PROJECT TITLE: Sources and fates of nutrients in non-agricultural Ohio surface waters
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PREPARED BY: Mažeika Sullivan, Lauren Pintor, Kai Zhao, Kay Stefanik - School of Environment and Natural Resources, The Ohio State University

PROJECT STATUS: The goal of this study is to quantify, both spatially and temporally, the sources and fates of phosphorus (P) and nitrogen (N), their effect on aquatic life, and the relative effects of various land-use types on HABs. Significant progress to date has included:

1. We have completed some initial model-based analyses of nutrient transport across the watersheds. For example, an initial SWAT run for the Hoover Reservoir captured the spatio-temporal patterns of runoff and nutrient leaching consistent with the general land-use practice and weather events (Fig. 1). In the simulation, the watershed was segmented into individual sub-catchments; the modeled annual P losses can be used as key indicators of critical source areas of nutrient leaching. A further check shows that those sub-catchments having high P loss generally coincided with planted areas with high slopes. To improve the model confidence and credibility, the SWAT model configuration is being evaluated, with the goal to develop a robust model calibration scheme. Our first attempt is at compiling historical in-situ hydrology and water chemistry measurements for our study watersheds, but such data are generally unavailable at the scale needed. Therefore, we currently seek an indirect hierarchical approach to model calibration and validation by embedding our study watersheds into larger watersheds for which adequate in-situ data are available.

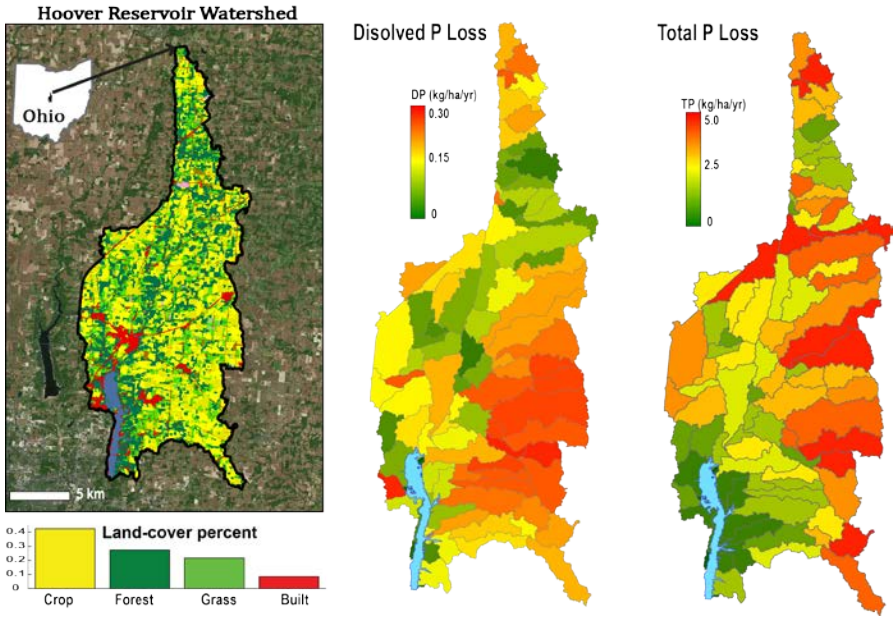

Figure 1. Linkages between land-use practice and water quality: Shown here are spatial distributions of land use and associated nutrient leaching, as simulated for one of the proposed study watersheds – Hoover Reservoir.

2. Winter water collection at the stream and reservoir study sites was conducted in February 2017 (Figure 2a). Water samples were collected for nutrients analysis (total nitrogen, total phosphorus, nitrate, ammonia, and orthophosphate; Figure 2b). At the time of stream-water collection, streamflow velocity (Figure 2c), water depth, and water-chemistry parameters (temperature, conductivity, dissolved oxygen, pH, and oxidation reduction potential) were also measured. At each reservoir site, water samples were collected from the surface and bottom waters of the lakes. Stratification, or lack thereof, was determined by examining the temperature and dissolved-oxygen gradient of the water column. Lake-water samples were collected for nutrient/chemical analysis, including temperature, conductivity, dissolved oxygen, pH, oxidation reduction potential total nitrogen, total phosphorus, nitrate, ammonia, and orthophosphate. At the time of winter water collection, water levels were higher than summer collection levels, with all streams containing flowing water (Figure 2d,e)

Figure 2. Winter stream sampling 2017. Weather conditions varied during sample collection, but light snow cover and ice along stream banks was a common occurrence at most sites (a). Water grab samples (b) were collected from stream and reservoirs for nutrient analysis. Water-chemistry parameters and streamflow velocity (c) were also measured at the time of water collection. Water levels were high during sampling, with all ephemeral streams containing water (d) and two stage agricultural ditches were near or at flood stage (e).

