

DATA FROM M. WOOD ORB

R. Bluff - KNIGHTS L.
32/144 EXCEED
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5/21/2002 Sacramento River, Verona	Sacramento River (Red Bluff to Delta)	1995 Asiatic Claira	ST
5/21/2002 Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	1995 Asiatic Claira	ST
1/31/2006 Sacramento River, Verona	Sacramento River (Red Bluff to Delta)	2003 American shad	F
1/31/2006 Sacramento River, Knights Landing	Sacramento River (Red Bluff to Delta)	2002 Largemouth Bass	X
1/31/2006 Sacramento River, Knights Landing	Sacramento River (Red Bluff to Delta)	2002 Largemouth Bass	X
1/31/2006 Sacramento River, Knights Landing	Sacramento River (Red Bluff to Delta)	2002 Sacramento Sucker	F
1/31/2006 Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	2002 Sacramento Pike Minn	X
1/31/2006 Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	2002 Sacramento Sucker	F
1/31/2006 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	2002 Rainbow Trout	F
5/16/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1998 Rainbow Trout	F
5/16/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1999 Rainbow Trout	F
5/16/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1997 Rainbow Trout	F
1/4/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1991 Crayfish	F
4/4/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1991 Crayfish	F
4/4/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1991 Crayfish	F
1/1/2002 Sacramento River, Hamilton City	Sacramento River (Red Bluff to Delta)	1981 Hardhead	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1983 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1990 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1982 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1986 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1989 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1980 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1992 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1992 Rainbow Trout	L
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1988 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1981 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1982 Sacramento Sucker	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1993 Rainbow Trout	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1987 Sacramento Sucker	F
1/1/2002 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1996 Rainbow Trout	F
1/1/2002 Sacramento River, Shasta Dam	Sacramento River (Shasta Dam to Red Bluff)	1985 Rainbow Trout	F
2/18/2003 Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	2001 Rainbow T Composite	F
5/23/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2000 Largemouth Bass	X
5/23/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2000 Sacramento Pike Minn	F
5/23/2002 Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2000 White Catfish	F
5/23/2002 Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	2000 Striped Bass	X
5/23/2002 Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	2000 Sacramento Pike Minn	F

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TSMP, 2002
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5/23/2002	Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	2000	Sacramento Sucker	F
5/23/2002	Sacramento River, Hamilton City	Sacramento River (Red Bluff to Delta)	2000	Sacramento Pike Minn	F
5/23/2002	Sacramento River, Hamilton City	Sacramento River (Red Bluff to Delta)	2000	Sacramento Sucker	F
5/23/2002	Sacramento River, Bend Bridge	Sacramento River (Shasta Dam to Red Bluff)	2000	Sacramento Sucker	F
5/23/2002	Sacramento River, Bend Bridge	Sacramento River (Shasta Dam to Red Bluff)	2000	Rainbow Trout	F
5/23/2002	Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	2000	Rainbow Trout	F
5/20/2002	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1997	White Catfish	X
5/20/2002	Sacramento River, Bend Bridge	Sacramento River (Shasta Dam to Red Bluff)	1997	Rainbow Trout	F
5/20/2002	Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1998	Rainbow Trout	F
5/20/2002	Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1997	Rainbow Trout	F
5/20/2002	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1998	Largemouth Bass	X
3/12/2002	Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	1998	Sacramento Pike Minn	X
3/12/2002	Sacramento River, Colusa	Sacramento River (Red Bluff to Delta)	1998	Carp	F
5/20/2002	Sacramento River, Hamilton City	Sacramento River (Red Bluff to Delta)	1998	Sacramento Pike Minn	F
5/20/2002	Sacramento River, Hamilton City	Sacramento River (Red Bluff to Delta)	1998	Sacramento Sucker	F
5/20/2002	Sacramento River, Bend Bridge	Sacramento River (Shasta Dam to Red Bluff)	1998	Sacramento Pike Minn	F
5/20/2002	Sacramento River, Keswick Dam	Sacramento River (Shasta Dam to Red Bluff)	1998	Rainbow Trout	F
5/20/2002	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	1999	Sacramento Sucker	F
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	F
1/31/2006	Sacramento River, Veterans Bridge	Sacramento River (Red Bluff to Delta)	2003	Largemouth Bass	F
1/31/2006	Sacramento River, Grimes	Sacramento River (Red Bluff to Delta)	2003	Sacramento Pike Minn	X

Shasta Dam — Veterans' Bridge.

