Comparison of Mercury Mass Loading in Streams to Atmospheric Deposition in Watersheds of the Western United States: Evidence for non-Atmospheric Mercury Sources

Revisiting the 2003 Mercury Strategy for the Bay Delta Ecosystem, January 26, 2016

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Western U.S. Mercury Sources

- Mining Legacy (Hg mines / Hg amalgamation)
- Atmospheric Deposition (Wet and Dry)
  - MDN network (Wet Deposition, few sites)
  - Dry Deposition (no regional networks, modeled only)
- Natural background (mineralized and non-mineralized locations)

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Presentation Outline

- Western North American Hg Synthesis (2000-2013)
- Wet Atmospheric Deposition (Annual amounts to watersheds)—Uncertainty
- Dry Deposition (One year of modeled analysis, how representative)
- Annual River Loads (27 sites)
- Ratios of Load to Deposition (Can we account for all sources?)
- Long-term trends (20 year, lower Sacramento River)
- Future monitoring recommendations

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Western North America Mercury Synthesis (WNAMS)

A Multi-disciplinary, tri-national assessment of the climate, landscape, and land use controls on mercury risk to ecological and human health across western North America

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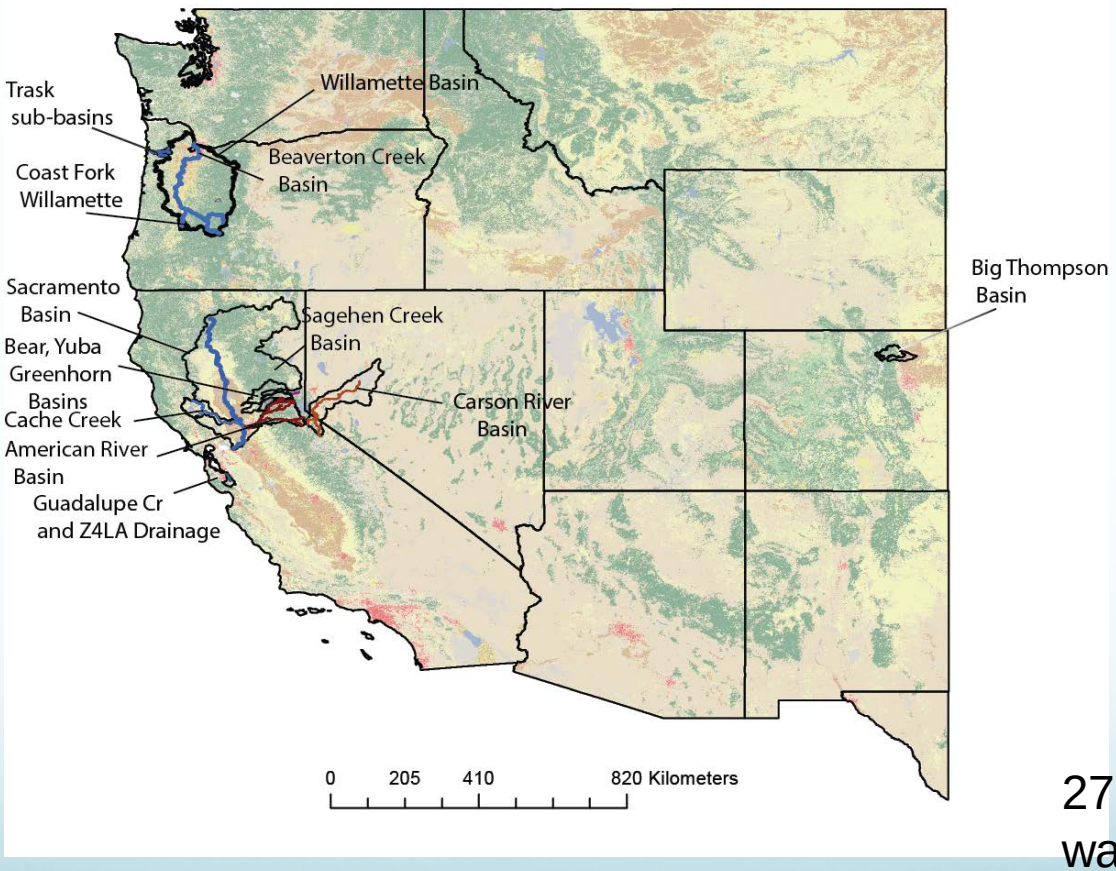
Tri-National Collaboration

Western North America Hg Synthesis

Data Requirements For Synthesis

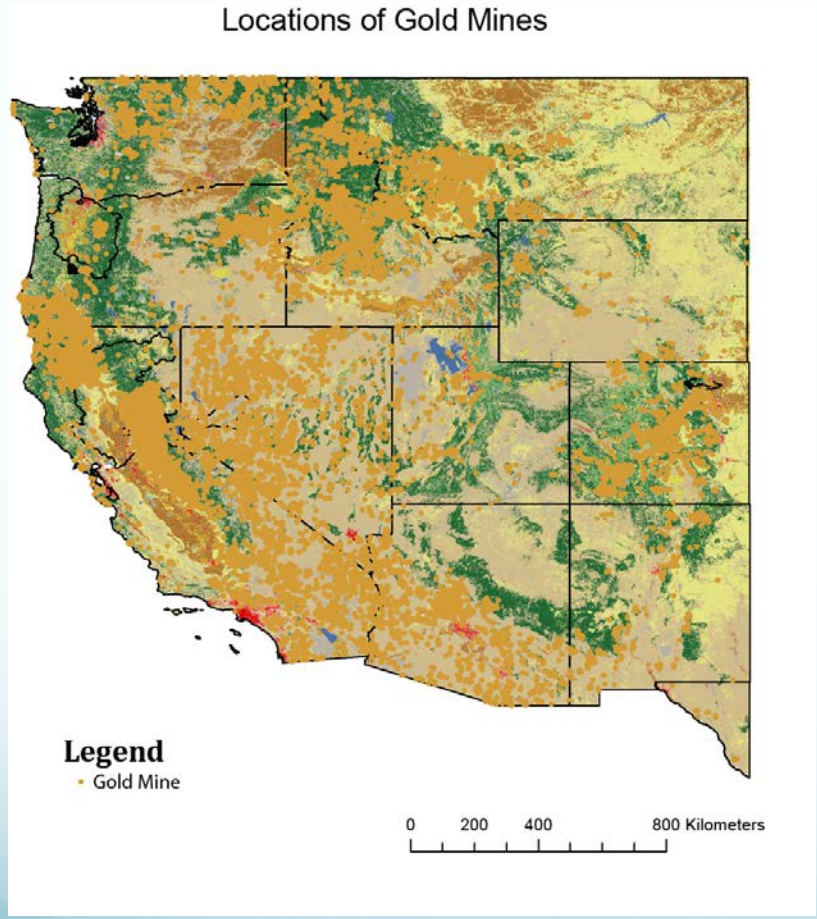
- Wet Deposition by year
- Dry Deposition by year
- Daily mean stream flow
- Aqueous mercury concentrations in water
  - Collected at various times throughout the year consistent with ranges of daily stream flow

