Great Lakes Ship Monitoring Project

GreatWaters
Research Collaborative

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UNIVERSITY of WISCONSIN
Superior

LSRI
Lake Superior Research Institute
Est. 1967

Great Waters Research Collaborative

Project of the University of Wisconsin-Superior's Lake Superior Research Institute (LSRI), in collaboration with University of Minnesota Duluth, AMI Consulting Engineers, and Penn State Behrens;

Devoted to objective, high-quality, third-party BWMS performance assessments and NIS risk research in the Great Lakes and other Great Waters of the world;

Team with over 15 years experience in BWMS Testing for IMO/USCG Certification, and R & D at Bench, Land and Shipboard scales.

Project Partners

Great Waters Research Collaborative

MN Pollution Control Agency

Lake Carriers Association
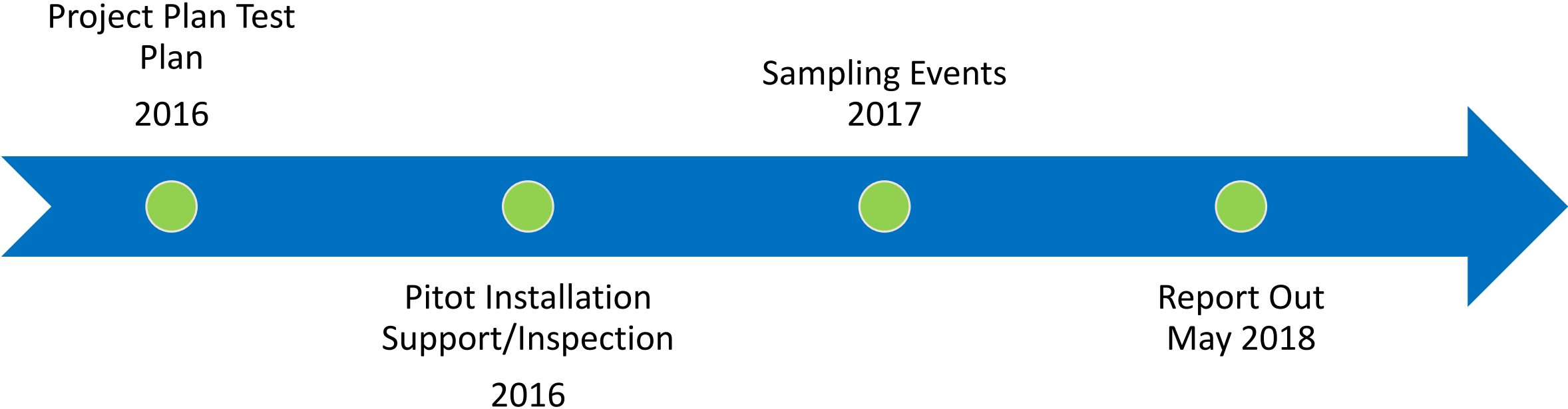
Chamber of Marine Commerce

Acknowledgment:

Project Objective:

❑ Proposed by laker organizations as a means for meeting their MN PCA CWA Permit Requirements …

❑ With the goal of better understanding what NIS US and CDN laker ships may be carrying **to** western Lake Superior **from** the lower four Great Lakes.

   ➢ Target organisms were *Hemimysis anomala* (common name: bloody red shrimp) and any other NIS not yet present in Lake Superior.

❑ Funded by the US EPA's GLRI *via* the Maritime Administration …

   ➢ In-Kind Contributions from Ship Companies

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Definitions:

❑ United States (US) Laker

❑ Canadian (CDN) Laker

❑ Project-Relevant Nonindigenous Species (NIS)

❑ Source System

❑ Receiving System

Project Timeline:

Project Plan Test Plan
2016

Pitot Installation Support/Inspection
2016

Sampling Events
2017

Report Out
May 2018

2016: Ship and Test Plan Preparation

❑ GWRC Inspection and Design/Location Recommendations

➤ USCG/IMO-Consistent for Representative, Time-Integrated Sampling of Ballast Uptake/Discharge.

❑ Laker Sample Port Installations

➤ 8 CDN Lakers

➤ 11 US Lakers

❑ GWRC Test Plan Development; Laker Review and Acceptance

2016-2017: Sampling

❑15 Laker discharges to Western Lake Superior (WLS) of ballast water originating in the lower four Great Lakes (i.e., 2.2% of ship visits to WLS in 2017)

❑Four of these discharges were part of "voyage-wide" sampling events including associated:

➢Southern Lake Michigan source water near to ballast uptake;

➢Southern Lake Michigan ballast uptake;

➢WLS ballast discharge;

➢WLS receiving water near to the ballast discharge.

