The Delta doughnut: a persistent pattern for methylmercury metrics

Lisamarie Windham-Myers, Jacob Fleck, Lisa Lucas, James Bishop, Robin Stewart, Rosanne Martyr, and Mark Marvin-DiPasquale

USGS science for a changing world

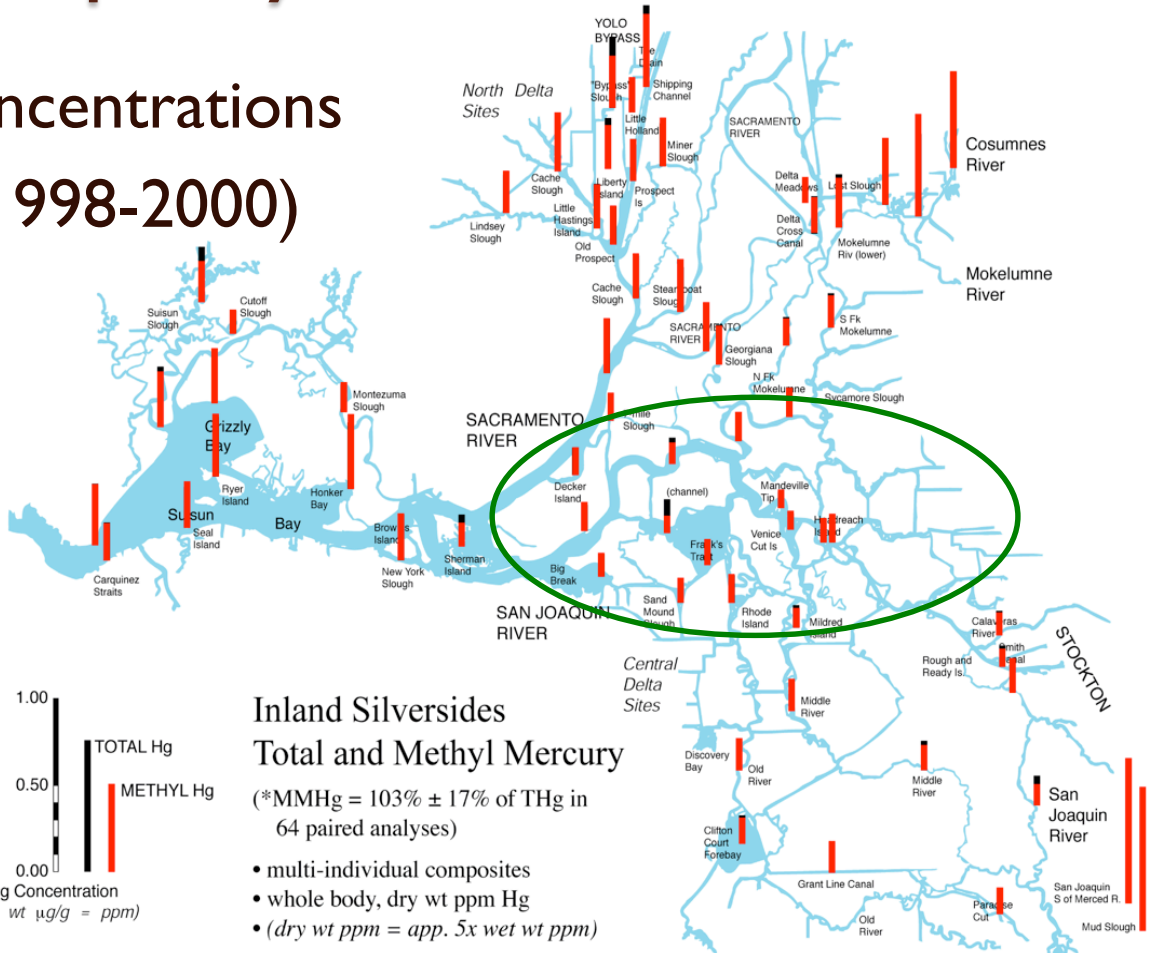
California Bay-Delta Science Conference, November 17, 2016

Acknowledgements: CASCaDE project (e.g. Mick Vanderwegen, Julia Vroom, DELFT-3D), and many SFB-Delta colleagues and data sources

UNESCO-IHE Institute for Water Education · SF State · Sacramento State · Delta Stewardship Council · SDSC San Diego Supercomputer Center UCSD · Deltares Enabling Delta Life

Elevated periphery v. lower center

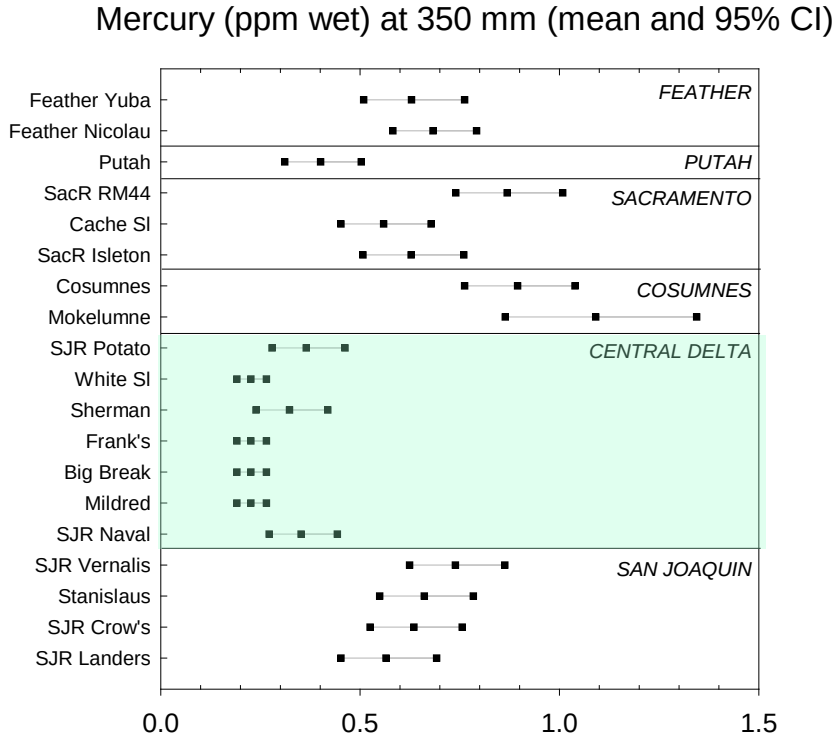
- Silverside Hg concentrations
  Darell Slotton (1998-2000)



