The Saginaw Bay Monitoring Consortium: Water quality results and their potential to inform conservation and restoration efforts

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Michigan SWCS Conference
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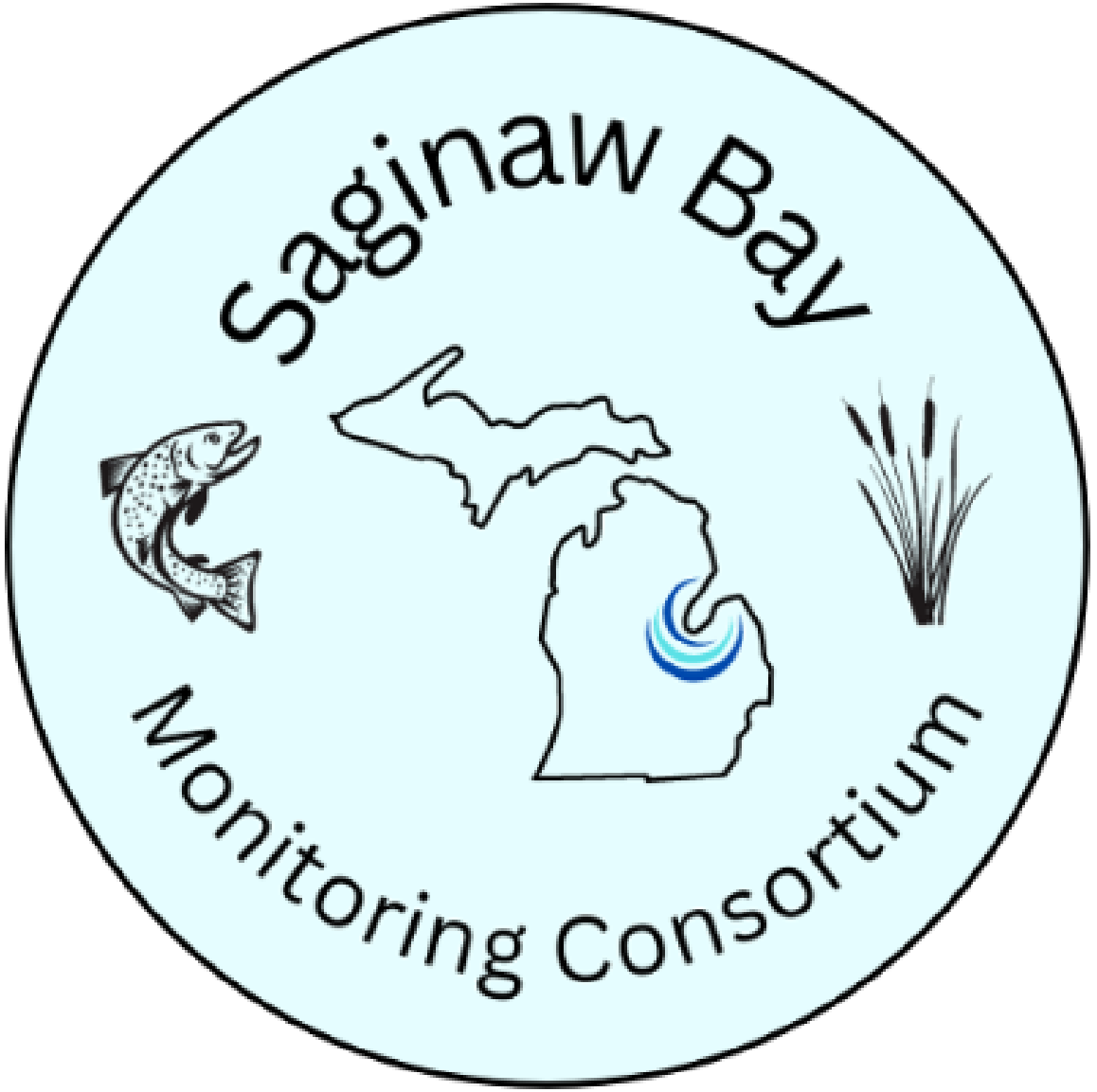
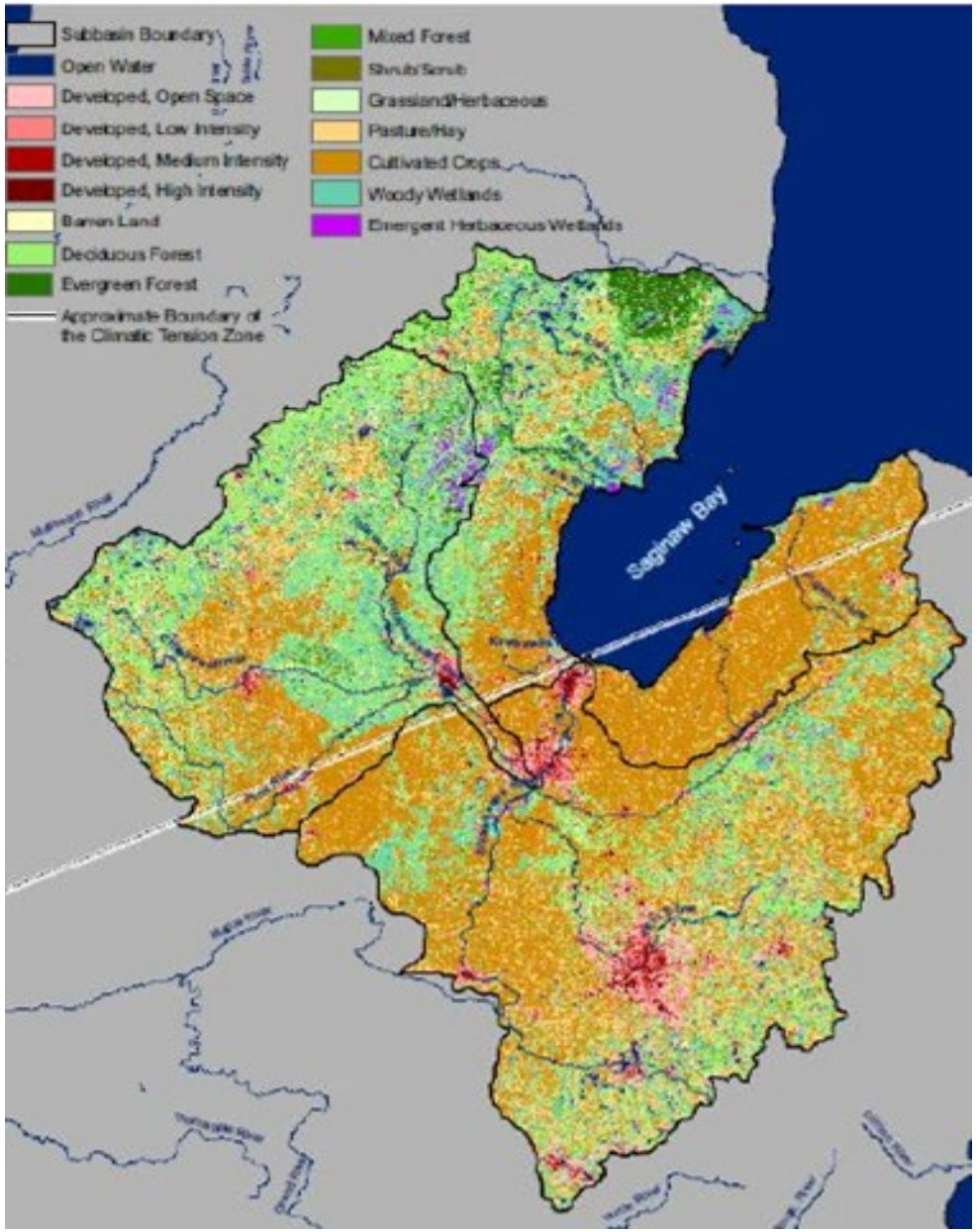
Overview

