Hetch Hetchy Reservoir Bioaccumulation Study (Hg)

July 2009

Bioaccumulation Symposium
California Department of Public Health
Richmond, CA

December 17, 2012

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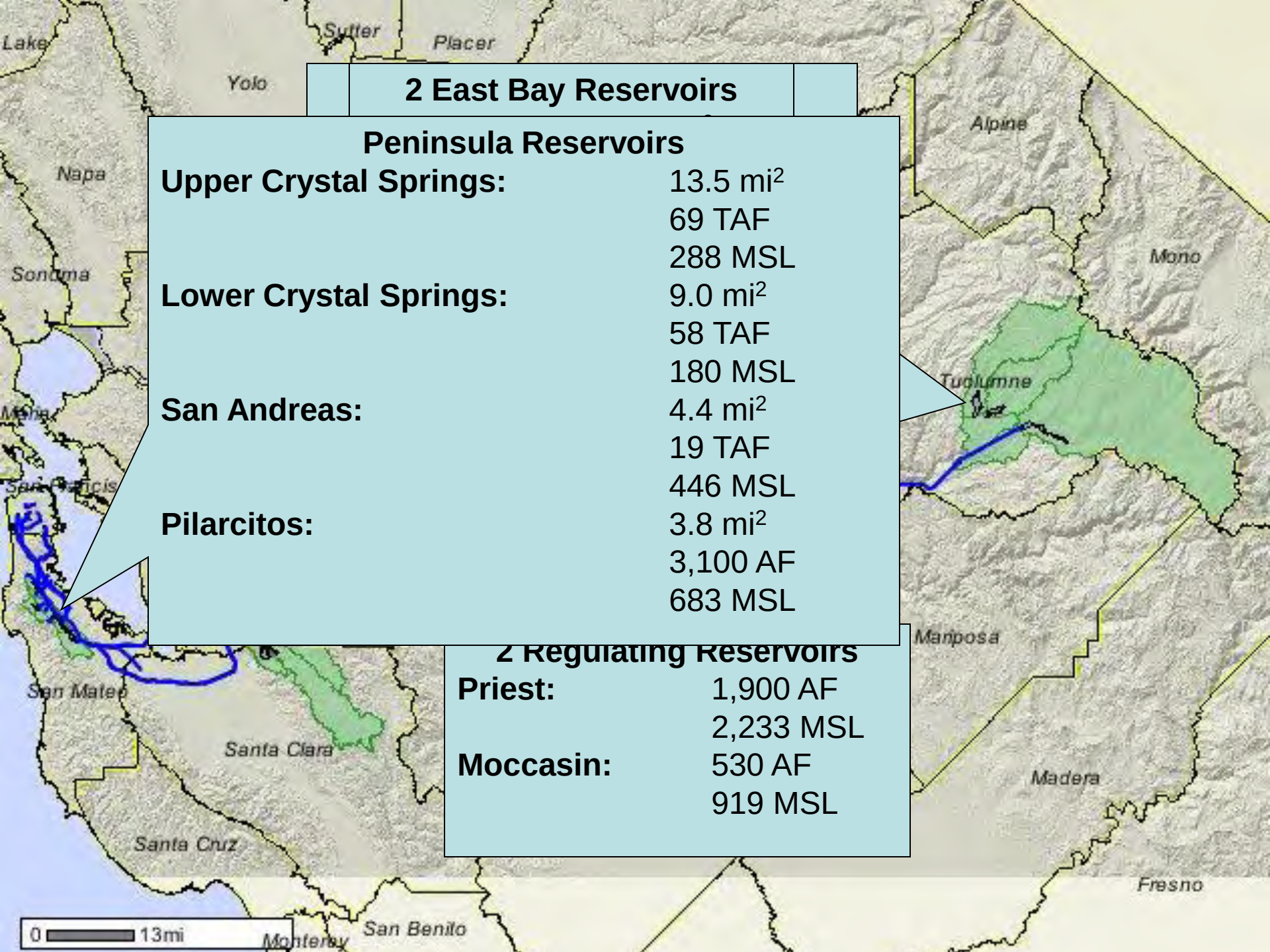
San Francisco Public Utilities Commission

