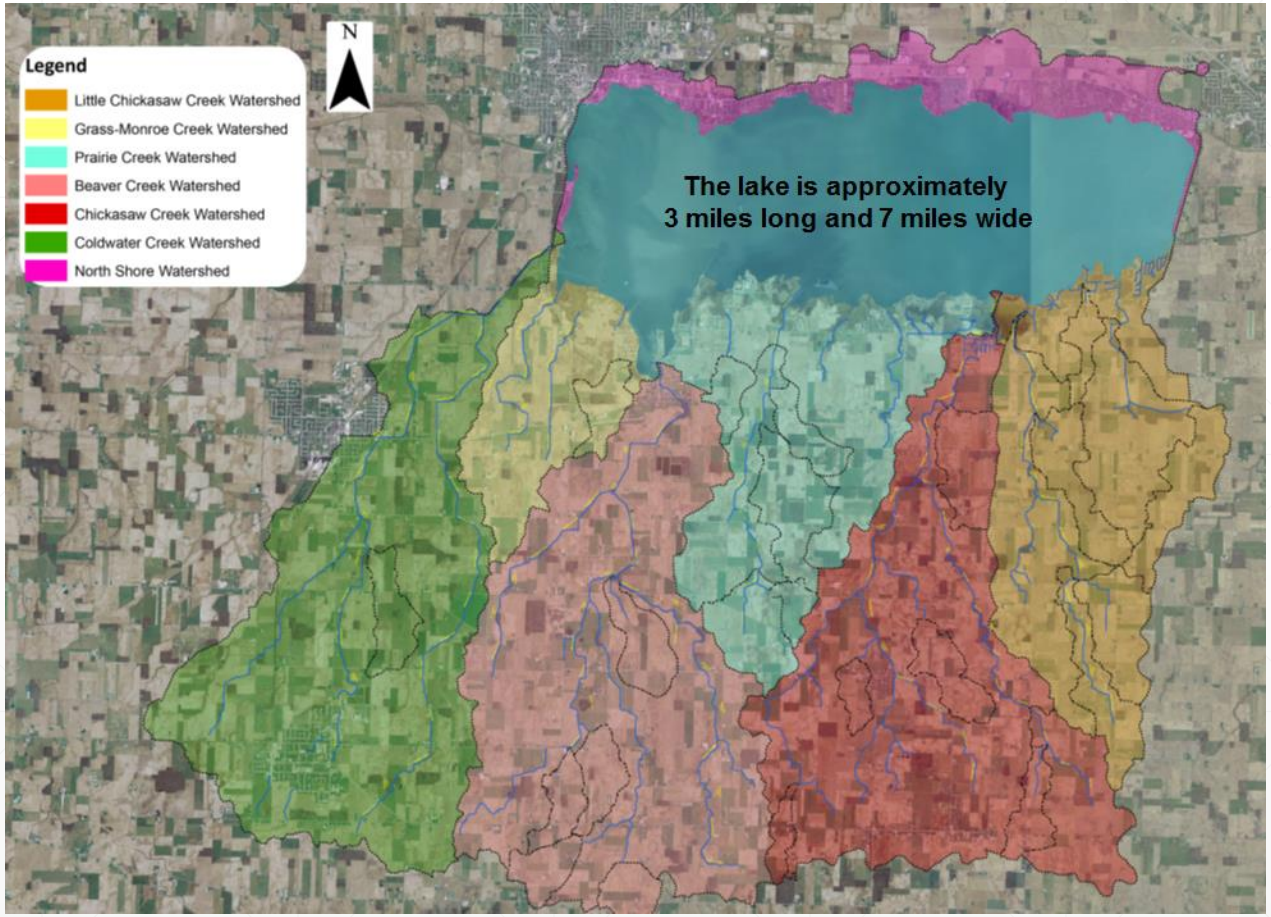
Grand Lake St Marys

Water Quality Initiatives & Progress

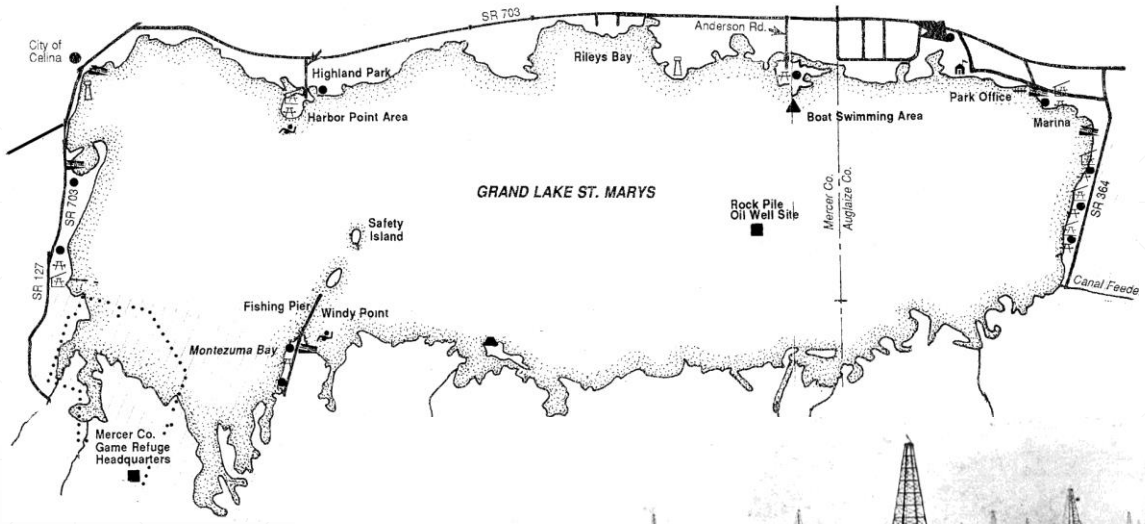
Terry M. Mescher, P.E.
Ohio Dept of Agriculture

Grand Lake St. Marys – Brief History



- Reservoir constructed to supply water to the Miami-Erie Canal in the 1830's and 1840's
- Prior to construction, Grand Lake was a wide marshy valley
- To construct the lake, levees were constructed on the east and west ends of the lake

