Modesto Irrigation District
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March 28, 2014

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12.3
888 First Street, NE
Washington, DC 20426

RE: Turlock and Modesto Irrigation Districts
Project No. 2299 – Article 58 Annual Report for 2013

Please find the enclosed 2013 Lower Tuolumne River annual report submitted to the Commission pursuant to Article 58 of the license for Project No. 2299 (76 FERC ¶ 61,117) and ordering paragraph (B) of the April 3, 2008 Order on Ten-Year Summary Report Under Article 58 (123 FERC ¶ 62,012). The report provides annual updates of Project operations and ongoing Chinook salmon monitoring activities required under Article 58. If you have any questions, please contact Steve Boyd at (209) 883-8364.

Respectfully submitted,

MODESTO IRRIGATION DISTRICT

Greg Dias
Project Manager

TURLOCK IRRIGATION DISTRICT

Steve Boyd
WRRA Director

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

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- FERC PROJECT NO. 2299 –

2013 ANNUAL SUMMARY REPORT

Turlock and Modesto Irrigation Districts

Background and Introduction

This is the sixth annual report to the Federal Energy Regulatory Commission (FERC) pursuant to the "Order on Ten-Year Summary Report Under Article 58" issued on April 3, 2008 (2008 Order). The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) ("Districts") have reported on operations and monitoring of the Don Pedro Project (Project) since 1972. A listing of the Article 39 and Article 58 technical reports filed from 1992 to the present is included in Section 9 at the end of this report.

An eight volume report pursuant to Article 39 of the License was filed in 1992 (20-Year Report) and included 28 technical reports. The 1996 Annual Report was filed in 1997 pursuant to the July 31, 1996 Order and consisted of seven volumes that included information for 1992-96 as well as other material not contained in the 20-Year Report. A Ten-Year Summary Report was filed in March 2005 as required by the 1996 Order and the Districts continued to file annual reports in 2005-2011.

The 2008 Order required, in part, (1) continued annual reporting by April 1 of San Joaquin River tributary salmon escapement numbers. Other directives of the 2008 Order pertaining to implementation and reporting of certain rainbow trout/steelhead (*Oncorhynchus mykiss*) monitoring elements have been completed in compliance with the Order and appear in previous Lower Tuolumne River Annual Report submittals.

This report covers the 2013 calendar year and contains:

(1) Fishery monitoring
(2) Other monitoring and studies
(3) Downstream issues
(4) Hydrology, flow schedules, and river operations
(5) Status of habitat restoration
(6) Coordination and regulatory information
(7) Technical reports on fishery/habitat monitoring and flow operations

The current FERC license for the Project on the Tuolumne River expires on April 30, 2016. On February 10, 2011, the Districts filed their notice of intent (NOI) to apply for a new license for the Project. The Don Pedro relicensing process is being reported separately under docket P-2299-075 and additional information may be found at the Project relicensing website: http://www.donpedro-relicensing.com/default.htm

1 - Fishery Monitoring

1.1 Fall-run Salmon Counts and Estimates

The commercial and sport ocean harvest season for fall-run Chinook salmon (*O. tshawytscha*) operated under traditional limits in California for the third consecutive year following the partial ban enforced in 2010. The Central Valley fall Chinook runs were similar to 2012 and catch totals were near projection estimates (PFMC 2014a). Exhibits 1 and 2 contain graphs of run estimates/counts for the current year and are summarized below.

1.1.1 San Joaquin Tributary Chinook Salmon Run Estimates

The San Joaquin River tributaries presently report fall run Chinook salmon escapement, with incidental numbers of Chinook salmon observed with other run timing outside of the September to mid-January period. The 2008 Order specified that the annual Article 58 report include a comparison the Stanislaus, Tuolumne, and Merced River Chinook salmon escapement (run) numbers. The California Department of Fish and Wildlife (CDFW) conducts their fall-run surveys on the tributaries each year and the Districts depend on them to provide such information in a timely manner. The CDFW estimates, previously obtained indirectly through an online CDFW "GrandTab" compilation, were not available as of March 17, 2014. The annual CDFW Tuolumne River fall spawning survey report for 2013 (Report 2013-1) along with preliminary carcass count data was also not available in time for this submittal. Summary details for these surveys, dating back to 1973 can be found in Report 2013-3, while specific details for any given year are in the annual survey reports as available. Results from the 2013 surveys are currently not available. A comparison of the Tuolumne River escapement to the Stanislaus River escapement can be made based on results of counting weir results from both rivers.

The counting weir operation was initiated at RM 24.5 on the Tuolumne River in 2009, with counting operations typically scheduled to begin in September of each year. The Tuolumne weir operation was supported by the Districts and CCSF and implemented by FISHBIO consultants, whom also operated a counting weir on the Stanislaus River. Weir operation in 2013 for both the Tuolumne and Stanislaus rivers was initiated in mid-September. The 2013 fall run weir count for the Tuolumne was 3,738 adult Chinook salmon, while a total of 5,457 salmon were counted at the Stanislaus weir (both counts through February 2, 2014). These counts represent an increase from the 2012 count of 2,114 salmon in the Tuolumne River and a decrease from the 2012 count of 7,043 salmon in the Stanislaus River.

CalFish, a cooperative program involving state and federal agencies is providing an updated system for accessing information on salmon escapement throughout California. The CalFish system is a query based, interactive website using the StreamNet database design. The system is currently operational, but does not contain data for the current year. It is expected that this new system will become fully updated and may ultimately replace the GrandTab reporting system. The CalFish website can be found at www.calfish.org.

The most recent CDFW spawning survey report is for the 2010 escapement. Consequently, Report 2013-2 only contains an abbreviated update for 2013, along with existing summary data from prior years. Report 2013-6 has a detailed review of the Tuolumne River counting weir operation in 2013.

1.1.2 Sacramento and Central Valley Fall-run Chinook Salmon Estimates

Overall numbers of fall-run salmon for the entire Central Valley (including hatcheries) and detailed numbers of fall-run escapements by tributary were not able to be developed in 2013 due to the unavailability of data from CDFW "Grand Tab" estimates. However, the Pacific Fishery Management Council (PFMC) also provides estimates for the Central Valley. The PFMC reports a total of 445,958 fall Chinook (hatchery and natural) for the Central Valley in 2013 (PFMC 2014a), which is greater than the revised total of 342,772 reported for 2012 and the highest since the 2003 total of 581,988.

The 2013 estimate of adult fall-run in the Sacramento basin was 404,666, higher than the revised 2012 total of 285,429 and greater than the PFMC upper management target of 180,000 combined hatchery and natural adults for the Sacramento River system (PFMC 2014a). The 2012 estimate was lower, however, than the PFMC escapement projection of 462,600 (PFMC 2014a).

The 2013 total number of estimated 2-year olds in the Sacramento basin was 20,248 (PFMC 2013b). The PFMC uses this estimate in their Sacramento Index (SI) as a predictor of population abundance for fishery management purposes. The SI forecast for the Sacramento basin in 2014 is 634,650 adults and is based on a newly implemented prediction formula using a logarithmic regression rather than a previously used linear regression. This forecast results in no projected restrictions during the 2014 salmon fishing season. Exhibits 1 and 2 contain graphs of historical harvest and abundance through 2013.

1.2 Seine Sampling

Report 2013-3 reviews the routine monitoring conducted in eleven beach seine surveys during January-June 2013 at eight Tuolumne River sites from RM 50.5-3.4 and two San Joaquin River locations. A total of 1,763 natural Chinook salmon were caught in the Tuolumne River and none in the San Joaquin River. This was similar to the salmon catch of 1,881 during the 2012 sampling period. Salmon were captured at Tuolumne River locations downstream to RM 24.9 (La Grange to Charles Road). There were no salmon captures in the lower section of the Tuolumne River and no captures in the two San Joaquin River locations upstream and downstream of the Tuolumne River confluence.

Density of fry (≤ 50 mm) peaked on January 29 and the density of juveniles peaked on May 7, similar in timing to other years of the 2007–2013 period. Fork length (FL) ranged from 28–104 mm. No fry were caught after the April 9 survey. A comparative review with other years is included in Report 2013-3. The seine report classifies "juvenile" salmon as >50 mm.

A total of 10 *O. mykiss* (26–75 mm FL) were caught in the Tuolumne River downstream to RM 31.6 from May 7–June 4. In addition to salmon, a total of 14 fish species were recorded in the Tuolumne River and 8 species in the San Joaquin River during the 2013 season.

1.3 Rotary Screw Trapping

Report 2013-4 reviews the 2013 rotary screw trap monitoring conducted near Waterford (RM 29.8) and near Grayson (RM 5.2) from January 2, 2013 through May 31, 2013 and includes a comparison with other years. Total juvenile salmon catches were 3,103 at the Waterford trap and 35 at the Grayson trap. The estimated total passage of salmon in 2013 was based on a revised linear model as reported in Robichaud andEnglish (2013). This method was then used to revise total passage estimates back to year 2006 at both the Waterford and Grayson sites.

The estimated total passage of salmon at Waterford in 2013 was 40,387 fish, a decrease from the revised estimate of 62,076 from the previous year. The Waterford estimate was comprised of 21,312 fry (<50 mm), 1,971 parr (50-69 mm), and 17,105 smolts (≥ 70 mm). The estimated passage of all lifestages decreased from the previous year estimate of 29,907 fry, 7,568 parr, and 24,601 smolts.

The estimated total passage of salmon at Grayson in 2013 was 642 fish, a decrease from the revised estimate of 2,268 from the previous year. The Grayson estimate was comprised of 6 fry (<50 mm), 7 parr (50-69 mm), and 629 smolts (≥ 70 mm). The estimated passage of all lifestages decreased from the previous year estimate of 72 fry, 10 parr, and 2,186 smolts.

An approximate survival index calculated between the upstream trap at Waterford and the downstream trap at Grayson was 1.6% in 2013. This index is developed from the ratio of estimated total passage at Grayson relative to the estimated total passage at Waterford and does not account for any salmon produced from spawning downstream of the Waterford trap site. The 2013 survival index was the lowest index calculated over the 2008-2013 period.

There were no captures of *O. mykiss* at the either the Waterford trap site or the Grayson trap site in 2013. There were 26 other fish species captured in the traps in 2013.

<u>1.4 Reference Count Snorkeling</u>

Report 2013-5 reviews the snorkel survey that was conducted on July 24-26 within the RM 31.5-50.7 (Waterford to La Grange) reach of the Tuolumne River. The survey was conducted at a flow of approximately 100 cfs with water temperature ranging from 12.9°C (55.2 °F) to 30.0°C (81.1 °F). A total of 93 juvenile Chinook salmon and 385 *O. mykiss* were recorded during the survey.

Chinook salmon were observed downstream to Riffle 7 (RM 46.9) and *O. mykiss* downstream to Riffle 23C (RM 42.3). Other native fish species observed were Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), hardhead (*Mylopharodon conocephalus*), and riffle sculpin (*Cottus gulosus*). Non-native species observed included bluegill sunfish (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*M. dolomieu*). Report 2013-5 also contains a comparison with other years, dating back to 1982.

<u>1.5 Counting Weir</u>

The year 2013 represents the fifth consecutive year in which the counting weir was operational on the Tuolumne River. A similar weir has been in operation on the Stanislaus River since 2003. Report 2013-6 provides detailed results and sampling conditions for the Tuolumne River weir during the 2013-2014 Fall/Winter monitoring season, which totaled 3,664 adult Chinook salmon counted for the lower Tuolumne River at RM 24.5 from September 24, 2013 through December 31, 2013. The 2013 Tuolumne River passage was the highest recorded over the 2009–2013 period. As discussed in previous annual spawning survey reports (e.g., report 2010-1), the weir count does not include fish spawning downstream of RM 24.5. There was no *O. mykiss* passage at the Tuolumne River weir in 2013.

2 - Other TRTAC Monitoring and Studies

2.1 Temperature

Daily average thermograph data and daily max-min air temperatures are graphed in Part 2 of Attachment A. Complete thermograph data for the Tuolumne and San Joaquin Rivers are posted at the TRTAC website, http://tuolumnerivertac.com/data.htm.

3 – Downstream Issues

Important factors influencing salmonid populations occur downstream of the Tuolumne River from the San Joaquin River to the Pacific Ocean where they spend most of their life. Some of these are reviewed in this section. Exhibits 3 and 4 have information on the size and numbers of salmon captured in sampling efforts from lower tributary stations, the San Joaquin River, and the Delta export facilities. Those include rotary screw trap, trawl, and export salvage sampling programs within the January-June season that spans the juvenile salmon (fry to smolt) rearing and migration period. Juvenile density increased in 2013 compared with 2012 for the Mossdale trawl catch and in the export salvage. [It should be noted that in the 2012 Summary Report, the export values (cfs) associated with the State Water Project and the Central Valley Project were inadvertently reversed in the table Exhibit 4A. As a result, computational data provided in 2012 for Exhibit 4A along with figures Exhibit 4D and 4E require revision].

3.1 Ocean Conditions

Central Valley Chinook salmon spend the majority of their lives in the eastern Pacific Ocean and the influence of ocean conditions on their growth and survival is widely recognized (Williams 2006). Temperature, upwelling, and general productivity of the Northern California Current vary considerably from year to year and the understanding of that environment has increased in recent years. The Northwest Fisheries Science Center (NWFSC) reported conditions in 2013 as being mixed with climate indicators, such as PDO (Pacific Decadal Oscillation) and El Niño reported as 'neutral', and sea surface temperatures warmer than usual. Biological indicators pointed to good ocean conditions, with large, lipid-rich zooplankton present in high numbers. The 2013 conditions were reported to indicate good returns of coho salmon in 2014 and both coho and Chinook salmon in 2015. Details pertaining to the NWFSC forecasts are available at NWFSC website (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/g-forecast.cfm). The effects of ocean conditions may not be evident for years until salmon cohorts (year classes) return to spawn.

3.2 Delta Issues

3.2.1. Salmon salvage and losses at Delta water export facilities

Exhibit 4 contains 2013 State Water Project (SWP) and Federal Central Valley Project (CVP) delta water export facility salmon salvage and loss information. Natural/unmarked salmon salvage for January-June at the facilities was higher in 2013 with combined facility estimates of 4,534 salmon salvaged compared with 923 in 2012. The number of salmon losses at the facilities was also higher in 2013 (total estimate of 8,649) compared with 2012 (total estimate of 2,335). The overall average export rate for this period was similar in 2013 compared with 2012. The reported numbers do not include associated indirect losses within the Delta. Additionally, the salvage loss estimates for fry (mostly in Jan-Mar) may be inherently low due to reduced screening efficiency. It is not known how many of these salmon were from the San Joaquin basin, but salmon within the same size range and timing are recorded in catches from tributary and mainstem (Mossdale) sampling programs (Exhibit 3).

Few salmon fry (<50 mm) were reported at the facilities from January-April. There was a predominant salvage of larger juveniles/smolts (75-90 mm) from mid-April through mid-June. Weekly density (combined salvage and loss/1,000 AF of export) was highest during April and May at both facilities.

3.2.2 Spring smolt conditions and evaluation

The Delta Operations for Salmonids and Sturgeon (DOSS) Technical Working Group is the primary agency organization for providing information on conditions in the Delta pertaining to Chinook salmon. The DOSS group provides recommendations to the Water Operations Management Team (WOMT) and the National Marine Fisheries Service (NMFS) for real-time management of the CVP and SWP. The DOSS also provides annual reports and oversees the implementation of the acoustic tag experiments involving San Joaquin River fish, among other tasks. A detailed description of DOSS along with meeting notes and a listing of annual reports can be found at: http://www.swr.noaa.gov/ocap/doss.htm.

The DOSS (2013) annual report includes information on the 6-year steelhead tagging study designed to provide information on increasing survival of salmonids as they migrate through the Delta to the ocean. Based on the findings, DOSS will make recommendations to NMFS, Reclamation, CDFW, DWR, and FWS on future actions to be undertaken in the San Joaquin Basin as part of an adaptive management approach aimed at analyzing distinct combinations of outflow and export as a measure of how salmonid survival through the Delta is influenced by inflow from the San Joaquin River.

The 2013 tagging study represents the third year of the 6-Year Acoustic Tag Experiment as required by the 2009 NMFS Biological Opinion (NMFS 2009). The 2013 tagging study included three release groups, ranging from 468 to 480 acoustically tagged steelhead smolts from the Mokelumne River Hatchery during March–May, which generally coincided with the Tuolumne River spring pulse flow release (See Section 4 for specific pulse flow volumes for the Tuolumne River). The releases were made into the San Joaquin River at Durham Ferry, downstream of both the Tuolumne and Stanislaus rivers and upstream of Old River. The study does not impose additional pulse flow volumes on the tributaries as was the case in previous years under the now-expired San Joaquin River Agreement (SJRA). Data analysis for this study is currently ongoing. A review of the 2013 study did not result in any proposed changes to the study, although an alternative loss calculation equation was evaluated using data from the previous two years (DOSS 2013).

3.2.3 Other Delta and San Joaquin Basin issues

Results from the Stipulation Study were analyzed in 2013 and reported by DWR in February 2014 (DWR 2014). The study was the result of the January 12, 2012, Plaintiffs, Plaintiff-Intervenor, and Federal Defendants to the Consolidated Salmonid Cases filed with the Federal court requiring a joint stipulation that included changes in Central Valley Project and State Water Project operations for April and May 2012[1].

The study involved tracking acoustically tagged steelhead smolts from the Mokelumne River Hatchery through the Delta under varying hydrodynamic conditions adaptively managed using Old and Middle River (OMR) reverse flows as related to the SWP/CVP export rates. The study was conducted in April and May 2012 and was designed to evaluate the migration rate, net migration direction, and survival rate based on three release groups into the San Joaquin River at Buckley Cove, downstream of Stockton, CA and tracked to Chipps Island. A total of three OMR reverse flow scenarios were tested, with results indicating little to no influence on the behavior of the tagged fish. Recommendations were made to conduct additional studies under a broader range of OMR flows.

The CDFW released the Salmon Simulator (SalSim) model developed for the San Joaquin River Restoration Program (SJRRP) to the public in June 2013. The SalSim model is designed to make estimates of fall-run Chinook salmon escapements in the San Joaquin Basin based on a variety of environmental and operational factors extending from Friant Dam downstream into the Delta. Several modifications to the model are pending additional funding. The model and user manual is available at: http://www.salsim.com/.

4 – Hydrology, Flow Schedules, and River Operations

The 2013 calendar year included part of the 2013 and 2014 water years (WY) from October 1st through September 30th. The preliminary WY2013 Tuolumne River computed natural runoff was 56% of the long-term average (http://cdec.water.ca.gov/cgi-progs/reports/FLOWOUT.201309). The final 2013 San Joaquin Basin 60-20-20 Water Supply Index was calculated at 1,706,346 (described in the October 8, 1013 letter) and corresponds to releases associated with "Median Critical" Water Year in the Article 37 classification, which run from April 15th through April 14th. The daily average computed natural flow, actual La Grange flow, and fish flow schedules of WYs 2013 and 2014 are graphed in Part 1 of Attachment A; actual flows at other SJR basin locations, Delta exports, Don Pedro Reservoir storage, and snow and precipitation data are also included.

Calendar year 2013 included Article 37 minimum flow and pulse flow requirements spanning the 2012 and 2013 FFYs. Part 3 of Attachment A contains the primary flow schedule correspondence. The final volume used in the April 2013 scheduling process was 108,482 AF representing a decrease from the maximum requirement of 127,346 AF scheduled in the previous

[1] Case 1:09-CV-1053 LJO-DLB ("Salmonid") Doc 659-2 - "Joint Stipulation Regarding CVP and SWP Operations in 2012"

year due to below average runoff conditions.
The spring (outmigration) pulse flow volume of 20,091 AF during April 15-May 7 (as shown in the October 8, 2013 letter), was scheduled with a base flow of 150 cfs to provide a pulse flow peaks of 750 cfs (April 21), 950 cfs (April 27), and 1,150 cfs (May 2) along with associated ramping flows. The fall (attraction) pulse flow volume of 5,482 AF was scheduled with the base flow of 126 cfs to provide a peak flow of 600 cfs from October 23-25, 2013 along with associated ramping flows.

There were no flood management releases pursuant to ACOE criteria required in 2013 as the Don Pedro Reservoir water surface elevation did not encroach the designated flood control storage space as shown in the graph in Part 1 of Attachment A.

5 – TRTAC Habitat Restoration Activities

As directed under the 1995 FSA, the TRTAC developed ten top priority habitat restoration projects aimed at improving both geomorphic and biological components of the lower Tuolumne River corridor. TID had acted as the Project Manager on behalf of the TRTAC for implementation of grant funding of these projects. No TRTAC habitat restoration activities have been undertaken since 2007.

The table below lists these projects under three categories (Channel and Riparian Restoration, Predator Isolation, and Sediment Management).

TRTAC Habitat Restoration Projects	Current Status
Channel and Riparian Restoration Projects	
Gravel Mining Reach Phase I (7-11 Segment)	Completed in 2003.
Gravel Mining Reach Phase II (MJ Ruddy Segment)	Design work completed. Implementation funding withheld.
Gravel Mining Reach Phase III (Warner-Deardorff Segment)	Design work completed. Implementation funding withheld.
Gravel Mining Reach Phase IV (Reed Segment)	Cost estimate developed, but no funding source was ever identified.
Predator Isolation Projects	
Special Run-Pool (SRP) 9	Completed in 2001.
Special Run-Pool (SRP) 10	Phase I hydraulic modeling and design completed in 2006. No Phase II funding for acquisition and construction has been identified.
Sediment Management Projects	
Riffle Cleaning (Fine sediment)	Survival to emergence study and pool sand volume assessment completed. Funding and permitting of Riffle Cleaning to be determined.
Gasburg Creek basin (Fine sediment)	Completed in 2007.
Gravel augmentation near La Grange (Coarse sediment)	Coarse Sediment Management Plan and Design Manual completed in 2006. Implementation funding

	withheld.
River Mile 43 (Coarse sediment)	Completed in 2005.

Four of the ten identified TRTAC projects have been completed. Three other projects followed a rigorous and competitive review/selection process, with substantial CALFED grant funding being approved. However, as reviewed in previous annual reports, funding for these projects was later withheld. Considerable FSA and the federal AFRP funds were expended for extensive related pre-project efforts, including proposal development and refinement, completion of the Habitat Restoration Plan, the Floodway Restoration Design Manual, and the Coarse Sediment Management Plan. Two of the projects were partially implemented, and the remaining project (Gravel Mining Reach Phase IV) had a cost estimate developed and was pending completion of the prior channel restoration projects.

A restoration project at Bobcat Flat (RM 43) initiated in two phases by the Friends of the Tuolumne (now Tuolumne River Conservancy) in 2005 was completed in September 2011, with post-project monitoring by USFWS occurring in 2012 and 2013.

6 – Tuolumne River Technical Advisory Committee (TRTAC)

Four quarterly TRTAC meetings were held in 2013: March, June, September, and December; the fishery agencies did not attend any of the meetings in 2013. Attachment B contains the 2013 TRTAC meeting agendas, summaries, handouts, and other materials. The website (http://tuolumnerivertac.com/) was used for posting various TRTAC related items (documents, reports, correspondence, meeting materials, etc.) and other fishery/habitat information.

7 - References

Delta Operations for Salmonids and Sturgeon (DOSS) 2013. Annual Report of Activities, October 1, 2012, to September 30, 2013. Technical Working Group. October 2013.

Department of Water Resources (DWR) 2014. Stipulation Study: Steelhead Movement and Survival in the South Delta with Adaptive Management of Old and Middle River Flows. Prepared by D. Delaney, P. Bergman, B. Cavallo, and J. Melgo. Cramer Fish Sciences. Auburn, CA. February 2014.

FERC (Federal Energy Regulatory Commission). 2008. Order on ten-year summary report under article 58. April 3. 123 FERC ¶62,012.

National Marine Fisheries Service (NMFS) 2009. Final Biological Opinion and Conference Opinion of the Proposed Long-term Operations of the Central Valley Project and State Water Project. U.S. Department of Commerce National Marine Fisheries Service. 4 June 2009.

Pacific Fishery Management Council (PFMC) 2014a. Review of 2013 Ocean Salmon Fisheries. Portland, OR. February 2014. http://www.pcouncil.org/wp-content/uploads/salsafe2013.pdf

PFMC 2014b. Preseason Report 1: Stock Abundance Analysis and Environmental Assessment Part I for 2014 Ocean Salmon Fishery Regulations. Portland, OR. February 2014. Available at: http://www.pcouncil.org/wp-content/uploads/Preseason_Report_I_2014_FINAL.pdf

Robichaud, D. and K. English. 2013. Analysis of Tuolumne River Rotary Screw Trap Data to examine the relationship between river flow and survival rates for Chinook smolts migrating between Waterford and Grayson (2006-12). LGL Limited, British Columbia, Canada. Draft Report submitted to Turlock and Modesto Irrigation Districts.

Williams, John G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science. Vol. 4, Issue 3 (December 2006), Article 2. http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2

8 - General List of Acronyms and Abbreviations

ACOE	Army Corps of Engineers
AF	acre-feet, a measure of water volume
AFRP	Anadromous Fish Restoration Program (part of USFWS)
AMF	Adaptive Management Forum
AT	air temperature
BAWSCA	Bay Area Water Supply and Conservation Agency
C	degrees Celsius
CALFED	now known as California Bay-Delta Authority
CBDA	California Bay-Delta Authority
CCSF	City and County of San Francisco
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDRR	combined differential recovery rate
cfs	cubic feet per second, a measure of flow rate
CRRF	California Rivers Restoration Fund
CSPA	California Sportfishing Protection Alliance
CWT	coded wire tag
CVP	Central Valley Project
CY	cubic yard
DPS	distinct population segment
DOSS	Delta Operations for Salmonids and Sturgeon
DWR	Department of Water Resources
ESA	Endangered Species Act
ESU	evolutionarily significant unit
F	degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
FL	fork length
FOT	Friends of the Tuolumne
FSA	Don Pedro Project 1995 FERC Settlement Agreement
FWS	see USFWS
HORB	Head of Old River Barrier
HRI	harvest rate index
IEP	Interagency Ecological Program
IFIM	Instream flow incremental methodology
mm	millimeter
MID	Modesto Irrigation District

NHI	Natural Heritage Institute
NMFS	National Marine Fisheries Service
NOAA Fisheries	also National Marine Fisheries Service
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NWFSC	Northwest Fisheries Science Center
NWS	National Weather Service
ORNL	Oak Ridge National Laboratory
PFMC	Pacific Fishery Management Council
R(letter and/or #)	specific riffle (location identifier, e.g. RA7 is Riffle A7)
RM	river mile
RST	rotary screw trap
SI	Sacramento Index
SJR	San Joaquin River
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SRP	Special Run/Pool (mined area of river, usually with #, e.g. SRP 9)
SWP	State Water Project
TID	Turlock Irrigation District
TRE	Tuolumne River Expeditions
TRT	Tuolumne River Trust
TRTAC	Tuolumne River Technical Advisory Committee
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VAMP	Vernalis Adaptive Management Plan
WOMT	Water Operations Management Team
WT	water temperature
WY	Water Year
YOY	Young of Year

9 - List of 1992-2013 Technical Reports by Topic

Salmon Population Models

1992 Appdx. 1: Population Model Documentation
1992 Appdx. 26: Export Mortality Fraction Submodel
1992 Appdx. 2: Stock Recruitment Analysis of the Population Dynamics of San Joaquin River System Chinook salmon
Report 1996-5: Stock-Recruitment Analysis Report

Salmon Spawning Surveys

1992 Appdx. 3: Tuolumne River Salmon Spawning Surveys 1971-88
Report 1996-1: Spawning Survey Summary Report
- 96-1.1 1986 Spawning Survey Report
- 96-1.2 1987 Spawning Survey Report
- 96-1.3 1988 Spawning Survey Report
- 96-1.4 1989 Spawning Survey Report
- 96-1.5 1990 Spawning Survey Report
- 96-1.6 1991 Spawning Survey Report
- 96-1.7 1992 Spawning Survey Report
- 96-1.8 1993 Spawning Survey Report
- 96-1.9 1994 Spawning Survey Report
- 96-1.10 1995 Spawning Survey Report
- 96-1.11 1996 Spawning Survey Report
- 96-1.12 Population Estimation Methods

1997-1: 1997 Spawning Survey Report and Summary Update
1998-1: Spawning Survey Summary Update
1999-1: 1998 Spawning Survey Report
2000-1: 1999 and 2000 Spawning Survey Reports
2000-2: Spawning Survey Summary Update
2001-1: 2001 Spawning Survey Report
2001-2: Spawning Survey Summary Update
2002-1: 2002 Spawning Survey Report
2002-2: Spawning Survey Summary Update
2003-1: Spawning Survey Summary Update
2004-1: 2003 and 2004 Spawning Survey Reports
2004-2: Spawning Survey Summary Update
2006-1: 2005 and 2006 Spawning Survey Reports
2006-2: Spawning Survey Summary Update
2007-1: 2007 Spawning Survey Report
2007-2: Spawning Survey Summary Update
2008-2: Spawning Survey Summary Update
2009-1: 2008 and 2009 Spawning Survey Reports
2009-2: Spawning Survey Summary Update
2009-8: 2009 Counting Weir Report
2010-1: 2010 Spawning Survey Report
2010-2: Spawning Survey Summary Update

2010-8: 2010 Counting Weir Report
2011-2: Spawning Survey Summary Update
2011-8: 2011 Tuolumne River Weir Report
2012-2: Spawning Survey Summary Update
2012-6: 2012 Tuolumne River Weir Report
2013-2: Spawning Survey Summary Update
2013-6: 2013 Tuolumne River Weir Report

Seine, Snorkel, Fyke Reports and Various Juvenile Salmon Studies

1992 Appdx. 10: 1987 Juvenile Chinook salmon Mark-Recapture Study
1992 Appdx. 12: Data Reports: Seining of Juvenile Chinook salmon in the Tuolumne, San Joaquin, and Stanislaus Rivers, 1986-89
1992 Appdx. 13: Report on Sampling of Chinook Salmon Fry and Smolts by Fyke Net and Seine in the Lower Tuolumne River, 1973-86
1992 Appdx. 20: Juvenile Salmon Pilot Temperature Observation Experiments
Report 1996-2: Juvenile Salmon Summary Report
96-2.1 1986 Snorkel Survey Report
96-2.2 1988-89 Pulse Flow Reports
96-2.3 1990 Juvenile Salmon Report
96-2.4 1991 Juvenile Salmon Report
96-2.5 1992 Juvenile Salmon Report
96-2.6 1993 Juvenile Salmon Report
96-2.7 1994 Juvenile Salmon Report
96-2.8 1995 Juvenile Salmon Report
96-2.9 1996 Juvenile Salmon Report
96-9 Aquatic Invertebrate Report
1997-2: 1997 Juvenile Salmon Report and Summary Update
1998-2: 1998 Juvenile Salmon Report and Summary Update
1999-4: 1999 Juvenile Salmon Report and Summary Update
2000-3: 2000 Seine/Snorkel Report and Summary Update
2001-3: 2001 Seine/Snorkel Report and Summary Update
2002-3: 2002 Seine/Snorkel Report and Summary Update
2003-2: 2003 Seine/Snorkel Report and Summary Update
2004-3: 2004 Seine/Snorkel Report and Summary Update
2005-3: 2005 Seine/Snorkel Report and Summary Update
2006-3: 2006 Seine/Snorkel Report and Summary Update
2007-3: 2007 Seine/Snorkel Report and Summary Update
2008-3: 2008 Seine Report and Summary Update
2008-5: 2008 Snorkel Report and Summary Update
2009-3: 2009 Seine Report and Summary Update
2009-5: 2009 Snorkel Report and Summary Update
2010-3: 2010 Seine Report and Summary Update
2010-5: 2010 Snorkel Report and Summary Update
2011-3: 2011 Seine Report and Summary Update
2011-5: 2011 Snorkel Report and Summary Update
2012-3: 2012 Seine Report and Summary Update

2012-5: 2012 Snorkel Report and Summary Update
2013-3: 2012 Seine Report and Summary Update
2013-5: 2012 Snorkel Report and Summary Update

Screw Trap Monitoring
1996-12: Screw Trap Monitoring Report: 1995-96
1997-3: 1997 Screw Trap and Smolt Monitoring Report
1998-3: 1998 Tuolumne River Outmigrant Trapping Report
1999-5: 1999 Tuolumne River Upper Rotary Screw Trap Report
2000-4: 2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
2000-5: 1999-2000 Grayson Screw Trap Report
2001-4: 2001 Grayson Screw Trap Report
2004-4: 1998, 2002, and 2003 Grayson Screw Trap Reports
2004-5: 2004 Grayson Screw Trap Report
2005-4: 2005 Grayson Screw Trap Report
2005-5: Rotary Screw Trap Summary Update
2006-4: 2006 Rotary Screw Trap Report
2006-5: Rotary Screw Trap Summary Update
2007-4: 2007 Rotary Screw Trap Report
2008-4: 2008 Rotary Screw Trap Report
2009-4: 2009 Rotary Screw Trap Report
2010-4: 2010 Rotary Screw Trap Report
2011-4: 2011 Rotary Screw Trap Report
2012-4: 2012 Rotary Screw Trap Report
2013-4: 2012 Rotary Screw Trap Report

Fluctuation Assessments
1992 Appdx. 14: Fluctuation Flow Study Report
1992 Appdx. 15: Fluctuation Flow Study Plan: Draft
Report 2000-6: Tuolumne River Chinook Salmon Fry and Juvenile Stranding Report
2005 Ten-Year Summary Report Appdx. E: Stranding Survey Data (1996-2002)

Predation Evaluations
1992 Appdx. 22: Lower Tuolumne River Predation Study Report
1992 Appdx. 23: Effects of Turbidity on Bass Predation Efficiency
2006-9: Lower Tuolumne River Predation Assessment Final Report

Smolt Monitoring and Survival Evaluations
1992 Appdx. 21: Possible Effects of High Water Temperature on Migrating Salmon Smolts in the San Joaquin River
1996-13: Coded-wire Tag Summary Report
1998-4: 1998 Smolt Survival Peer Review Report
1998-5: CWT Summary Update
1999-7: Coded-wire Tag Summary Update
2000-4: 2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
2000-8: Coded-wire Tag Summary Update
2001-5: Large CWT Smolt Survival Analysis

2001-6: Coded-wire Tag Summary Update
2002-4: Large CWT Smolt Survival Analysis
2002-5: Coded-wire Tag Summary Update
2003-3: Coded-wire Tag Summary Update
2004-7: Large CWT Smolt Survival Analysis Update
2004-8: Coded-wire Tag Summary Update
2005-6: Coded-wire Tag Summary Update
2006-6: Coded-wire Tag Summary Update
2007-5: Coded-wire Tag Summary Update

Fish Community Assessments

1992 Appdx. 24: Effects of Introduced Species of Fish in the San Joaquin River System
1992 Appdx. 27: Summer Flow Study Report 1988-90
Report 1996-3: Summer Flow Fish Study Annual Reports: 1991-94
- 96-3.1 1991 Report
- 96-3.2 1992 Report
- 96-3.3 1993 Report
- 96-3.4 1994 Report

2001-8: Distribution and Abundance of Fishes Publication
2002-9: Publication on the Effects of Flow on Fish Communities
2007-7: 2007 Rainbow Trout Data Summary Report
2008-6: 2008 July *Oncorhynchus mykiss* Population Estimate Report
2010 Tuolumne River *Oncorhynchus mykiss* Monitoring Report (submitted January 15)
Attachment 5: March and July 2009 Population Estimates of *Oncorhynchus mykiss* Report
2011 Tuolumne River *Oncorhynchus mykiss* Monitoring Summary Report (submitted January 15)
2010-6: 2010 *Oncorhynchus mykiss* Population Estimate Report
2010-7: 2010 *Oncorhynchus mykiss* Acoustic Tracking Report
2011-6: 2011 *Oncorhynchus mykiss* Population Estimate Report
2011-7: 2011 *Oncorhynchus mykiss* Acoustic Tracking Report

Invertebrate Reports

1992 Appdx. 16: Aquatic Invertebrate Studies Report
1992 Appdx. 28: Summer Flow Invertebrate Study
Report 1996-4: Summer Flow Aquatic Invertebrate Annual Reports: 1989-93
- 96-4.1 1989 Report
- 96-4.2 1990 Report
- 96-4.3 1991 Report
- 96-4.4 1992 Report
- 96-4.5 1993 Report

1996-9: Aquatic Invertebrate Report
2002-8: Aquatic Invertebrate Report
2004-9: Aquatic Invertebrate Monitoring Report (2003-2004)
2008-7: Aquatic Invertebrate Monitoring (2005, 2007, 2008) and Summary Update
2009-7: 2009 Aquatic Invertebrate Monitoring and Summary Update

Delta Salmon Salvage

1999-6: 1993-99 Delta Salmon Salvage Report

Gravel, Incubation, and Redd Distribution Studies

1992 Appdx. 6: Spawning Gravel Availability and Superimposition Report (incl. map)
1992 Appdx. 7: Salmon Redd Excavation Report
1992 Appdx. 8: Spawning Gravel Studies Report
1992 Appdx. 9: Spawning Gravel Cleaning Methodologies
1992 Appdx. 11: An Evaluation of the Effect of Gravel Ripping on Redd Distribution
1996-6: Redd Superimposition Report
1996-7: Redd Excavation Report
1996-8: Gravel Studies Report: 1987-89
1996-10: Gravel Cleaning Report: 1991-93
2000-7: Tuolumne River Substrate Permeability Assessment and Monitoring Program Report
2006-7: Survival to Emergence Study Report
2008-9: Monitoring of Winter 2008 Runoff Impacts from Peaslee Creek

Water Temperature and Water Quality

1992 Appdx. 17: Preliminary Tuolumne River Water Temperature Report
1992 Appdx. 18: Instream Temperature Model Documentation: Description and Calibration
1992 Appdx. 19: Modeled Effects of La Grange Releases on Instream Temperatures in the Lower Tuolumne River
1996-11: Intragravel Temperature Report: 1991
1997-5: 1987-97 Water Temperature Monitoring Data Report
2002-7: 1998-2002 Temperature and Conductivity Data Report
2004-10: 2004 Water Quality Report
2007-6: Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007

IFIM Assessment

1992 Appdx. 4: Instream Flow Data Processing, Tuolumne River
1992 Appdx. 5: Analysis of 1981 Lower Tuolumne River IFIM Data
1995 USFWS Report on the Relationship between Instream Flow and Physical Habitat Availability (submitted by Districts to FERC in May 2004)

Flow and Delta Exports

1997-4: Streamflow and Delta Water Export Data Report
2002-6: 1998-2002 Streamflow and Delta Water Export Data Report
2003-4: Review of 2003 Summer Flow Operation
2007-6: Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007
2008-8: Review of 2008 Summer Flow Operation
2009-6: Review of 2009 Summer Flow Operation

Restoration, Project Monitoring, and Mapping

1996-14: Tuolumne River GIS Database Report and Map
1999-8: A Summary of the Habitat Restoration Plan for the Lower Tuolumne River Corridor

1999-9: Habitat Restoration Plan for the Lower Tuolumne River Corridor
1999-10: 1998 Restoration Project Monitoring Report
1999-11: 1999 Restoration Project Monitoring Report
2001-7: Adaptive Management Forum Report
2004-12: Coarse Sediment Management Plan
2004-13: Tuolumne River Floodway Restoration (Design Manual)
2005 Ten-Year Summary Report Appdx. D: Salmonid Habitat Maps
2005 Ten-Year Summary Report Appdx. F: GIS Mapping Products
2005-7: Bobcat Flat/River Mile 43: Phase 1 Project Completion Report
2006-8: Special Run Pool 9 and 7/11 Reach: Post-Project Monitoring Synthesis Report
2006-10: Tuolumne River La Grange Gravel Addition, Phase II Annual Report
2006-11: Tuolumne River La Grange Gravel Addition, Phase II Geomorphic Monitoring Report

General Monitoring Information
1992 Fisheries Studies Report
2002-10: 2001-2002 Annual CDFW Sportfish Restoration Report
2005 Ten-Year Summary Report

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Exhibits

1. Spawning run estimates
    1.1. San Joaquin River tributary estimates
    1.2. Other Central Valley Fall-run estimates
2. Salmon harvest and Sacramento abundance data
    2.1. California Chinook ocean harvest
    2.2. Sacramento River Fall-run Estimates
    2.3. Abundance Index and Harvest Rates
3. January-June 2013 Basin salmon rearing/outmigration data
    3.1. Tributary screw trap catches and San Joaquin River (Mossdale) trawl catch
    3.2. Average size in catch and delta salvage
    3.3. Mossdale catch individual size and mark
4. January-June 2013 delta salmon salvage data, water exports, and basin flows
    4.1. Table of weekly salvage and flow/export data
    4.2. Graphs of estimated salvage/loss numbers and density (relative abundance)
    4.3. Weekly average flow and exports
    4.4. Size and hatchery origin of delta salvage
    4.5. Daily San Joaquin Basin flows and rainfall

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Exhibit 1 – Spawning run estimates

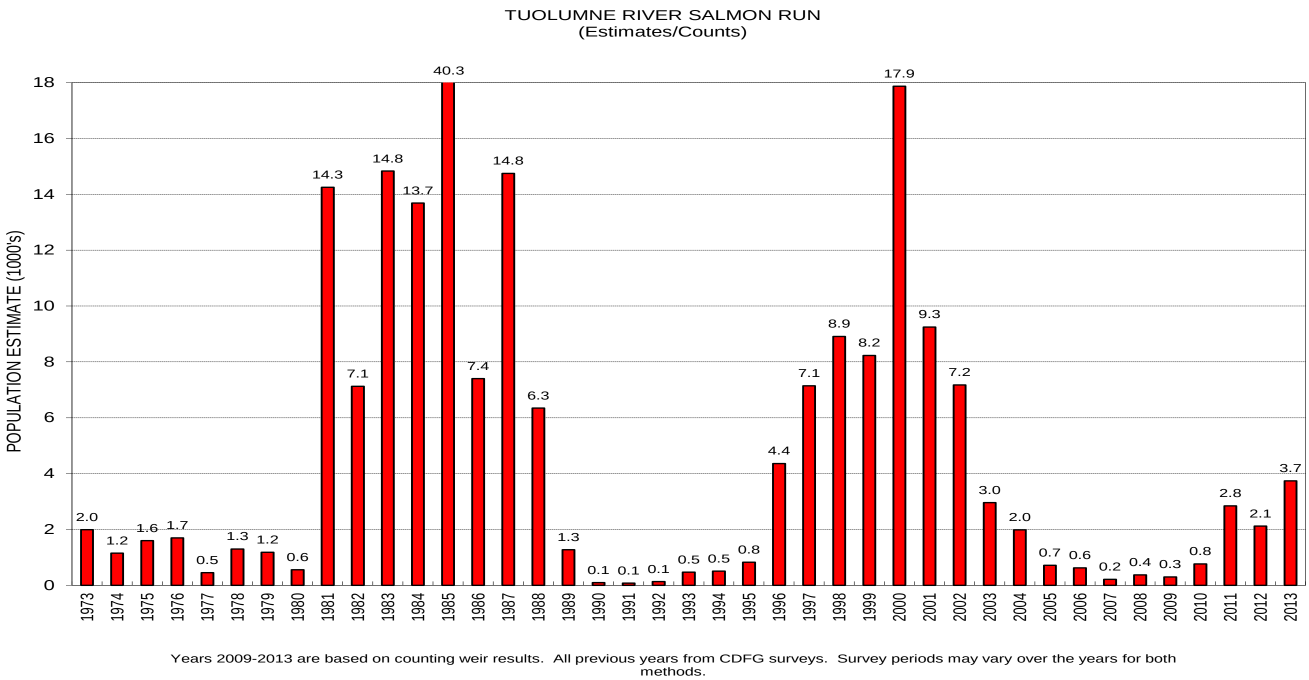


Exhibit 1A

San Joaquin River Tributaries Fall-run Salmon Estimates – Hatcheries are on Merced and Mokelumne (Mokelumne is an Eastside Delta tributary)

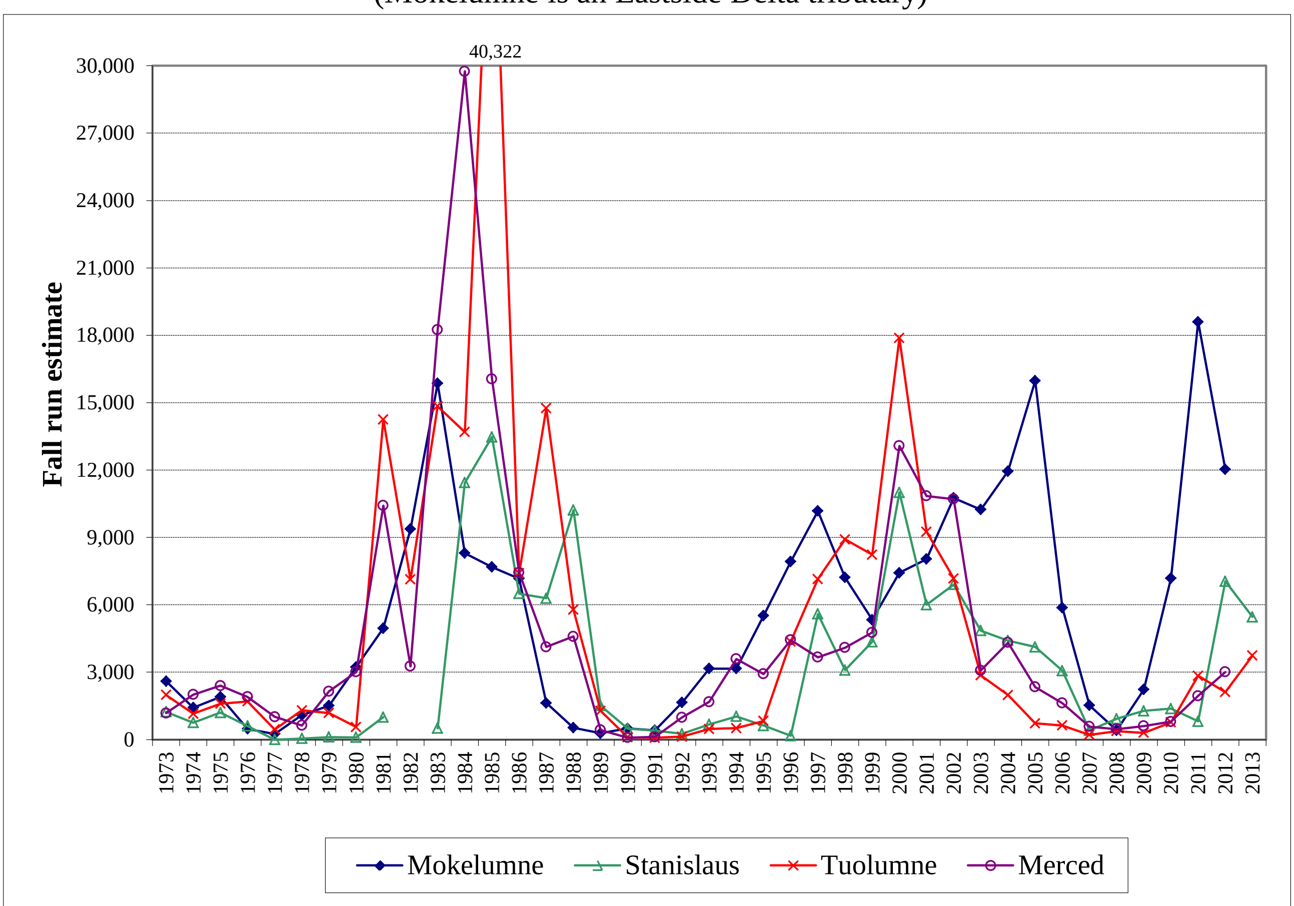


Exhibit 1B [2013 data for Mokelumne and Merced Rivers not available as of March 2014.]

Some Fall-run salmon rivers in Sacramento Basin
(Yuba River does not have a hatchery)

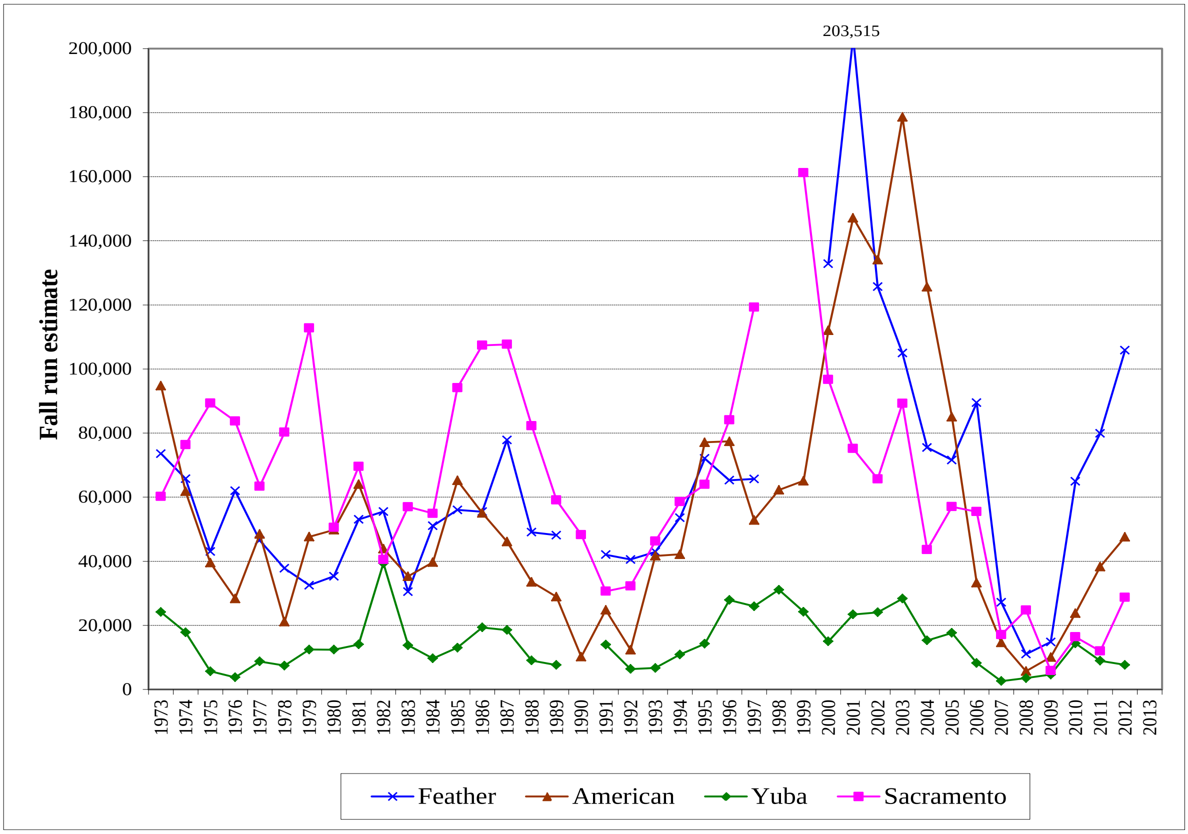


Exhibit 1C [2013 data not available as of March 2014]

Combined Natural Spawning and Hatchery Fall-run Total Since 1973

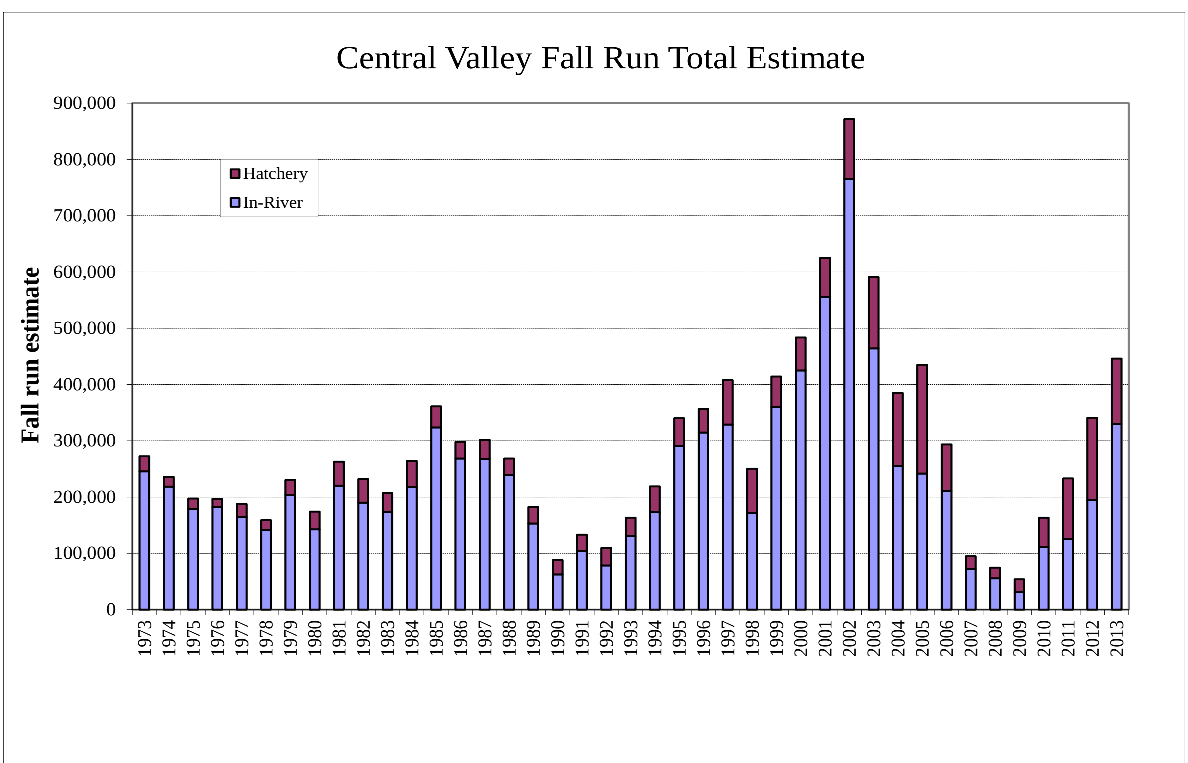


Exhibit 1D [2013 data from PFMC (2014a)]

Exhibit 2 – Salmon harvest and Sacramento abundance data

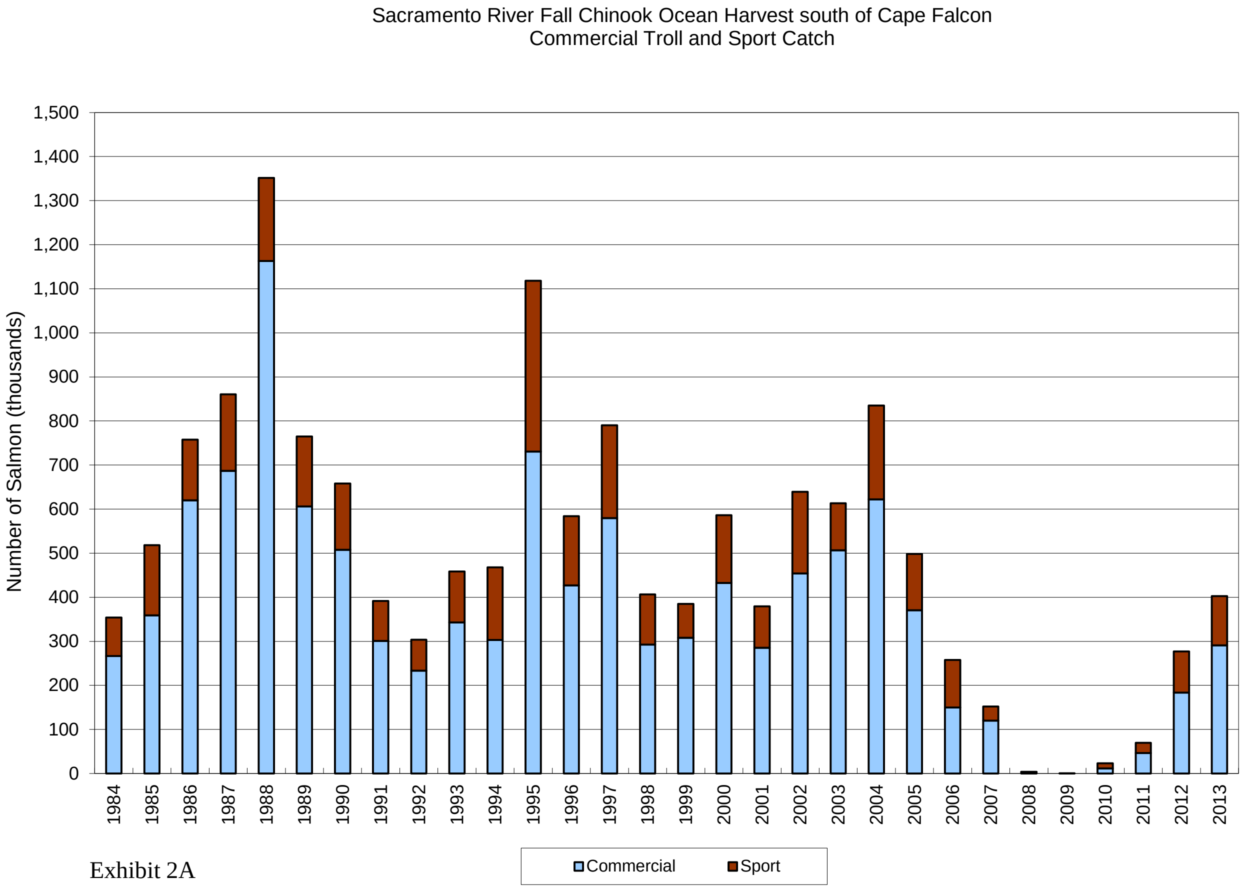


Exhibit 2A

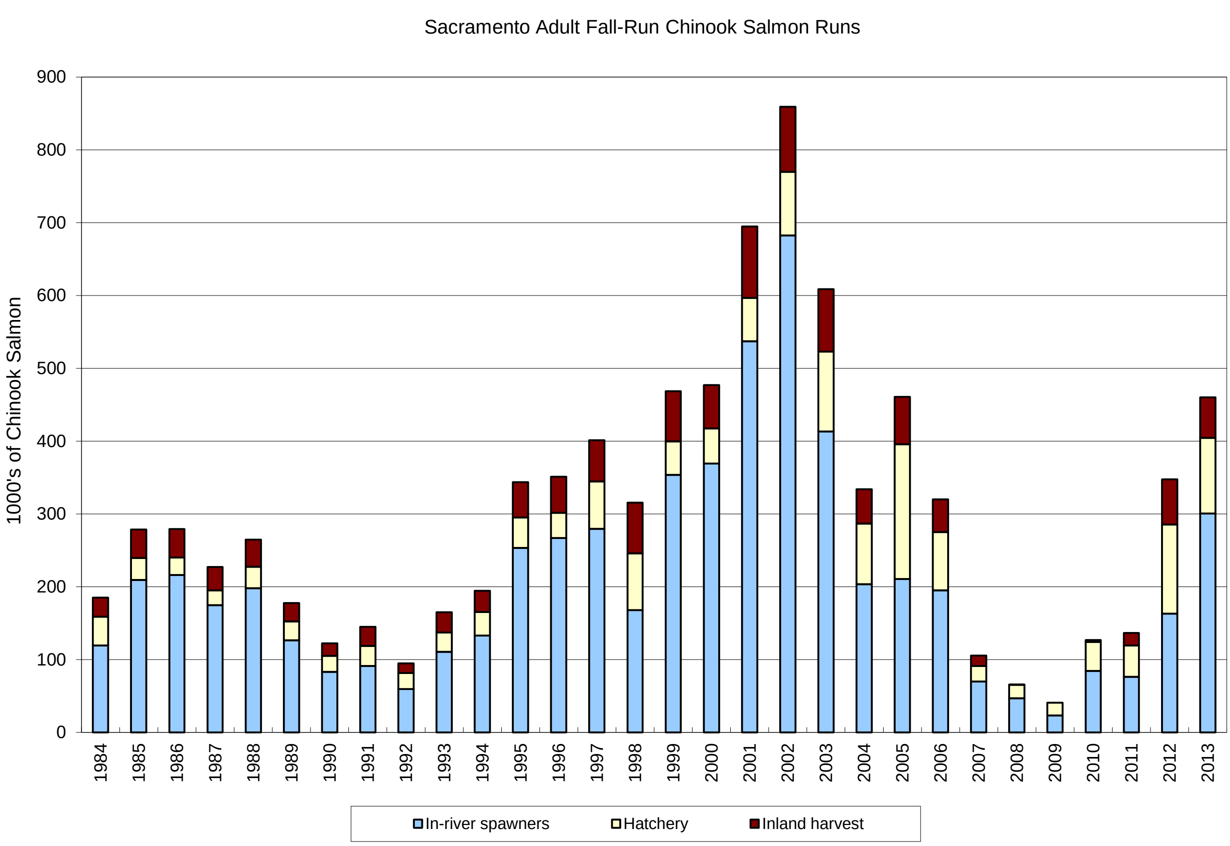


Exhibit 2B

Sacramento Harvest Index (south of Cape Falcon, OR)

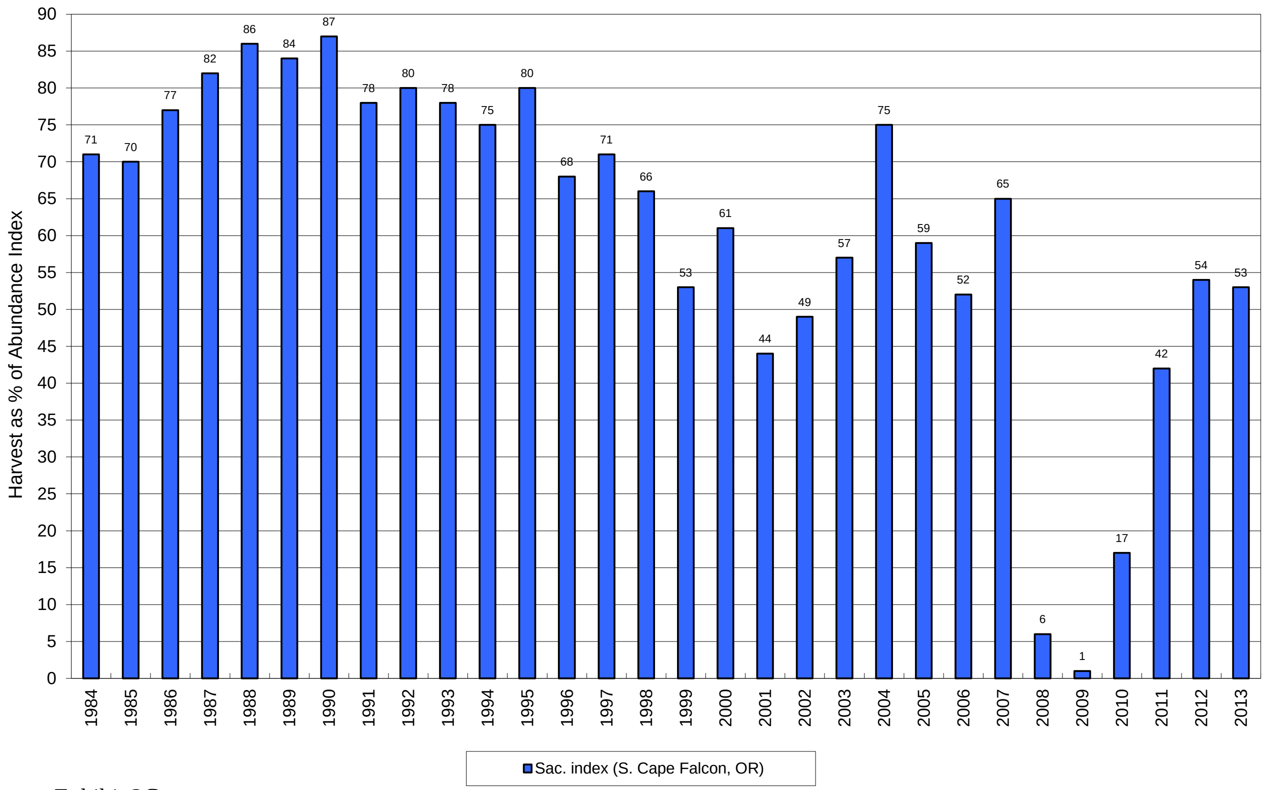


Exhibit 2C

Sacramento River Chinook Abundance Index: River and Ocean Totals

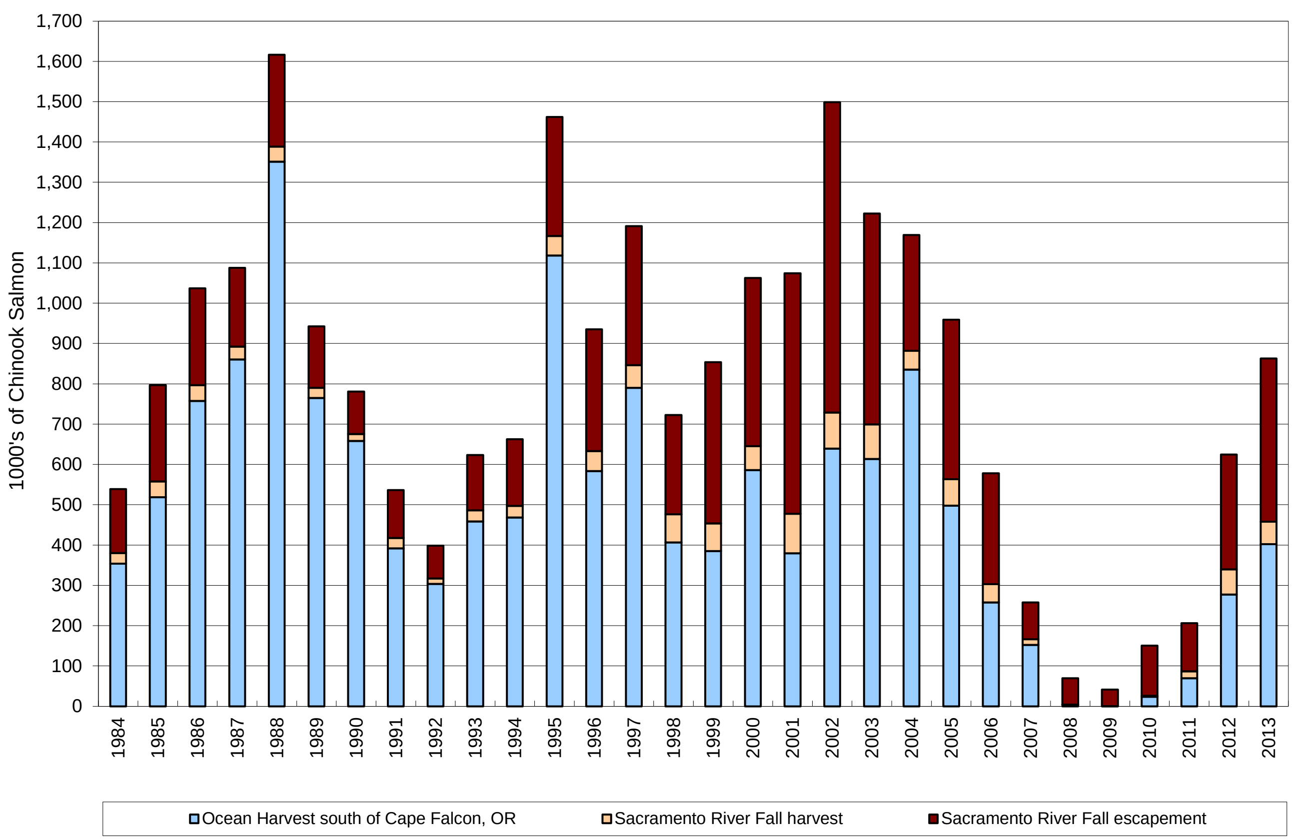


Exhibit 2D

Exhibit 3 – January-June 2013 Basin salmon rearing/outmigration data

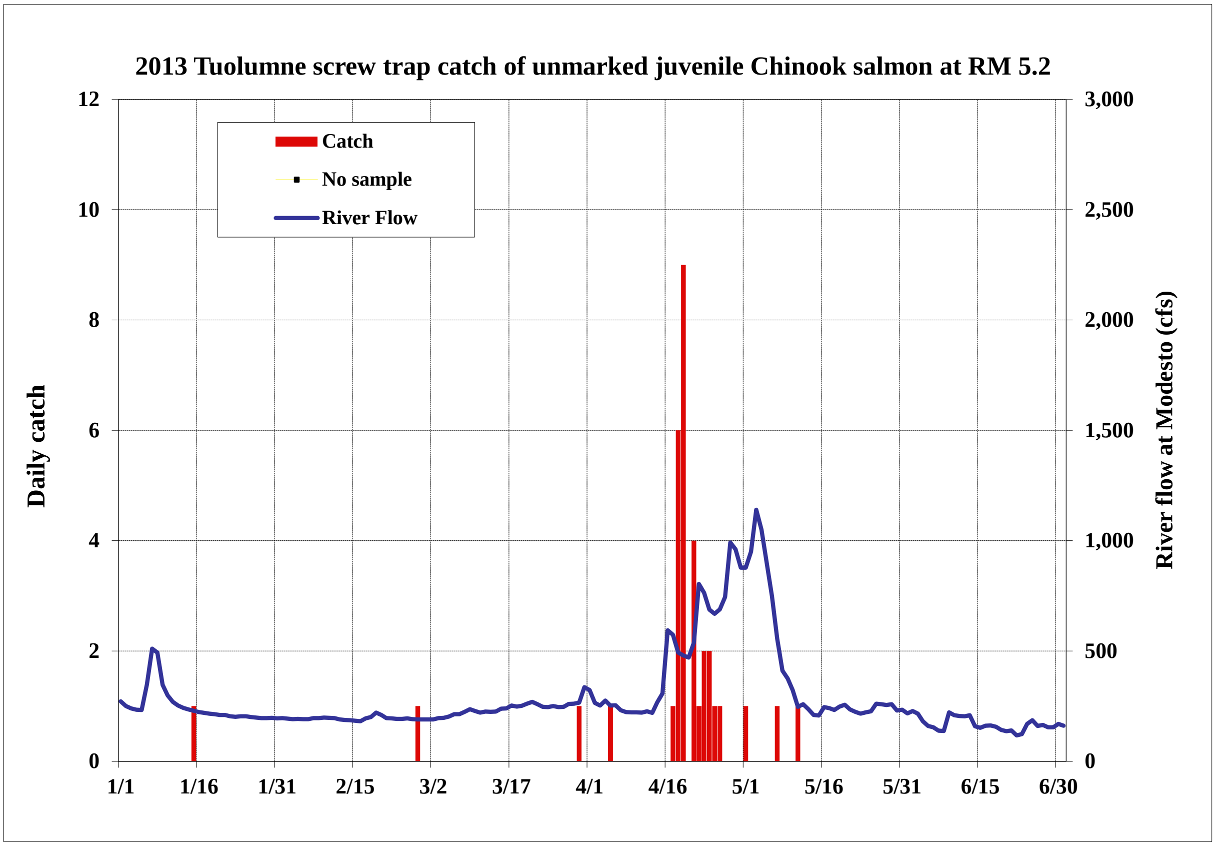


Exhibit 3A

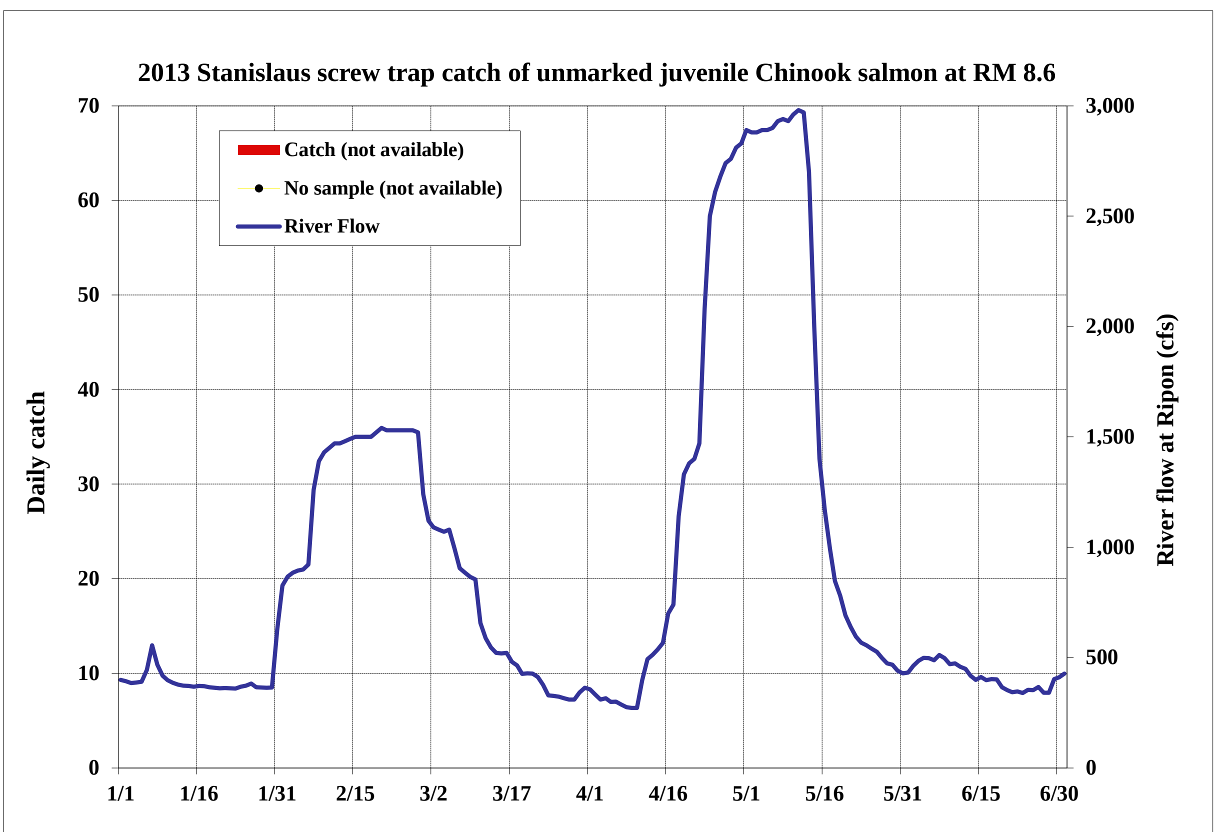
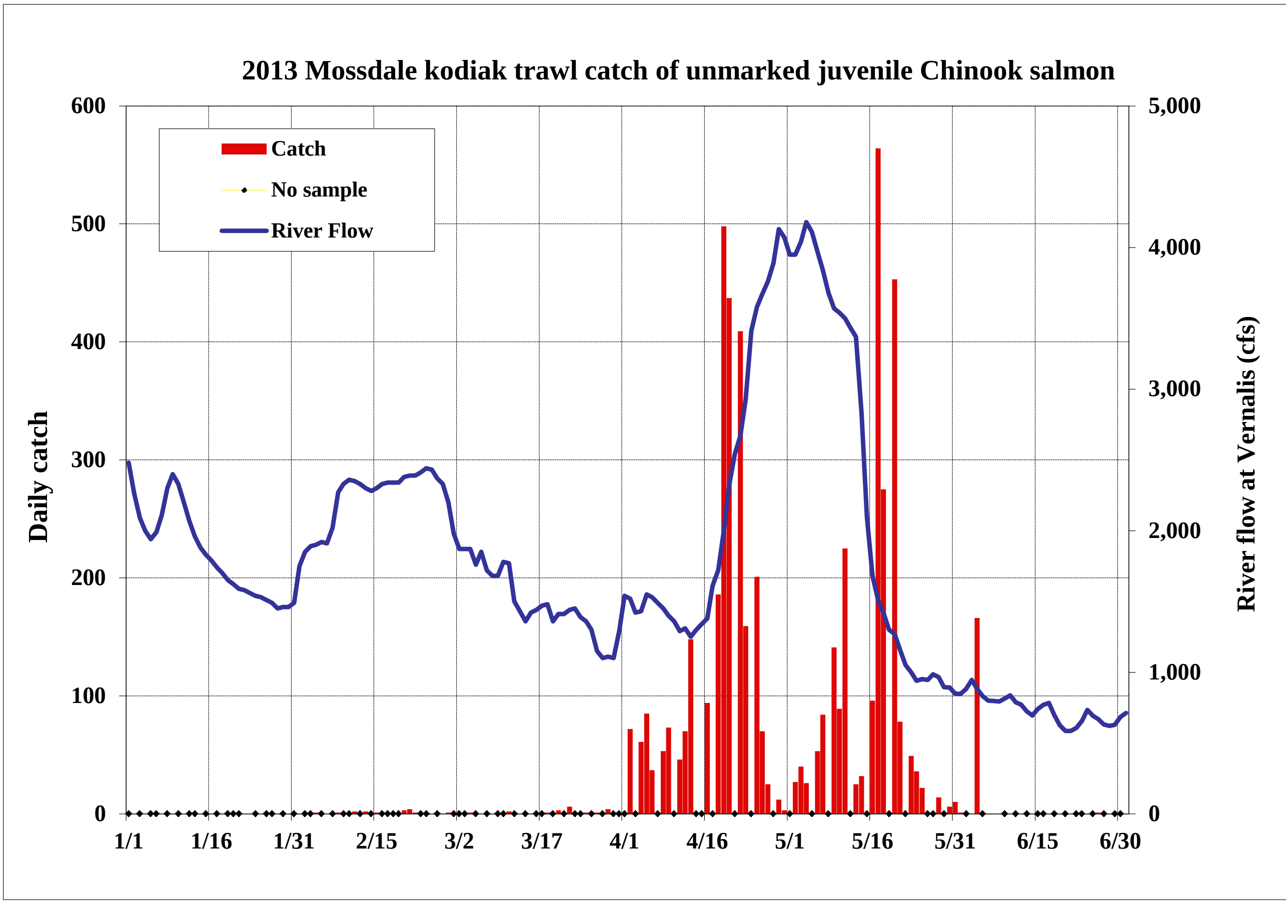


Exhibit 3B



2013 Mossdale kodiak trawl catch of unmarked juvenile Chinook salmon
Catch
No sample
River Flow
Daily catch
River flow at Vernalis (cfs)
600
500
400
300
200
100
0
5,000
4,000
3,000
2,000
1,000
0
1/1
1/16
1/31
2/15
3/2
3/17
4/1
4/16
5/1
5/16
5/31
6/15
6/30

Exhibit 3C

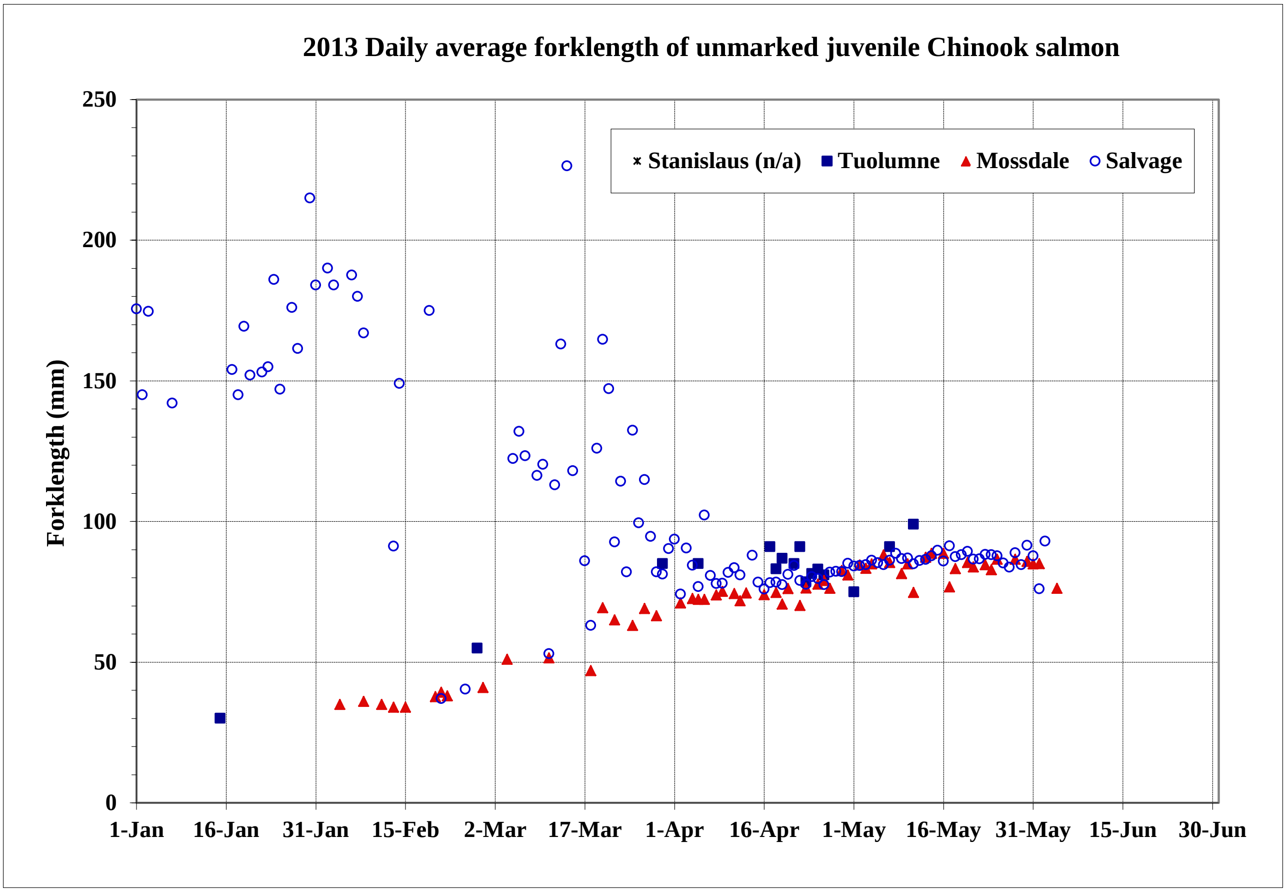


Exhibit 3D

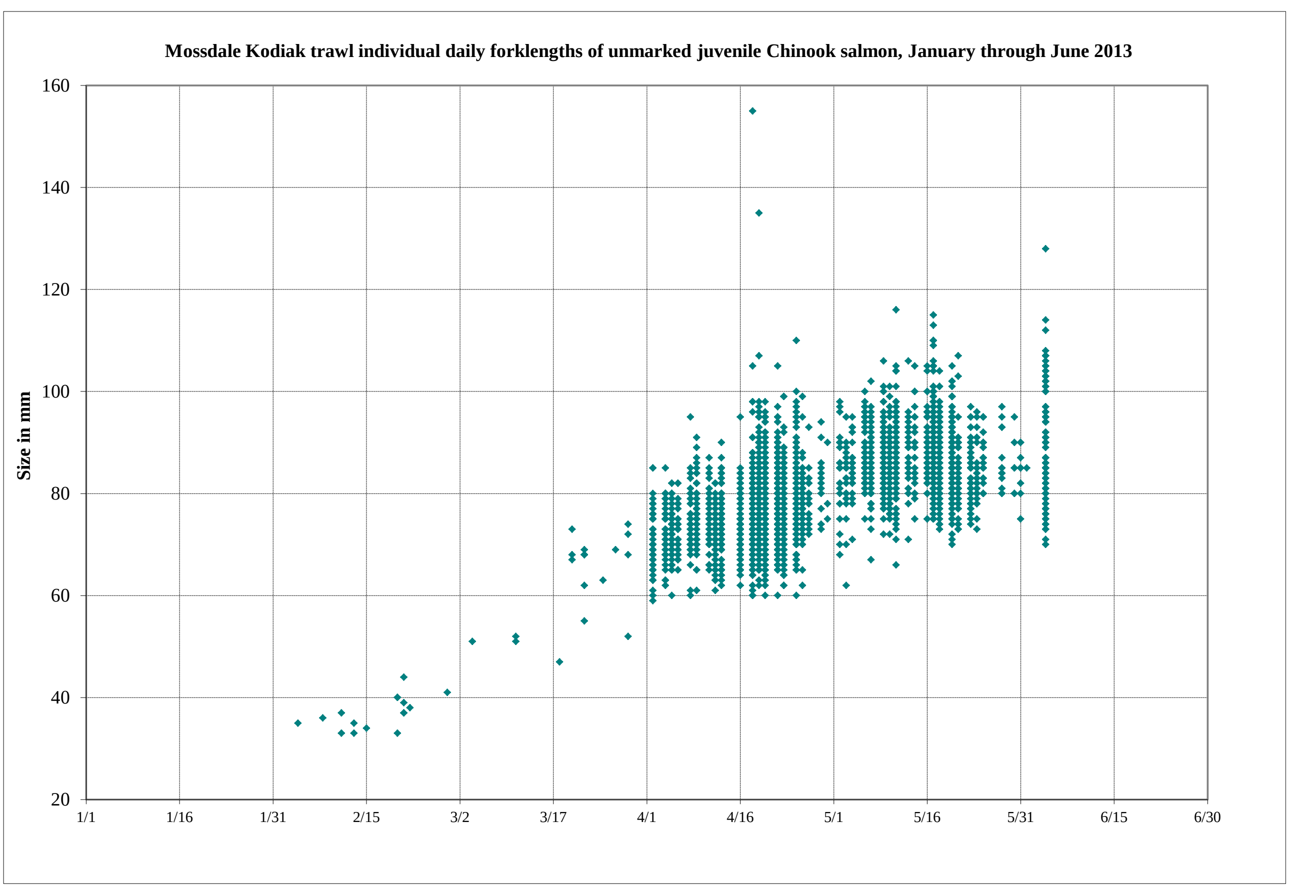


Exhibit 3E

Exhibit 4 – January-June 2013 Delta salmon salvage data, water exports and basin flows

STATE WATER PROJECT							SWP	SWP	CVP&SWP
week ending							Expanded	Combined	average
date	Total chinook salvage			Combined	Ave. cfs	Acre ft.	salvage /	salvage & loss	export rate
	Observed	Exp.Salvage	Est. Loss	salvage & loss	Export	Export	1,000 ac.ft.	per 1,000 ac.ft.	(cfs)
01/07/13	0	0	0	0	2,097	29,112	0.0	0.0	6,130
01/14/13	0	0	0	0	3,690	51,223	0.0	0.0	7,393
01/21/13	0	0	0	0	3,424	47,534	0.0	0.0	7,333
01/28/13	0	0	0	0	1,927	26,753	0.0	0.0	5,376
02/04/13	0	0	0	0	1,421	19,721	0.0	0.0	4,422
02/11/13	0	0	0	0	1,438	19,955	0.0	0.0	3,172
02/18/13	0	0	0	0	1,407	19,527	0.0	0.0	3,339
02/25/13	2	6	25	31	2,223	30,853	0.2	1.0	3,377
03/04/13	0	0	0	0	2,599	36,073	0.0	0.0	4,055
03/11/13	2	6	26	32	2,748	38,149	0.2	0.8	4,044
03/18/13	0	0	0	0	2,028	28,155	0.0	0.0	2,615
03/25/13	5	20	81	101	2,956	41,026	0.5	2.5	4,517
04/01/13	0	0	0	0	2,164	30,035	0.0	0.0	4,699
04/08/13	21	62	260	322	1,460	20,262	3.1	15.9	2,390
04/15/13	9	34	150	184	1,386	19,235	1.8	9.6	3,221
04/22/13	22	78	340	418	1,066	14,799	5.3	28.2	3,109
04/29/13	37	123	529	652	1,221	16,943	7.3	38.5	1,919
05/06/13	117	399	1,689	2,088	1,733	24,052	16.6	86.8	2,974
05/13/13	58	230	982	1,212	649	9,007	25.5	134.5	1,754
05/20/13	74	254	1,201	1,455	853	11,846	0.0	0.0	2,004
05/27/13	55	164	800	964	623	8,642	19.0	111.5	3,080
06/03/13	16	33	157	190	1,059	14,696	2.2	12.9	3,016
06/10/13	0	0	0	0	639	8,872	0.0	0.0	2,164
06/17/13	0	0	0	0	2,173	30,159	0.0	0.0	3,412
06/24/13	0	0	0	0	1,008	13,986	0.0	0.0	2,044
07/01/13	0	0	0	0	4,574	63,486	0.0	0.0	6,690
Total & avg	**418**	**1,409**	**6,239**	**7,648**	**1,868**	**674,101**	**3.1**	**442.3**	**3,779**

CENTRAL VALLEY PROJECT							CVP	CVP	
week ending							Expanded	Combined	Vernalis
date	Total chinook salvage			Combined	Ave. cfs	Acre ft.	salvage/	salvage & loss	flow
	Observed	Expanded	Est. Loss	salvage & loss	Export	Export	1,000 ac.ft.	per 1,000 ac.ft.	(cfs)
01/07/13	0	0	0	0	2,256	31,318	0.0	0.0	2,124
01/14/13	0	0	0	0	1,193	16,556	0.0	0.0	2,163
01/21/13	0	0	0	0	1,395	19,362	0.0	0.0	1,703
01/28/13	0	0	0	0	1,611	22,364	0.0	0.0	1,523
02/04/13	0	0	0	0	2,183	30,306	0.0	0.0	1,686
02/11/13	0	0	0	0	2,363	32,805	0.0	0.0	2,166
02/18/13	2	7	5	12	2,242	31,119	0.2	0.4	2,317
02/25/13	2	3	2	4	3,025	41,984	0.1	0.1	2,397
03/04/13	0	0	0	0	3,066	42,565	0.0	0.0	2,070
03/11/13	0	0	0	0	2,691	37,354	0.0	0.0	1,749
03/18/13	2	4	3	7	1,853	25,716	0.2	0.3	1,443
03/25/13	19	12	8	20	2,356	32,702	0.4	0.6	1,403
04/01/13	6	13	9	22	2,473	34,334	0.4	0.6	1,227
04/08/13	0	0	0	0	0	0	0.0	0.0	1,484
04/15/13	7	28	23	51	84	1,162	24.1	43.8	1,321
04/22/13	120	436	356	792	809	11,228	38.8	70.6	2,034
04/29/13	189	712	582	1294	816	11,323	62.9	114.3	3,624
05/06/13	974	890	588	1478	1,591	22,091	40.3	66.9	4,039
05/13/13	76	261	213	474	980	13,603	19.2	34.8	3,561
05/20/13	127	456	373	829	865	12,013	38.0	69.0	1,730
05/27/13	79	257	211	468	811	11,261	22.8	41.5	1,004
06/03/13	19	47	38	85	810	11,238	4.2	7.6	897
06/10/13	0	0	0	0	816	11,321	0.0	0.0	823
06/17/13	0	0	0	0	806	11,188	0.0	0.0	753
06/24/13	0	0	0	0	692	9,606	0.0	0.0	642
07/01/13	0	0	0	0	1,016	14,101	0.0	0.0	663
Total & avg	**1,622**	**3,125**	**2,410**	**5,536**	**1,492**	**538,618**	**9.7**	**450.4**	**1,790**

Exhibit 4A

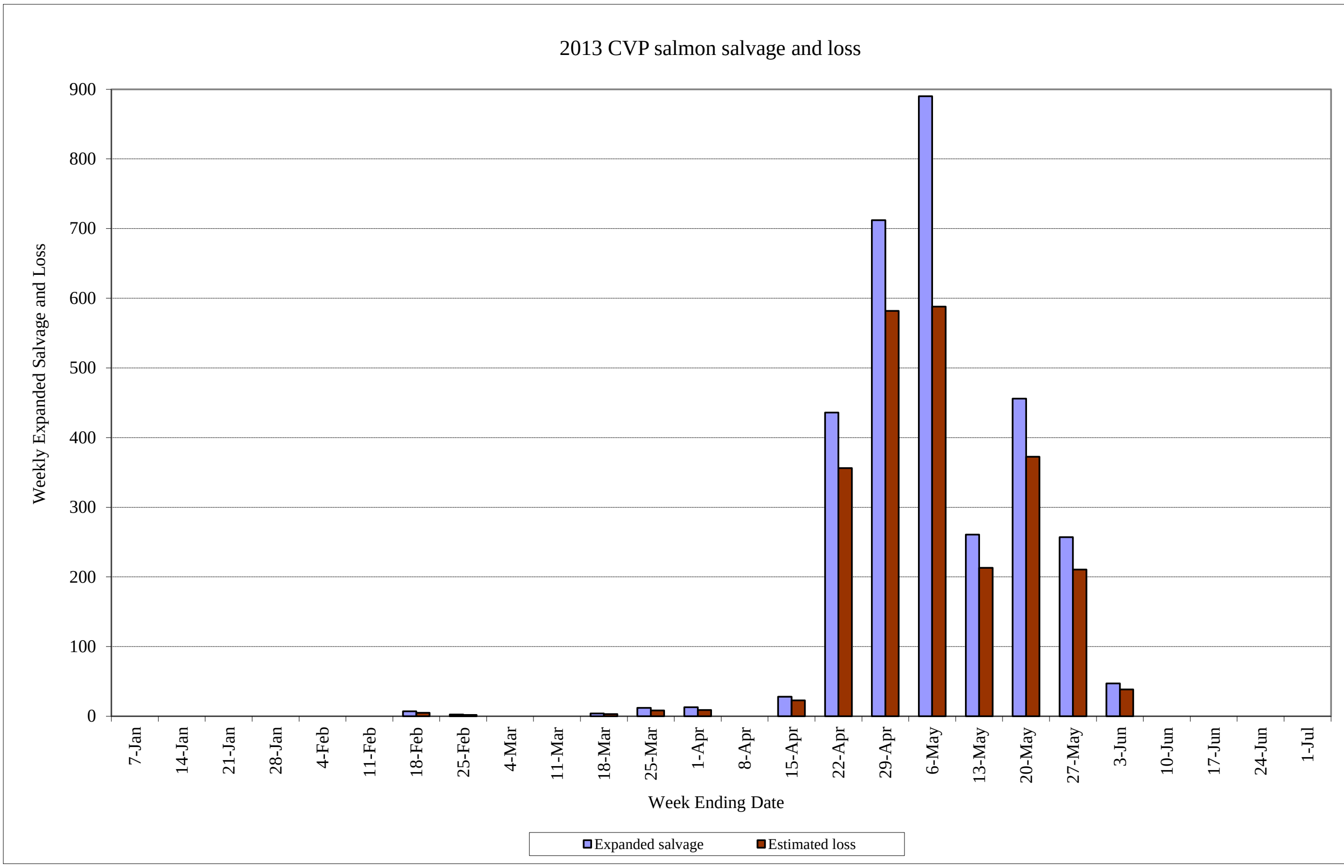


Exhibit 4B

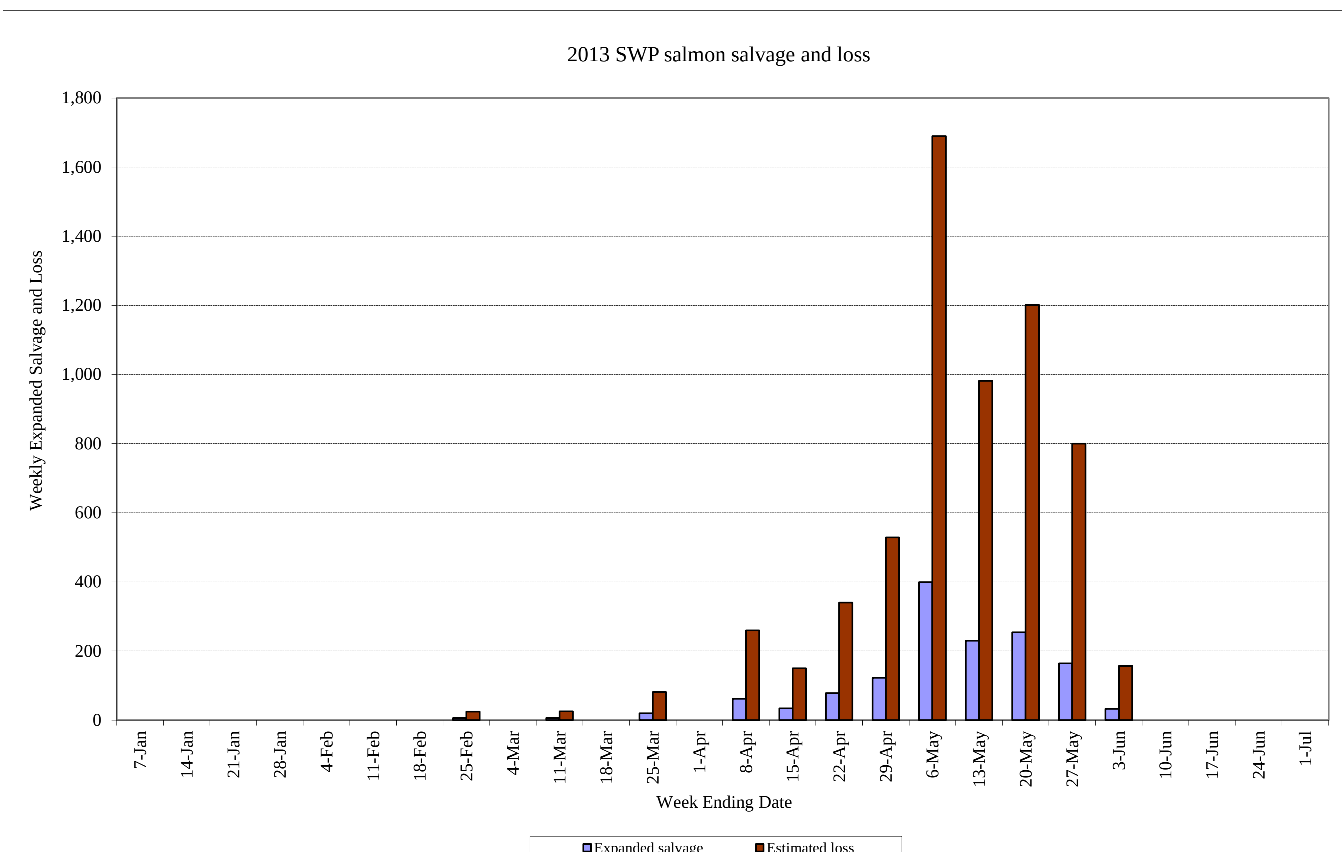


Exhibit 4C

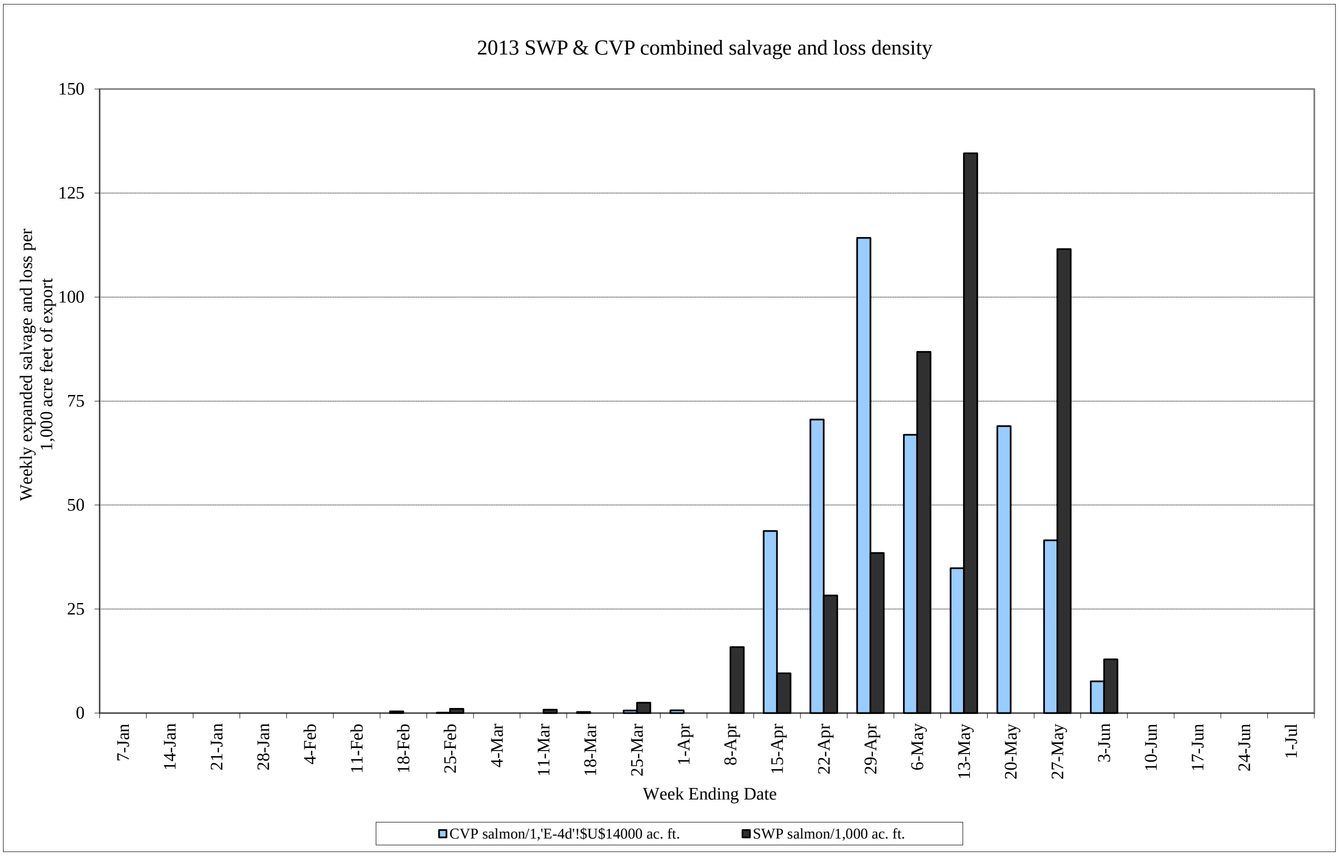


Exhibit 4D

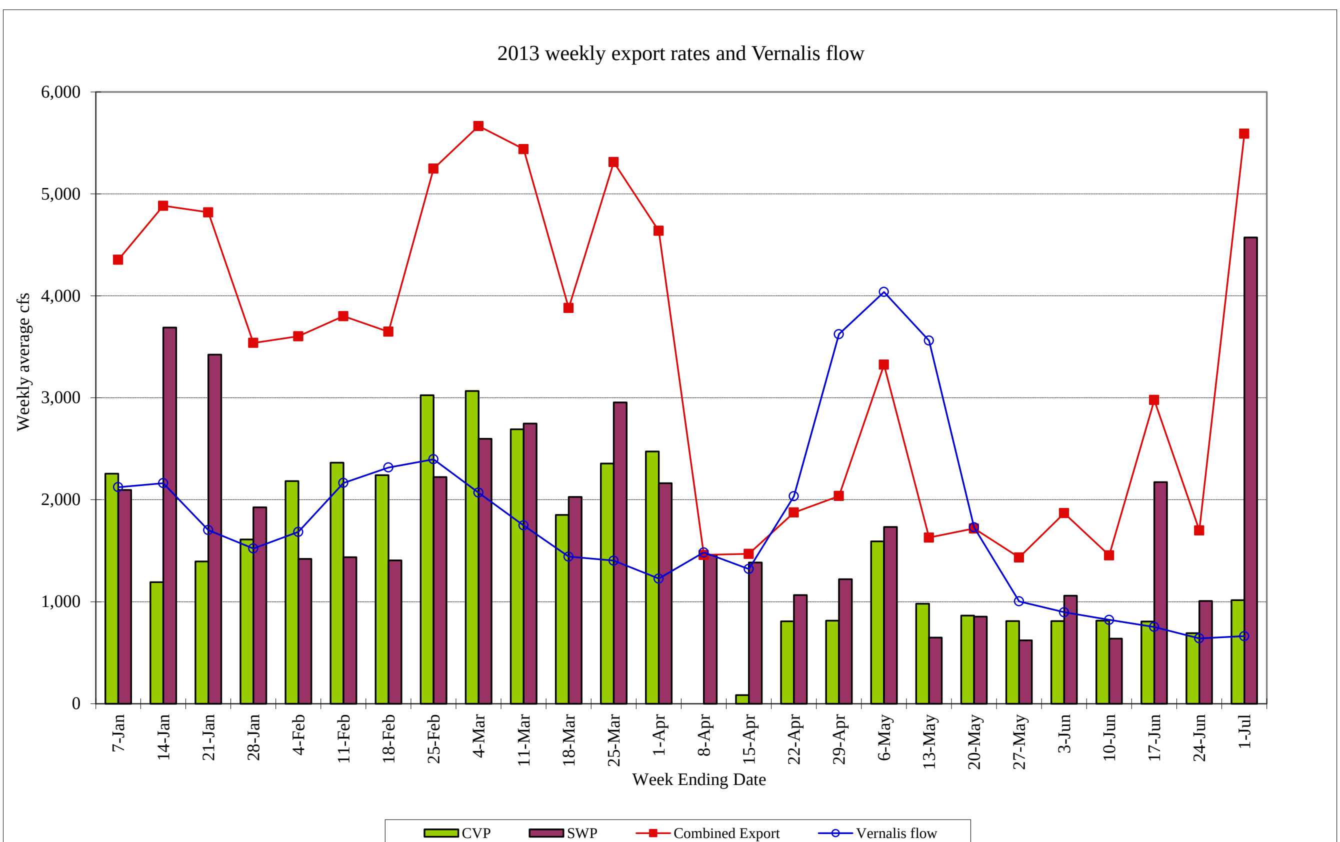
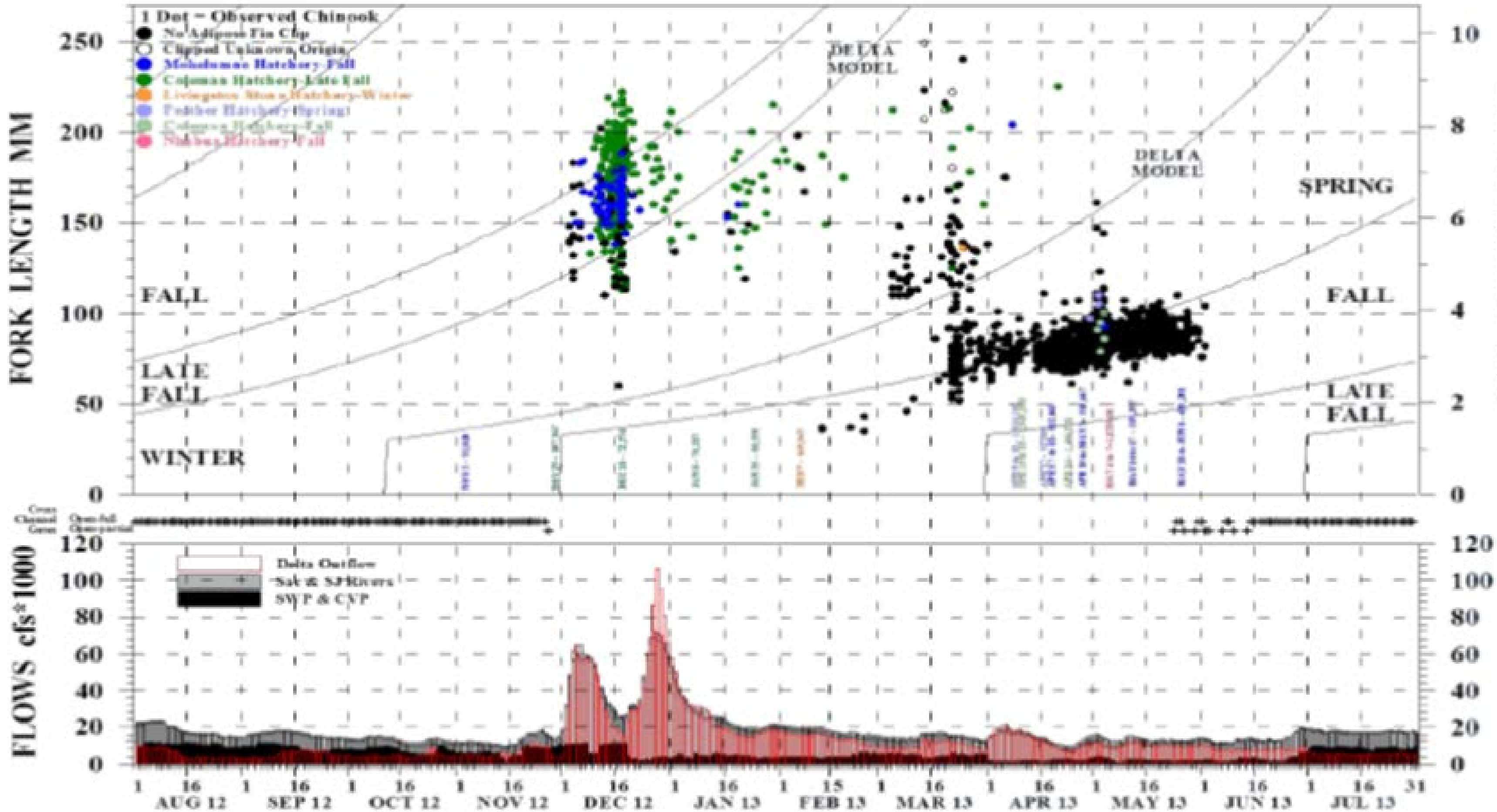


Exhibit 4E

OBSERVED CHINOOK SALVAGE AT THE SWP & CVP

DELTA FISH FACILITIES 8/1/2012 THROUGH 7/31/2013



Chinook salmon not measured for fork length or outside of the length-at-date criteria are not reported.