Natural Resources and Land Management Division

Moccasin, CA

Don’t Eat the Fish



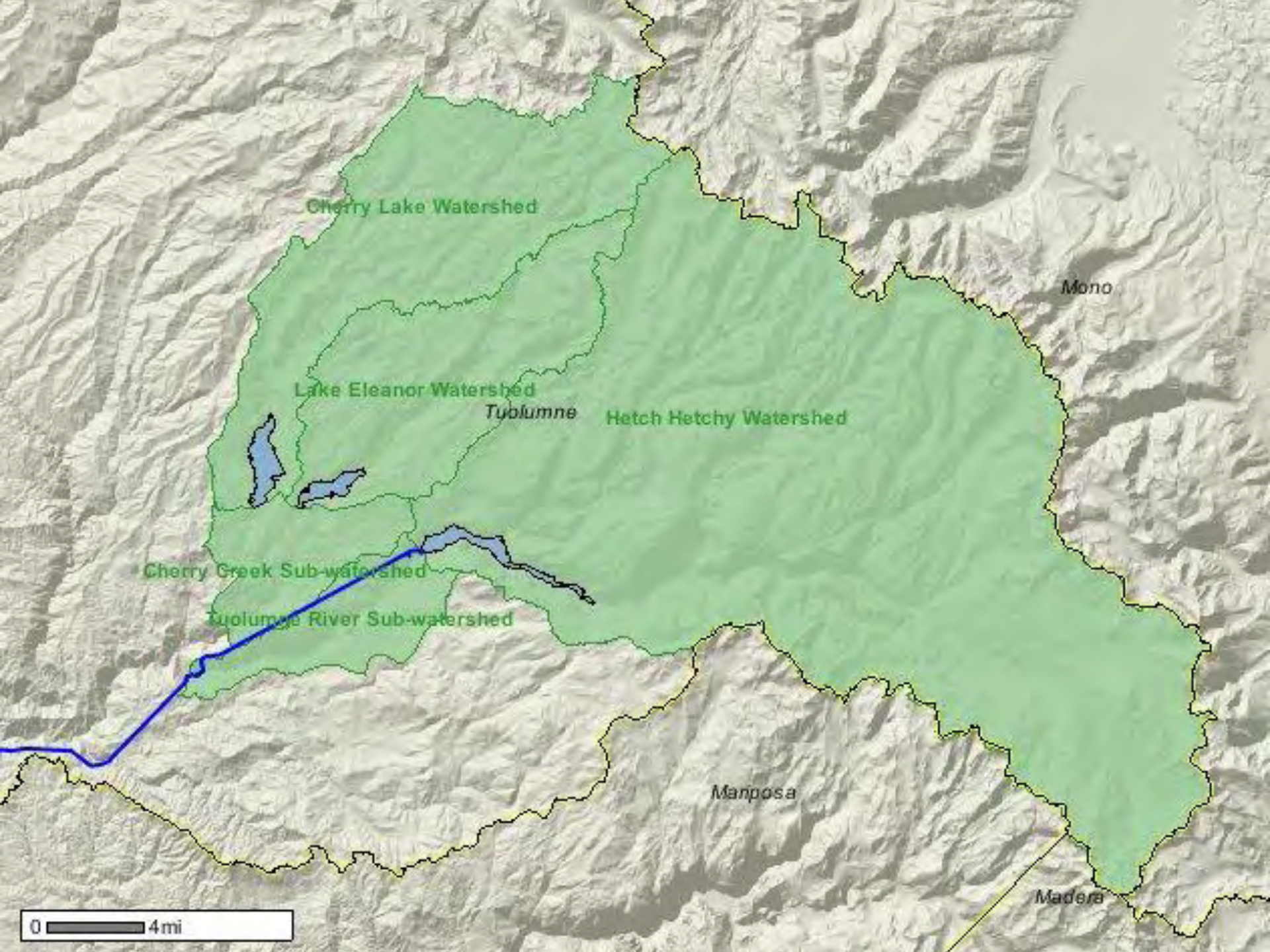
2 East Bay Reservoirs

Peninsula Reservoirs

Upper Crystal Springs:	13.5 mi^2
	69 TAF
	288 MSL
Lower Crystal Springs:	9.0 mi^2
	58 TAF
	180 MSL
San Andreas:	4.4 mi^2
	19 TAF
	446 MSL
Pilarcitos:	3.8 mi^2
	3,100 AF
	683 MSL

2 Regulating Reservoirs

Priest:	1,900 AF
	2,233 MSL
Moccasin:	530 AF
	919 MSL


Cherry Lake Watershed
Mono
Lake Eleanor Watershed
Tuolumne
Hetch Hetchy Watershed
Cherry Creek Sub-watershed
Tuolumne River Sub-watershed
Mariposa
Madera
0
4 mi

TUOLUMNE
RIVER

BACKGROUND

- 2007 SWAMP study revealed high Hg in fish tissue (only two samples)
- SFPUC initiated study in 2009 to:
  - Validate SWAMP study (more samples)
  - Test fish length vs. mercury concentration
  - Compare rainbow and brown trout [Hg]
  - Test sediment mercury in 3 reaches
  - Test water mercury 3 reaches, 3 depths
  - Measure water quality parameters

METHODS (Field)

- Fish
  - Hook & line, downriggers, trolling
  - Bagged (2X) and immediately frozen
- Water
  - Teflon kemmerer
  - EPA clean hand / dirty hand method
  - Field / equipment blanks with ultrapure water
- Sediment
  - SS Ekman dredge, acid wash between samples
  - All samples double bagged

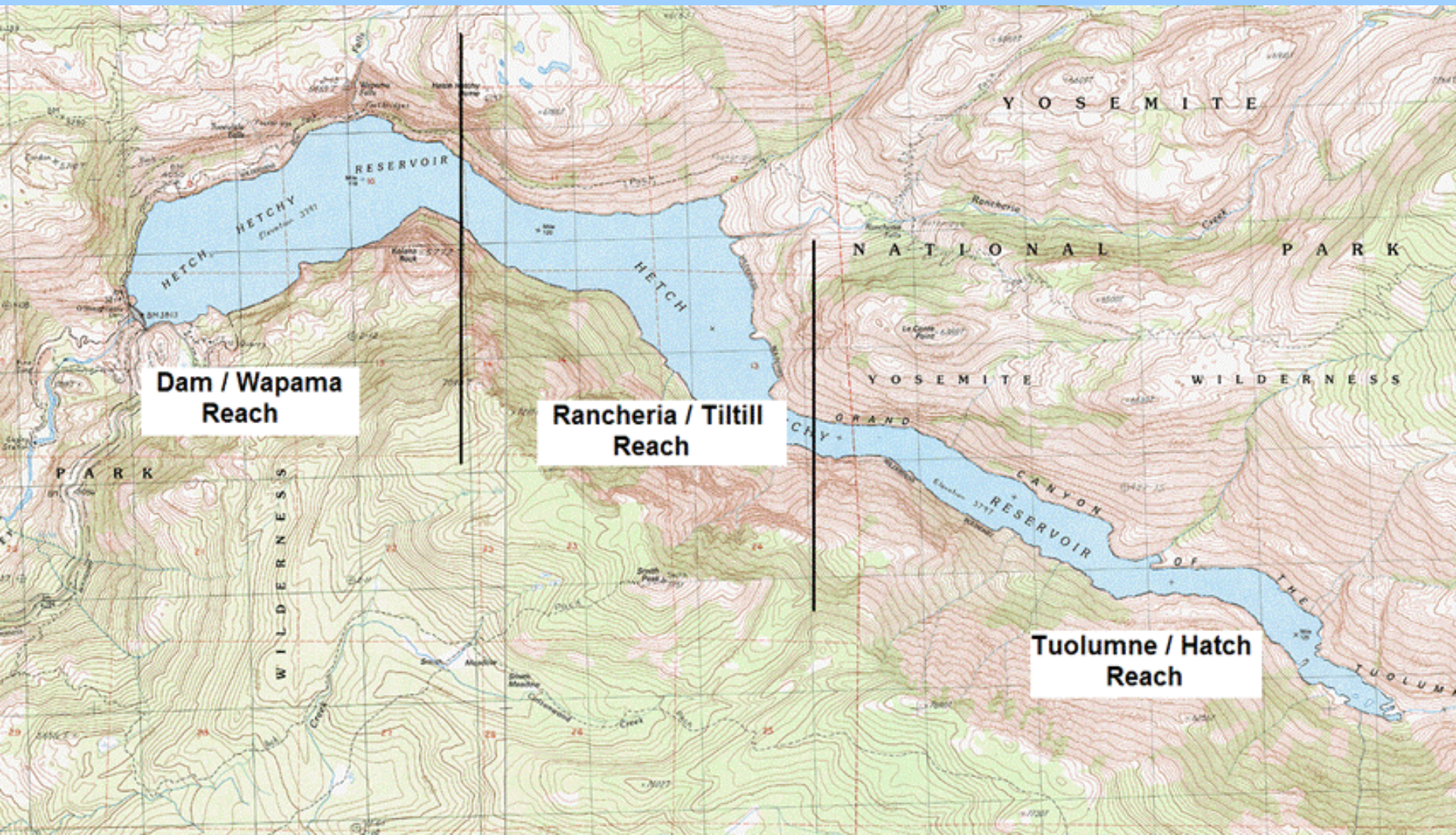
METHODS (SFPUC Southeast Laboratory)

