

Effects of the Devils Lake East End Outlet on Mussels in the Sheyenne River

Andre DeLorme; Department of Science,
Valley City State University,
Valley City, ND 58072



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Addition of Devils Lake Water 2012

- Devils lake has reached historic high levels
- To alleviate the problem the state of ND has opened 2 outlets from Devils Lake into the Sheyenne River
- The “East end outlet” opened in 2012 and carries high levels of dissolved ions which may impact biota of the Sheyenne River
- Sulfate levels are of special concern





Map from the ND State Water Commission website;
<http://www.swc.state.nd.us>



Using Mussels for Bioassessment

- Mussels are good indicators of water quality for many reasons
 - They are immobile.
 - Easy to collect, identify and measure.
 - Different species have different tolerances to changes in water quality.
 - They are filter feeders living in the water/sediments so they obtain maximum exposure to water contaminants.

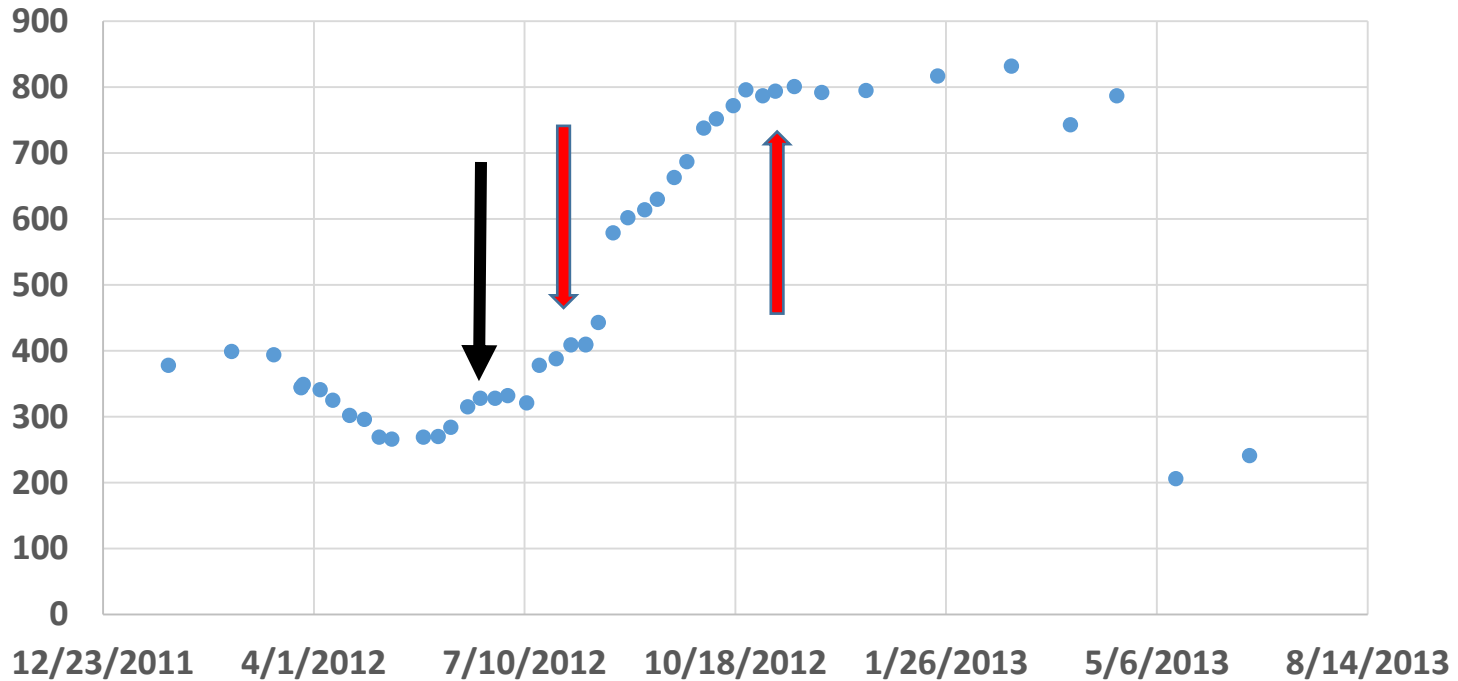
Study Design – Population Surveys

- We did a combination of qualitative and quantitative mussel sampling before the outlet opened
- In 2013, after the east end outlet had run for one season, we returned to the sites and sampled again
- Compare populations from before to after



