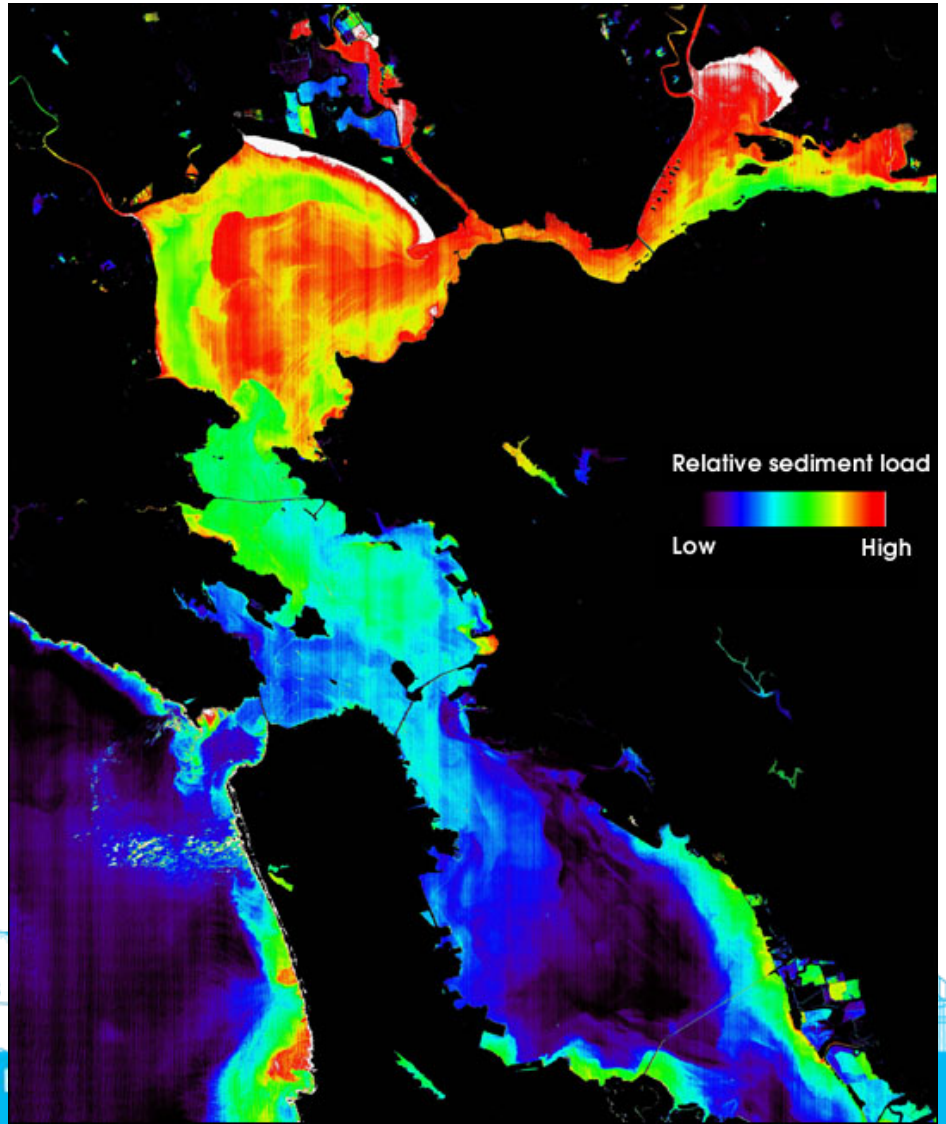
Transport and fate of sediment and associated contaminants in SF Bay



Mike Connor &
John Oram

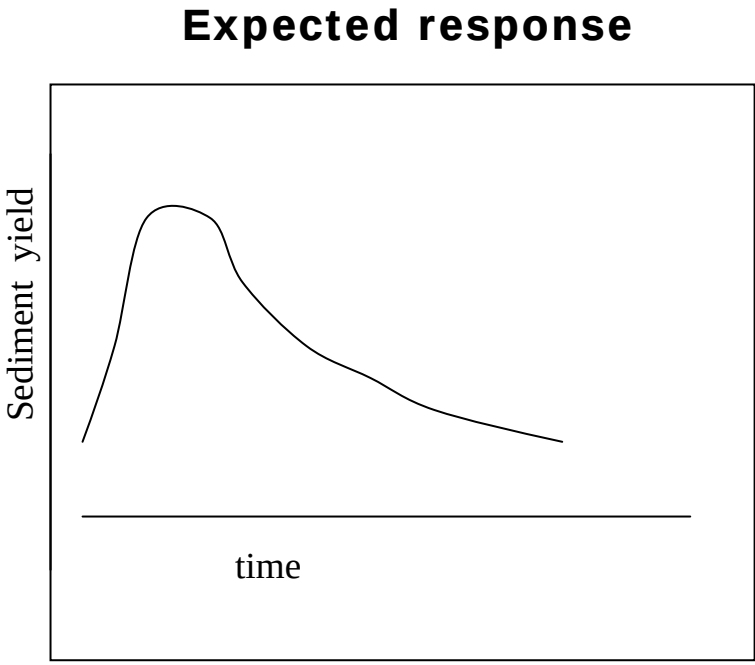
2007 LTMS Science Workshop

Major Points

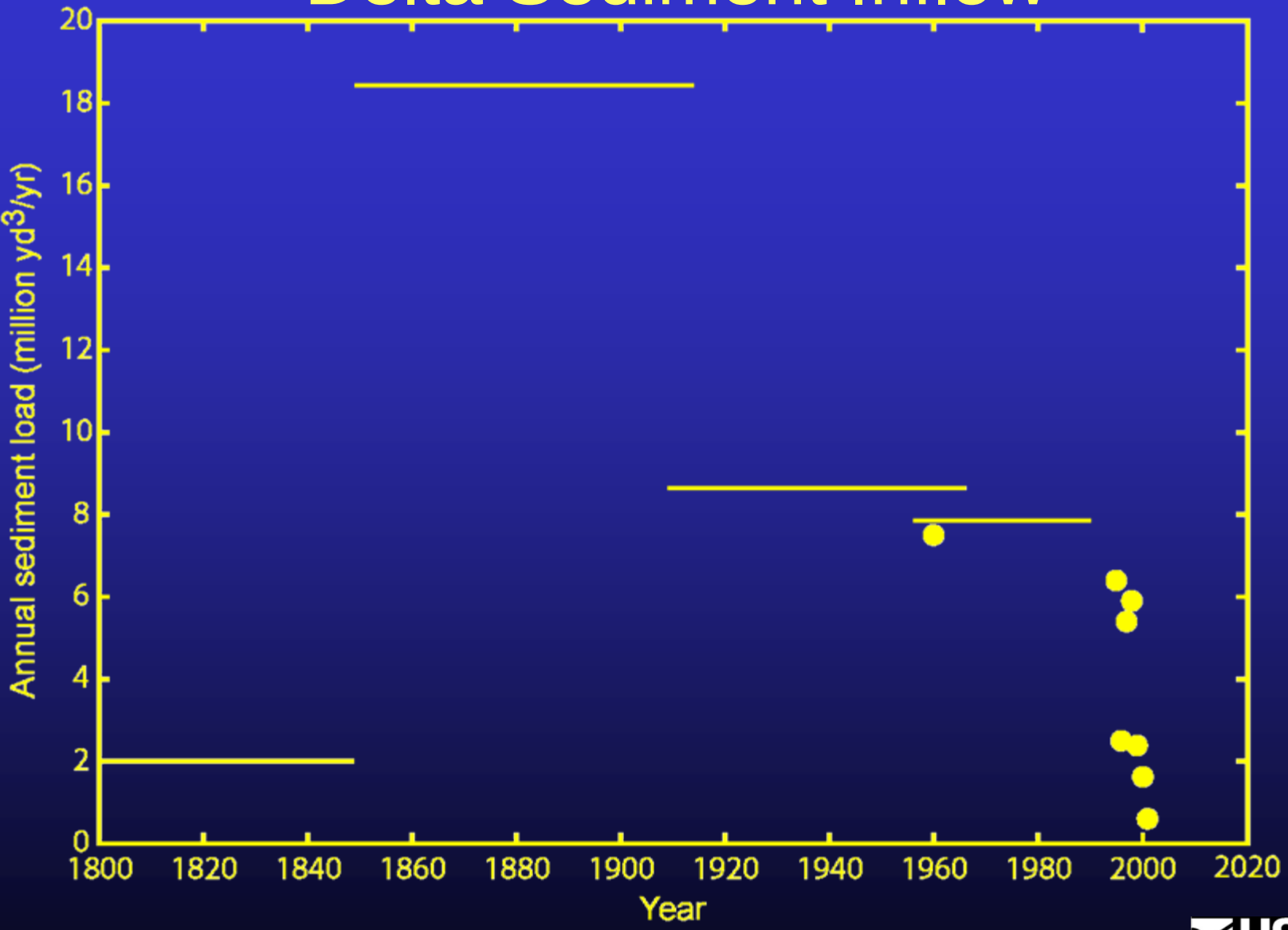
- Bay Still Responding to 1800's mgmt
- Transport Has Spread Contamination Widely
- Future Bay Depends on Mixing of Legacy Contaminants
- Bay Sediment Ecosystem in Major Overhaul
- Overall Bay Status Assessment Will Change with Sediment Quality Objectives

Hydraulic Mining Dominates the Bay Sediment Budget

Practiced from 1863 – 1884, then outlawed.
>100 million m3 of sediment washed into Central Valley.
Main bed sediment pulse passed Sacramento ~1950.
Channel and floodplain deposits remain. still moving thru system.



Delta Sediment Inflow



Gilbert, Porterfield, Krone, OBA, McKee et al.

USGS

Sediment Accounting 101

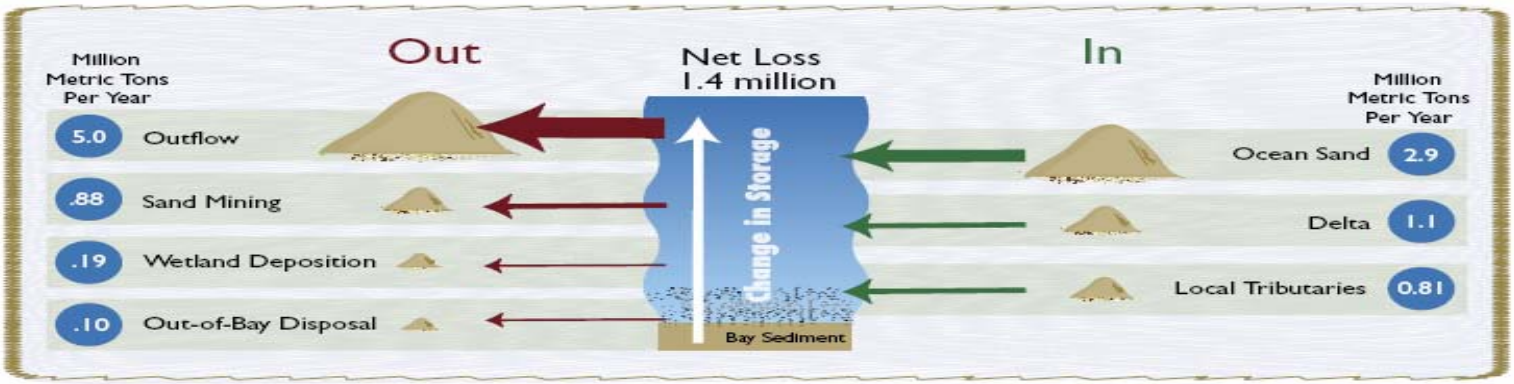


Figure 1. San Francisco Bay sediment budget for the period 1955-1990, in millions of metric tons per year. The areas of the sediment piles are proportional to their value in the budget. The size of the arrows also is proportional to budget values. The largest quantities are the outflow to the Ocean and inflow of ocean sand along the bottom. The uncertainty of the local tributary inflow is ±25 % and the uncertainty of the Delta inflow is ±17%. The other major sources of uncertainty are change in storage in Central Bay, sand inflow from the ocean, and sand mining. **The Bay experienced an average net loss of 1.4 million metric tons during this period.**

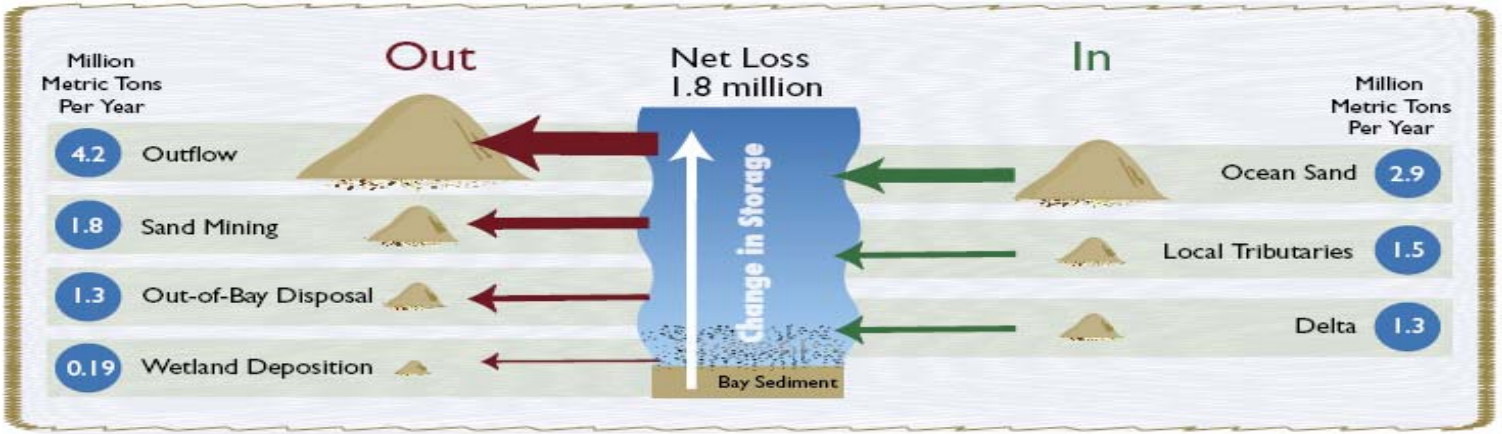
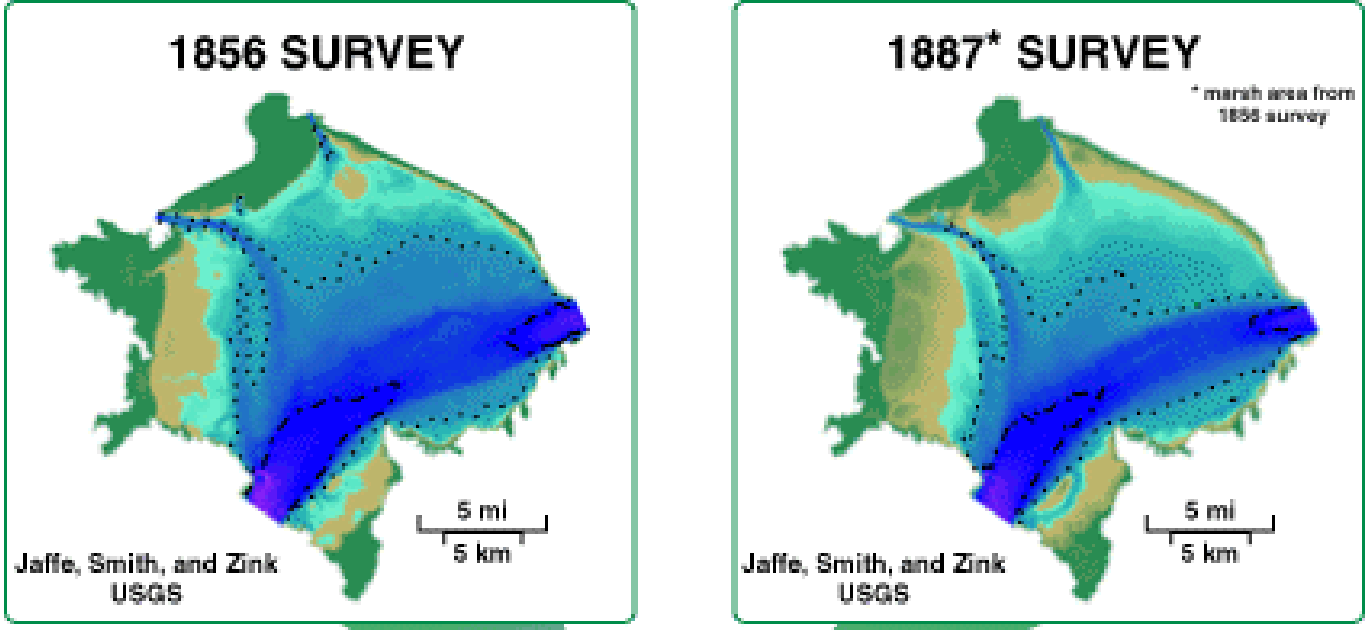
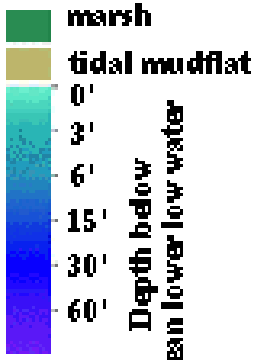
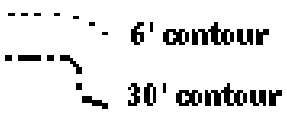
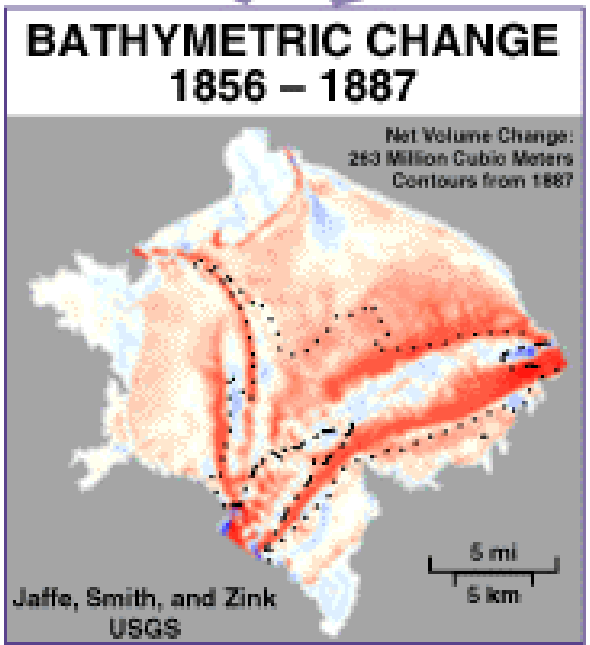