- Background
- History and purpose of the SBMC
- Status and activities
- Details of monitoring approach
- Preliminary results
- Application of findings
- Questions



The Saginaw Bay Watershed – Michigan's largest



- 8,700 square miles, all or part of 22 counties
- ~ 7,000 miles of rivers and streams
- Home to Over 1.4 million people

The importance of this ecosystem reaches far beyond its border.

Saginaw Bay and Watershed: Economy – Environment – Culture

- More than 138 endangered or threatened species
- Largest contiguous freshwater coastal wetland system in the United States (Public Sector Consultants, 2002)
- Audubon Important Bird Area
- Recreational fishery valued at $30 million (MDNR)
- Michigan's highest concentration of prime farmland – 45% of watershed is in agricultural use
- Diverse crop rotations and higher yields than other areas in Michigan

Problems in the Bay and Watershed

Altered hydrology

- 1,930 miles of ditches

Historical changes

- Lumbering & late 19th century fires
- Forests gave way to tilled fields

Impacts from sediment & nutrients

- Degraded stream fish and invertebrate communities
- Loss of reef spawning habitat
- Excessive algal growth (Muck) → nearshore
- Invasive species → zebra & quagga mussels
- Lake Huron offshore → nutrients decreasing

Saginaw River and Bay

➢ EPA designated Area of Concern
  - Beneficial use impairments

2012 Great Lakes Water Quality Agreement

Substance Objectives

"To help achieve these Substance Objectives, the Parties shall use the following phosphorus loading targets for the Waters of the Great Lakes on an interim basis until the loading targets are updated"

Interim Phosphorus Load Targets

(Metric Tonnes Total P Per Year)

Lake Superior	3400
Lake Michigan	5600
Main Lake Huron	2800
Georgian Bay	600
North Channel	520
Saginaw Bay	440
Lake Erie	11000
Lake Ontario	7000

State of the Bay 2017

- Partnerships are established BUT…
- Data are insufficient to report on status!

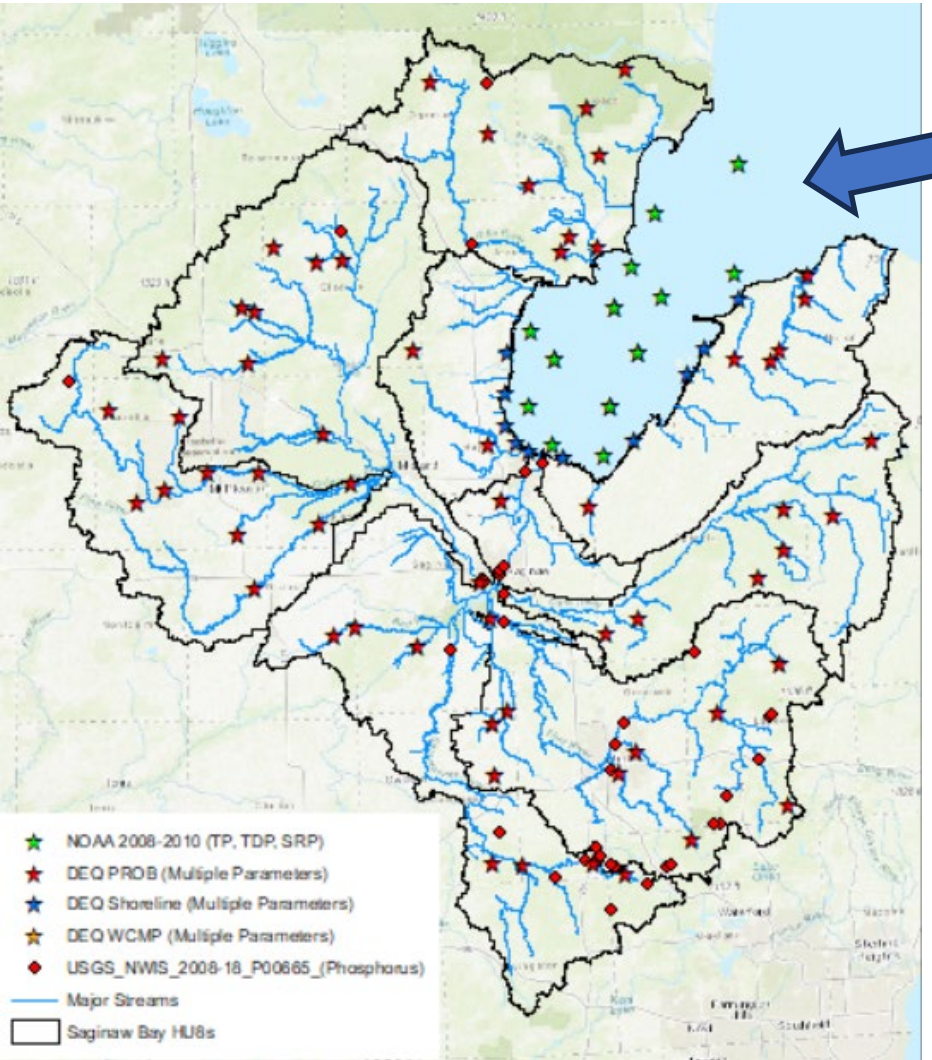
- Jeff Reutter

State of the Bay 2019

- **Data and knowledge gaps hinder mitigation and evaluation of progress.**
  - Long-term data is needed.
  - Stressor - response relationships are needed.

