The Contribution of Sacramento Valley Rice Systems to Methylmercury in the Sacramento River

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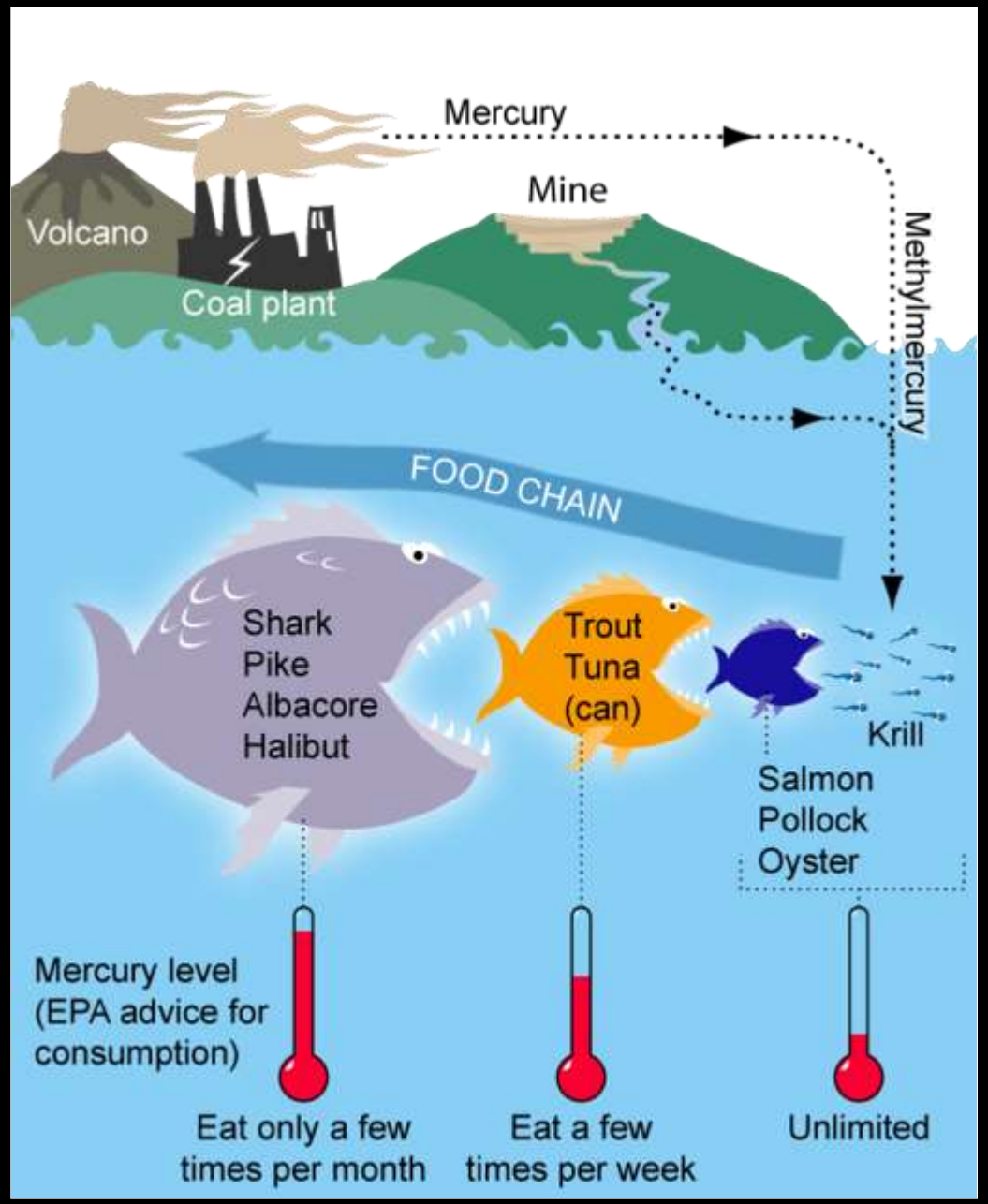
Introduction

- Methylmercury (MeHg) is toxic and bioaccumulative
- Total Maximum Daily Load (TMDL)
  - 0.06 ng/L goal
- Produced in flooded soils
- 200,000 Ha of paddy rice in the Sacramento Valley



Objectives and Hypothesis

- Gather data from previous studies of MeHg concentrations
- Assess spatial and temporal patterns in MeHg concentration
  - Seasonal patterns?
  - Differences between the Sacramento and Feather Rivers?
- Hypothesis: Rice drainage waters are an important source of MeHg to the Sacramento River
  - Are MeHg concentrations higher in ag drainage canals?
  - What is the MeHg load from agricultural drainages?

Outline

- Methods and overview of the dataset
- Results
  - Temporal patterns
  - Spatial patterns
  - Loads from agricultural drainages
- Conclusions

Ten years of Data Available

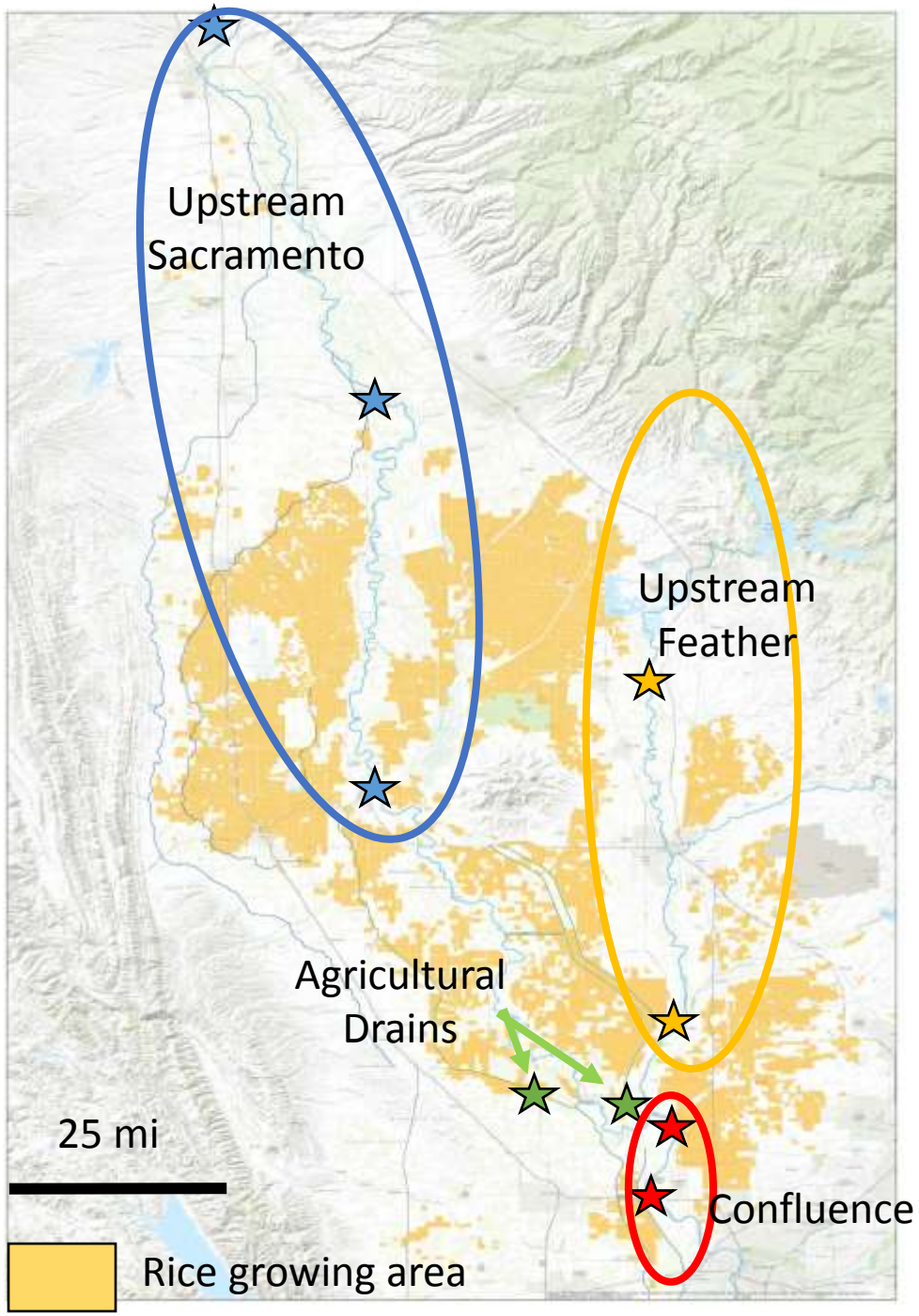
Program	Sampling period 1996-2007	# of sites	# of samples/site
USGS National Water Quality Assessment	2.5 years	5	23-29
Sacramento River Watershed Program	3.5 years	10	14-18
	<1 year	8	4
	1.5 years	12	17-18
CALFED Bay-Delta Program	3.5 years	16	23-31

