



# South River Phase 1 Interim Measures: Refinement of Bank Management Areas

March 19, 2014

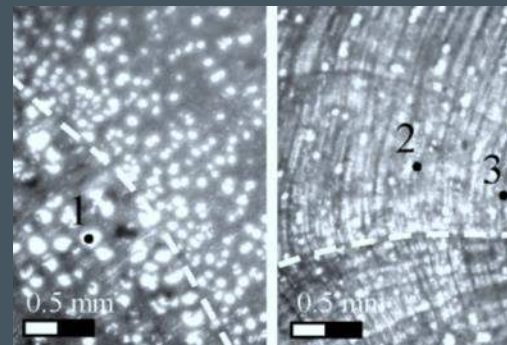
# Agenda

- Bank erosion rates from exposed tree roots
- Hydrodynamic modeling
- Bank erosion rate regression relationships
- RRM 0-2 bank mercury loading rates
- Preliminary RRM 0-2 bank management areas (BMAs)

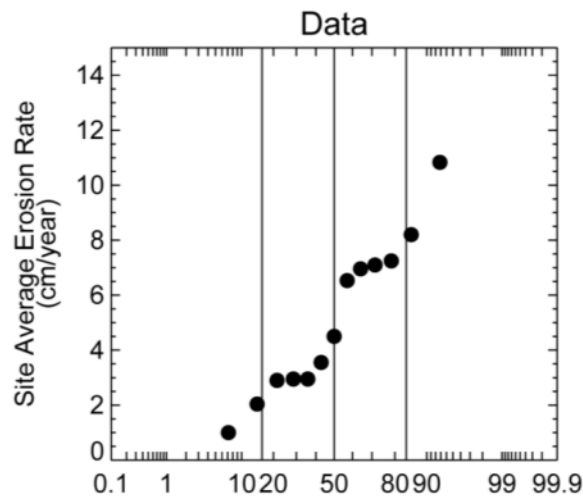


# Bank Erosion Rates: Exposed Tree Roots

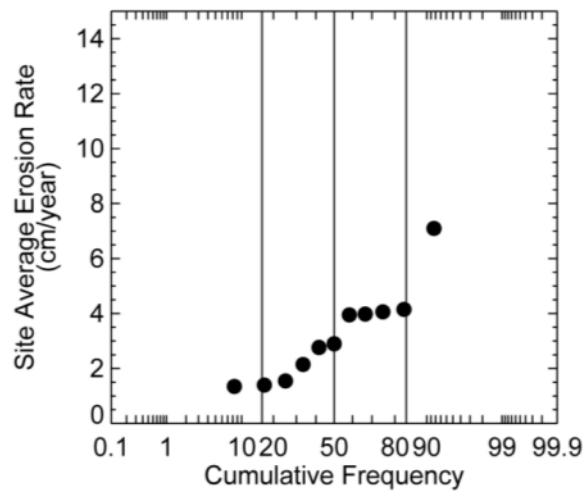
- 2013 Stephanie Stotts University of Delaware Doctor of Philosophy dissertation
- 24 riparian root stations sampled in RRM 2-10
  - Evaluated anatomical changes in riparian tree roots exposed by bank erosion
  - Accurate and precise estimates of contemporary bank erosion rates (years to decades)



Left Bank



Right Bank



Note: Left and right banks oriented looking downstream

## Bank Erosion Rate Data: RRM 2-10

- Range of measured erosion rates
- Higher erosion rates (> 3 cm/ year) corroborated with independent photogrammetric techniques

# Hydrodynamic Modeling Objectives

- Refine BMA identification
  - Estimate peak velocities and shear stresses during high flow events
  - Support regression analyses of measured bank erosion rates at RRM 2-10 exposed tree roots
  - Extrapolate erosion rates to RRM 0-2
- Support follow-on bank stabilization design

# Hydrodynamic Model Framework

- Model developed using Environmental Fluid Dynamics Code (EFDC), a widely accepted hydrodynamic modeling system
  - Computational fluid dynamics
  - Approved and supported by USEPA
  - Frequently used to support sediment cleanup evaluations and designs in rivers, estuaries and coasts
- Simulates flow in up to three dimensions
  - Two-dimensional model used for South River

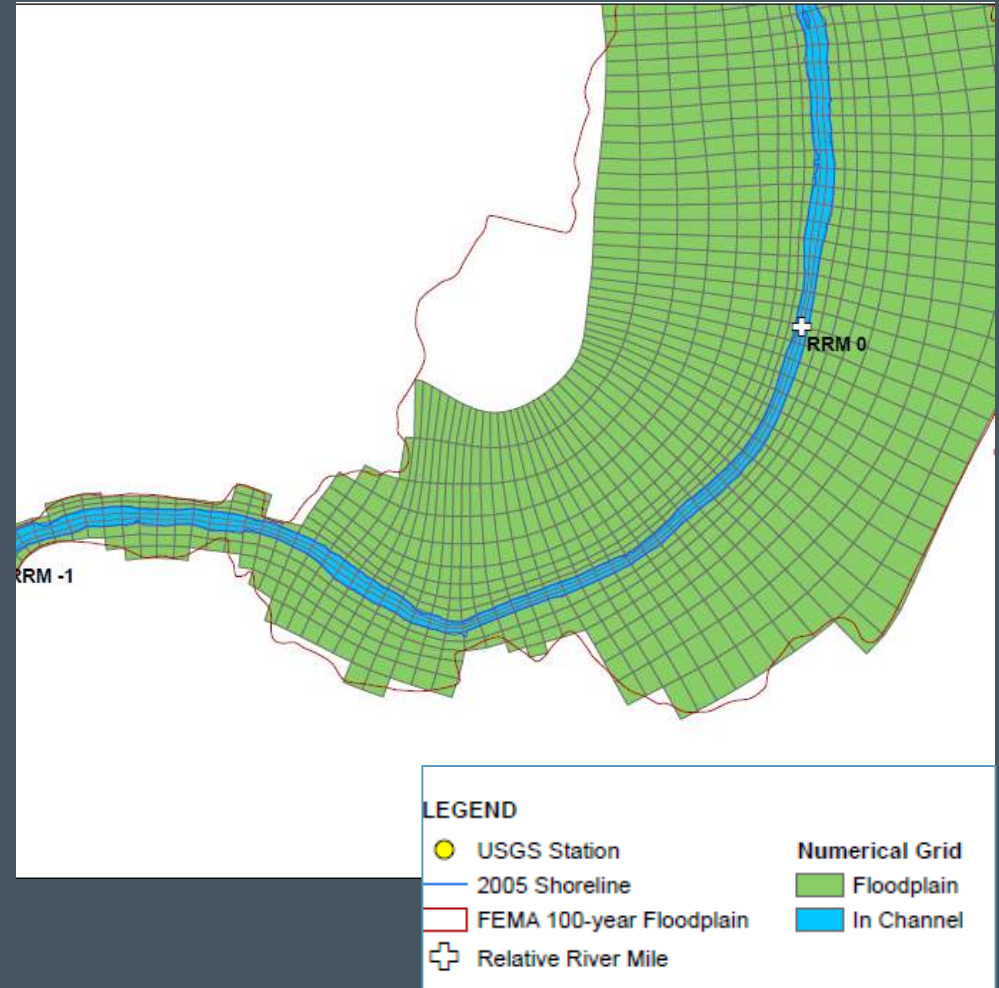
# Hydrodynamic Model Domain

- Covers 18.5 miles of the South River
  - From Waynesboro (RRM -2)
  - To Harriston (RRM 16.5)
- Laterally extended to the FEMA 100-year flood contour