Grand Lake St. Marys – Brief History



- Upon completion Grand Lake St. Marys was the largest man made lake in the world

- Grand Lake was the site of the world's first off-shore oil wells, with over 150 oil wells on the lake in 1915

Grand Lake St. Marys - Challenges

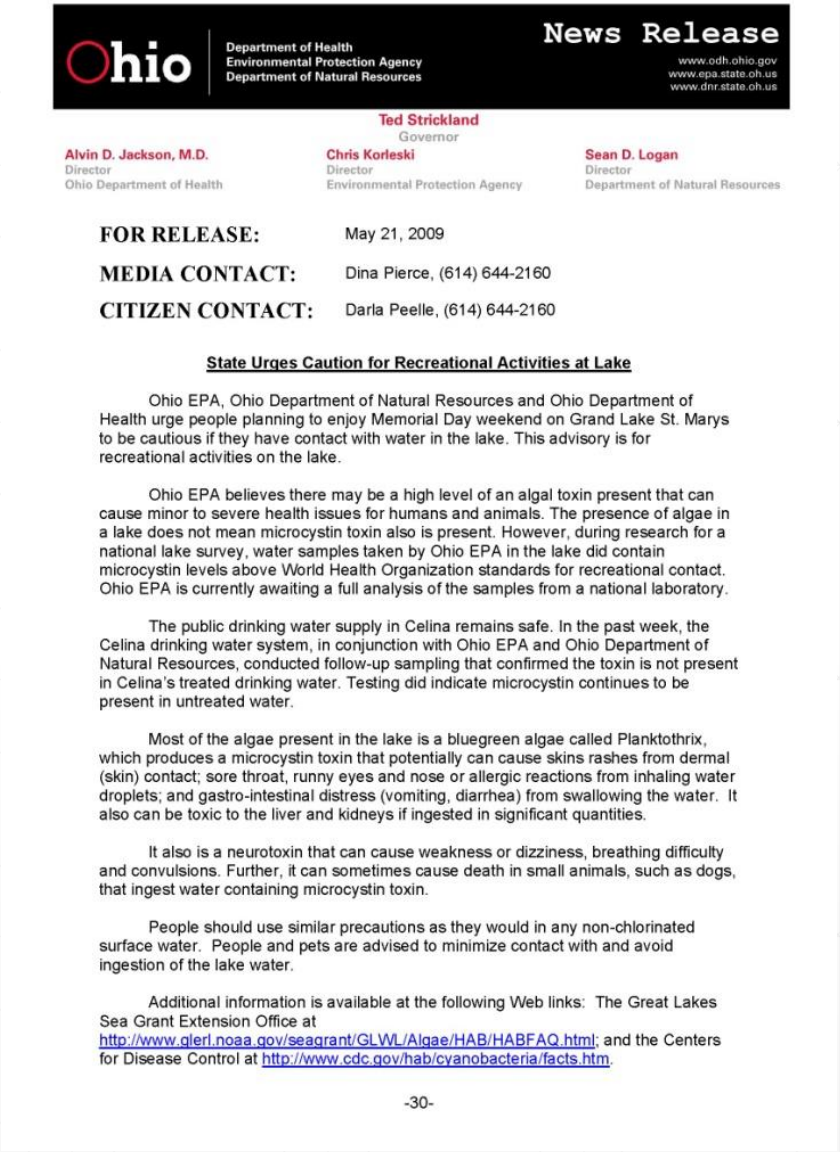
- Shallow, less than 6’ deep in most areas
- Long detention time – estimated to be nearly 18 months
- Age - Sediment and debris washed into the lake over the last 172 years