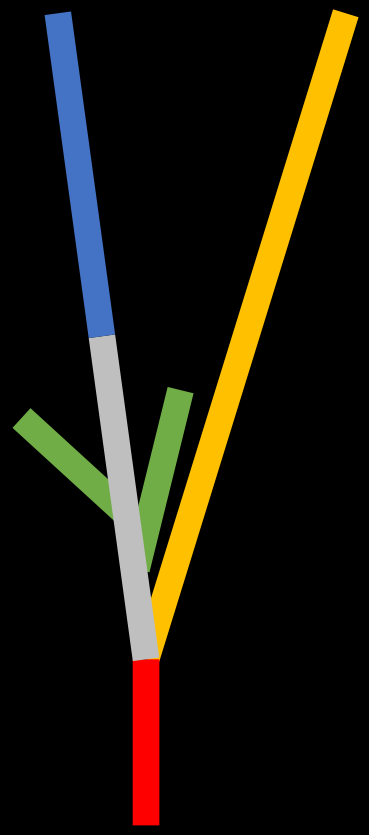
Selected most relevant sites

- Location with respect to rice
- Data availability

Only three sites sampled in all studies

Confluence sites sampled in one study each





Methods

- Un-balanced data set
  - Not all sites sampled in all years

- Mixed effects model
  - Random effects: site and year
  - Fixed effects: location and season

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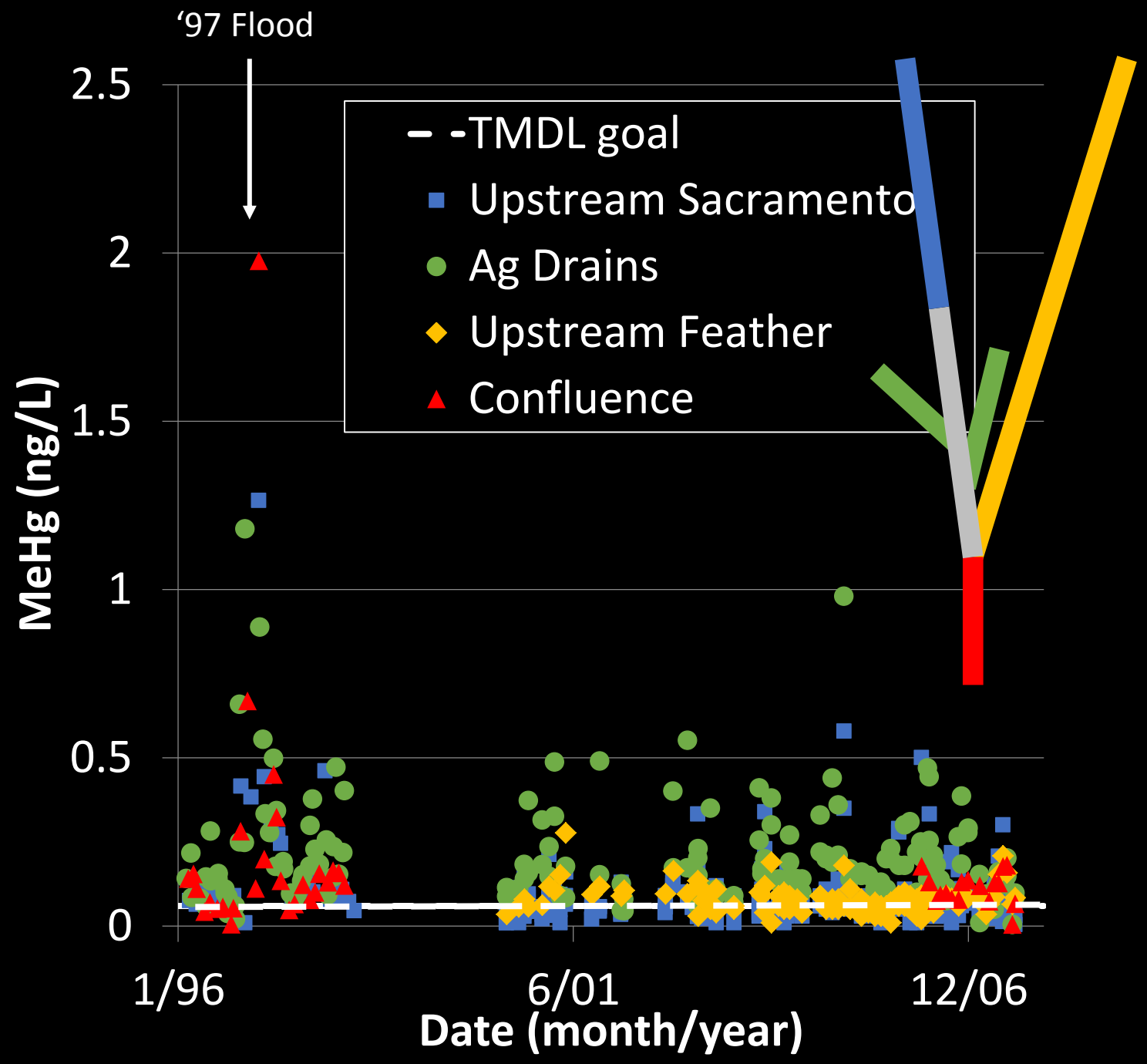
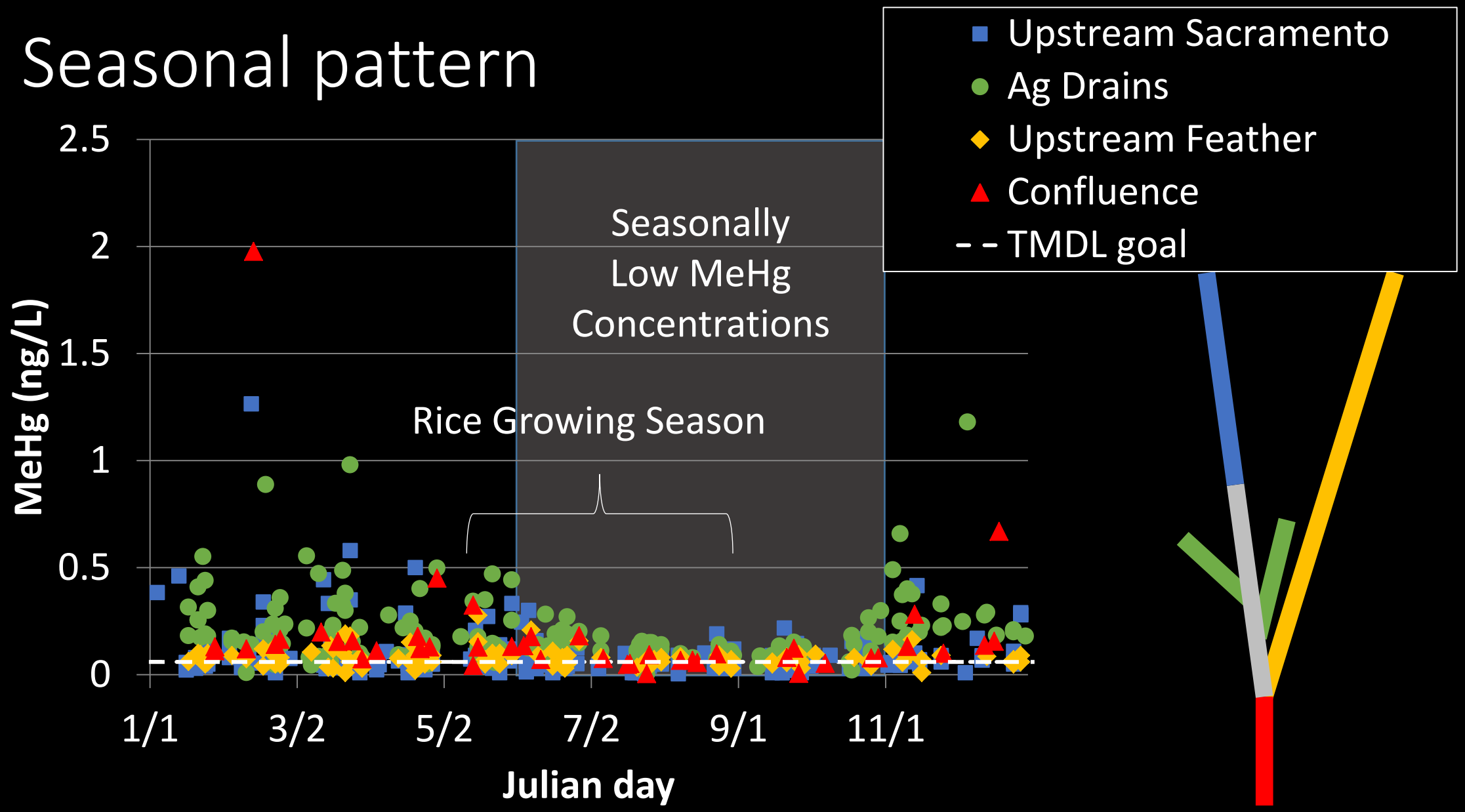
Long term trends