USGS
science for a changing world

Elevated periphery v. lower center

Jay Davis, SFEI
RMP largemouth bass (LMB)
San Francisco Bay-Delta



USGS science for a changing world

MeHg: TMDL Relationship between aqueous and LMB

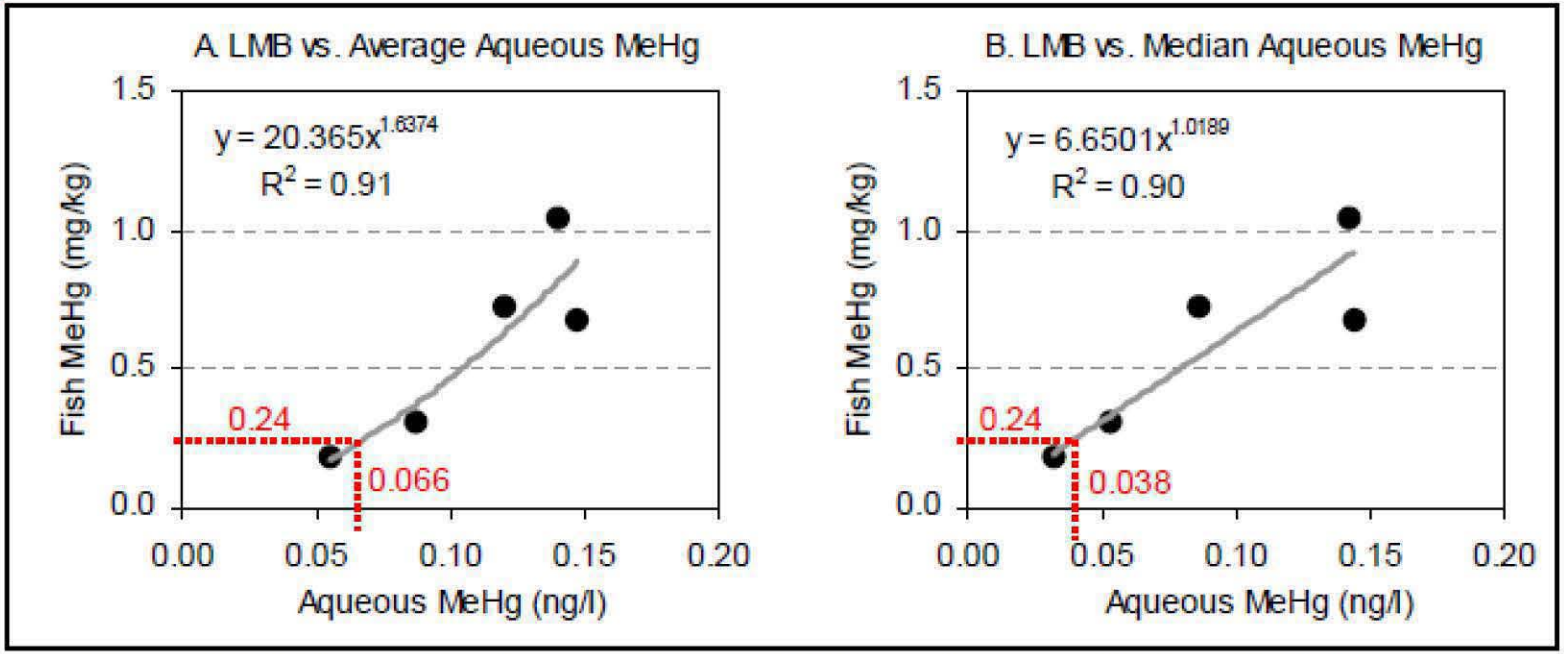
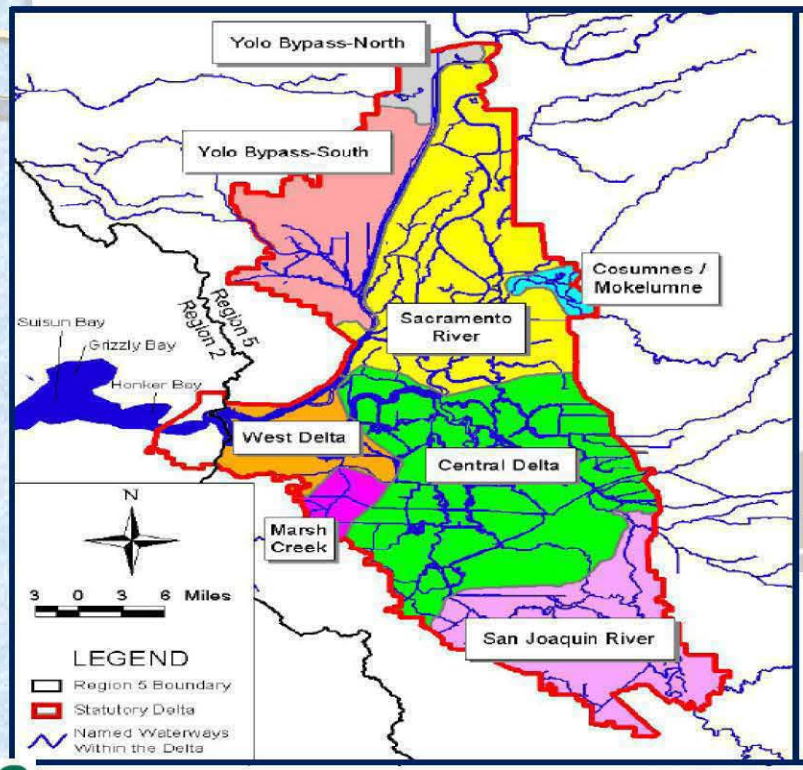
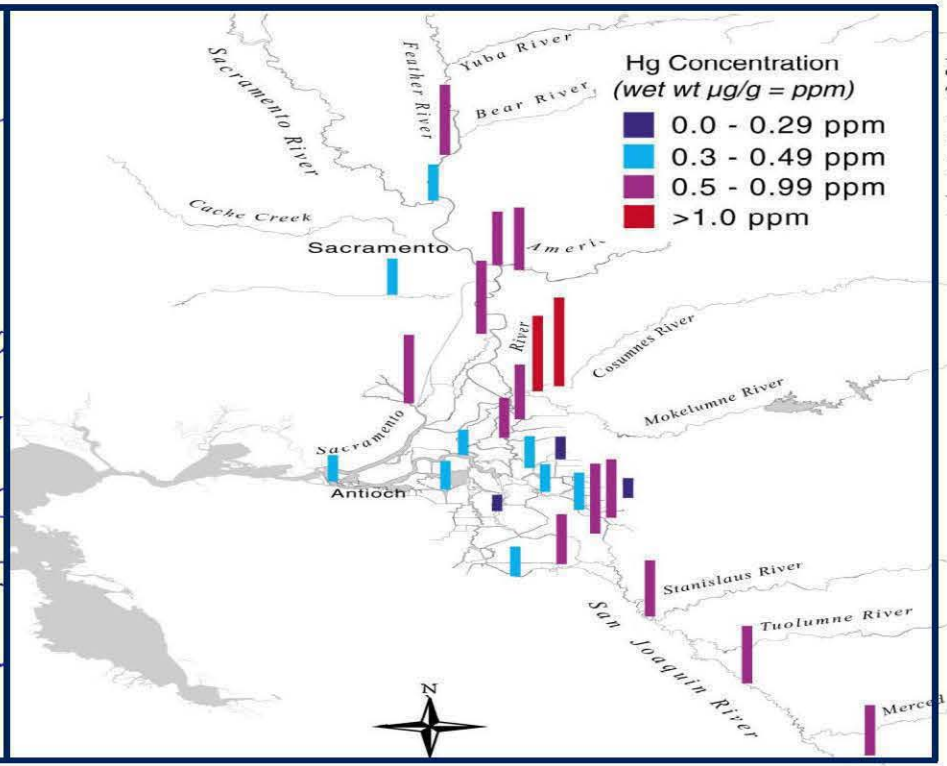


Figure 5.2: Relationships between Standard 350-mm Largemouth Bass Methylmercury and March to October 2000 Unfiltered Aqueous Methylmercury.
The proposed implementation goal for standard 350-mm largemouth bass is 0.24 mg/kg.