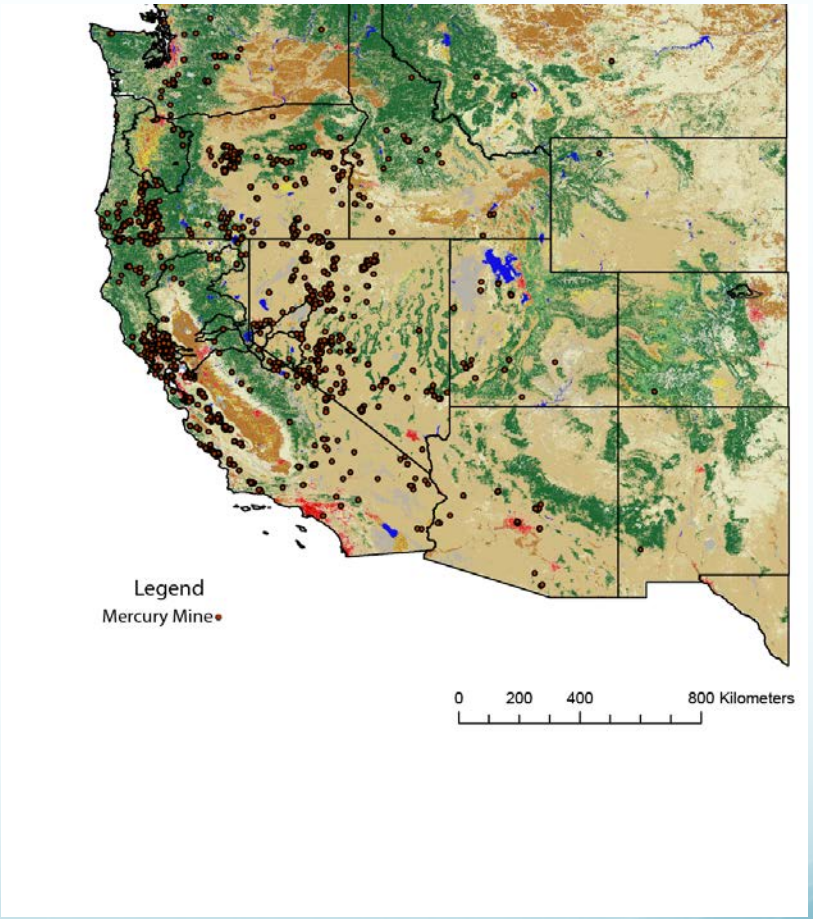
Map of Basins that fit criteria



27 individual watersheds

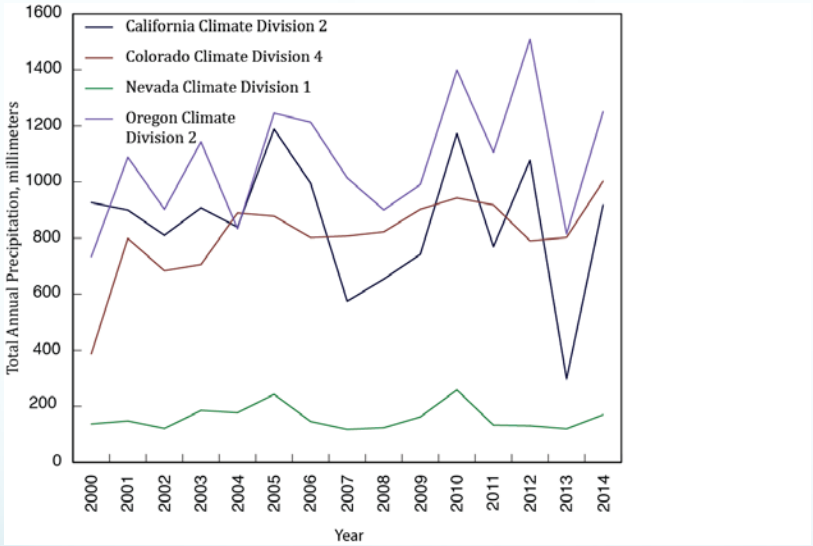
Land-use in Selected Basins



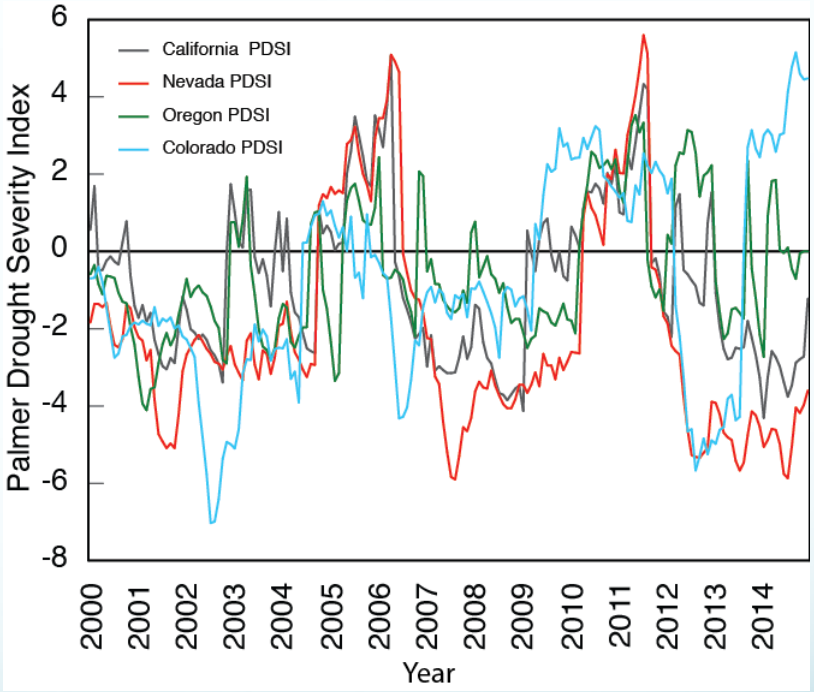


Climate Differences in across Western U.S.

