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Potential for Wetlands to Remediate Harmful Pathogenic Fecal Coliform Bacteria from Streams

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Abstract

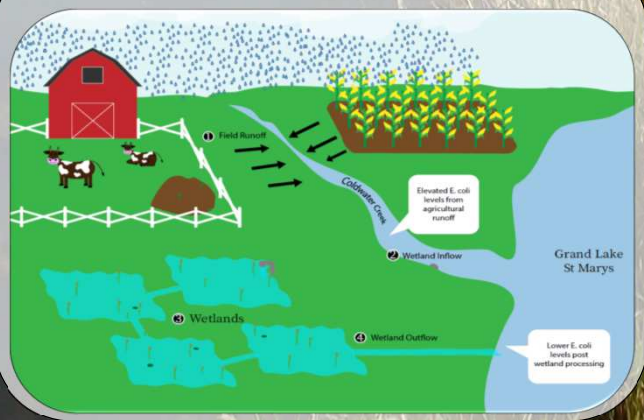
Wetlands are increasingly becoming a cornerstone of stream remediation in the highly eutrophic regions of the Midwestern United States. Wetlands have numerous advantages over other technologies as they incorporate natural biological process resultant from plants and bacteria while also providing an increase in wildlife habitat and greenspaces rather than relying on costly and technologically complex processes to treat waterways. The capacity for wetlands to remediate nutrients and improve water clarity is well established. However, less is known about their potential to affect changes in the pathogenic microbial communities (such as E. coli) commonly associated with runoff in agricultural areas with high populations of livestock and manure runoff. The objective of our research study was to assess remediation potential by quantifying stream bacterial concentration of fecal coliforms before and after flowing through a wetland in Grand Lake St Marys watershed. Results indicated that stream water far exceeded established Ohio Dept of Health exposure guidelines of ~235CFU per 100ml sample, ranging up to over 4,000 CFU but that the wetlands reduced concentrations of Ecoli from between 50 and 85% on average with highest reductions in the spring. These results provide additional positive information regarding the potential for wetland remediation of fecal coliforms in waterways.

Project Objectives

E. coli and Fecal Coliform Monitoring

- Establish weekly monitoring dataset of coliforms in Coldwater Creek and estimate reduction of pathogenic microbes, including E. coli and coliform bacteria, associated with the Grand Lake St Marys constructed wetlands when wetlands are operational.

Conceptual Flow Of E. coli Through The Watershed

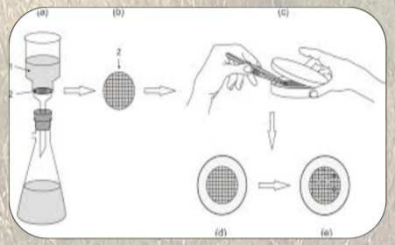


Project Background

Eutrophication is one of the greatest threats to water quality today[1-3]. This phenomenon is borne out of excess nutrients flushing into watersheds at both a local and regional scale[1-3]. However, this is not the only facet of clean water that should be monitored in management of aquatic resources. One additional aspect of improving water quality that has received less attention compared with nutrient runoff relates to microbial watershed runoff and subsequent proliferation in recreational waters. This facet of maintaining clean water has direct implications on human health as exposure to such microbes as E. coli and fecal coliform bacteria can lead to illness or death. Thus, strategies which reduce this microbial load in waters of the state are increasingly applicable. This project assessed the efficacy of Coldwater Creek reconstructed wetlands on the reduction of microbial load in GLSM watershed.

Arial view of Coldwater Creek Wetland

Collecting water samples for analysis

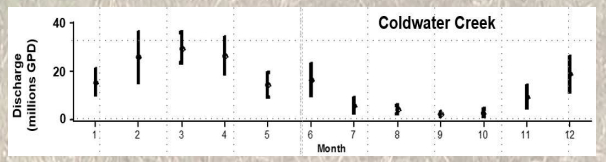


Filtering water for analysis

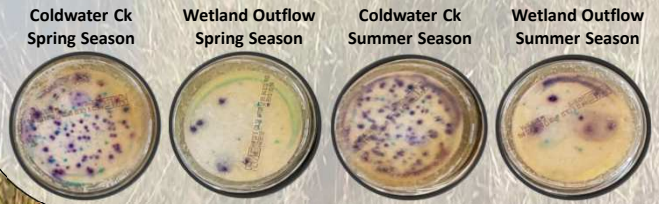
Reading BIO-RAD Quickplate for Ecoli

Project Methodology

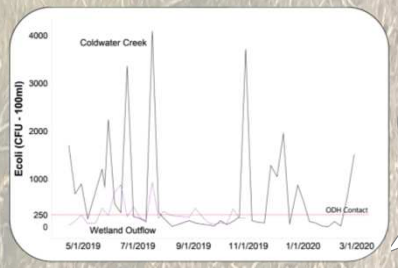
This watershed and wetland pairing were chosen for the study based on proximity to the lake as well as high potential for coliform runoff given the large tonnage of manure spread on the agricultural landscape. To assess microbial load, we took 1 liter grab samples from both the stream and wetland outflow weekly from 2019 to 2020. Samples were returned to the lab in coolers where a sub sample of water was filtered onto gridded MCE paper and incubated for 21 hours on coliform -specific media following sterile protocol. Colony forming units were counted and recorded.



Mean monthly streamflow for Coldwater Creek



Project Monitoring Results



- Ohio Dept Health recommends maximum E.coli levels of ~235 CFU to ensure safety and use potential of water resources
- Levels in this study peaked at 4,088 CFU in summer 2019
- E.coli levels covaried strongly as a function of season and precipitation runoff from land

Wetlands were HIGHLY effective at reducing E.coli concentrations anywhere from 50 to 85%+ --- These numbers are extraordinary and signify need for wider implementation

Seasonal Means E.coli Monitoring (CFU 100ml)				
Site	Fall	Winter	Spring	Summer
Coldwater Ck	460	534	1105	850
Wetland Outflow	182	*	167	402
% Change	-60%	*	-85%	-53%

Project Implications

- Over the long term, these wetlands have the potential to prevent millions of bacterial colonies from being flushed off fields and into GLSM
- Results align with previous studies, with efficiency between 50 and 80+%
- Results of this study can be related to other watersheds, such as Lake Erie, that are experiencing similar issues with agricultural runoff

Acknowledgements

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Literature Cited

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3. Jaynes DB, Isenhart TM. 2014. Reconnecting tile drainage to riparian buffer hydrology for enhanced nitrate removal