- 566 samples at selected sites
  - Concentrations ranged from method detection limits to 1.98 ng/L
  - 75% of samples >0.06 ng/L (TMDL goal)



Seasonal pattern



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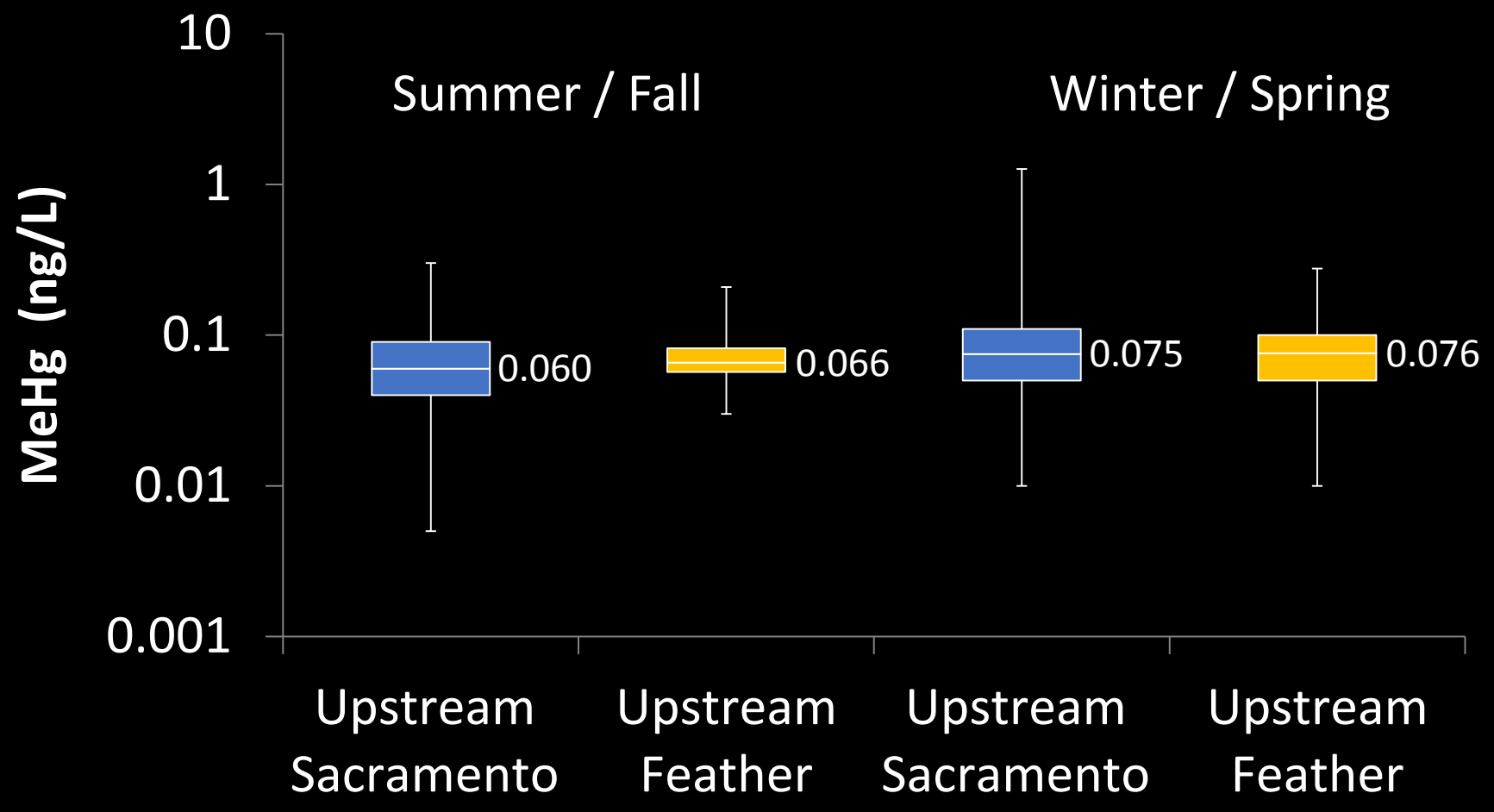
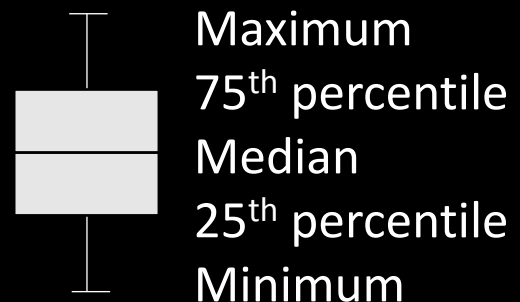
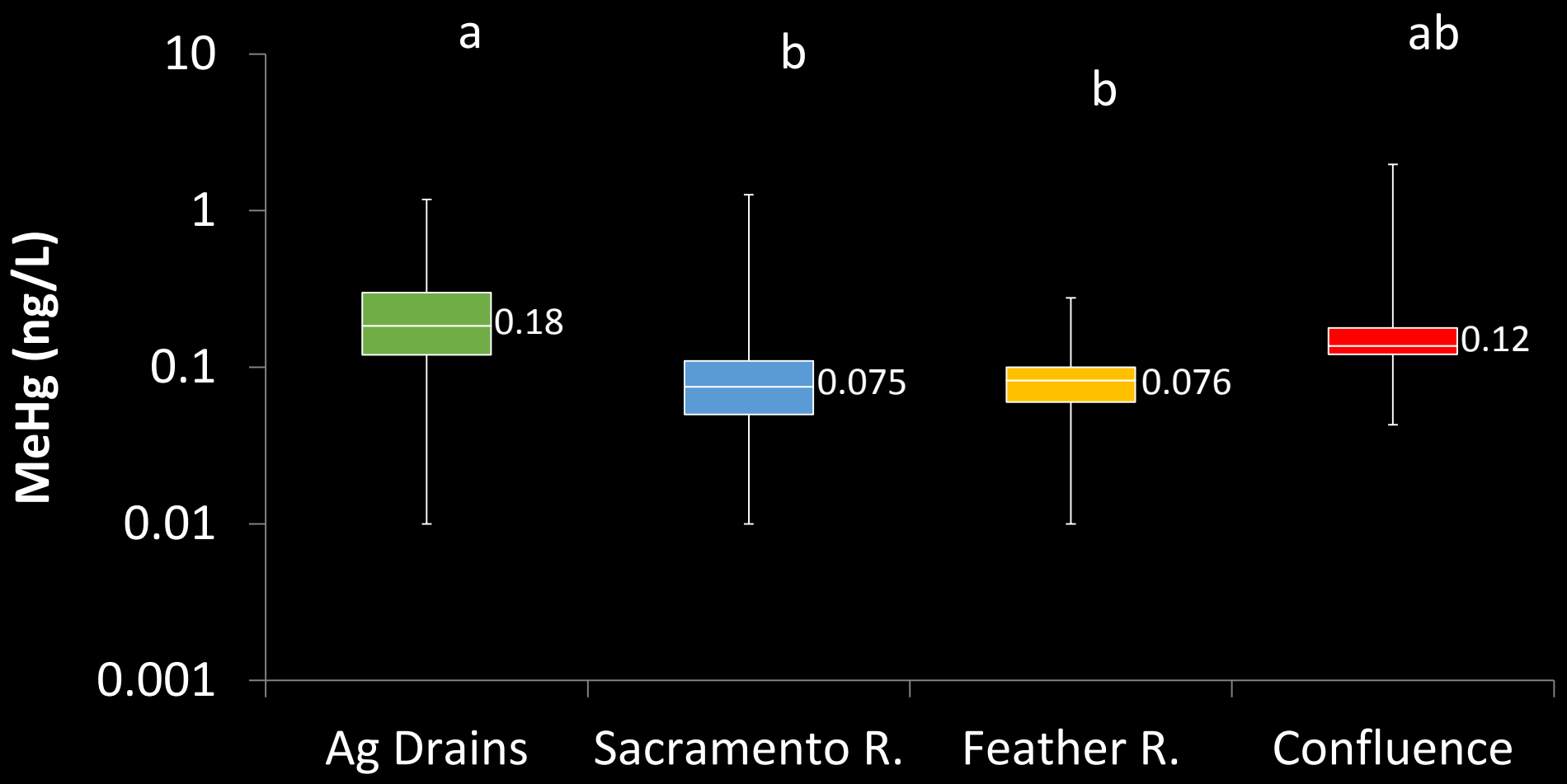
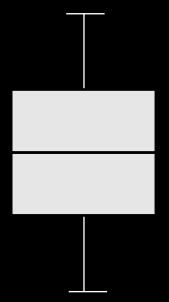
No difference between Sacramento and Feather Rivers