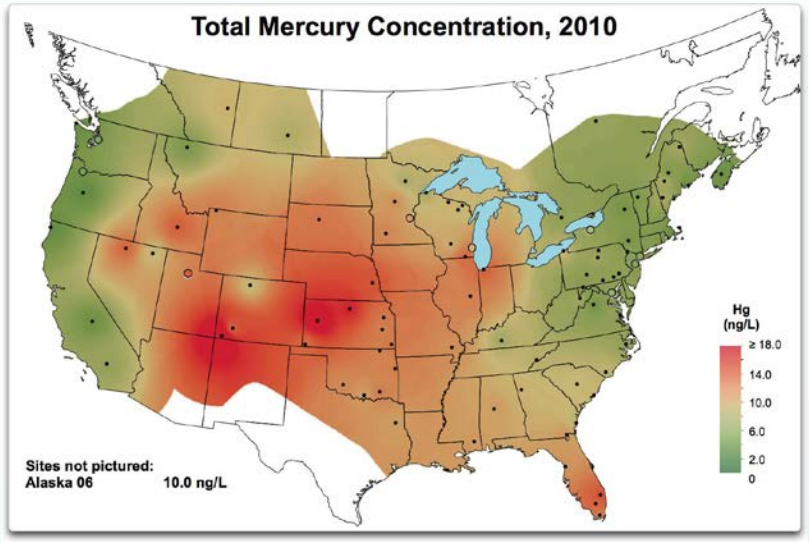
Precipitation by Climate Division



Palmer Drought Index by Climate Division

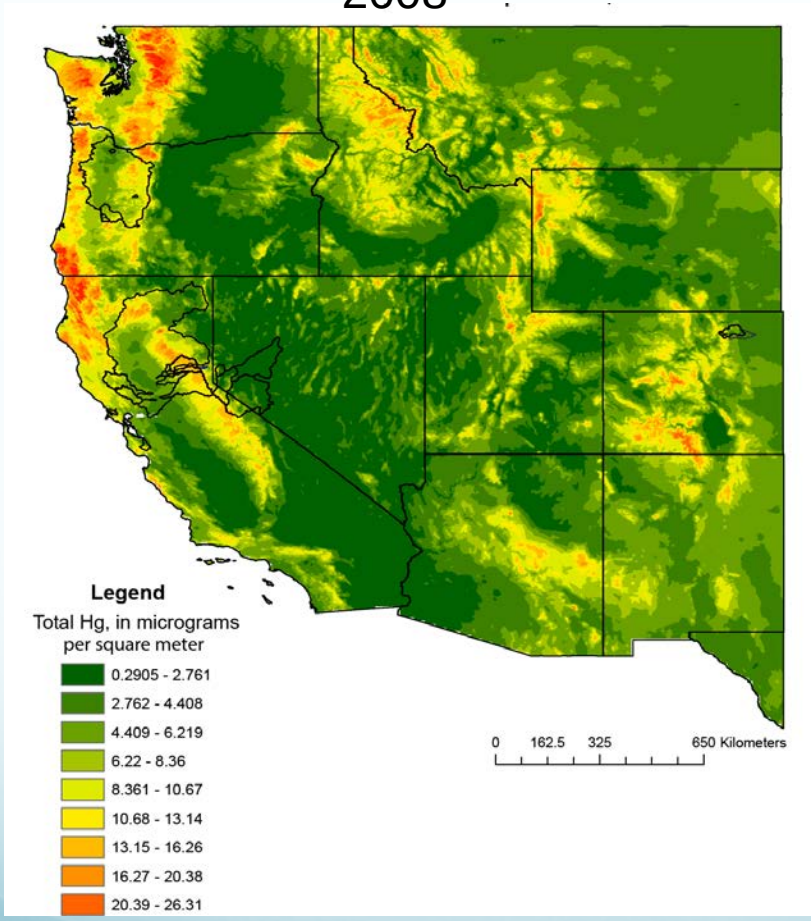


Mercury Deposition Network Locations

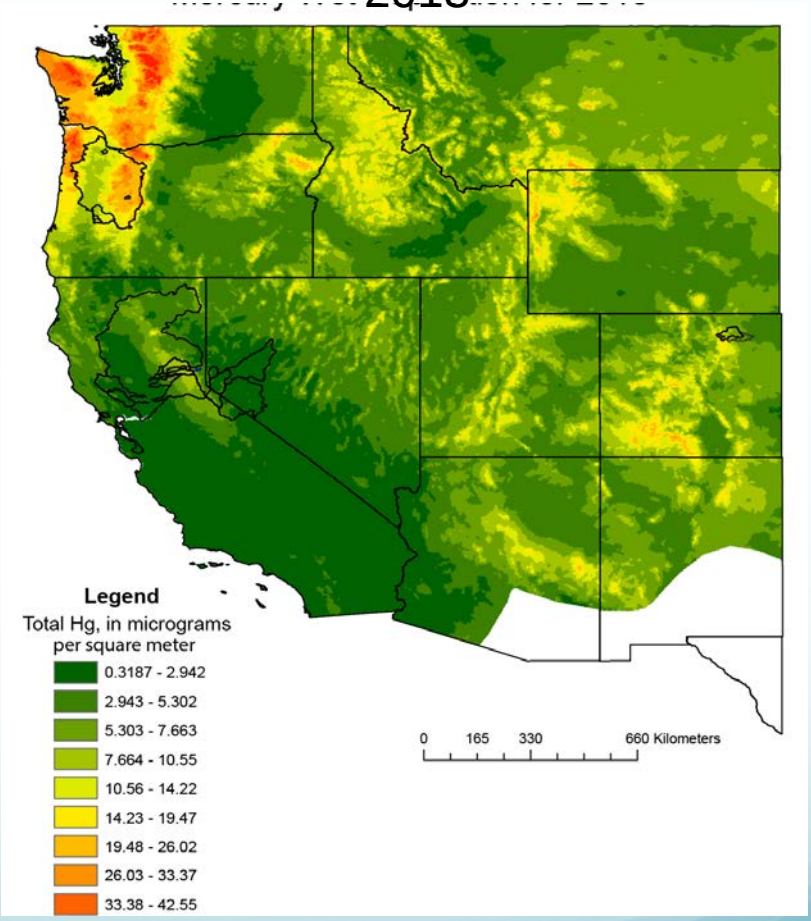


Mercury Wet Deposition

2008



2013



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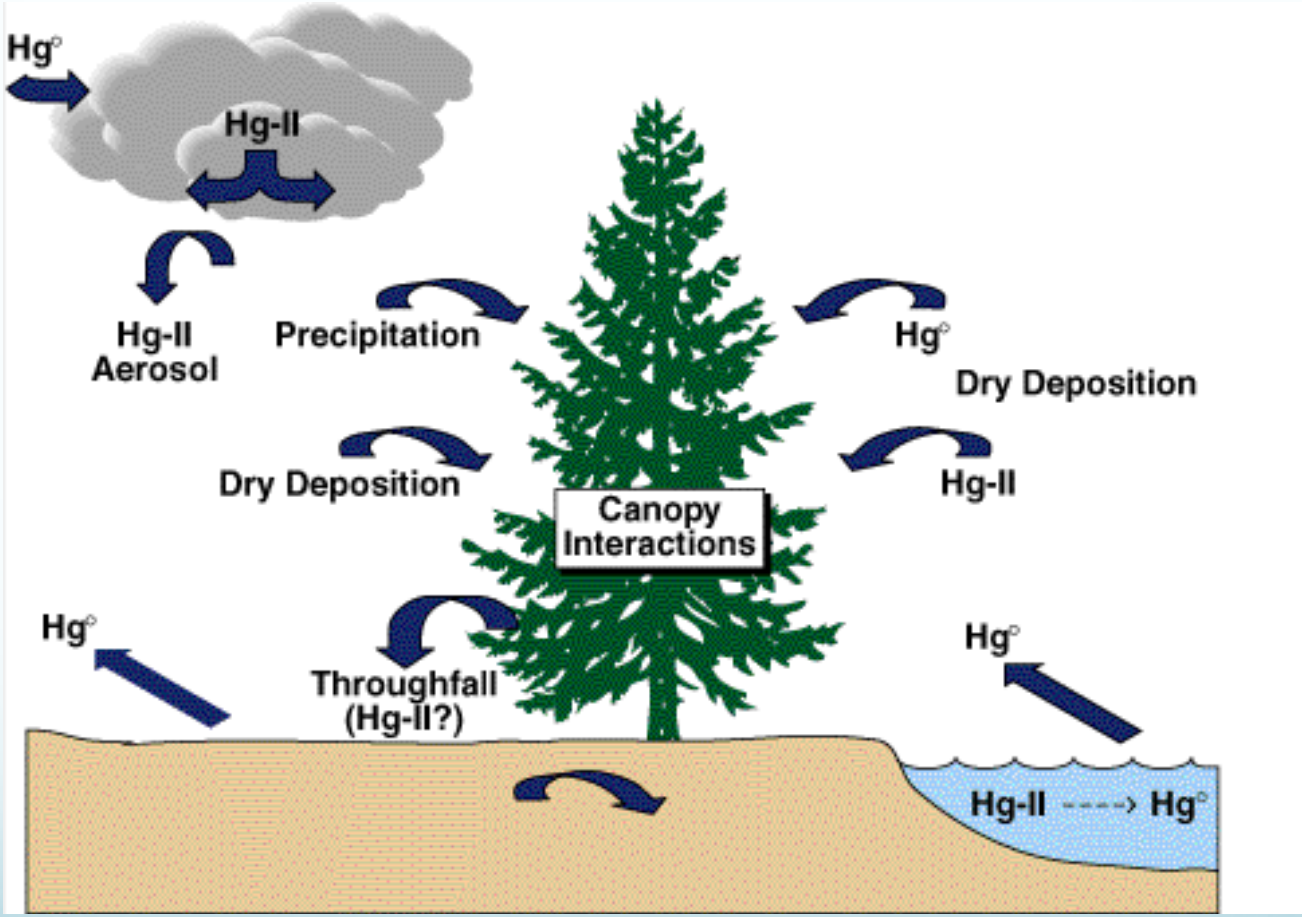
Mercury Dry Deposition



Mercury Deposition

- Regional Dry Deposition Data are Not Available
- Community Multi-scale Air Quality Model was used to estimate dry deposition, one year only
- How important is dry deposition relative to wet?
- Dry Deposition model was only available for 2009,
- Our synthesis data suggests that dry deposition, average is about 80% of wet

