State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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EDMUND G. BROWN JR., Governor
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Public Comment
2016 Bay-Delta Plan Amendment & SED
Deadline: 3/17/17 12:00 noon

March 15, 2017

RECEIVED
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SWRCB Clerk

Ms. Jeanine Townsend
Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814-0100

Dear Ms. Townsend:

Subject: Comments regarding the Recirculated Draft of the Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality

The California Department of Fish and Wildlife (Department) appreciates the opportunity to review and comment on the State Water Resources Control Board's (State Water Board) "Recirculated Draft of the Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality" (SED). The Department agrees with the SED that the San Francisco Bay/San-Joaquin River Estuary (Bay-Delta) is in ecological crisis, with many native fish species populations at all time low abundances. In recent years, the poor water quality conditions in the Bay-Delta and Sacramento and San Joaquin river watersheds, exacerbated by drought, have brought fish species listed under the protection of the state or federal Endangered Species Acts to levels near extinction or extirpation.

The Department is California's Trustee Agency for fish and wildlife resources, and holds those resources in trust by statute for all the people of the state. (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a).) The Department, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. (Id., § 1802.) Similarly, for purposes of CEQA, the Department is charged with providing, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects, and related activities that have the potential to adversely affect fish and wildlife resources.

The Department recognizes the tremendous effort the State Water Board and staff have put into developing this environmental document and associated amendments, in addition to addressing our concerns with the previously proposed amendments. Below is a summary of the Department's comments regarding the draft revised SED. Enclosed with this letter are more detailed comments and supplemental attachments to support the Department's comments.

1. **Hydrology** – The Department would like to reiterate its support for the State Water Board's use of water quality objectives to reasonably protect all beneficial uses of water, including establishing and maintaining viable salmonid populations. An objective can be numeric or narrative, and there are several different possible metrics to preserve the shape and variability of the natural hydrograph in river systems. The Department is interested in flows to provide specific and measurable benefits to fish populations, and the Department recognizes that the best approach to achieving those benefits may differ depending on whether the State Water Board is approving individually negotiated voluntary agreements tailored to specific tributaries or establishing a broader regulatory program of general applicability.

   The Department believes that voluntary agreements provide a promising approach to achieving the water quality objectives in a timely, effective, and durable manner, and the Department is in the process of negotiating voluntary agreements directly with public water agencies and other stakeholders in the three San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers). In the context of voluntary agreements negotiated directly with specific districts, the Department believes the best approach is to structure tributary-specific functional flow regimes, in coordination with appropriate non-flow measures, which address the underlying stressors and make substantial contributions toward achieving the State Water Board's water quality objectives. The Department recommends that the State Water Board consider any such voluntary agreements in light of the functional benefits they confer in a tributary along with the contribution they make to achieve the overall water quality objectives.

   In the absence of negotiated voluntary agreements with functional flow regimes tailored for that river's needs, the broader regulatory program proposed by the State Water Board, which relies on the percent of unimpaired flow from each San Joaquin River tributary and allows for shaping those flows through the adaptive management process to achieve functional benefits, is appropriate. The use of this UIF methodology can allow for instream flow protections through preserving the shape and variability of the natural hydrograph (Poff et al. 1997; Bunn and Arthington 2002) to support natural ecosystem processes. Providing conditions that mimic the natural hydrograph provides a "functional flows" approach that can be supportive of all native populations without attempting to control the specific mechanisms (e.g., physiological, chemical, fluvial, or biogeochemical) that are governing population size.

In addition, the aquatic habitat that a natural hydrograph produces can constrain the proliferation of non-native species which reduce the survival and productivity of native species.

The State Water Board's 2010 Report, "Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem", concluded that 60% of unimpaired San Joaquin River (SJR) inflow from February through June, as a criteria indicating general timing and magnitude, was needed to protect and ensure viable Lower San Joaquin River (LSJR) native fish populations and the ecosystem functions and services upon which they rely. In addition to the February through June period, minimum year-round flows are necessary to fully protect all aquatic life beneficial uses. The Department agrees that flow shifting, as described in proposed Alternatives 3 and 4 of the Bay-Delta Plan amendment may benefit native fish populations within and outside of the February through June period. However, to effectively manage this flow shifting and to maximize benefits, it is imperative that the Bay-Delta Plan include the framework for a rigorous adaptive management program.

The Department believes that both flow and non-flow actions are necessary in the LSJR and tributaries to recover native species. Non-flow actions (e.g., habitat restoration) must be coordinated with flow actions in order to ensure the intended benefits to the aquatic ecosystem can be realized. For example, Figure 1 displays natural salmon escapement in the Stanislaus and Tuolumne rivers from 1995 to 2015. Both rivers have had extensive habitat restoration projects conducted over the last few decades. Escapement on the Stanislaus River has shown a steady increase since the instream flow requirements were implemented as identified in the 2009 BiOP (NMFS 2009). During the same period, the Tuolumne River has had no revised flow regime required or implemented, nor has the river exhibited escapement increases from the non-flow habitat restoration actions. The data suggest that non-flow actions alone will not provide the necessary habitat benefits to recover anadromous salmonid populations.

The Department believes that the inclusion of June in the Bay-Delta Plan flow objectives is needed to support the full expression of life history diversity of anadromous salmonids. Chinook salmon juveniles are present and migrate in the LSJR tributaries and Delta in June, and in some years, June emigration comprises a substantial proportion of the total number of emigrants for the year (e.g., 1998, 2006, and 2011) (Table 1). From 1994 to 2016, Chinook salmon juveniles emigrated out of the LSJR watershed in 17 out of 22 years with the current impaired flow management regime. The currently proposed February through June "block of water" strategy provides the flexibility to adaptively manage flow regimes in real-time to optimize the use of water for aquatic ecosystem benefits, depending on current hydrodynamic and meteorologic conditions, fish presence, current ocean age class structure/abundance, population abundance trends, water quality conditions, etc.

The managed hydrology of the LSJR must be able to support all the freshwater life-stages of anadromous species. This includes the connectivity of flow between the tributary watersheds and the Bay-Delta ecosystem to facilitate Delta migration and juvenile rearing. Flow from each of the tributaries must be able to continue through the Delta to facilitate olfactory cues to minimize straying from the LSJR and between its tributaries. This phase of the Water Quality Control Plan update develops new requirements for the flow from the LSJR to the Delta. It is critical that the new and revised flow requirements developed for Phase 2 of the Bay-Delta Plan update protect this flow through the Delta to protect the anadromous migratory corridor.

2. **Adaptive Management and Monitoring** – The SED and proposed implementation plan have benefited greatly from the expanded description of the adaptive management process and the overall flexibility of shifting flow outside of the February through June time period. The proposed Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) outlines a process by which the San Joaquin River and tributaries' flow and restoration activities can be adaptively managed. However, the SED and proposed amendments lack clarity in the governance structure and decision-making process for the adaptive management framework needed to support decisions on flows necessary to achieve viable native fish populations. The efficacy of the adaptive management process to protect all aquatic beneficial uses relies heavily on the ability of the STM Working Group to operate transparently, collaboratively, and efficiently. The Department recommends that the State Water Board consider alternative governance structures that will maximize flexibility, efficiency, and effectiveness in making decisions about adaptive management and, as part of such a structure, the Department recommends that State Water Board staff be assigned an active and clear leadership role in the STM Working Group that will allow them to facilitate forward progress and ensure compliance with the proposed water quality objectives, biological goals, etc.

   The Department strongly supports the use of SMART (specific, measurable, achievable, relevant, and time-bound) objectives as key components for adaptive management decisions. Clear goals and objectives are necessary to measure the success or failure of implemented actions (both flow and non-flow) to improve aquatic ecosystem conditions and anticipated anadromous fish population responses. When implementing established goals and objectives, it is important to identify the responsible parties and the extent to which each is accountable for achieving the goals and objectives. While the Program of Implementation requires the development of biological goals, the SED generally is unclear on how these biological goals, and any associated objectives, will be used to adjust the percent of UIF within the specified range (e.g., 30 to 50%). The Department recommends that the Program of Implementation specifically identify how and when the percent of UIF can be adjusted within the specified range using biological goals or objectives as the determinate trigger to adjust the percent of UIF.

A robust monitoring and assessment program is also fundamental for an effective adaptive management program. The Department recommends that water right permits and water quality certifications require that the appropriate data be collected and be readily available to the STM Working Group for use in the adaptive management process. The necessary types of information likely include, but are not limited to, both current and forecasted water operations and reservoir conditions (e.g., water deliveries, current and projected reservoir levels, flows, water temperatures, cold water pool volume, and water transfers), diversion rates and volumes, and biological metrics for anadromous fish species (e.g., juvenile abundance, survival estimates, ocean age class abundance, and escapement). A collaborative and transparent assessment of environmental and biological conditions in the LSJR watershed will greatly improve the efficiency of the STM Working Group for real-time and long-term management of the system.

3. **SalSim** – The Department appreciates the efforts of the State Water Board staff to include SalSim estimates in their analyses to evaluate the effect of flow prescriptions on salmonid populations. The simulations performed by State Water Board staff resulted in fish population estimates lower than would have been expected based on empirical data. Through investigating the State Water Board's SalSim modeling results and the mathematical functions in the model, the Department determined that model parameter values in equations for egg incubation, alevin, and juvenile survival were in error. In combination, these errors produced excessively high egg and alevin mortality during warmer water flow events and juvenile survival that was not sensitive to river temperatures once flows exceeded approximately 450 cubic feet per second. In response, the Department revised the SalSim model, thus correcting the parameter values for these equations so that temperature responses for all life stages were more logical and better aligned with temperature guidelines. Please see the attached SalSim memorandum for further details in your continued efforts to update the Bay-Delta Plan.

4. **Impaired Waters** – Increasing flow in the LSJR tributaries could preclude the need to develop Total Maximum Daily Load or other discharge control programs to eliminate currently identified or future water quality impairments in the LSJR and tributaries and the Delta. Streamflow is often considered a "master variable" because it is strongly associated with many critical physicochemical characteristics (e.g., temperature, salinity, residence time, and habitat diversity) of rivers (Poff et al. 1997). The release of high quality reservoir water into the tributaries of the LSJR can also alleviate other identified impairments in these watersheds. The benefits to water quality in the LSR watershed would be analogous to those realized by the conditions imposed on the United States Bureau of Reclamation by the Revised Water Right Decision 1641 to comply with the salinity standards.

The salinity conditions in the SJR, Stanislaus River to Delta Boundary, have been effectively controlled by flow releases from New Melones Reservoir, and as a result, this river reach has been approved by the Central Valley Regional Water Quality Control Board to be removed from the impaired waters list (Resolution No. R5-2016-0083) for elevated electrical conductivity.

Increasing the percent of UIF in rivers not only increases and improves habitat for fish and wildlife, but it also improves conditions for other beneficial uses (e.g., drinking water supply and agricultural supply). Increasing instream flow in the LSJR and Delta may remove impairments in these water bodies caused by salinity, elevated temperatures, and low dissolved oxygen (Table 2), thereby removing the efforts and costs to develop control programs and basin plan amendments, to implement mitigation actions to comply with new water quality objectives for these constituents, etc. In addition, increasing the volume of water in rivers will increase their assimilative capacity for other constituents (e.g., pesticides, metals, sediment, and selenium), thus decreasing their adverse impacts.

5. **Voluntary Agreements** – The Department believes voluntary agreements have the potential to provide the most efficient and effective means of achieving the water quality objectives and the Department appreciates the State Water Board's recognition of the efforts of the Department and stakeholders to secure collaborative voluntary agreements for restoration and water management. The use of voluntary agreements will likely expedite environmental improvements and the implementation of the proposed objectives by combining both flow and non-flow actions within the watersheds and obtaining the resulting benefits far more quickly than a full regulatory process would. The Department will continue to collaborate with stakeholders to develop solutions to protect all beneficial uses of water within the framework identified in the SED and proposed amendments and looks forward to submitting voluntary agreements to the State Water Board for approval.

The Department appreciates the opportunity to provide comments on the draft revised SED. If you have any questions, please feel free to contact Stephen Louie at (916) 327-8758 or at Stephen.Louie@wildlife.ca.gov.

Sincerely,

Scott Cantrell

Scott Cantrell
Chief, Water Branch

Enclosure

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Attachment 1

Tables and Figures

Table 1: IEP Delta Juvenile Fish Monitoring Program Mossdale Trawl Raw Catch Data for Chinook Salmon.

	Monthly Mossdale Trawl Survey Catch											
Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
1994				304	194							
1996				701	366	104						
1997			13	464	377	55						
1998				515	1263	550						
1999	81	316	84	264	407	183						
2000	7	298	60	469	532	41						
2001		4	47	1709	2450	44	1					
2002	1			644	3252	17						
2003	59		31	1586	1181	8				1		
2004	1	9	273	835	1033							
2005	26	17	43	362	1827	105	2					1
2006	2	2	20	137	1726	894	5					
2007		1	2	1699	1567	128						
2008	1	1	1	419	1248	27						
2009			13	267	365	4						
2010		2	14	136	126	17	1					7
2011	6	2	6	56	1834	1318	7					
2012			1	1453	1686	101						
2013		16	19	2763	2362	168						
2014	1	1	3	498	860							
2015		1	6	68								
2016	2		3	128	78				1			

Available: https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm, accessed: 2/2/2017. Sum of monthly catch of unmarked fish.

Table 2: Current and Proposed Impaired Water Bodies in the LSJR and Delta Due to Parameters Highly Influenced by Flow.

Water Body	Pollutant	2012 Impaired Listing		New Listings:	New Delistings:
		TMDL Required	Addressed by USEPA-Approved TMDL	TMDL Required	Addressed by USEPA-Approved TMDL
Delta Waterways (export area)	Electrical Conductivity	X			
Delta Waterways (southern portion)		X			
Delta Waterways (western portion)		X			
Old River (San Joaquin River to Delta-Mendota Canal; in Delta Waterways)		X			
San Joaquin River (Merced River to Tuolumne River)		X			
San Joaquin River (Tuolumne River to Stanislaus River)		X			
Old River (San Joaquin River to Delta-Mendota Canal; in Delta Waterways)	Total Dissolved Solids	X			
Old River (San Joaquin River to Delta-Mendota Canal; in Delta Waterways)		X			
Delta Waterways (Stockton Ship Channel)	Organic Enrichment/Low Dissolved Oxygen		X		
Merced River, Lower (McSwain Reservoir to San Joaquin River)	Temperature, water	X			
San Joaquin River (Merced River to Tuolumne River)		X			
San Joaquin River (Tuolumne River to Stanislaus River)		X			
San Joaquin River (Stanislaus River to Delta Boundary)		X			
Stanislaus River, Lower		X			
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)		X			
Delta Waterways (Stockton Ship Channel)				X	
Grant Line Canal subwatershed at Clifton Court Rd (San Joaquin County)	Specific Conductivity			X	
Grant Line Canal subwatershed near Calpack Rd (San Joaquin County)				X	
San Joaquin River (Merced River to Tuolumne River)				X	
San Joaquin River (Merced River to Tuolumne River)	Total Dissolved Solids			X	
San Joaquin River (Stanislaus River to Delta Boundary)	Electrical Conductivity				X

From: Central Valley Regional Water Quality Control Board Resolution No. R5-2016-0083.

