Delta TRIM Hydrodynamic modeling in CASCaDE

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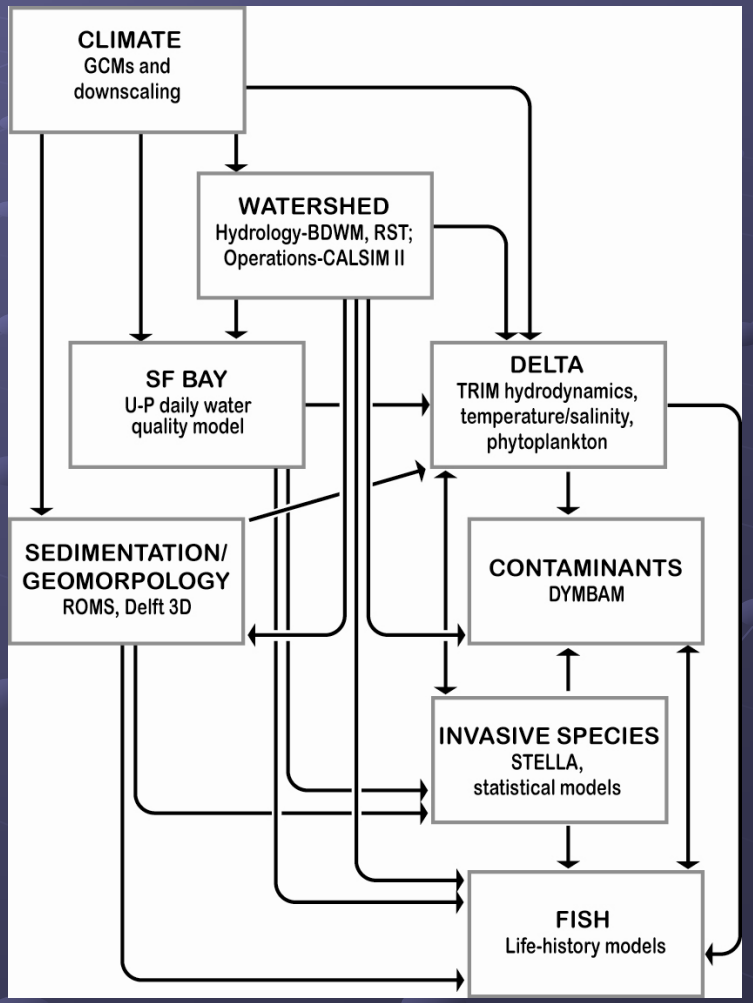
USGS

Funding from IEP and CALFED have been critical to the development of Delta TRIM.

National Science Foundation Fellowship	*NSF 1994-1996*
Hydrodynamic Modeling of the Bay-Delta System	*IEP 1997*
Assessment of Organic Matter in Habitat and its Relationship to the Food Chain	*CALFED 1997*
Transport, Transformation and Effects of Se and Carbon in the Delta: Implications for Ecosystem Restoration	*CALFED 2001*
How does the Delta Work? Understanding Fundamental Hydrodynamic and Transport Mechanisms	*CALFED 2002*
CASCaDE: Computational Assessment of Scenarios of Change in the Delta Ecosystem	*CALFED 2004*

CASCaDE: Computational Assessment of Scenarios of Change in the Delta Ecosystem

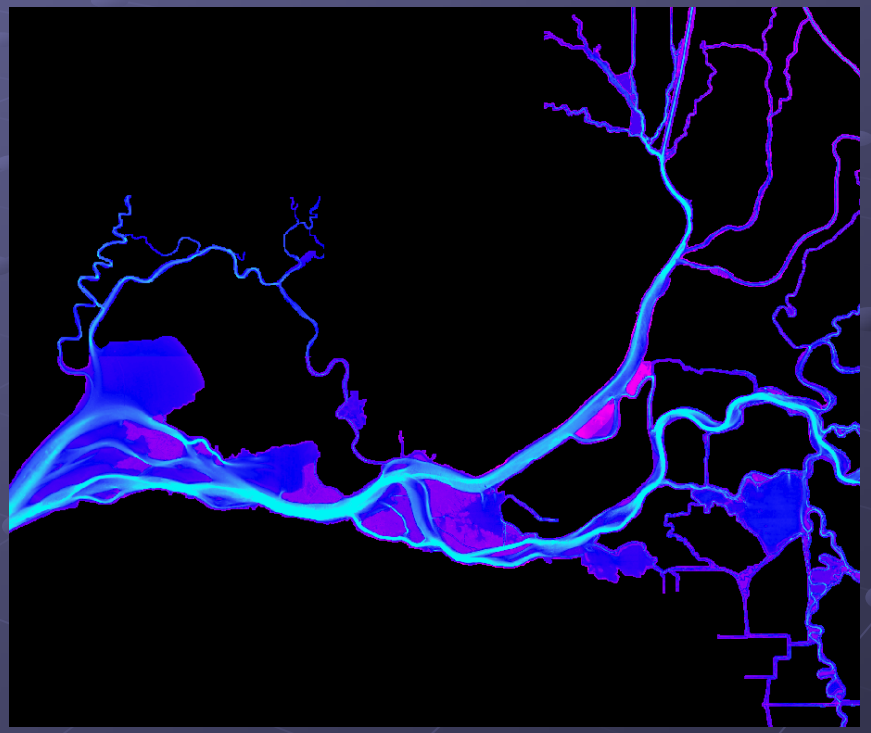
- End date for CASCaDE: September 2009
- Future funding: ???



Delta TRIM Hydrodynamic model

What the model does do:

1. Calculates stage,velocity and scalar concentrations at a 50 m resolution for the entire Delta and Suisun Bay
2. Accounts for real tides and river inflows, gate operations, temporary barriers, and pump operations

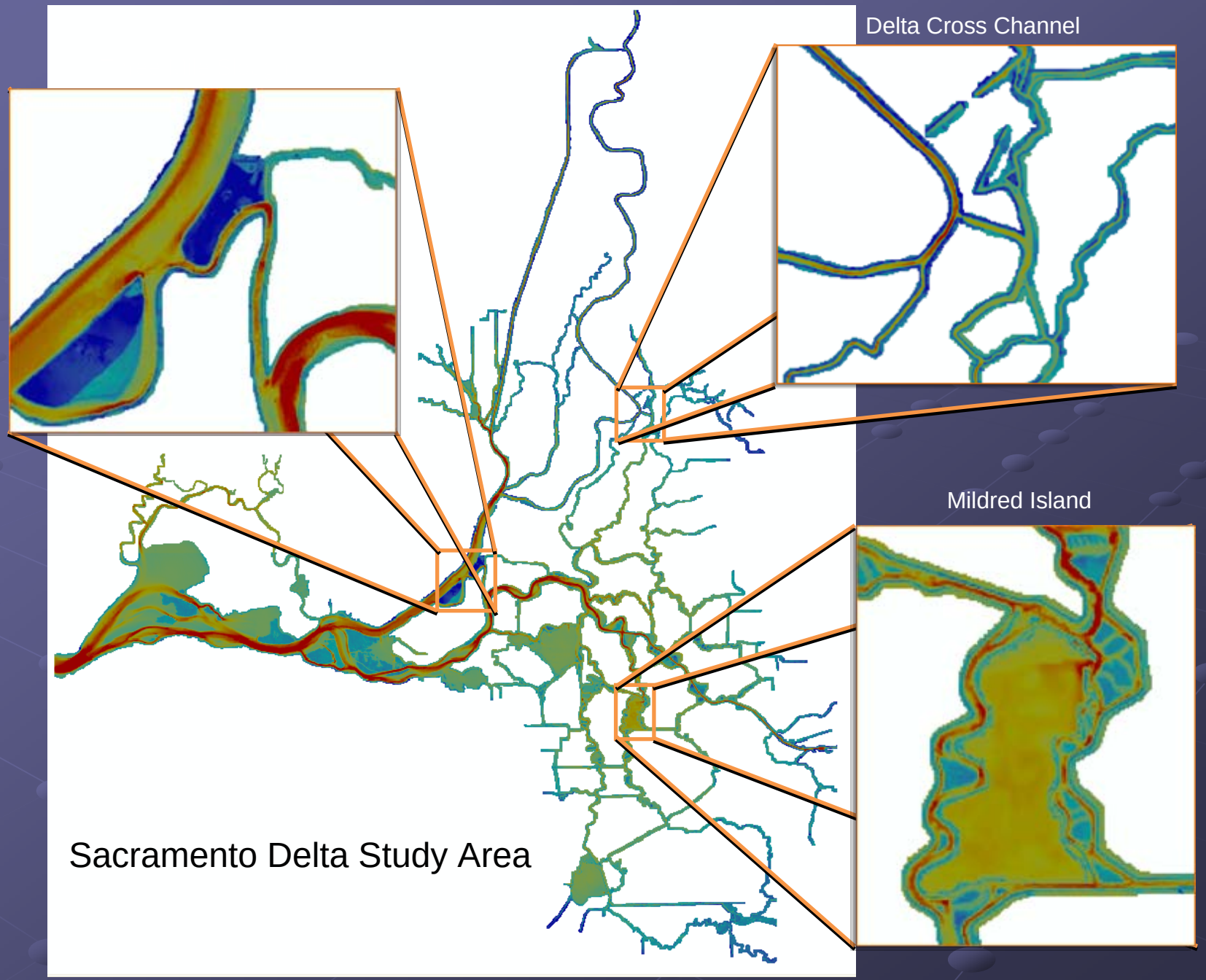


References:

Casulli and Cattani (1994) {Hydro}

Gross (1999) {Scalar Transport}

Monsen (2001) {Delta TRIM}


Delta Cross Channel
Mildred Island
Sacramento Delta Study Area

Delta TRIM Model GRID
Junction of the Sacramento and San Joaquin Rivers at Three Mile Slough

Delta TRIM has a 50 m grid resolution. Velocities are computed on the walls of the computational volume while the stage elevation is computed at the center of the cell. This figure shows the depths specified at the walls of the cells.

Hydrology
(Climate Change)

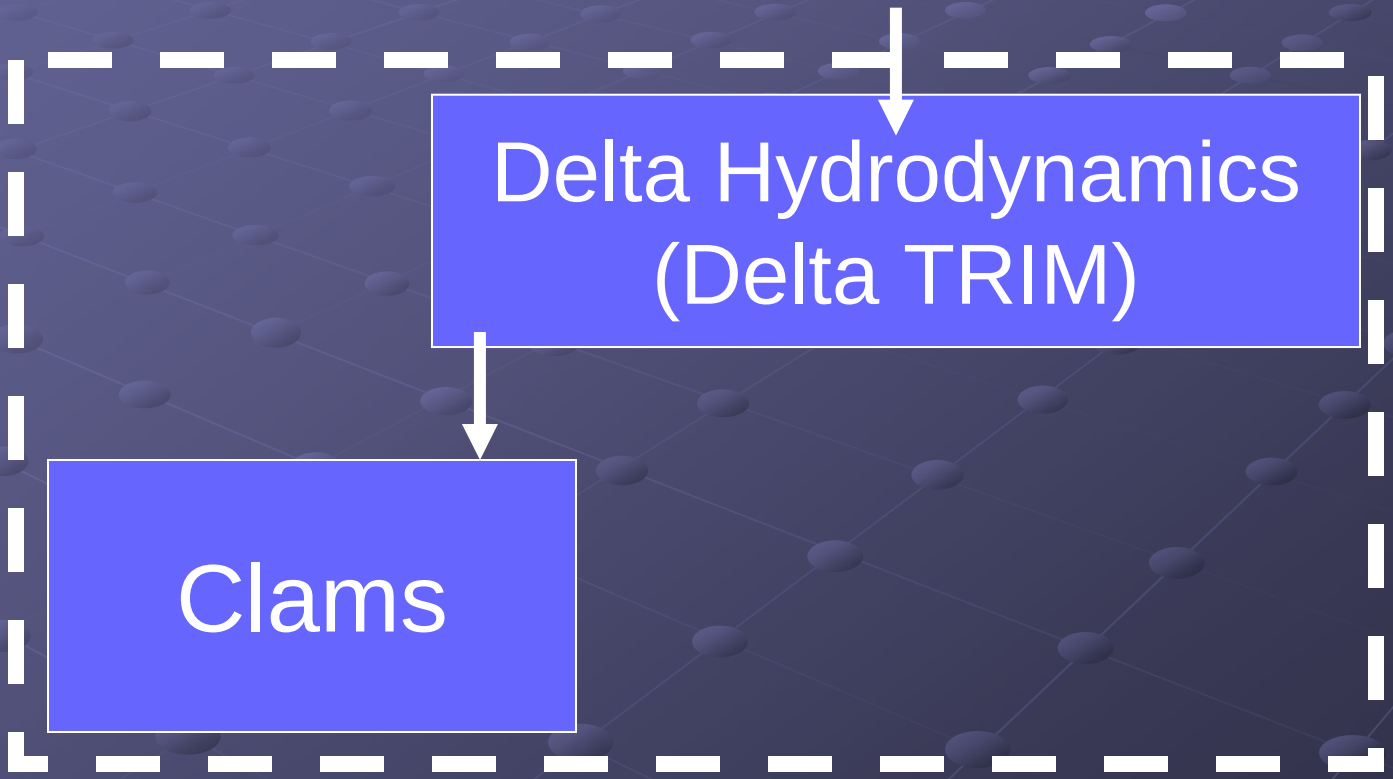
Delta Hydrodynamics
(Delta TRIM)