Exhibit 4F

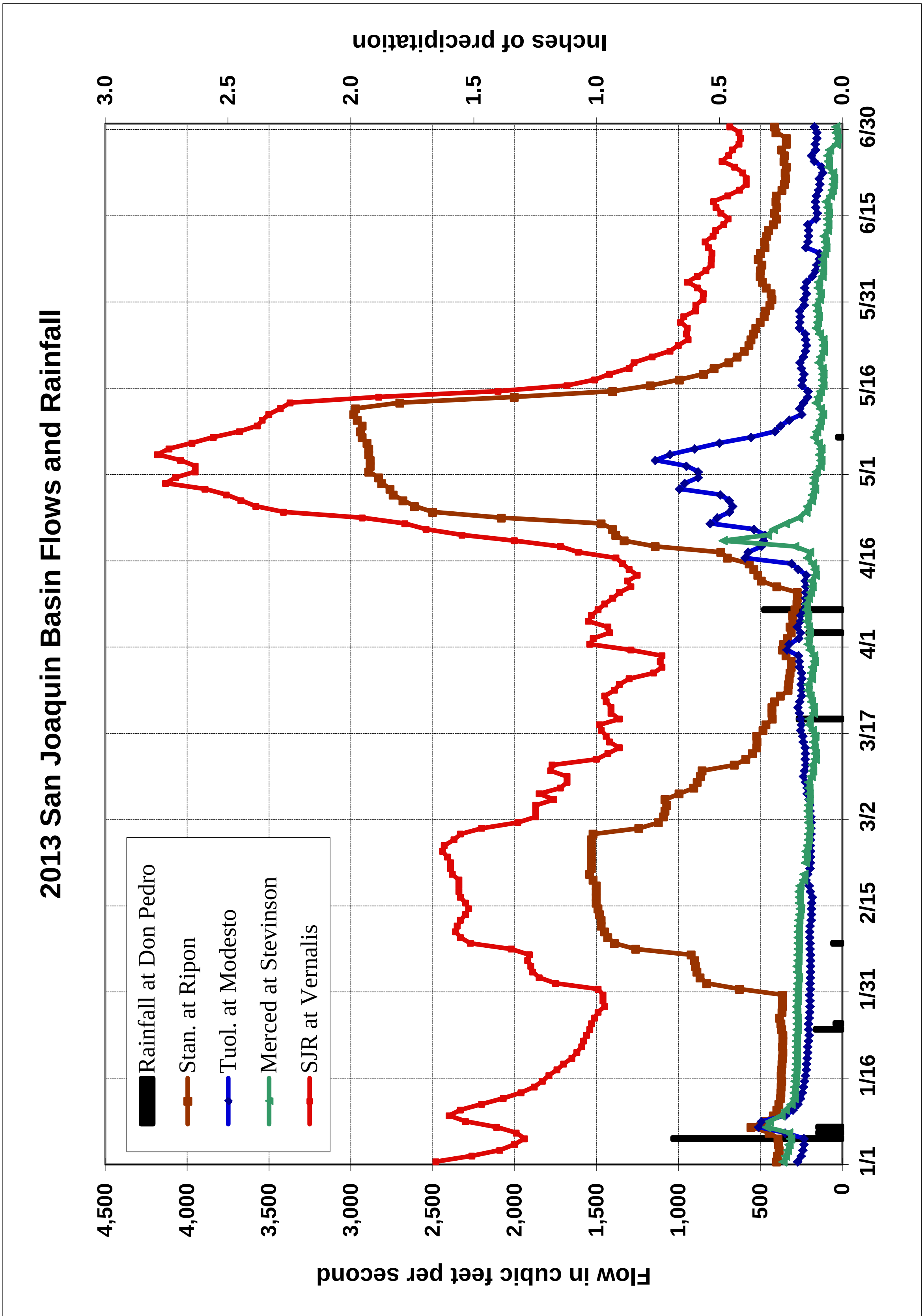

2013 San Joaquin Basin Flows and Rainfall
Flow in cubic feet per second
Inches of precipitation
Rainfall at Don Pedro
Stan. at Ripon
Tuol. at Modesto
Merced at Stevinson
SJR at Vernalis
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1/1
1/16
1/31
2/15
3/2
3/17
4/1
4/16
5/1
5/16
5/31
6/15
6/30

Exhibit 4G

Attachment -A-

Water, Flows, Temperature, and Flow Schedule Correspondence

1. Graphs of flows, FERC flow schedule, reservoir status, and precipitation data
    1.1. 2013/2014 Water Years (Oct-Sep) daily average computed natural flow, actual flow, and FERC flow schedule at La Grange
    1.2. 2013/2014 Water Years actual flow: Tuolumne at Modesto, Stanislaus at Ripon, Merced nr Stevinson, and San Joaquin at Fremont Ford and at Vernalis. San Joaquin at Vernalis and combined CVP and SWP exports, San Joaquin at Vernalis minus combined CVP and SWP exports.
    1.3. Required flow volume forecasts and final amount
    1.4. 2013/2014 Water Years Don Pedro Reservoir storage
    1.5. 2013/2014 Precipitation Years (Sep-Aug) watershed precipitation index and snow sensor water content index as percent of average.
2. Graphs of water temperature and air temperature
    2.1. Water Year 2013 daily water temperature for Tuolumne and San Joaquin Rivers
    2.2. Modesto air temperature for Water Year 2013
    2.3. Modesto air temperature for Water Year 2014
3. Flow schedule correspondence for 2013
    3.1. Oct. 8, 2013 – Update of Water Year Classification and Flow Schedule

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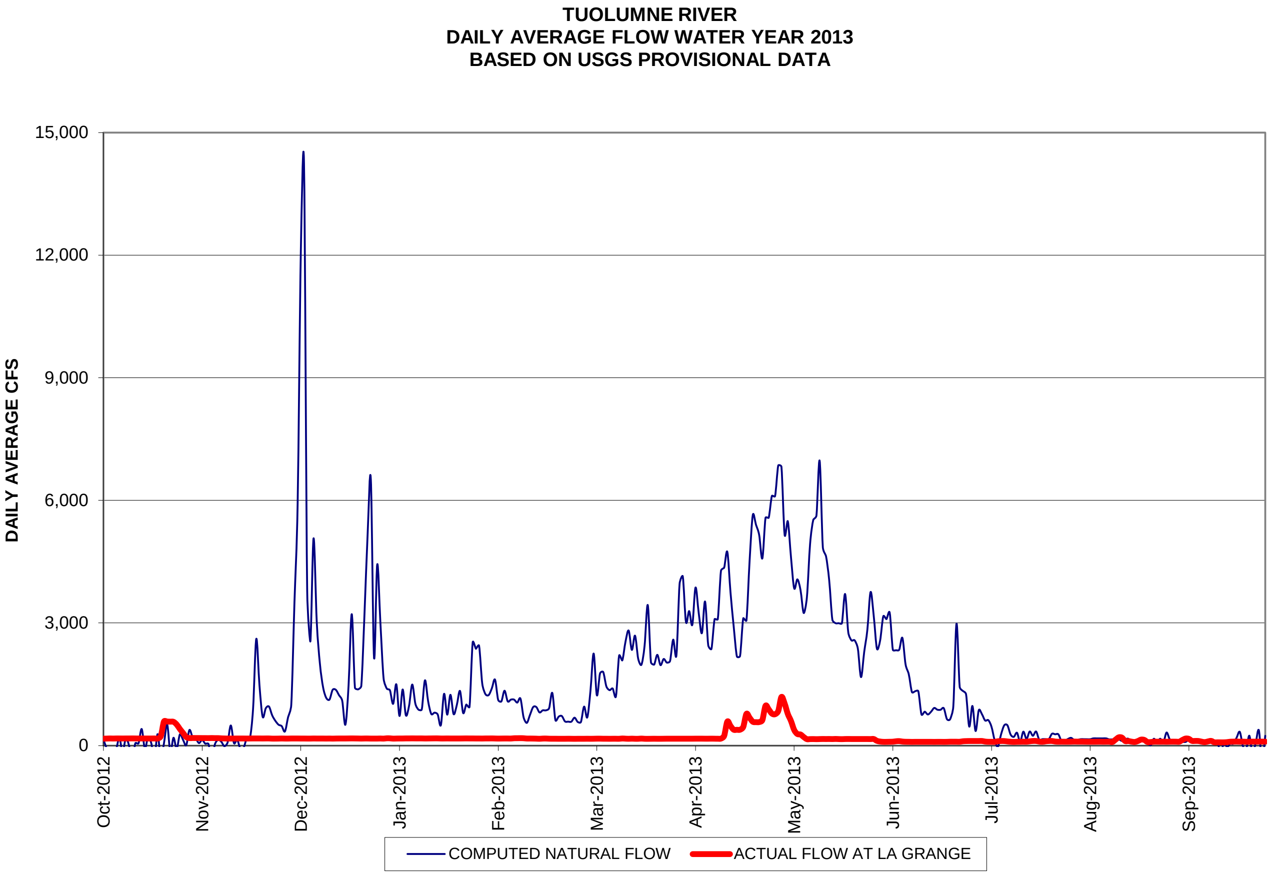
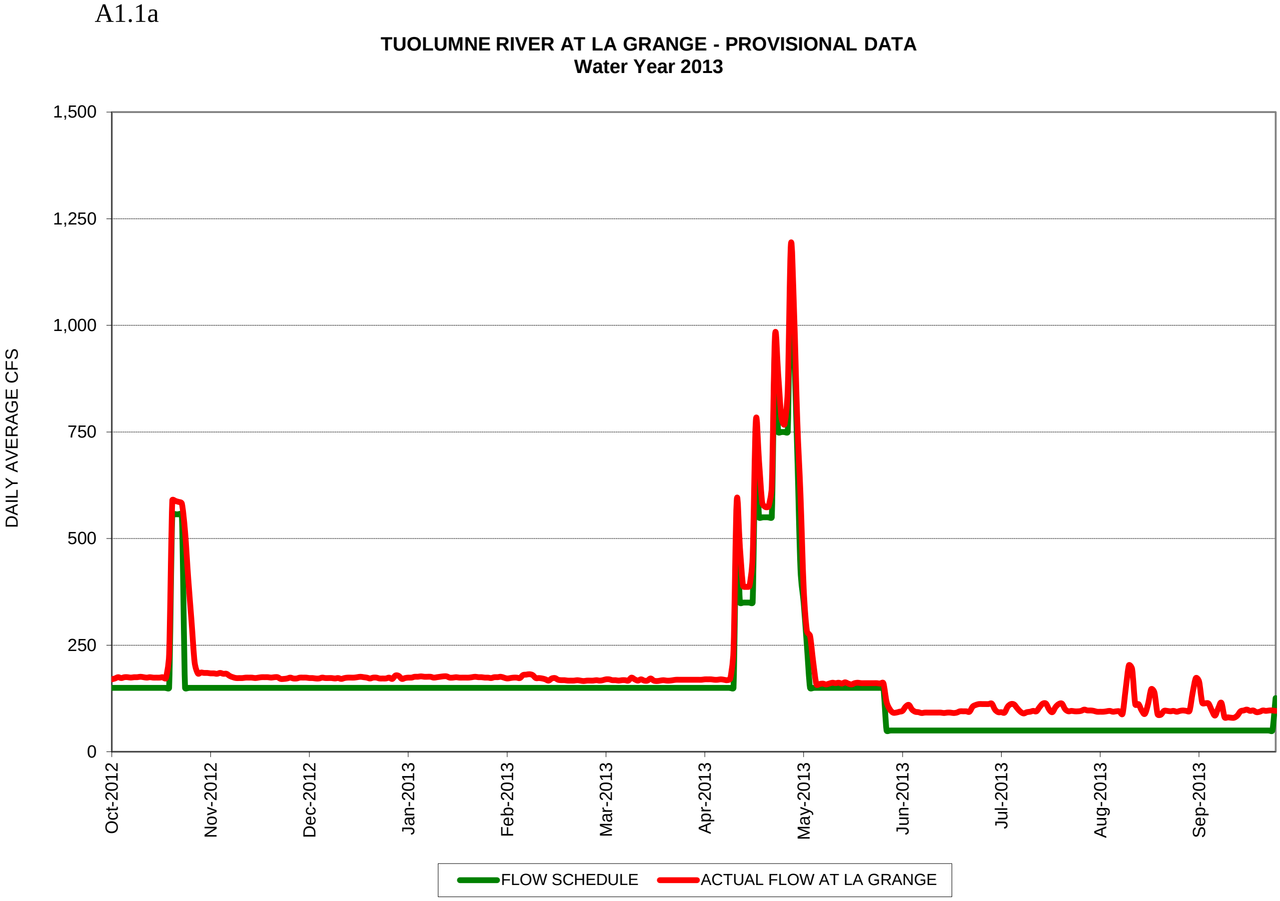
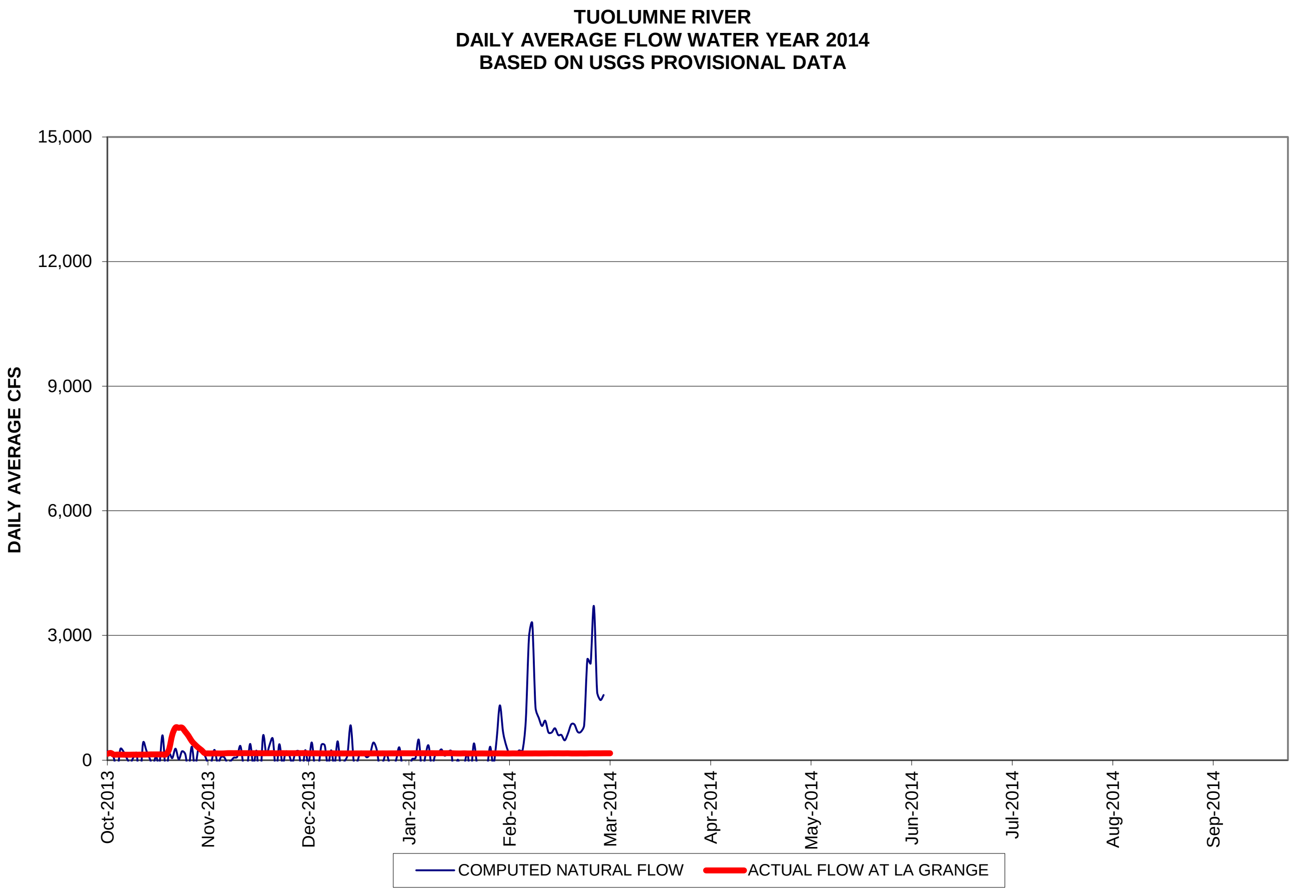
1. Graphs of flows, FERC flow schedule, reservoir status, and precipitation data



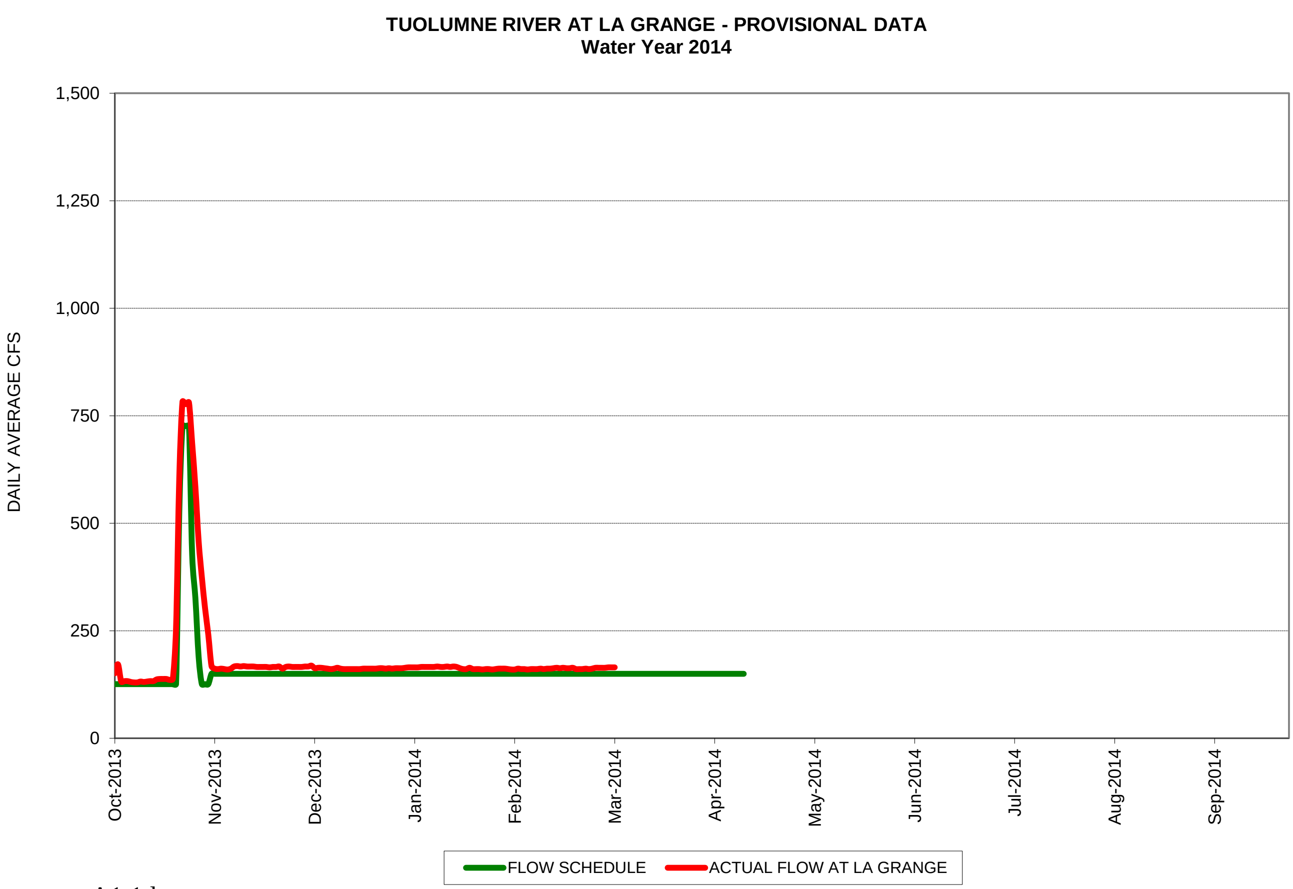
A1.1a



A1.1b


TUOLUMNE RIVER
DAILY AVERAGE FLOW WATER YEAR 2014
BASED ON USGS PROVISIONAL DATA
DAILY AVERAGE CFS
15,000
12,000
9,000
6,000
3,000
0
Oct-2013
Nov-2013
Dec-2013
Jan-2014
Feb-2014
Mar-2014
Apr-2014
May-2014
Jun-2014
Jul-2014
Aug-2014
Sep-2014
COMPUTED NATURAL FLOW
ACTUAL FLOW AT LA GRANGE

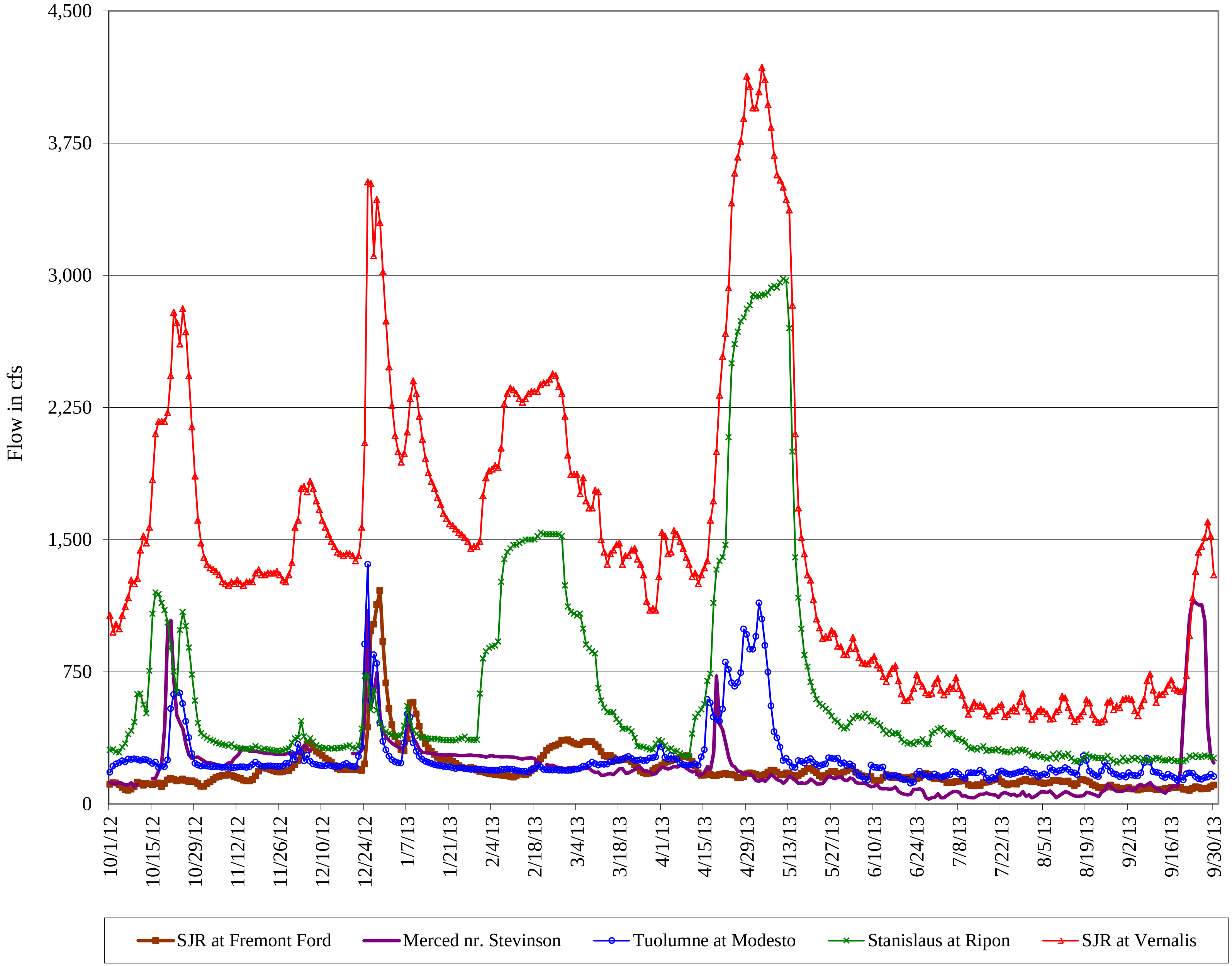
A1.1c


TUOLUMNE RIVER AT LA GRANGE - PROVISIONAL DATA
Water Year 2014
DAILY AVERAGE CFS
1,500
1,250
1,000
750
500
250
0
Oct-2013
Nov-2013
Dec-2013
Jan-2014
Feb-2014
Mar-2014
Apr-2014
May-2014
Jun-2014
Jul-2014
Aug-2014
Sep-2014
FLOW SCHEDULE
ACTUAL FLOW AT LA GRANGE

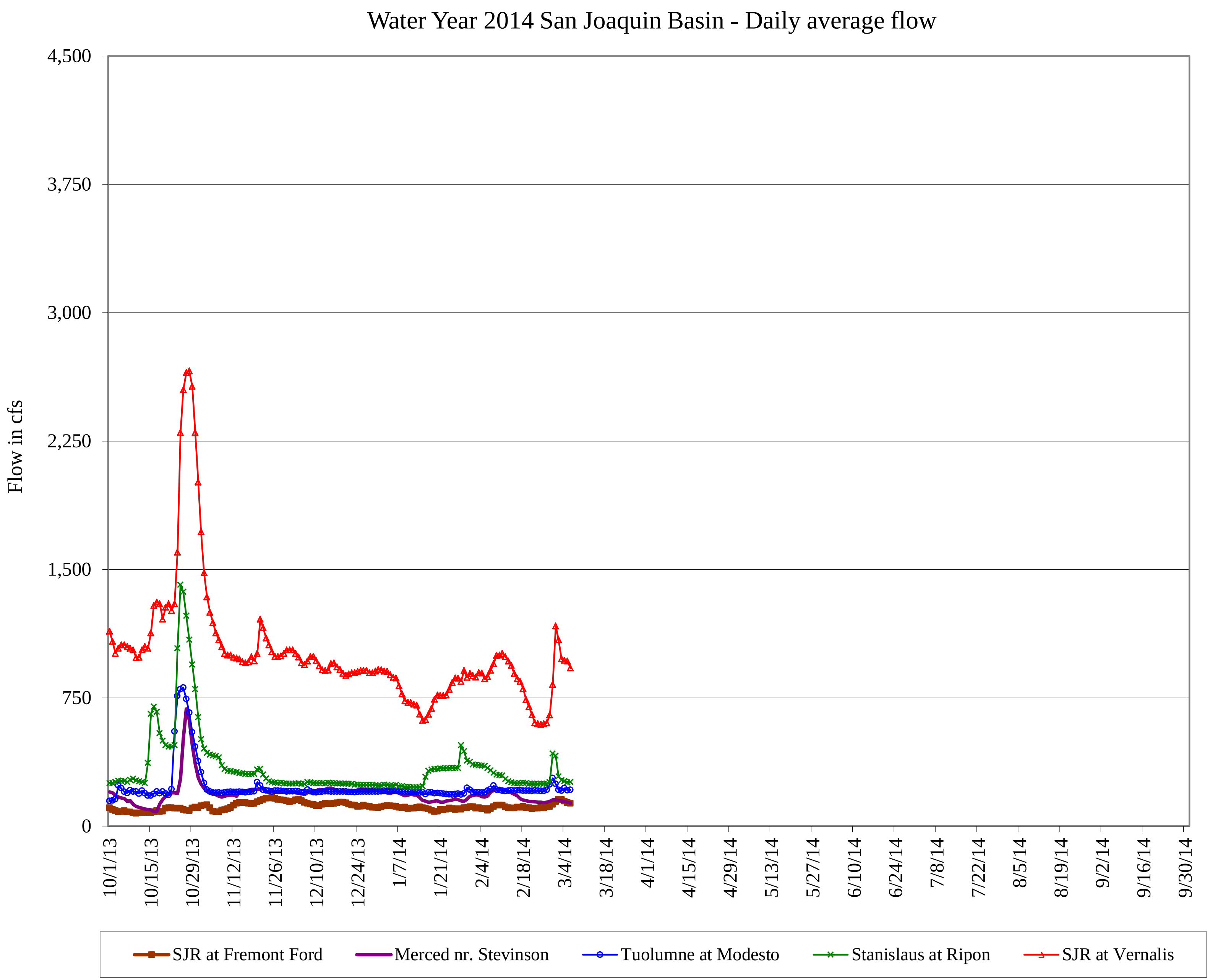
A1.1d

A1.2a

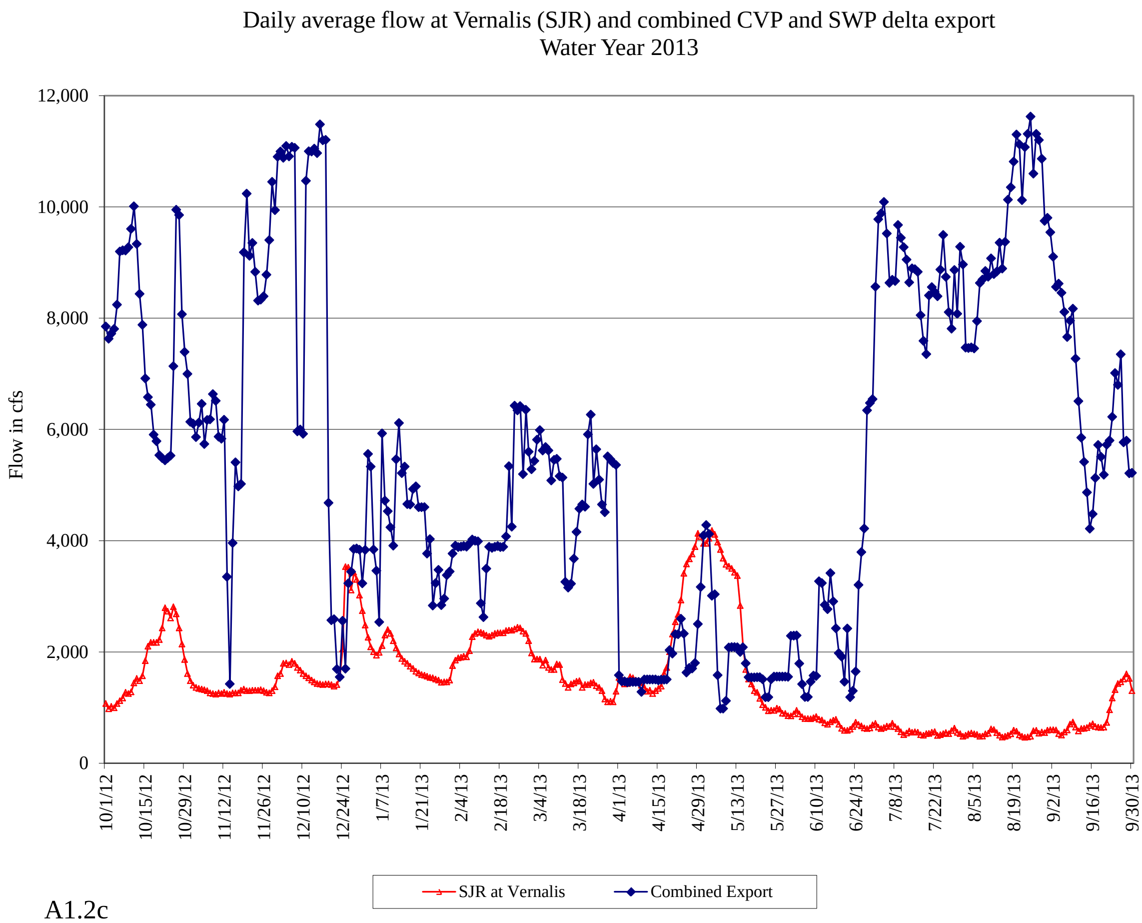
Water Year 2013 San Joaquin Basin - Daily average flow



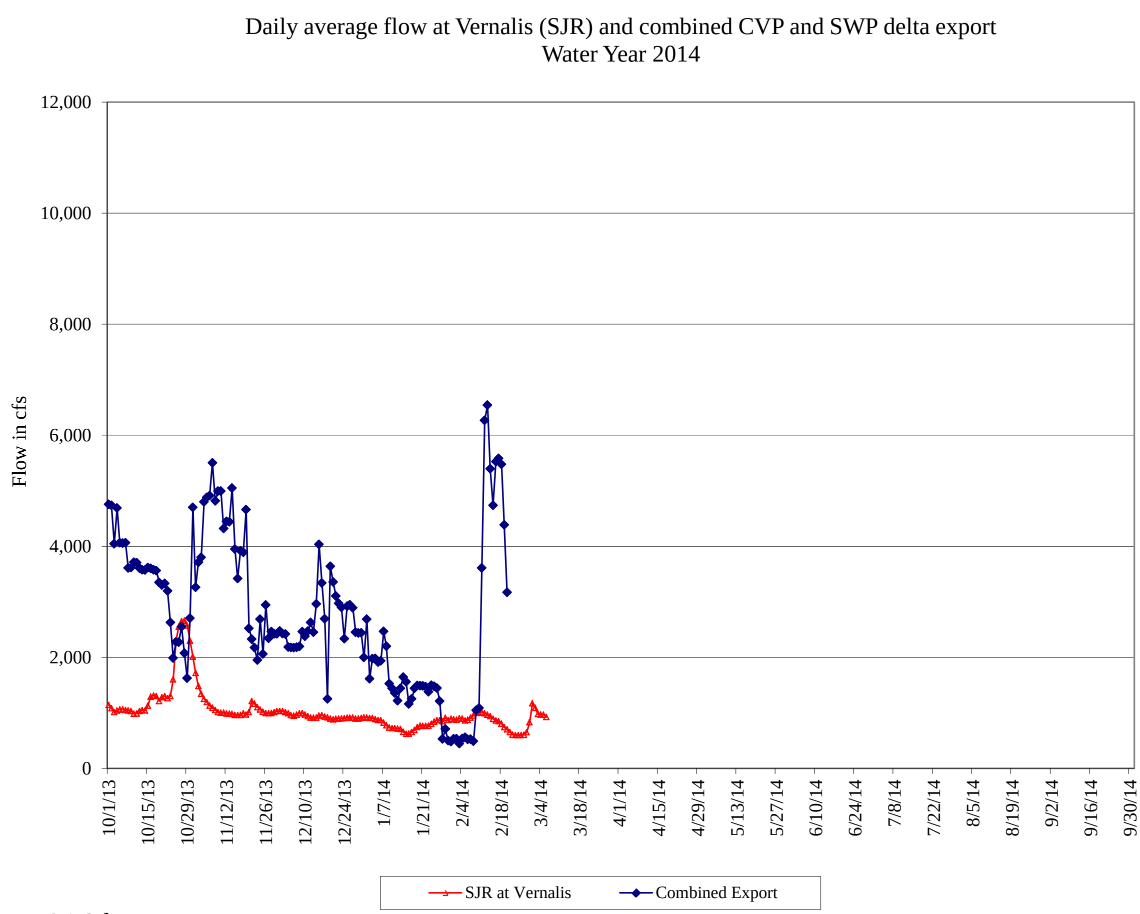
A1.2b



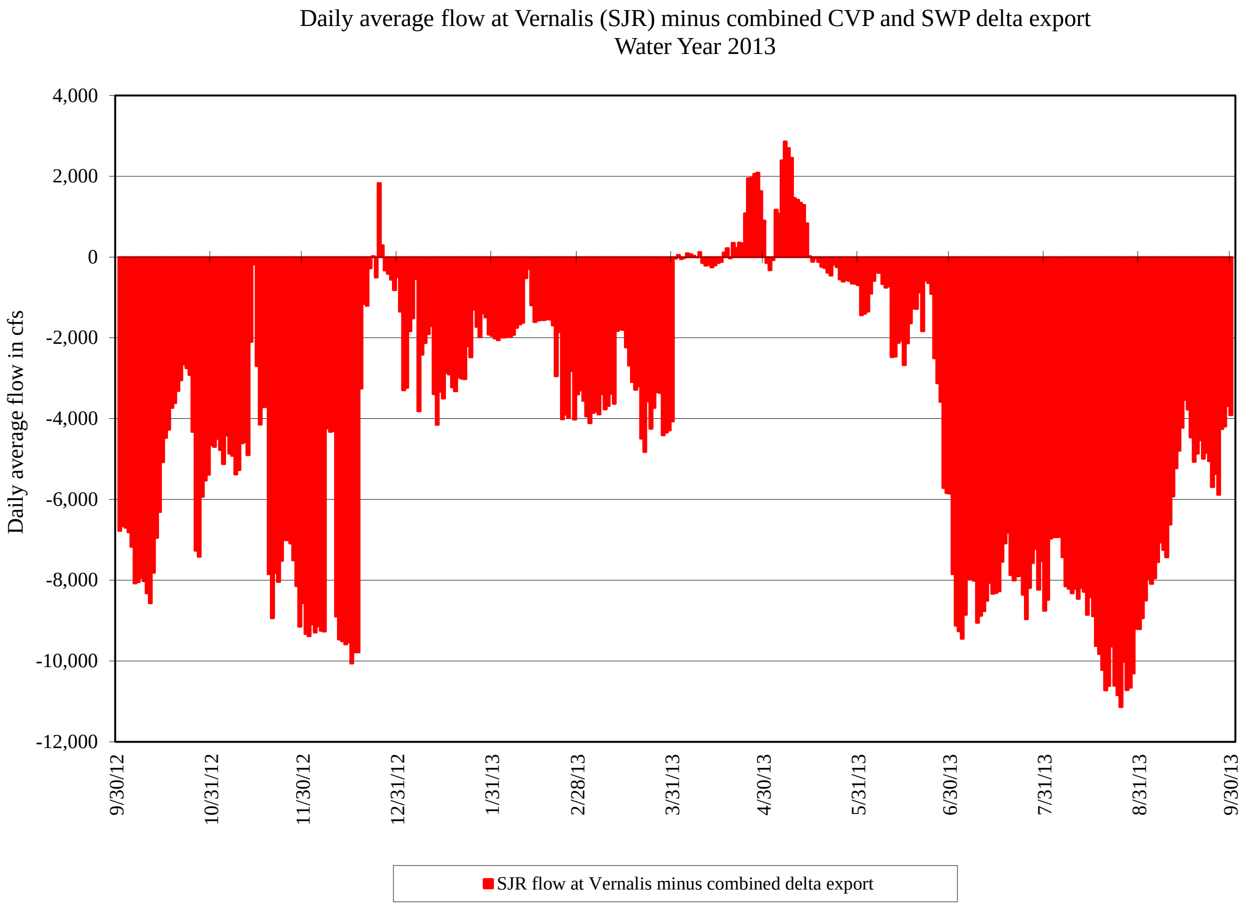
Water Year 2014 San Joaquin Basin - Daily average flow
Flow in cfs
4,500
3,750
3,000
2,250
1,500
750
0
10/1/13
10/15/13
10/29/13
11/12/13
11/26/13
12/10/13
12/24/13
1/7/14
1/21/14
2/4/14
2/18/14
3/4/14
3/18/14
4/1/14
4/15/14
4/29/14
5/13/14
5/27/14
6/10/14
6/24/14
7/8/14
7/22/14
8/5/14
8/19/14
9/2/14
9/16/14
9/30/14
SJR at Fremont Ford
Merced nr. Stevinson
Tuolumne at Modesto
Stanislaus at Ripon
SJR at Vernalis


Daily average flow at Vernalis (SJR) and combined CVP and SWP delta export
Water Year 2013
Flow in cfs
12,000
10,000
8,000
6,000
4,000
2,000
0
10/1/12
10/15/12
10/29/12
11/12/12
11/26/12
12/10/12
12/24/12
1/7/13
1/21/13
2/4/13
2/18/13
3/4/13
3/18/13
4/1/13
4/15/13
4/29/13
5/13/13
5/27/13
6/10/13
6/24/13
7/8/13
7/22/13
8/5/13
8/19/13
9/2/13
9/16/13
9/30/13
SJR at Vernalis
Combined Export

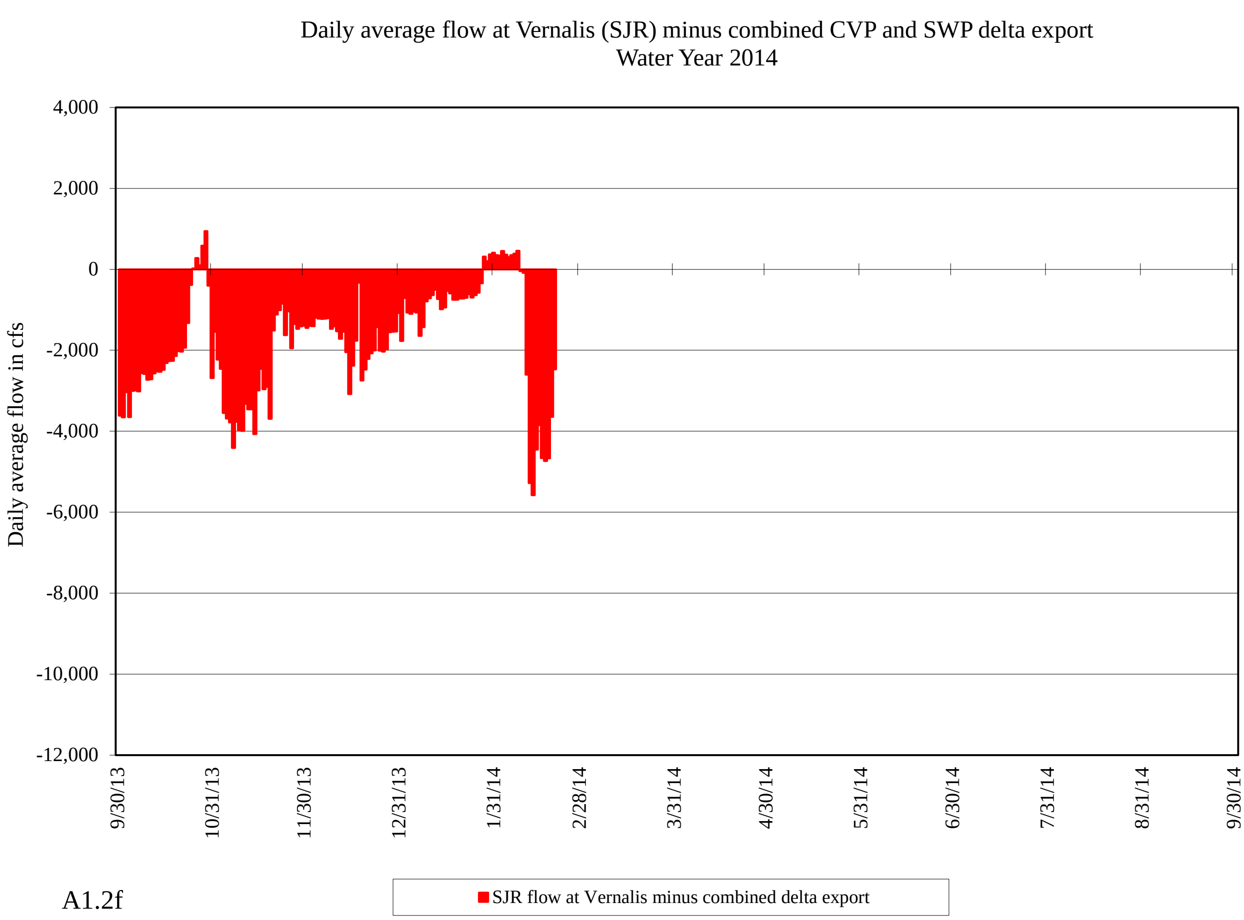
A1.2c


Daily average flow at Vernalis (SJR) and combined CVP and SWP delta export
Water Year 2014
Flow in cfs
12,000
10,000
8,000
6,000
4,000
2,000
0
10/1/13
10/15/13
10/29/13
11/12/13
11/26/13
12/10/13
12/24/13
1/7/14
1/21/14
2/4/14
2/18/14
3/4/14
3/18/14
4/1/14
4/15/14
4/29/14
5/13/14
5/27/14
6/10/14
6/24/14
7/8/14
7/22/14
8/5/14
8/19/14
9/2/14
9/16/14
9/30/14
SJR at Vernalis
Combined Export

A1.2d

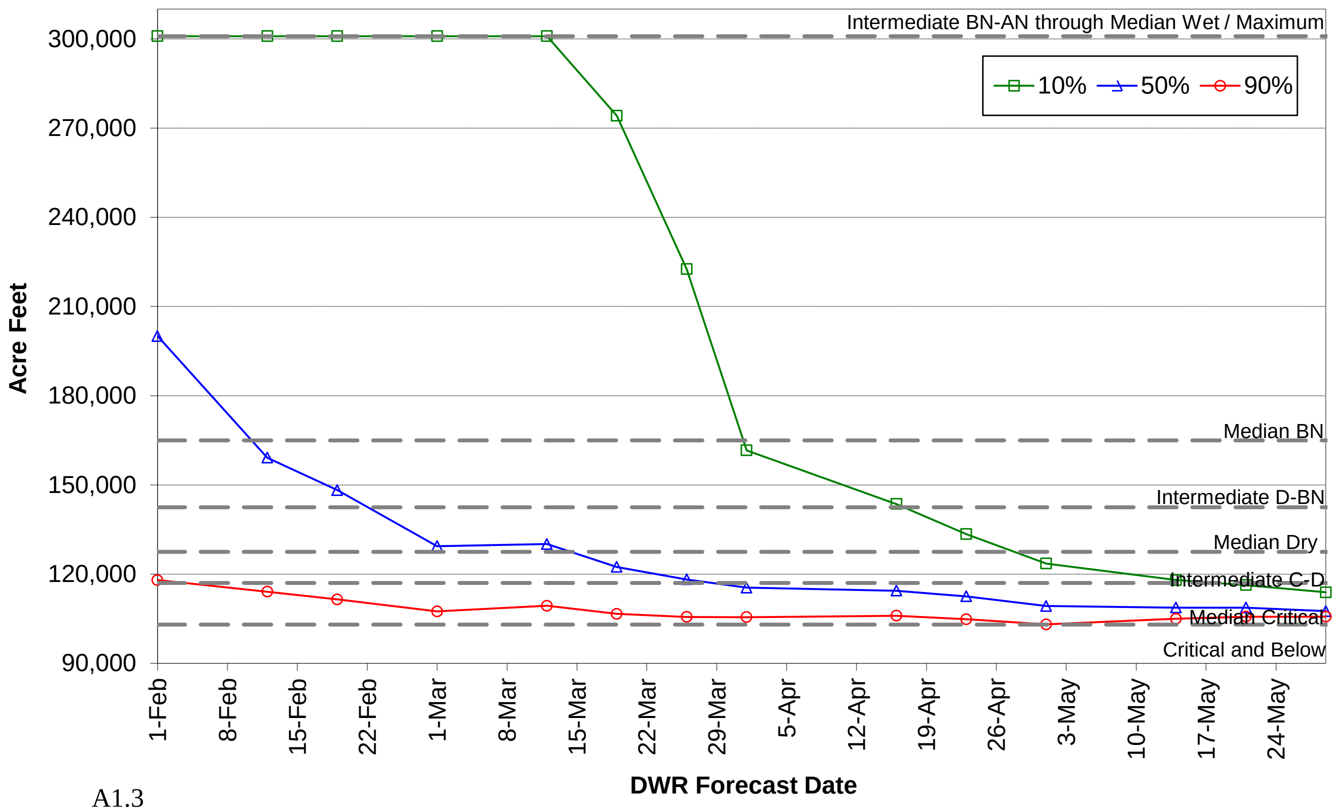

Daily average flow at Vernalis (SJR) minus combined CVP and SWP delta export
Water Year 2013
Daily average flow in cfs
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
9/30/12
10/31/12
11/30/12
12/31/12
1/31/13
2/28/13
3/31/13
4/30/13
5/31/13
6/30/13
7/31/13
8/31/13
9/30/13
SJR flow at Vernalis minus combined delta export

A1.2e


Daily average flow at Vernalis (SJR) minus combined CVP and SWP delta export
Water Year 2014
Daily average flow in cfs
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
9/30/13
10/31/13
11/30/13
12/31/13
1/31/14
2/28/14
3/31/14
4/30/14
5/31/14
6/30/14
7/31/14
8/31/14
9/30/14
SJR flow at Vernalis minus combined delta export

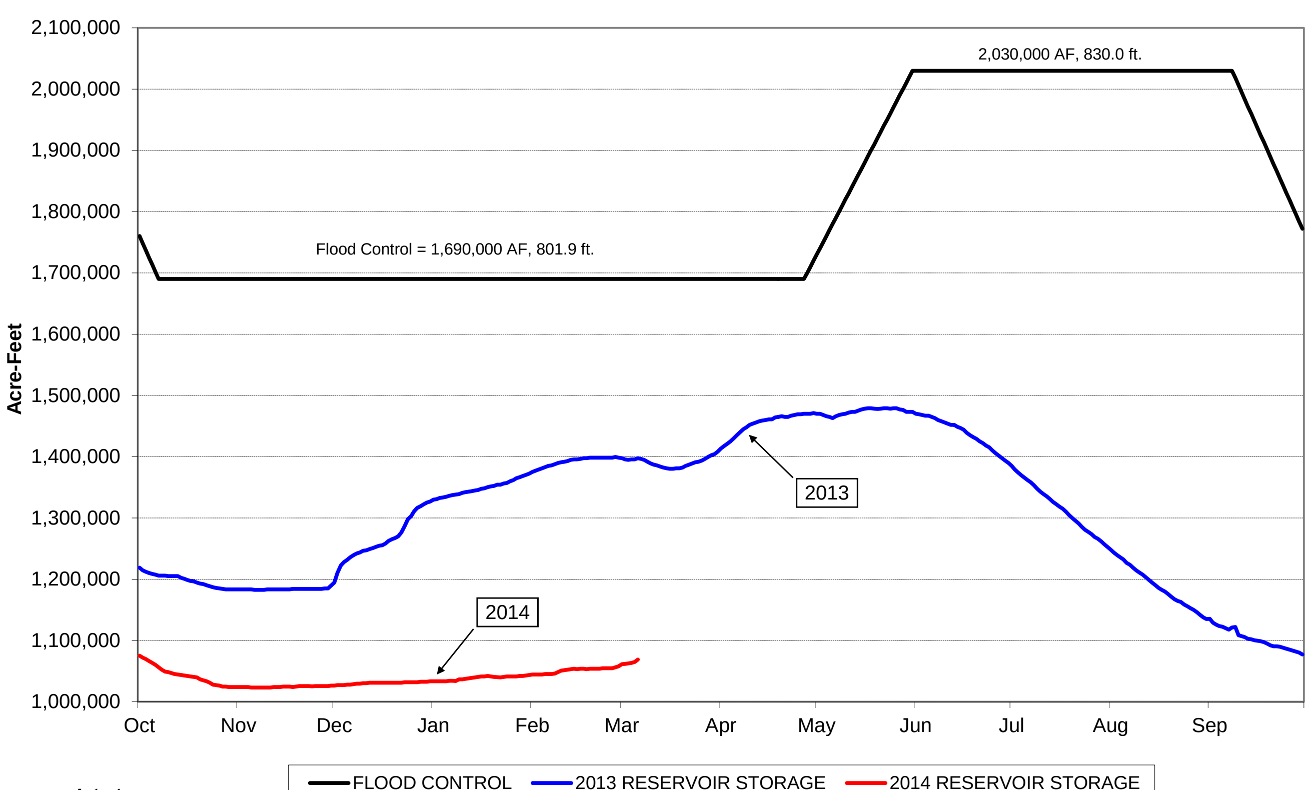
A1.2f

2013 FERC Flow Volumes (10%, 50%, 90% exceedence values)

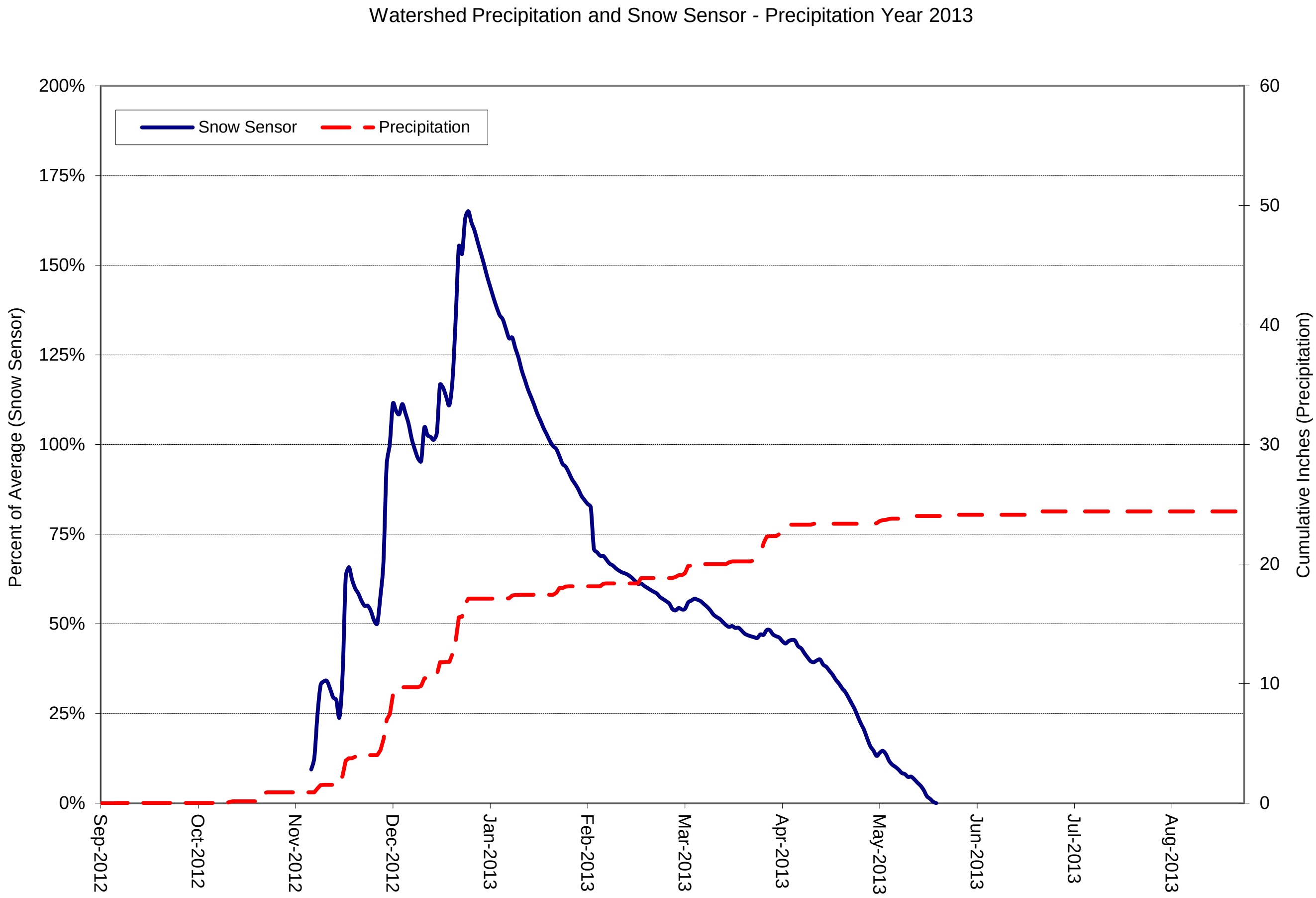


A1.3

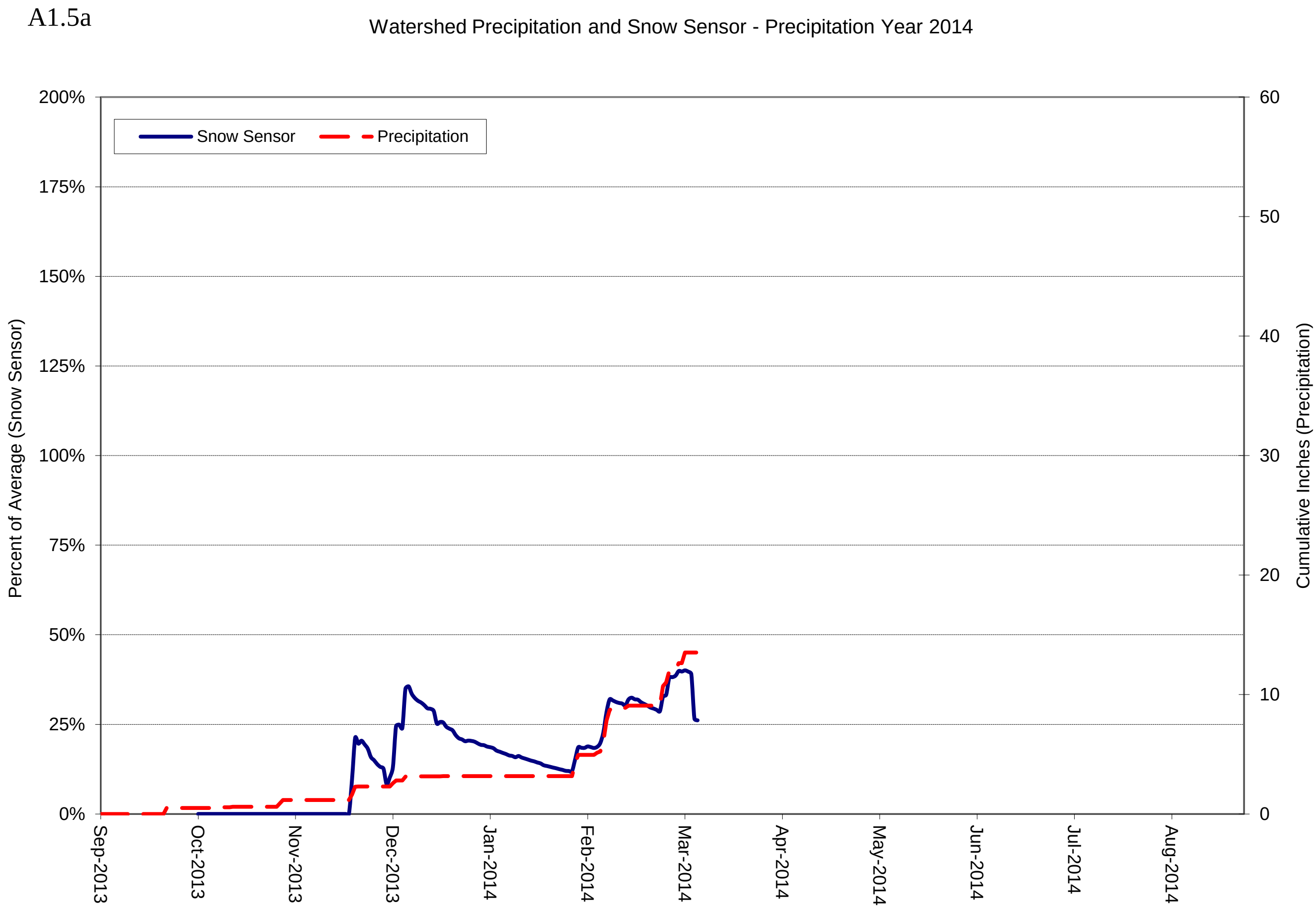
DON PEDRO STORAGE
Water Year 2013 and 2014



A1.4

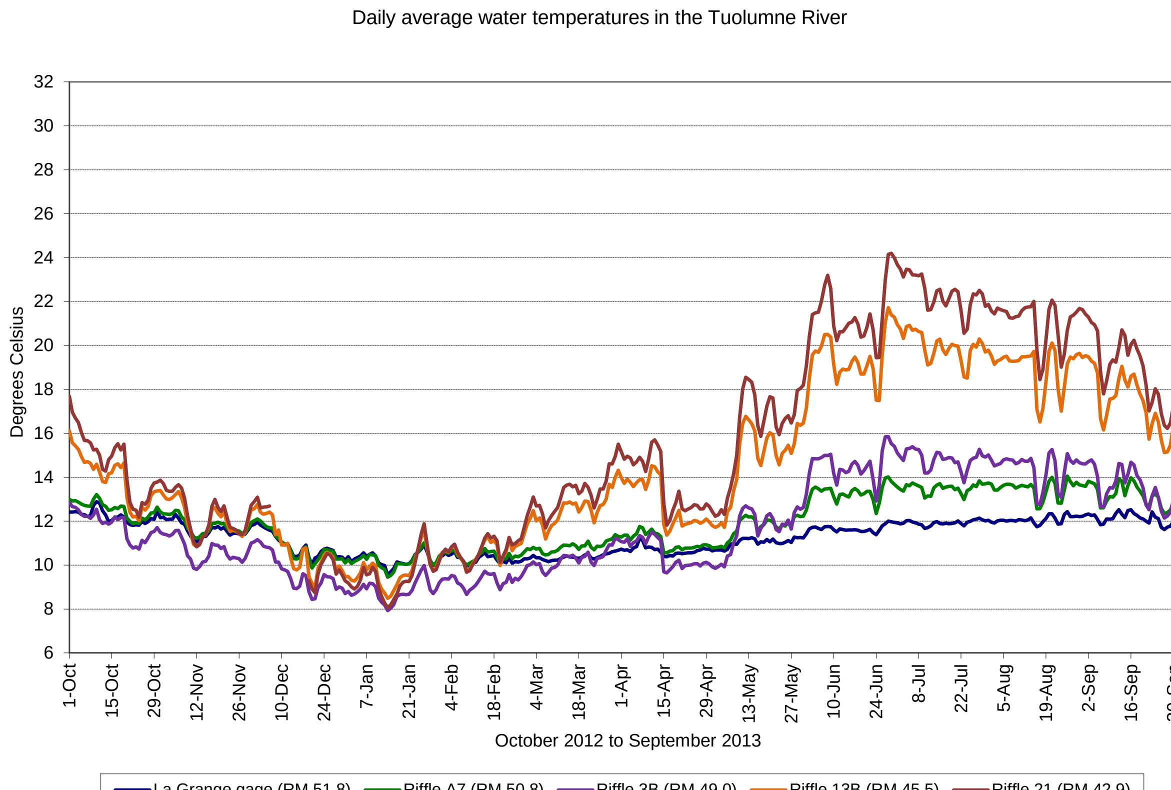

Watershed Precipitation and Snow Sensor - Precipitation Year 2013
Snow Sensor
Precipitation
Percent of Average (Snow Sensor)
Cumulative Inches (Precipitation)
200%
175%
150%
125%
100%
75%
50%
25%
0%
60
50
40
30
20
10
0
Sep-2012
Oct-2012
Nov-2012
Dec-2012
Jan-2013
Feb-2013
Mar-2013
Apr-2013
May-2013
Jun-2013
Jul-2013
Aug-2013

A1.5a

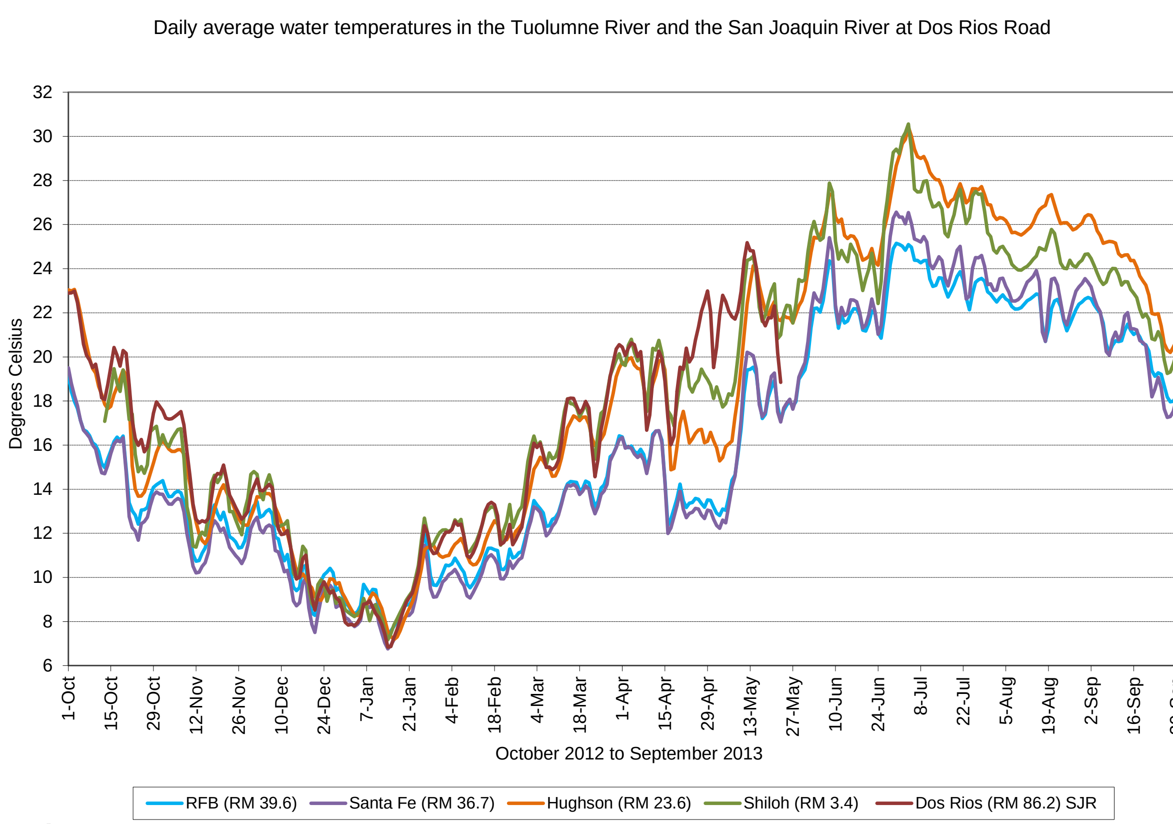

Watershed Precipitation and Snow Sensor - Precipitation Year 2014
Snow Sensor
Precipitation
Percent of Average (Snow Sensor)
Cumulative Inches (Precipitation)
200%
175%
150%
125%
100%
75%
50%
25%
0%
60
50
40
30
20
10
0
Sep-2013
Oct-2013
Nov-2013
Dec-2013
Jan-2014
Feb-2014
Mar-2014
Apr-2014
May-2014
Jun-2014
Jul-2014
Aug-2014

A1.5b

2. Graphs of water temperature and air temperature

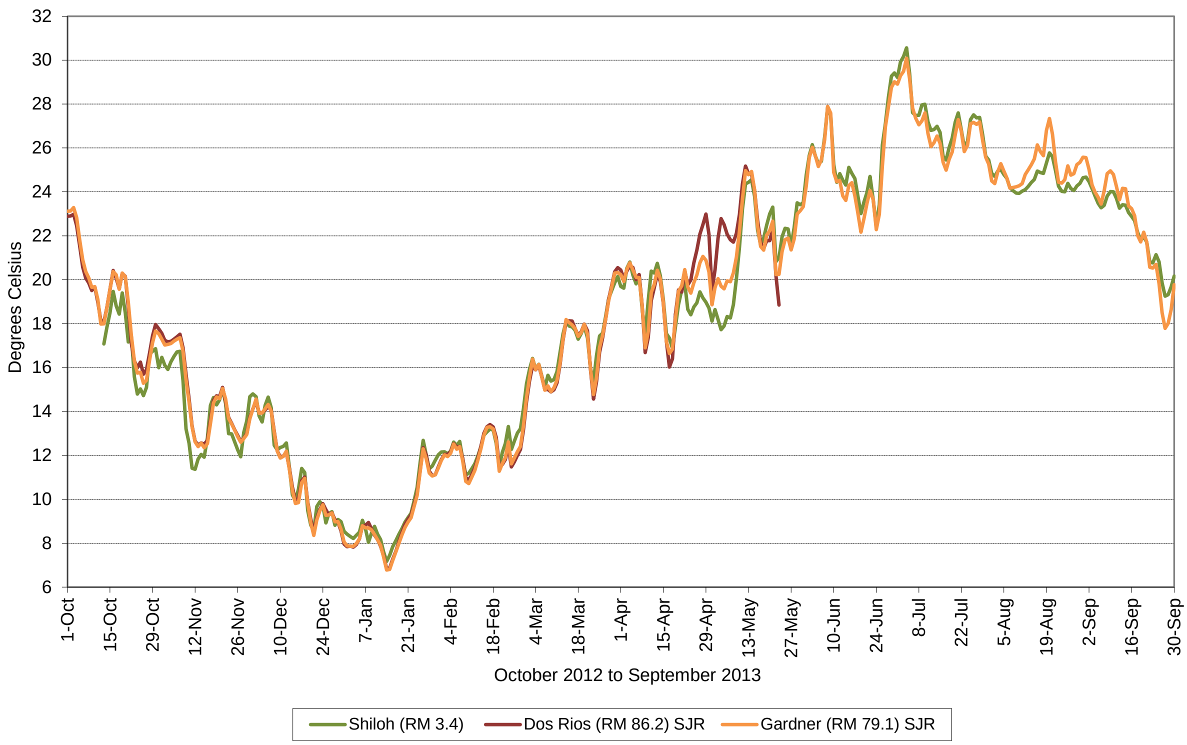


A2.1a



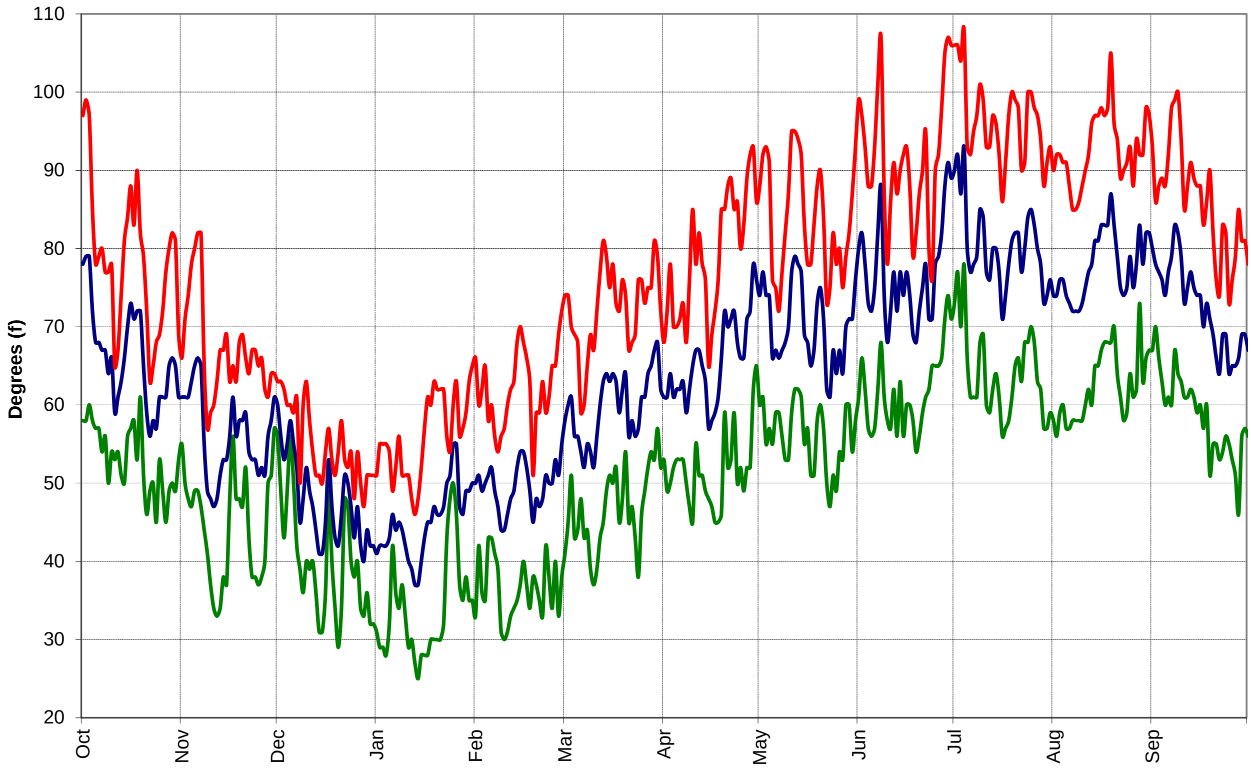
A2.1b

Daily average water temperatures in San Joaquin River and Tuolumne River at Shiloh Road



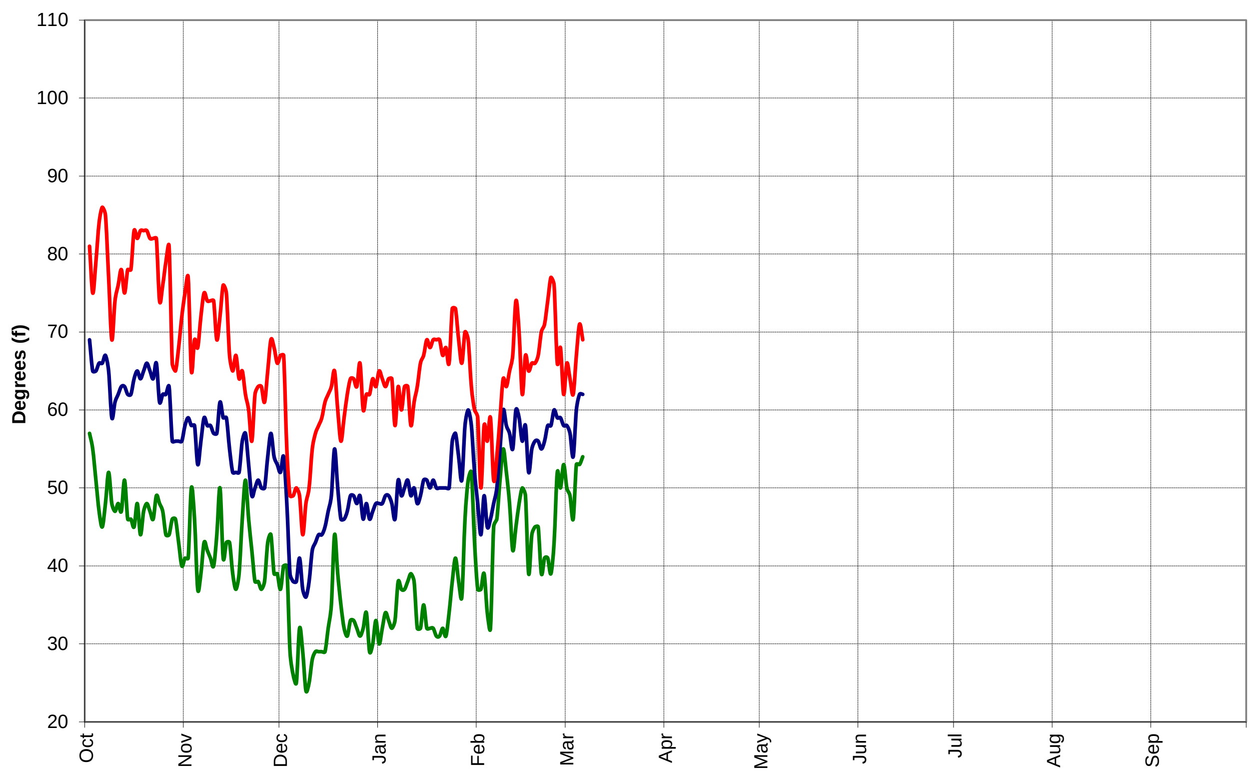
A2.1c

Modesto Airport Air Temperature - Max, Min, Avg (Water Year 2013)



A2.2

Modesto Airport Air Temperature - Max, Min, Avg (Water Year 2014)



A2.3

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Attachment -B-

2013 Tuolumne River
Technical Advisory Committee Materials:

- List of 2013 TRTAC Activities/Materials

- March Meeting
- June Meeting
- September Meeting
- December Meeting

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Tuolumne River Technical Advisory Committee

Don Pedro Project - FERC License 2299

Modesto Irrigation District
Turlock Irrigation District
City & County of San Francisco
California Department of Fish & Game
U. S. Fish & Wildlife Service

333 East Canal Drive
Turlock, CA 95381-0949
Phone: (209) 883-8278
Fax: (209) 656-2180
Email: pemaloney@TID.org

TECHNICAL ADVISORY COMMITTEE MEETING

March 14, 2013 at 9:30 AM

Turlock Irrigation District, Room 152

DRAFT AGENDA

1. Introduction and Announcements

2. Administrative Items:
   - Review/revise agenda
   - Approve notes from Dec 2012 meeting
   - Items since last meeting

3. Monitoring/Reports:
   - Fall run information – weir; river surveys
   - Ongoing monitoring – seine, screw trap, weir
   - Don Pedro Relicensing Initial Study Report
   - 1D IFIM Study Draft report
   - 2012 annual FERC report

4. Flow Operations:
   - Current watershed conditions, runoff and flow volume forecasts
   - Spring flow schedule(s)

5. Agency/NGO updates
   - USFWS Bobcat Flat habitat utilization surveys

6. Additional items

7. Next meeting Dates – June 13, September 12, December 12

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
CALIFORNIA DEPARTMENT OF FISH & GAME
U. S. FISH & WILDLIFE SERVICE

333 East Canal Drive
Turlock, CA 95381-0949
Phone: (209) 883-8278
Fax: (209) 656-2180
Email: pemaloney@TID.org

TECHNICAL ADVISORY COMMITTEE MEETING

14 March 2013 at 9:30 AM

Turlock Irrigation District, Room 152

Summary

1. **INTRODUCTION AND ANNOUNCEMENTS**
   - Participants made self introductions. See attendance below.

2. **ADMINISTRATIVE ITEMS:**
   - Review/Revise agenda – No Changes.
   - Approve notes from September meeting – No changes were identified. Notes for the last meeting are posted to the TRTAC website: http://tuolumnerivertac.com/
   - Items since last meeting – A handout list posted at http://tuolumnerivertac.com/ was reviewed. The list included meeting summaries and notes from the December 2012 TRTAC Meeting, correspondences regarding FERC licensing of La Grange operations (UL11-1), Don Pedro Relicensing ISR comments, USACE Correspondence regarding flood storage rules at Don Pedro Reservoir, and email announcement of posting the Draft 2013 IFIM Study Report. No annual monitoring report documents were posted, but will be included in the 2012 Annual Summary Report on April 1st..

3. **MONITORING/REPORTS:** (*Handouts were reviewed*)
   - Preliminary run estimates and fish passage on the Tuolumne River counting weir was reviewed. Andrea Fuller reported Tuolumne River weir counts were 2,136 as of March 11th. Boat surveys are conducted ½ mile upstream and downstream, of the weir to document any local spawning activity. No *O. mykiss* passage has been noted.
   - The 2013 annual FERC Report status was discussed and it was noted that CDFG Grand Tab spawner data would not be available until April 2013 at the earliest and would not included as part of the 2013 FERC Summary Report. Patrick will request provisional information from Steve Tsao (CDFW).
   - Other winter and spring monitoring plans: Ongoing weir operations, seining surveys, rotary screw trap operations were discussed for spring 2013. Weir operations may continue through 2013 for use in documenting striped bass movements unless pulse flows exceed 1,300 cfs, necessitating removal.

4. **FLOW OPERATIONS:**
   - Indications are that 2013 will be a critical or dry water year, with a corresponding minimum flow volume requirement of 109 TAF, 130 TAF, and 301 TAF based on a 10%, 50%, and 90% exceedance of DWR runoff estimates.

- The spring pulse flow amounts are 20,091 AF based on a 90% exceedance and 37,060 AF based on a 50% exceedance. Proposed flow schedules to be distributed by April 15th

5. AGENCY/NGO UPDATES

- USFWS Bobcat Flat Habitat Utilization Surveys: USFWS has been collecting site specific hydraulic information and salmonid habitat use at recent gravel rehabilitation projects and nearby control sites near Bobcat Flat
- No announcements from TRT or TRC

6. ADDITIONAL ITEMS

- Discussion of Bay-Delta Plan Substitute Environmental Document hearings

7. NEXT MEETING DATES – (*Quarterly on 2nd Thursday at 9:30am*)

- 2013 meeting dates: June 13th, September 12th, and December 12th

TRTAC Meeting Attendees

	Name	**Organization**
1.	Patrick Maloney	TID
2.	Walter Ward	MID
3.	Jason Carkeet	TID
4.	Andrea Fuller	FISHBIO
5.	Noah Hume	Stillwater

2013 TRTAC Materials/Postings to Website

2012Dec13-2013Mar13 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
  - December 2012 TRTAC meeting summary and handouts
  - March 2013 TRTAC meeting agenda

- Correspondence
  - December 19, 2012. Order finding licensing of hydroelectric project required Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13137463
  - December 21, 2012. California Department of Fish and Game Objectives for ILP Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13140707
  - December 28, 2012. Turlock Irrigation District and Modesto Irrigation District response to comments provided by California Department of Fish and Game on the development of unimpaired hydrology for the Tuolumne River Operations Model under Don Pedro Project P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13144038
  - January 1, 2013. Districts, under Don Pedro P-2299, submittal of Attachment 1 for Dec 21, 2012 letter to Peter Barnes (SWRCB) filed Dec 28, 2012, in response to comments provided by CDFG on development of unimpaired hydrology for Tuolumne River Operations Model. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13146219
  - January 9, 2013. Supplemental Information of Thomas H. Terpstra, A Professional Corporation. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13150874
  - January 9, 2013. Lowe Tuolumne Farmers submits comments re the Study Plan Determination for the Don Pedro Hydroelectric Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155021
  - January 11, 2013. Notice clarifying party status re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152675
  - January 11, 2013. Motion to Intervene and Comments of National Marine Fisheries Service under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152896
  - January 16, 2013. ILP Comments of California Department of Fish and Wildlife on Water and Aquatic Resource Studies 6 and 10 and update on water temperature criteria for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13154795
  - January 17, 2013. ILP Water & Aquatics Resources Initial Study Reports of Turlock Irrigation District and Modesto Irrigation District for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13156015
  - January 17, 2013. ILP Initial Terrestrial Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155590
  - January 17, 2013. ILP Initial Recreation Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155572

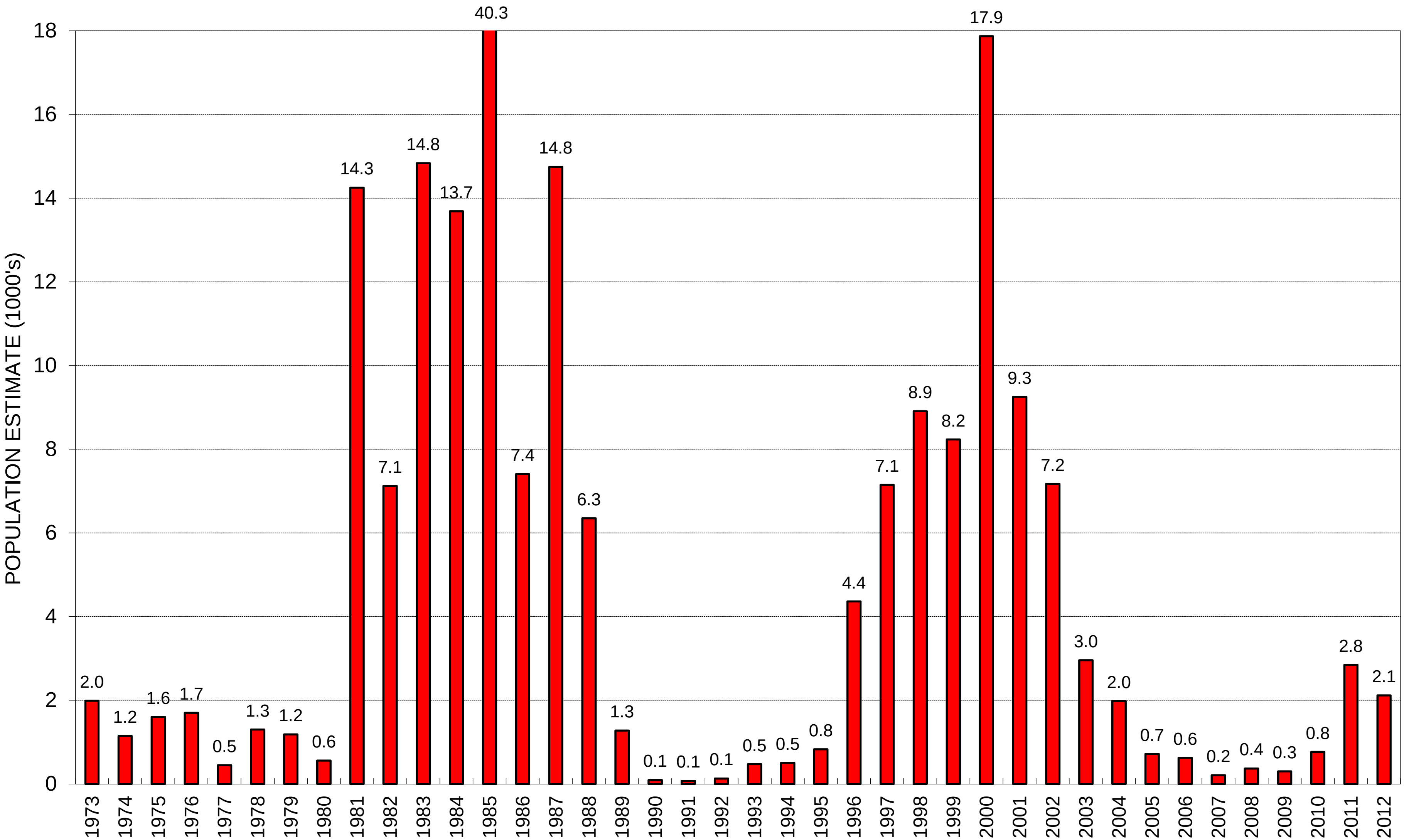
- January 17, 2013. ILP Initial Study Report of Turlock Irrigation District and Modesto Irrigation District transmittal letter, ISR, IFIM Progress Report and Cultural Resources Progress Reports. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155318
- January 18, 2013. Districts submittal of Attachment A-Photos missing from the Jan 17 2013 ISR filing of Don Pedro Project Relicensing Recreation Resources Study Plan No. 2 - Whitewater Boating Take-Out Improvement Feasibility Study Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13159071
- January 23, 2013. Conservation Groups' Amended Letter Regarding the Districts Request for Rehearing and Motion to Stay under P-2299, et al.
- January 23, 2013. Conservation Groups' Letter Regarding Districts' Request for Rehearing and Motion to Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13160201
- January 21, 2013. Lower Tuolumne Farmers submits comments re the Don Pedro Dam under P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13166937
- February 1, 2013. Conservation Groups' Answer in Opposition to Turlock and Modesto Irrigation Districts' Motion for Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13168520
- February 8, 2013. ILP Submittal by John Devine, HDR, of Initial Study Report Meeting Summary of Turlock Irrigation District and Modesto Irrigation District's Initial Study Report Meeting held January 30-31, 2013. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13175880
- February 12, 2013. Motion of Tuolumne River Preservation Trust under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13180063
- February 19, 2013. Order granting rehearing for further consideration Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13183741
- March 7, 2013. Response of the US Army Corps of Engineers to HDR Engineering, Inc's 7/12/12 letter re the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096098
- March 8, 2013. American River Touring Association, Inc submit comments on the Whitewater Boating Take-Out Improvement Feasibility Study Report and requesting a new study due to the inadequacy of the Initial Study Report under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096296
- March 8, 2013. Comments on RR-02 of project P-2299 Comment of Martin S McDonnell under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096436
- March 11, 2013. Comment of USDA Forest Service under P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096524
- March 11, 2013. Comment of O.A.R.S. Companies, Inc. on Initial Study Reports in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096531
- March 11, 2013. Comment of TUOLUMNE RIVER EXPEDITIONS, INC. on Initial Study Report in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096532
- March 11, 2013. Comment of Bob Hackamack under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096545
- March 11, 2013. Comment of NPS - CALIFORNIA HYDRO PROGRAM on ISR of P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096690
- March 11, 2013. Comments on the Initial Study Report, Licensee Study Reports, and Initial Study Report Meeting and Summary; Commission?s Study Plan; NOAA Fisheries Service, Southwest Region, under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096819

- March 11, 2013. USFWS Comments on the Initial Study Report for the Don Pedro Hydroelectric Project, FERC No. P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, CA. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096823
- March 11, 2013. ILP Comments or Study Request of Tuolumne River Preservation Trust under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096564
- March 11, 2013. ILP Comments or Study Request of Restore Hetch Hetchy under P-2299-075. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096679
- March 11, 2013. Comments on ISR from California Department of Fish and Wildlife under P-2299 et., al. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096810
- March 11, 2013. Comments of Conservation Groups Regarding ISR under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096882
- March 11, 2013. Responses to ISR of BUREAU OF LAND MANAGEMENT under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096884
- March 11, 2013. ILP Comments or Study Request of State Water Resources Control Board (CA) under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096901
-

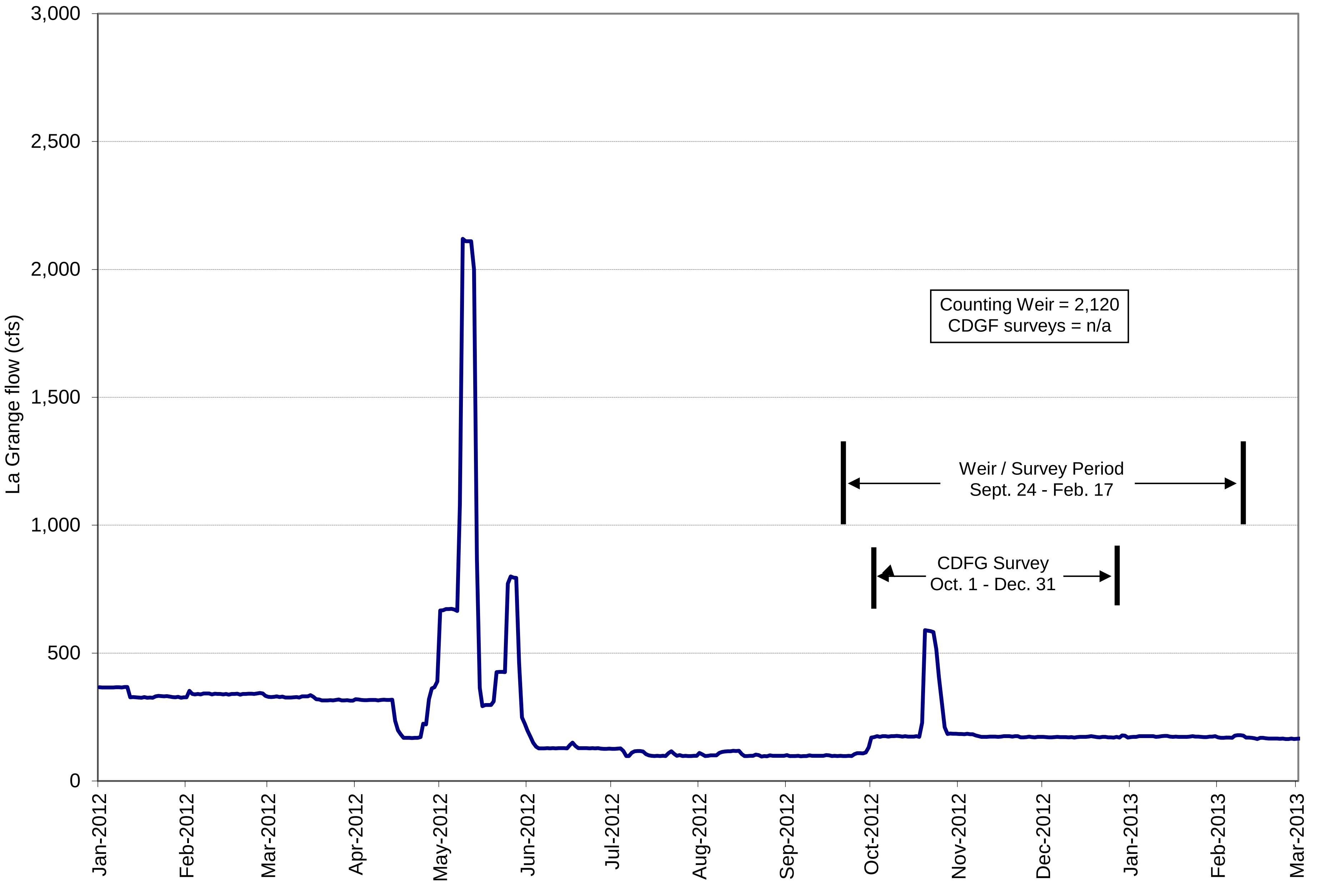
- Documents
  - No Documents
  - No postings

- Data/Monitoring
  - No postings

TUOLUMNE RIVER SALMON RUN
(Estimates/Counts)



Years 2009-2012 are based on counting weir results. All previous years from CDFG surveys. Survey periods may vary over the years for both methods.



Tuolumne River spawning surveys 2012. Counting weir (FISHBIO), no 2012 data available from CDFG surveys (www.calfish.org)

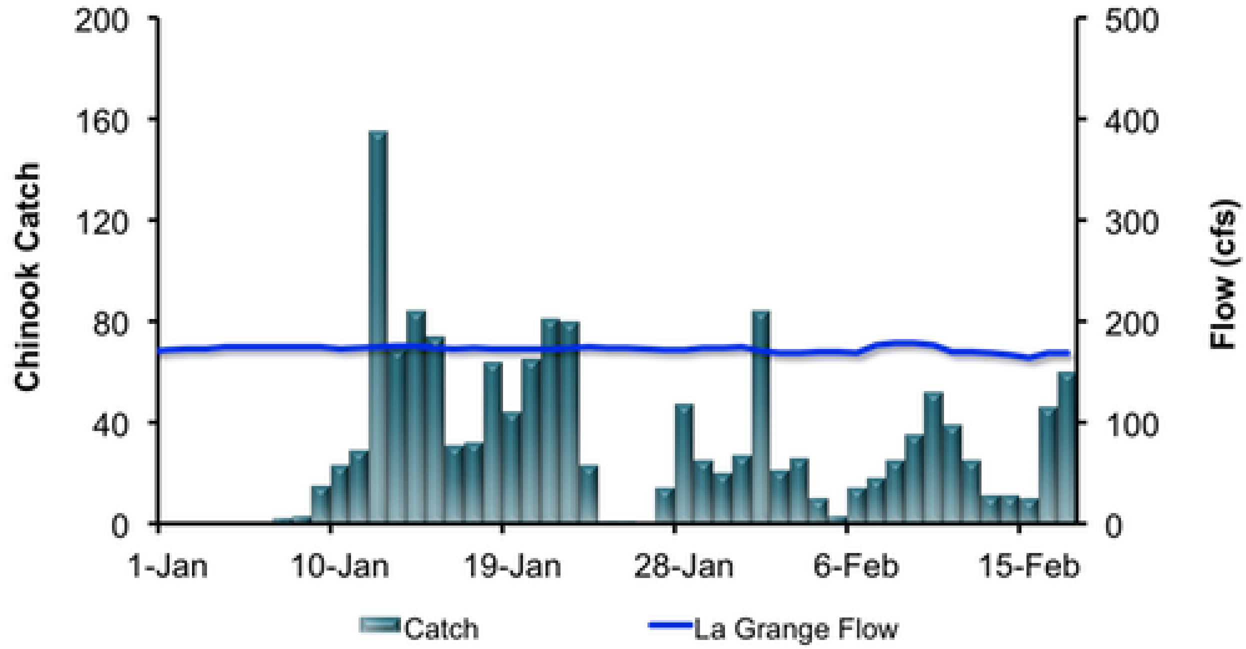
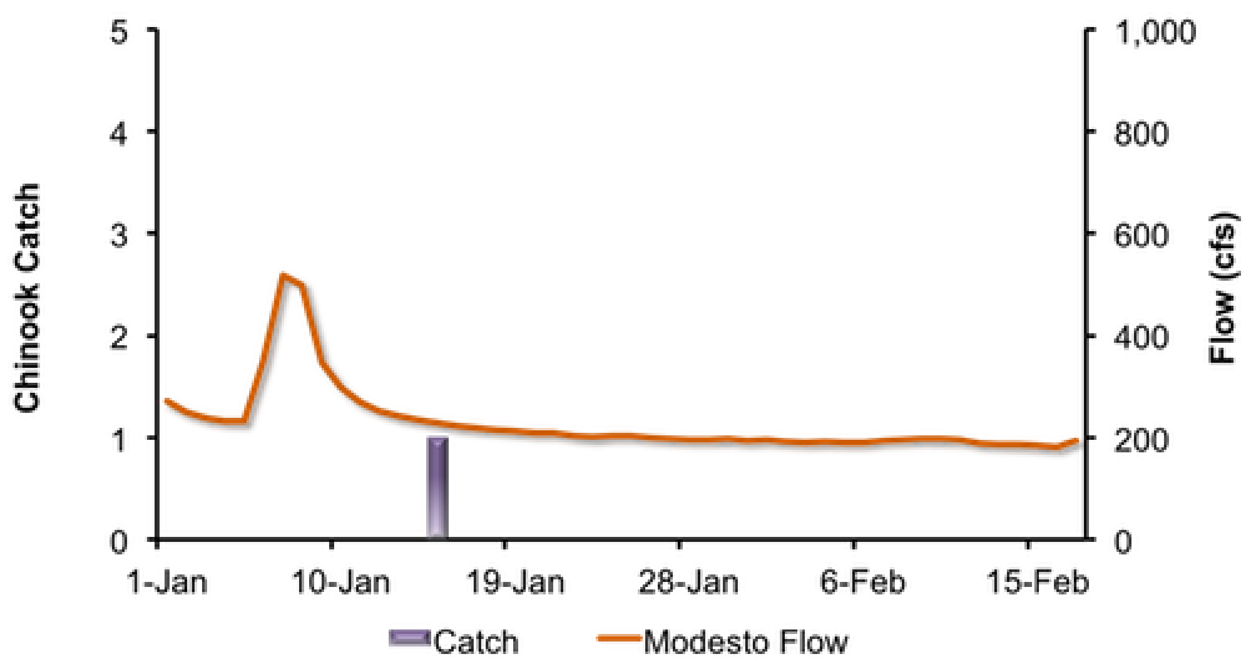
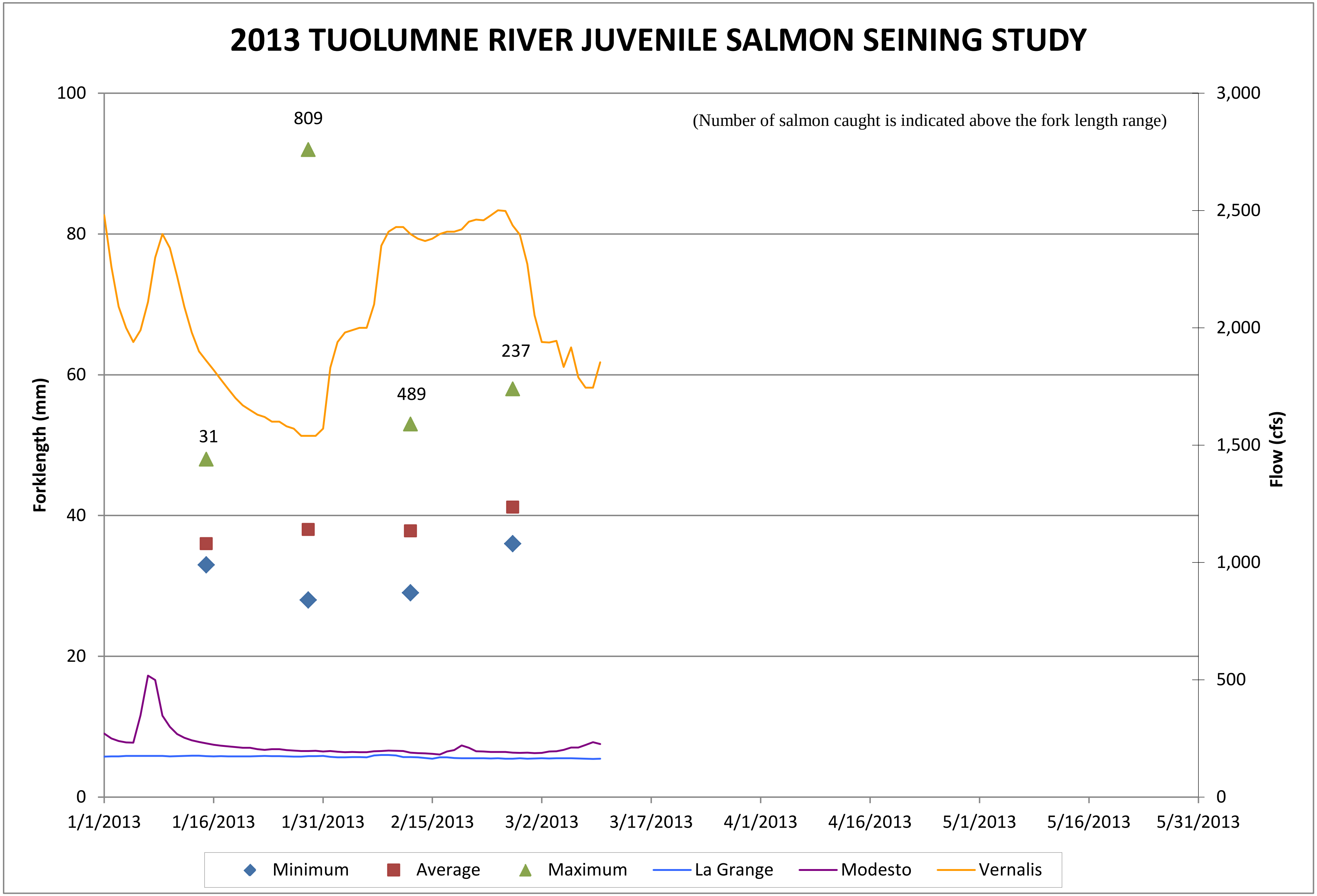


Figure 3. Juvenile Chinook catch at Waterford and Tuolumne River flow at La Grange (LGN) and Modesto (MOD). Total catch = 1,499.



Juvenile Chinook catch at Grayson and Tuolumne River flow at La Grange (LGN) and Modesto (MOD). Total catch = 1.



Tuolumne River seine surveys; salmon captures, size range, and flow.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

DRAFT COVER

2012 LOWER TUOLUMNE RIVER ANNUAL REPORT

2012 Annual Summary Report (SWS In progress)

Exhibits: Spawning runs, harvest data, rearing/outmigration data, Delta salvage and exports (SWS In progress, near completion)

Attachment A: Water Conditions, Flows, Temperature, and Flow Schedule Correspondence (SWS Complete)

Attachment B: 2012 Tuolumne River Technical Advisory Committee Materials (SWS Complete)

Report 2012-1: 2012 Spawning Survey Report (CDFW Completion TBD)

Report 2012-2: Spawning Survey Summary Update (SWS Complete, pending CDFW data)

Report 2012-3: 2012 Seine Report and Summary Update (FISHBIO Complete)

Report 2012-4: 2012 Rotary Screw Trap Report (FISHBIO Complete)

Report 2012-5: 2012 Snorkel Report and Summary Update (SWS Complete)

Report 2012-6: 2012 Tuolumne River Weir Report (FISHBIO Pending final review)

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TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
CALIFORNIA DEPARTMENT OF FISH & GAME
U. S. FISH & WILDLIFE SERVICE

333 East Canal Drive
Turlock, CA 95381-0949
Phone: (209) 883-8214
Fax: (209) 656-2180
Email: rmnees@TID.org

TECHNICAL ADVISORY COMMITTEE MEETING

June 13, 2013 at 9:30 AM

Turlock Irrigation District, Room 152

DRAFT AGENDA

1\. INTRODUCTION AND ANNOUNCEMENTS

2\. ADMINISTRATIVE ITEMS:
- Review/revise agenda
- Approve notes from March 2013 meeting
- Items since last meeting

2\. MONITORING/REPORTS:
- Review spring monitoring (Seine, RSTs)
- Review 2012 weir operation
- Planned summer 2013 FERC Relicensing studies
- Other summer 2013 Monitoring (Reference count snorkeling, Water temperature)

4\. FLOW OPERATIONS:
- Review spring pulse flows.
- Review summer flow schedule and fluctuation methodology.

5\. AGENCY/NGO UPDATES

6\. ADDITIONAL ITEMS

7\. NEXT MEETING DATE: SEPTEMBER 12, 2013

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
CALIFORNIA DEPARTMENT OF FISH & GAME
U. S. FISH & WILDLIFE SERVICE

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TECHNICAL ADVISORY COMMITTEE MEETING

June 13, 2013 at 9:30 AM

Turlock Irrigation District, Room 152

Summary

1. INTRODUCTION AND ANNOUNCEMENTS

- Participants made self introductions.
- Brief discussions were held regarding Water Year Classification Index and Flow Schedule, predation studies 2013-2014, DNA analysis of predator gut contents and gravel augmentation.

2. ADMINISTRATIVE ITEMS:

- Review/Revise agenda – No changes
- Approve notes from March meeting – No changes were identified. Notes for the last meeting are posted to the TRTAC website: http://tuolumnerivertac.com/
- Items since last meeting – A handout list posted at http://tuolumnerivertac.com/ was reviewed. The list included meeting summaries and correspondence since December 19, 2012.

3. MONITORING/REPORTS: (*Handouts were reviewed*)

- Spring monitoring: RST counts, seine data and final weir counts from the Tuolumne River were reviewed. 3,106 Chinook salmon were captured in the RST at Waterford, and 35 were captured in the RST at Grayson. The Grayson RST was removed on May 23, 2013 and the Waterford RST was removed May 31, 2013. Seine data is included in the June 13, 2013 "Handout" posted at http://tuolumnerivertac.com/. Seining surveys were terminated on June 4, 2013. 2032 adult Chinook salmon migrated upstream past the weir during the 2012-2013 spawning season. The weir was removed May 23, 2013.
- Two studies are planned for the summer of 2013:
  1. Additional thermographs are planned to be installed beginning June 24, 2013 as part of the ongoing HEC-RAS Water Temperature Model being developed for relicensing.
  2. Routine "Reference Count" snorkel surveys will be conducted through the summer period.

4. FLOW OPERATIONS:

- Reviewed spring Tuolumne River flows and forecasted flows through summer.
  - Due to water year classification, minimum flows are set at 50 cfs.
  - A buffer flow will be provided by the Districts similar to recent historic

practice.

- Reviewed spring/summer San Joaquin River Index with Associated FERC Flows.

5. AGENCY/NGO UPDATES

- None

6. ADDITIONAL ITEMS

- None

7. NEXT MEETING DATES – SEPTEMBER 12, DECEMBER 12, 2013.

TRTAC Meeting Attendees

	Name	Organization
1.	Patrick Maloney	TID
2.	Noah Hume	Stillwater

2013 TRTAC Materials/Postings to Website

2012Dec13-2013Mar13 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
  - December 2012 TRTAC meeting summary and handouts
  - March 2013 TRTAC meeting agenda

- Correspondence
  - December 19, 2012. Order finding licensing of hydroelectric project required Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13137463
  - December 21, 2012. California Department of Fish and Game Objectives for ILP Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13140707
  - December 28, 2012. Turlock Irrigation District and Modesto Irrigation District response to comments provided by California Department of Fish and Game on the development of unimpaired hydrology for the Tuolumne River Operations Model under Don Pedro Project P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13144038
  - January 1, 2013. Districts, under Don Pedro P-2299, submittal of Attachment 1 for Dec 21, 2012 letter to Peter Barnes (SWRCB) filed Dec 28, 2012, in response to comments provided by CDFG on development of unimpaired hydrology for Tuolumne River Operations Model. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13146219
  - January 9, 2013. Supplemental Information of Thomas H. Terpstra, A Professional Corporation. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13150874
  - January 9, 2013. Lowe Tuolumne Farmers submits comments re the Study Plan Determination for the Don Pedro Hydroelectric Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155021
  - January 11, 2013. Notice clarifying party status re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152675
  - January 11, 2013. Motion to Intervene and Comments of National Marine Fisheries Service under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152896
  - January 16, 2013. ILP Comments of California Department of Fish and Wildlife on Water and Aquatic Resource Studies 6 and 10 and update on water temperature criteria for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13154795
  - January 17, 2013. ILP Water & Aquatics Resources Initial Study Reports of Turlock Irrigation District and Modesto Irrigation District for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13156015
  - January 17, 2013. ILP Initial Terrestrial Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155590
  - January 17, 2013. ILP Initial Recreation Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155572

- January 17, 2013. ILP Initial Study Report of Turlock Irrigation District and Modesto Irrigation District transmittal letter, ISR, IFIM Progress Report and Cultural Resources Progress Reports. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155318
- January 18, 2013. Districts submittal of Attachment A-Photos missing from the Jan 17 2013 ISR filing of Don Pedro Project Relicensing Recreation Resources Study Plan No. 2 - Whitewater Boating Take-Out Improvement Feasibility Study Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13159071
- January 23, 2013. Conservation Groups' Amended Letter Regarding the Districts Request for Rehearing and Motion to Stay under P-2299, et al.
- January 23, 2013. Conservation Groups' Letter Regarding Districts' Request for Rehearing and Motion to Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13160201
- January 21, 2013. Lower Tuolumne Farmers submits comments re the Don Pedro Dam under P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13166937
- February 1, 2013. Conservation Groups' Answer in Opposition to Turlock and Modesto Irrigation Districts' Motion for Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13168520
- February 8, 2013. ILP Submittal by John Devine, HDR, of Initial Study Report Meeting Summary of Turlock Irrigation District and Modesto Irrigation District's Initial Study Report Meeting held January 30-31, 2013. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13175880
- February 12, 2013. Motion of Tuolumne River Preservation Trust under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13180063
- February 19, 2013. Order granting rehearing for further consideration Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13183741
- March 7, 2013. Response of the US Army Corps of Engineers to HDR Engineering, Inc's 7/12/12 letter re the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096098
- March 8, 2013. American River Touring Association, Inc submit comments on the Whitewater Boating Take-Out Improvement Feasibility Study Report and requesting a new study due to the inadequacy of the Initial Study Report under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096296
- March 8, 2013. Comments on RR-02 of project P-2299 Comment of Martin S McDonnell under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096436
- March 11, 2013. Comment of USDA Forest Service under P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096524
- March 11, 2013. Comment of O.A.R.S. Companies, Inc. on Initial Study Reports in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096531
- March 11, 2013. Comment of TUOLUMNE RIVER EXPEDITIONS, INC. on Initial Study Report in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096532
- March 11, 2013. Comment of Bob Hackamack under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096545
- March 11, 2013. Comment of NPS - CALIFORNIA HYDRO PROGRAM on ISR of P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096690
- March 11, 2013. Comments on the Initial Study Report, Licensee Study Reports, and Initial Study Report Meeting and Summary; Commission?s Study Plan; NOAA Fisheries Service, Southwest Region, under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096819

- March 11, 2013. USFWS Comments on the Initial Study Report for the Don Pedro Hydroelectric Project, FERC No. P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, CA. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096823
- March 11, 2013. ILP Comments or Study Request of Tuolumne River Preservation Trust under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096564
- March 11, 2013. ILP Comments or Study Request of Restore Hetch Hetchy under P-2299-075. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096679
- March 11, 2013. Comments on ISR from California Department of Fish and Wildlife under P-2299 et., al. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096810
- March 11, 2013. Comments of Conservation Groups Regarding ISR under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096882
- March 11, 2013. Responses to ISR of BUREAU OF LAND MANAGEMENT under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096884
- March 11, 2013. ILP Comments or Study Request of State Water Resources Control Board (CA) under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096901

- Documents
  - No Documents
  - No postings

- Data/Monitoring
  - No postings

2013Mar13-2013June14 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
  - March 2013 TRTAC meeting summary and handouts
  - June 2013 TRTAC meeting agenda

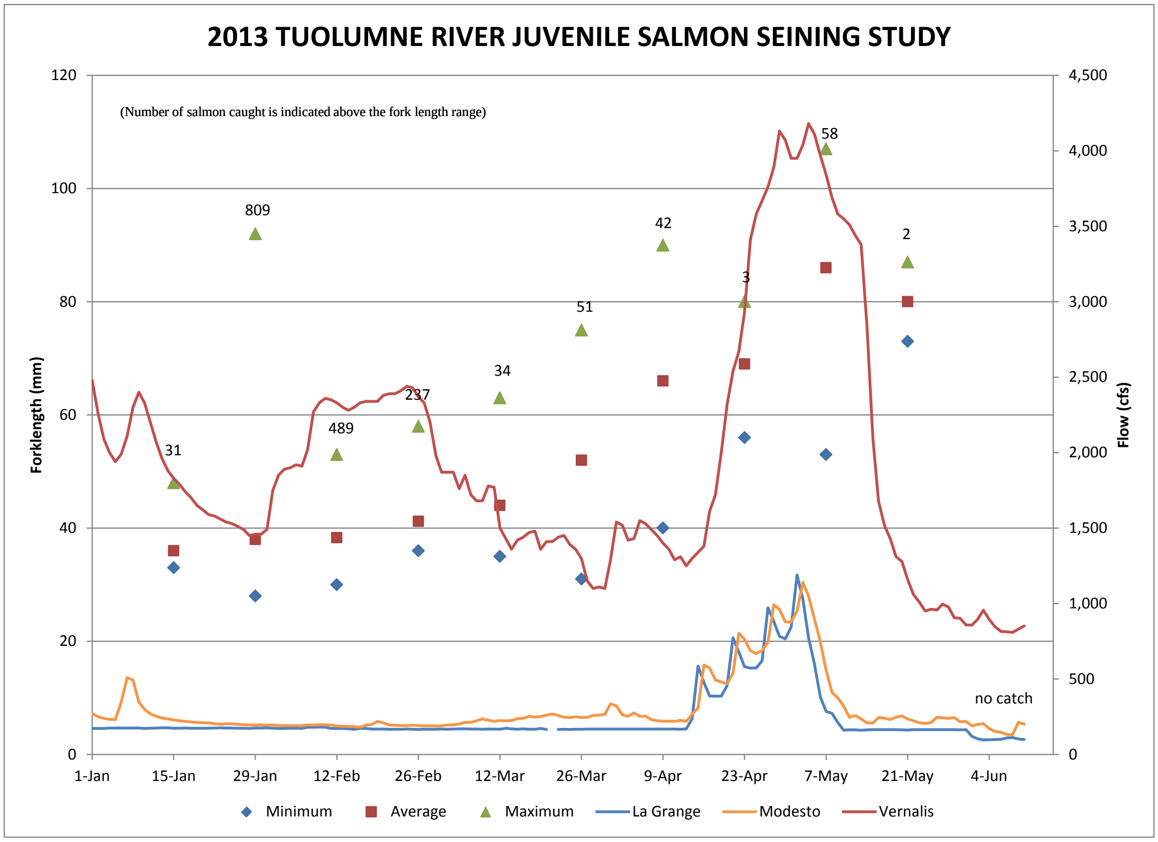
- Correspondence
  - March 13, 2013. Tuolumne County Board of Supervisors submits comments re the relicensing process of the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14097991
  - March 18, 2013. HDR Engineering, Inc submittal on behalf of Turlock Irrigation District & Modesto Irrigation District of Final Meeting Notes and Responses to Participant Comments - Nov 15, 2012 W&AR-06 and W&AR-10 Modeling Workshop No. 1. under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14098853
  - March 19, 2013. John Devine HDR, under P-2299, Don Pedro Project, submittal Final Meeting Notes, Comments, & Districts' Reply Comments W&AR-02 Consultation Workshop No. 2 held Sept 21, 2012; along with Final W&AR-02 Accretion Flow Measurements June/Oct 2012 & Feb 2013. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14099014

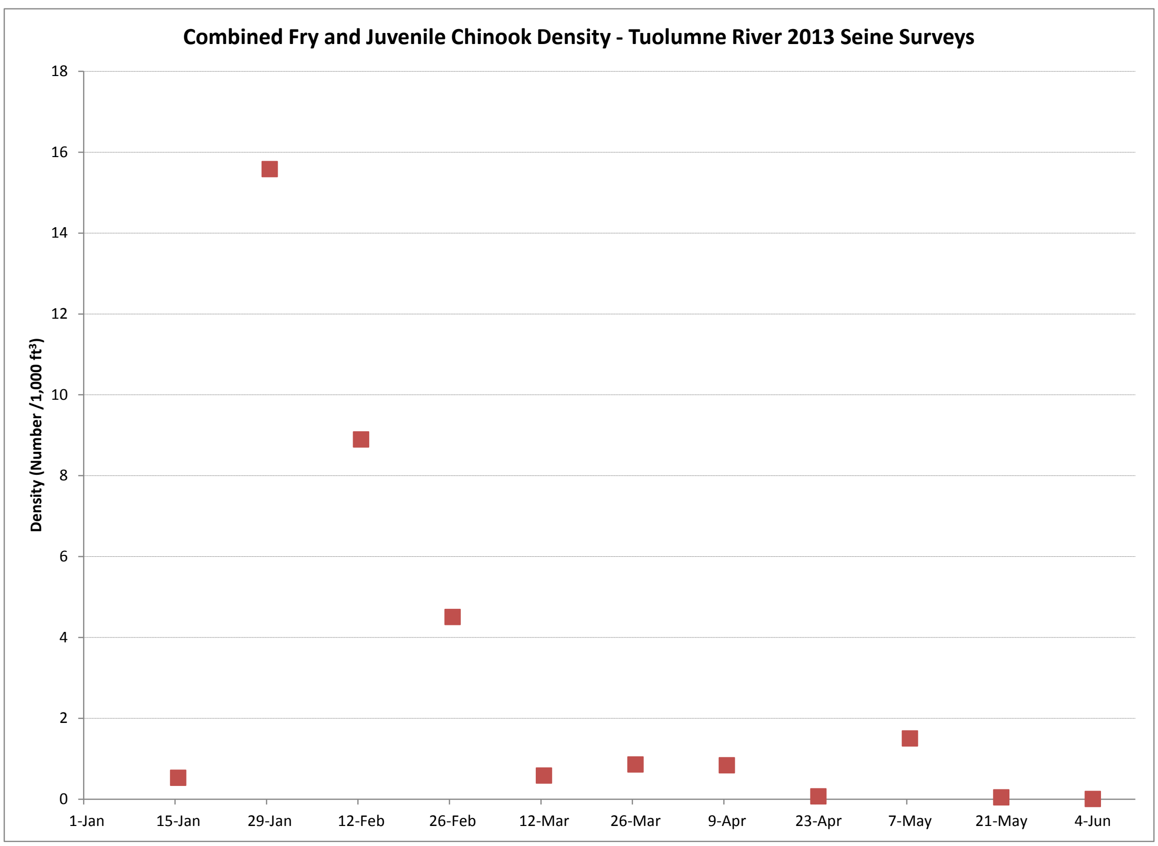
- March 19, 2013. Comments of California State Water Resources Control Board re the Don Pedro Hydroelectric Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14099398
- March 28, 2013. TURLOCK & MODESTO IRRIGATION DIST. 2012 Lower Tuolumne River annual report submitted to the Commission pursuant to Article 58 of the license under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14101678
- April 2, 2013. Comments of California Department of Fish and Wildlife on La Grange Hydro Project under UL11-1, et al. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14103535
- April 9, 2013. ILP Districts Response to Relicensing Participants' Comments on Initial Study Report of Turlock Irrigation District and Modesto Irrigation District under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14105376
- April 9, 2013. USFWS Comments on the February 2013 Draft Report for the Lower Tuolumne River Instream Flow Study, FERC Project P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, CA. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14105215
- April 15, 2013. La Grange Dam Project license Motion to Intervene of Tuolumne River Conservancy under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14106662
- April 29, 2013. Turlock and Modesto Irrigation Districts' Final Instream Flow Study Report submitted in accordance with Ordering Paragraph D) of the May 12, 2010 Order Modifying and Approving Instream Flow and Water Temperature Model Study Plans for the Don Pedro Project. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14110681
- April 30, 2013. ILP 2013 Predation Study Plan of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14111742
- May 17, 2013. Notice Denying Late Intervention re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14115764
- May 21, 2013. Letter to Turlock Irrigation District and Modesto Irrigation District re determination on requests for study modifications and new studies for the Don Pedro Hydroelectric Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14116522

- Documents
  - FERC Annual Report
  - TID-MID Final Instream Flow Report

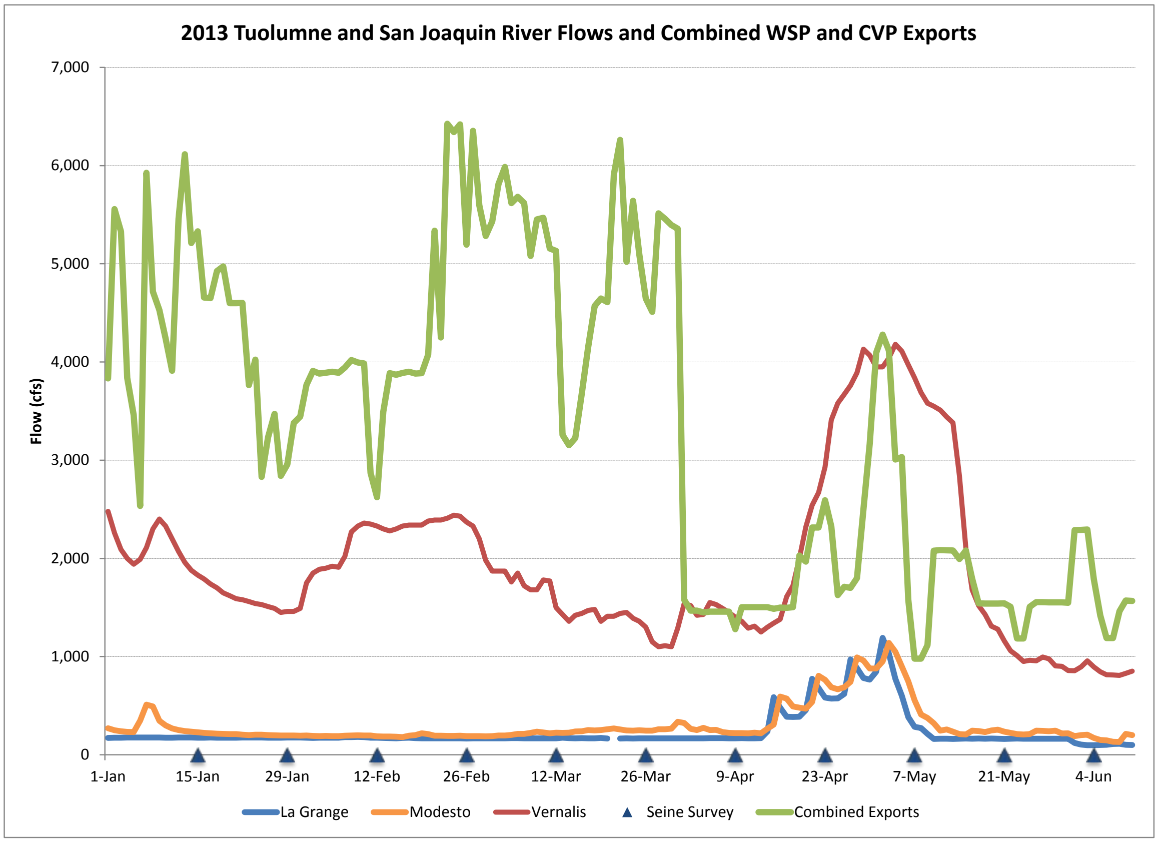
- Data/Monitoring
  - No postings

Lower Tuolumne River seine data for 2013

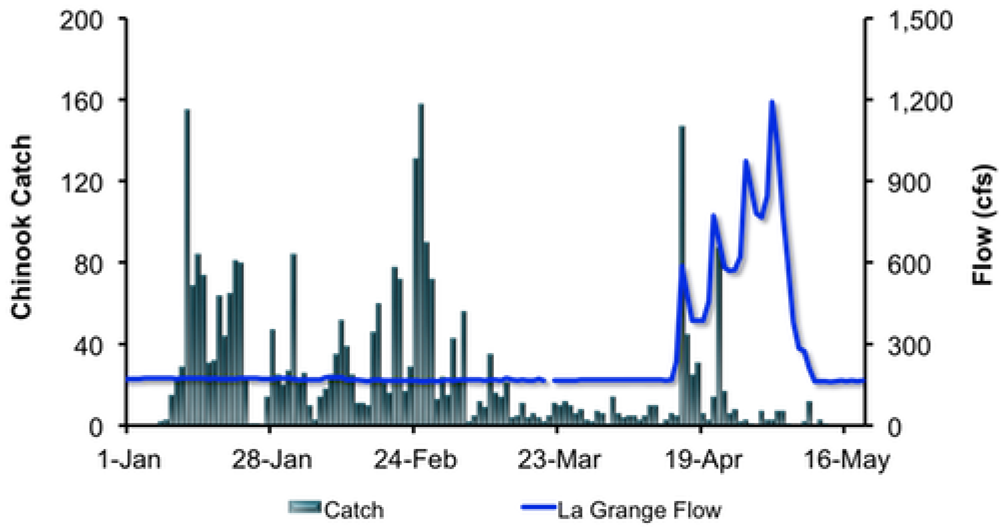




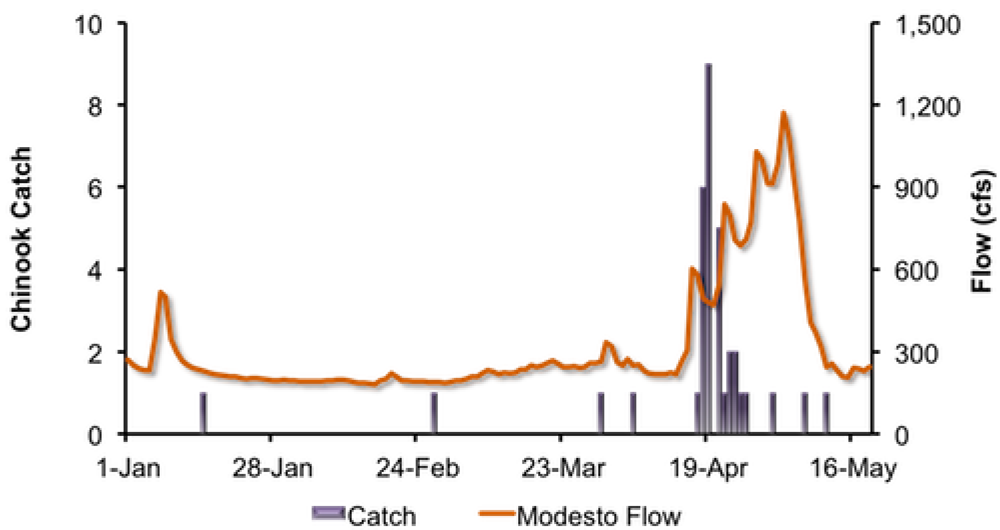
River flows and delta exports during 2013 seine surveys



Lower Tuolumne River RST data for 2013



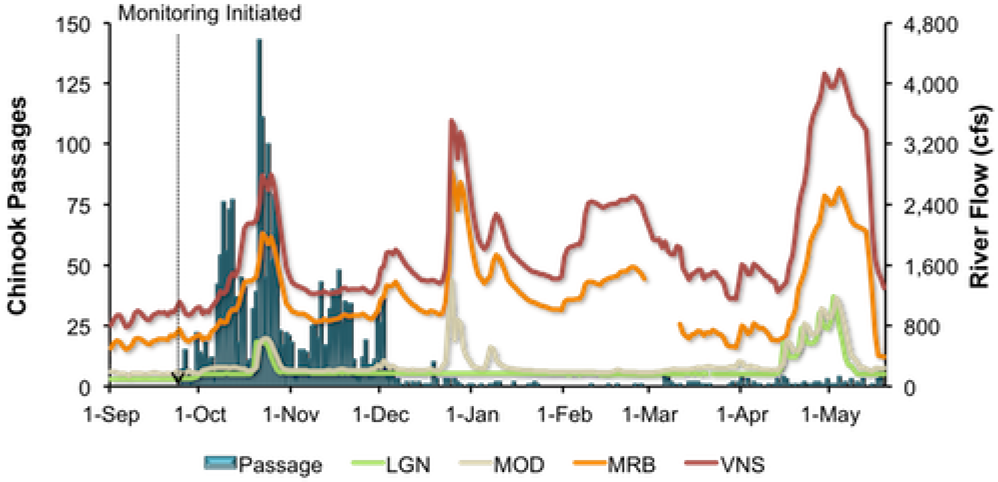
Daily Chinook salmon catch at Waterford and Tuolumne River flow recorded at La Grange (LGN) between January 1 and May 19, 2013. Season total = 3,106 captures.



