California Statewide Mercury Control Program for Reservoirs

California Lake Management Society
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Multi-Region Team

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& many others
California Statewide Mercury Control Program for Reservoirs

Goal:
Quickly, measurably reduce fish MeHg

Website with fact sheets & updates
www.waterboards.ca.gov/water_issues/programs/mercury
Outline

(a) Hg sources

(b) Water chemistry

(c) Food web

Multiple factors

Methylmercury Production

Food Web Transfer
Limited benefits from source control
Limited Benefits from Source Control

Fish mercury

Background mercury

Elevated mercury

Reservoir sediment mercury

Fish target

units: mg/kg
Manage redox conditions

**Redox sequence:**
- $\text{O}_2$ aerobic heterotrophs
- $\text{NO}_3^-$ denitrifiers
- $\text{MnO}_2(s)$ fermenters
- $\text{Fe(OH)}_3(s)$ fermenters
- $\text{SO}_4^{2-}$ sulfate reducers
- $\text{H}^+$ methane producers

Avoid Methylmercury Production

Desirable
Oxygenation Pilot Tests

Santa Clara Valley Water District
- Solar-powered circulators
- HOS line diffuser
Santa Clara Valley Water District

Citation:
Dave Drury
SCVWD

HOS:
Hypolimnetic Oxygenation System

Citation: Dave Drury
SCVWD
Full-scale oxygenation

Maybe a bonus
Might reduce methylmercury

Effect of HOS on fish mercury
Manage redox conditions

Redox sequence:
- $O_2$ aerobic heterotrophs
- $NO_3^-$ denitrifiers
- $MnO_2(s)$ fermenters
- $Fe(OH_3)(s)$ fermenters
- $SO_4^{2-}$ sulfate reducers
- $H^+$ methane producers

Avoid
- Methylmercury Production

Desirable
Source Removal and Nitrate Addition
Onondaga Lake, New York

Citation:
Charles T. Driscoll
Syracuse University
Manage redox with NO$_3^-$

Citation:
Charles T. Driscoll
Syracuse University
Manage fishery

Food lower in MeHg
Cull fish
Select species

Food Web Transfer
Food lower in MeHg:
Algal Bloom Dilution

Fertilize
increase algae
same MeHg

Carefully
no more than 2x Chl-a
and Chl-a ≤5 ug/L
Food lower in MeHg

Stock prey with low MeHg e.g., Rainbow trout

Citation: Jesse Lepak
Cull or “intensive fishing”
Select species

Stock – hatchery diets low MeHg

- Rainbow trout

Restore native anadromous fish

Citation: Mike Horvath, SFPUC
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Source control
manage expectations

Pilot tests

(a) Hg sources
(b) Water chemistry
(c) Food web

Multiple factors

Website with fact sheets & updates
www.waterboards.ca.gov/water_issues/programs/mercury
Next: 4 stations

- Reduce Sediment Hg
- Manage Redox
- Increase Productivity
- Manage Fisheries

(a) Hg sources
(b) Water chemistry
(c) Food web
Solar-powered circulator \( \downarrow \text{MeHg} \)

Annual coincidence: MeHg & seasonal anoxia

Citation: Santa Clara Valley Water District
Manage redox with $\text{NO}_3^-$

Citation:
Charles T. Driscoll
Syracuse University
Vertical Profiles of MeHg: 2007-2011

Citation:
Charles T. Driscoll
Syracuse University
Extensive remediation at former factory sites

Upland and in-lake remediation areas

Isolation cap 172 ha

Thin layer cap 11ha

Groundwater barrier wall

Citation:
Charles T. Driscoll
Syracuse University
Hg → reservoir (source control)

(a) Hg sources
(b) Water chemistry
(c) Food web

Mines
mercury and gold
Atmospheric Deposition
Mercury from atmospheric deposition and mines

- Reservoirs with no record of upstream gold or mercury mines; 60 have fish MeHg > target
- Can have high fish MeHg but low atm dep and no mines
- Can have low fish MeHg but very high atm Hg dep
- Very highest fish MeHg associated with extensive Hg mining
California: 350 reservoirs and lakes

Multiple factors: fish species

Average of highest trophic level

Target 0.2 mg/kg
SF Bay Region: hotspot for high fish mercury levels

- Target 0.2 mg/kg
- Region 2
- Other Regions

Large dots: High prevalence of R2 reservoirs at extreme of distribution