Five Voyage Routes/Twenty BW Events/Eight Ships

Voyages Uptake Location	Voyages Sampled	Paired Uptakes and Discharges
Lake Erie	4	
St. Clair River or Detroit River	2	
Northern Lake Michigan	1	
Southern Lake Michigan	8	4
Lake Ontario	1	

Uptake and Discharge Sampling

☐ Random Portion of Total Ballast –
  ➢ Not Before & After Sampling!
☐ 5-55% of Total Volume
☐ Sample Volume/Sensitivity Varied*
☐ Analyzed for:
  ➢ Project Relevant NIS—including *Hemimysis*—Specimens
  ➢ *Hemimysis* DNA**
 ➢ Plankton Composition Generally
 ➢ Physical/Chemical Conditions
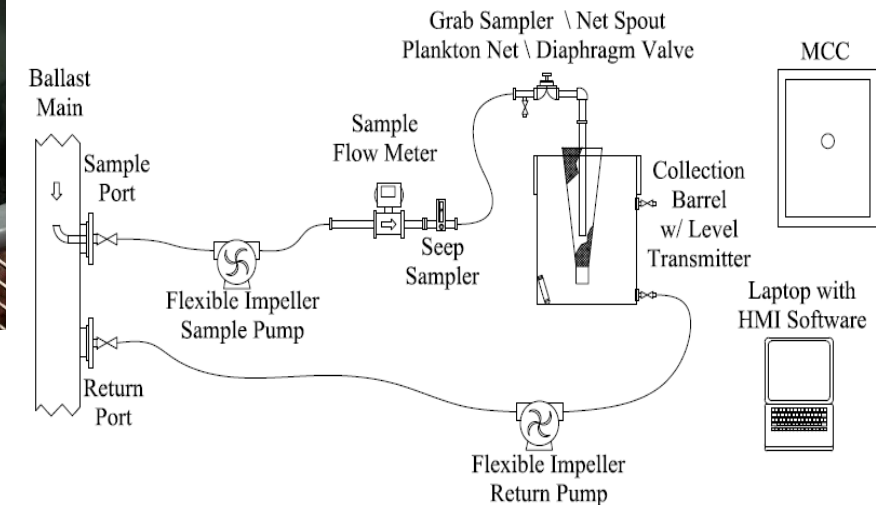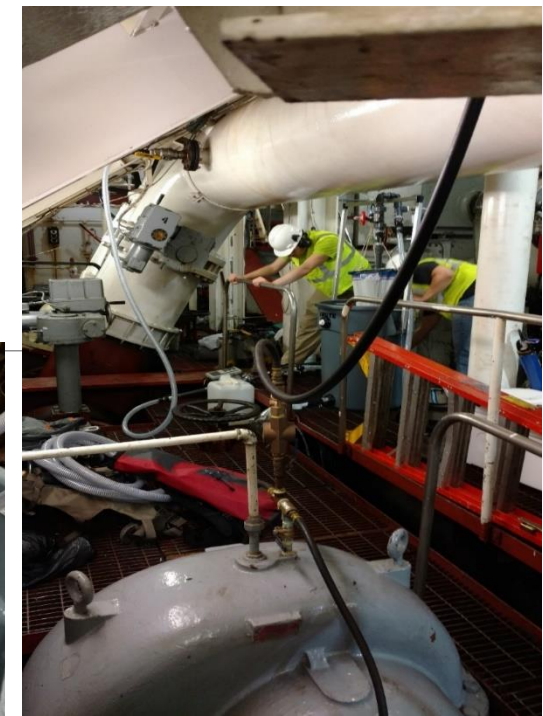
*Large Volume Sample in 5 out of 15 Discharges; ** Analyzed in 11 out of 15 Discharges Only
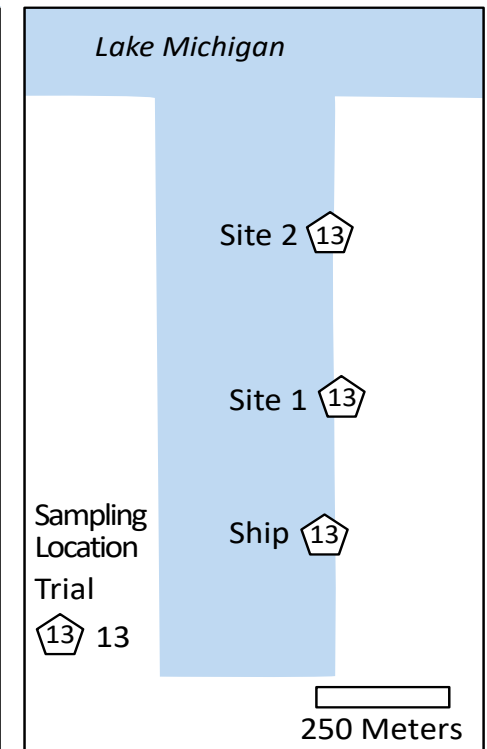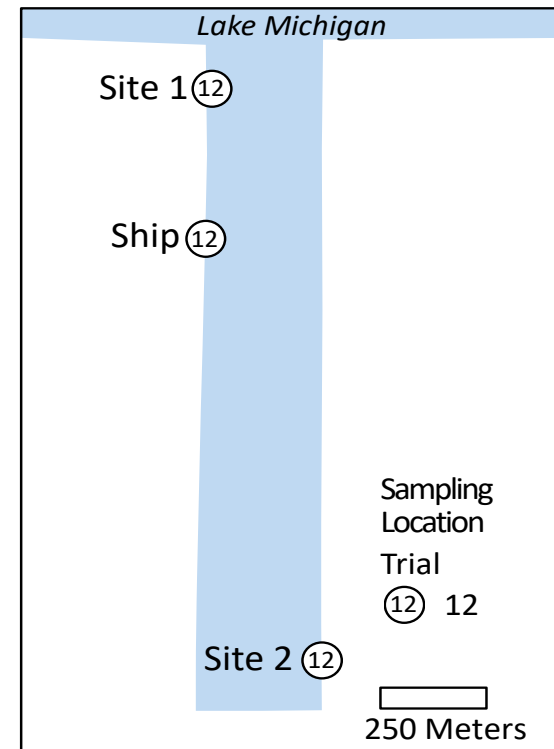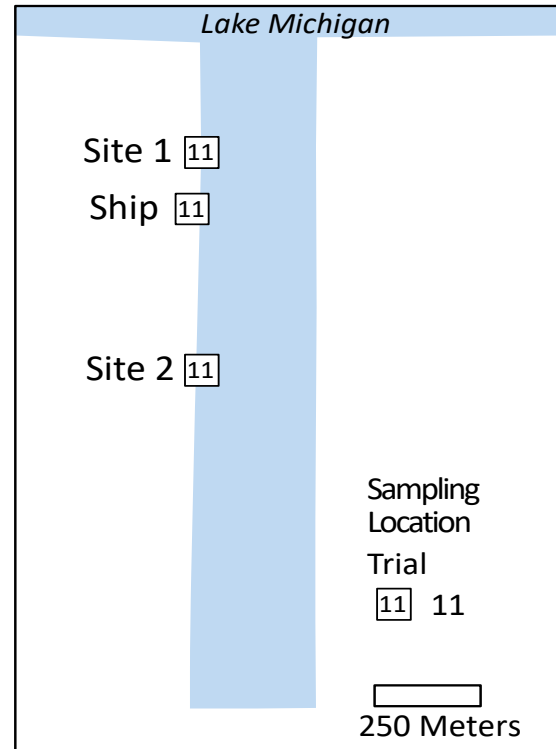
Source Water Sampling