USGS science for a changing world

Delta sub-basin mean aqueous [MeHg] & LMB [Hg]





Aqueous MeHg in ng/L, CVRWQCB, 2005

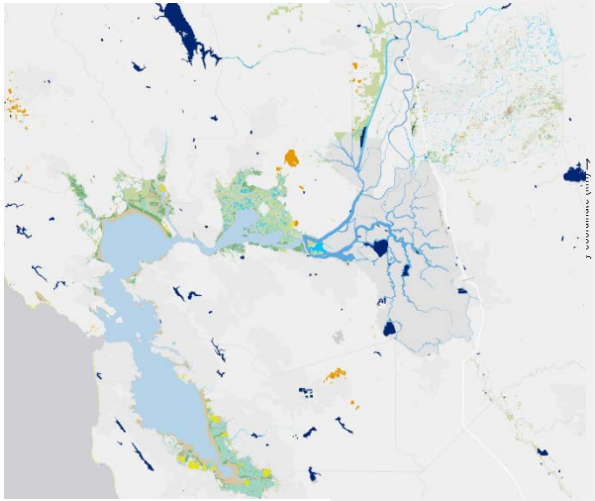
Largemouth Bass THg (ppm), Darell Slotton, 2000

USGS science for a changing world

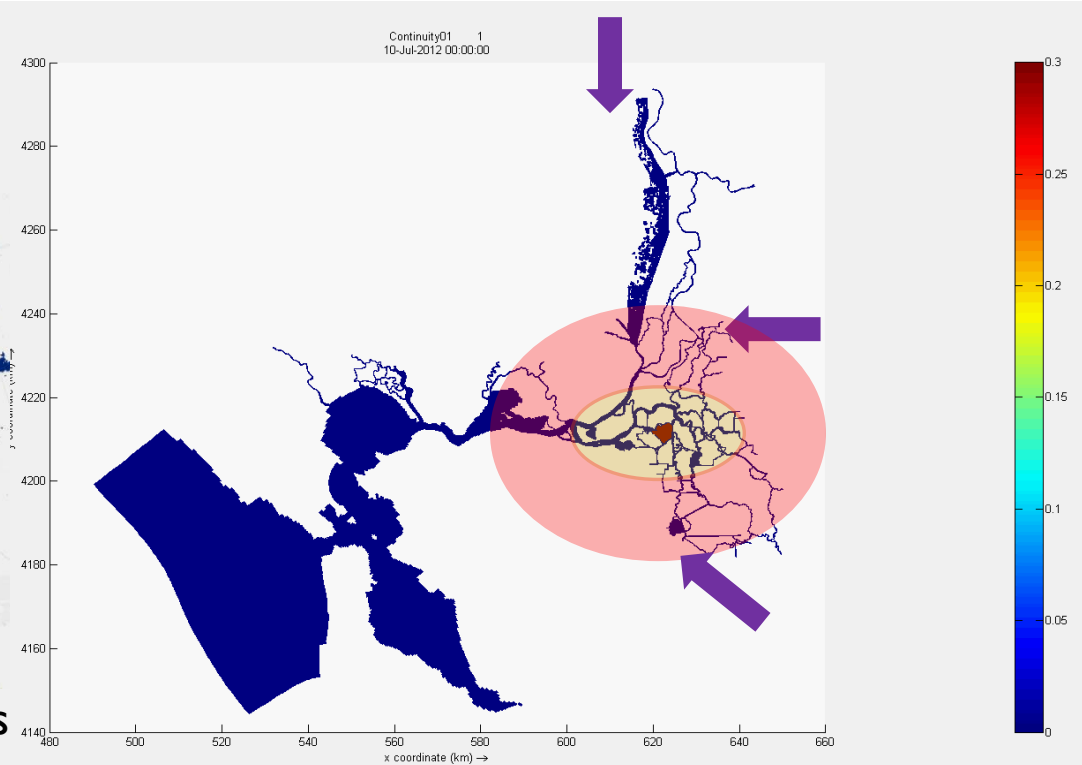
MeHg: Why is the center "low" and the periphery "high"?

- Transport: Flushing
- Transport: Delivery/sources
- Production
- Loss

CASCaDE hydrodynamic tracer example



Wetlands, 2016, SFEI Eco Atlas



USGS science for a changing world

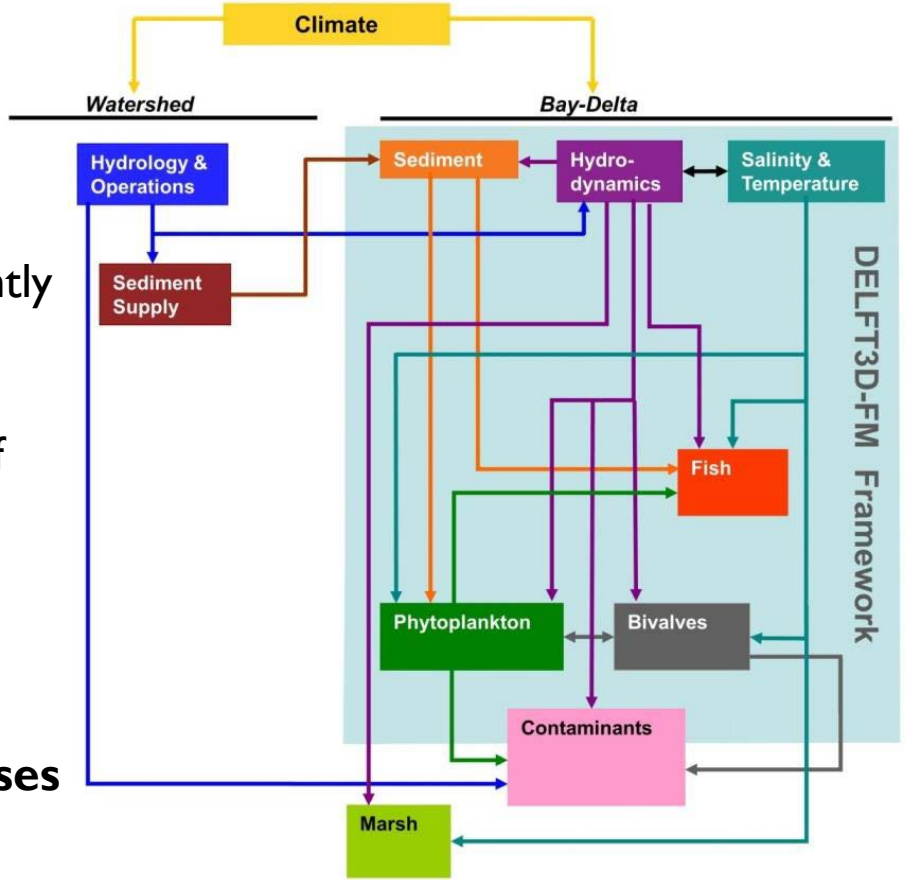
CASCaDE Project: www.cascade.wr.usgs.gov

1. Not a single model but 12 models
2. Hydrodynamic model feeds into DELWAQ (water quality model)
3. CASCaDE products do not currently include Hg or MeHg

These runs are an early exploration of **transport effects only** on MeHg

- Delivery (sources)
- Flushing (advective and dispersive)

No MeHg production/loss processes involved in current simulations.