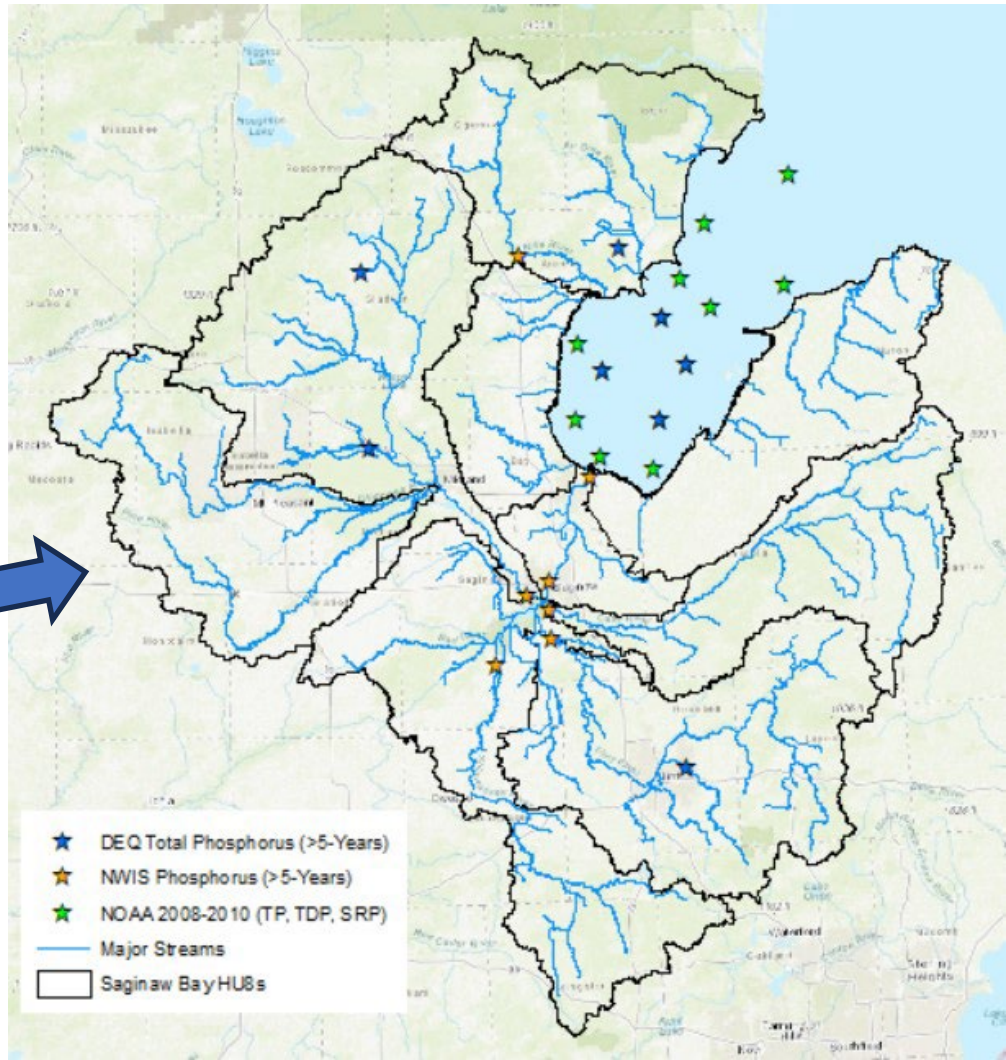
- David Karpovich

Tributary sampling prior to 2023:



- **Map with all data**
- USGS NWIS = 30
- DEQ PROB = 61
- DEQ Shoreline = 10
- DEQ WCMP = 4 (in bay)
- So, about 100 tributary sites

- **Map with data collected >5 Years**
- USGS NWIS = 7
- DEQ PROB = 4
- So, about 11 tributary sites
- Even fewer at gage sites
- Even fewer with same protocols/methods
- Even fewer in ‘idealized’ locations



Saginaw Bay Monitoring Consortium

A consortium of partners working together to develop a coordinated monitoring framework and new ecosystem models for the Saginaw Bay Watershed and the bay itself.

The SBMC Coordinating Team

Gust Annis
Douglas Pearsall
Rebecca Hagerman
Autumn McGowan

The Nature Conservancy

Lisa Fogarty
Sherry Martin
Jim Wilkinson

USGS science for a changing world

Bretton Joldersma
Jennifer Tewkesbury

EGLE

Craig Stow

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

GLERL Great Lakes Environmental Research Laboratory

Jennifer Stevens
Ayla Sisco

Saginaw Chippewa Indian Tribe of Michigan

John Bratton

LimnoTech Water Environment | Scientists Engineers

Abigail Eaton
Joseph Kelpinski

Michigan Department of Agriculture & Rural Development

David Karpovich
Rebecca Bowen

Saginaw Bay Environmental Science Institute at Saginaw Valley State University
Smarter Water

Rod Lammers

Central Michigan University

Saginaw Bay Monitoring Consortium

Objectives:

1. Establish and implement a collaborative WQ monitoring initiative ✅
2. Conduct a retrospective analysis to establish baselines ☑
3. Establish an online data and information management and delivery portal ✅
4. Calculate nutrient loadings (including TP), determine ecosystem responses, and evaluate trends
5. Strategically engage partners ☑
6. Develop a long-term strategy to maintain a monitoring framework ☑

Saginaw Bay Monitoring Consortium

Timeline of Funding and Activities of the SBMC

2017-2021

- Establish collaborative team
- Engage interested parties
- Determine need and priority parameters
- Outreach to raise awareness
- Establish Advisory Committee
- Raise funds (private and public)

2022

- EPA approves NOAA and USGS funding
- Private foundations support TNC
- EPA notifies EGLE of intent to fund tributary monitoring
- Begin building dashboard
- Develop Quality Assurance Project Plans
- Purchase and install stream gages

2023

- Install new sensors in outer bay
- Purchase sampling and lab equipment
- Complete installation of stream gages and WQ sensors
- Begin collecting data(!)
- Build beta version of dashboard
- Expand partnerships through engagement

2024-2026

- Finalize and publish dashboard
- Build models linking tribs, bay, and Lake Huron
- Continue and adapt monitoring
- Continue updating dashboard
- Complete climate impact modeling and publish results
- Complete 3-year reports
- Establish sustainable funding mechanisms

updated 03/07/2024

Funding and Governance:

Funding secured to support monitoring through 2026 season

4-yr budget for the Saginaw Bay Monitoring Consortium

Partner	FY23	FY24	FY25	FY26	4-year Total
NOAA	$621,430	$621,430	$621,430	$0	$1,864,291
USGS	$752,000	$258,060	$263,224	$308,999	$1,582,283
EGLE/ SVSU	$302,081	$327,128	$330,165	$333,261	$1,292,634
TNC	$45,766	$47,139	$48,553	$50,010	$191,468
TOTALS	**$1,721,277**	**$1,253,757**	**$1,263,372**	**$692,269**	**$4,930,675**

The members of the Saginaw Bay Monitoring Consortium acknowledge the generous support of the project by the following:

