USGS Activities in the Lake Superior Basin

U.S. Department of the Interior
U.S. Geological Survey
November 2014

USGS MISSION

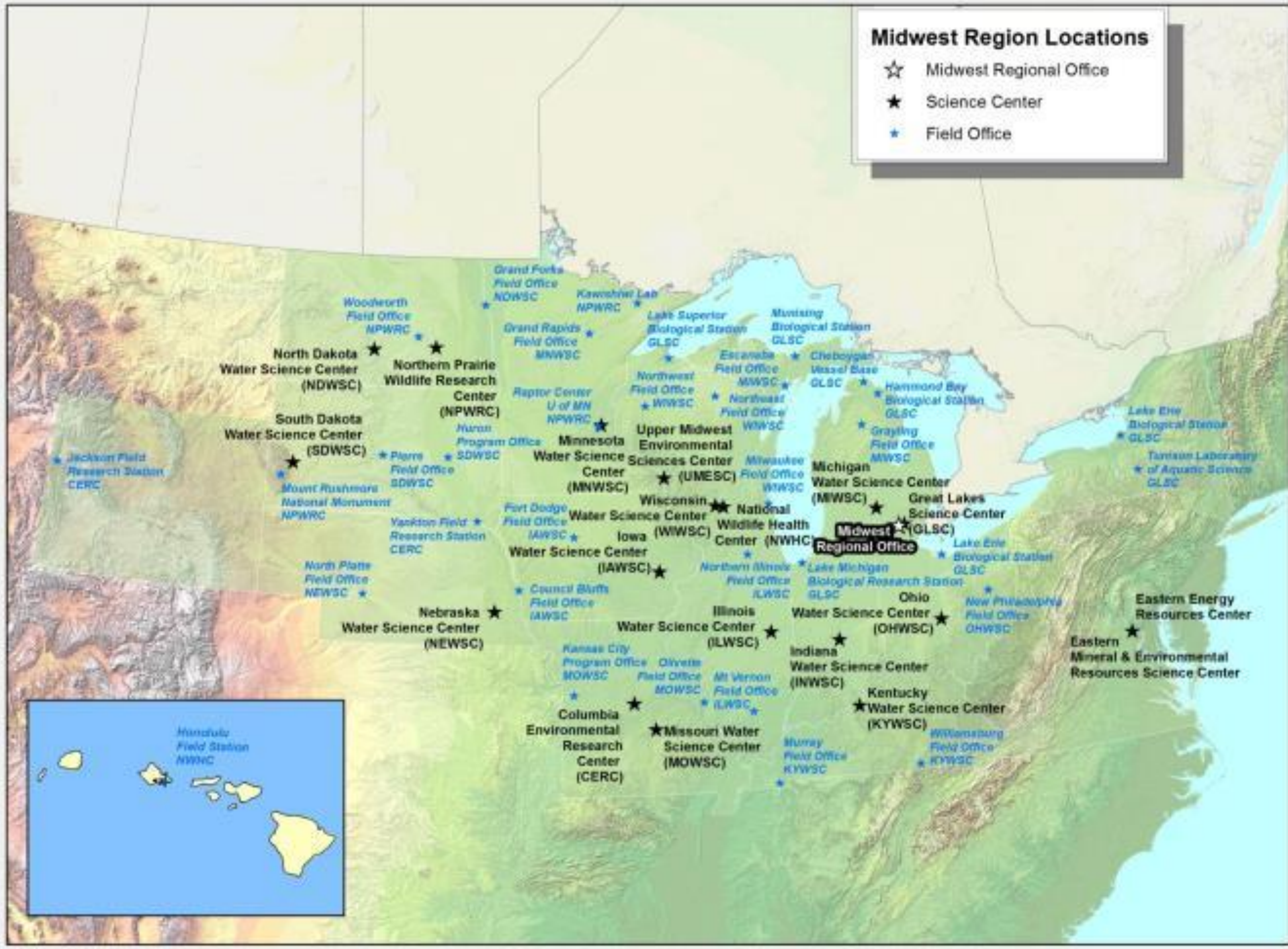
- Collect, monitor, analyze, and understand natural resources
- Conduct multi-disciplinary investigations that provide impartial scientific information
- Address broad societal and environmental problems--with partners and stakeholders

Integrated Science

- Hydrology and water quality
- Biology and ecosystem health
- Contaminant occurrence, transport, fate
- Science to assess environmental effects
- Quality and quantity of mineral resources

USGS Science Centers provide integrated science

- Hydrology and water quality
- Aquatic/terrestrial biology/ecosystem health
- Toxic/contaminant occurrence, transport, fate
- Science to assess environmental effects
- Studies of the quality and quantity of mineral resources.

