Assessing Water-Quality from Edge of Field to the Great Lakes

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Michigan’s Water Resources

Drinking Water
Agriculture Production
Recreation
Energy Production
Foundation for Healthy Ecosystem

USGS
Michigan’s Water Resources

- USGS Michigan-Ohio Water Science Center
  - Who we are and what we do

- Viewing our water resources across large landscapes

- USGS water quality and quantity studies in Michigan and Great Lakes
The USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The diversity of our scientific expertise enables us to carry out large-scale, multi-disciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers.

Water
Environmental Health
Natural Hazards
Ecosystems
Energy and Minerals
Core Science Systems
Climate and Land Use Change
Michigan-Ohio Water Science Center

- Work with local, State, and other Federal agencies, as well as tribes and universities.
- Investigate spatial and temporal distribution of water quantity and quality, as related to human and ecosystem needs, as affected by human and natural influences.
- The interpretive analysis and supporting data are freely available through the internet.

USGS data, analysis, and products supports policy analysts and decision makers, and provides the general public with tools to assist the management, stewardship, and wise use of Michigan’s water resources.
**USGS Daily Streamflow Data**

**USGS Current Water Data for Michigan**

http://waterdata.usgs.gov/mi/nwis/rt

⚠️ NOTE: During winter months, stage and discharge may be affected by ice. Click here for more information.

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**Daily Streamflow Conditions**

Select a site to retrieve data and station information.

- **Discharge, cubic feet per second**
  - Most recent instantaneous value: 653 02-29-2016 14:30 EST

- **Statewide Streamflow Current Conditions Table**

The colored dots on this map depict streamflow at each station. The gray circles indicate other stations that may be affected by ice or other factors. Some stations may be subject to revision.
Evaluating Water Resources Across the Landscape
From Edge of Field to Open Lake

Edge of Field
- Sampling from tile drains
- Runoff from field
- Downstream drain/ditch
Urban Runoff
• Storm & Sanitary Sewer
• Impacts of Best Management Practices (including Green Infrastructure)
• Hydrology, chemistry, microbiology
From Edge of Field to Open Lake

In stream processes
- Nutrient cycling
- Storage in stream
- Groundwater influence
Tributary Monitoring
• Chemistry, flow, intermittent microbiology
• Surrogate models
• Real-time load estimation
From Edge of Field to Open Lake

Chemicals of Emerging Concern
- Wastewater, pesticides, viruses, and pathogens
- Discrete and passive samplers
- Loads
- Comparison to land use
River Mouth Processing
- Nutrient processing
- Primary and secondary productivity
- Sediment transport
- Mixing impacts
From Edge of Field to Open Lake

Open Lake Processes/HABs
- Community succession
- Primary and secondary productivity
- Bloom toxicity
- Bloom cessation
From Edge of Field to Open Lake

Edge of Field
- Sampling from tiles
- Run off from field
- Downstream drain/ditch
Great Lakes Restoration Initiative Priority Watershed Edge of Field Project
Priority Watershed GLRI Edge of Field

The goal is to quantify the effectiveness of agricultural management practices on nutrient and sediment retention in diverse landscape settings.
GLRI-Edge of Field

- All farms participating in the study are privately owned
- Locations were chosen to represent multiple agricultural landscape settings
- Monitoring at this scale provides information for calibration of process-based watershed models
- Results may help farmers implement cost saving nutrient management programs and/or practices
GLRI- Edge of Field Approach

- Coordinate with NRCS for “on-farm” data collection
- Pre- and Post-BMP approach
  - May not be able to evaluate all BMP types
  - Try to characterize “typical/abundant” conservation practices for that particular watershed
- Collect samples year-round
GLRI- Edge of Field Approach

- Installed at an existing low point in the field, berm was created during dredging of drain
Typical field level stations
Monitoring Field Tile Drains
Typical station set-up

- Refrigerated autosamplers
- Data loggers
- Stage sensors
- Power Source [A/C or Solar]
- Time-lapse camera
- Rain gage
- Cellular service modems*
Most of the year, we expect no flow through the flume.
Rain Event Triggered Sampling
Flow-weighted composite sampling

- Samples are composited and weighted according to time on storm hydrograph when samples were collected.
BMP IMPLEMENTATION
Precipitation and Runoff

Peak month of precipitation varies each year. Because crop cover can reduce runoff, the timing of precipitation could be important for sediment and nutrient loss.
Sediment Yields - WY12 - WY15

Annual Surface Runoff - WY12 - WY15

Preliminary Information—Subject to Revision. Not for Citation or Distribution
Pesticide Application and Influence on Water Quality

Partnership with Michigan Department of Agriculture and Rural Development

Isoxaflutole (IFT) – Pesticide recently approved for use on corn in Michigan.

- There are concerns that persistence of the IFT and its metabolites in groundwater and/or surface water could negatively impact water-quality.

