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

Year 2

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The State University of New York

Research team

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US Army Corps of Engineers

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Buffalo State, The State University of New York

University at Buffalo

Virginia Tech

Environment Canada

The Emerald Shiner Connects the Niagara Ecosystem

Niagara River globally recognized as an
Important Bird Area (IBA)

Research

- Habitat use
- Reproductive success
- Year-class formation
- Opportunity for river-lake movement
- Importance in predator diets: sport fish and common terns

Emerald Shiner Project in the Upper Niagara River

Sample Type	Sampling Regime	Number of Sites
Electrofishing (juveniles and adults)	Every other week	11
Wetland Seining (fish larvae)	Every other week	6
Marina Sampling – larval nets	Weekly	8
Bongo nets – larval sampling	Early in the season	5
Zooplankton, Chlorophyll *a*, Total Phosphorus	Every other week	3
Physico-chemistry (T, D.O., Conductivity, pH)	Weekly	13

Population Comparisons

Catch per Unit Effort (CPUE)

- Electrofishing gear mounted on boat

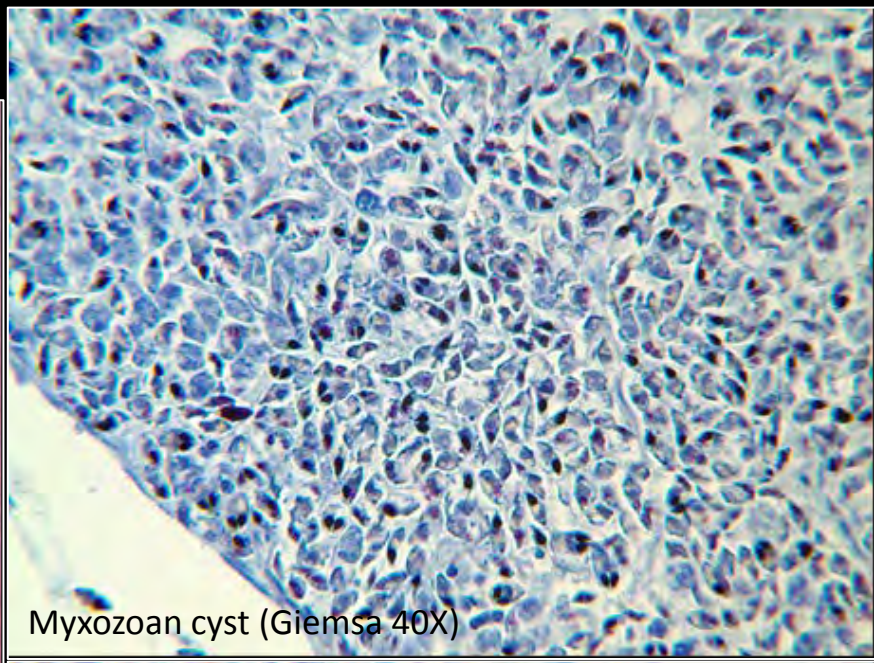
- CPUE 2014: 11.9 shiners/minute
- CPUE 2015: 2.7 shiners/minute

- Emerald shiner population in 2015 was one-fourth the size of the population in 2014. Population reduction of 75%.

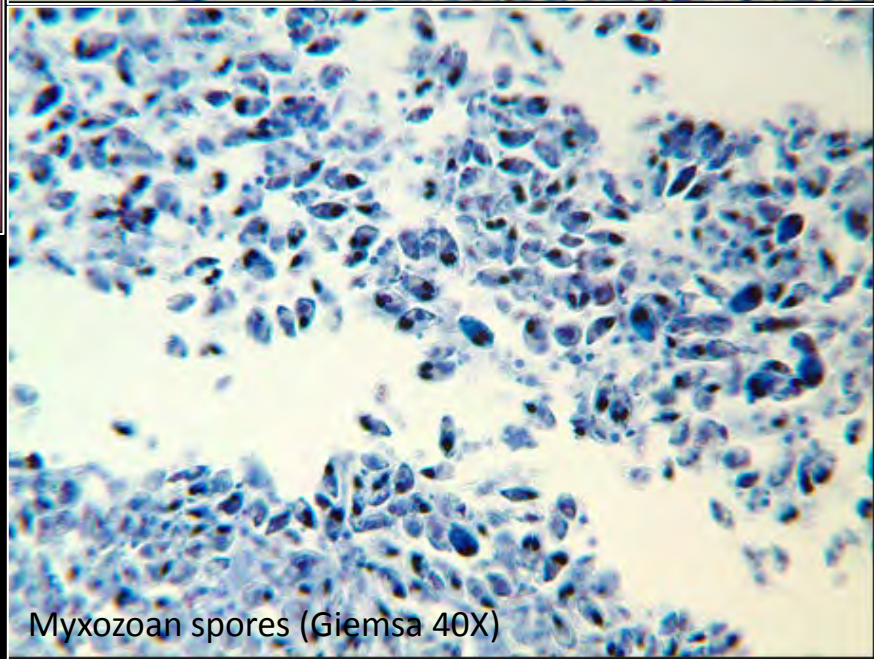
- Population reductions reported in the western, central and eastern basins of Lake Erie in 2015 (source L. Erie Forage Task Group, *pers. comm.*)

Signs of disease in 2015 – Pathology: Cornell Veterinary School

Gill myxozoan cyst (H&E 40X)



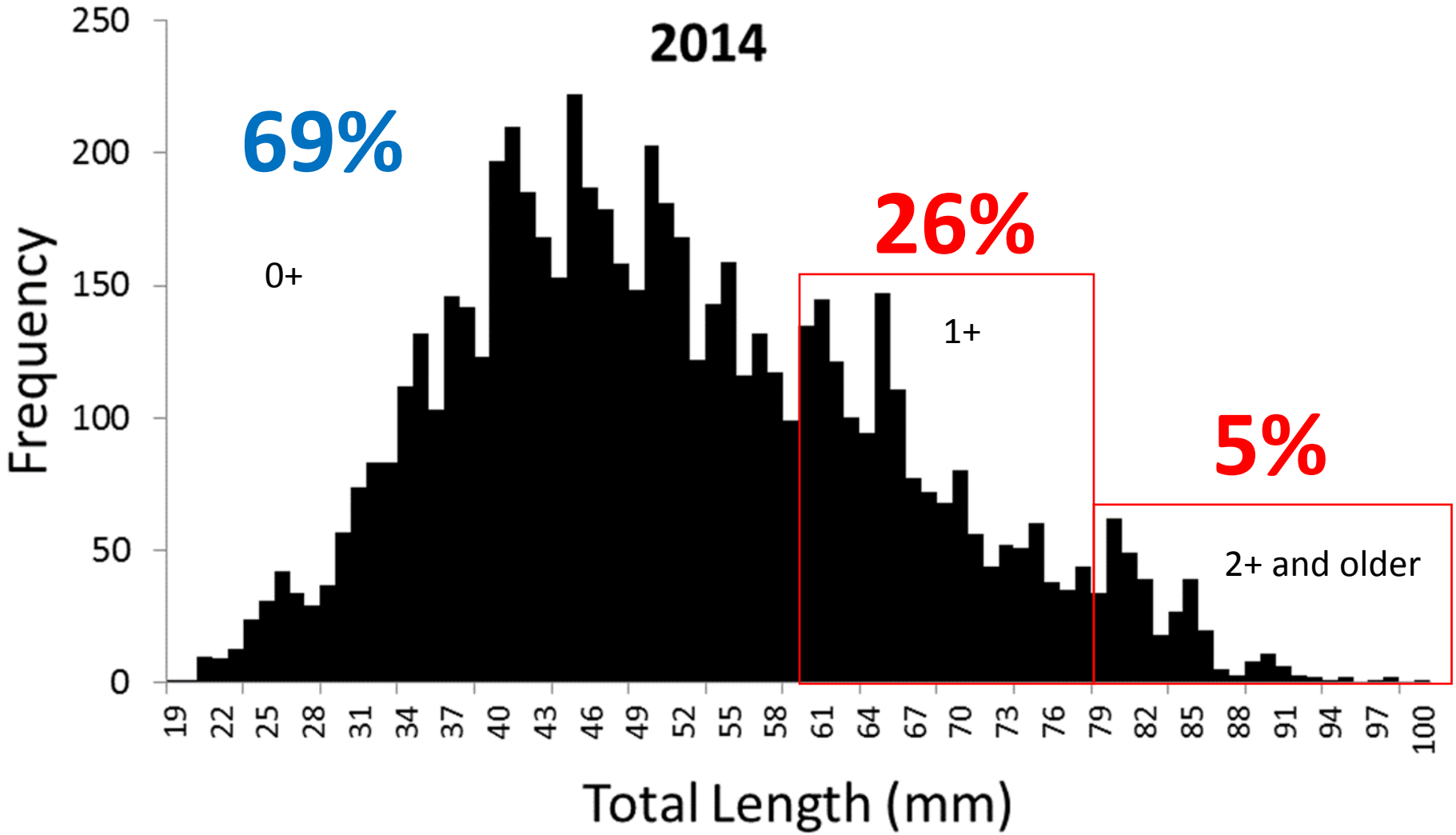
Myxozoan cyst (Giemsa 40X)



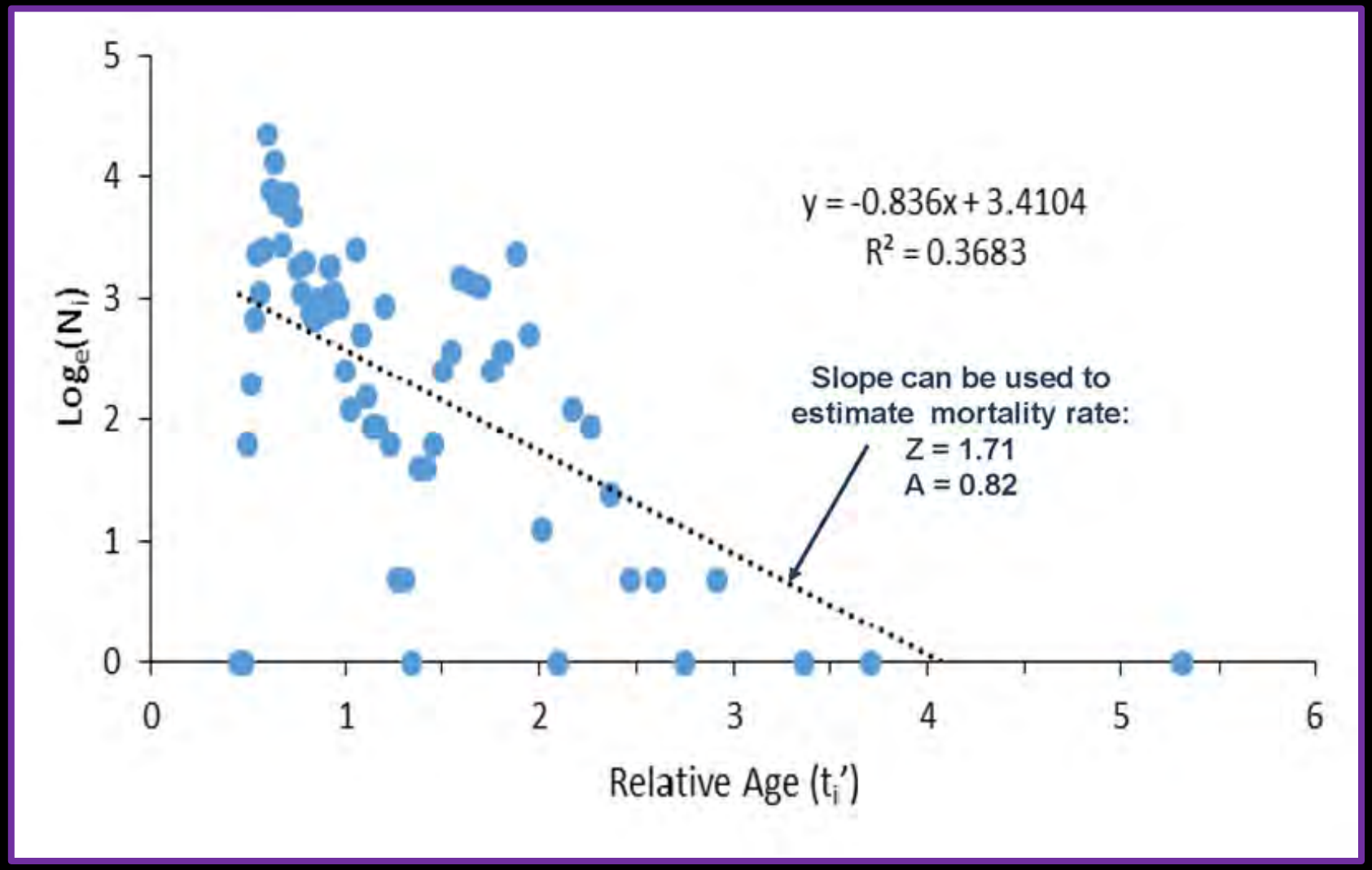
Myxozoan spores (Giemsa 40X)

Emerald shiners presented myxozoan parasite infestation of gills and coelomic cavity, in some cases internal organs were compressed to the side.