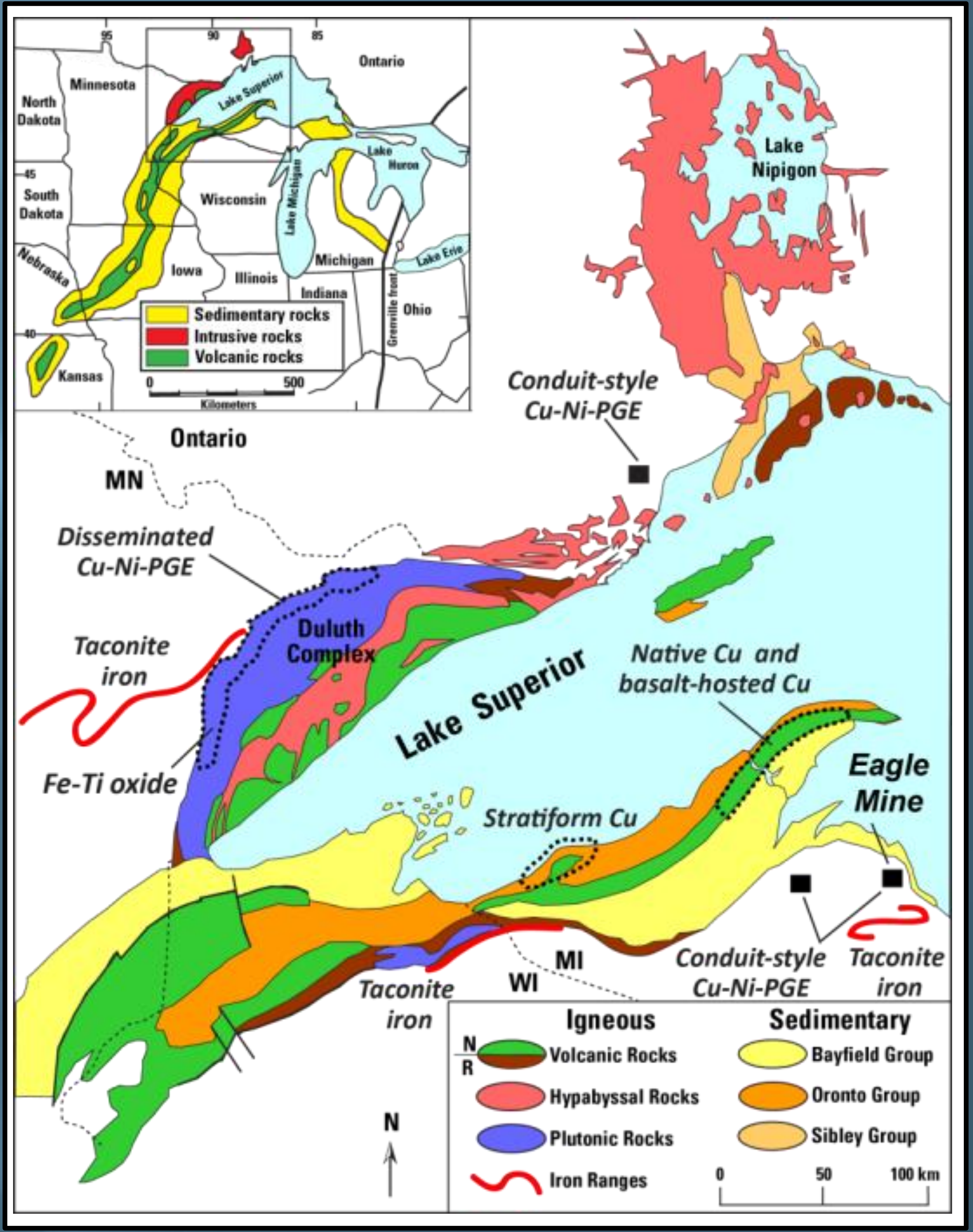


Mineral resources in the Lake Superior Basin

Bedrock contains tremendous mineral wealth.

Iron and copper mining for more than 150 years

The Eagle Mine (Michigan) is the first of several Ni-Cu-PGE mines that may be permitted



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Concerns about Mineral Extraction Involving Water Quality/Quantity and Ecosystem Health

Mining is a polarizing issue. There is need for reliable, unbiased scientific data

We need to work together to address these concerns

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2011- Mining Workshop

"Understanding Impacts of Mining"

- **Multiple agencies involved: Bad River Band of Lake Superior Chippewa, Great Lakes Indian Fish and Wildlife Commission (GLIFWC), Fond du Lac Band of Lake Superior Chippewa, and USGS**

- **24 presentations, 150 attendees from federal, state, local and tribal organizations as well as mining companies**

- ***Outcomes: Information for the public. What do we know? What are the concerns and impacts? What information is needed for the environmental review? Set the stage for future work.***

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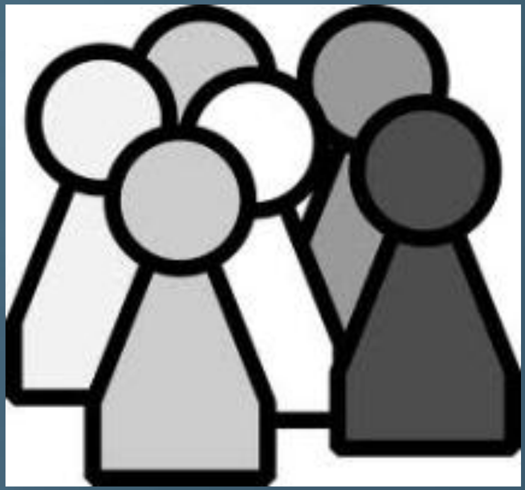
USGS Model to Address Concerns Around Mining

Binational input from LaMP Working Group



Impartial data and synthesis to address concerns and potential problems

Partnership with Federal, State, and Tribal partners. Input from USGS subject matter experts.

Backbone for USGS focus on mining issues

USGS Partners and Stakeholders

- GLNPO, EPA-ORD, BIA, NOAA, Forest Service and other federal agencies
- LaMP Binational Working Group, Coop Science and Monitoring Initiative (CSMI), Binational Forum
- State Entities-- MPCA, MN DNR, LCCMR
- University Partners: (NRRI), MGS
- Tribal partners, including GLIFWC

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USGS projects and partners

(long history of USGS work in iron country)

USGS Regional funding
(2008-2009)

USGS, GLIFWC EPA-5
(2011-2015)

USGS Mining Initiative funding
(2012-2014)

Synthesis Studies: USGS-NRRI-MN DNR
(2013-2016)

USGS – Mineral Resource Program focus on the Midcontinent Rift
(2014-2017)

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USGS Seed Funding: 2008-2009

Water quality and geochemical baseline conditions prior to metal exploration or development in a small watershed in Michigan

Refined an approach for regional environmental baseline studies in the Lake Superior Basin

http://pubs.usgs.gov/sir/2010/5121/

science for a changing world

Environmental Baseline Study of the Huron River Watershed, Baraga and Marquette Counties, Michigan

Scientific Investigations Report 2010–5121

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

Additional Baseline Studies- 2011-2012

- Baseline Studies in Michigan, Minnesota, and Wisconsin
- Stream gage installation
- Synoptic sampling of water quality and streambed sediment in watersheds with potential future mining
- Support from USGS, GLIFWC, EPA-5, Tribal Entities
- Status of pre-mine hydrology and water quality?

