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

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U.S. Geological Survey
Michigan-Ohio Water Science Center, Lansing MI

Michigan's Water Resources

Drinking Water
Agriculture Production
Recreation
Energy Production
Foundation for Healthy Ecosystem

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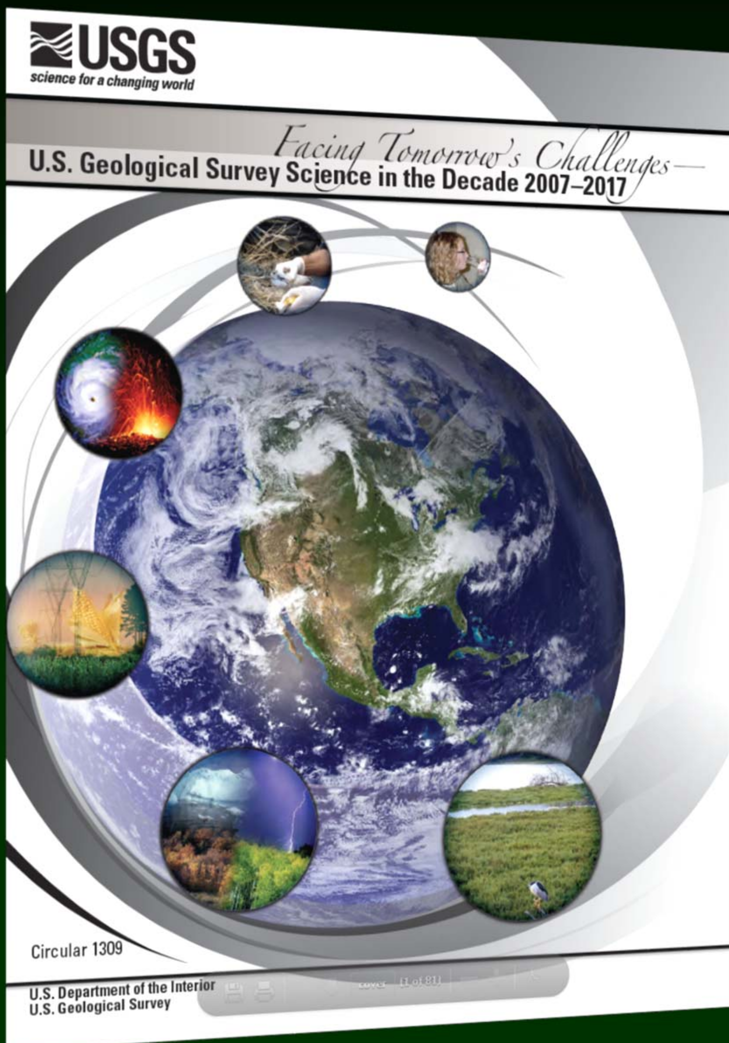
Michigan's Water Resources

- 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

U.S. Geological Survey



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

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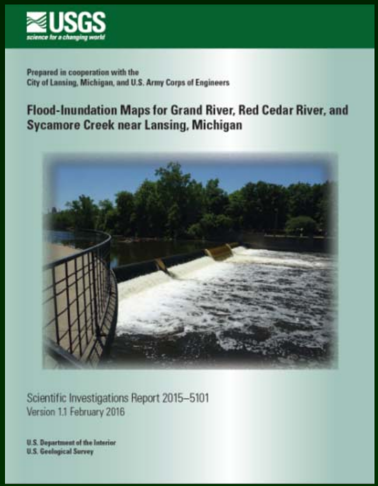
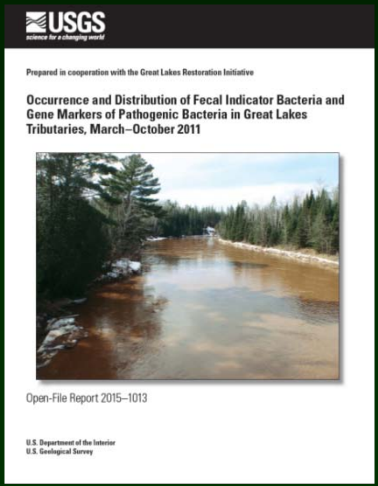
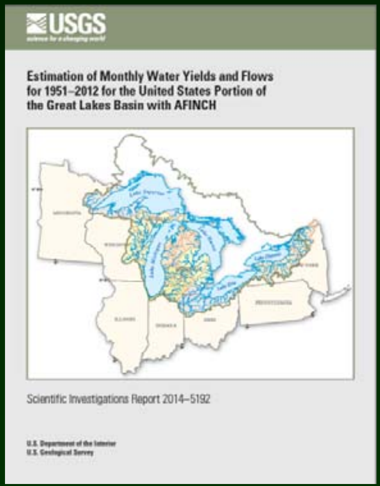
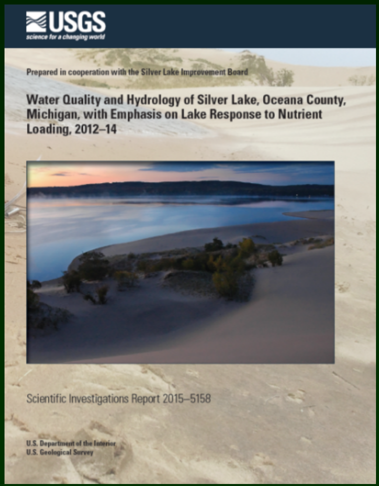
Michigan-Ohio Water Science Center

- 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

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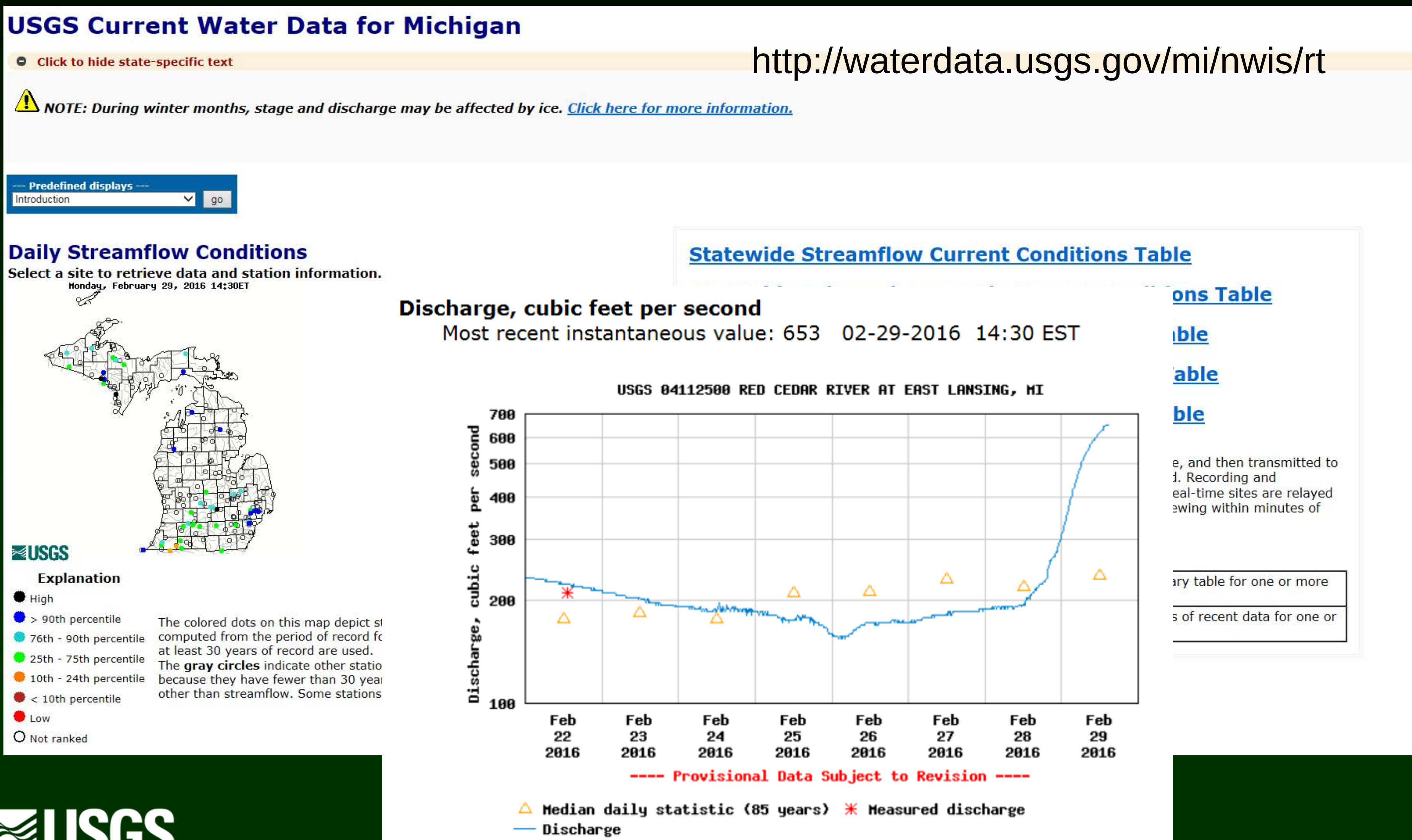
USGS Daily Streamflow Data

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



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Evaluating Water
Resources Across the
Landscape
USGS
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Practitioners' Views of Science Needs

FOR THE

Great Lakes Coastal Ecosystem

Pebbles, V., E.C. Lillard, P.W. Seelbach, and L.R. Fogarty | AUGUST 2015

This report is Contribution 1982 of the U.S. Geological Survey Great Lakes Science Center.