➤ To Determine Possible Presence of Established HM Population

➤ Associated with 4 Lower Lakes Uptake Events

➤ *Hemimysis* DNA

➤ Near in Location & Time to Ship Ballast Op

➤ Multiple Sites per Sampling Event

Generic Drawings of Ships Berths
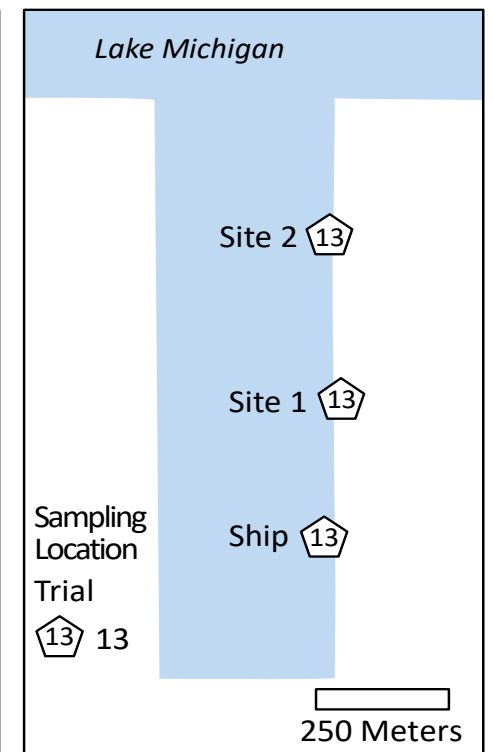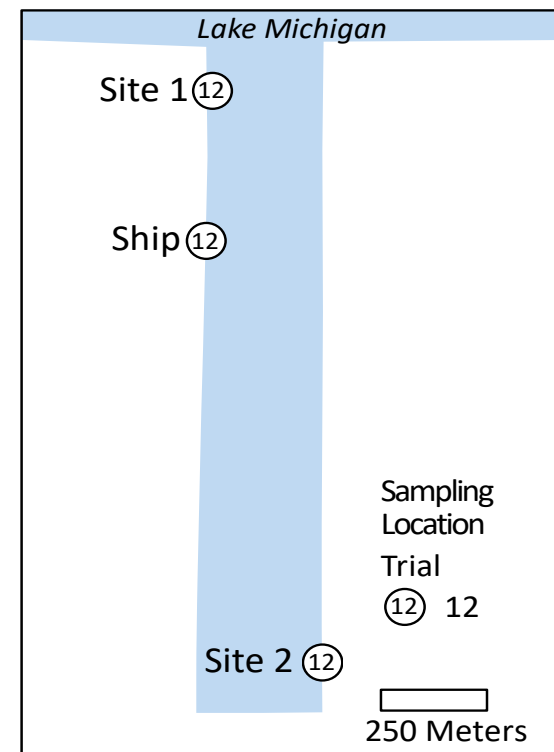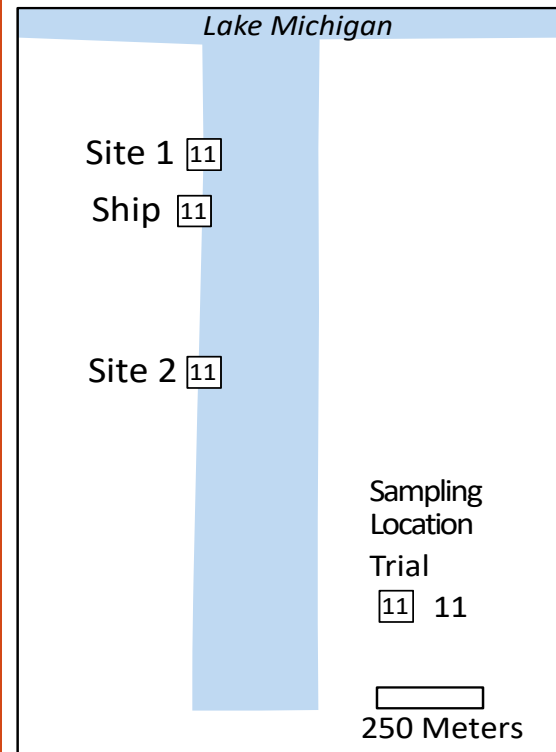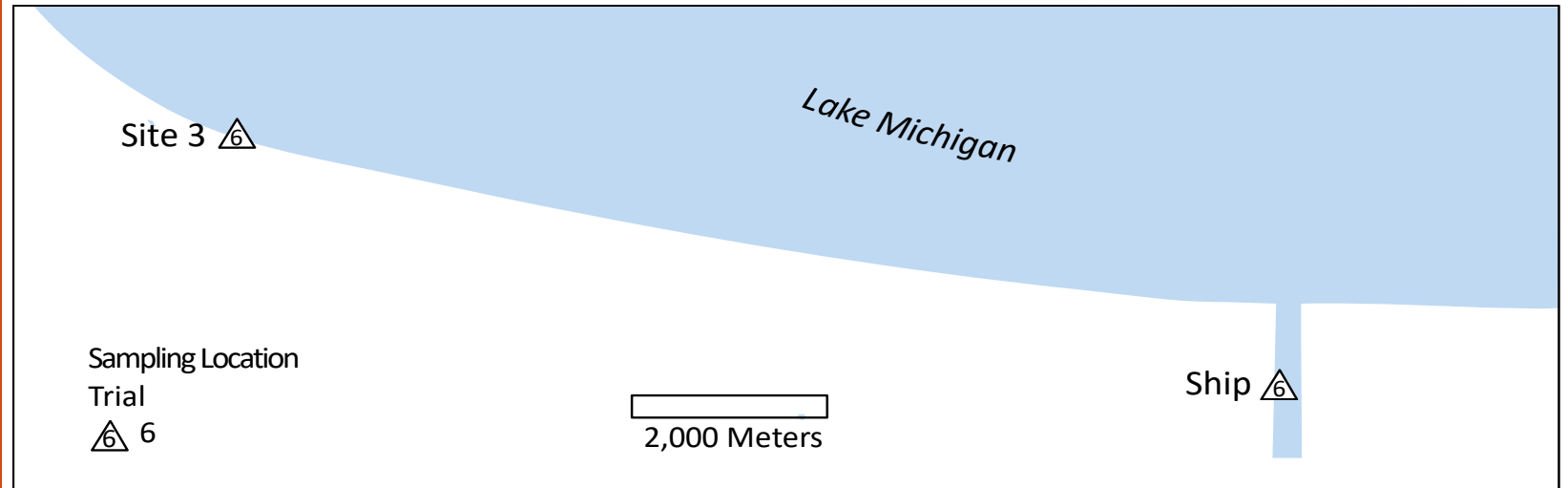
Source Water Sampling