Sulfate levels in 2012

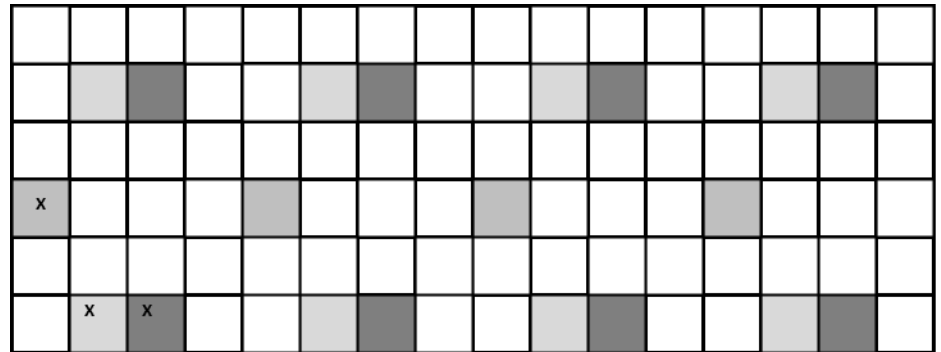
2012 Sulfate levels Sheyenne River below Baldhill Dam



Black arrow = time of sampling; Red arrows represent when the outlet was running

Quantitative Sampling

- Quantitative sampling consisted of 0.25 m² quadrats
 - Used a systematic sampling protocol incorporating three random starts
 - Sampled over 200 quadrats in a 100 m stretch of the river
- Every fourth quadrat was excavated to a depth of 10 cm.



Population changes

Site	2009 (Sh16) and 2012 (Sh13, Sh14, ShTang, and Sh21) Data				2013 Data				% change in population
	# species	Total Mussels	# quadrats	Mussels/m ²	# species	Total Mussels	# quadrats	Mussels/m ²	
Sh13	3	41	240	0.68	3	12	220	0.22	-68%
Sh14	7	55	220	1.02	7	80	271	1.18	16%
Sh16	8	1421	100	56.84	8	991	236	16.8	-70%
Shtang	8	417	240	6.95	7	127	220	2.3	-67%
Sh21	9	332	238	5.58	6	139	256	2.2	-61%