Daily Chinook salmon catch at Grayson and Tuolumne River flow recorded at Modesto (MOD) between January 1 and May 19, 2013. Season total = 35 captures.

Source: San Joaquin Basin Newsletter, Volume 2012/13, Issue 15 (FISHBIO)

Lower Tuolumne River counting weir data for 2012-2013



Daily upstream Chinook passage at the Tuolumne River Weir in relation to daily average flows (cfs) recorded in the Tuolumne River at La Grange (LGN) and Modesto (MOD), and in the San Joaquin River at Vernalis (VNS) in 2012/13. Season total of Chinook detections = 2,300. Season total of *O. mykiss* detections = 3.

Source: San Joaquin Basin Newsletter, Volume 2012/13, Issue 15 (FISHBIO)

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April 12, 2013

Tim Heyne
California Dept. of Fish and Game
P.O. Box 10
La Grange, CA 95329

Deborah Giglio
U.S. Fish and Wildlife Service
2800 Cottage Way, W-2605
Sacramento, CA 95825

Maria Rea
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814-4708

RE: Project 2299 – Update of Water Year Classification Index and Flow Schedule

Dear Fishery Agency Representatives:

The 1996 FERC Order, Amended Article 37, contained a Water Year Classification Index for determining the volume of scheduled stream flows for each fish flow year. The classifications were based on the San Joaquin Basin 60-20-20 Indices for water years 1906-1995. The order stated, "60-20-20 index numbers used each year shall be updated to incorporate subsequent water years pursuant to standard Water Resources Department procedures so as to maintain approximately the same frequency distribution of water year types." The index is now updated to incorporate water years through 2012 (Table 1). While the frequency distribution remains the same, some index numbers may change slightly with each annual update to maintain the frequency distribution.

As you know, the final 60-20-20 San Joaquin Basin Index is not available until August of each year. Therefore, all flows prior to August are based upon index estimates using both the dry and average scenarios when the 60-20-20 San Joaquin Basin Index is below its average. TID has conferred with the California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS) as to the current dry conditions and the desire of the fishery agencies until April 8 to begin spring pulse flows on April 10.

With the fishery agencies' reconsideration and reallocation of their desired start date to April 15, TID was able to use the published Bulletin 120 data from the California Department of Water Resources' (DWR) April 1 forecast for the purpose of deriving an updated 60-20-20 San Joaquin

Basin Index (Table 2). Based on those values and the resulting calculations, the forecast Tuolumne River volumes for the dry and average scenarios are 105,498 acre-feet (dry) and 115,448 acre-feet (average), which are within the Median Critical Water Year range. Therefore, the spring pulse flow volumes (and shapes) for the dry and average schedules are identical. Attached is the flow schedule based on the dry scenario (Table 3). According to the National Weather Service, there is no rain in the forecast for the next 16 days.

With concurrence of all parties, the interpolation water can be allocated differently during the remainder of the 2013-2014 fish year once the exact figure is known. Please contact Wes Monier at (209)-883-8321 if you wish to discuss such a possibility or have any other questions.

Sincerely,

Steve Boyd
Director of Water Resources and Regulatory Affairs

C: Casey Hashimoto - TID
Roger Van Hoy- MID
Michael Carline - CCSF
FERC Secretary

TABLE 1

DETERMINATION OF WATER YEAR CLASSIFICATION THRESHOLDS

Water Year Classification

					602020 INDEX (x 1000)			
Water Year Classification	Cumulative Occurrence				Settlement Agreement	2010	2011	2012
Critical Water Year and Below	0.0%	-	6.4%	<	1500	1,515	1,515	1,515
Median Critical Water Year	6.4%	-<	14.4%	>=	1500	1,515	1,515	1,515
Intermediate Critical Dry Water Year	14.4%	-<	20.5%	>=	2000	2,005	2,005	2,005
Median Dry	20.5%	-<	31.3%	>=	2200	2,187	2,187	2,184
Intermediate Dry-Below Normal	31.3%	-<	40.4%	>=	2400	2,441	2,442	2,441
Median Below Normal	40.4%	-<	50.7%	>=	2700	2,725	2,725	2,725
Intermediate Below Normal-Above Normal	50.7%	-<	66.2%	>=	3100	3,183	3,183	3,183
Median Above Normal	66.2%	-<	71.3%	>=	3100	3,689	3,740	3,689
Intermediate Above Normal-Wet	71.3%	-<	86.7%	>=	3100	3,903	4,028	4,028
Median Wet/Maximum	86.7%	-<	100.0%	>=	3100	4,754	4,754	4,754

Table 2

San Joaquin Index With Associated FERC Flows

SAN JOAQUIN VALLEY WATER YEAR HYDROLOGIC CLASSIFICATION

602020 INDEX

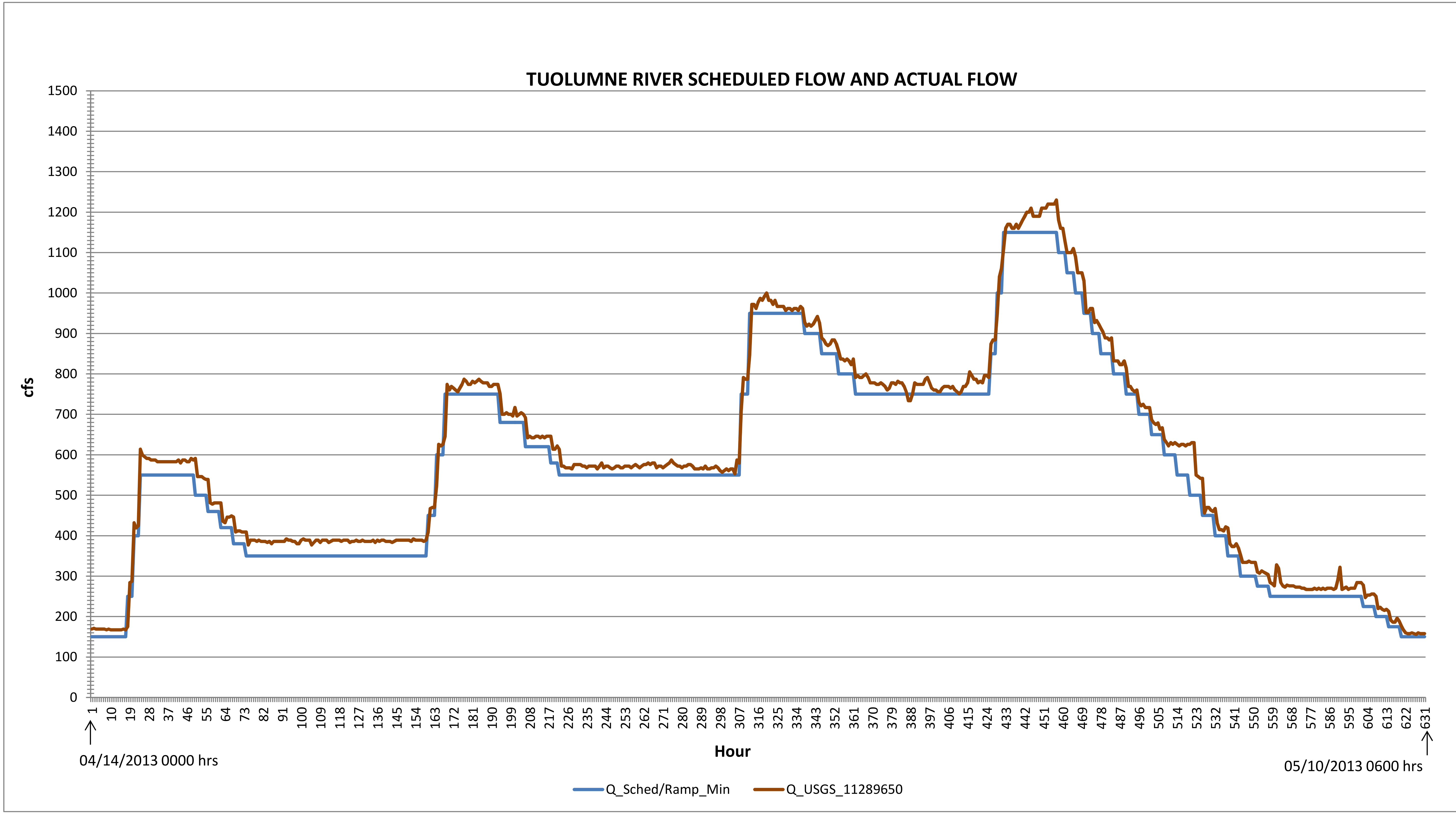
	APRIL-JULY RUNOFF (AF)					OCTOBER-MARCH RUNOFF (AF)					602020	TUOLUMNE RIVER	San Joaquin Index (not the FERC Index)
YEAR	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	INDEX	MINIMUM FLOW REQUIREMENT	
12	394,507	609,424	300,876	558,917	1,863,724	215,106	254,324	114,994	244,726	829,150	2,184,064	127,506	Dry
13	420,000	740,000	310,000	610,000	2,080,000	323,159	476,812	207,327	318,805	1,326,103	1,950,033	115,449	Critical
Feb 1 Forecast													
Dry	400,000	730,000	370,000	770,000	2,270,000	295,000	415,000	165,000	240,000	1,115,000	2,021,813	118,010	Critical
Average	630,000	1,120,000	550,000	1,130,000	3,430,000	430,000	625,000	285,000	400,000	1,740,000	2,842,813	200,004	Below Normal
Wet	1,090,000	1,910,000	1,060,000	1,950,000	6,010,000	615,000	765,000	405,000	600,000	2,385,000	4,519,813	300,923	Wet
Feb 12 Update													
Dry	360,000	670,000	340,000	700,000	2,070,000	295,000	415,000	165,000	240,000	1,115,000	1,901,813	114,071	Critical
Average	570,000	1,010,000	500,000	1,030,000	3,110,000	430,000	625,000	285,000	400,000	1,740,000	2,650,813	159,148	Below Normal
Wet	1,000,000	1,730,000	950,000	1,760,000	5,440,000	615,000	765,000	405,000	600,000	2,385,000	4,177,813	300,923	Wet
Feb 19 Update													
Dry	340,000	630,000	310,000	640,000	1,920,000	295,000	415,000	165,000	240,000	1,115,000	1,811,813	111,498	Critical
Average	530,000	940,000	460,000	950,000	2,880,000	430,000	625,000	285,000	400,000	1,740,000	2,512,813	148,216	Below Normal
Wet	950,000	1,620,000	870,000	1,620,000	5,060,000	615,000	765,000	405,000	600,000	2,385,000	3,949,813	300,923	Wet
Mar 1 Forecast													
Dry	320,000	580,000	220,000	540,000	1,660,000	290,000	445,000	185,000	270,000	1,190,000	1,670,813	107,467	Critical
Average	490,000	840,000	360,000	820,000	2,510,000	330,000	495,000	215,000	330,000	1,370,000	2,216,813	129,420	Dry
Wet	880,000	1,460,000	710,000	1,410,000	4,460,000	420,000	615,000	285,000	440,000	1,760,000	3,464,813	300,923	Above Normal
Mar 12 Update													
Dry	360,000	620,000	230,000	560,000	1,770,000	290,000	445,000	185,000	270,000	1,190,000	1,736,813	109,354	Critical
Average	510,000	850,000	360,000	810,000	2,530,000	330,000	495,000	215,000	330,000	1,370,000	2,228,813	130,121	Dry
Wet	850,000	1,390,000	670,000	1,310,000	4,220,000	420,000	615,000	285,000	440,000	1,760,000	3,320,813	300,923	Above Normal
Mar 19 Update													
Dry	340,000	580,000	200,000	490,000	1,610,000	290,000	445,000	185,000	270,000	1,190,000	1,640,813	106,609	Critical
Average	480,000	790,000	320,000	720,000	2,310,000	330,000	495,000	215,000	330,000	1,370,000	2,096,813	122,400	Critical
Wet	790,000	1,280,000	610,000	1,160,000	3,840,000	420,000	615,000	285,000	440,000	1,760,000	3,092,813	274,104	Below Normal
Mar 26 Update													
Dry	340,000	570,000	200,000	440,000	1,550,000	290,000	445,000	185,000	270,000	1,190,000	1,604,813	105,580	Critical
Average	470,000	760,000	310,000	650,000	2,190,000	330,000	495,000	215,000	330,000	1,370,000	2,024,813	118,186	Critical
Wet	750,000	1,190,000	570,000	1,040,000	3,550,000	420,000	615,000	285,000	440,000	1,760,000	2,918,813	222,530	Below Normal
Apr 1 Forecast													
Dry	300,000	570,000	210,000	420,000	1,500,000	323,100	476,700	207,200	318,800	1,325,800	1,601,973	105,498	Critical
Average	420,000	740,000	310,000	610,000	2,080,000	323,100	476,700	207,200	318,800	1,325,800	1,949,973	115,448	Critical
Wet	670,000	1,130,000	550,000	950,000	3,300,000	323,100	476,700	207,200	318,800	1,325,800	2,681,973	161,616	Below Normal

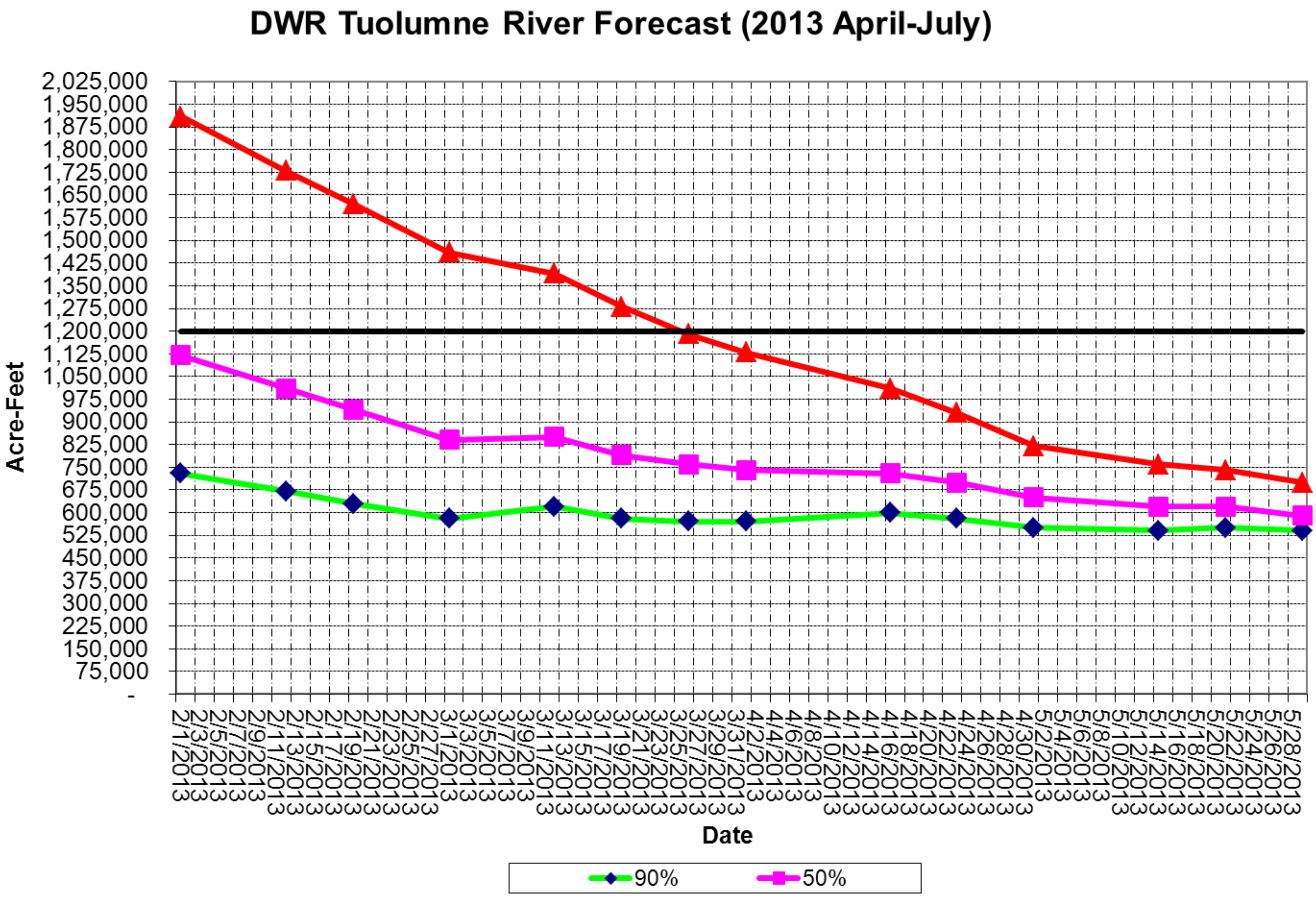
Table 3
Tuolumne River Flow Schedule
Based on DWR April 1, 60-20-20 Index for 2013, Hydrologic Conditions
Schedule For 2013-2014 Fish Flow Year

DATE		Number of	BASE FLOW			PULSE FLOW [1]			INTERPOLATION FLOW			Other Adjusted Flow			TOTAL FERC FLOW	
From:	To:	DAYS	CFS	AF	ACCUM. A.F.	CFS	AF	ACCUM. A.F.	CFS	AF	ACCUM. A.F.	CFS	AF	ACCUM. A.F.	CFS	ACCUM. A.F.
15-Apr-2013	15-Apr-2013	1	150	298	298	400	793	793	0	0	0	0	0	0	550	1,091
16-Apr-2013	16-Apr-2013	1	150	298	595	200	397	1,190	0	0	0	0	0	0	350	1,785
17-Apr-2013	17-Apr-2013	1	150	298	893	200	397	1,587	0	0	0	0	0	0	350	2,479
18-Apr-2013	18-Apr-2013	1	150	298	1,190	200	397	1,983	0	0	0	0	0	0	350	3,174
19-Apr-2013	19-Apr-2013	1	150	298	1,488	200	397	2,380	0	0	0	0	0	0	350	3,868
20-Apr-2013	20-Apr-2013	1	150	298	1,785	200	397	2,777	0	0	0	0	0	0	350	4,562
21-Apr-2013	21-Apr-2013	1	150	298	2,083	600	1,190	3,967	0	0	0	0	0	0	750	6,050
22-Apr-2013	22-Apr-2013	1	150	298	2,380	400	793	4,760	0	0	0	0	0	0	550	7,140
23-Apr-2013	23-Apr-2013	1	150	298	2,678	400	793	5,554	0	0	0	0	0	0	550	8,231
24-Apr-2013	24-Apr-2013	1	150	298	2,975	400	793	6,347	0	0	0	0	0	0	550	9,322
25-Apr-2013	25-Apr-2013	1	150	298	3,273	400	793	7,140	0	0	0	0	0	0	550	10,413
26-Apr-2013	26-Apr-2013	1	150	298	3,570	400	793	7,934	0	0	0	0	0	0	550	11,504
27-Apr-2013	27-Apr-2013	1	150	298	3,868	800	1,587	9,521	0	0	0	0	0	0	950	13,388
28-Apr-2013	28-Apr-2013	1	150	298	4,165	600	1,190	10,711	0	0	0	0	0	0	750	14,876
29-Apr-2013	29-Apr-2013	1	150	298	4,463	600	1,190	11,901	0	0	0	0	0	0	750	16,364
30-Apr-2013	30-Apr-2013	1	150	298	4,760	600	1,190	13,091	0	0	0	0	0	0	750	17,851
01-May-2013	01-May-2013	1	150	298	5,058	600	1,190	14,281	0	0	0	0	0	0	750	19,339
02-May-2013	02-May-2013	1	150	298	5,355	####	1,983	16,264	0	0	0	0	0	0	1,150	21,620
03-May-2013	03-May-2013	1	150	298	5,653	800	1,587	17,851	0	0	0	0	0	0	950	23,504
04-May-2013	04-May-2013	1	150	298	5,950	550	1,091	18,942	0	0	0	0	0	0	700	24,893
05-May-2013	05-May-2013	1	150	298	6,248	279	553	19,496	0	0	0	0	0	0	429	25,743
06-May-2013	06-May-2013	1	150	298	6,545	200	397	19,892	0	0	0	0	0	0	350	26,438
07-May-2013	07-May-2013	1	150	298	6,843	100	198	20,091	0	0	0	0	0	0	250	26,934
08-May-2013	08-May-2013	1	150	298	7,140	0	0	20,091	0	0	0	0	0	0	150	27,231
09-May-2013	09-May-2013	1	150	298	7,438	0	0	20,091	0	0	0	0	0	0	150	27,529
10-May-2013	10-May-2013	1	150	298	7,736	0	0	20,091	0	0	0	0	0	0	150	27,826
11-May-2013	11-May-2013	1	150	298	8,033	0	0	20,091	0	0	0	0	0	0	150	28,124
12-May-2013	12-May-2013	1	150	298	8,331	0	0	20,091	0	0	0	0	0	0	150	28,421
13-May-2013	13-May-2013	1	150	298	8,628	0	0	20,091	0	0	0	0	0	0	150	28,719
14-May-2013	14-May-2013	1	150	298	8,926	0	0	20,091	0	0	0	0	0	0	150	29,016
15-May-2013	15-May-2013	1	150	298	9,223	0	0	20,091	0	0	0	0	0	0	150	29,314
16-May-2013	16-May-2013	1	150	298	9,521	0	0	20,091	0	0	0	0	0	0	150	29,611
17-May-2013	17-May-2013	1	150	298	9,818	0	0	20,091	0	0	0	0	0	0	150	29,909
18-May-2013	18-May-2013	1	150	298	10,116	0	0	20,091	0	0	0	0	0	0	150	30,206
19-May-2013	19-May-2013	1	150	298	10,413	0	0	20,091	0	0	0	0	0	0	150	30,504
20-May-2013	20-May-2013	1	150	298	10,711	0	0	20,091	0	0	0	0	0	0	150	30,801
21-May-2013	21-May-2013	1	150	298	11,008	0	0	20,091	0	0	0	0	0	0	150	31,099
22-May-2013	22-May-2013	1	150	298	11,306	0	0	20,091	0	0	0	0	0	0	150	31,396
23-May-2013	23-May-2013	1	150	298	11,603	0	0	20,091	0	0	0	0	0	0	150	31,694
24-May-2013	24-May-2013	1	150	298	11,901	0	0	20,091	0	0	0	0	0	0	150	31,991
25-May-2013	25-May-2013	1	150	298	12,198	0	0	20,091	0	0	0	0	0	0	150	32,289
26-May-2013	26-May-2013	1	150	298	12,496	0	0	20,091	0	0	0	0	0	0	150	32,586
27-May-2013	27-May-2013	1	150	298	12,793	0	0	20,091	0	0	0	0	0	0	150	32,884
28-May-2013	28-May-2013	1	150	298	13,091	0	0	20,091	0	0	0	0	0	0	150	33,181
29-May-2013	29-May-2013	1	150	298	13,388	0	0	20,091	0	0	0	0	0	0	150	33,479
30-May-2013	30-May-2013	1	150	298	13,686	0	0	20,091	0	0	0	0	0	0	150	33,777
31-May-2013	31-May-2013	1	150	298	13,983	0	0	20,091	0	0	0	0	0	0	150	34,074
01-Jun-2013	01-Jun-2013	1	50	99	14,083	0	0	20,091	0	0	0	0	0	0	50	34,173
02-Jun-2013	02-Jun-2013	1	50	99	14,182	0	0	20,091	0	0	0	0	0	0	50	34,272
03-Jun-2013	03-Jun-2013	1	50	99	14,281	0	0	20,091	0	0	0	0	0	0	50	34,372
04-Jun-2013	04-Jun-2013	1	50	99	14,380	0	0	20,091	0	0	0	0	0	0	50	34,471
05-Jun-2013	05-Jun-2013	1	50	99	14,479	0	0	20,091	0	0	0	0	0	0	50	34,570
06-Jun-2013	06-Jun-2013	1	50	99	14,579	0	0	20,091	0	0	0	0	0	0	50	34,669
07-Jun-2013	30-Jun-2013	24	50	2,380	16,959	0	0	20,091	0	0	0	0	0	0	50	37,049
01-Jul-2013	31-Jul-2013	31	50	3,074	20,033	0	0	20,091	0	0	0	0	0	0	50	40,124
01-Aug-2013	31-Aug-2013	31	50	3,074	23,107	0	0	20,091	0	0	0	0	0	0	50	43,198
01-Sep-2013	30-Sep-2013	30	50	2,975	26,083	0	0	20,091	0	0	0	0	0	0	50	46,173
01-Oct-2013	01-Oct-2013	1	126	250	26,332	0	0	20,091	0	0	0	0	0	0	126	46,423
02-Oct-2013	07-Oct-2013	6	126	1,497	27,829	0	0	20,091	210	2,494	2494	0	0	0	335	50,414
08-Oct-2013	19-Oct-2013	12	126	2,994	30,824	0	0	20,091	0	0	2494	0	0	0	126	53,408
20-Oct-2013	21-Oct-2013	2	126	499	31,323	0	0	20,091	0	0	2494	0	0	0	126	53,907
22-Oct-2013	23-Oct-2013	2	126	499	31,822	0	0	20,091	0	0	2494	0	0	0	126	54,406
24-Oct-2013	31-Oct-2013	8	126	1,996	33,818	0	0	20,091	0	0	2,494	0	0	0	126	56,403
01-Nov-2013	30-Nov-2013	30	150	8,926	42,744	0	0	20,091	0	0	2,494	0	0	0	150	65,328
01-Dec-2013	31-Dec-2013	31	150	9,223	51,967	0	0	20,091	0	0	2,494	0	0	0	150	74,552
01-Jan-2014	31-Jan-2014	31	150	9,223	61,190	0	0	20,091	0	0	2,494	0	0	0	150	83,775
01-Feb-2014	28-Feb-2014	28	150	8,331	69,521	0	0	20,091	0	0	2,494	0	0	0	150	92,105
01-Mar-2014	31-Mar-2014	31	150	9,223	78,744	0	0	20,091	0	0	2,494	0	0	0	150	101,328
01-Apr-2014	14-Apr-2014	14	150	4,165	82,909	0	0	20,091	0	0	2,494	0	0	0	150	105,494
No. of days		365	(April 10 through April 14)													

1 cfs day = 1.983471 acre-feet (af)

1. The pulse flows are a target that represents a daily average.


TUOLUMNE RIVER SCHEDULED FLOW AND ACTUAL FLOW
cfs
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Hour
04/14/2013 0000 hrs
05/10/2013 0600 hrs
Q_Sched/Ramp_Min
Q_USGS_11289650



DWR Tuolumne River Forecast (2013 April-July)
Acre-Feet
2,025,000
1,950,000
1,875,000
1,800,000
1,725,000
1,650,000
1,575,000
1,500,000
1,425,000
1,350,000
1,275,000
1,200,000
1,125,000
1,050,000
975,000
900,000
825,000
750,000
675,000
600,000
525,000
450,000
375,000
300,000
225,000
150,000
75,000
-
Date
90%
50%

Table 1

SAN JOAQUIN VALLEY WATER YEAR HYDROLOGIC CLASSIFICATION

602020 INDEX

YEAR	APRIL-JULY RUNOFF (AF) STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	OCTOBER-MARCH RUNOFF (AF) STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	602020 INDEX	TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT	San Joaquin Index (not the FERC Index)
12	394,507	609,424	300,876	558,917	1,863,724	215,106	254,324	114,994	244,726	829,150	2,184,064	127,506	Dry
13	300,000	590,000	260,000	510,000	1,660,000	323,159	476,812	207,327	318,805	1,326,103	1,698,033	108,245	Critical
Feb 1 Forecast													
Dry	400,000	730,000	370,000	770,000	2,270,000	295,000	415,000	165,000	240,000	1,115,000	2,021,813	118,010	Critical
Average	630,000	1,120,000	550,000	1,130,000	3,430,000	430,000	625,000	285,000	400,000	1,740,000	2,842,813	200,004	Below Normal
Wet	1,090,000	1,910,000	1,060,000	1,950,000	6,010,000	615,000	765,000	405,000	600,000	2,385,000	4,519,813	300,923	Wet
Feb 12 Update													
Dry	360,000	670,000	340,000	700,000	2,070,000	295,000	415,000	165,000	240,000	1,115,000	1,901,813	114,071	Critical
Average	570,000	1,010,000	500,000	1,030,000	3,110,000	430,000	625,000	285,000	400,000	1,740,000	2,650,813	159,148	Below Normal
Wet	1,000,000	1,730,000	950,000	1,760,000	5,440,000	615,000	765,000	405,000	600,000	2,385,000	4,177,813	300,923	Wet
Feb 19 Update													
Dry	340,000	630,000	310,000	640,000	1,920,000	295,000	415,000	165,000	240,000	1,115,000	1,811,813	111,498	Critical
Average	530,000	940,000	460,000	950,000	2,880,000	430,000	625,000	285,000	400,000	1,740,000	2,512,813	148,216	Below Normal
Wet	950,000	1,620,000	870,000	1,620,000	5,060,000	615,000	765,000	405,000	600,000	2,385,000	3,949,813	300,923	Wet
Mar 1 Forecast													
Dry	320,000	580,000	220,000	540,000	1,660,000	290,000	445,000	185,000	270,000	1,190,000	1,670,813	107,467	Critical
Average	490,000	840,000	360,000	820,000	2,510,000	330,000	495,000	215,000	330,000	1,370,000	2,216,813	129,420	Dry
Wet	880,000	1,460,000	710,000	1,410,000	4,460,000	420,000	615,000	285,000	440,000	1,760,000	3,464,813	300,923	Above Normal
Mar 12 Update													
Dry	360,000	620,000	230,000	560,000	1,770,000	290,000	445,000	185,000	270,000	1,190,000	1,736,813	109,354	Critical
Average	510,000	850,000	360,000	810,000	2,530,000	330,000	495,000	215,000	330,000	1,370,000	2,228,813	130,121	Dry
Wet	850,000	1,390,000	670,000	1,310,000	4,220,000	420,000	615,000	285,000	440,000	1,760,000	3,320,813	300,923	Above Normal
Mar 19 Update													
Dry	340,000	580,000	200,000	490,000	1,610,000	290,000	445,000	185,000	270,000	1,190,000	1,640,813	106,609	Critical
Average	480,000	790,000	320,000	720,000	2,310,000	330,000	495,000	215,000	330,000	1,370,000	2,096,813	122,400	Critical
Wet	790,000	1,280,000	610,000	1,160,000	3,840,000	420,000	615,000	285,000	440,000	1,760,000	3,092,813	274,104	Below Normal
Mar 26 Update													
Dry	340,000	570,000	200,000	440,000	1,550,000	290,000	445,000	185,000	270,000	1,190,000	1,604,813	105,580	Critical
Average	470,000	760,000	310,000	650,000	2,190,000	330,000	495,000	215,000	330,000	1,370,000	2,024,813	118,186	Critical
Wet	750,000	1,190,000	570,000	1,040,000	3,550,000	420,000	615,000	285,000	440,000	1,760,000	2,918,813	222,530	Below Normal
Apr 1 Forecast													
Dry	300,000	570,000	210,000	420,000	1,500,000	325,000	475,000	205,000	320,000	1,325,000	1,601,813	105,494	Critical
Average	420,000	740,000	310,000	610,000	2,080,000	325,000	475,000	205,000	320,000	1,325,000	1,949,813	115,443	Critical
Wet	670,000	1,130,000	550,000	950,000	3,300,000	325,000	475,000	205,000	320,000	1,325,000	2,681,813	161,603	Below Normal
Apr 16 Update													
Dry	300,000	600,000	220,000	410,000	1,530,000	325,000	475,000	205,000	320,000	1,325,000	1,619,813	106,008	Critical
Average	410,000	730,000	300,000	580,000	2,020,000	325,000	475,000	205,000	320,000	1,325,000	1,913,813	114,414	Critical
Wet	590,000	1,010,000	480,000	840,000	2,920,000	325,000	475,000	205,000	320,000	1,325,000	2,453,813	143,542	Dry
Apr 23 Update													
Dry	290,000	580,000	210,000	380,000	1,460,000	325,000	475,000	205,000	320,000	1,325,000	1,577,813	104,808	Critical
Average	390,000	700,000	280,000	540,000	1,910,000	325,000	475,000	205,000	320,000	1,325,000	1,847,813	112,527	Critical
Wet	530,000	930,000	420,000	760,000	2,640,000	325,000	475,000	205,000	320,000	1,325,000	2,285,813	133,452	Dry
May 1 Forecast													
Dry	270,000	550,000	200,000	340,000	1,360,000	323,000	477,000	207,000	319,000	1,326,000	1,518,013	103,098	Critical
Average	360,000	650,000	260,000	490,000	1,760,000	259,000	407,000	206,000	331,000	1,203,000	1,733,413	109,256	Critical
Wet	460,000	820,000	370,000	660,000	2,310,000	305,013	559,603	228,774	378,500	1,471,890	2,117,191	123,592	Dry
May 14 Update													
Dry	270,000	540,000	230,000	430,000	1,470,000	323,000	477,000	207,000	319,000	1,326,000	1,584,013	104,985	Critical
Average	340,000	620,000	270,000	500,000	1,730,000	259,000	407,000	206,000	331,000	1,203,000	1,715,413	108,742	Critical
Wet	420,000	760,000	350,000	620,000	2,150,000	305,013	559,603	228,774	378,500	1,471,890	2,021,191	117,974	Critical
May 21 Update													
Dry	270,000	550,000	240,000	450,000	1,510,000	323,000	477,000	207,000	319,000	1,326,000	1,608,013	105,671	Critical
Average	330,000	620,000	270,000	510,000	1,730,000	259,000	407,000	206,000	331,000	1,203,000	1,715,413	108,742	Critical
Wet	400,000	740,000	330,000	610,000	2,080,000	305,013	559,603	228,774	378,500	1,471,890	1,979,191	116,283	Critical
May 29 Update													
Dry	270,000	540,000	240,000	460,000	1,510,000	323,000	477,000	207,000	319,000	1,326,000	1,608,013	105,671	Critical
Average	300,000	590,000	260,000	510,000	1,660,000	259,000	407,000	206,000	331,000	1,203,000	1,673,413	107,541	Critical
Wet	350,000	700,000	310,000	580,000	1,940,000	305,013	559,603	228,774	378,500	1,471,890	1,895,191	113,882	Critical

Ranking of years

(years after Intermediate Critical were removed so as to get full table on page)

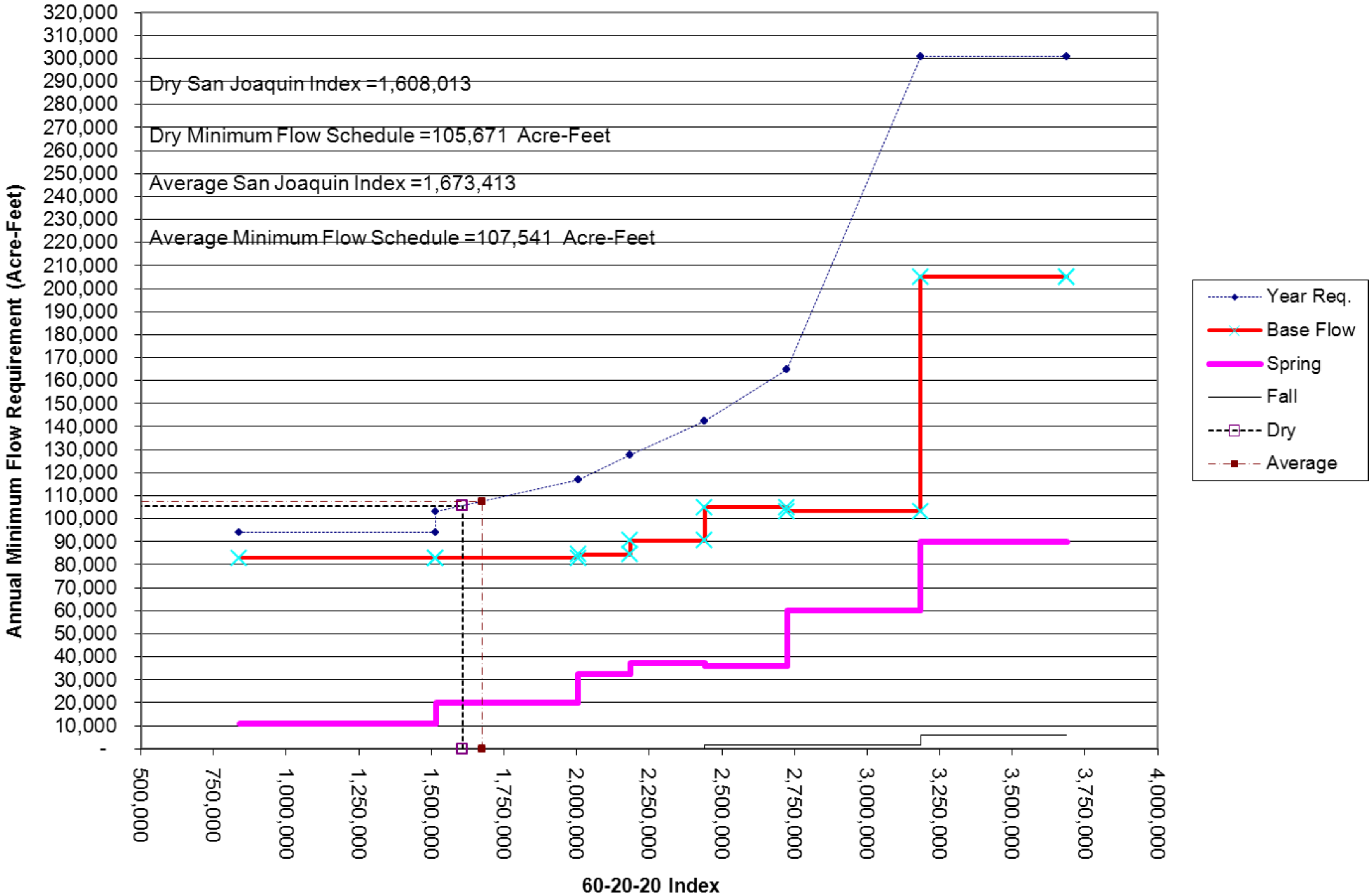
TABLE 2

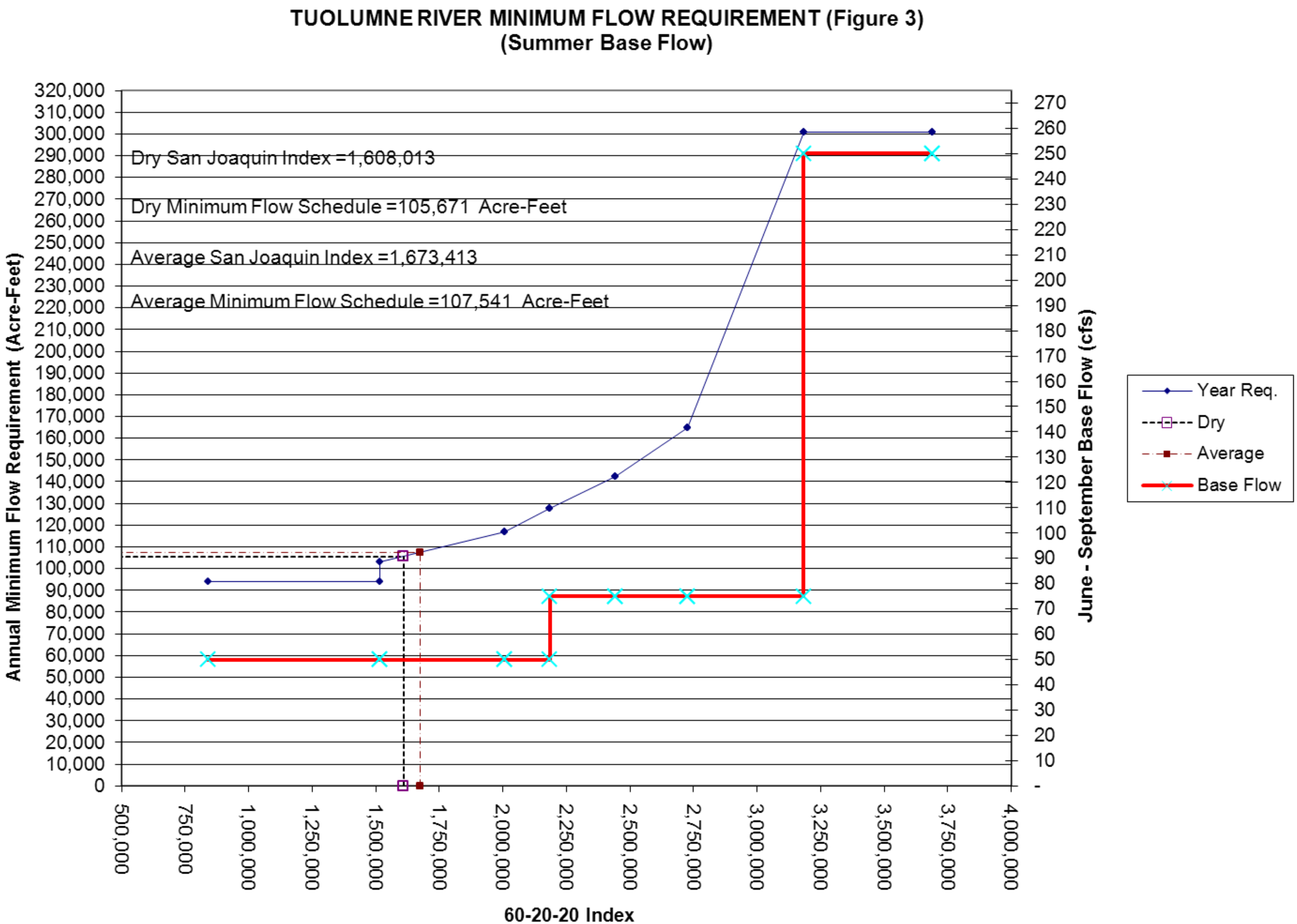
SAN JOAQUIN VALLEY WATER YEAR HYDROLOGIC CLASSIFICATION

602020 INDEX (1906-2013)

	APRIL-JULY RUNOFF (AF)					OCTOBER-MARCH RUNOFF (AF)					602020	TUOLUMNE RIVER				
Year	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	INDEX	MINIMUM FLOW REQUIREMENT	% Occurrence			RANKING
77	115,510	301,020	123,290	261,910	801,730	37,290	75,447	23,960	83,830	220,527	838,770	94,000	0.93%	6.4%	Critical Water Year and Below	1
31	215,400	422,580	189,200	349,400	1,176,580	99,200	176,960	69,260	112,500	457,920	1,200,755	94,000	1.87%	6.4%	Critical Water Year and Below	2
61	292,320	525,700	226,750	451,300	1,496,070	102,740	190,340	81,710	160,300	535,090	1,375,467	94,000	2.80%	6.4%	Critical Water Year and Below	3
24	167,200	381,920	174,600	310,000	1,033,720	93,900	160,710	74,600	119,000	448,210	1,419,746	94,000	3.74%	6.4%	Critical Water Year and Below	4
34	219,400	442,590	189,000	408,500	1,259,490	202,700	353,950	166,100	261,700	984,450	1,440,719	94,000	4.67%	6.4%	Critical Water Year and Below	5
88	221,363	494,015	273,584	562,724	1,551,686	147,688	319,524	132,264	264,996	864,472	1,476,178	94,000	5.61%	6.4%	Critical Water Year and Below	6
90	284,227	522,338	271,588	514,221	1,592,374	183,526	315,971	127,174	205,469	832,140	1,514,587	103,000	6.54%	14.4%	Median Critical Water Year	7
92	**265,933**	**525,254**	**299,041**	**568,447**	**1,658,675**	**208,210**	**291,924**	**141,018**	**214,560**	**855,712**	**1,557,439**	**104,225**	**7.48%**	**14.4%**	**Median Critical Water Year**	**8**
76	192,810	362,547	167,420	350,000	1,072,777	160,410	273,828	121,590	220,200	776,028	1,568,133	104,531	8.41%	14.4%	Median Critical Water Year	9
13	300,000	590,000	260,000	510,000	1,660,000	323,159	476,812	207,327	318,805	1,326,103	1,698,033	108,245	9.35%	14.4%	Median Critical Water Year	10
60	398,750	720,210	343,480	608,300	2,070,740	193,260	321,230	138,780	195,900	849,170	1,854,036	112,705	10.28%	14.4%	Median Critical Water Year	11
87	236,229	472,644	220,693	553,900	1,483,466	125,682	172,140	74,504	178,700	551,026	1,861,362	112,914	11.21%	14.4%	Median Critical Water Year	12
91	407,650	878,256	446,291	835,932	2,568,129	94,026	195,094	108,498	160,701	558,319	1,955,459	115,605	12.15%	14.4%	Median Critical Water Year	13
89	512,169	865,641	377,875	668,116	2,423,801	257,337	434,481	146,206	232,772	1,070,796	1,963,675	115,840	13.08%	14.4%	Median Critical Water Year	14
07	285,037	502,525	238,765	431,011	1,457,338	276,100	328,109	160,216	228,256	992,681	1,972,939	116,104	14.02%	14.4%	Median Critical Water Year	15
13	475,400	878,000	341,600	645,800	2,340,800	102,100	146,830	61,200	127,300	437,430	2,001,850	116,931	14.95%	20.5%	Intermediate Critical Dry Water Year	16
29	411,700	791,650	387,100	701,500	2,291,950	100,400	182,820	95,600	137,000	515,820	2,004,815	117,016	15.89%	20.5%	Intermediate Critical Dry Water Year	17
30	513,100	855,790	385,300	683,000	2,437,190	207,500	281,790	121,600	153,300	764,190	2,016,115	117,677	16.82%	20.5%	Intermediate Critical Dry Water Year	18
94	310,876	621,864	268,027	602,238	1,803,005	138,318	228,143	96,587	198,194	661,242	2,053,560	119,869	17.76%	20.5%	Intermediate Critical Dry Water Year	19
08	420,178	785,350	418,664	824,581	2,448,773	197,515	334,052	186,169	267,895	985,631	2,060,978	120,303	18.69%	20.5%	Intermediate Critical Dry Water Year	20
72	466,700	747,739	351,300	652,500	2,218,239	305,300	436,497	186,200	326,000	1,253,997	2,158,908	126,034	19.63%	20.5%	Intermediate Critical Dry Water Year	21
47	393,550	676,350	338,320	707,200	2,115,420	233,330	414,950	225,780	389,900	1,263,960	2,183,022	127,445	20.56%	31.3%	Median Dry	22
08	412,000	702,600	339,300	713,000	2,166,900	190,600	292,000	160,500	338,200	981,300	2,396,400	139,914	30.84%	31.3%	Median Dry	33
85	433,120	800,741	386,800	785,850	2,406,511	242,590	394,804	169,010	301,600	1,108,004	2,403,226	140,313	31.78%	40.4%	Intermediate Dry-Below Normal	34
33	517,100	923,010	424,600	901,400	2,766,110	81,900	160,750	86,100	166,000	494,750	2,440,676	142,502	32.71%	40.4%	Intermediate Dry-Below Normal	35
48	769,430	1,178,790	597,970	1,035,700	3,581,890	116,560	222,110	85,550	138,100	562,320	2,698,202	162,902	40.19%	40.4%	Intermediate Dry-Below Normal	43
54	640,620	1,019,780	483,640	1,015,900	3,159,940	238,140	405,170	184,080	268,600	1,095,990	2,720,188	164,643	41.12%	50.7%	Median Below Normal	44
09	638,467	1,104,952	564,927	1,042,315	3,350,661	335,715	545,114	254,462	375,366	1,510,657	2,724,724	165,003	42.06%	50.7%	Median Below Normal	45
62	784,570	1,313,980	660,500	1,485,900	4,244,950	200,810	432,920	257,650	365,700	1,257,080	3,073,479	268,373	49.53%	50.7%	Median Below Normal	53
18	593,200	1,085,190	560,200	1,159,300	3,397,890	221,000	355,270	252,800	240,800	1,069,870	3,079,512	270,161	50.47%	50.7%	Median Below Normal	54
51	530,760	943,500	438,980	916,500	2,829,740	1,148,730	1,521,840	782,620	899,100	4,352,290	3,139,076	287,816	51.40%	66.2%	Intermediate Below Normal-Above Norm	55
10	697,100	1,137,400	592,300	1,194,400	3,621,200	691,300	965,400	454,100	759,200	2,870,000	3,646,720	300,923	65.42%	66.2%	Intermediate Below Normal-Above Norm	70
79	760,550	1,267,931	668,860	1,295,280	3,992,621	386,570	618,989	385,400	475,680	1,866,639	3,668,900	300,923	66.36%	71.3%	Median Above Normal	71
37	810,100	1,420,270	800,100	1,625,100	4,655,570	282,200	555,090	406,600	538,100	1,781,990	3,897,744	300,923	71.03%	71.3%	Median Above Normal	76
74	890,300	1,398,577	734,900	1,507,500	4,531,277	643,600	802,284	378,100	603,800	2,427,784	3,903,413	300,923	71.96%	86.7%	Intermediate Above Normal-Wet	77
43	847,430	1,373,490	718,200	1,341,500	4,280,620	693,290	966,310	550,540	646,700	2,856,840	4,027,938	300,923	72.90%	86.7%	Intermediate Above Normal-Wet	78
16	1,029,900	1,623,000	920,500	1,925,100	5,498,500	608,000	826,570	508,200	726,800	2,669,570	4,652,601	300,923	85.98%	86.7%	Intermediate Above Normal-Wet	92
80	923,700	1,695,742	883,720	1,910,780	5,413,942	842,250	1,268,308	718,980	911,490	3,741,028	4,730,351	300,923	86.92%	100.0%	Median Wet/Maximum	93
07	1,691,800	2,381,000	1,304,500	2,229,000	7,606,300	1,052,900	1,204,900	759,800	654,500	3,672,100	6,198,200	300,923	99.07%	100.0%	Median Wet/Maximum	106
06	1,710,000	2,682,000	1,491,200	3,354,990	9,238,190	628,300	767,220	470,700	666,800	2,533,020	6,697,454	300,923	100.00%	100.0%	Median Wet/Maximum	107

TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 1)
Annual Flow Requirement





TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 3)
(Summer Base Flow)
Dry San Joaquin Index =1,608,013
Dry Minimum Flow Schedule =105,671 Acre-Feet
Average San Joaquin Index =1,673,413
Average Minimum Flow Schedule =107,541 Acre-Feet
Annual Minimum Flow Requirement (Acre-Feet)
June - September Base Flow (cfs)
60-20-20 Index
Year Req.
Dry
Average
Base Flow
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
160,000
170,000
180,000
190,000
200,000
210,000
220,000
230,000
240,000
250,000
260,000
270,000
280,000
290,000
300,000
310,000
320,000
-
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
500,000
750,000
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1,750,000
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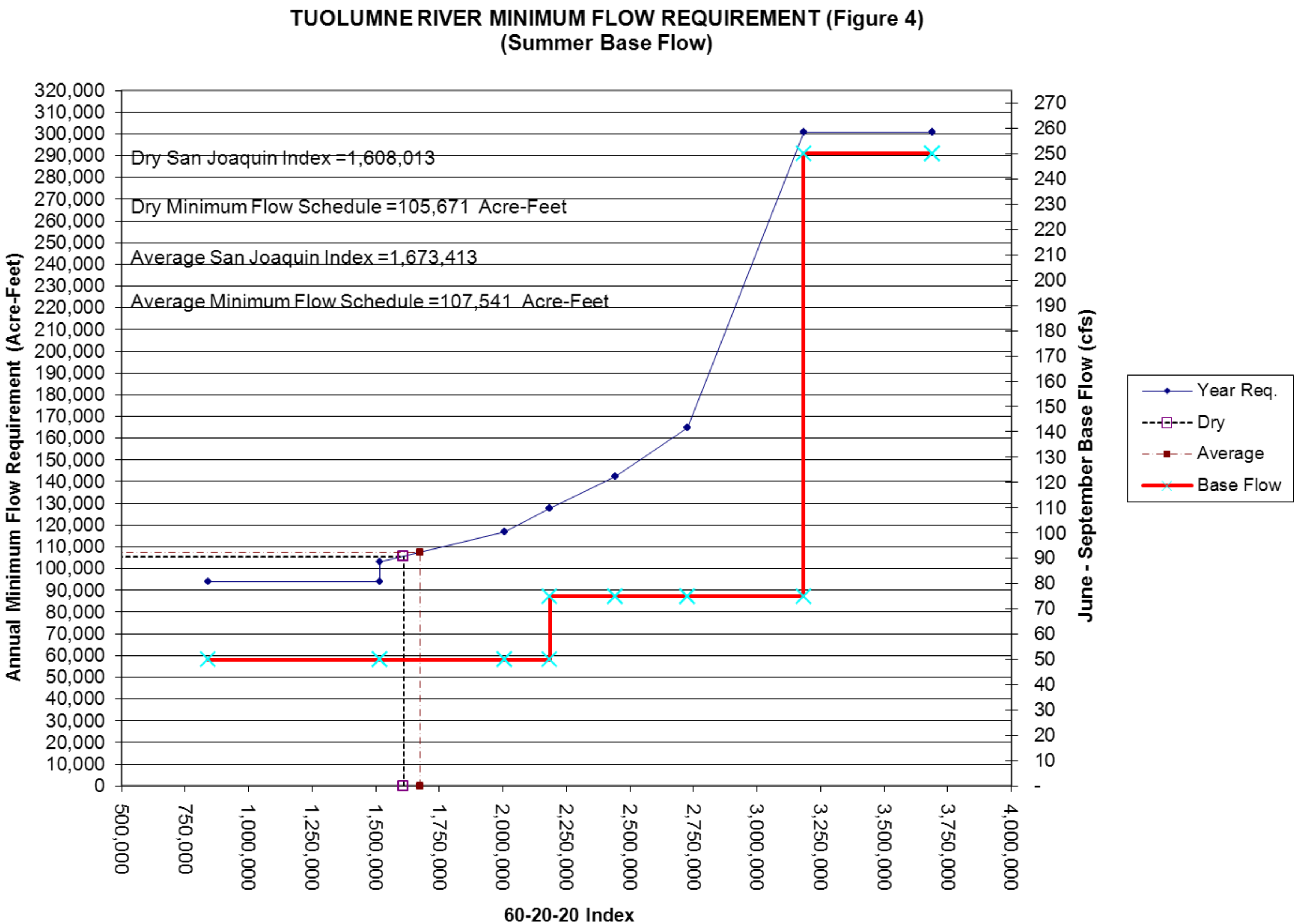
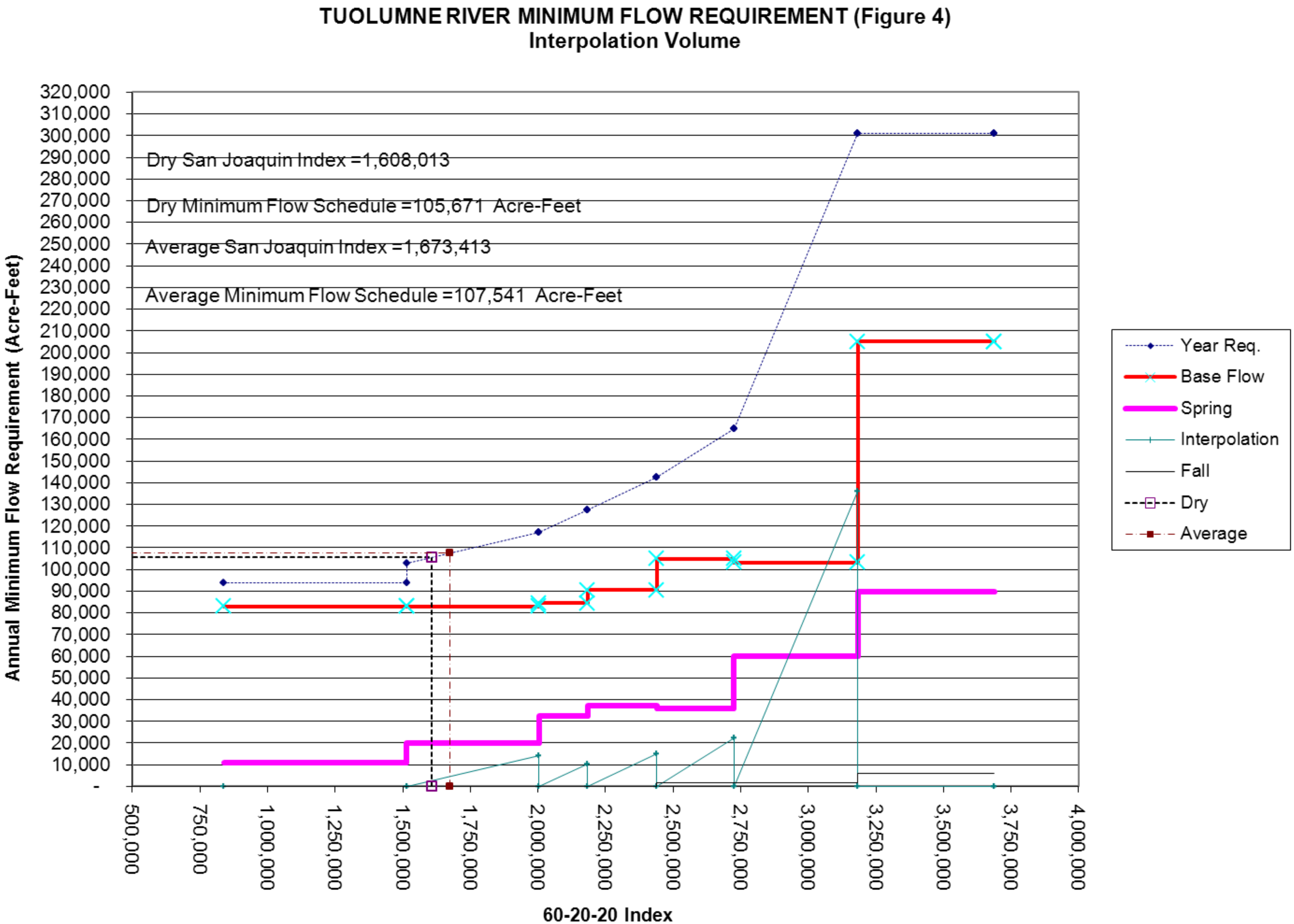
3,750,000
4,000,000


TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 4)
(Summer Base Flow)
Dry San Joaquin Index =1,608,013
Dry Minimum Flow Schedule =105,671 Acre-Feet
Average San Joaquin Index =1,673,413
Average Minimum Flow Schedule =107,541 Acre-Feet
Annual Minimum Flow Requirement (Acre-Feet)
June - September Base Flow (cfs)
60-20-20 Index
Year Req.
Dry
Average
Base Flow



TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 4)
Interpolation Volume
Dry San Joaquin Index =1,608,013
Dry Minimum Flow Schedule =105,671 Acre-Feet
Average San Joaquin Index =1,673,413
Average Minimum Flow Schedule =107,541 Acre-Feet
Annual Minimum Flow Requirement (Acre-Feet)
60-20-20 Index
Year Req.
Base Flow
Spring
Interpolation
Fall
Dry
Average
320,000
310,000
300,000
290,000
280,000
270,000
260,000
250,000
240,000
230,000
220,000
210,000
200,000
190,000
180,000
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
500,000
750,000
1,000,000
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1,500,000
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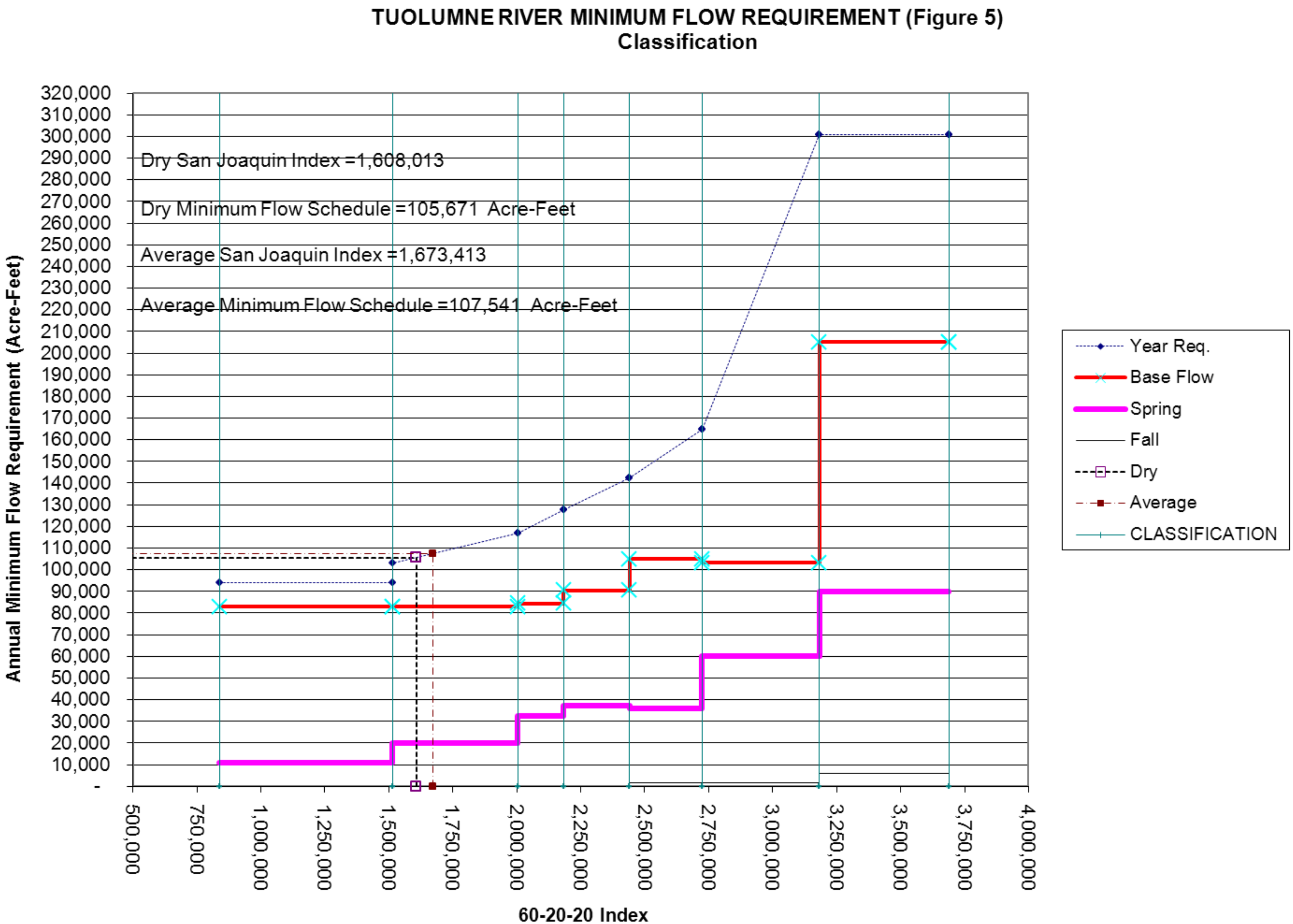
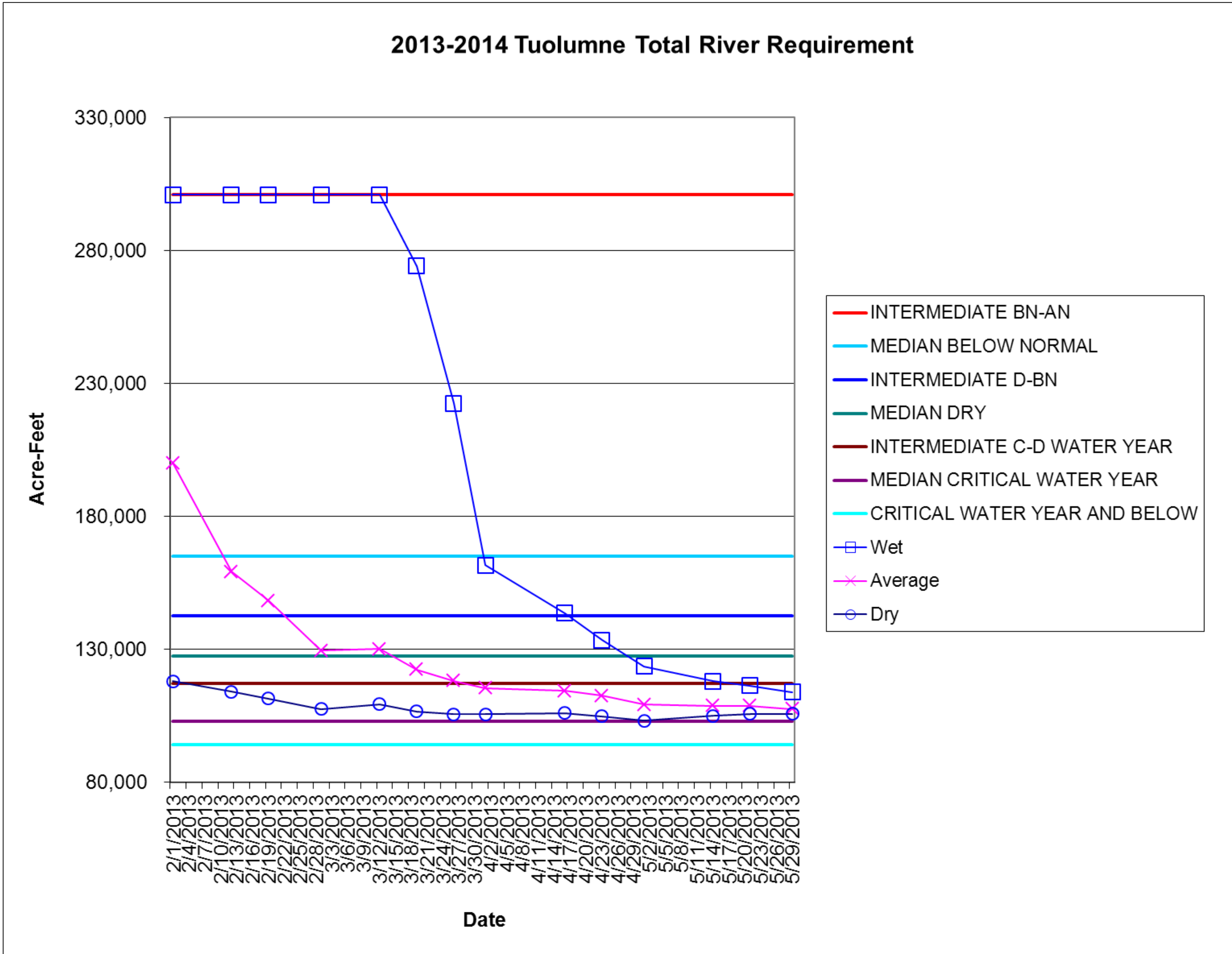
3,750,000
4,000,000



TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 5)
Classification
Dry San Joaquin Index = 1,608,013
Dry Minimum Flow Schedule = 105,671 Acre-Feet
Average San Joaquin Index = 1,673,413
Average Minimum Flow Schedule = 107,541 Acre-Feet
Annual Minimum Flow Requirement (Acre-Feet)
320,000
310,000
300,000
290,000
280,000
270,000
260,000
250,000
240,000
230,000
220,000
210,000
200,000
190,000
180,000
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
500,000
750,000
1,000,000
1,250,000
1,500,000
1,750,000
2,000,000
2,250,000
2,500,000
2,750,000
3,000,000
3,250,000
3,500,000
3,750,000
4,000,000
60-20-20 Index
Year Req.
Base Flow
Spring
Fall
Dry
Average
CLASSIFICATION


2013-2014 Tuolumne Total River Requirement
Acre-Feet
330,000
280,000
230,000
180,000
130,000
80,000
2/1/2013
2/4/2013
2/7/2013
2/10/2013
2/13/2013
2/16/2013
2/19/2013
2/22/2013
2/25/2013
2/28/2013
3/3/2013
3/6/2013
3/9/2013
3/12/2013
3/15/2013
3/18/2013
3/21/2013
3/24/2013
3/27/2013
3/30/2013
4/2/2013
4/5/2013
4/8/2013
4/11/2013
4/14/2013
4/17/2013
4/20/2013
4/23/2013
4/26/2013
4/29/2013
5/2/2013
5/5/2013
5/8/2013
5/11/2013
5/14/2013
5/17/2013
5/20/2013
5/23/2013
5/26/2013
5/29/2013
Date
INTERMEDIATE BN-AN
MEDIAN BELOW NORMAL
INTERMEDIATE D-BN
MEDIAN DRY
INTERMEDIATE C-D WATER YEAR
MEDIAN CRITICAL WATER YEAR
CRITICAL WATER YEAR AND BELOW
Wet
Average
Dry

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
CALIFORNIA DEPARTMENT OF FISH & GAME
U. S. FISH & WILDLIFE SERVICE

333 East Canal Drive
Turlock, CA 95381-0949
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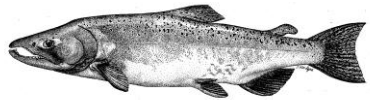
Email: pemaloney@tid.org



TECHNICAL ADVISORY COMMITTEE MEETING

September 12, 2013 at 9:30 AM

Turlock Irrigation District, Room 152

DRAFT AGENDA

1. INTRODUCTION AND ANNOUNCEMENTS

2. ADMINISTRATIVE ITEMS:
   - Review/revise agenda
   - Approve Notes from June 2013 meeting
   - Items since last meeting

3. MONITORING/REPORTS:
   - Routine snorkel and temperature
   - In-progress FERC relicensing studies
   - Fall monitoring 2013
   - Planned Annual FERC Report progress

4. FLOW OPERATIONS:
   - Review status of final basin index; annual fish flow volume
   - Fall flow schedule

5. AGENCY/NGO UPDATES:

6. ADDITIONAL ITEMS

7. NEXT MEETING DATES-DECEMBER 12, 2013, MARCH 13, 2014, JUNE 12, 2014

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
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Fax: (209) 656-2191
Email: pemaloney@tid.org

TECHNICAL ADVISORY COMMITTEE MEETING

September 12, 2013 at 9:30 AM
Turlock Irrigation District, Room 152

Summary

1. INTRODUCTION AND ANNOUNCEMENTS

- Participants made self introductions.
- There was a brief discussion regarding the Rim Fire with approximately 25% of the upper watershed (South Fork Tuolumne, Cherry Creek) affected by the fire.

2. ADMINISTRATIVE ITEMS:

- Review/Revise agenda – No changes
- Approve notes from September meeting – No changes were identified. Notes for the last meeting are posted to the TRTAC website: http://tuolumnerivertac.com/.
- Items since last meeting – A handout list posted at http://tuolumnerivertac.com/ was reviewed. The list included meeting summaries, notes from the June TRTAC Meeting and correspondence since December 19, 2012.

3. MONITORING/REPORTS: (*Handouts were reviewed*)

- Summer monitoring included routine snorkel surveys in July 2013, seining surveys which ended in June 2013, rotary screw trapping also ended in June 2013 and routine thermograph downloads which were conducted in August 2013.
- FERC Relicensing Study activities included river and reservoir temperature monitoring (W&AR 16 and W&AR 3, respectively) and Boatable Flow Study (RR 3). For further updates on the relicensing process, please visit: http://www.donpedro-relicensing.com/default.htm.
- FISHBIO to resume counting weir operations by September 27th

4. FLOW OPERATIONS: (*Handouts were reviewed*)

- Summer flows ranged between 100 and 125 cfs depending on forecasted air temperature. However, additional flows wer released several times since August 2013 in order to satisfy the Boatable Flow Study (RR 3) requirements.
- Reviewed final SJ Basin Index of 1.7 MAF which corresponds to a Dry Water Year Type with a FERC Flow volume of 108,516 AF.
- Fall Pulse flow of 5,484 AF with interpolation volume (Formal agreement with Resource Agencies on timing pending)

5. AGENCY/NGO UPDATES

- None

6. ADDITIONAL ITEMS

- None

7. NEXT MEETING DATE – December 12th , 2013 (Meetings are held Quarterly on the second Thursday of the month at 9:30 A.M.)

TRTAC Meeting Attendees

	Name	Organization
1.	Walter Ward	MID
2.	Patrick Maloney	TID
3.	Noah Hume	Stillwater
4.	Herb Smart	TID

2013 TRTAC Materials/Postings to Website

2012Dec13-2013Mar13 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
  - December 2012 TRTAC meeting summary and handouts
  - March 2013 TRTAC meeting agenda

- Correspondence
  - December 19, 2012. Order finding licensing of hydroelectric project required Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13137463
  - December 21, 2012. California Department of Fish and Game Objectives for ILP Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13140707
  - December 28, 2012. Turlock Irrigation District and Modesto Irrigation District response to comments provided by California Department of Fish and Game on the development of unimpaired hydrology for the Tuolumne River Operations Model under Don Pedro Project P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13144038
  - January 1, 2013. Districts, under Don Pedro P-2299, submittal of Attachment 1 for Dec 21, 2012 letter to Peter Barnes (SWRCB) filed Dec 28, 2012, in response to comments provided by CDFG on development of unimpaired hydrology for Tuolumne River Operations Model. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13146219
  - January 9, 2013. Supplemental Information of Thomas H. Terpstra, A Professional Corporation. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13150874
  - January 9, 2013. Lowe Tuolumne Farmers submits comments re the Study Plan Determination for the Don Pedro Hydroelectric Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155021
  - January 11, 2013. Notice clarifying party status re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152675
  - January 11, 2013. Motion to Intervene and Comments of National Marine Fisheries Service under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152896
  - January 16, 2013. ILP Comments of California Department of Fish and Wildlife on Water and Aquatic Resource Studies 6 and 10 and update on water temperature criteria for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13154795
  - January 17, 2013. ILP Water & Aquatics Resources Initial Study Reports of Turlock Irrigation District and Modesto Irrigation District for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13156015
  - January 17, 2013. ILP Initial Terrestrial Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155590
  - January 17, 2013. ILP Initial Recreation Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155572
  - January 17, 2013. ILP Initial Study Report of Turlock Irrigation District and Modesto Irrigation District transmittal letter, ISR, IFIM Progress Report and Cultural Resources Progress Reports. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155318
  - January 18, 2013. Districts submittal of Attachment A-Photos missing from the Jan 17 2013 ISR filing of Don Pedro Project Relicensing Recreation Resources Study Plan No. 2 - Whitewater Boating Take-Out Improvement Feasibility Study Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13159071
  - January 23, 2013. Conservation Groups' Amended Letter Regarding the Districts Request for Rehearing and Motion to Stay under P-2299, et al.
  - January 23, 2013. Conservation Groups' Letter Regarding Districts' Request for Rehearing and Motion to Stay under UL11-1, et al.

http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13160201

- January 21, 2013. Lower Tuolumne Farmers submits comments re the Don Pedro Dam under P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13166937
- February 1, 2013. Conservation Groups' Answer in Opposition to Turlock and Modesto Irrigation Districts' Motion for Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13168520
- February 8, 2013. ILP Submittal by John Devine, HDR, of Initial Study Report Meeting Summary of Turlock Irrigation District and Modesto Irrigation District's Initial Study Report Meeting held January 30-31, 2013. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13175880
- February 12, 2013. Motion of Tuolumne River Preservation Trust under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13180063
- February 19, 2013. Order granting rehearing for further consideration Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13183741
- March 7, 2013. Response of the US Army Corps of Engineers to HDR Engineering, Inc's 7/12/12 letter re the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096098
- March 8, 2013. American River Touring Association, Inc submit comments on the Whitewater Boating Take-Out Improvement Feasibility Study Report and requesting a new study due to the inadequacy of the Initial Study Report under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096296
- March 8, 2013. Comments on RR-02 of project P-2299 Comment of Martin S McDonnell under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096436
- March 11, 2013. Comment of USDA Forest Service under P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096524
- March 11, 2013. Comment of O.A.R.S. Companies, Inc. on Initial Study Reports in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096531
- March 11, 2013. Comment of TUOLUMNE RIVER EXPEDITIONS, INC. on Initial Study Report in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096532
- March 11, 2013. Comment of Bob Hackamack under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096545
- March 11, 2013. Comment of NPS - CALIFORNIA HYDRO PROGRAM on ISR of P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096690
- March 11, 2013. Comments on the Initial Study Report, Licensee Study Reports, and Initial Study Report Meeting and Summary; Commission’s Study Plan; NOAA Fisheries Service, Southwest Region, under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096819
- March 11, 2013. USFWS Comments on the Initial Study Report for the Don Pedro Hydroelectric Project, FERC No. P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, CA. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096823
- March 11, 2013. ILP Comments or Study Request of Tuolumne River Preservation Trust under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096564
- March 11, 2013. ILP Comments or Study Request of Restore Hetch Hetchy under P-2299-075. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096679
- March 11, 2013. Comments on ISR from California Department of Fish and Wildlife under P-2299 et., al. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096810
- March 11, 2013. Comments of Conservation Groups Regarding ISR under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096882
- March 11, 2013. Responses to ISR of BUREAU OF LAND MANAGEMENT under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096884
- March 11, 2013. ILP Comments or Study Request of State Water Resources Control Board (CA) under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096901

• Documents
  - No Documents
  - No postings

• Data/Monitoring
  - No postings

2013Mar13-2013June14 Postings to TRTAC website http://tuolumnerivertac.com/

• Meetings
  - March 2013 TRTAC meeting summary and handouts
  - June 2013 TRTAC meeting agenda

• Correspondence
  - March 13, 2013. Tuolumne County Board of Supervisors submits comments re the relicensing process of the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14097991
  - March 18, 2013. HDR Engineering, Inc submittal on behalf of Turlock Irrigation District & Modesto Irrigation District of Final Meeting Notes and Responses to Participant Comments - Nov 15, 2012 W&AR-06 and W&AR-10 Modeling Workshop No. 1. under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14098853
  - March 19, 2013. John Devine HDR, under P-2299, Don Pedro Project, submittal Final Meeting Notes, Comments, & Districts' Reply Comments W&AR-02 Consultation Workshop No. 2 held Sept 21, 2012; along with Final W&AR-02 Accretion Flow Measurements June/Oct 2012 & Feb 2013. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14099014
  - March 19, 2013. Comments of California State Water Resources Control Board re the Don Pedro Hydroelectric Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14099398
  - March 28, 2013. TURLOCK & MODESTO IRRIGATION DIST. 2012 Lower Tuolumne River annual report submitted to the Commission pursuant to Article 58 of the license under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14101678
  - April 2, 2013. Comments of California Department of Fish and Wildlife on La Grange Hydro Project under UL11-1, et al. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14103535
  - April 9, 2013. ILP Districts Response to Relicensing Participants' Comments on Initial Study Report of Turlock Irrigation District and Modesto Irrigation District under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14105376
  - April 9, 2013. USFWS Comments on the February 2013 Draft Report for the Lower Tuolumne River Instream Flow Study, FERC Project P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, CA. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14105215
  - April 15, 2013. La Grange Dam Project license Motion to Intervene of Tuolumne River Conservancy under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14106662
  - April 29, 2013. Turlock and Modesto Irrigation Districts' Final Instream Flow Study Report submitted in accordance with Ordering Paragraph D) of the May 12, 2010 Order Modifying and Approving Instream Flow and Water Temperature Model Study Plans for the Don Pedro Project. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14110681
  - April 30, 2013. ILP 2013 Predation Study Plan of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14111742
  - May 17, 2013. Notice Denying Late Intervention re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14115764
  - May 21, 2013. Letter to Turlock Irrigation District and Modesto Irrigation District re determination on requests for study modifications and new studies for the Don Pedro Hydroelectric Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14116522

• Documents
  - FERC Annual Report
  - TID-MID Final Instream Flow Report

• Data/Monitoring
  - No postings

2013June14-2013August 29 Postings to TRTAC website http://tuolumnerivertac.com/

• Meetings
  - June 2013 TRTAC meeting summary and handouts
  - September 2013 TRTAC meeting agenda

• Correspondence
  - June 13, 2013. District Letter to FERC re: Request for Extension of Time to File Study Plans under Don Pedro Hydroelectric Project No. 2299-075. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14122445
  - June 20, 2013. USFWS Letter to FERC re: Concurring with Districts Proposal to Extend the Final Study Plan Filing Deadline. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14124238
  - June 19,2013. Reply Comments to the Commission's May 21, 2013 Determination on Requests for Study Modifications and New Studies by the Turlock Irrigation District and Modesto Irrigation District under P-2299- Don Pedro http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14123498
  - June 21, 2013. USFWS Concurrence to Extend the Deadline for Filing Final Study Plans with the Commission for 2014 Predation and Juvenile Chinook Salmon Floodplain Rearing Hydraulic Analysis for the Don Pedro Hydroelectric Project, FERC No. P-2299 on the Tuolumne River http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14124238
  - June 24, 2013. Commission Staff submits Emails from CDFW and Water Board in support of the Districts EOT request to file two study plans for Predation and Floodplain IFIM Analysis by Sept. 15, 2013 under P-2299 http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14124724
  - June 25, 2013. Comments of California Department of Fish and Wildlife on Office of Energy Projects May 21 2013 Study Plan Determination under P-2299. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14124882
  - June 27, 2013. Order modifying and granting extension of time re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14125694
  - June 27, 2013. Letter order granting Turlock Irrigation District's 6/13/13 filing of the response to request for extension of time for filing two study plans re the Don Pedro Hydroelectric Project under P-2299. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14125751
  - July 1, 2013. 2005-2012 Fisheries Management Program Summary Report submitted in accordance with Ordering Paragraph (C) of the May 10, 2010 Order modifying and approving in part the Tuolumne River Oncorhynchus mykiss Ten-Year Monitoring Report Pursuant to Article 58 http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14126319
  - July 12, 2013. Submittal on behalf of Turlock Irrigation District and Modesto Irrigation District the final notes from the October 23, 2012 and December 7, 2012 W&AR-02 Project Operations Model Workshops under P-2299 Don Pedro Project. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14129581
  - July 19, 2013. Order on rehearing, clarifying intervention status, and denying stay pending judicial review re the Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14131640
  - July 25, 2013. Comments of California Department of Fish and Wildlife on June modeling workshops under P-2299. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14133026
  - August 15, 2013. Letter order accepting Turlock Irrigation District's et al 7/1/13 filing of the 2012 Fisheries Management Program Summary Report for the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=14138259

- Documents
    - No Documents
    - No postings

- Data/Monitoring
    - No postings

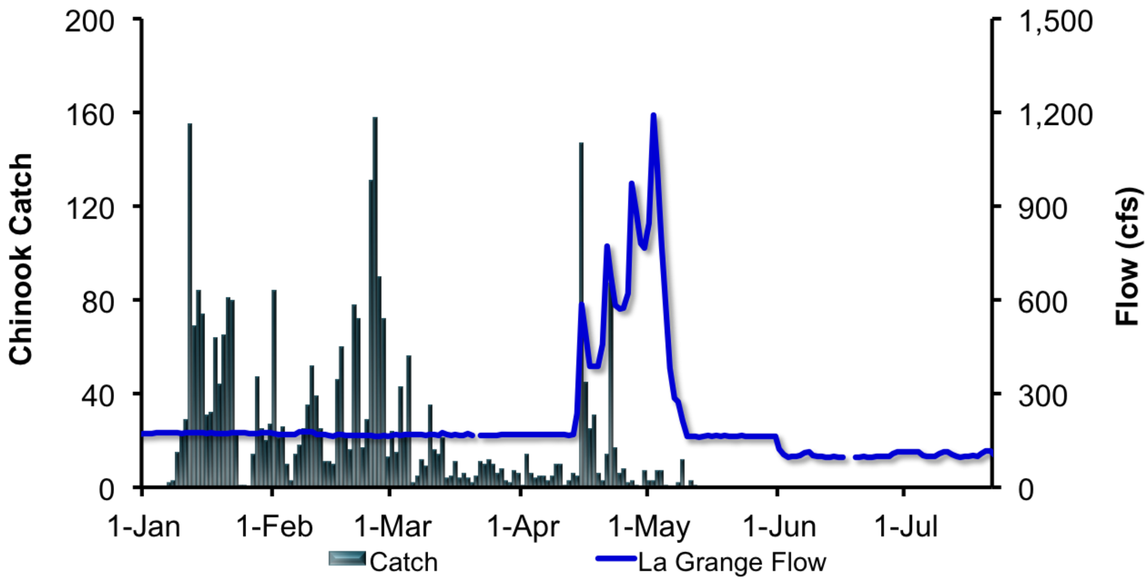


Figure 1. Waterford Chinook catch and La Grange flow, 2013.

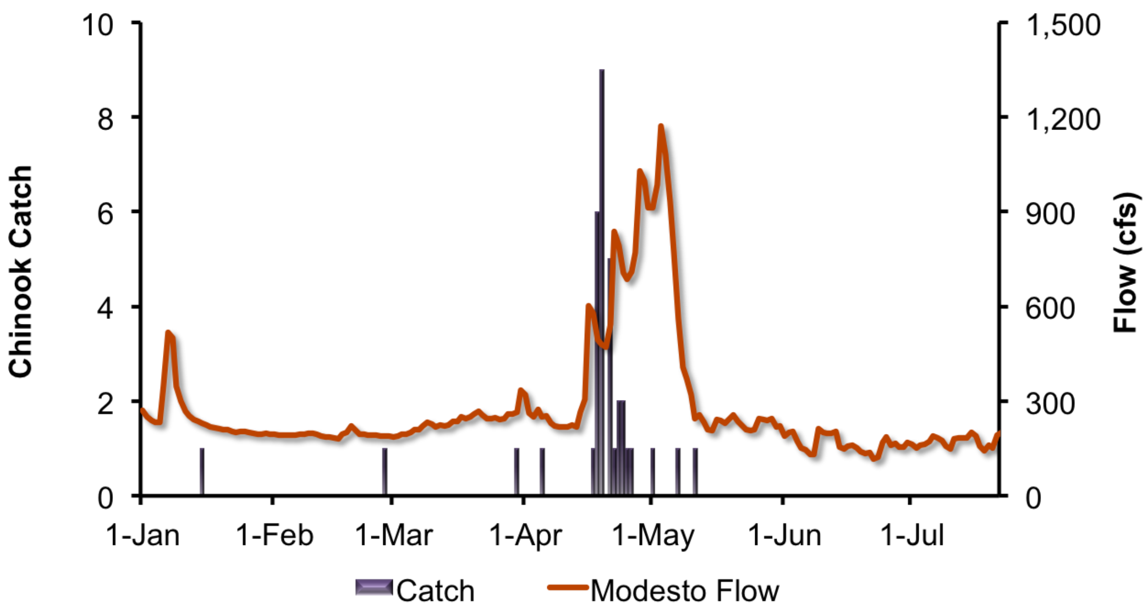


Figure 2. Grayson RST Chinook catch and Modesto flow, 2013.

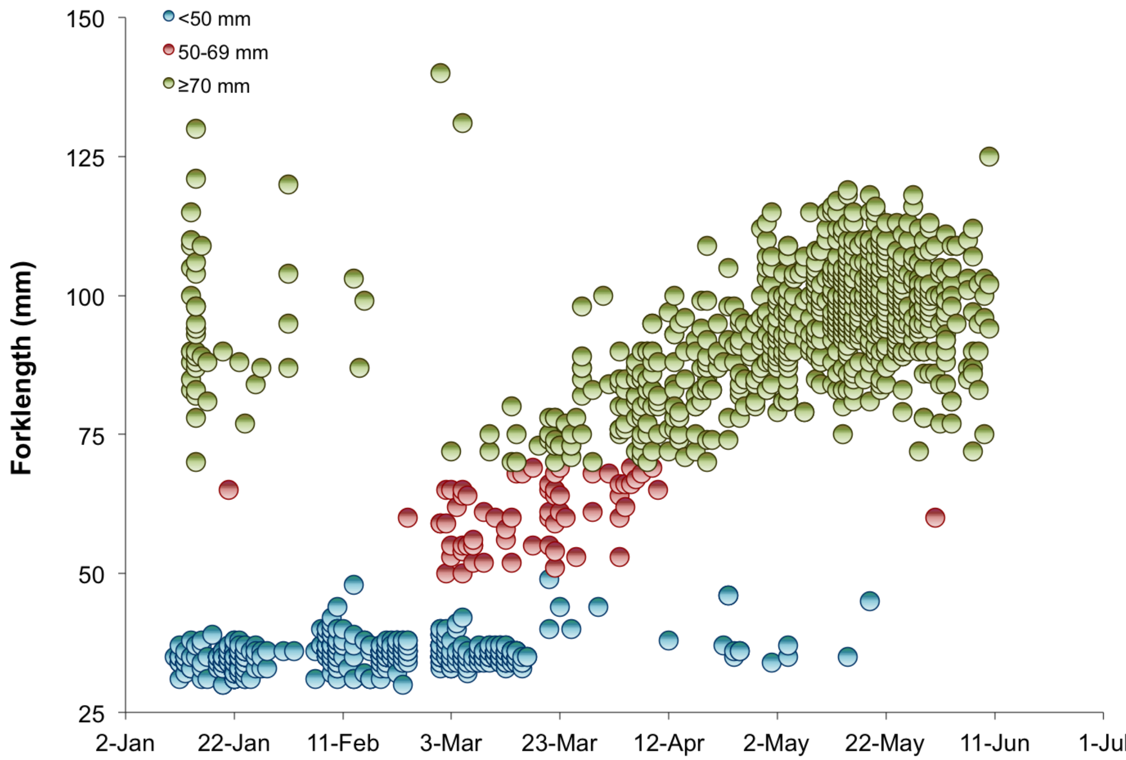


Figure 3. Chinook forklength by lifestage at Waterford, 2013.

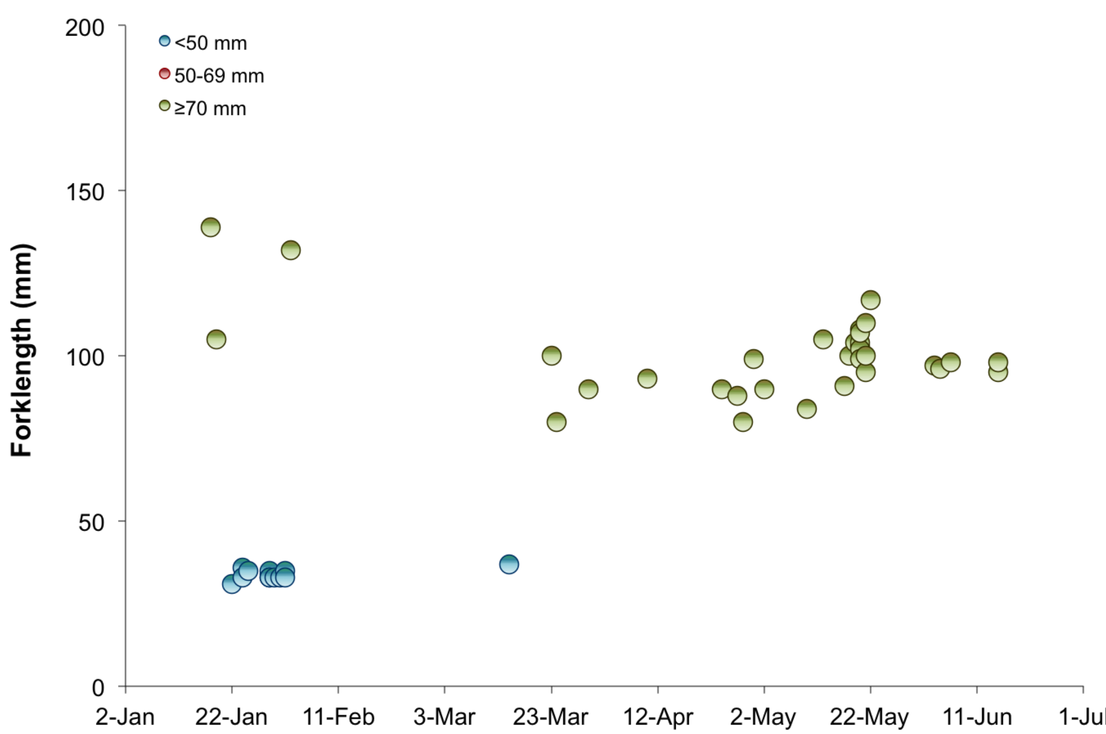
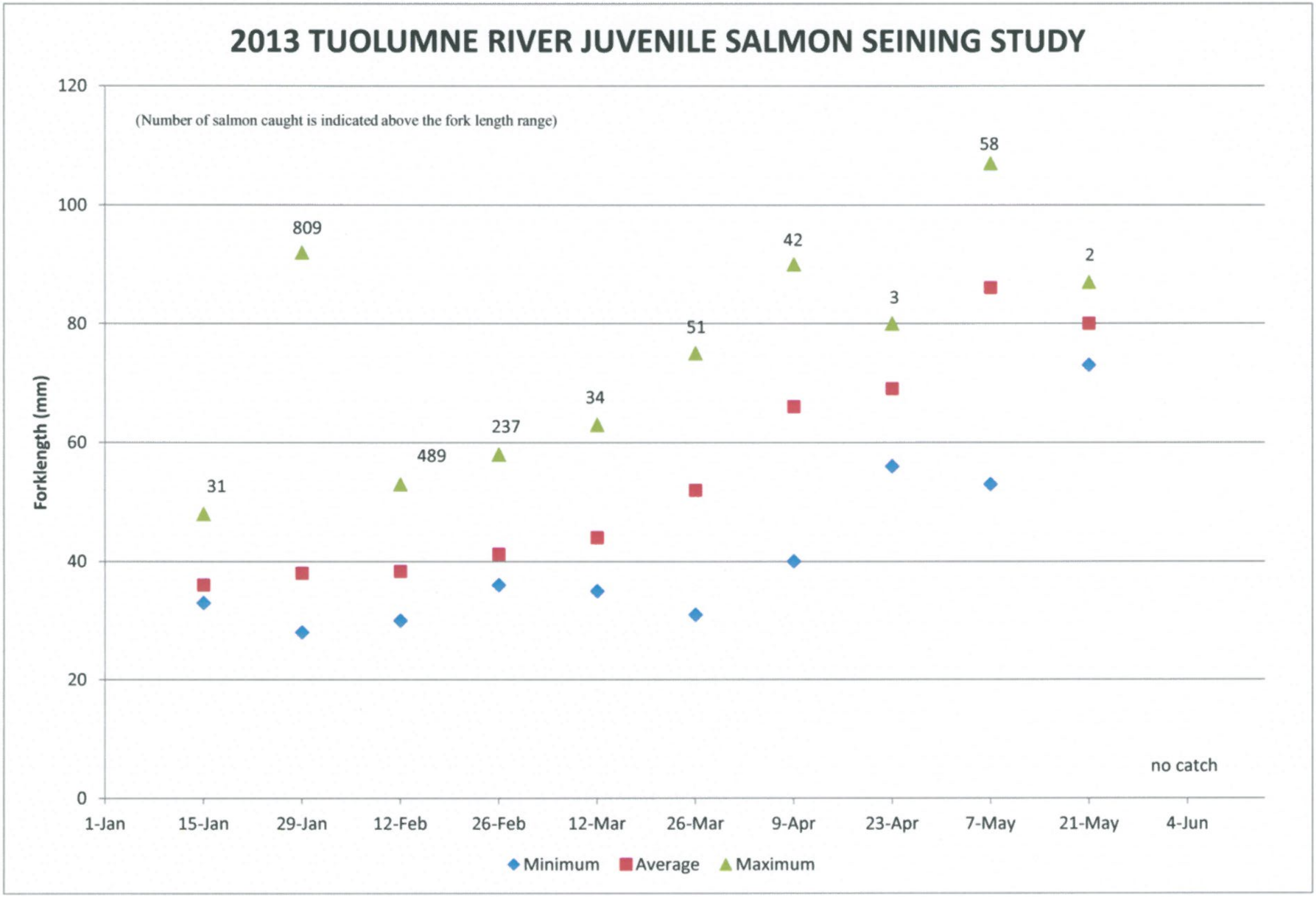
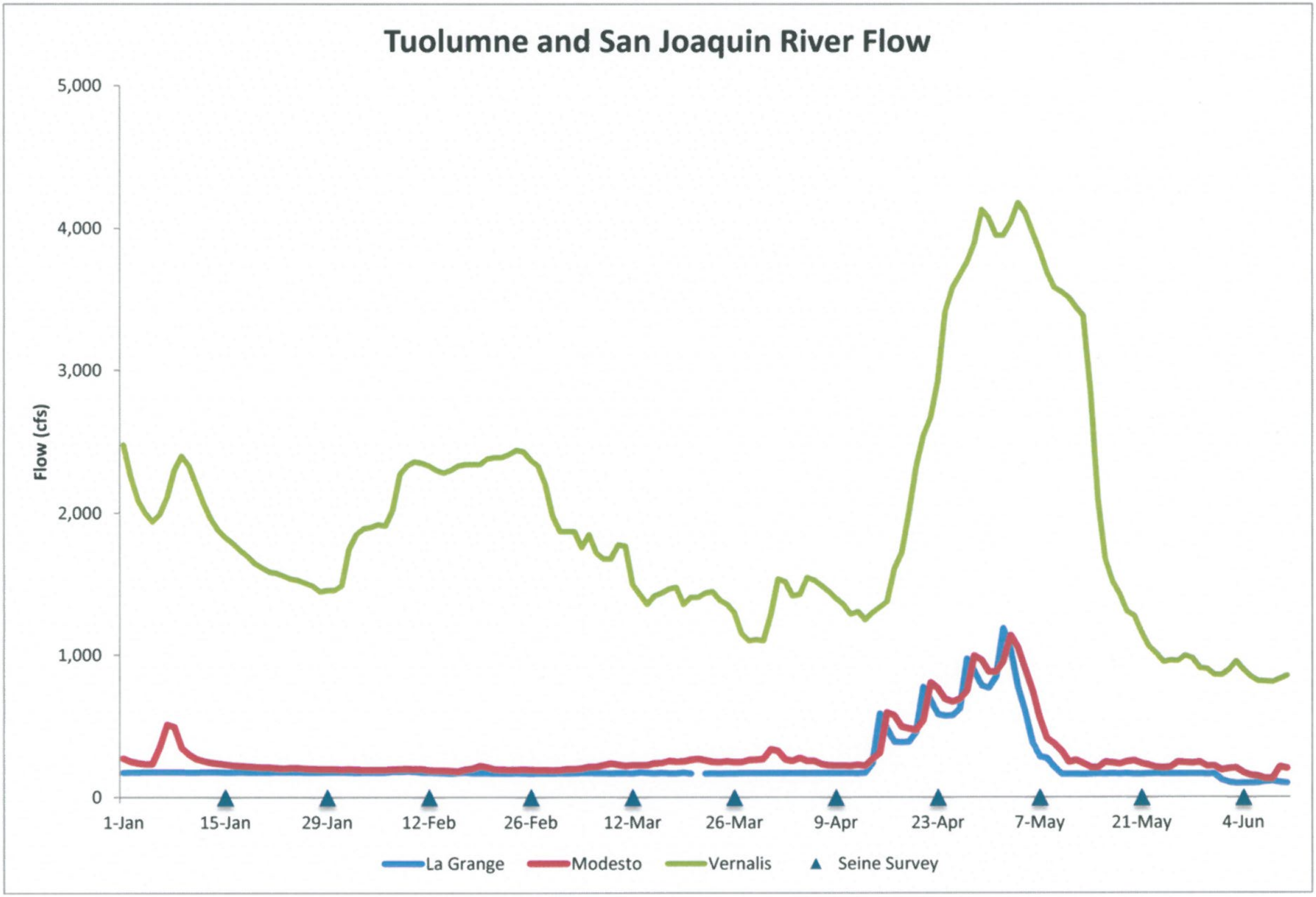
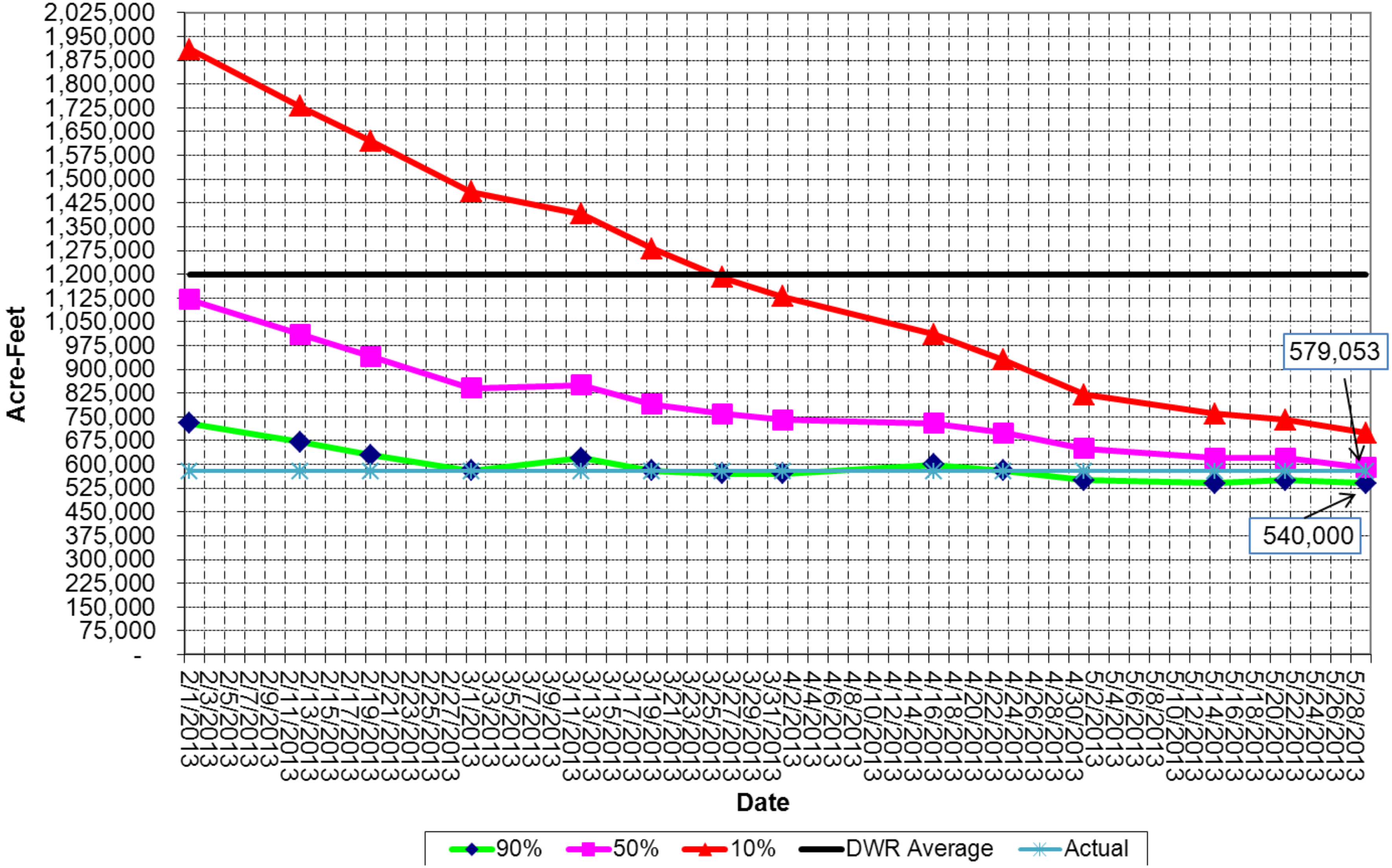


Figure 4. Chinook forklength by lifestage at Grayson, 2013.