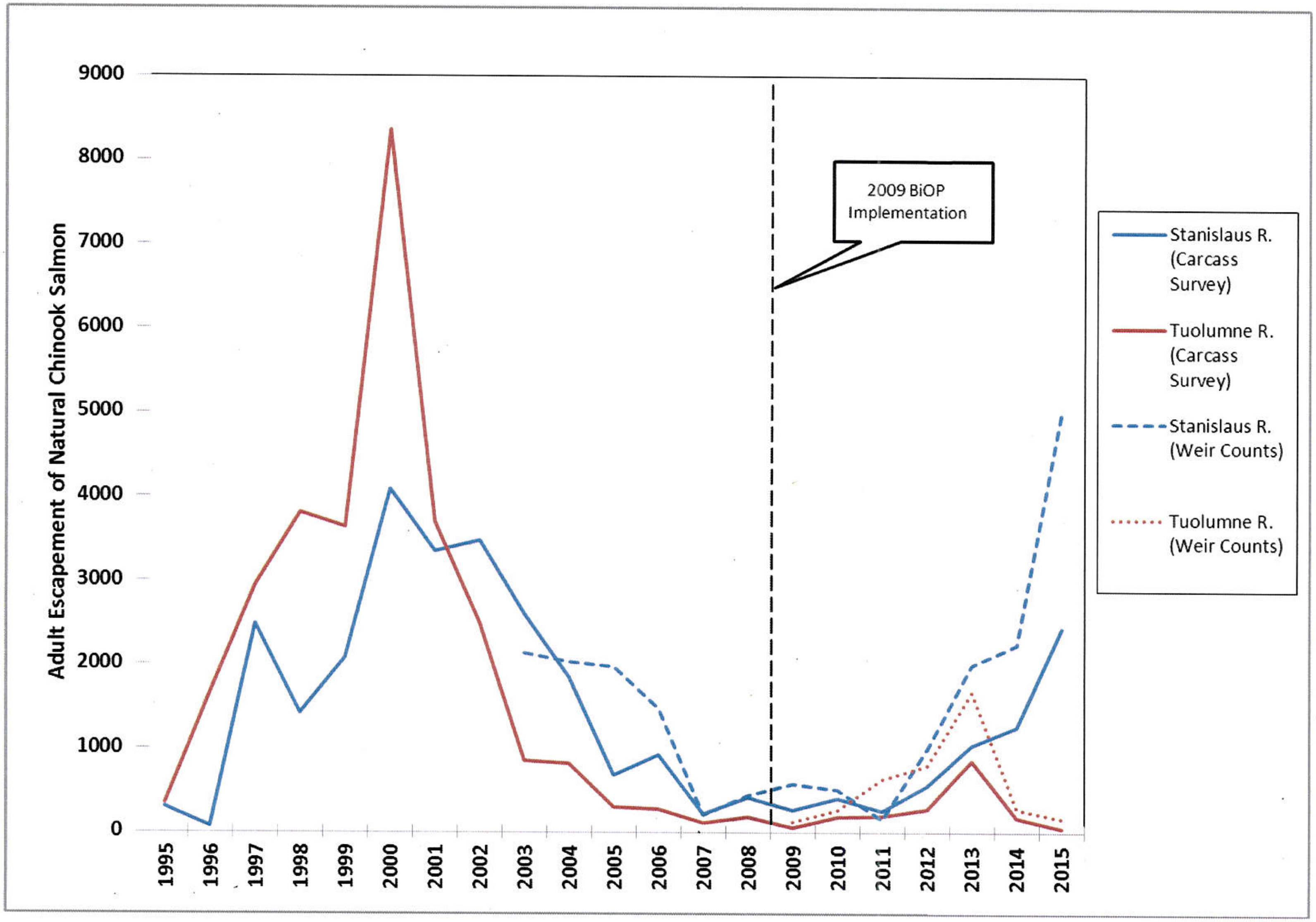

Figure 1: Adult Escapement of Natural Chinook Salmon on the Stanislaus and Tuolumne Rivers from 1995 to 2015. Data Sources: FishBio Weir Counts, CDFW Carcass Surveys, and UCD Otolith Analyses. Funded by: TID, MID, USFWS, and CDFW.

Attachment 2

Literature Cited

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Attachment 3

CDFW Chapter-Specific Comments

SED Chapter	Page #	SED Text, Paragraph, Sentence in Question	Staff Comment or Suggested Edits
Exec Summary	ES-8	Following are critical reasons why revised flow objectives are needed to reasonably protect fish and wildlife in the three eastside, salmon-bearing tributaries and the LSJR.	Commercial and Sport Fishing (COMM) is a designated beneficial use that requires protection. The Delta once supported a robust commercial and sport fishing industry. Reductions in fish populations have greatly impaired COMM beneficial uses, which includes the decimation of a once thriving commercial fishery. The reduction in ecological health, as a result of flow alterations, impacts recreational fishery and local economies that rely on it. As well, the reduction in healthy fish in the watersheds makes it more difficult for subsistence fishers to provide the proper nutrition to their families. The Delta MeHg TMDL contains an analysis of subsistence fishers in the Delta region (Wood et al. 2010). In addition, State Board Resolution No. 2016-0011 confirms the past, present, and future uses of inland surface waters and enclosed bays for cultural and subsistence fishing by directing Water Board staff to develop for adoption specific beneficial uses to protect these uses.
Exec Summary	ES-13	For example, if the flow requirement is 40 percent of unimpaired flow from February through June, the remaining 60 percent is available for all other uses. In practice, even more than 60 percent is available for other uses because some of the water used is returned to the river, and would contribute to the 40 percent unimpaired flow requirement. Unimpaired flow is therefore a more transparent way to allocate water towards the protection of fish and wildlife resources and other uses of water.	A volume of water (e.g., 40% UIF) released from the reservoir is not equivalent to the same volume of water contributed partially from agriculture return, urban run-off, and wastewater discharges. Clearly, discharges from agricultural drainages, urban runoff, and WWTPs are of lesser quality than surface waters. Surface waters are often treated as dilution for contaminants contained in these discharge waters. Furthermore, it is well known that waters discharged from agricultural drainages have higher temperatures than the surface waters that they discharge to. The percent of UIF released for fish and wildlife beneficial uses should be measured as reservoir releases, and then protected from diversions to the downstream compliance location.
2	2-19	2.4 Tuolumne River-2.4.2 Water Diversion and Use-Modesto Irrigation District	The SED states that Modesto Irrigation District (MID) provides water and electrical services to a "…small portion located in Calaveras County around the New Don Pedro Dam". The report appears to mistake Calaveras County for Tuolumne County. (map of service area http://www.mid.org/mid-map.pdf)

2	2-21	2.4 Tuolumne River-2.4.3 Flow Requirements	Table 2-13 displays flows from the original FERC license, not the 1995 settlement flows, which have been required for the last 20 years. Using the current flow regime from the 1995 settlement agreement would give a more realistic view of the current state of the Tuolumne River.
Appendix C	3-13		Table 3.12 FERC Project Number 2179 is for Merced River not Tuolumne River.
Appendix C	3-15		The SED should define "advanced stage of maturity." From carcass survey monitoring, there are examples of female carcasses containing undeveloped eggs. So the advanced stage of maturity should refer to the development of sex organs when entering fresh water versus females with fully developed eggs ready for fertilization. Rapid movement was demonstrated in Department tracking data, but not all fish appear to have such rapid movement. Only fish migrating in September or early October, when water temperature was unfavorable to migrating adults, such as 18° C, displayed rapid movement into lower reaches of the tributaries or in the main stem SJR just downstream of the Stanislaus River. Migrating adults do not exhibit a crepuscular movement pattern. Based on telemetry data, fish movement patterns are random up and down stream movements (in Delta movements may relate to tidal effects) in the SJR and tributaries. Based on the Department's survey data in the SJR tributaries, adults may build redds and spawn up to 70 days after freshwater entry, versus a few weeks as stated in the report.
Appendix C	3-16	section 3.2.3 third paragraph	The Department's aerial redd survey has not been conducted in the SJR basin.

3	3-17 3-18		It is very important that the State Water Board identify the responsible parties for monitoring and reporting. There are clear examples in the Sacramento River and Central Valley where parties do not agree on who is responsible for the coded-wire tagging program monitoring. Accordingly, the monitoring does not get performed.
Appendix C	3-24		SJR basin monitoring program CWT releases/recapture was done by the Department and one time by Cramer and Associates. Additional monitoring includes fish counting weirs at Stanislaus and Tuolumne rivers by FishBio. The Mossdale trawl is conducted by both USFWS and CDFW. In addition, rotary screw traps are operated by FishBio.
3	3-34	However, pursuant to the San Joaquin River Restoration Program (SJRRP), spring-run Chinook salmon are planned to be reintroduced to the Upper SJR no later than December 31, 2012. Flows needed to support this reintroduction are being determined and provided through the SJRRP. During the next review of the Bay-Delta Plan, the State Water Board will consider information made available through the SJRRP process, and any other pertinent sources of information, in evaluating the need for any additional flows from the Upper SJR Basin to contribute to the narrative LSJR flow objective.	It is past December 2012, and portions of the SJRRP have been implemented. The SED should now incorporate the new information from this program.
3	3-8	The lower bound represents the minimum quantity of water at which there is a reasonable expectation that fish and wildlife protection goals will be achieved, although at this level, it may require other actions, such as non-flow measures.	The lower bound description states it may require non-flow measures to reasonably protect fish and wildlife; the State Water Board has limited authority to require these non-flow measures. In the absence of implementing non-flow measures., there is no reasonable assurance that the lower bound objectives will reasonably protect fish and wildlife.

4	Throughout		Description of Ch. 16: Throughout Ch. 4, Ch. 16 is described. The non-flow alternatives are listed several times. The description of these alternatives is unclear in certain sections and leads the reader to believe that compliance with flow objectives could result from the implementation of non-flow actions only. The document should clarify how the use of non-flow actions could be used in conjunction with flow actions for compliance with the flow objectives.
5	5-33 5-34	Last paragraph, last sentence, "4,000 TAF/y". Third paragraph, last sentence, "... 4,100 TAF/y."	Both volumes are applied to the SWP pumping contract demands, so there is an inconsistency in the values.
5	5-54	Because flows are not expected to change in response to the SDWQ alternatives, the WSE model was not needed to assess effects of the SDWQ alternatives.	Once USBR's permit is renewed, and they start to manage to meet the 1 mS WQO versus the 0.7 mS, then flow at Vernalis may be reduced.
5	5-82 to 5-83	Table 5-23	It would be better if the results were presented on a weekly basis because of the wide variability throughout a given month. For example, October starts out very warm and ends very cool. Also it would be more comprehensible if the results are presented as the predicted temperature instead of plus/minus.
6	6-13	Although the channel capacity is 8,000 cfs, there is agriculture within the floodway that may be affected by seepage and high water tables at flows above 1,500 cfs (McAfee 2000; Kondolf et al. 2001). Concerns about seepage involve potentially adverse impacts that may occur to agricultural crops such as damage to the root systems of tree crops when the groundwater level rises due to high river flows...	Over the years the USACE acquired, through easement or fee title, property within the 8,000 cfs floodway that extends from Goodwin Dam to the San Joaquin River confluence for flowage, flooding, and habitat conservation purposes. The USACE easement properties now mitigate the impacts of flows over 1,500 cfs, so easements now permit flexibility to implement recommended fishery flow levels above 1,500 cfs to protect the fishery resource in the lower Stanislaus River (Brantley 2016). Flow up to 8,000 cfs should be considered in future New Melones operation planning because impacts due to seepage above 1,500 cfs should not be considered adverse.
7	7-9	7.2.1 Fish Species (p 7-9)	"Blackfish" should be Sacramento Blackfish.

7	7-16		Rearing temperatures: while all information stated is technically correct in certain context, the applicability of the temperature ranges should be described. There are significant differences between laboratory and field studies as well as size and maturation levels between studies. The amount of food present is also very important, as is alluded to in the Myreck Cech citation but not fully explained. The Department suggests either expanding this section greatly or changing it such that the discussed information is better explained.
7	7-35		Please clarify the applicability of the winter-run example for the LSJR watershed.
7	7-13	Table 7-3 Recreationally Important Fish Species in the Plan Area-Largemouth Bass (p 7-13)	Habitat - Largemouth bass are found in the main stem of the tributaries and LSJR, not just backwaters.
7	7-14	Table 7-3 Recreationally Important Fish Species in the Plan Area-Striped Bass (p 7-14)	Habitat - Striped bass are also found in rivers (tributaries and LSJR).
7	7-16	7.2.1 Fish Species. Chinook Salmon. Central Valley Fall Run (p 7-16, 2nd paragraph)	The discussion about optimum growth rates is confusing. In one sentence it notes optimum temperature for growth occurs at temperatures of (10-15.6°C) but the next sentence states optimum growth rates occur at about 19°C when fed maximal rations. Please distinguish the different rations or conditions (e.g., laboratory versus *in situ*) which differentiate the conditions which allow optimal growth at the different temperatures.
7	7-17	Under, "Rainbow trout and Central Valley Steelhead," first paragraph	Influence of hatchery stocking should be taken from Garza and Pearse (2008), not from Moyle (2002).
7	7-17	7.2.1 Fish Species. Chinook Salmon. Central Valley Spring Run (p 7-17, 1st paragraph) "In 2010, the SJR reconnected to the LSJR at the Merced River confluence."	This sentence suggests that the SJR has been connected continually since 2010. However, the connection between the upper SJR and lower SJR has been intermittent.

