Sources of Contamination within the Upper Tributaries of the Portage Watershed to Reduce Harmful Algal Blooms in Lake Erie

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National Science Foundation GRAMS Grants 0850026, 0966189
Ohio Board of Regents Choose Ohio First Grant: BOSEF

Abstract

In response to the negative consequences of harmful algae blooms (HAB) in Lake Eire, a survey of the middle section of the Portage River watershed was conducted to identify contamination sources in Wood County. Physiochemical, nutrient, bacteriolog–ical and macroinvertebral analyses were conducted at each site. An ecological dead zone was identified at the merge of Poe Ditch and North Branch. East/South Branch and Poe Ditch consistently had high levels of phosphorus, which facilitates HAB growth, and fecal matter contamination. Spikes of contamination from the Middle Branch could help identify other sources of contamination in continued research.

Figure 0.1: Log jam located @ merge of Poe Ditch & the North Branch.

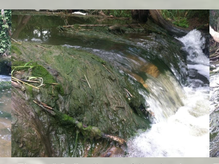

Figure 0.2: Small waterfall at log jam creating jet scour.

Figure 0.3: Algae and raw sewage build up on log jam.

Introduction

Harmful algal blooms are periods when large amounts of harmful species of algae grow. These algal blooms produce toxins, cause taste and odor problems in drinking water, create aesthetic problems, and compete with local organisms for energy (Reutter et al., 2011). Harmful algal blooms have been caused by increased siltration, bacteria, nutrient loading, and/or loss of habitat in tributaries. National Oceanic & Atmospheric Administration anticipates another heavy algal bloom for the Northwestern portions of Lake Erie for late summer 2013 (Henry, 2013).

The Portage River is a moderate size tributary to Lake Erie, but the results found from understanding this river system can be used as a model for understanding other tributaries. Many of the causes for impairments in the Portage watershed are residual of the 1847 Ohio Drainage laws to ditch and drain the Great Black Swamp creating prime agricultural land.

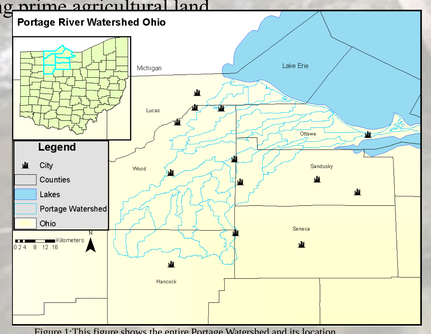

Figure 1:This figure shows the entire Portage Watershed and its location.

The overall purpose of this study is to find the sources contamination within the upper tributaries of the Portage watershed within Wood County. Understanding the sources of contamination will help to reduce water quality impairments while supporting agriculture, recreation, local economy, and other community benefits (Toledo Metropolitan Area Council of Governments, 2011).

Methodology

Site Selection

- General survey of the Portage River upper tributaries
- Data analyses revealed contamination spikes which required additional sampling sites

Methodology

All methods within Environmental Protection Agency (EPA) Regulations.

Physicochemical Data

- Description of the Site
- Time of sample collection
- GPS coordinates of location
- Recent weather conditions
- Dimensions of the waterway:
  - Width
  - Depth
  - Average flow
- Odor intensity
- Water level
- Presence of runoff and algae
- Hach HQ40d analyzer probes:
  - Water temperature
  - pH
  - Dissolved oxygen
  - Conductivity
- Turbidity
- Daily precipitation amount

Nutrient Analyses

$AQ2^+$ Discrete Chemical Analyzer identified concentrations of:

- Nitrate + Nitrite
  - Spectrophotometric measurement at 520nm of the product of reduced nitrate to nitrite with sulfanilamide in diluted H_3PO_4, coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride . EPA Method 114-A Rev. 7.
- Reactive Phosphorus
  - Spectrophotometric measurement 880nm of the product of reactive phosphorus, $MoO_3 \cdot H_2O$ and ascorbic acid. EPA-118-A Rev. 4.
- Ammonia (NH_3)
  - Spectrophotometric measurement at 650-660nm of the product of NH_3 and alkaline phenol and sodium nitroferricyanide. EPA Method 103-A Rev. 6.