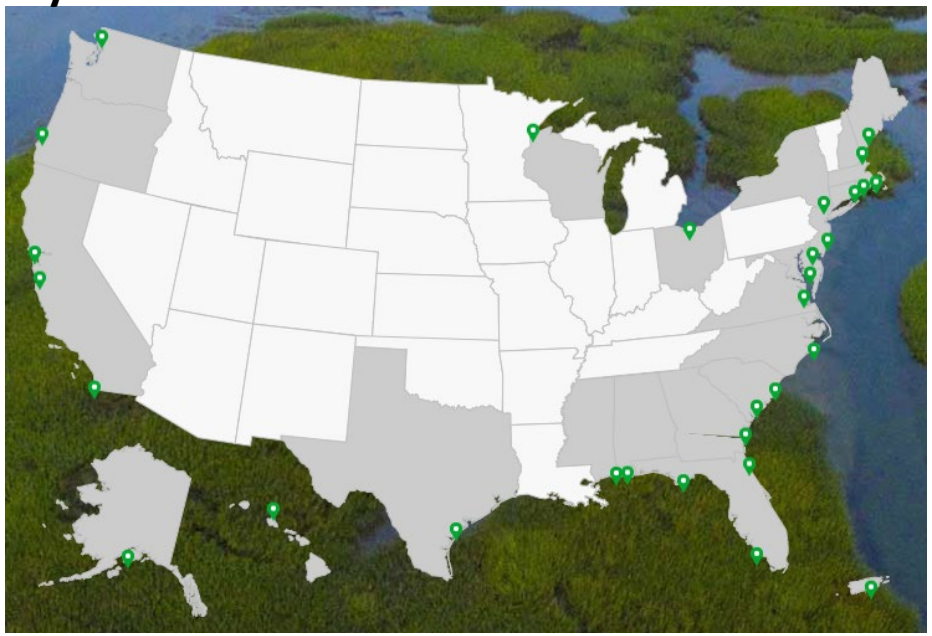
- US EPA's Great Lakes Restoration Initiative
- Michigan Department of Environment, Great Lakes, and Energy
- The Cook Family Foundation;
- The Jury Foundation
- The Erb Family Foundation

Funding and Governance:

Scoping opportunities for sustainable funding and governance

National Estuary Program Study Areas

NOAA National Estuarine Research Reserve System



Key Questions:

- What is the condition of the Bay?
- Has progress been made toward restoration?
- Has the interim phosphorus loading target* been met and is it appropriate?
- What is the status of the AOC's Eutrophication BUI?
- What are appropriate restoration criteria for the Eutrophication BUI?

*440 metric tonnes per year, *2012 Great Lakes Water Quality Agreement*

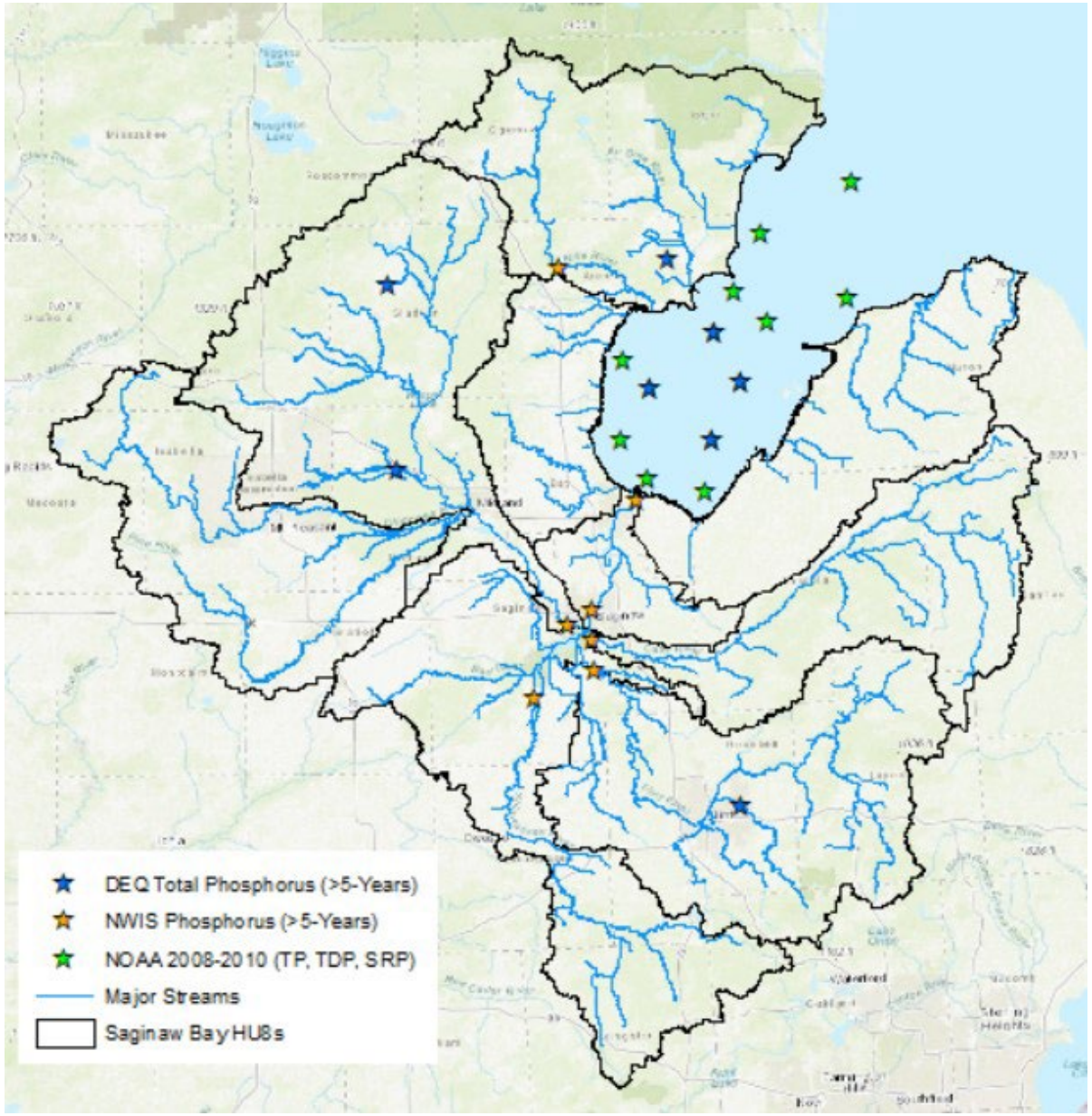
Limited data

To answer our questions, we need additional data

- In the right locations and frequency
- Collected over several years
- Co-located with active stream gages
- Uniformity of sampling and analysis protocols

Map with data >5 Years →

- About 11 tributary sites
- Even fewer at gage sites
- Even fewer with same protocols/methods
- Even fewer in ‘idealized’ locations



Tributary monitoring objectives

- Capture major sub-watersheds of the Saginaw River:
- Represent smaller, coastal tributaries with substantial ag land in the western and eastern parts of the watershed.
- Inform where pollutants in run-off are an issue and how they affect the bay, i.e., calculate sediment and nutrient loadings