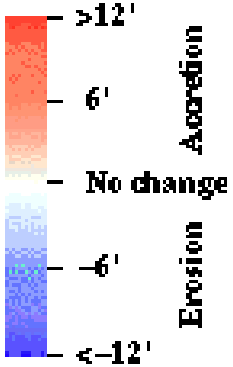
Figure 2. San Francisco Bay sediment budget 1995-2002. While this is the estimated actual budget for 1995-2002, average water flow into the Bay during this period was higher than for 1955-1990, making the two budgets not directly comparable. Data in millions of metric tons per year. The areas of the sediment piles are proportional to their value in the budget. The size of the arrows also is proportional to budget values. **The annual net loss of sediment from the Bay during this period was 1.8 million metric tons.**


1856 SURVEY
5 mi
5 km
Jaffe, Smith, and Zink
USGS
1887* SURVEY
* marsh area from
1856 survey
5 mi
5 km
Jaffe, Smith, and Zink
USGS

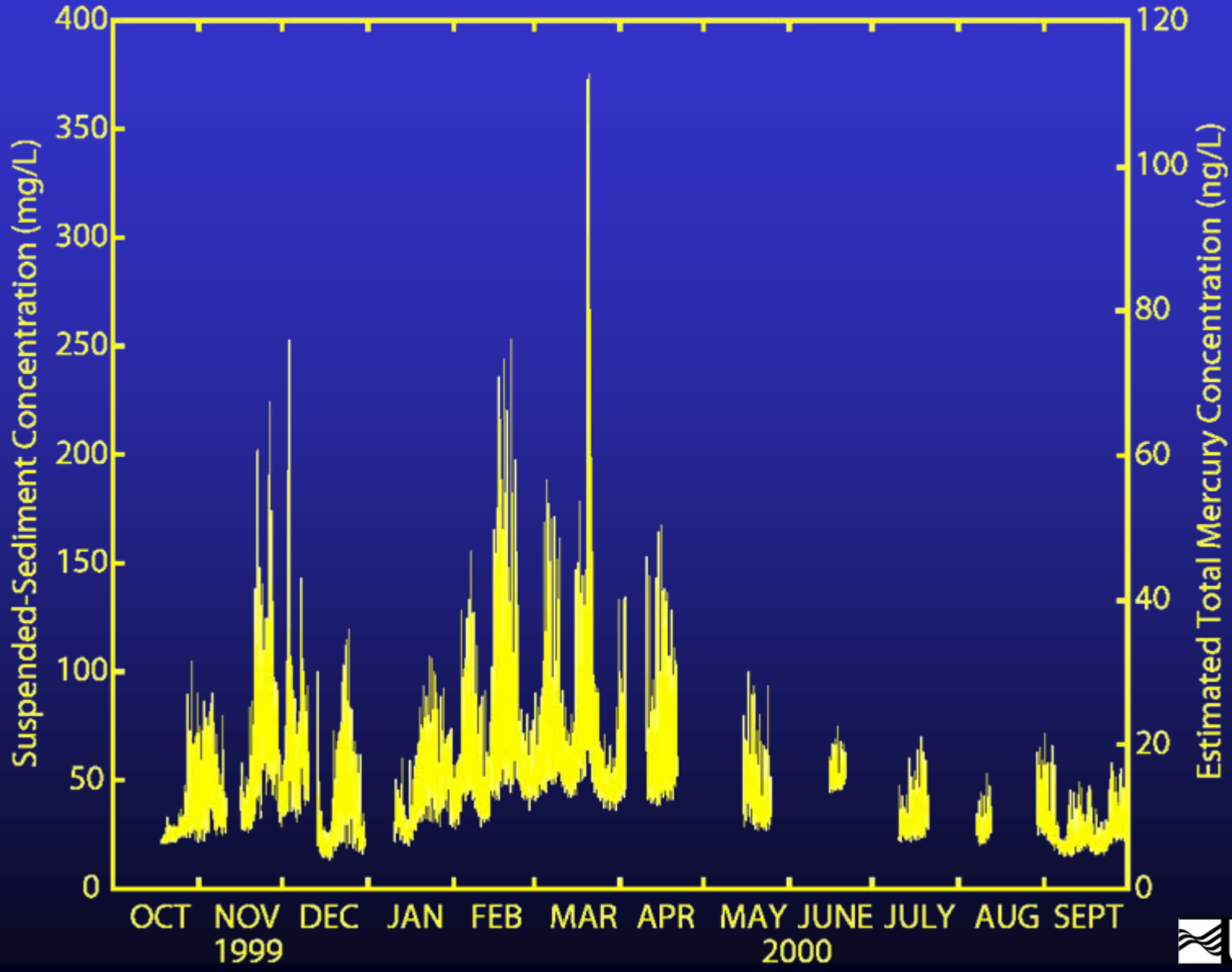

marsh
tidal mudflat
0'
3'
6'
15'
30'
60'
Depth below
mean lower low water


6' contour
30' contour


BATHYMETRIC CHANGE
1856 – 1887
Net Volume Change:
263 Million Cubic Meters
Contours from 1887
5 mi
5 km
Jaffe, Smith, and Zink
USGS

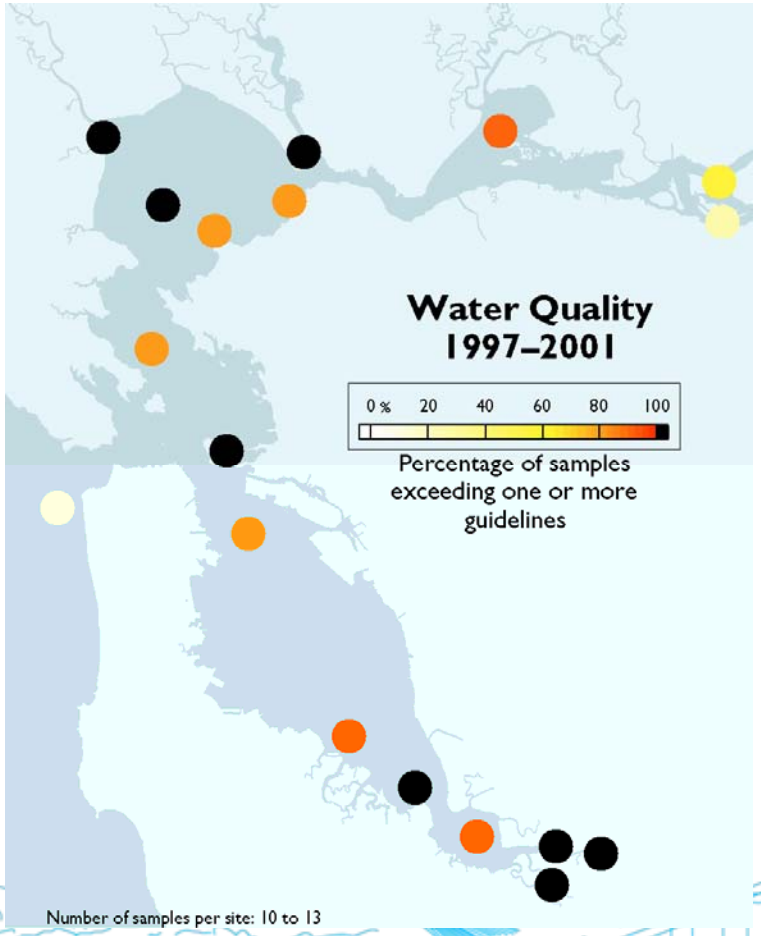

>12'
6'
No change
–6'
<–12'
Accretion
Erosion

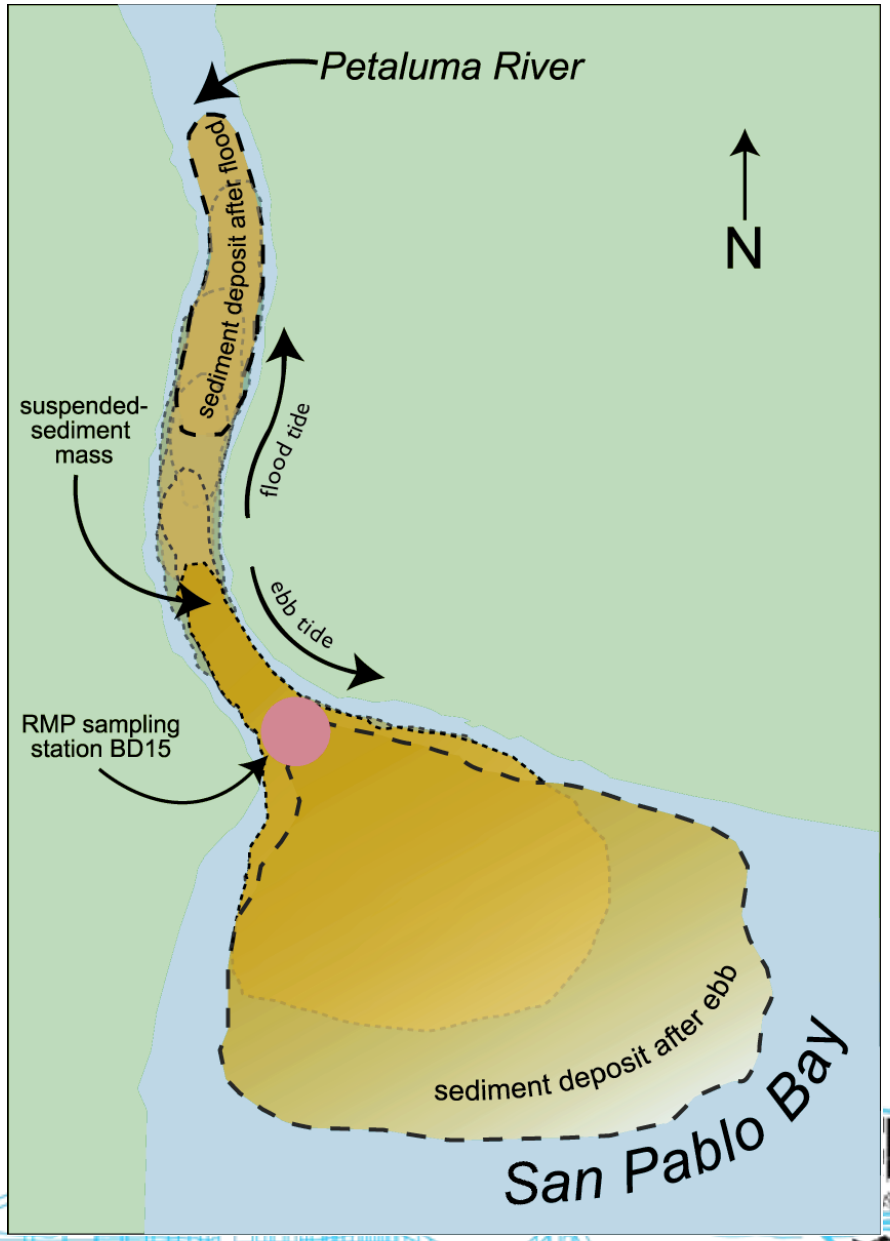
Point San Pablo SSC and Mercury



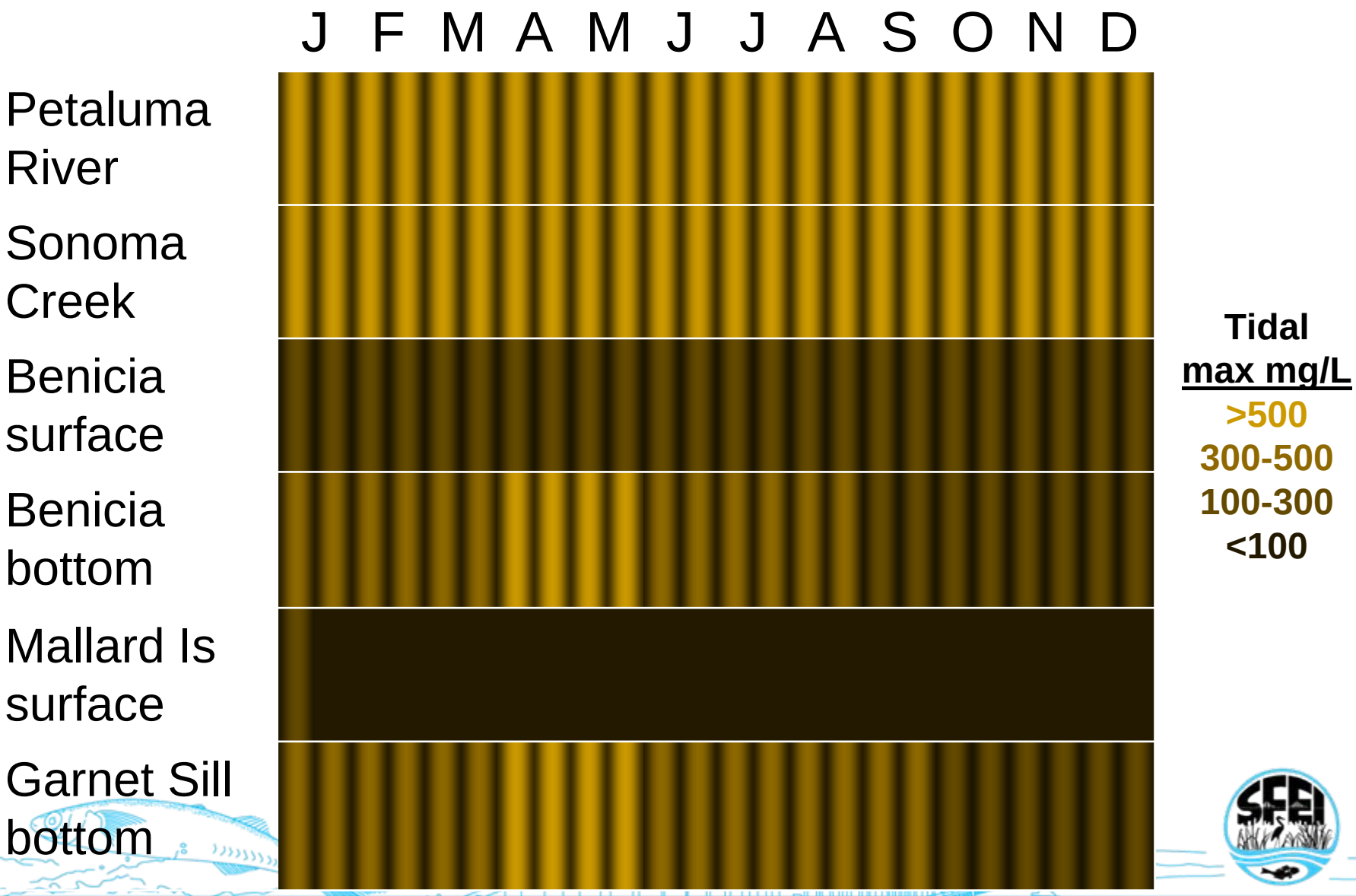
USGS

Sediment dynamics explain spatial patterns in contaminant concentrations.

