Lower American River and Lake Natoma Methylmercury TMDL Public Participation

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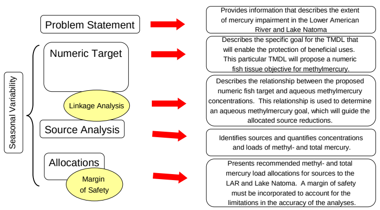
Abstract

The lower American River (LAR) from Folsom Dam to the Sacramento River is impaired due to elevated levels of methylmercury (MMHg) in fish that pose risks to human and wildlife health. Available data suggest that 33% and 21% of fish in the LAR and Lake Natoma, respectively, exceed the USEPA criterion of 0.3 ppm methylmercury for the protection of human health. Fish tissue levels will likely need to be reduced by 40-95% to protect humans and wildlife that consume LAR fish. The mercury control program will likely need to focus on reducing sources of both methylmercury and inorganic mercury to achieve fish methylmercury concentrations that are protective of human and wildlife health.

The Central Valley Water Board is developing a methylmercury TMDL (total maximum daily load) control program for the LAR to resolve the mercury impairment. Public participation is a vital component of developing the methylmercury control program. Public participation will enable stakeholders to become more informed about the impairment and about required elements of a TMDL control program. In addition, stakeholders can recommend options for numeric targets, allocations, implementation actions, etc., and identify potential environmental impacts that could result from implementation of a control program.

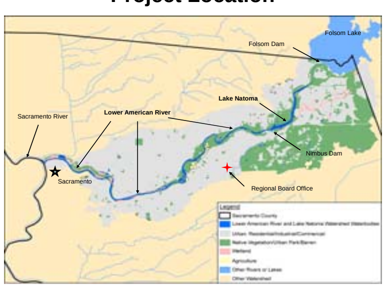
There will be a variety of opportunities for public participation during the development of the TMDL control program. This poster gives scoping-level information about the TMDL process and offers an interactive way for the public to provide verbal and written comments, ideas, and questions.

TMDL Elements



Problem Statement
Provides information that describes the extent of mercury impairment in the Lower American River and Lake Natoma
Numeric Target
Describes the specific goal for the TMDL that will enable the protection of beneficial uses. This particular TMDL will propose a numeric fish tissue objective for methylmercury.
Linkage Analysis
Describes the relationship between the proposed numeric fish target and aqueous methylmercury concentrations. This relationship is used to determine an aqueous methylmercury goal, which will guide the allocated source reductions.
Source Analysis
Identifies sources and quantifies concentrations and loads of methyl- and total mercury.
Allocations
Margin of Safety
Presents recommended methyl- and total mercury load allocations for sources to the LAR and Lake Natoma. A margin of safety must be incorporated to account for the limitations in the accuracy of the analyses.
Seasonal Variability

Project Location



Mercury Problem

- Mercury is a neurotoxicant that impairs the nervous, reproductive, and immune systems in humans and wildlife.
- Mercury can have lethal and sub-lethal effects.
- Offspring can be exposed to mercury during embryonic development.
- MMHg is one of the most toxic forms because it is more readily absorbed and excreted more slowly.
- Exposure is mainly through the consumption of fish.
- MMHg bioaccumulates.

Extent of Impairment

Summary of Mercury Concentrations in Fish Tissue Samples Collected from the Lower American River and Lake Natoma from 1970-2008.

Water Body	Fish Trophic Level	# of Samples	Average Mercury Concentration	Range of Mercury Concentrations	% of samples Exceeding USEPA Criteria (0.3 ppm)
Lower American River	3	112	0.14	0.029 - 0.75	8%
	4	103	0.48	0.062 - 1.43	60%
Lake Natoma	3	144	0.12	0.020 - 1.95	5%
	4	114	0.46	0.069 - 1.98	42%

Numeric Target Evaluation

- Numeric targets are the specific goals for the TMDL that will enable the protection of the beneficial uses of the LAR and Lake Natoma.
- Board staff proposes a numeric fish tissue target for mercury because it provides the most direct assessment of fishery conditions and improvements.