Sampling in the St. Louis River, MN

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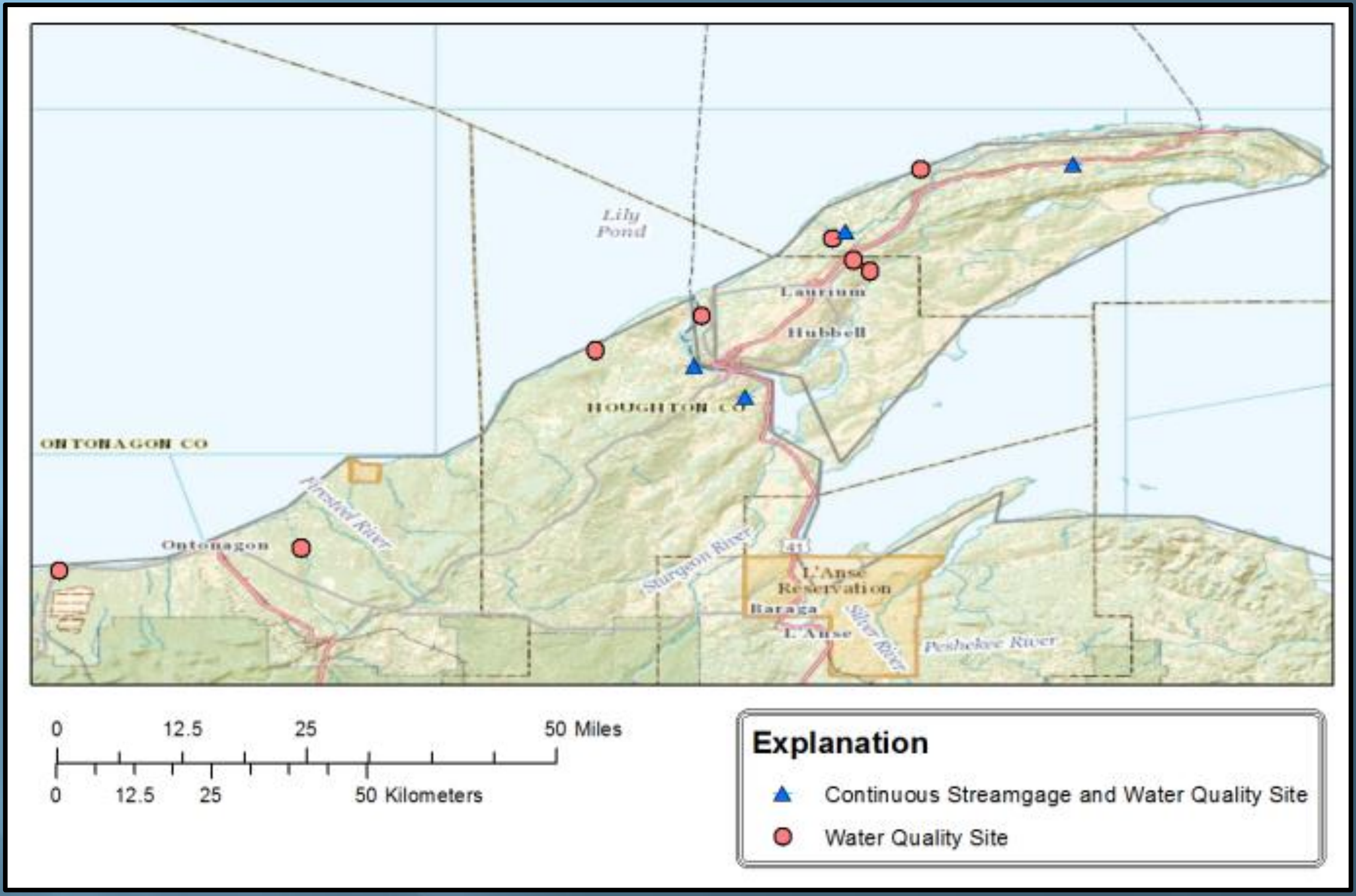
USGS monitoring in watersheds with mineral deposit development or exploration

Stream gage installation and seasonal sampling of water and streambed sediments

Sampling Salmon Trout River

Sites in Keweenaw Peninsula: 2014-2015



Area produced more than 11 billion pounds of native copper

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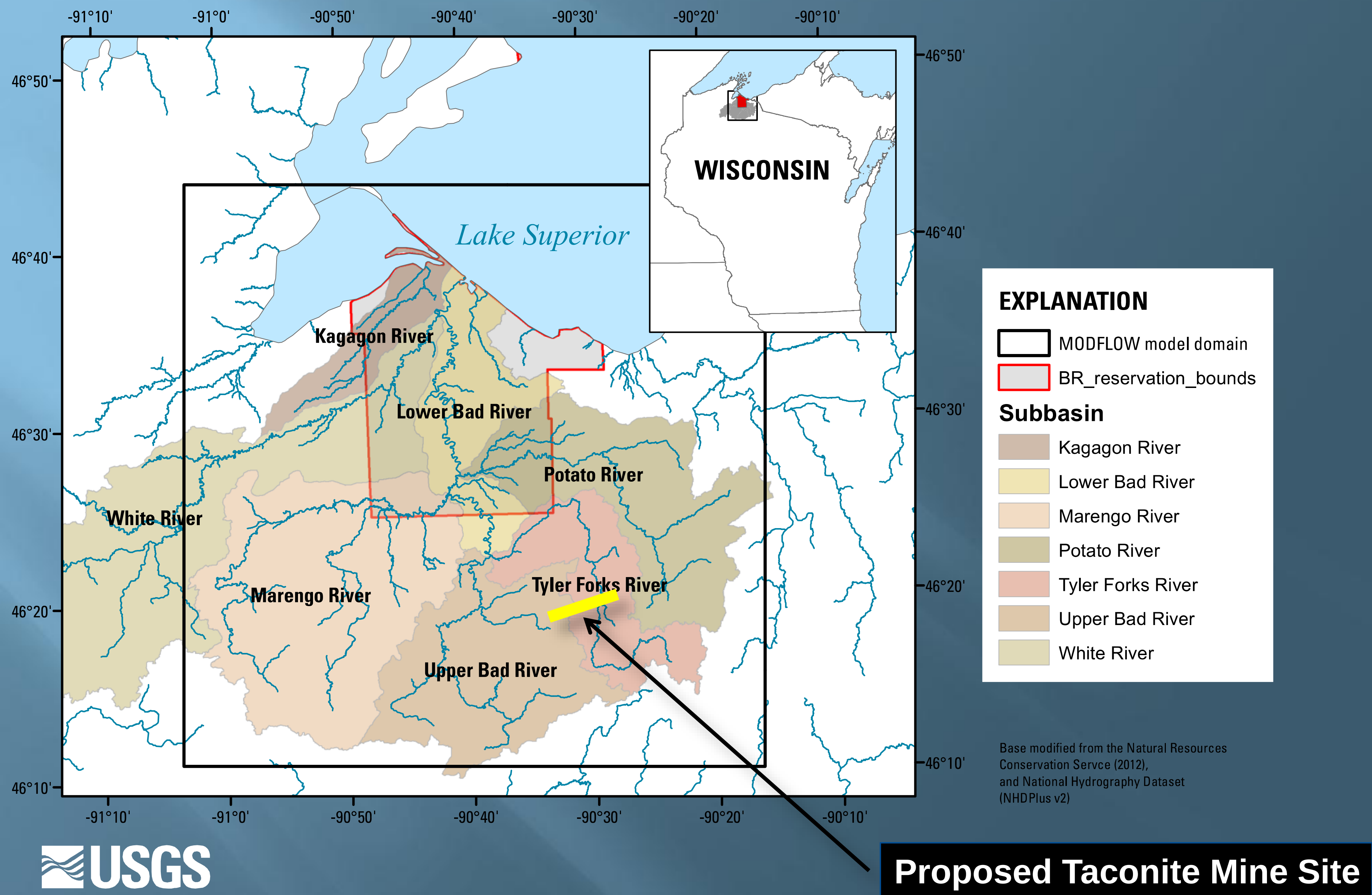
Sites in Bad River Basin, Wisconsin



