DOER Environmental Resource Management Focus Area

Dr. Doug Clarke
Douglas.G.Clarke@usace.army.mil

Dr. Todd Swannack
Todd.Swannack@usace.army.mil

ERDC
Engineer Research and Development Center

Structure

- Focus Area consists of two “work unit” topic areas
  - T&E Species protection
  - Environmental windows and other management practices related to resource protection

Ongoing Research Projects

- **T&E Species protection**
  - **Improving management of coastal and inland avian habitat during navigation project construction, operation, and maintenance (Fischer)**
  - **Develop improved technologies for SAV mapping (Sabol/Shafer)**
  - **Evaluate new sensors for T&ES detection in the vicinity of dredging operations (Sabol)**
  - **Develop more effective take mitigation measures for sea turtles (Dickerson)**
  - **Improve methods for determining risk of sturgeon entrainment (Clarke/Reine/Hoover)**

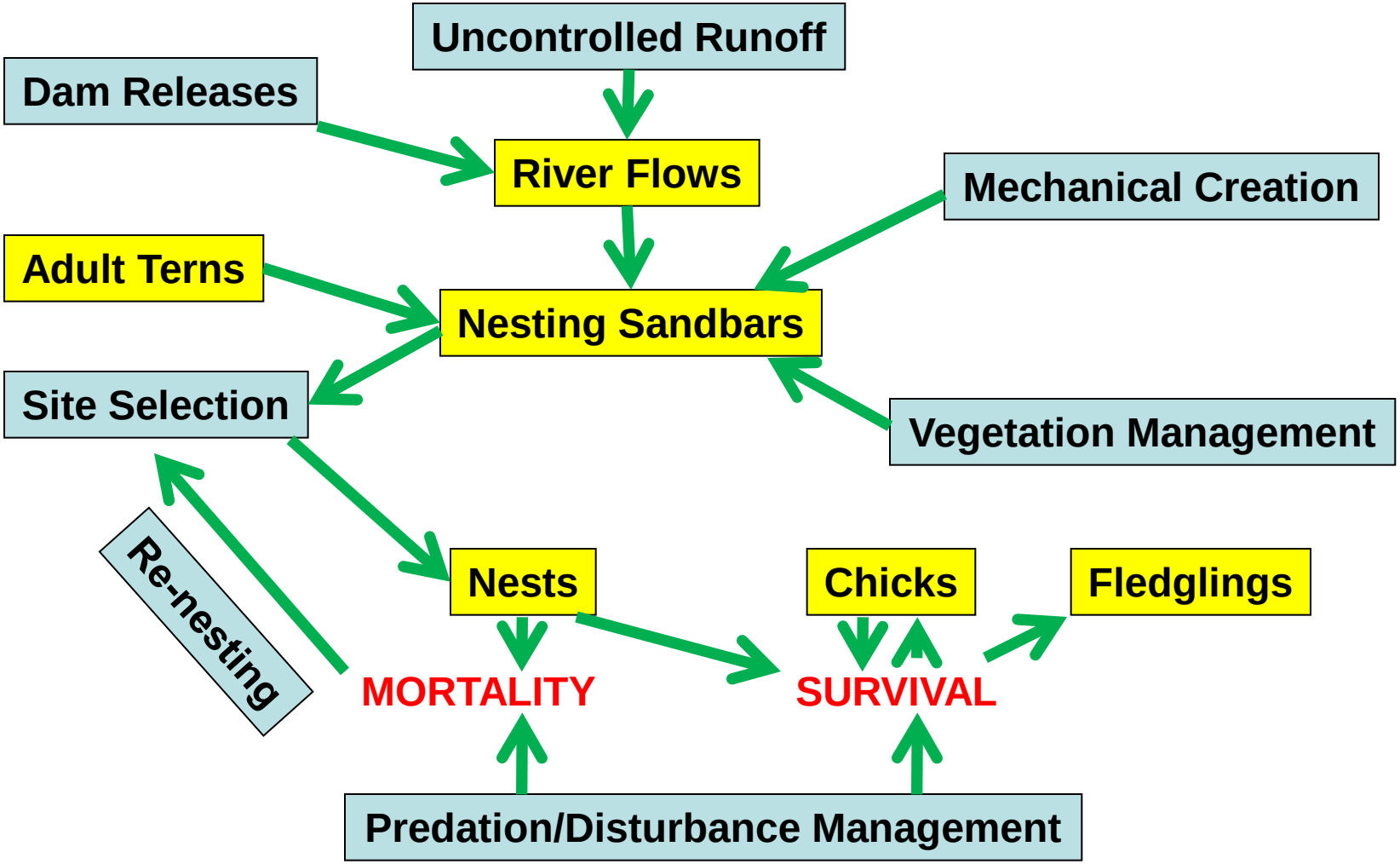
An Individual-Based Simulation Model to Evaluate Management Alternatives for Endangered Interior Least Tern

Casey Lott, Stephen Railsback, Douglas Miller, and Richard Fischer

- **PROBLEM: ESA concerns affect flood control, navigation flows, hydrpower, water supply, dike and revetment construction, ecosystem restoration, recreation. Some but not all tern population size targets for recovery have been exceeded. Tools for chronic threat management needed.**
- **OBJECTIVES: Apply and assess the validity of an IBPM for the Missouri River ILT population to determine factors that limit population. Compare the performance of alternative management strategies for increasing reproductive success. Identify gaps in monitoring data. Improve decisions about river management (e.g., dam releases) and direct threats (e.g., predator controls).**
- **BENEFITS: Provide a robust analytical approach. Address chronic threats using adaptive management strategies. Make progress toward delisting.**

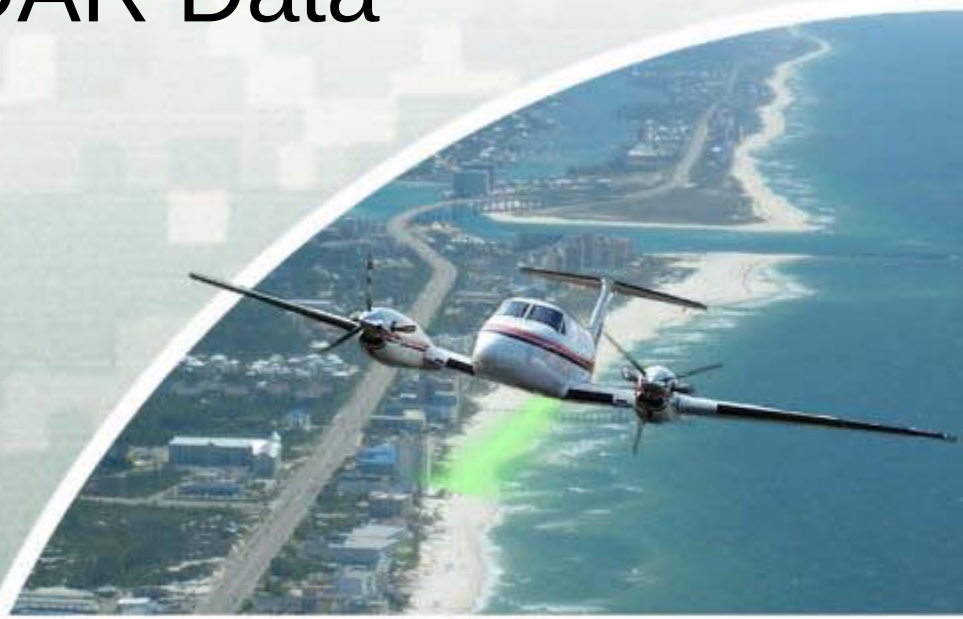
Dredged Material Assessment and Management Seminar, May 2011, Jacksonvlle, FL

Individual-based Model for ILT



Developing Techniques for SAV Species Discrimination Using Fused Airborne Hyperspectral and LIDAR Data

BRUCE SABOL and
DEBORAH SHAFER



US Army Corps of Engineers
BUILDING STRONG®

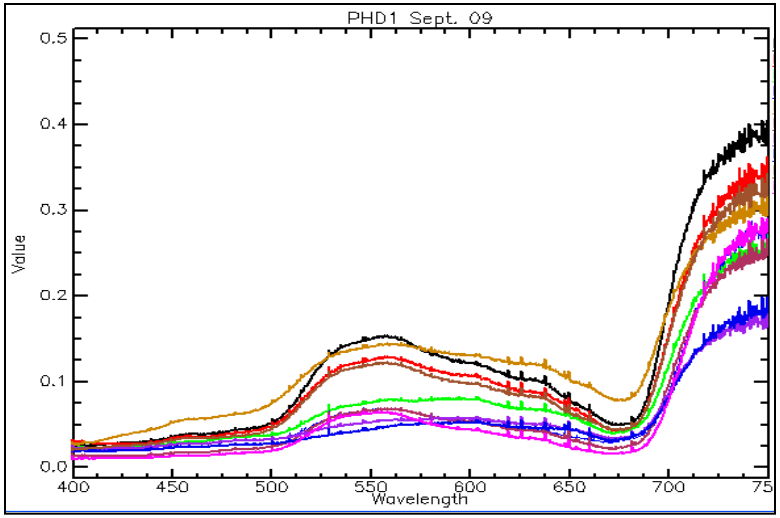
Joint Airborne Lidar Bathymetry
Technical Center of eXpertise

Use of Airborne Lidar and Hyperspectral Data to Detect and Discriminate SAV Species at Corps Dredging Sites

Purpose: Evaluate and demonstrate the use of fused airborne hyperspectral and bathymetric LIDAR data to detect and discriminate species of estuarine SAV and macroalgae in two representative dredged small-craft harbors

Background: Dredging impacts to SAV vary by species; CWA lists SAV as a Special Aquatic Site; Mapping species is important for:

- **Planning dredging operations**
- **Mitigating ecological damage**
- **Monitoring SAV**



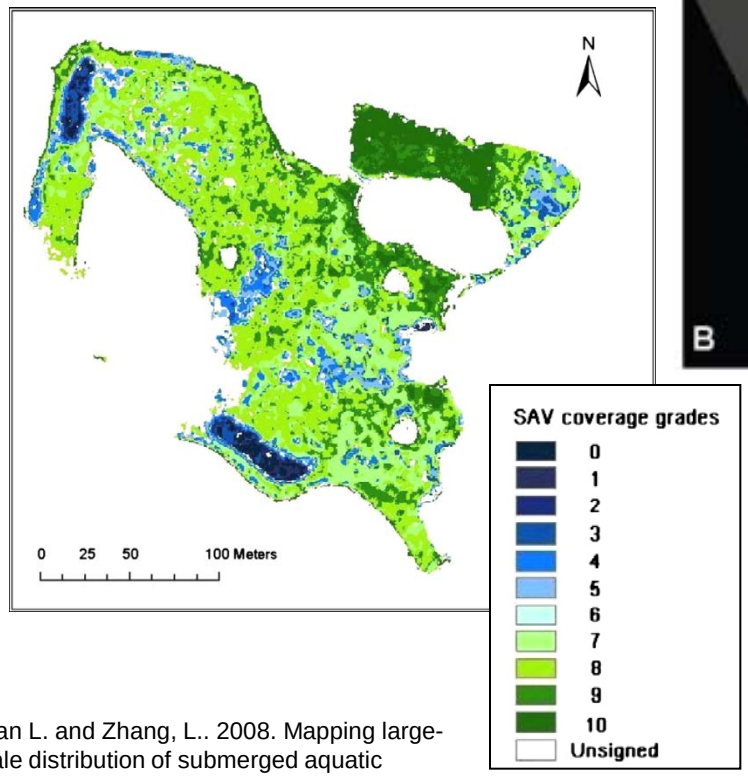
Submersed Eelgrass spectra, Plymouth Harbor, MA

