Sedimentation Processes and Turbidities Favoring Endangered Fish Northwestern Sacramento-San Joaquin River Delta Cache Slough Complex

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Lead Agencies: DWR-USGS

Interagency Ecological Program
POD Special Studies

Delta Sediment and Turbidity

Historic Scenario – sediment accumulation in Delta
Current Scenario – reduced delivery (changes in water management)

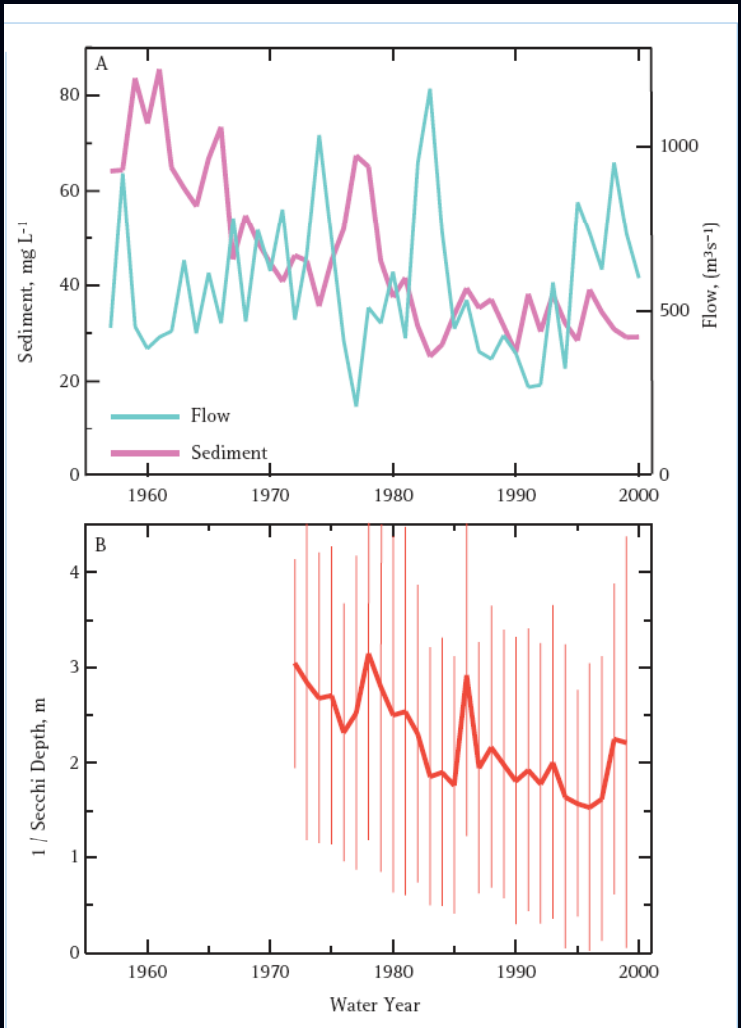
Reduced Turbidity Leads to:
Less suitable habitat for native fish species

SSC, TURBIDITY & FISH

- Sac River -primary source of Delta sediment
- BUT,…

  50% decline in SSC 1957-2001

  (Wright and Schoellhamer 2004)



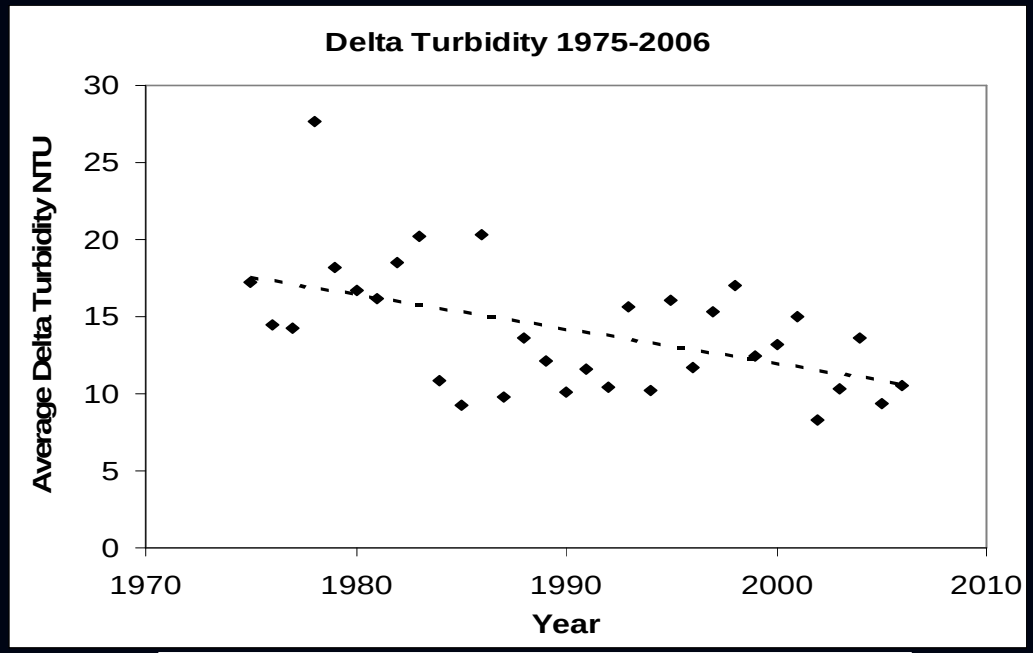
Kimmerer et al. 2004

SSC, TURBIDITY & FISH

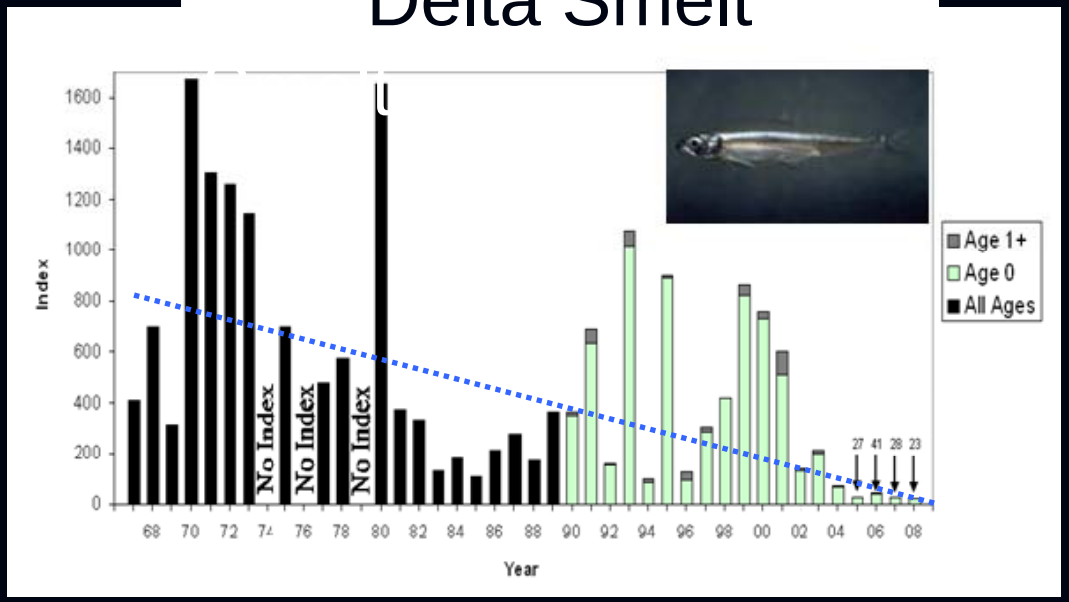
AND,…

40% decline in turbidity within 3 decades

Pelagic Fish Decline within Delta (POD)



