Impacts of Aquatic Invasive Species on the Lake Superior Fishery

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Can humans really impact the fishery of such a large waterbody?
Lake Superior Fishery Change

- Invasive Species
  cause of the greatest fishery impacts

- Chemical Pollution
- Sedimentation
- Commercial Fishing
- Recreational Fishing
- Habitat Loss
# 55 Non-Native Species in Lake Superior
(Only 33 Native Fish Species)

## FISH (n=21)
- Alewife
- American eel
- Brook silverside
- Common carp
- Eurasian ruffe
- Freshwater drum
- Goby, round
- Goby, tubenose
- Goldfish
- Rainbow smelt
- Sea lamprey
- Stickleback, fourspine
- Stickleback, threespine
- White perch
- 7 Trout/Salmon

## INVERTEBRATES (n=21)
- Asian clam
- *Bosmina coregoni* (zooplankton)
- *Cyclops strenuus* (zooplankton)
- *Echinogammarus ischuus* (shrimp)
- *Eurytemora affinis* (zooplankton)
- *Gammarus fasciatus* (shrimp)
- New Zealand mudsnail
- Spiny waterflea
- *Ripistes parasita* (worm)
- Rusty crayfish
- *Vejdovskyella intermediad* (worm)
- Zebra and Quagga mussels

## Other (n=13)
- 9 parasites and diseases
- 4 submerged/wetland plants
Environmental impact of two invasive species with the most demonstrable impacts

- **Lamprey**
  Atlantic Ocean via canals

- **Smelt**
  Atlantic Ocean via stocking
But first a description of two Lake Superior fish that endured precipitous declines not caused by invasive species – lake sturgeon and brook trout.

Lake Sturgeon

- Unique fish
- Long lived
- Slow maturing
Lake Superior Lake Sturgeon Production

Overfishing, habitat destruction, and dams caused decline of lake sturgeon.

Dramatic declines already by 1900.
Coaster Brook Trout

- Lake Superior brook trout remain close to shore and historically spawned in 118 tributaries
- Provided a great sport fishery
Causes of Decline?

- Overharvest
  - Primarily sport fishing

Significant declines already apparent by 1880
Causes of Decline?

• Overharvest
• Stream habitat degradation
Research and management efforts toward rehabilitation are underway

Linked to the Lake, Tied to the Past
Now, Invasive Species Induced Impacts

SEA LAMPREY

- Most devastating invader in Great Lakes
What prevented lamprey from entering the upper Great Lakes?

Niagara Falls:
Welland Canal
Opened access to upper lakes

- Welland Canal was completed in 1829
- Welland Canal was deepened in 1919
- First sea lamprey in L. Erie 1921
Lake trout were the top predator and provided a commercial harvest of 4 to 6 million lbs. annually.
• Sea lamprey caused lake trout extinction in Great Lakes, except Lake Superior
• Heavily impacted whitefish, burbot, walleye, suckers, rainbow trout, brown trout

Note: Commercial harvest data doesn’t perfectly reflect changes in abundance because of changing net efficiencies, changing market demand, and changed regulations.
Sea Lamprey Control

Based on life cycle, focused controls in streams

- Prevent upstream spawning migration of adults – mechanical and electrical barriers, trapping
- Kill juveniles in streams with selective chemicals
- Sterile male releases to reduce viable eggs produced.
- Attractants and repellants
Lamprey Chemical Control

First TFM application – Lake Superior, 1958
Lake Trout Rehabilitation after 50 Years

- Self-sustaining populations in most areas
- Stocking of hatchery reared fish has ceased in many areas
- Abundance is at or exceeds historical levels in many areas
Sea lampreys continue to kill as many or more lake trout than humans, but recovery has succeeded.
Siscowet
Fat Lake Trout
Not found in other Great Lakes
Lake Trout Forms

Lean
15% fat

Siscowet
40-67% fat

Lean Lake Trout

Siscowet Lake Trout
Siscowets are approximately 14 times more abundant than lean lake trout.

The State of Lake Superior in 2000
http://www.glfc.org/pubs/SpecialPubs/Sp07_2.pdf

Siscowets also appear to have experienced a strong recovery from lamprey devastation.

Lean lake trout
Lake Superior Cisco Fishery

- Ciscoes were formerly called lake herring
- Historically, most abundant native fish

Supported an annual commercial harvest of 10 to 15 million pounds
Millions of pounds of lake trout disappeared because of lamprey -- so many more millions of pounds of cisco were not be eaten by lake trout -- therefore, cisco numbers were expected to dramatically increase.

Therefore, Cisco should
Instead, cisco numbers declined
Rainbow Smelt Introduction

- Introduced into a MI inland lake in 1912
- Found in Lake Superior in 1930s
- Found along North Shore in 1946 after which populations exploded
Rainbow Smelt

- Small coastal Atlantic Ocean fish
- Has had negative impacts on native species
Smelt Impacts

Contributed to declines in native fish populations such as cisco and lake whitefish
Cisco and Smelt Production

Note: Commercial harvest data doesn't perfectly reflect changes in abundance because of changing net efficiencies, changing market demand, and changed regulations, but I think it adequately portrays cisco decline and smelt rise and fall.

http://www.glfc.org/databases/commercial/commerc.php
Unlike the invasion of lamprey, smelt at least created a commercial fishery.
It also created a party every spring in the “good old days”
And more fun than anyone should have!
After 1979, smelt abundance declined and cisco increased.

We’re not sure why smelt crashed, but it was the increasing number of predators since the early 1980’s that has kept them in check.
Cisco Recovery

- Several strong year classes since their population lows in the 1970s
- Greatest biomass of prey fish
- Cautiously optimistic about future
Cisco, Lake Trout, Smelt harvest and Lamprey Index

Less predators and less forage fish (food) available than prior to lamprey and smelt

http://www.glfc.org/databases/commercial/commerc.php
The “Old” Invasive Species had **Significant** Environmental Impacts

- **Lamprey**
  - Atlantic Ocean via canals

- **Smelt**
  - Atlantic Ocean via stocking

*A story of devastation and successful recovery.*

We have had dramatic declines in the most abundant and valuable fish in Lake Superior – caused by the introduction of lamprey and smelt. These were both Atlantic Ocean fish that entered through canals (lamprey) or by intentional stocking (smelt). The impacts that they caused 40 – 50 years ago have largely been reversed.
There are many more recently introduced invasive species:

**What will their legacy be?**

**Here already**
- Ruffe – 1986
- Fourspine sticklebacks – 1986
- Threespine sticklebacks - 1987
- Spiny waterfleas - 1987
- Zebra mussels - 1989
- Round gobies - 1995
- New Zealand mudsnails – 2001
- Quagga mussels - 2005

**Coming soon?**
- Bloody red shrimp
- VHS virus
- Fishhook waterfleas
- Others?
Only time will tell