Review of Mapping Methods

Distribution

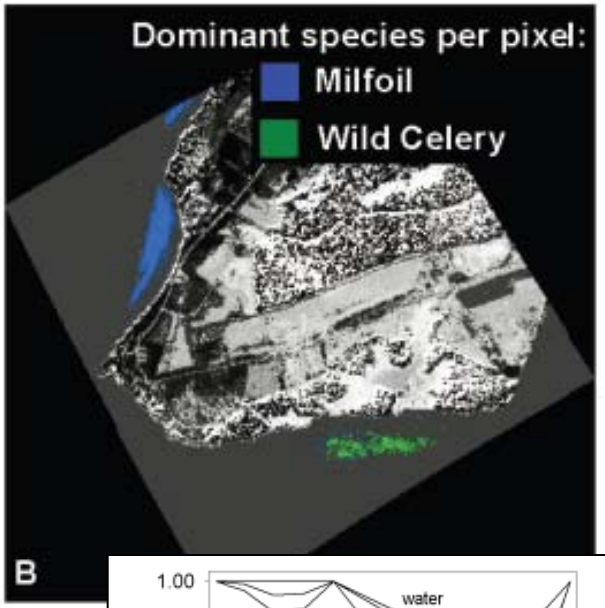
Massachusetts Dept. of Environmental Protection, 1995, 2001 eelgrass surveys and online maps

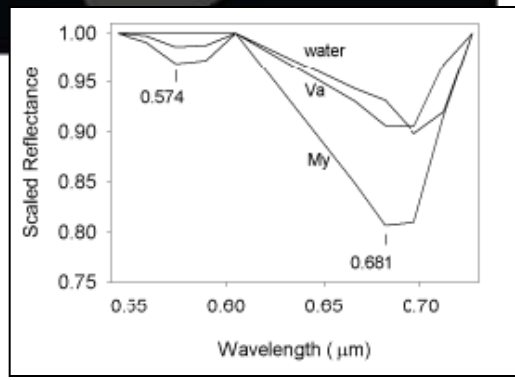
Density



Yuan L. and Zhang, L.. 2008. Mapping large-scale distribution of submerged aquatic vegetation coverage using remote sensing. *Ecological Informatics.* 3:245-251.

Species





Williams, D.J. et al. 2003. Preliminary investigation of submerged aquatic vegetation mapping using hyperspectral remote sensing. *Environmental Monitoring and Assessment.* 81(1):383–392.

Study Sites

Plymouth Harbor, MA

Buttermilk Bay, MA

Preliminary CHARTS Data

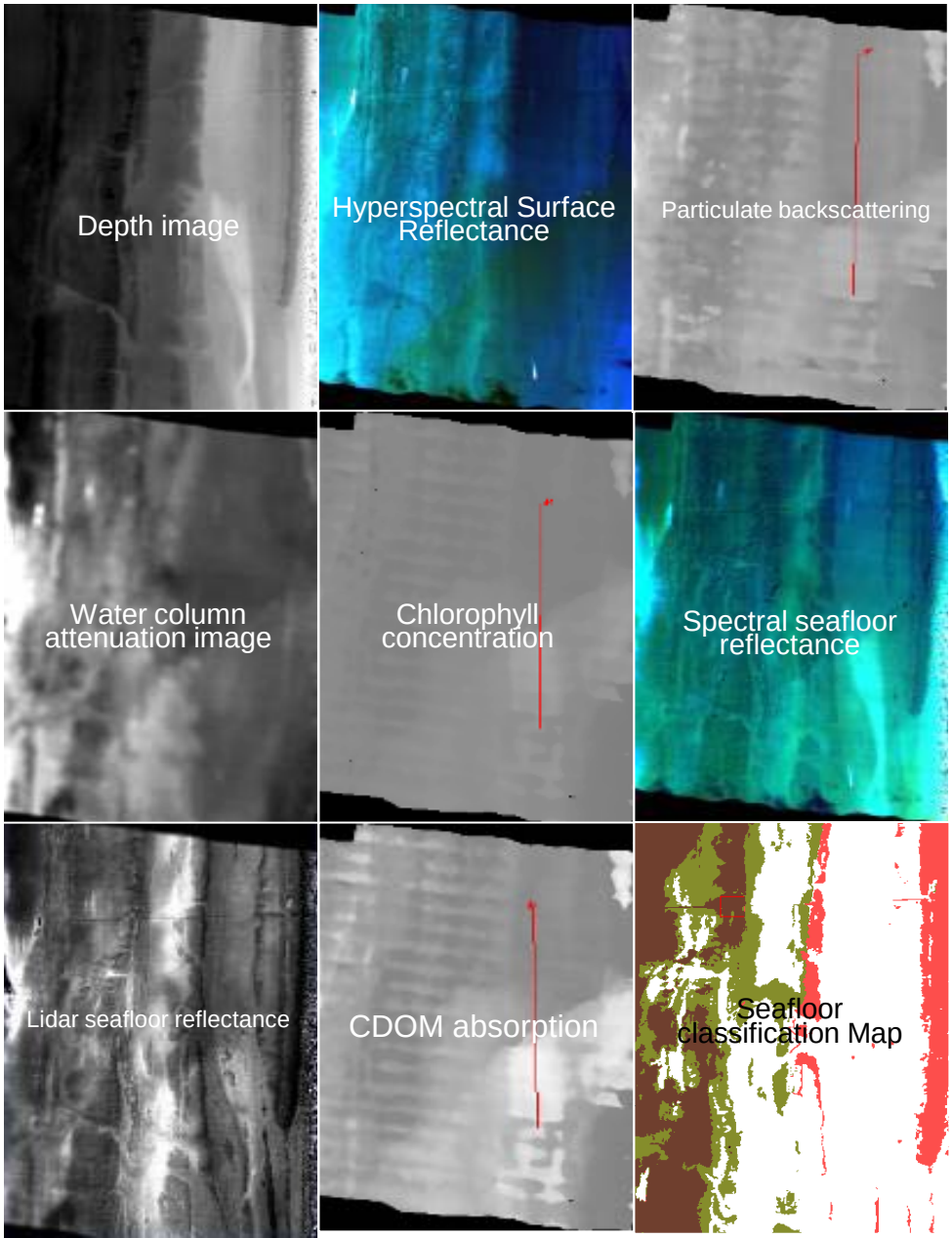
- **Google Earth KMZs: preliminary CHARTS data and ground truth site locations also available online soon**

- **LIDAR elevation data**
- **Survey polygons**
- **Flight lines**
- **Ground truth sites**

Buttermilk Bay, KMZ

Image Processing

- **Coastal Zone Mapping and Imaging Lidar (CZMIL) Data Processing System**
  - **DPS with *Spectral Optimization* to characterize seafloor and water column constituents**
  - * **Invert the hyperspectral image with bathymetric lidar depth as constraint to obtain bottom, reflectance, IOPs, etc.**
  - **Classification of seafloor reflectance to solve for species**



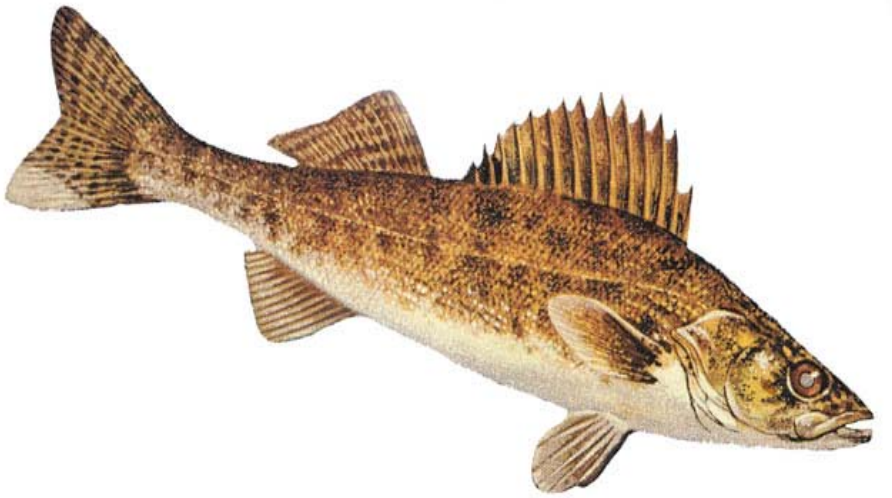
Future Steps

- **Refinement of spectral optimization based on in-situ input (chlorophyll, dissolved organic matter, and backscattering)**
- **Run multiple classification iterations using hierarchical approach to identify SAV presence>Eelgrass vs non-eelgrass>Eelgrass attributes>Macroalgae species>bottom type**
- **Accuracy assessment and comparisons to other techniques such as conventional aerial photography**

Ongoing Research Projects

- **Environmental windows**
  - **Develop risk-informed decision tools specifically for non-contaminant stressors (Suedel/Lutz)**
  - **Proactively assess risk of dredging-induced impacts caused by underwater noise (Reine/Clarke)**
  - **Apply advanced simulation modeling capabilities to environmental windows scenarios (Lackey)**
  - **Documentation of EFH attributes of coastal open-water BU projects (Reine/Clarke)**

Recent Dredging Studies Relevant to Environmental Windows



Doug Clarke, Kevin Reine, Burton Suedel and Charles Lutz

TOPICS

- **Characterization of spatial scales and temporal dynamics of bucket dredging plumes in Maumee Bay, Toledo, OH**

