Understanding hydrodynamic characteristics in the Brandon Road Lock and approach channel for application of Asian Carp Controls

Frank L. Engel, Ph. D.
Geographer
U.S. Geological Survey
Illinois-Iowa Water Science Center
fengel@usgs.gov

Great Lakes Panel on Aquatic Nuisance Species

NOAA Great Lakes Environmental Research Laboratory
Ann Arbor, Michigan
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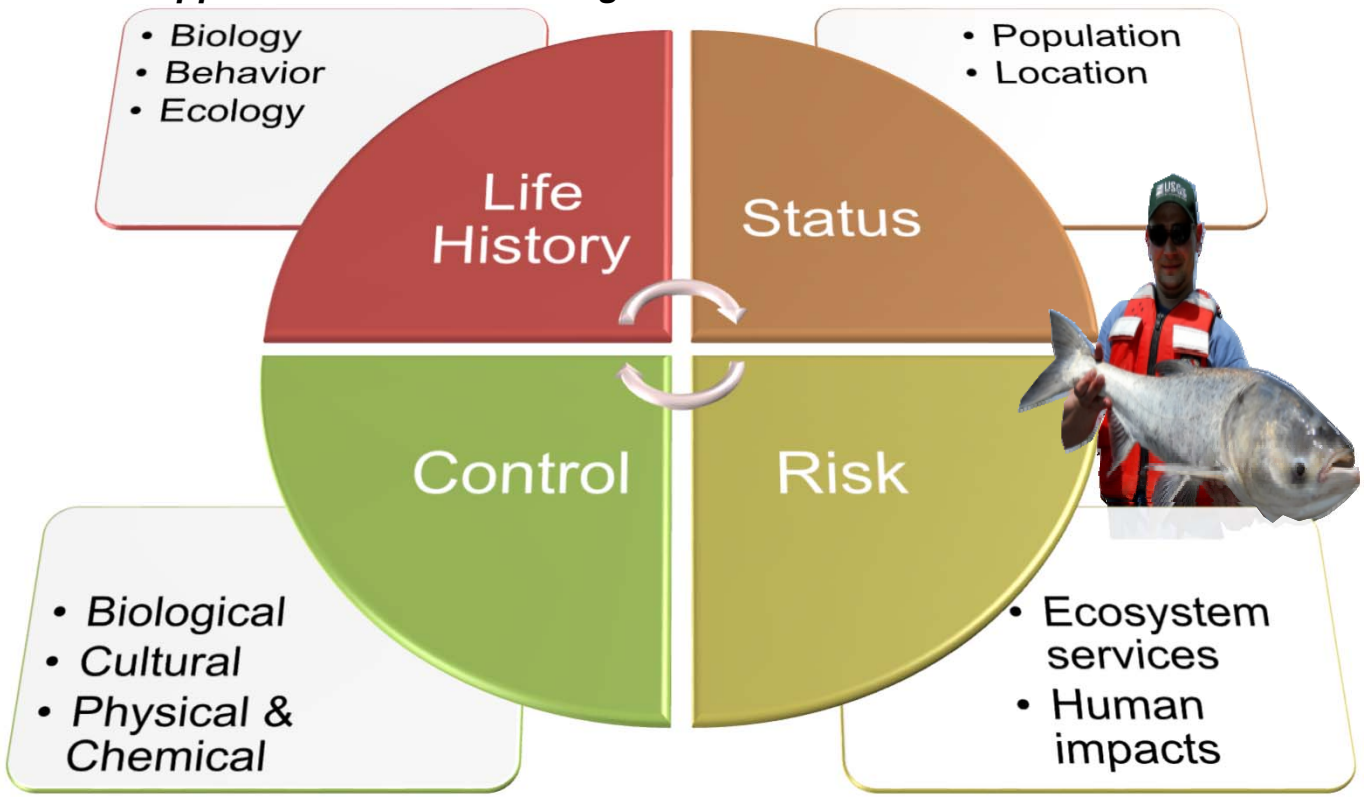
U.S. Department of the Interior
U.S. Geological Survey

Integrated Pest Management Framework

Science Support for Decision Making Process



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Our data & analyses help define a baseline of channel characteristics & behavior.

Purpose of Work

Science Support for Decision Making Process

New control technologies requires holistic understanding of a *complex system*

USGS collects data to aid in decision making process

Data Collection & Analysis Highlights

- Continuous gaging (velocity and water quality)
- Field measurements of hydraulics in and around the lock
- Dye tracing experiments to quantify mixing characteristics
- Seasonal targeted water quality synoptic surveys
- Ambient sound recording

