MERCURY IN CALIFORNIA LAKES AND RESERVOIRS: FACTORS INFLUENCING BIOACCUMULATION

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INTRODUCTION

Much of the environmental mercury (Hg) in California is derived from past gold, silver, and Hg mining that occurred during the "gold rush" era in the latter part of the 18th century. Runoff and weathering from historic mining areas has mobilized legacy Hg from the landscape into many of California's lakes and reservoirs. This legacy contamination is the most likely source of relatively high background concentrations of Hg that persist in many water bodies throughout the state.

The primary pathways for increased methylation of inorganic Hg in lakes are thought to relate to wetlands, forests, and sediments. However, direct association between watershed sources and biota MeHg concentrations has yet to be shown on a broad spatial scale.

OBJECTIVE

In this study, we examined 28 lakes and reservoirs in California, where a variety of water quality constituents were measured, including aqueous total Hg and MeHg, total Hg in sediments, and total Hg in fish tissue. Variables associated with lake morphometry and land-use were also determined for each lake. This poster presents data from 17 of the lakes where largemouth bass (*Micropterus salmoides*) were collected. The objective was to develop a statistical model identifying factors influencing MeHg bioaccumulation in upper trophic level fish.

STUDY AREA

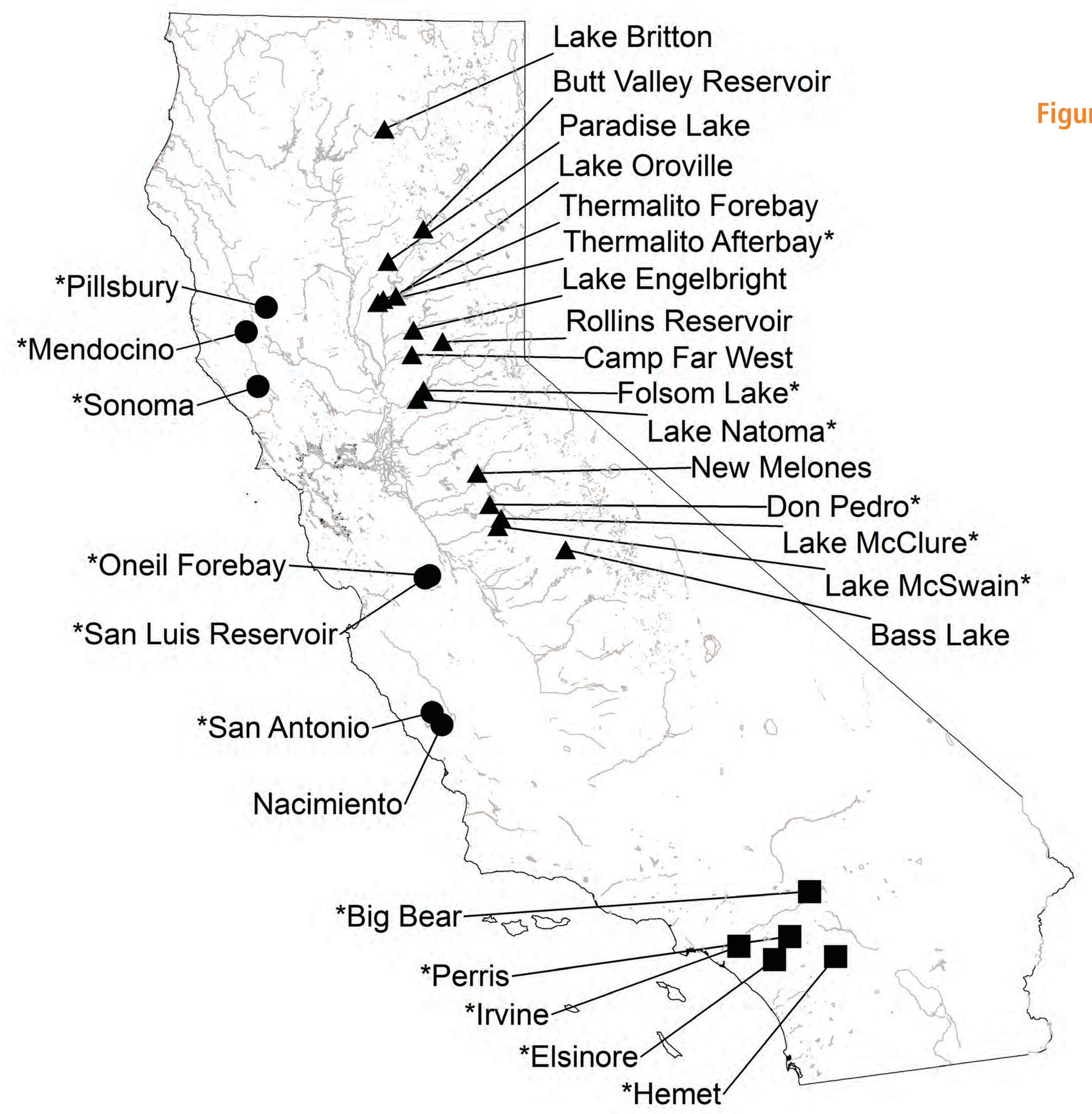


Figure 1. All 28 study lakes.

▲ Sierra Nevada Range

● Central and Northern Coast Range

■ Southern California Range

