Will restoration mobilize mercury in tidal sloughs?

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UNESCO-IHE
Institute for Water Education

USGS
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Main Points

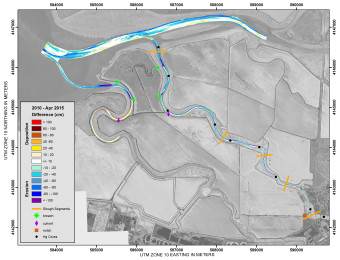
1) Scour, and associated mercury mobilization, in Alviso Slough is spatially and temporally variable

2) Mercury mobilization, which has amounted to ~35 kg since restoration began in 2010, is greatest in the winter and near the A6 breaches

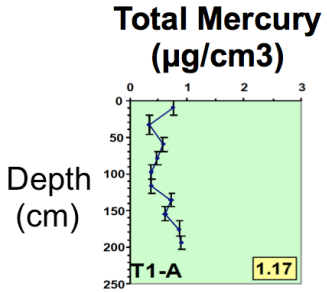
3) Coupled hydrodynamic/sediment transport/geomorphic change modeling is a useful tool for understanding the causes for mercury mobilization and exploring whether the rates of mobilization will decrease or increase in the future in response to widening/deepening of the slough and sea level rise

Outline

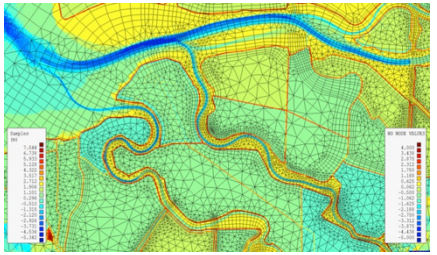
- **Observations of scour**



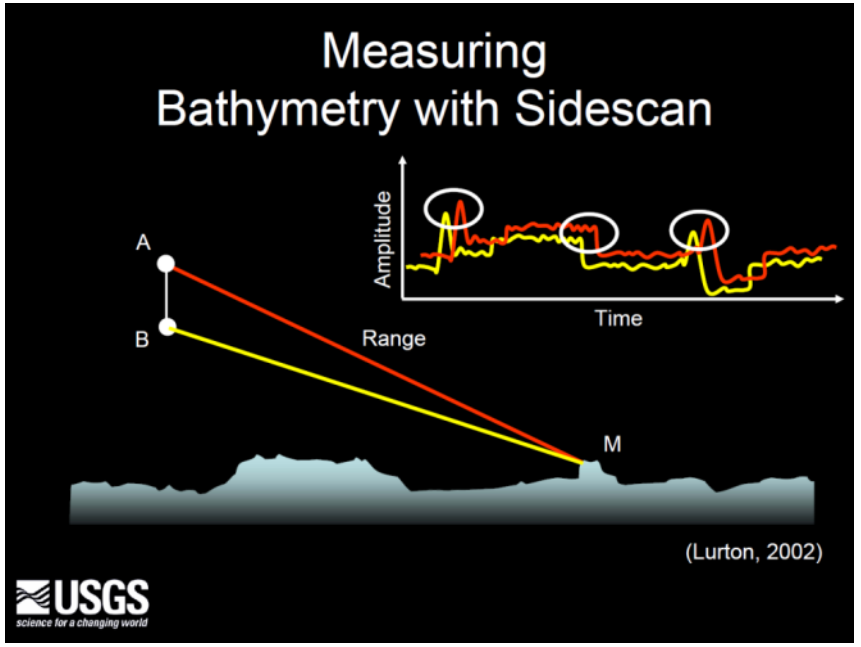
- **Estimates of mercury mobilization**



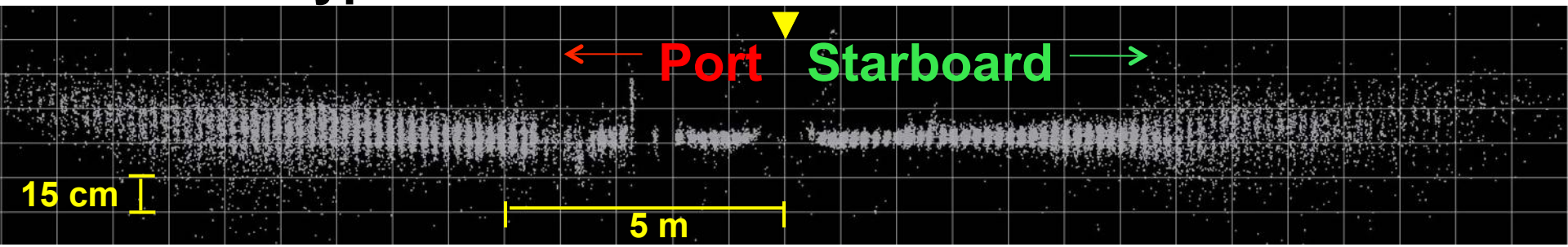
- **Modeling of scour and mercury mobilization**