Clams

Phytoplankton
(Fish Food)

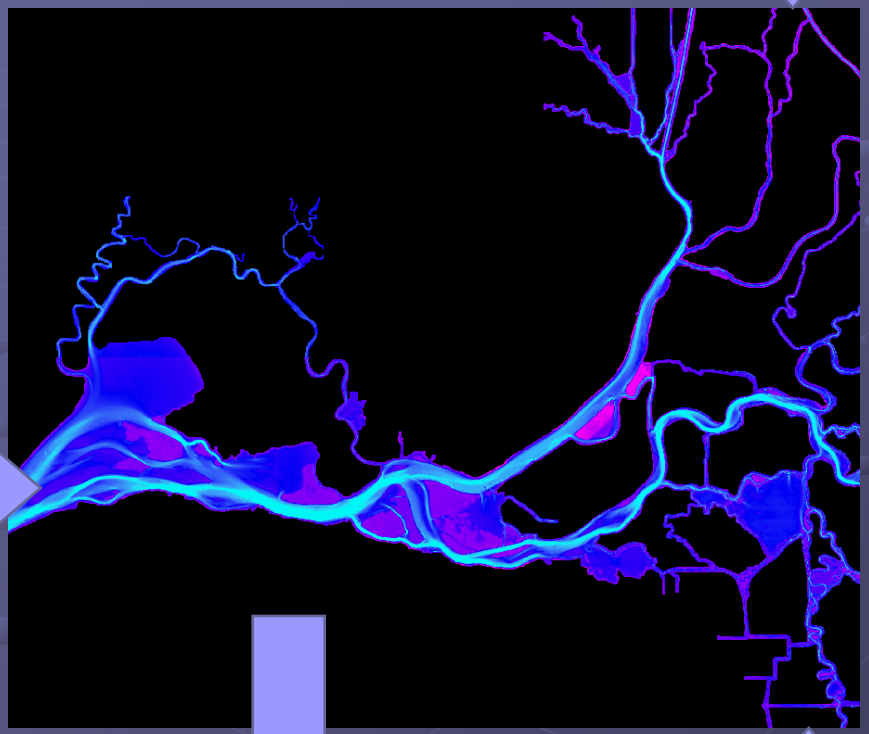
Toxins

Is there tidal exchange between the Suisun Bay and Western Delta environments?



Sacramento Flow

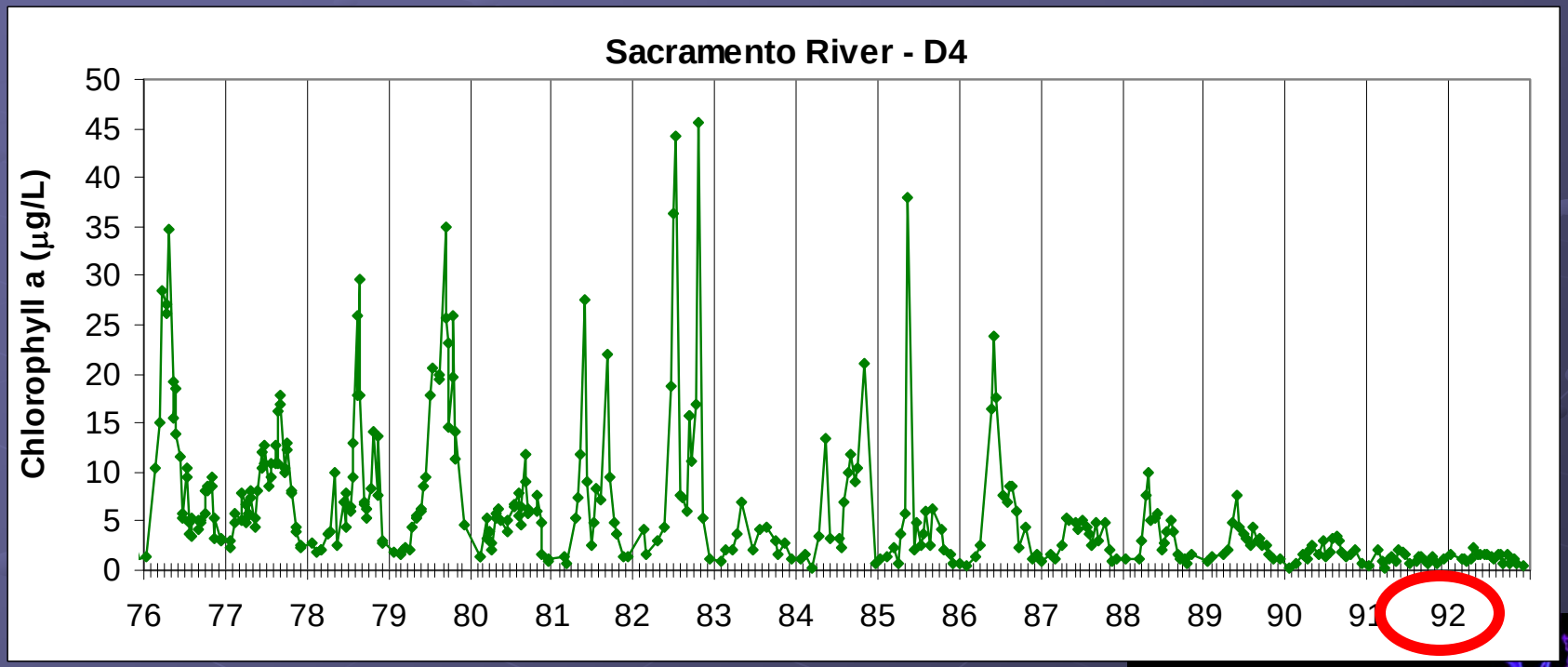
Tides



Ecosystem Response

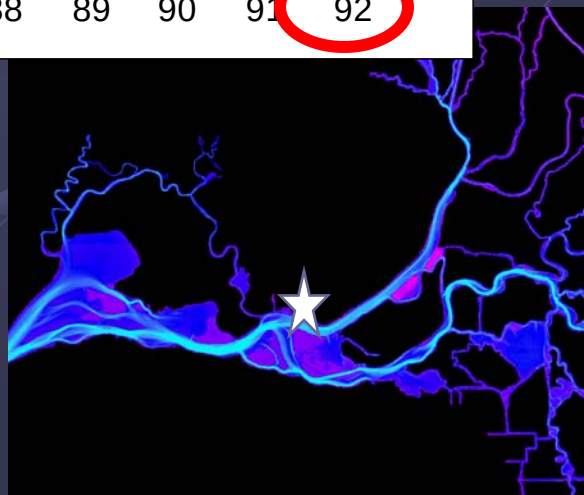
San Joaquin Flow

What we know about the clams:



Channel station at Collinsville.

Source: Jan Thompson



Peaks in Chlorophyll *a* do not start until Summer/Early Fall in pre-corbula years.

An Observation:

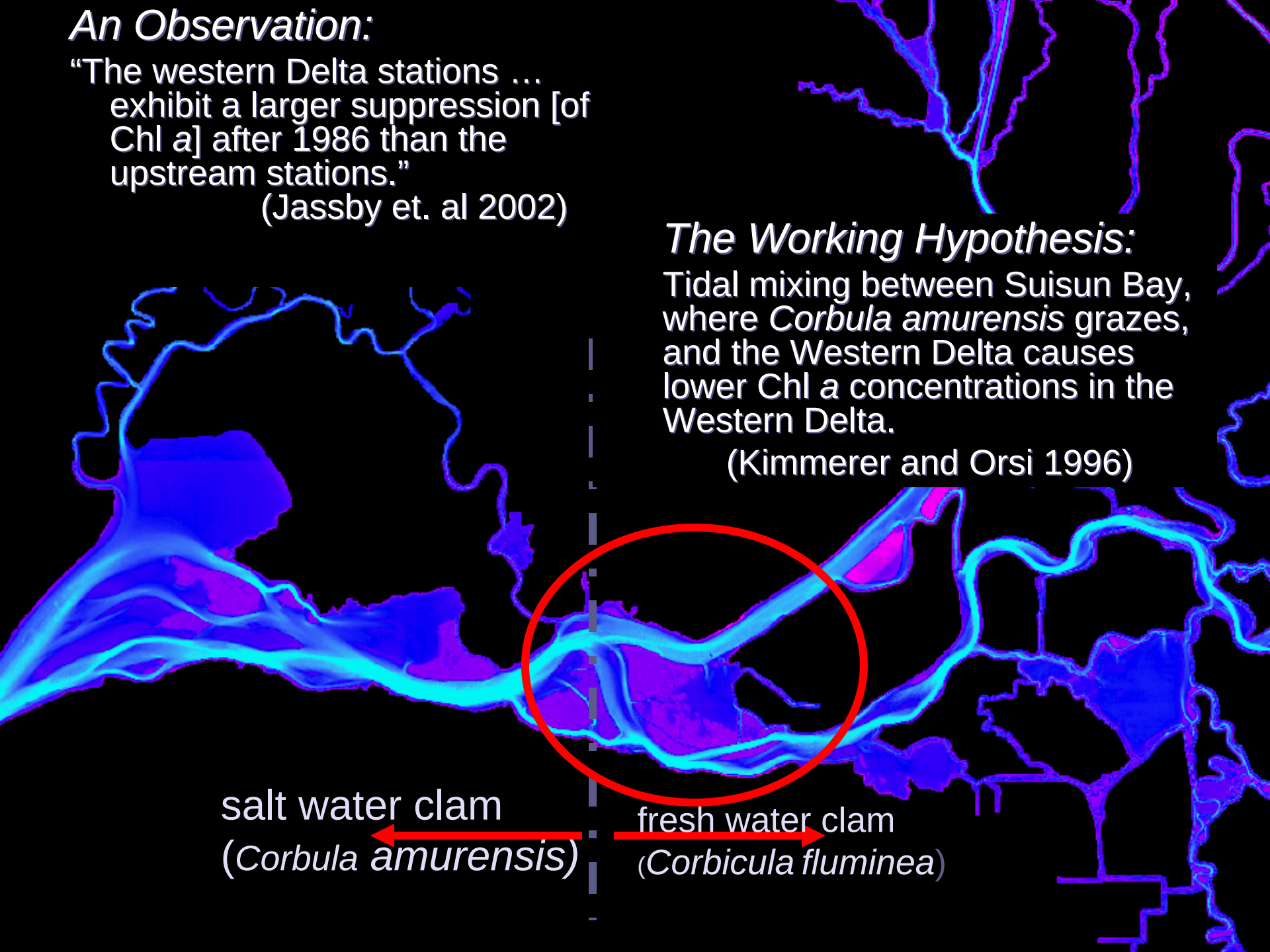
"The western Delta stations … exhibit a larger suppression [of Chl *a*] after 1986 than the upstream stations."

