A. WATERWAYS WITHIN THE SACRAMENTO-SAN JOAQUIN DELTA

This appendix lists the Sacramento-San Joaquin Delta and Yolo Bypass waterways (1) to which the proposed TMDL fish tissue targets (a.k.a. water quality objectives for methylmercury in fish) and implementation program apply. These waterways are distinct, readily identifiable water bodies within the boundaries of the "legal" Delta (as defined in California Water Code Section 12220) and Yolo Bypass north of the Delta that are hydrologically connected by surface water flows (not including pumping) to the Sacramento and/or San Joaquin Rivers. Table A.1 lists all the waterways in alphabetical order with Yolo Bypass waterways north of the legal Delta boundary listed at the end. Figures A.1 through A.3 show the locations of the waterways.

The methylmercury allocations proposed for the Delta methylmercury control program are specific to Delta subareas, which are shown on Figure A.4. Table A.2 lists the waterways within each of the subareas.

Table A.1: Delta and Yolo Bypass Waterways

Map Label # / Waterway Name
1. Alamo Creek
2. Babel Slough
3. Barker Slough
4. Bear Creek
5. Bear Slough
6. Beaver Slough
7. Big Break
8. Bishop Cut
9. Black Slough
10. Broad Slough
11. Brushy Creek
12. Burns Cutoff
13. Cabin Slough
14. Cache Slough
15. Calaveras River
16. Calhoun Cut
17. Clifton Court Forebay
18. Columbia Cut
19. Connection Slough
20. Cosumnes River
21. Crocker Cut
22. Dead Dog Slough
23. Dead Horse Cut
24. Deer Creek (Tributary to Marsh Creek)
25. Delta Cross Channel
26. Disappointment Slough
27. Discovery Bay
28. Donlon Island
29. Doughty Cut
30. Dry Creek (Marsh Creek tributary)
31. Dry Creek (Mokelumne River tributary)
32. Duck Slough
33. Dutch Slough
34. Elk Slough
35. Elkhorn Slough
36. Emerson Slough
37. Empire Cut
38. Fabian and Bell Canal
39. False River
40. Fisherman's Cut
41. Fivemile Creek
42. Fivemile Slough
43. Fourteenmile Slough
44. Franks Tract
45. French Camp Slough
46. Georgiana Slough
47. Grant Line Canal
Map Label # / Waterway Name
48. Grizzly Slough
49. Haas Slough
50. Hastings Cut
51. Hog Slough
52. Holland Cut
53. Honker Cut
54. Horseshoe Bend
55. Indian Slough
56. Italian Slough
57. Jackson Slough
58. Kellogg Creek
59. Latham Slough
60. Liberty Cut
61. Lindsey Slough
62. Little Connection Slough
63. Little Franks Tract
64. Little Mandeville Cut
65. Little Potato Slough
66. Little Venice Island
67. Livermore Yacht Club
68. Lookout Slough
69. Lost Slough
70. Main Canal (Duck Slough tributary)
71. Main Canal (Italian Slough tributary)
72. Marsh Creek
73. Mayberry Cut
74. Mayberry Slough
75. Middle River
76. Mildred Island
77. Miner Slough
78. Mokelumne River
79. Mormon Slough
80. Morrison Creek
81. Mosher Slough
82. Mountain House Creek
83. North Canal
84. North Fork Mokelumne River
85. North Victoria Canal
86. Old River
87. Paradise Cut
88. Piper Slough
89. Pixley Slough
90. Potato Slough
91. Prospect Slough
92. Red Bridge Slough
93. Rhode Island
94. Rock Slough

Table A.1: Delta and Yolo Bypass Waterways, *Continued*

Map Label # / Waterway Name	Map Label # / Waterway Name
95. Sacramento Deep Water Channel	124. Toe Drain
96. Sacramento River	125. Tom Paine Slough
97. Salmon Slough	126. Tomato Slough
98. San Joaquin River	127. Trapper Slough
99. Sand Creek	128. Turner Cut
100. Sand Mound Slough	129. Ulatis Creek
101. Santa Fe Cut	130. Upland Canal (Sycamore Slough tributary)
102. Sevenmile Slough	131. Victoria Canal
103. Shag Slough	132. Walker Slough
104. Sheep Slough	133. Walthall Slough
105. Sherman Lake	134. Washington Cut
106. Short Slough	135. Werner Dredger Cut
107. Smith Canal	136. West Canal
108. Snodgrass Slough	137. Whiskey Slough
109. South Fork Mokelumne River	138. White Slough
110. Steamboat Slough	139. Winchester Lake
111. Stockton Deep Water Channel	140. Woodward Canal
112. Stone Lakes	141. Wright Cut
113. Sugar Cut	142. Yosemite Lake
114. Sutter Slough	143. Yolo Bypass
115. Sweany Creek	144. Deuel Drain
116. Sycamore Slough	145. Dredger Cut
117. Taylor Slough (Elkhorn Slough tributary)	146. Highline Canal
118. Taylor Slough (near Franks Tract)	147. Cache Creek Settling Basin Outflow
119. Telephone Cut	148. Knights Landing Ridge Cut
120. The Big Ditch	149. Putah Creek
121. The Meadows Slough	150. Tule Canal
122. Three River Reach	
123. Threemile Slough	

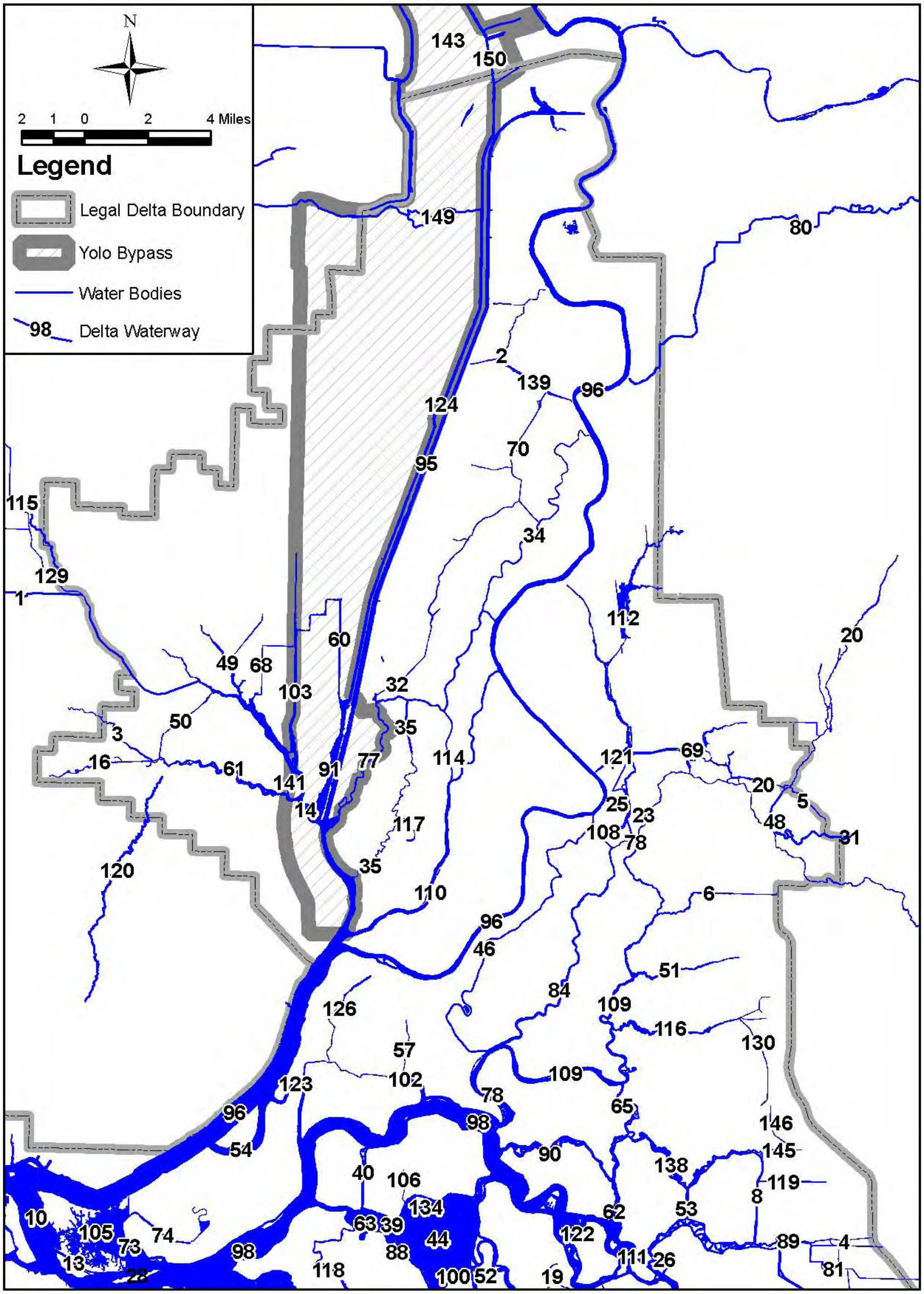

Figure A.1: Delta Waterways (Northern Panel)

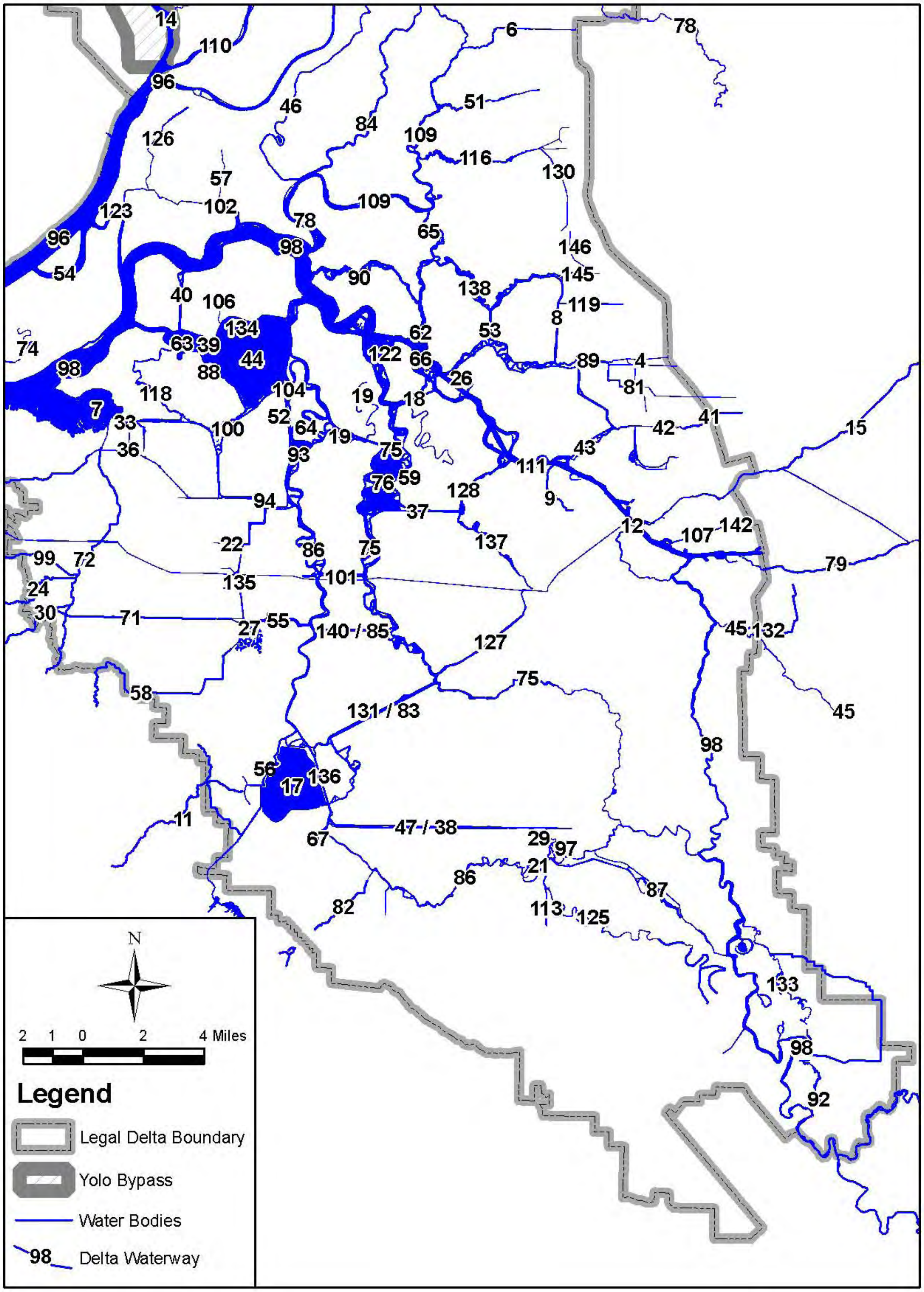

Figure A.2: Delta Waterways (Southern Panel)

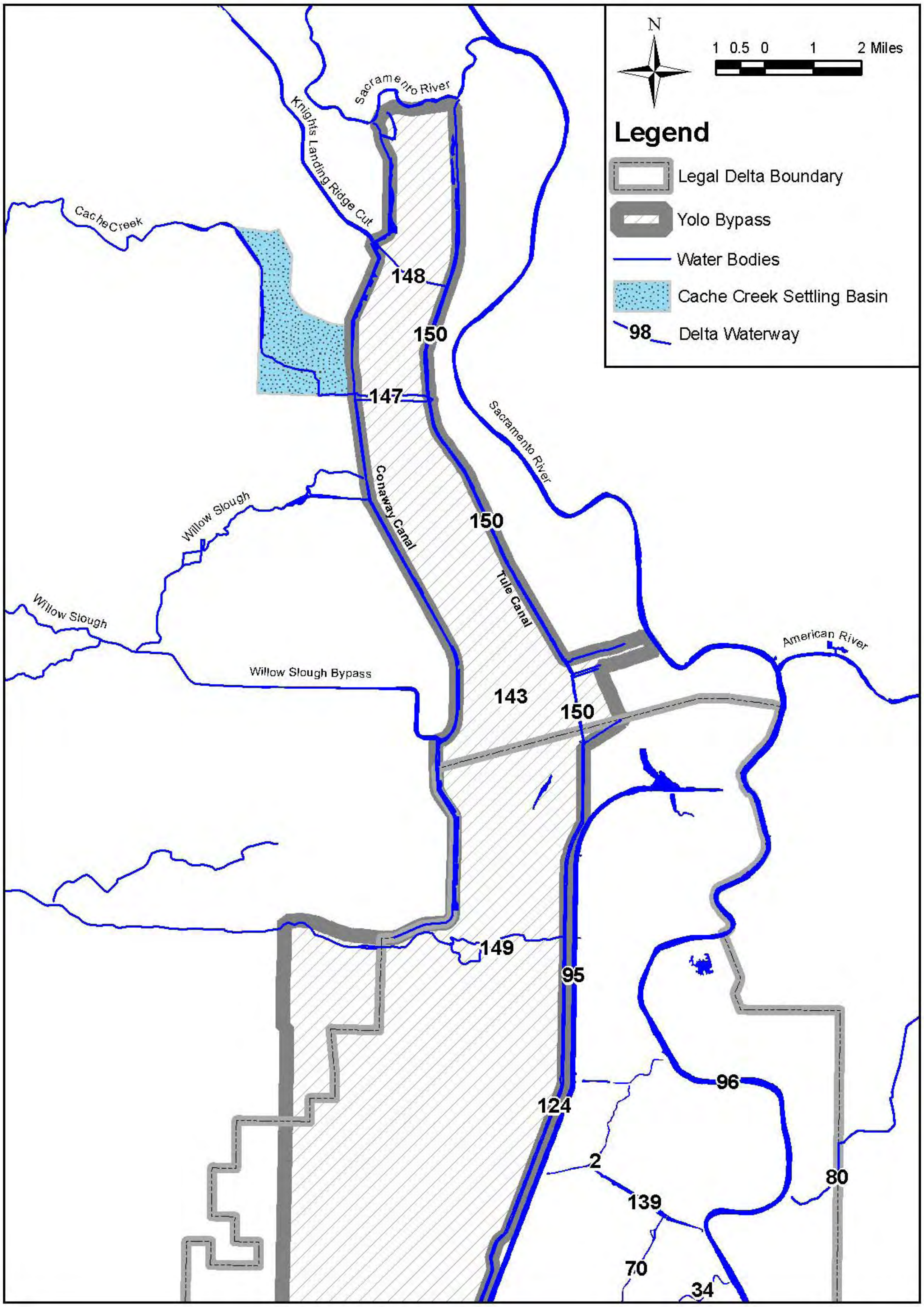

Figure A.3: Northern Yolo Bypass

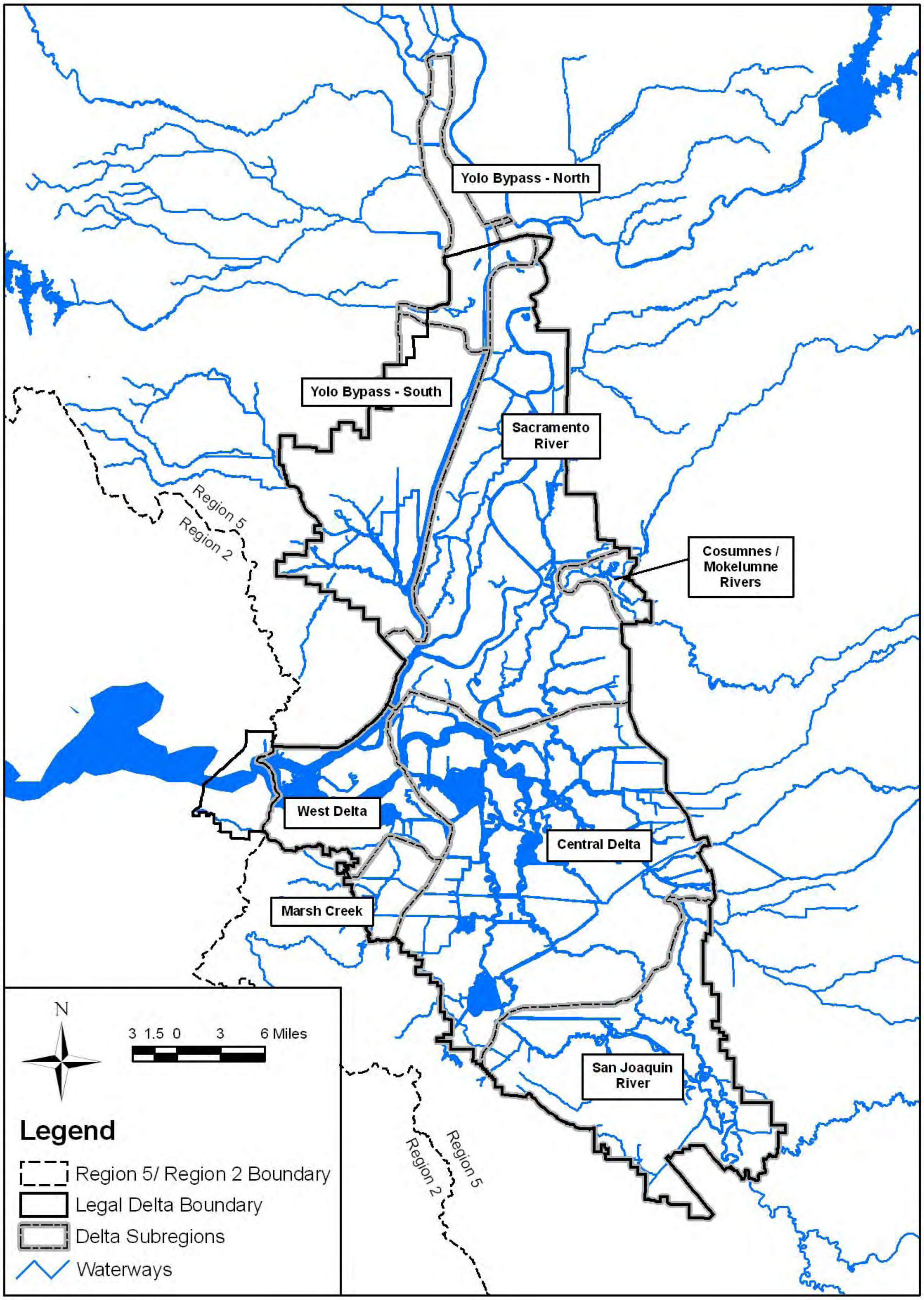

Figure A.4: Subareas for the Delta Methylmercury Control Program

Table A.2: Delta and Yolo Bypass Waterways by Methylmercury Allocation Subarea

Waterway Name [Map Label #]	Waterway Name [Map Label #]	Waterway Name [Map Label #]
CENTRAL DELTA		
Bear Creek [4]	Indian Slough [55]	San Joaquin River [98]
Bishop Cut [8]	Italian Slough [56]	Sand Mound Slough [100]
Black Slough [9]	Jackson Slough [57]	Santa Fe Cut [101]
Brushy Creek [11]	Kellogg Creek [58]	Sevenmile Slough [102]
Burns Cutoff [12]	Latham Slough [59]	Sheep Slough [104]
Calaveras River [15]	Little Connection Slough [62]	Short Slough [106]
Clifton Court Forebay [17]	Little Franks Tract [63]	Smith Canal [107]
Columbia Cut [18]	Little Mandeville Cut [64]	Stockton Deep Water Channel [111]
Connection Slough [19]	Little Potato Slough [65]	Taylor Slough [nr Franks Tract] [118]
Dead Dog Slough [22]	Little Venice Island [66]	Telephone Cut [119]
Disappointment Slough [26]	Livermore Yacht Club [67]	Three River Reach [122]
Discovery Bay [27]	Main Canal [Indian Slough trib.] [71]	Threemile Slough [123]
Dredger Cut [145]	Middle River [75]	Tomato Slough [126]
Empire Cut [37]	Mildred Island [76]	Trapper Slough [127]
Fabian and Bell Canal [39]	Mokelumne River [78]	Turner Cut [128]
False River [39]	Mormon Slough [79]	Upland Canal [Sycamore Slough tributary] [130]
Fisherman's Cut [40]	Mosher Slough [81]	
Fivemile Creek [41]	North Canal [83]	Victoria Canal [131]
Fivemile Slough [42]	North Victoria Canal [85]	Washington Cut [134]
Fourteenmile Slough [43]	Old River [86]	Werner Dredger Cut [135]
Franks Tract [44]	Piper Slough [88]	West Canal [136]
Grant Line Canal [47]	Pixley Slough [89]	Whiskey Slough [137]
Highline Canal [146]	Potato Slough [90]	White Slough [138]
Holland Cut [52]	Rhode Island [93]	Woodward Canal [140]
Honker Cut [53]	Rock Slough [94]	Yosemite Lake [142]
MOKELUMNE/COSUMNES RIVERS		
Bear Slough [5]	Dry Creek [Mokelumne R. trib.] [31]	Lost Slough [69]
Cosumnes River [20]	Grizzly Slough [48]	Mokelumne River [78]
MARSH CREEK		
Deer Creek [24]	Main Canal [Indian Slough trib.] [71]	Rock Slough [94]
Dry Creek [Marsh Creek trib.] [30]	Marsh Creek [72]	Sand Creek [99]
Kellogg Creek [58]		
SACRAMENTO RIVER		
Babel Slough [2]	Little Potato Slough [65]	Stone Lakes [112]
Beaver Slough [6]	Lost Slough [69]	Sutter Slough [114]
Cache Slough [14]	Main Canal [Duck Slough trib.] [70]	Sycamore Slough [116]
Dead Horse Cut [23]	Miner Slough [77]	Taylor Slough [Elkhorn Slough tributary] [117]
Delta Cross Channel [25]	Mokelumne River [78]	
Duck Slough [32]	Morrison Creek [80]	The Meadows Slough [121]
Elk Slough [34]	North Mokelumne River [84]	Tomato Slough [126]
Elkhorn Slough [35]	Sacramento River [96]	Upland Canal [Sycamore Slough tributary] [130]
Georgiana Slough [46]	Snodgrass Slough [108]	
Hog Slough [51]	South Mokelumne River [109]	Winchester Lake [139]
Jackson Slough [57]	Steamboat Slough [110]	

TABLE A43-2: DELTA AND YOLO BYPASS WATERWAYS BY METHYLMERCURY ALLOCATION SUBAREA, *Continued*

Waterway Name [Map Label #]	Waterway Name [Map Label #]	Waterway Name [Map Label #]
SAN JOAQUIN RIVER		
Crocker Cut [21] Deuel Drain [144] Doughty Cut [29] Fabian and Bell Canal [38] French Camp Slough [45] Grant Line Canal [47]	Middle River [75] Mountain House Creek [82] Old River [86] Paradise Cut [87] Red Bridge Slough [92] Salmon Slough [97]	San Joaquin River [98] Sugar Cut [113] Tom Paine Slough [125] Walker Slough [132] Walthall Slough [133]
WEST DELTA		
Big Break [7] Broad Slough [10] Cabin Slough [13] Donlon Island [28] Dutch Slough [33] Emerson Slough [36] False River [39]	Horseshoe Bend [54] Marsh Creek [72] Mayberry Cut [73] Mayberry Slough [74] Rock Slough [94] Sacramento River [96]	San Joaquin River [98] Sand Mound Slough [100] Sherman Lake [105] Taylor Slough [near Franks Tract] [118] Threemile Slough [123]
YOLO BYPASS-NORTH (a)		
Cache Creek Settling Basin Outflow [147] Knights Landing Ridge Cut [148]	Toe Drain [124]/Tule Canal [150] Putah Creek [149])]	Sacramento Deep Water Ship Channel [95]
YOLO BYPASS-SOUTH (a)		
Alamo Creek [1] Babel Slough [2] Barker Slough [3] Cache Slough [14] Calhoun Cut [16] Duck Slough [32] Haas Slough [49] Hastings Cut [50]	Liberty Cut [60] Lindsey Slough [61] Lookout Slough [68] Miner Slough [77] Prospect Slough [91])] Sacramento Deep Water Ship Channel [95] Shag Slough [103]	Sweany Creek [115] Sycamore Slough [116] The Big Ditch [120] Toe Drain [124] Ulatis Creek [129] Wright Cut [141]

(a) Both the “Yolo Bypass-North” and “Yolo Bypass-South” subareas contain portions of the Yolo Bypass flood conveyance channel shown in Figure IV-4. When flooded, the entire Yolo Bypass is a Delta waterway. When the Yolo Bypass is not flooded, the Toe Drain [127] (referred to as Tule Canal [C] for its northern reach), Cache Creek Settling Basin Outflow [A], and Knights Landing Ridge Cut [B] are the only waterways within the Yolo Bypass hydrologically connected to the Sacramento River.

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B. SUMMARY OF FISH MERCURY DATA USED IN TMDL NUMERIC TARGET AND LINKAGE ANALYSIS CALCULATIONS

Section B.1 summarizes the fish mercury data used in the numeric target and linkage analysis chapters. Table B.1 lists the fish species and lengths of fish included in the weighted-average[1] fish mercury concentrations. Tables B.2 through B.5 list the number of samples and fish included in the calculations for each Delta subarea. Data for fish sampled in the Cosumnes River and Mokelumne River and in the northern portion of the Yolo Bypass were included in the numeric target development calculations. However, only data for fish sampled in the Mokelumne River downstream of the Cosumnes River confluence were included in the linkage analysis calculations; these data are summarized in Tables B.4 and B.5. All fish data summarized in these tables are provided in Appendix K. Section B.3 provides figures that illustrate the range of mercury levels in the species within each Delta subarea trophic level food group. Appendix C provides a description of the available mercury data for important commercial and sport fisheries – such as striped bass, salmon, crayfish, clams and blackfish – not included in this data summary because they either do not represent local conditions or do not fit within the trophic level food groups defined by the numeric targets.

[1] Weighted average mercury concentration is based on the number of fish in the composite samples analyzed, rather than the number of samples.

B.1 Description of Fish Mercury DATA Used in the Numeric Target and Linkage Analysis Chapters

Table B.1: Summary of Fish Species & Lengths Used in the Numeric Target & Linkage Analysis Chapters

Trophic Level 4 Species & Length Ranges Used for Estimation of Human & Bald Eagle Health Risk [150-500 mm, unless CDFG minimum catch limit applies] [a, b] Black crappie (> 150 mm) Channel catfish (> 200 mm) [b] Largemouth bass (> 305 mm) [a] Sacramento pikeminnow (> 150 mm) [b] Smallmouth bass (> 305 mm) [a] White catfish (> 200 mm) [b] White crappie (> 150 mm) [b]	**Trophic Level 4 Species & Length Ranges Used for Estimation of Otter and Osprey Health Risk** [c] Black crappie (150 - 350 mm) Channel catfish (200 - 350 mm) Largemouth bass (150 - 350 mm) Sacramento pikeminnow (150 - 350 mm) Smallmouth bass (150 - 350 mm) White catfish (200 - 350 mm) White crappie (150 - 350 mm)
Trophic Level 3 Species & Length Ranges Used for Estimation of Human Health and Bald Eagle Risk [150-500 mm] [d] Black bullhead Bluegill Carp Channel catfish (150 - 200 mm) Golden shiner Goldfish [e] Redear sunfish Sacramento blackfish Sacramento splittail Sucker Unid goby White catfish (150 - 200 mm) Yellowfin goby	**Trophic Level 3 Species & Length Ranges for Estimation of Osprey, Grebe and Merganser Health Risk.** [All TL3 fish species, 150-350 mm. Small individuals of TL4 species of catfish are included.] [c] Black bullhead Bluegill Carp Channel catfish (150 - 200 mm) Golden shiner Goldfish Redear sunfish Sacramento blackfish Sacramento splittail Sucker Threadfin Shad Unid goby White catfish (150 - 200 mm) Yellowfin goby
Trophic Level 3 Species & Length Ranges for Estimation of Cormorant, Otter, Mink and Kingfisher Health Risk. [All TL3 fish species, 50-150 mm. Small individuals of TL4 species of bass, crappie, and catfish, are included.] [f] Bigscale logperch Bluegill Channel catfish (50 - 150 mm) Golden shiner Inland silverside Largemouth bass (50 - 100 mm) Mosquitofish Prickly sculpin Red shiner Redear sunfish Shimofuri goby Threadfin Shad Unid goby White catfish (50 - 150 mm) White crappie (50 - 120 mm) Yellowfin goby	**Trophic Level 3 for Estimation of Least Tern Health Risk.** [All TL3 and juveniles of TL4 fish species less than 50 mm.] [g] Bluegill Inland silverside Mosquitofish Prickly sculpin Red shiner Shimofuri goby White catfish White crappie

TABLE B.1 FOOTNOTES:

(a) Size minimum based on CDFG fishing regulations: 12 inch minimum (305 mm) for largemouth and smallmouth bass.

(b) Size minimum based on prey type of the fish species. Example: on average, catfish 200 mm and larger are mainly piscivorous, meaning that a majority of their diet is trophic level three species. Catfish smaller than 200 mm eat mainly prey from trophic level 2. Minimum sizes based on length of fish when they become mostly piscivorous are given for bass, catfish, pikeminnow and crappie (Source: Moyle PB, 2002. Inland Fishes of California, Revised and Expanded, Berkeley, Univ. California Press)

(c) Size minimum based on prey type of the fish species - see note (b). Maximum size of 350 mm is based on largest size generally consumed by osprey or otter. (For bald eagle, use average concentration in TL4 fish grouped for humans to assess risk).

(d) TL3 species for calculating human health risk are those species assumed to be eaten by humans, based on general knowledge of the fishery and size of fish. Staff assumes that most fish eaten are at least 150 mm (6 inches). Small bass are not included in the trophic level 3 species for human consumption because they cannot legally be fished and kept. Crappies are not included because juvenile crappies (TL3) are generally less than 120 mm.

(e) Although goldfish is a TL2 species, large ones may be consumed by humans and are included to estimate human risk. Only one Delta goldfish was analyzed for mercury.

(f) Fish length range of 50-150 mm based on the size of fish typically consumed by kingfisher, cormorant and mink (USFWS, 2004).

(g) Size maximum of 50 mm based on general size limit of prey consumed by California least terns (USFWS, 2003).

Table B.2: Number of Composite Samples and the Total Number of Fish in the Composite Samples Used to Estimate the Weighted Average Trophic Level 3 and 4 Fish Mercury Concentrations for Human and Eagle Health Risk Assessments [(a)]

Trophic Level (Length Range) / Species	Central Delta		Cosumnes River		Mokelumne R. d/s Cosumnes R.		Sacramento River		San Joaquin River		West Delta		Yolo Bypass-North		Yolo Bypass-South		Total # of Samples	Total # of Fish
	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish		
TL4 (150-350 mm)	144	218	16	20	15	21	103	166	95	179	31	39	3	11	52	75	459	729
Channel Catfish	1	4							3	14					1	2	5	20
Crappie	2	9									1	3	2	10	1	5	6	27
Largemouth Bass	102	146	14	18	14	18	52	73	60	92	29	33	1	1	15	24	287	405
Sacramento Pike Minnow					1	3	15	33	1	3	1	3					18	42
Smallmouth Bass							1	5									1	5
White Catfish	39	59	2	2			35	55	31	70					35	44	142	230
TL3 (150-350 mm)	17	80	4	12	5	17	11	47	12	47	2	9	2	10	5	23	58	245
Black Bullhead	2	9					2	10									4	19
Bluegill	6	30			2	10	5	20	4	19							17	79
Carp													2	10	4	18	6	28
Redear Sunfish	9	41	1	5					4	20	1	5					15	71
Sacramento Blackfish									1	5							1	5
Sacramento Splittail							1	4									1	4
Sacramento Sucker			3	7	3	7	3	13			1	4			1	5	11	36
White Catfish									3	3							3	3
TOTAL	161	298	20	32	20	38	114	213	107	226	33	48	5	21	57	98	517	974

(a) Cosumnes River and Yolo Bypass-North fish data were used in the Delta-wide numeric target evaluation (Chapter 3) but not in the linkage analysis because aqueous methylmercury samples were not collected in these subareas. Marsh Creek fish samples collected upstream of any tidal influence, although within the statutory Delta boundary, were not used in any Delta TMDL evaluations because a separate TMDL effort will be conducted for the Marsh Creek watershed. No fish data that met the data use rules described in Section 4.3.1 were available for the Mokelumne River upstream of the Cosumnes River confluence.

Table B.3: Number of Composite Samples and the Total Number of Fish in the Composite Samples Used to Estimate the Weighted Average Trophic Level 3 and 4 Fish Mercury Concentrations for Wildlife Health Risk Assessments [(a)]

Trophic Level (Length Range) / Species	**Central Delta**		**Cosumnes River**		**Mokelumne R. d/s Cosumnes R.**		**Sacramento River**		**San Joaquin River**		**West Delta**		**Yolo Bypass-North**		**Yolo Bypass-South**		**Total # of Samples**	**Total # of Fish**
	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish		
TL4 (150-350 mm)	**100**	**143**	**17**	**17**	**12**	**18**	**78**	**122**	**59**	**117**	**13**	**17**	**2**	**10**	**43**	**56**	**324**	**500**
Crappie	2	9									1	3	2	10	1	5	6	27
Largemouth Bass	67	83	16	16	11	15	35	47	31	48	11	11			8	8	179	228
Sacramento Pike Minnow					1	3	7	15	1	3	1	3					10	24
Smallmouth Bass							1	5									1	5
White Catfish	31	51	1	1			35	55	27	66					34	43	128	216
TL3 (150-350 mm)	**23**	**82**	**2**	**6**	**3**	**11**	**9**	**32**	**10**	**37**	**1**	**5**					**48**	**173**
Black Bullhead	2	9					2	10									4	19
Bluegill	5	25			1	5	5	20	3	14							14	64
Golden Shiner	1	1															1	1
Redear Sunfish	11	43	1	5					3	15	1	5					16	68
Sacramento Blackfish									1	5							1	5
Sacramento Sucker			1	1	2	6											3	7
Threadfin Shad	3	3															3	3
Unid Goby							2	2									2	2
White Catfish									3	3							3	3
Yellowfin Goby	1	1															1	1
TL3 (50-150 mm)	**193**	**1391**	**45**	**320**	**9**	**71**	**134**	**711**	**47**	**456**	**66**	**281**			**168**	**833**	**662**	**4063**
Bigscale Logperch			1	12			10	30	1	2	1	3			27	122	40	169
Bluegill	23	74	10	18	1	5	4	16	6	68	3	13			1	3	48	197
Golden Shiner	24	210					3	45	5	31							32	286
Largemouth Bass	24	133			1	2	8	81	7	60	5	15					45	291
Mosquitofish															1	1	1	1
Prickly Sculpin	1	1													5	8	6	9
Red Shiner							1	1	2	4					1	4	**4**	**9**
Redear Sunfish	8	8							1	5							9	13
Shimofuri Goby							3	6			1	1			15	53	19	60
Silverside	86	801	32	282	6	62	80	424	18	235	45	189			80	498	347	2491

Table B.3: Number of Composite Samples and the Total Number of Fish in the Composite Samples Used to Estimate the Weighted Average Trophic Level 3 and 4 Fish Mercury Concentrations for Wildlife Health Risk Assessments (a)

Trophic Level (Length Range) / Species	Central Delta		Cosumnes River		Mokelumne R. d/s Cosumnes R.		Sacramento River		San Joaquin River		West Delta		Yolo Bypass-North		Yolo Bypass-South		Total # of Samples	Total # of Fish
	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish	# of Samples	# of Fish		
Threadfin Shad	20	147					12	70	5	45	1	5			16	49	54	316
Unid Goby							3	3									3	3
White Catfish							6	15									6	15
White Crappie	3	11	1	1			1	1	1	3	1	2			6	17	13	35
Yellowfin Goby	4	6	1	7	1	2	3	19	1	3	9	53			16	78	35	168
TL3 (<50 mm)	**37**	**201**	**14**	**222**	**2**	**9**	**24**	**124**	**26**	**384**	**22**	**88**			**62**	**296**	**187**	**1324**
Bluegill	17	136	8	78			8	90	11	276	2	6					46	586
Mosquitofish	4	17	6	144	2	9	2	7	2	13	5	34			11	81	32	305
Prickly Sculpin	1	1															1	1
Red Shiner									11	75					5	27	16	102
Shimofuri Goby							1	3			1	1			3	11	5	15
Silverside	14	43					11	19	2	20	13	37			29	75	69	194
Threadfin Shad	1	4									1	10			13	99	15	113
White Catfish							1	2									1	2
White Crappie							1	3							1	3	2	6
TOTAL	**353**	**1817**	**78**	**565**	**26**	**109**	**245**	**989**	**142**	**994**	**102**	**391**	**2**	**10**	**273**	**1185**	**1221**	**6060**

(a) Cosumnes River and Yolo Bypass-North fish data were used in the Delta-wide numeric target evaluation (Chapter 3) but not in the linkage analysis because aqueous methylmercury samples were not collected in these subareas. Marsh Creek fish samples collected upstream of any tidal influence, although within the statutory Delta boundary, were not used in any Delta TMDL evaluations because a separate TMDL effort will be conducted for the Marsh Creek watershed. No fish data that met the data use rules described in Section 4.3.1 were available for the Mokelumne River upstream of the Cosumnes River confluence.