3. In the laboratory, invertebrate samples are being sorted to remove debris and isolate invertebrates by a laboratory technician and undergraduate research assistants (Figure 3). Invertebrate samples from a portion of Hoover reservoir and streams are currently being identified by a graduate student and an undergraduate researcher. Remaining samples are being packed to send to Rhithron Associates, Inc. for identification. In addition to invertebrate samples, a subset of algal samples is being sent to Rhithron Associates, Inc. for identification.

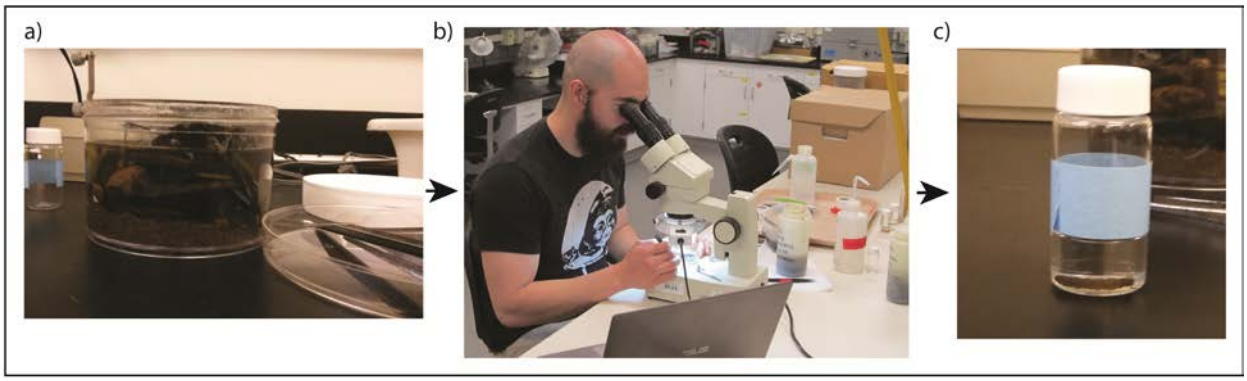

Figure 3. Invertebrate sample processing. Invertebrates, sediment, and other debris are collected from each stream (a) and brought back to the lab for processing (b) where invertebrates are separated out for identification and enumeration (c).

4. Field equipment (including in-stream ISCO samplers) has been received and we anticipate deployment in spring 2017. ISCO samplers will be used to collected water samples on a daily basis throughout spring, summer, and fall to determine the sediment load in the water column (Figure 3a,b). A water-quality sonde that will continuously measure water-chemistry parameters (temperature, conductivity, dissolved oxygen, pH, and oxidation reduction potential) will be deployed near the mouth of the largest river flowing into each reservoir (Figure 3c).

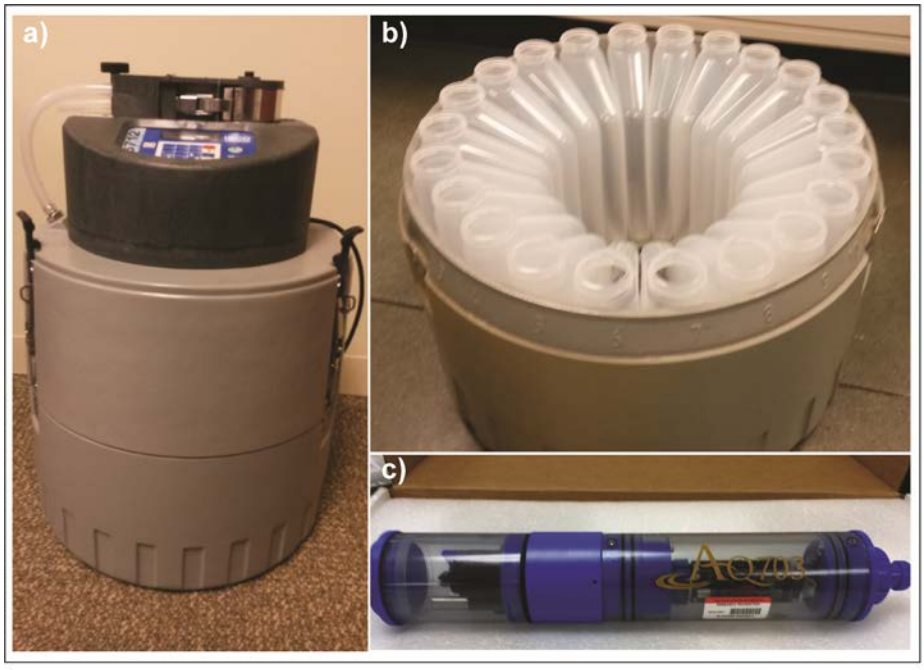

Figure 4. ISCO automated samplers for collection of sediment load in the water column (a and b) and sonde (c) for continuous water quality monitoring at the mouth of the largest inflows into each reservoir.