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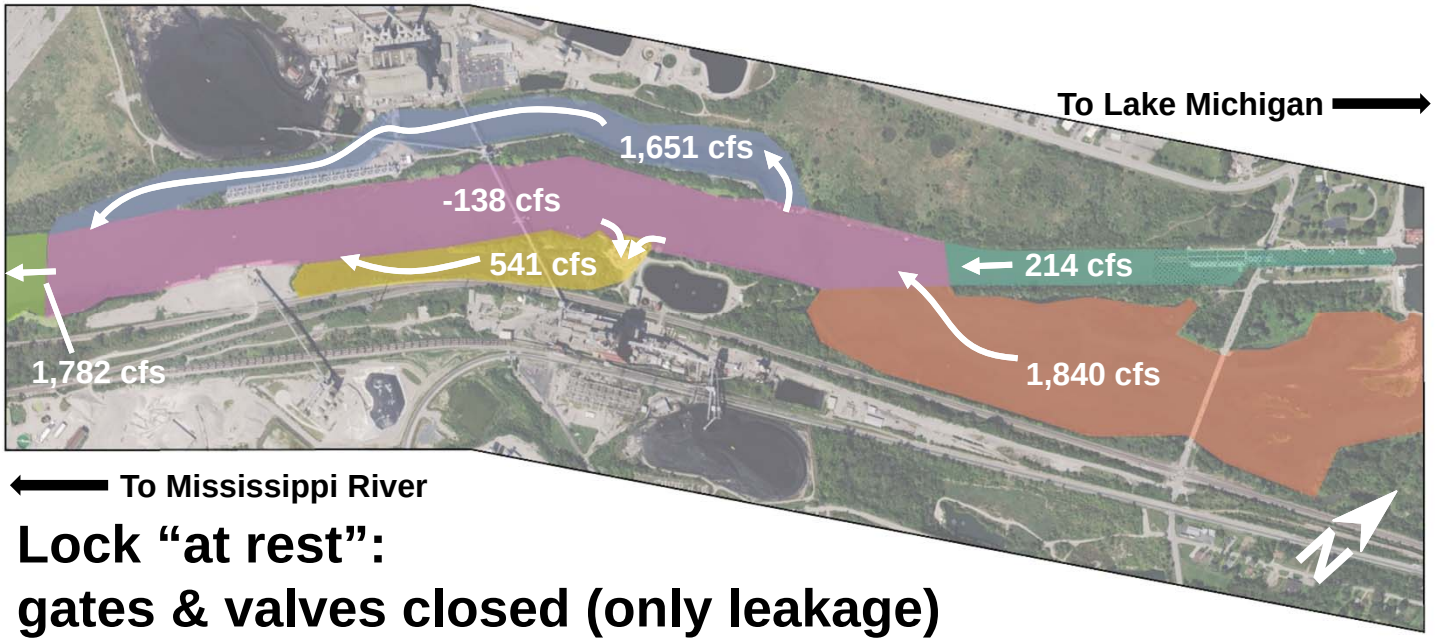
Flow distribution In the Downstream Reach

Life is really simple, but we insist on making it complicated. *–Confucius (misattributed)*



Lock “at rest”:
gates & valves closed (only leakage)

- Power plant intakes capture all available flow
- Pink reach is essentially a dead zone affected by many factors
- Implications for hydraulics at end of approach (and dye fate)

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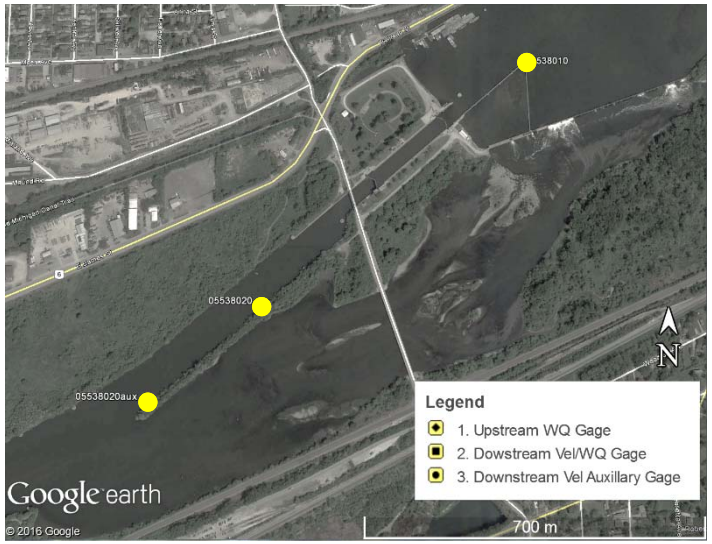
Continuous Gaging