(Jassby et. al 2002)

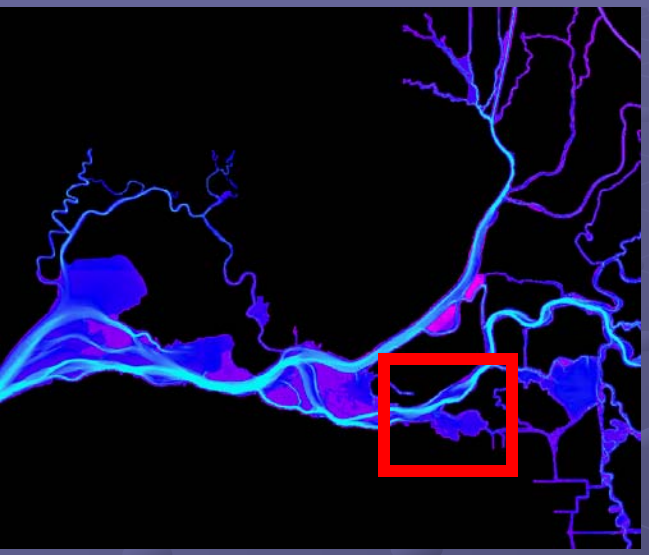
The Working Hypothesis:

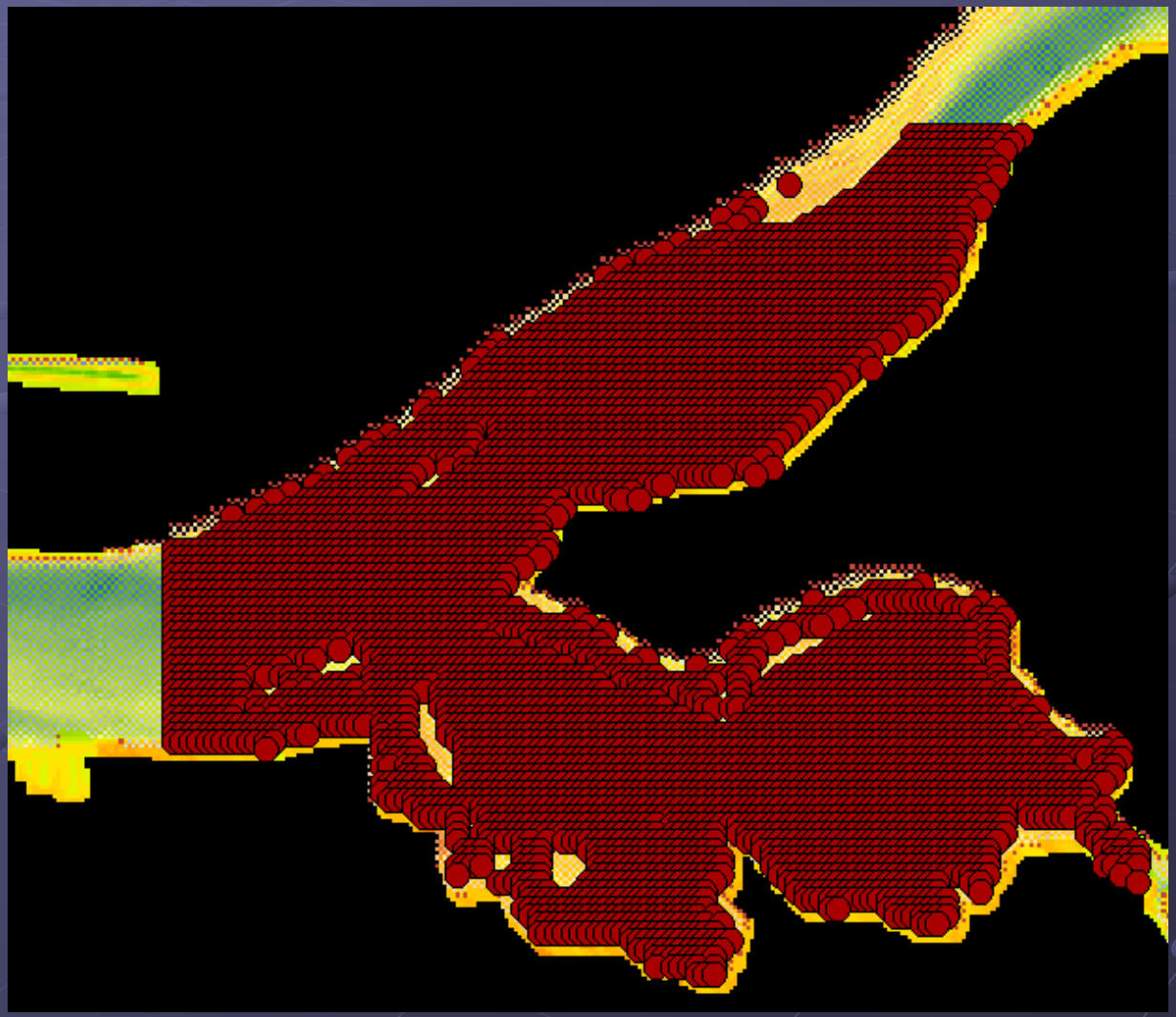
Tidal mixing between Suisun Bay, where *Corbula amurensis* grazes, and the Western Delta causes lower Chl *a* concentrations in the Western Delta.

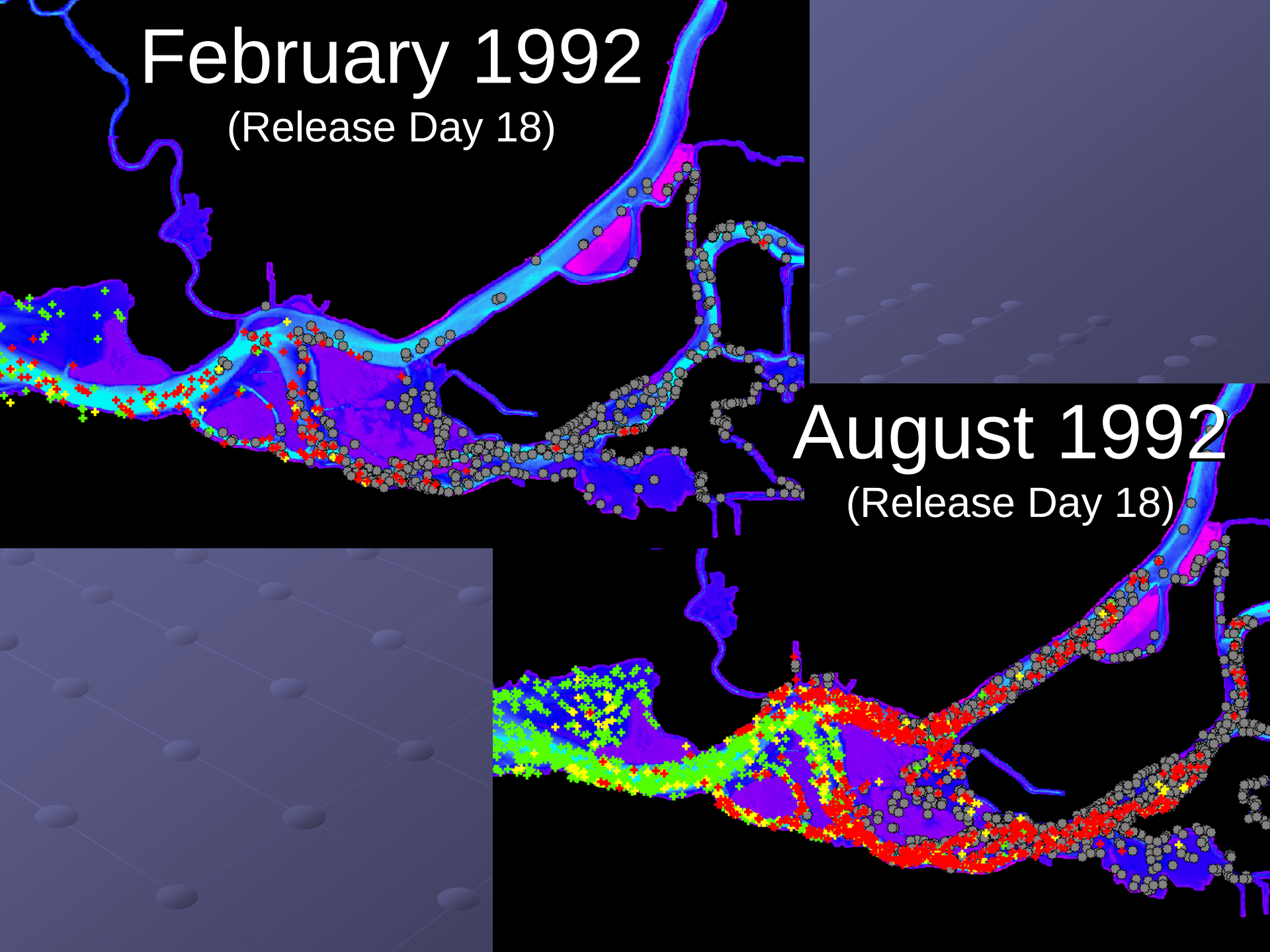
(Kimmerer and Orsi 1996)



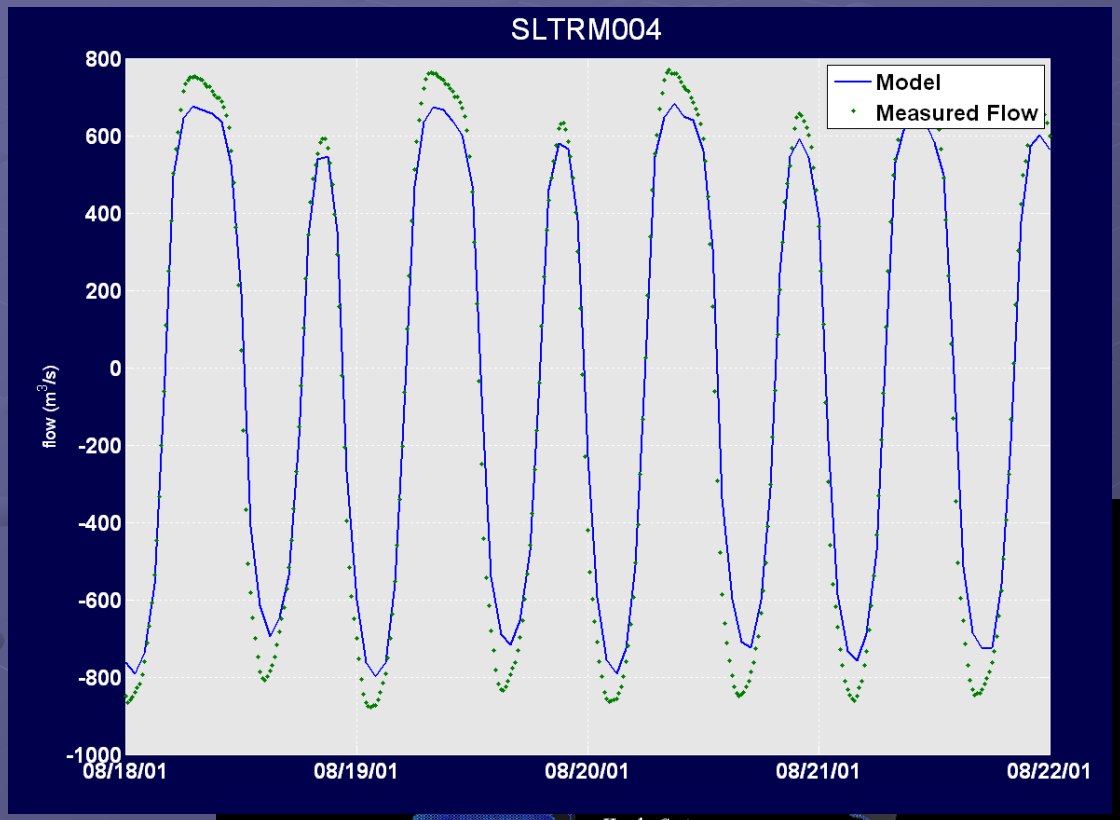
Numerical “drogues” released at every grid cell (50 m x 50 m) in the Lower San Joaquin & Big Break region

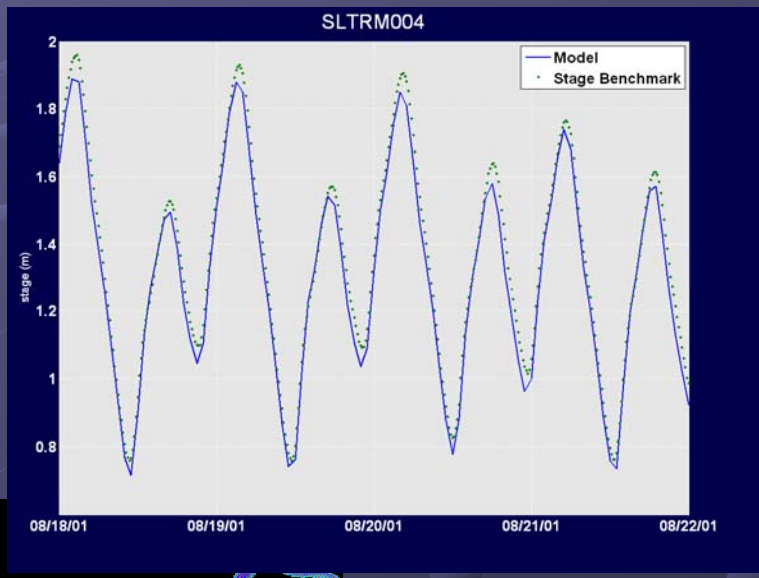


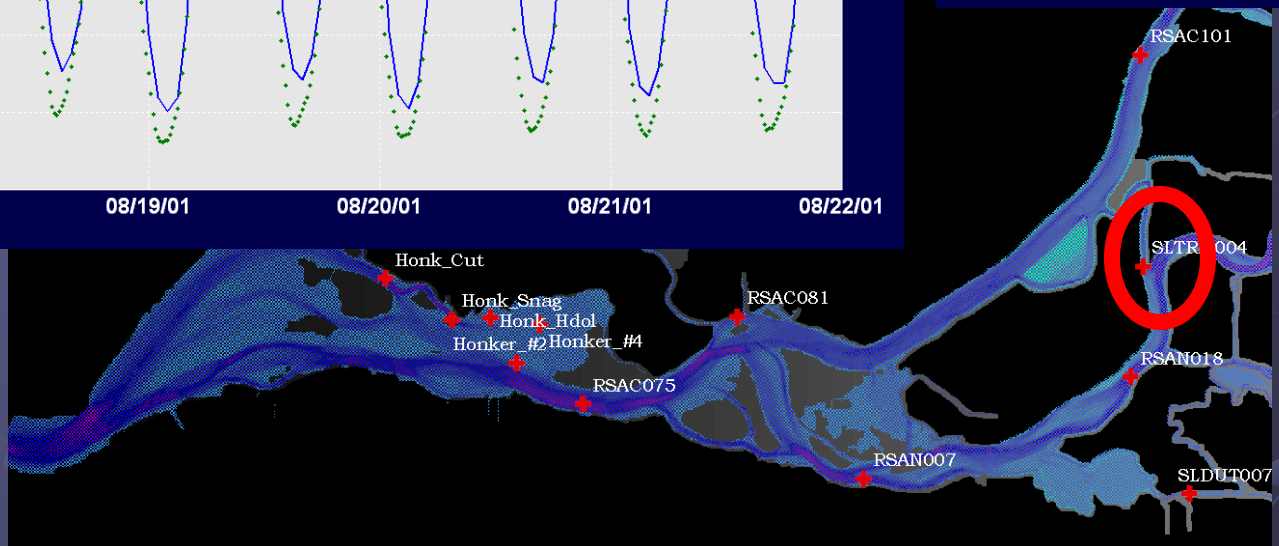



February 1992
(Release Day 18)
August 1992
(Release Day 18)

Model representation of Three Mile Sl. exchange is important for dispersion.