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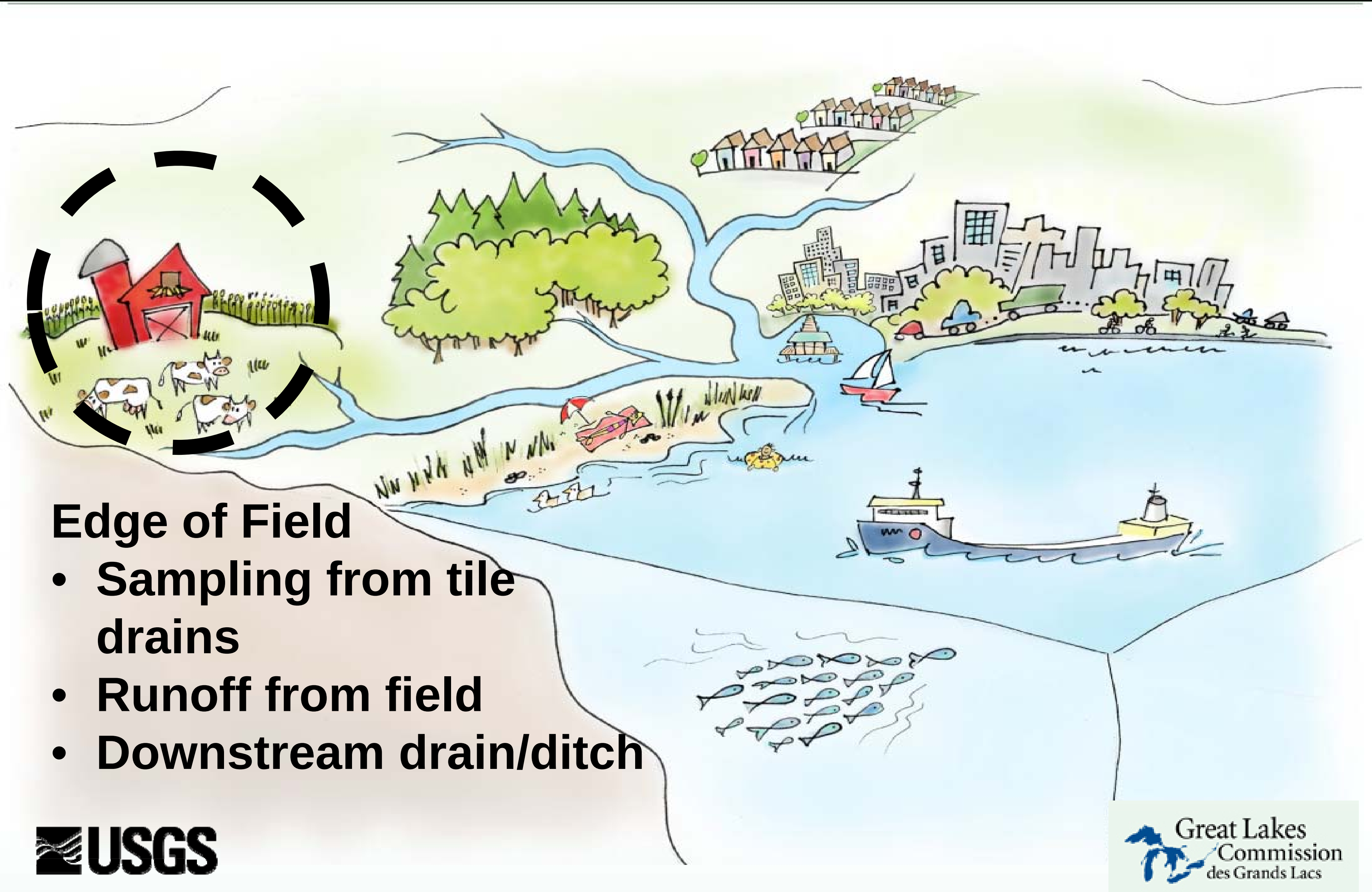
From Edge of Field to Open Lake



Edge of Field

- **Sampling from tile drains**
- **Runoff from field**
- **Downstream drain/ditch**

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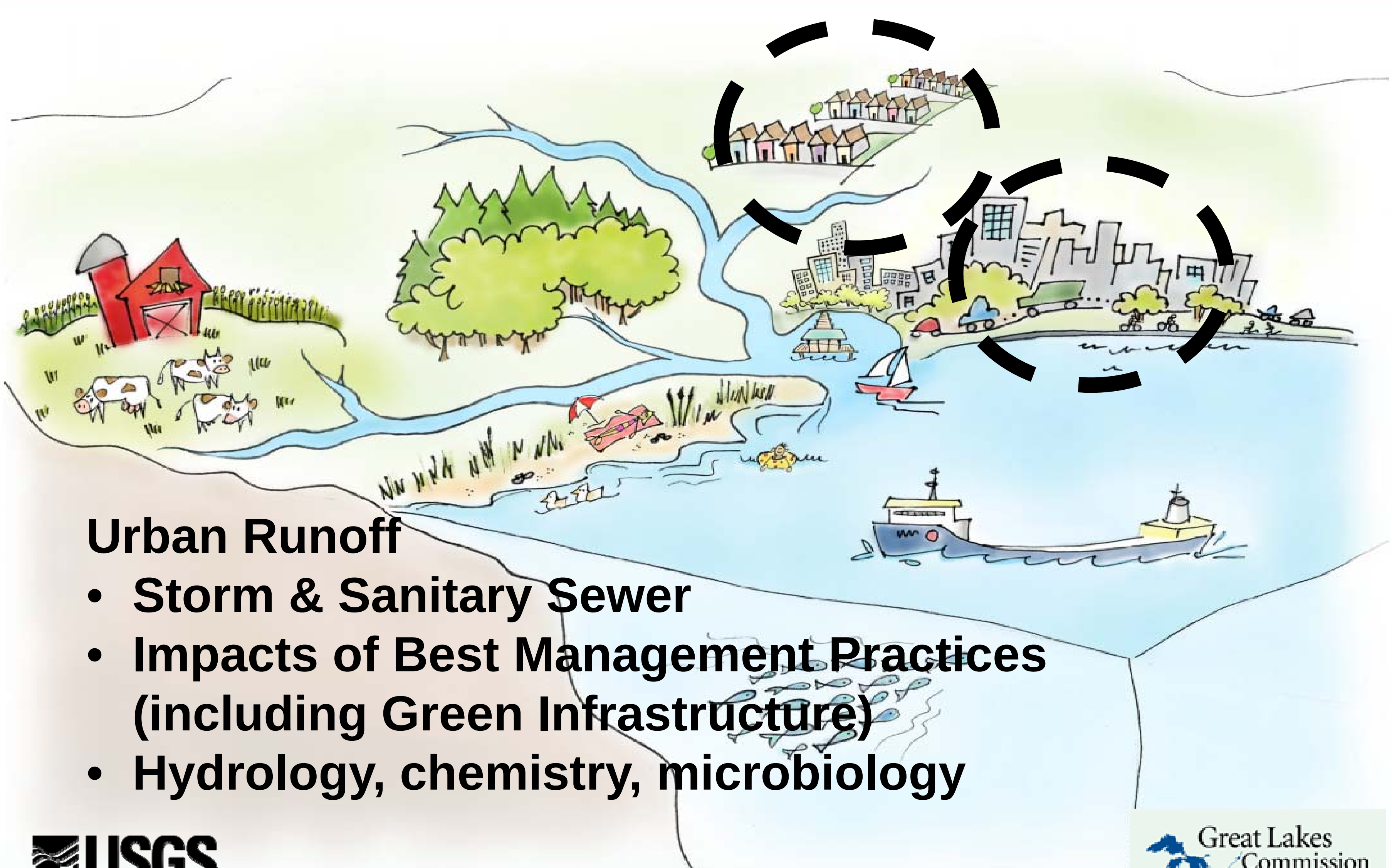
From Edge of Field to Open Lake



Urban Runoff

- **Storm & Sanitary Sewer**
- **Impacts of Best Management Practices (including Green Infrastructure)**
- **Hydrology, chemistry, microbiology**

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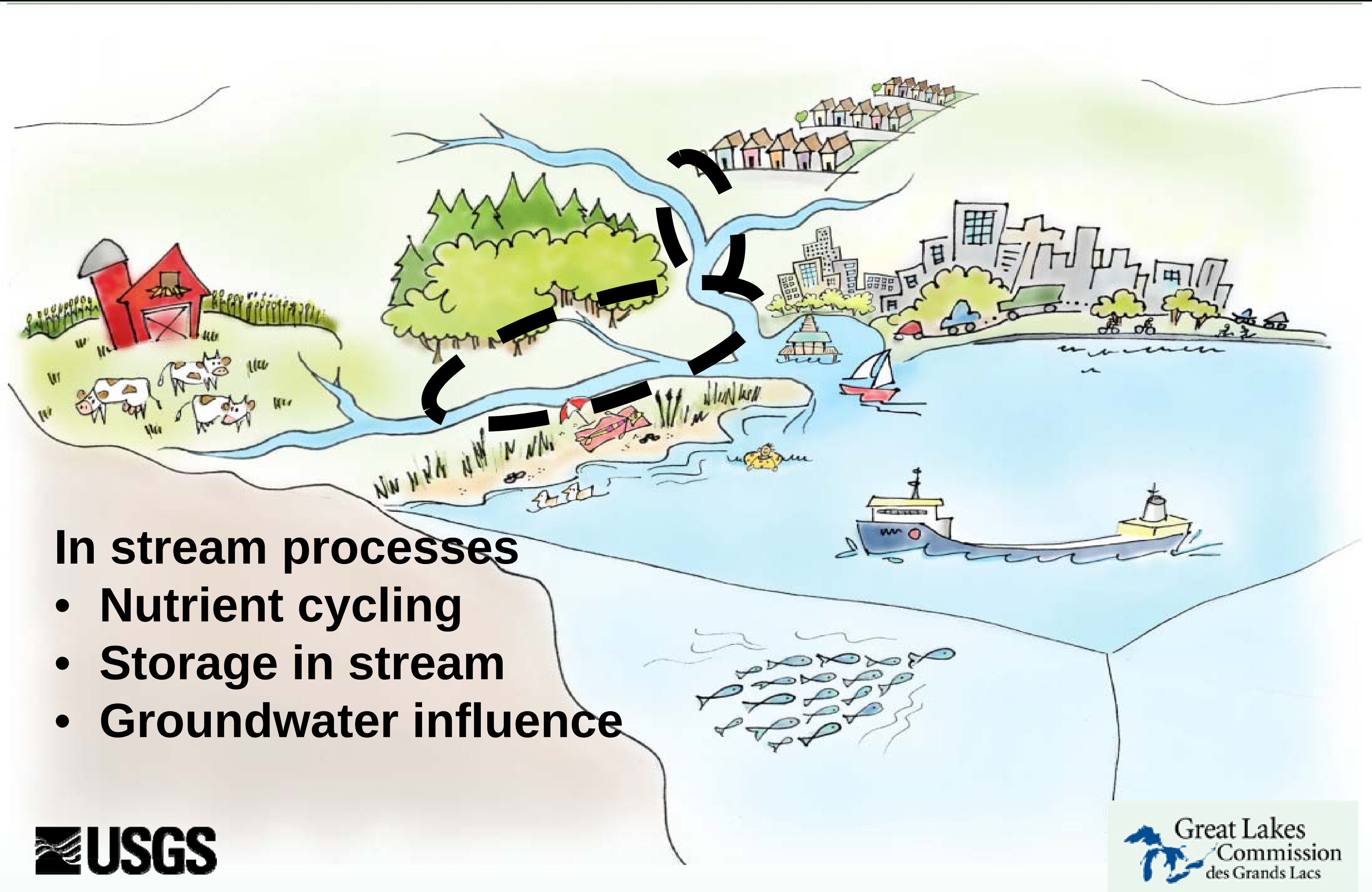
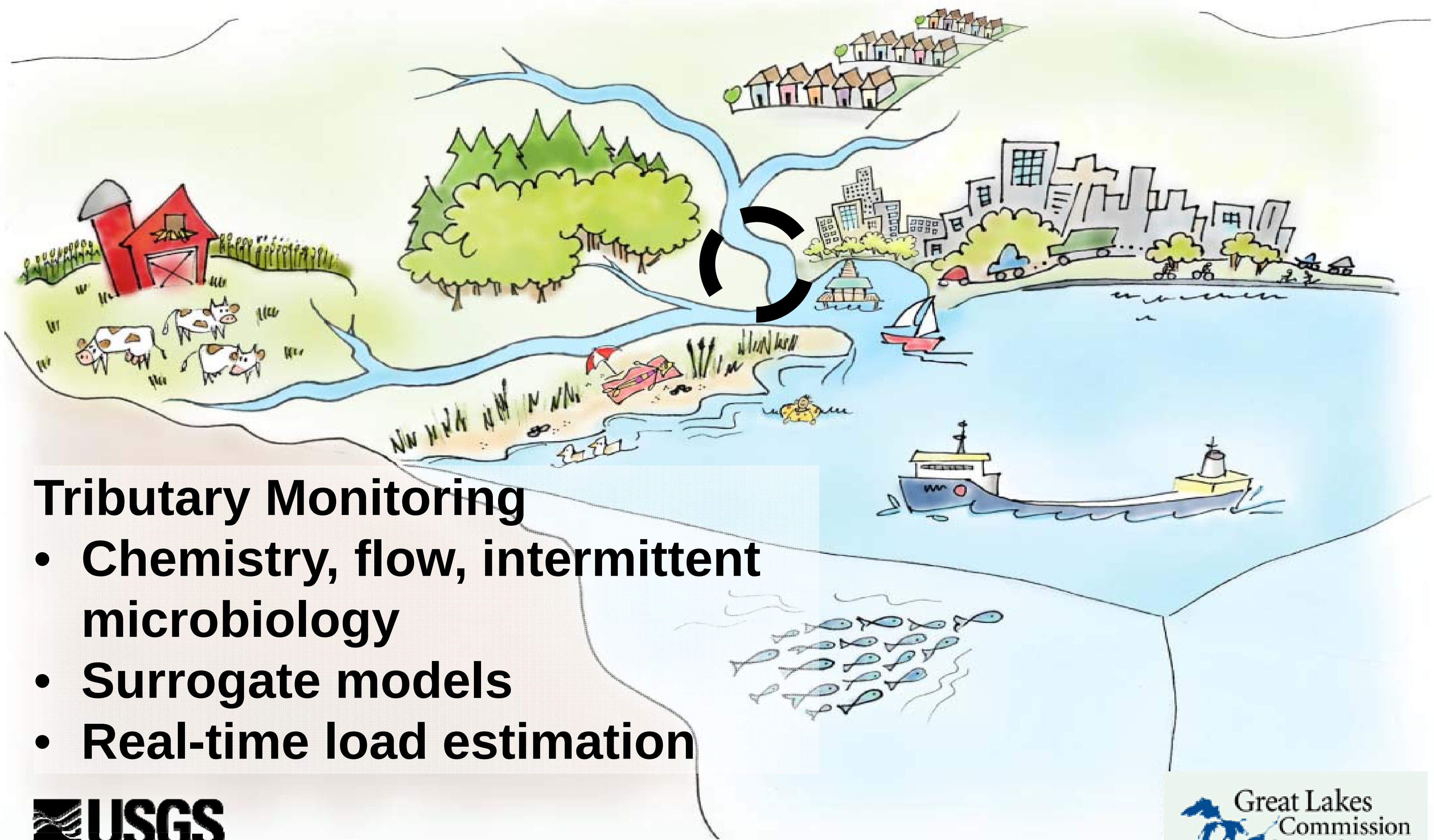
From Edge of Field to Open Lake