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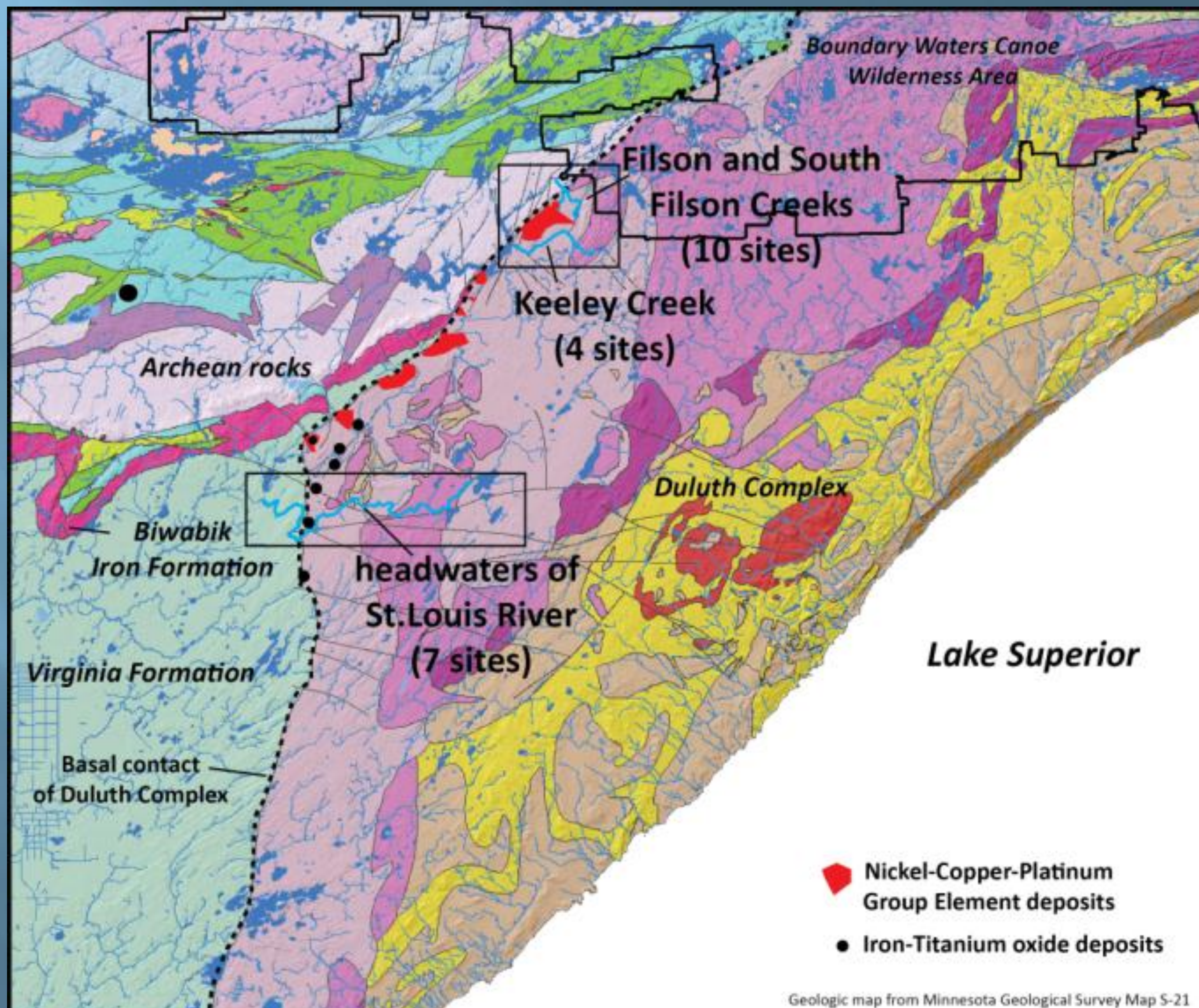
Sites in NR Minnesota
(Filson and Keeley Creeks, St. Louis River)



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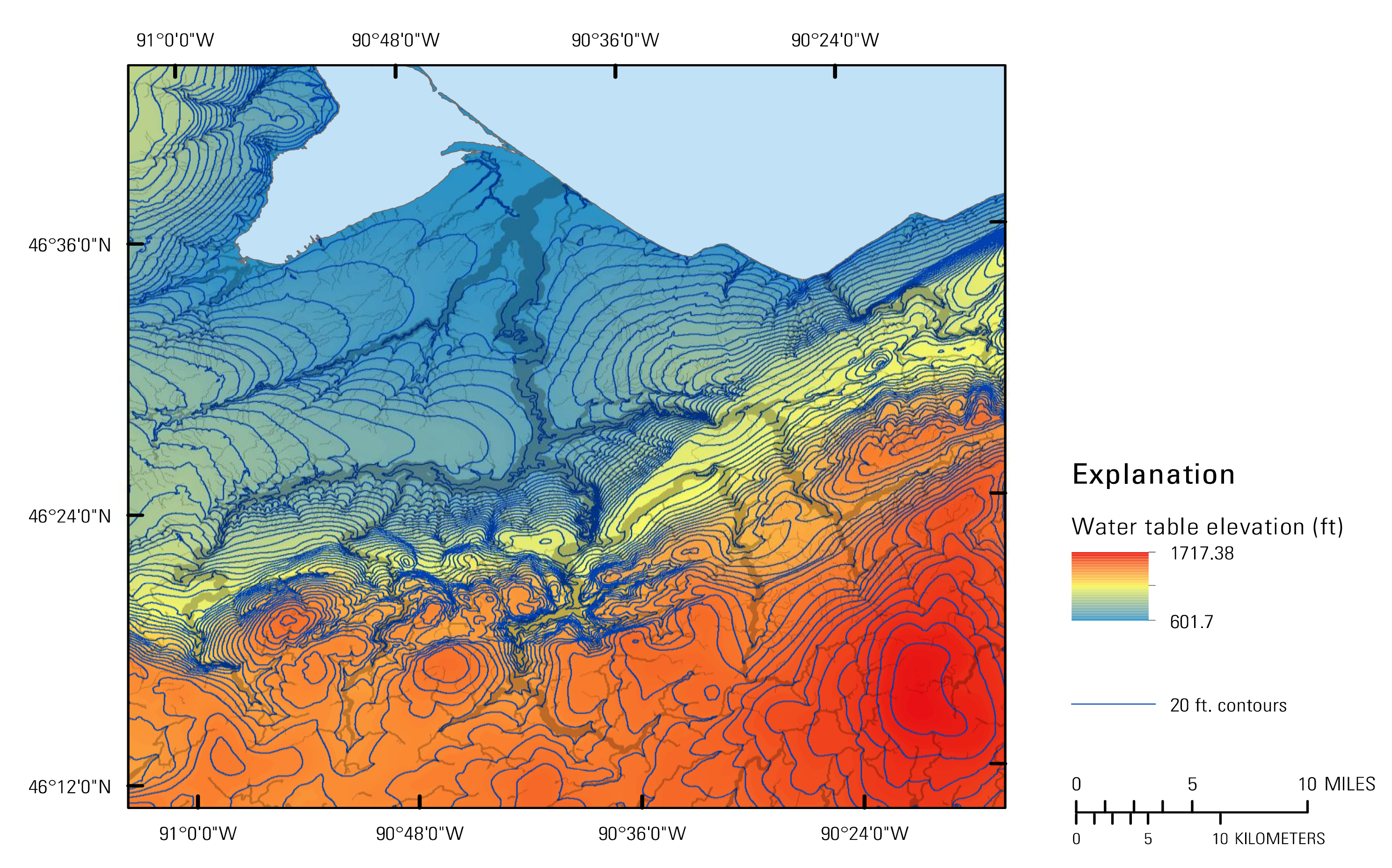
Bad River Basin--Groundwater Modeling