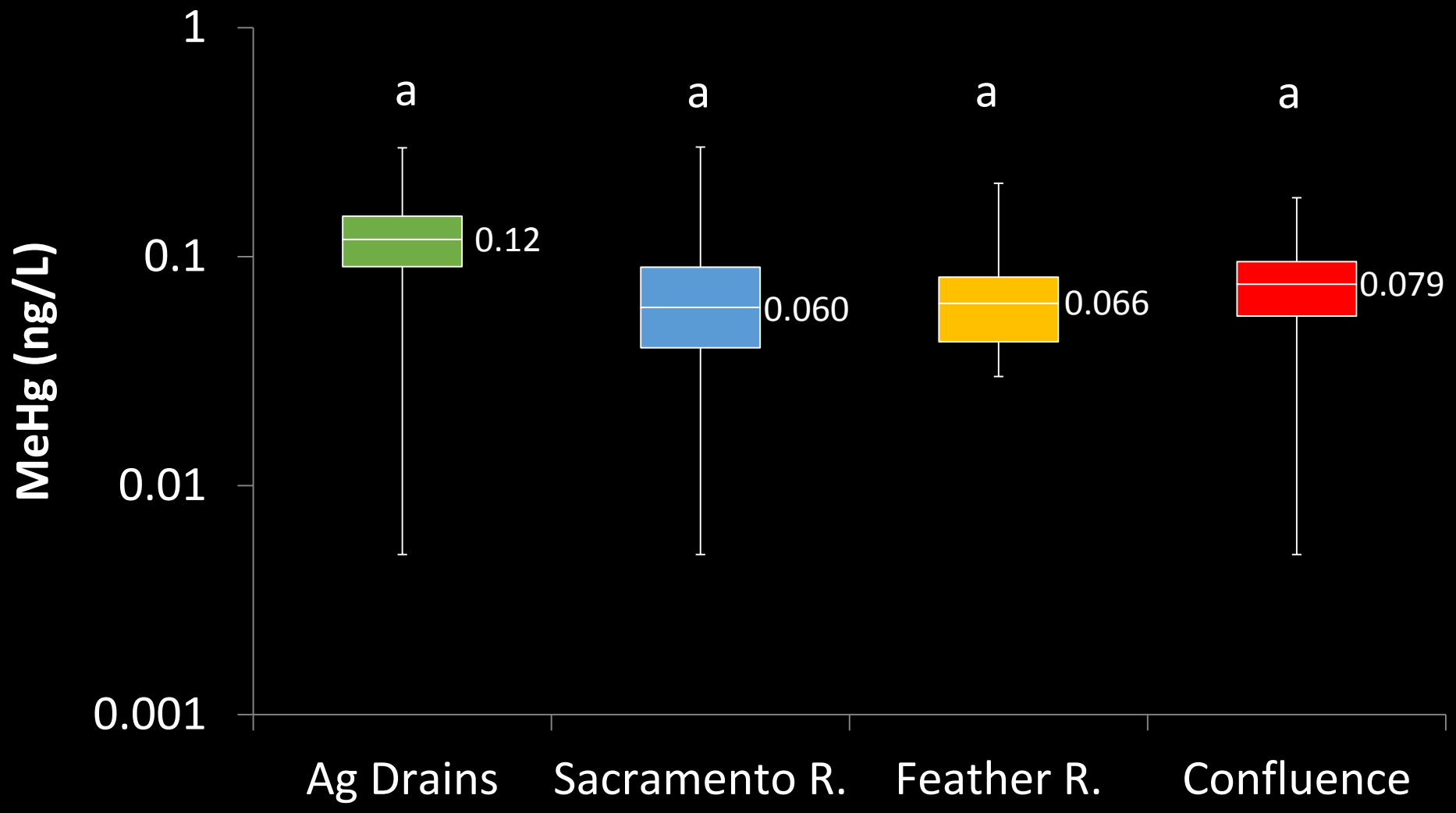


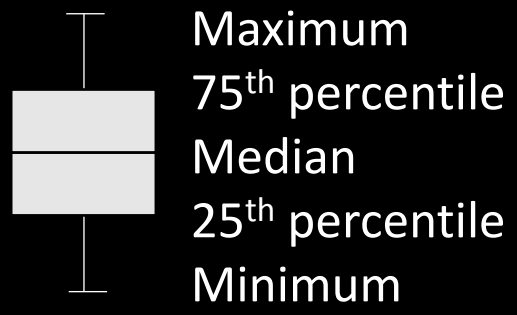
Winter/Spring MeHg concentrations are higher in Ag Drains