B.2 Range of Mercury Levels in Species Present in Each Delta Subarea

This section provides graphs that show the range of mercury levels in Delta species by trophic level, species, and Delta subarea evaluated in the numeric target and linkage analyses:

- Figure B.1: TL4 Food Group (150-500 mm) Mercury Levels
- Figure B.2: TL3 Food Group (150-500 mm) Mercury Levels
- Figure B.3: TL4 Food Group (150-350 mm) Mercury Levels
- Figure B.4: TL3 Food Group (150-350 mm) Mercury Levels
- Figure B.5: TL3 Food Group (50-150 mm) Mercury Levels
- Figure B.6: TL3 Food Group (<50 mm) Mercury Levels

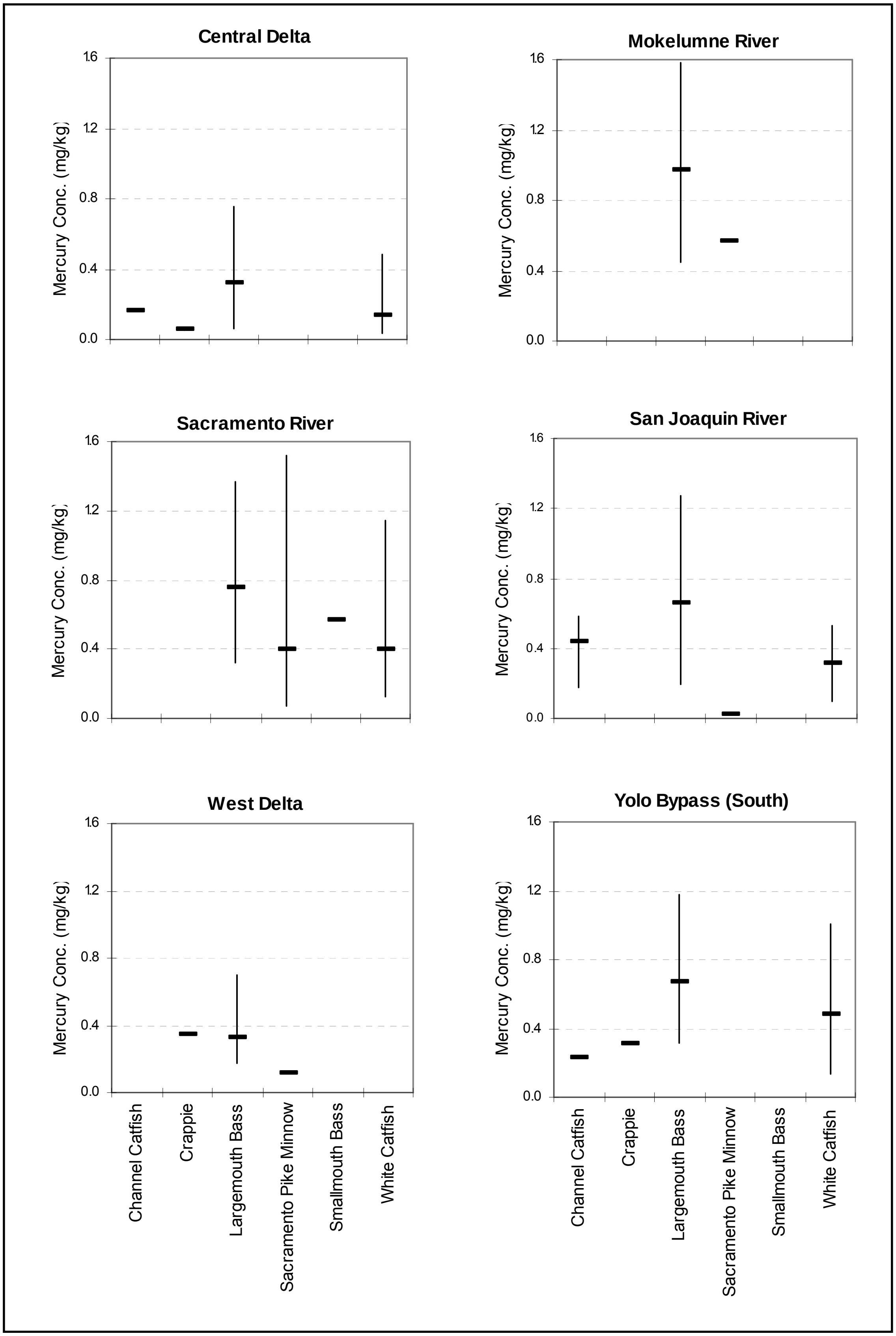

Figure B.1: TL4 Food Group (150-500 mm) Mercury Levels

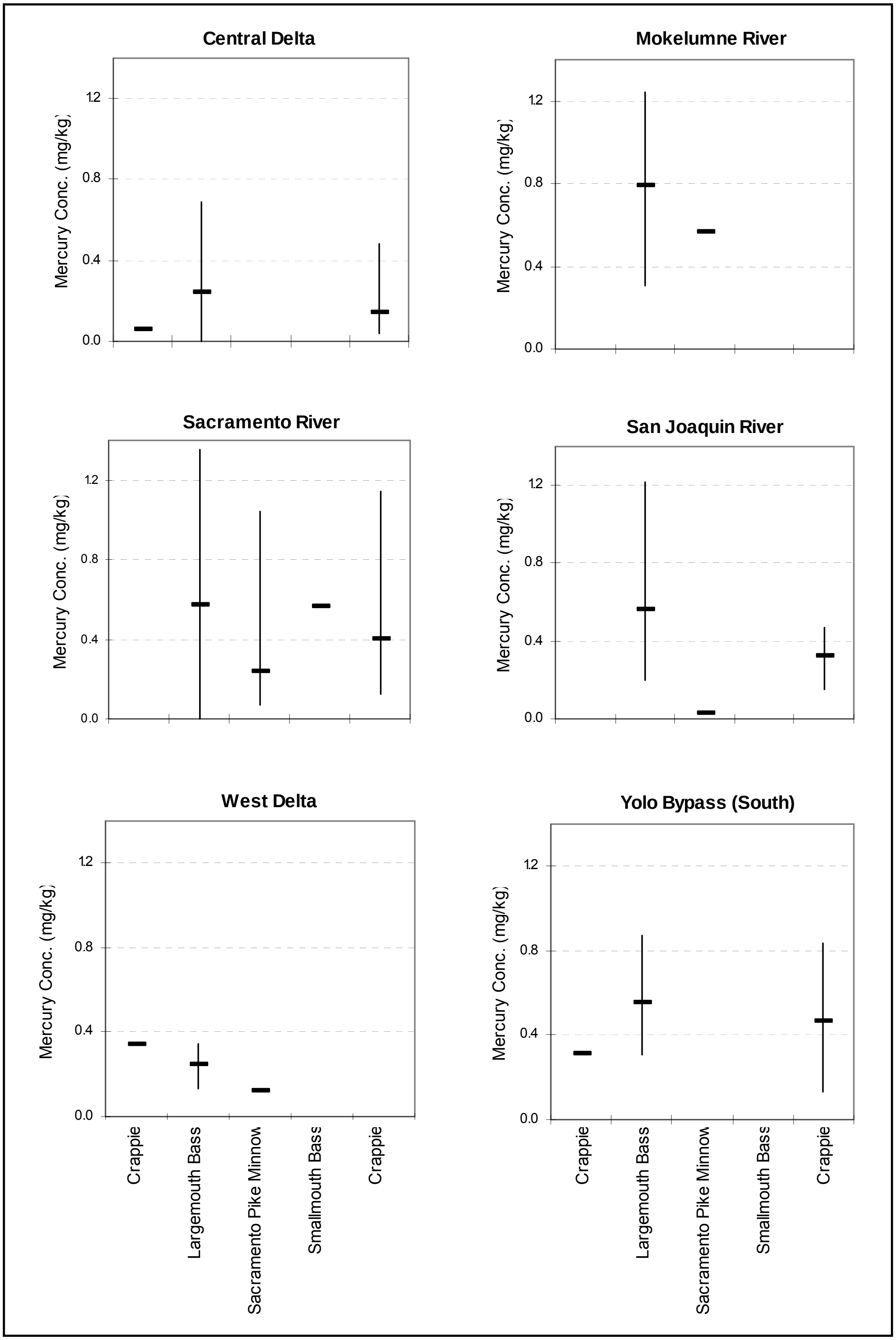

Figure B.2: TL3 Food Group (150-500 mm) Mercury Levels

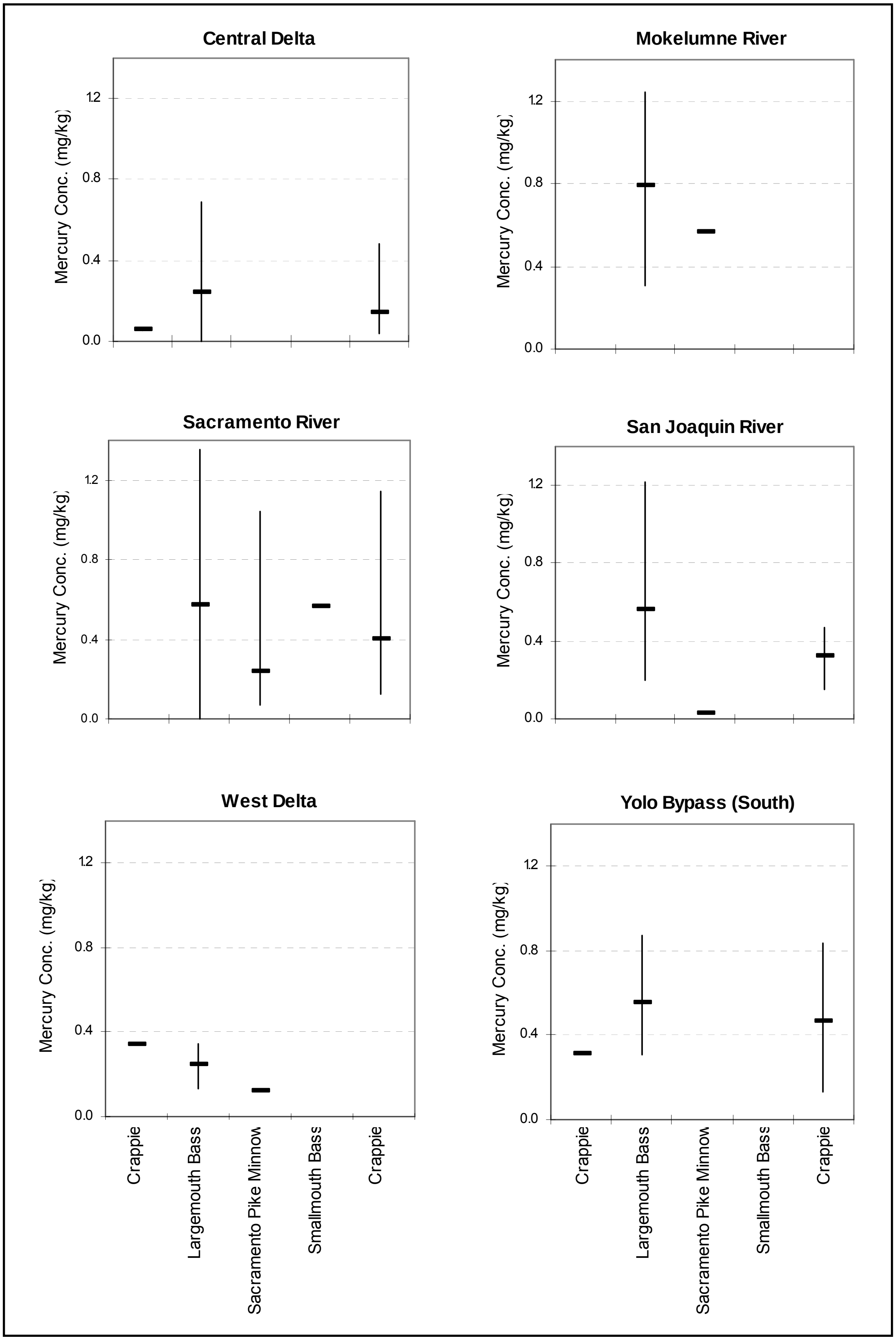

Figure B.3: TL4 Food Group (150-350 mm) Mercury Levels

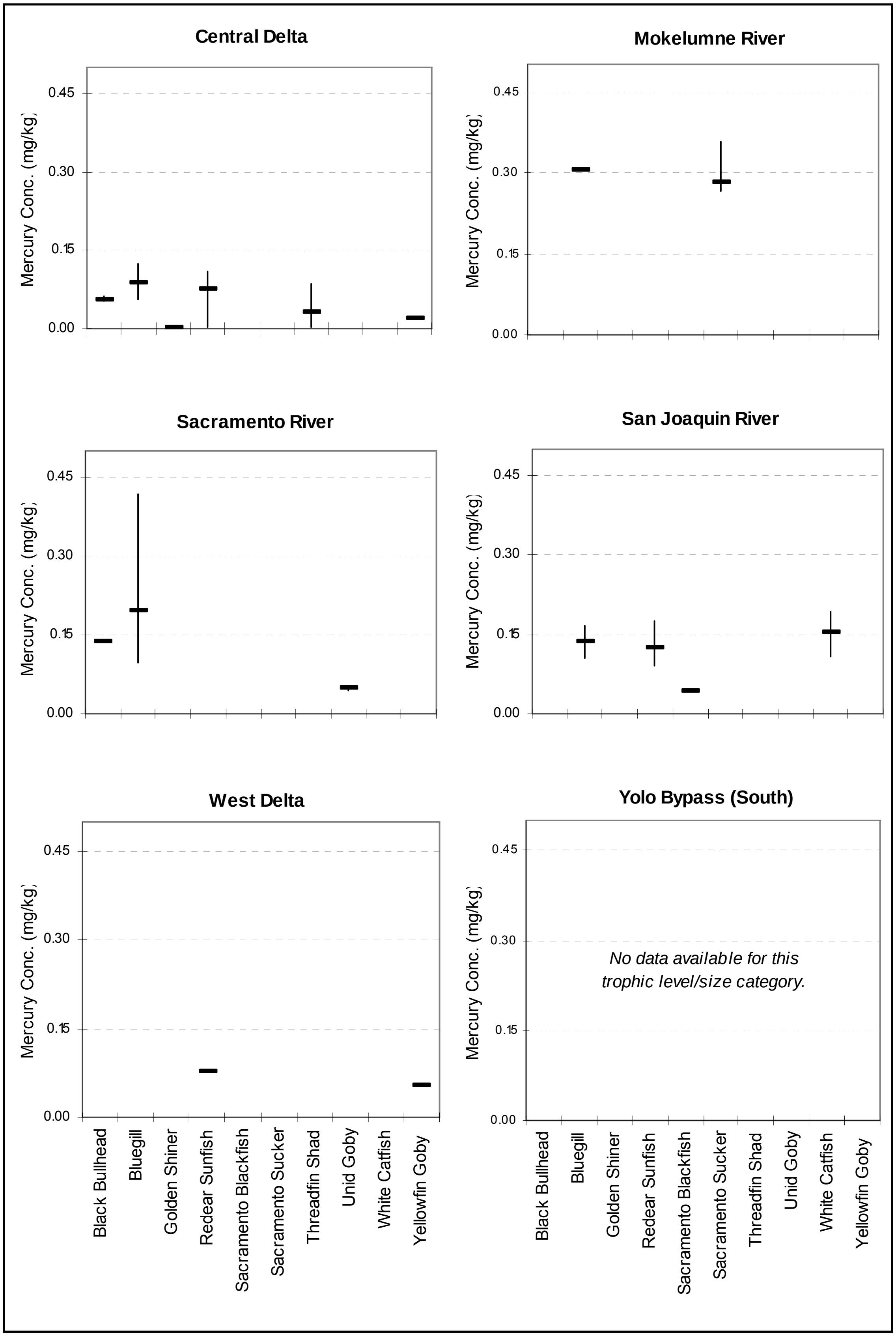

Figure B.4: TL3 Food Group (150-350 mm) Mercury Levels

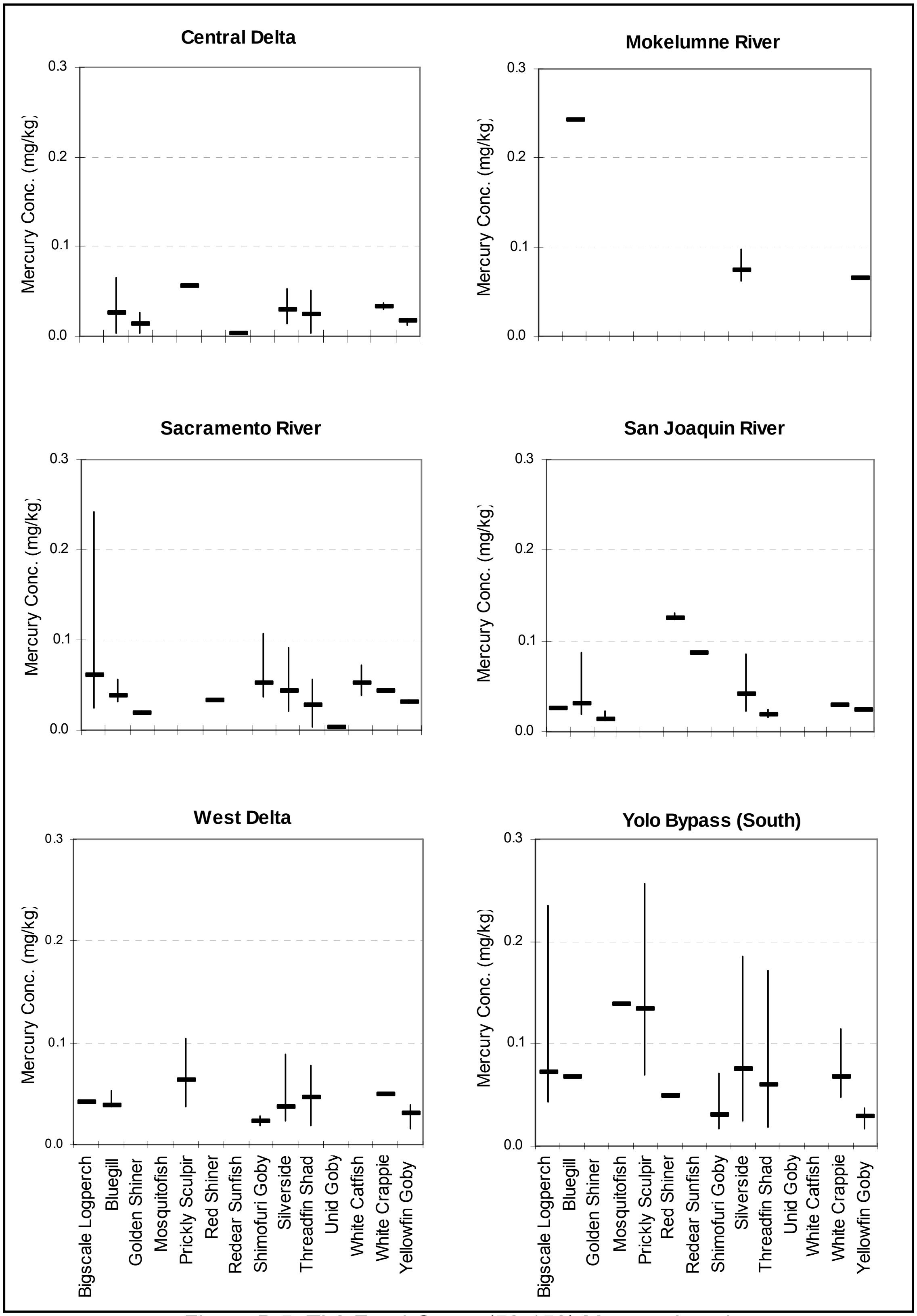

Figure B.5: TL3 Food Group (50-150) Mercury Levels

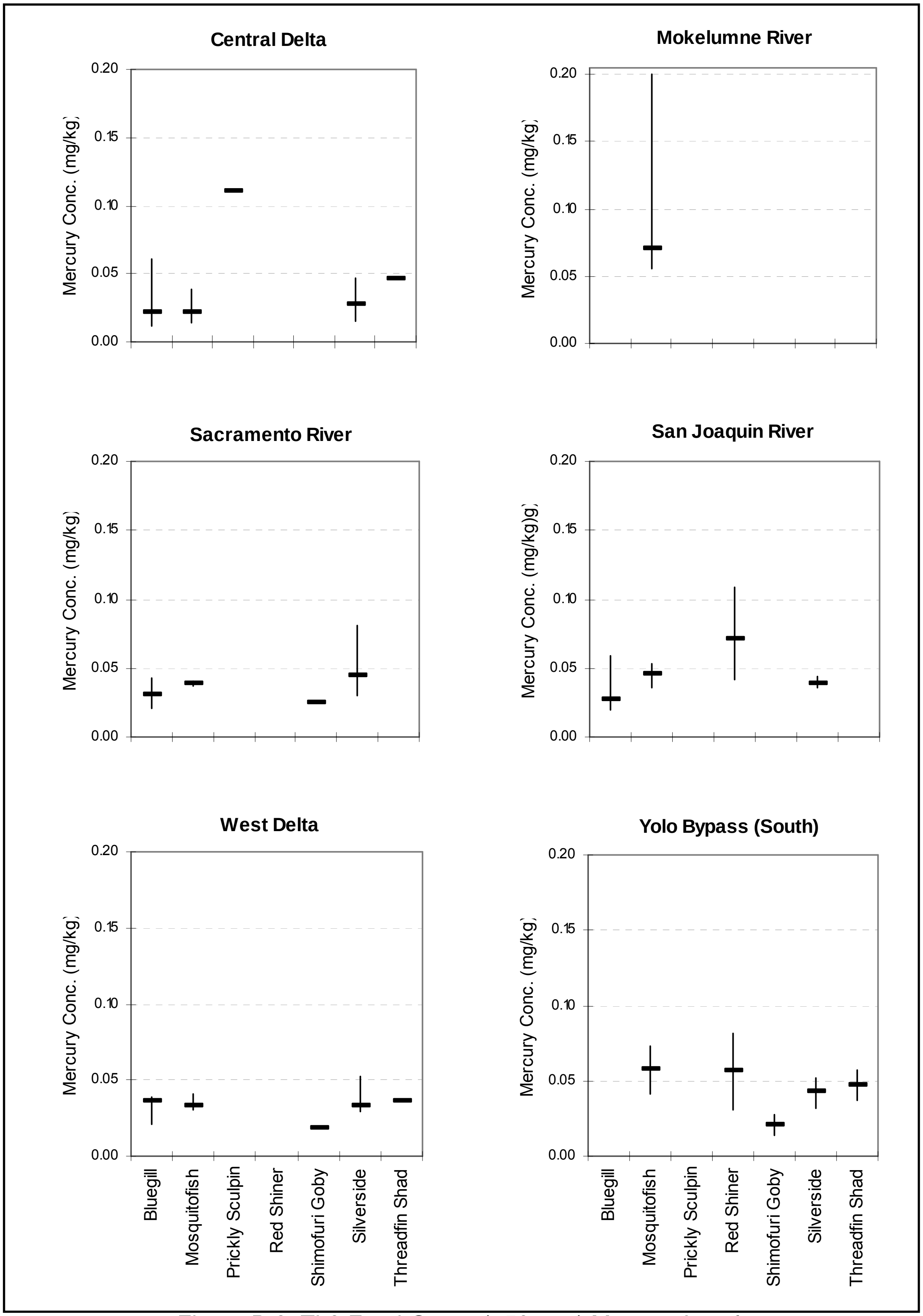

Figure B.6: TL3 Food Group (<50 mm) Mercury Levels

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C. COMMERCIAL AND SPORT FISHING IN THE SACRAMENTO-SAN JOAQUIN DELTA

As noted in Chapter 2, the Basin Plan lists the existing and potential beneficial uses of the Delta. The Basin Plan provides a standard definition for commercial and sport fishing (COMM). The COMM designation is defined as "uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes" (CVRWQCB, 1998). The current Basin Plan does not include the commercial and sport fishing (COMM) designation for the Sacramento-San Joaquin Delta. However, commercial and sport fishing is a past and present use of the Delta. The proposed Basin Plan Amendment would add COMM for the Delta as a potential beneficial use, as fish in all parts of the Delta are not yet safe to eat in accordance with the proposed fish tissue objectives (a.k.a. numeric targets). The Delta provides habitat for as many as forty freshwater, saltwater and anadromous fishes (Moyle, 2002). Sport fish species that reside in the Delta include striped bass, black bass (e.g., largemouth and smallmouth bass), sturgeon, Chinook salmon, American shad, and catfish.

Fish and other aquatic organisms are collected commercially. CDFG issues commercial fishing licenses in California and reports active commercial fishing in the Delta. Detailed historic commercial fishing data were not available; CDFG's Marine Resources website provides summary data for commercial landings and associated values for fishing years 2001 and 2002 (Table C.1). The predominant species targeted include bay shrimp, crayfish and threadfin shad. Threadfin shad are used mainly as baitfish for catching striped bass.

Sport and subsistence fishing is common throughout the Delta and takes place year-round. On average, sport fishing license sales in the six Delta counties account for 19% of all licenses issued in the State (Table C.2). Although some of these licenses may have been purchased for use elsewhere, a survey of anglers indicates similar popularity of the Delta for fishing. The Delta Protection Commission and the Department of Parks and Recreation evaluated fishing in the Delta by surveying, via mail, adults who purchased fishing licenses in California in 1996 (DPRec, 1997). Of licensed anglers, 23% reported fishing in the Delta. Delta anglers spent an average of 14 days per year fishing. Authors of the survey multiplied the number of anglers that use the Delta by the average days spent fishing from boat and shore, and in tournaments. In 1996, the total of fishing days in the Delta by licensed anglers was 21.6 million. Fishing from boat was most popular (11.8 million activity days), followed by fishing from shore (9.6 million activity days) and tournament fishing (0.2 million activity days).

Creel surveys and interviews also provide evidence that sport and subsistence anglers actively fish the Delta waterways year-round by boat and from banks. CDFG's creel surveys indicate that a variety of species are caught and kept (Table C.3, Figure C.1). Fishing derbies for striped bass, black bass and sturgeon take place in the Delta annually. The CDHS Environmental Health Investigations Branch staff conducted interviews of community-based organizations in the Delta region and found that members of many communities regularly eat local fish, especially striped bass, catfish, salmon, sturgeon, crappie, and carp (CDHS, 2004). In addition to the species listed in Tables C.1 and C.3, Sacramento blackfish and shimofuri goby may also be collected from the Delta (Moyle, 2002; anecdotal information). Crayfish are popular with some consumers (CDHS, 2006; Silver *et al.*, 2007). Clams are also collected for human consumption, particularly by some Hispanic/Latino and Southeast Asians groups (CDHS, 2004; 2006). A recent fish consumption and advisory awareness survey of low-income women at a WIC[2] clinic in Stockton indicated that 32% of the 500 survey participants consumed sport fish, 29% consumed a combination of commercial and sport fish that exceeded the USEPA/FDA national advisory limit,[3] and women who demonstrated advisory awareness and knowledge of health-protective behaviors ate less fish overall (Silver *et al*., 2007).

Mercury data from Delta sampling efforts (Table C.4) are available for all of the species listed in Tables C.1 and C.3 (or for similar species) except hitch, longjaw mudsucker, rainbow and steelhead trout, starry flounder, American shad and salmon. Except for American shad and salmon, these species do not appear to be key commercial and sport fish in the Delta. To evaluate American shad and salmon mercury levels for impairment, data from additional Suisun Bay, San Francisco Bay and Delta tributary locations were reviewed. Because salmon are anadromous and spend the majority of their lives in the Pacific Ocean, salmon that are caught in the Delta will most likely have mercury levels similar to those caught upstream in the tributary watersheds. The same is likely true for American shad. Table C.4 includes mercury data for American shad and Chinook salmon collected in the Delta and its upstream tributaries.

Per CDFG fishing regulations, some Delta fish species have size limits:

- Black bass (e.g., largemouth and smallmouth bass) – minimum 12 inches (305 mm);
- Striped bass – minimum 18 inches (457 mm); and
- Sturgeon – between 46 and 72 inches (1,168 to 1,829 mm)

Only samples collected from the tissue (fillet) of fish that met the size limits for these species were included in Table C.4. For other sport fish, only tissue samples collected from fish greater than 100 mm were included. Both fillet and whole fish samples were included for all sizes of threadfin shad, which is used as bait. In addition, all sizes of crayfish and clams were included. Data summarized in Table C.4 were collected between 1970 and 2003.

The Delta-wide weighted average mercury levels in each species were compared to the USEPA criterion for the protection of human health of 0.3 mg/kg and the FDA action level for commercially caught fish of 1.0 mg/kg (Figure C.2). Although many individual samples had mercury levels that exceeded the FDA action level, none of species-specific weighted average mercury concentrations exceeded the action level. In addition, none of the species for which commercial fishing licenses were issued exceeded the USEPA criterion. However, the average mercury concentrations of several sport fish – sturgeon, catfish, crappie, Sacramento splittail, Sacramento pike minnow, largemouth bass, small bass, and striped bass – approached or

[2] Special Supplemental Nutrition program for Women, Infants, and Children (WIC).

[3] The USEPA and FDA recommend that sensitive populations (i.e., women of childbearing age, pregnant and breastfeeding women and children) completely avoid consuming high-mercury fish (e.g., shark, swordfish, king mackerel, and tilefish) and limited consumption of other commercial fish (12 oz/week, or 48.6 g/day) and sport-caught fish (6 oz/week, or 24.3 g/day). Silver and others attempted to evaluate in their WIC clinic survey whether a woman's combined intake of sport and commercial fish exceeded the USEPA/FDA advisory limits. Because the advisory allows women to eat twice as much commercial fish (12 oz) as sport fish (6 oz) in a week, they halved each woman's commercial intake and added it to her sport intake. If this combined amount exceeded 6 oz/week, or if the woman ate shark, swordfish, tilefish or king mackerel, she was considered to have exceeded the advisory limit.

exceeded the USEPA criterion. The bass had the highest average mercury concentrations of any species. Largemouth bass had mercury levels comparable to striped bass mercury levels.

The linkage analyses described in Chapter 5 and fish data described in Appendix B are based on samples collected between 1998 and 2001 for species that represent local conditions and fit within the trophic level food groups defined by the numeric targets (Chapter 4). All of the species listed in Table C.4 and Figure C.1 were addressed by the numeric target development and linkage analysis (Chapters 4 and 5, Appendix B), except American shad, Asiatic and resident freshwater clams, Chinook salmon, Crangon shrimp, crayfish, striped bass and sturgeon. Of these, only striped bass and sturgeon had average mercury concentrations that exceeded the USEPA criterion of 0.3 mg/kg. As methyl and total mercury reduction efforts take place and the numeric targets are approached throughout the Delta for the species described in Appendix B, striped bass and sturgeon data also will be re-evaluated for compliance with the USEPA criterion and other adopted, Delta-specific water quality objectives.

Table C.1: Commercial Fisheries Landings in the Sacramento-San Joaquin Delta and Associated Value [(a)]

Species	**Landings (pounds)**		**Value**	
	2001	2002	2001	2002
Bay shrimp	9,509	9,744	$56,954	$63,149
Carp	214		$253	
Crayfish	100,008	108,427	$120,403	$114,712
Hitch	20		$20	
Longjaw mudsucker	29		$0	
Threadfin shad	53,936	49,343	$37,258	$55,028
Yellowfin goby	285		$24	
TOTAL:	**164,001**	**167,514**	**$214,912**	**$232,889**

(a) Source: http://www.dfg.ca.gov/mrd/fishing.html#commercial

Table C.2: Average Number of Sport Fishing Licenses Issued in Six Delta Counties [a, b]

County	Resident Fish Licenses	Striped Bass Tag	Salmon Tag	Steelhead Tag
Alameda	46,240	21,768	429	897
Contra Costa	42,230	26,948	380	1,039
Sacramento	89,617	43,260	1,231	6,306
San Joaquin	43,230	27,906	158	668
Solano	24,338	19,473	161	469
Yolo	9,694	4,567	70	293
Total for Delta Counties:	255,349	143,923	2,427	9,672
Total for California:	1,356,694	342,638	29,293	56,864
% Delta Licences:	19%	42%	8%	17%

(a) Source: http://www.dfg.ca.gov/licensing/statistics/statistics.html
(b) Resident fish licenses and salmon tags are averaged over a 10-year period, striped bass averaged over 7 years, and steelhead averaged over 8 years.

Table C.3: Sum of Fish Kept by Delta Anglers per the CDFG's Central Valley Angler Surveys for 1999 and 2000. [a]

Species [Acronym Used in Figure C.1]	Trophic Level	# of Fish Kept
Catfish [CF]	4	4307
Striped Bass [SB]	4	2496
Chinook Salmon [a.k.a. king salmon, KS]	3	812
American Shad [AS]	3	549
Splittail [SPT]	3	439
Sunfish [SF]	3	344
Black Bass [BB]	4	154
Sturgeon [ST]	3	94
Starry Flounder [STF]	3	27
Sacramento Pikeminnow [SPM]	4	22
Common Carp [CP]	3	20
Steelhead Trout [SH]	3	7
Sacramento Sucker [SKR]	3	6
Rainbow trout [RT]	3	1

(a) Data obtained from Fraser Shilling (University of California, Davis), who requested the query of actual reported number of fish kept and released by species and river mile from the CDFG Creel Database for the 1999 and 2000 Central Valley Angler Surveys 1999 and 2000. A summary of fish kept by Delta subarea is shown in Figure C.1.

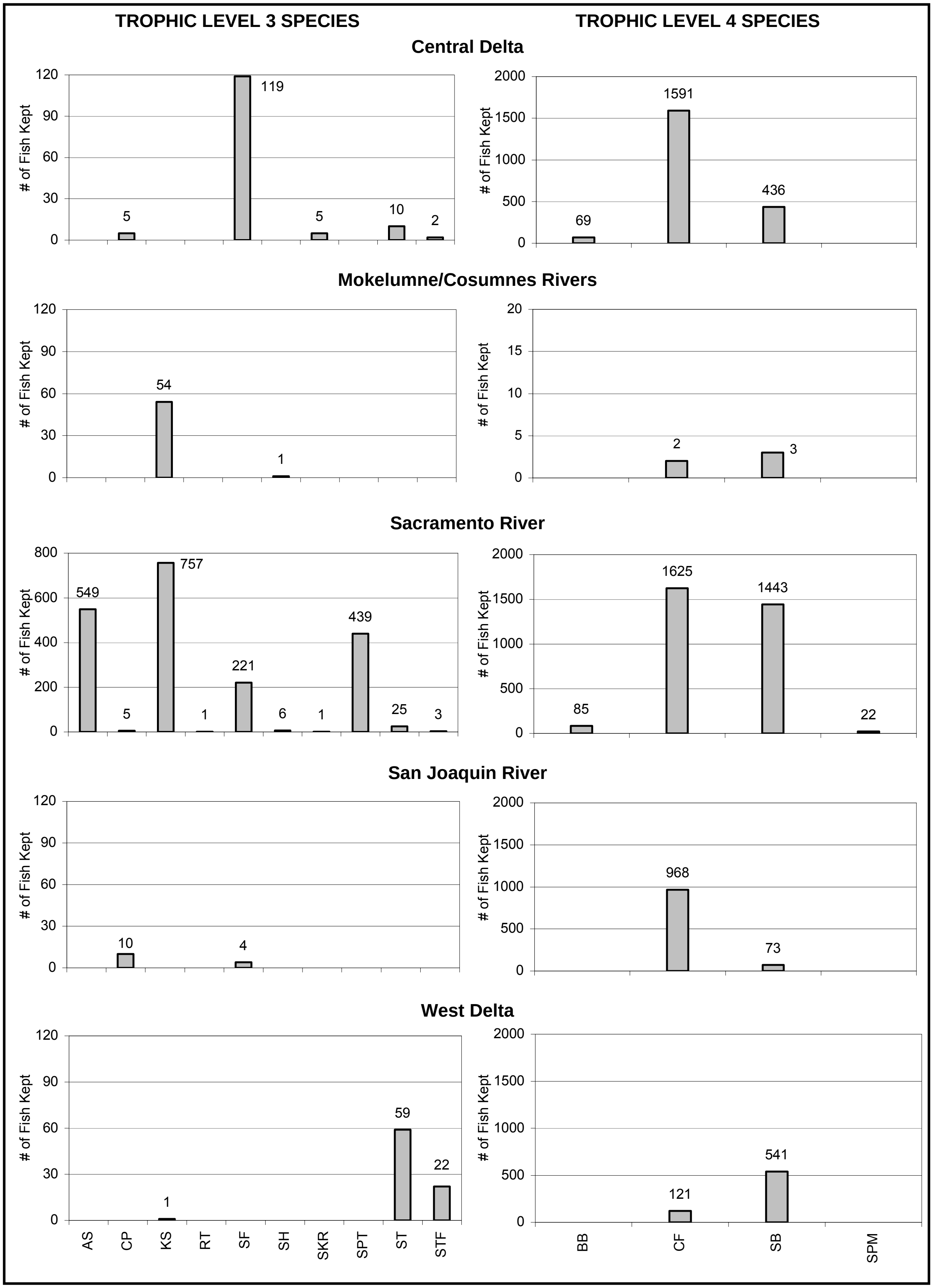

Figure C.1: Sum of Fish Kept by Delta Anglers by Delta Subarea per the CDFG's Central Valley Angler Surveys for 1999 and 2000. (Species acronyms are defined in Table C.3.)

Table C.4: Summary of Available Mercury Concentration Data for Species Targeted by Sport and Commercial Fishing [a, b, c]

Common	# of Samples	# of Fish	Min Hg Conc. (mg/kg)	Ave Hg Conc. (mg/kg)	Max Hg Conc. (mg/kg)	Weighted Ave (mg/kg)
American Shad	5	18	0.030	0.047	0.066	0.048
Black Bullhead	4	19	0.053	0.097	0.138	0.099
Black Crappie	1	6	0.130	0.130	0.130	0.130
Bluegill	31	135	0.028	0.147	0.418	0.129
Carp	13	59	0.107	0.235	0.340	0.234
Catfish	28	28	0.060	0.249	1.180	0.249
Channel Catfish	28	82	0.060	0.235	0.600	0.291
Chinook Salmon	10	15	0.040	0.072	0.120	0.062
Clam, Asiatic	275	717	0.007	0.042	0.195	0.039
Clam, Resident Freshwater	3	3	0.016	0.035	0.050	0.035
Crangon Shrimp	10	72	0.006	0.008	0.010	0.008
Crappie	6	27	0.054	0.296	0.591	0.301
Crayfish	383	413	0.003	0.191	1.828	0.182
Largemouth Bass	298	433	0.062	0.585	2.090	0.561
Redear Sunfish	17	88	0.027	0.106	0.329	0.106
Sacramento Blackfish	1	5	0.043	0.043	0.043	0.043
Sacramento Pike Minnow	26	55	0.028	0.572	2.400	0.429
Sacramento Splittail	1	4	0.370	0.370	0.370	0.370
Sacramento Sucker	12	43	0.100	0.271	0.492	0.234
Shimofuri Goby	24	75	0.013	0.034	0.107	0.031
Smallmouth Bass	1	5	0.570	0.570	0.570	0.570
Striped Bass	201	245	0.060	0.572	1.850	0.571
Sturgeon	11	11	0.080	0.271	0.800	0.271
Threadfin Shad	72	432	0.003	0.038	0.171	0.034
White Catfish	190	425	0.031	0.343	1.270	0.365
Yellowfin Goby	2	33	0.040	0.050	0.060	0.048

(a) CDFG's legal limit is 12 inch minimum (305 mm) for largemouth and smallmouth bass, 18 inch minimum (457 mm) for striped bass, and between 46 and 72 inches (1,168 to 1,829 mm) for sturgeon; only data collected from tissue (fillet) samples were included. For other sport fish, only tissue samples collected from fish greater than 100 mm were included. Both fillet and whole fish samples were included for all sizes of threadfin shad, which is typically used as bait. In addition, all sizes of crayfish and clams were included. Results represent total mercury, wet weight concentrations.

(b) Little-to-no mercury data were available for adult salmon and American shad caught in the Delta. To evaluate salmon mercury levels for impairment, data from Suisun Bay and Delta's tributary watersheds were reviewed. Because salmon are anadromous (they spend the majority of their lives in the Pacific Ocean and return to fresh waters only to spawn) adult salmon (typically >750 mm) that are caught in the Delta most likely have mercury levels similar to those caught elsewhere in the Bay-Delta and tributary watersheds. The same is likely true for American shad. American shad samples were collected from the American River, Sacramento River downstream of the Feather River confluence, and Suisun Bay. Chinook salmon samples were collected from the upper Sacramento River near Red Bluff, American River, Sacramento River at River Mile 44 and San Francisco Bay.

(c) Data summarized in this table were collected between 1970 and 2003. In contrast, the numeric target development and linkage analyses are based on data collected between 1998 and 2001.