- Fish tissue
  - EPA 1631, Inductively coupled plasma mass spectrometry
  - Duplicates, spiked samples, low MDL
- Water
  - EPA 1631E, Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry
- Sediment
  - EPA Method 7471A, Cold Vapor Atomic Absorption Method for solid/semi-solid

Dam Wapama
Falls Creek
46 mi^2

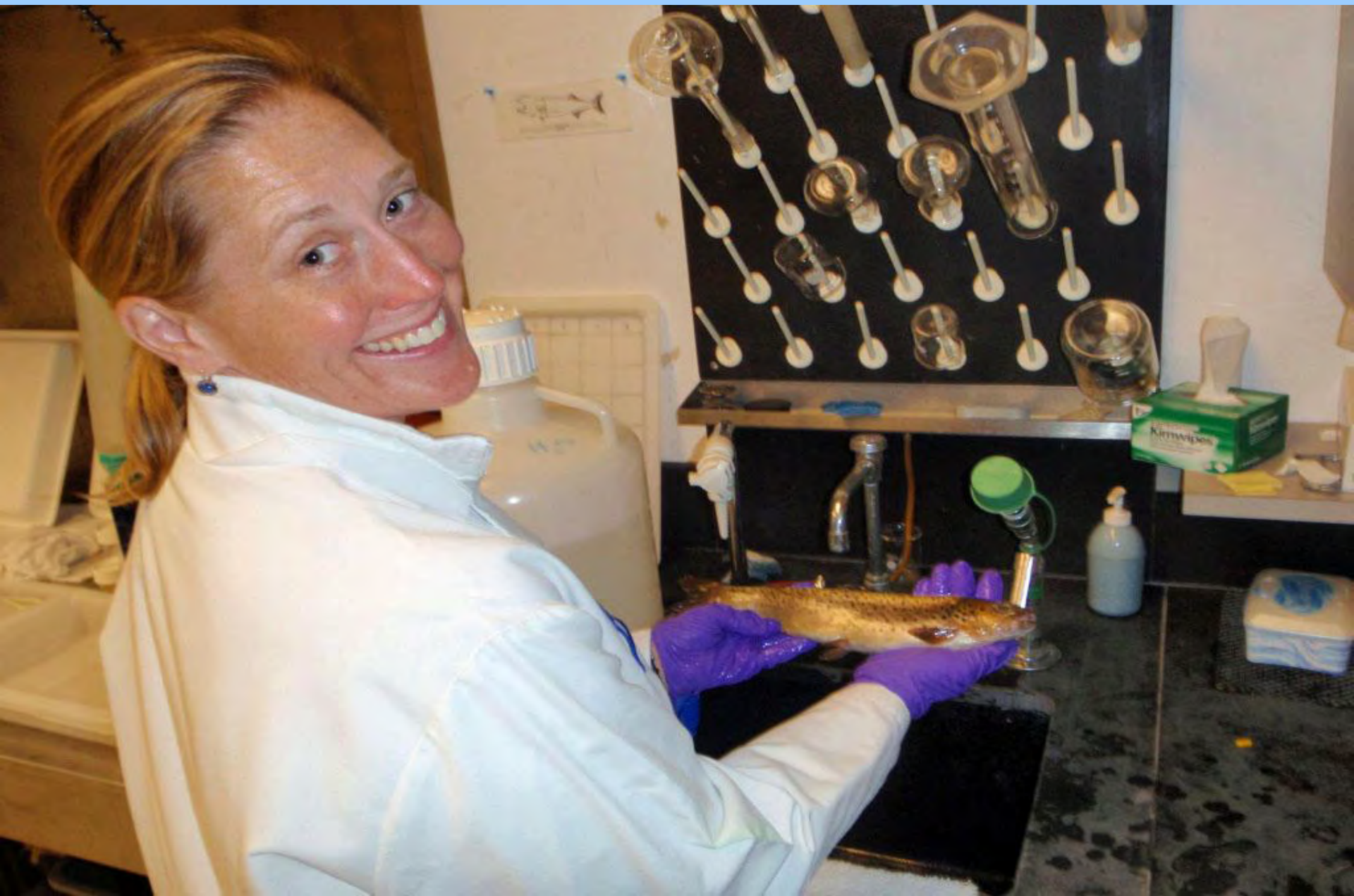
Rancheria Tiltill
65 mi^2

Tuolumne Hatch
(Tuolumne 301 mi^2)
325 mi^2



4 sed samples – problems with deployment – but good data

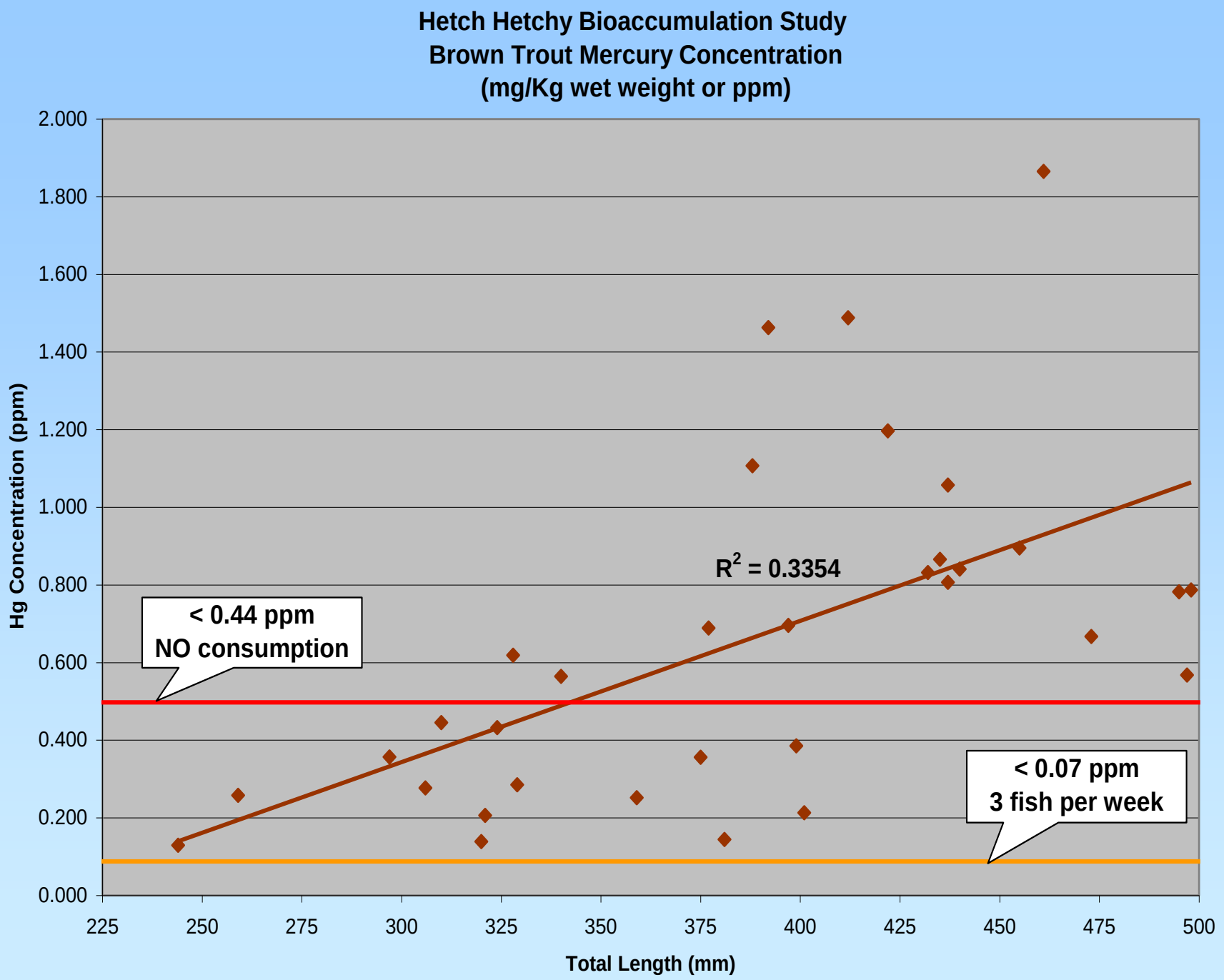