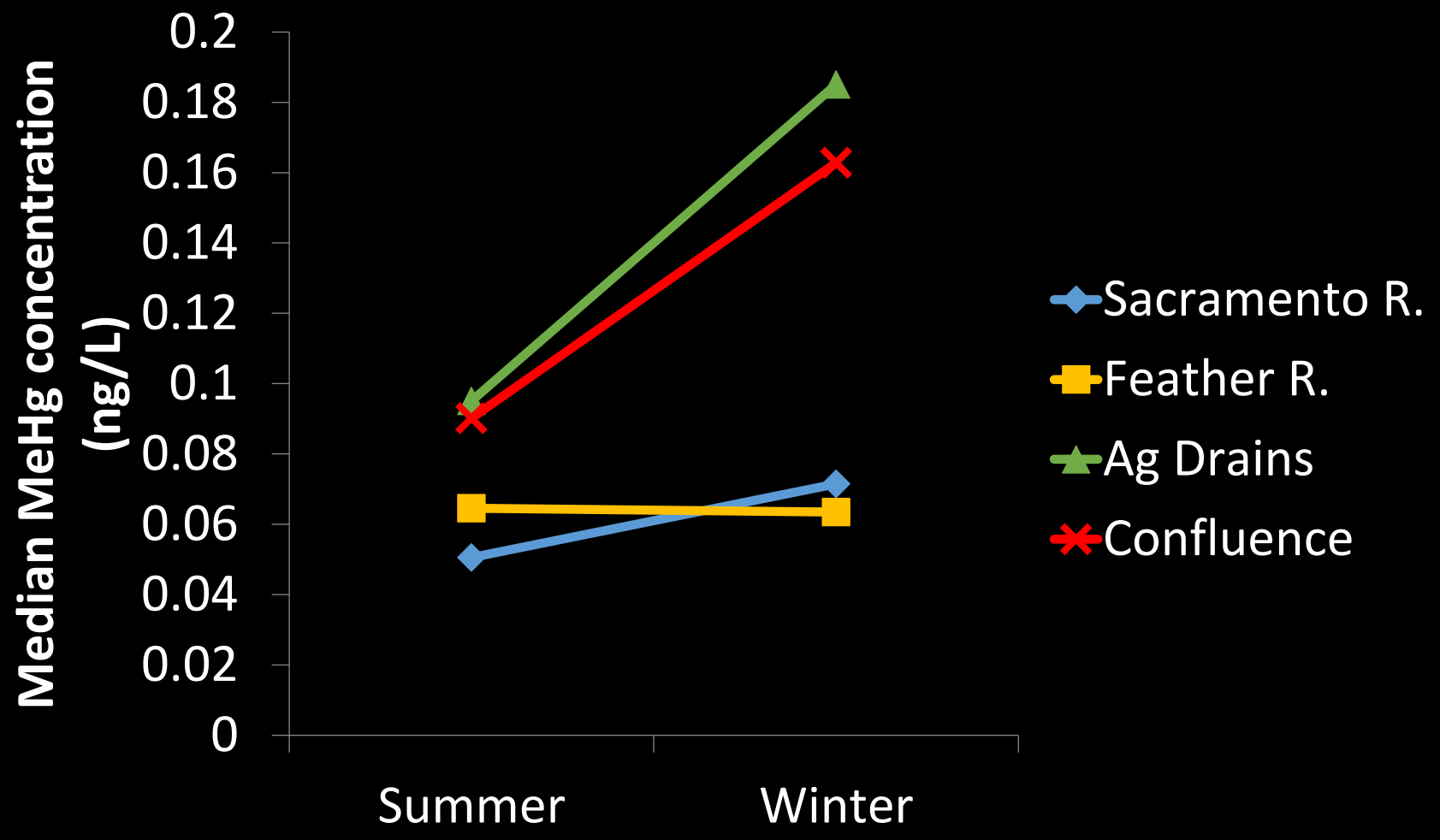


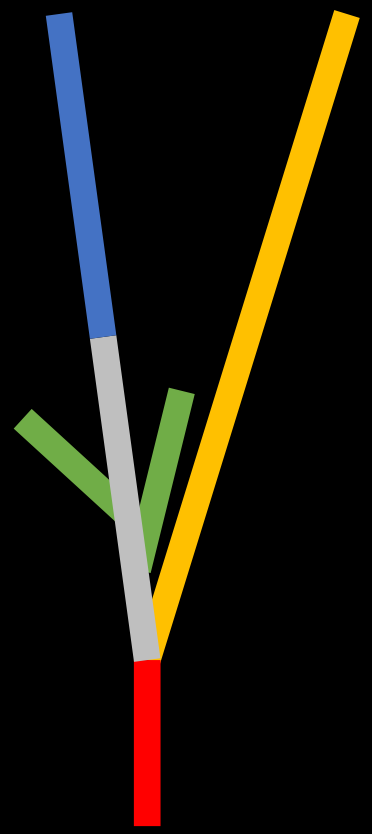
Summer/Fall: Same pattern but not significant