State Water Board's Proposed 303(d) Listing of the Sacramento River from Knights Landing to Red Bluff for Mercury Impairment

Comments Prepared by Michelle Wood, Environmental Scientist, Mercury TMDL Unit,
Central Valley Water Board, 1 February 2006

Two issues are addressed in this document: (1) a response to comments from Greg Jones (City Manager, City of Chico) on the State Water Board's proposed 303(d) listing of the Sacramento River from Knights Landing to Red Bluff for mercury impairment, and (2) an evaluation of data not included in the State Water Board's analysis described in the 2004 303(d) Listing Fact Sheet for mercury in the Sacramento River.

According to the 2004 303(d) Listing Fact Sheet, State Water Board staff based the proposed listing of the 154-mile segment of the Sacramento River from Knights Landing to Red Bluff on the results from a total of five fish samples collected at Knights Landing and Colusa. Based on my evaluation of this five-sample dataset and the expanded dataset, I conclude:

- I would not have listed the river segment upstream of Knights Landing based on the five-sample dataset; however,
- I would list the river segment Knights Landing to Hamilton City based on the expanded dataset.

My evaluation and data summaries are described below. I can provide the full dataset and my calculations electronically in an Excel file upon request.

Response to Comments from the City of Chico

State Water Board staff based the proposed listing of a 154-mile segment of the Sacramento River [Knights Landing (river mile [RM] 90) to Red Bluff (RM244)] based on the results from five fish samples collected at two locations in 2002 by the Toxic Substances Monitoring Program (TSMP):

- Knights Landing (RM90): one largemouth bass composite (5 fish) sample with 0.763 mg/kg mercury (wet weight), one largemouth bass single-fish sample with 0.604 mg/kg mercury, and one Sacramento sucker composite (5 fish) sample with 0.194 mg/kg mercury.
- Colusa (RM144): one Sacramento pike minnow composite (5 fish) sample with 0.505 mg/kg mercury and one Sacramento sucker composite (6 fish) sample with 0.076 mg/kg mercury.

The City of Chico¹ argues that these five samples are not representative of the 154-mile river reach listed as impaired. First, Jones stated that largemouth bass and Sacramento pike minnow are highly mobile, and that the largemouth bass sampled at Knights Landing – adjacent to the confluence of the Sacramento River and Colusa Basin Drain – could easily have traveled from the impaired section of the Sacramento River (Knights Landing to Delta). My review of available literature indicates that one of the reasons largemouth bass are considered a good bioindicator species is because they have high site fidelity compared to many freshwater species (Davis and Greenfield, 2002). As noted in Davis and Greenfield's 2002 CalFed-funded study on mercury levels in Delta and Central Valley sport fish, "Of 1206 tag returns

¹ The City of Chico Waste Water Treatment Plant effluent enters the Sacramento River at approximately RM194; therefore, listing of this segment of the river as impaired by mercury could affect the permitted mercury loading from the Chico WWTP to be determined by the Sacramento River mercury TMDL that is currently being developed.

recorded by CDFG, 65% of the fish were found within 1 mile of the site of release, 83% were within 5 miles, and the median distance was 0 miles (Ray Schaffter, CDFG, unpublished data)". However, even with such high site fidelity by largemouth bass, the Knights Landing samples cannot be assumed to be indicative of upstream impairment because of the nearby (within one mile) Colusa Basin Drain confluence. Fish mercury data collected between 1997 and 2003 by the Sacramento River Watershed Program (SRWP), TSMP and Central Valley Water Board indicate that, if the State Water Board's binomial distribution is used to evaluate compliance with OEHHA's screening level of 0.3 mg/kg mercury (wet weight) in fish tissue, both Colusa Basin Drain and the Knights Landing reach of the Sacramento River are impaired by mercury. In addition, available aqueous mercury data indicate the Colusa Basin Drain may contribute to the impairment of the Sacramento River, which is why the previous 303(d) List indicated the river as impaired from the Delta to Knights Landing. Therefore, because of the potential mobility of the fish and mercury contributions from Colusa Basin Drain, I advise against using the fish data collected from the Sacramento River at Knights Landing to characterize the river segment between Red Bluff and Knights Landing.