Reproducing Population

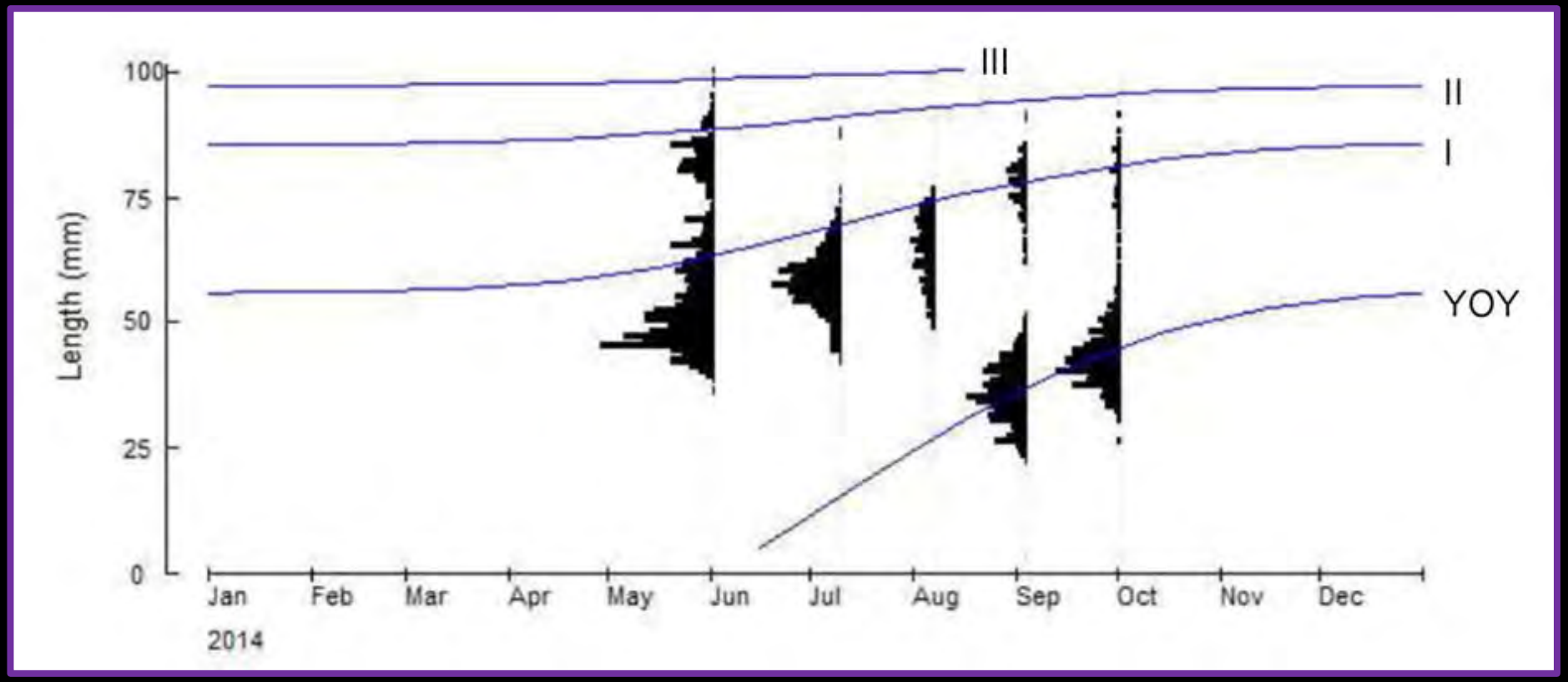


Emerald shiner mortality rate in upper Niagara



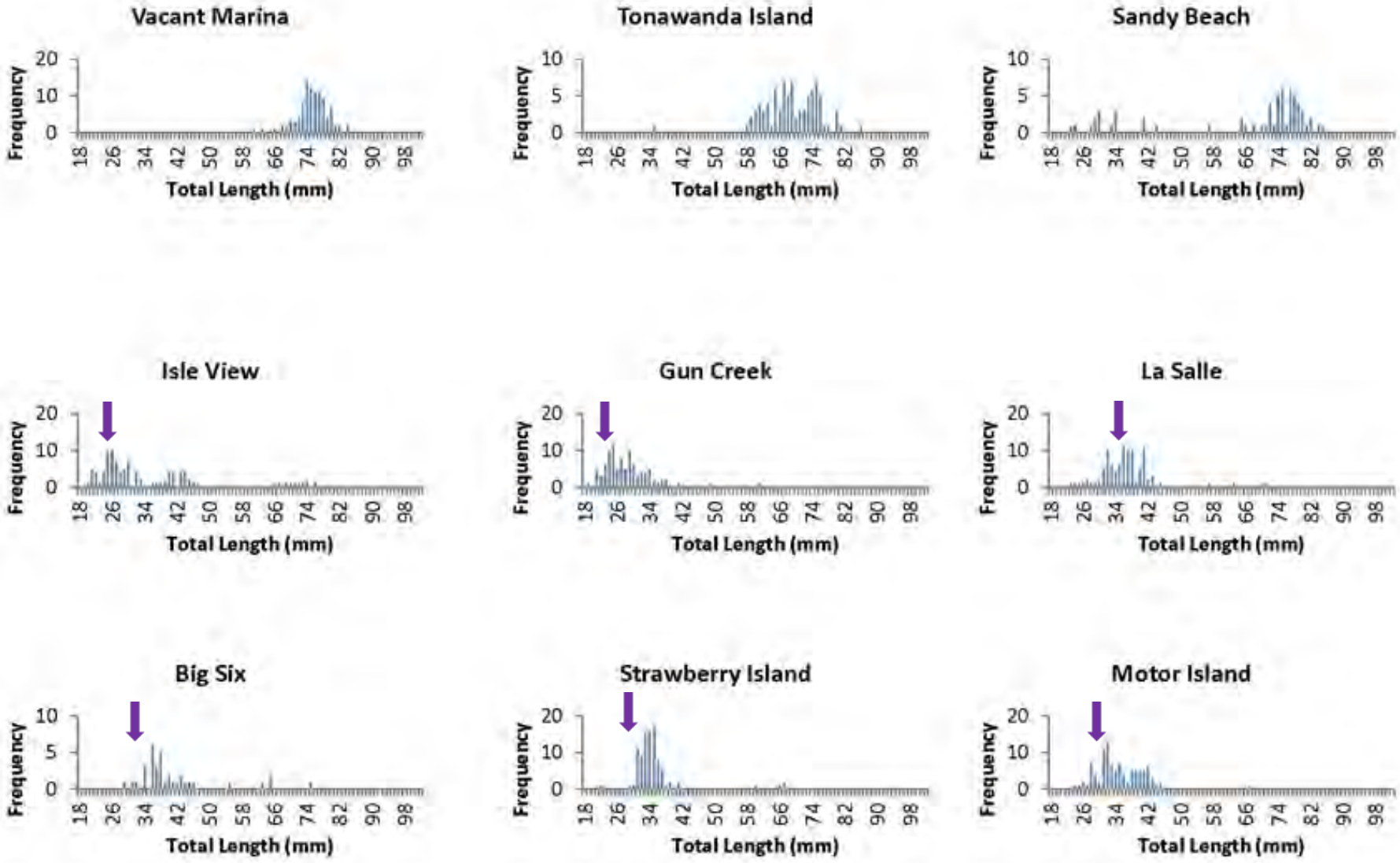
Annual emerald shiner mortality = 82%, survivorship = 18%

Growth rates of emerald shiners

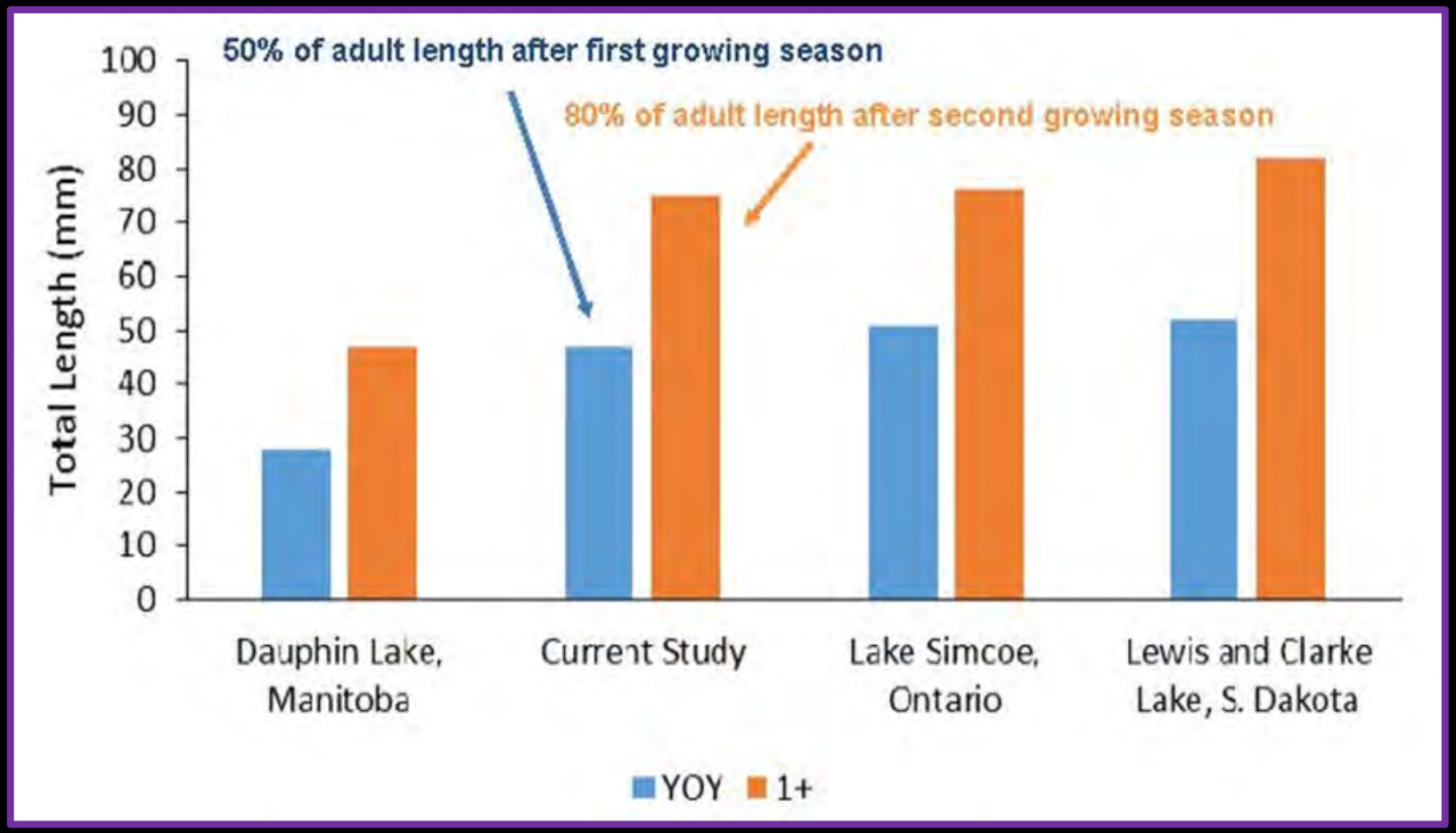


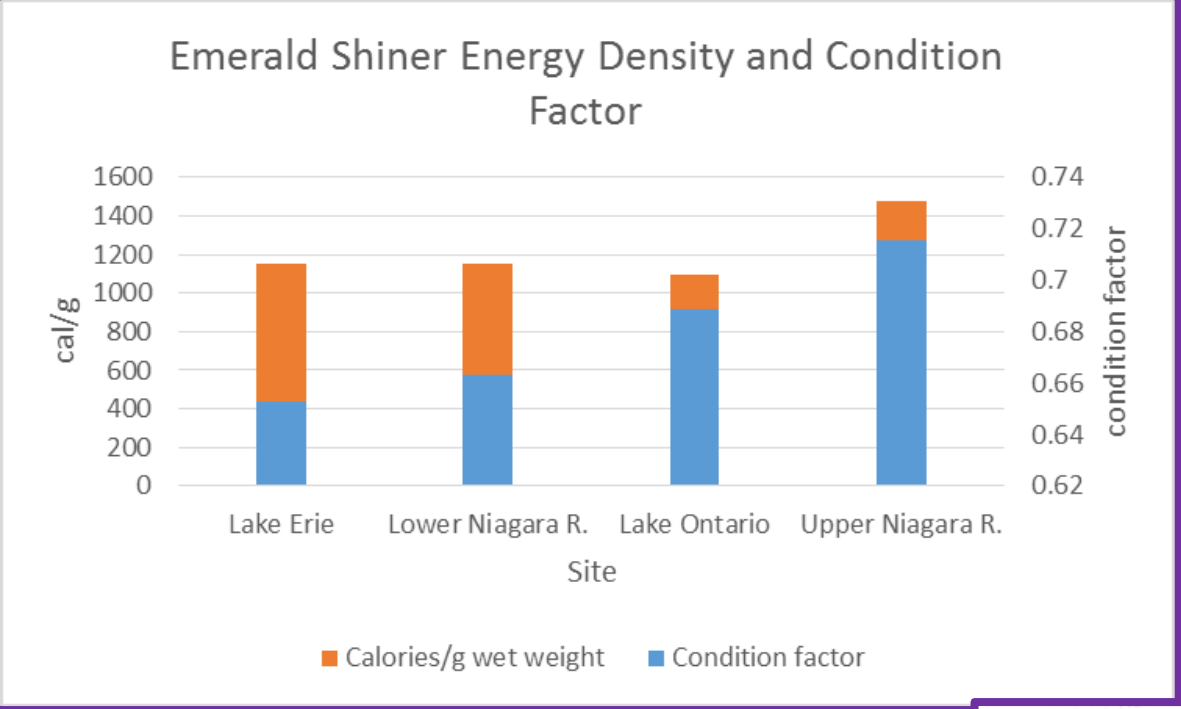
von Bertalanffy growth curves

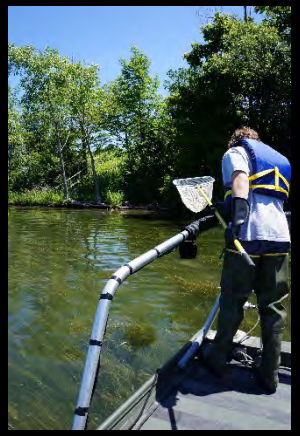
Sites where YOY emerald shiners first appeared