Cleaning – DI water wash & rinse

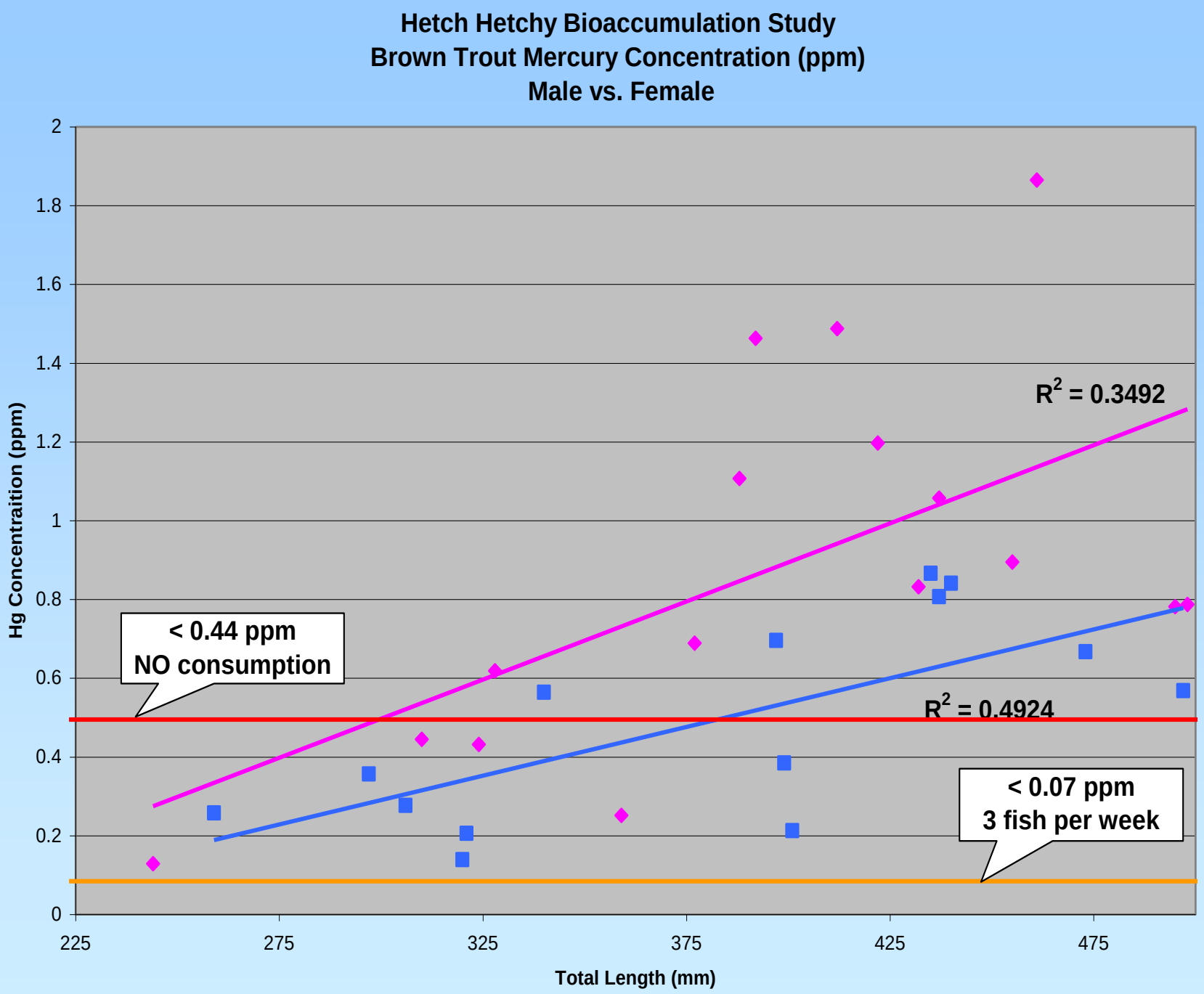


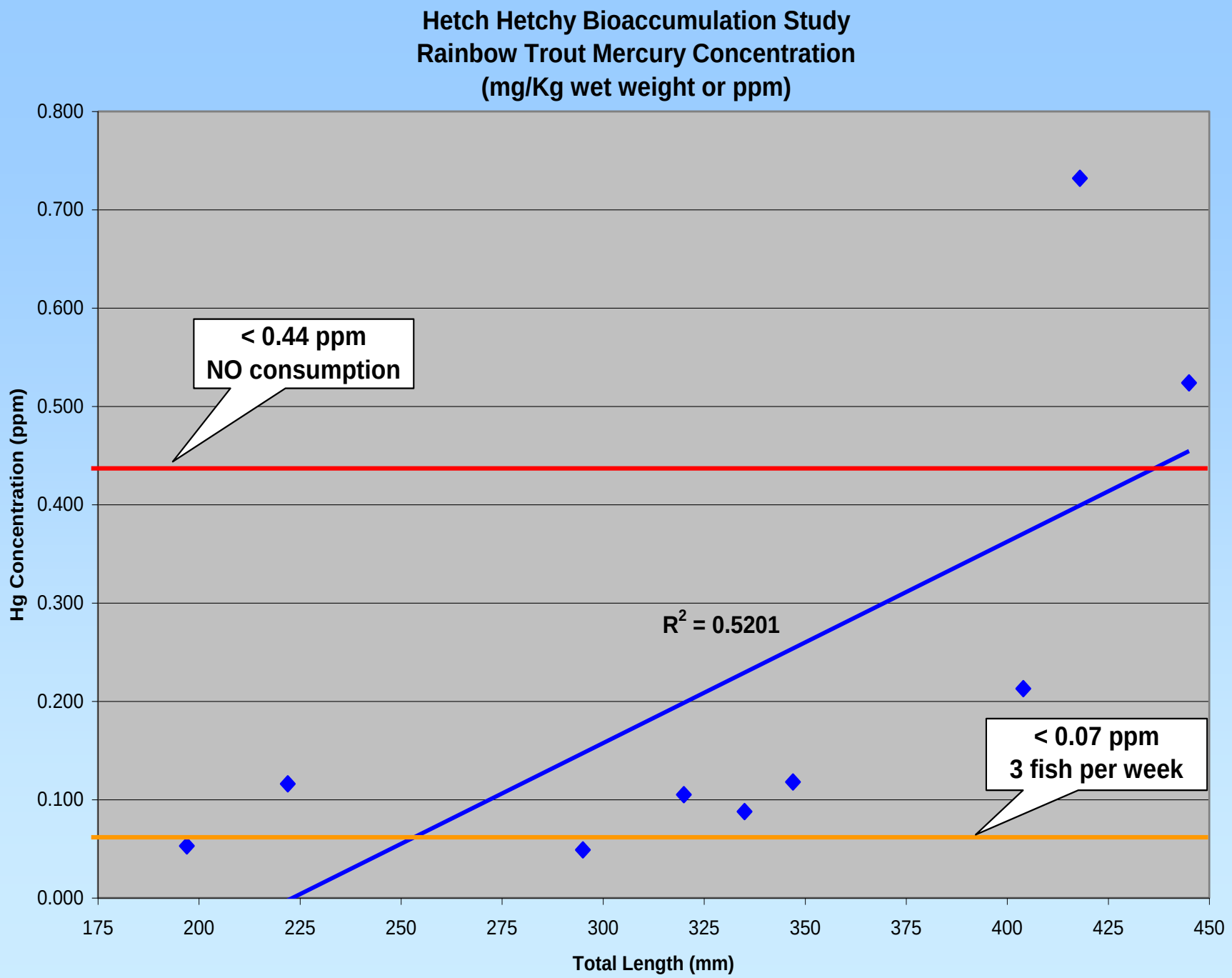
Tissue dissection – hood, nose breathe

SWAMP 0.54 and 0.96 (brown trout, composites, Tuolumne Reach
OEHHA 0.07 3 fish per week 0.44 NO consumption