# Hydrodynamic Model Grid

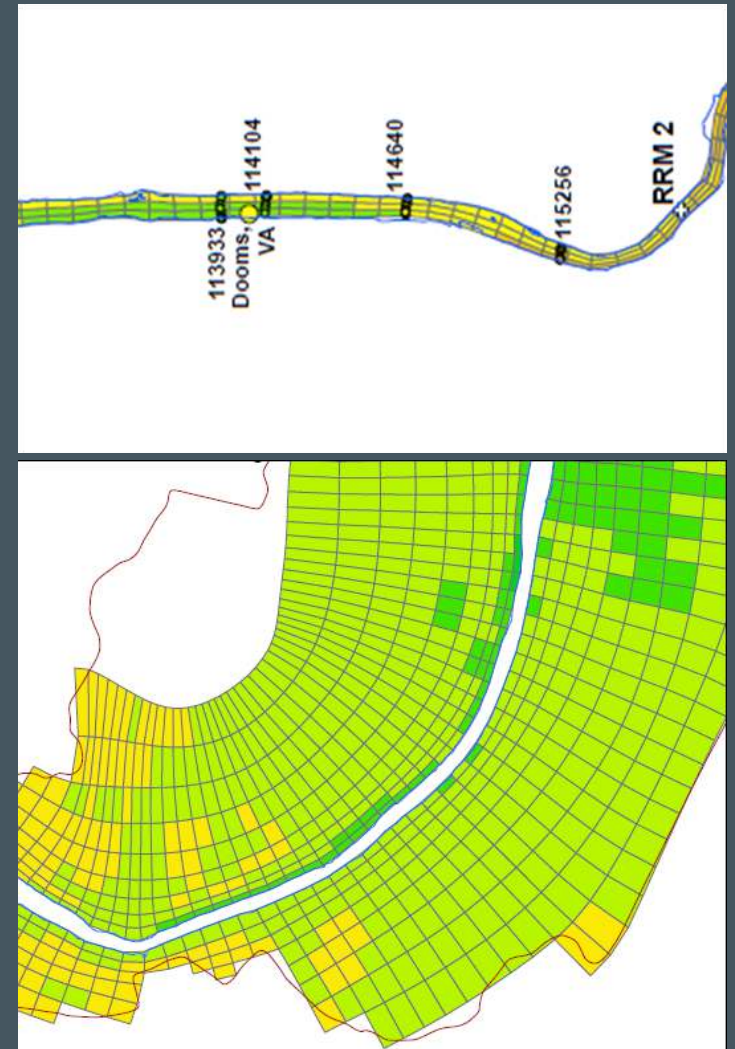
- Defined channel boundary with 2005 shoreline
- In-channel grid
  - 3-cells across
  - Average length: 100 ft
  - Average width: 30 ft
- 13,300 cells total
  - Includes floodplain and channel



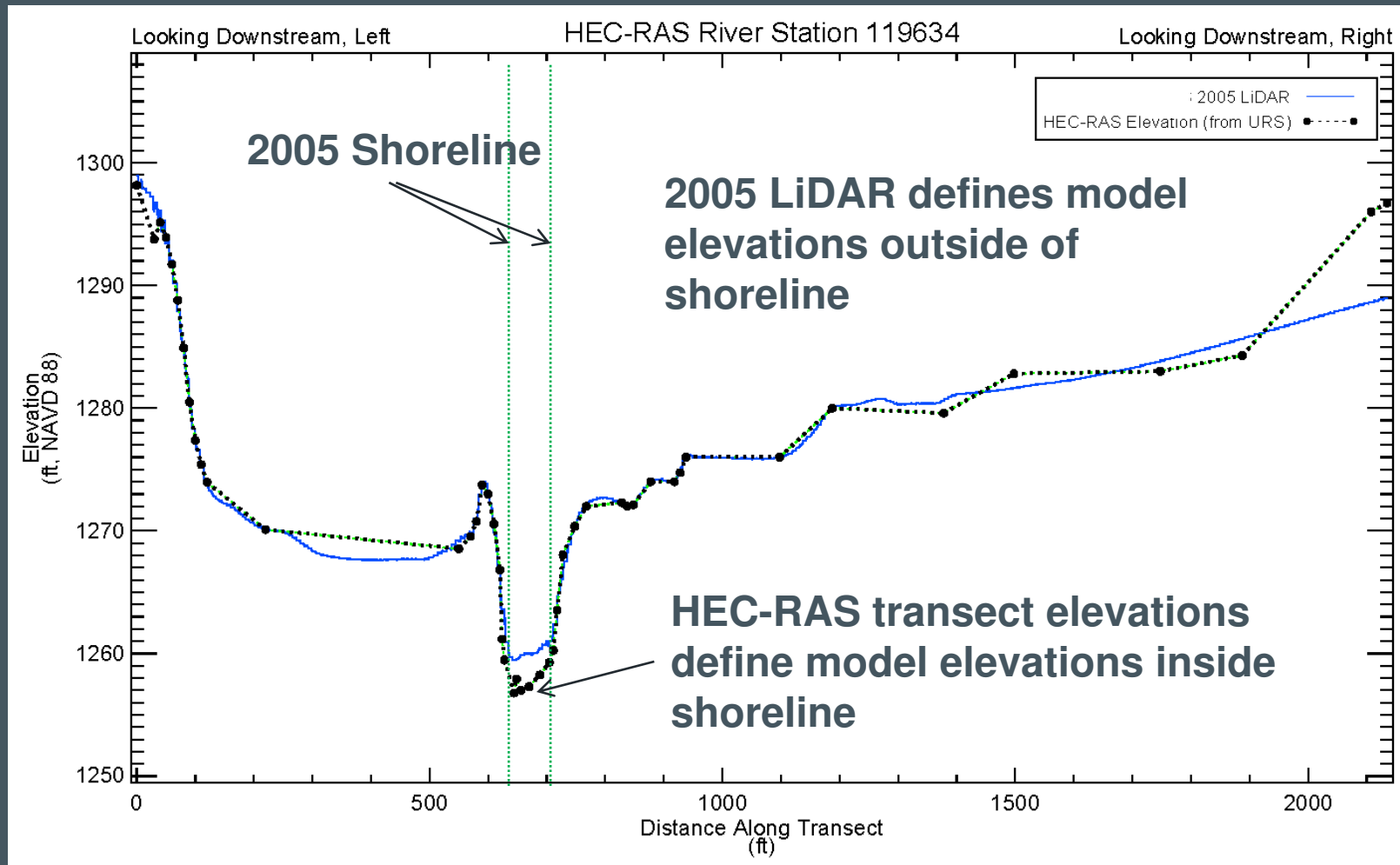


# Model Bathymetry and Topography

- Bank and floodplain elevations defined with extensive 2005 LiDAR data
- Channel bed elevations defined with HEC-RAS cross-sections
  - Interpolated bed elevations between cross-sections
  - Cross-checked interpolation with published channel elevation profiles



