

Tuolumne River *O. mykiss* Acoustic Tracking Study 2011 Technical Report



Submitted To:
Turlock Irrigation District
Modesto Irrigation District

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Table of Contents

Introduction	1
Study area description	1
Purpose and history of study.....	2
Methods	3
Capturing study fish	3
Tagging O. mykiss	4
Tracking O. mykiss	5
River conditions.....	5
Results	6
Capturing study fish	6
Tagging O. mykiss	7
Fixed station monitoring	9
Mobile tracking	11
Discussion	13
Spawning locations of tagged adult O. mykiss.....	13
Use of restored river reaches by tagged adult O. mykiss	14
Migration patterns of tagged adult O. mykiss.....	14
Literature Cited	15

LIST OF FIGURES

Figure 1. Location map of the Tuolumne River within the San Joaquin River Basin..... 1
 Figure 2. Location map of study area on the Tuolumne River..... 4
 Figure 3. Release locations of tagged *O. mykiss* between La Grange Dam and Basso Bridge..... 8
 Figure 4. Release locations of tagged *O. mykiss* from Basso Bridge to Turlock Lake State Recreation Area..... 9
 Figure 5. Tuolumne River flow at La Grange (LGN) and dates of mobile tracking surveys..... 12
 Figure 6. Tuolumne River daily average water temperature data. 12

LIST OF TABLES

Table 1. Number of *O. mykiss* captured and tagged, and incidental species captured during 2010 sampling..... 6
 Table 2. Date, location, and biological data for all *O. mykiss* tagged during 2010..... 7
 Table 3. Detection history for the Zanker fixed station array..... 10
 Table 4. Detection history for the Grayson fixed station array of tagged *O. mykiss* that were released at Durham Ferry..... 10
 Table 5. Distance between mobile tracking detections by survey date (upstream [+], downstream [-], not detected [ND]). 11

Introduction

Study area description

The Tuolumne River is the largest of three major tributaries (Tuolumne, Merced, and Stanislaus Rivers) to the San Joaquin River, originating in the central Sierra Nevada in Yosemite National Park and flowing west between the Merced River to the south and the Stanislaus River to the north (Figure 1). The San Joaquin River itself flows north and joins the Sacramento River in the Sacramento-San Joaquin Delta within California's Central Valley. The Tuolumne River is dammed at several locations for generation of power, water supply, and flood control – the largest impoundment is Don Pedro Reservoir.

The lower Tuolumne River corridor extends from its confluence with the San Joaquin River to La Grange Dam at river mile (RM) 52.2. The La Grange Dam site has been the upstream limit for anadromous fish migration since at least 1871.

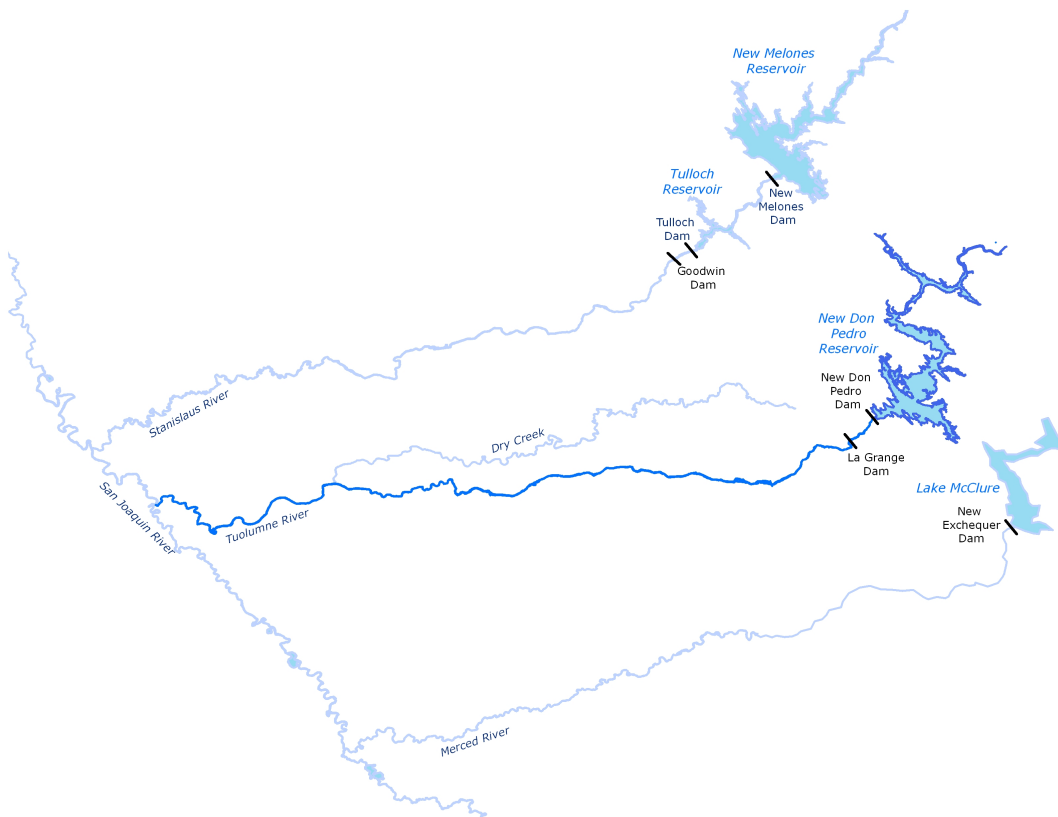


Figure 1. Location map of the Tuolumne River within the San Joaquin River Basin.