7	7-17	"The major goal of the SJRRP is to establish a naturally self-sustaining population (see Chapter 17, Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources, for a discussion of the program) (USBR 2011)."	The sentence is missing words (of Salmon).
7	7-27	7.2.1 Fish Species. Striped Bass (p 7-27, 1st paragraph)	The paragraph notes that striped bass are anadromous and only return to freshwater to spawn. However, there are also resident striped bass in these rivers.
7	7-3	Footnote 5: ...but distinguished taxonomically by their different forms.	Change to: ...but distinguished by their different life-history forms.
7	7-31	Table 7-4 Geographic and Seasonal Occurrence of Indicator Fish Species and Life Stages (p 7-31)	Table 7-4 may be more appropriately placed in Section 7.2.1. Central Valley fall-run Chinook salmon-spawning/incubation- should include January. Rainbow Trout- Adult migration- The table suggests that all fish migrate, and that they are only present in the reservoirs and not river downstream of dam.
7	7-32	7.2.2 Reservoirs, Tributaries, and LSJR. Stanislaus River. Indicator Species. Fall-run Chinook Salmon (p 7-32, 2nd paragraph)	Spawner abundance estimates are discussed up to 1998. CDFW suggests that the report include estimates of the most recent monitoring data.
7	7-34	7.2.2 Reservoirs, Tributaries, and LSJR. Stanislaus River. Environmental Stressors. Introduced Species and predation(p 7-34)	Please clarify the applicability of winter-run predation rates for the LSJR watershed. (last sentence)
7	7-34, 7-39, 7-43	Water Quality sections	Recommend updating the Water Quality sections with the impaired waters list using the State Water Board adopted 2012 list as well as the Central Valley Water Board adopted 2014 list.
7	7-35	In Introduced Species and Predation: Use of term 'predated' for preyed upon	Recommend changing 'predated' to 'preyed upon,' throughout the report.

7	7-35	7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Tuolumne River below New Don Pedro Reservoir (p 7-35)	The habitat accessible to anadromous fish is generally considered to be 52 miles, not the stated 47 miles. Please clarify.
7	7-37	7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Indicator Species. Steelhead(p 7-37 1st paragraph)	Please expand the description and conclusions from the cited tagging study.
7	7-38	7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Environmental Stressors. Habitat Alteration(p 7-38 3rd paragraph)	The report states that 14 channel restoration projects were identified in the Habitat Restoration Plan for the Lower Tuolumne River Corridor. It would be helpful if the report included how many projects have been completed to date.
7	7-38	Table 7-6. Tuolumne River Gravel Augmentation Projects (p 7-38)	Table is incomplete, other gravel restoration projects have occurred.
7	7-39, 7-142	7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Environmental Stressors. Introduced Species and Predation (p 7-39)	FishBio (2013) study was found by FERC to have limitations on its applicability to the entire river. Estimates of predators were produced using areas known to have higher predator density than typical for the entire river. Predation rate monitoring and estimates coincided with unusually low flow and elevated water temperatures, which favor conditions to support non-native warm water fishes. This study may not represent typical conditions for predation rates, so the caveats should be presented in the report.
7	7-39	7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Environmental Stressors. Hatchery Operations (p 7-39) "As discussed above, large numbers of unmarked hatchery salmon are released into the Merced River each year and may stray into the Tuolumne River"	The report does not previously provide information on the possible magnitude of hatchery proportions on Tuolumne River escapement. Please include the analyses or citations to support possible hatchery influences on Tuolumne River escapement.
7	7-39	"In recent years, up to 200,000 hatchery-origin salmon from the Merced River Hatchery have been released annually in the Tuolumne River."	"Recent years" may not be accurate, Merced River hatchery fish have not been released in the Tuolumne River in at least 5 years.

7	7-39	"Fish produced by the hatcheries have the potential to negatively affect natural fall-run Chinook salmon by displacing wild salmonid juveniles through competition and predation, competing with natural adults for limited resources, and hybridizing Central Valley Chinook salmon with fish from outside the SJR Basin (CDFG 2011a).	The last part of the sentence is confusing because the rest of the paragraph discusses fish straying from the Merced hatchery which is part of the SJR Basin.
7	7-40	7.2.2 Reservoirs, Tributaries, and LSJR. Merced River. Merced River below Crocker-Huffman Dam (p 7-40 2nd paragraph)	Merced River Hatchery also releases production fish into the San Joaquin River at Jersey Point.
7	7-40	7.2.2 Reservoirs, Tributaries, and LSJR. Merced River. Indicator Species. Fall Run Chinook Salmon (p 7-40)	CDFW does not currently operate a RST on the Merced River (monitoring ended in 2003).
7	7-42	7.2.2 Reservoirs, Tributaries, and LSJR. Merced River. Environmental Stressors. Introduced Species and Predation (p 7-42) "As discussed previously, some hot-spots exists, such as in-river mining pits provide habitat for largemouth bass and other nonnative predatory fish species (Grossman et al. 2013)."	The report could help the reader by stating the location in the report where predation hot-spots were discussed.
7	7-44	7.2.2 Reservoirs, Tributaries, and LSJR. LSJR. (p 7-44 1st paragraph)	Scientific name for Sacramento Blackfish is given- this is not the first time the species was mentioned. (Similar issues throughout the section)
7	7-49	In Water Quality: temperatures... regularly exceed 77F (Moyle 2002).	Throughout the report, there is too much reliance on Moyle (2002) as a source, when there are other, original sources available, such as in this case regarding stream temperatures.

7	7-66	7.4.2 Methods and Approach. LSR Alternatives. Water Temperature and Dissolved Oxygen (p 7.66 paragraph 3)	The Department agrees that there have been limited studies as to the effect of depressed dissolved oxygen levels on fish and wildlife in the San Joaquin River watershed upstream of the Delta; however, dissolved oxygen monitoring data from the San Joaquin River at Maze Blvd and the Stanislaus River at Ripon (from CDWR Water Data Library and California Data Exchange Center) show periods where dissolved oxygen levels drop below the CVRWQCB Sacramento-San Joaquin River Basin Plan water quality objectives for dissolved oxygen. It appears that the report may misrepresent the environmental conditions where it states "DO levels are expected to remain within acceptable levels..."
7	7-72	7.4.3 Impacts and Mitigation Measures. Impact Aqua 2 (p 7.72)	The SED predicts an increase in end of September storage as a result of coldwater pool storage guidelines. Coldwater storage should be explicitly stated as a water quality objective, so that coldwater pool storage can be guaranteed.
7		Possibly overlooked literature source for comparison of Stanislaus modeling results on stranding and isolation in response to flow fluctuations	Brown, M.S., R.G. Titus, and W.S. Snider. 2008. Flow fluctuations effects on anadromous salmonid populations of the Stanislaus River, California. California Department of Fish and Game, Fisheries Branch, Final Contract Report to U.S. Bureau of Reclamation.
7	7-142	7.4.3 Impacts and Mitigation Measures. Impact Aqua 10 (p 7-142 3rd paragraph)	See comment 7.2.2 Reservoirs, Tributaries, and LSJR. Tuolumne River. Environmental Stressors. Introduced Species and Predation (p 7-39)-about reference to FishBIO 2013.
7	7-102	7.4.3 Impacts and Mitigation Measures. Impact Aqua 4 (p 7-102)	Analysis does not seem to look at the effects of reservoir drawdown and loss of cold-water pool resulting in warm water at the dam, as occurred in fall 2015 on the Stanislaus River.
7	7-114	Use of 64.4 F as upper optimal temperature per USEPA (2003)	In addition to the USEPA criterion (64.4°F) for juveniles, empirical observations of steelhead rearing in the lower American River have shown detrimental impacts to steelhead at these temperatures.
7	7-117	Modeling focused on Jul-Aug for rearing steelhead in summer.	Recommend modeling also include September, possibly also October, when flow is still low and temperature is high.

7	7-117, 130	Use of 60.8 F for juvenile salmon in spring, 57.2 F for smolting in spring	The report presents periods of the year with conflicting temperature due to overlapping life stages occurring simultaneously. The report should clarify how the different criteria are reconciled during the analyses for these periods.
7	7-148	7.4.4 Impacts and Mitigation Measures: Extended Plan Area (p 7-148 1st paragraph) "The upstream reservoirs on the Stanislaus and Tuolumne Rivers may experience substantial changes in reservoir volume, which are not experienced by the rim reservoirs in the plan area..."	On the Tuolumne River, the City and County of San Francisco (CCSF) is the operator of the upstream reservoirs, while Turlock Irrigation District and Modesto Irrigation District are the operators of the rim reservoir with a water banking agreement with CCSF for storage in Don Pedro. Although not fully independently operated, CCSF would have the ability to choose to store more water in their upstream reservoirs rather than use the water bank option, and most of the water use in Don Pedro is allocated to irrigation water for the districts. Please clarify why upstream reservoirs could experience substantial changes in reservoir volume, while the rim reservoirs would not.
7			Water is habitat. Its velocity, vectors, temperature, dissolved solids, turbidity, depth, etc. are all "habitat". The Chapter should be clear that habitat for fish requires water. For example, spawning gravel without water is not "habitat".
7			Document is inconsistent in regards to temperature units- in some places Celsius temperatures are given in addition to Fahrenheit but not others. It would be helpful to provide temperatures in Celsius in addition to Fahrenheit throughout the document. Same issue for length, both millimeters and inches are given in some places but not others.
7			Please be consistent in the use of scientific names.
11	11-1	This chapter analyzes those alternatives and assumes that any increases in unimpaired flows would reduce surface water supplies that are available for irrigation purposes.	The assumption is worded incorrectly. An increase in unimpaired flow would increase the water availability for all beneficial uses for all alternatives. However, an increase in the percent of unimpaired flow allocated to the reasonable protection of fish and wildlife beneficial uses could reduce the surface water supplies that are

			available for irrigation purposes.
11 & 19	11-1, 19-49	It should be noted that this likely presents a more conservative (i.e., "worst case") estimate of potential acreage reduction than may actually occur. The reservoir release temperature is a "best case" scenario, and represents temperature habitat that few fish actually experience because temperatures can warm rapidly moving downstream under many flow conditions.	The SED makes comparisons between worst case scenarios for agriculture and best case scenarios for fish habitat. It does not appear that the Water Board analyzes equivalent metrics to equally balance beneficial uses. This method will overestimate benefits for fish and wildlife per measure of flow, thus underestimate the amount of flow necessary to protect the beneficial uses. Likewise, the analysis can overestimate the adverse impacts to agricultural beneficial uses. Ultimately, equivalent metrics for adverse impacts and beneficial impacts should be used to "balance" the use of water to support beneficial uses.
11	11-44	For the purpose of this analysis, a significant impact would result if the impact on crop yield for salt-sensitive crops is greater than 10 percent. Above this level, it would become more difficult for farmers to mitigate impacts with modified irrigation practices (e.g., increased leaching) and would start to substantially reduce the acreage of these types of crops in the southern Delta.	Ten percent appears to be an arbitrary threshold to measure reductions in crop yields. The report should provide citations to support the threshold where it becomes difficult enough to modify irrigation practices to represent an impact. The report should present the analysis of the annual variability of crop yields to show that a 10% reduction in yield could be statistically perceived. For example, estimated adverse impacts to aquatic life typically require adverse effects of 20-25% (e.g., percent effect in mortality or reduced reproduction, or population declines) to be considered toxic (SWRCB Draft Toxicity Policy). The SED should use comparable metrics to justify impacts.

11	11-47, 11-52	The precise amount of lands that are designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that could be converted to nonagricultural uses cannot be precisely quantified. However, potential impacts, based on the crop reduction modeling results, can be qualitatively discussed to determine possible conversion to nonagricultural uses. In other words, the analysis uses decreased crop production as a proxy for potential conversion to nonagricultural uses. Figure 11-9, for example shows that irrigated acreage in SSJID stays the same, at approximately 58,500 acres in most years under baseline.	Unique farmland does not require a dependable irrigation supply (e.g., 8 of 10 years) (DOC 2004), so it should not have the same metric as the other farmland types (e.g., 80%) to indicate conversion to non-agriculture. The frequency of available irrigation (e.g., 8 out of 10 years) cannot be used to estimate the conversion of the desired agriculture to non-agricultural uses because unique farmlands don't require "dependable" water supplies (DOC 2004). Prime farmland and farmland of statewide significance may be converted to unique farmland due to the reduced abundance of available surface water supplies, but that does not equate to the conversion to non-agricultural use. Because the analysis was to determine whether the alternatives could "Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to nonagricultural use", the analysis using the frequency of irrigation overestimates the conversion to non-agricultural use.
11	11-47, 11-49	At 30 percent unimpaired flow, the average acreage reduction for all irrigation districts increases from 1.2 percent (Table 11-15) to 2.3 percent (Table 11-16). If method 1 is used to increase the required percent of unimpaired flow to 30 percent unimpaired flow on a long-term basis, it is estimated that OID would experience an average decrease in irrigated acreage of 4.4 percent and MID would experience an average reduction in irrigated acres of 4.5 percent under 2009 conditions (Table 11-16). Therefore, impacts would be significant.	The report should present the 95% confidence intervals around the estimates of average acreage reductions. The 1.2-2.3% and 4.4-4.5% differences are likely within the 95% confidence intervals of the average and not actually distinguishable from the average number of acres. Thus a finding of significant and unavoidable for Alternative 2 with adaptive implementation is not warranted.

15	15-15	The No Project Alternative could result in conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses as a result of the reductions in surface water diversions on the Stanislaus River (see Table 15-2)	Similar to Chapter 11, the analyses does not properly characterize unique farmland as requiring a dependable water supply. Assuming that a less than 8 out of 10 year irrigation frequency would result in farmlands converting to non-agricultural uses would overestimate the loss of agricultural use.
17	17-11		The SED suggests that groundwater recharge projects in the Central Valley would reduce the amount of water available for agriculture irrigation; however, the SED should also highlight that groundwater recharge practices can prevent or minimize groundwater overdraft due to agricultural uses while replenishing water available for irrigation. Moreover, groundwater recharge projects could be beneficial and sustainable if they are coupled with floodplain restoration projects on the Eastern San Joaquin, Modesto, Turlock, and Merced Groundwater Sub basins, as well as with the implementation of the Sustainable Groundwater Management Act (SGMA). CDFW recommends a revision of the language addressing the anticipated cumulative impacts of groundwater recharge projects.
17	17-2	"Changes in timing and magnitude of flows in the plan area and reduced surface water availability for diversion that in turn have effects on groundwater….impact on the following resources in the plan area – Groundwater resources".	Impacts to groundwater could be temporary or mitigated through the implementation and compliance with the Sustainable Groundwater Management Act as well as the State Water Board's enforcement of waste and unreasonable use.