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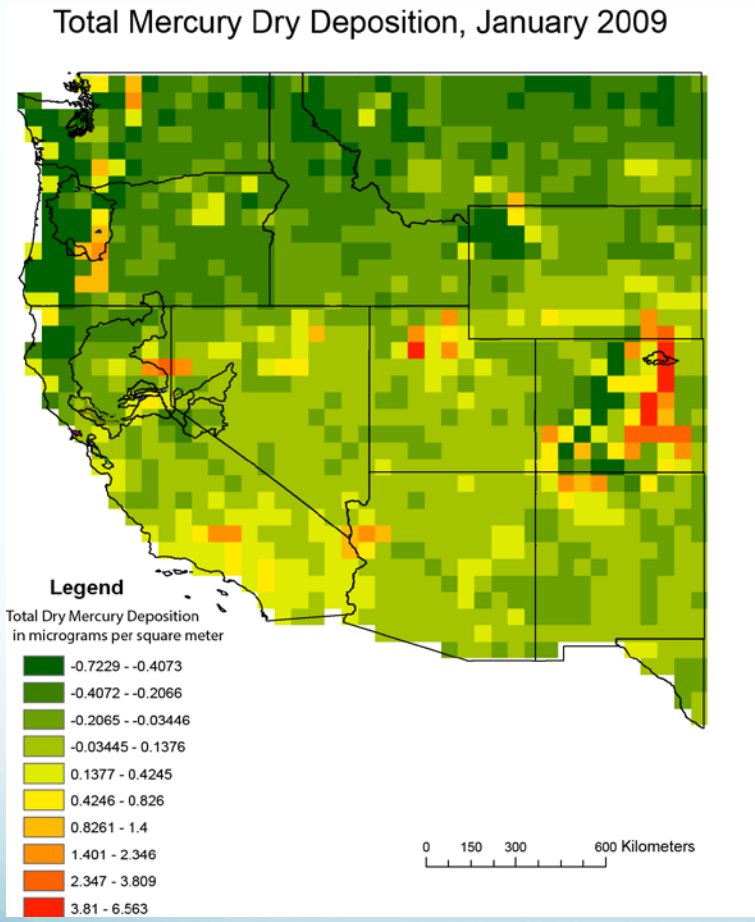
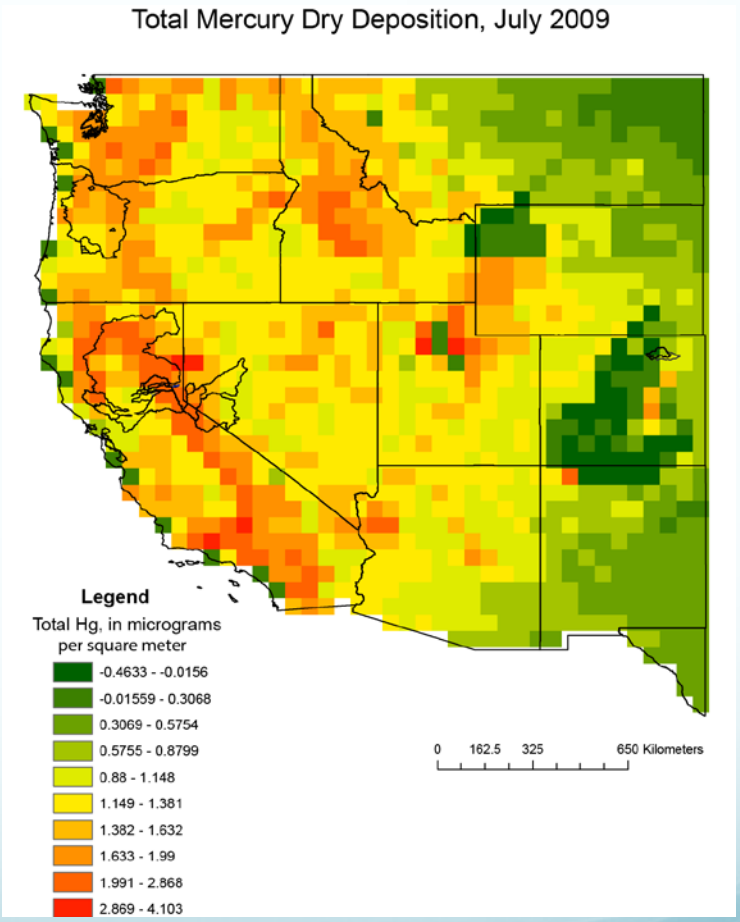
Mercury Dry Deposition by Month





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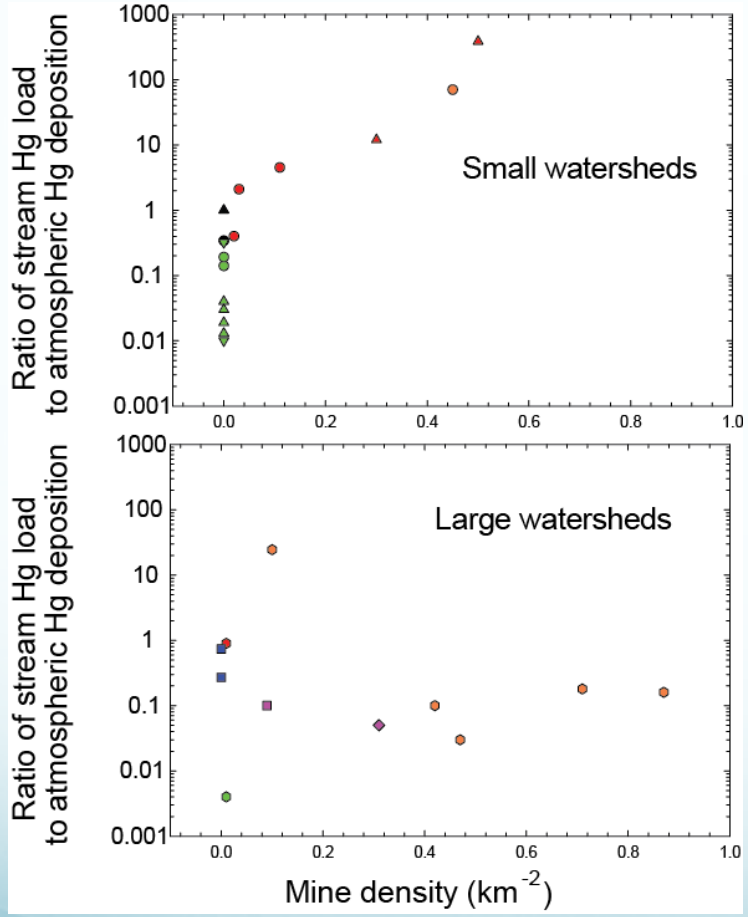
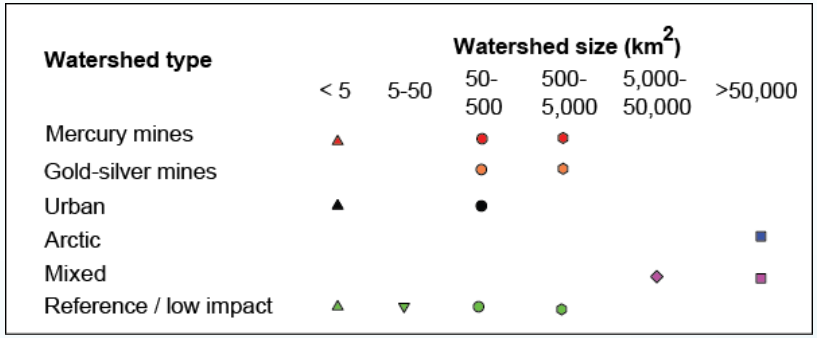
Ratio of Load to Total Atmospheric Deposition