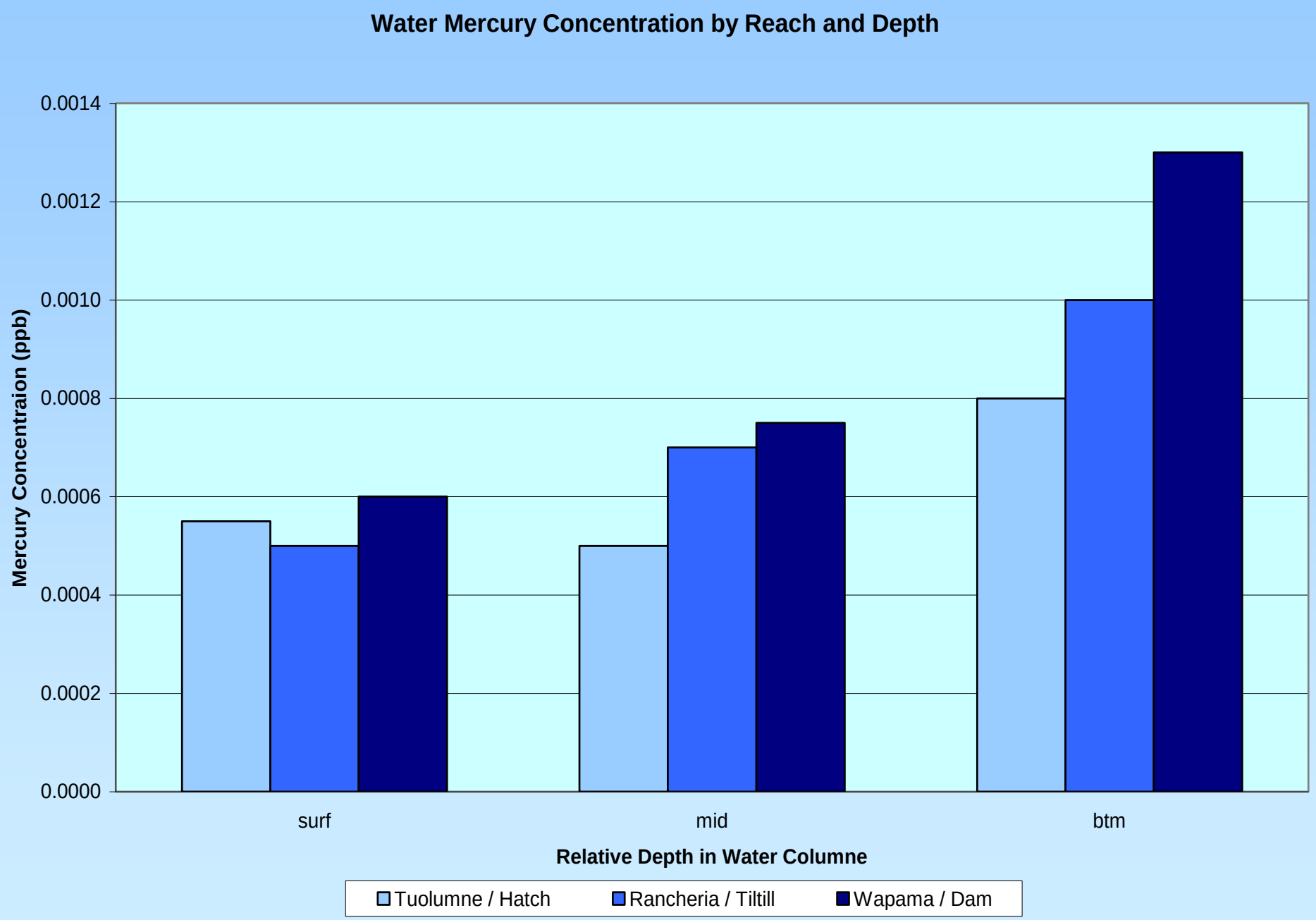
		BROWNS				RAINBOWS			
		ALL	HDW	RAN	WAP	ALL	HDW	RAN	WAP
both sexes	TL (mm)	386 (33)	422 (11)	383 (11)	353 (11)	331 (9)	7	1	1
	Hg (ppm)	0.66	0.64	0.74	0.59	0.22			
male	TL (mm)	380 (14)	405 (4)	405 (3)	355 (7)	321 (4)			
female		396 (16)	454 (5)	381 (7)	349 (4)	376 (4)			
male	Hg (ppm)	0.49	0.50	0.47	0.49	0.20			
female		0.88	0.92	0.92	0.76	0.29			
		3 unk	2 unk	1 unk		1 unk			


Hetch Hetchy Bioaccumulation Study
Brown Trout Mercury Concentration
(mg/Kg wet weight or ppm)
Hg Concentration (ppm)
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
225
250
275
300
325
350
375
400
425
450
475
500
Total Length (mm)
R2 = 0.3354
< 0.44 ppm
NO consumption
< 0.07 ppm
3 fish per week


Hetch Hetchy Bioaccumulation Study
Brown Trout Mercury Concentration (ppm)
Male vs. Female
Hg Concentraition (ppm)
Total Length (mm)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
225
275
325
375
425
475
R2 = 0.3492
R2 = 0.4924
< 0.44 ppm
NO consumption
< 0.07 ppm
3 fish per week


Hetch Hetchy Bioaccumulation Study
Rainbow Trout Mercury Concentration
(mg/Kg wet weight or ppm)
Hg Concentration (ppm)
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
175
200
225
250
275
300
325
350
375
400
425
450
Total Length (mm)
< 0.44 ppm
NO consumption
R2 = 0.5201
< 0.07 ppm
3 fish per week