➢ Associated with 4 Lower Lakes Uptake Events (3 Relevant)

➢ *Hemimysis* DNA

➢ Near in Location & Time to Ship Ballast Op

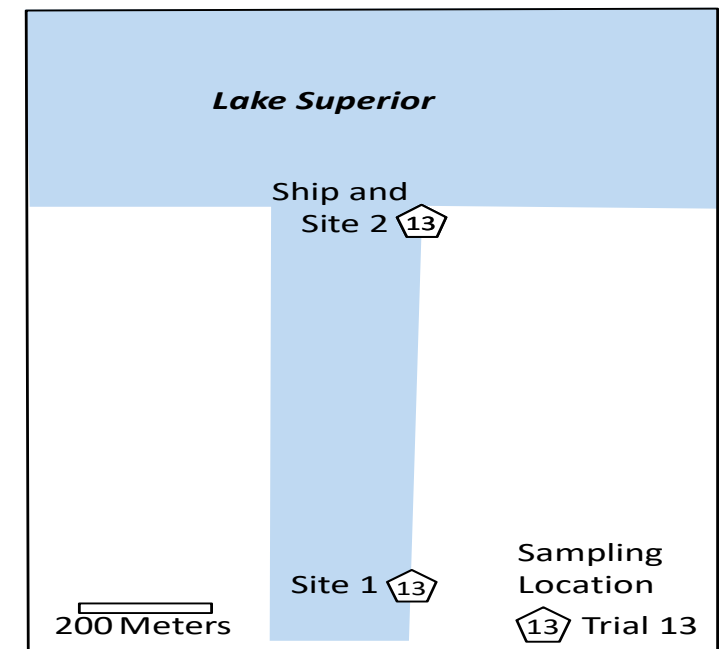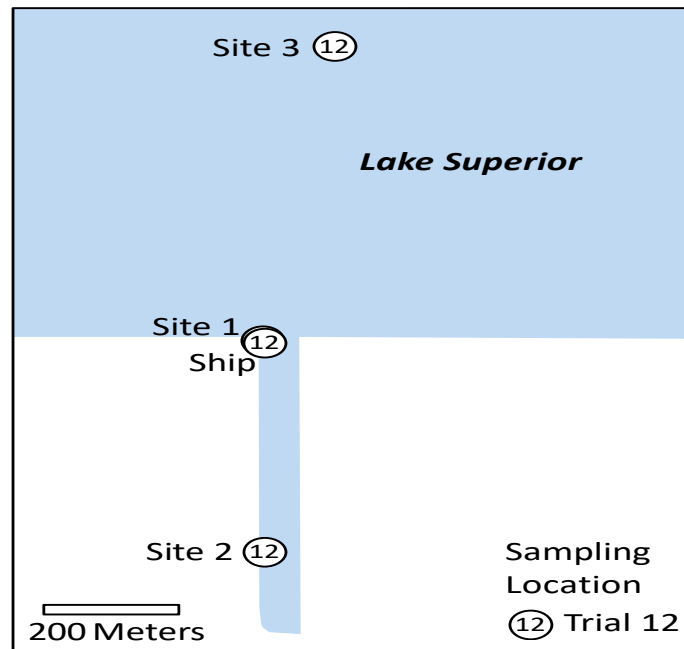➢ Multiple Sites per Sampling Event