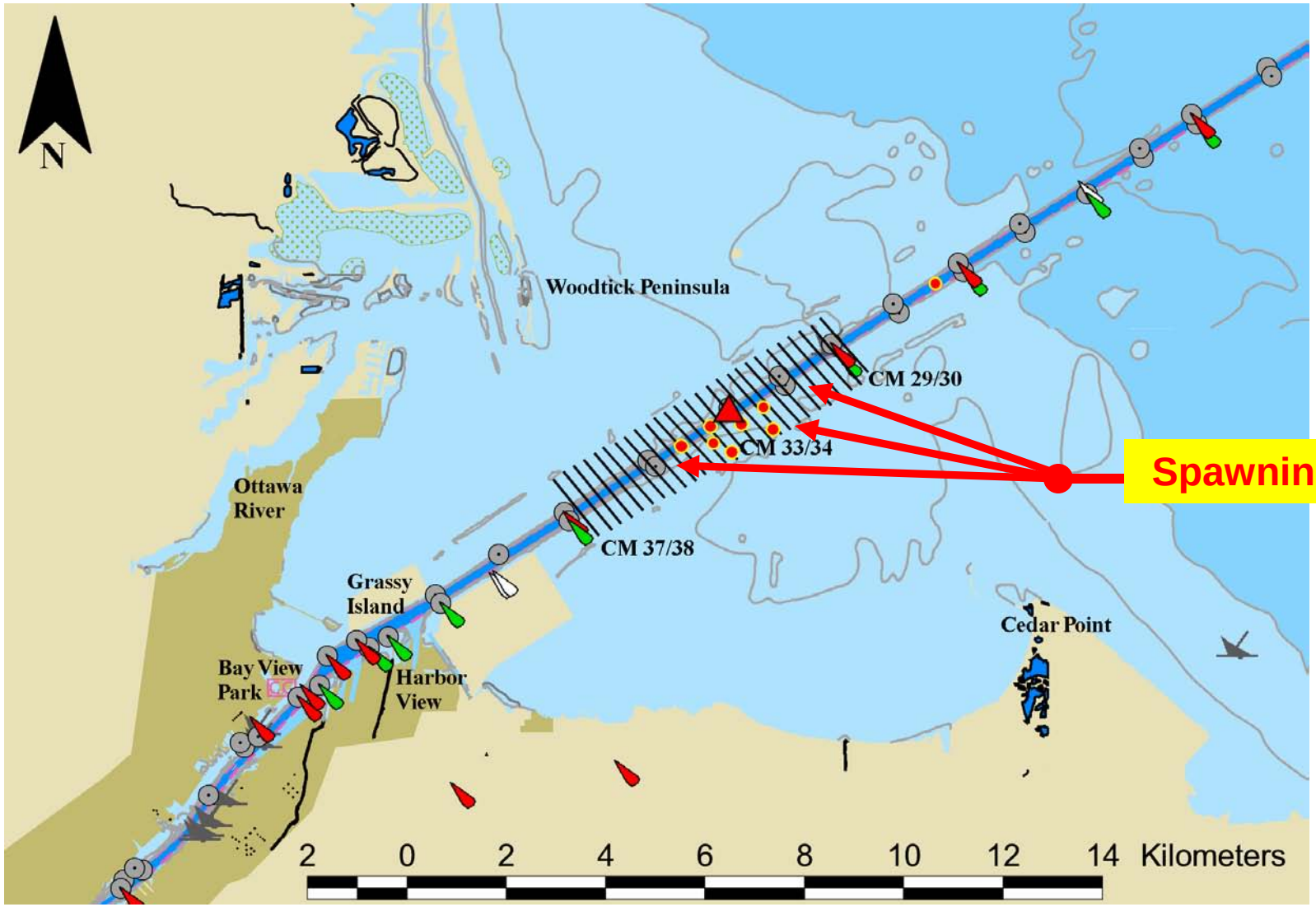
- **Determination of response thresholds of walleye eggs and fry to exposures to elevated suspended sediment concentrations**

- **Characterization of spatial scales and temporal dynamics of bucket dredging plumes in the Cuyahoga River, Cleveland,OH**

Maumee Bay Dredging Study

Characterize the spatial extent, concentration gradient structure, and temporal dynamics of suspended sediment plumes during bucket dredging operations.

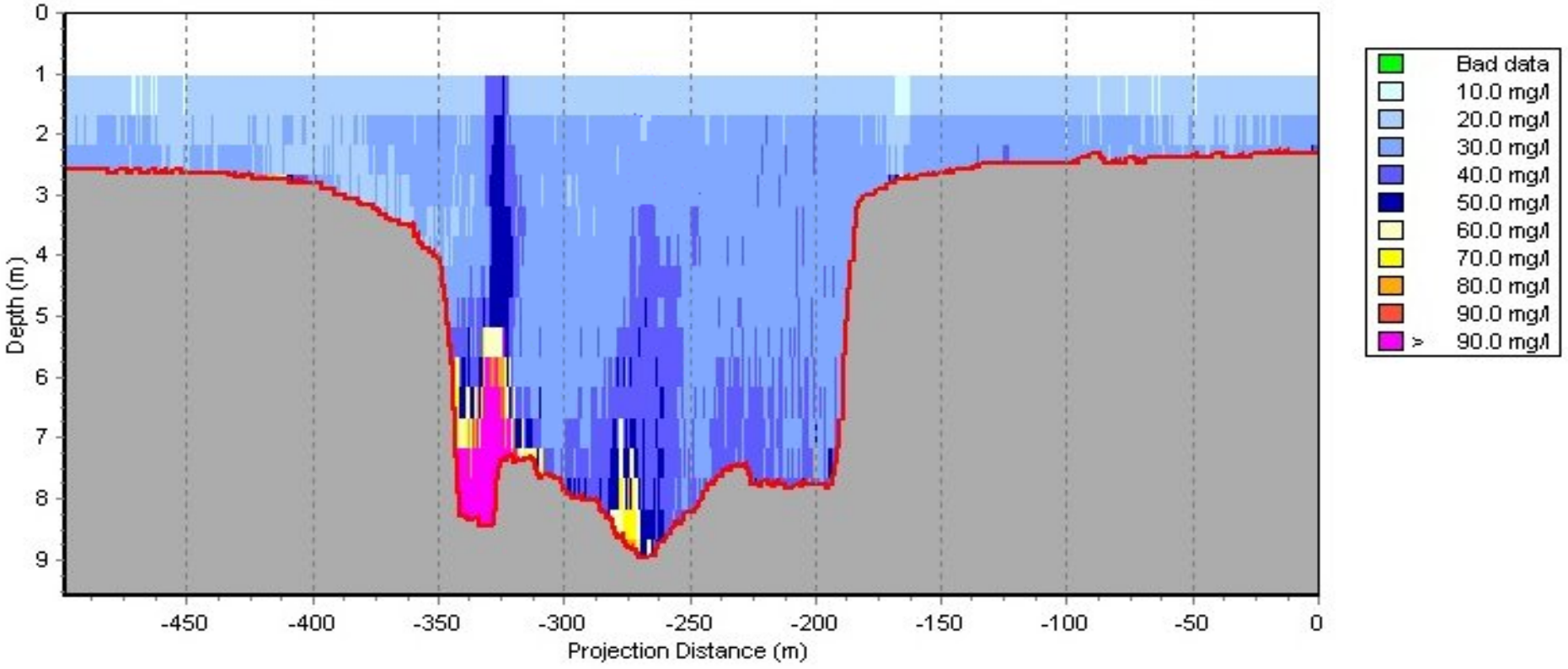
Maumee Bay Study Area



ADCP and Fisheries Hydroacoustics Transducers

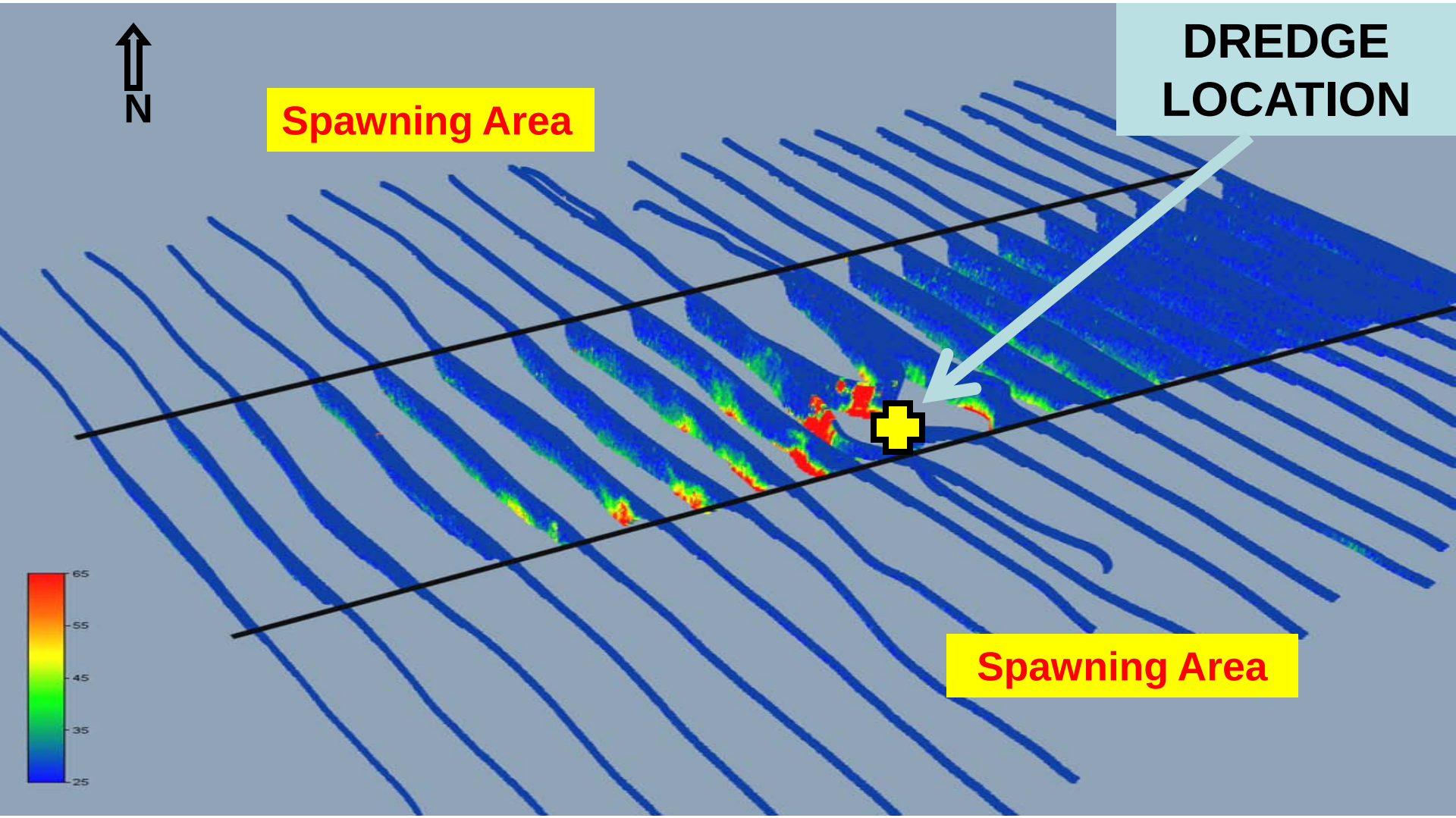
Near-Field ADCP Plume Transect

(27 Meters from Bucket Dredge)

