Cayuga Lake Model

2-D Hydrodynamic Model

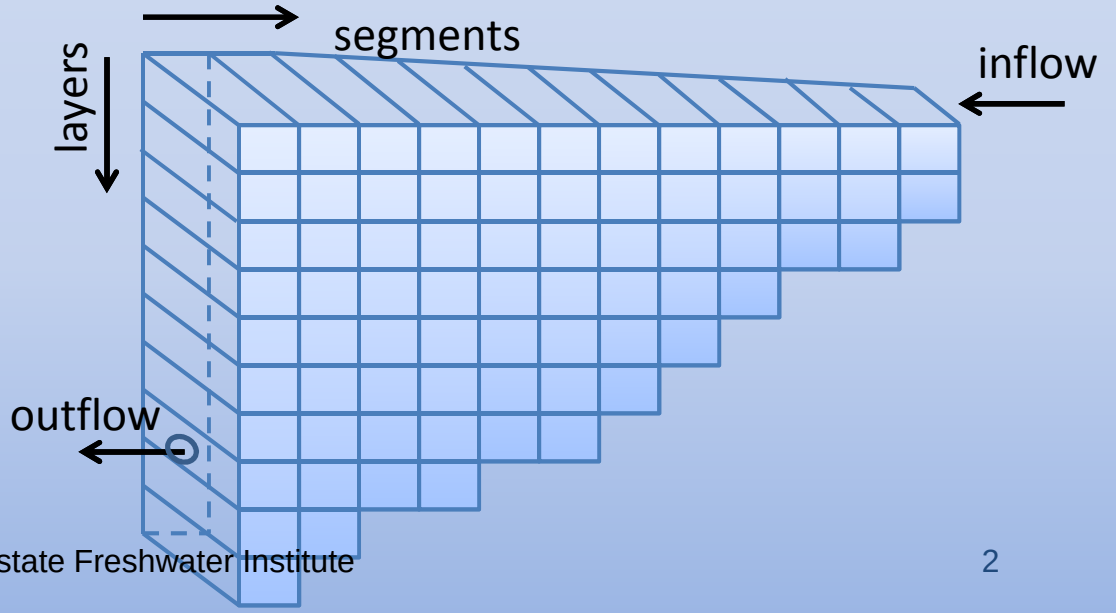
TAC Meeting
Wednesday, January 15, 2014
Cornell University, Ithaca, NY

Upstate Freshwater Institute

Two-Dimensional Model

- provide transport framework for a water quality model; TMDL analysis
- CE-QUAL-W2 (W2; US Army Corps of Engineers): dynamic, laterally averaged, two dimensional (longitudinal-vertical) model
- applied successfully to 100s of waterbodies worldwide
- hydrodynamic submodel predicts water surface elevations, velocities, and temperatures
- model can simulate baroclinic seiches

- long-term simulations (e.g., climate change)
- not suitable for near-field or 3-D simulations



Other Applications of CE-QUAL-W2 by UFI

Finger Lakes (3):

- Owasco
- Skaneateles
- Otisco

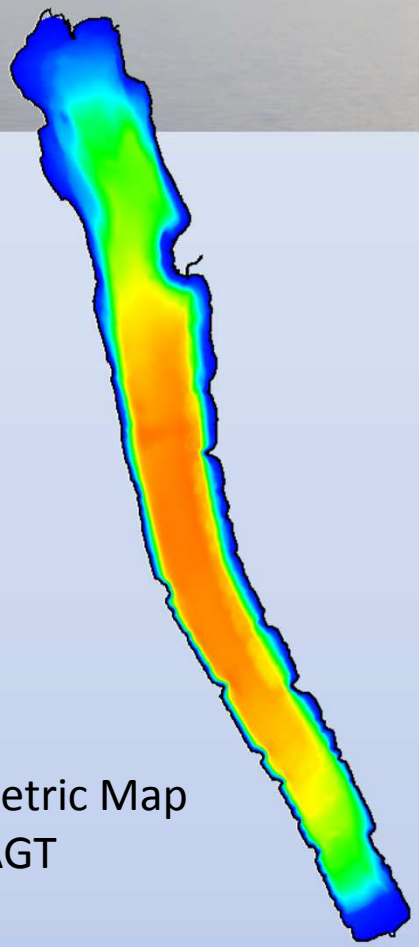
NYC Reservoirs (9):

- Ashokan
- Cannonsville
- Kensico
- Neversink
- Pepacton
- Rondout
- Schoharie
- West Branch
- New Croton

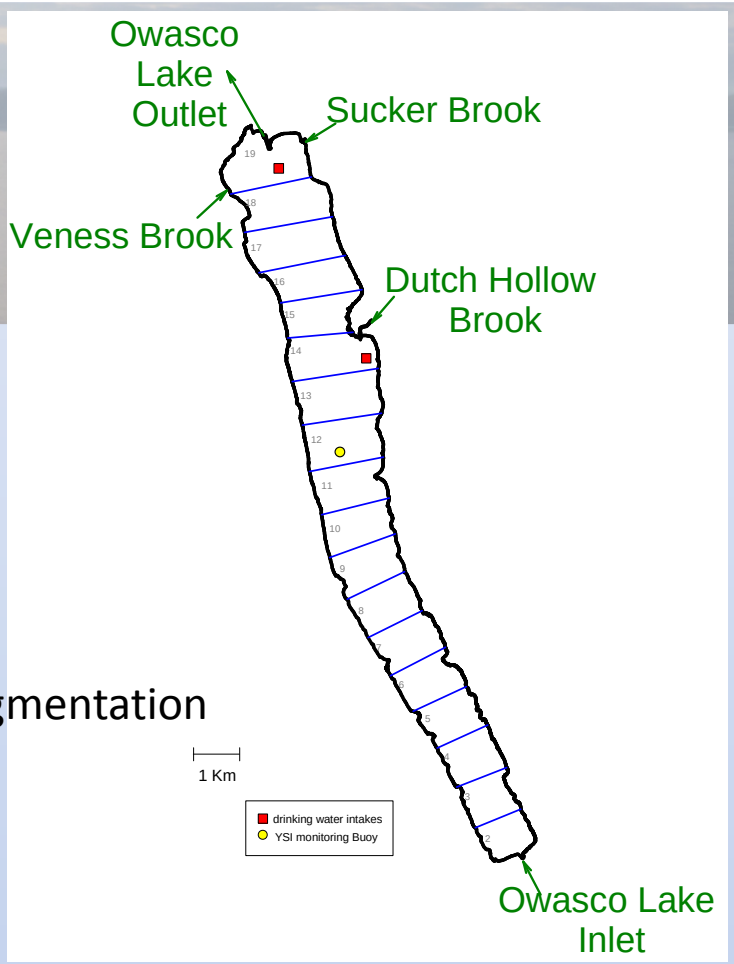
Others (1):