# Example Elevation Cross Section



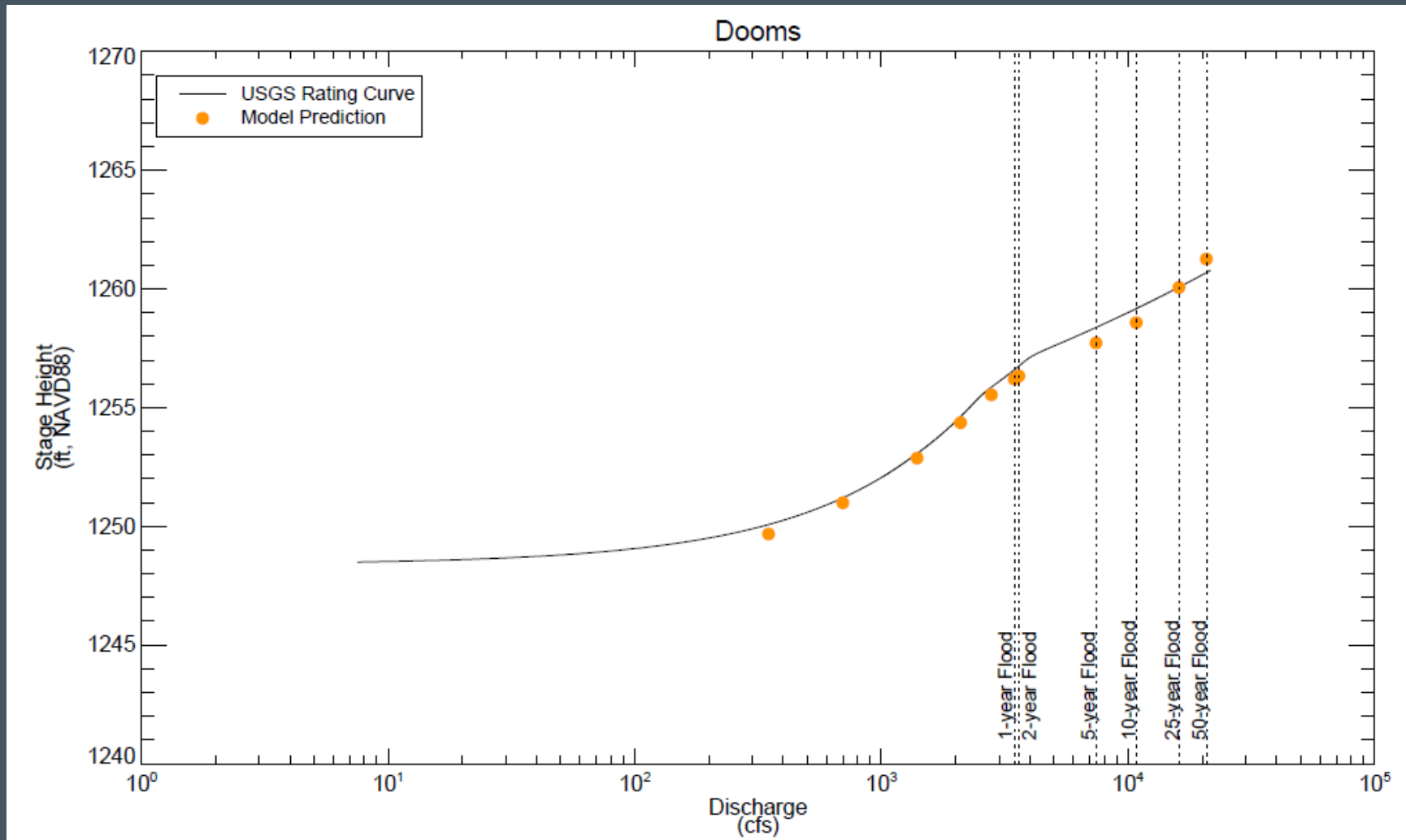
# Model Flow and Stage Inputs

- Upstream flow inputs from the USGS gage at Waynesboro
- Tributary in-flows
  - Grouped into 7 major tributaries
  - Estimated inflow rates using drainage area proportions
- Downstream water surface elevations from USGS rating curve for the Harriston gage

# Model Calibration & Validation

- Model calibrated to USGS stage height rating curves for the Dooms and Waynesboro gages
  - Calibration based on a series of steady state flow simulations for medium and high-flow events
  - Adjustable parameter: effective bed roughness in the channel and floodplain
- Model validated by simulating the Nov. 2013–Feb. 2014 hydrograph
  - Compared modeled and actual water surface elevations at the Waynesboro and Dooms gages during validation period