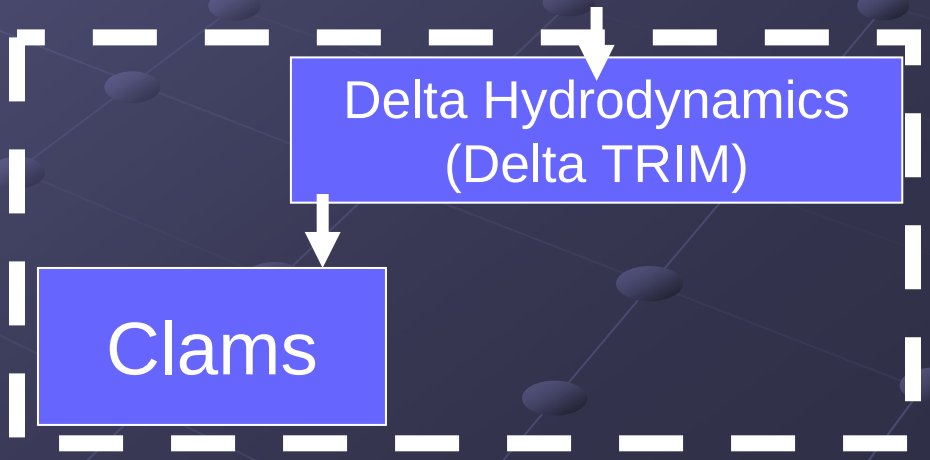




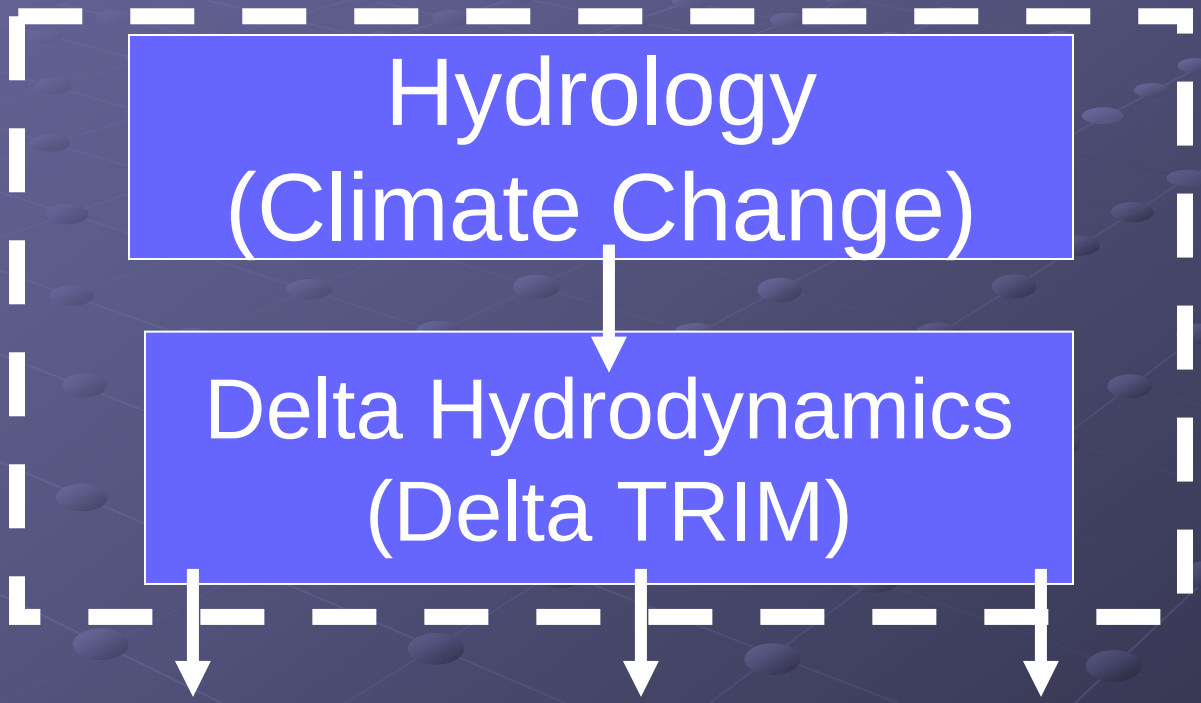


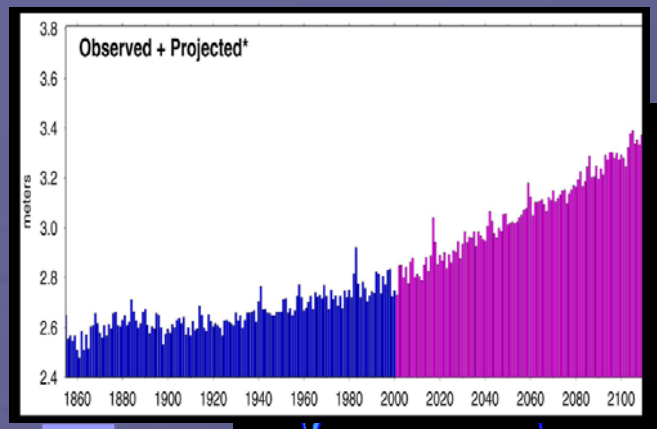
Is there tidal exchange between the Suisun Bay and Western Delta environments?

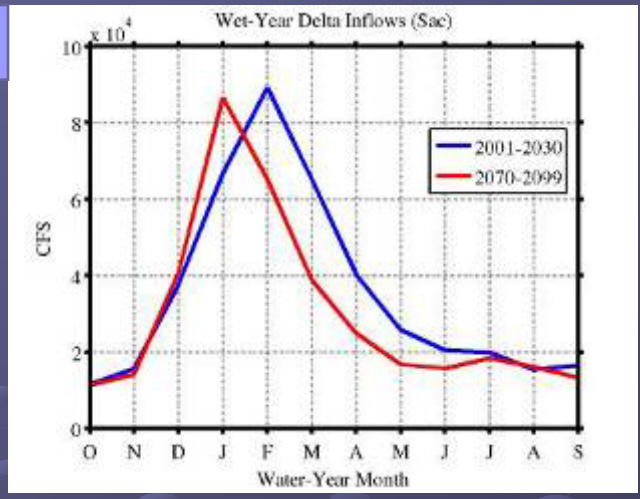
- The western Delta is a dispersive environment.
- Representing the complex junctions is very important in order to understand the mixing interactions between Suisun Bay, open water shallow regions (i.e. Dutch Sl. & Frank's Tract) and the main river channels.

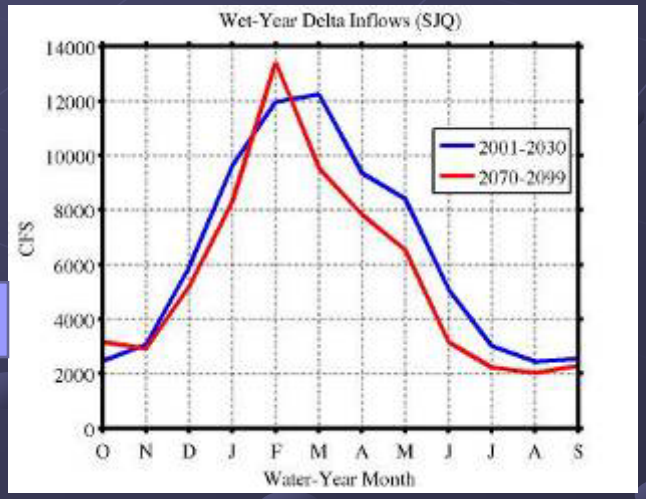


How “well” does the model represent stage elevations?