Second, Jones stated that the City of Chico also feels that the data used in the proposed listing violates Section 6.1.5.2 of the State Water Board's 303(d) Listing Policy (SWRCB, 2004) because the proposed listing uses data collected at RM90 and RM144 to characterize conditions another 100 miles upstream (Red Bluff is located at approximately RM244). Section 6.1.5.2 ("Spatial Representation") of the State Water Board's 303(d) Listing Policy states the following:

"Samples should be representative of the water body segment. To the extent possible, samples should represent statistically or in a consistent targeted manner the segment of the water body. Samples collected within 200 meters of each other should be considered samples from the same station or location. However, samples less than 200 meters apart may be considered to be spatially independent samples if justified in the water body fact sheet." [Page 23]

The State Water Board policy does not directly address the maximum river distance that can be characterized by one sampling location. Even given the mobility of fish, I do not think that fish samples collected at RM144 can be considered representative of conditions 100 miles upstream without additional supporting information (e.g., more fish sampling locations or a comparison of methyl and total mercury concentrations in water collected at RM144 and other locations between RM144 and RM244). In addition, it could be inferred that fish sampled greater than 200 meters apart should not be grouped as one site. Regardless of such an inference, I do not recommend grouping data collected 54 miles apart as one site for statistical analysis, as was done in the Fact Sheet. If the two sites are not grouped, then only one of the two samples collected at RM144 exceeds OEHHA's screening level of 0.3 mg/kg. This exceedance frequency does not meet the definition of impairment defined by State Water Board's use of the binomial distribution. Per Section 3.5 and Table 3.1, if there are only two samples in the data set, then both samples must exceed the screening level to list the water segment as impaired.

Based only on the small data set and sampling locations reviewed by the 2004 303(d) Listing Fact Sheet, I would not list the Sacramento River from Knights Landing to Red Bluff (RM244) as impaired by mercury. **However, as reviewed below, additional data are available.** This data review indicates that the Sacramento River may be impaired – at a minimum – from Knights Landing to Hamilton City (RM199).

Review of Additional Fish Mercury Data

The Fact Sheet for the proposed Sacramento River listing included five fish composites collected by the TSMP in 2002. However, more fish mercury data are available. Fish sampling on the Sacramento River

began in 1970. Figure 1 illustrates by year the fish mercury data collected from 1970 to 2003 between Veterans Bridge and Shasta Dam. Figure 2 graphs the same data set by river mile. The TSMP has collected fish samples on the Sacramento River since 1980. Between 1998 and 2003, fish sampling was funded by the TSMP, Sacramento River Watershed Program, and Central Valley Water Board. The results of the 2003 sampling funded by the Central Valley Water Board became available in September 2004 and included 90 samples collected between Knights Landing and Red Bluff.

Table 1 summarizes the results for samples collected from "edible" fish between Veterans Bridge and Keswick Dam from 1998 to 2003, the period defined by the greatest data collection efforts. Central Valley Water Board defines "edible" for humans as greater than 150 mm or greater than any legal catch limit (e.g., 305 mm / 12 inches for largemouth bass). Per Table 3.1 of the State Water Board's listing policy, a sample size between 2 and 24 samples must have at least 2 samples with mercury concentrations equal to or greater than OEHHA's screening level for the water segment to be considered impaired. A sample size between 25 and 26 samples must have at least 3 samples with mercury concentrations equal to or greater than OEHHA's screening level for the water segment to be considered impaired. According to this statistic, the river segment between Knights Landing and Hamilton City (RM199) would be considered impaired. Two samples collected at Bend Bridge (RM258, about 14 miles upstream of Red Bluff) exceed the OEHHA screening level. However, with a sample size of 29, two exceedances do not result in the fish at Bend Bridge being considered impaired. Therefore, the impairment ends at some undefined location between Hamilton City and Bend Bridge. Based on the available data and the State Water Board's listing policy, I recommend defining the extent of impairment as Knights Landing to Hamilton City.