* Lakes that had largemouth bass data are the focus of this poster presentation (Davis et al. 2009), where an average MeHg concentration standardized to 350 mm was estimated by employing an analysis-of-covariance model. Water quality and sediment parameters were measured at these lakes during 2008 and 2009.

RESULTS

Table 1. Total mercury concentrations in fish tissue at 17 lakes and reservoirs in California sampled during the 2007/2008 survey. Mercury concentrations were standardized to 350 mm total length. MeHg concentrations varied from 66 – 1314 ng•g^{-1}. Lakes in the North and Central Coast region exhibited the highest concentrations.

Lake Number	Region	Lake /Reservoir Name	Hg in 350 mm Largemouth Bass (ng•g^{-1})
1	North & Central Coast	Lake Sonoma	677
2	North & Central Coast	Lake Mendocino	543
3	North & Central Coast	Lake Pillsbury	1314
4	North & Central Coast	Lake San Antonio	302
5	Sierra Nevada	Thermalito Afterbay	211
6	Sierra Nevada	Folsom Lake	471
7	Sierra Nevada	Lake Natoma	542
8	Sierra Nevada	Don Pedro Reservoir	442
9	Sierra Nevada	Lake McClure	769
10	Sierra Nevada	Lake McSwain	535
11	Sierra Nevada	San Luis Reservoir	564
12	Sierra Nevada	Oneill Forebay	234
13	Southern California	Big Bear Lake	178
14	Southern California	Irvine Lake	479
15	Southern California	Perris Reservoir	98
16	Southern California	Lake Hemet	66
17	Southern California	Lake Elsinore	121

Figure 2. Relationship of mercury concentrations in 350 mm largemouth bass and longitude (top-left), methylmercury in surface water (top-right), forested area (bottom-left), and total mercury in soil (bottom-right) from 17 lakes and reservoirs in California. All correlations are significant at alpha = 0.05.