2013 TUOLUMNE RIVER JUVENILE SALMON SEINING STUDY
(Number of salmon caught is indicated above the fork length range)
Forklength (mm)
120
100
80
60
40
20
0
31
809
489
237
34
51
42
3
58
2
no catch
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
Minimum
Average
Maximum


Tuolumne and San Joaquin River Flow
Flow (cfs)
5,000
4,000
3,000
2,000
1,000
0
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
La Grange
Modesto
Vernalis
Seine Survey

DWR Tuolumne River Forecast (2013 April-July)

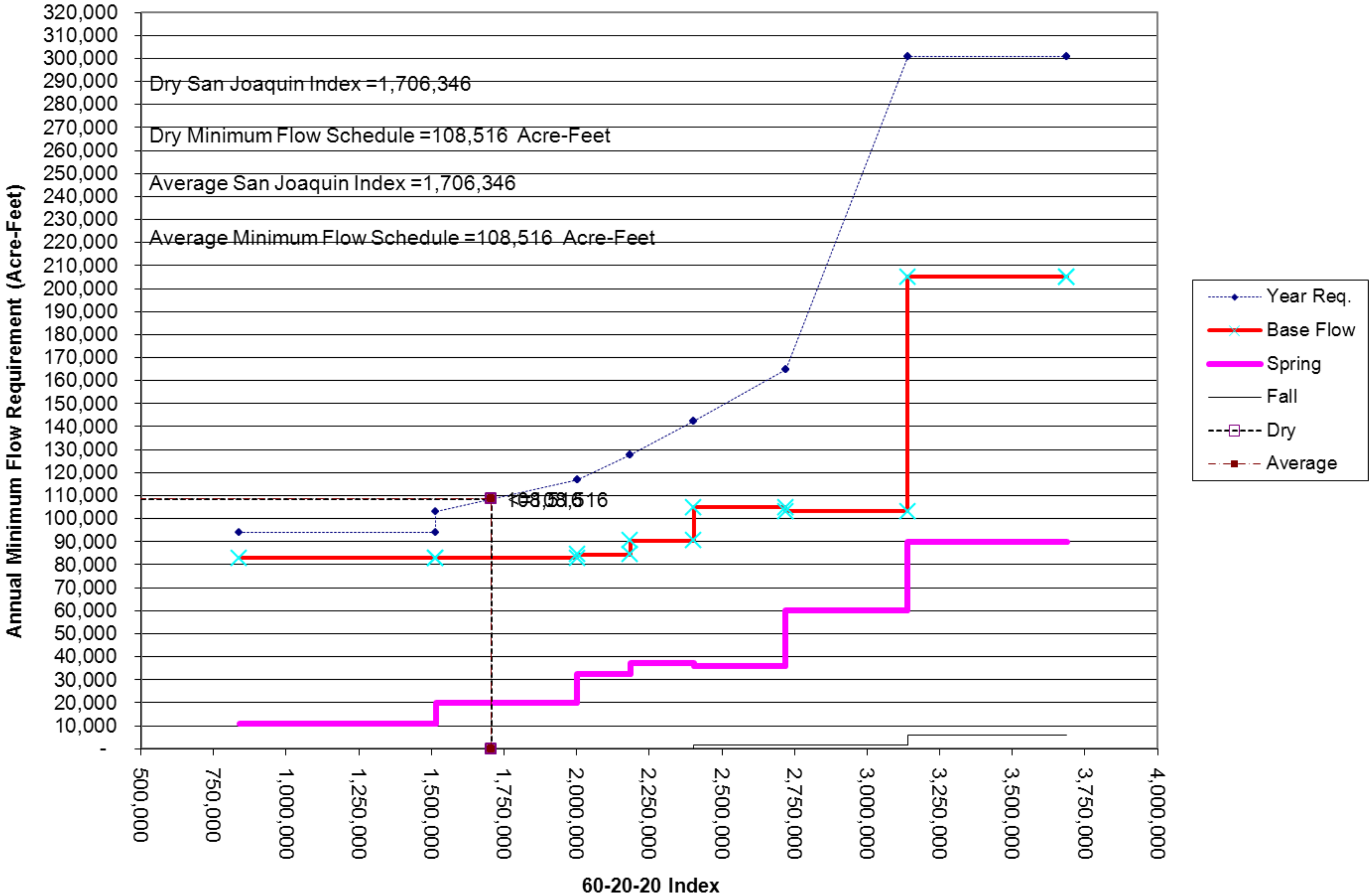


SAN JOAQUIN VALLEY WATER YEAR HYDROLOGIC CLASSIFICATION (Final for 2014)

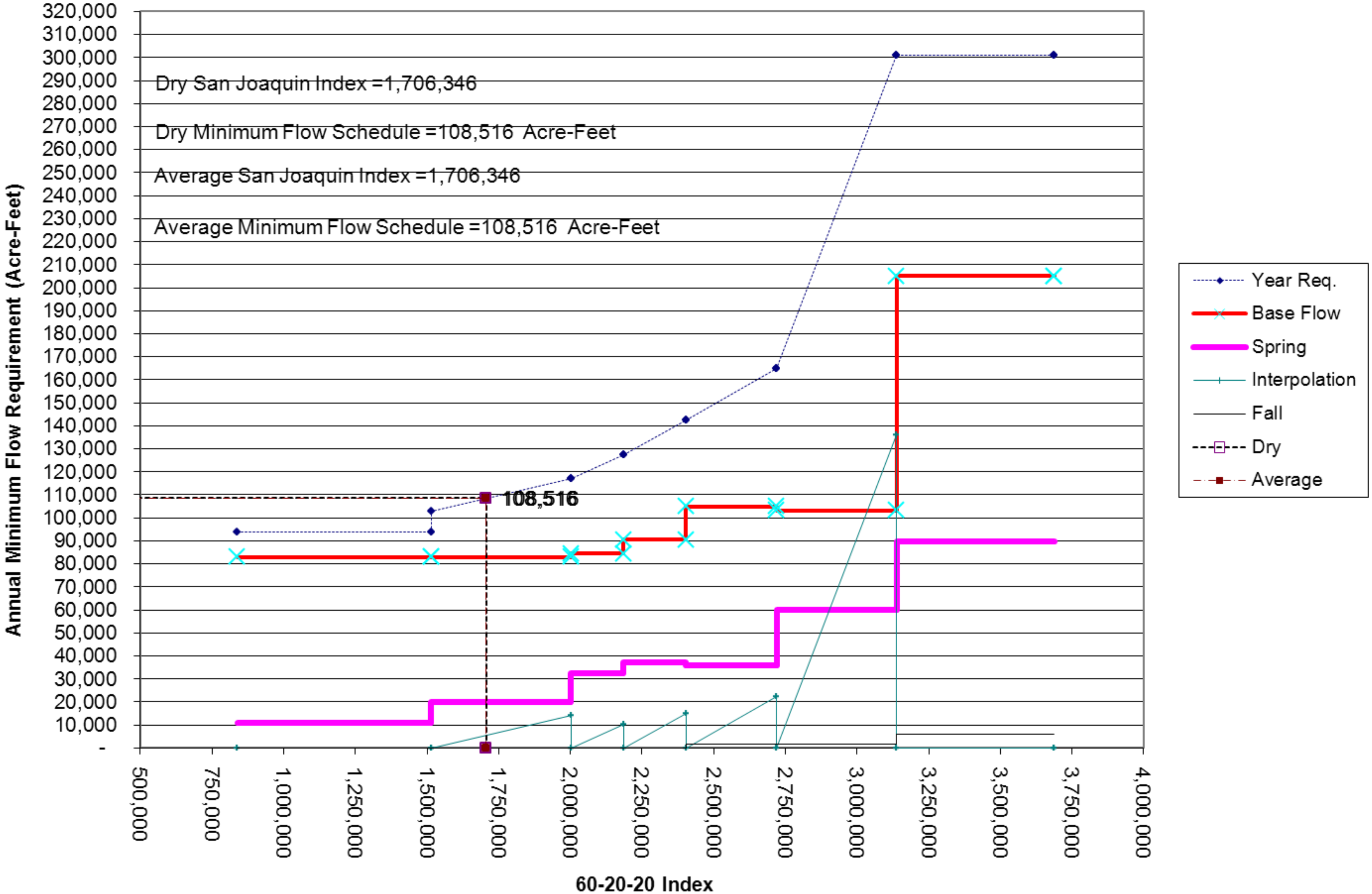
602020 INDEX

	APRIL-JULY RUNOFF (AF)					OCTOBER-MARCH RUNOFF (AF)					602020	TUOLUMNE RIVER	San Joaquin Index (not the FERC Index)
YEAR	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	STANISLAUS	TUOLUMNE	MERCED	FRIANT	TOTAL	INDEX	MINIMUM FLOW REQUIREMENT	
12	394,507	609,424	300,876	558,917	1,863,724	216,256	254,324	117,856	244,726	833,162	2,184,867	127,506	Dry
13	290,397	597,042	267,194	518,953	1,673,586	323,159	476,812	207,327	318,805	1,326,103	1,706,346	108,516	Critical
Feb 1 Forecast													
Dry	400,000	730,000	370,000	770,000	2,270,000	295,000	415,000	165,000	240,000	1,115,000	2,021,973	118,169	Critical
Average	630,000	1,120,000	550,000	1,130,000	3,430,000	430,000	625,000	285,000	400,000	1,740,000	2,842,973	204,844	Below Normal
Wet	1,090,000	1,910,000	1,060,000	1,950,000	6,010,000	615,000	765,000	405,000	600,000	2,385,000	4,519,973	300,923	Wet
Feb 12 Update													
Dry	360,000	670,000	340,000	700,000	2,070,000	295,000	415,000	165,000	240,000	1,115,000	1,901,973	114,143	Critical
Average	570,000	1,010,000	500,000	1,030,000	3,110,000	430,000	625,000	285,000	400,000	1,740,000	2,650,973	160,089	Below Normal
Wet	1,000,000	1,730,000	950,000	1,760,000	5,440,000	615,000	765,000	405,000	600,000	2,385,000	4,177,973	300,923	Wet
Feb 19 Update													
Dry	340,000	630,000	310,000	640,000	1,920,000	295,000	415,000	165,000	240,000	1,115,000	1,811,973	111,554	Critical
Average	530,000	940,000	460,000	950,000	2,880,000	430,000	625,000	285,000	400,000	1,740,000	2,512,973	150,293	Below Normal
Wet	950,000	1,620,000	870,000	1,620,000	5,060,000	615,000	765,000	405,000	600,000	2,385,000	3,949,973	300,923	Wet
Mar 1 Forecast													
Dry	320,000	580,000	220,000	540,000	1,660,000	290,000	445,000	185,000	270,000	1,190,000	1,670,973	107,498	Critical
Average	490,000	840,000	360,000	820,000	2,510,000	330,000	495,000	215,000	330,000	1,370,000	2,216,973	129,711	Dry
Wet	880,000	1,460,000	710,000	1,410,000	4,460,000	420,000	615,000	285,000	440,000	1,760,000	3,464,973	300,923	Above Normal
Mar 12 Update													
Dry	360,000	620,000	230,000	560,000	1,770,000	290,000	445,000	185,000	270,000	1,190,000	1,736,973	109,397	Critical
Average	510,000	850,000	360,000	810,000	2,530,000	330,000	495,000	215,000	330,000	1,370,000	2,228,973	130,535	Dry
Wet	850,000	1,390,000	670,000	1,310,000	4,220,000	420,000	615,000	285,000	440,000	1,760,000	3,320,973	300,923	Above Normal
Mar 19 Update													
Dry	340,000	580,000	200,000	490,000	1,610,000	290,000	445,000	185,000	270,000	1,190,000	1,640,973	106,635	Critical
Average	480,000	790,000	320,000	720,000	2,310,000	330,000	495,000	215,000	330,000	1,370,000	2,096,973	122,468	Critical
Wet	790,000	1,280,000	610,000	1,160,000	3,840,000	420,000	615,000	285,000	440,000	1,760,000	3,092,973	285,964	Below Normal
Mar 26 Update													
Dry	340,000	570,000	200,000	440,000	1,550,000	290,000	445,000	185,000	270,000	1,190,000	1,604,973	105,600	Critical
Average	470,000	760,000	310,000	650,000	2,190,000	330,000	495,000	215,000	330,000	1,370,000	2,024,973	118,341	Critical
Wet	750,000	1,190,000	570,000	1,040,000	3,550,000	420,000	615,000	285,000	440,000	1,760,000	2,918,973	229,504	Below Normal
Apr 1 Forecast													
Dry	300,000	570,000	210,000	420,000	1,500,000	325,000	475,000	205,000	320,000	1,325,000	1,601,973	105,514	Critical
Average	420,000	740,000	310,000	610,000	2,080,000	325,000	475,000	205,000	320,000	1,325,000	1,949,973	115,524	Critical
Wet	670,000	1,130,000	550,000	950,000	3,300,000	325,000	475,000	205,000	320,000	1,325,000	2,681,973	162,290	Below Normal
Apr 16 Update													
Dry	300,000	600,000	220,000	410,000	1,530,000	325,000	475,000	205,000	320,000	1,325,000	1,619,973	106,031	Critical
Average	410,000	730,000	300,000	580,000	2,020,000	325,000	475,000	205,000	320,000	1,325,000	1,913,973	114,488	Critical
Wet	590,000	1,010,000	480,000	840,000	2,920,000	325,000	475,000	205,000	320,000	1,325,000	2,453,973	146,104	Dry
Apr 23 Update													
Dry	290,000	580,000	210,000	380,000	1,460,000	325,000	475,000	205,000	320,000	1,325,000	1,577,973	104,823	Critical
Average	390,000	700,000	280,000	540,000	1,910,000	325,000	475,000	205,000	320,000	1,325,000	1,847,973	112,590	Critical
Wet	530,000	930,000	420,000	760,000	2,640,000	325,000	475,000	205,000	320,000	1,325,000	2,285,973	134,450	Dry
May 1 Forecast													
Dry	270,000	550,000	200,000	340,000	1,360,000	323,000	477,000	207,000	319,000	1,326,000	1,518,173	103,103	Critical
Average	360,000	650,000	260,000	490,000	1,760,000	259,000	407,000	206,000	331,000	1,203,000	1,733,573	109,299	Critical
Wet	460,000	820,000	370,000	660,000	2,310,000	305,013	559,603	228,774	378,500	1,471,890	2,117,351	123,636	Dry
May 14 Update													
Dry	270,000	540,000	230,000	430,000	1,470,000	323,000	477,000	207,000	319,000	1,326,000	1,584,173	105,002	Critical
Average	340,000	620,000	270,000	500,000	1,730,000	259,000	407,000	206,000	331,000	1,203,000	1,715,573	108,781	Critical
Wet	420,000	760,000	350,000	620,000	2,150,000	305,013	559,603	228,774	378,500	1,471,890	2,021,351	118,134	Critical
May 21 Update													
Dry	270,000	550,000	240,000	450,000	1,510,000	323,000	477,000	207,000	319,000	1,326,000	1,608,173	105,692	Critical
Average	330,000	620,000	270,000	510,000	1,730,000	259,000	407,000	206,000	331,000	1,203,000	1,715,573	108,781	Critical
Wet	400,000	740,000	330,000	610,000	2,080,000	305,013	559,603	228,774	378,500	1,471,890	1,979,351	116,369	Critical
May 29 Update													
Dry	270,000	540,000	240,000	460,000	1,510,000	323,000	477,000	207,000	319,000	1,326,000	1,608,173	105,692	Critical
Average	300,000	590,000	260,000	510,000	1,660,000	259,000	407,000	206,000	331,000	1,203,000	1,673,573	107,573	Critical
Wet	350,000	700,000	310,000	580,000	1,940,000	305,013	559,603	228,774	378,500	1,471,890	1,895,351	113,952	Critical
Jan 00 Update													
Dry	0	0	0	0	0	323,000	477,000	207,000	319,000	1,326,000	702,173	94,000	Critical
Average	0	0	0	0	0	259,000	407,000	206,000	331,000	1,203,000	677,573	94,000	Critical
Wet	0	0	0	0	0	305,013	559,603	228,774	378,500	1,471,890	731,351	94,000	Critical
Jan 00 Update													
Dry	0	0	0	0	0	323,000	477,000	207,000	319,000	1,326,000	702,173	94,000	Critical
Average	0	0	0	0	0	259,000	407,000	206,000	331,000	1,203,000	677,573	94,000	Critical
Wet	0	0	0	0	0	305,013	559,603	228,774	378,500	1,471,890	731,351	94,000	Critical
Manual Cal Don By TID (DWR estimate adjusted for rainfall)													
Dry	355,051	571,854	300,980	566,927	1,794,812	323,159	476,812	207,327	318,805	1,326,103	1,779,081	110,608	Critical
Average	403,613	650,070	342,146	644,469	2,040,297	323,159	476,812	207,327	318,805	1,326,103	1,926,372	114,845	Critical
Wet	562,245	905,567	476,620	897,764	2,842,196	323,159	476,812	207,327	318,805	1,326,103	2,407,512	142,806	Dry

TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 1)
Annual Flow Requirement



TUOLUMNE RIVER MINIMUM FLOW REQUIREMENT (Figure 4)
Interpolation Volume



Tuolumne River Flow Schedule
Based On Final Hydrologic Conditions, DWR 60-20-20 Index for 2013
Schedule For 2013-2014 Fish Flow Year

DATE		Number of	BASE FLOW			PULSE FLOW [2]			INTERPOLATION FLOW			Other Adjusted Flow			TOTAL FERC FLOW	
					ACCUM.			ACCUM.			ACCUM.			ACCUM.		ACCUM.[1]
From:	To:	DAYS	CFS	AF	A.F.	CFS	AF	A.F.	CFS	AF	A.F.	CFS	AF	A.F.	CFS	A.F.
15-Apr-2013	15-Apr-2013	1	150	298	298	400	793	793	0	0	0	0	0	0	550	1,091
16-Apr-2013	16-Apr-2013	1	150	298	595	200	397	1,190	0	0	0	0	0	0	350	1,785
17-Apr-2013	17-Apr-2013	1	150	298	893	200	397	1,587	0	0	0	0	0	0	350	2,479
18-Apr-2013	18-Apr-2013	1	150	298	1,190	200	397	1,983	0	0	0	0	0	0	350	3,174
19-Apr-2013	19-Apr-2013	1	150	298	1,488	200	397	2,380	0	0	0	0	0	0	350	3,868
20-Apr-2013	20-Apr-2013	1	150	298	1,785	200	397	2,777	0	0	0	0	0	0	350	4,562
21-Apr-2013	21-Apr-2013	1	150	298	2,083	600	1,190	3,967	0	0	0	0	0	0	750	6,050
22-Apr-2013	22-Apr-2013	1	150	298	2,380	400	793	4,760	0	0	0	0	0	0	550	7,140
23-Apr-2013	23-Apr-2013	1	150	298	2,678	400	793	5,554	0	0	0	0	0	0	550	8,231
24-Apr-2013	24-Apr-2013	1	150	298	2,975	400	793	6,347	0	0	0	0	0	0	550	9,322
25-Apr-2013	25-Apr-2013	1	150	298	3,273	400	793	7,140	0	0	0	0	0	0	550	10,413
26-Apr-2013	26-Apr-2013	1	150	298	3,570	400	793	7,934	0	0	0	0	0	0	550	11,504
27-Apr-2013	27-Apr-2013	1	150	298	3,868	800	1,587	9,521	0	0	0	0	0	0	950	13,388
28-Apr-2013	28-Apr-2013	1	150	298	4,165	600	1,190	10,711	0	0	0	0	0	0	750	14,876
29-Apr-2013	29-Apr-2013	1	150	298	4,463	600	1,190	11,901	0	0	0	0	0	0	750	16,364
30-Apr-2013	30-Apr-2013	1	150	298	4,760	600	1,190	13,091	0	0	0	0	0	0	750	17,851
01-May-2013	01-May-2013	1	150	298	5,058	600	1,190	14,281	0	0	0	0	0	0	750	19,339
02-May-2013	02-May-2013	1	150	298	5,355	1,000	1,983	16,264	0	0	0	0	0	0	1,150	21,620
03-May-2013	03-May-2013	1	150	298	5,653	800	1,587	17,851	0	0	0	0	0	0	950	23,504
04-May-2013	04-May-2013	1	150	298	5,950	550	1,091	18,942	0	0	0	0	0	0	700	24,893
05-May-2013	05-May-2013	1	150	298	6,248	279	553	19,496	0	0	0	0	0	0	429	25,743
06-May-2013	06-May-2013	1	150	298	6,545	200	397	19,892	0	0	0	0	0	0	350	26,438
07-May-2013	07-May-2013	1	150	298	6,843	100	198	20,091	0	0	0	0	0	0	250	26,934
08-May-2013	08-May-2013	1	150	298	7,140	0	0	20,091	0	0	0	0	0	0	150	27,231
09-May-2013	09-May-2013	1	150	298	7,438	0	0	20,091	0	0	0	0	0	0	150	27,529
10-May-2013	10-May-2013	1	150	298	7,736	0	0	20,091	0	0	0	0	0	0	150	27,826
11-May-2013	11-May-2013	1	150	298	8,033	0	0	20,091	0	0	0	0	0	0	150	28,124
12-May-2013	12-May-2013	1	150	298	8,331	0	0	20,091	0	0	0	0	0	0	150	28,421
13-May-2013	13-May-2013	1	150	298	8,628	0	0	20,091	0	0	0	0	0	0	150	28,719
14-May-2013	14-May-2013	1	150	298	8,926	0	0	20,091	0	0	0	0	0	0	150	29,016
15-May-2013	15-May-2013	1	150	298	9,223	0	0	20,091	0	0	0	0	0	0	150	29,314
16-May-2013	16-May-2013	1	150	298	9,521	0	0	20,091	0	0	0	0	0	0	150	29,611
17-May-2013	17-May-2013	1	150	298	9,818	0	0	20,091	0	0	0	0	0	0	150	29,909
18-May-2013	18-May-2013	1	150	298	10,116	0	0	20,091	0	0	0	0	0	0	150	30,206
19-May-2013	19-May-2013	1	150	298	10,413	0	0	20,091	0	0	0	0	0	0	150	30,504
20-May-2013	20-May-2013	1	150	298	10,711	0	0	20,091	0	0	0	0	0	0	150	30,801
21-May-2013	21-May-2013	1	150	298	11,008	0	0	20,091	0	0	0	0	0	0	150	31,099
22-May-2013	22-May-2013	1	150	298	11,306	0	0	20,091	0	0	0	0	0	0	150	31,396
23-May-2013	23-May-2013	1	150	298	11,603	0	0	20,091	0	0	0	0	0	0	150	31,694
24-May-2013	24-May-2013	1	150	298	11,901	0	0	20,091	0	0	0	0	0	0	150	31,991
25-May-2013	25-May-2013	1	150	298	12,198	0	0	20,091	0	0	0	0	0	0	150	32,289
26-May-2013	26-May-2013	1	150	298	12,496	0	0	20,091	0	0	0	0	0	0	150	32,586
27-May-2013	27-May-2013	1	150	298	12,793	0	0	20,091	0	0	0	0	0	0	150	32,884
28-May-2013	28-May-2013	1	150	298	13,091	0	0	20,091	0	0	0	0	0	0	150	33,181
29-May-2013	29-May-2013	1	150	298	13,388	0	0	20,091	0	0	0	0	0	0	150	33,479
30-May-2013	30-May-2013	1	150	298	13,686	0	0	20,091	0	0	0	0	0	0	150	33,777
31-May-2013	31-May-2013	1	150	298	13,983	0	0	20,091	0	0	0	0	0	0	150	34,074
01-Jun-2013	01-Jun-2013	1	50	99	14,083	0	0	20,091	0	0	0	0	0	0	50	34,173
02-Jun-2013	02-Jun-2013	1	50	99	14,182	0	0	20,091	0	0	0	0	0	0	50	34,272
03-Jun-2013	03-Jun-2013	1	50	99	14,281	0	0	20,091	0	0	0	0	0	0	50	34,372
04-Jun-2013	04-Jun-2013	1	50	99	14,380	0	0	20,091	0	0	0	0	0	0	50	34,471
05-Jun-2013	05-Jun-2013	1	50	99	14,479	0	0	20,091	0	0	0	0	0	0	50	34,570
06-Jun-2013	06-Jun-2013	1	50	99	14,579	0	0	20,091	0	0	0	0	0	0	50	34,669
07-Jun-2013	30-Jun-2013	24	50	2,380	16,959	0	0	20,091	0	0	0	0	0	0	50	37,049
01-Jul-2013	31-Jul-2013	31	50	3,074	20,033	0	0	20,091	0	0	0	0	0	0	50	40,124
01-Aug-2013	31-Aug-2013	31	50	3,074	23,107	0	0	20,091	0	0	0	0	0	0	50	43,198
01-Sep-2013	30-Sep-2013	30	50	2,975	26,083	0	0	20,091	0	0	0	0	0	0	50	46,173
01-Oct-2013	24-Oct-2013	24	126	5,989	32,071	0	0	20,091	0	0	0	0	0	0	126	52,162
25-Oct-2013	25-Oct-2013	1	126	250	32,321	0	0	20,091	400	793	793	0	0	0	526	53,205
26-Oct-2013	26-Oct-2013	1	126	250	32,571	0	0	20,091	800	1,587	2380	0	0	0	926	55,041
27-Oct-2013	27-Oct-2013	1	126	250	32,820	0	0	20,091	600	1,190	3570	0	0	0	726	56,481
28-Oct-2013	28-Oct-2013	1	126	250	33,070	0	0	20,091	400	793	4364	0	0	0	526	57,524
29-Oct-2013	29-Oct-2013	1	126	250	33,319	0	0	20,091	300	595	4959	0	0	0	426	58,368
30-Oct-2013	30-Oct-2013	1	126	250	33,569	0	0	20,091	200	397	5355	0	0	0	326	59,015
31-Oct-2013	31-Oct-2013	1	126	250	33,818	0	0	20,091	65	129	5,484	0	0	0	191	59,393
01-Nov-2013	30-Nov-2013	30	150	8,926	42,744	0	0	20,091	0	0	5,484	0	0	0	150	68,319
01-Dec-2013	31-Dec-2013	31	150	9,223	51,967	0	0	20,091	0	0	5,484	0	0	0	150	77,542
01-Jan-2014	31-Jan-2014	31	150	9,223	61,190	0	0	20,091	0	0	5,484	0	0	0	150	86,765
01-Feb-2014	28-Feb-2014	28	150	8,331	69,521	0	0	20,091	0	0	5,484	0	0	0	150	95,096
01-Mar-2014	31-Mar-2014	31	150	9,223	78,744	0	0	20,091	0	0	5,484	0	0	0	150	104,319
01-Apr-2014	14-Apr-2014	14	150	4,165	82,909	0	0	20,091	0	0	5,484	0	0	0	150	108,484
No. of days		365	(April 10 through April 14)													

1 cfs day = 1.983471 acre-feet (af)

1. Total accumulation amount pertains to 2013-2014 Fish Year Only
2. The pulse flows are a target that represents a daily average.

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
TURLOCK IRRIGATION DISTRICT
CITY & COUNTY OF SAN FRANCISCO
CALIFORNIA DEPARTMENT OF FISH & GAME
U. S. FISH & WILDLIFE SERVICE

333 East Canal Drive
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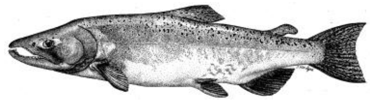

TECHNICAL ADVISORY COMMITTEE MEETING

December 12, 2013 at 9:30 AM

Turlock Irrigation District, Room 152

DRAFT AGENDA

1. INTRODUCTION AND ANNOUNCEMENTS

2. ADMINISTRATIVE ITEMS:
   - Review/revise agenda
   - Approve Notes from September 2013 meeting
   - Items since last meeting

3. MONITORING/REPORTS:
   - Fall run information – status of weir and red survey's
   - Status of technical reports for 2012 annual FERC report
   - Discuss winter monitoring and other studies

4. FLOW OPERATIONS:
   - Review status of flow schedule/watershed conditions

5. AGENCY/NGO UPDATES:

6. ADDITIONAL ITEMS

7. NEXT MEETING DATES- MARCH 13, 2014, JUNE 12, 2014, SEPTEMBER 11, 2014

TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

DON PEDRO PROJECT - FERC LICENSE 2299

MODESTO IRRIGATION DISTRICT
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TECHNICAL ADVISORY COMMITTEE MEETING

December 12, 2013 at 9:30 AM
Turlock Irrigation District, Room 152

Summary

1. INTRODUCTION AND ANNOUNCEMENTS

- Participants made self introductions.
- Two brief discussions took place; status of water quality monitoring in Don Pedro Reservoir in response to the Rim Fire and water hyacinth density in the lower Tuolumne River.

2. ADMINISTRATIVE ITEMS:

- Review/Revise agenda – No changes
- Approve notes from September meeting – No changes were identified. Notes for the last meeting are posted to the TRTAC website: http://tuolumnerivertac.com/.
  Items since last meeting – A handout list posted at http://tuolumnerivertac.com/ was reviewed. The list included meeting summaries and notes from the September TRTAC Meeting, preliminary Tuolumne River Chinook passage data, preliminary spawning season data from Merced, Tuolumne and Stanislaus Rivers, and a progress report regarding the Annual Report to FERC was outlined.

3. MONITORING/REPORTS: (*Handouts were reviewed*)

- Preliminary run estimates from the Tuolumne, Merced and Stanislaus Rivers were reviewed. As of December 11th 3,578 Chinook salmon had migrated upstream past the Tuolumne River weir, where as 5,383 salmon had migrated up past the Stanislaus weir. The proportion of hatchery fish (adipose fin-clipped) returning to the Tuolumne River so far this year is 11.3%. Several consultants, DFW personnel and TID personnel have reported that returning fish have been larger than normal this year on the Tuolumne. Weir operations will continue into July, 2014 in order to support the upcoming predation study.
- Redd surveys will continue through the end of December and possibly through the second week of January depending on spawning activity. Observations indicate broader use of the river this year as compared to last.
- Final 2013 thermograph download was completed the week of November 3, 2013, with data transferred to HDR and FISHBIO for use in various technical reports.
- Technical Reports to be included in the 2013 FERC Report were distributed as a draft Table of Contents.
- Other winter monitoring plans: Ongoing weir operations, redd-mapping, seining surveys, rotary screw trap operations, and project relicensing studies are planned for

winter and spring and summer of 2014 (such as the predation study).

4. FLOW OPERATIONS:

- Current Tuolumne River flows are approximately 160 cfs to the lower river.

5. AGENCY/NGO UPDATES

- Ramon Martin (USFWS) promoted and transferring to Georgia. No habitat restoration coordinator announced.
- Patrick Koepele (TRT) appointed as Executive Director, replacing Eric Wesselman.

6. ADDITIONAL ITEMS

- CDFW Merced River Fish Facility has spawned out about 400 females. Expecting near capacity in juvenile production in Spring 2014.

7. NEXT MEETING DATES – (*Quarterly on 2nd Thursday at 9:30am*)

- 2014 meeting dates: March 13th, June 12th, September 11th, and December 11th

TRTAC Meeting Attendees

	Name	Organization
1.	Patrick Maloney	TID
2.	Greg Dias	MID
3.	Jason Guignard	FISHBIO
4.	Noah Hume	Stillwater

2013 TRTAC Materials/Postings to Website

2012Dec13-2013Mar13 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
  - December 2012 TRTAC meeting summary and handouts
  - March 2013 TRTAC meeting agenda

- Correspondence
  - December 19, 2012. Order finding licensing of hydroelectric project required Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13137463
  - December 21, 2012. California Department of Fish and Game Objectives for ILP Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13140707
  - December 28, 2012. Turlock Irrigation District and Modesto Irrigation District response to comments provided by California Department of Fish and Game on the development of unimpaired hydrology for the Tuolumne River Operations Model under Don Pedro Project P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13144038
  - January 1, 2013. Districts, under Don Pedro P-2299, submittal of Attachment 1 for Dec 21, 2012 letter to Peter Barnes (SWRCB) filed Dec 28, 2012, in response to comments provided by CDFG on development of unimpaired hydrology for Tuolumne River Operations Model. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13146219
  - January 9, 2013. Supplemental Information of Thomas H. Terpstra, A Professional Corporation. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13150874
  - January 9, 2013. Lowe Tuolumne Farmers submits comments re the Study Plan Determination for the Don Pedro Hydroelectric Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155021
  - January 11, 2013. Notice clarifying party status re Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152675
  - January 11, 2013. Motion to Intervene and Comments of National Marine Fisheries Service under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13152896
  - January 16, 2013. ILP Comments of California Department of Fish and Wildlife on Water and Aquatic Resource Studies 6 and 10 and update on water temperature criteria for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13154795
  - January 17, 2013. ILP Water & Aquatics Resources Initial Study Reports of Turlock Irrigation District and Modesto Irrigation District for Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13156015
  - January 17, 2013. ILP Initial Terrestrial Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District for the Don Pedro Project. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155590
  - January 17, 2013. ILP Initial Recreation Resources Study Reports of Turlock Irrigation District and Modesto Irrigation District. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13155572
  - January 17, 2013. ILP Initial Study Report of Turlock Irrigation District and Modesto Irrigation District transmittal letter, ISR, IFIM Progress Report and Cultural Resources Progress Reports. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13155318
  - January 18, 2013. Districts submittal of Attachment A-Photos missing from the Jan 17 2013 ISR filing of Don Pedro Project Relicensing Recreation Resources Study Plan No. 2 - Whitewater Boating Take-Out Improvement Feasibility Study Initial Study Report. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13159071
  - January 23, 2013. Conservation Groups' Amended Letter Regarding the Districts Request for Rehearing and Motion to Stay under P-2299, et al.
  - January 23, 2013. Conservation Groups' Letter Regarding Districts' Request for Rehearing and Motion to Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13160201

- January 21, 2013. Lower Tuolumne Farmers submits comments re the Don Pedro Dam under P-2299. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13166937
- February 1, 2013. Conservation Groups' Answer in Opposition to Turlock and Modesto Irrigation Districts' Motion for Stay under UL11-1, et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13168520
- February 8, 2013. ILP Submittal by John Devine, HDR, of Initial Study Report Meeting Summary of Turlock Irrigation District and Modesto Irrigation District's Initial Study Report Meeting held January 30-31, 2013. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13175880
- February 12, 2013. Motion of Tuolumne River Preservation Trust under UL11-1, et. al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13180063
- February 19, 2013. Order granting rehearing for further consideration Re: Turlock Irrigation District et al under UL11-1 et al. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13183741
- March 7, 2013. Response of the US Army Corps of Engineers to HDR Engineering, Inc's 7/12/12 letter re the Don Pedro Project under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096098
- March 8, 2013. American River Touring Association, Inc submit comments on the Whitewater Boating Take-Out Improvement Feasibility Study Report and requesting a new study due to the inadequacy of the Initial Study Report under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096296
- March 8, 2013. Comments on RR-02 of project P-2299 Comment of Martin S McDonnell under P-2299. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096436
- March 11, 2013. Comment of USDA Forest Service under P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096524
- March 11, 2013. Comment of O.A.R.S. Companies, Inc. on Initial Study Reports in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096531
- March 11, 2013. Comment of TUOLUMNE RIVER EXPEDITIONS, INC. on Initial Study Report in P-2299-000. http://elibrary.ferc.gov/idmws/File_list.asp?document_id=14096532
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• Documents
  - No Documents
  - No postings

• Data/Monitoring
  - No postings

2013Mar13-2013June14 Postings to TRTAC website http://tuolumnerivertac.com/

- Meetings
    - March 2013 TRTAC meeting summary and handouts
    - June 2013 TRTAC meeting agenda

- Correspondence
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- Documents
    - FERC Annual Report
    - TID-MID Final Instream Flow Report

- Data/Monitoring
    - No postings

2013June14-2013August 29 Postings to TRTAC website http://tuolumnerivertac.com/

• Meetings
  - June 2013 TRTAC meeting summary and handouts
  - September 2013 TRTAC meeting agenda

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• Documents
  - No postings

• Data/Monitoring
  - No postings

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- Meetings
  - September 2013 TRTAC meeting summary and handouts
  - December 2013 TRTAC meeting agenda

- Correspondence

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-November 18, 2013. Letter requesting Turlock Irrigation District to file the requested information within 30 days re the deviation in the required minimum flow released for the Don Pedro Hydro Project under P-2299. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14162689
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-November 26, 2013. ILP Draft Licence Application of Turlock Irrigation District and Modesto Irrigation District under P-2299. Don Pedro Project. http://elibrary.ferc.gov/idmws/file_list.asp?document_id=14164684
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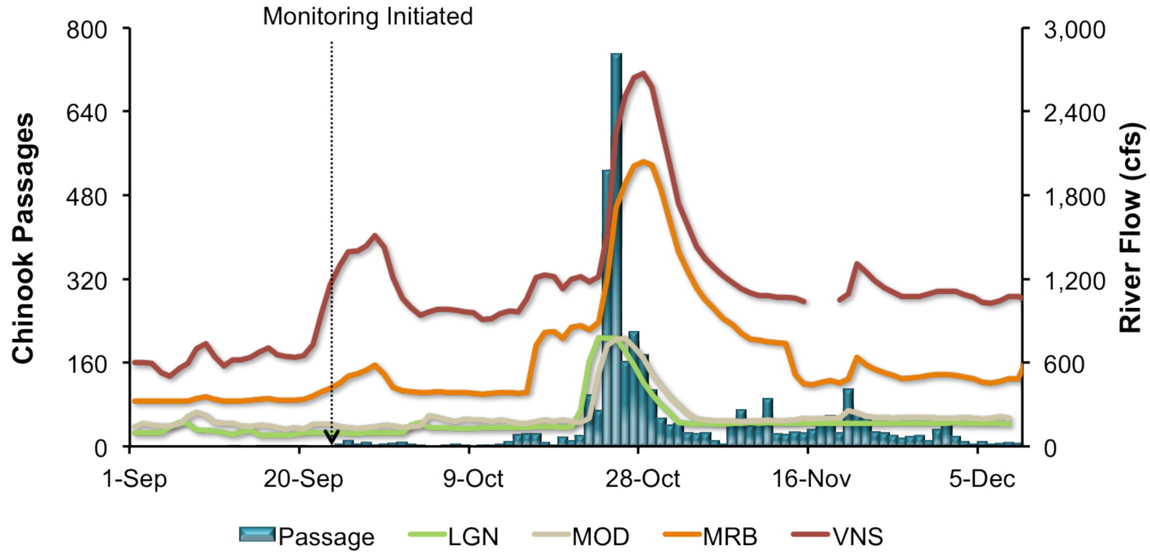
- Documents
  - No postings

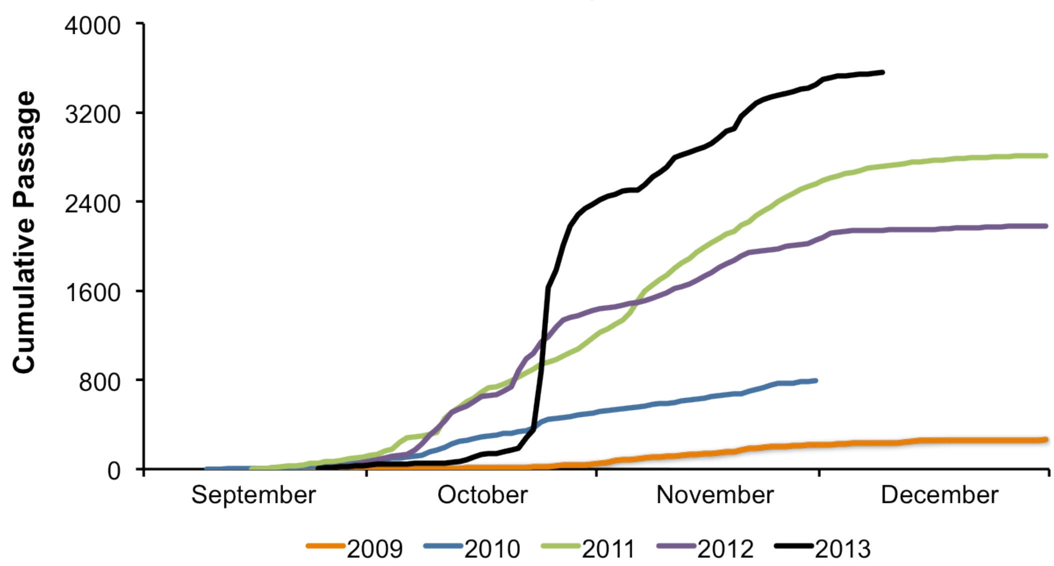
- Data/Monitoring
  - No postings

Preliminary Results



2013 Lower Tuolumne River Chinook Passage.
Total passage = 3,558 through December 8, 2013.

Preliminary Results



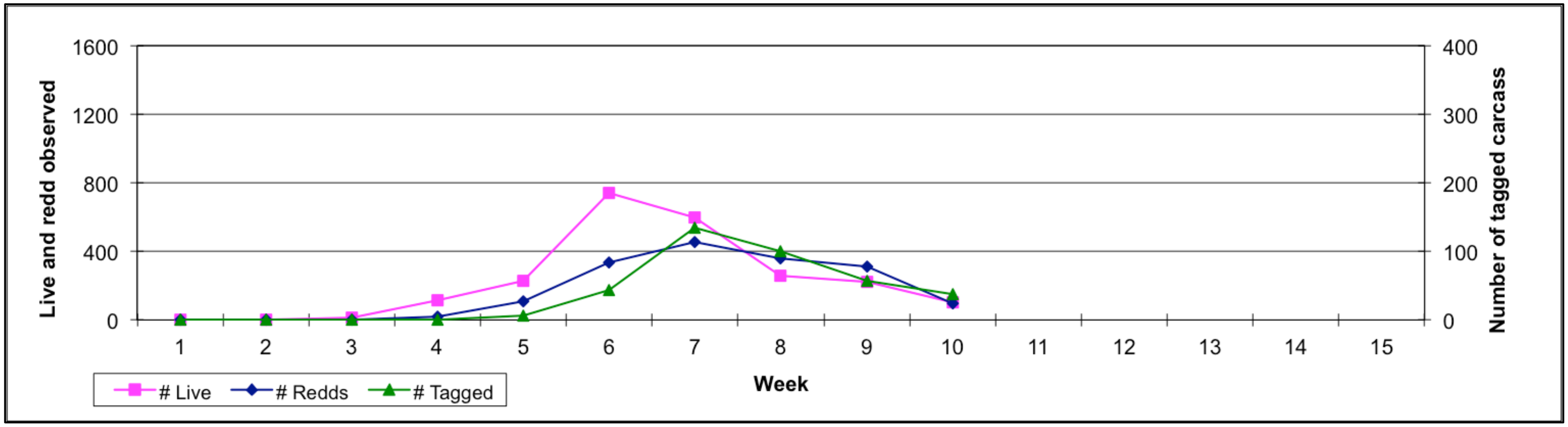
2009-2013 Lower Tuolumne River Chinook Passage.

Source: FISHBIO preliminary data.

Preliminary Data –

Lower Merced River

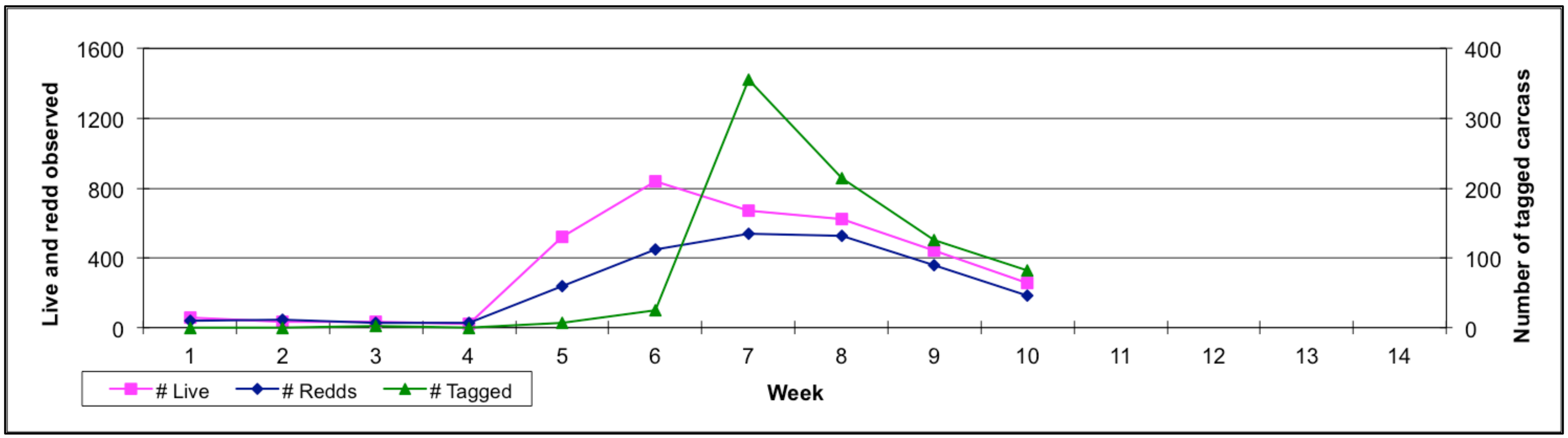
Week	Date	# Live	# Redds	# Skeletons	# Tagged	# AdClipped	# Scale Samples	# Recovered	Average Flow (cfs)	# Females spawned @ MRFF
1	30-Sep-2013	1	0	0	0	0	0	0	110	
2	7-Oct-2013	1	0	0	0	0	0	0	105	
3	14-Oct-2013	13	0	0	0	0	0	0	170	
4	21-Oct-2013	113	19	0	1	0	1	0	316	40
5	28-Oct-2013	229	111	1	7	0	7	0	318	45
6	4-Nov-2013	743	335	27	44	2	44	1	189	109
7	11-Nov-2013	597	452	130	134	18	134	11	228	97
8	18-Nov-2013	256	359	164	100	25	100	42	265	61
9	25-Nov-2013	221	314	170	57	15	57	30	238	40
10	2-Dec-2013	103	99	108	38	15	38	32	245	24
11	9-Dec-2013									
12	16-Dec-2013									
13	23-Dec-2013									
14	30-Dec-2013									
15	6-Jan-2014									



Preliminary Data –

Lower Tuolumne River

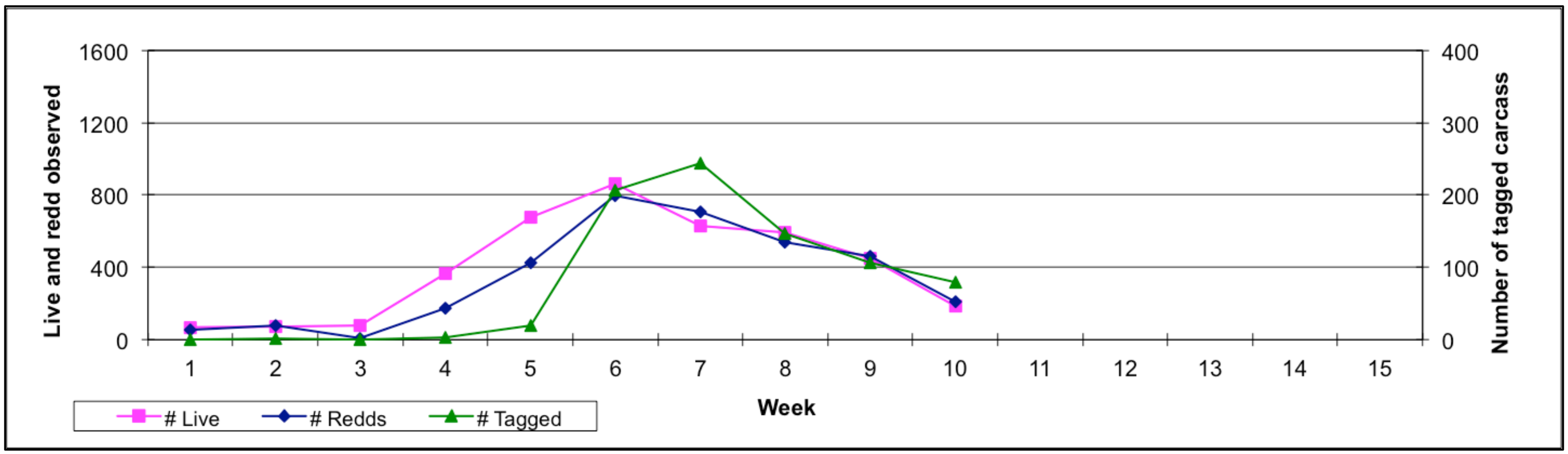
Week	Date	# Live	# Redds	# Skeletons	# Tagged	# AdClipped	# Scale Samples	# Recovered	Average Flow (cfs)
1	30-Sep-2013	57	42	4	0	0	0	0	97
2	7-Oct-2013	33	46	0	0	0	0	0	130
3	14-Oct-2013	31	27	2	3	0	3	0	130
4	21-Oct-2013	19	29	1	0	0	0	0	600
5	28-Oct-2013	521	238	3	7	0	7	0	366
6	4-Nov-2013	841	448	9	25	0	25	4	160
7	11-Nov-2013	673	541	214	355	33	355	22	164
8	18-Nov-2013	622	526	200	215	23	215	323	164
9	25-Nov-2013	445	357	179	126	17	126	437	160
10	2-Dec-2013	254	181	117	82	5	82	384	165
11	9-Dec-2013								
12	16-Dec-2013								
13	23-Dec-2013								
14	30-Dec-2013								
15	6-Jan-2014								



Preliminary Data –

Lower Stanislaus River

Week	Date	# Live	# Redds	# Skeletons	# Tagged	# AdClipped	# Scale Samples	# Recovered	Average Flow (cfs)
1	30-Sep-2013	69	55	0	0	0	0	0	254
2	7-Oct-2013	72	79	2	2	0	2	0	254
3	14-Oct-2013	78	9	0	0	0	0	0	699
4	21-Oct-2013	368	174	0	3	0	3	0	530
5	28-Oct-2013	674	425	7	19	5	19	0	773
6	4-Nov-2013	865	798	57	207	28	207	2	356
7	11-Nov-2013	630	705	123	244	78	244	57	300
8	18-Nov-2013	590	537	81	147	49	147	88	306
9	25-Nov-2013	452	464	207	107	28	107	136	245
10	2-Dec-2013	188	208	153	80	21	80	104	247
11	9-Dec-2013								
12	16-Dec-2013								
13	23-Dec-2013								
14	30-Dec-2013								
15	6-Jan-2014								



UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

DRAFT COVER

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

2013 Annual Summary Report

Exhibits: Spawning runs, harvest data, rearing/outmigration data, Delta salvage and exports

Attachment A: Water Conditions, Flows, Temperature, and Flow Schedule Correspondence

Attachment B: 2013 Tuolumne River Technical Advisory Committee Materials

Report 2013-1: 2013 Spawning Survey Report

Report 2013-2: Spawning Survey Summary Update

Report 2013-3: 2013 Seine Report and Summary Update

Report 2013-4: 2013 Rotary Screw Trap Report

Report 2013-5: 2013 Snorkel Report and Summary Update

Report 2013-6: 2013 Counting Weir Report

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-1

2010 Tuolumne River Fall Chinook Salmon Escapement Survey DRAFT

Prepared by

California Department of Fish and Wildlife
Tuolumne River Restoration Center
La Grange Field Office

March 2014

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2010 Tuolumne River Fall Chinook Salmon Escapement Survey

Prepared by:

Jennifer O'Brien
Fisheries Biologist

California Department of Fish and Game
Tuolumne River Restoration Center
La Grange Field Office

1 INTRODUCTION

The San Joaquin fall-run Chinook salmon is currently a species of concern under the federal Endangered Species Act. Population levels, as measured by escapement of returning adults, in the Tuolumne River declined in the latter half of the 20th century from a high of approximately 130,000 returning adults in 1944 (Fry 1961) to a low of 77 in 1991 (Neilands et al. 1993). A decade ago, population levels increased to 17,873 in 2000 (Vasques 2001) indicating a slight recovery period, but numbers have been in decline ever since. The decline of the species is believed to be caused by many factors. The reduction of spawning and rearing habitat in combination with stream flow management practices are thought to be the major factors limiting overall population numbers. Numerous additional factors, many an effect of flow regime, include predation, streambed alteration, pump diversion and land use practices. Other factors such as ocean conditions and ocean harvest contribute to a complex web of factors which affect the population dynamics of fall run Chinook salmon within the Tuolumne River.

The California Department of Fish and Game (CDFG) has conducted escapement surveys on the Tuolumne River since 1953. Mark-Recapture methods have been utilized since 1971 to estimate escapement. Various population models have been used including Schaefer (1951), Jolly-Seber (1973), and the Adjusted Peterson (Ricker 1975). Due to the low number of individuals tagged, the 2010 escapement survey was analyzed using the Adjusted Peterson formula.

The primary objectives of the Tuolumne River escapement survey are to:

- Estimate the escapement of fall run Chinook salmon on the Tuolumne River.
- Evaluate the distribution of spawning throughout the study area.
- Collect fork length and sex data.
- Collect and analyze coded wire tag data from hatchery fish.
- Collect tissue samples for genetic analysis.
- Collect scale and otolith samples with which to conduct age determination analysis and subsequent cohort analysis.

2 METHODS

General Information

Chinook salmon escapement surveys on the Tuolumne River typically begin around the first week of October and extend into the end of December or early January. The study area is surveyed weekly to monitor the distribution of spawning and to tally the number of carcasses found within the river. Crew members float downstream in a drift boat searching for carcasses, counting live fish and documenting redds in each riffle and subsequent pool. Occasionally, crew members get out of the boat to walk along the sides of the river in search of carcasses that may be too difficult to see from the boat. When a carcass is discovered, it is gaffed out of the water and held on the boat until the entire riffle section (riffle and adjacent downstream pool) has been completely surveyed (Figure 1).

All carcasses found within a riffle section are processed after the area has been adequately searched (Figure 2). “Processing” involves obtaining condition, sex, and forklength data as well as retrieval of scale, ototlith, coded-wire tag, and DNA samples. The survey crew resumes floating downstream once all carcasses found within a riffle section have been processed and returned to the tail end of the riffle. The same procedures are followed for each subsequent riffle/pool combination until the entire river section has been completed.

The duration of the survey depends on the availability of new carcasses in the river. Tagging continues until there are less than ten new carcasses found in a survey week. After tagging has ceased, surveys continue for two more "recovery" weeks. Any new carcass found during a recovery week is enumerated, chopped, and returned to the river. Redd and live counts continue during recovery weeks.

Study Area

Approximately 30.5 river miles were surveyed during the escapement survey in 2010 (Figure 3). The survey area was divided into five sections with Section 1 being the upstream most reach. Section 1, also referred to as the primary spawning reach, extends from riffle A1 at river mile 52.0 near La Grange Dam downstream to Basso Bridge at river mile 47.5. Section 2 extends from Basso Bridge down to the Turlock Lake State Recreation Area (TLSRA) at river mile 41.9. Section 3 extends from TLSRA to riffle S1 at river mile 34. Section 4 extends from riffle S1 downstream to Fox Grove Fishing Access at river mile 26. Section 5 extends from Fox Grove Fishing Access to Santa Fe Rd. at river mile 21.5.

Riffle Identification

All riffles in the study area have been identified and mapped using a Trimble GPS unit and the GIS computer program ArcView. Each riffle was systematically re-named in 2001 from upstream to downstream using sequential letter/number designations for river mile and riffle number within each river mile, respectively. For example, the first riffle surveyed below La Grange Dam in the first river mile (51) is named A1. The riffle immediately below La Grange Dam (riffle A1) is surveyed by foot and only redd and live fish counts are made. This numbering system is a departure from the historical riffle numbering system; however, the new riffle identification system is more conducive to editing and tracking riffles as river morphology changes. Changes in riffle locations which may occur during high flow periods, will affect riffle names only within that river mile. There were no changes in riffle names for sections 1-5 from 2009 to 2010 (Table 1).

Redd and Live Fish Counts

Weekly redd and live fish counts are conducted during the carcass survey. These counts utilize the riffle identification system noted earlier. Counts are made using tally counters as the field crew floats downstream through each riffle. The single pass method is utilized for conducting redd and live counts. Generally, one person remains responsible for redd counting throughout the entire season. In doing so, there is less variability in the data. Live fish are counted once they swim upstream past the boat in an attempt to prevent double counting.

Carcass Condition

The condition of each carcass is designated as fresh, decayed, skeleton, or recovery depending on the degree of decomposition or the presence of an aluminum field tag in the case of "recoveries". The condition of each carcass dictates how each individual will be processed. "Skeletons" are carcasses judged to be in an advanced state of decay and unlikely to have the same probability of recapture as fresh or decayed specimens (Figure 4). Skeleton condition ranges from a fungus covered carcass to an actual skeleton. Skeletons are enumerated and then chopped in half to avoid double counting before returning to the river. A carcass with at least one clear eye is classified as “fresh” (Figure 5). Carcasses that have cloudy eyes are considered “decayed” (Figure 6). Fresh and decayed carcasses are tagged and used for sample collection.

Coded-Wire Tags

Each fresh or decayed carcass is checked for the presence or absence of an adipose fin. Individuals lacking an adipose fin were raised in a hatchery and usually have a metal, coded-wire tag (CWT) implanted inside their head. Coded-wire tags are collected and later analyzed as part of survival testing of marked outmigrating smolts. Coded-wire tag returns provide information for determining hatchery contribution rates and can be utilized to analyze the incidence of straying from other river systems. Coded-wire tag data is also being used to validate scale and otolith age determination work.

Survey crews remove the upper portion of the heads of CWT carcasses while working on the river. The lower jaw of the carcass remains attached to the rest of the body so that a metal “field tag” can still be attached. Once the head has been removed, it is placed in a labeled “head bag” and catalogued by the unique field tag number so that it can be tracked to the specific date and riffle number of collection. Extraction and analysis of CWT’s is conducted at the La Grange field office after the spawning season has concluded.

Tissue Collection

Scale, otolith, and DNA samples are taken from as many carcasses as possible. Generally, otolith samples can be obtained from most carcasses, but some individuals may be too badly decomposed to collect DNA and scale samples. All samples are catalogued by the unique field tag number which allows the samples to be tracked to the specific date and riffle of collection. Samples are collected from both wild and CWT carcasses and are catalogued, stored, and analyzed at the CDFG La Grange Field Office

DNA Fin Clip and Scale Samples

DNA fin clip samples are taken from the “meaty” region of the pectoral fin. The sample size is between 15-20 mm long and 5-10 mm wide. The samples are dried for at least 48 hours upon arrival to the lab. Scales are collected to determine the size and age composition of annual spawning runs. Scale samples are obtained by using a knife to scrape in a back and forth motion along the side of the carcass. (Scales near the lateral line are avoided) Approximately twenty or more scales are collected from each carcass.

Otolith Samples

Otoliths are extracted from each carcass found on the river. A horizontal incision is made above the eyes and nostrils towards the posterior end of the fish ending slightly above the gill cover. The incision is made so that the top of the head can be removed and the brain capsule exposed. A pair of tweezers are used to reach inside and extract the otoliths which are the only hard structures found within the capsule (Figure 7). Any adhering tissue is removed from each otolith before placing the pair inside an individual vial marked with the field tag number**.**

Assignment of Unique Identification Number

Each carcass, with the exception of skeletons, is assigned a unique identification number by affixing a metal, numbered field tag to the bottom jaw (Figure 8). This number identifies each individual throughout the season so that it can be identified if found again at a later date. Tags are issued in sequential order throughout the season. Newly processed carcasses are redistributed to moving water in the tail end of the riffle, above the pool from which they were collected, for recovery in subsequent weeks.

Tag Recoveries

Previously tagged carcasses are considered "recoveries" if they are found again during a survey subsequent to the tag week. Each recovery is recorded by the unique field tag number before returning the carcass back into the water at the bottom end of the riffle. Recovery totals are essential in calculating annual population estimates because they determine the overall success rate of the field crew's ability to locate carcasses in the river.

In past years' escapement surveys, previously tagged carcasses were chopped in half upon recovery to prevent multiple recaptures. Since 2008, tagged carcasses were recovered as many times as they were found, and returned to the water in tact each time. This new technique is being utilized to determine the longevity of carcass retention within the river system. Multiple recapture data is not currently being utilized in the data analysis for determining the population estimate.

Data Management/Analysis

Datasheets are reviewed by a data entry technician prior to being entered into a Microsoft Access database. All newly entered data goes through a quality control process in which a second individual prints out line-by-lines to check for any data entry errors. The biologist receives a copy of the database after all data entry errors have been corrected. Microsoft Excel is the current program utilized for data analysis. Escapement reports generate annual population estimates but also analyze other factors such as population composition, egg production estimates, and distribution of spawning within the river.

CDFG has used a variety of population models since escapement surveys began in 1953. This year, the Adjusted Peterson equation was used in calculating the population estimate due to low numbers of Chinook salmon being marked. Carcasses are marked and subsequently recovered during weekly surveys of the spawning reach. A ratio of recoveries to the total tagged is used to calculate an estimate of the total spawning population. Total fish handled includes total fish tagged, skeletons, and recoveries by week.

The Adjusted Peterson equation:

$$N = \frac{(M+1)(C+1)}{R+1}$$

Where:
N=Population estimate
M=Number of carcasses tagged
C=Catch (total number of tagged and skeletons)
R=Number of recoveries

3 TUOLUMNE RIVER WEIR

The Tuolumne River weir was in its second year of operation in 2010. In 2009, high levels of spawning activity occurred within 1.5 miles downstream of the weir. This appeared to have been associated with fish passage problems at the weir. The Department of Fish and Game addressed its concerns regarding the design and location of the weir upon conclusion of the 2009 season. As a result, structural modifications were made to the existing weir prior to being put back in the water for the 2010 season. The modifications included the removal of approximately a nine foot section of the substrate rail and weir panels at the location of the passing chute, removal of the live box, and creation of a small funnel to direct fish into the passing chute (Figures 9 and 10).

Fish passage past the weir improved dramatically in 2010. Minimal spawning occurred downstream of the weir and only 2 live Chinook were observed downstream of weir during the 8 weeks that were surveyed. There were no carcasses found downstream of the weir in 2010. The Department will continue conducting carcass surveys downstream of the weir in the upcoming years to make sure that fish passage is not a problem in the future.

4 RESULTS

Survey Duration

The 2010 CDFG Tuolumne River Carcass survey ended early due to high river flows at the beginning of December. Surveys were conducted between October 4, 2010 and December 1, 2010. Drift boat surveys were conducted weekly between the La Grange Dam and Fox Grove fishing access (sections 1-4) for the entire 9 weeks of the survey. Section 5 was surveyed for 8 weeks between October 7, 2010 and November 24, 2010. Carcasses were tagged during all 9 weeks of the survey.

Escapement Estimate

A total of 85 carcasses were tagged during the 2010 Tuolumne River escapement survey. An additional 69 skeletons were tallied and chopped, giving a total of 154 individual Chinook salmon handled during the escapement survey.

The Adjusted Peterson model utilizes the number of recoveries of tagged carcasses, the total number of tagged fish, and the total number of carcasses handled to generate an escapement estimate**.** The overall recovery rate for the 2010 escapement survey was 29.4%.

Based on the Adjusted Peterson model, the 2010 escapement estimate was 547 salmon. Females and males accounted for 33% and 67% respectively of the total tagged fish on the Tuolumne River. Table 2 and figure 11 show historical Tuolumne River escapement estimates from 1978 to 2010. Table 3 shows tagged, skeleton, recovery, and CWT weekly totals.

Live Salmon and Redd Counts

Live fish observation peaked at week 5, and demonstrated an overall declining trend throughout the remainder of the survey. Redd counts peaked in week 7 with a maximum of 107 redds counted and then steadily declined for the remainder of the study period. Total carcass counts peaked in week 7, at 50 (Table 4 and Figure 12). The maximum number of redds counted for individual riffles is presented in Table 5.

Distribution of Spawning

Redd counts are strongly affected by time of day, visibility, sunlight, wind rippling the water surface, redd superimposition, and other physical factors as well as the natural variability between observers. Furthermore, redd counts are conducted with a single pass as opposed to an intensive systematic approach which is beyond the funding for this study.

The results of maximum weekly redd counts indicated that approximately 40% of the spawning activity was concentrated in the riffles of Section 1 (Figure 13). Sections 1 and 3 combined saw nearly 67% of the total spawning activity in 2010. Maximum redd counts for sections 2 and 4 were 13% and 14% respectively. Spawning activity in section 5 dropped significantly from 2009 in which high levels of spawning appeared to have been associated with fish passage problems past the newly constructed Tuolumne weir. Maximum redd counts for each riffle over the course of the season is listed in table 5. Figure 14 shows weekly maximum redds observed by river mile.

Population Composition

The total composition (field tagged carcasses only) for fall-run Chinook salmon in the Tuolumne River was 23.5% natural females, 44.7% natural males, 9.4% CWT females, and 22.4% CWT males (Figure 15). Table 6 shows the yearly percent composition of fall-run Chinook salmon on the Tuolumne River since 1992. Coded wire tagged fish comprised approximately 31.8% of the total tagged carcasses. Skeletons were not checked for adipose fin clips due to their advanced state of decomposition; however, it is likely that ratios calculated for tagged fish are representative for skeletons as well. Table 7 shows the tag code, brood year, release year, and release location for all CWT fish collected in the Tuolumne River in 2010.

Twenty eight female carcasses were jaw tagged in 2010, with forklengths ranging between 60cm and 82cm (average 74.3cm). Fifty seven male carcasses were field tagged with forklengths ranging between 30cm and 98cm (average 74.1cm). Figure 16 shows a length frequency histogram for all Chinook salmon tagged in 2010. Total grilse composition was 38.8% of all examined fish. Breakpoints between grilse and adult were determined from basin wide fork length data and applied to Tuolumne River fork length data to determine grilse composition. The breakpoints used in 2010 were $\leq$69cm for females and $\leq$74 cm for males. Twenty nine males were considered grilse based on fork lengths of 74cm or less. Four females had fork lengths of 69cm or less and were also considered grilse.

Scale, Otolith, and DNA Collection

Scale and otolith samples were collected from all tagged carcasses. DNA was also taken from most tagged carcasses; however, several individuals were too badly decomposed to retrieve adequate DNA samples (Tables 8, 9 and 10). Samples were not collected from skeletons due to the advanced state of decomposition. Scale and otolith samples will be utilized in the CDFG age determination program and for subsequent cohort analysis of the San Joaquin River Basin Chinook salmon populations. This data will also be essential for population models being developed as well as ongoing cohort analysis of factors affecting the populations.

Egg Production Estimation

An estimate for the number of eggs produced by the 2010 fall-run was generated using a standard regression equation (158.45 * fork length cm – 6138.91 = number of eggs). This fork length-fecundity relationship was determined for 48 San Joaquin fall-run Chinook salmon females ranging from 62.5 to 94.0 cm fork length (Loudermilk et al. 1990). The number of eggs was calculated for all females (CWT and natural) and expanded by the ratio method. The average fork length for all females in 2010 was 74.3cm. An estimated 1,014,000 eggs were produced by natural and CWT female Chinook. CWT females were estimated to have produced 230,000 eggs. Natural females were estimated to have produced 784,000 eggs.

Tuolumne River Flows

The Tuolumne River flows, recorded at the La Grange gauge, for the period of September 29, 2010 through December 6, 20010 are shown in figure 17 (preliminary data obtained from the California Data Exchange Center**).** A pulse flow was released during the period between October 6th and October 15th with a maximum flow of 859 cfs on October 12th. The average daily flow between September 29, 2010 and December 6, 2010 was 701 cfs. River flows rapidly increased beginning on December 1, 2010 making it impossible to continue surveys in subsequent weeks. The Tuolumne River continued to have higher than normal river flows well into the summer months of 2011 due to high levels of winter precipitation. Figure 18 shows Tuolumne River flows recorded at the La Grange gauge for the period of September 29, 2010 through September 1, 2011.

Tuolumne River Temperature

Water temperature on the Tuolumne River is recorded using onset temperature monitors at twelve different locations starting below the La Grange powerhouse and ending downstream below the Hickman spillway. Figure 19 shows Tuolumne River water temperatures recorded at riffle C1 and at the above Hickman spillway sites. These water temperatures are plotted verses flow, maximum thermal limit for successful egg incubation, and live fish/redd counts.

Multiple Recaptures

In past years' escapement surveys, tagged carcasses were chopped in half upon recovery to prevent multiple recaptures. Since 2008, tagged carcasses were recovered as many times as they were found, and returned to the water intact each time. This new technique is being utilized to determine the longevity of carcass retention within the river system. Of the twenty five carcasses recovered during the 2010 survey, seventeen were recovered only one time and eight were recovered two times (Figure 20). Multiple recapture data was not used in the data analysis for determining the population estimate.

Winter/Spring/Summertime Live Fish, Redds and Carcasses

The Department of Fish and Game only conducts carcass surveys between October and early January; however, live fish, redds and carcasses have been observed on the river by CDFG during other times of year. The following list documents the timing of these observations in 2010.

1) February 16, 2010 — Three live fish and 4 redds were observed in sections 1 and 2. One non-adclipped female carcass (FL 83cm) was found in the pool below riffle B1 just upstream of the Old La Grange Bridge.

2) February 17, 2010 — Two live fish and one redd were observed in riffle T2 (RM 32.5) near Waterford

3) February 22, 2010 — Three live fish and 3 redds were observed in sections 1 and 2.

4) February 23, 2010 — One live fish was observed near riffle O6 (RM 37.4). One live fish and one redd were observed in riffle T2 (RM 32.5) near Waterford.

5) September 7, 2010 — Six live fish were observed in sections 1 and 2.

6) September 14, 2010 — One live fish was observed at Riffle E1 (RM 47.8).

7) September 28, 2010 — Four live fish and 3 redds were observed in sections 1 and 2.

5 DISCUSSION

The 2010 escapement estimate of 547 salmon is the highest number of returning Chinook salmon to the Tuolumne River since 2006 (Table 2 and Figure 13). The increase in returning adults is a positive sign; however despite the rise in escapement, numbers on the Tuolumne River are still critically low. The Tuolumne River is not alone in declining Chinook salmon returns. Populations have been in decline throughout the San Joaquin River system with similar low population trends also occurring on the Stanislaus and Merced Rivers. In 2010, capture, mark and recapture numbers on the Tuolumne River were too low to use the Schaefer (1951) model to estimate escapement. As a result, the 2010 escapement estimate was calculated using the adjusted Peterson method.

Stream flow dynamics affect the likelihood of collecting carcasses in that it effects both how carcasses are distributed in the system and the effectiveness of recovering carcasses by field crews. The overall recovery rate indicates the percentage of carcasses that were recovered at least one time during the carcass survey. The 2010 tag recovery rate of 29.4% was the lowest since 2006. Recovery rates between 2007 and 2009 were relatively high ranging between 42.9% and 45.4%, likely due to significantly lower flows which averaged approximately 207cfs for those three years, making carcasses easily visible for survey crews to locate.

Flows were considerably higher during the 2010 carcass survey. The average daily flow between September 29th and November 26th was 425cfs, thus making carcasses less visible to field crews. On November 27, 2010 flows rapidly began to increase making it impossible to continue carcass surveys after December 1st. As a result, carcasses that were tagged in weeks 8 and 9 had little or no opportunity for recovery. Since 2008, tagged carcasses were recovered as many times as they were found, and returned to the water in tact each time to determine the longevity of carcass retention within the river system however, multiple recovery information was not utilized in generating the escapement estimate.

Redd counts are affected by time of day, visibility, sunlight, wind rippling the water surface, redd superimposition, and other physical factors as well as the natural variability between observers. Redd counts were conducted with a single pass as opposed to a more complete intensive systematic approach which is beyond the scope of current funding. Maximum weekly redd distribution of section one to section five was 40.1%, 13.4%, 26.7%, 14.0%, and 5.8% of total observed redds. With so few fish returning to spawn there was likely very little redd superimposition occurring in 2010.

There were twenty seven CWT carcasses encountered during the escapement survey in 2010. Skeletons were not checked for adipose fin clips due to their advanced state of decomposition. Females made up 33% of the returning adult population. The percentage of males returning to the Tuolumne in 2010 was 67%. The fork lengths of all salmon examined in the San Joaquin River Basin was utilized in determining grilse breakpoints. Twenty nine males were considered grilse based on fork lengths of 74cm or less. Four females had fork lengths of 69cm or less and were also considered grilse. The total percentage of grilse examined in the Tuolumne River was 38.8% of all examined fish.

The 2010 escapement estimate of 547 individuals causes great concern about the future survival of Chinook salmon in the Tuolumne River. There are many unanswered questions as to why the once healthy population has dropped to such dramatically low numbers. At this point, there is no definitive answer as to the cause of the Chinook population decline. A complex web of factors including flow management practices, predation by non-native species, reduction of spawning and rearing habitat, disease, streambed alteration, pump diversion, gravel mining, land use practices, ocean angler harvest and poor ocean conditions affect the population dynamics of Chinook salmon in the Tuolumne River.

Figure 1. The survey crew drifts through each riffle and subsequent pool until a carcass is found and gaffed out of the river.

Figure 2. The survey crew collects data and samples from each fresh or decayed carcass.

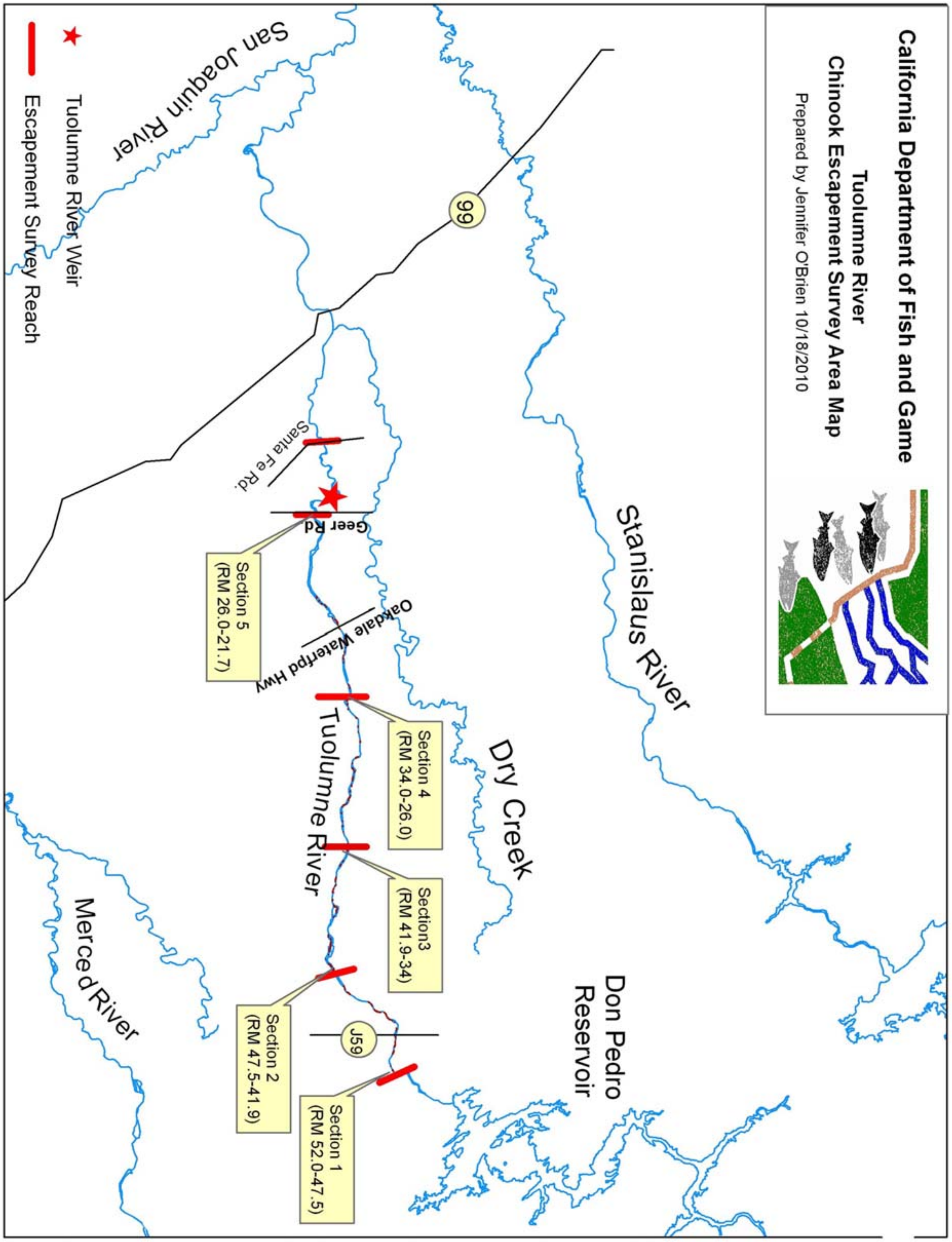

Figure 3. Tuolumne River Escapement Survey Section Map

Figure 4. “Skeletons” are in the advanced state of decomposition and are chopped in half to avoid double counting.

Figure 5. Fresh carcass indicated by a clear eye.

Figure 6. Decayed carcass indicated by cloudy eyes.

Figure 7. Extraction of otoliths from a female Chinook salmon.

Figure 8. Each carcass is assigned a unique identification number by affixing a metal, numbered field tag to the bottom jaw.

Figure 9. Modifications to the 2010 Tuolumne River weir included the removal of approximately a nine foot section of the substrate rail and weir panels at the location of the passing chute, removal of the live box, and creation of a small funnel to direct fish into the passing chute.

Figure 10. Modifications to the 2010 Tuolumne River Weir.

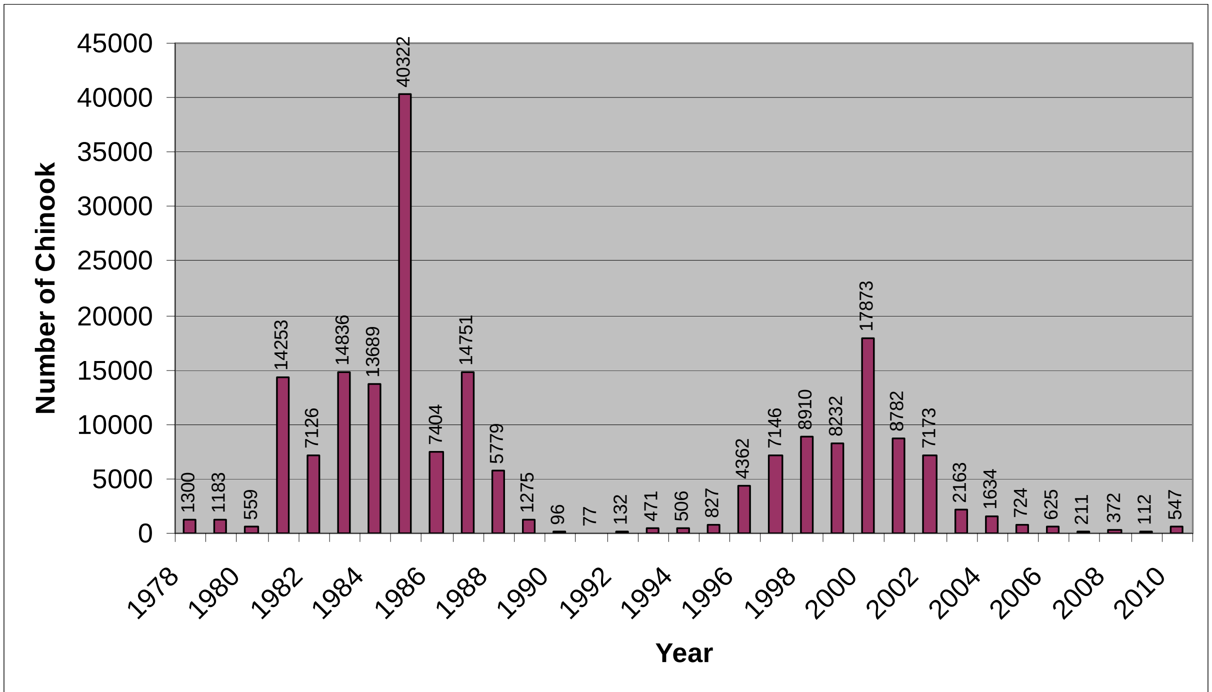

Figure 11. Yearly Tuolumne River Estimates.

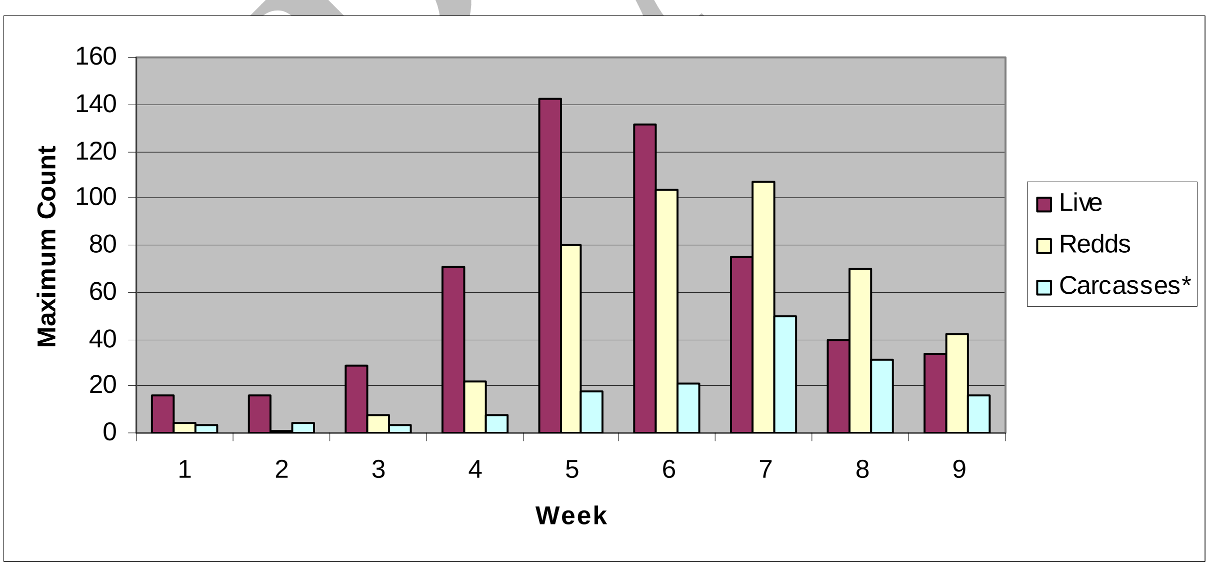

Figure 12. Live fish observation, redd, and carcass counts by week.
*Carcasses include all tagged carcasses and skeletons, but does not include recoveries.

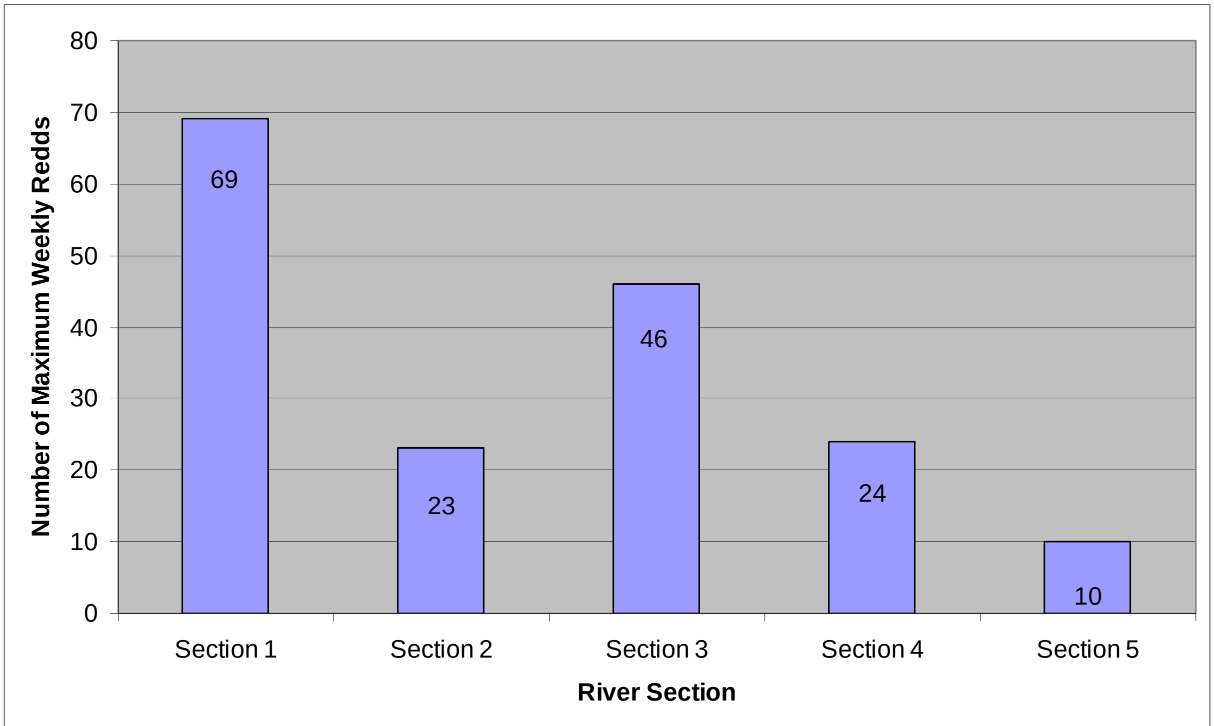

Figure 13. Weekly maximum redds observed by river section.

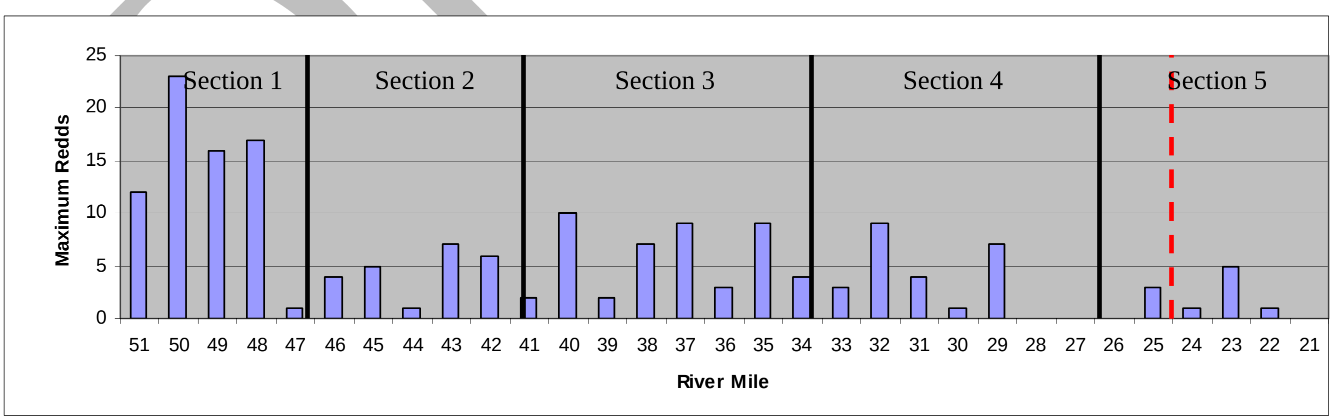

Figure 14. Weekly maximum redds observed by river mile. The approximate location of the Tuolumne weir is indicated by a dashed line.

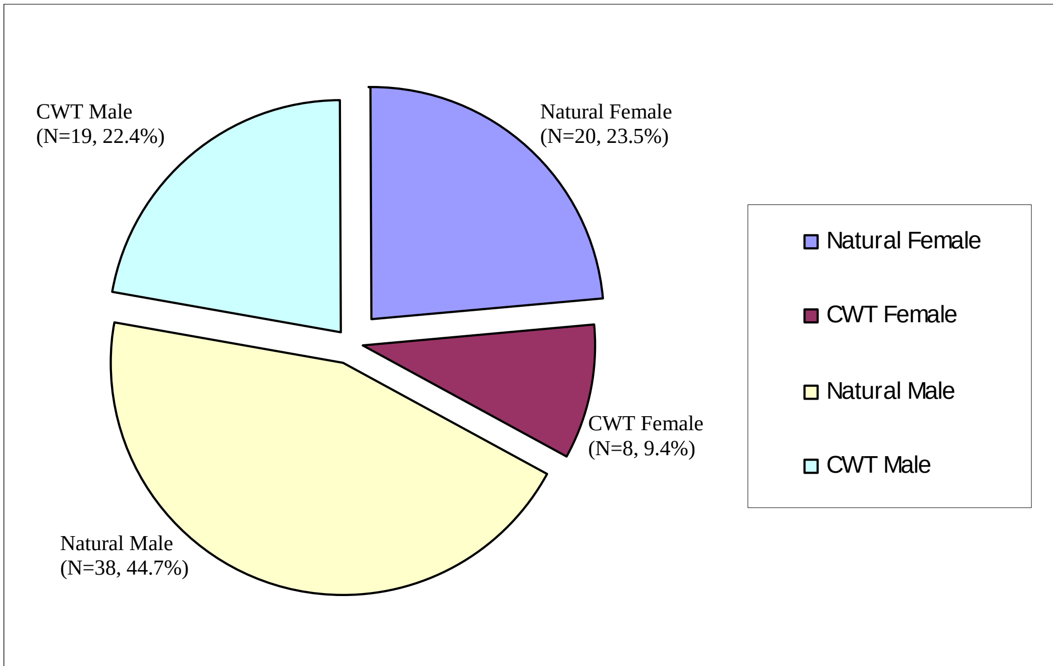

Figure 15. Composition of natural female, CWT female, natural male, and CWT male for the 2010 Tuolumne River escapement survey.

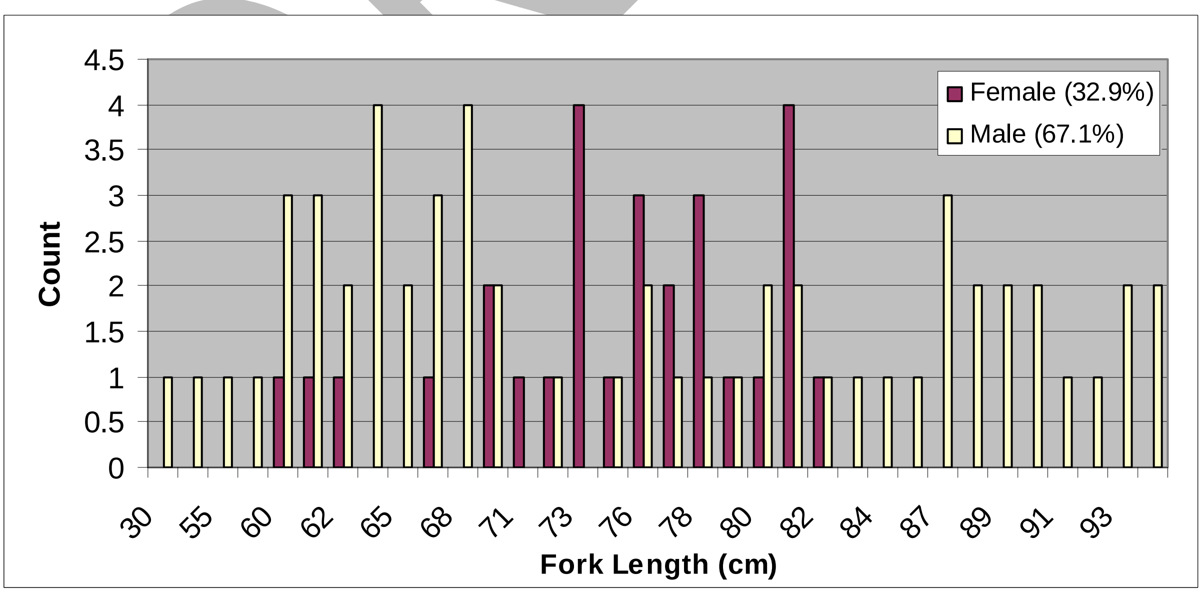

Figure 16. Length frequency histogram of female and male Chinook salmon.

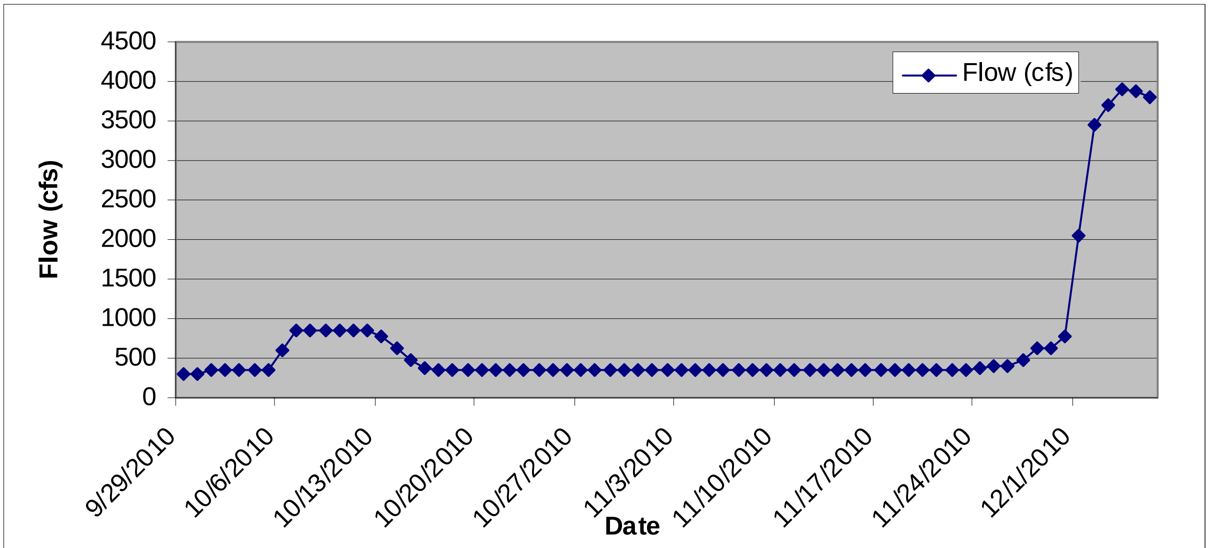

Figure 17. La Grange flow gauge data between September 29, 2010 and December 6, 2010 (California Data Exchange Center). The average flow during this time period was 701cfs.

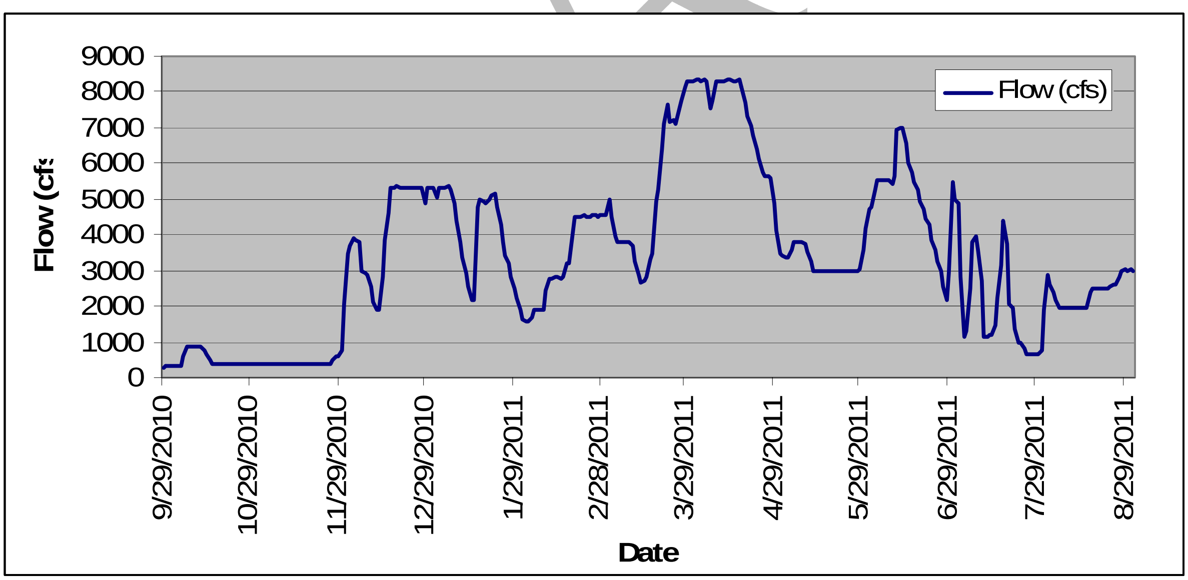

Figure 18. La Grange flow gauge data between September 29, 2010 and September 1, 2011.

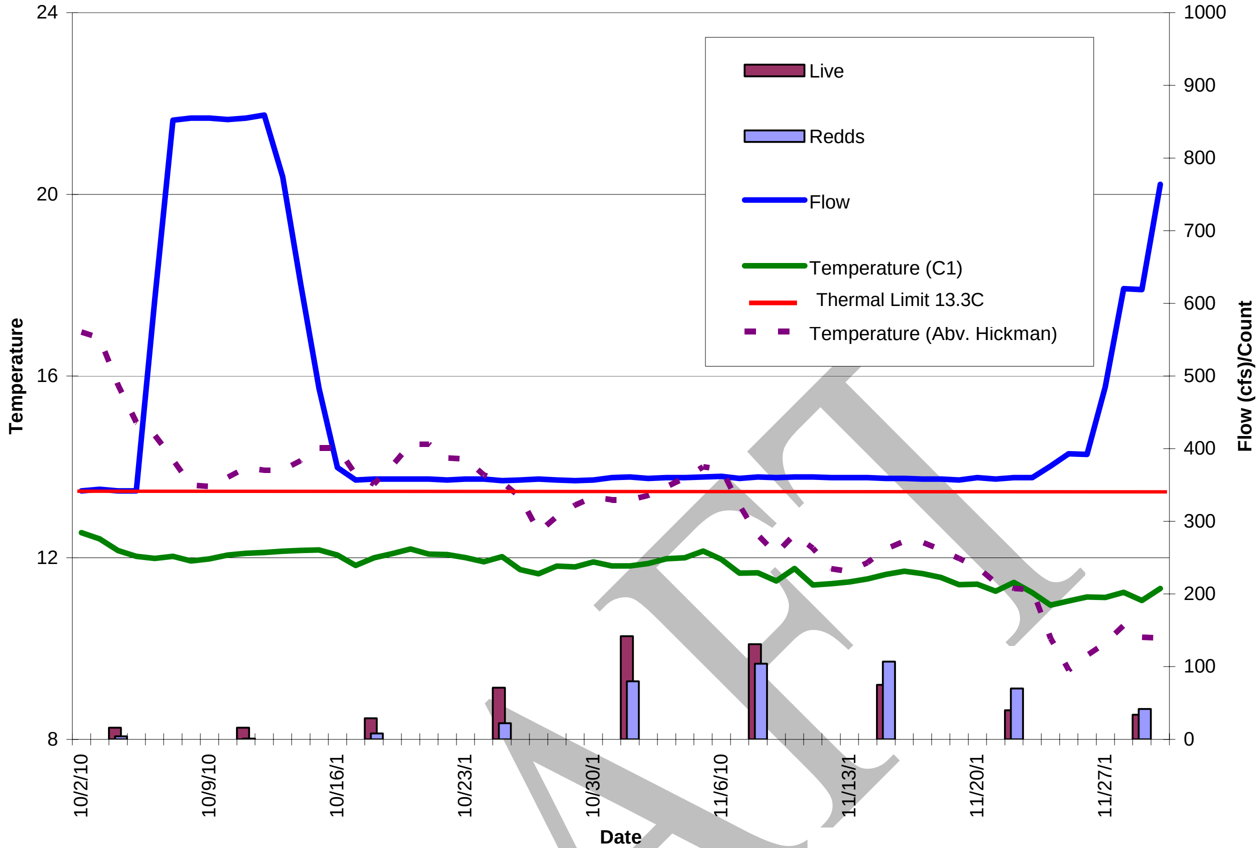

Figure 19. Tuolumne River flows (cfs) at the La Grange gauge, temperature at riffle C1 and the Above Hickman Spillway site, upper thermal limit for successful egg incubation (13.3°C) and number of live fish and redds counted.

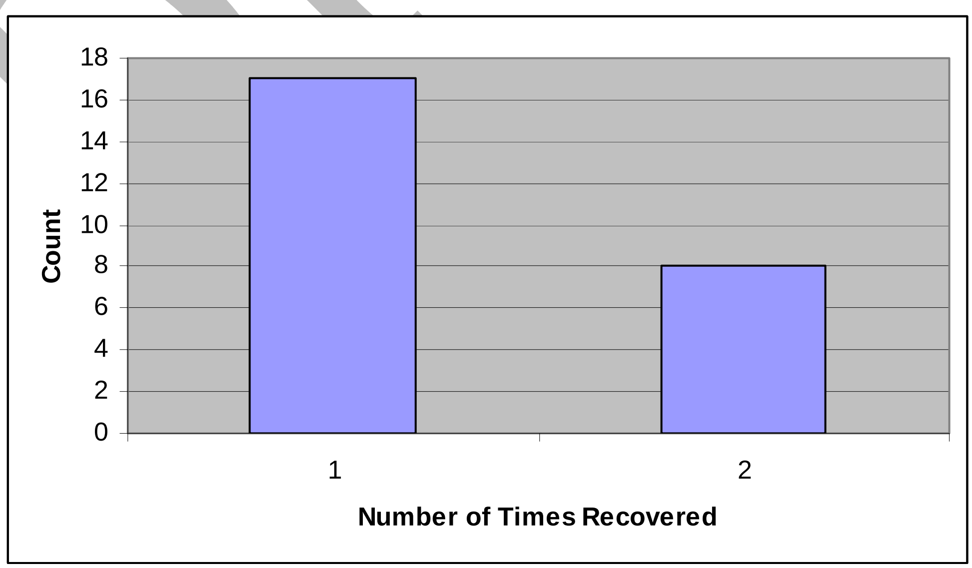

Figure 20. Recapture data for the twenty five carcasses recovered in 2010.

Table 1. Tuolumne River riffle identification cross-reference.

Section 1		Section 2		Section 3		Section 4		Section 5	
New ID	Old ID	New ID	Old ID	New ID	Old ID	New ID	Old ID	New ID	Old ID
A1	A1	F1	F1	K1	K1	S1	S1	ZA1	ZA1
A2	A2	F2	F2	K2	K2	S2	S2	ZA2	ZA2
A3	A3	F3	F3	K3	K3	S3	S3	ZA3	ZA3
A4	A4	G1	G1	L1	L1	S4	S4	ZA4	ZA4
B1	B1	G2	G2	L2	L2	T1	T1	ZA5	ZA5
B2	B2	G3	G3	L3	L3	T2	T2	ZA6	ZA6
B3	B3	G4	G4	L4	L4	T3	T3	ZA7	ZA7
B4	B4	G5	G5	M1	M1	T4	T4	ZB1	ZB1
C1	C1	G6	G6	M2	M2	T5	T5	ZB2	ZB2
C2	C2	H1	H1	N1	N1	U1	U1	ZB3	ZB3
C3	C3	H2	H2	N2	N2	U2	U2	ZB4	ZB4
D1	D1	H3	H3	N3	N3	U3	U3	ZB5	ZB5
D2	D2	H4	H4	N4	N4	V1	V1	ZB6	ZB6
D3	D3	H5	H5	O1	O1	V2	V2	ZC1	ZC1
D4	D4	H6	H6	O2	O2	V3	V3	ZC2	ZC2
D5	D5	H7	H7	O3	O3	V4	V4	ZC3	ZC3
D6	D6	I1	I1	O4	O4	W1	W1	ZC4	ZC4
E1	E1	I2	I2	O5	O5	W2	W2	ZD1	ZD1
		I3	I3	O6	O6	W3	W3	ZD2	ZD2
		I4	I4	O7	O7			ZD3	ZD3
		J1	J1	O8	O8			ZE1	ZE1
		J2	J2	P1	P1				
		J3	J3	P2	P2				
		J4	J4	P3	P3				
		J5	J5	P4	P4				
		J6	J6	P5	P5				
		J7	J7	Q1	Q1				
		J8	J8	Q2	Q2				
				Q3	Q3				
				R1	R1				
				R2	R2				
				R3	R3				

Table 2. Yearly escapement estimates

Year	Tuolumne River Estimate
1978	1,300
1979	1,183
1980	559
1981	14,253
1982	7,126
1983	14,836
1984	13,689
1985	40,322
1986	7,404
1987	14,751
1988	5,779
1989	1,275
1990	96
1991	77
1992	132
1993	471
1994	506
1995	827
1996	4,362
1997	7,146
1998	8,910
1999	8,232
2000	17,873
2001	8,782
2002	7,173
2003	2,163
2004	1,634
2005	724
2006	625
2007	211
2008	372
2009	112
2010	547

Table 3. Weekly Totals

Week	Total Tagged	Skeletons	Single Recoveries	Total Counted*	CWT's
1	1	2	0	3	1
2	2	2	0	4	2
3	2	1	0	3	2
4	3	5	1	9	1
5	12	6	3	19	1
6	10	11	2	22	7
7	35	15	4	53	11
8	15	16	13	40	1
9	5	11	2	18	1
Total	85	69	25	171	27

*Includes total tagged, skeletons, and all recoveries.

Table 4. Total live fish, redds, and carcass counts by survey week

Week	Live	Redds	Carcasses*
1	16	4	3
2	16	1	4
3	29	8	3
4	71	22	8
5	142	80	18
6	131	104	21
7	75	107	50
8	40	70	31
9	34	42	16
TOTAL	554	438	154

*Carcasses include all tagged carcasses and skeletons, but does not include recoveries.

Table 5. Maximum weekly redd count for each riffle by section.

Section 1		Section 2		Section 3		Section 4		Section 5	
Riffle	Max. # of Redds	Riffle	Max. # of Redds	Riffle	Max. # of Redds	Riffle	Max. # of Redds	Riffle	Max. # of Redds
A1	6	F1	2	K1	0	S1	0	ZA1	0
A2	4	F2	1	K2	0	S2	0	ZA2	1
A3	2	F3	1	K3	2	S3	0	ZA3	0
A4	0	G1	3	L1	2	S4	3	ZA4	0
B1	8	G2	0	L2	7	T1	3	ZA5	0
B2	10	G3	1	L3	0	T2	5	ZA6	2
B3	2	G4	1	L4	1	T3	0	ZA7	0
B4	3	G5	0	M1	2	T4	0	ZB1	0
C1	8	G6	0	M2	0	T5	1	ZB2	0
C2	1	H1	0	N1	5	U1	3	ZB3	0
C3	7	H2	0	N2	2	U2	1	ZB4	0
D1	1	H3	0	N3	0	U3	0	Weir	N/A
D2	7	H4	0	N4	0	V1	1	ZB5	0
D3	3	H5	0	O1	0	V2	0	ZB6	1
D4	3	H6	1	O2	0	V3	0	ZC1	1
D5	1	H7	0	O3	0	V4	0	ZC2	4
D6	2	I1	4	O4	0	W1	2	ZC3	0
E1	1	I2	3	O5	1	W2	2	ZC4	0
		I3	0	O6	3	W3	3	ZD1	0
		I4	0	O7	1			ZD2	1
		J1	0	O8	4			ZD3	0
		J2	0	P1	0			ZE1	ns
		J3	0	P2	0				
		J4	1	P3	0				
		J5	1	P4	1				
		J6	2	P5	2				
		J7	1	Q1	4				
		J8	1	Q2	5				
				Q3	0				
				R1	0				
				R2	0				
				R3	4				
Sub Total	69		23		46		24		10
Total					172				

Table 6. Yearly percent composition of fall-run Chinook salmon on the Tuolumne River.

Year	%Female	% Male	% Unknown
1992	41.7%	56.3%	2.1%
1993	57.4%	42.6%	0.0%
1994	42.4%	42.9%	14.7%
1995	52.0%	47.5%	0.5%
1996	33.5%	66.3%	0.2%
1997	57.3%	42.7%	0.0%
1998	50.6%	49.3%	0.1%
1999	45.9%	54.1%	0.0%
2000	62.8%	37.1%	0.0%
2001	54.0%	45.9%	0.1%
2002	54.5%	45.5%	0.0%
2003	59.8%	40.2%	0.0%
2004	59.0%	40.6%	0.4%
2005	66.5%	33.5%	0.0%
2006	47.9%	52.1%	0.0%
2007	37.8%	62.2%	0.0%
2008	57.1%	42.9%	0.0%
2009	56.8%	43.2%	0.0%
2010	32.9%	67.1%	0.0%

Table 7. CWT Recovered from the Tuolumne River in 2010.

Tag Code	Brood Year	Release Year	Hatchery Location	Release Location	Stock Location	# Recovered
06-80-09	2007	2008	Feather River	San Pablo Bay Net Pens	Feather River	3
06-86-07	2007	2008	Mokelumne River	San Pablo Bay Net Pens	American River	1
06-86-10	2007	2008	Feather River	Mare Island Net Pen	Feather River	1
05-48-70	2008	2009	Coleman Hatchery	Mare Island Minor PT	Coleman Hatchery	3
06-45-74	2008	2009	Merced River	Jersey PT, San Joaquin River	Merced River	7
06-45-75	2008	2009	Merced River	Jersey PT, San Joaquin River	Merced River	2
06-86-35	2008	2009	Feather River	San Pablo Bay Net Pens	Feather River	1
06-86-53	2008	2009	Mokelumne River	Sherman ISL OP JERSY	Mokelumne River	5
06-45-77	2009	2010	Merced River	Jersey PT, San Joaquin River	Merced River	1
No Tag Found						3

Table 8. Distribution of scale samples collected by section and week.

Week	Section 1	Section 2	Section 3	Section 4	Section 5	Total
1	1					1
2	2					2
3	2					2
4	5					5
5	12					12
6	5	2	3			10
7	25	3	5	2		35
8	14			1		15
9	4	1				5
Total	70	6	8	3	0	87

Table 9. Distribution of otolith samples collected by section and week.

Week	Section 1	Section 2	Section 3	Section 4	Section 5	Total
1	1					1
2	2					2
3	2					2
4	5					5
5	12					12
6	5	2	3			10
7	25	3	5	2		35
8	14			1		15
9	4	1				5
Total	70	6	8	3	0	87

Table 10. Distribution of DNA samples collected by section and week.

Week	Section 1	Section 2	Section 3	Section 4	Section 5	Total
1	1					1
2	2					2
3	1					1
4	2					2
5	10					10
6	3	2	3			8
7	19	3	5	2		29
8	9			1		10
9	3	1				4
Total	50	6	8	3	0	67

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-2

Spawning Survey Summary Update

Prepared by

Stillwater Sciences
Berkeley, CA

March 2014

SPAWNING SURVEY SUMMARY UPDATE

1. INTRODUCTION

The California Department of Fish and Wildlife (CDFW, formerly California Department of Fish and Game) has conducted fall-run Chinook salmon spawning surveys on the Tuolumne River since 1971 as part of the fish study program for the Don Pedro Project FERC license. TID/MID 1992 reviewed the 1971-1988 period and TID/MID 1997 summarized the 1989-1996 period. Due to the unavailability of 2013 data from CDFW at this time, this report provides only a minimal update for 2013 (Selected text [shown in *italics*] in Sections 2.1, 2.2, and 2.3 along with Figure 2 and Tables 1, 2, and 4) as part of the summary for the 1971-2012 period. The CDFW did provide a draft version of the 2010 spawning survey report (See Report 2013-1). Most of the data from the 2010 report was made available in 2011 and was included in the 2010 Spawning Survey Summary Update (TID/MID 2011) as well as this update.

2. SUMMARY UPDATE

2.1 Survey Reach

The reach surveyed by CDFW in 2010 extended downstream into Section 5 (Figure 1) from near Fox Grove (RM 26.4) to Santa Fe Bridge (RM 21.5). *It is presumed that the same survey reach was used in 2013.* If this is the case, then our records indicate this would be the *fourth* year in a row that Section 5 has been included in the CDFW survey. It is thought that previous surveys extending into Section 5 ended about 1989. The survey was extended downstream in 2010 to examine spawning activity above and below the Tuolumne River counting weir (RM 24.5) which began operation in 2009.

2.2 Population Estimates, Sex Composition, and Potential Eggs

Tuolumne River carcass numbers, mark/recapture survey results, and population estimates since 1971 are shown in Table 1 [*Note that based on a re-evaluation of existing data, the percentage of recaptured tagged carcasses previously reported for the 2011 and 2012 has been revised to reflect insufficient data exists to compute these values*]. The 2009 carcass data do not include Section 5 where CDFW reported an additional 15 total carcasses, including 13 tagged and 7 recovered in that mark/recapture effort. The 2009 run estimate of 300 is based on 280 counted at the Tuolumne weir through Jan 15 and 20 more salmon estimated below the weir (Figure 2). The 2010 run estimate of 766 was also taken from the weir counts which ended early, on November 30, due to high flows. *The 2013 run estimate of 3,738 is based on weir counts from the period September 24, 2013 through February 2, 2014.*

The initial CDFW estimates based on carcasses surveys were 112 and 540 for 2009 and 2010, respectively. The 2010 estimates (both weir count and CDFW survey) do not account for salmon spawning after November. The Tuolumne salmon run estimates for 1971-2010 have ranged from less than 100 salmon in 1990 and 1991 to 40,300 fish in 1985. Detailed and specific data on previous year's surveys can be found in past annual reports submitted to FERC. Estimates for the San Joaquin basin tributaries since 1940 are in Table 2. All estimates in this summary update report for *2009–2013* Tuolumne River fall Chinook salmon are based on calculations utilizing the weir count numbers and may differ from numbers contained in CDFW annual reports.

The percentage of females in the 1971-2010 runs has ranged from 25% in 1983 to 67% in 1978 (Figure 3). The years with less than 40% females usually had runs containing a large percentage of 2-year-old males. In 2009 there were about 57% females in the run and in 2010 there were about 34% based on all measured carcasses.

Beginning in 1981, the potential egg deposition for each year has been estimated using the number and average size of females. This is based on a formula from CDFW Los Banos trap data collected in 1988 using a female size to egg number relationship. These potential egg deposition estimates have ranged from 145,000 in 1991 to 128.6 million in 1985 (Figure 4, Table 3). The estimated 2009 potential egg number was about 1.03 million based on approximately 170 females with an average fork length of 76.8 cm. In 2010 the estimated potential egg number was about 1.47 million based on approximately 258 females with an average fork length of 74.6 cm.

2.3 Live and redd counts

Table 1 shows the maximum weekly counts of live salmon and redds from the CDFW surveys. Table 4 indicates the earliest date of the peak live count during the 1971–2013 period as being October 31, 1996 and the latest date of the peak live count being November 27, 1972. The 2013 run had a peak live count of 841 salmon during the week of November 4 and a peak redd count of 541 during the week of November 11.

2.4 Length Frequency Distribution and Age Class Composition

Fork length measurements have been recorded for carcasses since 1981. Males are typically longer than females of the same age. Generally, the average length of all males is longer than of all females with the exception of years that have a high proportion of 2-year-olds, which are mostly males (Figure 5, Table 5). Estimation of age-class composition based on visual examination of the length frequency distribution of fresh measured carcasses was made for the 1981-2010 surveys (Table 6). These initial estimates are made for comparative purposes and may be modified when age analysis of scale/otolith samples and lengths of known age hatchery fish is utilized. The estimated female maximum fork lengths for ages two, three, and four were typically about 65, 83, and 95 cm respectively. Male fork length maximums for ages two, three, and four were 70, 90-95, and 105 cm, respectively. The most notable exceptions to the age/length estimates occurred in 1983-1984 and 1997-2000 when ocean growth of salmon may have been reduced due to El Niño (warm water) conditions that affected food resources.

Runs are mainly dominated by either 2 or 3-year-old salmon as shown in Figure 6. The 1998, 1999, and 2004 runs were estimated to have fairly equal numbers of two and three-year-old salmon. The 2009 and 2010 runs were dominated by 3-year-old salmon. Four-year-olds were estimated to be the most abundant age class only in 2001, but were estimated to be more than 10% of the 1986, 1989, 1990, and 1997-2009 runs. 2001 and 2007 had the highest estimated percentage of four-year-old salmon in the 1981-2010 study period. Five-year-olds are estimated to have comprised from 0-8% of the runs.

2.5 Linear Regression Analysis of 2-year old salmon vs. following year 3-year olds

A linear regression analysis of the logarithmic values for all estimated 2-year old salmon and the following year estimated 3-year olds resulted in an r^2 = .82 for the 1981-2009 period (excluding the 1984 outlier). A similar analysis for estimated 2-year old female salmon only and the following year estimated 3-year old females resulted in an r^2 = .78 (Figure 7). These analyses indicate a high degree of correlation for both all 2-year old salmon and for 2-year old females returning the following year as 3-year olds of that brood year.

2.6 Estimated Cohort Returns

The number of returns from a given cohort (spawning run) to the Tuolumne River was estimated using the age class composition values previously described. This enables cohort return estimates from the 1979 run, which first returned as 2-year olds in 1981; up to the 2007 run with 3-year olds returning in 2010 (the 2007 cohort was almost complete with 4-year olds still to return in the 2011 run). Runs since 1987 have had higher percentage contributions of known hatchery origin fish but no attempt was made here to separately consider their influence on the cohort returns.

The cohort return for a given year was determined by adding the estimated age 2 through age 5 returning fish from the subsequent runs. For example, the 1979 spawning run cohort returned as 2-year olds in 1981, 3-year olds in 1982, 4-year olds in 1983, and 5-year olds in 1984. Table 7 contains the age-class percentage estimates for each run, the corresponding number estimates that were added to result in the estimated cohort returns, and the estimated age composition of the cohorts. Figure 8 depicts the estimated runs with their estimated cohort returns, showing a wide range of variability.

2.7 Coded wire tagged hatchery salmon

The 2009 run contained 4 coded wire tag (CWT) salmon that originated from the Mokelumne River Hatchery and were released at several bay area locations. The 2010 run contained 27 possible CWT's out of 86 measured salmon but the tags have not been read yet. The 2011 run had a total of 239 possible CWT fish, but no additional data information on these are available at this time. A high percentage of hatchery origin salmon might indicate that a high degree of straying is occurring from these releases.

3. REFERENCES

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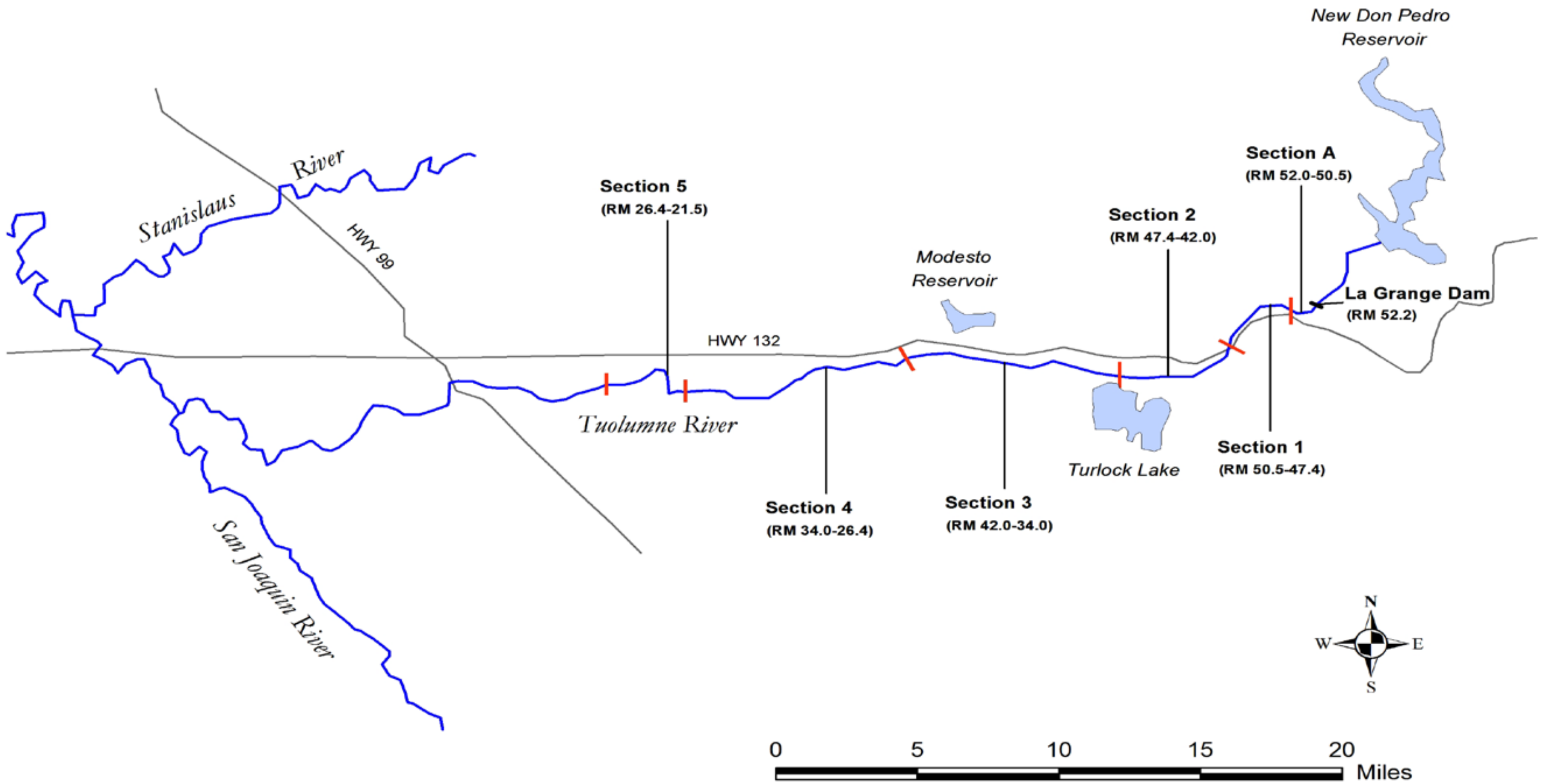


Figure 1. Map of the Tuolumne River salmon spawning survey reaches in 2010.