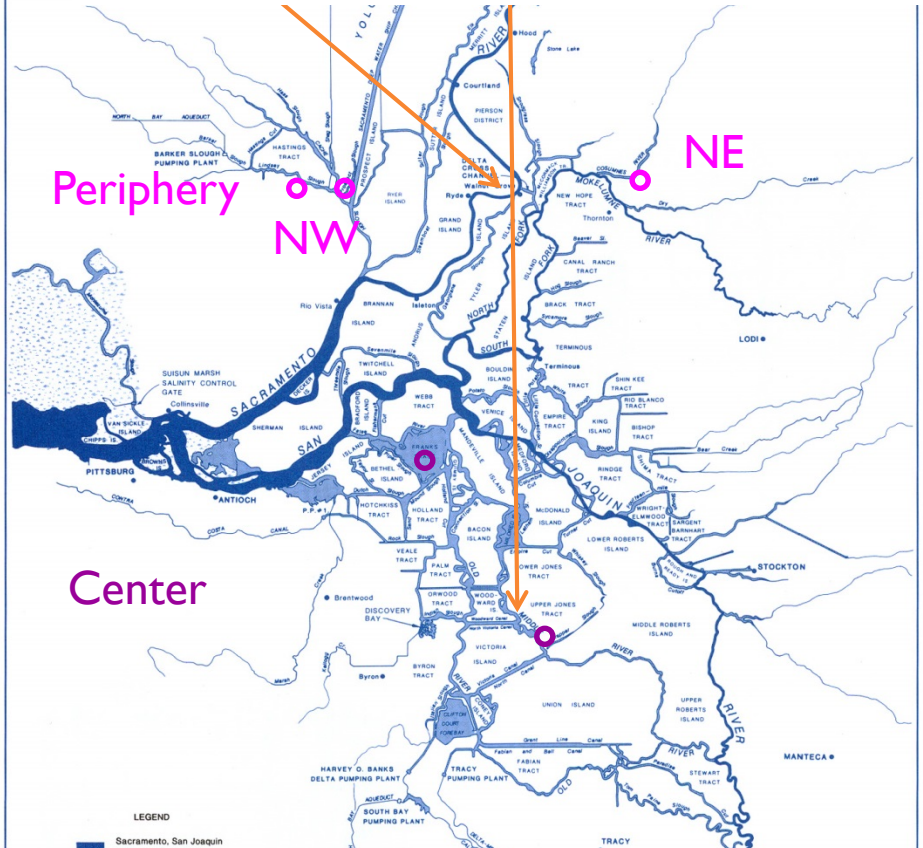


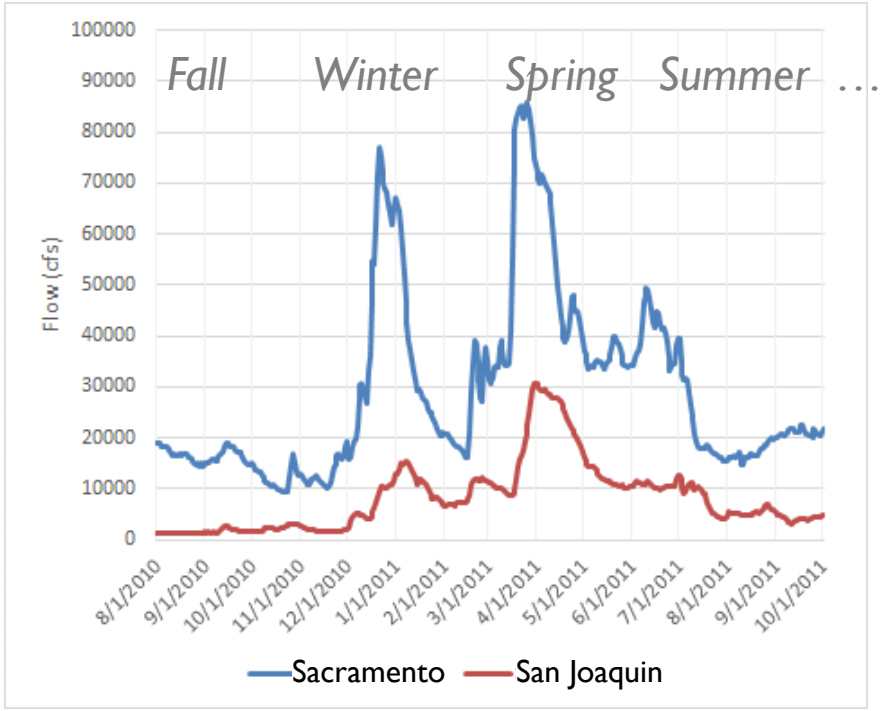
USGS science for a changing world

MeHg: Does transport alone make a doughnut?

Assumptions: boundaries, single annual concentrations, initial condition = 0.06 ng MeHg L^{-1}

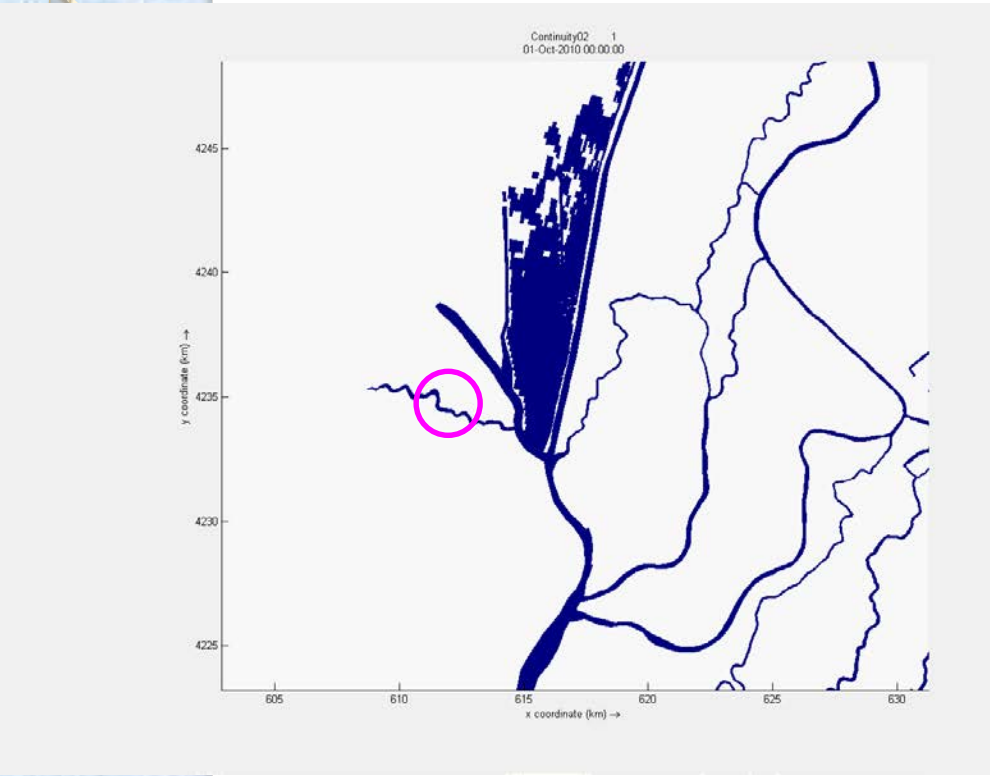
Things to look for: importance of flows, operations (cross-channel, barriers), tidal action