Delta Smelt



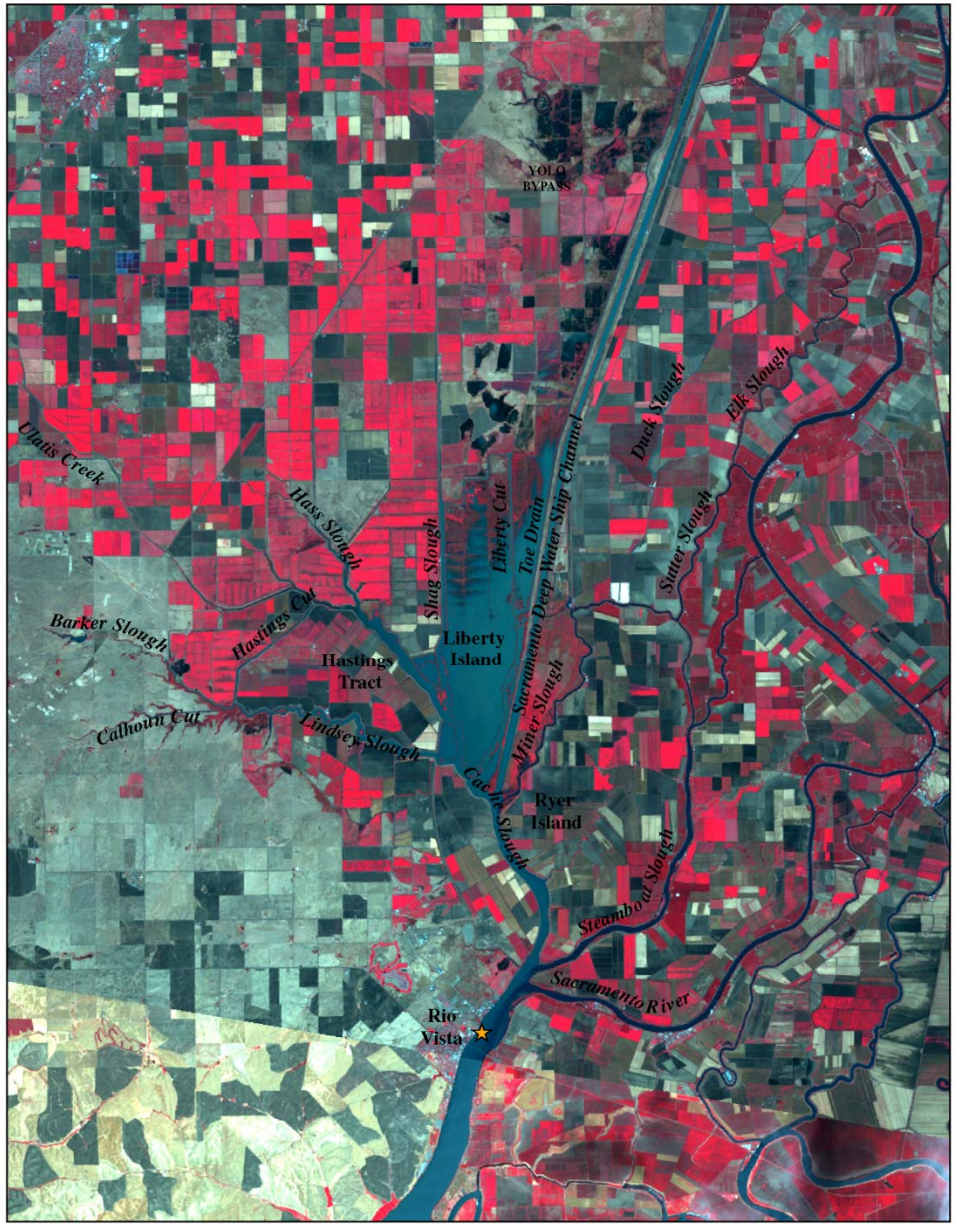
Long-term Changes in Turbidity

- Increasing Clarity

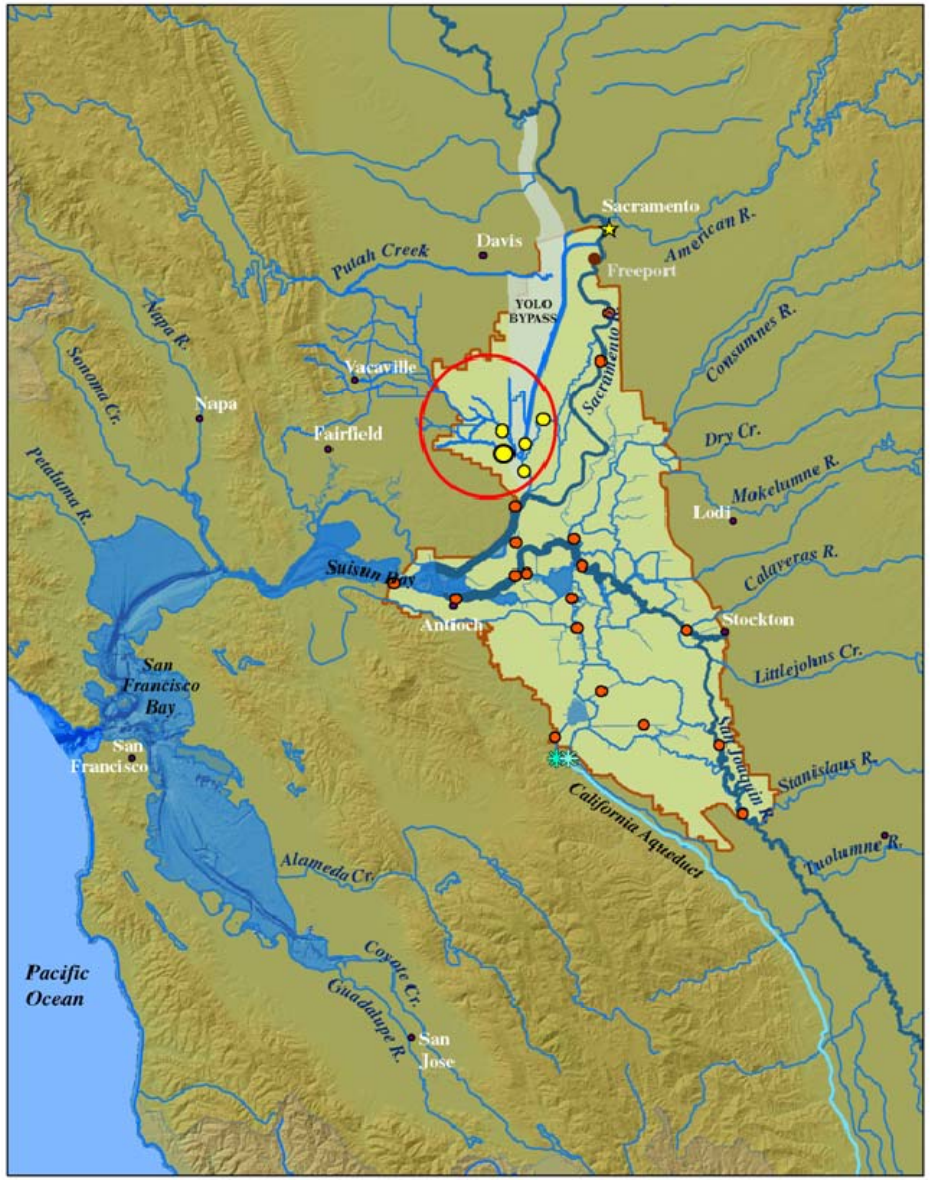
  (Size of circle illustrates magnitude of trend)

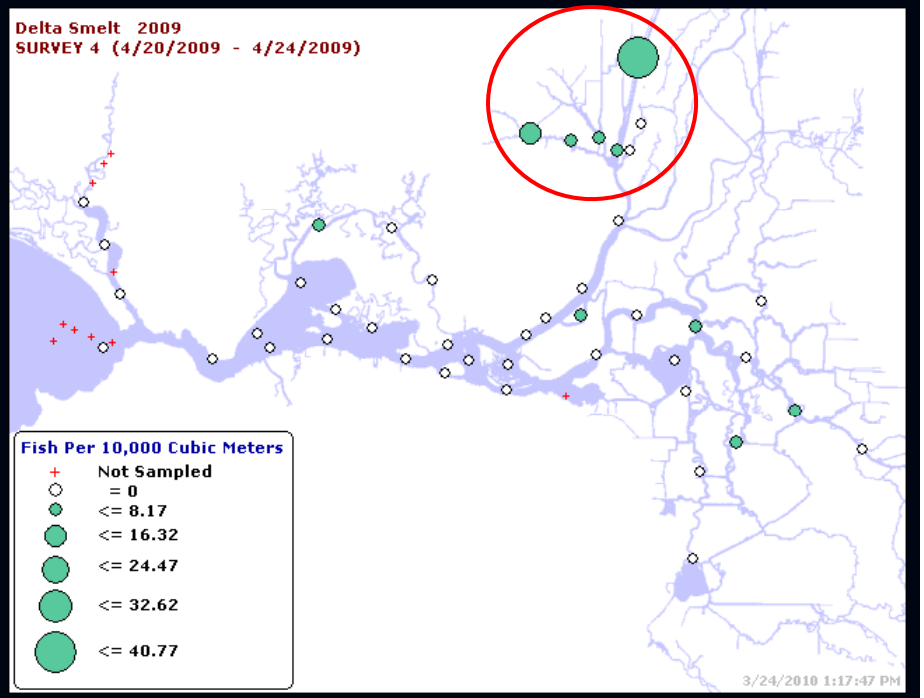
- What about the Northwest Delta?

Is this area more turbid? What is the effect of Liberty Island?



Northwest Delta
Smelt like it turbid!





Cache Slough Complex/Liberty Island

- USGS Sediment FLUX (study July 2008-current)
- 4 FLUX stations in Northwest Delta

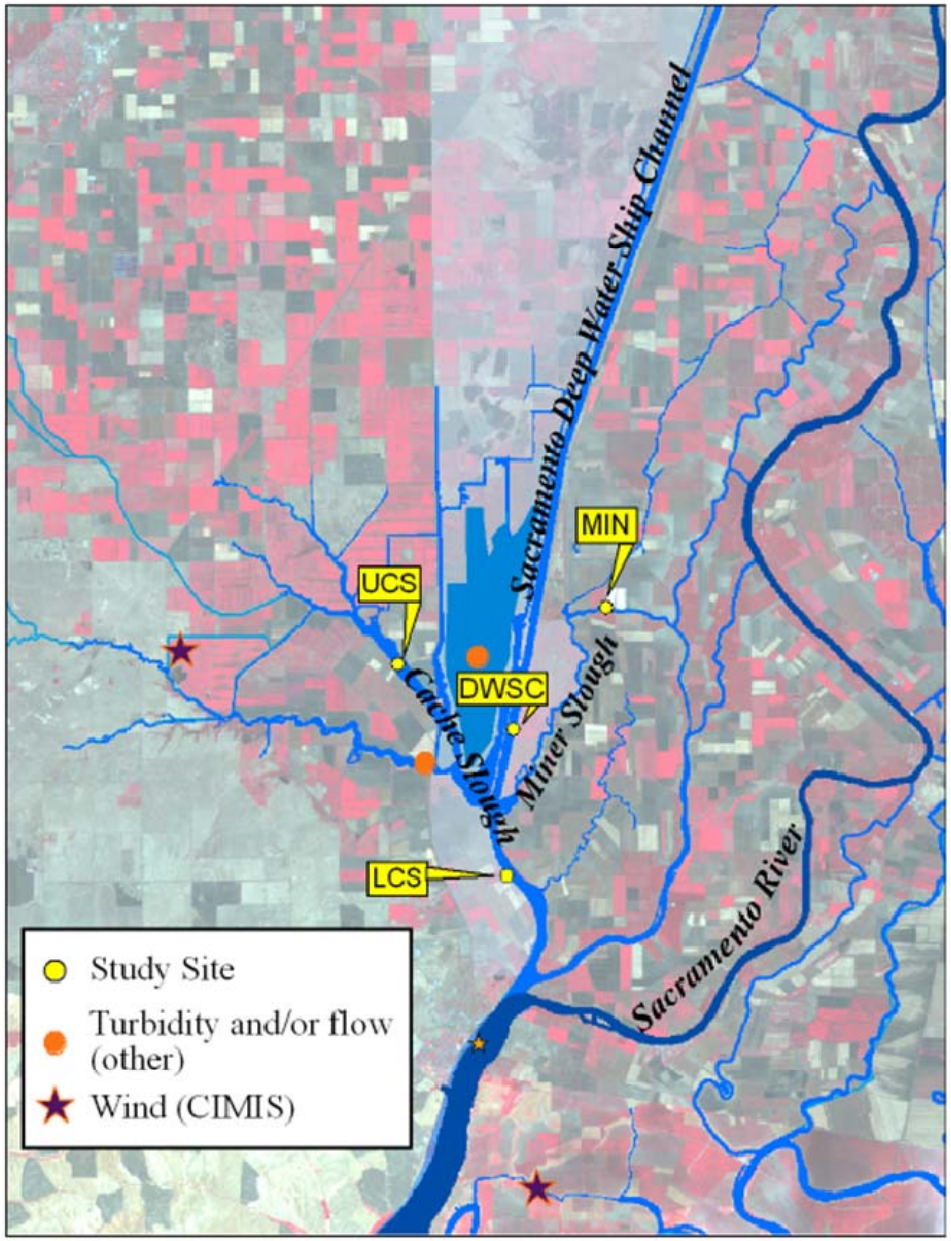
MIN = Miner Slough

DWSC=

Sac R. Deep Water Ship Channel

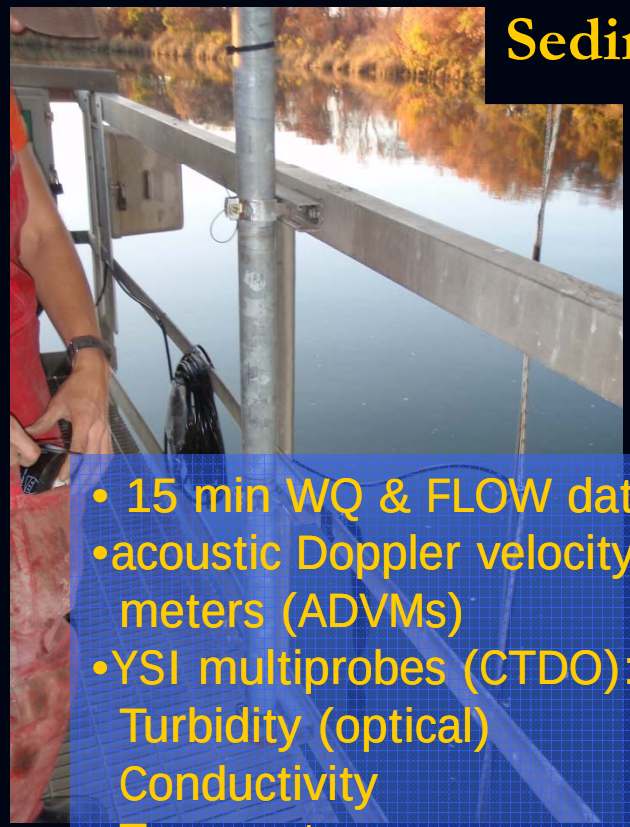
UCS = “Upper” Cache Slough

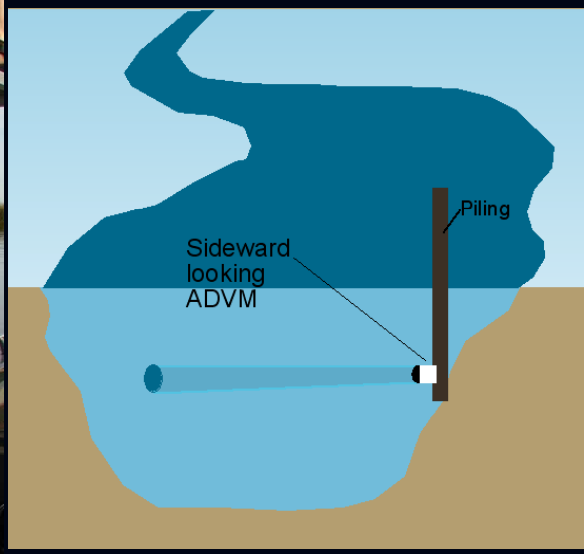
LCS = “Lower” Cache Slough



Funded by:
Interagency Ecological Program

Sediment FLUX Characteristics





- 15 min WQ & FLOW data:
- acoustic Doppler velocity meters (ADVMs)
- YSI multiprobes (CTDO):
  Turbidity (optical)
  Conductivity
  Temperature
  Depth