# Model Calibration at Dooms

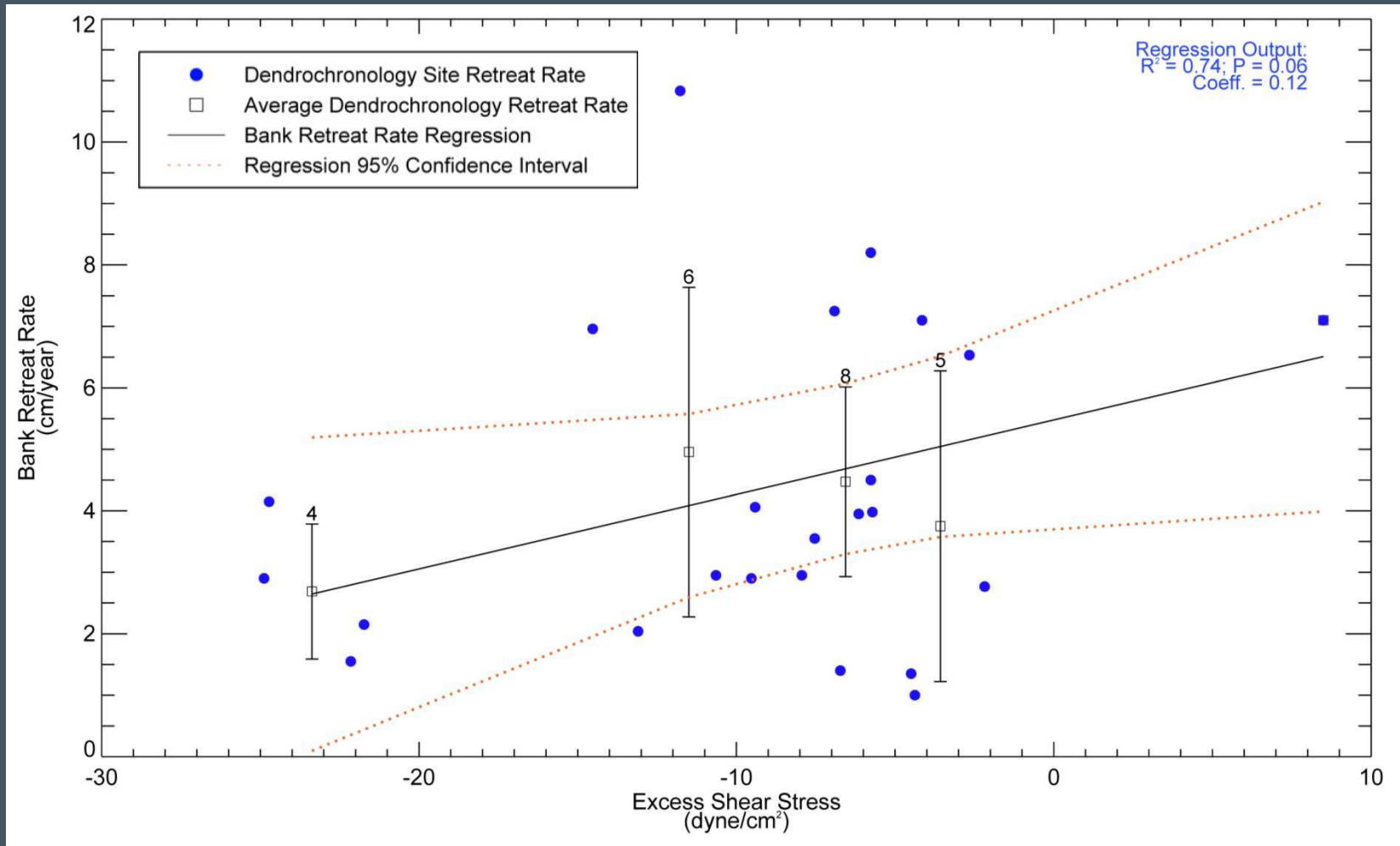


# Bank Erosion Rate Regressions

- Regression parameters:
  - Bank full velocity (~2-yr flow)
  - Excess bank shear stress
    - Bank shear stress minus cross channel average
  - Bank height and angle
- Bank erosion sediment loads correlated with excess bank shear stress and bank height
- Ongoing refinements
  - Univ. Delaware LiDAR surveys (addl. erosion rates)
  - Supplemental root density / root depth surveys

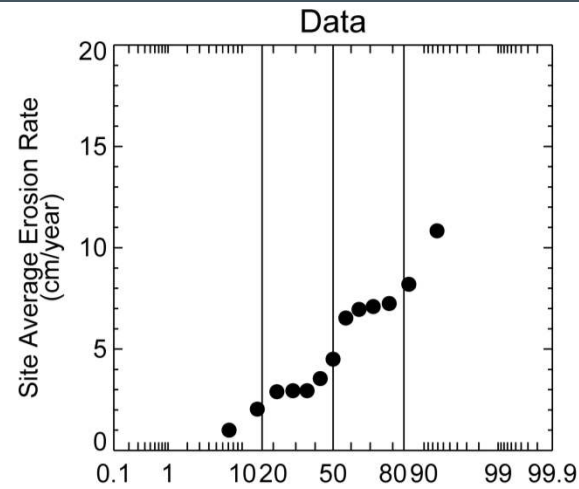
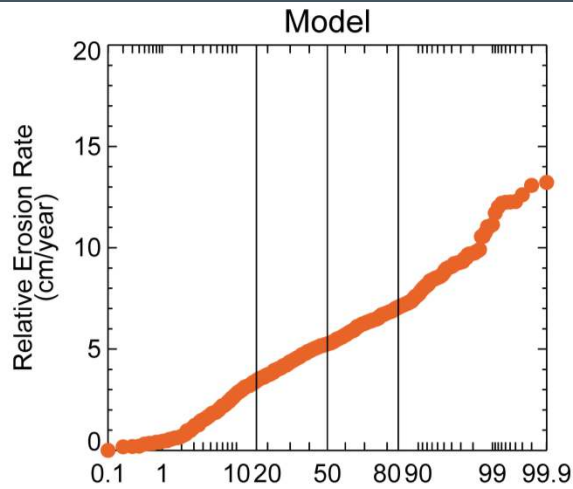


# Excess Shear Stress vs. Bank Erosion Rate Regression Relationship

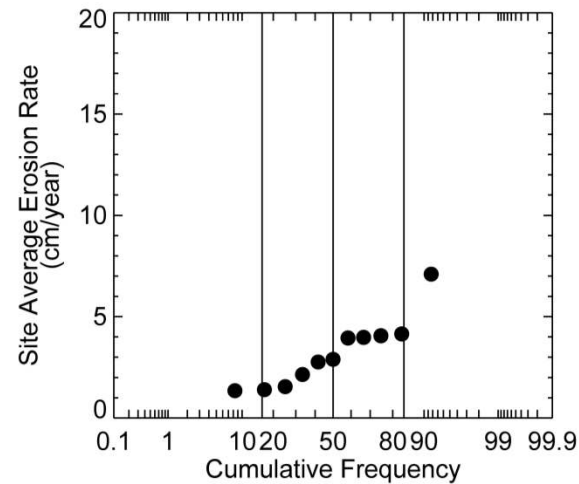
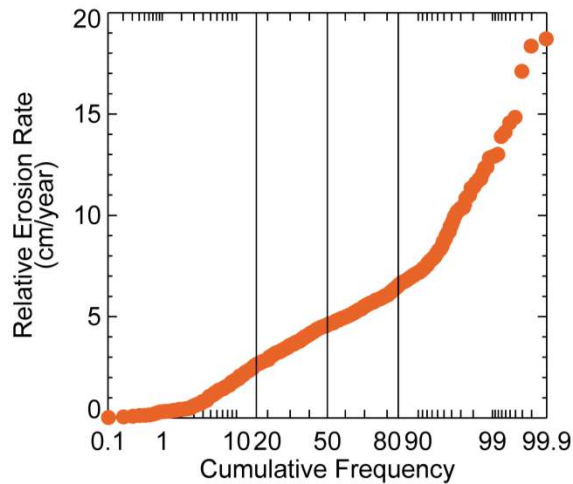