In stream processes

- **Nutrient cycling**
- **Storage in stream**
- **Groundwater influence**

From Edge of Field to Open Lake



Tributary Monitoring

- **Chemistry, flow, intermittent microbiology**
- **Surrogate models**
- **Real-time load estimation**

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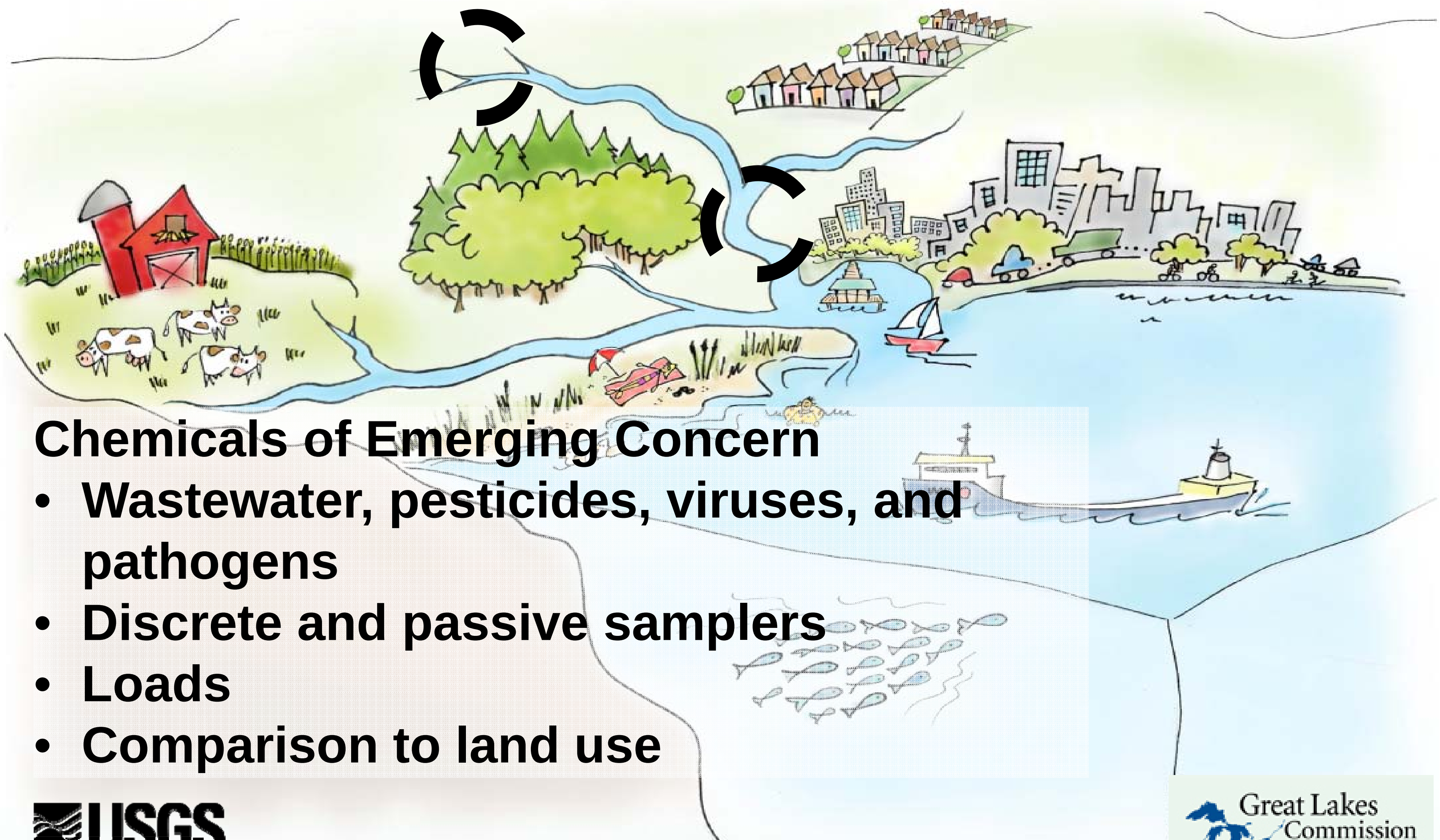

Chemicals of Emerging Concern

- **Wastewater, pesticides, viruses, and pathogens**
- **Discrete and passive samplers**
- **Loads**
- **Comparison to land use**