Central Valley Water Board staff does not use the State Water Board's binomial distribution to define the extent of impairment for mercury TMDLs. Instead, staff refers to the weighted average² mercury concentration in edible trophic level (TL) 3 and 4 fish.³ Table 2 summarizes the weighted average mercury concentrations in TL3 and TL4 fish sampled from the Sacramento River. If the OEHHA screening level of 0.3 mg/kg were compared to the TL4 fish mercury levels, the Sacramento River would be considered impaired from Knights Landing to Hamilton City. If the OEHHA screening level of 0.3 mg/kg were compared to the weighted average mercury of the pooled TL3/4 data set, the Sacramento River could possibly be considered impaired only in particular segments near Knights Landing and near Ord Bend (RM169), but not impaired for some undefined segment in between these two sites. Central Valley Water Board staff currently proposes water quality objectives for the Delta of 0.24 mg/kg in TL4 fish and 0.08 mg/kg in TL3 fish. If similar

Table 2. Summary of Mercury in Sacramento River fish by Trophic Level

River Mile	Site	Weighted Average Mercury Concentration		
		TL3	TL4	Pooled Samples
71	Veterans Bridge	0.098	0.795	0.706
90	Knights Landing	0.194	0.737	0.490
125	Grimes	0.125	0.452	0.249
144	Colusa	0.120	0.395	0.254
169	Ord Bend	0.142	0.692	0.373
199	Hamilton City	0.041	0.407	0.224
258	Bend Bridge	0.052	0.284	0.114
302	Keswick Dam	0.040		0.040

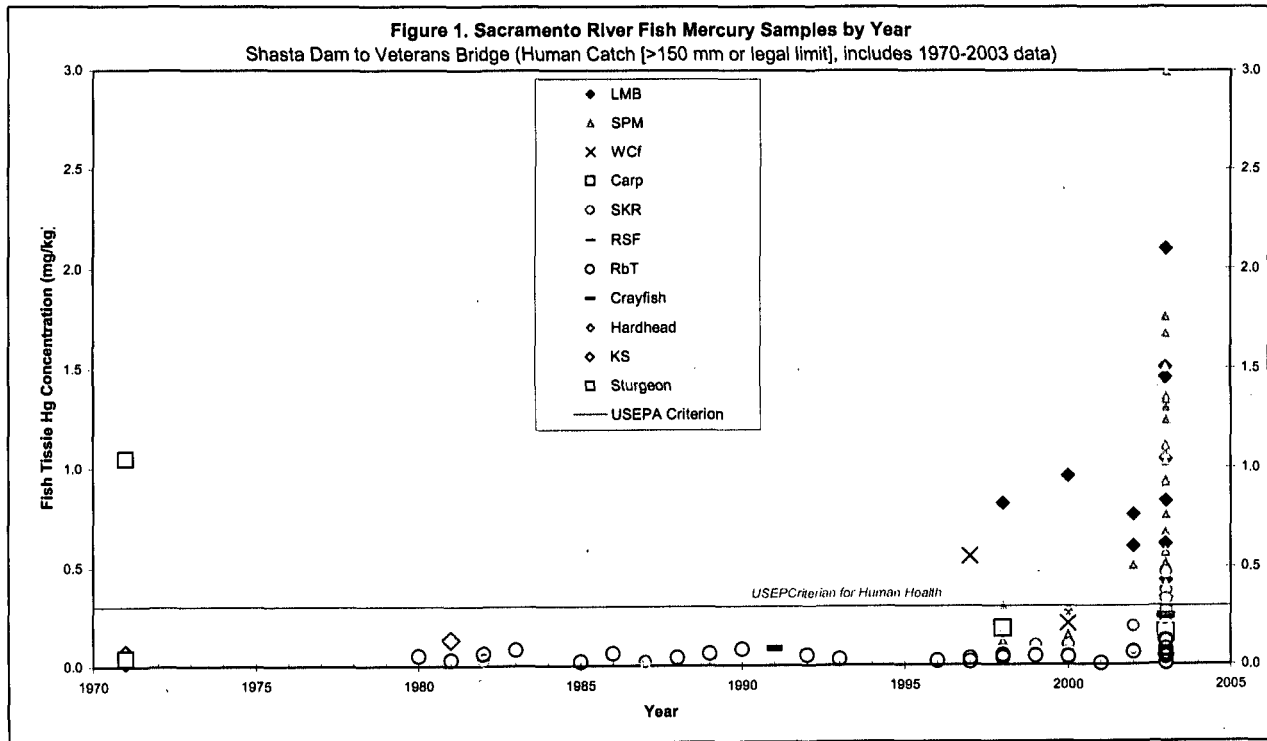
² The weighted average mercury concentration is based on the number of fish in the composite samples analyzed, rather than the number of samples.