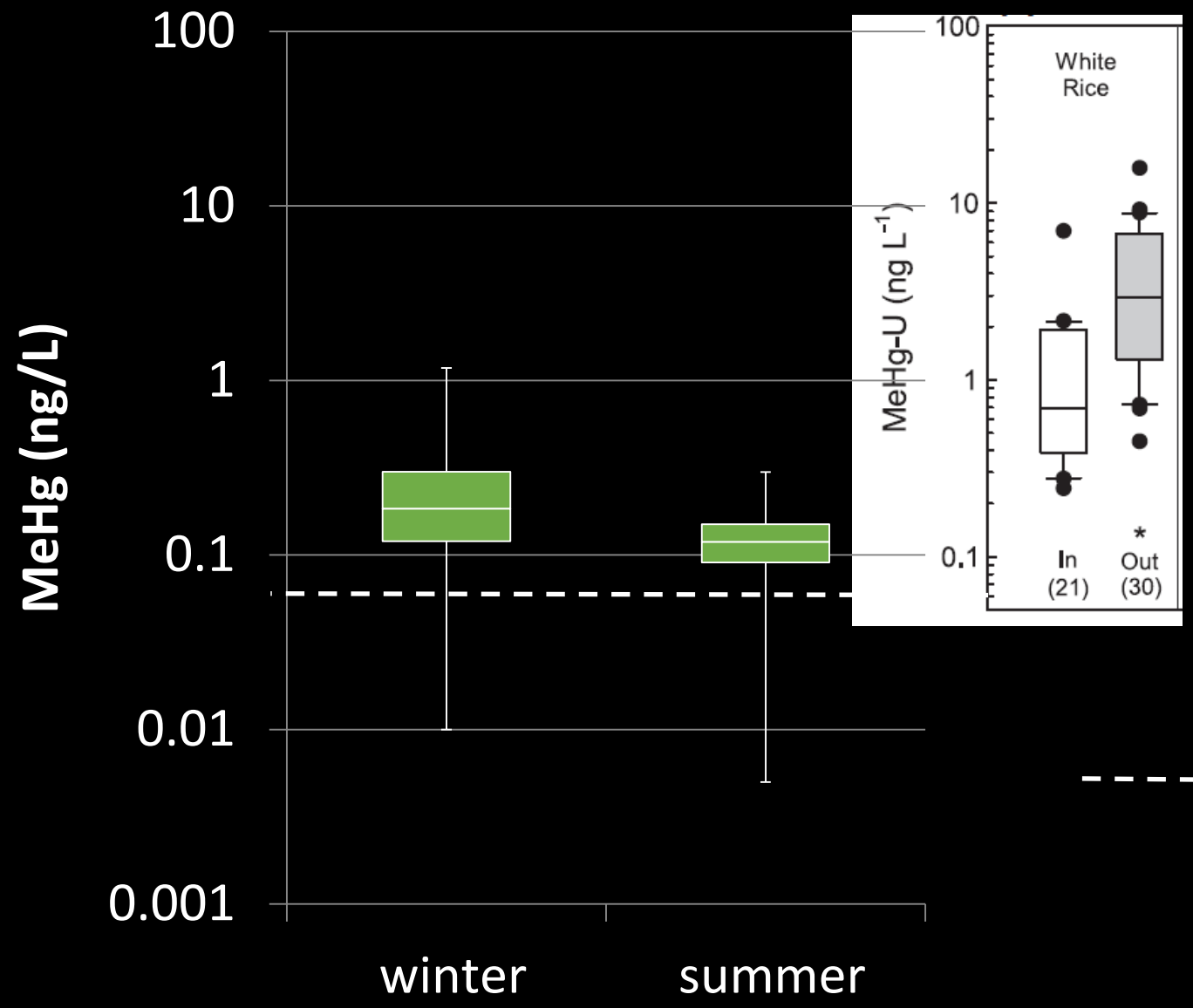


Location - Season Interaction





Ag Drain Concentrations lower than Yolo Bypass rice study



Alpers CN, Fleck JA, Marvin-DiPasqualebe M, Stricker CA, Stephenson M, Taylor HE. Mercury cycling in agricultural and managed wetlands, Yolo Bypass, California: spatial and seasonal variations in water quality. Sci Total Environ 2014e;484:276–87.

- - - - - TMDL goal (0.06 ng/L)

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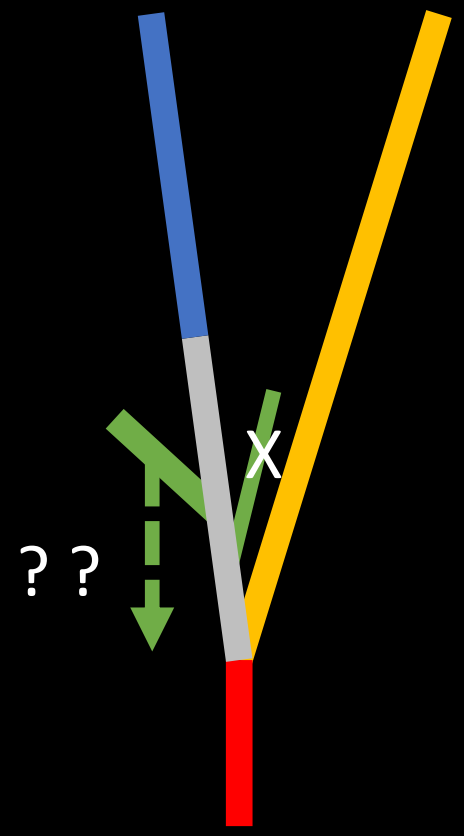
Load Calculations