Grand Lake St. Marys - Causes

- Agricultural runoff and nutrient loading
- One of the highest livestock concentrations in the country
- Disposition of the lake
  - Shallow; 6’–8’ deep
  - Long Detention Time

Grand Lake St. Marys - Rules

- Distressed Watershed Rules adopted in attempt to reduce nutrient loading from watershed
  - Manure Management Plans Req'd
  - More stringent manure application rules
  - Winter manure application ban
  - Ban on manure application of frozen and snow covered ground



Ohio | Department of Health, Environmental Protection Agency, Department of Natural Resources

News Release

www.odh.ohio.gov
www.epa.state.oh.us
www.dnr.state.oh.us

Ted Strickland
Governor

Alvin D. Jackson, M.D., Director, Ohio Department of Health
Chris Korleski, Director, Environmental Protection Agency
Sean D. Logan, Director, Department of Natural Resources

FOR RELEASE: May 21, 2009

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State Urges Caution for Recreational Activities at Lake

Ohio EPA, Ohio Department of Natural Resources and Ohio Department of Health urge people planning to enjoy Memorial Day weekend on Grand Lake St. Marys to be cautious if they have contact with water in the lake. This advisory is for recreational activities on the lake.

Ohio EPA believes there may be a high level of an algal toxin present that can cause minor to severe health issues for humans and animals. The presence of algae in a lake does not mean microcystin toxin also is present. However, during research for a national lake survey, water samples taken by Ohio EPA in the lake did contain microcystin levels above World Health Organization standards for recreational contact. Ohio EPA is currently awaiting a full analysis of the samples from a national laboratory.

The public drinking water supply in Celina remains safe. In the past week, the Celina drinking water system, in conjunction with Ohio EPA and Ohio Department of Natural Resources, conducted follow-up sampling that confirmed the toxin is not present in Celina's treated drinking water. Testing did indicate microcystin continues to be present in untreated water.

Most of the algae present in the lake is a bluegreen algae called Planktothrix, which produces a microcystin toxin that potentially can cause skins rashes from dermal (skin) contact; sore throat, runny eyes and nose or allergic reactions from inhaling water droplets; and gastro-intestinal distress (vomiting, diarrhea) from swallowing the water. It also can be toxic to the liver and kidneys if ingested in significant quantities.

It also is a neurotoxin that can cause weakness or dizziness, breathing difficulty and convulsions. Further, it can sometimes cause death in small animals, such as dogs, that ingest water containing microcystin toxin.

People should use similar precautions as they would in any non-chlorinated surface water. People and pets are advised to minimize contact with and avoid ingestion of the lake water.

Additional information is available at the following Web links: The Great Lakes Sea Grant Extension Office at http://www.glerl.noaa.gov/seagrant/GLWL/Algae/HAB/HABFAQ.html; and the Centers for Disease Control at http://www.cdc.gov/hab/cyanobacteria/facts.htm.