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SUSPENDED SEDIMENT FLUX

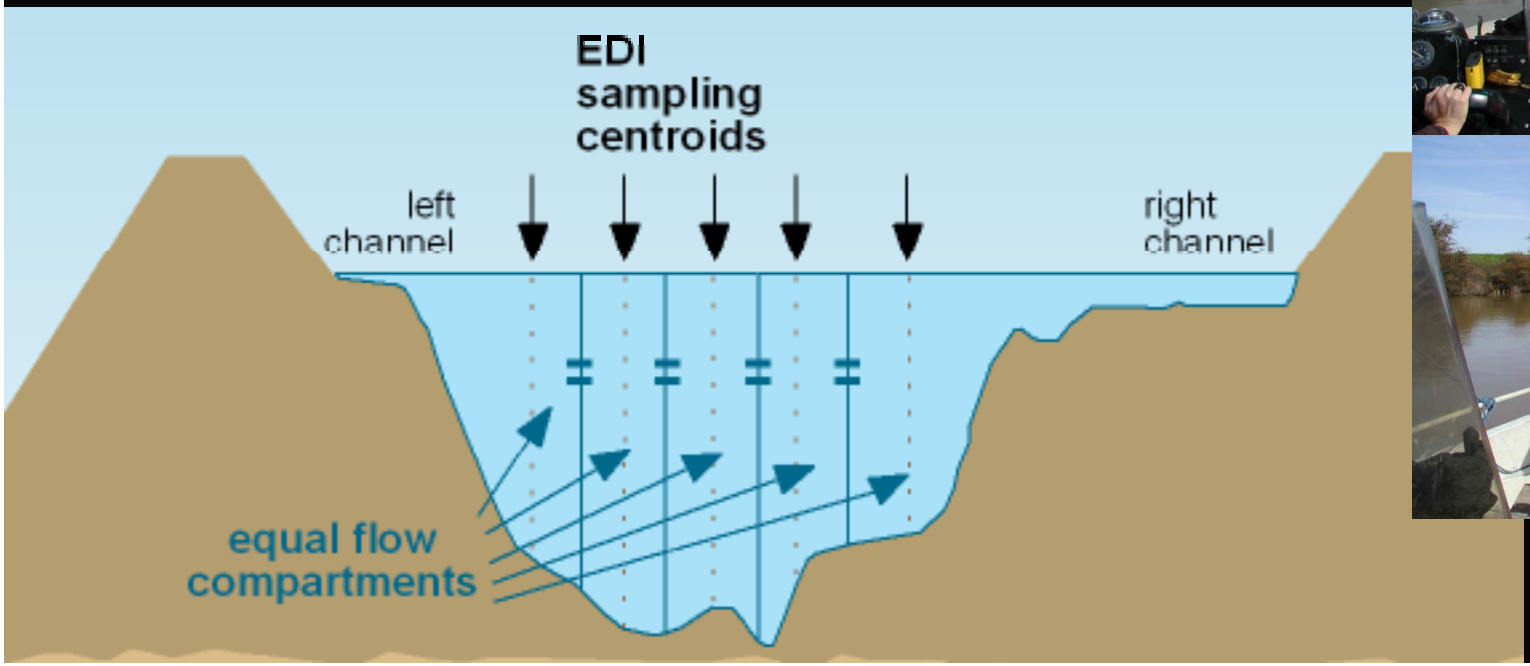
- Discharge Calculation (calibrated from moving boat)
  - -index velocity & x-sectional velocity
  - -stage & x-sectional area

$$Q = A\overline{V}$$

- Calibrate continuous point turbidity to measured cross-sectional averaged SSC

- Suspended sediment flux equals product of discharge and x-sectional avg. SSC

$$Flux_{xs} = SSC_{xs}\, Q_{xs}$$



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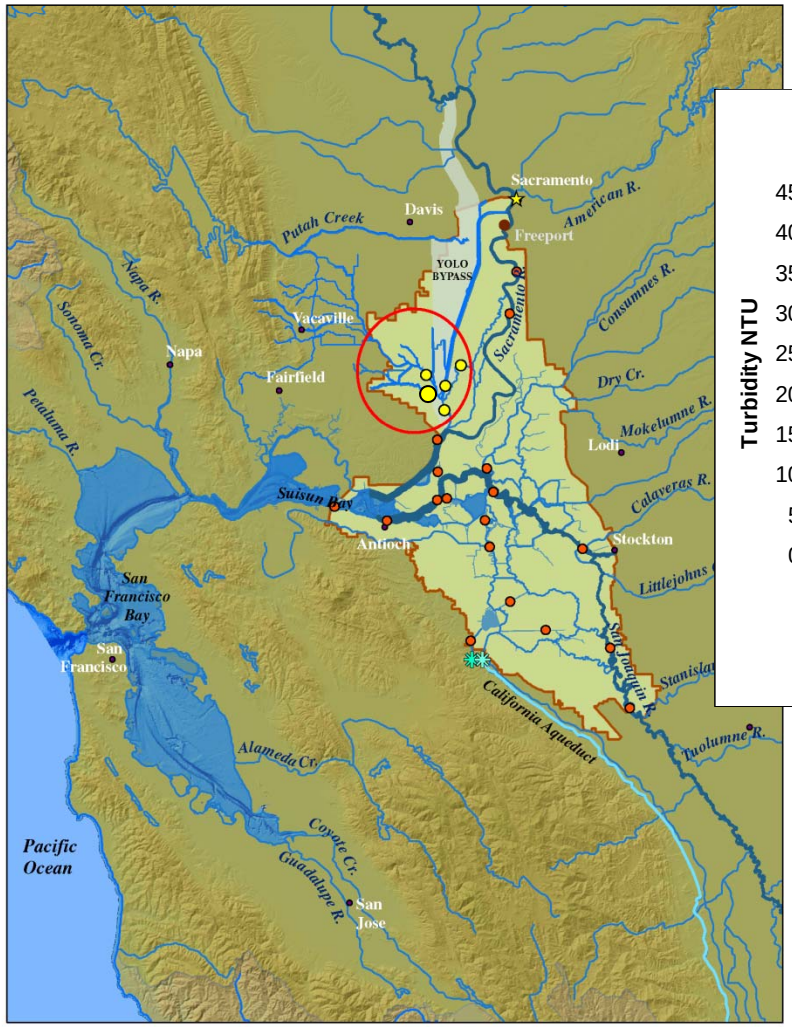
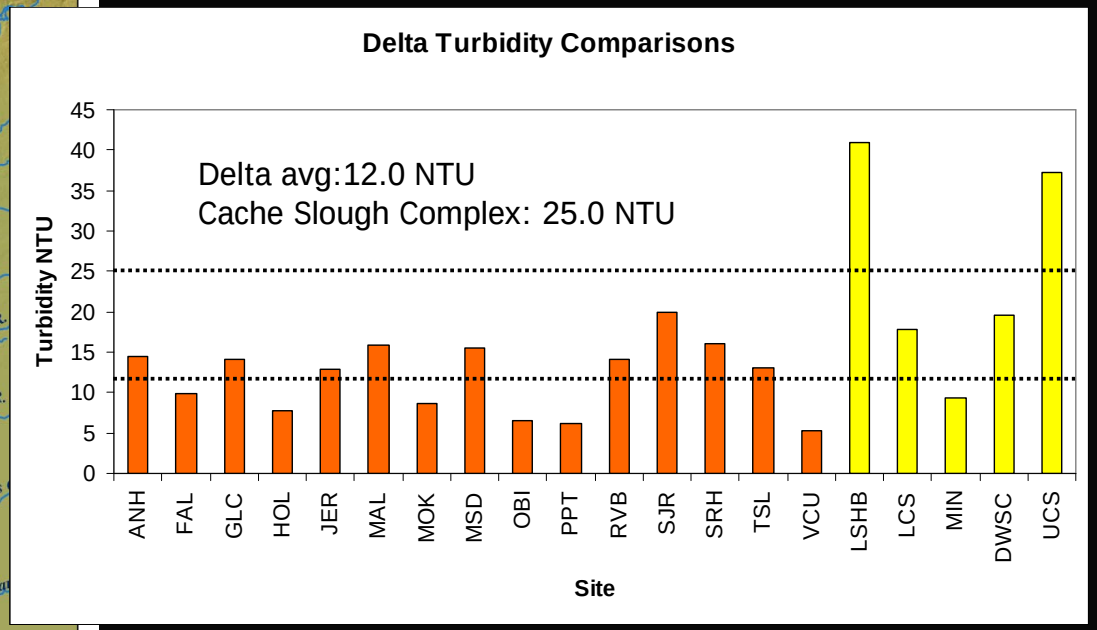
PRELIMINARY FINDINGS

The Cache Slough Complex is more turbid!





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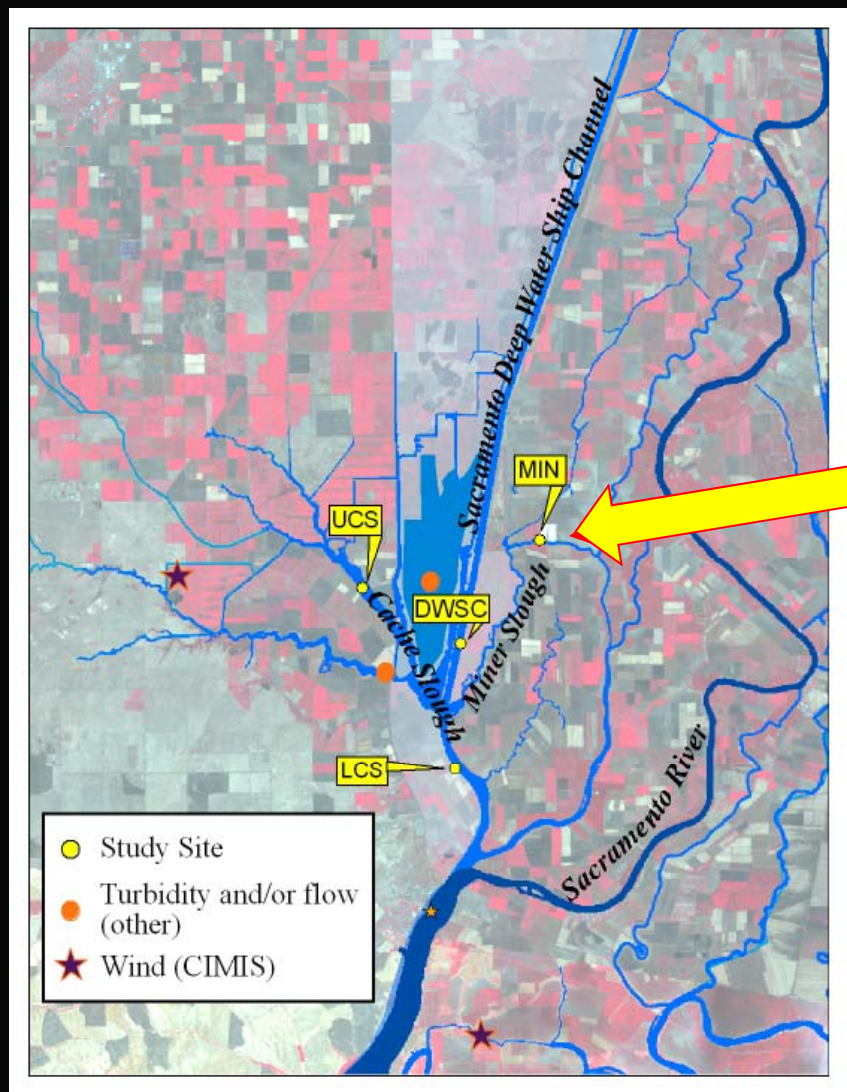
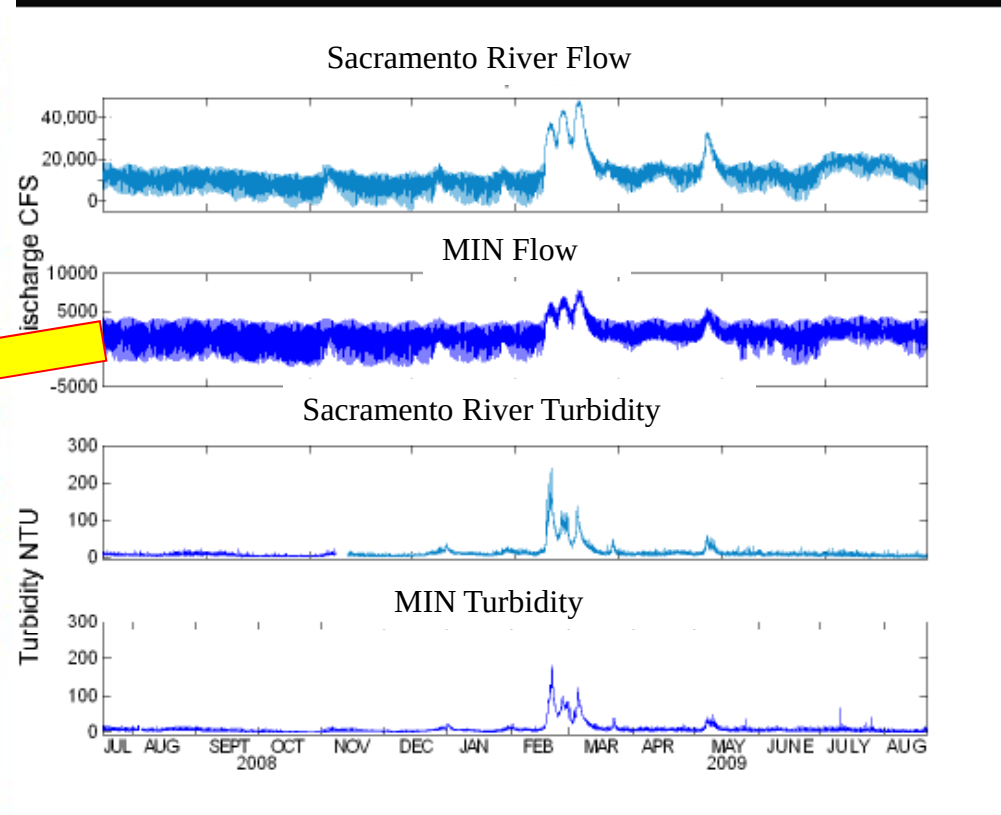
Miner Slough – a significant source