- Carroll County Lake, TN

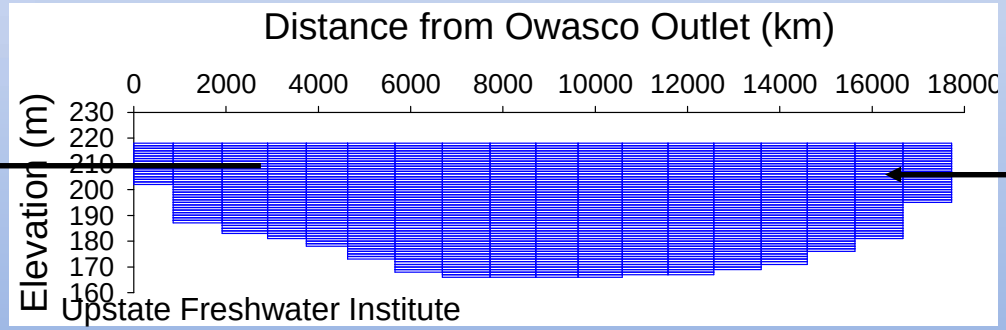
Owasco Lake



Bathymetric Map
From IAGT



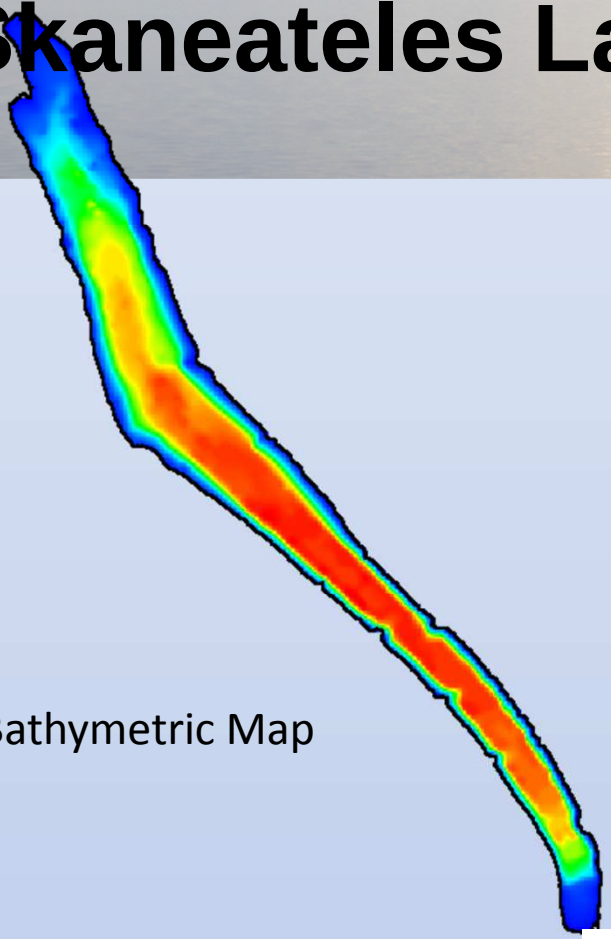
Model Segmentation



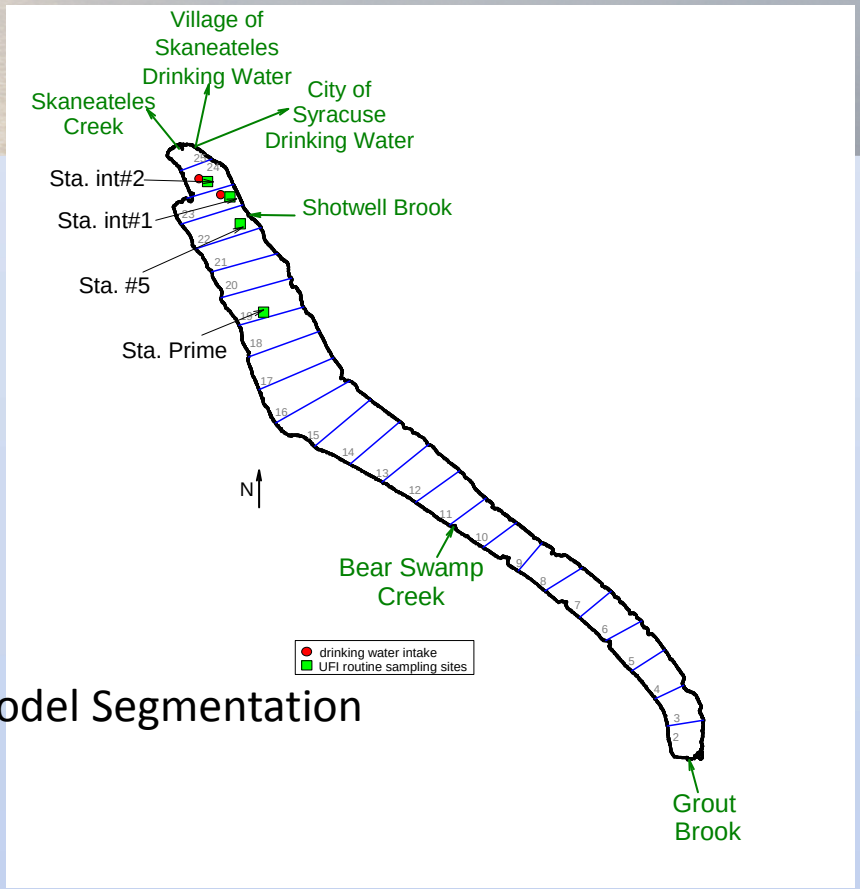
Owasco
Outlet

Owasco
Inlet

Skaneateles Lake



Bathymetric Map



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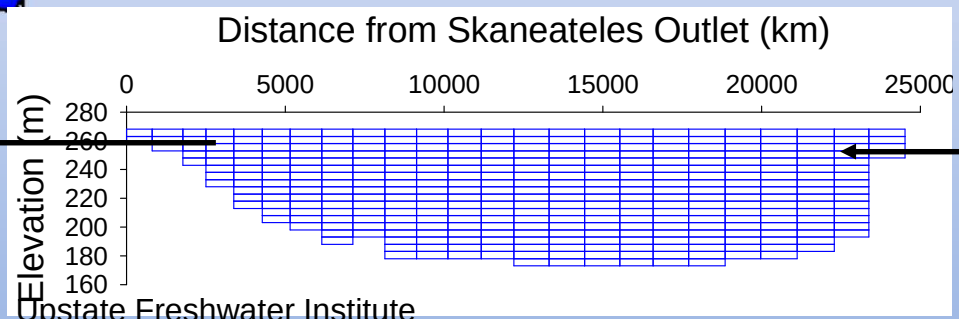
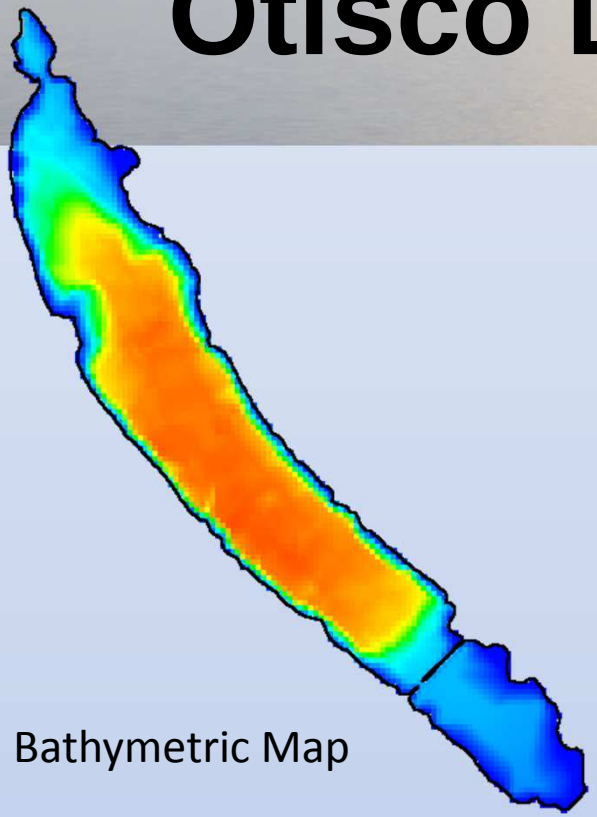