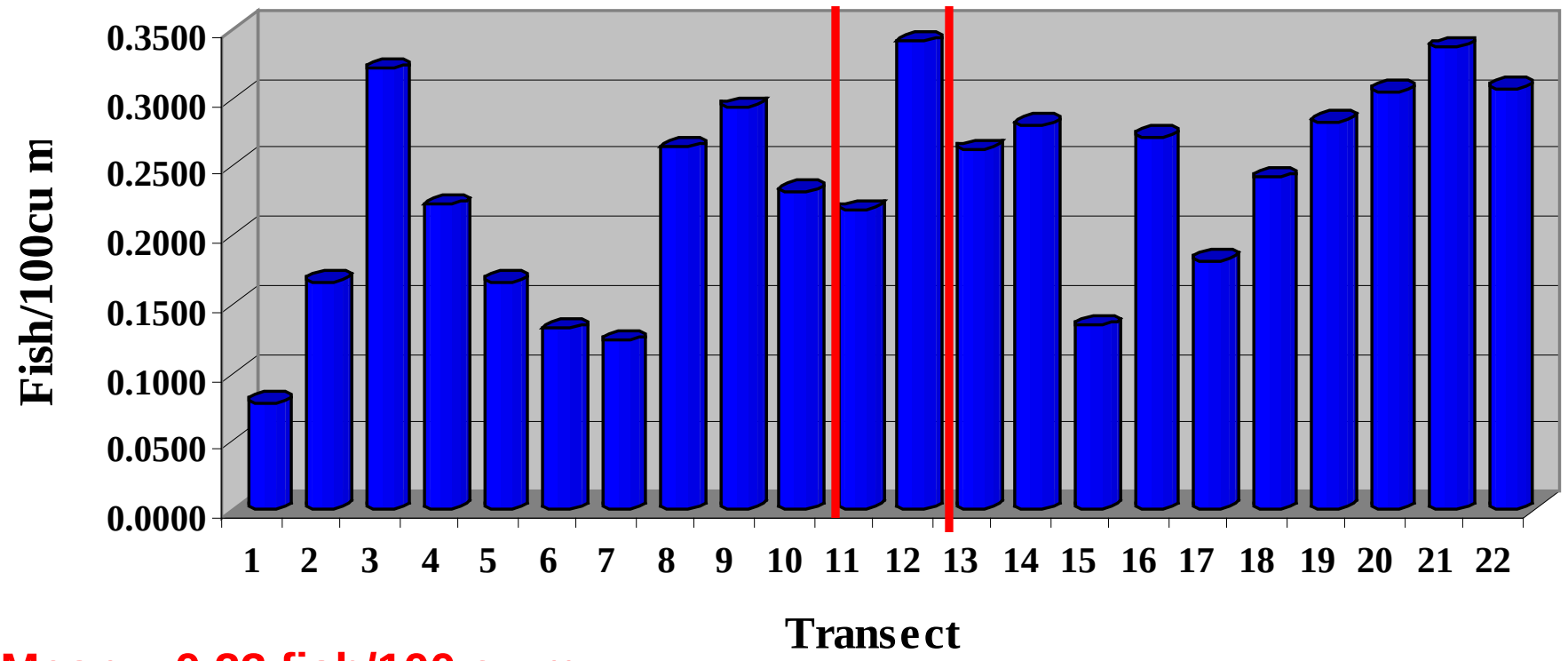


- **TSS decreased to < 300 mg/l at a distance of 24 m**
- **Highest TSS concs. found in lower 3-m of water column**
- **No detection of plume migration over shoals**
- **Very narrow surface plume 25 mg/l above background**

Spatial Distribution of Suspended Sediments

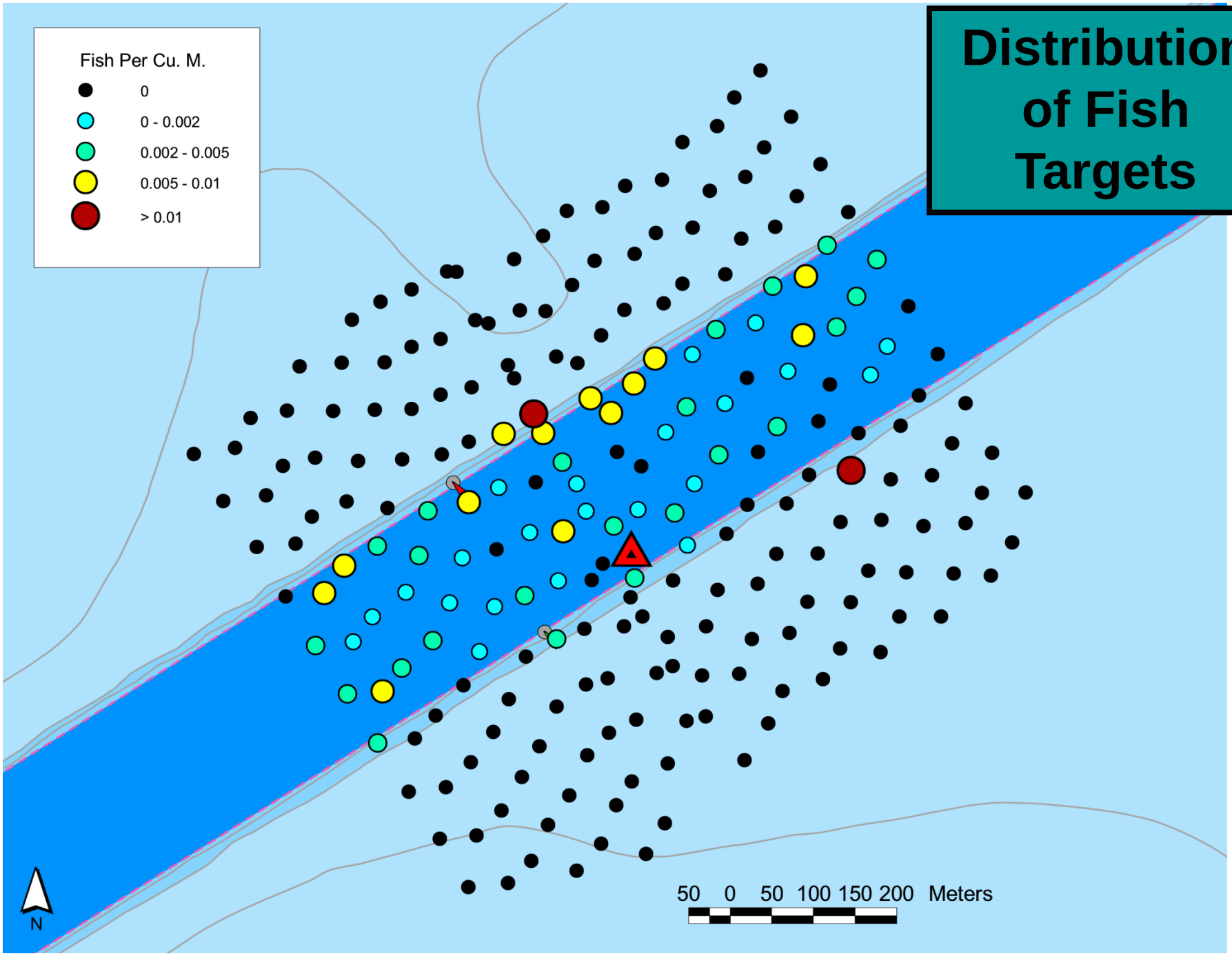


Maumee Bay Fish Target Density



Mean = 0.23 fish/100 cu m

Transects 1-10 occupied 2 to 261 m downriver from dredge
Transects 11 and 12 occupied port and starboard
Transects 13-22 occupied 2 to 254 m upriver from dredge


Distribution of Fish Targets
Fish Per Cu. M.
0
0 - 0.002
0.002 - 0.005
0.005 - 0.01
> 0.01
N
50 0 50 100 150 200 Meters

Tolerances of Walleye (*Sander vitreus*) Eggs and Fry to Suspended Sediment

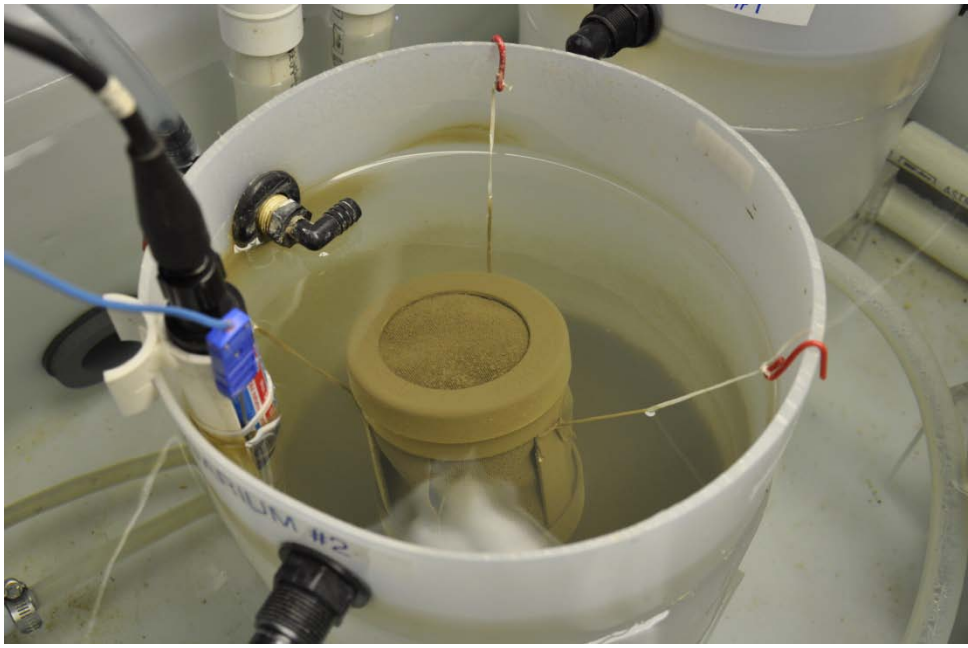
- **Historical experimental data on TSS effects not indicative of dredge plume conditions**
  - **Exposure concentrations <500 mg/L TSS**
  - **Exposure duration <3-4 days**
- **Life stage relevancy issues**
- **Walleye data lacking**