Purpose and history of study

Turlock Irrigation District and Modesto Irrigation District (Districts) have been required to conduct fisheries studies and monitoring under the Don Pedro Project Federal Energy Regulatory Commission (FERC) license starting in 1971. A required “Ten Year Summary Report” (TID/MID 2005) presenting results of these efforts was filed by the Districts with FERC in March 2005. FERC solicited input on the Report and held a public meeting during 2005-2006 which led to a December 20, 2006, request from FERC for a new Tuolumne River Fisheries Study Plan (Study Plan) to be prepared by the Districts and submitted by March 20, 2007. The Study Plan was intended to address information needs under Article 58 of the Project license that were identified during the review of the Report and in subsequent discussions. The primary goals of the Study Plan were to provide continued long-term trend monitoring and to undertake studies that clarify major factors that affect and potentially limit the Chinook salmon (*Oncorhynchus tshawytscha*) and *Oncorhynchus mykiss* (*O. mykiss*) populations in the Tuolumne River. The Study Plan was also expected to specifically include tasks on “Steelhead Presence/Protection.”

The Districts distributed a proposed Study Plan for review on February 2, 2007, and revised Study Plans that included a requested winter (January-March) adult *O. mykiss* tracking study were submitted by the Districts on March 20, 2007 and July 13, 2007. An Order issued by FERC on April 3, 2008, directed the Districts to conduct all of the *O. mykiss* studies identified in the Study Plan, including the adult tracking study beginning in January 2009. That task was intended to better determine habitat associations and potential spawning locations, including habitat use by *O. mykiss* adults in restored and nearby reference sites. While routine fisheries monitoring conducted by the Districts has long documented the presence of *O. mykiss* in the Lower Tuolumne River (TID/MID 2005), little is known about life history strategies of *O. mykiss* in the Tuolumne River (i.e.; habitat use, in-river migration patterns, and spawning location and timing).

Objectives of the adult *O. mykiss* acoustic tracking study include:

1. Determine spawning locations of tagged adult *O. mykiss*.
2. Document migration patterns of tagged adult *O. mykiss*.
3. Determine potential habitat use of restored river reaches and nearby reference sites by tagged adult *O. mykiss*.

This study was to begin in January 2009, and timely preparations were made by the Districts to implement the study on schedule including budgeting, contracting, equipment purchase, and requesting necessary permits and authorizations. However, necessary Endangered Species Act (ESA) take authorizations were not issued by the Agencies to permit moving forward with the study in 2009, and the study was delayed until March 2010. This report covers the tagging of all *O. mykiss* in 2010, the acoustic tracking conducted in 2011, and a summary of all acoustic tracking over the 2 years of the study.

Methods

Capturing study fish

Adult *O. mykiss* were targeted by hook and line sampling conducted between La Grange Dam (RM 52.2) and Turlock Lake State Recreation Area (TLSRA) (RM 42.6) during March, April, and October 2010 (**Error! Reference source not found.**). Artificial, barbless lures or flies were used to minimize potential injury or mortality. All fish captured were placed in 38-53 L perforated containers in the river while equipment was prepared to collect biological data and for tagging if the fish was of suitable size. Prior to collection of biological data, all fish were anesthetized in a separate 53 L container using a solution of 80-90 mg/L tricaine methanesulfonate in water buffered with an equal concentration of sodium bicarbonate.

Once anesthetized, fish were identified to species, fork length was measured to the nearest millimeter and weight was measured to the nearest gram. Non-biological data recorded for each fish included time and location (GPS coordinates) of capture, habitat type at capture site, photos, and other general conditions (i.e., weather conditions, substrate type, water temperature, turbidity, conductivity, and dissolved oxygen). Habitat unit designations were based on mapping conducted by Stillwater Sciences (2009) for the 2009 *O. mykiss* population surveys. Fish not selected for tagging were released immediately after necessary data was collected and they had recovered from anesthesia.

Tagging *O. mykiss*

HTI X-type acoustic transmitters were used for this study. These tags operate at 307 kHz and were programmed with tag periods ranging from 7000 to 7300 milliseconds using an HTI model 490-LP tag programmer. The separation between tag codes was 14 milliseconds. Healthy adult *O. mykiss* of suitable size were immediately tagged. The maximum permitted tag weight to body weight ratio of 3.5% was generally expected to correspond to adult *O. mykiss* greater than approximately 350 mm (14 in). However, in consultation with CDFG, the maximum tag weight to body weight ratio was increased to 4% after the first two days of sampling which corresponded to adult *O. mykiss* greater than approximately 300 mm (12 in). All fish were tagged at a mobile tagging station, which allowed all tagging to be completed near the original capture location.

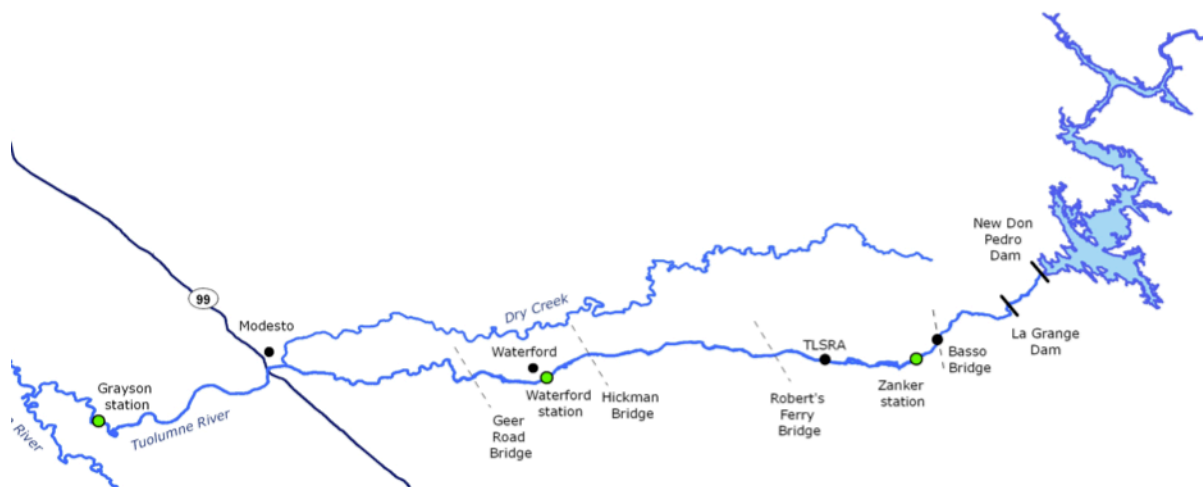


Figure 2. Location map of study area on the Tuolumne River.

