How has Maritime Transportation on the Great Lakes Impacted the Lake Erie water snake?

By

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Great Lakes Freighters have caused the introduction of the following exotic species:

- Sea lamprey
- Zebra mussel
- Quagga mussel
- Round goby
What is an exotic species?

Do exotic species help or hurt the native ecosystem (plants and animals)?
Why did freighters introduce exotic species?

- Discharge ballast water into the Great Lakes which allows stabilization of the ship when it enters freshwater from salt water (usually transoceanic vessels)
- Ballast water discharge held exotic species like zebra/quagga mussels and the round goby
- Ballast water when discharged into the Great Lakes allowed the introduction of exotic species
Sea Lamprey (*Petromyzon marinus*)

- Native to the Atlantic Ocean
- Introduced to Great Lakes via Welland Canal
- 1835-found in Lake Ontario
- 1921-found in Lake Erie
- Nearly destroyed fisheries in the Great Lakes!
- Controlled today by lampricide (TFM)
Zebra Mussel (*Dreissena polymorpha*)

- Native to Black and Caspian Seas
- Introduced through ballast water discharge
- 1988-found in the Great Lakes
- Cover over all solid surfaces under water, clog intake pipes and encrust all surfaces (negative effect)
- Have improved water clarity in Lake Erie (positive effect)
Quagga Mussel (*Dreissena bugensis*)

- Native to Black and Caspian Seas
- Introduced through ballast water discharge
- Early 1990s-introduced to the Great Lakes
- Similar to zebra mussel
- Clog intake water pipes and embed on all underwater surfaces (negative effect)
- Have improved water clarity in Lake Erie (positive effect)
Comparing zebra and quagga mussels:

*Dreissena polymorpha*  
(Actual size is 15 mm)  
Sits flat on ventral side  
Triangular in shape  
Color patterns vary

*Dreissena bugensis*  
(Actual size is 20 mm)  
Topples over; will not sit flat on ventral side  
Rounder in shape  
Usually have dark concentric rings on shell  
Paler in color near the hinge

Photo by Myriah Richerson
Round Goby (*Neogobius melanostomus*)

- Native to Black and Caspian Seas
- Introduced through ballast water discharge
- 1990-introduced to the Great Lakes
- Consumes native fish eggs and food resources (negative effect)
- Feeds on zebra/quagga mussels
- Serves as a new food source for the Lake Erie water snake (positive effect)
How are the Great Lakes protected from future invasive species?

- **Ballast Water Management Program (1996)** - requires the testing of all vessels carrying ballast water onboard to be tested at Massena, NY before entering the St. Lawrence Seaway into the Great Lakes.
- **If the ship does not pass the testing, it CANNOT enter the Great Lakes.**
- **U.S. Coast Guard oversees this operation.**
The Two Tools Used to monitor ballast water:

**Bailer:**
A tape measure with a small cylinder at the end that allows collection of ballast water at the bottom of the tank in the ship

**Refractometer:**
RefRACTOMETER

- Determines the salinity of the water based on the amount of salt in solution:
  - >30 ppt is acceptable to enter the seaway because salinity is high
  - <30 ppt ship will need to be inspected for exotic species before entering Seaway or prohibited from entering.
Why is it important to protect the Great Lakes from invasive species?

Invasive species are usually bad for the environment:

1. Invasive species disrupt natural systems
2. Invasive species take over habitat of native species
3. Invasive species can threatened or endanger native species

BUT... not always

some may actually help!
Case-in-point: The Lake Erie water snake (LEWS) *Nerodia sipedon insularum*

- Species endemic to western basin in Lake Erie including:
  - Lake Erie Islands of Ohio and Canada,
  - Marblehead Peninsula of Ohio
Range of the LEWS
LEWS is threatened

- In 1999, the population of Lake Erie water snakes had dropped so much that it was listed as threatened under the Endangered Species Act (U.S.)

- LEWS is threatened due to human persecution and habitat destruction
LEWS recovery strategy:

- Land management of public lands on the islands
- Outreach campaign to residents and visitors of the islands
- Encourage private land owners to benefit the snake
- Research to assess other threats to the snake’s survival

*This recovery strategy should work because it addresses the main threats to LEWS
A surprise of the LEWS survival:

- Lake Erie water snakes love to eat round gobies!
- Round gobies are an abundant food source and the snake is thriving on them.

= Yummy!
LEWS has benefited from the introduction of the round goby (invasive)

- 1980s and early 1990s the snakes were feeding exclusively on native fish and mudpuppies
- Today approximately 90% of their diet is the round goby!
- More food = greater survival rate for the snake!   Surprise....
LEWS with “belly full” of round goby
LEWS being prepared to “barf” it’s last meal
LEWS regurgitating
Last meal regurgitated
In the lab, regurgitation
Round goby “bagged” for analysis:
Results – Prey Composition

- 2006
  - round goby
  - Emerald Shiner
  - Spot tail shiner
  - Mudpuppy
  - 1 unidentified
  - ***One snake with 9 emeralds!***

![Pie chart showing prey composition]

- Goby: 88%
- Mudpuppy: 9%
- Native Fish: 3%

N=181
LEWS is a fluke!

- Most invasive species damage the natural environment!!
- LEWS has actually benefited from the introduction of the round goby
- This is a rare situation...
- Most invasive species damage the natural environment and species that live there
- This illustrates how complex an ecosystem can be and how introduction of exotic species can cause many unintended consequences
- This is why the Ballast Water Management Program exists, to reduce the introduction of more exotic species
Questions?
References:

- http://www.invasivespeciesinfo.gov/aquatics/zebramussel.shtml (zebra mussel)
- Great Lakes Maritime Transportation Teacher Institute, Michigan Tech, United States Coast Guard Presentation at Sault Ste. Marie, Michigan, August 2, 2006 (personal communication)
- Lawson, Tyler D. (July 17, 2006) Research Experience for Undergraduates Presentation at the Ohio State University’s Stone Laboratory: Round Goby Digestion Rate and Prey Composition of the Lake Erie water snake (pictures also)

IMAGES:
http://www.biol.paisley.ac.uk/biomedia/graphics/jpegs/fsh8.jpg (zebra mussel)
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