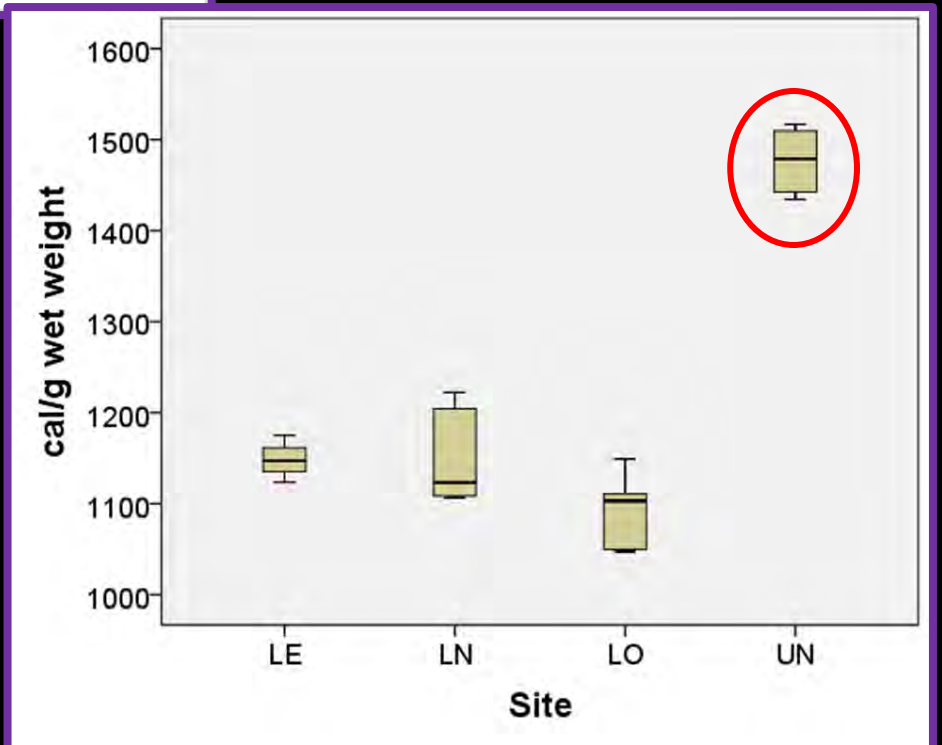


Comparison of emerald shiner growth




Emerald Shiner Energy Density and Condition Factor
1600
1400
1200
1000
800
600
400
200
0
cal/g
0.74
0.72
0.7
0.68
0.66
0.64
0.62
condition factor
Lake Erie
Lower Niagara R.
Lake Ontario
Upper Niagara R.
Site
Calories/g wet weight
Condition factor