Fish were surgically implanted with acoustic transmitters according to implantation procedures outlined in Adams et al. 1998 and Martinelli et al. 1998. A ventral incision approximately 20 mm long was made anterior to the apex of the pelvic girdle. The tag was inserted into the peritoneal cavity and the incision was closed with three interrupted sutures. Typical surgery times were less than four minutes. Fish were then placed into perforated holding containers in the river to recover from anesthesia. Fish were allowed to recover for 10-15 minutes before the container was turned on its side allowing for volitional release. Function of the tag was confirmed using an HTI model 492 acoustic tag detector prior to tag insertion and again during the recovery period.

Tracking *O. mykiss*

Fixed station acoustic arrays were installed near Basso Bridge (RM 47.5), the Waterford Rotary Screw Trap site (RM 29.8), and the Grayson Rotary Screw Trap site (RM 5.2) (Figure 2). Each array consisted of an acoustic tag datalogger (HTI Model 295G) attached to an omnidirectional hydrophone (HTI Model 590). The system was powered by a 12-volt deep cycle battery charged by a 3 ft by 5 ft solar panel (216 watt, 36 volt). These arrays were installed prior to the release of tagged fish, and were operational by February 18, 2010. A beacon tag was deployed at each site to continually document that the array was functioning properly and could detect passing tags. Data were downloaded and reviewed once per week, at minimum, to confirm proper function of the arrays, and to limit potential data loss in case of equipment failure or vandalism.

Mobile tracking was conducted by a raft outfitted with an HTI Model 295G datalogger with GPS tracking capabilities. Mobile tracking surveys consisted of actively searching for tagged fish to determine their specific locations, including macro or micro-habitat usage. The timing, frequency and location of mobile surveys were dependent on environmental conditions and detection data from fixed stations and mobile tracking. Mobile tracking surveys were also conducted within 10 days of each tagging event to confirm the location and proper function of each tagged fish.

Data recorded for each fish detected during mobile tracking included, tag code, time of detection, location of detection (GPS coordinates), surface water temperature at the hydrophone, and macro habitat unit type. Micro-habitat usage (e.g. depth, substrate, association with features such as undercut bank, woody debris, large boulder, etc.) was also evaluated by using signal strength to more precisely estimate the location of each fish. In some cases, after the general location of tagged fish was determined, snorkel and underwater video techniques were used to document fish location within the habitat unit, general behavior (spawning activity), and condition.

River conditions

Provisional daily average flow data for the Tuolumne River at La Grange was obtained from USGS at http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11289650&agency_cd=USGS. Water temperature data were also obtained from hourly recording Hobo Pro v2 water temperature data loggers (Onset Computer Corporation) maintained by the Districts at 5 sites from below La Grange Dam (RM 51.8) to Roberts Ferry Bridge (RM 39.4).

Results

Capturing study fish

During the spring period, FISHBIO staff conducted hook-and-line sampling on five days between March 23 and April 7, 2010 from La Grange (RM 50.5) to TLSRA (RM 42.6). Flows during this period ranged between 225 cfs and 650 cfs. A total of 17 *O. mykiss* were captured, with fork lengths ranging from 225-505 mm and weights ranging from 135->600 g (Table A-1).

The fall sampling period occurred over five days from October 15 to 28, 2010. Flows during this period ranged between 350 cfs and 550 cfs. A total of 25 *O. mykiss* were captured, forklengths ranged between 190 mm and 540 mm and weights ranging from 77-1619 g (Table A-1).

Of the 42 *O. mykiss* captured, 19 did not meet minimum size requirements and two were rejected for other reasons. One of the rejected fish had an old hook lodged deep in its throat, and the other had previously been tagged (code 7012.8). None of the captured *O. mykiss* during the 2010 sampling period were adipose fin clipped.

During the fall sampling period, five Chinook salmon smolts were incidentally captured, with fork lengths ranging from 116-170 mm. Chinook salmon were not captured during the spring sampling. Non-salmonid species incidentally captured during hook and line sampling included hardhead and striped bass (Table 1).

Table 1. Number of *O. mykiss* captured and tagged, and incidental species captured during 2010 sampling.

Survey Date	Reach	<i>O. mykiss</i> captured	<i>O. mykiss</i> tagged	Incidental capture		
				CHN	HH	STB
3/23	La Grange	3	3			
3/24	Basso	7	0			
3/29	Basso	3	3		1	
4/6	La Grange	0	0			
4/7	Basso	4	0			
10/15	La Grange	4	1	3		
10/19	Basso	9	4	2		1
10/20	La Grange	5	3			
10/27	Basso	3	2			
10/28	La Grange	4	4			

Species codes: CHN- Chinook salmon, HH- Hardhead, STB- Striped bass

Tagging *O. mykiss*

A total of 20 adult *O. mykiss* were successfully implanted with HTI X-type tags over two discrete periods during the spring and fall 2010 (Table 2). Tagged fish body weight ranged from 313 to 1,619 g (314 - 540 mm forklength). Average tag weight was 12.58 g (11.95 g to 13.35 g), and the average tag to body weight ratio was 2.2% (0.74% to 3.8%). The average surgery time (time that fish were removed from anesthesia until returned to fresh water) was 3 minutes 28 seconds, and average recovery time was 10.62 minutes (8.5 to 13.8 minutes). After recovery all fish were released in good condition at their original point of capture. One fish did not properly recover from tagging and, in compliance with permitting requirements, was sacrificed and provided to CDFG La Grange.