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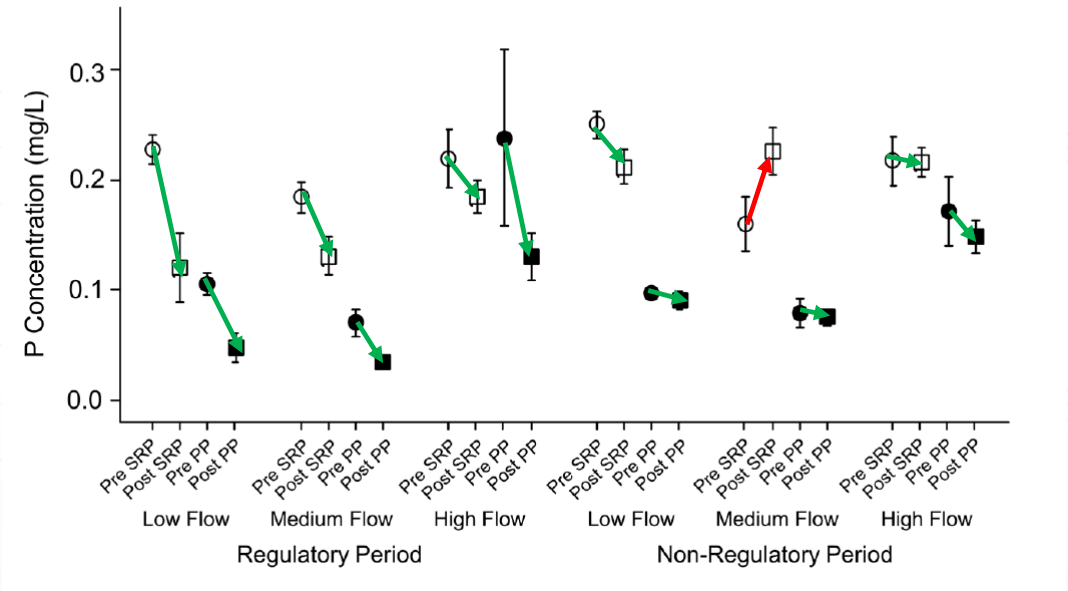
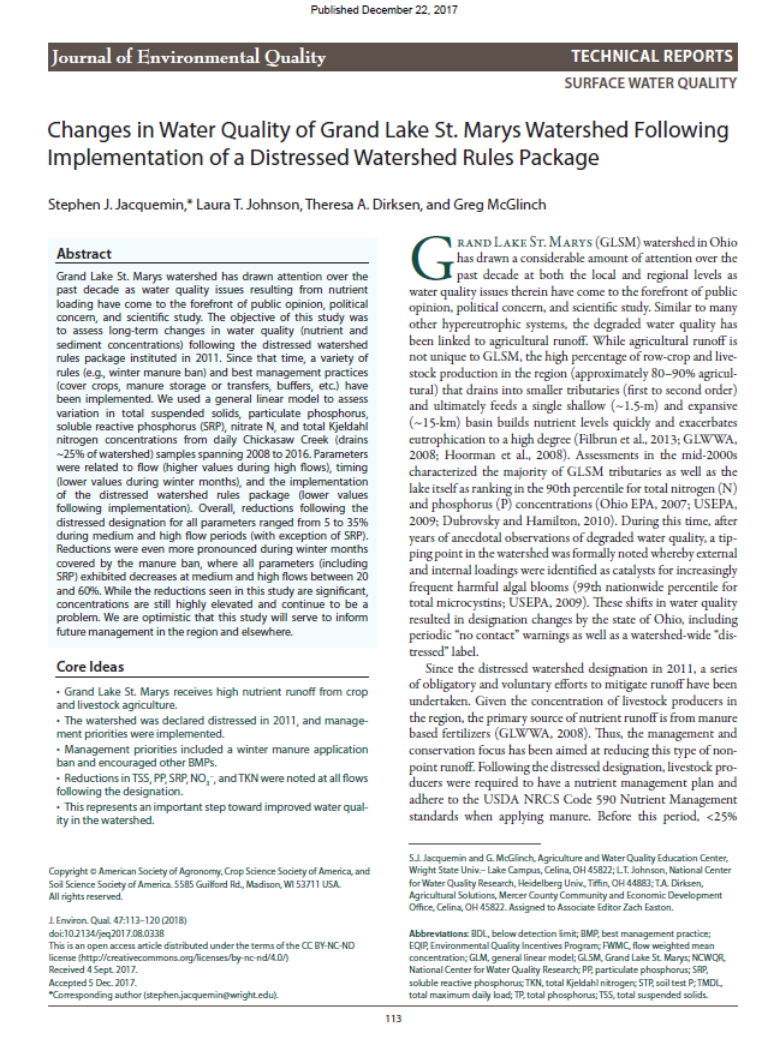
Grand Lake St. Marys – Loading Reductions



- Phosphorus loadings from Chickasaw Creek have shown significant reductions across nearly all flow regimes
- Data shows 1 increase in Dissolved Reactive Phosphorus Loadings in medium flows in the spring
- Other loadings showed statistically significant reductions – total Kjeldahl nitrogen, nitrate, and suspended solids

Grand Lake St. Marys – Loading Reductions



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SURFACE WATER QUALITY

Changes in Water Quality of Grand Lake St. Marys Watershed Following Implementation of a Distressed Watershed Rules Package