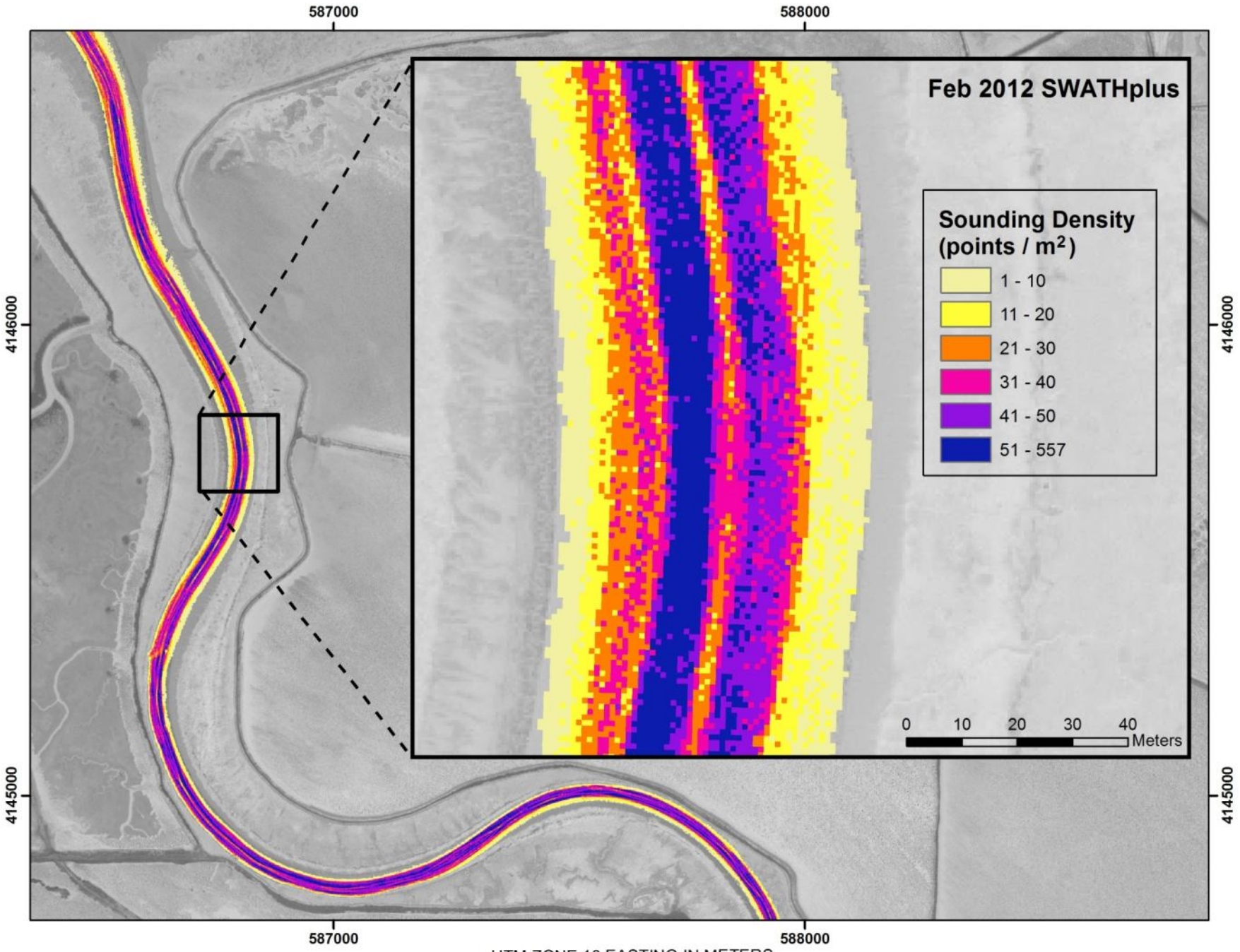


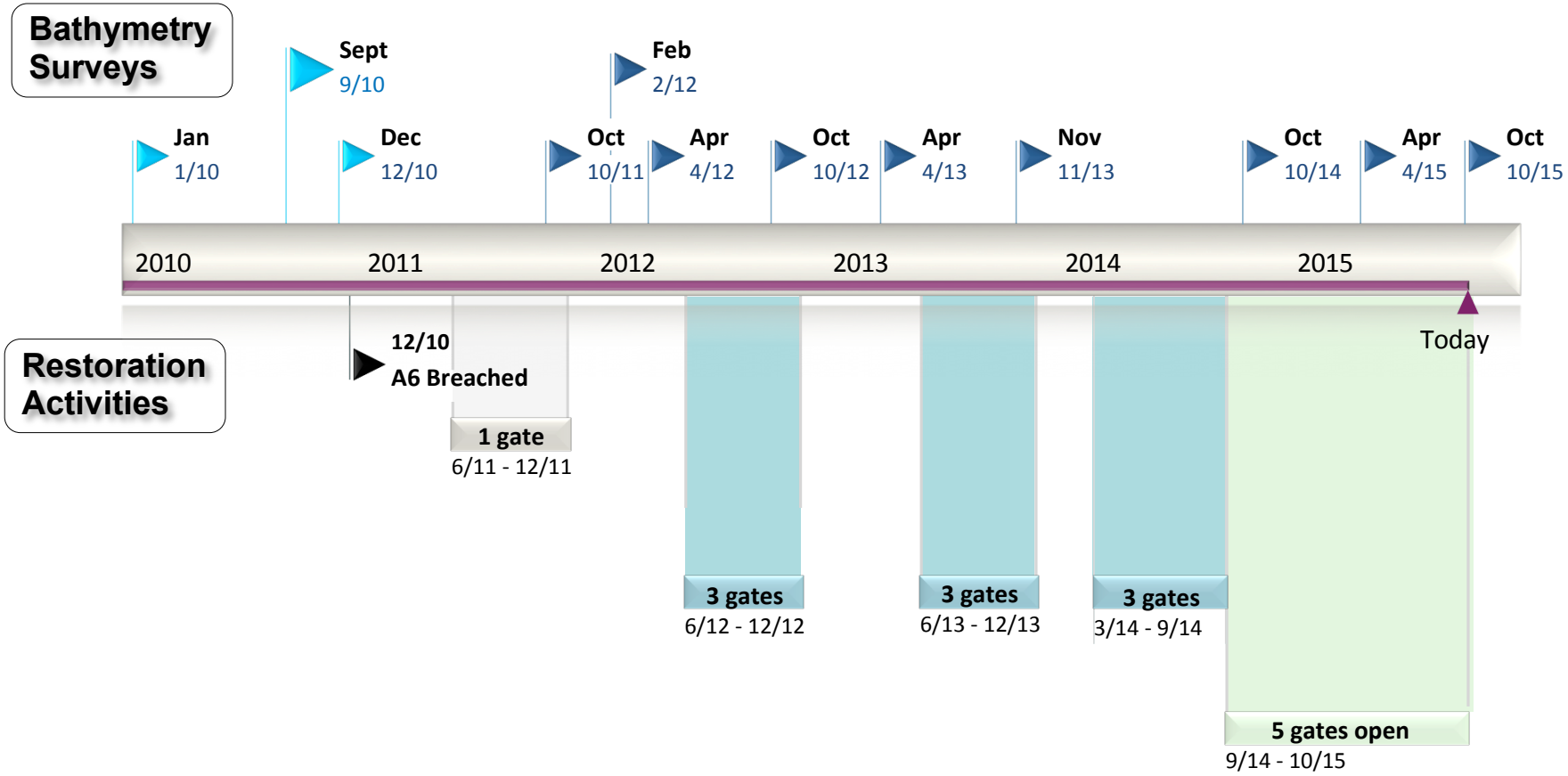
- **Summary and future work**

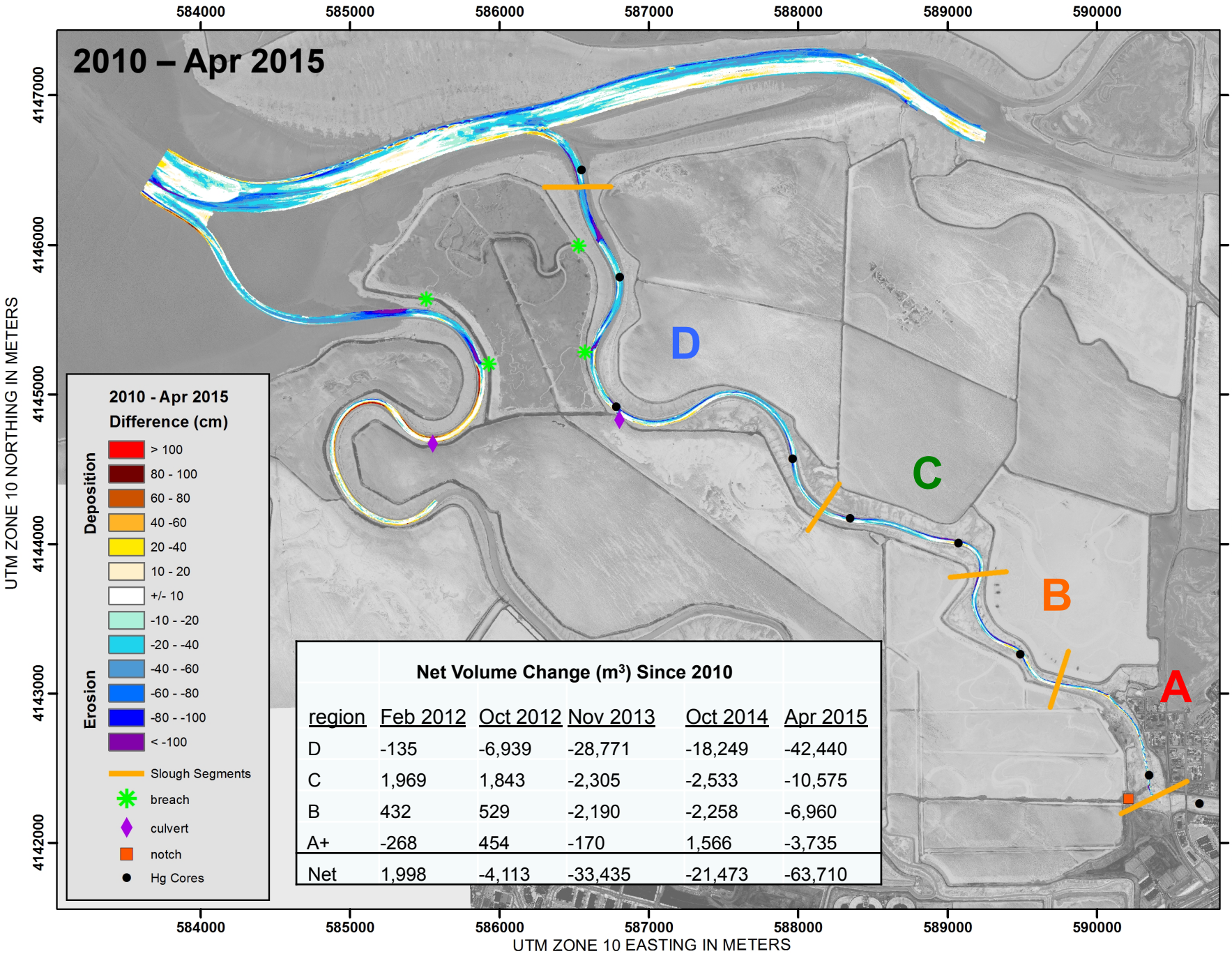


Typical Shallow-water Sidescan Returns



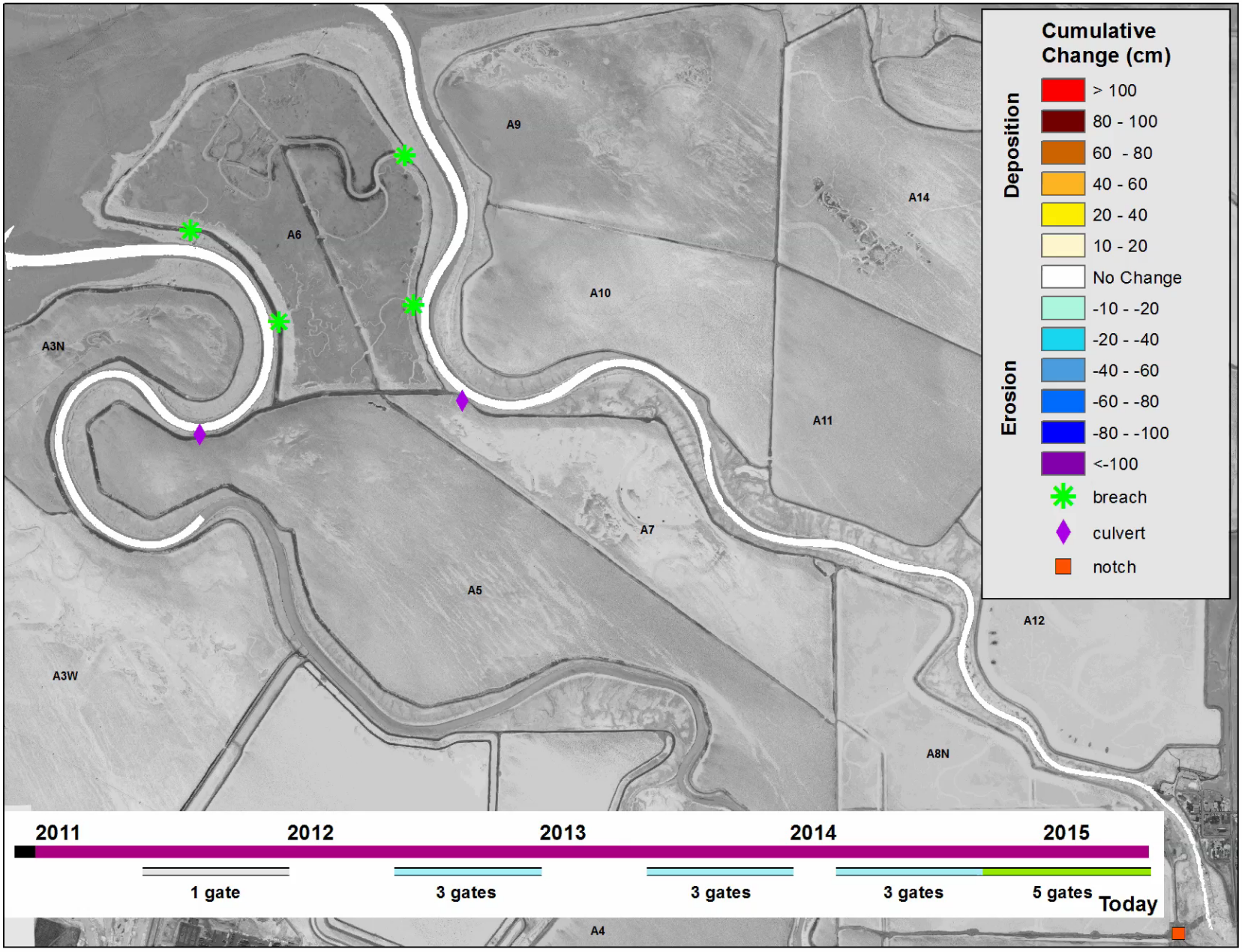

587000
588000
4146000
4145000
Feb 2012 SWATHplus
Sounding Density
(points / m²)
1 - 10
11 - 20
21 - 30
31 - 40
41 - 50
51 - 557
0 10 20 30 40
Meters
UTM ZONE 10 EASTING IN METERS


Bathymetry Surveys
Jan 1/10
Sept 9/10
Dec 12/10
Feb 2/12
Oct 10/11
Apr 4/12
Oct 10/12
Apr 4/13
Nov 11/13
Oct 10/14
Apr 4/15
Oct 10/15
2010
2011
2012
2013
2014
2015
Today
Restoration Activities
12/10 A6 Breached
1 gate 6/11 - 12/11
3 gates 6/12 - 12/12
3 gates 6/13 - 12/13
3 gates 3/14 - 9/14
5 gates open 9/14 - 10/15