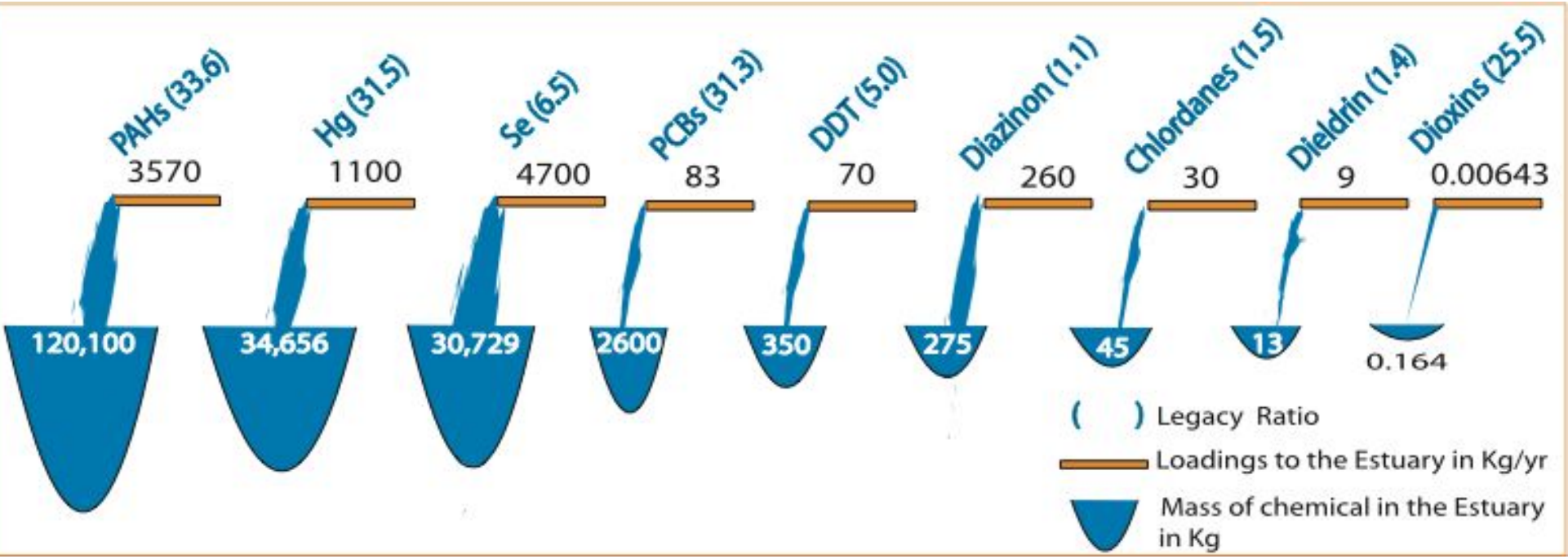




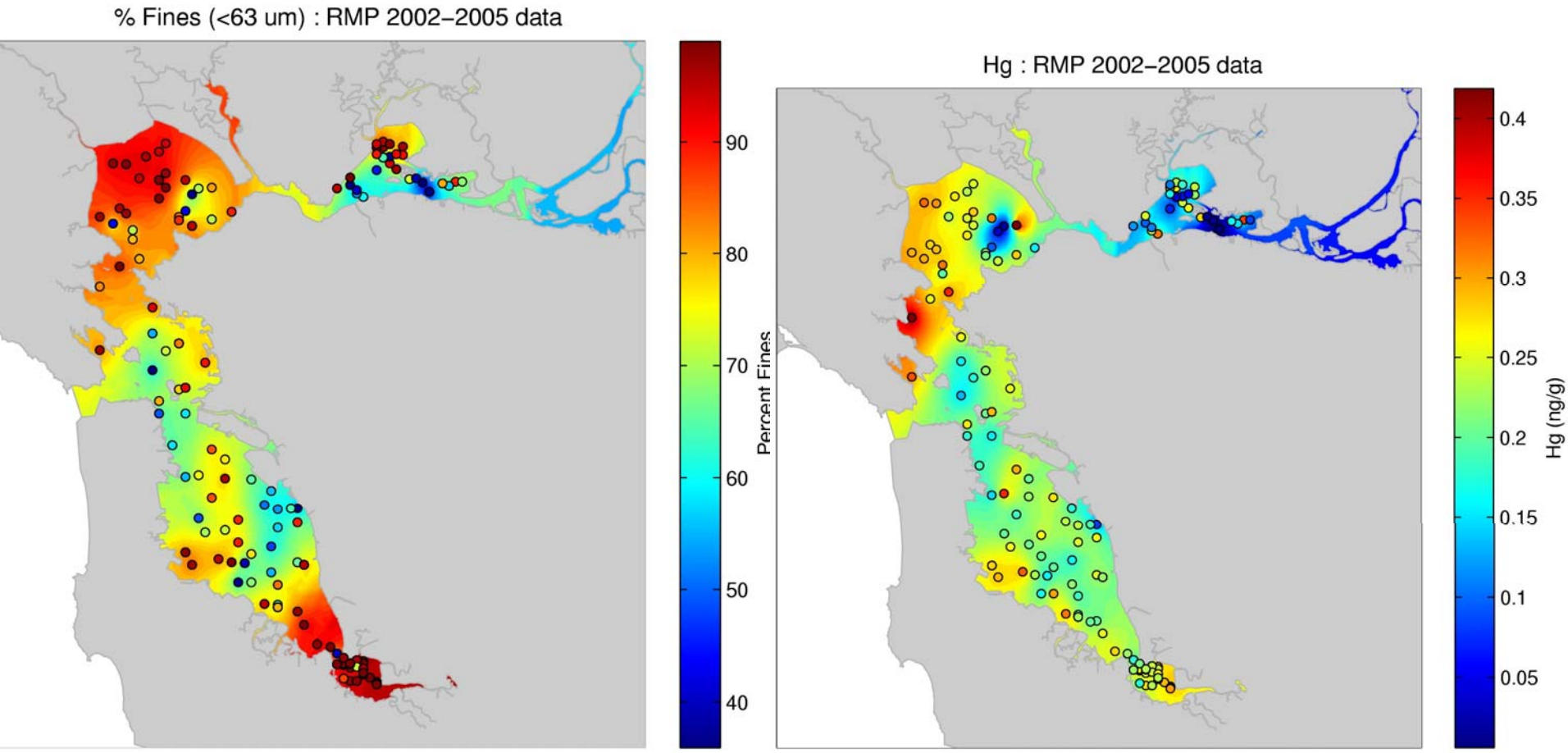
Estuarine Turbidity Maxima



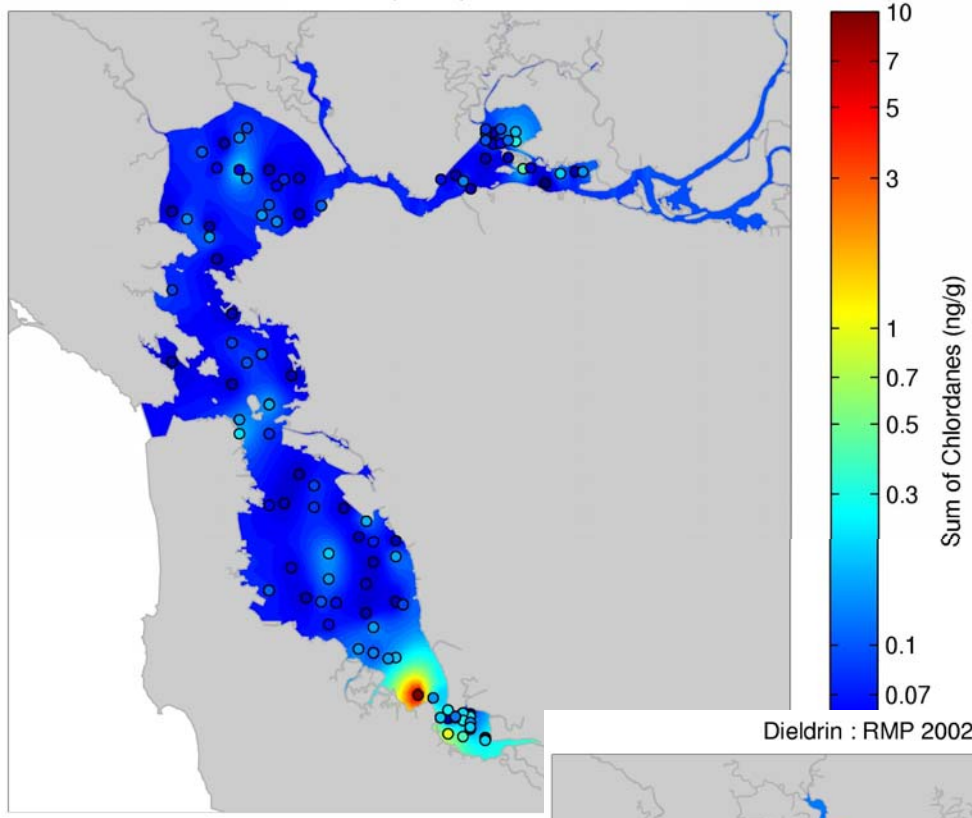
Legacy Ratio: Reservoir/Loadings



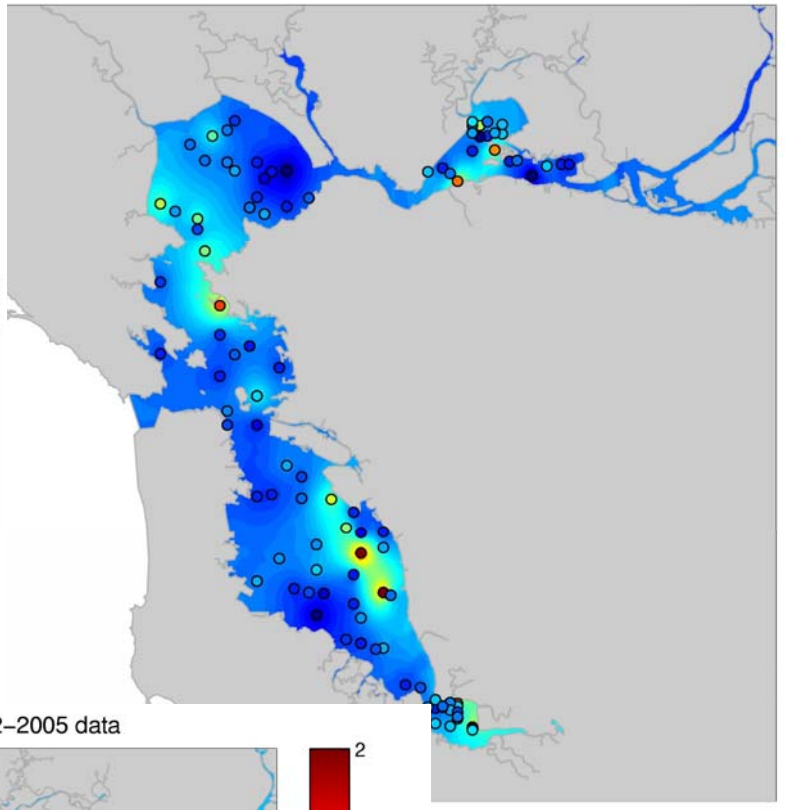
Contaminant Distribution Depends on Sources & Transport Processes