Stephen J. Jacquemin,* Laura T. Johnson, Theresa A. Dirksen, and Greg McGlinch

Abstract

Grand Lake St. Marys watershed has drawn attention over the past decade as water quality issues resulting from nutrient loading have come to the forefront of public opinion, political concern, and scientific study. The objective of this study was to assess long-term changes in water quality (nutrient and sediment concentrations) following the distressed watershed rules package instituted in 2011. Since that time, a variety of rules (e.g., winter manure ban) and best management practices (cover crops, manure storage or transfers, buffers, etc.) have been implemented. We used a general linear model to assess variation in total suspended solids, particulate phosphorus, soluble reactive phosphorus (SRP), nitrate N, and total Kjeldahl nitrogen concentrations from daily Chickasaw Creek (drains ~25% of watershed) samples spanning 2008 to 2016. Parameters were related to flow (higher values during high flows), timing (lower values during winter months), and the implementation of the distressed watershed rules package (lower values following implementation). Overall, reductions following the distressed designation for all parameters ranged from 5 to 35% during medium and high flow periods (with exception of SRP). Reductions were even more pronounced during winter months covered by the manure ban, where all parameters (including SRP) exhibited decreases at medium and high flows between 20 and 60%. While the reductions seen in this study are significant, concentrations are still highly elevated and continue to be a problem. We are optimistic that this study will serve to inform future management in the region and elsewhere.

Core Ideas

- Grand Lake St. Marys receives high nutrient runoff from crop and livestock agriculture.
- The watershed was declared distressed in 2011, and management priorities were implemented.
- Management priorities included a winter manure application ban and encouraged other BMPs.
- Reductions in TSS, PP, SRP, NO_3^-, and TKN were noted at all flows following the designation.
- This represents an important step toward improved water quality in the watershed.

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Grand Lake St. Marys (GLSM) watershed in Ohio has drawn a considerable amount of attention over the past decade at both the local and regional levels as water quality issues therein have come to the forefront of public opinion, political concern, and scientific study. Similar to many other hypereutrophic systems, the degraded water quality has been linked to agricultural runoff. While agricultural runoff is not unique to GLSM, the high percentage of row-crop and livestock production in the region (approximately 80–90% agricultural) that drains into smaller tributaries (first to second order) and ultimately feeds a single shallow (~1.5-m) and expansive (~15-km) basin builds nutrient levels quickly and exacerbates eutrophication to a high degree (Filbrun et al., 2013; GLWWA, 2008; Hoorman et al., 2008). Assessments in the mid-2000s characterized the majority of GLSM tributaries as well as the lake itself as ranking in the 90th percentile for total nitrogen (N) and phosphorus (P) concentrations (Ohio EPA, 2007; USEPA, 2009; Dubrovsky and Hamilton, 2010). During this time, after years of anecdotal observations of degraded water quality, a tipping point in the watershed was formally noted whereby external and internal loadings were identified as catalysts for increasingly frequent harmful algal blooms (99th nationwide percentile for total microcystins; USEPA, 2009). These shifts in water quality resulted in designation changes by the state of Ohio, including periodic "no contact" warnings as well as a watershed-wide "distressed" label.

Since the distressed watershed designation in 2011, a series of obligatory and voluntary efforts to mitigate runoff have been undertaken. Given the concentration of livestock producers in the region, the primary source of nutrient runoff is from manure based fertilizers (GLWWA, 2008). Thus, the management and conservation focus has been aimed at reducing this type of nonpoint runoff. Following the distressed designation, livestock producers were required to have a nutrient management plan and adhere to the USDA NRCS Code 590 Nutrient Management standards when applying manure. Before this period, <25%

