separated by a physical barrier.
- The Great Lakes have been connected by diversions to:
  - the James Bay / Hudson Bay Basin
  - the Mississippi River Basin
  - the Hudson River Basin
- Approximately 182 non-native species have become established.
- The most destructive invasive species have entered the Great Lakes via canals and ballast water.
- The only invasive species that is being successfully controlled is the sea lamprey.