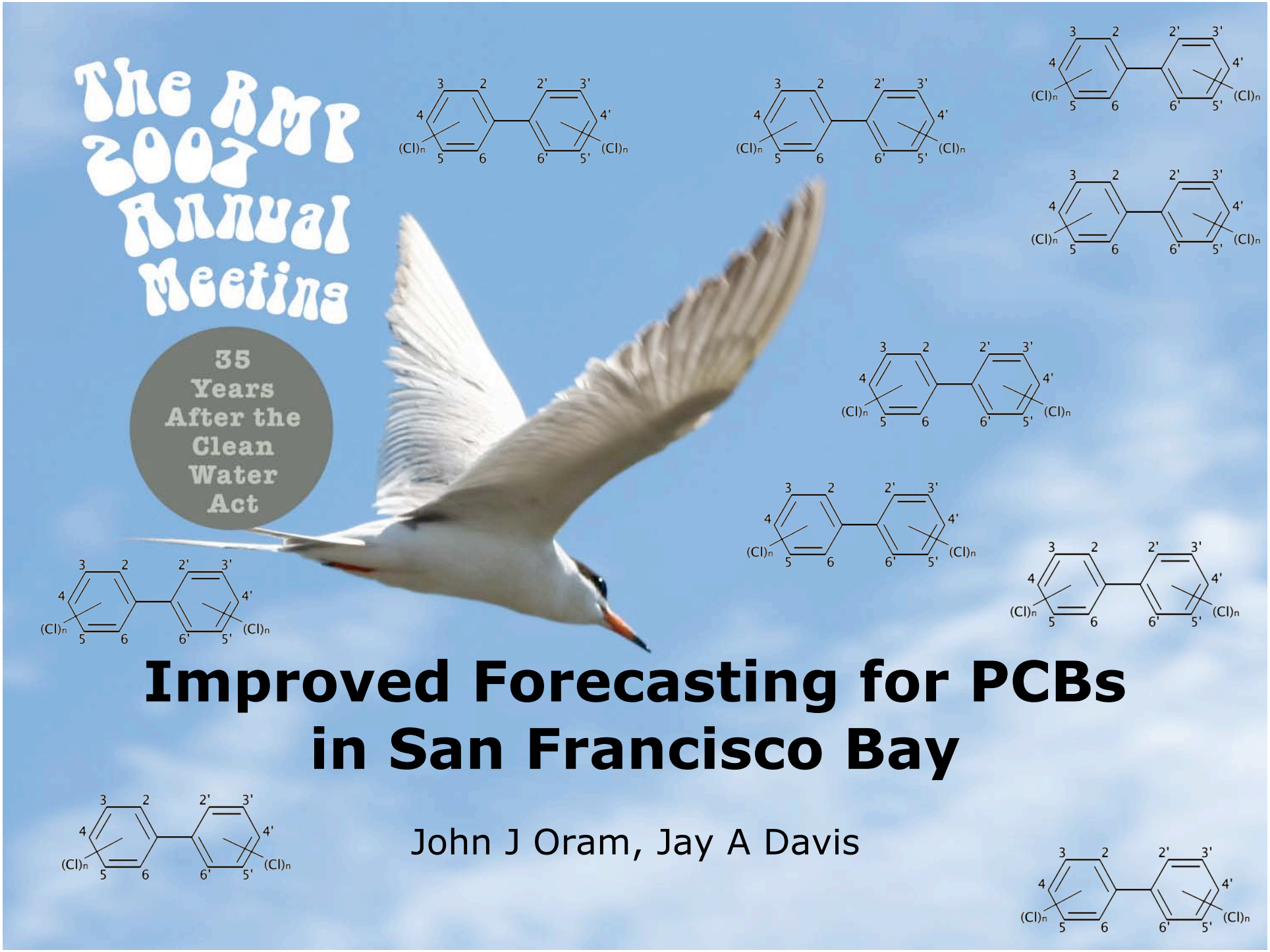
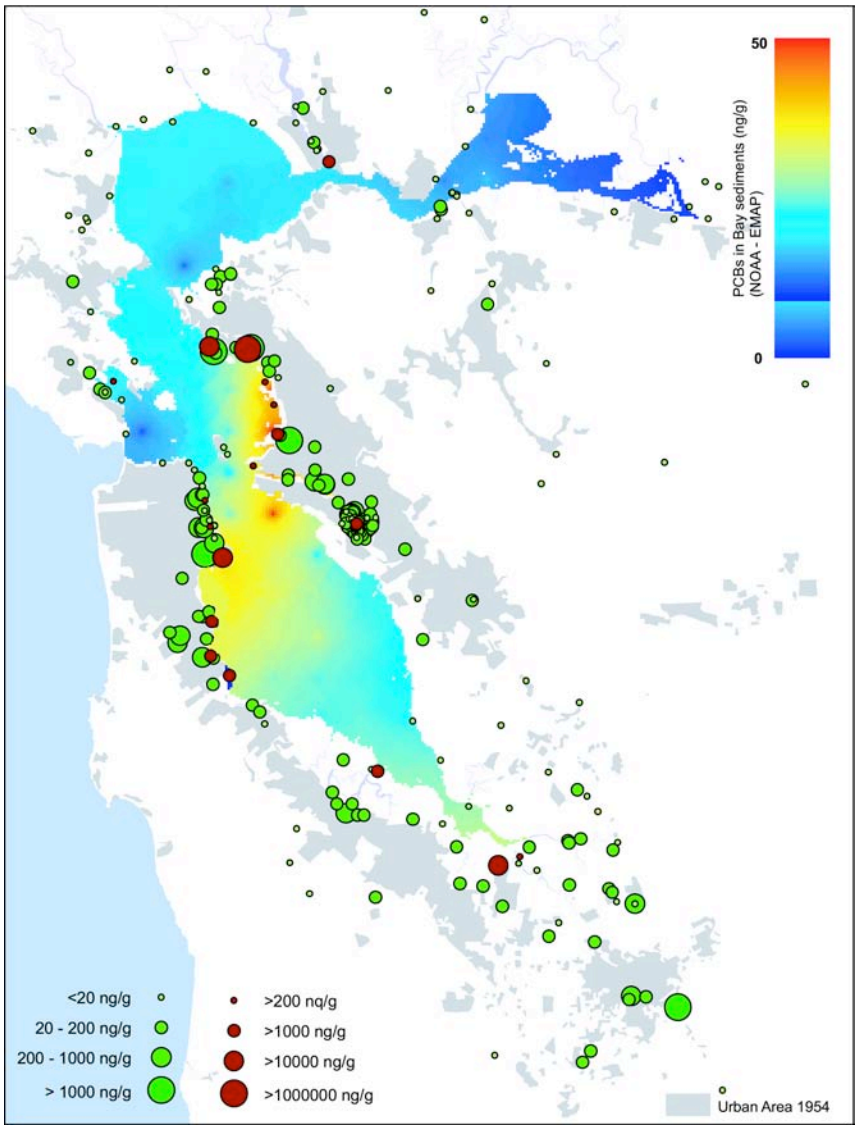


Improved Forecasting for PCBs in San Francisco Bay

John J Oram, Jay A Davis

“A Legacy of PCB Contamination”

- Spread across watershed
- Deep in Bay sediments
- Associated with urban and industrial zones
- Levels pose health risks to humans and wildlife