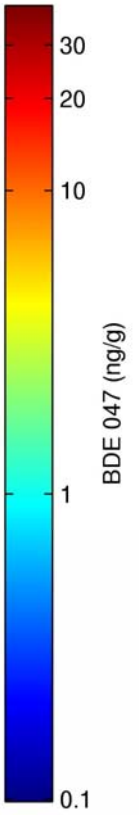


Sum of Chlordanes (SFEI) : RMP 2002–2005 data

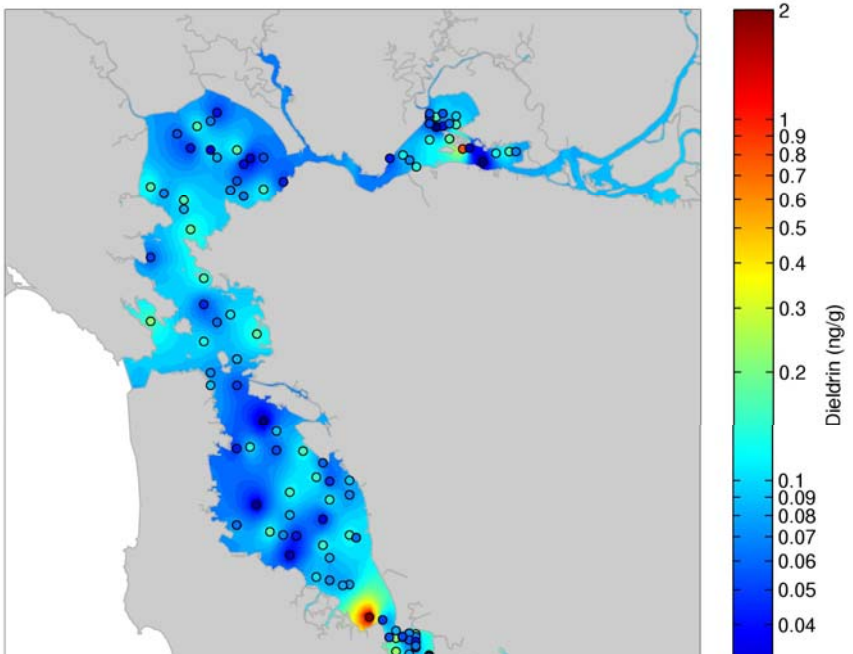


BDE 047 : RMP 2002–2005 data

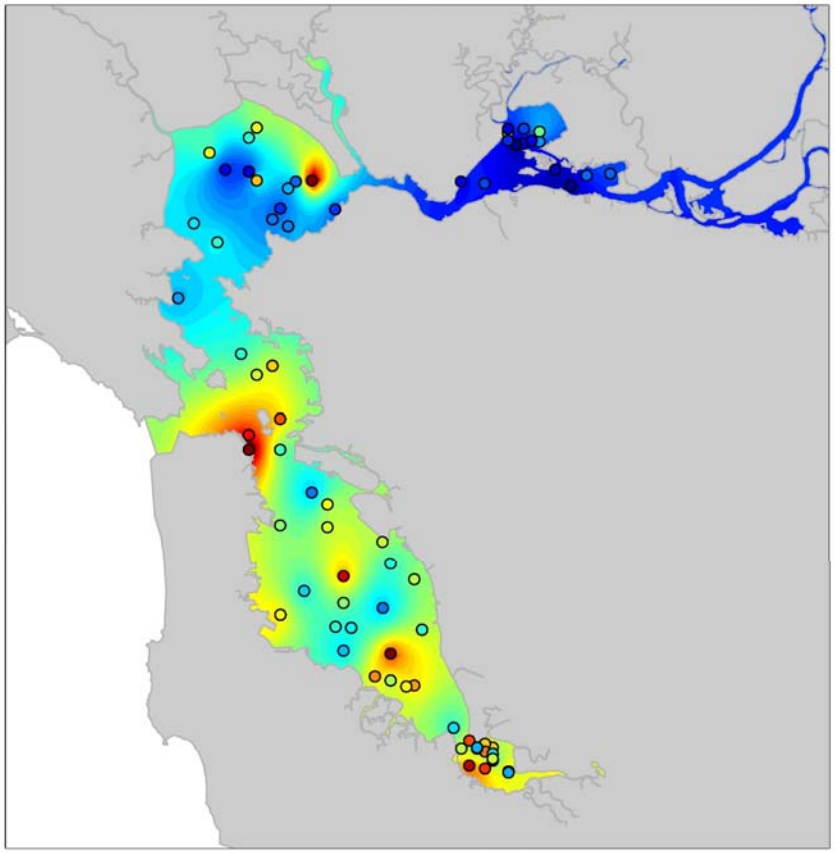


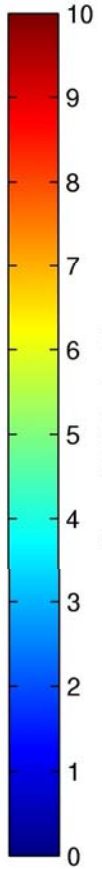


Dieldrin : RMP 2002–2005 data

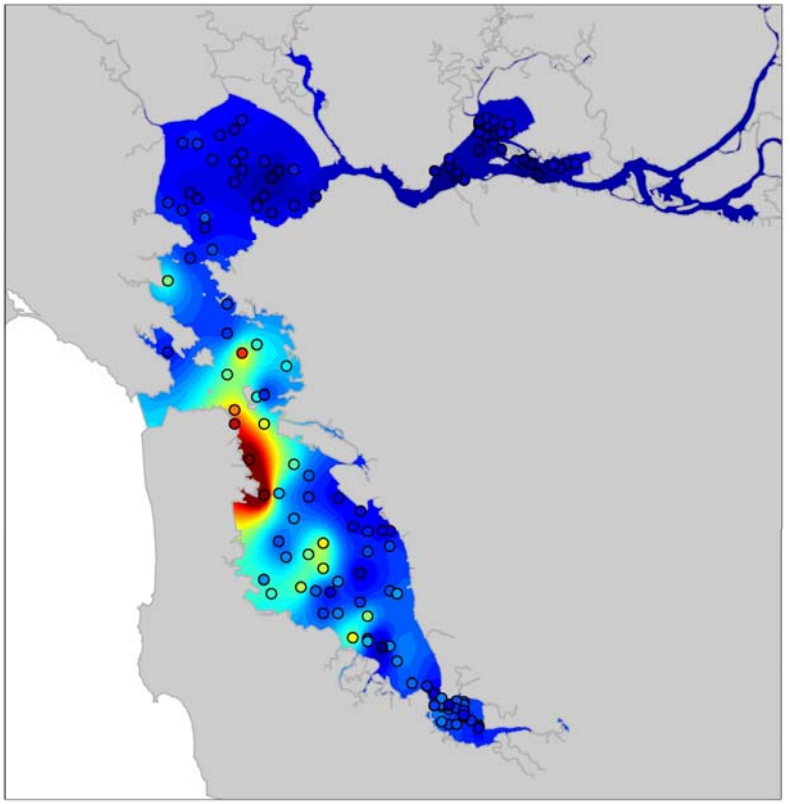


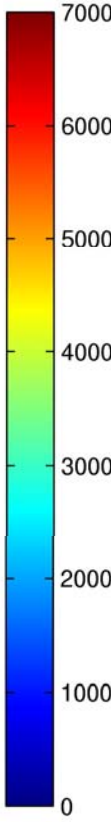
Sum of PCBs (SFEI) : RMP 2002–2005 data





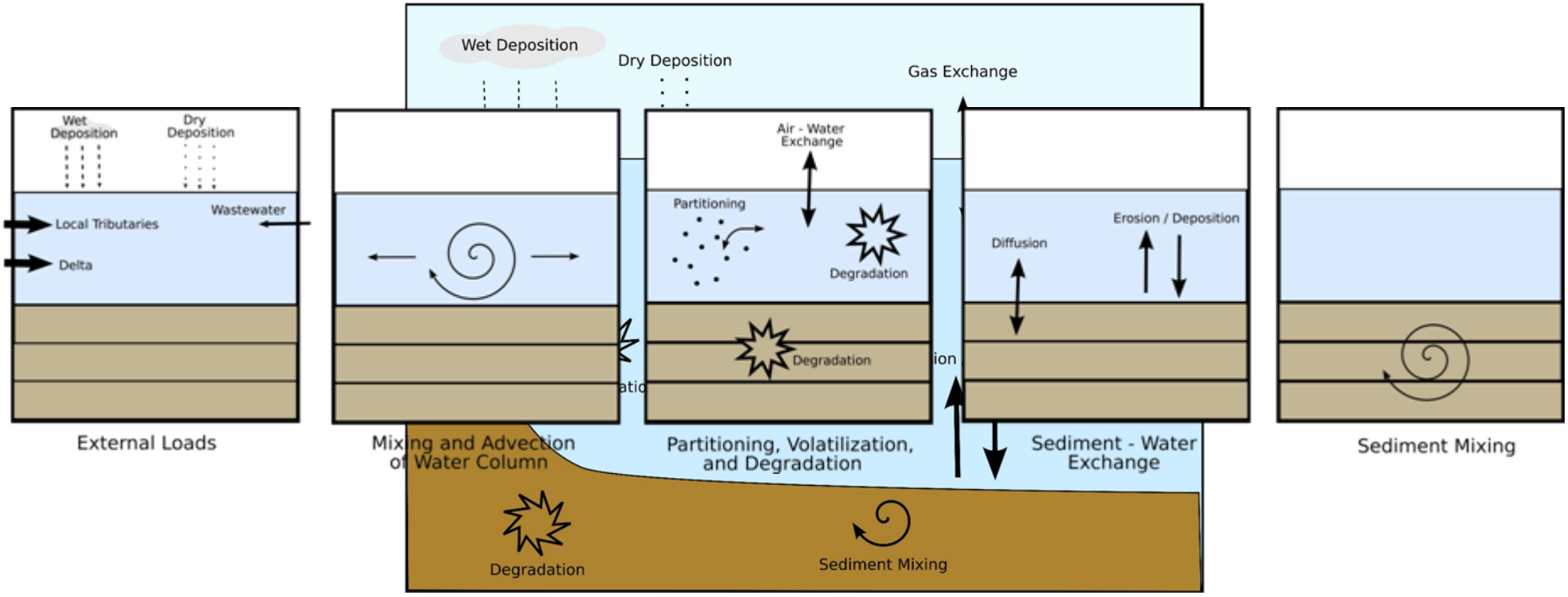
Sum of PAHs (SFEI) : RMP 2002–2005 data



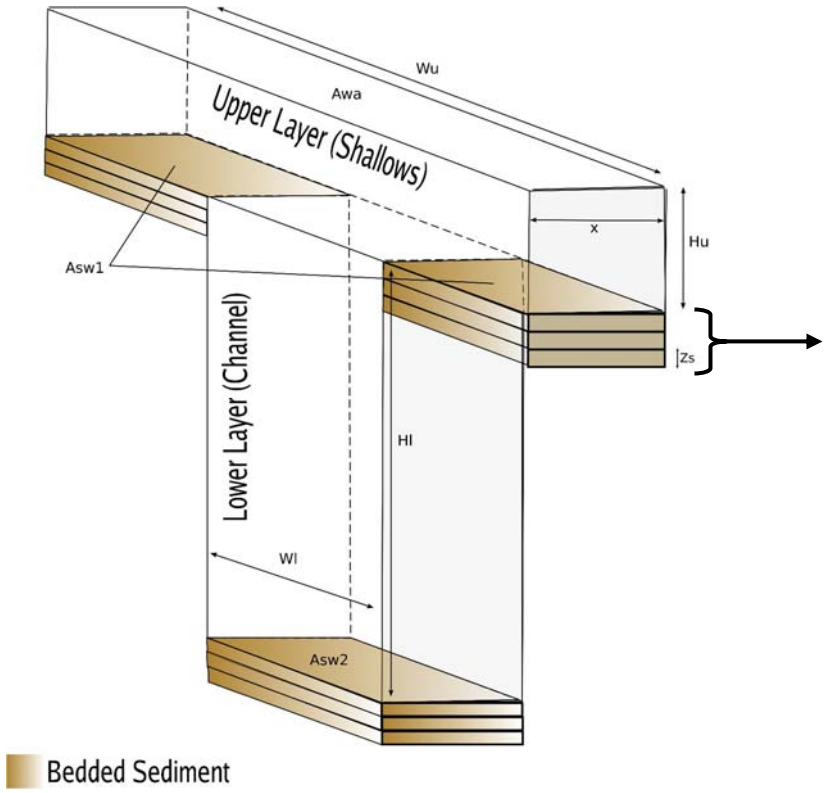


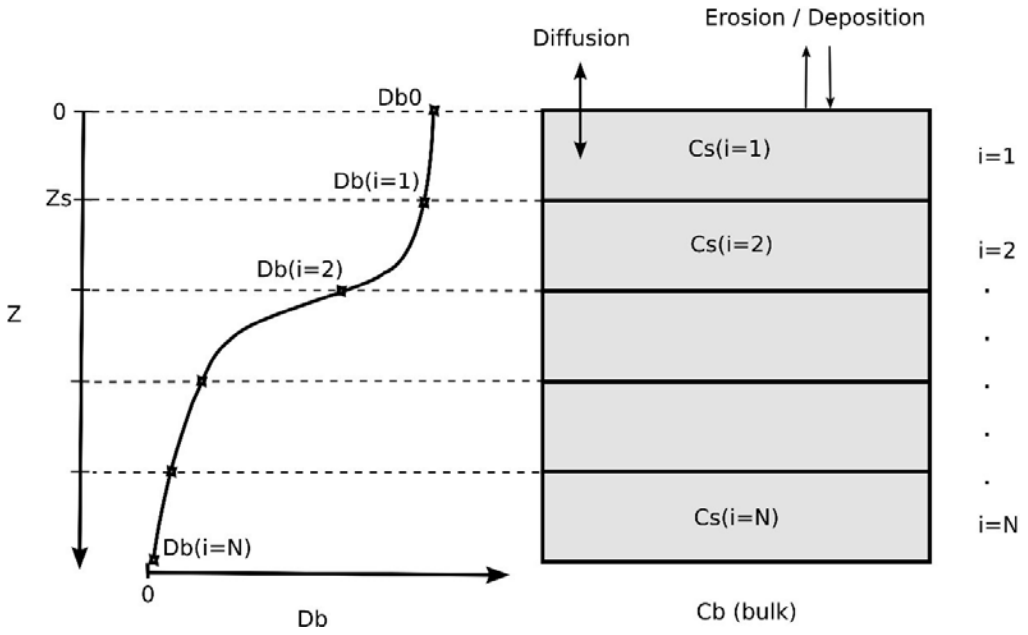
Sum of PCBs (ng/g)