Keeping tabs

Water Quality Upstream and Downstream



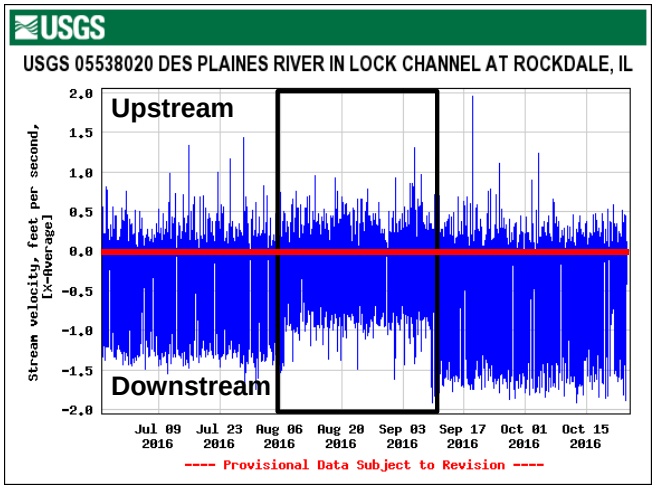
Velocity and Stage Downstream

Tracking water chemistry

- Specific conductance, DO, pH, Chlorophyll-a, CDOM, Turbidity, & dissolved CO_2

Understanding flow in the approach channel

- 2D velocities at 9 locations, mid-depth across the approach channel
- Downstream pool stage



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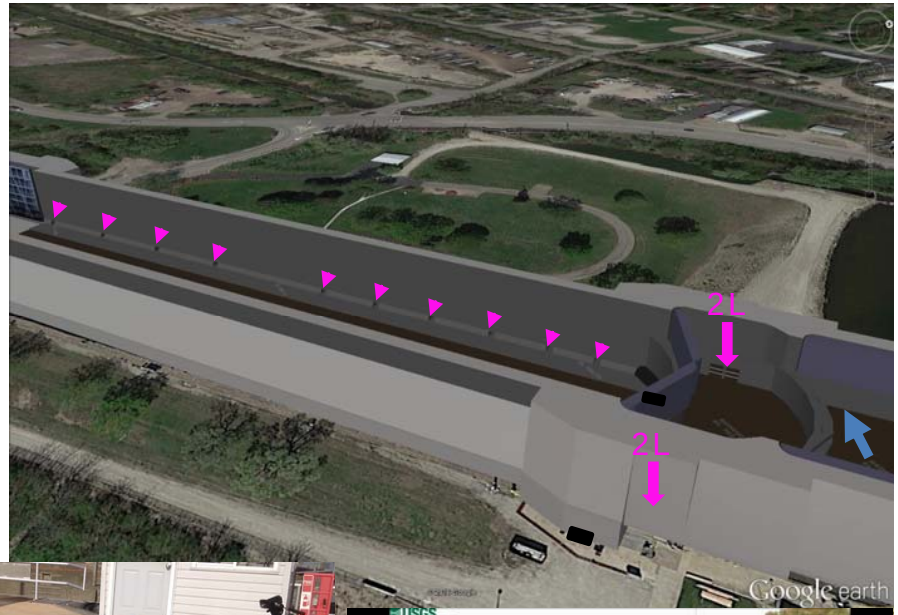
Flushing the Lock of Dissolved Constituents

Mixing in the lock chamber

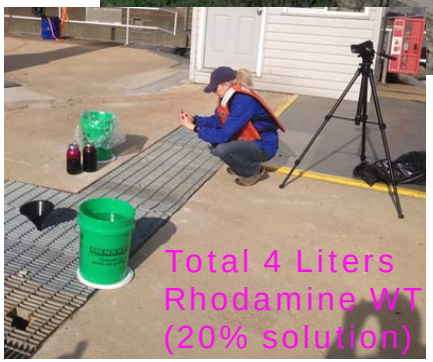
Research Questions:

1. How well can constituents be distributed through the lock chamber?
2. What does it take to flush the lock of constituents?



October 19, 2015

- Dye injected into lock as it filled



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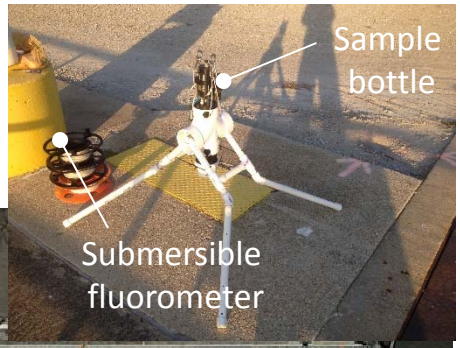

