ASSESSMENT OF NATIVE FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN COASTAL LAKE ERIE, LAKE ST. CLAIR, AND CONNECTING CHANNELS, 25 YEARS AFTER THE DREISSENID INVASION

David T. Zanatta[1], Jon Bossenbroek[2], Lyubov Burlakova[3], Todd Crail[2], Ferenc de Szalay[4], Traci Griffith[1], Doug Kapusinski[4], Alexander Karateyev[3], Robert A. Krebs[5], Elizabeth S. Meyer[6], Wendy Paterson[1], Trevor J. Prescott[5], Matthew Rowe[1], Don Schloesser[7], and Mary C. Walsh[6]

Introduction

The invasions of Ponto-Caspian dreissenid mussels (zebra mussels and quagga mussels) have caused massive change to the Great Lakes ecosystem. Among their more prominent and well documents effects was on the diversity and abundance of native unionid mussels in Lake Erie and Lake St. Clair. With support of funding from the Great Lakes Fish and Wildlife Restoration Act, our group conducted extensive surveys of known and potential unionid refugia from dreissenid mussels.

Methods

• Sampling locations in coastal wetlands, drowned river mouths, and protected embayments, and deltaic environments were selected based on previously published studies, local knowledge, or expert opinion.
• 142 0.5 ha sites (Figure 1) from 48 locations (Figure 2, Table 1) were searched for 2 person hours each by snorkeling, wading, raking, and/or SCUBA.

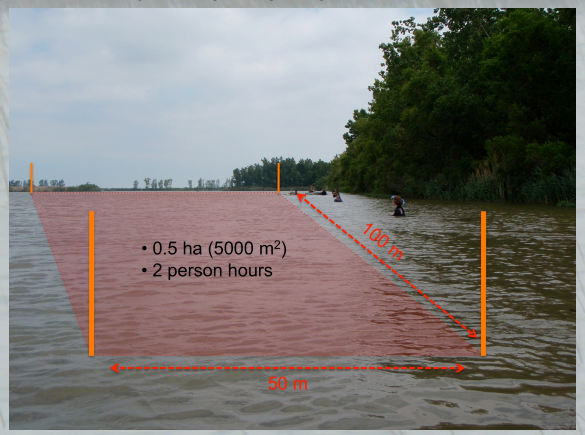
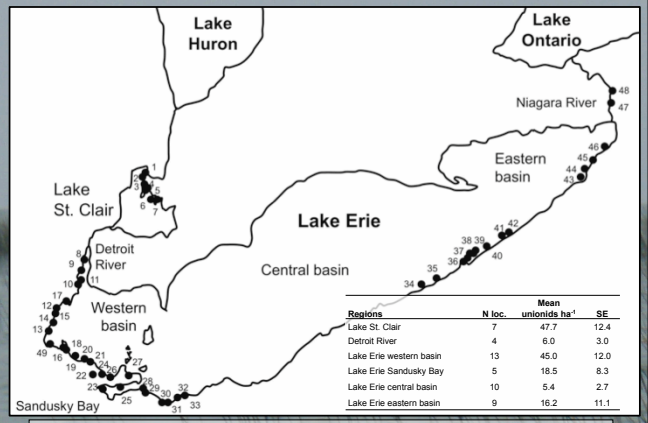


Figure 1. Site survey design.

• Unionids collected were identified to species, identified by gender (if sexually dimorphic), and shell length was measured along with wet weight.
• Dreissenid mussels found on living unionids were removed, weighed and preserved in 95% ethanol (for ongoing research).
• Habitat and water chemistry data were collected in triplicate from each site:
  • Water depth and soft sediment depth were measured with a 2 m stake with 1 cm calibrations.
  • Sediment composition proportions were qualitatively estimated for percentage bedrock, boulder, cobble, gravel, sand, silt, and clay. Estimates of sediment size composition were made to a maximum depth of 12 cm.
  • A multi-parameter water quality sonde (YSI) was used to measure turbidity, connectivity, pH, chlorophyll *a*, and temperature.
• Unoinid abundance, species richness, and diversity were calculated for each location and at lake wide scales.
• In order to prioritize locations as high, medium or low quality refuges for unionids, abundance, species richness, and effective number of species were calculated and then ranked by location.
• Length data for each individual for the six most common and/or widespread unionid species present was compiled and the variance in shell sizes were also considered as evidence of recruitment.

Objectives

1. Describe standardized survey methods used to compare potential unionid refuges in coastal areas across the lower Great Lakes
2. Determine relative abundance, density and diversity of remnant unionid assemblages among sampling locations
3. Compare the size structure of unionids among sampling locations as evidence of recent recruitment and/or stable size/age structure
4. Prioritize/rank the sampling locations as to refuge quality based on relative density, diversity and recruitment within communities.