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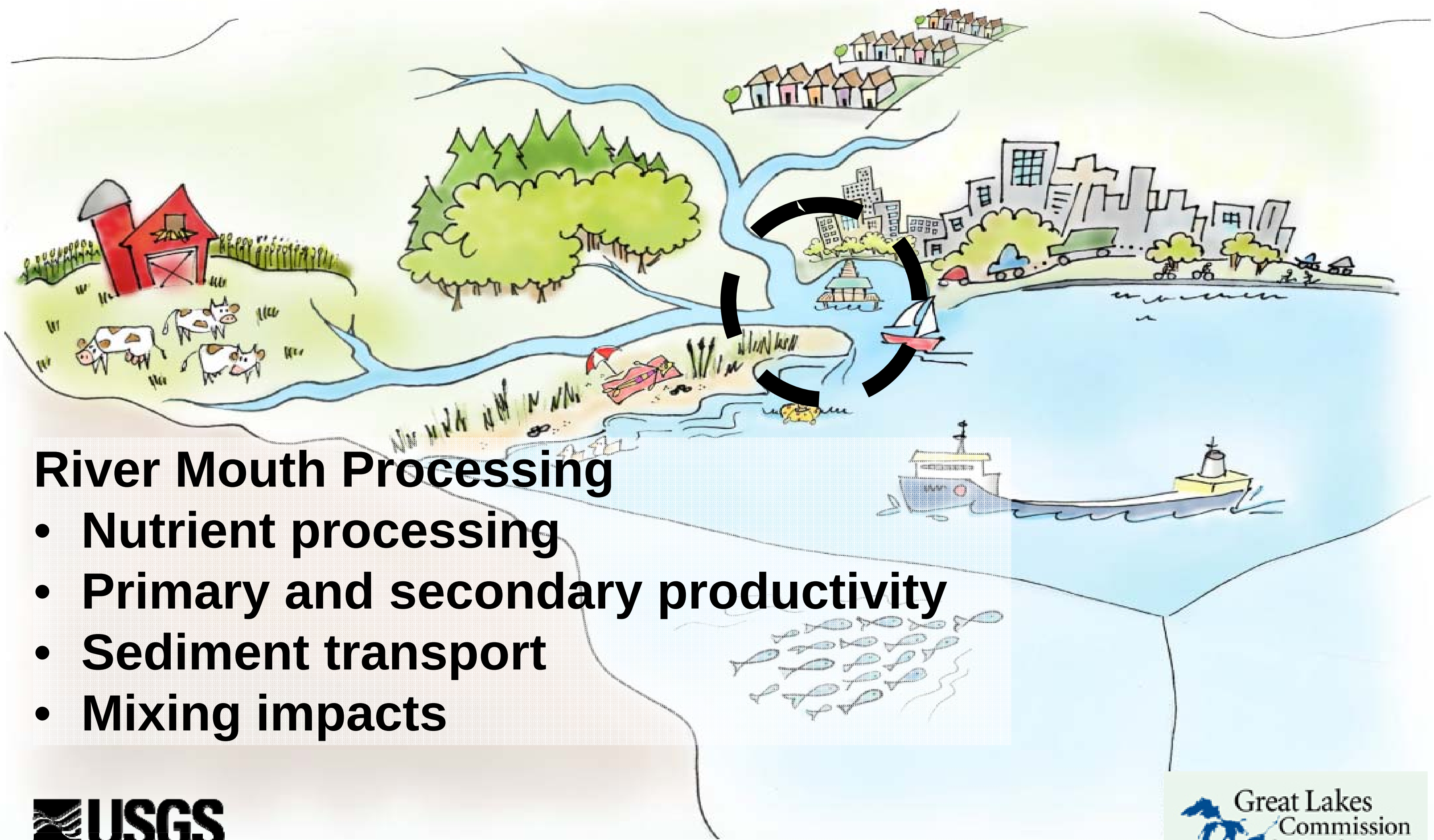
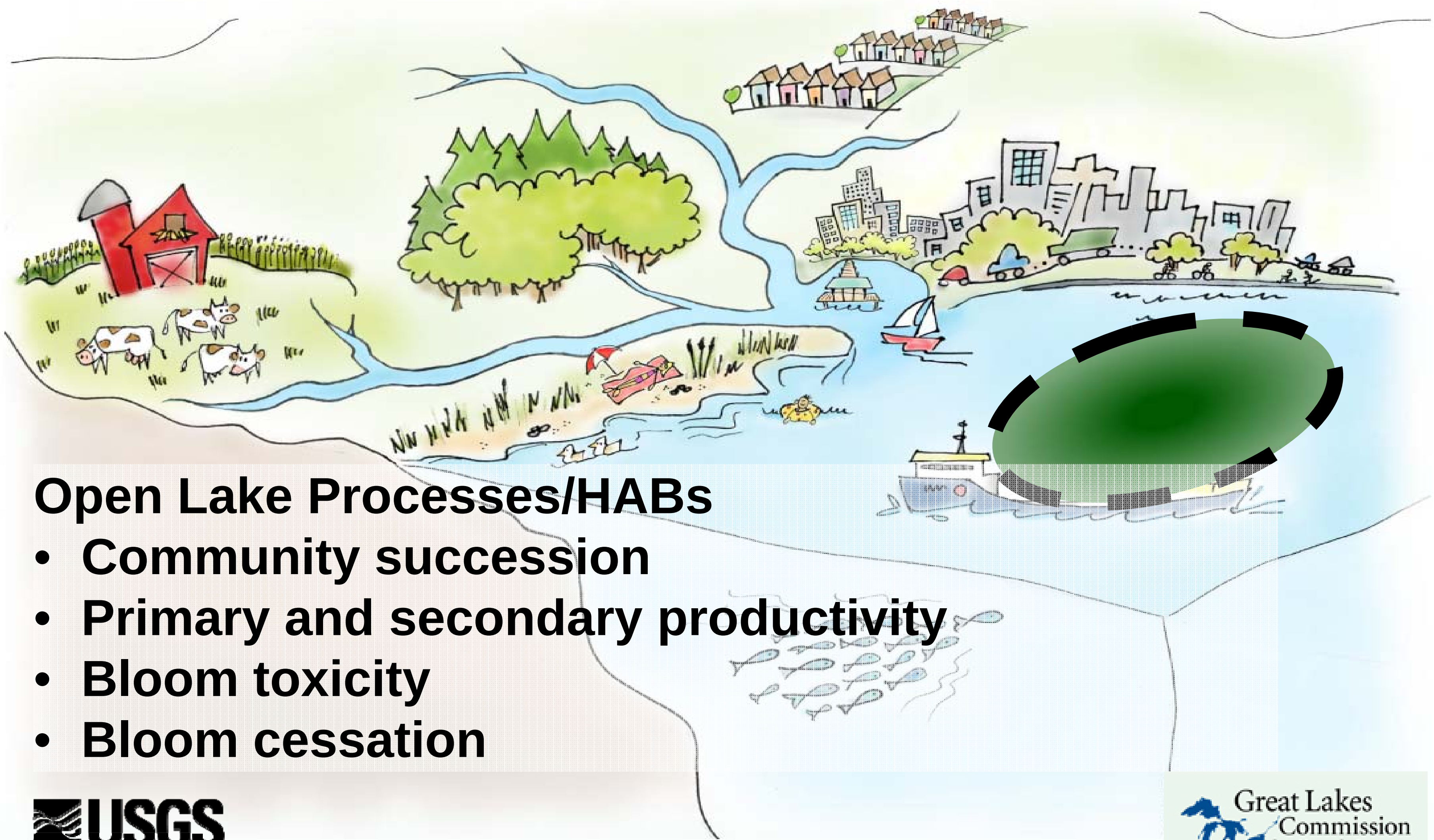


River Mouth Processing

- **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

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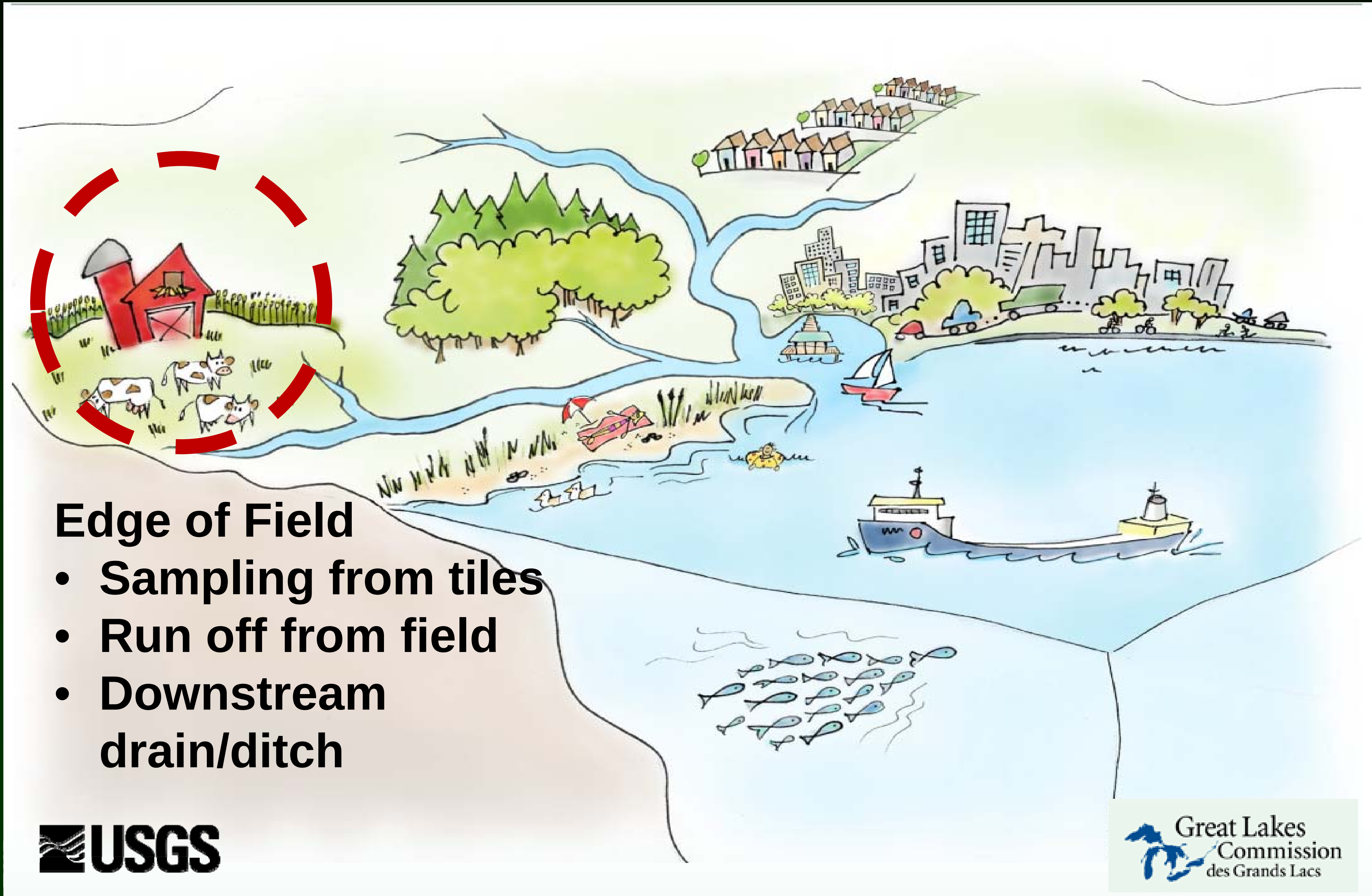
From Edge of Field to Open Lake



Edge of Field

- **Sampling from tiles**
- **Run off from field**
- **Downstream drain/ditch**

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Great Lakes Restoration Initiative Priority Watershed Edge of Field Project

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Great Lakes
RESTORATION

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

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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

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GLRI- Edge of Field Approach

- **Installed at an existing low point in the field, berm was created during dredging of drain**

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Typical field level stations

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Monitoring Field Tile Drains

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Typical station set-up

- ❑ Refrigerated autosamplers
- ❑ Data loggers
- ❑ Stage sensors
- ❑ Power Source [A/C or Solar]
- ❑ Time-lapse camera
- ❑ Rain gage
- ❑ Cellular service modems*

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Most of the year, we expect no flow through the flume.