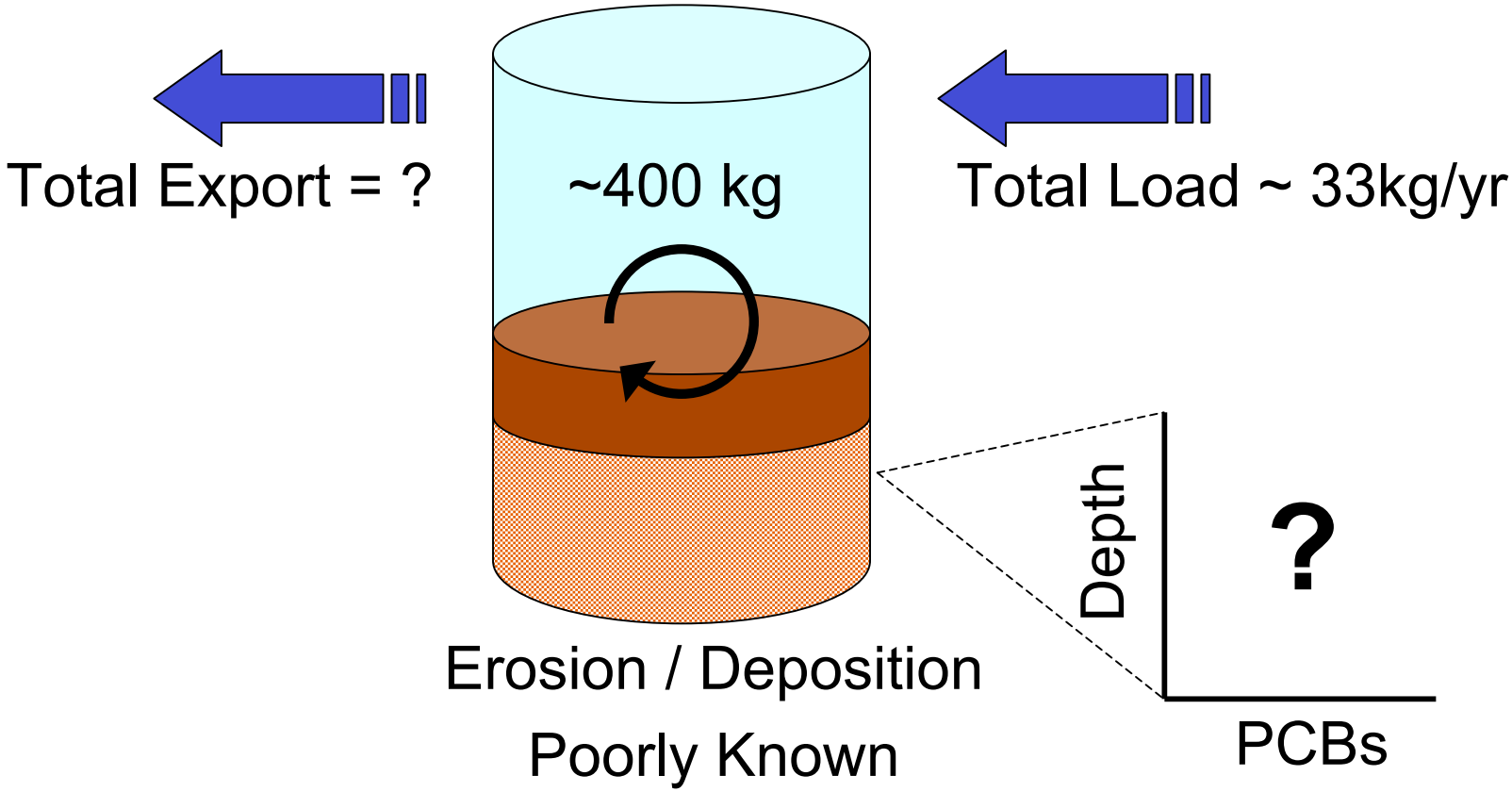


PCB Sources, Pathways, and Loadings

Total External Loads ~ 33 kg/yr
(RMP's Latest Best Estimate for WY 2000-2005)

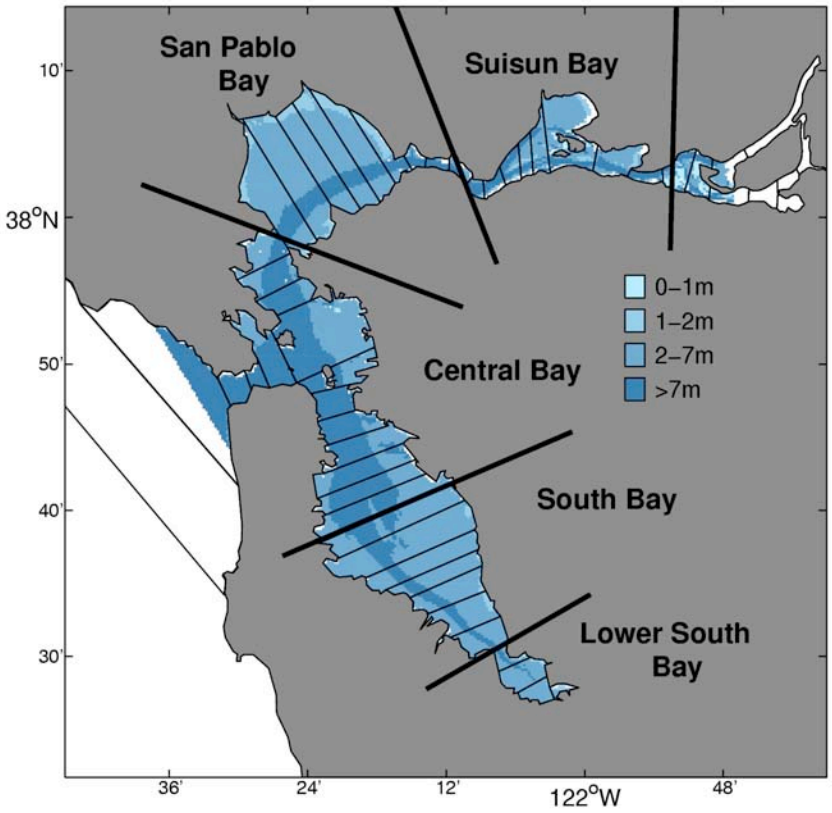
- Local Watersheds (20 kg/yr)
  - Diffuse sources
- Delta Outflow (11 kg/yr)
  - Low conc., large flows
  - Episodic flow-thru
- Wastewater (2 kg/yr)
- Atmospheric Dep. (0.5 kg/yr)
  - Volatilization > Deposition