# Bank Erosion Regression Model vs. Data

Left Bank



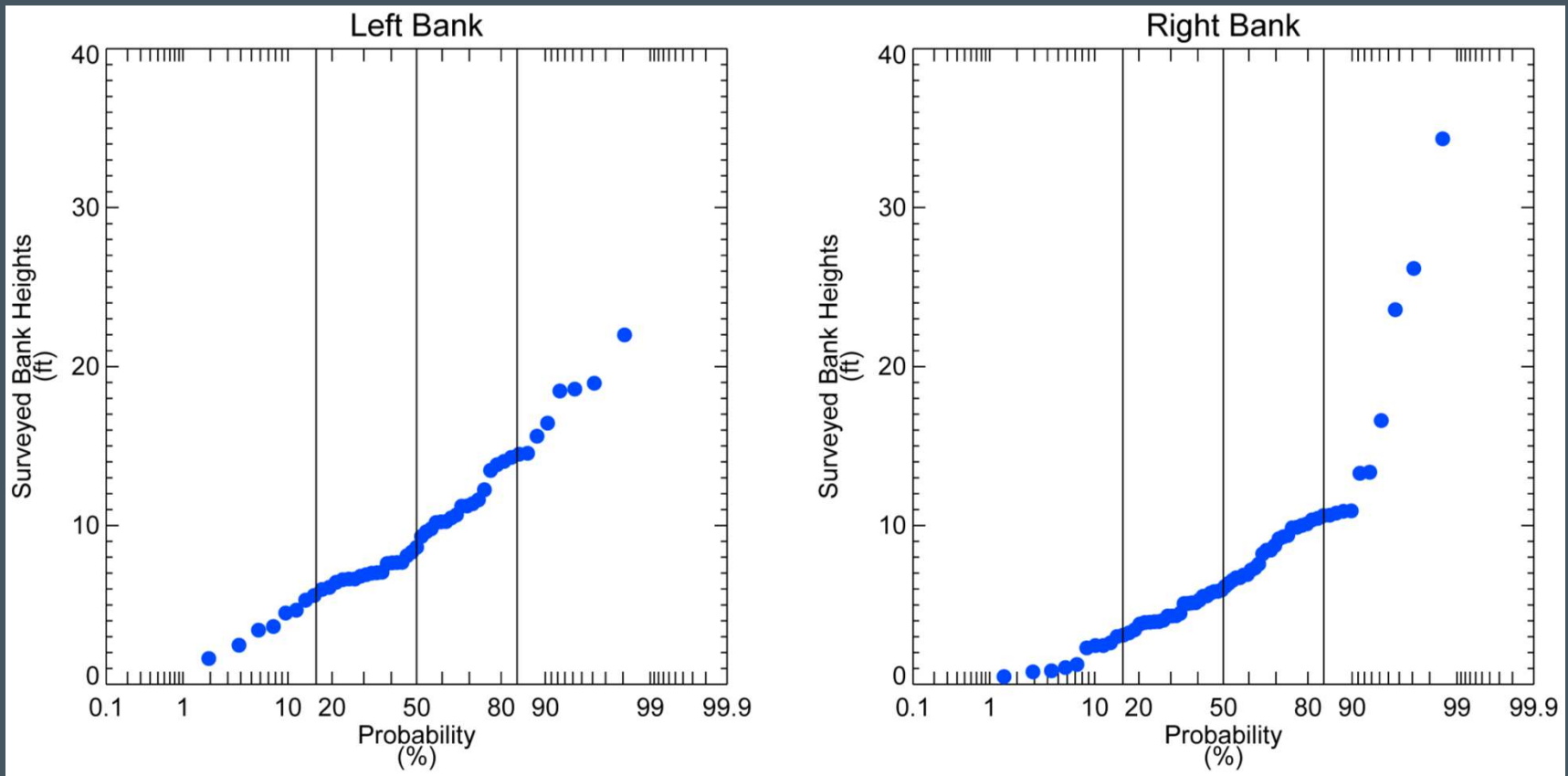
Right Bank



Note: Left and right banks oriented looking downstream

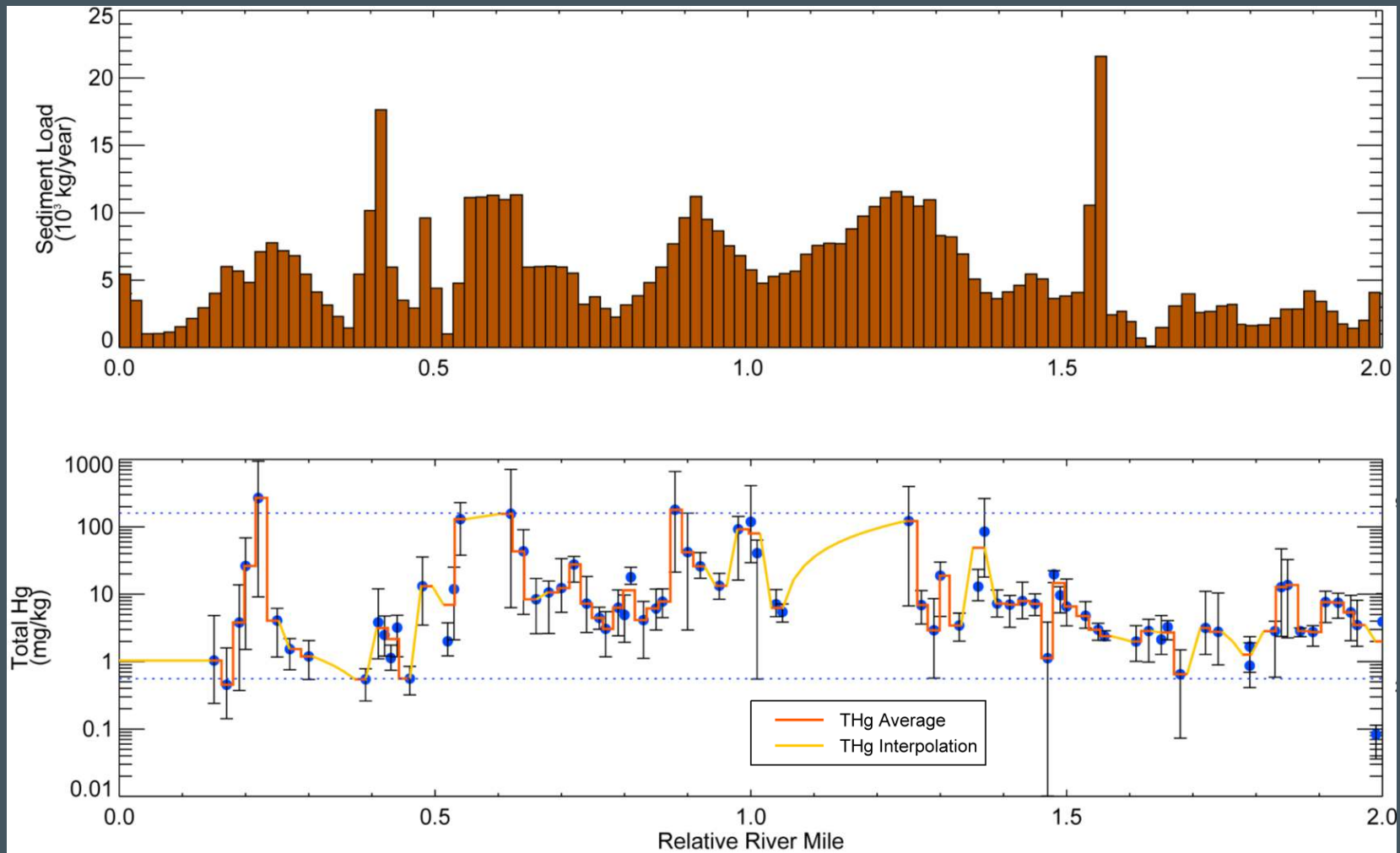


# Wide Range of Bank Heights

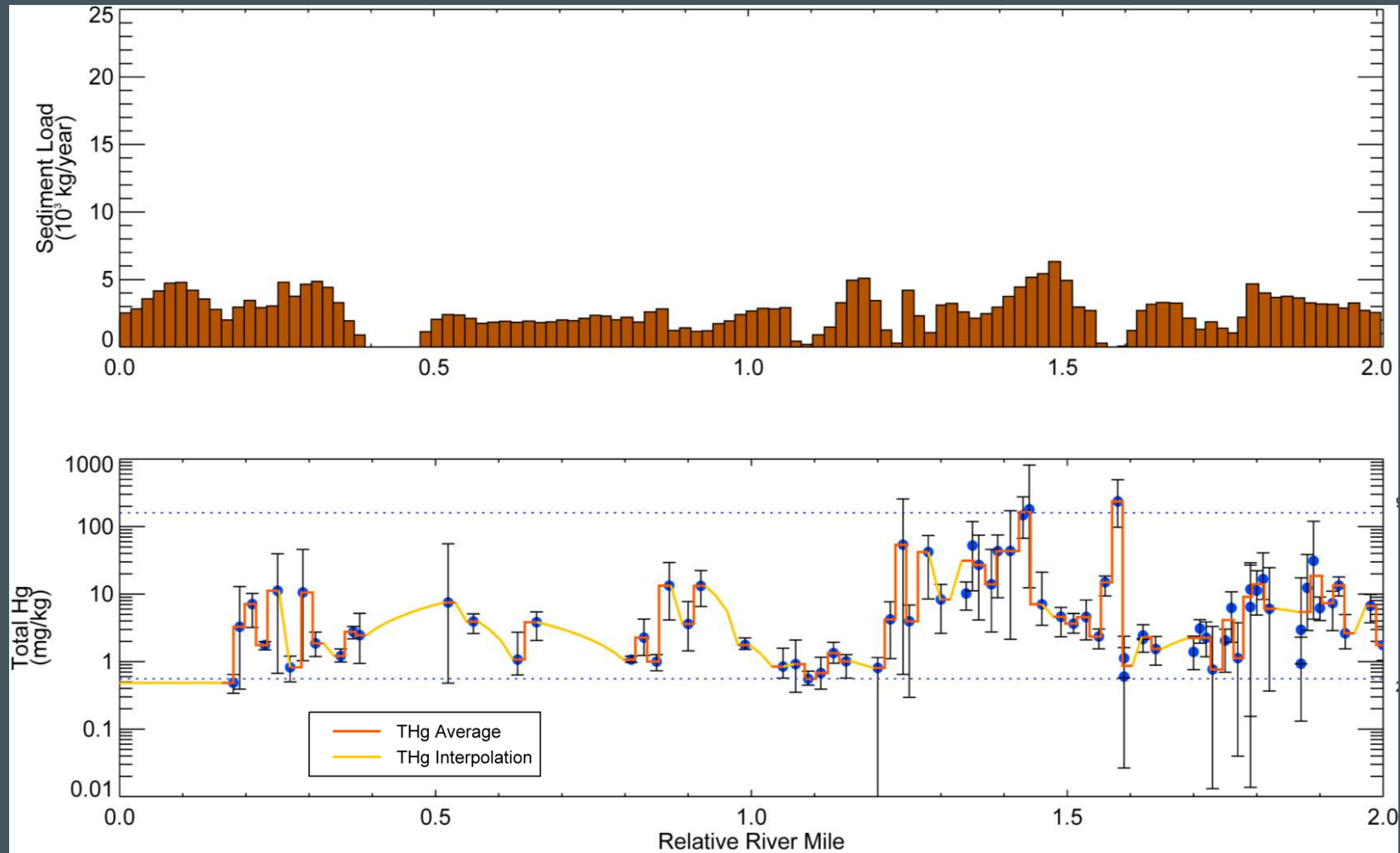