Table 2. Date, location, and biological data for all *O. mykiss* tagged during 2010.

Capture Date	Rivermile	Length (mm)	Weight (g)	Sex	Tag Code	Tag/Body Ratio	Habitat Unit	Habitat Type
3/23	50.0	425	>600	M	7054.8	<2.3%	023	Run Head
3/23	50.0	450	>600	M	7068.8	<2.2%	023	Run Head
3/23	49.2	505	>600	F	7012.8	<2.2%	033	Riffle
3/29	47.0	368	479	F	7110.8	2.8%	058	Run Head
3/29	45.0	360	395	F	7194.8	3.2%	086	Pool Head
3/29	45.0	353	396	F	7124.8	3.3%	086	Pool Head
10/15	51.6	314	313	unknown	7138.8	3.8%	005	Pool
10/19	47.0	463	1128	F	7026.8	1.2%	058	Run Head
10/19	46.0	370	508	unknown	7222.8	2.4%	067	Run
10/19	45.0	360	552	unknown	7208.8	2.2%	086	Pool
10/19	44.2	382	650	F	7166.8	1.9%	103	Run
10/20	52.1	350	520	unknown	7236.8	2.3%	--	Run
10/20	50.0	400	908	F	7040.8	1.4%	023	Run Head
10/20	49.3	360	492	unknown	7250.8	2.5%	031	Run
10/27	46.8	320	420	M	7264.8	2.8%	066	Run Head
10/27	46.8	350	477	F	7320.8	2.5%	066	Run Head
10/28	52.1	502	1207	M	7292.8	1.1%	--	Run
10/28	51.4	450	887	M	7152.8	1.4%	008	Run Head
10/28	49.2	380	690	F	7180.8	1.7%	033	Riffle
10/28	49.2	540	1619	F	7278.8	0.7%	033	Riffle

On March 23, two males (425 and 450 mm), and a post-spawn female (505 mm) were tagged between La Grange and Basso (Figure 3). On March 29, three female fish (353-368 mm) were tagged between Basso and TLSRA (Figure 4). During the fall period, eight tagged fish (314 – 502 mm) were captured between La Grange and Basso (Figure 3), and six (320 – 463 mm) were captured between Basso and TLSRA (Figure 4).

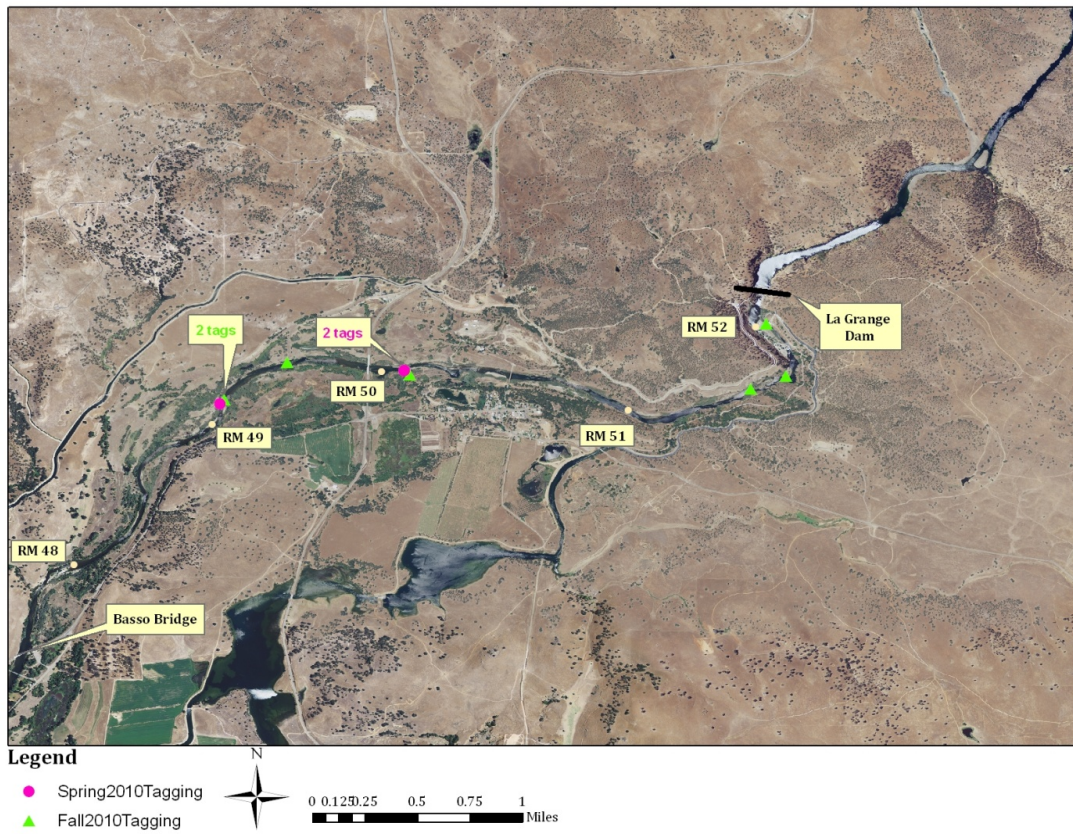


Figure 3. Release locations of tagged *O. mykiss* between La Grange Dam and Basso Bridge.