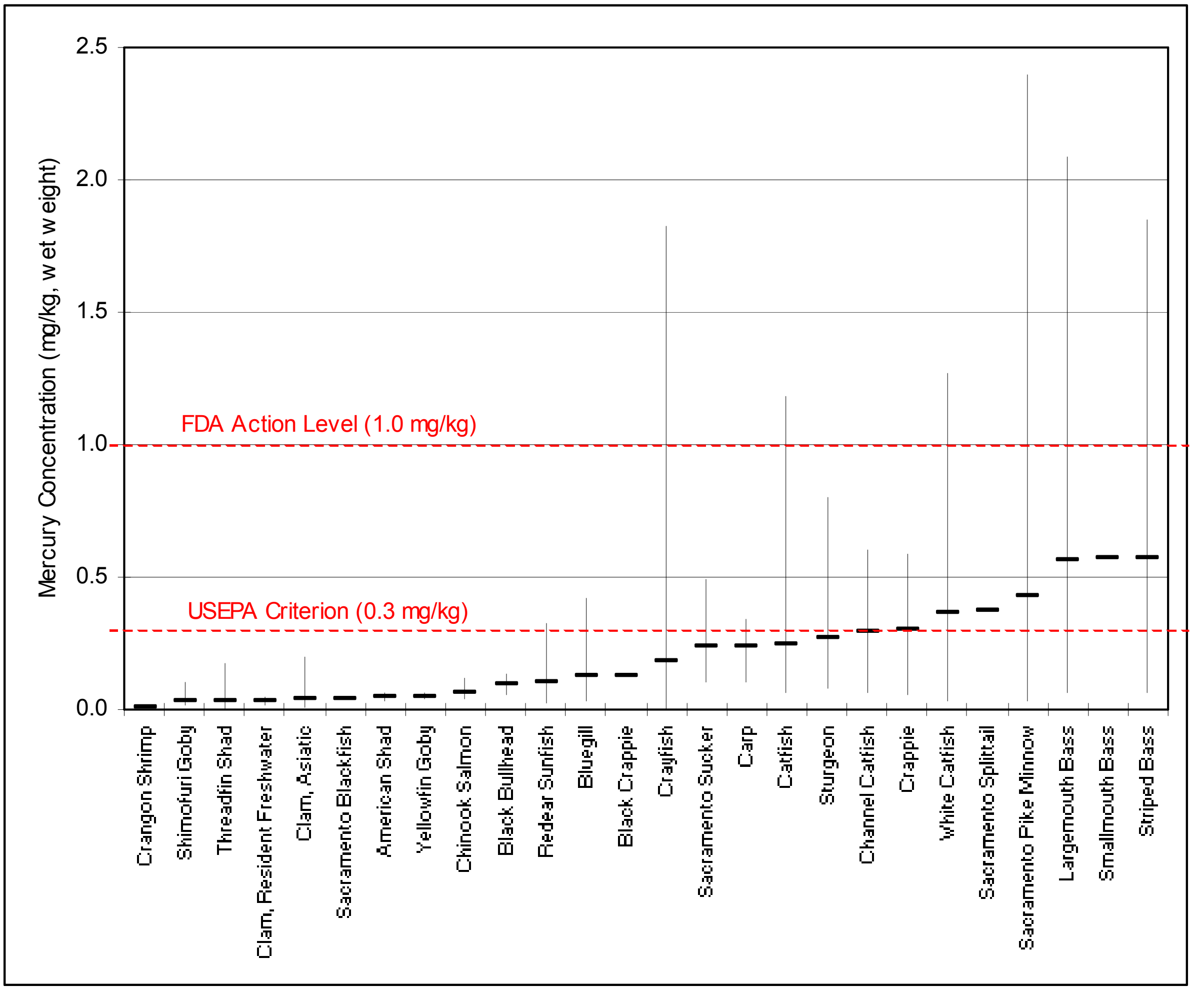

Figure C.2: Minimum, Maximum and Weighted Average Mercury Concentrations in Species Targeted by Sport and Commercial Fishing Based on Available Data

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D. AVAILABLE AQUEOUS METHYLMERCURY DATA AND POOLED VALUES USED IN DELTA LINKAGE & ALTERNATE BAF-BASED LINKAGE APPROACH

Section D.1 provides tables of methylmercury data, statistical summaries and regressions used in the Delta linkage analysis. Section D.2 describes an alternate approach to the linkage analysis using site-specific BAFs.

D. 1 Tables of Methylmercury Data, Statistical Summaries and Regressions Used in the Delta Linkage Analysis

Table D.1: Summary of Available Raw (Unfiltered) Methylmercury Data (ng/l) [(a)]

Sample Date	Data Source	Delta Mendota Canal	Mokelumne River @ I-5	Sacramento River @ Freeport	Sacramento River @ Greene's Landing	Sacramento River @ RM44	San Joaquin River @ Vernalis	State Water Project	X2
03/28-29/00	A	0.153	0.171		0.148		0.164	0.139	0.204
04/24/00	A	< 0.022	0.28		0.117		0.147	0.0469	0.0819
05/30/00	A	0.171	0.25		0.336		0.134	0.144	0.241
06/26/00	A	0.0737	0.114		0.0716		0.22	< 0.022	0.109
07/18/00	B			0.06					
07/19/00	A	< 0.022	< 0.022		0.052		0.118	< 0.022	< 0.022
07/21/00	C				0.052 [(b)]				
08/16/00	B			0.078					
08/21/00	A	< 0.022	0.154		0.11		0.14	< 0.022	< 0.022
09/21/00	C				0.063				
09/26/00	A	< 0.022	< 0.022		0.0514		0.0986	0.0581	0.0233
10/19/00	C				0.071				
10/28-29/00	A	< 0.022	0.13		0.08515 (FD: 0.0847 & 0.0856)		0.158	< 0.022	< 0.022
11/07/00	B			0.127		0.136			
11/08/00	C				0.099				
12/18/00	A	0.0628	0.0955		0.08905		0.102	0.0501	0.0595
12/19/00	B			0.108		0.13			
01/17/01	B, C			0.122	0.095	0.119			
01/28-29/01	A	0.144	0.246		0.244 (FD: 0.24 & 0.248)		0.239	0.113	0.0945
02/21/01	B, C			0.118	0.077	0.123			
02/26/01	A		0.32		0.1765		0.18	0.0767	0.165
03/20/01	B			0.168		0.141			
03/21/01	C				0.097				
03/25-26/01	A	0.0924	0.185		0.08405 (FD: 0.0825 & 0.0856)		0.178	0.0551	
04/11/01	D				0.07				
04/17/01	B			0.058		0.077			
04/18/01	C				0.076				
04/26/01	D				0.097				
04/29/01	A	0.024	0.201		0.113		0.0934	0.0584	< 0.014
05/15/01	B, D			0.122	0.116	0.153			
05/16/01	D				0.164				

Table D.1: Summary of Available Raw (Unfiltered) Methylmercury Data (ng/l) [(a)]

Sample Date	Data Source	Delta Mendota Canal	Mokelumne River @ I-5	Sacramento River @ Freeport	Sacramento River @ Greene's Landing	Sacramento River @ RM44	San Joaquin River @ Vernalis	State Water Project	X2
05/17/01	C				0.141 (FD: 0.136 & 0.146)				
05/27-28/01	A	0.0555	0.178		0.0986		0.122	0.0503	0.0409
05/29/01	D				0.09				
06/06/01	D				< 0.02				
06/14/01	D				0.122				
06/19/01	B			0.089		0.18			
06/25-26/01	A	0.0607	0.208		0.0878		0.256		0.0369
06/28/01	D				0.0878				
07/17/01	B			0.111		0.101			
07/30-31/01	A	0.0645	0.167		0.108		0.147	0.0213	0.0701
08/14/01	B			0.091		0.097			
08/27/01	A	0.0317	0.065		0.0712		0.194	< 0.014	0.0541
09/19/01	B			0.073		0.098			
10/01/01	A	< 0.014	0.184		0.0953		0.163	0.0321	< 0.014
10/17/01	B			0.072		0.069			
11/14/01	B			0.179		0.143			
12/19/01	B			0.154		0.172			
01/16/02	B			0.202		0.196			
02/05/02	B			0.13					
02/06/02	B					0.083			
03/06/02	B			0.05		0.062			
04/03/02	B			0.052		0.067			
05/08/02	B			0.092		0.107			
06/05/02	B			0.064		0.101			
07/10/02	B			0.144		0.135			
08/07/02	B			0.111		0.108			
09/04/02	B			0.068		0.077			
10/02/02	B			0.081		0.095			
11/06/02	B			0.062		0.076			
12/04/02	B			0.103		0.117			
01/08/03	B			0.111		0.14			
02/05/03	B			0.242		0.251			
02/16/03	B			0.094					
03/05/03	B			0.086		0.081			
03/15/03	B			0.066					
03/18/03	E				0.1687 (FD&LR: 0.168, 0.158, & 0.180)				
04/02/03	B			0.089		0.094			
04/15/03	E						0.122 (FD: 0.112 & 0.132)		
04/21/03	E				0.1115 (FD: 0.1 & 0.123)				
04/28/03	E		0.2605 (LR: 0.278 & 0.243)		0.146		0.105		0.093
05/07/03	B			0.12		0.133			

Table D.1: Summary of Available Raw (Unfiltered) Methylmercury Data (ng/l) [(a)]

Sample Date	Data Source	Delta Mendota Canal	Mokelumne River @ I-5	Sacramento River @ Freeport	Sacramento River @ Greene's Landing	Sacramento River @ RM44	San Joaquin River @ Vernalis	State Water Project	X2
05/13/03	E						0.122		
05/20/03	E				0.1002 (LR: 0.0993 & 0.101)				
05/27/03	E	0.0555	0.0925		0.0824		0.133		0.0759
06/10/03	E						0.126 (FD&LR: 0.126, 0.143, & 0.109)		
06/11/03	B			0.1		0.096			
06/18/03	E				0.0366				
06/30/03	E	0.0788					0.178	0.0291 (FD&LR: 0.0345, 0.0272 & 0.0256)	0.0856
07/01/03	E		< 0.0228		0.0233				
07/08/03	E						0.1845 (FD: 0.205 & 0.164)		
07/28/03	E	0.0932	0.076		0.0793 (FD: 0.0661 & 0.0924)		0.212	0.0284	0.0697
09/09/03	E						0.137 (FD: 0.134 & 0.140)		
09/17/03	E				0.0716				
09/29/03	E	0.0883					0.181	0.058	0.098
09/30/03	E		0.103		0.0632				
02/19/04	E				0.242				
02/26/04	E						0.17 (FD: 0.0642 & 0.0723)		
02/29/04	E				0.126 (FD: 0.132 & 0.12)				
03/24/04	E				0.122 (FD: 0.118 & 0.126)				
03/29/04	E						0.165		
04/12/04	E						0.135		
04/28/04	E				0.0956				

(a) FD: Average of field duplicates. LR: Average of laboratory replicates. Data sources: A – Foe, 2003; B – CMP, 2004; C – SRWP, 2004; D – Stephenson *et al*., 2002; E – Data collected by Central Valley Water Board staff to be published in 2008 CALFED report.

(b) Regional Board staff collected a sample at Greene's Landing on 19 September 2000 with a value of 0.052 ng/l. Coincidently, the SRWP program also collected a sample at Greene's Landing on 21 September 2000 with a value of 0.052 ng/l.

Table D.2: Monthly Average Methylmercury Concentrations (ng/l) for March 2000 to October 2000 Period Used to Calculate Average and Median Methylmercury Concentrations for Each Delta Subarea.

Month [(a)]	Sacramento River		San Joaquin River		Mokelumne River		Central Delta		Western Delta	
	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples
March	0.148	1	0.164	1	0.171	1	0.146	2	0.204	1
April	0.117	1	0.147	1	0.280	1	0.029*	2	0.082	1
May	0.336	1	0.134	1	0.250	1	0.158*	2	0.241	1
June	0.072	1	0.220	1	0.114	1	0.042	2	0.109	1
July	0.055	3	0.118	1	0.011*	1	0.011*	2	0.011*	1
Aug.	0.094	2	0.140	1	0.154	1	0.011*	2	0.011*	1
Sept.	0.057	2	0.099	1	0.011*	1	0.035*	2	0.023	1
Oct.	0.078	2	0.158	1	0.130	1	0.011*	2	0.011*	1
Average	0.120	13	0.147	8	0.140	8	0.055	16	0.087	8
Median	0.086		0.144		0.142		0.032		0.053	

(a) Monthly averages are the mean of all data collected during a given month. The Central Delta subarea includes data collected at the Delta Mendota Canal and State Water Project. The Sacramento subarea includes data collected at Freeport, River Mile 44 and Greene's Landing. The raw data are listed in Table D.1. Values with an asterisk were calculated from a water concentration that was below detection. Half the detection limit was used in the calculations.

Table D.3: Monthly Average Methylmercury Concentrations (ng/l) for March 2000 to April 2004 Period Used to Calculate Annual Average and Median Methylmercury Concentrations for Each Delta Subarea.

Month [(a)]	Sacramento River		San Joaquin River		Mokelumne River		Central Delta		West Delta	
	Ave. Conc.	# of Samples	Ave. Conc.	# of Samples	Ave. Conc.	# of Samples	Ave. Conc.	# of Samples	Ave. Conc.	# of Samples
January	0.154	8	0.239	1	0.246	1	0.129	2	0.095	1
February	0.151	11	0.175	2	0.320	1	0.077	1	0.165	1
March	0.106	12	0.169	3	0.178	2	0.110	4	0.204	1
April	0.090	14	0.120	5	0.247	3	0.035*	4	0.061*	3
May	0.133	14	0.128	4	0.174	3	0.095	5	0.119	3
June	0.087*	12	0.195	4	0.161	2	0.051*	5	0.077	3
July	0.087	10	0.165	4	0.066*	4	0.038*	6	0.050*	3
August	0.095	7	0.167	2	0.110	2	0.015*	4	0.033*	2
September	0.073	9	0.145	4	0.099*	3	0.042*	6	0.043*	3
October	0.079	6	0.158	1	0.130	1	0.011*	2	0.011*	1
November	0.117	7								
December	0.125	7	0.102	1	0.096	1	0.056	2	0.060	1
Annual Average	0.108	117	0.160	31	0.166	23	0.060	41	0.083	22
Annual Median	0.101		0.165		0.161		0.051		0.061	

(a) Monthly averages are the mean of all data collected during a given month. The Central Delta subarea includes data collected at the Delta Mendota Canal and State Water Project. The Sacramento subarea includes data collected at Freeport, River Mile 44 and Greene's Landing. The raw data are listed in Table D.1. Values with an asterisk were calculated using one or more samples with concentrations below detection. Refer to Table D.1 for detections limits associated with each non-detect value.

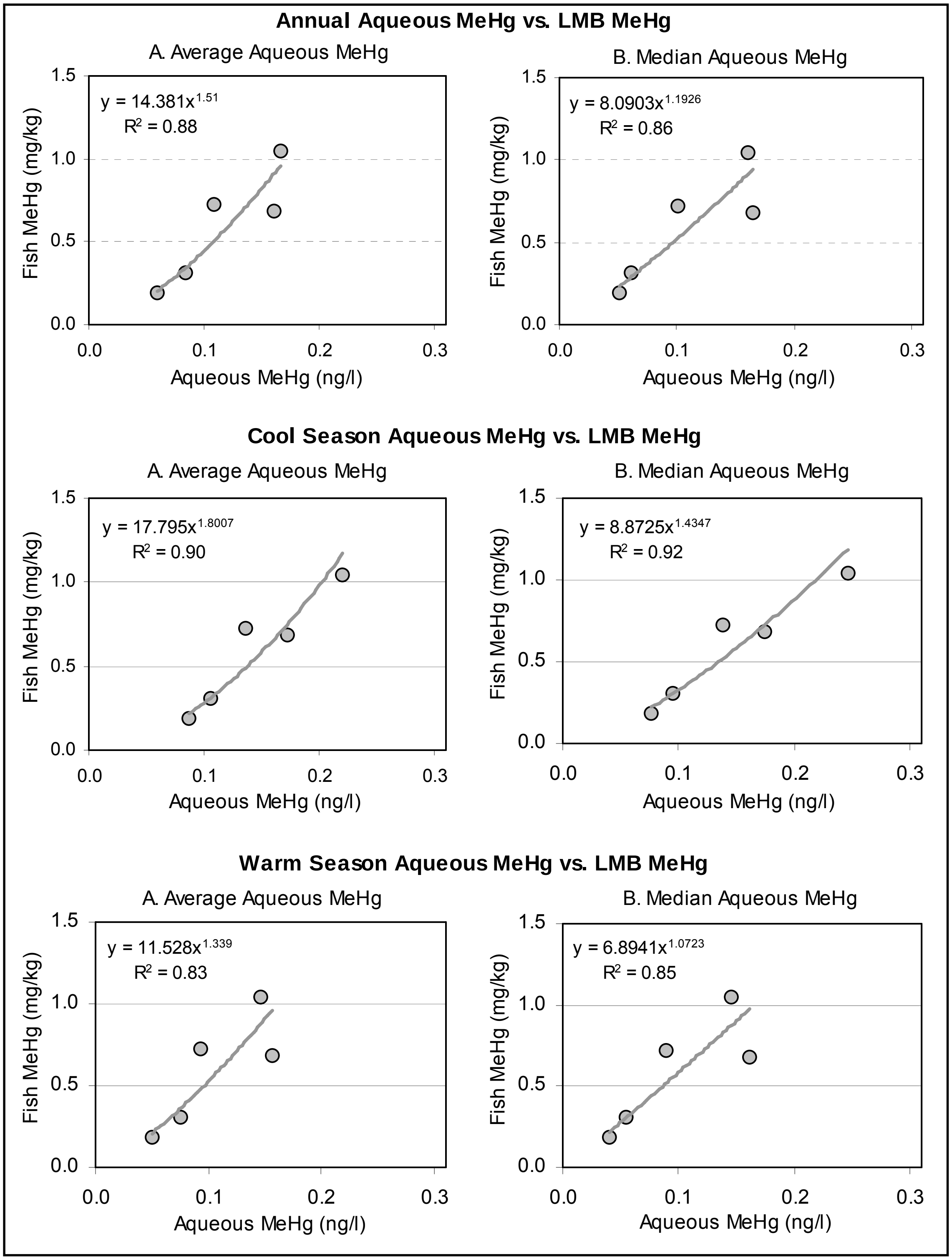

Figure D.1: Relationships between Standardized 350-mm Largemouth Bass Mercury Levels & March 2000 to April 2004 Aqueous Methylmercury.
The warm and cool seasons are defined as March to October and November to February, respectively.

Table D.4: Monthly Average Filtered Methylmercury Concentrations (ng/l) for March 2000 to October 2000 Used to Calculate Annual Average and Median Filtered Methylmercury Concentrations for Each Delta Subarea.

Month [(a)]	Sacramento River		San Joaquin River		Mokelumne River		Central Delta		Western Delta	
	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples	Average Conc.	# of Samples
March	0.039	1	0.051	1	0.074	1	0.077	2	0.058	1
April	0.011*	1	0.036	1	0.165	1	0.016*	2	0.011*	1
May	0.074	1	0.071	1	0.146	1	0.073	2	0.011*	1
June	0.042	1	- - -	0	0.057	1	0.024*	2	0.031	1
July	0.022	1	0.011*	1	0.011*	1	0.011*	2	0.011*	1
August	0.090	1	0.011*	1	0.098	1	0.011*	2	0.011*	1
September	0.039	2	0.033	1	0.011*	1	0.011*	2	0.011*	1
October	0.030*	4	0.042	1	0.063	1	0.011*	2	0.011*	1
Average	**0.043**	**12**	**0.037**	**7**	**0.078**	**8**	**0.029**	**16**	**0.019**	**8**
Median	**0.039**		**0.036**		**0.069**		**0.014**		**0.011**	

(a) Monthly averages are the mean of all data collected during a given month. The Central Delta subarea includes data collected at the Delta Mendota Canal and State Water Project. The Sacramento subarea includes data collected at Freeport, River Mile 44 and Greene's Landing. The raw data are provided in Appendix L. Values noted with an asterisk were calculated using one or more water concentrations that were below detection. Half the detection limit was used in the calculations.

D.2 Alternate BAF-Based Linkage Approach

The linkage method recommended by Central Valley Water Board staff and described in Chapter 5 is based on the statistically significant relationship between standard 350-mm largemouth bass and average water methylmercury concentrations. A second approach that does not rely on the correlation between largemouth bass and water methylmercury concentrations to derive an implementation goal for water makes use of the total bioaccumulation factor (BAF), an approach used in numerous USEPA-approved TMDLs across the country.[4] A BAF is the ratio of the concentration of a chemical in fish tissue to the concentration of the chemical in the water column. As defined in Mercury Study Report to Congress (USEPA, 1997), the BAF is the concentration of the methylmercury in fish divided by the concentration of dissolved methylmercury in water. According to USEPA's 2003 technical support document for the development of national bioaccumulation factors, a total BAF based on the total concentration of a chemical in water also can be used. By definition, BAFs imply a linear relationship between methylmercury in the water column and in fish.

Table D.5 lists the BAFs and safe aqueous methylmercury levels calculated for each Delta subarea and a Delta-wide BAF using standard 350 mm largemouth bass, average unfiltered water methylmercury values, and the following equations. Table D.6 lists BAFs and safe water methylmercury levels based on filtered water data.

Equation 5.1a:

$$BAF = LMB_{MeHgconc} \div Water_{MeHgconc}$$

Where: $Water_{MeHgconc}$ = Water column concentration of unfiltered MMHg (µg/L)
$LMB_{MeHgconc}$ = 350-mm LMB tissue concentration (µg/kg)

Equation 5.b:

$$\text{Safe Level for Water} = LMB_{MeHg\ Proposed}\ Goal \div BAF$$

Where: $LMB_{MeHgconc}$ = Proposed implementation goal for 350-mm LMB (µg/kg)

Using "Delta-wide" values from Table 5.3 as an example:

$$BAF = (0.59\ mg/kg \times 1000) \div (0.110\ ng/l \div 1000) = 5.35 \times 10^6$$

$$\text{Safe Level for Water} = (0.180 \div 5.35 \times 10^6) \div 10^6 = 0.034\ ng/l$$

The safe aqueous methylmercury concentrations produced by the BAF method are slightly less than but comparable to the safe levels produced using the regression-based approach. This similarity most likely occurs because both methods used the same data, and because the regressions are nearly linear at low fish and water methylmercury levels. However, the regression-based method is preferred because it does not inherently assume a linear relationship between fish and water methylmercury levels.

[4] Refer to: http://www.epa.gov/OWOW/tmdl/index.html.

Table D.5: Delta BAFs and Corresponding Safe Methylmercury Levels in Water Calculated Using Unfiltered Water

	Delta Subarea					**Delta-Wide** [(a)]
	Sacramento River	Mokelumne River	Central Delta	San Joaquin River	West Delta	
Standardized 350-mm Largemouth Bass MeHg (mg/kg)	0.72	1.04	0.19	0.68	0.31	0.59
March-October 2000 Average MeHg in Unfiltered Water (ng/l)	0.120	0.140	0.055	0.147	0.087	0.110
BAF	6.00×10^6	7.43×10^6	3.45×10^6	4.63×10^6	3.56×10^6	5.35×10^6
Safe Methylmercury Concentration in Water [(b)]	0.030	0.024	0.052	0.039	0.051	0.034

(a) Delta-wide largemouth bass and water methylmercury concentrations were estimated by averaging the subarea values. The Delta-wide BAF and safe water concentration were calculated using the Delta-wide largemouth bass and water values.
(b) Safe levels in water correspond to the proposed implementation goal of 0.18 mg/kg methylmercury in standard 350-mm largemouth bass.

Table D.6: Delta BAFs and Corresponding Safe Methylmercury Levels in Water Calculated Using Filtered Water Data

	Delta Subarea					**Delta-Wide** [(a)]
	Sacramento River	Mokelumne River	Central Delta	San Joaquin River	West Delta	
Standardized 350-mm Largemouth Bass MeHg (mg/kg)	0.72	1.04	0.19	0.68	0.31	0.59
March-October 2000 Average MeHg in Filtered Water (ng/l)	0.043	0.078	0.029	0.037	0.019	0.041
BAF	1.67×10^7	1.33×10^7	6.55×10^7	1.84×10^7	1.63×10^7	1.43×10^7
Safe Methylmercury Concentration in Water (b)	0.011	0.014	0.027	0.010	0.011	0.013

(a) Delta-wide largemouth bass and water methylmercury concentrations were estimated by averaging the subarea values. The Delta-wide BAF and safe water concentration were calculated using the Delta-wide largemouth bass and water values.
(b) Safe levels in water correspond to the proposed implementation goal of 0.18 mg/kg methylmercury in standard 350-mm largemouth bass.

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E. METHODS USED TO ESTIMATE WATER VOLUMES FOR DELTA AND SACRAMENTO BASIN INPUTS AND EXPORTS

Average annual water volume is a critical component of the source assessments described in Chapters 6 and 7 because water volume is multiplied by the concentration of each constituent to determine loads. Also, a balanced water budget indicates that all major water imports and exports have been identified. This appendix contains a hydrologic evaluation of wet and dry years during the methyl and total mercury source assessment study periods (Section E.1) and a description of methods used to estimate water volumes used in the source assessments (Section E.2). All figures and tables referenced in the text are provided at the end of Appendix E.

E.1 Hydrologic Evaluation of Source Assessment Study Periods

Water volumes entering the Delta vary from season to season and year to year. A “water year” (WY) is the period between October and September that encompasses the entire wet season; for example, WY2001 is the period between 1 October 2000 and 30 September 2001. The methylmercury load analyses (Chapter 6) focused on the four-year WY2000-2003 period, which encompasses the available methylmercury concentration data. The total mercury and sediment load analyses (Chapter 7) focused on two periods, WY2000-2003 and WY1984-2003. The WY2000-2003 period was selected for comparison to the methylmercury load estimates. Enough information was available to evaluate the twenty-year WY1984-2003 period for the Sacramento Basin tributaries, which input the most total mercury to the Delta of any source. This period was evaluated because it includes a fairly even mix of wet and dry years and better describes long-term average conditions.

Water year types in California are classified according to the natural water production of the major basins. The California Department of Water Resources (DWR) Hydrologic Classification Index (HCI) was used to evaluate the distribution of wet and dry years in the Central Valley. Figure E.1 graphs the Sacramento Valley and San Joaquin Valley indices for the period of record (1901 to 2003). The DWR HCI classifies water years as “wet”, “above normal”, “below normal”, “dry”, or “critical dry” (DWR, 2003). For the Sacramento Valley, normal hydrologic conditions equate to an index value of 7.8, wet is ≥9.2, dry is 5.4 to 6.5, and critical dry is ≤5.4. For the San Joaquin Valley, normal hydrologic conditions equate to an index value of 3.1, wet is ≥3.8, dry is 2.1 to 2.5, and critical dry is ≤2.1. The WY2000-2003 period has average indices of 7.3 and 2.7 for the Sacramento and San Joaquin watersheds, respectively, and appears to be a relatively dry period compared to the period of record. In comparison, the WY1984-2003 period appears to encompass a fairly even mix of wet and dry years. The Sacramento River HCI indicates that during the WY1984-2003 period, ten water years were “wet” or “above normal”, and ten years were “below normal,” “dry,” or “critical dry”. The San Joaquin River HCI indicates that nine water years were “wet” or “above normal”, and eleven years were “below normal,” “dry,” or “critical dry.”

The distribution of wet/dry years in the twenty-year study period was compared to the distribution of wet/dry years during the past century in the Sacramento and San Joaquin River watersheds. The Sacramento River index includes water years 1906 to 2003 and the San Joaquin River index includes water years 1901 to 2003. Using the Chi-square test, it was determined that the distribution of water year classifications between the WY1984-2003 period and the entire record was not statistically different (a=0.05) from the distributions for both the Sacramento and San Joaquin River watersheds. Therefore, it was concluded that the WY1984-2003 period is representative of long-term conditions.

E.2 Water Volume Estimation Methods

Average annual water volumes were estimated for the following Delta inputs and exports:

1. Tributary inputs to the Delta;
2. Wastewater treatment plants;
3. Atmospheric deposition;
4. Urban runoff;
5. Delta outflows to San Francisco Bay and diversions to southern California (Delta Mendota Canal and State Water Project);
6. Agricultural diversions;
7. Evaporation; and
8. Dredging.

The WY2000-2003 period is a relatively dry four-year period, while the WY1984-2003 period reflects an even mix of wet and dry years, conditions typical for the last 100 years. As illustrated by Table 6.1 in Chapter 6, the WY2000-2003 water budget balances within 5% and the WY1984-2003 water budget balances within 1%. This indicates that the major water inputs and exports have been identified.

Water volume information was obtained from a variety of sources (Table E.1). A DWR model, Dayflow, provided daily flow estimates for several of the major Delta exports, including outflow to San Francisco Bay, the Delta Mendota Canal (DMC), State Water Project (SWP), and agricultural withdrawals. Four-year and 20-year precipitation amounts and land use acreages were used to estimate wet weather inputs from urban areas, atmospheric deposition, and tributaries with no flow gages, whenever that duration of data was available for a given monitoring station. Project files were reviewed to determine recent average annual discharges from NPDDES-permitted facilities in the Delta and annual average volumes removed by dredging projects. The following sections describe how each water volume was derived.

E.2.1 Flow-Gage Based Water Volumes

Average annual water volumes were estimated for tributary inputs to the Delta using a variety of methods determined by available data (Table E.1). Flow gages provided daily flows for the major tributaries. If there was no nearby flow gage, Staff used precipitation-based runoff estimates to calculate loads (Section E.2.3).

Table E.2 lists the flow gages used to calculate average annual water volume. The use of multiple flow gages was required to estimate water volumes corresponding to the following monitoring locations: Feather River near Nicolaus, Mokelumne River downstream of I-5, and Yolo Bypass. Because of the complexities of the Yolo bypass hydrology, it is discussed in its own section (Section E.2.2).

Staff estimated flows for the Feather River at Nicolaus using the formula: 1.11 x [Bear at Wheatland + Yuba at Marysville + Feather at Gridley]. The coefficient of 1.11 was determined by fitting a regression of historical flow data at Nicolaus when flows were rated (1942 to 1983) and historical flow data for the same time period paired by date of the sum of Feather River at Gridley, Yuba River at Marysville and the Bear River at Wheatland. The coefficient of 1.11 compensates for inputs not included by the Gridley, Marysville, and Wheatland gages.

The flow of the Mokelumne River near I-5 was estimated by summing the gaged flows of the Mokelumne at Woodbridge and Cosumnes River at Michigan Bar. If Mokelumne at Woodbridge flows were missing for particular days, the sum of Camanche Dam outflow and Cosumnes River at Michigan Bar was used. If both the Mokelumne at Woodbridge flow and Camanche Dam outflow were missing, then those particular days were considered missing values. Flow records for Mokelumne at Woodbridge flow and Camanche Dam outflow for water years 1995 and 1996 were missing more than 20% of their values; all other water years during the study period had either Mokelumne at Woodbridge flow and/or Camanche Dam outflow records available. Therefore, the 20-year flow average was estimated by normalizing the total flows for the WY1984-2003 period. To estimate the missing values, first the number of days in the 20-year period (7305) was divided by the number of days with a recorded value in the flow record (6517). Then the resulting quotient was multiplied by the calculated sum of loads divided by 20 to obtain the average annual load. Normalization was not needed for the WY2000-2003 period.

E.2.2 Yolo Bypass Inflows & Outflows to the Delta & Hydrologic Conditions in January 1995

Yolo Bypass Boundary Definition & Hydrologic Features

The Yolo Bypass is a 73,300-acre floodplain on the west side of the lower Sacramento River in Yolo and Solano Counties (Figure E.2) within the levees of the Sacramento River Flood Control Project. The Fremont and Sacramento Weirs route floodwaters to the Yolo Bypass from the Sacramento and Feather Rivers, Sutter Bypass and their associated tributary watersheds. Cache and Putah Creeks, Willow Slough, and the Knights Landing Ridge Cut from the Colusa Basin all drain directly to the Yolo Bypass.

The Interstate 80 (I-80) causeway bisects the Yolo Bypass east to west. The bypass north of I-80 is bounded on the east by the Tule Canal (the upper extension of the Toe Drain) and the East Bypass Levee and bounded on the west by the West Bypass Levee. For the purpose of this TMDL, staff used the boundaries defined by 2001 Yolo Basin Foundation report, *A Framework for the Future: Yolo Bypass Management Strategy* (Jones & Stokes, 2001[5]) to delineate the bypass south of I-80. South of I-80 the bypass is bounded on the east by the Toe Drain and the East Bypass Levee (also considered the west levee of the Sacramento River Deep Water Ship Channel), downstream to the northwest corner of Prospect Island. At this location, the bypass extends east to include Prospect Island, although the East Bypass Levee remains intact along the west edge of the island. South of Prospect Island, the east side of the Bypass extends downstream of the confluence of Cache and Lindsey Sloughs to the downstream boundary of Egbert Tract. This eastern downstream limit of the bypass is roughly co-located with the confluence of Steamboat and Cache Sloughs. The west side of the bypass is bounded by the West Bypass Levee to just south of Putah Creek and the Putah Creek Sink downstream of Putah Creek. The southern bypass is unleveed on the west side for approximately eight miles, allowing floodwaters to flow unimpeded as far west as Yolo County Road (CR) 104. Farther downstream (approximately 1 mile north of Yolo CR 155), the West Bypass Levee resumes and extends south and west of Liberty Island. The west side of the bypass extends farther south, downstream of Liberty Island, and along the western boundary of Egbert Tract.

The southern portion of the Yolo Bypass (about 52,600 acres) lies within the statutory Delta boundary and has some tidally influenced areas. Tidal conditions are observed as far upstream in the Toe Drain as the I-80 causeway (Jones & Stokes, 2001). The Toe Drain, which drains to Prospect Slough, is the primary drainage in the Yolo Bypass. The water elevation in the Toe Drain typically fluctuates tidally between three and seven feet at the Yolo Bypass at Lisbon gage (operated by DWR, gage ID "LIS") (Figure E.2). A few hundred feet north of this gage, the Lisbon Weir limits the range of tidal fluctuation upstream of the weir. The main part of the weir consists of a sheet piling-reinforced rock mound with three "slap gates" (like trap doors) that allow water to flow northward with incoming tides, but not southward with outgoing tides (Jones & Stokes, 2001; Kirkland, personal communication). The weir impounds upstream inflow and tidal water at an elevation equal to the weir crest elevation (2.5 feet above sea level) (Jones & Stokes, 2001). This provides higher and more stable water levels for upstream agricultural diversion pumps.

When tributary inputs upstream of Lisbon Weir are greater than approximately 800 cfs, water flows southward over the weir (Kirkland, personal communication). During the summer season, the water stage is typically greater to the south of the weir, so that there is a net upstream flow on Toe Drain. However, even during the summer, very high tides cause the pool upstream of the weir to fill and then drain southward across the top of the weir when the tide turns (Kirkland, personal communication). Until recently, the Lisbon gage provided only stage information; it was rated for velocity in winter 2004. Preliminary calculations by DWR and Central Valley Water Board staff indicate that there was a monthly net downstream flow from the Yolo Bypass at Lisbon ranging between 56,00 and 152,000 acre-feet per month for the months of March, April and May 2004. However, there was a net upstream flow of 700 to 3,000 acre-feet per month in June and July 2004. That is, there was no net outflow from the Yolo Bypass to the Delta during these summer months. Observations during summer months in 2005 and 2006

[5] Jones & Stokes. 2001. *A Framework for the Future: Yolo Bypass Management Strategy.* Final report (J&S 99079) prepared for the CALFED Bay-Delta Program by the Yolo Bypass Working Group, Yolo Basin Foundation, and Jones & Stokes. August 2001.

indicate there is net outflow from the Yolo Bypass during wetter years (Foe, personal communication).

Yolo Bypass Inflow and Outflow Calculations

Aqueous methyl and total mercury sampling took place on Prospect Slough at the Toe Drain to estimate mercury concentrations in outflows from the Yolo Bypass to the central Delta. However, no flow gage is available at that location. Several gages are available upstream that can be used to estimate Yolo Bypass outflows. The "Yolo Bypass near Woodland" flow gage (USGS gage 11453000) represents the sum of inflow from Fremont Weir, Knights Landing Ridge Cut, and Cache Creek Settling Basin (Figure E.2); the USGS Woodland gage record includes only daily mean flows greater than 1,000 cfs. Flow gages are also active on Cache Creek at Yolo (USGS gage 11452500), Sacramento Weir (USGS gage 11426000), Putah Creek near Winters (USGS gage 11454000), and the Putah South Canal (USGS gage 11454210, available after 10/1/94), which diverts water from Putah Creek downstream of the Winters gage. No flow gages are active on Knights Landing Ridge Cut or Willow Slough Bypass and, as noted above, the gage on Toe Drain near Lisbon was only recently rated for velocity. Inflows from Knights Landing Ridge Cut, Putah Creek and Willow Slough to the Yolo Bypass were estimated using hydrologic models developed by Jones and Stokes (Jones & Stokes, 2001).

Knights Landing Ridge Cut. The Knights Landing Ridge Cut (KLRC) is an artificial overflow channel that connects the lower end of the Colusa Basin Drain (CBD) to the Yolo Bypass. Under low-flow conditions, the CBD discharges to the Sacramento River through a set of gates, and little to no water flows from the KLRC to the Yolo Bypass (Jones & Stokes, 2001). The daily discharge of the CBD to the Sacramento River is measured by a gage operated by DWR (Colusa Basin Drain at Knights Landing). However, when the Sacramento River stage exceeds 25 feet, the gates close and flow in the CBD is shunted through the KLRC to the Yolo Bypass (Jones & Stokes, 2001). These flows are not gaged; however, staff was able to estimate the KLRC inflows to the Yolo Bypass using a hydrologic model developed by the consulting firm, Jones and Stokes.

The daily discharge velocity of the CBD is measured by a gage operated by DWR at a location near Highway 20. The CBD near Highway 20 gage is about 20 miles upstream of the confluence between the CBD and the KLRC. Therefore, the gage flows do not include the runoff from 22 square miles of tributary watershed area to the CBD between the Highway 20 gage and the CBD-KLRC confluence (Jones & Stokes, 2001). According to the Jones & Stokes hydrologic model, during significant rainfall events (days with greater than 0.3 inches of rain at Colusa), the total flow arriving at the lower end of the CBD was estimated by multiplying the gaged daily flow at CBD near Highway 20 by the drainage area ratio of 1.21. Daily precipitation data at Colusa was obtained from a gage operated by the California Irrigation Management Information System. During days with no significant rainfall (less than 0.3 inches/day of rain at Colusa), the total flow at the lower end of the CBD was estimated to be equal to the CBD near Highway 20 gaged daily flow.

Greater than 0.3 inches of rain at Colusa:

$$Q_{CBD} = 1.21 Q_{CBD20}$$

Less than 0.3 inches of rain at Colusa:

$Q_{CBD} = Q_{CBD20}$

Where: Q_{CBD20} = Gaged flow of the Colusa Basin Drain at Highway 20
Q_{CBD} = Estimated total flow arriving at the lower end of the Colusa Basin Drain

Because the majority of the water from the CBD arriving at the Knights Landing Ridge Cut is discharged to the Sacramento River, the estimated KLRC inflow to the Yolo Bypass was then calculated by subtracting the gaged outflow to the Sacramento River (the CBD at Knights Landing DWR gage) from the estimated total flow arriving at the lower end of the drain (Jones & Stokes, 2001):

$Q_{YB} = Q_{CBD} – Q_{KNL}$

Where: Q_{YB} = Knights Landing Ridge Cut inflow to the Yolo Bypass
Q_{KNL} = Gaged outflow to the Sacramento River from the Knights Landing Ridge Cut

Putah Creek. Upstream of the Yolo Bypass, Putah Creek is impounded by the Monticello Dam, a large dam that creates Lake Berryessa, and the Putah Diversion Dam, a small rediversion dam that creates Lake Solano. The Putah Diversion Dam is about 7 miles downstream of the Monticello Dam. Much of the water trapped behind the Putah Diversion Dam is pumped southward through the Putah South Canal for agricultural uses. However, some of the water in Lake Solano is released to the lower Putah Creek channel. These releases to Putah Creek are gaged by USBR. However, the Putah Diversion Dam is located about 22 miles upstream of the West Bypass Levee of the Yolo Bypass. Flows between the Putah Diversion Dam and the Yolo Bypass are affected by seepage losses, tributary inflows, evapotranspiration, and channel storage (Jones & Stokes, 2001).