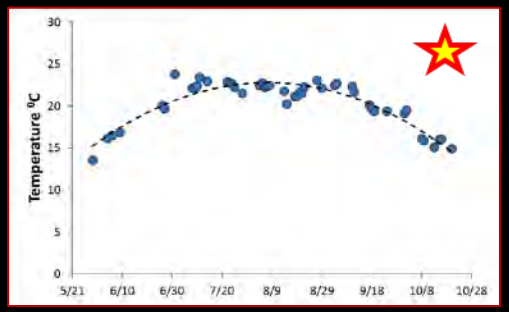



1600
1500
1400
1300
1200
1100
1000
cal/g wet weight
LE
LN
LO
UN
Site

Light

Temperature

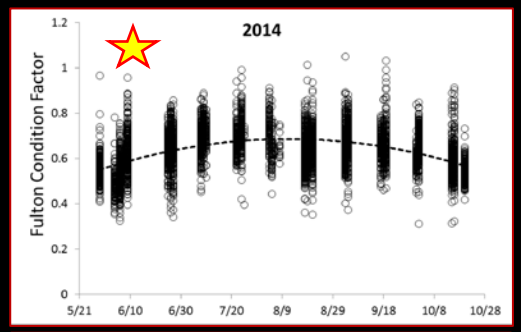
Emerald Shiner Condition

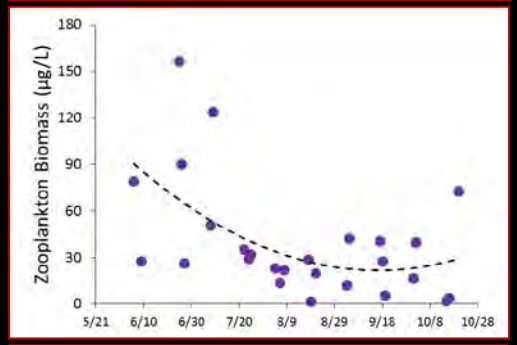


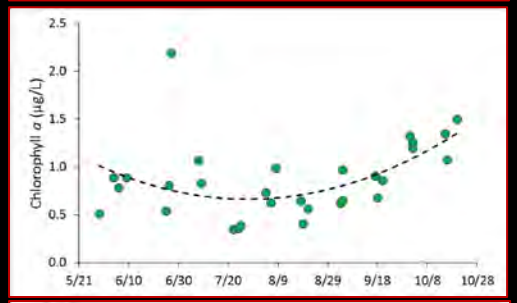
Zooplankton

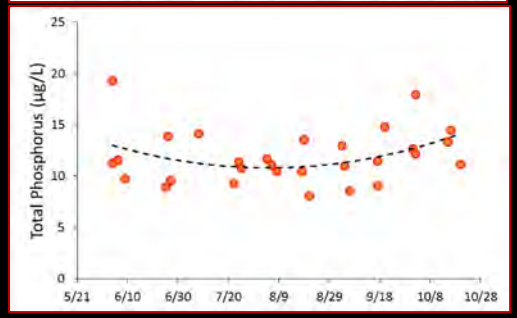
Algae

Nutrients



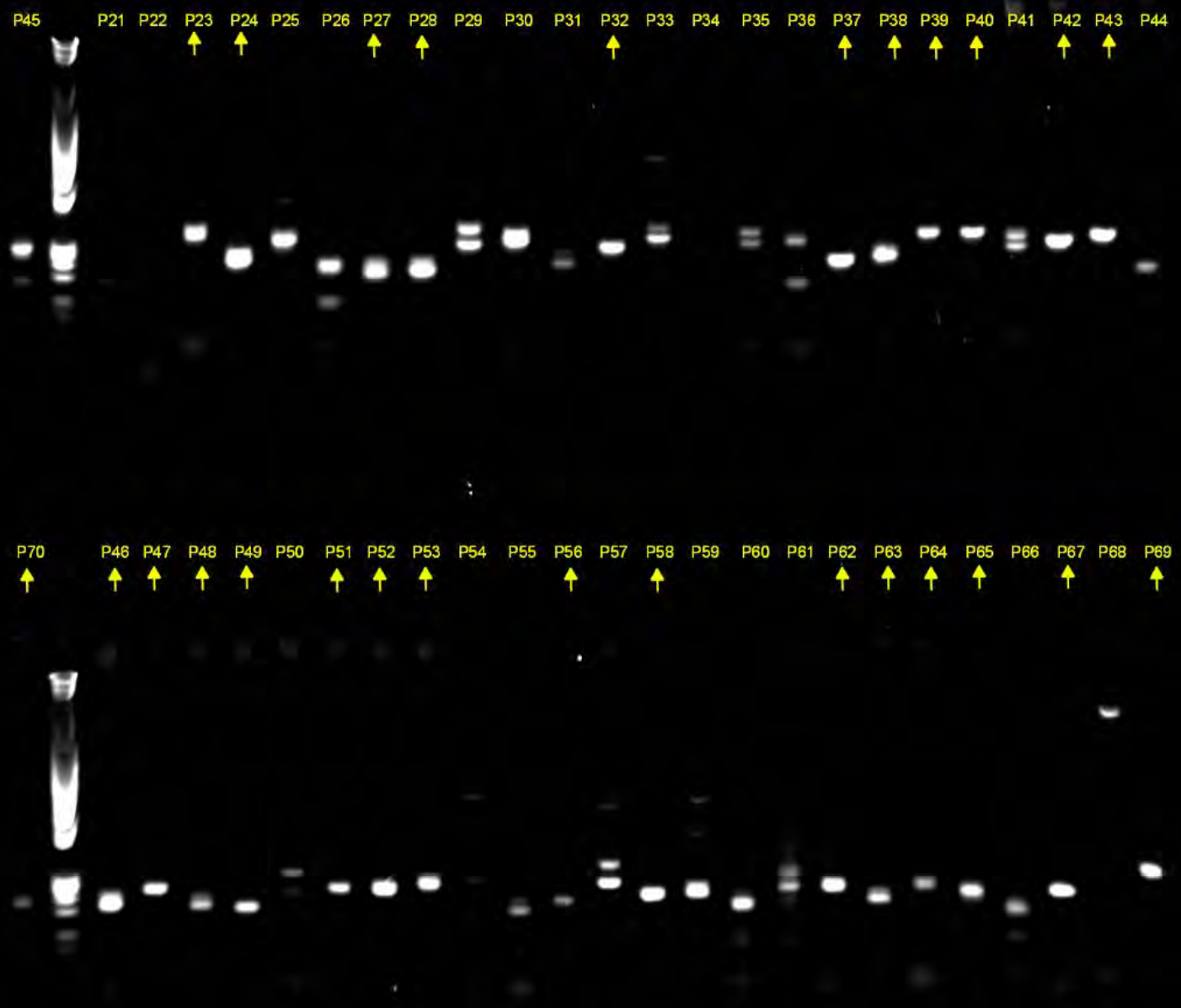




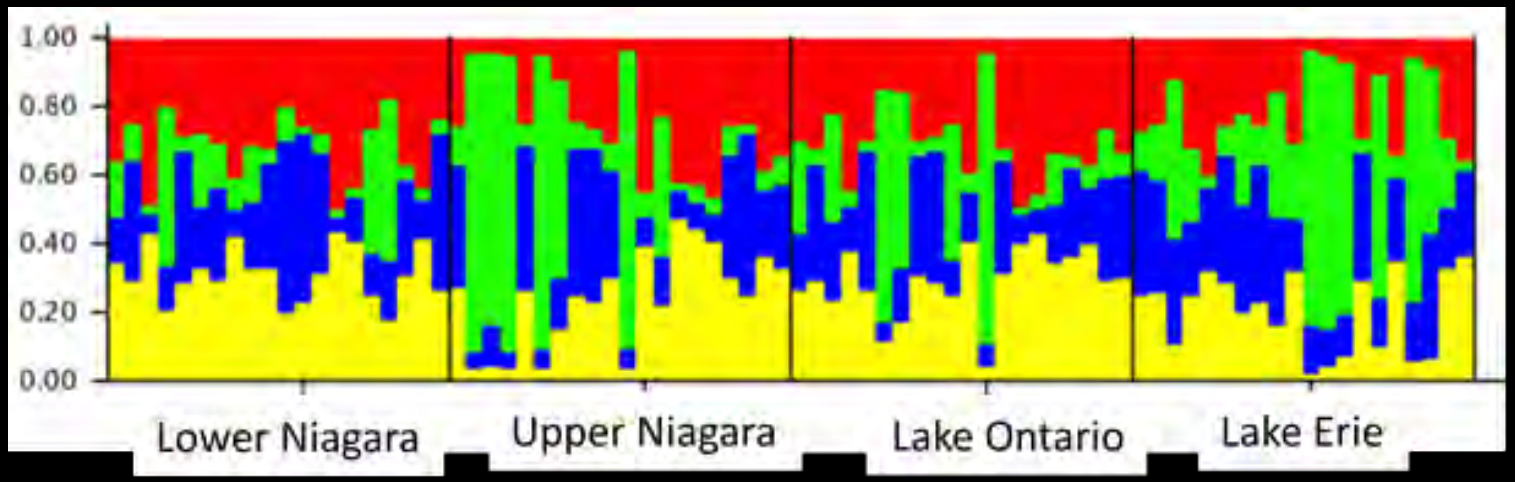


Temperature and Condition, Pearson correlation $P < 0.0001$

Genetic study



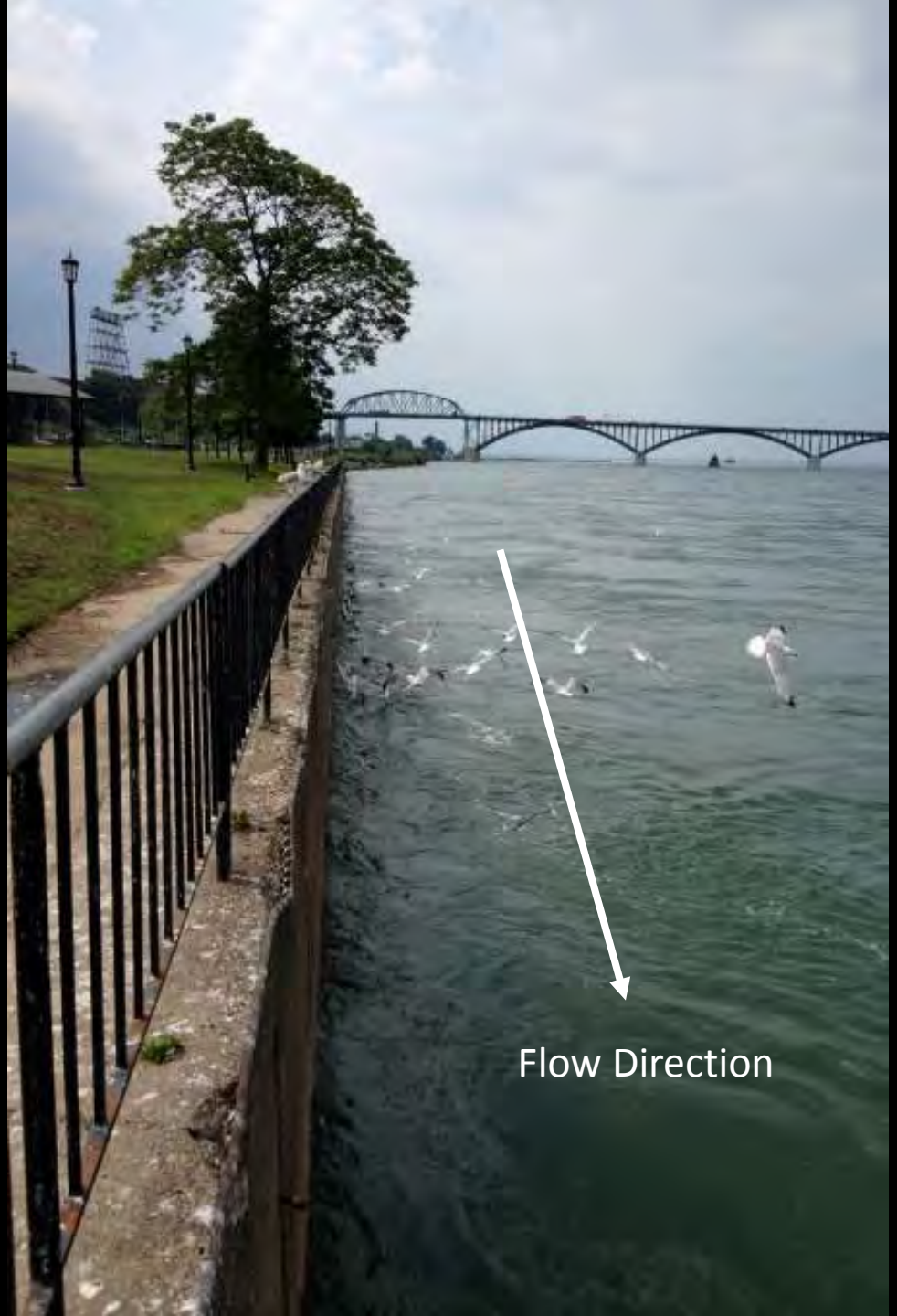
Inferred population structure for the microsatellite data



Seasonal sampling increased for more complete coverage

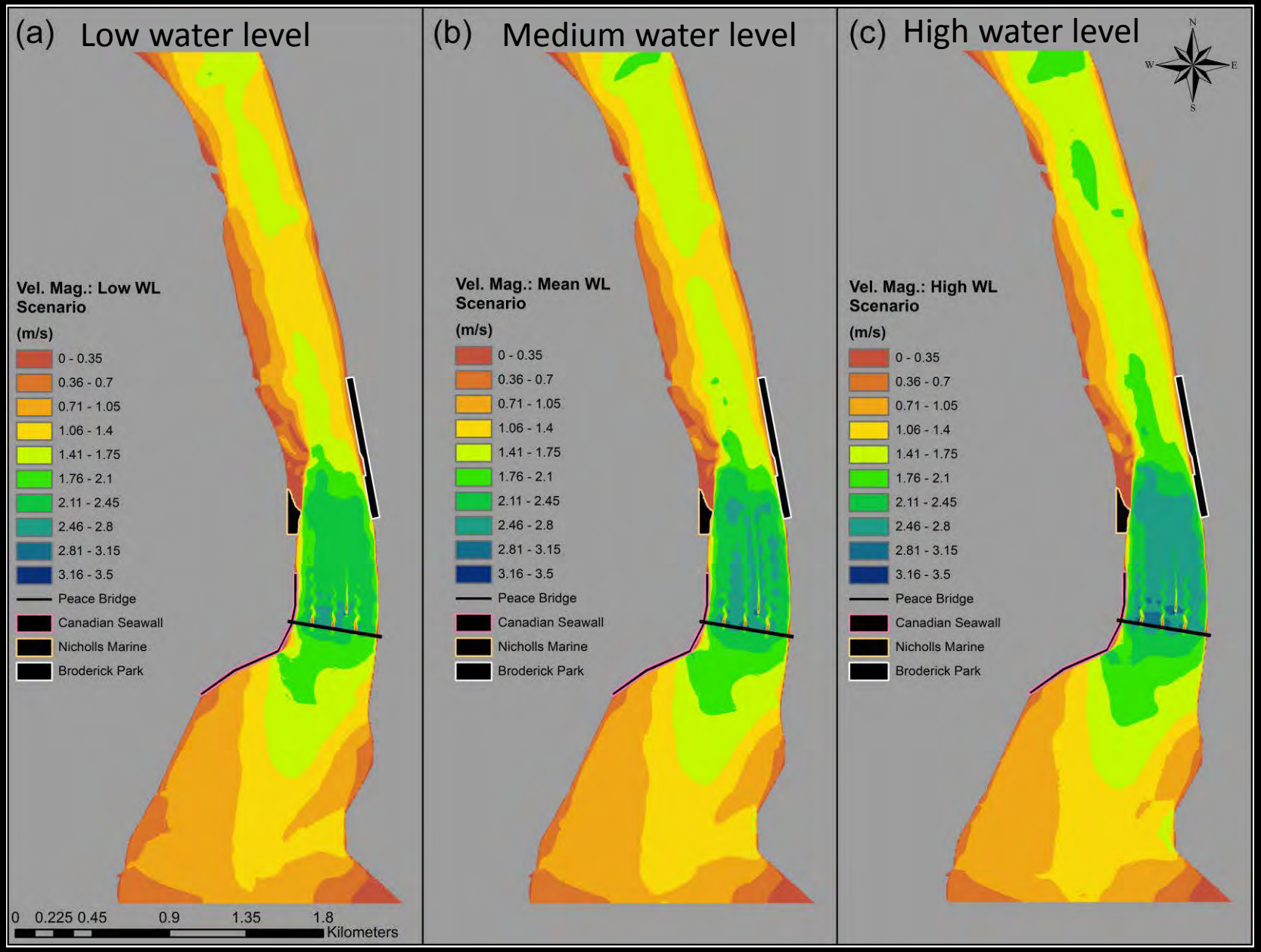
Date, 2015	Location	# shiners
June 15-19	Upper Niagara River	50
	Lower Niagara River	50
	Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)	50
	Western Lake Ontario (Wilson, NY)	50
July 27-31	Upper Niagara River	50
	Lower Niagara River	50
	Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)	50
	Western Lake Ontario (Wilson, NY)	50
October 5-9	Upper Niagara River	50
	Lower Niagara River	50
	Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek)	50
	Western Lake Ontario (Wilson, NY)	50