Methods

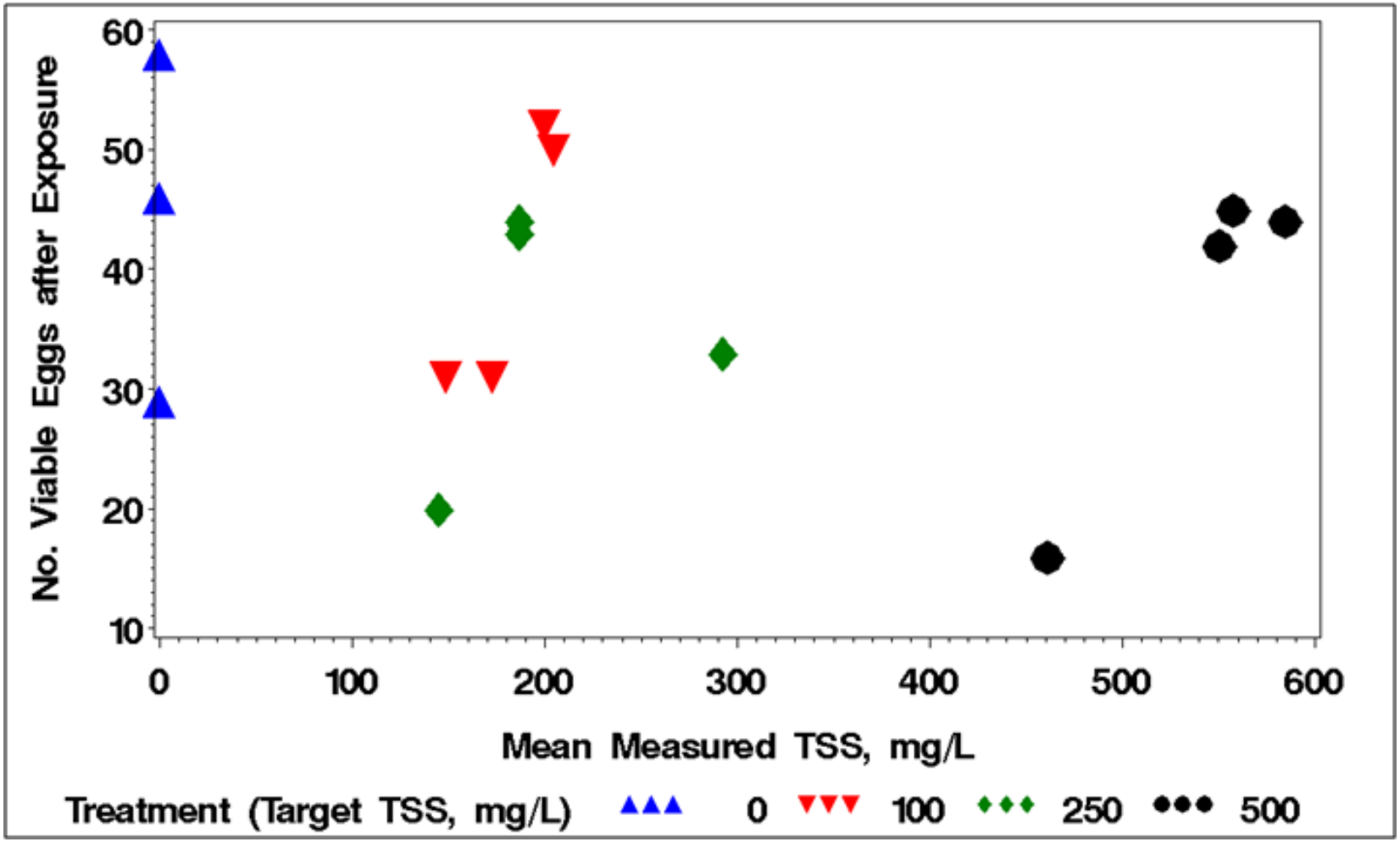
- Flow-through Fish Larvae and Egg Exposure System (FLEES)
- 3 modules/15 aquaria/3 500 L water baths
- Aquaria (15) constructed from 20 L polyethylene carboys
- Pump recirculated water and suspended sediment in aquaria
- Sediment mixed with water and stored in 375 L cone bottom tank via dbl diaphragm pump
- Slurry routed through FLEES and reused
- Sediment concs monitored using optical OBS® sensors

Methods

- **Walleye (*Sander vitreus*)**
- **Four experiments: northern and southern strain eggs (newly spawned) and fry (45-60 d)**
- **Sediment: Maumee Bay, Ohio (Lake Erie)**
- **Concentrations: 0, 100, 250, 500 mg/L TSS**
- **Duration: 3 days (72 h)**
- **Temp: 10-13°C eggs; 14-17°C larvae**
- **PVC cups for eggs**

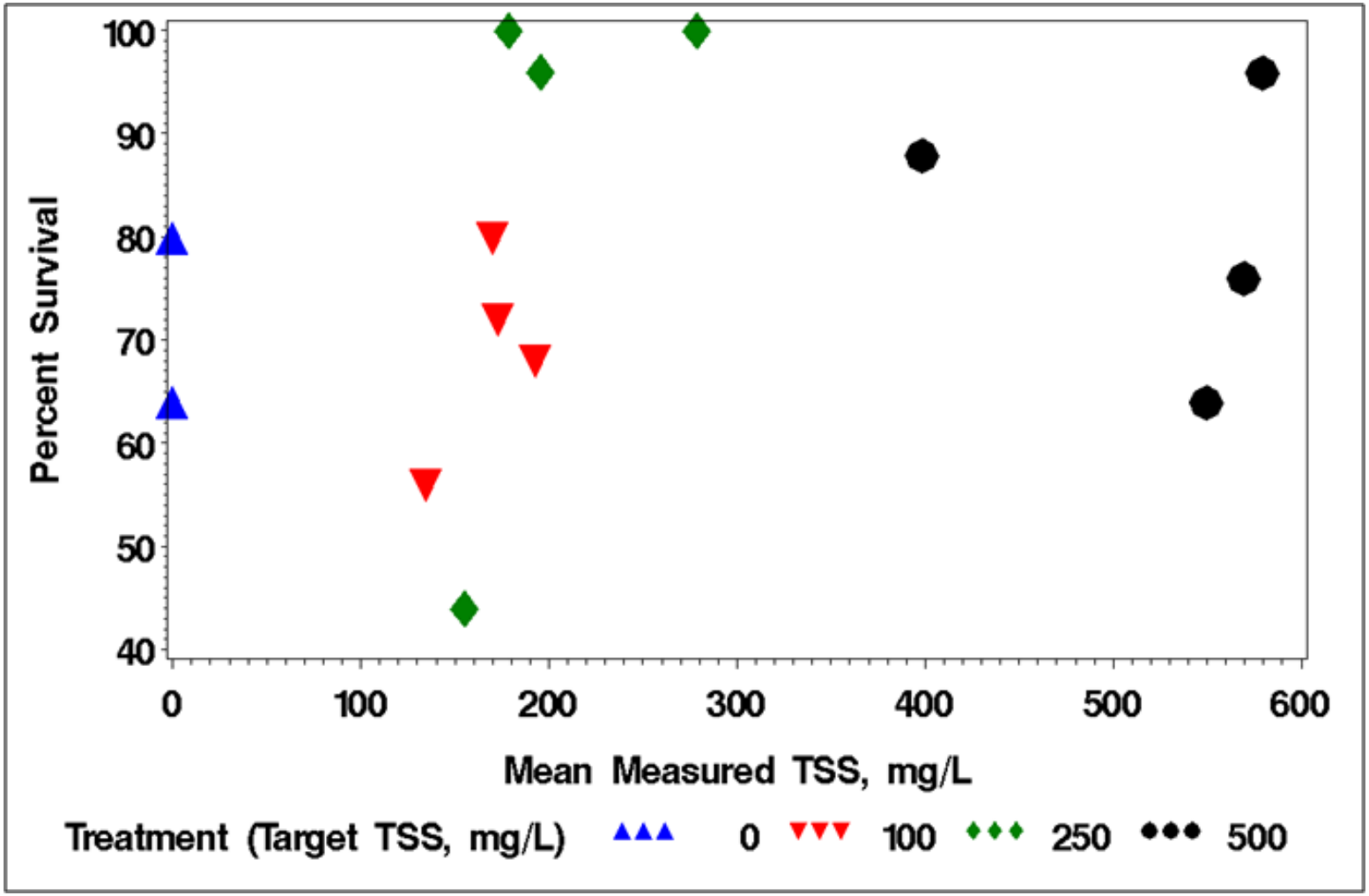


Number of Viable Northern Strain Eggs



No significant differences among treatments were observed for viable eggs (Anova, F=0.38, P=0.7678).

Northern Strain Fry Survival



Fry survival did not differ significantly among TSS treatments (Anova, F=1.53, P=0.2605).

Summary of 2010 Data

- **FLEES provided a means to simulate a dredge plume in the laboratory**
- **Southern strain:**
  - **No effects on egg viability or hatchability**
  - **Slight but not significant effect on egg viability at 500 mg/L TSS**
- **Northern strain:**
  - **No effects on egg viability or hatchability, or fry survival**
- **Path forward:**
  - **Repeat experiments to increase sample size**
  - **Assess sublethal endpoints: morphological and gill effects**

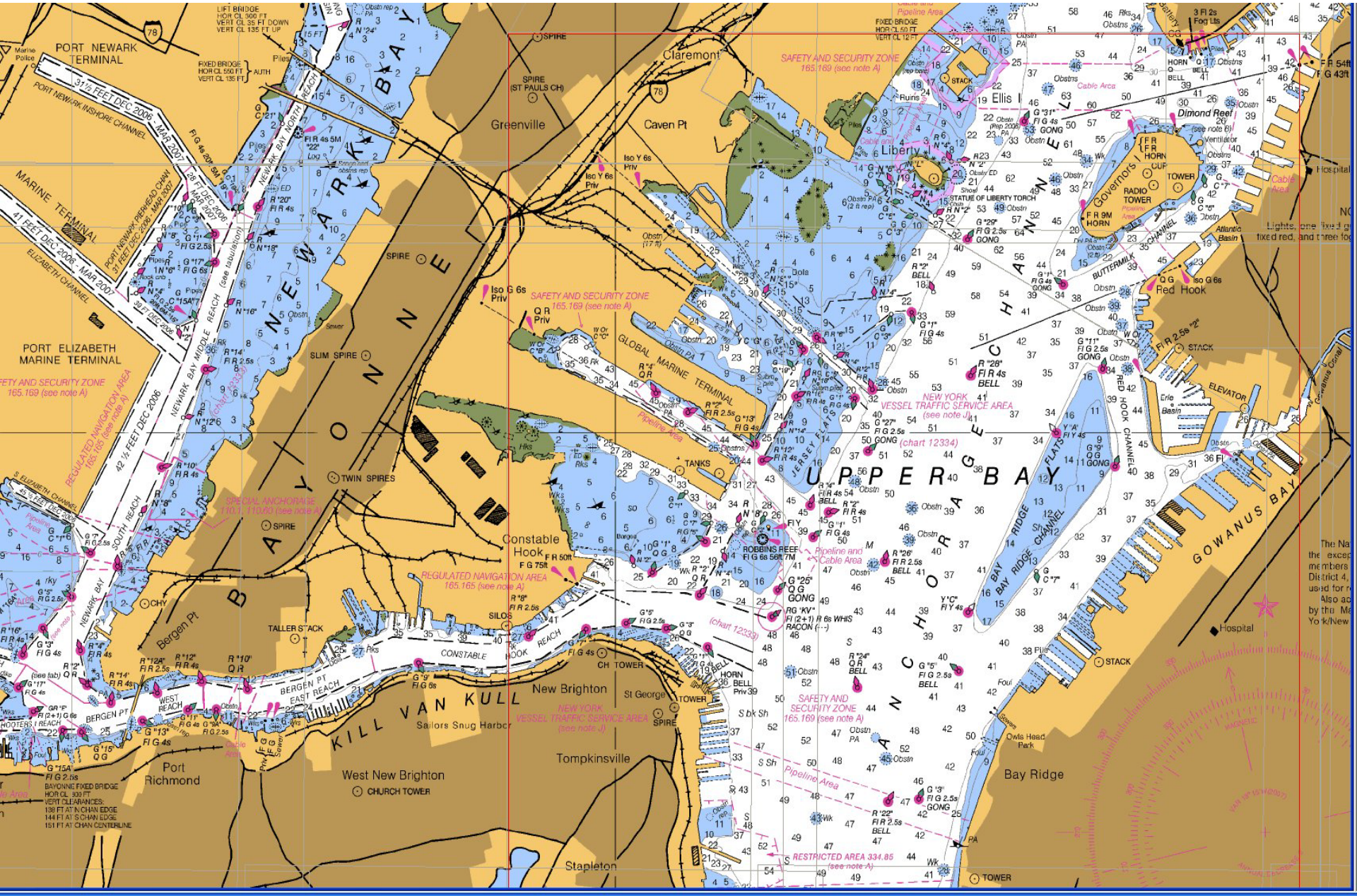
TRANSPORT AND FATE OF WINTER FLOUNDER EGGS IN A HIGHLY MODIFIED URBANIZED HARBOR