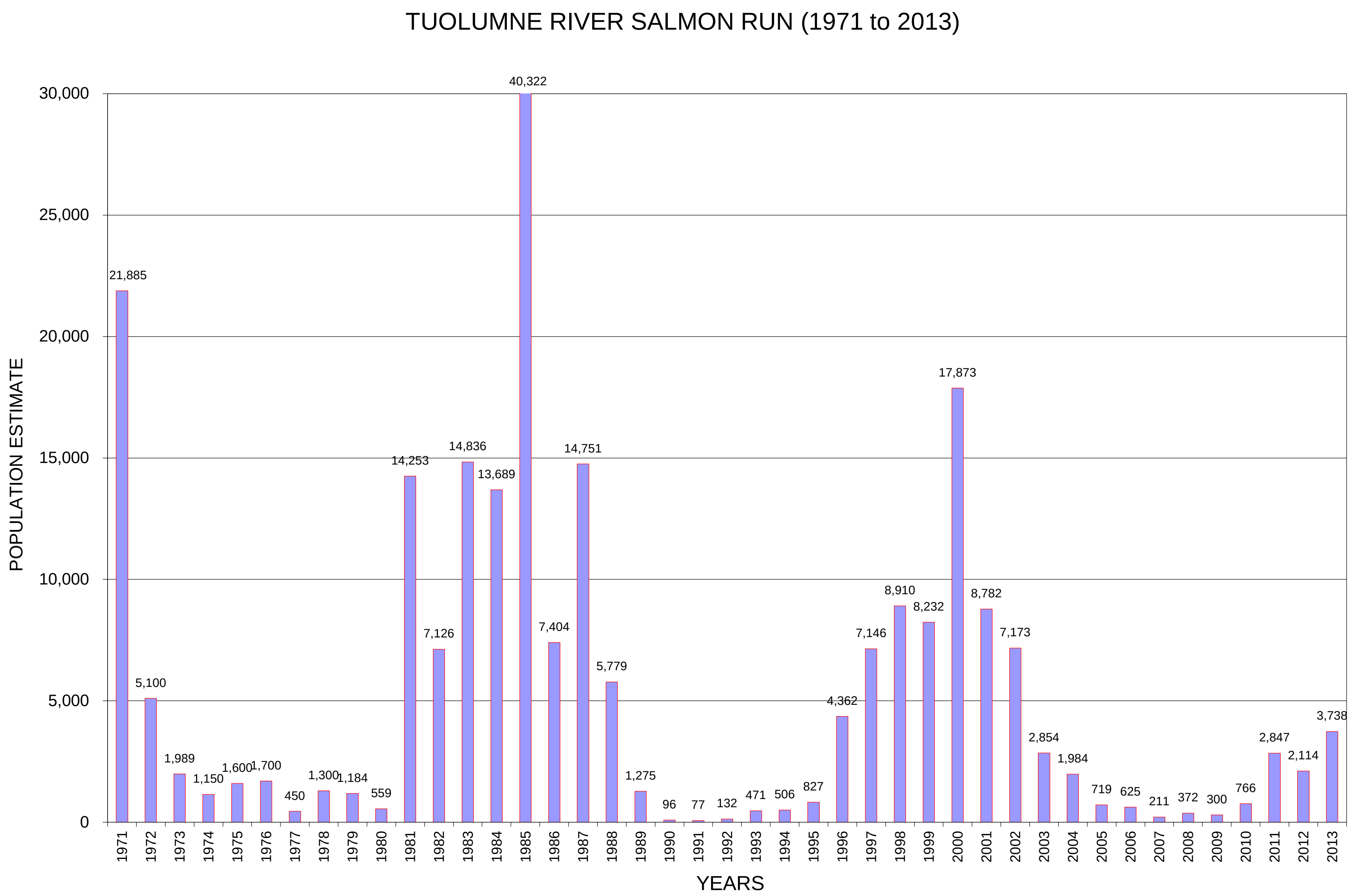


Figure 2. Tuolumne River Salmon Run Population Estimates, 1971-2013 (Years 2009-2013 based on weir counts).

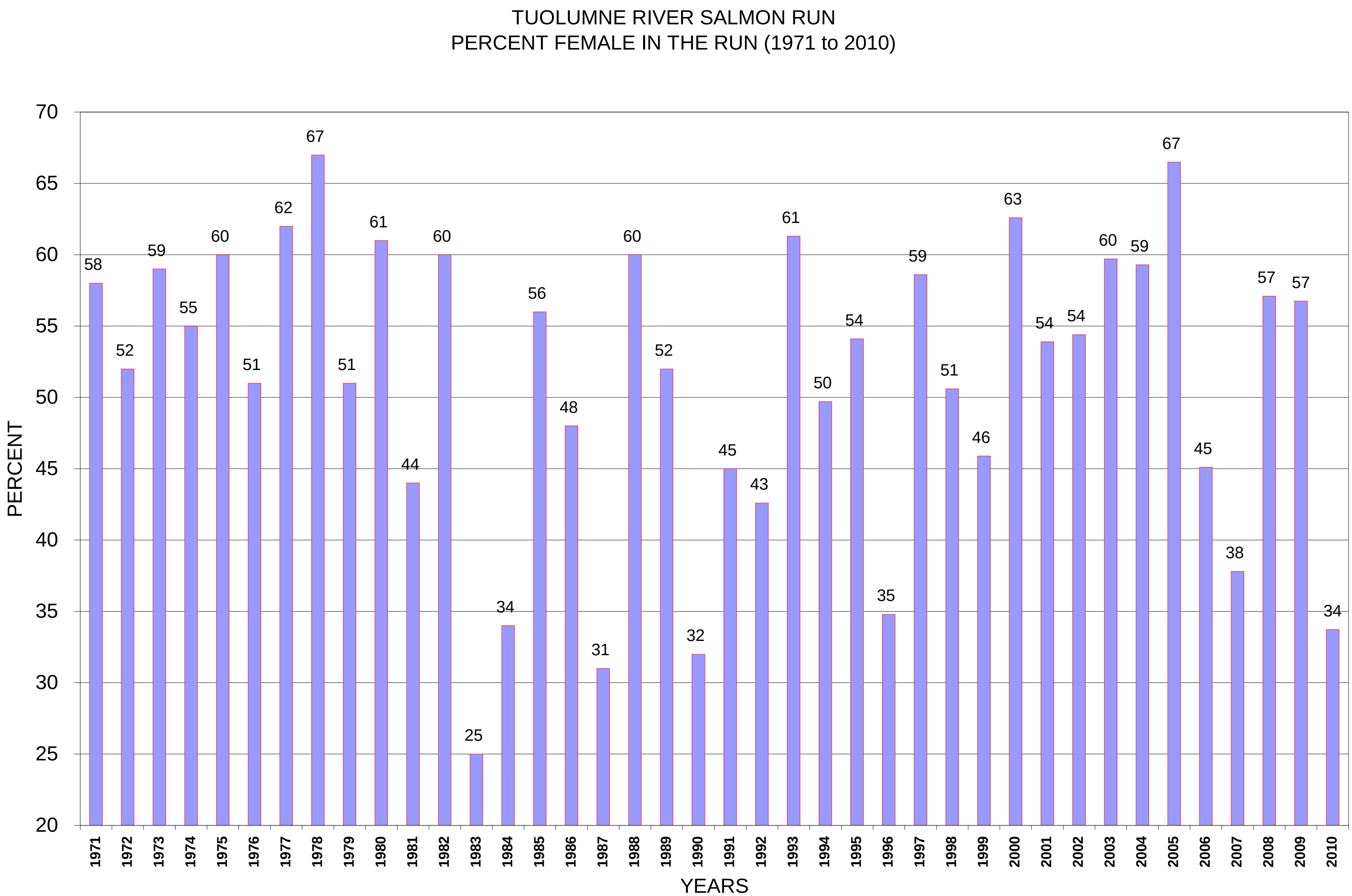


Figure 3. Percent Female salmon in the Tuolumne River runs, 1971-2010.

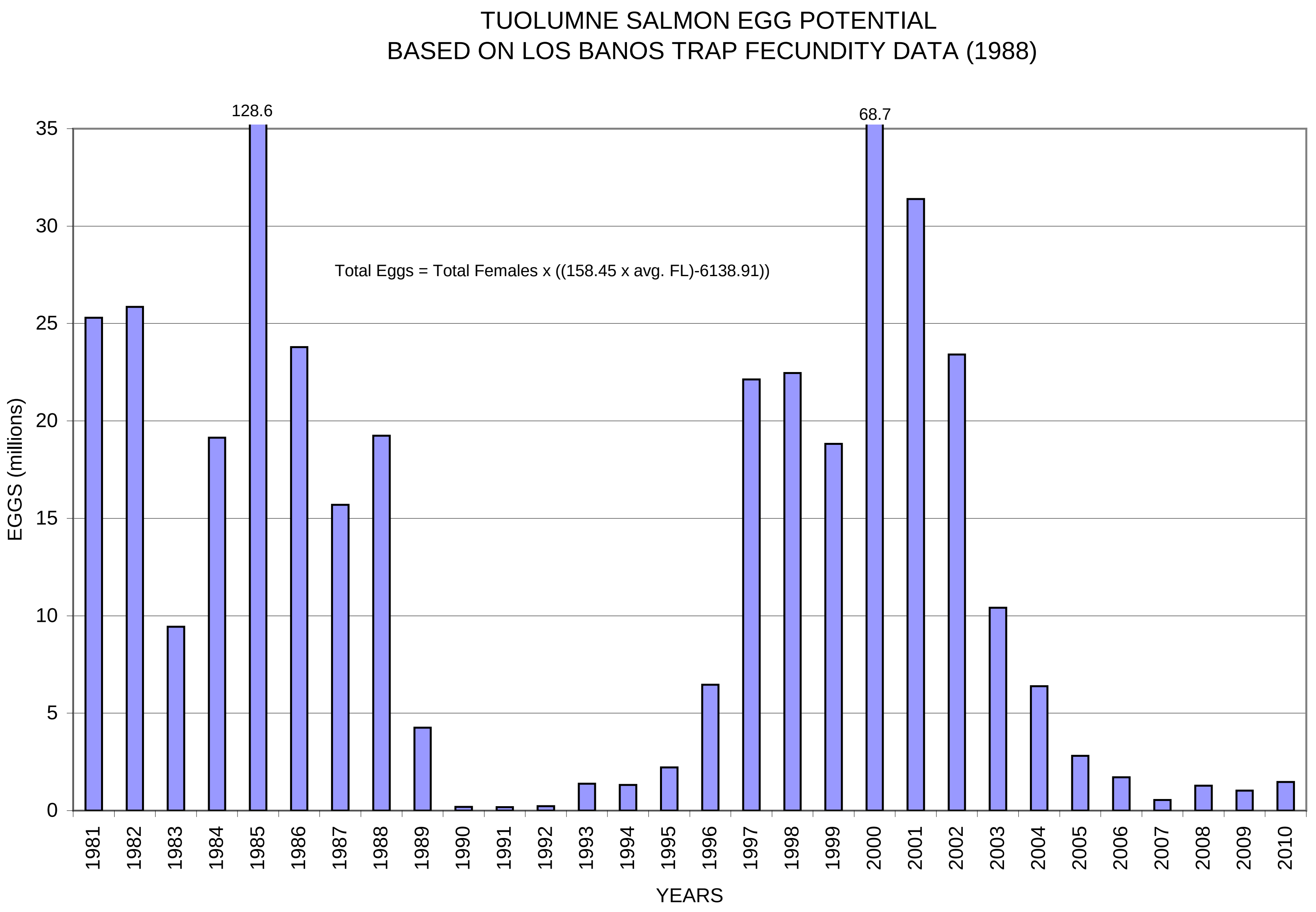


Figure 4. Potential egg deposition for Tuolumne River Chinook salmon, 1981-2010.

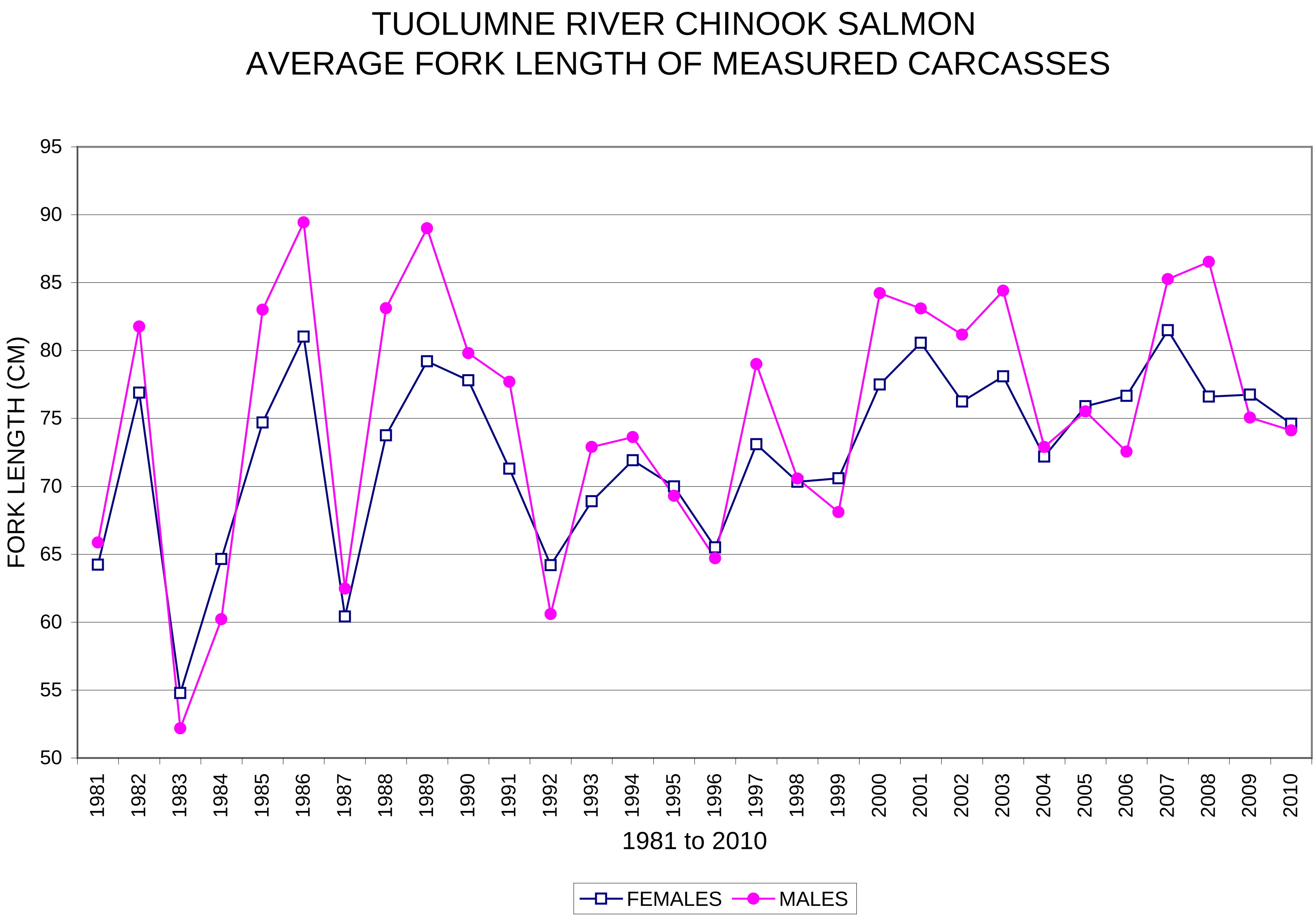
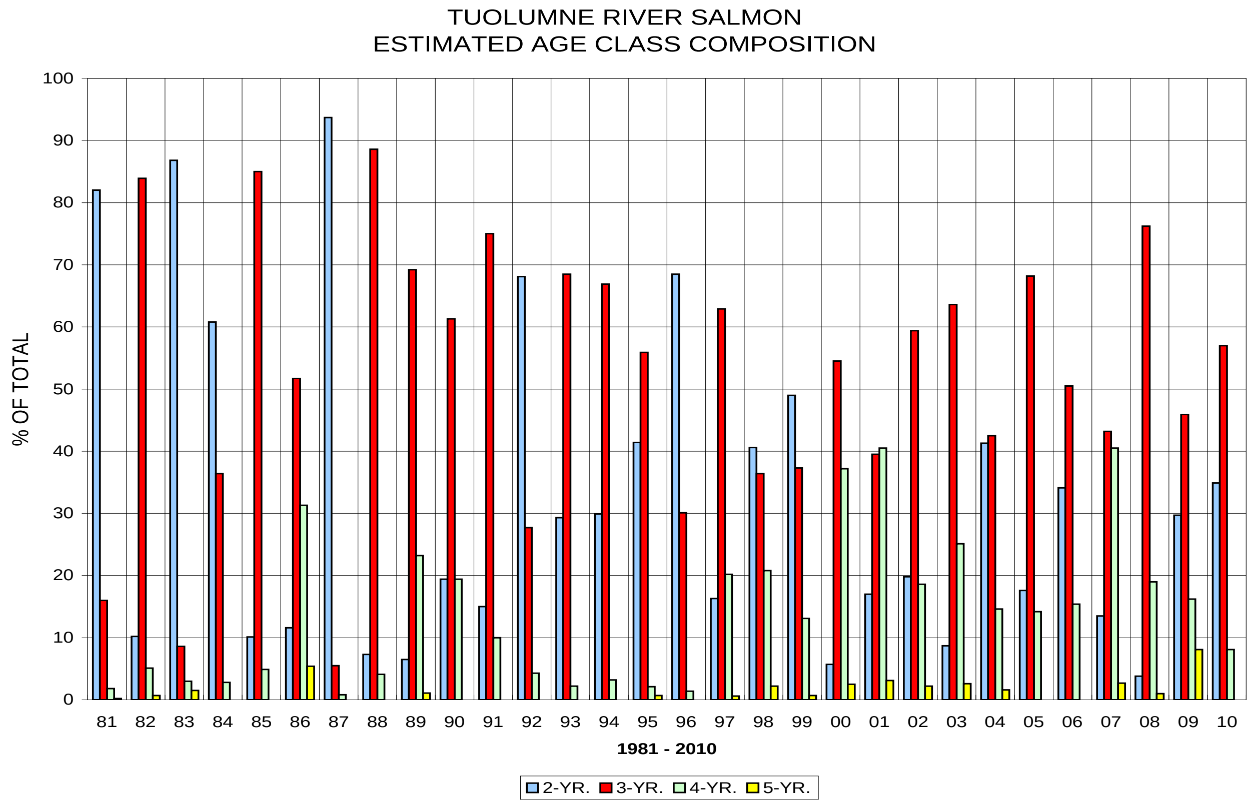


Figure 5. Average fork length of Tuolumne River salmon based on all measured carcasses, 1981-2010.



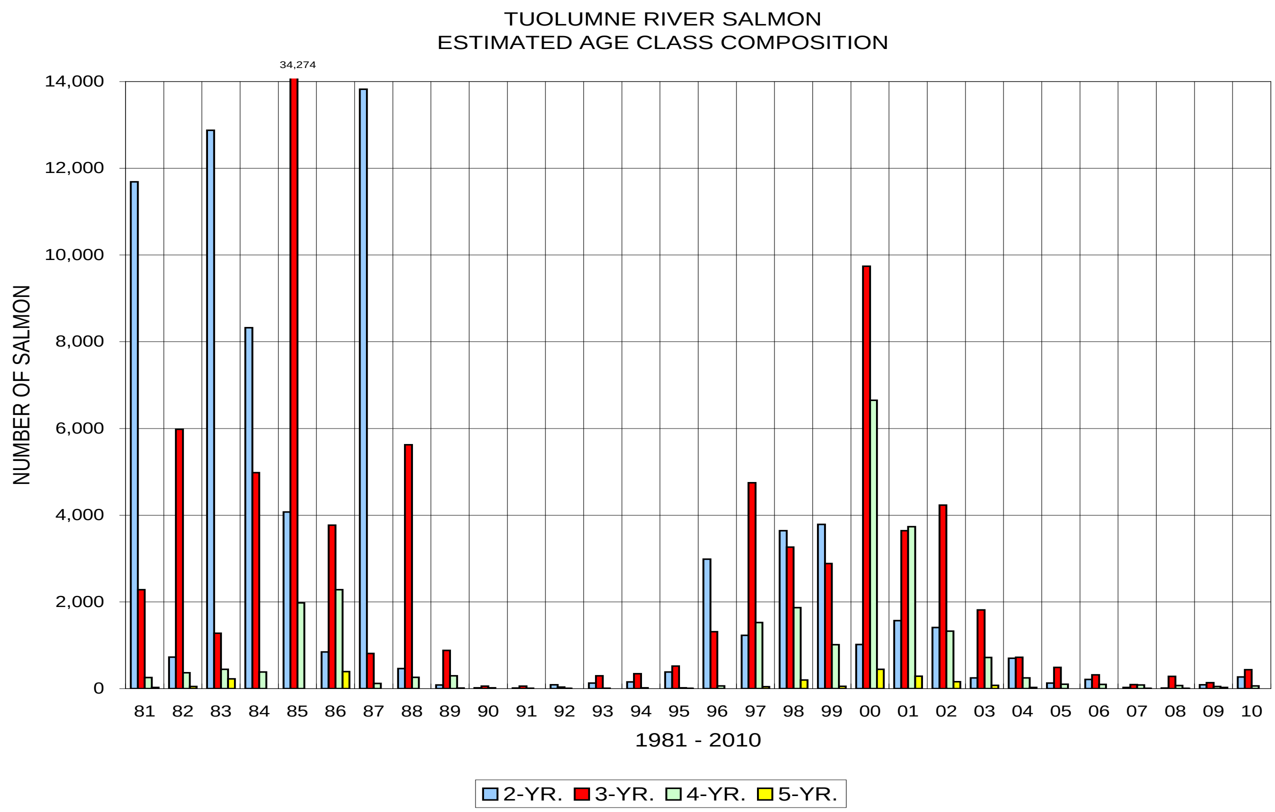
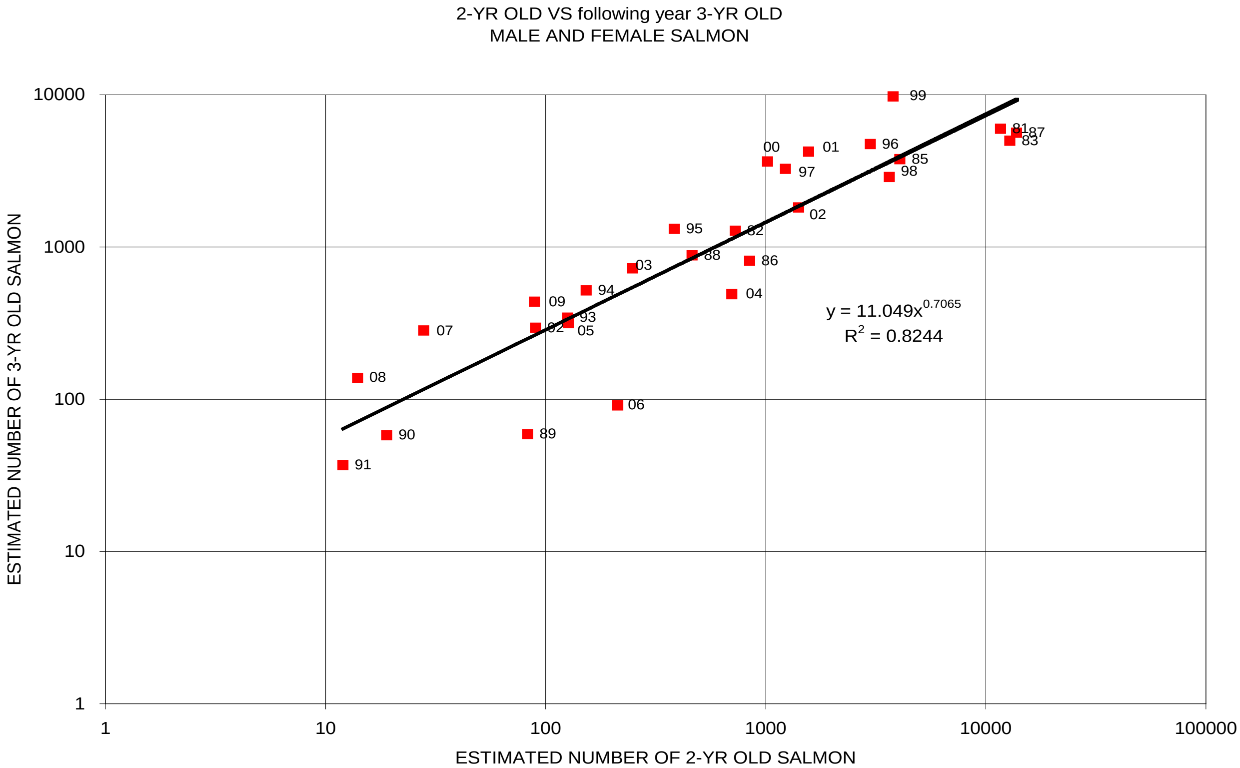


Figure 6. Estimated percent and number by age class for Tuolumne River salmon, 1981-2010.



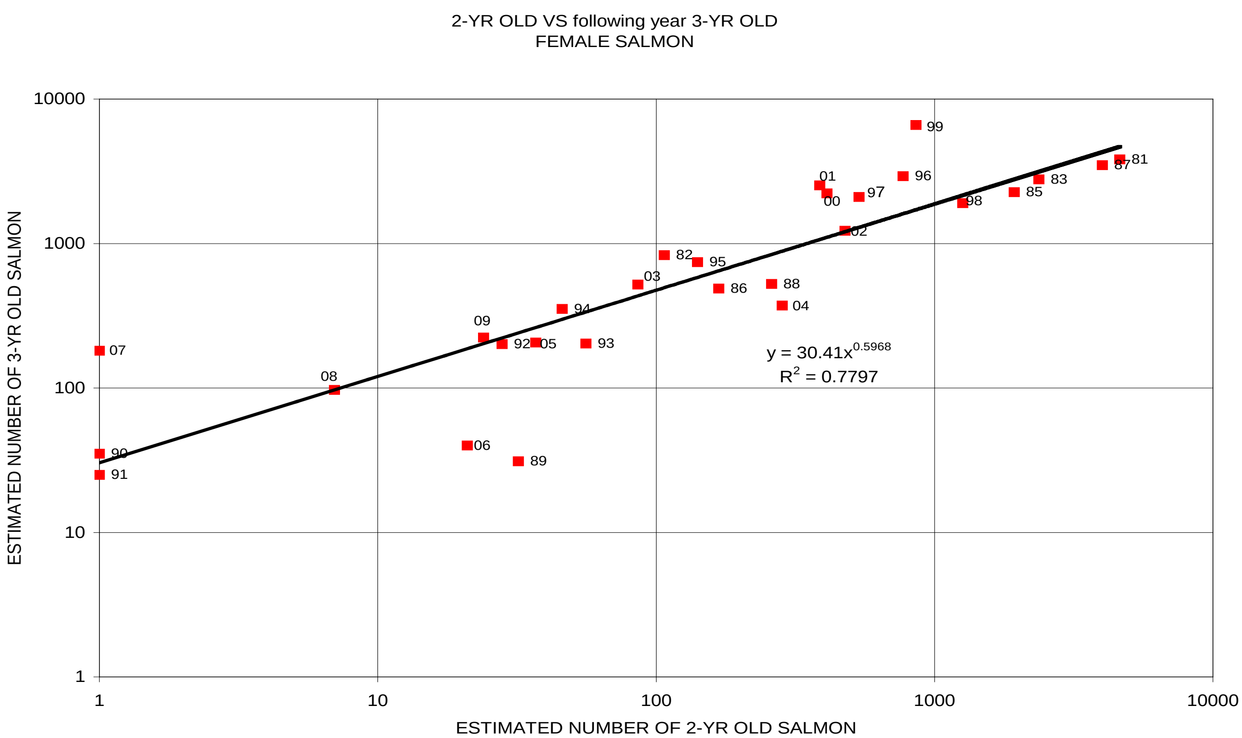


Figure 7. Estimated 2-yr-old salmon versus the following year 3-yr-old (1981-2009 Tuolumne River runs) excluding 1984 outlier, run years are for the 2-yr-olds.

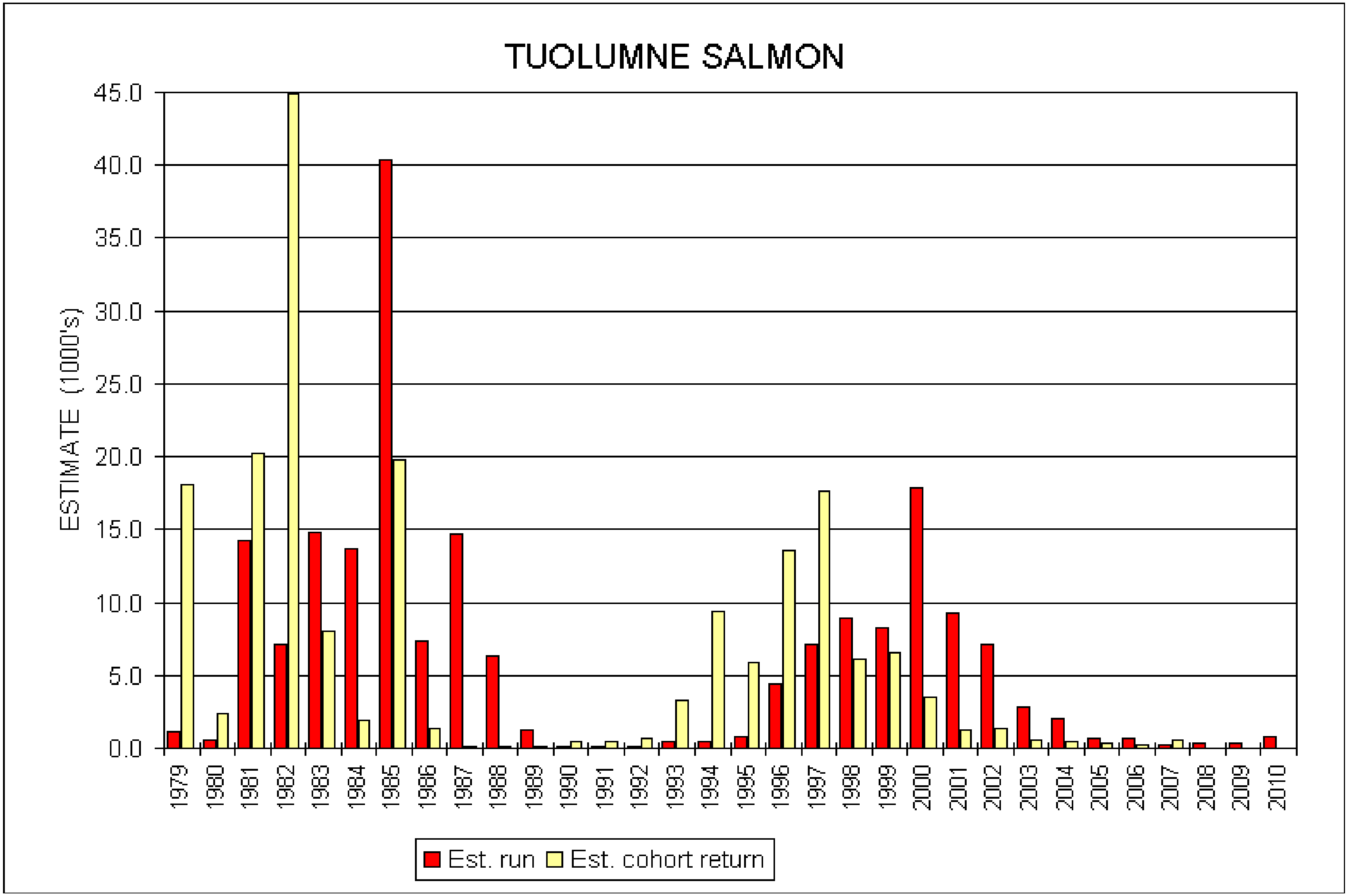


Figure 8. Estimated Tuolumne run numbers and spawner cohort returns, 1979-2010.

TABLE 1. TUOLUMNE RIVER SPAWNING SALMON SURVEY COUNTS AND ESTIMATES, 1971-2013.

							(WEEKLY)	(WEEKLY)	
			TAGGED CARCASSES				MAXIMUM	MAXIMUM	
	TOTAL	%	NUMBER	NUMBER	%		LIVE	REDD	ESTIMATED
YEAR	CARCASSES	FEMALE	TAGGED	RECOVERED[3]	RECOVERED		COUNT	COUNT[1]	RUN[2]
1971	2,283	58.0			10.4	e	2,128	1,598	21,885
1972	537	52.0			10.5	e	349	423	5,100
1973	351	59.0	270	35	13.0				1,989
1974	90	55.0	84	7	8.3				1,150
1975	130	60.0	125	8	6.4		154	212	1,600
1976	336	51.0	330	61	18.5		241	312	1,700
1977	45	62.0							450
1978	116	67.0	35	2	9.0	e	81	119	1,300
1979	305	51.0	75	22	29.3		153	204	1,184
1980	248	61.0	74	30	40.5		112	117	559
1981	5,819	44.0	664	334	50.3		1,646	1,650	14,253
1982	2,135	60.0	293	123	42.0		530	1,111	7,126
1983	1,280	25.0	270	25	9.3		263	465	14,836
1984	3,841	34.0	693	201	29.0		1,084	1,143	13,689
1985	11,651	56.0	895	273	30.5		2,986	3,034	40,322
1986	2,463	48.0	456	172	37.7		1,123	1,250	7,288
1987	5,280	31.0	1,069	461	43.1		2,155	850	14,751
1988	3,011	60.0	2,171	1,316	60.6		1,066	1,936	6,349
1989	625	52.0	491	318	64.8		291	461	1,274
1990	37	32.0	30	14	46.7		44	42	96
1991	30	45.0	12	7	58.3		24	51	77
1992	55	42.6	47	26	55.3		49	38	132
1993	187	61.3	169	96	56.8		94	215	431
1994	215	49.7	185	110	59.5		226	264	513
1995	461	54.1	415	175	42.2		270	174	928
1996	1,301	34.9	1,186	369	31.1		636	216	4,362
1997	1,520	58.6	1,056	253	24.0		1,258	716	7,548
1998	2,712	50.6	2,170	679	31.3		1,058	448	8,967
1999	3,980	45.9	2,375	1,398	58.9		1,403	404	7,730
2000	6,884	62.6	2,162	870	40.2		3,269	2,104	17,873
2001	5,400	53.9	1,170	717	61.3		1,865	1,251	9,222
2002	4,702	54.4	1,283	826	64.4		1,366	478	7,125
2003	1,489	59.7	585	328	56.1		463	349	2,961
2004	1,224	59.3	529	344	65.0		718	455	1,700
2005	312	66.5	176	58	33.0		129	124	719
2006	152	45.1	91	21	23.1		114	115	625
2007	87	37.8	37	15	40.5		92	107	211
2008	161	57.1	105	46	43.8		200	165	372
2009	40	56.8	23	18	78.3		69	62	300
2010	151	33.7	85	37	43.5		142	105	766
2011	n/a	n/a	n/a	n/a	n/a		170	95	2,847
2012	n/a	n/a	n/a	n/a	n/a		601	317	2,120
2013	n/a	n/a	n/a	n/a	n/a		841	541	3,738

(1) Redd counts were taken from TID/MID summary tables after 1980; redd counts for 1986 partially based on aerial photographs taken on 26 November 1986.

(2) Population estimate is based on weir counts beginning in 2009.

(3) Multiple recapture method implemented beginning in 2008.

e - estimated

Table 2. **SAN JOAQUIN BASIN CHINOOK SALMON SPAWNING STOCK ESTIMATES (in 1000's of fish)**

Year	Stan.	Tuol.	Merced	Merced	Merced	Trib.	SJR	Basin
			(river)	(hatchery)	(total)	Total	abv. MR	Total
1939							5.00	
1940	3.00	122.00	1.00		1.00	126.00		126.00
1941	1.00	27.00	1.00		1.00	29.00	9.00	38.00
1942		44.00				44.00		44.00
1943							35.00	
1944		130.00				130.00	5.00	135.00
1945							56.00	
1946		61.00				61.00	30.00	91.00
1947	13.00	50.00				63.00	6.00	69.00
1948	15.00	40.00				55.00	2.00	57.00
1949	8.00	30.00				38.00	8.00	46.00
1950							0.50	
1951	4.00	3.00				7.00		7.00
1952	10.00	10.00				20.00		20.00
1953	35.00	45.00	0.50		0.50	80.50		80.50
1954	22.00	40.00	4.00		4.00	66.00		66.00
1955	7.00	20.00				27.00		27.00
1956	5.00	6.00	0.00		0.00	11.00		11.00
1957	4.00	8.00	0.40		0.40	12.40		12.40
1958	6.00	32.00	0.50		0.50	38.50		38.50
1959	4.00	46.00	0.40		0.40	50.40		50.40
1960	8.00	45.00	0.40		0.40	53.40		53.40
1961	2.00	0.50	0.05		0.05	2.55		2.55
1962	0.30	0.20	0.06		0.06	0.56		0.56
1963	0.20	0.10	0.02		0.02	0.32		0.32
1964	4.00	2.10	0.04		0.04	6.14		6.14
1965	2.00	3.20	0.09		0.09	5.29		5.29
1966	3.00	5.10	0.04		0.04	8.14		8.14
1967	11.89	6.80	0.60		0.60	19.29		19.29
1968	6.39	8.60	0.60		0.60	15.59		15.59
1969	12.33	32.20	0.60		0.60	45.13		45.13
1970	9.30	18.40	4.70	0.10	4.80	32.50		32.50
1971	13.62	21.89	3.45	0.10	3.55	39.06		39.06
1972	4.30	5.10	2.53	0.12	2.65	12.05		12.05
1973	1.23	1.99	0.80	0.20	1.00	4.22		4.22
1974	0.75	1.15	1.00	0.40	1.40	3.30		3.30
1975	1.20	1.60	1.70	0.40	2.10	4.90		4.90
1976	0.60	1.70	1.20	0.30	1.50	3.80		3.80
1977	0.00	0.45	0.35	0.20	0.55	1.00		1.00
1978	0.05	1.30	0.53	0.10	0.63	1.98		1.98
1979	0.10	1.18	1.92	0.30	2.22	3.50		3.50
1980	0.10	0.56	2.85	0.16	3.01	3.67		3.67
1981	1.00	14.25	9.49	0.92	10.42	25.67		25.67
1982		7.13	3.07	0.19	3.26	10.39		10.39
1983	0.50	14.84	16.45	1.80	18.25	33.58		33.58
1984	11.44	13.69	27.64	2.11	29.75	54.88		54.88
1985	13.47	40.32	14.84	1.21	16.05	69.85		69.85
1986	6.50	7.40	6.79	0.65	7.44	21.34		21.34
1987	6.29	14.75	3.17	0.96	4.13	25.17		25.17
1988	10.21	6.35	4.14	0.46	4.59	21.15	2.30	23.45
1989	1.51	1.28	0.35	0.08	0.43	3.21	0.33	3.54
1990	0.48	0.10	0.04	0.05	0.08	0.66	0.28	0.94
1991	0.39	0.08	0.08	0.04	0.12	0.59	0.18	0.77
1992	0.26	0.13	0.62	0.37	0.99	1.37	0.00	1.37
1993	0.68	0.47	1.27	0.41	1.68	2.83		2.83
1994	1.03	0.51	2.65	0.94	3.59	5.13		5.13
1995	0.62	0.83	2.32	0.60	2.92	4.37		4.37
1996	0.17	4.36	3.29	1.14	4.43	8.96		8.96
1997	5.59	7.15	2.71	0.95	3.66	16.39		16.39
1998	3.09	8.91	3.29	0.80	4.09	16.09		16.09
1999	4.35	8.23	3.13	1.64	4.77	17.35		17.35
2000	11.00	17.87	11.00	1.95	12.95	41.82		41.82
2001	6.00	9.25	9.20	1.66	10.86	26.11		26.11
2002	6.90	7.17	8.87	1.80	10.67	24.74		24.74
2003	4.85	2.96	2.53	0.50	3.03	10.84		10.84
2004	4.41	1.98	3.27	1.05	4.32	10.71		10.71
2005	4.12	0.72	1.92	0.42	2.34	7.18		7.18
2006	3.07	0.63	1.47	0.15	1.62	5.31		5.31
2007	0.41	0.21	0.50	0.08	0.57	1.19		1.19
2008	0.92	0.37	0.40	0.08	0.47	1.77		1.77
2009	1.25	0.30	0.36	0.25	0.60	2.15		2.15
2010	1.38	0.77	0.65	0.15	0.80	2.94		2.94
2011	0.81	2.84	n/a	n/a	n/a	n/a	n/a	n/a
2012	7.04	2.12	n/a	n/a	n/a	n/a	n/a	n/a
2013	5.46	3.74	n/a	n/a	n/a	n/a	n/a	n/a

Tuolumne and Stanislaus estimates (2009-2013) were based on weir count data.

TABLE 3. Number and % of females in the Tuolumne River salmon runs, 1971-2010.

Year	Estimated Run	# of Females	% females	Ave. FL females (cm)	(Y) Eggs per female	Potential egg deposition (millions)
1971	21,885	12,693	58			
1972	5,100	2,652	52			
1973	1,989	1,174	59			
1974	1,150	633	55			
1975	1,600	960	60			
1976	1,700	867	51			
1977	450	279	62			
1978	1,300	871	67			
1979	1,184	604	51			
1980	559	341	61			
1981	14,253	6,271	44	64.2	4034	25.30
1982	7,126	4,276	60	76.9	6046	25.85
1983	14,836	3,709	25	54.8	2544	9.44
1984	13,689	4,654	34	64.7	4113	19.14
1985	40,322	22,580	56	74.7	5697	128.65
1986	7,404	3,554	48	81.0	6696	23.80
1987	14,751	4,573	31	60.4	3431	15.69
1988	5,779	3,467	60	73.8	5548	19.24
1989	1,275	663	52	79.2	6410	4.25
1990	96	31	32	77.8	6189	0.19
1991	77	35	45	71.3	5159	0.18
1992	132	56	43	64.2	4034	0.23
1993	471	289	61	68.8	4762	1.38
1994	506	251	50	71.9	5254	1.32
1995	827	447	54	70.0	4953	2.22
1996	4,362	1,518	35	65.6	4255	6.46
1997	7,146	4,188	59	72.1	5285	22.13
1998	8,910	4,508	51	70.2	4983	22.46
1999	8,232	3,778	46	70.2	4983	18.83
2000	17,873	11,188	63	77.5	6141	68.71
2001	8,782	4,733	54	80.6	6632	31.39
2002	7,173	3,902	54	76.6	5998	23.41
2003	2,854	1,704	60	77.3	6109	10.41
2004	1,984	1,177	59	73.0	5428	6.39
2005	719	478	67	75.9	5887	2.81
2006	625	282	45	76.9	6046	1.70
2007	211	80	38	81.5	6775	0.54
2008	372	212	57	76.6	5998	1.27
2009(1)	300	170	57	76.8	6024	1.03
2010(1)	766	258	34	74.6	5681	1.47

(1) Run estimate was from the weir count data

Y=158.45(ave. FL females)-6138.91 based on 1988 Los Banos trap data

Table 4. Tuolumne River salmon survey periods and peak live counts.

Year	Survey Period Start Date	Survey Period End Date	Peak Live Count Date	Peak Live Count Number	Tuolumne Estimate (x 1,000)	Peak Live / Pop.est. (%)
1940	26-Sep	02-Dec	04-Nov	5,447	122.0	4.5%
1941	21-Sep	18-Nov	13-Nov	2,807	27.0	10.4%
1942	13-Sep	30-Nov	01-Nov	3,386	44.0	7.7%
1944	30-Sep	30-Nov	06-Nov	10,039	130.0	7.7%
1946	11-Oct	20-Nov	04-Nov	6,002	61.0	9.8%
1957	05-Nov	03-Jan			8.0	
1958	06-Nov	09-Jan			32.0	
1959	03-Nov	01-Jan			46.0	
1960	12-Nov	13-Jan			45.0	
1961					0.5	
1962	08-Nov	04-Jan			0.2	
1963	10-Feb				0.1	
1964	04-Nov	18-Dec			2.1	
1965	19-Nov	12-Jan			3.2	
1966	08-Nov	18-Jan	09-Nov	271	5.1	5.3%
1967	18-Oct	13-Jan	21-Nov	184	6.8	2.7%
1968	11-Nov	15-Dec	22-Nov	1,490	8.6	17.3%
1969	20-Nov	12-Jan			32.2	
1970	19-Nov	20-Jan	20-Nov	1,517	18.4	8.2%
1971	15-Nov	27-Dec	16-Nov	2,128	21.9	9.7%
1972	13-Nov	23-Jan	27-Nov	349	5.1	6.8%
1973	05-Nov	17-Jan			2.0	
1974					1.2	
1975	06-Nov	31-Dec	06-Nov	154	1.6	9.6%
1976	03-Nov	29-Dec	15-Nov	241	1.7	14.2%
1977	29-Nov	20-Dec			0.5	
1978	26-Oct	19-Dec	24-Nov	81	1.3	6.2%
1979	05-Nov	17-Dec	02-Nov	153	1.2	12.8%
1980	12-Nov	18-Dec	12-Nov	112	0.6	18.7%
1981	04-Nov	16-Dec			14.3	
1982	08-Nov	29-Nov	15-Nov	545	7.1	7.7%
1983	07-Nov	01-Dec	15-Nov	263	14.8	1.8%
1984	01-Nov	30-Nov	01-Nov	1,084	13.7	7.9%
1985	29-Oct	20-Dec	12-Nov	2,986	40.3	7.4%
1986	27-Oct	05-Dec	03-Nov	1,123	7.3	15.4%
1987	28-Oct	16-Dec	17-Nov	2,155	14.8	14.6%
1988	25-Oct	29-Dec	14-Nov	1,066	6.3	16.8%
1989	24-Oct	29-Dec	09-Nov	291	1.3	22.8%
1990	23-Oct	26-Dec	19-Nov	44	0.1	45.8%
1991	22-Oct	02-Jan	25-Nov	24	0.1	31.2%
1992	05-Nov	21-Dec	19-Nov	49	0.1	37.1%
1993	14-Oct	18-Dec	06-Nov	94	0.4	21.8%
1994	03-Nov	05-Jan	21-Nov	226	0.5	44.1%
1995	27-Oct	30-Dec	03-Nov	270	0.9	29.1%
1996	22-Oct	04-Dec	31-Oct	636	4.4	14.6%
1997	14-Oct	23-Dec	12-Nov	1,258	7.5	16.7%
1998	07-Oct	22-Dec	02-Nov	1,058	9.0	11.8%
1999	04-Oct	28-Dec	01-Nov	1,403	7.7	18.2%
2000	02-Oct	05-Jan	06-Nov	3,269	17.9	18.3%
2001	04-Oct	05-Jan	05-Nov	1,865	9.2	20.2%
2002	01-Oct	02-Jan	04-Nov	1,366	7.1	19.2%
2003	30-Sep	30-Dec	18-Nov	463	3.0	15.6%
2004	04-Oct	06-Jan	08-Nov	718	1.9	37.8%
2005	03-Oct	22-Dec	14-Nov	129	0.7	17.9%
2006	05-Oct	28-Dec	13-Nov	114	0.6	18.2%
2007	02-Oct	28-Dec	19-Nov	92	0.2	43.6%
2008	06-Oct	08-Jan	04-Nov	200	0.4	53.8%
2009	5-Oct	13-Jan	23-Nov	69	0.3	23.0%
2010	4-Oct	30-Nov	1-Nov	142	0.8	18.5%
2011	3-Oct	9-Jan	21-Nov	170	2.8	6.0%
2012	1-Oct	31-Dec	5-Nov	601	2.1	28.3%
2013	30-Sep	6-Jan	4-Nov	841	3.7	22.5%
Years 2009-2013 estimate based on weir count						
For period 1971-2010:						
Minimum	30-Sep	29-Nov	31-Oct	---	---	---
Maximum	29-Nov	23-Jan	27-Nov	---	---	---
Median	26-Oct	29-Dec	12-Nov	---	---	---

TABLE 5. TUOLUMNE RIVER CHINOOK SALMON FORK LENGTHS (cm) OF CARCASSES MEASURED DURING SPAWNING SURVEYS, 1981-2010.

FEMALES	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NUMBER	289	153	92	286	524	251	349	222	193	11	9	20	56	78	79
MIN.	47	56	41	43	47	53	45	49	52	73	68	43	49.5	50	51
MAX.	86	97	85	77	90	99	93	90	99	89	74	88	87.5	88.5	87
AVG.	64.2	76.9	54.8	64.7	74.7	81.0	60.4	73.8	79.2	77.8	71.3	64.2	68.9	71.9	70.0
STD. DEV.	8.5	5.2	11.4	6.2	6.8	8.5	7.0	5.9	6.6	4.4	2.3	13.2	6.6	8.3	9.0
VARIANCE	72.5	27.0	130.9	38.0	46.7	72.0	48.6	35.4	43.8	19.4	5.1	173.6	44.0	69.2	81.4
MALES	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NUMBER	372	121	302	560	407	267	785	149	174	20	11	27	36	79	66
MIN.	37	29	34	30	54	35	39	50	46.5	44	52	46	47.5	52	49
MAX.	107	113	103	92	102	112	100	104	110.5	105	98	98	96	100.5	106
AVG.	65.9	81.8	52.2	60.2	83.0	89.4	62.5	83.1	89.0	79.8	77.7	60.6	72.9	73.6	69.3
STD. DEV.	10.0	14.5	11.7	10.5	9.6	16.1	7.3	9.6	12.2	17.2	15.5	12.3	12.6	12.6	13.6
VARIANCE	100.5	211.5	135.8	109.2	92.4	260.6	53.2	92.2	149.9	296.7	240.4	150.1	159.5	157.9	184.7

FEMALES	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NUMBER	150	232	378	382	594	844	658	278	245	117	42	14	60	21	29
MIN.	48	51	46	43	53	48	50	54	51	46	56	73	60	54	60
MAX.	89	95	93	93	105	105	104	98	98	93	92	91	86	90	83
AVG.	65.5	73.1	70.3	70.6	77.5	80.6	76.2	78.1	72.2	75.9	76.7	81.5	76.6	76.8	74.6
STD. DEV.	8.9	6.5	10.7	9.3	6.1	9.1	8.7	7.6	10.5	7.1	7.2	5.3	5.1	9.8	6.2
VARIANCE	79.3	41.8	113.6	86.6	37.0	83.7	76.5	57.5	110.3	50.2	51.4	28.0	26.0	95.8	38.5
MALES	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NUMBER	279	164	358	476	305	672	589	184	186	59	49	23	45	16	57
MIN.	41	45	46	43	46	47	31	30	43	46	56	59	59	52	30
MAX.	101	100	105	105	110	115	111	108	108	101	95	105	104	110	98
AVG.	64.7	79.0	70.6	68.1	84.2	83.1	81.2	84.4	72.9	75.5	72.6	85.3	86.5	75.1	74.1
STD. DEV.	11.3	11.7	15.1	12.4	10.5	15.6	14.5	13.7	14.2	14.3	10.8	14.1	9.2	18.5	13.6
VARIANCE	127.9	138.0	226.9	153.0	109.1	243.4	211.3	187.5	201.8	204.2	117.5	199.1	83.8	341.0	186.0

TABLE 6. ESTIMATED AGE CLASS COMPOSITION FROM LENGTH FREQUENCY DISTRIBUTIONS OF TUOLUMNE RIVER SALMON BASED ON FRESH MEASURED CARCASSES (1981-2010)

		2 YR. OLD			3 YR. OLD			4 YR. OLD			5 YR. OLD	
YEAR	SEX	MAX.	% OF TOT.	% OF SEX	MAX.	% OF TOT.	% OF SEX	MAX.	% OF TOT.	% OF SEX	% OF TOT.	% OF SEX
1981	FEMALE	68	32.5%	74.4%	85	10.4%	23.9%		0.8%	1.7%		
	MALE	75	49.5%	87.9%	95	5.6%	9.9%	105	1.1%	1.9%	0.2%	0.3%
	TOTAL		82.0%			16.0%			1.8%		0.2%	
1982	FEMALE	65	1.5%	2.6%	85	53.6%	96.1%		0.7%	1.3%		
	MALE	70	8.8%	19.8%	95	30.3%	68.6%	105	4.4%	9.9%	0.7%	1.7%
	TOTAL		10.2%			83.9%			5.1%		0.7%	
1983	FEMALE	60	16.0%	68.5%	74	5.6%	23.9%	83	1.3%	5.4%	0.5%	2.2%
	MALE	65	70.8%	92.4%	87	3.0%	4.0%	99	1.8%	2.3%	1.0%	1.3%
	TOTAL		86.8%			8.6%			3.0%		1.5%	
1984	FEMALE	62	11.3%	33.6%	74	20.3%	60.1%		2.1%	6.3%		
	MALE	65	49.4%	74.6%	87	16.1%	24.3%		0.7%	1.1%		
	TOTAL		60.8%			36.4%			2.8%		0.0%	
1985	FEMALE	65	4.8%	8.6%	85	49.4%	87.8%		2.0%	3.6%		
	MALE	70	5.3%	12.0%	95	35.6%	81.3%		2.9%	6.6%		
	TOTAL		10.1%			85.0%			4.9%		0.0%	
1986	FEMALE	67	2.3%	4.8%	85	31.1%	64.1%	93	12.0%	24.7%	3.1%	6.4%
	MALE	75	9.3%	18.0%	95	20.7%	40.1%	107	19.3%	37.5%	2.3%	4.5%
	TOTAL		11.6%			51.7%			31.3%		5.4%	
1987	FEMALE	68	27.2%	88.5%	85	3.3%	10.6%		0.3%	0.9%		
	MALE	75	66.5%	96.1%	95	2.2%	3.2%		0.5%	0.8%		
	TOTAL		93.7%			5.5%			0.8%		0.0%	
1988	FEMALE	65	4.1%	6.8%	85	54.9%	91.9%		0.8%	1.4%		
	MALE	70	3.2%	8.1%	95	33.8%	83.9%		3.2%	8.1%		
	TOTAL		7.3%			88.6%			4.1%		0.0%	
1989	FEMALE	67	2.5%	4.7%	85	41.1%	78.2%	94	8.7%	16.6%	0.3%	0.5%
	MALE	70	4.1%	8.6%	95	28.1%	59.2%	107	14.4%	30.5%	0.8%	1.7%
	TOTAL		6.5%			69.2%			23.2%		1.1%	
1990	FEMALE	65	0.0%	0.0%	85	32.3%	90.9%		3.2%	9.1%		
	MALE	70	19.4%	30.0%	94	29.0%	45.0%		16.1%	25.0%		
TOTAL			19.4%			61.3%			19.4%		0.0%	
(1) 1991	FEMALE	65	0.0%	0.0%	85	45.0%	100.0%		0.0%	0.0%		
	MALE	70	15.0%	27.3%	95	30.0%	54.5%		10.0%	18.2%		
TOTAL			15.0%			75.0%			10.0%		0.0%	
(1) 1992	FEMALE	65	21.3%	50.0%	85	19.1%	45.0%		2.1%	5.0%		
	MALE	70	46.8%	81.5%	95	8.5%	14.8%		2.1%	3.7%		
	TOTAL		68.1%			27.7%			4.3%		0.0%	
1993	FEMALE	65	13.0%	21.4%	85	46.7%	76.8%		1.1%	1.8%		
	MALE	70	16.3%	41.7%	95	21.7%	55.6%		1.1%	2.8%		
	TOTAL		29.3%			68.5%			2.2%		0.0%	
1994	FEMALE	65	8.9%	17.9%	85	39.5%	79.5%		1.3%	2.6%		
	MALE	70	21.0%	41.8%	95	27.4%	54.4%		1.9%	3.8%		
	TOTAL		29.9%			66.9%			3.2%		0.0%	
1995	FEMALE	65	15.2%	27.8%	85	37.9%	69.6%		1.4%	2.5%		
	MALE	70	26.2%	57.6%	95	17.9%	39.4%	105	0.7%	1.5%	0.7%	1.5%
	TOTAL		41.4%			55.9%			2.1%		0.7%	

TABLE 6. ESTIMATED AGE CLASS COMPOSITION FROM LENGTH FREQUENCY DISTRIBUTIONS OF TUOLUMNE RIVER SALMON BASED ON FRESH MEASURED CARCASSES (1981-2010)

			2 YR. OLD			3 YR. OLD			4 YR. OLD		5 YR. OLD	
YEAR	SEX	MAX.	% OF TOT.	% OF SEX	MAX.	% OF TOT.	% OF SEX	MAX.	% OF TOT.	% OF SEX	% OF TOT.	% OF SEX
1996	FEMALE	65	17.7%	50.7%	85	17.0%	48.7%		0.2%	0.7%		
	MALE	70	50.8%	78.1%	95	13.1%	20.1%	105	1.2%	1.8%		
	TOTAL		68.5%			30.1%			1.4%		0.0%	
(2)												
1997	FEMALE	65	7.1%	12.2%	77	38.7%	66.7%	90	11.7%	20.1%	0.6%	1.1%
	MALE	70	9.2%	21.9%	88	24.2%	57.7%	100	8.6%	20.4%		
	TOTAL		16.3%			62.9%			20.2%		0.6%	
(2)												
1998	FEMALE	63	14.1%	27.5%	78	23.4%	45.5%	92	13.7%	26.7%	0.1%	0.3%
	MALE	68	26.5%	54.5%	87	13.0%	26.8%	99	7.1%	14.5%	2.0%	4.2%
	TOTAL		40.6%			36.4%			20.8%		2.2%	
(2)												
1999	FEMALE	63	11.1%	24.9%	78	24.6%	55.2%	91	8.6%	19.4%	0.2%	0.5%
	MALE	70	37.9%	68.3%	87	12.7%	22.9%	99	4.4%	8.0%	0.5%	0.8%
	TOTAL		49.0%			37.3%			13.1%		0.7%	
(2)												
2000	FEMALE	65	2.3%	3.5%	79	37.0%	56.1%	90	25.6%	38.7%	1.1%	1.7%
	MALE	70	3.4%	10.2%	88	17.5%	51.5%	99	11.6%	34.1%	1.4%	4.3%
	TOTAL		5.7%			54.5%			37.2%		2.5%	
(2)												
2001	FEMALE	65	4.2%	7.5%	81	24.1%	43.2%	95	26.3%	47.3%	1.1%	2.0%
	MALE	70	12.8%	28.9%	90	15.4%	34.7%	105	14.2%	32.0%	2.0%	4.5%
	TOTAL		17.0%			39.5%			40.5%		3.1%	
(2)												
2002	FEMALE	65	6.7%	12.8%	82	35.4%	67.0%	94	9.9%	18.7%	0.8%	1.5%
	MALE	70	13.1%	27.7%	92	24.1%	50.9%	104	8.7%	18.5%	1.4%	2.9%
	TOTAL		19.8%			59.4%			18.6%		2.2%	
(2)												
2003	FEMALE	65	3.0%	5.0%	82	42.9%	71.2%	94	13.9%	23.0%	0.4%	0.7%
	MALE	70	5.6%	14.1%	90	20.8%	52.2%	103	11.3%	28.3%	2.2%	5.4%
	TOTAL		8.7%			63.6%			25.1%		2.6%	
(2)												
2004	FEMALE	65	16.7%	29.4%	82	30.6%	53.9%	94	8.8%	15.5%	0.7%	1.2%
	MALE	70	24.6%	57.0%	90	11.8%	27.4%	102	5.8%	13.4%	0.9%	2.2%
	TOTAL		41.3%			42.5%			14.6%		1.6%	
(1)												
2005	FEMALE	65	5.1%	7.7%	82	51.7%	77.8%	94	9.7%	14.5%		
	MALE	70	12.5%	37.3%	90	16.5%	49.2%	102	4.5%	13.6%		
	TOTAL		17.6%			68.2%			14.2%		0.0%	
(1)												
2006	FEMALE	65	3.3%	7.1%	82	33.0%	71.4%	94	9.9%	21.4%		
	MALE	70	30.8%	57.1%	90	17.6%	32.7%	102	5.5%	10.2%		
	TOTAL		34.1%			50.5%			15.4%		0.0%	
(1)												
2007	FEMALE	65	0.0%	0.0%	82	18.9%	50.0%	94	18.9%	50.0%		
	MALE	70	13.5%	21.7%	90	24.3%	39.1%	102	21.6%	34.8%	2.7%	4.3%
	TOTAL		13.5%			43.2%			40.5%		2.7%	
(1)												
2008	FEMALE	65	1.9%	3.3%	82	48.6%	85.0%	94	6.7%	11.7%		
	MALE	70	1.9%	4.4%	90	27.6%	64.4%	102	12.4%	28.9%	1.0%	2.2%
	TOTAL		3.8%			76.2%			19.0%		1.0%	
(1)												
2009	FEMALE	65	8.1%	14.3%	82	32.4%	57.1%	94	16.2%	28.6%		
	MALE	70	21.6%	50.0%	90	13.5%	31.3%	102	0.0%	0.0%	8.1%	18.8%
	TOTAL		29.7%			45.9%			16.2%		8.1%	
(1)												
2010	FEMALE	65	3.5%	10.3%	82	29.1%	86.2%	94	1.2%	3.4%		
	MALE	70	31.4%	47.4%	90	27.9%	42.1%	102	7.0%	10.5%		
	TOTAL		34.9%			57.0%			8.1%		0.0%	

(1) BASED ON ALL MEASURED CARCASSES
(2) EXCLUDES ADIPOSE FIN CLIPPED CARCASSES

TABLE 7. ESTIMATED TUOLUMNE SALMON RUN NUMBERS AND AGE COMPOSITION WITH ESTIMATED COHORT RETURNS AND COHORT AGE COMPOSITION

	Estimated	Age-class composition for salmon run								Cohort	Cohort Composition			
	Run	2-yr	3-yr	4-yr	5-yr	2-yr	3-yr	4-yr	5-yr	Total	2-yr	3-yr	4-yr	5-yr
Year	(x 1000)	(x 1000)	(x 1000)	(x 1000)	(x 1000)	(%)	(%)	(%)	(%)	(x 1000)	(%)	(%)	(%)	(%)
1978	1.30													
1979	1.18									18.11	64.5%	33.0%	2.5%	0.0%
1980	0.56									2.39	30.5%	53.5%	16.1%	0.0%
1981	14.25	11.69	2.28	0.26	0.03	82.0	16.0	1.8	0.2	20.24	63.6%	24.6%	9.8%	2.0%
1982	7.13	0.73	5.98	0.36	0.05	10.2	83.9	5.1	0.7	44.91	18.5%	76.3%	5.2%	0.0%
1983	14.84	12.88	1.28	0.45	0.22	86.8	8.6	3.0	1.5	8.02	50.8%	47.7%	1.5%	0.0%
1984	13.69	8.32	4.98	0.38	0.00	60.8	36.4	2.8	0.0	1.94	44.2%	41.7%	13.4%	0.7%
1985	40.32	4.07	34.27	1.98	0.00	10.1	85.0	4.9	0.0	19.74	70.0%	28.5%	1.5%	0.0%
1986	7.40	0.86	3.83	2.32	0.40	11.6	51.7	31.3	5.4	1.36	34.0%	64.7%	1.4%	0.0%
1987	14.75	13.82	0.81	0.12	0.00	93.7	5.5	0.8	0.0	0.15	55.5%	39.4%	5.2%	0.0%
1988	6.35	0.46	5.63	0.26	0.00	7.3	88.6	4.1	0.0	0.08	22.7%	70.4%	6.9%	0.0%
1989	1.28	0.08	0.88	0.30	0.01	6.5	69.2	23.2	1.1	0.06	19.8%	62.5%	17.7%	0.0%
1990	0.10	0.02	0.06	0.02	0.00	19.4	61.3	19.4	0.0	0.43	20.7%	74.3%	3.7%	1.3%
1991	0.08	0.01	0.06	0.01	0.00	15.0	75.0	10.0	0.0	0.49	27.9%	68.5%	3.5%	0.0%
1992	0.13	0.09	0.04	0.01	0.00	68.1	27.7	4.3	0.0	0.72	21.1%	64.4%	8.5%	6.0%
1993	0.47	0.14	0.32	0.01	0.00	29.3	68.5	2.2	0.0	3.29	10.4%	39.8%	43.8%	5.9%
1994	0.51	0.15	0.34	0.02	0.00	29.9	66.9	3.2	0.0	9.39	31.8%	47.8%	19.7%	0.6%
1995	0.83	0.34	0.46	0.02	0.01	41.4	55.9	2.1	0.7	5.93	19.6%	54.7%	18.2%	7.5%
1996	4.36	2.99	1.31	0.06	0.00	68.5	30.1	1.4	0.0	13.62	26.6%	22.5%	48.8%	2.1%
1997	7.15	1.16	4.49	1.44	0.04	16.3	62.9	20.2	0.6	17.68	22.8%	55.1%	21.2%	0.9%
1998	8.91	3.62	3.24	1.85	0.20	40.6	36.4	20.8	2.2	6.08	16.8%	60.1%	21.9%	1.2%
1999	8.23	4.03	3.07	1.08	0.06	49.0	37.3	13.1	0.7	6.58	23.9%	64.7%	10.9%	0.5%
2000	17.87	1.02	9.74	6.65	0.45	5.7	54.5	37.2	2.5	3.53	40.3%	51.5%	8.2%	0.0%
2001	9.25	1.57	3.65	3.75	0.29	17.0	39.5	40.5	3.1	1.19	20.8%	70.6%	8.6%	0.0%
2002	7.17	1.42	4.26	1.33	0.16	19.8	59.4	18.6	2.2	1.41	58.0%	34.7%	6.8%	0.4%
2003	2.85	0.25	1.82	0.72	0.07	8.7	63.6	25.1	2.6	0.53	23.9%	59.3%	16.1%	0.7%
2004	1.98	0.82	0.84	0.29	0.03	41.3	42.5	14.6	1.6	0.40	53.4%	22.8%	17.7%	6.1%
2005	0.72	0.13	0.49	0.10	0.00	17.7	68.2	14.2	0.0	0.36	7.9%	78.6%	13.5%	
2006	0.63	0.21	0.32	0.10	0.00	34.1	50.5	15.4	0.0	0.21	6.6%	64.4%	29.0%	
2007	0.21	0.03	0.09	0.09	0.01	13.5	43.2	40.5	2.7	0.53	16.9%	83.1%		
2008	0.37	0.01	0.28	0.07	0.00	3.8	76.2	19.0	1.0					
2009	0.30	0.09	0.14	0.05	0.02	29.7	45.9	16.2	8.1					
2010	0.77	0.27	0.44	0.06	0.00	34.9	57.0	8.1	0.0					

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-3

2013 Seine Report and Summary Update

Prepared by

Chrissy Sonke
Shaara Ainsley

FISHBIO
Oakdale, CA

2013 Seine Report and Summary Update

Tuolumne River

Submitted To:
Turlock Irrigation District
Modesto Irrigation District

Prepared By:
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March 2013

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1. INTRODUCTION

1.1 STUDY AREA

The Tuolumne River is the largest of three major tributaries (Tuolumne, Merced, and Stanislaus Rivers) to the San Joaquin River. The Tuolumne River originates in Yosemite National Park, in the central Sierra Nevada Mountains, and flows 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 the 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 to anadromous fish migration since at least 1871.

1.2 PURPOSE AND HISTORY OF STUDY

FISHBIO conducted seine surveys in the Tuolumne and San Joaquin Rivers in 2013 for the Turlock and Modesto Irrigation Districts (TID/MID). Sampling was conducted in both rivers pursuant to the Don Pedro Project river-wide monitoring program. This was the 28th annual TID/MID seining study. The primary objective was to document juvenile salmonid size, abundance, and distribution in the Tuolumne and San Joaquin rivers. The juvenile salmon captured in this study were the progeny of the 2012 fall-run Chinook salmon spawning population. Based on counts from the Tuolumne River weir, fall-run Chinook salmon escapement was estimated to be 2,180 fish (September through December 2012; Wright et al. 2013). A review of data collected since 1986 can be found in Section 4 of this report.

2. METHODS

2.1 SITE DESCRIPTIONS

The study area encompassed the lower Tuolumne River corridor, from La Grange Dam (RM 52.2) to its confluence (RM 0) with the San Joaquin River (at RM 83.8), and the San Joaquin River from Laird Park (RM 90.2) to Gardner Cove (RM 79.4; Figure 1). Ten sites were sampled during each sampling event; eight were located on the Tuolumne River and two on the San Joaquin River. Alternate sites, located a short distance either upstream or downstream of the original site, were used when access to original study sites was restricted due to high flow.

For the purpose of this study, the Tuolumne River was stratified into three sections. The upper section (RM 52 to 34) is a high gradient reach that includes the majority of salmonid spawning habitat in the river. Three sites were sampled in this section – Old La Grange Bridge (RM 50.5), Riffle 5 (RM 48.0), and Tuolumne River Resort (RM 42.4). The middle section (RM 34 to 17) is a transitional area of the river where the predominant substrate changes from gravel to sand. This section contains many of the in-channel areas that were historically mined for sand and/or gravel. Three sites were sampled in this section – Hickman Bridge (RM 31.6), Charles Road (RM 24.9), and Legion Park (RM 17.2). The lower section (RM 17 to 0) is a low gradient reach, located downstream of the Dry Creek confluence, with a predominately sandy substrate. Two sites were sampled in this section – Service Road (RM 7.4) and Shiloh Bridge (RM 3.4).

The San Joaquin River section (RM 79.4 to 90.2) is a low gradient reach with a substrate composed primarily of sand, that extends both upstream and downstream of the Tuolumne River confluence. Two sites were sampled in this reach – Laird Park (RM 90.2) and Gardner Cove (RM 79.4).

2.2 JUVENILE SALMON SAMPLING

The 2013 seining survey occurred between 15 January and 4 June. Sampling was conducted at two-week intervals resulting in a total of 11 sampling events. The same general areas at each site were surveyed during each sampling event to facilitate comparison between events.

2.2.1 Sampling

At each site, three downstream seine hauls were conducted parallel to the shoreline. Sampling was conducted using a 1/8-inch mesh nylon seine net measuring 4-ft high by 20-ft long. All fish captured in the seine were identified to species and enumerated. In addition, random samples of fish were collected to assess size and growth rate. At each site, up to 50 Chinook salmon and 20 individuals of each non-salmonid species were anesthetized with MS-222, measured (FL, in mm), weighed (in grams), and then allowed to recover in aerated containers prior to release. The smolting appearance of all measured Chinook salmon and *O. mykiss* was rated based on a seven category scale, where 1 = yolk-sac fry, 2 = fry, 3 = parr, 4 = silvery parr, 5 = smolt, 6 = mature adult, and IAD = immature adult (Interagency Ecological Program, unpublished). Any salmon undergoing outward signs of smoltification, such as losing scales during handling, were also noted.

2.2.2 Environmental Conditions Data Collection

The area sampled at each site during each event was determined by estimating the average length and width of each seine haul. In addition, maximum depth was determined with a stadia rod to the nearest 0.5-ft at each area sampled. Instantaneous water temperature (°C) was measured with a mercury thermometer. Conductivity (µS) and dissolved oxygen (mg/L) were measured using an ExStik® II EC500 Electrical Conductivity Meter and an ExStick II DO600 Dissolved Oxygen Meter (Extech Instruments Corporation, Waltham, MA), respectively. Instantaneous turbidity (NTU) was measured by collecting a water sample and later testing it at the field station using a

LaMotte turbidity meter (Model 2020e, LaMotte Company, Chestertown, MD). Time of day, weather conditions, and substrate type were also recorded at each site.

Flow data from the gauges closest to the sampling sites was obtained from the United States Geological Survey (USGS) and the California Data Exchange Center (CDEC), as downloaded from http://waterdata.usgs.gov and http://cdec.water.ca.gov, respectively. Flows upstream of Vernalis, at Patterson Bridge (RM 98.5) and Maze Road (RM 77.3), represent flow levels at the sampling locations of Laird Park (upstream of the Tuolumne confluence) and Gardner Cove (downstream of the Tuolumne confluence), respectively.

2.3 DATA ANALYSIS

Seine catch data was examined at three different spatial scales: river-wide; river section (upper, middle, lower); and site. Salmon catch data was divided into two size groups for analysis: "fry" were defined as fish with a fork length ≤ 50 mm; and "juveniles" were defined as fish with a fork length > 50 mm. For each of the three spatial scales, density indices were determined for fry and juveniles by dividing the total yearly catch by the area sampled during all 11 sampling events. These estimates of density are useful for comparisons of relative abundance. River-wide and section abundance indices were calculated for each river by multiplying the area in each river or section by the estimated density per ft^2 in the given area. Chinook salmon growth rates were indirectly estimated by dividing the amount of increase in maximum FL between the first and last sampling events, by the number of days during the entire sampling period.

A stochastic Ricker model was used to evaluate the relationship between abundance of parental stock S (defined as the estimated number of female Chinook salmon in year t; detail is found below), and production P (alternatively defined as peak or average index density of fry per 1000 ft^2) in year t+1. The Ricker model has been applied extensively to investigate stock-recruitment relationships for anadromous species (Quinn and Deriso, 1999) and is fit through the origin (no spawners = no recruits), with the resulting form

$$P = \propto Se^{-\beta S + \varepsilon}$$

where α is a productivity parameter, which is proportional to the fecundity of S, β is a density dependence parameter, and ε is a normally distributed error term. The Ricker model parameters α and β were estimated using non-linear least squares regression. S_{max} , defined as the population/abundance of parental stock expected to generate maximum fry density estimates, was calculated using a linearized form of the Ricker stock-recruitment equation (PFMC 2005) expressed as

$$ln(R/S) = \alpha + \beta S + \varepsilon$$

and,

$$\hat{S}_{max} = 1/-\widehat{\beta}.$$

For a comparative review, results from 2013 were compared to findings from Tuolumne and San Joaquin River seine surveys conducted in other years. Historical estimates of female Chinook salmon abundance were obtained from CDFG/DFW annual spawning and carcass surveys (years 1985 to 2008; TID/MID 2008) and from the Tuolumne Weir (years 2009 to 2012; FISHBIO 2010-2013). Chinook salmon density data (fry per 1000 ft^2) was obtained from TID/MID and FISHBIO seine surveys conducted from years 1986 to 2013. Due to the likelihood of fry outside of this timeframe not being progeny of fall-run Chinook salmon, only fry captured between 15 January and 15 March were used in the analysis (Modified Fisher Race Table).

3. RESULTS AND DISCUSSION

3.1 SEINE CATCH

During the 2013 survey, a total of 1,763 salmon were caught in the Tuolumne River. No salmon were caught in the San Joaquin River (Table 1 and 2). As a result, all subsequent discussion of 2013 catch data is in reference to the Tuolumne River.

3.1.1 Density of Fry and Juvenile Salmon

As salmon emerge from the gravel in the upper reaches of the Tuolumne River, they disperse downstream over time. Areas where fry emerge and begin rearing are often not conducive to sampling by seine net. As a result, peak densities of fry catch are influenced by a multitude of factors including, but not limited to, time since emergence, location of emergence, migration rates, and probability of capture.

Peak salmon fry catch density occurred between 15 January and 26 February (Figure 2). Fry densities were low in the uppermost sites (potentially due to low probability of capture) and highest in the middle reaches (Tuolumne River Resort and Hickman Bridge; Figure 2). No fry were captured in the lower section of the Tuolumne River. Juvenile salmon densities at the upper sites did not show a spatiotemporal pattern; however, juvenile densities at Hickman Bridge showed a gradual increase over time (corresponding with a decrease in fry catch at the same site) until a peak on 7 May (Figure 2; Table 3).

Examining the data by river section shows that fry density in the Tuolumne River peaked in the upper section on 29 January (53.9 fry/1,000 ft^2), and in the middle section on 12 February (39.3 fry/1,000 ft^2; Figure 3). The density of juveniles peaked in the upper and middle sections on 7 May (1.3 juveniles/1,000 ft^2 and 9.9 juveniles/1,000 ft^2, respectively). No juvenile salmon were captured in the lower section of the Tuolumne River during the sampling period (Figure 3).

Overall, Tuolumne river-wide maximum observed density (fry and juveniles combined) was 31.1 /1,000 ft^2 on 29 January. The highest density of fry was 27.6 /1,000 ft^2, observed on 29 January. The highest observed density of juveniles was 3.9 /1,000 ft^2, observed on 7 May (Table 3).

3.1.2 Size, Growth, and Smoltification

Observed size of Chinook salmon ranged from 28 mm to 107 mm (FL). The average FL of both size classes increased throughout the survey period (Figure 4; Figure 7). During the first survey (15 January) the maximum FL observed was 48 mm. The largest Chinook of the season was captured on 7 May and measured 107 mm FL. The difference in maximum FL between 15 January and 7 May (Figure 7), indicates a potential FL increase of approximately 0.53 mm/day (i.e., 59 mm/112 days; Table 3).

Length frequency distributions for each sampling event are displayed in Figure 5 and Figure 6. Size of Chinook salmon increased from late January to late May at most of the sampling locations. Fry were observed as late as 9 April. Salmon estimated to be large enough to undergo smoltification (> 70 mm FL) were first observed on 26 March. Two individuals captured on 29 January at Charles Road were larger than expected for fish captured during that time of year (87 mm FL and 92 mm FL), and it is likely that these fish were the progeny of spawning activity outside of the typical spawning period for fall-run Chinook salmon.

3.1.3 Tuolumne River Spawner to Fry Relationships

3.1.3.1 Peak Density of Chinook Fry

The parameter estimates of α and β from the non-linear least squares relationship were 6.16×10^{-5} and -3.6300, respectively. The stock-production (S-P) data and the estimate Ricker curve are shown in Figure 24. The spawner abundance expected to generate the maximum fry production (peak density) was 11,751.

3.1.3.2 Average Density of Chinook Fry

The parameter estimates of α and β from the non-linear least squares relationship were 7.2×10^{-5} and -4.244, respectively. The S-P data and the best-fit line are shown in Figure 25. The spawner abundance expected to generate the maximum fry production (average density) was 10,092.

3.1.3.3 Maximum Spawning Abundance

Due to the uncertainty (unknown magnitude of error) associated with past abundance estimates of female Chinook, *S*, a few caveats of these analyses should be considered. Prior to 2009, estimates of Chinook salmon spawner abundance in the Tuolumne River may have been flawed due to either the use of inappropriate models, or the failure to meet certain assumptions of those models. The reliability of the data has improved over the past few years due to improved estimation methods including direct counts of migrating adults using a VAKI video-monitoring system, and improved carcass mark-recapture methods. In addition, this analysis assumes that the abundance indices (peak or average) of Chinook salmon fry density are consistently proportional to (and therefore representative of) the true number of Chinook salmon fry.

Both relationships appear to be well represented with the stochastic Ricker model equation (Figure 24 and 25). The estimates of $S_{\max}$, the spawner abundance expected to generate the maximum production, were similar; 10,092 adult female Chinook (based on the index of average fry density) versus 11,751 adult female Chinook (based on the index of peak fry density). Within the past decade, escapement to the Tuolumne River declined to a low of 80 female spawners in 2007, but in recent years has begun to rebound, with 806 female spawners in 2013. Estimates of female spawner abundance exceeded 10,000 individuals in only two years (1985 and 2000) during the 1985-2012 Chinook escapement period (Table 9).

3.1.4 Species Richness

Sixteen fish species, in addition to Chinook salmon, were captured in this survey. Six of these species were common to both the Tuolumne and San Joaquin rivers. The Tuolumne River showed higher species diversity with 14 species caught overall, excluding Chinook, while eight non-focal species were captured in the San Joaquin River (Table 5). Of the native species observed, only Sacramento sucker were caught in both rivers, while *O. mykiss*, Sacramento pikeminnow, hardhead, and prickly sculpin were captured in the Tuolumne River. A total of ten *O. mykiss* (26 mm to 75 mm FL) were caught in the upper section of the Tuolumne River between 7 May and 4 June (Table 7). No *O. mykiss* were captured in the middle or lower sections of the Tuolumne River or in the San Joaquin River.

3.2 ENVIRONMENTAL CONDITIONS

Discharge in the Tuolumne River, downstream of La Grange Dam, was approximately 170 cfs at the beginning of the study period. Between 15 April and 9 May there was a series of four short pulse flows designed by the U.S. Fish and Wildlife Service (USFWS) to mimic the natural run-off pattern in the Tuolumne River prior to impoundment (Figure 8). Peaks in flow during the spring pulse period ranged from 588 cfs on 15 April to 1,190 cfs on 2 May. Following the pulse period, flows decreased to approximately 100 cfs by early June.

Discharge in the San Joaquin River at Vernalis (RM 72.5) ranged from 856 cfs to 4,176 cfs from January through June (Figure 2). Discharge upstream of Vernalis, at Patterson Bridge (RM 98.5) and Maze Road (RM 77.3), ranged from 387 cfs to 1,023 cfs, and 346 cfs to 2,612 cfs, respectively (Figure 8).

Instantaneous water temperatures generally increased over the study period. In both rivers, downstream reaches were consistently warmer than upstream reaches (Figure 9). The minimum recorded temperature in the Tuolumne River was 6.8 °C (44.2 °F) at Hickman, on 15 January. The maximum overall temperature recorded was 27.6 °C (81.6 °F) at Shiloh, the farthest downstream reach, on 4 June (Figure 9). Instantaneous water temperatures in the San Joaquin River exhibited a similar trend, with the lowest temperature at Laird Park on 15 January (7.1 °C; 44.7 °F) and the highest temperature at Gardner Cove on 4 May (26.3 °C; 79.4°F; Figure 9).

Dissolved oxygen concentrations ranged from 8.2 mg/L to 13.8 mg/L in the Tuolumne River, and from 8.4 mg/L to 12.8 mg/L in the San Joaquin River (Figure 10).

Conductivity ranged from 32 µS to 260 µS in the Tuolumne River, and from 440 µS to 1,780 µS in the San Joaquin River (Figure 11). Under base flow conditions, conductivity in the Tuolumne River generally increased with distance downstream of La Grange Dam (Table 1). Conductivity was similar across sites during the pulse flow period (Figure 8). Overall, conductivity in the San Joaquin River was much higher than in the Tuolumne River, with the highest conductivity observed at the downstream sampling site (Figure 11).

Turbidity in the Tuolumne River ranged from 0.0 NTU to 12.3 NTU. Turbidity in the San Joaquin River was generally higher than in the Tuolumne River, and ranged from 2.6 NTU to 48.9 NTU (Figure 12). Turbidity also generally increased with distance downstream of La Grange Dam (Table 1).

4. COMPARATIVE REVIEW

4.1 SEINE SURVEYS: 1986-2013

Annual TID/MID Tuolumne River seining surveys began in 1986. Sampling methodology has varied over this time, which has resulted in comparable, yet non-standardized, data (Table 8). The number of salmon captured in the Tuolumne River during a single year has ranged from as low as 120 (1991), to as high as 14,825 (1987). The total number of salmon captured in 2013 was 1,763, which ranks 15th among the years documented (Table 2). In order to maintain continuity with previous reports, the inter-annual comparison of density and fork length in this report, primarily focused on the past six years (2008-2013).

The San Joaquin River has been sampled upstream and downstream of the Tuolumne River confluence in each of the study years. The total number of salmon caught in the San Joaquin River has ranged from 0 (several years) to 854 (1986), with average densities consistently lower than those found in the Tuolumne River (Table 4). No salmon were captured in the San Joaquin River during the 2013 sampling period.

4.1.1 Tuolumne River Salmon Density

In 2013, the average river-wide density of Chinook salmon was 7.1 salmon/1,000 ft^2 (Figure 18, Table 3). This is the highest recorded density in the recent 2008-2013 period. However, this density index is only slightly higher than the average density in 2012 (6.9 salmon/1,000 ft^2), and less than average yearly river-wide density calculated for the entire 1986-2013 period (Figure 18). In 2013, the river-wide density of salmon fry and juveniles peaked on 29 January and 7 May, respectively. The peak fry density in 2013 was nearly double the peak density in 2012, and the highest since 2004 (Figure 16). Density of juveniles was relatively low throughout the 2013 study period (Figure 17, Table 3).

4.1.1.1 Density by Site

The highest salmon fry and juvenile densities were observed at the middle section sites of TRR and Hickman. No fry or juveniles were observed downstream of the Charles Road site. In the years 2008-2013, fry were typically only found in low densities below Hickman. Fry and juvenile densities are typically highest at the TRR and Hickman sites, indicating the importance of that reach as a rearing area in the Tuolumne River.

4.1.1.2 Density by River Section

In the upper section of the Tuolumne River, fry density generally peaks between early February and early March, before steadily declining as fish grow in size or move downstream (Figure 19). Subsequently, there is a corresponding increase in juvenile density in the upper section; typically beginning in late February, and peaking in early April to late May (Figure 19, Table 3). In 2013, the density of fry in the upper section peaked on 29 January, and declined to low levels by mid-March. Juvenile salmon density peaked on 7 May in the upper section (Table 3).

Fry and juvenile timing in the middle is generally similar to timing in the upper section (Figure 20). In 2013, fry density peaked on 12 February and juvenile density peaked on 7 May (Table 3).

In the lower section, density of fry and juvenile salmon has been relatively low in most years since 1986. In previous years, this section was often sampled only at the Shiloh Road location; since 1999, two sites have been sampled in the lower section. During the 2008-2013 period, the highest peak densities of fry occurred between early February (2011) and mid-March (2008; Figure 21). In the same 2008-2013 period, the highest peak densities of juveniles occurred between early February (2008) and mid-April (2012; Figure 21). In 2013, no salmon (fry or juvenile) were caught in the lower section. Since 2008, there have been no Chinook captured in three of the six years. The lack of Chinook salmon fry and juveniles captured in the lower section may be an indication of low capture probabilities, poor salmon survival in the lower section of river, active migration out of the river (i.e., no longer rearing) resulting in the absence of fish in river margin habitat where sampling is conducted, or some combination of these factors.

4.1.2 San Joaquin River Salmon Density

Densities of salmon caught in the San Joaquin River at Laird Park and Gardner Cove (or nearby sites) were reviewed to compare relative abundance of salmon upstream and downstream of the Tuolumne River confluence. Due to low capture rates, the abundance indices were calculated for both fry and juveniles combined. The average salmon abundance at Laird Park (upstream of the Tuolumne confluence) was extremely low for all years during the entire 1986-2013 period (Figure 23, Table 4). The total number of salmon caught annually at Laird Park ranged from 0 to 51, totaling 152 during the 27-year period. No salmon were caught at Laird Park in 2013. The average abundance at Gardner Cove (downstream of the Tuolumne River confluence) was highest in 1986 and 1999, and moderately high in 1995, 1998, 2001, and 2006. A total of 1,097 salmon were caught at this location during the entire 1986-2013 period, of which 509 were caught in 1999 (Table 4). No salmon were caught at Gardner Cove in 2013.

4.1.3 Size and Growth

Similar to other years, minimum FL of Chinook salmon captured in the Tuolumne River in 2013 was less than 45 mm FL until mid-March (Figure 13). The increase in average FL during the January to March period was similar in timing and magnitude to the pattern observed in the 2008-2013 period (Figure 14). In all years since 2008, higher variability in FL is observed beginning in April, due to decreasing capture rates and the migration of smolts out of the study area. Maximum FL in 2013 was highly variable throughout the entire sampling period (Figure 15). The estimated 2013 growth rate of 0.53 mm per day, during the January to June study period, was within the range of estimates of previous years (min = 0.45 mm per day, max = 0.79 mm per day, 1986-2013; Table 4).

4.1.4 Species Richness

The number of fish species (i.e., species richness), excluding Chinook salmon, captured during the 1986-2013 period, has ranged from 5 to 19 in the Tuolumne River (Table 10). Species richness was lowest in 2012, as only five other species were captured. In all other years since 1986, the number of species captured has ranged from 11 to 19.

Species richness in the San Joaquin River has decreased since 2006. Species richness observed in the San Joaquin River prior to 2006 averaged 16 species (range: 12-21). Since 2006, the average number of species captured has dropped to 9 species (range: 5-12; Table 10). Native species, including Sacramento blackfish, Sacramento splittail, Pacific lamprey, hitch; and tule perch, and non-native species, including brown bullhead, goldfish, golden shiner, striped bass, threadfin shad, and white catfish, have historically been captured in seine surveys, however, none of these species have been observed since 2008.

5. FIGURES

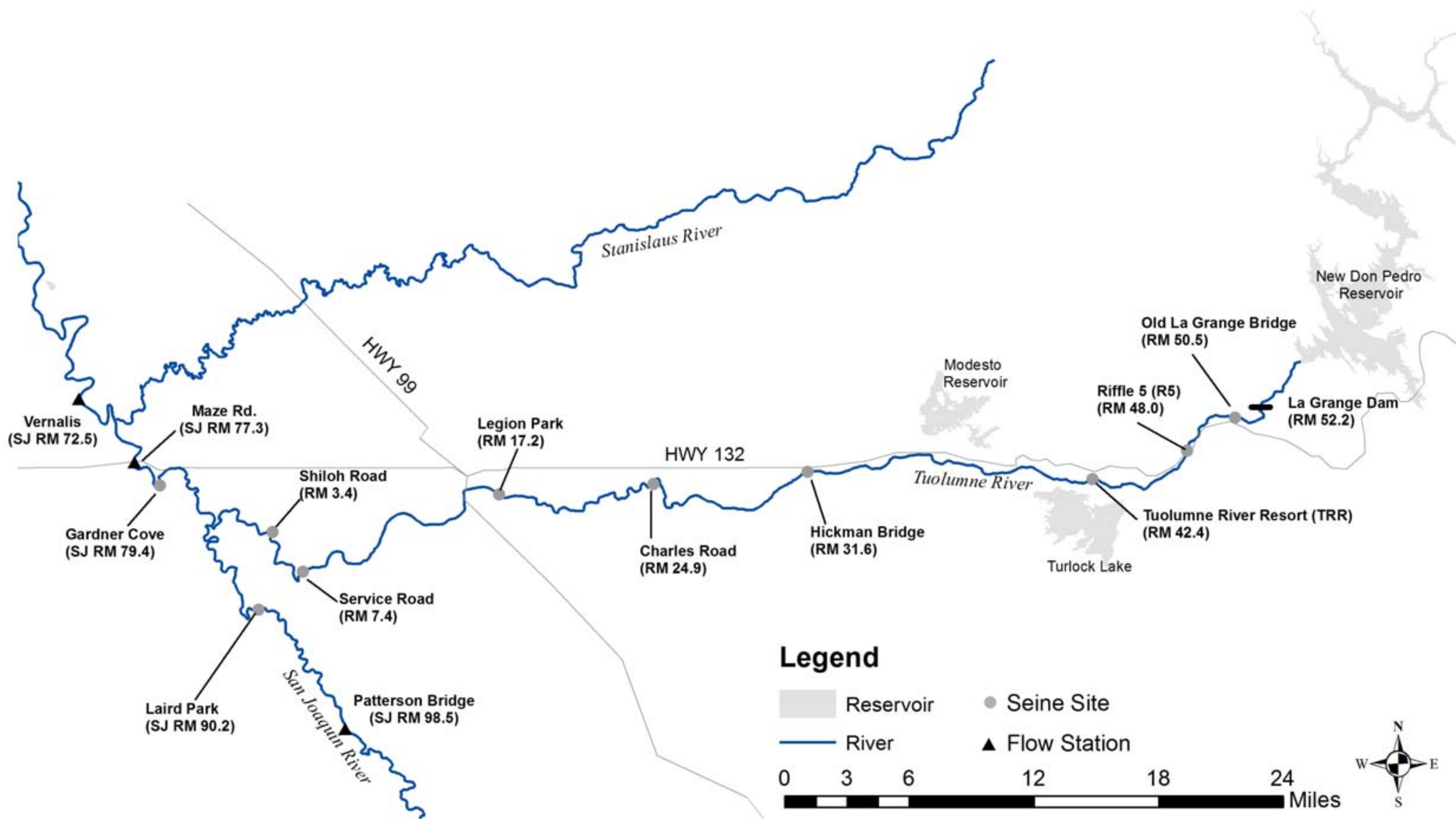
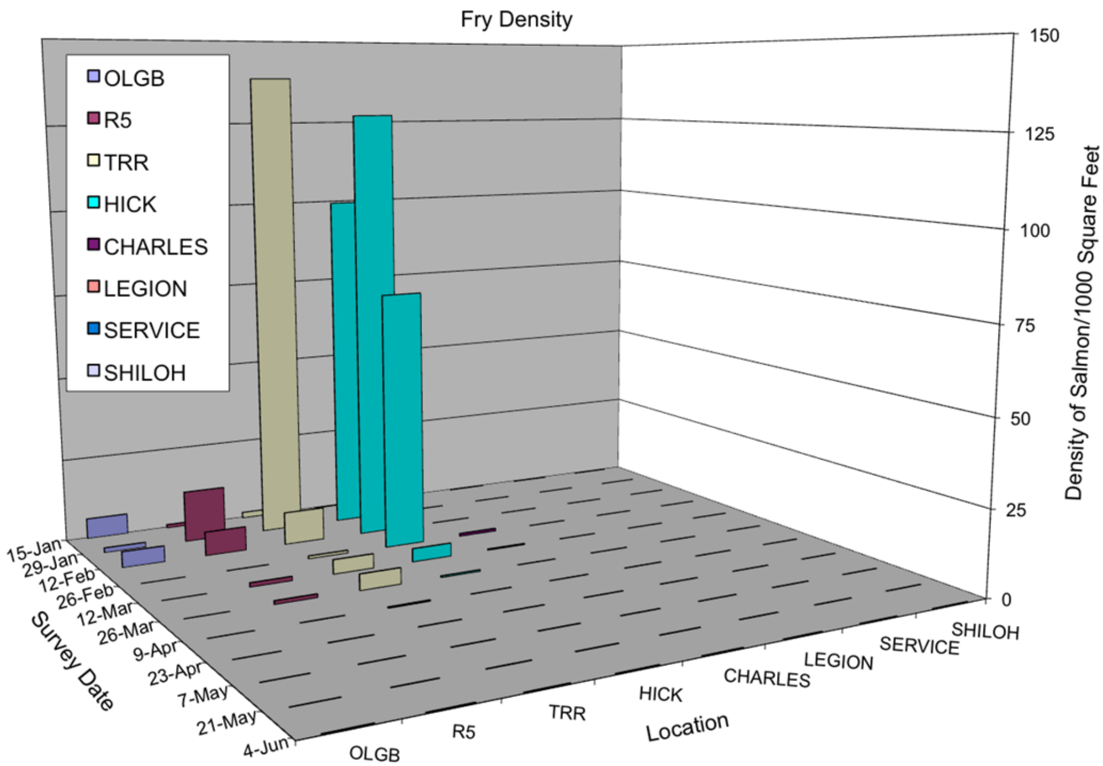


Figure 1. Locations of seine sampling sites on the lower Tuolumne and San Joaquin Rivers, 2013. Abbreviations used in figures below are as follows: OLGB = Old La Grange Bridge, R5 = Riffle 5, TRR = Tuolumne River Resort, HICK = Hickman Bridge, CROAD = Charles Road, LEGION = Legion Park, SERVICE = Service Road, SHILOH = Shiloh Bridge, LAIRD = Laird Park, and GARD = Gardner Cove.



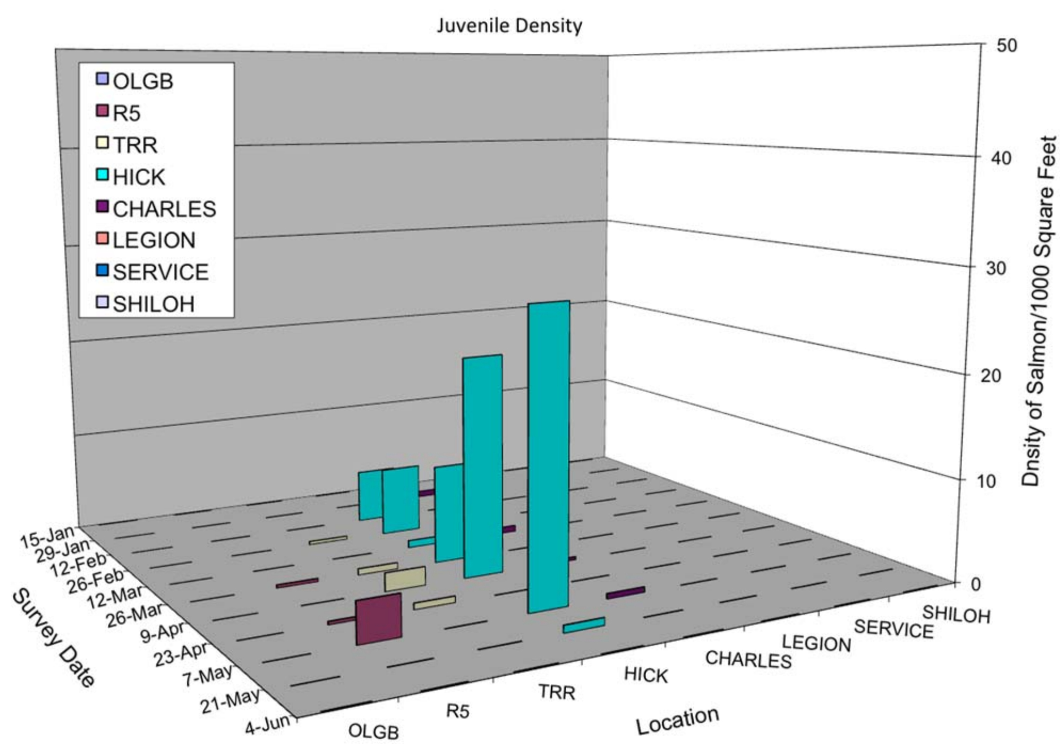


Figure 2. Tuolumne River density of fry and juvenile Chinook by location in 2013. See Figure 1 for site codes.

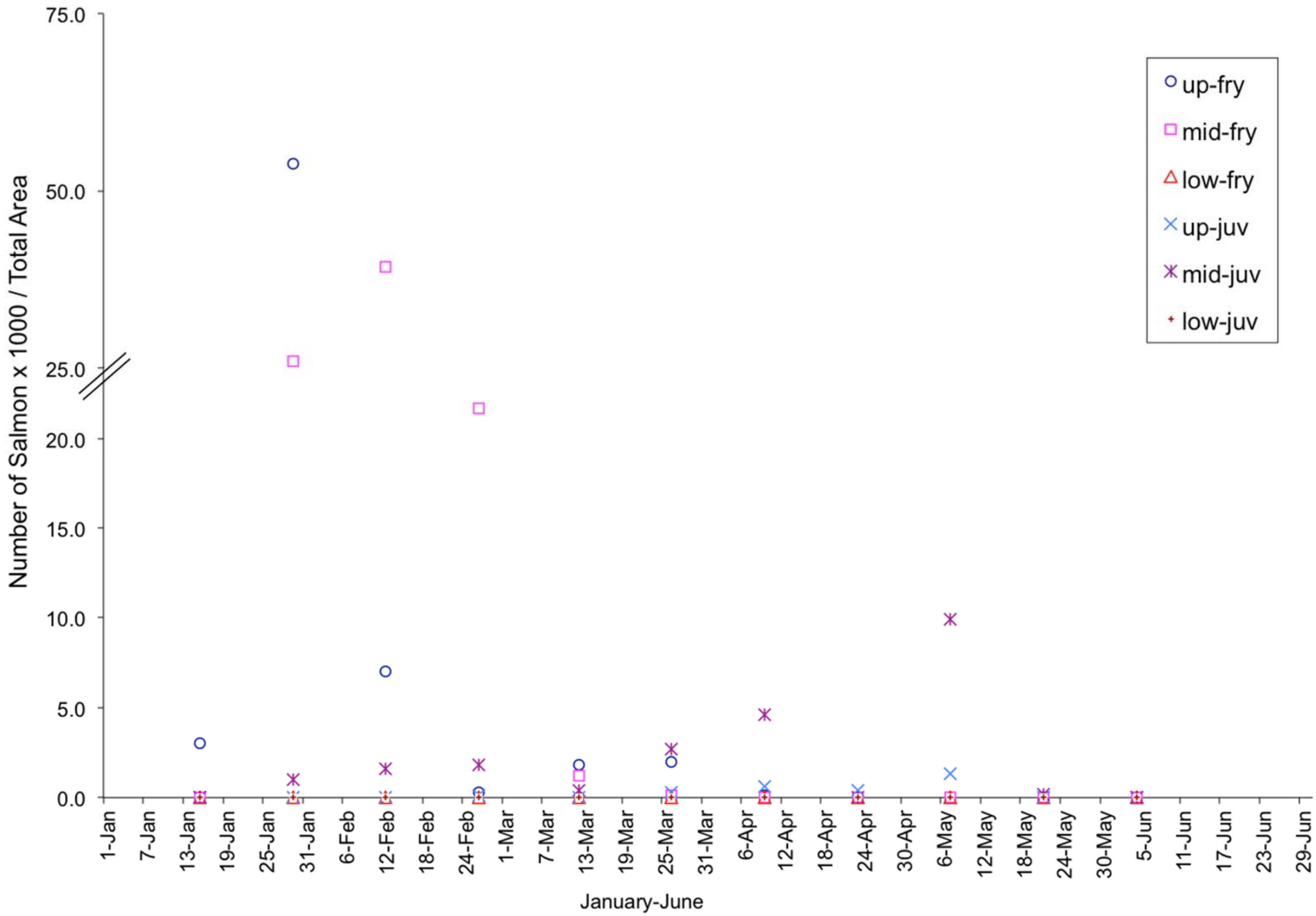


Figure 3. Tuolumne River fry and juvenile Chinook density by section (upper, middle and lower) in 2013. Note: scale change indicated by double lines on y-axis.

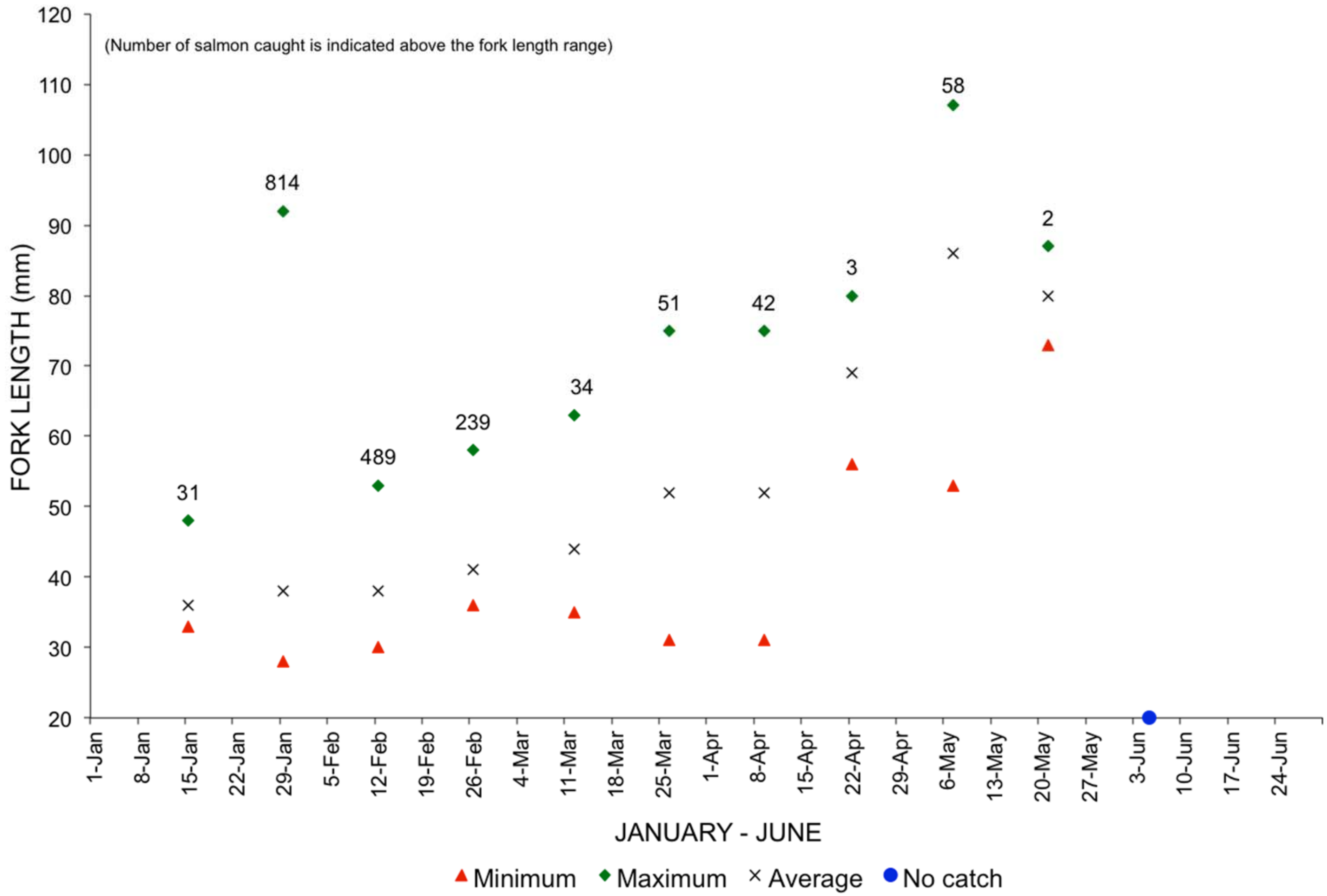


Figure 4. Ranges of fork lengths of wild Chinook salmon captured in the Tuolumne River in 2013.

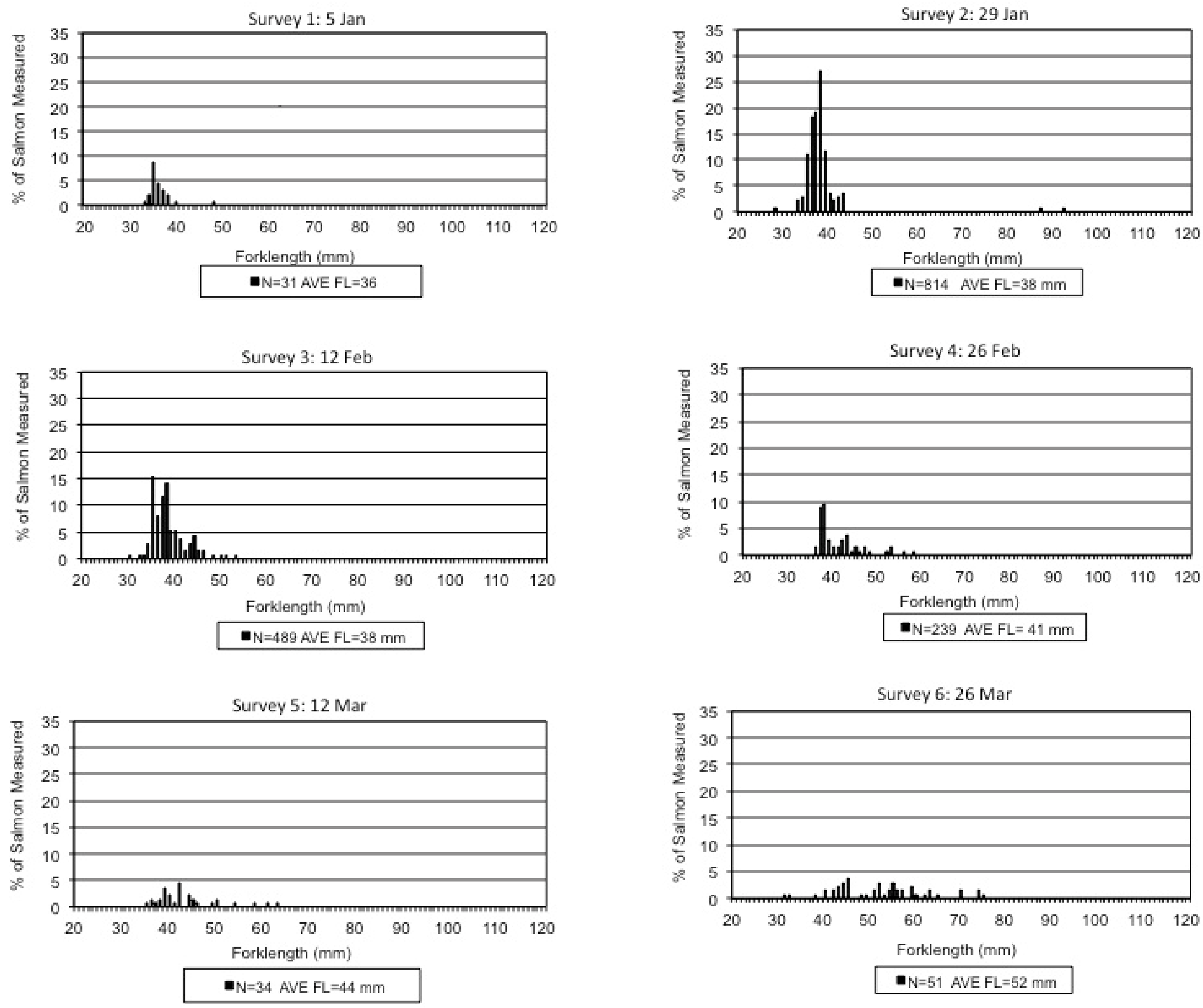


Figure 5. Length Frequency distribution by date of Chinook salmon captured in the Tuolumne River in 2013.

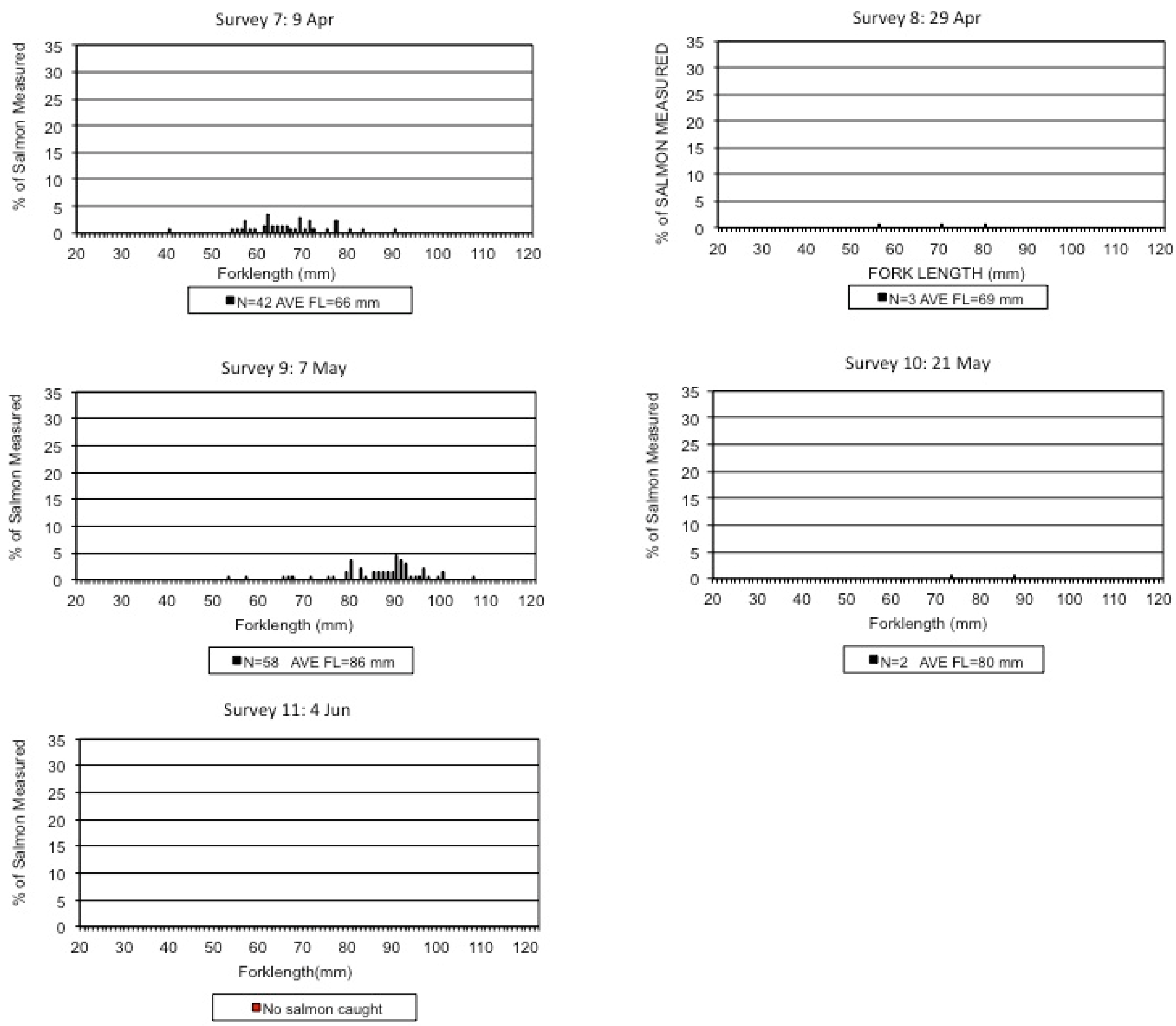


Figure 6. Length Frequency distribution by date of Chinook salmon captured in the Tuolumne River in 2013 (continued from Figure 5).