Site Selection Criteria

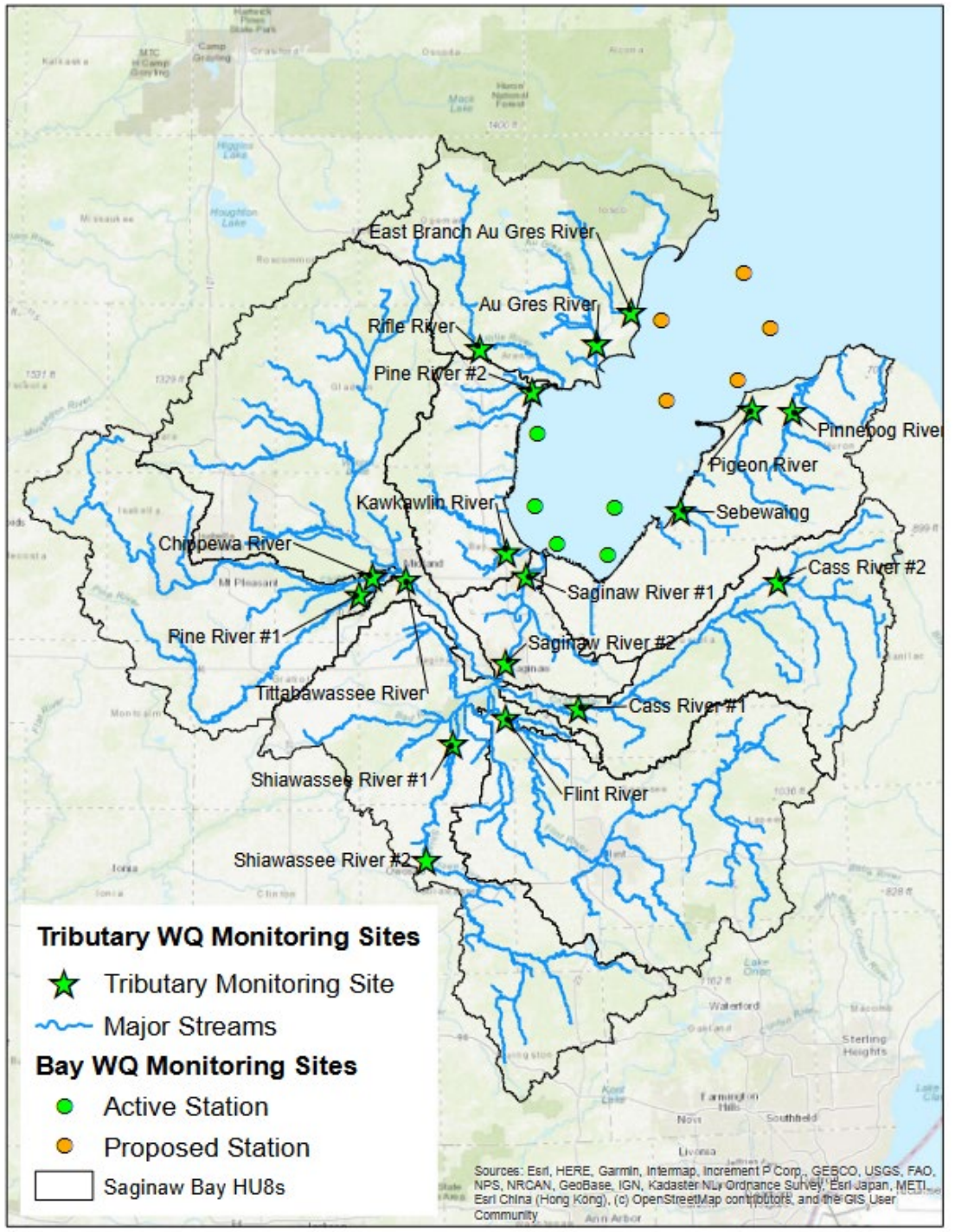
- Land use
- Proximity to Saginaw Bay
- Flow conditions
- Site conditions and year-round physical accessibility
- Local importance
- USGS Gage Status

18 tributary sampling locations

- 6 with existing USGS gages
- 12 new or upgraded gages
- 10 in Saginaw River watershed
- 8 in coastal watersheds

10 Saginaw Bay (open water) sites

- Sampled/measured by NOAA GLERL



Priority Water Quality Parameters

	Stream	Bay
Stressor	Total Phosphorus (TP) Dissolved Reactive Phosphorus (DRP) Nitrate (NO_3^-) Nitrite (NO_2^-) Ammonium (NH_4^+) Discharge (for loading) Total Suspended Solids (TSS)* E. coli*	Total Phosphorus (TP) Dissolved Reactive Phosphorus (DRP) Nitrate (NO_3^-) Nitrite (NO_2^-) Ammonium (NH_4^+) Total Suspended Solids (TSS)* E. coli*
Response	Stream health (macroinvertebrate IBI) Turbidity Dissolved oxygen (DO)	Harmful Algal Blooms Chlorophyll Dissolved oxygen (DO) Turbidity (secchi) Muck Beach closures

*These parameters are important to some stakeholders but not budgeted for the initial phase of implementation. They may be added later.

Here is what you may see at tributary sampling sites:

USGS gaging station, Saginaw River at Holland Avenue
David Karpovich photo

SVSU sampling at a tributary site.
Alaina Seman (SVSU) photo

Site activities

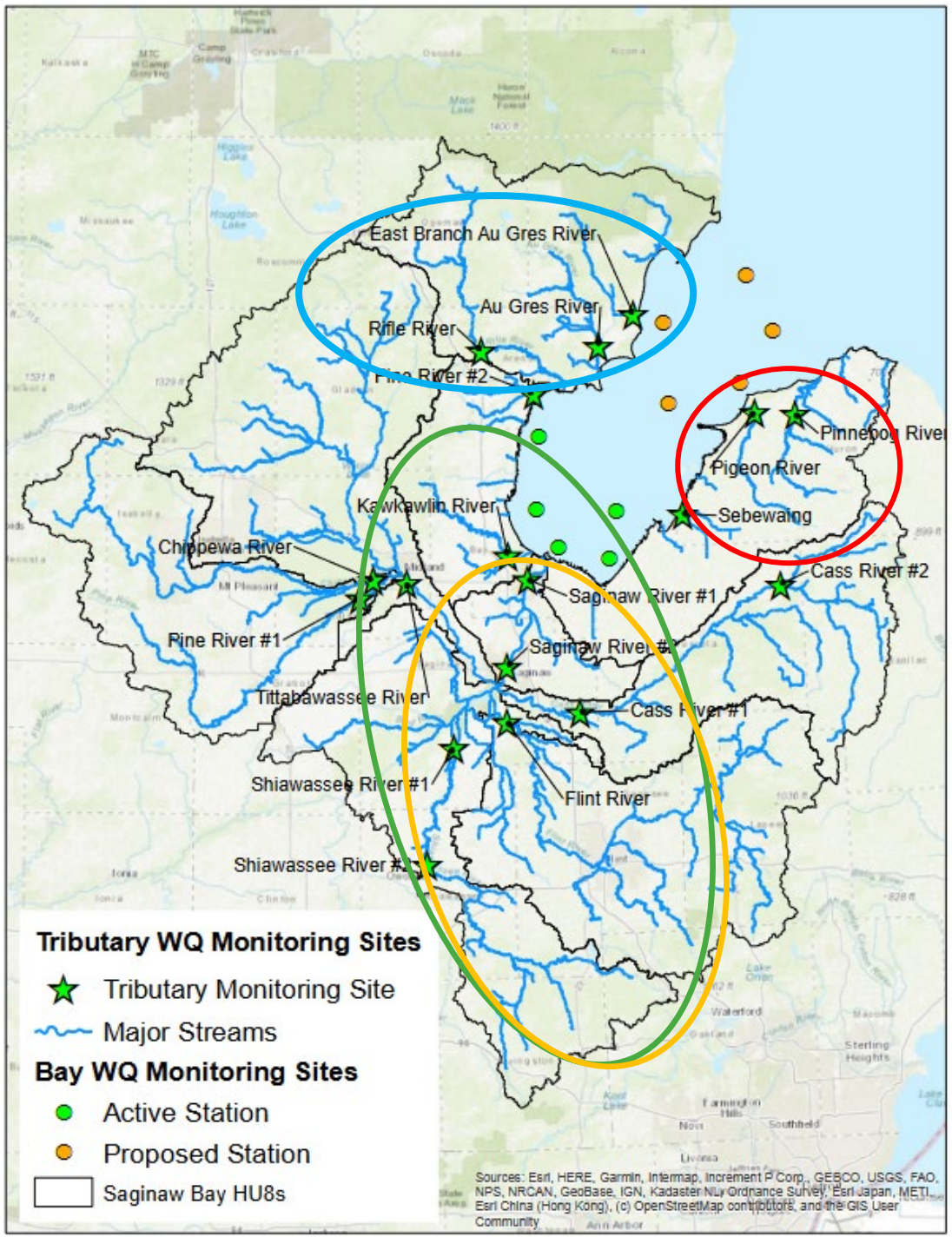
- Weekly tributary sampling at 18 locations
- Continuous USGS stream discharge measurements at each location
- Monthly USGS quality control checks at each location
- Bay sampling during ice free periods (April – October) on a biweekly basis at 10 locations