Target Options for the Protection of Human and Wildlife Health

Scenarios	Acceptable Daily LAR Fish MMHg Intake Level (ug/kg-day)	Total Consumption Rate of LAR Fish (g/day)	Proportion of LAR Fish in Diet			Possible Targets: Safe Concentrations of mercury in Fish by Trophic Level (TL) (mg/kg, w.w.)		
			TL2	TL3	TL4	TL2	TL3	TL4
A.1	0.073	17.5	21.7%	45.7%	32.6%	0.04	0.21	0.58
A.2			---	50%	50%		0.15	0.43
A.3			---	---	100%			0.29
B.1	0.073	32	21.7%	45.7%	32.6%	0.02	0.11	0.32
B.2			---	50%	50%		0.08	0.24
B.3			---	---	100%			0.16
C.1	0.1	17.5	21.7%	45.7%	32.6%	0.05	0.28	0.80
C.2			---	50%	50%		0.21	0.59
C.3			---	---	100%			0.40
D.1	0.1	32	21.7%	45.7%	32.6%	0.03	0.16	0.44
D.2			---	50%	50%		0.12	0.32
D.3			---	---	100%			0.22
E.1	0.073	61	21.7%	45.7%	32.6%	0.01	0.06	0.17
E.2			---	50%	50%		0.04	0.12
E.3			---	---	100%			0.08
F.1	0.1	61	21.7%	45.7%	32.6%	0.01	0.08	0.23
F.2			---	50%	50%		0.06	0.17
F.3			---	---	100%			0.11
G.1	0.1	142.4	21.7%	45.7%	32.6%	0.01	0.03	0.10
G.2			---	50%	50%		0.03	0.07
G.3			---	---	100%			0.05

For people eating fish from commercial markets and the lower American River, the safe intake level of methylmercury from lower American River fish is the USEPA reference dose minus the methylmercury from commercial fish (Scenarios A, B, and E). Scenarios C, D, F, and G assume no commercial fish are consumed. 17.5 g/day = one 8-ounce, uncooked, fish meal every two weeks; 32 g/day = 1 fish meal/week; 61 g/day = 2 meals/week; 142 g/day = 4.4 meals/week. Yellow boxes highlight fish tissue concentrations levels that will also be protective of wildlife consumers of fish.

Questions for stakeholders:

1. Are there other fish consumption scenarios that should be evaluated?

Methyl- and Inorganic Mercury Sources

- Folsom Lake discharge to Lake Natoma
- Upstream sources to Folsom Lake
- Atmospheric deposition
- Urban stormwater and tributary runoff
- NPDES facility dischargers
- River and lake bottom sediment flux
- Mine dredge tailings

Summary of Aqueous Total Mercury Samples Collected from the Lower American River and Lake Natoma Watersheds.

Station Name	n	Mean (ng/L)	Minimum	Median	Maximum
AR @ Discovery Park	240	2.60	0.46	1.71	18.51
Sump 111	41	23.31	2.16	22.7	72.3
AR @ Guy West Bridge	3	1.60	0.99	1.13	2.67
Strong Ranch Slough	40	90.64	3.07	28.75	1137.9
AR @ Goethe Park	8	2.12	0.57	1.46	6.23
AR @ Sunrise Blvd	2	1.96	1.25	1.955	2.66
AR @ Nimbus	199	2.09	0.083	1.33	15.4
Lake Natoma Bottom	1	1.64	1.64	1.64	1.64
Lake Natoma Top	5	0.99	0.476	0.876	1.63
Alder Creek	5	2.40	1.48	2.273	3.681
Willow Creek	14	20.88	1.83	7.63	110
Hinkle Creek	1	2.71	2.712	2.712	2.712
Folsom Lake Discharge	6	0.95	0.49	0.716	1.9
Folsom Lake Bottom	1	0.83	0.83	0.83	0.83
Folsom Lake Top	3	0.77	0.504	0.839	0.966

Summary of Aqueous Methylmercury Samples Collected from the Lake Natoma Watershed.

Station Name	n	Mean (ng/L)	Minimum	Median	Maximum
AR @ Nimbus	103	0.045	0.0096	0.033	0.406
Lake Natoma Bottom	6	0.018	0.01	0.01	0.04
Lake Natoma Top	6	0.028	0.01	0.0265	0.042
Lake Natoma Runoff 2	1	0.104	0.104	0.104	0.104
Alder Creek	5	0.192	0.082	0.177	0.294
Lake Natoma Willow Creek Arm	4	0.056	0.01	0.042	0.128
Willow Creek	14	0.256	0.049	0.127	0.998
Hinkle Creek	5	0.104	0.058	0.086	0.167
Lake Natoma Wetland 1	5	0.033	0.01	0.026	0.061
Lake Natoma Wetland 2	1	0.033	0.033	0.033	0.033
Folsom Lake Discharge	6	0.023	0.01	0.02	0.04
Folsom Lake Bottom	5	0.029	0.01	0.03	0.055
Folsom Lake Top	5	0.038	0.024	0.032	0.0695

Summary of Aqueous Methylmercury Samples Collected from the Lower American River Watershed.