Regions	N loc.	Mean unionids ha⁻¹	SE
Lake St. Clair	7	47.7	12.4
Detroit River	4	6.0	3.0
Lake Erie western basin	13	45.0	12.0
Lake Erie Sandusky Bay	5	18.5	8.3
Lake Erie central basin	10	5.4	2.7
Lake Erie eastern basin	9	16.2	11.1

Figure 2. Sampling locations in Lake St. Clair, the Detroit River, Lake Erie, and the Niagara River in 2011-2012. With summary of unionid abundance. Description of location codes as in Table 1.

Table 1. Names and codes for 49 locations in coastal areas of Lake St. Clair, the Detroit River, Lake Erie, and the Niagara River with mean number of unionids collected per hectare (± S.E. for locations with multiple sites), species richness (S_n), effective number of species ($e^{H'}$), and ranked assessment of quality as a refuge for unionids based on the three criteria. [a] from Bryan et al. (2013).

Location No.	Location Name	Waterbody	No. sites	Unionids ha⁻¹	S_n	Effective No. of Species	Ranked Refuge Quality	Refuge Quality Assessment
1	Pollet Bay	Lake St. Clair	2	12 ± 12	6	5	13	High
2	Goose Bay	Lake St. Clair	3	91 ± 30	11	4	2	High
3	Fisher Bay	Lake St. Clair	1	40	6	4	11	High
4	Big Muscamoot Bay	Lake St. Clair	5	19 ± 7.7	11	6	6	High
5	Little Muscamoot Bay	Lake St. Clair	3	95 ± 26	10	3	4	High
6	Pocket Bay	Lake St. Clair	1	38	2	1	25	Medium
7	Bass Bay	Lake St. Clair	2	39 ± 39	6	4	14	Medium
8	Humbug Island	Detroit River	1	0	0	0	32	Low
9	Calf Island	Detroit River	1	0	0	0	32	Low
10	Huron River (MI) mouth	Detroit River	3	12 ± 8.0	9	7	8	High
11	Celeron Island	Detroit River	1	0	0	0	32	Low
12	La Plaisance Bay	Lake Erie	1	18	2	1	27	Low
13	North Maumee Bay	Lake Erie	3	93 ± 36	6	4	5	High
14	North Maumee Bay - Dyked	Lake Erie	3	0	0	0	32	Low
15	Monroe Power Plant Discharge	Lake Erie	2	84 ± 30	4	1	19	Medium
16	Potters Pond - Ottawa NWR	Lake Erie	2	0	0	0	32	Low
17	Brest Bay	Lake Erie	1	0	0	0	32	Low
18	Cedar Creek/Meinke Marina	Lake Erie	1	4	2	2	27	Low
19	Crane Creek Marsh - Ottawa NWR	Lake Erie	5	112 ± 53	10	3	3	High
20	Turtle Creek	Lake Erie	4	52 ± 18	4	2	17	Medium
21	Toussaint River - Gath Kurdy Preserve	Lake Erie	4	96 ± 55	7	2	10	High
22	Portage River mouth	Lake Erie	4	80 ± 5.4	5	1	17	Medium
23	Muddy Creek Bay	Lake Erie	17	20 ± 6.2	10	3	11	High
24	Young Marsh	Lake Erie	2	44 ± 4.0	8	5	7	High
25	Sandusky Bay	Lake Erie	11	2.5 ± 2.0	5	4	15	Medium
26	Port Clinton Beach	Lake Erie	1	2	1	1	30	Low
27	East Harbor	Lake Erie	2	46 ± 34	3	1	23	Medium
28	Cedar Point - Sandusky Bay	Lake Erie	3	2.0 ± 1.2	3	3	24	Medium
29	Griffith Airport - Sandusky Bay	Lake Erie	3	7.5 ± 5.4	2	2	26	Low
30	Huron River (OH) mouth	Lake Erie	3	8.7 ± 6.7	5	3	21	Medium
31	Old Woman Creek mouth	Lake Erie	3	1.3 ± 0.7	1	1	31	Low
32	Chapel Creek mouth	Lake Erie	1	0	0	0	32	Low
33	Sugar Creek mouth	Lake Erie	1	0	0	0	32	Low
34	Raccoon Creek mouth	Lake Erie	1	0	0	0	32	Low
35	Elk Creek mouth	Lake Erie	2	0	0	0	32	Low
36	Presque Isle Bay	Lake Erie	15	1.7 ± 0.8	3	2	29	Low
37	Thompson Bay – Presque Isle	Lake Erie	3	20 ± 9.1	7	4	9	High
38	Gull Point - Presque Isle	Lake Erie	2	0	0	0	32	Low
39	Duck Pond - Presque Isle	Lake Erie	2	22 ± 20	4	2	19	Medium
40	Twelve Mile Creek mouth	Lake Erie	1	0	0	0	32	Low
41	Sixteen Mile Creek mouth	Lake Erie	1	0	0	0	32	Low
42	Twenty Mile Creek mouth	Lake Erie	1	0	0	0	32	Low
43	Silver Creek mouth / Walnut Creek mouth	Lake Erie	1	0	0	0	32	Low
44	Cattaraugus Creek mouth	Lake Erie	1	0	0	0	32	Low
45	Big Sister Creek mouth/ Bennett Beach	Lake Erie	1	0	0	0	32	Low
46	Eighteen Mile Creek backwater	Lake Erie	2	0	0	0	32	Low
47	Strawberry Island	Niagara River	3	56 ± 28	3	1	22	Medium
48	Spicer Creek mouth/ Grand Isle	Niagara River	1	90	4	2	16	Medium
49	*Bayshore – South Maumee Bay[a]*	*Lake Erie*	*4*	*2403 ± 801*	*13*	*4*	*1*	*High*