How does groundwater flow and interact with streams and wetlands?

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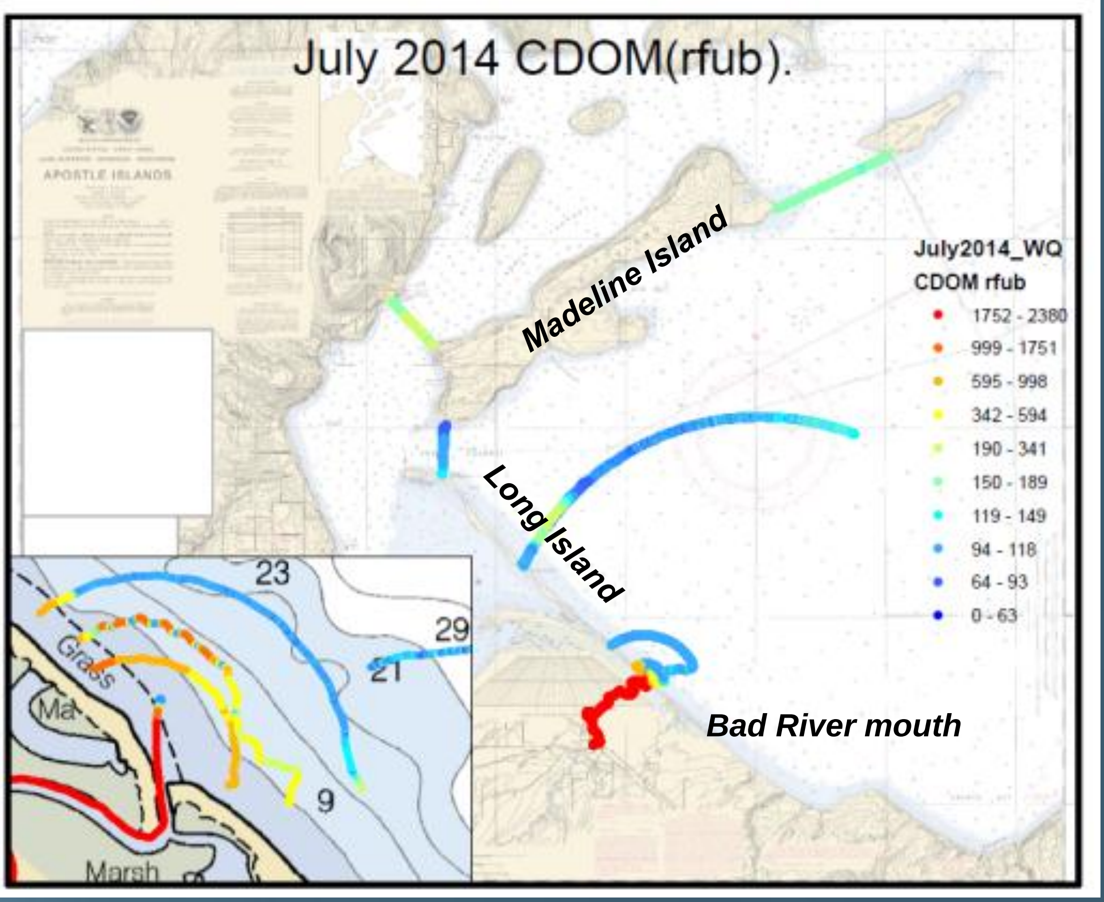
Assessment of potential mining on Apostle Islands National Lakeshore

- Baseline hydrodynamic and water quality study at the Bad River mouth, Long Island, and Madeline Island
- Baseline sampling of Bad River tributaries related to potential iron mining
- Compilation of existing data
- Coordinated with NPS and Bad River Tribal Government



Results from towable fluorescence sensor following small runoff event

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Understanding and Synthesis Studies

USGS Regional funding
(2008-2009)

USGS, GLIFWC EPA-5
(2011-2015)

USGS Mining Initiative funding
(2012-2014)

***Synthesis Studies: USGS-NRRI-LCCMR-MN DNR**
(2013-2016)

*** USGS – Mineral Resource Program focus on the Midcontinent Rift**
(2014-2017)

Minnesota: USGS–LCCMR-NRRI–MNDNR Study: 2014-2017

(expanding on the Mining Initiative)

- **Water quality, streambed sediment, *soil, and bedrock* sampling in watersheds with potential for nickel-copper-platinum group elements or iron-titanium oxide mining**

- **Developing models to understand water balances and to simulate hydrologic conditions under different potential mining scenarios**