³ Trophic levels are numerical descriptions of an aquatic food web. The USEPA's 1997 Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism's feeding habits:

- Trophic level 1: Phytoplankton and bacteria.
- Trophic level 2: Zooplankton, benthic invertebrates and some small fish.
- Trophic level 3: Organisms that consume zooplankton, benthic invertebrates, and other TL2 organisms.
- Trophic level 4: Organisms that consume TL3 organisms.

objectives were adopted for the Sacramento River, then the extent of impairment would be defined as Knights Landing to Bend Bridge for TL4 fish and to Ord Bend for TL3 species.

Based on a weight of evidence approach that maintains consistency with the State Water Board's listing policy, I recommend that the Sacramento River be listed as impaired by mercury from Knights Landing to Hamilton City. In about a year the extent of impairment can be re-evaluated using new data. An immense CalFed-funded fish sampling effort in the Central Valley – including many Sacramento River locations – was completed in Fall 2005. The analytical results are expected to be available by early 2007. Central Valley Water Board staff will re-evaluate the extent of mercury impairment as part of the Sacramento River mercury TMDL development process once the 2005 fish sampling results are available and recommend edits to the 303(d) List as needed.



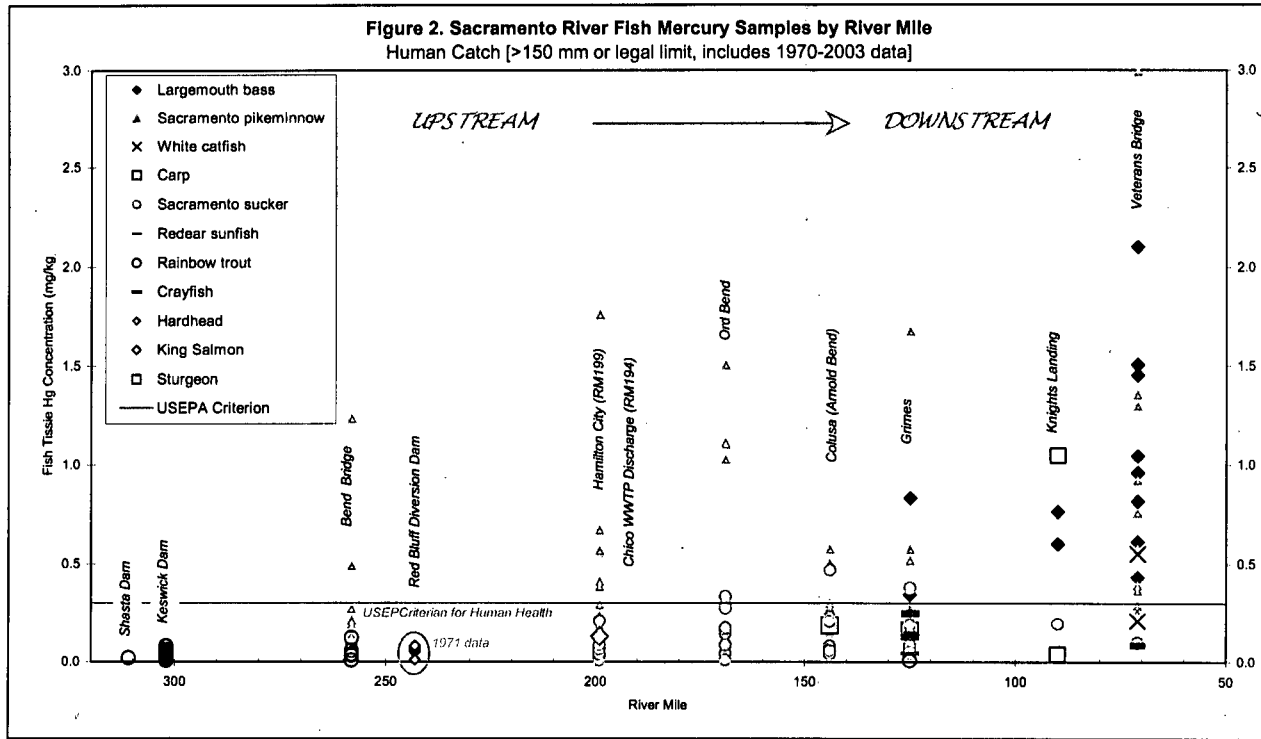


Table 1. Summary of Mercury Concentration Data for Samples Collected from Edible Fish between Veterans Bridge and Keswick Dam from 1998 to 2003