➢ To Determine Possible Presence of Established HM Population
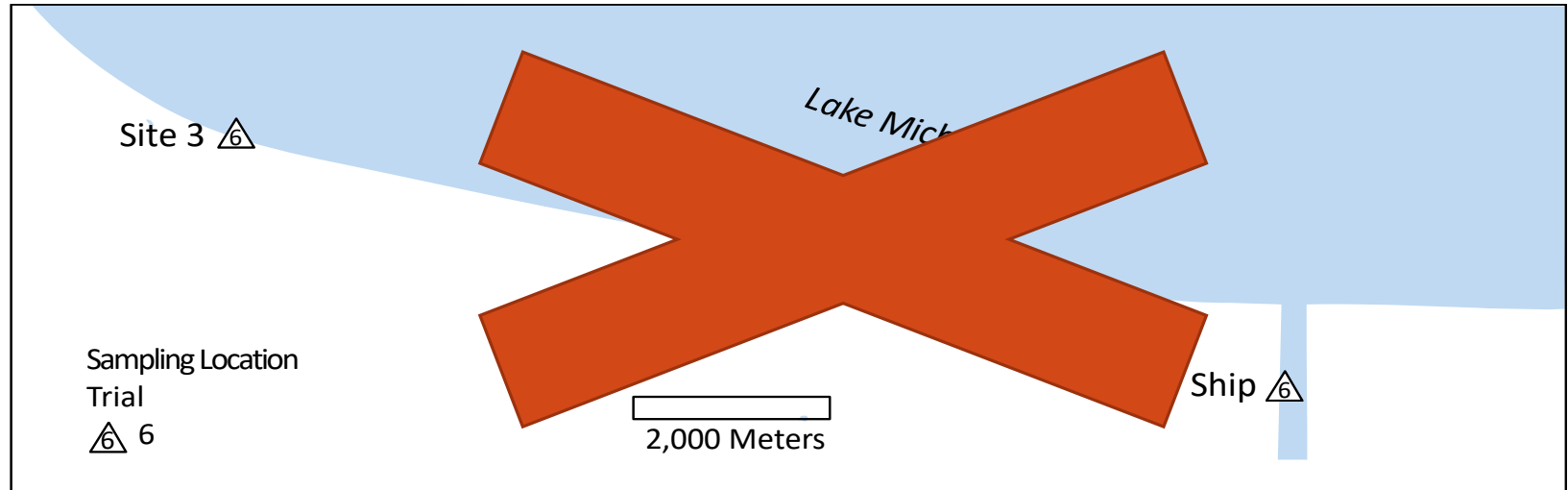
Receiving Port Sampling

➤ Associated with 4 WLS Discharge Events

➤ *Hemimysis* DNA

➤ Near in Location & Time to Ship Ballast Op

➤ Multiple Sites per Sampling Event

➤ To Determine Possible Presence of Established *Hemimysis* Population

Site 3 △6

Lake Superior

Site 1 △6
Ship △6

Site 2 △6

200 Meters

Sampling Location
△6 Trial 6

Site 3 ☐11

Lake Superior

Site 1 ☐11
Ship

200 Meters

Sampling Location

☐11 Site 2

☐11 Trial 11

Site 3 ◯12

Lake Superior

Site 1 ◯12
Ship

Site 2 ◯12

200 Meters

Sampling Location
◯12 Trial 12

Lake Superior

Ship and
Site 2 ⬠13

Site 1 ⬠13

200 Meters

Sampling Location
⬠13 Trial 13
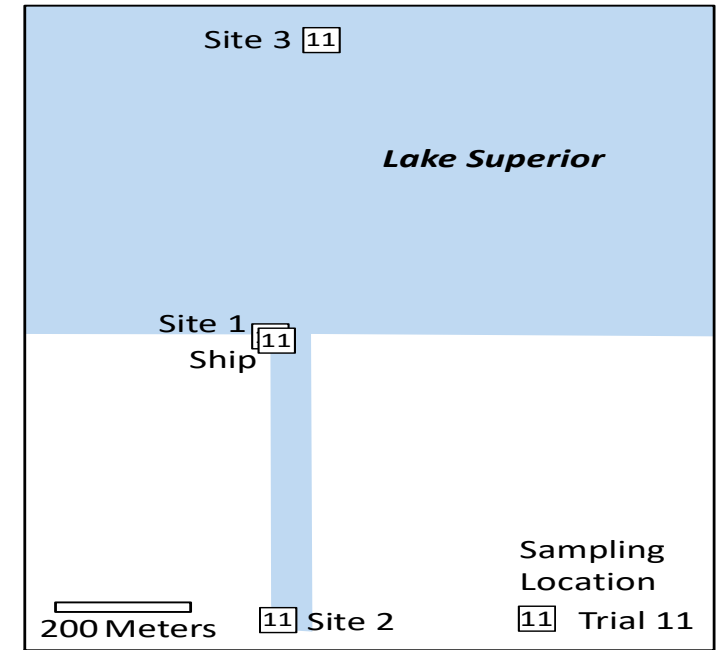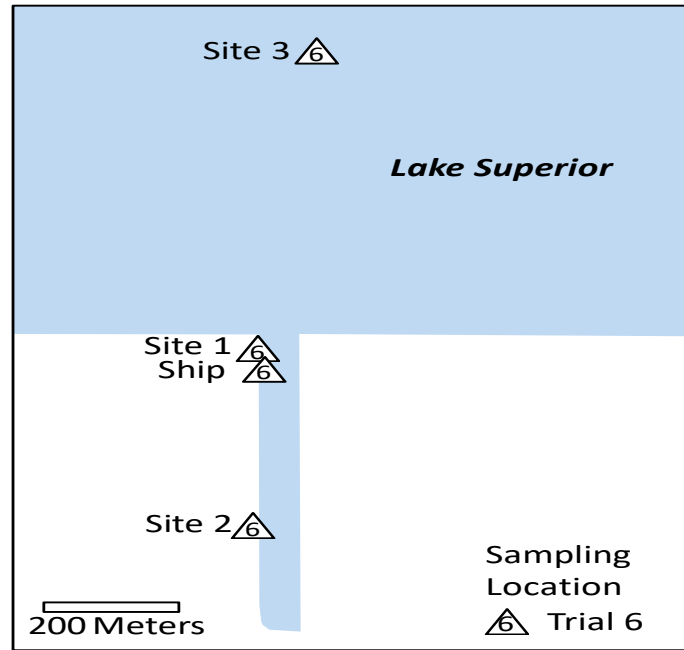
Findings

