Tuolumne River *Oncorhynchus mykiss* **Monitoring Report**

Submitted in compliance with Ordering Paragraph (C) (5) of the April 3, 2008 FERC Order on Ten-Year Summary Report under Article 58 for Project No. 2299

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SUMMARY

This report to the Federal Energy Regulatory Commission (FERC) is submitted in compliance with Ordering Paragraph (C) (5) of the April 3, 2008 Order on Ten-Year Summary Report under Article 58 for Project 2299. That Order required the Modesto and Turlock irrigation districts (Districts) to file a report by January 15, 2010 on the results of specific Tuolumne River *Oncorhynchus mykiss* (*O. mykiss* – rainbow trout/steelhead) monitoring efforts contained in a July 2007 study plan submitted to FERC and as modified by the Order.

The Districts implemented snorkel surveys during July 11–16, 2008, March 16–25, 2009, and July 9–14, 2009 to estimate *O. mykiss* abundance in the Tuolumne River downstream of La Grange Dam. The July 2009 *O. mykiss* juvenile population estimate of 3,475 was higher than the July 2008 estimate of 2,472 juveniles, but within the 95% confidence interval (CI) of the estimates in these two years. The July 2009 *O. mykiss* adult population estimate of 963 was also higher than the July 2008 estimate of 643, with both results within their respective 95% CI in these two years as well. The March 2009 surveys found very few *O. mykiss* of either size range, with a population estimate of only 63 juveniles and 170 adults.

Variable summer flow releases at La Grange in the dry years of 2008 and 2009 averaged about 100 cfs, with higher flows on the warmest forecasted days; March 2009 flow rates were about 170 cfs. River habitats were mapped over a 22-mile reach and observed *O. mykiss* were within the upper 11 river miles. For all three surveys, most juveniles (< 150 mm fork length) and adults (≥ 150 mm fork length) were found in riffle habitats, within the upstream heads of run habitats, and throughout pool (head, body, tail) habitats. Estimates of juvenile Chinook salmon (*O. tshawytscha*) abundance were also made and much higher summer numbers were present in July 2009 than in July 2008.

Survey results of relative *O. mykiss* utilization of restored habitats are inconclusive to date. This is in part due to the inability to conduct two other *O. mykiss* studies in the 2008 Order (testing for anadromy and adult tracking) as the necessary scientific collection permit applications for sampling were not approved by the California Department of Fish and Game. In addition, several anticipated gravel augmentation projects were not implemented, so fewer sites were available for evaluation of changes in habitat use or densities. However, *O. mykiss* records from the following Tuolumne River fisheries monitoring programs are included:

- Seining surveys conducted between January and May of most years since 1983.
- Snorkel surveys conducted in June/July and at other times of year in most years since 1986, except in years with high flows (1995, 1998, 2005, and 2006).
- Rotary screw trap monitoring conducted between January and May of most years since 1999.

Monitoring programs and general results from other San Joaquin River tributaries for *O. mykiss* are reviewed and recommendations for near-term *O. mykiss* protection measures and monitoring in the Tuolumne River are included.

1 BACKGROUND AND PURPOSE

The Modesto and Turlock irrigation districts (Districts) filed a Ten-Year Summary Report on March 25, 2005 (TID/MID 2005) to meet a requirement of the July 31,1996 Federal Energy Regulatory Commission (FERC) license amendment for the Don Pedro Project (FERC #2299). This report to FERC is submitted in compliance with Ordering Paragraph (C) (5) of the FERC April 3, 2008 "Order on Ten-Year Summary Report under Article 58" which stated:

> *By January 15, 2010, the Districts shall file a report with the Commission that includes the results of the O. mykiss monitoring. The report shall include a discussion of the results and, for Commission approval, recommendations for O. mykiss protection and/or for additional O. mykiss monitoring. The report shall be prepared in consultation with the NMFS, the USFWS, and the CDFG. The Districts shall allow the agencies 30 days to provide comments on the report prior to filing the report with the Commission. The report shall include the agencies' comments and the Districts' response to any such comments.*

Oncorhynchus mykiss (*O. mykiss)* applies to rainbow trout, in which any ocean-going individuals are commonly termed "steelhead". On March 19, 1998 (63 FR 13347), the National Marine Fisheries Service (NMFS) first listed the California Central Valley steelhead Evolutionarily Significant Unit as threatened under the Federal Endangered Species Act and issued a new final rule listing the Central Valley steelhead Distinct Population Segment on January 5, 2006 (71 FR 834). The Tuolumne River watershed was among those extending south from the Mokelumne River within the "Southern Sierra Nevada Diversity Group" range for *O. mykiss* identified by Lindley et al. (2007). More recently, Garza and Pearse (2008) found in a genetic evaluation of *O. mykiss* that Central Valley populations appeared to be largely introgressed with imported Northern California (coastal) stocks through their use in hatchery operations.

The FERC Order of April 3, 2008 and its July 16, 2009 *Order on Rehearing, Amending License, Denying Late Intervention, Denying Petition and Directing Appointment of a Presiding Judge for a Proceeding on Interim Measures* (July 16, 2009 Order) both recounted the history of *O. mykiss*-related issues and actions relative to the Project. Those actions included a draft limiting factors analysis for Tuolumne River salmonids (Mesick et al. 2007) that included recommendations for developing abundance estimates, habitat use surveys, and anadromy determination of resident *O. mykiss*. Those recommendations were conceptually used to develop the Districts' FERC Study Plan (TID/MID 2007; *O. mykiss* excerpt is Appendix A of this report) that was prepared in response to a December 20, 2006 FERC staff request. The April 3, 2008 Ordering Paragraph (C) also contained the following:

> *(C) The Districts shall implement their proposed O. mykiss monitoring plan, filed March 20, 2007, and revised July 16, 2007, with the following modifications:*
>
> *(1) The Districts, beginning in 2008, shall conduct population estimate surveys using two-phase snorkel surveys calibrated by electrofishing to determine population abundance by habitat type. The Districts' proposed population estimate survey shall be modified to include February and March, in addition to June and July sampling periods,*

> *unless agreed upon otherwise by the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (CDFG);*
>
> *(2) The Districts shall conduct their proposed sampling testing for anadromy in juvenile and adult O. mykiss beginning in 2008;*
>
> *(3) The Districts shall conduct their proposed adult O. mykiss tracking study beginning in January 2009;*
>
> *(4) Any changes to the O. mykiss monitoring methods or schedules shall be filed for Commission approval and include the comments of the agencies on the changes. Any change to the methods or schedules shall not be implemented until approved by the Commission*

The April 3, 2008 Order also stated (page 27), "Additionally, the Districts should use any applicable *O. mykiss* data from the Stanislaus, Merced, Mokelumne, and Calaveras Rivers in the development and refinement of their *O. mykiss* monitoring and resulting analysis." The *O. mykiss* study plan elements contained in the Districts' proposed Study Plan of July 16, 2007 (Appendix A) noted that the ability to conduct the studies as described was contingent upon necessary permits being issued by the fishery agencies. The Districts' letters of July 3, 2008 and March 31, 2009 notified FERC of the permitting status for each study. Sampling permit applications for 2009 *O. mykiss* anadromy and acoustic tracking studies were not approved (items 2 and 3 above). As a result, only the population estimate studies (item 1 above) proceeded. However, since a permit modification for an increase in the allowed incidental take associated with the electrofishing calibration component of the population estimate studies also was not approved, the proposed electrofishing element was not conducted and the population estimates were based upon snorkel surveys only.

The study documents produced pursuant to the April 3, 2008 Order to date include:

- an initial detailed *O. mykiss* population estimate study plan (Stillwater Sciences 2008a) that was submitted to FERC on July 3, 2008 for their July 2008 survey;
- a report on the July 2008 population size estimate (Stillwater Sciences 2008b) that was submitted as part of the Districts' 2008 annual report to FERC (TID/MID 2009);
- a study plan for the 2009 population estimate surveys (Stillwater Sciences 2009a); and
- a report on the March and July 2009 survey results (Stillwater Sciences 2009b).

Both 2008 and 2009 were drier year types in which summer flows were voluntarily increased above minimum required flow rates. Those designated rates of 50 cfs in 2008 and 75 cfs in 2009 were increased to an actual flow average of 100 cfs for the June 10 to September 30, 2008 period (Ford and Kirihara 2009a) and to an actual flow average of 105 cfs for the June 16 to August 31, 2009 period (Ford and Kirihara *in prep*). Bracketing that 2009 period, during June 1–15 and September 1–30, the scheduled minimum flow requirements were 95 cfs or higher. Both

summers had variable flow operations in which higher flows were provided during hotter forecasted air temperature periods.

This report contains:

- a summary and discussion of results of the completed April 3, 2008 Order *O. mykiss* monitoring activities, including consideration of *O. mykiss* monitoring from the Mokelumne, Calaveras, Stanislaus, and Merced rivers;
- an updated compilation of other Tuolumne River *O. mykiss* data since the last Districts' summary (Ford and Kirihara 2008); and
- recommendations for *O. mykiss* protection and for additional *O. mykiss* monitoring.

2 MONITORING RESULTS AND DISCUSSION

2.1 Tuolumne River Population Estimate Surveys 2008-2009

Stillwater Sciences conducted "bounded counts" population estimate surveys for *O. mykiss* in July 2008, March 2009, and July 2009 using snorkeling in a two-phase survey design after Hankin and Mohr (2001) to sample within different habitats found downstream of La Grange Dam (Stillwater Sciences 2008b, 2009b). General survey reaches were from river mile (RM) 51.8–29.5 (March 2009) and from RM 51.8–39.6 (July 2008/2009) (Figure 1). Prior to the snorkel surveys, float surveys were conducted to map seven habitat types (riffle, run head, run body, run tail, pool head, pool body, and pool tail) and document length, width, depth, and substrate composition of the habitat units. A subset of sampling units of each habitat type had single-pass snorkel surveys conducted and a portion of those were selected for multi-pass calibration sampling. A total of 42 sampling units were selected for either single pass or multi-pass snorkel surveys in July 2008, 66 habitat units were selected in March 2009, and 31 units were selected in July 2009.

The *O. mykiss* observed were recorded in 50 mm increments and classified as young-of-the-year (YOY)/juveniles of < 150 mm total length (TL) or as adults ≥ 150 mm TL. Table 1 contains the counts and estimates, grouped by life stage and habitat type; Figure 2 includes the counts and estimates with the 95% confidence intervals. Based upon the maximum count from all dive passes in each sampled unit, 128 YOY/juveniles and 41 adults (sum total of 169) were observed in July 2008, 5 YOY/juveniles and 7 adults (sum total of 12) were observed in March 2009, and 641 YOY/juveniles and 105 adults (sum total of 746) were observed in July 2009. For all surveys, most juveniles and adults were found in riffle, run heads or pool (head, body, tail) habitats.

Using a bounded counts population estimator, the counts were expanded to estimates of 2,472 YOY/juveniles and 643 adults (sum total of 3,115) in July 2008, 63 YOY/juveniles and 170 adults (sum total of 233) in March 2009, and 3,475 YOY/juveniles and 963 adults (sum total of 4,438) in July 2009. Due to the low counts in March 2009, the *O. mykiss* bounded counts population estimator was derived from counts of the March 2009 Chinook salmon (*O. tshawytscha*) juveniles (< 150 mm TL). The comparable juvenile Chinook salmon maximum counts (population estimates) were 96 (2,636) in July 2008, 4,281 (39,563) in March 2009, and 4,696 (29,389) in July 2009, respectively. The reaches in which *O. mykiss* were observed were RM 41.8-51.8 (July 2008), RM 43.0-51.5 (March 2009) and RM 41.9-51.8 (July 2009).

Additional information on *O. mykiss* and juvenile Chinook salmon densities and distribution, temperature conditions, and comparison with other June snorkel studies are in Stillwater Sciences (2008b, 2009b).