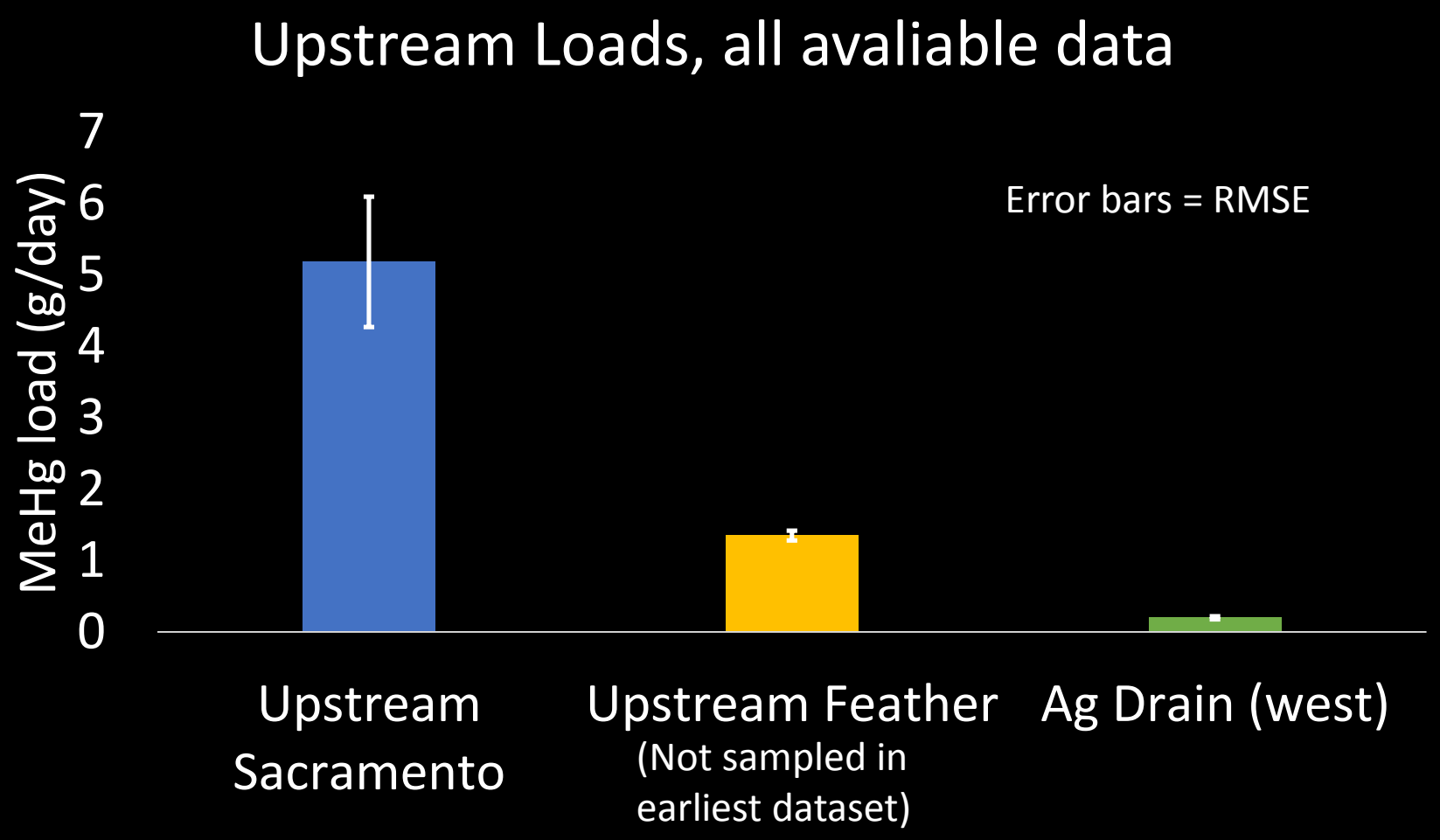
- Load = Concentration x Flow
- Used Ratio estimator method:

$$\textit{Over all load} = \frac{Average\ observed\ load}{Average\ observed\ flow} * \textit{Over all flow}$$

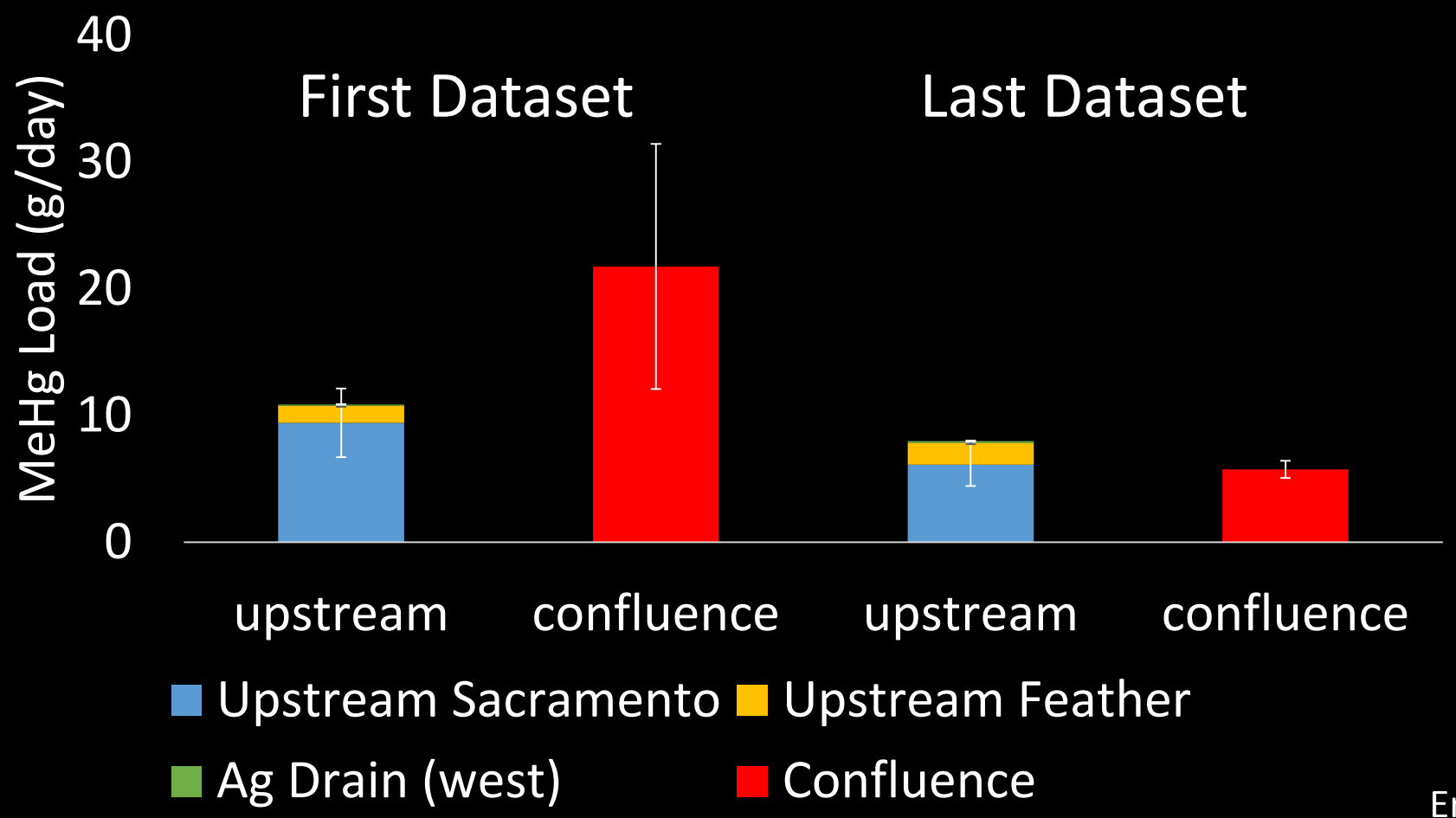
- Gaps in data:
  - No flow data for eastern Ag Drain
  - Western Ag Drain water partially diverted to Yolo Bypass
  - Limited data for confluence