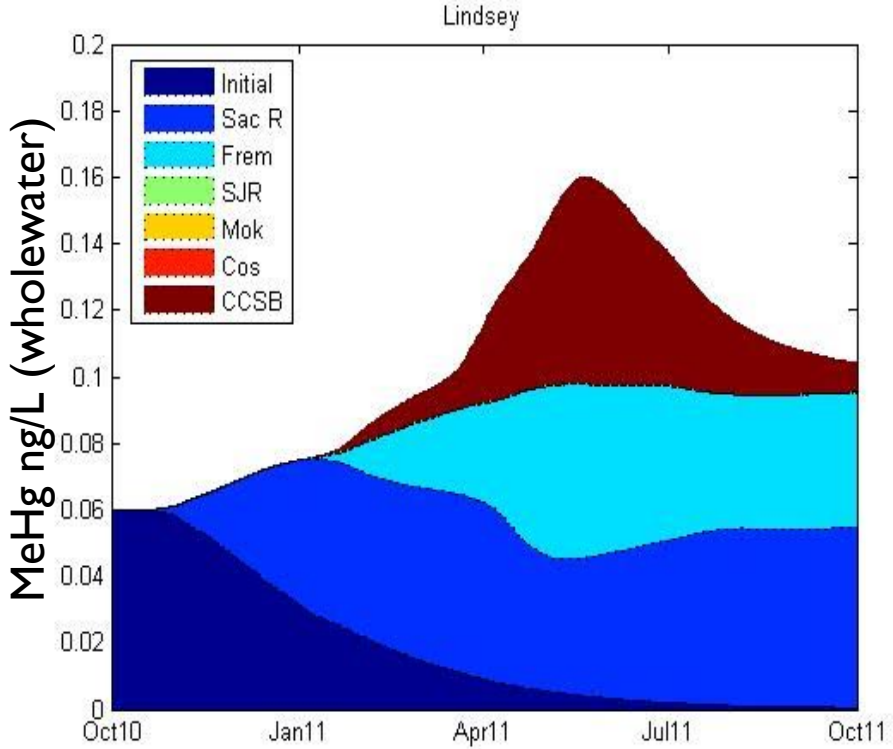




MeHg: Does transport alone make a doughnut?

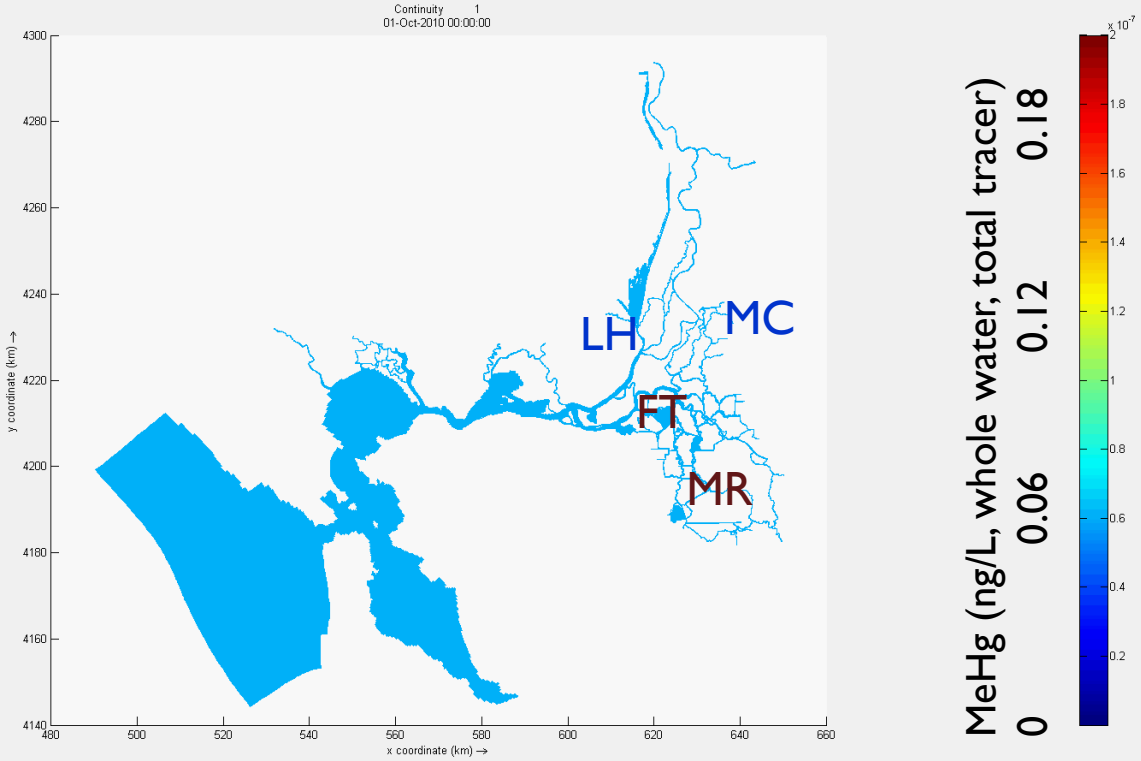
EXAMPLE: Sacramento as a MeHg source to Lindsay Slough





USGS science for a changing world

MeHg: Does transport alone make a doughnut?