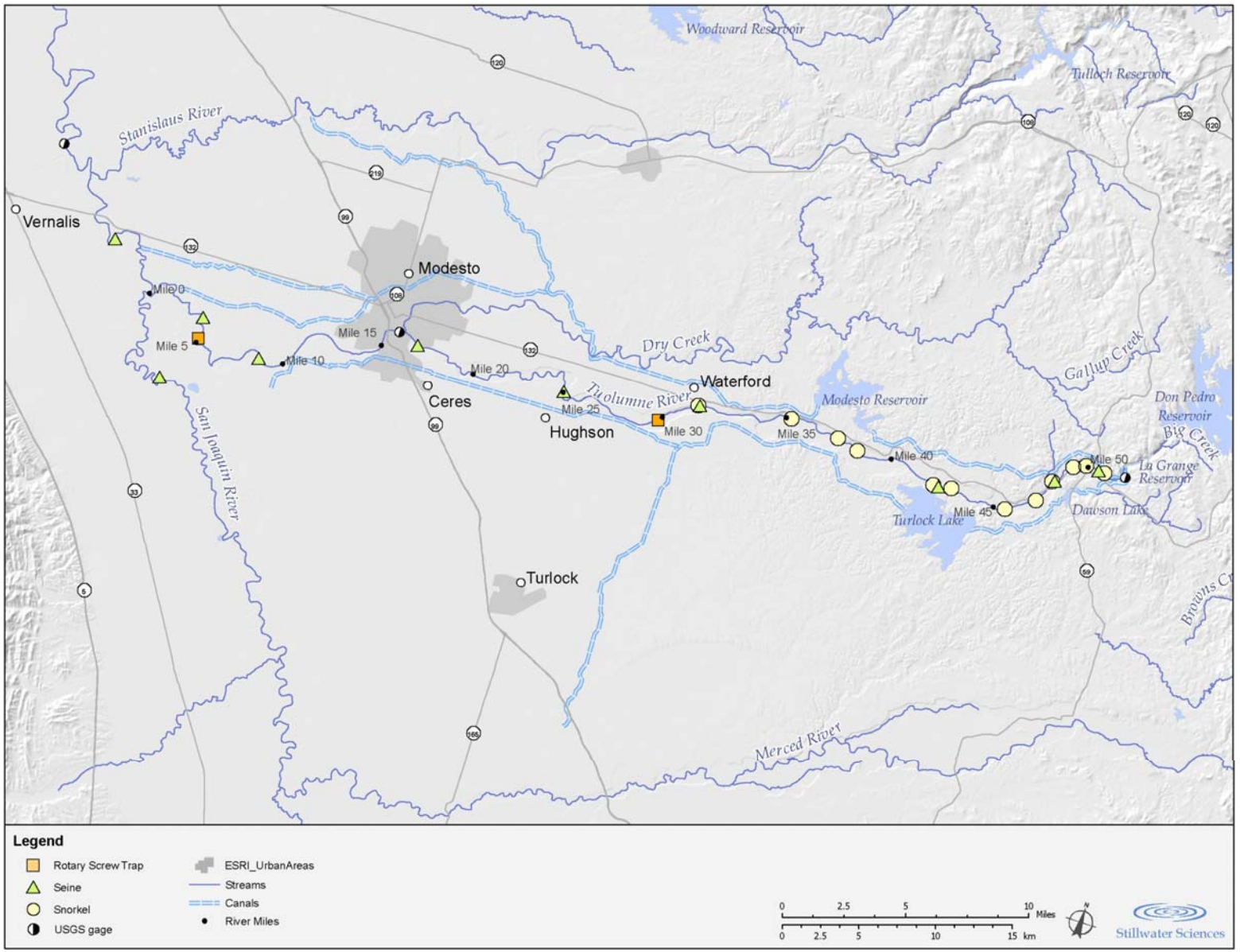


Figure 1. Lower Tuolumne River and reference locations.

Table 1. *O. mykiss* bounded count population estimates by fish length and habitat type in July 2008, March 2009, and July 2009.

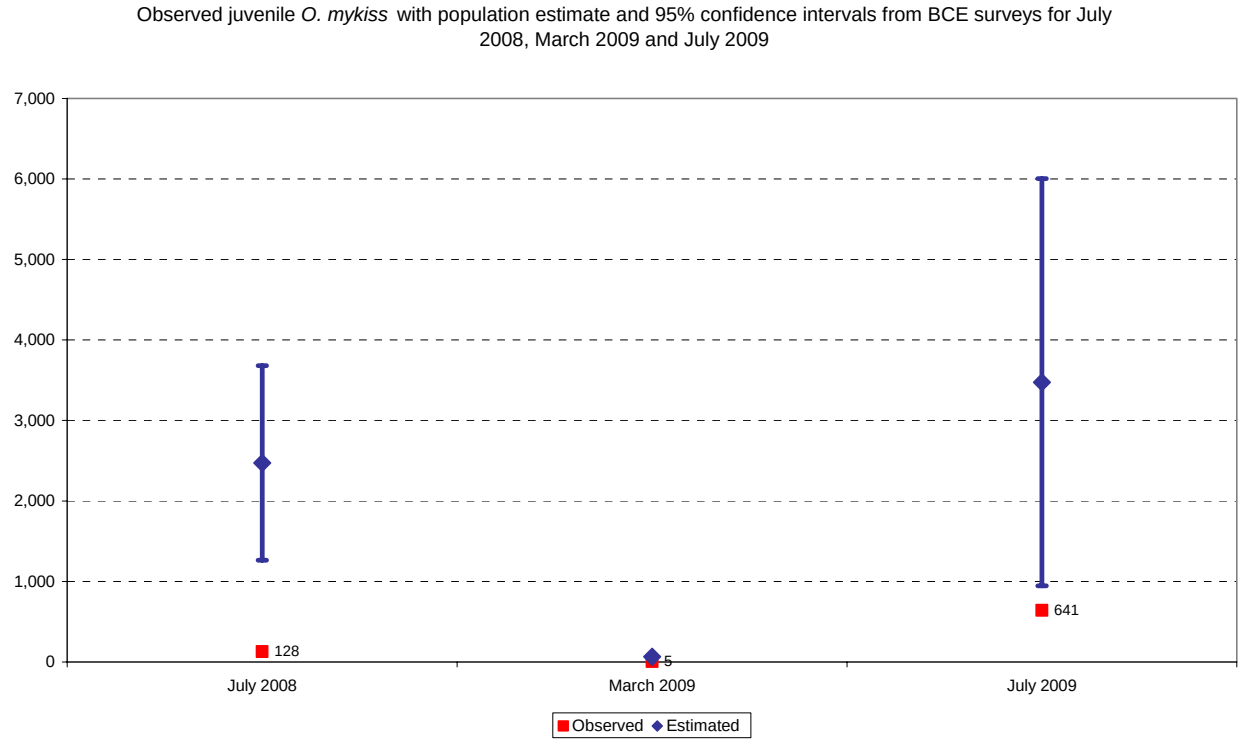
July 2008								
Habitat	***O. mykiss* < 150 mm**				***O. mykiss* ≥ 150 mm**			
	Obs.[1]	**Est.**	**St. dev.**	**95% CI[2]**	**Obs.[1]**	**Est.**	**St. dev.**	**95% CI[2]**
Pool head	12	20	8.2	12–36	17	45	13.8	18–72
Pool body	0	--	--	--	3	24	21.5	3–66
Pool tail	1	2	1.9	1–6	0	--	--	--
Riffle	65	1,428	263.6	911–1,944	13	226	142.5	13–505
Run head	45	162	243.6	45–639	2	30	19.8	2–68
Run body	5	860	501.6	5–1,843	6	319	161.4	6–635
Run tail	0	--	--	--	0	--	--	--
Total	128	2,472	616.9	1,263–3681	41	643	217.7	217–1,070
March 2009								
Habitat	***O. mykiss* < 150 mm**				***O. mykiss* ≥ 150 mm**			
	Obs.[1]	**Est.[3]**	**St. dev.**	**95% CI[2]**	**Obs.[1]**	**Est.[4]**	**St. dev.**	**95% CI[2]**
Pool head	0	--	--	--	1	≥1	--	--
Pool body	0	--	--	--	0	--	--	--
Pool tail	0	--	--	--	0	--	--	--
Riffle	5	63	--	--	6	170	86.3	6–339
Run head	0	--	--	--	0	--	--	--
Run body	0	--	--	--	0	--	--	--
Run tail	0	--	--	--	0	--	--	--
Total	5	63	--	--	7	170	86.3	7–339
July 2009								
Habitat	***O. mykiss* < 150 mm**				***O. mykiss* ≥ 150 mm**			
	Obs.[1]	**Est.[4]**	**St. dev.**	**95% CI[2]**	**Obs.[1]**	**Est.**	**St. dev.**	**95% CI[2]**
Pool head	4	≥4	---	--	23	26	0.0	26–26
Pool body/tail	304	1,382	898.2	304–3,143	16	147	56.8	36–259
Riffle	279	1,528	893.5	279–3,279	48	428	131.0	171–684
Run head	35	265	49.8	168–363	10	206	123.4	10–448
Run body/tail	19	299	240.5	19–771	8	156	170.6	8–490
Total	641	3,475	1,290.5	945–6,004	105	963	254.4	464–1,461

[1] Largest numbers seen in any single dive pass for each unit, summed over units. Note that because of the potential for the same fish to be assigned to different size classes on subsequent passes, summation of the largest numbers assigned to individual (50 mm) size bins yields may overestimate total fish observed.

[2] Nominal confidence intervals (CI) calculated as ± 1.96 standard deviations (SD). SD and CI undefined for multiple pass units with identical dive counts. The observed number of fish was used as the lower bound of the CI in the cases where the lower 1.96 SD yielded a lower value than the observed number.

[3] Estimate for *O. mykiss* juveniles in riffles based on the expansion used for Chinook juveniles in riffles, no uncertainty data provided.

[4] Estimate for *O. mykiss* adults in pool head not included in overall population estimate due to lack of multiple pass data.



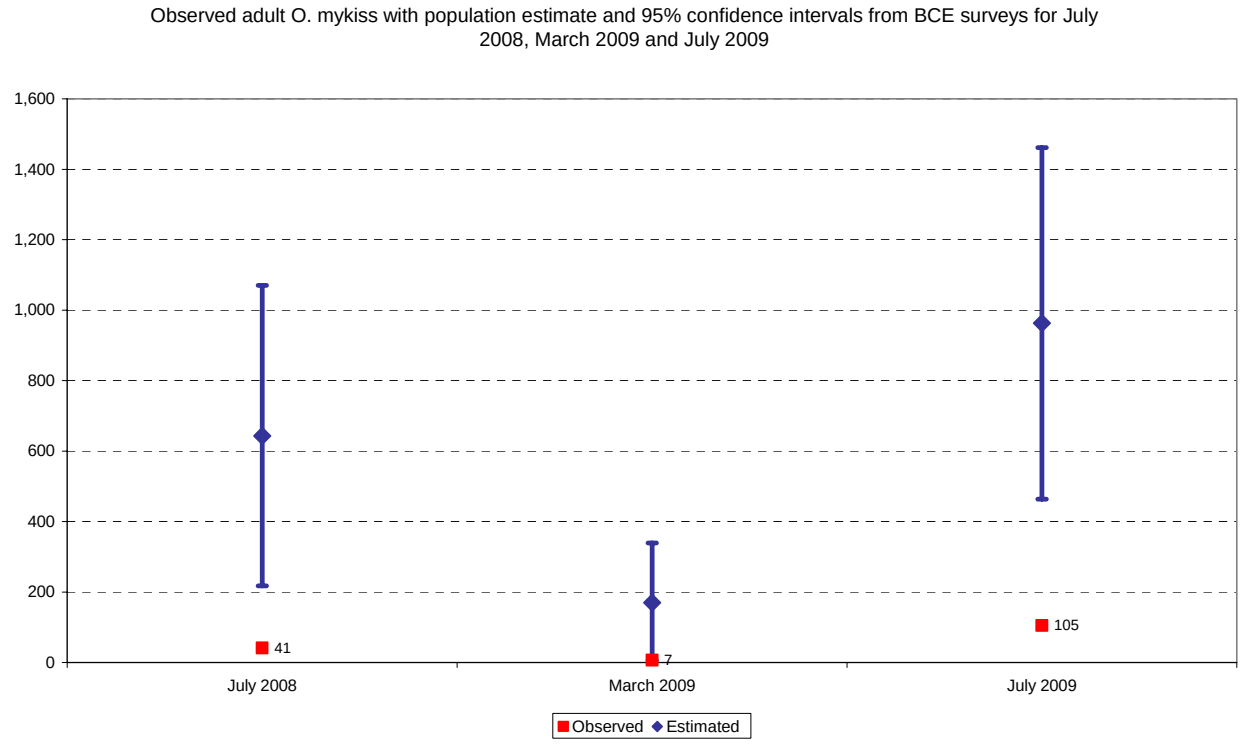


Figure 2. Juvenile and adult *O. mykiss* observed number and population estimates for July 2008, and March and July 2009.