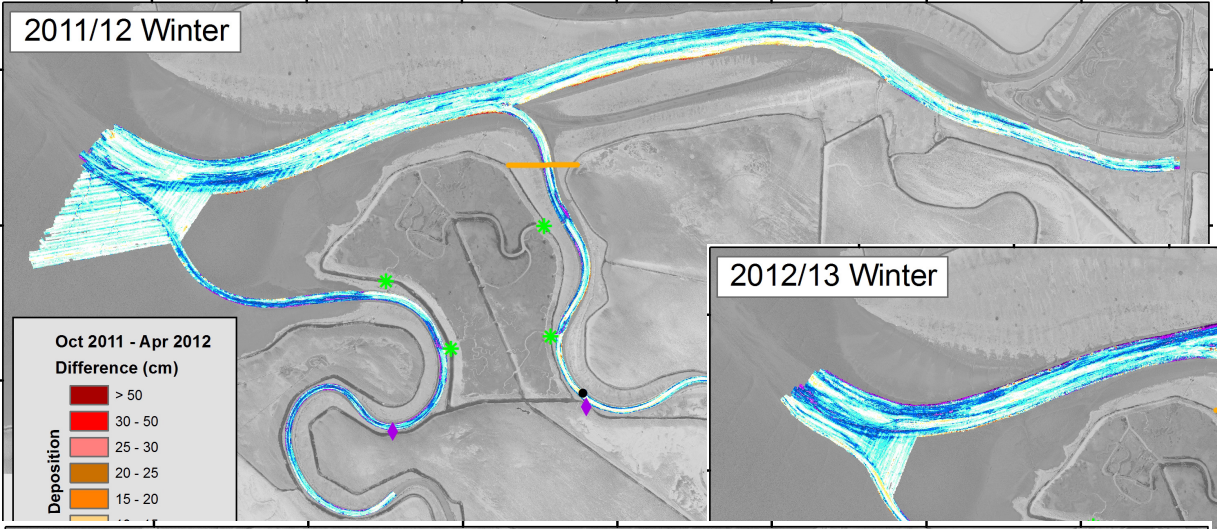


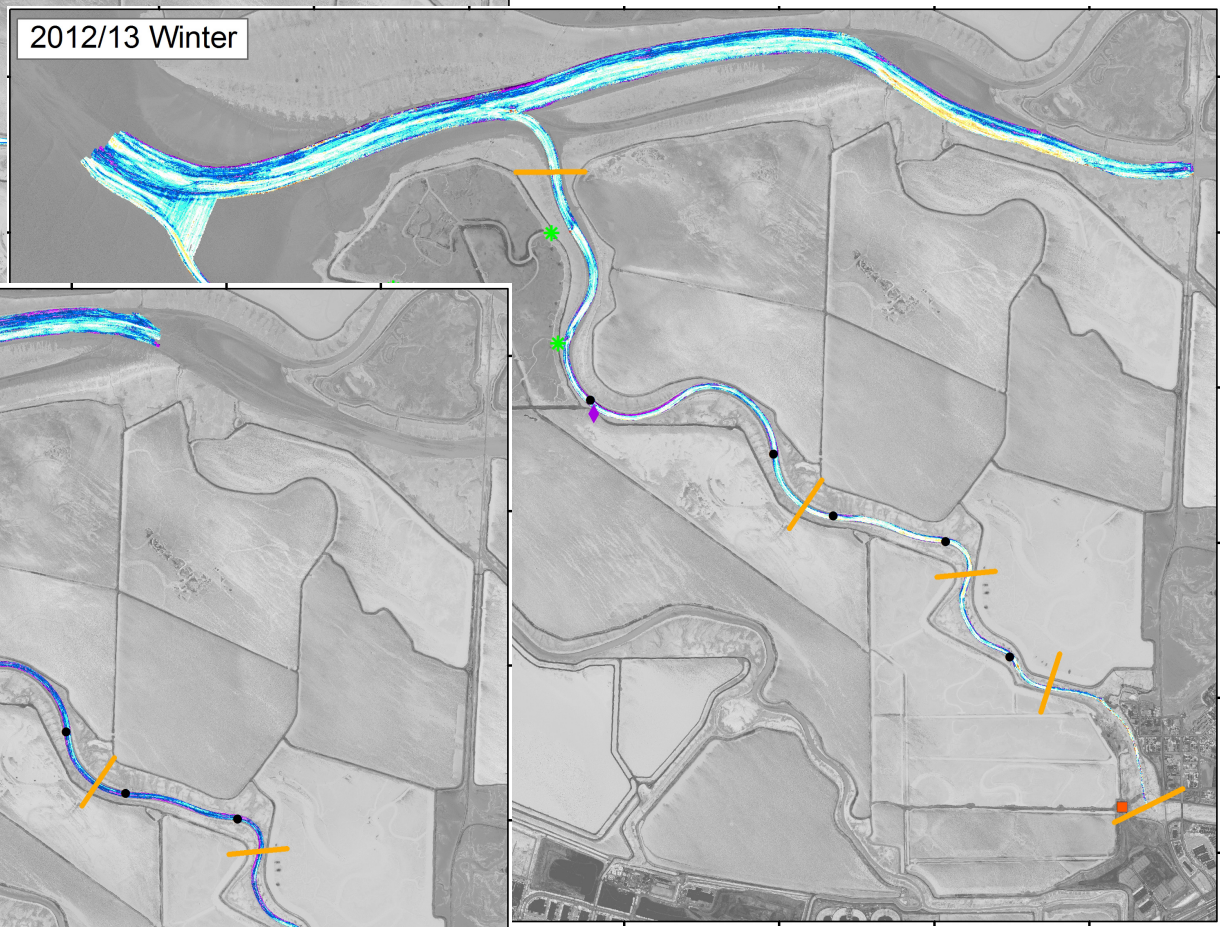
Net Volume Change (m^3) Since 2010

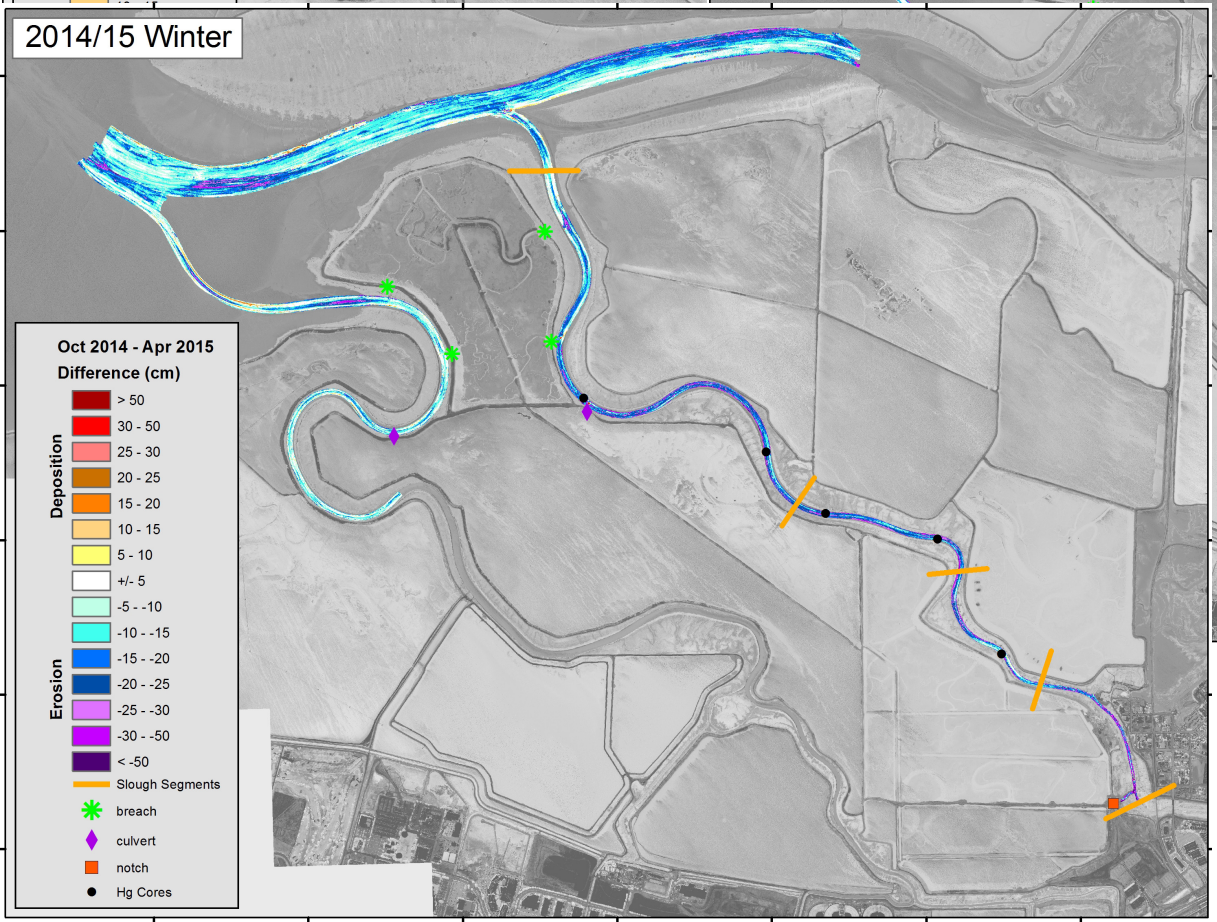
region	Feb 2012	Oct 2012	Nov 2013	Oct 2014	Apr 2015
D	-135	-6,939	-28,771	-18,249	-42,440
C	1,969	1,843	-2,305	-2,533	-10,575
B	432	529	-2,190	-2,258	-6,960
A+	-268	454	-170	1,566	-3,735
Net	1,998	-4,113	-33,435	-21,473	-63,710


Cumulative Change (cm)
Deposition
> 100
80 - 100
60 - 80
40 - 60
20 - 40
10 - 20
No Change
Erosion
-10 - -20
-20 - -40
-40 - -60
-60 - -80
-80 - -100
<-100
breach
culvert
notch
A9
A14
A6
A10
A3N
A11
A7
A5
A12
A3W
A8N
A4
2011
2012
2013
2014
2015
1 gate
3 gates
3 gates
3 gates
5 gates
Today