Tahirih Lackey, Jarrell Smith, Douglas Clarke and Sung-Chan Kim

U.S. Army Engineer Research & Development Center
Environmental Laboratory

Vicksburg, Mississippi, USA

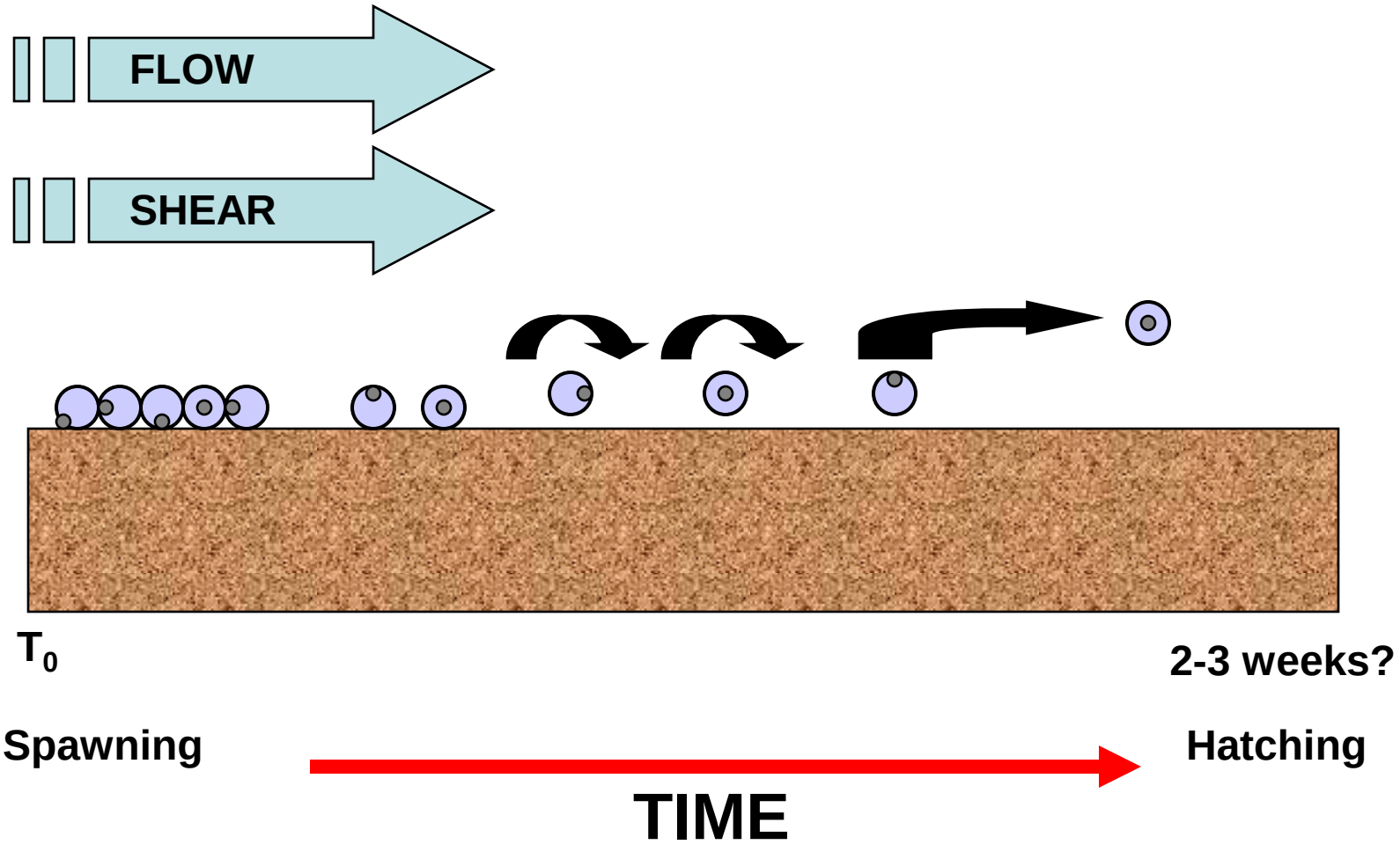
NY/NJ HARBOR - 2011



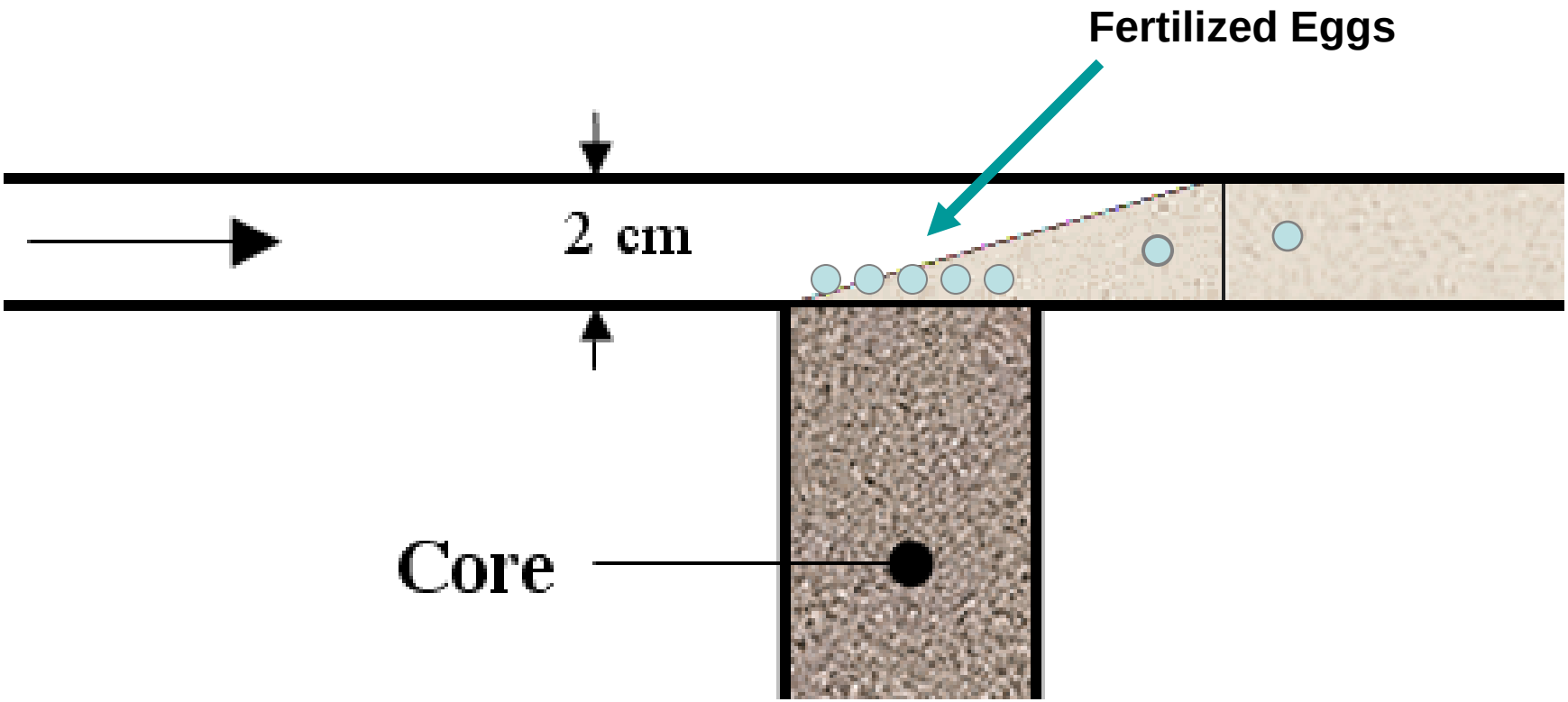
Ongoing R&D

- **Dredging process and sediment resuspension predictive models**
- **Egg transport and fate**
- **Physical attributes of spawning habitat**
- **Shear stress as a potential spawning habitat descriptor**
- **Model verification**