- ~ 15% of Sacramento River Flow
- Winter runoff intensifies ebb currents
- Delivers sediment to study area





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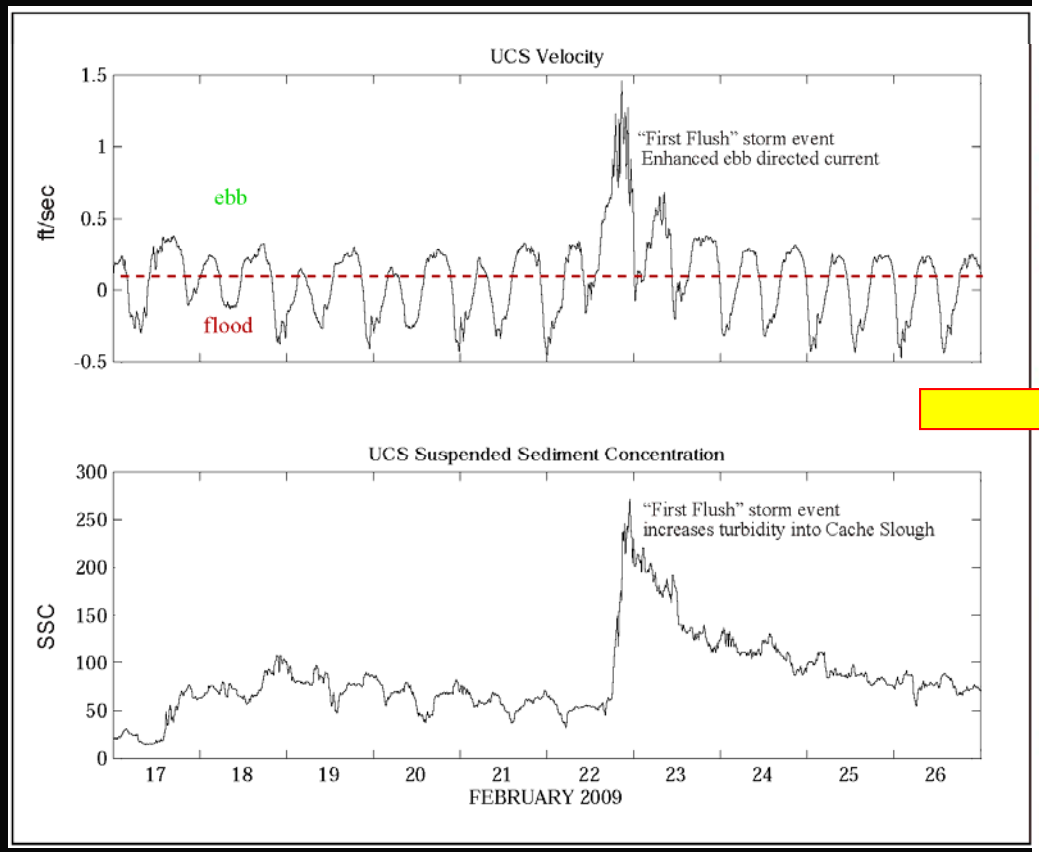
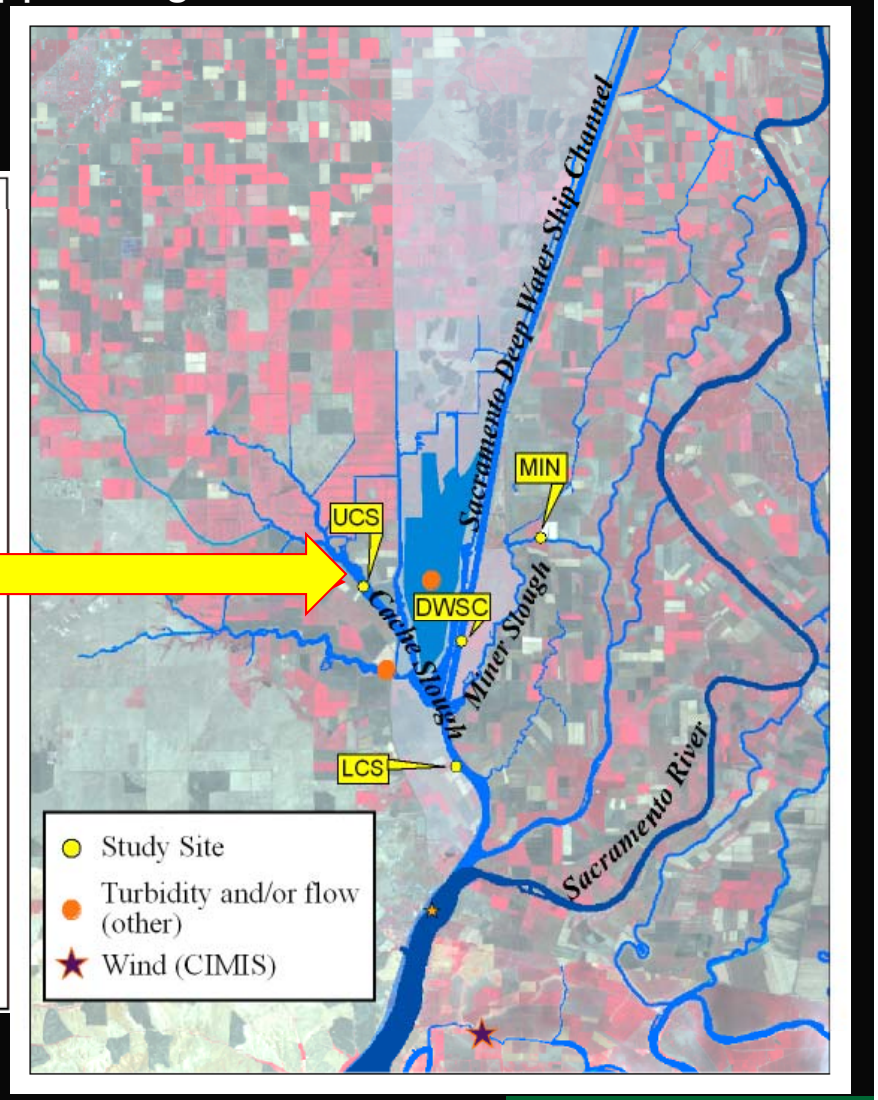
Upper Cache Slough

- Precipitation runoff intensifies ebb currents
- The Upper Cache Slough Watershed supplies significant sediment





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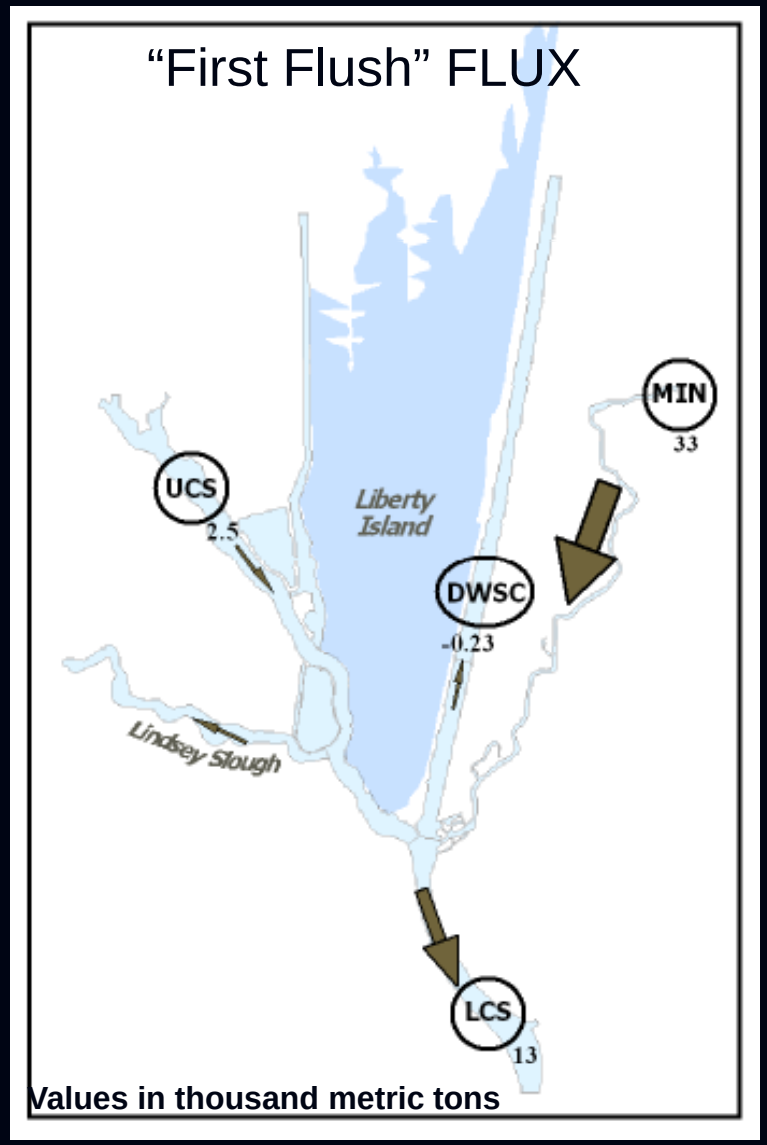
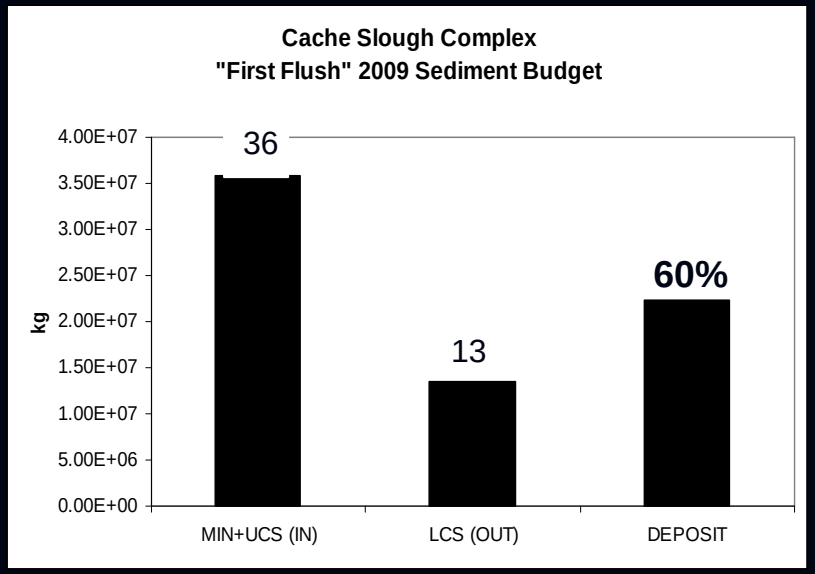
2009 First Flush Sediment Budget Conceptual Model