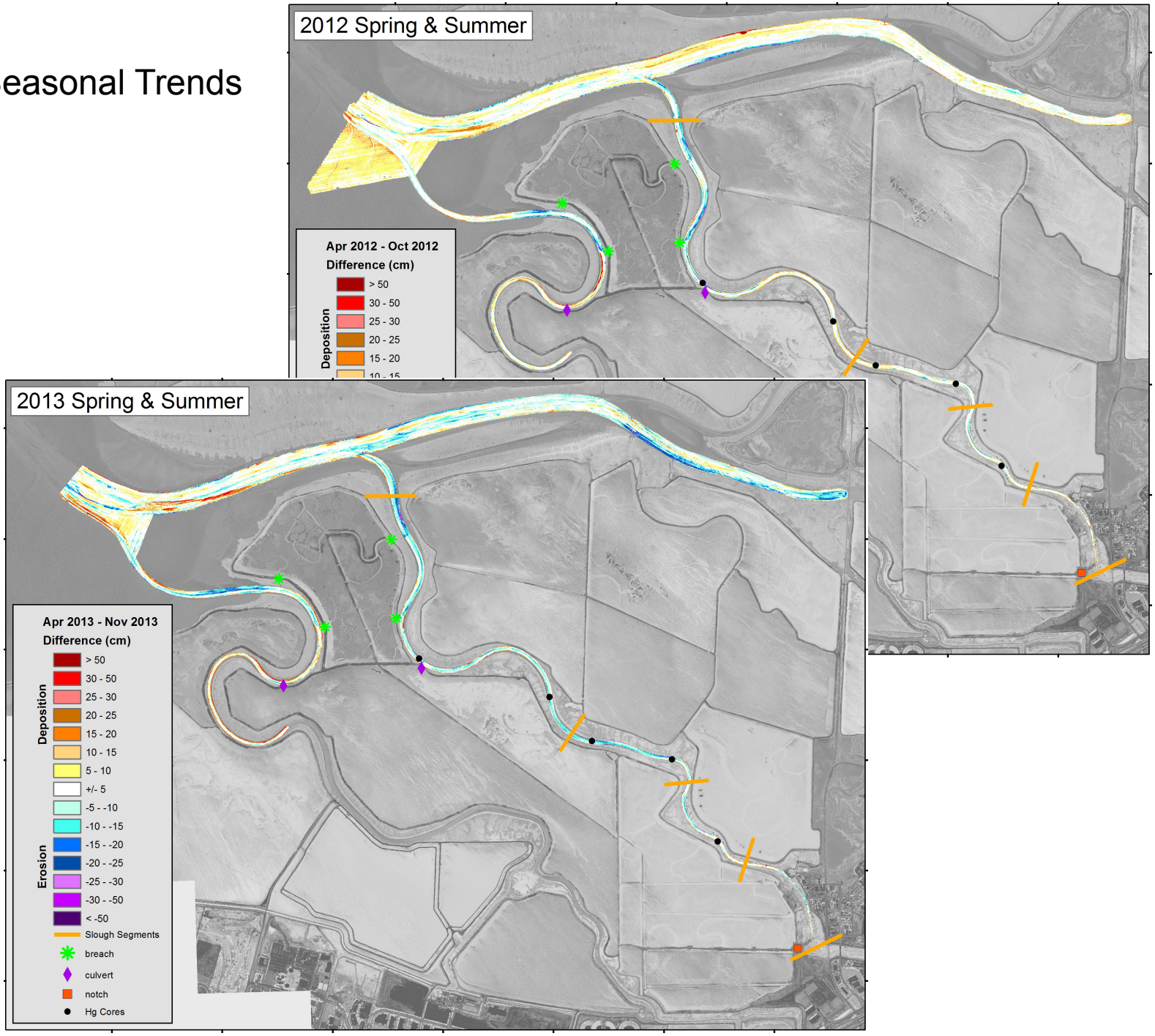
Seasonal Trends



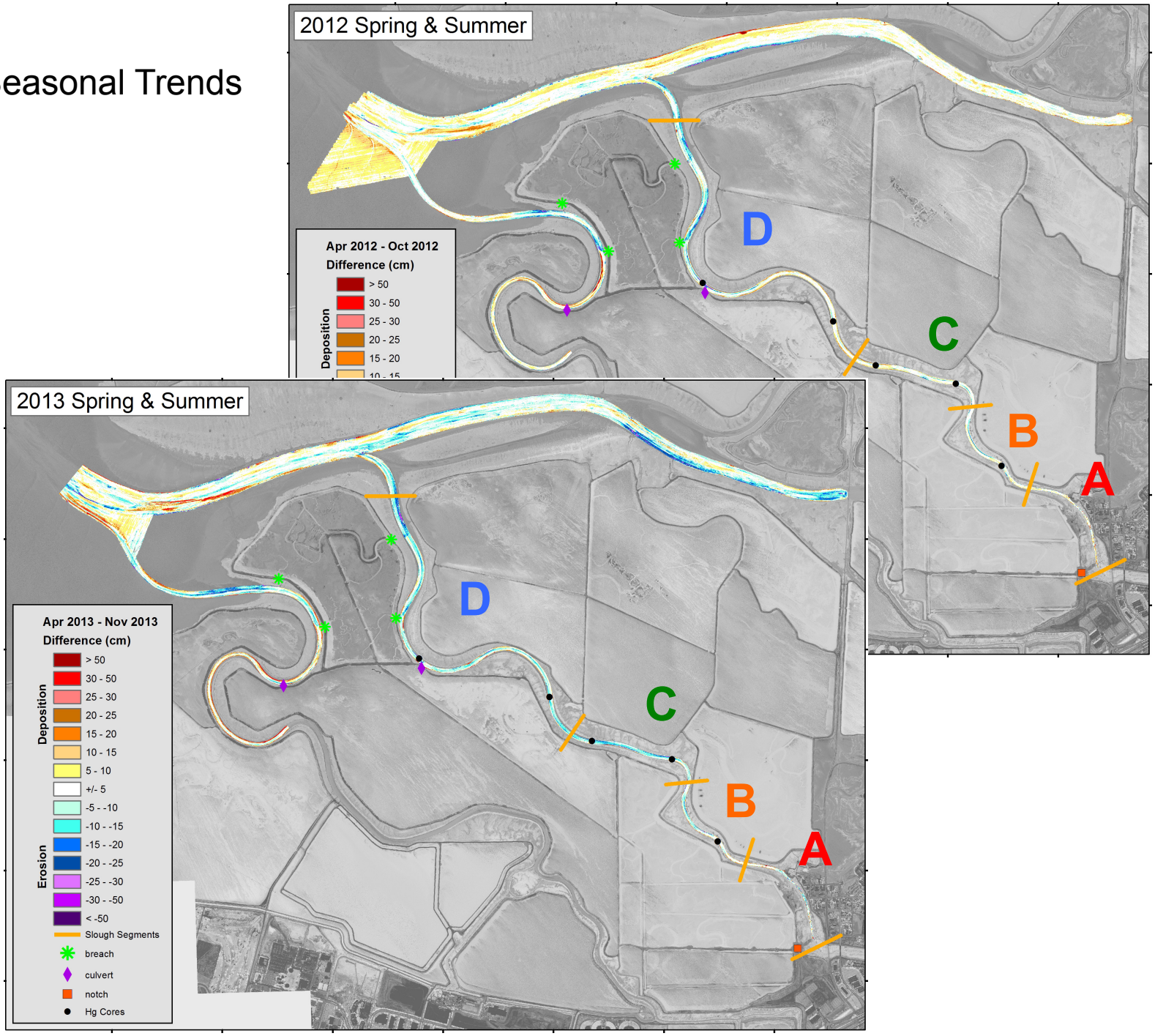


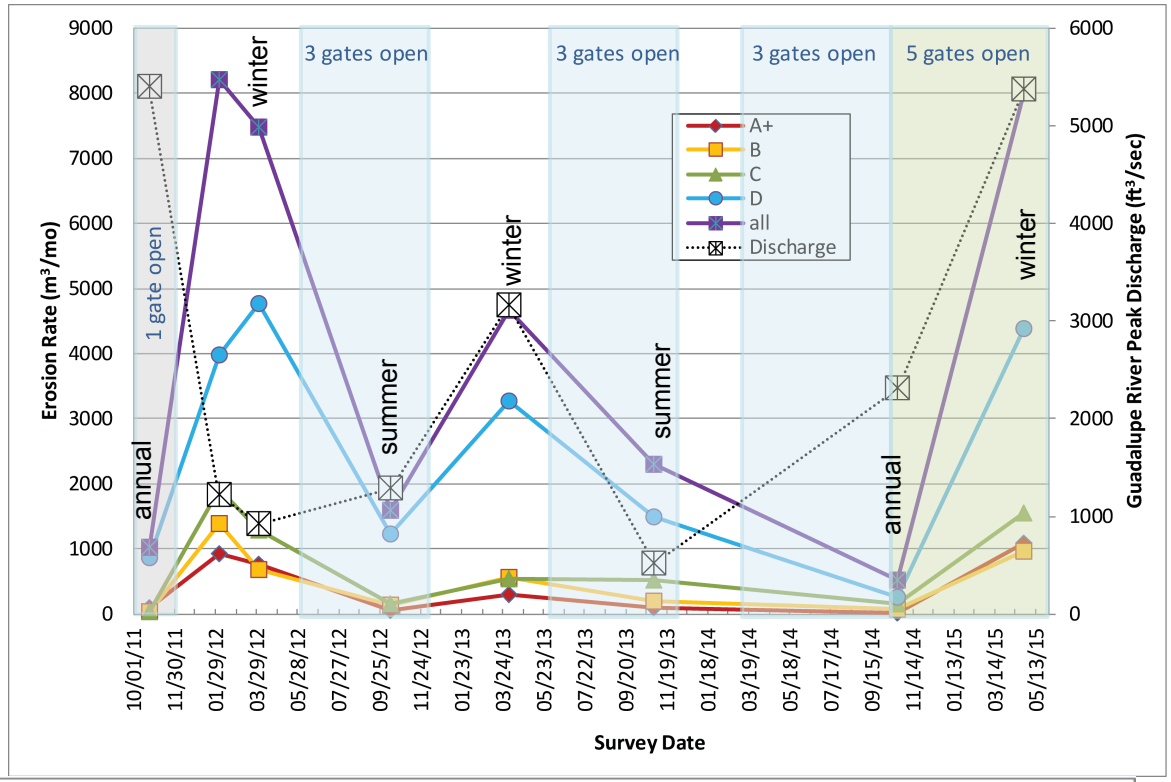


Seasonal Trends



Seasonal Trends




Erosion Rate (m³/mo)
Guadalupe River Peak Discharge (ft³/sec)
Survey Date
1 gate open
3 gates open
3 gates open
3 gates open
5 gates open
annual
winter
summer
winter
summer
annual
winter
A+
B
C
D
all
Discharge
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
6000
5000
4000
3000
2000
1000
0
10/01/11
11/30/11
01/29/12
03/29/12
05/28/12
07/27/12
09/25/12
11/24/12
01/23/13
03/24/13
05/23/13
07/22/13
09/20/13
11/19/13
01/18/14
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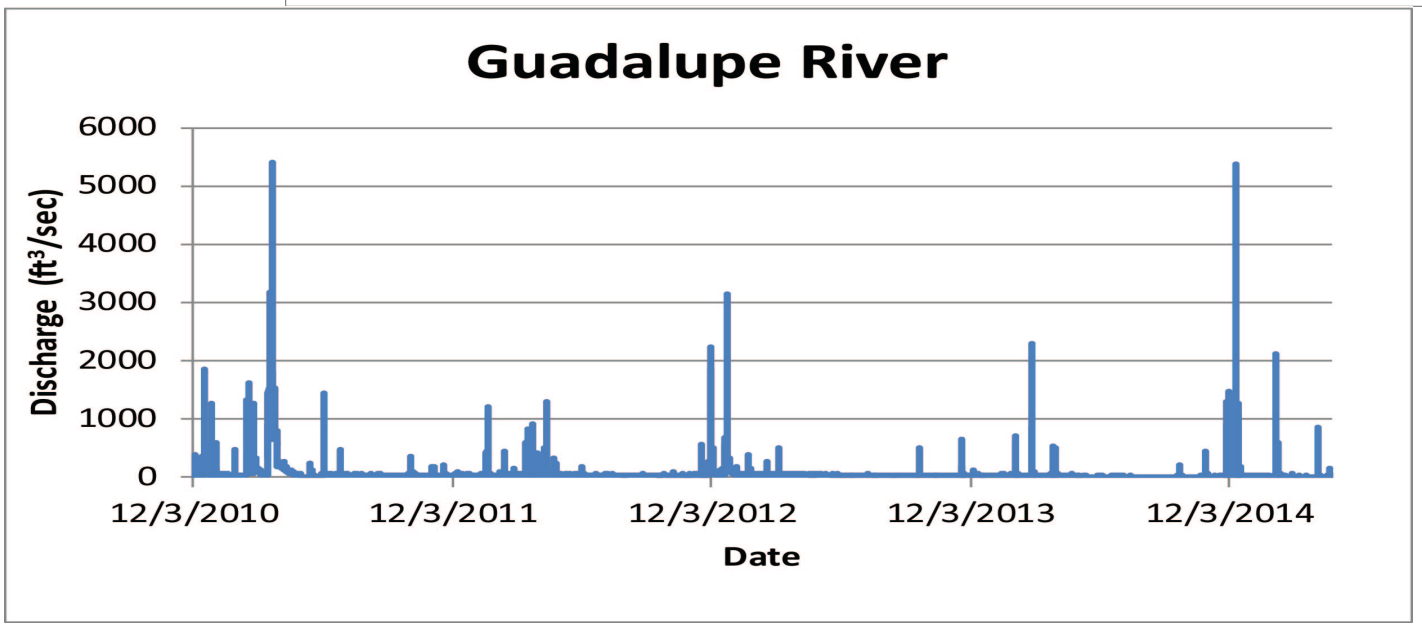
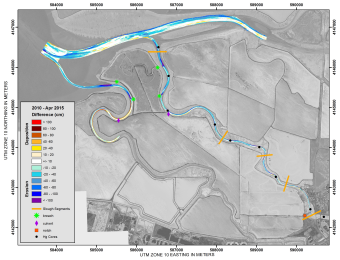
09/15/14
11/14/14
01/13/15
03/14/15
05/13/15

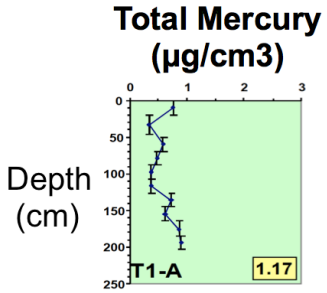

Guadalupe River
Discharge (ft³/sec)