Station Name	n	Mean (ng/L)	Minimum	Median	Maximum
AR @ Discovery Park	122	0.071	0.01	0.0575	0.714
Sump 111	26	0.287	0.0351	0.184	1.05
AR @ Hwy 80	19	0.073	0.025	0.0581	0.229
AR @ Guy West Bridge	3	0.051	0.044	0.0492	0.0609
Strong Ranch Slough	27	0.451	0.067	0.237333	2.04
Arden Pond	6	0.241	0.076	0.2325	0.454
LAR Pond 2	2	0.104	0.042	0.1035	0.165
LAR Wetland 3	1	0.177	0.177	0.177	0.177
LAR Wetland 2	4	0.045	0.01	0.0435	0.081
LAR Wetland 1	5	0.049	0.035	0.053	0.065
AR @ Goethe Park	12	0.053	0.035	0.051	0.0928
LAR Pond 4	1	4.690	4.69	4.69	4.69
San Juan Pond	2	0.089	0.049	0.089	0.129
Minnesota Creek	4	0.101	0.035	0.111	0.146
AR @ Sunrise Blvd	2	0.054	0.0508	0.0539	0.057
AR @ Nimbus	103	0.045	0.0096	0.033	0.406

Total Mercury Source Loads to Lake Natoma and the Lower American River.

Source/Sink	THg Load (g/yr)	% of Sources to Lake Natoma	% of Sources to LAR
Folsom Dam	3135	35%	
Urban Runoff/Urban Tribs[a]	218	2%	
Sediment Flux[b]	91	1%	
Atmospheric Deposition (Direct and Indirect)[c]	28	0.3%	
Hatchery & Canal[d]	-157	--	
Evasion[e]	-696	--	
Unknown Source to Lake Natoma/Error	**5,403**	61%	
Nimbus Dam	**8,022**		63%
Urban Runoff[a]	2,003		16%
Sediment Flux[b]	252		2%
Atmospheric Deposition (Direct and Indirect)[c]	55		0.4%
Evasion[d]	-1915		--
NPDES Facilities[f]	171		1%
Unknown Source to LAR/Error	**2202**		17%
American River @ Discovery Park	**10,790**		

[a] LWA, 2009. Sacramento Stormwater Quality Partnership, Additional Total Mercury and Methylmercury Analyses.
[b] Choe, 2004. Sediment Flux = 130 ng/m2/day
[c] Stephenson, 2008. Wet Deposition = 2.1 ng/m^2/day, Dry Deposition = 4.5 ng/m^2/day, multiplied by runoff coefficient.
[d] Loads calculated using reported export flow data (CA DFG = 59 cfs, Canal = 40 cfs) multiplied by average CA DFG influent total mercury concentrations.
[e] Stephenson, 2008. Evasion = 0.99 ug/m^2/day
[f] Bosworth, 2010. A Review of Methylmercury Discharges from NPDES Facilities in California's Central Valley for DGS Office of State Publishing. CA DFG loads calculated from SMR data. The two Aerojet permittees had no available data.

Methylmercury Source Loads to Lake Natoma and the Lower American River.

Source/Sink	MeHg Load (g/yr)	% of Sources to Lake Natoma	% of Sources to LAR
Folsom Dam	76.8	54%	
Urban Runoff/Urban Tribs[a]	2.4	2%	
Open Water Sediment Flux[b]	3.3	2%	
Atmospheric Deposition (Wet Deposition only)[c]	0.6	0.4%	
Hatchery & Canal[d]	-4.0	--	
Instream Wetlands[e]	7.9	6%	
Upstream Wetlands[f]	13	9%	
Unknown Source to Lake Natoma/Error	**37**	26%	
Nimbus Dam	**137**		62%
Urban Runoff[a]	21.6		10%
Open Water Sediment Flux[b]	9		4%
Atmospheric Deposition (Direct and Indirect)[c]	1		0.5%
Instream Wetlands[e]	23		10%
Upstream Wetlands[f]	12.8		6%
NPDES Facilities[g]	3.5		2%
Unknown Source to LAR/Error	**13**		6%
American River @ Discovery Park	**221**		