17	17-2	"As described in...with or without adaptive implementation would have a significant and unavoidable impact on the following resources in the plan area – Service providers, Energy and greenhouse gases".	The California Renewable Portfolio Standard (RPS), was established in 2002 from Senate Bill 1078, accelerated in 2006 from Senate Bill 107 and expanded in 2011 from Senate Bill 2. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase renewable energy resources to 33% by 2020. With the above requirement, impacts to greenhouse gases and service providers would be mitigated to less than significant and temporary. California Public Utilities Commission. 2016. Renewables Portfolio Standard. http://www.cpuc.ca.gov/RPS_Overview/. Accessed on October 18, 2016.
17	17-28		The impacts discussion regarding floodplain restoration projects states that "these restoration activities are not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential". CDFW recommends clarifying that floodplain restoration projects (e.g., Dos Rios Ranch) can considerably decrease downstream flooding potential, in some cases, by reducing peak flows on the main river channel during the highest flood flow releases in large storm events.
17	17-45		The SED impacts analysis states that "it is counter to the LSJR alternatives' purpose to provide additional flows during February–June to more closely mimic the natural hydrograph for the protection of fish and wildlife beneficial uses, and is therefore infeasible". This assertion should be followed by an explanation of the rationale behind the infeasibility to provide additional flows for the protection of biological resources during the February-June period, compared to year-round flow provisions.
17	17-8	"Resource areas with potential cumulative effects...Flooding".	Federal Energy Regulatory Commission Projects are required to comply with the Army Corps of Engineers Flood Control Rule Curves. Thus, any adjustment may be temporary and thus less than significant.

19	19-22 to 19-33	Tables 19-3 to 19-14	These tables are difficult to understand. It is recommended that the results be presented on a weekly basis because of wide variability throughout a given month. For example, October starts out very warm and ends very cool. Also it would be more comprehensible if the results are presented as the predicted temperature instead of a percentage. It is also not very clear as to what the baseline is.
19	19-36	19.2.3 Results of Temperature Evaluation - Tuolumne River Reproduction October 1 to March 1 (pg 19-36)	RM 38 is near Roberts Ferry Bridge; however, the spawning reach extends to RM 29. The evaluation of suitable temperature for spawning should extend through the entire spawning reach.
19	19-49	19.2.4 Summary and Conclusions of Temperature Evaluation (last paragraph of section, pg 19-49)	The section discusses the temperature disconnect between water temperatures above the dam and releases during the fall. There is discussion about the time delay on the Merced and Stanislaus rivers, but nothing about the fact that this temperature disconnect does not occur on the Tuolumne River. In fact, the water coming out of La Grange is quite a bit cooler than the upper river in the fall.
19	19-61	19.3.2 Methods of Floodplain Inundation Evaluation- Methods: Floodplain Versus Flow Relationships- Merced River (pg 19-61	Each river has a different amount of development/degradation/restoration which would affect the inundation thresholds. The applicability of thresholds from the Stanislaus and Tuolumne rivers may not be representative of Merced River floodplain potential.
19		Lack of analysis of flow benefits to native fish populations Jul.-Jan.	The SED should include benefits to native fishes during late summer-early fall juvenile steelhead rearing period and fall immigration and spawning period for adult Chinook Salmon to complete the analyses in response to LSJR alternatives.
24	24-3	G.O. Grading, PhD, as an additional contributor to the report	Typo: G.O. Graening, PhD

Chapter 19	19-47	Significant temperature improvements in the Stanislaus River primarily occur under 50%-60% unimpaired flows, and in the Merced River primarily occur under 30%-60% unimpaired flows. Significant temperature improvements in the Tuolumne River occur under all alternative unimpaired flows with the least benefit occurring under 20% unimpaired flow and the most benefit occurring under 60%	The conclusions of project benefits lack from not evaluating benefits to salmonid metrics such as, cohort replacement rates, survival, intrinsic population growth rates, etc., because arbitrary temperature improvements (e.g., improvements above baseline condition) give no insight as to the whether the conditions will support viable populations or just a delay in extinction or extirpation (e.g., the predicted improvements from the revised flow objectives will result in population growth rates of *X*). This analysis of temperature benefits is inconsistent with Water Board development of water quality criteria to protect designated beneficial uses, where any methodology used to derive water quality objectives must protect the beneficial uses (40 C.F.R. §131.11(a)). The current analysis in the SED does not evaluate the temperatures that are protective of the beneficial uses, only improvements from a degraded baseline. Developing temperature criteria for the SJR tributaries is particularly important because they are listed on the USEPA 303(d) for temperature impairments.
Chapter 23	23-27	For the impact analysis, the water temperature modeling covers the time period from 197–2003.	Typo: missing date.
Appendix K	1	1st paragraph: "The Bay-Delta Estuary itself is one of the largest ecosystems for fish and wildlife habitat and production in the United States."	The Bay-Delta Estuary itself is one of the largest ecosystems for fish and wildlife habitat and production in the United States, and its productivity is dependent upon adequate freshwater inflow from the main stem rivers and tributaries, which feed the estuary".
Appendix K	18	Narrative & Minimum 7-day running average flow rate (cfs) for February through June	The in-river flow regime should support all life stages of fish and wildlife including the temporal and spatial needs to maintain their genetic portfolio, which allows them to express the phenotypes necessary to utilize California's highly variable inter-annual hydroclimate (Dettinger and Cayan 2014; Sturrock et al. 2015). As a whole, California's inter-annual precipitation and subsequent streamflow are much more variable than the remainder of the United States, including other parts of the West Coast (Dettinger et al. 2011). Populations must contain the diversity (genotypic and

			phenotypic) to be able to be successful in variable hydrologic regimes, and maintaining population diversity is necessary for stabilizing ecosystem services (Schindler et al. 2010). There is clear evidence that different migratory phenotypes (e.g., fry, parr, and smolts) of Chinook salmon from the LSJR watershed contribute to the adult spawning population differentially, depending on, in part, the annual hydrologic conditions (Sturrock et al. 2015). The inability to predict which juvenile phenotype will be the most successful in any given year requires the flow management to support the entire range of phenotypes as best as possible.
Appendix K	18	Lower San Joaquin River Flows; February through June; 800 to 1200 cfs minimum flow rate at Vernalis: "Notwithstanding the above unimpaired flow requirement, a minimum base flow value between 800 – 1,200 cfs, inclusive, at Vernalis shall be maintained at all times during February through June."	As the San Joaquin River Restoration Program comes on line, upper SJR base flows, independent of east-side tributary flow, will increase. As currently written in the WQCP, it would be possible for the base flows to be met by main stem SJR flow only with little to no flow coming out of the SJR tributaries. The flow objectives should be designed to preserve the river flow from each tributary in addition to the upper SJR.
Appendix K	19	Export Limits_Apr. 15th through May 15th	Note: Footnote No. 17, for export limits, identifies that the Executive Director has the authority to grant deviations for purposes of conducting short (undefined length) export recirculation studies. The wording in footnote 17 should be amended to include not only feasibility but also "biological (or ecological) efficacy" so that whatever study is conducted looks at a larger suite of beneficial uses rather than only focusing on feasibility.
Appendix K	28	By 2022, the State Water Board will fully implement the February through June LSJR flow objectives through water right actions or water quality actions, such as Federal Energy Regulatory Commission (FERC) hydropower licensing processes.	Other requirements initiate within 180 days of OAL approval. It is unclear how these other STM related efforts would work if full implementation would not occur until 2022. For instance, it is likely that each tributaries' implementation would be staggered, based on the timing of permit renewals, etc. Suggest adding clarifying language to ensure phased implementation could occur regardless of when full implementation is in effect.

Appendix K	28	"implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods."	The language should clarify how minimum health and safety will be accounted for in the Annual Operations Plan.
Appendix K	28	Implementation of Feb through June LSJR Flow Objectives (3rd paragraph)..."When implementing the LSJR flow objectives, the State Water Board will include minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife or, if feasible, on other beneficial uses."	The State Water Board should identify the minimum carryover storage targets or define the process by which that would occur. To guarantee the implementation of minimum carryover storage, the requirements should be an objective in Table 3. A "tbd" can be inserted until the objective is numerically defined and included as a footnote for how, where, when the objective will be defined. At a minimum, the water quality objective should be a narrative objective, e.g., "Minimum reservoir carryover storage shall be maintained, as feasible, to minimize impacts to water quality conditions and other beneficial uses outside of the February to June period, e.g., cold water storage."
Appendix K	29	Flow Requirements for February through June; First paragraph: "The required percentage of unimpaired flow does not apply to an individual tributary during periods when flows from that tributary could cause or contribute to flooding or other related public safety concerns, as determined by the State Water Board or Executive Director through consultation with federal, state, and local agencies and other persons or entities with expertise in flood management."	The SED should clarify how flood prevention releases will be apportioned to each beneficial use in the "block of water" accounting.

Appendix K	30	a) The required percent of unimpaired flow may be adjusted to any value between 30 percent and 50 percent, inclusive. The Executive Director may approve changes within this range on an annual basis if all members of the Stanislaus, Tuolumne, and Merced Working Group (STM Working Group), described below, agree to the changes.	Based on the proposed membership of the STM, it is very unlikely that all members would agree to an adjustment up or down from 40% UIF. Suggest that there is an alternative path based on evaluating implementation against biological goals or some other SWRCB evaluation process.
Appendix K	31	Adaptive Methods for February through June Flows (sub-section C): "...If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. The Executive Director may approve changes on an annual basis if the change is recommended by one or more members of the STM Working Group.	Note: if water is banked, then this water should be accounted for as storage, and protected against loss (i.e., either due to flood control releases and/or evapotranspiration) and be available for release per the STM group. The governance for how the STM working group will operate is not specifically identified in this version of the SED; the Department suggests the addition of clarifying language of the STM working group.
Appendix K	32	The State Water Board will establish a STM Working Group to assist with the implementation, monitoring and effectiveness assessment of the February through June LSJR flow requirements.	Suggest that the language is clear that the SWRCB either facilitate the STM Working Group or provides a facilitator. This will help in ensuring a productive working group.
Appendix K	32	The State Water Board will seek participation in the STM Working Group by the following entities who have expertise in LSJR, Stanislaus, Tuolumne, and Merced Rivers fisheries management, hydrology, operations, and monitoring and assessment needs: the DFW; NMFS; USFWS; and water users on the Stanislaus, Tuolumne, and Merced Rivers.	This is a significant unfunded mandate for the Department. The Department will need a representative on the STM, as well as the high likelihood that subgroups will be established for each tributary that would require Department participation.

Appendix K	32	Stanislaus, Tuolumne, and Merced Working Group, 2nd paragraph: "The State Water Board will seek participation in the STM Working Group by the following entities who have expertise in LSJR, Stanislaus, Tuolumne, and Merced Rivers fisheries management, hydrology, operations, and monitoring and assessment needs: the DFW; NMFS; USFWS; and water users on the Stanislaus, Tuolumne, and Merced Rivers. The STM Working Group will also include State Water Board staff and may include any other persons or entities the Executive Director determines to have appropriate expertise. Subgroups of the STM Working Group may be formed as appropriate and State Water Board staff may also initiate activities in coordination with members of the STM Working Group."	Note: while the entities that will comprise the STM working group have been identified, the number of individuals representing each organization and how this group will operate (e.g., majority rule) has not been identified. It is recommended that the number of representatives per entity is limited, that a rotating chairperson be appointed annually, and that rules for governance be established according to applicable state and federal law (e.g., Brown Act etc.). It should be stated that the STM working group is to be comprised of individuals possessing relevant scientific expertise to enable the STM working group to make scientifically informed recommendations and decisions.
Appendix K	33	The State Water Board will consider approval of the biological goals within 180 days from the date of the Office of Administrative Law's (OAL) approval of this amendment to the Bay-Delta Plan	This is a short time period to provide biological goals for consideration by the Board. By generally stating biological goals for salmonids, there could be conflicting biological goals due to the flows only being quantified in the Feb-Jun time period. The SWRCB should clarify what the overarching implementation goal is for this effort to ensure the biological goals are useful for meeting the overarching goal (e.g., the support of all native species).
Appendix K	33	Implementation of the unimpaired flow requirement for February through June will require the development of information and specific measures to achieve the flow objectives and to monitor and evaluate compliance.	Clear direction should be provided to ensure a mechanism is in place for the appropriate monitoring requirements to provide a full evaluation of the overall implementation. This should include any monitoring to evaluate the biological goals approved by the Board.

Appendix K	33	Unimpaired Flow Compliance: "Implementation of the unimpaired flow requirement for February through June will require the development of information and specific measures to achieve the flow objectives and to monitor and evaluate compliance."	Notes: the verbiage states that "...development of information and specific measures to achieve the flow objectives and to monitor compliance" however, no specifics or examples are provided. The Department suggests that the SED provide the examples of measures to achieve flow objectives.
Appendix K	34	The STM Working Group or members or subsets of the STM Working Group, as appropriate, will be required to submit proposed annual plans for adaptive implementation actions (annual operations plans) for the coming season by January 10 of each year for approval by the State Water Board or Executive Director.	The Annual Operations Plan will need to be a "working plan" since forecast used for the January 10th Plan will not be accurate.
Appendix K	34	The STM Working Group or members or subsets of the STM Working Group, as appropriate, will be required to submit proposed annual plans for adaptive implementation actions (annual operations plans) for the coming season by January 10 of each year for approval by the State Water Board or Executive Director.	Notes: this is ambiguous as currently written given that up to three entities (STM working group, STM members, or sub-sets of the STM working group, etc.) could be required to provide an annual plan. To facilitate effective, and efficient, planning, and implementation, only one entity should be required to submit an annual plan. The WQCP should identify the specific entity that will be required to submit the plan.