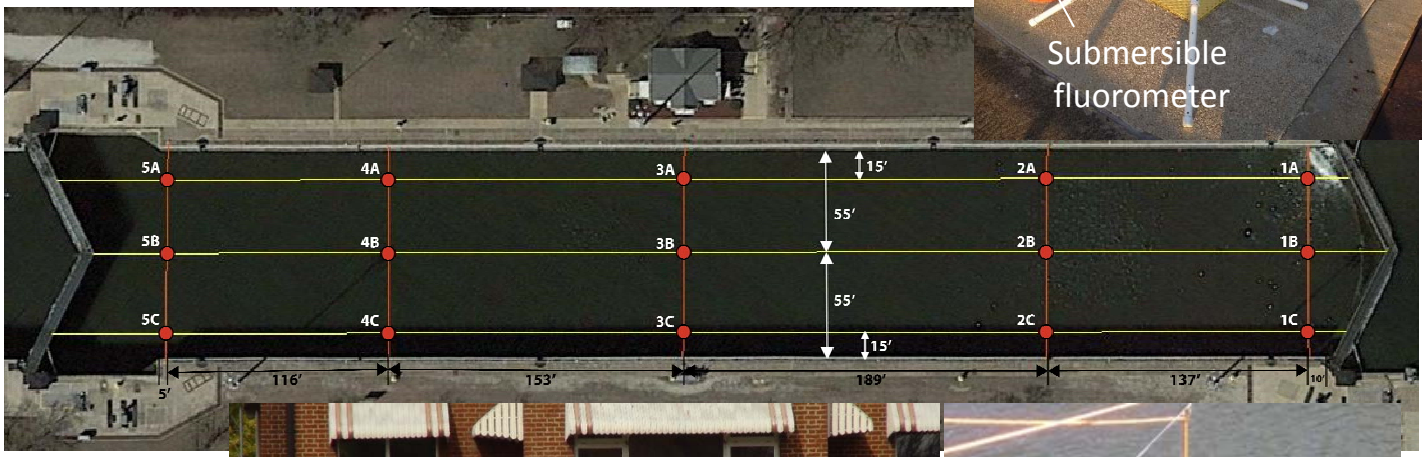

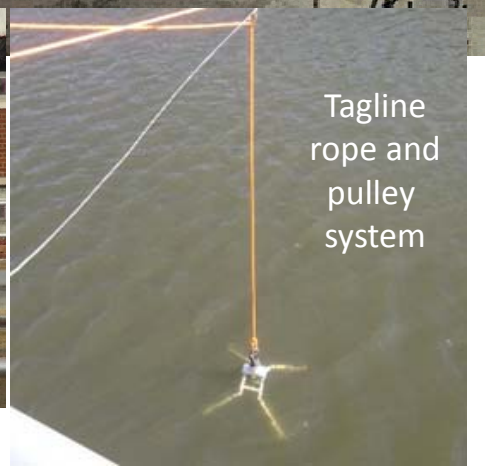

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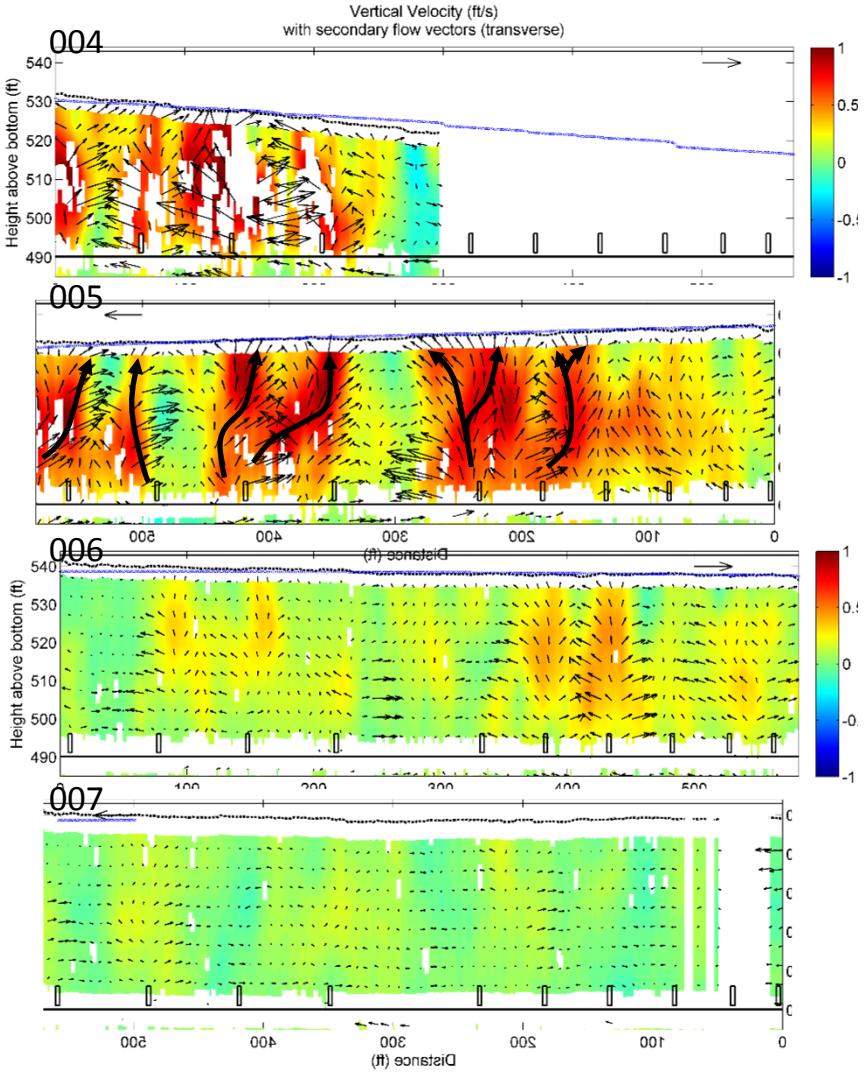
Hydrodynamics of Filling the Lock