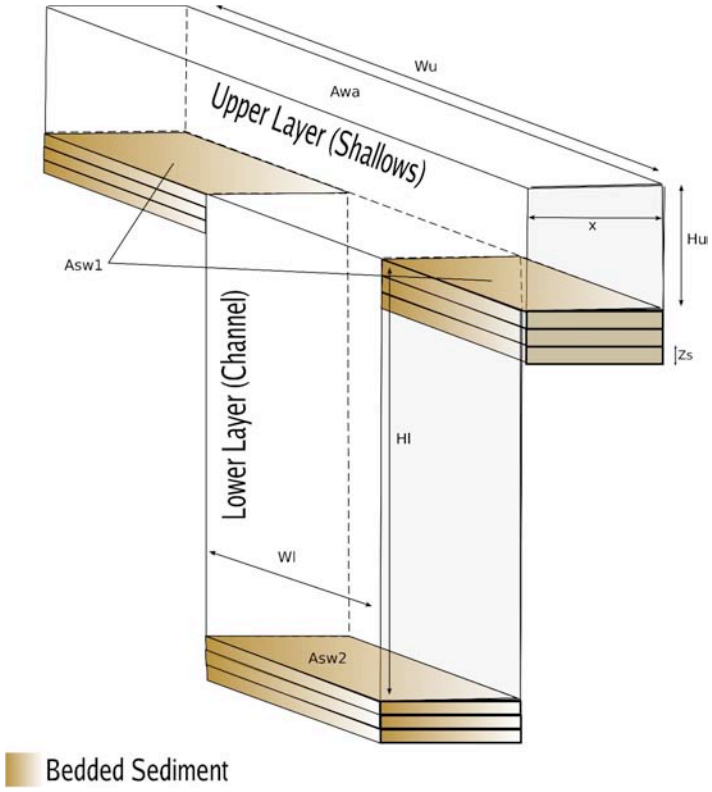
Conceptual Model*



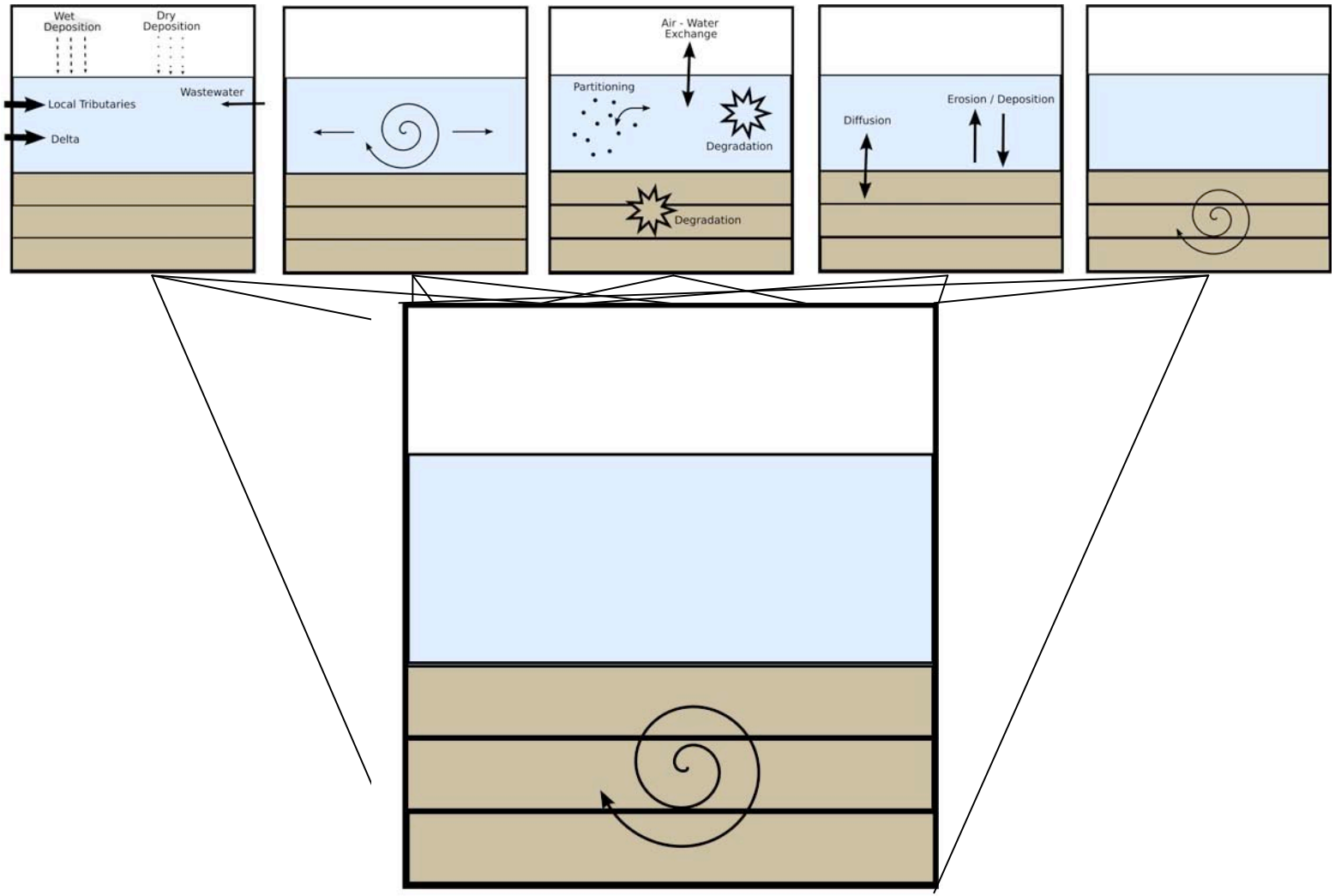
* Based on 2002-2006 RMP data

A Multibox Model of SF Bay





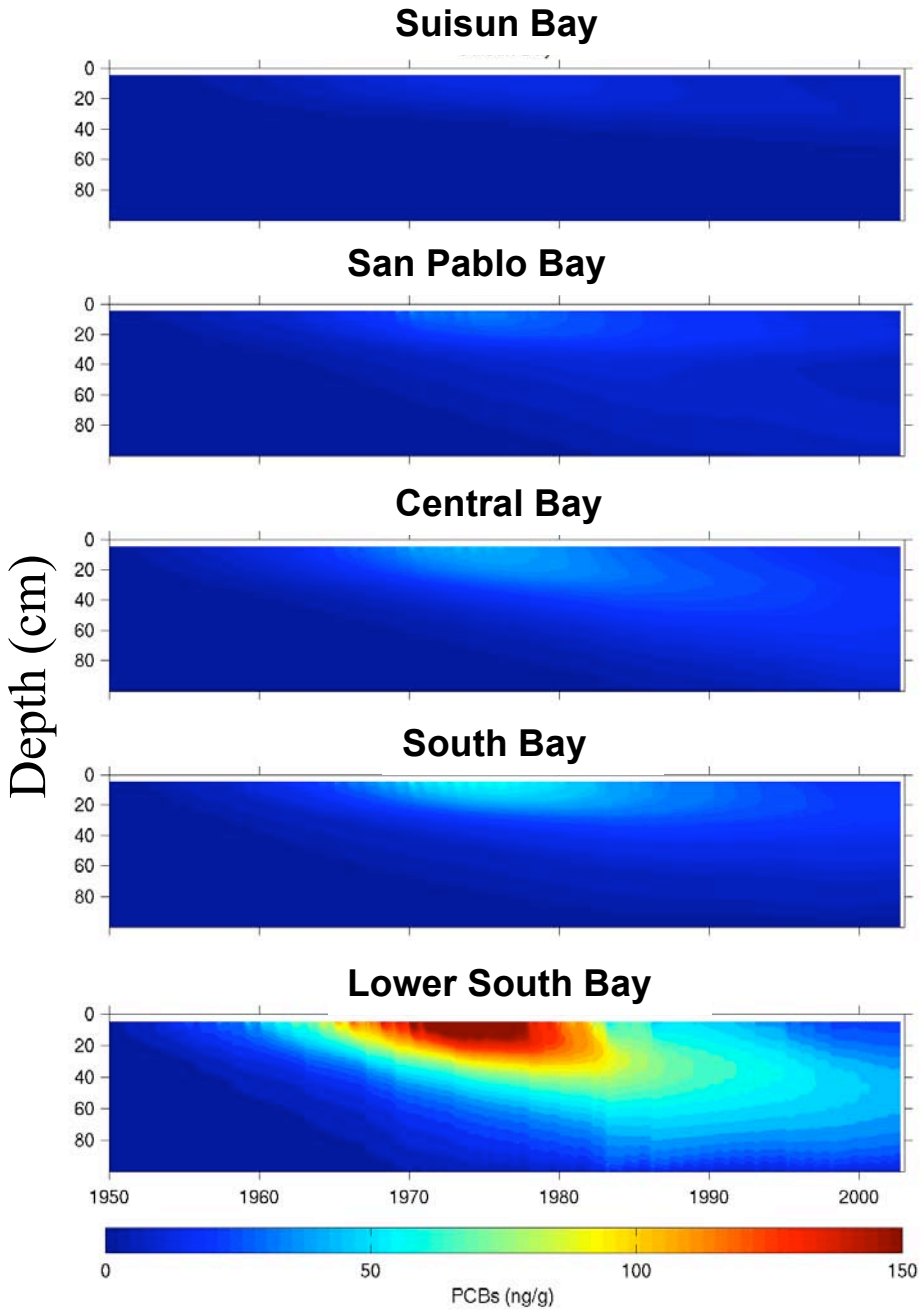
A Day in the Life of the Multibox Model

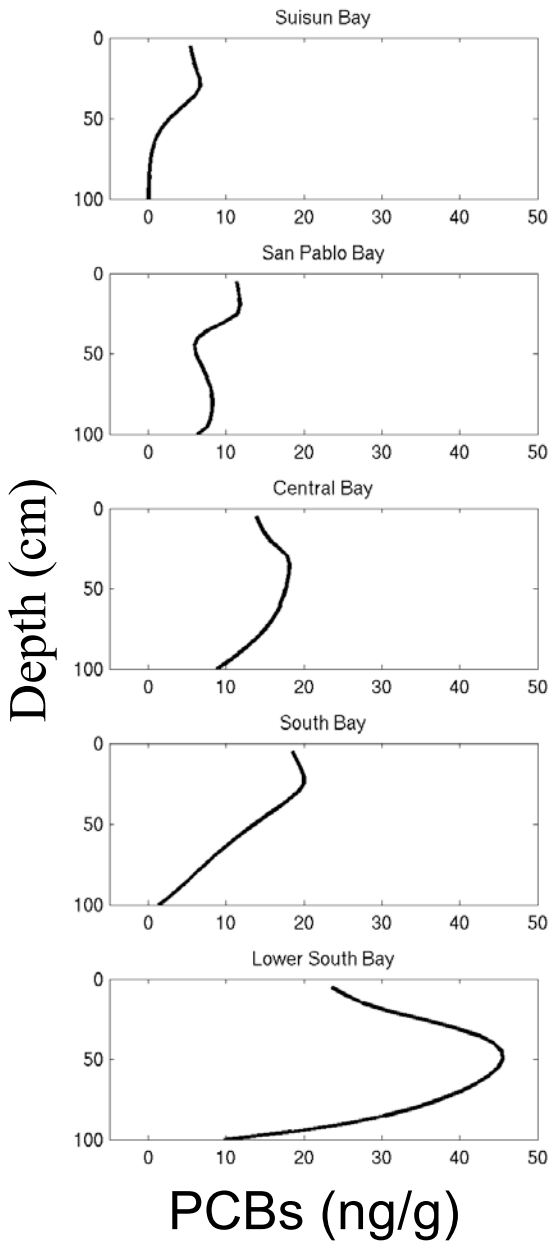


Model Applications

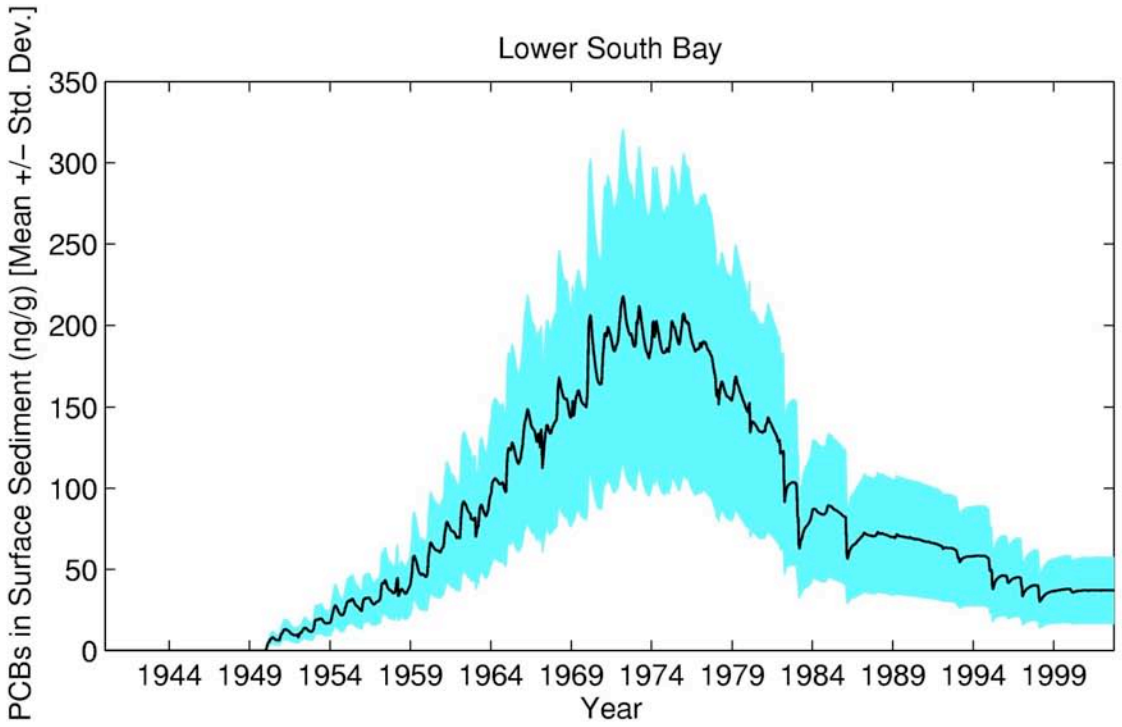
- Hindcast
  - 1940-2002
  - Model calibration and validation
  - Historic sediment and PCB budget
  - Assess model uncertainty
- Forecast
  - 2000-2099
  - Estimate future trajectory of Bay
  - Assess management options

Hindcast Results
1940-2002


Suisun Bay