Appendix K	35	San Joaquin River Monitoring and Evaluation Program	General comments: 1) a monitoring plan should have an overarching purpose. In this case, monitoring should be conducted to i) document WQCP objective compliance, ii) further refine WQCP objectives, iii) guide adaptive management, and iv) guide monitoring activities (i.e., identify if existing monitoring is sufficient). The expressed intent of monitoring is to ensure that tangible substantive progress towards achieving the overarching WQCP objective is being achieved, and if not, why not. Thus, the WQCP should include the overarching objective of creating and implementing a monitoring and evaluation program; 2) a date should be specified as to when the plan should be completed by; 3) an entity should be identified for plan preparation. Since the SWRCB will include monitoring as water right terms/conditions, perhaps they write the plan with STM working group assistance. If not, then perhaps the STM working group is charged with plan completion with the Board incorporating monitoring terms/conditions in to the permits they issue.
Appendix K	36	To inform the next year's operations and other activities, the State Water Board will require preparation and submittal of an annual report to the State Water Board by December 31 of each year.	Please clarify which entities will be required to prepare and submit these reports.
Appendix K	36	Additionally, every three to five years following implementation of this update to the Bay-Delta Plan, the State Water Board will require preparation and submittal of a comprehensive report that, in addition to the requirements of annual reporting, reviews the progress toward meeting the biological goals and identifies any recommended changes to the implementation of the flow objectives.	Please clarify which entities will be required to prepare and submit these reports.

Appendix K	40-52	B. Measures Requiring a Combination of State Water Board Authorities and Actions by Other Agencies	Many waterways in the LSJR and Delta are currently identified as being impaired by salinity related impairments (e.g., electrical conductivity, total dissolved solids, or specific conductivity) (Table 2, Attachment 1). In addition, the Central Valley Regional Water Quality Control Board has recently approved the addition of more LSJR and Delta waterways to the new impaired water list due to salinity impairments (Table 2). The diversion of water from rivers effectively reduces the assimilative capacity of the rivers to incorporate salt, as well as other contaminants, and causes adverse impacts to other beneficial uses. Water rights conditions in the LSJR watershed should require the implementation of salinity water quality standards to protect the appropriate beneficial uses until the necessary salt load reductions are implemented (e.g., through CV-SALTS or other control program). Two other identified impairments in the LSJR and Delta waterways, water temperature and dissolved oxygen, may be alleviated by increasing streamflow in these environments. The SED clearly presents benefits of reduced water temperature conditions in the watershed from increased %UIF remaining in the rivers. This inverse relationship is, in part, a function of the water's residence time. Increased residence time allows for the water to assimilate heat units, thereby increasing temperature. In addition, increased residence time in water bodies allows an increase in biochemical oxygen demand, thereby decreasing dissolved oxygen (Gowdy and Grober 2005; NCRWQCB 2006). Reduced flow in the San Joaquin River has specifically been identified as a major contributor of low dissolved oxygen in the Stockton Deep Water Ship Channel (Gowdy and Grober 2005). Increased flow from the LSJR tributaries through the Delta may result in improved dissolved oxygen conditions in the Stockton DWSC and other impaired Delta waterways. Furthermore, the State Water Board has the authority to develop pollutant control programs to benefit Bay-Delta water quality (e.g.,

			through amendments to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bay, and Estuaries of California). The evaluation of the interactions of pollutant discharges and hydromodification on fish and wildlife, drinking water, agricultural resources, etc. beneficial uses may result in a more robust analysis of the necessary coordinated water rights and pollutant control actions necessary to protect all beneficial uses.
Appendix K	52	San Joaquin River Dissolved Oxygen Objective	Dissolved oxygen objectives (6 mg/L) in the Stockton DWSC were developed to be barely adequate to allow salmonid passage during fall-run adult migration. The studies cited in the DO TMDL suggested that there are still impediments to fish biology and behavior at 6 mg/L. Much of the literature suggests that salmonid species need a minimum of 8 mg/L DO to prevent adverse impacts. In addition, the WQO of 6 mg/L only applies to the months September to November. ESA listed species (e.g., spring-run, steelhead, and green sturgeon) migrating through the DWSC outside of this time window could be subjected to even lower levels of DO, thus the WQOs are not fully protective. Likewise, many of the waterways and possible migratory corridors in the southern Delta are listed from DO impairments. The Stockton DWSC DO TMDL determined the 3 factors that contributed to the DO impairments in the Stockton DWSC were channel geometry, nutrient and BOD inputs, and increased residence time. Flow from the LSJR is directly related to the residence time in the Stockton DWSC and the southern Delta. The SWRCB should evaluate the necessary flow to provide the required residence time and DO conditions to support all life stages and species that rely on the Stockton DWSC and other Delta waterways.

Appendix K	55	Recommendations to other Agencies - Review and modify, if necessary, existing commercial and sport fishing regulations	General comments: 1) commercial fishing was completely shut down (through regulations) during the last salmon population crash, creating immense economic impacts to commercial fishermen; however, SJR diversions were not reduced during this same time. 2) The CDFW, CF&GC, PFMC, and NOAA have been and are continuing to review and modify fishing regulations.
Appendix K	55		section 1 and 2 needs updating of information and acronyms
Appendix K	56		section 3 and 4, needs updating of information and acronyms
Appendix K	58		section 8, needs updating of information and acronyms
Appendix K	62	San Joaquin River Non-Flow Actions - ix. Reduce Predation and Competition by Non-native Fish	As currently written, it is assumed that non-native predators are having an impact on anadromous salmonids; however, the impact is not defined. Since the impact is not defined there is currently no metric to measure any impact or "reduction" of impact. This section should be changed to evaluate what, if any, population level impact(s) non-native predators are having upon anadromous salmonids. If a population level impact is occurring, and the contributing factors have been identified, then impact reduction can be considered. In addition, the Department suggest that all studies and hypotheses that have bearing on this plan or the implementation of objectives of this plan be passed through the independent science board, as called for in earlier sections regarding changes in flow and non-flow management.
Appendix K	17 to 21	Table 3.	Fish and Wildlife beneficial uses (Table 3) are the only beneficial uses where flows are included as a parameter. This implies that flows are only being used to enhance fish, when in reality flows are also being used to improve all water quality parameters (e.g., EC and DO) for all beneficial uses in the LSJR and Delta. Most importantly, increased flows improve water quality for municipals and agriculture in the LSJR and Delta, as such, flows should be included as a parameter for these beneficial uses.

Appendix K	36-37	Voluntary agreements may include commitments to meet the flow requirements and to undertake non-flow actions. If the voluntary agreements include non-flow actions recommended in this Plan or by DFW, the non-flow measures may support a change in the required percent of unimpaired flow, within the range prescribed by the flow objectives, or other adaptive adjustments otherwise allowed in this program of implementation.	Non-flow measures may be able to create the environmental conditions that can support the needs of fish and wildlife, in lieu of some additional flow. However, the efficacy of these substitutions should be measured against the attaining of biological goals, environmental goals, or other appropriate metric.

Appendix K	45-48	.vii. The Central Valley Regional Water Board shall regulate impose discharge controls on in-Delta discharges of salts by agricultural, domestic, and municipal dischargers consistent with applicable state and federal law, including, but not limited to, establishing water-quality based effluent limitations and compliance, monitoring and reporting requirements as part of the reissuance of National Pollutant Discharge Salt and Boron in the Lower San Joaquin River… CVRWQCB Salt and Boron TMDL BPA (Pg 13) 1. The State Water Board should consider the continued use of its water rights authority to prohibit water transfers if the transfer contributes to low flows and related salinity water quality impairment in the Lower San Joaquin River. 2. The State Water Board should consider the continued conditioning of water rights on the attainment of existing and new water quality objectives for salinity in the Lower San Joaquin River, when these objectives cannot be met through discharge controls alone.	CVRWQCB Basin Plan and implementation programs suggest that the State Board should use their authority to improve salinity conditions. The State Board proposes in this plan amendment for the CVRWQCB to use their authority to improve salinity conditions. Both entities rely on the other to fix the conditions. A combined evaluation of the impact of salt discharges and water diversions comprehensively to determine the impacts from interactions of both alterations to the aquatic environment may help to develop a more robust regulatory program to improve salinity conditions. As mentioned in previous comments, many more impairments (e.g., temperature, electrical conductivity, dissolved oxygen, and pesticides) could be alleviated by increasing flow in the LSJR watershed.
Appendix K	59	Non-flow Actions	The Department believes that both improvements in the flow regime and non-flow actions are necessary in the LSJR and tributaries to recover native species. The flow actions should be coordinated with the non-flow restoration actions to maximize the benefits to the aquatic ecosystem. The data suggests that non-flow actions alone will not provide the

			necessary habitat benefits to recover anadromous salmon populations. Likewise, it is critical that improvements to the LSJR tributaries flow regimes are coordinated with additional non-flow actions to provide water quality and habitat improvements to recover native populations.
Appendix K	62-63	Section 10 ix.	The Department suggests that all studies and hypotheses that have bearing on this plan or the implementation of objectives of this plan be passed through the independent science board, as called for in earlier sections regarding changes in flow and non-flow management.
Appendix K	69, 70, 71	E. Other Studies conducted by agencies that may provide information relevant to future proceedings	These 3 pages appear to be outdated and need updating of information and acronyms.
Appendix K	Throughout	DFG Throughout Appendix.	DFG is now DFW.
Throughout		Use of the term 'smoltification.' Smoltification is not a real word.	Recommend change to 'smolting' throughout the report.
Throughout		Use of the term 'outmigration.'	Change to 'emigration', a recognized ecological term for outward movement from an area.

Attachment 4

CDFW Memorandum Regarding SalSim

San Joaquin River Fall-run Chinook Salmon Simulation Model (SalSim) Update

By

California Department of Fish and Wildlife

March 2017

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Executive Summary

The development of SalSim originated from a question that the State Water Resources Control Board (State Water Board) asked of the California Department of Fish and Wildlife (Department) in a 2005 workshop to update their 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). The question was basically: How much water is necessary to protect San Joaquin River juvenile emigrating fall-run Chinook salmon smolts? This question motivated the Department to develop a model focused on salmon production in the San Joaquin River and tributaries. Originally developed in Microsoft Excel, the model evolved over time and through responses to peer reviews to become SalSim; accessible via the internet (www.salsim.com) and publicly released in June 2013.

SalSim is a full lifecycle fall-run Chinook salmon (*Oncorhynchus tshawytscha*) population simulation model for the lower San Joaquin River (SJR) and its salmon bearing tributaries, the Merced, Tuolumne and Stanislaus rivers. SalSim has two versions: an internet based version (SalSim) and a desktop version (SJRSim). SalSim contains three sub-models that include: i) water operations involving reservoir inflow, storage, and outflow (both diversion and river); ii) water temperature response as a function of reservoir storage and release temperature, ambient air temperature, and instream flow level; and iii) salmon production response, for both natural and hatchery production (including adult spawning, egg incubation, juvenile rearing and emigration, adult contribution to ocean fisheries, and adult immigration). In addition, SalSim provides the ability to predict a salmon production response using imported water temperature and flow data from external models (e.g., HEC-5Q or CALSIM), if more precise water temperature and flow estimates are necessary. SJRSim contains only the salmon production response portion listed above, and for scenarios utilizing modified flows and temperatures requires imported flow and temperature data.

SalSim was not widely used until 2016 when the State Water Board staff utilized it to evaluate flow alternatives as part of their revised Substitute Environmental Document (SED) for Phase 1 of the Bay-Delta Plan update. Resulting from that use, the State Water Board staff informed the Department that their SalSim modeling results appeared flawed and illogical. Through investigating the State Water Board's SalSim modeling results and the mathematical functions in SalSim, the Department determined that parameter values in equations for egg, alevin, and juvenile survival, were in error. In combination these errors produced excessively high egg and alevin mortality during warmer water flow events, and juvenile survival that was not sensitive to river temperatures once flows exceeded about 450 cubic feet per second (cfs).

In response, the Department revised the SJRSim model, correcting the parameter values for these equations so that temperature responses for all life stages were more logical and better aligned with United States Environmental Protection Agency (USEPA) temperature guidelines. In addition, the Department also modified the juvenile downstream movement function so that

downstream movement is more variable, better reflecting the trend observed in empirical data derived from juvenile emigration timing and survival studies. The Department only modified SJRSim because only SJRSim provides the user access to the various parameter values without reprogramming or coding. Modification to SalSim would require the services of an external contractor. In addition, the Department has been periodically re-calibrating the SJRSim adult return estimates utilizing the model's fry density dependent survival functions for each river, so it is the model with the most up to date calibration.

The Department is providing this information to the State Water Board for use and consideration as it continues its Bay-Delta Plan update. Use of SJRSim, and any results, should be considered preliminary until a review of this revised desktop model has been conducted by the United States Bureau of Reclamation's SJRSim model developer. SJRSim is publicly available by request to the Department.

Abbreviated SalSim History (aka Why SalSim)

SalSim is a life-history population simulation model for fall-run Chinook salmon originating from the San Joaquin River (SJR) and its upper three east-side salmon bearing tributaries (Stanislaus, Tuolumne, and Merced rivers). The impetus for developing SalSim came about in 2005 when Department staff testified before the State Water Board regarding the need for increased flow during State Water Board workshops being conducted to update their 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. During Department testimony, the State Water Board asked the simple question, how much water is necessary to protect San Joaquin River juvenile emigrating fall-run Chinook salmon smolts? This question provided the motivation to develop a model focused on salmon production in the San Joaquin River and tributaries. The original SJR salmon model was initially developed using a Microsoft Excel spreadsheet platform and primarily focused on juvenile survival through the Delta. The model evolved over several years, funded by many grants, to become what is now SalSim, which is an internet accessible model. In December 2012, the Department conducted a peer review with a panel of independent experts at UC Davis (Anderson et al. 2012). In response to the peer review, SalSim was calibrated then released to the public in June 2013. SalSim's release included both a model development document (Dotan 2014) and a user's manual (CDFW 2013). Both the model document and user's manual are available for download at www.salsim.com.

What is SalSim

SalSim is a self-contained model containing three sub-models functioning together as one overall model, which includes the following:

i. A water operations model that accounts for water movement into and out of the lower rim dam reservoirs on the mainstem San Joaquin River (Friant) and the principal east-side tributaries including the Stanislaus River (New Melones), the Tuolumne River (New Don Pedro), and the Merced River (New Exchequer);

ii. A water temperature model that predicts both reservoir release and downstream river water temperature response as a function of reservoir storage, ambient air temperature, and reservoir inflow-storage-release patterns. The model predicts water temperature responses for the lower reaches of each tributary and the entire mainstem of the SJR from Friant downstream to Mossdale; and

iii. A salmon production model, which predicts salmon abundance beginning with the egg stage and extends through the entire salmon life cycle to adults returning inland to spawn two to four years later.