Date
6000
5000
4000
3000
2000
1000
0
12/3/2010
12/3/2011
12/3/2012
12/3/2013
12/3/2014

Outline

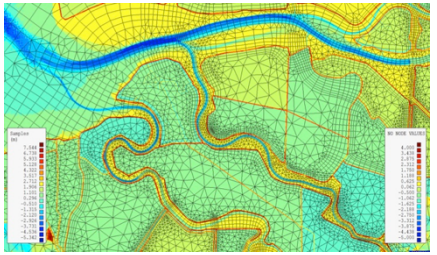
- Observations of scour



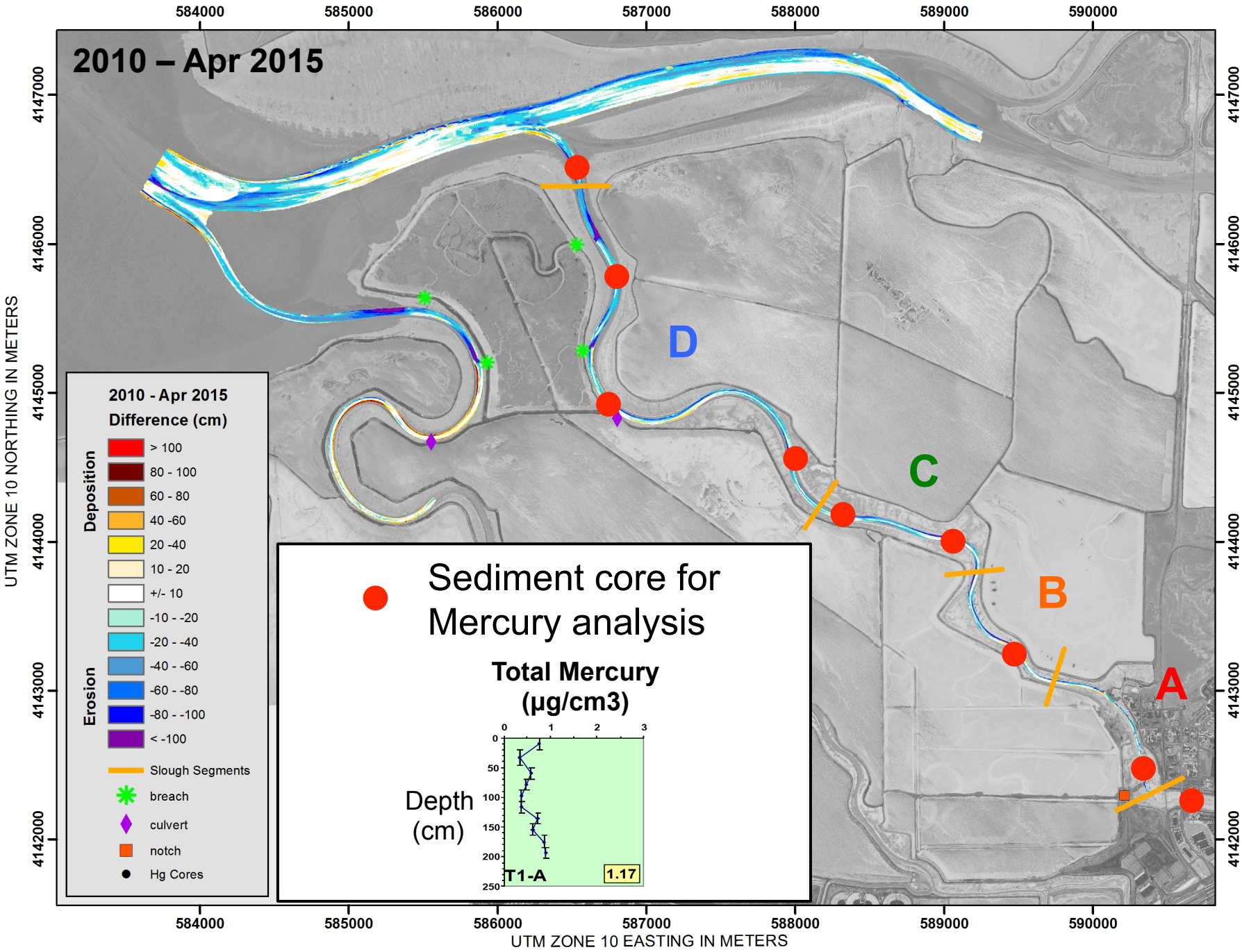
- Estimates of mercury mobilization



- Modeling of scour and mercury mobilization

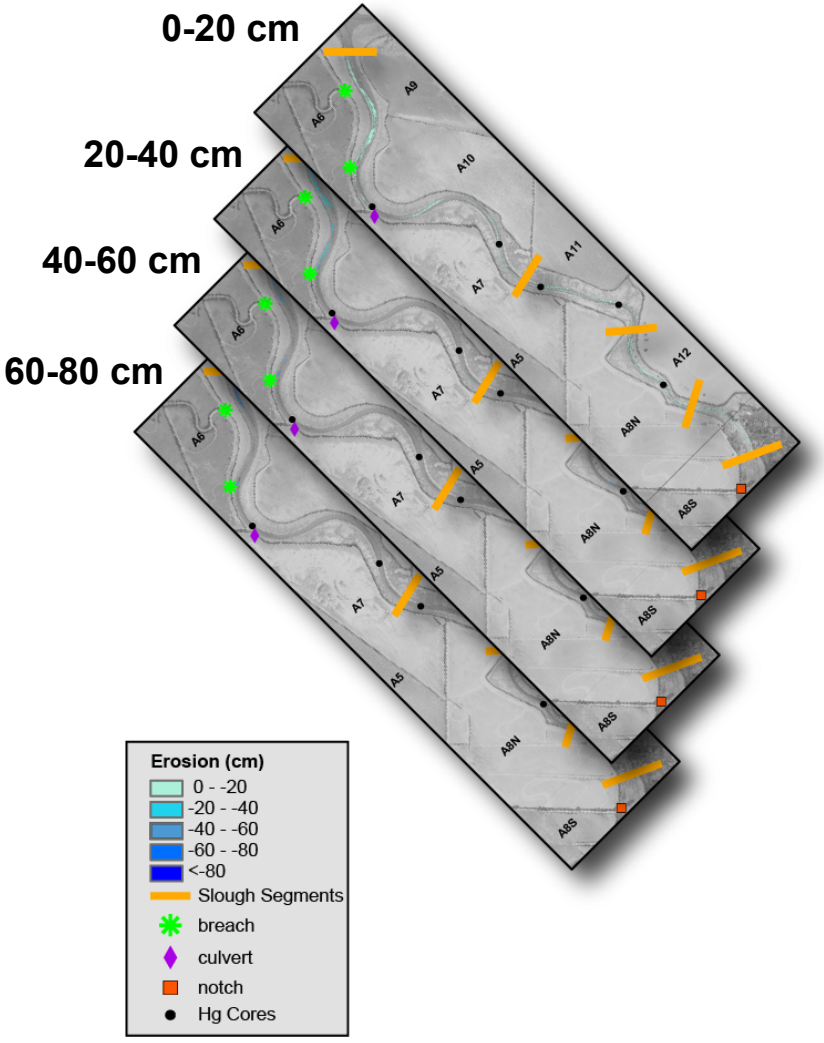


- Summary and future work


2010 – Apr 2015
584000
585000
586000
587000
588000
589000
590000
4147000
4146000
4145000
4144000
4143000
4142000
UTM ZONE 10 NORTHING IN METERS
UTM ZONE 10 EASTING IN METERS
D
C
B
A
2010 - Apr 2015
Difference (cm)
Deposition
> 100
80 - 100
60 - 80
40 -60
20 -40
10 - 20
+/- 10
Erosion
-10 - -20
-20 - -40
-40 - -60
-60 - -80
-80 - -100
< -100
Slough Segments
breach
culvert
notch
Hg Cores
Sediment core for Mercury analysis
Total Mercury (µg/cm3)
Depth (cm)
0
1
2
3
0
50
100
150
200
250
T1-A
1.17