5. Analysis of the data collected during the Summer and Fall 2016 sampling events is underway. A summary of water quality data can be found in Table 1.

Table 1. Average water-quality and chemistry data summary for 2016. SE = standard error

	Temp. (°C)	Conductivity (µS/cm)	DO (mg/L)	pH	ORP (mV)	TP (mg-P/L)	TN (mg-N/L)	PO4 (mg PO4-P/L)	NO3 (mg NO3-N/L)	Turbidity (NTU)
Burr Oak Lake	22.08 (SE 2.00)	196.44 (SE 14.98)	7.32 (SE 1.10)	8.05 (SE 0.17)	117.21 (SE 29.45)	0.07 (SE 0.01)	0.88 (SE 0.08)	0.02 (SE 0.003)	0.04 (SE 0.01)	4.49 (SE 2.06)
Burr Oak Streams	17.61 (SE 1.18)	271.82 (SE 14.70)	6.01 (SE 0.46)	7.66 (SE 0.08)	173.33 (SE 15.41)	0.05 (SE 0.01)	0.67 (SE 0.03)	0.01 (SE 0.001)	0.04 (SE 0.01)	5.90 (SE 2.14)
Hoover Reservoir	21.76 (SE 1.61)	341.56 (SE 7.23)	8.99 (SE 0.97)	8.24 (SE 0.13)	176.97 (SE 21.78)	0.07 (SE 0.01)	1.85 (SE 0.48)	0.01 (SE 0.001)	0.36 (SE 0.12)	4.50 (SE 0.68)
Hoover Streams	14.15 (SE 1.00)	742.48 (SE 21.70)	9.60 (SE 0.30)	8.01 (SE 0.03)	217.92 (SE 4.95)	0.08 (SE 0.01)	1.85 (SE 0.16)	0.05 (SE 0.01)	1.04 (SE 0.15)	4.21 (SE 0.49)
Indian Lake	20.28 (SE 1.44)	368.56 (SE 10.76)	11.48 (SE 0.81)	8.76 (SE 0.08)	207.81 (SE 12.72)	0.08 (SE 0.01)	1.34 (SE 0.08)	0.03 (SE 0.04)	0.06 (SE 0.03)	12.75 (SE 1.36)
Indian Streams	17.25 (SE 1.26)	714.32 (SE 24.70)	11.76 (SE 1.39)	8.21 (SE 0.04)	197.16 (SE 6.79)	0.11 (SE 0.04)	1.78 (SE 0.23)	0.07 (SE 0.03)	0.91 (SE 0.21)	6.62 (SE 1.43)

2017 Preliminary Sampling Timeline: Spring sampling will occur from April 17 – May 17, Summer sampling will occur from July 1 - September 1, and Fall sampling will occur from October 15 – November 15. Additional water-quality and nutrient sampling will occur at approximately bimonthly intervals between major sampling events. Water-column sediment load collected using the ISCO samplers will occur at 24-day intervals starting at Spring deployment until the end of Fall sampling. Parameters to be measured at each major sampling event can be found in Table 2.

Table 2. Parameters to be measured at each major sampling event, marked by an X.

Parameters	**Spring Sampling**	**Summer Sampling**	**Fall Sampling**
Water Quality	X	X	X
Water Nutrients	X	X	X
Phosphate Isotopes		X	X
Invertebrates	X	X	X
Algae	X	X	X
Fish		X	
Geomorphology		X	

Budget: In general, we are on track relative to spending. Because of the delayed start date, we were not able to hire some project staff until later than anticipated, and have received approval for funds to be carried over thru mid May 2017. Additional funding has been obtained for two full-time honors undergraduate research students through OSU's, Office of Undergraduate Research & Student Inquiry's Office as well as through the Summer Research Opportunities Program by universities in the Big Ten Academic Alliance. Further budgetary details can be provided upon request.