Results

• Remnant assemblages differ greatly in species composition between Lake Erie and Lake St. Clair, but unionid abundance, richness, and diversity are very similar.
  • Lake St. Clair's assemblage retains a similar species composition to what was present prior to the dreissenid invasion.
  • The unionid assemblage in Lake Erie has had a major shift toward species with equilibrium and opportunistic life history strategies (Haag 2012).
• Low quality locations, those that did not support unionids or that had relatively few living unionid species, and/or diversity, were expected and typically found in the drowned mouths of small high gradient streams in the central and eastern basins of Lake Erie, in highly exposed bays of Lake Erie, and around the islands at the outlet of the Detroit River.

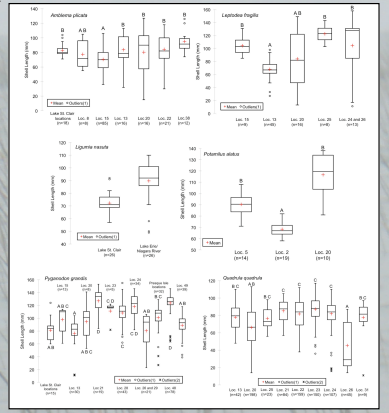


Figure 3. Box plots of shell lengths for six widespread unionids from coastal sampling locations in Lake St. Clair, Lake Erie, and the Niagara River (location codes as in Table 1). Letter codes adjacent to boxes (A, B, C, D) indicate significant groupings among means as revealed by Dunn's tests (α = 0.05, Bonferroni corrected for multiple comparisons).

• Size class data added only modestly to predictive power for higher quality refuges (Figure 3).

Conclusions/ Ongoing Research

➢ The highest quality unionid assemblages appear to be concentrated in the St. Clair delta, a select few coastal wetlands and drowned river mouths in the western basin of Lake Erie, and Thompson Bay at Presque Isle, PA.

➢ The large dataset collected as part of this study will lead to numerous analyses that will be published concurrently to this paper; projects that will: 1) compare the habitat characteristics where unionids are found (and not found) and create predictive models that can be extrapolated into other parts of the Great Lakes; 2) evaluate the impacts of dreissenid on unionids; 3) examine the genetic structure of the remnant unionid populations in the lower Great Lakes; and 4) test relationships between genetic and species diversity metrics across the varied habitats of the region.

➢ Many high quality refugia remain in areas threatened by anthropogenic disturbances.

Lit. Cited/ Acknowledgements

Bryan, N.J., *et al.* 2013. Freshwater mussel community response to warm water discharge in western Lake Erie. Journal of Great Lakes Research 39:449-454.

Haag, W. R. 2012. North American Freshwater Mussels: Natural History, Ecology and Conservation. Cambridge University Press, Cambridge UK. 505 pp.

Funding: U.S. Fish and Wildlife Service via the Great Lakes Fish and Wildlife Restoration Act

[1]Central Michigan University, Institute for Great Lakes Research, Biology Department; [2]University of Toledo, Dept. of Environmental Science, Lake Erie Center; [3]Buffalo State College, Great Lakes Center; [4]Kent State University, Dept. of Biological Sciences; [5]Cleveland State University, Dept. of BGES; [6]Pennsylvania Natural Heritage Program; [7]U.S. Geological Survey, Great Lakes Science Center