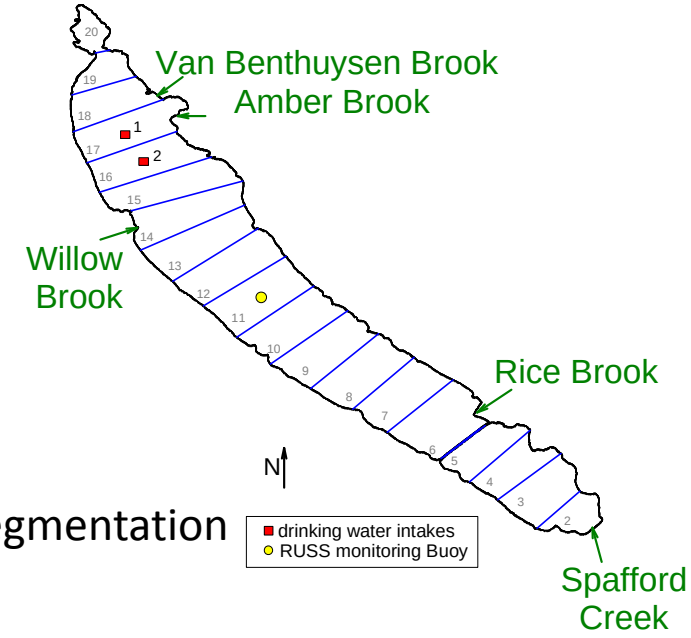
Skaneateles outlet

Grout Brook

Otisco Lake



Bathymetric Map



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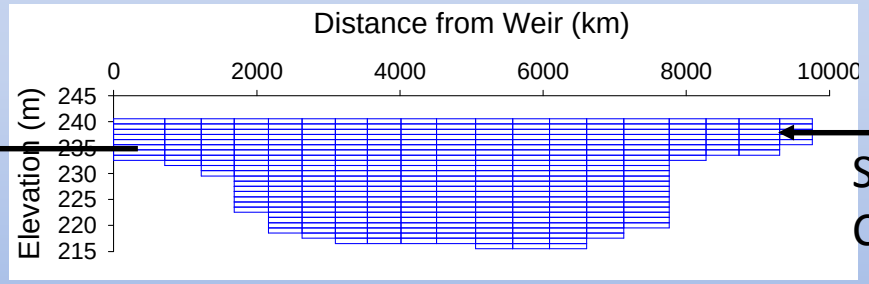
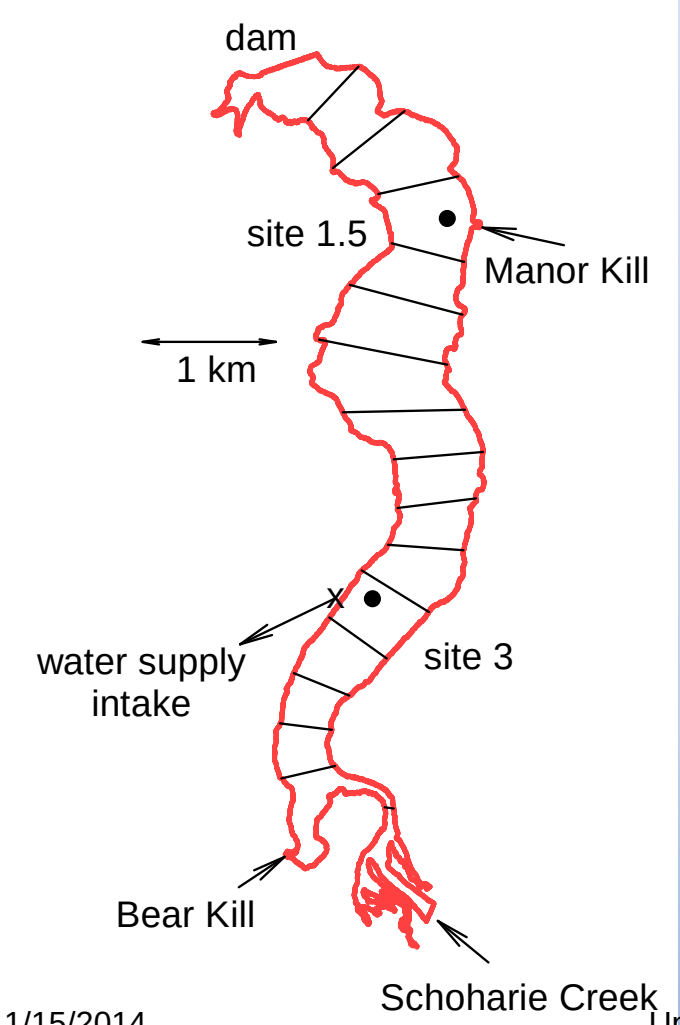
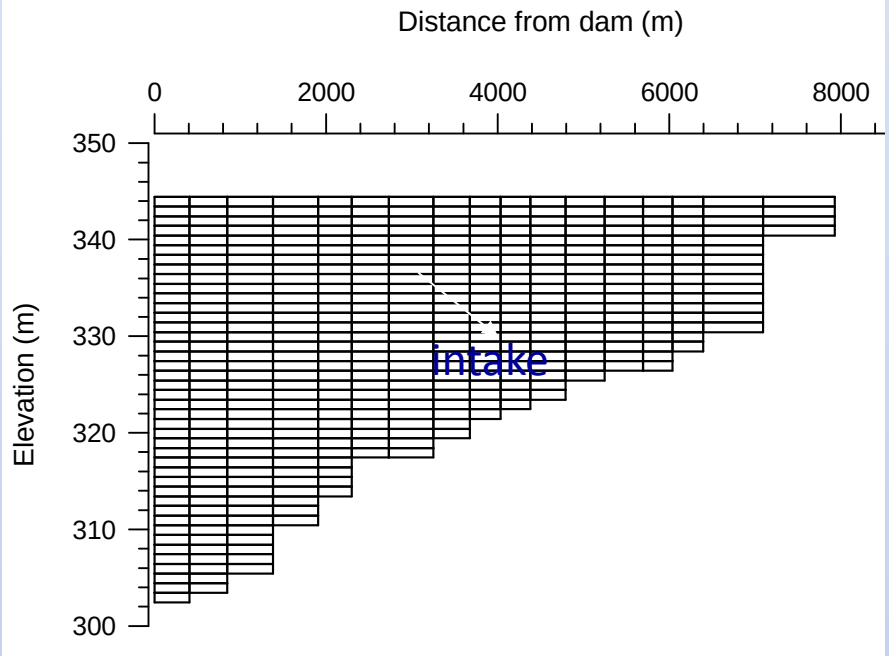