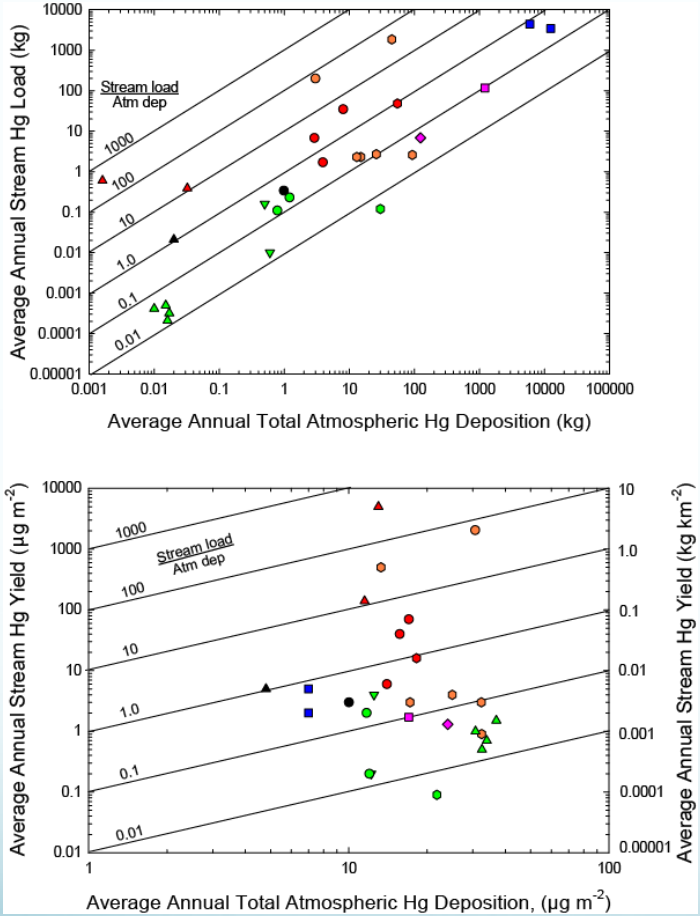


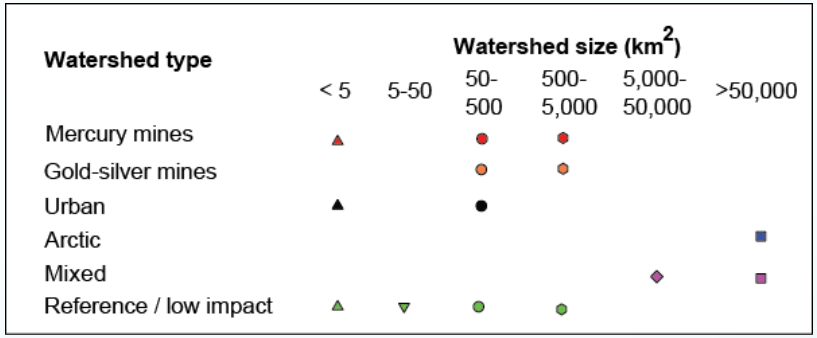


Implications of Load Ratios

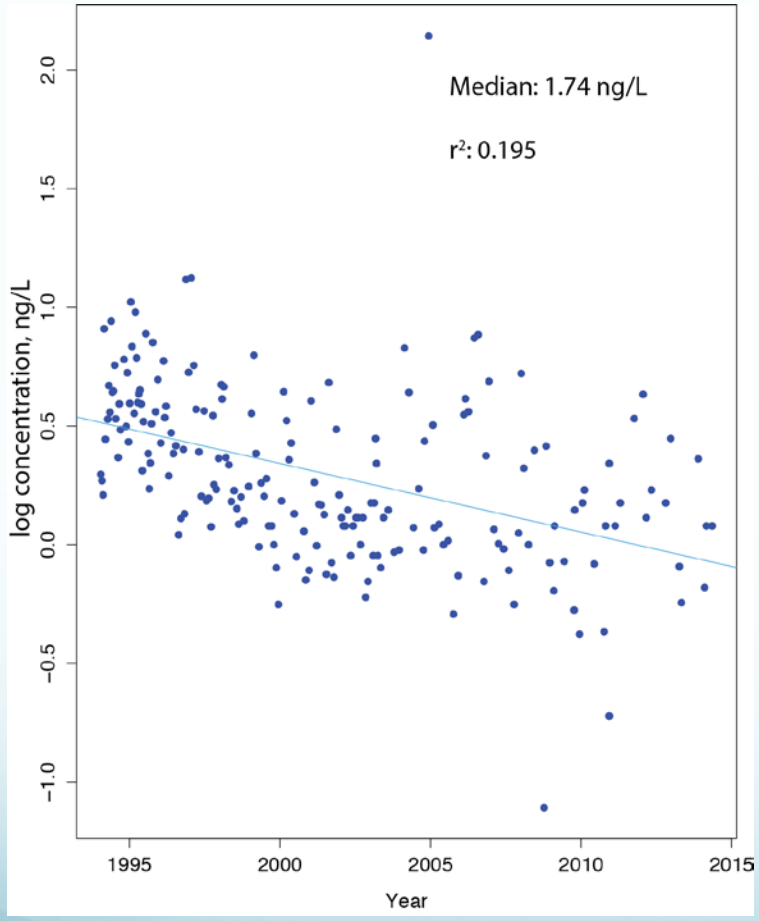
- Ratios greater than 1 imply sources other than atmospheric deposition
- Watersheds away from geologic/mining sources and with natural vegetation tend to retain atmospheric Hg
- Urban environments transport more atmospherically deposited Hg because of impervious surfaces
- Increased loading during wet years from larger watersheds??

