# Make Connections while Making Models

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### **Acknowledgements**



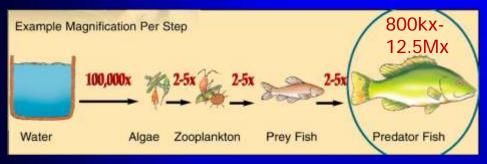
- Carol DiGiorgio
- Dave Bosworth
- Tara Smith
- Nicky Sandhu
- En-Ching Hsu
- Hari Rajbhandari



- Reed Harris
- Dave Hutchison
- Cody Beals

## Why is Mercury an Issue in the Delta?

 Small amounts of Hg in water can lead to a lot of Hg in fish

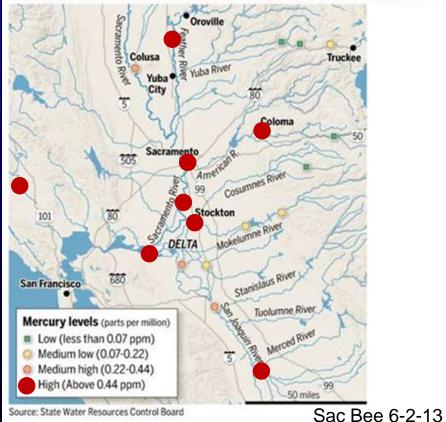


- Eating fish with high mercury concentrations can harm
  - nervous system, brain, heart, kidneys, lungs
  - pregnant women and children are most vulnerable

#### Delta sports fishes have high mercury levels

#### MERCURY CONCENTRATIONS

High levels of methylmercury in sport fish were found in eight locations statewide – seven of which were in the Delta or its tributaries. The survey measured 63 sites statewide.

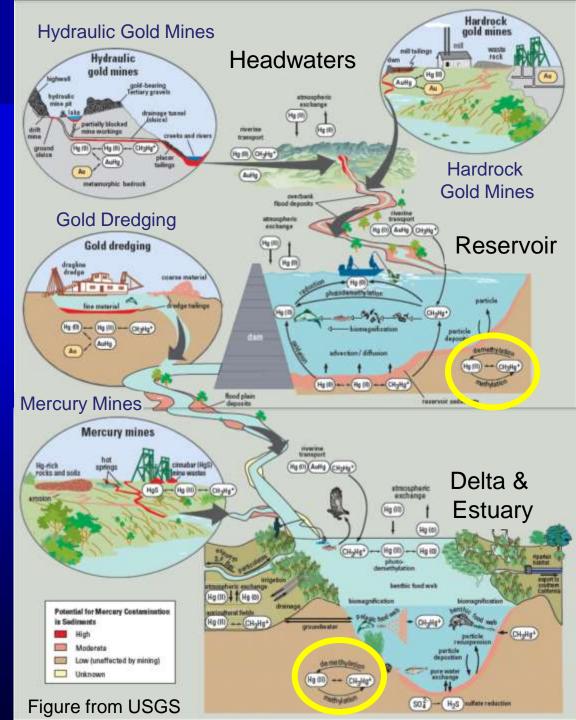


# Where does Delta mercury come from?

- Upstream sources
  - Historic mining
  - Natural deposits
- In Delta production
- Atmospheric deposition
- Storm water runoff
- Wastewater discharge

#### What is methylation?

- Anaerobic organisms convert inorganic Hg to organic methyl mercury (MeHg or CH<sub>3</sub>Hg<sup>+</sup>)
- MeHg can be consumed by organisms and it remains in their tissues