Temporal Aspects of Egg Movements on Bottom

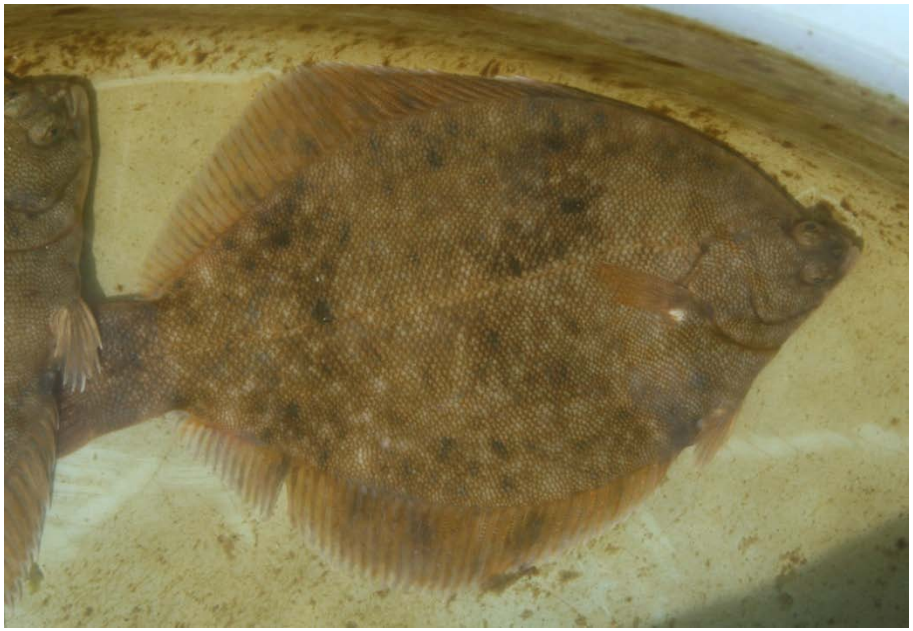


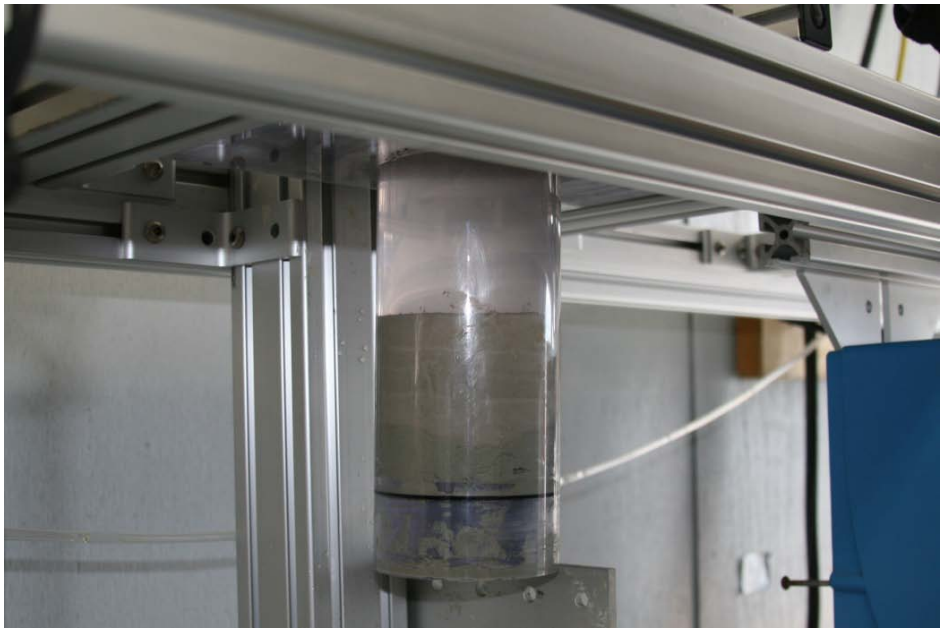
Flounder Egg Experiments to Quantify Bonding Factor



- Measure stress at which some or all eggs are removed from surface

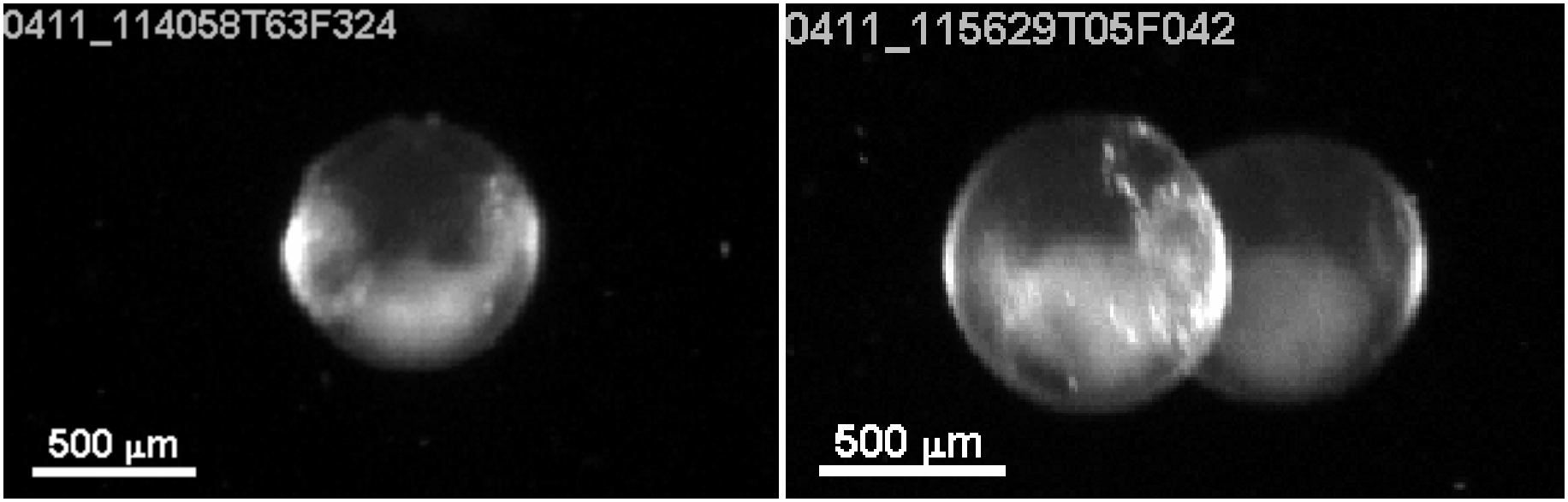
SEDFLUME DEVICE





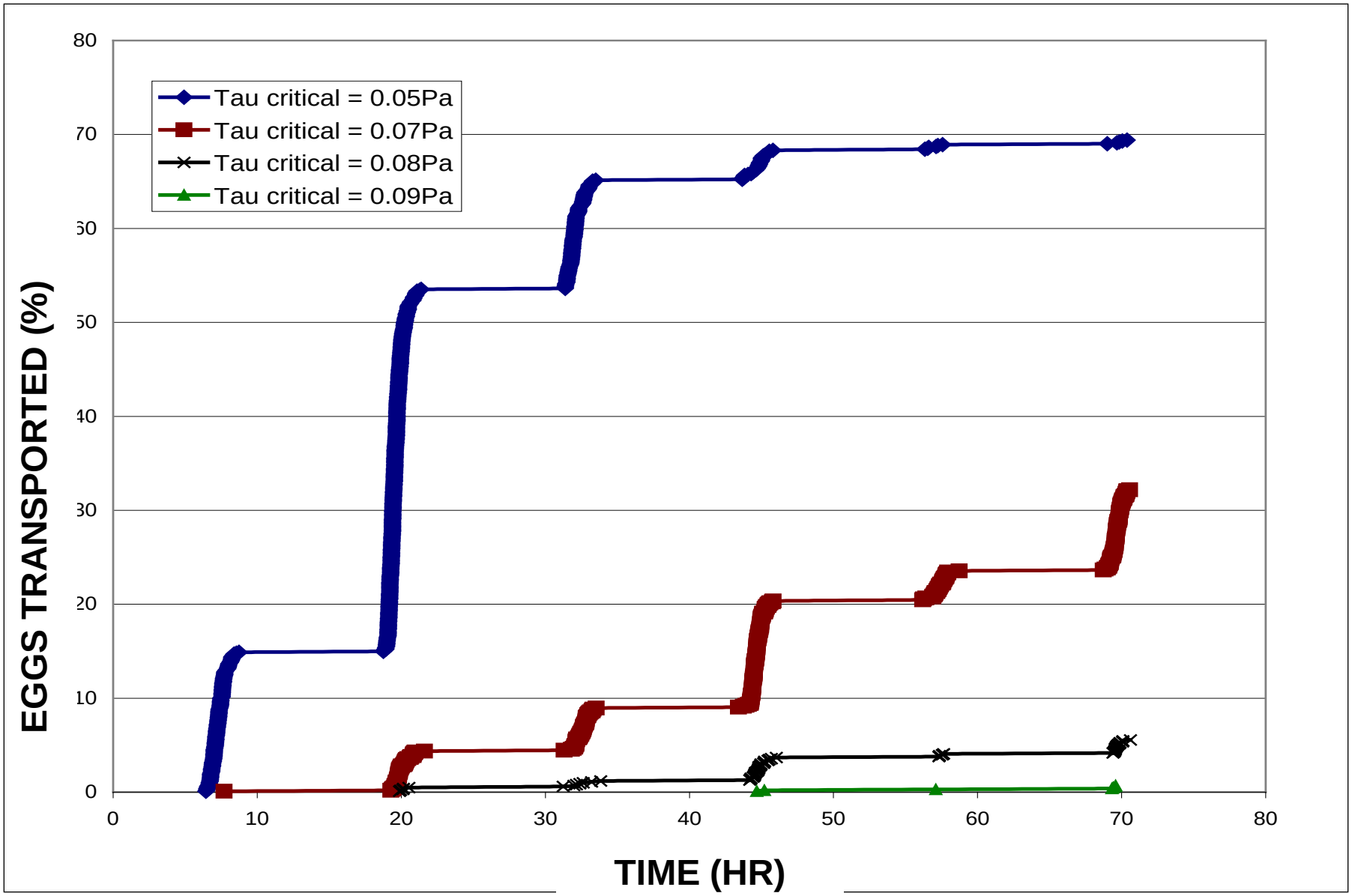
Flounder Egg Attributes

- **Settling velocity in clear water**
- **Settling velocity in elevated TSS concentrations**
- **Effects of TSS on substrate adhesion**