Note: Left and right banks oriented looking downstream

# Left Bank Sediment Loading and Total Hg



# Right Bank Sediment Loading and Total Hg



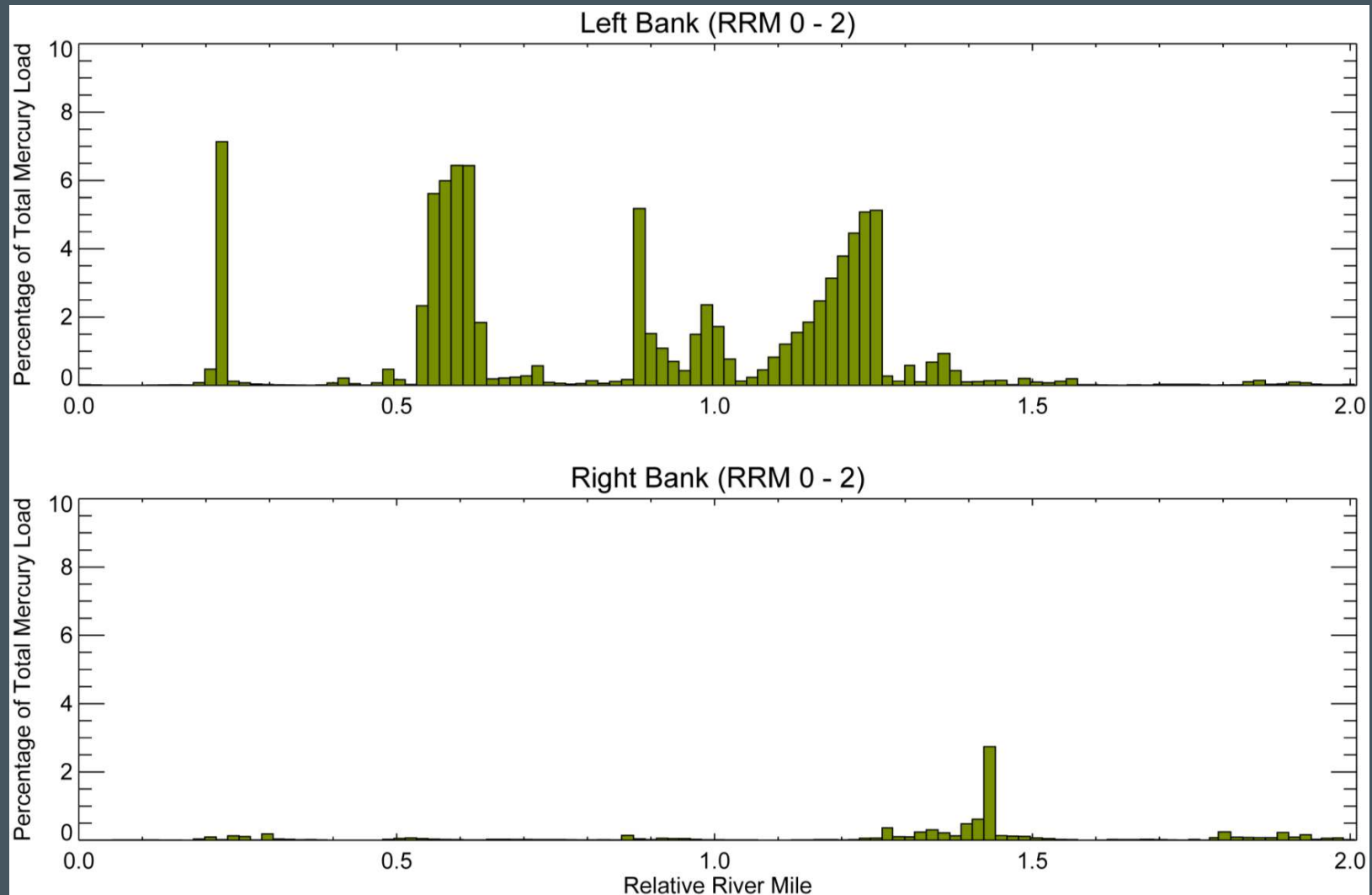
# Calculated RRM 0-2 Bank Mercury Loading