Screenshot showing two-weeks of tributary monitoring results.

Site and sample information | measured on-site | measured in the lab.

USGS station id	Site ID	Site Name	Sample date	Sample tim	Water Temp	pH	D.O. (mg/L)	Conductivity	Turbidity	TSS (mg/L)	TP (mg P/L)	SRP (mg P/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Ammonium (mg N/L)
US04138030	EA	E Br Au Gres R At E A	9/28/2023	2:06pm	15.6	7.4	10.8	422	5.2	4	0.007	-0.005	0.266	0.004	-0.011
US04138536	AG	Au Gres River At S Ma	9/28/2023	2:25pm	18.6	7.4	11.8	736	5.9	4.6	0.012	-0.005	0.324	0.006	-0.011
US04142000	RS	Rifle River Near Sterlin	9/28/2023	1:26pm	15.6	7.4	9.9	434	2.7	2.3	0.005	-0.005	0.14	-0.004	-0.011
US04143220	PS	Pine River At Pine Rive	9/28/2023	2:57pm	18.2	7.1	7.6	680	2.1	2.6	0.042	0.013	0.677	0.012	0.042
US04143600	KB	Kawkawlin River At St	9/26/2023	12:22pm	20.5	7.1	7.7	614	4.9	5.4	0.07	0.037	0.004	0.005	0.048
US04144500	SO	Shiawassee River At O	9/25/2023	1:52pm	19.3	7.5	10.5	678	1.9	2.5	0.033	0.006	0.512	0.005	
US04145000	SF	Shiawassee River Near	9/25/2023	2:31pm	19.6	7.5	9.3	685	3.7	3.1	0.017	-0.005	0.573	-0.004	
US04149000	FF	Flint River near Fosters	9/25/2023	12:44pm	19.7	7.3	9	699	6.5	6	0.091	0.041	2.786	0.012	
US04150500	CC	Cass River At Cass Cit	9/25/2023	2:35pm	19.9	8.6	15.2	715	0.6	1.4	0.038	-0.005	0.103	-0.004	
US04151500	CF	Cass River At Frankenr	9/26/2023	2:52pm	19.4	8.5	10.3	648	2.1	3.1	0.022	0.008	0.758	0.005	0.02
US04154512	CH	Chippewa River At S H	9/27/2023	12:21pm	17.4	7.4	9.7	527	2.8	2	0.018	-0.005	0.662	0.006	0.016
US04155500	PM	Pine River Near Midlar	9/27/2023	12:39pm	17.7	7.4	9.7	536	2.1	1.1	0.015	-0.005	0.445	0.005	0.02
US04156000	TM	Tittabawassee River At	9/27/2023	12:02pm	18.1	7.3	8.5	524	13.7	9.7	0.036	-0.005	0.334	0.011	0.103
US04157005	SH	Saginaw River At Holla	9/26/2023	4:47pm	20.1	8.4	9.3	714	10.4	10.3	0.049	0.012	0.884	0.01	0.013
US04157060	SB	Saginaw River At Midla	9/26/2023	1:05pm	19.9	7.3	9.2	695	14.6	13.4	0.065	0.014	0.754	0.016	0.068
US04157550	SC	Sebewaing River At Ce	9/25/2023	12:45pm	20.2	7.9		527	11.6	5.7	0.05	-0.005	1.129	0.007	
US04159005	PL	Pigeon River At Limeric	9/25/2023	1:21pm	18	8.4	12.7	742	1.4	1.7	0.051	-0.005	0.911	-0.004	
US04159046	PK	Pinnebog River At Kinc	9/25/2023	1:38pm	18.4	8.2	10.4	850	3.4	3.7	0.057	-0.005	1.044	-0.004	
US04138030	EA	E Br Au Gres R At E A	10/5/2023	2:27pm	17.3	8.2	8.9	411	7.7	7.4	0.013		0.244	-0.004	-0.011
US04138536	AG	Au Gres River At S Ma	10/5/2023	2:52pm	18.4	8.3	10	738	4.8	4.6	0.013		0.246	0.005	0.027
US04142000	RS	Rifle River Near Sterlin	10/5/2023	1:51pm	17.1	8.3	8.9	421	3.1	3.7	0.008		0.09	0.004	0.019
US04143220	PS	Pine River At Pine Rive	10/5/2023	3:22pm	19.5	7.8	6.5	655	1.9	3.3	0.066		0.474	0.013	0.178
US04143600	KB	Kawkawlin River At St	10/3/2023	1:34pm	21.1	8	7.8	635	3.5	5	0.087	0.048	0.032	0.009	
US04144500	SO	Shiawassee River At O	10/2/2023	1:30pm	19.8	8.3	10	588	1.8	2.9	0.027	-0.005	0.618	0.007	0.015
US04145000	SF	Shiawassee River Near	10/2/2023	2:30pm	20.4	8.4	9.1	724	2.2	3.4	0.032	0.007	0.943	0.009	0.012
US04149000	FF	Flint River near Fosters	10/3/2023	2:24pm	21.7	8.3	9.4	697	5.2	7.4	0.098	0.065	2.353	0.016	
US04150500	CC	Cass River At Cass Cit	10/2/2023	12:48pm	18.7	8.3	11.9	747	-1.4	1.1	0.016	-0.005	0.079	0.004	-0.011
US04151500	CF	Cass River At Frankenr	10/3/2023	2:55pm	21.7	8.3	9.3	613	5.2	2.8	0.014	-0.005	0.756	0.008	
US04154512	CH	Chippewa River At S H	10/4/2023	12:45pm	19.3	8.5	10.5	516	-1.4	3.4		-0.005	0.628	0.008	-0.011
US04155500	PM	Pine River Near Midlar	10/4/2023	12:30pm	20	8.5	10.1	524	-1.4	1.9		-0.005	0.432	0.007	0.017
US04156000	TM	Tittabawassee River At	10/4/2023	1:05pm	20.9	8.4	9.2	643	8.9	8.3		-0.005	0.381	0.013	0.087
US04157005	SH	Saginaw River At Holla	10/3/2023	3:20pm	21.2	8.2	9.3	666	8.6	8.7	0.046	0.009	0.916	0.014	
US04157060	SB	Saginaw River At Midla	10/3/2023	12:22pm	20.5	8	7.1	714	9.2	10.9	0.061	0.024	0.951	0.024	
US04157550	SC	Sebewaing River At Ce	10/2/2023	2:22pm	20.4	8.1	9.6	597	3	6.3	0.058	-0.005	0.561	0.011	0.013
US04159005	PL	Pigeon River At Limeric	10/2/2023	1:58pm	19.3	8.4	11.4	700	-1.4	1.1	0.027	-0.005	0.384	0.007	0.012
US04159046	PK	Pinnebog River At Kinc	10/2/2023	1:40pm	19.3	8.1	9	850	1.7	2.9	0.041	0.011	0.432	0.007	0.032