Staff estimated the Putah Creek inflows to the Yolo Bypass using the hydrologic model developed by Jones and Stokes (Jones & Stokes, 2001). The calculations were divided into three hydrologic conditions: scheduled Berryessa and Putah Diversion Dam water-rights releases only, active rainfall runoff, and Lake Berryessa spills. During periods when flows at Putah Diversion Dam consisted entirely of scheduled water-rights releases, inflow to the Yolo Bypass equals the Diversion Dam releases minus the net flow losses along the channel. During periods when there was active rainfall runoff but no spill from Lake Berryessa, inflow to the Yolo Bypass equals two times the gaged flow at Putah Diversion Dam minus net flow losses. When Lake Berryessa was spilling, inflow to the Yolo Bypass equals the gaged flow at Putah Diversion Dam minus net flow losses. The net flow losses along the 22 miles downstream of the Diversion Dam were estimated to be a constant 30 cfs in the Jones & Stokes model. The equations for the flow model are as follows:

Conditions 1 (scheduled releases only) and 3 (Lake Berryessa spill):

$Q_{YB} = Q_{PDD} – 30$

Condition 2 (active rainfall runoff):

If: 1. $Q_{PDD} > 60$ cfs (to eliminate scheduled release-only condition)
2. $Q_{BER} < 900$ cfs (to eliminate Lake Berryessa spill periods)
3. $Q_{INT} > 100$ cfs (to eliminate noise in the interdam runoff estimates)

Then: $Q_{YB} = Q_{PDD}(2) - 30$

Where: Q_{PDD} = Putah Creek flow at Putah Diversion Dam
Q_{BER} = Outflow from Lake Berryessa (releases plus spills from USBR gage)
Q_{INT} = Rainfall runoff from the reach between Lake Berryessa and Putah Diversion Dam
$Q_{INT} = Q_{INF} - Q_{BER}$ (Q_{INF} = estimated inflow to Lake Solano calculated by USBR)
Q_{YB} = Putah Creek outflow to Bypass

Willow Slough. Flows in Willow Slough were not gaged at any time during the study period. Staff estimated the Willow Slough inflows to the Yolo Bypass using a hydrologic model developed by Jones and Stokes (Jones & Stokes, 2001). This model estimated Willow Slough daily inflows to the Yolo Bypass by correlation with gaged runoff in the interdam reach of Putah Creek, adjusted for drainage area size. Runoff in the interdam reach of Putah Creek was calculated by subtracting gaged Lake Berryessa outflow (USBR gage BER) from the Lake Solano inflow (calculated by USBR from a daily water balance). The following equation was used to calculate the estimated Willow Slough inflow to the Yolo Bypass:

$$Q_{WS} = -0.000423(Q_{INT})^2 + 3.19Q_{INT}$$

Where: Q_{WS} = Willow Slough outflow to the Bypass
Q_{INT} = Rainfall runoff from the interdam reach between Lake Berryessa and Putah Diversion Dam

Yolo Bypass Inflows. To estimate total inflows to the Yolo Bypass upstream of Prospect Slough at Toe Drain on the days that average daily flows were greater than 1,000 cfs at Yolo Bypass near Woodland, the following equation was used:

Yolo Bypass Inputs = Yolo Bypass near Woodland + Putah Creek + Sacramento Weir Spill + Willow Slough

To estimate total inflows to the Yolo Bypass on the days that average daily flows were less than 1,000 cfs at Yolo Bypass near Woodland, the following equation was used:

Yolo Bypass Inputs = Cache Creek @ Yolo + Knights Landing Ridge Cut + Fremont Weir + Putah Creek + Sacramento Weir Spill + Willow Slough

Total outflow from the Yolo Bypass was estimated by subtracting 800 cfs from the total inflow to account flow trapped behind Lisbon Weir. If the estimated total inflow was less than 800 cfs, it was assumed that there was zero net flow past Lisbon Weir. As Figure E.3 illustrates, the average daily outflow estimates indicate that there is generally no net outflow between July and October, which is comparable with the preliminary outflow estimates described earlier that were developed by DWR and Regional Board staff using March-July 2004 flow data for the gage downstream of the Lisbon Weir.

Concentration/Flow Regressions & Hydrologic Conditions in January 1995

Total mercury and TSS samples were collected from Prospect Slough near Toe Drain typically during outgoing tides. As described in Section 7.1.1.1, total mercury and TSS concentrations observed were regressed against estimated daily Yolo Bypass outflows at Lisbon Weir to determine if statistically significant correlations might exist (Appendix I, Figure I.1). There is generally no net outflow from the Yolo Bypass's Toe Drain downstream of Lisbon Weir between July and October. Therefore, although sampling of Prospect Slough took place during outgoing tides with the intent of sampling outflows from the Yolo Bypass, during the summer months this sampling most likely represents waters tidally-pumped northward from Cache Slough, rather than outflows from the Yolo Bypass north of Lisbon Weir.

Extremely high total mercury and TSS concentrations were measured in Prospect Slough on 10 and 11 January 1995 (Figure I.1). Cache Creek Settling Basin (CCSB) and Fremont Weir spills were evaluated to determine whether these concentrations were likely to have occurred regularly during the 20-year study period. Flows from the CCSB are controlled by the following factors: (1) the CCSB can release up to 400 cfs through its low flow outlet; (2) above 400 cfs, the CCSB begins to fill at a rate of inflow (measured by the gage at Yolo) minus 400 cfs; and (3) when the basin fills beyond its capacity of approximately 43,200 acre-feet (weir height of 12 feet multiplied by 3,600 acres, the area of the CCSB), water begins spilling over the weir. Weir spill continues until inflow to the CCSB decreases to 400 cfs (CDM, 2004). Cache Creek Settling Basin daily outflows were estimated based on these factors and compared to the timing of Fremont Weir spills (Figure E.4). The high concentrations observed in Prospect Slough on 10 and 11 January 1995 may have resulted from the high releases from the Cache Creek Settling Basin that occurred on 9 January without any dilution flow from Fremont Weir. Although the CCSB has had such high releases several times throughout the 20-year record, all occurred concurrently with spills from Fremont Weir. Because the magnitude of CCSB release without any dilution that occurred on 9 January appears to have happened only once in the 20-year period, the 10 and 11 January 1995 total mercury and TSS concentration values were not included in the concentration/flow regressions used to predict average annual loads exported by the Yolo Bypass to the Delta.

E.2.3 Precipitation-Based Water Volumes

Atmospheric wet deposition, tributary inputs from ungaged watersheds, and storm runoff from urban areas were estimated using the rational method:

$$Q_e = Rf \times A \times RC$$

Where: Q_e = Estimated volumetric runoff rate (acre-feet per year)
Rf = Annual precipitation amount in the watershed (feet per year)
A = Watershed area (acres)
RC = Runoff coefficient

Precipitation data for seventeen gages located throughout the Delta source region (Table E.3) were compiled with a focus on gages that appeared to represent the general precipitation pattern of each region and had records at least 20 years in length. All but one of the gages used in this analysis had records that exceeded 20 years in length. The average annual precipitation amount for WY2000-2003 and WY1984-2003 were calculated for each gage. Land use information was obtained from the California Department of Water Resources Land Use Survey Data and USGS/USEPA National Land Cover Data (DWR, 1993-2002[6], USGS/USEPA, 1993[7]) to determine acreages for each land use in the Delta and its ungaged tributary watersheds. The Delta and its ungaged tributary subwatersheds were divided into areas defined by (1) proximity to a precipitation gage, and (2) land use category. Because of their size, tables of the land use acreages divided by land use type and precipitation area are not included in this appendix but can be provided electronically upon request. Table E.4 provides just the urban acreage in the Delta. Then runoff coefficients were assigned to each land use type (Table E.5). Using a combination of software programs (Microsoft Excel and ESRI ArcView), 4-year and 20-year average annual stormwater runoff amounts were calculated for each subarea using Equation E.1.

Dry weather urban runoff was estimated by adapting the daily dry season runoff values developed by Larry Walker Associates (LWA, 1996) for the Sacramento region. Larry Walker Associates determined average dry season runoff to be 49 mgd and inter-storm runoff to be 58 mgd in the greater Sacramento region. LWA estimated that there were 302 square miles (193,280 acres) of urban area in the Sacramento region. The daily dry season runoff value was divided by the acreage to obtain dry season runoff volume per acre:

$$\begin{aligned}\text{Dry Season Runoff} &= 49 \times 10^6 \text{ gallons/day} \div 193{,}280 \text{ acres} \\ &= 254 \text{ gallons/acre/day}\end{aligned}$$

It was assumed that the dry season runoff amounts in the greater Sacramento region are representative of all urban areas within the statutory Delta boundary and its ungaged tributary watersheds. LWA's dry season runoff estimates were used for dry days in both the dry season and wet season to estimate the annual average non-storm urban runoff in the Delta. The average number of non-rain days per year for the WY1984-2003 period (305 days) was multiplied by 254 gallons/acre/day and the Delta urban acreage (about 55,000 acres), to obtain an average annual runoff volume of 4,300 million gallons per year (13,000 acre-feet/year).

E.2.4 Dayflow Model

Output from the Dayflow Model was used to estimate the average annual water volume of outflows to San Francisco Bay and diversions south of the Delta *via* the Delta Mendota Canal (Central Valley Project pumping at Tracy) and State Water Project (Clifton Court Intake). Dayflow is a computer program maintained by the California Department of Water Resources Interagency Ecological Program (http://www.iep.ca.gov/dayflow/index.html). It was developed in 1978 as an accounting tool for determining historical Delta boundary hydrology (mean daily flows). In 2000, the software used to perform Dayflow calculations was rewritten in Java. The input data include the principal Delta stream inflows, Delta precipitation, Delta exports, and Delta gross channel depletions. These data include both monitored and estimated values.

[6] DWR. 1993-2003. Land Use Data. California Department of Water Resources. Available at: http://www.landwateruse.water.ca.gov/basicdata/landuse/digitalsurveys.cfm.

[7] USEPA/USGS Multi-Resolution Land Characterization Program National Land Cover Data available at: http://www.epa.gov/mrlc/nlcd.html.

Input data is stored in a HEC-DSS file, and output is written to an ASCII file. Dayflow output is used extensively in studies initiated by the Department of Water Resources, the Department of Fish and Game, and by other State and Federal agencies and private consultants. Dayflow output files can be downloaded from the IEP Dayflow website: http://www.iep.ca.gov/dayflow/output/index.html.

E.2.6 Evaporation

The amount of water lost through evaporation from Delta water surfaces was estimated by multiplying the average evaporation rate for the region by the water surface acreage. Mean evaporation at Brannan Island and Grizzly Island near Rio Vista is approximately 73.4 inches per year. Mean evaporation at the Oakdale Woodward Dam Station south of Stockton is approximately 78.43 inches per year. Staff used an evaporation rate of 73.4 inches per year and a water surface acreage of approximately 48,600 acres (1.97 x 10^8 square meters) (see Section 4.4.3) to estimate an evaporation water loss of about 300,000 acre/feet per year.

E.2.7 Dredging

Sediment is dredged at various locations in the Delta to maintain ship channels and marinas. Table 6.17 in Chapter 6 provides details on recent dredge projects within the Delta and Figure 6.9 shows their approximate locations. Approximately 533,400 cubic yards per year (cy/yr) of sediment are dredged on average. The amount of water removed by dredge projects was estimated using weight-volume relationships for saturated soils described by Das (1990)[8], specific gravity values of 1 and 2.65 for water and solids, respectively, and the assumption that the water content of the dredged material is 100% (50% water and 50% sediment by weight[9]):

Water Volume =
= (dredged material [cy/yr]) x (1 + (1 ÷ 2.65)) x (cy to acre-feet conversion factors)
= 533,400 cy x (1 ÷ 1.3774) x (27 ÷ 43,560)
= 240 acre-feet/yr

8 Das, B.M. 1990. Principles of Geotechnical Engineering. Second Edition. PWS-Kent Publishing Company, Boston, 665 pp.

9 This is a common assumption for dredging operations. (U.S. Army Corps of Engineers. 2002. "Moisture Content," personal communication from L. Fade to G. Collins, San Francisco Bay Regional Water Quality Control Board, October.)

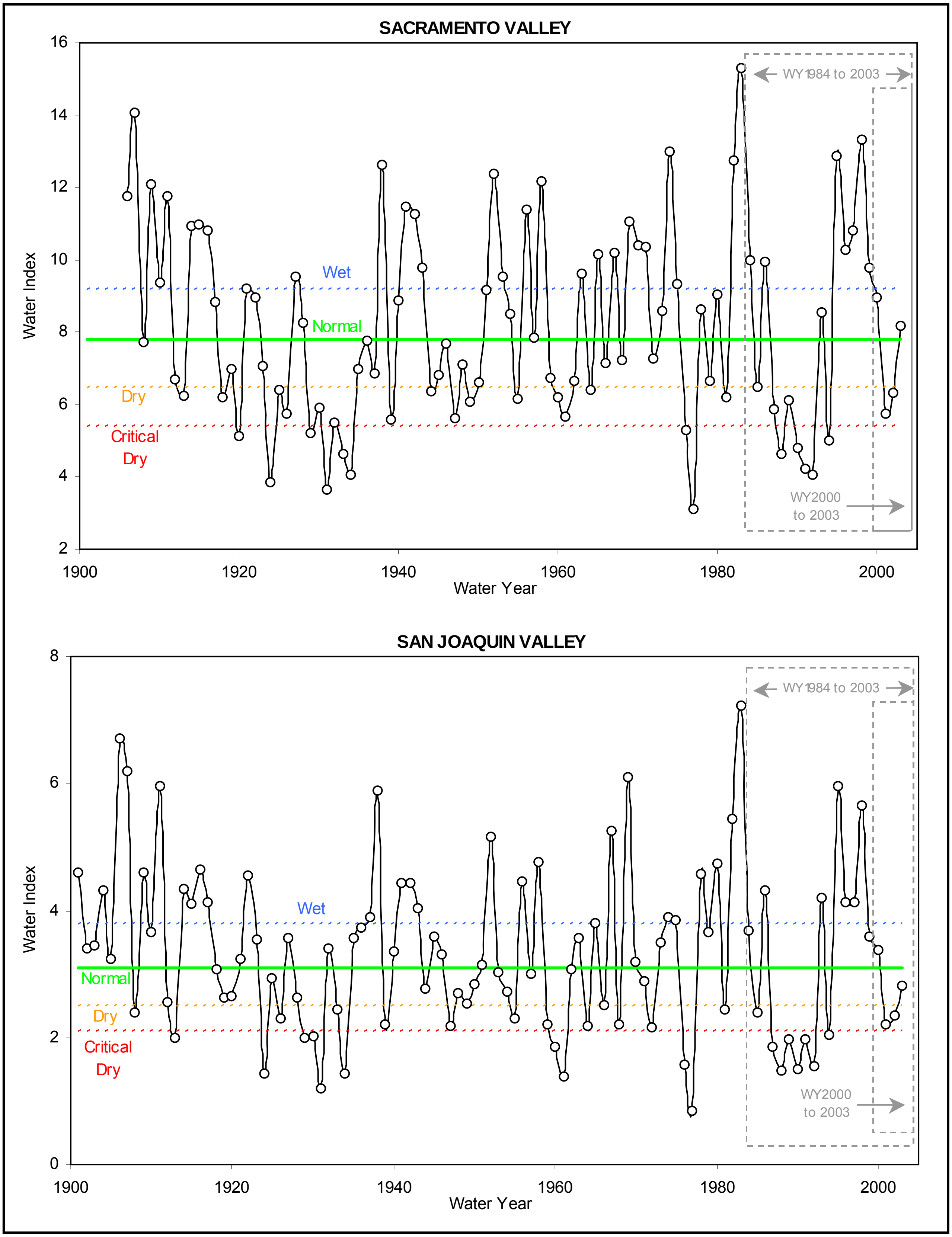


Figure E.1: California Dept. Water Resources Chronological Reconstructed Sacramento Valley & San Joaquin Valley Water Year Hydrologic Classification Indices (DWR, 2005)

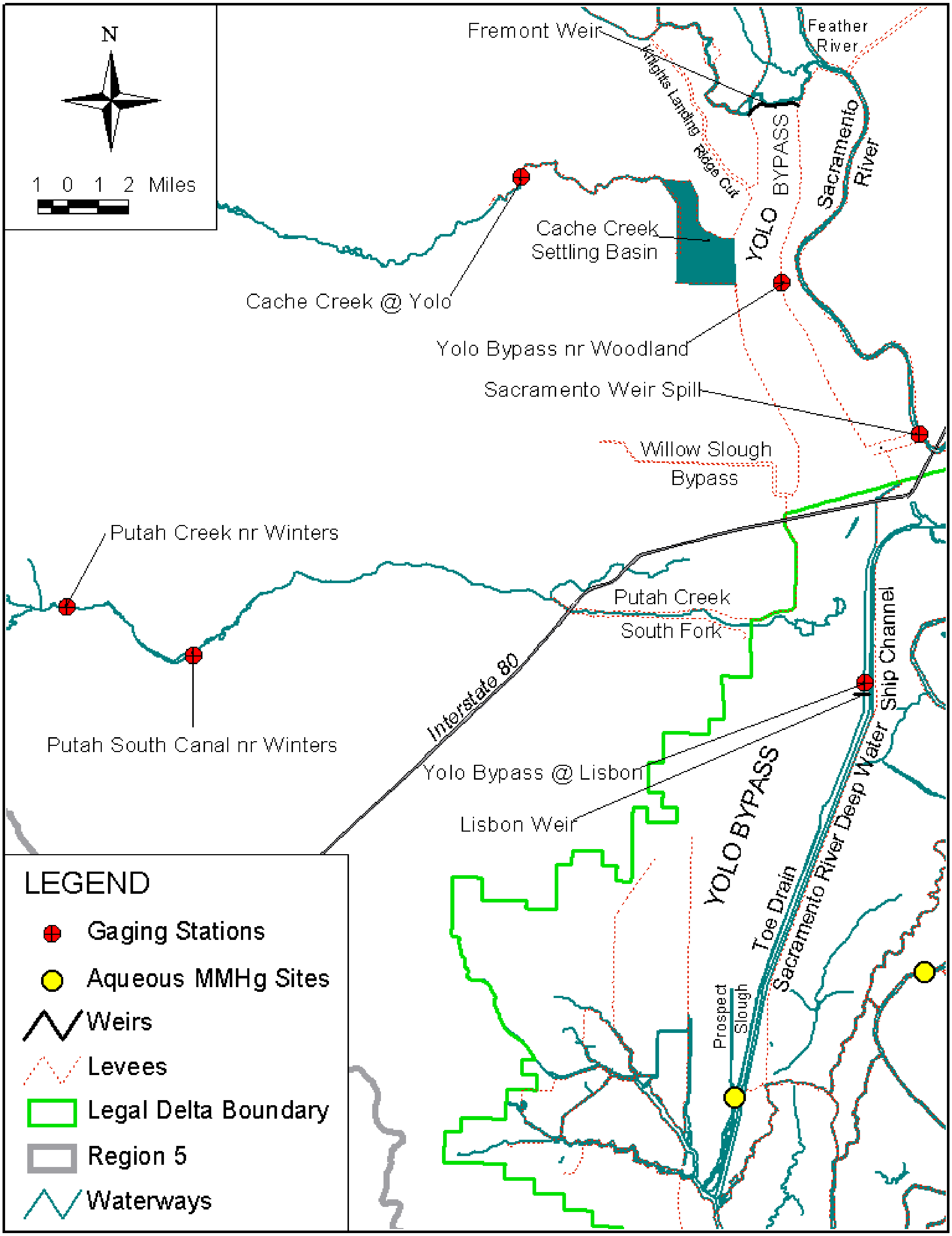


Figure E.2: Hydrologic Features of the Yolo Bypass.

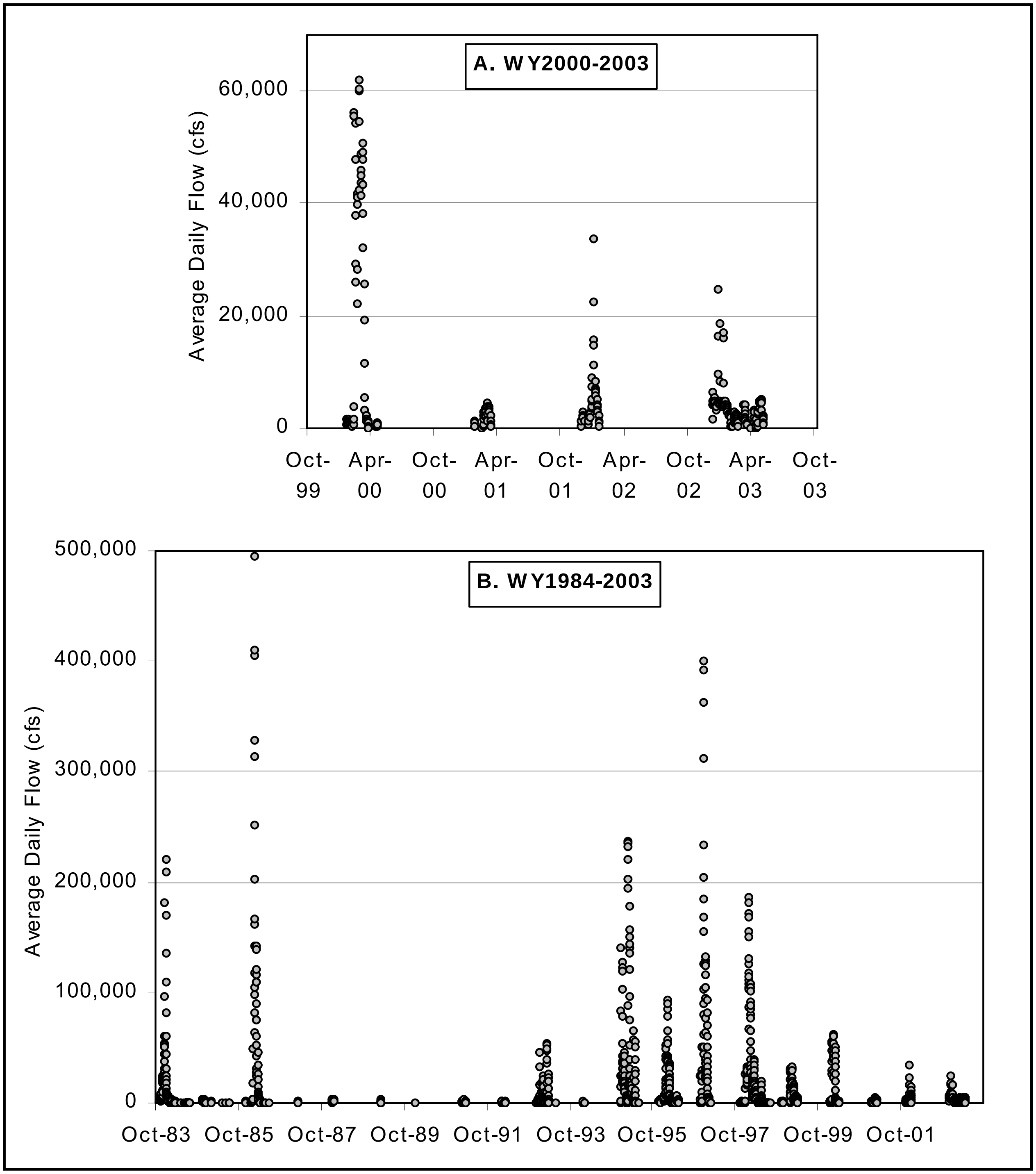


Figure E.3: Estimated Average Daily Outflows from the Yolo Bypass below Lisbon Weir during [A] WY2000-2003 and [B] WY1984-2003

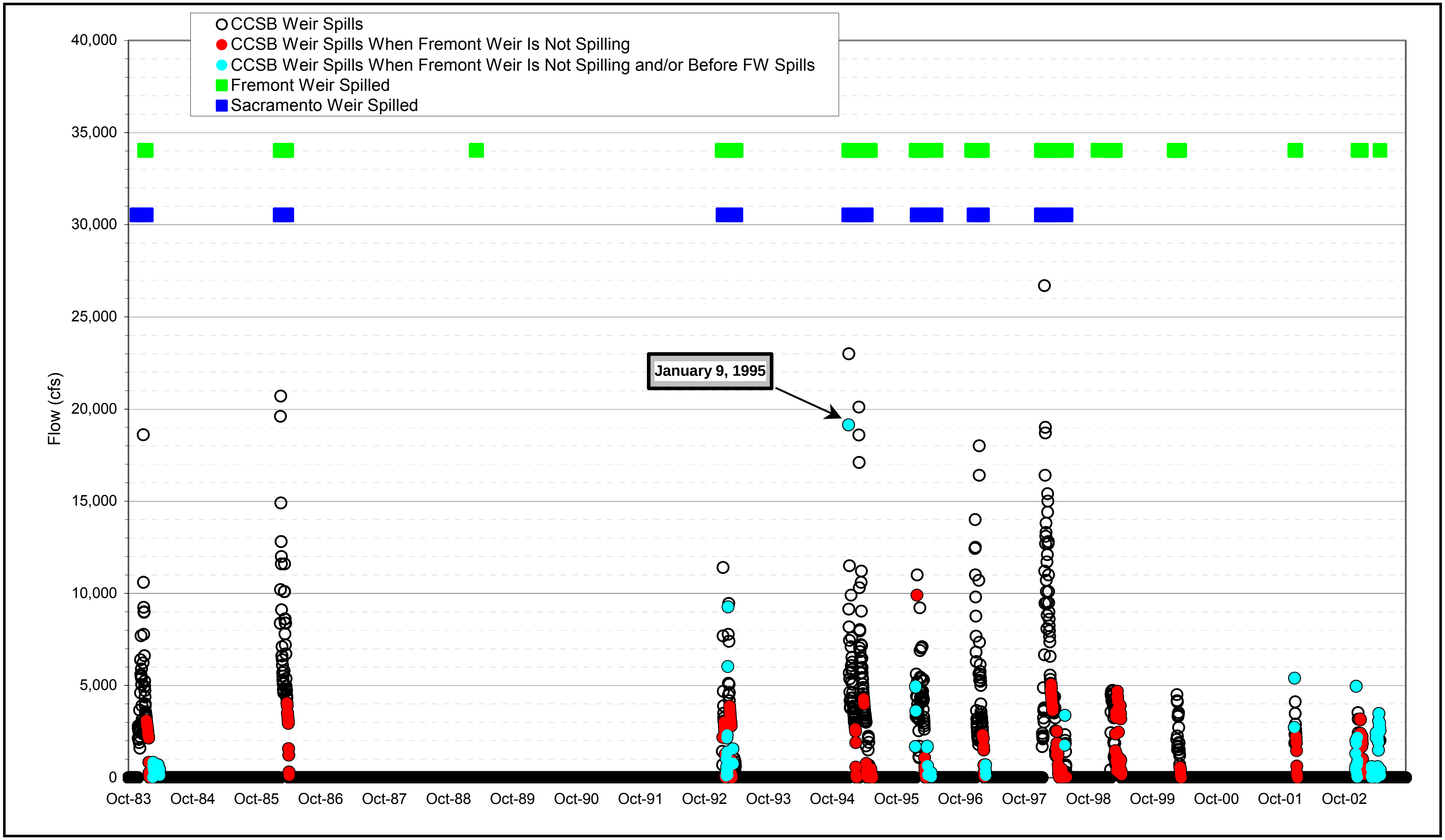


Figure E.4: Comparison of Estimated Cache Creek Settling Basin (CCSB) Outflows Compared to Fremont Weir Spills

Table E.1: Methods Used to Estimate Average Annual Water Volumes for Delta and Sacramento Basin Inputs and Exports

Type	Method	Location of Method Description
Tributary Inputs		
American River @ Discovery Park Cache Creek Settling Basin Colusa Basin Drain Feather River nr Nicolaus Fremont Weir Marsh Creek Mokelumne River d/s I-5 Sacramento River above Colusa Sacramento River @ Freeport San Joaquin River @ Vernalis Sutter Bypass	Flow -Gage Based Method	Section E.2.1
Yolo Bypass Outflows Knights Landing Ridge Cut Putah Creek @ Mace Blvd. Willow Slough	Flow-Gage + Hydrologic Model	Section E.2.2
Bear/Mosher Creek Calaveras River/Mormon Slough Coon Creek/Cross Canal French Camp Slough / Lone Tree Creek Morrison Creek Natomas East Main Drain Ulatis Creek Other Small Drainages to the Delta	Precipitation-Based Method	Section E.2.3
Other Inputs		
Wastewater Discharges	Project Files	Tables G.1 and G.2 (Appendix G)
Atmospheric deposition	Precipitation-Based Method	Section E.2.3
Urban runoff	Precipitation-Based Method + Dry Weather Estimate	Section E.2.3
Exports		
Delta Mendota Canal State Water Project Outflows to San Francisco Bay	Dayflow Model	Section E.2.4
Agricultural Diversion	Delta Island Consumptive Use Model	Section 6.2.4 (Chapter 6)
Evaporation	Evaporation Rate x Water Acreage	Section E.2.5
Dredging	Project Files	Section E.2.6

Table E.2: Gage Records Used to Calculate Average Annual Water Volumes for Delta and Sacramento Basin Tributaries.

Gage Name	Gage Operator	Gage ID [(a)]	Period of Record	Data Type
American River @ Fair Oaks	USGS and DWR	11446500	10/1/1904 - present	Daily
Bear River near Wheatland	USGS and DWR	BRW	1/24/97 - present	Event
Butte Slough near Meridian (Sutter Bypass)	DWR	BSL	10/1/1975 - present	Daily
Cache Creek @ Yolo	USGS and DWR	11452500	4/1/1903 - present	Daily
Colusa Basin Drain near Hwy 20	DWR	CDR, A02976	3/12/97 - present (CDR), 5/1/41 - present (A02976)	Event (CDR), Daily (A02976)
Colusa Basin Drain @ Knights Landing	DWR	A02945	10/1/1975 - present	Daily
Feather River @ Gridley	DWR	GRL	1/1/93 - present	Daily
Feather River near Nicolaus	USGS	11425000	4/1/42 - 9/30/83	Daily
Fremont Weir	DWR	FRE	10/1/1983 - present	Daily
Cosumnes River @ Michigan Bar	USGS and DWR	MHB	1/1/93 - present	Daily
Marsh Creek @ Brentwood	USGS	11337600	8/26/2000 - present	Daily
Mokelumne River @ Woodbridge	East Bay Municipal Utility District & USGS	WBR, 11325500	6/1/24 - 9/30/01	Daily
Putah Creek Outflow at Putah Diversion Dam	USBR		1/1/98 - present	Daily
Lake Solano Calculated Inflow	USBR		1/1/98 - present	Daily
Lake Berryessa Outflow	USBR	BER	10/4/93 - present	Daily
Sacramento River @ Colusa	USGS & DWR	COL	1/1/92 -present	Daily
Sacramento River @ Freeport	USGS	FPT	10/1/48 - present	Daily
San Joaquin near Vernalis	USGS & DWR	11303500, VNS	10/1/23 - present (11303500), 1/1/93 - present	Daily
Yolo Bypass near Woodland	USGS & DWR	11453000, YBY	6/29/98 - 7/13/98 (YBY), 10/1/39 - 3/17/03 (11453000)	Daily
Yuba River near Marysville	USGS	11421000	10/1/43 - present	Daily

(a) Letter-based “Gage ID” records were accessed through the California Data Exchange Center (CDEC) website, http://cdec.water.ca.gov. Alphanumeric “Gage ID” records were accessed through the DWR’s Water Data Library website, http://wdl.water.ca.gov/hydstra/index.cfm. Numeric “Gage ID” records were accessed through the U.S. Geological Survey Surface-Water Data for the Nation website, http://waterdata.usgs.gov/nwis/sw. Putah Creek outflow at the Putah Diversion Dam and Lake Solano Calculated Inflow were accessed through the U.S. Bureau of Reclamation Reservoir Operations Reports website, http://www.usbr.gov/mp/cvo/reports.html.

Table E.3: Summary of Precipitation Data Used to Estimate Runoff

Station [(a)]	Code	Latitude	Longitude	Beginning of Record [(b)]	Data Type	WY2000-2003 Average	WY1984-2003 Average
Adin RS	ADN	41.194	-120.944	10/01/1943	MA [(c)]	11.5	15.1
Calaveras Big Trees	CVT	38.283	-120.317	10/01/1929	MA	48.6	53.1
Capay	CPY	38.730	-122.130	01/01/1905	MA	20.4	22.5
Englebright (USACE)	ENG	39.239	-121.267	03/01/1989	MA	33.0	34.5
Fiddletown	FDD	38.533	-120.700	12/01/1937	MA	33.2	35.5
Folsom Dam	FLD	38.700	-121.167	10/01/1955	MA	22.2	24.2
Foresthill R S	FRH	39.017	-120.850	10/01/1936	MA	46.1	50.4
Los Banos	LSB	37.050	-120.867	01/01/1905	MA	7.8	9.5
New Exchequer-Lk McClure	EXC	37.585	-120.270	10/01/1935	MA	18.8	19.4
North Fork R S	NFR	37.233	-119.500	01/01/1905	MA	30.1	33.0
Orland	ORL	39.750	-122.200	01/01/1905	MA	18.7	21.6
Quincy RS (USFS)	QNC	39.960	-120.950	01/01/1905	MA	36.9	36.4
Sacramento WB City	SCR	38.583	-121.500	01/01/1905	MA	18.7	19.5
Shasta Dam (USBR)	SHA	40.718	-122.420	10/01/1957	DA [(c)]	63.6	61.4
Stockton Fire Station 4	STK	38.001	-121.317	01/01/1905	MA	16.6	17.2
Stony Gorge Reservoir	STG	39.583	-122.533	10/01/1926	MA	20.2	20.9
Yosemite Headquarters	YSV	37.740	-119.583	01/01/1905	MA	32.3	36.3

(a) All precipitation records were obtained from CDEC, http://cdec.water.ca.gov.
(b) All records continue through WY2003.
(c) MA: monthly accumulated; DA: daily accumulated.

Table E.4: Urban Acreage within the Legal Delta Boundary and Yolo Bypass North of the Delta

Delta Subarea (a)	Precipitation Gage Region / Land Use Code [(a)]															Grand Total
	Los Banos				Sacramento WB City						Stockton Fire Station 4					
	U	UI	UR	T	T	U	UC	UI	UR	UT	T	U	UI	UR	UT	
Central Delta					11	50	121	30	42		1276	12955	983	317		**15,785**
Marsh Creek											67	2891	88	381		**3,427**
Mokelumne River					26						57	44	39			**166**
Sacramento River					728	6286	225	206	921	198	258	176	107	38		**9,143**
San Joaquin River	9	1	0.3	21							2372	6802	2232	2125		**13,562**
West Delta					3	21	11	2	27	136	446	8423	323	335	23	**9,750**
Yolo Bypass-North					505	1407	40	1080	48	32						**3,112**
Yolo Bypass-South					437	168	7	3	43							**658**

(a) Acreages rounded after water volume and load calculations were made. Land use codes are defined in Table E.5. Acreages by subarea obtained using DWR land use GIS coverages (1993-2003) and ArcGIS [GIS software], Version 9.2, Redlands, CA: Environmental Systems Research Institute, Inc., 1999-2006. As described in Section 6.2.5, urban acreages corresponding to each MS4 permittee within each subarea were determined using available MS4 service area delineations (e.g., paper and electronic maps provided by the MS4 Permittees and 1990 city and county boundaries). Because of their size, these more detailed delineations are not included in this appendix but are available upon request.

Table E.5: Land Uses and Runoff Coefficients

Code Definition [(a)]	Runoff Coefficient
Agriculture - Other, mixed, or uncategorized	0.175
Barren	0.300
Commercial [UC]	0.71
Crop & Pasture - uncategorized	0.175
Entry Denied	0.175
Industrial [UI]	0.70
Landscaped (irrigated lawns, cemeteries, parks)	0.22
Native Vegetation - uncategorized	0.150
Open Recreation	0.175
Orchard	0.200
Orchard & Vineyard - uncategorized	0.200
Pasture	0.175
Rangeland	0.150
Residential [UR]	0.50
Rice Fields	0.175
Row and Field Crops	0.175
Strip Mine or Quarry	0.3
Transitional [UT]	0.70
Transportation, Communication, Utilities [T]	0.700
Urban unclassified (includes mixed use) [U]	0.56
Vineyard	0.200
Water	1.000
Wetland and Marsh	0.150

(a) Staff adapted runoff coefficients provided by: Lindeburg, M.R. 1992. Civil Engineering Reference Manual. Sixth Edition. Professional Publications, Inc.: Belmont, CA. Appendix A: Rational Method Runoff Coefficients. Urban land use codes used in Table E.4 are noted in brackets.

F. SUMMARY OF METHYLMERCURY CONCENTRATION DATA FOR MAJOR DELTA TRIBUTARY INPUT AND EXPORT LOADS

The monthly average methylmercury concentrations and water volumes used to estimate the WY2000-2003 annual average methylmercury loads for tributary inputs and exports are presented in Tables F.1 and F.2, respectively. Methylmercury concentration data for these and other major Sacramento Basin tributaries are included in Appendix L. Figures F.1a, F.1b, and F.2 present the plots of methylmercury concentration versus daily flow for each tributary input and export monitoring station with daily flow data available.

Table F.1: Monthly Average Methylmercury Concentrations (ng/l) for March 2000 to April 2004 Period Used to Estimate Annual Average Loads. [(a)]

Month	Cache Creek Settling Basin Outflow [(b)]	Delta Mendota Canal	Feather River near Nicolaus	Fremont Weir (Sacramento River @ Colusa) [(c)]	Knights Landing Ridge Cut (Colusa Basin Drain @ Road 99E)	Mokelumne River @ I-5	Outflow to San Francisco Bay (X2)	Putah Creek @ Mace Blvd	Sacramento River @ Freeport	San Joaquin River @ Vernalis	State Water Project
January		0.144	0.079	0.067	0.434	0.246	0.095	0.078	0.145	0.239	0.113
February	0.328	**0.133***	0.104	0.100	0.181	0.320	0.165	0.29	0.146	0.175	0.077
March	0.324	0.123	0.118	0.186	0.251	0.178	0.204	0.168	0.093	0.169	0.097
April	0.155	0.018	0.109	0.069*	0.096	0.247	0.061	0.12	0.066	0.120	0.053
May	0.532	0.094	0.172	0.103	0.086	0.174	0.119	0.456	0.111	0.128	0.097
June	0.421	0.071	0.106	0.155*	0.090	0.161	0.077	0.193	0.084	0.195	0.020
July	0.960	0.056	0.035	0.048*	0.088	0.066	0.050	0.189	0.105	0.165	0.020
August		0.021	***0.052****	0.071*	***0.086****	0.110	0.033	0.181	0.093	0.167	0.009
September	0.991	0.035	0.069	0.094*	0.084	0.099	0.043	0.139	0.071	0.145	0.049
October		0.011	0.088	0.124*	0.183	0.130	0.011	0.114	0.077	0.158	0.011
November		***0.037****	0.113	0.097*	0.421	***0.113****	***0.035****	***0.083****	0.123	***0.130****	***0.031****
December		0.063	***0.096****	0.054	***0.428****	0.096	0.060	0.053	0.122	0.102	0.050
Average of All Data	0.504	0.062	0.103	0.105	0.214	0.153	0.075	0.197	0.105	0.156	0.051
Median of All Data	0.432	0.061	0.096	0.089	0.125	0.167	0.070	0.126	0.097	0.147	0.049
Annual Average [(d)]	**0.504**	**0.064**	**0.099**	**0.102**	**0.191**	**0.166**	**0.083**	**0.180**	**0.103**	**0.160**	**0.054**

(a) No methylmercury concentration data were available for the month of February at the Delta Mendota Canal monitoring station, the months of August and December at the Feather River and Colusa Basin Drain monitoring stations, or for the month of November at the Delta Mendota Canal, Mokelumne River, Putah Creek, San Joaquin River, State Water Project, and X2 monitoring stations. Monthly average methylmercury concentrations were estimated for the months with no data by averaging the concentrations for months before and after the month with no data; these estimated values are shown in ***bold, italicized text*** with an asterisk.