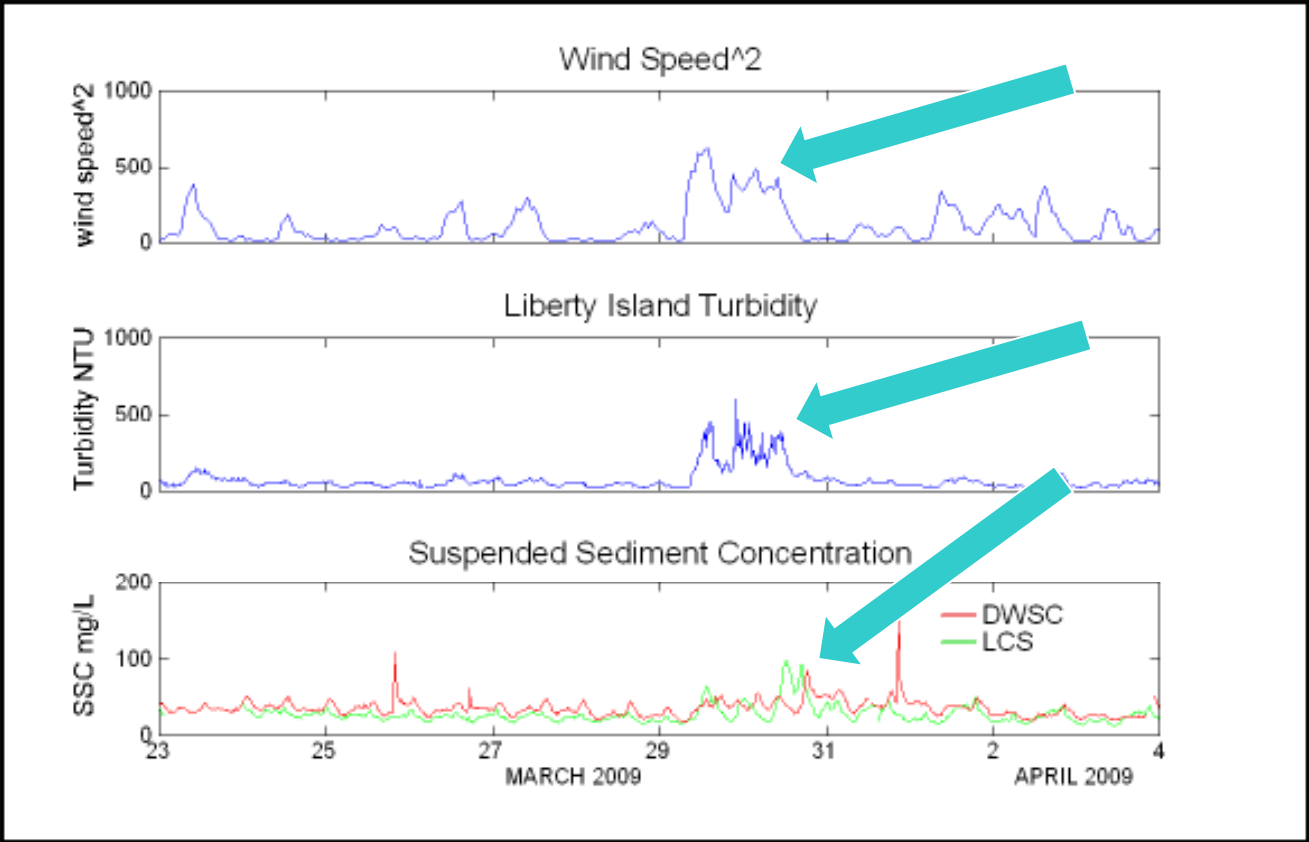
- MIN & UCS – contribute sediment ebb directional influx
- LCS ebb outflux
- ~60% of the sediment was deposited within the "control volume"
- Area of Control Volume = 28.6 km^2
- Avg. sediment deposited 1 mm





SEASONAL WINDS

- Delta Winds Resuspend Sediments
- Liberty Island – a sediment sink and a source?
- Liberty Island wind-wave resuspension
  north winds/ebb tide



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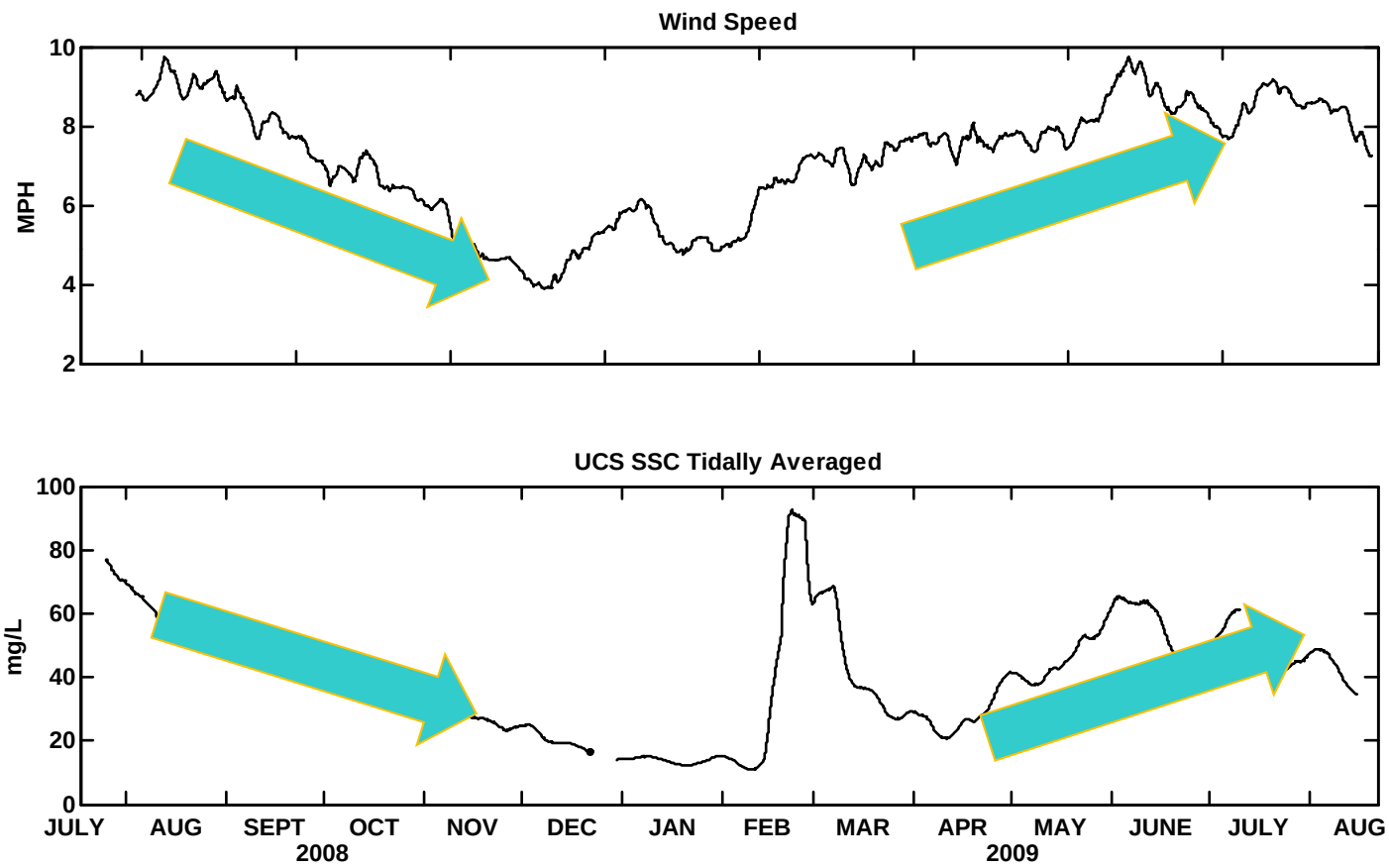
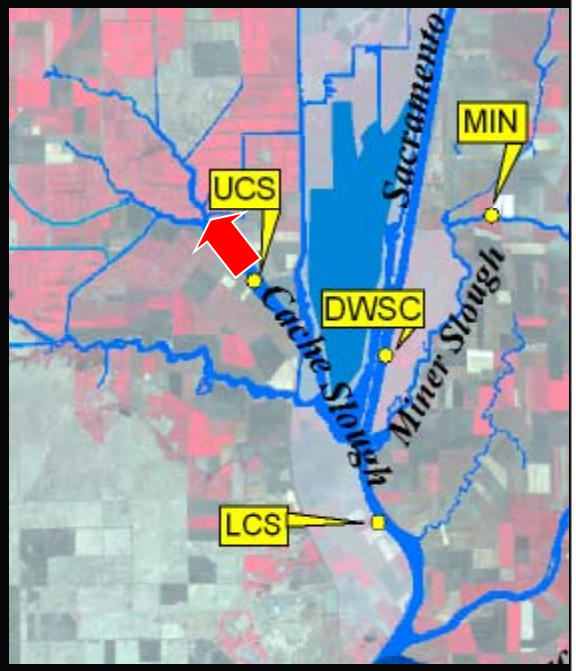
RESULTS – seasonal winds