Otisco outlet

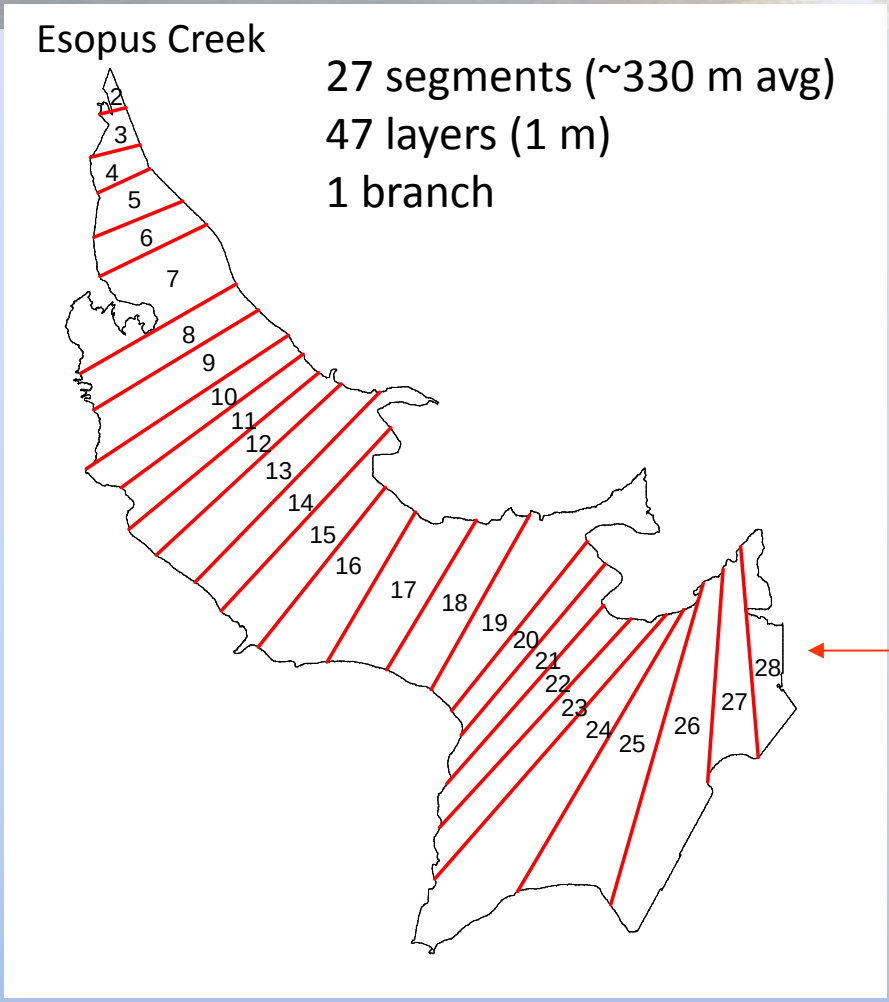
Spafford Creek

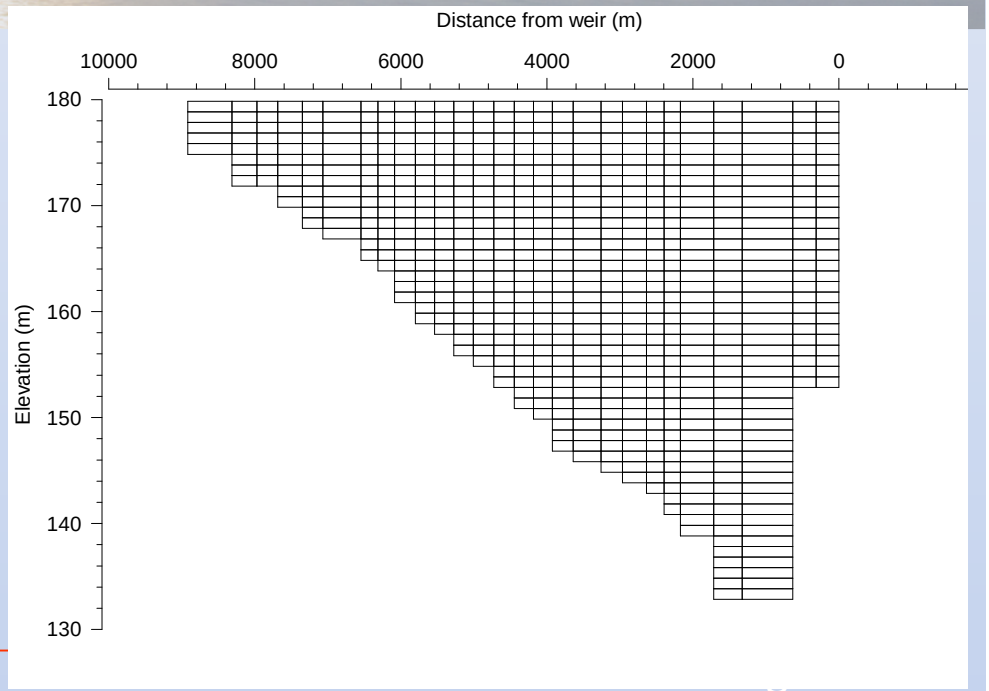
Schoharie Reservoir

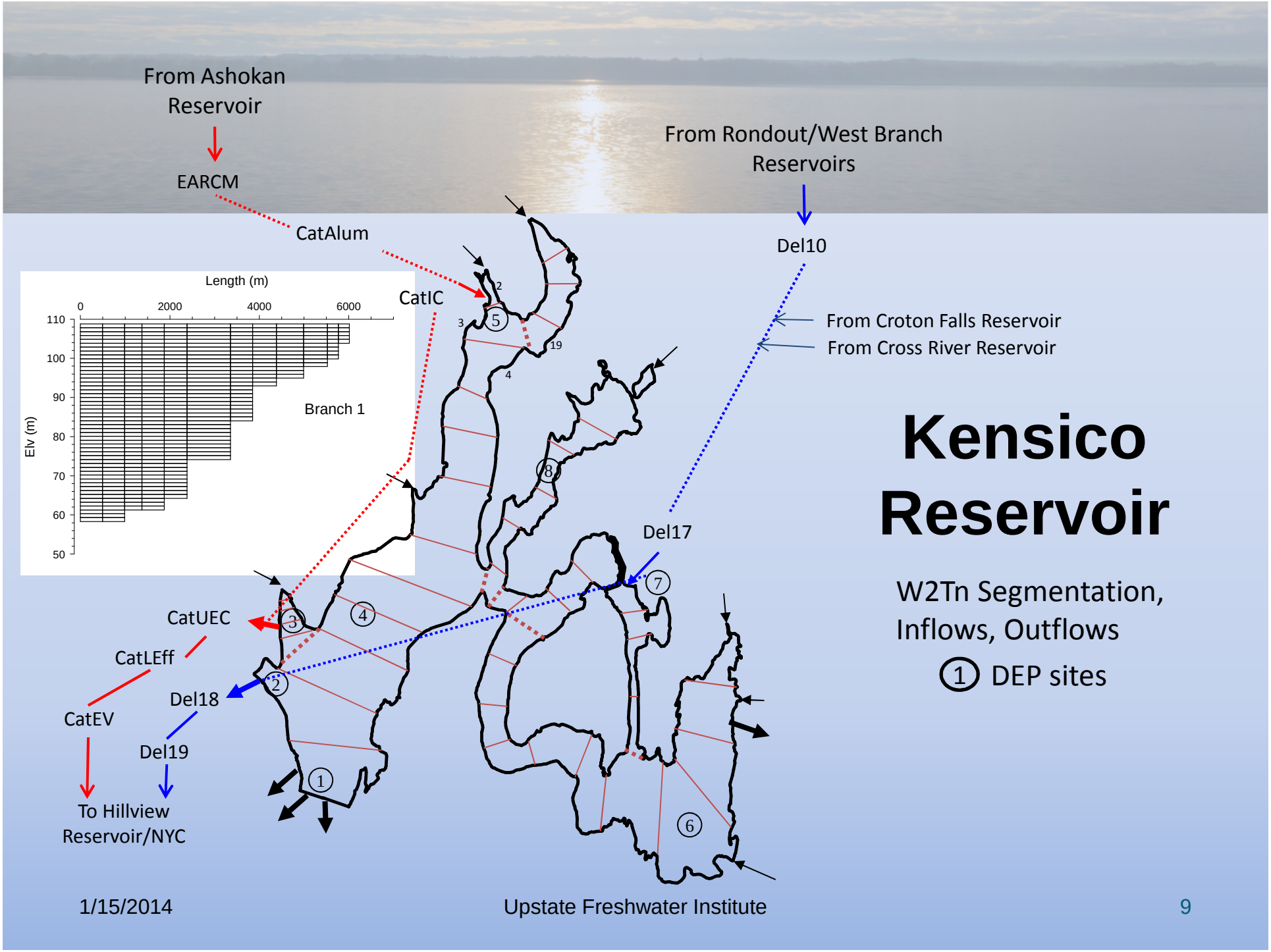




Ashokan – West Basin





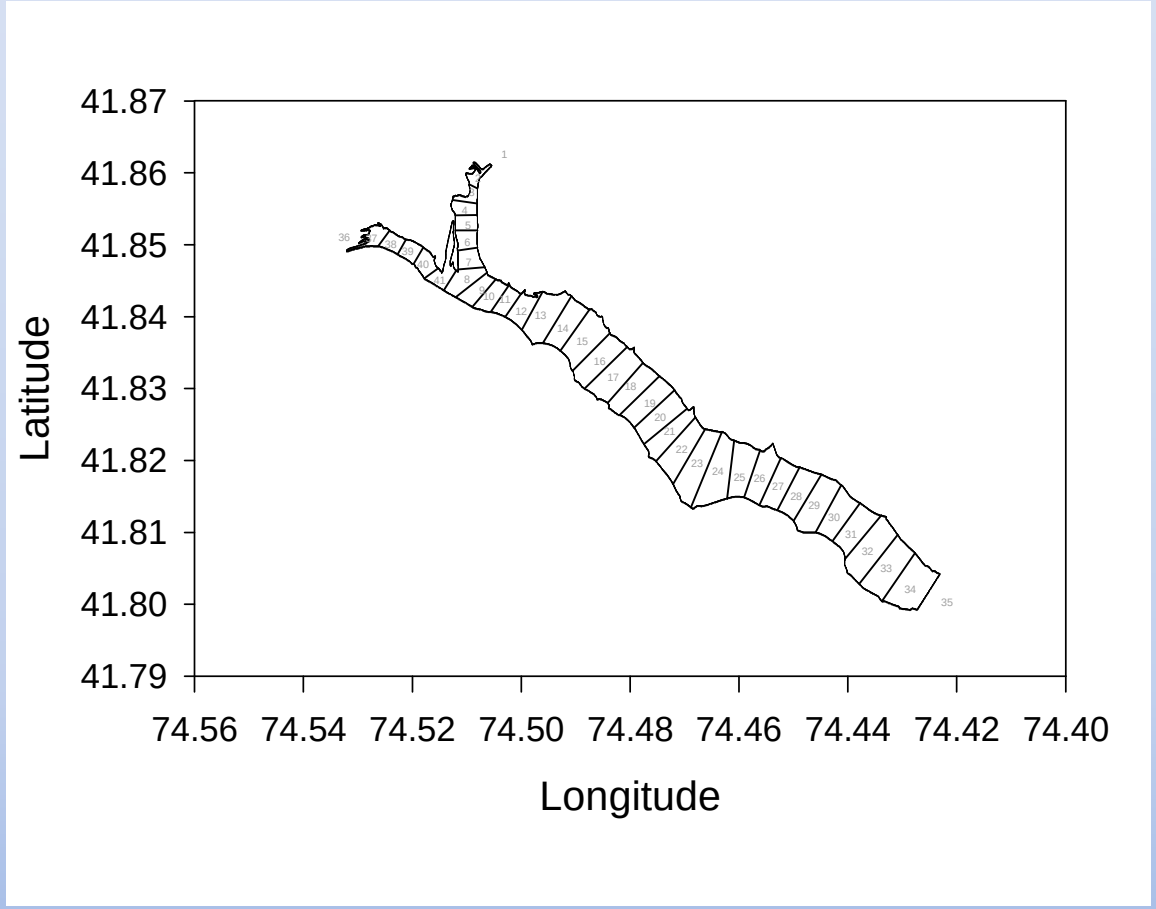


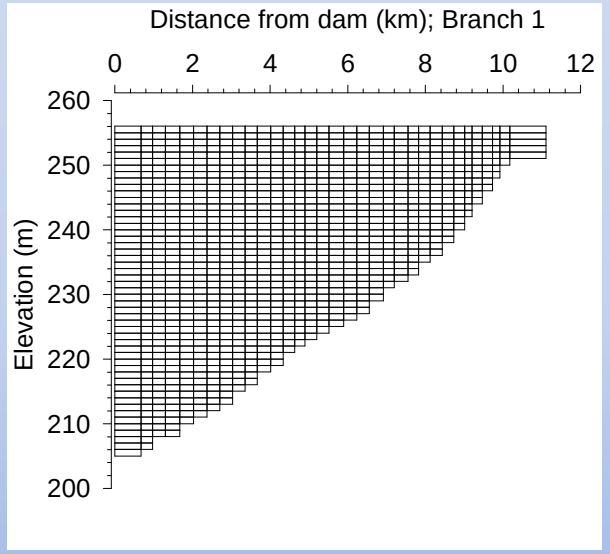
Kensico Reservoir

W2Tn Segmentation, Inflows, Outflows

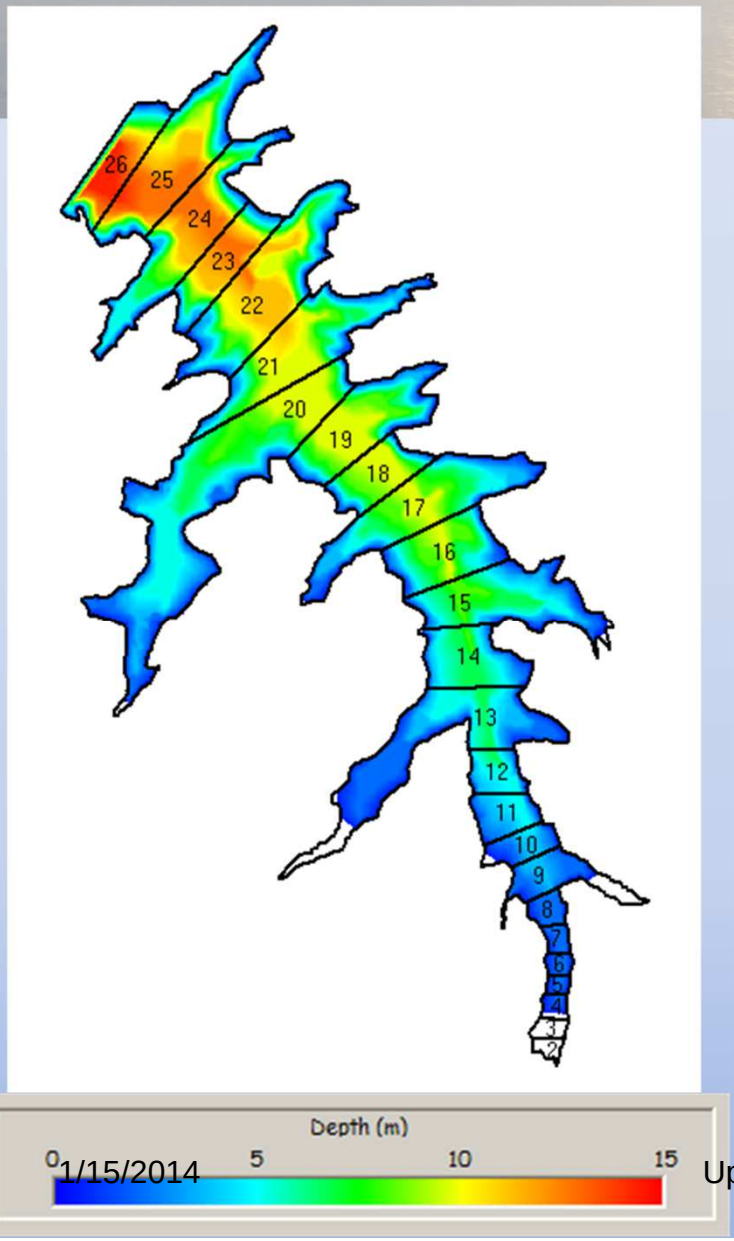
① DEP sites

Rondout Reservoir



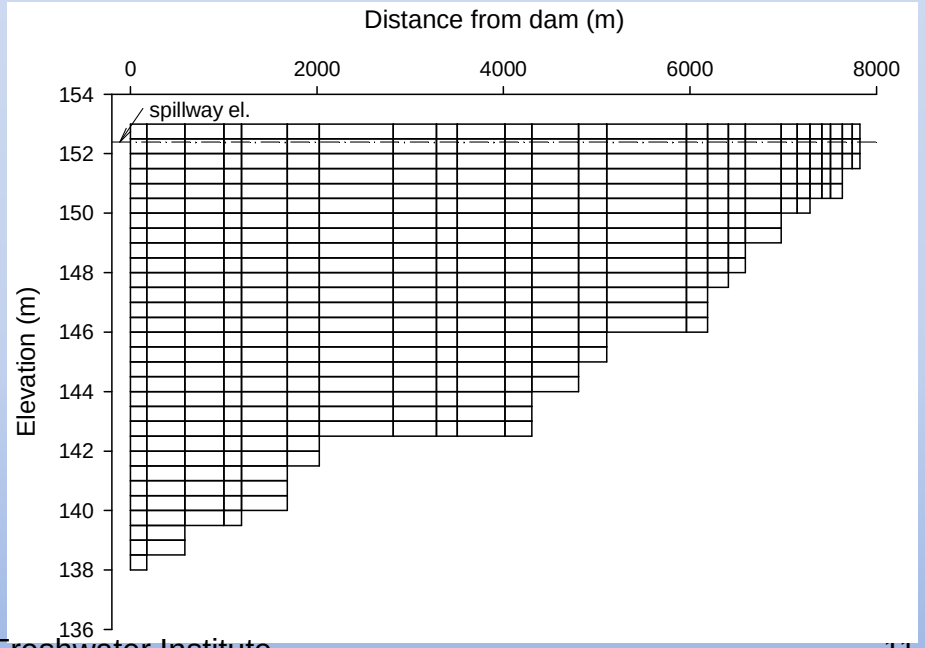


Carroll County Lake, TN



Overall Grid:
27 segments; ~300 m length
32 layers; 0.5 m depth interval

Design of a multi-level release structure



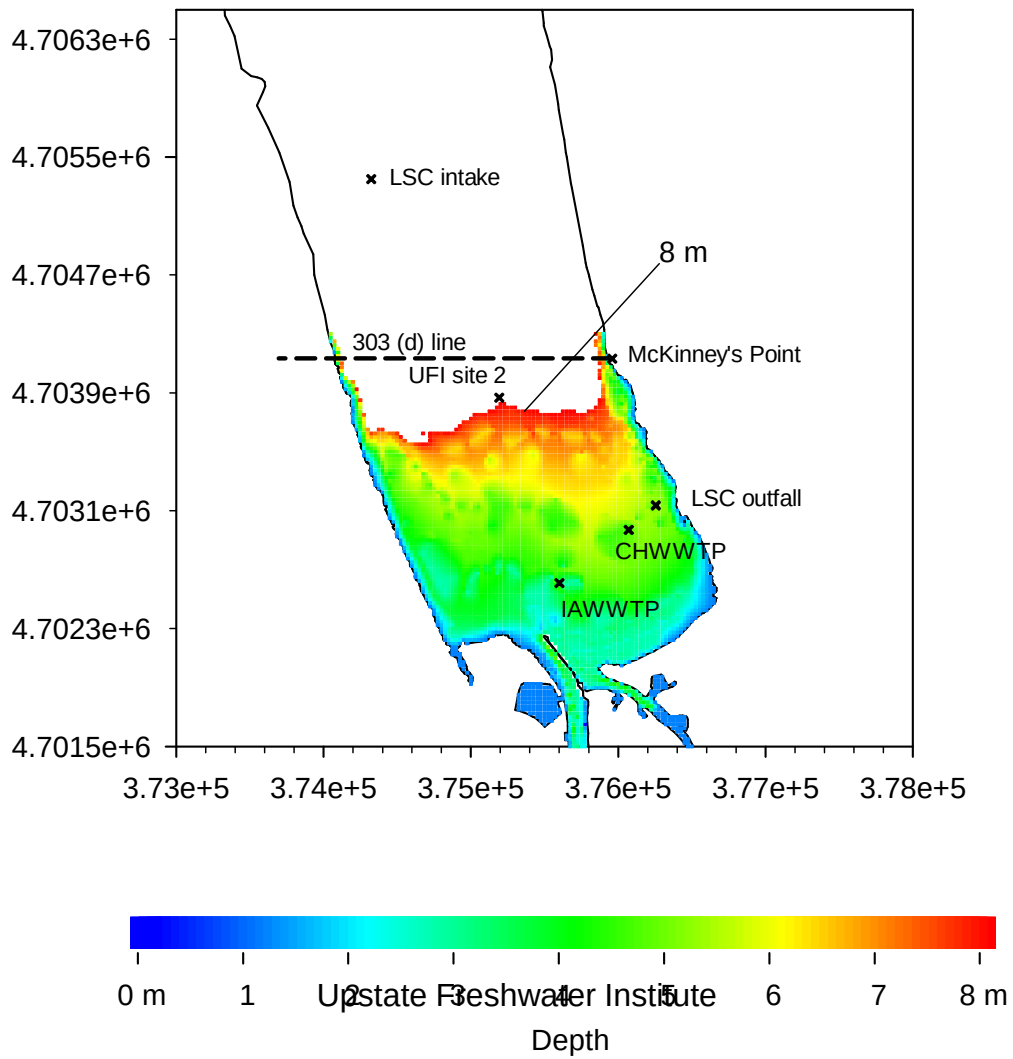