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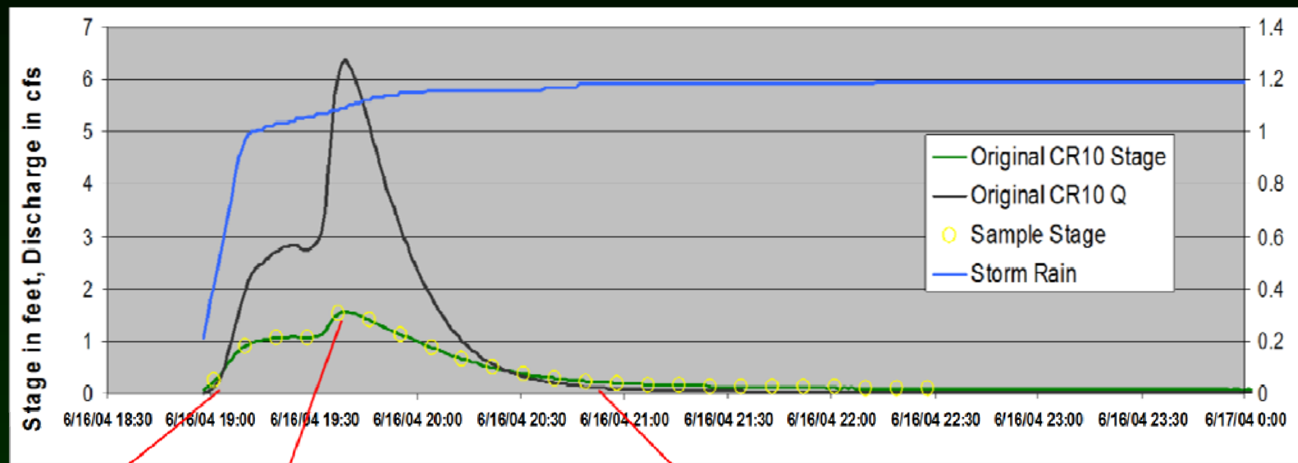
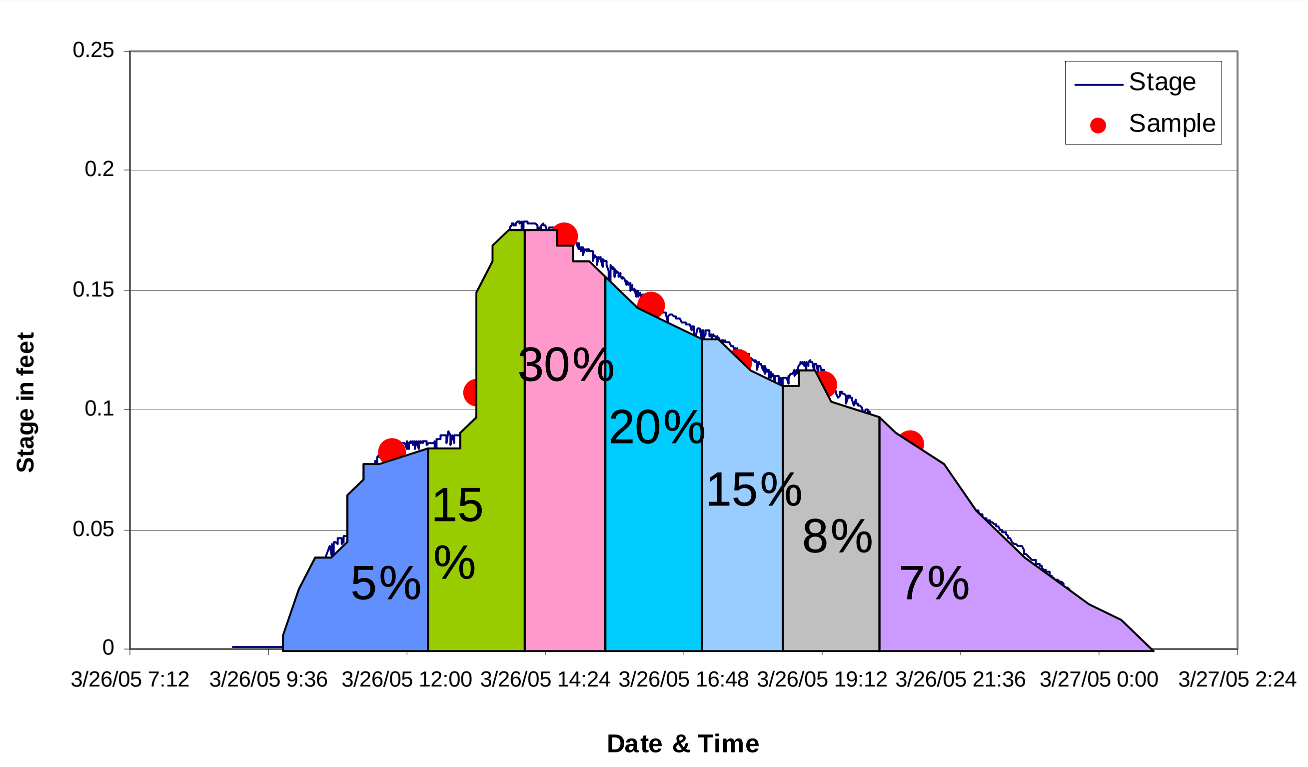
Rain Event Triggered Sampling



Flow-weighted composite sampling

- **Samples are composited and weighted according to time on storm hydrograph when samples were collected.**



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BMP IMPLAMENTATION

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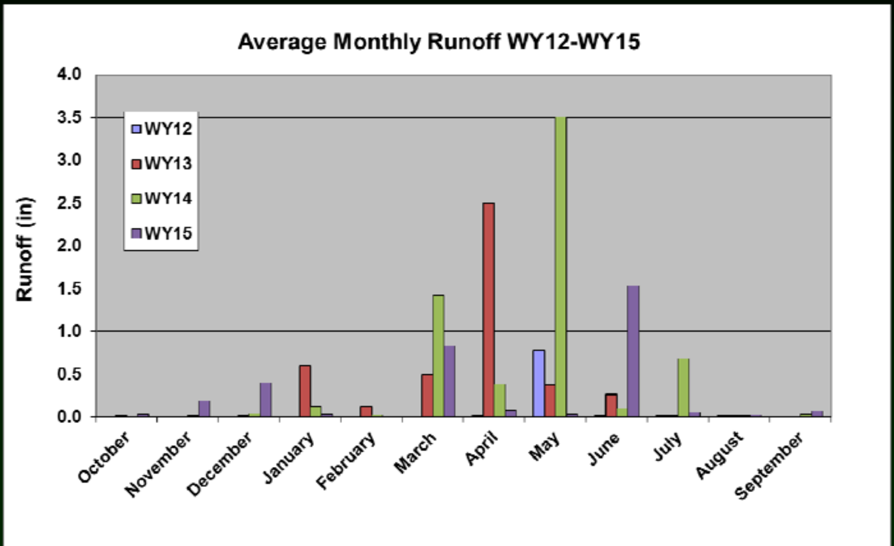
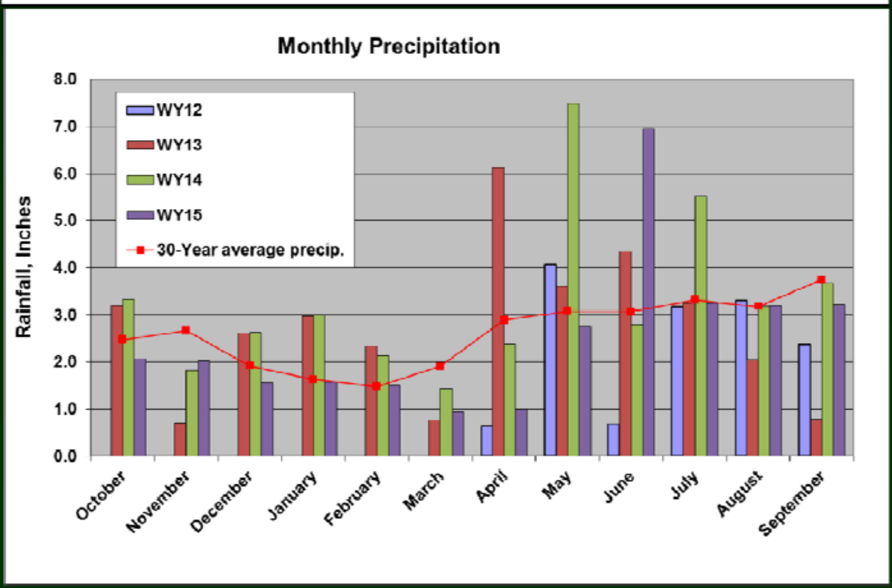
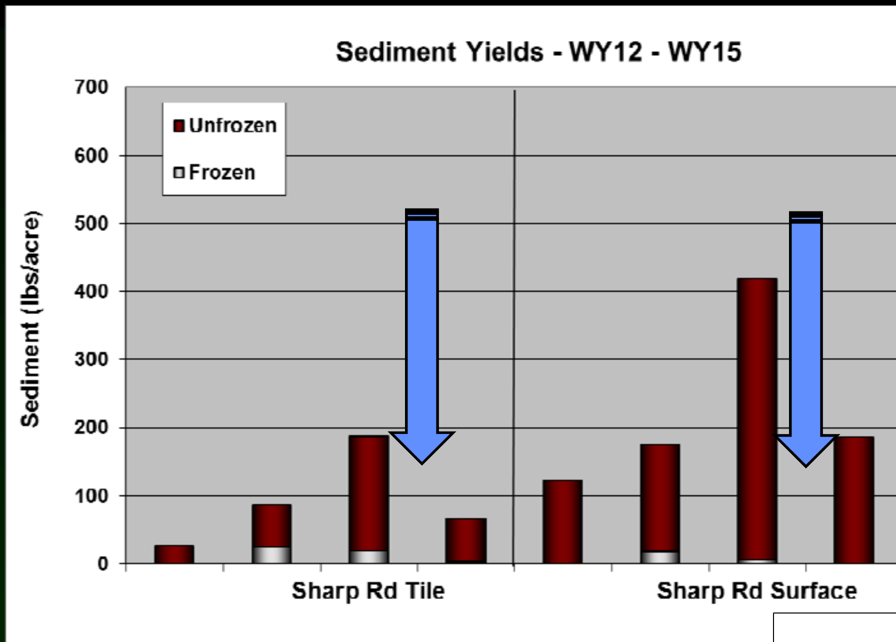
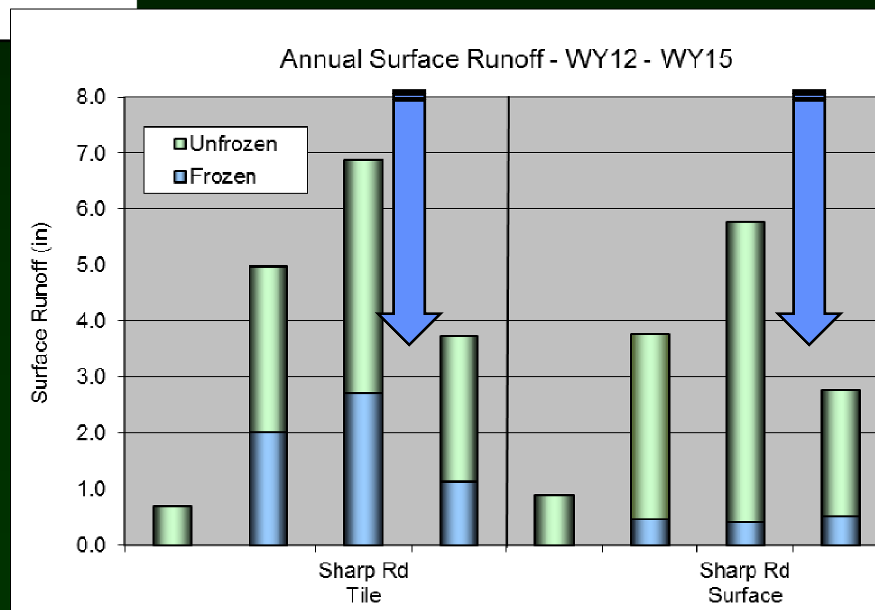
Precipitation and Runoff

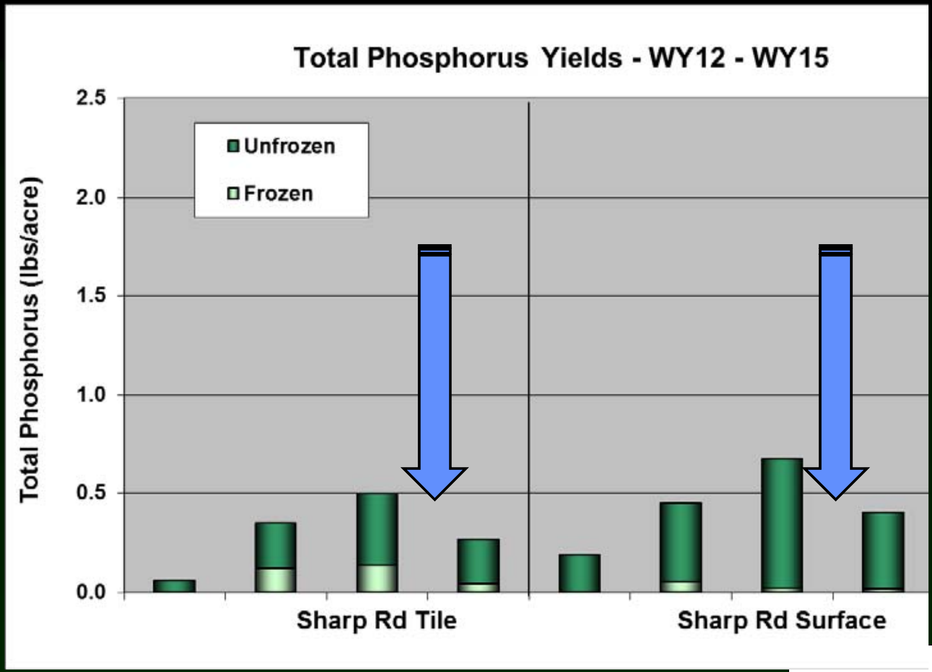
Peak month of precipitation varies each year. Because crop cover can reduce runoff, the timing of precipitation could be important for sediment and nutrient loss.