San Pablo Bay
Central Bay
South Bay
Lower South Bay
Depth (cm)
0
20
40
60
80
1950
1960
1970
1980
1990
2000
0
50
100
150
PCBs (ng/g)

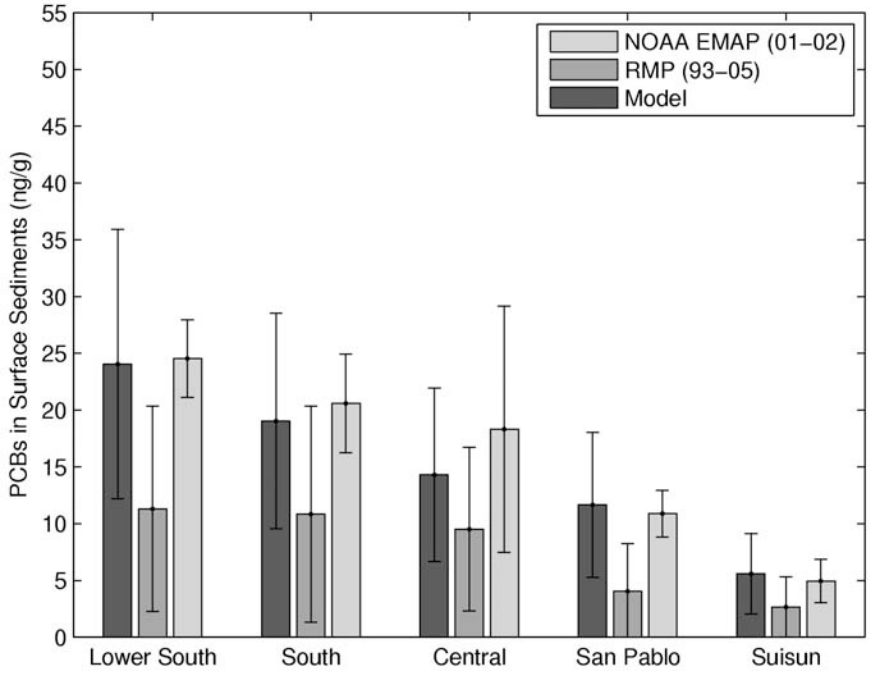

Suisun Bay
San Pablo Bay
Central Bay
South Bay
Lower South Bay
Depth (cm)
0
50
100
0
10
20
30
40
50
PCBs (ng/g)

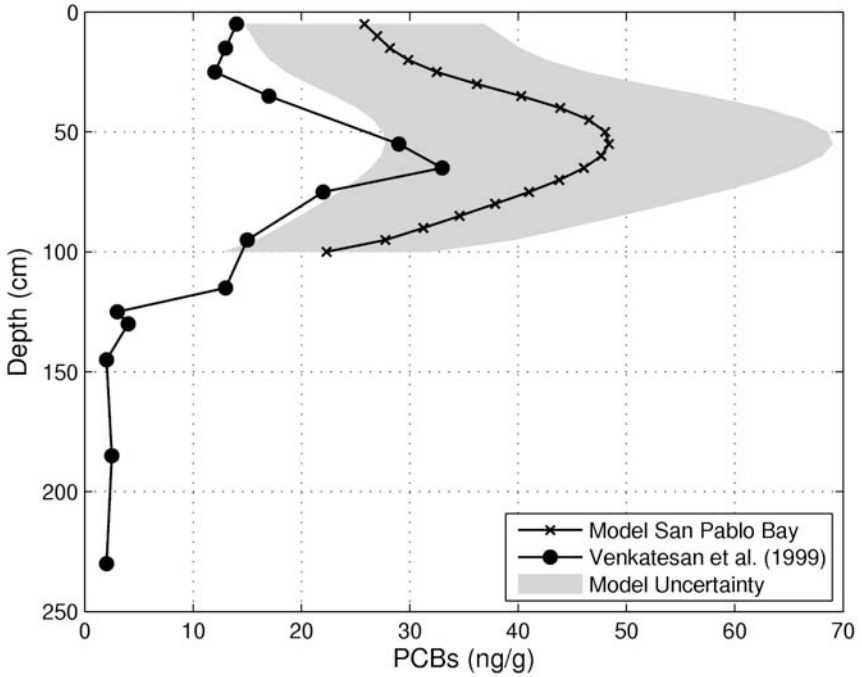
Hindcast : Model Uncertainty



Model Uncertainty is: +/- 100% at 95% CI

Hindcast Results : Comparison to Observations





* Uncertainty expressed at 70% CI

Hindcast Summary

- Model compares well to observations
  - Model captures key processes
- Model uncertainty is known & quantified