Barriers to emerald shiner movement

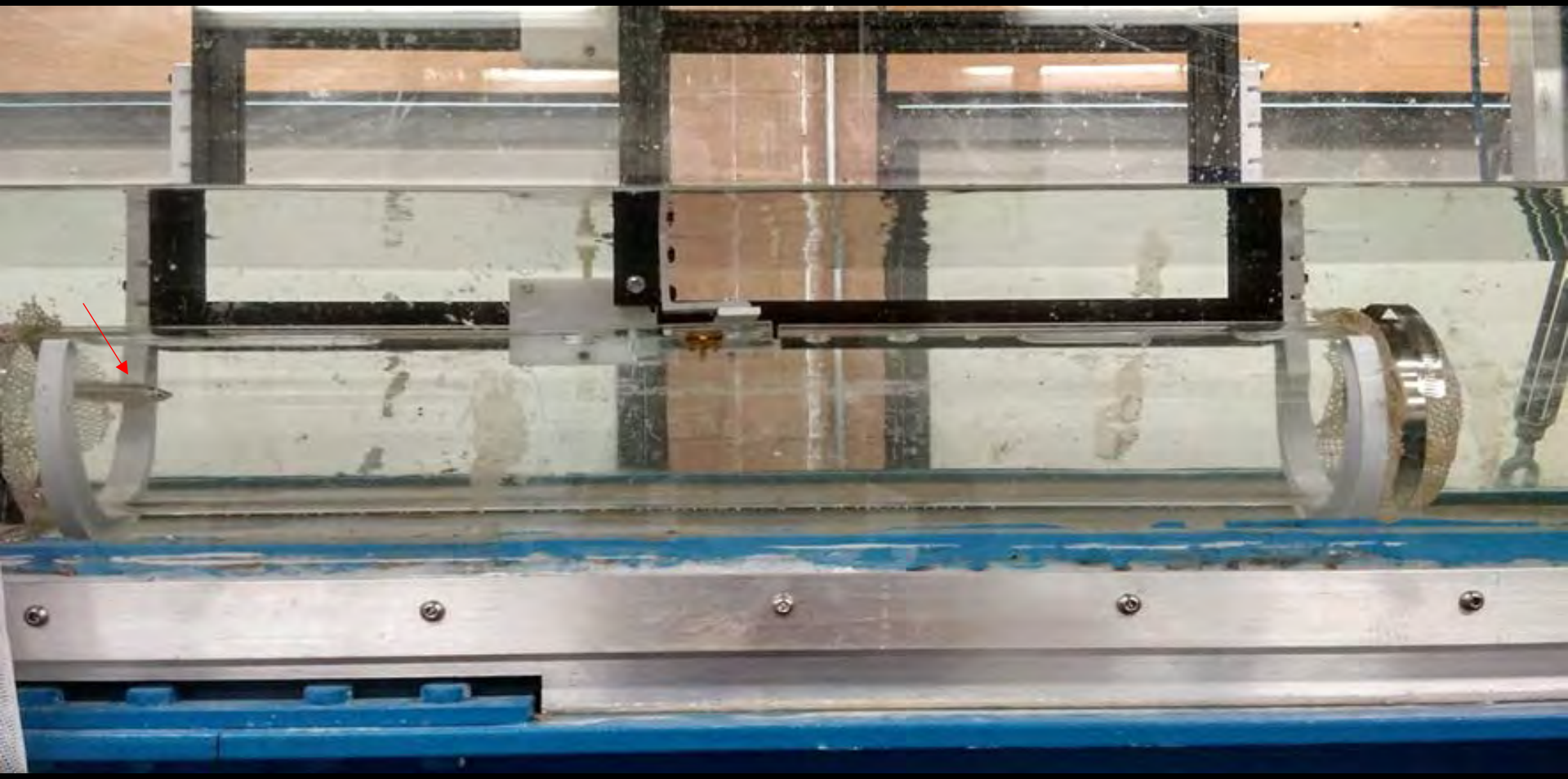


Vertical seawall located upstream of the shoreline recess at Broderick Park

Depth-averaged water velocity model

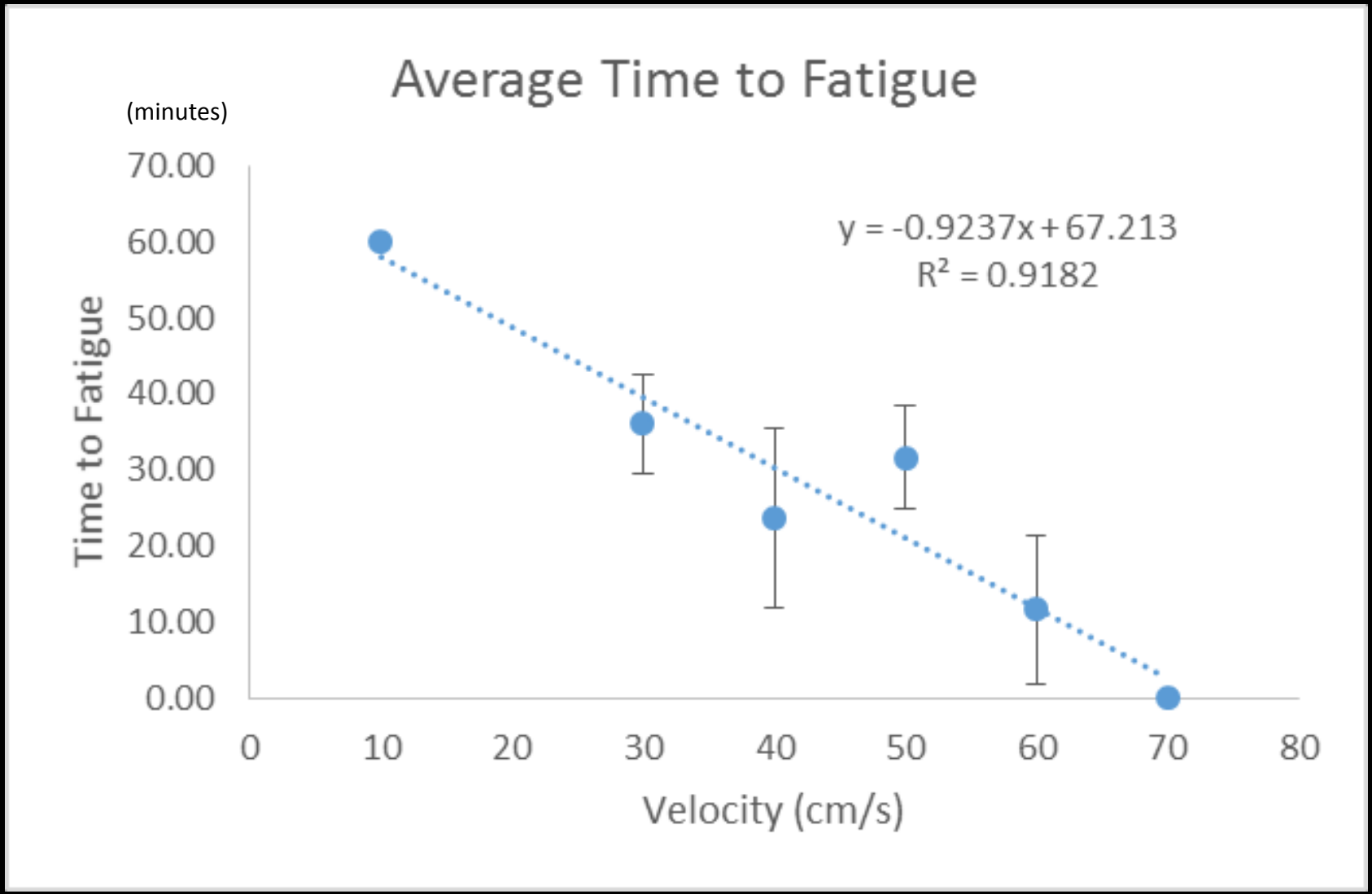


Emerald shiner swimming ability experiments



Swim tunnel placed in a recirculating flume

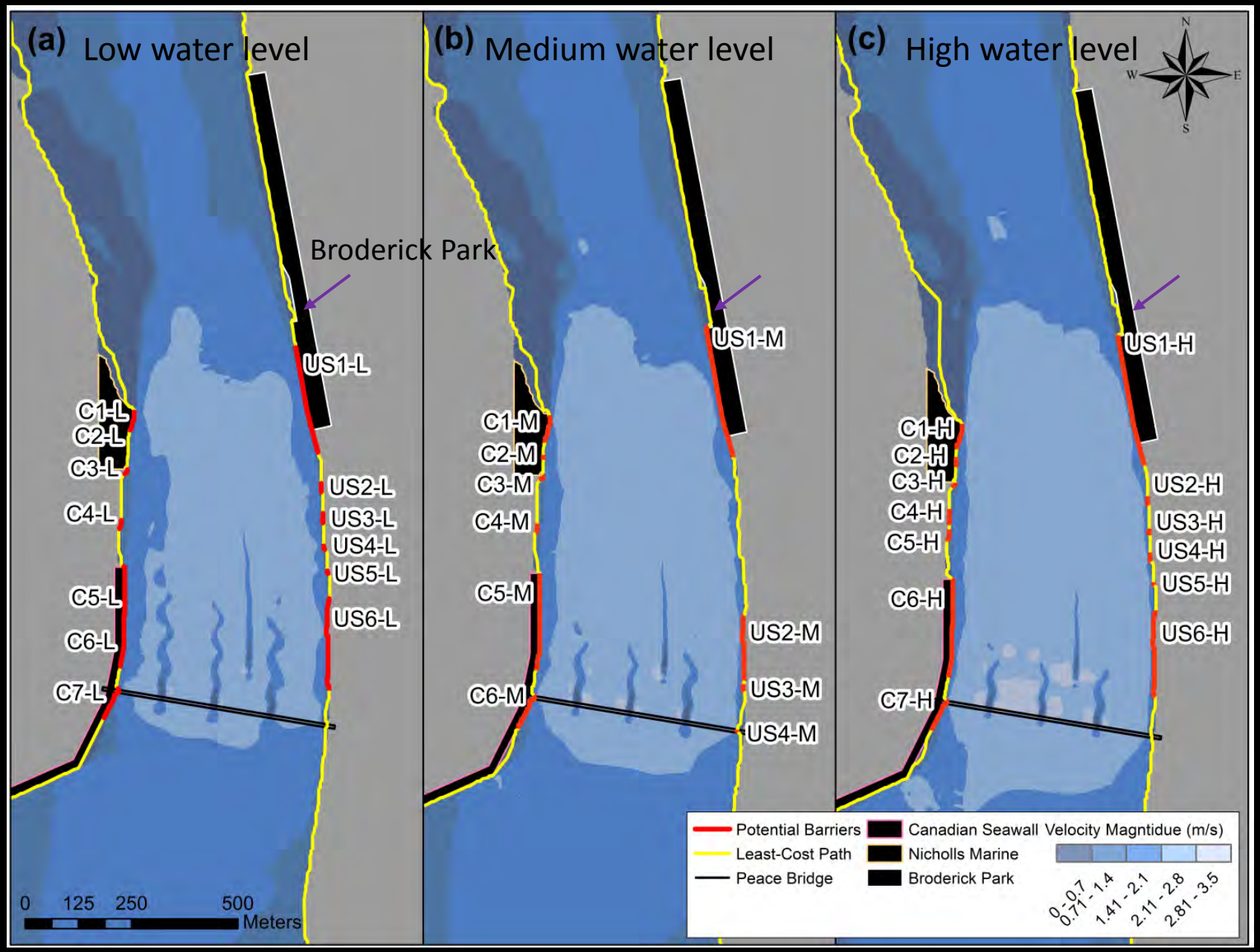
Laboratory measurements of emerald shiner swimming velocity



Compare to average velocity near pier upstream Broderick Park at 200 cm/s

Swimming against current

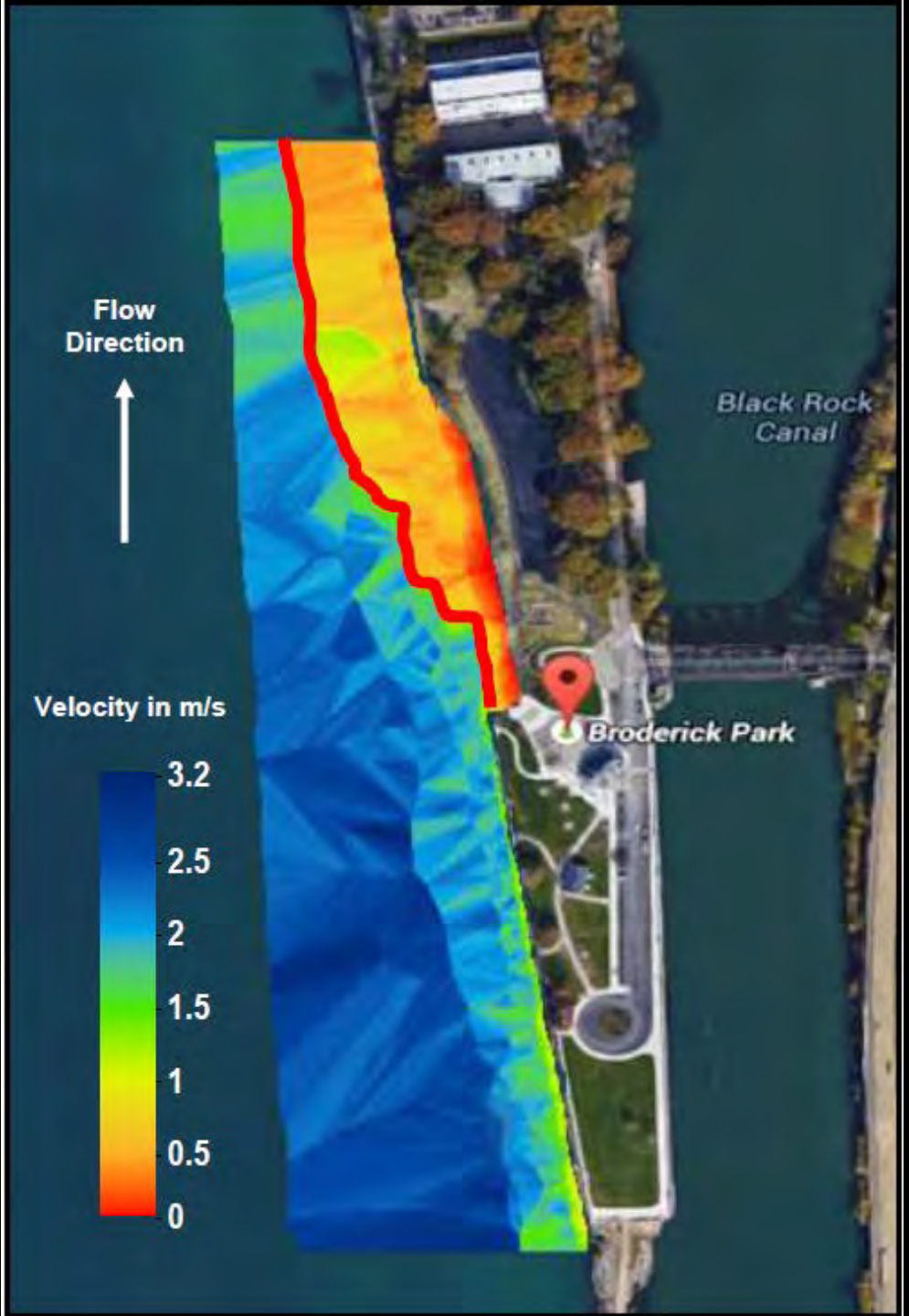
Potential barriers to emerald shiner passage along the least-cost paths



The issue with the Broderick Park seawall

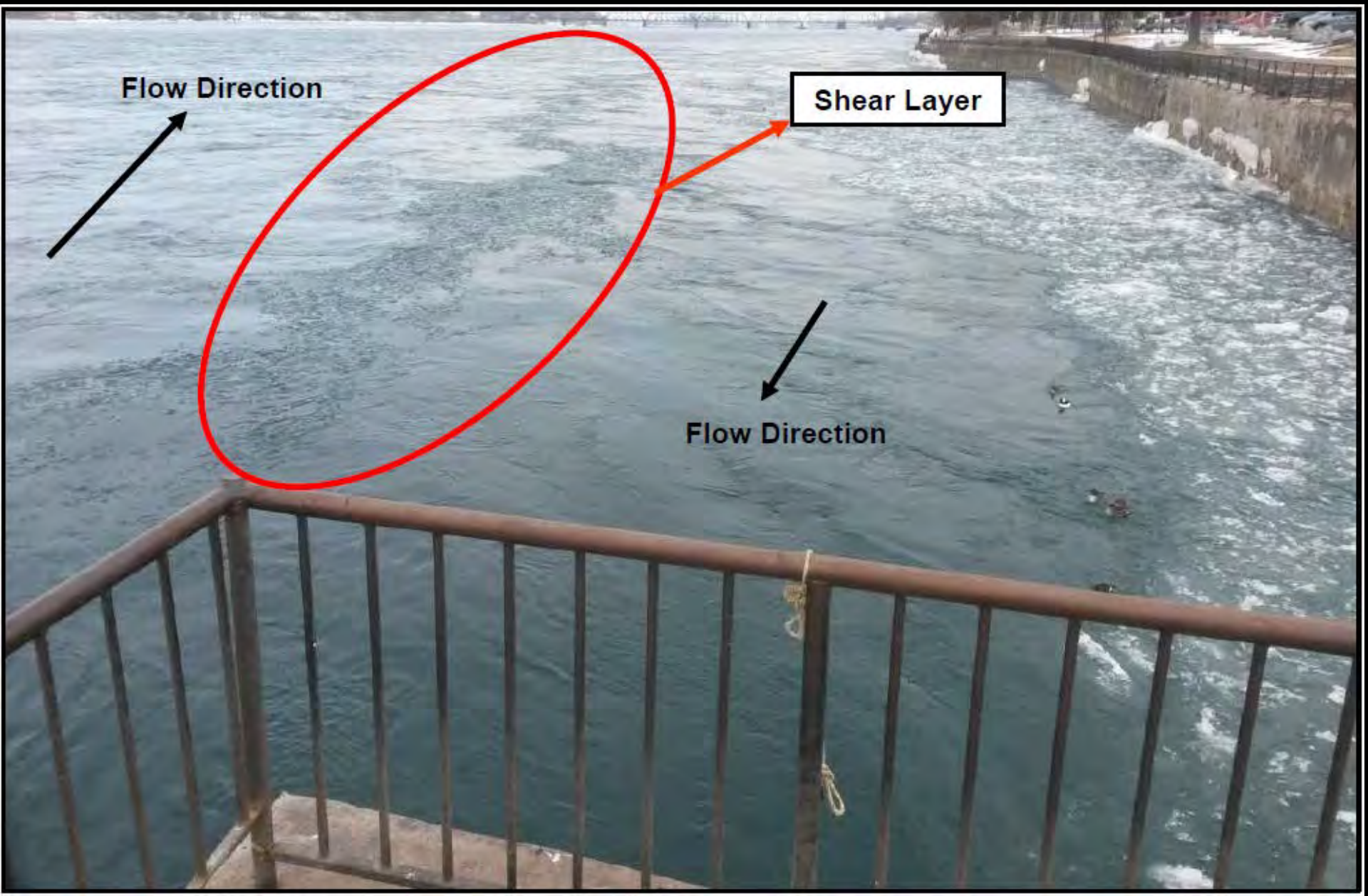
Collection of vertical water velocity profiles along the Broderick Park Seawall using an Acoustic Doppler Current Profiler

Plan view of the velocity magnitudes along the Broderick Park shoreline at a water depth of 1.15 *m*.