2.2 Other Tuolumne River *O. mykiss* Data

Annual seine survey results are summarized in Ford and Kirihara (2009b). Surveys in recent years were conducted at two-week intervals mainly from January through May. A total of eight Tuolumne River sites were sampled each survey period. In the 2008 seine survey, four *O. mykiss* fry (28-49 mm FL) were caught between 29 April to 13 May at Old La Grange Bridge (RM 50.5) and at Riffle R5 (RM 48.0). The 2009 survey caught seven *O. mykiss* (26-70 mm FL) from March 10- May 5 at RM 48.0-50.5. Low catch numbers of YOY/juveniles *O. mykiss* upstream of RM 42 are typical in the seine monitoring (Table 2, Figure 3).

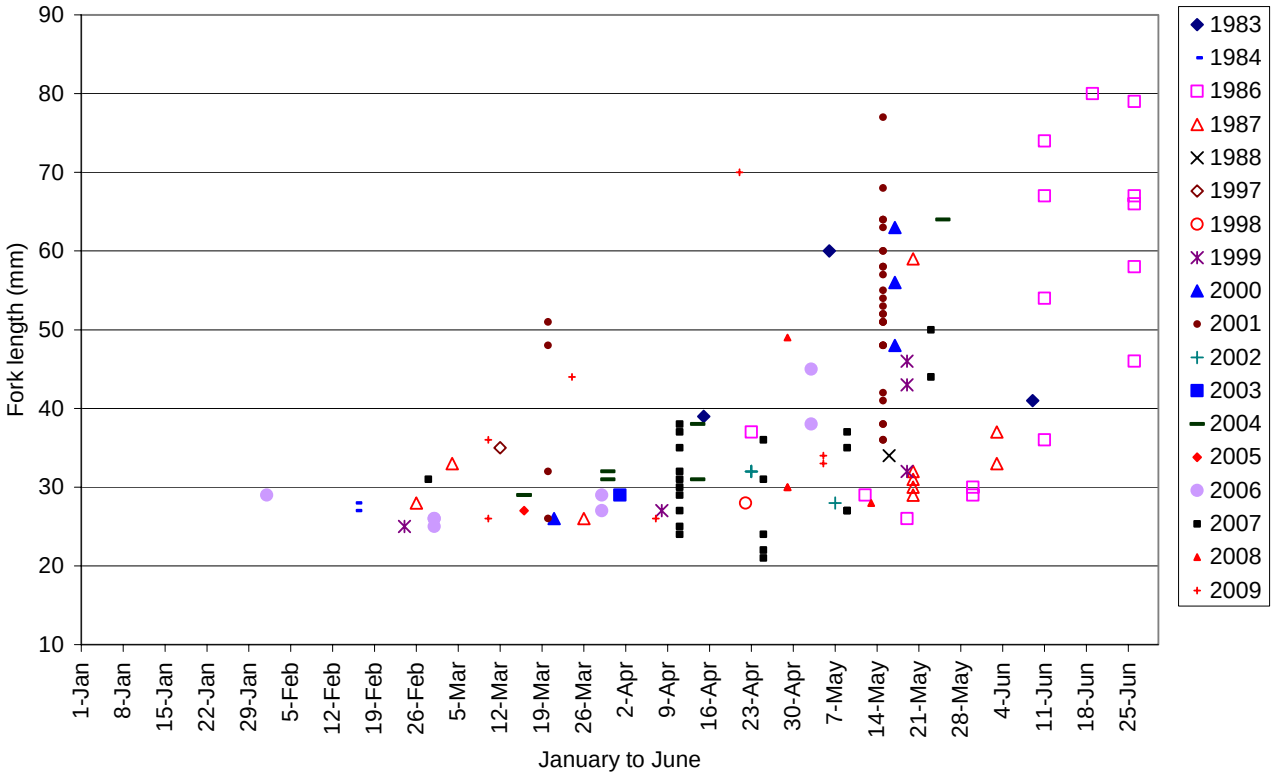


Figure 3. All measured *O. mykiss* caught from Old La Grange Br. (RM 50.5) to Tuolumne River Resort (RM 42.2) during the 1983 to 2009 Tuolumne seining surveys.

Tuolumne River rotary screw trap (RST) monitoring began in 1995 at Shiloh Road (RM 3.4). In 1998, upstream traps began to be utilized. RST site locations and sampling duration have varied over the years and are summarized by Palmer and Sonke (2008). The RST sites have been located near Waterford, CA (RM 29.8) and at Grayson (RM 5.2) since 2006. Like the seine monitoring, there are relatively few *O. mykiss* caught in the RST sampling, but larger *O. mykiss* from about 200–350 mm FL are captured in some years. In 2008 a total of nine *O. mykiss* (58 to 268 mm FL) were captured, with one juvenile (105 mm FL) captured in 2009 at the Waterford RST site. Fewer O. mykiss are captured in the Grayson RST: two adult sized fish in 2008 (200 and 224 mm FL) and none in 2009. Figure 4 shows the size and timing of the RST catches of YOY/juveniles and adult sized *O. mykiss* from 1999–2009.

Table 2. Tuolumne River seining locations (1983–2009) with number of *O. mykiss* caught.

Site	Location	River Mile	1983 [1]	1984 [1]	1985 [1]	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Old La Grange Bridge	50.5	3	8	X	10	6	1	X	X	X	X	X			X	X	X	3	X	1	2	X	1	1	2	X	4	3
2	Riffle 4B	48.4				5	2	X	X	X	X				X	X	X	1								2			
3	Riffle 5	47.9					2	X	X	X	X	X	X	X					1	3	42	1	X	3	X		8	X	4
4	Tuolumne River Resort	42.4						X	X	X	X	X	X	X	X	X	1	X	1	1	2	X	1	3	X	4	14	X	X
5	Turlock Lake State Rec. Area	42.0	X	X	X	X	X																						
6	Reed Gravel	34.0				X	X	X	X	X	X																		
7	Hickman Bridge	31.6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Charles Road	24.9					X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X
9	Legion Park	17.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10	Riverdale Park / Venn	12.3 / 7.4					X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X
11	McCleskey Ranch	6.0				X	X	X	X	X	X	X	X	X															
12	Shiloh Bridge	3.4	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

[1] CDFG seining

X = Locations that were sampled with no *O. mykiss* captured

Table 3. Tuolumne River snorkel survey locations (1982–2009) with number of *O. mykiss* observed.

	1982	1984		1985	1986		1987			1988					1989				1990				1991		1992	
	AUG	APR	AUG	MAR	JUL	AUG	JAN	APR	OCT	MAY	JUN	JUL	AUG	SEP	MAY	JUN	JUL	SEP	MAY	JUN	JUL	SEP	JUN	SEP	JUN	SEP
LOCATIONS																										
Riffle A3/A4 (RM 51.6)			27	2		6			X	X				X	X	X	X	X	X	X	X	X	X	X	1	X
Riffle A7 (RM 50.7)			26			13			X						X	X		X	X		X					
Riffle 1A (RM 50.4)								X									X									
Riffle 2 (RM 49.9)	X		X			25	X	X		X				X	X			X	X	X		X	X	X	X	X
Riffle 3B (RM 49.1)																										
Riffle 4B (RM 48.4)	X	12		X	5	10																				
Riffle 5B (RM 48.0)	2	X	X	X		10	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Riffle 7 (RM 46.9)																										
Riffle 9 (RM 46.4)										X				X	X			X		X		X	X	X	X	X
Riffle 12 (RM 45.8)																										
Riffle 13A-B (RM 45.6)																										
Riffle 17A2 (RM 44.4)																										
Riffle 21 (RM 42.9)																										
Riffle 23B-C (RM 42.3)										X				X	X			X		X		X	X	X	X	X
Riffle 24 (RM 42.0)					X																					
Riffle 26 (RM 40.9)																										
Riffle 27(RM 40.3)																										
Riffle 30B (RM 38.5)																										
Riffle 31 (RM 38.1)																										
Riffle 33 (RM 37.8)										X				X	X			X		X		X				
Riffle 35A (RM 37.0)																										
Riffle 36A (RM 36.7)																										
Riffle 37 (RM 36.2)								X																		
Riffle 39-40 (RM 35.4)										X				X	X			X		X		X	X	X	X	X
Riffle 41A (RM 35.3)																										
Riffle 46 (RM 34.0)					X		X																			
Riffle 52B (RM 32.2)										X				X												
Riffle 57-58 (RM 31.5)		X		X											X			X		X		X	X	X	X	X
Charles (RM 24.9)										X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Total O.mykiss	2	12	53	2	5	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Table 3 (continued)

	1993				1994			1995	1996	1997	1999	2000	2001		2002		2003		2004			2005	2006	2007		2008	2009
	MAY	JUN	JUL	OCT	MAY	JUL	OCT	NOV	JUL	JUN	JUN	JUN	JUN	SEP	JUN	SEP	JUN	SEP	JUN	AUG	SEP	SEP	SEP	JUN	SEP	JUN	JUN
LOCATIONS																											
Riffle A3/A4 (RM 51.6)	X	X	X	X		X	X	X		4										5							
Riffle A7 (RM 50.7)	X	X	X	X	X			1	**X**	2	14	14	7	3	5	1	66	16	12	6	11	10	115	106	75	76	80
Riffle 1A (RM 50.4)	X	X		X					**51**			3								4							
Riffle 2 (RM 49.9)	X	X		X		X	X		**91**	2	X		3	3	1	4	8	2	23	2	7	7	15	34	16	9	12
Riffle 3B (RM 49.1)									**138**	X	31	14	8	1	11	1	5	21	22	5	7	6	66	45	12	78	27
Riffle 4B (RM 48.4)	X								**55**											8							
Riffle 5B (RM 48.0)	X		X		X	X	X	2	**45**	X	10	19	4	2	3	X	6	10	11	15	6	36	54	92	10	21	11
Riffle 7 (RM 46.9)									4	X	15	52	4	X	5	2	14	9	13	5	2	2	106	22	7	13	6
Riffle 9 (RM 46.4)	X	X		X		X	X													3							
Riffle 12 (RM 45.8)												5															
Riffle 13A-B (RM 45.6)	X											20	3	X	2	4	1	6	5	13	X	46	103	15	57	24	4
Riffle 17A2 (RM 44.4)												14															
Riffle 21 (RM 42.9)									X			27	2	3	1	X	X	6	5	9	7	15	32	10	10	11	0
Riffle 23B-C (RM 42.3)			X		X					X	9	4	X	X	X	X	1	1	X	1	X	14	27	5	7	X	2
Riffle 24 (RM 42.0)	X							X																			
Riffle 26 (RM 40.9)												4															
Riffle 27(RM 40.3)												2															
Riffle 30B (RM 38.5)											X				X	X											
Riffle 31 (RM 38.1)												2	X	X			X	X	X	X	X	1	21	12	4	X	X
Riffle 33 (RM 37.8)																											
Riffle 35A (RM 37.0)									X			X			X	X	X	X	X	X	X	2		X	X	X	X
Riffle 36A (RM 36.7)	X		X		X				X	X	X												4				
Riffle 37 (RM 36.2)												X	X	X													
Riffle 39-40 (RM 35.4)		X		X		X	X																				
Riffle 41A (RM 35.3)												X	X	X	X	X	X	X	X	X	X	X	X	2	X	X	X
Riffle 46 (RM 34.0)												X															
Riffle 52B (RM 32.2)												X															
Riffle 57-58 (RM 31.5)	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Charles (RM 24.9)		X		X			X																				
Total O.mykiss	0	0	0	0	0	0	0	3	**384**	8	79	180	31	12	28	12	101	71	91	76	40	139	543	343	198	232	142

Note: 1996 data in bold type was collected by CDFG using different survey methods that are not comparable