Model Overview

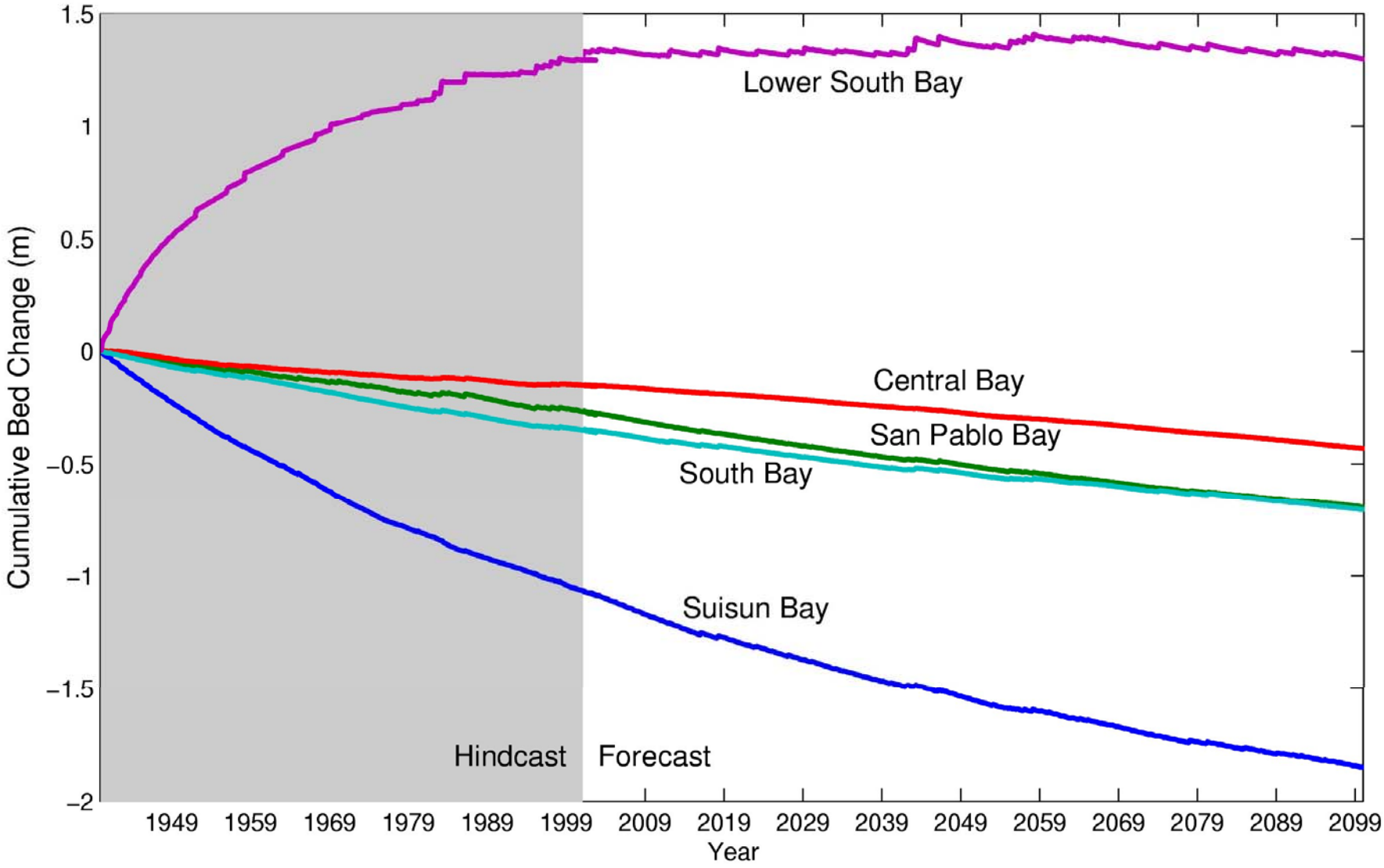


Model Overview

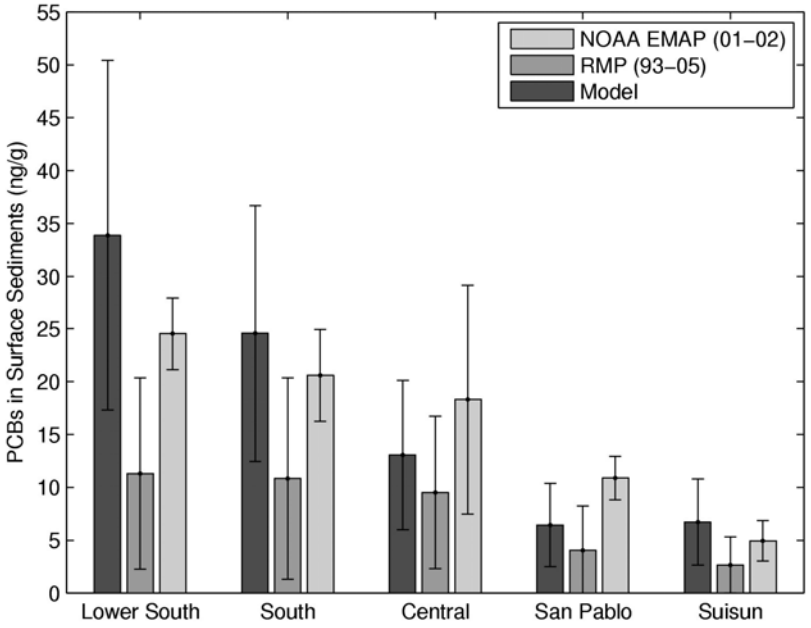


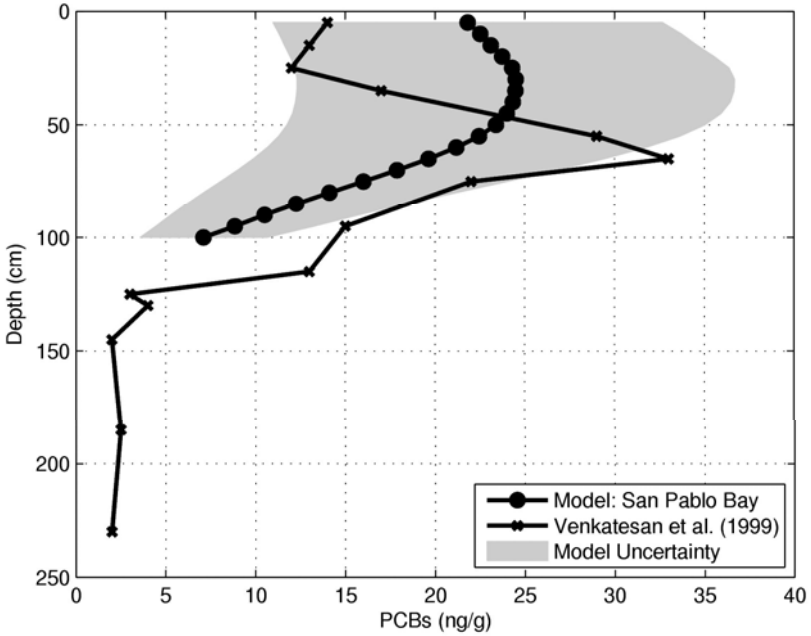


Forecast Setup : Sedimentation



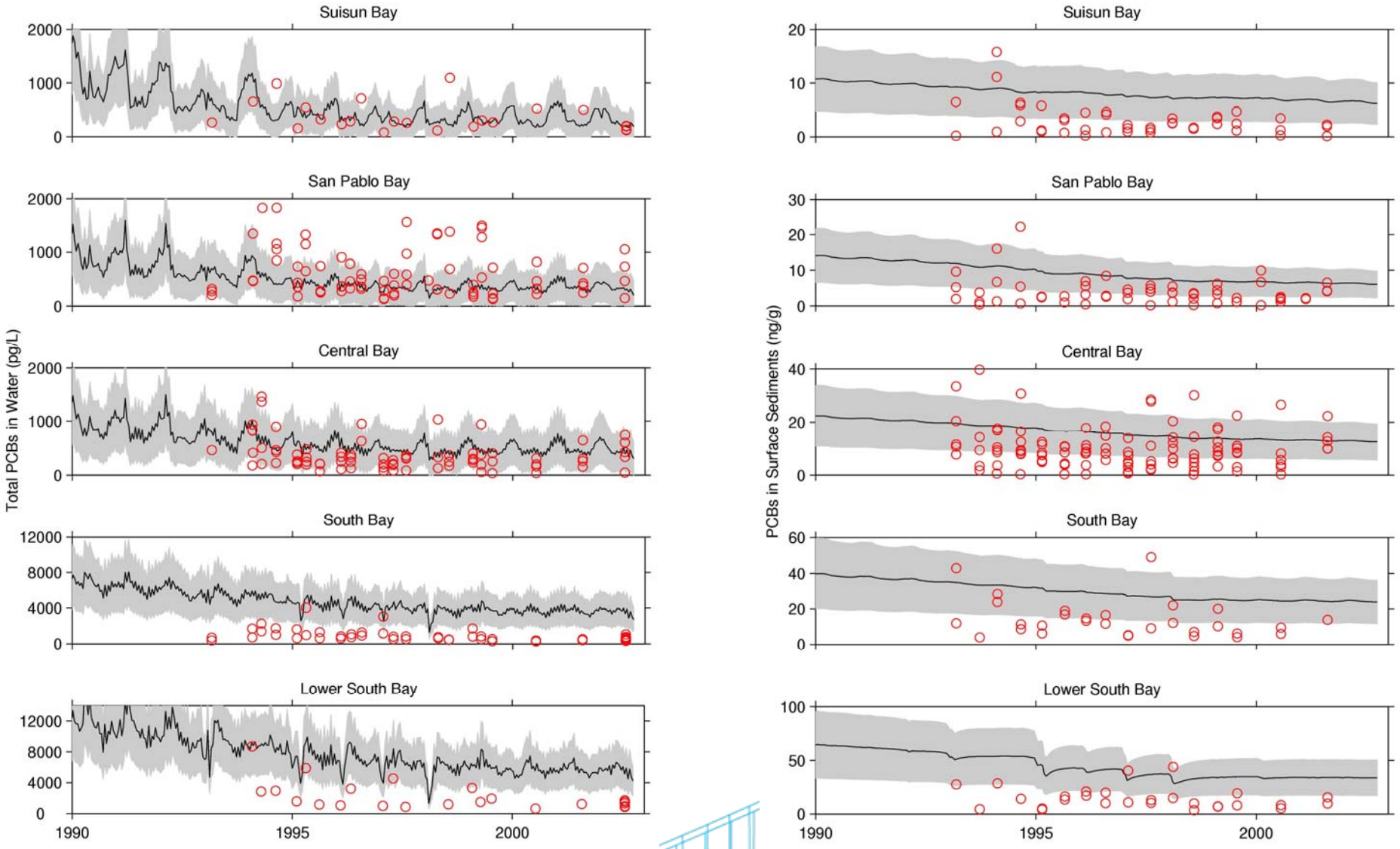
Hindcast Results After Calibration



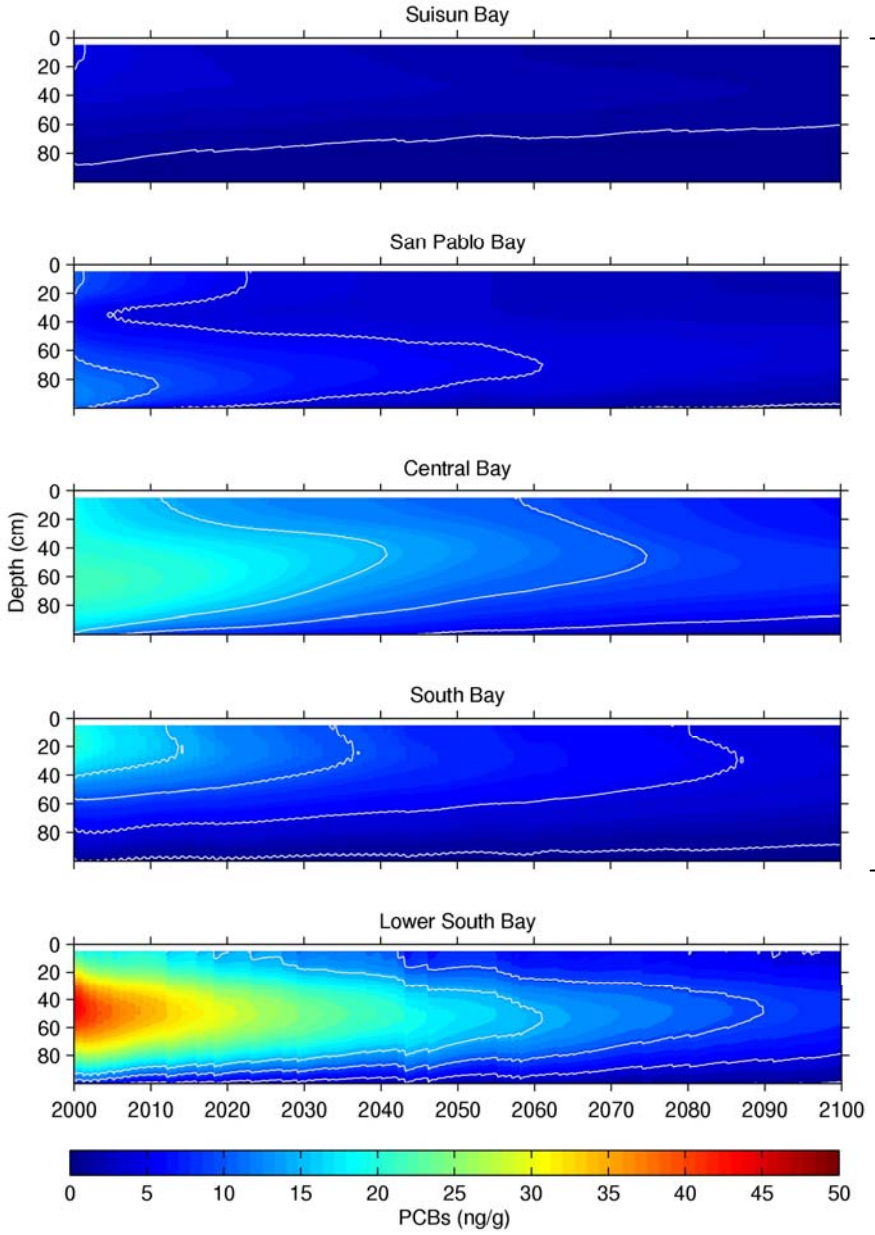


Error Bars:
EMAP & RMP = Standard Deviation of Samples
Model = Aggregate Uncertainty