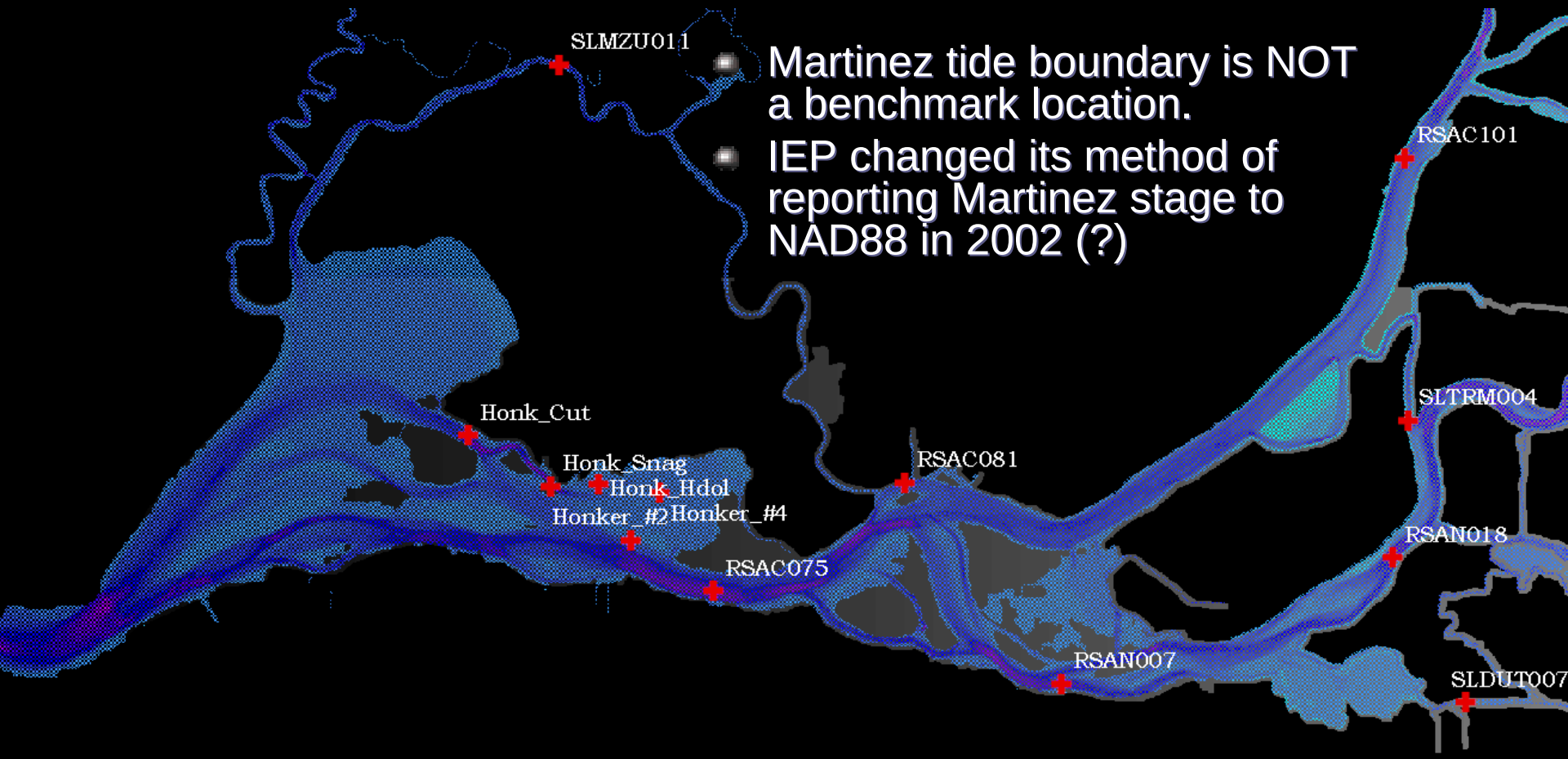


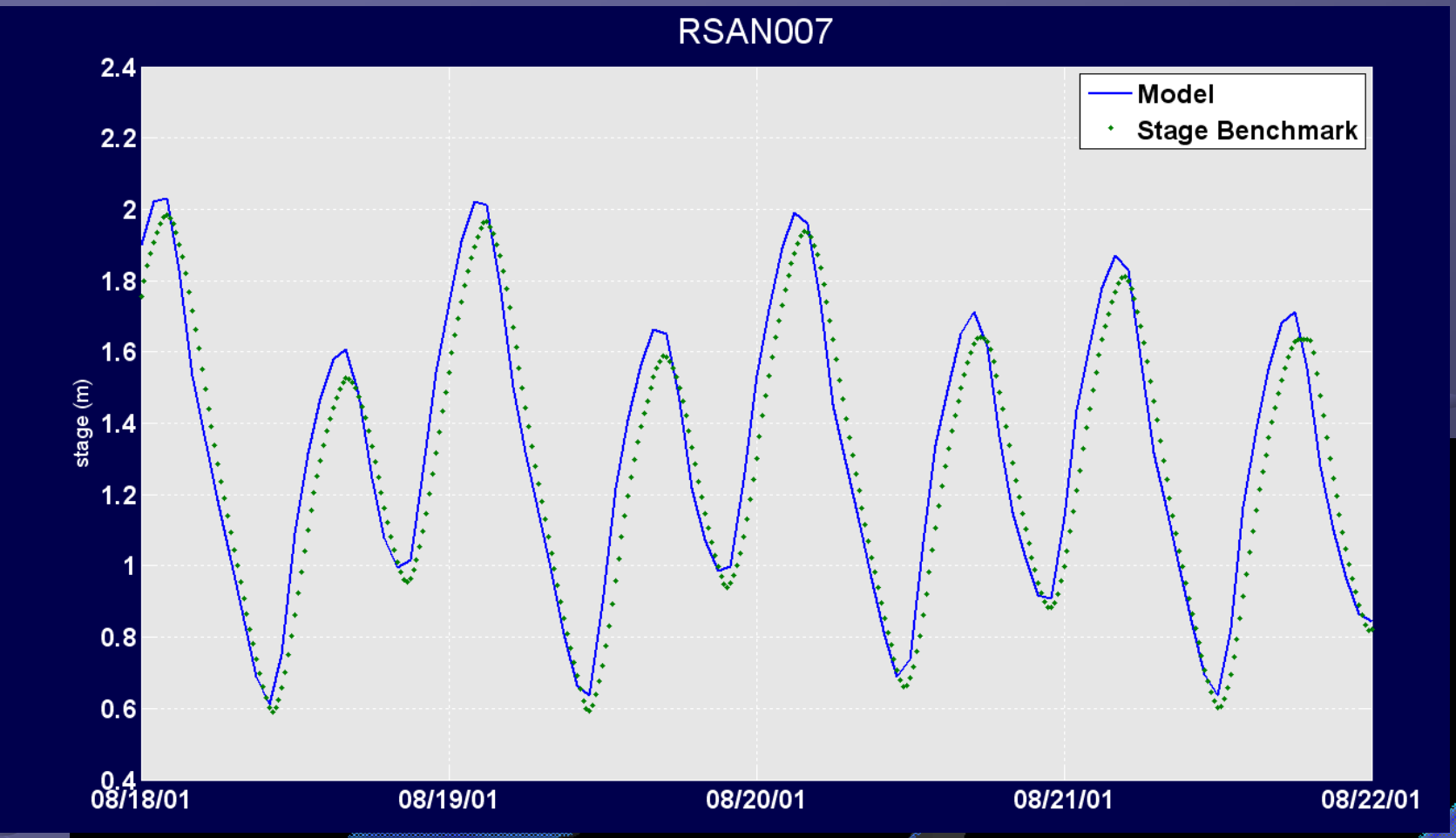


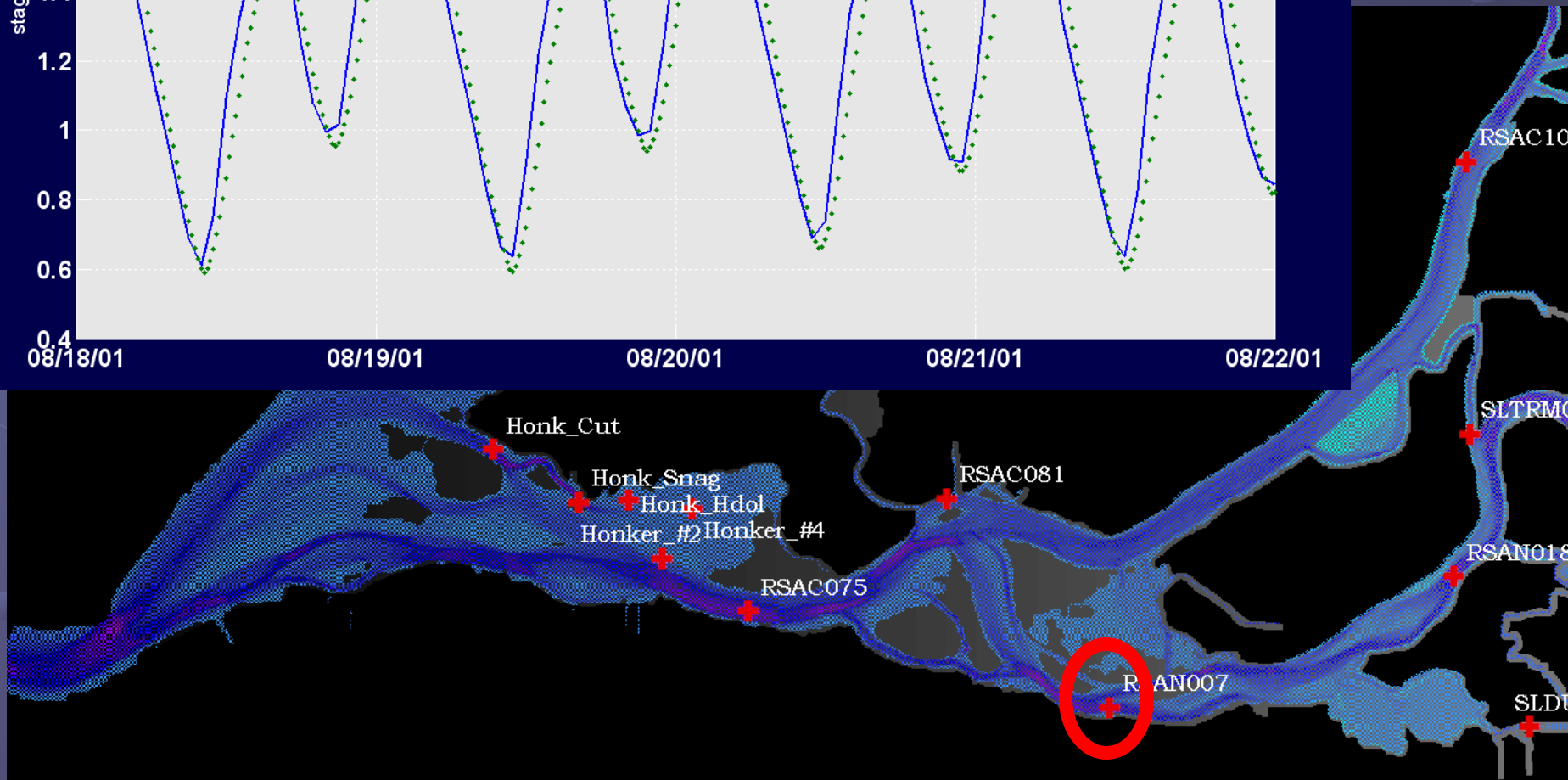
Ecosystem Response

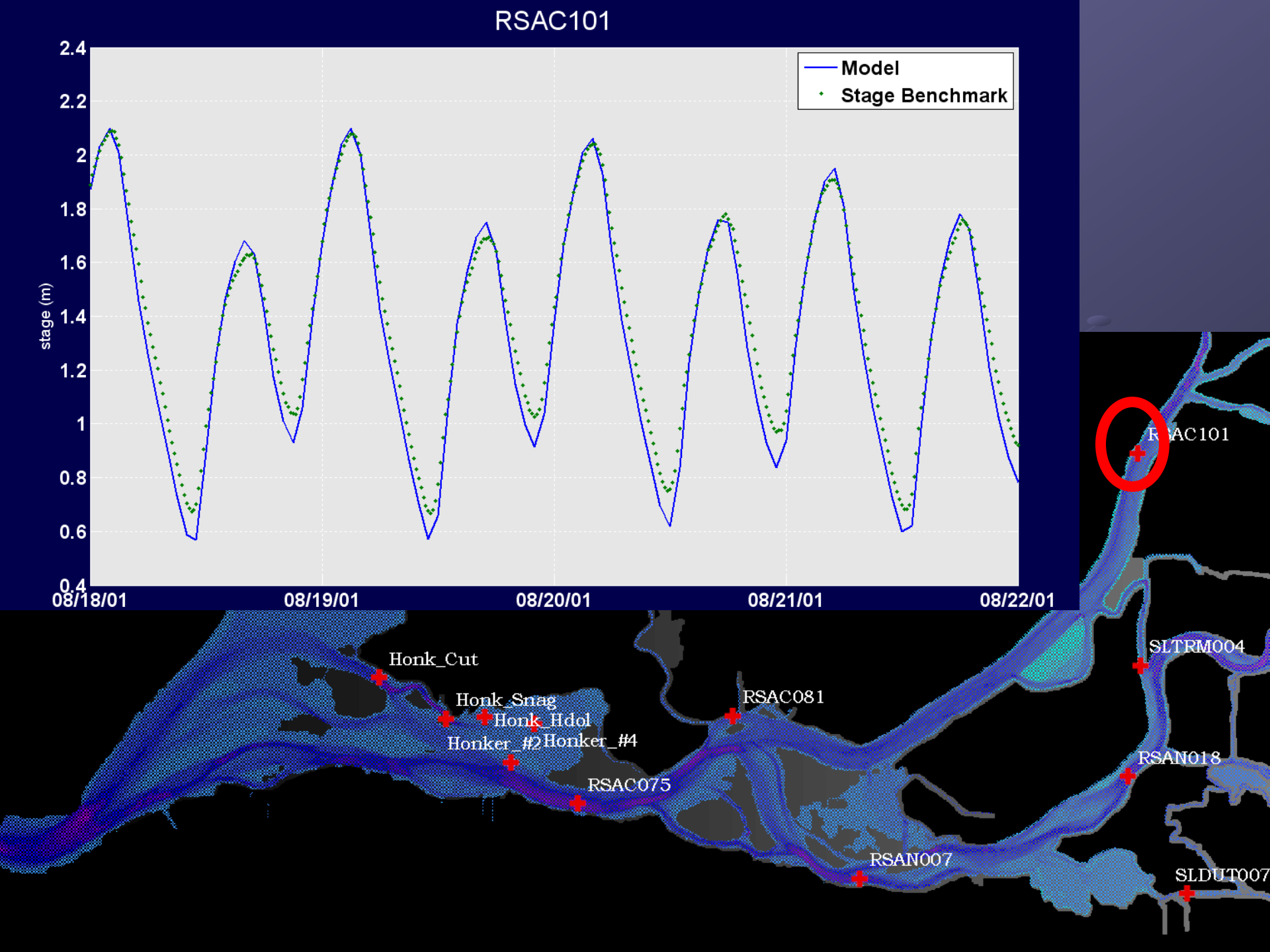
Stage Benchmarks

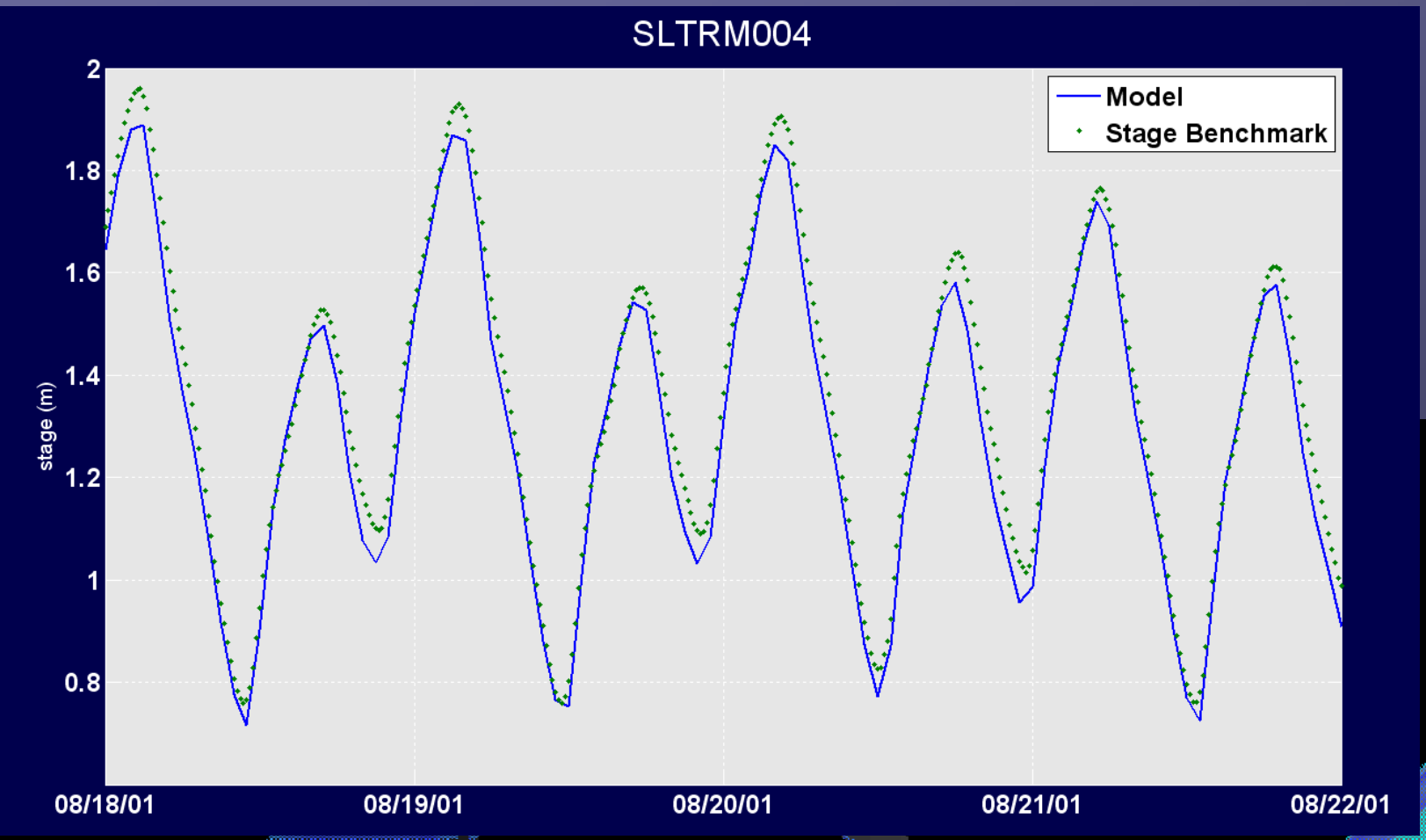
- Bathymetry grid referenced to NGVD 1929.
- Known stage values benchmarked to NAD88.



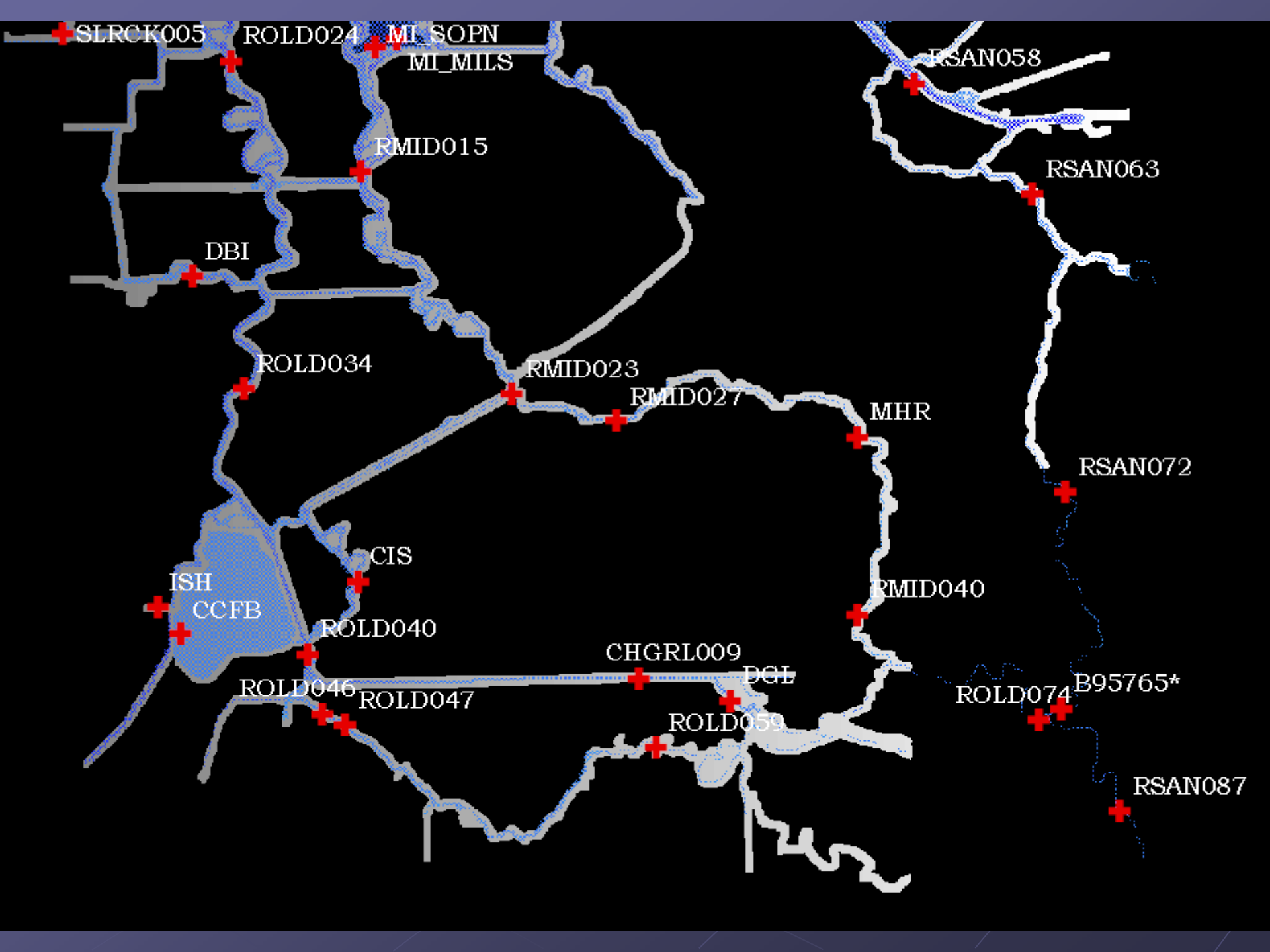

RSAN007
Model
Stage Benchmark
stage (m)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
08/18/01
08/19/01
08/20/01
08/21/01
08/22/01

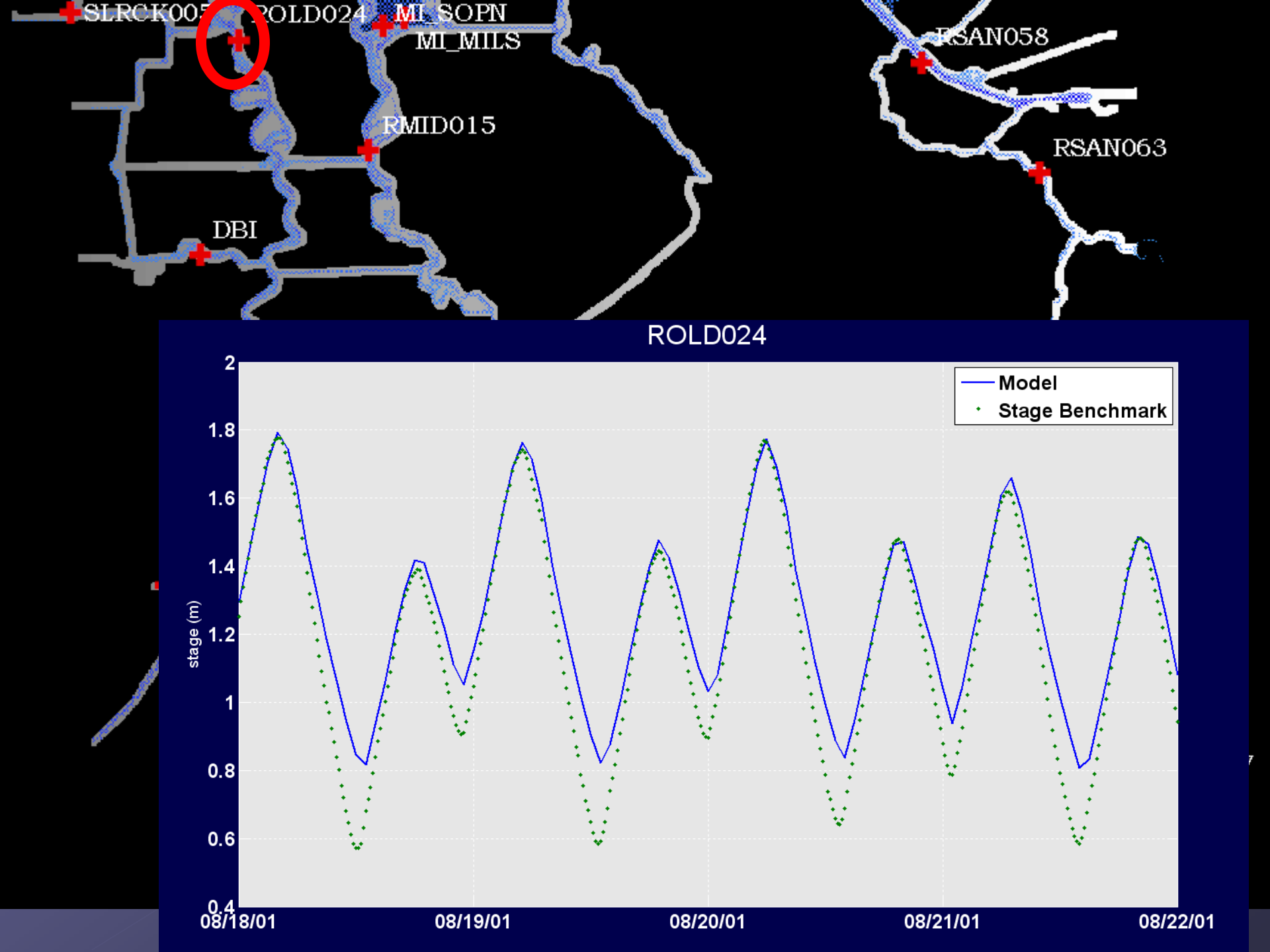

Honk_Cut
Honk_Snag
Honk_Hdol
Honker_#2
Honker_#4
RSAC081
RSAC075
RSAN007
RSAC10
SLTRM
RSAN018
SLDU


RSAC101
Model
Stage Benchmark
stage (m)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
08/18/01
08/19/01
08/20/01
08/21/01
08/22/01
RSAC101
SLTRM004
RSAN018
RSAC081
Honk_Cut
Honk_Snag
Honk_Hdol
Honker_#2
Honker_#4
RSAC075
RSAN007
SLDUT007


SLTRM004
Model
Stage Benchmark
stage (m)
2
1.8
1.6
1.4
1.2
1
0.8
08/18/01
08/19/01
08/20/01
08/21/01
08/22/01

RSAC101
SLTRM004
Honk_Cut
Honk_Snag
Honk_Hdol
Honker_#2
Honker_#4
RSAC081
RSAN018
RSAC075
RSAN007
SLDUT007


SLRCK005
ROLD024
MI_SOPN
MI_MILS
RSAN058
RMID015
RSAN063
DBI
ROLD034
RMID023
RMID027
MHR
RSAN072
CIS
ISH
CCFB
RMID040
ROLD040
CHGRL009
DGL
ROLD046
ROLD047
ROLD059
ROLD074
B95765*
RSAN087