River Mile	Site	Data Description	Trophic Level 3 Fish					Trophic Level 4 Fish				All Edible	
			Carp	Rainbow Trout	Redear Sunfish	Sacramento Sucker	Pooled TL3	Largemouth Bass	Sacramento Pike Minnow	White Catfish	Pooled TL4	FISH Pooled	
71	Veterans Bridge	# of Samples			1	1	1	8	10	1	19	20	
		# of Fish			5	5	5	16	13	5	34	39	
		Ave Hg Conc (mg/kg)			0.098	0.098	0.098	1.116	0.920	0.210	0.965	0.922	
		Weighted Ave Hg Conc (mg/kg)			0.098	0.098	0.098	1.002	0.765	0.210	0.795	0.706	
		# of Samples > 0.3 mg/kg						8	8		16	16	
90	Knights Landing	# of Samples			1	1	2				2	3	
		# of Fish			5	5	6				6	11	
		Ave Hg Conc (mg/kg)			0.194	0.194	0.194	0.684			0.684	0.520	
		Weighted Ave Hg Conc (mg/kg)			0.194	0.194	0.194	0.737			0.737	0.490	
		# of Samples > 0.3 mg/kg						2			2	2	
125	Grimes	# of Samples	1	1	6	10	18	2	9		11	29	
		# of Fish	1	1	6	10	18	2	9		11	29	
		Ave Hg Conc (mg/kg)	0.160	0.008	0.156	0.114	0.125	0.587	0.423		0.452	0.249	
		Weighted Ave Hg Conc (mg/kg)	0.160	0.008	0.156	0.114	0.125	0.587	0.423		0.452	0.249	
		# of Samples > 0.3 mg/kg				1	1	2	3		5	6	
144	Colusa	# of Samples	1			10	11		11		11	22	
		# of Fish	5			19	24		23		23	47	
		Ave Hg Conc (mg/kg)	0.186			0.132	0.137		0.479		0.479	0.308	
		Weighted Ave Hg Conc (mg/kg)	0.186			0.102	0.120		0.395		0.395	0.254	
		# of Samples > 0.3 mg/kg				1	1		6		6	7	
169	Ord Bend	# of Samples				11	11		8		8	19	
		# of Fish				11	11		8		8	19	
		Ave Hg Conc (mg/kg)				0.142	0.142		0.692		0.692	0.373	
		Weighted Ave Hg Conc (mg/kg)				0.142	0.142		0.692		0.692	0.373	
		# of Samples > 0.3 mg/kg				1	1		5		5	6	
169	Hamilton City	# of Samples				11	11		11		11	22	
		# of Fish				19	19		19		19	38	
		Ave Hg Conc (mg/kg)				0.049	0.049		0.519		0.519	0.284	
		Weighted Ave Hg Conc (mg/kg)				0.041	0.041		0.407		0.407	0.224	
		# of Samples > 0.3 mg/kg							6		6	6	
258	Bend Bridge	# of Samples		11		11	22		7		7	29	
		# of Fish		15		15	30		11		11	41	
		Ave Hg Conc (mg/kg)		0.028		0.063	0.046		0.378		0.378	0.126	
		Weighted Ave Hg Conc (mg/kg)		0.031		0.073	0.052		0.284		0.284	0.114	
		# of Samples > 0.3 mg/kg							2		2	2	
302	Keswick Dam	# of Samples		15		1	16					16	
		# of Fish		46		1	47					47	
		Ave Hg Conc (mg/kg)		0.035		0.075	0.038					0.038	
		Weighted Ave Hg Conc (mg/kg)		0.039		0.075	0.040					0.040	
		# of Samples > Screening Value											