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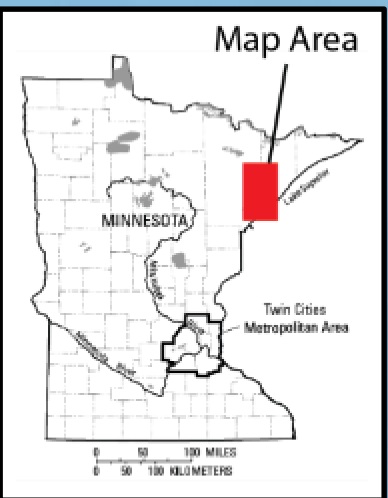
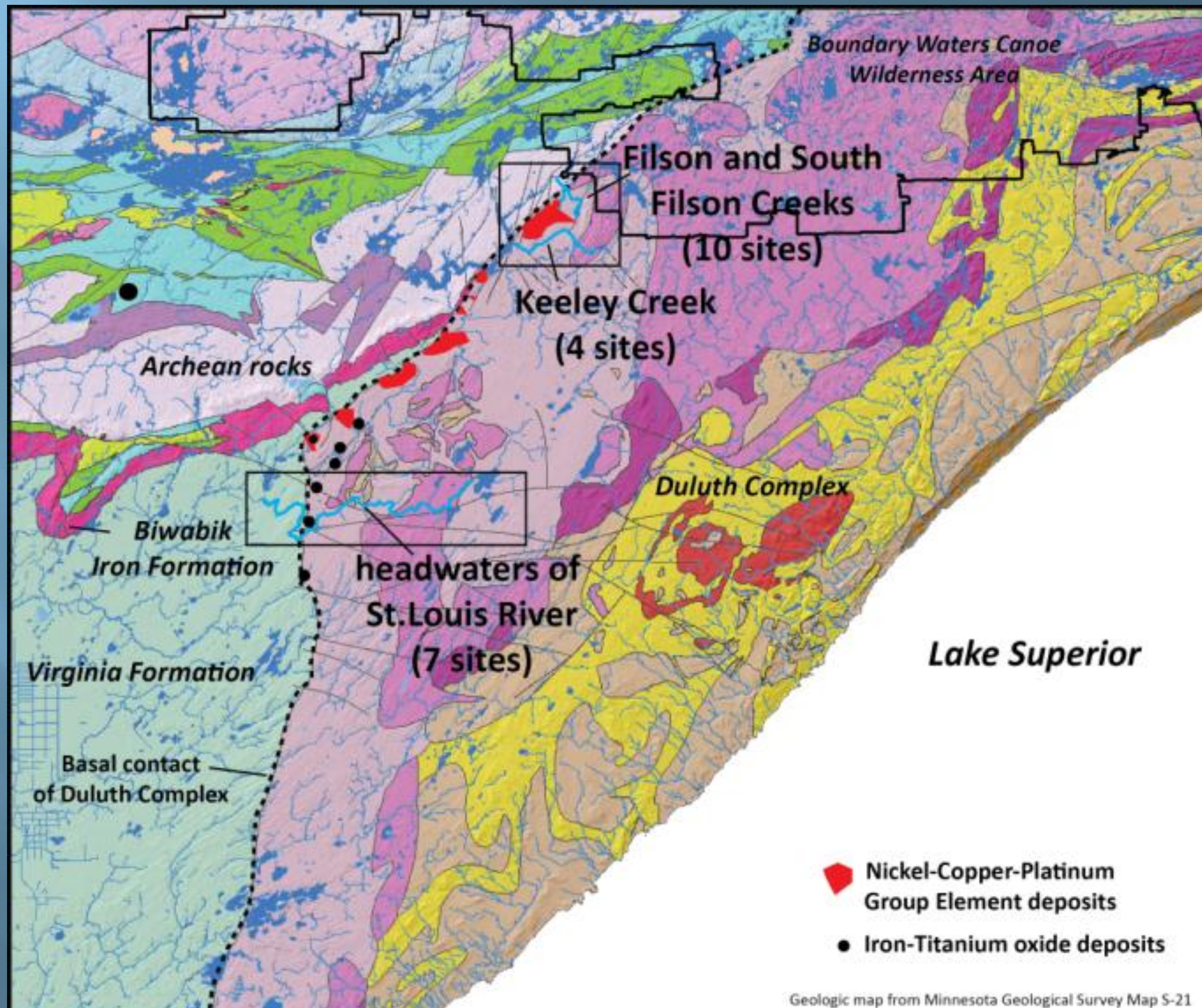
USGS–NRRI–MNDNR Cooperative study
(Filson and Keeley Creeks, St. Louis River)





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USGS Minerals Program: 2014 – 2017
(geo-environmental modeling)

- **Understand the environmental risks of Cu-Ni-PGE mineralization in differing geologic settings**
  - **Studies of exploratory drill core from the Duluth Complex to assess potential for acid generation**
- **Determine the resiliency of watersheds and ecosystems to possible toxicity from metals in the vicinity of proposed mining**
  - **Biotic ligand models to estimate surface-water resiliency to metals potentially released by mining**
- **Baseline landscape geochemistry in an area of past and possible future copper mining (rocks and soils)**
  - **Water quality, streambed sediment, and soil sampling across the western Upper Peninsula, Michigan**

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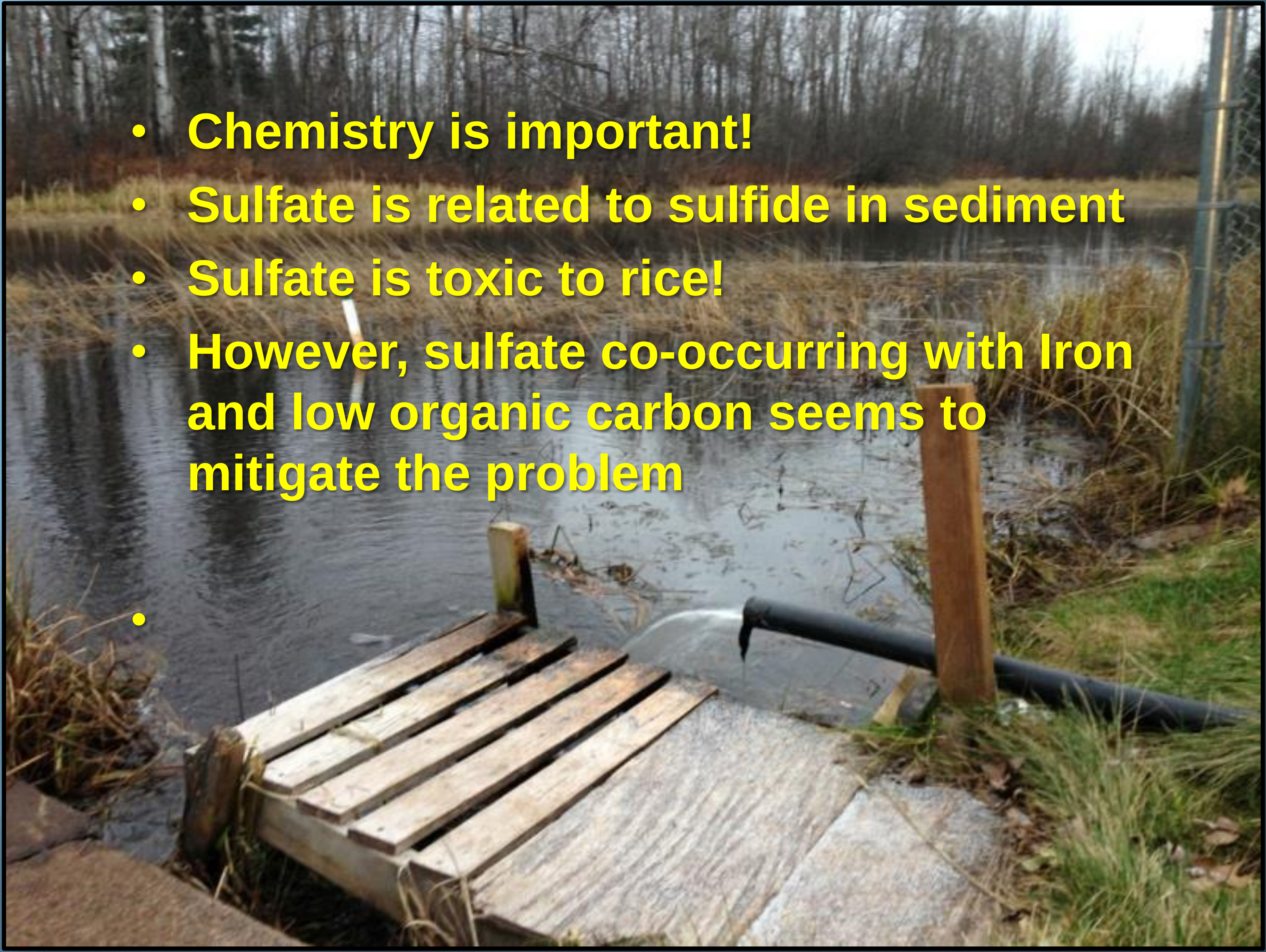
Wild Rice?