X = Locations that were sampled with no *O. mykiss* observed

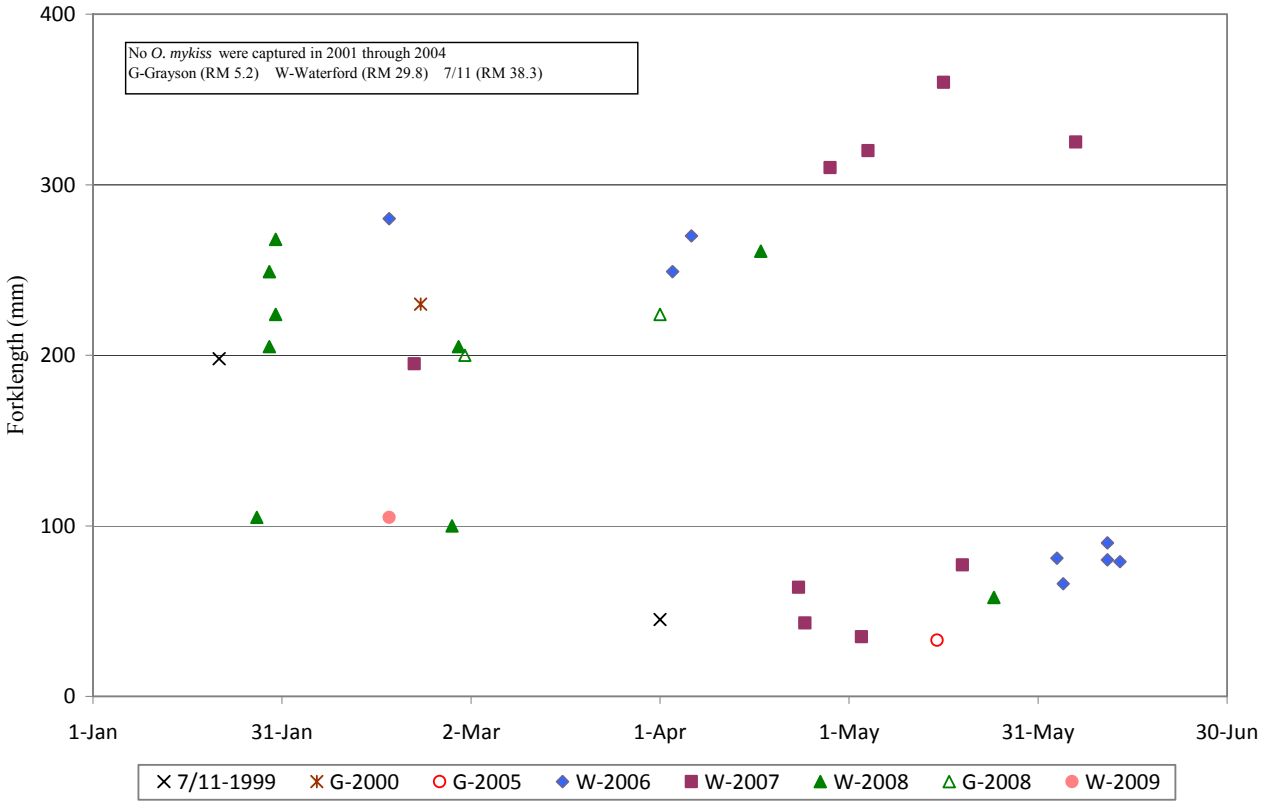


Figure 4. Tuolumne River rotary screw trap captures of *O. mykiss* from 1999 to 2009.

Other Tuolumne River snorkel surveys provide most of the *O. mykiss* information prior to 2008 and results are summarized in Ford and Kirihara (2009c). Table 3 has the month and locations surveyed, and the *O. mykiss* counts if any were observed. Early summer snorkel surveys (June/July) in the Tuolumne River have been conducted in most years since 1986, except in years with high flows (1995, 1998, 2005, 2006), and have been relatively standardized since 2001. These reference count (or "index") surveys also obtain fish density for YOY/juveniles (<150 mm TL) and adults (≥150 mm TL) using the areas searched at each snorkeling site. For the recent years with paired early and late summer surveys between 2001–2009, Figure 5 shows that June density of juvenile *O. mykiss* was much higher than for adults, with September surveys showing higher adult *O. mykiss* density than juveniles in some years. The highest observed *O. mykiss* density indices have generally been observed upstream of RM 42 (Figure 6). Water temperatures recorded at most snorkel locations with *O. mykiss* have ranged from about 51.8–71.6ºF (11–22ºC) (Figure 7).

A previous compilation of Tuolumne River *O. mykiss* records (Ford and Kirihara 2008) has been updated with 2008–2009 records from seine, RST, and snorkel monitoring programs (Appendix B).

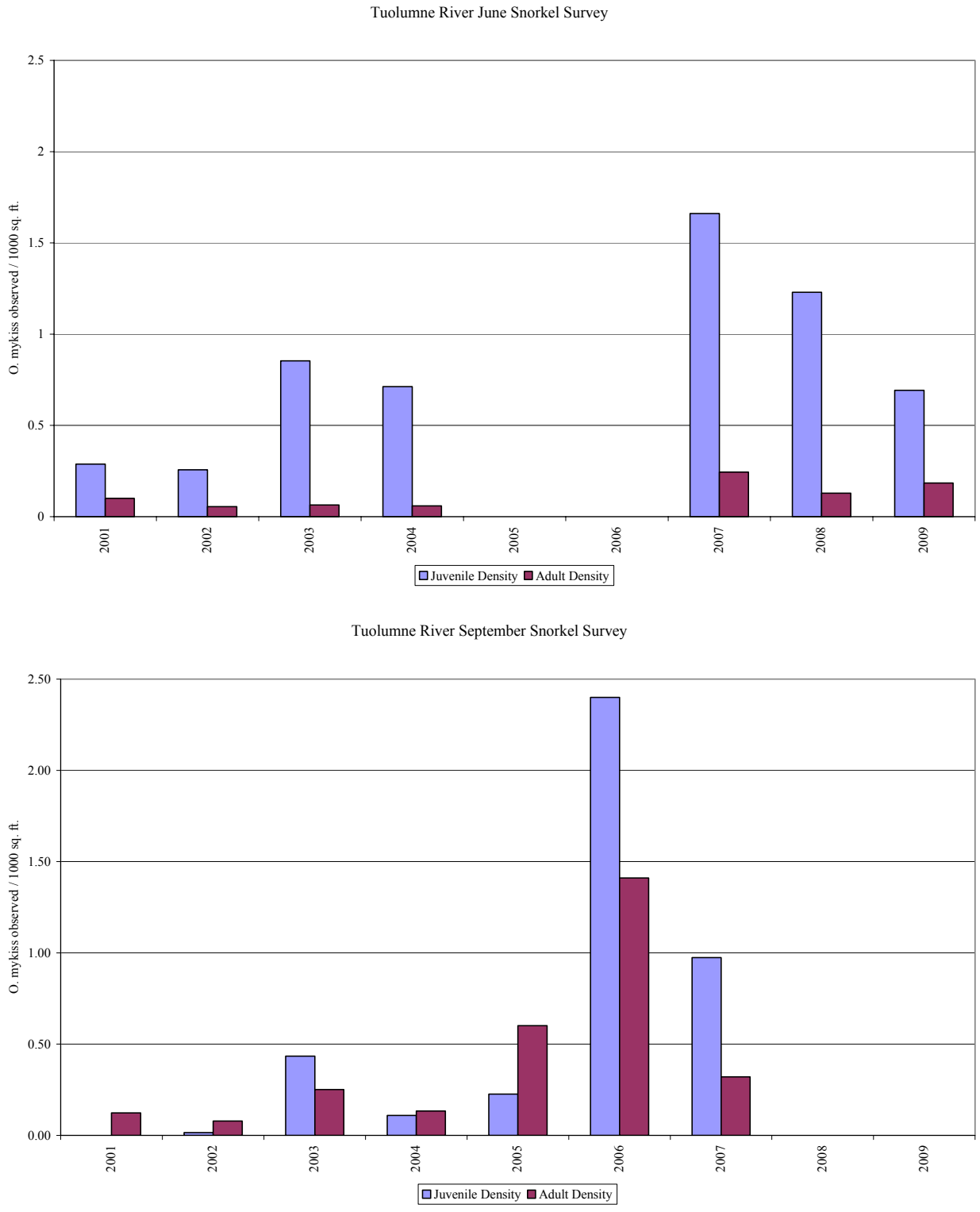


Figure 5. Density of juvenile (< 150 mm TL) and adult (=>150 mm TL) *O. mykiss* in Tuolumne River June and September snorkel surveys.

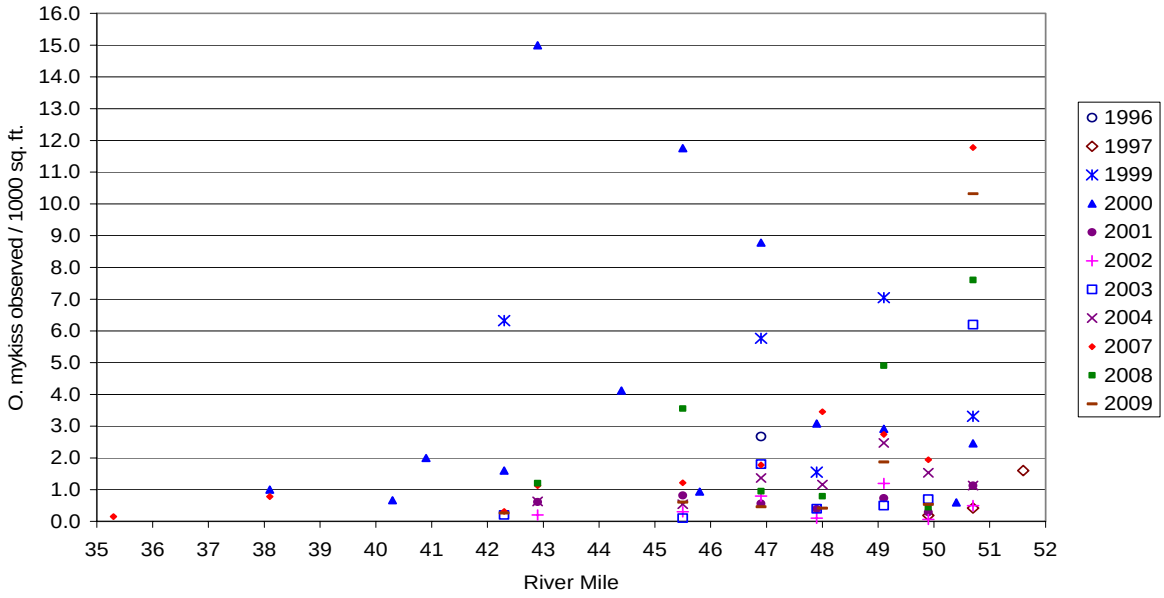


Figure 6. Density indices of *O. mykiss* in 1996–2009 Tuolumne River June/July snorkel surveys.

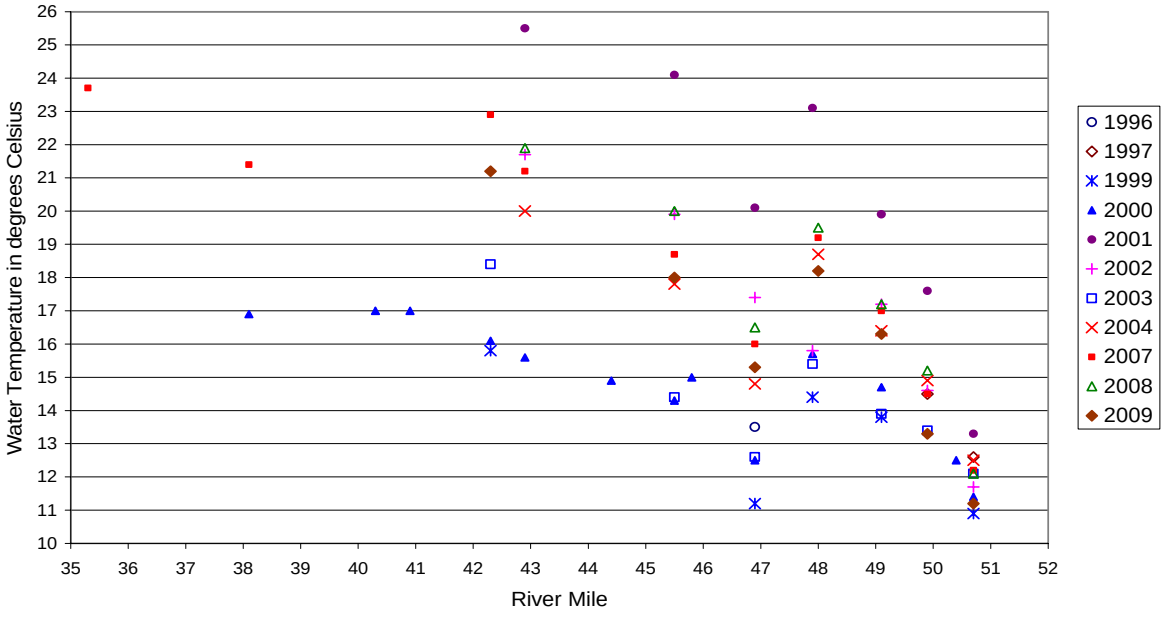


Figure 7. Water temperature where *O. mykiss* were observed in 1996–2009 Tuolumne River June/July snorkel surveys.