Bateriological Analyses

- Total coliform and *Escherichia coli* Colony Forming Units (CFU) per 100 mL.
  - IDEXX Colilert bacteriological nutrient reagents for 100mL samples with ONPG and MUG were dissolved in 1:9 diluted and undiluted samples, incubated in sealed 97-well Quanti-Trays for 24 hours at 35° C and CFUs calculated. Yellow-colored wells indicated coliform presence. Fluorescent wells under UV radiation indicated *E. coli* presence.

Macroinvertebral Analyses

- Biodiversity evaluation by surveying living organisms at site to indicate long-term localized water conditions.

Results & Discussion

Sites showing high levels of nutrients typically had low biodiversity of macro-invertebrates (Figure 2). The South/East Branch and the North Branch near Poe Ditch had the lowest biodiversity scores.

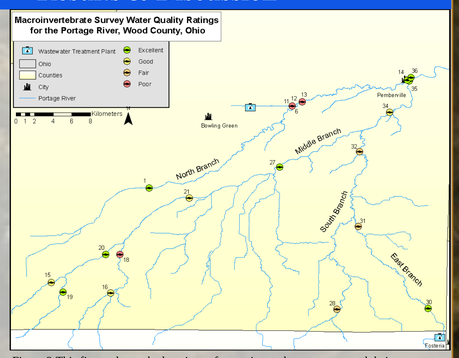

Figure 2:This figure shows the locations of macroinvertebrate surveys and their water quality rating.

The North Branch @ Scotch Ridge & Poe Rd. determined to be a dead zone due to:

- Decomposing algae & high nutrient levels from Poe Ditch
- Suspected raw sewage deposits and build up on log jam
- Anoxic conditions & low biodiversity

Results & Discussion

Point Sources:

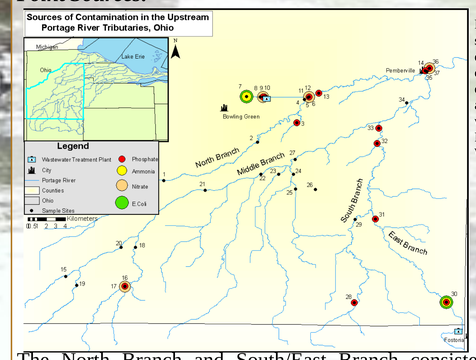

Figure 3:This figure shows the locations of continuous high contamination levels of phosphate, nitrate, ammonia, and *E. coli* within the Portage River tributaries in Wood county, Ohio.

The North Branch and South/East Branch consistently had the higher rates of contamination (Figure 3). Figure 4 shows that the high contamination levels of phosphate on the North Branch were from Poe Ditch and continue downstream from the merge.

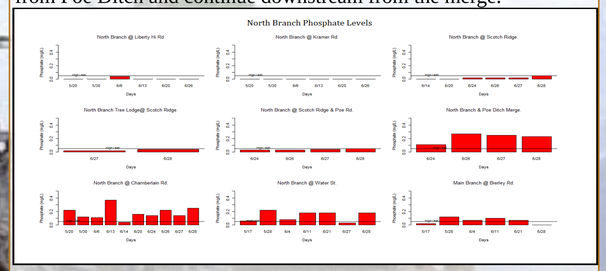

Figure 4:This figure shows the dissolved phosphate levels for the North Branch tributary of the Portage River.

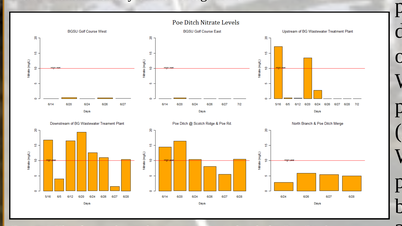

Figure 5:This figure shows the nitrate + nitrite levels for Poe Ditch.

Both nitrate and phosphate levels spike downstream from the outflow of the BG Wastewater Treatment plant (BG WWTP) (Figure 5 & 6). BG WWTP plans to add phosphate reducing biological practices by 2015 (BG WWTP).

The highest E. coli contamination, at Pelton Rd. on the East Branch, is downstream from the Fostoria Wastewater Treatment Plant and may be residual from overflow events (Figure 7). Fostoria hopes to separate storm water from regular wastewater by 2026 to reduce contamination (The Toledo Blade, 2006).