- Chemistry is important!
- Sulfate is related to sulfide in sediment
- Sulfate is toxic to rice!
- However, sulfate co-occurring with Iron and low organic carbon seems to mitigate the problem



There's more!

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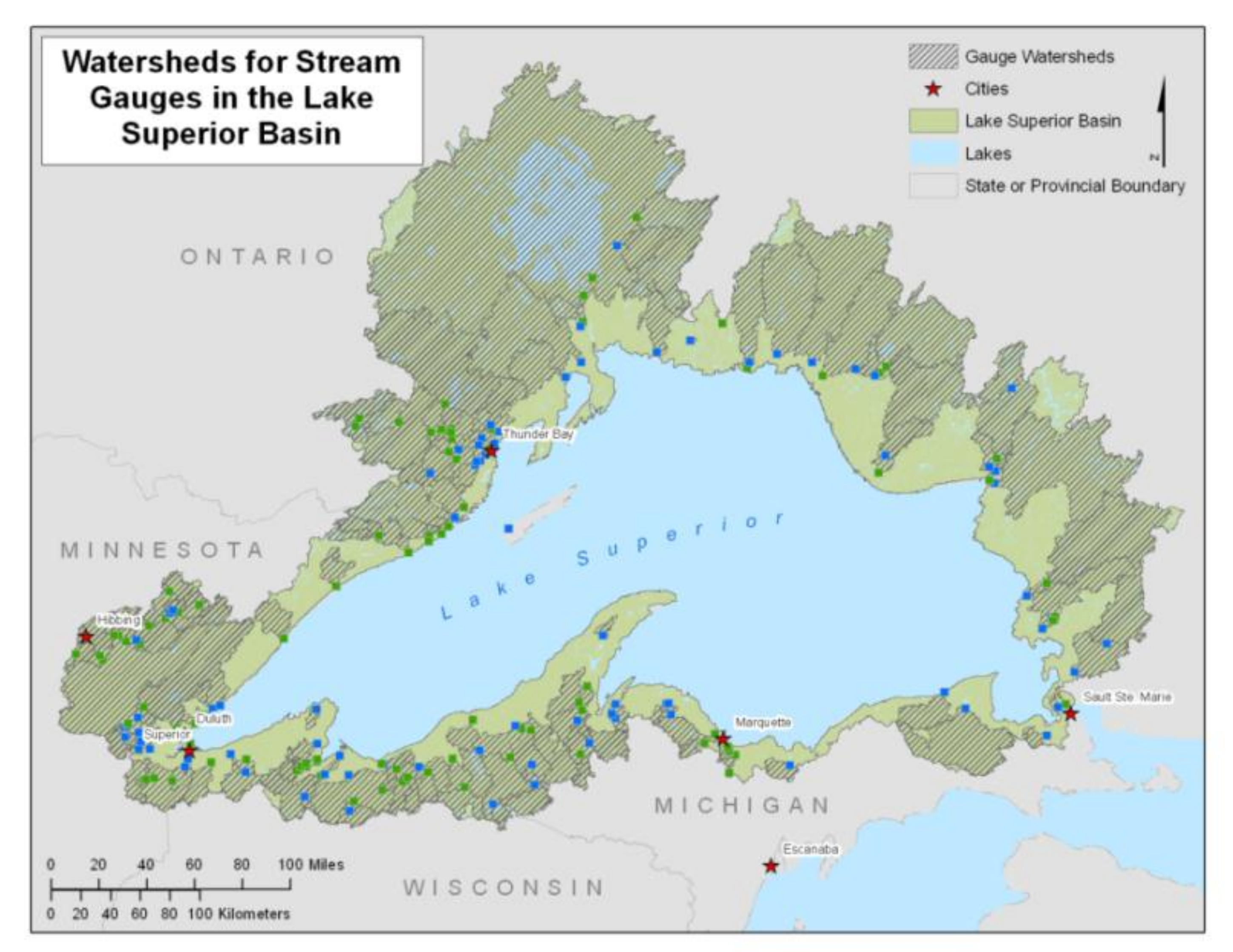
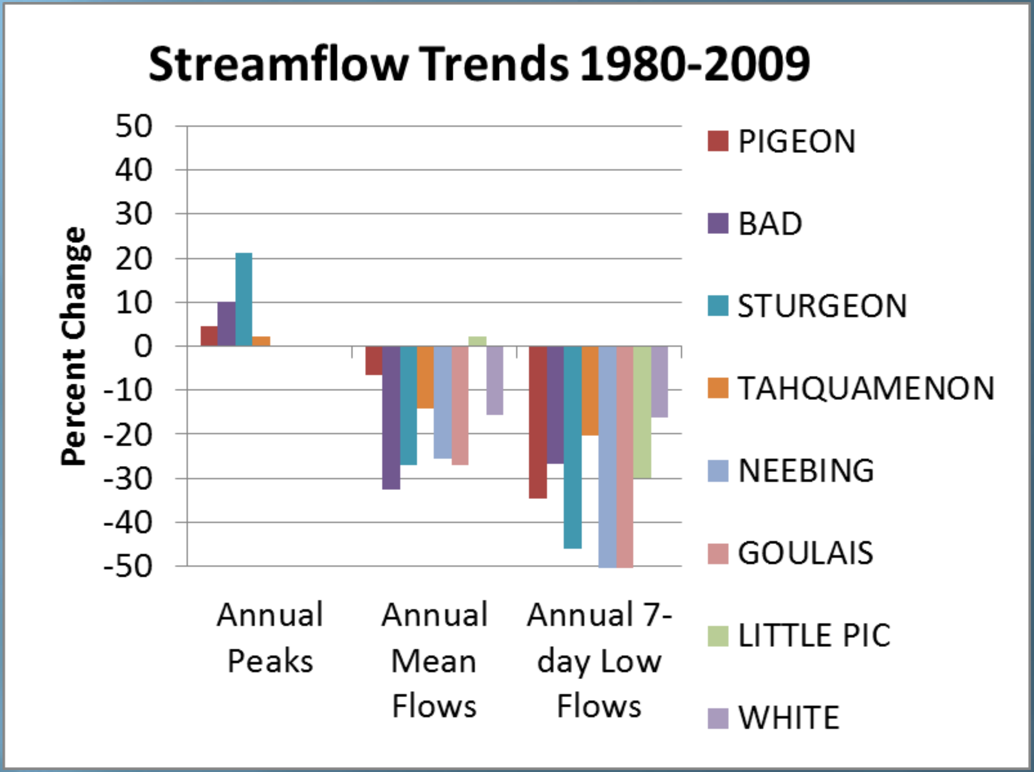
Tributary Monitoring -- Streamgages