Upwelling from ports leads to:

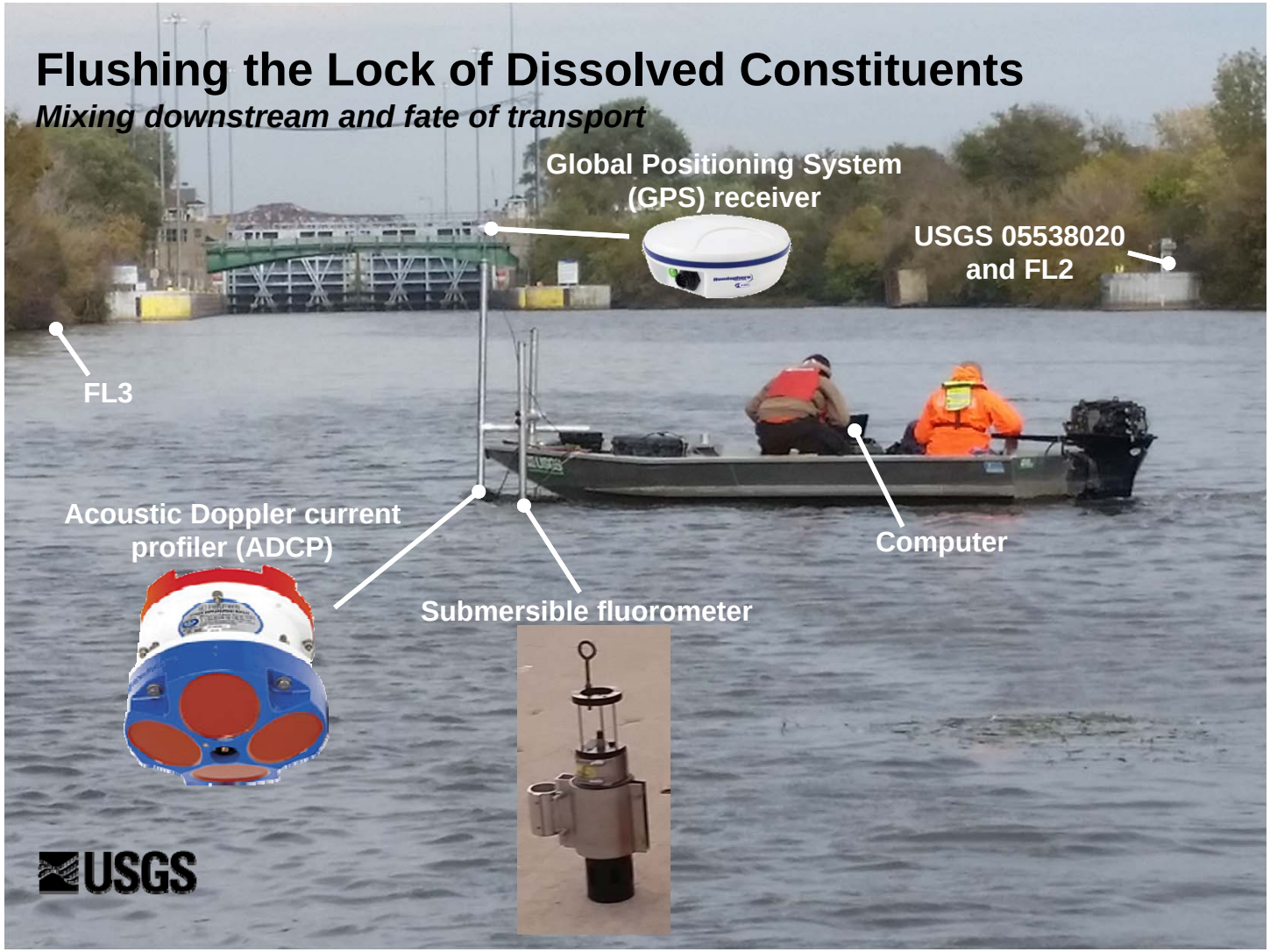
- Very good mixing process
- Nature of hydraulic "traps" surface particles
- Transient (pulsating) hydraulics