Please note: Non-detectable results are indicated by the negative of the detection limit.



Highlights for data from 8/14/23 to 1/11/24.

Please note: The data highlights indicated below are based on a relatively short time and provisional data. The areas circled on the map are also estimates. Conclusions should not be drawn from the information shown here. More complete treatment of the data will commence when additional results are available.

The highest (based on averages)…

- **TSS** Flint, Shiawassee, Tittabawassee, and Saginaw
- **SRP** Flint, Saginaw, Kawkawlin, Shiawassee
- **Nitrate** Pigeon, Pinnebog, Sebewaing, Cass

The lowest (based on averages)…

- **TP, SRP, and Nitrate** Au Gres, E. Br. Au Gres, and Rifle
- **TSS** Pigeon, Pinnebog, Pine

Concentrations are only one part of the picture.

Cautionary example:

- **loading calculation** from **provisional data**

Total Phosphorus concentration measured by SVSU:

0.055 mg/L

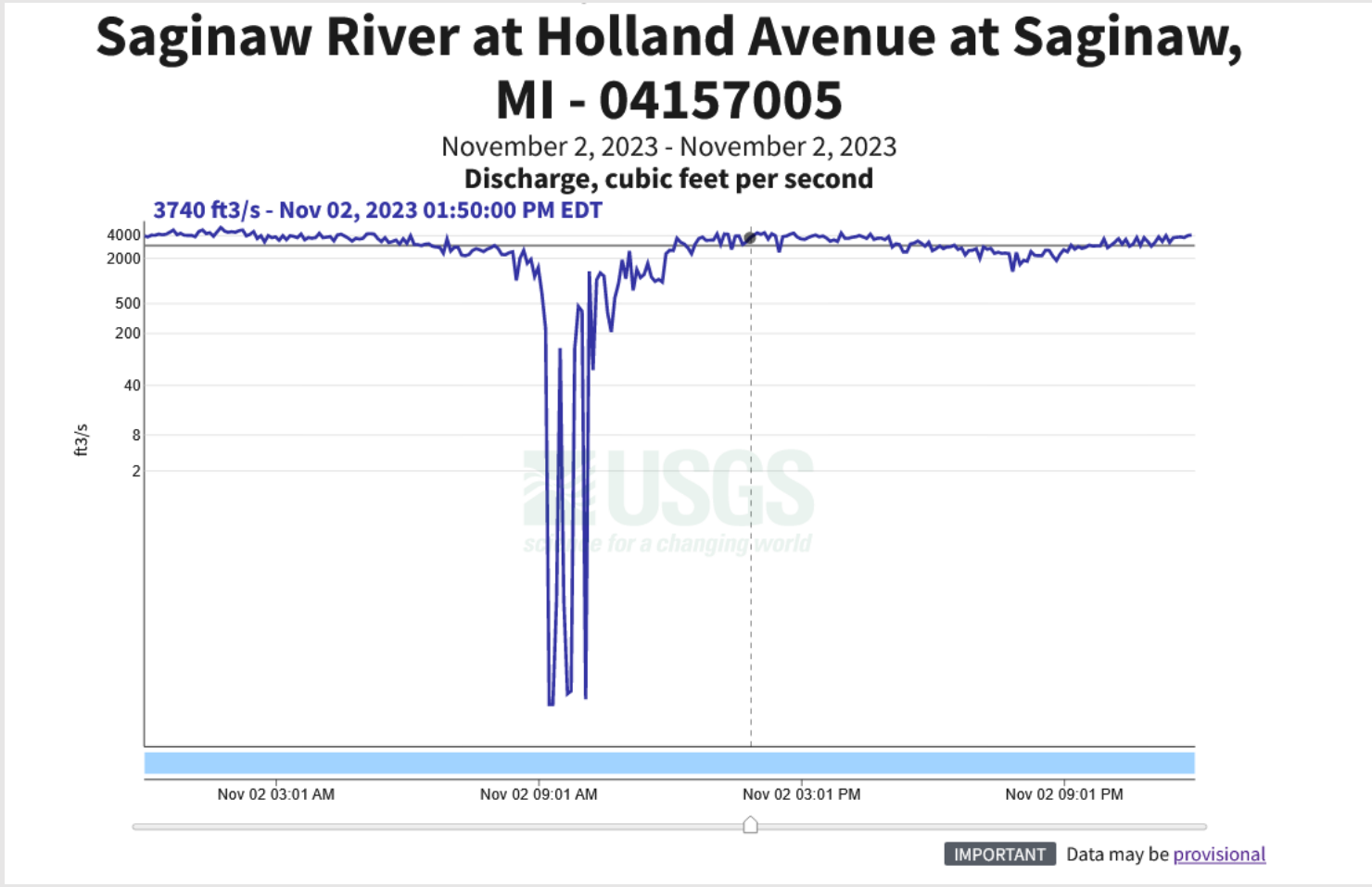
Instantaneous **discharge** measured by USGS at time of sampling:

3740 ft^3/s

Concentration x Discharge = Load

After unit conversion, the above numbers give

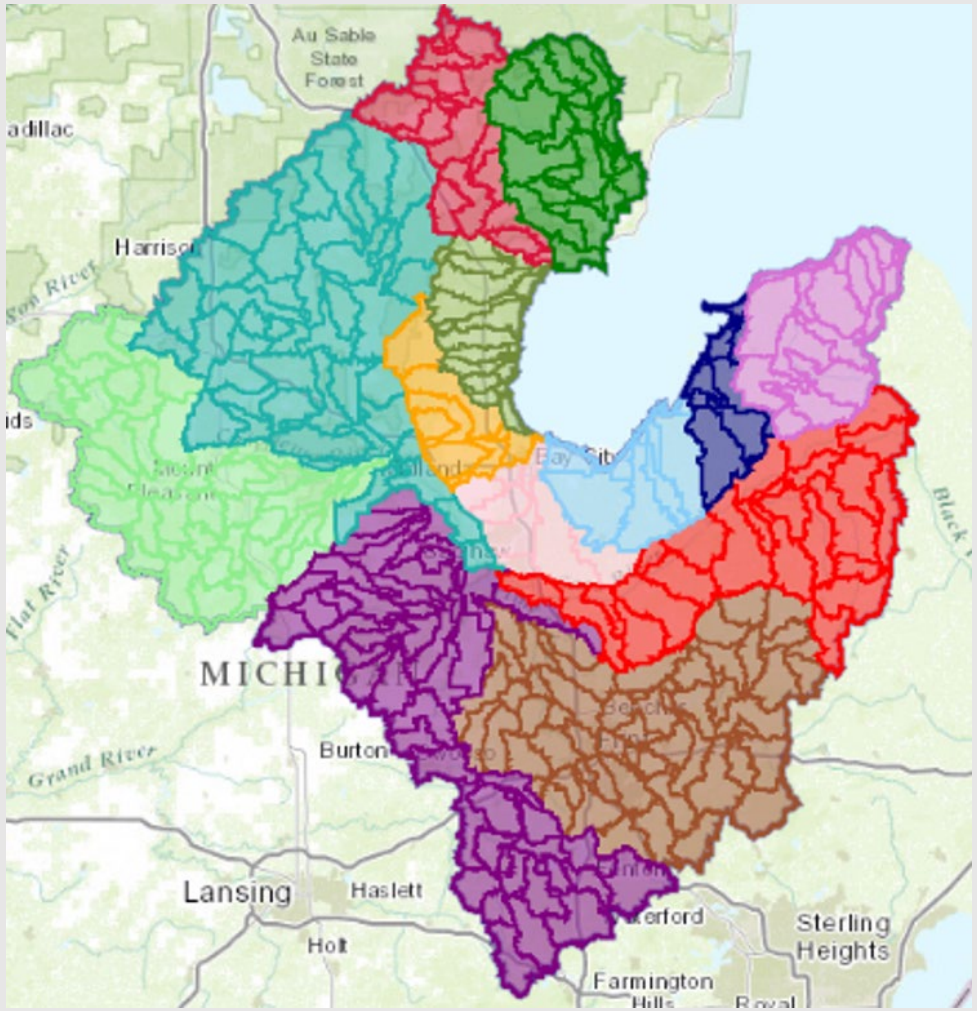
0.23 metric tons of P/yr



USGS online data at https://waterdata.usgs.gov/monitoring-location/04157005/

Please note: This calculation is for example purposes only. The load estimate is based on one water sample and one data point on the discharge curve. Conclusions should not be drawn from this example. More complete treatment of the data will commence when additional results are available.

What can we do with loading information?

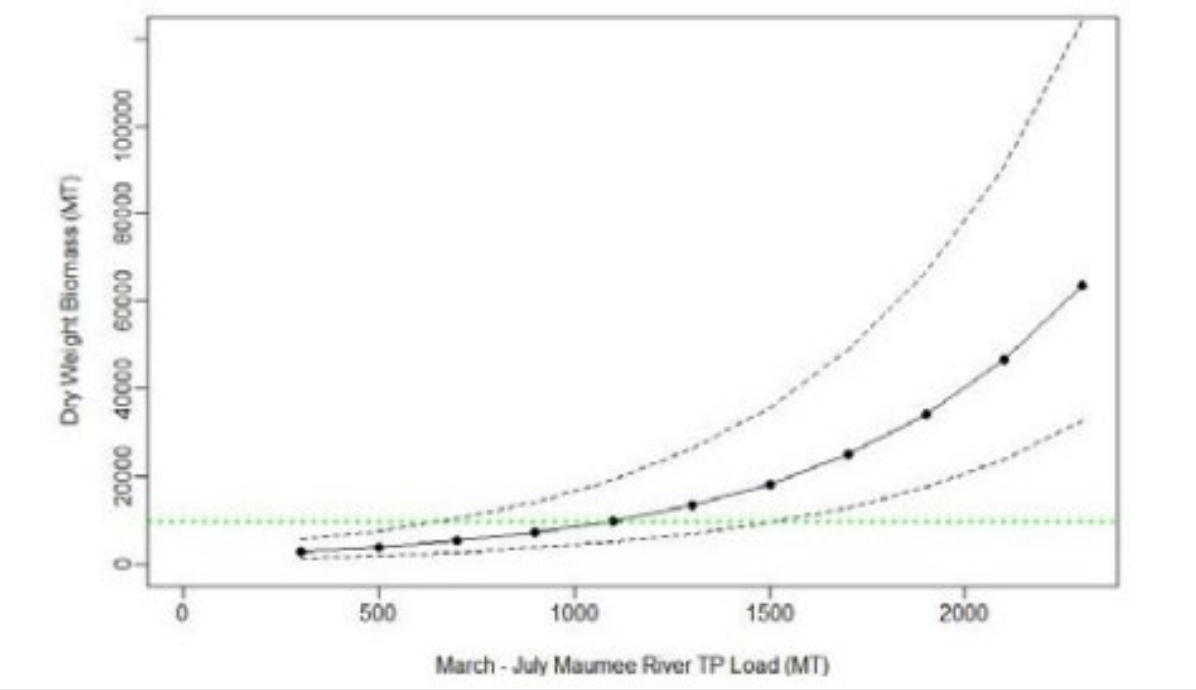


- Calculate seasonal and annual loads for sediment and nutrients
- Compare measured annual load with GLWQA limit set for Saginaw Bay
- Compare subwatershed load contributions
- Understand what could be done and where to reduce loading

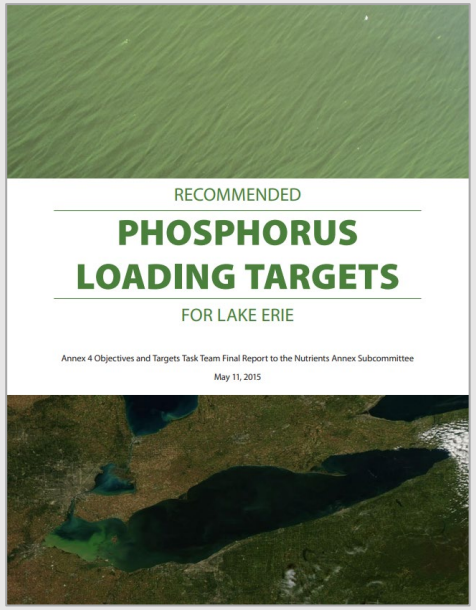
Map taken from https://www.saswa.org/

How will the new data be used?

- Determine the **nutrient and sediment loads** from tributaries to the bay
- Identify **priority sub-watersheds** for **soil and nutrient conservation**
- **Evaluate** and **update** the Saginaw Bay **annual phosphorus loading target**
- **Monitor progress** of Saginaw Bay restoration



Example model-generated “stressor-response curve” used to estimate updated Lake Erie phosphorus load target



Tributaries Dashboard

The Saginaw Bay Monitoring Consortium

Thank you!