(b) Sampling at the Cache Creek Settling Basin Outflow did not take place monthly; therefore all available methylmercury concentration data were averaged to estimate the annual average methylmercury concentration.

(c) Fremont Weir did not spill during months that are highlighted in gray and noted with an asterisk. The annual average methylmercury concentration for Fremont Weir was estimated by averaging the monthly averages of the months when a spill occurred.

(d) The annual average concentration was estimated by averaging the monthly averages (not including months during which no samples were collected), except for the Cache Creek Settling Basin and Fremont Weir. The methods used for these two locations are described in footnotes (b) and (c), respectively.

Table F.2: Monthly Average Water Volumes (acre-ft/month) for WY2000-2003 Used to Estimate Annual Average Loads.

Month	Cache Creek Settling Basin Outflow	Delta Mendota Canal	Fremont Weir	Knights Landing Ridge Cut Inflow to Yolo Bypass	Mokelumne River @ I-5	Outflow to San Francisco Bay (X2)	Putah Creek @ Mace Blvd	Sacramento River @ Freeport	San Joaquin River @ Vernalis	State Water Project
January	61,650	220,976	110,745	86,228	42,065	1,954,767	489	2,028,832	140,952	348,372
February	28,463	217,720	467,038	40,250	83,824	2,207,169	5,041	1,943,680	204,443	330,373
March	46,893	212,535	479,532	33,301	81,111	2,217,055	15,743	1,963,652	305,780	331,844
April	23,334	125,614	0	6,518	53,898	1,092,635	4,594	1,117,939	198,024	141,047
May	14,559	68,390	56	11,575	51,465	1,340,314	7,837	1,278,515	211,065	61,101
June	1,621	193,597	0	2,344	30,773	526,409	774	963,395	115,685	191,995
July	989	261,949	0	5,041	17,305	447,565	799	1,187,600	90,040	346,303
August	957	264,294	0	3,901	9,269	305,230	268	1,039,802	90,825	372,866
September	704	251,515	0	179	5,873	242,934	11	841,082	92,246	314,355
October	2,224	249,026	0	5,804	10,175	283,774	0	651,856	139,616	196,722
November	1,782	233,733	0	10,852	18,901	403,620	460	747,823	126,600	251,665
December	38,739	207,372	3,081	46,981	25,680	1,079,304	5,360	1,335,662	122,874	290,356
Average Annual Water Volume (M Acre-ft/yr)	**0.22**	**2.5**	**1.1**	**0.25**	**0.43**	**12.1**	**0.041**	**15.1**	**1.8**	**3.2**

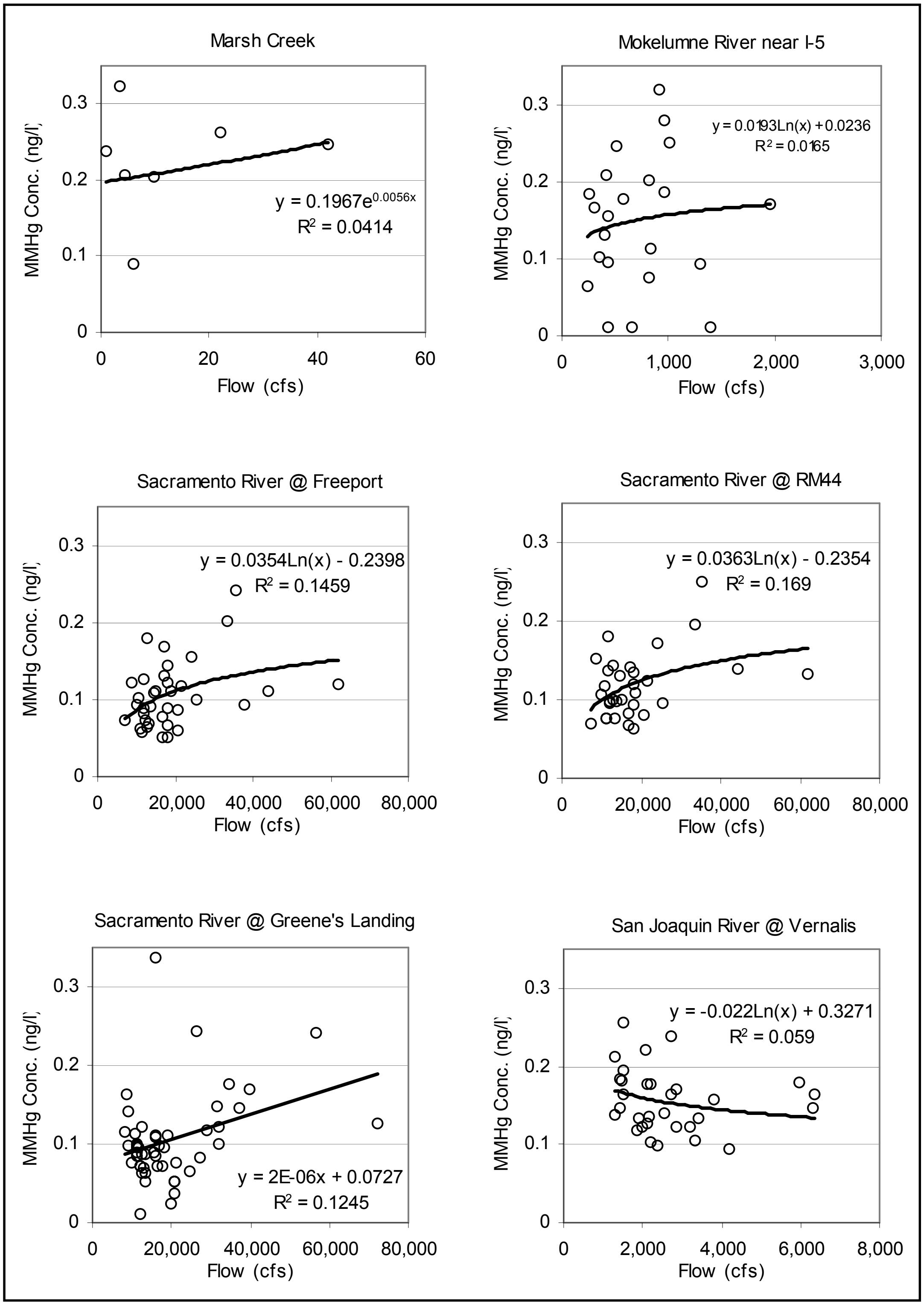


Figure F.1a: Methylmercury Concentration versus Daily Flow for Tributary Inputs with Daily Flow Data Available.

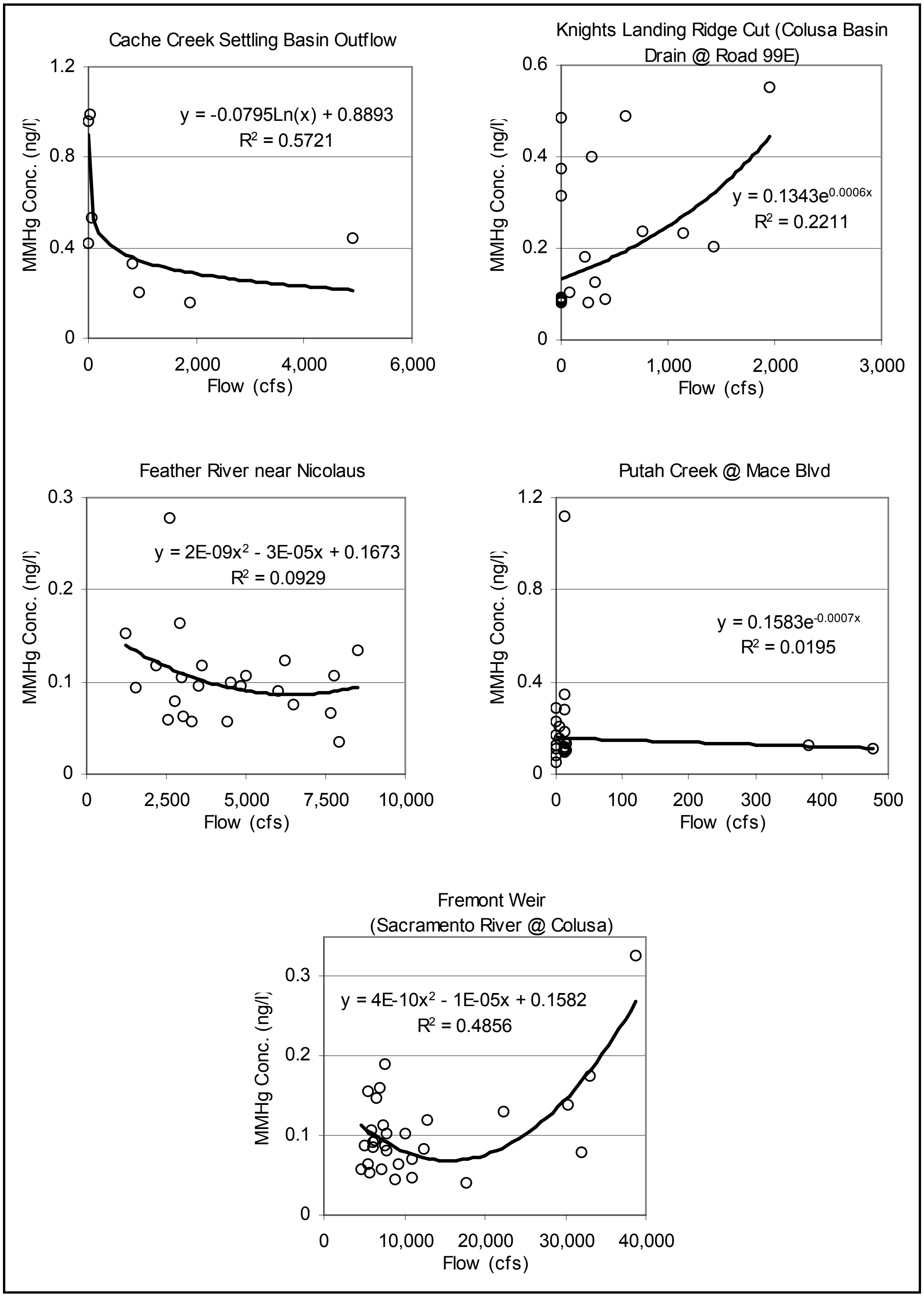
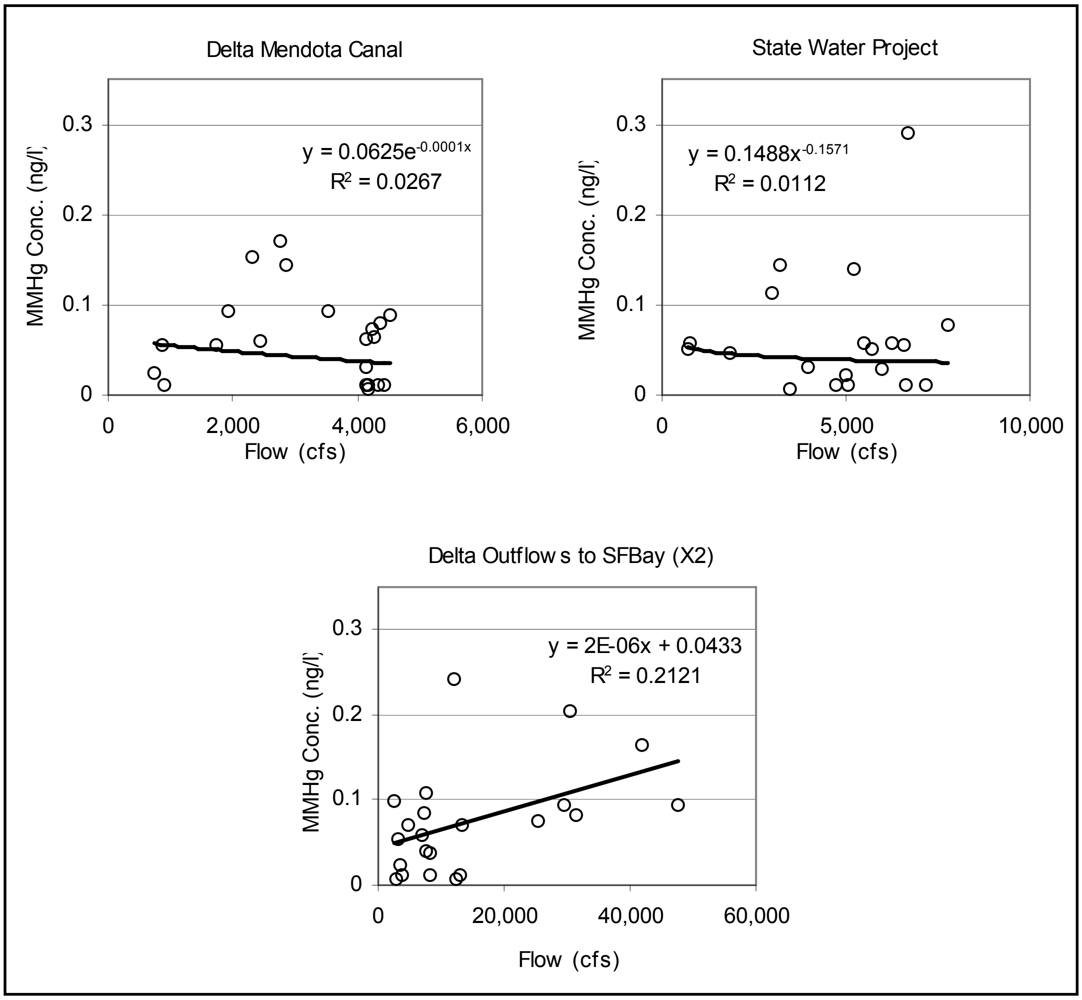


Figure F.1b: Methylmercury Concentration versus Daily Flow for Tributary Inputs with Daily Flow Data Available.



Figures F.2: Methylmercury Concentration versus Daily Flow for Exports with Daily Flow Data Available.

G. INFORMATION ABOUT NPDES-PERMITTED FACILITIES IN THE DELTA AND ITS TRIBUTARY WATERSHEDS

Table G.1: Summary of Unfiltered Total Mercury Concentrations in Discharges from Facilities within the Delta and Yolo Bypass

Facility Name (NPDES #) [a]	**Facility Type**	**Delta Subarea**	**Average Daily Discharge** (mgd)	**TotHg Sampling Period**	**Ave. Conc.** (ng/l)	**Conc. Range** (ng/l)	**# of Samples**	**Standard Deviation**	**t Value** (p = 0.975, conf 95%, df = n-1)	**95% Conf. Interval (ng/l)**	**Annual TotHg Load** ± 95% Conf. Interval (g/yr)
Brentwood WWTP (CA0082660)	Mun. WWTP	Marsh Ck	3.1	8/04-10/05	1.3	0.6- 2.2	15	0.54	2.145	0.30	5.5 ±1.3
Davis WWTP (CA0079049) Discharge 001 [e]	Mun. WWTP	Yolo Bypass	2.8	8/04-1/05, 7/05	7.4	2.0-10.8	7	2.84	2.447	2.63	16.8 ±6.0
Davis WWTP (CA0079049) Discharge 002 [e]	Mun. WWTP	Yolo Bypass	2.4	2/05-6/05	6.9	4.8-10.5	5	2.43	2.776	3.02	8.8 ±3.9
Deuel Voc.Inst. WWTP (CA0078093)	Mun. WWTP	San Joaquin	0.47	3/02-12/02	3.3	2.5-4.6	4	0.90	3.182	1.44	2.1 ±0.9
Discovery Bay WWTP (CA0078590)	Mun. WWTP	Central	1.5	8/04-10/05	5.0	1.8- 11.0	10	2.76	2.262	1.98	10.4 ±4.1
GWF Power Systems CA0082309)	Power	West	0.05	4/01-10/05	4.3	0.6- 25.7	42	3.74	2.021	1.17	0.27 ±0.07
Lodi White Slough WWTP (CA0079243)	Mun. WWTP	Central	4.5	8/04-10/05	3.3	1.6-7.2	15	1.38	2.145	0.77	20.8 ±4.8
Manteca WWTP CA0081558)	Mun. WWTP	San Joaquin	4.63	9/04-10/05	10.7	2.0-20.3	14	5.91	2.16	3.41	68.1 ±21.7
Mirant Delta LLC Contra Costa Power Plant, Outfall 1 & 2 (CA0004863)	Power	West	2.90	2/04-5/05	6.1	1.6-10.1	4	4.14	3.182	6.58	[b]
			121.03	2/04-5/05	7.1	4.1-11.8	4	3.64	3.182	5.79	[b]
Oakwood Lake Subdivision Mining Reclamation (CA0082783) [c]	Lake Dewatering	San Joaquin	9.15	1/02-11/02	2.9	2.1-3.9	4	0.97	3.182	1.54	36.8 ±19.5
Rio Vista Trilogy WWTP (CA0083771) [d]	Mun. WWTP	Sacramento	0.10	1/03	3.7	3.7	1	--	--	--	0.52
Rio Vista WWTP (CA0079588)	Mun. WWTP	Sacramento	0.47	12/01-12/03	9.5	1.7-19	20	4.69	2.086	2.19	6.2 ±1.4
San Joaquin Co DPW CSA 31 Flag City WWTP (CA0082848)	Mun. WWTP	Central	0.06	1/05-10/05	3.2	0.6-17	8	5.57	2.365	4.66	0.27 ±0.39
SRCSD Sacramento River WWTP (CA0077682)	Mun. WWTP	Sacramento	162	10/99-9/03	7.59	2.9-16.2	195	2.23	1.972	0.31	1,699 ±70
SRCSD Walnut Grove WWTP (CA0078794)	Mun. WWTP	Sacramento	0.08	12/00-1/04	21.5	11-29.4	9	5.24	2.306	4.03	2.4 ±0.45
State of California Central Heating/Cooling Plant (CA0078581)	Heating /Cooling	Sacramento	5.26	3/02-12/02	2.8	1.1-3.7	4	1.19	3.182	1.9	[b]
Stockton WWTP (CA0079138)	Mun. WWTP	San Joaquin	28	8/04-7/05	5.2	3.0-11	12	3.00	2.201	1.91	201 ±74
Tracy WWTP (CA0079154)	Mun. WWTP	San Joaquin	9.49	8/04-8/05	11.0	2.1-18.6	13	4.43	2.179	2.68	145 ±35
West Sacramento WWTP (CA0079171)	Mun. WWTP	Sacramento	5.60	8/04-7/05	3.3	1.6-5	11	1.08	2.228	0.72	25.7 ±5.6
Woodland WWTP (CA0077950)	Mun. WWTP	Yolo Bypass	6.05	8/04-7/05	6.1	0.91-53	12	1.08	2.201	0.68	50.7 ±5.7
Total Mercury Loading to the Delta: 2,300 g/yr (2.3 kg/yr) / 2,451 g/yr (2.5 kg/yr) including the Sacramento Combined WWTP [a]											

Table G.1 Footnotes:

(a) No mercury data are yet available for Metropolitan Stevedore (CA0084174), a marine bulk commodity terminal in the Central Delta subarea. Mercury and flow data for the Sacramento Combined WWTP (CA0079111) in the Sacramento River subarea are summarized in Table G.2. If the estimated loading from the Combined WWTP is included (151 g/yr, see Table G.2b), the total mercury loading to the Delta is approximately 2,460 g/yr or 2.5 kg/yr.

(b) Based on the comparison of the available intake and outfall mercury data for the Mirant Delta facility and other similar facilities that discharged to the Delta in years past (Table G.5 in Appendix G), such facilities may not act as measurable sources of mercury to the Delta. According to its NPDES permit, the Central Heating/Cooling Plant adds no chemicals to its supply water; however, the permits for Mirant Delta and other similar facilities in the tributary watersheds indicate that mercury-containing chemicals may be added to their cooling water and other low-volume waste streams may be included in their discharges (see Tables G.6 and G.7). Staff recommends that the assumption that power and heating/cooling plants do not contribute mercury to Delta and upstream surface waters be re-evaluated as additional information becomes available.

(c) The Oakwood Lake Subdivision Mining Reclamation was formerly known as the Manteca Aggregate Sand Plant.

(d) The City of Rio Vista's Trilogy WWTP was replaced by the Northwest WWTP, which began discharging to the Sacramento River subarea in 2007 under the same NPDES permit (CA0083771). The Northwest WWTP has a startup dry weather discharge of 1 mgd and peak discharge of 3 mgd. No effluent methylmercury concentration data were available for either the Trilogy or Northwest WWTPs, and no effluent total mercury concentration data were available for the Northwest WWTP, at the time the Delta methylmercury TMDL was developed. The above total mercury load is based on effluent total mercury concentration data available for the Trilogy WWTP and may not be characteristic of Northwest WWTP discharges. The Northwest WWTP effluent methyl and total mercury loads will be determined once it completes one year of monthly monitoring of its discharge.

(e) The City of Davis WWTP (CA0079049) has two seasonal discharge locations; wastewater is discharged from Discharge 001 to the Willow Slough Bypass upstream of the Yolo Bypass and from Discharge 002 to the Conaway Ranch Toe Drain in the Yolo Bypass. The Discharge 001 total mercury load is based on effluent volumes for October 2004 through January 2005 plus July 2005 through September 2005. The Discharge 002 total mercury load is based on effluent volumes for February 2005 through June 2005.

Table G.2a: Summary of City of Sacramento Combined Sewer System Total Mercury Concentration Data [a, b]

DATE	CWTP (ng/l)	PIONEER (ng/l)	SUMP-2 (ng/l)
12/03/1994	58	82	32
01/08/1995	47	120	
01/10/1995			220
03/02/1995	90		98
03/09/1995			85
03/21/1995	68		83
Average	**66**	**71**	**104**
# of Samples	4	2	5
Standard Deviation	18.30	26.87	69.78
t value (p=0.975, conf 95%, df =n-1)	3.182	12.706	2.776
Confidence Interval	29	241	87

(a) The City of Sacramento owns and operates a combined sewer system (CSS) that serves 7,510 acres in the downtown, East Sacramento, and Land Park areas. An additional 3,690 acres with separate sewers contributes sanitary sewage to the combined system. The CSS conveys domestic and industrial wastewater and storm runoff to Sump 2, where up to 60 mgd is pumped to the Sacramento Regional County Sanitation District's regional wastewater treatment plant (SRCSD) for secondary treatment prior to discharge to the Sacramento River. This discharge is designated as point 001 and is governed by NPDES No. CA0077682. When flow to Sump 2 exceeds 60 mgd, the City operates its Combined Wastewater Treatment Plant (CWTP), where an additional 130 mgd of combined wastewater receives primary treatment with disinfection and discharge to the Sacramento River at points 002 and 003. The CWTP basins may also be used for storage of flows and diversion of flows back to the SRCSD. Flows to Sump 2 greater than 190 mgd are diverted to the 28 million gallon Pioneer Interceptor and Reservoir for storage. During major storms, Sump 1/1A also pumps up to 120 mgd to Pioneer Reservoir. The stored combined wastewater is diverted back to the SRCSD or the CWTP for treatment as treatment capacity allows, or is discharged to the Sacramento River if storm flows exceed total treatment and storage capacity. The discharge from Pioneer Reservoir occurs at point 006 and receives partial settleable solids and floatables removal, in a flow-through process, without disinfection. During extreme high flow conditions, discharges of untreated combined wastewater may occur at Sump 2 bypass points 004 and 005 and at Sump 1 bypass point 007. Collected screenings are hauled to a landfill, and sludges and other solids removed from liquid wastes are pumped through the collection system to the SRCSD.

(b) Total mercury concentration data were obtained from a City of Sacramento monitoring report to the Regional Board (City of Sacramento, 1996). Only data collected using clean hands techniques (MDL of 0.1 ng/l) were used for TMDL calculations.

Table G.2b: City of Sacramento Combined Stormwater/Sewer System Annual Water Volumes & Total Mercury Load Estimates

Water Year	Water Volume (MG/year)				Total Mercury Load [a] (kg/year)			
	CWTP	PIONEER	SUMP 2	**TOTAL**	CWTP	PIONEER	SUMP 2	**TOTAL**
1993	459.6	42.5	243.9	**746.0**	0.114 ±0.051	0.016 ±0.039	0.096 ±0.08	**0.226** ±0.169
1994	190.5		18.6	**209.0**	0.047 ±0.021		0.007 ±0.006	**0.055** ±0.027
1995	399.7	189.7	435.9	**1025.3**	0.099 ±0.044	0.073 ±0.173	0.171 ±0.143	**0.343** ±0.36
1996	433.7	259.8	89.3	**782.8**	0.108 ±0.048	0.099 ±0.237	0.035 ±0.029	**0.242** ±0.315
1997	354.3	139.0	210.9	**704.2**	0.088 ±0.039	0.053 ±0.127	0.083 ±0.069	**0.224** ±0.235
1998	440.2	515.1		**955.3**	0.110 ±0.049	0.197 ±0.471		**0.306** ±0.519
1999	8.3	65.4		**73.7**	0.002 ±0.001	0.025 ±0.06		**0.027** ±0.061
2000	90.8	291.3	82.9	**465.0**	0.023 ±0.01	0.111 ±0.266	0.033 ±0.027	**0.166** ±0.303
2001		32.6		**32.6**		0.012 ±0.03		**0.012** ±0.03
2002		53.7		**53.7**		0.021 ±0.049		**0.021** ±0.049
2003		90.6		**90.6**		0.035 ±0.083		**0.035** ±0.083
Average Annual Water Volume (MG/year):				**467**	**Average Annual TotHg Load** (kg/year):			**0.151** ±0.196

(a) Total mercury load estimates are based on average total mercury concentrations and confidence intervals shown in Table G.2a.

Table G.3a: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

FACILITY	Foot-notes	EFF1 # of Samples	EFF1 # of non-detects	Ave EFF1 MeHg Conc (ng/l) [(p)]	Min EFF1 MeHg Conc (ng/l)	Max EFF1 MeHg Conc (ng/l)	EFF2 # of Samples	EFF2 # of non-detects	Ave EFF2 MeHg Conc (ng/l)	Min EFF2 MeHg Conc (ng/l)	Max EFF2 MeHg Conc (ng/l)
Aggregate											
Crystal Creek Aggregate	a	1	1	0.010	0.01	0.01					
J.F. Shea CO Fawndale Rock and Asphalt	a	1	1	0.010	0.01	0.01	1	1	0.010	0.01	0.01
Lehigh Southwest Cement Co.	a, b	1	1	0.010	0.01	0.01	1	1	0.010	0.01	0.01
Oakwood Lake Subdivision Mining Reclamation	a	2	1	0.027	0.01	0.043					
Aquaculture											
Calaveras Trout Farm (Rearing Facility)		2		0.060	0.027	0.092					
DFG Darrah Springs Fish Hatchery	a, c	4	1	0.024	0.01	0.031	4	1	0.028	0.01	0.043
DFG Merced River Fish Hatchery		1		0.037	0.037	0.037					
DFG Moccasin Creek Fish Hatchery	a	1	1	0.010	0.01	0.01					
DFG Mokelumne River Fish Hatchery	a	4	1	0.041	0.01	0.059					
DFG Nimbus Fish Hatchery		4		0.081	0.053	0.129					
DFG San Joaquin Fish Hatchery		2		0.060	0.047	0.073					
Pacific Coast Sprout Farms (Sacramento Facility)	a	1	1	0.010	0.01	0.01					
UC Davis Center for Aquatic Biology & Aquaculture	a, d	4	2	0.030	0.01	0.067	4	1	0.082	0.01	0.243
USDI BR Winter Run Rearing Facility	a	4	4	0.010	0.01	0.01					
USDI FWS Coleman Fish Hatchery		3		0.030	0.023	0.043					
Food											
Bell Carter Olive Company Inc.	a	4	2	0.017	0.01	0.027					
CA Dairies, Inc. Los Banos Foods	a	4	3	0.016	0.013	0.026					
Hershey Chocolate USA, Oakdale	a	4	4	0.010	0.01	0.01					
Heating/Cooling											
CA State of, Central Heating/Cooling Facility	a	4	3	0.015	0.01	0.029					
CALAMCO - Stockton Terminal		4		0.293	0.03	0.919					
Gaylord Container Corp. Antioch Pulp and Paper Mill		3		0.055	0.048	0.061					
Sacramento International Airport		2		0.035	0.023	0.046					
UA Local 38 Trust Fund Konocti Harbor Resort		1		0.079	0.079	0.079					
Manufacturing											
Formica Corporation Sierra Plant		1		0.050	0.05	0.05					
Proctor & Gamble Co. WWTP	a, e	3	3	0.010	0.01	0.01	1		0.033	0.033	0.033
Mines											
Sliger Mine	a	4		0.064	0.025	0.0909					

Table G.3a: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

FACILITY	Foot-notes	EFF1 # of Samples	EFF1 # of non-detects	Ave EFF1 MeHg Conc (ng/l) (p)	Min EFF1 MeHg Conc (ng/l)	Max EFF1 MeHg Conc (ng/l)	EFF2 # of Samples	EFF2 # of non-detects	Ave EFF2 MeHg Conc (ng/l)	Min EFF2 MeHg Conc (ng/l)	Max EFF2 MeHg Conc (ng/l)
Misc											
DGS Office of State Publishing	a, k	4 [3]	4 [3]	0.010	0.01	0.01					
South Feather Water & Power	a, k	2 [1]	2 [1]	0.013	0.013	0.013					
UC Davis Hydraulics Laboratory		3		0.057	0.038	0.082					
Paper Mill											
Pactiv Molded Pulp Mill	a	12	5	0.039	0.01	0.085					
SPI Anderson Division		4		0.106	0.036	0.14	2		0.154	0.13	0.177
SPI Shasta Lake (Effluent 1 & 2)		1		0.023	0.023	0.023	1		1.190	1.19	1.19
Stimpel Wiebelhaus Assoc. SWA at Mountain Gate		1		0.081	0.081	0.081					
POTW											
Aerojet Sacramento Facility	f, k	1 (0)		(k)	(k)	(k)					
Anderson WWTP	a	12	2	0.090	0.01	0.271					
Atwater WWTP	a	12	3	0.034	0.01	0.084					
Auburn WWTP	a	12	6	0.028	0.01	0.072					
Bella Vista Water District		1		0.027	0.027	0.027					
Biggs WWTP		2		1.605	0.15	3.06					
Brentwood WWTP	a	13	13	0.010	0.01	0.01					
Canada Cove LP French Camp Golf & RV Park		4		0.147	0.029	0.291					
Chico Regional WWTP		12		0.157	0.057	0.527					
Clear Creek CSD WWTP		2		0.036	0.028	0.043	1		0.041	0.041	0.041
Colfax WWTP		3		0.197	0.115	0.35					
Colusa WWTP		4		2.863	1.97	4.02					
Corning Industries/ Domestic WWTP	k	3 [2]		0.044	0.034	0.053					
Cottonwood WWTP		5		0.096	0.045	0.245					
Davis WWTP	o	7		0.546	0.305	1.04	5		0.613	0.247	1.44
Deer Creek WWTP	a	13	11	0.015	0.013	0.032					
Deuel Vocational Institute WWTP	a, k	4 [3]	4 [3]	0.010	0.01	0.01					
Discovery Bay WWTP	a	13	8	0.178	0.013	2.03					
El Dorado Hills WWTP	l	5	5	0.013	0.013	0.013	2	2	0.013	0.013	0.0125
Galt WWTP		6		0.139	0.027	0.22					
Grass Valley WWTP	a	16	2	0.160	0.01	0.938					
Jackson WWTP		4		0.108	0.061	0.161					
Lincoln WWTP	a, k	8 [7]	6	0.018	0.01	0.068					
Live Oak WWTP		4		0.591	0.427	0.785					

Table G.3a: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

FACILITY	Foot-notes	EFF1 # of Samples	EFF1 # of non-detects	Ave EFF1 MeHg Conc (ng/l) (p)	Min EFF1 MeHg Conc (ng/l)	Max EFF1 MeHg Conc (ng/l)	EFF2 # of Samples	EFF2 # of non-detects	Ave EFF2 MeHg Conc (ng/l)	Min EFF2 MeHg Conc (ng/l)	Max EFF2 MeHg Conc (ng/l)
Lodi White Slough WWTP	a, n	12 [10]	4 [3]	0.147	0.01	1.24					
Manteca WWQCF		11		0.216	0.037	0.356					
Mariposa PUD WWTP		4		0.393	0.04	0.912					
Maxwell PUD WWTP		4		0.993	0.044	1.72					
Merced WWTP		12		0.386	0.13	0.672					
Modesto ID Regional WWTP	k	3 [2]		0.056	0.045	0.066					
Modesto WWTP		4		0.125	0.109	0.161	1		0.140	0.14	0.14
Nevada City WWTP	a	4	2	0.048	0.01	0.146					
Nevada Co SD #1 Cascade Shores WWTP	a	3	1	0.142	0.01	0.286					
Nevada Co SD #1 Lake Wildwood WWTP	a	12	1	0.109	0.01	0.32					
Nevada Co SD #2 Lake of the Pines WWTP		2		1.409	0.708	2.11					
Olivehurst PUD WWTP	a	13	1	0.144	0.013	0.268					
Oroville WWTP		12		0.147	0.061	0.28					
Paradise Irrigation District	a	1	1	0.013	0.013	0.013					
Placer Co. SA #28 Zone #6		2		0.668	0.474	0.862					
Placer Co. SMD #1 WWTP		12		0.141	0.042	0.35					
Placer Co. SMD #3 WWTP		12		0.100	0.037	0.381					
Placerville Hangtown Creek WWTP	a	12	1	0.058	0.013	0.17					
Planada Comm. Service Dist. WWTP		4		1.168	0.374	2.04					
Red Bluff WWTP	a	12	6	0.030	0.01	0.057					
Redding Clear Creek WWTP	a	12	3	0.042	0.013	0.084					
Redding Stillwater WWTP	a	13	13	0.013	0.013	0.013					
Rio Alto WD- Lake CA WWTP		3		1.219	0.141	3.35					
Rio Vista Main WWTP		4		0.164	0.035	0.522					
Roseville Dry Creek WWTP	a	12	4	0.023	0.01	0.055					
Roseville Pleasant Grove WWTP	a	12	10	0.017	0.01	0.07					
San Andreas SD WWTP		4		0.249	0.178	0.293					
San Joaquin Co DPW - Flag City WWTP	a	3	1	0.081	0.013	0.152					
Shasta Lake WTP	a	2	1	0.025	0.01	0.04					
Shasta Lake WWTP	a	2	1	0.022	0.01	0.034					
SRCSD Sacramento River WWTP		60		0.718	0.144	1.640					
SRCSD Walnut Grove WWTP (CSD1)	k	3 [2]		2.155	0.949	3.36					
Stockton WWTP	a	12	1	0.935	0.01	2.09					
Tracy WWTP	a	13	1	0.145	0.013	0.422					

Table G.3a: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

FACILITY	Foot-notes	EFF1 # of Samples	EFF1 # of non-detects	Ave EFF1 MeHg Conc (ng/l) (p)	Min EFF1 MeHg Conc (ng/l)	Max EFF1 MeHg Conc (ng/l)	EFF2 # of Samples	EFF2 # of non-detects	Ave EFF2 MeHg Conc (ng/l)	Min EFF2 MeHg Conc (ng/l)	Max EFF2 MeHg Conc (ng/l)
Tuolumne UD Sonora RWTP/ Jamestown SDWTP		3		0.182	0.071	0.262					
Turlock WWTP	a, g	12	1	0.060	0.02	0.079					
UC Davis WWTP	a	13	4	0.038	0.010	0.078					
United Auburn Indian Community Casino WWTP	a	2	2	0.010	0.010	0.010					
Vacaville Easterly WWTP	a	12	4	0.024	0.010	0.057					
West Sacramento WWTP	a	12	1	0.050	0.010	0.085					
Williams WWTP		4		1.553	0.560	2.100					
Woodland WWTP	a	12	2	0.031	0.013	0.059					
Yuba City WWTP		12		0.295	0.106	0.625					
Power											
Calpine Corp. Greenleaf Unit One Cogen Plant		4		0.064	0.02	0.117					
Camanche Dam Powerhouse	a	4	3	0.020	0.01	0.039					
GWF Power Systems	a	4	4	0.013	0.013	0.013					
Mirant Delta CCPP	a, h	12	1	0.074	0.010	0.121	10		0.086	0.042	0.15
Sacramento Cogen Authority Procter & Gamble Plant	a	4	1	0.052	0.013	0.070					
SMUD Rancho Seco Nuclear Generating Station	a	12	4	0.040	0.013	0.104					
Stockton Congeneration Co.	a	4	3	0.017	0.013	0.029					
Wheelabrator Shasta Energy Co.		4		0.104	0.055	0.178					
WTP (GW)											
Aerojet Interim GW WTP	a, k	2 [1]	2 [1]	0.013	0.013	0.013	2 [1]	2 [1]	0.013	0.013	0.013
Boeing Company, Interim Treatment System	a	1	1	0.010	0.01	0.01					
Defense Logistics Agency Sharpe GW Cleanup	a, i	3	2	0.018	0.01	0.033	1	1	0.010	0.01	0.01
General Electric Co. GWCS	a, j, m	3	3	0.010	0.01	0.01	3	3	0.010	0.01	0.01

Table G.3a Footnotes:

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.
b. Lehigh Southwest Cement Co. Effluent 1: Outfall #1, Shale Quarry Tunnel Road. Effluent 2: Lehigh Southwest Cement Co., 002B: Shale Quarry
c. Darrah Springs Fish Hatchery Effluent 1: Upper Springs. Effluent 2: Darrah Springs Fish Hatchery - Lower Springs
d. UCD Center for Aquatic Biology & Aquaculture, Effluent 1: CABA Aquatic Center. Effluent 2: CABA Putah Creek Facility
e. Proctor & Gamble, Pond Effluent 2: Effluent PTI-660
f. Aerojet Sacramento facility, Effluent 1 sample collected from West Detention Pond because there was no discharge to the American River during the rainy season.
g. City of Turlock WWTP, Effluent 1: (R5)
h. Mirant Delta CCPP EFF 1:Outfall 001, Effluent 2: Outfall 002
i. Defense logistics agency, Sharp GW Cleanup; Effluent 1: CBCGWTPEFF = Central area B/C Aquifer zone, Effluent 2: NBGWTPEFF = North GWTP effluent
j. General Electric Co., GWCS: Effluent 1: Air Stripper Effluent, Effluent 2: 100-foot Zone Effluent
k. Results for the following facilities and sample dates were not incorporated in the calculations due to sample preservation hold times exceeding EPA recommendations: Aerojet Interim GW WTP (18 November 2005, EFF 1 and EFF 2 were both <MDL); Aerojet Sacramento Facility (18 March 2005, 0.057 ng/l); Corning Industries/ Domestic WWTP (22 September 2004, 0.041 ng/l); Deuel Vocational Institute WWTP (26 October 2004, <MDL); DGS Office of State Publishing (8 July 2005, <MDL); Lincoln WWTP (25 August 2005, 0.034 ng/l); Miners Ranch WTP (9 September 2004, <MLD);Modesto ID Regional WWTP (8 October 2004, 0.038 ng/l); and SRCSD Walnut Grove WWTP (CSD1) (29 December 2004, 0.759 ng/l).
l. El Dorado Hills WWTP sampled effluent when discharging to land and to surface water. Only samples collected when the plant discharged to surface water (December 2004 through April 2005) were used in the summary. Effluent that was reclaimed during the seven warm season months ranged from nondetect to 0.055 ng/l, with one sample (9 August 2005, 0.057 ng/l) excluded due to sample preservation hold time exceeding EPA recommendations.
m. General Electric Co. GWCS conducted four sampling events. However, results for General Electric Co. GWCS samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory.
n. Lodi White Slough WWTP sampled effluent when discharging to land and to surface water. Only samples collected when the plant discharged to surface water (September 2004 through June 2005) were used in the summary. Effluent that was reclaimed in August 2004 and July 2005 had methylmercury concentrations of 0.054 ng/l and <MDL, respectively.
o. Davis WWTP: Effluent 1: Willow Slough, Effluent 2: Conaway Ranch Toe Drain in the Yolo Bypass.
p. Tables 6.5 and 8.4 in the main text of the TMDL Report and Tables B and C in the draft Basin Plan amendment provide average concentration values rounded to two decimal places using un-rounded Excel calculations, while this table provides values rounded to three decimal places. For example, the Tracy WWTP had an average methylmercury concentration of 0.014465 ng/l per the Excel calculations, which rounds to 0.0145 ng/l in this table, and 0.14 ng/l (not 0.15 ng/l) in Table 6.5.