[a] LWA, 2009. Sacramento Stormwater Quality Partnership, Additional Total Mercury and Methylmercury Analyses.
[b] Stephenson, 2008. Sediment Flux = 4.65 ng/m^2/day
[c] Stephenson, 2008. MeHg wet deposition = 3.4% THg wet deposition. No estimate of MeHg dry deposition.
[d] Loads calculated using reported export flow data (CA DFG = 59 cfs, Canal = 40 cfs) multiplied by average CA DFG influent methylmercury concentrations.
[e] Wood, 2010. Delta wetland production rates: warm season = 40.6 ng/m^2/yr and cool season = 3.0 ng/m^2/yr. Wetland acreage located within 50 meters of mainstem water bodies.
[f] Wood, 2010. Delta wetland production rates: warm season = 40.6 ng/m2/yr and cool season = 3.0 ng/m2/yr. Wetland acreage located outside of 50 meters from mainstem water bodies.
[g] Bosworth, 2010. A Review of Methylmercury Discharges from NPDES Facilities in California's Central Valley. CA DFG loads calculated using SMR water effluent volumes. Aerojet Sacramento Facility had no available data.

Questions for stakeholders:

1. Are there others sources of methyl or inorganic mercury that should be considered?
2. Sediment flux is calculated using estimates from the Delta. Are there other flux rates available that would be more appropriate for the LAR watershed?
3. Loading rates from LAR dredge tailings have not been determined yet. Have mercury loading rates from runoff through dredge tailings been evaluated elsewhere?

Potential Fish Mercury Reduction Strategy Options

- Reduce concentrations of methylmercury in the water column to reduce fish tissue mercury concentrations.
  - Reduce discharges of MMHg.
  - Reduce methylation or promote de-methylation.
    - Reduce concentrations of THg in the sediment.
    - Adjust factors that control the rate of MMHg production or de-methylation.
- Adjust factors that control the rate of bioaccumulation.
- Incorporate a phased, adaptive management approach.

Possible Implementation Actions

- Reduce or remove inorganic mercury in the sediment.
  - Erosion control of contaminated sediment.
  - Cleanup of mine tailings adjacent to the river or lake.
  - Cleanup or cap contaminated sediment in the river or lake.
- Adjust water management practices to reduce methylation.
- Reduce Hg/MMHg from Folsom Lake and upstream.
- Develop plans to minimize mercury impacts from land use changes.
- Conduct studies to identify feasible THg and MMHg control options.
- BMP's for methylmercury reduction and erosion control.

Questions for stakeholders:

1. Are there other control options that could be implemented?

Allocations

- TMDL = The amount of a specific pollutant that a water body can receive and still meet water quality standards.

TMDL = wasteload allocations + load allocations

(point sources) (nonpoint sources)

Each point and nonpoint source must be assigned an allocation (maximum allowable load or concentration).

Allocation strategy options:

- Same % reduction to all sources?
- Variable % reduction, depending on source characterization?

Questions for stakeholders:

1. Can you suggest possible allocation strategies given variations in the distribution of inorganic and methyl- mercury from source loads?

Please share ideas, recommendations, and questions!

Write answers to questions and recommendations for options for numeric targets, allocations, implementation actions, etc. using the comment sheets provided. Return to the envelope labeled, "Return comments here".

Additional Information

More specific information regarding the background of the project including past and future stakeholder meetings, source analyses, numeric target calculations, draft reports, etc. can be found at the Central Valley Water Board website:

http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/american_river_hg/index.shtml

Questions, comments, and suggestions can also be sent to sjlouie@waterboards.ca.gov or the above address.

References

Bosworth, D.H., S.J. Louie, M.L. Wood, D.J. Little, and H. Kulesza. 2010. A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley. California Regional Water Quality Control Board, Central Valley Region, Final Staff Report. March 2010.

Choe, K., G. A. Gill, R. D. Lehman, S. Han. 2004. Sediment-water exchange of total mercury and monomethyl mercury in the San Francisco Bay-Delta. Limnology Oceanography, 49: 1512-1527.

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Wood, M.L., C.G. Foe, J.C. Cooke, S.J. Louie. 2010. Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury. California Regional Water Quality Control Board, Central Valley Region, Staff Report. April 2010.