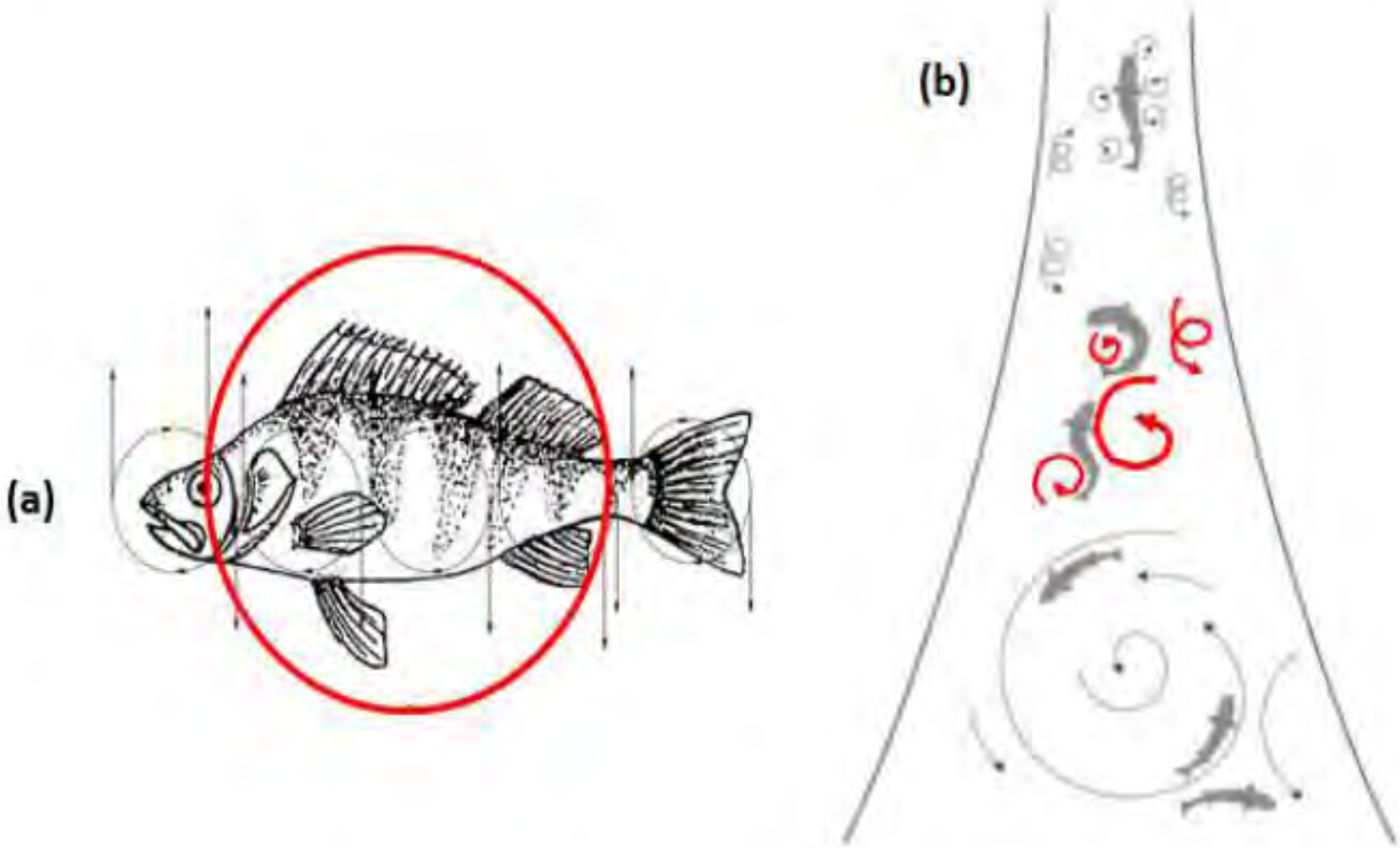
Shoreline recess at Broderick Park

The region in red represents the shear layer, which extends to 200 *m* downstream

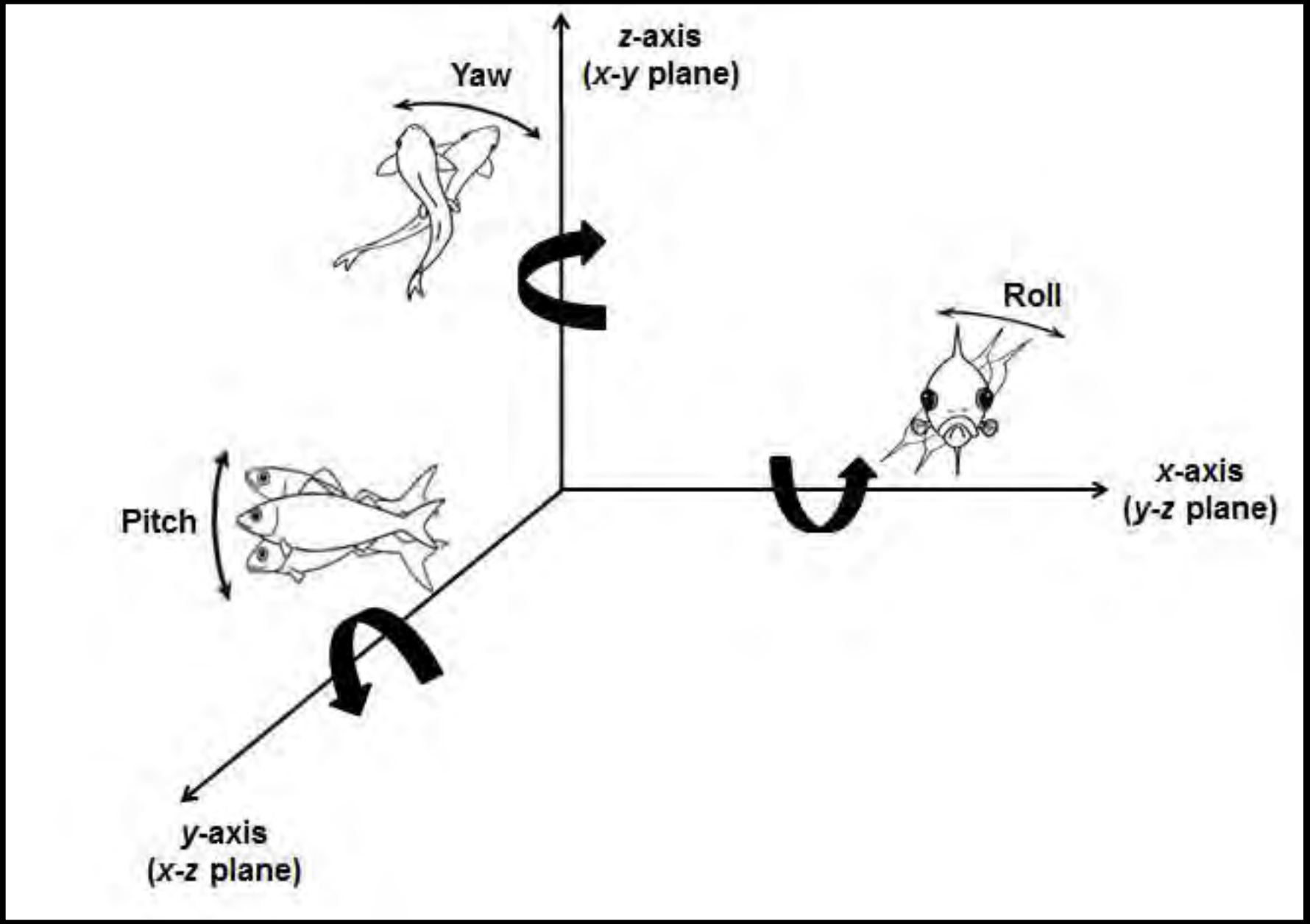


A. Hannes, USACE

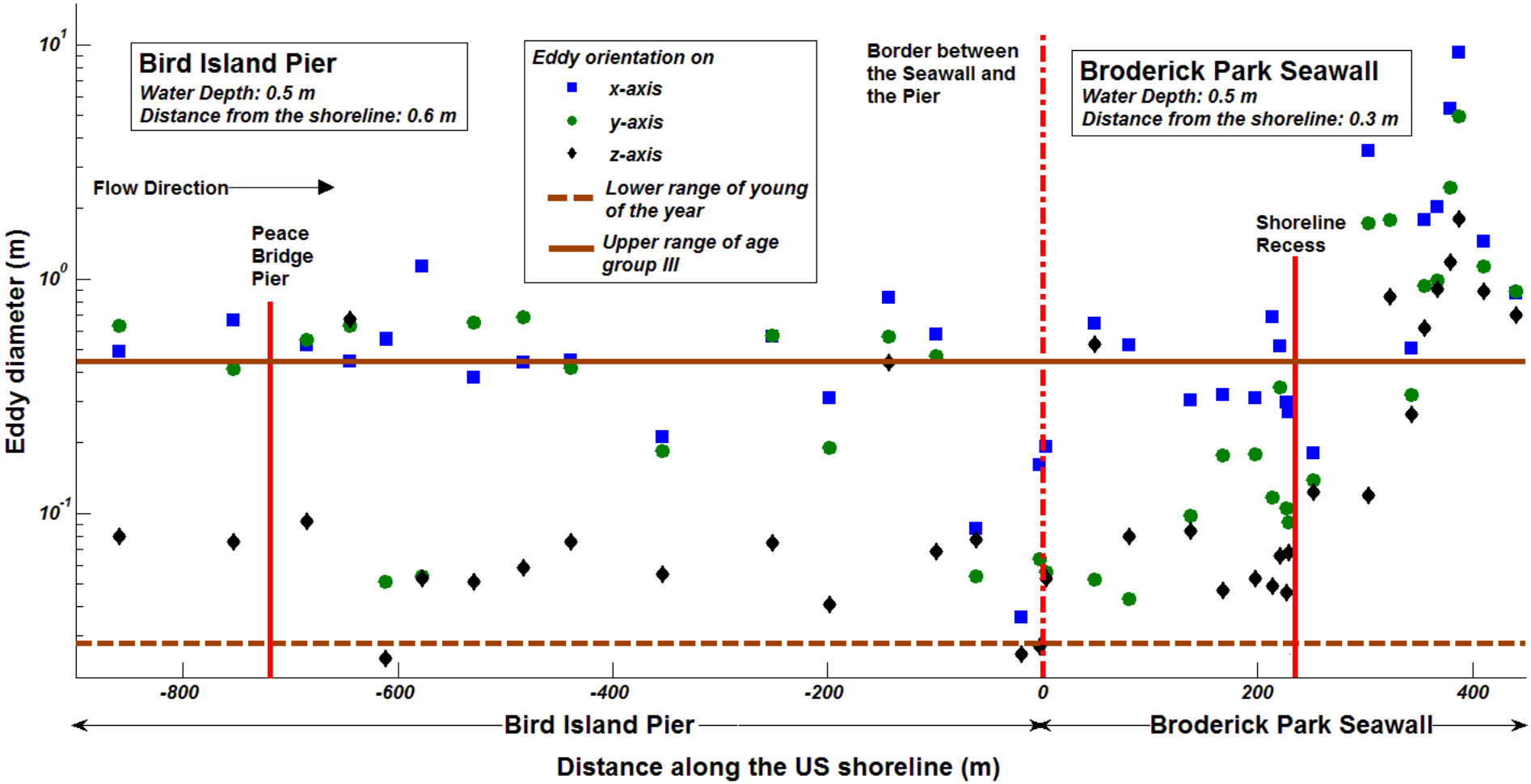
Schematic of fish interaction with eddies



The eddies highlighted in red represent the problematic range of eddy sizes for a fish


z-axis
(x-y plane)
Yaw
Roll
x-axis
(y-z plane)
Pitch
y-axis
(x-z plane)

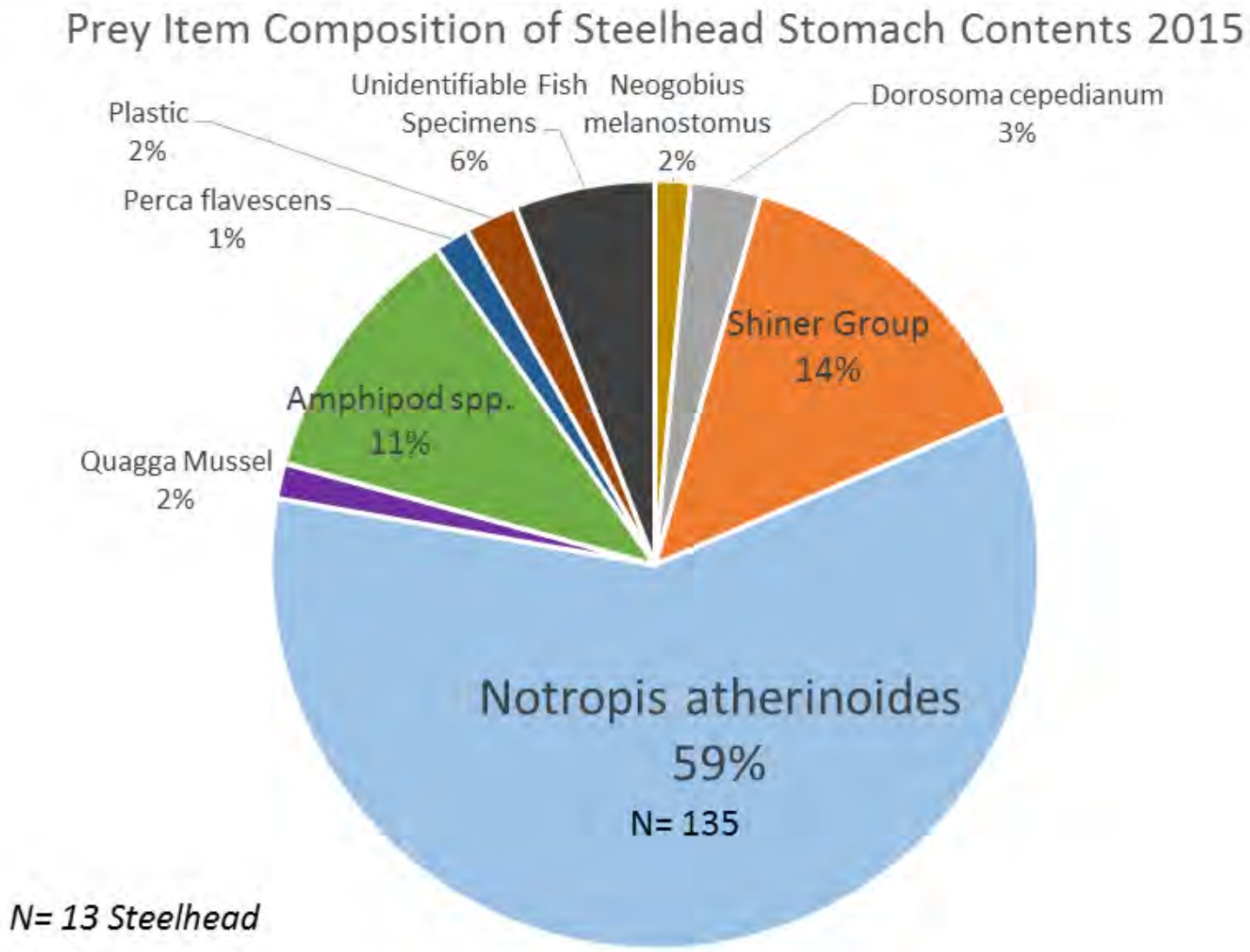
Size of eddies along the Broderick Park shoreline and the Bird Island Pier