Lake Superior Tributary Streamflow Trends

(LaMP/CSMI/USGS/NPS/USFS/EC collaborative effort for U.S./Canada)



- Sparse data network
- Decreasing base flows
- Increased peak flows, indicating increased intensity of rainfall events

USGS Work in the big lake - Water quality and Ecosystem Activities

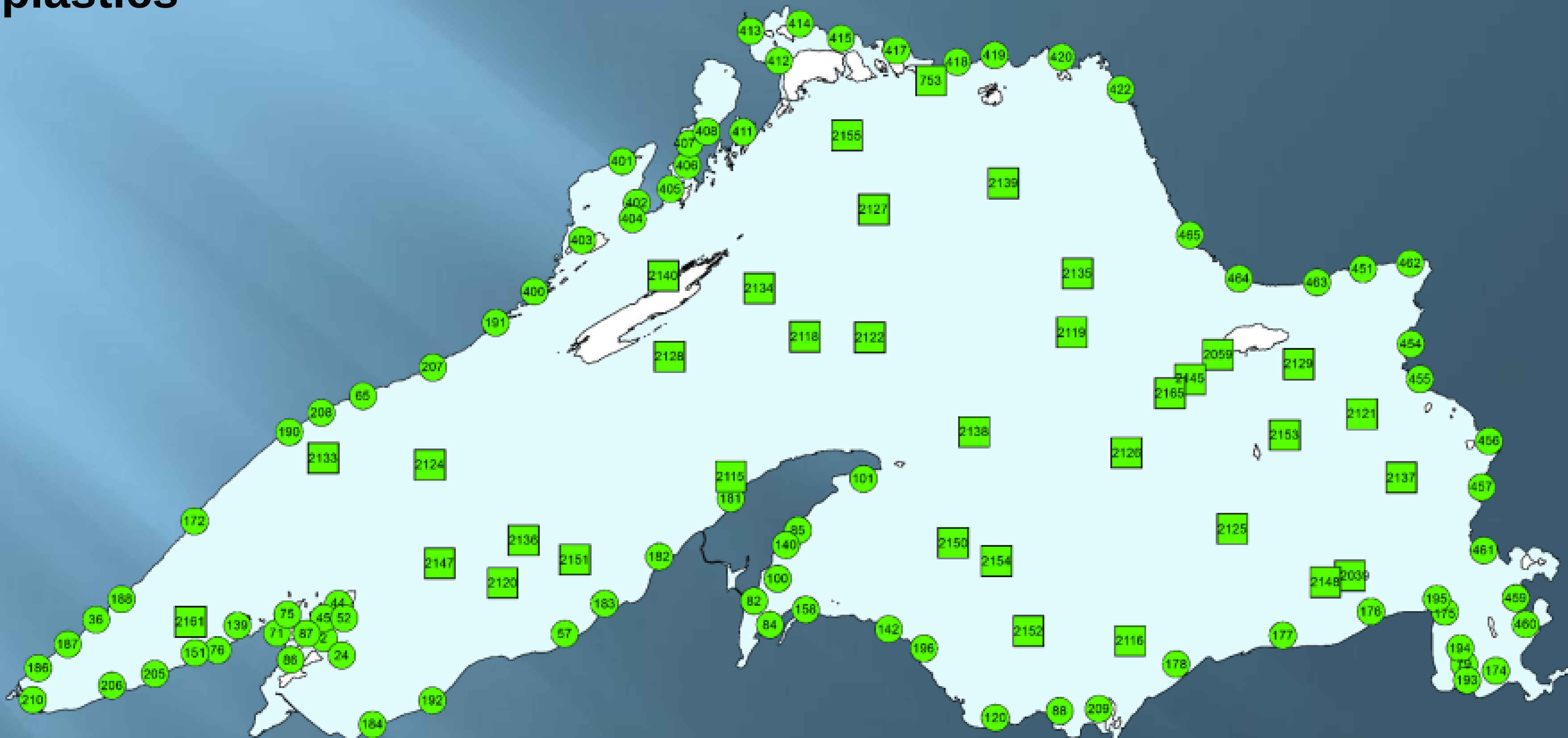
CSMI, ORD, CSMI, Binational LaMP

USGS

Lake Superior Biological Station

USGS Lake Superior fish survey focus areas

- **Annual surveys – 115 locations, spring and summer sampling: water profiles, zooplankton, larval and benthic fish, predator diets, micro-plastics**



- **Research – fish community dynamics, fish stock assessments, food web dynamics, methods development**
- **CSMI integrated studies – energy transfer, survey design**

USGS Program Model

Small efforts focused on synoptic and baseline environmental data: Pre-permit

Follow-up time series and detailed studies

Understanding environmental fate, transport and potential effects

Collecting basic data> ***Focusing data collection>*** ***Synthesis***

What is needed?

- Common platform to understand the body of knowledge for the watershed– What has been done? Who is involved? Where are the data? How do we share?
- Hydrology: Impact of wetlands on water quality and hydrology (DOC)
- Groundwater/surface water interaction
- Three dimensional understanding of geology/hydrology (geologic atlas)
- Groundwater flow in fractured rocks
- <u>Continued cooperation from partners and stakeholders</u>

THANK YOU!

USGS

Lake Superior Biological Station