Hindcast Results After Calibration



Base Forecast : Recovery Due to Natural Attenuation



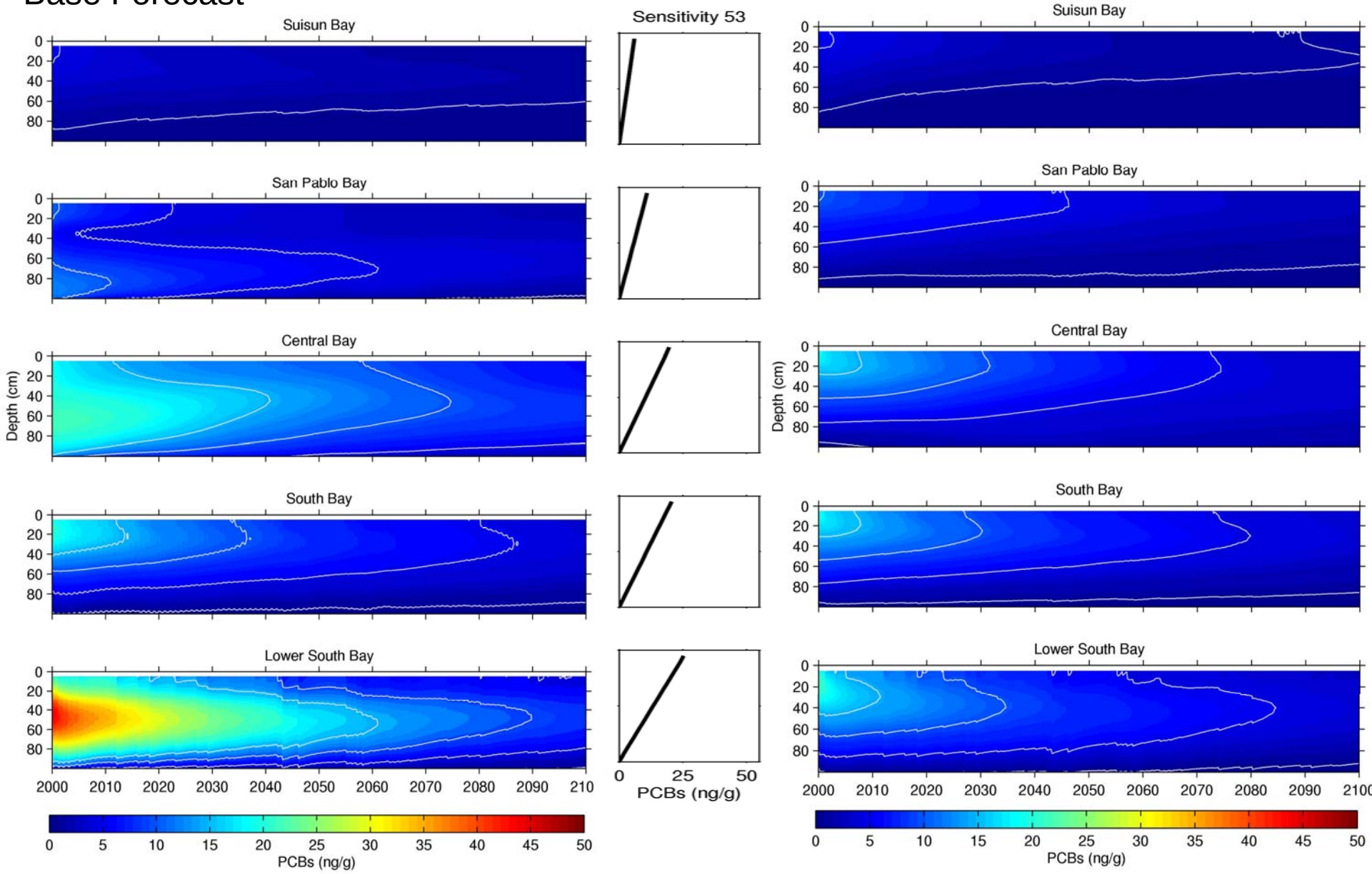
Net Erosional

Net Depositional

Sensitivity to PCB Profile

Base Forecast

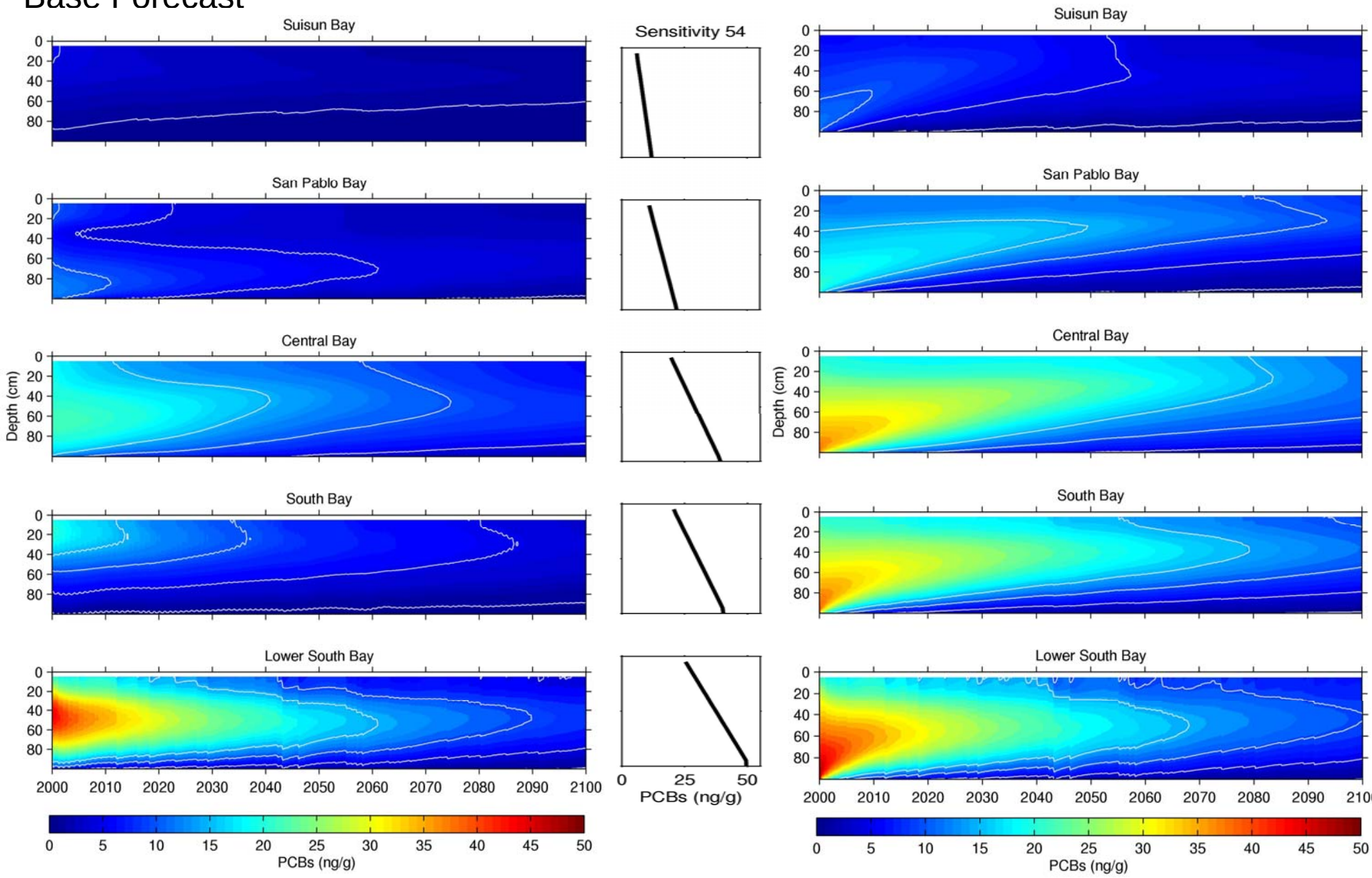
Sensitivity



Sensitivity to PCB Profile

Base Forecast

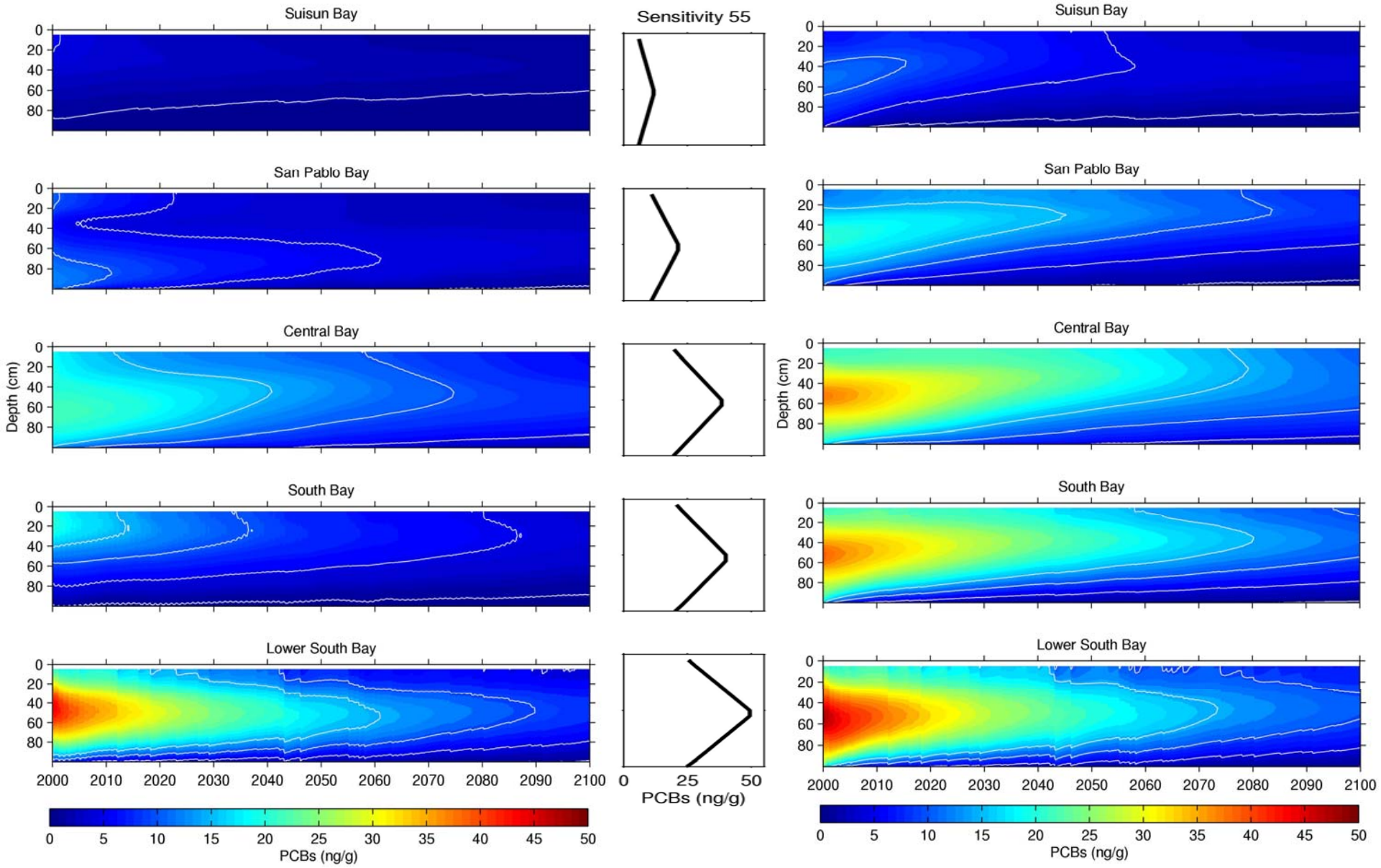
Sensitivity



Sensitivity to PCB Profile

Base Forecast

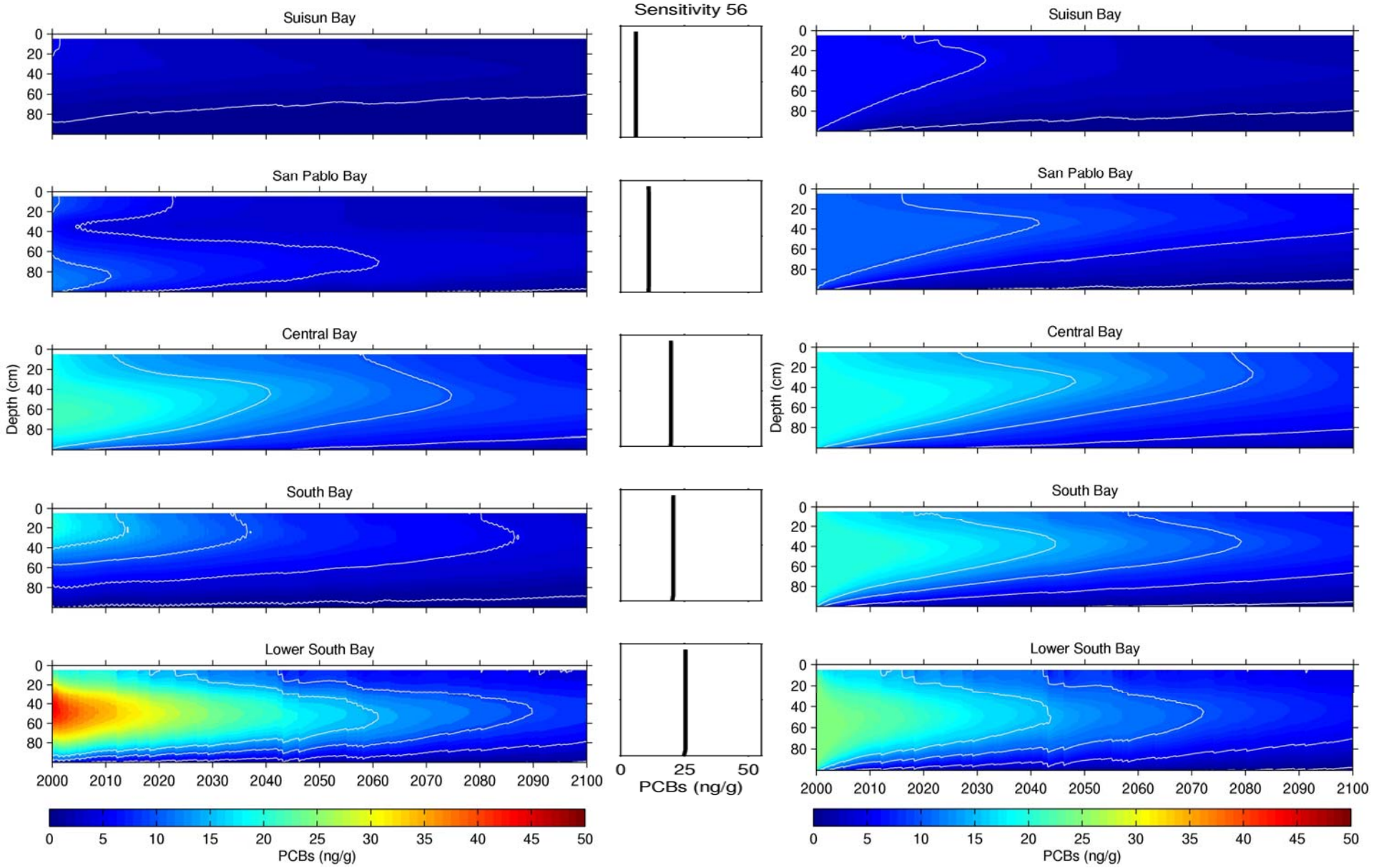
Sensitivity



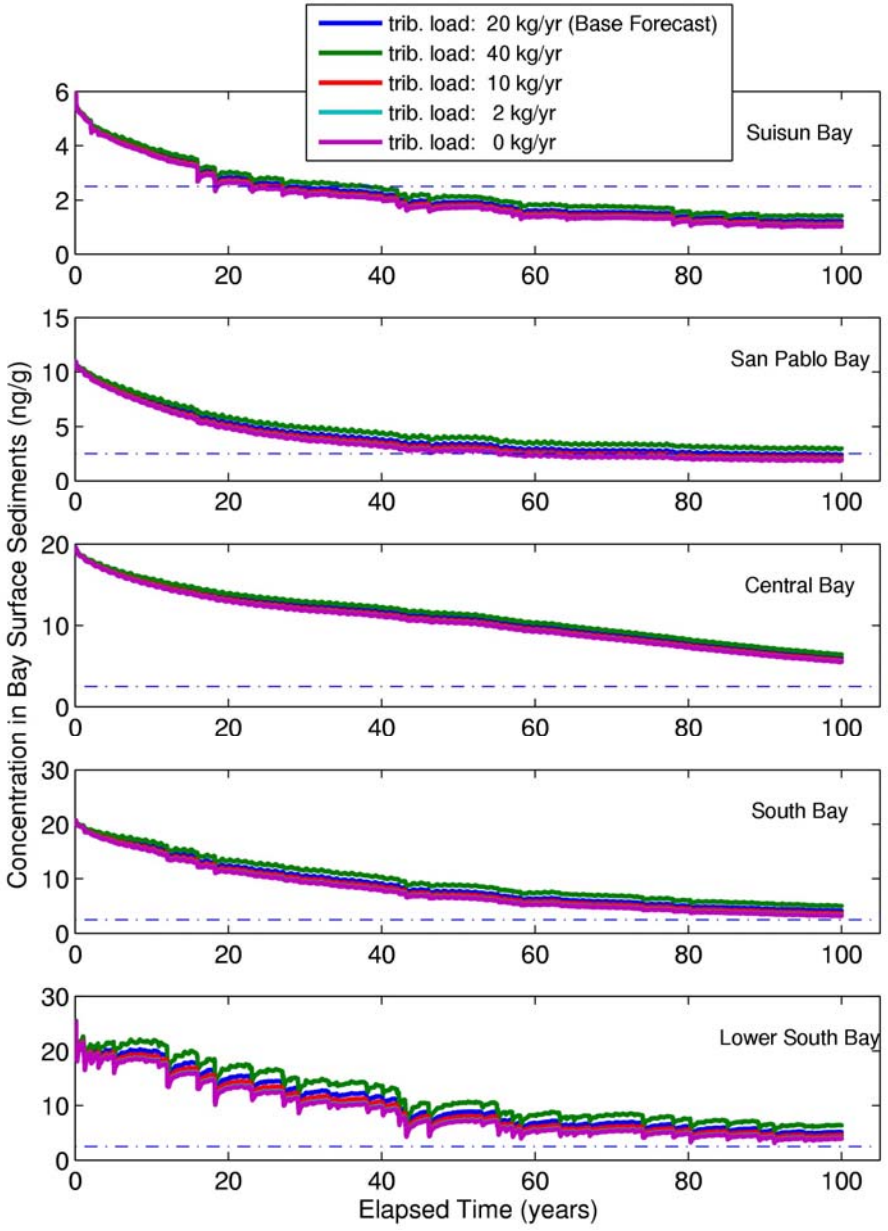
Sensitivity to PCB Profile

Base Forecast

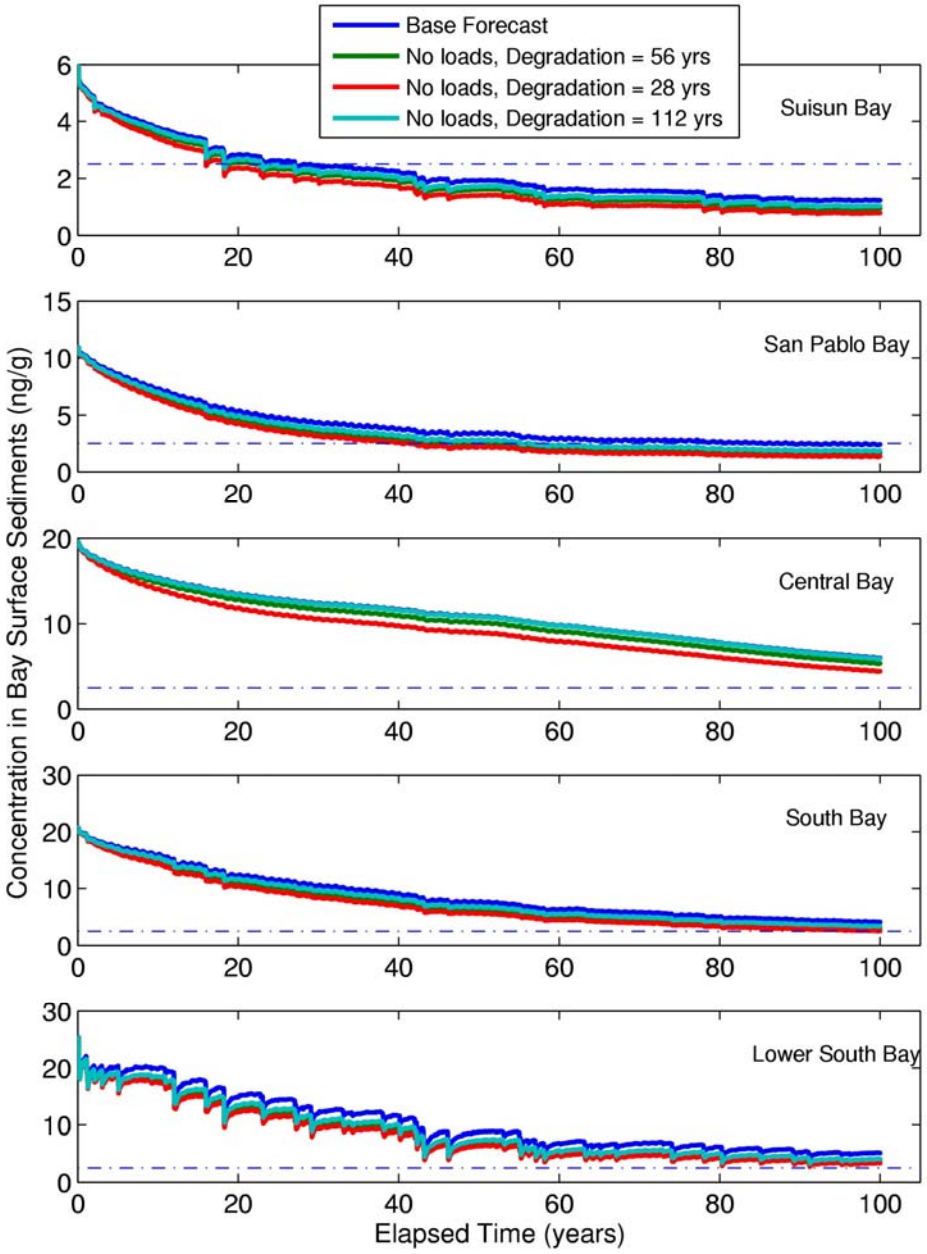
Sensitivity



Loading Scenarios : Local Tributary Loads

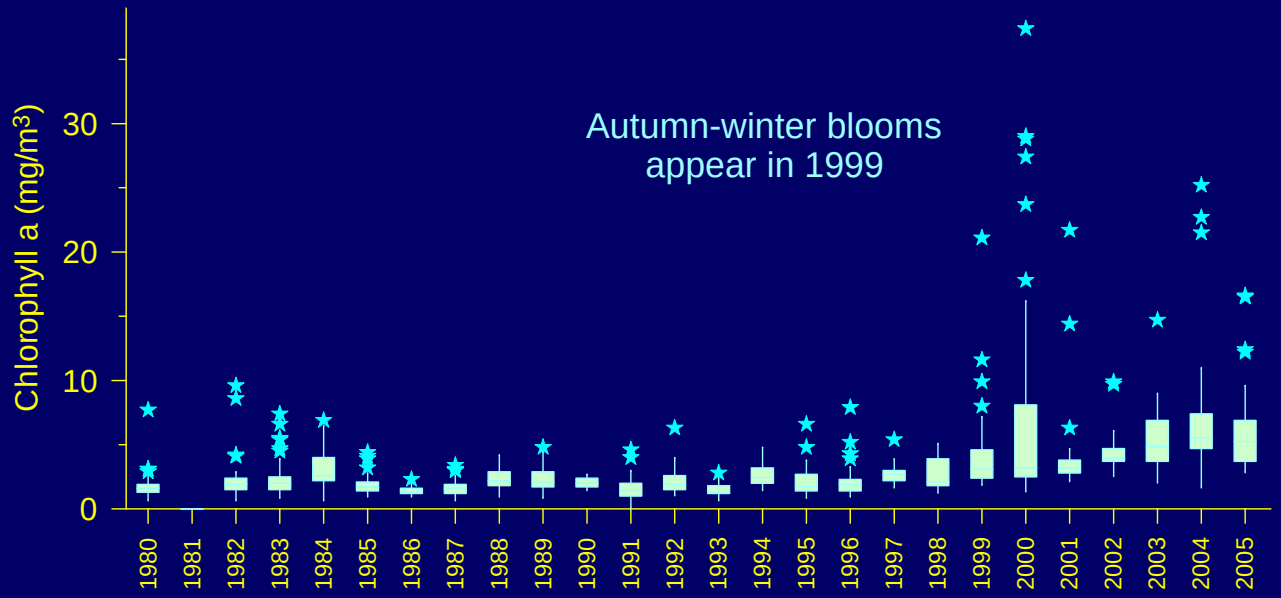


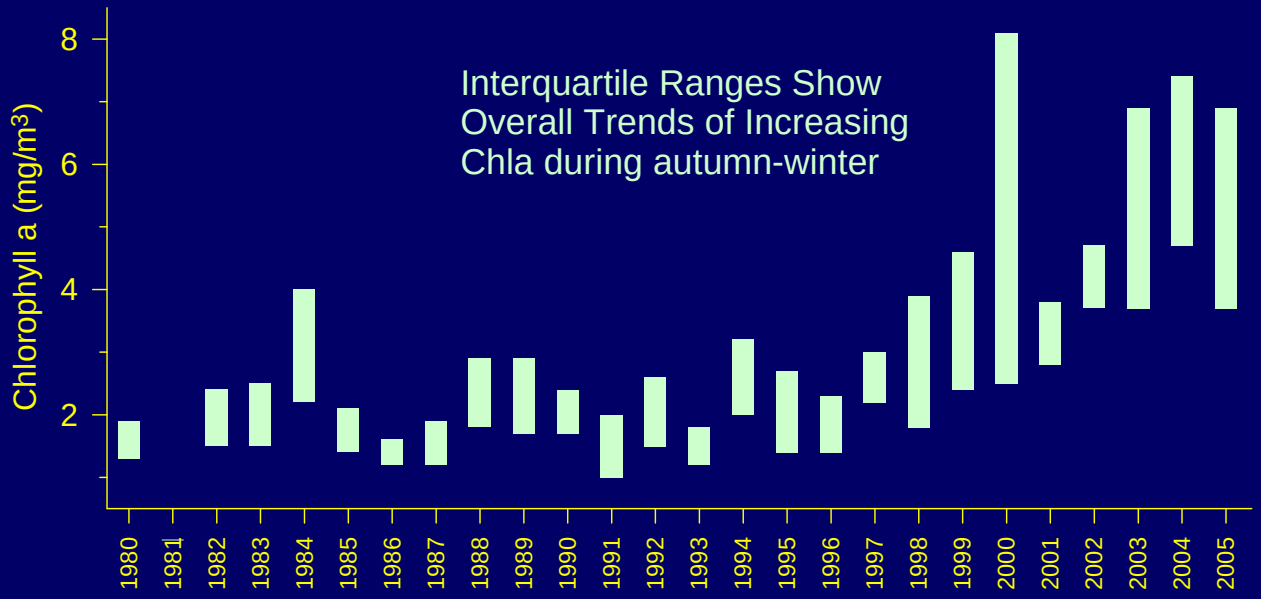
Loading Scenarios : No External Loads



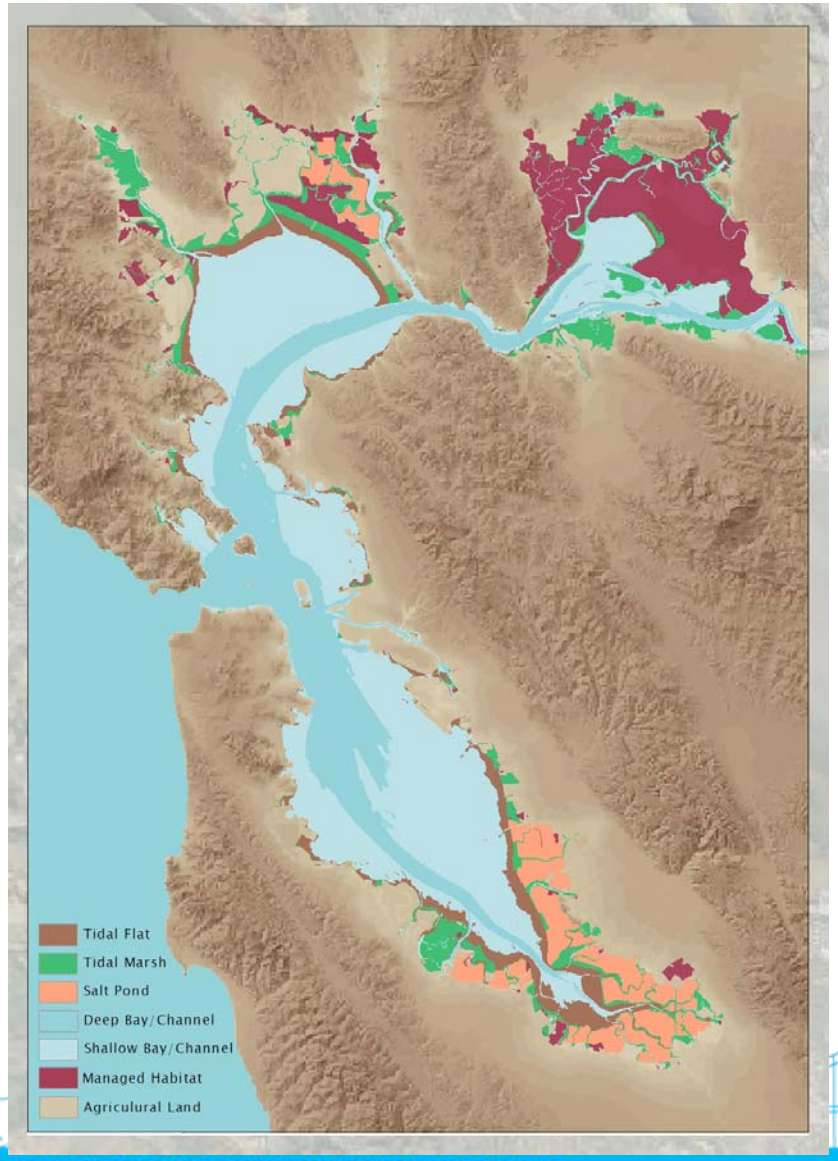
Changing Bay Sediment Ecosystem

- Sediment Supply
- Invasive Species