When more precise salmon production estimations are desired, given the linkage in SalSim between water temperature and fish production, SalSim was developed with the ability to import flow and temperature data files from other models such as the Department's HEC-5Q hydrologic model of the San Joaquin River basin. The overall computational flow of the model is shown in Figure 1.

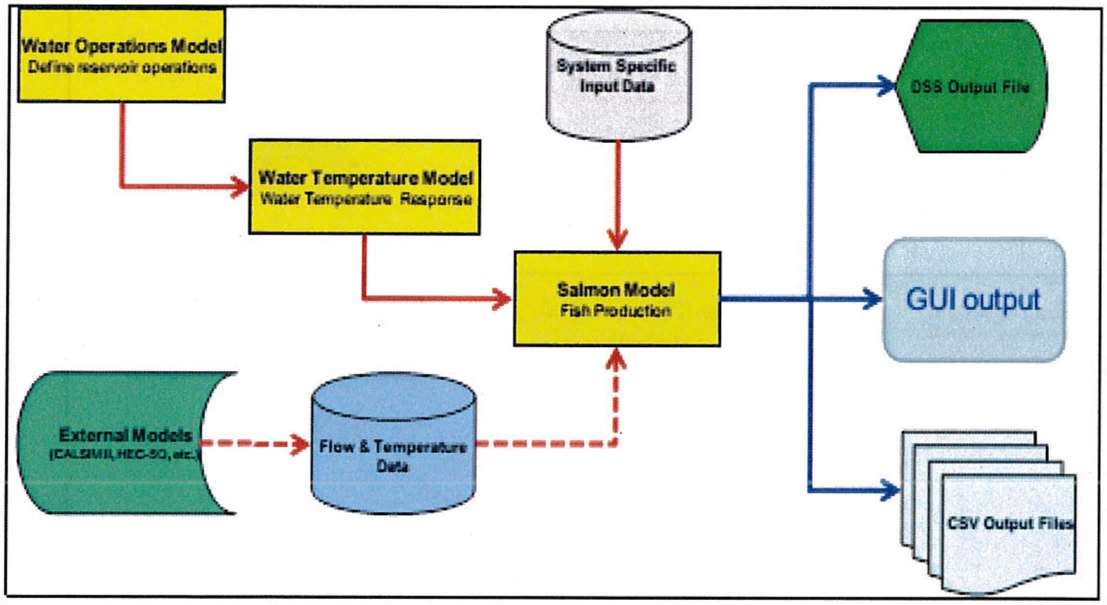

Figure 1 SalSim Package Design

SalSim includes the three ecosystems (inland, Delta, and ocean) that comprise the fall-run Chinook salmon's habitat over its full life cycle. These ecosystems overlap with the model's five modules. Each module simulates salmon production based on physical and environmental conditions. The connections between these modules are illustrated in Figure 2 below.

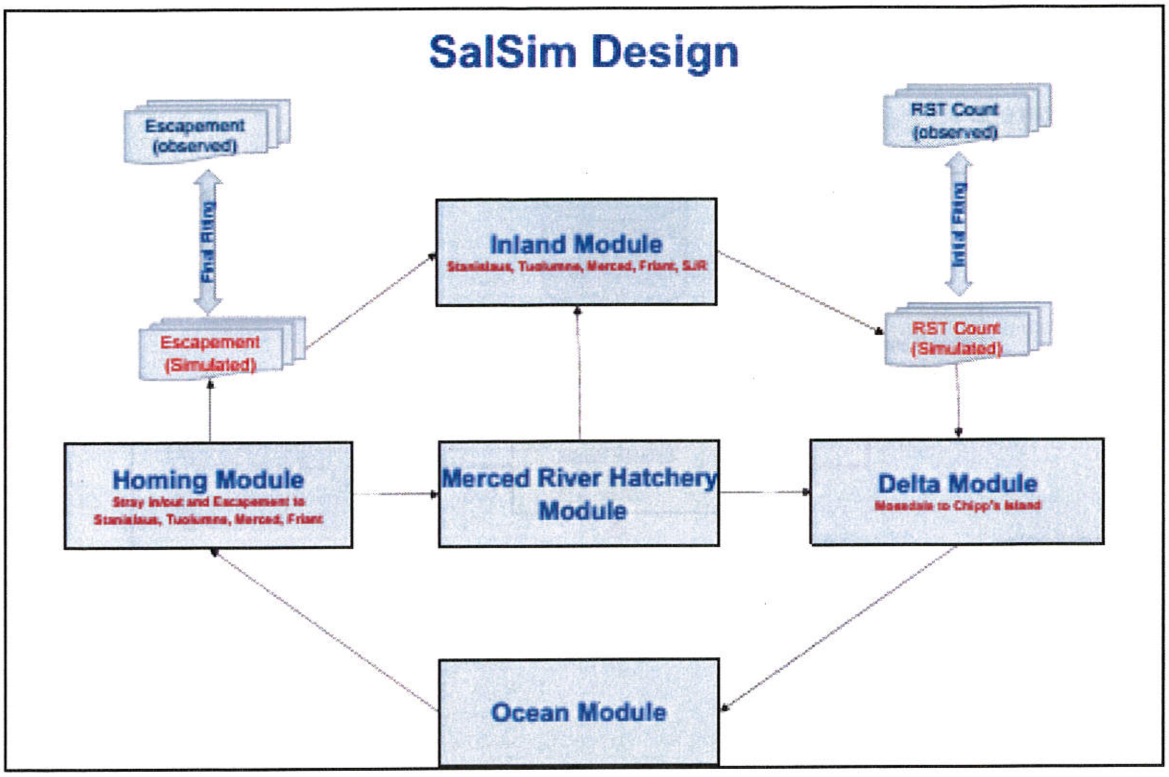

Figure 2 Connections between SalSim Modules

SalSim Applied (aka Errors Identified)

While SalSim was released to the public in 2013, it was not "put to the test" until 2016 when used by the State Water Board staff. In the process of being used by the State Water Board staff as part of the revised Substitute Environmental Document (SED) for Phase 1 of the Bay Delta Water Quality Control Plan update, illogical results were discovered. Through investigating the State Water Board's SalSim modeling results and the mathematical functions in SalSim, the Department determined that parameter values in equations for egg, alevin, and juvenile survival, were in error. In combination these errors produced excessively high egg and alevin mortality during warmer water flow events, and juvenile survival that was not sensitive to river temperatures once flows exceeded about 450 cubic feet per second.

Mathematical Corrections

The Department evaluated the equations and the associated parameter values for egg, alevin, and juvenile survival and juvenile downstream movement. The following sections outline the changes made to the various equation parameters and show comparisons between the original equation results and the revised equation results.

Egg and Alevin Survival

SalSim uses the following equation to determine daily egg and alevin survival:

$$Probability(Survival) = Expit(b(T-a))Expit(d(Q-c))$$

Where 'a' through 'd' are parameters relative to temperature and flow, 'T' is the temperature in degrees Celsius, and 'Q' is the flow in cubic feet per second. Table 1 shows a comparison of original parameters alongside revised parameter values.

Table 1 Egg and Alevin Survival Parameters

Variable or Parameter	Description	Egg Value		Alevin Value	
		Original	Revised	Original	Revised
a	Parameter for temperature, 50% survival point.	13.56	15.439	15.0114	17.145
b	Parameter for temperature slope.	-2.64718	-2	-1.22721	-1.75
c	Parameter for flow survival, 50% survival point.	52.5133	28.7	-188.726	-134.6
d	Parameter for flow slope.	0.0287344	1.075	0.0104744	0.0234
T	Variable for Temperature (°C) at the redd location.	Varies	Varies	Varies	Varies
Q	Variable for Flow (cfs) at the redd location.	Varies	Varies	Varies	Varies

The graphs in Figure 3-Original and Revised Egg and Alevin Survival Functions below compare the survival probability for eggs and alevin between the original survival curves in blue and the revised parameter curves in red. The original parameters resulted in excessive mortality when considering multi-day survival. The revised parameters allow the functions to better reflect empirical multi-day temperature-survival relationships.

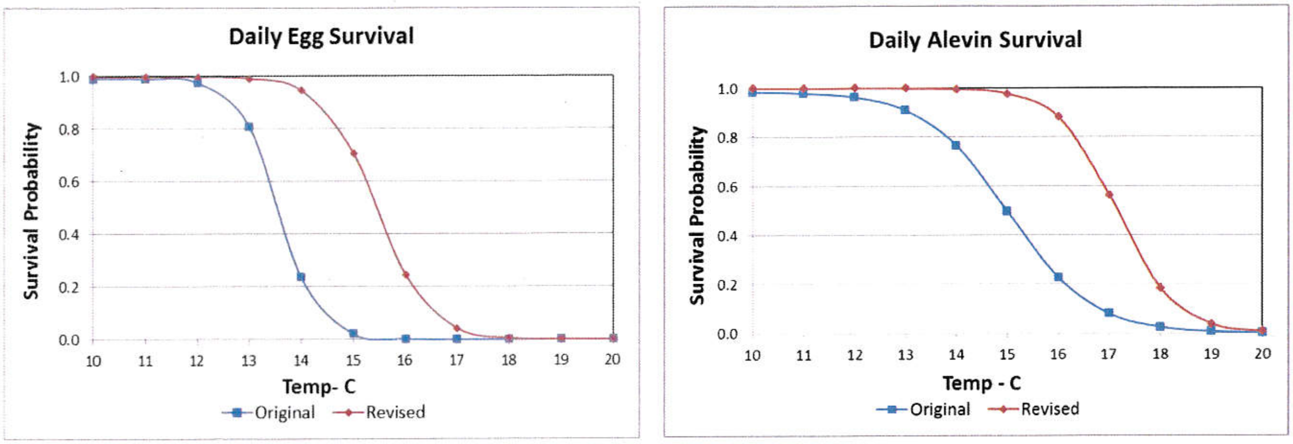

Figure 3 Original and Revised Egg and Alevin Survival Functions

In SalSim, eggs exposed to a constant 14°C suffer 100 percent mortality within five days (Figure 4, blue lines). The revised equations (red lines) more appropriately consider survival related to exposure (e.g., for eggs at the same 14°C exposure, mortality would be 80 percent after thirty days). Similar results are obtained with alevin, except at 15°C. Egg and alevin survival curves for 14°C and 15°C exposures, respectively, are shown in Figure 4-Egg and Alevin Survival Curves.

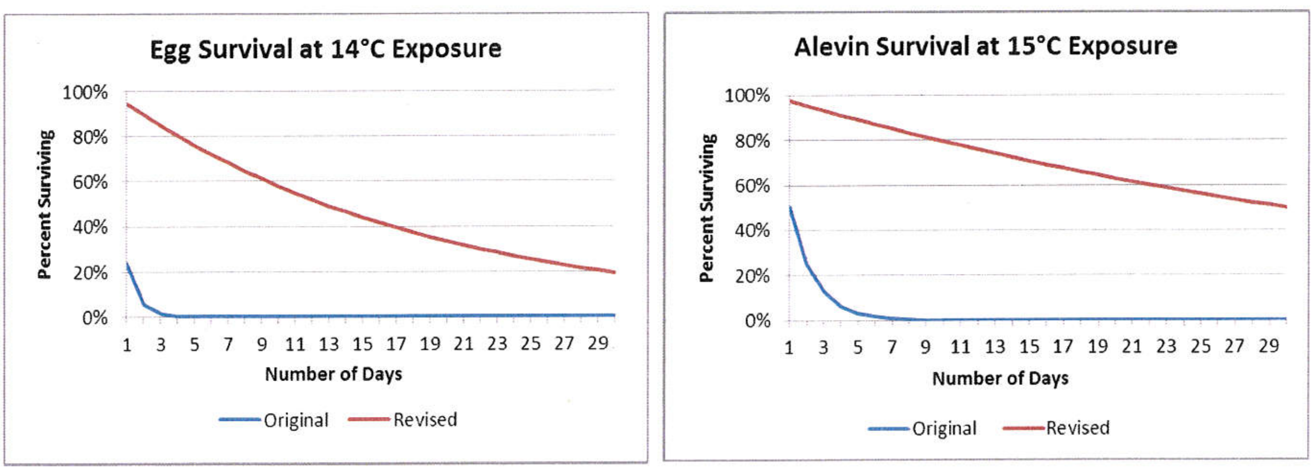

Figure 4 Egg and Alevin Survival Curves

Juvenile Survival

There are two juvenile survival equations affecting juvenile salmon populations prior to entering the Delta, which are density independent and density dependent. The **density independent equation** considers fish length, river temperature and flow parameters and calculates juvenile survival probabilities for the fry, parr, and smolt life stages. This equation is show below:

Density Independent:

$$Probability\ (Survival) = \frac{1}{(1+\exp(-(a+bT+cQ+dL+eTQ+fTL+gQL+hL^2)))}$$

Table 2 Juvenile Density Independent Survival Parameters

Variable or Parameter	Description	SalSim (Original)			Revised Value
		Stanislaus	Tuolumne	Merced	
a	Constant	0	0.02	0.01	21.64
b	Parameter for temperature slope (°C)	-0.23	-0.23	-0.23	-1.346
c	Parameter for flow (cfs)	0.018	0.02	0.02	0.000001
d	Parameter for length (mm)	0	0	0	0.012805
e	Parameter for temp-flow interaction	0	0	0	0.000025
f	Parameter for temp-length interaction	0	0	0	0.001273
g	Parameter for flow-length interaction (cfs*mm)	0.0001	0.0001	0.0001	0.0000001
h	Parameter for length-squared (mm^2)	-0.00001	0	0	-0.0000263
T	Variable for temperature (°C)	Varies	Varies	Varies	Varies
Q	Variable for flow (cfs)	Varies	Varies	Varies	Varies
L	Variable for fish length (mm)	Varies	Varies	Varies	Varies

Table 2 shows a comparison of original parameters for the three tributary rivers alongside revised parameter values, where the original SalSim parameter values for parameters 'd' through 'f' were erroneously set to zero. These values represent our initial attempts to calibrate the model to rotary screw trap estimates, which proved nearly impossible as that data contains such wide confidence intervals. However, as we moved to utilizing adult return estimates as a calibration factor, we mistakenly left these parameters set to zero in the model equation. This oversight caused the density independent survival function to disregard temperature effects once river flows exceeded about 450 cfs. These parameters have been revised, such that they are the same for each river. Results now reflect influences from fish length and river temperature (aligning more with USEPA and literature research temperature