- Key parameters for loading estimates:
  - Excess shear stress (modeled)
  - Bank height (measured)
  - Mercury concentration (measured and interpolated)
- Ongoing refinements
  - High resolution LiDAR surveys
    - Additional contemporary erosion rates
  - Supplemental root density / root depth surveys
  - Supplemental bank mercury concentration sampling

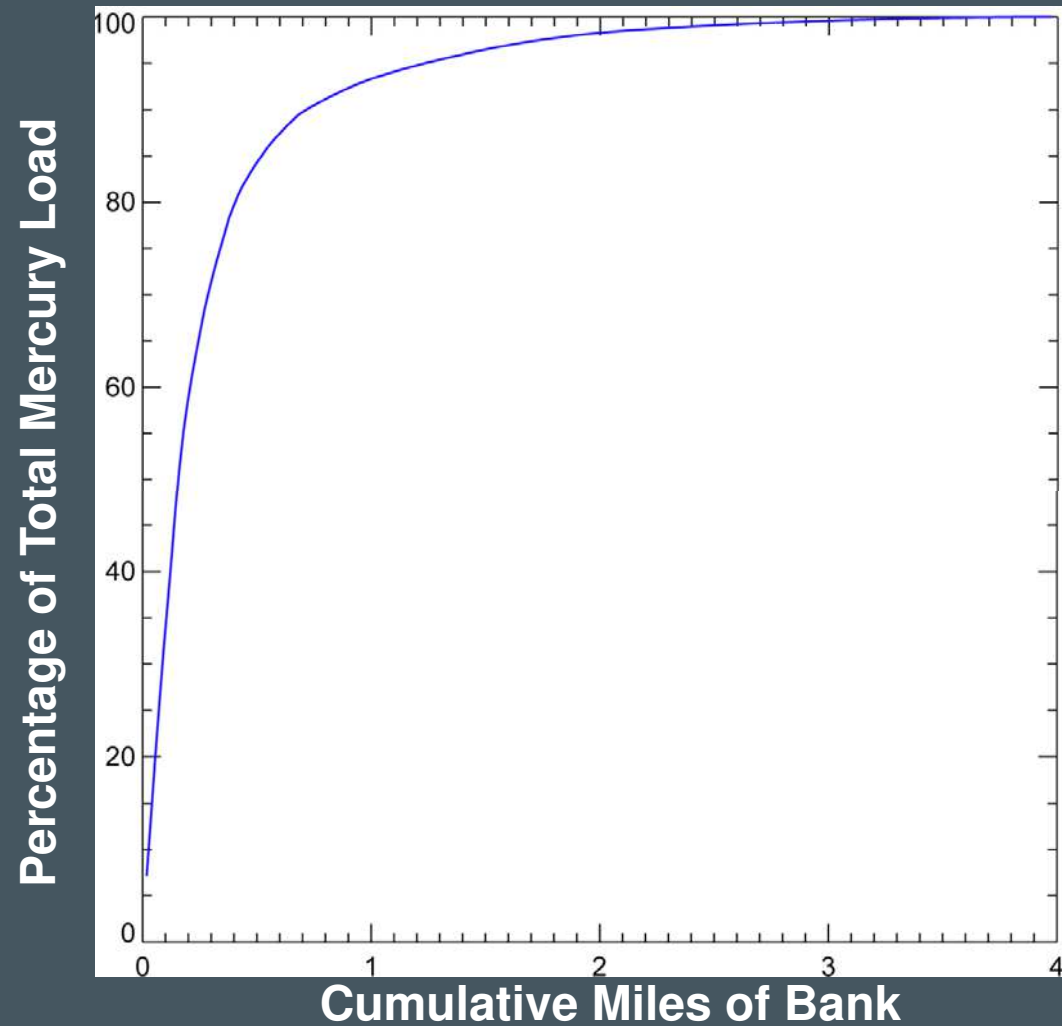
# High Resolution LiDAR Surveys



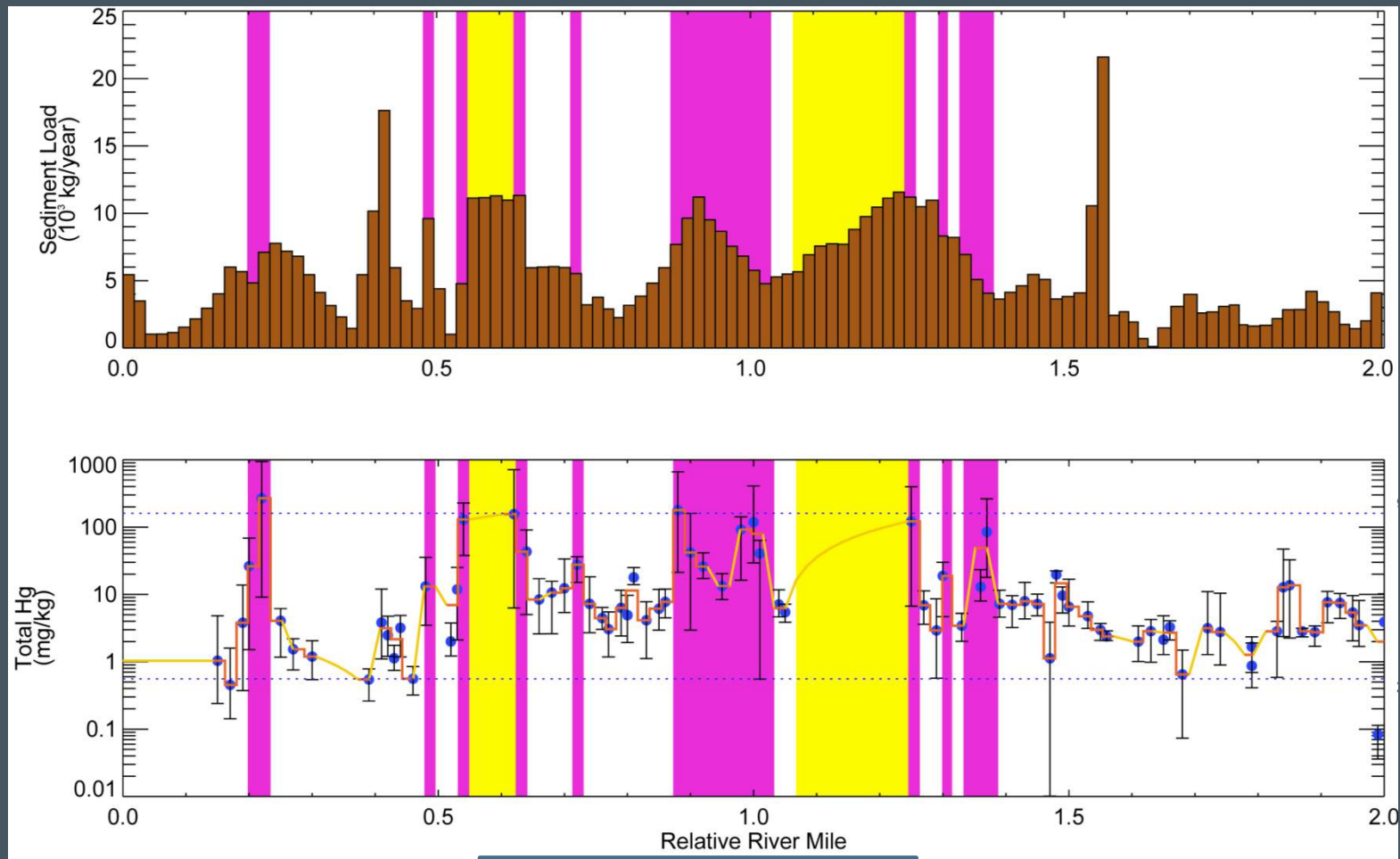