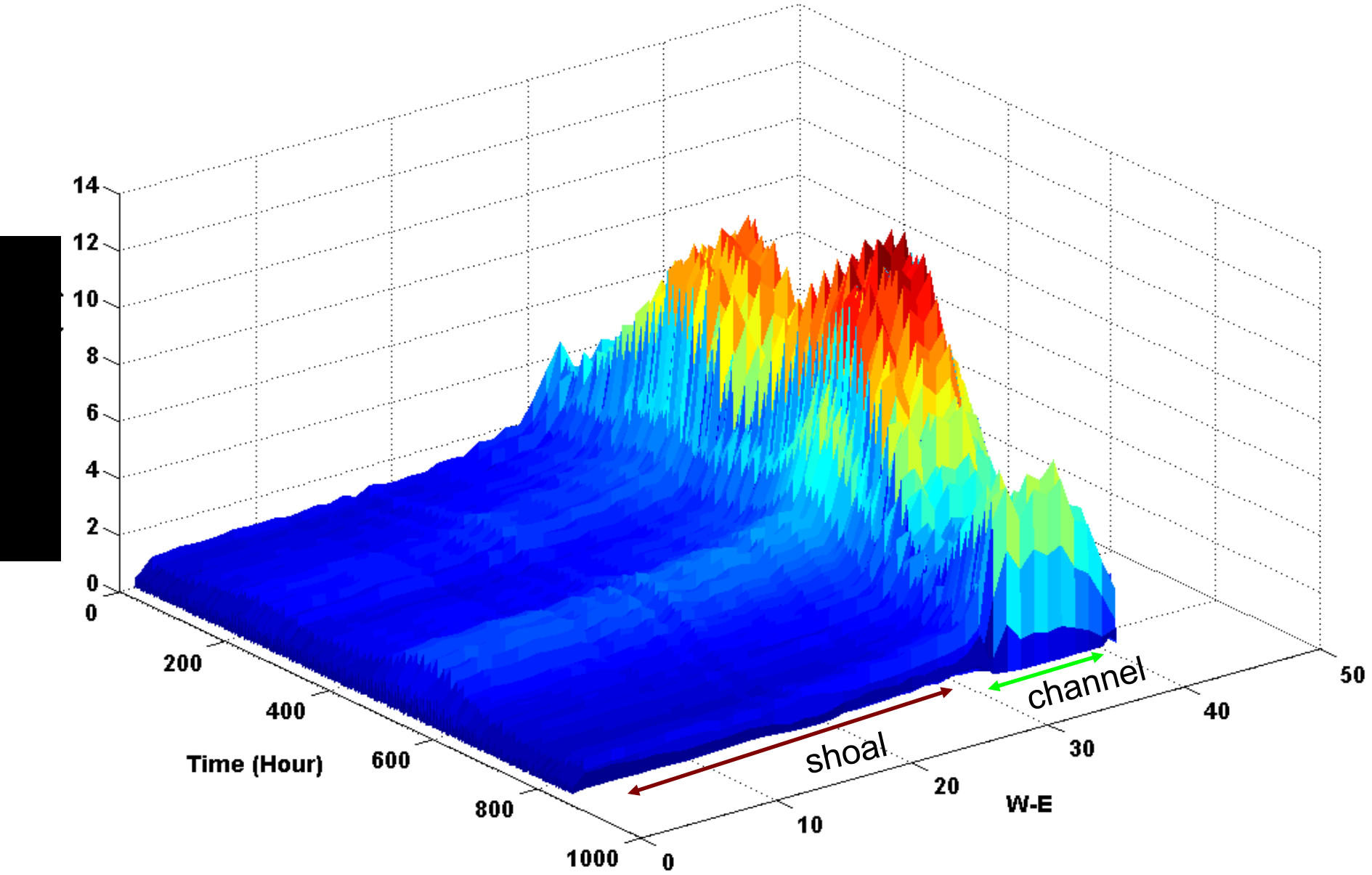


High resolution settling column video camera images

Critical Shear Stress Effect



Time Variation of Cross-Sectional Bottom Stresses



Egg particle distribution 24 hrs after deposition

Future Research Projects

- **T&E Species protection**
  - Apply advanced sensor technologies to detection of sea turtle and other T&E species
  - Document behavioral responses of target species that influence risk during encounters with dredging operations
  - Expand tools for evaluating potential impacts on T&E Species in a system wide/regional sediment management context
  - Fill knowledge gaps on high priority species (e.g., noise effects)

- **Environmental windows**
  - Customize comparative risk assessment approaches
  - Fully Integrate advanced modeling capabilities into evaluation of risks associated with dredging projects and management practices
  - Expand knowledge base concerning dose-response relationships of problematic species and life history stages

Your Input

- **What needs do you see in these areas:**
  - Knowledge gaps related to conflicts with T&E Species?
  - Effective tools and technologies for setting and evaluating environmental windows?

Dredged Material Assessment and Management
Seminar 2009, Detroit, MI

Purpose

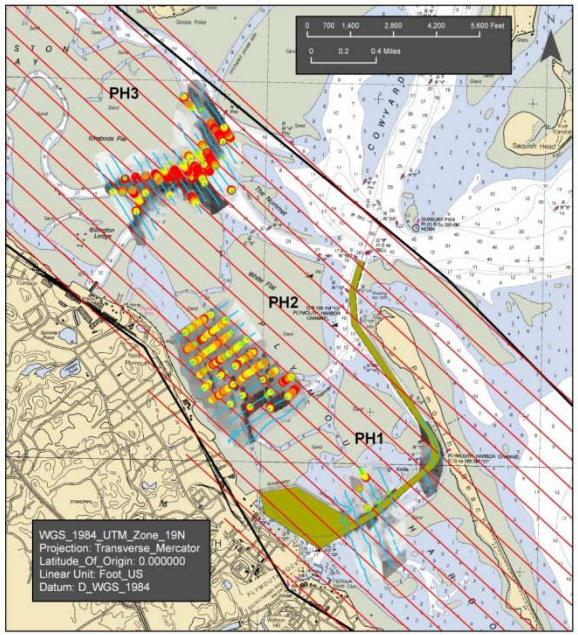
- Situation: USACE Districts are confronted by complex T&E Species issues that extend across District/Division boundaries, involving a very large number of target species. Many management practices intended to protect T&E and other sensitive species remain untested. Protecting the environment occurs against a backdrop of fewer acceptable dredged material placement options.
- Barriers: Opportunities to evaluate alternative management practices are constrained by both funding and logistics. Regulatory restrictions often prevent timely conduct of collaborative studies that address species with protected status.
- Solution: Provide tools for both proactive and retrospective evaluation of protection measures. Examine positive attributes of the dredging process (e.g., beneficial uses) that lead to increased flexibility and more options for environmental resource protection.

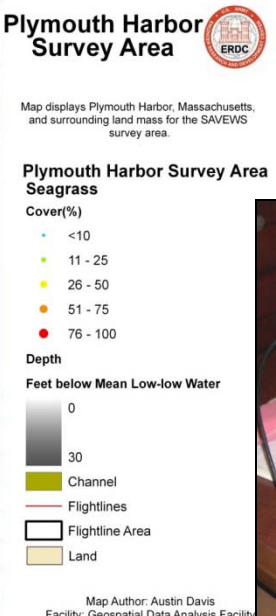
SAV DETECTION AND MAPPING

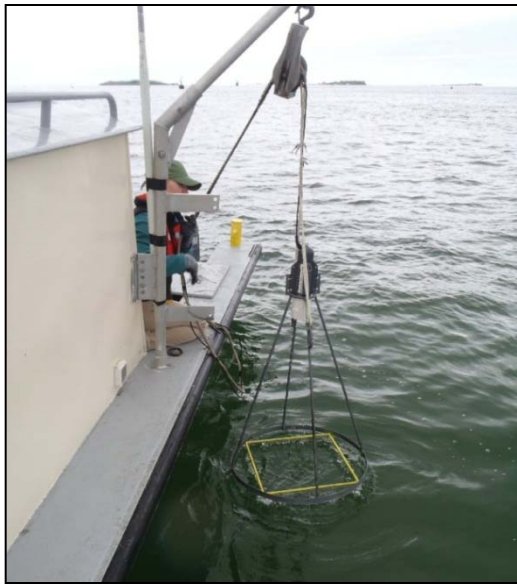
- **HYPERSPECTRAL IMAGING**
  - **Similar to multispectral imaging (e.g., LandSat), but has a very narrow spectral bandwidth (< 20nm) and uses many spectral channels**
  - **CHARTS system used here employed 36 spectral channels, each 19nm wide between UV (350nm) and near Infrared (1,050nm)**
  - **For SAV application used under 800nm (just past red) for suitable water column penetration**

Spatial Ground Truth

- **Acoustic Survey (SAVEWS) Sept 7 - 8**



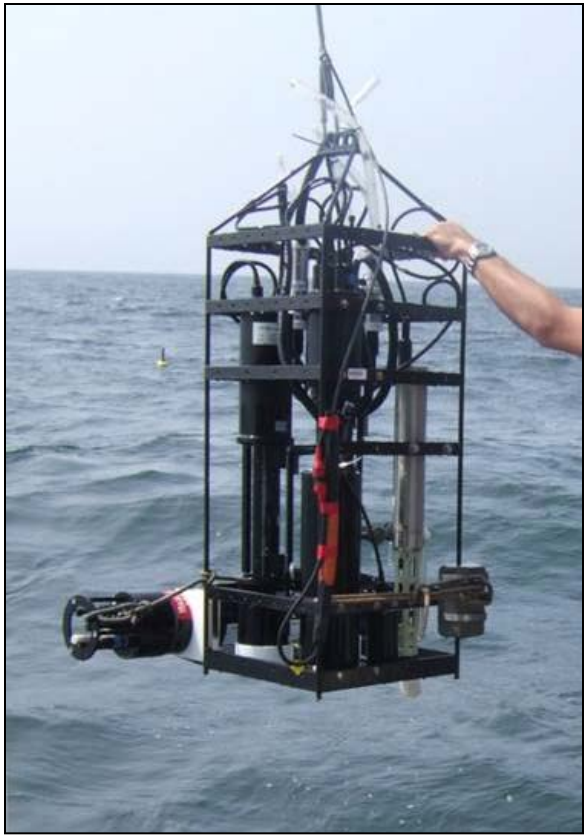


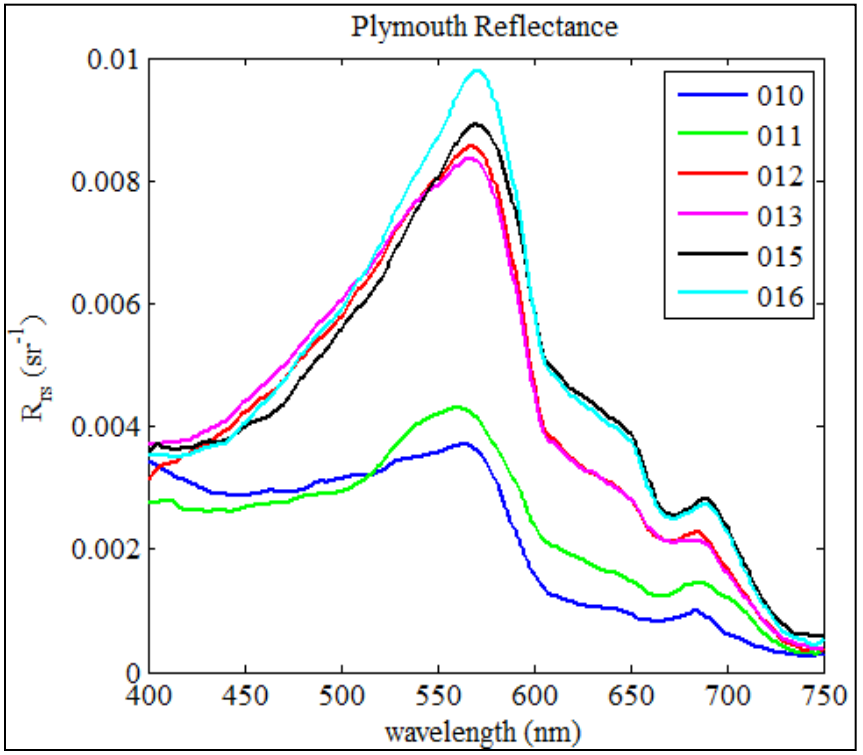


- **In-situ hyperspectral measurements of SAV/sediments and onshore features**
- **Underwater video imagery**
- **Diver observation and sampling (EPA)**

Dynamic Ground Truth

- **Spectral irradiance**
- **Tidal Height**
- **Water column optical properties: Chl a, absorption, backscattering, attenuation**





Hyperspectral water-leaving reflectance, Plymouth Harbor, MA