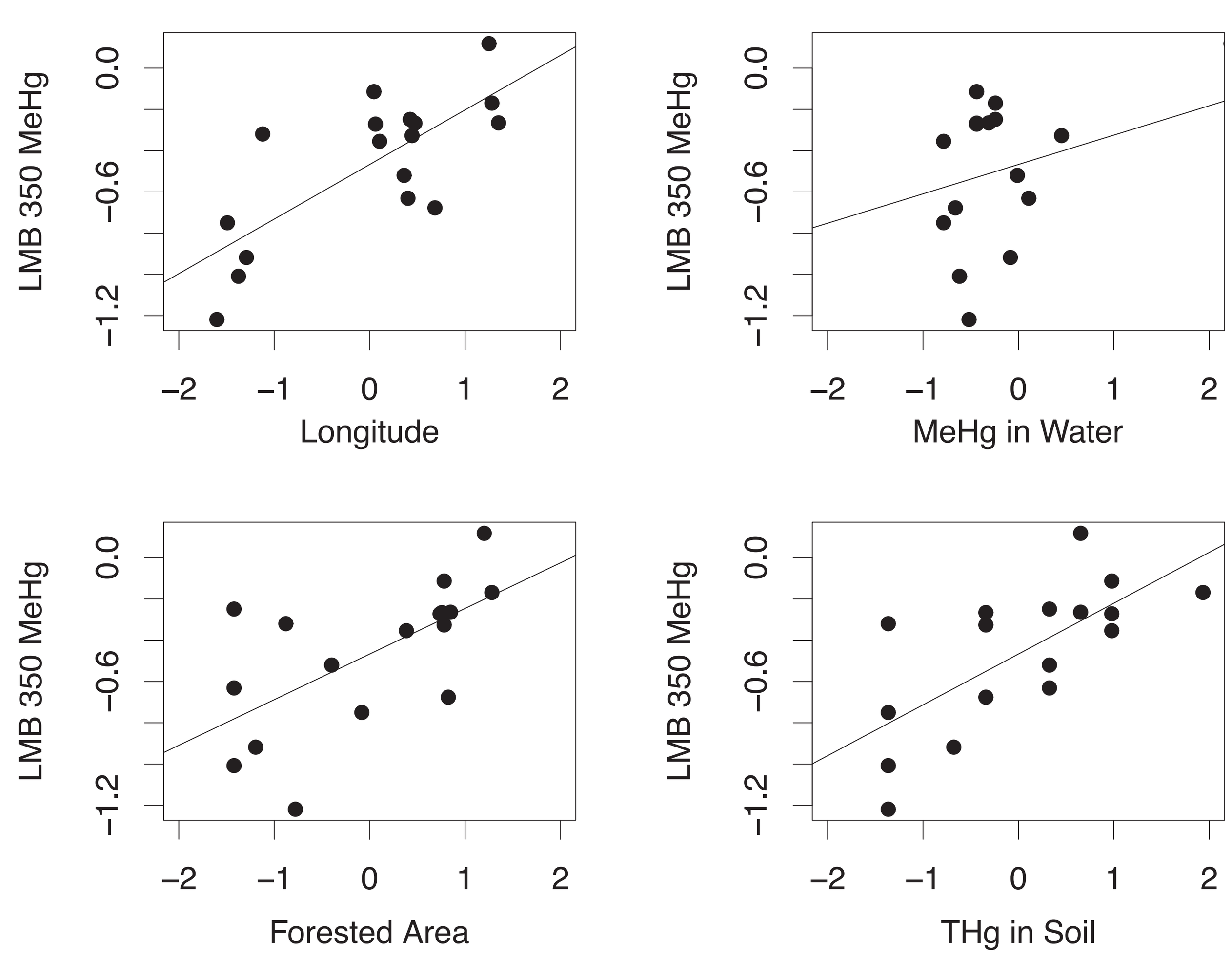


Figure 3. Relationship between total mercury in lake sediments and mercury concentrations in 350 mm largemouth bass from 17 lakes and reservoirs in California ($R^2 = 0.52$, $p = 0.001$). Solid line is the regression slope and dotted lines are 95% confidence intervals. This observation suggests that one potential pathway for MeHg bioaccumulation are local or watershed sediment