PROJECT-RELEVANT NIS DETECTIONS, OTHER FINDINGS

Target NIS:
Hemimysis anomala – "Bloody Red Shrimp"
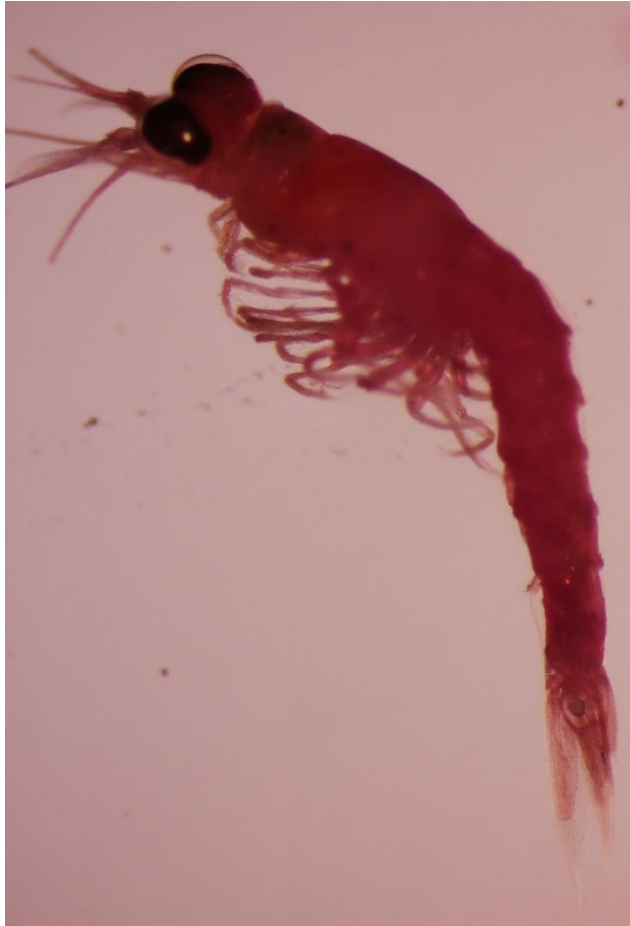
- Freshwater shrimp, 6–13 mm

- Native to Black-, Azov -, & eastern Ponto-Caspian Sea

- First Great Lakes record in 2006 (SE Lake Ontario and channel connecting Muskegon Lake to Lake Michigan)

- Now established in Lakes Ontario, Michigan, Erie and Huron. One specimen observed in Lake Superior, Summer 2017

- Found in 4 Project Uptakes (0.2-0.4 orgs/m3) and 3 Project Discharges (0.2-3.3 orgs/m3)

Kipp, R.M., A. Ricciardi, J. Larson, A. Fusaro, and T. Makled, 2018

Voyage Wide Sampling Results

- 4 Voyages: From Southern Lake Michigan to Western Lake Superior

- August 2017 – November 2017

- Up to one hour of random sampling

- Specimen Detection Sensitivity 0.2 – 0.5/m3

	SOURCE SYSTEM (Southern Lake MI)	UPTAKE (Southern Lake MI)	DISCHARGE (Western Lake Superior)	RECEIVING SYSTEM (Western Lake Superior)
HM eDNA	3/3	4/4	2/4	3/4
HM Whole Specimens	NA	4/4	2/4	NA

Overall NIS Discharge Detections

- 15 Total Discharges August 2017 – November 2017;

- All analyzed for NIS specimens with varying detection sensitivity (0.2 – 17.2/m3)

- 11 analyzed for HM eDNA

- Up to one hour of random sampling

	Hemimysis anomala eDNA	*Hemimysis anomala* specimens	Cyclopoid copepod (1 NIS spp)	Harpacticoid copepods (4 NIS spp)
Discharges with Detections	6 (N=11)	3 (N=15)	1 (N=15)	10 (N=15)
Densities Detected	NA	0.2-3.3 orgs/m3	2.4 orgs/m3	0.5-3.5 orgs/m3
Detection Sensitivity	NA	0.19-1.1 orgs/m3	0.49 orgs/m3	0.44-17.16 orgs/m3