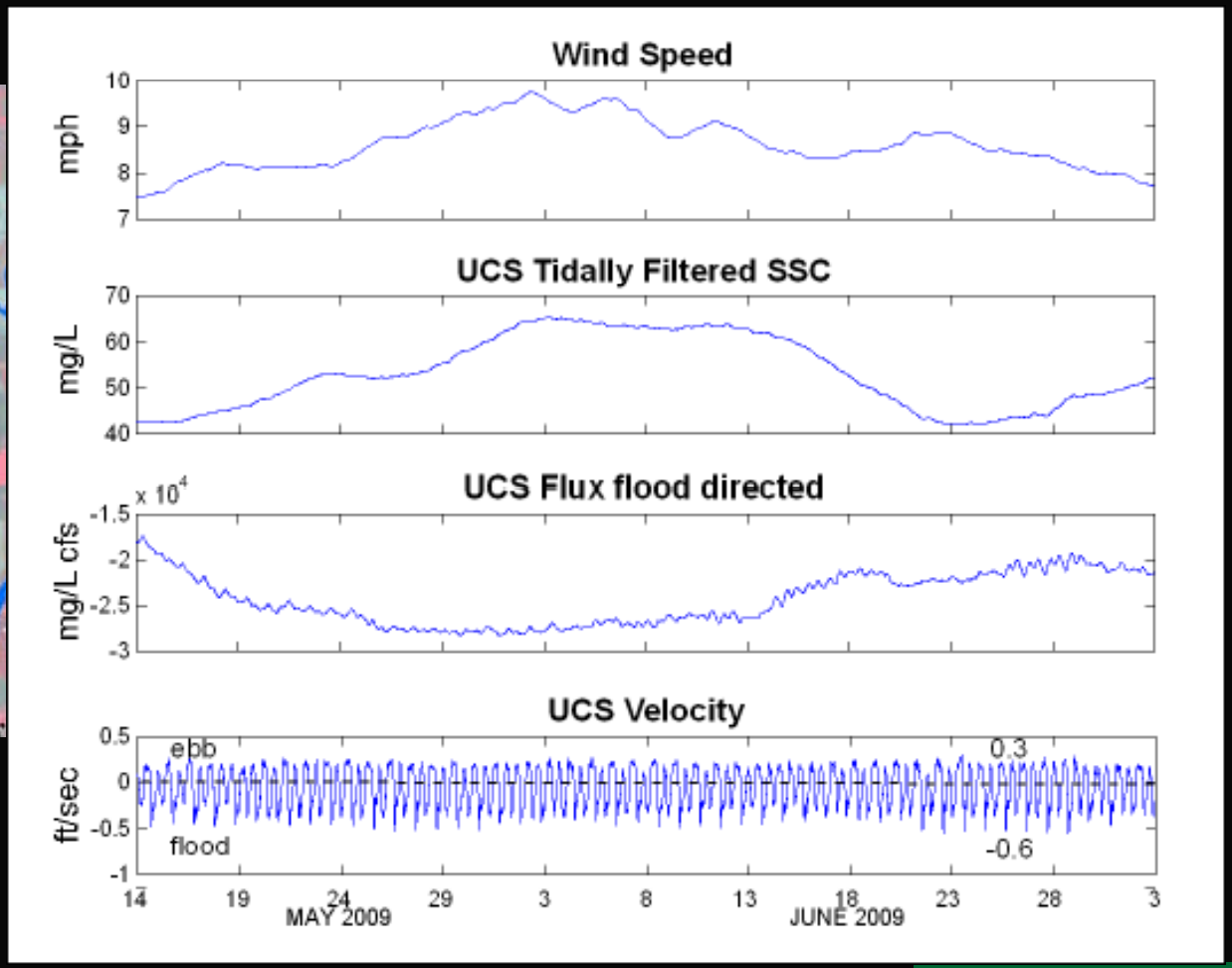
- Prolonged patterns of seasonal winds
- Likely sources – Liberty Island & wet season deposition



SEASONAL WINDS

- Winds Resuspend Sediments
- Increased SSC
- Flood directional flux





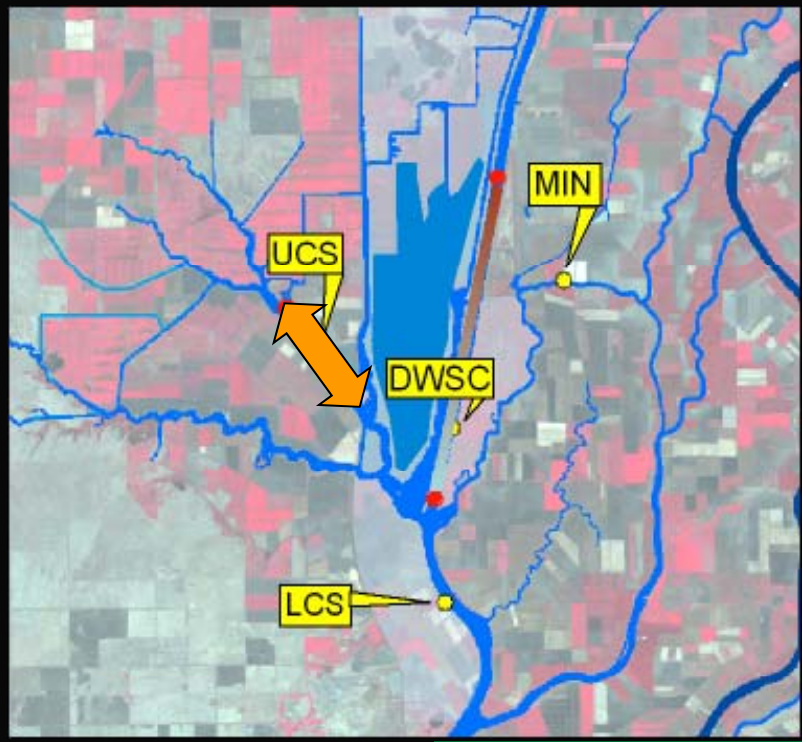
TIDALLY INDUCED SEDIMENT TRAPPING
Summary of mechanisms

- Flood Dominant Velocities = flood directed FLUX

- Limited Tidal Excursion
  sediment trapping – no outflux

- Concentration Gradient
  (higher turbidity on ebb tide)

  -Avg SSC at high tide: 28mg/L
  -Avg SSC at low tide: 45mg/L



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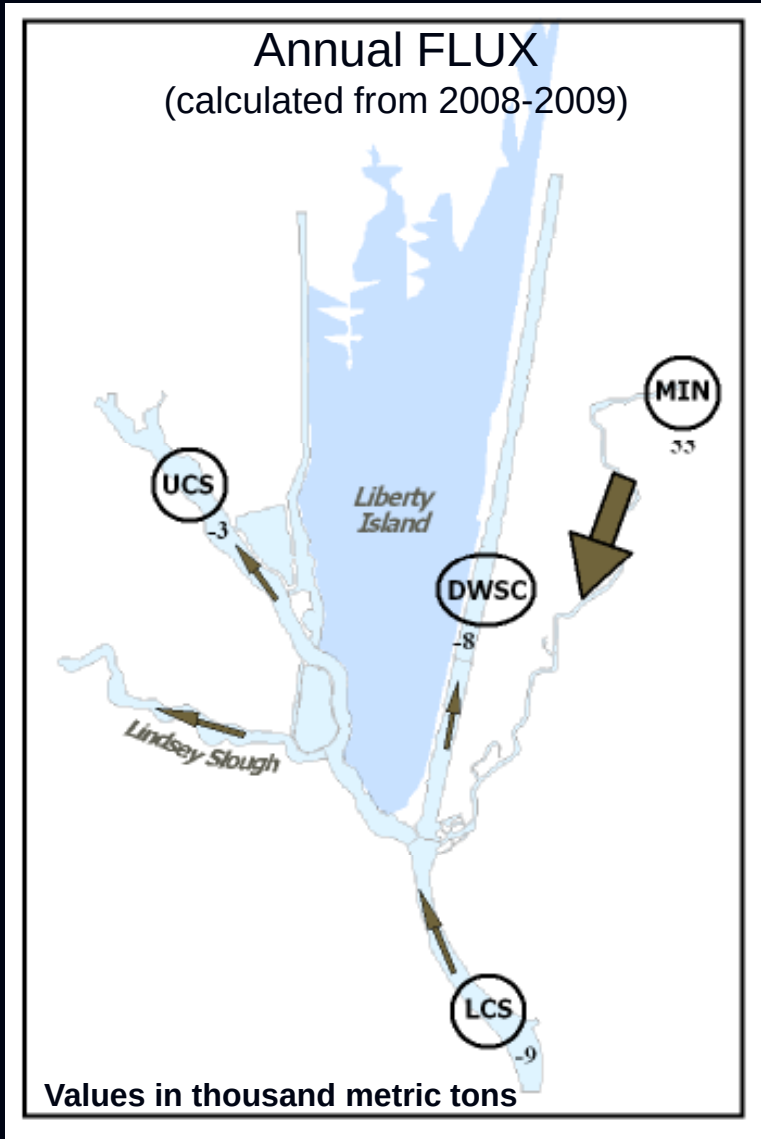
2009 Annual Sediment Budget
Conceptual Model

- MIN is a sediment source
  60% from “first flush”

- Cache Slough Complex:
  -strong tidal influence (flood dominant)
  -traps sediment (keeping it turbid)



What Have We Learned?

** dendritic dead-end channels
--maintains turbid conditions
--(most of the Delta is an interconnected maze)

a) Upper Watershed Contribution
Wet season influx -1st flush
b) Tidal Trapping –
high SSC remains in region
c) Wind-wave resuspension
mobilizes sediments

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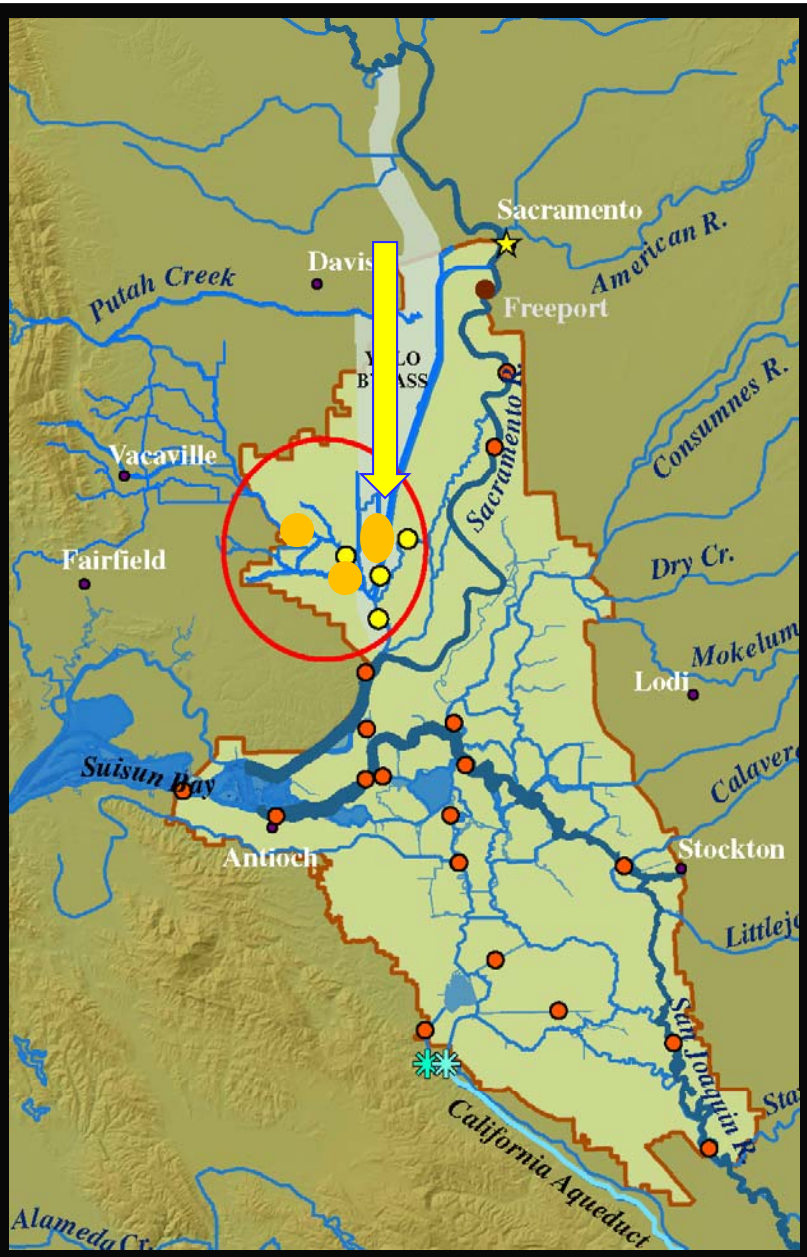
Remaining Questions?



1) Yolo Bypass Flood Conveyance for Sacramento River –
   - alternate hydrodynamics?

2) UCS – very turbid, …
   what is going on upstream?