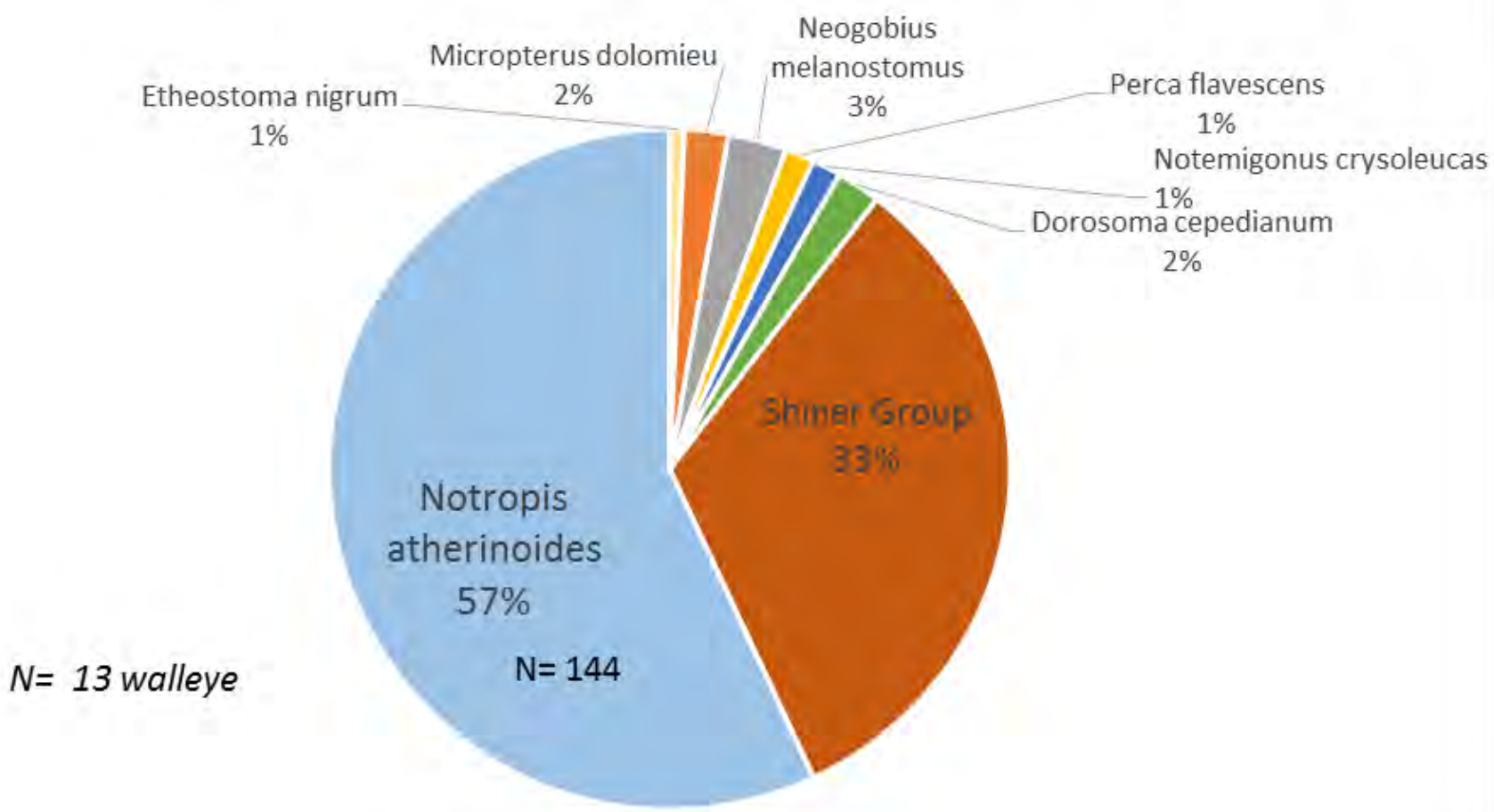
The solid brown line represents the upper value of the problematic eddy size range for 90 mm TL emerald shiners and the dotted brown line represents the lower value of the problematic eddy size range for young-of-the-year emerald shiners. The region between the dotted and solid brown line is the supposed problematic range of eddy sizes for the entire emerald shiner population.

Predatory fish consumption of emerald shiners

Predator Fish	Number
Bowfin	3
Largemouth bass	15
Muskellunge (stomach lavage only, fish released)	1
Northern Pike (stomach lavage only, fish released)	3
Rock Bass	6
Rudd	8
Smallmouth Bass	16
Steelhead trout	13
Walleye	17
White Bass	17
White Perch	1
Yellow Perch	15
Total	**115**

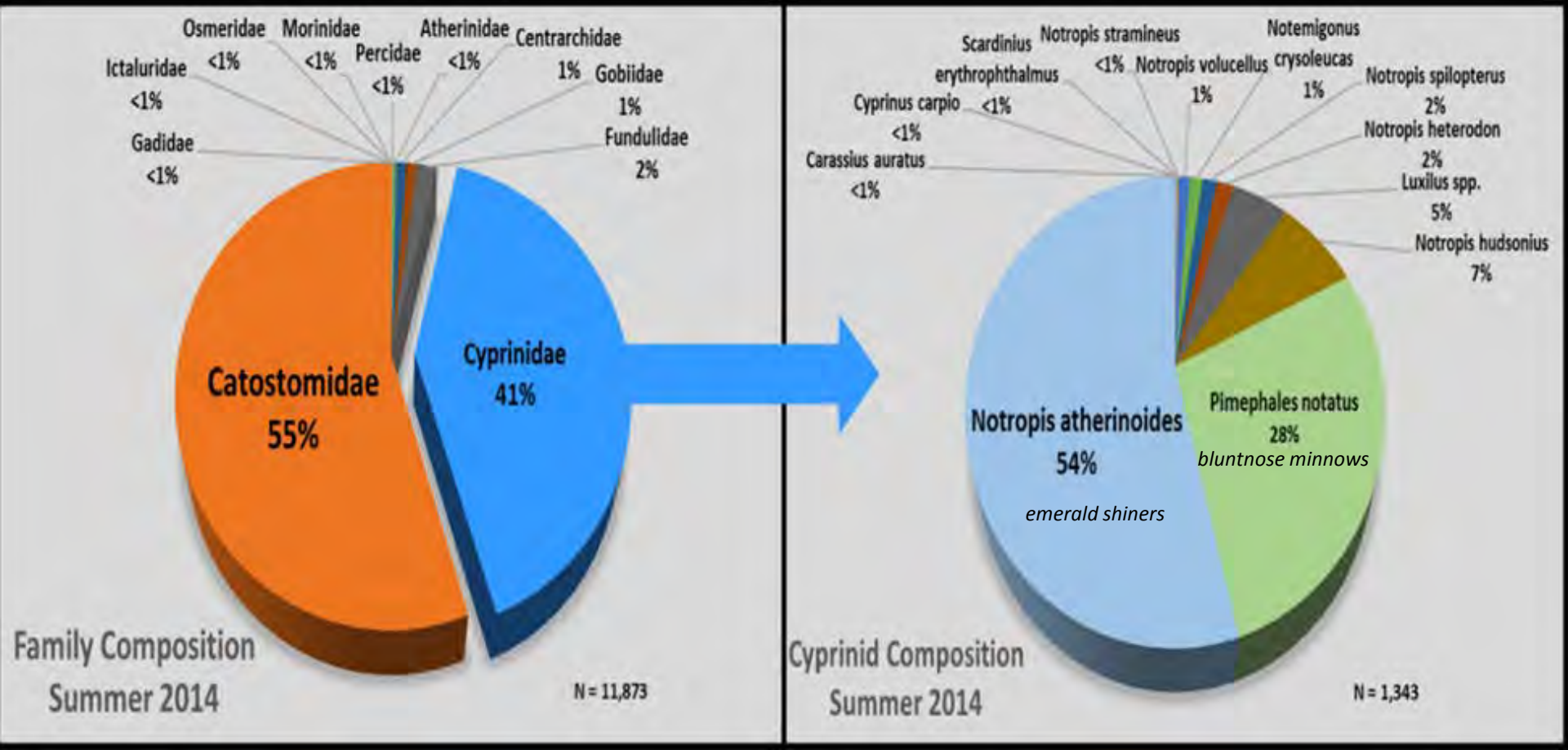


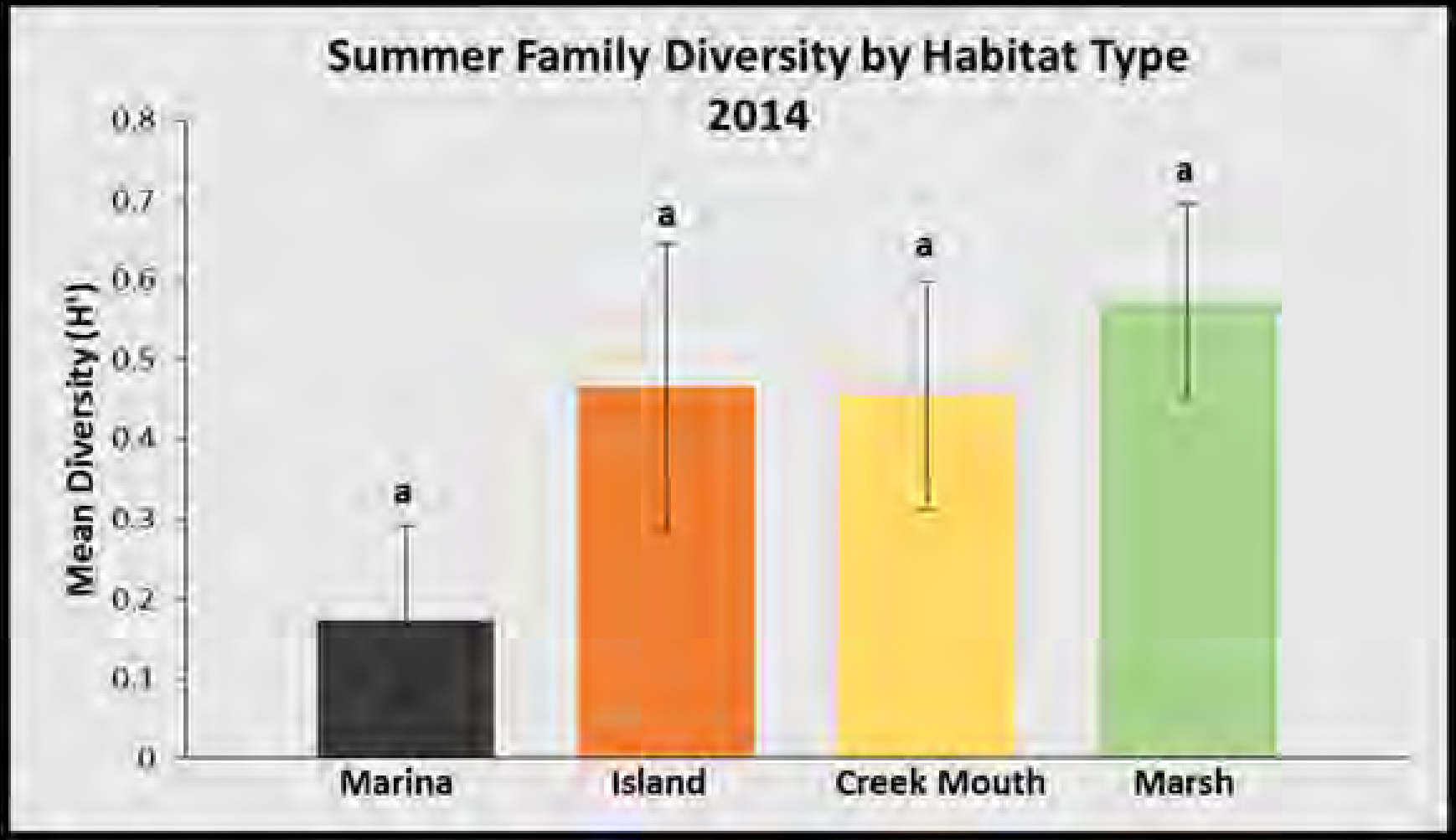
N= 13 Steelhead


Prey Item Composition of Walleye Stomach Contents 2015
Etheostoma nigrum
1%
Micropterus dolomieu
2%
Neogobius
melanostomus
3%
Perca flavescens
1%
Notemigonus crysoleucas
1%
Dorosoma cepedianum
2%
Shiner Group
33%
Notropis
atherinoides
57%
N= 144
N= 13 walleye