- 5-year monitoring program to investigate before/after and upgradient/downgradient conditions at two application sites.
Isoxaflutole Monitoring

Site Selection Criteria
(1) Isoxaflutole not having been applied to the field in the past,
(2) The landowner agreeing to participate in the study for five years
(3) The landowner agreeing to grow corn and apply isoxaflutole in years 1, 3, and 5 of the study.
Isoxaflutole Monitoring-Groundwater

- Shallow and deep wells near the application area, and upgradient and downgradient of the application area.
Isoxaflutole Monitoring-Surface Water

- Surface water samples before and after application
  - onsite tile drains
  - ponds or reservoir
  - runoff at edge of field
  - upstream and downstream from the application area
- Surface water samples will be collected during or immediately after rainfall events for 5 years to capture any trends that are occurring
From Edge of Field to Open Lake

Tributary Monitoring
- Chemistry, flow, intermittent microbiology
- Surrogate models
- Real-time load estimation
Monitoring Project Objectives

- Provide baseline information on contaminant loads from major Great Lakes tributaries.
- Provide quantifiable measures of restoration progress on major Great Lakes tributaries.
- Model potential load changes throughout the Great Lakes.
GLRI Tributary Monitoring

- Monthly Routine Sampling
- Automated samplers to capture high-flow events
- Continuous water-quality sensors (real-time measurement)
- Selected sites:
  - Pathogens, dissolved organic matter, emerging chemicals
Automated Sampling

- Analytes include:
  - suspended sediment,
  - nutrients —nitrogen, nitrite, nitrite + nitrate, total nitrogen,
  - ortho-phosphorus, and total phosphorus,
  - chloride,
  - one sample per storm event will be analyzed for major ions.

- Monthly base flow samples (12) plus eight storms will be sampled with 6 samples submitted per storm (60 environmental samples per site)

- Samples will be used to develop statistical relations between continuously measured parameters and lab analyzed parameters.
Water Quality Sensor Suite

- High Turbidity
- Low Turbidity
- Temperature
- Conductivity
- Dissolved Oxygen
- pH
Real-time sensor monitoring information available at: http://waterwatch.usgs.gov/wqwatch
## USGS 04166500 River Rouge at Detroit, MI

**Discharge, cubic feet per second**

**Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius**

**Turbidity, water, unfiltered, monochrome near infra-red LED light, 780-900 nm, detection angle 90 +/− 2.5 degrees, formazin nephelometric units (FNU)**

### Explanation
- **Discharge**
- **Measured discharge**
- **Median daily statistic (85 years)**
- **Specific conductance**
- **Median daily statistic (5 years)**
- **Turbidity**

### Table

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<th>Turbidity, IR LED light, det ang 90 deg, FNU</th>
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Real-time Water-Quality Monitors

**Directly Measure**
- Gage Height (Stage)
- Specific Conductance
- Turbidity

**Computed or Estimated**
- Streamflow (discharge)
- Chloride
- Total suspended solids, suspended sediment, fecal coliform, *E. coli*, total nitrogen, total phosphorus
Continuous Load Estimation

Surrogate data analyses – Regression R script

Approach:

- Pull concentration and unit value data from NWIS
- Determine best predictors by parameter (regression), with and without continuous water-quality variables.
- Calibrate regression equations for each site, with and without continuous variables (using consistent variables for each parameter).

- Goal: Publish results and release continuous data in real-time to the web.
  - Estimate Loads and Confidence Limits on a Daily, Monthly, and Annual Basis. No breaks in the computations.

R² = 0.85
Turbidity

R² = 0.72
Flow
Preliminary Load estimates for Total Phosphorus

- Loads were computed using streamflow and water quality data from the GLRI stations across the Great Lakes. An average daily load computed using the LOADEST code for R and is presented by water year and WLEB station.

- “These data are preliminary and are subject to revision. They are being provided to meet the need for timely best science. The data are provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the data.”
Bacterial Pathogens

Samples collected March – October 2011
Bacterial Pathogen Analysis

- A total of 134 environmental samples were collected during high flow and normal/low flow conditions, and analyzed by the USGS Michigan Bacteriological Research Laboratory (MI-BaRL).

- Water samples were analyzed for fecal indicator bacteria concentrations:
  - Fecal coliform bacteria, *Escherichia coli* (*E. coli*), and enterococci, according to EPA Standard Methods.

- Samples were also analyzed using polymerase chain reaction (PCR) to determine the occurrence of pathogen gene markers:
  - *Shigella spp.*, *Campylobacter*, *Salmonella*, and pathogenic *E. coli* including Shiga toxin-producing *E. coli* (STEC).
Bacterial Pathogen Targeted

- **STEC**, including *E. coli* O157:H7 can cause illness ranging from mild intestinal disease to severe kidney complications and death in animals and humans (*eaeA, stx1, stx2, rfb0157*)
- **Shigella** acts similarly to STEC, however it mainly affects humans (*ipaH*)
- **Salmonella** infection can cause diarrhea, fever, and abdominal cramps, and can even lead to death (*invA, spvC*)
- **Campylobacter** is one of the most common causes of diarrheal illness in the United States, causing symptoms including cramping, abdominal pain, and fever
Bacterial Pathogen Results

Occurrence and Distribution of Fecal Indicator Bacteria and Gene Markers of Pathogenic Bacteria in Great Lakes Tributaries, March–October 2011

Open-File Report 2015–1013
USGS Evaluating our Water Resources from Field to Lake

- Measuring flow in rivers and streams
- Measuring the runoff from fields
- Measuring nutrient, sediment, chemical concentrations in runoff
- Groundwater resource evaluations including groundwater-surface water interaction.
- Determining the presence of pathogens
- Quantifying the loads of contaminants
THANK YOU

HTTP://MI.WATER.USGS.GOV/

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