2.3 Habitat Restoration Monitoring

Few habitat restoration projects (gravel additions) have been implemented in the primary spawning reach of the Tuolumne River upstream of RM 40 since the gravel losses and fine sediment impacts associated with the 1997 floods (TID/MID 2005). Gravel addition projects were completed in riffle habitats between RM 50–51 (Riffles A7, 1A, 1B) in 2003 and between RM 43.0–43.2 (Bobcat Flat) in 2005. Other planned gravel additions by the Districts were not implemented due to CDFG opposition. Stillwater Sciences (2009b) reviewed the limited results to date from observations of habitat use made during the 2008–2009 the population estimate surveys. Habitat types surveyed in restoration sites were riffle, run head, and pool head with both YOY/juveniles and adult *O. mykiss* observed in restoration sites; juvenile *O. mykiss* had a relatively high use of riffle habitat at restoration sites.

3 *O. MYKISS* MONITORING IN OTHER SAN JOAQUIN RIVER TRIBUTARIES

O. mykiss monitoring programs from Eilers (2008) and other sources were reviewed for other San Joaquin River tributaries: Mokelumne, Calaveras, Stanislaus and Merced Rivers (Figure 8). In general, the monitoring efforts and reporting differ among the streams, in some cases are sporadic, and also vary in duration and type.

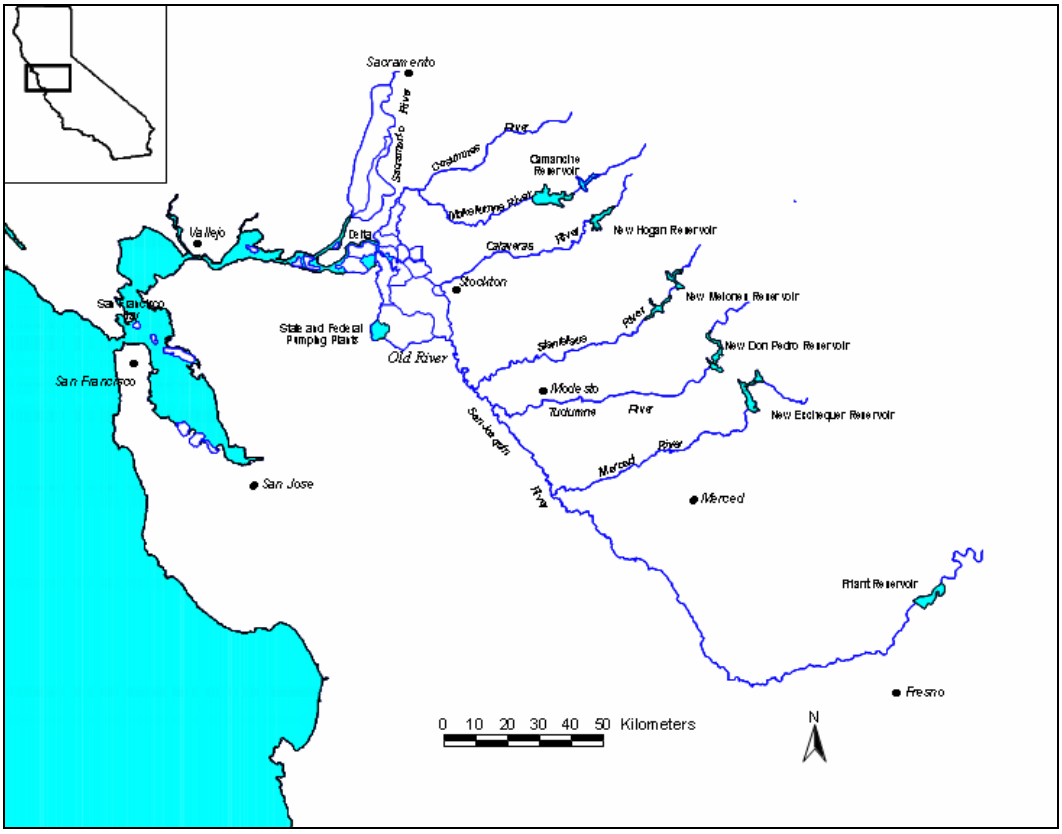


Figure 8. San Joaquin River and tributaries.

3.1 Mokelumne River

The Mokelumne *O. mykiss* population is mainly the product of an intensive hatchery program run by CDFG downstream of Camanche Dam (RM 63.8); data on adult trapping at the hatchery has been collected since 1963. Pagliughi (2008) was the source of most *O. mykiss* information summarized for the Mokelumne River. Historically, the first *O. mykiss* trapped at the hatchery arrives as early as October and as late as early January. Peak spawning activity occurs between December and January, with the last trapped fish arriving between February and March of most years. In addition, upstream adult migration monitoring conducted at Woodbridge Dam at RM 39 using videography as well as live trapping shows that peak adult *O. mykiss* migration occurs between September and February. Data on rearing and emigration of juvenile *O. mykiss* is obtained using seine, electrofishing, RST, bypass, and ladder trap monitoring. Juvenile *O. mykiss* passage downstream of Woodbridge Dam occurs between December and July, peaking in April/May (monitoring is not conducted between August and December). Smolts are also captured at Woodbridge Dam between December and July, with peak outmigration occurring between December and March. In addition, acoustic tagging of age 1+ *O. mykiss* was initiated in 2007 to examine behavior and movement of hatchery and naturally produced fish (Eilers, 2008).

3.2 Calaveras River

A review of accounts of *O. mykiss* in the Calaveras River reported steelhead are still present downstream of New Hogan Dam at RM 42, although some migration/passage issues are present (Marsh 2007). An RST has operated at Shelton Road (RM 28) from December through May since 2002 where smolt-sized *O. mykiss* have been documented each year with the majority caught from December to May and juveniles are generally observed from early March into June (Stockton East Water District, *unpublished data*). Snorkel surveys in 2002 found the following: *O. mykiss* <100 mm predominantly were in the upper reaches below New Hogan Dam with highest densities in early April; densities of *O. mykiss* 100–199 mm increased from summer through fall; *O. mykiss* >200 mm had highest densities in riffle/glide habitat during summer and in pool habitat during fall (Stillwater Sciences 2004).

3.3 Stanislaus River

Primary weir and RST monitoring results for *O. mykiss* were from FISHBIO Environmental, Oakdale, CA. Adult *O. mykiss* are monitored at the camera-mounted fish counting weir at RM 31.5 that has been operated intermittently since 2002, usually from September to December or January. The annual number of adult *O. mykiss* counted moving upstream through the weir has ranged from one to seventeen during 2005–2008. About 40% of those fish were identified as hatchery fish having clipped adipose fins. *O. mykiss* are also seasonally monitored at RSTs located at Oakdale (RM 40—beginning in 1993) and at Caswell (RM 9—beginning in 1995); the size and timing of the *O. mykiss* catch is shown in Figure 9. Eilers (2008) reported that *O. mykiss* were also monitored from 2002–2007 at sites from Goodwin Dam (RM 58.3) to Oakdale (RM 40) utilizing snorkel surveys conducted two times each month; results of 2002–2004 efforts were presented in Kennedy and Cannon (2005). Ongoing studies are also examining relationships of habitat availability (through mapping) and utilization by juveniles at various

flows employing snorkeling, seining, and electrofishing (Eilers 2008). Generalized life stage timing for the Stanislaus River is shown in Table 4.

Table 4. Generalized *O. mykiss* life stage timing for Stanislaus River—darker shading indicates peak use.

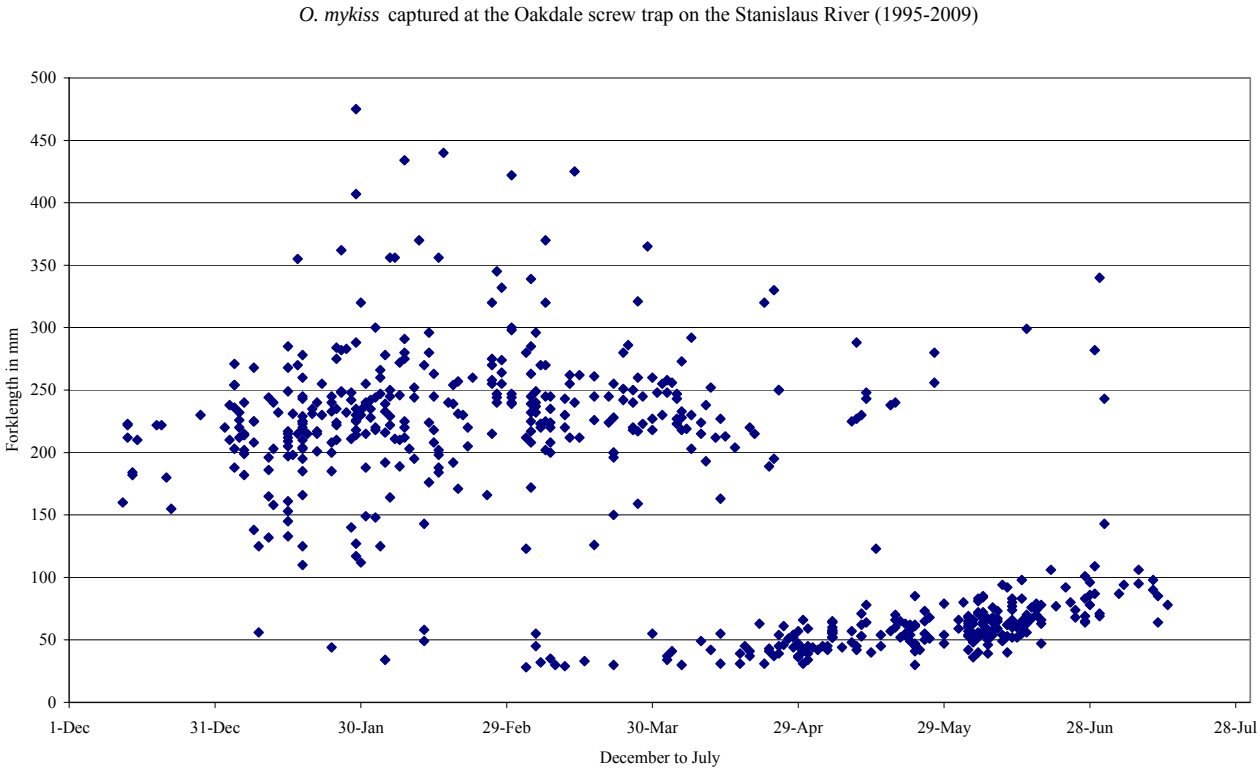
Life Stage	Fall			Winter			Spring			Summer		
	September	October	November	December	January	February	March	April	May	June	July	August
Central Valley Steelhead												
Adult Upstream Migration												
Adult Spawning												
Egg incubation and Fry Emergence												
Juvenile Rearing												
Yearling Smolt Emigration												

Notes

1. Adapted with modifications from NMFS 2009 - Fig. 5-21, pg 200
2. Dark Shading = Peak activity; Medium Shading = Potential activity

3.4 Merced River

RST monitoring has been intermittently conducted at RM 40 near Hopeton since 1999, downstream at RM 12.2 near Hagaman Park (1998–2003), and at RM 2 near Hatfield State Park (2007–2009). *O. mykiss* results from the RST sampling were not located, with the exception that none were caught at the RM 2 RST in 2007 (Montgomery, et al. 2007). An extensive two-year survey of native and non-native fish assemblages conducted over multiple events during 2006–2008 using snorkel surveys, seining, backpack electrofishing, and boat electrofishing found relatively few *O. mykiss*, all within a 7-mile reach below Crocker-Huffman Dam at RM 51.9 (Stillwater Sciences 2008c).