Drinking Water MCL = 2 ppb

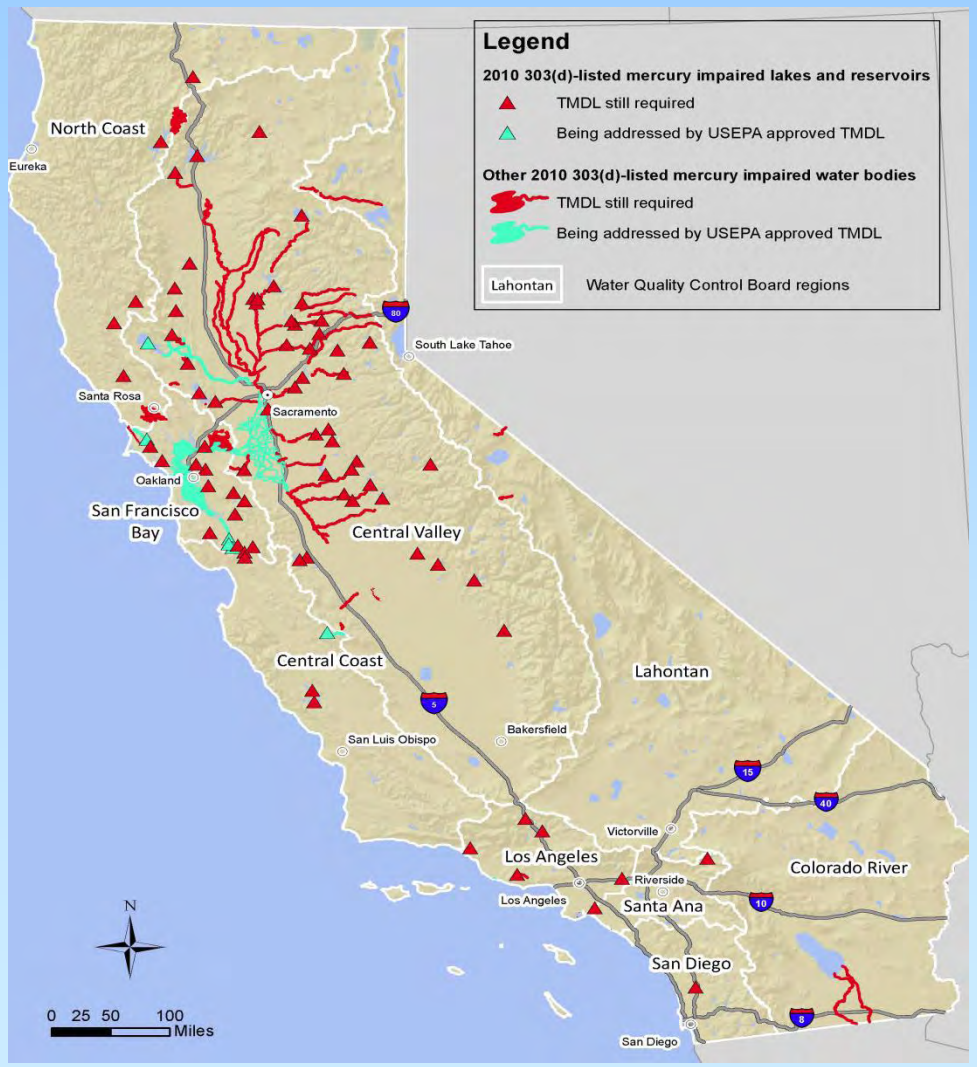


Sediment (only 4 samples) (ppm)

Lake Sediment Comparison

Sediment Mercury (total) ppb	Hetch Hetchy	
Dam Wapama	186	237
Rancheria Tiltill	165	
Tuolumne Hatch	31	
Other Remote Lakes		
Swedish forest lakes	50-300	
N. Wisconsin	63-289	
Rocky Mountain	90-100	
Finnish lkaesw	134-277	
Lake Baikal	40	
Lake Superior	16-209	
Not so Remote (polluted)		
Onondaga Lake NY	1,000-50,000	
Clear Lake, CA	30,000-150,000	

WHAT NEXT?



CWA 303(d) listing

Development of TMDL

Consumption Advisories

Watershed Wide Study

Atmospheric deposition

Educate

National Park Service
U.S. Department of the Interior

Yosemite National Park

Mapping and Attributing Sources of Mercury Bioaccumulation in the Tuolumne River Watershed

April 23, 2012 Update

Heather McKenny, Leland Tarnay, Ninette Daniele (NPS)
Mike Horvath (SFPUC)

Study Objectives

- To quantify the magnitude & extent of Methyl mercury bioaccumulation at two trophic levels within lake, river and reservoir ecosystems
- Qualitatively identify the extent to which regional vs. global air pollutants may be contributing to bioaccumulation

Methods: Air Sampling

- Passive sampling
- Surrogate

Methods:

- Sampled water, fish, and zooplankton from:
  - 8 natural lakes stratified throughout the Tuolumne River Watershed
  - 2 locations on Tuolumne River (Lyell Fork and below the O'Shaughnessy Dam)
  - 2 reservoirs (Cherry and Eleanor)
- Samples are being analyzed by the SFPUC laboratory