Increasing Time



Flushing the Lock of Dissolved Constituents

Mixing downstream and fate of transport



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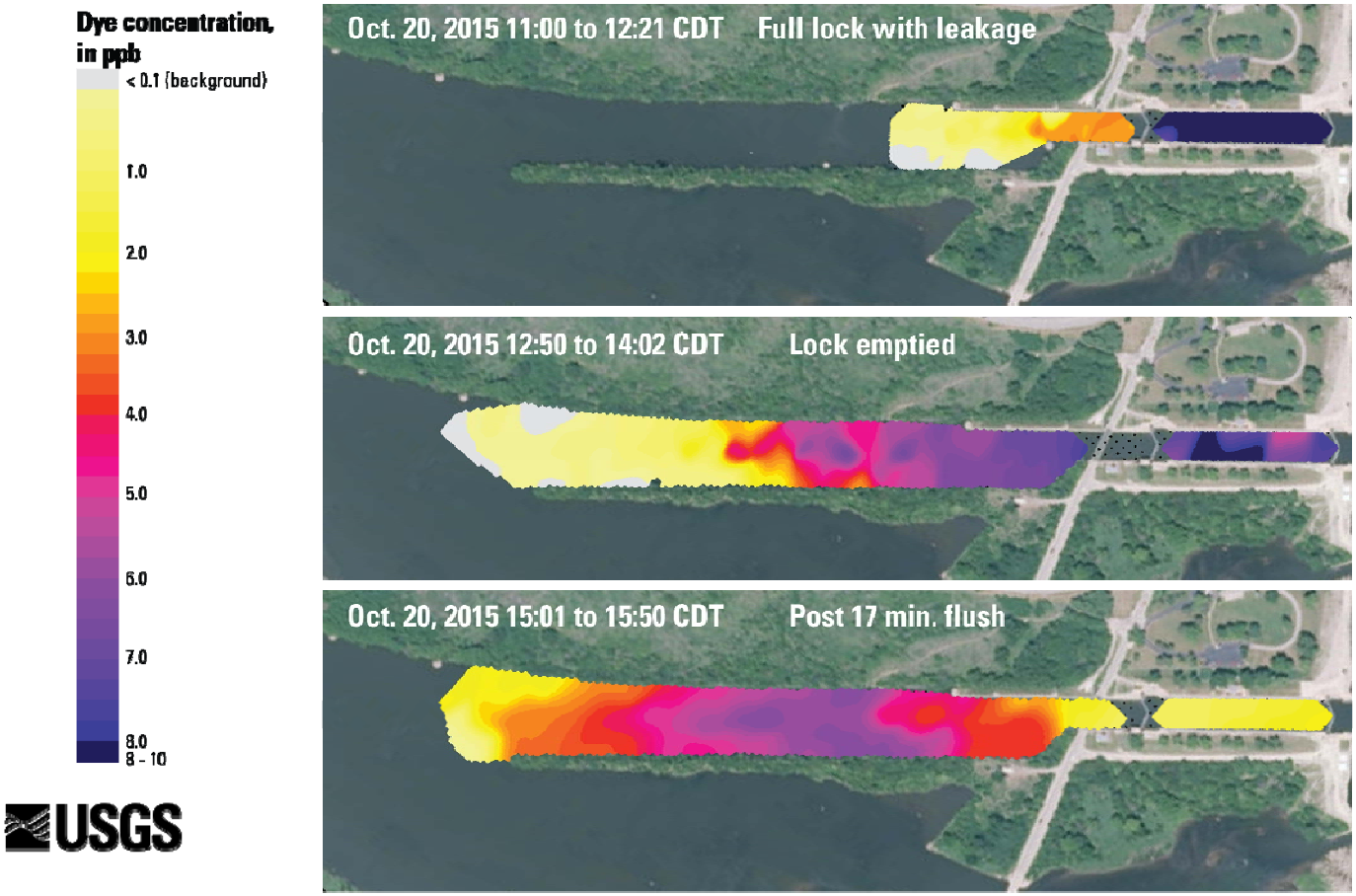