SLRCK005
ROLD024
MI_SOPN
MI_MILS
RMID015
DBI
RSAN058
RSAN063
ROLD024
Model
Stage Benchmark
stage (m)
2
1.8
1.6
1.4
1.2
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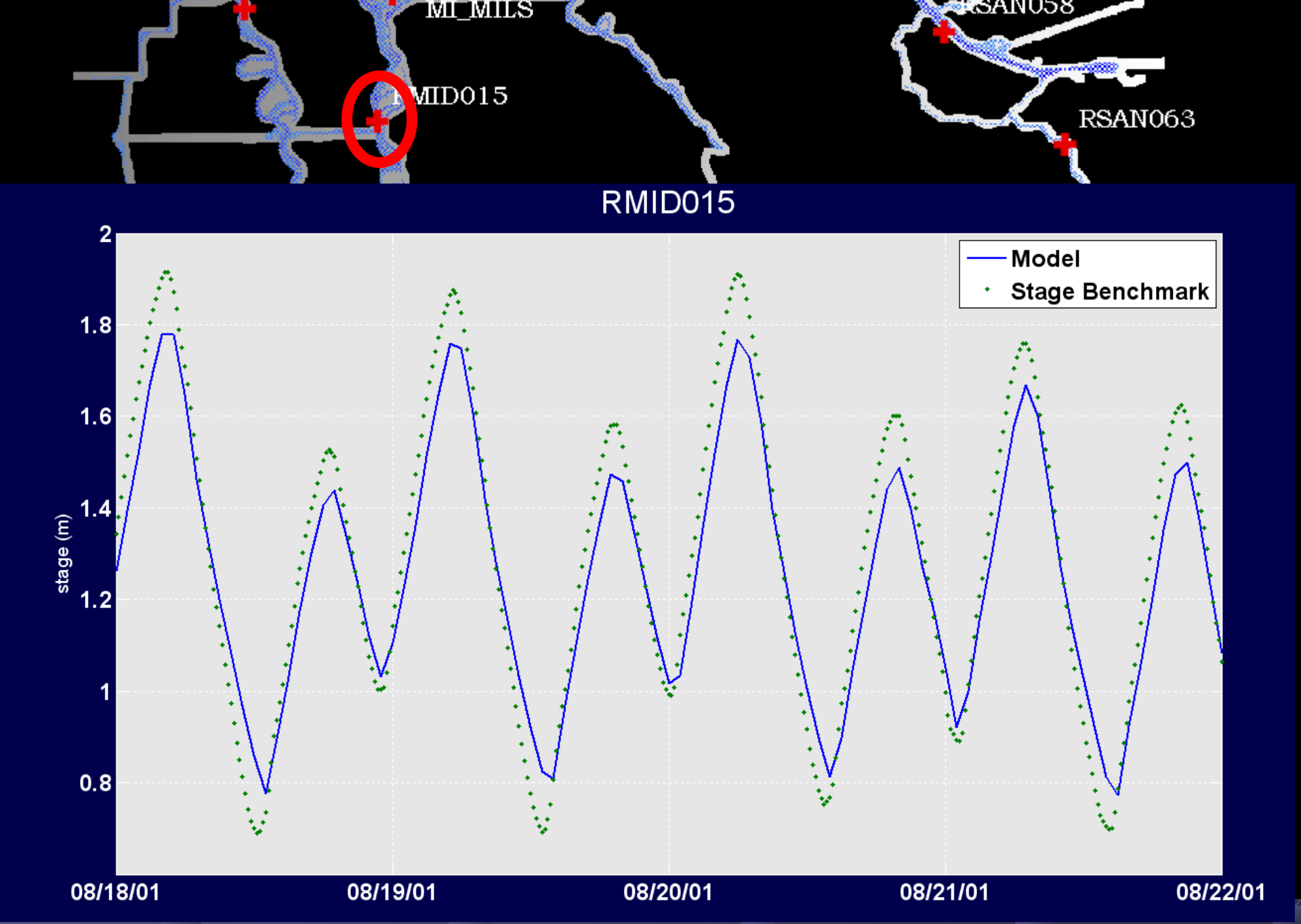
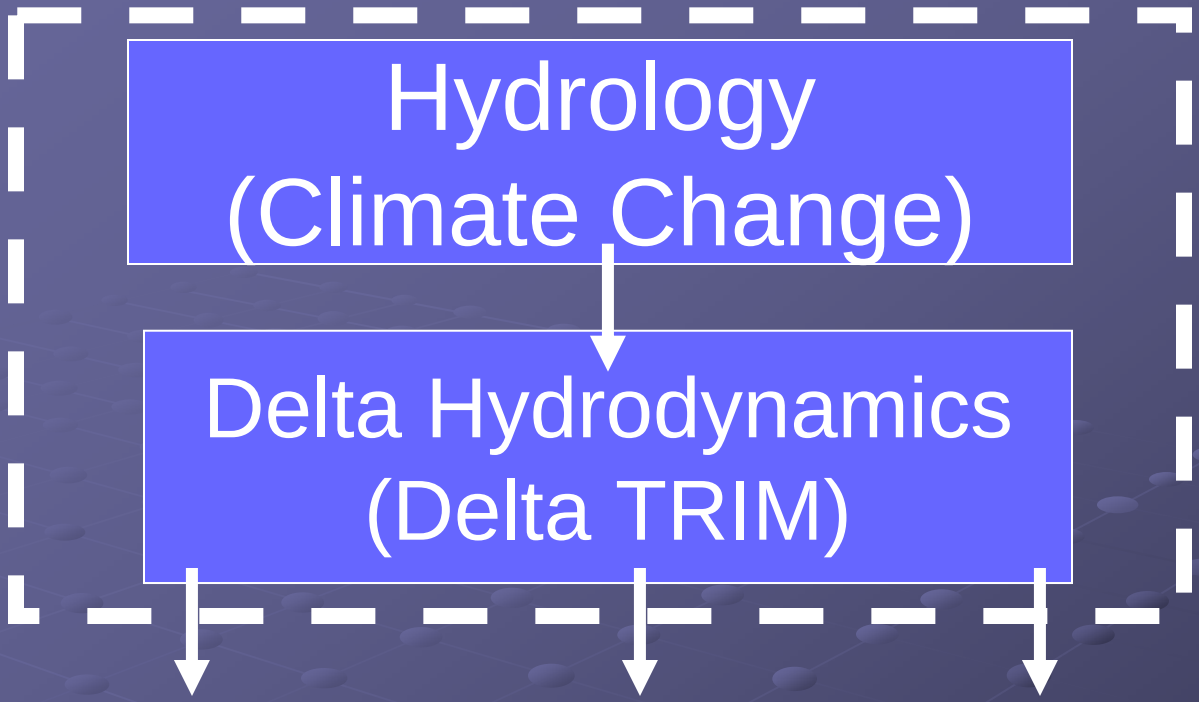
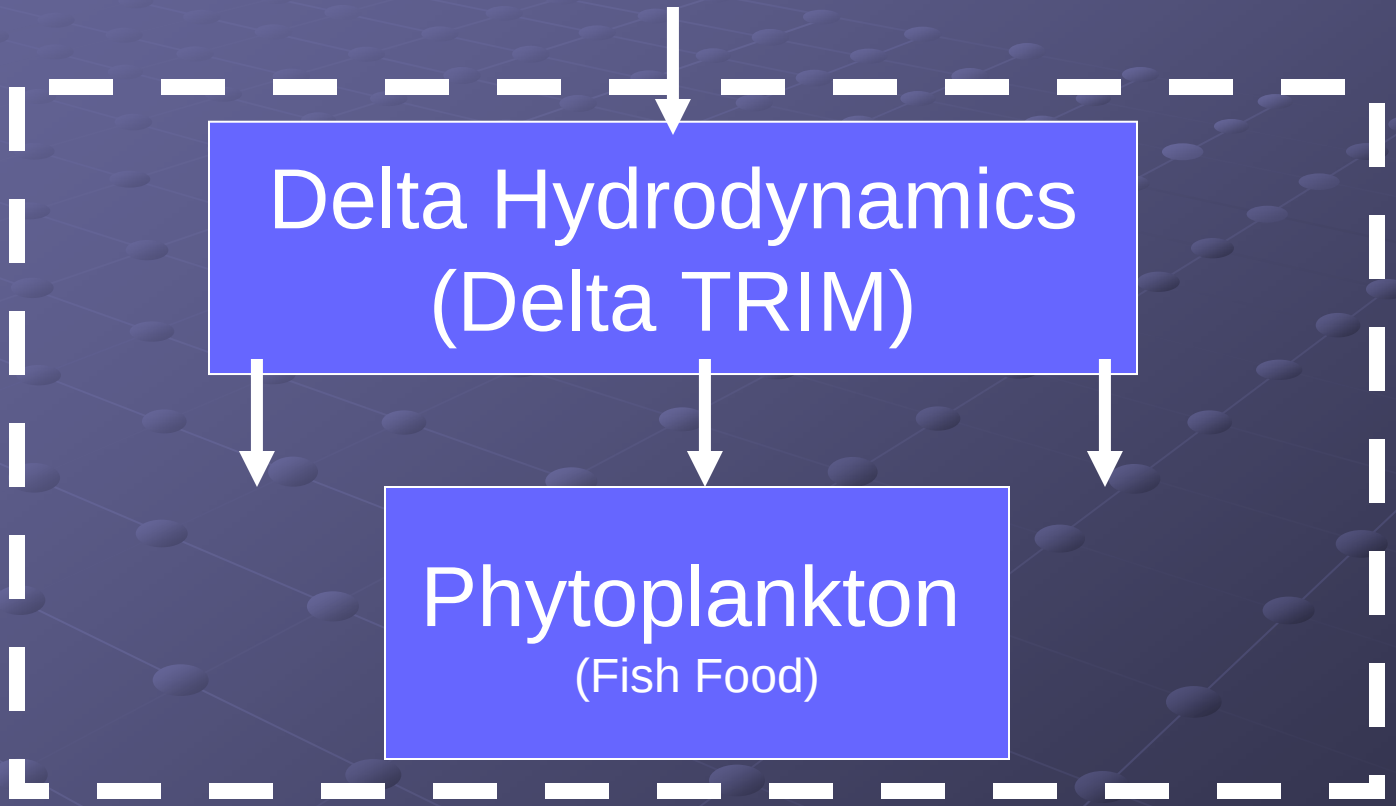
0.8
0.6
0.4
08/18/01
08/19/01
08/20/01
08/21/01
08/22/01


MI_MILS
RMID015
RSAN058
RSAN063
RMID015
Model
Stage Benchmark
stage (m)
2
1.8
1.6
1.4
1.2
1
0.8
08/18/01
08/19/01
08/20/01
08/21/01
08/22/01



- Do the models “work” – do they produce useful/reliable information for estuarine management?
  - Stage: agreement with benchmarked stage → visually.
  - Alternate measurement criteria.

Is Delta TRIM's representation of stages behind temporary barriers sufficient for the phytoplankton model?



At every grid cell and time step...

Hydro model

velocities,
surface
elevations

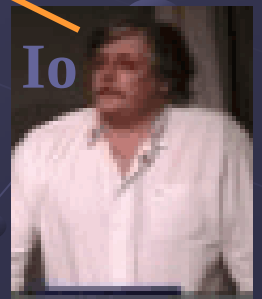
Linkage Equation

$$\frac{\partial B}{\partial t}+\frac{\partial}{\partial x}(UB)+\frac{\partial}{\partial y}(VB)+\frac{\partial}{\partial z}(BG^{*}B)=(\mu-ZP)B$$

Biomass (B)
Net Primary Production (NPP)