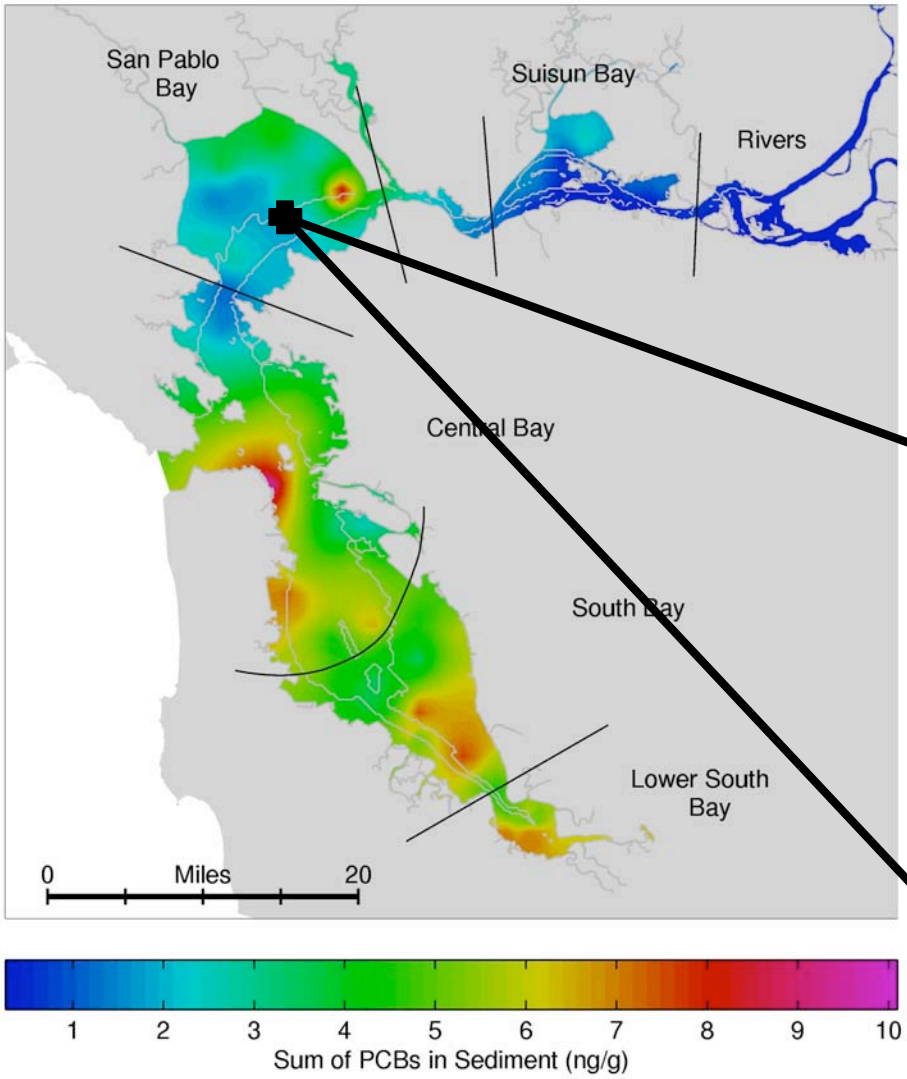
→ OK to extrapolate into future …

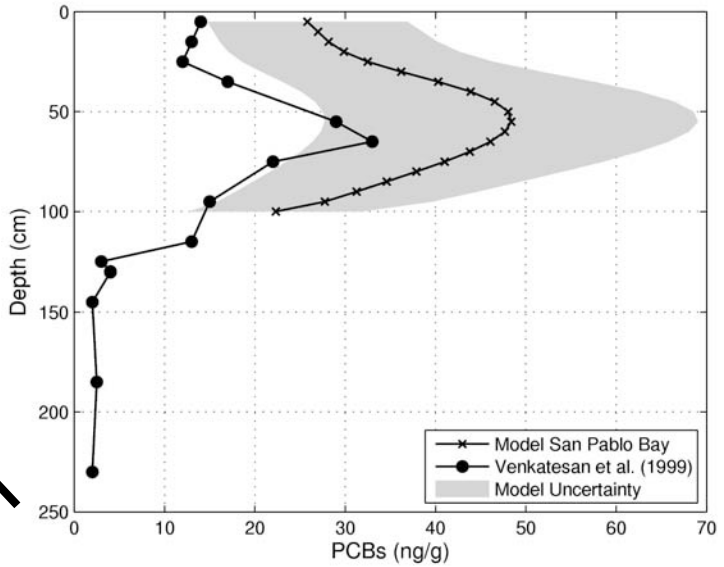
Forecast Assumptions

- Sedimentation
  - Lower South Bay depositional; Others erosional
- Watershed PCBs attenuate
- Climate conditions similar to last 30 years
  - Climate change captured by sea level rise and hydrograph modification

* Assessing probable future conditions of Bay given best current understanding

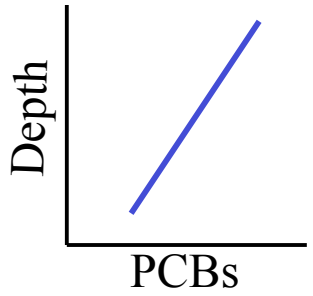
What About Vertical Profile?