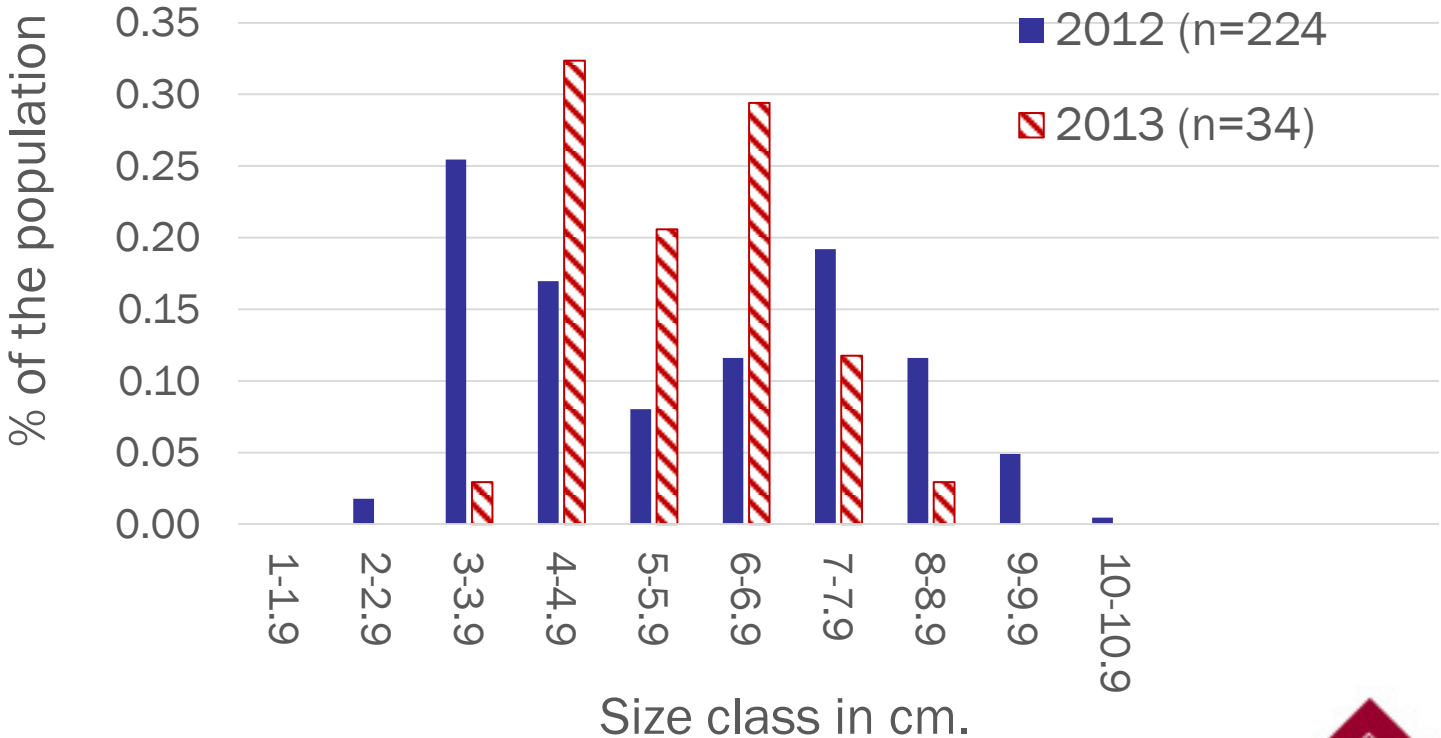
Effect on Population Densities

Site ShTangen - 2 miles South East of Kathryn

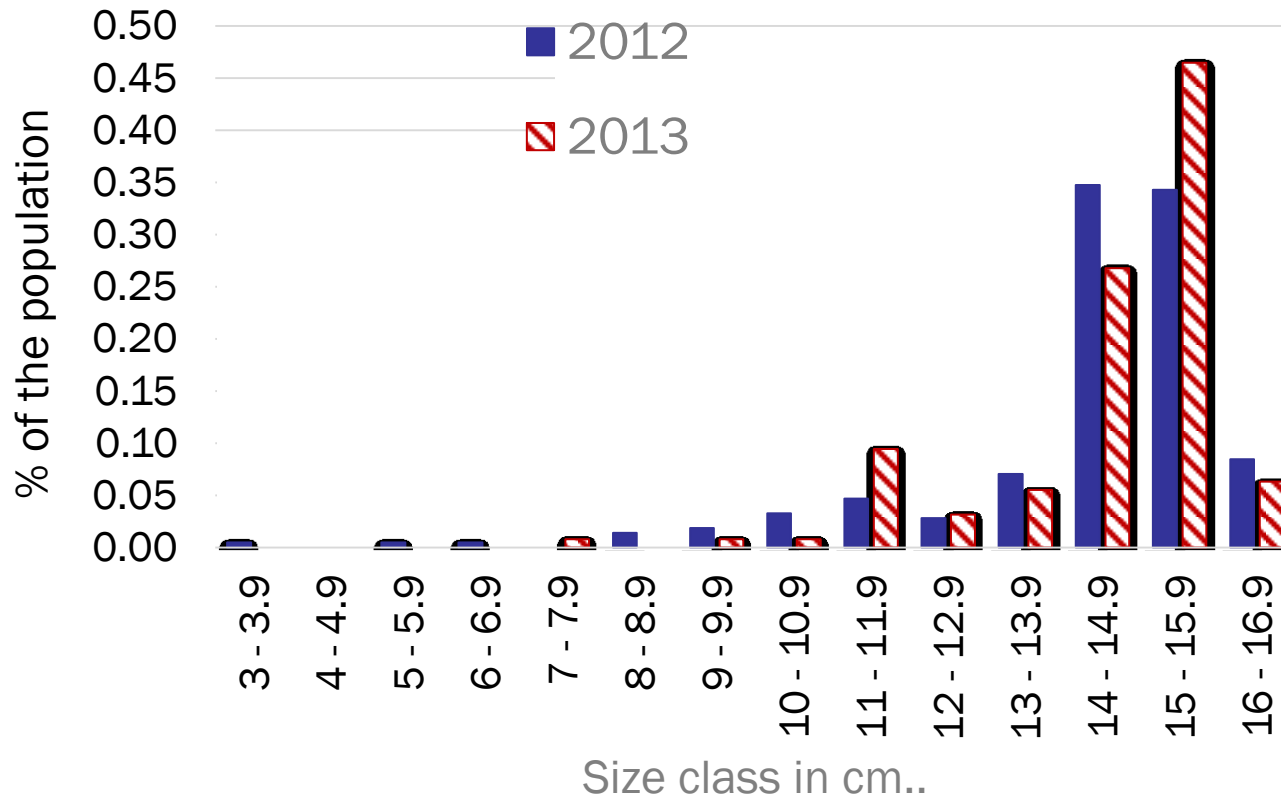
Mussel	2012 Mussels/m ²	2012 Relative Density	2013 Mussels/m ²	2013 Relative Density	Change in Density
Wabash Pigtoe	3.88	55.9%	0.62	26.8%	-84%
Pocketbook	1.17	16.8%	0.69	29.9%	-41%
Three Ridge	0.68	9.8%	0.44	18.9%	-35%
Black Sandshell	0.58	8.4%	0.40	17.3%	-31%
Fatmucket	0.4	5.8%	0.07	3.1%	-83%
White Heelsplitter	0.15	2.2%	0.05	2.4%	-67%
Creeper	0.05	0.7%	0.00	0.0%	-98%
Giant Floater	0.03	0.5%	0.04	1.6%	33%
Total	6.94	100%	2.31	100%	-67%

