Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River

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Research team

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Collaborators:
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S. Delavan
P. Michalak
A. Yagi
The Emerald Shiner Connects the Niagara Ecosystem

Emerald shiner (Notropis atherinoides)
Niagara River: Important Bird Area (IBA)

• The Niagara River is globally recognized as an IBA in the same conservation category as the Everglades and the Galapagos Islands.

• Important Bird Areas are sites that provide essential habitat for one or more species of bird for breeding, wintering, and/or migrating.
Habitat modifications

- Damming
- Water diversions
- River-channel modifications
- Shoreline alterations
Impacts on shiners

• Obstacles to movement
• Water velocity (e.g. Broderick Park)
• Water temperatures
• Mass mortality (tributaries)
Research

- Habitat use
- Reproductive success
- Year-class formation
- Opportunity for river-lake movement
- Importance in predator diets: sport fish and common terns
<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Sampling Regime</th>
<th>Number of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime Electrofishing</td>
<td>Every other week</td>
<td>11</td>
</tr>
<tr>
<td>Night-time Electrofishing</td>
<td>Once</td>
<td>3</td>
</tr>
<tr>
<td>Seining (larval, juveniles)</td>
<td>Every other week</td>
<td>6</td>
</tr>
<tr>
<td>Marina Sampling – larval nets</td>
<td>Weekly</td>
<td>8</td>
</tr>
<tr>
<td>Bongo nets – larval sampling</td>
<td>Every other week</td>
<td>5</td>
</tr>
<tr>
<td>Zooplankton, Chlorophyll a, Total Phosphorus</td>
<td>Every other week</td>
<td>3</td>
</tr>
<tr>
<td>Physico-chemistry (T, D.O., Conductivity, pH)</td>
<td>Weekly</td>
<td>13</td>
</tr>
</tbody>
</table>
ADULT SAMPLING

Daytime Electrofishing

YSI MPS
The Catch

Ripe Female
Night-time Electrofishing
Night-time Electrofishing
Laboratory Measurements of the Catch
Dissections to determine sex, gonadosomatic index and stomach contents

Male
Females

Days when samples were collected

Gonadosomatic Index

May | June | July | August | Sept.

6/25
6/27
7/10
Juvenile Seining
North Grand Island Emergent Marsh
Fish Larvae collected in Marinas

Fish larvae assemblages where routinely collected from marinas during June-July-August.
Family Cyprinidae (Emerald Shiner)
Total length = 13.6 mm
| **Jacob Cochran**  
| (start date 6/1/14)  
| GLES | Title: Ecology of the Young-of-the-Year Emerald Shiner (*Notropis atherinoides*) in the Upper Niagara River: Development, Growth, and Assemblage Interactions. |
| **Chris Osborne**  
| (start date 6/1/14)  
| BIO | Title: Assessing Reproductive Effort of the Emerald Shiner (*Notropis atherinoides*) in the Upper Niagara River: effects of age, sex, and seasonality. |
| **John Lang**  
| (start date 6/1/14)  
| BIO | Title: An Analysis of Morphometric and Genetic Differentiation in Lake and River Populations of the Emerald Shiner, *Notropis atherinoides*. |
| **Steven Fleck**  
| (start date 1/1/15)  
| BIO | Topic: Vegetation and substrate in the upper Niagara as habitat components for adult and juvenile emerald shiners. |
| **Rebecca Johnson**  
| (start date 6/1/15)  
| GLES | Topic: Microbiology and water chemistry of habitats utilized by larval and juvenile emerald shiners in the upper Niagara River. |
| **Colleen Kolb**  
| (start date 6/1/15)  
| GLES | Topic: Use of fatty acids and stable isotopes to investigate the diet of the emerald shiner in the Niagara River. |
Genetic make-up of the Niagara population

• Spatial differences:
  eastern L. Erie – upper Niagara – lower Niagara –
  western L. Ontario.

• Seasonality: Spring – Summer – Fall

Sample Processing for DNA
(Dr. Michalak, Virginia Tech):

• IonTorrent sequencing

• Illumina's TruSeq Synthetic Long-Read
  kit: produces 6-10 kb fragments, ideal
  for identification of repeat sequences
  such as microsatellites with virtually no
  error.
Illumina sequencing (low coverage genome)

Bioinformatic identification of microsatellite loci

Design of microsatellite site-specific assays

Population screening for microsatellite polymorphism

Estimates of population genetic parameters (e.g. Fst)
Genetic Parameters:

Wright fixation index ($F_{ST}$): The proportion of the total genetic variability that occurs among populations. It is a measure of the level of population genetic differentiation.