Proposed Hydrodynamic Modeling

- period of development of data for model simulations: 1987-2013 (27 years)
  - calibration: 2013
  - validation: 1998-2006
  - additional simulations: 1987-2013
- model performance features and analyses
  - state variables: water surface elevation, velocity, temperature
  - stratification regime: timing (onset and turnover), and duration of stratification; thicknesses of epilimnion and hypolimnion
  - assessment of barotropic and baroclinic seiches supported by thermistor chain data from 2013 (Cornell University)
- input from 3-D modeling (Cornell University), as necessary

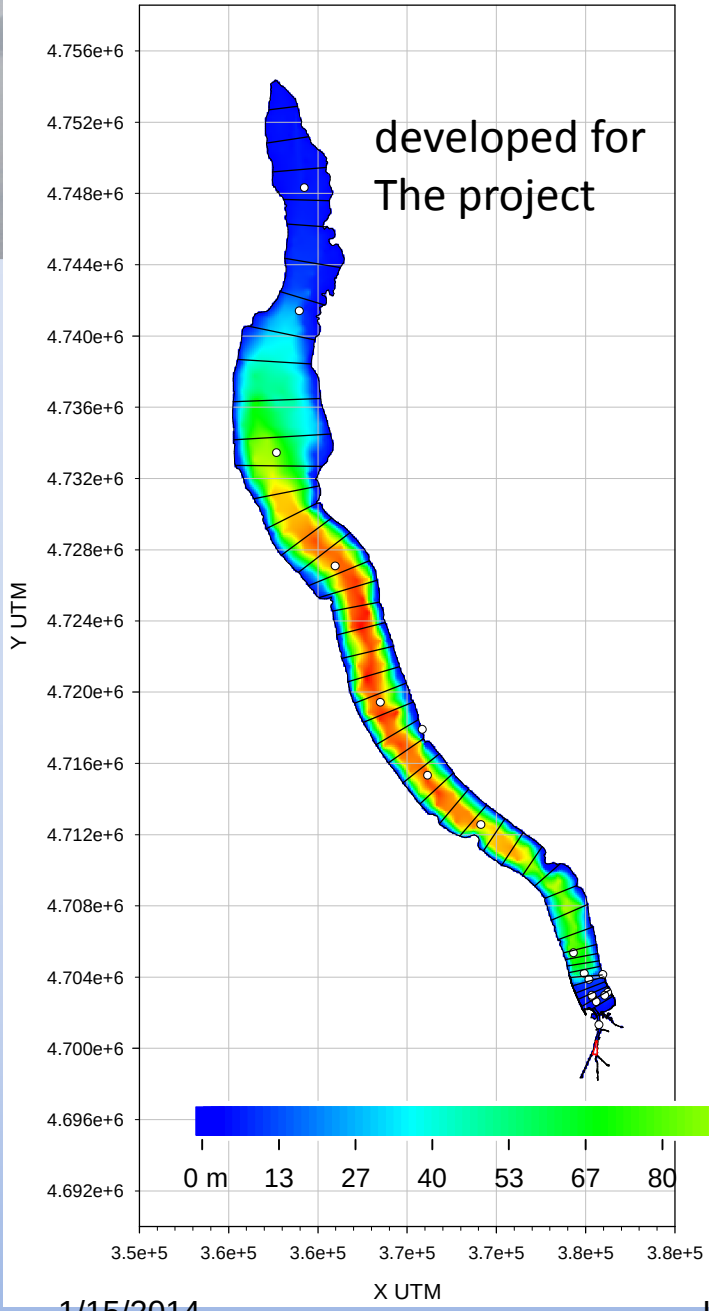
Data Requirements

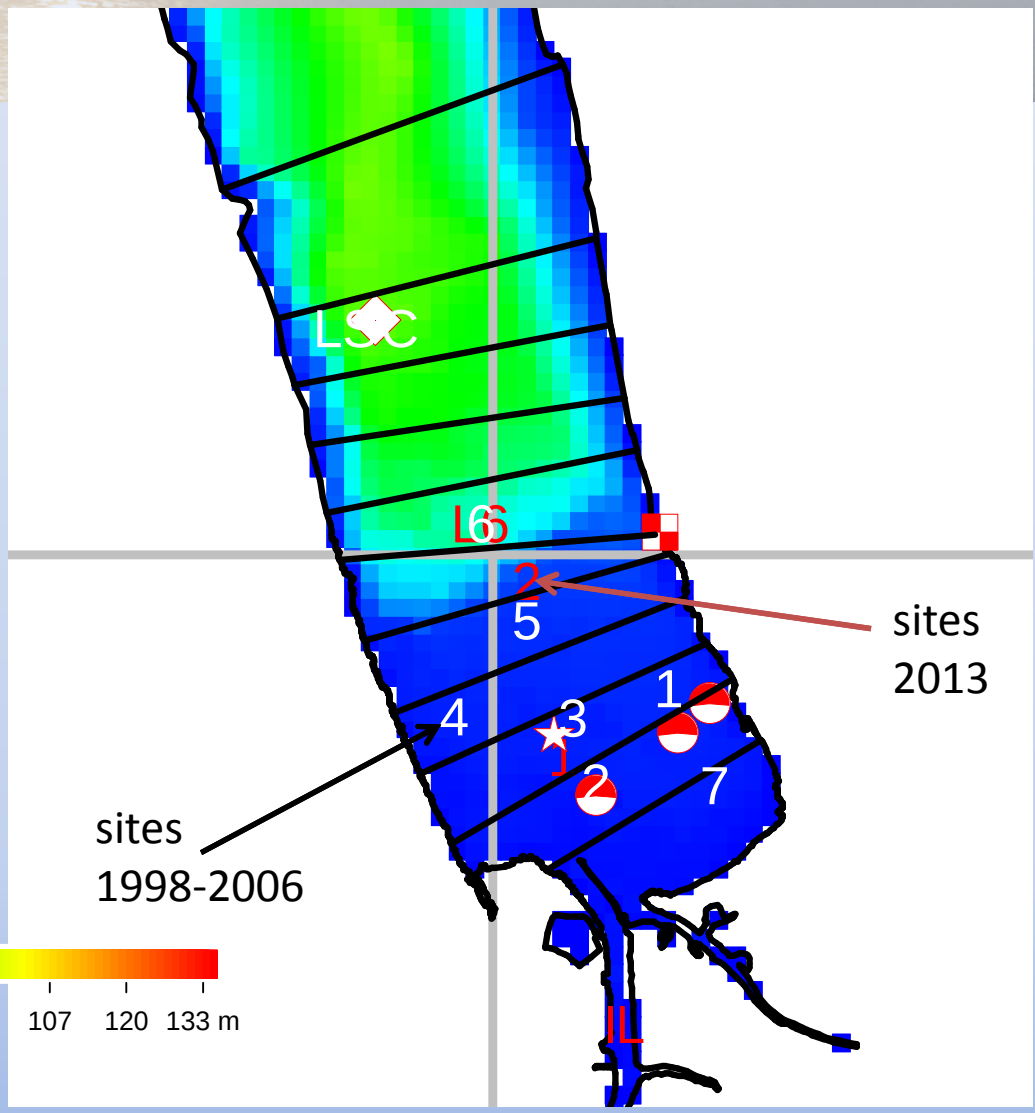
- bathymetry (Cornell)
  - longitudinal-vertical grid
- meteorological data
  - Game Farm Road, Piling Cluster, Ithaca Airport, Syracuse Airport
- inflows
  - Fall Creek, Cayuga Inlet, Six Mile Creek, Taughannock Creek, Salmon Creek, and LSC, IAWWTP, CHWWTP, Milliken Power Station discharges
  - other minor tributaries as distributed input
- outflows
  - downstream to Seneca River, LSC and Milliken Power Station withdrawals
- water surface elevation
- inflow temperatures
- light extinction coefficients
- in-lake temperatures for model testing