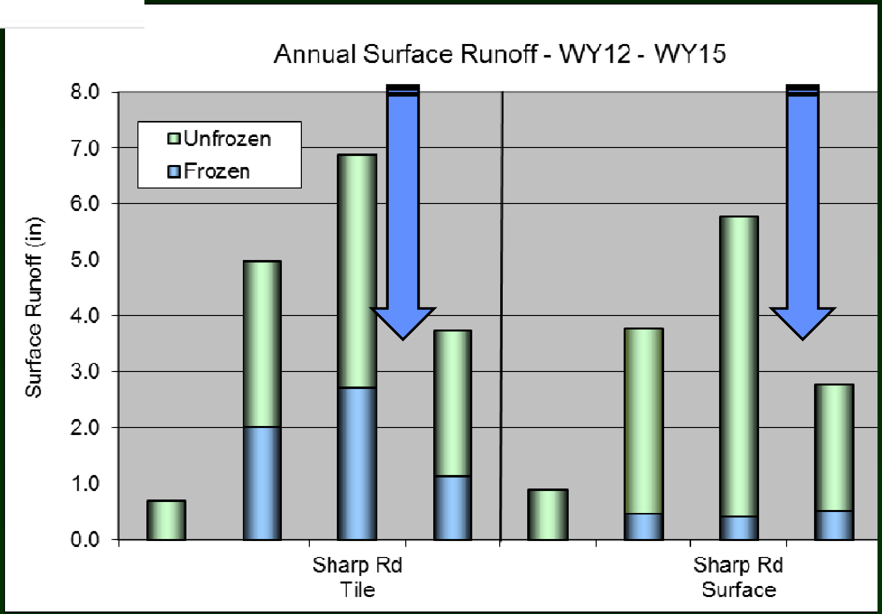





Sediment Yields - WY12 - WY15
Unfrozen
Frozen
Sediment (lbs/acre)
700
600
500
400
300
200
100
0
Sharp Rd Tile
Sharp Rd Surface


Annual Surface Runoff - WY12 - WY15
Unfrozen
Frozen
Surface Runoff (in)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Sharp Rd Tile
Sharp Rd Surface


Total Phosphorus Yields - WY12 - WY15
Total Phosphorus (lbs/acre)
2.5
2.0
1.5
1.0
0.5
0.0
Unfrozen
Frozen
Sharp Rd Tile
Sharp Rd Surface


Annual Surface Runoff - WY12 - WY15
Surface Runoff (in)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Unfrozen
Frozen
Sharp Rd Tile
Sharp Rd Surface

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.

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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.

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Isoxaflutole Monitoring-Groundwater

- **Shallow and deep wells near the application area, and upgradient and downgradient of the application area**

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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




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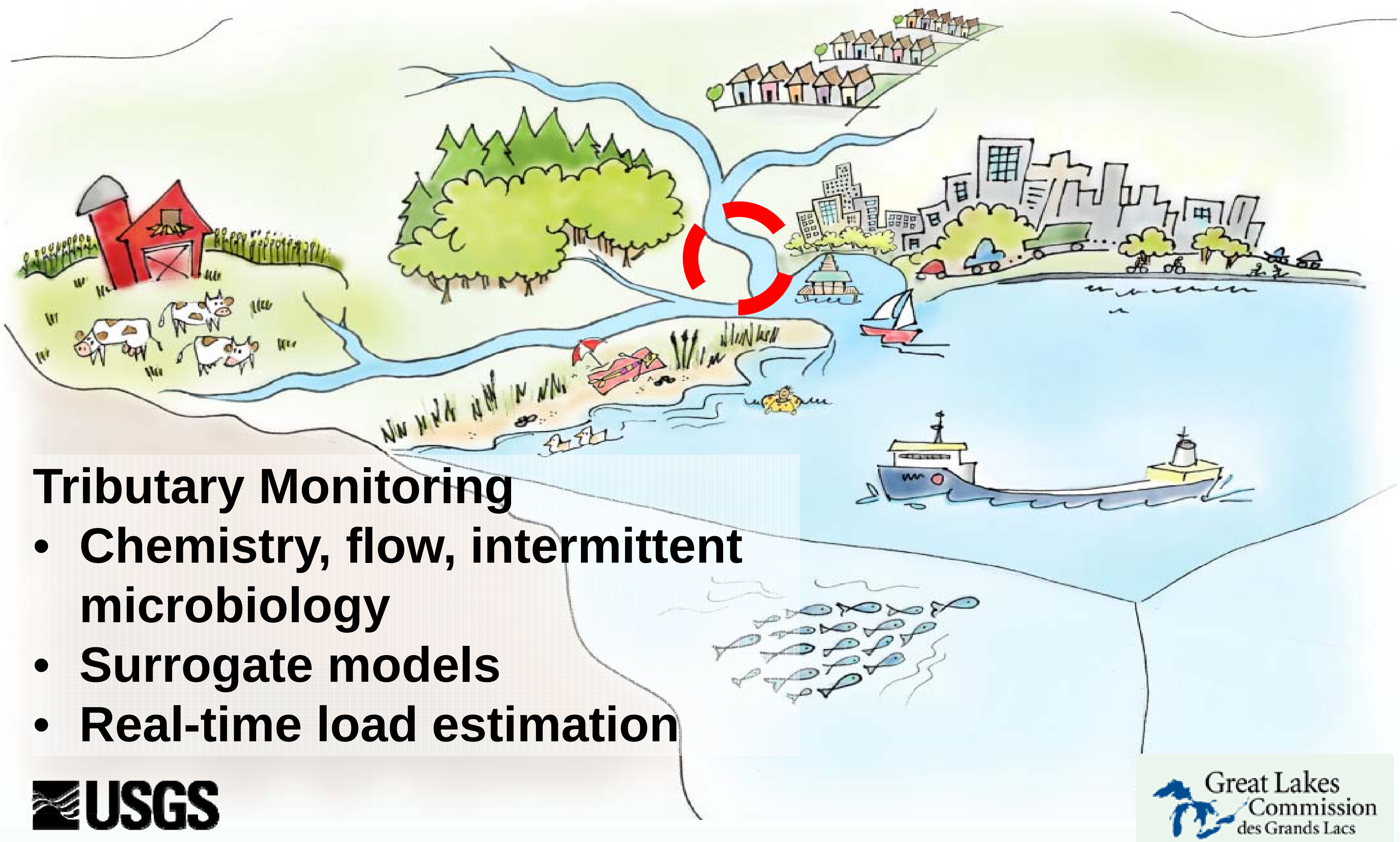
From Edge of Field to Open Lake



Tributary Monitoring

- **Chemistry, flow, intermittent microbiology**
- **Surrogate models**
- **Real-time load estimation**

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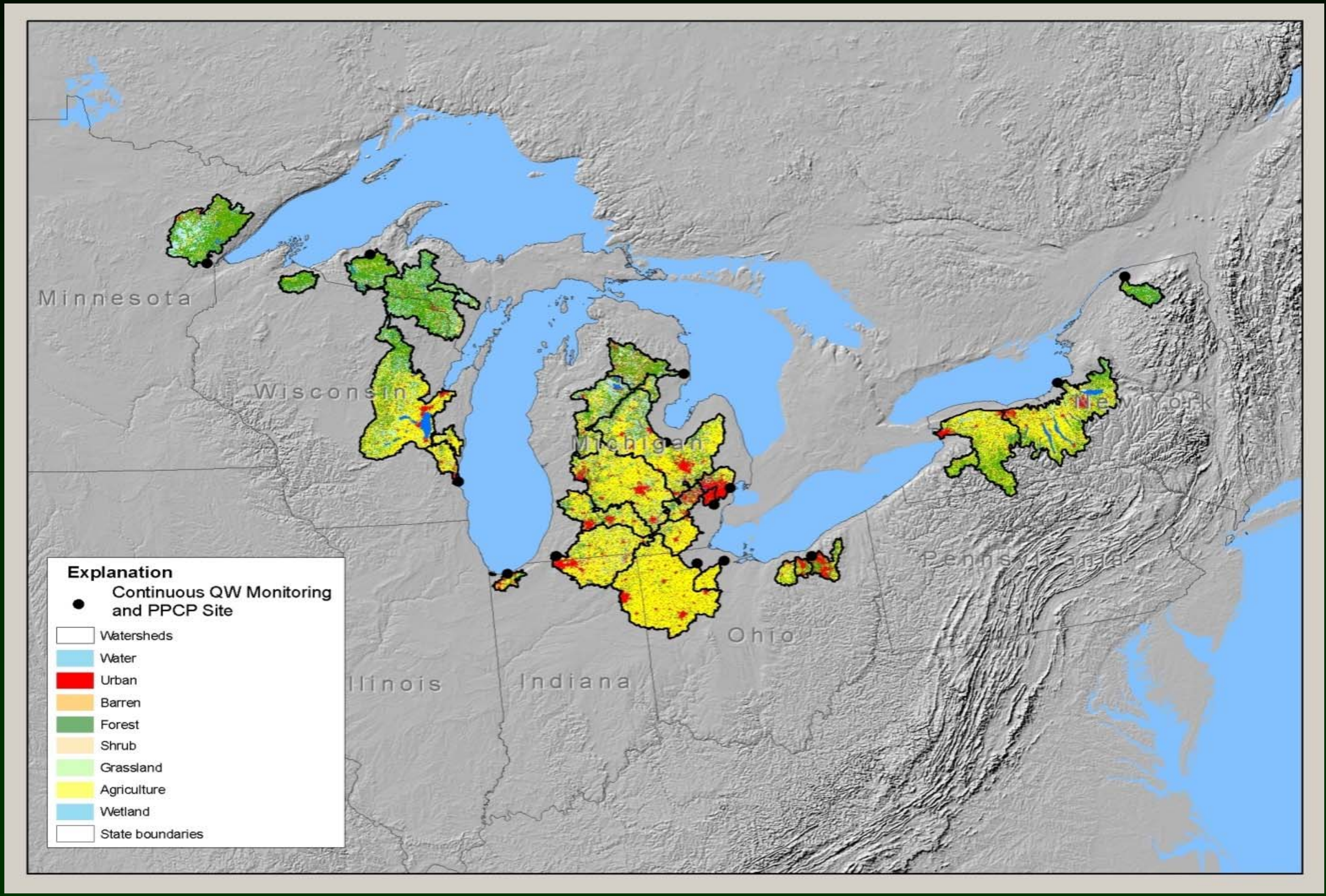
Great Lakes Commission des Grands Lacs

USGS GLRI Tributary Monitoring



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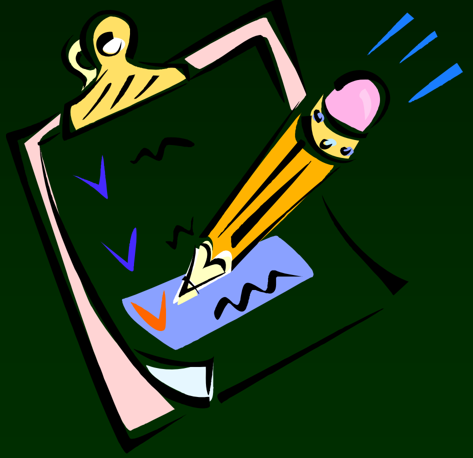
Monitoring Project Objectives

- 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.