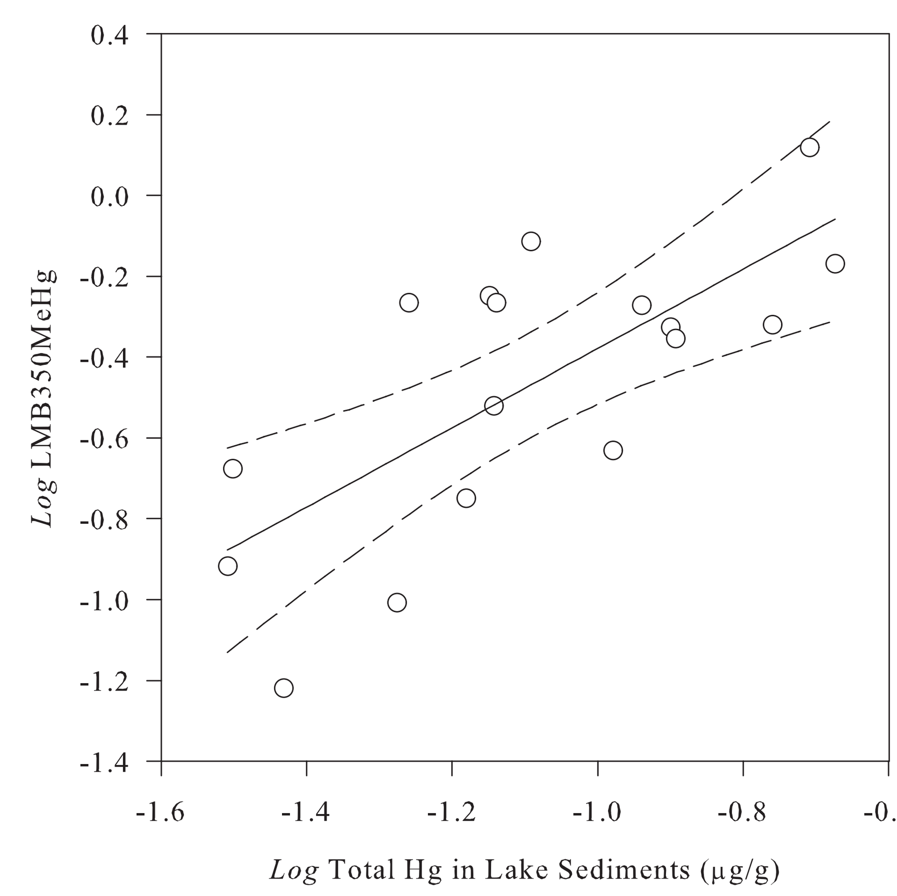


Figure 4. Biplot of latent x-scores and loadings from a partial least squared regression model. Numbers correspond to lakes and reservoirs listed in Table 1. Length of each vector indicates the relative strength in the model. Spatial location (longitude); land use (THg in soils, THg in sediment, forested area); methyl mercury in water; and specific conductivity were significant components of model. These groups of variables explained 81% of the variance in LMB_{350} MeHg.