Loads or Yields Relative to Atmospheric Deposition

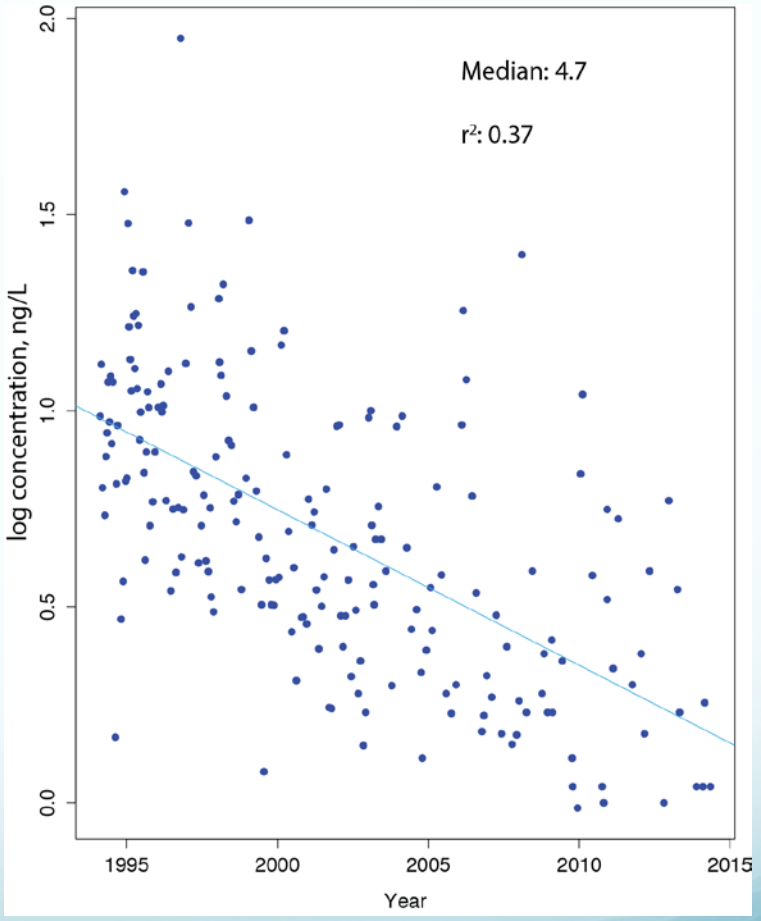




Trends in Mercury Concentrations and Loads



American River at Discovery Park



Sacramento River at Freeport

Sacramento Coordinated Monitoring Program

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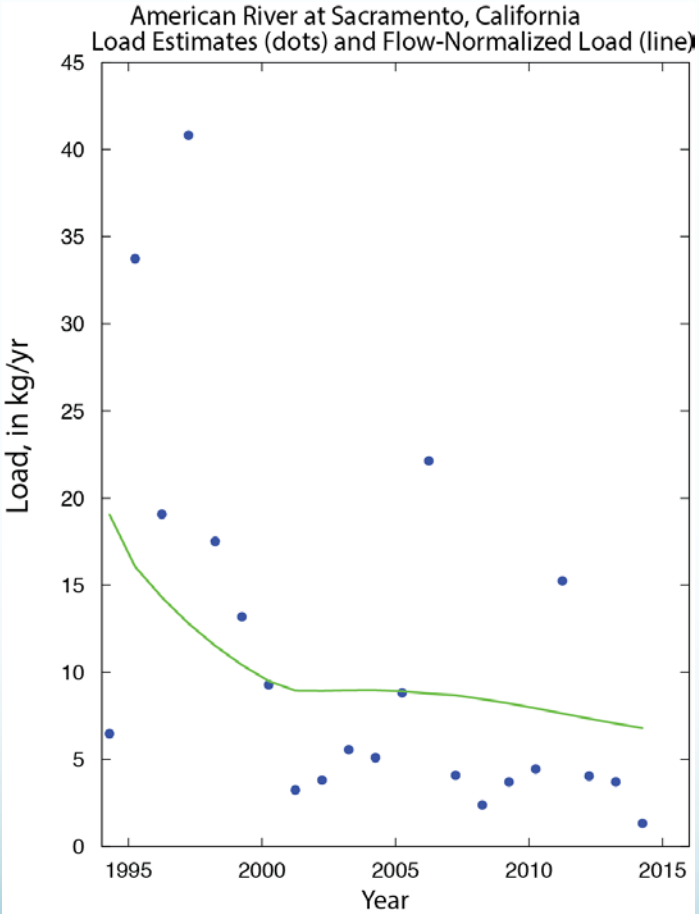
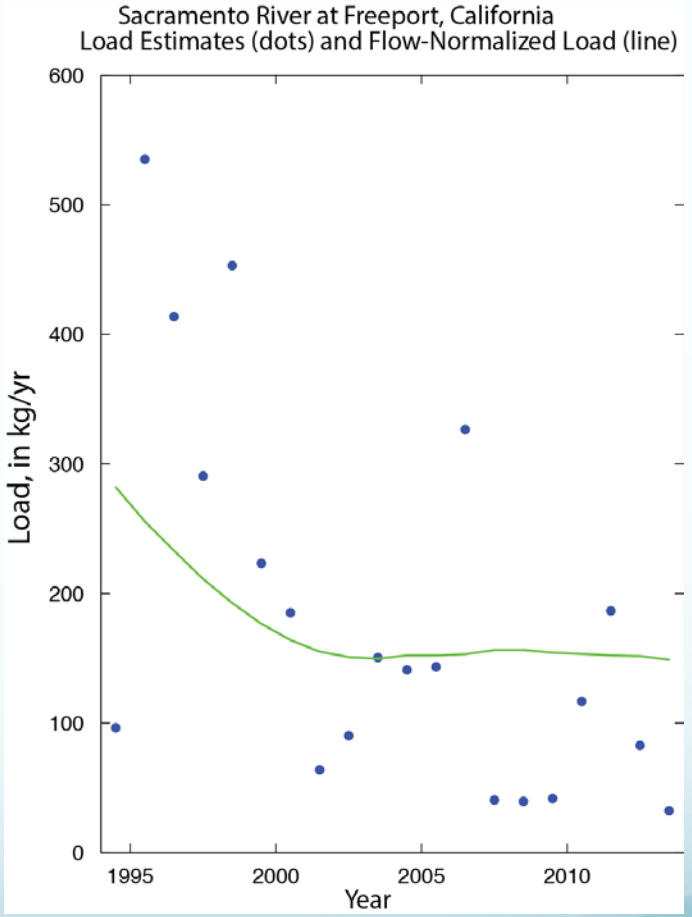
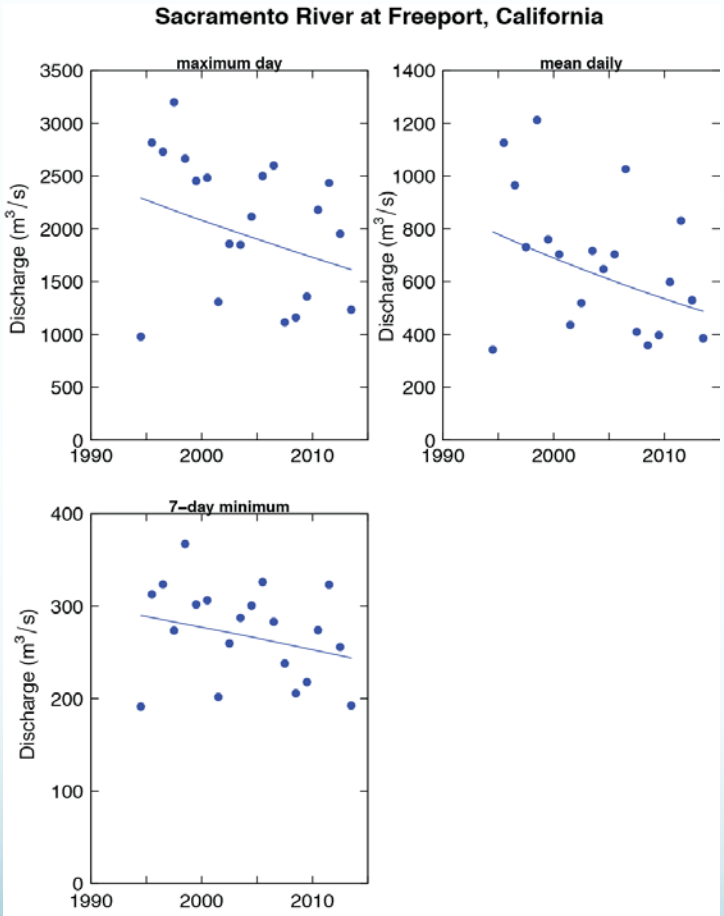
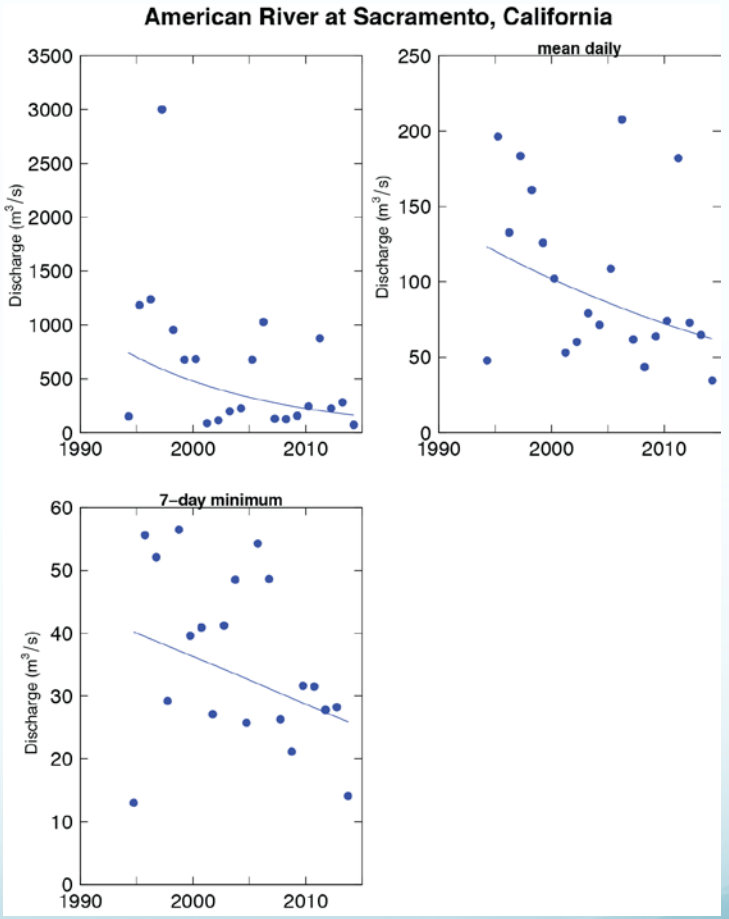
Trends in Mercury Concentrations and Loads






Sacramento River at Freeport, California
maximum day
mean daily
7–day minimum
Discharge (m3/s)
1990
2000
2010


American River at Sacramento, California
mean daily
7–day minimum
Discharge (m3/s)
1990
2000
2010

Discussion Topics

- What is the impact of wet or dry deposition to the Bay/Delta Ecosystem
- What role, if any, does wet or dry deposition have with respect to Hg methylation
- How can we improve upon our understanding of Hg atmospheric processes??