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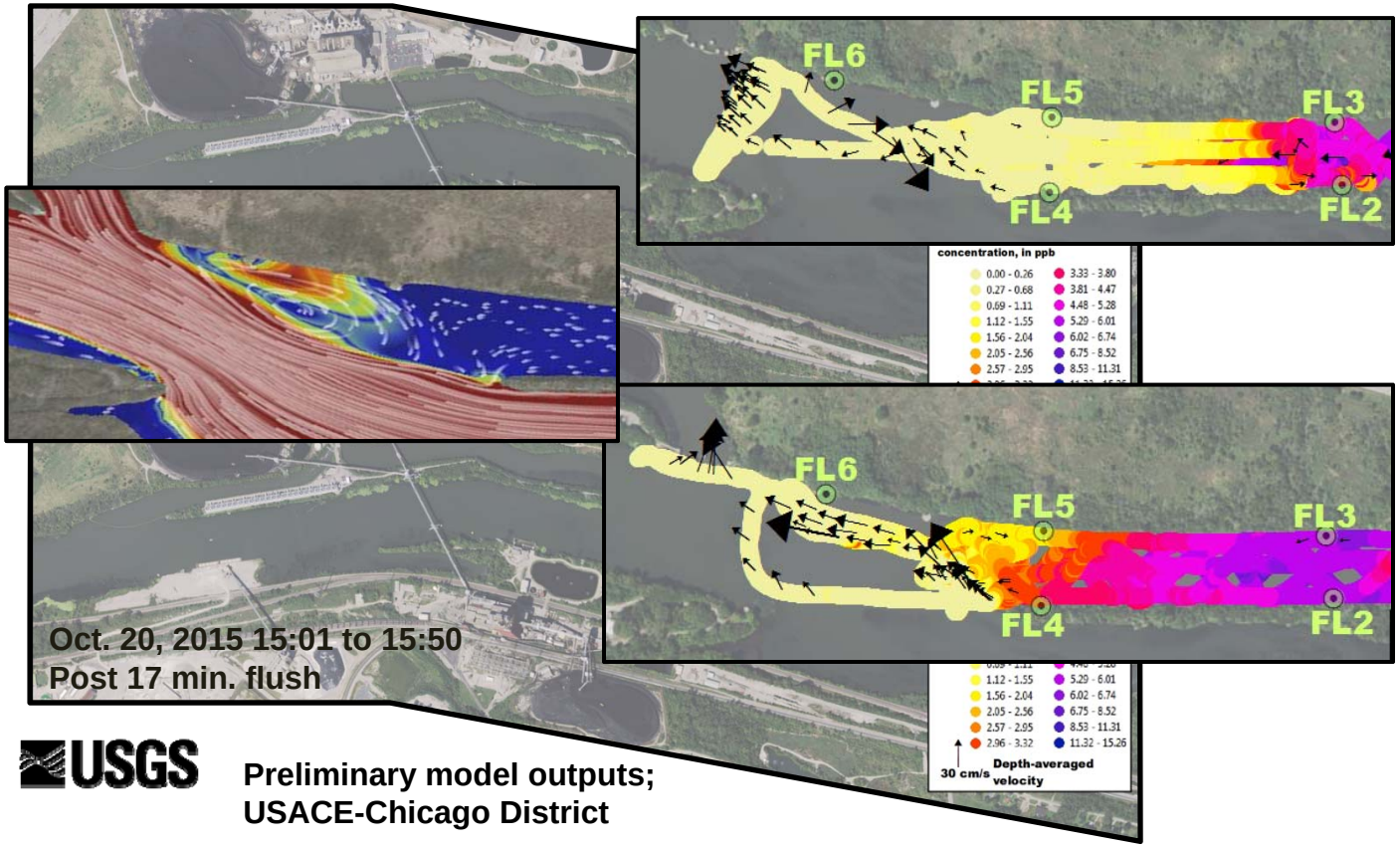

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Preliminary model outputs;
USACE-Chicago District

Synoptic Water Quality Monitoring

Seasonal sampling during important hydrologic events

- Continuous Data Sensors (gages)
- Transect Data across stream
- Longitudinal Transect Data
- Site in Lock

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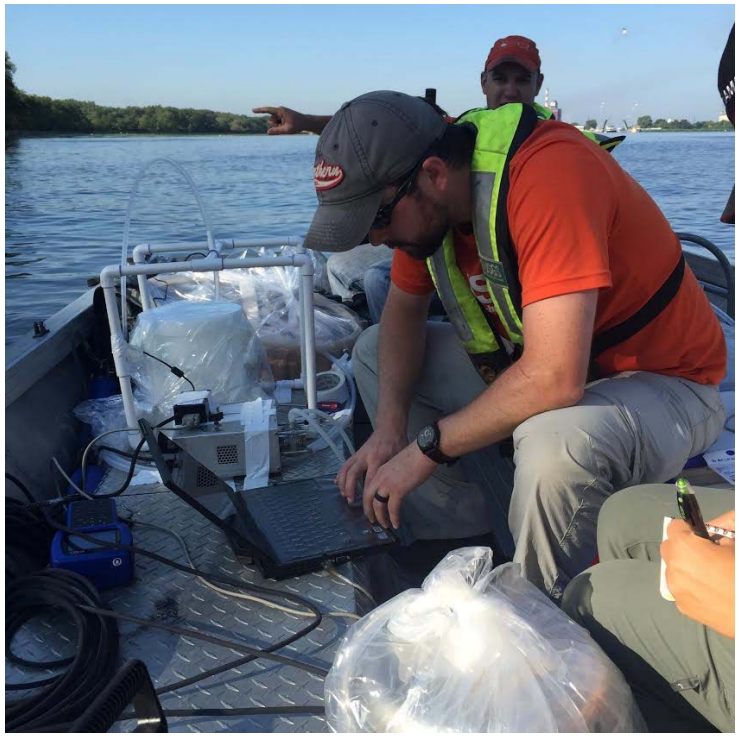
Synoptic Water Quality Monitoring

What are we tracking?