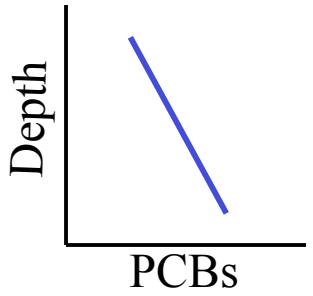


Vertical PCB Profiles in Sediment

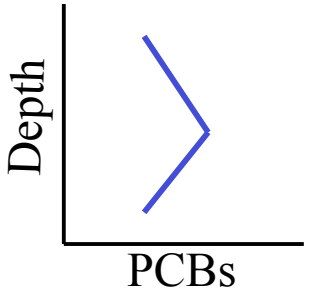
Scenario 1 : Decreasing



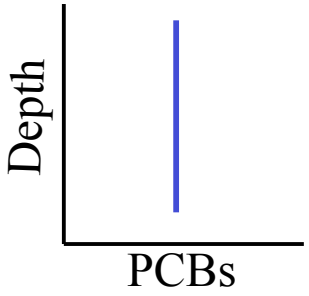
Scenario 2 : Increasing



Scenario 3 : Triangular

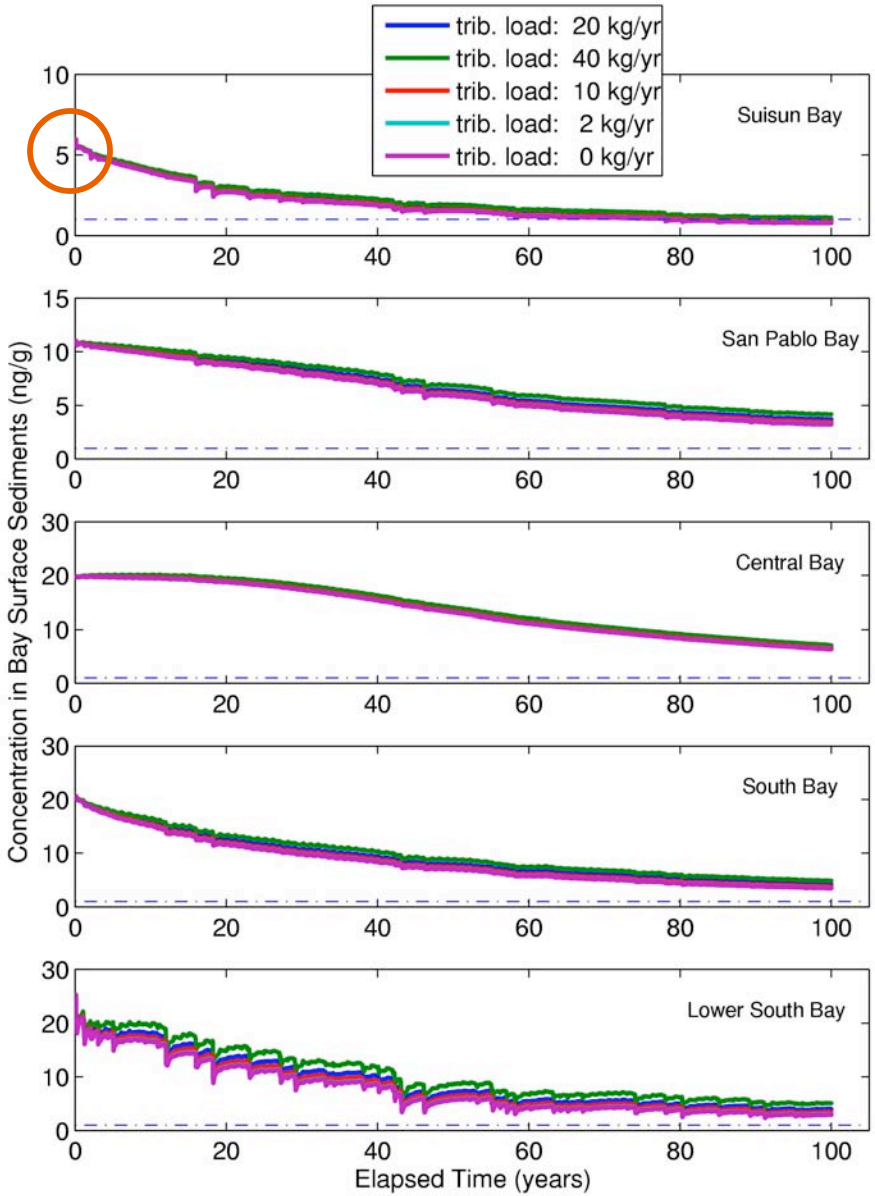


Scenario 4 : Uniform

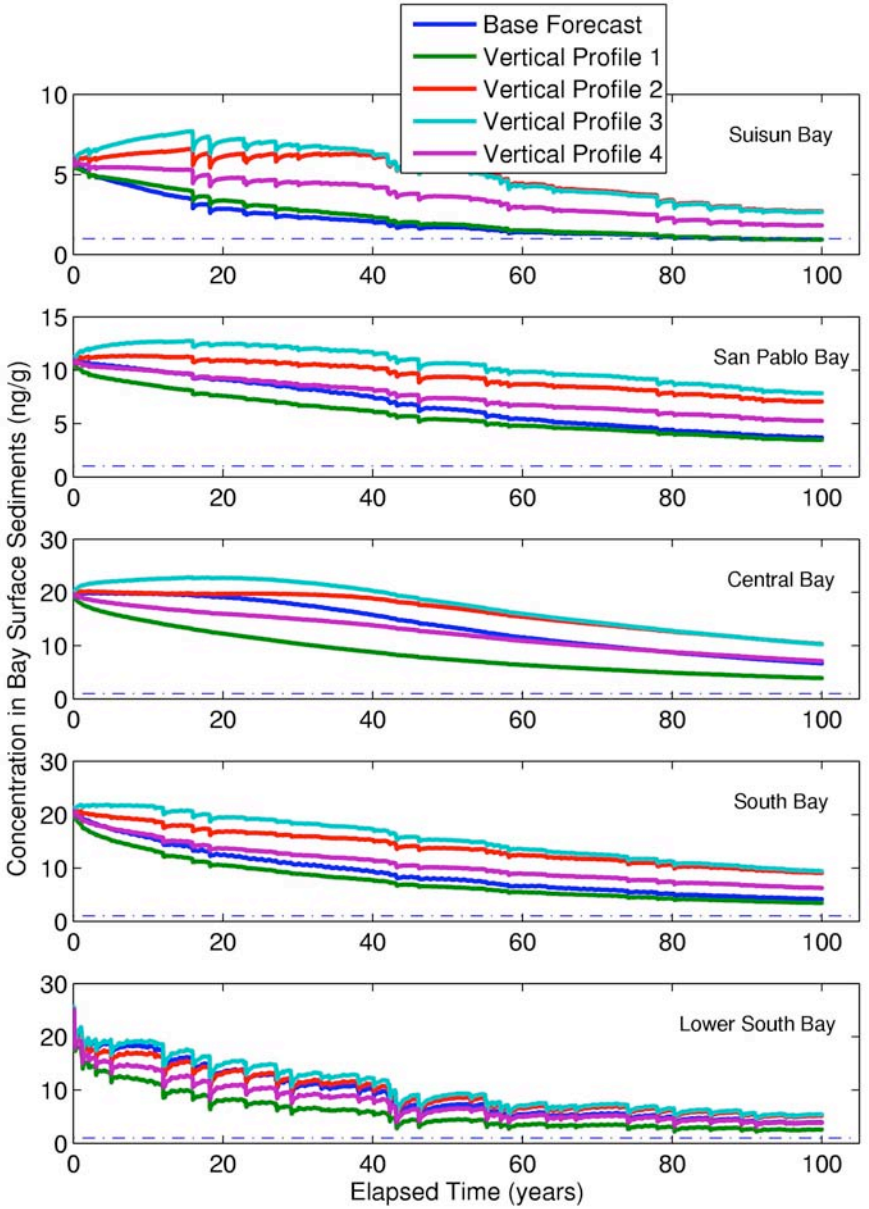