Standing genetic variation: existing variation in a population as opposed to variation that results from new mutations.

microsatellites, repeat units of 2-13 bp
<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th># shiners</th>
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<tbody>
<tr>
<td>June 12, 2014</td>
<td>Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)</td>
<td>50</td>
</tr>
<tr>
<td>June 13, 2014</td>
<td>Upper Niagara River</td>
<td>50</td>
</tr>
<tr>
<td>July 14, 2014</td>
<td>Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)</td>
<td>50</td>
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<tr>
<td>July 15, 2014</td>
<td>Upper Niagara River</td>
<td>50</td>
</tr>
<tr>
<td>July 16, 2014</td>
<td>Western Lake Ontario (Wilson, NY)</td>
<td>50</td>
</tr>
<tr>
<td>July 17, 2014</td>
<td>Lower Niagara River</td>
<td>50</td>
</tr>
<tr>
<td>Sept. 16, 2014</td>
<td>Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)</td>
<td>50</td>
</tr>
<tr>
<td>Sept. 17, 2014</td>
<td>Upper Niagara River</td>
<td>50</td>
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</tbody>
</table>
Shoreline Water Flow Velocities
Shoreline Water Flow Velocities

USACE Buffalo District

Vicinity Map

- > 0.81 m/s
- < 0.81 m/s

Niagara River

U.S.A.

Black Rock Canal

Shoreline Water Flow Velocities

Niagara River
Shoreline Water Flow Velocities

USACE
Buffalo District

Scale

• > 0.81 m/s
• < 0.81 m/s

Vicinity Map

International Railroad Bridge

Niagara River
Seining Locations

- Monthly sampling July – October 2014
- 20 stations
- Seining and water quality
Seining Black Rock Canal - USACE

Observations:
- Yearling and older shiners are using the canal.
- YOY shiners are in the lock and downstream from it in the river.
- YOY were not found in the canal.
THE EMERALD SHINER
KEYSTONE SPECIES OF THE
NIAGARA RIVER

The Study
Life History and Habitat Utilization

How do emerald shiners use the habitats in the upper Niagara River for spawning, growth and maturation?

In this study, we are identifying the habitats, along with nearshore vegetation and substrates, that are key for the success of the emerald shiner during different life stages.

Population and Genetics

Are emerald shiners in the upper Niagara River a genetically distinct population, or are they part of a broader population that can be found in lakes Erie and Ontario?

This study investigates if the population found in the Niagara River is genetically and morphologically similar or different from adjacent emerald shiner populations.

Meet the Emerald Shiner

The emerald shiner (Notropis atherinoides) is a native minnow species in the Niagara River. As prey, it fuels the food web in the upper river, sustaining predatory fish (walleye, smallmouth bass, steelhead, yellow perch, muskie) and piscivorous migrating bird populations (common tern, common loon, mergansers) in the Niagara Flyway. In addition, the emerald shiner is the most important baitfish harvested locally, contributing to economic prosperity in the region. The health of the emerald shiner population, and the ability of these fish to successfully reproduce and migrate, has direct and significant regional, ecological and economic impacts.

Contribution to the Food Web

What role do emerald shiners play in the diets of sport fish and the common tern?

By using various laboratory techniques and looking at stomach contents of predators, we can determine if the emerald shiner is a key species in the diets of important species in the system.

Effects of Man-Made Structures and Alterations to the Niagara River on Shiner Passage

In this project, we will investigate how bottlenecks in the river affect the movement of the emerald shiner by increasing water velocities.

Education and Outreach

We are committed to engaging and connecting with community members, policymakers, and educators. Our outreach and education specialist is working on getting the message out to the community about the importance to our region of this unique fish that supports many of the species that people love.

emeraldsniper@buffalostate.edu

It is bigger than just a little fish...
The Project

This is the first comprehensive study of the emerald shiner in the Niagara River, eastern Lake Erie, and western Lake Ontario. It includes investigations into the life history, genetics, habitat utilization, migration, and the role in the food web of this valuable species. Funding has been provided by the Niagara Greenway Ecological Standing Committee and by the US Army Corps of Engineers.

The focus of the project is on the important role of the emerald shiner in the Niagara River as it supports and connects the ecosystem through feeding interactions among the organisms in the river. Therefore, any improvements made in the Niagara River for shiner habitat and passage radiate outward, benefiting the whole ecosystem.

This project is unique and multi-disciplinary, and it coordinates with other projects running concurrently. Examples include: NYSDER work at Strawberry Island and Frog Island, Motor Island shoreline habitat restoration, Cherry Farm restoration site, USACE seawall repair project, Buffalo-Niagara Riverkeeper shoreline restoration projects, and emerald shiner population assessments conducted by the Ontario Ministry of Natural Resources.
Work to be accomplished next season - Year 2 (2015):

- Continue study of shiner population ecology and genetics.

- Continue water chemistry and physico-chemical parameter measurements.

- Continue sampling the Black Rock Canal and lock April – June.

- Sample piscivorous fish stomach contents.

- Initiate laboratory shiner swimming experiments.

- Mapping of vegetation and substrate in the upper Niagara.

- Activate emerald shiner project website.
Thank you!