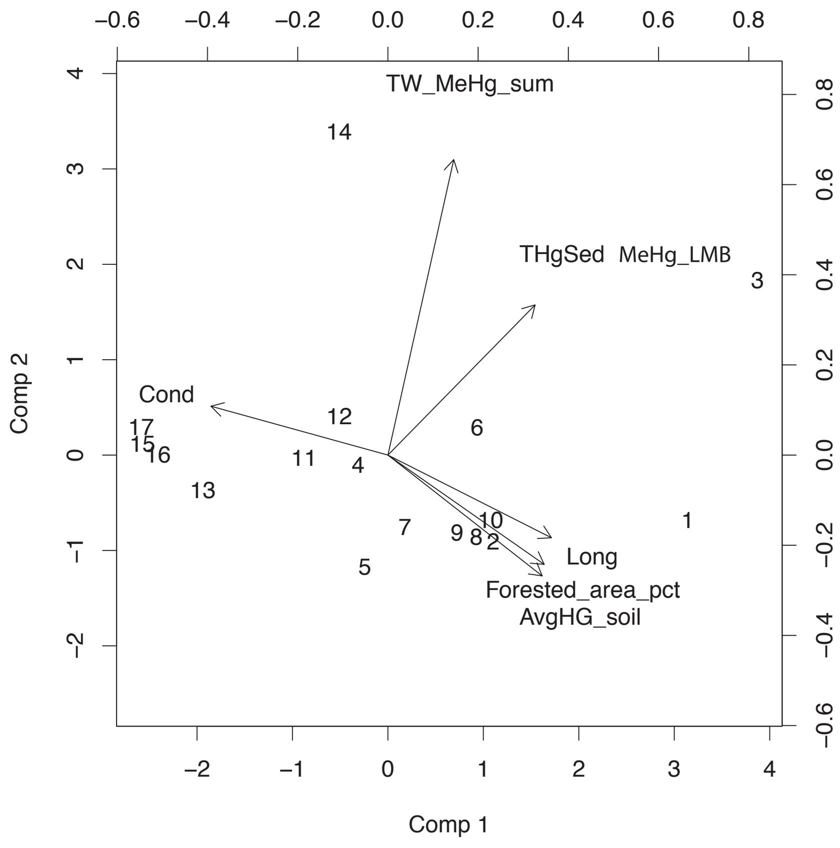
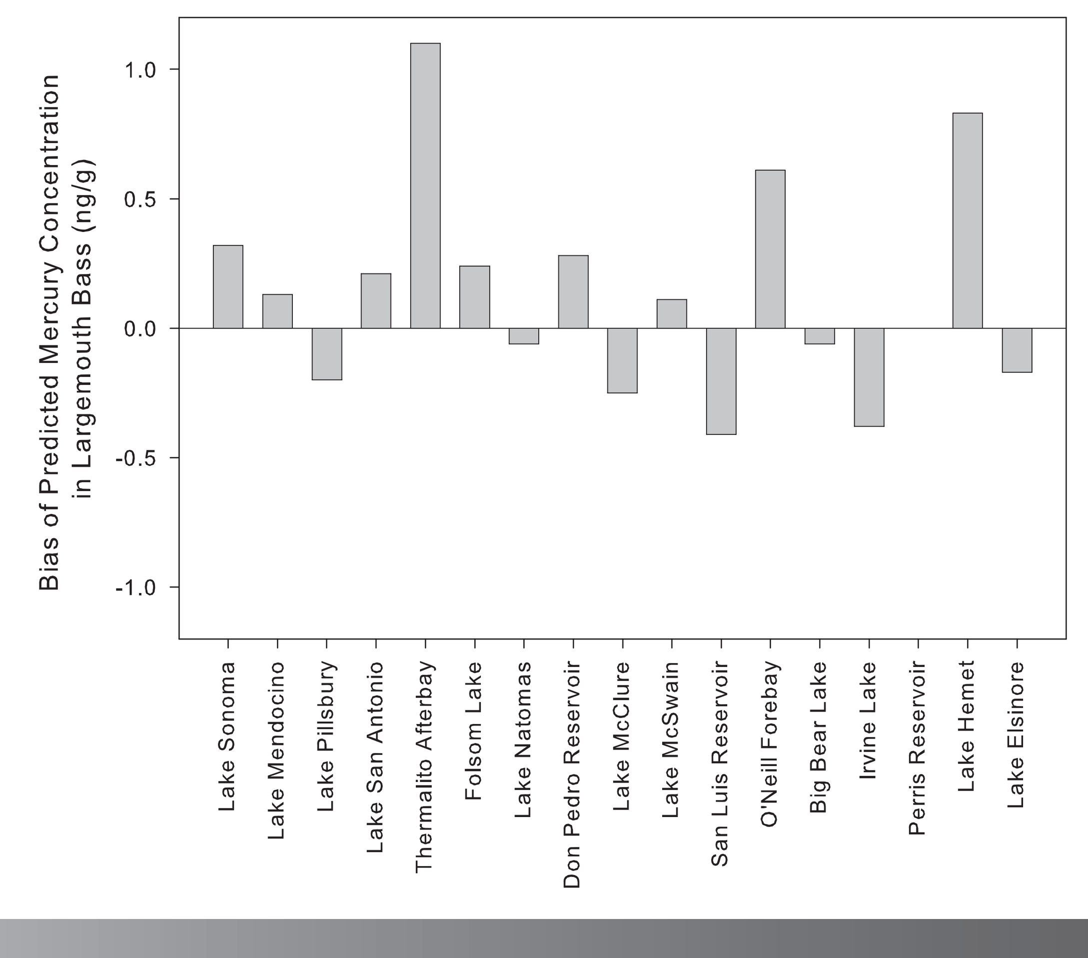


Figure 5. Comparison of bias in prediction of MeHg in size-standardized largemouth bass based on the regression model developed in this study. Bias of +0.5 indicates a 50% greater predicted than observed concentration. The majority of mean predicted values of LMB_{350} MeHg were within 250 ng•g^{-1} of the observed mean concentration. The least deviation from observed was evident at lakes in the low to moderate concentrations range (100 – 600 ng•g^{-1}).



SUMMARY

Methylmercury concentrations in largemouth bass from 17 lakes across California varied from 66 – 1314 ng•g^{-1}, with highest concentrations in the northern portion of the state. Lake variables that were related to MeHg concentrations in largemouth bass were total mercury in sediment and soils, forested area, specific conductivity, and MeHg in surface waters. These results suggest that MeHg is either suspended in the warmer surface waters or deposited in sediments on the periphery of these lakes. Both mechanisms could account for increased levels of MeHg in fish. Further studies are needed to determine whether the source of MeHg was from in-lake production or brought in externally through surficial waters.

Acknowledgments

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References

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SWAMP Surface Water Ambient Monitoring Program

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