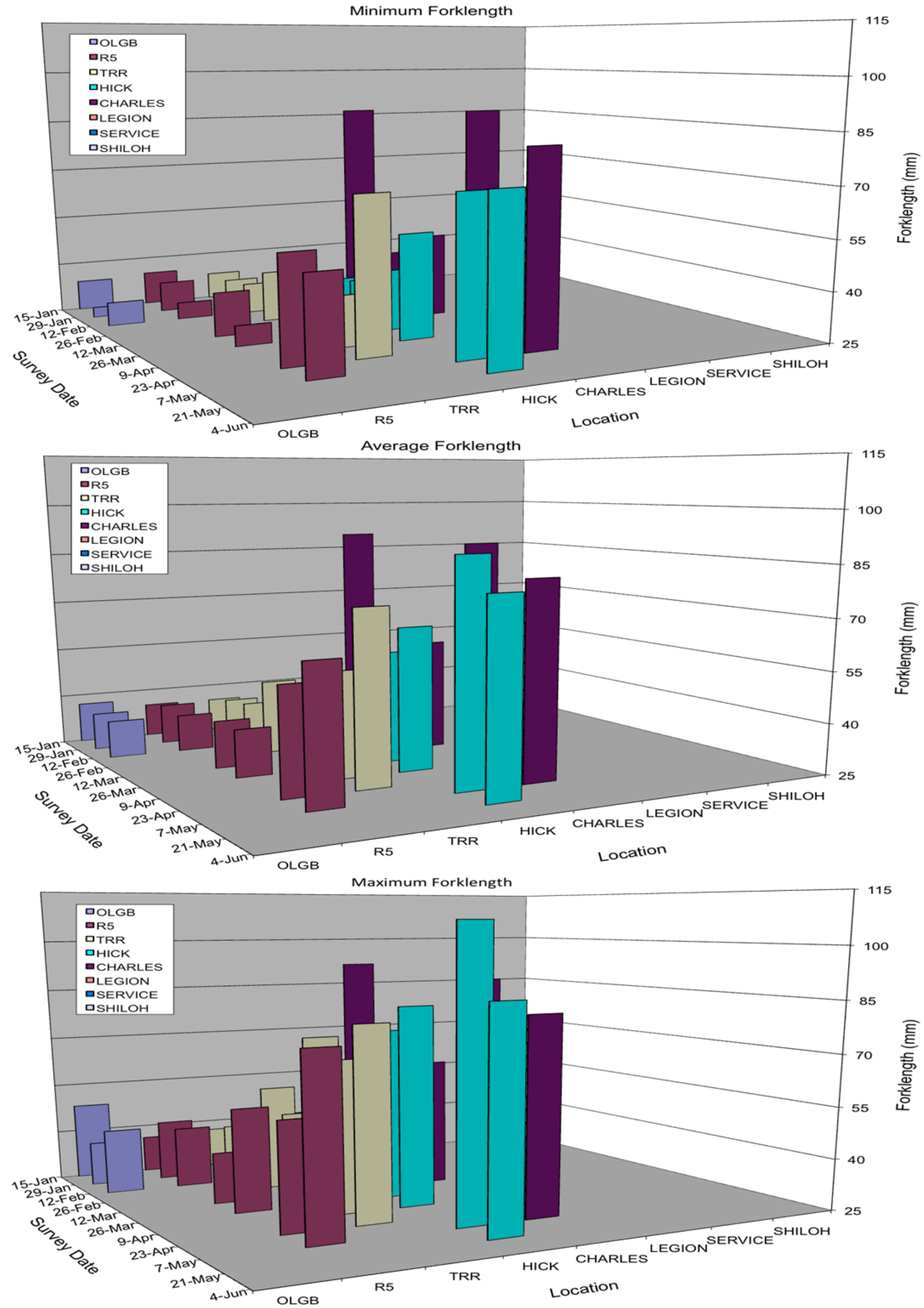


Figure 7. Minimum, average and maximum fork length of Chinook salmon by location and survey period in 2013. See Figure 1 for site codes.

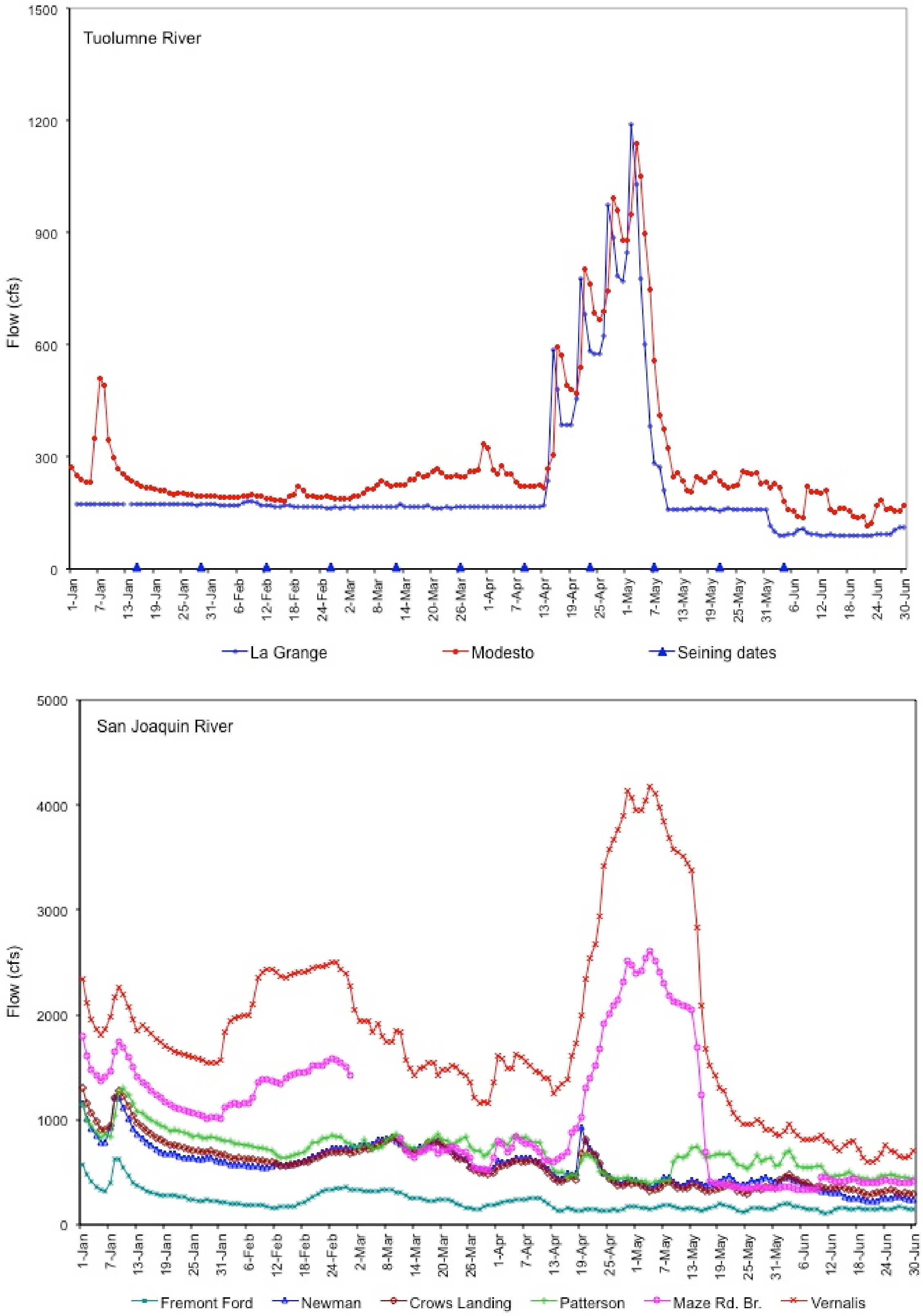


Figure 8. Tuolumne and San Joaquin River daily mean flows, 2013.

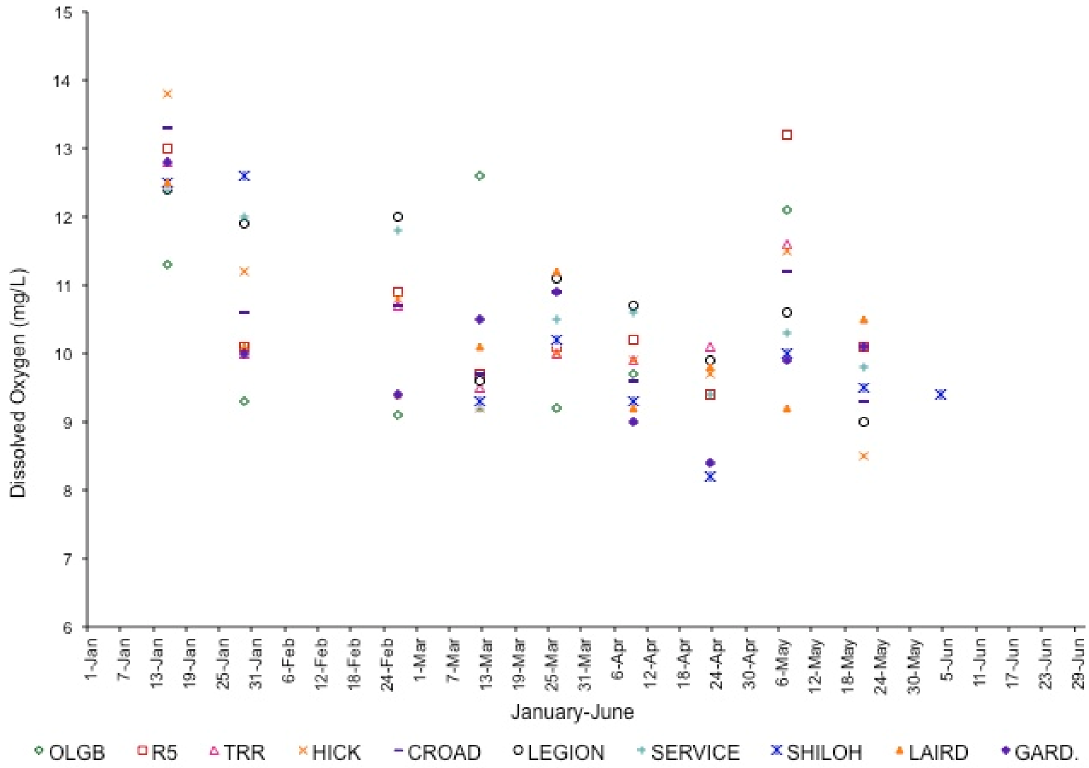


Figure 9. Tuolumne and San Joaquin River instantaneous water temperatures in 2013. See Figure 1 for site codes.

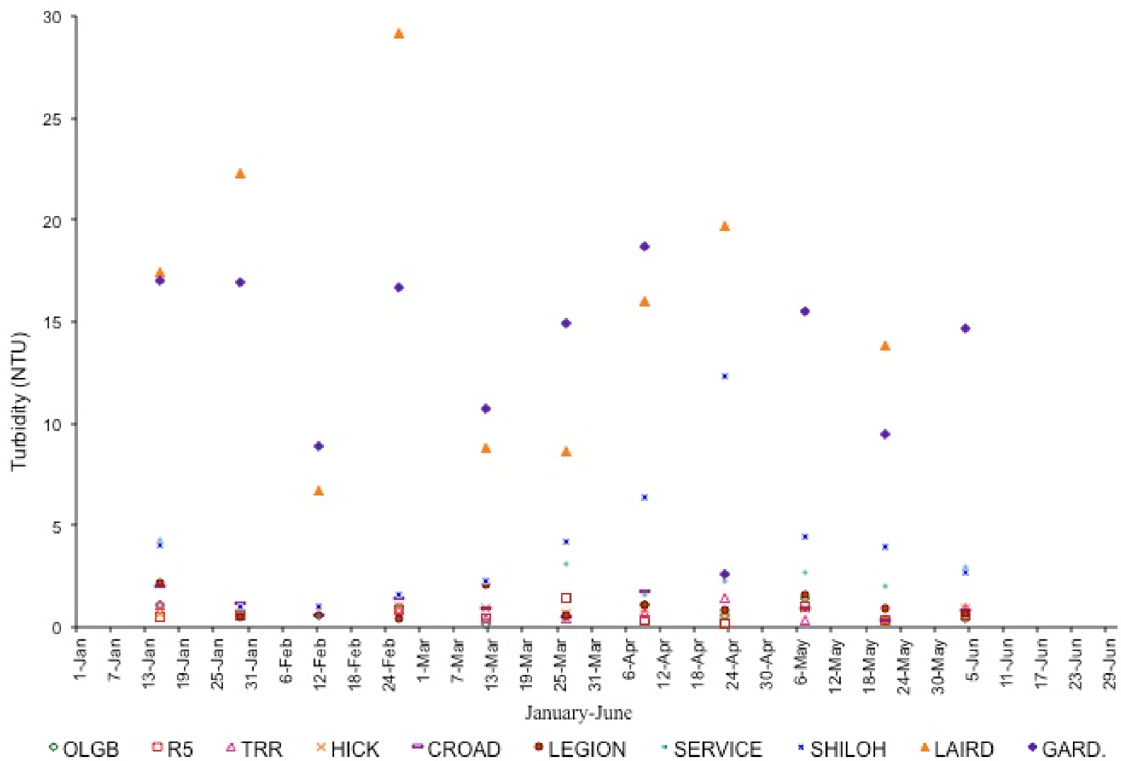


Figure 10. Tuolumne and San Joaquin River instantaneous dissolved oxygen in 2013. See Figure 1 for site codes.

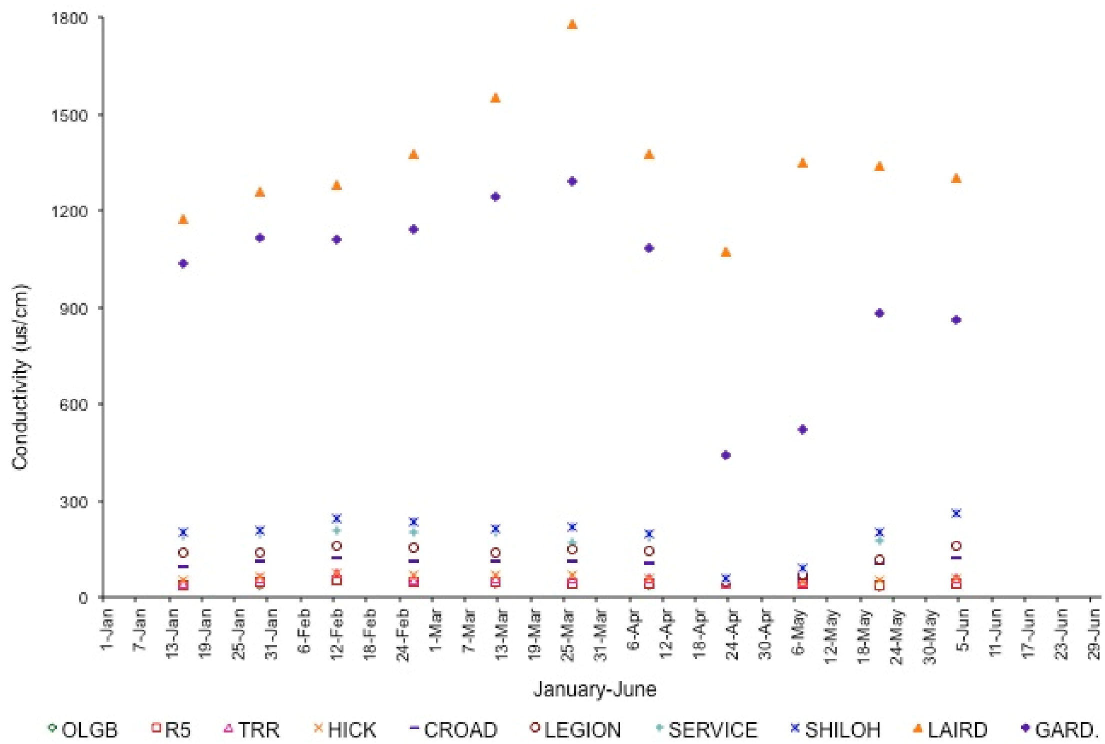


Figure 11. Tuolumne and San Joaquin River instantaneous conductivity in 2013. See Figure 1 for site codes.

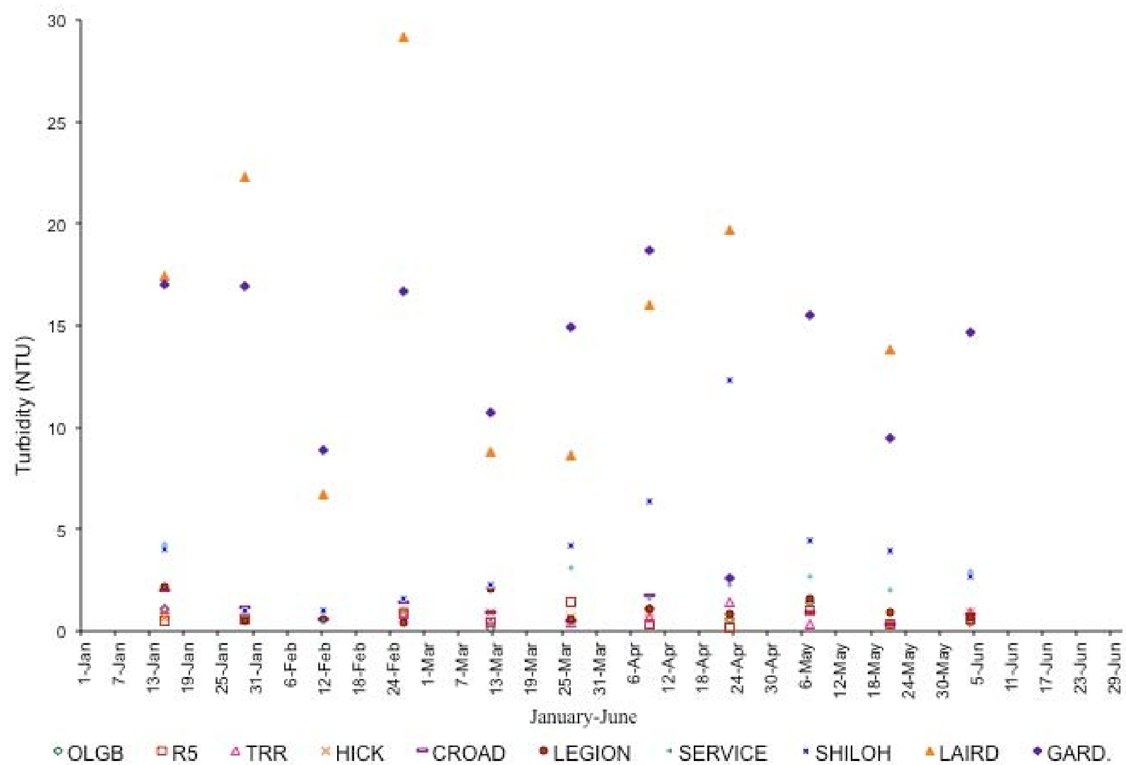


Figure 12. Tuolumne and San Joaquin River instantaneous turbidity in 2013. See Figure 1 for site codes.

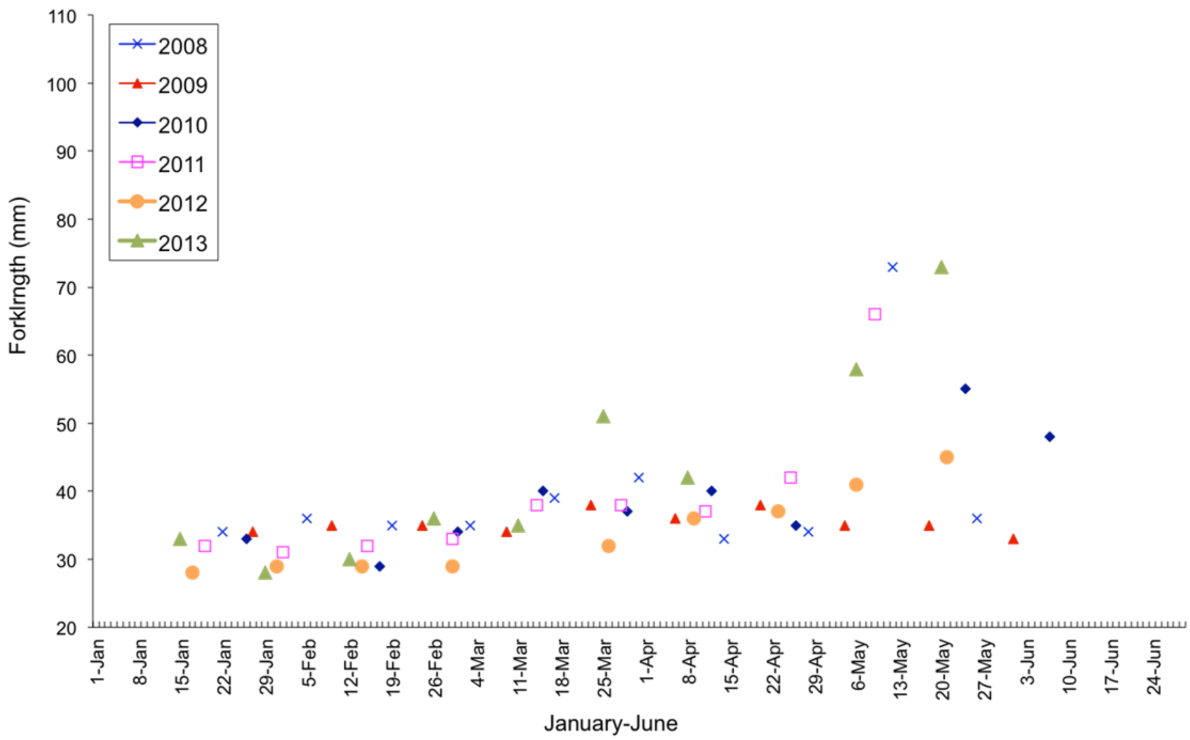


Figure 13. Minimum forklength of Tuolumne River fry and juvenile Chinook salmon, 2008-2013.

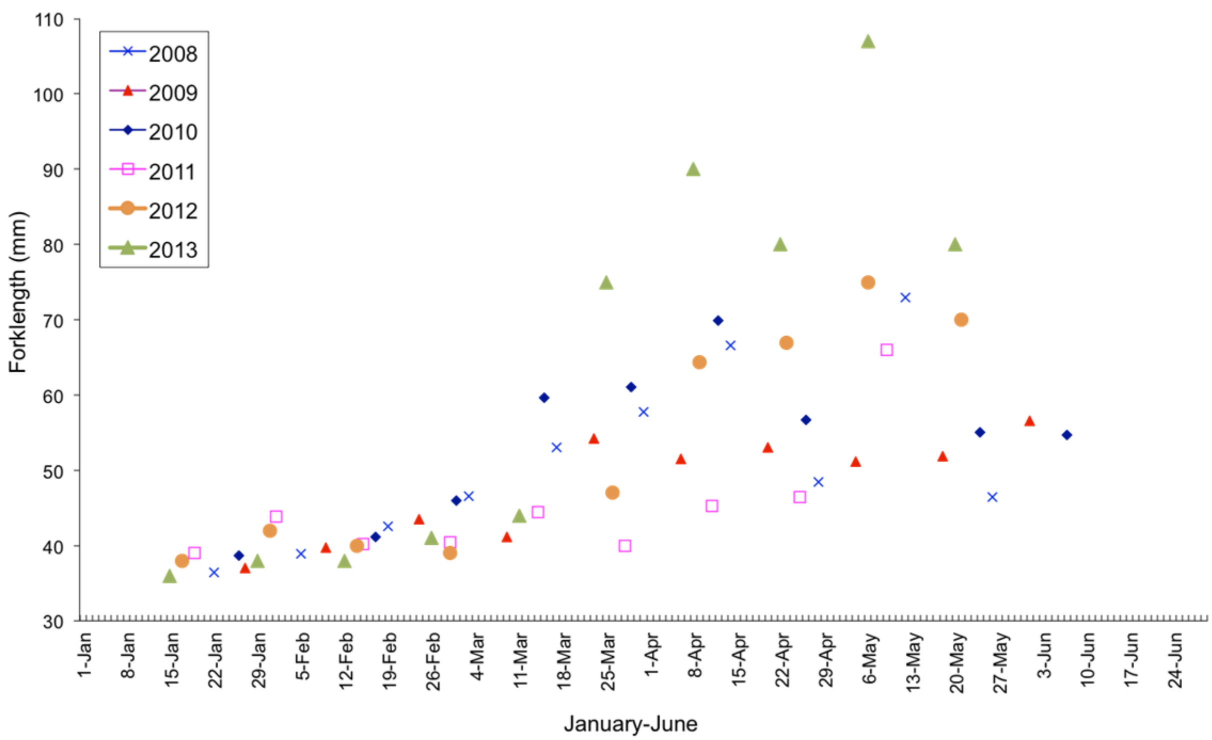


Figure 14. Average forklength of Tuolumne River fry and juvenile Chinook salmon, 2008-2013.

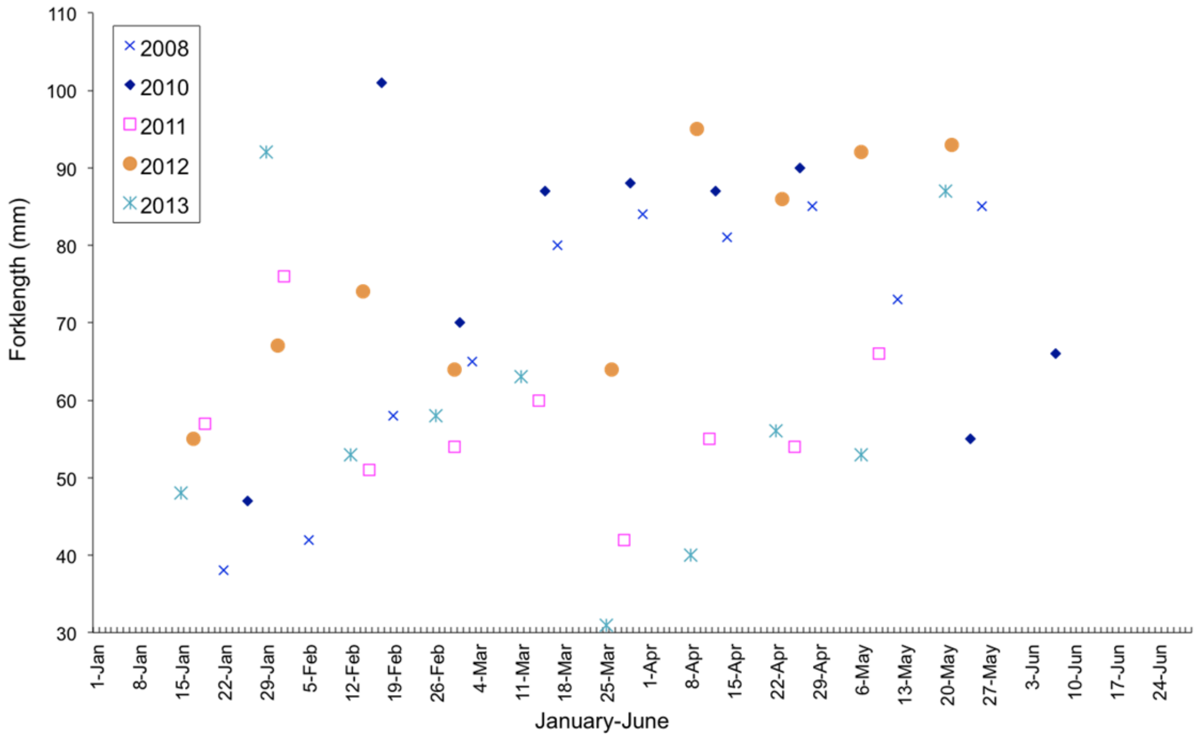


Figure 15. Maximum forklength of Tuolumne River fry and juvenile Chinook salmon, 2008-2013.

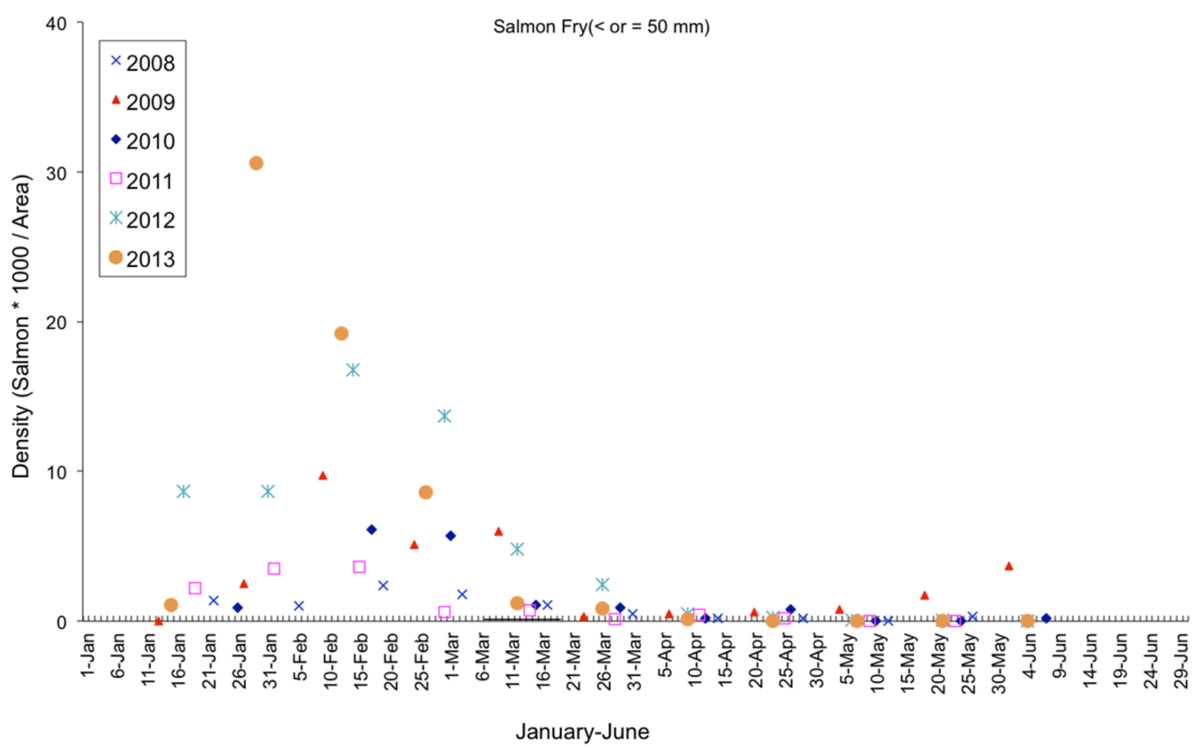


Figure 16. Density index of Tuolumne River Chinook salmon fry, 2008-2013.

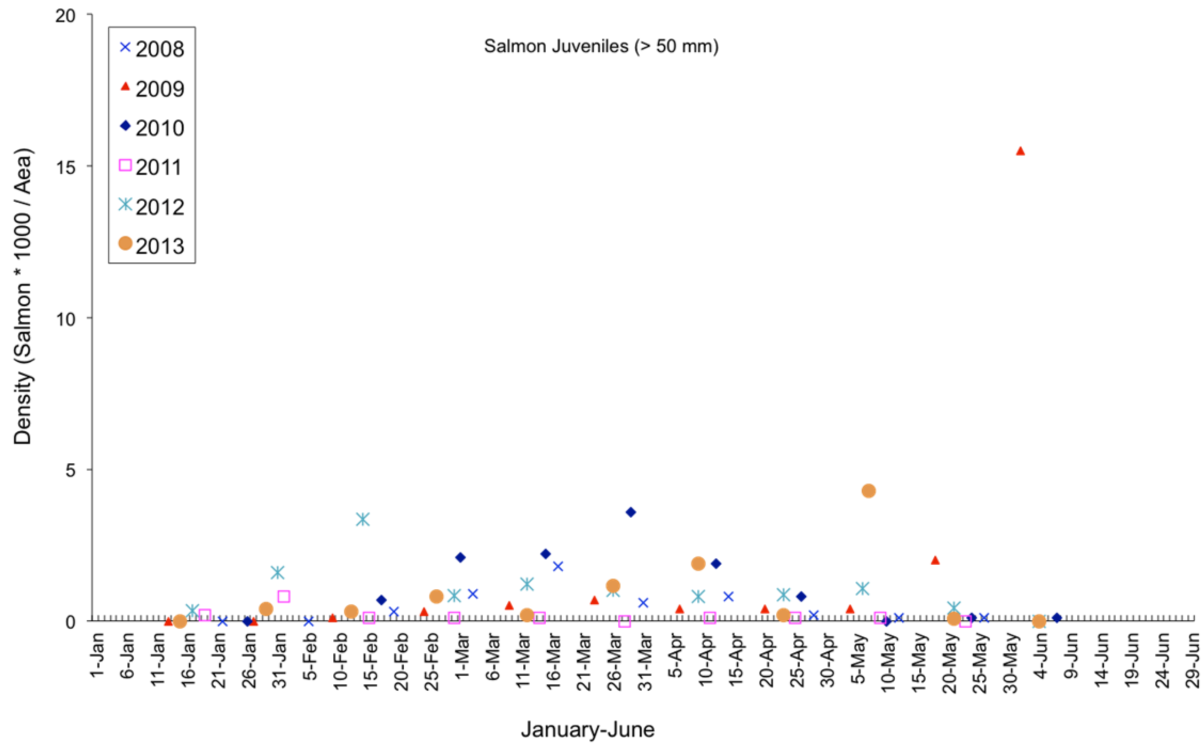


Figure 17. Density index of Tuolumne River Chinook salmon juveniles, 2008-2013.

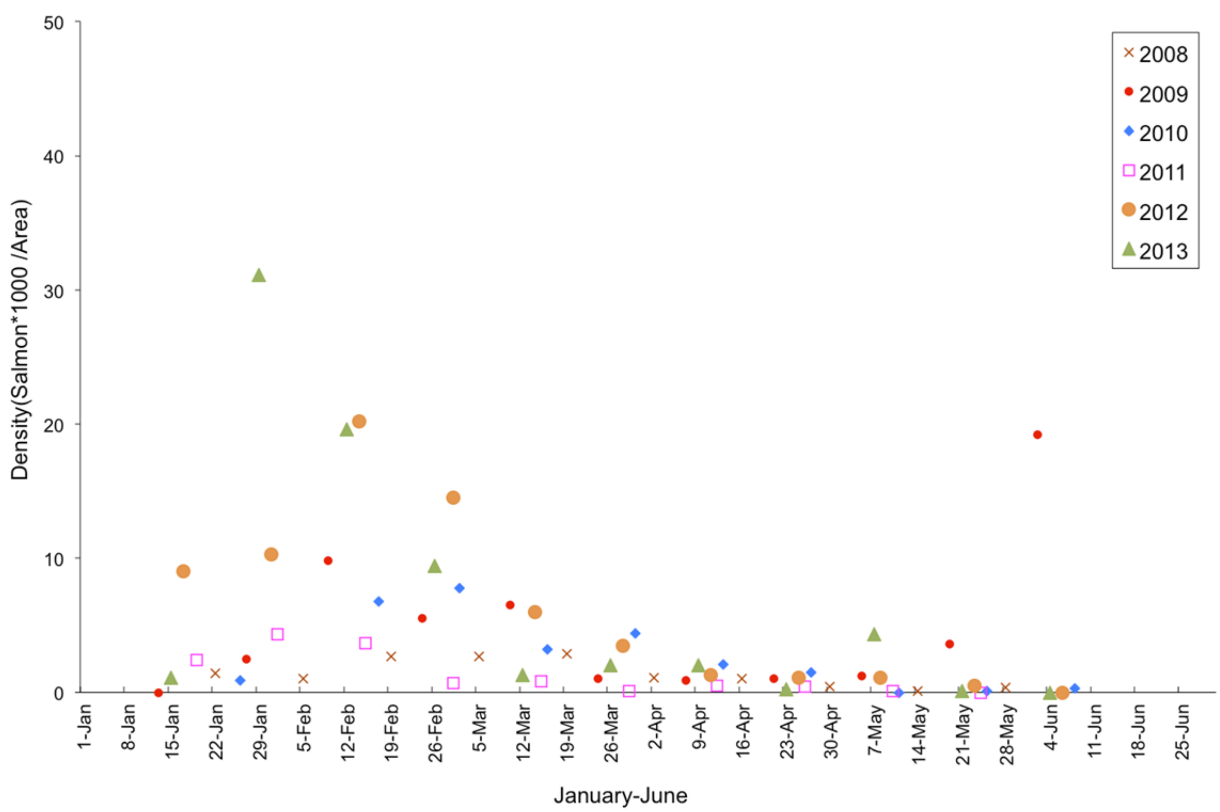


Figure 18. Density index of combined Tuolumne River fry and juvenile Chinook salmon, 2008-2013.

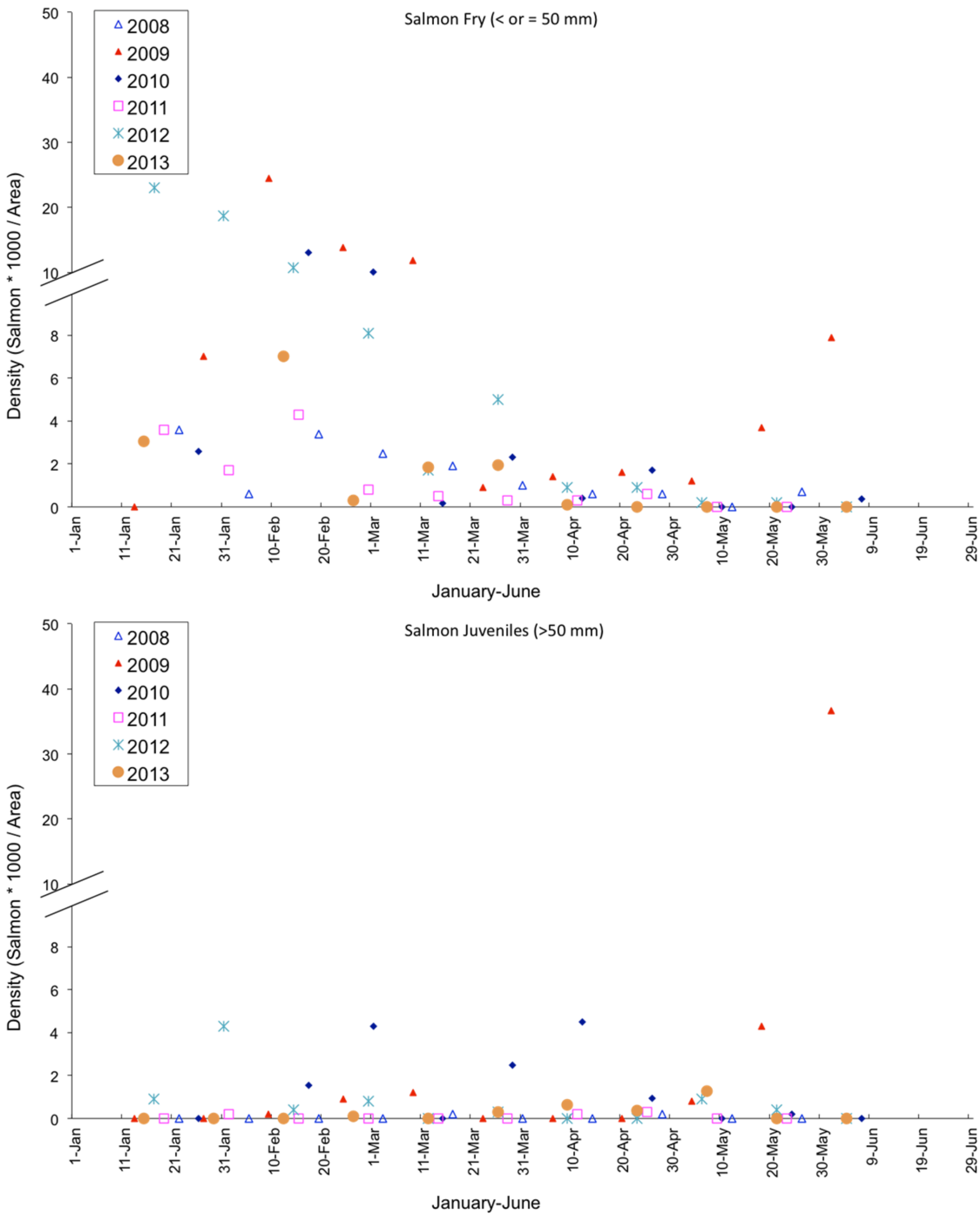
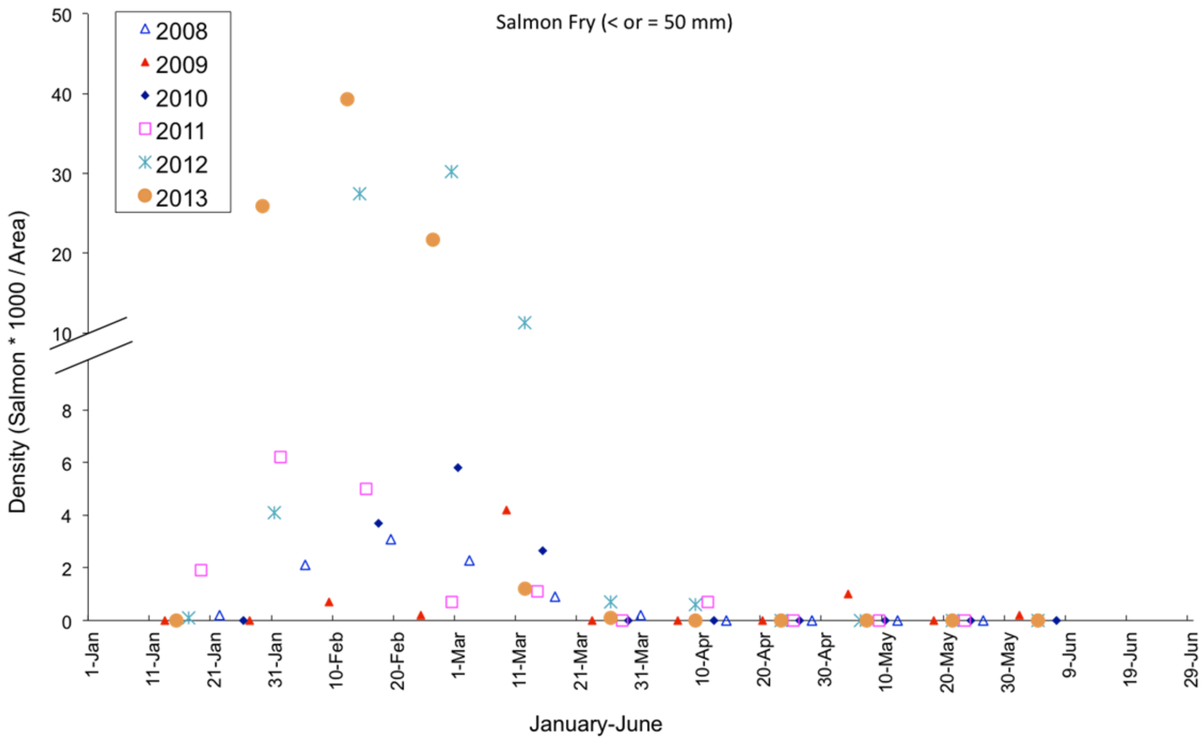


Figure 19. Upper section density indices for Chinook salmon fry and juveniles, 2008-2013. Note: double lines on y-axis indicate change in scale.



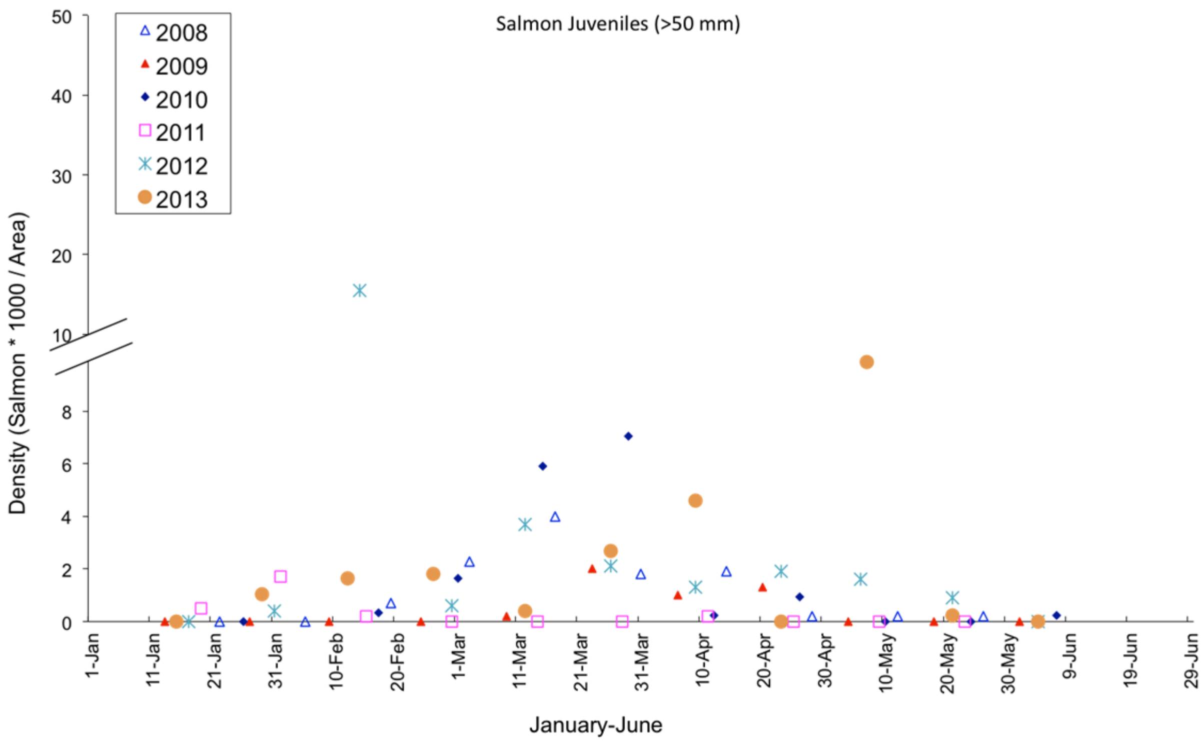


Figure 20. Middle section density indices for Chinook salmon fry and juveniles, 2008-2013. Note: double lines on y-axis indicate change in scale.

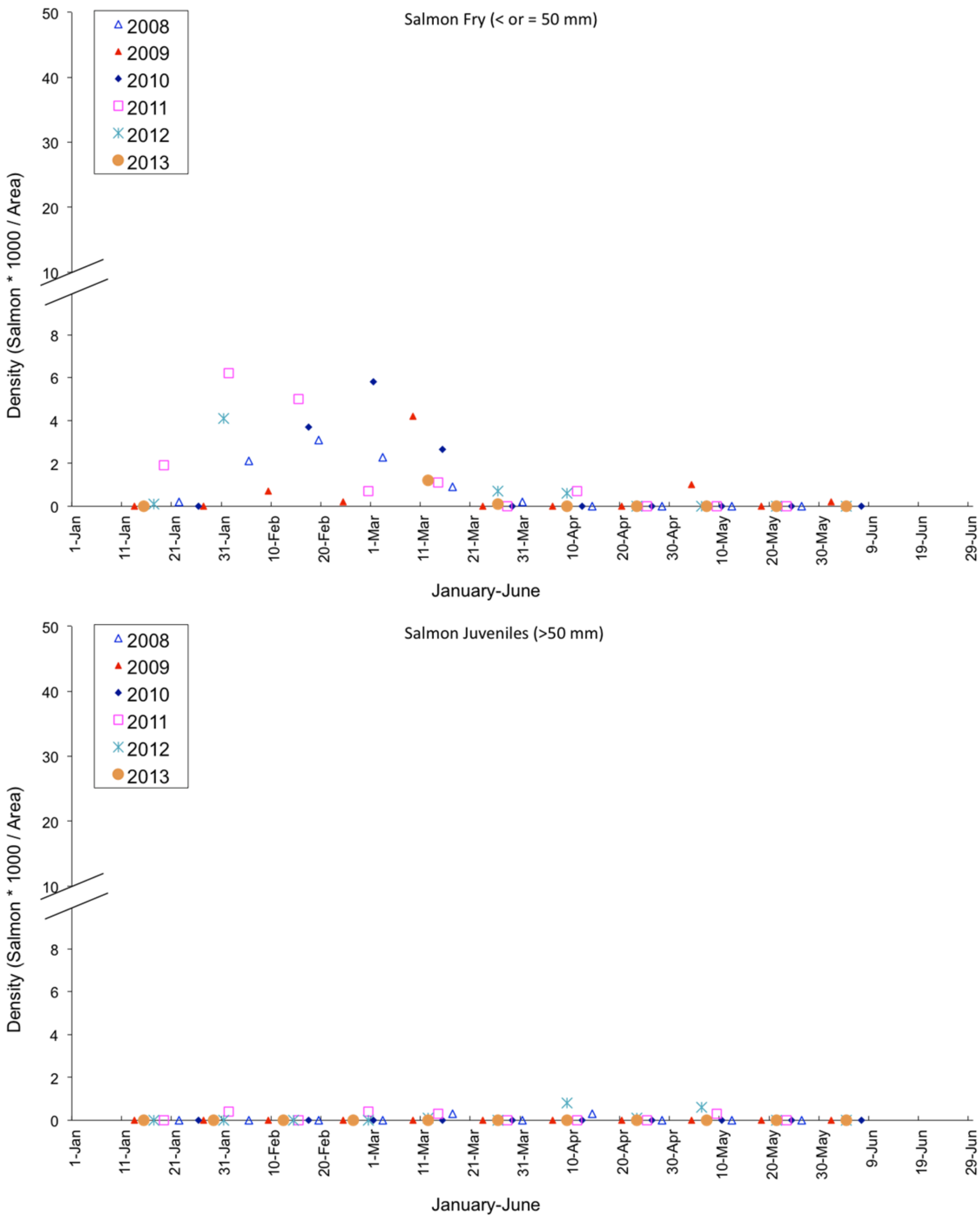


Figure 21. Lower section density indices for Chinook salmon fry and juveniles, 2008-2013. Note: double lines on y-axis indicate change in scale.

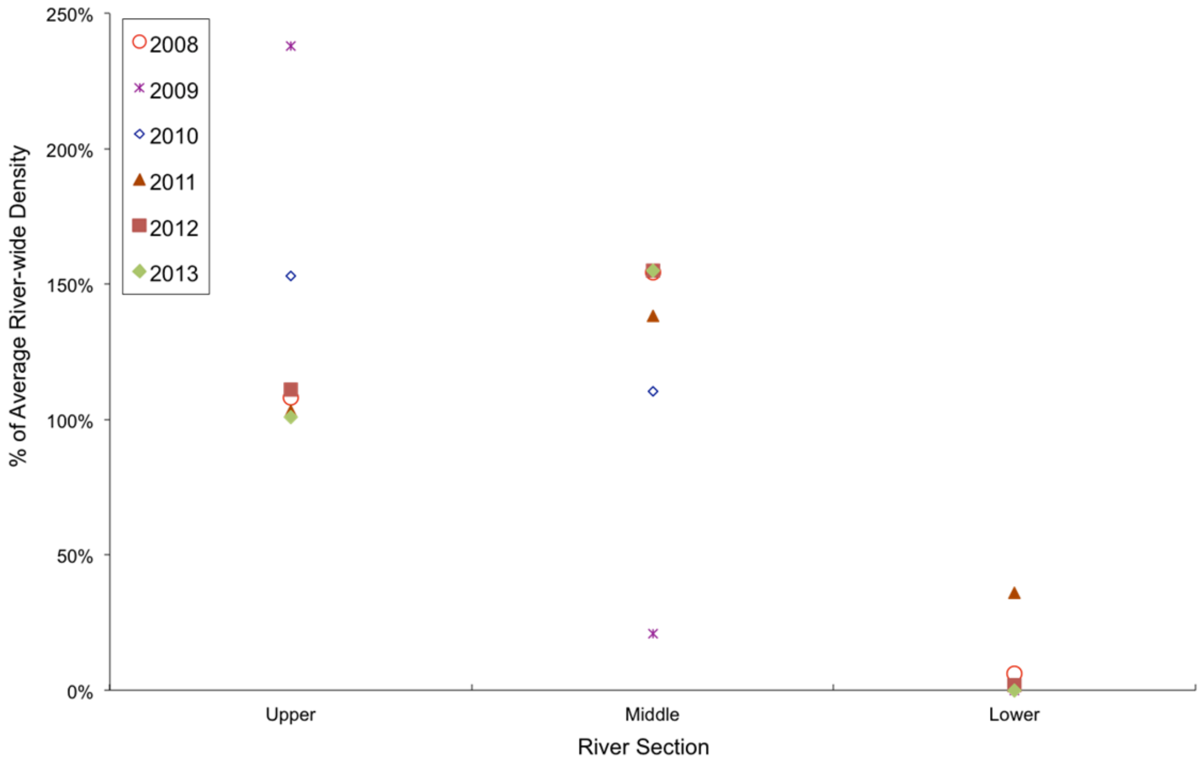


Figure 22. Tuolumne River Chinook salmon abundance indices standardized by section, 2008-2013.

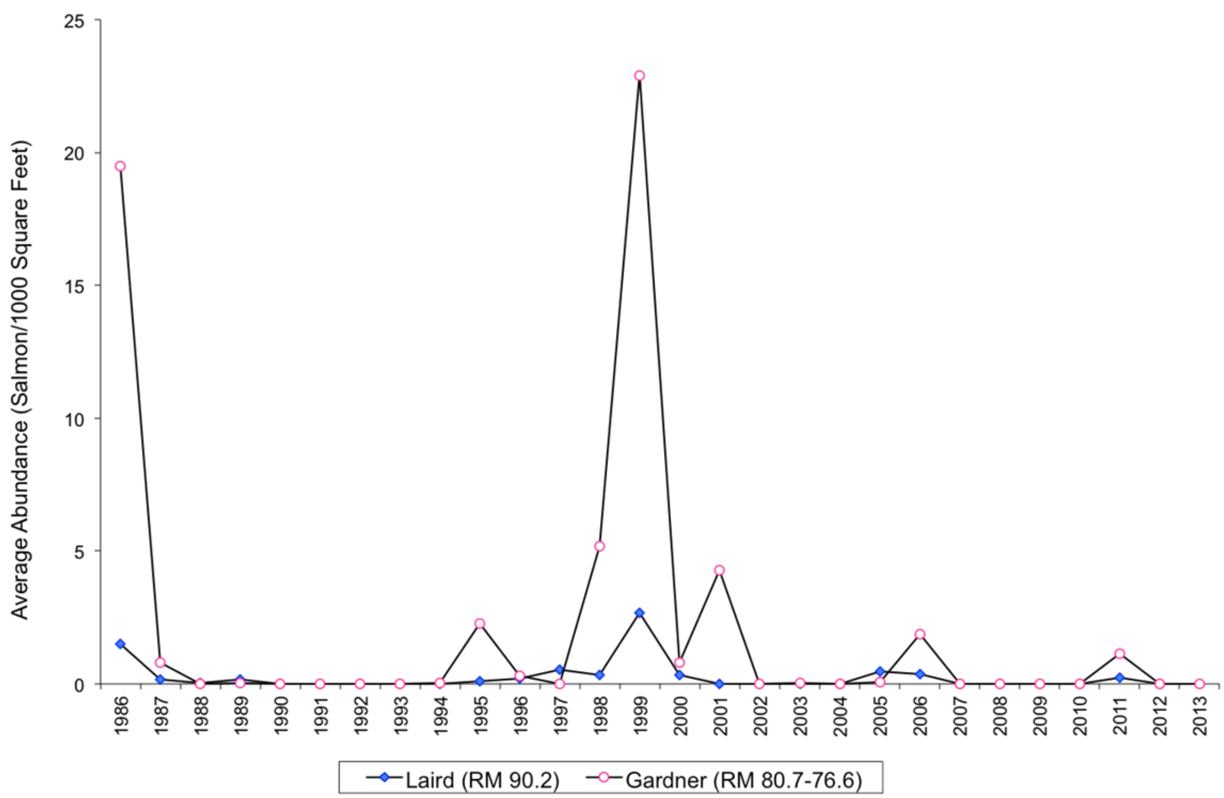


Figure 23. San Joaquin River Chinook salmon indices by location, 1986-2013. Partial sampling was done at all locations in 1986 and at Gardner Cove in 1997.

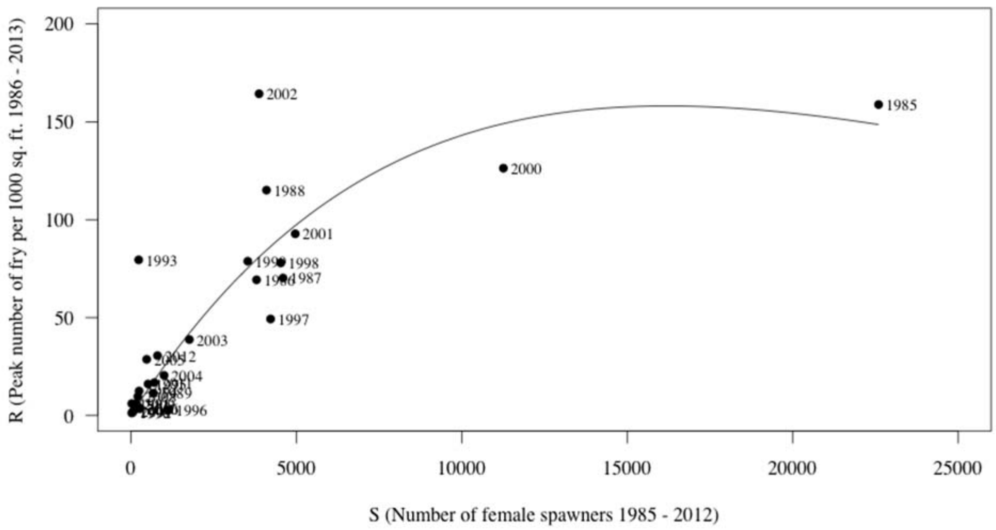


Figure 24. Tuolumne River peak Chinook salmon fry density in year *t+1* as a function of female spawner abundance in year *t.*

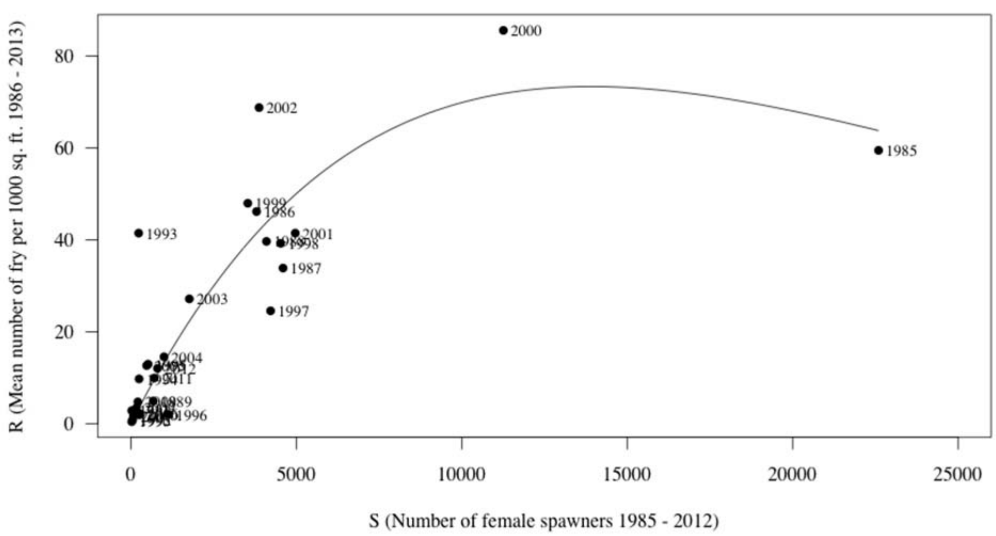


Figure 25. Tuolumne River average Chinook salmon fry density in year *t+1* as a function of female spawner abundance in year *t.*

6. TABLES

Table 1. Summary table of weekly seine catch by location for the Tuolumne and San Joaquin Rivers, 2013. Note: Some headings were abbreviated in the table. MORTS = number of mortalities encountered and ELEC COND = Electrical Conductivity.

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 1

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft²)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
15-Jan	OLGB	50.5	22	3,600	6.1	34	48	37.0	22		46.0	41				1.1	11.3
15-Jan	R5	48.4	3	3,000	1.0	35	36	35.0	3		45.8	38				0.5	13.0
15-Jan	TRR	42.0	6	3,600	1.7	33	37	35.0	6		44.9	42				1.1	12.8
15-Jan	Hickman	31.6	0	3,600	0.0						44.2	52				0.7	13.8
15-Jan	Charles	24.9	0	3,600	0.0						55.0	94				2.0	13.3
15-Jan	Legion	17.2	0	3,600	0.0						47.8	136				2.2	12.4
15-Jan	Service	6.4	0	3,600	0.0						46.9	193				4.3	12.4
15-Jan	Shiloh	3.4	0	3,600	0.0						46.5	202				4.0	12.5
15-Jan	Laird	90.2	0	1,300	0.0						44.7	1176				17.4	12.5
15-Jan	Gardner	79.5	0	1,400	0.0						45.1	1035				17.0	12.8
	TR TOT.		31	28,200	1.1	33	48	36.0	31				3.0	0.0	0.0		
	SJR TOT.		0	2,700	0.0												

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 2

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft²)	FL MIN	FL MAX	FL AVG[a]	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
29-Jan	OLGB	50.5	5	3,600	1.4	28	38	36.0	5		49.4	37				0.6	9.3
29-Jan	R5	48.0	46	3,000	15.3	34	43	38.0	39		48.5	47				0.6	10.1
29-Jan	TRR	42.3	499	3,600	138.6	33	40	37.0	50	1	49.4	57				0.7	10.0
29-Jan	Hickman	31.6	262	2,600	100.8	33	43	38.0	50		50.1	63				0.7	11.2
29-Jan	Charles	24.9	2	3,600	0.6	87	92	90.0	2		54.6	113				1.2	10.6
29-Jan	Legion	17.2	0	3,600	0.0						55.9	138				0.5	11.9
29-Jan	Service	6.4	0	3,600	0.0						54.6	196				0.8	12.0
29-Jan	Shiloh	3.4	0	2,600	0.0						55.5	208				1.0	12.6
29-Jan	Laird	90.2	0	1,200	0.0						55.9	1259				22.3	10.1
29-Jan	Gardner	79.5	0	1,700	0.0						56.1	1114				16.9	10.0
TR TOT.			814	26,200	31.1	28	92	38.0	146				53.9	26.9	0.0		
SJR TOT.			0	2,900													

[a] does not include outlier forklengths in the overall average.

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 3

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft²)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
12-Feb	OLGB	50.5	17	3,600	4.7	32	44	36.0	17		51.4	51				0.0	
12-Feb	R5	48.0	17	2,400	7.1	30	43	36.0	17		50.5	53				0.0	
12-Feb	TRR	42.3	29	3,000	9.7	34	48	38.0	29		52.3	74				0.0	
12-Feb	Hickman	31.6	426	3,200	133.1	35	53	40.0	50		51.9	72				0.0	
12-Feb	Charles	24.9	0	3,600	0.0						53.7	124				0.6	
12-Feb	Legion	17.2	0	3,600	0.0						53.4	158				0.6	
12-Feb	Service	6.4	0	3,600	0.0						54.3	205				0.5	
12-Feb	Shiloh	3.4	0	2,000	0.0						57.2	244				1.0	
12-Feb	Laird	90.2	0	1,200	0.0						56.8	1277				6.7	
12-Feb	Gardner	79.5	0	1,200	0.0						55.5	1112				8.9	

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
TR TOT.			489	25,000	19.6	30	53	38.0	113				7.0	41.0	0.0		
SJR TOT.			0	2,400													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 4

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
26-Feb	OLGB	50.5	0	3,600	0.0						48.5	49				0.8	9.1
26-Feb	R5	48.0	0	2,600	0.0						48.0	50				0.8	10.9
26-Feb	TRR	42.3	4	3,600	1.1	40	56	47.0	4		51.5	55				0.8	10.7
26-Feb	Hickman	31.6	232	2,800	82.9	36	58	41.0	50		52.1	69				1.0	10.8
26-Feb	Charles	24.9	3	3,600	0.8	43	48	46.0	3		55.9	109				1.4	10.7
26-Feb	Legion	17.2	0	3,600	0.0						57.3	154				0.4	12.0
26-Feb	Service	6.4	0	3,200	0.0						55.7	202				1.1	11.8
26-Feb	Shiloh	3.4	0	2,400	0.0						59.5	235				1.6	
26-Feb	Laird	90.2	0	1,200	0.0						57.2	1375				29.2	9.4
26-Feb	Gardner	79.5	0	1,000	0.0						58.8	1142				16.7	9.4
TR TOT.			239	25,400	9.4	36	58	41.0	57				0.4	23.5	0.0		
SJR TOT.			0	2,200													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 5

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
12-Mar	OLGB	50.5	0	3,600	0.0						50.2	40				0.2	12.6
12-Mar	R5	48.0	3	2,600	1.2	38	40	39.0	3		49.9	50				0.4	9.7
12-Mar	TRR	42.3	15	3,600	4.2	35	50	41.0	15		54.0	60				0.4	9.5
12-Mar	Hickman	31.6	13	2,800	4.6	38	58	44.0	13		57.0	70				0.9	9.2
12-Mar	Charles	24.9	3	3,400	0.9	50	63	58.0	3		59.8	110				0.9	9.7
12-Mar	Legion	17.2	0	3,600	0.0						62.0	140				2.1	9.6
12-Mar	Service	6.4	0	3,600	0.0						61.7	200				2.3	9.2
12-Mar	Shiloh	3.4	0	2,400	0.0						65.0	210				2.3	9.3
12-Mar	Laird	90.2	0	1,200	0.0						62.5	1550				8.8	10.1
12-Mar	Gardner	79.5	0	1,600	0.0						62.7	1240				10.7	10.5
TR TOT.			34	25,600	1.3	35	63	44.0	34				1.8	1.6	0.0		
SJR TOT.			0	2,800													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 6

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
26-Mar	OLGB	50.5	0	3,600	0.0						51.5	40				0.5	9.2
26-Mar	R5	48.0	4	3,000	1.3	31	55	39.0	4		51.2	40				1.4	10.1
26-Mar	TRR	42.3	19	3,600	5.3	40	74	46.0	19		55.0	60				0.4	10.0
26-Mar	Hickman	31.6	28	2,800	10.0	43	75	58.0	28		59.0	70				0.7	10.0
26-Mar	Charles	24.9	0	3,600	0.0						61.2	110				0.5	10.9
26-Mar	Legion	17.2	0	3,600	0.0						63.1	150				0.6	11.1
26-Mar	Service	6.4	0	3,600	0.0						63.9	170				3.1	10.5
26-Mar	Shiloh	3.4	0	2,000	0.0						65.2	220				4.2	10.2
26-Mar	Laird	90.2	0	-							64.3	1780				8.6	11.2
26-Mar	Gardner	79.5	0	1,200	0.0						64.4	1290				14.9	10.9
TR TOT.			51	25,800	2.0	31	75	52.0	51				2.3	2.8	0.0		
SJR TOT.			0	1,200	0.0												

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 7

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
9-Apr	OLGB	50.5	0	3,600	0.0						51.6	36				1.1	9.7
9-Apr	R5	48.0	0	2,400	0.0						51.1	41				0.3	10.2
9-Apr	TRR	42.3	7	3,400	2.1	40	69	56.0	7		56.7	60				0.7	9.9
9-Apr	Hickman	31.6	34	1,600	21.3	56	83	67.0	34		59.9	57				0.9	9.9
9-Apr	Charles	24.9	1	3,600	0.3	90	90	90.0	1		64.4	107				1.8	9.6
9-Apr	Legion	17.2	0	2,400	0.0						65.9	141				1.1	10.7
9-Apr	Service	6.4	0	2,400	0.0						65.0	184				1.6	10.6
10-Apr	Shiloh	3.4	0	2,000	0.0						69.0	199				6.4	9.3
10-Apr	Laird	90.2	0	1,200	0.0						63.8	1377				16.0	9.2
10-Apr	Gardner	79.5	0	1,400	0.0						62.6	1082				18.7	9.0
TR TOT.			42	21,400	2.0	40	90	66.0	42				0.7	4.6	0.0		
SJR TOT.			0	2,600													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 8

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
23-Apr	OLGB	50.5	0	1,200	0.0						50.5	40				0.6	9.4
23-Apr	R5	48.0	1	3,200	0.3	56	56	56.0	1		50.6	40				0.2	9.4
23-Apr	TRR	42.3	2	3,600	0.6	70	80	75.0	2		52.2	40				1.4	10.1
23-Apr	Hickman	31.6	0	2,000	0.0						57.0	40				0.7	9.7
23-Apr	Charles	24.9	0	-	-												
23-Apr	Legion	17.2	0	2,150	0.0						61.6	50				0.8	9.9
23-Apr	Service	6.4	0	480	0.0						64.4	60				2.3	9.4
23-Apr	Shiloh	3.4	0	1,200	0.0						67.5	60				12.3	8.2
23-Apr	Laird	90.2	0	1,200	0.0						66.4	1070				19.7	9.8
23-Apr	Gardner	79.5	0	1,800	0.0						67.5	440				2.6	8.4
TR TOT.			3	13,830	0.2	56	80	69.0	3				0.4	0.0	0.0		
SJR TOT.			0	3,000													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 9

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft^2)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
7-May	OLGB	50.5	0	1,950	0.0						54.0	40				1.4	12.1
7-May	R5	48.0	7	1,800	3.9	53	76	64.0	6		53.2	40				1.0	13.2
7-May	TRR	42.3	0	1,800	0.0						57.5	50				0.3	11.6
7-May	Hickman	31.6	50	1,800	27.8	71	107	89.0	48		59.7	50				0.9	11.5
7-May	Charles	24.9	1	1,875	0.5	82	82	82.0	1		62.2	60				0.9	11.2
7-May	Legion	17.2	0	1,500	0.0						65.4	70				1.6	10.6
7-May	Service	6.4	0	1,725	0.0						65.2	90				2.7	10.3
7-May	Shiloh	3.4	0	900	0.0						67.1	90				4.4	10.0
7-May	Laird	90.2	0	675	0.0						71.4	1350				41.1	9.2
7-May	Gardner	79.5	0	800	0.0						68.5	520				15.5	9.9
TR TOT.			58	13,350	4.3	53	107	86.0	55				1.3	9.9	0.0		
SJR TOT.			0	1,475													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 10

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft²)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
21-May	OLGB	50.5	0	3,600	0.0						52.5	32				0.3	9.5
21-May	R5	48.0	0	3,200	0.0						54.2	35				0.3	10.1
21-May	TRR	42.3	0	-	-	-	-										
21-May	Hickman	31.6	2	2,800	0.7	73	87	80.0	2		69.2	55				0.3	8.5
21-May	Charles	24.9	0	3,400	0.0						71.8	104				0.3	9.3
21-May	Legion	17.2	0	2,400	0.0						72.9	118				0.9	9.0
21-May	Service	6.4	0	3,600	0.0						72.8	176				2.0	9.8
21-May	Shiloh	3.4	0	1,800	0.0						76.7	202				3.9	9.5
21-May	Laird	90.2	0	1,200	0.0						72.3	1340				13.8	10.5
21-May	Gardner	79.5	0	2,000	0.0						72.7	880				9.5	10.1
TR TOT.			2	20,800	0.1	73	87	80.0	2				0.0	0.2	0.0		
SJR TOT.			0	3,200													

2013 TUOLUMNE RIVER SEINING STUDY (TID/MID)-SURVEY 11

DATE	LOCATION	RIVER MILE	CATCH	AREA	DENSITY (/1000ft²)	FL MIN	FL MAX	FL AVG	NO. MEAS	MORTS	WATER TEMP	ELEC COND	SECTION DENSITY UPPER	SECTION DENSITY MIDDLE	SECTION DENSITY LOWER	TURB	D.O. (ppm)
4-Jun	OLGB	50.5	0	3,000	0.0						56.7	40				0.4	-
4-Jun	R5	48.0	0	2,800	0.0						58.8	40				0.6	-
4-Jun	TRR	42.3	0	3,600	0.0						69.4	60				0.9	-
4-Jun	Hickman	31.6	0	3,000	0.0						67.2	60				0.9	-
4-Jun	Charles	24.9	0	3,200	0.0						77.5	120				0.8	-
4-Jun	Legion	17.2	0	2,800	0.0						78.5	160				0.7	-
4-Jun	Service	6.4	0	1,800	0.0						78.4	260				2.9	-
4-Jun	Shiloh	3.4	0	1,100	0.0						81.6	260				2.7	9.4
4-Jun	Laird	90.2	0	2,200	0.0						78.5	1300				48.9	-
4-Jun	Gardner	79.5	0	2,000	0.0						79.4	860				14.7	-
TR TOT.			0	21,300	0.0												
SJR TOT.			0	4,200	0.0												

Table 2. Summary of salmon catch by date in the Tuolumne Rivers, 2013. Note: No catch in the San Joaquin River in 2013.

TUOLUMNE RIVER

DATE	SALMON CATCH	AREA (ft^2)	DENSITY (/1000 ft^2)	MINIMUM FL	MAXIMUM FL	AVERAGE FL[a]	NUMBER MEAS.	NUMBER MORTALITIES
15-Jan	31	28,200	1.1	33	48	36.0	31	
29-Jan	814	26,200	31.1	28	92	38.0	146	1
12-Feb	489	25,000	19.6	30	53	38.0	113	
26-Feb	239	25,400	9.4	36	58	41.0	57	
12-Mar	34	25,600	1.3	35	63	44.0	34	
26-Mar	51	25,800	2.0	31	75	52.0	51	
9-Apr	42	21,400	2.0	31	75	52.0	42	
23-Apr	3	13,830	0.2	56	80	69.0	3	
7-May	58	13,350	4.3	53	107	86.0	55	
21-May	2	20,800	0.1	73	87	80.0	2	
4-Jun	0	21,300	0.0	-	-	-	0	
TOTAL:	1,763	246,880	7.1	28	107	47.5	534	1

[a] does not include outlier forklengths in the overall average.

Table 3. Summary table of weekly seine fry and juvenile density by location for the Tuolumne and San Joaquin Rivers, 2013. Density is reported as number of salmon/1000 ft^2.

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area (ft^2)	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
15-Jan	OLGB	22	3,600	22	0	6.1	0.0	6.1	37						
15-Jan	R5	3	3,000	3	0	1.0	0.0	1.0	35						
15-Jan	TRR	6	3,600	6	0	1.7	0.0	1.7	35						
15-Jan	Hickman	0	3,600	0	0	0.0	0.0	0.0							
15-Jan	Charles	0	3,600	0	0	0.0	0.0	0.0							
15-Jan	Legion	0	3,600	0	0	0.0	0.0	0.0							
15-Jan	Service	0	3,600	0	0	0.0	0.0	0.0							
15-Jan	Shiloh	0	3,600	0	0	0.0	0.0	0.0							
15-Jan	Laird	0	1,300	0	0	0.0	0.0	0.0							
15-Jan	Gardner	0	1,400	0	0	0.0	0.0	0.0							
TUOL.TOT.		31	28,200	31	0	1.1	0.0	1.1	36	3.0	0.0	0.0	0.0	0.0	0.0
SJR. TOT.		0	2,700	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL[a]	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
29-Jan	OLGB	5	3,600	5	0	1.4	0.0	1.4	36						
29-Jan	R5	46	3,000	39	0	15.3	0.0	15.3	37						
29-Jan	TRR	499	3,600	50	0	138.6	0.0	138.6	37						
29-Jan	Hickman	262	2,600	50	0	100.8	0.0	100.8	37						
29-Jan	Charles	2	3,600	0	2	0.0	0.6	0.6	90						
29-Jan	Legion	0	3,600	0	0	0.0	0.0	0.0							
29-Jan	Service	0	3,600	0	0	0.0	0.0	0.0							
29-Jan	Shiloh	0	2,600	0	0	0.0	0.0	0.0							
29-Jan	Laird	0	1,200	0	0	0.0	0.0	0.0							
29-Jan	Gardner	0	1,700	0	0	0.0	0.0	0.0							
TUOL.TOT.		814	26,200	144	2	30.6	0.4	31.1	38	53.9	25.9	0.0	0.0	1.0	0.0
SJR. TOT.		0	2,900	0	0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0

[a] Does not include outlier forklengths in overall average.

2013Weekly Summary of TID/MID Seining Study

							Estimated			UPPER SECTION	MIDDLE SECTION	LOWER SECTION	UPPER SECTION	MIDDLE SECTION	LOWER SECTION
Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Density Fry	Density Juvenile	Density Total	Average FL	Density Fry	Density Fry	Density Fry	Density Juvenile	Density Juvenile	Density Juvenile
12-Feb	OLGB	17	3,600	17	0	4.7	0.0	4.7	36						
12-Feb	R5	17	2,400	17	0	7.1	0.0	7.1	36						
12-Feb	TRR	29	3,000	29	0	9.7	0.0	9.7	38						
12-Feb	Hickman	426	3,200	48	2	127.8	5.3	133.1	40						
12-Feb	Charles	0	3,600	0	0	0.0	0.0	0.0							
12-Feb	Legion	0	3,600	0	0	0.0	0.0	0.0							
12-Feb	Service	0	3,600	0	0	0.0	0.0	0.0							
12-Feb	Shiloh	0	2,000	0	0	0.0	0.0	0.0							
12-Feb	Laird	0	1,200	0	0	0.0	0.0	0.0							
12-Feb	Gardner	0	1,200	0	0	0.0	0.0	0.0							
TUOL.TOT.		489	25,000	111	2	19.2	0.3	19.6	38	7.0	39.3	0.0	0.0	1.6	0.0
SJR. TOT.		0	2,400	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

							Estimated			UPPER SECTION	MIDDLE SECTION	LOWER SECTION	UPPER SECTION	MIDDLE SECTION	LOWER SECTION
Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Density Fry	Density Juvenile	Density Total	Average FL	Density Fry	Density Fry	Density Fry	Density Juvenile	Density Juvenile	Density Juvenile
26-Feb	OLGB	0	3,600	0	0	0.0	0.0	0.0							
26-Feb	R5	0	2,600	0	0	0.0	0.0	0.0							
26-Feb	TRR	4	3,600	3	1	0.8	0.3	1.1	47						
26-Feb	Hickman	232	2,800	45	4	76.1	6.8	82.9	41						
26-Feb	Charles	3	3,600	3	0	0.8	0.0	0.8	46						
26-Feb	Legion	0	3,600	0	0	0.0	0.0	0.0							
26-Feb	Service	0	3,200	0	0	0.0	0.0	0.0							
26-Feb	Shiloh	0	2,400	0	0	0.0	0.0	0.0							
26-Feb	Laird	0	1,200	0	0	0.0	0.0	0.0							
26-Feb	Gardner	0	1,000	0	0	0.0	0.0	0.0							
TUOL.TOT.		239	25,400	51	5	8.6	0.8	9.4	41	0.3	21.7	0.0	0.1	1.8	0.0
SJR. TOT.		0	2,200	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
12-Mar	OLGB	0	3,600	0	0	0.0	0.0	0.0							
12-Mar	R5	3	2,600	3	0	1.2	0.0	1.2	39						
12-Mar	TRR	15	3,600	15	0	4.2	0.0	4.2	41						
12-Mar	Hickman	13	2,800	11	2	3.9	0.7	4.6	44						
12-Mar	Charles	3	3,400	1	2	0.3	0.6	0.9	58						
12-Mar	Legion	0	3,600	0	0	0.0	0.0	0.0							
12-Mar	Service	0	3,600	0	0	0.0	0.0	0.0							
12-Mar	Shiloh	0	2,400	0	0	0.0	0.0	0.0							
12-Mar	Laird	0	1,200	0	0	0.0	0.0	0.0							
12-Mar	Gardner	0	1,600	0	0	0.0	0.0	0.0							
TUOL.TOT.		34	25,600	30	4	1.2	0.2	1.3	44	1.8	1.2	0.0	0.0	0.4	0.0
SJR. TOT.		0	2,800	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
26-Mar	OLGB	0	3,600	0	0	0.0	0.0	0.0							
26-Mar	R5	4	3,000	3	1	1.0	0.3	1.3	39						
26-Mar	TRR	19	3,600	17	2	4.7	0.6	5.3	46						
26-Mar	Hickman	28	2,800	1	27	0.4	9.6	10.0	58						
26-Mar	Charles	0	3,600	0	0	0.0	0.0	0.0							
26-Mar	Legion	0	3,600	0	0	0.0	0.0	0.0							
26-Mar	Service	0	3,600	0	0	0.0	0.0	0.0							
26-Mar	Shiloh	0	2,000	0	0	0.0	0.0	0.0							
26-Mar	Laird	0	-	0	0	0.0	0.0	0.0							
26-Mar	Gardner	0	1,200	0	0	0.0	0.0	0.0							
TUOL.TOT.		51	25,800	21	30	0.8	1.2	2.0	52	2.0	0.1	0.0	0.3	2.7	0.0
SJR. TOT.		0	1,200	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Density Fry	Estimated Density Juvenile	Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
9-Apr	OLGB	0	3,600	0	0	0.0	0.0	0.0							
9-Apr	R5	0	2,400	0	0	0.0	0.0	0.0							
9-Apr	TRR	7	3,400	1	6	0.3	1.8	2.1	56						
9-Apr	Hickman	34	1,600	0	34	0.0	21.3	21.3	67						
9-Apr	Charles	1	3,600	0	1	0.0	0.3	0.3	90						
9-Apr	Legion	0	2,400	0	0	0.0	0.0	0.0							
9-Apr	Service	0	2,400	0	0	0.0	0.0	0.0							
9-Apr	Shiloh	0	2,000	0	0	0.0	0.0	0.0							
9-Apr	Laird	0	1,200	0	0	0.0	0.0	0.0							
9-Apr	Gardner	0	1,400	0	0	0.0	0.0	0.0							
TUOL.TOT.		42	21,400	1	41	0.05	1.92	2	66	0.1	0.0	0.0	0.6	4.6	0.0
SJR. TOT.		0	2,600	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Density Fry	Estimated Density Juvenile	Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
23-Apr	OLGB	0	1,200	0	0	0.0	0.0	0.0							
23-Apr	R5	1	3,200	0	1	0.0	0.3	0.3	56						
23-Apr	TRR	2	3,600	0	2	0.0	0.6	0.6	75						
23-Apr	Hickman	0	2,000	0	0	0.0	0.0	0.0							
23-Apr	Charles	-	-	0	0	0.0	0.0	0.0							
23-Apr	Legion	0	2,150	0	0	0.0	0.0	0.0							
23-Apr	Service	0	480	0	0	0.0	0.0	0.0							
23-Apr	Shiloh	0	1,200	0	0	0.0	0.0	0.0							
23-Apr	Laird	0	1,200	0	0	0.0	0.0	0.0							
23-Apr	Gardner	0	1,800	0	0	0.0	0.0	0.0							
TUOL.TOT.		3	13,830	0	3	0.0	0.2	0.2	69	0.0	0.0	0.0	0.4	0.0	0.0
SJR. TOT.		0	3,000	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
7-May	OLGB	0	1,950	0	0	0.0	0.0	0.0							
7-May	R5	7	1,800	0	6	0.0	3.9	3.9	64						
7-May	TRR	0	1,800	0	0	0.0	0.0	0.0							
7-May	Hickman	50	1,800	0	48	0.0	27.8	27.8	89						
7-May	Charles	1	1,875	0	1	0.0	0.5	0.5	82						
7-May	Legion	0	1,500	0	0	0.0	0.0	0.0							
7-May	Service	0	1,725	0	0	0.0	0.0	0.0							
7-May	Shiloh	0	900	0	0	0.0	0.0	0.0							
7-May	Laird	0	675	0	0	0.0	0.0	0.0							
7-May	Gardner	0	800	0	0	0.0	0.0	0.0							
TUOL.TOT.		58	13,350	0	55	0.0	4.3	4.3	86	0.0	0.0	0.0	1.3	9.9	0.0
SJR. TOT.		0	1,475	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
21-May	OLGB	0	3,600	0	0	0.0	0.0	0.0							
21-May	R5	0	3,200	0	0	0.0	0.0	0.0							
21-May	TRR	0	-	0	0	0.0	0.0	0.0							
21-May	Hickman	2	2,800	0	2	0.0	0.7	0.7	80						
21-May	Charles	0	3,400	0	0	0.0	0.0	0.0							
21-May	Legion	0	2,400	0	0	0.0	0.0	0.0							
21-May	Service	0	3,600	0	0	0.0	0.0	0.0							
21-May	Shiloh	0	1,800	0	0	0.0	0.0	0.0							
21-May	Laird	0	1,200	0	0	0.0	0.0	0.0							
21-May	Gardner	0	2,000	0	0	0.0	0.0	0.0							
TUOL.TOT.		2	20,800	0	2	0.0	0.1	0.1	80	0.0	0.0	0.0	0.0	0.2	0.0
SJR. TOT.		0	3,200	0	0	0.0	0.0	0.0							

2013Weekly Summary of TID/MID Seining Study

Date	Location	Total Catch	Area	Meas. Fry	Meas. Juveniles	Estimated Density Fry	Estimated Density Juvenile	Estimated Density Total	Average FL	UPPER SECTION Density Fry	MIDDLE SECTION Density Fry	LOWER SECTION Density Fry	UPPER SECTION Density Juvenile	MIDDLE SECTION Density Juvenile	LOWER SECTION Density Juvenile
4-Jun	OLGB	0	3,000	0	0	0.0	0.0	0.0							
4-Jun	R5	0	2,800	0	0	0.0	0.0	0.0							
4-Jun	TRR	0	3,600	0	0	0.0	0.0	0.0							
4-Jun	Hickman	0	3,000	0	0	0.0	0.0	0.0							
4-Jun	Charles	0	3,200	0	0	0.0	0.0	0.0							
4-Jun	Legion	0	2,800	0	0	0.0	0.0	0.0							
4-Jun	Service	0	1,800	0	0	0.0	0.0	0.0							
4-Jun	Shiloh	0	1,100	0	0	0.0	0.0	0.0							
4-Jun	Laird	0	2,200	0	0	0.0	0.0	0.0							
4-Jun	Gardner	0	2,000	0	0	0.0	0.0	0.0							
TUOL.TOT.		0	21,300	0	0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
SJR. TOT.		0	4,200	0	0	0.0	0.0	0.0							

Table 4. Tuolumne, San Joaquin and Stanislaus seining summary, 1986-2013.

TUOLUMNE RIVER						SAN JOAQUIN			STANISLAUS				
Sampling Year	Sampling Periods	Salmon Captured	Sites Sampled	Average Density (/1000ft^2)	Growth Rate Index (mm/day)	Salmon Captured	Sites Sampled	Average Density (/1000ft^2)	Salmon Captured	Sites Sampled	Average Density (/1000ft^2)	Start Date	End Date
1986	18	5514	8	20.7	0.45	854	3	14.2	---	---	---	22JAN	27JUN
1987	21	14825	11	22.4	0.45	734	6	1.9	---	---	---	05JAN	04JUN
1988	14	6134	11	14.3	0.58	295	4	2.1	84	1	2.9	05JAN	17MAY
1989	13	10043	11	27.0	0.64	83	3	0.6	1206	1	45.4	05JAN	12MAY
1990	14	2286	11	6.0	0.57	48	3	0.5	---	---	---	04JAN	11MAY
1991	8	120	11	0.5	No estimate	0	3	0	3	1	0.2	15JAN	24MAY
1992	5	144	7	1.2	No estimate	0	3	0	54	1	3.9	27JAN	13MAY
1993	7	124	8	0.8	0.68	0	3	0	6	1	0.3	26JAN	12MAY
1994	7	2068	5	21.6	0.65	2	2	0	---	---	---	25JAN	20MAY
1995	8	512	5	6.1	0.79	43	2	1.1	---	---	---	09FEB	12JUL
1996	8	785	6	7.6	0.66	7	2*	0.2	---	---	---	17JAN	13JUN
1997	10	379	7	2.7	0.48	11	2*	0.4	---	---	---	14JAN	28MAY
1998	10	1950	7	14.4	0.46	99	2	2.5	---	---	---	14JAN	21MAY
1999	10	3443	8	24.6	0.54	560	2	13.6	---	---	---	14JAN	19MAY
2000	10	3213	8	27.0	0.46	19	2	0.6	---	---	---	11JAN	17MAY
2001	11	5567	8	41.3	0.67	83	2	2.6	---	---	---	09JAN	30MAY
2002	10	3486	8	25.6	0.64	0	2	0	---	---	---	15JAN	21MAY
2003	10	5983	8	39.3	0.68	1	2	0	---	---	---	21JAN	28MAY
2004	11	3280	8	19.3	0.55	0	2	0	---	---	---	20JAN	25MAY
2005	10	1341	8	8.9	0.53	8	2*	0.2	---	---	---	19JAN	25MAY
2006	11	1558	8	10.2	0.79	39	2	1.2	---	---	---	20JAN	15JUN
2007	10	204	8	1.5	0.58	0	2	0	---	---	---	17JAN	23MAY
2008	10	198	8	1.4	0.66	0	2	0	---	---	---	22JAN	27MAY
2009	11	779	8	4.7	0.64	0	2	0	---	---	---	13JAN	02JUN
2010	10	386	8	2.9	0.65	0	2	0	---	---	---	26JAN	08JUN
2011	10	164	8	1.2	No estimate	19	2	0.6	---	---	---	19JAN	24MAY
2012	11	1881	8*	6.9	0.47	0	2*	0	---	---	---	18JAN	5JUN
2013	11	1763	8	7.1	0.63	0	2	0	---	---	---	15JAN	4JUN

--- Not Sampled

*All San Joaquin River locations were not always sampled

Table 5. Number of individuals of other species captured by location and date during the 2013 Tuolumne and San Joaquin River seining study. Key to other species codes is in Table 6.

SURVEY 1

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
15-Jan	1	OLGB	50.5																
15-Jan	2	R5	48.4				1											1	
15-Jan	3	TRR	42.0															50	
15-Jan	4	Hickman	31.6																
15-Jan	5	Charles	24.9					5											
15-Jan	6	Legion	17.2																
15-Jan	7	Service	6.4		1			5						1					
15-Jan	8	Shiloh	3.4			1													
15-Jan	9	Laird	90.2			20			2										
15-Jan	10	Gardner	79.5			20			25						8				

SURVEY 2

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
29-Jan	1	OLGB	50.5																
29-Jan	2	R5	48.4		1		2												
29-Jan	3	TRR	42.0					3										38	
29-Jan	4	Hickman	31.6					1											
29-Jan	5	Charles	24.9							1									
29-Jan	6	Legion	17.2					2											
29-Jan	7	Service	6.4			7		1	1										
29-Jan	8	Shiloh	3.4			84													
29-Jan	9	Laird	90.2			120			1										
29-Jan	10	Gardner	79.5			631			2						2				

SURVEY 3

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
12-Feb	1	OLGB	50.5																
12-Feb	2	R5	48.4				2						1					1	
12-Feb	3	TRR	42.0										1					11	
12-Feb	4	Hickman	31.6																
12-Feb	5	Charles	24.9																
12-Feb	6	Legion	17.2			43		1											
12-Feb	7	Service	6.4			2													
12-Feb	8	Shiloh	3.4												1				
12-Feb	9	Laird	90.2			20													
12-Feb	10	Gardner	79.5			575						1							

SURVEY 4

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
26-Feb	1	OLGB	50.5																
26-Feb	2	R5	48.4				3												
26-Feb	3	TRR	42.0		1		1	2										6	
26-Feb	4	Hickman	31.6																
26-Feb	5	Charles	24.9							1									
26-Feb	6	Legion	17.2																
26-Feb	7	Service	6.4																
26-Feb	8	Shiloh	3.4												1				
26-Feb	9	Laird	90.2			520													
26-Feb	10	Gardner	79.5			2									1				

SURVEY 5

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
12-Mar	1	OLGB	50.5																
12-Mar	2	R5	48.4				1												
12-Mar	3	TRR	42.0															10	
12-Mar	4	Hickman	31.6																
12-Mar	5	Charles	24.9																
12-Mar	6	Legion	17.2																
12-Mar	7	Service	6.4																
12-Mar	8	Shiloh	3.4					1							2				
12-Mar	9	Laird	90.2			20						1							
12-Mar	10	Gardner	79.5			50					1				1				

SURVEY 6

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
26-Mar	1	OLGB	50.5																
26-Mar	2	R5	48.4				2											1	
26-Mar	3	TRR	42.0					2										7	
26-Mar	4	Hickman	31.6																
26-Mar	5	Charles	24.9																
26-Mar	6	Legion	17.2																
26-Mar	7	Service	6.4																
26-Mar	8	Shiloh	3.4					8							4				1
26-Mar	9	Laird	90.2																
26-Mar	10	Gardner	79.5			70					4				1				

SURVEY 7

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
9-Apr	1	OLGB	50.5																
9-Apr	2	R5	48.4		1		1												
9-Apr	3	TRR	42.0		1														
9-Apr	4	Hickman	31.6																
9-Apr	5	Charles	24.9																
9-Apr	6	Legion	17.2				1	5											
9-Apr	7	Service	6.4				37												
9-Apr	8	Shiloh	3.4												18		1		2
9-Apr	9	Laird	90.2			20													
9-Apr	10	Gardner	79.5			90		4						1					

SURVEY 8

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
23-Apr	1	OLGB	50.5																
23-Apr	2	R5	48.4																
23-Apr	3	TRR	42.0		1			1											
23-Apr	4	Hickman	31.6																
23-Apr	5	Charles	24.9																
23-Apr	6	Legion	17.2				13	4											
23-Apr	7	Service	6.4			12		1											
23-Apr	8	Shiloh	3.4				12	11							2				
23-Apr	9	Laird	90.2			190								2		1			
23-Apr	10	Gardner	79.5			184	1		1						5				

SURVEY 9

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
7-May	1	OLGB	50.5										2						
7-May	2	R5	48.4	2	1								2						
7-May	3	TRR	42.0															23	
7-May	4	Hickman	31.6	1															
7-May	5	Charles	24.9					3							14				
7-May	6	Legion	17.2																
7-May	7	Service	6.4											1					
7-May	8	Shiloh	3.4																
7-May	9	Laird	90.2			470			1										
7-May	10	Gardner	79.5			55	1		6					1	2				

SURVEY 10

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
21-May	1	OLGB	50.5	3									1						
21-May	2	R5	48.4	2															
21-May	3	TRR	42.0															170	
21-May	4	Hickman	31.6																
21-May	5	Charles	24.9		1			1						5					
21-May	6	Legion	17.2											3					
21-May	7	Service	6.4				1	5					1						
21-May	8	Shiloh	3.4					11											
21-May	9	Laird	90.2			45													
21-May	10	Gardner	79.5			345			1					2					

SURVEY 11

Date	Site	Location	RM	RT	PM	PRS	SKR	GAM	ISS	LMB	SMB	BLP	PSCP	CENT	BG	FHM	GSF	HH	RSF
4-Jun	1	OLGB	50.5	1									1						
4-Jun	2	R5	48.4	1			77						1						
4-Jun	3	TRR	42.0					1											
4-Jun	4	Hickman	31.6											4					
4-Jun	5	Charles	24.9																
4-Jun	6	Legion	17.2																
4-Jun	7	Service	6.4																
4-Jun	8	Shiloh	3.4																
4-Jun	9	Laird	90.2																
4-Jun	10	Gardner	79.5																

Table 6. Key to other species sampled and their distribution. X's denote species captured in 2013.

FAMILY	COMMON NAME	NATIVE SPECIES	ABBREV.	SAN JOAQUIN	TUOL.
Salmonidae	Chinook salmon	N	CS		X
Salmonidae	rainbow trout	N	RT		X
Cyprinidae	hardhead	N	HH		X
Cyprinidae	Sacramento pikeminnow	N	PM		X
Cyprinidae	red shiner		PRS	X	X
Cyprinidae	fathead minnow		FHM	X	
Catostomidae	Sacramento sucker	N	SKR	X	X
Poeciliidae	western mosquitofish		GAM	X	X
Atherinidae	inland silverside		ISS	X	X
Percichthyidae	striped bass		SB		X
Centrarchidae	green sunfish		GSF		X
Centrarchidae	bluegill		BG	X	X
Centrarchidae	redear sunfish		RSF		X
Centrarchidae	largemouth bass		LMB		X
Centrarchidae	smallmouth bass		SMB	X	
Percidae	bigscale logperch		BLP	X	X
Cottidae	prickly sculpin	N	PSCP		X
TOTAL:	32			8	15

Table 7. Summary of *O. mykiss* caught during the 2013 seining study.

Date	Location	River Mile	Rainbow Catch	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Average Fork Length (mm)
5/7/13	R5	48.0	2	28	42	35
5/7/13	HICKMAN	31.6	1	75	75	75
5/21/13	OLGB	50.5	3	30	36	33
5/21/13	R5	48	2	36	43	40
6/4/13	OLGB	50.5	1	26	26	26
6/4/13	R5	48.0	1	40	40	40

Table 8. Summary table of locations sampled, 1986-2013.

Site	Location	River Mile	1986	1987[a]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
TUOLUMNE RIVER																														
1	Old La Grange Bridge	50.5	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Riffle 4B	48.4	X	X	X	X	X	X				X	X	X	X								X					X		
3	Riffle 5	47.9		X	X	X	X	X	X	X	X					X	X	X	X	X	X	X		X	X	X	X		X	X
4	Tuolumne River Resort	42.4			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
5	Turlock Lake State Recreation Area	42.0	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	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	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	X
10	RPD/Service Rd./Venn	12.3-7.4		X	X	X	X	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	X
SAN JOAQUIN RIVER																														
13	Laird Park	90.2	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	X
14	Gardner Cover	77.8		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
15	Maze Road	76.6	X	X	X																									
16	Sturgeon Bend	74.3		X	X																									
17	Durham Ferry Park	71.3	X	X	X	X	X	X	X																					
18	Old River	53.7		X																										
STANISLAUS RIVER																														
19	Caswell State Park	8.5			X	X		X	X	X																				
DRY CREEK																														

[a] In 1987, additional sites on the Tuolumne, San Joaquin, Merced, and Stanislaus River were sampled occasionally (1987 annual report).

20	Beard Brook Park	0.5	X	X

Table 9. Tuolumne River analysis of female spawners to fry density.

Escapement Year	Total Female Spawners[a]	Outmigration Year	Juvenile Seining: Peak Fry Density 15JAN-15MAR	Juvenile Seining: Average Fry Density 15JAN-15MAR
1985	22600	1986	158.8	59.5
1986	3800	1987	69.3	46.2
1987	4600	1988	70.2	33.9
1988	4100	1989	115.1	39.7
1989	680	1990	11.4	5.0
1990	28	1991	1.3	0.5
1991	28	1992	6.1	2.9
1992	55	1993	1.7	0.9
1993	237	1994	79.5	41.5
1994	249	1995	12.5	9.8
1995	522	1996	16.1	13.0
1996	1142	1997	2.8	2.1
1997	4224	1998	49.3	24.6
1998	4527	1999	78.0	39.3
1999	3535	2000	78.8	48.0
2000	11260	2001	126.3	85.6
2001	4970	2002	92.8	41.5
2002	3876	2003	164.3	68.8
2003	1768	2004	38.8	27.2
2004	1004	2005	20.5	14.6
2005	478	2006	28.7	12.7
2006	282	2007	3.7	2.2
2007	80	2008	2.4	1.7
2008	212	2009	9.7	4.8
2009	170	2010	6.1	3.5
2010	258	2011	3.6	2.0
2011	712	2012	16.8	10.0
2012	806	2013	30.6	12.1

[a]Female spawner data from 1985-2008 were obtained from CDFG annual carcass surveys; 2009-2012 data was obtained from annual monitoring at the Tuolumne River weir.

Table 10. Occurrence of other species captured in the Tuolumne River, 1986-2013.

TUOLUMNE RIVER																															
Family	Common Name	Native Species	Code	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Petromyzontidae	Pacific lamprey	N	LP	X	X															X		X								
Clupeidae	threadfin shad		TFS	X	X	X	X							X	X			X												
Salmonidae	Chinook salmon	N	CS	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
Salmonidae	rainbow trout	N	RT	X	X	X									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinidae	carp		CP	X																			X					X		
Cyprinidae	goldfish		GF			X																								
Cyprinidae	golden shiner		GSH	X	X	X	X		X	X	X	X							X		X		X		X	X	X			
Cyprinidae	Sacramento blackfish	N	SBF	X																										
Cyprinidae	hardhead	N	HH	X	X	X				X		X						X	X		X	X	X	X	X	X	X	X		X
Cyprinidae	Sacramento pikeminnow	N	PM	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
Cyprinidae	Sacramento splittail	N	ST		X	X	X																							
Cyprinidae	red shiner		PRS				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinidae	fathead minnow		FHM														X													
Catostomidae	Sacramento sucker	N	SKR	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
Ictaluridae	channel catfish		CCF			X											X			X						X	X			
Ictaluridae	white catfish		WCF	X		X	X		X		X	X						X												
Ictaluridae	back bullhead		BLBH					X																						
Ictaluridae	brown bullhead		BBH									X																		
Poeciliidae	western mosquitofish		GAM	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
Atherinidae	inland silverside		ISS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X			X
Percichthyidae	striped bass		SB															X												
Centrarchidae	white/black crappie		WCR/BCR			X																								
Centrarchidae	warmouth		WM								X																			
Centrarchidae	green sunfish		GSF	X		X	X	X	X	X	X		X				X	X	X	X	X	X	X			X	X			X
Centrarchidae	bluegill		BG	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Centrarchidae	redear sunfish		RSF			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
Centrarchidae	largemouth bass		LMB	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X
Centrarchidae	smallmouth bass		SMB	X	X	X	X	X	X	X		X						X	X	X	X				X	X	X			
Percidae	bigscale logperch		BLP		X				X	X			X		X	X								X	X					
Embiotocidae	tule perch	N	TP																											
Cottidae	prickly sculpin	N	PSCP		X								X	X	X						X	X	X					X	X	X
Cottidae	riffle sculpin	N	RSCP	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
TOTAL:	32			18	16	20	16	12	15	15	13	15	12	11	14	11	14	17	15	15	16	15	16	12	15	15	16	11	6	12

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-4

Outmigrant Trapping of Juvenile Salmon in the Lower Tuolumne River, 2013

Prepared by

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Submitted To:
Turlock Irrigation District
Modesto Irrigation District

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INTRODUCTION

Study Area Description

The Tuolumne River is the largest of three major tributaries (Tuolumne, Merced, and Stanislaus Rivers) to the San Joaquin River. The Tuolumne River originates in Yosemite National Park, in the central Sierra Nevada Mountains, and flows 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 the purposes of power generation, water storage, and flood control – the largest impoundment is Don Pedro Reservoir.

The lower Tuolumne River corridor extends from the 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.

Purpose and History of Study

Rotary screw traps (RST) have been operated since 1995 at various locations in the Tuolumne River during the winter/spring period. RST monitoring was intended to meet several objectives including estimating abundance and migration characteristics of juvenile salmonids and other fishes, and evaluating reach survival relative to environmental conditions (Figure 1). The Turlock Irrigation District and Modesto Irrigation District ('Districts'), and the City and County of San Francisco have funded the majority of the RST monitoring efforts in the Tuolumne River.

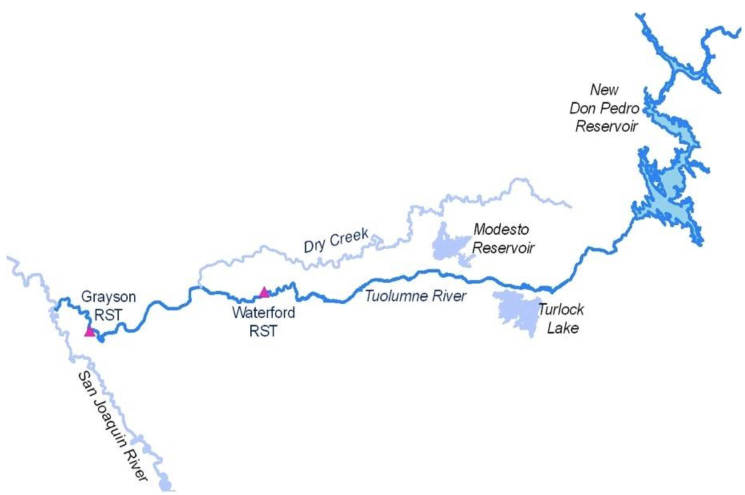

Figure 1. Location map of study area on the Tuolumne River.

Current sampling locations are Grayson River Ranch (Grayson – RM 5.2) near the mouth of the Tuolumne River and a site downstream of the City of Waterford (RM 29.8). Rotary screw trapping has been conducted annually near the mouth of the Tuolumne River since 1995 (Shiloh from 1995-1998; and Grayson from 1999-2013). Since 2006, sampling has also been conducted annually near Waterford, approximately 25 miles upstream of the Grayson site, to provide comparative information on the size, migration timing, and production of juvenile fall-run Chinook salmon, as well as data on other fishes.

Table 1. Rotary screw trap monitoring in the Lower Tuolumne River, 1995-2013.

Year	*Site*	*Period Sampled*	*Proportion of Outmigration Period Sampled*	*Total Catch*	*Total Estimated Passage*	*Results Reported In*
1995	Shiloh (RM 3.4)	Apr 25-Jun 01	24%	141	15,667[1]	Heyne and Loudermilk 1997
1996	Shiloh	Apr 18 - May 29	27%	610	40,385[1]	
1997	Shiloh	Apr 18 - May 24	24%	57	2,850[1]	Heyne and Loudermilk 1998
1998	Turlock Lake State Rec. (RM 42.0)	Feb 11-Apr 13	41%	7,125	259,581[1]	Vick and others 1998
	7/11 (RM 38.5)	Apr 15-May 31	31%	2,413		
	Charles Road (RM 25.0)	Mar 27-Jun 01	43%	981	66,848[1]	
	Shiloh	Feb 15-Jul 01	70%	2,546	1,615,673[1]	Blakeman 2004a
1999	7/11	Jan 19-May 17	79%	80,792	1,737,052[1]	Vick and others 2000
	Hughson (RM 23.7)	Apr 08-May 24	31%	449	7,175[1]	
	Grayson (RM 5.2)	Jan 12-Jun 06	93%	19,327	869,636[2]	Vasques and Kundargi 2001
2000	7/11	Jan 10-Feb 27	32%	61,196	298,755[1]	Hume and others 2001
	Deardorff (RM 35.5)	Apr 09-May 25	31%	634	15,845[1]	
	Hughson	Apr 09-May 25	31%	264	2,942[1]	
	Grayson	Jan 09-Jun 12	95%	2,250	107,617[2]	Vasques and Kundargi 2001
2001	Grayson	Jan 03-May 29	97%	6,478	106,580[2]	Vasques and Kundargi 2002
2002	Grayson	Jan 15-Jun 06	91%	436	13,928[2]	Blakeman 2004b
2003	Grayson	Apr 01-Jun 06	40%	359	9,074[2]	Blakeman 2004c
2004	Grayson	Apr 01-Jun 09	40%	509	17,600[2]	Fuller 2005

[1] Passage estimate reported in the annual report cited.
[2] Passage estimate derived from multiple regression equation based on data collected from 1999-2006 and 2008.

Year	*Site*	*Period Sampled*	*Proportion of Outmigration Period Sampled*	*Total Catch*	*Total Estimated Passage*	*Results Reported In*
2005	Grayson	Apr 02-Jun 17	39%	1,317	254,981[2]	Fuller and others 2006
2006	Waterford 1 (RM 29.8)	Jan 25-Apr 12	79%	8,648	364,494[3]	Fuller and others 2007
	Waterford 2 (RM 33.5)	Apr 21-Jun 21		458	134,872[3]	
	Grayson	Jan 25-Jun 22	84%	1,594	84,987[3]	
2007	Waterford (RM 29.8)	Jan 11-Jun 05	93%	3,312	52,841[3]	Fuller 2008
	Grayson	Mar 23-May 29	45%	27	952[3]	
2008	Waterford	Jan 8-Jun 2	96%	3,350	49,527[3]	Palmer and Sonke 2008
	Grayson	Jan 29-Jun 4	82%	193	3,020[3]	
2009	Waterford	Jan 7- Jun 9	96%	3,725	54,517[3]	Palmer and Sonke 2010
	Grayson	Jan 8-Jun 11	95%	155	4,072[3]	
2010	Waterford	Jan 5-Jun 11	97%	2,281	74,520[3]	Sonke and others 2010
	Grayson	Jan 6-Jun 17	97%	52	2,056[3]	
2011	Waterford	Dec 5-Jun 30	100%	4,394	365,904[3]	Sonke and others 2012
	Grayson	Jan 6-Jun 30	97%	1,645	95,156[3]	
2012	Waterford	Jan 3-Jun 15	99%	3,696	62,076[3]	Sonke and others 2013
	Grayson	Jan 3-Jun 15	99%	85	2,268[3]	
2013	Waterford	Jan 2-May 31	99.3%	3,103	40,387[3]	This report
	Grayson	Jan 3-May 23	93.3%	35	642[3]	

[3] Estimates derived using a linear regression model reported in Robichaud and English 2013.

METHODS

Juvenile Outmigrant Monitoring

Sampling Gear and Trapping Site Locations

Rotary screw traps (E.G. Solutions, Eugene, OR) were installed and operated at the Waterford and Grayson sites. The traps consist of a funnel-shaped core suspended between two pontoons. Traps are positioned in the current so that water enters the 8 ft wide funnel mouth and strikes the internal screw core, causing the funnel to rotate. As the funnel rotates, fish are trapped in pockets of water and moved rearward into a livebox where they remain until they are processed by technicians.

The single Waterford trap was located at RM 29.8, approximately two miles downstream of the Hickman Bridge. The trap was held in place by a 3/8-inch overhead cable strung between two large trees located on opposite banks. Cables fastened to the front of each pontoon were attached to the overhead cable. For public safety reasons, warning signs, flashing safety lights and buoys marked the location of the trap and cables. Sufficient velocity at the trap during 2010-2013 precluded the need for the "weir" structure used to increase catch efficiency during 2008 and a portion of 2009.

At Grayson two traps were fastened together in a side-by-side configuration, with ½ inch Ultra High Molecular Weight (UHMW) plastic strips that were bolted to each inner-pontoon at the cross-bars. The traps were positioned and secured in place by two 50 lb plow-style anchors (Delta Fast-Set model, Lewmar, Havant, UK). The anchors were fastened to the outer-pontoons of the traps using 3/8-inch stainless steel leader cables (each outer-pontoon was attached to a separate in-line anchor) and the length of each leader cable was adjusted using a manual winch that was bolted to the outer-pontoon. The downstream force of the water on the traps kept the leader cables taut. The "weir" structure used to increase catch efficiency during the 2008, 2009, and 2012 season was installed on February 13, 2013, and remained in place for the remainder of the season.

Trap Monitoring

Sampling at Waterford began on January 2, 2013. The trap was operated continuously (24 hours per day, 7 days per week) until May 31, 2013, when sampling was terminated due to low catch.

Sampling at Grayson began on January 3, 2013. The traps were operated continuously (24 hours per day, 7 days per week) until sampling was terminated on May 23, 2013 due to low catch.

Traps at both locations were checked at least every morning throughout the sampling period, with additional trap checks conducted as conditions required. During each trap check, the contents of the liveboxes were removed, all fish were identified and enumerated, and any marked fish were noted. In addition, random samples of fish were collected to assess size and growth rate. At each RST, up to 50 Chinook salmon and 20 individuals of each non-salmon species were randomly collected during each morning check, and up to 20 Chinook salmon and 10 individuals of each non-salmon species were collected during each evening check. These fish were anesthetized with Tricaine-S, measured (fork length in millimeters), and recorded. Chinook salmon were assigned to a lifestage category based on a fork length scale, where <50 mm = fry, 50-69 mm = parr, and $\geq$ 70 mm = smolt. In addition, the smolting appearance of all measured Chinook salmon and *O. mykiss* was rated based on a seven category scale, where 1 = yolk-sac fry, 2 = fry, 3 = parr, 4 = silvery parr, 5 = smolt, 6 = mature adult, and IAD = immature adult (Interagency Ecological Program, unpublished). Weights (to nearest tenth of a gram) were taken from up to 50 Chinook salmon each week (i.e., Monday through Sunday) and from all *O. mykiss* using a digital balance (Ohaus Corporation, Pine Brook, NJ). Fish were weighed in a small, plastic container partially filled with stream water, which was tared prior to measuring each individual fish. Fish were then placed in a bucket with freshwater and allowed to recover before release.

Daily salmon catch was equivalent to the number of salmon captured during a morning trap check, plus the number of salmon captured during any trap check(s) that occurred within the period after the previous morning check. For example, the daily salmon catch for April 10 is the sum of salmon from the morning trap check on April 10 and the evening trap check conducted on April 9. Separate daily catch data was maintained for marked (i.e., dye inoculated fish used for trap efficiency tests) and unmarked Chinook salmon.

After all fish were measured and recorded, the traps were cleaned to prevent accumulation of debris that might impair trap rotation or cause fish mortality within the liveboxes. Trap cleaning included removal of debris from all trap surfaces and from within the liveboxes. The amount of debris load in the livebox was estimated and recorded whenever a trap was checked.

Trap Efficiency Releases

Trap efficiency releases using naturally produced juvenile salmon were conducted to estimate the probability of capturing Chinook salmon at the Waterford trap. Juvenile salmon captured in the trap were used to conduct releases whenever catches were sufficient. Twelve groups of naturally produced juvenile salmon (ranging in number from 34 to 144 fish) were marked and released at RM 30 (approximately 0.2 miles upstream of the Waterford trap) between January 13 and March 4 to estimate trap efficiency at the Waterford trap. Catches of naturally produced juvenile salmon at Waterford after March 4 were insufficient for trap efficiency releases. Likewise, catches of natural fish throughout the study period were insufficient for trap efficiency releases to be conducted at Grayson. Hatchery produced fish were not available for releases during 2013.

Marking Procedure

At the Waterford trapping site, naturally produced juvenile salmon were marked onshore immediately adjacent to the trap, and were then transported to the release site where they were held until release. A photonic marking system was used for marking all of the release groups because of the high quality of marks and the ability to use the marking equipment in rapid succession. All fish were anesthetized with Tricaine-S before the appropriate mark was applied. A marker tip was placed against the caudal fin and orange photonic dye was injected into the fin rays. The photonic dye (DayGlo Color Corporation, Cleveland, OH) was chosen because of its known ability to provide a highly visible, long-lasting mark.

Holding Facility and Transport Method

Juvenile salmon were transported from the marking sites to the release sites in either 5-gallon buckets or 20-gallon insulated coolers depending on the number of fish, temperature, and distance traveled.

At the release sites, fish were held in livecars constructed of 15” diameter PVC pipe cut into 34” lengths (Figure 2). A rectangle approximately 6” wide by 23” long was cut longitudinally along the pipe and fitted with aluminum or stainless steel mesh. Livecars were tethered to vegetation or other structures and kept in areas of low water velocity to reduce fish stress.

Figure 2. Livecar used for holding trap efficiency test fish.

Pre-release Sampling

Prior to release, marked fish were sampled for length and mark retention. Fifty fish (or the entire release group if fewer than 50 fish) were randomly selected from each release group, anesthetized, and examined for marks; the remaining fish in each group were enumerated. Mark retention was rated as present or absent. A total of zero fish in 2013 were found to have lost their marks upon examination. Consequently, all fish released were presumed to have visible marks.

Release Procedure

All marked fish were released after nightfall. Livecars were located several feet away from the specific release point, and fish were poured from the live cars into buckets for release. Fish were released by placing a dip net into the bucket, scooping up a "net-full" of fish, and then emptying the fish into the river and allowing them to swim away. After releasing a "net-full" of fish, approximately 30 seconds to 3 minutes time elapsed before another "net-full" was released. The amount of time between “net-full” releases varied depending on how fast fish swam away after they were released. Depending on the group size, total release time for marked groups ranged from eight minutes to 30 minutes.

Monitoring Environmental Factors

Flow Measurements and Trap Speed

Provisional daily average flow for the Tuolumne River at La Grange was obtained from USGS, as downloaded from http://waterdata.usgs.gov. Provisional daily average flow for the Tuolumne River at Modesto was obtained from the USGS, as downloaded from http://waterdata.usgs.gov. The Modesto flow station is below Dry Creek, the largest seasonal tributary entering the river downstream of La Grange Dam. As a result, that site includes flow associated with major winter runoff events. Two methods were used to measure the velocity of water entering the traps. First, instantaneous measurements were taken daily with a Global Flow Probe (Global Water, Fair Oaks, CA). Second, an average daily trap rotation speed was calculated for each trap, by recording the time (measured in seconds) for three continuous revolutions of the cone, once before, and once after, the morning trap cleaning. The average of the two times was considered the average daily trap rotation speed.