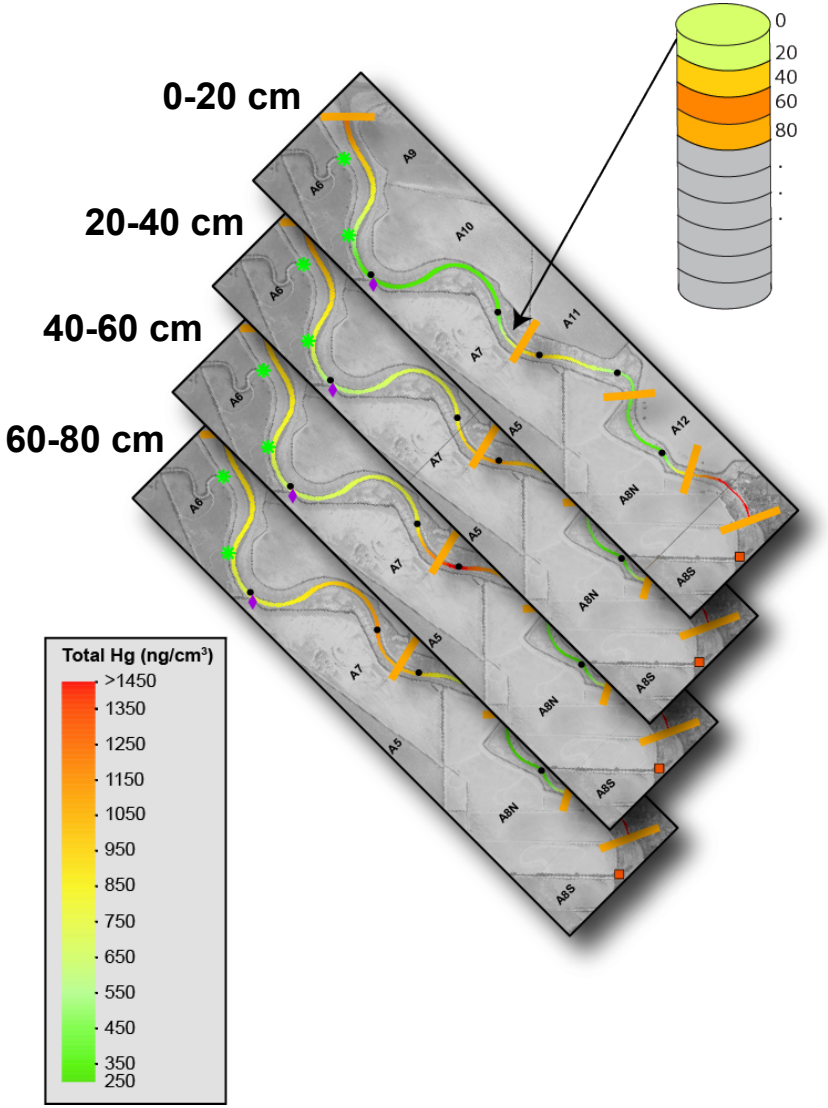
Estimating Hg Remobilization

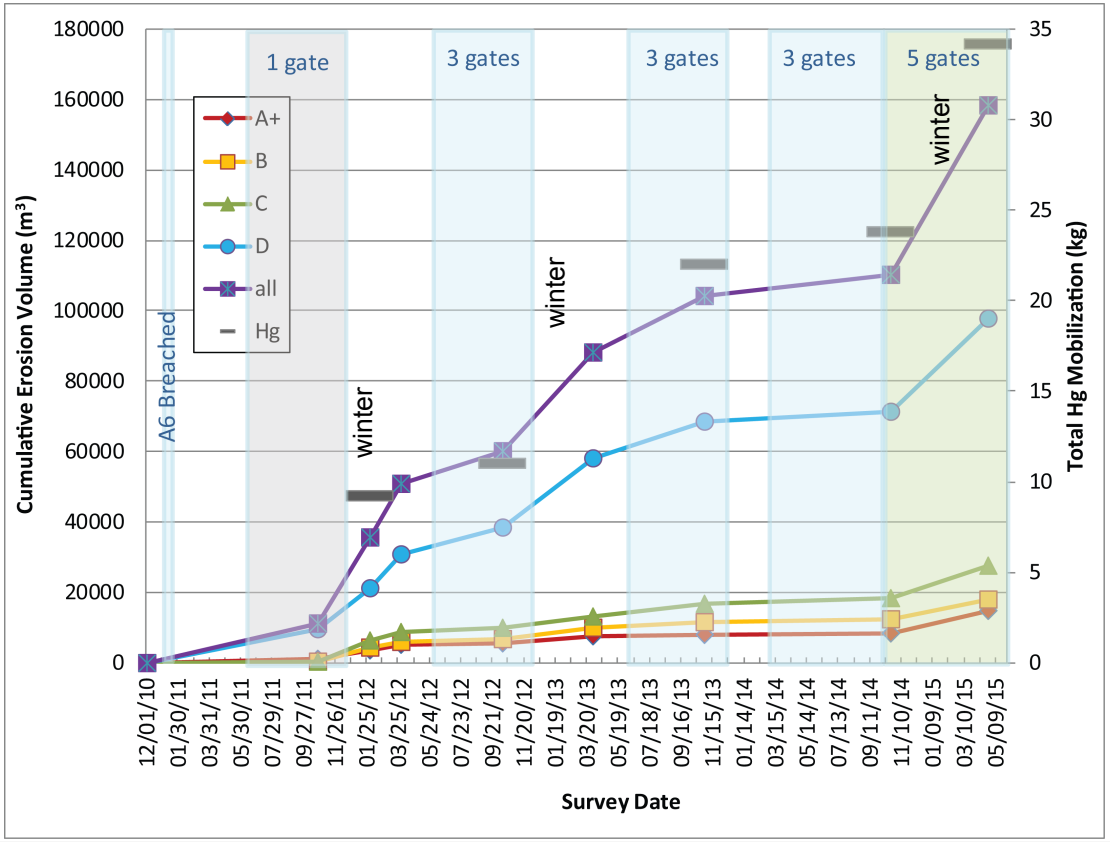
sediment scour



X

Hg concentrations




1 gate
3 gates
3 gates
3 gates
5 gates
A6 Breached
winter
winter
winter
A+
B
C
D
all
Hg
Cumulative Erosion Volume (m³)
Total Hg Mobilization (kg)
Survey Date
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
35
30
25
20
15
10
5
0
12/01/10
01/30/11
03/31/11
05/30/11
07/29/11
09/27/11
11/26/11
01/25/12
03/25/12
05/24/12
07/23/12
09/21/12
11/20/12
01/19/13
03/20/13
05/19/13
07/18/13
09/16/13
11/15/13
01/14/14
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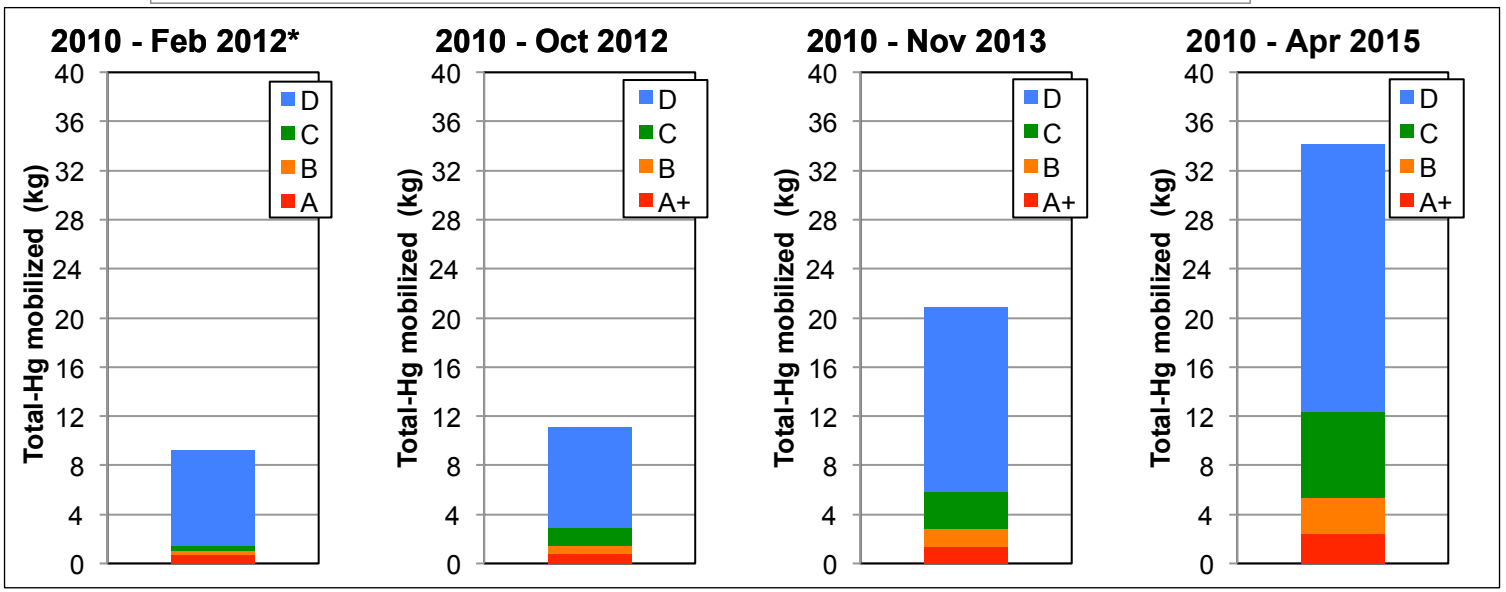
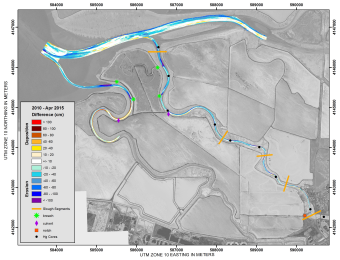
09/11/14
11/10/14
01/09/15
03/10/15
05/09/15

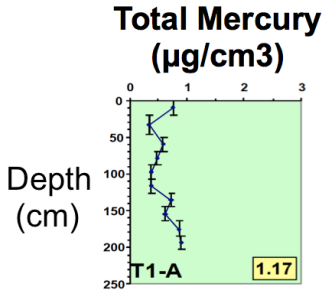

2010 - Feb 2012*
2010 - Oct 2012
2010 - Nov 2013
2010 - Apr 2015
Total-Hg mobilized (kg)
D
C
B
A
A+
40
36
32
28
24
20
16
12
8
4
0