Forecast Results
2000-2099

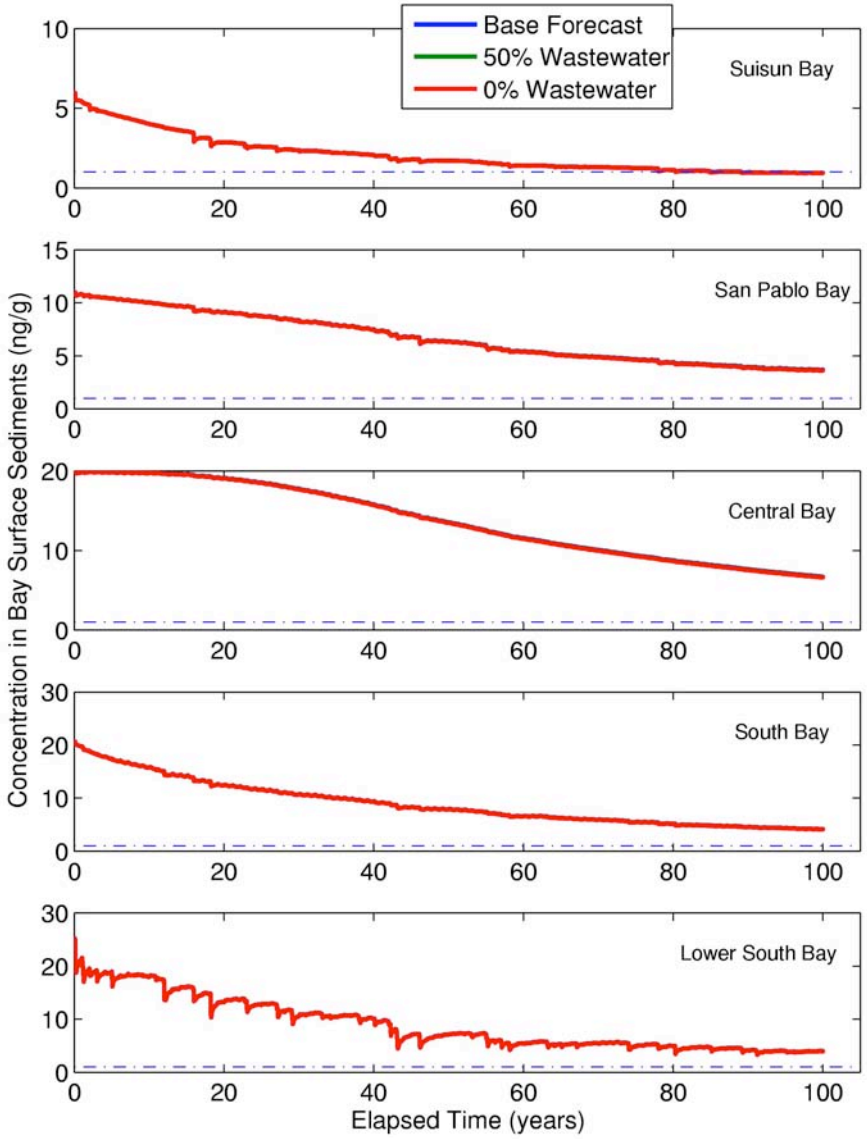
Tributary Loading Scenarios



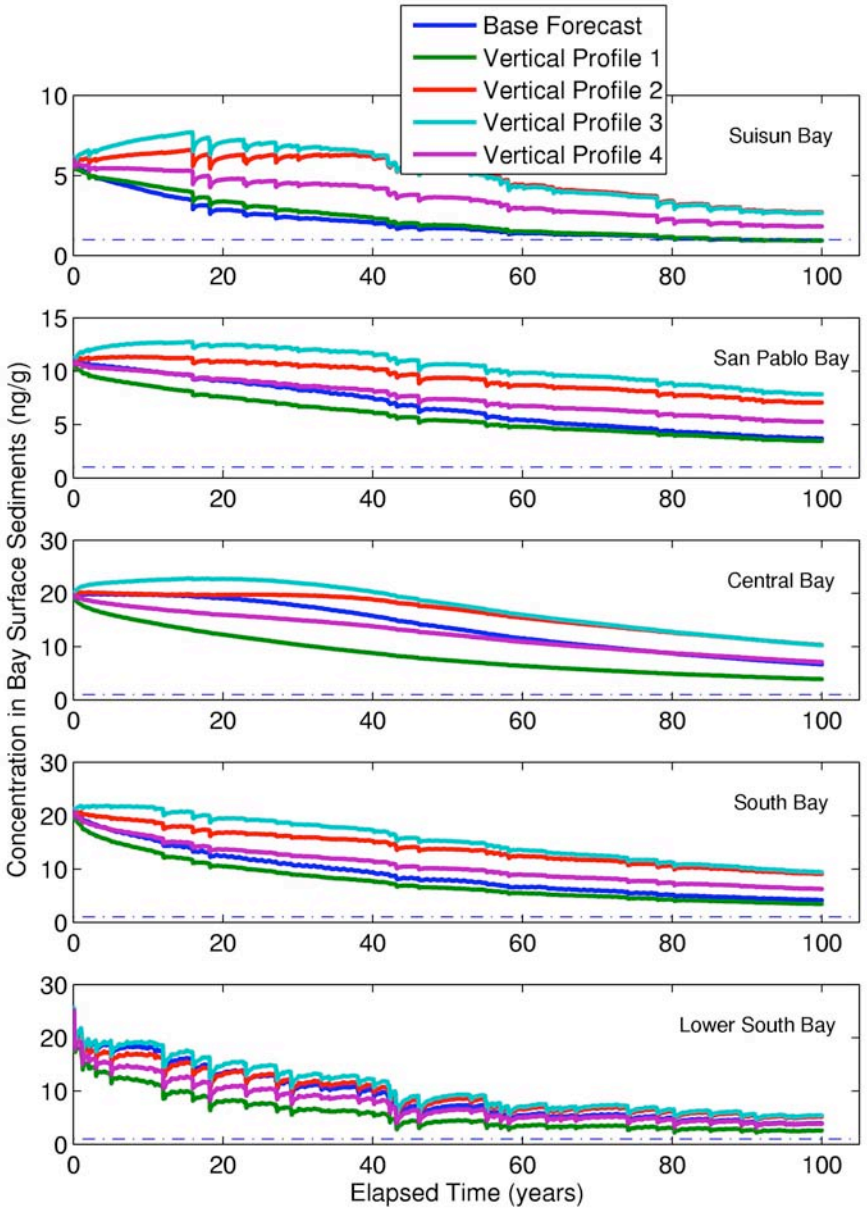
Vertical Profiles



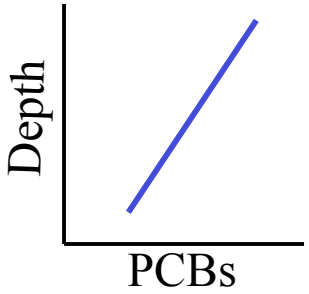
Wastewater Loading Scenarios

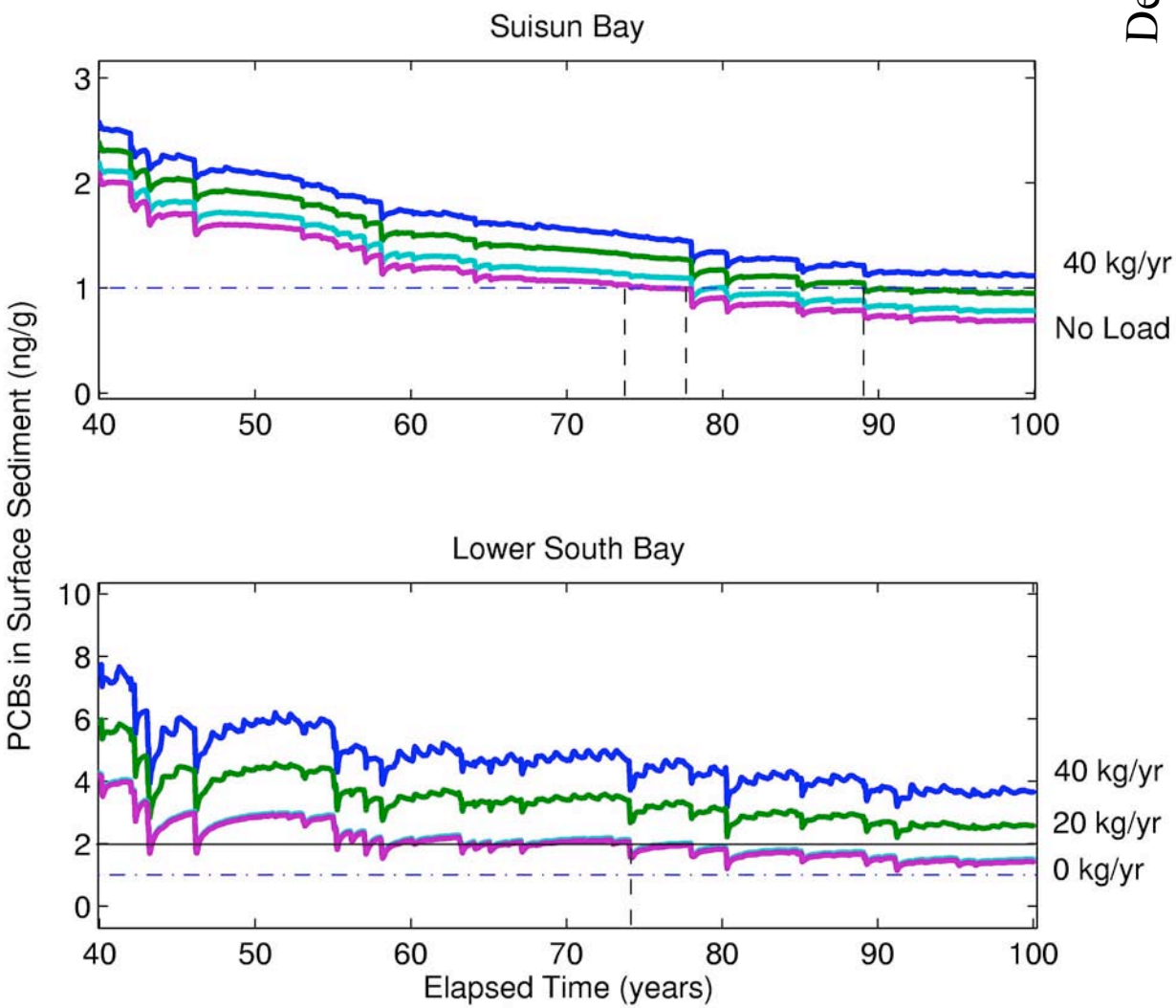


Vertical Profiles



What Management Options Affect Recovery?