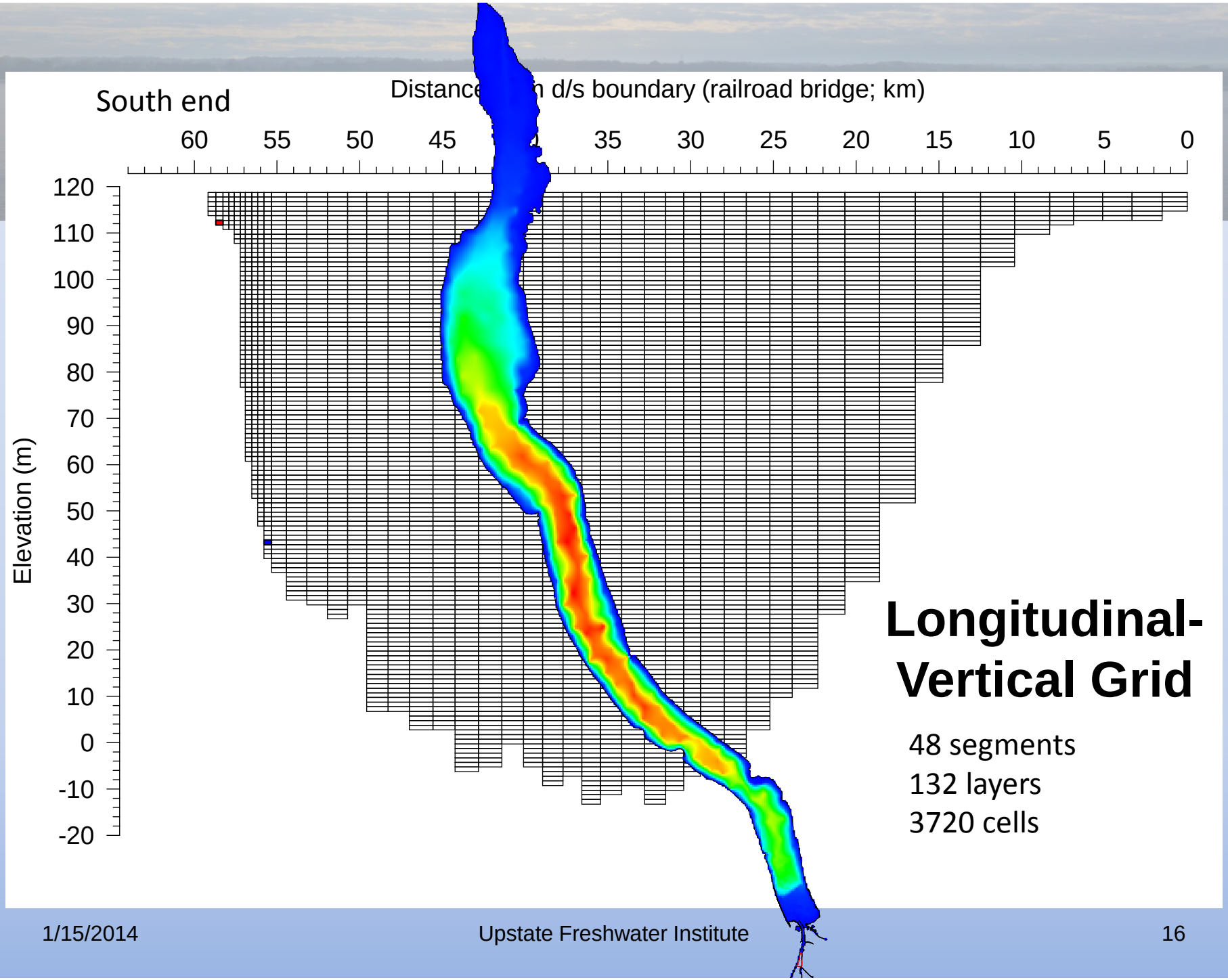
Cayuga Lake: Shelf Boundary



Longitudinal Grid

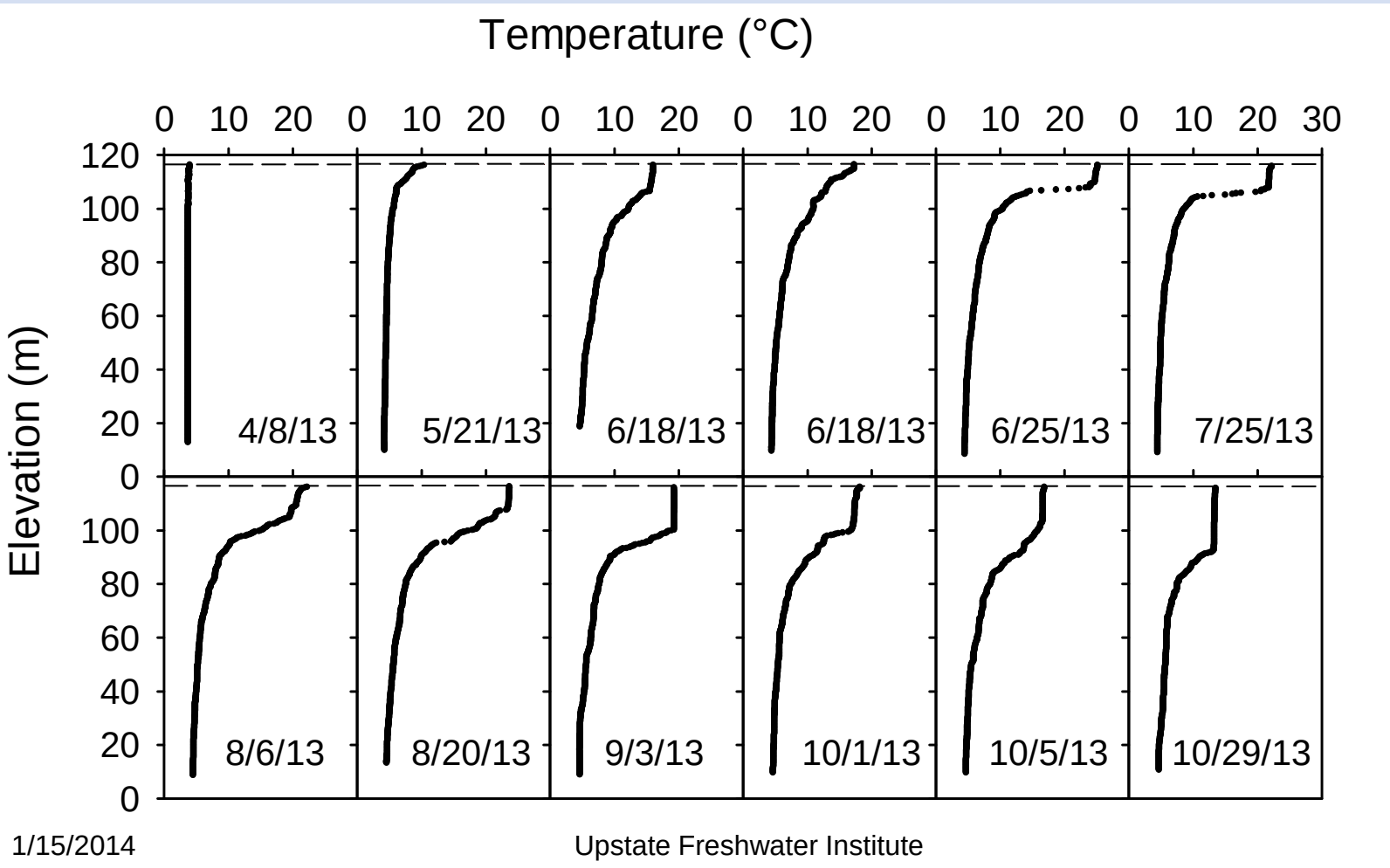





South end
Distance d/s boundary (railroad bridge; km)
60
55
50
45
35
30
25
20
15
10
5
0
Elevation (m)
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Longitudinal-Vertical Grid
48 segments
132 layers
3720 cells

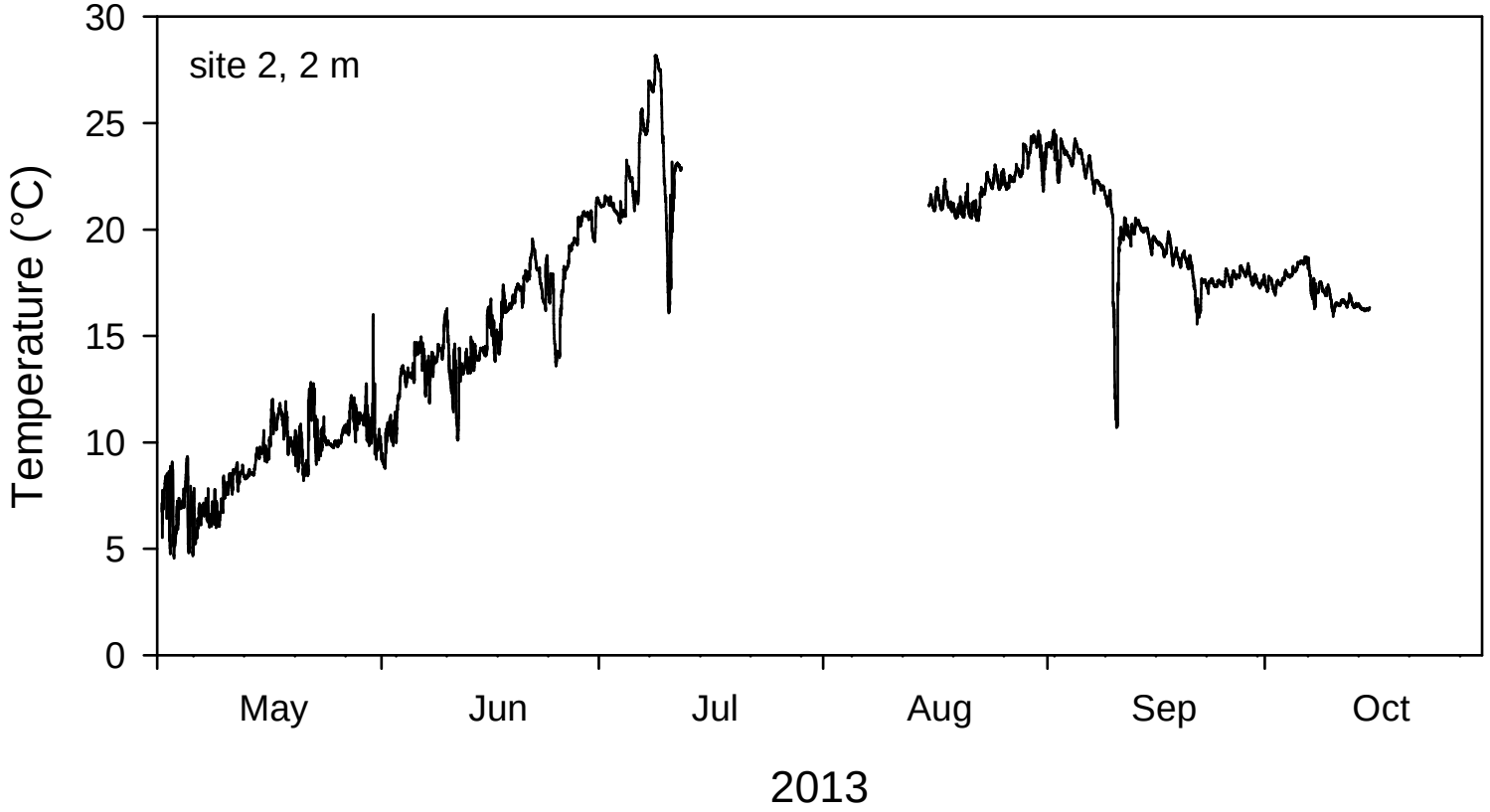
Example Calibration Data: Site 3

- depth-profiles