Outline

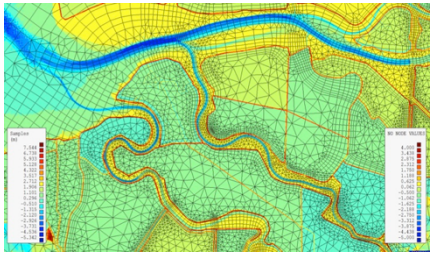
- Observations of scour



- Estimates of mercury mobilization

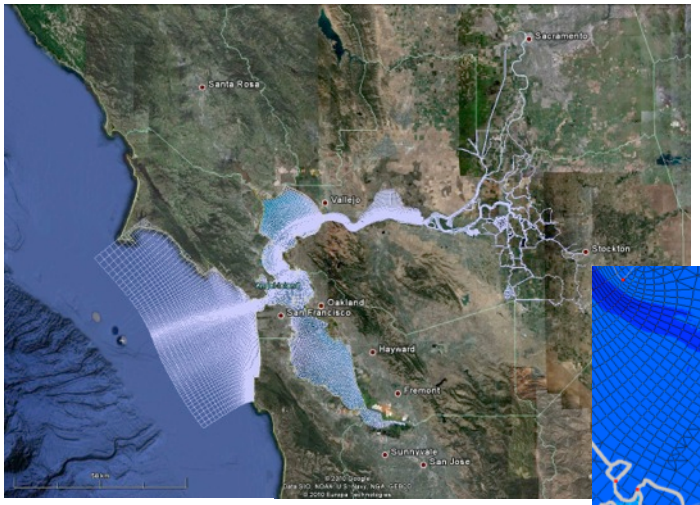


- Modeling of scour and mercury mobilization



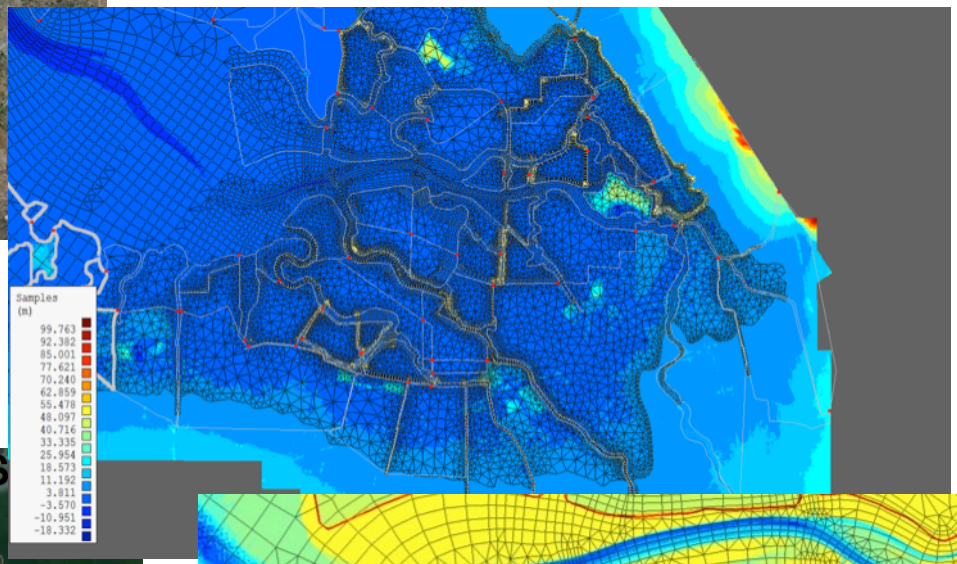
- Summary and future work

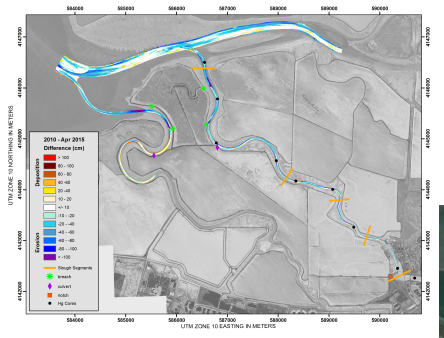
Scour Modeling

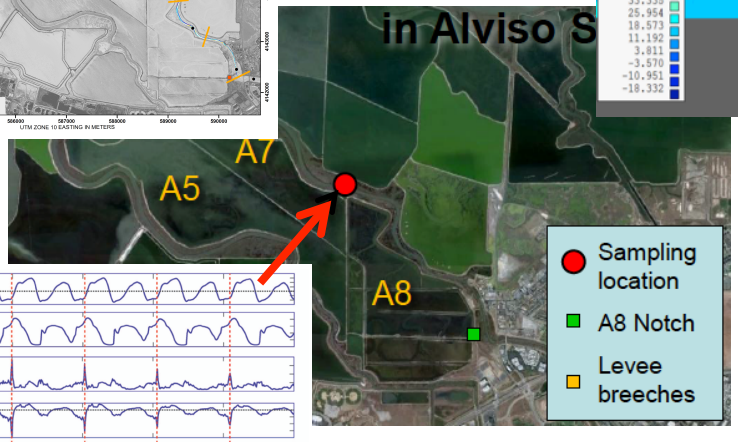


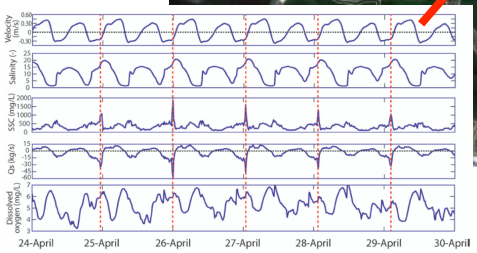
Builds on the USGS CASCaDE II Project

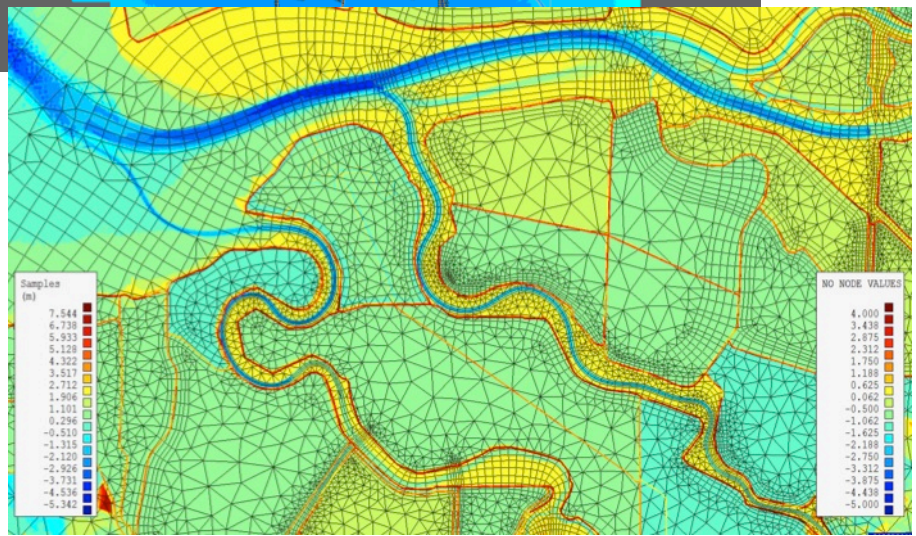
Flexibility: Orthogonal curvilinear grids + triangles + pentagons+…



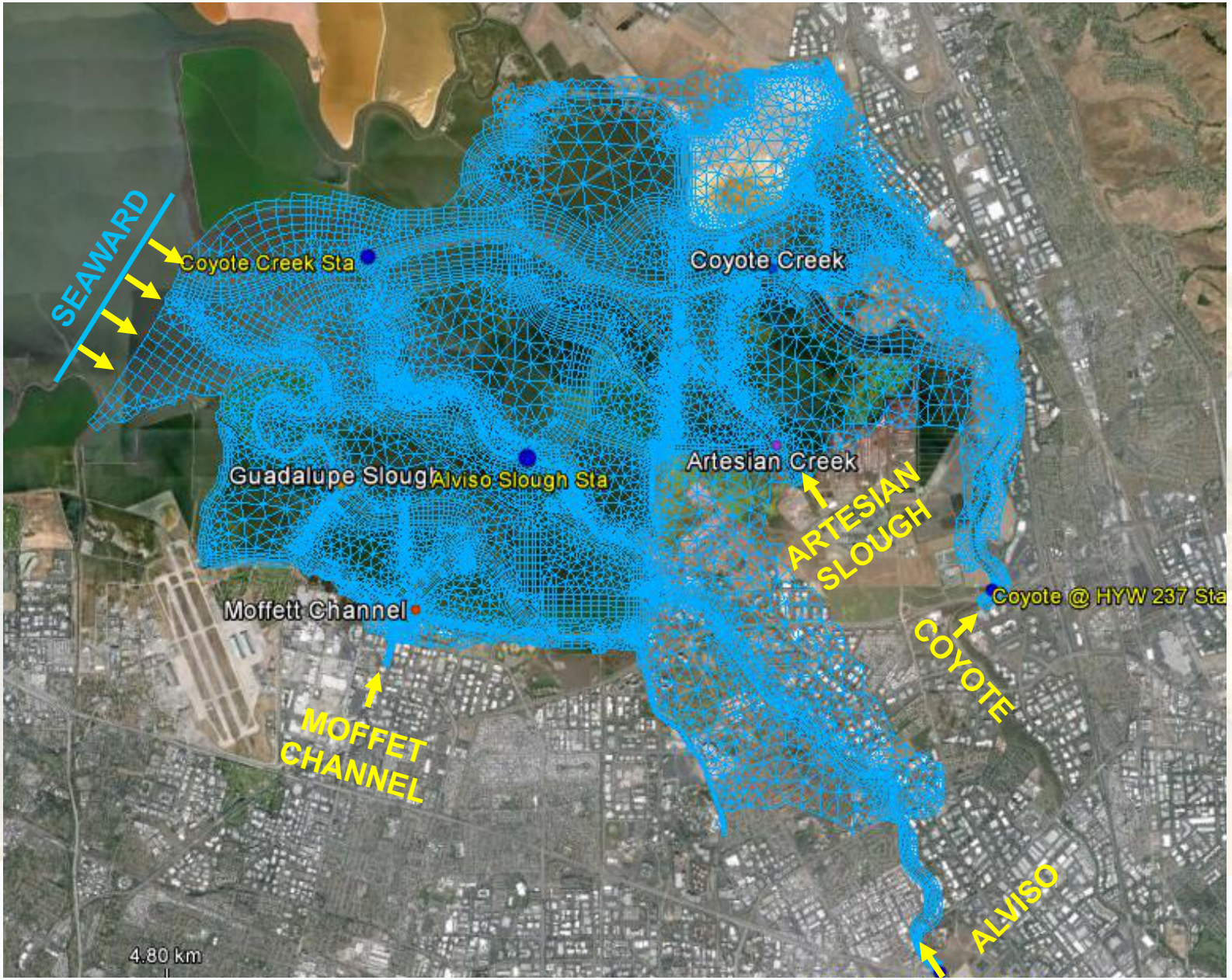








DFLOW - FM


SEAWARD
Coyote Creek Sta
Coyote Creek
Guadalupe Slough
Alviso Slough Sta
Artesian Creek
ARTESIAN SLOUGH
Moffett Channel
Coyote @ HYW 237 Sta
COYOTE
MOFFET CHANNEL
ALVISO
4.80 km