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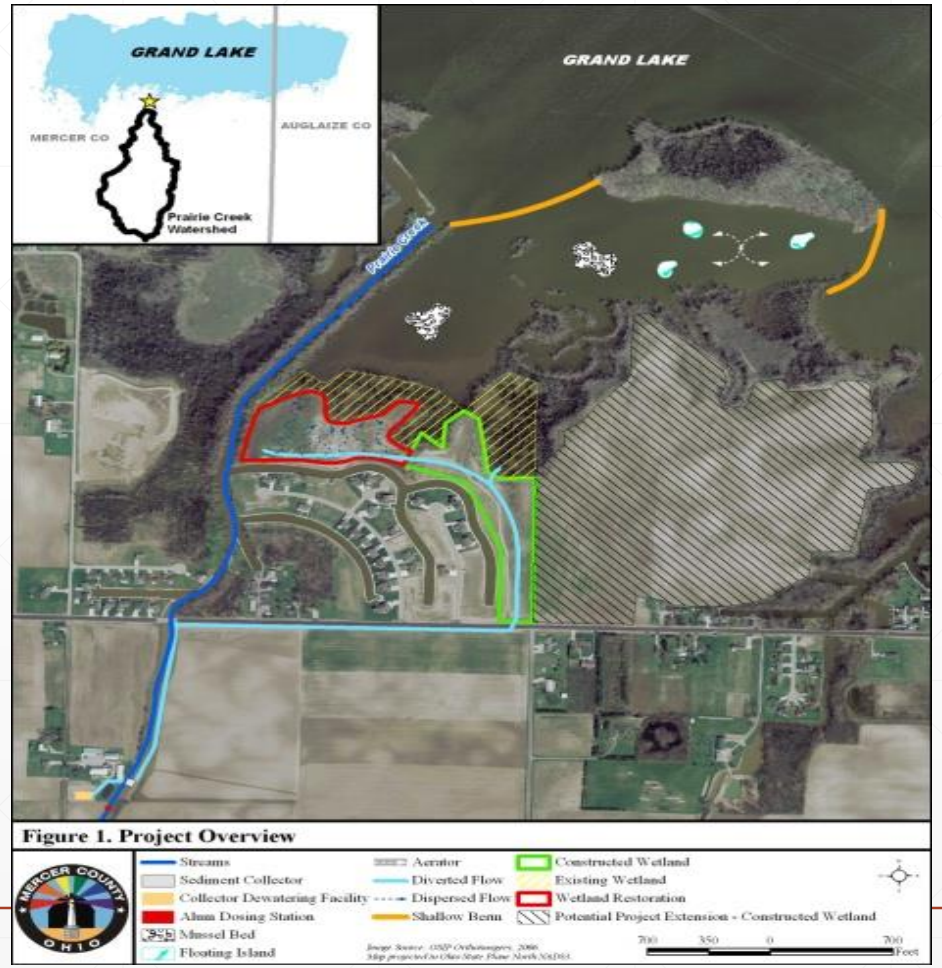
Abbreviations: BDL, below detection limit; BMP, best management practice; EQIP, Environmental Quality Incentives Program; FWMC, flow weighted mean concentration; GLM, general linear model; GLSM, Grand Lake St. Marys; NCWQR, National Center for Water Quality Research; PP, particulate phosphorus; SRP, soluble reactive phosphorus; TKN, total Kjeldahl nitrogen; STP, soil test P; TMDL, total maximum daily load; TP, total phosphorus; TSS, total suspended solids.

- Loading reductions have been published by the Journal of Environmental Quality
- Study is based on data collected from Chickasaw creek from 2008 through 2016
- Study and analysis were completed by Dr. Stephen Jacquemin with Wright State University

Grand Lake St. Marys – Treatment Trains



- Treatment trains are a series of sediment basins and wetlands constructed in series to process and treat water
- Three currently constructed, Prairie Creek,, Coldwater Creek, and Beaver Creek
- Due to site constraints, water is pumped into treatment trains from tributaries