MeHg load from Ag is small compared to loads in the Rivers

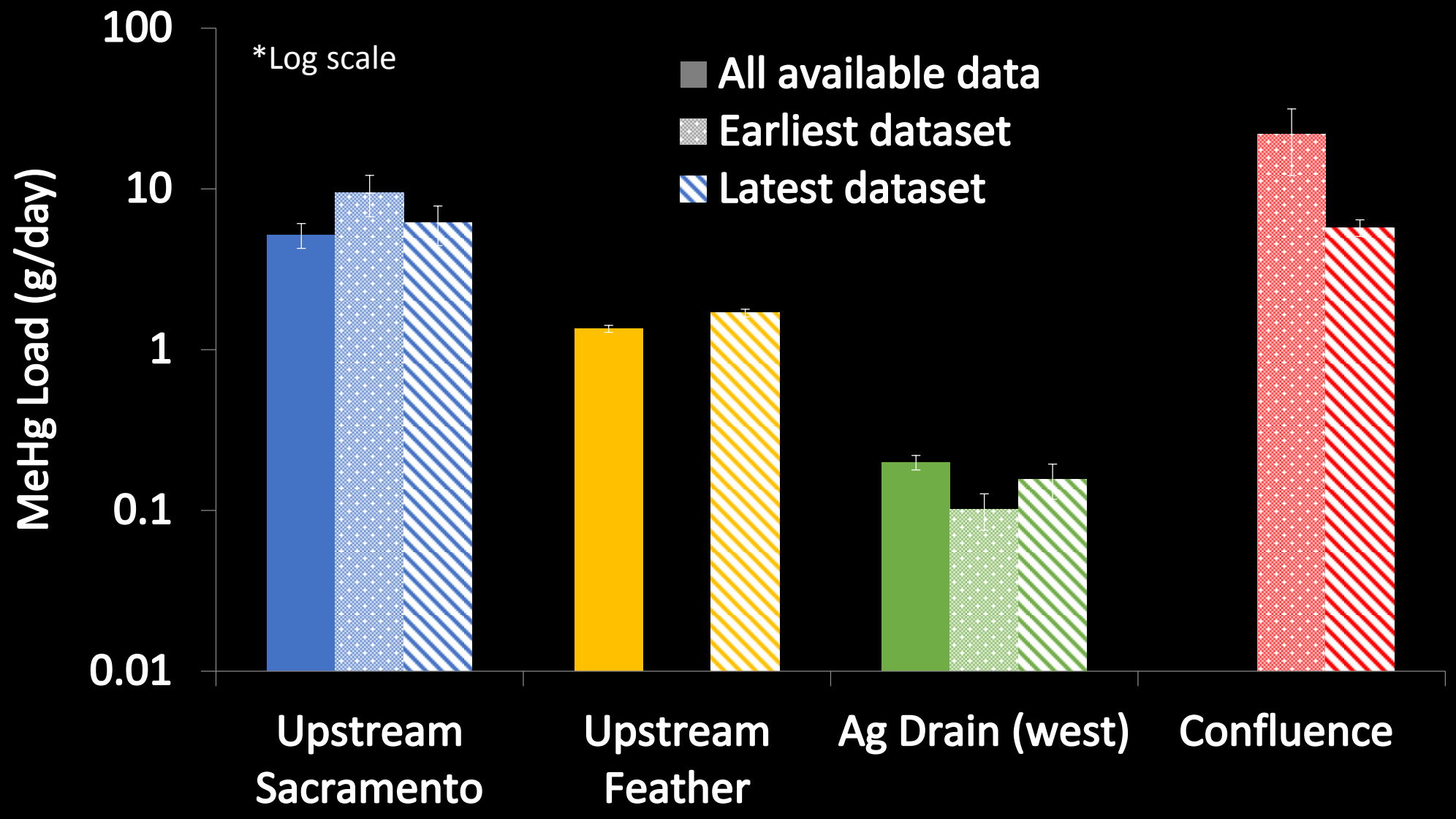


Sum of upstream loads is similar to confluence load



Error bars = RMSE

Load Estimates are consistent across studies



Conclusions

- Future studies should account for seasonal variation
- MeHg concentrations are elevated in agricultural drains
  - particularly in the winter
- MeHg concentrations were low compared to Yolo Bypass
- Measurable MeHg loads from agricultural drains were small compared to Loads in the Sacramento and Feather Rivers
  - Due to differences in flow

Acknowledgments

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  - Rice Research Board
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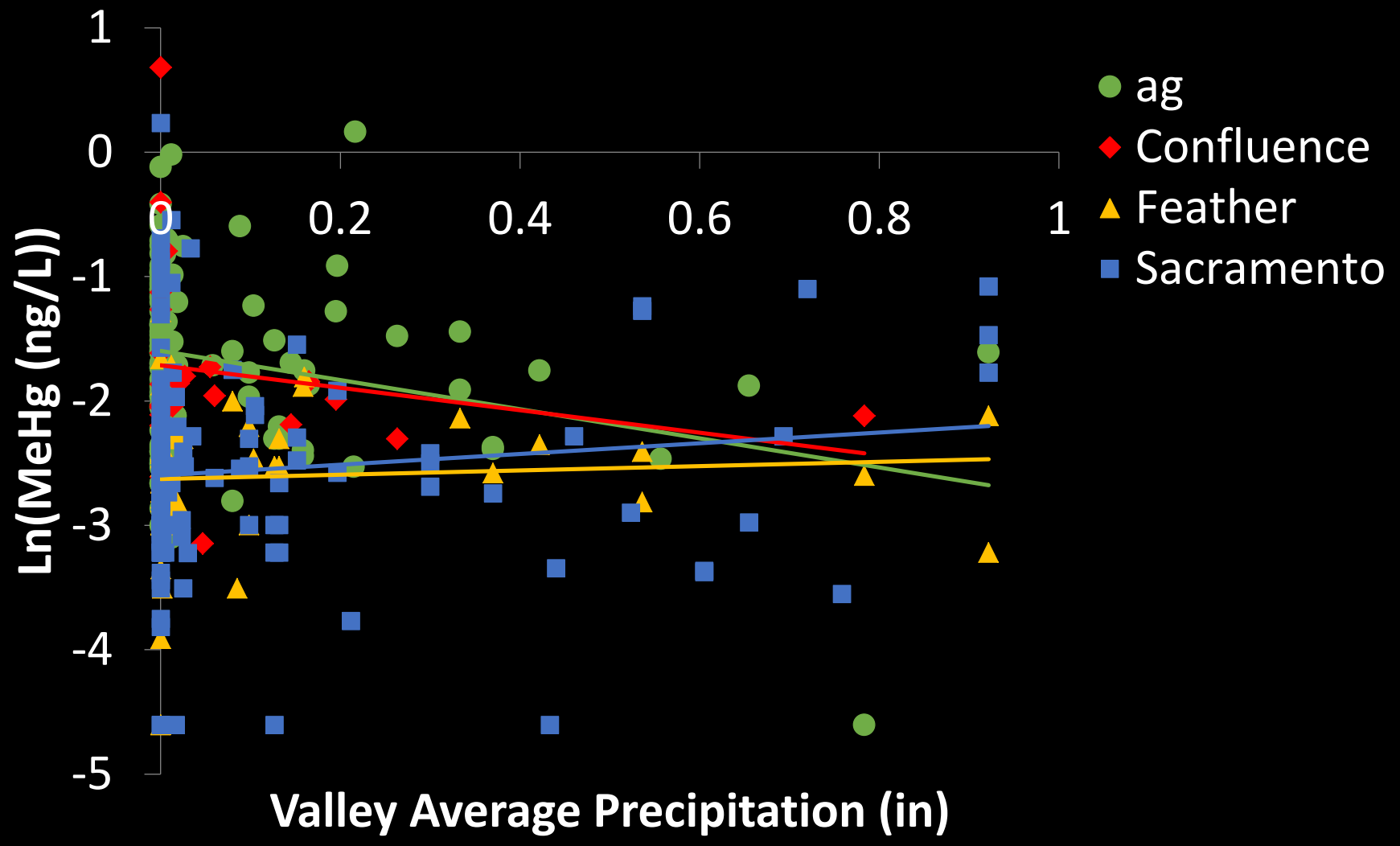
  - Sacramento River Watershed Program
  - J. Domagalski, National Water Quality Assessment
  - C. Foe, CALFED Bay-Delta Program
- Coauthors
- Agroecosystems Lab

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