# Calculated RRM 0-2 Bank Mercury Loading





# Preliminary Analysis of Cumulative Bank Mercury Loading: RRM 0-2



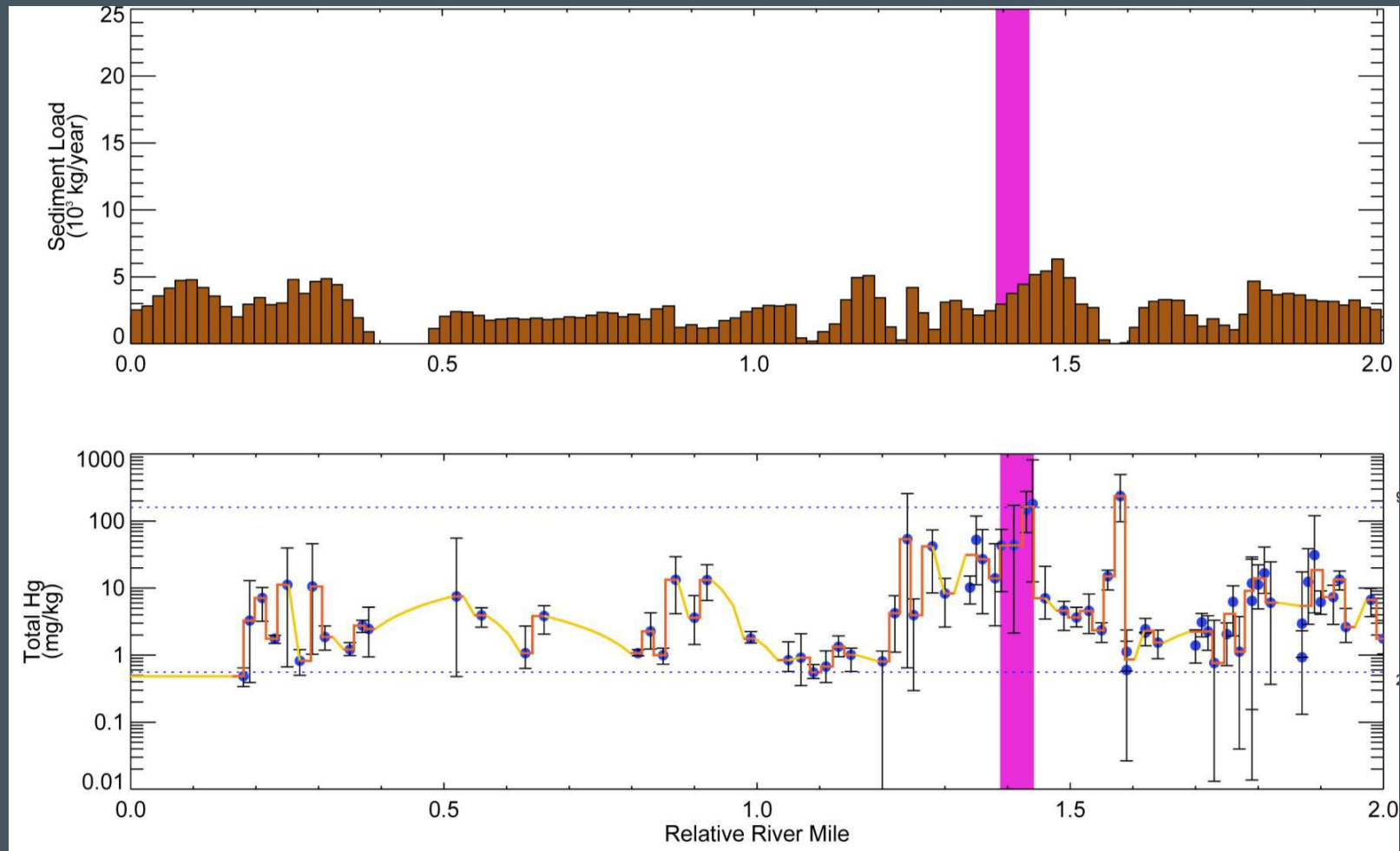
# RRM 0-2 Left Bank Preliminary BMAs and Data Gap Banks



 Preliminary BMA  
 Data Gap Bank



# RRM 0-2 Right Bank Preliminary BMA



Preliminary BMA

# Schedule / Path Forward

- March/ April – data gap sampling to refine BMAs
  - Supplemental bank Hg, LiDAR and other surveys
- June – draft Interim Measures Work Plan
- Summer/ fall – Interim measures design and permitting
  - Potentially continuing into mid-2015