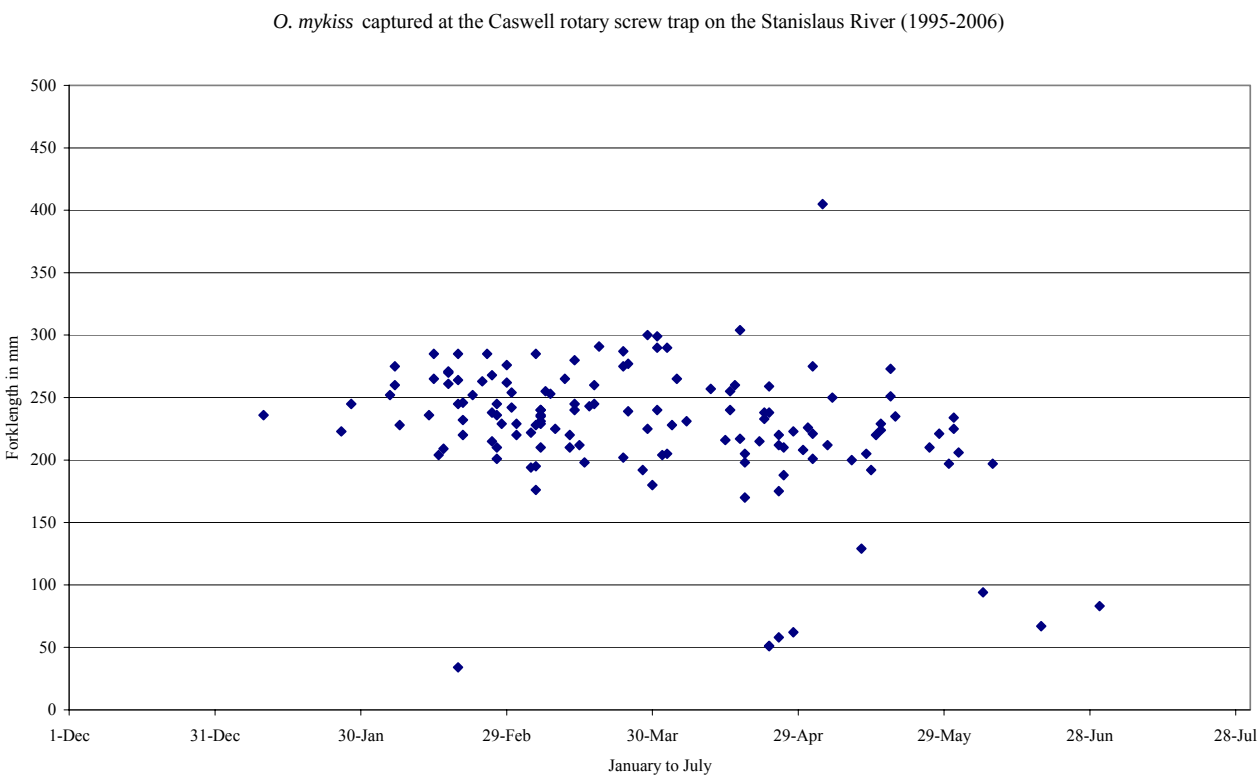


Figure 9. Forklength distribution of *O. mykiss* captured at Oakdale (1995–2009; preliminary data - FISHBIO) and Caswell (1995–2006; U.S. Fish and Wildlife Service data) rotary screw traps on the Stanislaus River

4 RECOMMENDATIONS FOR PROTECTION MEASURES AND MONITORING

In its July 16, 2009 Order, the Commission requested consideration of whether interim measures may be necessary to protect fishery resources on the Tuolumne pending Project relicensing. As part of the proceedings following the July 16, 2009 Order, the Districts provided a report on August 24, 2009 of proposed additional voluntary protective measures intended to benefit fishery resources in the Tuolumne River pending relicensing, including *O. mykiss*. Below it is recommended from those measures, as well as others, the following *O. mykiss* protection and monitoring actions.

Recommended protection measures are:

- Continue augmented summer flows in dry year types. This measure is intended to maintain or increase the extent of cool water habitat present in the river downstream of La Grange Dam (RM 51.8) during years similar to recent dry water year types. For example:
    - During periods when the existing FERC minimum instream flow requirement is 75 cfs, provide additional flows to maintain an average of about 110 cfs at the La Grange Gage (USGS 11289650).
    - During periods when the existing FERC minimum flow requirement is 50 cfs, provide additional flows to maintain an average of about 100 cfs.
- Continue variable summer flow operations in dry year types. A range of variable supplemental flows would provide higher flows on days with elevated National Weather Service forecasted air temperatures at Modesto (such as 100°F or greater), in addition to maintaining higher than required base flows. These flow operations are designed to evaluate the dynamics of air temperatures and flow changes in relation to downstream water temperature conditions and modeled projections. For example:
    - In water years when the FERC minimum instream flow requirement is 75 cfs, an augmented seasonal flow averaging about 110 cfs should be used, with variable flows within a range of about 100–130 cfs.
    - In water years when the FERC minimum instream flow requirement is 50 cfs, an augmented seasonal flow averaging about 100 cfs should be used, with variable flows depending upon air temperatures within a range of about 95–115 cfs.
- Fine sediment management. The Districts should continue to support state and federal regulatory efforts to minimize, and mitigate for, impacts of excessive fine sediment inputs to the river from poor land management practices in the watershed upstream of RM 39 (i.e., Peaslee Creek drainage).
- Habitat restoration. The Districts should continue to support implementation of previously identified gravel augmentation projects within the primary spawning reach downstream of

La Grange Dam (RM 40–52). These projects are consistent with the 1995 FERC Settlement Agreement (TID/MID 1996), the Habitat Restoration Plan for the lower Tuolumne River Corridor (McBain & Trush 2000), and the Tuolumne River Coarse Sediment Management Plan (McBain & Trush 2004). The Districts should continue to seek previously approved California Bay-Delta Authority funding and possibly other potential funding sources, such as the San Francisco Public Utilities Commission.

Recommended monitoring actions are:

- Population estimate surveys. The Districts should continue summer population estimate surveys using snorkel methods in 2010–2011 during July only and within the approximate reach of RM 40–52 where *O. mykiss* have been routinely observed. Sampling at flows greater than 350 cfs would be subject to postponement or cancellation as needed for safety purposes.

- Reference count snorkel surveys. The Districts should conduct reference count snorkel surveys at historical snorkeling sites on an expanded schedule during 2010 and 2011: June, September, and 1–2 surveys conducted between January and April. As described above, sampling at higher than typical flows, if they occur, would be subject to postponement or cancellation as needed for safety purposes.

- Adult *O. mykiss* tracking study. The Districts should conduct the adult tracking study in 2010–2011. This study is intended to document habitat use, movement patterns, in-river migration rates, and possibly spawning locations of acoustically tagged adult *O. mykiss* in the Tuolumne River. The pending scientific collection permit application for 2010 has identified implanting acoustic tags in up to 20 adult *O. mykiss* in each year. Study fish would primarily be obtained by angling within the winter/spring (Jan–Jun) period, with potential use of study fish captured at the Waterford RST. Three fixed station hydrophone locations as well as mobile tracking would be utilized for determining movement and habitat utilization.

- Routine Monitoring. The Districts should conduct the following routine monitoring activities in 2010-2011 for the purpose of maintaining the long-term comparative information of the Tuolumne River fisheries monitoring program:

    - Seining and screw trapping in winter/spring (January-May) to document size, abundance, migration, and distribution of juvenile salmonids and other fish species in the Tuolumne and San Joaquin Rivers

    - Year-round thermograph monitoring and analysis of flow/temperature conditions.

- Reporting. The Districts should continue to produce annual reports of monitoring results for 2010–2011 and annual compilation of *O. mykiss* records, including from other Tuolumne fishery monitoring programs (e.g., seine, screw trap); CDFG or other agencies could augment that summary by providing any additional relevant *O. mykiss* data (prior CDFG records available to the Districts were through mid-2004). It is also intended that

this report and the annual reports would supplant the proposed 2012 report of the 2007 study plan.

It should be noted that the previously proposed anadromy study of the 2007 study plan has not been supported by the fishery agencies due to the lethal sampling needed to obtain otoliths. The completion of a recent otolith evaluation that included Tuolumne River samples identified low proportions of anadromous *O. mykiss* (Zimmerman et al. 2009). In any case, the Districts should re-examine specific *O. mykiss* monitoring elements beyond 2011 with the fishery resource agencies.

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Appendix A

Excerpt from Tuolumne River Fisheries Study Plan
Don Pedro Hydroelectric Project (FERC No. 2299)

Turlock Irrigation District and Modesto Irrigation District

JULY 13, 2007

IV. STEELHEAD PRESENCE/PROTECTION

Identified FERC Issue:
The original FERC Letter requests that the size and habitat needs of the *O. mykiss* population in the Tuolumne River be determined. FERC also requests monitoring to document the absence or presence of anadromous *O. mykiss* (steelhead) of the population. FERC requests additional study elements to determine the flow and habitat needs of steelhead if they are present in the Tuolumne River population. Studies should include comparisons to steelhead data from nearby rivers.

Districts' Issue Assessment:
The Districts consider questions regarding habitat needs of anadromous *O. mykiss* to be the same as habitat needs of resident *O. mykiss*. Although agency monitoring (McEwan 2001) has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers to the north of the Tuolumne, studies of otoliths from both live *O. mykiss* captures and carcasses recovered by CDFG to date have not indicated that the Tuolumne River has a self-sustaining steelhead population (TID/MID 2005a). In addition, Mokelumne and Calaveras river steelhead are dominated by hatchery-origin non-native Central Valley steelhead stock.

Neither the Districts nor their consultants have been able to obtain the necessary regulatory authorization under Section 10 of the Endangered Species Act (ESA) to perform steelhead tracking studies or to determine habitat preferences. Also, no permits have been made available for sacrificial sampling of *O. mykiss* to determine anadromy by micro-chemical analysis of otoliths. Therefore, without explicit Fish Agency support for these sampling programs it may not be possible to address the steelhead issue requested in the original FERC letter utilizing currently available methods of study mandated to protect the anadromous form of *O. mykiss* under the ESA. .

In accordance with the 1995 FSA, TID has proceeded with development of an irrigation only diversion at RM 26 and the Turlock Area Drinking Water Project (now called Turlock Regional Surface Water Supply Project). Assuming that a mutually agreeable multi-party funding arrangement can be achieved for the capital and annual operation and maintenance costs of the fish-only portion of the supplemental irrigation water project, then diversions for supplemental irrigation water at RM 26 could possibly begin by June 1, 2009. Commercial operation of the Regional Project is estimated to begin in 2011. It is anticipated that diversions for the Regional Project could initially add up to 50 cfs of additional flow during the summer of all water year types, with a maximum capacity of near 100 cfs depending on project demands and available multi-party funding for supplemental irrigation water diversions.

Hypotheses:
Whether or not a self-sustaining steelhead population is present in the lower Tuolumne River and because any anadromous and resident *O. mykiss* in upstream areas have the same habitat requirements as Chinook Salmon, the Districts believe the identified issue is best addressed by documenting the relative abundance and the habitat requirements of *O. mykiss* present in the Tuolumne River in order to test the following hypotheses:

> Hypothesis 1: Summertime distribution of suitable habitat by observed life stages of *O. mykiss* is related to ambient river water temperature.
>
> Hypothesis 2: Habitat use by *O. mykiss* juveniles and adults observed in the Tuolumne River occurs at the same density in both restored and nearby reference sites.
>
> Hypothesis 3: A self-sustaining population of anadromous *O. mykiss* (steelhead) is present on the Tuolumne River.

The Districts have long documented the presence of *O. mykiss* in the Tuolumne River (TID/MID 2005a). As noted in the 2005 Ten Year Summary Report, FERC began informal consultation with NOAA Fisheries and the Districts in 2003 regarding steelhead issues. That consultation was followed by several information requests and submittals by the Districts. Hypotheses No. 1 is partially addressed with past summertime snorkel observations that show *O. mykiss* distribution and habitat use has extended downstream by several miles in response to the increased flows under the flow schedules in the 1996 FERC Order (TID/MID 2005a).