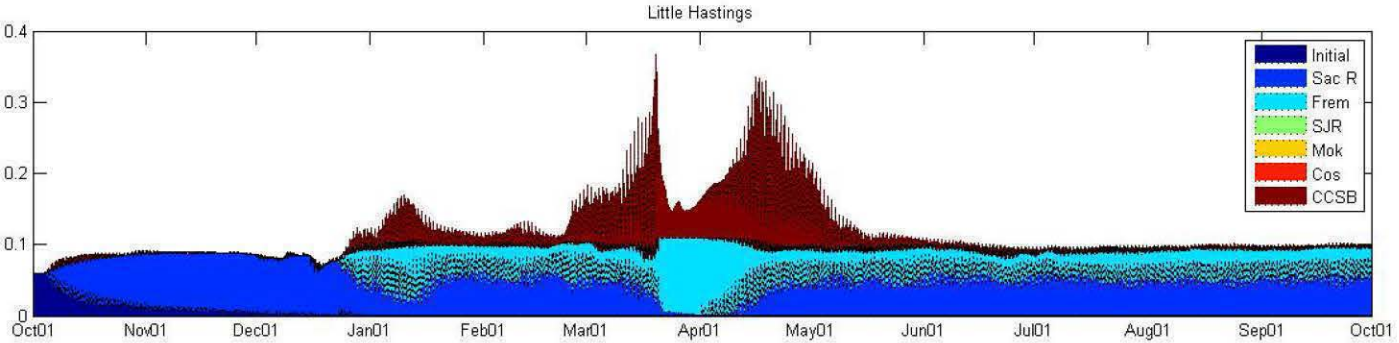


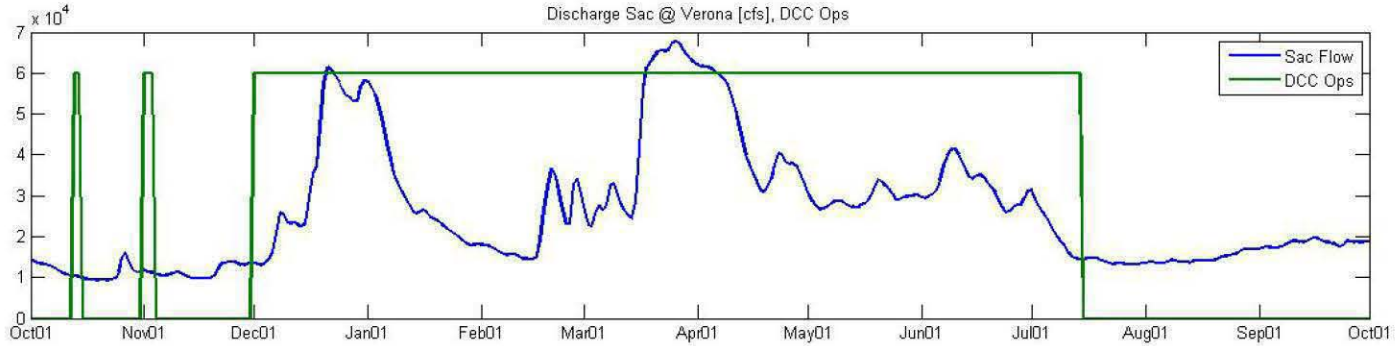
October 2010- September 2011

USGS science for a changing world

Timing and sources: Northwest periphery

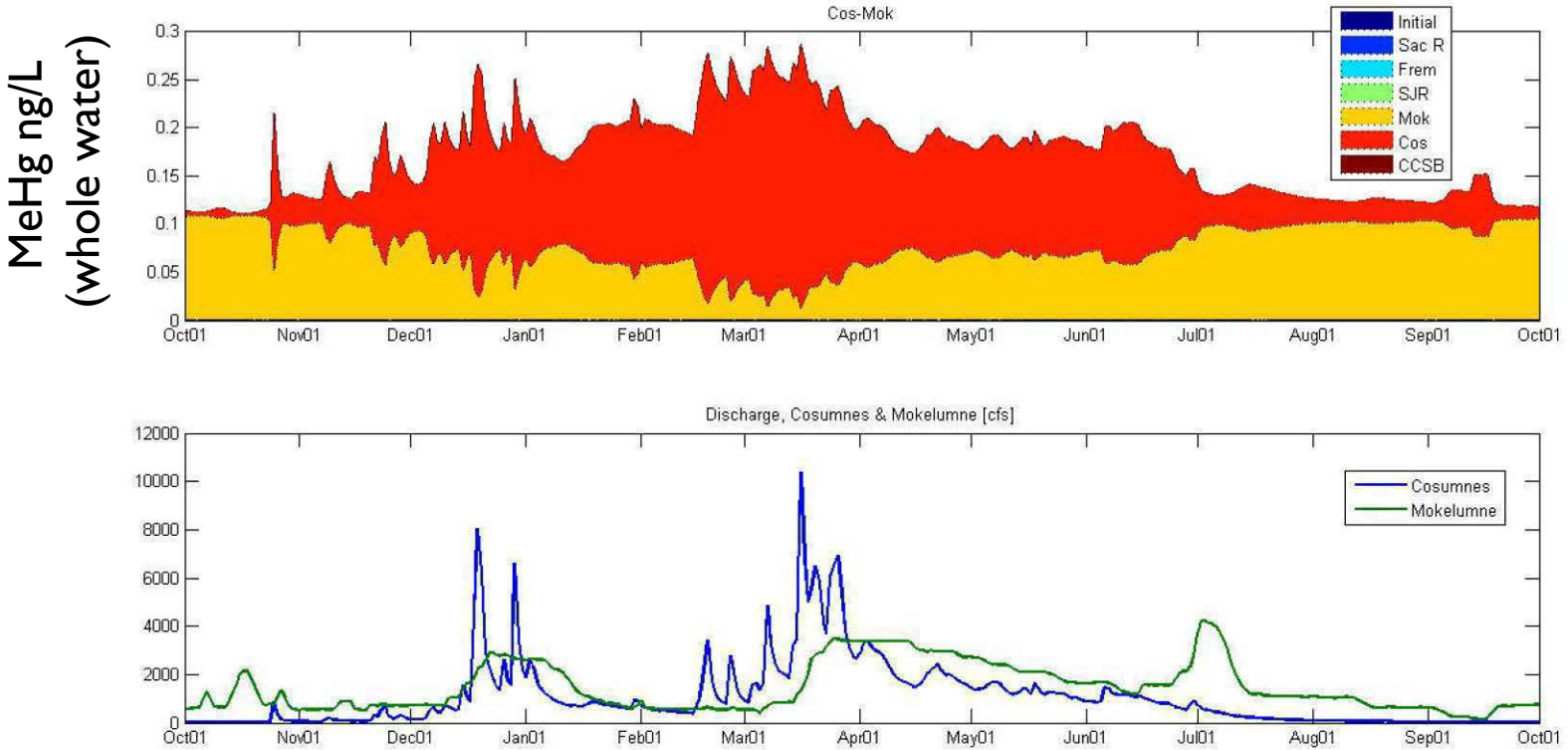
MeHg ng/L (whole water)