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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**

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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.

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Water Quality Sensor Suite

- High Turbidity
- Low Turbidity
- Temperature
- Conductivity
- Dissolved Oxygen
- pH

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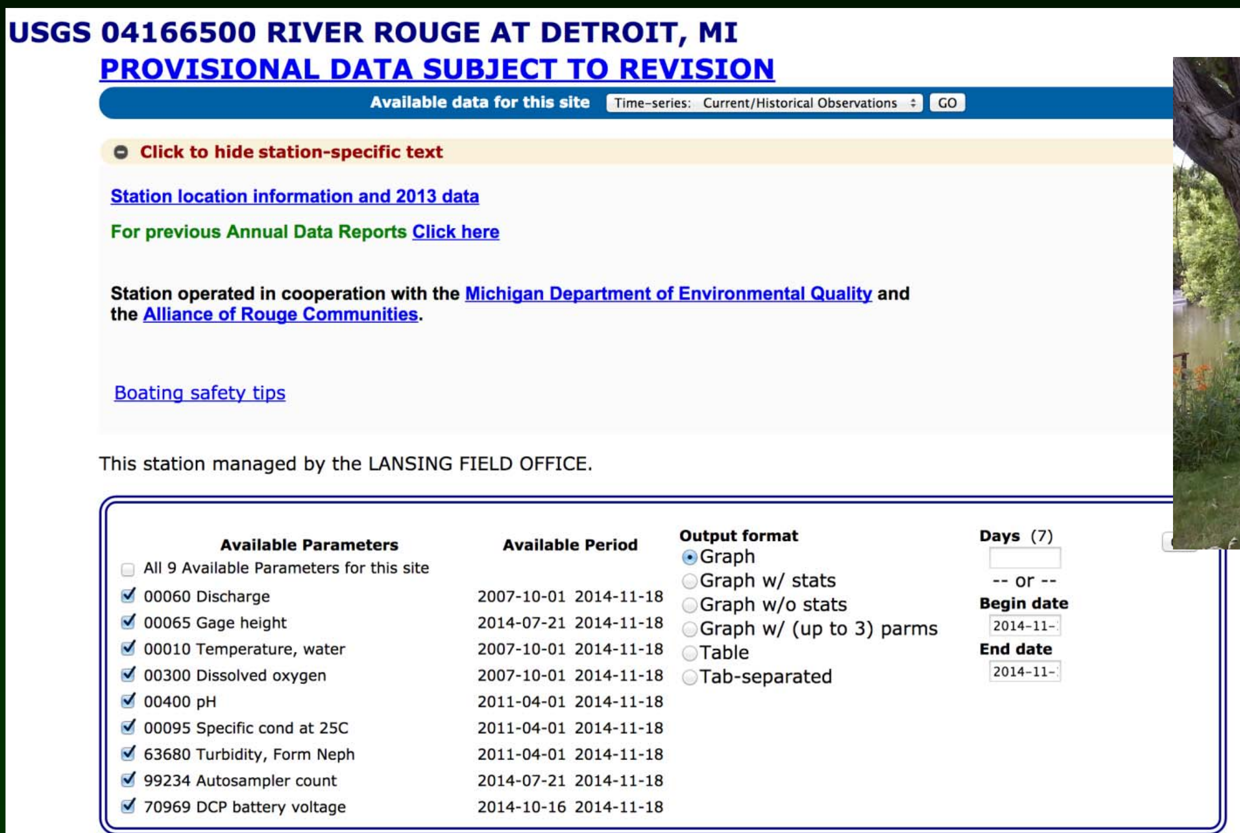
Real-time sensor monitoring information available at: http://waterwatch.usgs.gov/wqwatch



USGS 04166500 RIVER ROUGE AT DETROIT, MI

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Time-series: Current/Historical Observations GO

Click to hide station-specific text

Station location information and 2013 data

For previous Annual Data Reports Click here

Station operated in cooperation with the Michigan Department of Environmental Quality and the Alliance of Rouge Communities.

Boating safety tips

This station managed by the LANSING FIELD OFFICE.

Available Parameters	Available Period	
All 9 Available Parameters for this site		
00060 Discharge	2007-10-01	2014-11-18
00065 Gage height	2014-07-21	2014-11-18
00010 Temperature, water	2007-10-01	2014-11-18
00300 Dissolved oxygen	2007-10-01	2014-11-18
00400 pH	2011-04-01	2014-11-18
00095 Specific cond at 25C	2011-04-01	2014-11-18
63680 Turbidity, Form Neph	2011-04-01	2014-11-18
99234 Autosampler count	2014-07-21	2014-11-18
70969 DCP battery voltage	2014-10-16	2014-11-18

Output format
- Graph
- Graph w/ stats
- Graph w/o stats
- Graph w/ (up to 3) parms
- Table
- Tab-separated

Days (7)

-- or --

Begin date 2014-11-

End date 2014-11-

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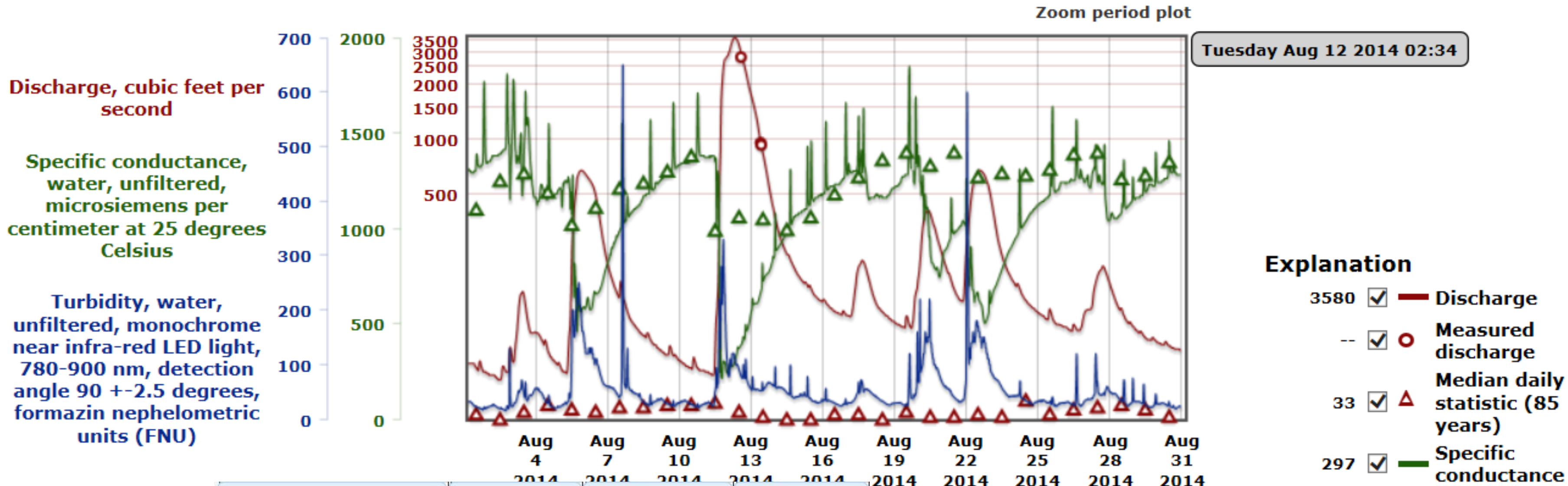
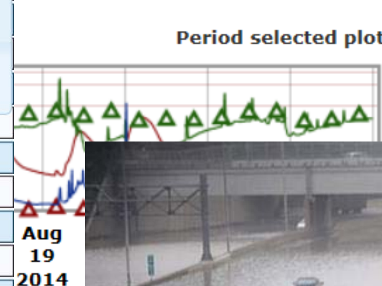
USGS 04166500 RIVER ROUGE AT DETROIT, MI



Date / Time	Dis-charge, ft3/s,	Specif-ic conduc-tance, wat unf uS/cm @ 25 degC,	Turbid-ity, IR LED light, det ang 90 deg, FNU,
08/11/2014 23:15 EST	2,780[A]	246[A]	130[A]
08/11/2014 23:30 EST	2,800[A]	240[A]	120[A]
08/11/2014 23:45 EST	2,810[A]	239[A]	110[A]
08/12/2014 00:00 EST	2,820[A]	243[A]	110[A]
08/12/2014 00:15 EST	2,830[A]	250[A]	100[A]
08/12/2014 00:30 EST	2,840[A]	253[A]	95[A]
08/12/2014 00:45 EST	2,860[A]	254[A]	89[A]
08/12/2014 01:00 EST	2,870[A]	258[A]	85[A]
08/12/2014 01:15 EST	2,890[A]	264[A]	82[A]
08/12/2014 01:30 EST	2,920[A]	271[A]	79[A]
08/12/2014 01:45 EST	2,950[A]	281[A]	78[A]
08/12/2014 02:00 EST	2,980[A]	289[A]	77[A]
08/12/2014 02:15 EST	3,000[A]	289[A]	79[A]
08/12/2014 02:30 EST	3,040[A]	291[A]	82[A]
08/12/2014 02:45 EST	3,070[A]	292[A]	94[A]
08/12/2014 03:00 EST	3,100[A]	291[A]	110[A]



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Real-time Water-Quality Monitors

Directly Measure		Computed or Estimated
Gage Height (Stage)	→	Streamflow (discharge)
Specific Conductance	→	Chloride
Turbidity	→	Total suspended solids, suspended sediment, fecal coliform, *E. coli*, total nitrogen, total phosphorus