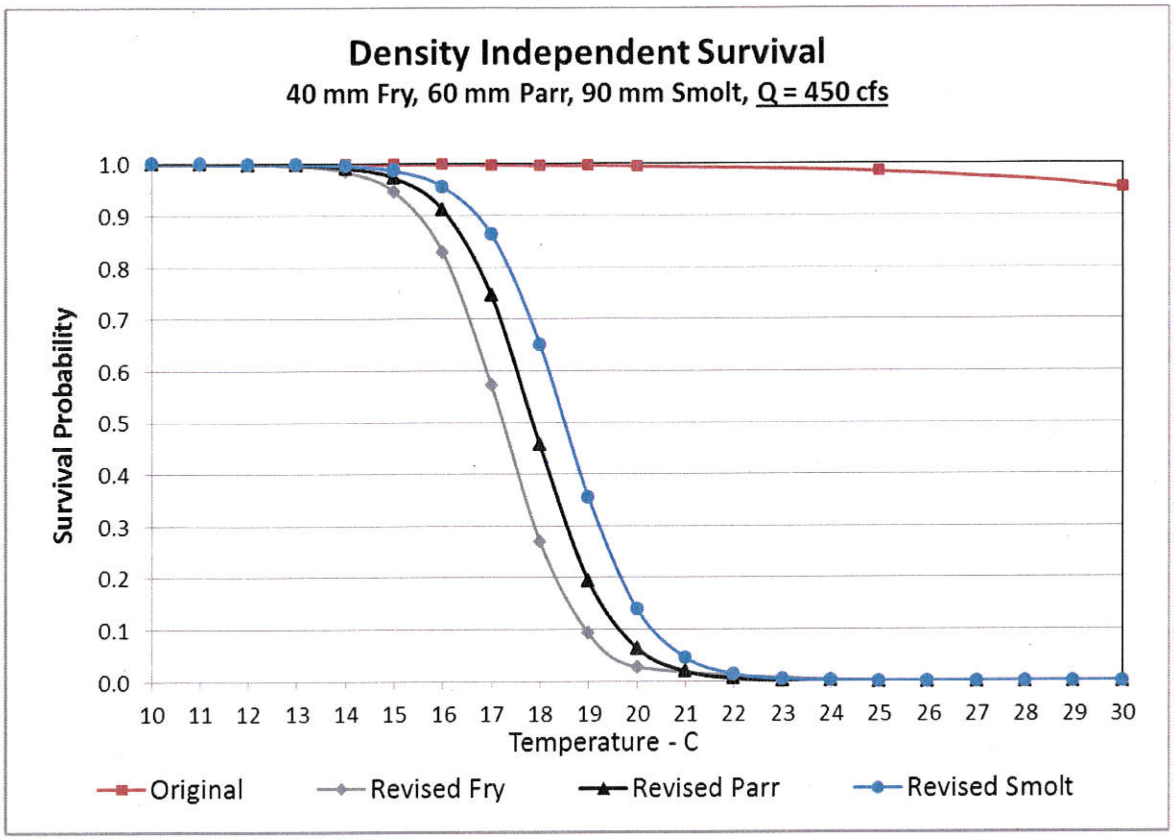

Figure 5 Juvenile Density Independent Survival Function at Flow of 450 cfs

guidelines). Previous results were primarily driven by flow as seen in Figure 5 at a flow of 450 cfs.

At flows around 200 cfs, the flow value does not overly drive survival estimates, and influences from temperature and fish length can be observed (e.g., comparison of Figures 5 and 6 "Original" survival estimates (red lines)). The revised survival probability curves are similar for 200 cfs and 450 cfs using the revised equations. The revised density independent equation produces results that are logical and defensible when considering juvenile salmon responses to temperature, which is critical when considering benefits of increasing flows with the goal of reducing temperatures.

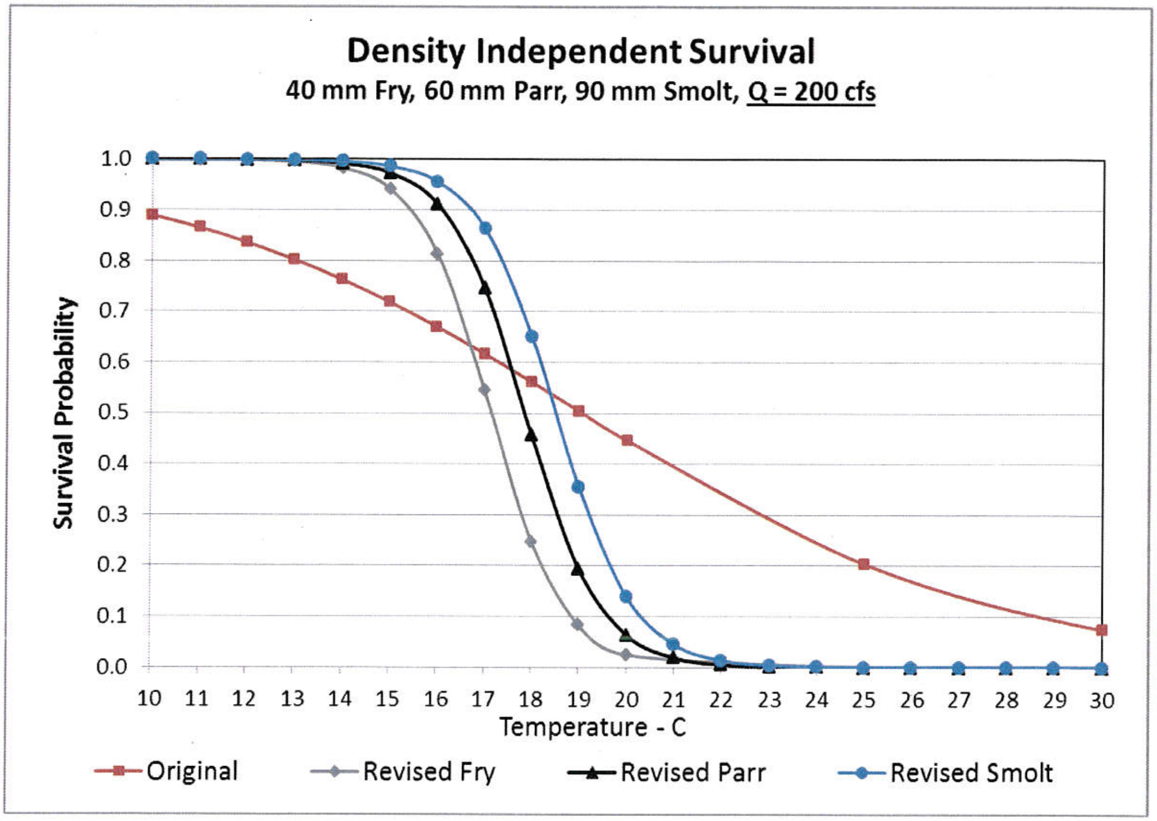

Figure 6 Juvenile Density Independent Survival Function at Flow of 200 CFS

In SalSim, the **density dependent equation** is used to generally reflect fry overcrowding and competition for limited habitat. The abundance of fry habitat, which can differ from river to river or within a river at varying flows, has not been directly measured, thus flow is used as a proxy for habitat. Further, because of this variability, we primarily used this equation to re-calibrate the model (see Re-Calibration Effort section) to adult returns by adjusting the parameters *k1, k2,* and *k3* for each river. The density dependent equation takes the form:

Density Dependent:

$$Probability\ (Survival) = k3 + \frac{1-k3}{(1+\frac{density}{k1})^{k2}}$$

$$\text{Where, } density = \frac{reach\ fry\ count}{reach\ length\ x\ reach\ flow}$$

The parameter values and descriptions shown in Table 3 indicate our most recent effort at calibrating the SJRSim model.

Table 3 Density Dependent Juvenile Survival Parameters

Variable or parameter	Description	Stanislaus	Tuolumne	Merced
k1	Parameter for horizontal shift	350	750	1000
k2	Parameter for slope	0.4	1.6	1.6
k3	Parameter for Function minimum	0.7	0.3	0.7
Density	Density as defined	Varies	Varies	Varies

This results in the probability for fry survival for each of the tributary rivers as shown Figure 7 below.

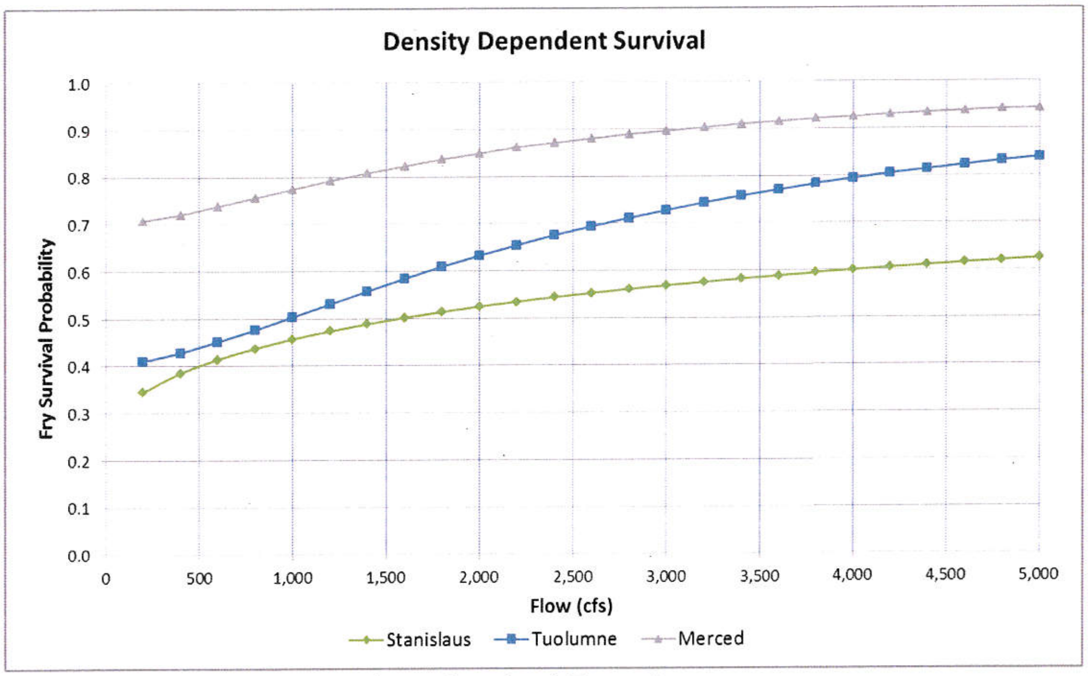

Figure 7 Fry Density Dependent Survival Function

These parameters are justifiable, if the fry carrying capacities are such that the Merced River has greater capacity or habitat than the Tuolumne River, which has greater capacity than the Stanislaus River. If you assume that wider non-incised channels have greater potential for fry carrying capacity, then the Merced River does have greater carrying capacity. This is based on comparing the channel widths at varying flows from 500 to 3,000 cfs for the upper 20 miles of each river using data from the Department's HEC-5Q model for the San Joaquin River Basin. The Department does realize that one cannot accurately model complex habitat, fry density and flow conditions using a simplified equation, but the flow to river channel width comparison does help support these parameter values.

Juvenile Downstream Movement

Juvenile movements are evenly divided into one of three downstream movement classifications (aka movement cohorts), identified as one of slow, medium, or fast downstream movers. We recognize this is a simplistic way of reflecting the fact that downstream juvenile movement varies widely with some fish from a production cohort occupying specific habitat for some time, while members from the same production cohort may move downstream immediately, carried away by stream velocity. We also recognize that when flood plain conditions arise, many thrive within this habitat as long as it persists, and only move downstream as the flows recede. In SalSim, the movement equation considers movement class (slow, medium, or fast), and the model looks at the river for conditions where floodplain habitat might occur. Flood plain habitat estimates are based on cross-sectional data developed by the Army Corps of Engineers for a flood capacity study following the flooding that occurred in 1997. This data is contained within the Department's San Joaquin River Basin-Wide water temperature and EC Model (Dotan et al. 2013), for roughly each mile of each river. The equation determines downstream movement in miles per day and is in the following form:

$$MilesMoved = Max(a_0 + a_1 speedClass + \frac{a_2}{{a_3}^{a_4}} Min((Q, Q_{cutoff})^{a_4} + a_5 inundation, 0)$$

The original and revised parameter values are shown in Table 4.

Table 4 Juvenile Downstream Movement Parameters

		Original Values			Revised
Variable or Parameter	Description	Stanislaus	Tuolumne	Merced	All Rivers
a_0	Constant	0.20	0.20	0.20	0.530
a_1	Parameter for speed class multiplier	0.30	0.30	0.30	0.747
a_2	Parameter for flow component vertical scale parameter	1.50	1.50	1.00	0.90
a_3	Parameter for flow component horizontal scale parameter	2100	2100	1000	3310.00
a_4	Parameter for flow component curvature parameter	0.50	0.60	0.70	0.39
a_5	Parameter for inundation multiplier	-0.01	-0.01	-0.01	-0.006
speedClass	Variable for juvenile speed class (fast=1, med=0 or slow=1)	Varies	Varies	Varies	Varies
Q	Variable for flow at juvenile's current location (cfs)	Varies	Varies	Varies	Varies
Q_{cutoff}	Variable for flow level at which flooding occurs at the juvenile's current location	Varies	Varies	Varies	Varies
Inundation	Variable for level of inundation into the flood plain (flood plain incremental width (ft))	Varies	Varies	Varies	Varies

The movement equation with the parameters identified in Table 4 produces the movement curves for the fast, medium, and slow downstream moving juveniles as shown in Figure 8. The dashed lines indicate the much less variable original movement curves used in SalSim. The revised equation, we believe, represents a more realistic approach that encompasses a broader range of movement among the juveniles, without having empirical data that would indicate a different movement pattern. The peak occurring in each curve around 3,000 cfs is the result of floodplain inundation for a specific river at a specific location, and is a result of when floodplain conditions begin to affect the juveniles' downstream movement.