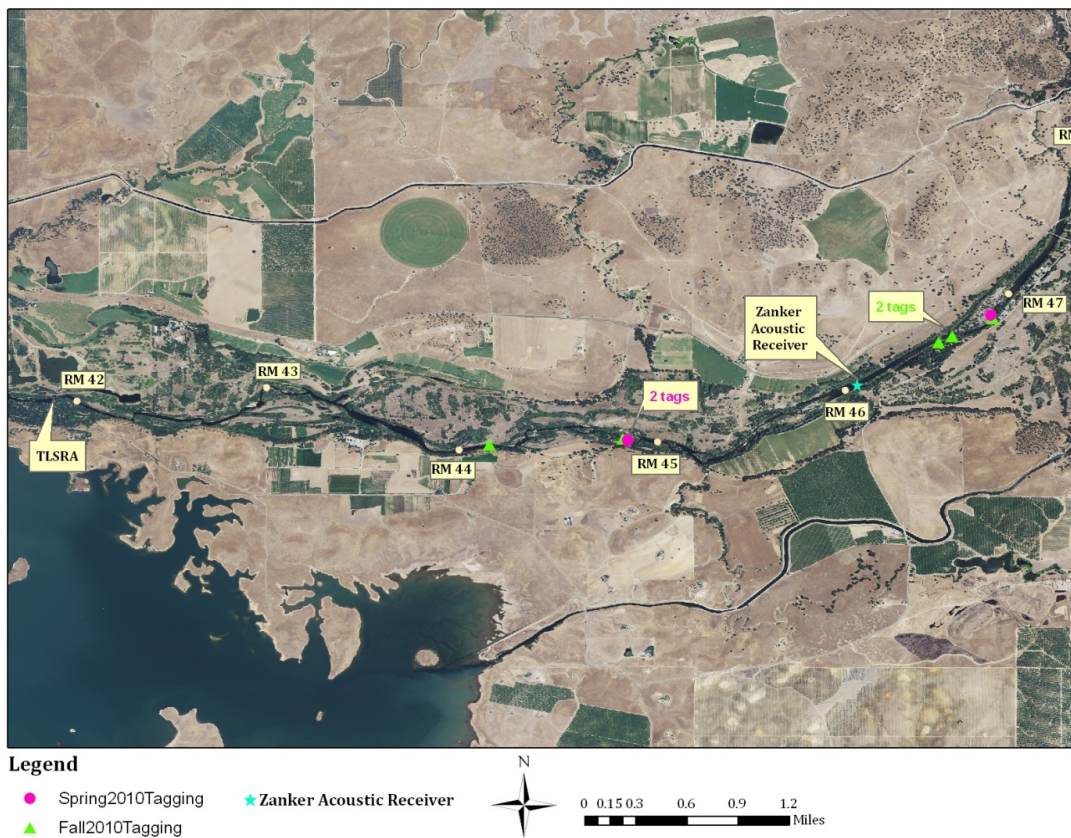


Figure 4. Release locations of tagged *O. mykiss* from Basso Bridge to Turlock Lake State Recreation Area.

Fixed station monitoring

The Zanker fixed station array was actively recording data during 77.8% of the entire study period (3/23/10- 7/1/11). The receiver was inactive for a total of 2,315 hours. These outages were due to the solar array not charging during extended periods with limited sunlight, datalogger malfunction, or high flows covering the hydrophone with debris. The Waterford array was actively recording data during 82.5% of the period, and was inactive for 1,812 hours. Outages at this site were also due to charging issues, datalogger malfunction, high flow debris, as well as some vandalism issues. The Grayson array was actively recording during 82.1% of the period, and was inactive for 1,987 hours. Outages at this site were due to charging issues or datalogger malfunction.

Seven acoustically tagged fish were detected at the Zanker fixed station array (RM 47.5) between August 18, 2010 and March 20, 2011 (Table 3). A total of 1,575 detections were recorded at this location. These detections do not all represent a fish

moving past the receiver, but rather a tagged fish that is holding within the detection range of the receiver. A new acoustic file is saved hourly, so it is possible to have multiple detections within a day. For example, tag 7320.08 recorded 1,163 detections on 71 out of 76 consecutive days with a range of 2 to 25 detections per day. A similar detection pattern was recorded with tags 7110.08 and 7222.08.

Table 3. Detection history for the Zanker fixed station array.

Tag Code	First Detection Date	Last Detection Date	Total Days Detected	Total Number of Detections
7110.08	8/18/10	9/10/10	18	125
7138.08	11/28/10	2/18/10	20	31
7166.08	11/29/10	12/24/10	4	6
7222.08	10/27/10	12/29/10	22	245
7250.08	11/8/10	11/24/10	2	2
7264.08	3/20/11		1	3
7320.08	12/18/10	3/5/11	71	1163

The other acoustically tagged fish detected by a fixed station array were not associated with this study. A total of 13 tags were detected at the Grayson receiver (RM 5.2) between June 16 and August 4, 2011 (Table 4). These tags were implanted in yearling steelhead from the Mokelumne River Hatchery, and were released downstream in the San Joaquin River at Durham Ferry (RM 66) between March 22 and June 18 as part of the USBR RPA studies. At the time of release, these fish ranged from 221 to 318 mm and weighed 114.3 to 363.0 g.

Table 4. Detection history for the Grayson fixed station array of tagged *O. mykiss* that were released at Durham Ferry.