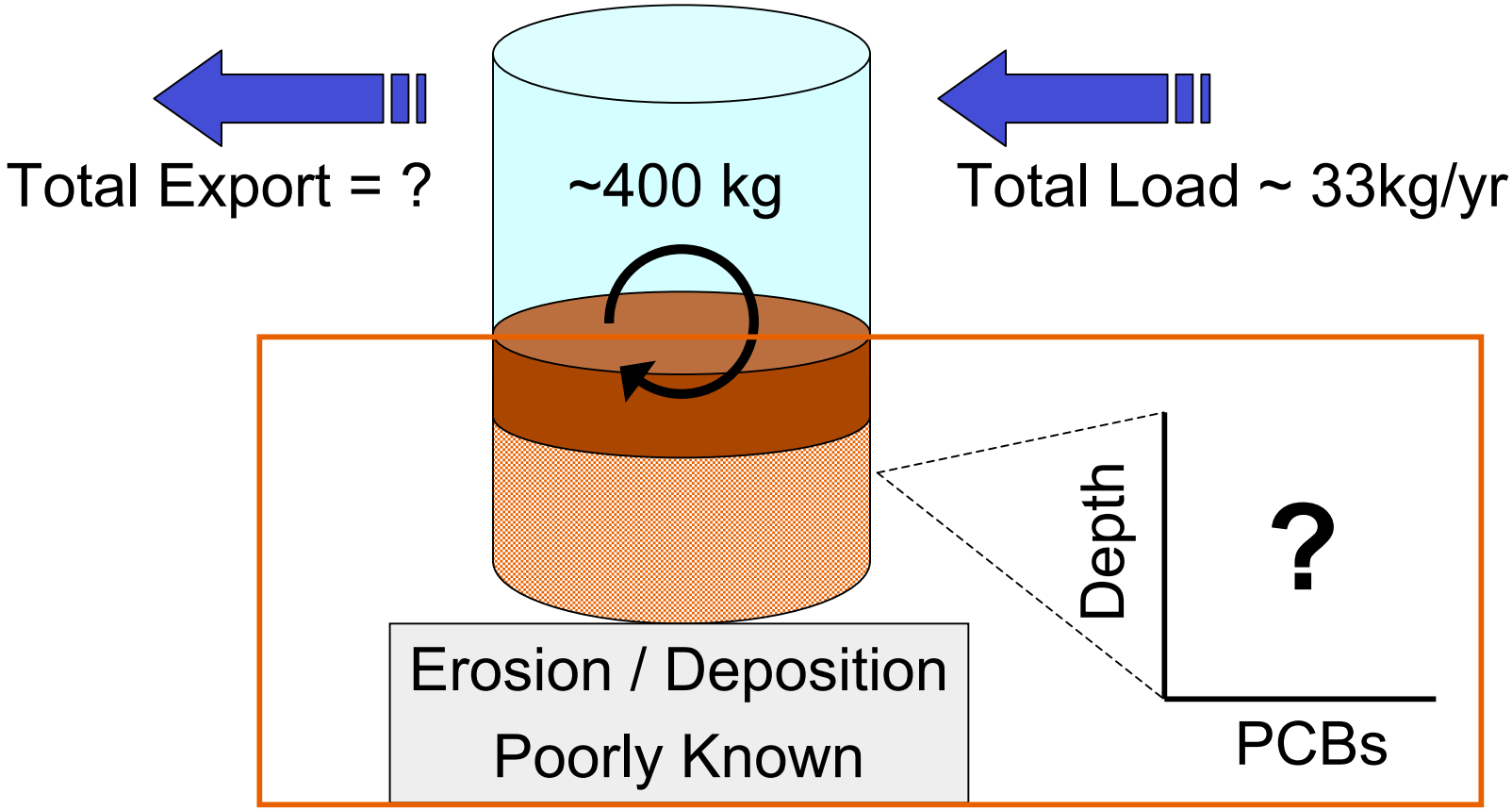
Confidence in Model Estimates Bolstered by:

- Peer review
- Comparison to observations
  - Ability to reproduce spatial patterns and depth of maximum concentration
- Scenario testing
  - Pulse loads and extreme Delta loads
- Uncertainty and Sensitivity Analyses
- Independent testing by Tetra Tech
- Multiple iterations / Collaborative development

Summary of Forecast Findings

- Anticipate slow recovery of Bay
  - Northern reach faster than southern
- Effectiveness of management actions depends on PCB profile in sediments, degradation, and attenuation

Conceptual Model*

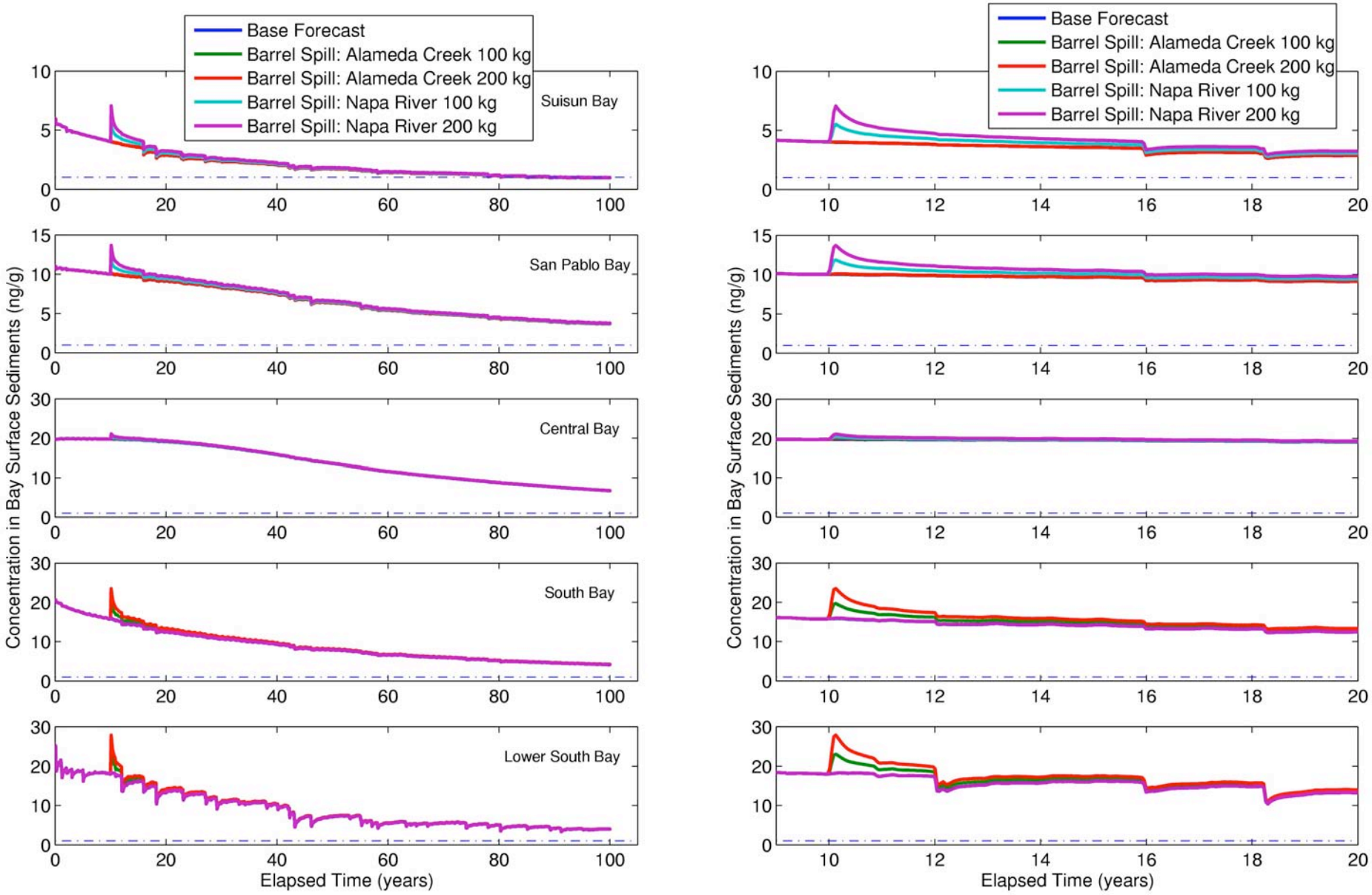


* Based on 2002-2006 RMP data

Next Steps

- Reporting / Publishing
- Sediment coring pilot study
  - Incorporate results of sediment cores and re-calibrate model as needed
  - Analyze wetland cores to estimate loading history and attenuation
- CFWG Guidance
  - Consider multiple contaminants
  - Look towards future models

Barrel Spills



Sedimentation