Table G.3b: Summary of Effluent 3 and Effluent 4 Methylmercury Concentrations

FACILITY	Foot-notes	EFF 3 # of Samples	EFF 3 # of non-detects	Ave EFF 3 MeHg Conc (ng/l)	Min EFF 3 MeHg Conc (ng/l)	Max EFF 3 MeHg Conc (ng/l)	EFF 4 # of Samples	EFF 4 # of non-detects	Ave EFF 4 MeHg Conc (ng/l)	Min EFF 4 MeHg Conc (ng/l)	Max EFF 4 MeHg Conc (ng/l)
Aggregate											
Lehigh Southwest Cement Co.	a, b	1	1	0.010	0.010	0.010	1		0.062	0.062	0.062
Paper Mill											
SPI Shasta Lake (Effluent 1 & 2)		1		0.485	0.485	0.485					
WTP (GW)											
Aerojet Interim GW WTP	a, e	2 [1]	2 [1]	0.013	0.013	0.013	2 [1]	2 [1]	0.013	0.013	0.013
Defense Logistics Agency Sharpe GW Cleanup	a, c	2	2	0.010	0.010	0.010	3	1	0.047	0.010	0.108
General Electric Co. GWCS	a, d	3	3	0.010	0.010	0.010					

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.

b. Lehigh Southwest Cement Co., EFF 3: 001A: Limestone Quarry, EFF 4: 00X: Cement Plant

c. Defense logistics agency, Sharp GW Cleanup, EFF 3: SBGWTPEFF= South GWTP effluent, EFF 4: SSJCUPST = South San Joaquin Irrigation District Canal (upstream sample).

d. General Electric Co. EFF 3: GWCS: Multizone Effluent

e. Aerojet Interim GW WTP results for samples collected on 18 November 2005 (both <MDL) were not incorporated in the calculations due to sample preservation hold time exceeding EPA recommendations.

f. General Electric Co. GWCS conducted four sampling events. However, results for General Electric Co. GWCS samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory.

Table G.4: Available Intake and Outfall Methylmercury Concentration Data for Aquaculture, Power and Heating/Cooling Facilities in the Delta and Its Upstream Tributary Watersheds [(a)]

Facility [NPDES #, Type]	Sample Date	Outfall 1 MeHg Conc (ng/l) [(b)]	Outfall 1 MeHg Qual. [(b)]	Outfall 2 MeHg Conc (ng/l)	Outfall 2 MeHg Qual. [(b)]	Outfall 2 Field Dup MeHg Conc (ng/l)	Outfall 2 Field Dup MeHg Qual. [(b)]	Intake 1 MeHg Conc (ng/l) [(a)]	Intake 1 MeHg Qual. [(b)]	Intake 1 Dup. MeHg Conc (ng/l)	Intake 1 Dup. MeHg Qual. [(b)]	Intake 2 MeHg Conc. (ng/l)	Intake 2 MeHg Qual. [(b)]
CALAMCO - Stockton Terminal [CA0083968, Heating /Cooling]	8/26/04	0.030	B					0.026	B				
Calaveras Trout Farm (Rearing Facility) [CA0081752, Aquaculture]	9/30/04	0.027	B					0.067					
DFG Darrah Springs Fish Hatchery [CA0004561, Aquaculture]	9/15/04	0.029	B, (nn)	0.043	B, X, (mm)			ND	<MDL, (nn)			0.020	<MDL, (nn)
DFG Mokelumne River Fish Hatchery [CA0004791, Aquaculture]	11/16/04	0.048	A					ND	<MDL, A	0.020	<MDL, A		
DFG Nimbus Fish Hatchery [CA0004774, Aquaculture]	11/16/04	0.129	A					0.051	A				
	2/17/05	0.053						0.031				0.053	
	6/20/05	0.085						0.052					
DFG San Joaquin Fish Hatchery [CA0004812, Aquaculture]	9/28/04	0.073						0.021	B				
GWF Power Systems [CA0082309, Power]	8/11/04	ND	<MDL					ND	<MDL				
	11/4/04	ND	<MDL					ND	<MDL				
	2/3/05	ND	<MDL					0.263					
	5/5/05	ND	<MDL					ND	<MDL				

Table G.4: Available Intake and Outfall Methylmercury Concentration Data for Aquaculture, Power and Heating/Cooling Facilities in the Delta and Its Upstream Tributary Watersheds, *continued*

Facility [NPDES #, Type]	Sample Date	Outfall 1 MeHg Conc (ng/l) (a)	Outfall 1 MeHg Qual. (b)	Outfall 2 MeHg Conc (ng/l)	Outfall 2 MeHg Qual. (b)	Outfall 2 Field Dup MeHg Conc (ng/l)	Outfall 2 Field Dup MeHg Qual. (b)	Intake 1 MeHg Conc (ng/l) (a)	Intake 1 MeHg Qual. (b)	Intake 1 Dup. MeHg Conc (ng/l)	Intake 1 Dup. MeHg Qual. (b)	Intake 2 MeHg Conc. (ng/l)	Intake 2 MeHg Qual. (b)
Mirant Delta CCPP [CA0004863, Power]	2/4/04	0.081		0.0835	(k)	0.0799	(k)	0.296	(l)				
	3/3/04	0.116		0.127	(k)			0.12	(l)	0.122	(l)		
	8/3/04	ND	<MDL, J	0.070	(k)			ND	<MDL				
	9/1/04	0.080		0.060	(k)			0.080	(l)				
	10/5/04	0.049	B	0.060	(k)			0.038	(l), B				
	11/2/04	0.047	B	0.042	(k), B			0.040	(l), B				
	12/2/04	0.030	B	0.063	(k)			0.070	(l)				
	1/11/05	0.083		0.081	(k)			0.102	(l)				
	2/8/05	0.097		0.120	(k)			0.098	(l)				
	3/8/05	0.121		0.150	(k)			0.15	(l)				
	4/26/05	0.083			Y			0.069	(l)				
	5/25/05	0.091			Y			0.077	(l)				
Sacramento Cogen Authority Procter & Gamble Plant [CA0083569, Power]	8/11/04	0.056						ND	<MDL				
	10/6/04	0.069						ND	<MDL				
	1/5/05	0.070						0.080					
	5/4/05	ND	<MDL					ND	<MDL				

(a) ND: nondetect (below method detection limit). Analytical method detection limits were 0.025 ng/l or less.
(b) < MDL: below method detection limit; detection limits ranged between 0.020 and 0.025 ng/l.
A: Samples were received out of optimal temperature range.
B: Sample results above the MDL and below the ML; should be considered an estimate.
J: Detected but below the reporting limit; result is an estimated concentration.
X: Collected 9/14/04.
Y: No discharge.
(l): Mirant Delta CCPP Intake 002.
(mm): Darrah Springs Fish Hatchery - Lower Springs.
(nn): Darrah Springs Fish Hatchery - Upper Springs.

Table G.5a: Available Intake and Outfall Total Mercury Concentration Data for Power and Heating/Cooling Facilities in the Delta Region

Facility [NPDES #, Type]	Proximity to Delta	Sample Date	Outfall 1 TotHg Conc. (ng/l)	Outfall 2 TotHg Conc. (ng/l)	Intake 1 TotHg Conc. (ng/l)	Intake 2 TotHg Conc. (ng/l)
CALAMCO – Stockton Terminal [(a)] [CA0083968, Heating/Cooling]	Delta / Yolo Bypass	1/15/02	6.60		6.70	
Gaylord Container Corp. Antioch Pulp and Paper Mill [(a)] [CA0004847, Heating/Cooling]	Delta / Yolo Bypass	5/27/04	6.40		6.70	
		6/17/04	7.00		7.60	
		7/19/04	9.10		10.00	
		8/26/04	3.50		3.80	
		9/23/04	3.80		2.60	
		10/14/04	5.00		7.50	
Mirant Delta CCPP [CA0004863, Power]	Delta / Yolo Bypass	3/28/2000	6.17	9.23	5.6	9.23
		12/11/2001	4.6	3.6		4.9
		7/9/2002	6.54	6.38		6.77
		5/6/2003		6.29		5.45
		7/15/2003	7.88	8.42		4.97
		2/4/2004	3.69	4.21 [(b)]		4.3
		2/9/2004	3.68	2.60		5.58
		3/3/2004	9.15	8.19		8.06
		8/3/2004	10.1	11.8		8.40
		2/8/2005	1.6	4.25		3.90

(a) The CALAMCO and Gaylord facilities no longer discharge to surface water. The Gaylord facility discharged non-contact cooling water from operation of its power plant. It obtained its water from wells.
(b) Average of field duplicates, 4.14 and 4.27 ng/l.

Table G.5b: Mirant Delta CCPP Evaluation of Total Mercury Concentrations (ng/l) in Inputs to Its Discharge.

Sample Date	Demineralizer-Regeneration Wastewater (Discharge to Outfall 1)	Oil-Water Separator (Discharge to Outfall 1)	Reverse Osmosis Reject Water (Discharge to Outfall 1)	Boiler Blowdown (Discharge to Outfall 2)	E-011-1M Firewater System Testing (Discharge to Outfall 2)
3/28/2000					11.1
7/24/2002		1.75	21.8	1.01	
7/30/2002	69.0				
10/9/2002	4.62	4.02	13.8	1.78	
1/14/2003	6.73	6.09	5.65	5.19	

Table G.6: Description of Discharges from Power and Heating/Cooling Plants in the Delta Region.

Agency (NPDES No.)	Proximity to Delta	Discharge Volume (mgd)	Discharge Description	Added Chemicals That May Contain Mercury above Detectable Levels (see Table G.7 [(a)])
Aerojet Sacramento Facility (CA0004111)	Downstream of Dam	0.02	The discharge contains stormwater, cooling tower overflow, boiler blowdown and some wastewater. The facility has 53 treated boilers, 12 non-treated boilers, 69 non-treated cooling towers, 13 treated cooling towers, 56 evaporation condensers, and numerous other similar systems. Water is used to cool rocket exhaust deflector plates during test firings. Wastewater may include water used to operate propellant vapor scrubbers when tanks are vented, and to draw a vacuum on propellant-contaminated components prior to disassembly. The Discharger states that this wastewater contains hydrazines, oxides of nitrogen, and N-nitrosodimethylamine. The wastewater is collected in a batch process, analyzed for compliance with effluent specifications and discharged to the sanitary sewer or Buffalo Creek, or if not meeting effluent limits, is either treated (neutralization and chemical oxidation) for discharge or is hauled to a Class I disposal site. Maximum concentrations of treatment chemical in the boiler discharges (10 gallons per day [gpd]) are 40 ppm potassium hydroxide, 40 ppm dipotassium sulfite. Chemicals added to boilers and cooling towers: Betz Entec Opti-guard ACS or Betz Entec Optisperse 24; Betz Entrec 552 or Betz Entrec 367.	potassium hydroxide
California (State of) Central Heating/ Cooling facility	Delta / Yolo Bypass	5.26	Facility discharges closed-system cooling water. The heating of downtown State buildings is achieved through the use of boilers that do not discharge waste to surface waters. The Central Heating/Cooling Plant adds no chemicals to its cooling water.	
Calpine Corp. Greenleaf Unit One Cogen Plant (CA0081566)	Downstream of Dam	0.11	The discharger owns and operates a natural gas cogeneration plant that uses water for steam generation and cooling. The discharge consists of cooling water blowdown, which consists of reverse osmosis reject water, boiler blowdown, and condensed steam. The permit did not identify the water supply source for cooling water. Chemicals added to Cooling Water: Chlorine, Nalco 8305 Plus, Nalco 8300 dispersant, Nalco Stabrex ST40, sodium bisulfite solution, sodium hypochlorite solution, sulfuric acid, Nalco 1742, Nalco Elimin-Ox Oxygen Scavenger, Nalco Tri-act 1820 Inhibitor.	chlorine / chloride, potassium hydroxide, sodium bisulfite, sodium hypochlorite, sulfuric acid
East Bay Municipal Utility District Camache Dam Powerhouse (CA0082040)	Downstream of Dam	0.04	The discharger owns and operates an industrial wastewater collection, treatment, and disposal system at the Camanche Dam Power House. The facility obtains process water from the Mokelumne River. Within the powerhouse, drainage, washdown, and leakage waters that contain lubricating oil and other petroleum products are collected in a sump, treated with a belt skimmer, pumped to a separation/retention pond where additional oil is removed with a rope skimmer and a series of separation baffles, and then discharged to the Mokelumne River.	lubricating oil
GWF Power Systems (CA0082309)	Delta / Yolo Bypass	0.05	The facility generates electrical power from the burning of petroleum coke as its primary fuel. Its discharge contains process wastewater from cooling tower blowdown, boiler blowdown, gland steam condensate, plant drains, reverse osmosis reject water and storm water. Water for cooling purposes and steam production is obtained from the City of Antioch. Chemicals added: Sulfuric acid, Stabrex ST40 (microbiocide), dispersant, Phosperse-Plus 8309 Inhibitor (corrosion inhibitor), and water conditioners.	sulfuric acid, sodium hydroxide

Table G.6: Description of Discharges from Power and Heating/Cooling Plants in the Delta Region.

Agency (NPDES No.)	Proximity to Delta	Discharge Volume (mgd)	Discharge Description	Added Chemicals That May Contain Mercury above Detectable Levels (see Table G.7 [(a)])
Mirant CCPP (CA0004863)	Delta / Yolo Bypass	123.93	Discharge consists of non-cooling water and other low-volume waste streams resulting from the operation of the CCPP. Cooling water is drawn from the San Joaquin River. Waste streams to Outfall 1 include oil/water separator effluent [0.156 mgd], demineralization regeneration wastewater [0.0033 mgd], and reverse osmosis reject water [0.047 mgd]. Waste streams to Outfall 2 include boiler blowdown [0.030 mgd], boiler wastewater management system effluent [0.00165 mgd], cooling tower blowdown [3.63 mgd], HRSG blowdown [0.032 mgd], evaporative cooler blowdown [0.0324 mgd], and treatment chemicals [volume not available]. Chemicals added: Chlorine, sodium hypochlorite, sodium bromide, polyacrylate, sodium bisulfate, and terbuthlazine.	chlorine / chloride, sodium hypochlorite, sodium bisulfate
SMUD Rancho Seco Nuclear Generating Station (CA0004758)	Downstream of Dam	0.09	Discharge contains stormwater, irrigation runoff, treated liquid radioactive wastewater, fire protection water, treated municipal wastewater, and dilution water from the Folsom South Canal. The facility plans to decrease the domestic wastewater effluent volume as the decommissioning process of the nuclear plant continues. Chemicals added: Sodium hypochlorite may be added to the retention basins for algae control.	sodium hypochlorite *[discharge should be classified as predominantly domestic wastewater]*
Wheelabrator Shasta Energy Co. (CA0081957)	Downstream of Dam	0.02	The Shasta facility is a wood-burning power plant and the Lassen facility is a natural gas fired plant. The combined discharges from these plants contain cooling water, plant maintenance water, storm water runoff, groundwater from the "internal under drain" system, boiler blowdown, reject water from a reverse osmosis system, demineralization system backwash, fuel storage pile leachate and seepage, fly ash, bottom ash, waste petroleum products, and domestic waste. Firewater system, cooling, blowdown, maintenance, and drinking water are obtained from groundwater wells. Chemicals added: Sodium hydroxide (50%), sulphuric acid (93%), Drew Phos 2600, Amercor 8750, Mekor 70, Cortrol OS7700, Vitec 3000, Conntect 5000 (engine cleaner detergent), ammonia, sodium hypochlorite solution, caustic soda liquid (25%), Drew 2215, DrewSperse, and Hypersperse MSI 300.	sodium hydroxide, sulfuric acid, ammonia, sodium hypochlorite, caustic soda

(a) Mercury data were not available for many of the added chemicals, especially the proprietary formulations for which lists of all product-specific ingredients are not publicly available. Potassium hydroxide and sodium hydroxide may be active ingredients in several of the formulations; see Table G.7.

Table G.7: Mercury Concentrations in Chemicals Commonly Used at Power and Heating/Cooling Facilities.

Chemicals	Hg Concentration [a]	Comment
ammonia (NH3)	0.00243 ppb, 0.001 mg/l.	The MASCO Mercury Database had two compound test results for ammonium hydroxide, a common commercial form of ammonia.
bleach (not defined)	0.000568 ppb, 0.001 ppm	
caustic soda (50% membrane grade)	1 ppb	
caustic soda (50% solution)	1 ppb	
caustic soda (flake)	50 ppb	
caustic soda (water care grade)	0.5 ppm	
caustic soda liquid (25%)	0.5 ppm	
chlorine	535 ppm	Chlorine is extracted from chlorides through oxidation and electrolysis. Per a compound test result in the MASCO Mercury Database, chloride had a concentration of 535 ppm.
hydrogen peroxide (H2O2, a.k.a. bleach)	0.0012 mg/L	
Oil (lubricating)	239-578 ng/l (LDGV), 4.2 ng/l (HDDV)	4 samples collected from three light-duty gasoline vehicles (LDGVs), 1 sample collected from one heavy-duty diesel vehicle (HDDV).
phosphoric acid	0.0002 ppb	
potassium hydroxide	0.000212 ppb	Potassium hydroxide may be an active ingredient in Nalco 8305 Plus and Betz Entec products. [b]
sodium bisulfate	0.010 ppm, 0.000208 ppb	
sodium bisulfite (solution)	0.001 mg/L	
sodium chloride (sodium salt)	0.001 mg/l (saline)	
sodium hydroxide	0.000624 ppb	Sodium hydroxide may be an active ingredient in Nalco Stabrex ST40. [b]
sodium hypochlorite (12.5% solution, a.k.a. bleach)	<1 ppb to 20 ppb	
sulfuric acid (25% solution)	5 ppb	
sulfuric acid (50% solution)	2 to 10 ppb	
sulfuric acid (ACS Reagent)	5 ppb	
sulfuric acid (industrial)	0.05 mg/L	
sulfuric acid/sulphuric acid (% not defined)	0.0002 ppb, 0.3 ppb	

(a) All mercury concentration data were obtained from the MASCO Mercury Database (MASCO, 2008) except for the data for oil (Hoyer *et al*., 2002). Units of measure provided in this table are cited precisely as stated in these references.
(b) Many of the products that facilities reported using are proprietary formulations for which lists of all product-specific ingredients are not publicly available; publicly available Material Safety Data Sheets were available for some formulations.

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H. URBAN RUNOFF CONSTITUENT CONCENTRATION DATA

Figure H.1 Site Codes:

1. Arcade Creek
2. City of Sacramento Strong Ranch Slough
3. City of Sacramento Sump 104
4. City of Sacramento Sump 111
5. Stockton Calaveras River Pump Station
6. Stockton Duck Creek Pump Station
7. Stockton Mosher Slough Pump Station
8. Stockton Smith Canal Pump Station
9. Tracy Drainage Basin 10 Outflow
10. Tracy Drainage Basin 5 Outflow
11. Tracy Lateral to Sugar Cut Slough

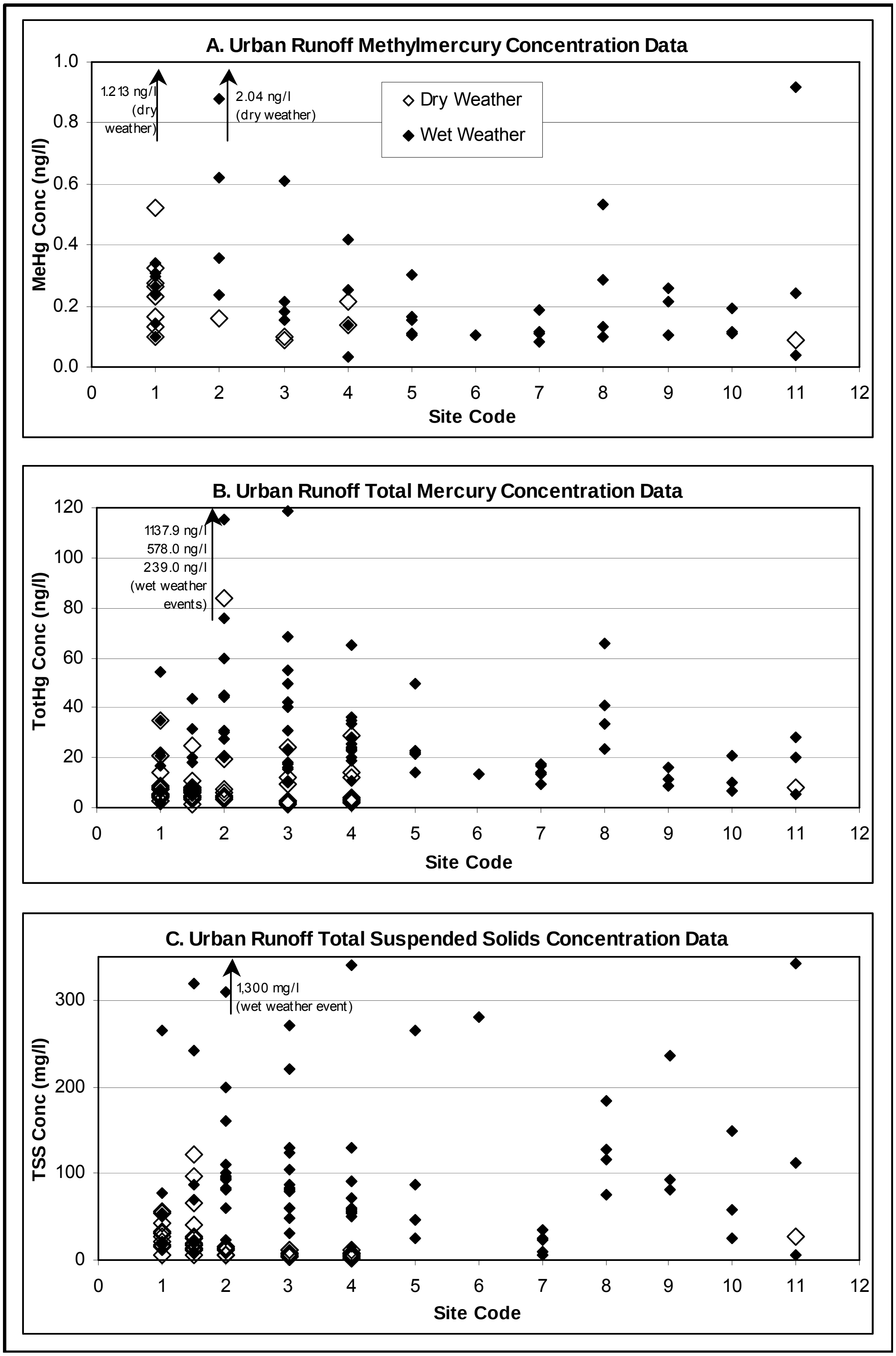

Figure H.1: Urban Runoff Constituent Concentrations.
(Site codes are defined on the next page. Appendix L provides the raw data and data sources.)

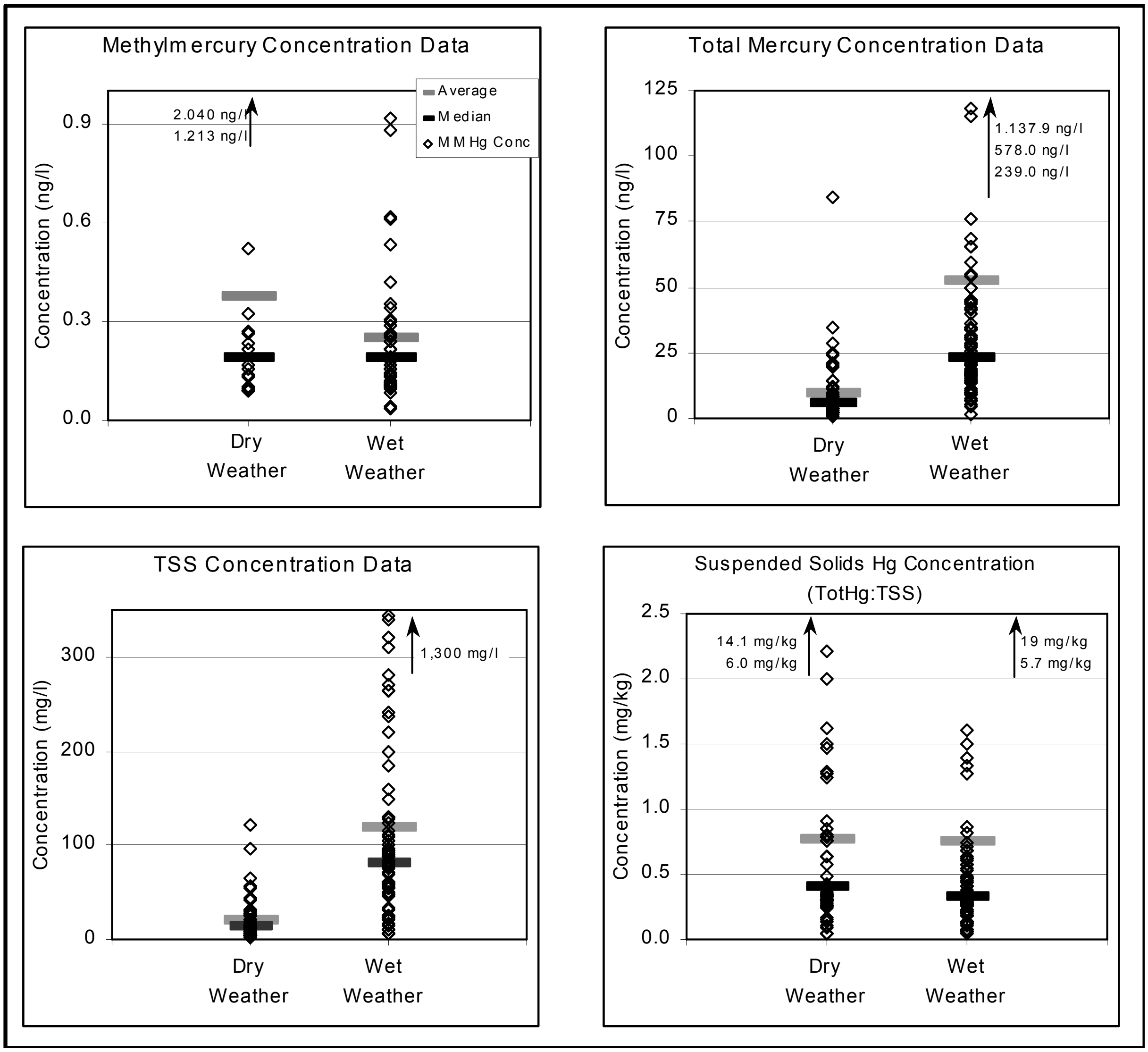

Figure H.2: Pooled Urban Runoff Constituent Concentrations.

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I. SUMMARY OF TOTAL MERCURY AND TSS CONCENTRATION DATA FOR MAJOR DELTA TRIBUTARY INPUT AND EXPORT LOADS

This appendix is organized into six sections that provide the following information:

1. Figures that summarize available total mercury and TSS concentration data for monitoring stations.
2. Load and confidence interval calculation methods for tributary locations with statistically significant total mercury and/or TSS concentration/flow regressions and linear regression plots for the stations with statistically significant regressions.
3. Load and confidence interval calculation methods for tributary sampling locations without statistically significant concentration/flow regressions.
4. Error propagation calculation methods for the mass balances presented in Chapter 7.
5. Figures that illustrate the regressions between total mercury and TSS concentrations used to calculate "Method B. Linear Regression Slope for Paired TotHg/TSS" cited in Table 7.17 for Delta inputs and exports.
6. Tables that provide the regression-based annual mercury loads and sums of the three, five, and ten highest daily mercury loads in each water year for the Sacramento River at Freeport and Yolo Bypass at Prospect Slough.

I.1 Total Mercury and TSS Concentration Time Series Plots

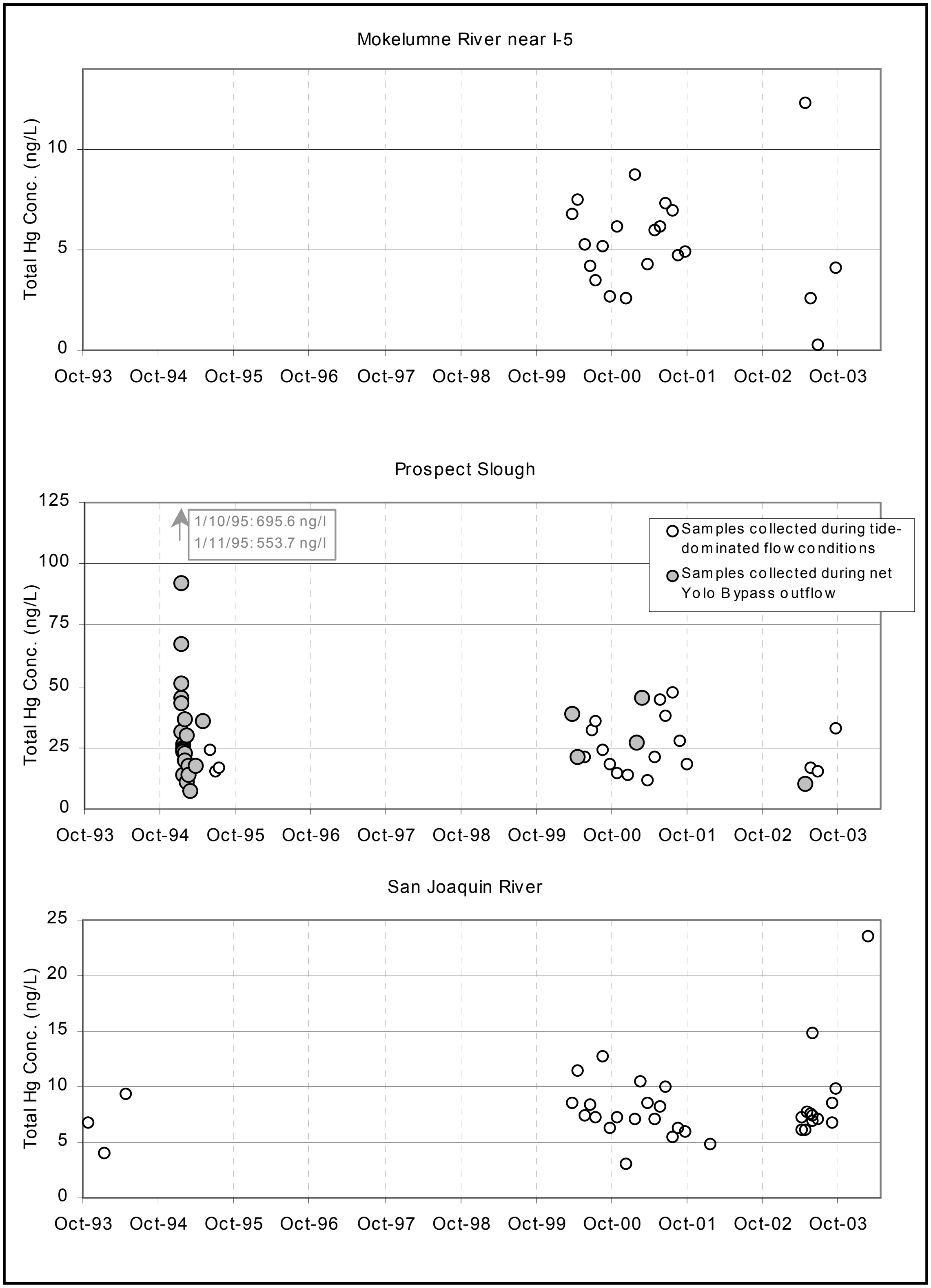

Figure I.1a: Available Total Mercury Concentration Data for the Mokelumne River, Prospect Slough and San Joaquin River.

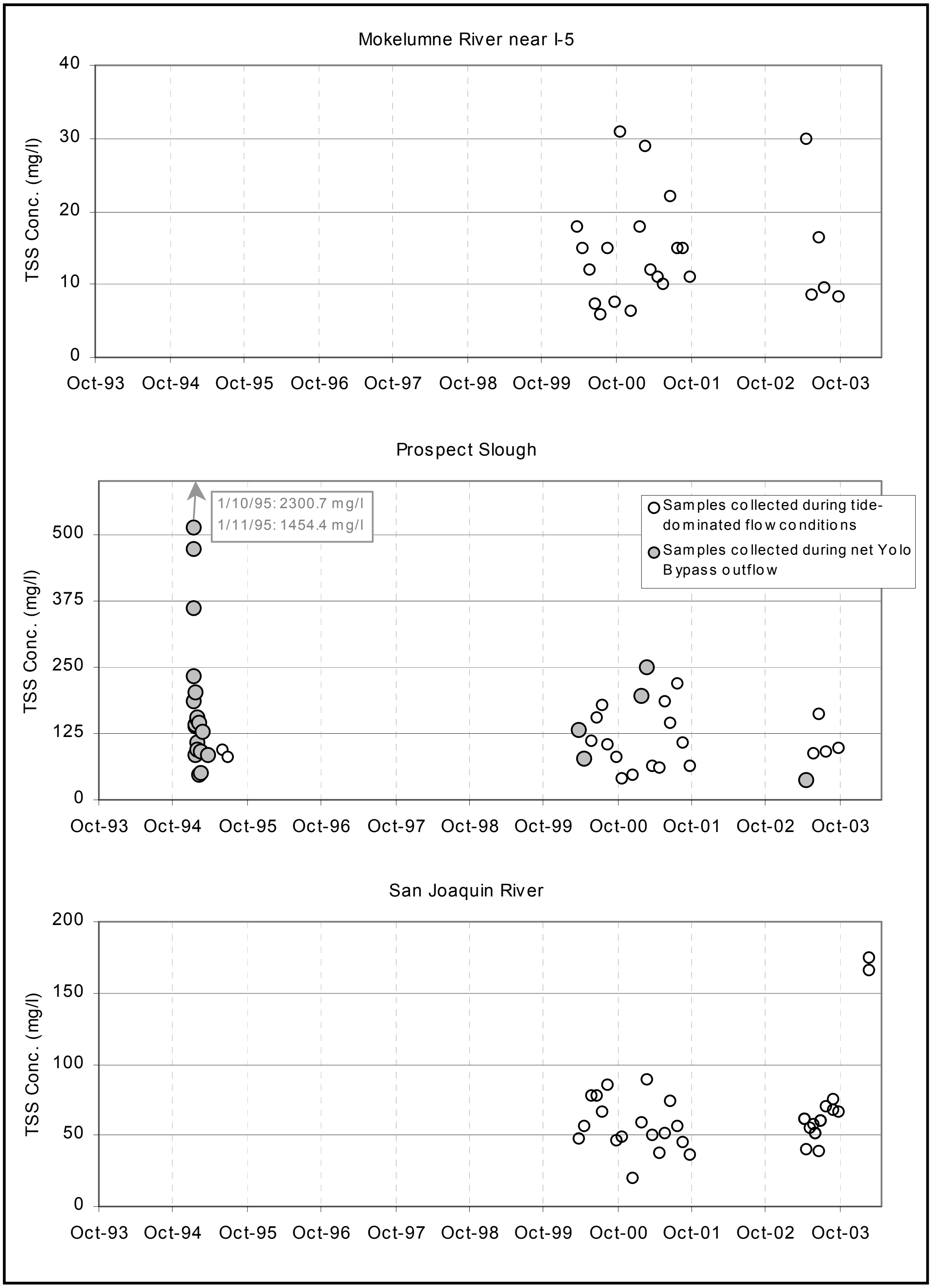

Figure I.1b: Available TSS Concentration Data for the Mokelumne River, Prospect Slough and San Joaquin River.

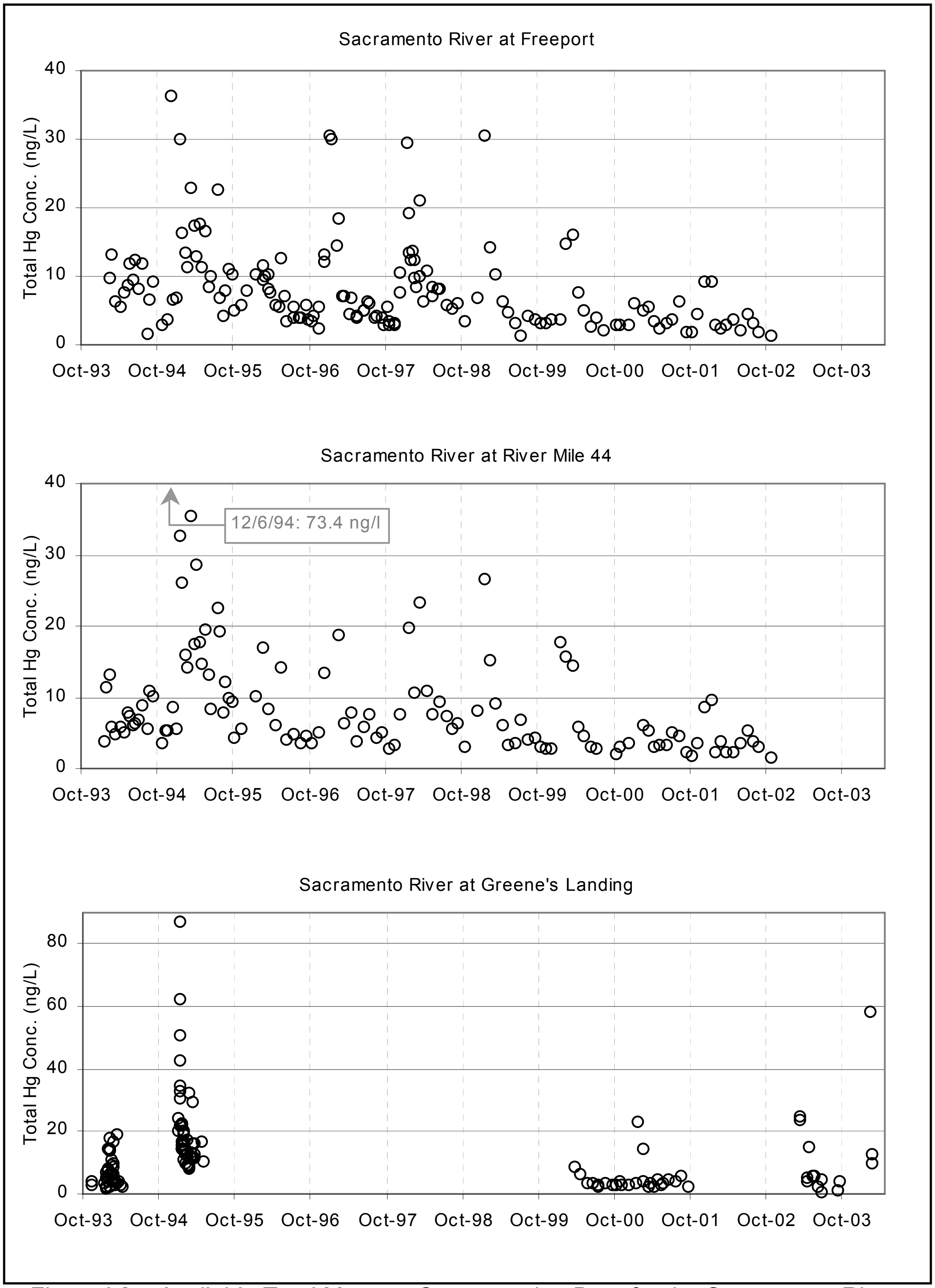

Figure I.2a: Available Total Mercury Concentration Data for the Sacramento River.