River Temperature, Relative Turbidity, and Dissolved Oxygen

Instantaneous water temperature was measured daily with a mercury thermometer at the trap site. Temperature data was also available from hourly recording thermographs maintained by the Districts at both trapping sites. To measure daily instantaneous turbidity, a water sample was collected each morning and later tested at the field station using a LaMotte turbidity meter (Model 2020e, LaMotte Company, Chestertown, MD). Turbidity was recorded in nephelometric turbidity units (NTU). Instantaneous dissolved oxygen was measured during each trap check with an ExStik® II D600 Dissolved Oxygen Meter (Extech Instruments Corporation, Waltham, MA) at the trapping sites and recorded in milligrams per liter (mg/L).

Estimating Chinook Salmon Abundance

The number of fish passing each site each day was estimated using either a linear regression model (Waterford and Grayson 2006-2013), or multiple regression model (Grayson 1999-2005). Annual abundance estimates at each trapping location are presented in Table 1.

Linear regression model

Trap efficiency data collected at Waterford (2006-2013) and Grayson (1999-2013) was used to create a linear regression model in order to predict daily Chinook abundance at each trapping location. Abundance estimates were calculated for Waterford and Grayson using methods described in Robichaud and English (2013). Below is a brief summary of calculations used to estimate abundance.

For each trap efficiency release, the mean fish fork length at release and recapture were calculated. For each release (i) at each trap (t), the percent of flow sampled (Φ_{ti}) was calculated as the ratio of flow through the RST ($F_{RST_{ti}}$) to that of whole-river flow ($F_{RIVER_{ti}}$):

$$(\Phi_{ti}) = F_{RST_{ti}} / F_{RIVER_{ti}} \qquad \text{(Eq. 1)}$$

Flow through each RST was calculated by multiplying the water velocity at the RST by the surface area of the trap. Trap efficiency (i.e., catchability) was calculated as the proportion of the total adjusted number of individuals released that were recaptured. The mean length at release was used to statistically separate the releases by life-history stage. Thus, trap efficiencies were calculated for fry (mean length at release < 50 mm), parr (50 mm ≥ fork length < 69 mm) and smolts (≥ 70 mm).

For each life stage (s) at each trap (t), if sample-size sufficed, catchability (C_{tsi}) was regressed against percent of flow sampled (Φ_{ti}) during trap efficiency release i. Linear regression was used to estimate the slope of the line (m_{ts}), with the intercept forced through 0, as

$$C_{tsi} = (m_{ts} \cdot \Phi_{ti}) \qquad \text{(Eq. 2)}$$

Daily counts of fry, parr, and smolts were summed at each trapping location for all days the traps were sampled each year. The percent of the flow sampled was estimated for each day at each trap as described above. Missing velocity observations were interpolated from adjacent values (except during a short period in 2007 and two long data gaps in 2010; linear regressions were performed on the available 2007 and 2010 data to estimate missing velocity values from flow). Instantaneous measurements of turbidity were also recorded daily at the traps, and daily average water temperatures were obtained from hourly recording thermographs deployed at or near each trap site.

To account for varying catchability, a four-stage process was used to estimate total fish passage (N) from catch numbers, as follows. First, proportional catch contributions (ρ_{jw}) were calculated for the three life stages for each week (w) as:

$$\rho_{tsw} = \frac{A_{tsw}}{\sum_s^3 A_{tsw}} \qquad \text{(Eq. 3)}$$

Where

$$A_{tsw} = \frac{\sum_d^7 O_{tswd}}{\left(m_{ts} \cdot \frac{\sum_d^7 \Phi_{twd}}{7}\right)} \qquad \text{(Eq. 4)}$$

and where O_{tswd} was the observed catch of life stage s at trap t on day d in week w, and Φ_{twd} was the percent flow sampled by trap t on day d in week w. Average catchability was then calculated for each day at each trap, weighted by the proportional life-stage-specific catch contributions, as:

$$\overline{C_{twd}} = \sum_s^3 \left[\rho_{tsw} \cdot (m_{ts} \cdot \Phi_{td}) \right] \qquad \text{(Eq. 5)}$$

Third, daily total Chinook salmon passage was calculated by dividing total observed catch (of all life stages combined) by the weighted average catchability:

$$N_{twd} = \frac{\sum_s^3 O_{tswd}}{\overline{C_{twd}}} \qquad \text{(Eq. 6)}$$

Lastly, the daily total Chinook salmon passage was partitioned into the three life stages, based on the proportional catch rates from Equation 3:

$$N_{tswd} = N_{twd} \cdot \rho_{tsw} \qquad \text{(Eq. 7)}$$

If total fish passage on a given day was below the level of measurement error (i.e., the inverse of catchability for that day), this method produced passage estimates of zero fish.

Multiple Regression Model

Juvenile salmon abundance at Grayson prior to 2006 was estimated using a multiple regression equation developed from trap efficiency data collected from 1999 through 2008 and 2011. Specifically, average daily river flow at Modesto, average fish size at release, and proportions of fish (natural log transformed) recovered from each release event, were used in order to develop the following trap efficiency predictor equation (adjusted R^2 =0.62):

> Daily Predicted Trap Efficiency= EXP(-0.479988+(-0.00043*flow at MOD)+(-0.03153* fish size))

Where flow at MOD= daily average river flow (cfs) at Modesto and fish size= daily average fork length (mm) of fish captured at Grayson
These daily predicted trap efficiencies (DPTE) were then applied to the daily catch (DC) to estimate daily passage as follows:

$$\text{Estimated Daily Passage} = DC/DPTE$$

RESULTS AND DISCUSSION

Chinook Salmon

<u>*Number of Unmarked Chinook Salmon Captured*</u>

The fall-run juvenile salmon outmigration in the San Joaquin Basin typically occurs during the winter and spring, extending primarily from January through May. The outmigration consists primarily of fry in winter (typically <50 mm fork length), and smolts in spring (typically >69 mm fork length). It is not uncommon to observe some larger fish migrating in winter and some fry migrating in late spring. These fish may be the progeny of individuals that spawned outside the reproductive period typical of fall-run Chinook salmon.

During 2013, daily catches of juvenile salmon at Waterford ranged from zero to 158 fish (Figure 3), with a total catch of 3,103 salmon (Table 2). Catches of juvenile Chinook salmon at Waterford were highest from mid-January to mid-March (peaking on February 25), and primarily consisted of fry (<50 mm; Figure 3) Daily salmon catch during this period was variable and did not correlate with trends in flow or turbidity which were both low and realtively stable (Figure 3). During late-April catches increased in response to brief pulse flow spikes of approximately 600 cfs and 800 cfs.

At Grayson, daily catches of juvenile salmon ranged from zero to 9 fish (Figure 4), with a total catch of 35 juvenile salmon captured (Table 2). Nearly all (94%) juvenile salmon captured at Grayson during 2013 were smolts, and were captured during the pulse flow period between mid-April and early May.

Table 2. Catch by lifestage at Waterford and Grayson, 2013.

Trapping Site	*Fry (<50 mm)*	*Parr (50-69 mm)*	*Smolt (≥ 70 mm)*
Waterford	2,230	305	568
Grayson	1	1	33

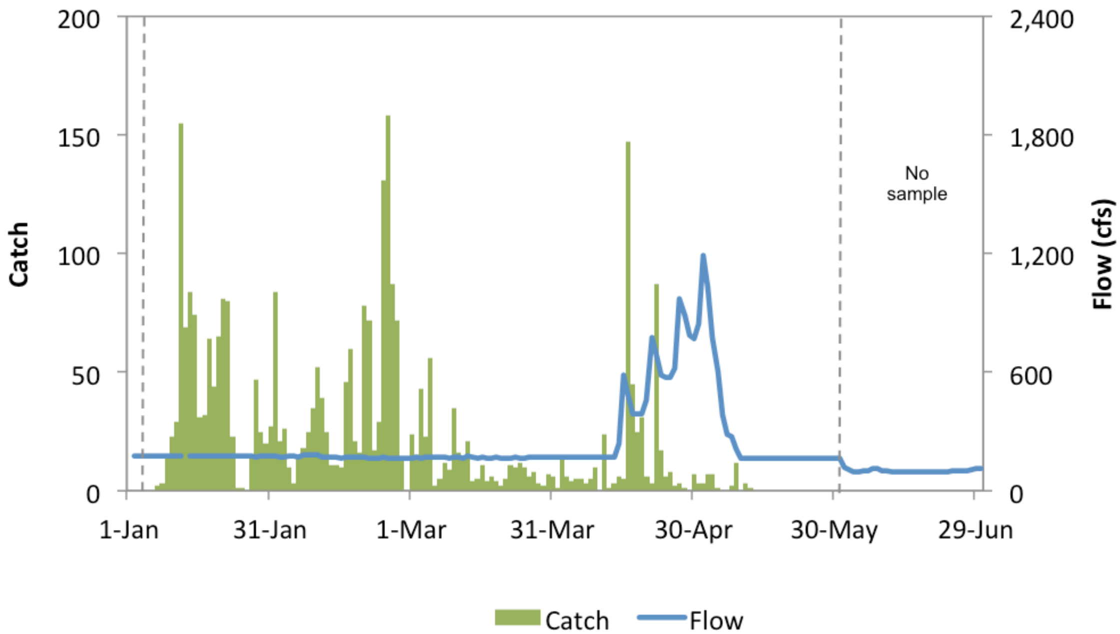

Figure 3. Daily catch of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2013.

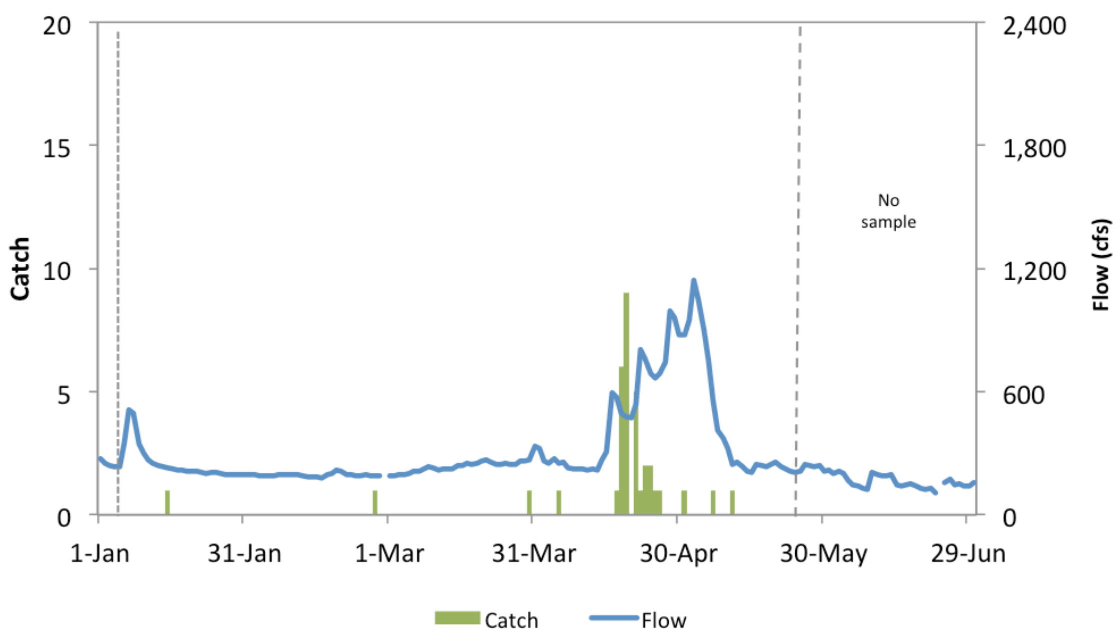

Figure 4. Daily catch of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2013.

Trap Efficiency Releases

Twelve trap efficiency releases were conducted during 2013 at Waterford using naturally produced salmon fry and parr/smolt at low flows (i.e., less than 1,000 cfs). Resulting efficiency estimates from these releases ranged from 1.9% to 22.2% at flows (La Grange) between 166 cfs and 176 cfs (Table 3). Results from trap efficiency releases at Waterford from 2006-2013 were used to derive the linear regression model for predicting Chinook abundance, and the observed efficiencies ranged from 0% to 34.4% at flows (La Grange) between 165 cfs and 8,870 cfs (Table 3; Figure 5).

No trap efficiency tests were conducted at Grayson in 2013. Observed trap efficiency estimates from 1999-2008 and 2011 were used to derive the linear regression model for predicting daily Chinook abundance, and the observed efficiencies ranged from zero to 21.2% at flows (Modesto) between 280 cfs and 7,942 cfs (Figure 6).

Daily catch, predicted catchability, and estimated passage at Waterford and Grayson during 2013 are provided in Appendices A and B, respectively.

Table 3. Trap efficiency results from 2013 used to update the linear regression model at Waterford.

Release Date	Origin	Mark	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) LGN
1/13/13	WILD	CFO	144	32	22.2%	34.6	34.7	176
1/14/13	WILD	CFO	68	9	13.2%	35.0	35.7	176
1/21/13	WILD	CFO	63	6	9.5%	35.7	35.2	174
1/22/13	WILD	CFO	74	5	6.8%	36.3	35.8	175
2/2/13	WILD	CFO	83	8	9.6%	36.3	37.6	172
2/11/13	WILD	CFO	47	3	6.4%	37.7	37.3	173
2/12/13	WILD	CFO	34	7	20.6%	36.9	36.7	173
2/18/13	WILD	CFO	54	1	1.9%	38.0	37.0	169
2/21/13	WILD	CFO	69	5	7.2%	37.2	37.0	167
2/25/13	WILD	CFO	126	19	15.1%	44.6	46.4	167
2/26/13	WILD	CFO	117	10	8.5%	37.3	37.3	166
3/4/13	WILD	CFO	38	2	5.3%	41.2	47.5	168

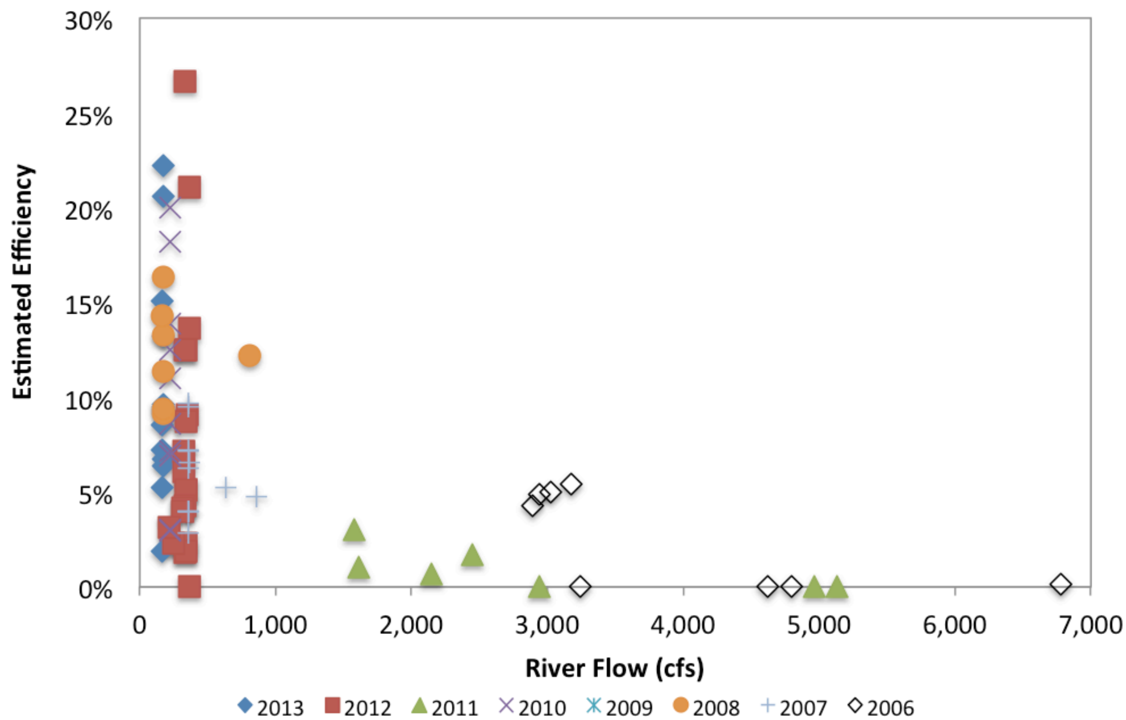

Figure 5. Trap efficiency estimates at Waterford relative to river flow at La Grange (LGN) during 2006-2013.

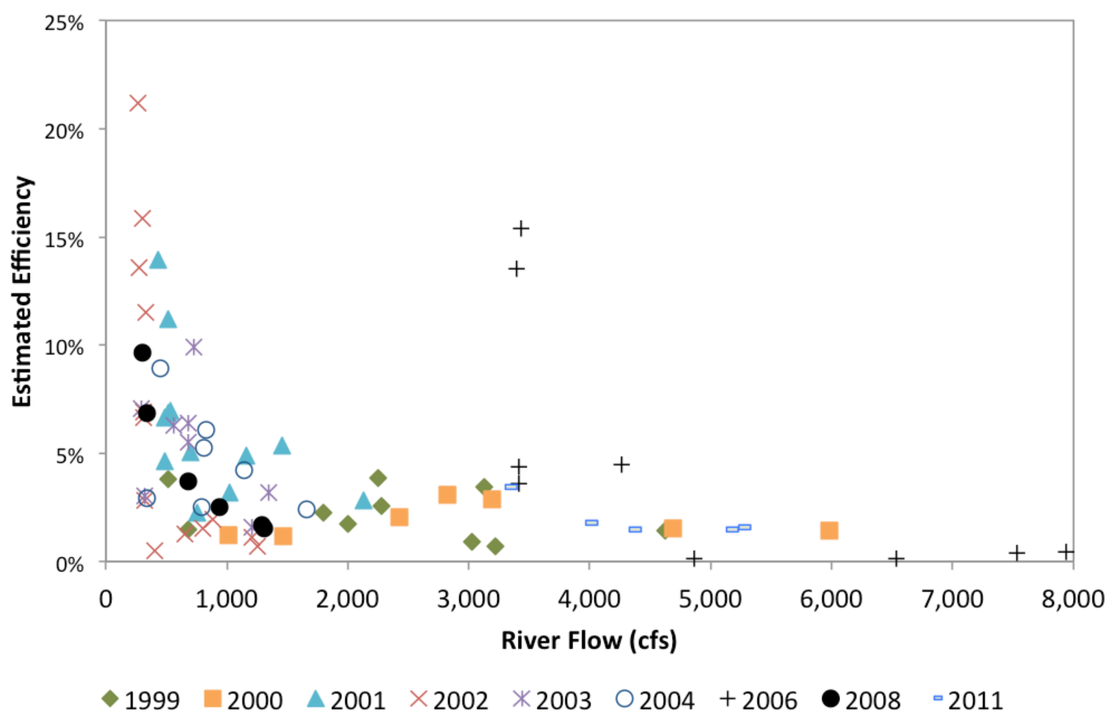

Figure 6. Trap efficiency observations at Grayson relative to river flow at Modesto (MOD), 1999-2008 and 2011.

Estimated Chinook Salmon Abundance

Based on daily passage estimates, an estimated 40,387 Chinook salmon passed Waterford during 2013, of which 42.4% were smolts (Table 4). In 2013, as in previous years, a majority of the salmon observed passing Waterford prior to mid-March were fry; passage was then dominated by smolts from late-March through June (Table 4; Figure 7). The peak in daily passage for fry occurred on January 16, and smolt passage peaked on April 16 (Figure 7). Daily estimated Chinook salmon passage at Waterford ranged from 0 to 4,020. In previous years sampled at Waterford (i.e., 2006-2013), total estimated passage ranged from as high as 499,366 in 2006, to as low as 40,387 in 2013 (Figure 8). The proportion of passage as smolts ranged from 20.7% in 2011 to 84.4% in 2010 (Table 4). In 2006, sampling efforts were affected by high spring flows resulting in passage estimates that were likely underestimated (particularly for smolts).

An estimated 642 unmarked Chinook salmon passed Grayson during 2013 and of these, 1.0% were fry, 1.0% were parr, and 98.0% were smolts (Table 4). Daily estimated passage at Grayson ranged from 0 to 144 salmon. Peak daily passage for smolts occurred on April 17 (Figure 9). During comparable seasonal sampling in previous years at Grayson (i.e., winter/spring sampling in 1999-2002, 2006, and 2008-2013), total estimated passage ranged from a high of 869,636 in 1999 to a low of 642 in 2013 (Table 1; Figure 10). The proportion of passage as smolts was the highest in 2013 (98.0%) and the lowest in 1999 (2.9%). In spring-only sampling years at Grayson/Shiloh (i.e., 2003-2005 and 2007 at Grayson and 1995-1997 at Shiloh), total estimated passage ranged from a high of 254,539 in 2005 to a low of 952 in 2007 (Table 1; Figure 10). The majority of migrants in all spring-only years were smolts (≥95.0%; Table 4). Among all years, estimated passage was the highest during 1998 (Table 1; Figure 10), when sampling effort was intermediate, and the proportion passing as smolts was low (5.7%). However, the 1998 passage estimate of 1,615,673 fish may be inflated and the proportion passing as smolts may be underestimated because no trap efficiency tests were conducted with fry. In 1998, estimates for trap efficiency only existed for smolts, which were subsequently applied to other life stages. The use of smolt-specific (low) capture probability to extrapolate on fry captures may result in drastic overestimation of fish passage.

Juvenile Chinook salmon sampled in the 2013 RST operation were the progeny of an estimated 2,120 adult Chinook salmon (806 females) that spawned in the fall of 2012 (Wright et al. 2013). During the 2012-13 spawning season, approximately 50 juveniles were produced per female spawner, based on the estimated 806 female spawners, and the total estimated passage at the Waterford trap. This is low compared to 1,118 juveniles per female in 2011, 857 juveniles per female in 2010, 257 in 2009, 619 in 2008, and 635 in 2007 (Table 5). However, this estimate is similar to 2012 when each spawner produced an estimated 87 juveniles. Approximately 60% of the female Chinook salmon observed at the Tuolumne River weir in 2013 were less than 700 mm, indicating they were most likely two-year old fish (Wright et al 2013). The young age and smaller size of the returning females may explain the low female spawner to juvenile ratio observed in 2013.

Table 4. Estimated passage by lifestage at Waterford and Grayson during 1995-2013.

		Sampling Period	Fry		Parr		Smolts		Total
			Number	%	Number	%	Number	%	
Waterford	2006	w/s	323,170	64.7%	16,261	3.3%	159,934	32.0%	499,366
	2007	w/s	12,375	23.4%	4,993	9.4%	35,472	67.1%	52,840
	2008	w/s	17,806	36.0%	1,921	3.2%	29,800	60.2%	49,527
	2009	w/s	17,492	32.1%	7,306	13.4%	29,719	54.5%	54,517
	2010	w/s	10,595	14.2%	1,049	1.4%	62,876	84.4%	74,520
	2011	w/s	284,444	77.7%	5,689	1.6%	75,771	20.7%	365,904
	2012	w/s	29,907	48.2%	7,568	12.2%	24,601	39.6%	62,076
	2013	w/s	21,312	52.8%	1,971	4.9%	17,105	42.4%	40,387
Grayson	1995	spring	-	-	-	-	22,067	100%	22,067
	1996	spring	-	-	-	-	16,533	100%	16,533
	1997	spring	-	-	-	-	1,280	100%	1,280
	1998	intermediate	1,196,625	74.1%	327,422	20.3%	91,626	5.7%	1,615,673
	1999	w/s	830,064	95.4%	14,379	1.7%	25,193	2.9%	869,636
	2000	w/s	55,309	51.4%	21,396	19.9%	30,912	28.7%	107,617
	2001	w/s	65,845	61.8%	26,620	25.0%	14,115	13.2%	106,580
	2002	w/s	75	0.5%	5,705	41.0%	8,147	58.5%	13,928
	2003	spring	26	0.3%	128	1.4%	8,920	98.3%	9,074
	2004	spring	155	0.9%	727	4.1%	16,718	95.0%	17,600
	2005	spring	-	-	442	0.2%	254,539	99.8%	254,981
	2006	w/s	47,688	56.1%	2,420	2.8%	34,879	41.0%	84,987
	2007	spring	-	-	-	-	952	100%	952
	2008	w/s	1,251	41.4%	25	0.8%	1,744	57.7%	3,020
	2009	w/s	57	1.4%	138	3.4%	3,877	95.2%	4,072
	2010	w/s	92	4.5%	0	0.0%	1,964	95.5%	2,056
	2011	w/s	71,071	74.7%	2,130	2.2%	21,955	23.1%	95,156
	2012	w/s	72	3.2%	10	0.5%	2,186	96.4%	2,268
	2013	w/s	6	1.0%	7	1.0%	629	98.0%	642

Table 5. Estimated number of juvenile salmon at Waterford produced per female spawner, 2006-2013.

Outmigration Year	Females[4]	Juveniles/female spawner
2006	478	1,045
2007	282	179
2008	80	619
2009	212	257
2010	87	857
2011	326	1,118
2012	712	87
2013	806	50

[4] Based on estimated abundance and gender ratios from carcass surveys during 2005-2008 (Blakeman 2006-2008; O'brien 2009), and number of female Chinook salmon observed (excluding salmon of undetermined gender) at the Tuolumne River weir during 2009-2012 (Wright et al 2013; Cuthbert et al 2012; Becker et al 2011; Cuthbert et al 2010).

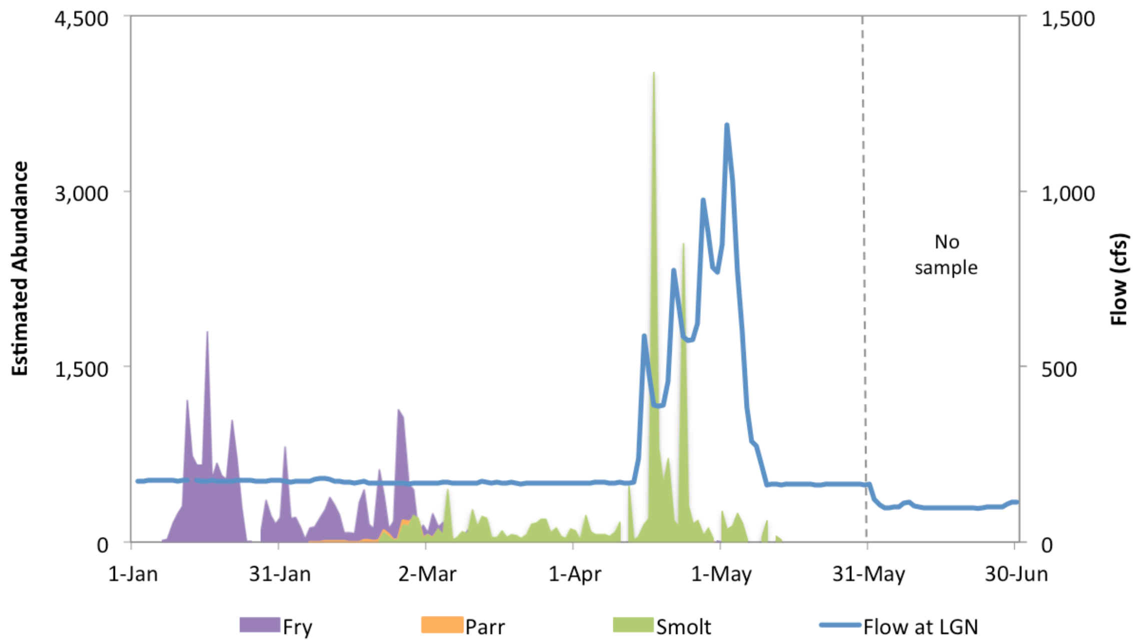

Figure 7. Juvenile salmon passage by lifestage at Waterford during 2013.

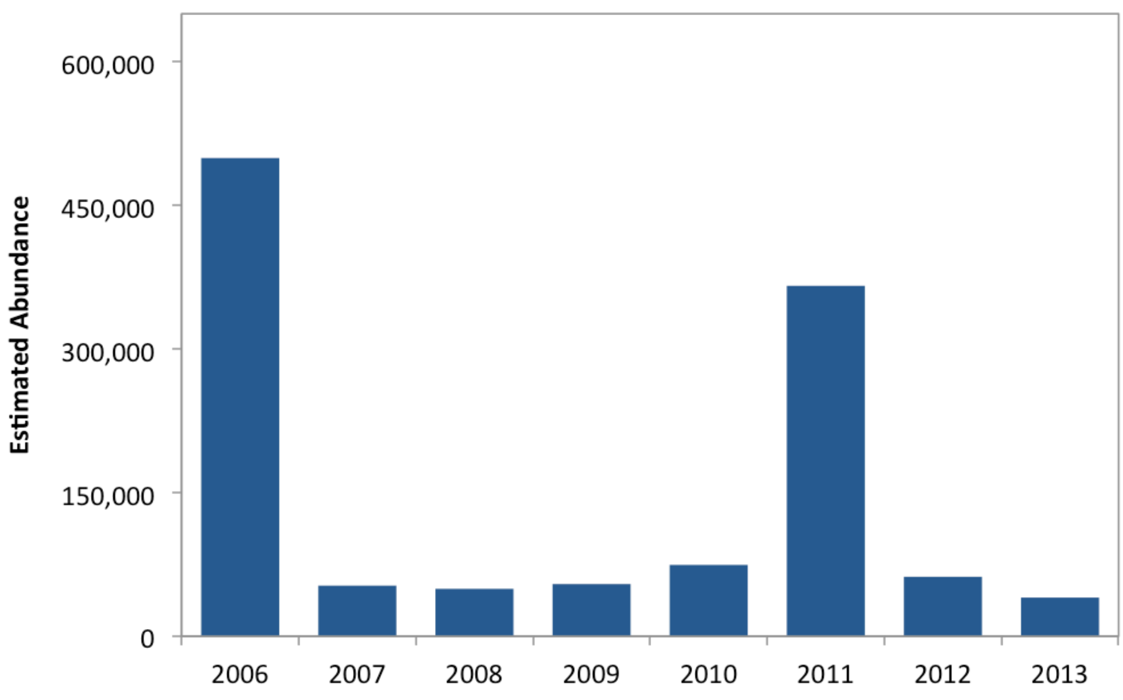

Figure 8. Total estimated Chinook passage at Waterford, 2006-2013.

Estimated Chinook Salmon Abundance and Environmental Factors

Discharge in the Tuolumne River, downstream of La Grange Dam, was approximately 170 cfs during January through mid-April. During this time there were no obvious correlations between peaks in salmon passage and changes in flow, rainfall, or turbidity at Waterford. River flow near Grayson during this period was slightly more variable as a result of storm run-off early in the season, particularly from Dry Creek, and ranged from 181 cfs to 510 cfs at Modesto. The few passages at Grayson during this time occurred concurrent to or shortly after brief and relatively low magnitude run-off events.

Between April 15 and May 9 there was a series of four short pulse flows designed by the U.S. Fish and Wildlife Service (USFWS) to mimic the natural run-off pattern in the Tuolumne River prior to impoundment. Peaks in flow during the spring pulse period ranged from 588 cfs on 15 April to 1,190 cfs on 2 May. Following the pulse period, flows decreased to approximately 100 cfs by early June. Peaks in smolt migration activity were observed at both the Waterford and Grayson traps in response to the spring pulse flows (Figure 7 and Figure 9).

During 2013 monitoring, daily average water temperatures ranged from 44.5°F to 74.0°F at the Waterford trap (Figure 11) and from 44.3°F to 76.6°F at the Grayson traps (Figure 12). Water temperatures generally increased throughout the outmigration season. There were no obvious correlations between trends in fry passage and water temperature during 2013 (Figure 11), but smolt passage appeared to peak with slight fluctuations in temperature at both traps during the spring (Figure 11 and Figure 12).

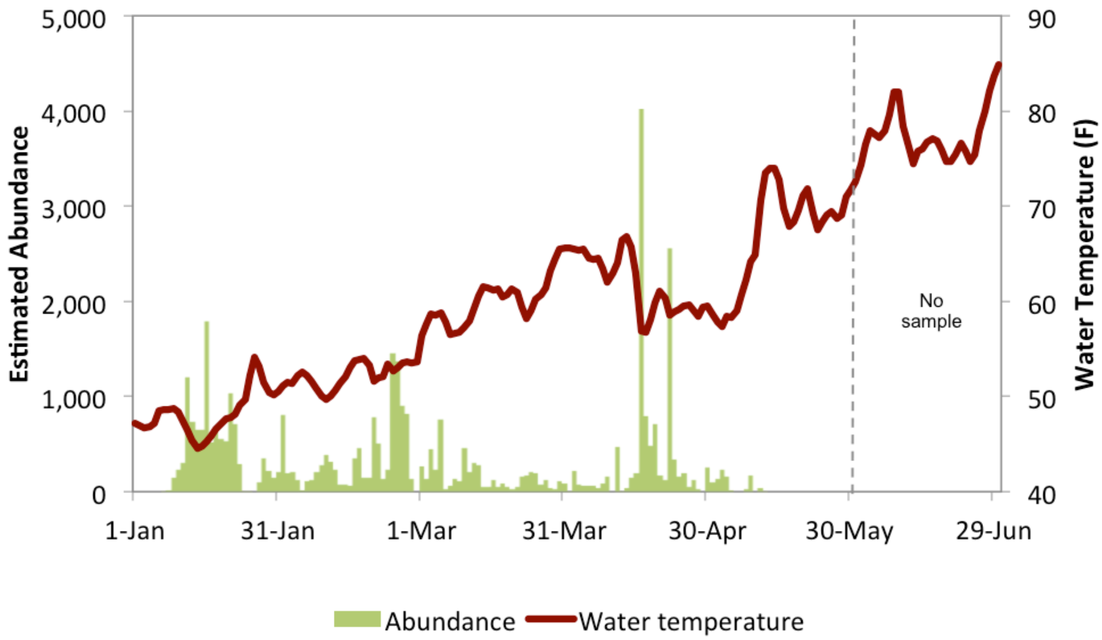

Figure 11. Daily estimated passage of unmarked Chinook salmon and daily average water temperature at the Waterford trap during 2013.

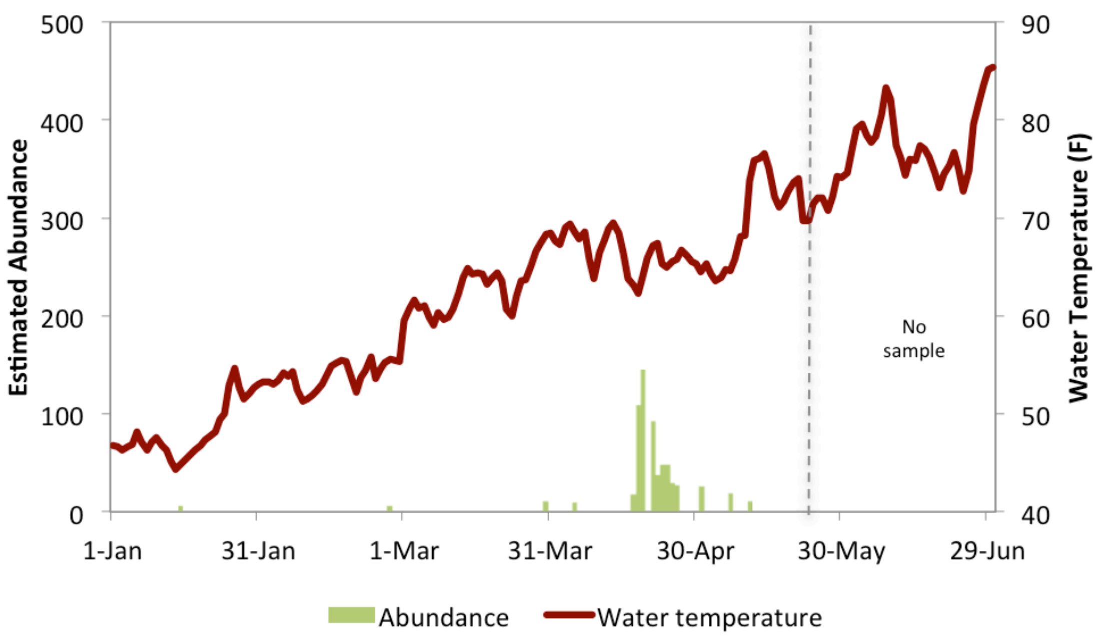

Figure 12. Daily estimated passage of unmarked Chinook salmon and daily average water temperature at the Grayson trap during 2013.

Background turbidity was generally less than 4.5 NTU at Waterford (Figure 13) and less than 10 NTU at Grayson (Figure 14) during the 2013 monitoring period. During a run-off event in early January (Figure 15) turbidity increased to as much as 6.8 NTU at Waterford and 33.7 NTU (Figure 14). There was no apparent increase in juvenile migration activity at either site in relation to this run-off event and increased turbidity.

The ratio of estimated total passage at Grayson relative to the estimated total passage at Waterford provides an index of annual juvenile survival through the river between the sites (24.6 miles) during years when the majority of the outmigration period is sampled at both sites (2008-2013). Total juvenile survival indices have ranged from a high of 26% in 2011 to a low of 1.6% in 2013, and with the exception of 2011 have been lower than 8% (Table 6). During 2011, when heavy run-off and flood control releases resulted in flows approaching 7,500 cfs at Modesto, approximately 78% of juveniles passed Waterford as fry (Table 4) and an estimated 25% of the fry passing Waterford survived to pass Grayson (Table 6). In contrast, both the proportion of juveniles migrating as fry and the proportion of fry surviving to Grayson were substantially lower in years without flood control releases, with 14-53% (Table 4) migrating as fry and generally less than 1% estimated to have survived to Grayson (Table 6). Estimated fry survival was 7% in 2008 (Table 6), and a key difference between this year and other years without flood control releases was the occurrence of five run-off events from Dry Creek resulting in peak flows ranging from approximately 750 cfs to 1,700 cfs as measured at Modesto.

Using relative passage of Chinook salmon smolts, survival indices ranged from a high of 29% in 2011 to a low of 3.1% in 2010, and the smolt survival index for 2013 was 3.7% (Table 6). Spring pulse flows, designed to stimulate salmon migration and improve juvenile survival out of the lower river, occur annually. In some years, such as 2011, spring flows are driven by flood control operations. With the exception of 2011, peak spring pulse flows measured at La Grange have ranged from approximately 900 cfs in 2007 to approximately 3,200 cfs in 2010 with no clear correlation between total smolt survival indices and peak pulse flow magnitudes (Table 6).

Analyses of event-specific smolt survival indices calculated from relative passage between Waterford and Grayson during discrete flow periods found positive relationships between survival and river flow measured at La Grange (Robichaud and English 2013). Further, abundance of smolts, duration of the pulse flow, and turbidity also appear to explain variations in the calculated survival indices. In 2012, a pulse flow of 2,100 cfs for approximately one week resulted in the highest smolt survival (18.7%) observed during any of the pulses in the 2007-2013 period. A similar, but lower magnitude pulse of approximately 1,000 cfs in 2009 resulted in an estimated smolt survival of 16.2% during the pulse flow event. During 2013, the majority (66%) of smolt migration occurred during a shaped pulse flow event with ascending steps, and approximately 5% of these smolts were estimated to survive to Grayson. Smolt response was highest during the first four days when brief pulses of approximately 600 cfs and 800 cfs occurred, and there was diminishing response to subsequent higher magnitude pulses of 1,000 cfs and 1,200 cfs (Figure 7 and Figure 9). While this design appeared to provide an emigration trigger to smolts in response to the initial flow increase, there are indications that changing the pulse flow shape to provide a larger initial pulse flow peak may provide for greater survival than the ascending design used in 2013. Additional years of monitoring will improve understanding of the influence of flow and other factors on migration timing and success.

Table 6. Survival indices through the lower Tuolumne River between Waterford and Grayson.

Year	Total Survival Index	Fry Survival Index	Peak Fry Flow	Smolt Survival Index	Peak Smolt Flow
2007	-	-	957	2.7	869
2008	6.1	7.0	1,690	5.9	1,310
2009	7.5	0.3	1,300	13.0	955
2010	2.8	0.9	767	3.1	3,300
2011	26.0	25.0	7,490	29.0	8,380
2012	3.7	0.2	599	8.9	2,120
2013	1.6	<0.1	510	3.7	1,190

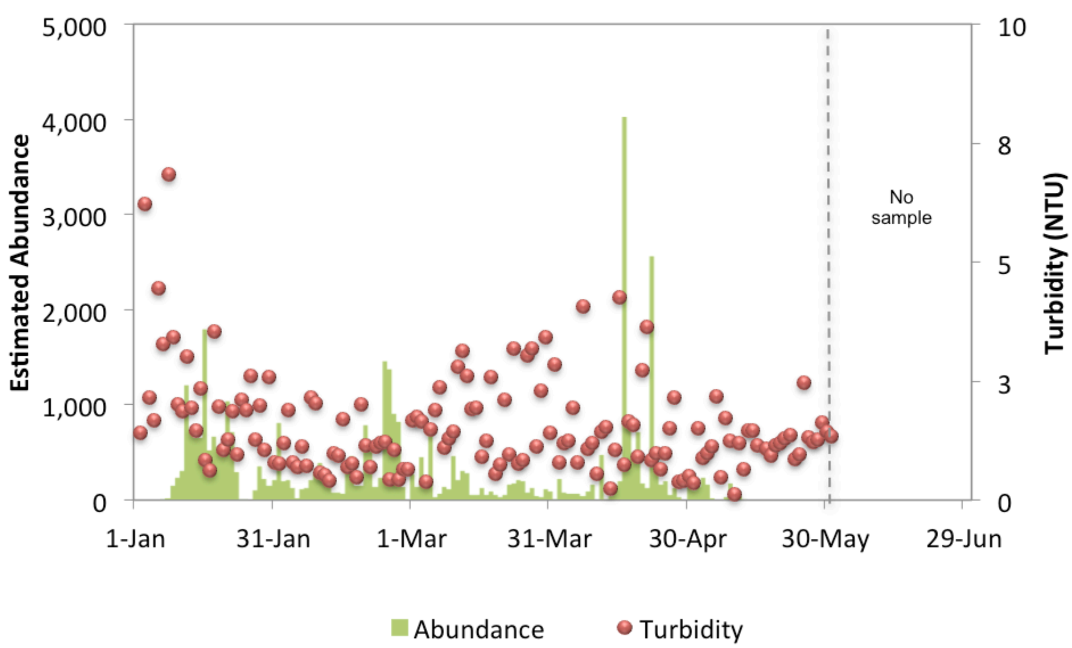

Figure 13. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Waterford during 2013.

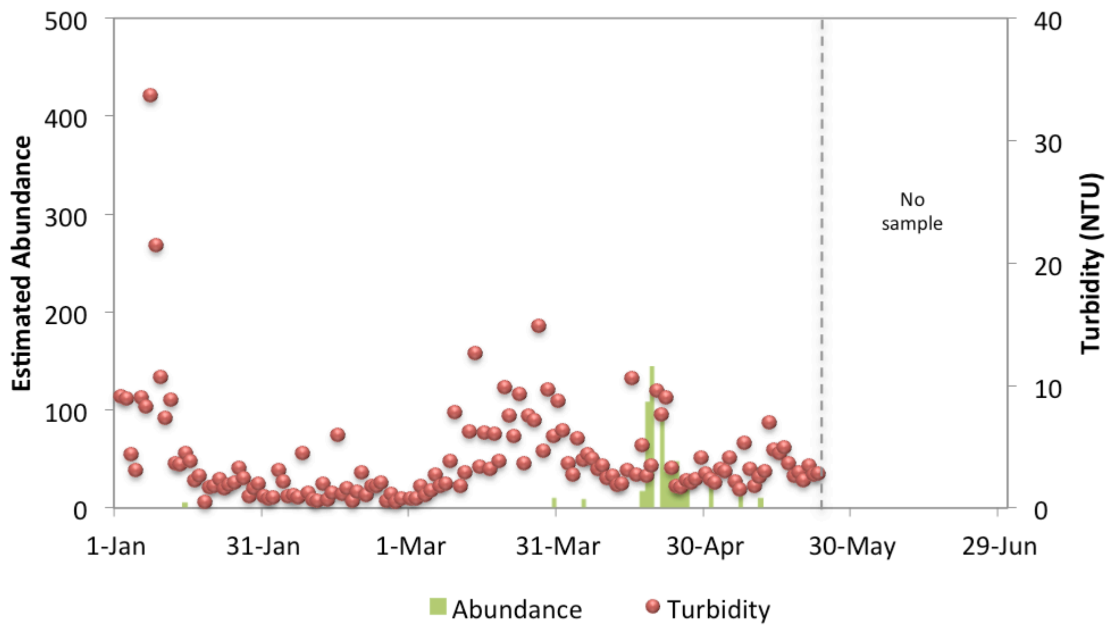

Figure 14. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Grayson during 2013.

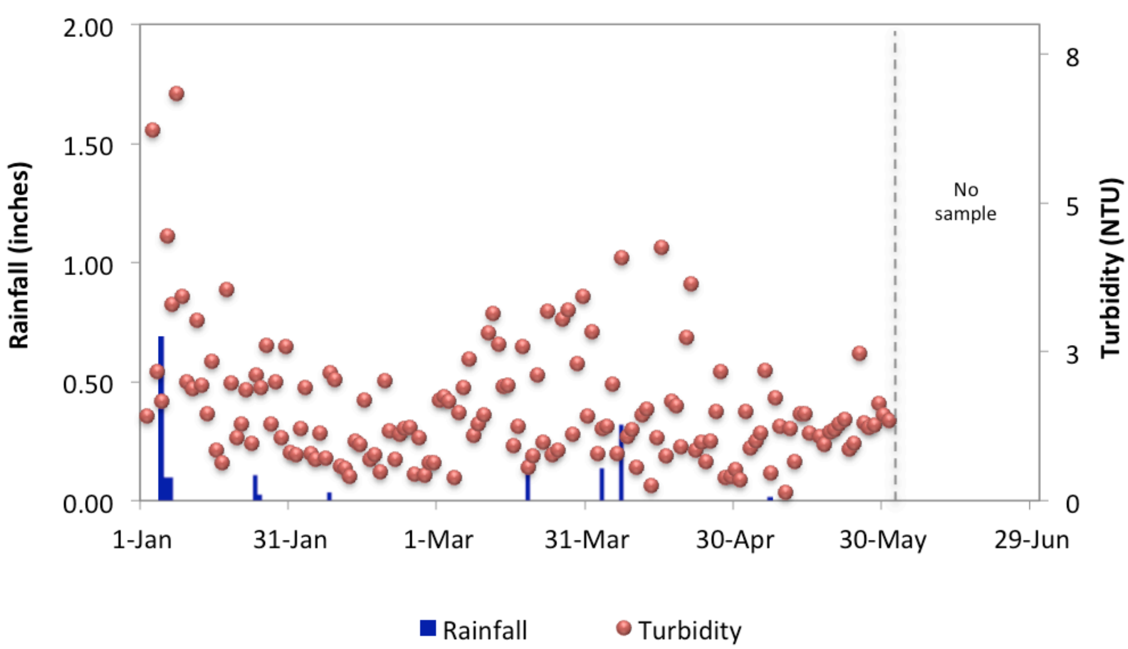

Figure 15. Daily rainfall measured at Don Pedro Reservoir and instantaneous turbidity at Waterford during 2013.

Chinook Salmon Length at Migration

Individual fork lengths of unmarked salmon captured at Waterford during 2013 ranged from 28 mm to 120 mm (Figure 16). Daily average length gradually increased from approximately 34 mm to 100 mm during the course of the sampling period (Figure 17 and Figure 18). Most of the juvenile salmon passing Waterford during 2013 were fry measuring 30-39 mm (Figure 19). In total, it is estimated that 21,312 fry (<50 mm), 1,971 parr (50-69 mm), and 17,105 smolts (>70 mm) passed Waterford during 2013 (Table 4). Individual fork lengths of unmarked Chinook salmon captured at Grayson during 2013 ranged from 30 mm to 99 mm (Figure 20), and daily average length ranged between 30 mm and 99 mm during the sampling period (Figure 18 and Figure 21). Approximately 98% of the salmon estimated to have passed Grayson during 2013 were smolts (Figure 22). In total, it is estimated that 6 fry (<50 mm), 7 parr (50-69 mm), and 629 smolts (>70 mm) passed Grayson during 2013 (Table 4).

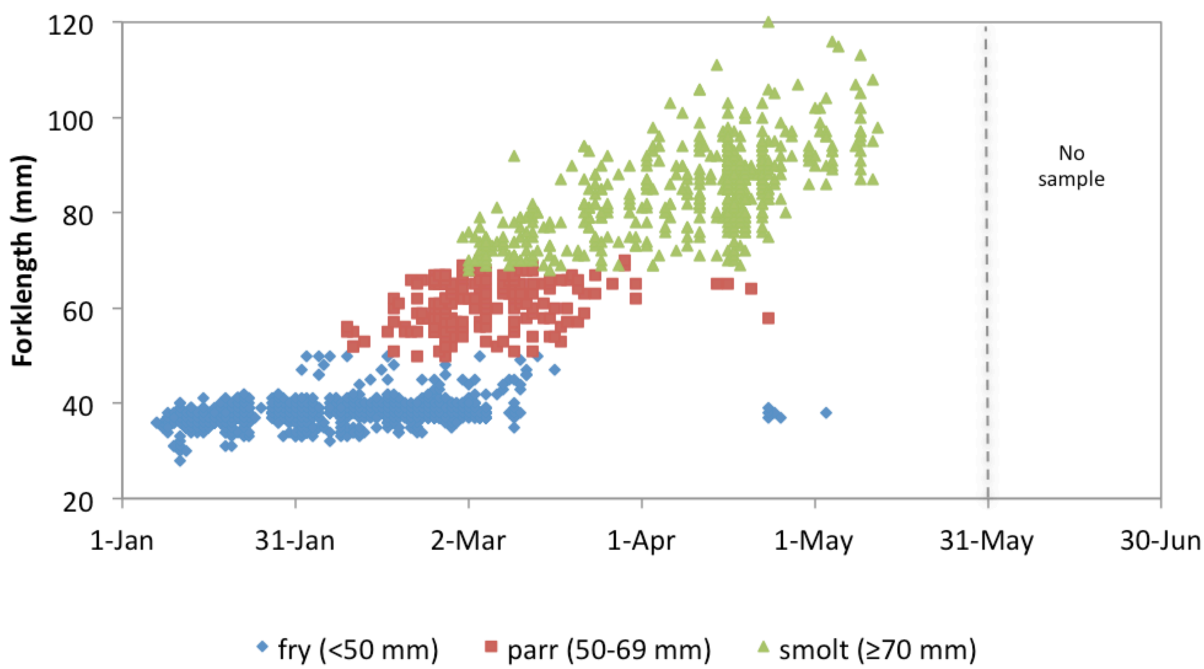

Figure 16. Individual fork lengths of juvenile salmon captured at Waterford during 2013.

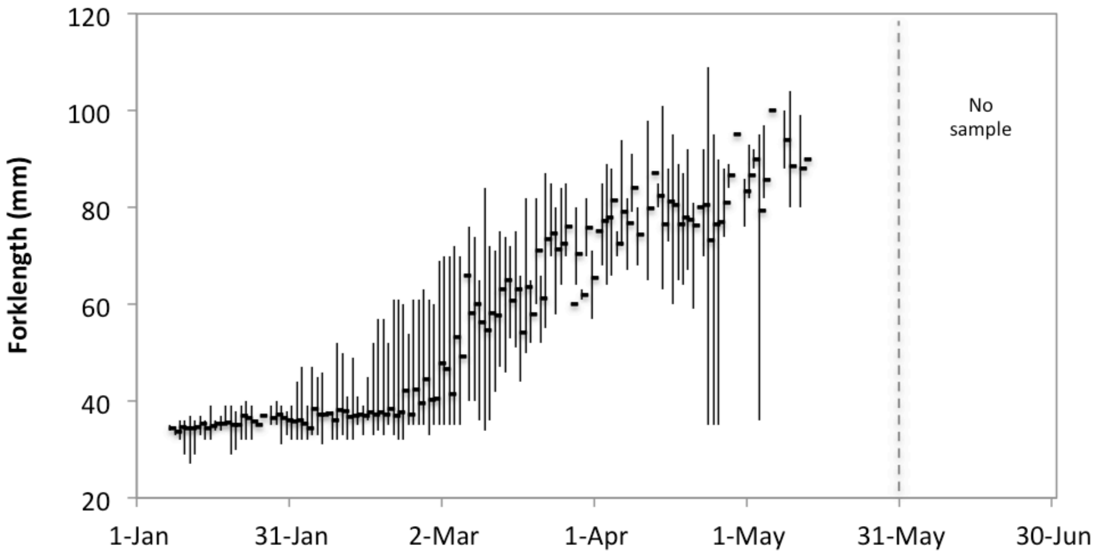

Figure 17. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Waterford during 2013.

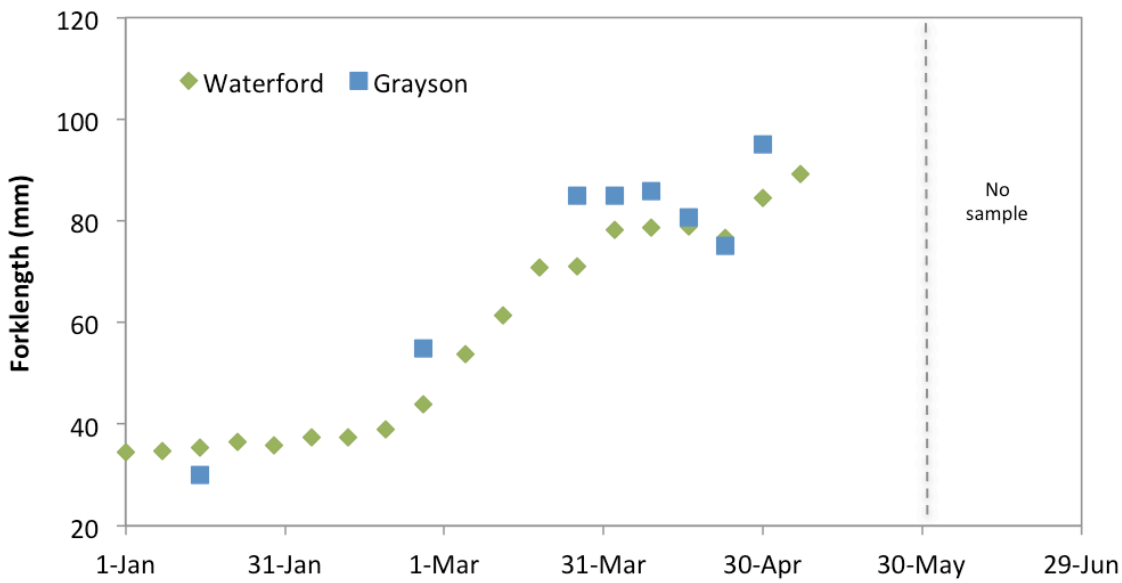

Figure 18. Average fork length of juvenile Chinook salmon captured at Waterford and Grayson by julian week during 2013.

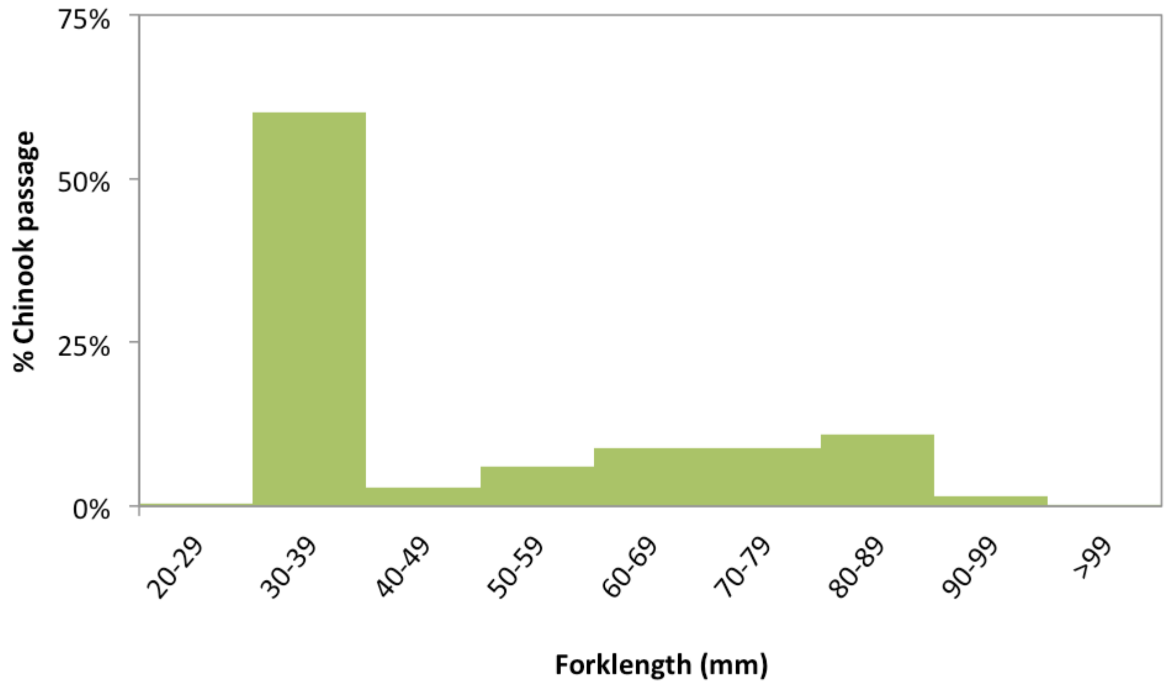

Figure 19. Length-frequency histogram of estimated Chinook passage (10 mm fork length bins) at Waterford during 2013.

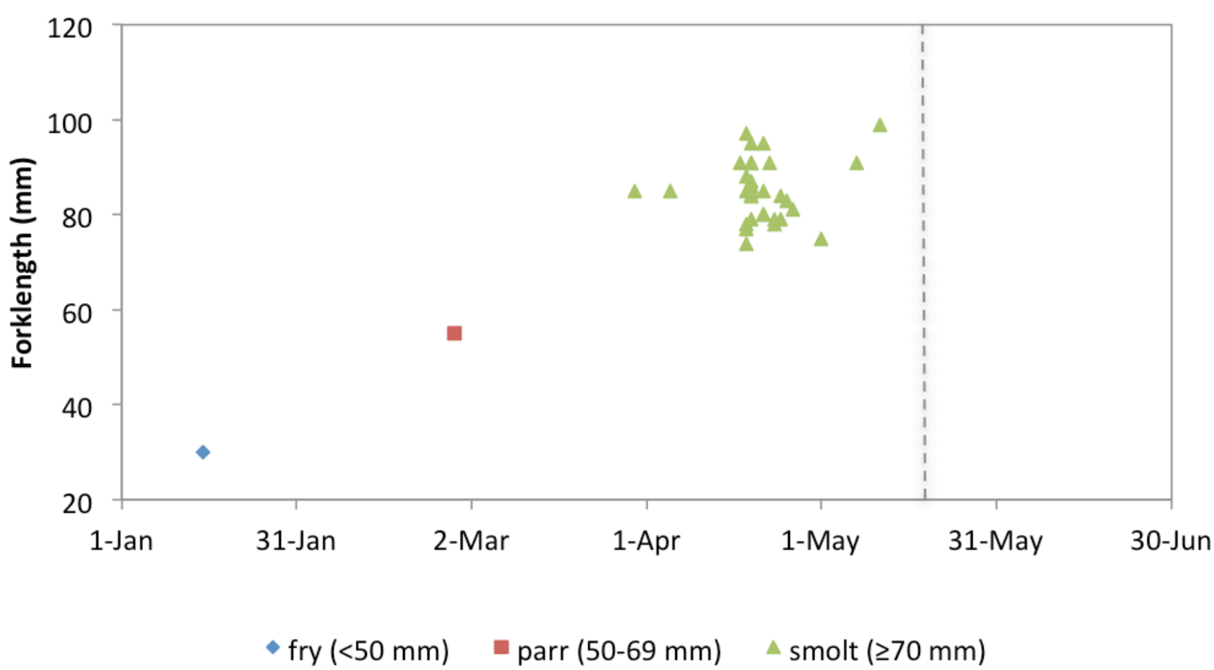

Figure 20. Individual fork lengths of juvenile salmon captured at Grayson during 2013.

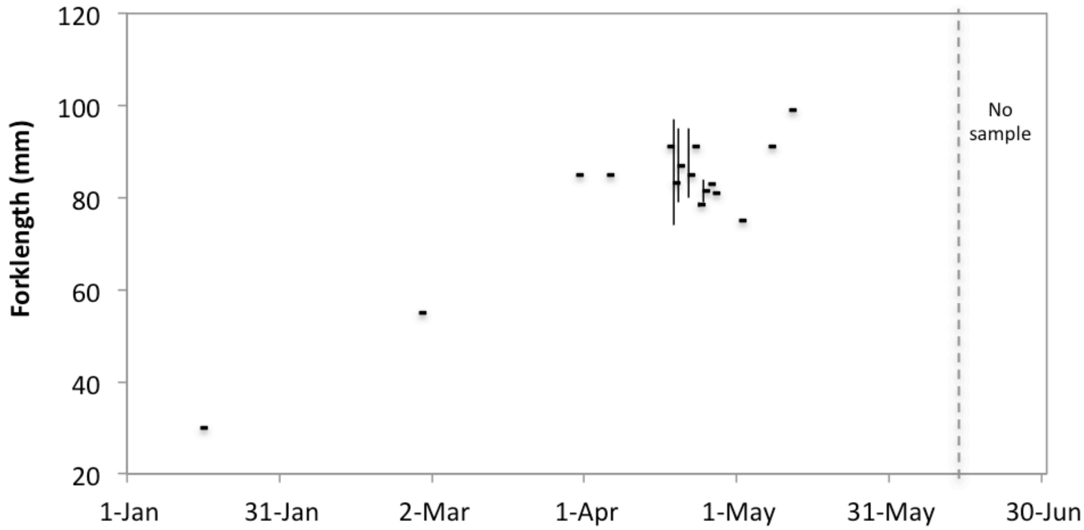

Figure 21. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Grayson during 2013.

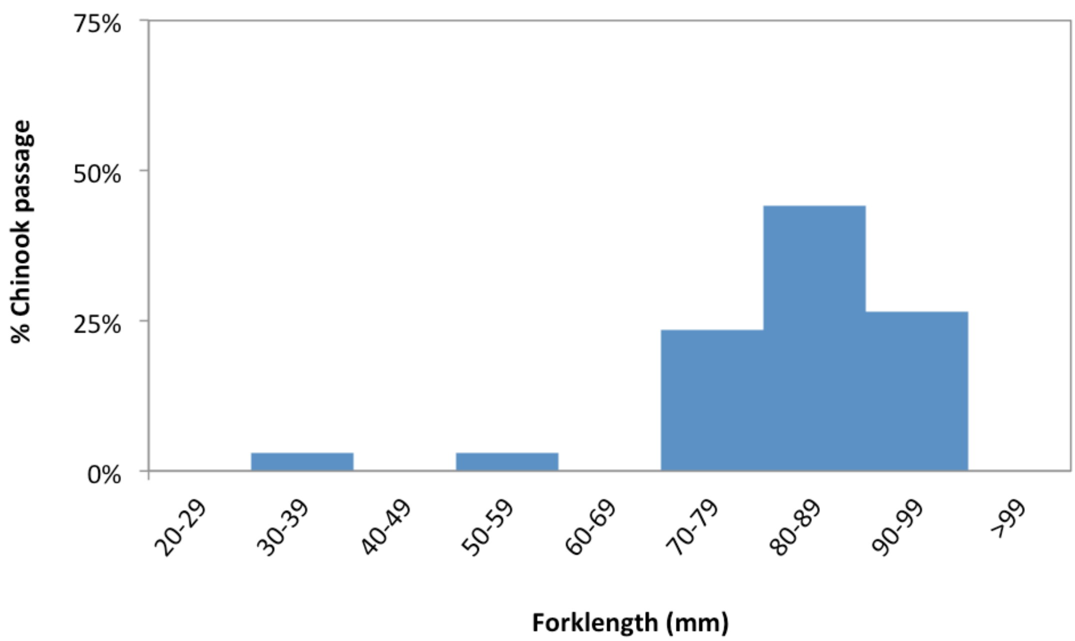

Figure 22. Length-frequency histogram of estimated Chinook passage (10 mm fork length bins) at Grayson during 2013.

Chinook Salmon Condition at Migration

Juvenile salmon captured at both Waterford and Grayson during 2013 appeared healthy without visually discernible signs of disease or stress. Salmon smolts collected in the RSTs during March and April 2013 were sampled by the USFWS National Wild Fish Health Survey (NWFHS) to monitor health and physiology changes that may affect smolt survival (Nichols 2103). Juvenile salmon from the Tuolumne River were found to be in good conditions with no bacterial or viral pathogens detected. Length-weight relationships were similar between sites (Figure 23 and Figure 24).

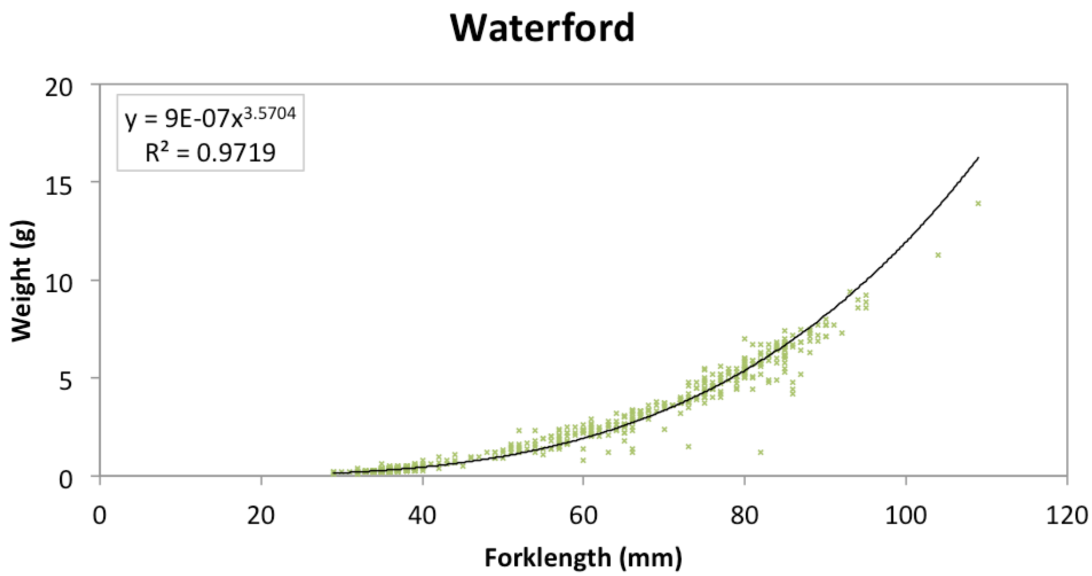

Figure 23. Length-weight relationship of fish measured at Waterford during 2013.

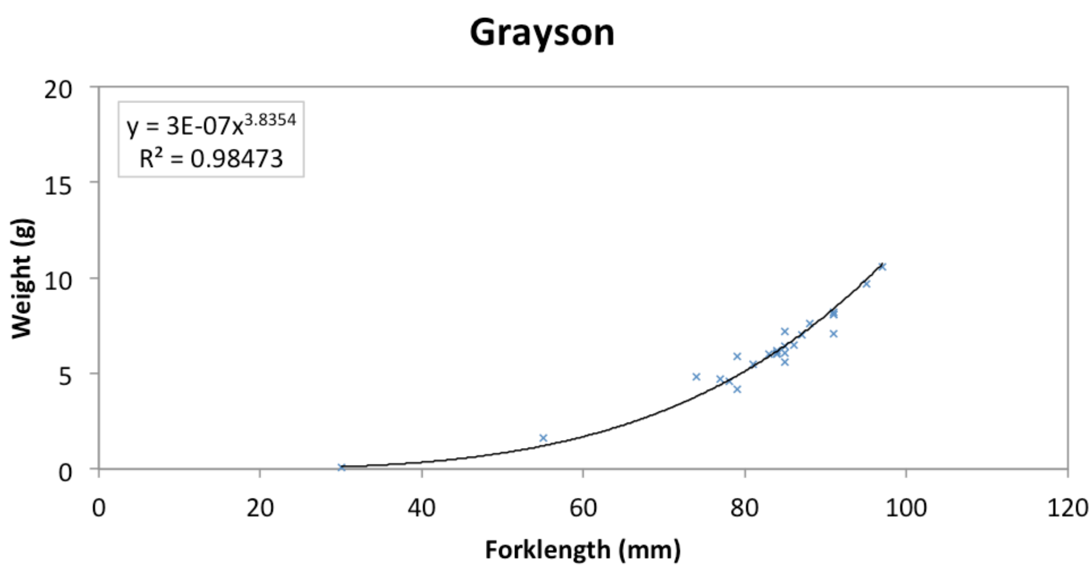

Figure 24. Length-weight relationship of fish measured at Grayson during 2013.

Oncorhynchus mykiss **(Rainbow Trout/Steelhead)**

Zero *O. mykiss* were captured at Waterford and Grayson in 2013. Total annual *O. mykiss* catch at the Grayson and Waterford traps between 2000 and 2013 ranged from 0 to 11 (Figure 25).

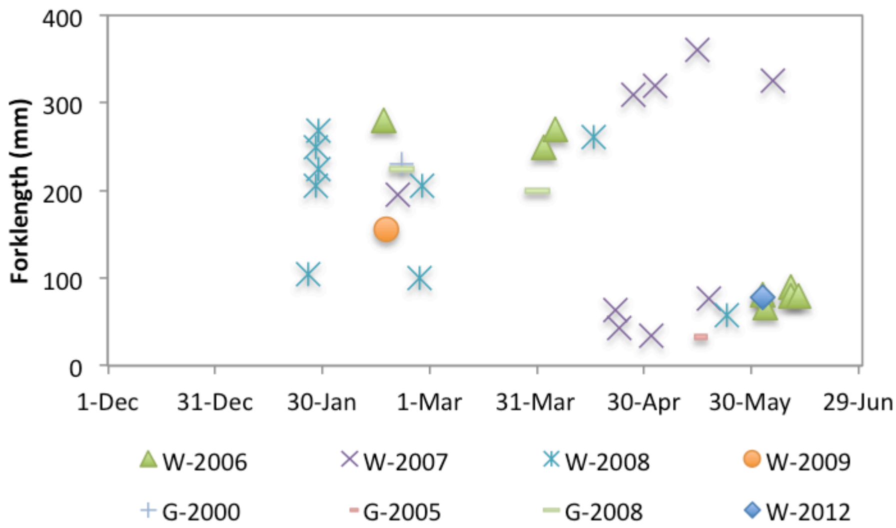

Figure 25. Date, size, and location of *O. mykiss* captured at Waterford (W) and Grayson (G).

Other Fish Species Captured

A total of 2,346 non-salmonids representing at least 26 species (7 native, 19 introduced) were captured during operation of the Waterford and Grayson traps in 2013 (Table 7; Appendices C and D). The same species were generally observed at both sites, with the exception of goldfish, which were only observed at Waterford, and black bullhead, brown bullhead, carp, hitch, inland silverside, striped bass, and tule perch only observed at Grayson. Native species comprised only 31% of the total non-salmonid catch, consisting primarily of lamprey (n=80). Lampreys captured in the traps were primarily ammocoetes and were not identified to species or measured. No adult lamprey were captured at either trapping location.

Table 7. Non-salmonid species captured at Waterford and Grayson during 2013. Native species are indicated in bold.

			Waterford				*Grayson*			
	Common Name	**Scientific Name**	**Total Catch**	**Minimum Length (mm)**	**Average Length (mm)**	**Maximum Length (mm)**	**Total Catch**	**Minimum Length (mm)**	**Average Length (mm)**	**Maximum Length (mm)**
Catfish Family										
	Black bullhead	*Ameiurus melas*	0	-	-	-	6	182	199	217
	Brown bullhead	*Ameiurus nebulosus*	0	-	-	-	3	217	235	252
	Channel catfish	*Ictalurus punctatus*	4	56	70	82	23	55	79	142
	White catfish	*Ictalurus catus*	53	44	114	290	414	45	80	320
	Unidentified catfish	Not applicable	0	-	-	-	1	-	-	-
Lamprey Family										
	Lamprey - unidentified	Not applicable	3	-	-	-	80	-	-	-
Livebearer Family										
	Mosquitofish	*Gambusia affinis*	10	27	33	41	46	21	35	47
Minnow Family										
	Carp	*Cyprinus carpio*	0	-	-	-	3	225	239	253
	Goldfish	*Carassius auratus auratus*	1	195	195	195	0	-	-	-
	Golden shiner	*Notemigonus crysoleucas*	7	7	58	76	121	22	53	120
	Hardhead	*Mylopharodon conocephalus*	15	52	71	114	1	134	134	134
	Hitch	*Lavinia exilicauda*	0	-	-	-	5	57	78	100
	Red shiner	*Cyprinella lutrennsis*	1	43	43	43	33	27	41	57
	Sacramento pikeminnow	*Ptychochelius grandis*	21	27	73	165	23	27	46	109
Sculpin Family										
	Prickly Sculpin	*Cottusasper*	44	53	76	111	7	80	94	110
Silverside Family										
	Inland silverside	*Menidia beryllina*	0	-	-	-	15	29	69	100

			Waterford				Grayson			
	Common Name	Scientific Name	Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)	Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)
Sucker Family										
	Sacramento sucker	*Catostomus occidentalis*	20	25	50	187	3	25	27	30
Sunfish Family										
	Bluegill	*Lepomis macrochirus*	67	35	54	73	29	23	91	165
	Black crappie	*Pomoxis annularis*	1	78	78	78	4	92	123	162
	Green sunfish	*Lepomis cyanellus*	1	71	71	71	4	75	102	155
	Largemouth bass	*Micropterus salmoides*	4	77	132	239	12	95	119	144
	Pumpkinseed	*Lepomis gibbosus*	1	71	71	71	1	82	82	82
	Redear sunfish	*Lepomis microlophus*	7	44	71	89	1	49	49	49
	Smallmouth bass	*Micropterus dolomieu*	10	72	166	375	129	90	127	265
	Striped bass	*Morone saxatilis*	0	-	-	-	1	nd	nd	nd
	Warmouth	*Lepomis gulosus*	13	56	72	82	1	155	155	155
	Unidentified bass	Not applicable	87	13	62	159	1,001	15	34	242
	Unidentified sunfish	Not applicable	2	51	51	51	0	-	-	-
	Unidentified species	Not applicable	2	20	20	20	4	17	36	50
Surfperch Family										
	Tule perch	*Hysterocarpus traskii*	0	-	-	-	1	110	110	110
Total Species Captured = 26 (19 introduced, 7 native)			374				1,972			
Total Native Individuals Captured = 718 (103 at Waterford; 615 at Grayson)										

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Appendix A. Daily Chinook catch, length, predicted catchability, and estimated passage at Waterford and associated environmental data from 2013.

	Unmarked Chinook Salmon									*Environmental Conditions*			
		Fork Length (mm)			-	Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Average Catchability	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temp at Trap (F)	Turbidity
1/2/13	0	-	-	-	9.5%	0	0	0	0	174	1.1	47.0	1.42
1/3/13	0	-	-	-	11.2%	0	0	0	0	174	1.3	46.7	6.22
1/4/13	0	-	-	-	12.8%	0	0	0	0	176	1.5	46.9	2.16
1/5/13	0	-	-	-	11.1%	0	0	0	0	176	1.3	47.2	1.67
1/6/13	0	-	-	-	13.6%	0	0	0	0	177	1.6	48.5	4.45
1/7/13	2	34	35	35	15.4%	13	0	0	13	176	1.8	48.7	3.29
1/8/13	3	33	34	34	13.6%	22	0	0	22	176	1.6	48.6	6.84
1/9/13	15	32	35	36	9.4%	160	0	0	160	176	1.1	48.8	3.43
1/10/13	23	29	34	36	9.5%	242	0	0	242	174	1.1	48.4	2.00
1/11/13	29	27	34	37	9.4%	307	0	0	307	175	1.1	47.5	1.87
1/12/13	155	29	35	36	12.8%	1211	0	0	1211	176	1.5	46.4	3.02
1/13/13	69	33	35	37	9.4%	737	0	0	737	nd	1.1	45.4	1.94
1/14/13	84	32	35	36	12.7%	660	0	0	660	177	1.5	44.5	1.45
1/15/13	74	32	35	39	11.2%	660	0	0	660	174	1.3	44.8	2.34
1/16/13	31	34	35	36	1.7%	1796	0	0	1796	174	0.2	45.2	0.84
1/17/13	32	34	35	37	6.0%	533	0	0	533	175	0.7	45.9	0.63
1/18/13	64	35	36	39	9.5%	674	0	0	674	174	1.1	46.6	3.55
1/19/13	44	29	35	39	7.8%	567	0	0	567	174	0.9	47.2	1.97
1/20/13	65	30	35	38	12.1%	538	0	0	538	174	1.4	47.6	1.06
1/21/13	81	32	37	39	7.8%	1043	0	0	1043	174	0.9	47.8	1.28
1/22/13	80	32	36	40	11.2%	717	0	0	717	175	1.3	48.2	1.86
1/23/13	23	32	36	39	7.7%	300	0	0	300	176	0.9	49.1	0.96
1/24/13	1	35	35	35	12.0%	8	0	0	8	175	1.4	49.7	2.10
1/25/13	1	37	37	37	13.7%	7	0	0	7	175	1.6	52.2	1.89
1/26/13	0	-	-	-	9.5%	0	0	0	0	174	1.1	54.1	2.60
1/27/13	14	35	36	39	12.9%	108	0	0	108	174	1.5	53.2	1.28
1/28/13	47	35	37	40	13.0%	361	0	0	361	173	1.5	51.5	1.99
1/29/13	25	31	37	39	11.2%	224	0	0	224	175	1.3	50.4	1.05
1/30/13	20	33	36	38	12.9%	155	0	0	155	175	1.5	50.1	2.58
1/31/13	27	32	36	39	12.8%	211	0	0	211	176	1.5	50.5	0.80
2/1/13	84	32	36	44	10.4%	811	0	0	811	174	1.2	51.1	0.77
2/2/13	21	32	35	47	10.5%	200	0	0	200	172	1.2	51.5	1.20
2/3/13	26	32	34	39	12.2%	214	0	0	214	173	1.4	51.4	1.90
2/4/13	10	33	38	47	7.8%	129	0	0	129	174	0.9	52.2	0.78
2/5/13	3	33	37	45	12.9%	23	1	0	23	174	1.5	52.5	0.69
2/6/13	14	31	37	46	11.2%	122	3	0	125	173	1.3	52.2	1.13
2/7/13	18	37	38	38	13.3%	133	3	0	136	180	1.6	51.6	0.71
2/8/13	25	32	36	38	11.5%	212	5	0	217	181	1.4	50.9	2.15
2/9/13	35	32	38	52	12.3%	278	6	0	285	182	1.5	50.0	2.03
2/10/13	52	33	38	50	13.3%	383	9	0	392	180	1.6	49.7	0.58
2/11/13	39	32	37	41	12.1%	316	7	0	323	173	1.4	50.1	0.54
2/12/13	25	32	37	49	10.3%	233	10	0	243	173	1.2	50.6	0.40
2/13/13	11	35	37	41	13.0%	81	3	0	85	172	1.5	51.3	0.99
2/14/13	11	33	37	39	13.1%	81	3	0	84	170	1.5	52.1	0.94
2/15/13	10	36	38	45	13.3%	72	3	0	75	167	1.5	53.1	1.69
2/16/13	46	33	37	52	13.0%	341	15	0	355	172	1.5	53.7	0.70
2/17/13	60	34	38	57	12.9%	447	19	0	466	173	1.5	53.9	0.77
2/18/13	21	33	37	57	13.2%	153	7	0	159	169	1.5	54.1	0.48
2/19/13	16	35	38	52	10.6%	117	18	15	151	168	1.3	53.2	2.02
2/20/13	78	33	37	61	9.8%	618	97	81	796	168	1.2	51.6	1.16
2/21/13	72	32	38	61	14.0%	401	63	52	516	167	1.7	52.0	0.70
2/22/13	17	32	42	60	11.5%	115	18	15	148	167	1.4	52.1	1.12

	Unmarked Chinook Salmon									Environmental Conditions			
		Fork Length (mm)			-	Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Average Catchability	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temp at Trap (F)	Turbidity
2/23/13	29	35	37	54	12.3%	183	29	24	235	167	1.5	53.4	1.20
2/24/13	131	35	42	61	9.0%	1133	178	148	1459	168	1.1	52.6	1.23
2/25/13	158	35	40	61	11.5%	1067	168	139	1374	167	1.4	53.1	0.44
2/26/13	87	35	45	63	9.6%	497	187	226	910	166	1.3	53.5	1.06
2/27/13	72	33	40	61	8.8%	448	169	204	821	167	1.2	53.7	0.43
2/28/13	13	35	41	60	8.8%	81	31	37	148	167	1.2	53.6	0.64
3/1/13	24	35	48	69	8.8%	149	56	68	274	167	1.4	56.4	1.68
3/2/13	15	35	47	70	10.2%	80	30	37	148	168	1.3	57.6	1.75
3/3/13	43	35	41	70	9.5%	247	93	112	453	167	1.3	58.7	1.66
3/4/13	23	35	53	72	9.4%	133	50	61	244	168	nd	58.6	0.39
3/5/13	56	35	49	70	7.3%	173	142	450	765	170	1.1	58.8	1.48
3/6/13	2	66	66	66	6.2%	7	6	19	32	170	1.2	57.8	1.89
3/7/13	5	40	58	76	6.8%	17	14	43	73	168	1.4	56.5	2.38
3/8/13	12	40	60	74	8.0%	34	28	89	151	168	1.3	56.6	1.10
3/9/13	9	36	56	65	7.4%	27	22	71	121	167	nd	56.7	1.29
3/10/13	35	34	55	84	7.4%	107	88	278	473	168	1.3	57.3	1.43
3/11/13	16	36	58	72	7.4%	49	40	127	216	168	0.9	58.0	2.81
3/12/13	14	42	58	71	4.5%	19	73	217	308	167	1.5	59.2	3.14
3/13/13	21	47	63	75	7.3%	17	68	203	289	174	1.3	60.6	2.62
3/14/13	4	46	65	74	6.5%	4	15	44	62	170	1.6	61.5	1.92
3/15/13	5	53	61	72	8.1%	4	15	44	62	167	1.6	61.4	1.93
3/16/13	11	51	63	75	7.9%	8	33	97	138	170	1.3	61.2	0.92
3/17/13	4	44	54	66	6.6%	4	14	43	61	167	nd	61.3	1.25
3/18/13	6	50	64	82	6.6%	6	22	64	91	167	1.5	60.5	2.58
3/19/13	4	52	58	65	6.4%	0	5	58	63	172	1.3	60.7	0.56
3/20/13	2	60	71	82	5.7%	0	3	33	35	167	1.7	61.2	0.74
3/21/13	5	52	61	66	7.5%	0	5	62	67	166	1.5	60.9	2.10
3/22/13	11	55	74	87	6.6%	0	12	155	168	167	1.3	59.4	0.97
3/23/13	10	70	75	85	5.7%	0	13	164	177	168	1.3	58.2	3.18
3/24/13	12	58	71	80	5.7%	0	16	195	211	167	1.1	59.0	0.76
3/25/13	10	64	73	84	4.8%	0	15	192	208	167	1.7	60.2	0.84
3/26/13	6	70	76	85	7.2%	0	2	82	84	168	1.5	60.8	3.04
3/27/13	8	60	60	60	6.3%	0	2	125	127	169	1.4	61.4	3.19
3/28/13	3	64	70	80	5.9%	0	1	50	51	169	1.4	63.2	1.12
3/29/13	2	61	62	63	5.9%	0	1	33	34	169	1.4	64.4	2.30
3/30/13	7	70	76	82	5.9%	0	2	117	119	169	1.4	65.5	3.42
3/31/13	6	57	66	71	5.9%	0	2	100	102	169	1.6	65.6	1.41
4/1/13	1	75	75	75	6.7%	0	0	15	15	169	1.5	65.6	2.84
4/2/13	14	68	77	85	6.2%	0	0	225	225	169	1.6	65.4	0.8
4/3/13	6	64	78	89	6.6%	0	0	90	90	169	1.4	65.4	1.21
4/4/13	4	66	82	88	5.8%	0	0	69	69	169	1.8	65.5	1.24
4/5/13	5	70	73	75	7.4%	0	0	67	67	170	1.8	64.6	1.95
4/6/13	5	72	79	94	7.4%	0	0	67	67	170	1.4	64.4	0.78
4/7/13	3	67	77	82	5.8%	0	0	52	52	170	1.3	64.5	4.07
4/8/13	5	79	84	91	5.4%	0	0	93	93	169	1.4	63.4	1.07
4/9/13	10	68	74	80	5.8%	0	0	172	172	169	1.2	62.0	1.19
4/10/13	0	-	-	-	5.0%	0	0	0	0	170	1.2	63.0	0.56
4/11/13	24	65	80	98	5.0%	0	0	482	482	169	1.4	64.0	1.44
4/12/13	1	87	87	87	5.8%	0	0	17	17	168	1.6	66.4	1.54
4/13/13	3	80	82	85	6.5%	0	0	46	46	172	1.3	66.7	0.25
4/14/13	6	63	77	101	3.8%	0	0	157	157	238	2.1	65.7	1.06
4/15/13	5	73	81	88	2.5%	0	0	200	200	588	2.5	62.9	4.25
4/16/13	147	60	81	95	3.7%	0	7	4013	4020	480	3.1	56.9	0.8
4/17/13	45	65	76	89	5.6%	0	1	803	804	389	2.8	56.7	1.66
4/18/13	25	64	78	87	5.1%	0	1	491	492	387	2.4	58.1	1.59

	Unmarked Chinook Salmon									Environmental Conditions			
		Fork Length (mm)			-	Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Average Catchability	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temp at Trap (F)	Turbidity
4/19/13	31	67	77	92	4.3%	0	1	714	716	389	2.1	59.8	0.90
4/20/13	6	59	76	81	3.2%	0	0	186	186	457	2.5	61.1	2.74
4/21/13	3	80	80	80	2.3%	0	0	132	133	776	3.3	60.4	3.63
4/22/13	87	70	81	92	3.4%	0	5	2552	2557	681	3.7	58.6	0.85
4/23/13	17	35	73	109	4.8%	24	7	321	351	584	2.7	58.9	0.98
4/24/13	6	35	77	95	3.6%	11	3	152	167	574	2.9	59.1	0.66
4/25/13	8	35	77	90	3.8%	14	4	190	208	576	2.6	59.5	0.99
4/26/13	2	74	81	88	3.2%	4	1	57	63	622	2.9	59.6	1.50
4/27/13	3	84	87	89	2.3%	9	2	120	132	974	3.5	59.0	2.16
4/28/13	1	95	95	95	3.0%	2	1	30	33	886	3.5	58.4	0.39
4/29/13	0	-	-	-	3.4%	0	0	0	0	784	2.8	59.4	0.40
4/30/13	7	76	83	86	2.6%	5	0	264	269	768	3.4	59.4	0.51
5/1/13	3	82	87	93	2.9%	2	0	103	105	847	3.5	58.5	0.35
5/2/13	3	88	90	92	2.1%	2	0	140	143	1190	4.1	57.8	1.5
5/3/13	7	36	79	95	2.8%	4	0	242	246	1030	4.6	57.4	0.88
5/4/13	7	82	86	97	4.2%	3	0	162	165	776	3.6	58.4	0.99
5/5/13	1	100	100	100	4.3%	0	0	23	23	603	3.2	58.3	1.13
5/6/13	0	-	-	-	6.0%	0	0	0	0	384	3.1	59.0	2.18
5/7/13	0	-	-	-	7.6%	0	0	0	0	286	2.1	60.6	0.47
5/8/13	2	88	94	100	5.4%	0	0	37	37	274	2.0	62.3	1.72
5/9/13	12	80	89	104	6.6%	0	0	182	182	213	1.4	64.2	1.24
5/10/13	0	-	-	-	6.0%	0	0	0	0	163	1.5	64.8	0.13
5/11/13	3	80	88	99	6.4%	0	0	47	47	164	1.4	70.6	1.21
5/12/13	1	90	90	90	6.0%	0	0	17	17	164	1.0	73.5	0.65
5/13/13	0	-	-	-	4.3%	0	0	0	0	162	2.1	74.0	1.46
5/14/13	0	-	-	-	0.0%	0	0	0	0	165	1.3	74.0	1.45
5/15/13	0	-	-	-	0.0%	0	0	0	0	165	1.2	72.8	1.14
5/16/13	0	-	-	-	0.0%	0	0	0	0	164	0.8	69.8	nd
5/17/13	0	-	-	-	0.0%	0	0	0	0	165	1.2	67.9	1.08
5/18/13	0	-	-	-	0.0%	0	0	0	0	164	1.3	68.4	0.93
5/19/13	0	-	-	-	0.0%	0	0	0	0	165	1.3	69.6	1.2
5/20/13	0	-	-	-	0.0%	0	0	0	0	163	0.8	71.1	1.19
5/21/13	0	-	-	-	0.0%	0	0	0	0	162	1.5	71.8	1.29
5/22/13	0	-	-	-	0.0%	0	0	0	0	164	1.2	69.2	1.37
5/23/13	0	-	-	-	0.0%	0	0	0	0	165	1.3	67.6	0.86
5/24/13	0	-	-	-	0.0%	0	0	0	0	164	1.5	68.4	0.95
5/25/13	0	-	-	-	0.0%	0	0	0	0	164	1.1	69.0	2.47
5/26/13	0	-	-	-	0.0%	0	0	0	0	164	1.1	69.4	1.3
5/27/13	0	-	-	-	0.0%	0	0	0	0	164	1.1	68.8	1.22
5/28/13	0	-	-	-	0.0%	0	0	0	0	164	0.3	69.1	1.27
5/29/13	0	-	-	-	0.0%	0	0	0	0	164	1.1	71.0	1.63
5/30/13	0	-	-	-	0.0%	0	0	0	0	163	1.3	71.7	1.43
5/31/13	0	-	-	-	0.0%	0	0	0	0	164	1.1	72.5	1.34

Appendix B. Daily Chinook catch, length, average catchability, and estimated passage at Grayson and associated environmental data from 2013.

	Unmarked Chinook Salmon									*Environmental Conditions*				
Date	Catch	Fork Length (mm)			Average Catchability	Estimated Passage				Flow (cfs)	Velocity (ft/s)		Temp at the traps (F)	Turbidity (NTU)
		Min	Avg	Max		Fry	Parr	Smolt	Total	Modesto Flow	North	South		
1/3/13	0	-	-	-	0.0%	0	0	0	0	239	1.3	1.5	46.35	8.95
1/4/13	0	-	-	-	0.0%	0	0	0	0	233	1.5	1.5	46.65	4.38
1/5/13	0	-	-	-	0.0%	0	0	0	0	232	1.6	1.3	46.85	3.12
1/6/13	0	-	-	-	0.0%	0	0	0	0	348	1.6	1.5	48.11	8.99
1/7/13	0	-	-	-	0.0%	0	0	0	0	510	1.6	1.5	47.18	8.26
1/8/13	0	-	-	-	0.0%	0	0	0	0	493	2.1	2.1	46.27	33.70
1/9/13	0	-	-	-	0.0%	0	0	0	0	346	1.5	0.9	47.10	21.50
1/10/13	0	-	-	-	0.0%	0	0	0	0	299	1.0	1.2	47.63	10.72
1/11/13	0	-	-	-	0.0%	0	0	0	0	269	1.2	1.1	46.79	7.33
1/12/13	0	-	-	-	0.0%	0	0	0	0	253	1.6	1.5	46.31	8.85
1/13/13	0	-	-	-	0.0%	0	0	0	0	242	1.5	1.1	45.20	3.68
1/14/13	0	-	-	-	0.0%	0	0	0	0	235	1.3	1.6	44.30	3.60
1/15/13	1	30	30	30	16.1%	6	0	0	6	229	1.5	1.3	44.87	4.52
1/16/13	0	-	-	-	16.1%	0	0	0	0	223	1.3	1.5	45.43	3.81
1/17/13	0	-	-	-	16.1%	0	0	0	0	219	1.1	0.7	45.80	2.25
1/18/13	0	-	-	-	16.1%	0	0	0	0	216	1.3	1.3	46.33	2.61
1/19/13	0	-	-	-	16.1%	0	0	0	0	213	1.5	1.5	46.82	0.54
1/20/13	0	-	-	-	16.1%	0	0	0	0	210	1.5	1.4	47.41	1.72
1/21/13	0	-	-	-	16.1%	0	0	0	0	210	1.2	0.8	47.71	1.82
1/22/13	0	-	-	-	16.1%	0	0	0	0	204	1.5	1.7	48.12	2.35
1/23/13	0	-	-	-	16.1%	0	0	0	0	201	nd	nd	49.40	1.65
1/24/13	0	-	-	-	16.1%	0	0	0	0	204	1.3	1.5	49.99	1.92
1/25/13	0	-	-	-	16.1%	0	0	0	0	204	1.5	1.7	52.97	2.08
1/26/13	0	-	-	-	16.1%	0	0	0	0	200	1.3	1.6	54.63	3.26
1/27/13	0	-	-	-	16.1%	0	0	0	0	198	1.6	1.6	52.69	2.42
1/28/13	0	-	-	-	16.1%	0	0	0	0	196	1.3	1.7	51.48	0.98
1/29/13	0	-	-	-	16.1%	0	0	0	0	196	1.5	1.9	52.12	1.58
1/30/13	0	-	-	-	16.1%	0	0	0	0	197	1.6	1.7	52.66	2.03
1/31/13	0	-	-	-	16.1%	0	0	0	0	194	1.4	1.4	53.03	1.00
2/1/13	0	-	-	-	16.1%	0	0	0	0	196	1.5	1.6	53.30	0.76
2/2/13	0	-	-	-	16.1%	0	0	0	0	193	1.2	1.0	53.29	0.88
2/3/13	0	-	-	-	16.1%	0	0	0	0	191	1.4	1.6	53.09	3.12
2/4/13	0	-	-	-	16.1%	0	0	0	0	192	1.6	1.0	53.42	2.18
2/5/13	0	-	-	-	16.1%	0	0	0	0	191	1.3	1.5	54.23	0.98
2/6/13	0	-	-	-	16.1%	0	0	0	0	191	1.3	1.7	53.89	1.02
2/7/13	0	-	-	-	16.1%	0	0	0	0	195	1.6	1.7	54.31	0.91
2/8/13	0	-	-	-	16.1%	0	0	0	0	196	1.7	1.8	52.47	4.45
2/9/13	0	-	-	-	16.1%	0	0	0	0	198	1.3	1.3	51.35	1.20
2/10/13	0	-	-	-	16.1%	0	0	0	0	197	1.5	1.7	51.47	0.70
2/11/13	0	-	-	-	16.1%	0	0	0	0	196	1.7	2.1	51.86	0.55
2/12/13	0	-	-	-	16.1%	0	0	0	0	189	1.4	1.8	52.36	1.99
2/13/13	0	-	-	-	16.1%	0	0	0	0	187	1.8	1.7	53.05	0.68
2/14/13	0	-	-	-	16.1%	0	0	0	0	186	1.8	1.3	53.92	1.21
2/15/13	0	-	-	-	16.1%	0	0	0	0	184	1.5	1.2	54.94	5.99
2/16/13	0	-	-	-	16.1%	0	0	0	0	181	1.2	1.5	55.22	1.17
2/17/13	0	-	-	-	16.1%	0	0	0	0	194	1.7	1.7	55.50	1.66
2/18/13	0	-	-	-	16.1%	0	0	0	0	200	1.6	1.7	55.37	0.59
2/19/13	0	-	-	-	16.1%	0	0	0	0	220	1.3	1.2	53.92	1.34
2/20/13	0	-	-	-	16.1%	0	0	0	0	210	1.3	1.4	52.20	2.92
2/21/13	0	-	-	-	16.1%	0	0	0	0	195	1.7	1.6	53.73	1.09
2/22/13	0	-	-	-	16.1%	0	0	0	0	194	1.7	1.5	54.48	1.82
2/23/13	0	-	-	-	16.1%	0	0	0	0	192	1.8	1.5	55.85	1.79

	Unmarked Chinook Salmon									Environmental Conditions				
Date	Catch	Fork Length (mm)			Average Catchability	Estimated Passage				Flow (cfs)	Velocity (ft/s)		Temp at the traps (F)	Turbidity (NTU)
		Min	Avg	Max		Fry	Parr	Smolt	Total	Modesto Flow	North	South		
2/24/13	0	-	-	-	16.1%	0	0	0	0	192	nd	1.4	53.67	2.12
2/25/13	0	-	-	-	16.1%	0	0	0	0	194	1.5	1.4	54.56	0.62
2/26/13	0	-	-	-	16.1%	0	0	0	0	191	1.7	1.3	55.23	1.17
2/27/13	1	55	55	55	14.9%	0	7	0	7	190	1.5	1.3	55.64	0.54
2/28/13	0	-	-	-	14.9%	0	0	0	0	190	1.2	1.5	55.43	0.78
3/1/13	0	-	-	-	14.9%	0	0	0	0	189	1.3	1.7	59.58	0.76
3/2/13	0	-	-	-	14.9%	0	0	0	0	190	nd	nd	60.76	0.79
3/3/13	0	-	-	-	14.9%	0	0	0	0	196	1.7	1.9	61.63	1.82
3/4/13	0	-	-	-	14.9%	0	0	0	0	197	nd	1.6	60.82	1.02
3/5/13	0	-	-	-	14.9%	0	0	0	0	202	1.3	1.4	61.08	1.46
3/6/13	0	-	-	-	14.9%	0	0	0	0	213	1.3	1.3	59.84	2.73
3/7/13	0	-	-	-	14.9%	0	0	0	0	213	1.5	1.3	59.05	1.80
3/8/13	0	-	-	-	14.9%	0	0	0	0	224	1.3	1.2	60.29	1.96
3/9/13	0	-	-	-	14.9%	0	0	0	0	236	2.1	1.8	59.61	3.84
3/10/13	0	-	-	-	14.9%	0	0	0	0	228	1.5	1.7	59.84	7.87
3/11/13	0	-	-	-	14.9%	0	0	0	0	220	1.2	1.3	60.70	1.77
3/12/13	0	-	-	-	14.9%	0	0	0	0	225	1.3	1.0	62.36	2.95
3/13/13	0	-	-	-	14.9%	0	0	0	0	224	0.9	0.4	63.89	6.22
3/14/13	0	-	-	-	14.9%	0	0	0	0	225	1.6	1.8	64.86	12.62
3/15/13	0	-	-	-	14.9%	0	0	0	0	238	1.3	1.5	64.33	3.35
3/16/13	0	-	-	-	14.9%	0	0	0	0	239	1.1	1.5	64.37	6.12
3/17/13	0	-	-	-	14.9%	0	0	0	0	253	1.5	1.3	64.26	3.22
3/18/13	0	-	-	-	14.9%	0	0	0	0	248	1.5	1.5	63.26	6.09
3/19/13	0	-	-	-	14.9%	0	0	0	0	251	1.7	1.5	63.81	3.88
3/20/13	0	-	-	-	14.9%	0	0	0	0	261	1.9	1.6	64.40	9.88
3/21/13	0	-	-	-	14.9%	0	0	0	0	269	1.3	1.5	63.61	7.57
3/22/13	0	-	-	-	14.9%	0	0	0	0	258	1.7	1.6	60.73	5.91
3/23/13	0	-	-	-	14.9%	0	0	0	0	247	1.7	1.4	60.00	9.33
3/24/13	0	-	-	-	14.9%	0	0	0	0	245	1.5	1.5	62.09	3.61
3/25/13	0	-	-	-	14.9%	0	0	0	0	250	1.7	1.3	63.55	7.55
3/26/13	0	-	-	-	14.9%	0	0	0	0	245	1.6	1.3	63.72	7.19
3/27/13	0	-	-	-	14.9%	0	0	0	0	246	1.7	1.7	65.22	14.87
3/28/13	0	-	-	-	14.9%	0	0	0	0	260	1.6	1.4	66.62	4.66
3/29/13	0	-	-	-	14.9%	0	0	0	0	261	1.4	1.6	67.39	9.73
3/30/13	1	85	85	85	9.4%	0	0	11	11	266	1.8	1.8	68.30	5.84
3/31/13	0	-	-	-	9.4%	0	0	0	0	336	1.7	1.8	68.42	8.80
4/1/13	0	-	-	-	9.4%	0	0	0	0	323	2.2	2.0	67.59	6.38
4/2/13	0	-	-	-	9.4%	0	0	0	0	264	1.8	2.0	67.34	3.67
4/3/13	0	-	-	-	9.4%	0	0	0	0	253	1.3	1.7	69.0	2.8
4/4/13	0	-	-	-	9.4%	0	0	0	0	275	1.8	1.6	69.42	5.73
4/5/13	1	85	85	85	9.9%	0	0	10	10	253	1.8	1.8	68.60	3.90
4/6/13	0	-	-	-	9.9%	0	0	0	0	254	1.6	1.5	67.93	4.41
4/7/13	0	-	-	-	9.9%	0	0	0	0	231	1.6	1.4	68.59	4.05
4/8/13	0	-	-	-	9.9%	0	0	0	0	223	0.4	1.3	65.73	3.20
4/9/13	0	-	-	-	9.9%	0	0	0	0	221	1.7	1.5	63.83	3.45
4/10/13	0	-	-	-	9.9%	0	0	0	0	221	1.4	1.0	66.43	2.48
4/11/13	0	-	-	-	9.9%	0	0	0	0	220	1.8	1.7	67.68	2.62
4/12/13	0	-	-	-	9.9%	0	0	0	0	226	2.2	1.6	68.93	1.85
4/13/13	0	-	-	-	9.9%	0	0	0	0	219	1.6	1.2	69.52	2.00
4/14/13	0	-	-	-	9.9%	0	0	0	0	267	1.9	1.0	68.50	3.07
4/15/13	0	-	-	-	9.9%	0	0	0	0	307	1.8	2.0	66.38	10.61
4/16/13	0	-	-	-	9.9%	0	0	0	0	593	1.6	2.0	63.84	2.73
4/17/13	1	91	91	91	5.5%	0	0	18	18	573	2.3	2.2	63.2	5.1
4/18/13	6	74	83	97	5.5%	0	0	109	109	493	2.2	1.7	62.26	2.65
4/19/13	9	79	87	95	6.3%	0	0	144	144	480	2.1	2.2	64.00	3.47
4/20/13	0	-	-	-	6.3%	0	0	0	0	470	1.6	1.2	65.93	9.61

Date	Unmarked Chinook Salmon									Environmental Conditions				
	Catch	Fork Length (mm)			Average Catchability	Estimated Passage				Flow (cfs)	Velocity (ft/s)		Temp at the traps (F)	Turbidity (NTU)
		Min	Avg	Max		Fry	Parr	Smolt	Total	Modesto Flow	North	South		
4/21/13	5	80	85	95	5.4%	0	0	92	92	538	2.0	2.2	67.13	7.63
4/22/13	1	91	91	91	2.7%	0	0	37	37	804	1.7	1.4	67.45	9.03
4/23/13	2	78	79	79	4.2%	0	0	48	48	763	2.2	2.4	65.29	3.27
4/24/13	2	79	82	84	4.2%	0	0	48	48	687	2.1	2.0	64.94	1.80
4/25/13	1	83	83	83	3.3%	0	0	30	30	668	1.7	1.5	65.55	1.69
4/26/13	1	81	81	81	3.7%	0	0	27	27	688	2.0	1.6	65.84	2.28
4/27/13	0	-	-	-	3.7%	0	0	0	0	744	2.5	2.3	66.76	2.04
4/28/13	0	-	-	-	3.7%	0	0	0	0	992	2.5	2.4	66.14	2.36
4/29/13	0	-	-	-	3.7%	0	0	0	0	961	2.1	2.4	65.61	4.16
4/30/13	0	-	-	-	3.7%	0	0	0	0	878	2.4	nd	65.36	2.86
5/1/13	1	75	75	75	3.9%	0	0	26	26	878	2.3	2.6	64.47	2.39
5/2/13	0	-	-	-	3.9%	0	0	0	0	950	2.4	2.2	65.27	2.07
5/3/13	0	-	-	-	3.9%	0	0	0	0	1140	2.1	2.2	64.3	3.2
5/4/13	0	-	-	-	3.9%	0	0	0	0	1050	2.5	2.2	63.60	3.03
5/5/13	0	-	-	-	3.9%	0	0	0	0	899	2.4	2.6	63.91	4.15
5/6/13	0	-	-	-	3.9%	0	0	0	0	748	2.1	2.2	64.70	2.19
5/7/13	1	91	91	91	5.1%	0	0	19	19	556	1.8	2.3	64.64	1.53
5/8/13	0	-	-	-	5.1%	0	0	0	0	410	2.2	1.8	65.77	5.28
5/9/13	0	-	-	-	5.1%	0	0	0	0	375	1.6	1.8	68.09	3.23
5/10/13	0	-	-	-	5.1%	0	0	0	0	322	1.5	1.5	68.24	1.83
5/11/13	1	99	99	99	9.4%	0	0	11	11	246	1.6	1.7	73.74	2.57
5/12/13	0	-	-	-	9.4%	0	0	0	0	258	1.7	1.7	75.87	2.98
5/13/13	0	-	-	-	9.4%	0	0	0	0	236	1.2	1.5	76.10	7.00
5/14/13	0	-	-	-	9.4%	0	0	0	0	210	1.3	1.1	76.56	4.74
5/15/13	0	-	-	-	9.4%	0	0	0	0	207	1.1	1.0	75.10	4.51
5/16/13	0	-	-	-	9.4%	0	0	0	0	245	1.4	1.2	72.17	4.94
5/17/13	0	-	-	-	9.4%	0	0	0	0	241	0.9	1.3	71.16	3.66
5/18/13	0	-	-	-	9.4%	0	0	0	0	232	0.8	0.7	71.70	2.64
5/19/13	0	-	-	-	9.4%	0	0	0	0	248	0.8	1.3	72.79	2.94
5/20/13	0	-	-	-	9.4%	0	0	0	0	256	1.5	0.4	73.7	2.3
5/21/13	0	-	-	-	9.4%	0	0	0	0	235	0.4	0.6	73.98	3.48
5/22/13	0	-	-	-	9.4%	0	0	0	0	224	1.3	1.3	69.75	2.77
5/23/13	0	-	-	-	9.4%	0	0	0	0	210	1.1	1.3	69.69	2.80

Appendix C. Daily counts of non-salmonids captured at Waterford during 2013. See key below for species codes.

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
1/2/13																						
1/3/13																						
1/4/13																						
1/5/13								1														
1/6/13								4														
1/7/13								2			1											
1/8/13																						
1/9/13									1													1
1/10/13								1					1									
1/11/13																						
1/12/13																						
1/13/13													1									
1/14/13		2																				
1/15/13																						
1/16/13																						
1/17/13																1						
1/18/13																						
1/19/13								1														
1/20/13																						
1/21/13													1									
1/22/13													1									
1/23/13										1			2									
1/24/13		1											2									
1/25/13																						
1/26/13																						
1/27/13													6									
1/28/13		2											3									

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
1/29/13													1									
1/30/13		1											3			1						
1/31/13																						
2/1/13		1											2									1
2/2/13																						
2/3/13																						
2/4/13													1									
2/5/13																						
2/6/13																						
2/7/13	1																					
2/8/13																						
2/9/13																						
2/10/13													1									
2/11/13													1									
2/12/13										1			2									1
2/13/13													1									
2/14/13											1											
2/15/13																						
2/16/13																						
2/17/13													1				1					
2/18/13																						1
2/19/13																						
2/20/13		1																				
2/21/13		1																				
2/22/13		1											1									
2/23/13																						
2/24/13		1																				
2/25/13		3														1						
2/26/13		1														1						

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
2/27/13		1											1									
2/28/13		1																				
3/1/13																						
3/2/13																	1		1			
3/3/13																						
3/4/13		1																				
3/5/13		10							1				6								1	
3/6/13																2			1			
3/7/13		2																				
3/8/13		2																			1	
3/9/13																						
3/10/13																2						
3/11/13		4						1														2
3/12/13		2																				
3/13/13		1												2								
3/14/13				1												2						
3/15/13																						1
3/16/13		1																				
3/17/13		1																				
3/18/13		1											1				1					
3/19/13		1														1					1	2
3/20/13						1																
3/21/13		1								1			1			1						
3/22/13		1																				
3/23/13		3									1		1			1						
3/24/13																						
3/25/13													1					1				
3/26/13																						
3/27/13																	1				1	

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
3/28/13	1															1						
3/29/13											1											
3/30/13		1																				
3/31/13																		1				
4/1/13																						
4/2/13																						
4/3/13		1		1																		1
4/4/13																		1				
4/5/13								1														
4/6/13																		1				1
4/7/13													1									1
4/8/13																						1
4/9/13																						
4/10/13																						
4/11/13		1								1								1				1
4/12/13													1					2				1
4/13/13																						
4/14/13	1																					
4/15/13																		1				1
4/16/13		1										1									1	
4/17/13		1												2				1				
4/18/13									1													
4/19/13		1									1					1						1
4/20/13																1						1
4/21/13																						
4/22/13	1	1	1	1							1										1	
4/23/13							2	1			1					2					1	2
4/24/13							1				1										2	1
4/25/13		3																			1	

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
4/26/13		1												1			1					
4/27/13		2													1							1
4/28/13	1																					2
4/29/13		1														1	6					
4/30/13																						2
5/1/13							1				1						3					
5/2/13																					2	
5/3/13								3									1					3
5/4/13		1					2				1			1								2
5/5/13		1																				2
5/6/13							1							1		1	2					
5/7/13																	2					1
5/8/13		1																				1
5/9/13		2			1												1	1			1	
5/10/13																						2
5/11/13	1																					2
5/12/13																						1
5/13/13	2																					2
5/14/13																						
5/15/13	1																					1
5/16/13																						4
5/17/13																						
5/18/13	2																					1
5/19/13	1															1						2
5/20/13																						
5/21/13	1																					1
5/22/13	1																					1
5/23/13																						
5/24/13																						

Batch Date	BAS	BGS	BKS	CHC	GF	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SMB	SNF	UNID	W	WHC
5/25/13	1																					1
5/26/13	2			1																		
5/27/13	9																					
5/28/13																						
5/29/13	46																			2		
5/30/13																						
5/31/13	15																					

Appendix D. Daily counts of non-salmonids captured at Grayson during 2013. See key below for species codes.

Date	BAS	BGS	BKB	BKS	BRB	C	CAT	CHC	GSF	GSN	HCH	HH	LAM	LMB	MQK	MSS	PKS	PRS	RES	RSN	SASQ	SASU	SMB	STB	TP	UNID	W	WHC
1/3/13	2					1																				1		
1/4/13	2	2						2					1								15							
1/5/13		1								1					1			1		8								
1/6/13		2								2		1								1								
1/7/13					1					7			3		2													
1/8/13		1											2															
1/9/13										1			2															
1/10/13		2								1						1												1
1/11/13								1		3			2					1										
1/12/13										1					3					2								
1/13/13				1						1											1	1						
1/14/13																												1
1/15/13																					1							
1/16/13																												
1/17/13								1		2						1												1
1/18/13		1																										1
1/19/13										3									1									
1/20/13										1										1								
1/21/13										1																		
1/22/13																2		1										
1/23/13																				1								
1/24/13						1									1													1
1/25/13																												
1/26/13		1																		1								
1/27/13																				1								
1/28/13																												
1/29/13											1					1												

Date	BAS	BGS	BKB	BKS	BRB	C	CAT	CHC	GSF	GSN	HCH	HH	LAM	LMB	MQK	MSS	PKS	PRS	RES	RSN	SASQ	SASU	SMB	STB	TP	UNID	W	WHC
1/30/13																												
1/31/13										1																		
2/1/13																1												
2/2/13																												
2/3/13																												
2/4/13																												
2/5/13																												
2/6/13																		1					1					
2/7/13																		1										
2/8/13																												
2/9/13																												
2/10/13																												
2/11/13																1												1
2/12/13																												
2/13/13																							1					
2/14/13																												
2/15/13																												
2/16/13																												
2/17/13																												
2/18/13																							1					
2/19/13														1														
2/20/13								1					3															
2/21/13										3																		
2/22/13																												
2/23/13																												
2/24/13																												
2/25/13																												
2/26/13													1					1										
2/27/13										1																		

Date	BAS	BGS	BKB	BKS	BRB	C	CAT	CHC	GSF	GSN	HCH	HH	LAM	LMB	MQK	MSS	PKS	PRS	RES	RSN	SASQ	SASU	SMB	STB	TP	UNID	W	WHC
2/28/13																												
3/1/13																												
3/2/13																												
3/3/13																												
3/4/13																												1
3/5/13										1			1															2
3/6/13																												
3/7/13																												
3/8/13																												1
3/9/13																												
3/10/13																												
3/11/13																												
3/12/13																												
3/13/13																												2
3/14/13		1								1			2															1
3/15/13													2					1		1								3
3/16/13													3															3
3/17/13																												1
3/18/13		1								1			1															9
3/19/13								1		1																		7
3/20/13										1																		
3/21/13										1			12	1									2					8
3/22/13		1								2			10			1							4					4
3/23/13													3		2	1							1					2
3/24/13	1									1			1												1			2
3/25/13	1									2					1								1					3
3/26/13										1																		
3/27/13									1	2					2													6
3/28/13		1																										

Date	BAS	BGS	BKB	BKS	BRB	C	CAT	CHC	GSF	GSN	HCH	HH	LAM	LMB	MQK	MSS	PKS	PRS	RES	RSN	SASQ	SASU	SMB	STB	TP	UNID	W	WHC
3/29/13																							1					17
3/30/13	1				2			1					6		1					3								21
3/31/13															1								1					8
4/1/13			1	1			1	3		1			22			1							15					28
4/2/13	1							7		5													9					15
4/3/13		1	4							8	1												2					21
4/4/13										9					2													11
4/5/13										3													5					18
4/6/13	1														1								1					9
4/7/13								4		1																		7
4/8/13																							2					3
4/9/13																				1								6
4/10/13															1	1												10
4/11/13																							2					7
4/12/13									1	2																		12
4/13/13																												4
4/14/13	1												1															4
4/15/13										1												1						10
4/16/13			1																				1			3		6
4/17/13										3				10	4								7					13
4/18/13										3						3							21				1	7
4/19/13	1			1						6													9					6
4/20/13	3																			2								3
4/21/13	3	1				1				2										2			1					2
4/22/13	4														3					4								4
4/23/13										3					4		1						6					19
4/24/13	1			1					1	9					2	1						1	5					4
4/25/13	2									3					4								3					2
4/26/13	2	2								3					1								1					6

Date	BAS	BGS	BKB	BKS	BRB	C	CAT	CHC	GSF	GSN	HCH	HH	LAM	LMB	MQK	MSS	PKS	PRS	RES	RSN	SASQ	SASU	SMB	STB	TP	UNID	W	WHC
4/27/13										1	1									3				1				5
4/28/13	1														1								3					4
4/29/13	4									3										1			1					3
4/30/13	1														2													2
5/1/13											2												1					3
5/2/13	5									1					1								1					5
5/3/13																												
5/4/13	1									1					1													1
5/5/13																												
5/6/13	5									5					1								1					1
5/7/13	13	1						1		4					1													2
5/8/13																												
5/9/13	13									1										1			2					5
5/10/13	8														1													1
5/11/13	20																											6
5/12/13	17																											1
5/13/13	18												1															3
5/14/13	7																						5					9
5/15/13	20																											1
5/16/13	117	1																					1					3
5/17/13	104														1						6		4					3
5/18/13	70	1																					2					
5/19/13	53	4																										5
5/20/13	195														1													3
5/21/13	115	2																					2					
5/22/13	57	1																										1
5/23/13	131	1						1	1				1										3					3

Appendix E. Key to species codes.