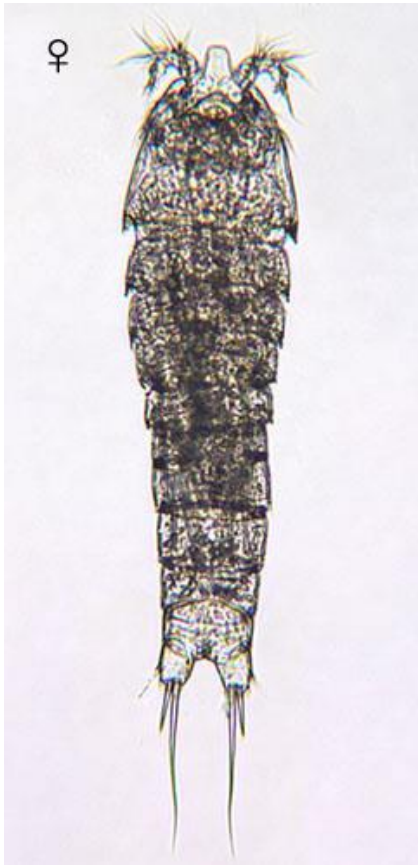# *Thermocyclops crassus* –

Credit: Joe Connolly, Cornell University

❑ Cyclopoid copepod, 0.7-1.1 mm

❑ Native to Eurasia

❑ First Great Lakes record 2014, in western basin Lake Erie; Now established in Lake Erie

❑ Found in 1 Project Discharge to WLS (2.4 orgs/m3)

Sturtevant, R., and P. Alsip, 2018

Heteropsyllus nunni–

- ❑ Harpacticoid copepod, 0.5 mm

- ❑ Euryhaline species found in estuaries along east coast of North America

- ❑ First Great Lakes record from Lake Michigan in 1996; Collected from Lake St. Clair in 2000 and Northern Lake Huron in 2007

- ❑ Found in 3 Project Uptakes (0.4-1.2 orgs/m3) and 3 Discharges (0.5-1.5 orgs/m3)

U.S. Geological Survey, 2018,

Paraleptastacus wilsoni–

GWRC, 2018

❏ Harpacticoid copepod, 0.45-0.48 mm

❏ Ours is the first record in the Great Lakes

❏ Native to Atlantic Coast of North America

❏ Found in 2 Project uptakes (0.8 – 1.8 orgs/m3)

Nitokra Hibernica –

U.S. Geological Survey

❑ Harpacticoid copepod, 0.5 – 0.75 mm
❑ Native to Eurasia where it has a broad distribution
❑ First Great Lakes record in 1972 (mouth of Niagara River)
❑ Established in Lake Ontario, Lake Erie, Lake Huron, and Lake Michigan
❑ Found in 3 Project Uptakes (0.9-22.9 orgs/m3) and 8 Project Discharges (1.5 – 3 .0 orgs/m3)

Kipp, R.M., A.J. Benson, J. Larson, T.H. Makled, and A. Fusaro, 2018

Schizopera borutzkyi –

- ❑ Harpacticoid copepod, 0.5-0.6 mm
- ❑ Native to Black Sea basin
- ❑ First Great Lakes record: 1988 Lake Michigan
- ❑ Now established in Lakes Michigan and Erie
- ❑ Found in 4 Project Uptakes (2-29 orgs/m3) and 3 Project Discharges (0.6-2 orgs/m3)

Kipp, R.M., J. Larson, T.H. Makled, and A. Fusaro, 2018

Discussion and Conclusions

❑ There were numerous detections of Project-relevant NIS in laker uptakes and discharges, despite limited study duration, # of voyages and sample volumes;

❑ *Hemimysis* and NIS Cyclopoid copepod (*T. crassus*) likely new to Lake Superior at time of study; provenance of four NIS harpacticoid copepods spp. less certain;

❑ Next research steps should:
  ➢ Identify and validate practicable and effective BWMS options for lakers which selectively or categorically reduce transfers of live NIS to Lake Superior
  ➢ Monitor harbors for target NIS to determine potential source locations, guide prevention attention, and evaluate effectiveness of management regimes
  ➢ Help elucidate any "Risk-Release Relationship" which could be predicted across species or for a particular organism

Contributors:

Dr Mary Balcer contributed to this PPT.

Link to Report:

https://www.uwsuper.edu/lsri/publications/upload/LSRI-GWRC-TR-GLSBM-1_FINAL-FOR-RELEASE_31May2018_2_ForSignature.pdf

Questions?
Thank you!