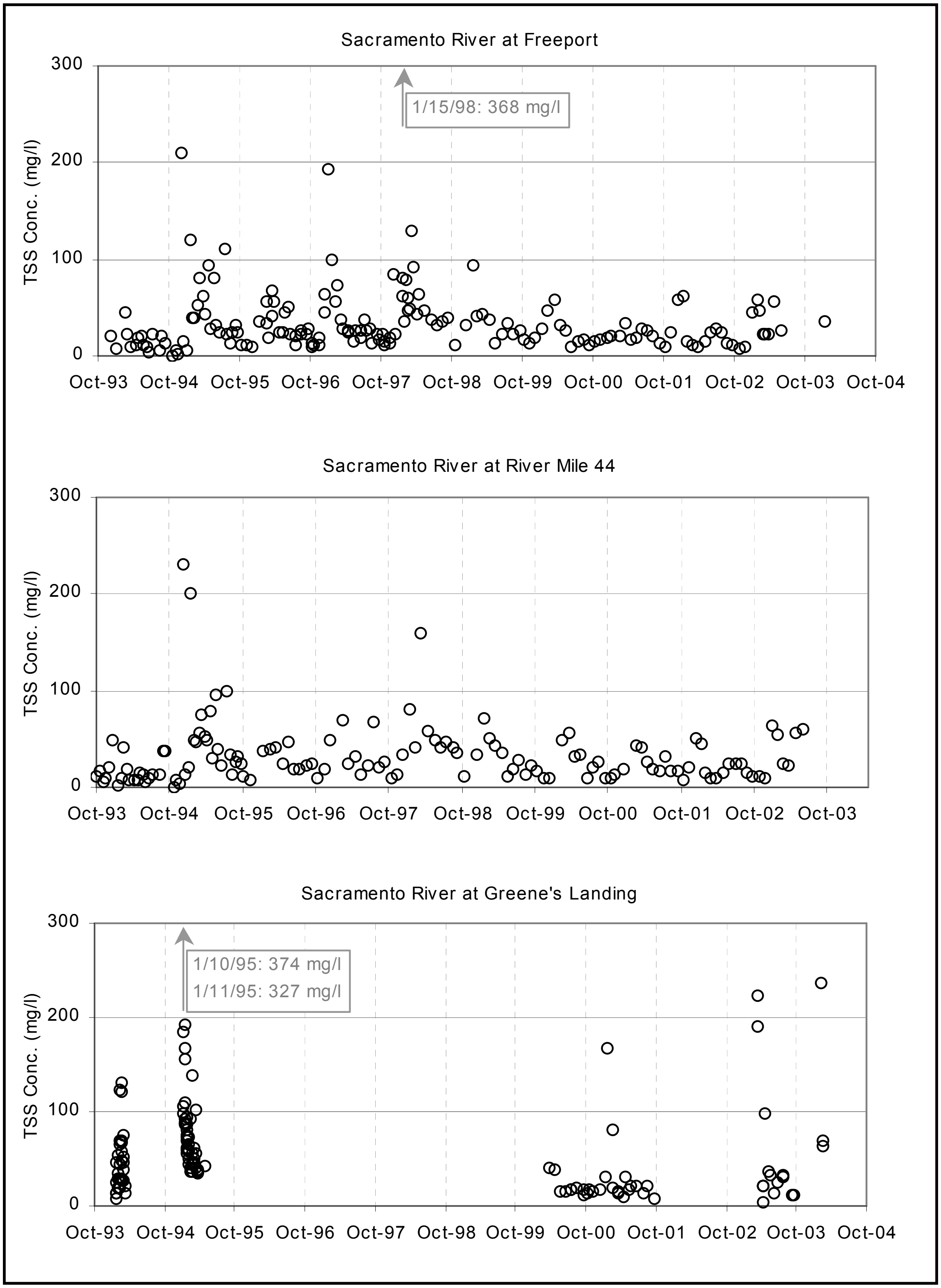

Figure I.2b: Available TSS Concentration Data for the Sacramento River.

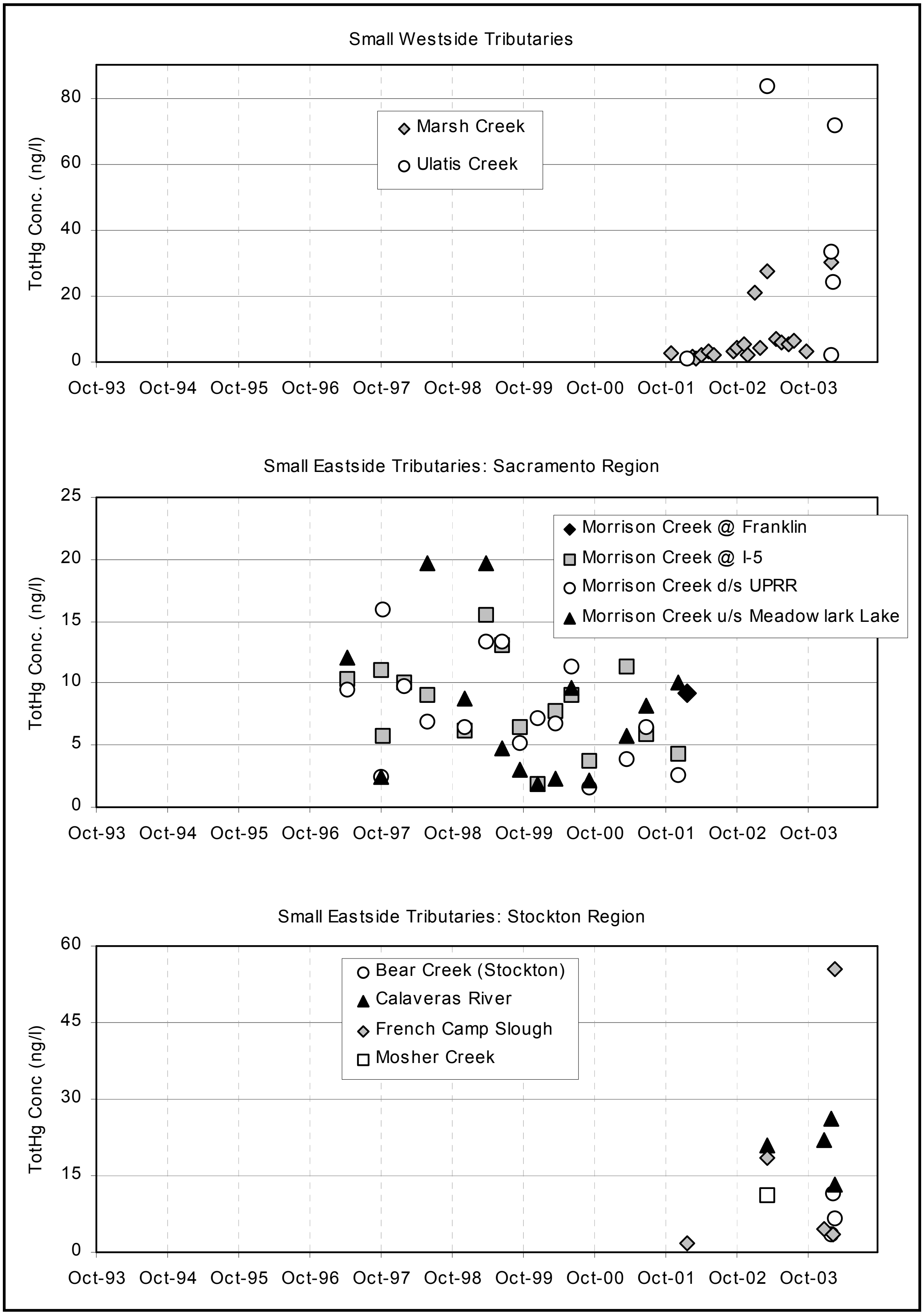

Figure I.3a: Available Total Mercury Concentration Data for Small Westside and Eastside Tributaries.

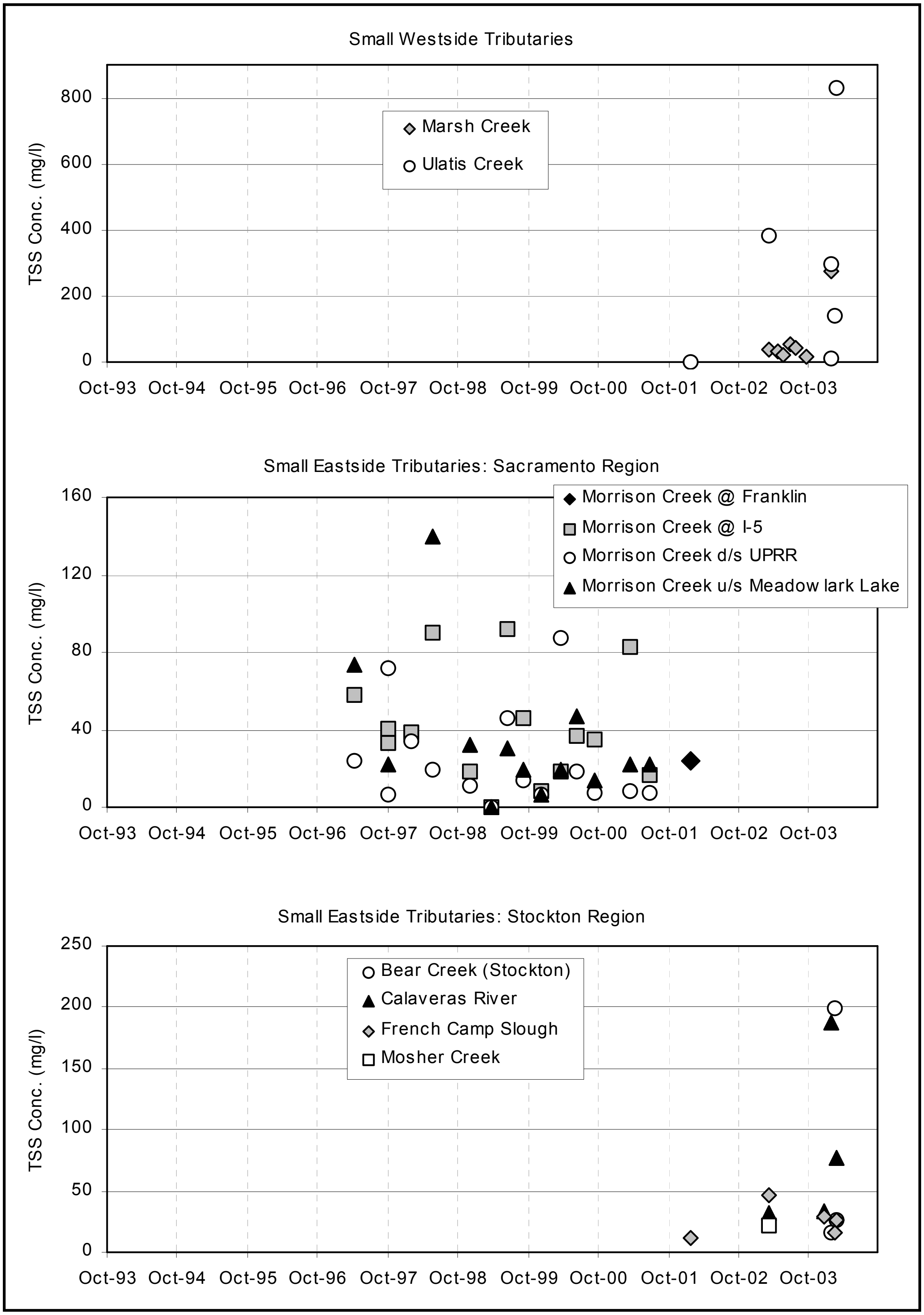

Figure I.3b: Available TSS Concentration Data for Small Westside and Eastside Tributaries.

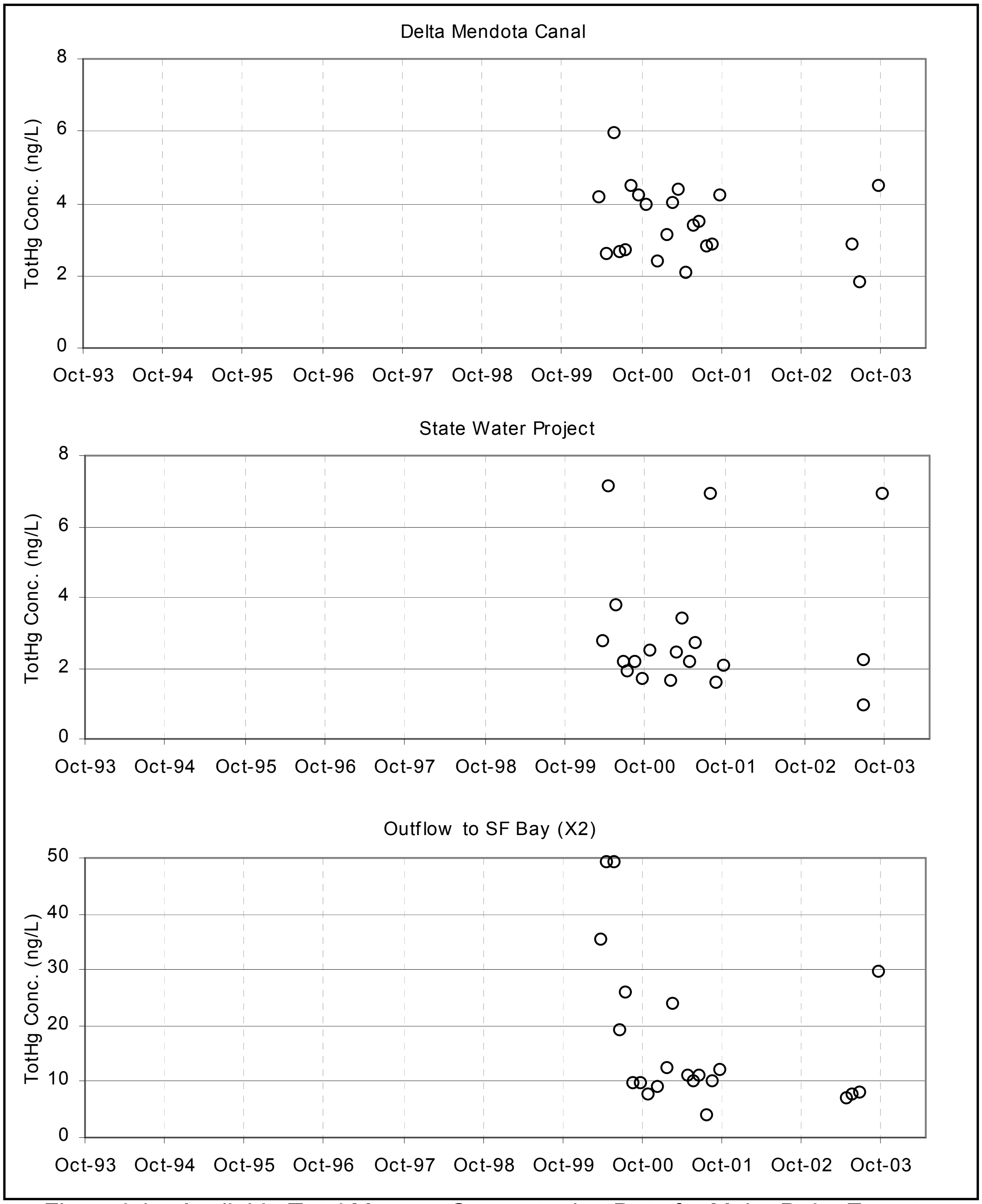

Figure I.4a: Available Total Mercury Concentration Data for Major Delta Exports.

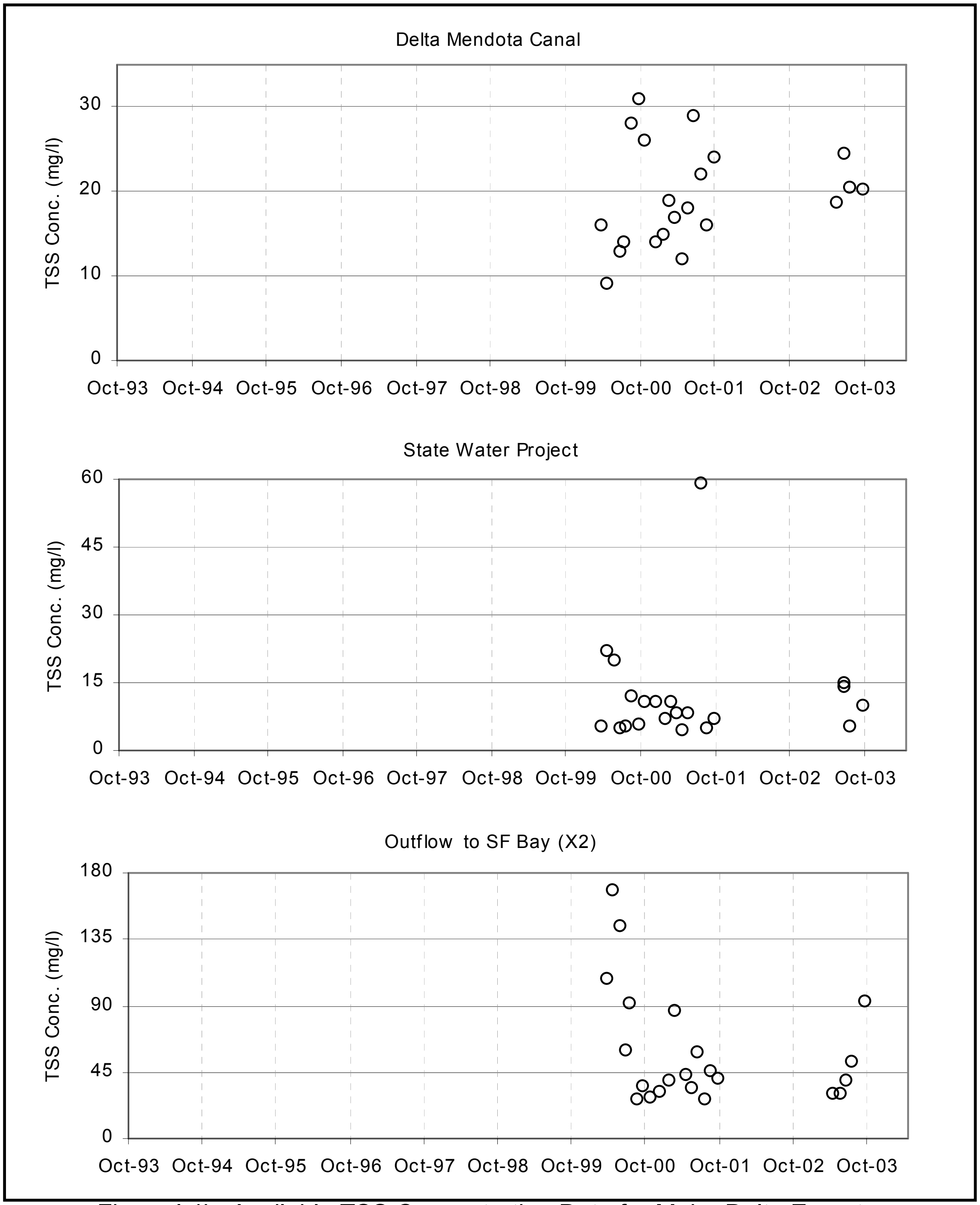

Figure I.4b: Available TSS Concentration Data for Major Delta Exports.

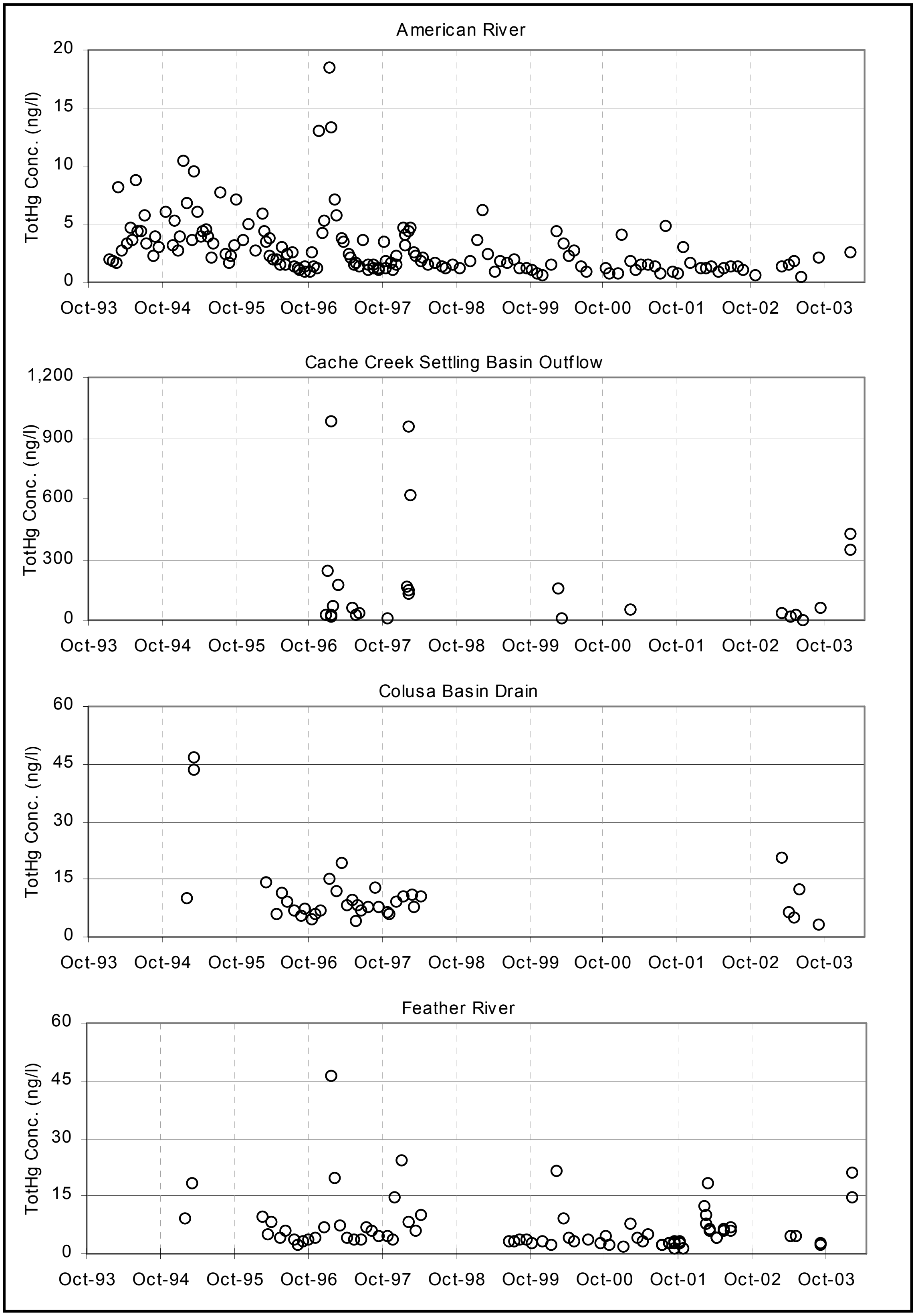

Figure I.5a: Available Total Mercury Concentration Data for American River, Cache Creek, Colusa Basin & Feather River Watershed Outflow Locations.

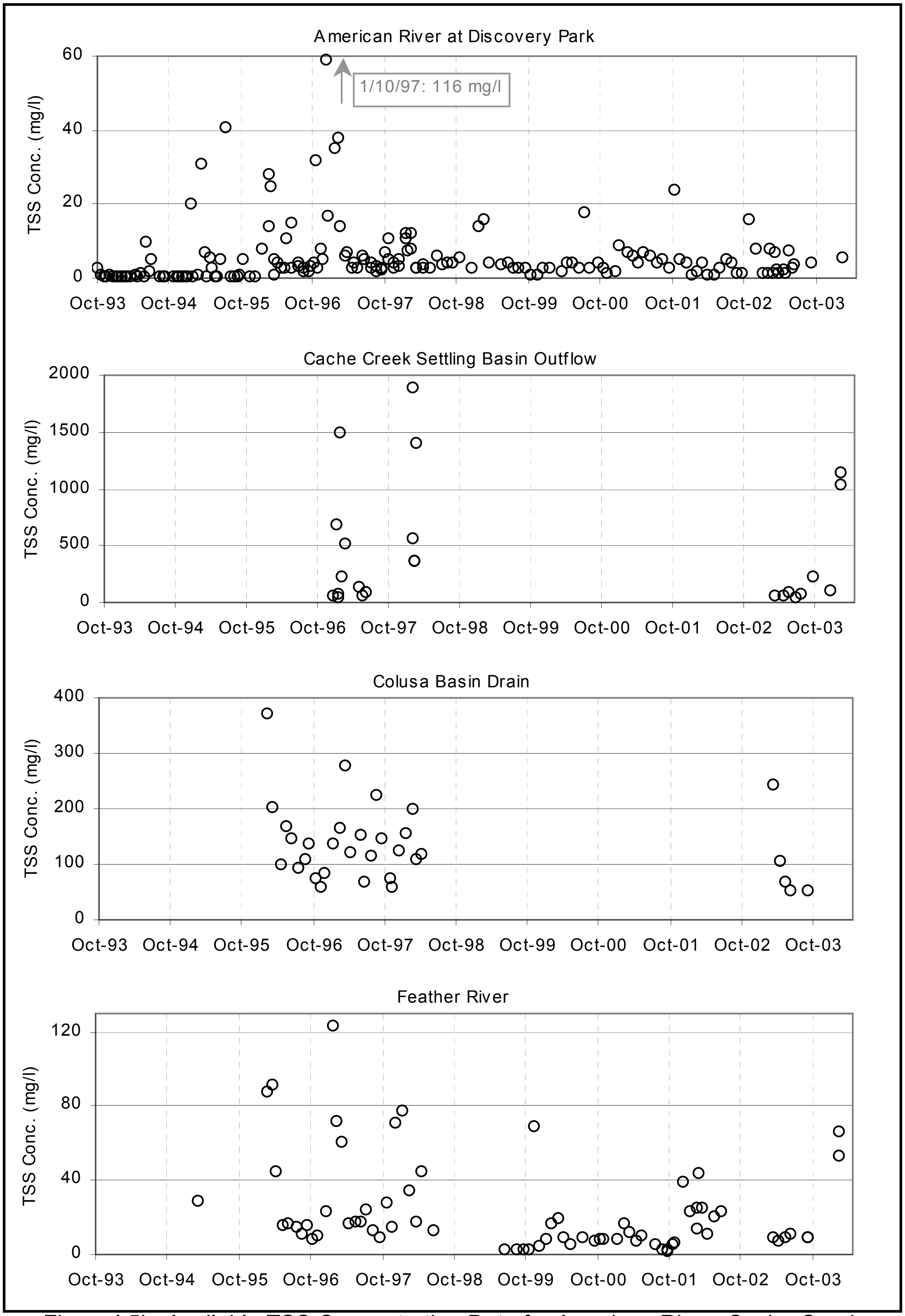

Figure I.5b: Available TSS Concentration Data for American River, Cache Creek, Colusa Basin & Feather River Watershed Outflow Locations.

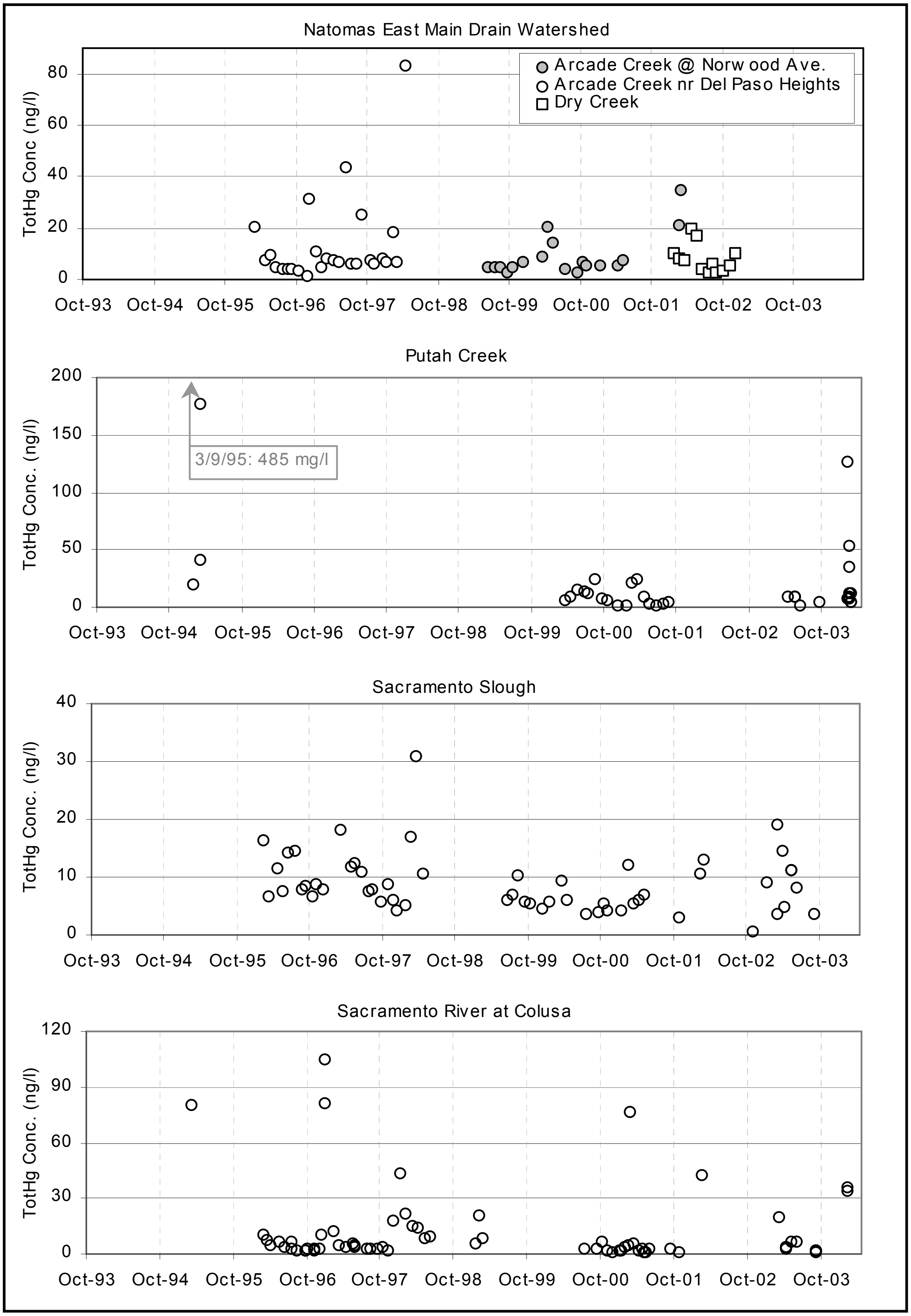

Figure I.6a: Available Total Mercury Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.

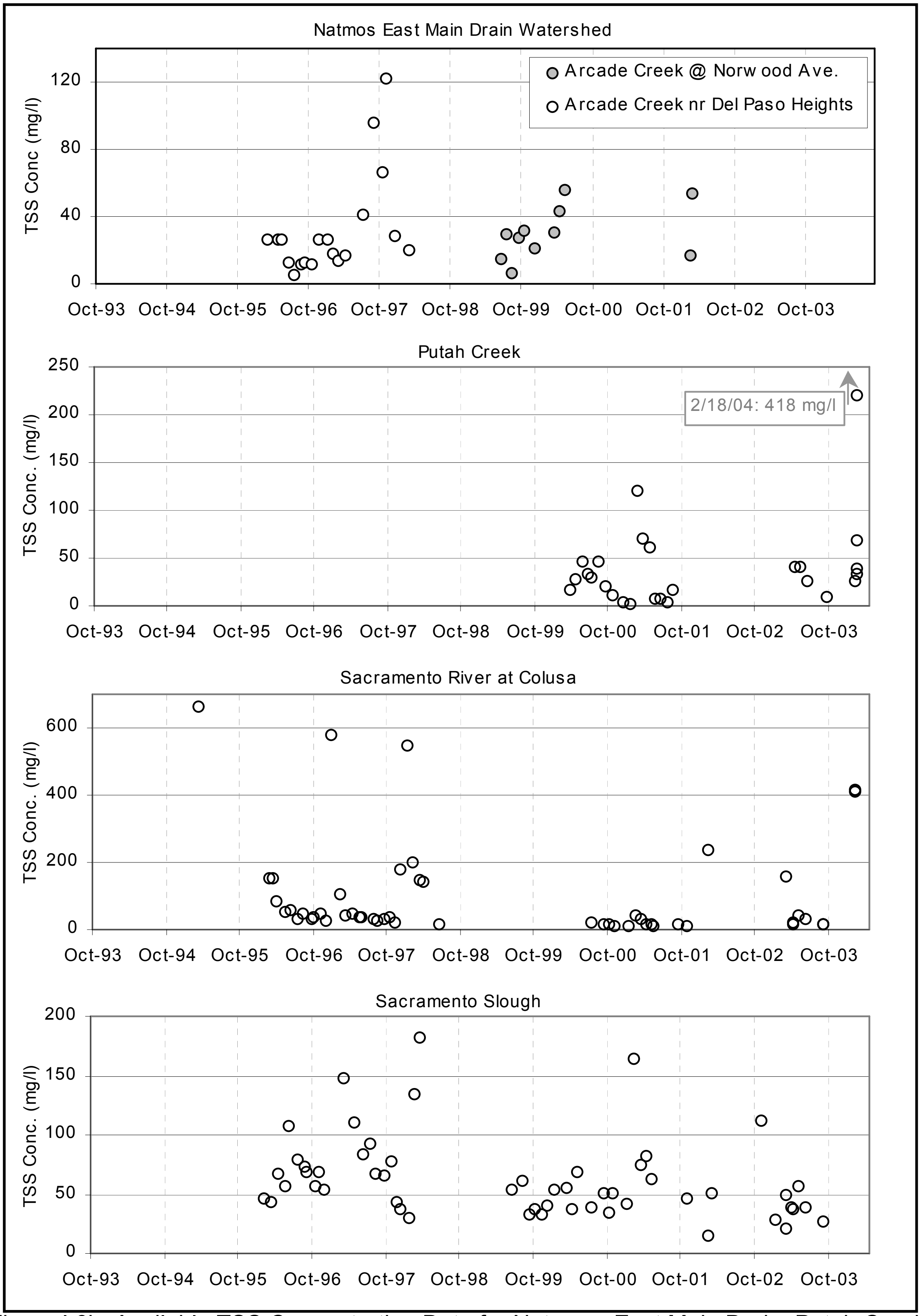

Figure I.6b: Available TSS Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.

I.2 Average Annual Load and Confidence Interval Calculations for Tributary Sampling Stations with Statistically Significant Concentration / Flow Regressions

Staff predicted the concentration of total mercury and/or TSS from flow for tributary sampling stations with significant (P < 0.05) concentration/flow linear regressions (Table I.1 and Figures I.7a and I.7b). Daily mercury and/or TSS concentrations were predicted for each tributary for two periods: WY2000-2003 and WY1984-2003. Daily loads were calculated using daily average flow data (Appendix E). Average annual loads were calculated using Equation I.1.

Equation I.1:

$$\text{Average Annual Load} = \frac{1}{H}\sum c_i \bar{Y}^* + \frac{b_1}{H}\sum c_i (X_i - \bar{X}^*)$$

Where:

- H = Number of years being averaged (20 or 4 years)
- c_i = Constant of proportionality
- $\bar{Y}^*$ = Average concentration (i.e. Total mercury or TSS) of the data used for the regression
- b_1 = Slope derived from the linear regression
- X_i = Daily average flow (cfs) from the flow record for 20 or 4 years
- $\bar{X}^*$ = Average of the daily average flow of the data used for the regression

The variance of the average annual loads was calculated from Equation I.2.

Equation I.2:

$$\text{Variance } (s^2) \quad \left(\frac{1}{H}\right)^2 \left(\sum c_i\right)^2 \left(\frac{\sigma^2}{n^*}\right) + \left(\frac{\sum c_i (X_i - \bar{X}^*)}{H}\right)^2 \left(\frac{\sigma^2}{\sum (X_i^* - \bar{X}^*)^2}\right) =$$

Where:

- H = Number of years being averaged (20 or 4 years)
- c_i = Constant of proportionality
- σ^2 = Residual mean square (*MSE*) from the regression
- n^* = Sampled population size of the data on which the regression was based
- X_i = Daily average flow (cfs) from the flow record for 20 or 4 years
- X_i^* = Daily average flow (cfs) of the data used for the regression
- $\bar{X}^*$ = Average of the daily average flow of the data used for the regression

From the variance, standard error was calculated using Equation I.3.

Equation I.3:

Standard Error (*SE*) = $\left(s^2 \big/ (n^* - 2) \right)^{1/2}$

Where:

s^2 = Variance calculated by Equation I.2

n^* = Sampled population size of the data on which the regression was based

Using the above standard error, the confidence interval was calculated from Equation I.4.

Equation I.4:

Confidence Interval (*CI*) = Average Annual Load $\pm SE \times t_{\alpha,df}$

Where:

SE = Standard error calculated by Equation I.3

$t_{\alpha,df}$ = Critical t-value with the probability (α) of 0.05 and (n^* -2) degrees of freedom

This method was developed by Professor Neil Willits (Willits, 2005-2006) at the University of California at Davis. All calculations were made using Microsoft Excel's Data Analysis ToolPak.

The method for calculating average annual loads and confidence intervals for tributary sampling stations without statistically significant concentration/flow regressions is described in Section J.3 after Table I.1 and Figures I.7a and 7.b.

Table I.1: Statistical Significance of Linear Regressions Between Concentration and Daily Flow at Tributary and Export Sampling Stations.

Sampling Stations [(a)]	Total Mercury/Flow Regression Statistically Significant (P < 0.05)	TSS/Flow Regression Statistically Significant (P < 0.05)
Delta Imports		
American River at Discovery Park	Yes	Yes
Cache Creek d/s Settling Basin	Yes	Yes
Colusa Basin Drain	Yes	Yes
Feather River	Yes	Yes
Mokelumne River d/s I-5	No	No
Putah Creek at Mace Blvd	Yes	Yes
Sacramento River at Colusa	Yes	Yes
Sacramento River at Freeport	Yes	Yes
San Joaquin River at Vernalis	No	No
Marsh Creek	Yes	No
Prospect Slough (Yolo Bypass)	Yes	Yes
Delta Exports		
Export to San Francisco Bay Delta (X2 and Chipps Island)	No	No
Delta Mendota Canal at Byron Highway	No	No
State Water Project at Bethany Reservoir	No	No

(a) Bear, Mosher, Morrison and Ulatis Creeks, Calaveras River, Natomas East Main Drain, and French Camp Slough tributary stations were not evaluated because there are no flow gages near the stations. The flow gage near the Sacramento Slough station is not rated for high flows and is therefore not adequate for this analysis.