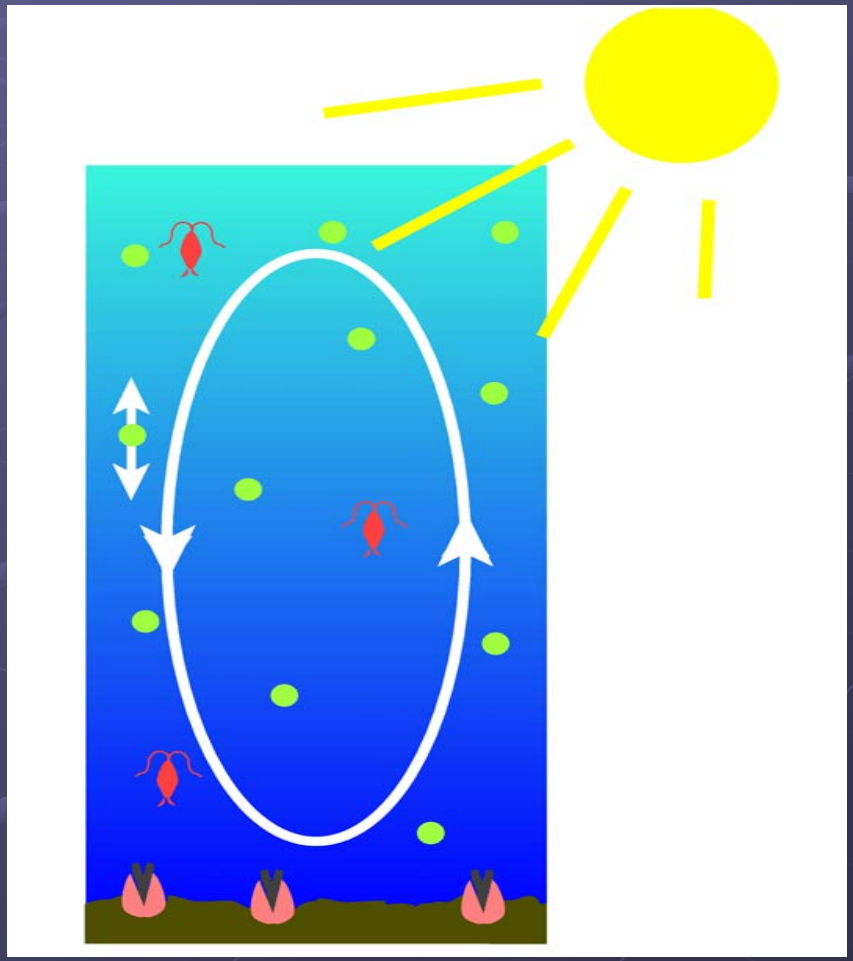
Phyto model

rates of growth,
respiration,
grazing

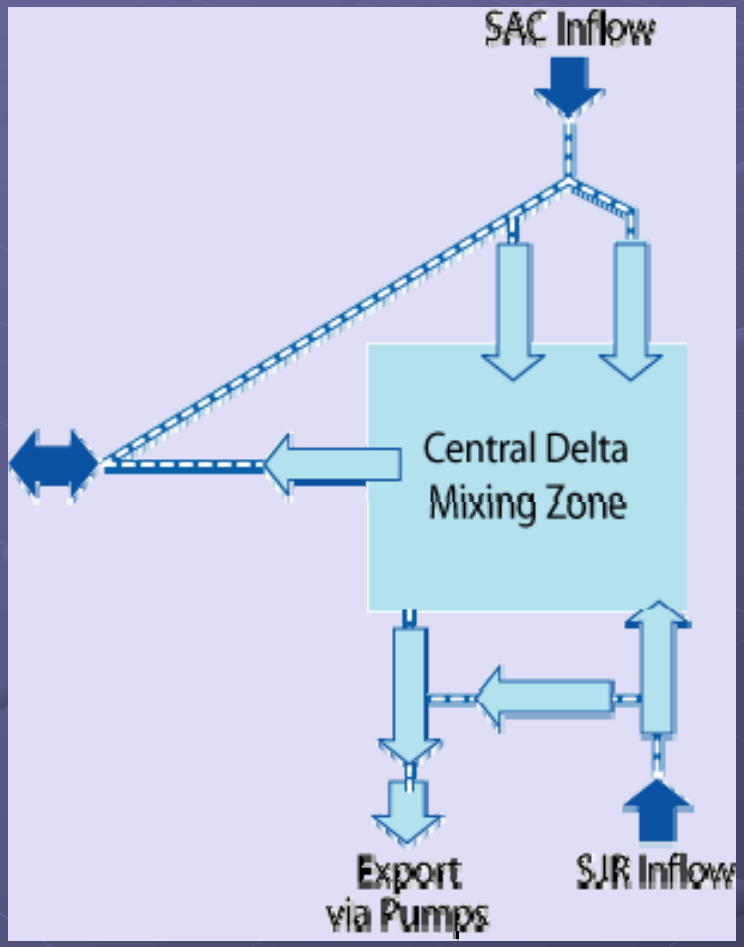


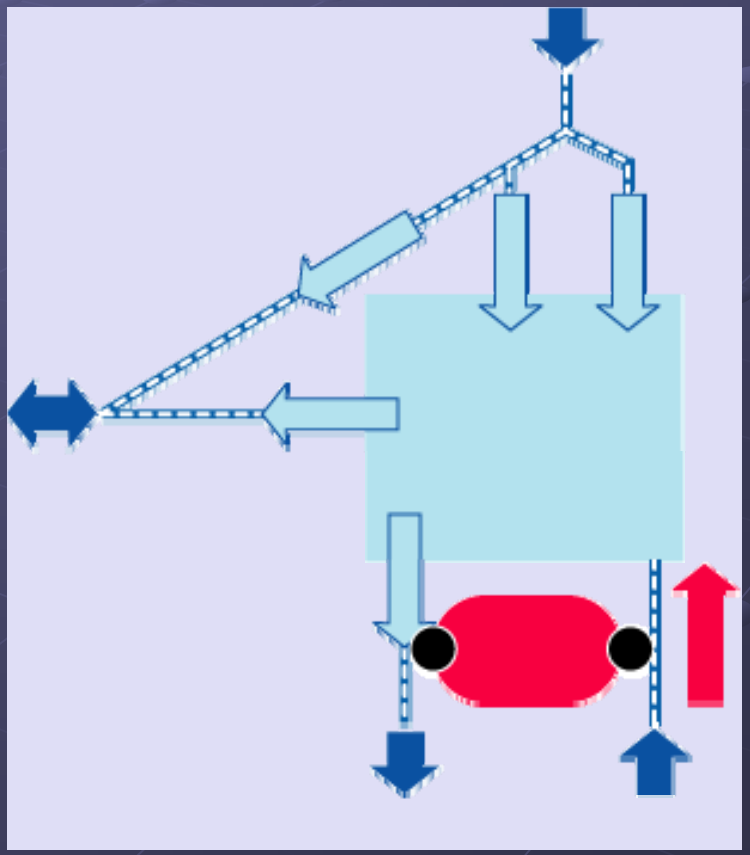
Depth of the water column is a critical variable in the biomass equation.

- Depth-averaged light
  - Photosynthesis ↑
  - Water column height ↓
- Depth-averaged effect of benthic grazers
  - Influence of clams ↑
  - Water column height ↓

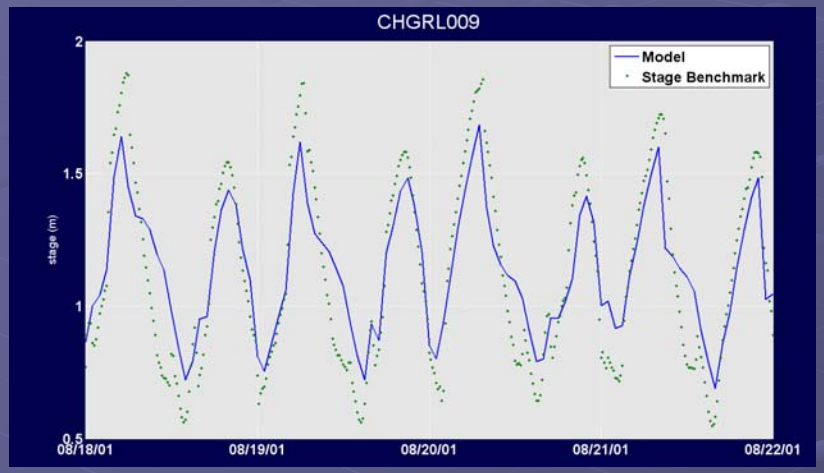


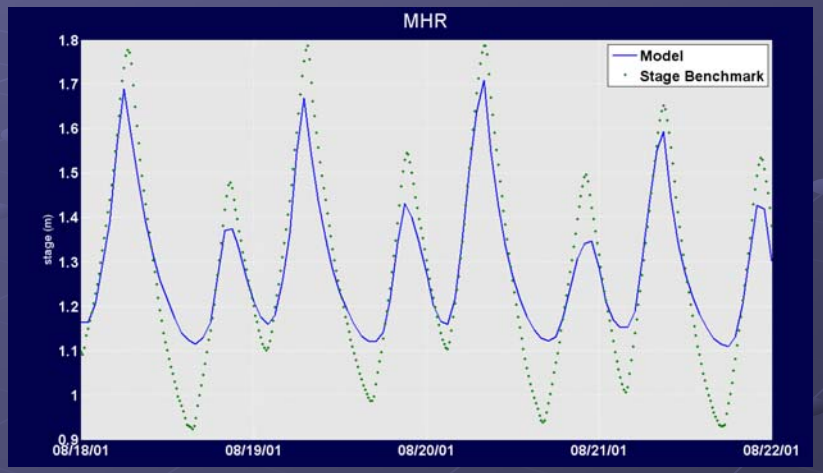
Four temporary barriers create a reservoir in the South Delta

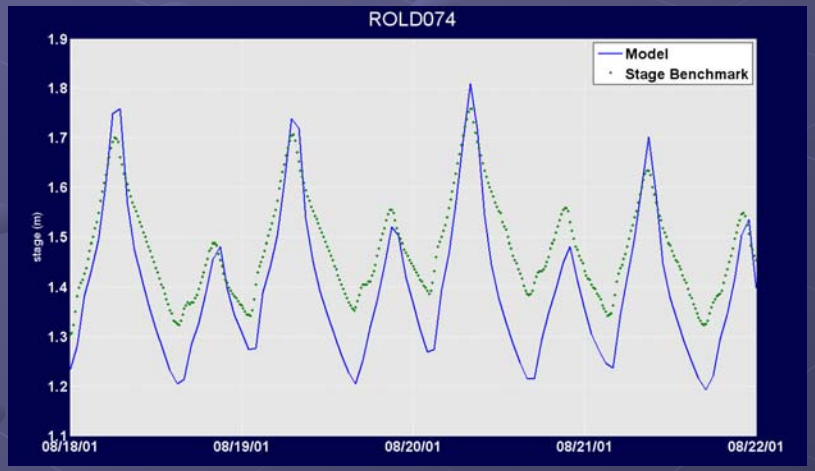


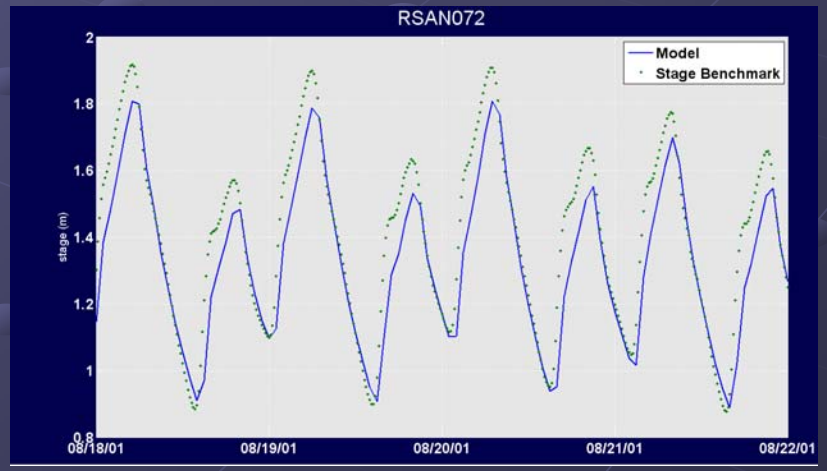


Stage representation around barriers



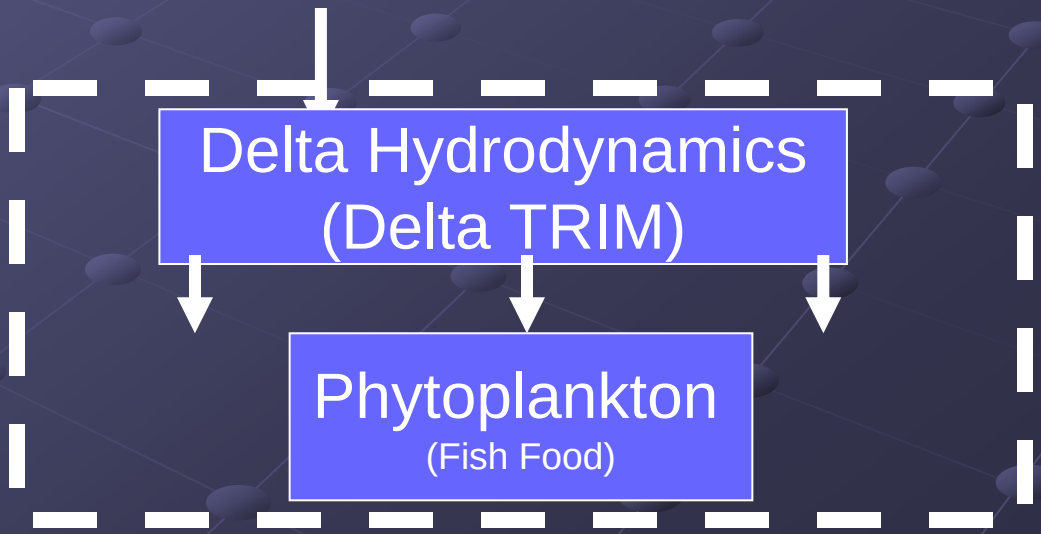






Is Delta TRIM's representation of stages behind temporary barriers sufficient for the phytoplankton model?

- Representing the temporary barriers as overtopping rather than infinite walls, significantly improved the representation of stage in the south Delta.
- I am intentionally keeping the representation simple because the barrier configuration changes yearly.



Hydrology
(Climate Change)

Delta Hydrodynamics
(Delta TRIM)

Clams

Phytoplankton
(Fish Food)

Toxins

Where IEP could support modeling

- Additional support for maintaining key stations.
  - Martinez (RSAC054) needs redundancy
  - Freeport (RSAC155)
  - Vernallis (RSAN112)
- Additional flow stations
  - Steamboat Sl
  - Miner Sl
  - Mokelumne system
- Data distribution to modelers from IEP database
  - Much better interface for downloading data from IEP servers
- Quality control of CDEC database
  - Valuable information but not in a publishable form
- Additional sampling for future needs
  - SEDIMENT TRANSPORT