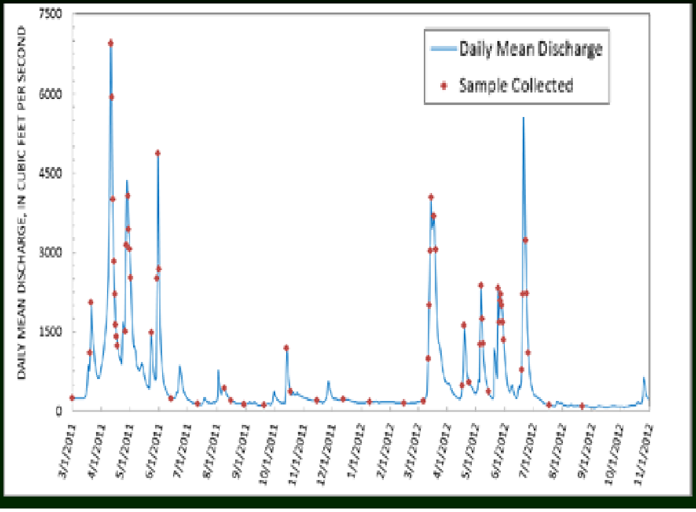
Continuous Load Estimation

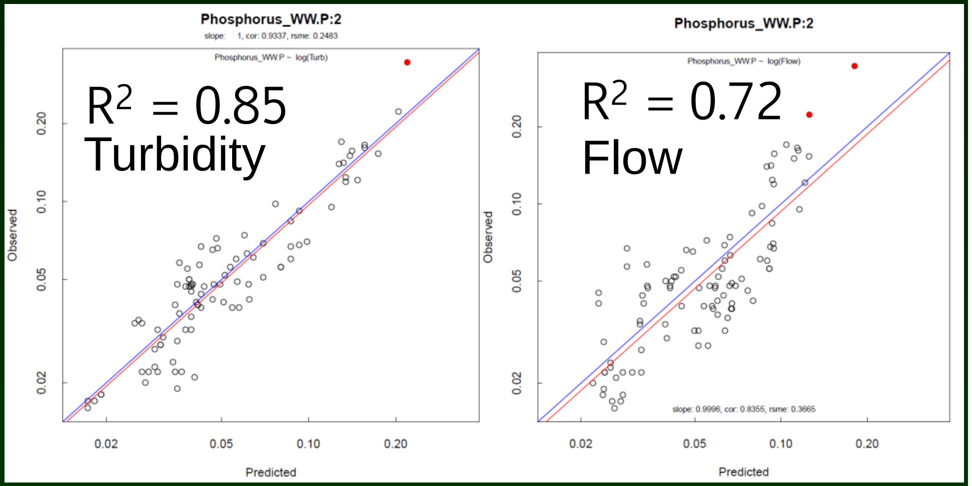
Surrogate data analyses – Regression R script

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.**





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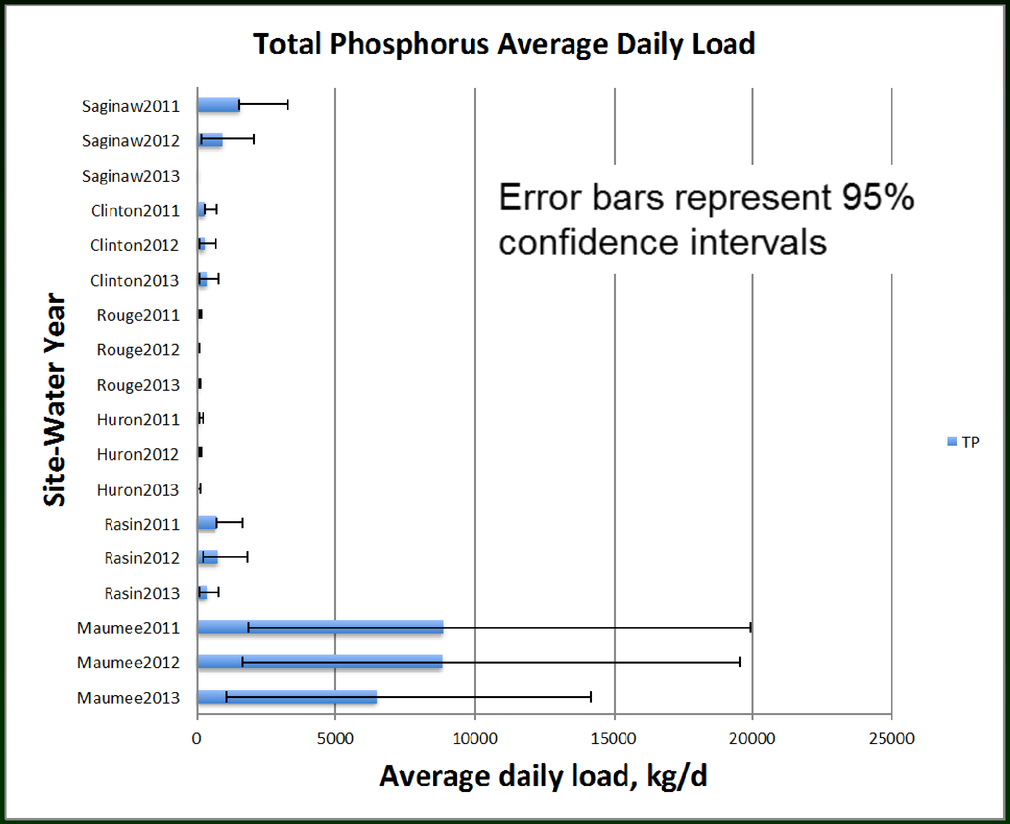
Preliminary Load estimates for Total Phosphorus

- **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."**



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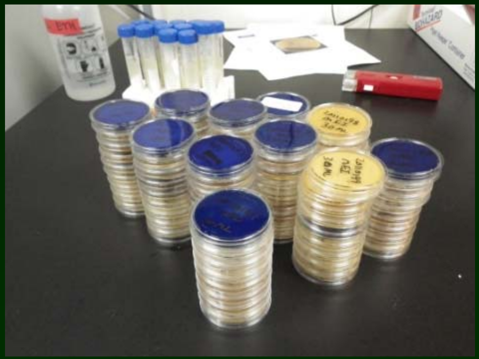
Bacterial Pathogens

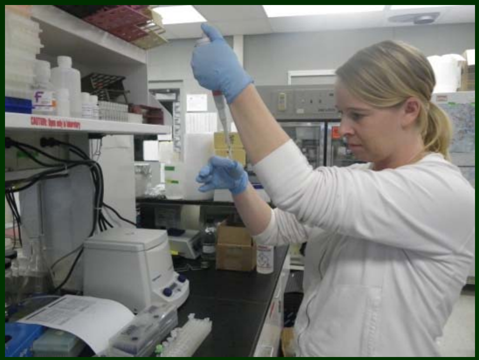
Samples collected March – October 2011

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).**



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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 (*eae*A, *stx*1, *stx*2, rfb0157)
- ***Shigella*** acts similarly to STEC, however it mainly affects humans (*ipa*H)
- ***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

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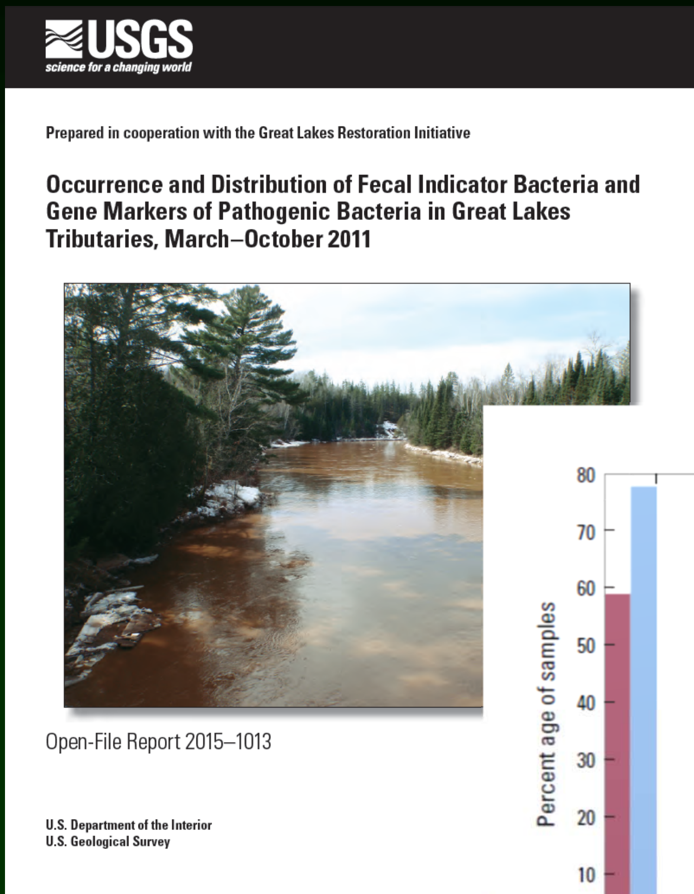
Bacterial Pathogen Results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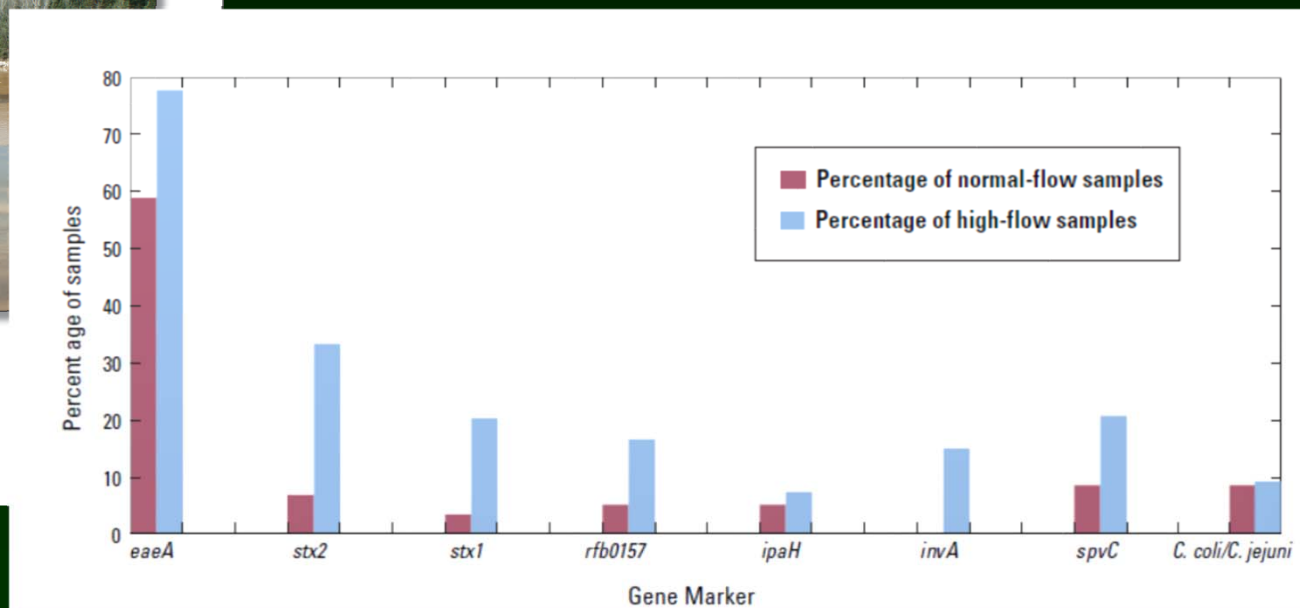
science for a changing world

Prepared in cooperation with the Great Lakes Restoration Initiative

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

U.S. Department of the Interior
U.S. Geological Survey



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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