## Mercury Cycling

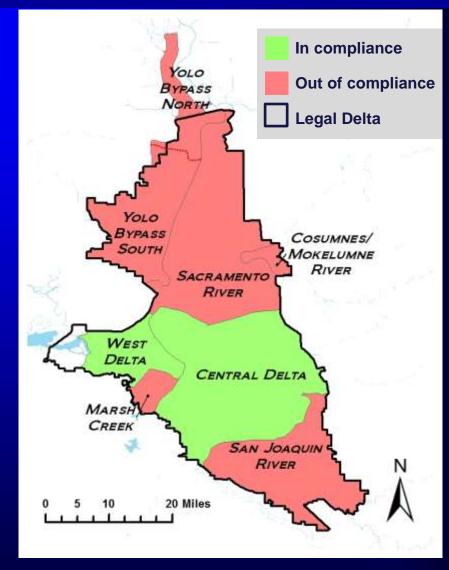
				Rxn No.	Conditions Favoring Reaction
	+ 2H5"	<u>← R</u>	Hg(SH) <sup>*</sup> <sub>2</sub>	(1)	Reducing Conditions/Low Sulfide (e.g., Anoxic Hypolimnion)
Hg <sup>2+</sup>	+ 2e*	R R	Hg°	(2)	Mildly Reducing Conditions - Highly Volatile Product
	► + R		R:Hg	(3)	High DOC Waters (e.g., Bog Systems)
	+ R-SH		R-SH:Hg	(4)	Association with Biomass
	+ A Mineral Colloid	←	Hg: 🎝	(5)	High Suspended Solids Circumneutral and Greater pH
	+ + - +	<del></del>	eH:	(6)	Association with Biomass
	+Hg*	▲ R	Hg <sub>2</sub> <sup>2+</sup>	(7)	Presence of Elemental Hg
	+ 20H"	<u> </u>	Hg(OH) <sup>°</sup> <sub>2</sub>	(8)	Circumneutral and Higher pH
Rate-limited	► +xCl*	<del>```</del>	HgCl <sup>(2-x)</sup>	(9)	Lower pH and Even Small Amounts of CI <sup></sup>
Reaction which quickly comes to equilibrium	+ 2CH <sub>3</sub> .	R R	CH3HgCH3	(10)	Moderately Reducing Conditions, Higher pH (Ocean Waters) - Highly Volatile Product
to equilibrium	► + CH <sub>3</sub> .	<b>→</b> R →	CH <sub>3</sub> Hg <sup>+</sup>	(11)	Moderately Reducing Conditions - Moderately Volatile Product

Tetra Tech - Mercury in the Environment

Slide from Marc Buetel WSU

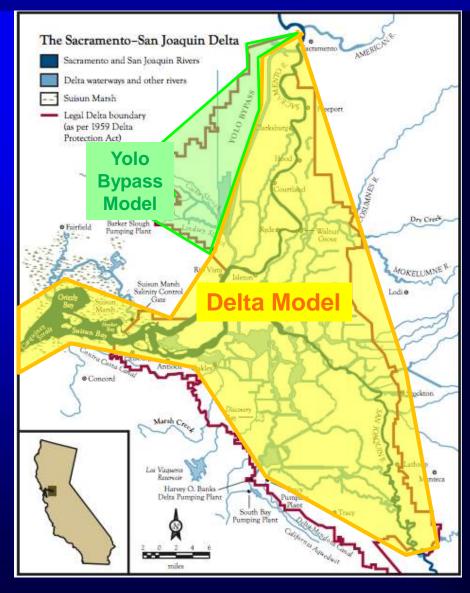
#### Delta Mercury Total Maximum Daily Load (TMDL)

- 1990 Sacramento-SJ Delta listed as impaired for fish consumption due to mercury [Clean Water Act 303 (d) list]
- 2010 Regional Water Quality Control Board adopted amendments to the Sacramento River and San Joaquin River Basin Plan to establish the Delta Mercury Control Program which establish Total Maximum Daily Loads (TMDL) for mercury in the Delta
- 2011 US EPA approved the TMDL and DWR is required to comply with the TMDL

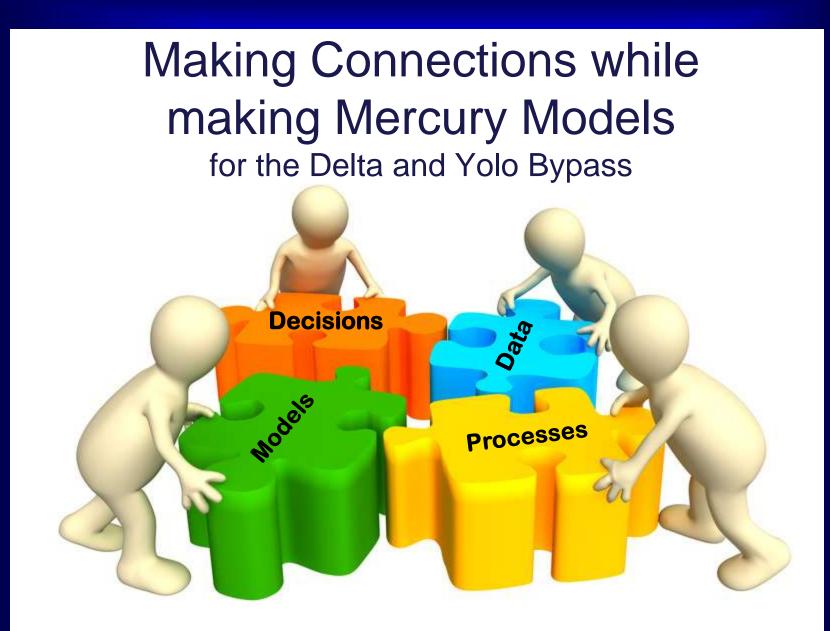


## Modeling Objectives to Support Hg TMDL

- Two models are being developed
  - Yolo Bypass
    Tuflow + D-MCM
  - Delta Open Waters
    DSM2 + D-MCM
- Goal: assess impacts of current & proposed operational changes on mercury methylation potential
  - Flood conveyance
  - Water management