Effect on sizes

Proportion of size class for Wabash Pigtoe mussels between 2012 - 2013



Proportion of Size Classes for Threeridge mussels between 2012 and 2013



Study Design - Bioassay

- Bioassay to see if water from the Devils Lake outlets was impacting the physiology of individual mussels in the Sheyenne River
- Used American Society for Testing and Materials (ASTM) protocols for field bioassay on caged mussels
- Changes in a mussels weight indicates physiological effects

Study Design - Bioassay

- Collected, tagged, measured, and weighed over 300 Fatmucket mussels
- Slot limit – 7 to 9 cm
- Placed in plastic “grow out” bags for late summer and fall of 2013
- We checked their weight 4 times during the study





09/07/2013



09/07/2013





07/19/2013

Upper Sheyenne River Study

- One control site and 2 experimental sites – app. 100 mussels per site
- Control site = just upstream of the west end outlet
- First experimental site = between the two outlets
- Second experimental site = downstream of the east end outlet





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Upper Sheyenne Results

	Starting # of mussels	# mussels surviving	Mortality rate	Avg. Wt. Change in grams	Proportional wt change
Control Site	102	83	18.7%	-0.79	-1.3
Experimental Site 1	104	91	12.5%	-0.45	-0.5
Experimental Site 2	(107) 51	42	17.6%	-3.26	-4.8



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Statistical Analysis

- Arcsine transformed the data
- Conducted a One Way Analysis of Variance
- A significant difference was found ($\alpha = 0.05$)
- Fishers Least Significant Difference test (LSD; $\alpha = 0.05$) for all pairwise comparisons.
- The control site and Exp. Site 1 had a significant difference compared to Exp. Site 2 ($P < 0.001$)

Summary

- Correlation of east end outlet water to:
 - Drop in mussel populations
 - Greater weight loss
- “West end outlet” water did not show these effects
- The combination of our studies indicates there are effects on biota in the Sheyenne River from the east end outlet

Recommendations

- Continue mussel studies
- Do further biota studies
- Controlled toxicological testing – pinpoint causation
- If outlet continues operating may need to consider propagation to try and restore mussel populations post outlet operation

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