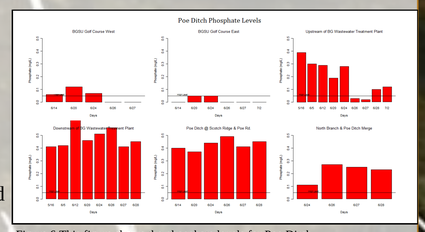

Figure 6:This figure shows the phosphate levels for Poe Ditch.

Figure 7:This figure shows the *E. coli* levels for the South and East Branch tributaries of the Portage River.

Results & Discussion

Nonpoint Sources:

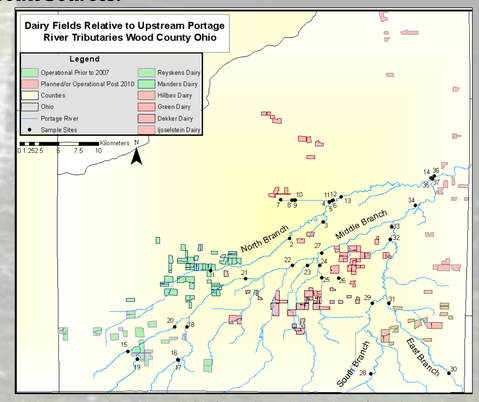

Figure 8:This figure shows the locations of sample sites in comparison to locations of chemical and manure applied dairy fields.

The Middle Branch spikes after rainfall events symbolizing nonpoint sources of contamination of runoff from nearby fields. Ammonia levels are normally low except on 6/14 after a rainfall event of .81 in. the ammonia levels increase (Figure 9).

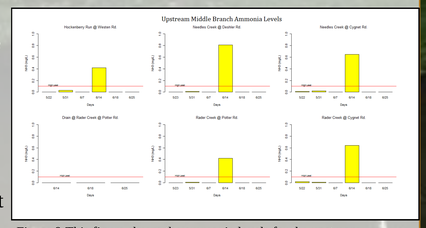

Figure 9:This figure shows the ammonia levels for the upstream tributaries that make up the Middle Branch.

A similar event with phosphate happened further downstream on 7/8 after a rainfall event of .87 in. (Figure 10).

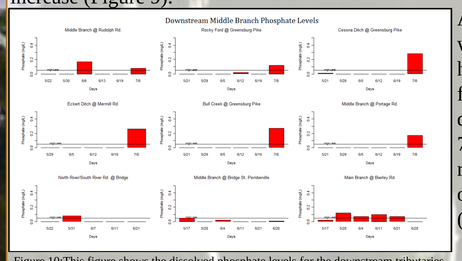

Figure 10:This figure shows the dissolved phosphate levels for the downstream tributaries that make up the Middle Branch.

Next Steps

- Further monitor contamination at key locations in the watershed.
- Localize the sources of highest concern.
  - Study contamination levels at sites during high flow events.
- Further investigate Dead Zone @ North Branch & Poe Ditch merge.
- Learn more about nutrient reduction strategies in areas similar to Northwest Ohio.
  - Phytoremedial plants which absorb contaminants.
  - Artificial wetland construction.
- Compare dissolved phosphorus to BG WWTP total phosphorus results.
- Clean Poe Ditch of trash and algae.

Resources

2011. *Portage River Watershed Plan: Hancock, Ottawa, Sandusky, Seneca, and Wood Counties, Ohio.* Toledo Metropolitan Area Council of Governments. Portage river Basin Council.

2006. Fostoria sued over Sewage Violations. The Blade. The Toledo Blade Company, Toledo Ohio.

Henry, T. 2013. *Toxic Algae Could Hit Third of W. Lake Erie: NOAA says bloom to be heavy, but smaller than 2011's dense growth.* The Blade. The Toledo Blade Company. Toledo, Ohio.

Reutter, J.M., Ciborowski, J., and DePinto, J. 2011. *Lake Erie Nutrient Loading and Harmful Algal Blooms: Research Findings and Management Implications.* Final Report of the Lake Erie Millennium Network Synthesis Team. Ohio Sea Grant College Program, Ohio State University.