Tilden
Wilma Lake
Kibbie Lake
Benson
Vernon
Cherry Lake
Eleanor Lake
McCabe Lakes
Below Hetch Hetchy Dam
Hetch Hetchy Reservoir
Dog Lake
Lyell Fork, Tuolumne River
Spillway
Evelyn Lake
Tioga Rd
395
120
Image © 2012 GeoEye
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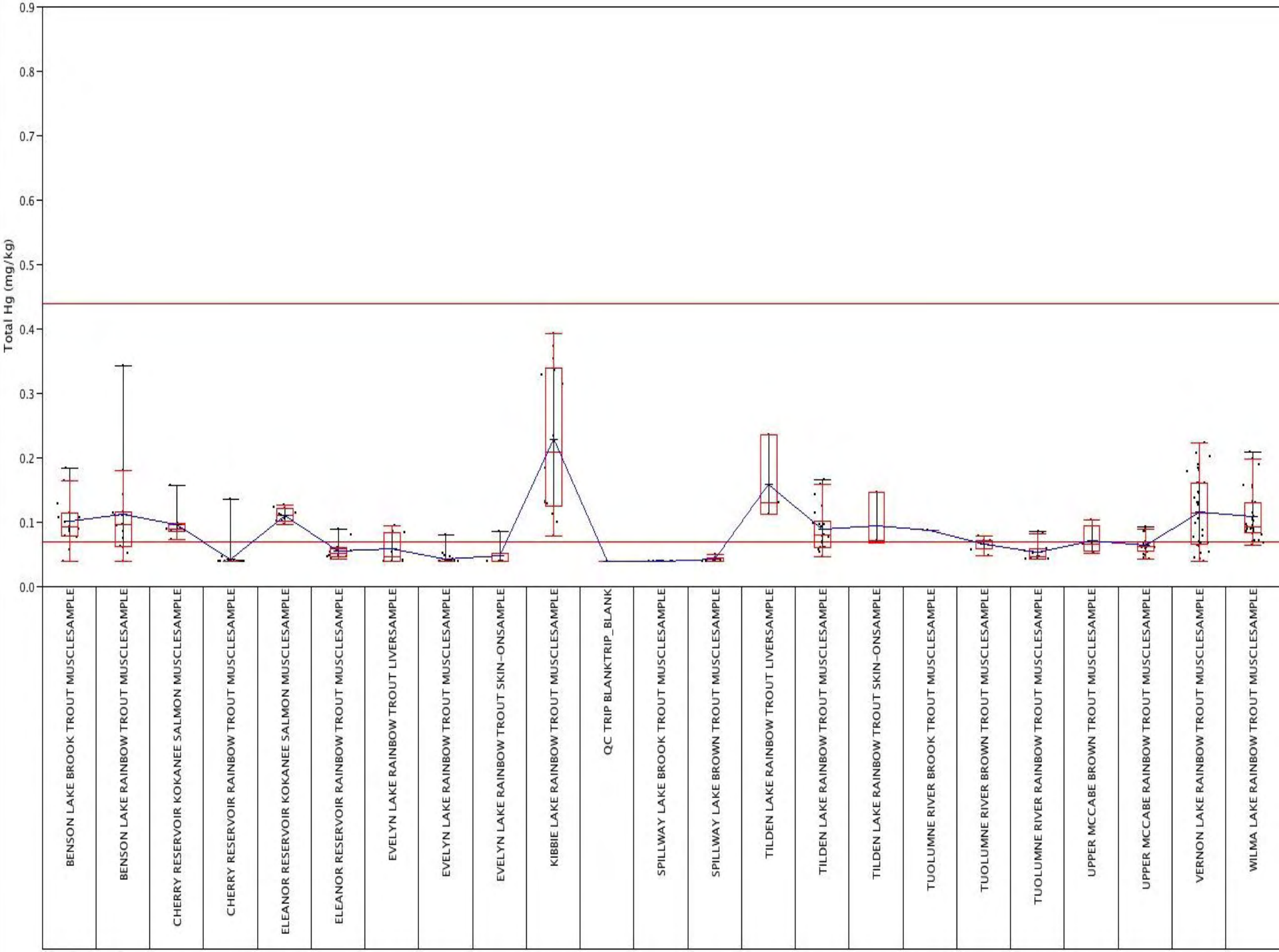
Image USDA Farm Service Agency
Google earth

Samples

Name	Rainbow Trout	Brown Trout	Brook Trout	Kokanee Salmon	Zooplankton	Water
Kibbie Lake	30	-	-	-	Yes	Yes
Tilden Lake	30	-	-	-	Yes	Yes
Wilma Lake	30	-	-	-	Yes	Yes
Lake Vernon	36	-	-	-	Yes	Yes
Benson Lake	15	-	15	-	Yes	Yes
Upper McCabe Lake	20	4	-	-	No	No
Spillway Lake	-	15	16	-	Yes	Yes
Evelyn Lake	30	-	-	-	Yes	Yes
Lyell Fork Tuolumne River	4	11	4	-	No	Yes
Tuolumne River below Dam	20	-	9	-	No	No
Cherry Lake	34	-	-	8	Yes	Yes
Lake Eleanor	12	-	-	13	Yes	Yes
Dog Lake	-	-	-	-	Yes	Yes


Total Hg (mg/kg)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
BENSON LAKE BROOK TROUT MUSCLESAMPLE
BENSON LAKE RAINBOW TROUT MUSCLESAMPLE
CHERRY RESERVOIR KOKANEE SALMON MUSCLESAMPLE
CHERRY RESERVOIR RAINBOW TROUT MUSCLESAMPLE
ELEANOR RESERVOIR KOKANEE SALMON MUSCLESAMPLE
ELEANOR RESERVOIR RAINBOW TROUT MUSCLESAMPLE
EVELYN LAKE RAINBOW TROUT LIVERSAMPLE
EVELYN LAKE RAINBOW TROUT MUSCLESAMPLE
EVELYN LAKE RAINBOW TROUT SKIN-ONSAMPLE
KIBBIE LAKE RAINBOW TROUT MUSCLESAMPLE
QC TRIP BLANKTRIP_BLANK
SPILLWAY LAKE BROOK TROUT MUSCLESAMPLE
SPILLWAY LAKE BROWN TROUT MUSCLESAMPLE
TILDEN LAKE RAINBOW TROUT LIVERSAMPLE
TILDEN LAKE RAINBOW TROUT MUSCLESAMPLE
TILDEN LAKE RAINBOW TROUT SKIN-ONSAMPLE
TUOLUMNE RIVER BROOK TROUT MUSCLESAMPLE
TUOLUMNE RIVER BROWN TROUT MUSCLESAMPLE
TUOLUMNE RIVER RAINBOW TROUT MUSCLESAMPLE
UPPER MCCABE BROWN TROUT MUSCLESAMPLE
UPPER MCCABE RAINBOW TROUT MUSCLESAMPLE
VERNON LAKE RAINBOW TROUT MUSCLESAMPLE
WILMA LAKE RAINBOW TROUT MUSCLESAMPLE

THE END (take 1)

just came from the doctor,
turns out i got humans

Acknowledgements

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