BAS	Unidentified bass
BGS	Bluegill
BKB	Black bullhead
BKS	Black crappie
BRB	Brown bullhead
C	Carp
CAT	Unidentified catfish
CHC	Channel catfish
CHN	Chinook
GF	Goldfish
GSF	Green sunfish
GSN	Golden shiner
HCH	Hitch
HH	Hardhead
LAM	Lamprey, unidentified species
LMB	Largemouth bass
MQK	Mosquitofish
MSS	Inland silverside
PKS	Pumpkinseed
PRS	Prickly sculpin
RES	Redear sunfish
RSN	Red shiner
SASQ	Sacramento pikeminnow
SASU	Sacramento sucker
SMB	Smallmouth bass
SNF	Unidentified sunfish
STB	Striped bass
TP	Tule perch
UNID	Unidentified species
W	Warmouth
WHC	White catfish

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-5

2013 Snorkel Report and Summary Update

Prepared for

Turlock and Modesto Irrigation Districts

By

Stillwater Sciences
Berkeley, CA

March 2014

SUMMARY

In 2013, a routine snorkel survey was conducted on July 24th – 26th within the 20-mile reach of the Tuolumne River below La Grange Dam. Preliminary USGS flow at La Grange was approximately 100 cfs and water temperature ranged from 12.9°C (55.2 °F) to 30.0°C (81.1 °F). A total of 93 juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and 385 rainbow trout (*Oncorhynchus mykiss*) were observed in various habitats. Chinook salmon were observed downstream to Riffle 7 (River Mile [RM] 46.9) and rainbow trout downstream to Riffle 23C (RM 42.3). Other native fish species observed were Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), hardhead (*Mylopharodon conocephalus*), and riffle sculpin (*Cottus gulosus*). Non-native species observed included bluegill sunfish (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*M. dolomieu*).

Early summer surveys conducted in June/July have been completed in most years since 1986 except in years with extended high flows into the summer survey period (i.e., 1995, 1998, 2005, 2006, 2010, and 2011) that precluded the surveys. Rainbow trout were absent in surveys from 1987 through 1994 (with the exception of a single observation in June 1992). Since 1996, rainbow trout have been observed in each of the June/July surveys conducted, with the highest counts seen in June 1996 and second highest counts in June 2007. With the exception of 1991 and 1992, Chinook salmon have been observed in each year when an early summer survey was conducted, with the highest counts seen in June 2009.

Late summer surveys have been conducted in September of most years during the recent 2001–2012 period with the exception of 2008, 2009, and 2012. Rainbow trout were observed in all years surveyed with the highest counts seen in 2011 and the second highest counts seen in 2006. Chinook salmon were seen in much lower numbers or not at all for the same period of years with the highest counts observed in 2010.

The river-wide distribution of non-salmonid species (species other than trout or salmon) encountered in either routine or reference count snorkel surveys shifted beginning in the summer of 1996. In surveys from 1982–1996, warm water species (e.g. common carp, goldfish, catfish species, and sunfish species) were commonly observed, even upstream to Riffle 2 (RM 49.9). After 1996, these species were observed less frequently and typically only farther downstream. The change in species distribution coincided with higher required summer flows implemented with the 1996 FERC Order and lower upstream water temperatures associated with these flows.

CONTENTS

1 INTRODUCTION

Annual snorkel surveys have been conducted by the Turlock and Modesto Irrigation Districts (Districts) at locations along the lower Tuolumne River since 1982, with standard "reference" locations established since 2001. The location, area sampled by site, and season have varied over the years prior to 2001. The surveys completed from 1982–1987 were in limited locations and in varying seasons. A June/July snorkel survey has often been conducted since 1986 to evaluate the abundance, size, and distribution of salmonids and other fish species in "early summer" when required flow releases are less than in other seasons and is after the primary outmigration period of juvenile salmon. Summer surveys during June through September have been conducted in most years since 1988, although very wet years with high summer flows were not sampled for safety reasons. The surveys in 1988–1994 were part of the Districts' "summer flow" studies examining conditions affecting Chinook salmon while those since 1996 were part of the Tuolumne River fish management program implemented under the current FERC license for the Don Pedro Project. A total of 12 sites per survey have been done since 2001 with a comparable September snorkel survey in 2001–2007 and again in 2010–2011. In 2013 a single survey was conducted in July at a total of 12 sites.

Locations were selected to include a range of habitat types (i.e., riffles, runs, pools) at sites where salmonids may occur and are spaced at intervals down the river in general areas of suitable access. The overall river section examined is limited to the reach with suitable underwater visibility, this generally being about a 20-mile section from La Grange Dam (RM 52.2) downstream to near the city of Waterford (RM 31.5), although one site near RM 25 was sampled in 1988–1993.

1.1 2013 STUDY SITES

The area studied was the Tuolumne River from La Grange Dam (RM 52.2) to Hickman Bridge (RM 31.5) (Figure 1). Sites were selected based upon historical observations of fish habitat use, with presence/absence of fish at these sites and relative numbers used as indicators of river conditions such as flow and temperature. A total of eleven sites sampled are listed below. The site located at Bobcat Flat (R21) [RM 42.9] which is typically included in the snorkel surveys was not sampled in 2012 due to access restrictions. Riffle names are interchangeably designated with an "R" in this report (i.e. R2 = Riffle 2).

Site	Location	River Mile
1	Old La Grange Bridge (Riffle A7)	50.7
2	Riffle 2	49.9
3	Riffle 3B	49.1
4	Basso Bridge (R5B)	47.9
5	Riffle 7	46.9
6	Zanker Farm (R13B)	45.5
7	Bobcat Flat (R21)	42.9
8	Tuolumne River Resort (R23C)	42.3
9	7/11 Gravel (R31)	38.0
10	Santa Fe Gravel (R35A)	37.1
11	Deardorff Farm (R41A)	35.3
12	Hickman Bridge (R57)	31.5

1.2 2013 SAMPLING CONDITIONS

The flow at La Grange during the 24–26 July surveys was approximately 100 cfs (Figure 2). Water temperature collected during the surveys ranged from 12.9 °C (52.2 °F) at Riffle A7 on 24 July to 27.3 °C (81.1 °F) at Riffle 57 on 26 July.

2 METHODS

Underwater observations were conducted using an effort-based method where a snorkeler examined within a specified area for a given period of time and recorded the species, numbers, and size estimates of fish observed. A combination of different habitat types were observed; including riffles, runs, and pools. The snorkeling method provides for an index of species composition and relative abundance.

Each habitat type sampled usually involved one observer who snorkeled the specified habitat area for a certain time period. Whenever feasible, the surveys were conducted moving upstream against the current. A side-to-side (zigzag) pattern was used as the width of the survey section required. Occasionally, two snorkelers moved upstream in tandem, with each person counting fish on their side of the center of the survey section. Whenever possible, the entire width of the habitat section selected was surveyed. The only exceptions were the habitat areas that were too wide to effectively cover, in these cases the width of the survey area was estimated based on visibility. If high water velocity precluded upstream movement, snorkelers would float downstream with the current, remaining as motionless as possible through the study area, although stream margins at those sites would still be viewed in an upstream direction.

Usually the total length of an observed fish was estimated using a ruler outlined on the diving slate and recorded to the nearest 10 mm. For some larger fish, the lengths may be estimated by viewing the fish in reference to adjacent objects and then measuring that estimated length. In cases where larger numbers of fish are observed, the observer estimated the length range and number of fish in the group. Care was taken to observe and count each fish just once in the survey area.

Other data recorded for each location included water temperature, electrical conductivity, turbidity, dissolved oxygen, and horizontal visibility. Site-specific data that was recorded included area sampled, average depth, sample time, general habitat type, and substrate type.

3 RESULTS AND DISCUSSION

Survey conditions and fish observations from the snorkel survey conducted on 24–26 July are summarized in Table 1. The six native fish species observed were characteristic of the lower elevation zone adjacent to the Sierra foothills. These species were Chinook salmon, rainbow trout, Sacramento sucker, Sacramento pikeminnow, hardhead, and riffle sculpin. The non-native species observed were largemouth bass and smallmouth bass. Chinook salmon were observed downstream to R7 (RM 46.9) and rainbow trout to R23C (RM 42.3)

During the July survey, there were 93 juvenile Chinook salmon observed in various riffle, run, and pool habitats from RA7 (RM 50.7) near La Grange Dam downstream to R7 (RM 46.9), ranging in size from 35–90 mm total length (TL). One adult Chinook salmon estimated at 600 mm TL was observed in run-pool habitat at the Riffle 5B site (RM 47.9). There were 385 rainbow trout observed ranging in size from 25–400 mm TL, also seen in riffle, run, and pool habitats. A total of 364 juvenile (<150 mm TL) and 21 adult rainbow trout were observed. Water temperature at those locations where rainbow trout were observed ranged from 12.9 ºC (52.2 ºF) to 22.3 ºC (72.1 ºF). Sacramento sucker, along with Sacramento pikeminnow and hardhead were often co-occurring, while riffle sculpin were observed at two locations in low numbers usually hidden under cobble/boulder substrate.

4 COMPARISON WITH OTHER YEARS

4.1 Rainbow trout and Chinook salmon: 1982-2013

Tables 2 and 3 summarize rainbow trout and Chinook salmon observations for all snorkel surveys conducted between 1982 and 2013. Low numbers of rainbow trout were observed downstream of La Grange Dam to Riffle 5 (RM 48.0) in limited surveys from 1982 to 1986. Rainbow trout were almost entirely absent from the lower Tuolumne River in surveys from 1987 to 1995 surveys. Beginning with the increased summer base flows implemented under the 1996 FERC Order, the number and distribution of rainbow trout increased and since 1999 these fish have been observed intermittently at locations downstream to RM 35.3. For the 1982–2013 period, Chinook salmon were recorded in all years except 1991 and 1992 although in some years the counts were very low after May. Chinook salmon were intermittently seen downstream to RM 31.5. Figures 3 and 4 graphically represent Tables 2 and 3, respectively, for the June–September period. Dates and locations where rainbow trout and Chinook salmon were observed for the 2001-2013 period are shown in Figures 5 and 6 respectively, and include November surveys conducted in years 2010 and 2011.

4.2 Recent surveys: 2001-2013

The locations sampled since 2001 were the same each year, with the exception of the Bobcat Flat (R21) [RM 42.9] site in 2012. These surveys were the most comparable for showing presence or absence along the lower Tuolumne River by year, and allowing for a general indication of abundance based on observed counts. Rainbow trout counts increased from 2001 to 2006 and were much higher in 2011, with relatively lower counts in 2007 and 2010 (Figure 7) and decreasing counts in 2012 and 2013. The observed increases in counts of rainbow trout in 2006 and 2011, especially of fish less than 250 mm TL, may be the result of increased spawning and rearing habitat downstream of the La Grange Dam combined with the potential introduction of trout from overflows of the La Grange reservoir during flood control releases during the spring of those years. Chinook salmon counts in were high in years 2001–2004 and 2009, with comparatively low counts during 2007, 2008, 2012, and 2013 (Figure 8).

4.3 Other species observed: 1986-2013

The distribution and abundance of non-salmonid fish species observed during the summer snorkel surveys has changed over time. Prior to 1996, more introduced warmwater species were commonly seen with goldfish (*Carassius auratus*), common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), white catfish (*Ameiurus catus*), and various sunfish species usually observed (Table 4). After 1996 these species were often absent at upstream sites or observed in lower numbers. The change in species distribution of warmwater species appears to be associated with higher minimum summer flow releases. Unlike two recent years (2010 and 2011), in which they were observed for the first time during snorkel surveys, no observations of striped bass were made in 2012 or 2013.

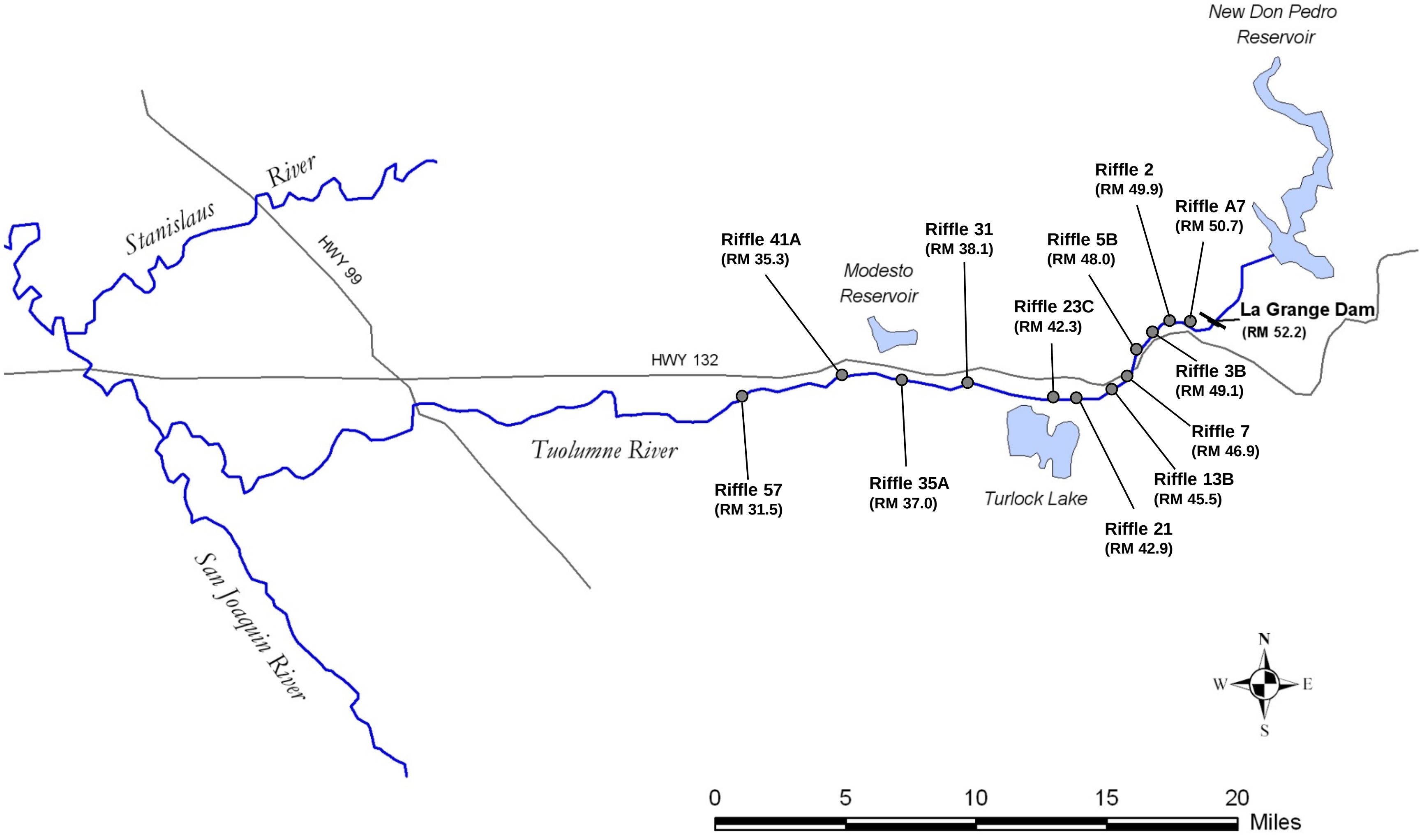

Figure 1. Locations of snorkel survey sites on the lower Tuolumne River, 2013.

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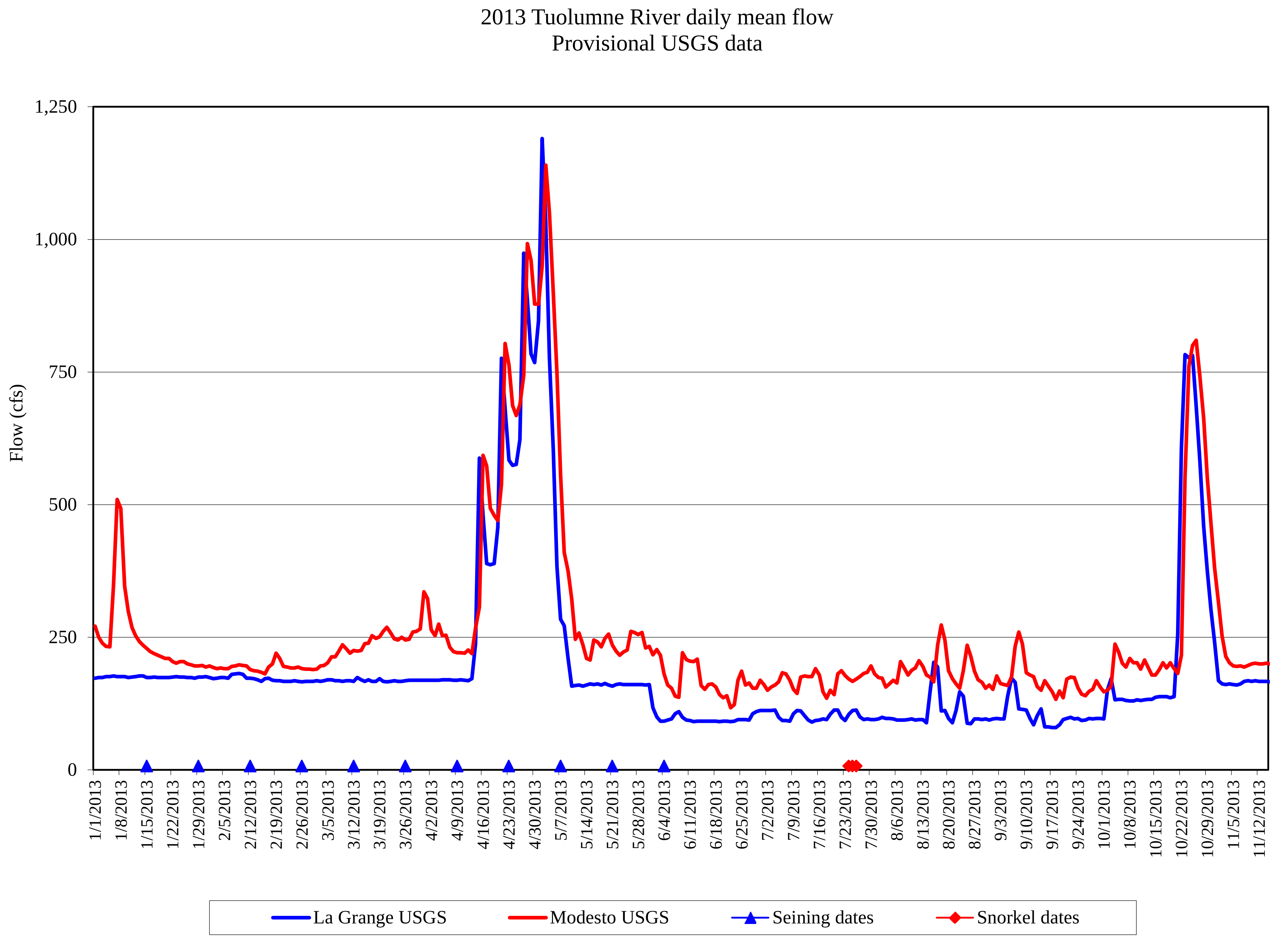

Figure 2. Tuolumne River flows at La Grange and Modesto USGS stations during 2013

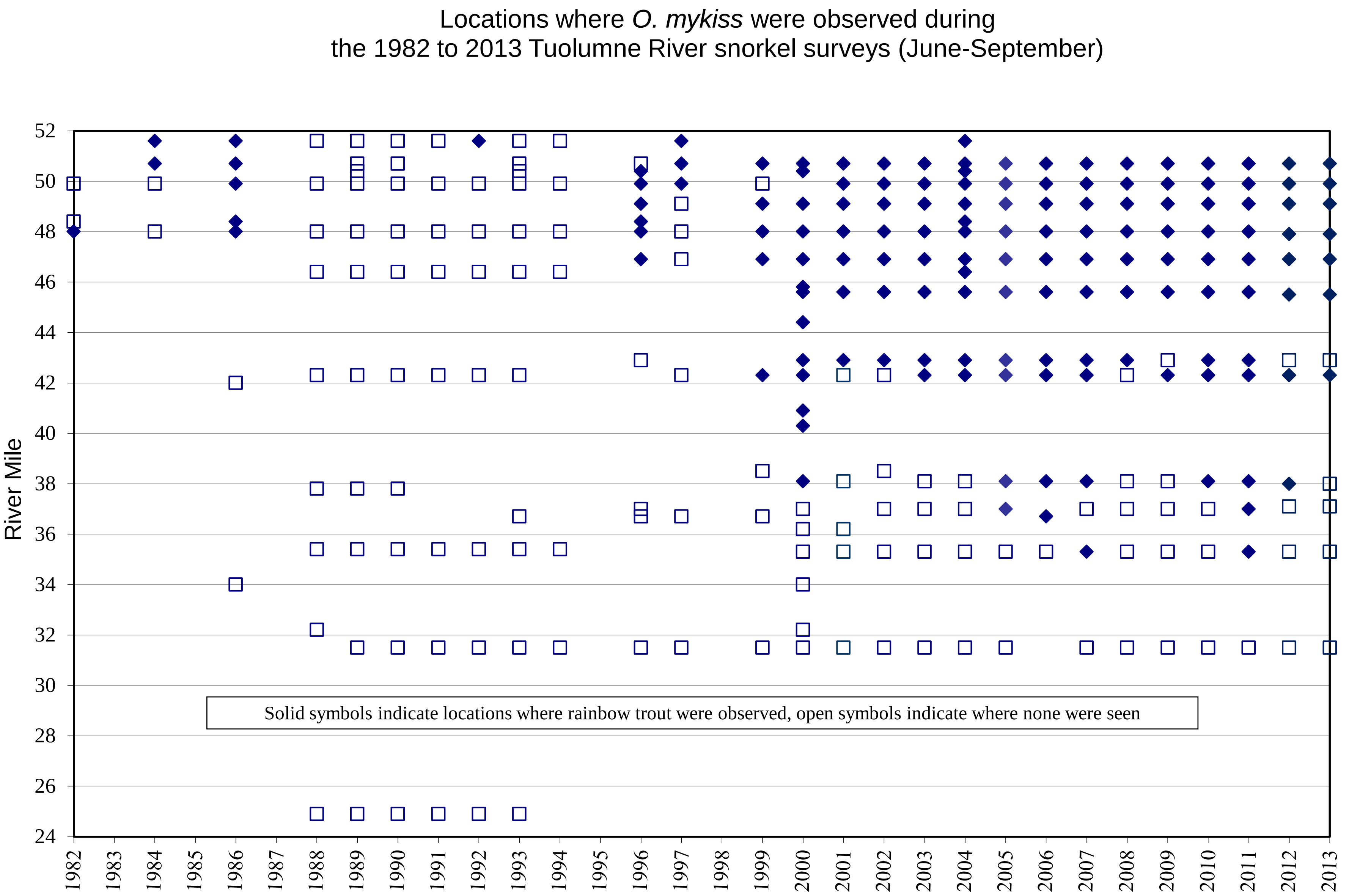

Figure 3. Locations where *O. mykiss* were observed

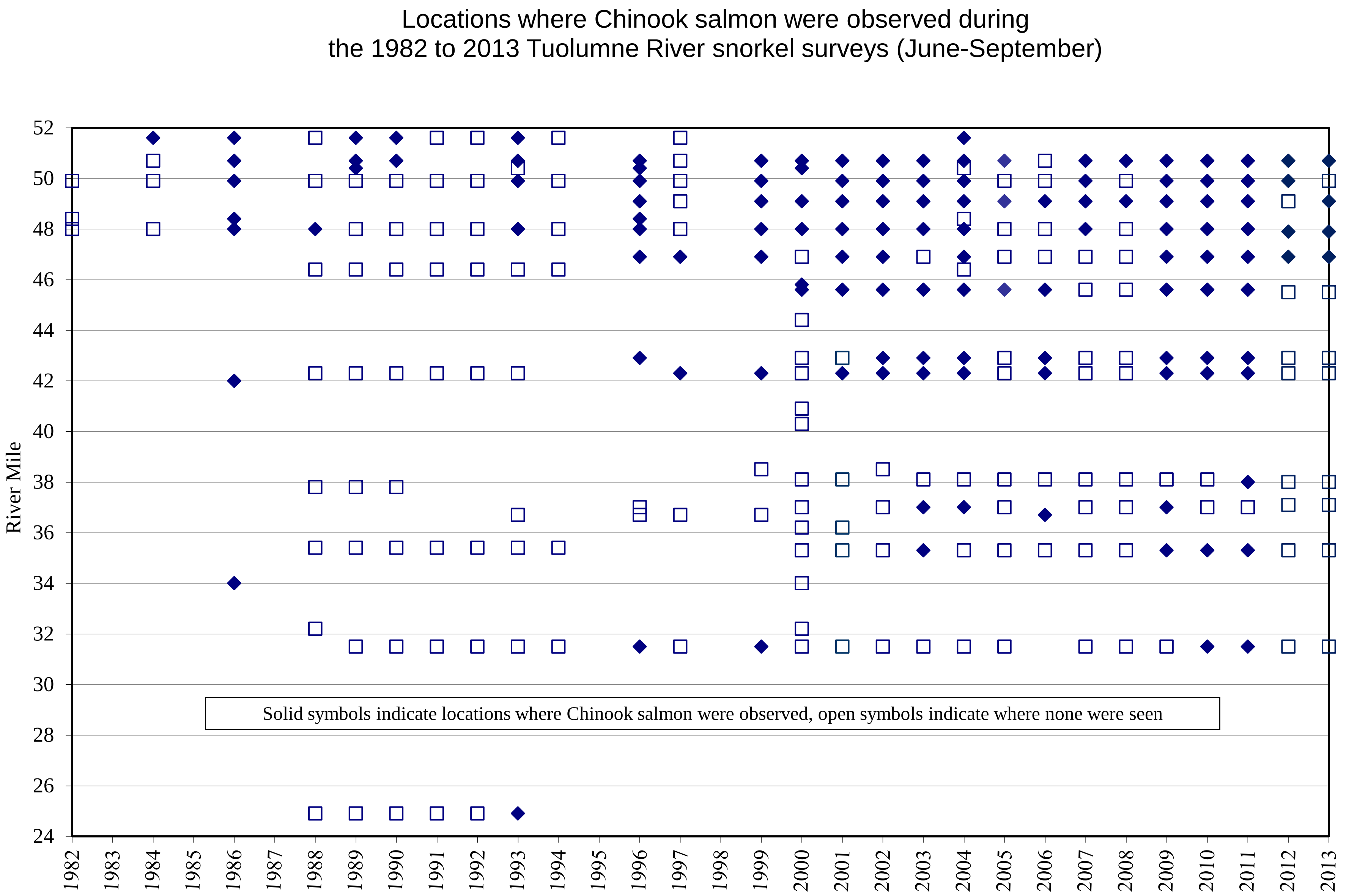

Figure 4. Locations where Chinook salmon were observed

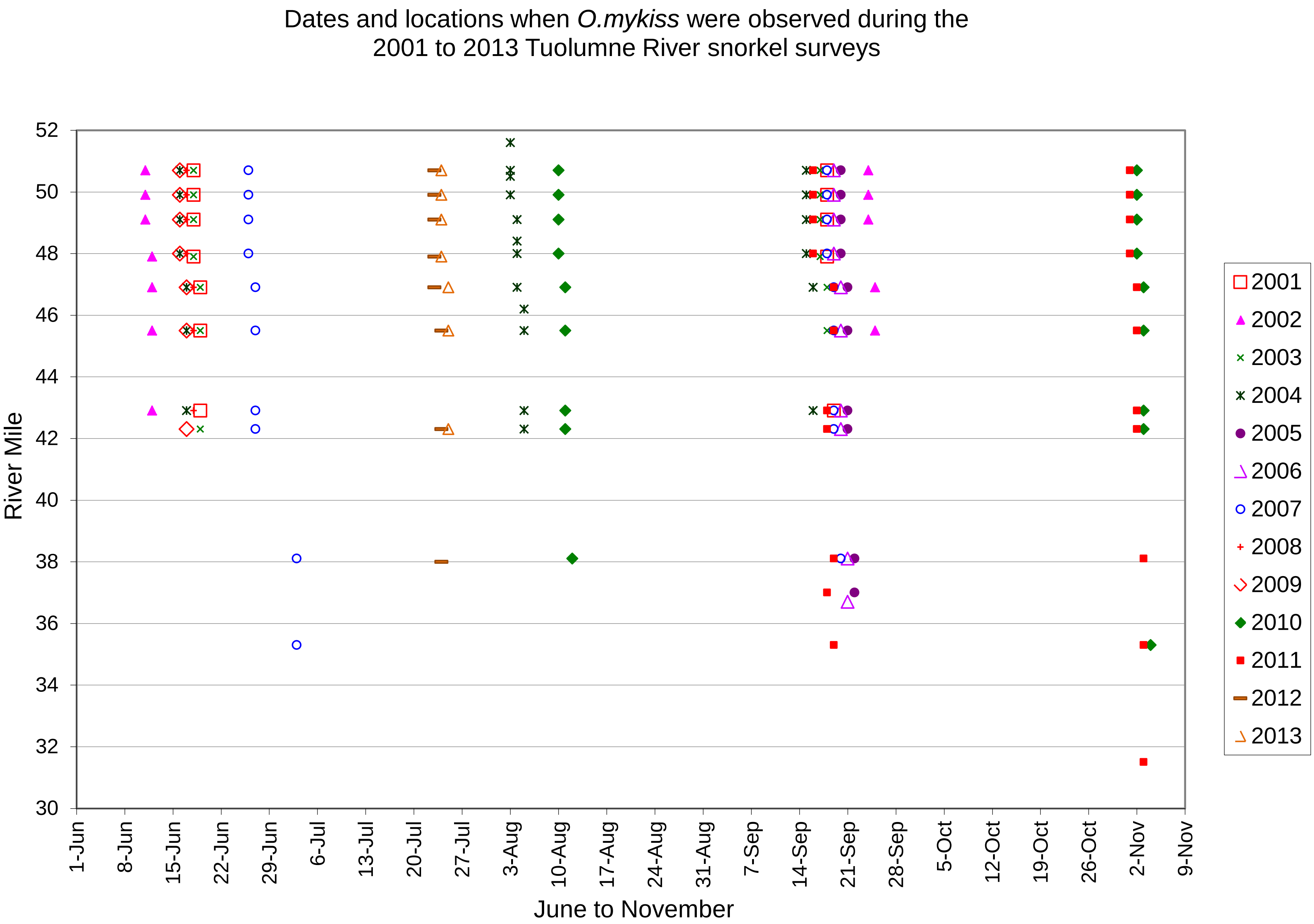

Figure 5. Dates and locations where *O. mykiss* were observed during the snorkel surveys

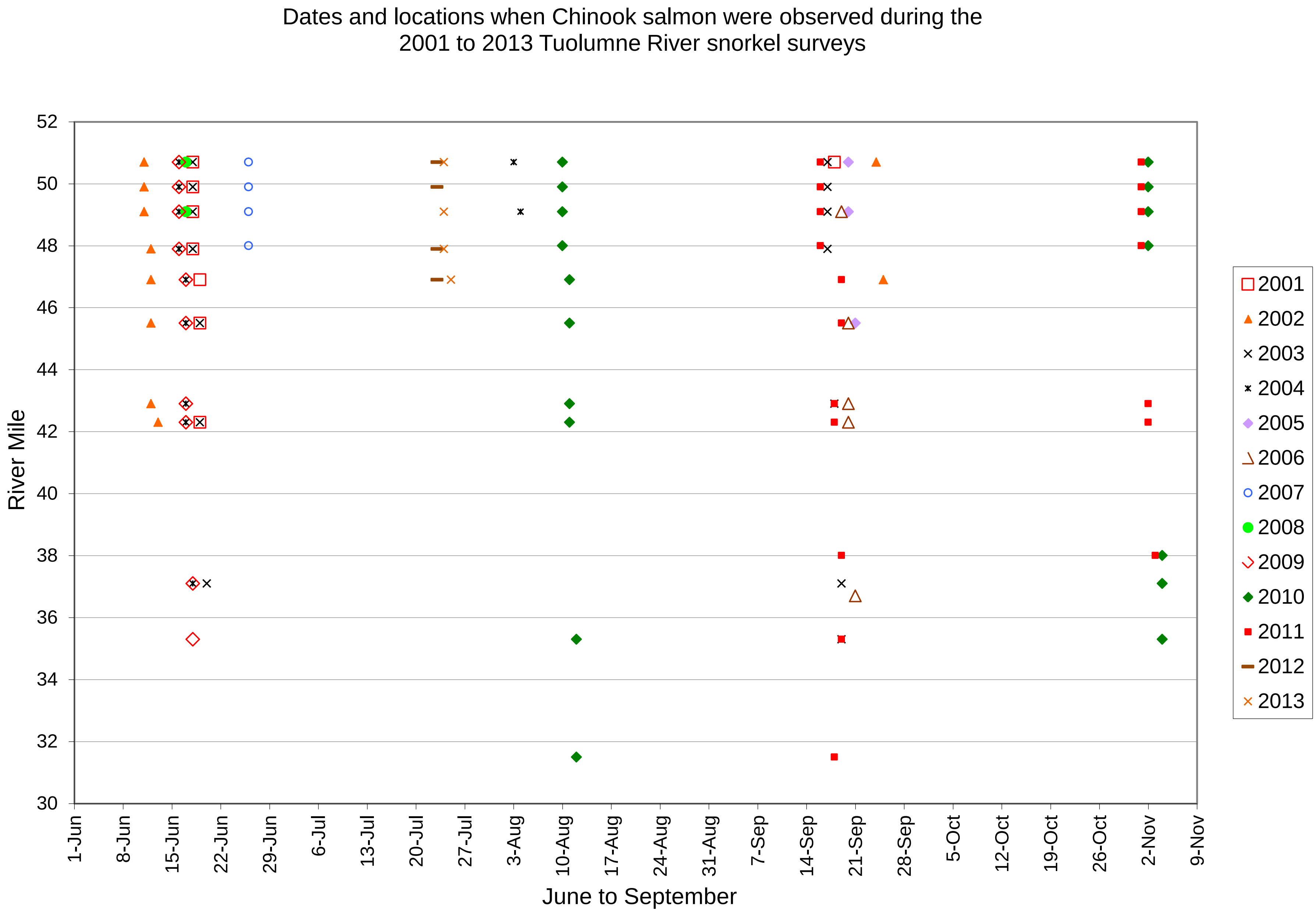

Figure 6. Dates and locations where Chinook salmon were observed during the snorkel surveys.

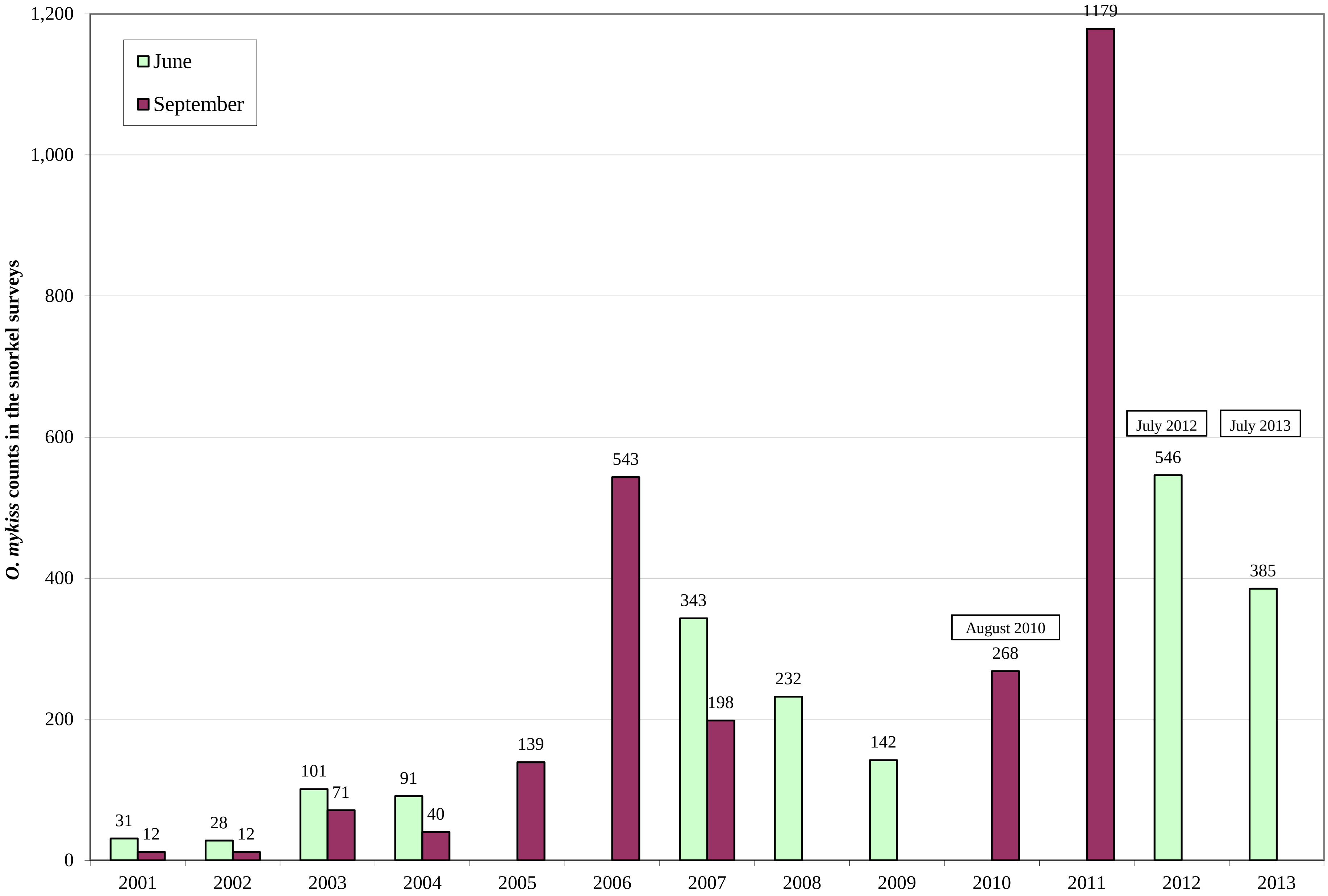

Figure 7. *O. mykiss* counts during the June and September snorkel surveys

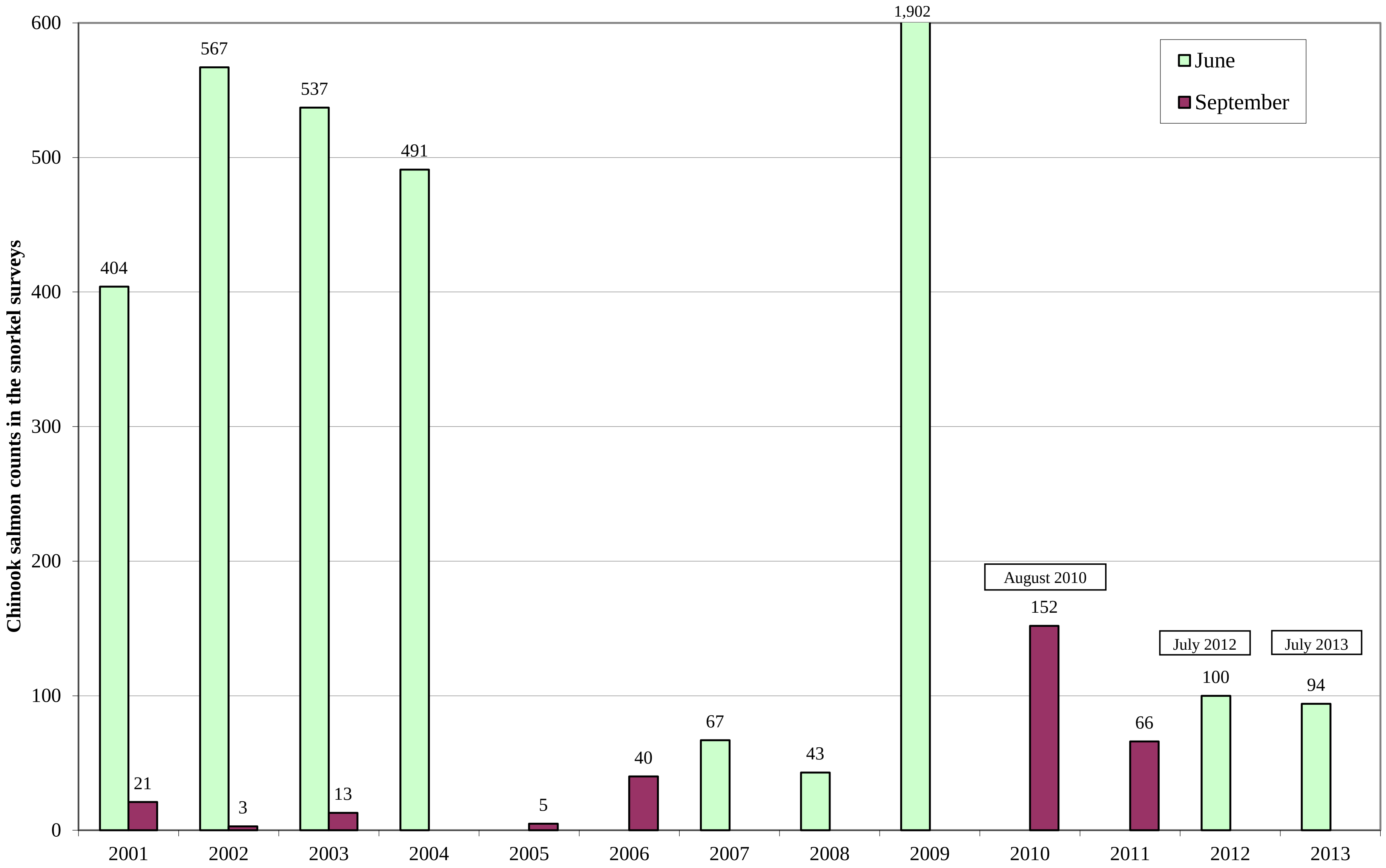

Figure 8. Chinook salmon counts during the June and September snorkel surveys

Table 1. July 2013 Tuolumne River Snorkel Summary (TID/MID)

DATE	START TIME	LOCATION	RIVER MILE	SITE	AREA (Sq. Ft.)	AVG. DEPTH (FEET)	TIME (Min)	HABITAT	SUBSTRATE	WATER TEMP. (C)[1]	DO (mg/l)[1]	COND. (S/cm)[1]	TURB. (NTU)	HORIZ. VISIB. (FEET)	CHINOOK count/est.	CHINOOK size	O. mykiss count/est.	O. mykiss size	NUMBER COUNTED (ESTIMATED TOTAL LENGTH OR SIZE RANGE IN MM) SACRAMENTO SUCKER	SACRAMENTO PIKEMINNOW	CYPRINAD (HARDHEAD AND PIKEMINNOW)	RIFFLE SCULPIN	BLUEGILL SUNFISH	SMALLMOUTH BASS	LARGEMOUTH BASS
24JUL	0925	Riffle A7	50.7	1	7,500	2.0	30	Run-Riffle	cobble,gravel,bedrock	12.9	10.45	38	1.00	19	14	(60-90)	16	(80-140)							
	0920			2	5,000	2.5	35	Riffle-Run	cobble,gravel,sand						38	(35-50)	242	(40-150)				1 (75)			
24JUL	1050	Riffle 2	49.9	1	7,200	1.0	15	Riffle	cobble,gravel,sand	15.1	11.00	34	1.20	15	--	--	4	(60-140)	8 (25-40)			1 (60)			
	1110			2	11,250	6.0	20	Pool	boulder,cobble,sand						--	--	--	--		11 (20-25)					
	1115			3	8,000	4.0	15	Run-Pool	cobble,boulder,sand						--	--	4	(120-140)	6 (150-250)						4 (160-200)
																	2	(160-180)							
24JUL	1305	Riffle 3B	49.1	1	7,500	2.8	27	Riffle	cobble,gravel,sand	16.3	10.43	42	1.40	18	--	--	10	(25-100)	5 (25-50)	1 (600)					
																	6	(300-500)							
	1305			2	5,250	3.0	17	Run	cobble,bedrock,boulder						40	(50-80)	60	(60-140)	40 (25-40)	55 (100-250)					
																	7	(160-180)							
24JUL	1420	Riffle 5B	47.9	1	3,500	4.5	20	Run-Pool	sand,cobble,gravel	17.5	11.76	42	1.67	10	1	(600)	1	(150)		7 (100-150)					
	1500			2	10,000	6.0	15	Pool-Run	cobble,bedrock,silt						--	--	--	--	1 (350)						
	1420			3	10,500	4.5	20	Run-Pool	cobble,bedrock,boulder						--	--	7	(120-140)	9 (150-700)						2 (180,190)
																	2	(180-190)							
					75,700		**214**			**Subtotal**					**93**		**361**		**69**	**74**	**0**	**2**	**0**	**0**	**6**
25JUL	0945	Riffle 7	46.9	1	5,000	1.5	20	Riffle	cobble,gravel,sand	17.4	9.50	52	1.48	20	1	(80)	7	(100-140)	5 (180-280)	1 (350)					
																	2	(200-220)		60 (120-200)					
	0945			2	6,250	2.5	22	Run	sand,cobble,gravel						--	--	1	(350)	16 (120-150)	62 (120-300)			1 (150)		2 (170,200)
25JUL	1106	Riffle 13B	45.5	1	5,400	2.0	21	Riffle-Run	cobble,sand,gravel	20.2	9.97	54	0.82	15	--	--	3	(130-140)	250 (100-300)		300 (120-250)				
	1110			2	2,550	1.0	36	Riffle	gravel,cobble,sand						--	--	10	(80-120)	32 (100-200)		46 (20-200)				
25JUL	1320	Riffle 21	42.9	1	7,500	2.0	20	Run-Riffle	cobble,gravel,sand	22.0	9.59	35	1.03	10	--	--	--	--	75 (100-350)		180 (100-300)				1 (300)
	1325			2	3,000	6.0	11	Pool	cobble,sand,silt						--	--	--	--		6 (200-300)	206 (100-150)				2 (175,250)
25JUL	1437	Riffle 23C	42.3	1	3,750	1.5	18	Run-Riffle	cobble,gravel,sand	22.3	9.85	54	1.82	14	--	--	--	--	60 (100-250)		550 (100-300)				3 (110-140)
	1440			2	3,250	2.0	20	Riffle	cobble,sand,bedrock								1	(400)	8 (150-250)		54 (50-150)				2 (170,200)
					36,700		**168**			**Subtotal**					**1**		**24**		**446**	**129**	**1,336**	**0**	**1**	**0**	**10**
26JUL	0945	Riffle 31	38.0	1	2,500	1.5	20	Riffle	cobble,gravel,sand	23.7	8.97	56	1.30	16	--	--	--	--		44 (100-250)				2 (100)	
	0945			2	9,600	2.5	19	Run	cobble,sand,gravel						--	--	--	--		2 (330,350)	550 (120-300)			5 (80-330)	
26JUL	1055	Riffle 35A	37.1	1	3,000	1.0	18	Riffle	cobble,gravel,sand	25.1	9.65	35	1.80	16	--	--	--	--	60 (200-300)	3 (250)	84 (150-200)			2 (100)	1 (70)
	1054			2	4,500	2.5	16	Run	gravel,sand,cobble						--	--	--	--			110 (120-250)			5 (100-120)	3 (140-180)
26JUL	1236	Riffle 41A	35.3	1	2,500	2.0	17	Run-Riffle	gravel,sand,cobble	25.1	8.72	37	1.72	15	--	--	--	--	1 (200)	1 (370)	140 (100-250)			7 (90-400)	2 (140,240)
	1236			2	1,050	4.0	10	Run-Pool	sand,gravel,silt						--	--	--	--		1 (350)	16 (150-200)		6 (80-120)	4 (60-300)	3 (150-200)
	1247			3	1,200	1.5	15	Riffle	cobble,gravel,sand						--	--	--	--	17 (50-250)	2 (250)	12 (200)			14 (60-100)	3 (140-300)
26JUL	1348	Riffle 57	31.5	1	3,125	1.0	15	Riffle	cobble,gravel,sand	27.3	8.38	33	2.04	14	--	--	--	--		26 (120-320)			1 (200)	4 (120-130)	2 (300,320)
	1347			2	4,200	2.5	13	Run	bedrock,cobble,sand						--	--	--	--		4 (200-250)			17 (50-125)	21 (50-175)	11 (100-200)
					31,675		**143**			**Subtotal**					**0**		**0**		**78**	**83**	**912**	**0**	**24**	**64**	**25**
					144,075		**525**			**TOTAL#**					**94**		**385**		**593**	**286**	**2,248**	**2**	**25**	**64**	**41**

[1] Water quality parameter as measured on July 31, 2013 under similar conditions

Table 2. Tuolumne River snorkel survey locations (1982-2013) with number of O. mykiss observed, otherwise none were seen.

	1982	1984		1985	1986		1987			1988					1989				1990				1991		1992		1993			
	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	MAY	JUN	JUL	OCT
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	X	X	X	X
Riffle A7 (RM 50.7)			26			13			X						X	X		X	X		X						X	X	X	X
Riffle 1A (RM 50.4)								X									X										X	X		X
Riffle 2 (RM 49.9)	X		X			25	X	X		X				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																					X			
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	X		X	
Riffle 7 (RM 46.9)																														
Riffle 9 (RM 46.4)										X				X	X			X		X		X	X	X	X	X	X	X		X
Riffle 12 (RM 45.8)																														
Riffle 13A-B (RM 45.6)																											X			
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			X	
Riffle 24 (RM 42.0)					X																						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)																											X		X	
Riffle 37 (RM 36.2)								X																						
Riffle 39-40 (RM 35.4)										X				X	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	X	X		X
Charles (RM 24.9)										X	X	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	0	0	0	0

Table 2 (cont). Tuolumne River snorkel survey locations (1982-2012) with number of O. mykiss observed, otherwise none were seen.

	1994			1995	1996	1997	1999	2000	2001		2002		2003		2004			2005	2006	2007		2008	2009	2010		2011		2012	2013
	MAY	JUL	OCT	NOV	JUL	JUN	JUN	JUN	JUN	SEP	JUN	SEP	JUN	SEP	JUN	AUG	SEP	SEP	SEP	JUN	SEP	JUN	JUN	AUG	NOV	SEP	NOV	JUL	JUL
LOCATIONS																													
Riffle A3/A4 (RM 51.6)		X	X	X		4										5													
Riffle A7 (RM 50.7)	X			1	**X**	2	14	14	7	3	5	1	66	16	12	6	11	10	115	106	75	76	80	35	33	249	6	115	258
Riffle 1A (RM 50.4)					**51**			3								4													
Riffle 2 (RM 49.9)		X	X		**91**	2	X		3	3	1	4	8	2	23	2	7	7	15	34	16	9	12	58	67	203	27	151	10
Riffle 3B (RM 49.1)					**138**	X	31	14	8	1	11	1	5	21	22	5	7	6	66	45	12	78	27	73	67	261	8	98	83
Riffle 4B (RM 48.4)					**55**											8													
Riffle 5B (RM 48.0)	X	X	X	2	**45**	X	10	19	4	2	3	X	6	10	11	15	6	36	54	92	10	21	11	26	16	149	41	70	10
Riffle 7 (RM 46.9)					4	X	15	52	4	X	5	2	14	9	13	5	2	2	106	22	7	13	6	25	6	88	9	18	10
Riffle 9 (RM 46.4)		X	X													3													
Riffle 12 (RM 45.8)								5																					
Riffle 13A-B (RM 45.6)								20	3	X	2	4	1	6	5	13	X	46	103	15	57	24	4	33	14	129	8	69	13
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	X	8	2	33	8		X
Riffle 23B-C (RM 42.3)	X					X	9	4	X	X	X	X	1	1	X	1	X	14	27	5	7	X	2	9	10	52	32	24	1
Riffle 24 (RM 42.0)				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	1	X	10	2	1	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	X	X	3	X	X	X
Riffle 36A (RM 36.7)	X				X	X	X												4										
Riffle 37 (RM 36.2)								X	X	X																			
Riffle 39-40 (RM 35.4)		X	X																										
Riffle 41A (RM 35.3)								X	X	X	X	X	X	X	X	X	X	X	X	2	X	X	X	X	3	2	6	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	1	X	X
Charles (RM 24.9)			X																										
Total O.mykiss	0	0	0	3	**384**	8	79	180	31	12	28	12	101	71	91	76	40	139	543	343	198	232	142	268	218	1179	148	546	385

Data in bold type (JUL96, RA7 to R5B) was collected by CDFG using different survey methods that are not comparable

Table 3. Tuolumne River snorkel survey locations (1982-2013) with number of Chinook Salmon observed, otherwise none were seen.

	1982	1984		1985	1986		1987			1988					1989				1990				1991		1992		1993			
	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	MAY	JUN	JUL	OCT
LOCATIONS																														
Riffle A3/A4 (RM 51.6)			7	X		75			X	3				X	127	56	18	X	135	12	X	X	X	X	X	X	9	35	X	10
Riffle A7 (RM 50.7)			X			20			X						X	11		X	144		3						54	X	2	7
Riffle 1A (RM 50.4)								150		22							25										14	X		7
Riffle 2 (RM 49.9)	?		X			50	100+	100+		1				X	X			X	11	X		X	X	X	X	X	6	2		11
Riffle 3B (RM 49.1)										1																				
Riffle 4B (RM 48.4)	?	?		60	30	25				1																	5			
Riffle 5B (RM 48.0)	?	?	X	X		40	130	400		129	1	X	X	X	X	X	X	X	4	X	X	X	X	X	X	X	33		3	3
Riffle 7 (RM 46.9)																														
Riffle 9 (RM 46.4)										3				X	X			X		X		X	X	X	X	X	3	X		7
Riffle 12 (RM 45.8)																														
Riffle 13A-B (RM 45.6)																											X	X		X
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			X	X
Riffle 24 (RM 42.0)					10																						X	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)										1				X	X			X		X		X								
Riffle 35A (RM 37.0)																														
Riffle 36A (RM 36.7)																											8		X	X
Riffle 37 (RM 36.2)								40																						
Riffle 39-40 (RM 35.4)										X				X	X			X		X		X	X	X	X	X		X		X
Riffle 41A (RM 35.3)																														
Riffle 46 (RM 34.0)					8		800+																							
Riffle 52B (RM 32.2)										X				X																
Riffle 57-58 (RM 31.5)		?		40											X			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		1		X
Total Chinook Salmon	0	0	7	100	48	210	1030+	690+	0	161	1	0	0	0	127	67	43	0	294	12	3	0	0	0	0	0	132	38	5	45

Table 3 (cont). Tuolumne River snorkel survey locations (1982-2013) with number of Chinook Salmon observed, otherwise none were seen.

	1994			1995	1996	1997	1999	2000	2001		2002		2003		2004			2005	2006	2007		2008	2009	2010		2011		2012	2013
	MAY	JUL	OCT	NOV	JUL	JUN	JUN	JUN	JUN	SEP	JUN	SEP	JUN	SEP	JUN	AUG	SEP	SEP	SEP	JUN	SEP	JUN	JUN	AUG	NOV	SEP	NOV	JUL	JUL
LOCATIONS																													
Riffle A3/A4 (RM 51.6)		X	X	2		X										X													
Riffle A7 (RM 50.7)	X			17	**20**	X	23	211	277	21	429	2	426	2	390	77	X	1	X	13	X	26	1401	22	51	20	6	77	52
Riffle 1A (RM 50.4)					**29**			47								X													
Riffle 2 (RM 49.9)		X	X		**16**	X	3		4	X	10	X	72	1	16	X	X	X	X	18	X	X	43	21	32	1	3	15	X
Riffle 3B (RM 49.1)					**4**	X	108	34	52	X	83	X	16	3	59	3	X	3	10	32	X	17	333	68	35	7	2	X	40
Riffle 4B (RM 48.4)					**43**											X													
Riffle 5B (RM 48.0)	29	X	X	3	**154**	X	20	35	47	X	17	X	4	4	4	X	X	X	X	4	X	X	92	14	20	4	2	4	1
Riffle 7 (RM 46.9)					20	1	57	X	17	X	15	1	X	X	4	X	X	X	X	X	X	X	9	10	X	5	X	4	1
Riffle 9 (RM 46.4)		X	X													X													
Riffle 12 (RM 45.8)								6																					
Riffle 13A-B (RM 45.6)								5	6	X	10	X	9	X	3	X	X	1	8	X	X	X	2	2	X	13	X	X	X
Riffle 17A2 (RM 44.4)								X																					
Riffle 21 (RM 42.9)					2			X	X	X	1	X	X	1	7	X	X	X	10	X	X	X	7	2	X	2	1		X
Riffle 23B-C (RM 42.3)	2			1		2	1	X	1	X	2	X	8	X	1	X	X	X	8	X	X	X	12	3	X	5	10	X	X
Riffle 24 (RM 42.0)				1																									
Riffle 26 (RM 40.9)								X																					
Riffle 27(RM 40.3)								X																					
Riffle 30B (RM 38.5)							X				X	X																	
Riffle 31 (RM 38.1)								X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	30	4	1	X	X
Riffle 33 (RM 37.8)																													
Riffle 35A (RM 37.0)	X				X			X			X	X	2	1	7	X	X	X		X	X	X	1	X	1	X	X	X	X
Riffle 36A (RM 36.7)	X				X	X	X												4										
Riffle 37 (RM 36.2)								X	X	X																			
Riffle 39-40 (RM 35.4)		X	X																										
Riffle 41A (RM 35.3)								X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	2	6	1	4	X	X	X
Riffle 46 (RM 34.0)								X																					
Riffle 52B (RM 32.2)								X																					
Riffle 57-58 (RM 31.5)	5	X	X		1	X	1	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	4	X	1	X	X	X
Charles (RM 24.9)			X																										
Total Chinook Salmon	36	0	0	24	**289**	3	213	338	404	21	567	3	537	13	491	80	0	5	40	67	0	43	1902	152	170	66	25	100	94

Data in bold type (JUL96, RA7 to R5B) was collected by CDFG using different survey methods that are not comparable

Table 4. Fish species observed in the Tuolumne River snorkel surveys during the June-September period.

Summary table of fish species observed in the Tuolumne River snorkel studies 1986 to 2013, June to September survey period.

FAMILY	COMMON NAME	NATIVE SPECIES	ABBREV.	1986	1988	1989	1990	1991	1992	1993	1994	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Petromyzontidae	Pacific lamprey	N	LP	X										X					X						X			
Salmonidae	Chinook salmon	N	CS	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Salmonidae	rainbow trout	N	RT	X					X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinidae	goldfish		GF		X	X	X	X	X	X	X																	
Cyprinidae	carp		CP	X	X	X	X	X	X	X	X						X	X										
Cyprinidae	hardhead	N	HH	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X	X		X	X
Cyprinidae	Sacramento pikeminnow	N	PM	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
Catostomidae	Sacramento sucker	N	SKR	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
Ictaluridae	brown bullhead		BBH				X	X	X																			
Ictaluridae	white catfish		WCF		X	X	X	X	X	X	X								X			X		X				
Centrarchidae	green sunfish		GSF		X	X	X	X	X		X																	
Centrarchidae	bluegill		BG	X	X	X	X	X	X		X						X	X	X			X	X	X				X
Centrarchidae	redear sunfish		RSF		X	X	X	X	X	X	X		X				X	X	X				X	X	X			
Centrarchidae	warmouth		WM						X																			
Centrarchidae	largemouth bass		LMB	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Centrarchidae	smallmouth bass		SMB	X	X	X	X	X	X	X	X					X	X	X	X	X		X	X	X	X	X	X	X
Cottidae	riffle sculpin	N	RSCP	X	X		X	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Moronidae	striped bass		SB																						X	X		

(List includes all species observed during 1986-2013 snorkel studies)

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2013 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2013-6

Fall Migration Monitoring at the Tuolumne River Weir
2013 Annual Report

Prepared by

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Jason Guignard
and
Andrea Fuller

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Fall Migration Monitoring at the Tuolumne River Weir

2013 Annual Report

Submitted To:
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Modesto Irrigation District

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March 2014

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INTRODUCTION

The California Department of Fish and Wildlife (CDFW) has reported salmon escapement estimates on the Tuolumne River since 1940 (Fry 1961). Estimates of adult fall-run Chinook salmon *(Oncorhynchus tshawytscha)* escapement varied from about 100 to 130,000 from 1940 to 1997 (mean: 18,300; median: 7,100) (Ford and Brown 2001). During 1998-2012 estimates of adult fall-run Chinook salmon ranged from a high of 17,873 in 2000 (Vasques 2001) to a low of 124 in 2009 (mean: 3,953; median: 893) (Azat 2013). Until 2009, most estimates of escapement were obtained using carcass surveys (some weir counts were made at Modesto in the 1940's). While carcass surveys provide data to coarsely describe timing and distribution of spawning, population estimates from mark-recapture models are prone to bias if rigid assumptions are not met. Alternatively, resistance board weirs have been widely used in Alaska to estimate salmonid escapement since the early 1990's (Tobin 1994), and were introduced in the San Joaquin Basin in 2003. Resistance board weirs provide direct counts that are not subject to the same biases, and precise migration timing data.

Annual Tuolumne River Weir monitoring began in fall 2009, and is jointly supported by the Turlock Irrigation District (TID), Modesto Irrigation District (MID), and the City and County of San Francisco. Monitoring objectives include:

- Determine escapement of fall-run Chinook salmon and Central Valley steelhead (*Oncorhynchus mykiss*) to the Tuolumne River through direct counts.
- Document migration timing of adult fall-run Chinook salmon and Central Valley steelhead in the Tuolumne River and evaluate potential relationships with environmental factors.
- Determine size and gender composition of adult salmon population.
- Estimate hatchery contribution to spawning population.
- Document passage of non-salmonid fishes.

Study Area

The Tuolumne River is the largest tributary to the San Joaquin River, draining a 1,900 square-mile watershed that includes the northern half of Yosemite National Park (McBain and Trush 2000). The Tuolumne River originates in the central Sierra Nevada Mountains and flows west between the Merced River to the south and the Stanislaus River to the north (Figure 1). The San Joaquin River 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 power generation, water supply, and flood control, with Don Pedro Reservoir being the largest impoundment. 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 migration since 1871. The spawning reach of the Tuolumne River has been defined as extending 28.1 miles downstream of La Grange Dam to below the location of the Tuolumne weir RM 24.1 (O'Brien 2009).

The weir is located at RM 24.5 (Figure 1), and this site was selected for weir operation because it is located downstream of the majority of spawning. Site selection was also based on operational criteria that include water velocity, channel width, bank slope, channel gradient, channel uniformity, and substrate type.

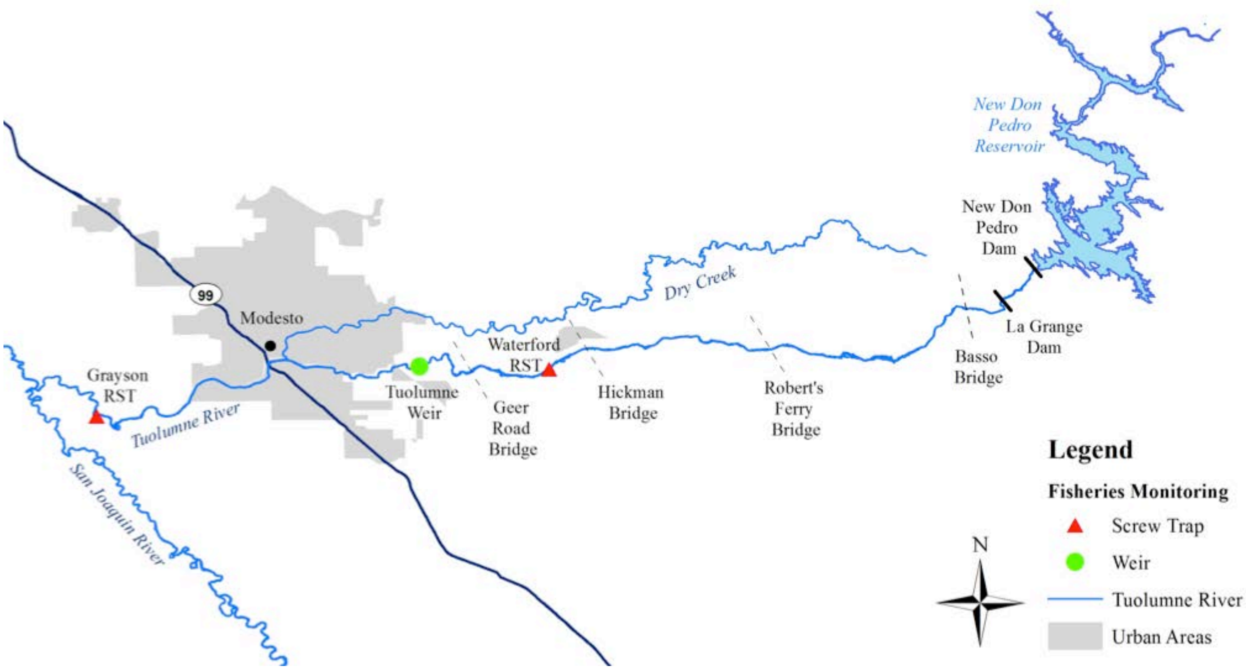

Figure 1. Map of the Tuolumne River displaying the location of the Tuolumne River Weir and other key points of interest.

METHODS

A resistance board weir (Tobin 1994; Stewart 2002, 2003) and Vaki Riverwatcher fish counting system (Vaki system) were installed in the Tuolumne River at RM 24.5 on

September 24, 2013. Monitoring occurred continuously throughout the fall-run Chinook salmon migration period.

Weir Operations

The Tuolumne River weir guides upstream migrating adult salmonids through a confined passage area where they can be observed and counted, while allowing water to pass unimpeded across the entire stream width (Figure 2). The weir consists of several components including a substrate rail, resistance board panels, bulkheads, rigid weir panels, and a passing chute (Figure 3). The resistance board portion of the weir is an array of 24 rectangular panels that measure 3 feet by 20 feet and consist of evenly spaced (2-5/8 inches on-center) polyvinyl chloride (PVC) pickets that are aligned parallel to the direction of stream flow. The upstream end of each panel is hinged to a rail that is anchored in the stream bottom, and the downstream end is held at the water surface by a resistance board that planes upward in flowing water. Sealed plastic barrels were occasionally used to provide additional flotation during periods of heavy debris or high flows (Figure 2).

Bulkheads consist of aluminum frames with PVC pickets that run parallel to the water surface, and provide an interface between resistance board panels and the rigid weir panels or passing chute (Figure 3). Bulkheads are the same length as the resistance board panels and are tall enough to remain above the surface of the water during high flows. Bulkheads are attached to the resistance board panels allowing them to float up and down with the resistance board panels for unobstructed lateral fish movement.

Two sections of rigid, stationary weir (one for each stream bank) block fish passage between the stream bank and the bulkheads (Figure 3). The rigid weir panels are 3-foot x 10-foot panels consisting of steel angle and spaced pipe held in place by 8-foot tall aluminum tripod supports. Metal cross braces connect adjacent tripods to each other.

The weir was inspected and cleaned a minimum of once per day between September 24 and December 15, and a minimum of three days per week during December 16 and December 31. During periods of heavy debris or high flows, the weir was checked more frequently. Weir performance was documented during each check by recording any observations of scouring beneath the substrate rail or overtopping of resistance board panels. If overtopping occurred, the number of affected panels was recorded.

Figure 2. Photograph of the weir with sealed plastic barrels used for additional flotation.

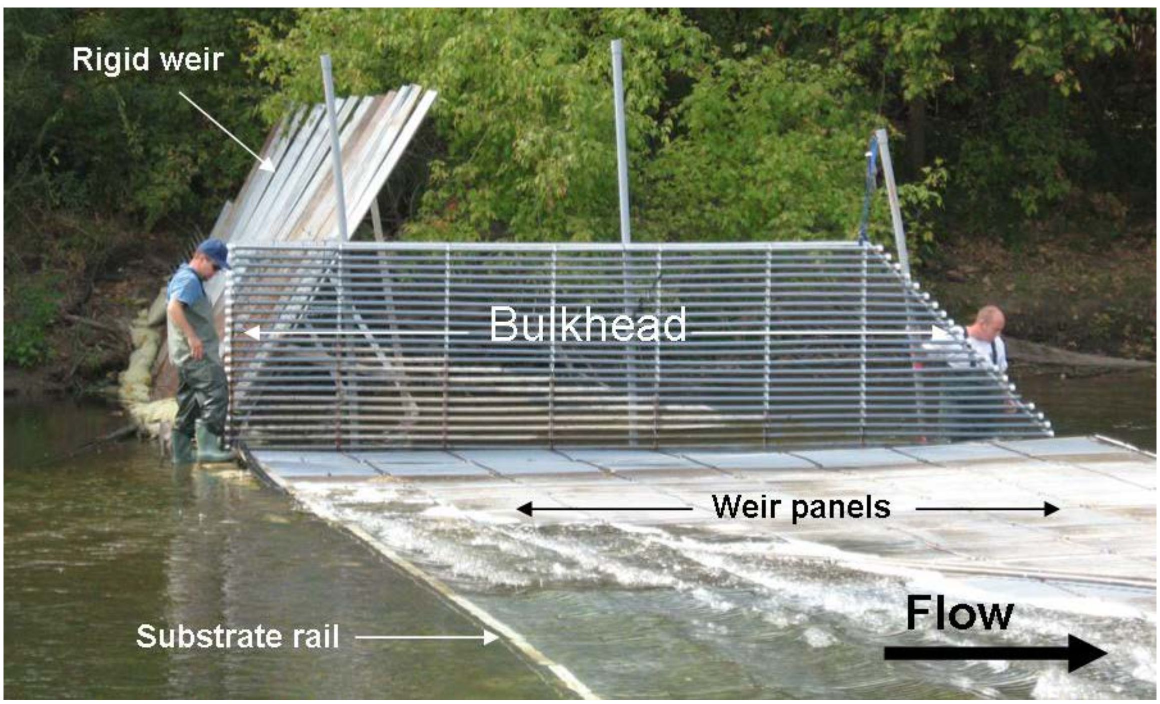

Figure 3. Photograph of weir components.

Vaki Operations

In conjunction with the weir, a Vaki Riverwatcher fish counting system (Vaki system) was used during the study period to monitor fish passage without the need to capture or handle fish. The Vaki system is comprised of three main components: an infrared scanner, a digital video camera with lights, and a computer system (Figure 4). The Vaki infrared scanner was attached to a fyke at an opening in the weir where data was relayed to a computer system that generated infrared silhouettes and video clips of objects passing upstream (Figure 5), and silhouettes only for objects passing downstream. The system also recorded the time, speed, and direction of passage, as well as the depth of the passing object. Data was downloaded and reviewed daily between September 24 and December 15 and three days a week through December 31. Any outages in operation of the Vaki system were recorded.

Infrared silhouettes were used in conjunction with digital video to identify passing objects. Quality of infrared silhouettes and video clips were ranked as good, fair, poor, or none. Identity to species can be uncertain if based on infrared silhouettes alone, or if the quality of the video is reduced by elevated turbidity. ID certainty for each passing object was ranked as positive, very likely, or likely. Video provides the only means of distinguishing morphologically similar species such as Chinook salmon and *O. mykiss*.

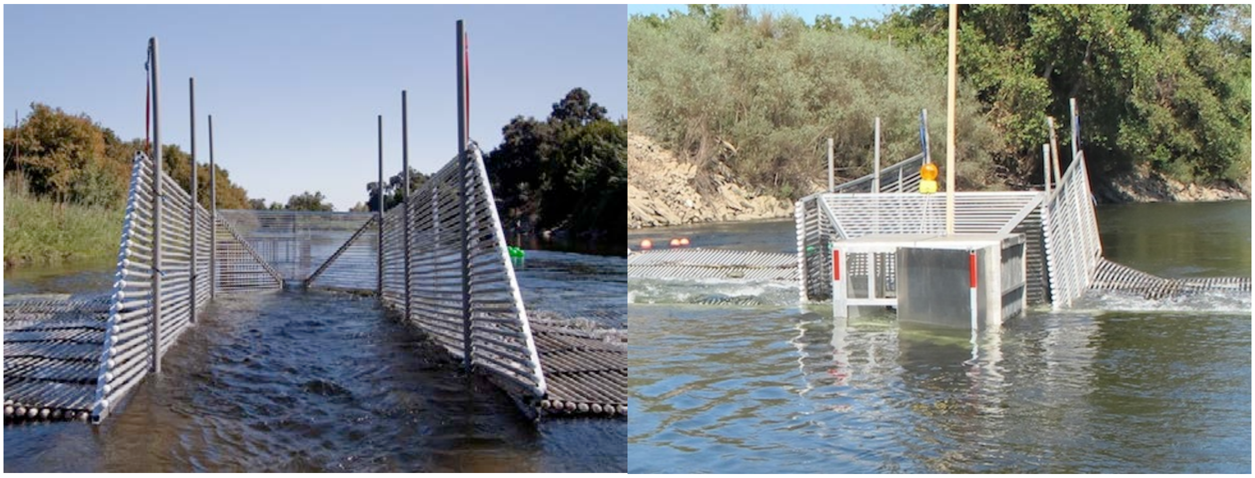

Figure 4. Left: Downstream photo of the fyke that contains Vaki system. Right: Upsteam side of livebox where fish migrating upstream of the weir exit the Vaki system.

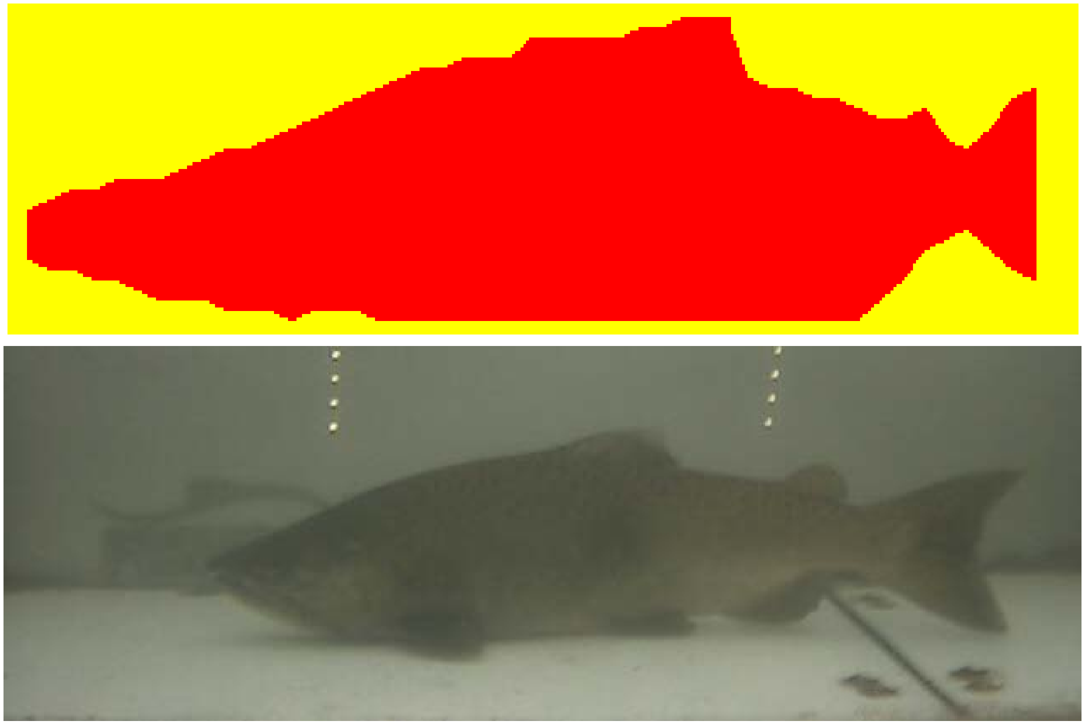

Figure 5. Example of a typical salmonid silhouette and a screen capture from a video clip of the same fish.

After each passage was identified to species, other data was recorded from video clips and silhouettes including the presence/absence of an adipose fin, fish condition (abrasion, lacerartion, fungal infection, hook scar, or lamprey scar), gender (male, female, or unknown), and life stage (adult, grilse, juvenile, or unknown). Lengths of fish were estimated by applying user-defined length coefficients to body depths recorded by the Vaki system. User-defined coefficients for Chinook salmon were derived from measurements of body depth to total length ratios from 846 fish handled at the Stanislaus River during 2003-2010 using the following equation:

where, *L* is the estimated total length, *D* is the body depth measured by the Vaki system, and ***l*** is the length coefficient.

Monitoring Fish Presence Upstream and Downstream of Weir

Visual assessments were conducted a half-mile upstream and a half-mile downstream of the weir site to monitor for potential migration delays and/or redd construction activity within this reach. Boat surveys were conducted on Monday, Wednesday and Friday of each week during September and daily from October 1 through December 15. After December 15 boat surveys were conducted Monday, Wednesday and Friday. A "stacking ratio" was calculated each day by dividing the sum of salmon observed downstream of the weir on that day plus the preceeding 2 days by the sum of passages through the Vaki system over the previous three days.

Environmental Data Collection

Environmental data collected during each weir check included conductivity (μS/ml), dissolved oxygen (mg/L), stream gauge (ft), turbidity (NTU), water temperature (°F), water velocity (ft/s) at the opening of the Vaki system scanner, and weather conditions (RAN=rain, CLD=cloudy, CLR=clear, FOG=fog). Instantaneous water temperature and dissolved oxygen were recorded using an ExStik II model DO600 Dissolved Oxygen Meter and instantaneous conductivity was recorded using an ExStik II model EC500 Conductivity Meter (Extech Intruments Corporation). Hourly water temperature data was logged using a Hobo Water Temp Pro V2 submersible data logger (Onset Computer Corporation). Turbidity was recorded using a T-100 Turbidimeter (Oakton Instruments), and water velocity was measured using a digital Flow Probe model FP-111 (Global Water Instrumentation, Inc.). Flow and water temperature records were also downloaded from the United States Geological Survey (USGS) water data website. (La Grange: 11289650; Modesto: 11290000).

RESULTS

Weir Performance

The weir generally performed well during 2013, with few instances of minor overtopping recorded. During early October and on December 16 there were five instances when a single panel was overtopped and two instances when two panels were overtopped due to heavy clumps of water hyacinth washing onto the weir (Table 1). Since the precise timing that the weir was overtopped is unknown, the maximum duration of each overtopping event was estimated as the time elapsed between identification of overtopping and the previous weir check.

On the night of October 24 large rafts of water hyacinth had accumulated upstream of the weir and four panels were intentionally submerged for twelve hours to allow the water hyacinth to pass downstream. During this period staff observed five Chinook salmon passing upstream through the submerged section, and these fish were added to the database.

Table 1. Summary of instances when one or more weir panels were overtopped.

Date	# of Submerged Panels	Observation Time (hh:mm)	Previous Observation Time (hh:mm)	Maximum Duration (hh:mm)	Average Daily Flow (cfs) at La Grange	Average Daily Flow (cfs) at Modesto
Oct. 4	1	845	1900	1345	132	237
Oct. 6	1	1115	1130	2345	133	201
Oct. 7	1	1300	1115	2545	131	194
Oct. 8	1	830	1300	1930	130	210
Oct. 9	1	845	830	2415	130	202
Oct. 10	2	900	2245	1015	132	202
Oct. 25	4	700	1900	1200	166	206
Dec 16	2	1300	945	2715	161	203

Vaki Performance

The Vaki system generally performed well during 2013, with only two confirmed outages (Table 2). There were an additional four instances when relatively large intervals without any detection activity suggest that the Vaki system may not have been working properly. All but one of the known or suspected outages occurred near the beginning or near the end of the season when few adult Chinook salmon were migrating.

Table 2. Summary of Vaki Riverwatcher outages.

Date of Last Record	Time of Last Passage	Maximum Outage Duration (hh:mm)	Computer Restart Time	Computer Connected on Arrival
Oct 3	18:33	14:12	8:45	No
Nov 28	4:09	6:21	10:30	No

Chinook salmon stacking ratio

Stacking ratios during the 2013 sampling season ranged from zero to 1.12 (mean: 0.12), and remained below the threshold of 1.15. Stacking ratios were highest on October 18 and October 19, a few days before peak Chinook salmon passage was observed.

Chinook salmon abundance and migration timing

Between September 24, 2013 and December 31, 2013, the Vaki system detected net passage of 3,664 adult fall-run Chinook salmon moving upstream of the weir. The first salmon was observed on September 24, and peak daily passage of 742 Chinook salmon occurred on October 25 (Figure 6). Cumulatively, 1% of total passage (n=38) occurred by October 1, 65% (n=2,398) occurred by November 1, and 95% (n=3,472) occurred by December 1 (Figure 7).

Chinook salmon gender and size

Total fall-run Chinook salmon passage was composed of 47% male (n=1,733), 51% female (n=1,864), and 2% undetermined gender (n=68). Sizes of Chinook salmon ranged from 196 mm to 1,060 mm (Figure 8). Mean sizes of upstream migrating Chinook salmon were 749 TL mm (n=2,294) for male, 731 TL mm (n=2,207) for female, and 631 TL mm (n=139) for undetermined gender (Table 3). No statistically significant differences in mean lengths were identified between male and female Chinook salmon (ANOVA: F=0.01, P=0.93).

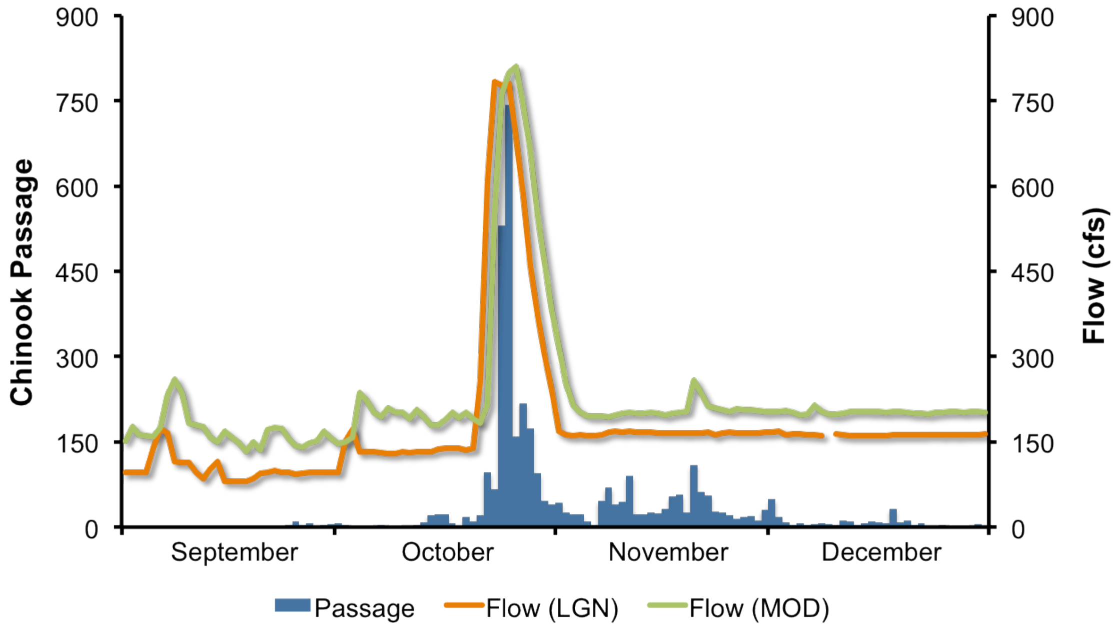

Figure 6. Daily upstream Chinook salmon passage recorded at the Tuolumne River Weir in relation to daily average flows recorded in the Tuolumne River at La Grange (LGN) and Modesto (MOD) between September 1, 2013 and December 31, 2013.

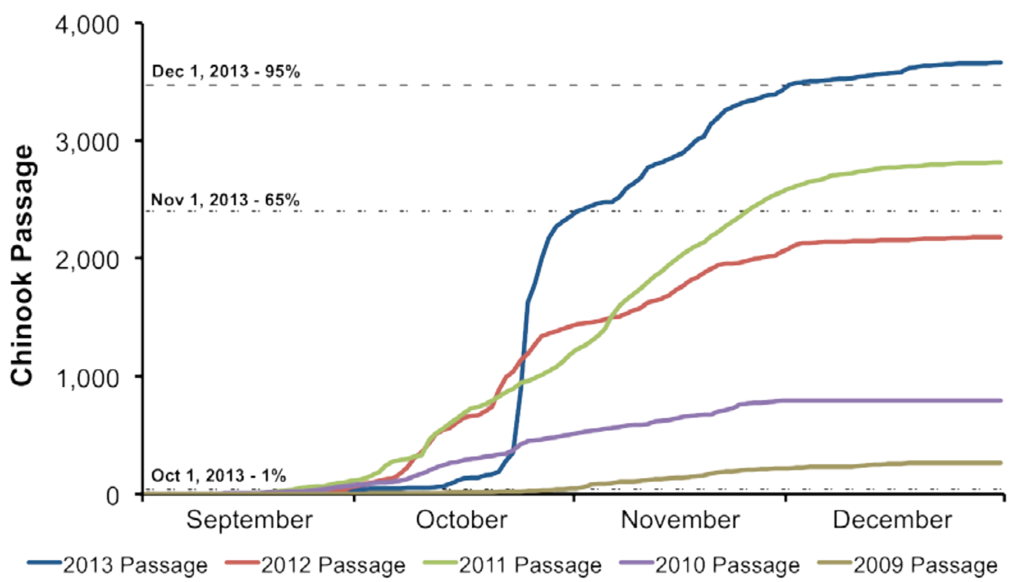

Figure 7. Cumulative adult fall-run Chinook salmon passage from September 1 through December 31 during 2009 - 2013.

Origin of Chinook salmon production

Adipose fin clips (ad-clips), suggesting hatchery origin, were observed in 11% (n=402) of the Chinook salmon for which a positive identification of presence/absence of an adipose fin could be made. The percentage of ad-clips remained below 10% through November 7, suggesting that the majority of early arriving salmon were of naturally spawned salmon. Since not all hatchery fish are ad-clipped, the actual proportion of hatchery origin fish cannot be estimated until coded wire tags recovered by CDFW during carcass surveys are read to determine the hatchery of origin. No statistically significant difference was found between the sizes of female Chinook salmon that were ad-clipped or uclipped; however, ad-clipped male Chinook salmon (mean: 688 mm) were smaller than those that were unclipped (mean: 758 mm), and this difference was statistically significant (Table 3).

Observation of *O. mykiss*

No *O. mykiss* were recorded passing the weir between September 24, 2013 and December 31, 2013.

Table 3. Summary of Fall-run Chinook salmon gender, size, and presence/ absence of adipose fin. Note: Upstream passage counts only; data are not directly comparable to net passage. Parenthesis indicates range.

Gender	Adipose Fin Clip	Mean TL (mm)	95% CI (mm)	n
Male	No	758 (209-1,037)	758 ± 6	2,003
	Yes	688 (332-1,037)	688 ± 18	279
	Undetermined	696 (492-947)	696 ± 88	12
Female	No	729 (219-1,060)	729 ± 4	1,941
	Yes	741 (266-987)	741 ± 14	256
	Undetermined	734 (601-1,000)	734 ± 82	10
Undetermined	No	626 (238-941)	626 ± 28	76
	Yes	625 (439-761)	625 ± 51	16
	Undetermined	642 (196-961)	642 ± 43	47

Spring 2013 Monitoring

After the fall 2012 season (Wright et al. 2013), weir monitoring continued through the winter and spring from January 1 through May 22, 2013. Net upstream passage of 122

Chinook salmon was observed during this period. Daily passage and environmental data are provided in Appendix A. Total Chinook salmon passage for this period was composed of 28% male (n=34), 57% female (n=70) and 15% undetermined gender (n=18). Adipose fin-clips were observed in 5% of fish examined in the spring of 2013.

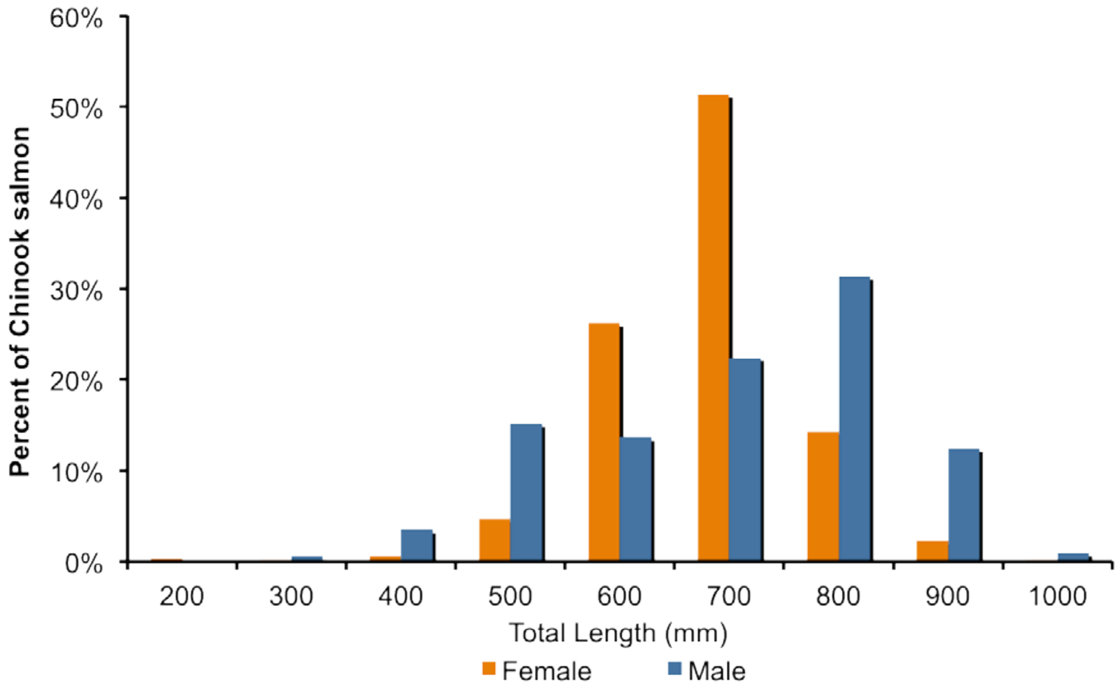

Figure 8. Length distributions of male and female Chinook salmon upstream passage.

Non-salmonids

The majority of non-salmonid species (92%) were non-native, and many of the non-native species are known to prey on juvenile Chinook salmon (e.g. largemouth bass, smallmouth, striped bass, and catfish) (Tabor et. al. 2007). A total of 12 non-salmonid species were identified at the weir including American shad *(Alosa sapidissima)*, common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), goldfish (*Carassius auratus*), hardhead (*Mylopharodon conocephalus*), largemouth bass (*Micropterus salmoides*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), smallmouth bass (*Micropterus dolomieu*), striped bass (*Morone saxatilis*), tuleperch *(Hysterocarpus traski)*, white catfish (*Ictalurus catus*); as well black bass (*Micropterus spp.*), catfish (*Ameiurus spp. and Ictalurus spp.*), and sunfish (Lepomis spp.) that could only be identified to the genus (Table 4). Black bass appeared to be most active during the pulse flow in late October (Figure 9).

Table 4. Incidental species upstream and downstream passage data from September 24, 2013 through December 31, 2013. Parenthesis indicates range.

Native Species	*Length Coefficient*	*Mean TL (mm)*	*Date Range*	*Upstream Passages*	*Downstream Passages*
Hardhead	5.2	302 (208-442)	10/10/2013 - 12/29/2013	42	13
Sacramento pikeminnow	5.2	424 (208-832)	10/23/2013 - 10/31/2013	7	3
Sacramento sucker	5.6	428 (224-1,064)	9/26/2013 - 12/29/2013	86	27
Tuleperch	2.8	120	10/14/2013	1	0
<u>Non-native Species</u>					
American Shad	4.6	184	12/25/2013	1	0
Common carp	3.7	540 (222-777)	10/4/2013 - 12/23/2013	224	59
Channel catfish	6.3	348 (284-599)	9/28/2013 - 12/21/2013	9	1
Goldfish	3.0	268 (150-531)	9/24/2013 - 12/3/2013	370	26
Largemouth bass	3.7	270 (148-426)	10/5/2013 - 12/22/2013	181	34
Smallmouth bass	3.7	263 (148-407)	9/25/2013 - 12/19/2013	160	50
Striped bass	4.5	258 (212-302)	10/8/2013 - 10/16/2013	7	7
White catfish	4.5	211 (180-347)	9/27/2013 - 11/20/2013	51	1
Unidentified black bass	3.7	254 (148-363)	9/25/2013 - 11/27/2013	103	57
Unidentified catfish	4.5	210 (180-293)	9/24/2013 - 11/29/2013	49	13
Unidentified sunfish	2.0	110 (80-200)	9/26/2013 - 10/29/2013	182	6
Unidentified	6.0	483 (240-1,290)	9/25/2013 - 12/31/2013	45	85

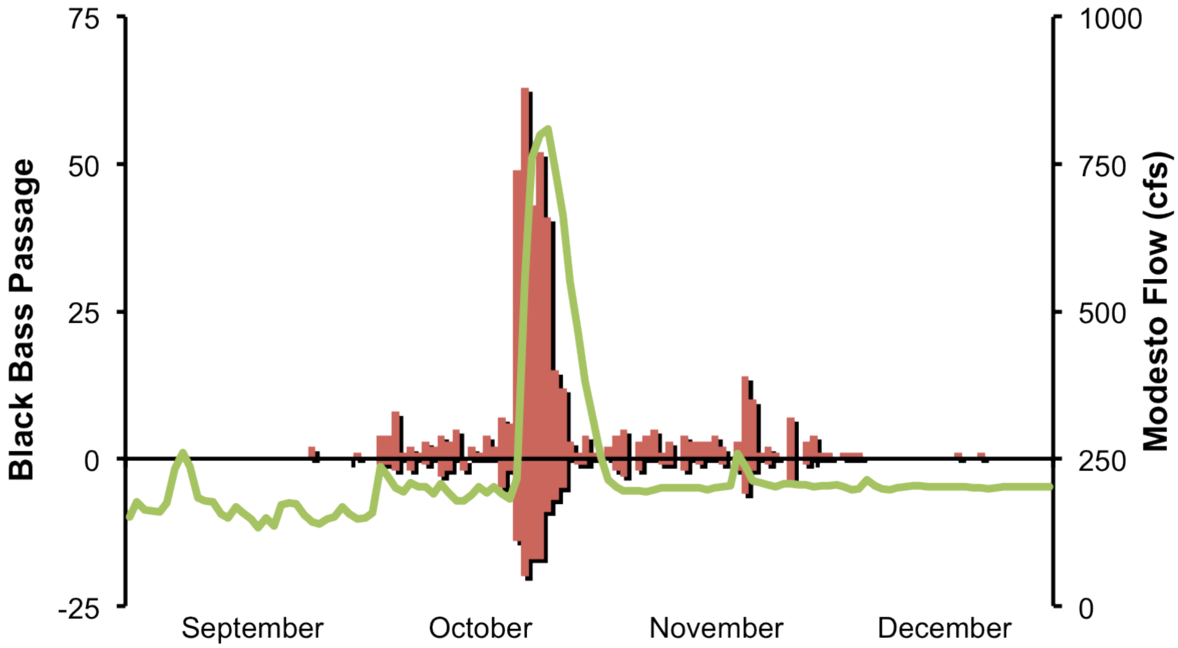

Figure 9. Black bass passages recorded at the Tuolumne River Weir between September 24, 2013 and December 31, 2013.

Environmental Conditions

Average daily base flows at La Grange (RM 51.8) averaged approximately 100 cfs during September, 130 cfs during October, and 165 cfs during November and December (Figure 6). Resulting flows at Modesto were approximately 40 cfs greater than at La Grange (RM 17; Figure 6). The fall pulse flow occurred between October 21 and October 31, with peak flows of approximately 780 cfs at La Grange during October 23-October 25 and approximately 750-800 cfs at Modesto during October 24-October 27 (Figure 6). Daily average water temperatures measured at the weir ranged between 42.0˚F and 79.6˚F (Figure 10). Instantaneous turbidity ranged between 0.19 NTU and 6.89 NTU (1.36 NTU season average; Figure 11). Instantaneous dissolved oxygen ranged between 8.47 mg/L and 13.58 mg/L (10.53 mg/L season average; Figure 12).

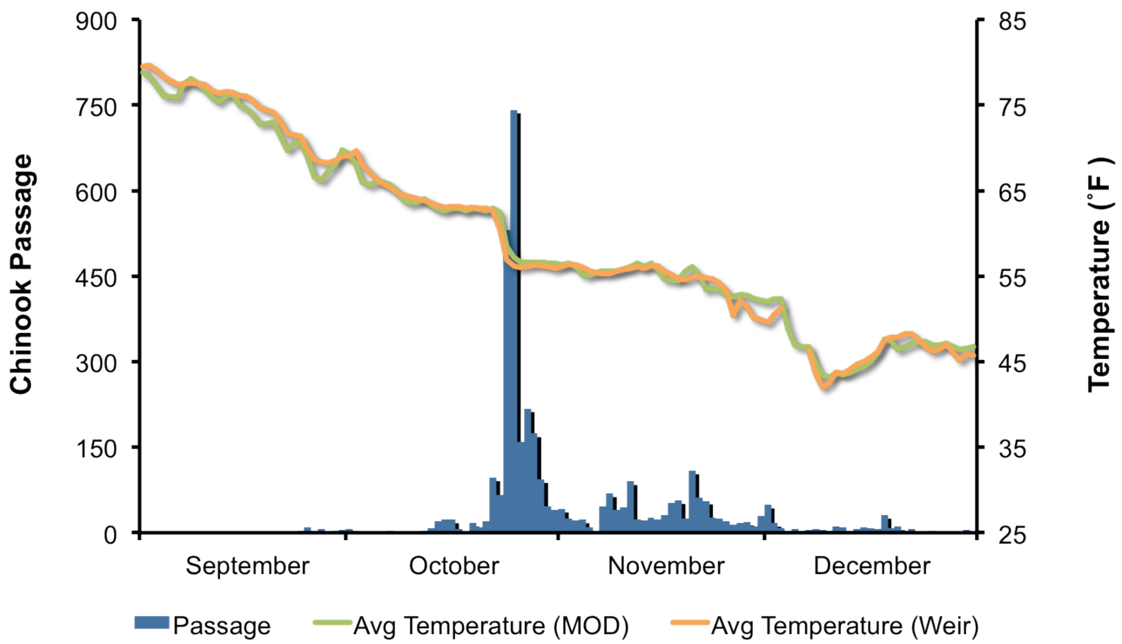

Figure 10. Daily Chinook salmon passage and daily average water temperature at the Tuolumne River Weir and daily average water temperature at Modesto (MOD) between September 1, 2013 and December 31, 2013.

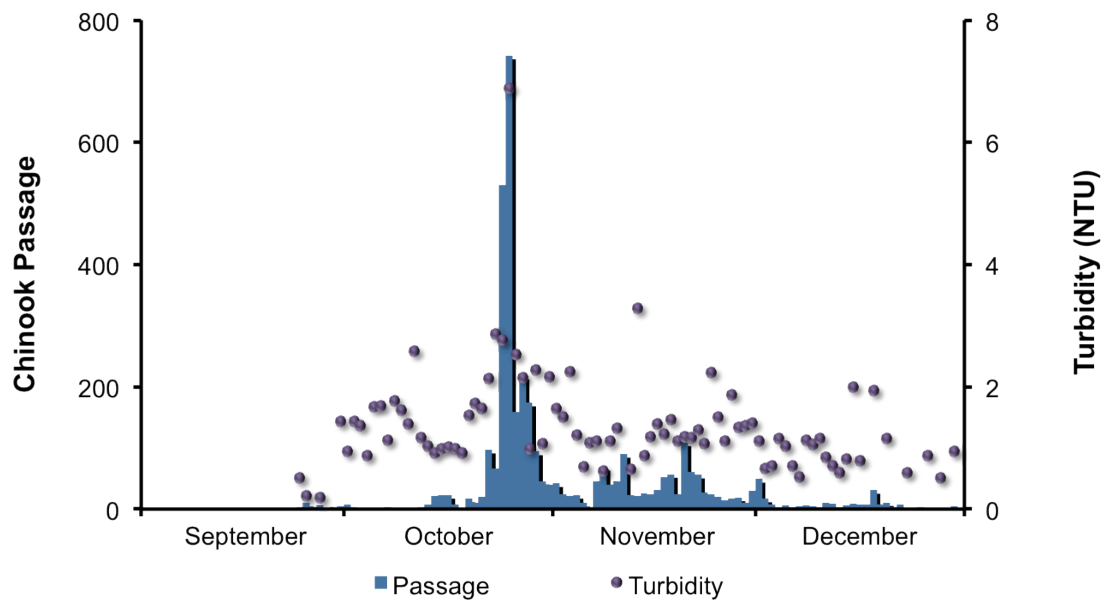

Figure 11. Daily Chinook salmon passage and instantaneous turbidy recorded at the Tuolumne River Weir between September 1, 2013 and December 31, 2013.

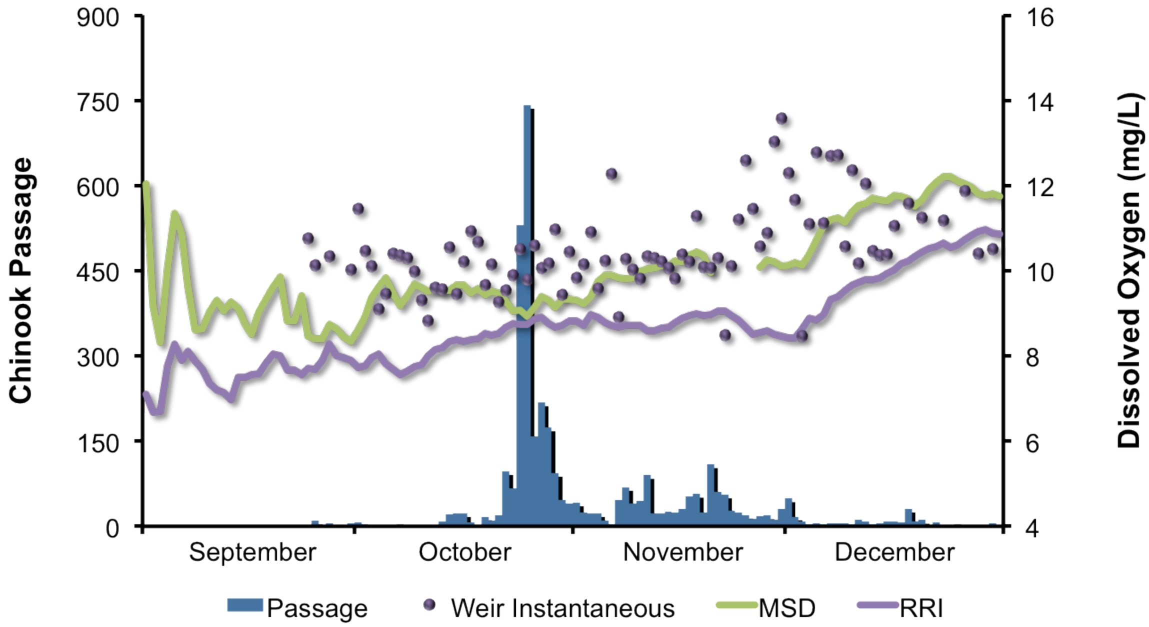

Figure 12. Daily Chinook salmon passage recorded at the Tuolumne River Weir in relation to instantaneous dissolved oxygen and daily average dissolved oxygen measured at Mossdale (MSD) and Rough and Ready Island (RRI) between September 1, 2013 and December 31, 2013.

DISCUSSION

Net upstream passage of 3,664 fall-run Chinook salmon during 2013 represents the largest season total escapement to the Tuolumne River since weir monitoring began in 2009 (Table 5). Escapement estimates from carcass surveys conducted by CDFW during 2013 are not yet available. Weir counts and and escapement estimates from CDFW carcass surveys (Azat 2013) differed greatly during 2009-2012, with carcass surveys grossly underestimating abundance in all years (Table 5).

Similar to previous years on the Tuolumne and Stanislaus Rivers, migration activity increased during the fall pulse flow period. During previous years of weir operation, pulse flows on the Tuolumne River were initiated as early as October 6 and as late as October 21 (Table 6). Between 2009 and 2012, 1.9%-13.5% of total passages had occurred by October 6, whereas only 1.2% of passages occurred by October 6 in 2013 (Table 6). The low early season counts were suggestive of conditions prohibitive to fish passage in the lower river, potentially caused by large accumulations of water hyacinth noted to have been present downstream of the weir by biologists beginning in August.

On October 14, 2013, extensive growth of water hyacinth was found along both banks of the river between Riverdale Park (RM 12.3) and the confluence with the San Joaquin River. In five locations water hyacinth was found to blanket the entire width of the channel from bank to bank (Figure 13). Water hyacinth was occasionally so dense that the river was not navigable by canoe. A repeat visit to the same reach between Riverdale Park and the confluence with the San Joaquin River on October 31 confirmed that nearly all of the water hyacinth observed during mid-October had washed downstream.

Approximately 5% of the Chinook salmon observed at the Tuolumne River weir were less than 600 mm TL, and the majority (87%) of these were males. Small males are commonly known as jacks and these fish may contribute up to 67% of all runs in some years (Moyle 2002). Jacks are widely used in escapement prediction models (Beer et. al. 2006) where a large return of jacks suggests an increase in escapement for the following year. However, a large variation in forecast predictions and actual abundance has forced the Pacific Fishery Management Council to modify the prediction model (Winship et. al. 2013).

The Tuolumne River Chinook salmon population is not supplemented with hatchery fish however, 11% of the salmon observed in 2013 were ad-clipped suggesting hatchery origin. Given that roughly 75% of hatchery fish are not clipped, and assuming that un-clipped and clipped hatchery fish are equally likely to stray, it is likely that many of the un-clipped fish observed in 2013 were of hatchery origin. In previous years, straying of fish released off-site into San Pablo Bay has been estimated to be as high as 70% (CDFG & NMFS 2001) and may be found to be even greater once analysis of CWT data for the most recent years are completed. In comparison, ad-clips were observed in 29% of fish examined in 2012.

Table 5. Annual adult Chinook salmon passage counts by run-type and range of dates that adult Chinook salmon passed the Tuolumne River Weir with CDFW annual escapement counts.

Year	Monitoring Type	Passage Date Range	Total Passage Count
	Fall Weir	September 24 - December 31	3,664
2013	CDFW Carcass Survey	Fall Run	Not available
	Winter/Spring Weir	January 1 - Present	36*
	Fall Weir	September 24 - December 31	2,180
2012	CDFW Carcass Survey	Fall Run	783
	Winter/Spring Weir	January 1 - May 22	122
	Fall Weir	September 16 - December 31	2,817
2011	CDFW Carcass Survey	Fall Run	893
	Winter/Spring Weir	January 1 - May 30	90
	Fall Weir	September 9 - December 1	785
2010	CDFW Carcass Survey	Fall Run	540
	Winter/Spring Weir	No Sample	-
	Fall Weir	September 22 - December 31	264
2009	CDFW Carcass Survey	Fall Run	124
	Winter/Spring Weir	January 1 - February 10	31

*Preliminary passage through February 7, 2014. Monitoring still in progress.

Table 6. Annual passages of fall-run Chinook salmon at the Tuolumne River weir by October 6, total passage, and proportion of total passage occurring by October 6 from 2009-2013.

Year	Begin Pulse Flow	Passage by October 6^{th}	Total Passage	% passage by October 6^{th}
2013	October 21	45	3,664	1.2%
2012	October 19	130	2,180	6.0%
2011	October 10	279	2,817	9.9%
2010	October 6	106	785	13.5%
2009	October 12	5	264	1.9%

Figure 13. Water hyacinth observed in the lower Tuolumne River, October 14, 2013.

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Appendix A

Chinook salmon passages and instantaneous environmental measurements at the Tuolumne River weir between January 1, 2013 and May 22, 2013.

Date	Female	Male	Unknown	Adipose Clipped	Cummulative Passage	Percent Ad-clip	Water Temp.	D.O.	Turbidity
1/1/13	1				1	0.0			
1/2/13					1	0.0			
1/3/13					1	0.0			
1/4/13		1			2	0.0	46.2	11.95	2.22
1/5/13					2	0.0			
1/6/13					2	0.0			
1/7/13	1				3	0.0	48.2	11.57	2.68
1/8/13	1				4	0.0			
1/9/13	1	1		1	6	16.7			
1/10/13	2				8	12.5			
1/11/13					8	12.5	48.2	12.29	3.11
1/12/13					8	12.5			
1/13/13					8	12.5			
1/14/13					8	12.5	45.3	12.8	1.65
1/15/13	2				10	10.0			
1/16/13					10	10.0			
1/17/13					10	10.0			
1/18/13					10	10.0	46.5	12.46	1.61
1/19/13					10	10.0			
1/20/13	1				11	9.1			
1/21/13			1		12	8.3	48.5	12.65	2.58
1/22/13	1	1			14	7.1			
1/23/13	1				15	6.7			
1/24/13					15	6.7	49.6	11.68	1.99
1/25/13					15	6.7			
1/26/13					15	6.7			
1/27/13					15	6.7			
1/28/13					15	6.7	54	10.32	1.99
1/29/13					15	6.7			
1/30/13					15	6.7			
1/31/13					15	6.7			
2/1/13					15	6.7	53.2	12.12	1.66
2/2/13					15	6.7			
2/3/13					15	6.7			
2/4/13					15	6.7	54.5	11.12	1.18
2/5/13					15	6.7			
2/6/13					15	6.7			
2/7/13					15	6.7			
2/8/13					15	6.7			
2/9/13					15	6.7	55.7	11.47	1.18
2/10/13	1				16	6.3			
2/11/13					16	6.3	54.1	11.28	1.8
2/12/13					16	6.3			
2/13/13					16	6.3			

Date	Female	Male	Unknown	Adipose Clipped	Cummulative Passage	Percent Ad-clip	Water Temp.	D.O.	Turbidity
2/14/13					16	6-.3	55.1	11.16	1.94
2/15/13					16	6.3			
2/16/13	1			1	17	11.8			
2/17/13					17	11.8			
2/18/13					17	11.8	57.2	11.42	0.85
2/19/13	1				18	11.1			
2/20/13					18	11.1			
2/21/13					18	11.1	55.5	11.78	0.65
2/22/13					18	11.1			
2/23/13					18	11.1			
2/24/13					18	11.1			
2/25/13			1	1	19	15.8	57.2	11.36	0.62
2/26/13					19	15.8			
2/27/13		1		1	20	20.0			
2/28/13					20	20.0	58.1		1.52
3/1/13					20	20.0			
3/2/13					20	20.0			
3/3/13					20	20.0			
3/4/13					20	20.0	64		0.86
3/5/13					20	20.0			
3/6/13	3	1	1		25	16.0			
3/7/13	4	1			30	13.3	59.7	10.26	1.45
3/8/13	1				31	12.9			
3/9/13	1				32	12.5			
3/10/13					32	12.5			
3/11/13			1		33	12.1	61.5	10.79	2.9
3/12/13					33	12.1			
3/13/13					33	12.1			
3/14/13		1	1		35	11.4	64.1	10.25	3.07
3/15/13		2			37	10.8			
3/16/13	2				39	10.3			
3/17/13	2				41	9.8			
3/18/13		1			42	9.5	64.4	10.44	1.51
3/19/13		1			43	9.3			
3/20/13					43	9.3			
3/21/13	1	1			45	8.9	63.6	10.01	2.94
3/22/13					45	8.9			
3/23/13					45	8.9			
3/24/13					45	8.9			
3/25/13					45	8.9	63.1	10.98	1.49
3/26/13					45	8.9			
3/27/13					45	8.9			
3/28/13	1				46	8.7	64.5	10.17	1.17
3/29/13	2				48	8.3			
3/30/13					48	8.3			
3/31/13	2				50	8.0			
4/1/13	2		1	2	53	11.3	68.1	9.42	1.46
4/2/13					53	11.3			
4/3/13	1	1	1		56	10.7			
4/4/13					56	10.7	69.6	9.31	1.78
4/5/13	2				58	10.3			

Date	Female	Male	Unknown	Adipose Clipped	Cummulative Passage	Percent Ad-clip	Water Temp.	D.O.	Turbidity
4/6/13		1			59	10.2			
4/7/13		1			60	10.0			
4/8/13					60	10.0	66	9.22	1.75
4/9/13					60	10.0			
4/10/13			1		61	9.8			
4/11/13					61	9.8	66.7	9.11	1.36
4/12/13	1				62	9.7			
4/13/13	2	1			65	9.2			
4/14/13	1				66	9.1			
4/15/13	3	1			70	8.6	66	8.95	1.42
4/16/13	1	1	1		73	8.2	64	9.45	1.32
4/17/13	1				74	8.1	59.5	10.02	1.75
4/18/13					74	8.1			
4/19/13	1				75	8.0	63.1	10.95	1.5
4/20/13					75	8.0	63.3	9.92	3.91
4/21/13	1				76	7.9	65.8	9.45	8.32
4/22/13	1		1		78	7.7	62.4	8.72	1.75
4/23/13					78	7.7	62.2	10.17	1.35
4/24/13			1		79	7.6	63.6	7.75	2.51
4/25/13	1				80	7.5	65.3	11.75	1.12
4/26/13	2				82	7.3	64.4	12.17	1.99
4/27/13	1	1			84	7.1	67.1	7.32	0.26
4/28/13	1				85	7.1	62.5	9.41	0.76
4/29/13	1				86	7.0	62.6	12.4	
4/30/13	1	1	1		89	6.7	64.4	8.47	1.21
5/1/13			1		90	6.7	62.4		1.1
5/2/13	1				91	6.6	62.6	9.68	1.2
5/3/13	1				92	6.5	60.4	9.94	1.44
5/4/13	1	3			96	6.3	61.5	10.93	1.52
5/5/13	1				97	6.2	60.9	10.38	1.58
5/6/13		2			99	6.1	63.8	10.53	1.16
5/7/13					99	6.1	63.3	9.82	0.73
5/8/13	1	3	1		104	5.8	64	9.83	2.83
5/9/13					104	5.8	67.8	9.66	0.72
5/10/13	1	1			106	5.7	68	8.91	0.75
5/11/13		1			107	5.6			
5/12/13	2		1		110	5.5			
5/13/13					110	5.5	77.1	8.12	1.98
5/14/13					110	5.5			
5/15/13	1				111	5.4			
5/16/13					111	5.4	72.6	8.37	5.58
5/17/13	3				114	5.3			
5/18/13	1	3	2		120	5.0			
5/19/13					120	5.0			
5/20/13					120	5.0	74.3	8.74	1.36
5/21/13		1	1		122	4.9			
5/22/13					122	4.9	68.9	8.98	0.91