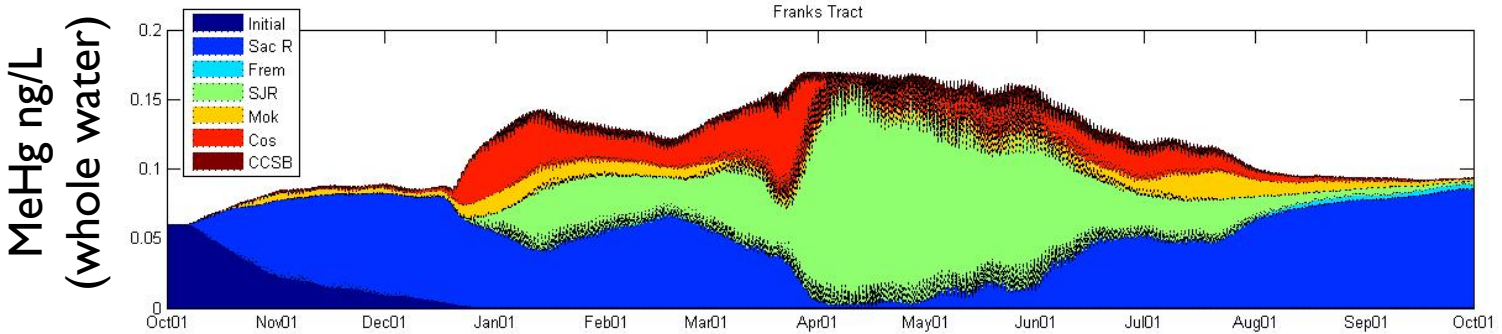
USGS science for a changing world

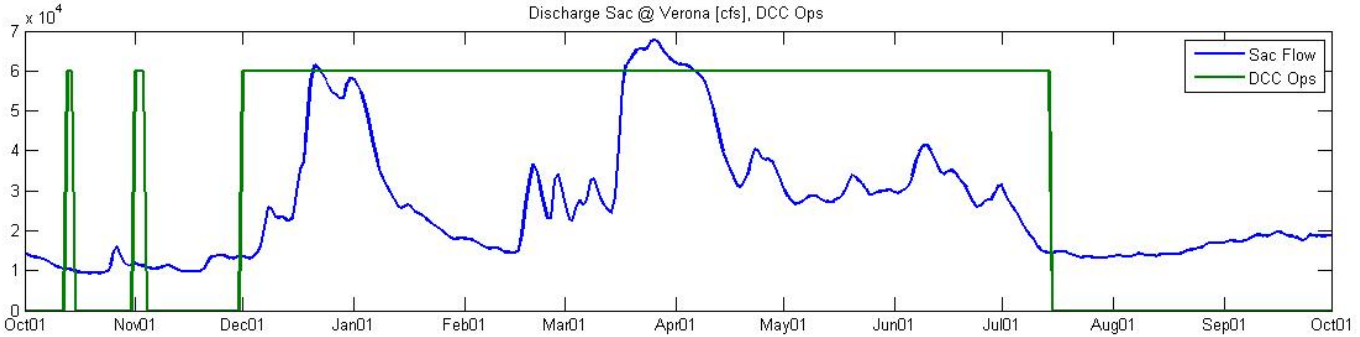
Timing and sources: Northeast periphery



USGS
science for a changing world

Timing and sources: Central Delta

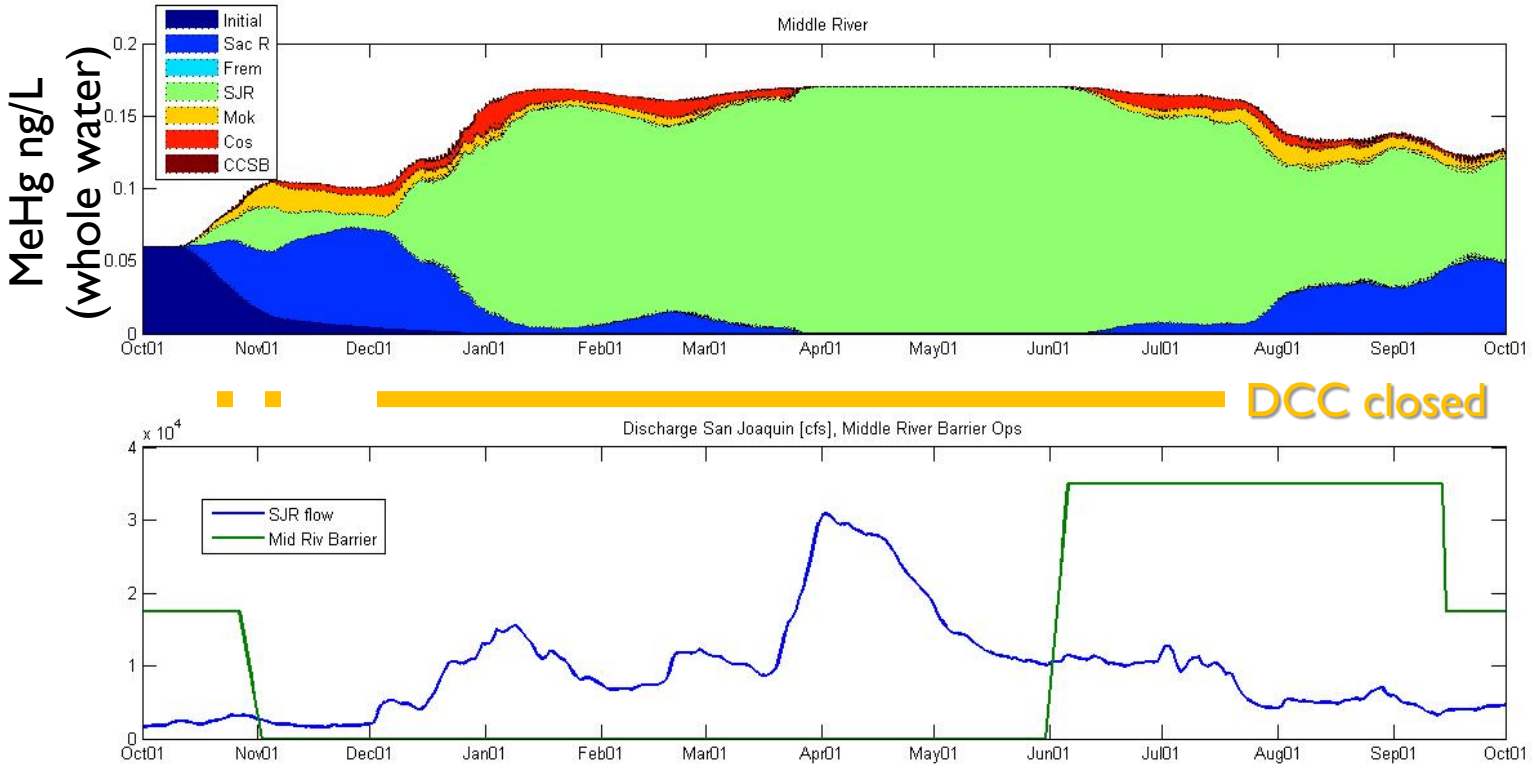




DCC closed

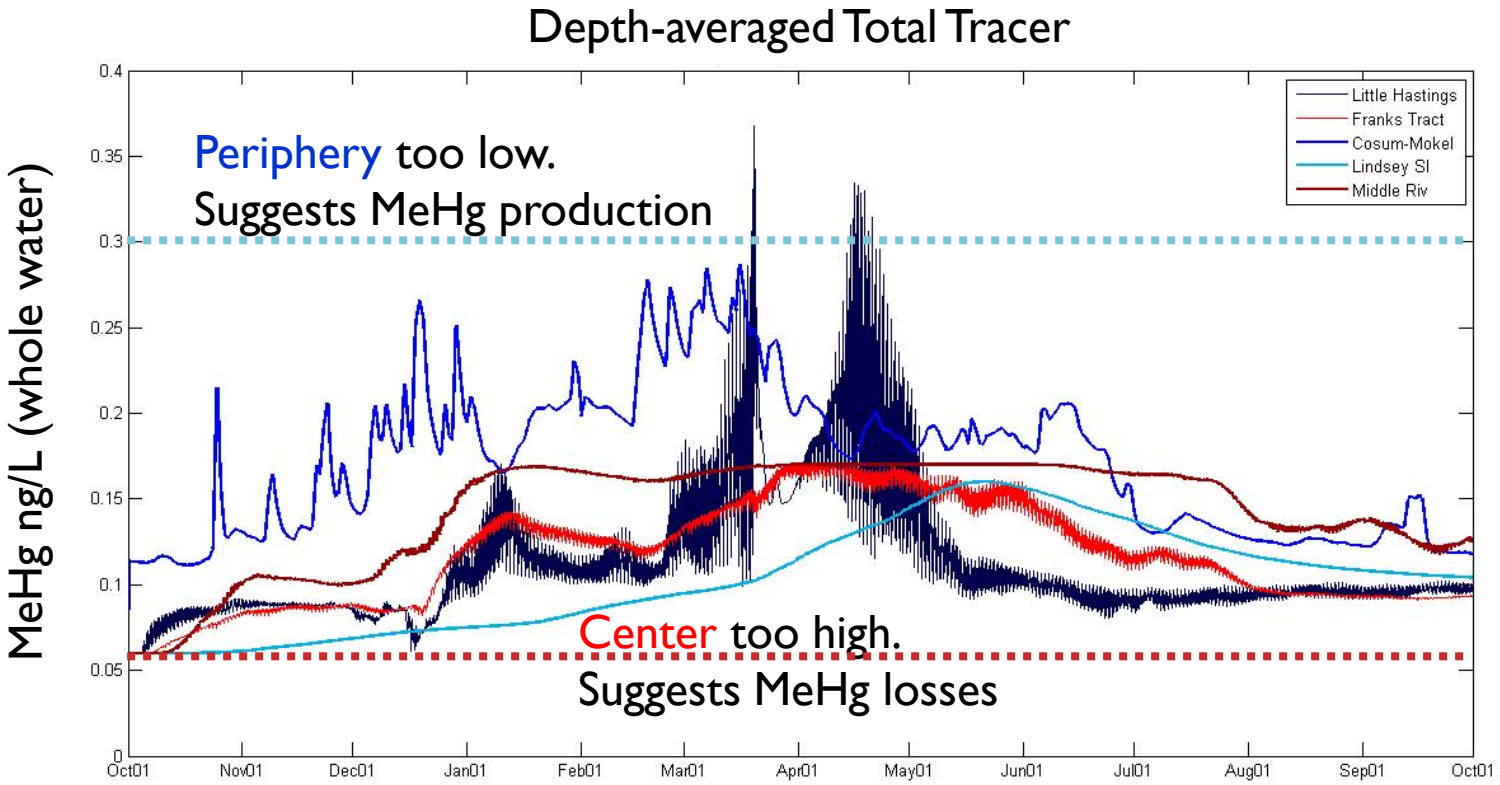
USGS
science for a changing world

Timing and sources: South Central Delta



USGS science for a changing world

Periphery vs. Central Delta



USGS
science for a changing world

Next steps: refine runs and include partitioning (filtered v particulate MeHg monitoring data)

- Better boundary conditions
(American River, Cache Creek, more?)
- Realistic time-series for source [MeHg]
- Multi-month spin-up vs. IC=0.06