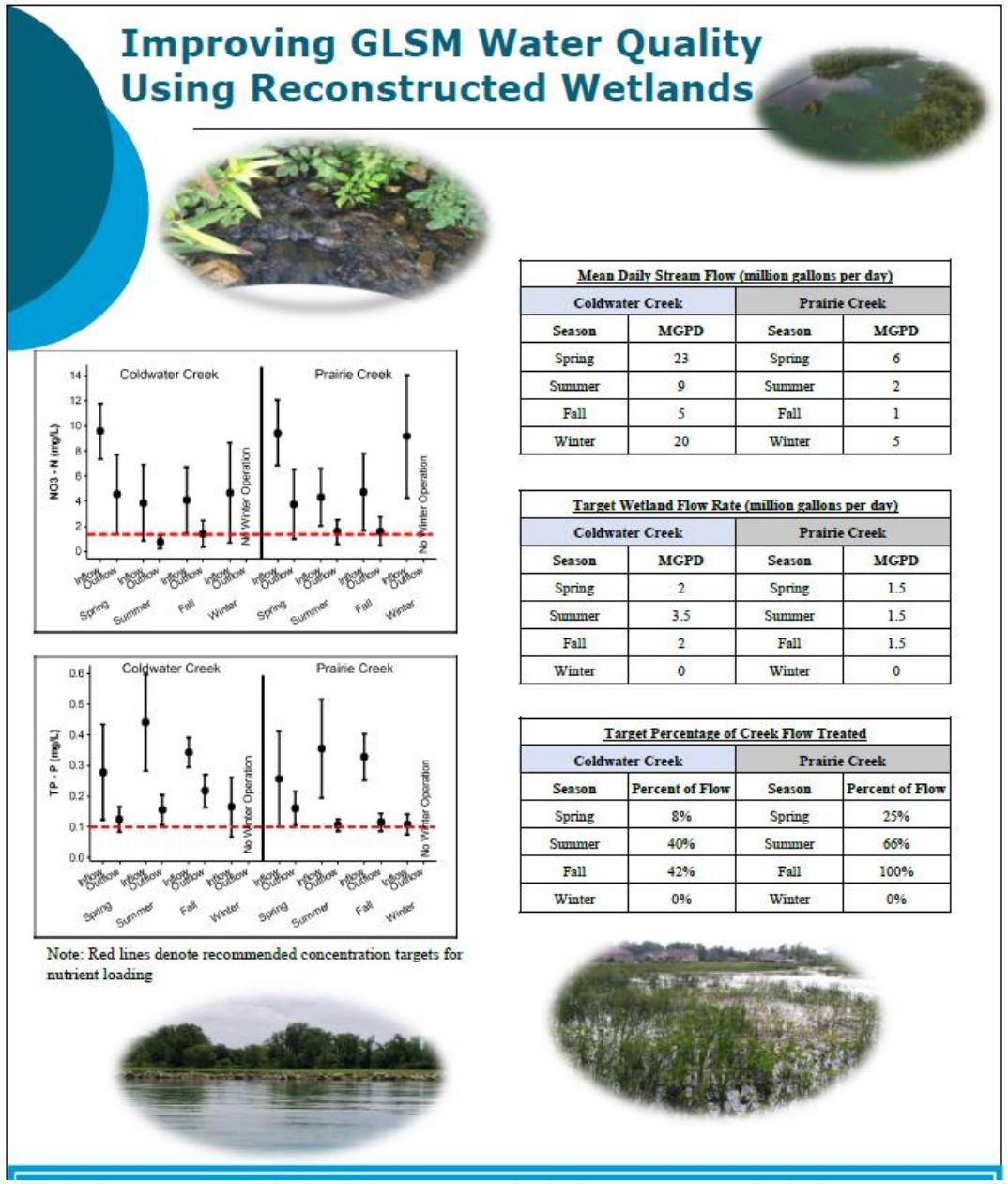
Treatment Trains

- Treatment trains show an incredible capacity to reduce loading and treat nutrients during the growing season given their small size

Coldwater Creek Treatment Train								
	Spring		Summer		Fall		Winter	
Parameter	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal
NO_3^--N	9.56	53%	3.86	81%	4.06	66%	4.68	0%
TP-P	0.28	55%	0.44	65%	0.34	37%	0.16	0%
DRP-P	0.11	74%	0.15	46%	0.10	5%	0.06	0%
Prairie Creek Treatment Train								
	Spring		Summer		Fall		Winter	
Parameter	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal	Stream Concentration (mg/L)	Percent Removal
NO_3^--N	9.43	60%	4.29	64%	4.71	67%	9.15	0%
TP-P	0.26	38%	0.35	70%	0.33	65%	0.11	0%
DRP-P	0.08	87%	0.15	94%	0.12	88%	0.05	0%

Treatment Trains

- Treatment trains show an incredible capacity to reduce loading and treat nutrients given their small size
- Challenge now is to develop design process to achieve the nutrient removal in a natural flowing system



Mean Daily Stream Flow (million gallons per day)			
Coldwater Creek		Prairie Creek	
Season	MGPD	Season	MGPD
Spring	23	Spring	6
Summer	9	Summer	2
Fall	5	Fall	1
Winter	20	Winter	5

Target Wetland Flow Rate (million gallons per day)			
Coldwater Creek		Prairie Creek	
Season	MGPD	Season	MGPD
Spring	2	Spring	1.5
Summer	3.5	Summer	1.5
Fall	2	Fall	1.5
Winter	0	Winter	0