Analysis

+

-Before/After openings

- Spring – Neap tides

-High /low river discharge

UNESCO-IHE
Institute for Water Education

USGS
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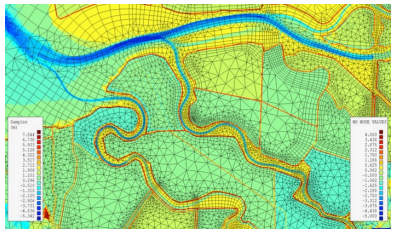
Evaluating effects of breaching A6 and opening A8 gates

Net sediment flux, before restoration



Bayward

Landward

Mouth

Breach 1

Breach 2

Intake 1

A8 Notch

A6 Pond

A7 Pond

A8 Pond

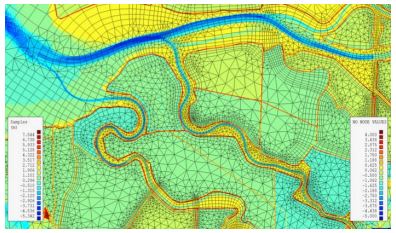
~ 7 km

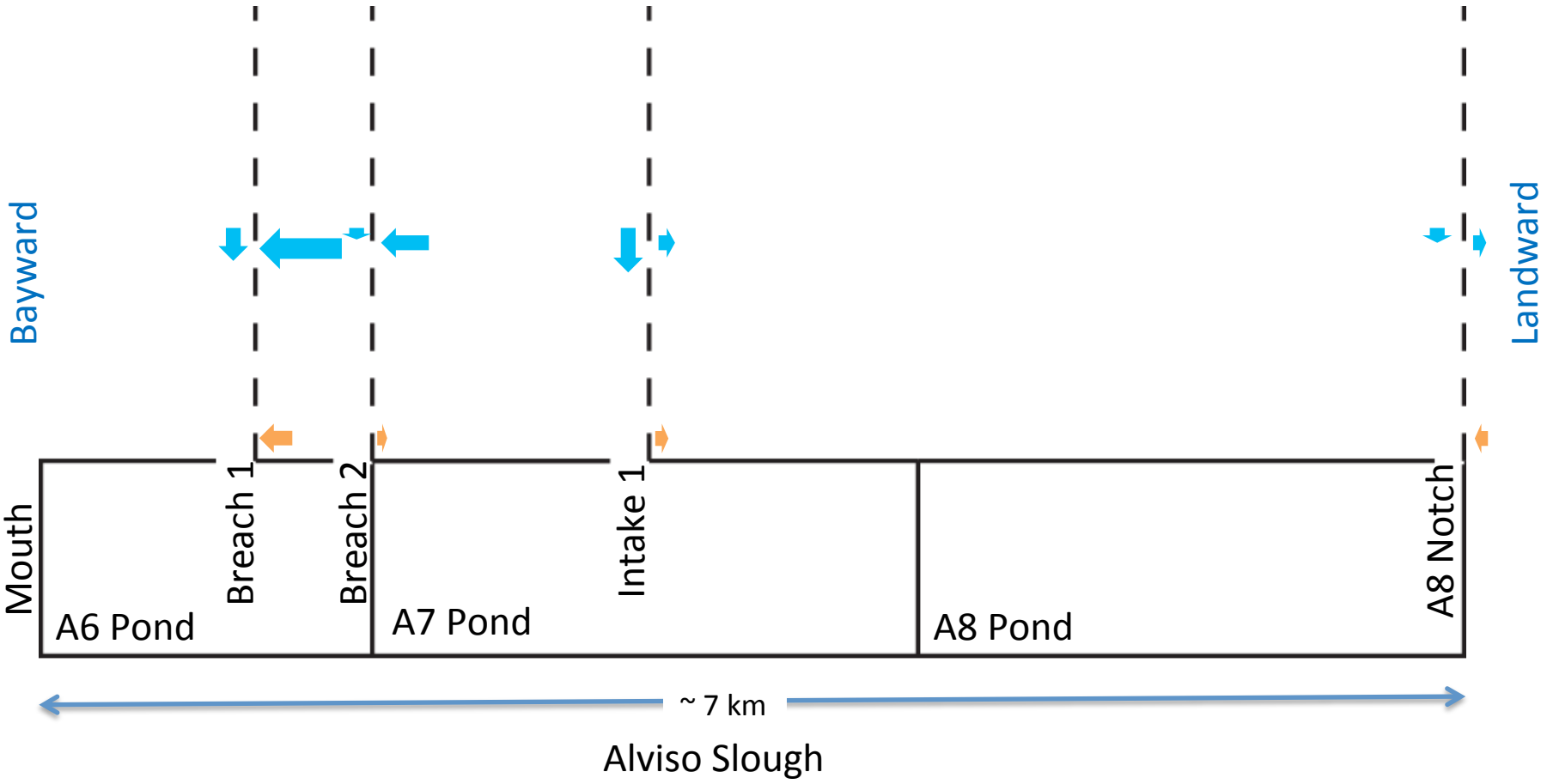
Alviso Slough

Evaluating effects of breaching A6 and opening A8 gates

Net sediment flux, A6 breached, A8 gates open to 5 m

Net sediment flux, before restoration



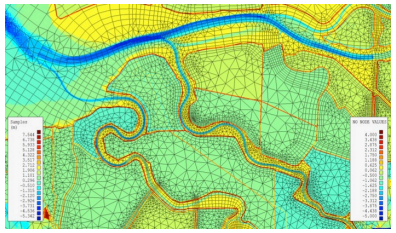


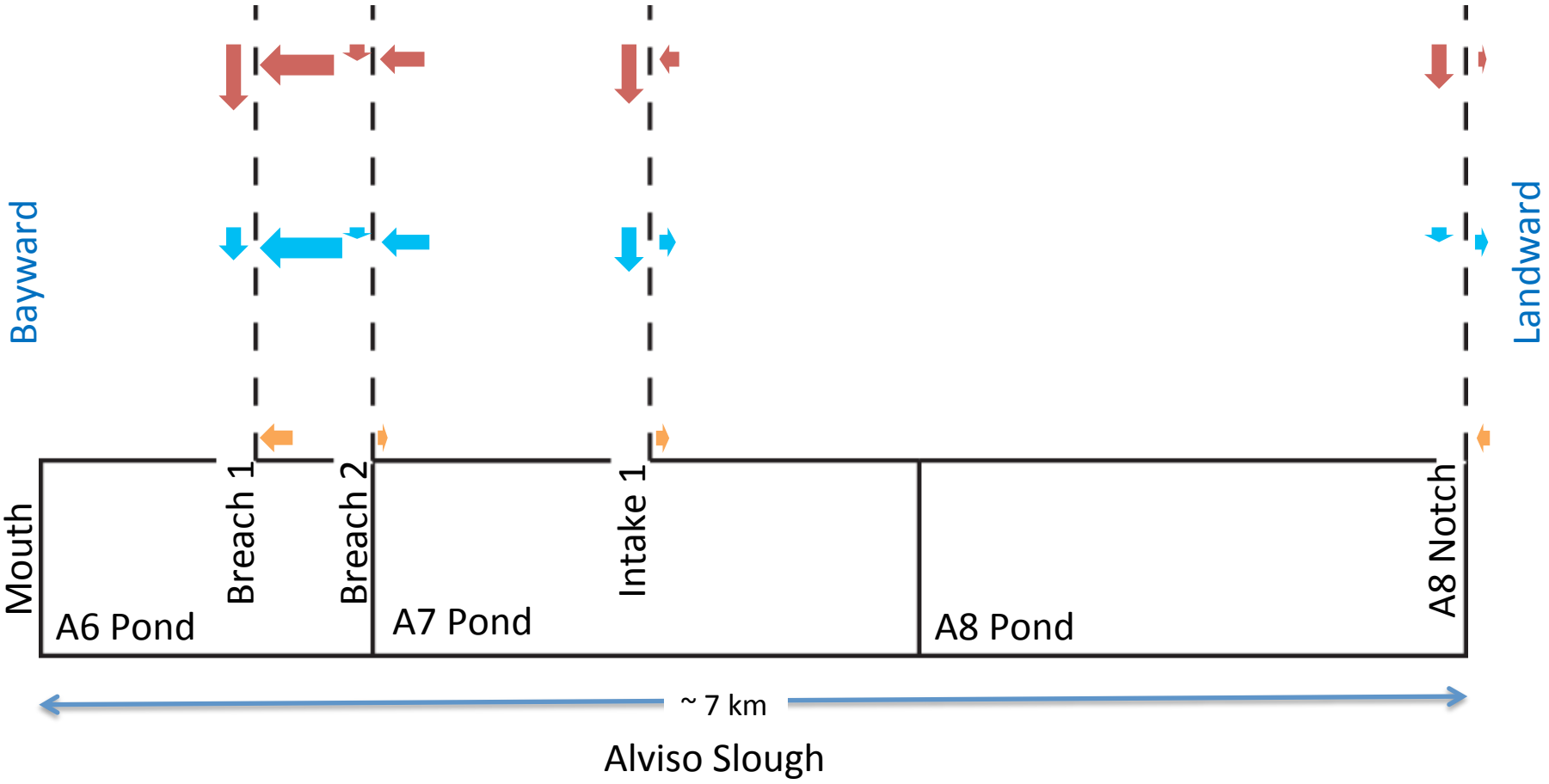
Evaluating effects of breaching A6 and opening A8 gates

Net sediment flux, a6 breached, A8 gates open to 15 m

Net sediment flux, A6 breached, A8 gates open to 5 m

Net sediment flux, before restoration





Summary and Future Work

- Scour, and associated mercury mobilization, in Alviso Slough is spatially and temporally variable.

- Mercury mobilization, which has amounted to ~35 kg since restoration began in 2010, is greatest in the winter and near the A6 breaches.

- Coupled hydrodynamic/sediment transport/geomorphic change modeling is a useful tool for understanding the causes for mercury mobilization and exploring whether the rates of mobilization will decrease or increase in the future in response to widening/deepening of the slough and sea level rise

Summary and Future Work

- Future work- questions yet to be answered
  - How will restoration (e.g., gate operations) affect mercury mobilization? (approach: observations, calculations, modeling)
  - Where is mobilized mercury deposited? (approach: modeling)
  - Will the system reach equilibrium decreasing mercury mobilization? (approach: modeling with morphologic feedback)
  - How will the combination of sea level rise and restoration affect mercury mobilization? (approach: modeling with morphologic feedback)