Tag Code	First Detection Date	Last Detection Date	# of Detection Events	Release Date	Length (mm)	Weight (g)
5438.26	6/29/11	7/6/11	10	6/15/11	275	214.8
5920.04	7/1/11		1	5/7/11	313	345.0
5977.26	6/28/11	7/5/11	4	6/16/11	280	218.4
6249.04	6/16/11	7/28/11	3	5/20/11	294	252.6
6732.04	6/26/11		2	5/18/11	242	164.7
8265.04	7/25/11	7/27/11	4	5/5/11	318	363.0
8812.26	7/29/11	7/31/11	4	5/25/11	317	307.9
9420.04	6/29/11	8/4/11	3	5/6/11	286	241.2
9568.26	7/1/11		1	5/23/11	221	114.3
10057.04	6/26/11	8/4/11	7	5/5/11	253	141.0
10149.26	8/4/11		1	5/21/11	252	150.6
10646.26	6/30/11	7/7/11	4	5/23/11	273	244.2
10771.04	7/7/11		1	5/6/11	257	151.7

Mobile tracking

A total of 11 mobile tracking surveys were conducted between November 1, 2010 and July 31, 2011 (Table 5). During the initial surveys after tagging events the location of all 14 fish from the fall tagging period was confirmed. Mobile tracking was limited to the reach between La Grange Dam (RM 52.0) and Roberts Ferry Bridge (RM 39.4), as no fish tagged for this study were detected moving past the Waterford or Grayson fixed receivers. A single survey was conducted between Roberts Ferry Bridge and the Waterford receiver (RM 29.8) on March 31, however no tags were detected in this reach. Flows during this period ranged between 357 cfs and 8,353 cfs (Figure 5). Average daily water temperature near La Grange Dam (RM 51.8) ranged from 9.4-11.9o C, while the temperature near Roberts Ferry Bridge ranged from 9.5- 14.9 o C during the study period (Figure 6).

Tag 7166.8 was implanted in a female *O. mykiss* captured in habitat unit NSO 103 (Stillwater habitat maps) at RM 44.2 on October 19. During subsequent mobile tracking surveys on October 27 and November 1, this tag was detected within 45 meters of the original release location. This tag was detected passing the Zanker fixed receiver (RM 47.5) on November 29, before again being detected on December 1 through mobile tracking at NSO 014 (CDFG gravel introduction site, riffle A7) 10,315 m upstream of the release location. Between December 22 and 24, this tag was again detected downstream at the Zanker receiver. On January 19 and February 2 mobile surveys, this tag was detected back upstream at NSO 014. The next detection of this tag was back downstream in the same habitat unit where it was originally captured (NSO 103), where it was detected 3 times between May 6 and July 8.

Table 5. Distance between mobile tracking detections by survey date (upstream [+], downstream [-], not detected [ND]).

Tag ID	Distance Between Detections (m)										
	1-Nov	1-Dec	9-Dec	23-Dec	19-Jan	2-Feb	24-Mar	30-Mar	6-May	13-May	8-Jul
7026.8	+60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7040.8	-55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7138.8	0	-5785	+5715	ND	-10940	ND	ND	ND	ND	ND	ND
7152.8	-20	ND	+80	ND	ND	ND	ND	ND	-40	-90	ND
7166.8	+45	+10270	ND	ND	-20	+45	ND	ND	-10225	+55	-130
7180.8	-215	+395	-315	ND	ND	ND	ND	ND	ND	ND	ND
7208.8	-100	-70	+175	+30	+10	-20	ND	ND	ND	ND	ND
7222.8	-540	+290	-105	ND	ND	ND	ND	ND	ND	ND	ND
7236.8	-40	ND	-60	ND	ND	ND	ND	ND	ND	ND	ND
7250.8	-6030	+730	ND	ND	ND	ND	ND	ND	ND	ND	ND
7264.8	0	+2615	+1370	ND	ND	ND	ND	ND	ND	ND	ND
7278.8	+20	+100	+45	ND	ND	ND	ND	ND	ND	ND	ND
7292.8	-20	ND	-415	ND	ND	ND	ND	ND	ND	ND	ND
7320.8	0	-65	ND	-785	0	ND	ND	ND	ND	ND	ND

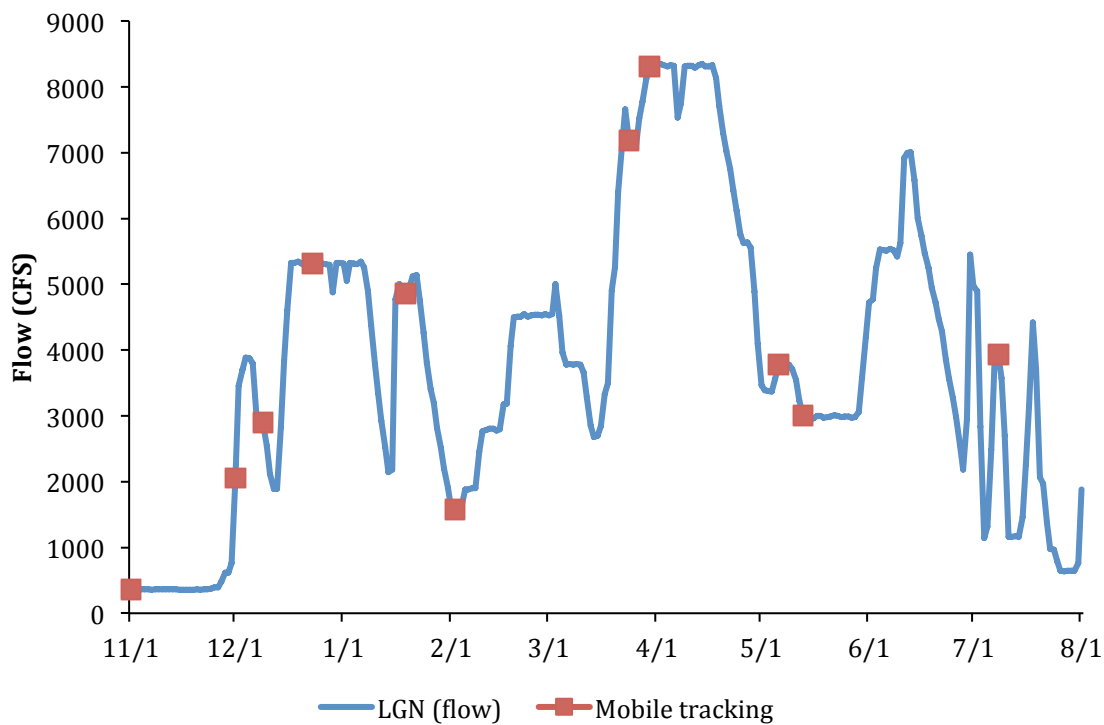


Figure 5. Tuolumne River flow at La Grange (LGN) and dates of mobile tracking surveys.