As described under Habitat Restoration, a number of ongoing monitoring activities are underway to assess Hypotheses No. 1 and No. 2 above. The Coarse Sediment Management Plan (Report 2004-12, TID/MID 2004) included conceptual designs with appropriate gravel sizes and habitat features intended to provide favorable spawning and feeding stations for *O. mykiss*. These habitat design recommendations have also been included in the recently completed Bobcat Flat/RM 43 restoration projects as well as coarse sediment augmentation projects planned for implementation in 2007–2008.

Building upon pre-project and post-project monitoring of suitable in-channel rearing habitat at the SRP-9 and GMR-I restoration project sites (McBain & Trush and Stillwater Sciences 2006), the hypotheses above will be examined by comparisons of observed life stages of *O. mykiss* at constructed and planned gravel augmentation sites relative to reference riffles in each of three years of the current TRTAC monitoring program (CDFG Grant No. ERP-04-S04). Surveys will be conducted using electrofishing, snorkel, and seining methods as allowed by the fish agencies. Lastly, further fine scale habitat suitability mapping will be conducted adjacent to gravel augmentation sites under a pending amendment of the Coarse Sediment Transfusion Project (CDFG Grant No. ERP-02-P29).

Recommended Approach and Methods:
As described above, there are several ongoing monitoring programs related to post-project monitoring of completed and planned restoration projects. Each program has its own set of inter-related hypotheses and performance metrics that range from geomorphic and fluvial processes, to the fishery resource objectives discussed in the FERC public meeting on July 25, 2006; and on to broader issues of riparian and ecosystem functioning and NEPA/CEQA compliance. At this time, the Districts believe that the projects that have been initiated to date will address the monitoring issues above. Below the Districts describe analyses and additional monitoring activities to address the identified hypotheses:

1) Summer Population Estimate. The proposed surveys make use of a two-phase sampling approach using bounded count population estimates (Hankin and Mohr 2001) from snorkel and electrofishing surveys of representative habitat types within areas where *O. mykiss* have been frequently observed during the summer in the lower Tuolumne River (approximately RM 52-40). In the first phase, 24 sampling units will be selected to span the major habitat types (i.e., riffles, runs, pools) represented in the river. These sites will be surveyed using standard snorkel survey techniques (Edmundson et al. 1968, Hankin and Reeves 1988, McCain 1992, Dolloff et al. 1996) and calibrated to electrofishing techniques described by Reynolds (1996) and Beechie et al (2005). Where possible, block nets will be used to prevent migration in and out of the sample site and will facilitate an accurate assessment of the sample population. In the second phase, four sites of each habitat type will be randomly selected for an additional three survey passes using a combination of snorkel and electrofishing surveys. Limited backpack electrofishing outside of spawning and rearing areas for Chinook salmon is currently permitted under the CDFG 4d permit program, with a Section 10 permit pending with NMFS. Sample methods may be modified depending upon permitting restrictions. In all, this represents 60 dive passes to be conducted by 2–4 divers over 3–4 days. Analysis methods will generally follow the estimators described in Hankin and Mohr (2001) with population estimates on a habitat unit, length and areal basis from

the existing Tuolumne River GIS. The surveys will be conducted during summers 2007 through 2011.

2) Sampling of *O. mykiss* for Anadromy. As a means of testing Hypothesis No. 3, the Districts will seek permits for scientific collection of *O. mykiss* samples for a period of four years (2008–2011). Contingent upon permitting support from NMFS and CDFG, the Districts will collect otoliths from up to 10 percent of all juvenile *O. mykiss* captured during river-wide seining, RST monitoring, and electrofishing for subsequent otolith analysis using micro-chemical testing of Sr:Ca ratio within growth rings (Zimmermann 2005). Adult *O. mykiss* will be captured during spring in two surveys using hook and line sampling. Otoliths will be collected from a subset of adult *O. mykiss*. Analysis of otoliths from adults will be used to determine the proportions of resident and anadromous *O. mykiss*. Analysis of otoliths from adults will be used to indicate the proportion of resident and anadromous *O. mykiss*. Analysis of juvenile otoliths will be used to determine maternal anadromy and steelhead spawning within the Tuolumne River.

3) Adult *O. mykiss* Tracking Study. Contingent with permitting approval, habitat use and needs of adult *O. mykiss* will be assessed in a 2-year acoustic tracking study performed in conjunction with other tracking studies under Instream Flows and Predator Control. Adult fish will be captured by angling and acoustic tags surgically implanted, followed by both passive (using fixed hydrophones) and active monitoring (using mobile hydrophones). As a means of addressing future habitat restoration projects, Hypothesis No. 2 will be examined by determining habitat associations and potential spawning locations of *O. mykiss* within the river. The tracking study will be performed from approximately January 1 through March 31 of each study year.

4) Synthesize Results of Past and Ongoing Studies by 2012. Using all of the past and ongoing monitoring studies described above, the Districts will synthesize the results of ongoing studies and the above new surveys and studies to compare *O. mykiss* abundance and distribution at habitat restoration sites implemented between 2001 and 2009. Increased downstream extent of rearing habitat will be compared to pre- and post-project assessments at gravel augmentation sites (CDFG Grant No. ERP-02-P29) and previous surveys to address the hypotheses above. To the extent feasible, pertinent steelhead data from nearby rivers will be used as a means of informing the development of potential restoration and management actions in the future.

Table 4. Summary of methods, metrics, and schedule to examine Steelhead Presence/Protection issue

Approach	Methods	Metrics	Schedule	Report Progress/Product
1. Summer Population Estimate	Two-phase snorkel surveys calibrated by electrofishing.	Population abundance by habitat unit type	June and July 2008-2011	Data reports and preliminary analysis with annual FERC reports (2008–2011). Complete analysis by 7/1/2012.
2. Sampling of *O. mykiss* for Anadromy	Collect otoliths from juvenile and adult *O. mykiss.*	Micro-chemical testing of Sr:Ca ratio within otolith growth rings	2008–2011	Data reports and preliminary analysis with annual FERC reports (2007–2011). Complete analysis by 7/1/2012.
3. Adult *O. mykiss* Tracking Study	Acoustic tagging of adult *O. mykiss* during winter. Monitor riverwide movement and habitat use in conjunction with other acoustic tracking studies under Instream Flows and Predator Control.	Movement patterns and habitat associations	January through March 2008–2009	Data reports and preliminary analysis with annual FERC reports (2009–2010). Complete analysis by 7/1/2012.
4. Synthesize Results of Past and Ongoing Studies by 2012, including information from nearby rivers	Compare *O. mykiss* abundance and distribution at habitat restoration sites implemented between 2001 and 2009. Assess downstream extent of rearing habitat and compare to pre- and post project studies.	Change in distribution and abundance of *O. mykiss*	2008–2011	Data reports and preliminary analysis with annual FERC reports (2008–2011). Complete analysis by 7/1/2012.

Appendix B

TID/MID *O. mykiss* **Records**

***O. mykiss* observations in the Tuolumne River (TID/MID)**

Method	Location	River Mile	Date	#	Fork Length (mm) [1]
Snorkel	R5	48.0	08/01/82	2	350
Seine (DFG)	OLGB	50.5	04/15/83	1	39
Seine (DFG)	OLGB	50.5	05/06/83	1	60
Seine (DFG)	OLGB	50.5	06/09/83	1	41
Seine (DFG)	OLGB	50.5	02/16/84	4	?
Seine (DFG)	OLGB	50.5	03/01/84	2	?
Stranding	R4B	48.4	03/16/84	4	25-30
Snorkel (spring)	R4B-5	48.0-48.4	04/11/84	12	150-300
Snorkel	RA3	51.6	08/10/84	27	100-200
Snorkel	RA7	50.7	08/10/84	26	?
Snorkel (spring)	RA3	51.6	03/21/85	2	300,350
Seine	R4B	48.4	04/23/86	1	37
Seine	OLGB	50.5	05/12/86	1	29
Seine	OLGB	50.5	05/19/86	1	26
Seine	OLGB	50.5	05/30/86	1	29
Seine	R4B	48.4	05/30/86	1	30
Seine	OLGB	50.5	06/11/86	2	36,54
Seine	R4B	48.4	06/11/86	2	74,67
Seine	R4B	48.4	06/19/86	1	80
Seine	OLGB	50.5	06/26/86	5	46,66,79,58,67
Snorkel	R4B	48.4	07/01/86	5	40-80
Snorkel	RA3	51.6	08/14/86	6	5(100-160), (350)
Snorkel	RA7	50.7	08/14/86	13	70-150
Snorkel	R2	49.9	08/14/86	25	<175
Snorkel	R4B	48.4	08/14/86	10	<175
Snorkel	R5	48.0	08/14/86	10	<175
Seine	R4B	48.4	02/26/87	1	28
Seine	R4B	48.4	03/04/87	1	33
Seine	OLGB	50.5	03/26/87	1	26
Mark-Recap.	R4A	48.8	05/14/87	1	88
Seine	R5	48.0	05/20/87	2	59,32
Seine	OLGB	50.5	05/20/87	3	31,30,29
Stranding	RA4	51.6	06/01/87	7	29-35
Stranding	R5	48.0	06/02/87	5	62-92
Seine	OLGB	50.5	06/03/87	2	33,37
Seine	OLGB	50.5	05/16/88	1	34
Electro	R2	49.9	05/30/90	1	73
Snorkel	RA3	51.6	06/09/92	1	150
Snorkel (late fall)	RA7	50.7	11/30/95	1	250
Snorkel (late fall)	R5	48.0	11/30/95	2	220,250
Snorkel	R7	46.9	07/03/96	4	90-110
Seine	TRR	42.2	03/12/97	1	35
Snorkel	RA3	51.6	06/25/97	4	200,250,250,300
Snorkel	RA7	50.7	06/25/97	2	250,400
Snorkel	R2	49.9	06/25/97	2	250
Seine	R4B	48.4	04/22/98	1	28
RST 7/11	7/11	38.5	01/21/99	1	198
Seine	TRR	42.2	02/24/99	1	25
RST 7/11	7/11	38.5	04/01/99	1	45
Seine	R5	48.0	04/08/99	1	27
Seine	OLGB	50.5	05/19/99	3	32,43,46
Snorkel	RA7	50.7	06/15/99	14	70-110
Snorkel	R3B	49.1	06/15/99	31	70-100
Snorkel	R5	48.0	06/15/99	10	4(75-100), 6(220-300)
Snorkel	R7	46.9	06/16/99	15	75-130
Snorkel	R23B-C	42.3-42.4	06/16/99	9	80-130
Seine	TRR	42.2	03/21/00	1	26
Angling	R3B, R13B	49.1, 45.5	04/12/00	2	385,355
Seine	R5	48.0	05/17/00	3	48,56,63
Snorkel	RA7	50.7	06/05/00	14	50-120
Snorkel	R1A	50.4	06/05/00	3	60,70,80
Snorkel	R3B	49.1	06/05/00	14	11(70-110), 200,225,250
Snorkel	R5	48.0	06/05/00	19	14(50-110), 5(200-350)
Snorkel	R7	46.9	06/21/00	52	47(45-100), 5(225-350)
Snorkel	R12	45.8	06/06/00	5	250-350
Snorkel	R13A	45.6	06/06/00	20	19(60-110), 200
Snorkel	R17A2	44.4	06/06/00	14	75-120
Snorkel	R21	42.9	06/06/00	27	25(70-110), 225,250
Snorkel	R23C	42.3	06/06/00	4	70,80,90,225
Snorkel	R26	40.9	06/07/00	4	150-225
Snorkel	R27	40.3	06/07/00	2	275,325
Snorkel	R31	38.1	06/07/00	2	200,325