- Light Penetration
- Bathymetry
- Erosional Processes
- Biological Structure

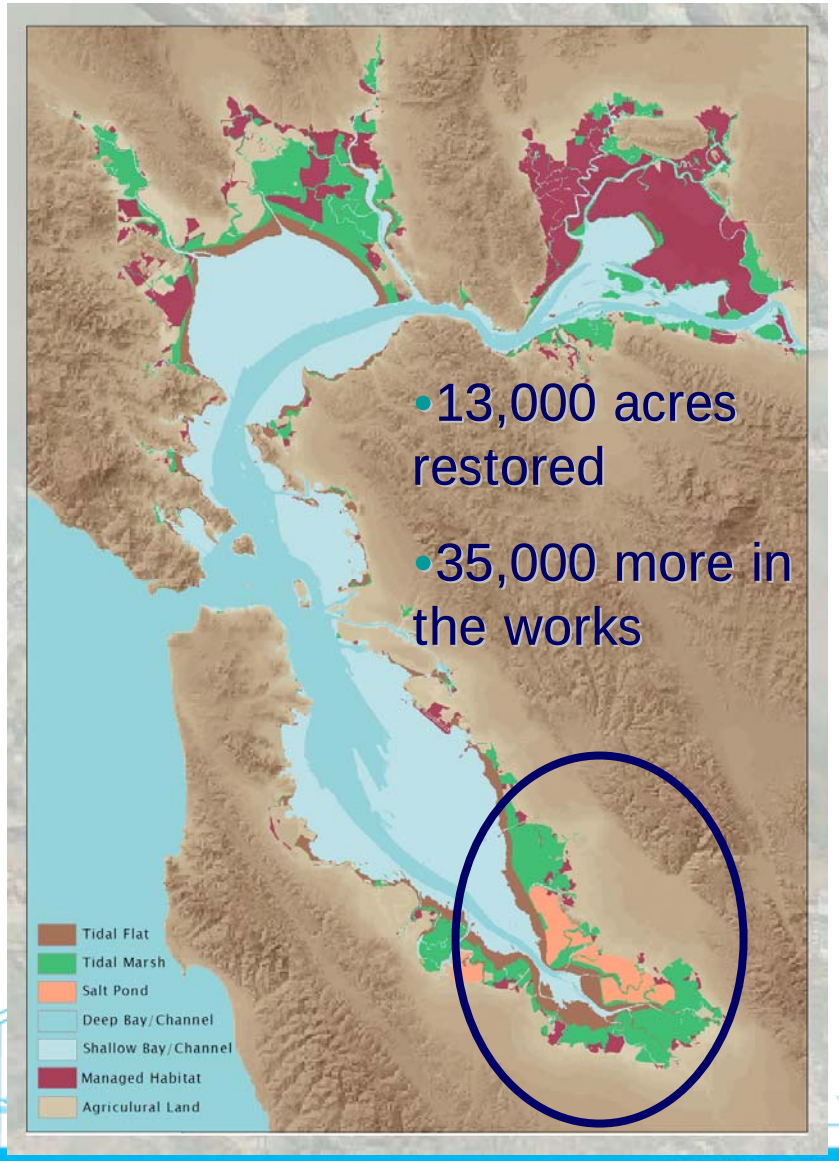

Autumn-winter blooms
appear in 1999
Chlorophyll a (mg/m³)
0
10
20
30
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005


Interquartile Ranges Show
Overall Trends of Increasing
Chla during autumn-winter
Chlorophyll a (mg/m³)
2
4
6
8
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

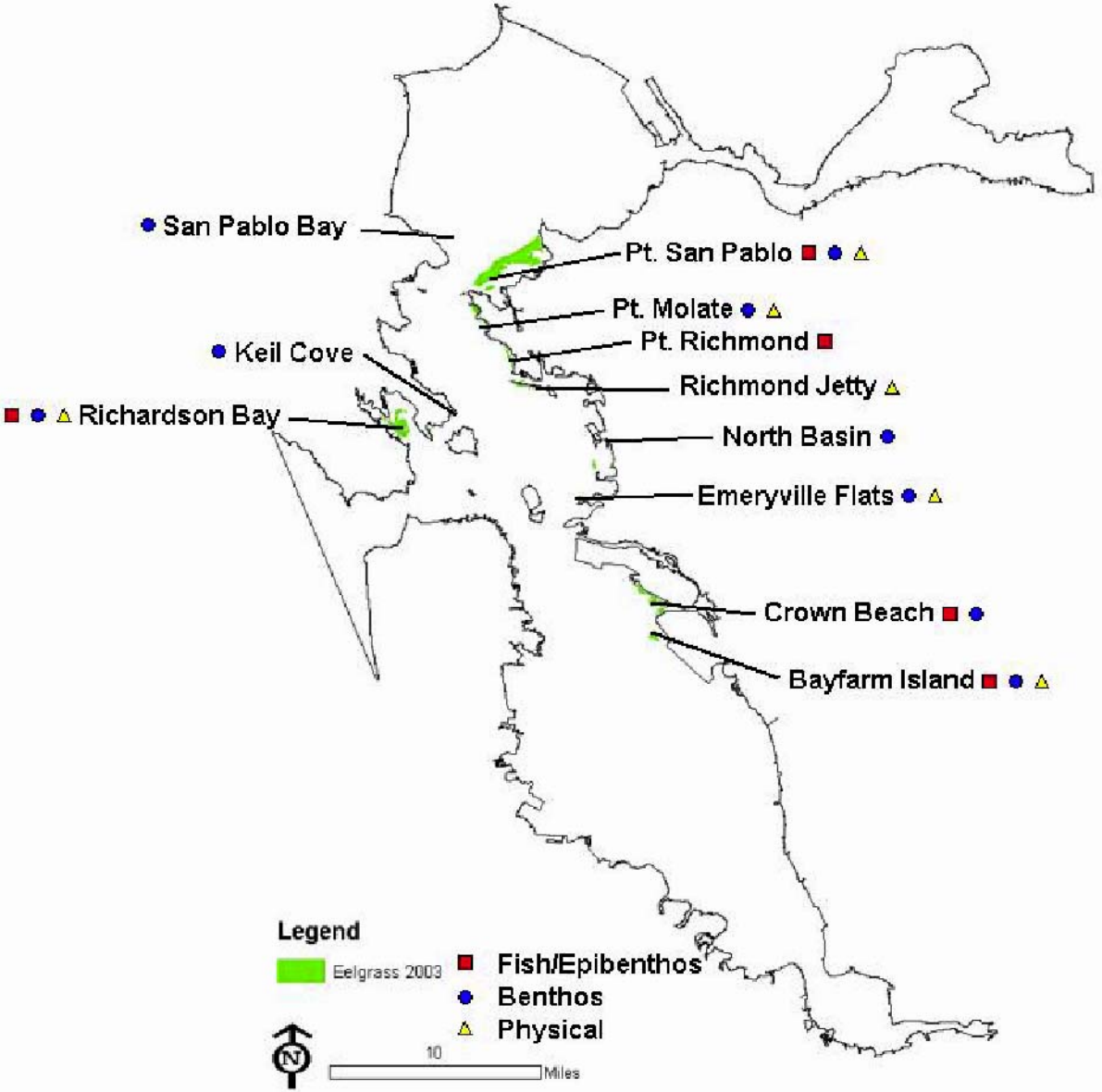
Present (~2000)



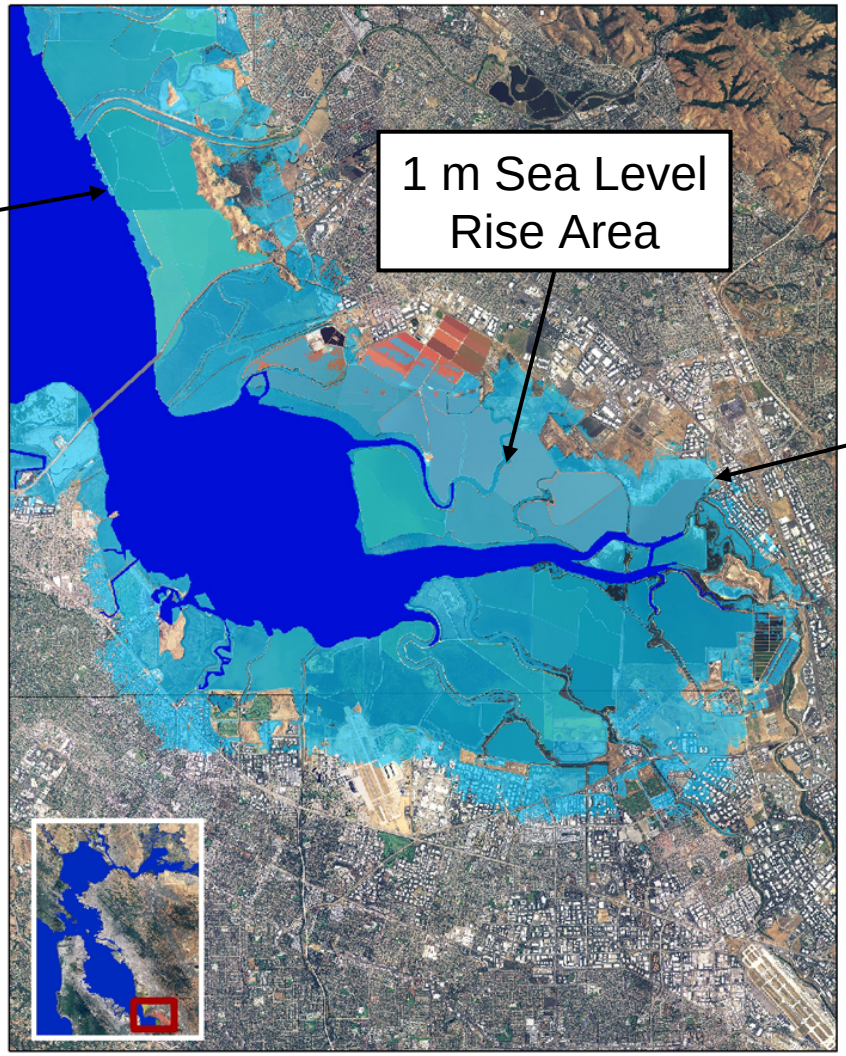
Future (~2030)

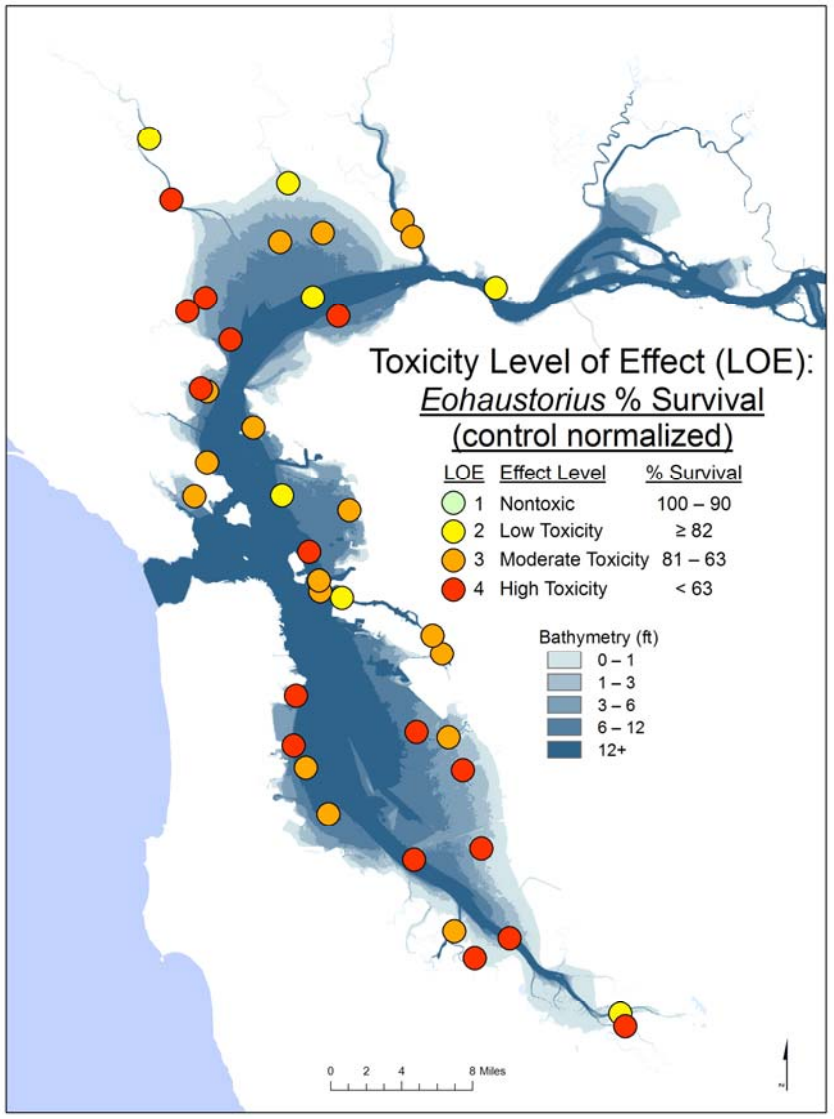


Few Eelgrass Beds Remaining in Bay



San Francisco Bay Scenarios for Sea Level Rise
South Bay





Statewide Assessment Results (Draft)
for San Francisco Estuary

Data: West Coast EMAP 2000 Study (40 stations evaluated)
Southern California Coastal Water Research Project (SCCWRP)
5/22/07 (Analysis Date)