- Vertical sampling points along transect
- Insitu water chem.(3 pts / Vert):
  - pH, SpC, DO, pH, Turbidity, Chl-a, CO_2
- Grab Samples:
  - Chlorophyll-a
- Dissolved Gas:
  - 2 pts: below surface & 2/3 Depth

- Composite Samples (over vertical)
  - Biological Oxygen Demand (BOD5)
  - Alkalinity
  - Major Ions
  - Nutrients
  - Dissolved Organic Carbon (DOC)
  - Dissolved Inorganic Carbon (DIC)



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Continuing Control Technology Testing

Interagency Cooperation→Smarter Science

- Carbon Dioxide
  - Reaeration study
- Hot water / Chlorine
- Sound
- Barge Entrainment / Mitigation

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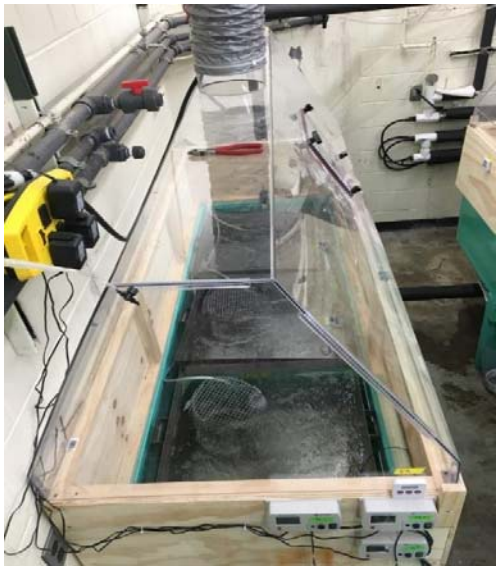
Control: Hot Water / Chlorine



Hot water (>35° C), Ozone, Chlorine

- Individually and in combination
- 10 to 60 minute exposure
- Fish, invertebrates, plants

Hot water / ozone tested:

- Bighead Carp, Silver Carp, and Grass Carp
- Zebra mussels
- Scuds

Next

- Hot water / chlorine on fish and invertebrates;
- Hot water, ozone, and chlorine on aquatic plants

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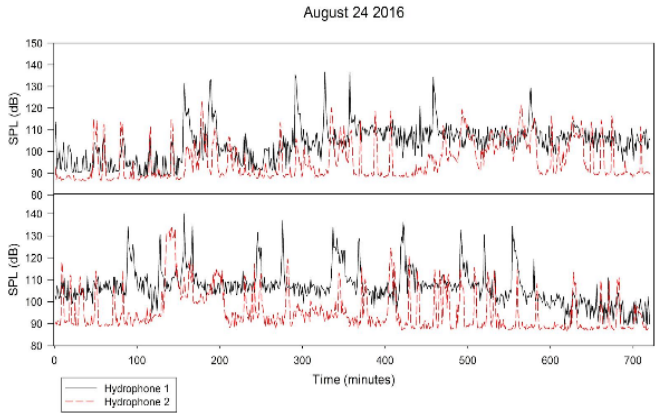
Control: Sound

Brandon Road Activities

- Ambient sound recording complete
- Developing sound model (ERDC)
- Fish data to use in comparing to data collected during the speaker deployment
- Goal is to test ***engineering feasibility*** at Brandon Road



Other Related Activities

- Hearing range (lab)
- Copperas Creek experiment

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Publications and Available Data

*****reviewed, awaiting approval
******in review

Brandon Road Related Pubs

1. In-lock dye concentration profiles *doi:* 10.5066/F77W69B7
2. Fixed fluorometer dye concentration time series doi: 10.5066/F74747Z7
3. Moving boat fluorometer data *doi:* 10.5066/F70G3H8C
4. In-lock water surface elevation data*
5. Moving boat velocity data *doi:* 10.5066/F76W986V
6. Spillway bathymetry*
7. Discharge time series data *doi:* 10.5066/F7S180NN

Two Upcoming Scientific Investigations Reports (SIR) on velocity/mixing and water quality/CO_2 findings

Other Control Pubs

- Responses of invasive silver and bighead carp to a carbon dioxide barrier in outdoor ponds *doi:* 10.1139/cjfas-20
- Effects of carbon dioxide on juveniles of the freshwater mussel *doi:* 10.1002/etc.356715-04\72

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Questions?

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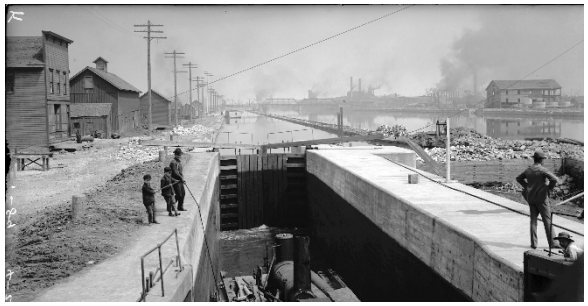

I & M Canal old Lock 5 (1899?)
Joliet, IL
MWRD, Illinois State Archives

Building upper miter gates of Brandon Lock 1935 (2014-01-I&MCanal-0063)

I & M Canal new Lock 5
Retrieved from the Library of Congress

Building lock house, Brandon Lock 1935 (2014-01-I&MCanal-0067)