Example Calibration Data: Site 2

- timeseries

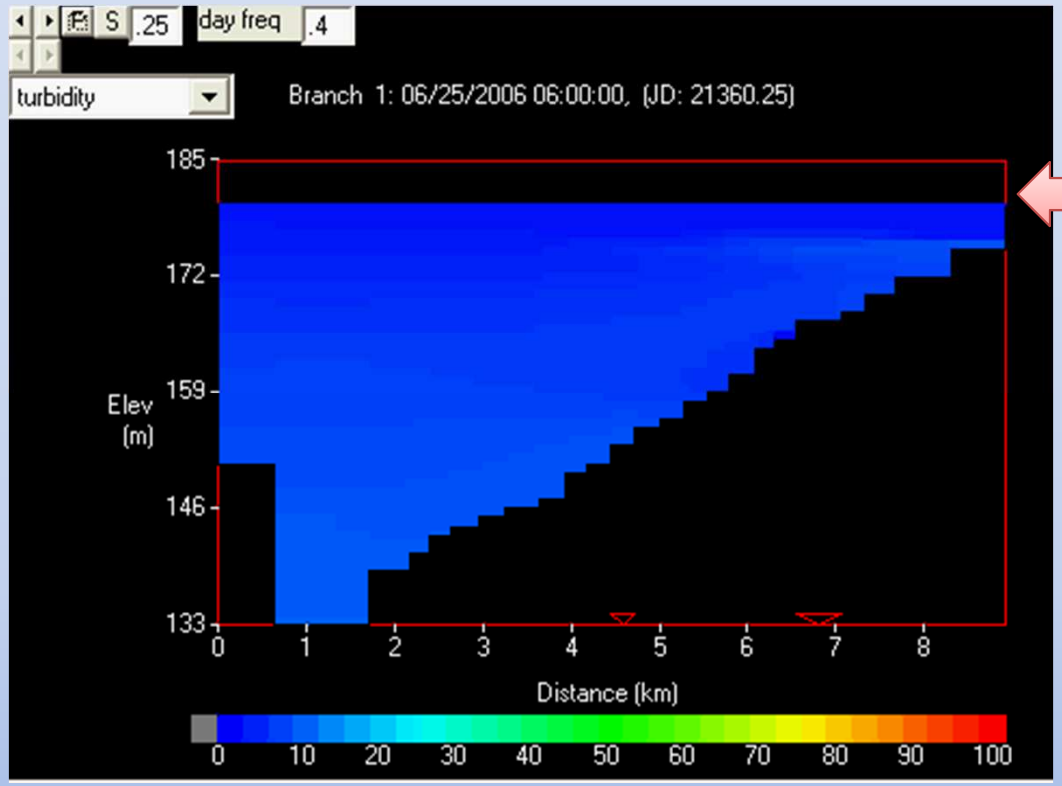


Next Steps

- complete data files for 2013
- estimate ungaged inflows (hydrologic budget)
- preliminary hydrodynamic model calibration
- evaluate model grid
- model performance evaluation (stratification, hydrodynamics)

Visualization of Turbidity Predictions Following a Runoff Event

Ashokan West – June 25, 2006 through July 11, 2006



Esopus Creek