Larval fish in the upper Niagara

Fish larvae in the Niagara collected in nursery wetland areas

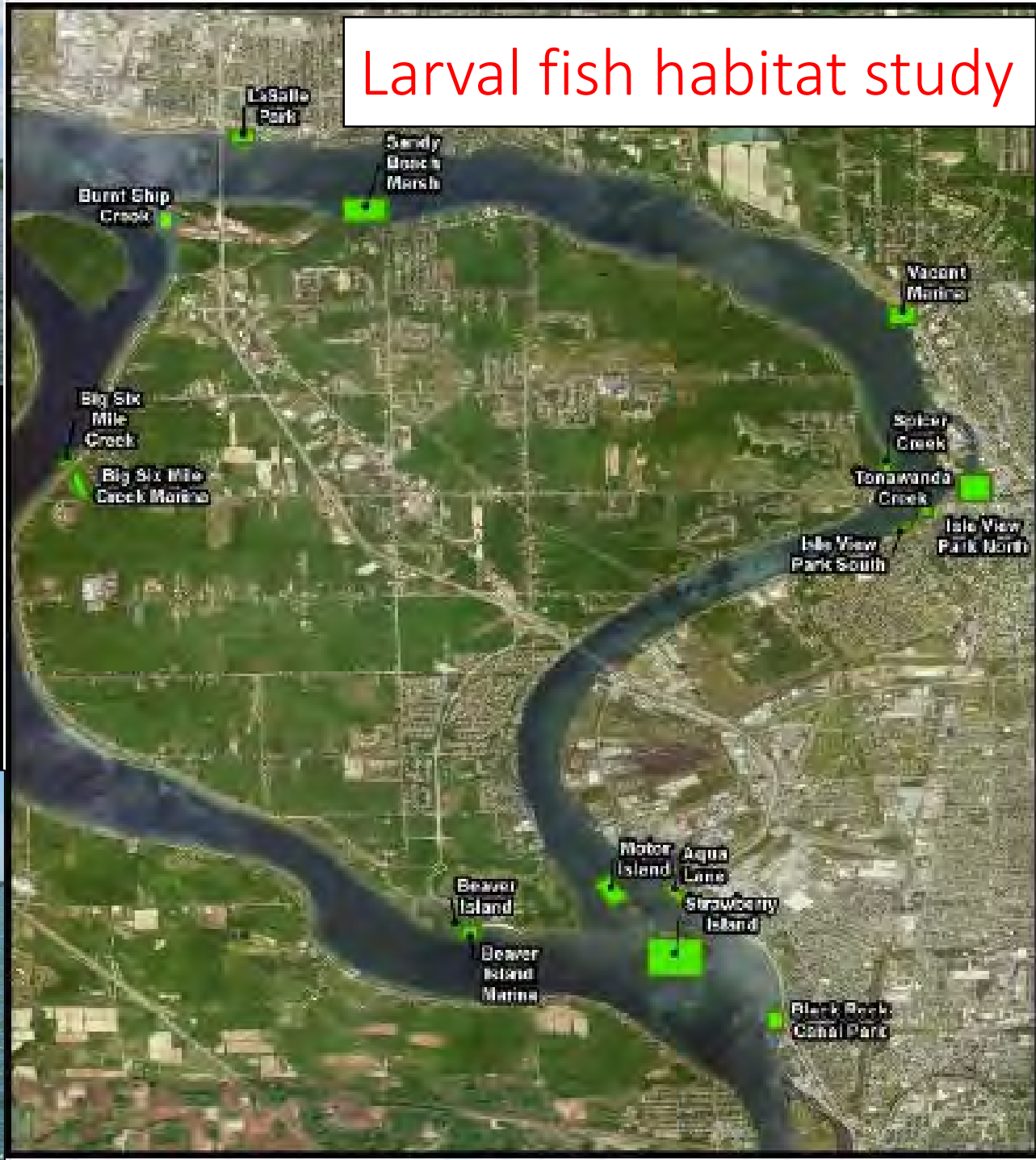



Summer Family Diversity by Habitat Type
2014
Mean Diversity (H')
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
a
a
a
a
Marina
Island
Creek Mouth
Marsh

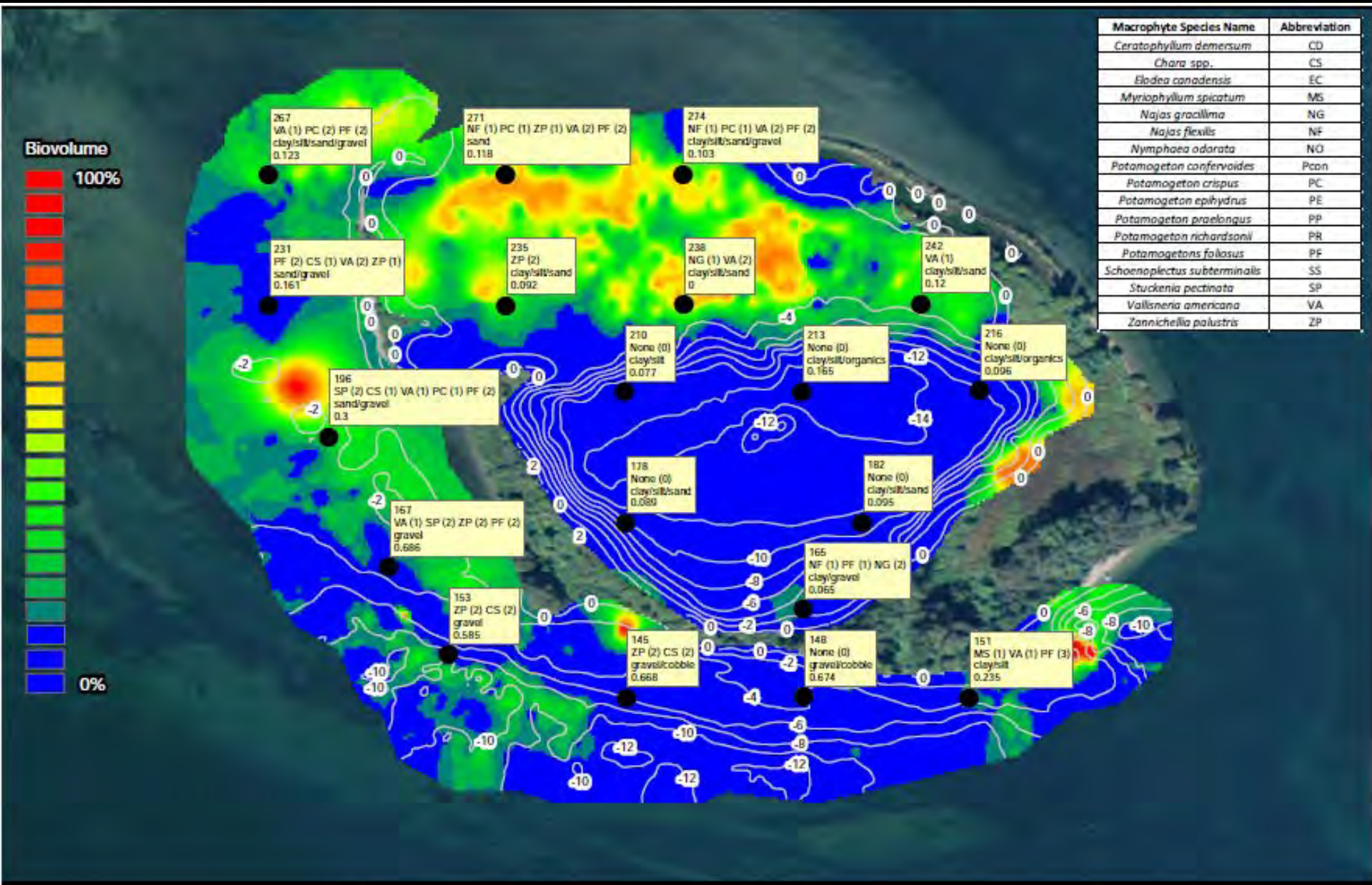
Larval fish habitat study

Vegetation sampling for:
Species identification
and biovolumes.

Sonar equipment used
with BioBase® software
to create vegetation and
substrate coverage maps.



Example of one site: Strawberry Island habitat characterization map

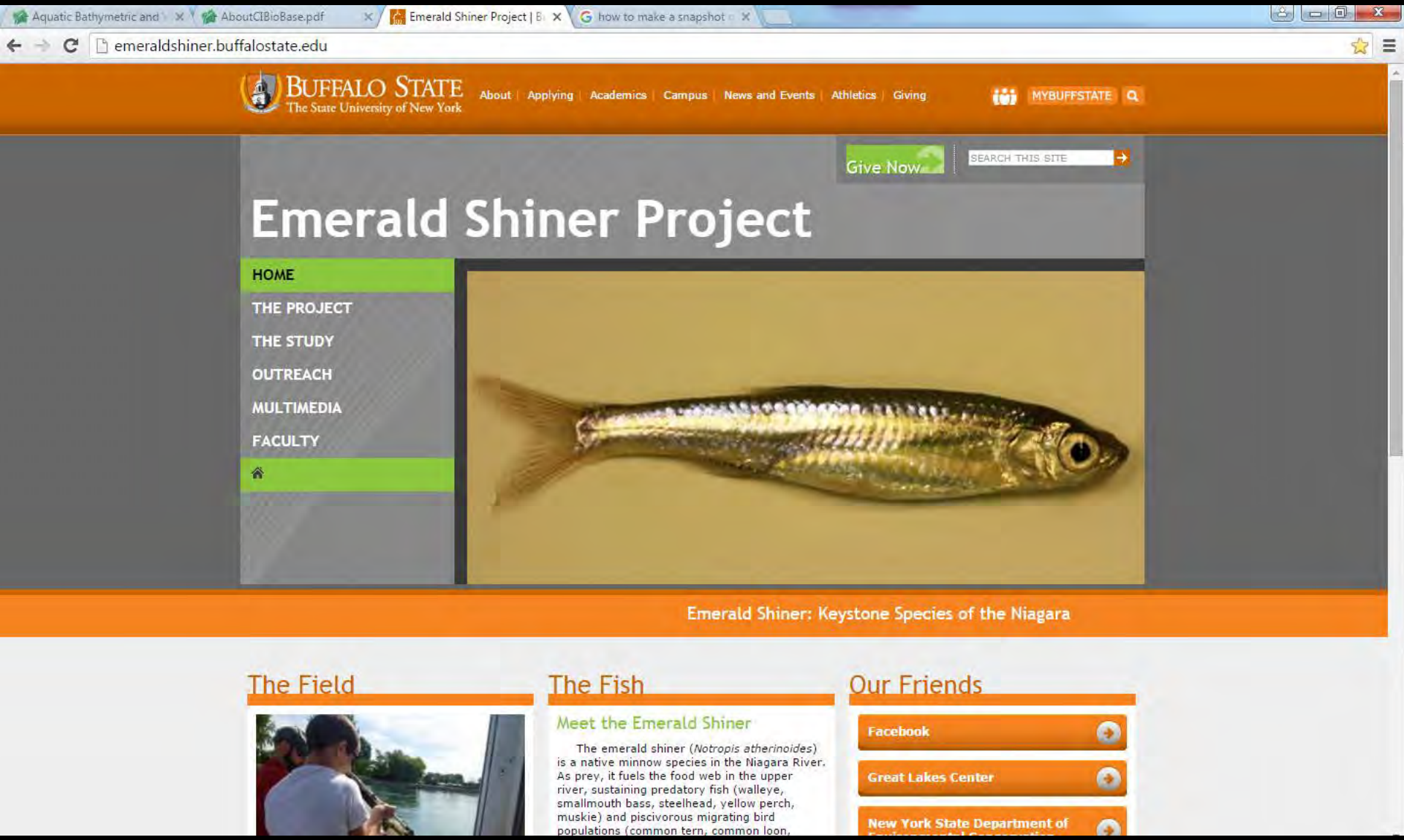


Macrophyte Species Name	Abbreviation
Ceratophyllum demersum	CD
Chara spp.	CS
Elodea canadensis	EC
Myriophyllum spicatum	MS
Najas gracillima	NG
Najas flexilis	NF
Nymphaea odorata	NO
Potamogeton confervoides	Pcon
Potamogeton crispus	PC
Potamogeton epihydrus	PE
Potamogeton praelongus	PP
Potamogeton richardsonii	PR
Potamogetons foliosus	PF
Schoenoplectus subterminalis	SS
Stuckenia pectinata	SP
Vallisneria americana	VA
Zannichellia palustris	ZP

Strawberry Island substrate characterization map

Macrophyte Species Name	Abbreviation
Ceratophyllum demersum	CD
Chara spp.	CS
Elodea canadensis	EC
Myriophyllum spicatum	MS
Najas gracillima	NG
Najas flexilis	NF
Nymphaea odorata	NO
Potamogeton confervoides	Pcon
Potamogeton crispus	PC
Potamogeton epihydrus	PE
Potamogeton praelongus	PP
Potamogeton richardsonii	PR
Potamogetons foliosus	PF
Schoenoplectus subterminalis	SS
Stuckenia pectinata	SP
Vallisneria americana	VA
Zannichellia palustris	ZP

Outreach: http://emerald shiner.buffalostate.edu



The project is also featured in in Facebook, Twitter and Instagram

Project presented at multiple venues for education and outreach in collaboration with BNRiverkeeper

Products in development for 2016

- Geographic Information Systems (GIS) platform that includes on site project data to be made available to DEC, USACE and other interested parties.

- Development of habitat quality indices for emerald shiner recruitment based on the information collected in years 1 and 2.

- Design of engineering structures to be placed in areas of hydrological barriers to fish passage along the US headwaters of the Niagara River.

Thank you to our students and staff

SUNY Buffalo State
Biology and Great Lakes Ecosystem Science (GLES) Programs:

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Colleen Kolb

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Joshua Fisher
Kathleen Hastings

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