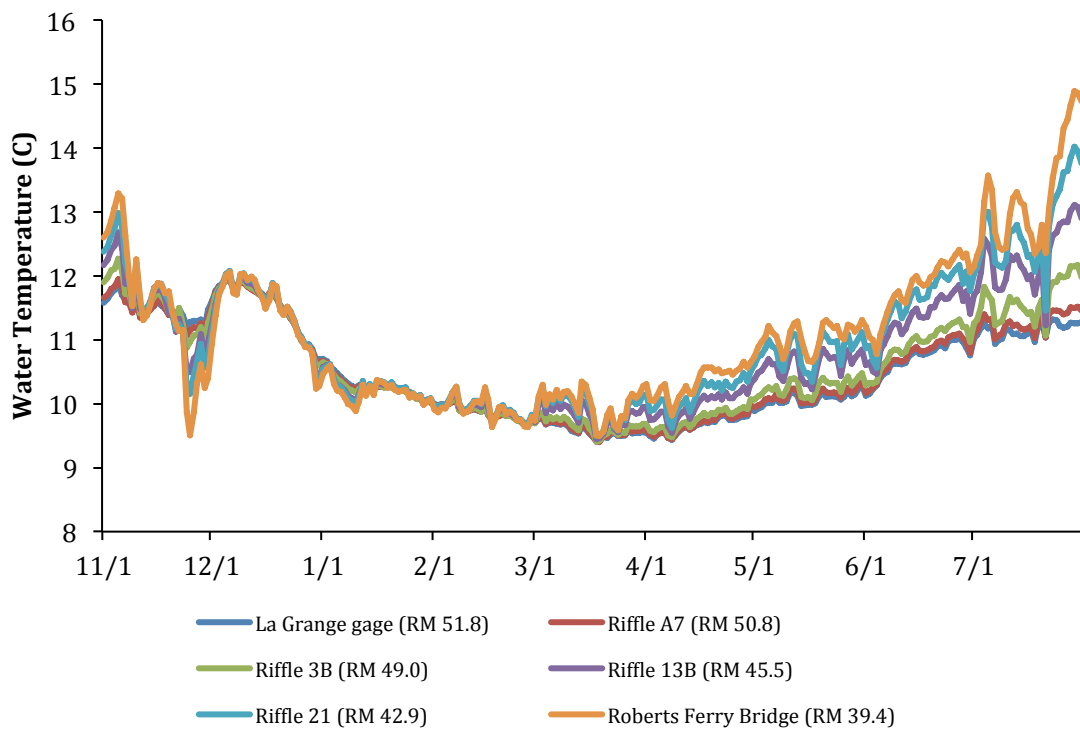


Figure 6. Tuolumne River daily average water temperature data.

On October 27, a male *O. mykiss* was tagged (tag code 7264.8) at RM 46.8 (NSO 066). This tag was detected near the release location on November 1. During the December 1 mobile survey, this tag was detected 2,615 m upstream of the release location. On December 9, it was detected an additional 1,370 m upstream at NSO 33. Although this fish was not detected again through mobile surveys, it was detected at the Zanker fixed receiver on March 20.

Tag code 7138.8 was captured and released on October 15 at RM 51.6 (NSO 005). On November 1, this tag was detected near the same location it was released. On November 28 and 30, this tag was detected passing the Zanker receiver. During the December 1 mobile survey, this tag was detected 2,725 m upstream of the Zanker receiver at NSO 054. On the following survey, December 9, it was detected an additional 5,715 m upstream near the original release location. Between January 1 through 16, this tag was again detected at the Zanker receiver. On the January 19 mobile survey, it was detected 11,010 m downstream from the original release location at NSO 095.

Tag code 7208.8 was captured and tagged at RM 45.0 (NSO 086) on October 19. This individual was detected 7 times between October 27 and February 2, with all detections within 220 m of the original release location.

Tag code 7152.8 was implanted into a male *O. mykiss* captured in NSO 008 at RM 51.4 on October 28. This individual was detected 4 four times between November 1 and May 13, with all detections within 70 m of the original release location.

The remaining nine tag codes (7026.8, 7040.8, 7180.8, 7222.8, 7236.8, 7250.8, 7278.8, 7292.8, and 7320.8) had limited detections during the mobile surveys, ranging from one to three detections during the November 1 –December 23 period. None of these tags were detected through mobile surveys after December 23. However, two of the tags (7222.8 and 7320.8) had multiple detections at the Zanker fixed receiver. Tag code 7222.8 was detected 245 times between October 27 and December 29, and tag code 7250.8 was detected 1,163 times between December 18 and March 5.

Discussion

Spawning locations of tagged adult O. mykiss

The ability to determine the spawning locations of adult *O. mykiss* was limited in 2011 due to a number of factors associated with the high river flows. These factors included increased background noise reducing detection efficiencies, inability to observe fish through snorkeling, and possibility of tagged fish moving into off-channel habitats that were not sampled.