3) What is the role of Liberty Island

4) What is the flux in Lindsey Slough

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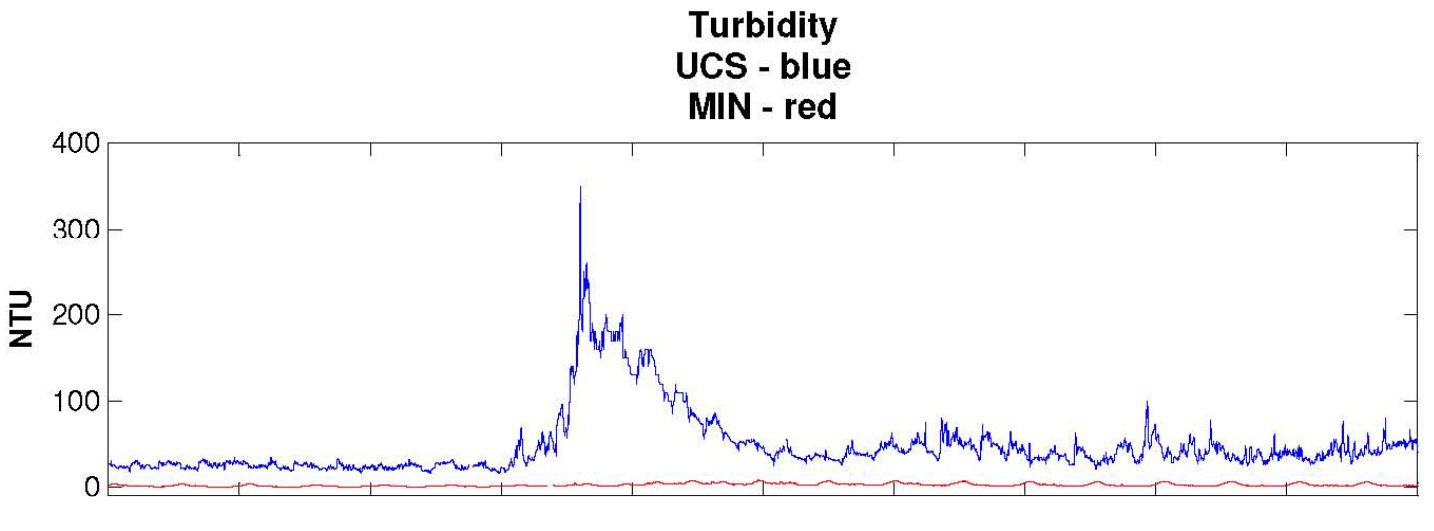
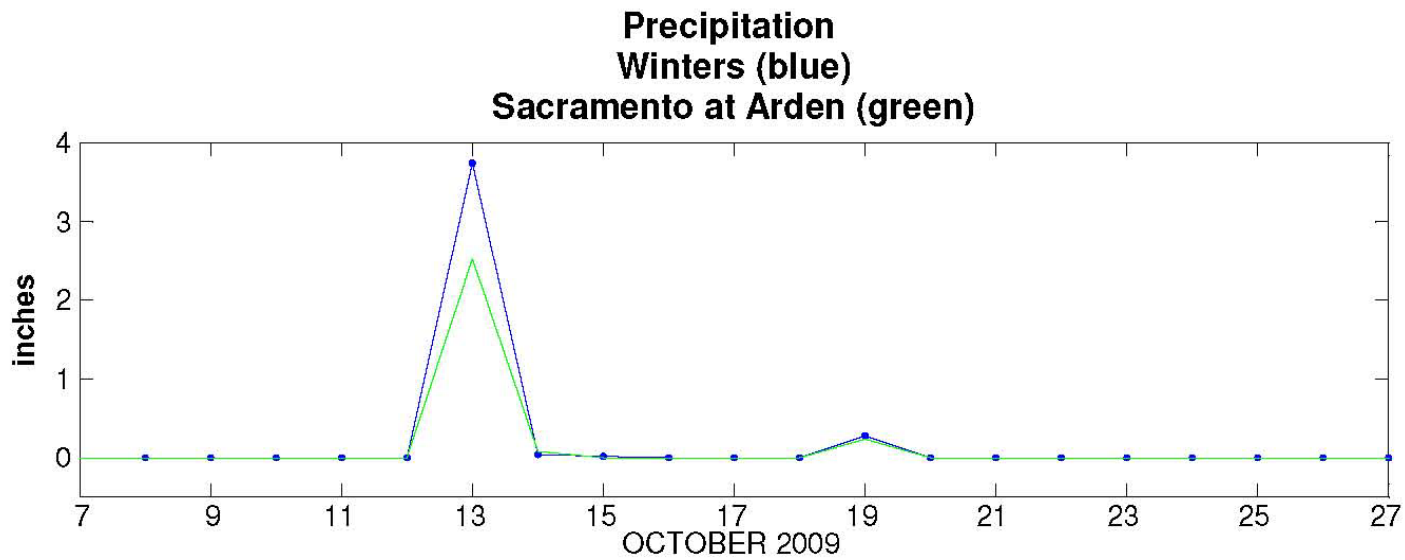
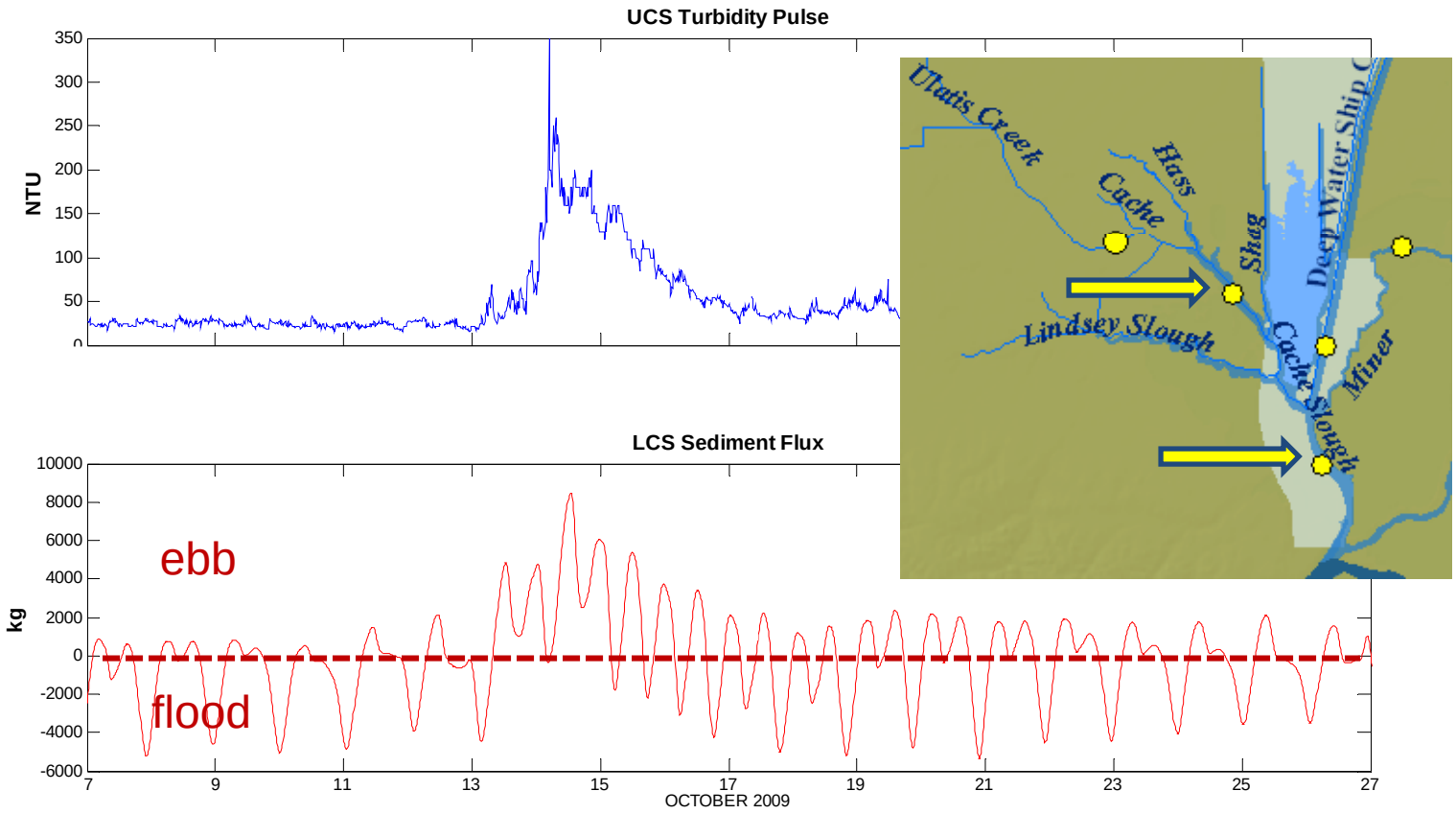
While we wait for a Sacramento –San Joaquin 2010 First Flush:



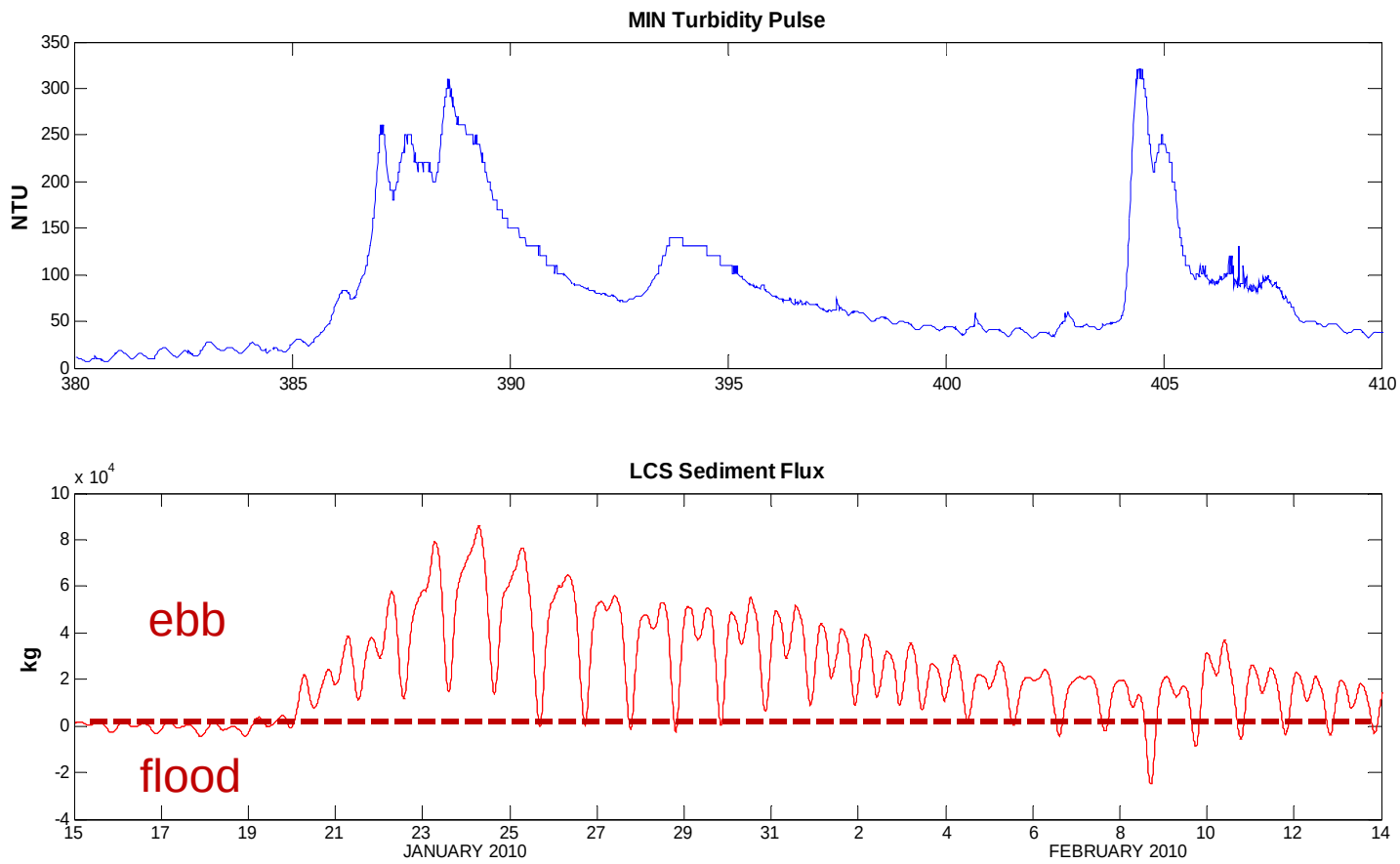


Downstream turbidity pulse directly attributed to Upper Cache Slough



2010 First Flush Sediment Dynamics

less deposition than 2009

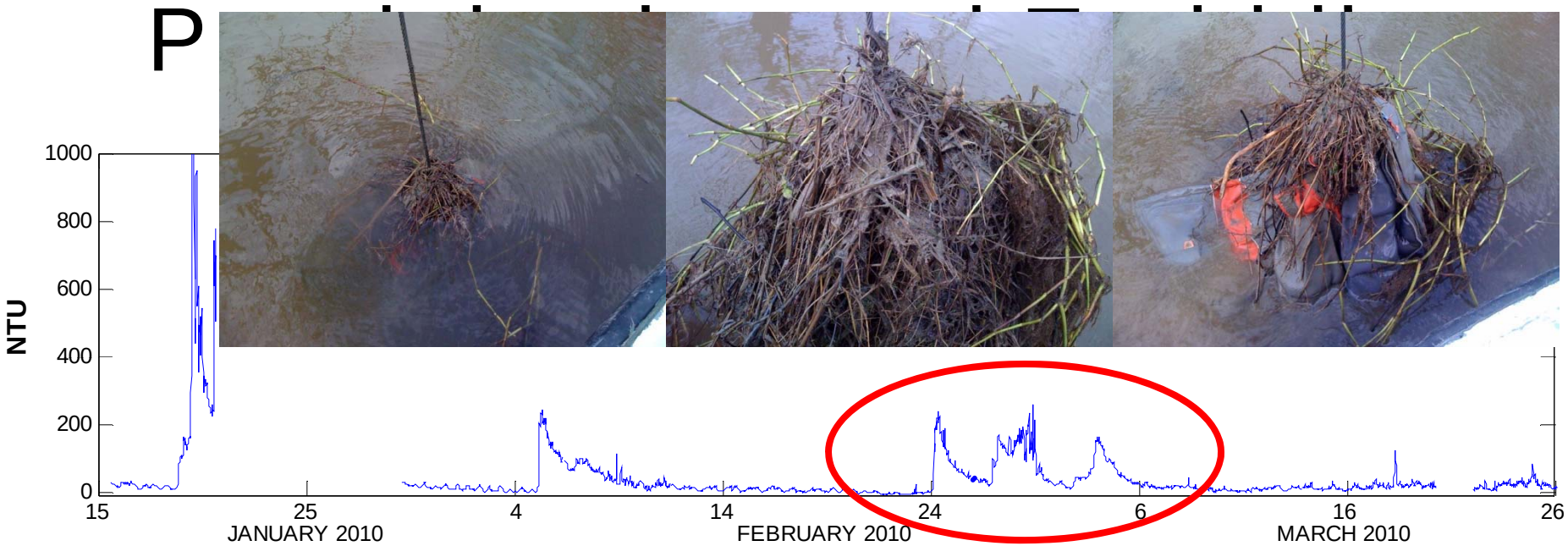


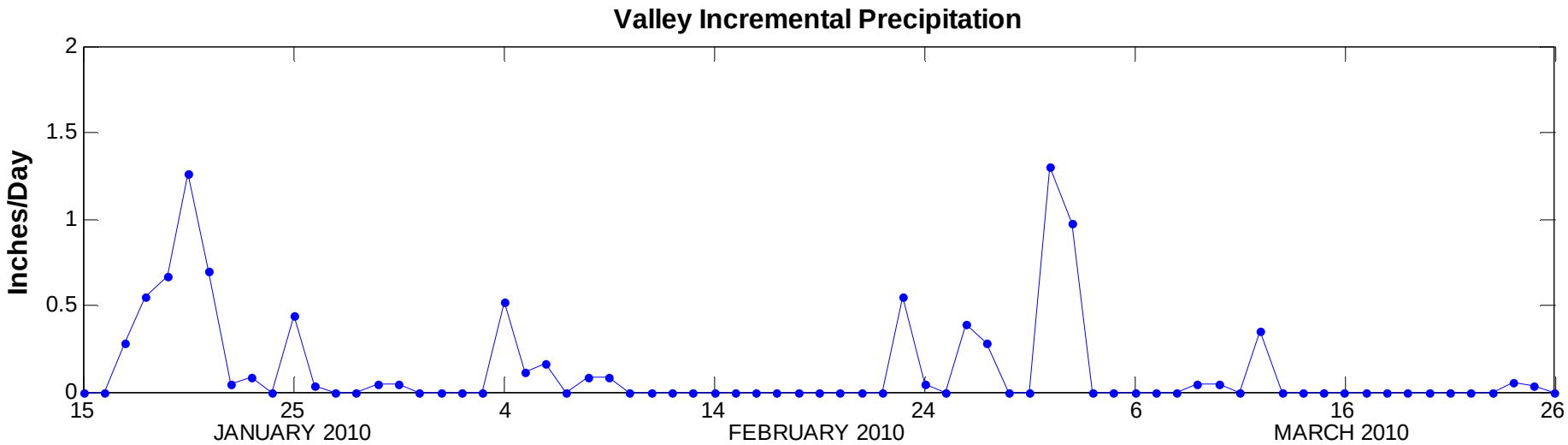
Ulatis Creek

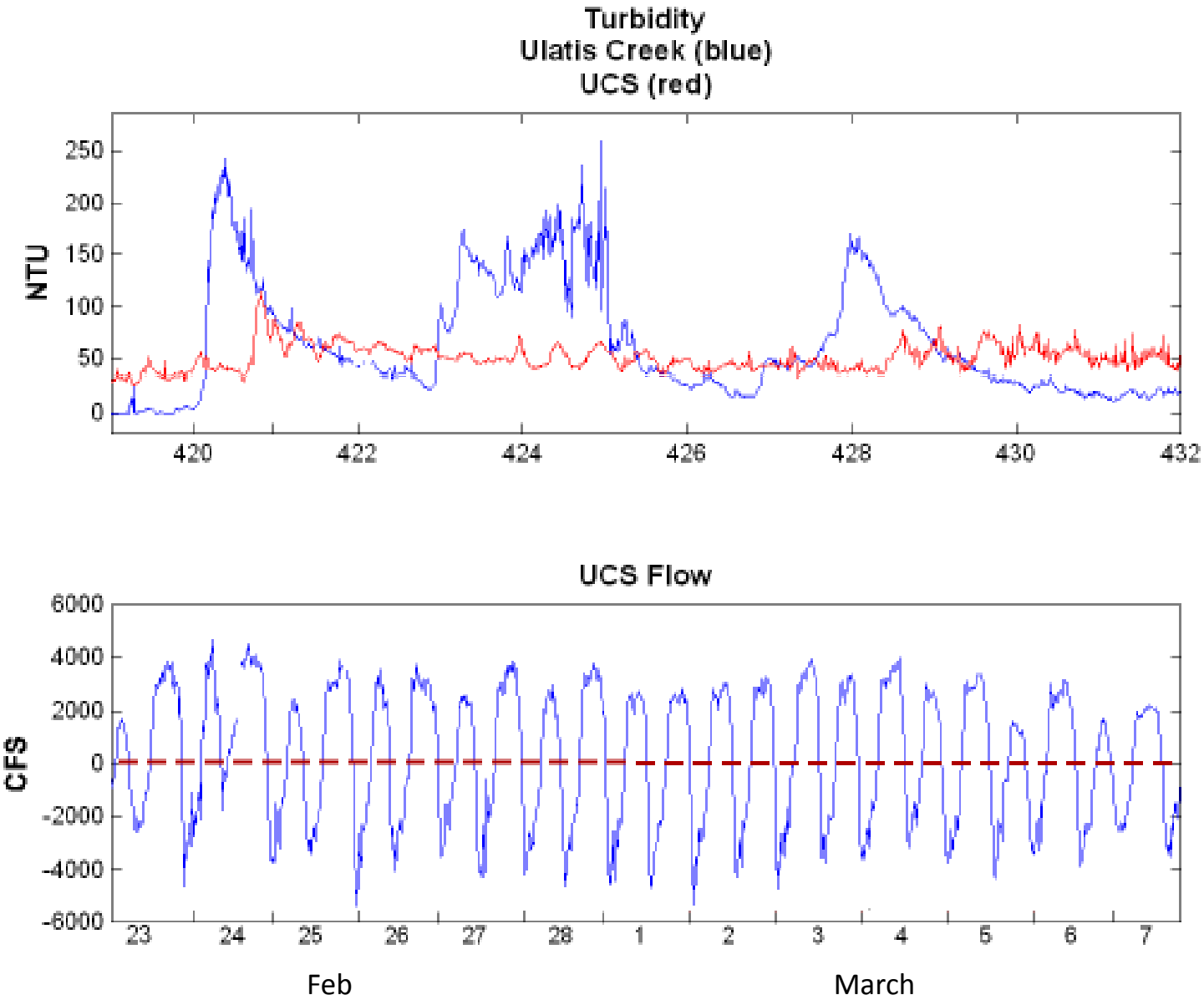
•Sediment source during storm runoff and ebb tide

Ulatis Storm Runoff

P



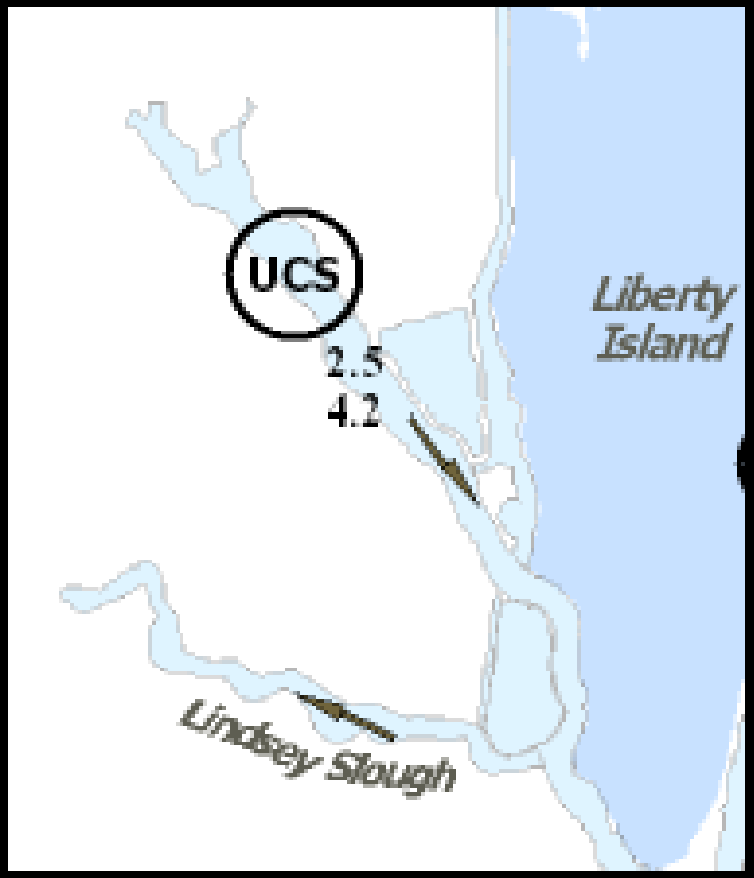



Turbidity
Ulatis Creek (blue)
UCS (red)
NTU
250
200
150
100
50
0
420
422
424
426
428
430
432
UCS Flow
CFS
6000
4000
2000
0
-2000
-4000
-6000
23
24
25
26
27
28
1
2
3
4
5
6
7
Feb
March

Cache Slough/Ulatis Creek supplies sediment to the region

2009: 2.5 thousand metric tons
(during “first flush”)

2010: Ulatis/Cache Event
--post 2010 “first flush”
(an isolated event supplies sediment into the region)
Feb. 24, 2010 to March 6, 2010:
4.2 thousand metric tons



Continued Study Questions

- Liberty Island sediment flux?
  --source and/or sink
  Sediment flux at main breach

- Seasonal wind wave resuspension
  --seabird wave gauge and YSI within island (2010)

THANK YOU!

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