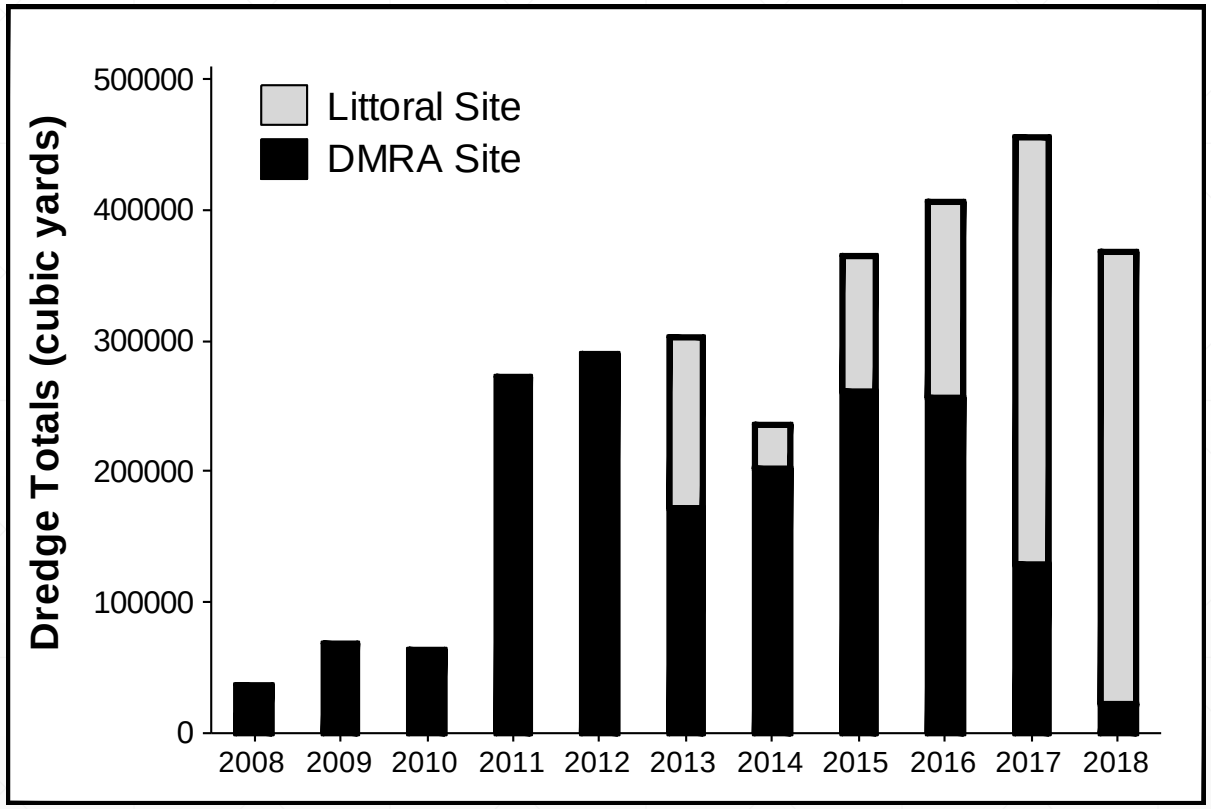
Target Percentage of Creek Flow Treated			
Coldwater Creek		Prairie Creek	
Season	Percent of Flow	Season	Percent of Flow
Spring	8%	Spring	25%
Summer	40%	Summer	66%
Fall	42%	Fall	100%
Winter	0%	Winter	0%

Treatment Trains – Looking Forward

- Water quality data is still being collected on the treatment trains
- Wetlands are being considered to address nutrient concerns in the Western Lake Erie Basin based on this data
- We may be discussing storm water retention and detention on the agricultural landscape in the future

Increased Dredging

- Historically, dredging has been used in Grand Lake to maintain channels and boat access
- Since 2011 dredging efforts have increased 5 to 10 times the 2008 dredge totals
- Currently, 350,000 to 400,000 cubic yards are being dredged annually



Dredging – Where to go with it?

- Traditionally, dredge materials was pumped into DMRA sites where it was allowed to dewater and dry over several years

- Finding land to construct the DMRA's is a continual challenge for dredge operations

DMRA Pond

DMRA Pond - Dried out

Dredging – Where to go with it?

- More recently, littoral wetlands have been developed within the lake, and provide additional sites for dredge material

- The in-lake wetlands are also encouraging more plant life and improving water quality within the lake

Dredging

- Current dredging operations are outpacing sediment loads coming into the lake
- Data is still being collected, but early results indicate dredging totals are roughly 3.5 times the sedimentation totals
- 2.9 M yards over the last 10 years; 181 tons of phosphorus removed

Conclusions

- Progress is being made to reduce nutrient and sediment loadings from watershed – Still work to be done
- Treatment Trains & Dredging efforts are turning back the clock slowly
- However, Grand Lake is 170+ years old, monumental maintenance efforts are needed