Two acoustically tagged fish made large upstream movements in late fall/early winter, and moved back downstream near the original release locations. While spawning activity was not observed due to high flows, it is likely that these fish were spawning. Tag code 7166.8, implanted in a female, was detected on four occasions at NSO 014 (riffle A7, CDFG gravel introduction site) between December 1 and February 2.

Similarly, tag code 7264.8 was detected 3,985 m upstream of the original release location at NSO 033. Although this fish was not detected in any subsequent mobile surveys, it was detected at the Zanker receiver on March 20. Habitat unit NSO 033 is the same location that a post-spawn female *O. mykiss* was captured during 2010 sampling.

The capture and detection histories of these 3 individuals supports the thought that *O. mykiss* spawning occurs during the December through March period. There is limited data available on the spawn timing of *O. mykiss* in the San Joaquin basin, however it is believed to occur primarily from January through March (McEwan 2001).

Use of restored river reaches by tagged adult *O. mykiss*

Three fish were captured and tagged (tags 7040.8, 7054.8, and 7068.8) just downstream of the CDFG gravel introduction riffle 1A/1B (NSO 018-022) in a unit identified as sensitive *O. mykiss* habitat (McBain & Trush 2004). While these fish were not detected within the restoration reach, they were repeatedly detected in the same location and may have been attracted to this area by features associated with the restored habitat such as increased invertebrate production. No other *O. mykiss* were captured or detected within restored reaches of the Tuolumne River.

Seventeen of the 20 tagged fish were captured in eight habitat units that were identified as sensitive *O. mykiss* habitat (McBain & Trush 2004). The 2004 mapping surveys identified a total of 47 sites as sensitive *O. mykiss* habitat between La Grange Dam and Roberts Ferry Bridge, with 43 sites occurring above TLSRA.

Migration patterns of tagged adult *O. mykiss*

Operation of fixed acoustic arrays also provided information about straying of hatchery produced *O. mykiss* into the Tuolumne River. A total of 2209 hatchery produced yearling *O. mykiss* implanted with acoustic tags were released into the San Joaquin River at Durham Ferry (RM 66), approximately 23 miles downstream of the Grayson receiver, between March 22 and June 18, as part of USBR's six-year RPA studies. Thirteen of these tags were detected in the Tuolumne River at Grayson between June 26 and August 4. The time from release to initial detection at the Grayson receiver

ranged from 14 to 81 days (mean- 47 days). It is unknown whether the tagged fish were still alive, or had been consumed by predators that were migrating upstream. However, the acoustic signals from some of these tags and their detections over extended periods were similar to those of known tagged predators from other studies. This is the second consecutive spring that tagged fish from South Delta studies have been detected entering the Tuolumne River. Straying of hatchery-produced yearling *O. mykiss* has also been documented at the Stanislaus River Weir (Ryan Cuthbert, FISHBIO, personal communication).

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Appendix A.

Table A-1. Date, location, and biological data for all *O. mykiss* captured during 2010.

Capture Date	Reach	Length (mm)	Weight (grams)	Sex	Tagged (Y/N)	Tag Code	Tag/Body Ratio
3/23	La Grange	425	>600	M	Y	7054.8	< 2.3%
3/23	La Grange	450	>600	M	Y	7068.8	<2.2%
3/23	La Grange	505	>600	F	Y	7012.8	<2.2%
3/24	Basso	293	306.4	unknown	N		
3/24	Basso	272	249.0	unknown	N		
3/24	Basso	271	222.8	unknown	N		
3/24	Basso	310	335.0	unknown	N		
3/24	Basso	282	263.0	unknown	N		
3/24	Basso	225	134.6	unknown	N		
3/24	Basso	293	--	unknown	N		
3/29	Basso	368	479.0	F	Y	7110.8	2.8%
3/29	Basso	360	395.0	F	Y	7194.8	3.2%
3/29	Basso	353	395.7	F	Y	7124.8	3.3%
4/7	Basso	310	215.2	unknown	N		
4/7	Basso	307	216.0	unknown	N		
4/7	Basso	283	--	unknown	N		
4/7	Basso	290	--	unknown	N		
10/15	La Grange	257	194.5	unknown	N		
10/15	La Grange	314	313.0	unknown	Y	7138.8	3.8%
10/15	La Grange	230	140	unknown	N		
10/15	La Grange	218	99.6	unknown	N		
10/19	Basso	463	1128.0	F	Y	7026.8	1.2%
10/19 ^a	Basso	375	553.0	unknown	N		
10/19	Basso	370	508.0	unknown	Y	7222.8	2.4%
10/19	Basso	190	77.1	unknown	N		
10/19	Basso	360	552.0	unknown	Y	7208.8	2.2%
10/19	Basso	382	650.0	F	Y	7166.8	1.9%
10/19	Basso	210	101.4	unknown	N		
10/19	Basso	195	79.4	unknown	N		
10/19	Basso	200	87.8	unknown	N		
10/20	La Grange	350	520.0	unknown	Y	7236.8	2.3%
10/20	La Grange	400	908.0	F	Y	7040.8	1.4%
10/20	La Grange	360	492.0	unknown	Y	7250.8	2.5%
10/20 ^b	La Grange	497	1224.0	F	N		
10/20	La Grange	390	716.0	unknown	N		
10/27	Basso	320	420.0	M	Y	7264.8	2.8%
10/27	Basso	350	477.0	F	Y	7320.8	2.5%
10/27	Basso	210	109	unknown	N		
10/28	La Grange	502	1207	M	Y	7292.8	1.1%
10/28	La Grange	450	887	M	Y	7152.8	1.4%
10/28	La Grange	380	690	F	Y	7180.8	1.7%
10/28	La Grange	540	1619	F	Y	7278.8	0.7%

^aFish did not recover from surgery, sacrificed and given to CDFG.

^bRecapture of tag code 7012.8, tag was no longer active.