Toxicity Categories

Nontoxic: Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species (e.g., control sediments)

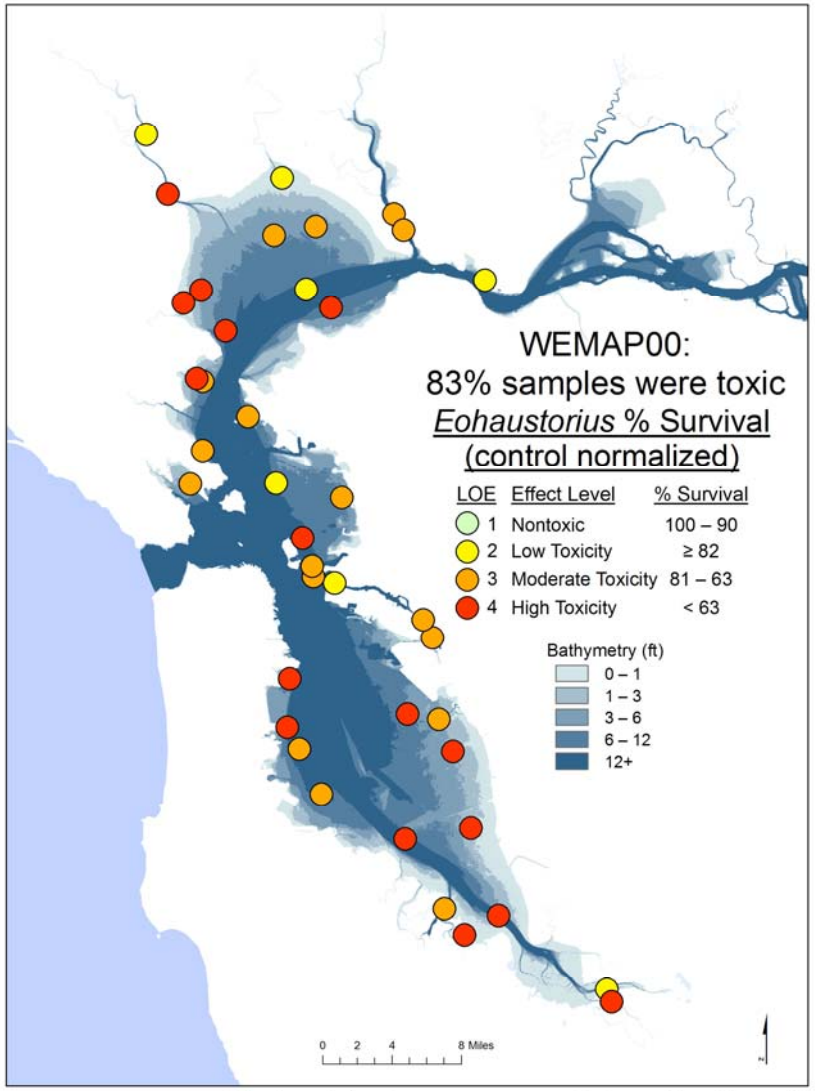
Low toxicity: A response that is of relatively low magnitude; the response may not be greater than test variability

Moderate toxicity: High confidence that a statistically significant toxic effect is present

High toxicity: High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test

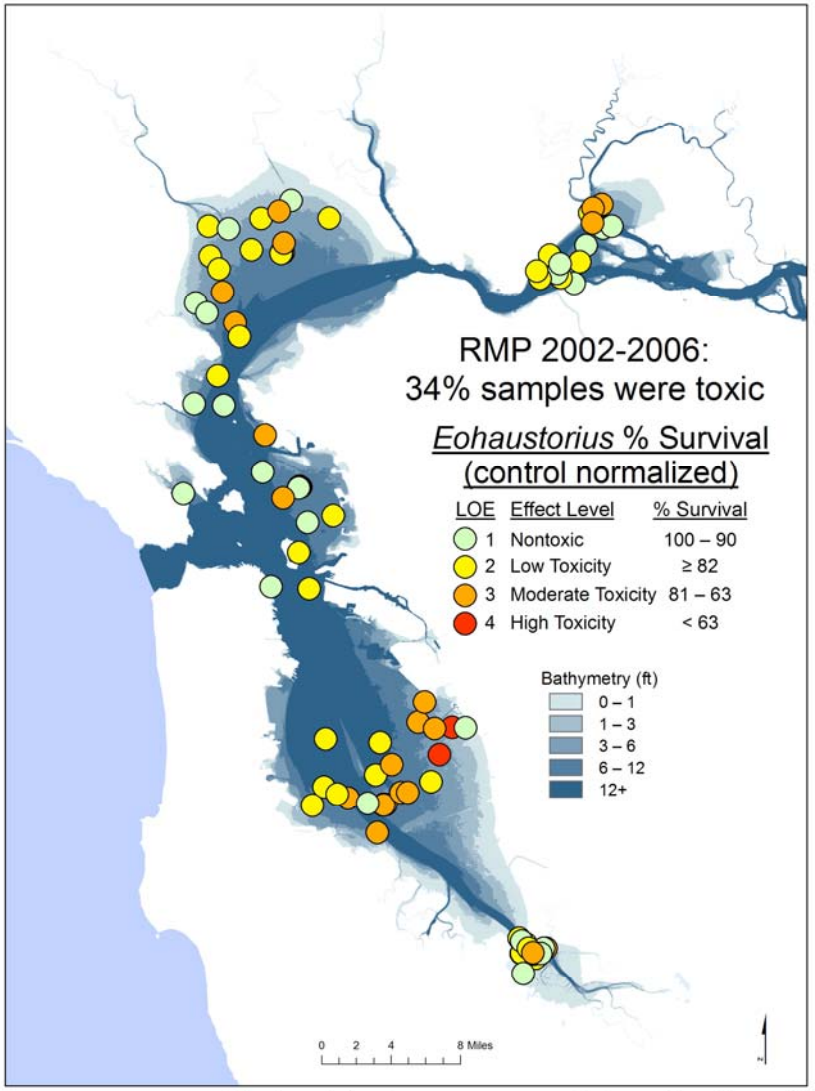
Amphipod Species Recommendations

- **Recommended**
  - ***Eohaustorius estuarius***
  - ***Leptocheirus plumulosus***
- **Not recommended**
  - ***Ampelisca abdita***
    - **Low sensitivity**
    - **Low test success rate**



Statewide Assessment Results (Draft)
for San Francisco Estuary

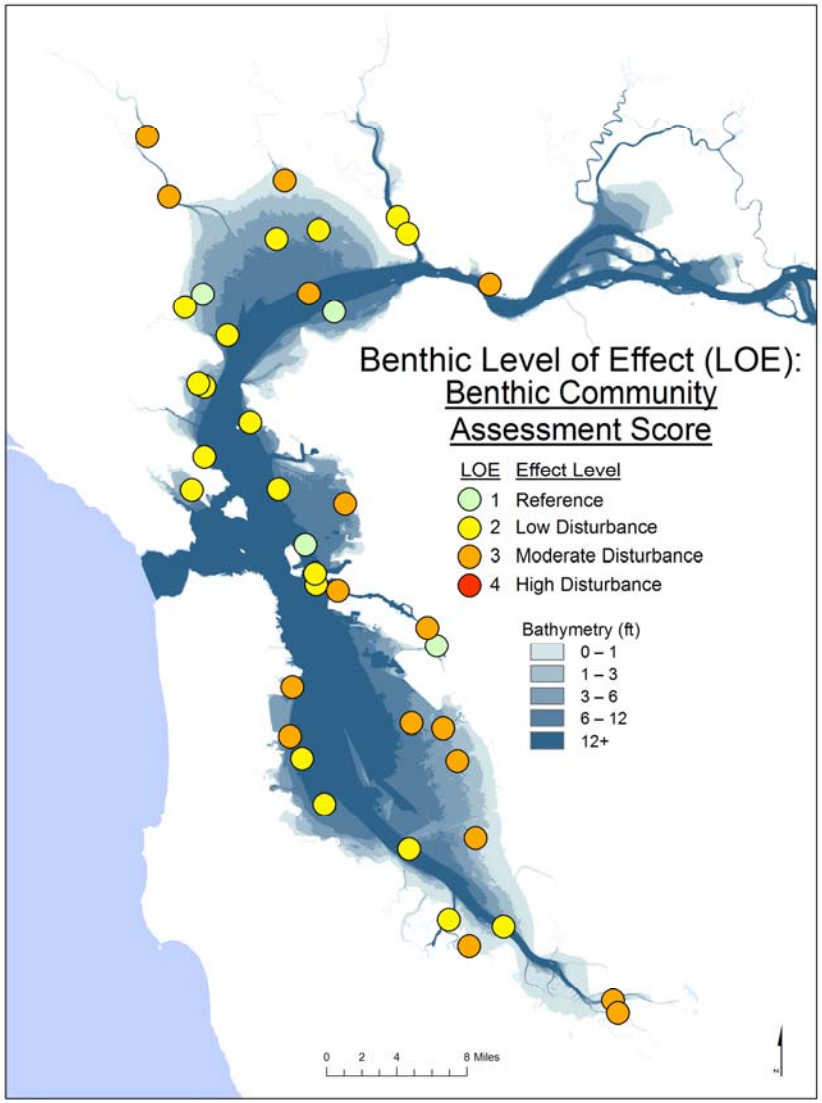
Data: West Coast EMAP 2000 Study (40 WEMAP samples evaluated)
Southern California Coastal Water Research Project (SCCWRP)
Revised SQO Assessment (05/22/07)



Statewide Assessment Results (Draft)
for San Francisco Estuary

Data: RMP Status and Trends Program (100 samples evaluated)
Regional Monitoring Program (SFEI)

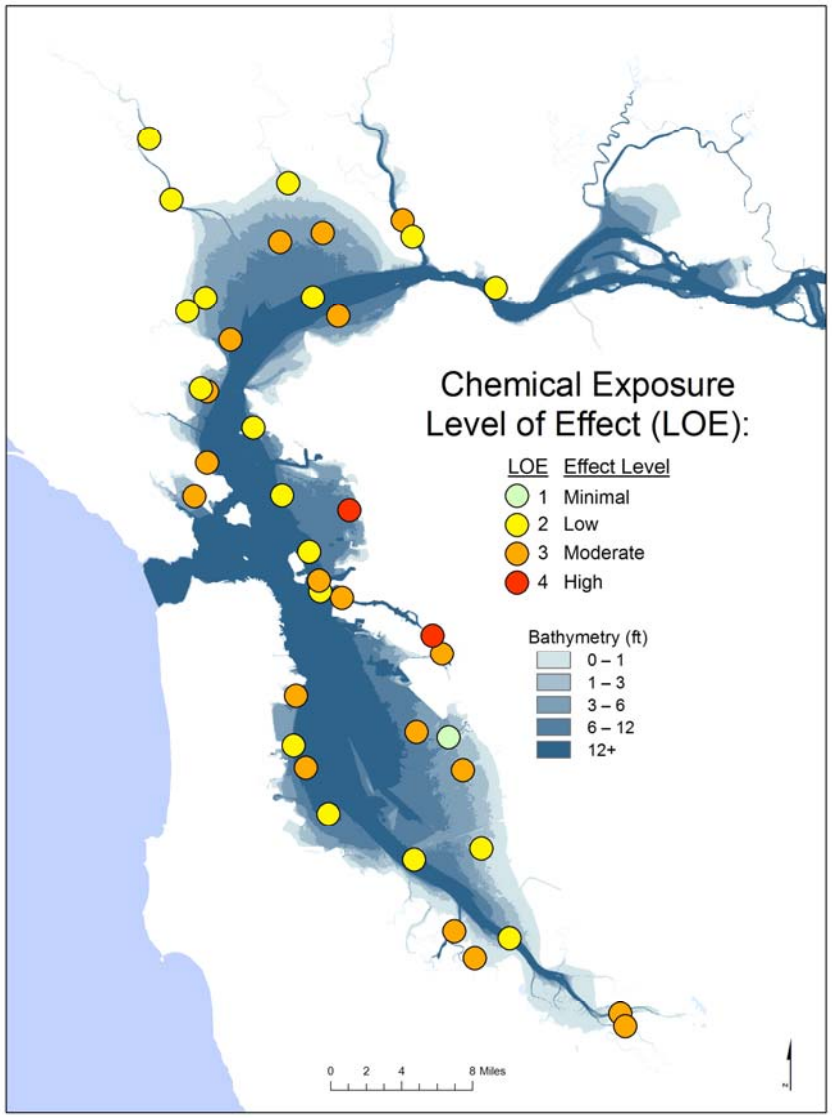
Benthic Effects



Statewide Assessment Results (Draft)
for San Francisco Estuary

Data: West Coast EMAP 2000 Study (40 stations evaluated)
Southern California Coastal Water Research Project (SCCWRP)
5/22/07 (Analysis Date)

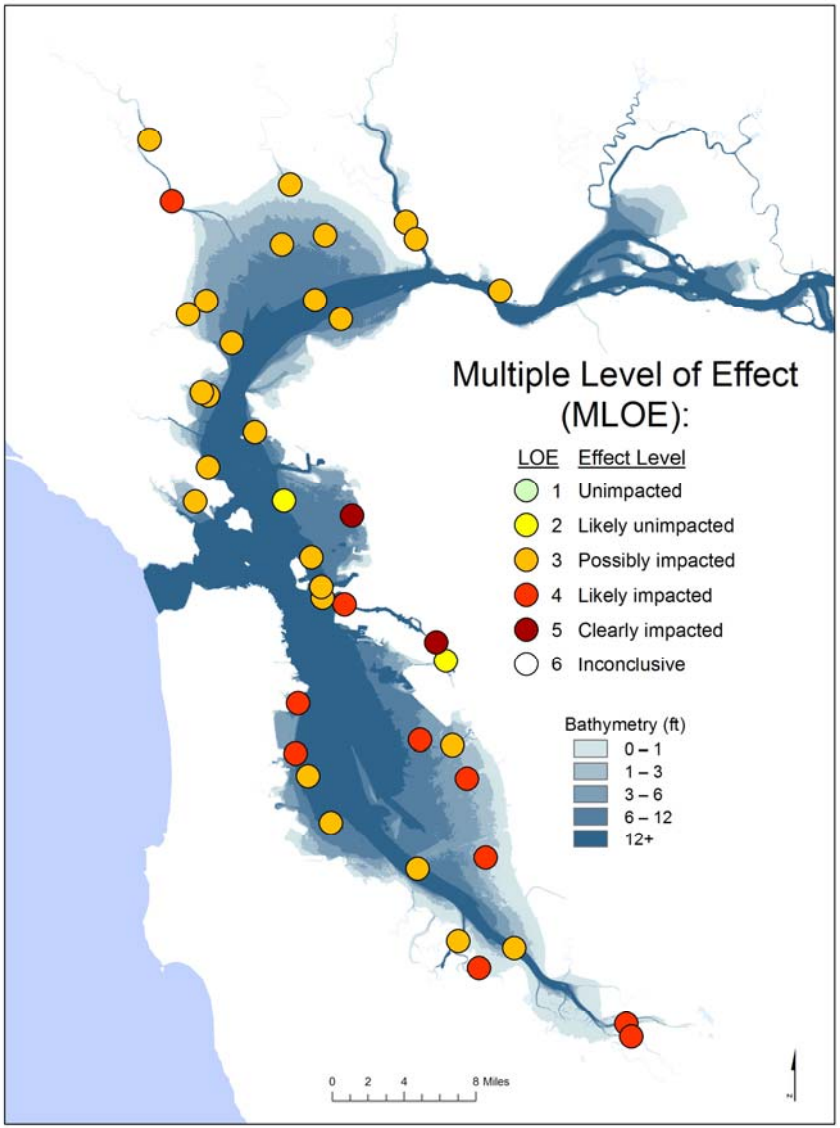
Chemical Exposure



Statewide Assessment Results (Draft)
for San Francisco Estuary

Data: West Coast EMAP 2000 Study (40 stations evaluated)
Southern California Coastal Water Research Project (SCCWRP)
5/22/07 (Analysis Date)

Multiple Level of Effects (MLOE)



Statewide Assessment Results (Draft)
for San Francisco Estuary

Data: West Coast EMAP 2000 Study (40 stations evaluated)
Southern California Coastal Water Research Project (SCCWRP)
5/22/07 (Analysis Date)

Major Points

- Bay Still Responding to 1800's mgmt
- Transport Has Spread Contamination Widely
- Future Bay Depends on Mixing of Legacy Contaminants
- Bay Sediment Ecosystem in Major Overhaul
- Overall Bay Status Assessment Will Change with Sediment Quality Objectives