- Test companion model on suspended sediment for particulate MeHg dynamics

Achete et al. Hydr. Earth Sys. Sci. 2015

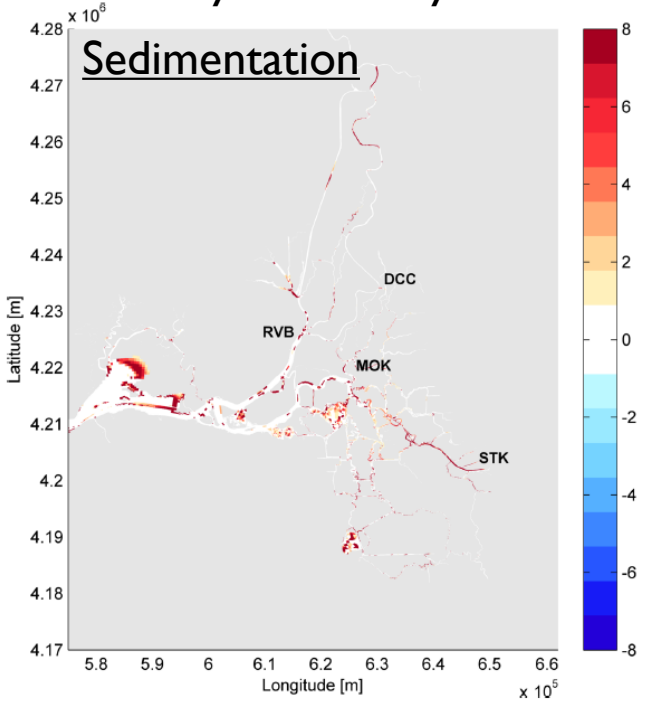
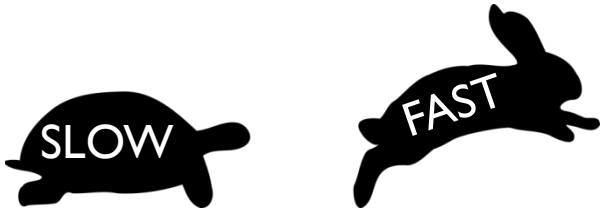


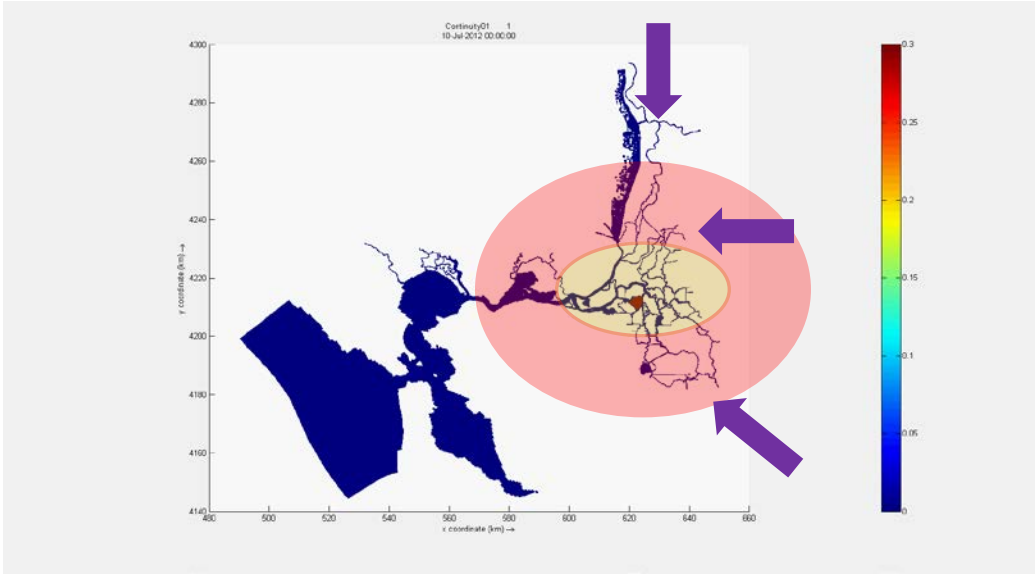
Figure 11. Modeled deposition in millimeters for 1 year period.

USGS science for a changing world

Transport alone did not make persistent doughnut. Incorporating rates of additional processes is suggested.



- Transport: Flushing
- Transport: Delivery
- Production
- Loss



USGS
science for a changing world

Conclusion: close to finding the nature of the doughnut

and how persistent it actually is!

Thank you for your interest.
Questions for the team?

USGS
science for a changing world