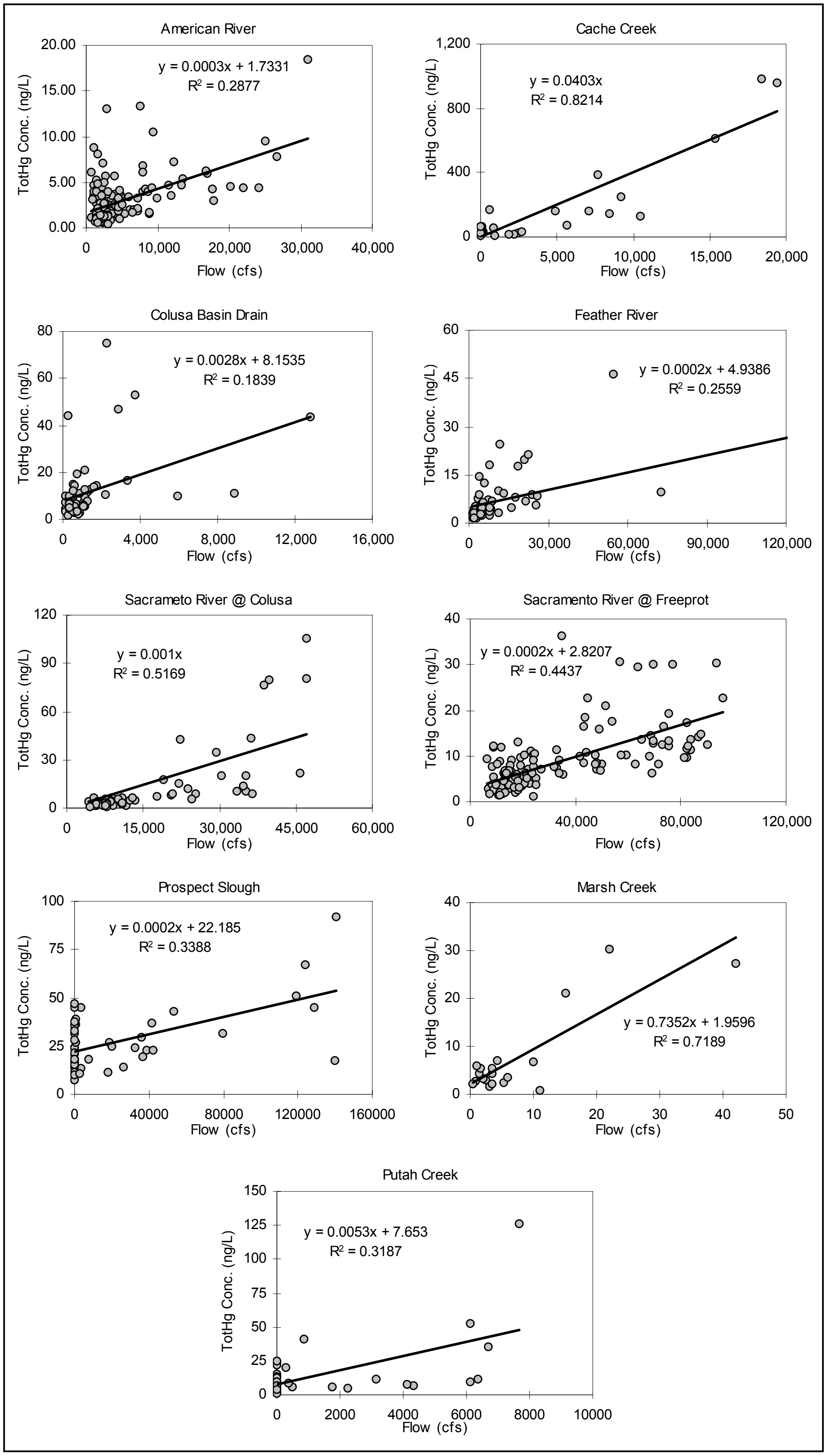

Figure I.7a: Total Mercury Concentration versus Daily Flow for Tributary Inputs With Statistically Significant ($P < 0.05$) Linear Regressions.

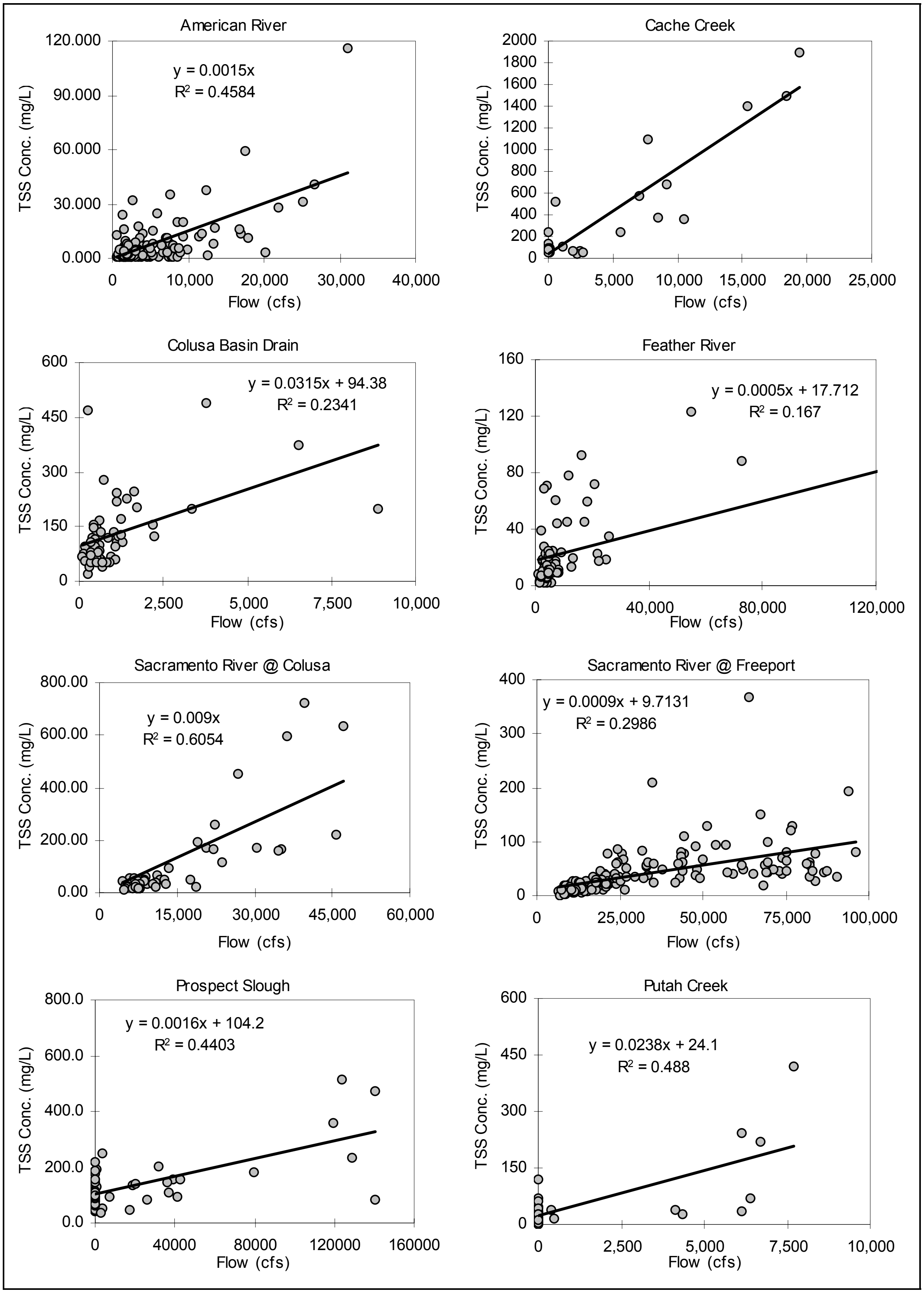

Figure I.7b: TSS Concentration versus Daily Flow for Tributary Inputs With Statistically Significant ($P < 0.05$) Linear Regressions.

I.3 Annual Average Load and Confidence Interval Calculations for Tributary Sampling Stations without Statistically Significant Concentration / Flow Regressions

For the tributary and export sampling locations where linear regressions were not statistically significant ($P < 0.05$, see Table I.1), the daily loads for total mercury and TSS were calculated by multiplying the mean concentration for the sampled data by each water bodies' daily flow for two different periods: WY2000-2003 and WY1984-2003. Then the daily loads were summed (1461 days for 4 years or 7305 days for 20 years) and divided by the appropriate number of years to determine the average annual loads for each period. If the flow record was missing or unavailable for any number of days, then the sums of the daily loads were normalized to 7305 days for 20 years or 1461 days for 4 years before dividing by the number of years. For example, a 20-year record would be normalized by dividing 7305 (the number of days in the 20-year period) by the number of days with a recorded value in the flow record and then multiplying the resulting quotient by the calculated sum of loads; the result was then divided by 20 to obtain the average annual load.

To determine the upper and lower confidence intervals for the annual loads, the upper and lower 95% confidence limits of the concentration means, respectively, were multiplied by each water bodies' daily flow for 20 and 4 years, summed, and divided by the appropriate number of years.

The sampled data's concentration mean, standard error, and 95% confidence interval were calculated using the Microsoft Excel Data Analysis ToolPak option, "Descriptive Statistics".

I.4 Calculations for Error Propagation for the Mass Balances

To determine the confidence intervals of the mass balance components (i.e., sum of input loads or sum of export loads), staff determined the propagated error of the summed loads using Equation I.5 and the confidence interval for the summed loads using Equation I.6. This method was developed by Professor Neil Willits (Willits, 2005-2006) at the University of California at Davis. All calculations were made using Microsoft Excel's Data Analysis ToolPak.

Equation I.5:

Standard Error of Summed Loads (SE_{all}) = $\sqrt{\left(SE_{load_1}\right)^2 + \left(SE_{load_2}\right)^2 + \left(SE_{load_3}\right)^2 + ...}$

Equation I.6:

Confidence Interval of the Summed Loads (CI_{all}) = Summed Loads $\pm\ SE_{all} \times t^*_{\alpha,df}$

Where:

SE_{all} = Standard error calculated in *Equation I.5*

$t^*_{\alpha,df}$ = Critical t-value with the probability (□) of 0.05 and (n_{all}-1) degrees of freedom.

n_{all} = $\sum\left(n^*_{load_1} + n^*_{load_2} + n^*_{load_3} + ...\right)$

I.5 Regressions between Total Mercury and TSS Concentrations for Delta Inputs and Exports

Figure I.8: TotHg:TSS Regressions for Delta Inputs

Figure I.9: TotHg:TSS Regressions for Tributary Inputs to the Sacramento Basin

Figure I.10: TotHg:TSS Regressions for Delta Exports

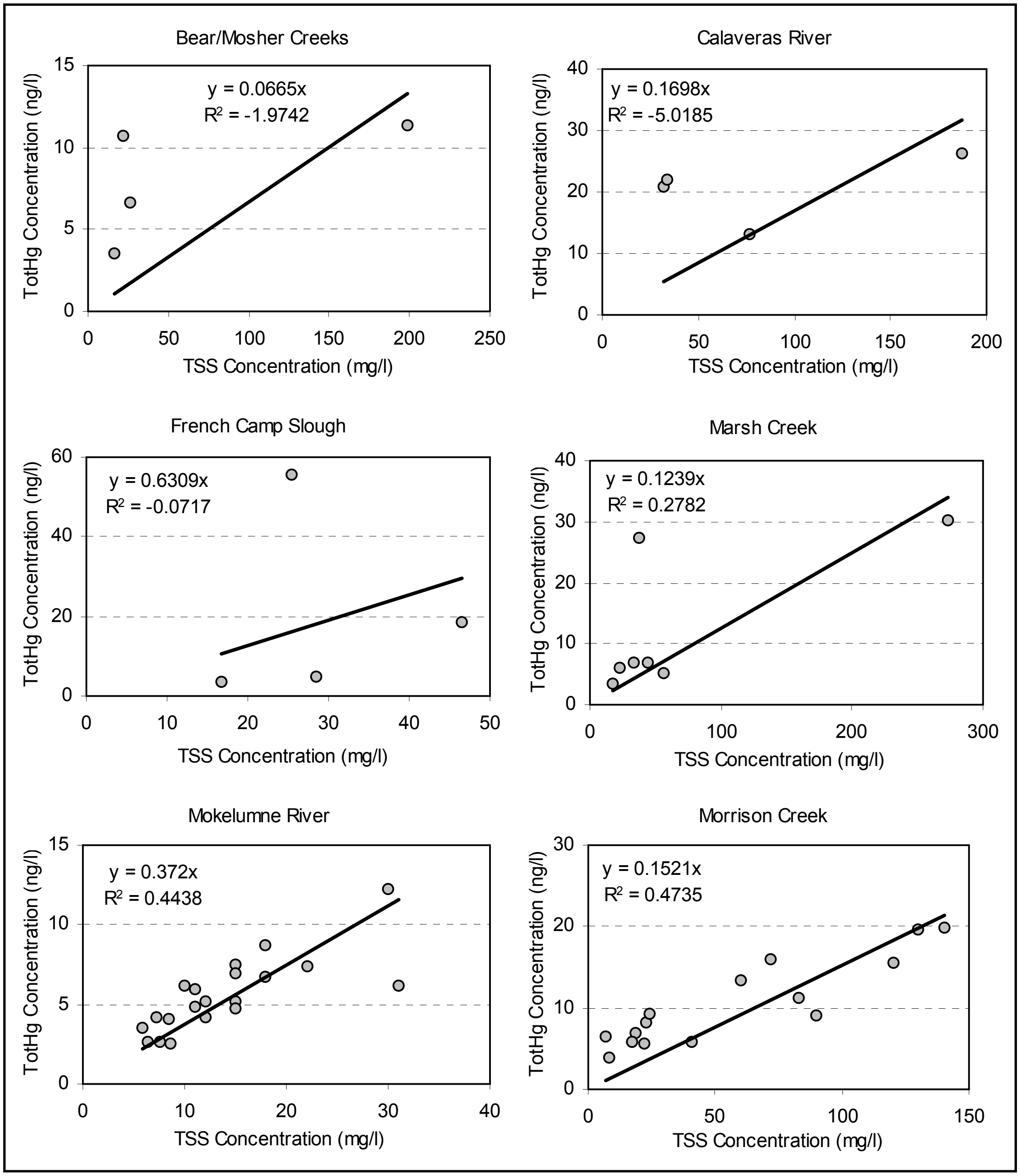

Figure I.8a: TotHg:TSS Regressions for Delta Inputs

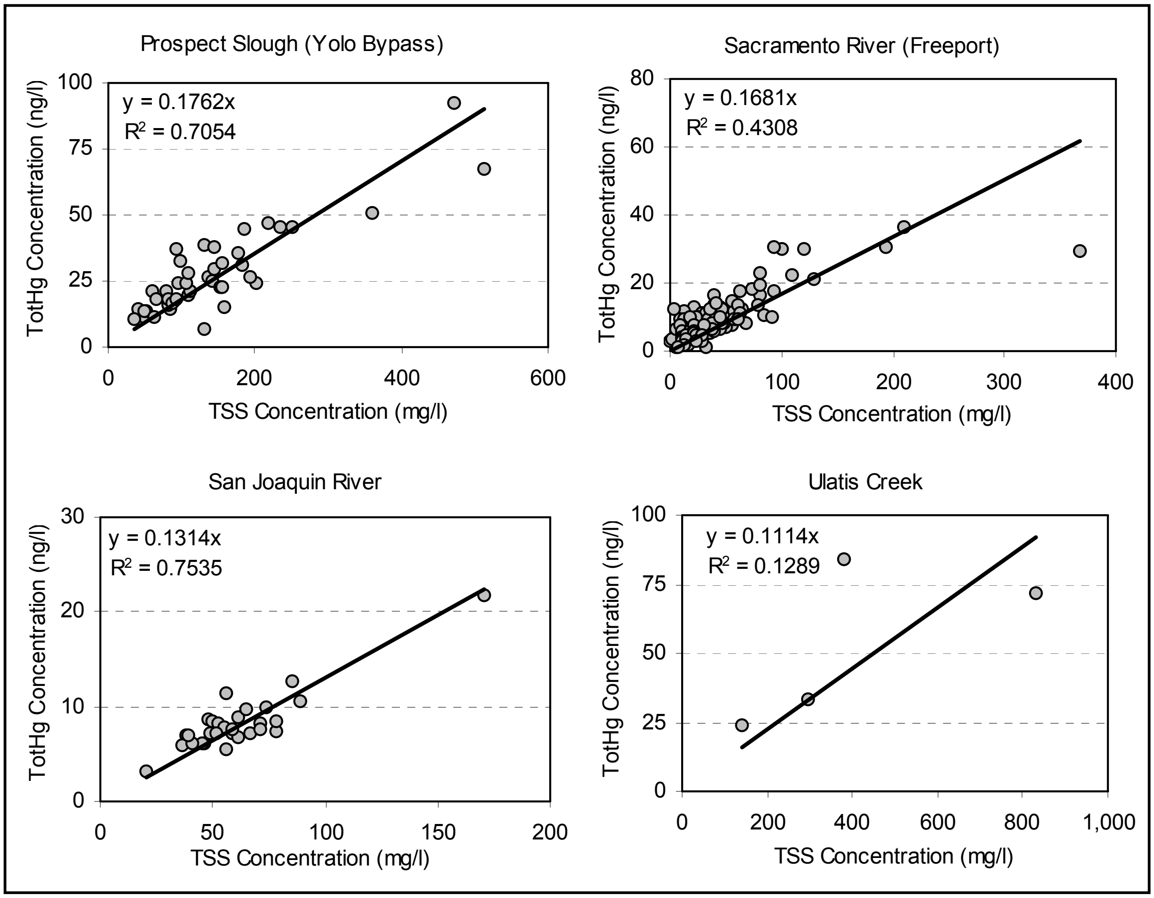

Figure I.8b: TotHg:TSS Regressions for Delta Inputs

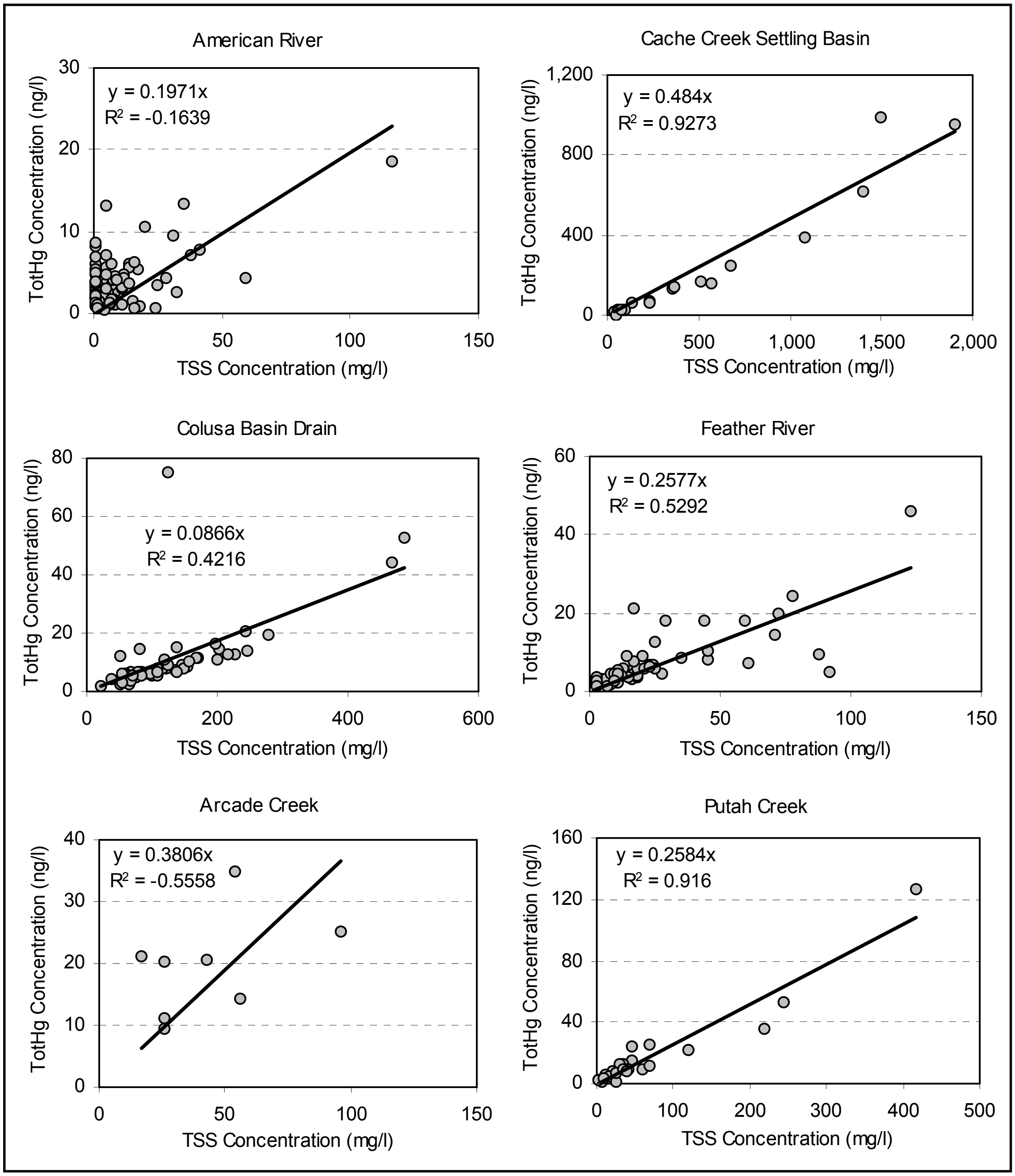

Figure I.9a: TotHg:TSS Regressions for Tributary Inputs to the Sacramento Basin

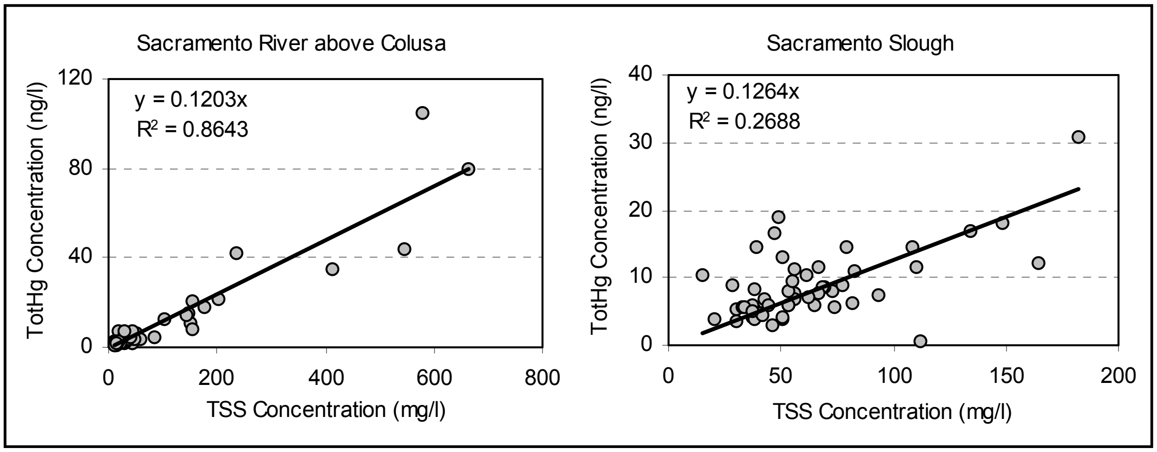

Figure I.9b: TotHg:TSS Regressions for Tributary Inputs to the Sacramento Basin

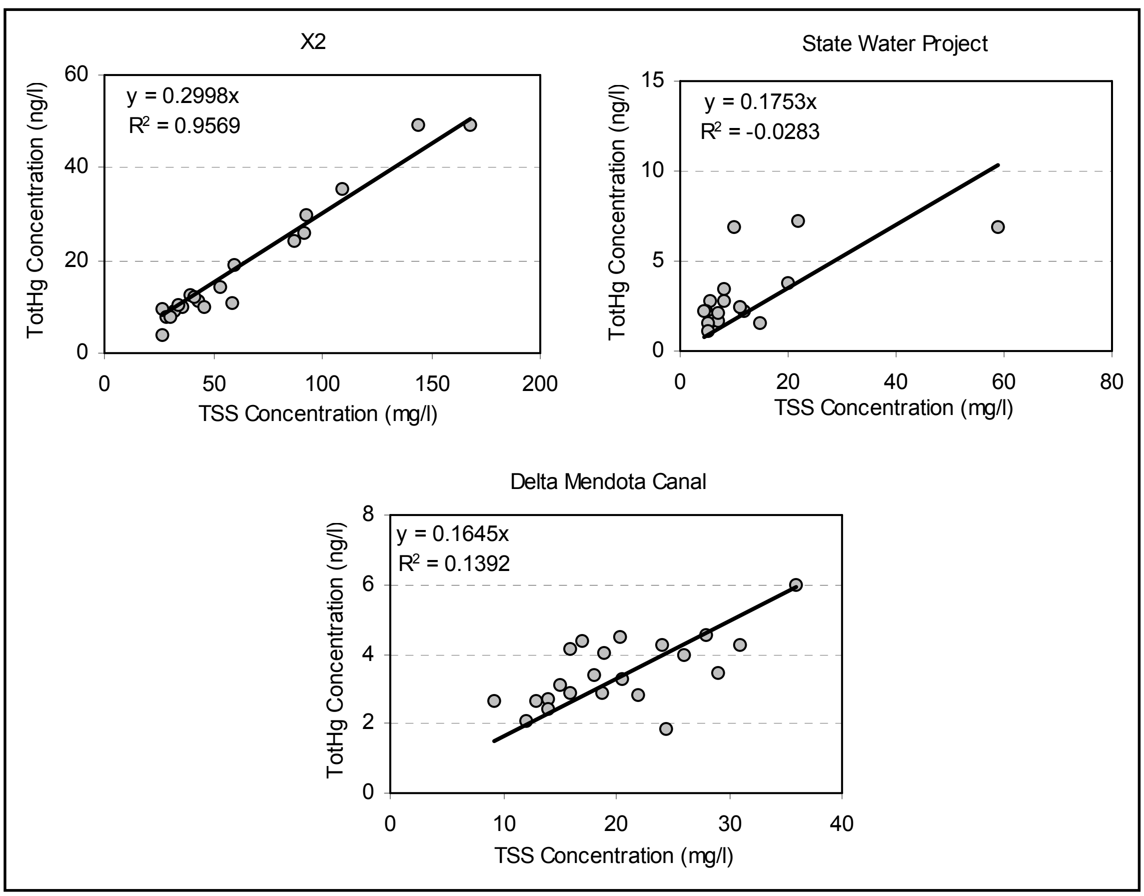

Figure I.10: TotHg:TSS Regressions for Delta Exports

I.6 Regression-based Annual and Highest Daily Mercury Loads for the Sacramento Basin.

Table I.2 provides the regression-based annual mercury loads and sums of the three, five, and ten highest daily mercury loads in each water year for the Sacramento River at Freeport, Yolo Bypass at Prospect Slough, and total Sacramento Basin outflows (Sacramento River + Yolo Bypass). The daily and annual loads were calculated using the daily total mercury concentrations predicted by the concentration/flow regressions described in Section J.2 and daily average flow data for WY1984-2003 described in Appendix E.

Table I.2: Regression-based Annual Mercury Loads and Sums of the Three, Five, and Ten Highest Daily Mercury Loads in Each Water Year for Sacramento Basin Outflows.

A. Sacramento River @ Freeport				
Water Year	Annual TotHg Load (kg/yr)	Sum of 3 Highest Daily Loads (kg)	Sum of 5 Highest Daily Loads (kg)	Sum of 10 Highest Daily Loads (kg)
1984	268	11	18	34
1985	85	3	4	9
1986	212	15	24	43
1987	59	2	4	7
1988	57	2	4	7
1989	93	7	10	19
1990	56	2	3	5
1991	40	3	5	8
1992	47	3	6	10
1993	219	9	15	29
1994	54	2	3	5
1995	385	12	20	37
1996	266	10	17	32
1997	269	14	22	42
1998	391	11	17	33
1999	248	10	16	30
2000	194	10	16	31
2001	65	3	5	9
2002	100	6	10	18
2003	179	6	10	20

B. Yolo Bypass @ Prospect Slough				
Water Year	Annual TotHg Load (kg/yr)	Sum of 3 Highest Daily Loads (kg)	Sum of 5 Highest Daily Loads (kg)	Sum of 10 Highest Daily Loads (kg)
1984	230	92	131	168
1985	3	1	1	1
1986	833	355	491	628
1987	0	0	0	0
1988	2	1	1	2
1989	1	0	1	1
1990	0	0	0	0
1991	1	1	1	1
1992	2	1	1	2
1993	61	12	20	33
1994	0	0	0	0
1995	600	121	188	301
1996	122	26	39	60
1997	704	279	382	498
1998	408	73	114	187
1999	43	7	11	19
2000	102	15	25	45
2001	4	1	1	2
2002	14	5	6	9
2003	24	4	6	8

C. Sacramento Basin Outflows [(a)]				
Water Year	Annual TotHg Load (kg/yr)	Sum of 3 Highest Daily Loads (kg)	Sum of 5 Highest Daily Loads (kg)	Sum of 10 Highest Daily Loads (kg)
1984	497	103	148	200
1985	88	3	5	10
1986	1045	370	515	668
1987	59	3	4	7
1988	59	3	4	8
1989	94	7	11	19
1990	56	2	3	5
1991	41	4	6	9
1992	49	4	6	12
1993	280	21	34	61
1994	54	2	3	5
1995	985	131	205	335
1996	388	36	55	91
1997	972	294	404	536
1998	799	83	130	218
1999	291	16	26	48
2000	296	24	40	75
2001	69	4	6	11
2002	114	11	16	27
2003	203	10	16	27

(a) The predicted daily mercury loads for the Sacramento River at Freeport and Yolo Bypass at Prospect Slough were summed by date to estimate total daily outflows from the Sacramento Basin and then ranked within each water year to determine the highest three, five and ten daily loads in each water year for the Sacramento Basin. As a result, the highest daily loads in (C) may not equal the sum of the highest daily loads in (A) and (B).

J. 2002 ANNUAL TOTAL MERCURY LOADS FROM AIR EMISSION FACILITIES THAT REPORTED TO THE CALIFORNIA AIR RESOURCES BOARD (ARB, 2003)

FACILITY TYPE / TOTAL MERCURY LOAD (kg)	American River below Folsom Dam	Bear Creek, Fresno R. & San Joaquin R. abv Res.	Butte Creek / Sutter Bypass	Cache Creek	Colusa Basin	Coon Creek & Cross Canal	Delta	Feather River below Oroville Dam	Morrison Creek	Natomas East Main Drain & Arcade Creek	Putah - Cache Low-lands	Sacra-mento River abv Colusa	Sacra-mento River abv Keswick Dam	San Joaquin River abv Vernalis	Ulatis Creek	**Grand Total**
ANIMAL & MARINE FATS AND OILS	4.048															**4.048**
BEET SUGAR							1.438									**1.438**
BRICK AND STRUCTURAL CLAY TILE									0.006							**0.006**
CANNED FRUITS AND VEGETABLES											0.00026			0.384		**0.384**
CANNED SPECIALTIES														0.000045		**0.000045**
CEMENT, HYDRAULIC												35.337				**35.337**
CHOCOLATE AND COCOA PRODUCTS														0.000076		**0.00008**
COLLEGES & UNIVERSITIES, NEC	0.002															**0.002**
COMMERCIAL PRINT / LITHOGRAPH									0.803							**0.803**
CONCRETE PRODUCTS, NEC									10.579							**10.579**
CONSTRUCTION SAND AND GRAVEL	0.004			2.275					0.104			0.00005				**2.383**
CORRECTIONAL INSTITUTIONS															0.012	**0.012**
COTTON GINNING														0.077		**0.077**
COTTONSEED OIL MILLS														8.844		**8.844**
CROP PREPARATION SVCS FOR MKT			0.001		0.006	0.001		0.003								**0.011**

FACILITY TYPE / TOTAL MERCURY LOAD (kg)	American River below Folsom Dam	Bear Creek, Fresno R. & San Joaquin R. abv Res.	Butte Creek / Sutter Bypass	Cache Creek	Colusa Basin	Coon Creek & Cross Canal	Delta	Feather River below Oroville Dam	Morrison Creek	Natomas East Main Drain & Arcade Creek	Putah - Cache Low-lands	Sacra-mento River abv Colusa	Sacra-mento River abv Keswick Dam	San Joaquin River abv Vernalis	Ulatis Creek	**Grand Total**
CRUSHED AND BROKEN STONE, NEC					0.018											**0.018**
DRILLING AND OIL AND GAS WELLS			0.003													**0.003**
ELECTRIC & OTHER SERVICES COMB					9.934		4.193					0.324	0.658	0.00004		**15.109**
ELECTRIC SERVICES							3.656									**3.656**
FOOD PREPARATIONS, NEC									1.313							**1.313**
FUNERAL SERVICE & CREMATORIES	1.643							0.617	7.194	2.343		2.801				**14.598**
GENERAL MED/SURGICAL HOSPITALS	0.00042								0.00011							**0.001**
GLASS CONTAINERS														0.00014		**0.00014**
GUIDED MISSILES AND SPACE VEH	0.00025															**0.00025**
INDUSTRIAL ORGANIC CHMLS, NEC									0.00005							**0.00005**
LAMINATED PLSTCS PLATE & SHEET						0.025										**0.025**
LAND MINERAL WILDLIFE CONSERV	0.006															**0.006**
MILLWORK										0.018						**0.018**
MISC NONMETALLIC MINERALS													0.053			**0.053**
NATIONAL SECURITY							0.000	13.041	0.001							**13.042**

FACILITY TYPE / TOTAL MERCURY LOAD (kg)	American River below Folsom Dam	Bear Creek, Fresno R. & San Joaquin R. abv Res.	Butte Creek / Sutter Bypass	Cache Creek	Colusa Basin	Coon Creek & Cross Canal	Delta	Feather River below Oroville Dam	Morrison Creek	Natomas East Main Drain & Arcade Creek	Putah - Cache Low-lands	Sacra-mento River abv Colusa	Sacra-mento River abv Keswick Dam	San Joaquin River abv Vernalis	Ulatis Creek	**Grand Total**
NITROGENOUS FERTILIZERS														0.00035		**0.00035**
PAPER MILLS							0.577									**0.577**
PAVING MIXTURES AND BLOCKS		0.030							0.045	0.079		5.382		0.002		**5.538**
PLASTICS MATERIALS AND RESINS									0.00010							**0.00010**
PREPARED FEEDS, NEC							0.00132									**0.00132**
RICE MILLING			0.0006		0.014		0.00093				0.001					**0.017**
SANITARY SERVICES, NEC												2.050				**2.050**
SAWMILLS & PLANING MILLS, GNL						0.005						0.068	3.062			**3.134**
SEMICONDUCTORS /RELATED DEVICES	0.002															**0.002**
VEGETABLES OIL MILLS, NEC					0.00059											**0.00059**
VET SERV, SPECIALISTS	0.009									0.232						**0.241**
Grand Total	**5.714**	**0.030**	**0.005**	**2.275**	**9.972**	**0.031**	**9.867**	**13.661**	**20.045**	**2.672**	**0.001**	**45.964**	**3.772**	**9.308**	**0.012**	**123.330**

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K. FISH MERCURY CONCENTRATION DATA INCORPORATED IN TMDL REPORT

Regional Board staff compiled and evaluated mercury concentration results for more than 2,800 fish samples collected from Delta waterways between 1970 and 2002. Because of the extensive nature of the raw data, a paper copy of the data set is not included in this report. Instead the database is available electronically in a Microsoft Excel file upon request or from the following website:

http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/

The database includes sample results from the following sources:

CDFG. 1973. Department of Fish and Game Striped Bass Mercury Data, 1970-1973.

Davis, J.A, B.K. Greenfield, G. Ichikawa and M. Stephenson. 2003. *Mercury in Sport Fish from the Delta Region.* Final report submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed (Task 2A). San Francisco Estuary Institute and Moss Landing Marine Laboratories. Available at: http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

Davis, J.A., M.D. May, G. Ichikawa, and D. Crane. 2000. *Contaminant Concentrations in Fish from the Sacramento-San Joaquin Delta and Lower San Joaquin River – 1998*. San Francisco Estuary Institute report. Richmond, California. September 2000. Available at: http://www.sfei.org/sfeireports.htm.

ICEM. 1971. *Mercury in the California Environment.* Compiled by the Interagency Committee on Environmental Mercury, July 1970 - July 1971. Published by the California State Department of Public Health, Environmental Health and Consumer Protection Program. Berkeley, California.

LWA. 2003. *Sacramento River Watershed Program Annual Monitoring Report: 2001–2002 (Final Draft).* Larry Walker and Associates (LWA). Davis, CA. June 2003. Available at: http://www.sacriver.org/.

Schwarzbach, S. and T. Adelsbach. 2002. *Field Assessment of Avian Mercury Exposure in the Bay-Delta Ecosystem.* Submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed (Task 3A). U.S. Geological Survey Biological Research Division and U.S. Fish and Wildlife Service. September 2002. Available at: http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

SWRCB-DWQ. 2002. State Mussel Watch Program / Toxic Substances Monitoring Program. Electronic databases. State Water Resources Control Board, Division of Water Quality (SWRCB-DWQ). Available at: http://www.waterboards.ca.gov/programs/smw/.

Slotton, D.G., S.M. Ayers, T.H. Suchanek, R.D. Weyland, A.M. Liston, C. Asher, D.C. Nelson, and B. Johnson. 2002. The Effects of Wetland Restoration on the Production and Bioaccumulation of Methylmercury in the Sacramento-San Joaquin Delta, California. Draft final report submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed. University of California, Davis, Dept. of Environmental Science and Policy, Dept. of Wildlife, Fish & Conservation Biology, and Division of Microbiology; U.S. Fish and Wildlife Service, Division of Environmental Contaminants. Available at: http://loer.tamug.tamu.edu/calfed/DraftReports.htm.

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L. AQUEOUS METHYLMERCURY, TOTAL MERCURY AND TSS CONCENTRATION DATA INCORPORATED IN TMDL REPORT

Central Valley Water Board staff compiled and evaluated methylmercury, total mercury, and TSS concentration results for thousands of water and effluent samples characterizing Delta inputs and exports. Because of the extensive nature of the raw data, a paper copy of the data set is not included in this report. Instead the database is available electronically in a Microsoft Excel file upon request or from the following website:

http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/

The database includes sample results from ongoing Central Valley Water Board sampling programs, NPDES facility and MS4 monitoring reports, and the following sources:

Alpers, C.N., R.C. Antweiler, H.E. Taylor, P.D. Dileanis, and J.L. Domagalski, 2000. *Metals Transport in the Sacramento River, California, 1996-1997, Volume1: Methods and Data.* U.S. Geological Survey Water-Resources Investigation Report 99-4286. Sacramento, CA.

CMP. 2004. Microsoft Access database of Coordinated Monitoring Program water quality data through August 2003. Database and updates provided by Larry Walker Associates (Mike Trouchon) and Sacramento Regional County Sanitation District (Steve Nebozuk, CMP Program Manager) to Central Valley Regional Water Quality Control Board (Michelle Wood, Environmental Scientist, Sacramento).

Domagalski J, Slotton DG, Alpers CN, Suchanek TH, Churchill RK, Bloom NS, Ayers SM, Clinkenbeard JP, 2002. *Summary and Synthesis of Mercury Studies in the Cache Creek Watershed, California, 2000-2001.* Final Report. U.S. Geological Survey; UC Davis; U.S. Fish and Wildlife Service; California Department of Conservation; California Geological Survey; and Frontier Geosciences, Inc. Prepared for the CALFED Bay-Delta Program, Directed Action #99-B06. Available at: http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

Domagalski, J.L., P.D. Dileanis, D.L. Knifong, C.M. Munday, J.T. May, B.J. Dawson, J.L. Shelton, and C.N. Alpers. 2000. *Water-Quality Assessment of the Sacramento River Basin, California: Water-Quality, Sediment and Tissue Chemistry, and Biological Data, 1995-1998.* U.S. Geological Survey Open-File Report 00-391. Available at: http://ca.water.usgs.gov/sac_nawqa/waterindex.html

DWR. 2001. California Department of Water Resources Special Tributary Project and Offstream Storage Investigation (OSI). Unpublished electronic data e-mailed by DWR (Jerry Boles) to Central Valley Regional Water Quality Control Board (Michelle Wood, Environmental Scientist, Sacramento) on October 15, 2001.

Foe, C.G. 2003. *Mercury Mass Balance for the Freshwater Sacramento-San Joaquin Bay-Delta Estuary*. Final report submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed (Task 1A). California Regional Water Quality Control Board, Central Valley Region. Sacramento, CA. Available at: http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

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