Making a Model is an Opportunity to Make Connections











#### Connecting early on will have the greatest potential impact on the model development



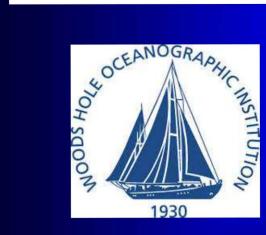






















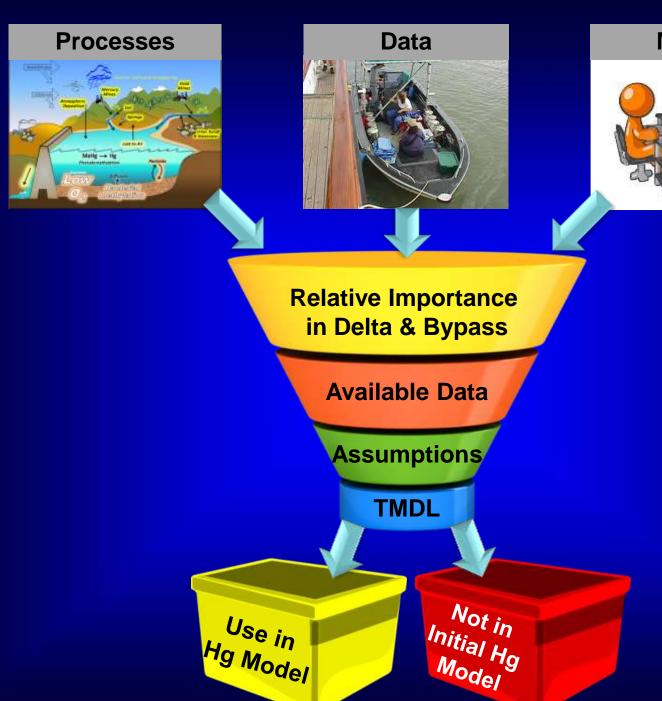
**Delta Regional Monitoring Program** 

### Drinking from the fire hydrant



## Models help us organize our thoughts

-Eli Ateljevich DWR Delta Modeling



#### Models

## Models only include connections that we put in them

Processes & Connections

are specified in a model

Processes not in the model

16

# Though Delta Transport and Deposition are the major sources/sinks of Delta MeHg

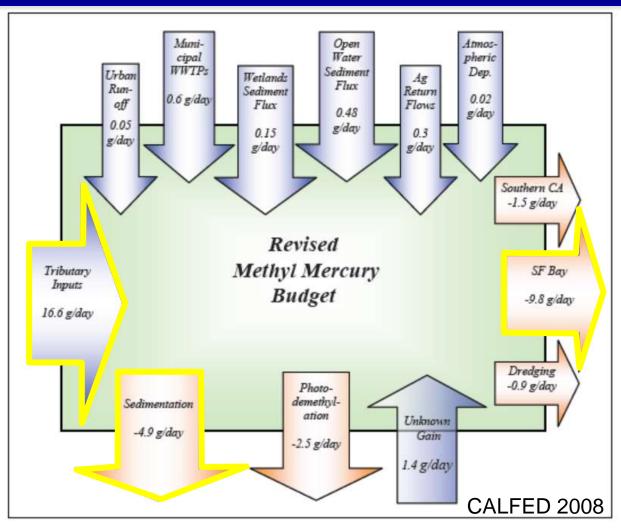


Figure 9. Revised methyl mercury mass balance model for the Delta. The revised model incorporates both some new rates for previously measured terms (tributary inputs and exports to southern California and San Francisco Bay) and rates for two previously unmeasured processes, (photo demethylation and sedimentation).

### Future DSM2 with Sediment & Mercury

#### **HYDRO**

Hydrodynamics Model 1-D flow, velocity, & water levels

GTM General Transport Model

New & improved water quality model Salinity, DO, etc

Designed to connect with other processes Sediment Transport Suspended sediment in the water column (sand, clay, organics)

**Bed load** 

Mercury Cycling Mercury transport dissolved in water and on sediments, reactions including methylation, and dispersion

Sediment Bed Deposition (settling), Erosion (re-suspension) Anoxic conditions, MeHg production Exchange MeHg with water column **PTM** Particle Tracking Model

Qualsi-3D transport of neutrally buoyant particles

#### Modules to be created for Delta mercury modeling project

### **Take Home Points**

- Creating a model is an opportunity to build connections, especially early on
- Models can help us organize our thoughts
- Models only include processes & connections that we put in them
- CALL ME with ideas or data for Hg modeling



# Thank You!

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