[1] estimated total length for snorkel data

***O. mykiss* observations in the Tuolumne River (TID/MID)**

Method	Location	River Mile	Date	#	Fork Length (mm) [1]
Seine	OLGB	50.5	03/20/01	1	26
Seine	R5	48.0	03/20/01	1	32
Seine	TRR	42.2	03/20/01	2	48,51
Seine	R5	48.0	05/15/01	41	(36-77)
Snorkel	RA7	50.7	06/18/01	7	70-95
Snorkel	R2	49.9	06/18/01	3	75,80,90
Snorkel	R3B	49.1	06/18/01	8	4(120-160), 4(180-200)
Snorkel	R5	48.0	06/18/01	4	80,140,160,280
Snorkel	R7	46.9	06/19/01	4	90,90,100,150
Snorkel	R13B	45.5	06/19/01	3	90,130,160
Snorkel	R21	42.9	06/19/01	2	120,150
Snorkel	RA7	50.7	09/18/01	3	160,270,300
Snorkel	R2	49.9	09/18/01	3	225,280,330
Snorkel	R3B	49.1	09/18/01	1	280
Snorkel	R5	48.0	09/18/01	2	275,300
Snorkel	R21	42.9	09/19/01	3	190,225,275
Seine	OLGB	50.5	04/23/02	2	32,32
Seine	R5	48.0	05/07/02	1	28
Snorkel	RA7	50.7	06/11/02	5	70-80
Snorkel	R2	49.9	06/11/02	1	225
Snorkel	R3B	49.1	06/11/02	11	60-120
Snorkel	R5	48.0	06/12/02	3	160,300,380
Snorkel	R7	46.9	06/12/02	5	100, 4(140-160)
Snorkel	R13B	45.5	06/12/02	2	120,140
Snorkel	R21	42.9	06/12/02	1	125
Snorkel	RA7	50.7	09/24/02	1	400
Snorkel	R2	49.9	09/24/02	4	300,330,420,480
Snorkel	R3B	49.1	09/24/02	1	200
Snorkel	R7	46.9	09/25/02	2	150,225
Snorkel	R13B	45.5	09/25/02	4	110,160,200,220
Seine	TRR	42.3	04/01/03	1	29
Snorkel	RA7	50.7	06/18/03	66	65(45-140), (350)
Snorkel	R2	49.9	06/18/03	8	5(120-130), 300,325,420
Snorkel	R3B	49.1	06/18/03	5	110-150
Snorkel	R5	48.0	06/18/03	6	5(90-120), 370
Snorkel	R7	46.9	06/19/03	14	13(80-125), 375
Snorkel	R13B	45.5	06/19/03	1	390
Snorkel	R23C	42.3	06/19/03	1	90
Snorkel	RA7	50.7	09/17/03	16	15(45-60), 210
Snorkel	R2	49.9	09/17/03	2	200,350
Snorkel	R3B	49.1	09/17/03	21	16(60-80), 180,200,220,325,475
Snorkel	R5	48.0	09/17/03	10	9(60-70), 325
Snorkel	R7	46.9	09/18/03	9	125-225
Snorkel	R13B	45.5	09/18/03	6	60, 190,210,225,300,330
Snorkel	R21	42.9	09/18/03	6	5(190-225), 320
Snorkel	R23C	42.3	09/18/03	1	210
Seine	OLGB	50.5	03/16/04	1	29
Seine	TRR	42.3	03/16/04	1	29
Seine	TRR	42.3	03/30/04	2	31,32
Seine	R5	48.0	04/14/04	2	31,38
Seine	R5	48.0	05/25/04	1	64
Snorkel	RA7	50.7	06/16/04	12	11(50-80), 420
Snorkel	R2	49.9	06/16/04	23	20(80-130), 180,320,400
Snorkel	R3B	49.1	06/16/04	22	21(80-130), 480
Snorkel	R5	48.0	06/16/04	11	9(90-130), 300,370
Snorkel	R7	46.9	06/17/04	13	110-140
Snorkel	R13B	45.5	06/17/04	5	110-125
Snorkel	R21	42.9	06/17/04	5	110-130
Snorkel	RA3/A4	51.6	08/03/04	5	170-275
Snorkel	RA7	50.7	08/03/04	6	120-200
Snorkel	R1A	50.5	08/03/04	4	300-425
Snorkel	R2	49.9	08/03/04	2	290,320
Snorkel	R3B	49.1	08/04/04	5	140,150,160,350,525
Snorkel	R4B	48.4	08/04/04	8	7(90-200),350
Snorkel	R5	48.0	08/04/04	15	60, 14(150-225)
Snorkel	R7	46.9	08/04/04	5	140-160
Snorkel	R10	46.2	08/05/04	3	340,400,450
Snorkel	R13B	45.5	08/05/04	13	100-210
Snorkel	R21	42.9	08/05/04	9	100-170
Snorkel	R23C	42.3	08/05/04	1	200
Snorkel	RA7	50.7	09/15/04	11	40-110
Snorkel	R2	49.9	09/15/04	7	100, 6(200-380)
Snorkel	R3B	49.1	09/15/04	7	4(60-110), 360,400,425
Snorkel	R5	48.0	09/15/04	6	45, 5(140-360)
Snorkel	R7	46.9	09/16/04	2	180,300
Snorkel	R21	42.9	09/16/04	7	4(160-180), 3(280-310)

[1] estimated total length for snorkel data

***O. mykiss* observations in the Tuolumne River (TID/MID)**

Method	Location	River Mile	Date	#	Fork Length (mm) [1]
Seine	OLGB	50.5	03/16/05	1	27
RST	GRAYSON	5.2	05/14/05	1	33
Snorkel	RA7	50.7	09/20/05	10	4(110-180), 6(350-500)
Snorkel	R2	49.9	09/20/05	7	(225-420)
Snorkel	R3B	49.1	09/20/05	6	(180-460)
Snorkel	R5	48.0	09/20/05	36	30(110-200) 6(230-480)
Snorkel	R7	46.9	09/21/05	2	160,260
Snorkel	R13B	45.5	09/21/05	46	10(70-150) 36(160-260)
Snorkel	R21	42.9	09/21/05	15	3(120-130) 12(175-250)
Snorkel	R23C	42.3	09/21/05	14	120,130, 12(160-225)
Snorkel	R31	38.0	09/22/05	1	300
Snorkel	R35A	37.1	09/22/05	2	120,130
Seine	TRR	42.2	02/01/06	1	29
RST	WATERFORD	29.8	02/16/06	1	280
Seine	TRR	42.2	03/01/06	3	25,26,26
Seine	R4B	48.4	03/29/06	2	27,29
RST	WATERFORD	29.8	04/02/06	1	249
RST	WATERFORD	29.8	04/05/06	1	270
Seine	OLGB	50.5	05/03/06	2	38,45
RST	WATERFORD	33.5	06/02/06	1	81
RST	WATERFORD	33.5	06/04/06	1	66
RST	WATERFORD	33.5	06/10/06	2	80,90
RST	WATERFORD	33.5	06/12/06	1	79
Snorkel	RA7	50.7	09/19/06	115	102(100-180) 13(200-420)
Snorkel	R2	49.9	09/19/06	15	(250-400)
Snorkel	R3B	49.1	09/19/06	66	39(100-160) 27(180-525)
Snorkel	R5	48.0	09/19/06	54	20(100-150) 34(160-450)
Snorkel	R7	46.9	09/20/06	106	76(50-150) 30(170-440)
Snorkel	R13B	45.5	09/20/06	103	82(50-160) 21(180-300)
Snorkel	R21	42.9	09/20/06	32	14(100-160) 18(180-420)
Snorkel	R23C	42.3	09/20/06	27	10(100-150) 17(160-220)
Snorkel	R31	38.0	09/21/06	21	(60-160)
Snorkel	R36A	36.7	09/21/06	4	(60-70)
RST	WATERFORD	29.8	02/01/07	1	-
RST	WATERFORD	29.8	02/20/07	1	195
Seine	TRR	42.2	02/28/07	1	31
Seine	R5	48.0	04/11/07	3	25,27,37
Seine	TRR	42.2	04/11/07	7	(24-38)
RST	WATERFORD	29.8	04/22/07	1	64
RST	WATERFORD	29.8	04/23/07	1	43
Seine	TRR	42.2	04/25/07	5	21,22,24,31,36
RST	WATERFORD	29.8	04/27/07	1	310
RST	WATERFORD	29.8	05/02/07	1	35
RST	WATERFORD	29.8	05/03/07	1	320
Seine	R5	48.0	05/09/07	3	27,27,37
Seine	TRR	42.2	05/09/07	1	35
RST	WATERFORD	29.8	05/15/07	1	360
RST	WATERFORD	29.8	05/18/07	1	77
Seine	R5	48.0	05/23/07	2	44,50
RST	WATERFORD	29.8	06/05/07	1	325
Snorkel	RA7	50.7	06/26/07	106	101(60-110) 5(240-480)
Snorkel	R2	49.9	06/26/07	34	26(70-100) 8(230-420)
Snorkel	R3B	49.1	06/26/07	45	36(60-120) 9(260-440)
Snorkel	R5	48.0	06/26/07	92	79(50-150) 13(250-480)
Snorkel	R7	46.9	06/27/07	22	16(80-125) 6(280-380)
Snorkel	R13B	45.5	06/27/07	15	15(70-140)
Snorkel	R21	42.9	06/27/07	10	10(80-160)
Snorkel	R23C	42.3	06/27/07	5	4(120-140) (350)
Snorkel	R31	38.0	07/03/07	12	12(90-160)
Snorkel	R41A	35.3	07/03/07	2	(160,180)
Snorkel	RA7	50.7	09/18/07	75	70(40-160) 5(250-380)
Snorkel	R2	49.9	09/18/07	16	7(100-140) 9(220-480)
Snorkel	R3B	49.1	09/18/07	12	4(100-130) 8(290-500)
Snorkel	R5	48.0	09/18/07	10	3(120-160) 7(300-450)
Snorkel	R7	46.9	09/19/07	7	7(280-420)
Snorkel	R13B	45.5	09/19/07	57	57(100-170)
Snorkel	R21	42.9	09/19/07	10	9(110-170) (320)
Snorkel	R23C	42.3	09/19/07	7	7(120-150)
Snorkel	R31	38.0	09/20/07	4	4(280-360)

[1] estimated total length for snorkel data

***O. mykiss* observations in the Tuolumne River (TID/MID)**					
Method	**Location**	**River Mile**	**Date**	**#**	**Fork Length (mm) [1]**
RST	WATERFORD	29.8	01/26/08	1	105
RST	WATERFORD	29.8	01/28/08	2	205,249
RST	WATERFORD	29.8	01/29/08	2	224,268
RST	WATERFORD	29.8	02/26/08	1	100
RST	WATERFORD	29.8	02/27/08	1	205
RST	GRAYSON	5.2	02/28/08	1	200
RST	GRAYSON	5.2	03/31/08	1	224
RST	WATERFORD	29.8	04/16/08	1	261
Seine	OLGB	50.5	04/29/08	3	30,30,49
Seine	OLGB	50.5	05/13/08	1	28
RST	WATERFORD	29.8	05/23/08	1	58
Snorkel	RA7	50.7	06/17/08	76	74(50-120) (425,480)
Snorkel	R2	49.9	06/17/08	9	(90) 8(230-450)
Snorkel	R3B	49.1	06/17/08	78	75(60-120) (140,300,320)
Snorkel	R5	48.0	06/17/08	21	17(70-100) (140,300,320,400)
Snorkel	R7	46.9	06/18/08	13	12(70-140) (450)
Snorkel	R13B	45.5	06/18/08	24	24(70-140)
Snorkel	R21	42.9	06/18/08	11	5(70-140) 6(160-300)
RST	WATERFORD	29.8	02/17/09	1	105
Seine	OLGB	50.5	03/10/09	1	26
Seine	R5	48.0	03/10/09	1	36
Seine	R5	48.0	03/24/09	1	44
Seine	OLGB	50.5	04/07/09	1	26
Seine	R5	48.0	04/21/09	1	70
Seine	OLGB	50.5	05/05/09	1	34
Seine	R5	48.0	05/05/09	1	33
Snorkel	RA7	50.7	06/16/09	80	80(40-120)
Snorkel	R2	49.9	06/16/09	12	5(70-90) 7(160-500)
Snorkel	R3B	49.1	06/16/09	27	19(60-150) 8(160-500)
Snorkel	R5	48.0	06/16/09	11	11(160-400)
Snorkel	R7	46.9	06/17/09	6	2(140) 4(160-170)
Snorkel	R13B	45.5	06/17/09	4	4(90-120)
Snorkel	R23C	42.3	06/17/09	2	120,130

[1] estimated total length for snorkel data