Re-Calibration Effort

The Department's initial re-calibration effort was done using the desktop version of the model, SJRSim. This version of the model was developed by AD Consultants (part of the original SalSim development team) for the United States Bureau of Reclamation and its work with the San Joaquin River Restoration Program. SJRSim provides access to many of the model's parameters to allow manipulation of equations to conduct "what if" analyses for comparing juvenile survival relative to habitat, since the upper San Joaquin River does not have a recurring

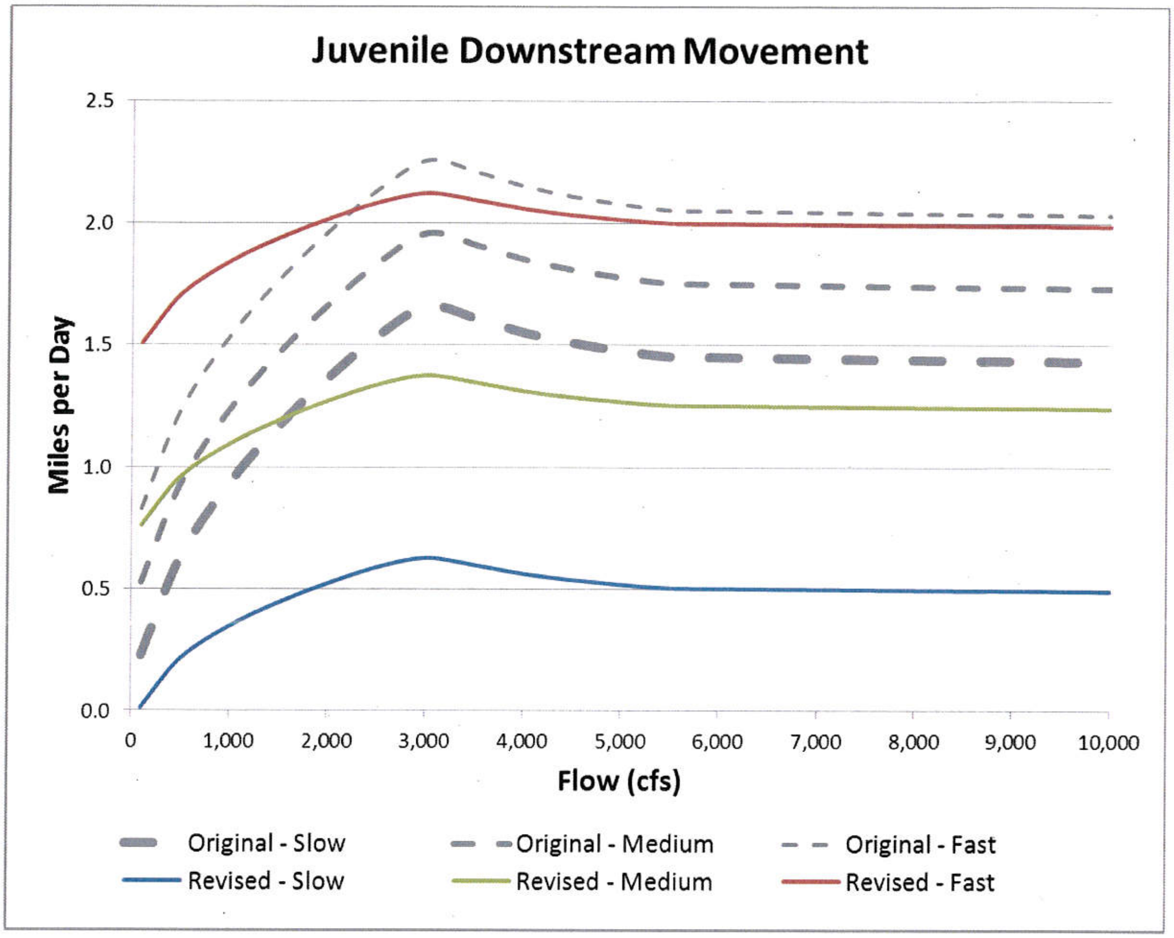

Figure 8 Juvenile Downstream Movement Function

population to establish calibration. Having access to the various parameters allowed the Department to use this model in its initial re-calibration effort. We maintained the same parameter values for all three tributaries (Stanislaus, Tuolumne, and Merced rivers) for egg and alevin survival and juvenile density independent survival, as previously discussed, as these equations are primarily temperature driven. We also kept the movement equation parameters the same for the three rivers, assuming juvenile responses to flow velocity and floodplain conditions to be the same within all three tributaries. We then used the fry density dependent survival equation to vary parameters independently for each river, since this equation considers population and habitat availability in terms of fry density. This is a logical approach given that habitat availability can vary from river to river or within a river due to varying flows.

The following figures show the re-calibrated SJRSim results for each of the three tributary rivers and a total for all rivers. The graphs on the left show the correlation results and include the R-squared regression value that simply provides a "goodness of fit" between historical and simulated data, where a "1" value would indicate that the dependent variable (modeled results) matches exactly the independent variable (empirical escapement estimates) and a zero means there would be no correlation between historical and simulated results. The graphs on the right show comparisons between the historical and simulated adult salmon escapements. It is possible that additional calibration efforts could improve these results.

For the Merced River (Figure 9, with the correlation graph on the left and the historical versus simulated results in the graph on the right):

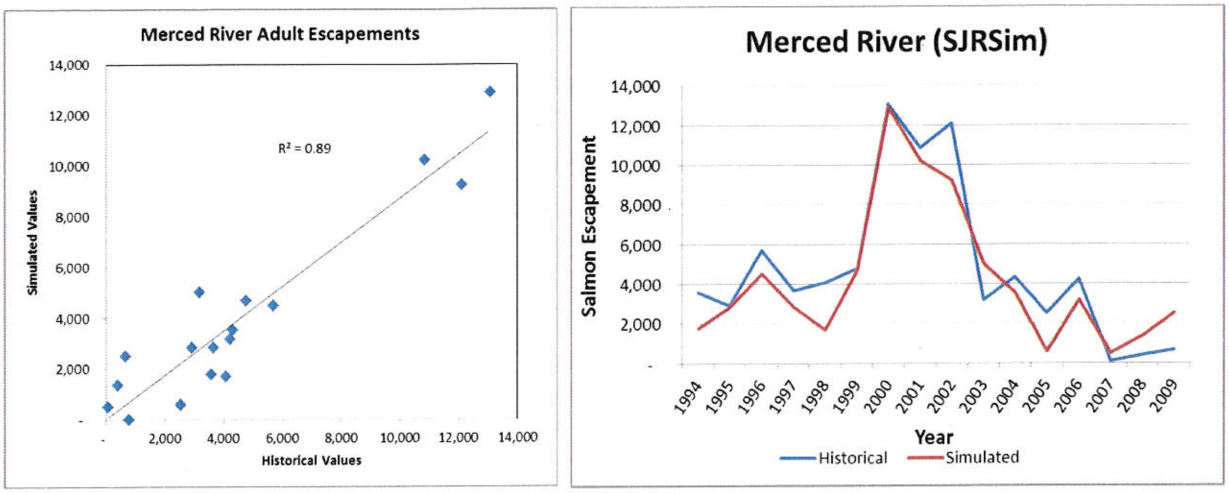

Figure 9 Merced River Re-Calibration (SJRSim)

For the Tuolumne River (Figure 10, with the correlation graph on the left and the historical versus simulated results in the graph on the right):

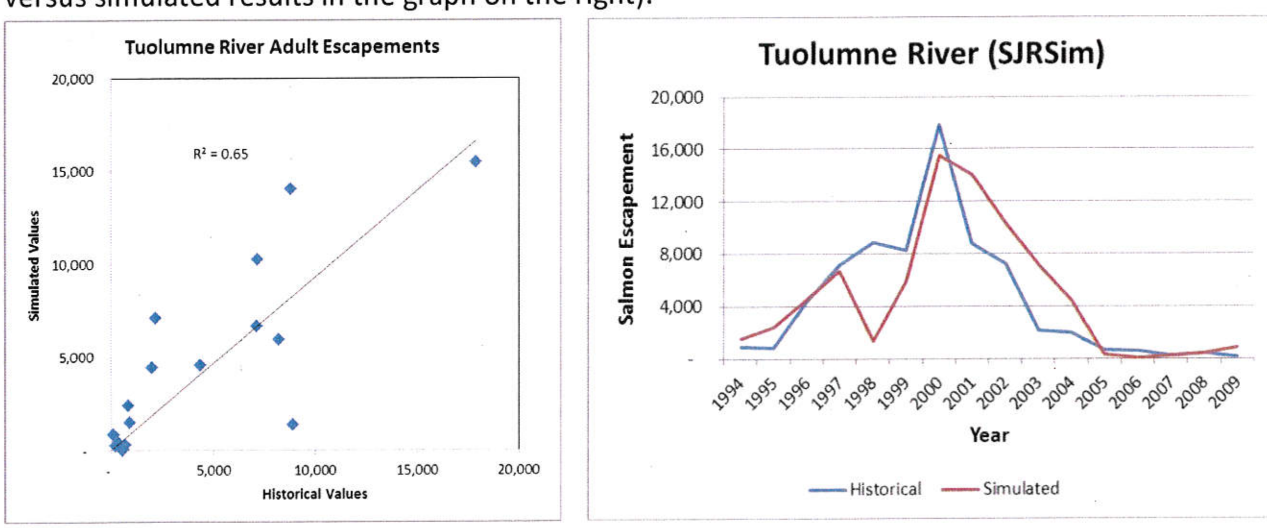

Figure 10 Tuolumne River Re-Calibration (SJRSim)

For the Stanislaus River (Figure 11, with the correlation graph on the left and the historical versus simulated results in the graph on the right):

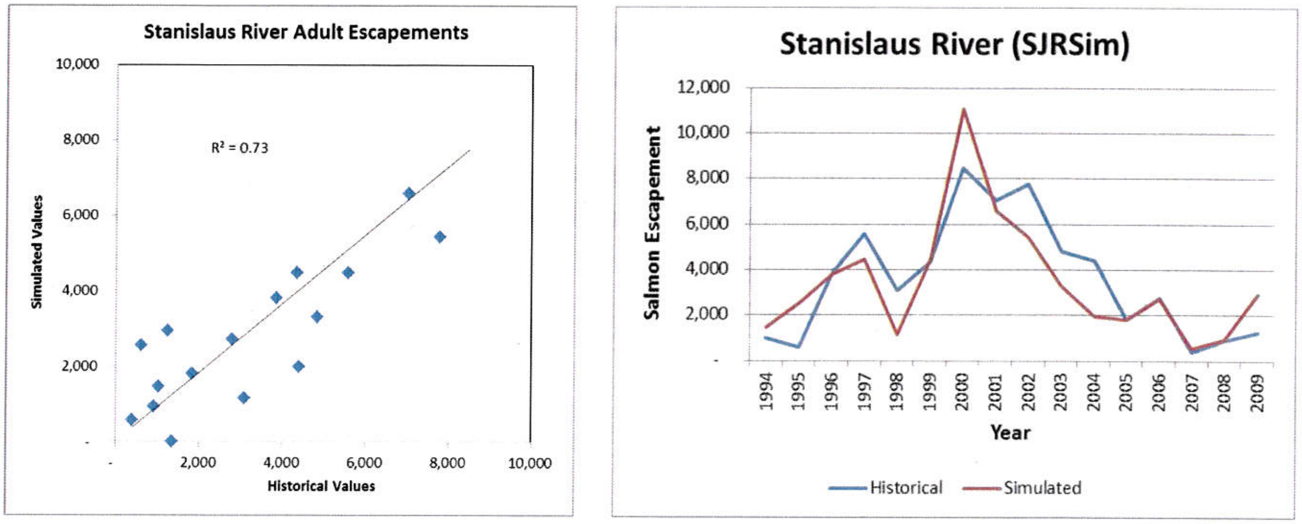

Figure 11 Stanislaus River Re-Calibration (SJRSim)

For all tributaries combined (Figure 12, with the correlation graph on the left and the historical versus simulated results in the graph on the right):

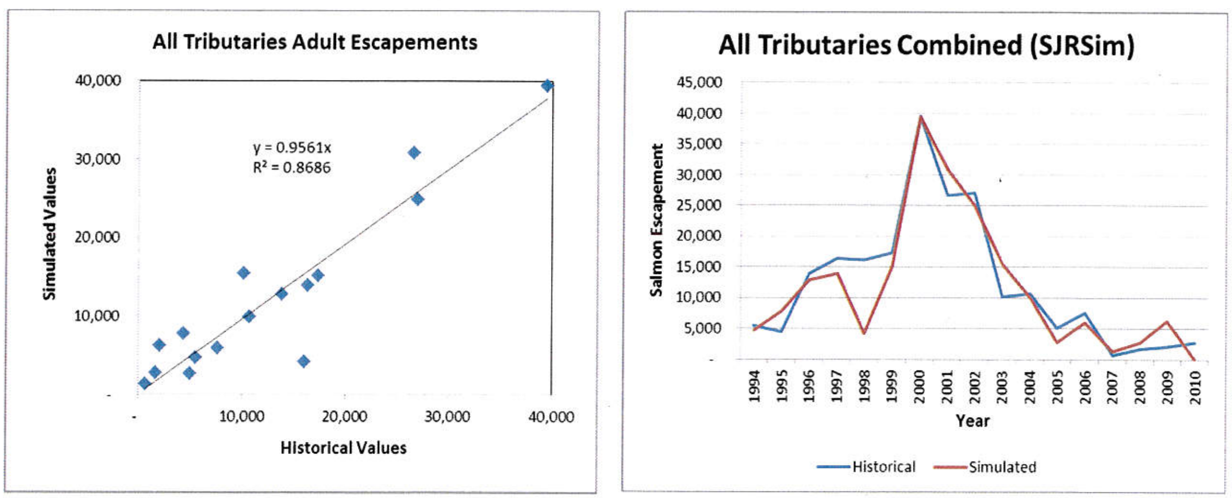

Figure 12 All Rivers Re-Calibration (SJRSim)

The SJRSim's 1998 adult Chinook salmon decline is anomolous at this point, and without further evaluation is unexplainable. Otherwise, the re-calibration results for all tributaries, as shown in Figure 12, provides a reasonable "fit" to historical adult returns.

Concluding Remarks

The Department has revised SJRSim to be the most up to date model, until the internet based interactive SalSim can be updated. As a result, the revised desktop SJRSim no longer has the ability to conduct flow simulations internally. All scenarios either utilize the calibrated HEC-5Q flow and temperature data (which reside within the model) or require flow and temperature data to be imported for alternative scenarios. SalSim also provided graphical and animated outputs that are no longer available with the desktop version. SalSim provided a button to click on to download model output, but the desktop version provides this feature only by clicking on desired output files; however, all output files are automatically saved by SJRSim to the user's hard drive after each run, and files are overwritten unless different scenarios have a different run name. Since SJRSim's developer (AD Consultants) was not available to assist with the recent SJRSim refinement, any model simulation results from the new desktop version of SJRSim should be viewed as preliminary.

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